

# The new BMW C evolution. Contents.



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# 1. Overall concept. Summary.



## **Dynamic riding fun with zero emissions.**

The arrival of the new C evolution marks the start of a new chapter in the urban mobility segment for BMW Motorrad. The two conventionally powered maxi scooter models – the C 600 Sport and C 650 GT – already succeed in combining the superb ride qualities of a motorcycle with the specific agility of a scooter and the design's inherent comfort. The new electrically powered C evolution now goes even further by fusing riding fun and dynamism with the benefits of zero-emission performance to create a whole new experience on two wheels.

In keeping with the BMW Group's sustainability strategy, BMW Motorrad is taking a fully committed approach to electric mobility. As with BMW i, development of the C evolution revolved around creating a visionary vehicle concept offering maximum everyday practicality and an inspirational design.

## **Powerful drive unit with liquid-cooled electric motor and air-cooled high-voltage battery. Range of 100 kilometres (62 miles) under practical conditions.**

The C evolution is powered by a drivetrain swing arm with liquid-cooled permanent magnet synchronous motor via a toothed belt and ring gearing. The rated power output is 11 kW (15 hp), with a peak output of 35 kW (47 hp). This enables the C evolution to achieve a top speed of 120 km/h (75 mph, electronically limited) and gives it better acceleration than some maxi scooters powered by engines with displacements of 600 cc or more.

The generous 8 kWh capacity of the air-cooled lithium-ion high-voltage battery allows the two-wheeler to cover a range of up to 100 kilometres (62 miles) before it needs to be charged from any domestic mains supply. When plugged in to a standard 220V domestic socket with a 12A charge current, recharging fully from empty takes around 4 hours (with  $220V / 16A = 3 \text{ h}$ ).

## **Intelligent recuperation and four ride modes ensure riding fun as well as efficiency.**

BMW Motorrad has opted for a form of energy regeneration for the C evolution that has never been seen before on a single-track vehicle. Recuperation takes place automatically both when coasting with the throttle closed and when braking.

Riders of the C evolution can set their preferred mix of dynamic performance and efficiency by selecting from the four ride modes. In Road mode, for instance, they have at their disposal maximum acceleration, approximately 50 per cent energy regeneration when coasting and full regeneration when braking. In Eco Pro mode, meanwhile, acceleration and therefore energy consumption are restricted, while the maximum possible amount of energy is recuperated. Sail mode suppresses recuperation while coasting, allowing the C evolution to glide along virtually free of any braking effect when the throttle is released. And for an added touch of dynamism, Dynamic mode combines full accelerating power with a high degree of recuperation.

### **Supreme safety thanks to synergies with BMW Automobile.**

As part of the BMW Group, BMW Motorrad was able to harness synergies with BMW Automobile during development of the C evolution. Besides adopting the same energy storage modules and electronic componentry used in the BMW i3, this was particularly beneficial for electrical safety, which is to passenger car standard. The C evolution is the first electrically powered two-wheeler to meet the ISO 26262 standard for functional safety and the ECE R100 standard governing high-voltage safety, both of which have been ratified by the leading carmakers.

As far as the chassis is concerned, the C evolution no longer has a main frame in the conventional sense. The central component here is the battery casing made from diecast aluminium, which has a steering head support made from steel tubing attached to it at the front and, at the rear, the single-sided swing arm as well as a rear frame, also made from steel tubing. The task of wheel suspension and damping is performed by an upside-down telehydraulic fork at the front and a spring strut mounted on the left at the rear. As on all vehicles from BMW Motorrad, the C evolution comes equipped with safety-boosting ABS together with powerful disc brakes as standard.

### **Torque Control Assist (TCA) for superior traction control.**

The new C evolution is available with Torque Control Assist (TCA), which works in a similar way to the Automatic Stability Control feature on BMW motorcycles with combustion engines. TCA limits the motor's torque depending on the slip at the rear wheel.

To ensure optimum controllability of the drive torque for the rider, the electric motor's control electronics monitor the rear wheel speed and reduce the drive torque if a certain plausibility threshold is exceeded. TCA is a particularly useful aid for the rider when starting off and prevents uncontrolled spinning of the rear wheel on road surfaces with reduced grip (e.g. wet cobblestones).

The Torque Control Assist additionally serves to stop the rear wheel from skidding when a sharp rate of recuperation produces a correspondingly high level of drag torque, especially on slippery road surfaces.

### **Large TFT colour display and LED daytime running light.**

A host of other features further underline the innovative character of the C evolution. It is equipped with a reversing aid, for instance, that enables easy manoeuvring at walking pace. There is also a first in the form of an LED daytime running light, which additionally dims to double as the sidelight. And for added comfort on cold days, there are heated handlebar grips.

A large TFT colour display in the instrument cluster offers a wealth of information. Apart from the current speed, the rider is also kept informed of data such as the average consumption in kWh/100 km, total power consumption, battery charge status in kWh, average speed, voltage of the on-board electrical system and the high-voltage system, as well as the remaining range in kilometres taking into account the selected ride mode. A bar graph furthermore indicates the current level of energy draw or regeneration.

### **Inspirational design.**

Last but not least, the C evolution also charts new territory in terms of styling and colour scheme. Design-wise, the C evolution fits harmoniously into the BMW Motorrad family, while the colour combination of Light White non-metallic and Electric Green symbolises its ability to blend maximum eco-friendliness with superb dynamic performance.

### **The highlights at a glance:**

- Innovative electric drive system via drivetrain swing arm with liquid-cooled permanent magnet synchronous motor, toothed belt and ring gearing.
- Rated power output 11 kW (homologated according to ECE R85) and 35 kW peak output.
- Maximum torque 72 Nm (53 lb-ft).
- Top speed 120 km/h (75 mph).
- Acceleration 0 – 50 km/h (31 mph) in 2.7 s.
- Acceleration 0 – 100 km/h (62 mph) in 6.2 s.
- High range of 100 kilometres (62 miles) in practical operation.
- 4 ride modes available to choose from: Road, Eco Pro, Sail and Dynamic.
- Reversing aid for supremely easy manoeuvring.
- Torque Control Assist (TCA).
- High-voltage battery with high capacity of 8 kWh and innovative air cooling.
- Intelligent recuperation when coasting and when braking.
- Recharged from the domestic mains supply.

- Takes just 4 h to charge to 100 % capacity at 220V / 12A (220V / 16A = 3 h).
- Synergies with BMW Automobile harnessed during development.
- Electrical safety to passenger car standards.
- Hybrid chassis with agile handling due to low centre of gravity.
- Powerful braking system with ABS.
- Large TFT colour display.
- LED daytime running light and sidelight.
- Inspirational colour scheme and design.

## 2. Technology and design.



### **Dynamic performance on a par with a conventionally powered maxi scooter.**

With a rated output of 11 kW (15 hp, homologated according to regulation ECE R85 for measuring power) and a peak output of 35 kW (47 hp), the C evolution has plenty of power on tap. Its maximum torque of 72 Nm is constantly available at motor speeds up to approx. 4,500 rpm.

The motor's punchy performance means the C evolution can accelerate from 0 to 50 km/h (31 mph) in just 2.7 seconds, for example. This is the sort of time achieved by today's maxi scooters with displacements of 600 cc or more and translates into tremendous riding fun. The top speed is electronically limited to 120 km/h (75 mph).

Thanks to its powerful drive unit, the new model effortlessly handles motorway riding and overtaking, even when carrying a passenger, while hill starts on steep slopes are likewise performed with the greatest of ease. What's more, the electric drive of the C evolution has significant benefits to offer over conventional drive systems at low speeds in particular. The intricate tuning of the power electronics ensures immediate, spontaneous response from the electric motor, for instance, while there are absolutely none of the delays in torque build-up typically experienced with combustion engines due to the clutch engaging and disengaging. As a result, riders of the C evolution enjoy exceptionally direct responsiveness accompanied by sensitive power control.

### **High battery capacity enables a high range of up to 100 kilometres (62 miles).**

The battery's considerable storage capacity of 8 kWh is sufficient for a range of up to 100 kilometres (62 miles) in Road mode (higher in Eco Pro mode), allowing practical travel with zero emissions in both city centres and any urban environment. The lithium-ion energy storage modules are the same as those fitted in the BMW i3; they meet the most exacting standards in terms of both quality and service life, ensuring that the range of the C evolution is just as high even after many years of use or in cold weather.

The battery is made up of three storage modules, each comprising twelve cells with a capacity of 60 Ah and a nominal voltage of 3.7 volts. The cells used are prismatic lithium-ion cells.

### **Innovative air cooling of the high-voltage battery.**

The developers also invested a great deal of their technical expertise in the cooling of the high-voltage battery. On the one hand, it was important to stop temperatures from dropping too low, as this would increase the cells' internal resistance, thereby reducing power output. At the same time, excessively high temperatures also had to be prevented in order to maximise cell life.

In contrast to the battery cooling systems with cooling agents that are employed in electrically powered cars, air cooling is used on the C evolution as this takes up less space and keeps the weight lower. The heat from the high-voltage battery is dissipated by the air stream passing through a cooling air shaft positioned in the centre of the battery casing so that it is facing the direction of travel. In order to make cooling as efficient as possible, the base of the battery casing furthermore includes cooling ribs aligned in the direction of travel.

The battery's diecast aluminium casing doesn't just hold the battery cells, it also contains the electronics needed to monitor them. The casing additionally acts as a load-bearing chassis element, dispensing with the need for a frame in the conventional sense.

The power electronics for the electric drive are installed behind the battery casing and take care of energising the electric motor in a range between 100 and 150 volts, with a nominal voltage of 133 volts. The power electronics also process the rider's commands, such as throttle grip position, along with information from the braking system. Furthermore, they control the energy recuperation process by deciding whether to apply recuperation torque to the rear wheel and how much depending on the rider's inputs and the ride mode.

### **Innovative, liquid-cooled electric drive system with drivetrain swing arm, toothed belt and ring gearing, plus reversing aid.**

The compact drive unit for the C evolution takes the form of a drivetrain swing arm, with a permanent magnet synchronous motor positioned behind the battery casing acting as an integral part of the swing arm. Due to the close proximity of the swing arm axle and the electric motor's output shaft, the moment of inertia around the swing arm's pivot point is kept low, allowing for optimum suspension/damper settings as well as sensitive response.

A maintenance-free toothed-belt drive transmits the power from the electric motor to the rear belt pulley. The torque is then directed to the rear wheel via a planetary gear with an overall reduction ratio of 1:8.28. The electric motor's maximum rotational speed is 9,200 rpm.

The electric motor and its power electronics are liquid cooled, with the cooler located at the front right in the front cowling. An electric fluid pump is used to circulate the coolant.

One of the stand-out comfort features of the C evolution is its reversing aid. It is enabled via a control on the left handlebar, with a light jolt confirming activation for the rider. With the activation button pressed, the C evolution can be reversed at no more than walking pace to make manoeuvring easier. Activation of the reversing aid is also indicated in the TFT display by a corresponding ride enable message.

### **Energy regeneration when coasting and braking.**

During development of the C evolution, BMW Motorrad opted for a form of energy regeneration (recuperation) that has never been seen before on a single-track vehicle and is perfectly transparent for the rider. Recuperation takes place automatically depending on the selected ride mode. This means that riders do not have to activate recuperation themselves and basically ride the C evolution in exactly the same way as a maxi scooter powered by a combustion engine.

**Recuperation when coasting with the throttle closed:** closing the throttle grip triggers recuperation in accordance with the selected ride mode. As with a combustion engine, the electric motor's generator function creates a drag torque or "motor braking" effect. Its intensity depends on the rate of recuperation, which can be varied by selecting from the different ride modes.

**Recuperation while braking:** recuperation is also carried out when braking, converting kinetic energy to electrical energy so as to charge the battery. This process involves using sensors to pick up the brake pressures at the front and rear wheel brakes. If the power electronics detect a braking manoeuvre, the electric motor will automatically build up a drag torque so as to aid braking and recuperate energy.

### **Torque Control Assist (TCA) for superior traction control.**

The new C evolution is available with Torque Control Assist (TCA), which works in a similar way to the Automatic Stability Control feature on BMW motorcycles with combustion engines. TCA limits the motor's torque depending on the slip at the rear wheel.

For optimum controllability of the drive torque, the electric motor's control electronics monitor the rear wheel speed and reduce the drive torque if a certain plausibility threshold is exceeded, just as Automatic Stability Control does on BMW motorcycles with combustion engines. TCA is therefore a

particularly useful aid for the rider when starting off and prevents uncontrolled spinning of the rear wheel on road surfaces with reduced grip, such as wet cobblestones.

The Torque Control Assist additionally serves to stop the rear wheel from skidding when a sharp rate of recuperation produces a correspondingly high level of drag torque, especially on slippery road surfaces.

### **A choice of ride modes for efficient operation and everyday practicality.**

During development of the C evolution, BMW Motorrad made it a particular priority to ensure that its riders would be able to enjoy either the greatest possible efficiency or maximum riding pleasure as desired. As a result, the C evolution includes four ride modes.

**Road mode:** full accelerating power is available here, while energy is recuperated at a rate of approx. 50% when coasting with the throttle closed. Recuperation takes place during braking as well. The standard operating range is achieved in this mode.

**Eco Pro mode:** the drag torque when coasting is increased significantly in this mode and a maximum recuperation rate together with the restricted accelerating power and the resulting limit on energy output enables the range to be extended by 10-20%. The higher drag torque manifests itself for the rider as a sharper decelerating torque when the throttle is released. The highest range is achieved in this ride mode.

**Sail mode:** in this mode, the electric motor does not build up drag torque and recuperation only takes place when braking. As a result, riders will notice that next to no braking torque is generated when the throttle is released, allowing the vehicle to glide along virtually free of any braking effect – a riding experience that is unheard of on conventionally powered two-wheelers.

**Dynamic mode:** for extra-dynamic performance, this mode combines full accelerating power with a sharp rate of recuperation and therefore a high level of drag torque.

### **Short, practical charging times.**

The C evolution is recharged via its built-in charger by connecting it to either a domestic mains socket or a suitable charging station. The charging cable supplied as standard is fitted with the standard connector for the respective country's domestic mains supply. National variant coding ensures the maximum charge current is set to the correct value. If necessary, the rider can reduce

this charge current in increments by going to the set-up menu. The charging socket is located behind a cover in the front left of the leg well.

When plugged in to a standard 220V domestic socket with a 12A charge current, fully recharging the battery from empty takes around 4 hours (with  $220V / 16A = 3 \text{ h}$ ).

### **Supreme technical safety thanks to synergies with BMW Automobile.**

As part of the BMW Group, BMW Motorrad was able to draw on the automotive expertise of BMW Automobile during development of the C evolution in a way that no other motorcycle manufacturer can. The synergies available extended beyond the use of the same technical components to the high-voltage technology and its specific safety requirements for cables, connectors, the battery electronics and the safety shutdown. Further synergies with the automotive arm of the BMW Group were tapped into for the ISO insulation monitor, the high-voltage indicator, the high-voltage distributor as well as the DC-DC transformer, which is responsible for converting the high voltage into low voltage to supply power to the 12-volt onboard electrical system and the control units.

The C evolution is the first electrically powered two-wheel vehicle to have been developed in accordance with the ISO 26262 standard for functional safety and the ECE R100 standard governing high-voltage safety (> 60 volt direct current), both of which have been ratified by the leading carmakers. They ensure that the development of all functionally relevant features takes place in accordance with set standards and reflects the state of the art and science.

Besides the storage modules for the high-voltage battery, further components were likewise taken straight from the BMW i3. This is true of the battery electronics, for example, which monitor the battery modules as well as the total current and calculate how much energy is available for use. The battery electronics additionally have the task of preventing any of the battery cells from overcharging or deep discharging, and activate a safety shutdown of the entire battery if necessary to guard against damage in such cases. The module electronics for monitoring cell temperature and voltage were also adopted from the BMW i3. The inclusion of these elaborate monitoring systems plays no small part in ensuring that the battery continues to provide at least 80% of its original capacity after five years of use.

### **Hybrid chassis with low centre of gravity and agile handling.**

The overriding objective for the development of the C evolution chassis was to combine impressive straight-line stability at high speeds, such as when

travelling on motorways and expressways, with delightfully simple handling, easy manoeuvrability and outstanding low-speed riding qualities in urban traffic. With this in mind, the development team capitalised fully on the advantages offered by the battery casing's low positioning.

Consequently, the C evolution does not have a frame in the traditional sense. Instead the chassis concept employs a torsionally rigid hybrid construction with the load-bearing, torsion-resistant battery casing in diecast aluminium with integrated mounting for the single-sided drivetrain swing arm acting as the main element. It has the steel tubing structures for the steering head support and rear frame bolted onto its front and rear respectively. This intelligent design, furthermore, has a positive impact on the overall weight of the C evolution, which is on a par with comparable maxi scooters driven by combustion engines.

Wheel location at the front is handled by an upside-down fork with 40-millimetre stanchion tubes and 120 millimetres of suspension travel, whereas the rear wheel is guided by the single-sided drivetrain swing arm. The tasks of wheel suspension and damping at the rear are performed by a directly controlled spring strut positioned on the left-hand side with adjustable spring preload. Suspension travel here is 115 millimetres.

The C evolution rides on a five-spoke diecast alloy wheel at the front, size 3.5 x 15 inches, and a 4.5 x 15-inch rear wheel.

### **Powerful braking system with ABS.**

A twin-disc brake system at the front with 270-millimetre disc diameter and two sets of 2-piston floating callipers provides sure, fade-resistant stopping power. The same task is handled at the rear wheel by a single-disc system, also with a diameter of 270 millimetres and a 2-piston floating calliper. Steel-braided brake lines ensure a constant pressure point and optimum controllability.

As on all other vehicles from BMW Motorrad, the C evolution also features safety-boosting ABS as standard. Weighing just 700 grams and extremely small in size, the Bosch 9M dual-channel ABS that has been fitted allows independent control of the two brake circuits for the front and rear brakes.

Before being installed on the C evolution, however, the system was first tailored to the specific needs of this highly innovative electric vehicle. The ABS software has therefore been specially adapted so as to control the recuperation process. As on the C 600 Sport and C 650 GT maxi scooters

from BMW Motorrad, the parking brake is activated automatically when the side stand is folded out.

### **Multifunctional TFT colour display, LED daytime running light and heated grips.**

The instrumentation on the C evolution consists of a large, easily legible TFT colour display. The multi-chamber lamps at the top comprise all the mandatory warning and fault telltale lights, including turn signals, hazard warning lights, high beam, daytime running light, as well as the general control lamp, which causes an icon to appear at the top left of the TFT display when it is activated.

Besides a digital speed readout, the TFT display offers a wealth of further information. By pressing the Info button on the left handlebar, the rider is able to call up the following data: current power output in kW, average consumption in kWh/100 km, total power consumption, battery charge status, average speed, voltage of the onboard electrical system and the high-voltage system, and the remaining range in kilometres taking into account the selected ride mode. In addition to all of the above information, the C evolution instrumentation also includes the status indicators required by law in electrically powered vehicles for displaying an insulation fault or power limitation in the event of overload (see ECE R100). The various ride enable messages also appear in the TFT display.

One of the key features is the visualisation of the energy balance using a bar graph. This shows the rider whether energy is currently being converted into forward propulsion or recuperated in order to charge the battery. This information is intended to help riders plan their journey individually and choose their driving style accordingly.

The front light unit encompasses the headlights for high and low beam, and an LED tail light is fitted at the rear. The C evolution also features a centrally positioned daytime running light that can be operated from the left handlebar controls. As a novel feature, the daytime running light can also be dimmed to act as a sidelight, thereby doing away with the previous separate sidelight unit. This function can be controlled from the set-up menu by selecting "Automatic daytime running light".

And for rides on cold days, the C evolution also comes equipped with heated handlebar grips.

### **Inspirational styling and colour scheme.**

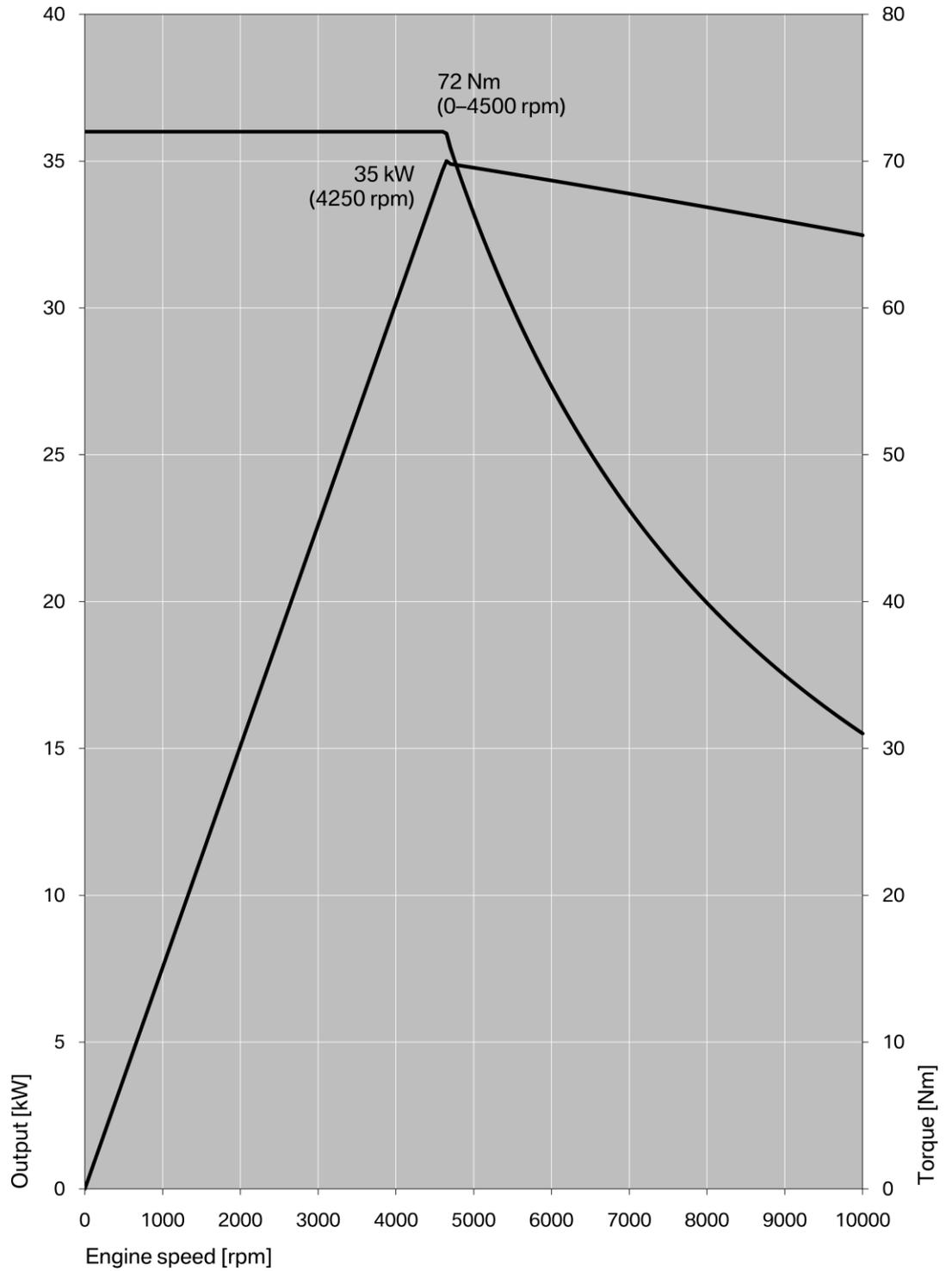
The C evolution takes its cue from the rest of the BMW Motorrad family by employing an innovative styling concept to create an inspirational design that gives this new form of drive technology an added sense of fascination and emotional appeal.

It also features the “split face” extending across the upper section of the front cowl, a characteristic BMW Motorrad design trait that gives the two-wheeler a highly distinctive and dynamic appearance from the front.

The trademark styling of BMW Motorrad Design is also reflected in the twin-tipped spoiler on the front cowl and the boomerang-shaped floating panels in the front side trim. The model’s short, sporty-looking rear with integral helmet compartment further underlines the eager nature of the C evolution.

The interplay between the Light White non-metallic paint colour and the highlight colour Electric Green succinctly symbolises two outstanding qualities of the C evolution: maximum eco-friendliness and superb dynamic performance.

### 3. Output and torque.



## 4. Specifications.



<b>BMW C evolution</b>		
<b>Drive</b>		
Nominal output	kW/hp	11/15
Maximum output	kW/hp	35/47.5
at rpm	rpm	4,650
Torque	Nm	72
at rpm	rpm	0 to approx. 4,500
Type	Drivetrain swingarm with liquid-cooled electric motor; permanent magnet synchronous motor with surface magnets, max. torque 9,200 rpm	
<b>Electrical system</b>		
Drive battery	Air-cooled lithium-ion high-voltage battery with auxiliary cooler	
Battery capacity	kWh	8 (3 modules, 12 cells each with 60 Ah)
Battery voltage (nominal)	V	133
Charge capacity	kWh	3 (built-in charger)
Charge time	At 220V / 12A charge current: approx. 4h for 100%; 2:45 h for 80% At 220V / 16A charge current: approx. 3h for 100%; 2:15h for 80%	
Secondary battery	V/Ah	12 / 8
Generator	W	DC-DC transformer integrated into the charger, 475
Headlights	High/low beam: 12V/55W, halogen; LED daytime running light/sidelight	
Rear light	LED brake/rear light	
<b>Power transfer gearbox</b>		
Secondary drive	Drivetrain swingarm with toothed belt and ring gearing	
Overall reduction ratio	1 : 8.28	
<b>Chassis</b>		
Frame type	Hybrid chassis with load-bearing battery casing made from diecast aluminium, bolted-on steering head support and rear frame made from steel tubing	
Front suspension	Upside-down telescopic fork, Ø 40 mm	
Rear suspension	Single-sided swing arm with directly controlled spring strut; spring preload manually adjustable in 7 stages	
Spring travel front/rear	mm	120/115
Wheel castor	mm	95
Wheelbase	mm	1,594
Steering head angle	°	65.9
Brakes	front	Hydraulically actuated double-disc brake, Ø 270 mm, twin-piston floating calliper
	rear	Hydraulically actuated single-disc brake, Ø 270 mm, single-piston floating calliper
ABS	BMW Motorrad ABS as standard	
Rims	Cast aluminium	
	front	3.50 x 15"
	rear	4.50 x 15"
Tyres	front	120/70 R15
	rear	160/60 R15

<b>BMW C evolution</b>		
<b>Dimensions and weights</b>		
Length	mm	2,190
Width incl. mirrors	mm	947
Height		
Seat height (without rider)	mm	780
DIN unladen weight, road ready	kg	265
Permitted total weight	kg	445
<b>Riding data</b>		
Top speed	km/h	120 (electronically limited)
Acceleration		
0–50 km/h	s	2.7
0–100 km/h	s	6.2
Range		approx. 100 km commuting
Recuperation		Automatic recuperation when coasting and braking, simulated drag torque ("motor braking"), potential range increase approx. 10–20%