

IF Design Award Challenge

HENRY RADBURN - THE DYSON URBAN E BIKE

A product designed to redefine and change the DNA for modern urban living to establish a healthier and more sustainable environment for years to come.

The aim for this project is to create an electric push bike (e-bike) produced by Dyson, for the purpose of commuting to work in urban areas for the year 2030. It will address a variety of the sustainable development goals set out by the United Nations. This includes, introducing affordable and clean energy supplies, and adopting more sustainable cities and communities for the future. To gain a better understanding of what each of these scenarios mean, I have conducted some further research about each segment so I can aid a well-engineered design response.

Firstly, affordable, and clean energy is essential for agriculture, healthcare, education, and infrastructure. To date, 660 million lack electricity and two billion rely on harmful cooking fuels for energy supply. Some of the consequences of a lack of energy access include an increase in climate change through the reliance on fossil fuels and a decrease in educational opportunities. Poverty and healthcare delivery are also massively affected. Some actions have been introduced to address energy issues by various levels of hierarchy. For instance, Employers can promote telecommuting and sustainable transportation, plus individuals themselves can save energy at home, use public transport and advocate for sustainability. By prioritizing these concepts as a collective we can drive economic growth, improve health outcomes, and combat climate change (*United Nations. (n.d.)*)

Another area I want to tackle is advocating for more sustainable cities and communities for the future. Currently, inequality, high energy consumption and climate vulnerability is leading to unhealthy growth in our cities. Cities are a massive benefactor to global warming as they use 60 – 80% of energy and they contribute to 75% of global carbon emissions. As a result, despite considerable progress has been made, active participation in sustainable urban development is essential for creating resilient and inclusive cities for the future. Both of these goals I need to use and consider in my design to make my product all round more future proof in our ever-growing cities. (*United Nations (n.d.)*)

My main target consumer for this product is young adults, students and young professionals aged between 18 - 25, who commute daily in urban environments as this aligns well with the overall design and brand image. Ultimately, this demographic is the driving force to make a change and impact on the future, hence why I want my product to embody this meaning.

Scope and area of study

During this report, I want to focus on the benefits and challenges of renewable energy and how it has the potential to impact our lives and communities. Additionally, I want to promote the benefits of exercise by making it more engaging and accessible for all, this can be achieved and implemented in my design by introducing the newest technology to enhance the consumer experience and appeal of the product. Another area of study I want to address is how the impact of commuting via modes of transport like cycling, can promote a more sustainable lifestyle and combat the growing congestion issues and pollution in our cities.

Additionally, I am going to produce a brand analysis account on Dyson, to discover various elements about the company and the role it will play in developing my bike. Dyson is a British technology company; it was founded in 1991 by James Dyson in Malmsbury, England. The company manufactures household appliances such as vacuum cleaners, air purifiers, hand dryers and bladeless fans. It has also ventured into the automotive industry into 2020. The journey began in 1978, when James was frustrated by his vacuums diminishing performance. He took it apart and discovered the bag was clogging up with dust particles causing suction to drop. As a result, he set to work on a new vacuum cleaner, after 5 years and 5127 prototypes, he invented the world first bagless vacuum cleaner. Today, there are over sixty-five countries with Dyson products around the world. To quote. Dyson states that “Like everyone we get frustrated by products that do not work properly. As design engineers we do something about it. We are all about invention and improvement ‘. This is an indication of the strives and commitment that Dyson has gone through to establish a clear brand ethos and top of the range products (*Dyson. (n.d.)*)

James Dyson has also established a unified design language that permeates across all his products. This design language is characterized by sleek lines, minimalist aesthetics, and an emphasis on functionality. Dyson’s products are instantly recognizable, with their distinctive shapes and bold colour schemes such as deep purples and golds. This unified design language creates a cohesive brand identity and reinforces the notion that form, and function can exist harmoniously. This is what I aim to achieve with my product to instantly create that resemblance with the brand by using similar colours, shapes, and materials across the bike. (*Ajal Connect. (2020)*)

Environment

My bike will be used in an urban setting as a tool to commute and explore the growing number of cities across the planet. However, I want to primarily promote the bike to people that live and work in the UK, as I feel the bike will stand out and work effectively in this market, having been produced by Dyson domestically. This is because major

cities like London and Birmingham have the infrastructure in place currently to suit the needs and demands, which the bike needs to work efficiently, such as cycle paths and storage facilities. The bike will be manufactured in the UK but is available to many countries. This is important as it will massively affect the overall design and look of the bike as it needs to adapt to the opportunities and challenges of city life.

Currently, more than half of the world's population live in urban areas, and that number is expected to increase to 70% by 2050. (*United Nations. (n.d.)*) Sustainable development depends critically on the successful management of urban growth to create sustainable cities in both developed and developing countries. United Nations (*Department of Economic and Social Affairs (n.d.)*) In the future, cities will need to be more efficient in their use of resources, reduce waste and emissions, and become more resilient to climate change. This could include using green spaces to absorb water, planting trees to provide shade, and establishing urban farms to produce food locally (*Chatham House. (2022)*).

Transportation will also be heavily impacted by urbanisation with the growing need for more sustainable modes of transport due to the current problems surrounding global warming and overcrowding. Transport infrastructure is a fundamental element of an urban space as it connects both communities and businesses together, which in turn will promote sustainability. Therefore, I strongly feel E -Bikes are the perfect solution to this issue as they are particularly close substitutes for cars, two-wheelers, and motorcycles because they can cover longer distance trips with less effort, relative to traditional pedal bikes. Thus, e-bikes will have a significant role to play in shifting people away from high-polluting private vehicles.

To back this theory up, a report by IDTP (Institution for transportation and development policy), positions e-bikes as a critical element to making cities more liveable and equitable due to their potential to replace a large share of vehicle trips and reduce related emissions and congestion. The report identifies the individual countries with the largest emissions reductions potential as India and the United States, where a switch to e-bikes could take more than 40 million vehicles (cars and two-wheelers) in India, and 8 million cars in the US, off the road (*Institute for Transportation and Development Policy (ITDP). (2024)*)

Need for the Bike

The main need for the bike is to create a device that is more efficient and sustainable substitute to high emission vehicles by promoting its health benefits and increased versatility in a developing urban world. As cities deal with the complex issues of accessibility, pollution, and traffic congestion, there is a considerable need for sustainable and alternative modes of transportation. There is gap in the market for an innovative and creative vehicle that can effectively operate in a modern world without compromising on attractiveness and efficiency. This is why I want to target the e bike industry as it is seen as the growing future of technology and mobility.

An e bike is defined as a motorized bicycle with an integrated electric motor used to assist propulsion. They are offered in a variety of styles, including cargo bikes, commuting bikes, mountain bikes, folding bikes and more (*REI Co-op. (n.d.)*). This bike will be positioned in the premium, innovative and high-tech category of current urban e-bikes. In terms of the current competition, Fiido, Canyon and Ribble are all brands, which are seen as the pinnacle and industry segment exemplars. I want to situate my product in line and potentially be the benchmark for a contemporary and innovative push bike for the future.

Vehicle Benchmarking

To justify and establish my brand in the industry I need to study these market leading brands further so that I can improve on and install a design proposal, which is not only original but also well considered. First of all, Canyon is a world-leading manufacturer of road, mountain, triathlon, urban, fitness and electric bikes. Their current urban e bike, named the Commuter ONFLY, will provide you with a fast, comfortable, and environmentally friendly ride in the city. It combines innovative technological solutions with functional design, making it a desirable choice for city lovers. In terms of specifications, the bike uses a powerful and compact motor (FAUZA) with a peak power of 450 watts to assist uphill. It is also compatible with trailers to provide storage and has a smart ultra mini lights integrated into the beam (*Canyon. (n.d.)*). This product has many interesting features that I can use as platform and further adapt into my design. Equally, this is another reason I have chosen Dyson to accompany this design as they embody innovation and clever design language like Canyon.

For my design, I need get a clear understanding of the key components that are needed for an e-bike to work effectively. To date, the key elements of an e bike are the battery, motor, sensor, display, and controller. These will provide the backbone of my design and will provide an opportunity to improve and adapt on the current modern-day bike.

In more detail, the battery powers the motor and is usually lithium-ion, which is seen as lightweight, high-performing, and sustainable (*Pirelli. (n.d.)*). The motor is the powerhouse of the e- bike, it is usually situated in the front wheel, crank set, or rear wheel (*eMovement. (n.d.)*). The sensor activates the motor to assist with pedalling through speed/torque (*Eskute. (n.d.)*) and the display monitors the batteries motor and performance to show the rider how much assistance provided (*Bolt. (n.d.)*). Lastly, the controller works alongside the display and is usually developed for a set of kit functions (*eBikes.ca. (n.d.)*). Also, other feature like pedals, lights and brakes are also seen as essential features.

To create a well-designed bike all these components need to work seamlessly together to provide a smooth and pleasant ride. Therefore, in my design to provide a bike that is top of the range and a benchmark for innovation and sustainability, these key features need to catch the eye and help to generate the ultimate user experience for the consumer.

Infrastructure and technology study

Technology will play a massive role in my design process; I want to include the latest in bike technology and some fresh innovative ideas for the future. As I have mentioned earlier, I want to target the battery, motor, sensor, display, and controller as these aspects have the most effect on usability and design language of the overall product. However, I will also use other new accessories and features, such as tyres, brakes, and app connectivity, which will enhance the rider experience and establish a more cohesive design proposal.

Battery

To begin with, I researched in depth the latest technology in e bike batteries. Solid state batteries are seen as a game changer for the future of e bikes in comparison to the current use of lithium – ion batteries. Some of the many positives of this battery is that it can fully charge in 15 minutes and is smaller and lighter. For example, a 90kwh battery made by lithium-ion chemistry weighs about 800lbs, while a solid-state battery of the same capacity weighs 580lbs (*Automotive World. (2023)*). Additionally, it can provide 50 % more capacity and is a safer option as they do not catch fire (*eBike24. (n.d.)*). Hence, why I have chosen to install this technology on the bike as it is a clear upgrade and seems well equipped for future needs.

Motor

Another vital role of an e bike is the motor, which is often considered as the fundamental building block to a bike's performance. In order, to combine Dyson and the bike industry I feel using the brands rich history in developing motors could be implemented and woven into my design. Dysons newest hyperdium motor is engineered to run at speeds of up to 125,000rpm making it the most powerful vacuum motor engineered, but also its lightest and most durable. It uses neodymium magnets and builds in ceramic shaft that is three times stronger than steel. Dysons team has meticulously researched this motor to perform to its optimum level of performance through its illustrious use of state-of-the-art technology. For this reason, it is used on a number of its vacuums such as its V11 cordless and robot cleaners. James Dyson, the engineer and founder of Dyson, states "As engineers. we must see beyond existing technology and ask, 'Is there a better way?'" This in turn, has been remarkably successful motto for the company as many people see their brand and products as the pioneers of modern-day innovation. (*Dyson. (n.d.)*)

I want to mirror this is my design to continue with Dysons legacy and brand identity, thus why I am going to use this motor to assist in powering my bike. The reason for this is its many positive qualities, including its lightweight, durable, and compact size making it a very adequate addition to this e bike and one, which is sustainable and fit for the future.

Sensor

A torque sensor is another important avenue as they are expected to become more accurate, efficient, and integrated in the future. Technology such as artificial intelligence, miniaturization and advancements in safety features are all ideas expected to be utilised in sensors soon.

First, artificial intelligence has immense potential as it has the ability to analyze the riders' pedalling patterns and preferences. This enables the e bike to dynamically adjust the power assist level in real time, providing a deeply personal rider experience. Another development is that manufacturers are striving to produce sensors, which are far more lightweight and compact, without compromising on durability or accuracy.

Subsequently, leading to improved efficiency performance and a sleeker, more minimalist appeal (*Eskute. (n.d.)*) This also matches Dysons design language and ethos as well as the added technology to improve on a product.

Display and controller

As bikes continue to expand and become more advanced, the desire for better integration, information and control seems to grow. In terms of current displays, Bosch smart systems represent a significant leap forward in e-bike technology. Their displays combine various unique components into a cohesive, optimized system designed for enhanced performance, control and most importantly user experience. The Kiox three hundred display is a high-resolution digital display that offers many features designed to aid the rider. Some of the more basic features include a battery level status, a range status, and a speed monitor. (*e-Bikeshop. (n.d.)*)

However, further advancements suggest that ideas such as, connectivity, customisation and protection is recognised as the gateway for a new wave of technology to be introduced. As my bike, is set to be in production for the year 2030 and my main client base is young adults. I feel getting a smart display system is vital to enhance the appeal and accessibility for the product. In addition, the growing phone industry, and a dynamic change into a more digital world, is the perfect opportunity to combine these two elements together. Smartphone apps are becoming the central hub for e bike control such as Bosch's ebike flow app. These apps allow you to fine tune power assist levels, run remote diagnostics checks, plan optimized routes and security control all from the power of your mobile device. This is an area I want to use in my ebike as it makes the product more user friendly and future proof as it aligns with the current trends of society and is something that will enhance the bikes appeal in the industry. (*Really Good E-Bikes. (n.d.)*)

Safety features

Safety is a huge concern for e bike riders for several reasons. In the UK, an average of 77,000 bikes are stolen each year (*Department for Transport. (2023)*) and in 2023 87 pedal cyclists were killed, 3,942 were seriously injured, and 10,970 were slightly injured due to crashes (*The Best Bike Lock. (n.d.)*). These numbers are concerning, hence why in my bike safety and protection will be at the forefront of the process. I will include safety features such as, integrated lighting, which will adjust automatically based on

ambient light conditions and speed. Moreover, to prevent collisions I am going to use sensors that detect and warn riders of potential dangers in advance, similar to cars. Finally, the bike will have enhanced security features like GPS tracking via a smartphone and remote locking, this will help to prevent theft and recover stolen bikes.

User profile

The Dyson Urban Electric E-Bike is a contemporary, high-performance electric bike designed for students and young professionals living in busy urban environments for the year 2030. It combines, Dyson's famous innovation policy and design language, making it the perfect and most luxury everyday commute tool. It achieves this by delivering speed, comfort, and convenience without sacrificing on the fundamentals of style or sustainability. Featuring state of the art technology, lightweight materials and a long-lasting battery and range, the Dyson Urban Electric Bike meets the requirements of my target user.

The primary users of the Dyson Urban Electric E-Bike are university students and young professionals, typically between the ages of 18 and 25, who live in cities and are looking for an efficient, environmentally friendly, and economical way to get around. The people I want to target are those who value sustainability, convenience, and advanced technology, and are looking for transportation that effectively complements their active, fast-paced lifestyles.

The main reason for this is because University students and young professionals need a flexible and affordable transportation solution as many live in crowded, traffic-congested cities. Therefore, they are seeking alternatives to traditional public transportation, such as buses and trains, or the immense hassle of owning a car in modern times. Hence, why students would be drawn to the Dyson Urban Electric E-Bike for its practicality, sustainability, and useability in these situations. The bike allows them to navigate between classes, libraries, and social events with speed and minimal effort. Students also appreciate the bike's lightweight design, making it easy to manoeuvre in small flats and houses. Plus, the bike is easy to store and remove parts such as wheels and handlebars.

Potential Scenario

In order, to establish a scenario where this bike would prosper and benefit a young adult, I have created a story to display the benefits of the bike. For example, A young student named, Oliver aged twenty-one, requires a new innovative ebike to transport him effectively from his house to campus. He has a large budget in the region of £3000 - £5000, so wants a bike that looks and feel expensive but offers innovative technology that sets it apart from the rest of the competition. He wants a brand that is unique and different to the likes of market leading brands such as, Canyon and ribble, yet still has strong design language and ethos. The main reason for the bike, is to replace his current

car as he is getting frustrated at the amount of traffic congestion building up in the city, which is affecting his studies. Oliver feels like a bike is best suited to tackle this problem as he can use cycle paths to make his commute smoother and more efficient. Despite this, he is keen that the bike does not compromise on style and function and is an improvement on his current vehicle.

Other requirements are that it can last for the duration of the day to transport him to and from university, which is a 30-minute journey. Therefore, he wants a bike with a long range and fast charging speed. Additionally, he also wants to improve his overall health and reduce his carbon footprint, hence why he has opted for an electric assisted push bike as it will aid future communities and will also benefit his own wellbeing.

Taking all this into consideration, the Dyson urban e bike is the perfect solution for four main reasons. To begin with, it can dramatically reduce commute times, allowing students and professionals to focus and be more productive. Furthermore, it is an eco-friendly transport option that produces a low carbon footprint, mainly due to its energy efficient design and sustainable use of materials. Another benefit is the Dyson urban ebike is a cost-effective option overall as it cuts out extra costs such as fuel and parking fees, which you would receive running a car for instance. Moreover, the bike is very stylish as it blends Dysons flawless design language with innovative technology seamlessly making it a smart piece of equipment to have for a professional environment.

Design Direction

Aesthetically, it will adopt and look like current e bikes with the enhancement of Dysons clever design thinking and cutting-edge technology. The world leading brand is commonly known for its minimalistic, yet futuristic look, which is a distinctive trait that carries across most of Dyson's lineup, from the supersonic hair dryer to the bladeless air purifier. I feel in my eyes this will correlate well to a modern and visually striking urban vehicle, fit for the future.

Frame aesthetics

To begin with, the frame would feature smooth and flowing lines with an emphasis on form and aerodynamics. Dyson's philosophy centres around organic and sculptural shapes. Potentially, it might have a frame that integrates the battery and the motor in a secretive way to portray a cleaner and more streamlined feel. In addition, the body of the frame can use materials like carbon fibre or a lightweight composite replacement to benefit from weight efficiency as well as durability.

Colour schemes

Dysons are often easily recognisable by their unique colour schemes. As a brand, the palette of colours is very sophisticated and subtle. The primary colours are often silvers, matte blacks and cool greys, whilst other features are finished off in deep purples and

golds, which gives the perception of luxury and futurism. For the texture of the paint, I want to use a ceramic matte or rubberised coating, to not only add protection, but offer that extra element of elegance and beauty.

Smart and simple controls

Many of Dyson's products, have highly effective controls as a lot of the functions are very user friendly and designed with the consumer at the forefront. As discussed earlier, I want an initiative and minimal control interface that clearly shows valuable information. It will be touchscreen, compact and discretely positioned on the handlebars to show speed, range, and rider mode, plus much more. The control will also be able to use voice activation to improve overall rider satisfaction and experience for the rider.

Refined lighting

Lighting plays a key role both for safety reasons and aesthetically. For this reason, I am going to adopt a smart LED lighting system incorporated into the frame or wheels. This will outline the silhouette of the bike and make it more visible in darker settings, whilst also looking visually pleasing. Another option is the front light could collaborate with the controller as a smart navigation aid to guide the rider through the journey.

Ergonomic Design

In my design, I want to provide the rider with the optimum level of comfort during daily commutes. To do this, I want the bikes geometry to align with the needs of the typical urban commute, which usually involves a more upright seating position to be able to scan what is in front of you more effectively. The seat will add further comfort, by using a breathable smart fabric, such as memory foam technology, which will adapt to the rider's temperature and posture, establishing a fully personalised experience. Not only that, but I also want to make sure the handlebars are easily changeable to meet the needs of the rider as well as smart grips, which monitor the users heart rate and body temperature displayed on the main console.

Sustainability features

A big part of this project revolves around creating an ecofriendly bike to support the brief of creating sustainable cities and communities, alongside an uprise in more clean energy supplies. Thus, the materials for the bike will use recyclable and ecofriendly composites or potentially biodegradable segments. Furthermore, the bike will also have the ability to regenerate energy through heavy braking to then transfer back into the battery where it can be stored and used again. Dyson has a huge focus on energy that regenerates so a state-of-the-art system that recycles energy through braking, would mirror the brands ethos as well as creating a more sustainable vehicle for the future.

Wheels and tyres

In modern day bikes, wheels and tyres have seen dramatic improvement, the brand Dyson could completely redefine this area of the bike via smart innovative technology

and sleek design. Consequently, airless, puncture resistant tyres could be the way forward. The look of these tyres will have a slick and futuristic tread design, which maximises grip for slightly rougher terrain, yet still capable of high-speed movements for optimized efficiency in the city. The rims will look more aerodynamic to decrease drag and further increase efficiency like what you would see on a race bike designed for the velodrome circuit.

Autonomous modes and smart integration

Another dimension of the bike, could include self-balancing technology by using robotics or even an automatic mode that takes control of pedalling to reduce tiredness and therefore improve productivity.

I also want the bike to connect and be supported with an app produced by Dyson, which allows riders to track routes, battery, and further performance data. It will also have locked and unlocking features, plus an alarm to help you located your bike in congested areas via GPS tracking.

Overall, the Dyson urban E bike would see the bike look extremely modern and futuristic with an emphasis on functionality and clever integrated technology throughout. It would combine engineering excellence with contemporary aesthetic features to make it stand out and be the perfect commuter tool for any young adult, in any urban setting.

Inspiration

The main inspiration for this project is to create a vehicle driven by Dysons brand language that is different to the rest of the competition. The main attributes that drew me to Dyson as a company is their keen interest to strive for sustainability, which I believe will coincide well with the e bike industry and the overall brief of the project. This includes Dysons advancements in engineering, innovative technology and a clear commitment to elegance and sophistication. Here, are a few points that led me to create a bike for this brand.

Firstly, Dyson has a clear history of clean technology and efficiency like its bladeless fans and high-powered vacuums, which correlates well to a futuristic e bike. Moreover, a lot of their design uses innovative materials and u smart integration and artificial intelligence systems to enhance their products. Other areas of inspiration include, safety and stability, Quiet performance, modular design, and brand philosophy. All these segments have aided and inspired me to reimagine the urban commute in a new and futuristic style. I also feel the e bike industry is on the rise and needs an exciting and groundbreaking bike to propel it to the next level in 5-year time.

Brief dimensions

The main dimensions of the e bike will be based of the Canyon ONFly with a few changes to enhance performance and aesthetics. The bike will range from medium to extra-large depending on the user's height so the overall dimensions will change accordingly. For a medium bike, body height should be below 180 cm, whilst the extra-large frame suits people above 190 cm. The main geometry hardpoints I want to address is the wheelbase, reach and seat height as they have the most impact on the rider's comfort and level of performance. Therefore, the wheelbase, which is the distance from the centre of the front and rear wheel, will range from approximately from 1.055m to 1.120m and the reach, which is the centre of the bottom bracket to the top of the head tube, will range from 400mm to 450mm. The seat height can change easily; however, a medium bike can start at 665mm and rise to 815mm, and an extra-large frame fluctuates from 715mm to 910mm. (*Canyon. (n.d.)*)

Basic technical points

Frame: Dyson Urban E- Bikes Lightweight and durable Carbon shell, with a painted silver rubberised coating

Drivetrain: Dysons Hyperdium motor and a compact solid-state battery integrated into the frame

Brakes: Shimano MT200 regenerative Disc brakes

Wheels and tyres: Dysons airless, puncture resistant tyres and aerodynamic rims.

Design Brief and Summary

In 2030, I set out to design an electric urban e bike produced by the technology and innovation brand, Dyson. It will be designed for young student and professionals, aged between 18 – 25 years, who seek a sleek, sustainable, and efficient commuting solution. The bike features a lightweight, aerodynamic carbon frame, paired with Dyson Hyperdium motor technology for a smooth and efficient ride. Equipped with a long range and compact solid-state battery, which can cover up to approximately fifty miles on a single charge making it ideal for city commuting. The intuitive control system integrates seamlessly with Dysons mobile app, for route planning, traffic updates and smart lock features. With its minimalist design, high tech components and safety features, the Dyson Urban Electric bike, offers a futuristic and sustainable alternative for future mobility.

Bibliography

- 1: United Nations. (n.d.). *Affordable and clean energy: Why it matters*. United Nations. Available at: <https://www.un.org/sustainabledevelopment/energy/>
- 2: United Nations (n.d.) *Sustainable cities and communities*. United Nations. Available at: <https://www.un.org/sustainabledevelopment/cities/>
- 3: Dyson. (n.d.). *About Dyson*. Dyson. Available at: <https://www.lb.dyson.com/en-LB/community/aboutdyson.aspx>
- 4: Ajal Connect. (2020). *The genius of James Dyson: Revolutionizing design in the household*. Medium. Available at: <https://medium.com/@ajal.connect/the-genius-of-james-dyson-revolutionizing-design-in-the-household-17e8351958fa>
- 5: United Nations. (n.d.). *Fact sheet: Economic and Social Council (ECOSOC)*. United Nations. Available at: https://www.un.org/en/ecosoc/integration/pdf/fact_sheet.pdf
- 6: United Nations Department of Economic and Social Affairs (n.d.). *Urbanization*. United Nations. Available at: <https://www.un.org/development/desa/pd/content/urbanization-0>
- 7: Chatham House. (2022). *Cities of the future: How to make cities more efficient and sustainable*. Chatham House. Available at: <https://www.chathamhouse.org/2022/11/cities-future#:~:text=of%20natural%20resources-,All%20cities%20of%20the%20future%20need%20to%20become%20more%20efficient,become%20hubs%20for%20new%20industries>
- 8: Institute for Transportation and Development Policy (ITDP). (2024). *Why we need e-bikes as a climate and mobility solution*. Institute for Transportation and Development Policy. Available at: <https://itdp.org/2024/03/12/why-we-need-e-bikes-as-a-climate-and-mobility-solution/>
- 9: REI Co-op. (n.d.). *What is an electric bike?* REI Co-op. Available at: <https://www.rei.com/learn/expert-advice/what-is-an-electric-bike.html#:~:text=Electric%20bikes%20looks%20a%20lot,bikes%2C%20folding%20bikes%20and%20more>
- 10: Canyon. (n.d.). *Commuter ON.Fly 7 Mid Step*. Canyon. Available at: https://www.canyon.com/en-gb/electric-bikes/electric-city-bike/commuter-on/commuter-onfly-7-mid-step/3334.html?dwvar_3334_pv_rahmenfarbe=BK
- 11: Pirelli. (n.d.). *The main components of an e-bike*. Pirelli. Available at: <https://www.pirelli.com/global/en-ww/road/bicycles/electric/the-main-components-of-an-e-bike-53920/>

12: eMovement. (n.d.). *Types of e-bike motors*. eMovement. Available at: <https://emovement.co.uk/blogs/news/types-of-e-bike-motors#:~:text=The%20motor%20is%20placed%20directly,located%20in%20the%20front%20wheel>

13: Eskute. (n.d.). *Torque sensors vs speed sensors*. Eskute. Available at: <https://eskute.co.uk/blogs/news/torque-sensors-vs-speed-sensors#:~:text=The%20pedal%20assist%20works%20because,power%20to%20drive%20the%20bike>

14 : Bolt. (n.d.). *How do electric bikes work?* Bolt. Available at: <https://bolt.eu/en/blog/how-do-electric-bikes-work/#:~:text=Depending%20on%20your%20input%20C%20the,your%20e%2Dbike%20riding%20experience>

15 : eBikes.ca. (n.d.). *E-bikes parts explained*. eBikes.ca. Available at: <https://ebikes.ca/getting-started/ebikes-parts-explained.html#:~:text=The%20displays%20are%20generally%20developed,alone%2010%20years%20from%20now>

16 : Automotive World. (2023). *Can solid-state batteries help EVs shed weight?* Automotive World. Available at: <https://www.automotiveworld.com/articles/can-solid-state-batteries-help-evs-shed-weight/>

17: eBike24. (n.d.). *Solid-state e-bike batteries: The future of e-bike power?* eBike24. Available at: <https://www.ebike24.com/blog/solid-state-ebikes-batteries#:~:text=Solid%2Dstate%20batteries%20could%20unleash,they%20are%20unsuitable%20for%20ebikes>

18 : Dyson. (n.d.). *Hyperdymium motor*. Dyson. Available at: <https://www.dyson.co.uk/vacuum-cleaners/cordless/hyperdymium-motor>

19 : Eskute. (n.d.). *E-bike torque sensors and their role in cycling performance*. Eskute. Available at: <https://eskute.co.uk/blogs/news/e-bike-torque-sensors#:~:text=Integration%20with%20Artificial%20Intelligence:%20As,smartphone%20apps%20or%20connected%20devices>

20: e-Bikeshop. (n.d.). *Bosch Kiox 300 Display BHU3600 Smart System*. e-Bikeshop. Available at: <https://www.e-bikeshop.co.uk/products/bosch-kiox-300-display-bhu3600-smart-system>

21 : Really Good E-Bikes. (n.d.). *E-bike trends for 2024*. Really Good E-Bikes. Available at: <https://reallygoodebikes.com/blogs/electric-bike-blog/e-bike-trends-2024#:~:text=This%20year%2C%20there's%20a%20wave,in%20place%20to%20protect%20privacy>

22 : Department for Transport. (2023). *Reported road casualties in Great Britain: Pedal cycle factsheet 2023*. Gov.uk. Available at: <https://www.gov.uk/government/statistics/reported-road-casualties-great-britain->

[pedal-cyclist-factsheet-2023/reported-road-casualties-in-great-britain-pedal-cycle-factsheet-2023#:~:text=other%20vehicles%20involved-,2.,cyclist%20traffic%20decreased%20by%207%25](#)

23 : The Best Bike Lock. (n.d.). *Bike theft statistics in the UK*. The Best Bike Lock. Available at: <https://thebestbikelock.com/bike-theft-statistics-uk/#:~:text=An%20average%20of%2077%2C313%20bicycles,been%20at%20least%20double%20that>

24: Canyon. (n.d.). *Commuter ON.Fly 7*. Canyon. Available at: https://www.canyon.com/en-gb/electric-bikes/electric-city-bike/commuter-on/commuter-onfly-7/3333.html?dwvar_3333_pv_rahmenfarbe=BK#productDetailModalTriggerGridContainer

