Climate Change Education Best Practices and Industry Transition Pathway Analyses - How Zurich Insurance Can Improve its Advising Capabilities

SEAS MASTERS PROJECT
FINAL REPORT
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Executive Summary

The Zurich Insurance Group is a Swiss-based company that is dedicated to being among the most impactful and responsible businesses across the globe. As such, Zurich Insurance was the first insurance company to sign the UN Compact Business Ambition for 1.5 Pledge. That said, Switzerland's largest insurance company has encountered problems across its employees in their knowledge of and comfort with sustainability and climate change.

Zurich Insurance has recognized that to better influence and serve its clients in their transition towards a 1.5C future, its underwriting team needs to be able to understand how sustainability impacts their work. Currently, the firm does not have the ability to advise clients on industry specific transition pathways towards a 1.5C future and is looking to develop a product or service to meet this need.

To assist Zurich Insurance in identifying and developing these capabilities, the UM SEAS team conducted primary and secondary research in the project's three main phases. The first phase of the project involved developing easily interpretable overviews of the transition pathways across ten industries of interest for underwriters to reference. The second phase explored the current state of Zurich Insurance's underwriting team's climate change and sustainability awareness. To do this, the UM SEAS team conducted internal interviews with members of the underwriting team and collecting results of an internal survey,

After establishing the baseline of Zurich Insurance employees' knowledge and comfort with sustainability, the team set forth on the final phase of the project, which involved researching and benchmarking best education practices for climate change across academia and companies. Insights gleaned from interviews with academic experts and sustainability professionals guided the team's recommendations for Zurich Insurance on how to approach engaging and empowering employees in becoming sustainability champions.

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Introduction

Company Background

Zurich Insurance Group Ltd. is Switzerland's largest insurance company, founded in 1872. It is named for the city in which its headquarters are located, and has customers all over the world, including individuals, small- and medium-sized enterprises, and major multinational corporations. It is publicly traded on the SIX Swiss Exchange, and as of March 21, 2022, had a market capitalization of US $67.18 billion.

Industry Landscape

The insurance business is a part of the financial services industry. Put simply, insurance companies provide protection against financial risk for their customers in exchange for a fee. This is done through the provision of insurance policies on all manner of potential risks. Customers pay a premium to the company, typically on a regular basis, for protection against some potential risk or risks. The types of risks, as well as the variety of property (tangible or intangible), or entities that may be insured, are nearly endless. Common examples include the risk of an automobile accident or personal injury to an individual, the risk of property damage from floods or fire, or the risk to a corporation of legal liability. In the event that a policyholder suffers financial loss from one of the events they have expressly insured, they receive payment from the insurance company.

Insurance companies profit by pooling the risk of many customers. Policyholders typically pay regular, relatively small premiums to cover the risk of a sudden, large financial shock. Since many of the insured events do not come to fruition, or happen only infrequently, insurance companies are able to profit from the premiums they collect but never need to expend in payouts. Companies which are able to accurately assess risk stand to benefit most from this difference. This is called underwriting profit.

In addition to underwriting profit, insurance companies also take advantage of the time gap between the collection of premiums and the future payout of an insurance claim. They use this period to invest the premiums, and to earn a return on those investments.

The global insurance market includes more than 17,000 companies, with total premiums of more than US $5 trillion.

Zurich Insurance

Zurich Insurance employs approximately 56,000 people worldwide. It serves customers in more than 210 countries and territories with a full spectrum of policies. Its business is divided between several regions: North America (35% of gross written premiums); Latin America (9%); Europe, Middle East and Africa (46%); and Asia Pacific (10%).

In 2021, Zurich's business operating profit was US $5.7 billion. Its Property & Casualty line of business was its largest, providing coverage for businesses large and small, as well as motor, home, and commercial products and services for individuals. It included US $40.1 billion in written premiums and policy fees and accounted for US $3.1 billion in business operating profit in 2021.

Zurich's Life business segment includes a range of life and health insurance policies, totaling US $28.4 billion in premiums, policy fees, and deposits last year, and accounting for US $1.8 billion in business operating profit. Zurich also wholly owns Famers Group, Inc., which serves as attorney-in-fact for three policyholder-owned insurers, called the Farmers Exchanges. It collects fees for providing them non-claims and ancillary services, amounting to US $4.3 billion in 2021, for a business operating profit of US $1.6 billion.

In terms of market capitalization, Zurich is the 10th most valuable insurance company in the world. By net premiums written, it is the 23rd largest.

Project Context

As the first insurer to sign on to the UN Compact Business Ambition for 1.5 Pledge, Zurich is committed to a sustainable future. One of the firm's three key sustainability commitments is to enhance resiliency by actively tackling the risk and opportunity of climate change to achieve a 1.5º Celsius future. Because Zurich Insurance wants to be an industry leader in sustainability, the company is seeking to help customers transition to a more sustainable future with low-carbon operations.

That said, Zurich Insurance does not have industry specific strategy guidance on how customers should be transitioning towards a 1.5ºC future, or a product or service that can support customers in their transitions. This is largely due to inconsistent levels of knowledge of and comfort with the topic of sustainability among employees. Educational efforts to correct these skill gaps have had limited success historically because underwriters have not fully understood all of the ways in which climate change impacts their day-to-day jobs.

Project Scope and Objectives

At its core, the main objective of this project was to provide the Zurich Sustainability Team with the tools to run an effective education campaign that would fully integrate understanding of climate risk and sustainability into the day-to-day work of the Commercial Insurance business unit. The end goal of this work is to empower its underwriting team to advise clients on the pathways to transition to a more sustainable future. Building this capability requires developing a standardized and engaging way to educate the Zurich Insurance underwriting team on the climate risks and opportunities associated with key industries.

The UM SEAS team approached this challenge hoping to answer four key questions:

1. What is the current state of employee understanding of climate change and sustainability, and its relevance to employee day-to-day work?
2. What is preventing employees from incorporating sustainability into their day-to-day job?
3. How have other companies successfully educated employees and integrated sustainability across all business units?
4. How can a successful education campaign be implemented at Zurich?

A three-phased approach was used to answer these questions: building out easily interpretable overviews of the transition pathways across ten industries of interest for underwriters to reference; exploring the current state of climate change and sustainability awareness at Zurich Insurance; and researching and benchmarking best education practices for climate change across academia and companies.

Performance Measures

The performance measures utilized to understand whether the Zurich team's recommendations are proving successful lie in a survey the team designed for internal use. Zurich Insurance has sent out the survey to its Commercial Insurance Division and therefore has baseline numbers for climate change knowledge. In the future, the survey can be sent out to determine the effectiveness of new climate change education initiatives.

Deliverables

While the deliverables changed throughout the project as a result of project findings, the team ultimately will deliver two pieces of deliverables – Literature Review-Based Industry Memos as well as Academic and Company SME Benchmark Analyses.

Literature Review-Based Industry Memos

One of the key objectives of this project is to help the Zurich sustainability team to educate their employees on sustainability issues and help them to engage with this topic more at the work level. Developing consumable memos with a couple of PowerPoint slides for each key industry allows the employees to quickly digest the current trends, enhancing their level of understanding for their clients' industries and deepening the depth of conversation they could have with clients around mitigating risks associated with the climate change. Our team aligned with the Zurich team on the ten industries for which we created memos – Cement, Steel, Construction, Shipping, Crops and Livestock, Food Manufacturing, Retail Automobile, Hydrogen Power, Aviation, and Retail Clothing. We did a literature review on each of these ten industries, synthesizing the findings from at least fifteen reports from accredited research institutions such as McKinsey & Company, all resources from Kresge Library at the University of Michigan, as well as a host of relevant academic and journalistic sources. The actual deliverables will be submitted along with this written report.

Academic and Company SME Benchmark Analyses

Aside from secondary research, the UM SEAS team also wanted to offer some proprietary ideas about how Zurich could keep exceeding its own standard on being a sustainable business leader within its space. We conducted primary research that consisted of both quantitative and qualitative research to understand the current state of Zurich in terms of their employees' knowledge level and the principles and strategies to improve on the engagement level of sustainability issues within a company. The analyses of this research are presented in this report in the current state analysis section. The solution strategies and recommendations that stemmed from our analyses are also covered in this report, following the analysis section.

Methodology

Overview

The initial motivation of the project was to understand the landscape of the business transition and to educate Zurich employees on tools and techniques of incorporating climate change into their daily activities. This project consisted of several phases that addressed sustainable business transition pathways and targeted educational initiatives within Zurich.

Phase 1: Literature Review and Internal Interviews

We started with a literature review to understand the general trends and risks associated with climate change efforts and their effects on Zurich's business operations. The literature review was broken down into 10 specific industries: Agriculture, Automotive, Aviation, Cement, Construction, Fashion, Food Manufacturing, Hydrogen, Shipping, and Steel. Our team synthesized academic and corporate information about each industry to develop an outline of what is required for a successful business transition. Materials were generally found in scientific databases like Google or provided by subject matter experts (SMEs) within Zurich and the University of Michigan. We compiled information gleaned from the literature review into short, digestible memos that we hope will be easily accessible and easily understood by Zurich employees. This is meant to facilitate a baseline understanding.

Information collected through the literature review process was complemented by the SME interviews with Zurich employees working in each industry. A list of target employees was provided by Zurich to ensure the conversations were grounded in experience and current business operations. The information from these conversations informed the approach and content of the resulting memos. These interviews served as the bridge between the academic literature and real-world application within Zurich. Furthermore, these interviews revealed that a key issue for Zurich was not necessarily a lack of access to information, but a lack of engagement and time to understand how climate change pertained to each individual's role. This led the team to adjust the project plan in favor of further evaluating this hypothesis and designing an education strategy that would best facilitate learning for the Commercial Insurance group.

Phase 2: Internal Employee Survey

Following our initial literature review and interviews with Zurich subject matter experts, we determined the need to measure the current understanding of climate change and levels of engagement with business transition pathways, so that we could attempt to set a baseline and illuminate targeted areas of impact and consideration. A 22-question survey enabled us to develop an understanding of climate change literacy within Zurich. The focus of the survey centered around employee's general climate change knowledge, opinions on Zurich's climate change efforts, understanding of climate implications in their day-to-day work, and areas of additional interest. It consisted of sixteen multiple choice and one fill-in-the-blank question to address the areas listed above, as well as five demographic questions.

The survey was sent to the Commercial Insurance Distribution List, though the exact number of recipients is unknown. Consequently, we are unable to determine a response rate or whether certain groups (offices, teams, or level of experience) are over- or underrepresented. In total the team received 856 responses. Because the questions were individually optional, most questions received a lower number of responses. In response to a question regarding the geographical distribution of respondents, our results came from: [redacted]

We note that the survey was not mandatory, meaning that employees had to elect to complete it. Though we cannot measure it, there is a chance of a self-selection bias, in which employees already interested and knowledgeable about the topic complete the survey at a higher rate, or where employees with extreme views (both extremely positive and extremely negative) are the most passionate, and so respond disproportionately. The team believes this may play a role in the positive results, which demonstrated a high-level of understanding across Zurich, as this conflicts with the qualitative information and experiences shared by the subject matter expert interviews and the sustainability team.

Phase 3: Academic and Corporate Interviews

Lastly, our team conducted interviews with six subject matter experts in academia and six experts in the corporate setting. These experts were selected due to their experience and knowledge with climate change communications in their respective settings, particularly as it relates to encouraging action in large organizations. A set of interview questions was standardized for all interviews, along with a set of targeted questions related to the knowledge and background of the individual experts. After the interviews, conversations were analyzed for common themes and key takeaways that resulted in a list of recommendations for education efforts within Zurich, driven by their CI Commercial Insurance Academy. Key takeaways are meant to guide Zurich's education efforts, but we were explicit in not recommending specific educational materials. Rather, the goal of these interviews was to provide a generalized strategy for increased engagement effectiveness. We believe Zurich itself is best positioned to develop internal education materials.

Literature Review

Overview

As mentioned previously, the first deliverable for the project involved conducting a literature review on the transition pathways for industries of interest for the Zurich Insurance team. After reviewing the initial list of Zurich Insurance's industries of interest, the UM SEAS team narrowed down the list to the following ten industries based on mutual interest: agriculture, automotive, aviation, cement, construction, fashion, food manufacturing, hydrogen, shipping, and steel. The following section presents the high-level findings of each industry's transition pathways.

Agriculture

Agriculture accounts for about 17% of global GHG emissions, and another 7-14% through land use change.[1] Emissions come from livestock as well as agricultural soils and crop production. However, land use change is also a big contributor to emissions as it involves the removal of carbon sinks such as soil, which is the world's largest terrestrial carbon pool.[2]

Three of the key low-carbon farming practices to which the agriculture sector is transitioning are: practices for precision application of fertilizer, crop-livestock-forest and agroforestry systems, and reclamation of degraded lands. Other solutions that are being pursued in the industry that are not explored in this literature review include: no-till farming or conservation tillage, use of biochar, composting, rotational grazing, use of cover crops and agrivoltaics.[3]

Precision Application Practices of Fertilizer

Nitrous oxide (N_20) is 300 times more potent a greenhouse gas than CO_2 and remains in the atmosphere for 100 years. Nitrogen-based fertilizers have increased emissions of N_20 by 30% over the last forty years.[4] Current practices only see about half of applied fertilizer taken up by plants.[5] Precision application can reduce this emission-causing waste through as-needed spatial and temporal application. That is: fertilizer should be applied only where it is needed and only when it is needed. These solutions can also reduce the amount of excess nitrogen entering groundwater, from which place it can be released into the atmosphere to combine with oxygen and create nitrous oxide.[6]

Less fertilizer use also means less fertilizer production. These processes create emissions of their own. To further address this aspect of the problem, equipment can be installed at production sites

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[1] Hannah Ritchie & Max Roser, *Emissions by Sector*, Our World in Data (Last accessed Apr. 8, 2022), https://ourworldindata.org/emissions-by-sector
[2] IUCN. (2015). Land degradation and climate change. Retrieved from International Union for Conservation of Nature: https://www.iucn.org/resources/issues-briefs/land-degradation-and-climate-change.
[3] Blush, Jennifer. "Agriculture and Climate Change." Foundations of Sustainable Food Systems, 23 September 2021, University of Michigan. Class handout.
[4] Thin Lei Win, *Nitrogen emissions from rising fertiliser use threaten climate goals*, Reuters (Oct. 7, 2020), https://www.reuters.com/article/us-global-climatechange-agriculture/nitrogen-emissions-from-rising-fertiliser-use-threaten-climate-goals-idUSKBN26S2HV.
[5] Neville Millar, *Management of Nitrogen Fertilizer to Reduce Nitrous Oxide Emissions from Field Crops (E3152)*, MSU Extension (Oct. 19, 2015), https://www.canr.msu.edu/resources/management_of_nitrogen_fertilizer_to_reduce_nitrous_oxide_emissions_from_fi
[6] Birgitte Hansen et al., *Groundwater nitrate response to sustainable nitrogen management*, 7 Scientific Reports 8566 (2017), https://www.nature.com/articles/s41598-017-07147-2

to curb emissions of nitric acid, which eventually leads to added nitrous oxide in the atmosphere as well.[7]

The greatest risks associated with precise fertilizer application could result in loss of yield if either the amount of fertilizer or the timing of application is miscalculated. It is important to conscientiously apply these techniques so that, in solving one problem, we do not exacerbate others.

Crop-livestock-forest and Agroforestry Systems

Crop-livestock-forest systems focus on creating biodiversity. A focus on functional diversity of the different species in the agroecosystem through methods such as intercropping can reduce the need for pesticides.[8]

Agroforestry creates increased resilience to climate variability through increased complexity of systems. Given the increasing droughts in certain parts of the world, utilization of those organic systems have been observed to lead to higher yields under these drought conditions.[9] Furthermore, complex organic systems reduce GHG emissions through a decreased need for synthetic inputs and increased root system water retention.[10]

Reclamation of Degraded Lands

Land degradation is a major contributor to climate change – the process releases soil carbon (C) and N_20 into the atmosphere.[11] More specifically, it is a process where the biological or economic productivity and complexity of land is reduced, often occurring as the result of monoculture farming practices.[12] Soil carbon management practices are cost-effective methods that can be used to increase carbon levels in the soil. Common techniques include agroforestry, fallowing soil, and herd mobility pasture management. Fallowing is a farming practice where land is taken out of crop rotation to allow the soil to replenish its nutrients and increase its carbon levels.[13]

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[7] U.S. EPA Office of Air and Radiation, *Technical Support: Document for the Nitric Acid Production Sector: Proposed Rule for Mandatory Reporting of Greenhouse Gases* (Jan. 22, 2009), https://www.epa.gov/sites/default/files/2015-02/documents/subpart_v_tsd-nitric_acid.pdf
[8] Blush, Jennifer. "Managing nutrients and soil fertility: A windshield tour and implications for sustainable food systems." Foundations of Sustainable Food Systems, 16 September 2021, University of Michigan. Class handout.
[9] *Id.*
[10] *Id*.
[11] IUCN. (2015). Land degradation and climate change. Retrieved from International Union for Conservation of Nature: https://www.iucn.org/resources/issues-briefs/land-degradation-and-climate-change.
[12] *Id*.
[13] Larum, Darcy. "What Is Fallow Ground: Are There Any Benefits Of Fallowing Soil." Gardening Know How, 4 March 2021, https://www.gardeningknowhow.com/garden-how-to/soil-fertilizers/what-is-fallow-ground.htm.

Automotive

Road transport accounts for around 10% of total global greenhouse gas emissions.[14] The activity of drivers must be adjusted to be less emissions intensive, fuels must be made cleaner, and the vehicle manufacturers themselves will need to adopt greener technologies.[15]

Human Activity

In terms of human activity, commuting choices are among the most important adjustments that can be made. Since the coronavirus pandemic began, commutes have become less frequent as more people work from home for at least part of the week. Whether this will be a permanent shift is still to be seen. As of yet, the benefits of this adjustment have not been made manifest, as sales of more inefficient SUVs rose during the pandemic.[16] Another shift that could be impactful, however, and which has been aided by mapping and GPS technologies, is the choice to take the most efficient route to and from destinations. Finally, greater usage of public transport would have a major positive impact on emissions reduction.

Alternative Fuels

With regard to fueling, there is much still to be done. Some fuels that are less carbon intensive than standard gasoline are under development and, in some cases, in use. Ethanol, made from corn, can be up to 40% less GHG intensive than gasoline. Other varieties of biofuel can be made from vegetable oils, animal fats, or recycled cooking grease. These biofuels can hypothetically be carbon neutral, since new vegetation grown for fuel production can sequester those emissions resulting from burning biofuels. At present, though, both of these fuels are more expensive than gasoline, and in the case of biofuels, infrastructure is not readily available. This is also a problem with natural gas, which can otherwise be cost-competitive with gasoline. In addition to lack of infrastructure, however, natural gas vehicles do not have great fuel efficiency, and cost more than their gasoline-powered counterparts. Hydrogen may be the most promising replacement fuel in the longer term. It has the potential to be cleaner, more powerful, and more efficient than modern fuels. But presently, the technology is too expensive and underdeveloped to compete.[17]

Many new vehicles are powered by electricity, in full or in part. These vehicles have the potential to be fully powered by renewable energy. This, though, requires broader uptake of renewable sources of energy, and their subsequent connection to the grid. Only when batteries are charged at stations powered by renewable energy will the vehicles themselves be operating without creating new emissions.

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[14] Hannah Ritchie & Max Roser, *Emissions by Sector*, Our World in Data (Last accessed Apr. 8, 2022), https://ourworldindata.org/emissions-by-sector

[15] Routes to Lower Greenhouse Gas Emissions Transportation Future, EPA (Last accessed Apr. 8, 2022), https://www.epa.gov/greenvehicles/routes-lower-greenhouse-gas-emissions-transportation-future

[16] Camila Domonoske, *Pandemic Drasticall Cut Emissions from Cars. The Lone Exception? SUVs*, NPR (Jan. 20, 2021, 7:00 pm), https://text.npr.org/958472682

[17] *Alternative Fuels and Advanced Vehicles*, Alternative Fuels Data Center, US Dept. of Energy (Accessed Apr. 8, 2022), https://afdc.energy.gov/fuels

Next Generation Vehicle Design

The sorts of vehicles that are replacing internal combustion engines fit in three general categories. Most people are now familiar with hybrid electric vehicles. As their name implies, these vehicles are not purely electric, but rather include both an internal combustion engine and an electric motor that runs off a battery. These vehicles increase fuel economy by shutting the internal combustion engine off during complete stops.[18] They also use the battery to start the car and to power vehicle accessories, and can smoothly transition from one power source to the other. Mileage per gallon is generally 20-35% better in hybrid vehicles.[19] The vehicle uses a process called regenerative braking, in which kinetic energy at deceleration is captured and stored in the battery. Using this mechanism, hybrid vehicles dispense with the need to recharge batteries via a plug.[20]

The concept of a hybrid vehicle is elaborated upon with the plug-in hybrid electric vehicle. These, too, include both an internal combustion engine and an electric motor, but generally have larger batteries than pure hybrids. Some models, called extended range electric vehicles, can be charged ahead of time through a plug, allowing them to run on pure electric power, without the use of fuel. Charge time is between 2 and 6 hours. The range of these types of vehicles is fairly limited. Most models can travel somewhere between 15 and 30 miles without the use of the ICE, though the BMW i3 can go as far as 126 miles.[21] Other vehicles, called parallel or blended plug-in hybrid electric vehicles use both the ICE and the electric motor to propel the car.[22] However, these vehicles require larger batteries, and more complicated hardware and software, making them more expensive than pure hybrids.[23]

For total decarbonization of automobiles, fully electric vehicles (EVs) will need to make up the entirety of the world's fleet. EVs run on a drivetrain powered purely by batteries and therefore produce no tailpipe emissions.[24] At present, the range of EVs is generally lower than their gas-powered counterparts. This is particularly so in cold weather, when battery power is also used to warm the cabin.[25] The model with the longest range at present, the Tesla Model 3 Long Range, is rated to travel 353 miles between charges. Most others hover between about 250-300 miles.[26] Charge times vary based on the speed of the port, but a full charge from empty to full will usually take eight hours at a 7kW charging point. Many models, though, can be rapidly charged at a 50kW

[18] Chanel Lee, *What is EV, BEV, HEV, PHEV? Here's your guide to types of electric cars*, MarketWatch (Apr. 14, 2021, 5:05 am), https://www.marketwatch.com/story/what-is-ev-bev-hev-phev-heres-your-guide-to-types-of-electric-cars-11617986782
[19] Hearst Autos Research, *Hybrid Batteries: Everything You Need to Know*, Car and Driver (Accessed Aug. 16, 2021, 12:06 pm), https://www.caranddriver.com/research/a32768969/hybrid-battery/
[20] Jil McIntosh, *How It Works: Regenerative Braking*, Driving (May 20, 2021), https://driving.ca/column/how-it-works/how-it-works-regenerative-braking
[21] Gary Witzenburg, *Hybrids vs. Plug-In Hybrids: Pros and Cons*, Car and Driver (Apr. 16, 2019), https://www.caranddriver.com/features/a27127697/plug-in-hybrid-2019/
[22] Lee, *supra*.
[23] Witzenburg, *supra*.
[24] Lee, *supra*.
[25] Dave Vanderwerp, *EV Range: Everything You Need to Know*, Car and Driver (May 22, 2020), https://www.caranddriver.com/shopping-advice/a32603216/ev-range-explained/
[26] Scooter Doll, *Longest range electric vehicles (EVs) you can buy in 2021*, Electrek (July 3, 2021, 9:10 am), https://electrek.co/2021/07/03/longest-range-evs-2021/

charging point, which can add up to 100 miles in about 35 minutes.[27] Still, combined with the lack of charging points in most places, this pace, especially in comparison to the speed of filling a fuel tank, remains a hurdle for EV adoption.

Possible Obstacles

All of the above vehicle types contain relatively advanced batteries. Both of these components have been the source of concern recently, as bottlenecks disrupt the production process. Rare earth metals are needed in batteries of all sorts as well as in other cutting-edge infrastructure, and as the economy as a whole transitions to greener technologies, these materials have come under demand pressure. Particularly troublesome is the fact that a large majority of the production of these materials is controlled by China, which has at times tightened restrictions on their trade.[28] It is not difficult to imagine a scenario in which geopolitical turmoil creates a supply shock.

Additionally, EVs contain roughly twice as many computer chips, as a measure of value, than ICE vehicles. Presently, a shortage of semiconductors has reduced the production capacity for automobiles of all varieties, and especially for EVs. Carmakers had reduced their orders of electronics as a result of weakened demand during the covid-19 pandemic, so when it recovered rapidly, they found themselves low on the order list for chipmakers. In response, many have sought closer relationships with chip designers and manufacturers. Some automobile companies and suppliers have also begun to invest in chip design/manufacturing capacity of their own.[29]

Aviation

Aviation accounts for about 1.9% of global GHG emissions and 2.5% of global energy-related CO_2 emissions.[30] Given the production and operations of airplanes, the aviation industry involves many sectors, including energy, transportation, tourism, shipping, steel, and chemicals. Aviation-specific efforts to reduce emissions focus mainly on airplane fuel, operations, design, and materials.

The three main long-term transitions are related to airplane fuel energy and airplane design and include utilizing sustainable alternative fuels (SAFs), carbon composite materials, and either twin-engine jets or electric jets.

Migrating from Traditional Fuels to SAFs

SAFs are less carbon intensive fuels and are broken down into two categories. These two types of SAFs are biogenic (made from food crops) and synthetic (made from chemical processes). Because

[27] *How Long Does It Take to Charge an Electric Car?*, Pod Point (Aug. 2, 2021), https://pod-point.com/guides/driver/how-long-to-charge-an-electric-car
[28] The Economist, *Governments have identified commodities essential to economic and military security* (Mar. 31, 2021)
[29] The Economist, *Pinned by chips* (Aug. 7, 2021)
[30] Hannah Ritchie, *Climate change and flying: what share of global CO2 emissions come from aviation?*, Our World in Data, https://ourworldindata.org/co2-emissions-from-aviation (Oct. 22, 2020).

of their costly and energy intensive production processes, SAFs tend to be more expensive than existing fuel options.[31]

Synthetic fuels have the greatest potential because they can be sourced with CO_2 captured directly from the air, making them carbon neutral. At present, however, they are more expensive than traditional fuels.[32] Furthermore, supply chain-related risks exist due to logistical transportation challenges, airport infrastructure designed for traditional fuels, geopolitical disruption, and hydrogen power dependency. There is also no existing standardized certification process – all SAFs are categorized and treated identically.

Replacing Traditional Aluminum Alloy Materials with Carbon Composite Materials

A second avenue for greater emissions efficiency would be to replace traditional materials, such as aluminum alloy in aircraft structures and cabin interiors, with carbon composite materials. These are more lightweight and rigid, meaning a greater strength-to-weight ratio. Structural advances in this ratio have the potential to increase fuel efficiency 4-22%.[33] One of the biggest barriers to this transition is that new materials can be more costly and time-consuming to repair.

Redesigning the Conventional Jet

A redesign of the traditional airplane is one of the most impactful ways to reduce emissions, as aerospace companies will have the opportunity to evaluate the potential lifecycle of different types of jets. For example, simply optimizing jet engines could add a further 15-30% in fuel efficiency and refining aircraft aerodynamics could make planes 4-17% more fuel efficient.[34]

In terms of design, twin-engine jets have begun replacing four engine models, resulting in up to 20% fuel efficiency per passenger.[35] One of the newest potential solutions is the electric jet. It has been heavily researched by several companies such as Airbus and Boeing. Using either electric or hybrid airplanes is seen as a solution since access to SAFs appears to be a long way off. By 2035, UBS estimates that the aviation industry will be 25% hybrid or fully electric.[36]

Short-term Mitigation Strategies

There are other, short-term strategies that can be employed in the interim as the aviation industry migrates to lower emissions strategies. Two of the most feasible methods involve improving daily

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[31] Miguel A. Carriquiy et al., *Second generation biofuels: Economics and policies*, 39 Energy Policy 7, 4222-4234, https://www.sciencedirect.com/science/article/abs/pii/S0301421511003193?via%3Dihub (2011).
[32] IEA, *Direct Air Capture Tracking Report – June 2020*, https://www.iea.org/reports/direct-air-capture (Accessed June 17, 2021).
[33] Tecolote Research, *Final Report: Aviation Fuel Efficiency Technology Assessment*, 31, https://theicct.org/sites/default/files/publications/Aviation%20Fuel%20Efficiency%20Technology%20Assessment%20%28AFETA%29%202015%20Final%20Report%2018Jan2016.pdf (Dec. 26, 2015).
[34] *Id*.
[35] *Id*.
[36] Coren, Michael J. "Electric airplanes are getting tantalizingly close to a commercial breakthrough." *Quartz*, 13 December 2020, https://qz.com/1943592/electric-airplanes-are-getting-close-to-a-commercial-breakthrough/.

aerospace operations and increasing the number of carbon offsetting projects, both of which are outlined below.

Increasing efficiency of day-to-day aerospace operations
Commercial airlines and operations are large contributors to climate change and GHG emissions. Inefficiencies exist in how pilots fly and how airplanes consume fuel. Airport operations also impact fuel usage. Studies have shown that optimizing air traffic systems can decrease fuel consumption and require less extra fuel to be carried per trip.[37] Decreasing extra fuel carried per trip will lower the weight of the aircraft and result in less fuel consumption. These small optimizations have the potential to cut emissions by 20-30%.[38, 39]

Engaging in carbon offsetting projects
Carbon offsetting projects are pledges to counteract unavoidable emissions by implementing carbon reduction projects elsewhere (e.g. planting trees, funding solar fields). A McKinsey & Company poll deemed carbon offsetting projects as the least appropriate action.[40] Currently, this option is only offered by 50% of airlines, and less than 1% of fliers choose to utilize it. However, starting in 2027, airlines will be required to partake in these projects for all flights between countries that individually account for more than 0.5% of international aviation emissions. Increasing the number of carbon offsetting projects is expected to cover 78% of the growth in aviation emissions from 2021-2035, and 21.6% of total emissions in that period.[41]

Cement

The Cement industry represents 3% of global greenhouse emissions, with the most CO_2 emissions coming from the kiln, preheater, and precalcinator process.[42] Cement manufacturers will need to adopt several transition pathways to reduce emissions to meet the Paris Accord's goals. Slow implementation and economic unviability pose risks for the reduction of Zurich's portfolio's carbon intensity, while the technology transition and facility retrofitting may have implications for underwriting strategies. In addition, policy changes like a carbon tax could make several options economically viable, but the policy landscape remains unclear.[43] Unclear policy creates the largest amount of risk surrounding the cement industry and is a key point of contention. Ultimately, there

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[37] Hirada, Akinori, et. al. "Air Traffic Efficiency Analysis of Airliner Scheduled Flights Using Collaborative Actions for Renovation of Air Traffic Systems Open Date." *Journal of Advance Transportation*, vol. 2018, 2018. https://doi.org/10.1155/2018/2734763
[38] Alex Dichter et al., *How airlines can chart a path to zero-carbon flying*, McKinsey & Company, https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/how-airlines-can-chart-a-path-to-zero-carbon-flying (May 13, 2020)
[39] Singh, Vedant and Sharma, Somesh K. "Fuel consumption optimization in air transport: a review, Classification, critique, simple meta-analysis, and future research implications." *European Transport Research Review*, vol. 7, no. 12, pp. 1-24, 2015. https://doi.org/10.1007/s12544-015-0160-x
[40] Alex Dichter et al., *How airlines can chart a path to zero-carbon flying*, McKinsey & Company, https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/how-airlines-can-chart-a-path-to-zero-carbon-flying (May 13, 2020)
[41] *ICAO*, What is CORSIA and how does it work?, https://www.icao.int/environmental-protection/pages/a39_corsia_faq2.aspx
[42] Our World in Data. 2020. Sector by sector: where do global greenhouse gas emissions come from? Available at https://ourworldindata.org/ghg-emissions-by-sector
[43] Obrist, M.D. Kannan, R. Schmidt, T. and Tom Kober. 2021. Decarbonization pathways of the Swiss cement industry towards net zero emissions. Journal of Cleaner Production. 288.

are currently options available to reduce cement industry emissions (e.g. alternative inputs), but additional action (e.g. policy and R&D) needs to be taken to enable the cement industry to meet reduction goals. The most likely transition pathways for the cement industry included: Carbon Capture, Storage, and Utilization; Alternative Inputs and Reduced Clinker Content[*]; and Green Energy and Energy Efficiency.

Process Steps and CO_2 Kilograms/Ton of Cement[44]

Raw Mill	Kiln, Preheater, Precalcinator	Cooler	Cement Mill	Logistics
17 CO_2	798 CO_2	28 CO_2	49 CO_2	22 CO_2

Carbon Capture, Storage, and Utilization (CCSU)

CCSU describes a process to capture carbon emissions and subsequently store them in a location that prevents them entering the atmosphere. This technology allows emissions reductions in hard to decarbonize areas. 65% of all cement carbon emissions occur during the manufacturing process, meaning they can't be reduced without CCSU.[45] CCSU can reduce these emissions by capturing the carbon released during clinker production and storing it or reusing it in production. Calcium looping carbon capture is a particularly promising technology for use in the production process because it captures carbon during energy production and uses waste materials in cement production processes.[46] CO_2 can also be reused to grow algae for biomass that later is used for fuel.

Despite the advantages of CCSU, the implementation of technologies is costly and can have varying effects on overall energy consumption.[47] These factors need to be considered before implementation. CCSU is still in the R&D phase, and it will require time and money to bring the technology to the mainstream. CCSU and green energy use will require retrofitting or early retirement of existing facilities, which has a huge economic cost. This creates risk given the industry's low margins. The implementation of current CCSU technologies without policy incentives will double production costs.[48]

Alternative Inputs and Reduced Clinker Content

The use of limestone as a raw material is a large source of industry emissions. Alternative inputs like calcium carbide can reduce emissions intensity at relatively low costs.[49] These inputs can lower emissions while maintaining clinker ratios. Clinker is a product of the kiling process, and a main component of cement. It serves as the binding agent in cement. However, clinker content in the final cement product can also be changed to reduce emissions. The global average clinker ratio

[44] McKinsey. 2020. Laying the foundation for zero-carbon cement. Available at https://www.mckinsey.com/industries/chemicals/our-insights/laying-the-foundation-for-zero-carbon-cement
[45] International Energy Agency. 2019. World Energy Outlook 2019.
[46] Yang, F. Meerman, J.C., and A.P.C. Faaij. 2021. Carbon capture and biomass in industry: A techno-economic analysis and comparison of negative emission options. Renewable and Sustainable Energy Reviews. 144.
[47] Plaza, M.G. Martínez, S. and Fernando Rubiera. 2020. CO2 Capture, Use, and Storage in the Cement Industry: State of the Art and Expectations. Energies. 13.
[48] Leilac Project. 2021. Carbon Capture. Available at https://www.project-leilac.eu/carbon-capture-and-storage
[49] Zhang, C. Yu, B. Chen, J. and Y. Wei. 2021. Green transition pathways for cement industry in China. Resources, Conservation and Recycling. 166.

has dropped to .66 in 2018 from .83 in 1990.[50] A lower ratio means less emissions from chemical reactions, but it can also mean lower strength classes.[51] This pathway is currently the most economically viable, but it is not a standalone solution to reach emission targets.[52]

Green Energy and Energy Efficiency

Current heat generation techniques in production predominantly use coal-based fuel.[53] Alternative fuels (waste, hydrogen, biofuel from CCS, etc.) can replace coal-based fuel to reduce emissions intensity from heat generation.[54] Furthermore, dry kilning processing techniques can increase energy efficiency. Dry kilning is a cement production process that turns inputs (usually limestone) into clinker product. Dry kilning does this in the absence of water, which is more energy efficient and quicker than wet kilning. Although an older development, all facilities should be retrofitted to incorporate this method. Additional energy efficient technologies will be adopted due to cost effectiveness in the coming years like vertical milling, roll pressing, and clinker cooling technology.[55] The greatest risk of this transition pathway is simply that most of the emissions (65%) come from the actual manufacturing process.[56] Steps can be taken to reduce the other emissions, but they need to be accompanied by additional measures.

Construction

The global building sector, which includes the construction and operation of buildings, made up over a third of both total energy use, at 36%, and energy-related carbon dioxide emissions, at 37%, in 2021.[57] The significance of the construction industry is represented by a broad scientific literature which is focused on reducing emissions of two types of emissions, operational and embodied.

Operational emissions occur from the building's maintenance and use on the day-to-day level. These emissions come from activities like using electricity, heating and cooling, etc., and can be reduced after the building is built through activities like installing energy efficient appliances, using renewable energy, etc. However, constructing buildings with operational emissions in mind is a primary way of reducing these emissions in the long-term through energy efficient design that takes advantage of a myriad of efficient technologies and design. Operational emissions throughout the lifetime of the buildings account for 28% of all global energy-related carbon dioxide emissions.

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[50] Robbie M. Andrew. 2018. Global CO2 emissions from cement production. Earth System Science Data. 10, 195–217.
[51] Reis, D. Abrão, P.C.R. Sui, T. and Vanderley M John. 2020. Influence of cement strength class on environmental impact of concrete. Resources, Conservation and Recycling. 163
[52] Zhang, C. Yu, B. Chen, J. and Y. Wei. 2021. Green transition pathways for cement industry in China. Resources, Conservation and Recycling. 166.
[53] Plaza, M.G. Martínez, S. and Fernando Rubiera. 2020. CO2 Capture, Use, and Storage in the Cement Industry: State of the Art and Expectations. Energies. 13.
[54] International Energy Agency. 2018. Technology Roadmap Low-Carbon Transition in the Cement Industry.
[55] Zhang, C. Yu, B. Chen, J. and Y. Wei. 2021. Green transition pathways for cement industry in China. Resources, Conservation and Recycling. 166.
[56] Plaza, M.G. Martínez, S. and Fernando Rubiera. 2020. CO2 Capture, Use, and Storage in the Cement Industry: State of the Art and Expectations. Energies. 13.
[57] United Nations Environment Program. 2021. Global Status Report for Buildings and Construction.

The other 11% of emissions from the construction industry comes from embodied emissions.[58] Embodied emissions constitute the emissions from building material production, procurement, and transportation in the construction process. These emissions are associated with the materials needed to construct the building and end once the building is complete. This means that a building's emission profile starts with a large influx of embodied emissions during the construction process and increases steadily after construction in the form of use and maintenance. Embodied emissions can be reduced by improving the efficiency of construction machines and using low carbon building materials.

Effective strategies to reduce the emissions of the construction industry must work to reduce emissions in both categories to ensure that science-based targets come within reach. Fortunately, there are several strategies that exist currently to reduce the emissions of the construction industry.

Emissions Reduction Strategies

Constructing energy efficient (EE) buildings is a primary way to reduce operational emissions. It is important to consider energy efficient technologies in the design of buildings to maximize cost effectiveness. Building retrofits are generally more expensive, though solutions exist on a spectrum. These range from relatively lower costs like EE appliances and machines, to higher cost projects like renewable energy development and management. These retrofits are the best option once the building has been constructed, but investments go further when they are incorporated into the planning and design of the building. Formal guidelines have been created to encourage green development and design.

Currently, four building standards are becoming commonplace in the construction industry: LEED, WELL, Living Building Challenge, and Energy Star. LEED is the most widely used and most comprehensive standard and offers four levels: certified, silver, gold, and platinum. Each rating level has more stringent requirements than the last. All focus on the environmental impact of the building. The other three standards focus on a variety of concerns beyond environmental impact such as human health (WELL) and overall wellness (Living Building Challenge). The Energy Star standard narrows the focus specifically to energy, which can provide a more tailored, in-depth analysis on that topic.

As more construction companies move toward greener buildings, it is important to consider where the building materials are sourced. Demand for low carbon building materials is rising due to their ability to decrease embodied emissions. An increasing focus on low carbon buildings will further stress the importance of embodied emissions, with percentages of total construction emissions reaching up to 90% as operational emissions decrease. Over half of these embodied emissions are coming from hard to decarbonize industries like steel and cement, highlighting the need for low carbon building materials.

Climate Change Construction Risks

[58] Röck, M., Saade, M. R. M., Balouktsi, M., Rasmussend, F. N., Birgisdottir, H., Frischknecht, R., Habert, G., Lützkendorf, T., and Alexander Passer. 2020. Embodied GHG emissions of buildings – The hidden challenge for effective climate change mitigation. Applied Energy.

Climate change is creating significant risks for the construction industry which concern the insurance industry. These risks are a result of the increasing prevalence and severity of natural disasters like wildfires, floods, and hurricanes. It is important to understand the implications of these new risks and the effects they will have on the insurance business model.

Wildfires

Climate change results in higher temperatures, extended fire seasons, and increased droughts, which all contribute to increasing fire severity. This means that fires are causing more damage to structures and spread to more developed areas. This is compounded by the increasing prevalence of forest fires and creates a significant threat to construction in the Wildland-Urban Interface (WUI), which is defined as the area where manmade structures and other human development meet with undeveloped wildland. Increasing rate of development in the WUI accelerates wildfire risks and contributes to higher probability of structure loss to fire damage. This combination results in significant structural loss potential and high prevention costs. Adoption of international WUI building codes[59] and heightened site planning and construction standards[60] can help mitigate these risks and improve protection against new levels of wildfires. These measures create additional costs, but improved site planning and building codes significantly reduce wildfire risk in the WUI.

Floods

Widespread human development has significantly increased impervious surfaces, which decreases the ability for adequate drainage and raises the risks of flooding. The reduction of soil permeability's impact on flood risk is exacerbated by increased heavy rainfalls and rising sea levels caused by climate change. Flood insurance is already becoming hard to market in areas with high levels of flood risk, and the changing climate only stands to make the situation harder to address. These are some ways to mitigate some of these risks, but they depend on the scale of the construction and on the existing infrastructure. Green roofs, specifically roofs that utilize Crassulacean Acid Metabolism (CAM) plants, are used for water retention to reduce the amount of runoff and flooding.[61] Additionally, sustainable urban drainage systems can be constructed to help manage excess rainfall and reduce the stress on the drainage infrastructure. These actions will raise the cost of construction but reduce future costs of flooding risk.

Hurricanes

Climate change is increasing the prevalence and severity of hurricanes, with largest increases projected to occur in category 5 storms.[62] An increasing number of category 5 storms drastically raises construction risks in hurricane prone areas and requires significant mitigation techniques to reduce risk where possible. Currently, development continues to increase along high-risk coastlines and shows no sign of slowing. Increasing development exacerbates the problem and creates risk for construction companies and insurance agencies. Current models predict an increase

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[59] International Code Council. 2021. 2021 International Wildland-Urban Interface Code.

[60] Syphard, A. D., Brennan, T. J., and Jon E. Keeley. 2017. The importance of building construction materials relative to other factors affecting structure survival during wildfire. International Journal of Disaster Risk Reduction. 21: 140-147.

[61] Galdersisi, A., and Erica Treccozzi. 2017. Green strategies for flood resilient cities: The Benevento case study. Procedia Environmental Sciences. 37: 655-666.

[62] Grenier, R. R., Sousounis, P., Schneyer, J., and Dan Raizman. 2020. Quantifying the Impact from Climate Change on U.S. Hurricane Risk.

in hurricane related loss of 20% in the United States, which has a two-fold effect. First, more construction will need to occur to rebuild the lost structures. Second, new construction will have a higher probability of being damaged by hurricanes, raising insurance costs. There are several techniques to mitigate risk, but the cost effectiveness of adaption strategies for hurricane risk prevention is highly variable based on projected changes to hurricane intensity. Currently, the most cost-effective strategy is structurally strengthening "weak" construction in high-risk areas to prevent severe damage.

Fashion

The fashion industry accounts for 4% of global CO_2 emissions, and are growing at an annual rate of 2.7%. Emissions across the fashion value chain are broken down by Upstream Production (71%) which includes material production, yarn preparation, fabric preparation, wet processes, and cutting, making, and trimming; Usage & End-of-Use (23%) which includes production use and end of use; and Brand Operations (6%) which includes retail and transport.[63]

Transition Pathways

Upstream Production includes raw material production, material preparation and processing, and product manufacturing. There are several decarbonization strategies to consider for each of these steps which result in varying levels of CO_2 emission reduction.[64] For raw material production companies can consider decarbonizing material production including using new machinery technology to improve polyester production and reducing the use of fertilizer and pesticide in cotton production. Improving the material mix can also help reduce emissions through increasing the use of recycled polyester (rPET) and other recycled, biobased or organic textiles. Together this has the potential to reduce emissions by 14%. Material preparation and processing can be improved through increased efficiency through air pressure modifications to machinery, the use of dry (rather than wet) processing, less energy intense technologies, and the use of 100% renewable energy in production. Additionally, improved design and cutting techniques can minimize production waste. All together these improvements in material preparation and processing can reduce emissions by 43%. Finally, changes to product manufacturing can reduce emissions by 5% through energy efficient heating, ventilation, and air conditioning, upgraded sewing machines and other technologies, and use of 100% renewable energy in manufacturing, as well as by minimizing manufacturing wastage through better designs and cutting techniques.[65]

There is limited potential to decrease transportation & distribution, with the strategies identified only reducing emissions by 2%. This would be achieved by shifting from air to sea transport,

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[63] Berg, Achim, et al. *Fashion on Climate Full Report*. Mckinsey & Company and Global Fashion Agenda, 2020, https://www.mckinsey.com/~/media/mckinsey/industries/retail/our%20insights/fashion%20on%20climate/fashion-on-climate-full-report.pdf.

[64] All reduction potential percentages are based on 2,740 Million Tons of CO_2 emission in 2018 if no action is taken. Carbon reduction from minimizing production waste and manufacturing waste have been calculated together and included solely in the Materials Preparation and Processing reduction. Therefore, the Product Manufacturing only includes reduction potential from decarbonizing garment manufacturing

[65] Berg, Achim, et al. *Fashion on Climate Full Report*. Mckinsey & Company and Global Fashion Agenda, 2020, https://www.mckinsey.com/~/media/mckinsey/industries/retail/our%20insights/fashion%20on%20climate/fashion-on-climate-full-report.pdf.

taking advantage of digitization to improve demand focused supply chains, and electrifying fleets. Increased efficiency may also be pursued through improvements to packaging, for example by using a better material mix and reducing packaging weight.[66]

Within the retail stage of the value chain emissions can be reduced by adjusting operations and implementing new business models. Retail operations can be addressed by improving the energy mix across retail: reducing energy consumption across heating, ventilation and air conditioning equipment; switching to LED lighting; and transitioning to 100% renewables. Additionally, retail operations can reduce waste by using new advanced technology to minimize purchases with intent to return and reducing overproduction through better demand forecasting. For example, Foot Locker EU used Fit Finder to reduce their return rate by 14% in 6 months.[67] Together these actions have the potential to reduce emissions by 13%. New business models have the potential to reduce emissions by 9%, these new business model focus circular economy models such as rental, re-commerce, upcycling, and repair. A good case study would be H&M. It launched garment-to-garment system called Looop by which it creates new clothes with discarded clothes for customers.[68, 69]

Making changes to the "use" phase of life could reduce emissions by 11%. This is achieved through reducing washing and drying. It requires educating customers to skip unnecessary washes, minimize small loads, and air dry. Brands such as Levi's created campaigns to educate consumers against washing clothing too frequently. Finally, the end of use phase can be improved slightly, with a 1% potential reduction in emissions, through improved recycling and collection programs. By increasing recycling & collection the industry can minimize incineration without recovery and landfill. This includes using advancements in chemical textile-to-textile recycling and improved textile sorting and blending technology.[70]

Top Challenges for Transition Pathways

There are three key challenges to the transitions pathways outlines above. These include changing the energy mix, increasing the amount of sustainable material used, and implementing new business models.

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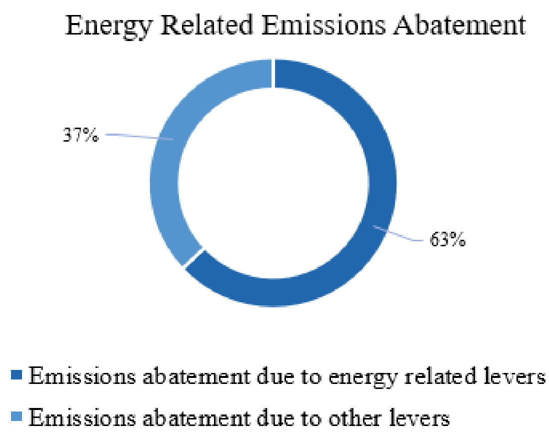
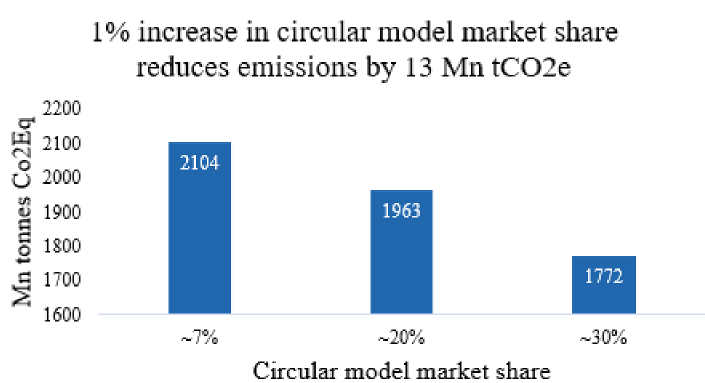
[66] *Id*.
[67] "Foot Locker EU Results Show Fit Finder as Best Online Shoe Size Advisor." *Foot Locker EU Results Show Fit Finder as Best Online Shoe Size Advisor*, https://www.fitanalytics.com/success-story-footlocker-eu.
[68] Kavilanz, Parija. "H&M Will Let People Convert Old Clothing Items into New Ones at Stockholm Store." *CNN*, Cable News Network, 8 Oct. 2020, https://www.cnn.com/2020/10/08/business/hm-clothing-recycling/index.html.
[69] Berg, Achim, et al. *Fashion on Climate Full Report*. Mckinsey & Company and Global Fashion Agenda, 2020, https://www.mckinsey.com/~/media/mckinsey/industries/retail/our%20insights/fashion%20on%20climate/fashion-on-climate-full-report.pdf.
[70] *Id.*

Nearly 55% of the energy abatement across the value chain in the apparel industry can be delivered by transitioning the electricity mix to renewable energy, while the rest can be achieved by improving energy efficiency in the production and manufacturing process. Two main ways to increase the portion of renewables in the mix are through power purchase agreements and energy attribute certificates.[71] Though power purchase agreements are gaining traction in major textile exporters such as China, India and Vietnam, this energy procuring model is currently not available in Bangladesh and Turkey, which are top 5 countries of upstream sources for both EU and the U.S.[72, 73, 74]



Organic cotton and manmade fibers each use 50% less emissions than conventional cotton and fibers, and rPET uses 40% less of the emissions as regular polyester. A transition to a low carbon fashion industry will necessitate a significant increase in the use of these materials. However, there are challenges to overcome. During the transition phase organic cotton can have lower yields than conventional, disincentivizing farmers from making the transition. Additionally, the demand for plastic bottles, the main source of rPET, is increasingly competitive, as the packaging industry also decarbonizes. Alternatives, such as bio-based polyester and closed-loop rPET, are needed to meet demand, but these solutions do not currently have commercial scale and are cost prohibitive. Finally, sustainable manmade cellulose fibers do not have commercial scale due to limited recycling technology.



Beyond 2030, businesses need circular economy models to help us achieve the 1.5º goal. Among circular models, re-commerce and rental models are the two primary avenues. To incorporate these types of business, retailers will need to expand their logistical capacities. Moreover, determining how these retailers move away from low-cost sourcing models that have created

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[71] *Textiles and Apparel*. United States International Trade Commission, https://www.usitc.gov/research_and_analysis/trade_shifts_2017/textiles.htm.
[72] "Foot Locker EU Results Show Fit Finder as Best Online Shoe Size Advisor." *Foot Locker EU Results Show Fit Finder as Best Online Shoe Size Advisor*, https://www.fitanalytics.com/success-story-footlocker-eu.
[73] *Decarbonising Fashion - Milestones Document* . UNFCCC, June 2021, https://unfccc.int/sites/default/files/resource/Milestones.pdf.
[74] Berg, Achim, et al. *Fashion on Climate Full Report*. Mckinsey & Company and Global Fashion Agenda, 2020, https://www.mckinsey.com/~/media/mckinsey/industries/retail/our%20insights/fashion%20on%20climate/fashion-on-climate-full-report.pdf.

overproduction issues and make a case for new business models is a challenge.

Food Manufacturing – Confectionary Products

The food system is responsible for as much as 40% of all global GHG emissions from human activity.[75] Looking at confectionary products specifically, the food manufacturing segment is the third most GHG intensive process within their life cycles. Within the manufacturing process, packing and shipping are the most energy-intensive stages. Currently, increasing energy efficiency is the main way of reducing GHG emissions. Packaging is the second most GHG intensive process. The polypropylene layer is the least environmentally impactful material among all common materials used in the industry. Two aluminum foil combination and fiber-based material combinations are more impacting than polypropylene, mainly because of the aluminum-based material production environmental impacts. The two confectionary products explored were refined sugar and chocolate/cocoa powder.

Refined Sugar

Raw material production is the major hotspot for this product - sugarcane residues comprise 11% of global agricultural residues.[76] Sugarcane burning is an especially harmful and unnecessary practice that releases N_2O and methane into the atmosphere.[77] Meanwhile, GHG emissions at a sugar refinery are largely due to the fuel energy necessary to melt the raw sugar. How much fuel is necessary depends on a particular refinery's steam/melt ratio. For example, a refinery with a steam/melt ratio of 1.0 requires about 0.125 tons of coal to produce the required energy.[78]

There are two key transition strategies that refined sugar manufacturers can take and they pertain to the procurement of the raw sugar and the energy used to refine it. Firstly, refiners should seek to source from raw sugar suppliers that engage in sustainable practices and which have low emissions. Specifically, refiners should seek to procure raw sugar from suppliers that do not engage in sugarcane burning practices. Secondly, use of clean, non-fossil fuel energy to melt the raw sugar, such as hydroelectric power or natural gas, has the potential to reduce GHG emissions by up to 40%.[79]

Chocolate and Cocoa Powder

Because in chocolate and cocoa powder production the raw material is the major hotspot, accounting for 67%–81% of the total impact[80], ingredients should be the priority in reducing

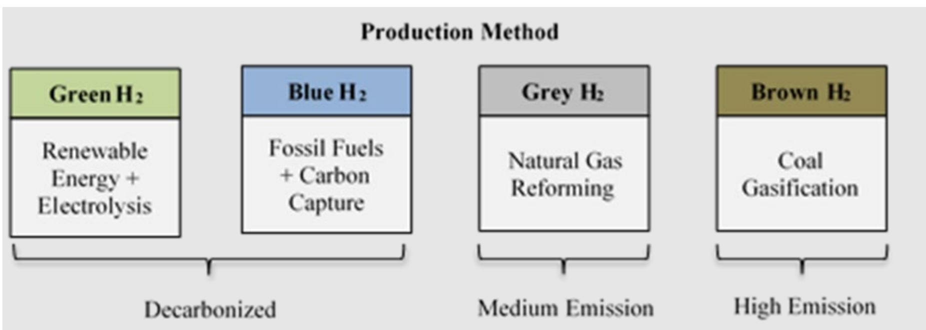
[75] Gustin, Georgina. "Greenhouse Gas Emissions From Food Production are Far Greater Than Previous Estimates Suggest". Inside Climate News, 10 June 2021, https://insideclimatenews.org/news/10062021/agriculture-greenhouse-gas-emissions-food-production-climate-change-paris-agreement/.
[76] de Figueiredo, E.B., Panosso, A.R., Romão, R. et al. "Greenhouse gas emission associated with sugar production in southern Brazil". *Carbon Balance and Management*, vol. 5, no. 3, 2010. https://doi.org/10.1186/1750-0680-5-3
[77] Rein, Peter W. "Sustainable Production of Raw and Refined Cane Sugar." Bonsucro, 2011, https://bonsucro.com/assets/rein_paper.pdf.
[78] *Id*.
[79] *Id.*
[80] Nieburg, Oliver. "What is chocolate's biggest environmental impact?" Confectionary News, 15 March 2018, https://www.confectionerynews.com/Article/2018/03/15/What-is-chocolate-s-biggest-environmental-impact#.

environmental impacts: milk powder (for milk chocolate), cocoa liquor, cocoa butter, and sugar. Product reformulation can be a powerful strategy to reduce the environmental impact generated by confectionery products. For example, the use of soy milk instead of cow milk could reduce the impacts by 70–99%[81]. This would, however, impact both flavor and markets. Producers will need to diligently investigate their options to make these sorts of shifts work.

Hydrogen

Types of Hydrogen

Hydrogen fuel (H2) is a burgeoning industry with significant implications for decarbonizing the transportation and industrial sectors, but not all hydrogen is alike. The carbon footprint of hydrogen power is determined by the method of production. Different colors are given to varying production methods that result in different carbon emission levels.



Regulation

Regulatory frameworks for hydrogen are still in their early stages and will continue to develop with the technology. For example, the United States does not currently have formal regulation, but the Department of Energy has released a Hydrogen Program Plan. Additional agencies like the Federal Energy Regulatory Committee, the Environmental Protection Agency, and the PHMSA will play roles in regulating transportation, standards, and storage.[82] In Europe, the frameworks are more complete, and goals have been set. The European Commission's goal for renewable hydrogen production (green) is one million tons by 2024 and ten million tons by 2030.[83,84] This amounts to nearly the amount of grey hydrogen currently being used as feedstock for industries (the main use of hydrogen today).

Future Needs and Prospects

The industrial application of decarbonized hydrogen (green + blue) has significant potential to reduce global emissions by replacing high emissions fuel and other inputs. However, current

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[81] Miah, J.H., et. al. "Environmental management of confectionery products: Life cycle impacts and improvement strategies. *Journal of Cleaner Production*, vol. 177, pp 732-751, 2018. https://doi.org/10.1016/j.jclepro.2017.12.073
[82] Vinson and Elkins. 2020. Federal Hydrogen Regulation In The United States: Where We Are And Where We Might Be Going.
[83] European Parliament. 2021. EU hydrogen policy: Hydrogen as an energy carrier for a climate-neutral economy.
[84] European Commission. 2020. A hydrogen strategy for a climate-neutral Europe.

technological limitations make green hydrogen hard to scale for industrial application. New technological developments, like lower cost renewable energy and cheaper electrolyzers, are necessary to bring green hydrogen to an economically competitive level. Fortunately, hydrogen is seeing unprecedented levels of investment with more than 200 projects in the works, 85% of this coming from Europe, Asia, and Australia.[85] The EU, Japan, and Australia have each released hydrogen strategy reports outlining roadmaps for hydrogen investment and integration.[86,87] The surge in projects and investments has several countries betting big on hydrogen as a low-carbon fuel source of the future, but there are some inherent risks.

Risk

Hydrogen, as a flammable gas, is a known fire and explosion hazard. Care should be taken to ensure the handling and distribution systems of hydrogen are constructed with safety in mind. Hydrogen is also known to weaken common metals, a process known as embrittlement. Additional investigation is required to determine the extent of risk posed by hydrogen embrittlement.[88] Despite the associated risks, hydrogen is poised to become a large industry that can assist the decarbonization of multiple industrial sectors.

Key Business Applications

Road Transportation:

Why is hydrogen still a hot topic for net zero emission when the electric vehicle sector is burgeoning? It is because hydrogen can reduce recharging time by 50% and can be stored in higher densities and lighter weights than batteries to meet long duration storage needs. Therefore, hydrogen could find application in tackling specific needs for certain situations. For example, Fuel Cell Electric Vehicle (FCEVs) are best positioned for long-haul use because batteries would be bulkier than fuel cells to meet the energy requirements. In May 2021, Daimler, the world's biggest long-haul truck maker, announced its goal of selling hydrogen-fueled long-haul trucks by 2027 that will be cheaper to buy and operate than diesel models.[89] GM and Navistar are also entering the market.[90] McKinsey & Company expects FCEV to become the cheapest option in terms of Total Costs of Ownership (i.e. upfront price of asset purchased plus costs of operation) by 2030. The key challenges in the development of the fuel cell in the industry are cost, performance, and durability.[91]

<u>Ammonia Production</u>

Ammonia represents about 45% of global hydrogen offtake, making it the largest consumer of hydrogen today. 98% of ammonia is made from natural gas, resulting in the high carbon intensity of the ammonia production process (30-40% of cradle-to-gate greenhouse gas emissions per ton

[85] McKinsey and Company. 2021. Hydrogen Insights: A perspective on hydrogen investment, market development and cost competitiveness.
[86] Japanese Government: Ministry of Economy, Trade, and Industry - Hydrogen and Fuel Cell Strategy Council. 2019. The Strategic Road Map for Hydrogen and Fuel Cells.
[87] Australian Government: Department of Industry, Science, Energy, and Resources. 2019. Australia's National Hydrogen Strategy.
[88] Allianz Risk Consulting. 2021. The Hydrogen Economy: Opportunities and Risks in the Energy Transition.
[89] New York Times. 2021. World's Largest Long-Haul Truckmaker Sees Hydrogen-Fueled Future.
[90] Green Car Reports. GM and Navistar will create and support 2,000 long-haul hydrogen fuel-cell semis. 2021.
[91] Office of Energy Efficiency and Renewable Energy. Fuel Cells.

of ammonia).[92] Hence, besides using green electricity to power the manufacturing process, replacing gray hydrogen with green hydrogen as ammonia's feedstock is the most effective way to reduce emissions. Incumbents have been taking action. In October 2020, Yara, the world largest fertilizer producer, announced it would replace some gray hydrogen with green hydrogen, abating 100,000 tonnes of CO_2 per year.[93] Ammonia production is highly sensitive to the production costs of clean hydrogen. As the cost of hydrogen production is driven by renewable energy sources, the competitiveness of clean ammonia varies by location. It is estimated that a drastic drop for the production cost for clean ammonia will happen by 2030.

Steel Production

Steel production is an emissions intensive industry accounting for 8% of global emissions and is notoriously hard to decarbonize[94]. Hydrogen offers an opportunity to transition to clean energy and low carbon inputs. Industry trends are pointing toward the use of carbon-free hydrogen as a power source and reduction agent that would replace coke (high emissions) in the production process, with a potential reduction of 35% for the EU steel industry.[95] The largest obstacle to hydrogen use is cost-competitiveness, due to the costly nature of producing green or blue hydrogen. However, a recent McKinsey report found that a carbon tax of $45/ton of CO_2 would make hydrogen competitive. In lieu of policy changes, companies like HYBRIT are currently working on developing a low-cost solution to increase the use of H2 in the steel industry, but progress still needs to be made before it is economically viable.[96]

Shipping

Shipping accounts for 2.9% of global CO_2 emission with 90% of world trade transported by sea.[97] This sector features strong industry governance led by the International Maritime Organization (IMO). Currently, 174 countries are governed by the IMO which is leading the industry towards complete decarbonization.[98] The IMOs International Convention for the Prevention of Pollution from Ships (MARPOL) is intended to reduce carbon intensity of the global shipping industry by 40% by 2030, and spur full decarbonization by 2050 through ship design, operations, and fuel alternatives.

Design and Operations

There are four key requirements regarding ship design and operations that will dramatically change the shipping industry in the coming decades. Across these areas a vessel's performance will be rated on an A to E letter grade scale. A vessel receiving a D (minor inferior) rating three years

[92] Environmental Protection Agency. Synthetic Ammonia.
[93] Ørsted. Ørsted and Yara seek to develop groundbreaking green ammonia project in the Netherlands.
[94] McKinsey and Company. 2021. Hydrogen Insights: A perspective on hydrogen investment, market development and cost competitiveness.
[95] Abhinav Bhaskar, Mohsen Assad, and Homam Nikpey Somehsaraei. 2020. Decarbonization of the Iron and Steel Industry with Direct Reduction of Iron Ore with Green Hydrogen. Energies. 13
[96] Rocky Mountain Institute. 2021. Hydrogen's Decarbonization Impact for Industry
[97] Saul, Jonathan. "Time to Launch Carbon Plan for Shipping Is Now, Industry Says." *Reuters*, Thomson Reuters, 11 Nov. 2020, https://www.reuters.com/article/shipping-environment-imo/time-to-launch-carbon-plan-for-shipping-is-now-industry-says-idUSKBN27R1IM.
[98] "Member States, Igos and Ngos." *International Maritime Organization*, https://www.imo.org/en/About/Membership/Pages/Default.aspx.

running, or an E (inferior) performance level in any year will need to develop a corrective plan explaining how it will come into compliance.

First, the Energy Efficiency Design Index (EEDI) is a set of requirements enforced at the design stage on most merchant ships. It requires a minimum energy efficiency level for new ships, measured in grams of carbon dioxide emissions per ton mile (a measure of workload). The efficiency requirement for new ships is tightened every five years, therefore as old ships retire, they are replaced will significantly more efficient ones.[99]

Second, the Energy Efficiency Existing Ship Index (EEXI) will apply, on a one-time basis, to individual vessels. Compliance will be a prerequisite for a ship to obtain its International Energy Efficiency Certificate, a MARPOL requirement. Each ship will be categorized by size and type and then assigned a reduction factor by which it must reduce its carbon intensity.[100] Methods for achieving this reduction include retrofitting more energy efficient technologies, switching to lower carbon fuels, or implementing limitations on engine power.[101] A review will be conducted in 2026 to determine whether the EEXI should be further tightened.[102]

Third, the Ship Energy Efficiency Management Plan (SEEMP), a requirement for all ships for a ship to obtain its International Energy Efficiency Certificate, includes a list of best practices for each vessel and a list of personnel responsible for ensuring each measure is carried out. Practices can include management of electric power or the use of weather routing systems, which avoid choppy weather that reduce energy efficiency.[103]

Finally, new amendments require ships of 5000 gross tonnage or more to add a Carbon Intensity Indicator (CII) to the SEEMP. The CII is a measure of vessel efficiency, expressed in grams of carbon dioxide emissions per deadweight mile (another measure of workload). Each ship will be subject to a "required annual operational CII." SEEMPs will need to follow the CII calculation methodology to report their CII to their flag state. They will also need to report the required annual operational CII for the next three years and their plan for meeting these levels.[104]

Alternative Fuels

Beyond ship design and operations, finding alternative fuel options is essential to meet decarbonization goals. Currently, no truly green option exists for ship fuel. Therefore, there is a need to use bridge fuels in the medium term that will reduce emission while further research and development is done on promising new fuel sources. These bridge fuels include liquified natural gas, methanol, and advanced biofuel, while long term fuel options include hydrogen and ammonia.

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[99] "Technical-and-Operational-Measures." *International Maritime Organization*, https://www.imo.org/en/OurWork/Environment/Pages/Technical-and-Operational-Measures.aspx.
[100] *Amendments to MARPOL Annexes I, IV and VI*. International Maritime Organization, 2 Dec. 202AD, https://ww2.eagle.org/content/dam/eagle/regulatory-news/2021/MEPC75/Circ-letter-4350.pdf.
[101] "Don't Wait. Act Now. Manage Your EEXI Complexity and Risk." *Lloyd's Register*, https://www.lr.org/en-us/eexi-energy-efficiency-existing-ship-index/.
[102] IMO, Circular Letter No. 4350, supra, at Annex 3, p. 8.
[103] IMO, Energy Efficiency Measures, supra.
[104] IMO, Circular Letter No. 4350, supra, at Annex 3, p. 9.

Liquefied natural gas (LNG) is cost-effective and readily available in meaningful quantities. Although engines built for heavy fuel oil (HFOs) cannot run on LNG, orders for LNG-capable ships are rising.[105] However, since ships have lifespans of about 30 years, ships built now must be capable of switching fuel sources if decarbonization is to be achieved by 2050.[106]

Methanol could reduce CO2 emissions by 25% compared to HFOs. It is plentiful and can be produced from renewable sources. While not as significant as LNGs, the market for methanol is quickly expanding.[107]

Finally, advanced biofuels made from agriculture or forestry wastes, non-food feedstocks, or algae can be blended with gasoline or diesel and have low CO2 emissions. While unlikely due to questions on supply, storage, and expense, this is another possible bridge fuel, though there has been little experience with them in the shipping industry to date.[108]

In the long term, hydrogen may replace HFOs to serve as a zero-GHG energy source. But hydrogen still requires further development to be a cost-effective, safe, zero-carbon fuel source. Additional infrastructure and system design is also needed, because for hydrogen to be stored efficiently, it must be kept at high pressure and/or very low temperatures. If this can be achieved, hydrogen is attractive because it can be used as a "drop-in" fuel, which can be blended with traditional fuels in diesel engines.[109] Ammonia is also a potential zero-carbon replacement of HFOs. This would require ammonia production to be carbonless. This process is not yet cost-competitive with traditional ammonia production. Compared to hydrogen, however, ammonia has similar energy density but is much more cheaply stored. It can also be used as a drop-in fuel.[110]

Risks

During and beyond the transition there may be increased or changing risks associated with new practices. These may include: risk of inadvertently violating new IMO rules; risk of fire if fuel is not stored and deployed properly; risk of engine failure, stranded goods, or collision from improper mixing of fuels, perhaps due to lack of availability or lack of understanding; and risk of employee injury from changing fuels, filtration problems, or leaks.[111] There is an opportunity for educational business initiatives, for example in ensuring that ship owners and operators are aware of the new rules and their responsibilities under them. Likewise, there are possible programs that could inform operators about fuel mixing, or which encourage them to install devices or compartments that ensure fuels remain separate. Training and protection programs could be used for workers at risk.

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[105] https://www.wsj.com/articles/ship-operators-move-toward-lng-to-pare-emissions-11619117449.
[106] https://ocean.economist.com/innovation/articles/how-the-shipping-sector-is-decarbonising.
[107] Mallouppas & Yfantis, supra, at 10-11.
[108] Mallouppas & Yfantis, supra, at 14-15.
[109] George Mallouppas & Elias Ar. Yfantis, Decarbonization in Shipping Industry: A Review of Research, Technology Development, and Innovation Proposals, Journal of Marine Science & Engineering 9, 415 at 8 (2021).
[110] George Mallouppas & Elias Ar. Yfantis, Decarbonization in Shipping Industry: A Review of Research, Technology Development, and Innovation Proposals, Journal of Marine Science & Engineering 9, 415 at 10 (2021).
[111] https://www.insurancejournal.com/news/international/2019/12/12/551099.htm

Steel

The steel industry accounts for 7% of global emissions.[112] These emissions are highly dependent upon the method of steel production. The top three types of steel technology used in global production are Blast Furnace / Basic Oxygen Furnace (BF-BOF) (71%), Electric Arc Furnace (EAF) Scrap (24%), and EAF Direct Reduced Iron (DRI) (5%).[113]

Blast Furnaces (BF) are used to produce pig iron from iron ore, which is later used in the Basic Oxygen Furnace to produce steel. Basic Oxygen Furnaces (BOF) are furnaces in which oxygen is injected alongside pig iron from the Blast Furnace and steel scrap to produce steel. There are three main options for improving emissions for this technology: optimizing BF burden mix by increasing iron content and decreasing coal; increasing fuel injection through pulverized coal injection, natural gas, plastics, biomass, or hydrogen reagent; and/or using coke oven gas, a byproduct of the coke oven, as an energy source for the BF. All of these strategies are technologically viable. However, though they will reduce emissions, these methods will not eliminate them completely. Technology and inputs are available at a competitive cost.[114,115]

The EAF is a furnace used to convert steel scrap or DRI into liquid steel through high-current electric arcs. Direct Reduced Iron (DRI) is iron ore that has had the oxygen removed and therefore been reduced into a pellet or lump. To decrease the emissions from these methods, producers can increase use of scrap-based production through high quality scrap or low-quality scrap with DRI (if high-quality is unavailable), shift to renewable electricity, use natural gas to produce DRI and use DRI to produce steel that uses less carbon emissions than integrated methods, and/or use green hydrogen to produce DRI and scraps to produce emissions free steel. During the transition hydrogen does not need to be completely green to meet carbon goals. Due to regional availability of different inputs and competition for scraps, the cost of each option may be prohibitive in certain regions. However, the technology is proven and readily available except for a nascent green hydrogen industry. [116,117]

Another method for reducing emissions is to use biomass reductants by replacing reductant and/or fuel with alternatives such as sugar, energy cane, or pyrolyzed eucalyptus. This strategy is technologically viable; however, it is only feasible in geographies with access to significant

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[112] International Energy Agency. 2020. Iron and Steel Technology Roadmap. Available at https://www.iea.org/reports/iron-and-steel-technology-roadmap

[113] Zhiyuan Fan and Julio Friedmann. 2021. Low-Carbon Production of Iron & Steel: Technology Options, Economic Assessment, and Policy. Columbia Center on Global Energy Policy. Available at https://www.energypolicy.columbia.edu/research/article/low-carbon-production-iron-steel-technology-options-economic-assessment-and-policy

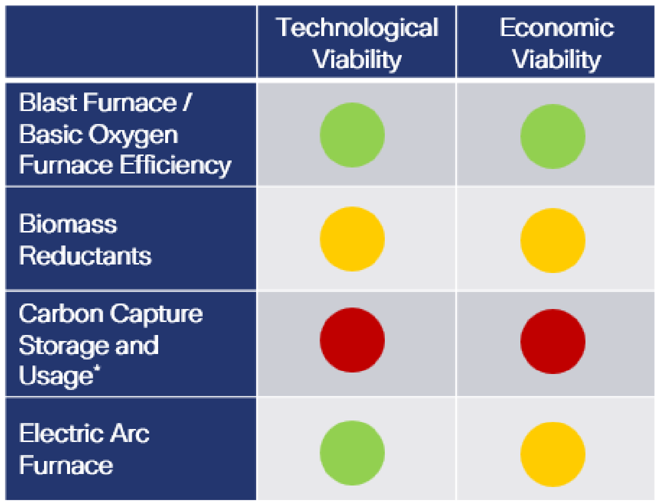
[114] McKinsey. 2020. Decarbonization challenge for steel. https://www.mckinsey.com/industries/metals-and-mining/our-insights/decarbonization-challenge-for-steel

[115] McKinsey. 2021. Tackling the challenge of decarbonizing steelmaking. https://www.mckinsey.com/industries/metals-and-mining/our-insights/tackling-the-challenge-of-decarbonizing-steelmaking

[116] McKinsey. 2020. Decarbonization challenge for steel. https://www.mckinsey.com/industries/metals-and-mining/our-insights/decarbonization-challenge-for-steel

[117] McKinsey. 2021. Tackling the challenge of decarbonizing steelmaking. https://www.mckinsey.com/industries/metals-and-mining/our-insights/tackling-the-challenge-of-decarbonizing-steelmaking

biomass. Due to regional availability, cost may be prohibitive in certain regions. Carbon Capture Storage and Usage (CCSU) is another option to reduce emissions. Captured CO_2 released throughout the production process can be reused to create chemical products such as ammonia or bioethanol, or to grow algae and other bacteria for biomass and fuel. The CO_2 can also be stored underground. The technology to support these strategies is still in the early stages of development and therefore is not yet commercially priced.



Top Transition Strategies

Of these options the three most promising strategies are: BF-BOF Efficiency, using Green Hydrogen as a reduction agent for DRI steel, and CCSU.

BF-BOF is known as the primary production route for steel. Several cost-competitive strategies for emissions reduction for BF-BOF exist, but the emissions reduction potential is low. Two of these strategies reduce emissions by replacing coal as a reduction agent by maximizing iron content in the blast furnace,[118] or by using hydrogen as an alternative reduction agent or fuel source.[119] However, the emissions reduction potential of green hydrogen in the BF-BOF production route is 21%, meaning the potential emissions reductions for hydrogen is much less for BF-BOF than EAF.[120] Although this strategy is economically viable and will reduce emissions, it is not sufficient to meet industry reduction targets. This strategy should be adopted right now, but additional actions (e.g., CCSU) need to be taken to ensure climate goals are met.

Green hydrogen can be used to replace fossil fuels in the electric arc furnace manufacturing process and completely remove the emissions of steel production. This strategy will become a large part of the transition of the steel industry, but it is not a silver bullet. Current scenarios project this type of steel will become 15% of total output by 2050,[121] but this depends heavily on several factors

[118] McKinsey. 2020. Decarbonization challenge for steel. Available at https://www.mckinsey.com/industries/metals-and-mining/our-insights/decarbonization-challenge-for-steel
[119] Bellona Foundation. 2021. Hydrogen in steel production: what is happening in Europe – part one. Available at https://bellona.org/news/climate-change/2021-03-hydrogen-in-steel-production-what-is-happening-in-europe-part-one
[120] *Id.*
[121] International Energy Agency. 2020. Iron and Steel Technology Roadmap. Available at https://www.iea.org/reports/iron-and-steel-technology-roadmap

including the availability of renewable energy, hydrogen production capacity, storage, and transportation infrastructure, and the scalability of existing prototype technology. The largest obstacle to hydrogen use is cost-competitiveness, due to the costly nature of producing green hydrogen. The use of hydrogen in its current state is not cost-competitive, but that can change with technological or policy developments. A recent McKinsey report found that a carbon tax of $45/ton of CO_2 would make competitive in the EU.[122] This strategy is not meant to be a standalone solution but is a large part of the strategy to decarbonize the steel industry.

The steel sector is hard to decarbonize due to manufacturing inputs and the heat required for production. Coal is commonly used for heat generation and provides 75% of total energy used in production.[123] Due to the BF method's relative cost, it will continue to be a large production method for steel, making CSSU necessary to completely reduce emissions during production.[124] With technical developments CCSU can be used to abate some of the emissions released during the production process, but it is not a stand-alone solution. CCSU technology is still in the developing stages and not currently cost effective. Policy and technological changes are required to make CCSU a reliable strategy to meet reduction goals. However, policies like a global carbon tax are being advocated by the International Monetary Fund.[125] Such a tax can drastically change economic incentives and would make CCSU viable in its current state.[126]

Current State Analysis

Zurich's Existing Sustainability Education Campaigns and Morale

To answer the first two research questions (1) *What is the current state of employee understanding of climate change/sustainability, and its relevance to employee day-to-day work?* and (2) *What is preventing employees from incorporating sustainability into their day-to-day job?),* interviews were conducted with subject matter experts throughout the organization and a survey was sent to the entire Commercial Insurance division. The goal was to collect both qualitative and quantitative data that would create a complete picture of the strengths and opportunities.

[redacted]

[122] McKinsey. 2020. Decarbonization challenge for steel. https://www.mckinsey.com/industries/metals-and-mining/our-insights/decarbonization-challenge-for-steel
[123] `International Energy Agency. 2020. Iron and Steel Technology Roadmap. Available at https://www.iea.org/reports/iron-and-steel-technology-roadmap
[124] De Ras, K. Van de Vijver, R. Galvita, V. Marin, G. and Kevin Van Geem. 2019. Carbon capture and utilization in the steel industry: challenges and opportunities for chemical engineering. Current Opinion in Chemical Engineering. 26
[125] International Monetary Fund. 2021. Proposal for an International Carbon Price Floor Among Large Emitters. Available at https://www.imf.org/en/Publications/staff-climate-notes/Issues/2021/06/15/Proposal-for-an-International-Carbon-Price-Floor-Among-Large-Emitters-460468

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Zurich Insurance Internal Microsoft Team Survey

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Having answered the first two research questions through this survey and the internal interviews the UM SEAS team, then conducted interviews with experts in academia and the business work to answer the third research question *How have other companies successfully educated employees and integrated sustainability across all business units?*

Academia's Take on Sustainability Education Best Practices

Academia is the ideal starting point for understanding best practices for educational initiatives. This is particularly true regarding climate change education due to the high level of current academic interest. Our team interviewed six academic professionals focusing on research related to climate change education, best practices, and implementation techniques. These individuals were chosen by their research interests and educational platforms, which were broken down into three categories: climate change education, corporate social responsibility, and human behavior. These categories answer three questions: what companies should address, why it is important, and how to achieve company-wide climate change understanding. The answers to these questions will help with creating educational initiatives within Zurich. Our interviews provided us with a well-rounded approach to climate change adoption within Zurich insurance. We have elected to exclude the names and institutions of our interviewees, but key takeaways and implications of the conversations are outlined below.

Climate Change Education

Using Active Engagement and Action-based Learning to Speak to Diverse Audiences

Experts agreed that the biggest obstacle of climate change education is appealing to diverse audiences and perspectives. Diverse audiences, like those found within large companies, will often include a sizeable percentage of individuals who are not motivated by calls to combat "climate change". This is due to a variety of reasons, but the underlying implication is that effective education efforts need to find ways to address a breadth of perspectives. The first step to this process is meeting individuals where they are and working to understand their perspective. This is pivotal to the process because it uncovers what people care about, how they see the world, and what motivates them. A key part of this process is to engage in authentic conversation, with a particular focus on leveling the playing field. This means approaching the conversation with the understanding that you are there not only to educate but to learn as well. This provides space for perspective-sharing and gives the knowledge needed to craft an educational platform that really speaks to its targets. The next step is understanding how to speak to a variety of perspectives.

We learned that the best way to convey a strong message to a wide variety of perspectives is to help people learn for themselves. Action-based learning was a common theme across our conversations and was revered as the best way to increase engagement from a variety of stakeholders. The key benefit of this approach is deeper engagement with the material and an enhanced understanding of the issue at hand. Simulations can play a vital role in this process because they offer people the ability to make their own decisions when faced with large issues like climate change. The benefit is twofold. First, the simulation can lay out what factors need to be considered and why, which offers an opportunity to speak to impacts. Second, people can learn from their decisions in real time. There is a direct cause and effect of their choices, and it affects the overall landscape of the issue. These benefits can be compound when placed in a role-playing setting, where those with differing perspectives can learn from and grow with one another. These techniques have proven track records of creating lasting momentum within organizations. [redacted] The program offers simulations designed to increase engagement, facilitate learning, and enhance understanding.

<u>Corporate Social Responsibility</u>

Using Positive Psychology to Boost CSR Efforts

Corporate social responsibility (CSR) is becoming increasingly important as companies begin to grapple with the climate implications of their business. The landscape surrounding CSR is shifting from a paradigm of predominately internal climate change issues to one concerning external influence and responsibility. Ultimately, this means that companies currently on the forefront of climate change initiatives need to redefine what CSR means to them and their stakeholders. Current CSR trends are moving to a policy-based focus, in which companies advocate for policies that will enable successful transitions for society at large, beyond the goals of the company itself. Importantly, companies are not expected to go against their own interest, but there is a need for corporate advocacy for policy solutions that are informed by business practices; essentially, helping policy makers understand the key levers and implications of the private sector and how policy and business can work together. This shift will require significant internal buy-in across the company hierarchy, which is non-trivial. Fortunately, there are techniques that will help facilitate this process.

Experts stated that positive psychology is the biggest tool to building momentum with climate change education and buy in. Positive psychology can play a key role in effective management education and help combat “apocalypse fatigue”, where people believe their situation is hopeless and nothing can be done to improve it (Levine et al. 2022). This is such a common occurrence that it was addressed by nearly all the academics we spoke to. They went on further to say that passion is no substitute for budget. This means that once companies foster passion for combating climate change, they need to allocate resources to ensure this passion is sustained. Burnout is exceptionally common in large organizations without proper resource allocation. The combination of positive psychology and a shift in CSR efforts can enable Zurich to properly engage their employees and continue pushing the boundaries of corporate engagement with climate change.

<u>Human Behavior</u>

Framing Information to Encourage Engagement

An expert familiar with the common factors that influence environmental decision making stated that the terminology surrounding climate change is the key component that inhibits concern about solutions. People associate climate change with social and political beliefs, affecting their ability to engage with climate change terminology. Further, even if they are concerned about climate change, they often believe that solutions require fundamental changes that are beyond the individual, rendering them hopeless and without recourse. Effective communication uses language that ties larger issues of climate change, like increase in storm frequency, to specific impacts, like flooding risks and traffic delays. The key is to make the language specific to the impacts and explain how the impacts are getting worse. This process decouples the term climate change from the impacts and risks associated with it, and instead focuses on those specifics. If this is done successfully, people will better understand that climate change has impacts that affect their everyday lives and that their actions can contribute to the solution.

A second expert in the psychology of decision making highlighted for us how difficult it is, not only for people to envision the dangers of climate change, but also to imagine a truly green future. It is difficult for most of us to conceive of a world in which all of the current causes of environmental damage have been replaced by more beneficent substitutes, and in which we are able to maintain the level of comfort that we currently enjoy. He believes that the invariable association of climate change mitigation with significant personal sacrifice has been detrimental to the problem-solving effort. He agrees with the idea that it is important to frame the issue in terms that are relevant to the individual, and again emphasizes how important it is that educational programs do not aim to pour knowledge into target individuals, but rather that they foster engagement. To this end, he suggests that instead of pursuing a single initiative with a mass audience, it may be more effective to put people into smaller groups and then to deliver more targeted communications.

Our attention was drawn to two barriers to effective climate change education. The first is the tendency to judgment among those who are very preoccupied with climate issues in their conception of those who care less about them. It is important to recognize that we all have a certain amount of mental bandwidth, and that the way in which people allocate this bandwidth is very personal. We may try to encourage an increase in focus on these issues without treating the target individual as a malefactor. The second barrier is inertia. Our expert visualized this problem in terms of train tracks. Presently we are on a set of tracks going in a direction with which we are familiar. Things are not perfect, but they are pretty well understood. Our challenge is to inspire people to choose to move to a second train about which we know much less, and for which the destination is not entirely clear. In this effort, it is important to illuminate the fact that the risk from remaining on the first train is much higher than was previously recognized.

Sustainability Engagement and Education Best Practices in Industry

As briefly mentioned in the methodology section of the paper, the UM SEAS team reached out to numerous sustainability professionals from the team members' networks across a variety of industries. Due to the proprietary nature of the information provided from the interviewees, interviewees' names have been changed and company names have been removed. Key takeaways from these interviews and their implications are outlined below.

Company and Employee Values Alignment

There should be a top-down push alongside a bottom-up commitment within the company. Employees' values need to be aligned with the company's values so that employees feel like they are a part of something greater than themselves. This is different from company loyalty, because someone can be loyal to a company but not work toward improving it.

The UM SEAS team interviewed Sarah[127], who currently works at a major player in the food industry, which shall be referred to as Company C. She revealed that she saw sustainability had become a very big part of how the company was making decisions and that there was a big push from executives to bring sustainability to each team. This is what attracted her to Company C as opposed to her previous employer, Company S, which is also a major player in the food industry. Prior to Sarah's departure, Company S had seen a change in leadership, one that downgraded the importance of sustainability, moving the department from directly reporting to the CEO to instead "be under legal – a check the box performance item". This new CEO's priority shift, Sarah reflected, was one of the biggest factors that drove her and other likeminded individuals to leave Company S.

Contrary to Company S, Company C advocating for sustainability as part of its core mission demonstrates that the firm is working to attract like-minded individuals, such as Sarah, to its ranks. Employees want to feel like they are a part of something bigger than themselves, and Company C is creating a positive feedback loop through its emphasis on sustainability.

In an interview with Emily[128], an Associate Vice President in Sustainability at a major player in the construction industry, Company D, it was highlighted that there has been a shift in the company's values over the last decade where sustainability is more top of mind. Among the employees, there had always been "little pockets of employee-led groups" that would meet at lunch and discuss how to make their offices more sustainable. Having this initial bottom-up approach already in place made it all the easier for the company to fully incorporate sustainability when the top-down initiatives began around 2020. Company D taking a stance has been useful in setting company-wide standards as to what sort of client work the firm will take on. Emily mentioned that there is now even a checklist that employees will go through when going after projects to determine what the environmental impacts of a given project will be.

Similar to Company C, Company D is focused on bringing in talent that really aligns with its sustainability values and is ultimately fostering a community that thinks about sustainability

Demonstrating Role of Company and Employee in Value Chain

Showing the employees how they or the company fit into the whole value chain and the impact on the environment they could bring to the system could create a stronger sense of accountability and interest in sustainability.

There is a clear pattern in different companies that the nature of a company, in terms of how strongly sustainability issues could impact their business, would determine the engagement of employees with sustainability. Creating linkages between employees' work and where exactly the impact would flow through different parts of industries amplifies the relevancy of sustainability in employees' work contexts.

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[127] Name changed for confidentiality

[128] Name changed for confidentiality

At Company D, the employees are largely driven by how they can be better for their clients and give them better services. “Clients are asking for sustainability and stakeholders are driving it” Emily said. Because of Company D’s large size, the adoption of sustainability is fueled by client demands and the ability to make money instead of the concept itself. That said, when the firm rolled out its ESG commitments, individual teams began hosting webinars related to how people do work. Emily herself has demonstrated to different teams how sustainability relates to Company D, its goals, and what the company does.

Similarly, Sarah shared that during the employee workshop she runs at Company C, she often shows where people fit into the food system and where they can contribute. With that lens, showing what other companies are doing has also encouraged her colleagues to put effort into incorporating sustainability into their daily jobs.

While this finding is motivating, not all companies are at the same starting line. During her time at Company S, Sarah shared that communication was at first a challenge, especially given where the company sat in the food value chain. It wasn’t until she started to “meet people where they are” that she saw a change. Part of this new communication strategy involved her laying out the food supply chain and explaining basic sustainability knowledge to build up employees’ foundational understanding. Company S shows that due to the nature of their businesses, some companies sit in places where they are less impactful on the overall emission of the whole value chain. Creating connections and strong relations between a company’s core business and its counterparts seems to be critical.

Incentivizing Sustainability Action Through Performance Reviews and Projects

Incorporating sustainability involvement into performance reviews to incentivize employees is likely to be one of the most effective ways to promote sustainability initiatives within an organization. It is especially true when the performance of leadership in a company is also evaluated with sustainability metrics.

For instance, during the interview with Sarah, she revealed that Company C set up a corporate sustainability target, from which the firm’s enterprise performance scorecard was developed. This scorecard not only ties to employee performance incentive programs, but also makes up part of executive compensation plans. This has ensured reinforcement from the leadership.

Aside from the existence of key performance indicators (KPIs), the communication of those KPIs is crucial to embed the motivation behind them into a company’s culture. One way of doing so is to visualize sustainability goals and how the company has performed. In an interview with Jane[129], the Supply Chain Sustainability Director at an American multinational apparel corporation, Company A, she pointed out that Company A’s facilities have rooms where all metrics and projects are tracked. This serves as a constant reminder for employees to think about their work through a sustainability lens. Jane also suggested that the company emphasizes defining KPIs clearly and ensuring employees have a full understanding of why leadership set up these KPIs and the expectation for them.

[129] Name changed for confidentiality

Companies that would like to design KPIs should keep in mind that metrics should be relevant, and actually determine the sustainability performance of a company.

Similar scenarios are occurring at other companies the team had the opportunity to speak with. For example, an interview with Kate[130], a Senior Leader in Sustainability at an American aerospace company, Company B, revealed that creating sustainability-related projects or competitions for employees has significantly increased employee engagement in company-wide sustainability initiatives.

Recommendations

The answer to the final research question *How can a successful education campaign be implemented at Zurich Insurance?* is that a successful education campaign requires a two-pronged approach. Firstly, it is critical for Zurich to build a strong company culture and organizational structure that ensures collective agreement, buy-in, and leadership support for climate and sustainability goals. Secondly, Zurich must engage employees with various educational opportunities by using team-specific tools and resources that allow them to incorporate climate risk and sustainability into day-to-day work.

Company Culture and Organization

[redacted]

[redacted]

[130] Name changed for confidentiality

[redacted]

[redacted]

Education Opportunities

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

Risks

In terms of the risks that companies need to keep in mind in implementing a major sustainability initiative, many stem from mixed messaging or lack of commitment. If the importance of the message is not made apparent, there is a strong likelihood that it will be ignored. If employees perceive sustainability initiatives as mere platitudes, the risk of things going in one ear and out the other, or being totally drowned out among other company initiatives, will be significant.

Without a manifest commitment to sustainability, the company may be perceived as opportunistic. Consistent communication without corresponding action may create the perception that the company is paying mere lip service. It will be of no benefit to be painted as greenwashing. Likewise, even with commitment at higher levels of the corporate hierarchy, if managers are not made to understand their concrete importance, they may feel justified in sidelining sustainability initiatives when tension arises between competing corporate goals, frustrating success.

There is a further risk of the focus on sustainability being misplaced or improperly calibrated. If employees feel that sustainability initiatives are pointless or that the level of ambition is not up to par, they may draw the conclusion that they are not actually very important. For those who are not personally interested in sustainability, this may cause disengagement. For those who feel strongly about the importance of sustainability, the initiatives may backfire to create feelings of dissatisfaction and resentment.

In addition to ensuring that initiatives are made relevant to the individual's daily work, it is also important that companies make sure they do not come off as preachy or judgmental. This may cause outreach to be self-defeating, creating resentment among staff rather than inspiring new action. It may harden existing doubts or negative preconceptions about the overall theme of sustainability and the company's role in pursuing it.

Success Factors

[redacted]

[redacted]

Next Steps

[redacted]

[redacted]

[redacted]

Appendix A: Subject Matter Experts

Internal Subject Matter Experts (SMEs)

[redacted]

External Experts

Academic

- Person A, Expert in bridging business education and corporate sustainability efforts
- Person B, Expert in corporate climate change education through simulations
- Person C, Expert in political responsibility of corporations in an evolving world
- Person D, Expert in corporate social responsibility centered around climate change and diversity, equity, and inclusion
- Person E, Expert in leveraging understanding of human behavior to promote environmental sustainability and social well-being
- Person F, Expert in environmental psychology through the lens of human cognition, emotions, and behavior

Corporate

- Sarah, Sustainability Lead at Company C, a global food corporation, and ex-employee at Company S, a major food manufacturing company
- Jane, Supply Chain Sustainability Director at Company A, a multinational fashion company
- Kate, Senior Leader in Sustainability at Company B, a major aerospace company
- Emily, Associate Vice President in Sustainability at Company D, a major player in the construction industry

Appendix B: Employee Survey

REDACTED

Appendix C: Industry Memos

REDACTED

Appendix E: Zurich Employees Willing to Help

REDACTED