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eBike: from sustainability to management of electric mobility innovations

Evaluation of the Bosch eBike Systems' Sustainability Strategy

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Abstract

Rapid urbanization doesn't have much control over air pollution caused by the transport sector, but innovative technologies are crucial in reducing global environmental problems. The current emissions linked to transportation are about 20% of the global CO2 emissions but this number is supposed to grow exponentially in the next thirty years, potentially reaching half of the whole emissions [1]. Nonetheless, pathways toward sustainable transportation have received limited attention. This thesis investigates the electric bicycle (eBike) as a sustainable and innovative solution in contemporary transportation. They can be used in urban, peri-urban, and outdoor contexts; the study employs a comprehensive methodology to analyze macro, micro, and external factors influencing the adoption of eBikes. Macroeconomic factors encompass market dynamics, key players, re-shoring trends, and infrastructure upgrades, emphasizing the transformative role of eBikes in transportation. Microeconomic aspects highlight economic benefits such as reduced transportation costs, the possibility of replacing a second car, savings on social costs particularly in health and physical activity, traffic congestion mitigation, CO2 emissions reduction and road safety.

Bosch company reached the climate neutrality for scope 1 and 2 emissions, and focusing on the eBike Systems division it’s possible to compare the benefits in CO2 emissions with the other means of transport, a battery recycling program developed with the downstream supply chain and new circular packaging solutions.

Finally, Bosch's marketing strategies are presented, emphasizing the role of eBikes in fostering sustainable urban mobility and the contribution of marketing strategy towards company's goals.

The thesis attempts to underscore the advantages from both individual citizens' perspectives and communities’ viewpoints. Emphasizing the significance of eBikes as a pivotal innovation in addressing the climate crisis, it sheds light on their role in environmental sustainability.

1 Introduction

In the ever-evolving landscape of transportation, where concerns over carbon dioxide emissions and environmental sustainability have become paramount, the electric bicycle (eBike) emerges as a compelling solution at the intersection of innovation and ecological responsibility. As the global community grapples with the profound impact of traditional modes of transportation on the environment, the eBike represents a paradigm shift towards cleaner, greener mobility options.

This thesis explores the multifaceted dimensions of eBikes, scrutinizing their impact on urban, peri-urban, and outdoor transportation systems. At its core, the research aims to unravel the factors influencing the adoption of eBikes, ranging from macroeconomic trends to microeconomic implications and sustainability strategies.

While developing the literature review the author tried to answer the following question: “What are the main economic and social implications of electric bicycles sector growth?”

To develop this research the tools used have been Scopus, Web of Science, Taylor & Francis and Google Scholar; looking for documents with Electrical Bicycle, eBike, sustainab*, LCA, carbon footprint, sustainab* strategy, soft mobility, micro-mobility, circular economy, and supply chain responsibility as key words.

For the economic part, reports from practitioners supplied by the Bosch company have been analyzed.

Following a sector-wide overview of eBikes, the remaining part of the thesis focuses on the Bosch case study [2], answering, the question: “How does the sustainability strategy of a major eBike manufacturer, such as Bosch eBike Systems, align with and influence the overall environmental impact of eBikes, considering factors such as product life cycle, critical raw materials transparency, and circular economy practices?”

To write this part the author mainly used annual and sustainability reports of the company, supported by academic literature and also strategic marketing presentations in line with the grey literature related to the marketing theme.

The introductory section sets the stage by framing the significance of eBikes within the broader context of contemporary market trends. As urbanization accelerates and environmental concerns intensify, the quest for sustainable and efficient modes of transportation gains paramount importance. The research methodology encompasses a thorough examination of macroeconomic factors (Section 3), including market growth, key players, re-shoring trends, and infrastructure upgrades, offering a holistic understanding of the transformative role eBikes play in reshaping transportation dynamics.

Transitioning to microeconomic aspects (Section 4), the investigation explores the tangible economic benefits of eBikes for citizens. From reduced transportation costs to a potential replacement of second cars, the thesis illustrates the economic advantages while underscoring the broader societal gains, including improvements in health (Section 5), increased physical activity, traffic congestion mitigation, CO2 emissions reduction, and enhanced road safety.

A crucial aspect of the research is the in-depth case study of Bosch (Section 6), a prominent player in the eBike market. The examination encompasses the company overview and divisions. The analysis continues in Section 7 with an exploration of Bosch's sustainability strategy, including its commitment to climate neutrality, emission categorization, and the three pillars of eBike Systems (Carbon footprint, Supply chain responsibility, Circular economy).

Section 8 of the thesis investigates Bosch eBike Systems' product features, life cycle, and sustainability initiatives, probing into critical areas such as the eBike footprint, CO2 emissions, transparency in critical raw materials, cobalt reduction, circular economy practices, and recycling methods for eBike batteries. This granular analysis not only sheds light on Bosch's approach but also contributes to the broader context on sustainable practices within the electric mobility sector.

As the thesis unfolds, Section 9 critically evaluates Bosch's marketing strategy and eco-innovation approach, offering a nuanced understanding of their effectiveness and suggesting potential areas for improvement. The discussion underscores the pivotal role eBikes play in fostering sustainable urban mobility and calls for a continued exploration of innovative solutions in this dynamic and evolving landscape.

Section 10 provides a personal touch to the research, offering insights from the author's curricular internship in Bosch eBike Systems' marketing department. This practical perspective adds depth to the theoretical framework, providing an overview of the challenges and goals a company like Bosch pursues through its marketing strategy in the electric mobility segment.

2 eBike

2.1 General description

Electric bicycles, commonly known as eBikes, have surged in popularity in recent years, offering a sustainable and versatile solution to modern transportation challenges. Equipped with battery-powered motors that assist the rider's pedal power, eBikes have become a transformative force in fighting environmental pollution and promoting eco-friendly mobility [3].

Notably, eBikes offer various modes of assistance, adapting to riders' preferences and terrain types; the engine thrust kicks in as the cyclists pedal and then decreases and stops when a certain speed is reached (25 km/h for the pedal-assisted electric bicycle or pedelec, the most common eBike, or 45 km/h for the speed-pedelec). This adaptability, coupled with their ability to effortlessly navigate hilly, rugged, and urban landscapes, distinguishes eBikes as an exceptional choice for commuters facing diverse environmental obstacles [4].

EBikes represent a promising avenue to address the pressing issue of climate change. The global eBike market is anticipated to double by 2028, reaching $48 billion, reflecting a growing shift toward sustainable transportation options[5]. eBikes play a crucial role in reducing greenhouse gas emissions linked to internal combustion vehicles, offering a potential modal shift that significantly contributes to minimizing environmental impacts. Studies estimate that eBike adoption could lead to substantial CO2 emissions reductions per person annually, making them a powerful tool in combating climate change [6]. Additionally, the health benefits associated with eBikes are noteworthy. Although offering a lighter intensity than traditional cycling, eBikes encourage physical activity, enhancing cardiovascular health and promoting active lifestyles, especially in urban areas where sedentary behavior poses significant health concerns[7].

EBikes also contribute to building healthier and more inclusive communities. They facilitate independent mobility for older adults and individuals with physical disabilities, allowing them to engage in cycling comfortably and fostering social connections[8]. Moreover, the design of eBikes varies widely, accommodating different preferences and needs. While definitions of eBikes differ globally, they generally include a range of electrically assisted

bicycles, from pedal-assist eBikes to throttle-assist eBikes. This diversity in eBike styles ensures that individuals can find options that suit their mobility requirements, promoting inclusivity within communities[9].

Despite their numerous benefits, the widespread adoption of eBikes has led to challenges related to their definitions and regulations. Ambiguities in classifications have resulted in confusion, particularly regarding fully motorized e-scooters and throttle-assist eBikes. To harness the full potential of eBikes and create harmonious communities, evidence-based policies are essential. Municipalities worldwide are recognizing the economic, social, and environmental advantages of eBikes. Studies [10] have shown that investments in cycling infrastructure led to increased property values, consumer spending, and economic activity, underlining the broader positive impacts of eBike integration. Thus, developing inclusive policies, accessible infrastructure, and incentives, such as subsidies, are crucial steps toward a future where eBikes serve as the backbone of sustainable and active transportation, fostering healthier, happier, and more vibrant communities.

2.2 eBikes History

The historical progression of electric bicycles (EBs) reveals a fascinating journey of innovation and technological advancement. In the late 19th century, pioneers like Ogden Bolton and Hosea W. Libbey laid the groundwork by integrating electric motors into bicycles, as we can appreciate in Fig 1. Their inventions marked the inception of EBs, setting the stage for a century of evolution[11]

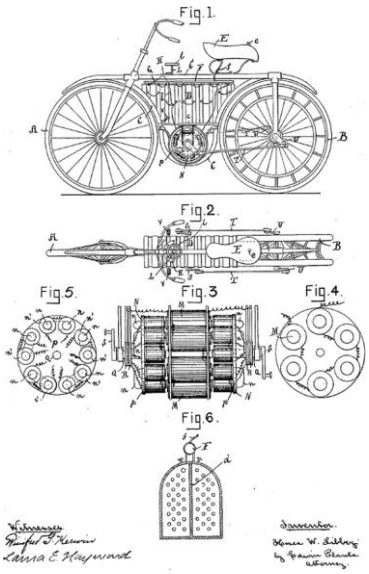


Figure 1: Electric Bicycle invented by Hosea W. Libbey [11]

Throughout the 20th century, a myriad of inventors across the globe contributed to refining EB designs. Notable developments included the introduction of hub motors and efficient power transmission systems. These inventions paved the way for the commercial availability of EBs in the 1990s. During this period, inventors introduced solar charging systems and torque sensors, enhancing the efficiency and usability of EBs. These innovations not only extended the range of EBs but also made them more user-friendly, and appealing to a broader audience.

In the early 21st century, the pace of innovation in the EB industry accelerated. Foldable EBs became popular, addressing the need for convenient storage and portability. Additionally, the integration of pedal generators in chainless designs provided users with the option to generate electric energy while pedaling[12]. This energy could either charge the batteries or directly power the hub motors, ensuring a more sustainable and efficient riding experience.

Moreover, advancements in control systems transformed EB technology. The integration of smart mobile devices and cloud technology allowed for sophisticated control mechanisms. These systems enabled users to customize their riding experience, monitor the performance of their EBs, and even implement anti-theft features, enhancing the overall user experience and security[4].

The evolution of EBs mirrors not only the progress of technology but also the collective human endeavor to find cleaner and greener transportation solutions. As innovation

continues to drive the EB industry forward, the future holds exciting possibilities, promising a world where electric bicycles play a pivotal role in shaping the way we commute, while contributing significantly to a more sustainable planet [11].

2.3 Soft mobility

Soft mobility is a transportation paradigm that champions non-motorized means like walking and cycling; it plays a critical role within the broader context of the European Green Deal and its mission to combat climate change and environmental degradation. At the heart of this approach is the EU Strategy on Green Infrastructure [13], which places special emphasis on fostering healthy green spaces.

Soft mobility, defined as a zero-impact alternative to car use, is an integral part of sustainable transportation initiatives. Its core objective is to minimize the environmental footprint of the transport sector while simultaneously enhancing the quality of life in urban settings[14].

An innovative urban model within the realm of soft mobility, blurs the lines between pedestrian, cyclist, and vehicle spaces, fostering a shared environment that encourages reduced speeds and prioritizes safety. The implementation of strategies such as small speed bumps, greenery, and thoughtful pavement design ensures a harmonious coexistence between different modes of transport, further promoting the ideals of soft mobility[14].

The concept of the "greenway" emerges as a cornerstone in the soft mobility framework. These motor-free pathways, catering to pedestrians, cyclists, horse riders, skaters, and more, serve as vital connectors between urban and rural spaces. These green corridors not only facilitate access to public green areas but also play a pivotal role in the preservation of biodiversity. In Italy, the Italian Greenways Association (IGA) serves as a guiding force, setting standards and ensuring the effective design and planning of these greenways.

Beyond their environmental benefits, soft mobility initiatives have proven to be catalysts for urban regeneration. By reconnecting cycle paths and implementing pedestrian-friendly access points, municipalities can breathe new life into degraded urban areas. These interventions, often economically and ecologically sustainable, hold the potential to significantly enhance the quality of life for residents and tourists alike[15].

Additionally, soft mobility dovetails seamlessly with the tourism sector. Sustainable tourism projects, which optimize combinations of transportation modes such as rail, bus, taxi, bicycle, and others, have contributed to a more environmentally conscious approach towards traveling. This synergy between soft mobility and tourism underscores the broader societal shift toward environmentally responsible practices [14].

The role of eBikes is vital in the development of soft mobility within urban landscapes act, in fact, they represent a bridge between traditional cycling and motorized vehicles, making cycling a practical and feasible choice for a larger segment of the population. By enhancing accessibility, reducing effort, and promoting health and environmental benefits.

2.4 The Growing Popularity of eBike Cycling Tours

The tourism industry in Europe is growing rapidly and accounts for 10% of the region's GDP[16]. In 2016, a staggering 538 million international tourists visited the region, with leisure activities, particularly cycling, a major draw. While Eurostat statistics do not capture cycle tourism data comprehensively, studies highlight the importance of cycling for leisure in countries like Austria, Belgium, and France [16].

Holiday cycling, where bicycles are used as an alternative means of exploration during vacations, is gaining traction. This trend has spurred the development of rental businesses for conventional bikes as well as electric bicycles (eBikes). eBikes, operating at speeds up to 25 km/h, are reshaping travel patterns. They reduce trip durations and physical exertion, yet eBike users cover longer distances compared to traditional cyclists [17].

Unlike typical bike tours, eBikes provide a unique exploration technique, making them appealing to a broader audience, including people with physical or endurance restrictions. One of their main advantages is their capacity to go long distances, allowing riders to visit rural and inaccessible areas that would be difficult for normal bikes. Families may now travel together, regardless of age differences, cultivating a love of outdoor activities and generating lasting memories.

Furthermore, eBikes allow cycling lovers to explore challenging terrains such as mountain trails and gravel roads, delivering a unique and adventurous experience. These electric bicycles offer rich cultural contacts by allowing travelers to readily access local cuisine in tiny

communities and connect with the local inhabitants, thus improving the whole holiday experience. As a result, eBike cycling tours have reshaped the way people explore, providing a safe, enjoyable, and engaging travel experience for both individuals and families[18].

In response to environmental concerns, initiatives like the EU Ecolabel have emerged. This voluntary scheme recognizes products and services meeting high environmental standards, including those in the tourism sector. There is a growing focus on green practices within tourism. Incentives to encourage these practices are being explored through dynamic evolutionary game models, involving governments, tourism enterprises, and tourists. Businesses that promote eco-labeling have found that it improves their sales, customer base, and marketing position, encouraging them to invest in eco-certification programs.

Crucially, guest perceptions play a pivotal role in this transition toward environmentally friendly practices. Mainstream tourism is gradually embracing these changes [17]. Although the EU Ecolabel criteria for tourist accommodation do not include transportation services, [18]argue that hotel-based eBike rental services, particularly if powered by renewable energy, significantly raise guests' perceptions of the hotel's environmental quality and friendliness. These initiatives represent a significant step toward sustainable and eco-friendly tourism practices in Europe.

2.5 Mountain biking eMTB

From its early roots in 1970s Marin County, California, mountain biking transitioned from a niche activity to a mainstream sensation in the 1980s, leading to a surge in innovations driven by diverse terrain demands [19]. This trajectory of innovation found a parallel in the emergence of electric Mountain Bikes (eMTBs). Technological strides, particularly in electric motor development around 2012, birthed viable eMTBs. The introduction of mid-mounted motors, coupled with enhanced power output, battery options, and range-extender batteries, revolutionized eMTB capabilities. Riders can adjust motor assistance levels, and while eMTBs are heavier than regular bikes, design advancements have mitigated weight concerns, offering riders unprecedented exploratory capabilities [20].

The adoption of eMTBs is rapidly reshaping the cycling landscape, enabling riders to venture into previously challenging terrains. Recent studies in tourism have centered on enhancing visitor satisfaction, emphasizing psychological states like "flow," where individuals become

fully immersed in an activity, leading to increased gratification and psychological well-being. Flow experiences are particularly pertinent to mountain biking, making it a rapidly growing segment in adventure tourism [20].

Mountain bike tourism, especially when bolstered by eMTBs, provides a sustainable economic model for smaller communities. Despite the challenges in measuring its global market size, the industry's growth is evident. Australia, for instance, boasts a mountain bike market valued at over $5 billion annually [21]. The sector attracts a diverse demographic, from competitive enthusiasts to families seeking engaging outdoor experiences. As the industry evolves, innovations such as fat bikes and 'mullets' (with varying wheel sizes) emerge, indicating the dynamic nature of the market. Notably, eMTBs have transcended the status of a passing trend, becoming a staple in outdoor recreation [22].

The allure of eMTBs lies in their democratization of outdoor adventures. By providing greater accessibility, these bikes allow both seasoned cyclists and newcomers to explore nature's wonders, fostering a deeper appreciation for natural landscapes. European eMTB trails, including renowned ones like the Dolomiti Superbike Trail in Italy and Portes du Soleil in France/Switzerland, draw enthusiasts from all over the globe[23]. Another noteworthy example is Finale Ligure (Italy), which stands out as one of the top mountain biking destinations in Italy and across the world due to its location. The vast area features countless MTB trails, offering a wide range of scenic environments and terrains, ranging from steep and rocky paths that offer stunning sea views to awe-inspiring flow trails. These trails not only showcase the breathtaking European landscapes but also signify a shift in the market, making wilderness accessible to a broader audience with varying fitness levels and experiences [22].

However, with this increased accessibility, the importance of responsible behavior becomes paramount. Proper trail management and raising awareness about environmental conservation are pivotal in preserving natural mountain systems amidst this biking revolution [19]. As eMTBs continue to weave their way into global cycling culture, their impact on both adventure and environmental consciousness is undeniable, reshaping how people experience and appreciate the great outdoors.

3 Macroeconomics aspects

Analyzing the broader economic consequences of the widespread adoption of eBikes involves examining various aspects. At a macroeconomic level, it encompasses factors such as employment, economic growth, and gross domestic product (GDP) effects linked to eBike production and usage. This study delves into the eBike industry, exploring employment figures and the sector's growth potential. The aim is to understand the comprehensive economic impact of eBike production and utilization in Italy, focusing on job creation, economic growth, and potential industry expansion.

3.1 Market growth

The global market for EBs experienced remarkable growth, with China leading the way as the largest market as shown in Fig. 2. Projections indicate a continuing upward trajectory in EB sales globally, with estimates reaching staggering figures by the end of the century. This surge in demand underscores the growing recognition of EBs as viable and sustainable alternatives to traditional modes of transportation.

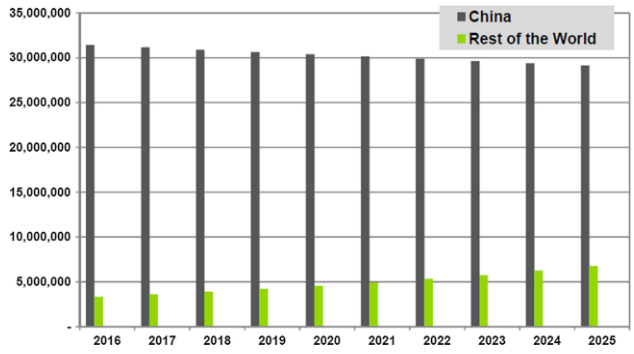


Figure 2: Annual EBike Sales, China and the Rest of the World: 2016–2025 [11]

Beyond China, various regions, including Western Europe, Latin America, and North America, witnessed substantial growth in EB adoption. The global eBike market is expanding, with Europe, particularly Germany, the Netherlands, and Belgium, witnessing a surge in eBike sales. This widespread acceptance reflects a global shift towards eco-friendly transportation solutions, driven by environmental consciousness and the pursuit of sustainable living.

The report [24] on shared-mobility growth emphasizes a global shift in transportation dynamics, with a focus on micro-mobility solutions, including e-bicycles. The shared mobility market, valued at $10-15 billion worldwide, is witnessing a rising popularity in micro-mobility solutions. More than 60% of global mobility users are open to shared autonomous shuttles, while a third of urban respondents plan to increase their use of micro-mobility. These trends underline the growing demand for sustainable and efficient urban transportation solutions, which is in line with the positive outlook for eBikes highlighted by Banca IFIS[25].

The data reported in [26] highlights a significant shift in the transportation landscape, indicating a trend towards electric bicycles (eBikes) that is reshaping the industry. Within the European market, eBikes have experienced a substantial rise, accounting for 23% of all bicycle sales in 2021, marking a significant increase from the 4% recorded in 2011 (Table 1). The economic impact of this shift is substantial, with the production value of eBikes in Europe projected to reach 6 billion euros annually by 2025 [27].

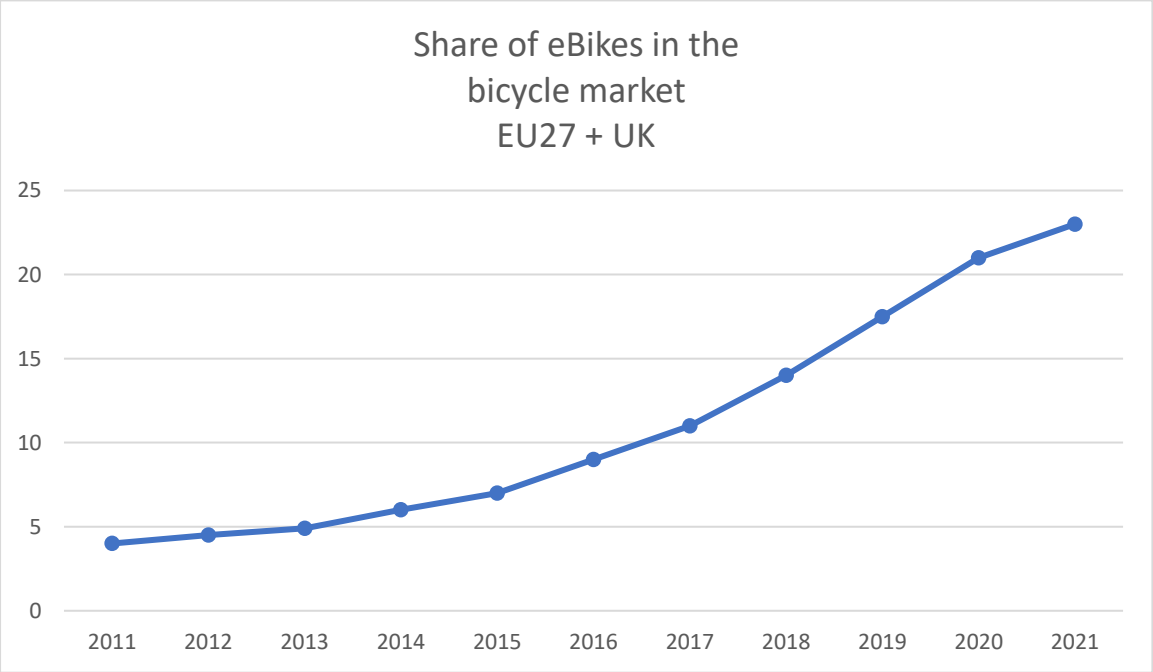


Table 1: Share of eBikes in the bicycle market, based on [26]

A study from Banca Ifis [25]highlights a remarkable 10% growth in revenues for Italian bicycle and components manufacturers in 2022, surpassing the historic threshold of 2.0 billion euros in revenues. Italy continues to assert its leadership in European bicycle production, with an optimistic outlook for 2023 projecting a further 6% revenue growth. Key

drivers of this growth include an increasing demand for sustainable mobility, a rising interest in cyclo-tourism, and a significant acceleration in the production of eBikes.

This aligns with the Italian scenario, where the production of eBikes emerges as a driving force behind the industry's positive economic indicators, compensating for inflation impacts and contributing to a positive trade balance [28].

Italy, despite a 10% decline in overall bicycle sales in 2022, witnessed a surge in eBike purchases, reaching 337,000 units—an impressive 14% increase compared to 2021 (Fig 3). The average price of an eBike stands around 1500€, and the Italian market is currently experiencing a period of robust growth [28].

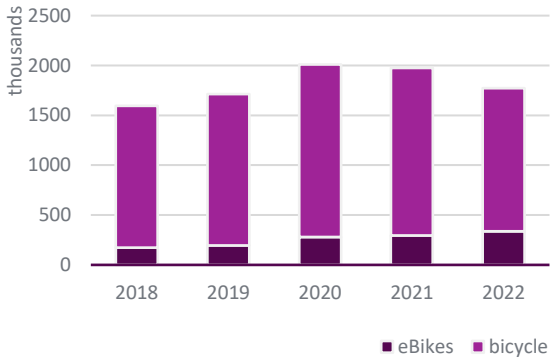


Figure 3: Italian bicycle and eBikes sales [self-developed based on[28]

Within Italy, eBikes are categorized into five main types: eCity, gravel, eMTB, eTrekking, and urban lifestyle. Interestingly, the eCity and eMTB segments dominate the market, collectively accounting for more than half of the total eBike sales in the country (Table 2). This data underscores the transformative impact of eBikes on the transportation industry, indicating a paradigm shift towards eco-friendly and sustainable modes of travel, with Italy playing a notable role in this evolution.

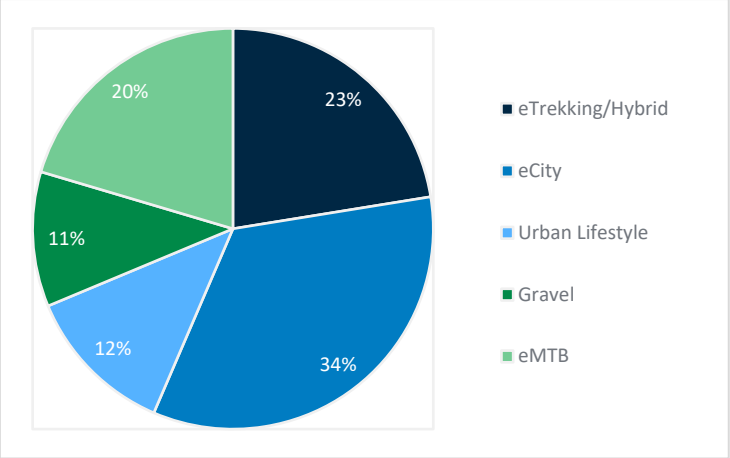


Table 2: Italian eBikes shares [self-developed with company's data]

The synergy between data from different reports [24], [25] on shared mobility and eBike transformations collectively paints a comprehensive picture of a dynamic market with robust growth prospects. eBikes play a pivotal role in the evolving landscape of urban transportation, responding to the increasing emphasis on sustainability, the surge in cyclo-tourism, and the broader trends in shared mobility. As consumers increasingly consider alternatives to private vehicles, the eBike market is positioned for long-term growth, presenting a unique opportunity for manufacturers, investors, and stakeholders to capitalize on the changing dynamics of urban mobility.

3.2 Players & Competitors

In the eBike system manufacturing process, manufacturers deliver the finished product to bike manufacturers (Original Equipment Manufacturers) who integrate the entire system (motor, display, battery and in some cases ABS) onto their bikes. Once assembled, these bikes are then distributed to retailers, who represent the final link in the chain before reaching the end customer. It's important to distinguish between business-to-business (B2B) and business-to-consumer (B2C) dynamics. Motor manufacturers typically engage with OEMs rather than directly with end customers.

Regarding the eBike system, several key players are active in the sector, reflecting the industry's ongoing expansion. **Bosch**, a major player, produces propulsion systems comprehending motors, batteries, and management systems for various eBike brands. **Shimano**, renowned for its bicycle components, offers a broad range of motors and batteries for eBikes. **Bafang**, a Chinese company, specializes in manufacturing high-

performance motors for electric bicycles. **Yamaha**, well-known for motorcycles and vehicles, has entered the eBike market by providing motors and electric assistance systems. **Brose**, a German company, produces high-quality and quiet eBike motors used by various electric bicycle brands. **Fazua**, another German company, manufactures a lightweight eBike motor and battery system utilized by numerous brands. Lastly, **Panasonic**, primarily recognized for lithium-ion batteries, is also involved in supplying motors for eBikes. This varied assortment of players accentuates the dynamic and multifaceted aspect of the expanding eBike industry.

3.3 Re-shoring

Re-shoring refers to the relocation of previously offshored activities[29]; this concept is experiencing a notable surge in relevance within the European eBike industry, implying a significant transformation in production dynamics. This phenomenon, a reversal of the traditional "off-shoring" trend, involves bringing manufacturing processes back to European soil [26]. Notably, this trend is backed by the return of component production and assembly facilities to various European countries. The motivation behind this shift is multifaceted, encompassing increased demand for bicycles during and after the COVID-19 pandemic, a growing emphasis on sustainable mobility, and escalating transportation costs from the Middle East. Additionally, new import taxes have diminished the competitiveness of offshoring, despite lower labor costs. The re-shoring movement is a recent development with far-reaching implications, not only contributing to the revival of local economies but also aligning with the global shift toward sustainable and localized production practices [26]. This transition is reflected in the eBike industry's shift towards increased production in Europe, with a notable rise in European bicycle production over the last few years, as observed in Portugal and Italy[30]. Furthermore, key players in the industry, such as **Riese & Müller**, emphasize the advantages of local production, highlighting the benefits of shorter transport routes and reduced emissions. While challenges such as surging energy costs and longer lead times persist, the trend toward reshoring in the eBike sector appears to be gaining momentum [30]. Major brands like **Giant** have been expanding their production capabilities in Europe, exemplifying a broader industry movement toward localized manufacturing. The push for reshoring is not only a response to pandemic-induced disruptions but also aligns with a strategic shift towards sustainable and resilient supply

chains. As the eBike market continues to grow and adapt to changing consumer behaviors, the reshoring trend is poised to play a pivotal role in shaping the future landscape of the industry [30]. The complexities of the global supply chain, marked by challenges such as lockdowns, labor shortages, and increased shipping costs, have prompted industry leaders to advocate for increased investment in local production. This sentiment is echoed by Erhard Büchel, CONEBI President, who emphasizes the need to invest more in local production for the long-term health of European industry members. The future trajectory of reshoring in the eBike industry remains uncertain, with ongoing debates about whether this trend is a temporary bubble or a structural change. Nevertheless, forecasts indicate a positive outlook for the eBike market, with an increasing number of brands and manufacturers embracing local production as a strategic response to challenges and a step towards building more resilient and sustainable business models. As the industry continues to evolve, reshoring initiatives are likely to shape the eBike market's trajectory, influencing production practices, supply chain strategies, and the overall sustainability of the sector in the years to come.

3.4 Infrastructure upgrades

Investing in pedestrian and cycling infrastructure emerges as a potent strategy for generating employment within the transportation sector. The focus on walkability and bike-ability not only enhances sustainable mobility but also proves to be an efficient catalyst for job creation. Allocating resources to the construction of cycling paths, bike lanes, and pedestrian zones generates a substantial number of jobs per euro invested, surpassing many other areas in the transportation sector (Fig.4). This approach ensures a direct conversion of the budget into manpower, with nearly every invested euro utilized to create employment opportunities. Unlike endeavors necessitating extensive raw material procurement or the acquisition of private lands for new road construction, investments in cycling and pedestrian infrastructure allocate the majority of their budget to labor-intensive activities. Moreover, these initiatives exhibit a rapid implementation timeline, often concluding within a few years of funding[31]. This swift execution injects capital into the economy much faster compared to larger, long-term projects, thereby yielding a more immediate and impactful economic boost [32].

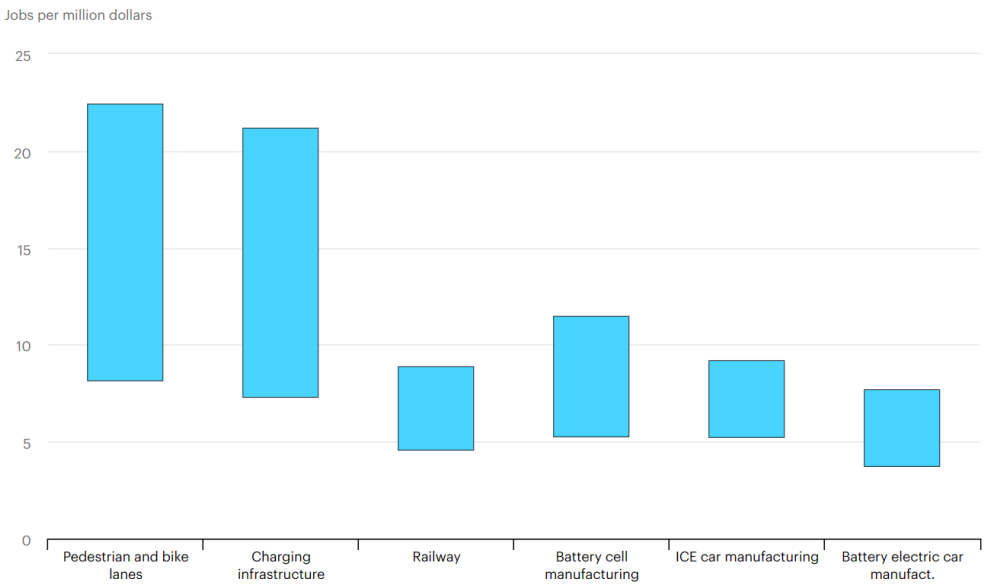


Figure 4: IEA, Employment multipliers for investment in the transport sector[33]

4 Microeconomics aspects - Economic benefits for citizens

Electric bicycles encourage individuals to cover greater distances daily compared to traditional bicycles, leading to increased usage throughout the week. Furthermore, eBike users often substitute their private cars with electric bicycles, finding them a convenient alternative mode of transportation [34]. Interestingly, riders of eBikes sometimes feel as if they are cheating, a sentiment echoed by others; this perception raises the question of why there is an expectation for cycling to require significant physical effort.

Consider a family living in an urban area that already owns a car and is contemplating the purchase of a second vehicle. Their requirements include transporting children to school, shopping for groceries, and commuting to work. In this scenario, opting for a utility eBike or eCargo bike becomes a viable choice[26].

Electric bicycles should not be compared or compete with traditional bicycles.

Instead, they should be evaluated in the context of private cars. Rather than referring to them as "pedal-assisted bikes," a more accurate description might be "acceleration-assisted cars." This terminology better captures the natural role of eBikes: seamlessly replacing a significant portion of short-distance trips typically undertaken by cars [34].

4.1 Transportation costs

Transportation accounts for a significant portion of a family's expenses, ranking as the third highest expenditure category[26]. On average, Italian families spend €240 per month on transportation, of which €105 is spent on fuel for motorized vehicles. This highlights the financial burden associated with commuting and travel. When considering a family's monthly expenses, transportation accounts for 10% of the total cost, indicating the significant impact it has on the overall budget[26]. Managing these expenses becomes critical to effectively balancing the household budget, especially considering the rising costs associated with fueling and maintaining motorized vehicles.

A study made by Decisio [26] estimates the savings an italian family could gain by replacing the second car with an eBike or eCargo bike (Table 3).

	Car	*eBike (premium brand)*
Fixed costs	350-650€	0-80€
Maintenance costs	150-350€	100-200€
Usage costs	300-500€	10-20€
Total (per year)	800-1500€	110-300€
Acquisition cost (one-off)	15000	5000

Table 3: cost estimation [26]

A family with two cars in 60 years spends more than 300,000€ for their purchase and maintenance.

If one of the two cars were replaced with an eBike or an eCargobike, a family could save:

- about 1,200€ per year for management and use alone.
- more than 100,000€ over a 60-year period.

The electric bike holds significant potential for encouraging a shift from motorized to active transportation. [35] explores the impact of eBikes on cycling frequency and mode-switching effects and discusses whether individuals who acquire an eBike experience a comparable increase in daily cycling compared to participants in a short-term trial; this comprehensive analysis of data from the Dutch Mobility Survey [35] in a large-scale study revealed that eBike users cover an average of 3.0 km per day, surpassing the 2.6 km per day recorded for conventional cyclists. Furthermore, eBike users tend to travel fewer distances by car compared to their conventional cycling counterparts. [36] reviewed studies on the mode change effects of eBikes. The studies consistently showed that eBikes replaced car journeys at rates ranging from 16% to 76%.

5 Social Impacts of cycling and eBikes

The adoption of sustainable forms of transportation has emerged as a critical solution in the face of rising concerns related to climate change, health inequities, and social fairness. Walking and cycling can reshape the approach to urban mobility. There is a pressing need to address the climate crisis, as road cars are responsible for approximately 75% of transport-related CO2 emissions worldwide, and this figure is projected to increase [37]. Urban transport is expected to emit 50 billion tons of CO2 in the next 30 years [37]. With urban travels expected to treble between 2020 and 2050, with 60% covering distances of less than 5 kilometers, the underutilization of walking and cycling becomes clear [37].

A modest 30 minutes of daily movement, such as walking or cycling, meets the World Health Organization's minimal health standards, while also lowering the risk of early death by 20-30%[38]. This discovery not only establishes active mobility as a personal well-being strategy, but it also challenges cultural conventions that promote inactive lifestyles. Prioritizing and investing in these forms of transportation is not only a cost-effective approach, but it is also critical to meet the goals established in the Paris Climate Agreement.

Walking and cycling benefits must be integrated into nationally determined contributions[37], together with strategic infrastructure development, public awareness initiatives, and coordinated land use planning, to realize a sustainable and inclusive urban transportation paradigm.

5.1 Health impacts

The benefits of participating in physical activities are well-established in the literature. In addition to producing noticeable advantages like weight loss and muscle growth, physical activity also provides inconspicuous benefits. For example, moderate physical activity reduces the risk of chronic diseases such as heart disease, asthma, and arthritis. Cycling can reduce the risk of Alzheimer’s disease by 29% and slow cognitive decline by around 26%. A comprehensive meta-analysis indicates that physical activity is associated with a 17% lower chance of developing depression [39]. cycling prevents 18,110 premature deaths annually in the EU-28, equivalent to a public health economic value of $52 billion per year [39]. Additionally, cycling promotes a healthier lifestyle and serves as a preventive measure

against severe and chronic diseases. Cardiovascular diseases, type 2 diabetes, cancer, and osteoporosis [40] are all serious health conditions that can be prevented or mitigated through regular physical activity such as cycling. Whether electric or not, cycling offers numerous health benefits to individuals.

A study [41] examined the differences in usage frequency among eBikers and traditional cyclists, revealing that eBikes are preferred by those who previously relied on private motorized transportation and public transit. Furthermore, the emergence of the COVID-19 pandemic has significantly impacted commuting habits.

Significant changes occurred in the urban mobility concept [42]; to minimize the risk of infection, individuals began to increase their walking and cycling activities, while avoiding the use of public transportation. It is worth noting that bike-sharing programs experienced a surge in popularity during the pandemic [43]. Consequently, a vital concern for the post-pandemic era is keeping these newfound enthusiasts engaged in cycling.

Encouraging cycling could play a significant role in mitigating or preventing another health concern, specifically the issue of overweight in children and young people. This problem poses a significant health risk for this generation, and there is a concerning trend of overweight individuals. The 21st century has seen an increase in cases of sedentary behavior among children and youth [43]. The prevalence of activities such as virtual gaming and virtual reality has resulted in reduced physical movement and energy expenditure, leading to weight gain. Therefore, engaging in regular physical activity is crucial. To prevent and manage childhood obesity, a condition linked to numerous health challenges during youth and a higher vulnerability to noncommunicable diseases [39], advocating for walking and cycling to school has demonstrated efficacy in increasing physical activity levels among children. Young people who walk or cycle to school can potentially reduce excessive weight gain [44]. According to [39], individuals who opt for these modes of transportation demonstrate an 8% increase in concentration levels. Students who commute to school by bike have been found to have higher concentration levels, even four hours after arriving in class, compared to those who are driven by car. In Portugal, the government is taking steps to encourage sustainable mobility by promoting bike use among students, starting with those in higher education.

Adoption of eBikes among older individuals has shown considerable positive impacts, especially in terms of improving both independent mobility and social engagement [45]. Older persons who were familiar with the uses of eBikes indicated a more positive impression and a greater readiness to try them. EBikes have been shown to reduce physical and environmental barriers to mobility, allowing riders to travel further with less effort, making them a critical mobility assistance for persons with injuries or health concerns [45]. EBikes had an important role in extending independent and active mobility for those transitioning between cycling and cycling cessation. Importantly, eBikes enabled bikers who faced physical challenges to maintain social connections, promoting social events, weekly interactions, friendships, and a sense of belonging [46]. This combined advantage of boosting mobility and social engagement corresponds with the goals of active aging as described by the World Health Organization's Age-Friendly Communities initiative [46]. Cycling clubs, assisted by eBikes, can address both social and mobility components, encouraging active lifestyles and promoting sustainable and active transportation among older persons. Despite being understudied on a global scale, eBikes emerge as a viable technology to aid older persons in continuing active lives, particularly in automobile-dependent regions.

5.2 Traffic congestion & road safety impacts

Road congestion is a multidimensional problem that includes the finite and non-renewable resource of time.

Bicycles offer a nuanced solution to urban traffic problems, as demonstrated by their effectiveness in combating congestion and addressing environmental concerns. The limitations of a city's infrastructure are evident in the global surge of car-specific traffic congestion, leading to wasted space, energy consumption, and compromised air quality. Motor vehicles operate efficiently in clear paths but face slowdowns in the presence of small lanes, pedestrians, and urban activities. Bicycles, however, provide an alternative by taking up less space and energy, and reducing congestion by having fewer cars on the road. Shared bicycle systems further contribute to this solution, proving profitable and aligning with the growing trend of micro-mobility. Moreover, building better infrastructure is crucial

for fostering urban micro-mobility, as inadequate bicycle lanes hinder its incentive. Creating cycling-friendly infrastructures, not only reduces congestion but also boosts income for local businesses and promotes sustainable habits [47]. The presence of shared micro-mobility fleets signals investment in improved city infrastructure, with permits facilitating the use of electric scooters or eBikes. These measures collectively pave the way for a safer and more efficient urban transportation system.

According to [48], a balanced approach that integrates cycling and walking for commuting boasts much greater average speeds during peak motorized traffic hours compared to Italian counterparts (Fig 5).

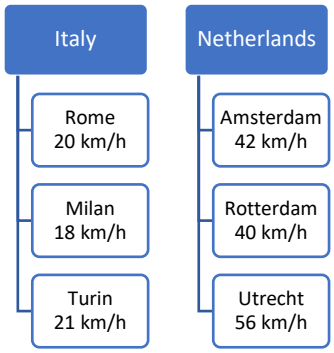


Figure 5: Average speed during rush hour[49]

When safety conditions are met, people tend to prefer walking or cycling over driving[47], emphasizing the impact of transportation choices on the quality of our time, allowing to socialize more. The eBike, with its ability to cover greater distances than traditional bicycles, holds the potential to capture a larger share of automobile trips and contribute to relieving congestion.

Italian cities, grappling with significant traffic congestion, rank three out of the top 10 most congested European cities[49], resulting in substantial time lost during commutes. In economic terms, the cost of congestion in Rome alone exceeds 2 billion euros annually.

Many European countries aspire to absorb future growth in local travel through sustainable transport modes; but in order to promote cycling mobility within urban areas, the importance of road safety is essential.

The Safety in Numbers theory [50] provides a compelling counterargument to concerns about a potential increase in crashes associated with a shift from motorized to non-

motorized travel. The non-linear statistical relationships between the number of pedestrians or bicyclists and the number of injuries within the same group challenge the assumption that an increased number of cyclists or pedestrians would automatically lead to more crashes. Proposed mechanisms for Safety in Numbers suggest that as the number of pedestrians and cyclists rises, motorists become more attentive and adjust their behavior, creating a safer environment. Additionally, the improved interaction between different road user groups as they gain experience and develop more accurate expectations of each other contributes to overall safety. The incorporation of cyclists and pedestrians at a later stage may involve individuals who are more cautious and risk-averse, further enhancing safety. Therefore, it is crucial to consider not only the volume of nonmotorized travelers but also their dynamic actions and interactions, which collectively contribute to creating a secure urban environment.

6 Bosch

The Bosch Group is a leading global supplier of technology and services.

The company generated sales revenue of 88.2 billion euros in the 2022 business year [51].

The Bosch Group comprises Robert Bosch GmbH and its roughly 470 subsidiaries and regional companies in more than 60 countries. Including sales and service partners, Bosch's global manufacturing, engineering, and sales network covers nearly every country in the world.

The parent company is Robert Bosch GmbH, which is headquartered in Stuttgart, Germany. It started as a "Workshop for Precision Mechanics and Electrical Engineering," founded in Stuttgart in 1886 by Robert Bosch (1861–1942).

Bosch is pursuing a vision of mobility that is sustainable, safe, and exciting. It uses its expertise in sensor technology, software, and services, as well as its own IoT cloud, to offer its customers connected, cross-domain solutions from a single source. The Bosch Group's strategic objective is to facilitate connected living with products and solutions that either contain artificial intelligence (AI) or have been developed or manufactured with its help.

With a workforce of more than 420,000 associates worldwide, the Bosch Group is divided into four business sectors (Fig 6): **Mobility Solutions, Industrial Technology, Consumer Goods, and Energy and Building Technology**. The group's business activities are shaped by general trends such as increasing electrification, growing digitalization and connectivity, the considerably increased importance of sustainability – especially of climate action – as well as intense global competition[52]. Nonetheless, the business sectors' markets and competitive environments vary, in some cases considerably.

With more than 400 locations worldwide, the Bosch Group has been carbon neutral since the first quarter of 2020.

Figure 6: Bosch Group business sectors division

In the case of **Mobility Solutions**, the Bosch Group has long competed mainly with a small number of major automotive suppliers. Its chief customers have been globally operating automakers and major regional producers. However, this market is changing due to increasing electrification, automation, connectivity, and multimodal mobility, as well as due to the rise in the significance and value of software in vehicles. The integration of electronics and software into vehicles, as well as growing complexity, are having an impact on vehicle architectures. In this context, customers in the automotive industry often no longer buy hardware and software as a single package, but independently of each other. At the same time, they expect software to combine and integrate functions that were previously separate. At present, vehicle architectures focus on what can be offered in the car. In the future, however, there will also be a stronger focus on hardware and software outside the vehicle, with the cloud also playing a central role. This will enable software updates throughout the vehicle life cycle and scaling of applications in other markets.

The result is shorter time-to-market, end-to-end architectures, and hardware-agnostic software and services. It also means that new business models will arise. The complexity involved in operating systems for vehicles means that many automakers seek support from software providers in the automotive segment.

These trends make the market attractive for additional suppliers, including suppliers from industries such as consumer electronics, semiconductors, and the services and internet sector, as well as for the providers of mobility platforms. In addition, automakers are looking to increase the value they generate themselves in the promising areas of electronics, software, and electromobility. The notable decrease in the percentage of diesel-powered passenger cars in the major European and Indian markets, as well as the increasingly strict regulatory requirements that combustion engines must meet, many of which are regionally specific, are additional significant issues for businesses.

Mobility Solutions key data are highlighted in Fig. 7

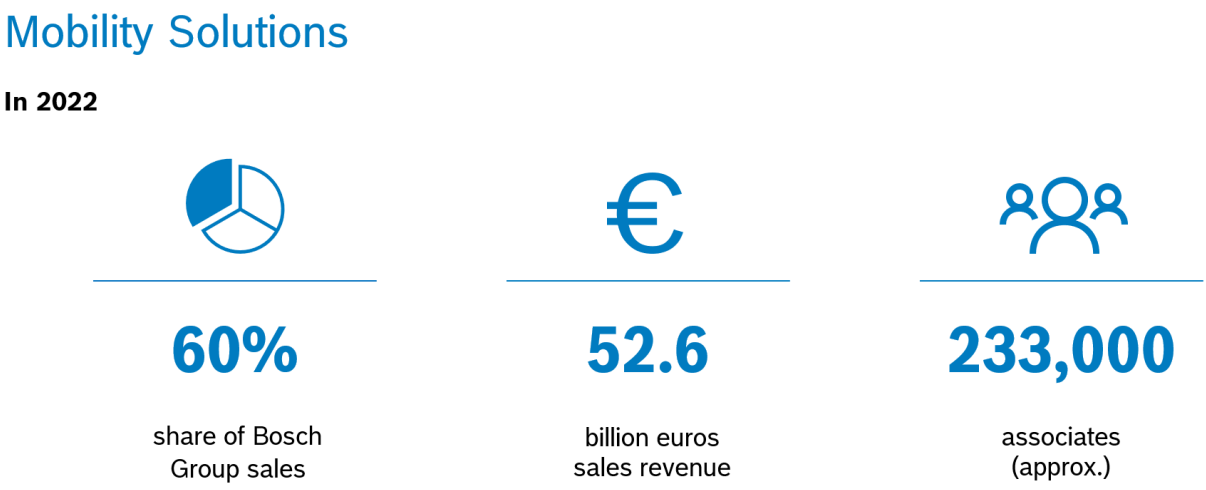


Figure 7: Bosch Mobility Solutions highlights

Within **Industrial Technology**, the Drive and Control Technology division supplies hydraulics and factory automation components and systems in fairly fragmented markets with many competitors and customers. The nature of these competitors and customers is changing as a result of trends such as electrification, the inroads being made by digital solutions, and market consolidation in areas such as hydraulics.

Industrial Technology key data are highlighted in Fig. 8

Industrial Technology

In 2022

Figure 8: Bosch Industrial Technology highlights

In the **Consumer Goods** business sector, the product solutions offered by the Power Tools division and the BSH Hausgeräte GmbH subsidiary align with end-user and consumer requirements. These solutions compete with those from both global and regional providers. In mid-2022, the extraordinary boom in the consumer goods segment due to the coronavirus pandemic, particularly in Europe and especially among private customers, came to an end. Even before the coronavirus pandemic, there was growing evidence of a global shift from traditional brick-and-mortar retail to online commerce. This trend has been reinforced by the pandemic, even though traditional retail is currently regaining ground. Consumer Goods key data are highlighted in Fig. 9

Consumer Goods

In 2022

Figure 9: Bosch Consumer Goods highlights

In **Energy and Building Technology**, the Building Technologies and Thermotechnology divisions compete with a small number of international suppliers and many regional ones.

Moreover, the different domains that makeup energy and building technology are converging. One key growth market, especially in Europe, is heat pumps as a replacement for current fossil-fuel technologies. This development is receiving government support in the form of subsidy programs, such as those in Germany and Italy[51]. This trend is gaining additional momentum from increases in the price of fossil fuels owing to the war in Ukraine. The Bosch Global Service Solutions division offers its services in a fragmented market featuring both large international rivals and smaller local providers.

Energy and Building Technology key data are highlighted in Fig. 10

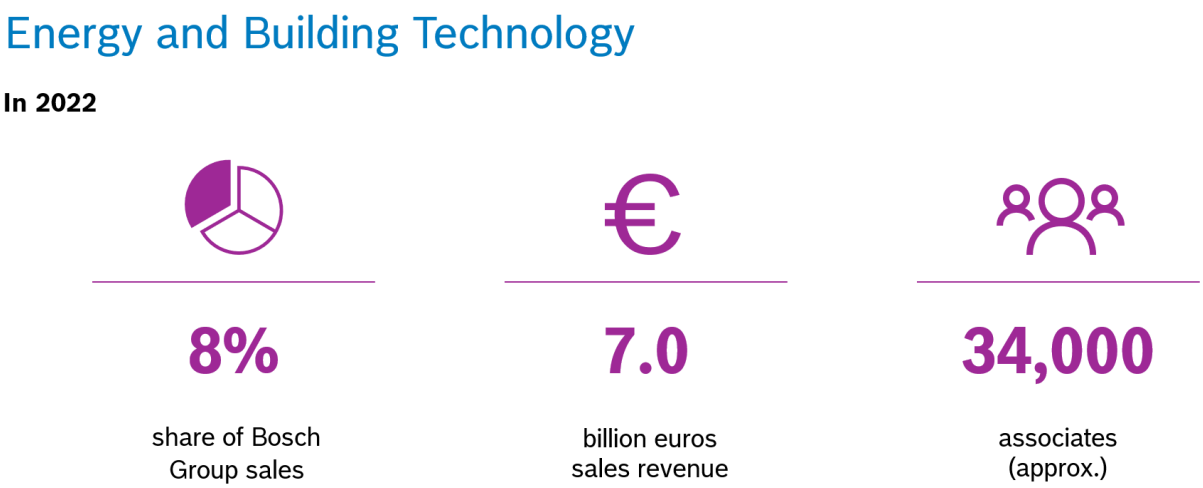


Figure 10: Bosch Energy and Building Technology highlights

7 Bosch sustainability strategy

Bosch's innovative strength is the basis for the company's future growth. Bosch employs 85,500 associates in research and development at 136 locations around the globe. Sustainability is a central theme of Bosch's research, with a focus on three fields of innovation [53]:

- **Innovations for resource and energy efficiency:** Considering the increasing scarcity of resources, solutions for decoupling economic growth from resource consumption must be found in any sustainable development strategy. The circular economy is considered a crucial element in the sustainable use of resources. When new products are developed and existing ones are updated, design principles that facilitate closing the loop at the level of parts or materials are increasingly applied.
- **E-mobility and electrified systems:** Electrification in the mobility sector significantly contributes to achieving climate targets. To this end, the company is developing concepts for electric drive vehicles and is working on integrated power trains at both system and component levels.
- **Chemical energy conversion:** In the field of chemical energy conversion, Bosch is already developing systems that will lower carbon emissions in the future. To secure a sustainable energy supply in the future, Bosch is conducting research into generating electricity from renewable energy sources and storing it in a climate-friendly way.

  Innovative technological solutions are required for both mobile and stationary fuel cell systems, as well as for the production of hydrogen as an energy carrier.

Sustainability refers to a balance between economic, environmental, and social factors, and is now a well-established concept in capital markets known as ESG (environmental, social, governance). Bosch embraces both approaches to sustainability, striving to strike a balance between the economic, environmental, and social aspects of its business activities, as part of its commitment to responsible corporate governance [54].

As a leading global supplier of technology and services, Bosch operates in numerous markets worldwide. Directly or indirectly, business operations impact the interests of a broad range of stakeholders. To discern these interests and incorporate them into activities,

dialogue with stakeholders is actively pursued by Bosch. For this reason, back in 2018, a sustainability management vision was developed “New Dimensions – Sustainability 2025”, outlining six dimensions (Fig 11). These dimensions [53] are based on company-relevant megatrends and material topics, providing a framework for actions. Sustainability actions cover the full range of the value chain, from the acquisition of materials and goods through manufacturing operations at Bosch sites, to the usage phase of sold products, and concluding with their end-of-life.

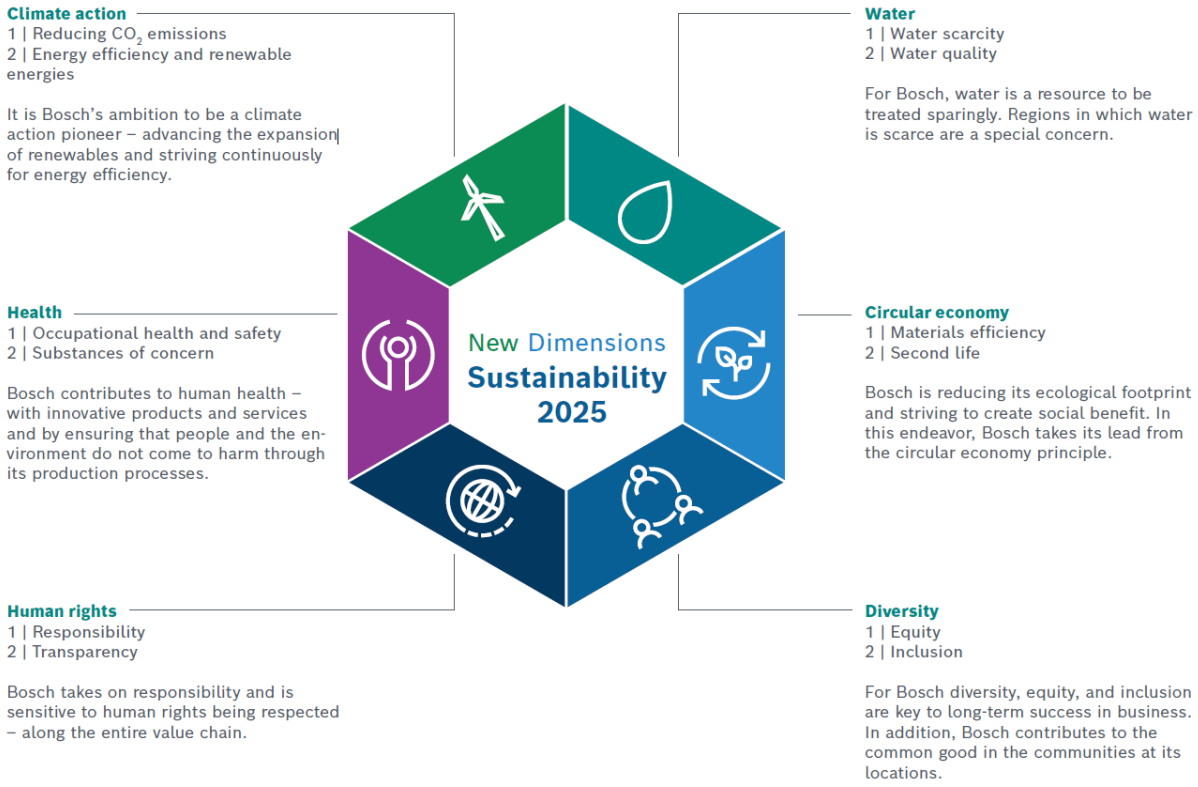


Figure 11: New Dimensions for Bosch Sustainability Strategy[53]

To effectively address global social challenges, it is essential to participate in various initiatives (Fig. 12). Robert Bosch GmbH, for instance, has been affiliated with the United Nations Global Compact since 2004. As a member, the company is committed to the Ten Principles of the United Nations Global Compact regarding human rights, labor standards, environmental protection, and anti-corruption measures [55].

Bosch also supports the United Nations Sustainable Development Goals (SDGs) adopted in 2015, and regularly benchmarks its sustainability activities against the 17 SDGs.

Figure 12: Players and goals involved in the Bosch sustainable action

The report guarantees transparency regarding companies' dedication. Bosch's sustainability report adheres to the globally recognized guidelines of the Global Reporting Initiative (GRI). External auditing is also crucial to verify selected performance indicators and statements, like the Science Based Targets Initiative (SBTi) that evaluates Bosch for its carbon neutrality.

Supporting various reporting formats, the Bosch Group is rated for its sustainability performance according to the values displayed in Table 4.

Rating	Rating 2022	Rating 2021	Rating 2020
CDP	Climate: Score "A" Water: Score "B"	Climate: Score "A" Water: Score "B"	Climate: Score "A" Water: Score "B"
Ecovadis	67/100 points Gold medal	63/100 points	59/100 points
ISS ESG	Prime status B-	Prime status B-	Prime status B-
Morningstar Sustainalytics	14.0 points (low-risk category)	14.8 points (low-risk category)	18.7 points (low-risk category)

Table 4: Bosch's ratings

CDP, formerly “the Carbon Disclosure Project”, is a not-for-profit charity that runs the global disclosure system for investors, companies, cities, states, and regions to manage their environmental impacts. The world’s economy looks to CDP as the gold standard of environmental reporting with the richest and most comprehensive dataset on corporate and city action [56].

EcoVadis is a globally recognized assessment platform that rates businesses’ sustainability based on four key categories: environmental impact, labor and human rights, ethics, and procurement practices. Companies undertake a self-assessment based on a questionnaire with hundreds of questions. The questions require the respondent to provide evidence of their sustainability performance for the different listed categories; after that, the assessment is externally verified by EcoVadis’ sustainability experts, who assign the company a score from zero to 100, which is used to create reliable industry rankings.

ISS ESG is a rating system that measures the extent to which companies are managing negative externalities in their operations across the entire value chain to minimize negative impacts, while at the same time making use of existing and emerging opportunities in their products and services to contribute to the achievement of the Sustainable Development Goals.

Morningstar Sustainalytics provides high-quality, analytical environmental, social, and governance (ESG) research, ratings, and data to institutional investors and companies[57].

NQC | Supplier Assurance automates the compliance management process, assessing supplier practice down multiple tiers in line with current legislation, and evolving best practices.

7.1.1 Bosch climate neutrality

Bosch aims to be at the forefront of climate action, an aspiration that is integrated into its sustainability vision. By achieving carbon neutrality, a measurable contribution is made to this objective. To immediately impact the reduction of greenhouse gases and make a substantial difference within a short timeframe, the initial focus was directed toward Bosch's own facilities. As a result, carbon neutrality is achieved concerning self-generated energy and the energy sourced for manufacturing, development, and administration (scopes 1 and 2 of the Greenhouse Gas Protocol)[53].

Simultaneously, activities have been expanded in recent years to decrease emissions occurring outside Bosch's immediate sphere of influence, such as those at suppliers, within logistics, or when products are used (referred to as scope 3). The goal is to reduce these upstream and downstream emissions by 15 percent in absolute terms by 2030 (Fig 13), as compared to the baseline year of 2018, regardless of the company's growth[54]. Consequently, the focus is increasingly shifting towards activities in procurement, logistics, and product development.

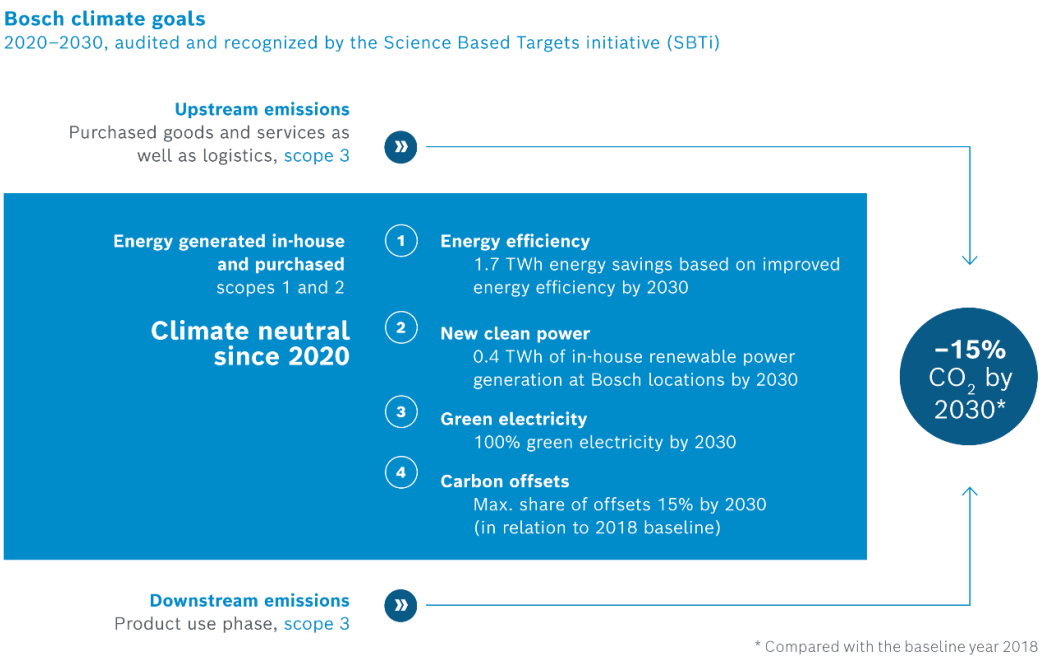


Figure 13: Bosch climate goals

Carbon neutrality is audited by EY and the entire program is recognized by the Science Based Targets Initiative (SBTi) that sets worldwide accepted standards for ambitus climate targets of companies, and defines step-by-step and science-based criteria to assure transparency and credibility; these targets are consistent with the long-term goal of reaching net-zero emissions in the 2nd half of the century.

Starting in 2020, Bosch endorsed the climate targets for the 1.5 degree pathway; as a result, Bosch became the world’s first automotive supplier to achieve “targets set” status. The company now has science-based climate targets for the entire value chain – from purchasing to the product use phase.

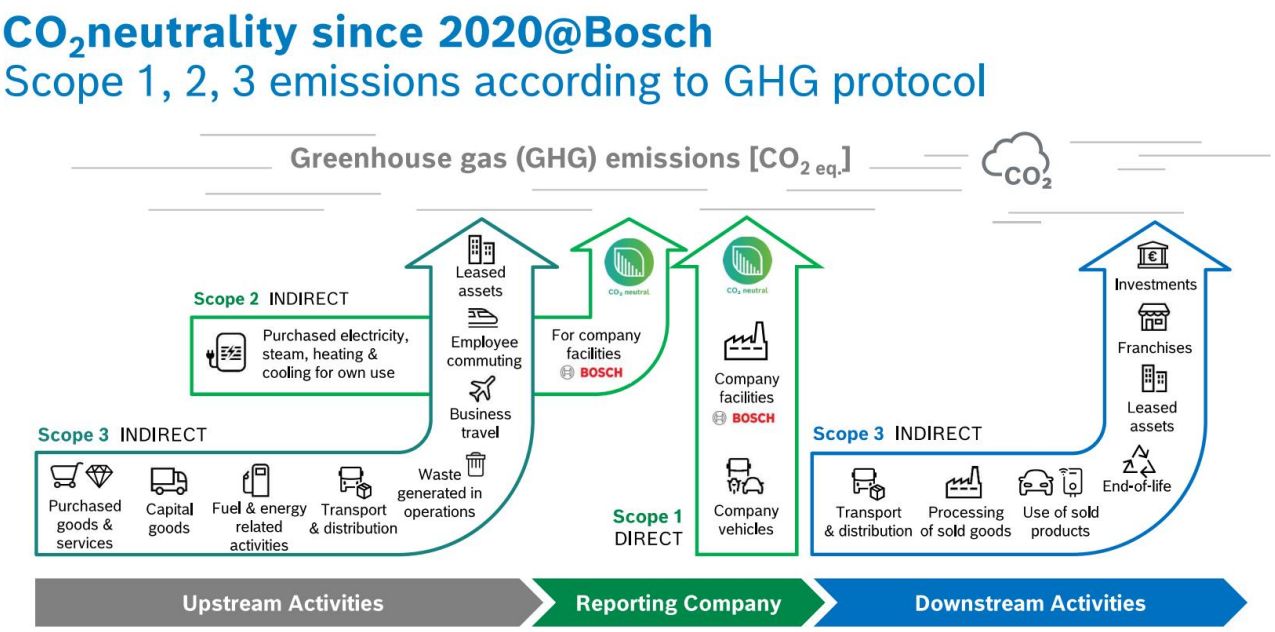


Figure 14: Bosch GHG emissions scheme

The GHG Protocol Corporate Accounting and Reporting Standard provides requirements and guidance for companies and other organizations preparing a corporate-level GHG emissions inventory [58].

The standard covers the accounting and reporting of seven greenhouse gases covered by the Kyoto Protocol – carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PCFs), sulfur hexafluoride (SF6) and nitrogen trifluoride (NF3).

In this case, carbon neutrality covers the manufacturing, administrative, and research facilities. It considers all carbon emissions produced by burning fossil fuels such as gasoline, diesel, heating oil, natural gas, and coal, as well as all the industrial gases that the company uses for processes such as welding (scope 1). Beyond that, it also includes indirect carbon emissions attributable to energy consumed in the form of electricity, district heating, and steam (scope 2)[54] (Fig 14).

Bosch's climate action strategy comprises four levers, as detailed in Fig. 15: increasing energy efficiency, generating energy in-house from renewable sources (new clean power), purchasing electricity from renewable sources (green electricity), and – as the last resort – using carbon credits to offset unavoidable CO_2 emissions.

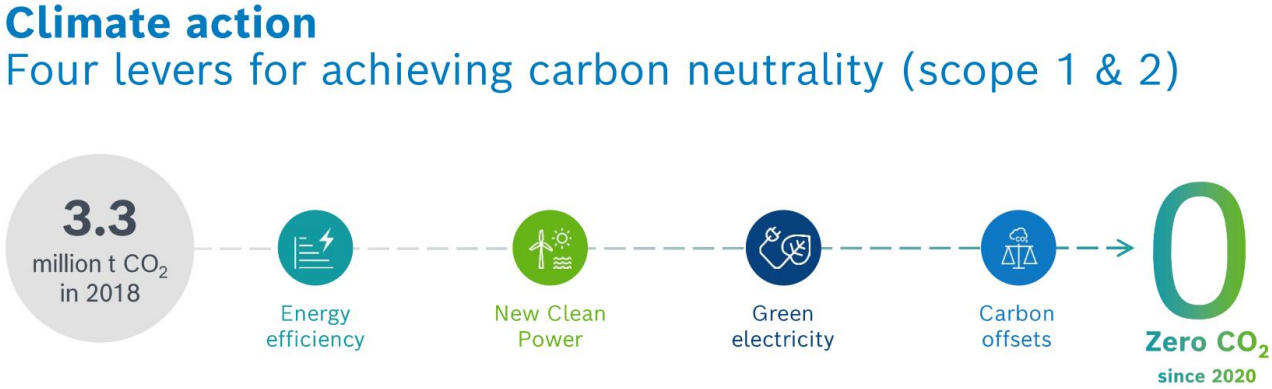


Figure 15: the four levers used to achieve carbon neutrality

Energy efficiency: By 2030, Bosch aims to substantially increase its energy efficiency and operationalize measures at its company locations, with savings potential totaling 1.7 terawatt-hours (TWh).
Since 2019, the company has initiated more than 4,000 projects worldwide, with around 1,000 new projects added in 2022 alone. In total, Bosch has captured savings potential of 805 GWh through these measures, corresponding to 47 percent of the goal achievement[53].

New Clean Power: By 2030, Bosch aims to generate 400 GWh of the annual energy demand in-house at its company locations from renewable sources. Emphasis is placed on photovoltaics, with 98 Bosch locations already relying on solar power for their energy supply. Additionally, a hydroelectric power plant is operated at the company's site in Blaichach, Germany. In total, Bosch generated around 121 GWh of renewable energy in 2022, achieving 30 percent of the target by year-end. New photovoltaic systems were installed at 31 sites, covering an area equivalent to about 18 soccer fields[53].

Green electricity: To enhance the quality of its carbon neutrality, Bosch has focused on procuring green electricity from existing plants. Since 2019, the company has significantly increased its purchase volume from renewable sources, accompanied by corresponding guarantees of origin. In 2022, 95 percent of the Bosch Group’s global electricity demand was already covered using green electricity. The objective is to achieve 98 percent coverage by 2025, progressing toward exclusively sourcing green electricity by 2030. The new interim target for 2025 signifies a specific step in clarifying the objective further and acknowledging the progress made[53].

Carbon offsets: Currently, carbon credits are utilized to offset residual CO_2 emissions from combustion processes like heating and process heat. Additionally, these credits are used to compensate for electricity sourced from regions with limited availability of green energy. As progress is made with initiatives the other initiatives, the aim of Bosch is to gradually decrease the offset percentage for achieving carbon neutrality to no more than 15 percent by 2030. In 2022, significant strides were made toward this objective. Improvements in the quality of carbon neutrality measures, particularly the transition from gray to green electricity, led to a reduction in emissions requiring offsetting to 0.7 million metric tons of CO_2 Fig. 16. This represents a decrease of approximately 0.2 million metric tons of CO_2 or 21 percent compared to the previous year. When selecting carbon offset projects, internationally recognized and independent certifications such as the Gold Standard guide the choices, aligning to promote social development alongside environmental efforts. To reduce residual emissions, the key measure involves increasing the proportion of green power in the electricity mix to 100 percent by 2030; other strategies include enhancing e-mobility within the company fleet, adopting lower-emission district heating, electrification, and utilizing hydrogen and biogas.

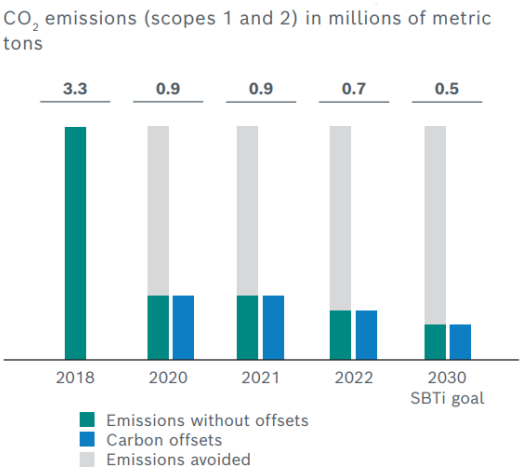


Figure 16: CO2 emissions for scope 1 and 2

Fig.17 summarizes the data from previous years regarding the different types of emissions and scope.

Bosch Group 2020–2022, in 1,000 metric tons of CO_2e

	2020	2021	2022
Bosch Group with carbon offsets	**0**	**0**	**0**
Carbon offsets	938	907	717
Bosch Group	**938**	**907**	**717**
Manufacturing	350	383	328
Vehicle fleet	117	109	117
Volatile GHG	18	76	78
Scope 1	**485**	**569**	**523**
Electricity	367	248	119
District heat, steam, cooling energy	86	90	75
Scope 2	**453**	**338**	**194**

Figure 17: Bosch Scope 1 and Scope 2 GHG emissions breakdown

Upstream emissions within the Bosch value chain primarily involve purchased goods and services as well as logistics. Downstream emissions are primarily a result of product usage (Fig. 18).

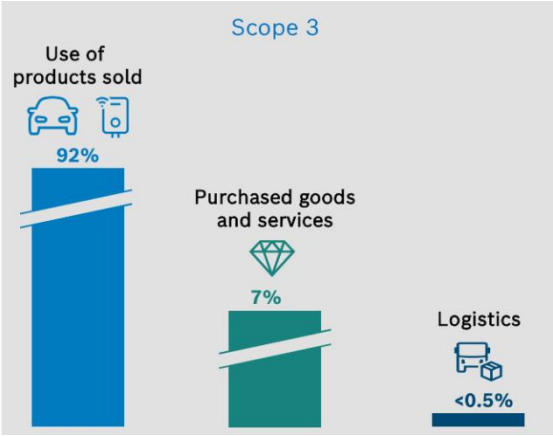


Figure 18: Bosch GHG scope 3 emissions

At 453 million metric tons of CO_2 in the baseline year 2018, upstream and downstream emissions exceeded those in scopes 1 and 2 several times . Since 2018 Bosch has cut scope 3 emissions by around 16 percent, down to 382 million metric tons of CO_2 in 2021. The main challenge now is to mitigate future emissions relating to the anticipated sales

growth by 2030. There are also a large number of external factors Bosch can only influence indirectly, such as suppliers' success in reducing CO_2 emissions.

The steps developed to reach the goal of 2030 are the following:

Purchased goods and services

- **General target agreements** with suppliers to improve CO_2 performance, preferably in combination with a specific SBTi commitment. These target agreements will be consolidated and tracked centrally. The corporate carbon footprint (CCF) indicates a supplier's development and target achievement. It is mapped via CDP or platforms in which Bosch is involved.
- **Specific agreements for focus materials** such as steel, aluminum, copper, and plastics which are responsible for a significant portion of the supply chain's carbon footprint. To purchase future materials that are as low carbon as possible, maximum CO_2 levels are defined for each material, which decrease over the next few years. To track these levels the product carbon footprint (PCF) methodology will be used at the division level.
- **Measures relating to product design** are aimed at improving materials efficiency – i.e. reducing the amount of materials utilized per product and increasing the share of recycled materials used, particularly concerning plastics, aluminum, and steel; if they prove to be successful, these measures will lead to changes in the purchasing volume for the different kinds of materials and to the sourcing of raw materials containing a higher proportion of recycled materials. Improvements in product design will translate into lower PCFs.

Logistics

- **Transportation of goods** currently relies on three main levers for its CO_2 optimization: reducing air cargo, optimizing freight, and consistently applying the total cost of ownership (TCO) approach, which factors in key cost components such as freight costs. The proximity of potential suppliers to plant sites is therefore an important selection criterion for keeping CO_2 emissions as low as possible. Whenever possible, the aim is to switch shipments destined for Bosch from air to sea or rail freight.

- **Transport management centers (TMC)** have been established worldwide to manage shipments between suppliers, Bosch plants, and customers. A high degree of standardization in this area has already been achieved and can guarantee efficient transport – also concerning environmental criteria – by pooling freight. To secure even higher capacity utilization, especially for road shipments, a new transport management system will be introduced at Bosch in 2023 to reach a capacity utilization rate of 80 percent by 2025.
- In the realm of **Green Packaging**, the emphasis is on raising the packing density to reduce the amount of packing materials used, storage space needed, and transportation capacity required. This approach not only leads to cost savings but also aligns with CO_2 optimization efforts and waste reduction initiatives. By improving packing density and reducing resource consumption, the objectives of achieving environmental sustainability, cost-efficiency, and waste reduction are seamlessly accomplished.

Use of products sold

Although Bosch products are designed with energy efficiency in mind, the use of these products is responsible for approximately 90% of scope 3 emissions. It seems that the biggest potential for reducing these CO_2 emissions is in segments where products require significant energy, such as mobility, thermotechnology, industrial drive and control technology, and household appliances. The focus is on three leverage points in each case:

- **boosting energy efficiency.**
- **shaping the product portfolio.**
- **the transformation of the energy sector** through the use of green electricity, hydrogen, and biogas.

Bosch was able to significantly reduce scope 3 emissions caused by product usage; the emissions decreased from 416 million metric tonnes of CO_2 in the baseline year of 2018 to 344 million metric tonnes of CO_2 by 2021 Tab. 5. This reduction was achieved by migrating towards higher energy efficiency classifications, establishing more energy-saving motors and pumps, providing heat pumps and solar collectors, and embracing the transition to e-mobility.

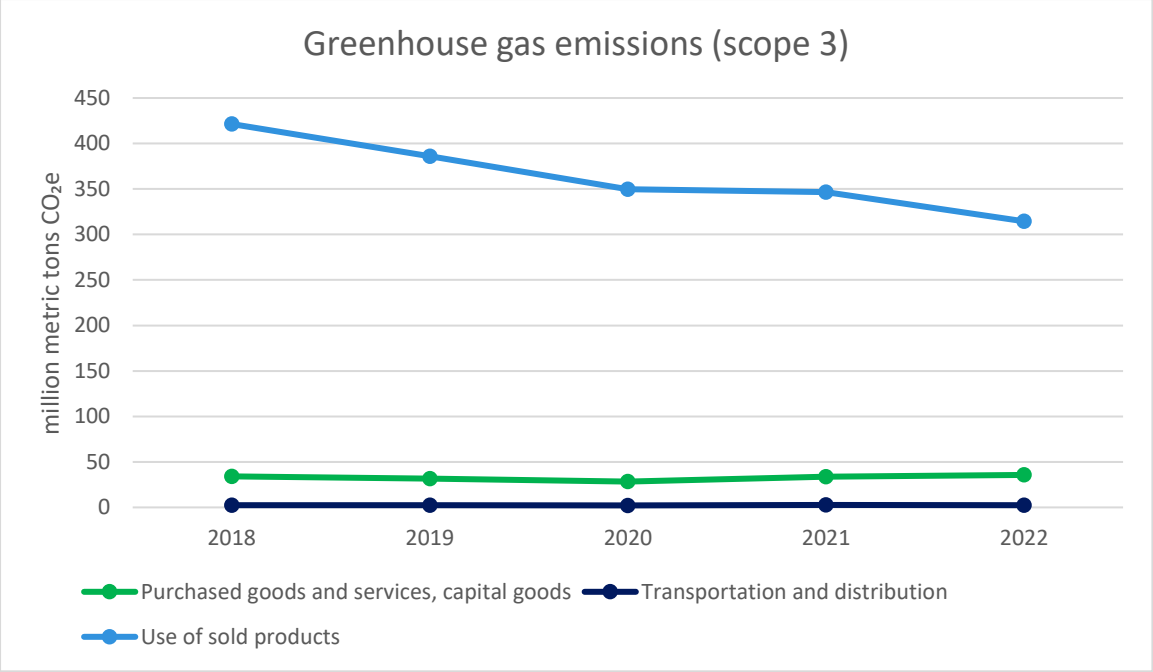


Table 5: Bosch GHG Scope 3 emissions timeline

7.1.2 eBike Systems' 3 pillars

Every division within Bosch further develops its own sustainability strategy; at Bosch eBike Systems, a strong commitment is made towards three strategic pillars (Fig. 19) of the global sustainability strategy[59]:

1. minimizing the carbon footprint of the products
2. responsibility and transparency in the supply chains
3. the development of a functioning recycling economy

Figure 19: Bosch eBike Systems - 3 pillars

From the outset of product development, attention is paid to the associated product environmental impact. The approach, known as Design for Environment, guides the process of designing new products to maximize sustainability throughout the value chain. This involves choosing eco-friendly raw materials and incorporating recycling practices from the design phase. It also includes incorporating energy-saving manufacturing processes and designing packaging for optimal sustainability. The three pillars are analyzed in depth in Chapter 8.

8 Bosch eBike Systems

Bosch eBike Systems provides an extensive range of products for pedelecs, from efficient drive units and high-quality batteries to user-friendly on-board computers and solutions for Connected Biking. The division, which started as a start-up within the Bosch Group in 2009, was able to gather vital expertise from various domains of the Group: rechargeable battery technology from wireless power tools as well as electric motors, electronics, and sensors from the automotive industry.

Now, Bosch eBike Systems is one of the leading manufacturers of eBike drive systems in the premium segment. More than 100 notable bicycle brands worldwide produce eBikes that are "epowered by Bosch".

On January 1, 2020, the Bosch Group established the former Bosch eBike Systems business unit as an independent division. Until this point, Bosch eBike Systems was a branch of the Automotive Electronics division. Based on its business model focused on the bicycle market, Bosch eBike Systems can now respond more flexibly to the specific needs of the bicycle industry.

8.1 The product

Bosch eBike Systems prioritizes the requirements of eBike riders with its drive systems, while also considering the needs of bicycle manufacturers and retailers and innovative solutions that link pedelec riders with the online sphere, paving the way for the future of cycling. This approach results in a highly efficient and well-balanced system, comprised of the drive unit, battery, and onboard computer (Fig. 20).

Systems: To optimize the riding experience, all components communicate with each other within a system that adjusts to the rider's specific situation. This promotes greater efficiency, comfort, and riding enjoyment.

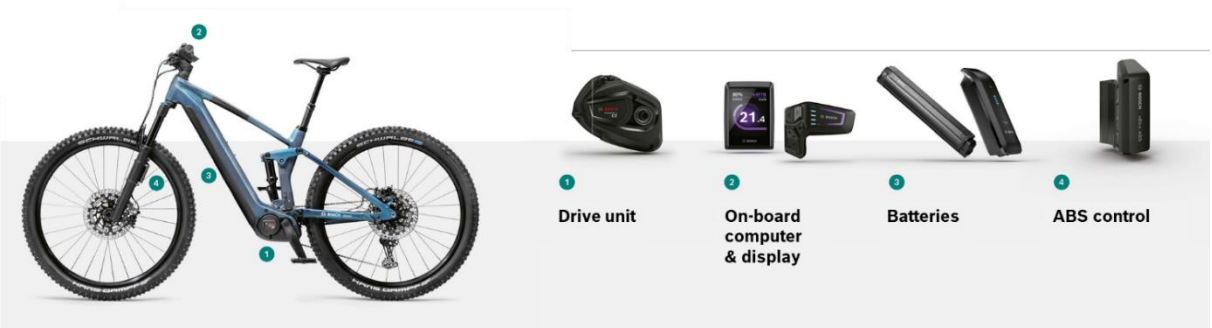


Figure 20: Bosch eBike Systems products

1) ***Drive units:*** The eBike motor, referred to as the drive unit, delivers extra electrical support according to effort, speed, and the chosen riding mode (Off, Eco, Tour, Tour+, Sport, eMTB, Auto, Turbo, Cargo, Race, Sprint). The drives are tailored for different eBike types to provide appropriate assistance. Three sensors measure the rider's pedal power, cadence, and speed over 1,000 times per second.

Functionality and Design: In 90% of pedelecs, a mid-motor is responsible for propelling the bike forward. This positioning, at the bottom bracket in the middle of the bike, lowers the center of gravity and ensures a balanced weight distribution. This design facilitates easier bike handling, and the direct power transmission to the chain provides a natural riding feeling.

The use of a mid-motor in most eBikes, as opposed to a front or rear wheel motor, offers another advantage. It preserves the natural and familiar cycling sensation, eliminating the feeling of being pushed (as with a rear-wheel motor) or pulled (as with a front-wheel motor). Moreover, the mid-motor allows precise control of power through pedal pressure.

There are different riding styles for the customer to choose from:

- **City** Relaxed riding or commuting on surfaced roads or cycle paths as part of everyday life.
- **Suburban** Comfortable riding or commuting, primarily on surfaced roads and cycle paths with moderate inclines.
- **Tours** Sporty riding and longer distances, predominantly on paved paths and roads.
- **Mountains** Very sporty riding in challenging terrain on unpaved roads.

2) ***On-board computer & display:*** The display functions as the control center on the handlebar, shows various information like range or selected riding mode. It provides the option to adjust riding modes/assistance levels. Displays come in different variations and offer different functions. It goes from small control units with minimalistic displays of riding modes and range, like Purion or the LED remote, to traditional displays with screens, and fully networked on-board computers with smart features and automatic over-the-air updates. The displays enhance the eBike experience with digital features and services such as navigation and route planning.

Through Bosch eBike Systems apps, eBikes can be connected to the digital world. For instance, routes can be effortlessly transferred from smartphones to the on-board computer.

3) ***Batteries***: The eBike motor derives its energy from the eBike battery, supplying power and significantly affecting the range. Consequently, various eBike batteries are available to cater to different needs and installation preferences. Regardless of the chosen eBike model or specific requirements, Bosch offers suitable lithium-ion batteries.

PowerTube batteries integrate into the bike frame, whereas PowerPacks can be mounted on either the frame or the rear rack.

4) ***ABS control***: Bosch introduces the first standard anti-lock braking system (ABS) for pedelecs, enhancing the carefree riding experience. Drawing on 40 years of ABS expertise, Bosch developed the eBike ABS based on established motorcycle ABS technology, showcasing their pioneering role in the field. The system, which includes front-wheel ABS and rear-wheel lift control, optimizes brake pressure to improve riding stability and steerability, especially on slippery roads. This innovative technology ensures harmonious and sensitive braking, significantly enhancing control, stability, and safety for riders.

8.2 The eBike life-cycle

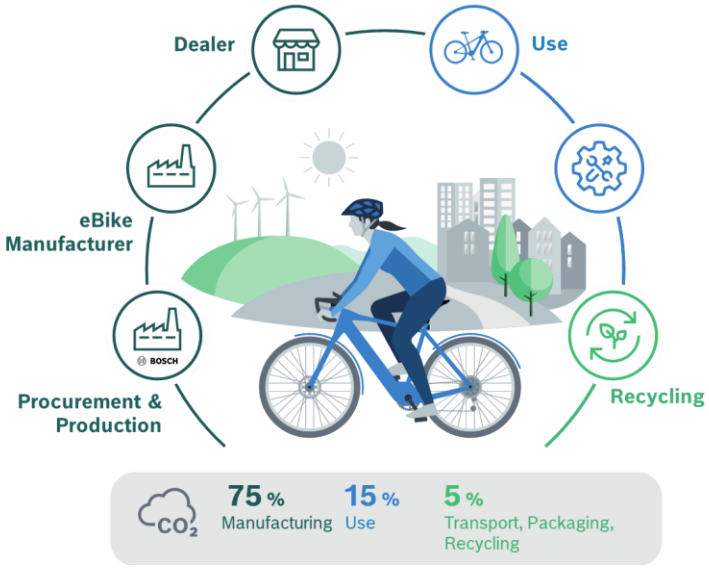


Figure 21: eBike life cycle scheme

The life cycle of a Bosch eBike involves multiple phases.

Fig.21 highlights the percentage of CO2 emissions linked with every phase of the product: first, Bosch designs and develops various system components, such as motors, batteries, displays, control units, and ABS systems, as previously mentioned. Afterwards, these components are sent to bicycle manufacturers who then integrate them into their respective bikes. Once the bicycles are fully assembled, they are distributed to independent bike dealers who act as the final point of contact with consumers.

The use phase of the eBike, which involves repair needs throughout its life cycle, concludes with the possibility of entering a recyclability program. The program returns Bosch's original components to the parent company for recycling.

8.3 Sustainability strategy

As mentioned in Section 7.1.2, Bosch eBike's sustainability strategy comprises three main pillars: eBike footprint, Supply Chain responsibility and Circular Economy. This analysis will commence with an examination of the carbon footprint.

8.3.1 eBike footprint

Road traffic's impact on CO2 emissions in the European Union is a major concern, accounting for about one-fifth of total emissions, according to the European Environment Agency [60]. Nevertheless, the adoption of eBikes for personal transportation, primarily in urban areas, is a feasible remedy that can significantly reduce these emissions. eBikes present a cleaner and more sustainable alternative compared to conventional motorized vehicles. They do not produce any noise pollution or emit any exhaust fumes, making them a promising choice for environmentally conscious commuters [38]. Furthermore, eBikes require minimal space, which makes them even more attractive in congested urban environments.

Compared to other transportation modes, eBikes are a considerate choice for flexible, quiet travel that emits lower levels of CO2[59].

Despite a slightly higher carbon footprint compared to normal bikes, which is mainly attributed to components such as the battery and drive, eBikes show a lower overall environmental impact when considering their increased frequency and distance of use [41]. Individuals using eBikes tend to ride more frequently and cover longer distances, especially when compared to regular cyclists. In everyday situations, eBikes can effectively substitute cars, particularly for short trips such as shopping with an e-cargo bike.

8.3.1.1 CO2 footprint and life cycle analysis

eBikes are an environmentally friendly alternative for transport. [59] has disclosed that considering power consumption, eBikes produce an average of approximately 2g/km of CO2 emissions. In contrast to this, as documented by the Federal Environment Agency [59], cars produce about 152g CO2/passenger kilometer (pkm). Higher efficiency notwithstanding, public transport emits between 50 to 111g CO2/pkm. The visible disparity in emissions indicates that eBikes serve as a considerably more environmentally friendly alternative in the realm of transportation (Fig 22).

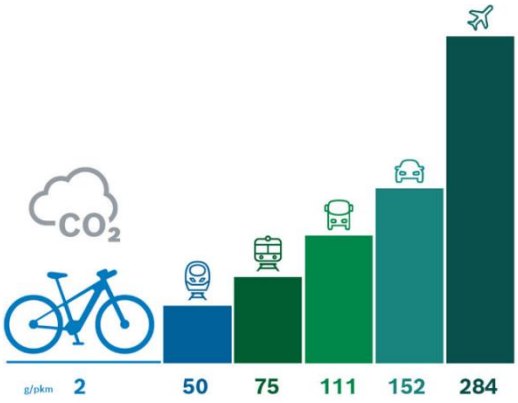


Figure 22: CO2 emissions from a pedelec in use and from other means of transport [59]

Cycling helps to address issues such as finite resources, climate change, and urbanization. The eBike, being the subsequent transitional phase in cycling, contributes to face these challenges. The efficacy of eBikes in transporting people and goods over short distances positions it as a practical alternative to conventional vehicles. Embracing eBikes can benefit the environment and support a sustainable future by aligning individual mobility decisions with contemporary demands.

In the realm of sustainable transportation solutions, assessing the environmental impact of a product is essential. Throughout every stage of an eBike's life cycle, a thorough evaluation of relevant environmental factors guides the process of continuous improvement. This comprehensive analysis, referred to as a Life Cycle Assessment (LCA), examines each phase in detail, from procurement and manufacturing to usage and disposal.

In close collaboration with TÜV Rheinland, comprehensive scrutiny of an eBike's carbon footprint occurred at Bosch, dissecting the components of the Bosch eBike system - the drive unit, battery, display, and control unit. This detailed analysis facilitated the identification of critical areas where substantial environmental savings are attainable.

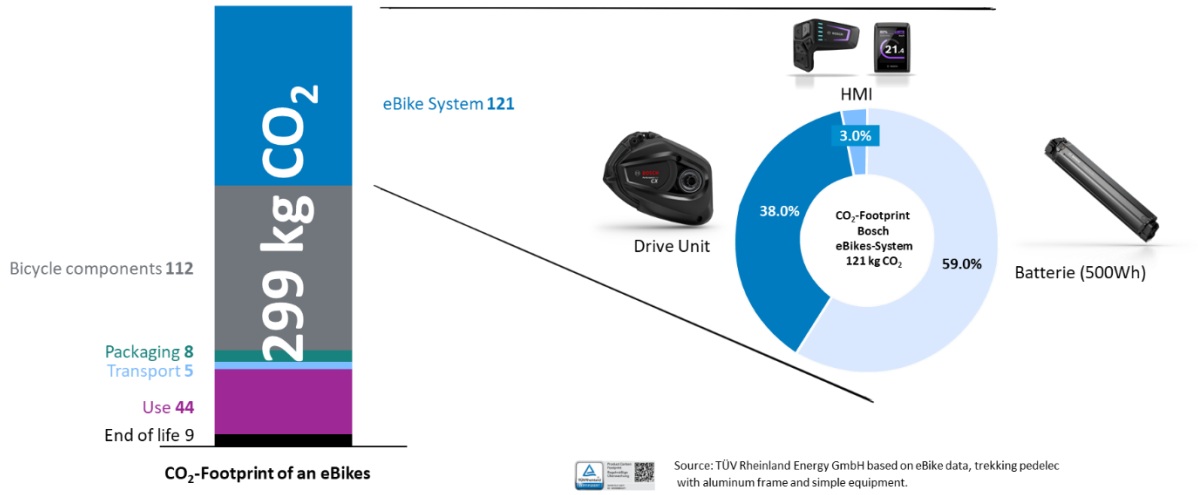


Figure 23: CO2 footprint of a Bosch eBike

Throughout its life cycle, including production and recycling, an eBike has a carbon dioxide equivalent of about 300 kg (Fig. 23). From the breakdown, it is important to note that approximately 75% of these emissions come from materials and manufacturing, while around 15% come from the eBike's actual use. The remaining 10% is attributed to transportation, packaging, and recycling efforts. An intriguing insight arises when focusing on the components of the eBike system: they account for approximately 36% (121 kg) of the total footprint, converting a traditional bicycle into an efficient eBike. Remarkably, the eBike battery is responsible for the majority of this environmental impact.

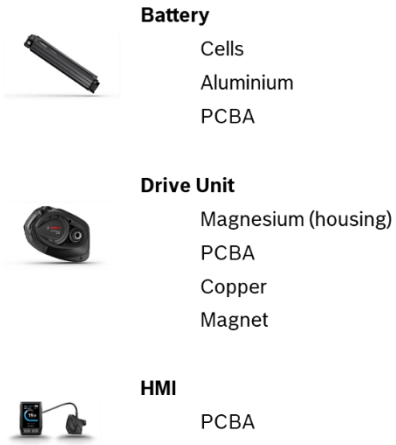


Figure 24: Materials breakdown structure

Once the LCA study is complete and the components that have the greatest impact are identified, the hotspots are located (Fig. 24), and a roadmap is established. It is essential to understand the source of the materials for each component.

With this noteworthy information at hand, initiatives are being undertaken to identify areas where CO2 emissions can be reduced. Understanding the main factors that contribute to the carbon footprint, notably the important part played by eBike batteries, shapes the design of future products. Progress towards reducing emissions brings us closer to a greener, more sustainable future, where eBikes lead the way as eco-friendly urban mobility pioneers.

8.3.2 Supply Chain Responsibility

In recent years the necessity of supply chain transparency has become a focal point for organizations all around the world. A commitment to social and environmental responsibility is pursued at Bosch eBike through a systematic effort to identify and reduce risks across the whole value chain.

This paragraph digs into the holistic strategy, which reflects a commitment to transparency, ethical principles, and long-term development in the manufacturing of every Bosch eBike product.

The operations of Bosch eBike span continents and cultures, with a strong commitment to transparency at the heart of the global presence. The complex network of suppliers and entities engaged in the development of eBike goods is acknowledged. Legal and moral framework criteria are preserved through close collaboration with suppliers. Partnerships are founded on shared principles such as human rights, environmental conservation, and progressive standards.

Every supplier has a quality control system in place that seeks to assure defect-free delivery from the start of series production. Bosch coordinates the necessary procedures at the start of a project as part of preventive quality assurance. Furthermore, purchasing teams collaborate with suppliers to ensure continued adherence to quality criteria, such as by giving trainings.

Recognizing the supplier network's complexity, Bosch eBike engages with associations, certifiers, and auditing projects. These collaborations ensure regulated supply chains, allowing recyclables to be traced back to their origins, including mines. All raw material suppliers are subjected to stringent auditing methods, which improves supply chain transparency.

8.3.2.1 Critical Raw Materials Transparency

Maintaining a transparent supply chain that allows for detailed tracing of vital raw materials (Table 6) is a fundamental part of sustainability activities. The eBike battery is the focus of this effort. A collaborative mapping endeavor has been established in collaboration with battery cell suppliers to unearth critical information about the supply chain, which can be traced back to the mine's raw material purchase.

The supply chain is monitored from the ground up to ensure that raw materials are responsibly supplied. Active participation in efforts such as the German National Action Plan for Business and Human Rights (NAP) and adherence to the United Nations Guiding Principles on Business and Human Rights are essential.

To achieve transparency, Bosch eBike works with renowned certification authorities such as TÜV, depending on their knowledge to confirm efforts. TÜV certificates are used to highlight accomplishments and demonstrate commitment to sustainability. Collaborations with independent bike dealers and original manufacturers highlight the significance of ethical sourcing and business methods. Information regarding sustainability efforts and Hotspots is disseminated through newsletters, media centers, and partnerships, highlighting active areas of influence.

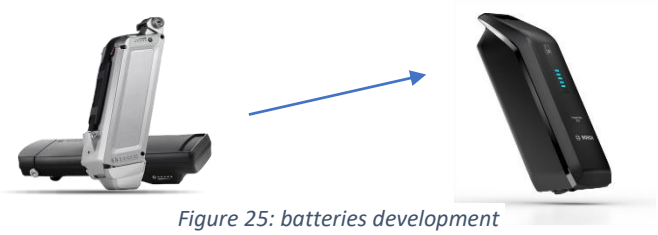
Material	Focus on eBike: where is it used?
Cobalt, Graphite, Lithium, Nickel	Cell
Rare Earth	Magnet
3TG	Electronic
Aluminum	Housing
Copper	Copper wires

Table 6: materials involved

8.3.2.2 Cobalt reduction in battery cells

2.6 kg Weight

288 Wh Power



4.0 kg Weight

725 Wh Power

Figure 25: batteries development

In terms of capacity, batteries are becoming increasingly powerful.

This breakthrough has numerous benefits, not only technological ones: The cobalt level in the cathode of the eBike battery cell has been lowered by 65% compared to earlier technology thanks to the continued development of the battery cells by Bosch suppliers (Fig 25).

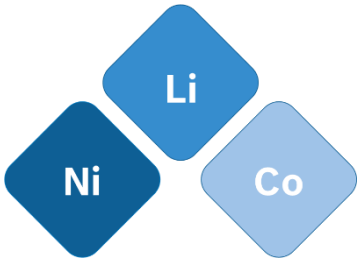


Figure 26: cells materials

Within the cell (Fig. 26) the materials involved are: Lithium that is the most important reactive element in Li-ion cells; Nickel the material responsible for higher energy and finally Cobalt, the main important for performance and service life

Between 2013 and 2021 the percentage of cobalt in the cathode decreased of 65%, and the future improvements are established in order to reach high-energy cells with 0 % cobalt in the cathode.

8.3.3 Circular economy

By implementing a circular economy strategy, the focus is on improving the sustainability of products throughout their entire life cycle - from sourcing and production to use, return, remanufacturing, and ultimately recycling and reuse of materials. Efforts are made to create loops either within the organization or externally, using established recycling processes. This approach significantly reduces the amount of materials used and reduces the carbon footprint of products, contributing to the achievement of Scope 3 targets. It also helps mitigate potential risks associated with environmental and social compliance. Creating a closed-loop system for materials offers the advantage of eliminating vulnerable parts of the value chain. Three actions fall within the Circular Economy at Bosch: material efficiency, second life and recycled materials, as illustrated in Figure 27.

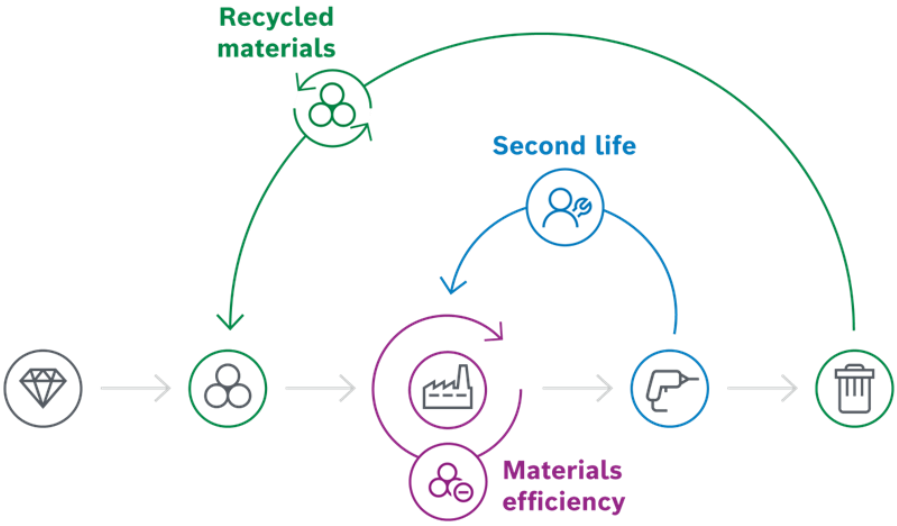


Figure 27: Circular economy at Bosch

Materials efficiency

Improvements in material utilization play a significant role in reducing the carbon footprint and cutting the manufacturing costs of products. Influence over these measures is within reach of the company. Over the years, material efficiency has remained a consistent criterion in the product development process, anchored in the Design for Environment (DfE) principle; the standard includes specific design and manufacturing rules for developers and product owners that cover the entire life cycle of products – from materials used and efficiency in the product development process to recycling or environmentally compatible disposal at the end of the product life cycle. The assessment considers the eco-efficiency of materials and the environmental and social effects associated with specific raw materials. The goal is to minimize the environmental impact of materials used while simultaneously considering social aspects.

Second life

In the second lever, measures have been grouped to improve materials flows or close loops within the company. With multiple objectives and impacts, this lever represents the most complex aspect of the circular economy strategy. The concepts and activities vary from reusing products and components to repairs and remanufacturing, all aimed at extending product and component life cycles. Closing the materials and products loop can mitigate

negative effects, but the effectiveness of these measures also relies on adequate demand, imposing rigorous demands on product development.

Recycled materials

The third lever of the circular economy strategy focuses on recycled materials, with measures to close the loop for materials such as steel, aluminum, and plastics. This approach aims to reduce the use of primary materials, mitigating environmental impact and human rights risks associated with raw material extraction. The effectiveness of these measures depends on factors such as the availability of high-quality materials, the verifiable percentage of recycled materials used, and cost-effective procurement.

The utilization of recycled materials in production processes has been a longstanding practice. Across products, the average percentage of recycled steel used is approximately 56 percent. The share of recycled aluminum matches the industry average of 35 percent. Regarding plastics, the raw material consists of around 5 percent recycled material. There are plans to substantially increase this percentage in the future. Purchase agreements for focus materials with key suppliers, part of scope 3 climate action activities, are expected to contribute to these efforts. Specifications for purchased goods and materials will incorporate a material-specific CO_2 cap, progressively reduced over time, with an increased focus on incorporating recycled materials to achieve these goals.

8.3.3.1 Circular packaging

In pursuit of a circular economy, Bosch eBike Systems has made significant strides in adopting sustainable packaging practices. Since September 2020, eBike drives are now delivered in eco-friendly molded fiber packaging, replacing polystyrene. This switch not only conserves materials and reduces recycling costs but also enhances packing density during transport and storage, leading to approximately 45% CO2 savings. Moreover, meticulous testing led to the elimination of plastic wrapping for PowerTube batteries, reducing CO2 emissions by around 20%. Emphasizing environmental responsibility, Bosch eBike Systems opts for Euro pallets, fostering a system of exchange and reuse post-unloading. Furthermore, the company is committed to selecting eco-conscious materials, minimizing plastic usage, and promoting the adoption of multi-use packaging solutions. Concrete examples include implementing pulp packaging for Drive Units (Fig. 29), introducing

returnable packages for single battery components (Fig. 28), and eliminating plastic bags for batteries. Additionally, Bosch eBike Systems has raised the packaging unit from 100 to 200 for all cables, contributing to resource reduction and waste management in packaging design. These initiatives reflect the company's dedication to a sustainable circular economy, marked by innovative packaging and reduced environmental impact; in line with that Bosch has also signed the Sustainable Packaging Pledges of the bicycle industry in Europe (CIE and CONEBI) [61].

Figure 29: drive unite pulp packaging

Figure 28: returnable packaging for batteries

8.3.3.2 Recycling eBike batteries

The company's dedication to ethical battery management is evidenced by the recycling eBike batteries practices. . Users are encouraged to return eBike batteries at the end of their lifecycle to local dealers, who play critical roles in assuring correct disposal and recycling.

Although Bosch is a component supplier and not the distributor of entire eBikes, the company actively promotes industry solutions, partnering with bicycle manufacturers to establish collection systems in markets where eBikes are sold. Recycling efforts comply with EU regulations, and industry-wide programs are in place in European countries such as Germany, the Netherlands, Belgium, and France. In regions lacking adequate recycling solutions, Bosch collaborates closely with partners, supporting pilot projects and sustainable recycling methods. This commitment to environmentally sound recycling procedures not only preserves valuable resources but also reintroduces vital raw materials into the materials cycle.

Bosch eBike Systems aggressively promotes innovative and ecological recycling methods, with new solutions boasting a recycling effectiveness of more than 90%. This commitment demonstrates the company's commitment to supporting environmentally aware activities in

the eBike market. When batteries arrive at the recycling center, they are processed by expert professionals. Steel, aluminum, copper, graphite/carbon, cobalt, and nickel are meticulously destroyed, segregated, and repurposed for the creation of new products. This transformational journey from used batteries to priceless resources is critical to a greener, more sustainable future.

. Batteries are often returned and recycled for free, indicating the company's dedication to both environmental responsibility. This integrated strategy not only ensures that batteries are treated ethically but also displays Bosch eBike Systems' ongoing commitment to environmental preservation and sustainability in the ever-changing field of eBike technology.

8.3.3.3 Remanufacturing of eBike drives

Repairability and straightforward maintenance stand as crucial criteria in product development to ensure longer product life, serving as fundamental cornerstones of a functional recycling economy. Independent bicycle retailers are equipped with the necessary knowledge and tools to conduct maintenance and minor repairs on the drive unit. Drive units from Bosch eBike, which are replaced at no cost under warranty and goodwill, undergo reconditioning. This process involves comprehensive technical overhauls, ensuring the drives are fully functional. Subsequently, after a final test, these reconditioned drive units are made available to customers once again.

9 Bosch Marketing Strategy for eBikes

During my curricular internship, I worked in the marketing department at Bosch eBike Systems, and in the following chapter, I will cover various aspects of modern marketing, starting with a broader definition that goes beyond traditional advertising. The discussion then delves into Bosch eBike Systems' innovative B2B2C strategy, emphasizing a shift from traditional sales-oriented marketing to a happiness-oriented approach.

This discussion introduces the concept of holistic marketing, which advocates a unified focus on delivering an exceptional customer experience across all business activities, and explores a contemporary role reversal in marketing, where the context and needs of the target audience guide product development and communication strategies.

The following focus will be on green marketing, highlighting its commitment to sustainable development and the challenges associated with avoiding green marketing myopia and greenwashing. The overarching theme emphasizes the importance of aligning marketing strategies with consumer values and environmental responsibility for long-term success.

9.1 Marketing strategy

At a fundamental level, marketing is the process of understanding consumers as well as building or maintaining customer relationships.

Modern marketing can be defined as the science and art of exploring, creating, and delivering value to satisfy the needs of a target market at a profit[62]. Marketing identifies unfulfilled needs and desires. It defines, measures, and quantifies the size of the identified market and the profit potential. It pinpoints which segments the company is capable of serving best, and it designs and promotes the appropriate products and services [63]

As the definition above explains, marketers try to attract customers who might be interested in buying a company's product or service through highly targeted messages and communications. With hundreds of competitors in most industries, a marketing communication strategy offers the chance to outline how an organization plans to capture and keep the attention of consumers.

Marketing communication, often referred to as marcom or integrated marketing communication (IMC) [64], is a comprehensive approach to promoting a product, service, or brand to a target audience.

The primary goal of marketing communication is to influence the perceptions, attitudes, and behaviors of the target audience in a way that supports the company's overall marketing objectives[65].

9.1.1 The B2B2C strategy of Bosch eBike Systems

Bosch eBike Systems is a company founded as a start-up within the Bosch Group, part of the Mobility business, and like the other business units in the group, it also produces an original equipment system.

The product designed for bicycle builders (Business 2 Business), Bosch eBike's direct customers, would only achieve its success if it was understood by those who would then buy those bicycles (Business 2 Costumers). Only eBike enthusiasts have been able to understand from the very beginning, what the eBike propulsion system was and what advantages and benefits it brings Hence the need to have and define a marketing strategy that was not split and addressed separately to the two channels, but a communication strategy that passed through both channels, so that B2B and B2C became both Pull and Push actors: the B2B2C strategy.

The B2B2C approach of companies consists of bringing together companies and customers. The brand itself becomes an intermediary between them. This approach refers to a strong collaboration between stakeholders to co-create value. This value, however, is no longer only given by the quality of the product and its reliability, but this 'non-appealing' and highly technological product must, however, remain true to its market objective: to give greater quality to the life of the individual, the community and the environment. This is why the eBike marketing strategy has had to change its DNA over the years, stripping itself of the purest connotation of marketing devoted to sales, in favor of marketing that was the narrative of a unique, customized, and exciting experience (Fig.30).

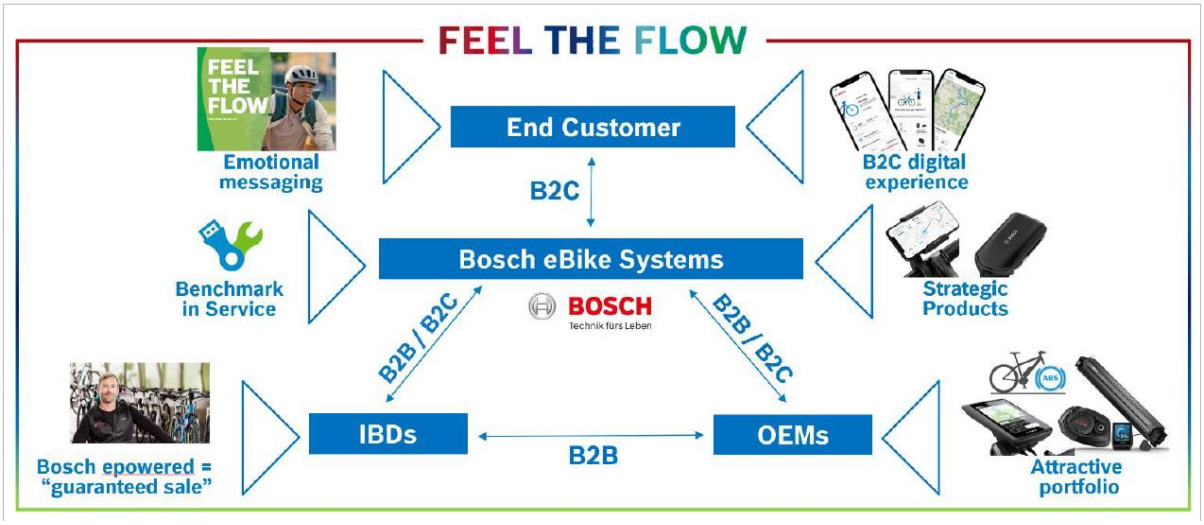


Figure 30: Bosch eBike Systems marketing strategy

9.1.2 The holistic marketing approach

Bosch eBike drafted their entire plan of marketing on one goal: Happiness - "We make cyclists smiling" (Fig. 31). Bosch did not just market its product, but marketed Happiness. The strategy was very smart; Happiness is one of the most cherished things of all, they added 'Feel the Flow" at the one of the brand to make the experience of riding a bike even more intimate and personal, without focusing primarily on why to use an eBike, but on how to ride, with what emotion and for what benefit, seeking one's own Flow. In a way, they proved that whenever you are happy, you can ride an eBike.

This marketing strategy was a success: the new strategy based on the centrality of the emotional experience has not only changed the company's approach to its strategic plan, but in a way it has been the trendsetter of a change of pace, in the consideration of the eBike as a traveling companion, in everyday life (e.g. commuting) but also in moments of leisure.

Figure 31: Bosch eBike Systems motto

The holistic marketing concept believes that the business and all its parts should focus on one single goal which is a great customer experience.

All business activities, processes, communication, and services should be aligned toward providing a customized experience. All tactics must be designed and integrated to work together to provide a consistent, uniform, and seamless customer experience.

Holistic marketing focuses on marketing strategies designed to market the brand and all people connected to it, including customers, employees, shareholders, suppliers, channel partners, regulators, and financial institutions. This type of marketing, also called relationship marketing, emphasizes customer loyalty and satisfaction, instead of focusing on sales transactions. Relationship marketing differs from other types of marketing because it identifies the long-term value of customer relationships and extends communication beyond invasive advertising and promotional messages.

Relationship marketing aims to focus on marketing activities that create a strong, emotional bond between the business and the stakeholders and cultivate loyalty from them, rather than simply interacting with them only during transactions.

9.2 The Green Marketing

Marketers are always trying to identify new opportunities and threats that the marketing environment constantly presents while understanding the importance of continuously monitoring and adapting to that environment [63].

Today, the main challenge for marketers is to think creatively about how marketing can meet the needs of most of the world's population for a better standard of living in the midst of sustainable development.

Green marketing is a philosophy that supports sustainable development. Realizing the importance of people's interest in a healthy environment to live in and preferring environmentally friendly products and services for consumption, marketers seek to capitalize on this to ensure sustainable development and to use these concepts in the development of their strategies. Many companies strive to respond to their customers' desires and have begun producing environmentally conscious products in line with their responsibilities as inhabitants of this planet. Green marketing has a beneficial impact on

public health and the environment. Every aspect of a business, from packaging to public relations, is encompassed by this marketing approach. With green marketing, companies have a significant chance to positively impact the planet and aid environmentally aware individuals. Through the creation of sustainable products, companies aim to minimize the negative effects of waste on nature. Adopting green practices also allows a business to earn the trust and loyalty of customers [66].

However, there are many challenges associated with green marketing. The fundamental challenges in green marketing are how to avoid green marketing myopia and greenwashing. Green marketing must satisfy two objectives, improve environmental quality and customer satisfaction. Misjudging either or overemphasizing the former at the expense of the latter can be termed “green marketing myopia”[67]. Several environmentally friendly products have failed in the market due to marketing professionals' short-sighted emphasis on their eco-friendliness rather than addressing the wider expectations of consumers and other market players.

There are three key principles for avoiding green marketing myopia. These three key principles are consumer value positioning, calibration of consumer knowledge, and the credibility of product claims [67].

The first key principle “Consumer Value Positioning” elucidates that marketers should design environmental products to perform as well as (or better than) alternatives. Marketers should promote and deliver the consumer-desired value of environmental products and target relevant consumer market segments (such as market health benefits among health-conscious consumers). Marketers should broaden mainstream appeal by bundling (or adding) consumer-desired value into environmental products (such as fixed pricing for subscribers of renewable energy). The second key principle “Calibration of Customer Knowledge” elucidates that marketers should educate consumers with marketing messages that connect environmental product attributes with desired consumer value. Marketers should frame environmental product attributes as “solutions” for consumer needs (for example, “rechargeable batteries offer longer performance”). Marketers should create engaging and educational Internet sites about environmental products‟ desired consumer value. The third key principle “Credibility of Product Claims” elucidates that Marketers should employ environmental product and consumer benefit claims that are

specific, meaningful, unpretentious, and qualified (that is, compared with comparable alternatives or likely usage scenarios). Marketers should procure product endorsements or eco-certifications from trustworthy third parties and educate consumers about the meaning behind those endorsements and eco-certifications[68].

Another challenge that is affecting green marketing is “greenwashing”. Corporations are increasingly recognizing the benefits of green marketing, although there is often a thin line difference between doing so for its own benefit only and for social responsibility reasons. The term “greenwashing” refers to all industries that adopt outwardly green acts with an underlying purpose to increase profits. The term greenwashing was first used by environmentalist Jay Westerveld when objecting to hoteliers' practice of placing notices in hotel rooms that asked their guests to reuse towels to “save the environment”[69]. Westerveld noted that there was little else to suggest that the hoteliers were interested in reducing their environmental impacts and that their interest in washing fewer towels seemed to be motivated by a concern to save costs rather than the environment. Since then greenwashing has become a central feature of debates about marketing communications and sustainability, with “awards” for greenwashing established and numerous campaigns, laws and advices developed in an attempt to reduce or curb it. These two problems should be tackled tactfully so that green marketing can get its real meaning and achieve its real objectives.

10 Conclusions

In conclusion, this thesis reveals the diverse benefits that electric bicycles (eBikes) offer to our communities. Of particular importance is the significant contribution of eBikes towards mitigating environmental issues, as they emit far fewer pollutants than traditional modes of transport. This holds profound implications, aligning with the principles of the Paris Agreement and advising a potential paradigm shift in urban mobility. However, this transformation necessitates cities to be adequately prepared, with infrastructures capable of accommodating the growing demand for eBikes.

Beyond the environmental sphere, eBikes emerge as catalysts for holistic community well-being. They serve not only as an eco-friendly mode of transportation but also as a means to promote physical exercise and social interactions, underlining their potential to enrich the fabric of our daily lives.

As the eBike market experiences significant economic growth, it becomes imperative to address the legal and ethical dimensions of this burgeoning industry. The influx of critical raw materials into the supply chain underscores the need for stringent regulations and supplier audits to ensure compliance with both legal requirements and sustainability standards companies aspire to achieve.

The effective marketing of eBikes is crucial for their successful integration. Authentic highlighting of their benefits should be the focus, while avoiding greenwashing and misleading advertisements in an era where sustainability claims are prevalent. Educating consumers regarding the positive impact of eBikes on communities is required for this balance to be achieved.

In a globalized landscape, the harmonious collaboration of different departments within companies is paramount. Coordinated efforts are essential to realize a shared goal of sustainable urban mobility, fostering an environment where every facet of a company aligns to contribute positively to the communities we inhabit. Through conscientious development, legal adherence, strategic marketing, and collective action, eBikes can indeed serve as transformative agents in shaping a more sustainable and interconnected future.

11 Bibliography

[1] A. Awan, M. Alnour, A. Jahanger, and J. C. Onwe, “Do technological innovation and urbanization mitigate carbon dioxide emissions from the transport sector?,” *Technol Soc*, vol. 71, p. 102128, Nov. 2022, doi: 10.1016/j.techsoc.2022.102128.

[2] R. K. Yin, *Case Study Research: Design and Methods*, vol. 5. SAGE, 2003.

[3] P. Rérat, “The rise of the e-bike: Towards an extension of the practice of cycling?,” *Mobilities*, vol. 16, no. 3, pp. 423–439, May 2021, doi: 10.1080/17450101.2021.1897236.

[4] E. Fishman and C. Cherry, “E-bikes in the Mainstream: Reviewing a Decade of Research,” *Transp Rev*, vol. 36, no. 1, pp. 72–91, Jan. 2016, doi: 10.1080/01441647.2015.1069907.

[5] L. Market Study Report, “Global e-bike market size to reach USD 48.46 billion by 2028,” 2021.

[6] M. McQueen, J. MacArthur, and C. Cherry, “The E-Bike Potential: Estimating regional e-bike impacts on greenhouse gas emissions,” *Transp Res D Transp Environ*, vol. 87, p. 102482, Oct. 2020, doi: 10.1016/j.trd.2020.102482.

[7] H. B. Sundfør and A. Fyhri, “A push for public health: the effect of e-bikes on physical activity levels,” *BMC Public Health*, vol. 17, no. 1, p. 809, Dec. 2017, doi: 10.1186/s12889-017-4817-3.

[8] T. Jones, L. Harms, and E. Heinen, “Motives, perceptions and experiences of electric bicycle owners and implications for health, wellbeing and mobility,” *J Transp Geogr*, vol. 53, pp. 41–49, May 2016, doi: 10.1016/j.jtrangeo.2016.04.006.

[9] A. Fyhri and N. Fearnley, “Effects of e-bikes on bicycle use and mode share,” *Transp Res D Transp Environ*, vol. 36, pp. 45–52, May 2015, doi: 10.1016/j.trd.2015.02.005.

[10] M. Jenkins *et al.*, “What do we know about pedal assist E-bikes? A scoping review to inform future directions,” *Transp Policy (Oxf)*, vol. 128, pp. 25–37, Nov. 2022, doi: 10.1016/j.tranpol.2022.09.005.

[11] N. B. Hung and O. Lim, “A review of history, development, design and research of electric bicycles,” *Appl Energy*, vol. 260, p. 114323, Feb. 2020, doi: 10.1016/j.apenergy.2019.114323.

[12] E. Salmeron-Manzano and F. Manzano-Agugliaro, “The electric bicycle: Worldwide research trends,” *Energies (Basel)*, vol. 11, no. 7, p. 1894, 2018.

[13] European Environment Agency, “Green Infrastructure (GI) — Enhancing Europe’s Natural Capital,” 2013. Accessed: Nov. 23, 2023. [Online]. Available: https://eur-lex.europa.eu/resource.html?uri=cellar:d41348f2-01d5-4abe-b817-4c73e6f1b2df.0014.03/DOC_1&format=PDF

[14] R. Corticelli, M. Pazzini, C. Mazzoli, C. Lantieri, A. Ferrante, and V. Vignali, “Urban Regeneration and Soft Mobility: The Case Study of the Rimini Canal Port in Italy,” *Sustainability*, vol. 14, no. 21, p. 14529, Nov. 2022, doi: 10.3390/su142114529.

[15] L. Barbarossa, “The post pandemic city: Challenges and opportunities for a non-motorized urban environment. An overview of Italian cases,” *Sustainability*, vol. 12, no. 17, p. 7172, 2020.

[16] R. Weston and J. C. Mota, “Low Carbon Tourism Travel: Cycling, Walking and Trails,” *Tourism Planning & Development*, vol. 9, no. 1, pp. 1–3, Feb. 2012, doi: 10.1080/21568316.2012.658168.

[17] S. Edge, J. Goodfield, and J. Dean, “Shifting gears on sustainable transport transitions: Stakeholder perspectives on e-bikes in Toronto, Canada,” *Environ Innov Soc Transit*, vol. 36, pp. 197–208, Sep. 2020, doi: 10.1016/j.eist.2020.07.003.

[18] K. N. Genikomsakis, N.-F. Galatoulas, and C. S. Ioakimidis, “Towards the development of a hotel-based e-bike rental service: Results from a stated preference survey and techno-economic analysis,” *Energy*, vol. 215, p. 119052, Jan. 2021, doi: 10.1016/j.energy.2020.119052.

[19] V. Mitterwallner *et al.*, “Electrically assisted mountain biking: Riding faster, higher, farther in natural mountain systems,” *Journal of Outdoor Recreation and Tourism*, vol. 36, p. 100448, Dec. 2021, doi: 10.1016/j.jort.2021.100448.

[20] A. Hardy, R. J. Buning, P. Boudreau, and J. Thomas, “When flow meets business: A study of mountain biking,” *Annals of Tourism Research Empirical Insights*, vol. 4, no. 2, p. 100102, Nov. 2023, doi: 10.1016/j.annale.2023.100102.

[21] AusCycling, “Mountain Biking in Australia: An Economic and Participation Analysis,” 2021. Accessed: Nov. 23, 2023. [Online]. Available: https://assets.auscycling.org.au/s3fs-public/2021-03/mountain-biking-in-australia-final-report-march-2021.pdf?sOhdYZLJUG1eZnmPE8yYmFQbbuOqrfm4=

[22] S. Taylor, C. Burrow, and S. Button, “Challenging hegemonic velocipedic modality in the great outdoors: The seemingly inexorable rise of the electric mountain bike,” *Journal of Outdoor Recreation and Tourism*, vol. 43, p. 100684, Sep. 2023, doi: 10.1016/j.jort.2023.100684.

[23] mountain bike worldwide, “BEST E-MOUNTAIN BIKE RIDES IN EUROPE.” Accessed: Nov. 25, 2023. [Online]. Available: https://www.mountainbikeworldwide.com/e-mtb/e-mountain-biking-in-europe

[24] K. Heineke, S. Lakhsassi, D. Scurtu, and F. Rupalla, “Consumer pull: The growth of shared urban mobility,” *McKinsey Center for Future Mobility*, Jun. 2023, Accessed: Nov. 23, 2023. [Online]. Available: https://www.mckinsey.com/features/mckinsey-center-for-future-mobility/our-insights/consumer-pull-the-growth-of-shared-urban-mobility#/

[25] Banca ifis, “Ecosistema della bicicletta,” 2023.

[26] C. Bonaria, B. E. Campisi, M. Jarre, M. Noussan, and F. Cudini, “Trasformare la mobilità urbana: l’opportunità per eBike e eCargobike,” 2023. Accessed: Nov. 23, 2023. [Online]. Available: https://www.bosch-ebike.com/fileadmin/EBC/1_News/2023/trasformare-la-mobilita-urbana/D1-Dossier.pdf?_=1683803970

[27] Conebi, “Industry and market Figures,” 2022.

[28] Confindustria Associazione Nazionale Ciclo Motori Accessori, “Monitoraggio vendite negozi di biciclette ,” Mar. 2023.

[29] B. Wiesmann, J. R. Snoei, P. Hilletofth, and D. Eriksson, “Drivers and barriers to reshoring: a literature review on offshoring in reverse,” *European Business Review*, vol. 29, no. 1, pp. 15–42, Jan. 2017, doi: 10.1108/EBR-03-2016-0050.

[30] M. Sutton, “Reshoring: How far has the trend come and what obstacles remain?,” *Cycling Industry News*, Jul. 20, 2022. Accessed: Nov. 23, 2023. [Online]. Available: https://cyclingindustry.news/reshoring-production-in-the-bicycle-industry/

[31] Smart Growth America, “Recent Lessons from the Stimulus: Transportation Funding and Job Creation,” Feb. 2011. Accessed: Nov. 23, 2023. [Online]. Available: https://smartgrowthamerica.org/wp-content/uploads/2016/08/lessons-from-the-stimulus.pdf

[32] I. Energy Agency, “Recovery Sustainable World Energy Outlook Special Report in collaboration with the International Monetary Fund,” 2020. Accessed: Nov. 23, 2023. [Online]. Available: https://www.iea.org/reports/sustainable-recovery

[33] “IEA, Employment multipliers for investment in the transport sector, IEA, Paris https://www.iea.org/data-and-statistics/charts/employment-multipliers-for-investment-in-the-transport-sector, IEA. Licence: CC BY 4.0”.

[34] A. Fyhri and H. Beate Sundfør, “Do people who buy e-bikes cycle more?,” *Transp Res D Transp Environ*, vol. 86, p. 102422, Sep. 2020, doi: 10.1016/j.trd.2020.102422.

[35] M. Kroesen, “To what extent do e-bikes substitute travel by other modes? Evidence from the Netherlands,” *Transp Res D Transp Environ*, vol. 53, pp. 377–387, Jun. 2017, doi: 10.1016/j.trd.2017.04.036.

[36] S. Cairns, F. Behrendt, D. Raffo, C. Beaumont, and C. Kiefer, “Electrically-assisted bikes: Potential impacts on travel behaviour,” *Transp Res Part A Policy Pract*, vol. 103, pp. 327–342, Sep. 2017, doi: 10.1016/j.tra.2017.03.007.

[37] Partnership for Active Travel and Health, “Make way for walking and cycling,” 2022. Accessed: Nov. 23, 2023. [Online]. Available: https://walk21.com/wp-content/uploads/2022/10/PATH-report-Make-way-for-walking-and-cycling.pdf

[38] World Health Organization, “Walking and cycling: latest evidence to support policy-making and practice,” 2022.

[39] B. F. Azevedo, K. Metzger, and A. I. Pereira, “A comprehensive data analysis of e-bike mobility and greenhouse gas emissions in a higher education community: IPBike study of case,” *SN Appl Sci*, vol. 5, no. 11, p. 291, Nov. 2023, doi: 10.1007/s42452-023-05504-7.

[40] P. Oja *et al.*, “Health benefits of cycling: a systematic review,” *Scand J Med Sci Sports*, vol. 21, no. 4, pp. 496–509, Aug. 2011, doi: 10.1111/j.1600-0838.2011.01299.x.

[41] A. Castro *et al.*, “Physical activity of electric bicycle users compared to conventional bicycle users and non-cyclists: Insights based on health and transport data from an online survey in seven European cities,” *Transp Res Interdiscip Perspect*, vol. 1, p. 100017, Jun. 2019, doi: 10.1016/j.trip.2019.100017.

[42] J. F. Teixeira and M. Lopes, “The link between bike sharing and subway use during the COVID-19 pandemic: The case-study of New York’s Citi Bike,” *Transp Res Interdiscip Perspect*, vol. 6, p. 100166, Jul. 2020, doi: 10.1016/j.trip.2020.100166.

[43] A. Nikiforiadis, G. Ayfantopoulou, and A. Stamelou, “Assessing the Impact of COVID-19 on Bike-Sharing Usage: The Case of Thessaloniki, Greece,” *Sustainability*, vol. 12, no. 19, p. 8215, Oct. 2020, doi: 10.3390/su12198215.

[44] J. R. Sirard and M. E. Slater, “Walking and Bicycling to School: A Review,” *Am J Lifestyle Med*, vol. 2, no. 5, pp. 372–396, Sep. 2008, doi: 10.1177/1559827608320127.

[45] S. J. Leger, J. L. Dean, S. Edge, and J. M. Casello, “‘If I had a regular bicycle, I wouldn’t be out riding anymore’: Perspectives on the potential of e-bikes to support active living and independent mobility among older adults in Waterloo, Canada,” *Transp Res Part A Policy Pract*, vol. 123, pp. 240–254, May 2019, doi: 10.1016/j.tra.2018.10.009.

[46] World Health Organization., *Global Age-friendly Cities : a Guide.* World Health Organization, 2007.

[47] Joy Ride, “Yes, bicycles are the solution to urban traffic problems.” Accessed: Nov. 23, 2023. [Online]. Available: https://joyride.city/blog/bicycles-solution-urban-traffic/

[48] O. Rubin, A. Nikolaeva, S. Nello-Deakin, and M. te Brömmelstroet, “What can we learn from the COVID-19 pandemic about how people experience working from home and commuting,” *Centre for Urban Studies, University of Amsterdam*, vol. 1, no. 9, pp. 1–9, 2020.

[49] TomTom, “Traffic Index.” Accessed: Nov. 24, 2023. [Online]. Available: https://www.tomtom.com/traffic-index/

[50] A. Fyhri, H. B. Sundfør, T. Bjørnskau, and A. Laureshyn, “Safety in numbers for cyclists—conclusions from a multidisciplinary study of seasonal change in interplay and conflicts,” *Accid Anal Prev*, vol. 105, pp. 124–133, Aug. 2017, doi: 10.1016/j.aap.2016.04.039.

[51] Bosch, “Annual Report,” 2022.

[52] J. Ebberg, “Sustainable ‘like a Bosch’: Smart, climate-friendly solutions for health, home, industry, and mobility,” Jan. 11, 2021. Accessed: Nov. 25, 2023. [Online]. Available: https://www.bosch-presse.de/pressportal/de/en/sustainable-like-a-bosch-smart-climate-friendly-solutions-for-health-home-industry-and-mobility-223381.html

[53] Bosch, “Sustainability Report,” 2022.

[54] Bosch Global, “Environment .” Accessed: Nov. 25, 2023. [Online]. Available: https://www.bosch.com/sustainability/environment/

[55] United Nations Global Compact, “The Ten Principles of the UN Global Compact.” Accessed: Nov. 23, 2023. [Online]. Available: https://unglobalcompact.org/what-is-gc/mission/principles

[56] CDP disclosure insight action, “About Us.” Accessed: Nov. 25, 2023. [Online]. Available: https://www.cdp.net/en/info/about-us

[57] Sustainalytics, “About Us.” Accessed: Nov. 25, 2023. [Online]. Available: https://www.sustainalytics.com/

[58] J. Ranganathan, L. Corbier, P. Bhatia, S. Schmitz, P. Gage, and K. Oren, “The Greenhouse Gas Protocol. A Corporate Accounting and Reporting Standard,” 2004.

Accessed: Nov. 23, 2023. [Online]. Available: https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf

[59] Bosch eBike Systems, “Movement for Responsible Mobility.” Accessed: Nov. 23, 2023. [Online]. Available: https://www.bosch-ebike.com/en/service/sustainability

[60] European Environment Agency., *Decarbonising road transport : the role of vehicles, fuels and transport demand.* 2021.

[61] Confederation of the European Bicycle Industry and Cycling Industries Europe, “Cycling Industry Sustainable Packaging Pledge.” Accessed: Nov. 23, 2023. [Online]. Available: https://www.conebi.eu/wp-content/uploads/2022/03/cycling_industry_sustainable_packaging_commitment__letter_2.1_conebie.pdf

[62] P. Kotler and kotler Marketing Group, “Dr. Philip Kotler Answers Your Questions on Marketing.” Accessed: Nov. 25, 2023. [Online]. Available: https://www.kotlermarketing.com/phil_questions.shtml

[63] G. Armstrong, S. Adam, S. Denize, and P. Kotler, *Principles of marketing*. Pearson Australia, 2014.

[64] I. M. Zahra, “Integrated Marketing Communications (IMC),” pp. 102–123. doi: 10.4018/978-1-5225-3878-3.ch008.

[65] K. Ntloko, “Why You Need a Marketing Communication Strategy,” Meltwater. Accessed: Nov. 25, 2023. [Online]. Available: https://www.meltwater.com/en/blog/why-you-need-a-marketing-communication-strategy

[66] Send Pulse, “Green Marketing.” Accessed: Nov. 23, 2023. [Online]. Available: https://sendpulse.com/support/glossary/green-marketing

[67] J. A. Ottman, E. R. Stafford, and C. L. Hartman, “Avoiding Green Marketing Myopia: Ways to Improve Consumer Appeal for Environmentally Preferable Products,” *Environment: Science and Policy for Sustainable Development*, vol. 48, no. 5, pp. 22–36, Jun. 2006, doi: 10.3200/ENVT.48.5.22-36.

[68] S. M. Das, B. M. Dash, and P. C. Padhy, “Green marketing strategies for sustainable business growth,” *Journal of Business Management & Social Sciences Research*, vol. 1, no. 1, pp. 82–87, 2012.

[69] B. Watson, “The troubling evolution of corporate greenwashing,” *Chain Reaction*, no. 129, pp. 38–40, 2017.