

# The BMW i3. Contents.



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# 1. The BMW i3. Outline.



The world, and with it the sphere of personal mobility, is in a state of ecological, economic and social upheaval. Global developments such as climate change, dwindling resources and increasing urbanisation call for fresh solutions. BMW i is finding those solutions. The brand stands for visionary vehicle concepts, inspiring design and a new understanding of premium that is strongly defined by sustainability.

In the BMW i3 – the first series-produced model by BMW i – zero-emission mobility in a premium car package proves to be a recipe for pure driving pleasure. The first BMW Group model running on electric power alone offers customers totally new and groundbreaking ways to experience driving pleasure, sustainability and connectivity on city roads. The visionary design of the BMW i3 showcases both BMW's customary sporting capability and the efficiency of a four-seater with authentic clarity. Its innovative vehicle concept, including a passenger compartment made from carbon-fibre-reinforced plastic (CFRP), combines lightness, stability and safety with extraordinary spaciousness. Meanwhile, the driver assistance systems and mobility services from BMW Connected Drive and the 360° ELECTRIC services – all developed specially for BMW i – turn zero-emission urban mobility into a compelling everyday driving experience.

The electric motor powering the BMW i3 generates a maximum output of 125 kW/170 hp and peak torque of 250 Newton metres (184 lb-ft). Its instantaneous power flows to the rear wheels via a single-speed transmission. The motor sources its energy from lithium-ion storage cells integrated into the car's underfloor section. The significantly lower centre of gravity of the i3 – the result of the low, central placement of the battery units – and even weight distribution make an additional contribution to the car's agile handling. The battery gives the car a range in everyday conditions of 130 – 160 kilometres (81 – 99 miles) when fully charged from a conventional domestic power socket, BMW i Wallbox or public charging station.

## **BMW i: a new brand, a new understanding of premium.**

Already a globally successful manufacturer of premium vehicles, the BMW Group is also set to play a leading and groundbreaking role in shaping the face of personal mobility in the future. The research and development work carried out since 2007 as part of project i has laid the foundations for

sustainable mobility solutions influenced by environmental, economic and social change around the world. The BMW Group is pursuing an integrated approach, as embodied by the new BMW i brand, in its drive to achieve the necessary balance between individual needs and the global mobility requirements of the future. BMW i is committed to creating innovative vehicles and mobility services with a premium character that is defined squarely in terms of sustainability. This vision is about to become reality: the BMW i3, the first series-produced model from the new brand, offers customers emission-free mobility in a premium car package.

The BMW i3 is the world's first premium car designed from the ground up to be powered by an electric drive system. The result is hallmark BMW driving pleasure, delivered with zero emissions and an engaging intensity unmatched by any other electrically powered vehicle. Like the i3's unique vehicle architecture – based around the LifeDrive structure, with its CFRP passenger cell and aluminium module encompassing the powertrain, battery and chassis – the electric motor, power electronics and high-voltage lithium-ion battery have been developed independently by the BMW Group under its BMW eDrive programme. This ensures that BMW's time-honoured Sheer Driving Pleasure is also a central feature of the BMW i3.

The use of lightweight, durable and crash-safe CFRP on this scale is unique in volume car production. And thanks to its weight-reducing properties, the BMW i3 is no heavier than a comparable vehicle with a conventional drive system and full fuel tank. Its DIN kerb weight stands at 1,195 kilograms – including a high-voltage battery that allows the driver to enjoy both sporting performance attributes and an operating range sufficient for everyday use.

### **Visionary design as an expression of agility, innovation and sustainability.**

The LifeDrive architecture and BMW eDrive drive technology allow an exceptional degree of freedom in terms of design. Indeed, the appearance of the BMW i3 is as memorable as the feeling of space and driving experience on board. A body measuring 3,999 millimetres in length, 1,775 mm wide and 1,578 mm in height gives the BMW i3 distinctive proportions whose dynamism and compactness underline the car's agility in urban use. The short overhangs of the BMW i3 are also a clear pointer to its nimble driving characteristics. Large glass surfaces imbue the i3 with a compelling lightness and, together with its visible carbon structures, provide a window into the car's low-weight design.

The use of the light yet extremely rigid material CFRP in the construction of the passenger compartment allows it to dispense with B-pillars, making

access to the two rows of seats extremely easy. One of the signature features of BMW i models is their “black belt”, which extends from the bonnet over the roof and into the rear of the car. Another product of the stand-alone BMW i design language is the “stream flow” sweep of the side contours, which allows larger side window surfaces at the rear and thereby magnifies the generous feeling of space inside the car.

The front-end design of the BMW i3 is defined by a powerfully contoured apron, by the distinctive interpretation of the BMW kidney grille as an enclosed element, and by headlights bordered with U-shaped LED light units. The likewise U-shaped LED rear lights are integrated as “floating” elements into the large, fully glazed tailgate.

Opposing “coach” doors, coupled with the absence of B-pillars and the centre tunnel normally found in conventional vehicles, form the basis for the unusually high degree of spaciousness and freedom of movement inside the BMW i3 (given its compact exterior dimensions). The lines and surface sculpting of the cockpit and door trim accentuate the impression of lightness and contemporary functionality. The mixture of naturally treated leather, wood, wool and other renewable and recycled raw materials ensures that the premium character of the BMW i3 – complemented by the extra allure of impressive sustainability – is something you can both see and feel.

The BMW i3 is fitted with lightweight seats featuring extremely slim backrests. A slightly raised seating position optimises the driver’s view over city traffic. The gear selector and start/stop switch share a control element projecting from the steering column. Both the instrument cluster and the iDrive operating system’s Control Display (6.5 inch or 8.8 inch) come in free-standing display form.

The BMW i3 can be ordered with exterior paintwork in a choice of two non-metallic and four metallic colours, all of which present an eye-catching contrast to the black belt. The interior can be tailored to the customer’s personal style with the Loft, Lodge and Suite equipment lines available as alternatives to the standard Atelier trim. Standard equipment for the BMW i3 includes the iDrive system and Radio Professional, telephone hands-free facility, air conditioning, Park Distance Control with rear-mounted sensors, stationary climate control and a variable luggage compartment. Also standard are onboard connectivity via an integrated SIM card and extensive Smartphone integration via USB and Bluetooth, including the BMW i Remote App. Additional options include a choice of navigation systems, Adaptive LED Headlights, an electrically operated glass roof, automatic climate control, heated seats, Comfort Access and a host of BMW ConnectedDrive features.

Also available as options are a range extender and driver assistance systems such as Driving Assistant Plus, Parking Assistant, a rear view camera and Speed Limit Info.

### **LifeDrive architecture and BMW eDrive: a commitment to electric driving pleasure.**

The familiar sense of driving pleasure embodied by the BMW i3 is the result of a rigorously implemented overall concept, part of which has involved creating the optimum balance of weight, performance and range for urban mobility. The key elements here are the LifeDrive architecture and BMW eDrive technology. The use of lightweight CFRP for the passenger cell cancels out the extra weight contributed by the lithium-ion battery, while the low, central positioning of the battery pack enhances the car's agility thanks to perfectly balanced 50 : 50 weight distribution. Additionally, the electric motor mounted in close proximity to the driven rear axle offers unique performance characteristics for this type of drive system as well as providing unbeatable traction. The standard 19-inch forged light-alloy wheels of the BMW i3 are ultra-lightweight yet also boast outstanding torsional stiffness. The wheels are fitted with low rolling resistance tyres in 155/70 R19 format, their bespoke, relatively narrow dimensions providing an ideal combination of lower drag and a contact area designed for dynamic cornering. Customers can order 20-inch light-alloy wheels as an option.

The driving characteristics of the BMW i3 are dominated by its manoeuvrability – a direct response to the demands of city driving. The instantaneous power delivery of the electric motor, allied to the car's stiff suspension set-up, precise steering and impressively small turning circle (9.86 metres), produces a typically BMW take on electric mobility. The electric motor generates output of 125 kW/170 hp and peak torque of 250 Newton metres (184 lb-ft), which is on tap from the word go. The motor weighs just 50 kilograms and boasts power density and responsiveness unprecedented in the world of electric mobility. The specific construction of the hybrid synchronous electric motor, developed exclusively for the BMW i3, maintains a linear flow of power into the higher reaches of the rev range. The BMW i3 sprints from 0 to 60 km/h (37 mph) in a mere 3.7 seconds and 0 to 100 km/h (62 mph) in 7.2 seconds.

The single-pedal control concept in the BMW i3 – configured by the BMW Group's drive system development engineers – also contributes to the engaging driving experience. Recuperation mode is activated the moment the driver takes his foot off the accelerator. The electric motor switches from drive to generator mode, feeding power into the lithium-ion battery. At the same time, it generates a precisely controllable braking effect. This recuperation is

speed-sensitive, which means the car “coasts” with maximum efficiency at high speeds and generates a strong braking effect at low speeds.

The lithium-ion battery enables the BMW i3 to achieve a range of 130 to 160 kilometres (81 – 99 miles) in everyday driving. This rises by around 20 kilometres (12 miles) in ECO PRO mode and by the same distance again in ECO PRO+ mode. If desired, the BMW i3 is also available with a range-extender engine, which maintains the charge of the lithium-ion battery at a constant level while on the move as soon as it dips below a specified value. This role is performed by a 650cc two-cylinder petrol engine developing 25 kW/34 hp and mounted immediately adjacent to the electric motor above the rear axle. The range extender increases the car’s maximum range in day-to-day driving to around 300 kilometres (approx. 180 miles).

**Optimal safety: protection in all situations.**

The horizontally split LifeDrive architecture, consisting of two separate, independent modules, is similar in principle to a body-on-frame design. While the aluminium Drive module – the chassis – provides the vehicle’s sturdy foundation, and incorporates the battery, the drive system and the basic structural and crash functions, the Life module consists mainly of a high-strength, ultra-lightweight CFRP passenger cell.

The high-strength passenger cell, in conjunction with intelligent distribution and absorption of impact forces, provide optimal standards of occupant protection. Even in a 64 km/h (40 mph) offset frontal impact, the extremely rigid material of the passenger cell ensures that the occupant survival space is not compromised, while aluminium crash structures in the front and rear of the Drive module provide additional protection. As a result, deformation of the body in an impact is actually less than for a comparable sheet-steel body. In a pole impact and side impact, the CFRP body demonstrates exceptional energy-absorbing capabilities. Despite the high impact forces and the fact that they are concentrated in relatively small areas, the material suffers only minor deformation. These outstanding qualities provide optimal protection not only for passengers but also for the high-voltage battery. In the side impact test, pole penetration does not extend as far as the battery.

**The world’s first fully networked electrically powered car, courtesy of BMW ConnectedDrive.**

The BMW i3 is the world’s first fully networked electrically powered car. No other model boasts such far-reaching exchange of information between the vehicle, its driver and the outside world. A SIM card fitted as standard in the BMW i3 is the key that unlocks the BMW ConnectedDrive services – in their recalibrated 2013 guise – available to the new electric model. For example, it

introduces navigation services specially developed to enhance electric mobility alongside familiar features including the Concierge Services information facility and the Intelligent Emergency Call function. Moreover, drivers can use the BMW i Remote app to share information with their car at any time using their smartphone. The pedestrian navigation function guides the driver from parking place to final destination and back, while BMW ConnectedDrive also offers unique intermodal route guidance as a world first, which incorporates local public transport connections into journey planning. The aim of this intelligent networking is to enable maximum driving pleasure in a car emitting zero local emissions.

The BMW ConnectedDrive services specifically designed for BMW i focus on the areas of navigation and energy management. The Range Assistant is engaged both for route planning and during journeys already under way. If the destination programmed into the navigation system is beyond the car's range, the system suggests switching to ECO PRO or ECO PRO+ mode and calculates a more efficient route. If the driver needs to charge the battery at a public charging station, a list of available stations in the area is displayed. The navigation system of the BMW i3 also comes with a dynamic range display, which supplies drivers with exceptionally precise, up-to-date and reliable information on whether there is sufficient charge to reach their destination and, if so, how much power will remain at the end of the journey. All the factors affecting range are considered in the calculation process, which is carried out on a BMW server and sent to the navigation system via the SIM card installed in the car. The range readout, presented in the form of a spidergram on the navigation map in the central information display, is extremely clear.

The link-up between driver and car also enters a new dimension in the BMW i3. The BMW ConnectedDrive Remote app for BMW i enables smartphone access to useful vehicle data for journey planning. If the BMW i3 is hooked up to a charging station or the BMW i Wallbox, the supply of energy can be controlled via smartphone, while the air conditioning and heating function for the high-voltage battery pack can also be activated remotely. In addition, customers can use their smartphone to send destinations to their car's navigation system. The app also shows the driver charging stations (both available and in use) and can establish if the car has sufficient power remaining to reach them. The car's range limit display on the smartphone screen replicates that provided by the car's navigation system. The BMW i3 is also available with an array of other innovative BMW ConnectedDrive driver assistance systems developed specifically to enhance convenience and safety in urban conditions.

The Driving Assistant Plus option comprises Collision Warning with braking function (which responds to both moving and stationary vehicles ahead as well as to pedestrians) and Active Cruise Control with Stop & Go function. In addition to giving visual and audible warnings, the system is also able to brake the vehicle automatically if required, with up to maximum stopping power. The Parking Assistant – a further option – performs steering manoeuvres at the same time as controlling the accelerator, brake and gear selection, enabling fully automatic parking of the BMW i3 in a space parallel to the road. To supplement the standard Park Distance Control (PDC) with rear-mounted sensors, a rear view camera is also available for the BMW i3. Further driver assistance systems are the Traffic Jam Assistant and Speed Limit Info.

**Integrated approach: 360° ELECTRIC provides an all-encompassing energy supply and mobility solution.**

The aim in determining the range of the BMW i3 was to ensure that customers could cover their typical energy needs by charging the car twice or three times per week. The studies carried out as part of project i – involving more than 1,000 participants and conducted over some 20 million kilometres (approx. 12.5 million miles) – revealed that the average daily distance covered was around 45 kilometres (28 miles). Customers can charge their cars using either the wallbox supplied by BMW i or a conventional domestic power socket. BMW i offers an extensive range of products and services in its 360° ELECTRIC package designed to meet all individual customer needs for energy supply and journey planning. The spectrum of services ranges from the installation of the BMW i Wallbox in the customer's garage and special renewable energy supply offers, to the charging card for user-friendly access to the public charging infrastructure and additional assistance services from BMW ConnectedDrive. If the BMW i3 concept fails to meet mobility requirements in a specific situation, 360° ELECTRIC provides flexible mobility solutions including alternative vehicles from the BMW and DriveNow ranges.

**New sales models in the personal mobility sector.**

BMW i stands for a new approach to personal mobility. In selected markets, sales of BMW i products and services will be handled via an innovative multi-channel sales model. In addition to dealerships, this model will also comprise a mobile sales team, a Customer Interaction Centre (CIC) and Internet sales. All the new platforms are fully interlinked. Whichever sales channel a customer chooses, and regardless of whether they buy or lease the vehicle, their contract is always with BMW AG and not with the dealer, as would normally be the case. At launch, it is expected that more than 10 per cent of European BMW dealers will also be handling sales of BMW i models.

### **Sustainability throughout the value chain.**

The revolutionary character of the BMW i3 is based on an overall concept which has been systematically designed from the ground up to provide sustainable mobility, and incorporates an unusually large number of technical features geared towards maximum efficiency. The new concept in premium mobility embodied by BMW i – “next premium” – is, however, not just focused on the vehicle itself. When it comes to the choice of materials, the production process, the supply chain and recycling, the BMW i3 likewise sets unrivalled standards for sustainability in the automotive industry.

The BMW Group production network also builds the BMW i3's electric motor and battery. At its Dingolfing and Landshut plants in Lower Bavaria, the BMW Group has created a “competence network” for electric mobility. The BMW plant in Dingolfing produces the battery, the transmission and the aluminium Drive module structure, while the BMW Landshut plant produces CFRP components for the Life module, plastic exterior parts, castings and the cockpit of the BMW i3.

The lightweight design strategy specially developed for BMW i models makes extensive use of the lightweight, corrosion-proof and crash-resistant high-tech material CFRP. CFRP components are around 50 per cent lighter than corresponding steel components with comparable properties. In this field, too, the BMW Group is breaking new ground – both in the use of this innovative material and in its manufacture and processing.

### **Sustainability at every stage – including production.**

The production of the BMW i3 sets new standards in environmental protection and consumes around 50 per cent less energy and around 70 per cent less water in comparison with the current average figures for production in the BMW Group, which are already extremely efficient. All the electricity used to produce the BMW i models at the Leipzig plant is wind-generated and therefore 100 per cent renewable. This is the first time an automobile manufacturing plant in Germany has installed wind turbines on site to directly power production. Likewise, all of the energy used in carbon fibre production in Moses Lake is entirely derived from renewable, locally generated hydroelectric power and is therefore completely carbon-free. BMW i is thus achieving the goal it envisaged at the outset: compared to the World Green Car of the Year 2008 – the BMW 118d – the BMW i3's carbon footprint is around a third smaller. And if the customer runs the BMW i3 on power generated from renewable sources, its performance is 50 per cent better again.

## 2. A window into the future: Innovative design and sustainable materials.



The BMW i3 is the first premium-segment model conceived to run purely on electric power. And the car's innovative vehicle concept also shines through in its design. The exterior and interior design of the i3 are heavily influenced by its LifeDrive architecture and pioneering drive system. Indeed, not content with conjuring up an unmistakable feeling of space and extraordinary driving experience, these two elements also have a significant stylistic impact.

The origins, identity and individuality of the BMW i3 share equal prominence in its design. The fresh interpretation of established design features offers a nod to the car's BMW family ties. Its standalone design language, which will also mark out future BMW i models, embodies lightness, safety, efficiency and driving pleasure, underlining the particular skill-set of the BMW i3. The appearance of the BMW Group's first all-electric model reflects the extra focus on sustainability within its premium character, the role of the LifeDrive architecture in optimising the car's functionality, and the i3's innovative expression of emission-free driving pleasure in urban areas.

### **LifeDrive architecture forms the basis for innovative design.**

The structure of the LifeDrive architecture represents the basic construction of the BMW i3. The central element of the Life module is the carbon-fibre-reinforced plastic (CFRP) passenger compartment. A robust plastic outer skin is attached onto this compartment, allowing extensive freedom in design. The Life module is fixed to the aluminium Drive module, which houses all the drive and chassis technology. This distinctive two-way split is reflected in the design of the BMW i3. Indeed, both the exterior and interior make a feature of this structural characteristic through the visible layering and intertwining of different surfaces.

The use of lightweight, yet extremely rigid, CFRP for the passenger compartment allows the car to dispense with B-pillars, making access to the two rows of seats even more comfortable. The carbon frame, part of which is visible when the doors are opened, serves as a connecting element between the exterior and interior. The exposed structure of the two-dimensional carbon matting gives this section of the CFRP construction an extremely functional look.

### **Proportions point to agility and spaciousness.**

A body measuring 3,999 millimetres in length, 1,775 mm in width and 1,578 mm in height gives the BMW i3 distinctive proportions whose dynamic character and compactness emphasise the car's agility in urban use. The extremely short front and rear overhangs of the BMW i3 are also a clear pointer to its nimble driving characteristics. Large glass surfaces imbue the i3 with a compelling lightness and, together with its exposed carbon structures, lend visual expression to the car's low weight.

From the side, the flowing silhouette and long wheelbase of the BMW i3 catch the eye – and highlight the unusually generous levels of space on board. The car's functional qualities are also underlined by the opposing “coach” doors, which allow extremely easy access to the airy interior.

### **Black belt and stream flow: two signature BMW i features.**

One of the signature features of BMW i cars is the “black belt” extending from the bonnet over the roof into the rear, where it spreads around the central section of the rear apron, framing the licence plate recess and reflectors. At the front end, the black belt is framed by the body-coloured front apron and side panels. This creates a striking segmentation of the car body, emphasising the lightweight construction of the BMW i3.

Another element of the standalone BMW i design language is the “stream flow” tapering dynamically to the rear of the car. This feature is formed by the convergence between the upward sweep of the shoulderline around the C-pillar and the downward slope in the roofline. The dip in the shoulderline just rearwards of the front doors creates a larger side window surface for the rear compartment, giving passengers a particularly generous feeling of space. Passengers are also immersed more deeply in the driving experience than ever before. The shoulderline and stream flow provide distinctive features to match the Hofmeister kink at the trailing edge of the rear side windows on BMW models, while also setting the tone for the aerodynamically optimised body shape of the BMW i3.

### **Front end: a new interpretation of familiar BMW features.**

A powerfully formed front apron, eye-catching colour combinations and a fresh interpretation of hallmark BMW features are the headline elements of the front end. In the centre stands the distinctively styled BMW kidney grille, which has a blue- or silver-coloured surround (depending on the body colour) and is blanked off, as the electrically powered BMW i3 does not require cooling air to be channelled through its front end. Positioned at the same height are the headlights which extend well into the car's flanks. The headlights display an individual character and are framed by U-shaped LED

light units. A black border connects the lower edge of the apron with the circular foglamps positioned to its outer edges.

### **Glazed tailgate with integrated U-shaped light units.**

The design of the rear section accentuates both the functionality and surefooted roadholding of the BMW i3. The large tailgate opens high and the slim, upright roof pillars make it easier to load items into the boot, whose capacity can be expanded by folding down the rear seat backrests as and when required.

The tailgate takes the form of a homogeneous black glass surface. It forms part of the black belt which continues down to the lower edge of the body at the outer extremities of the rear end. In combination with the side panels, which extend slightly into the rear, it creates an eye-catching colour contrast. This, in turn, underlines the car's planted stance as the "cascading" body gains in width towards the road. The light units appear to be floating in the tailgate's glass. Intricate LED lights provide a striking night design, their U-shape adopting the now characteristic BMW i headlight profile.

Six colour shades designed exclusively for BMW i are available for the paintwork of the side body panels and the front and rear aprons of the BMW i3. The two non-metallic and four metallic colours form a prominent contrast to the black belt. The accent surfaces on the side skirts and the BMW kidney grille surround come in BMW i Blue or Frozen Grey metallic, depending on the variant.

### **Interior: freedom in design creates freedom of movement.**

The LifeDrive architecture, including the CFRP passenger compartment, also opens up new freedoms in the design of the BMW i3 interior. Opposing "coach" doors and the absence of B-pillars pave the way for the unusually generous levels of space and freedom of movement (given the car's exterior dimensions). Thanks to the positioning of the electric motor directly on the driven axle, the central tunnel – normally a feature of conventional vehicles – has also been omitted, allowing for a totally open connection between the footwells on the right- and left-hand side of the car. Again, this contributes to the generous impression of space on board and also has functional benefits – such as when getting in and out of the car in particularly tight city parking spaces. Sliding from the right rear seat to the left is as refreshingly easy as moving over from the front passenger seat to behind the steering wheel. Folding down the rear seat backrests creates a totally level load compartment floor and allows the car's variable load capacity to expand to 1,100 litres.

A slightly raised seating position optimises the view out over city traffic. The BMW i3 is fitted with lightweight seats whose slim backrests also provide additional legroom in the rear. The freestanding steering column has a two-section construction that exudes lightness and elegance, attributes that are underlined by the colour concept. The gear selector and start/stop button share a control element projecting from the steering column. The driver selects gears using a rotary control, which moves forwards or backwards according to the desired direction of travel.

Both the instrument cluster and the Control Display of the BMW i3 (6.5 inches in diameter as standard, 8.8 inches as an option) come in free-standing display form. The positioning of the displays lends further emphasis to the heavily three-dimensional design of the cockpit. In the centre of the cockpit, a flat control surface – tilted slightly towards the driver – for climate control and audio functions forms the lower edge of the instrument panel. The Controller and direct menu control buttons for the iDrive system are arranged between the driver and front passenger at seat surface height.

### **Striking colour contrasts, natural materials.**

The lines and surfaces of the cockpit and door panels reinforce the impression of lightness and modern functionality. Taut lines, powerful contours and small radii are the dominant geometrical forms. The most prominent feature of the instrument panel design is the layering structure employed for the interior as well as the exterior. The layers cover three levels which adopt different colours and materials depending on the equipment variant. A central design element is the curved trim surface which extends from the air vents on the left-hand side of the cockpit, continues behind the steering column and reaches its full height above the glove compartment. This surface can be specified in bright, open-pored eucalyptus wood. The range of other materials available includes naturally treated leather, wood, wool and other renewable raw materials, and ensures that the premium character of the BMW i3 – complemented by the added allure of impressive sustainability – is something you can both see and feel.

The leather used inside the BMW i3 is treated solely with natural substances. For example, with olive tree leaf extract which serves as a tanning agent. Plus, the instrument panel surround and door trim panels use fibres from the kenaf plant which are made into technically high-quality surfaces and whose natural structure has distinctive visual and tactile properties. Added to which, 25 per cent (by weight) of the plastic used in the interior has been replaced with recycled materials or renewable raw materials.

The Loft, Lodge and Suite equipment lines can be specified as alternatives to the standard Atelier trim. The basic variant stands out with colour and material contrasts which underline the contours of the interior design.

The Loft equipment line uses a stylish balance of colours to provide a relaxing ambience. The surfaces for the seats and door panels are made using a PUR-Sensatec material and a textile made entirely from recycled raw material. Light colours dominate every area of the interior. The leather steering wheel in a warm Carum Grey tone has an accent strip in BMW i Blue.

The combination of high quality and sustainability associated with a “next premium” character is embodied – in the Lodge equipment line in particular – by the trim strip in eucalyptus wood, a climate-active wool fabric, and leather surfaces with a coarse grain for the seats and armrests, as well as an extremely fine structure for the instrument panel. The light Carum Grey colour shade is complemented by the light brown of the leather surfaces.

Dalbergia Brown leather surfaces for the seats, centre console and door armrests lend the Suite equipment line a particularly exclusive appeal. This variant also includes the eucalyptus wood trim strip and an accent ring in Satin Silver for the leather steering wheel.

### 3. Driving pleasure redefined: Drive system and chassis.



The market launch of the BMW i3 also heralds the dawn of a new era for electric mobility. The first series-produced vehicle from the BMW i brand is also the world's first premium car with an all-electric drive system. The design, space concept and driving characteristics of the BMW i3 are part of an overall package that opens up an all-new experience of emission-free mobility. The revolutionary character of the BMW i3 is the result of a unique vehicle architecture combined with drive system technology developed in-house at the BMW Group exclusively for BMW i models. The LifeDrive architecture and BMW eDrive technology – constituting the next development stage in the BMW EfficientDynamics strategy – form the basis for electric mobility at a premium level and pave the way for undiluted driving pleasure.

#### **Emission-free, light, intelligent: Efficient Dynamics in the BMW i3.**

The fundamental principle of BMW EfficientDynamics – maximum driving pleasure combined with minimal energy use – has also had a major influence on the development process for the BMW i3. Electric mobility is as much a central pillar of Efficient Dynamics as petrol and diesel engines with permanently optimised efficiency, hybrid concepts and the use of hydrogen as an energy source for combustion-based drive systems and fuel cells. All the drive technologies are developed with the intention of delivering ever greater driving pleasure yet also consistent reductions in energy consumption and emissions.

The electric motor, power electronics and lithium-ion battery developed by the BMW Group for the BMW i3 are all examples of BMW eDrive technology. The BMW eDrive banner encompasses any BMW concept that delivers pure electric driving and zero local emissions, making it a further pillar of BMW EfficientDynamics in the exploration of future mobility. The all-electric drive system of the BMW i3 represents the fullest possible expression of BMW eDrive technology.

#### **BMW i3 – designed from day one to deliver all-electric mobility.**

The vehicle concept behind the BMW i3 was designed from the outset to incorporate an all-electric drive system. This has numerous advantages over “conversion” vehicles, in which the original combustion engine is later swapped for an electric motor. Firstly, the engineers have free rein in terms of the construction, dimensions and configuration of all the electric drive

system's components. The trajectory of the car's development is also dictated by the characteristics designed into by the car by the development team and not by the constraints imposed by a pre-existing vehicle design. For example, the space in a conversion vehicle set aside for the fuel tank or exhaust system cannot be put to particularly constructive use. In the BMW i3 there has been no need for this kind of compromise.

Instead, the engineers were able to focus entirely on shaping the character of the BMW i3 as a sporty and agile, yet also comfortable premium car for an urban environment. When it comes to the driving attributes of the i3, the engineers have achieved a perfect balance of vehicle weight, performance and range. This is particularly important since these three factors are so inextricably linked. The operating range of electric vehicles can be extended by increasing battery size, but that adds weight and therefore has a negative impact on performance. Similarly, a more powerful motor requires more energy, which again means heavier batteries or restricted range. A lightweight body, on the other hand, enhances performance and the weight saving can be "invested" in larger batteries which, in turn, boost the car's range.

In its mission to deliver driving pleasure in urban areas, the BMW i3 has come up with the perfect package. With a DIN kerb weight of 1,195 kilograms the car is lighter than most compact vehicles, yet offers significantly more space for up to four occupants. It also has the edge over conventionally powered models of a comparable size and output in the sprints from 0 to 100 km/h / 62 mph, which it completes in 7.2 seconds, and 0 to 60 km/h / 37 mph (3.7 seconds). Furthermore, extensive road tests conducted as part of project i proved that the car's range of 130 to 160 kilometres (81 – 99 miles) in everyday conditions is adequate to comfortably meet the day-to-day mobility needs of the target customer group.

**Rear-wheel drive, a low centre of gravity, balanced weight distribution and a specific suspension set-up provide the perfect platform for agility and driving pleasure.**

The low and central position of the battery pack has a similarly positive effect on the car's agility to the balanced 50 : 50 weight distribution enabled by the arrangement of all the components in the Drive module. The battery is encased in aluminium sections and is particularly well positioned from a crash safety perspective. The electric motor and transmission unit are located in direct proximity to the driven rear axle. Underpinning their space-saving integration into the Drive module is a compact and harmonised construction facilitated by the in-house development of the drive components at the BMW Group. The clear subdivision of Life and Drive modules means no central tunnel is necessary – a particular feature of the car's construction that

has noticeable benefits for the freedom of movement and the generous space available inside the BMW i3.

The car's rear-wheel drive allows the front axle to remain free of torque steer and fulfil its steering function to full effect. As with current models from the BMW and MINI brands, electric power assistance also sends the BMW i3 driver's steering commands to the road with smoothness and precision. Its extraordinarily small turning circle of 9.86 metres and a steering set-up that demands just 2.5 turns from lock to lock enhance the agile handling of the BMW i3. This agility is the defining characteristic of the driving experience, especially in the car's preferred urban habitat. In addition, a long wheelbase (2,570 millimetres), the Drive module's rigid aluminium frame and advanced chassis technology provide the perfect ingredients for a sure-footed and relaxing ride.

The suspension components of the BMW i3 stand out with their minimised weight yet extremely stiff construction. The BMW i3 has MacPherson single-joint front suspension and a five-link rear axle mounted directly to the Drive module. This design assists the functional separation of wheel location and suspension, resulting in sporting driving characteristics defined by impressive longitudinal and lateral dynamics combined with superior suspension comfort. The rigorous adherence to lightweight design principles yields a reduction in unsprung masses to the benefit of ride comfort at all speeds. The BMW i3's forged aluminium wheels also boast outstanding rigidity and extremely low weight at less than seven kilograms each.

The dimensions of the standard tyres (155 / 70 R19) are specific to the BMW i3. The large and comparatively narrow tyres allow an excellent balance between dynamics and drag, and the aerodynamic properties and rolling resistance of the tyres are designed to provide extremely efficient driving. However, their contact patch barely differs from that of the tyres fitted as standard on conventional cars. Indeed, even when the BMW i3 is driven with sporting intent, longitudinal and lateral dynamic forces are always transferred with great assurance and poise. Interventions by the BMW i3's DSC (Dynamic Stability Control) driving stability system are only required in extreme situations, and body movements are minimal.

The standard DSC system offers all the functions familiar from current BMW models, including the Anti-lock Braking System (ABS), Cornering Brake Control (CBC), Dynamic Brake Control (DBC), Brake Assist, Brake Standby, Start-Off Assistant, Fading Compensation and the Brake Drying function. The DTC (Dynamic Traction Control) mode raises the intervention thresholds of the stability control system and allows a controlled degree of slip through the

BMW i3's driven wheels when pulling away on snow or loose sand or in particularly dynamic cornering.

**BMW eDrive: electric motor sets new standards in power density and efficiency.**

The hybrid synchronous electric motor developed and produced specially by the BMW Group for use in the BMW i3 generates output of 125 kW/170 hp and puts maximum torque of 250 Newton metres (184 lb-ft) on tap from the moment the car pulls away. The BMW i3 dashes from 0 to 100 km/h (62 mph) in 7.2 seconds, having accelerated from rest to 60 km/h (37 mph) in just 3.7 seconds. With a time of 4.9 seconds for the sprint from 80 to 120 km/h (50 – 75 mph), it boasts a level of sporting ability that comparably sized combustion-engined cars would require far higher outputs to achieve.

Beyond the traditional immediacy of response offered by electric motors when pulling away, power development in the BMW i3 also remains unbroken through higher speeds. Power is sent to the rear wheels through a single-speed transmission, allowing the BMW i3 to accelerate with an uninterrupted flow of power up to its top speed, which is limited to 150 km/h (93 mph) in the interests of efficiency.

This linear power delivery extending into high rev ranges can be attributed to a special electric motor design developed exclusively for the BMW i3. BMW eDrive technology has been employed to take the principle of the permanently excited synchronous motor to another new level through detailed optimisations. A specific arrangement and dimensions for the components used to generate drive produces a self-magnetising effect only otherwise induced by reluctance motors. This additional excitation causes the electromechanical field formed by the current supply to remain stable even at high revs. The maximum revs of the motor developed for the BMW i3 – known as a hybrid synchronous motor on account of its specific combination of properties – are 11,400 rpm.

The innovative design principle behind the electric motor in the BMW i3 helps it to run extremely effectively across a wide load band. The motor's average power consumption of around 0.13 kilowatt hours per kilometre (0.21 kilowatt hours per mile) in the New European Driving Cycle (NEDC) plays a key role in optimising the car's range. This is an extraordinarily low figure, especially considering its maximum output and torque. The BMW i3 is therefore the most economical electrically powered car of its size and output class. The power density of the electric motor, weighing in at no more than around 50 kilograms, sets a new benchmark for electric vehicles. The BMW i3's motor also stands out with its smooth running and low vibrations, while

acoustic comfort and vibration damping similarly meet the high standards expected of a premium car.

**Driving pleasure, BMW i-style: instantly responsive, agile and uniquely assured.**

Zero local CO<sub>2</sub> emissions provide the most compelling argument for electric mobility in urban areas. But the appeal of all-electric vehicles is further enhanced by their instantaneous power delivery – which also allows the BMW i3 to deliver rousing acceleration in city traffic – and their quietness, which is a major contributor to the relaxed and comfortable driving experience on board the BMW i3.

Also helping to deliver the BMW i3's engaging driving experience is the single-pedal control feature carefully configured by the BMW Group's drive system development engineers. Recuperation mode is activated the moment the driver takes his foot off the accelerator. The electric motor switches from drive to generator mode, feeding power into the lithium-ion battery. At the same time, it generates a precisely controllable braking effect. This recuperation is speed-sensitive, which means the car "coasts" with maximum efficiency at high speeds and generates a strong braking effect at low speeds. The ability to accelerate and brake using just one pedal creates an unusually direct interaction between driver and car. Thinking ahead in city traffic can allow the driver to carry out 75 per cent of braking manoeuvres without applying the brake pedal. The brake lights illuminate if the amount of recuperation in progress produces the same braking effect as actually pressing the brake pedal. The conventional braking system only joins the action if the driver summons greater braking power by depressing the brake pedal.

Intensive use of this form of brake energy recuperation through the motor also increases the range of the BMW i3 by as much as 20 per cent compared with conventional recuperation concepts. And the "coasting" facility further enhances the user-friendly nature of single-pedal control. The BMW i3's accelerator has a distinct "neutral" position; i.e. rather than switching straight to energy recuperation when the driver eases off the accelerator, the electric motor uses zero torque control to decouple from the drivetrain and deploy only the available kinetic energy for propulsion. In this mode, the BMW i3 glides along using virtually no energy at all. This is another example of how an anticipatory driving style can preserve energy and further increase the car's range on electric power.

### **Optimised performance and range through the in-house development of storage technology and energy management.**

Specially developed lithium-ion storage cells supply the drive system with the energy required. The BMW Group also utilises its technological expertise in the development of numerous battery system components in order to bring about a comprehensive optimisation of the high-voltage battery pack. These include specific components which ensure the interconnection of the cells themselves as well as the connection between the battery system and the vehicle. They also comprise the integrated control unit and the electronic components in the proximity of the cells, including battery management sensors. Apart from procurement of storage cells from a specialist manufacturer, all the development and manufacturing stages are carried out at the BMW Group. The high-voltage battery is produced on a state-of-the-art assembly line at BMW Plant Dingolfing.

The high-voltage battery in the BMW i3 consists of eight modules (each with 12 individual cells), which together produce a rated voltage of 360 volts and generate approximately 22 kilowatt hours of energy. The lithium-ion cells used in the battery stand out with their high energy density and impressive cycle life. They are designed to perform their energy storage function over the vehicle's entire lifespan. In order to maintain their output and storage capacity over time, the battery management system therefore controls both the charging and the discharging processes, as well as the operating temperature of the cells. When the vehicle is on the move all the cells are used equally to supply energy. However, it is also possible to replace individual modules in the event of a fault. The air conditioning coolant is used to provide extremely effective cooling of the high-voltage battery, and this fluid can also be warmed using a heat exchanger. All these characteristics enable the optimum operating temperature of around 20 degrees Celsius to be reached before a journey begins, even when the ambient temperature is low. This preconditioning ensures the battery operates to optimum effect in terms of power output, range and durability.

The BMW Group has planned and developed this battery to last for the full life of the vehicle. The battery warranty is valid for eight years or 100,000 kilometres (62,000 miles).

As well as the drive unit, all the other electrically powered systems on board the BMW i3 are also designed to run as efficiently as possible. For example, energy-saving light diodes are used to provide interior and exterior illumination. And an optional interior heating system based on the principle of a heat pump uses up to 30 per cent less energy in city driving than conventional electric heating.

The battery pack is mounted flat in the Drive module and weighs approximately 230 kilograms. The battery casing and its model-specific attachment systems were developed by the BMW Group to provide the high-voltage battery with extensive protection against environmental factors and in the event of a crash. Three levels of safety, including a cut-off mechanism, for the car's software and hardware provide reliable protection for the electrical system as a whole.

The power electronics responsible for the interaction between the battery and electric motor are also developed by the BMW Group. The power electronics serve both as an inverter for the power supply from the battery to the electric motor and as a voltage transducer interacting between the high-voltage battery and the 12-volt onboard power system. Highly sophisticated software control ensures the best possible current flow during energy recuperation on the overrun. And the operation of battery charging systems is also integrated into the power electronics, which regulate charge outputs of between 3 kW and 50 kW, depending on the electricity source.

**Flexible, fast and convenient: charging from the mains supply.**

In order to make topping up the car's power supply as user-friendly as possible for the driver, the BMW i3 lays on an extremely flexible and efficient charging system. Customers can charge their car from a conventional domestic plug socket or have a BMW i Wallbox installed, which uses the maximum current strength available at the property to charge the battery in around six hours – even in its basic configuration. Different versions of the BMW i Wallbox are available, depending on the country, to reflect the current strength and voltage in the individual markets. Charge times will therefore vary according to the power supply and type of wallbox.

When the BMW i3 is plugged into a modern public fast-charging station (50 kW) it only takes about 30 minutes for the battery to reach 80 per cent capacity. And even in the unlikely event of the car being almost down to zero range, a lunch break is still long enough to recharge the battery.

**Optional range extender acts as a spare tank.**

If desired, the BMW i3 is also available with a range extender engine, which maintains the charge of the lithium-ion battery at a constant level while on the move as soon as it dips below a certain value. Performing this role is a 650cc two-cylinder petrol engine developing 25 kW/34 hp, which is mounted immediately adjacent to the electric motor above the rear axle. Specifying the range extender has no effect on luggage capacity: the nine-litre fuel tank is located in the front section of the car.

The combustion engine develops maximum output of 25 kW/34 hp and drives a generator to produce electricity. It is brought into play as required, responding optimally to match the load and running extremely efficiently. Driving in ECO PRO mode or ECO PRO+ mode can increase the range of the BMW i3, in each case by around 20 kilometres (12 miles). And if the range extender is specified, the BMW i3 will be able to travel more than 100 kilometres (over 60 miles) further before refuelling. Maximum range stands at approximately 300 kilometres (186 miles). The BMW i3 is the world's first electrically powered car with a range extender engine used exclusively to generate electric power.

**Lightweight design at its best: kerb weight (DIN) 1,195 kg.**

Weight is a key factor in the development of an electrically powered vehicle – as with battery capacity and energy consumption, it has a direct impact on how far the car can travel on a single charge. That is why a particularly sharp focus on intelligent lightweight design has been a key factor in achieving the greater driving pleasure, lower energy requirement and longer range of the BMW i3.

The LifeDrive architecture developed specifically for BMW i models has created the perfect framework for purpose-built electrically powered car concepts. Here, the carbon-fibre-reinforced plastic (CFRP) construction of the passenger cell (Life module) plays a central role. Such extensive use of this lightweight and crash-safe high-tech material is unique in volume car production. The principle of lightweight design also governs the aluminium Drive module and the connection between the two elements. The body structure – shaped by its LifeDrive architecture – enables the use of a trailing edge element made by glass-fibre-reinforced plastic injection moulding. And that contributes a 30 per cent weight saving compared with a conventional sheet steel solution. The direct connection between the power electronics and electric motor in the rear of the BMW i3 reduces the length of cabling required and cuts the overall weight of the drivetrain by around 1.5 kilograms. Weight-minimising construction also sets the tone for the chassis components of the BMW i3. For example, the forged aluminium suspension links weigh around 15 per cent less than in a conventional design, the hollow drive shaft is 18 per cent lighter than a conventional equivalent, and the standard 19-inch forged aluminium wheels of the BMW i3 are 36 per cent lower in weight than comparable steel rims of the same size.

Using a magnesium supporting structure for the instrument panel saves weight on two fronts. Superior material attributes over conventional sheet steel allow these components to boast optimised geometry, which results in a weight reduction of some 20 per cent. In addition, the high composite rigidity

of the magnesium supporting structure lends it a strengthening effect, which allows a reduction in components and lowers weight by a further 10 per cent. The door trim panels are made from renewable raw materials and tip the scales around 10 per cent lighter than conventional equivalents. And the rigorous application of the lightweight design strategy extends to screws and bolts made from aluminium. The engineers' detailed commitment to the principle of lightweight design is lent visible expression by the honeycomb structure of the windscreen wiper blades. In addition, a cast aluminium mount was developed specially for the wipers of the BMW i3, its force-flow-optimised geometry also yielding a reduction in weight.

## 4. **Safety: Unbeatable protection in any situation.**



From an efficiency standpoint, the body of the BMW i3 needs to be not only strong but, above all, light. However, from a safety point of view, it has to be not only light but, above all, strong. This apparent conflict of interests highlights the engineers' pioneering work in developing the vehicle architecture of the BMW i3. Here, there is no contradiction between lightweight construction and safety. Quite the opposite, in fact: the LifeDrive concept of the BMW i3, with its combination of aluminium and carbon-fibre-reinforced plastic (CFRP), is on a par with other structures and even performs better in some areas of crash testing despite its lightweight design. The use of CFRP essentially allows the construction of extremely lightweight bodies. Moreover, CFRP possesses an impressive ability to absorb energy and is extremely damage-tolerant. CFRP is the lightest material that can be used in the construction of car bodies without compromising on safety.

The LifeDrive concept is based around two horizontally separate independent modules. The Drive module – the aluminium chassis – gives the car its high-strength foundations and integrates the battery and drive system into a single structure. The Life module, meanwhile, consists principally of a high-strength and extremely lightweight passenger compartment made from CFRP. With this innovative concept, the BMW Group takes the combination of lightweight design, vehicle architecture and crash safety to an entirely new dimension.

### **LifeDrive module offers optimal safety.**

The crash requirements in automotive manufacture are very strict. Numerous impact criteria stipulated by the stringent guidelines of global consumer protection organisations and legislators have to be taken into account. During the development of the BMW i3 concept, there was close consultation with the international crash test institutes on the innovative car body and safety concept of the BMW i models.

The high-strength passenger compartment teams up with the intelligent distribution of forces within the LifeDrive module to provide the cornerstones for optimum occupant protection. Even after the structurally debilitating offset front crash at 64 km/h (40 mph), the extremely rigid material maintains an intact survival space for passengers. The crash-activated aluminium structures at the front and rear end of the Drive module provide additional safety, so that less body deformation occurs compared with comparable steel

bodies. Furthermore, the “cocoon effect” of the CFRP car body ensures that the doors can be opened without any problem and the interior remains largely free of any intrusions.

Even rescue scenarios have been worked through and checked. In standard cutting tests, the process of rescuing occupants from a BMW i3 involved in an accident was comparable to that for a conventional vehicle. In some respects, indeed, it was more straightforward since the lighter components can be more easily cut than high-strength steels, for example.

Impressive rigidity, combined with its ability to absorb an enormous amount of energy, makes CFRP extremely damage-tolerant. Even at high impact speeds it displays barely any deformation. As in a Formula One cockpit, this exceptionally stiff material provides an extremely strong survival space. Furthermore, the body remains intact in a front or rear-on impact, and the doors still open without a problem after a crash.

In its dry, resin-free state CFRP can be worked almost like a textile, and as such allows a high degree of flexibility in how it is shaped. The composite only gains its rigid, final form after the resin injected into the lattice has hardened. This makes it at least as durable as steel, but it is much more lightweight.

The high tear resistance along the length of the fibres also allows CFRP components to be given a high-strength design by following their direction of loading. To this end, the fibres are arranged within the component according to their load characteristics. By overlaying the fibre alignment, components can also be strengthened against load in several different directions. In this way, the components can be given a significantly more efficient and effective design than is possible with any other material that is equally durable in all directions – such as metal. This, in turn, allows further reductions in terms of both material use and weight, leading to another new wave of savings potential. The lower accelerated mass in the event of a crash means that energy-absorbing structures can be scaled back, cutting the weight of the vehicle.

### **Unbeatable protection in a side-on impact.**

The ability of CFRP to absorb energy is truly extraordinary. Pole impacts and side-on collisions both highlight the impressive safety-enhancing properties of CFRP. Despite the heavy, in some cases concentrated forces, the material barely sustains a dent, and passengers enjoy unbeatable protection. All of which makes CFRP perfectly suited for use in a vehicle’s flanks, where every centimetre of undamaged interior is invaluable. However, there are limits to what CFRP can endure. If the forces applied go beyond the limits of the

material's strength, the composite of fibres breaks up into its individual components in a controlled process.

### **The best of both worlds – combining aluminium and CFRP.**

The new Drive module has also been carefully designed and structured with these exacting crash requirements in mind. Crash-active aluminium structures in the front and rear sections of the vehicle provide additional safety. In a front or rear-on collision, these absorb a large proportion of the energy generated. The battery, meanwhile, is mounted in the underbody section of the car to give it the best possible degree of protection. Statistically, this is the area that absorbs the least energy in the event of a crash, and the vehicle shows barely any deformation here as a result. Moreover, positioning the battery in the underbody allows the BMW Group development engineers to give the vehicle an ideal low centre of gravity, which makes it extremely agile and unlikely to roll over.

In the Euro NCAP side impact test, in which a pole strikes the side of the vehicle dead centre at 32 km/h (20 mph), the carbon fibre composite also demonstrates its extraordinary energy-absorbing capacity. The Life module absorbs the entire impact with minimal deformation, guaranteeing optimum passenger protection. Even when CFRP dissipates energy, there is no danger to passengers or other road users.

The high-voltage battery also benefits from the excellent deformation properties of the CFRP Life module. In the side crash test, the pole does not penetrate as far as the battery. The mix of materials used and the intelligent power distribution in the LifeDrive module ensure that the high-voltage battery is optimally protected even in the side sill area.

All in all, the high-strength CFRP passenger cell teams up with the intelligent distribution of forces in the LifeDrive module to lay the foundations for optimum occupant protection.

### **Lithium-ion batteries are safe even in the event of a fire.**

Safety is a key criterion in the development of the BMW i models. A range of systems and measures have been implemented in the vehicle that ensure safety in normal operation and in the event of accidental fires. The high-voltage system is designed to cope with accidents beyond the legal requirements, with the high-voltage battery including features that ensure its safe reaction even in situations such as this.

The latest series of tests conducted by the renowned DEKRA E-Mobility Competence Center were extremely extensive – ranging from how a car might catch fire, how the flames might spread and what would be required to extinguish the fire, to the pollution caused by run-off of the water used for fighting the fire. The experts concluded that electric and hybrid cars with lithium-ion drive system batteries are at least as safe as vehicles with conventional drive systems in the event of fire.

To ensure maximum safety in such a crash scenario, the high-voltage battery is disconnected from the high-voltage system and the connected components discharged when the passenger restraint systems are triggered. This safely prevents the possibility of a short circuit, which could lead to electric shocks or cause a fire.



## 5. Intelligent connectivity for sustainable mobility: BMW ConnectedDrive in the BMW i3.

The BMW i3 is the world's first electric car offering complete connectivity. Cutting-edge driver assistance systems coupled with mobility services from BMW ConnectedDrive that have been specially tailored for the all-electric drive technology serve to optimise safety, convenience and the usability of in-car infotainment products, as well as providing the ideal conditions for completing everyday journeys with zero emissions. BMW ConnectedDrive is unique in the way it helps drivers to implement their mobility plans to combine sustainability and driving pleasure in perfect harmony.

Navigation services that have been purpose-developed with the demands of electric mobility in mind complement the proven products from the revised BMW ConnectedDrive portfolio unveiled in 2013. These include mobility services, such as the Concierge Services for information and the Intelligent Emergency Call function, along with an array of innovative driver assistance systems that make an effective contribution to enhancing the convenience and safety of urban mobility. Access to the BMW ConnectedDrive services is ensured by a SIM card that comes built into the vehicle as standard.

Connectivity between driver and car is also taken into a whole new dimension in the BMW i3. The BMW ConnectedDrive Remote app for BMW i also makes the vehicle data used for mobility planning available on the customer's smartphone. Alongside the pedestrian navigation function for finding the way from the parked car to the final destination and back again, BMW ConnectedDrive also boasts a unique intermodal route guidance feature that is capable of incorporating local public transport connections into mobility planning. The BMW ConnectedDrive services for BMW i guide customers to any destination accurately and efficiently. They can plot the route for the BMW i3 from the driveway to a parking space, assist in the driver in changing to the correct bus or underground line, and help complete the final leg of the journey on foot.

### **BMW ConnectedDrive driver assistance systems for safe, convenient mobility in the urban landscape.**

The Driving Assistant Plus that is optionally available for the BMW i3 comprises Collision Warning with brake priming function, which is activated at speeds up to 60 km/h (approx. 37 mph) and is able to respond to both moving and stationary vehicles ahead, as well as to pedestrians. It also comes with Active Cruise Control including Stop & Go function. In addition to visual and

audible warnings, the system is furthermore capable of braking the vehicle by itself, if required, with up to maximum stopping power. The Parking Assistant can likewise be found on the list of optional extras and performs the steering manoeuvres at the same time as controlling accelerator, brake and gear selection, enabling fully automated parallel parking of the BMW i3. There is also the option of a rear view camera for the BMW i3 to supplement the standard Park Distance Control (PDC) with rear sensors. Another handy optional extra is the Traffic Jam Assistant that allows drivers to delegate the tasks of pulling away, braking and steering to keep the vehicle in lane. Meanwhile, the Speed Limit Info system is also offered in conjunction with the navigation system.

The various mobility services from BMW ConnectedDrive und 360° ELECTRIC that have been specially developed for BMW i focus on the aspects of navigation and energy management. The comprehensive exchange of information between driver and vehicle allows the current mobility requirements to be checked against the available energy resources. Under everyday conditions, a fully charged BMW i3 is capable of covering a distance of 130 to 160 kilometres (80 – 100 miles) before having to be plugged into a power supply again. The field trials conducted as part of project i, which involved over 1,000 test customers and clocked up more than 20 million kilometres (approx. 12.5 million miles) of practical driving, revealed that this driving range is more than enough for day-to-day mobility requirements in urban environments, where the average distance covered daily is around 45 kilometres (approx. 28 miles). The BMW ConnectedDrive mobility services included with the BMW i3 as standard help to tailor this general compatibility to any individual driving situation. Intelligent connectivity paves the way to maximum driving pleasure in a car whose drive system produces zero local emissions.

**Precise, up-to-date and reliable: navigation system with dynamic range display.**

The BMW i3 can be optionally equipped with a navigation system whose functionality has been extended to include the BMW ConnectedDrive services developed specifically for BMW i. The Driving Range Assistant is invaluable for both route planning and the current journey. If the destination selected in the navigation system lies beyond the vehicle's current range, it comes to the driver's aid by suggesting switching to the ECO PRO or ECO PRO+ mode, as well as calculating a more efficient alternative route. And if the battery has to be recharged at a public charging station, the driver is given a choice of available stations in the neighbourhood.

A further key element of the linked-up navigation unit is a dynamic range display, which delivers remarkably precise, up-to-date and reliable information

by factoring in all the relevant variables. The battery's charge status, the driving style, activity of electric comfort functions and the selected driving mode are all taken into account for the calculation, along with the route's topography, current traffic levels and the outside temperature. The system is therefore able to make allowance for the extra energy required for an upcoming climb, stop-start traffic or a traffic jam on the selected route, and lower its range calculation accordingly. The up-to-the-minute and detailed real-time traffic information provided by the RTTI system is also added to the equation. The information is analysed and evaluated centrally by the BMW ConnectedDrive server that is in permanent communication with the vehicle. The SIM card that comes built into the BMW i3 ensures a reliable connection between the vehicle and the BMW ConnectedDrive server.

The dynamic range display is visualised on the central information display in the BMW i3 as a peripheral contour within the navigation map. Taking the vehicle's current location as a starting point, all points that can be reached in the various driving modes are displayed in the form of a range spidergram.

### **BMW ConnectedDrive Services enable mobility planning to the current destination and beyond.**

Apart from the information required for the route guidance currently in progress, the navigation system also helps drivers to plan mobility requirements beyond their present destination. For the purpose of energy management, not only are the current battery capacity levels taken into account, but the various options for recharging are also considered. The lithium-ion battery in the BMW i3 can be recharged from a standard domestic socket to give maximum flexibility since the charging lead for connecting to the mains supply is carried in the vehicle at all times. However, energy levels can be topped up very quickly and conveniently at one of the charging stations specially designed for electric vehicles. The BMW ConnectedDrive services help drivers to quickly pinpoint these charging points by displaying all available charging stations along the route or in the vicinity of the destination on the navigation map.

In the same way that points of interest such as restaurants, hotels and tourist sights are visualised, charging stations and parking facilities can also be shown in the information display if desired. The driver can see which car parks and charging stations are full or have spaces, and the information is constantly updated via the connection to the BMW server. And it won't be long before drivers are able to reserve a space at a charging station from the comfort of their vehicle. The complete connectivity concept also gives customers the option of booking these and other products from BMW ConnectedDrive after taking delivery of their vehicle.

The BMW ConnectedDrive server additionally provides up-to-the-minute data indicating whether potential charging stations will actually have spaces available on arrival. For instance, drivers can call up a station located close to the journey's destination in advance. The system also notifies them of the charging time required before commencing the return journey or the onward journey to the next destination. The wealth of functions offered by the navigation system with its BMW i-specific BMW ConnectedDrive services makes it possible to plan journeys using electric power alone with supreme precision, reliability and convenience.

### **Intelligent link-up between driver and vehicle: the BMW ConnectedDrive Remote app for BMW i.**

The mobility planning information provided is made available on the customer's smartphone as well as in the vehicle. This connectivity is provided by an application developed especially for BMW i for mobile phones with the iOS and Android operating systems. The app is an enhanced version of the remote services offered by BMW ConnectedDrive.

The Remote app for BMW i allows drivers to access vehicle data and relevant information on route planning at any time. The driver is also able to use the app to call up a display of charging stations that are either full or have spaces, and see whether they are located within the vehicle's current driving range. To this end, the range contour is also displayed here just as it is in the vehicle's navigation system. This highly intelligent form of connectivity allows drivers to check the status of their BMW i3 and even plan forthcoming journeys while away from their vehicle – whether at home, at work or walking to the car park. A real-time overview of charging stations and parking facilities can also be found online by visiting the BMW ConnectedDrive customer portal. The recharging facilities provided by the ChargeNow network of charging stations are also shown.

If the vehicle is plugged into a public charging station or the BMW i Wallbox, the charging procedure can be controlled both remotely and using a timer function. A range calculation graphic identical to that in the vehicle can be viewed on the smartphone too. The BMW i App can also be used to search for and select a navigation destination or a free charging station and then import it to the vehicle's system. Besides this, the available charging stations along the route and in the vicinity of the destination are likewise visualised in the BMW i App, just as they are in the vehicle's information display. This enables the driver not only to plan the upcoming journey in good time and with foresight, but also to make adequate preparations for further mobility requirements beyond the immediate future.

Drivers furthermore have the ability to control not just the charging process remotely but also the advance preparation of the vehicle. If the BMW i3 is plugged into a charging station or the BMW i Wallbox, the energy supply can be controlled from the smartphone. The vehicle's air conditioning and heating of the high-voltage battery can likewise be activated remotely. Pre-heating the battery ensures optimum operating status for performance, range and battery durability, even at low ambient temperatures. There is also the option of programming the charging process using the app so that charging takes place when electricity is cheaper, for example using off-peak tariffs at night.

**Intermodal route planning: BMW i mobility services speed you to your destination efficiently and easily.**

After leaving the vehicle at a selected car park, customers can also use the pedestrian navigation function integrated in the BMW i App to guide them to their final destination. The navigation destination selected by the driver in the vehicle is automatically transferred to the BMW i App via the BMW ConnectedDrive server so that route guidance can be continued by smartphone. The navigation system specifically developed for BMW i and the demands of travel in urban centres also features a unique intermodal route planning function.

This function also includes local public transport networks, allowing the available transport connections to be incorporated into route planning if required and displayed by the navigation system in the BMW i3 en route. This gives drivers the option of selecting an intermodal route while driving in their BMW i3, initially being directed to a public car park by the navigation system. After leaving their car, the BMW i App is now used to guide them first to the correct bus or underground line, then on to their destination while completing the final leg of the journey on foot. When they return, they are directed all the way back to their car again. The app lets drivers see where they left their car parked at any time.

Once a journey has been completed, customers are able to compare the efficiency of their driving style anonymously with that of other BMW i3 users. At the same time, they are given further efficiency-enhancing pointers as well as tips for honing the way they drive.

## 6. BMW thinks beyond the car – 360° ELECTRIC, sales and services.



An extensive range of products and services is available for the BMW i3 which cover the customer's individual needs beyond the vehicle alone. The comprehensive 360° ELECTRIC package provides an especially reliable, convenient and flexible way of harnessing the benefits of electric mobility during everyday driving, with customers deciding for themselves which particular features they wish to use. The 360° ELECTRIC portfolio has four mainstays essentially covering the areas of home charging, public charging stations, safeguarding mobility, and integration into innovative mobility concepts to overcome range restrictions.

### **Home charging: the most convenient option.**

BMW i is able to offer customers who have their own garage or a private parking space tailor-made solutions to make domestic charging a safe, simple and particularly quick procedure. To achieve this aim, BMW i entered into a far-reaching partnership agreement with Schneider Electric and The Mobility House (TMH) in January 2013. The aim is to provide customer-friendly and efficient charging facilities by the time the BMW i3 is launched that will allow for recharging in the comfort of the customer's own garage. To that end, BMW i not only offers a charging point (the BMW i Wallbox) but also checks the electrical installation in customers' homes, supplies and assembles the charging point, as well as providing maintenance, advice and other services.

BMW i also backs the use of electricity from renewable sources and has joined forces with selected partners to offer a choice of green power products. A strategic alliance between BMW AG and German eco power supplier Naturstrom AG will in future give customers in Germany the opportunity to obtain an eco power package for running their BMW i3. Naturstrom AG supplies electricity entirely from renewables, with a very high proportion of wind power, ensuring that the electric vehicle can be operated with zero CO<sub>2</sub> output. And BMW i can also assist if the customer decides, for example, to install a carport with solar panels.

### **Public charging: topping up on the move.**

360° ELECTRIC also comprises individual solutions for anyone who is unable to recharge their BMW i3 at home or at work. Thanks to collaboration with car park operators and public charging station providers, BMW i grants customers highly reliable access to the public charging infrastructure. BMW i together with its partners fosters connectivity between vehicle, driver and the outside world, providing users with convenient features such as the display of available charging stations in the navigation system and on the customer's

smartphone, along with a simple and transparent payment method with the ChargeNow card. This card enables universal access to charging poles and provides a cashless means of payment. In so doing, it groups together the maximum number of public charging infrastructure suppliers in all BMW i markets, allowing the customer to access the charging stations of different providers with a single card and receive a single standardised invoice from BMW i.

In Germany alone, there are over 70 different providers of public charging facilities, who currently operate a variety of payment and service concepts. Harmonising this situation is of crucial importance. BMW i already offers customers an intelligent solution with its ChargeNow card. The challenge now is to join forces with all the partners involved and further extend the range of products that are universally available.

One of the latest examples of how the public charging infrastructure can be interlinked is the recently unveiled portfolio of solutions from Hubeject GmbH, a joint venture between the BMW Group, Bosch, Daimler, the power companies EnBW and RWE, and Siemens. The company enables providers of electric mobility services to expand their product offering to include eRoaming. Drivers of electric vehicles therefore only need a single service provider contract to obtain access to every public charging point in an expanding European network, which BMW i customers can use with their ChargeNow card. In future, recharging electric vehicles will therefore become as straightforward as withdrawing money from a cash dispenser. The charging pole is accessed using a standardised QR code, which starts and ends the charging procedure by means of a scan function and smartphone app.

### **Flexible mobility: making smart use of alternatives.**

When the range of the BMW i3 is not sufficient for requirements, customers have recourse to various complementary mobility modules to help them cover larger distances, such as the temporary use of a BMW with a conventional engine or hybrid drive. For this purpose, individual annual quotas can also be booked through 360° ELECTRIC. Moreover, BMW i customers also have the DriveNow car-sharing service available to them.

### **Assistance services.**

With the BMW i3, drivers can enjoy driving a reliable vehicle with the additional reassurance of being able to call on assistance round the clock if they need it, thanks to a comprehensive servicing system and mobility guarantees, as well as intelligent comfort and convenience features.

Drivers can use their Smartphone to check on or program the battery status and charge level, or remaining vehicle range, or to check on or pre-program

the heating and air conditioning systems. A navigation system with special additional options provides useful assistance with journey planning. For example it can be programmed to select the most energy-efficient route. Drivers can also view charging stations situated along their route, so that they make optimal use of the BMW i3's driving range. In this context BMW i, together with other partners, is also actively supporting the development of an integrated public charging infrastructure which will offer EV customers further convenience features such as advance booking of charging stations and easy and transparent payment processes.

To make sure the BMW i3 runs smoothly in everyday operation, the battery and other electrical systems are monitored at all times, even while the vehicle is being driven. In the unlikely event of a malfunction, BMW Mobile Service vehicles or service workshops can diagnose the problem, pinpoint faulty parts and get the BMW i3 up and running again as quickly as possible. The service provided is of exactly the same scope and standard as offered for conventionally powered BMW cars. Customers can also count on the BMW service if a depleted battery forces them to take an unscheduled break. An onboard charging facility in the BMW Mobile Service vehicle acts as a sort of "spare fuel can", powering up the high-voltage battery in the BMW i3 so that customers can quickly resume their journey.

All service or repair work requirements are covered by a comprehensive service package. The work is performed by a BMW i service partner, and the BMW i customer is offered an extensive choice of replacement mobility options while the car is off the road. BMW i also provides prompt service in the highly unlikely event of a breakdown or if the battery runs out, and is able to recharge the BMW i3 on the spot.

### **Repair costs for the BMW i models are at class level.**

Tests by vehicle insurers and BMW Accident Research show that most accidents primarily result in minor damage. Comprising around 90 per cent of all recorded accidents involving conventional vehicles, these involve damage to the outer skin. The BMW i3 takes account of this and is equipped with robust screw/clip-on plastic plating all around. Minor bumps are absorbed without leaving dents, as usually occurs with metal parts. Damage to the paint does not lead to rusting. If a section of the external skin of the BMW i3 needs to be replaced, this can be carried out quickly and economically – repair costs are around 40 per cent lower compared with a conventionally built car. Overall, the accident repair costs are similar to those of a BMW 1 Series. It can therefore be assumed that the first insurance classifications will be at the usual compact car class level.

### **“Cold” repair methods for aluminium and CFRP components.**

The aluminium Drive module structure welded in series production is repaired using the “cold” repair methods of bonding and riveting. These methods have been in successful use in BMW workshops since 2003.

The reparability of the CFRP structure of the Life module was already taken into account during development of the vehicle concept. For example, several repair stages were defined for the side frame together with the option of replacing it as a whole. If only a damaged side sill needs to be replaced after a side impact, the workshop carries out a visual inspection and damage assessment, and then removes only the side sill repair section using a patented milling tool. The required side sill component is manufactured to fit, and then installed on the damaged vehicle. The new part is bonded to the separation points using repair elements.

Any authorised BMW i dealer can repair the outer skin. Due to the product-specific features of the LifeDrive module, there will be repair centres in which specialised employees repair vehicles with damage to the aluminium or CFRP structure.

### **New sales models provide flexible access to personal mobility.**

BMW i stands for visionary vehicles featuring inspirational design and a strong focus on sustainability. It also stands for a new approach to premium mobility – personal mobility and flexibility that is focused on future requirements and user needs. New BMW i sales channels will ensure that access to the range of products and services is as easy and customer-friendly as possible, catering in particular to customers’ increasing expectations regarding flexibility within the sales process. A rigorous focus on customer preferences will open up an entirely new brand experience and at the same time differentiate BMW i clearly from the competition.

In selected markets, sales of BMW i products and services will be handled via an innovative multi-channel sales model. In addition to the established “stationary” sales channel, i.e. authorised dealerships, this model will also comprise a mobile sales team, a Customer Interaction Centre (CIC) and Internet sales. All the new sales channels will be fully interlinked, ensuring that throughout the buying process customers can select – or switch – sales channels to suit their preferences. The Customer Interaction Centre (CIC) offers customers personalised, specialised support. This includes a full range of information on the topics of mobility services and sustainability, as well as the services of a mobile sales advisor.

The mobile sales adviser offers potential customers the option of one-to-one consultancy on BMW i products. This flexible service is provided without the customer having to come into a BMW showroom. It allows individual requirements – covering everything from model selection, equipment specification and choice of colour to finance options – to be pinpointed at an early stage in the process. On request, the mobile sales adviser can arrange for an initial test drive at the BMW i outlet nearest to the customer, and can even continue to provide personal assistance during the initial briefing on the car and during the test drive itself.

Whichever procedure a customer chooses, and regardless of whether they buy or lease the vehicle, their contract is always with BMW AG and not with the dealer, as would normally be the case. Of course, the traditional sales channel in the form of independent authorised BMW dealers will continue to play an important role in vehicle sales. Expanding the system into a multi-channel model will create additional resources at the dealerships that will allow dealers to focus on time spent with customers.

Not all BMW dealers will also handle sales of BMW i models. Bearing in mind the target groups and the general characteristics of the product, the plan is to concentrate on areas with the highest demand, i.e. major urban areas, where specially appointed BMW i dealers will handle sales. At launch, it is expected that more than 10 per cent of European BMW dealers will also be handling sales of BMW i models.

On the service side, meanwhile, there will be a clear focus on providing a full network of service outlets in order to maximise customer satisfaction and to cater to the specific needs of BMW i vehicles in terms of driving range. Standard service work can be performed by the existing BMW service network, while work on product-specific features of the carbon fibre Life module and the high-voltage battery will be handled by expert personnel at the specially appointed BMW i dealers.

## 7. Sustainable at every stage: Production.



The BMW i3 is based on a unique vehicle architecture, the LifeDrive concept, which meets all the necessary technical specifications for electric propulsion, while at the same time offering low weight, maximised range, generous space, effortless driving characteristics and high standards of safety. This innovative architecture comprises two modules: the Drive module, made of aluminium, which incorporates the powertrain, chassis and battery, and the Life module or passenger cell, made from carbon-fibre-reinforced plastic (CFRP). To implement this revolutionary concept, the BMW Group has developed equally innovative production processes which broach new territory in the automotive industry. This new production concept was also a pivotal factor for the implementation of the BMW i sustainability principle in the manufacturing process.

### **BMW i – a pioneer in the use of CFRP in the automotive industry.**

A key feature of this vehicle concept is its extensive use of carbon-fibre-reinforced plastic. With its CFRP passenger cell, the electrically powered BMW i3 (including battery pack) is no heavier than a comparable conventionally powered vehicle with a full fuel tank. Use of CFRP on this scale is unprecedented in the global automotive industry. The BMW Group is breaking new ground here as well – not only in the use of this innovative material but also in its manufacture and processing.

Production of the carbon fibre raw material takes place at a plant in Moses Lake in the US state of Washington, which is operated by the BMW Group and its joint venture partner, the SGL Group. This plant is firmly integrated in the BMW i production and value chain and provides the BMW Group with a secure supply of high-quality, sustainably produced raw materials for the production of CFRP components. The fact that all the stages in this process chain are under its own direct control gives the BMW Group a unique position in the industry.

Around 100 million US dollars (72 million euros) has been invested in the Moses Lake carbon fibre plant to date, and 80 jobs have been created. To make sure the BMW i3 can go into production on schedule at the end of 2013, the plant has been producing ultra-lightweight high-tech fibres ever since the end of 2011. The two production lines in Moses Lake currently each have a capacity of 1,500 tonnes a year – which means the plant already accounts for around 10 per cent of global CFRP production today.

### **Sustainable carbon fibre production in Moses Lake: energy generated entirely from hydroelectric power.**

The factory in Moses Lake produces carbon fibres from a polyacrylonitrile-based thermoplastic textile fibre precursor. In a complex multi-stage process, the various constituent elements of the fibre are removed by gasification, eventually leaving a fibre that consists of virtually pure carbon with a stable graphite structure. The resulting carbon fibres are just seven microns (0.007 millimetres) thick. A human hair, by comparison, has a diameter of 50 microns. For automotive application, approximately 50,000 of these individual filaments are bundled into so-called rovings or heavy tows and wound on reels, prior to further processing. In addition to automotive applications, fibre bundles of this thickness are also used, for example, in large rotor blades for wind turbines.

All of the energy used in carbon fibre production in Moses Lake is obtained from renewable, locally generated hydroelectric power and is therefore completely carbon-free. The state-of-the-art plant in Washington State also sets standards in energy efficiency. CO<sub>2e</sub> (global warming potential) emissions are around 50 per cent less than for conventional carbon fibre production.

### **Wackersdorf: processing into carbon fibre laminates.**

The rovings are sent to the joint venture's second site, at the Wackersdorf Innovation Park, for industrial processing into lightweight carbon fibre laminates. In contrast to a woven fabric, in these laminates the fibres are not interlaced or interwoven, but all lie in the same plane. Weaving would kink the fibres and detract from their special properties. The fibre orientation in the laminate is crucial to achieving optimal quality in a CFRP component.

Following an investment of 20 million euros and the creation of around 100 new jobs, today several thousand tonnes of carbon fibre laminates can be manufactured annually at the Wackersdorf site. These laminates form the raw material for the manufacture of CFRP parts and components at the BMW plants in Landshut and Leipzig.

### **Landshut: processing into CFRP components.**

At the CFRP press shops in Landshut and Leipzig, the carbon fibre laminates supplied from Wackersdorf are processed into CFRP body parts. Over the past 10 years, the BMW Group's CFRP specialists have steadily refined and automated the CFRP production process at the Landshut plant so that, for the first time, it is now possible to mass-produce CFRP body components cost-efficiently, to a high quality and with high process stability. CFRP roofs for the BMW M3 and M6 models and the bumper supports for the M6 have already been in mass production in Landshut for some time.

Following an investment of 40 million euros and the start of carbon component production with around 100 employees in March 2012, the Landshut site is now the key innovation and production centre for CFRP components. To safeguard its high level of technical expertise in the manufacture of innovative lightweight materials, the Landshut plant is investing heavily in its labour force and has increased its intake of trainees to 40 a year.

**Leipzig: manufacture of custom-formulated materials.**

The new press shop in Leipzig is equipped with state-of-the-art technology for the manufacture of CFRP automotive components. In this industrial-scale facility, BMW now produces its own carbon fibre composite materials. Properties such as the formulation, strength and geometry of the CFRP parts can be adapted to suit design requirements. At the initial “preforming” stage, the pre-cut carbon fibre laminate supplied by the Wackersdorf plant begins to acquire a shape. During this process a heat source is used to give a fabric stack a stable, three-dimensional form. Several of these preformed stacks (preformed blanks) can then be joined to form a larger component. In this way CFRP can be used, for example, to produce components with a large surface area that would be difficult to manufacture from aluminium or sheet steel.

Preforming and preform joining are followed by the next stage in the process: high-pressure resin injection using Resin Transfer Moulding (RTM). This technique, used in the aerospace industry, shipbuilding and the manufacture of wind turbine rotors, involves high-pressure injection of liquid resin into the preforms. As the fibres and the resin bond, and in the subsequent hardening process, the material acquires the rigidity which is key to its outstanding qualities.

Working to precisely defined time, pressure and temperature parameters, the CFRP presses apply a clamping force of up to 4,500 tonnes, until the resin and hardener are fully cross-linked and the resin is hard. BMW's own special manufacturing process eliminates the need for an additional time-consuming hardening process in a separate oven, which would normally be required for newly formed CFRP parts.

This new press shop, specially designed for CFRP, has little in common with a conventional sheet-steel press facility. It boasts a leaner production structure which is also reflected in terms of investment costs. For example, construction costs are significantly reduced by the fact that a conventional paint shop and cathaphoretic immersion priming are not required. The groundbreaking production process brings enormous time savings and for the first time makes

it feasible to mass-produce large CFRP composite components, with newly formed parts leaving the press in less than 10 minutes.

Even complex assemblies such as an entire side frame for the BMW i3 Life module leave the facility with many structural elements already integrated, and with optimal product quality, flawless functionality and very high dimensional accuracy. All that remains is the finishing work such as precise contour cutting and the insertion of further openings. This work is performed using a special waterjet cutting system. The bonding surfaces are then sandblasted and roughened before further processing. A conventional sheet-steel side frame, by contrast, would have to be built up successively from several different inner and outer components. Conventional sheet-steel architecture would require significantly more body parts in total and so would be inherently heavier than the Life module of the BMW i3.

### **Revolution in car body manufacture thanks to new, high-precision production equipment.**

The new CFRP composite components produced in the new Leipzig press shop and the CFRP components supplied from the Landshut press shop then make their way to the new car body shop. The basic structure of the Life module of a BMW i3 comprises around 150 parts, a third of the number required for conventional sheet-metal architecture. There is no noise from bolting or riveting and no sparks from welding. Instead, only the latest bonding technology is used, which is 100 per cent automated. The BMW Group is the only company proficient in this technology. In this unique, BMW-developed assembly process, the individual components are positioned 1.5 millimetres apart at the bond line gap in order to ensure optimal strength of the resulting joint. This precision ensures perfect transmission of forces between the individual CFRP components and therefore the highest level of volume production quality. The total length of bonded joints per vehicle is precisely predetermined, at 160 metres (20 millimetres width).

### **Innovative technology accelerates processes.**

Nowadays, CFRP passenger cells are generally only built for special vehicles, for racing cars or for particularly exotic sports cars. The production cost and complexity is of relatively minor importance for these small production quantities. Here, the hardening times for bonded joints can be more than one day. For mass production of the BMW i3 at the Leipzig plant, BMW has developed a greatly accelerated hardening process.

The newly developed adhesive used in CFRP production in Leipzig is workable for only 90 seconds after being applied to a component, before adhesion begins. An hour and a half later it is hard. This represents a tenfold

acceleration of conventional adhesive hardening times. In order to further reduce the hardening time to below 10 minutes, BMW has developed a supplementary thermal process. This involves heating specific points on the CFRP parts to be bonded, thereby further accelerating the hardening process by a factor of 32.

The high-strength CFRP passenger cell (Life module) produced in Leipzig then passes from the body shop to the new assembly shop for the “marriage”, where it is united with the aluminium Drive module. The basic Drive module supplied by Dingolfing and built up in Leipzig is now bolted and bonded inseparably to the Life module. Only then is the CFRP Life module fitted with its outer plastic skin. The painted multi-piece skin consists mainly of injection-moulded thermoplastics such as those also used in conventional vehicle manufacturing (front/rear apron, side sill etc.). During final assembly, the coloured plastic mouldings are bolted to the inner cell of the Life module at special mounting points that cannot be seen from the outside.

### **Closed-loop CFRP recycling.**

In the course of development work on the BMW i, the BMW Group devised a world-first commercial-grade recycling concept for CFRP components, body components and segregated production waste. Using various methods, high-grade materials from the production process and even from damaged or end-of-life vehicles are reused, being either fed back into the vehicle production process or used in other applications.

In the recycling process, a distinction is drawn between “dry” recycling of non-resin-impregnated carbon fibre and “wet” recycling of resin-impregnated components. Dry carbon offcuts from the production process can be reprocessed into high-grade non-woven fabrics and reused in the manufacturing cycle. Secondary (recycled) material already accounts for around 10 per cent of the carbon fibre used in the BMW i3. This process, too, is the first of its kind in the global automotive industry.

For composite recycling – the recycling of resin-impregnated carbon fibres – CFRP is first separated industrially from the other plastics and processed, for example, in a pyrolysis facility. The process heat from the breakdown of resins is used to separate the undamaged carbon fibres. These fibres can then be used to manufacture new components, thereby reducing the consumption of new fibre. The rear seat pan, for example, is made from such recycled carbon fibre. It fully meets the BMW quality standard and weighs 30 per cent less than a seat made from conventional fibreglass matting. Ground or cut into short fibres, the recycled CFRP or carbon fibres are also used in many areas outside the automotive industry, for example in the textile and electronics

industries (control unit housings). The use of secondary CFRP fibres is part of a sustainable material recycling strategy that conserves resources and provides a supply of raw materials for future applications.

### **Electricity for BMW i3 production in Leipzig is 100 per cent wind-generated.**

The production of the BMW i models will set new standards in environmental protection and consume around 50 per cent less energy and around 70 per cent less water in comparison with current average figures for production in the BMW Group, which are already extremely efficient. All the electricity used to produce the BMW i models at the Leipzig plant is wind-generated and therefore 100 per cent renewable.

At the Leipzig plant, for the first time in Germany, wind turbines have been installed on site at an automobile manufacturer to directly power production. Generating around 26 GWh a year, the four 2.5 MW Nordex N100/2500 wind turbines actually produce more electricity than is needed for BMW i production. An annual surplus of up to two GWh is anticipated, which can be used elsewhere at the Leipzig plant.

### **Competence network for e-mobility at the Dingolfing and Landshut sites.**

The BMW Group production network also builds the electric motor and battery for the BMW i3. The company is using its world-leading position in the field of powertrain technology to develop groundbreaking innovations in electric mobility. At its Dingolfing and Landshut plants in Lower Bavaria, the BMW Group has created a “competence network” for electric mobility.

The BMW plant in Dingolfing will produce the battery, the transmission and the aluminium Drive module structure. The expansion of the two production plants was accompanied by innovative measures to reduce water and energy consumption. At the Dingolfing plant, a groundwater recycling system which uses groundwater in three ways – for process cooling, for toilet flushing and as process water – will reduce groundwater consumption by around 2,500 cubic metres annually and electricity consumption by around one million kilowatt-hours. Energy consumption is further reduced by extensive building shell insulation and particularly systematic use of waste process heat. Process heat recovered in this way can be used to heat incoming fresh air. Around 72 per cent of waste process heat can be reused in the same process in which it was generated.

The BMW Landshut plant produces the BMW-developed electric motor. In addition, it builds Life module CFRP components, plastic exterior parts, castings and cockpits for use in the BMW i3. The Landshut plant is also home to the Landshut Innovation and Technology Centre. Specialising in lightweight materials and electric mobility, this research centre develops innovative materials and production processes. The CFRP production lines at the Landshut plant were chosen by an independent jury of experts for the “JEC Europe Innovation Award 2013”. This European industry award recognises innovative fibre composite solutions with high market potential. Earlier, in 2012, the BMW Landshut plant was already named German national winner by the “Industrial Excellence Award/Best Factory” jury. It also received the “Lean and Green Efficiency Award” for its outstanding combination of resource-efficient production and lean processes.

## 8. Technical specifications. BMW i3.



		BMW i3	BMW i3 (Range Extender)
<b>Body</b>			
No of doors / seats		5 / 4	5 / 4
Length	mm	3999	3999
Width	mm	1775	1775
Height (* with roof fin)	mm	1578 (* 1597)	1578 (* 1597)
Wheelbase	mm	2570	2570
Turning circle	m	9.86	9.86
Front / rear overhang	mm/mm	707 / 722	707 / 722
Ground clearance	mm	140	140
Luggage compartment volume	m <sup>3</sup>	0.260 – 1.100	0.260 – 1.100
Tank capacity	ltr	0	9
Weight, unladen, according to DIN/EU	kg	1195 / 1270	1315 / 1390
Max permissible weight / load	kg / kg	1620 / 425	1730 / 415
Air resistance (C <sub>d</sub> /A/C <sub>d</sub> x A)	- / m <sup>2</sup> / m <sup>2</sup>	0.29 / 2.38 / 0.69	0.30 / 2.38 / 0.71
<b>Drive system</b>			
Type of electric motor		BMW eDrive technology: Hybrid synchronous motor with integrated power electronics, charger and generator mode for recuperation	
Output	kW/hp	125 / 170	125 / 170
Torque	Nm	250	250
Recuperation	kW	up to 50	up to 50
<b>High-voltage battery</b>			
Rated voltage	V	360	360
Energy capacity (gross)	kWh	22	22
Storage technology		Lithium-ion	Lithium-ion
<b>Combustion engine</b>			
Torque	Nm	-	55
Config / No of cyls / Valves per cyl		-	in-line / 2 / 4
Capacity	cm <sup>3</sup>	-	647
Stroke / bore	mm/mm	-	66 / 79
Output / at rpm	kW/hp/ rpm	-	25 (34) / 4300
Torque / at rpm	Nm/ rpm	-	55 / 4300
Compression ratio / poss fuel (recommended)	:1/-	-	10.6 / RON87-98 (RON95)
Exhaust standard / fuel		-	EU6 / RON 95
<b>Driving dynamics</b>			
Drive concept		Rear-wheel drive	
Front suspension		Aluminium single-joint MacPherson spring strut with anti-dive	
Rear suspension		Five-link axle directly mounted to the Drive module	
Tyres front / rear		155/70 R19 / 155/70 R19	155/70 R19 / 175/65 R19
Rims front / rear		5J x 19 light-alloy / 5J x 19 light-alloy	5J x 19 light-alloy / 5.5J x 19 light-alloy
<b>Transmission</b>			
Type of transmission		Automatic, single speed with fixed ratio	
<b>Performance</b>			
Power-to-weight ratio (DIN)	kg/kW	9.6	10.5
Acceleration	0–100 km/h	s	7.9
	0–60 km/h	s	3.9
	80–120 km/h	s	5.5
Top speed	km/h	150	150
Range in everyday driving			
(Comfort mode)	km	130 – 160	240 – 300
(most efficient driving mode)	km	up to 200	up to 340
Range in EU cycle			
(Comfort mode)	km	190	170

	<b>BMW i3</b>	<b>BMW i3 (Range Extender)</b>	
<b>Charging times (for 80% charge)</b>	from < 30 min at 50 kW fast charge to ~ 8 h at domestic socket		
<b>Consumption in EU cycle</b>			
Power	kWh/100 km	12.9	13.5
Fuel / CO <sub>2</sub> *	ltr/100 km / g	0	0.6 / 13

Specifications apply to ACEA markets; data relevant to homologation applicable in part only to Germany (weight)

\* Based on EU cycle calculation regulation for vehicles with range extender; also applies if the range extender is not used in the test cycle.