Evaluating Upstream Scope 3 Emissions and Setting Science-Based Targets for Cree Inc.

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1. Abstract

Cree Inc. is a manufacturing company headquartered in Durham, North Carolina that produces LED, power and radio frequency products. Using data provided by Cree and an emissions calculation tool based on input-output LCA provided by Quantis and the Greenhouse Gas Protocol, we calculated Cree's upstream scope 3 emissions. This included the following categories: Purchased Goods and Services, Capital Goods, Fuel and Energy-Related Activities Not Included in scope 1 or scope 2, Upstream Transport, and Employee Commuting. These calculations built off of previous collaborations with Duke student teams and completed an inventory of Cree's scope 1, 2, and 3 emissions. We then modeled science-based targets using a twelve-year timeline and based on a 1.5° Celsius global warming projection scenario. Our team supplemented this data by providing Cree with case study observations and next step recommendations for how to implement the suggested targets and achieve the necessary emissions reductions.

Key Words: Cree Inc., Science Based Targets, Scope 3 Emissions, Greenhouse Gas Protocol, Quantis, Purchased Goods and Services, Capital Goods, Manufacturing, Supply Chain, Silicon Carbide, Case Study, Sustainability Strategy

2. Executive Summary

Within this report, we provide background information about Cree Inc., scope 3 emissions, and science-based targets. We also discuss the methodology we used throughout the process and the results of our emissions analysis and target modeling. We then briefly analyze companies who have enacted science-based targets to provide Cree with case study observations of successful initiatives being used to achieve target goals that they could also pursue. We conclude the report with future steps that Cree needs to take, including developing a strategy action plan to achieve their emission reduction targets over the next decade and the Science Based Target initiative submission process.

2.1 The Climate Crisis

In 2018, the Intergovernmental Panel on Climate Change (IPCC) released a report with a stark warning: the world collectively has just 12 years left to reduce greenhouse gas emissions to a level that will limit global temperature rise to 1.5° C and prevent the more drastic effects of climate change.[1] The IPCC models show that in order to achieve this goal, the world will need to reduce carbon emissions by 45% of 2010 levels by the year 2030 and achieve net zero carbon by approximately 2050.[2] While the ramifications of climate change are already occurring, if global average temperature rises above 1.5° C the world will experience an even more extreme shift in climate and weather patterns.[3] As both the intensity and frequency of inclement weather increases, adaptation will become more difficult and expensive. Beyond 2° C, irreversible ramifications for ecosystems, species, and modern human life will occur.[4]

2.2 Science Based Target Initiative

Limiting anthropogenic carbon emissions and the average global temperature from rising above 1.5° C will require ubiquitous participation from the private sector (in addition to governments and citizens). Whether acted upon through their own volition because of core values or outside pressure from their competitors and consumers, major companies have begun

[1] Intergovernmental Panel on Climate Change. 2018. *Special Report: Global Warming of 1.5° C*. Accessed February 7, 2020. https://www.ipcc.ch/sr15/.
[2] *Ibid*
[3] *Ibid*
[4] *Ibid*

to acknowledge the significant role that they play in the developing climate change crisis and are taking the necessary steps to reduce their carbon footprint. A component of this growing trend is setting science-based targets, emission reduction goals made with the purpose of keeping the global average temperature below 1.5° C.[5] While the overall number of companies setting official targets through the Science Based Target initiative is still relatively low, momentum to participate is building.

2.3 Overview of Cree Project

For this project, we were tasked with calculating the upstream scope 3 emissions for Cree Inc., as well as suggesting science-based targets based on the final emissions data. Other master's project teams at Duke's Nicholas School of the Environment have previously worked with Cree to calculate their scope 1, 2, and downstream scope 3 emissions. After completing their supply chain data analysis, Cree has a full understanding of its scope 1, 2, and 3 emissions. To calculate Cree's upstream scope 3 emissions, we used the Scope 3 Evaluator tool created through a partnership between Quantis and the Greenhouse Gas Protocol (GHG Protocol). The free tool calculates all thirteen scope 3 categories using input-output data that links total economic spend (USD) to CO_2 equivalent greenhouse gas emissions.[6]

While the tool is in compliance with the GHG Protocol recommendations, it is meant to be used as a scope 3 emissions screening that provides companies with an initial emissions inventory.[7] Our calculation revealed that Cree's total scope 3 emissions for 2018 were approximately 221.64 million metric tons CO_2 equivalents. The majority of these emissions come from the Use Phase of Products, Purchased Goods and Services, and Capital Goods. Cree also had approximately 255,500 metric tons CO_2 equivalents in scope 1 emissions and 172,400 metric tons CO_2 equivalents in scope 2 emissions for the same year. Therefore, Cree's scope 3 emissions account for approximately 99.81% of their total emissions footprint.

2.4 Setting Science Based Targets for Cree

[5] Science Based Targets. n.d. *Science Based Targets: Driving Ambitious Corporate Climate Action.* Accessed February 5, 2020. https://sciencebasedtargets.org/.
[6] GHG Protocol and Quantis. n.d. *Scope 3 Evaluator*. Accessed January 2020. https://quantis-suite.com/Scope-3-Evaluator/.
[7] *Ibid*

After completing a final emissions inventory for Cree, which included scope 1, 2, and 3 emissions, we modeled potential science-based targets that the company could submit for approval. This process involved using a Microsoft Excel modeling tool (SBTi-tool) provided by the Science Based Target initiative. The "new integrated target-setting tool for companies includes the Absolute Contraction Approach and the Sectoral Decarbonization Approach with updated temperature pathways, and a sheet to calculate targets aligned with scope 3 criteria".[8]

After inputting emissions data and selecting criteria like the approach and timeframe, the model provides projections for potential targets aligned with reducing emissions to keep the global average temperature from rising above 1.5° C. The model calculated that Cree needs to reduce their scope 1 and 2 emissions and scope 3 emissions by 50.4% by 2030 in order to keep in line with a 1.5° C average global warming scenario.

2.5 Next Steps and Recommendations

Once the sustainability team and the executive board at Cree agree on a science-based target commitment, they will have to submit the proposal form to the Science Based Target initiative. If the targets are accepted, then Cree will need to get to work on realizing their carbon reductions over the set timeline. This will include developing climate action strategies so that they have a plan for how to achieve the reductions that they set. Mitsubishi has worked to reduce their scope 3 emissions by implementing Green Accreditation certificates to their suppliers and reducing the size of manufactured products.[9] Dell Technologies is working to reduce their scope 3 emissions by providing training to their suppliers, creating responsible sourcing policies, and requiring their suppliers to track their own impacts and set their own targets.[10] Cree can reduce all three of their scope emissions by developing innovations within their manufacturing process, sourcing more renewable energy, and working more closely with their suppliers.

3. Background

3.1 Brief History of Cree Inc.

[8] Science Based Targets. n.d. *Sbti-tool*. Accessed January 2020. https://sciencebasedtargets.org/sbti-tool/.
[9] Mitsubishi Electric Corporation. n.d. *Mitsubishi Electric Global Sustainability*. Accessed February 20, 2020. https://us.mitsubishielectric.com/en/about/global/sustainability/index.html.
[10] Dell Technologies. 2018. *Supply Chain Sustainability Progress: 2018 Annual Report*. Accessed February 20, 2020. https://corporate.delltechnologies.com/content/dam/delltechnologies/assets/corporate/pdf/progress-made-real-reports/scs-report-2018.pdf.

Founded in 1987, Cree is a leading company in manufacturing LED, power, and radio frequency products. Cree commercialized the world's first blue LED and had their IPO in 1993.[11] As an emerging leader in shaping the market of semiconductors, Cree released the world's first commercial SiC wafers in 1991, and strived to provide robust and high-quality materials for the creation of SiC and GaN products that are beyond industry standard.[12]

Sustainability is a core value for Cree. By manufacturing products that offer solutions to reduce energy use and greenhouse gas emissions, Cree strives to minimize the resource use of its customers and reduce the environmental impact of its production process. Since 2015, Cree has developed Environmental Health and Safety (EH&S) policies to realize its sustainability goals.[13] With the aspiration of increasing energy efficiency, minimizing environmental impacts, and promoting sustainable life cycles, Cree has been continuously improving its environmental performance.[14] In order to advance its sustainability program, Cree reached out to Duke University to calculate its upstream scope 3 emissions and set science-based targets. Cree has an ongoing relationship with Duke and several student teams have previously worked on projects with them. In 2018, MEM student Bobbi Lesser performed an analysis of Cree's 2016 scope 3 GHG emissions in the following four phases: sold products, end of life, waste, and transportation and distribution.[15] Cree was subsequently able to repeat her calculation methodology over the last couple of years and her work was the foundation for this current project.

3.2 Science Based Target Initiative

There are myriad reasons as to why science-based targets are a growing trend within the private sphere. The Science Based Target initiative lays out a case for companies to participate in the initiative through five main points:[16]

1. Increasing innovation

[11] Cree Inc. 2020. *History & Milestones*. Accessed February 15, 2020. https://www.cree.com/about/history-and-milestones.
[12] *Ibid*
[13] Cree Inc. 2020. *Environment.* Accessed February 15, 2020. https://www.cree.com/about/sustainability/environment.
[14] *Ibid*
[15] Lesser, Bobbi. 2018. "Duke University." *An Analysis of Cree's 2016 Scope 3 Greenhouse Gas Emissions*. April 26. Accessed April 6, 2020. https://hdl.handle.net/10161/16561.
[16] We Mean Business. 2020. *Science Based Target initiative*. Accessed March 4, 2020. https://www.wemeanbusinesscoalition.org/commitment/adopt-a-science-based-emissions-reduction-target/.

The pressure to meet emissions reduction targets can force companies to look for new solutions that they otherwise would not have previously considered. If status quo operation processes are affordable and effective, there is often little incentive for companies to look at alternative options. However, working under the constraints of a constricting carbon budget can artificially force companies to innovate. This willingness to analyze the value chain for new opportunities can reap both fiscal and environmental benefits, while helping companies maintain a competitive edge and inhibit complacency.

2. Strengthening investor confidence

Sustainability and ESG strategies are becoming increasingly important to investors and venture capital firms. The conversation has shifted in the past several years so that not only are shareholders asking about a company's sustainability performance, but major investors are starting to incorporate it into their portfolio decisions. "Investment in sustainable, responsible and impact strategies by U.S. investors totaled $11.6 trillion in the U.S. in 2018, up 38% from 2016, per the U.S. SIF Foundation's most recent biennial U.S. Sustainable, Responsible and Impact Investing Trends report."[17] Major firms like BlackRock are also committing to increasing ESG investment and reducing investment in companies that do not track these metrics.[18] By committing to science-based targets, companies can show investors that they are both responsible and future-oriented.

3. Reducing regulatory risk and uncertainty

Setting science-based targets also demonstrates that a company is serious about both acknowledging and addressing climate change risks and regulatory uncertainty. Despite a lack of policy direction from the government (and often outright denial of anthropogenic climate change), it is likely that the government will eventually need to take action. Companies that have already committed to greenhouse gas emission reductions will be ahead of the curve and may not need to make any adjustments to appease new regulations, giving them a competitive advantage over companies that need to catch up.

[17] Pensions & Investments. 2020. *BlackRock is all in on firmwide sustainability*. January 22. Accessed March 9, 2020. https://www.pionline.com/esg/blackrock-all-firmwide-sustainability.
[18] BlackRock. 2020. *Sustainability as BlackRock's New Standard for Investing*. Accessed March 9, 2020. https://www.blackrock.com/corporate/investor-relations/blackrock-client-letter.

"$27.5 trillion (USD), or 93 percent of US equities by market capitalization are significantly affected in some way by climate risk. 64 international jurisdictions already have carbon taxes or emissions trading systems – covering 13% of global GHG emissions."[19] These statistics reveal the extent to which corporations in every sector all over the world face major market risks as a result of climate change and need to be prepared to address and mitigate them. Companies who are not taking action to reduce their unsustainable dependence on natural resources and prepare for unpredictable climate trends will suffer supply chain disruptions, material damages, and reputational repercussions.

4. Cost savings

While certain sustainability measures may not see a return on investment, the goal of most energy efficiency initiatives is to reduce costs for companies over time. This is also true for new innovations that companies enact to reduce waste and resource consumption. Actions to reduce greenhouse gases can be low-hanging fruit that are easy to achieve and instantly save the company money through increased efficiency. They can also be complex with long-term returns on investment. Public companies may need to adopt a more future-oriented approach, in addition to the traditional quarterly mindset, in order to see the benefits and payoffs of sustainability investments.

5. Customers embrace it

Whether a company is business to business (B2B) or business to consumer (B2C), customers increasingly care about sustainability. Major corporate retailers such as Walmart and Target are mandating that their brand suppliers submit a climate report to the Carbon Disclosure Project and track their Scope 3 emissions.[20] Likewise, consumers (particularly Millennials and Gen Z) are becoming increasingly concerned with company's values and commitments as a corporate citizen.[21] Setting science-based targets shows both customers and consumers that a company is committed to addressing climate change and will help sustain business opportunities.

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[19] *Supra Note 16*
[20] Walmart. 2019. *Using your 2019 CDP disclosure to report to Walmart's Project Gigaton*. Accessed April 16, 2020. https://www.walmartsustainabilityhub.com/media-library/document/cdp-disclosure-and-walmart-project-gigaton-2019/_proxyDocument?id=0000016c-068b-d2b6-abef-66db94ad0000.
[21] Forbes. 2019. *8 Characteristics of Millennials That Support Sustainable Development Goals (SDGs)*. June 19. Accessed April 17, 2020. https://www.forbes.com/sites/margueritacheng/2019/06/19/8-characteristics-of-millennials-that-support-sustainable-development-goals-sdgs/#6a1e673329b7.

3.3 GHG Emissions Reporting

The increase in average global temperature as a result of anthropogenic climate change has generated significant attention over the past several decades. Greenhouse gases circulating in Earth's atmosphere trap heat and help sustain the conditions necessary for a wide diversity of life.[22] The Kyoto Protocol identifies six greenhouse gases: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.[23] While greenhouse gases are a natural phenomenon, the typical carbon cycle is being disrupted. As more greenhouse gases are released and accumulate in the atmosphere due to human activities, the greenhouse effect increases in intensity and causes an unprecedented overall global warming.[24]

As seen in Figure 1, anthropogenic greenhouse gas emissions can be broken down into three categories: scope 1, scope 2, and scope 3 emissions. Scope 1 emissions are GHG emissions that directly occur from company-owned sources. Scope 2 emissions refer to greenhouse gases emitted during the generation of electricity that is purchased by companies for energy. Scope 3 emissions include all other indirect emissions that occur in the value chain of companies, including both upstream and downstream.[25]

While many companies track and report their scope 1 & 2 emissions, scope 3 emissions are more difficult to calculate and often account for the biggest greenhouse emissions footprint of a company.[26] Scope 3 emissions include purchased goods and services, business travel, employee commuting, waste disposal, use of sold products, transportation and distribution, investments, and leased assets and franchises.[27] The GHG Protocol emerged as both the World Resources Institute (WRI) and the World Business Council for Sustainable Development

[22] UCAR Center for Science Education. 2011. *The Greenhouse Effect*. Accessed March 25, 2020. https://scied.ucar.edu/longcontent/greenhouse-effect.
[23] David Suzuki Foundation. 2020. *What are greenhouse gases?* Accessed February 20, 2020. https://davidsuzuki.org/what-you-can-do/greenhouse-gases/.
[24] United States Environmental Protection Agency. 2017. *Climate Change Indicators: Greenhouse Gases.* February 27. Accessed March 25, 2020. https://www.epa.gov/climate-indicators/greenhouse-gases.
[25] Greenhouse Gas Protocol. n.d. "GHG Protocol." *FAQ*. Accessed February 15, 2020. https://ghgprotocol.org/sites/default/files/standards_supporting/FAQ.pdf.
[26] Science Based Targets. 2018. "Science Based Targets." *Value Change in the Value Chain: Pest Practices in Scope 3 Greenhouse Gas Management*. November. Accessed February 15, 2020. https://sciencebasedtargets.org/wp-content/uploads/2018/12/SBT_Value_Chain_Report-1.pdf.
[27] Carbon Trust. 2020. *What are Scope 3 Emissions?* Accessed February 15, 2020. https://www.carbontrust.com/resources/faqs/services/scope-3-indirect-carbon-emissions/.

(WBCSD) realized that it was necessary to create an international standard for GHG accounting.[28]

The GHG Protocol has established standardized frameworks and developed tools for both the public and private sectors to calculate GHG emissions. The GHG Protocol is also widely adopted for regulation purposes by governments, credibility by NGOs, and compliance by companies.[29] Given its integrity, multinational companies and other institutions have adopted GHG Protocol standards when assessing their carbon footprint.[30] As of 2016, at least 92% of Fortune 500 companies used the GHG Protocol for one of their programs, tools, or standards.[31]

Incorporating sustainability into business operations is becoming increasingly mandatory. The globalization of supply chains allows corporate customers, powerful investment firms, and individual consumers to hold companies responsible for their values and pressure them to set emission reductions goals.[32] While the GHG Protocol has been encouraging companies to audit their scope emissions, special attention has been drawn to scope 3 emissions because they comprise the largest proportion of GHG emissions within the value chain, especially for multinational companies.[33] As indicated by the United Nations Conference on Trade and Development, world GHG emissions would significantly drop even if only the top 500 multinational companies successfully reduced their scope 3 emissions.[34]

Reporting scope 3 emissions can help companies assess their performance, live their values, and positively impact societies by helping to define emission regulations. Pioneer companies have proved the enormous benefits associated with reporting GHG emissions. For example, the identification of 90% of scope 3 emissions within Kraft's value chain has led to an innovative collaboration between the company's research and development teams to reduce their GHG emissions. Additionally, Walmart is another ambitious retailer which has successfully helped its suppliers reduce GHG emissions from energy consumption by 20%. Toshiba, an

[28] Greenhouse Gas Protocol. n.d. *About Us*. Accessed February 10, 2020. https://ghgprotocol.org/about-us.
[29] Patchell, J. 2018. "Can the Implications of the GHG Protocols Scope 3 Standard be Realized?" *Journal of Cleaner Production*, *185*, 941–958.
[30] Green, J. F. 2010. "Private Standards in the Climate Regime: The Greenhouse Gas Protocol." *Business and Politics*, *12*(3), 1–37.
[31] Greenhouse Gas Protocol. n.d. *Companies and Organizations*. Accessed February 17, 2020. https://ghgprotocol.org/companies-and-organizations.
[32] Boström, M., Jönsson, A. M., Lockie, S., Mol, A. P., & Oosterveer, P. 2015. "Sustainable and Responsible Supply Chain Governance: Challenges and Opportunities." *Journal of Cleaner Production*, *107*, 1–7.
[33] *Supra Note 30*
[34] United Nations Conference on Trade and Development. 2011. *World Investment Report 2011*. Accessed February 17, 2020. https://unctad.org/en/PublicationsLibrary/wir2011_en.pdf.

electronic product and service provider, has also benefited from scope 3 reporting by adjusting its management approach to be more flexible.[35] All of these successful cases affirm that by working with the GHG Protocol and measuring their GHG emissions, companies can better their own performance as well as create value for society through emissions reduction.

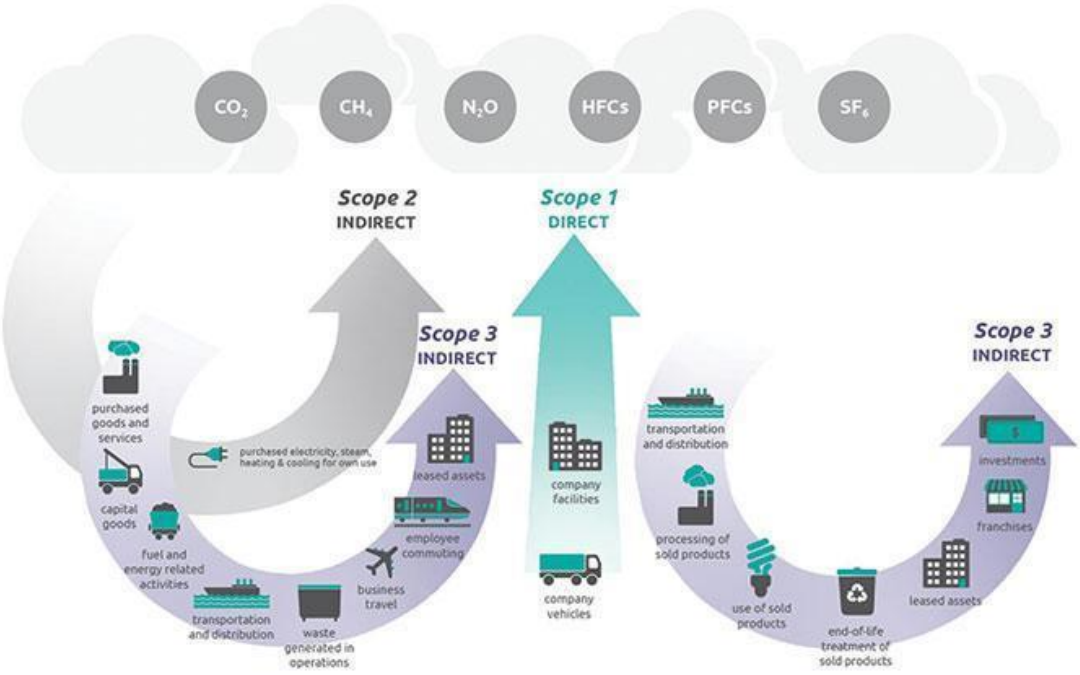

Figure 1: Explanation of scope 1, 2, and 3 emissions from GHG Protocol[36]

3.4 Science-Based Targets

While measuring GHG emissions is a necessary component of addressing climate change for companies, it is also important for them to set targets. The Paris Agreement originally proposed keeping global average temperature rise to well below 2° C from pre-industrial levels and, more recently, updated their goal even further to limiting the temperature increase to 1.5° C.[37] This was a major geopolitical signal encouraging companies worldwide to incorporate sustainability into their daily operations. Science-based targets are targets set by companies to reduce greenhouse gas emissions in line with the Paris Agreement.[38] They are managed by the

[35] Schuchard, R. and Springer, N. 2013. *3 Ways Business Can Benefit from Scope 3 Emissions Reductions*. May 10. Accessed February 14, 2020. https://www.greenbiz.com/blog/2013/05/10/3-ways-business-can-benefit-scope-3-emissions-reductions.
[36] *Supra Note 6*
[37] United Nations Climate Change. 2020. *The Paris Agreement*. Accessed January 15, 2020. https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement.
[38] Science Based Targets. n.d. *What is a Science Based Target?* Accessed January 20, 2020. https://sciencebasedtargets.org/what-is-a-science-based-target/.

Science-Based Targets initiative (SBTi), which is a partnership amongst the World Resources Institute (WRI), the United Nations Global Compact (UNGC), World Wild Fund (WWF), and CDP. After companies finish their GHG emissions reporting, they can then start developing emission reduction targets to submit to SBTi for approval. Currently, there are over 800 companies taking action by moving forward with targets.[39]

In compliance with the Paris Agreement, the beginning of a shift to a low carbon economy is now underway, with the goal of every sector and industry being transformed into a greener operation. By setting science-based targets, companies can "increase innovation, reduce regulatory uncertainty, strengthen investor confidence and credibility, and improve profitability and competitiveness".[40]

There are three approaches to setting science-based targets: absolute-based approach, sector-based approach, and economic-based approach.

1. *Absolute-based approach*: "The percent reduction in absolute emissions required by a given scenario is applied to all companies equally."[41]

2. *Sector-based approach*: "The global carbon budget is divided by sector and then emission reductions are allocated to individual companies based on its sector's budget."[42]

3. *Economic-based approach*: "A carbon budget is equated to global GDP and a company's share of emissions is determined by its gross profit, since the sum of all companies' gross profits worldwide equate to global GDP."[43]

The absolute-based, or absolute contraction, approach is the most straightforward method among these three approaches. It asks companies to reduce an absolute amount of emissions each year, meaning that they need to show annual linear reductions to reach their targets.[44] The advantages of this approach include easier calculations and less complicated progress tracking

[39] Science Based Targets. n.d. *About the Science Based Targets Initiative*. Accessed January 20, 2020. https://sciencebasedtargets.org/about-the-science-based-targets-initiative/.
[40] Science Based Targets. n.d. *Why Set a Science Based Target?* Accessed January 20, 2020. https://sciencebasedtargets.org/why-set-a-science-based-target/.
[41] Science Based Targets. n.d. *Methods.* Accessed January 20, 2020. https://sciencebasedtargets.org/methods/.
[42] *Ibid*
[43] *Ibid*
[44] Science Based Targets. 2020. "Science-Based Target Setting Manual." *Science Based Targets*. April. Accessed April 2020. https://sciencebasedtargets.org/wp-content/uploads/2017/04/SBTi-manual.pdf.

requirements. Additionally, this method can be applied to almost all sectors. Using the absolute-based approach delivers a message to the public that companies are utilizing robust efforts in emission reduction.[45] However, because of its strict requirement to reduce emissions by a set amount every year, the absolute-based approach may not be the best option for rapidly growing companies.[46]

The second method is the sector-based, or sectoral decarbonization, approach. This approach is based on dividing a companies' carbon budget relative to their sector.[47] The sector-based approach is defined by SBTi as a method for "setting physical intensity targets that use convergence of emissions intensity".[48] The purpose of this method is to understand each sector's potential for emission reduction while taking into account economic and population growth over time.[49] SBTi highly recommends that companies use this approach because it targets specific sectors. Currently, sectors including power generation, iron & steel, aluminum, cement, pulp & paper, services/commercial buildings, and passenger and freight transport are able to apply the sector-based approach.[50] The biggest advantage of adopting this approach is that companies can determine specific targets based on their corresponding economic sector.[51] Due to a lack of credible information and data, SBTi has not developed a target setting tool using the sector-based approach for emission-intensive sectors like agriculture and oil/gas.[52]

The third method is the economic-based approach, also referred to as economic intensity contraction. This approach is considered more corporate friendly because it asks companies to allocate their carbon budget corresponding to their projected economic growth.[53] The primary methodology for this approach utilizes GHG emissions per value added (GEVA) and targets are formulated with the unit tCO_2e/$ value added.[54] Despite its more business oriented nature, the economic-based approach is less robust than the other two approaches. This is because GEVA maintains a global emission budget, while assuming that there is a constant economic growth

[45] *Supra Note 44*
[46] Walenta, J. 2019. "Climate Risk Assessments and Science-based Targets: A Review of Emerging Private Sector Climate Action Tools." *WIREs Climate Change*, *11*(2).
[47] *Ibid*
[48] *Ibid*
[49] Krabbe, O., Linthorst, G., Blok, K., Crijns-Graus, W., Vuuren, D. P. V., Höhne, N., Pineda, A. C. 2015. "Aligning Corporate Greenhouse-gas Emissions Targets with Climate Goals." *Nature Climate Change*, *5*(12). 1057–1060.
[50] *Supra Note 44*
[51] *Supra Note 46*
[52] *Supra Note 44*
[53] *Supra Note 46*
[54] *Supra Note 44*

rate for all companies and that the GDP growth rate will be accurately predicted. However, these projections might not accurately match reality.[55]

Each of the three methodologies has benefits and drawbacks. Therefore, Cree should carefully make choices that best reflect their own needs and performances. Based on the data and information available, we chose to pursue the absolute contraction approach for setting Cree's scope 1, 2, and 3 emissions.

4. Methods

This section will be separated into two sub-sections: Methods for Upstream Scope 3 Emissions Calculation and Methods for Setting Science-Based Targets for Scope 1, 2, and 3 Emissions. Each sub-section covers 4 parts: a brief theory of the methodology, calculation tools, data collection, and limitations/challenges. As the results of upstream scope 3 emissions were used to calculate science-based targets, this section will start off by explaining the methods used in estimating upstream scope 3 emissions.

4.1 Methods for Upstream Scope 3 Emissions Calculation

4.1.1 Theory of the Methodology

In general, a company can use either the process-based or economic input-output (EIO) life cycle assessment (LCA) methods to calculate the emissions from the life cycles of their products or services. The process-based LCA evaluates the impact in each step during a product's production process.[56] Therefore, it generates more detailed and accurate results. However, most companies do not choose this approach for their initial assessment because the process-based LCA can require a significant amount of time and money. EIO-LCA estimates the impact of a product based on the monetary transaction relationship in the market, using industry level emission factors to calculate emissions caused from change in demand for a product.[57] Compared with the process-based LCA approach, EIO-LCA is more comprehensive, relatively

[55] *Supra Note 44*
[56] Carnegie Mellon University. 2016. *Economic Input-Output Life Cycle Assessment: A Primr on Life Cycle Assessment*. Accessed March 4, 2020. http://www.eiolca.net/Method/LCA_Primer.html.
[57] *Supra Note 56*

less time-consuming, cheaper, allows systems-level comparisons, and is easier to apply with less detailed results.[58]

The input-output model is a better choice for companies with multiple products and services wishing to establish an initial assessment of their current performance. Therefore, many companies like Cree, that hope to achieve a good estimate of their emissions inventory in a relatively short period of time and without an extensive supplier data collection process, would choose the evaluation tool based on the EIO-LCA model.

The Quantis tool that was used during this project is based on a combination of the EIO-LCA model and the process-based LCA inventory data, giving more detailed results than just a traditional EIO-LCA model.[59] According to the GHG Protocol Corporate Value Chain Accounting and Reporting Standard, there are 15 subcategories within scope 3 emissions, which are further divided into eight upstream and seven downstream categories.[60] Suggested formulas for emissions calculation in each category are embedded in Quantis as primary sub-functions in the EIO-LCA model.[61]

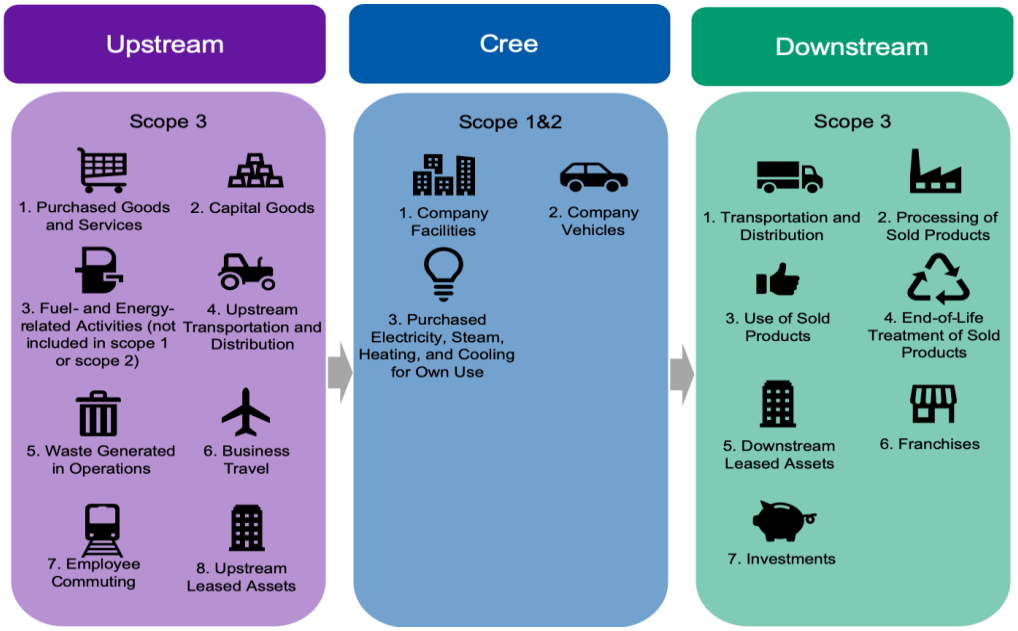

Figure 2: Categories for scope 1,2, and 3 emissions

[58] *Supra Note 57*
[59] *Supra Note 6*
[60] *Supra Note 28*
[61] *Supra Note 6*

4.1.2 EIO-LCA model and Quantis Tool

Quantis is an international environmental consulting firm specializing in the application of life cycle methodology.[62] To help facilitate companies with estimating emissions from their supply chain, GHG Protocol partnered with Quantis to create a free screening tool.[63] The tool is a scope 3 emission evaluator in alignment with the WRI/WBCSD GHG Protocol and is meant to be used for initial screenings.[64] This user-friendly tool aims to help companies generate a rough approximation on their current supply chain GHG emissions in different categories without the need to conduct process LCA for all of their products and prepare for a future in-depth GHG inventory analysis. The calculation behind the tool is based on a combination of economic input-output and process life cycle inventory data.[65]

In 1930, Wassily Leontief developed the economic input-output (EIO) models based on the U.S. economy and aimed to expand the theory with non-economic data.[66] The EIO models demonstrate the monetary transactions between industry sectors, showing which outputs are consumed by other industries as inputs and the overall economic impact.[67] EIO-LCA is a mathematical method for computing LCAs in a single sector by using the theory of input-output models and has been used in multiple sectors to facilitate the understanding of a product's impacts through supply-chains by studying the changes in demand for different sectors.[68] Due to the input-output relationship, shifts in a product's demand can directly and indirectly cause changes within its supply chain. Differing from traditional EIO models, EIO-LCA has an additional column representing the input to the "environment sector", which is equivalent to the pollution output of industries. Therefore, using simple linear algebraic functions, the EIO-LCA model can capture and calculate the change in input to the environment sector based on the change in output/demand from an industry sector.[69]

For international companies like Cree, tracking emissions from each product's international supply-chain can take a long time, especially when data are missing or confidential

[62] *Supra Note 6*
[63] *Supra Note 6*
[64] *Supra Note 6*
[65] *Supra Note 6*
[66] *Supra Note 56*
[67] *Supra Note 56*
[68] *Supra Note 56*
[69] *Supra Note 56*

and therefore require extra effort and time to acquire. While companies are working to establish their own tracking systems, they can use the Quantis tool to help them calculate a rough estimation of their current performance and prepare them for emissions disclosure in a relatively short period of time.[70] To facilitate the data collection and LCA calculation process, Quantis provides a data collection list detailing the required data types, a user-friendly online model estimating scope 3 emissions, and a color-coded dashboard showing the results indicating severity level for each category.[71] This can further inform action plans and in-depth analysis.

The data collection excel file from Quantis requires a company to either provide quantitative data for the total number of consumed resources or for the economic value of the consumed resources. Companies are also asked to input industry information and the time period for reported emissions to help Quantis select corresponding industry-based datasets. After adjusting the results based on the provided reporting time period, economic status, and industry sector, the Quantis tool then multiplies the emission factors referred from Open IO emissions data (TSC 2011) to calculate the total emissions in each category.[72] The functions used in calculating each upstream scope 3 emissions category within the Quantis tool are organized in Table 1 below.[73]

Upstream Scope 3 Categories	Build-in Formulas Based on GHG Protocol Technical Guide (Quantis)
Purchased goods and services	• Average-data method $\sum(mass\ of\ purchased\ good\ or\ service\ (kg) \times emission\ factor\ of\ purchased\ good\ or\ service\ per\ unit\ of\ mass(kgCo_2e/kg))$ • Spend-based method $\sum(value\ of\ purchased\ good\ or\ service\ (\$) \times emission\ factor\ of\ purchased\ good\ or\ service\ per\ unit\ of\ economic\ value\ (kg\ CO_2e/\$))$
Capital goods	• Average-data method $\sum(mass\ of\ purchased\ good\ or\ service\ (kg) \times emission\ factor\ of\ purchased\ good\ or\ service\ per\ unit\ of\ mass(kgCo_2e/kg))$ • Spend-based method $\sum(value\ of\ purchased\ good\ or\ service\ (\$) \times emission\ factor\ of\ purchased\ good\ or\ service\ per\ unit\ of\ economic\ value\ (kg\ CO_2e/\$))$
Fuel and Energy related activities (not included in scope 1 or scope 2	A. Purchased Fuel $\sum(fuel\ consumed\ (e.g., kWh) \times upstream\ fuel\ emission\ factor(kg\ CO_2e/kWh)$ B. Upstream CO_2e emissions of purchased electricity $\sum(electricity\ consumed(kWh) \times upstream\ electricity\ emission\ factor(kgCO2e)/kWh) + (steam\ consumed(kWh) \times upstream\ steam\ emission\ factor\ (kg\ CO2e)/kWh)) + (heating\ consumed\ (kWh) \times upstream\ heating\ emission\ factor(kg\ CO2e)/kWh)) + (cooling\ consumed\ (kWh) \times upstream\ cooling\ emission\ factor\ (kg\ CO2e)/kWh)$ C. Transmission and distribution (T&D) losses $\sum(electricity\ consumed(kWh) \times electricity\ life\ cycle\ emission\ factor((kg\ CO2e)/kWh) \times T\&D\ loss\ rate(\%)) + (steam\ consumed(kWh) \times steam\ life\ cycle\ emission\ factor((kg\ CO2e)/kWh) \times T\&D\ loss\ rate\ (\%)) +$

[70] *Supra Note 6*
[71] *Supra Note 6*
[72] *Supra Note 6*
[73] *Supra Note 28*

	$(heating\ consumed\ (kWh) \times heating\ life\ cycle\ emission\ factor\ ((kg\ CO2e)/kWh) \times T\&D\ loss\ rate\ (\%)) +$ $(cooling\ consumed(kWh) \times cooling\ life\ cycle\ emission\ factor((kg\ CO2e)/kWh) \times T\&D\ loss\ rate(\%))$ D. Emissions from power that is purchased and sold $\sum(electricity\ purchased\ for\ resale(kWh) \times electricity\ life\ cycle\ emission\ factor(kg\ CO2e)/kWh)) +$ $(steam\ purchased\ for\ resale(kWh) \times steam\ life\ cycle\ emission\ factor(kg\ CO2e)/kWh)) +$ $(heating\ purchased\ for\ resale(kWh) \times heating\ life\ cycle\ emission\ factor(kg\ CO2e)/kWh)) +$ *(cooling purchased for resale(kWh)×cooling life cycle emission factor(kg CO2e)/kWh))*
Upstream Transportation and Distribution	• Fuel-based method (Transportation) $\sum(quantity\ of\ fuel\ consumed\ (liters) \times emission\ factor\ for\ the\ fuel\left(kg\frac{CO_2e}{liter}\right)) +$ $\sum(quantity\ of\ electricity\ consumed\ (kWh) \times emission\ factor\ for\ electricity\ grid\left(kg\frac{CO_2e}{kWh}\right)) +$ $\sum(quantity\ of\ refrigerant\ leakage \times global\ warming\ potential\ for\ the\ refrigerant\ (kg\ CO_2e)$ • Spend-based method (Transportation) $\sum(amount\ spent\ on\ transportation\ by\ type\ (\$) \times$ $relevant\ EEIO\ emission\ factors\ per\ unit\ of\ economic\ value\ (kg\ CO_2e/\$)$ • Average-data method (Distribution) $\sum(volume\ of\ stored\ goods(m^3\ or\ TEU) \times average\ number\ of\ days\ stored \times$ $emission\ factor\ for\ storage\ facility\ (kg\ CO_2e/m^3\ or\ TEU/day$
Waste Generated in Operations	• Average-data method $\sum(total\ mass\ of\ waste\ (tonnes) \times proportion\ of\ total\ waste\ being\ treated\ by\ waste\ treatment\ method \times$ $emission\ factor\ of\ waste\ treatment\ method\ (kg\ CO_2e/tonne)$
Business Travel	• Fuel-based method Same as the fuel-based method in category 4 (Upstream transport and distribution) • Spend-based method Same as the fuel-based method in category 4 (Upstream transport and distribution) • Distance-based method $\sum(distance\ travelled\ by\ vehicle\ type\ (vehicle - km\ or\ passenger - km) \times$ $vehicle\ specific\ emission\ factor\ (kg\ CO_2e/vehicle - km\ or\ kg\ CO_2e/passenger - km\ )$
Employee Commuting	• Average-data method $\sum(total\ number\ of\ employees \times \%\ of\ employees\ using\ mode\ of\ transport \times$ $one\ way\ commuting\ distance\ (vehicle - km\ or\ passenger - km) \times 2 \times working\ days\ per\ year \times$ $emission\ factor\ of\ transport\ mode\ (kg\ CO_2e/vehicle - km\ or\ kg\ CO_2e/passenger - km\ )$
Upstream Leased Assets	• Asset-specific method Sum of scope 1 and scope 2 emissions of each leased asset • Average-data method $\sum(total\ floor\ space\ of\ building\ type(m^2) \times average\ emission\ factor\ for\ building\ type(kg\ CO_2e/m\text{^}2/year)$ Or $\sum(number\ of\ assets \times average\ emissions\ per\ asset\ type\ (kg\ CO_2e/asset\ type/year)$

Table 1: Summary of formulas for each upstream scope 3 emissions category[74]

4.1.3 Data Collection

2019 Sustainability Report

The 2019 Sustainability Report includes holistic information on Cree's environmental impact from the year 2016 to the year 2018. As seen in Table 2, the report provided us with their previous scope 1 and 2 emissions results, as well as scope 3 emissions information that contributed to the total scope 3 emissions calculation. For example, Cree already completed calculations for five scope 3 emissions categories, which included use of sold products, downstream transportation and distribution, business travel, waste generated in operations, and end of life treatment of sold products. By determining which data was missing from the report, we narrowed down the scope of the project to estimating emissions for five scope 3 categories

[74] *Supra Note 28*

that still needed data. This included purchased goods and services, capital goods, employee commuting, fuel-and-energy related activities, and upstream transportation and distribution.

Scope Category	2018 Data	Unit
Scope 1 GHG Emissions (by GHG Type)	255,500	metric tons CO_2e
Scope 2 GHG Emissions	172,400	metric tons CO_2e
Scope 3 – Use of sold products	220,040,400	metric tons CO_2e
Scope 3 – Downstream transportation and distribution	34,283	metric tons CO_2e
Scope 3 – Waste generated in operations, including disposal and transportation of waste	1,662	metric tons CO_2e
Scope 3 – Business travel (does not include Asia employees)	3,422	metric tons CO_2e
Scope 3 – End of life treatment of sold products	1,032	metric tons CO_2e

Table 2: 2018 emissions calculated before this project

Spend on Scope 3 Emissions by Category

The Spend on Scope 3 Emissions by Category dataset lists the total spend (USD) for each type of consumable within the purchased goods and services category, as well as total spend (USD) for electricity, gas, and water supply in the fuel-and-energy-related-activities category. The material categories in purchased goods and services include: Electrical and Optical

Equipment, Chemicals and Chemical Products, Construction, Machinery (not elsewhere specified), Basic Metals and Fabricated Metals, Rubber and Plastics, Renting of M&Eq and Other Business Activities, Textile and Textile Products, Non-Metallic Mineral, Pulp, Paper, Paper, Printing and Publishing, Manufacturing (not elsewhere specified); Recycling, Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies, Electricity, Gas and Water Supply. According to this data set, Cree has spent most of its money on purchasing chemicals, metals, and electrical and optical equipment, which are necessary resources for creating Cree's products, such as silicon carbide.

Upstream Transportation

The Upstream Transportation dataset was used to calculate the Upstream Transport category within scope 3 emissions and includes monetary spend and generated emissions for four different types of transportation modes: Air, Truck, Ocean, and All Modes. Cree provided detailed data containing emission results based on two types of methods using the emission factors found from the EPA's website: distance-based and spend-based. According to the chart below, the company has generated most of its transport related emissions from the Air mode, which is airplanes. This is most likely because Cree is an international company that not only owns facilities worldwide but also has suppliers from different countries that require flying as a primary means of transportation.

	Mode	**lb-mile**	**CO_2e from lb-mile method**	**Spend**	**CO_2e from spend method**
Total	Air	1.35E+09	8,932	5.55E+06	9,094
Total	Ocean	1.95E+09	59	8.20E+04	158
Total	Truck	5.48E+09	555	2.47E+06	1,919
Total	All Modes	2.10E+09	9,545	8.11E+06	11,171

Table 3: Upstream transportation data

Cleaned Consumables List

The Cleaned Consumables List covers detailed purchasing information about each item that Cree purchased for its supply chain in 2018, including Chemicals/Gases/Metals, consumables, non-chemical materials, and fuels. Since the majority of Cree's supplier information, ingredients, costs, and manufacturing process are proprietary, it was challenging to gather the necessary information. From the given list, we determined that the majority of purchased goods and services are within the Chemicals/Gases/Metals categories along their supply chain, which makes sense as they are necessary resources for the company's manufacturing and operations. Therefore, it will be more difficult for Cree to reduce emissions from these raw materials.

4.1.4 Limitations and Challenges

According to the State of Green Business 2013 report from GreenBiz, Scope 3 emissions tend to be the largest body of greenhouse gas emissions for companies.[75] Per Quantis and the GHG Protocol, "for many companies, more than 80% of their GHG impacts occur outside of their own operations".[76] This means that they are also often the most difficult to reduce because they are outside the direct control of companies and encompass suppliers in both the upstream and downstream value chain. The immense scale of a company's supply chain can also make it difficult to collect accurate and timely emission data.[77] As a global company, it is challenging for Cree to collect all of the relevant data from its suppliers. Furthermore, the process of manufacturing silicon carbide is extremely temperamental and the same quantity of the same ingredient from two different suppliers will create products of varied quality. Therefore, information revealing the supplier, location, or quantity of material is highly proprietary to Cree and it is important for them to preserve the secrecy of this data. This means that supply chain transparency is particularly challenging for the company and was a major challenge to work around during this project.

[75] Makower,, J. 2013. *State of Green Business Report 2013*. February 12. Accessed February 21, 2020. https://www.greenbiz.com/research/report/2013/02/state-green-business-report-2013.
[76] *Supra Note 28*
[77] *Supra Note 28*

Besides limitations along the data collection process, the EIO-LCA model used in the Quantis tool has technical limitations. Unlike the process-based LCA model, the EIO-LCA model does not collect and evaluate the direct impact along each step of a product's path in the supply chain.[78] To assess the impact across the supply chain, EIO-LCA has to link the monetary value with the physical value to calculate emissions based on monetary transaction relationships.[79] The emission factors are also based on money value products and services in each step. As the relationship between money value and physical value is dynamic over time, the uncertainty of results can be significant if the underlying data has not been periodically updated.[80]

4.2 Methods for Setting Science-Based Targets

4.2.1 Theory of the Methodology

The first step is determining the science-based targets (SBT) scope. According to the latest Science Based Targets initiative (SBTi) Criteria (4.0), a company must cover scope 1 and 2 emissions and relevant GHG emissions based on the GHG Protocol Corporate Standard. Additionally, a company may exclude up to 5% of total scope 1 and 2 emissions in the boundary of SBT and GHG inventory. Since October 15th, 2019, companies have also needed to include direct emissions and GHG removals associated with biofuels, biomass, and bioenergy feedstocks within the boundary of targets. Based on Cree's current emission portfolio, the company will cover scope 1, 2, and 3 emissions in their targets without excluding any scope 1 and 2 emissions or including biofuel/biomass/bioenergy related emissions.

Overall, there are three basic methods of setting science-based targets: Sector-based approach, Absolute-based approach, and Economic-based approach.[81] The key components of these three approaches are the carbon budget, emissions scenario, and allocation. Emission scenarios are "the magnitude and timing of emissions reductions".[82] Currently, there are two kinds of scenarios that are approved by the SBTi Criteria (4.0): WB2° C scenario and 1.5°C

[78] *Supra Note 56*
[79] *Supra Note 56*
[80] *Supra Note 56*
[81] *Supra Note 41*
[82] *Supra Note 41*

scenario.[83] The carbon budget is the total GHG that can still be produced within the limit imposed by the goal of the well-below 2° C and 1.5° C global temperature rise scenarios.[84] The allocation approach is the method companies use to distribute their allotted piece of the carbon budget within the company.[85] Companies from all sectors, except for the power sector, can choose any approach that best represents the company's ambitions and drives the greatest emissions reductions. Companies from the power sector have to use a sector-based approach as their sector is the biggest contributor to total emissions and has to take more responsibility than companies in other sectors.[86] Each approach has its advantages and disadvantages for companies, depending on their individual situation.

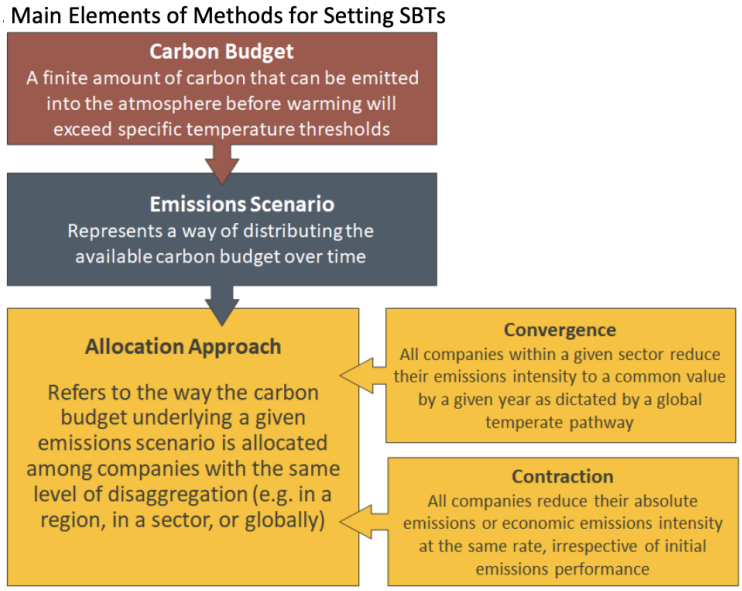

Figure 3: Main Elements of Methods for Setting Science Based Targets[87]

Since Cree is a company with different products, there is not a single sector that can cover and represent all of their business units. Therefore, the estimated target results would contain significant levels of uncertainty if Cree used the sector-based approach and chose one industrial sector to apply to their data. Additionally, the sector based decarbonization approach cannot be used for a 1.5° C target due to the lack of sector-based data for the 1.5° C scenario.[88]

[83] *Supra Note 41*
[84] *Supra Note 41*
[85] *Supra Note 41*
[86] *Supra Note 41*
[87] Science Based Targets. 2018. "Science Based Targets." *SBTi Criteria and Recommendations.* May 23. Accessed January 22, 2020. https://sciencebasedtargets.org/wp-content/uploads/2017/02/SBTi-criteria.pdf.
[88] *Ibid*

The absolute-based approach is the most commonly used method for estimating scope 1, 2, and 3 emissions targets. These targets require companies to reduce their emissions by the same percentage as the absolute emission reduction required given a temperature scenario.[89]

GEVA is the methodology used for the economic intensity approach. Under this approach, companies need to annually reduce their emissions 7% based on an absolute reduction goal of 75% from 2010 to 2050.[90] GEVA can only estimate an emission target based on the limit of projected global economic value added over time in an idealized condition.[91] Therefore, due to the natural volatility of the global economy and gradually increasing rate of emissions, the economic intensity approach is considered to be less ambitious and less robust than the other approaches.[92] Based on this analysis, Cree should implement the absolute-based approach to set their scope 1, 2, and 3 emissions.

4.2.2 SBTi-Tool

The tool that we used for establishing preliminary science-based targets is available online from the SBTi. It is an excel-based tool that allows users to input their base year scope 1, 2, and 3 emissions and then projects targets based on the 1.5° C and WB2° C scenarios. The input data and the output produced by the model is indicated in Table 4 below.[93]

Approach	Scope	Scenario	Company Input	Method Output	Example
Absolute Emissions Contraction	1,2,3	1.5°C, WB 2°C	● Base year ● Target year ● Base year emissions, disaggregated by scope	Overall reduction in the amount of absolute GHGs emitted to the atmosphere by the target year, relative to the base year	Cisco commits to reduce absolute scope 1 and 2 GHG emissions 60% by FY2022 from a FY2007 base-year

[89] *Ibid*
[90] *Ibid*
[91] *Ibid*
[92] *Supra Note 87*
[93] *Supra Note 44*

Sectoral Decarbonization Approach (SDA)	1,2	WB2°C	● Base year ● Target year ● Base year emissions, disaggregated by scope ● Activity level in the base year (e.g., building floor area, distance travelled, etc.) ● Projected change in activity by target year	A reduction in emissions relative to a specific production output of the company (e.g., tonne CO_2e per MWh)	European real estate operator Covivio commits to reduce Scope 1 and 2 GHG emissions 35% per sqm by 2030 from a 2017 base-year.
Economic Intensity Approach	1,2,3 (prefer 3)	1.5°C, WB 2°C	●Base year ●Target year ●Base year emissions, disaggregated by scope ●Value added in the base year Projected change in value added by target year	A reduction in emissions relative to financial performance of the company (e.g., tonne CO_2e per value added).	Manufacturer of outdoor power products Husqvarna Group AB commits to reduce scope 1 and scope 2 emissions 30% per unit of value added by 2020 from a 2015 base year.

Table 4: The scope, scenario, input, output, and examples for all three SBT approaches[94]

In addition to receiving these numerical targets, the SBTi tool can also generate charts and tables showing projected yearly reduction targets based on the base-year values and two types of scenarios to help companies track their performance over time.

4.2.3 Data Collection

The data used in this step are total emissions from scope 1, 2, and 3 emissions, which were gathered from the previously discussed documents and our own calculations. Additionally, we chose the base and target years after consulting with Cree about the available options.

4.2.4 Limitations and Challenges

One of the biggest limitations of the SBTi tool is its lack of sector-based data for utilizing the SDA approach. Currently, under the WB2°C scenario, there is only data available for six industrial sectors: Power Generation, Iron & Steel, Aluminum, Cement, Pulp & Paper, Services/Commercial Buildings. To improve the accuracy of each sector's GHG emissions contribution to global warming and climate change, the SBTi tool needs to collect more data from different sectors and build models for each type of sector.[95] For companies that are trying to calculate their targets, it can be challenging to decide which type of approach to consider, as all

[94] *Supra Note 44*
[95] *Supra Note 44*

three approaches can generate distinct targets. The most ambitious option might not be achievable for the company and the most achievable option might not be accepted by the SBTi as being ambitious enough. Science-based targets are hefty long-term commitments and companies should take time to evaluate their ability to meet the targets that they plan to set. It is also important to examine the state-of-art practices within their sector to prepare for the hardest step, execution.

5. Results

5.1 Scope 3 Results

After utilizing the Quantis and GHG Protocol tool, Cree has a complete scope 3 carbon emissions inventory. For our calculations in this project, five of the fifteen scope 3 categories were relevant to Cree and still missing data. The five scope 3 emission categories that we analyzed for Cree are:

1. Purchased Goods and Services
2. Capital Goods
3. Fuel and Energy-Related Activities Not Included in Scope 1 or Scope 2
4. Upstream Transport
5. Employee Commuting

As seen in Figure 4, of these categories, the most significant source of emissions is Purchased Goods and Services, which has approximately 1.26 million metric tons of CO_2 equivalents per year. Within the five scope 3 categories that we calculated, this category accounts for approximately 79% of total emissions. Capital goods accounts for 209,910 metric tons of CO_2 equivalents per year, or 13% of the scope 3 emissions that we calculated. Fuel and energy related activities account for 98,350 metric tons of CO_2 equivalents per year, or 6% of the scope 3 emissions that we calculated. Employee commuting accounts for 12,750 metric tons of CO_2 equivalents per year and upstream commuting accounts for 11,174 metric tons of CO_2 equivalents per year. Both upstream transport and employee commuting each makeup less than 1% of the scope 3 emissions that we calculated.

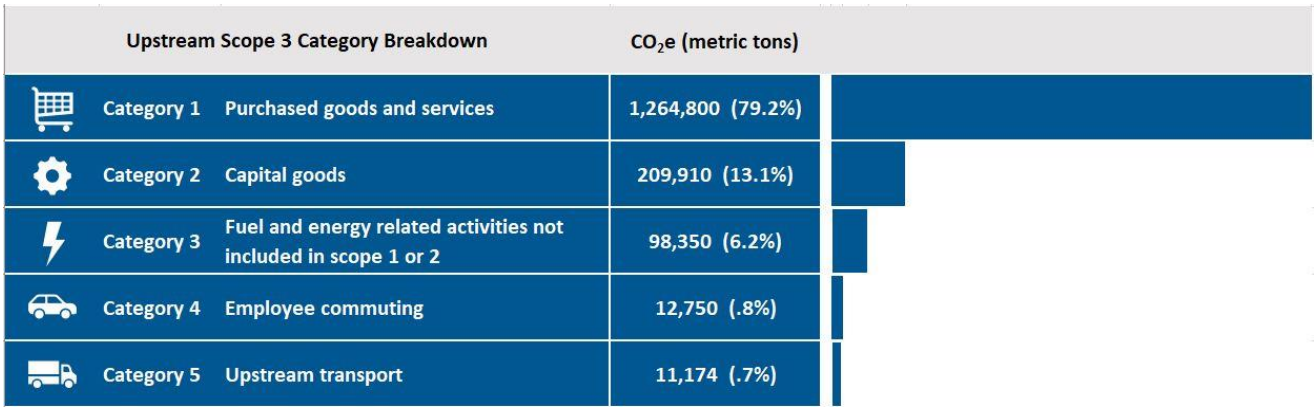

Figure 4: This project's scope 3 emission calculations per category

Purchased Goods and Services contains all emissions that occur from purchased products that are used within the business, excluding any large-scale equipment. We divided all of these products into categories based on their material composition and then calculated each category's emissions. Cree utilizes eleven different material categories within its value chain:

1. Pulp, Paper, Printing and Publishing
2. Chemicals and Chemical Products
3. Manufacturing (not elsewhere classified), Recycling
4. Other Non-Metallic Minerals
5. Electricity, Gas, and Water Supply
6. Construction
7. Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies
8. Rubber and Plastics
9. Base Metals and Fabricated Metal
10. Textiles and Textile Products
11. Renting of Machinery and Equipment and Other Business Activities

We were then able to identify four material hotspots within this category. Due to this information being proprietary to Cree, we cannot disclose the exact number of CO_2 emissions for each of these material categories, but the two major sources of emissions are Chemicals and Chemical Products and Basic and Fabricated metals. Other non-metallic minerals and Rubber and Plastics each also had a significant amount of emissions within the category. These are the four main groups that Cree should focus on when developing strategies to reduce their scope 3

emissions from purchased goods and services. The emissions from the other material categories each individually equated to less than 1 percent of the overall category's emissions and therefore aren't a significant source of emissions for Cree to try to reduce.

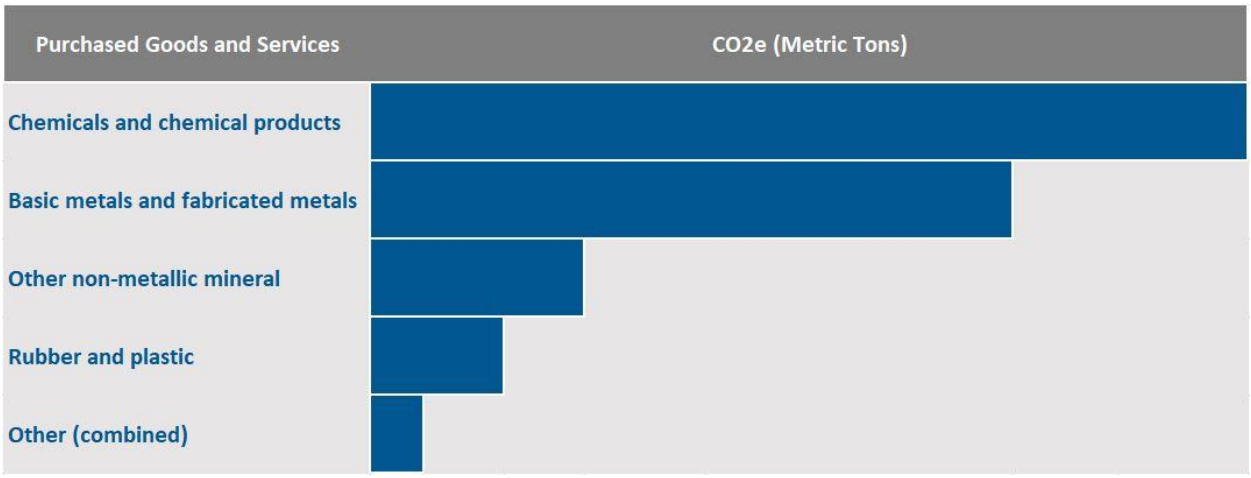

Figure 5: Breakdown of purchased goods and services emissions

5.2 Scope 1, 2, and 3 Emissions Analysis

After we completed calculating Cree's Upstream Scope 3 data, we combined it with the previous scope 1, 2 and downstream scope 3 emissions calculations so that there is now a complete account of the company's total emissions. As seen in Figure 6, Cree's scope 1 emissions total approximately 255,500 metric tons of CO_2 equivalents, or .12% of Cree's total emissions, and their scope 2 emissions total approximately 172,400 metric tons of CO_2 equivalents, which are only .08% of Cree's total emissions. Cree's upstream scope 3 emissions account for approximately 1.6 million metric tons of CO_2 emissions, which is .7% of total emissions, and downstream scope 3 emissions total approximately 220 million metric tons of CO_2 equivalents, which accounts for 99.09% of their total emissions. Overall, scope 3 emissions account for 221.64 million metric tons of CO_2 equivalents. This reveals that the overwhelming majority of their emissions are indirect emissions within their value chain and fall within scope 3, particularly downstream scope 3.

Scope	Duke MP Team	CO_2e (metric tons)	Percent
Scope 1	Previous	255,500	0.12%
Scope 2	Previous	172,400	0.08%
Downstream Scope 3	Previous	220,040,400	99.09%
Upstream Scope 3	Current	1,597,000	0.72%

Figure 6: Breakdown of Cree's scope 1, 2, and 3 emissions

Combining our analysis of Cree's upstream scope 3 emissions, Figure 7, with the previous downstream scope emissions data, Figure 8, creates a complete picture of Cree's scope 3 emissions. The largest contributor of emissions within scope 3 is by far the use phase of their products. This category accounts for 220 million metric tons of CO_2 equivalents. This makes sense, as a large portion of Cree's business is lighting products, which are used for electricity and energy and therefore would have a larger footprint than the other categories. Typically, this category is challenging to tackle for emissions reduction, as it often requires changing consumer behavior.

However, earlier this year, Cree sold its lighting division in order to focus on its silicon carbide semiconductor business, so it will be interesting to see if this changes their emissions from the use of sold products and makes it easier for them to achieve their emissions reduction target.[96]

[96] Cree Inc. 2019. *Cree Closes on the Sale of Cree Lighting to IDEAL INDUSTRIES, Inc*. May 13. Accessed April 1, 2020. https://www.cree.com/news-events/news/article/cree-closes-on-the-sale-of-cree-lighting-to-ideal-industries-inc.

Upstream Scope 3 Category	CO_2e (metric tons)
Purchased goods and services	1,265,000
Capital goods	209,910
Fuel- and energy- related activities, not included in scope 1 and 2	98,350
Employee commuting	12,750
Upstream transport	11,174

Figure 7: Breakdown of Cree's scope 3 emissions calculated during this project

Downstream Scope 3 Category	CO_2e (metric tons)
Use of sold products	220,000,000
Downstream transportation and distribution	34,283
Business travel	3,422
Waste generated in operations, including disposal and transportation of waste	1,662
End of life treatment of sold products	1,032

Figure 8: Breakdown of Cree's scope 3 emissions calculated during other projects

If the CO_2 emissions from use of sold products drastically decreases without their lighting products, then the new priority category for emissions reduction might be purchased goods and services, whose hotspots we previously analyzed. As seen in Figure 9, there would also be opportunities within capital goods, transportation, commuting, and fuel and energy related activities to achieve significant emissions reductions.

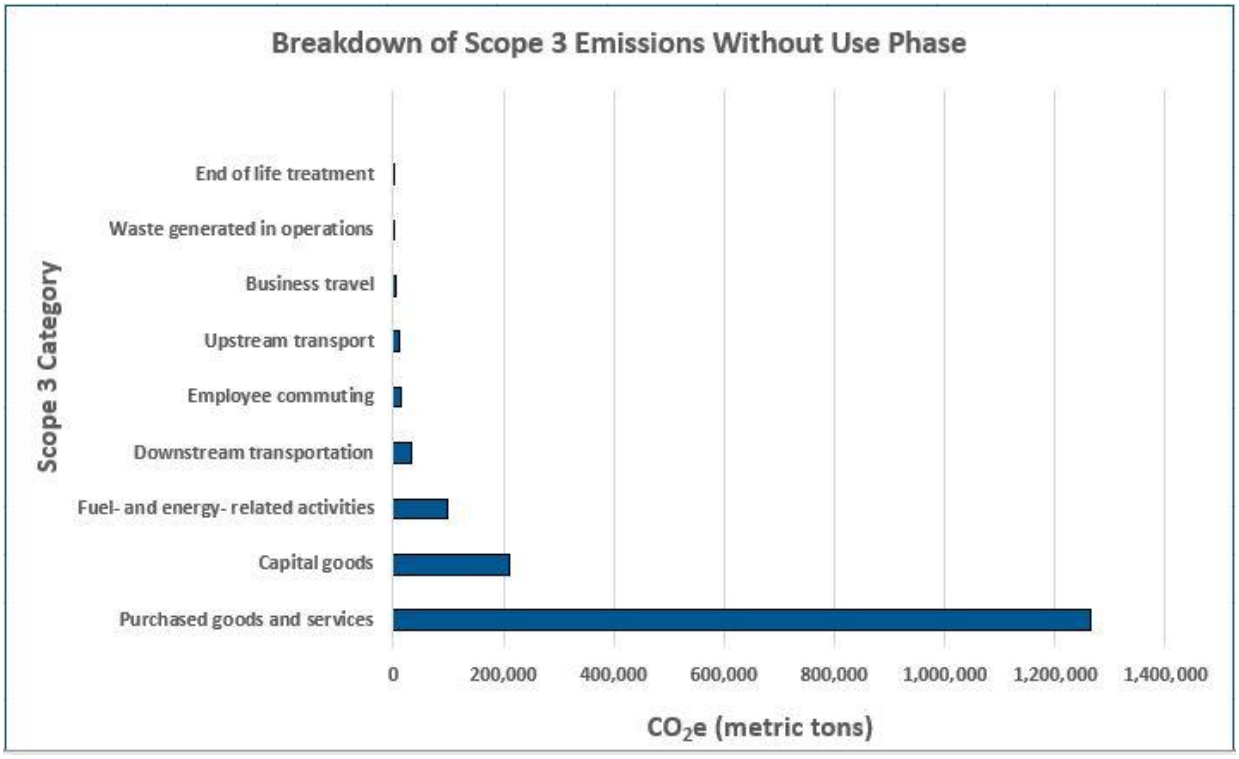

Figure 9: Breakdown of scope 3 emissions by category without use phase

5.3 Science Based Targets Model and Projections

After compiling the final emissions data for all three scopes, we modeled potential science-based targets that the company could submit for approval. To calculate the targets, an Absolute Contraction Approach was used with 2018 as the base year and 2030 as the target year. As seen in Figure 10, after inputting the emissions data and selecting the criteria, the model calculated that Cree needs to reduce both their combined scope 1 and 2 emissions, and scope 3 emissions, 50.4 percent by 2030 in order to keep in line with a 1.5° C temperature scenario. This means that Cree will need to reduce their combined scope 1 and 2 emissions from approximately 430,000 metric tons of CO_2 equivalents to 212,000 metric tons by 2030, and reduce their scope 3 emissions from approximately 220 million metric tons of CO_2 equivalents to approximately 109

million metric tons of CO_2 equivalents by 2030. While Cree doesn't need to follow a precise annual emission reduction schedule, it can serve as a helpful benchmark for them as they attempt to reduce their emissions over time and meet the 2030 target goal.

1.5 Degree Celsius Scenario	Base Year 2018 (mt CO2e)	Target Year 2030 (mt CO2e)	Reduction
Scope 1 emissions	255,500	126,728	50.40%
Scope 2 emissions	172,376	85,498	50.40%
Scope 1 + 2 emissions	427,867	212,226	50.40%
Scope 3 emissions	220,040,399	109,140,038	50.40%

Figure 10: Scope 1, 2, and 3 science-based targets for Cree

6. Conclusion

6.1 Case Studies Observations and Strategy Recommendations

6.1.1 Mitsubishi Electric Corporation

As a core competitor to Cree in power production, electronics, and electrical equipment, manufacturing company Mitsubishi Electric has committed to reduce their scope 1 and 2 emissions 18% by 2020, and their scope 3 emissions 15% by 2030.[97] Promoting sustainable societies worldwide is an integral part of Mitsubishi's vision. Since 1994, Mitsubishi Electric has continued formulating three-year plans to progress its environmental goals.[98] Since scope 3 emissions account for the majority of its GHG emissions, this section focuses on effective practices being implemented to reduce these emissions.

Based on the results from the Quantis tool, purchased goods and services is the largest contributor to Cree's scope 3 emissions. Mitsubishi Electric implemented a Green Accreditation System to reduce environmental risks associated with its value chain. The company issues Green Accreditation certificates to suppliers who successfully meet environmental criteria, including compliance with environmental regulations, management of chemical substances, and individual

[97] Science Based Targets. 2020. *Meet the companies already setting their emissions reduction targets in line with climate science*. Accessed February 20, 2020. https://sciencebasedtargets.org/companies-taking-action/.
[98] *Supra Note 9*

supplier's environmental management systems.[99] In addition to reducing GHG emissions from purchased products, Mitsubishi Electric also manages to reduce the size and weight of products during the manufacturing stage. Both practices have helped Mitsubishi Electric step up its environmental goals.

6.1.2 Dell Technologies

As a multinational computer technology company, Dell Technologies has committed to reduce its scope 1 and 2 emissions 40% by 2020. While they do not compete with Cree in the same industry, there are three practices worth examining. Similar to Cree, Dell purchases chemical products from their suppliers. In order to improve the monitoring of their mineral supply chain, Dell actively engages with their suppliers and implements multiple approaches to prevent negative consequences from occurring. The first practice we want to highlight is that Dell provides training to suppliers and their factories to help them achieve long-term success. As part of this program, Dell presents webinars and in-person sessions to deliver training on setting science-based targets, water risk mitigation, and energy management.[100] The second practice is to enhance transparency through their mineral supply chain. Specifically, Dell created a Responsible Sourcing Policy to assess risks associated with their minerals and they require their suppliers to use an industry developed Conflict Minerals Reporting Template to ensure transparency within their mineral supply chain.[101] The third practice is asking their suppliers to "report on their GHG emission levels, set reduction targets, and publish sustainability reports".[102]

6.1.3 Actions Cree Can Take

Modeling off of the effective practices in these case studies, Cree can emulate Mitsubishi Electric while customizing their strategies to Cree's own specific needs and conditions. We recommended that Cree establish an environmental auditing system that allows them to monitor their suppliers' environmental data. As a leading company, Cree can leverage its influence in multiple countries and require its suppliers to be compatible with Cree's environmental goals and indices. Additionally, they can offer help and resources to their suppliers to help make this

[99] *Supra Note 9*
[100] *Supra Note 10*
[101] *Supra Note 10*
[102] *Supra Note 10*

transition possible. Once suppliers lower their GHG emissions, Cree would see a drop in its scope 3 emissions. Moreover, Cree could benefit from inventing new technologies or utilize its current technological assets to reduce its emissions during the product manufacturing stage.

Similar to Dell Technologies, Cree has factories overseas and needs to purchase large amounts of chemicals and metals from suppliers. In order to reduce its scope 3 emissions, Cree can first develop its own requirements and then have suppliers agree to meet them as a prerequisite of doing business together. In addition, Cree can work with suppliers to set emission reduction goals and continue monitoring their progress. Cree can also help improve suppliers' internal audit system so that they can better monitor their own risks. It is undeniable that engaging with suppliers is a challenging task; however, both Cree and its suppliers would benefit from doing so in terms of reducing their environmental impact on the planet and having a better understanding of their operations and value chain.

6.2 Next Steps

There are four basic steps of setting a target:

1. Step 1 - Submit the commitment letter: When a company signs the SBTi commitment letter, it indicates that they will work on developing a science-based emission reduction target.

2. Step 2 - Develop a target: After signing the commitment letter, a company will have up to 24 months to determine, finalize, and submit their targets for official validation.

3. Step 3 - Submit your target for validation: Once a company has developed a target, they then need submit the 'Target Submission Form' as a Microsoft Word document via email to targets@sciencebasedtargets.org.

4. Step 4 - Announce the target: If a company receives notice that their target meets SBTi's criteria and is approved, they will be able to use the SBTi logo for company communications and their target will be showcased on the SBTi website.

Through this project, Cree has completed Step 2 of the SBT submittal process. However, they have started the process out of order, as the company has not completed Step 1 yet. Once

Cree submits their commitment letter, they will have 2 years to complete Step 3 by submitting their targets for validation via the Target Submission Form. If their targets meet all of the necessary criteria and the SBTi approves them, Cree will then publicly announce their target. Then the real work begins, as Cree sets about the process to achieve their emission reduction goals. This will require developing a strategy action plan and tracking all future emissions reductions so that Cree can correctly measure their progress.