Introduction of Products

Battery-powered Hydraulic Excavator PC138E-11

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As a "zero-emission construction machinery" installed with a large-capacity lithium-ion battery and motor, we have developed and launched battery-powered hydraulic excavators with strength for long hours of operation and a small machine body, PC138E-11. This paper reports on the main features of the product.

Key Words: *Carbon neutrality, Electrification, Long operation hours, Lithium-ion battery, Semi short tale, Quietness, Heat reduction*

1. Introduction

To realize carbon neutrality as well as to respond to the various environmental-measure related demands from the customers, Komatsu has positioned FY2023 as the first year for the market introduction of electrified construction machinery and has developed and introduced a 13-ton class battery-powered hydraulic excavator to the market as part of this effort. Hydraulic excavators have the highest versatility among the construction machinery; especially their 13-ton class machinery is used in various fields and applications, mainly for the small worksites like urban civil engineering. With the market introduction of this machinery, we will proceed with developing a market for electrified construction machinery with an eye to achieving carbon neutrality by 2050 by cultivating much broader market needs.

Fig. 1 Appearance of PC138E-11

Table 1 Main specifications

Item		Unit	PC138E-11
Bucket capacity		m^3	0.50
Transport dimensions	Overall length	mm	7,970
	Overall width	mm	2,490
	Overall height	mm	3,005
Tail swing radius		mm	1,830
Machine weight		kg	15,300
Motor output		kW	72.5
Battery capacity		kWh	225.6

2. Aims of development

We developed PC138E-11 as a machine equipped with a large-capacity lithium-ion battery which is capable of operating for long hours even with a small tail swing radius. The outline and features are described below.

(1) Environment
- Zero emission
- Significant reduction of machine noise and exterior noise
- Reduction of waste heat and oscillation

(2) Workability
- Being equipped with a large-capacity lithium-ion battery
- Semi short tail
- EU Charging standard CCS Type-2

(3) Safety
- KomVision (all-round machine monitoring camera system)
- Motor-in-operation revolving lamp
- Compliant with ROPS & OPG Top Guard Standards
- Safety equipment equivalent to the PC138US-11

(4) Maintainability
- Reduction of maintenance items
- Daily maintenance

(5) ICT
- Remote monitoring of the daily operating status by Komtrax

3. Major features

3.1 Environment

3.1.1 Zero emission

PC138E-11 is equipped with a lithium-ion battery and electric motor, which realized the zero-emission of exhaust gas at a worksite and significantly improved the work environment of customers. PC138E-11 has also received the initial qualification of the “GX Construction Machinery Qualification System” which was newly established in 2023 by Japanese Ministry of Land, Infrastructure and Transport to qualify the machinery that contributes to carbon neutrality.

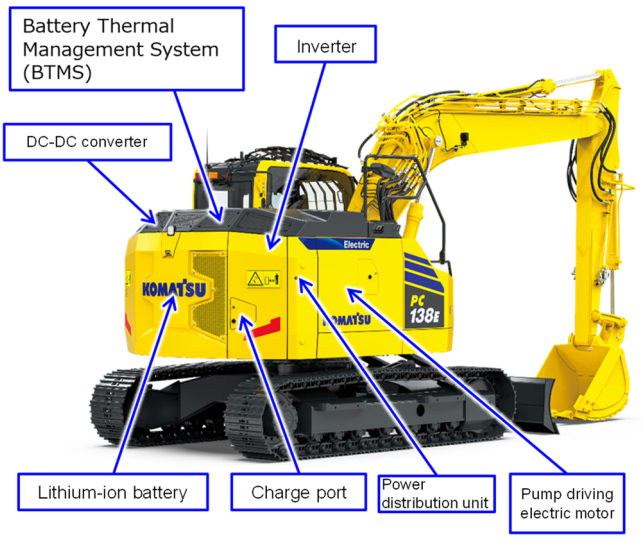


Fig. 2 Arrangement of main electric components

3.1.2 Significant reduction of machine noise and exterior noise

Since PC138E-11 is equipped with a lithium-ion battery and electric motor instead of an engine, there is no engine noise and significantly less noise compared to the conventional construction machinery. Electric fans are also adopted, which controls the fan speed according to the hydraulic oil temperature. Under the conditions where the ambient temperature is low or with light load, the noise would farther get lower (**Fig. 3**). As the standard, it is applicable to the super low-noise type construction machinery designated by Japanese Ministry of Land, Infrastructure and Transport.

Fig. 3 Adoption of electric fans

3.1.3 Reduction of waste heat and oscillation

By replacing the engine with an electric motor, the temperature around the machine does not rise, and the oscillation conducted to the operator significantly lowered. This allows the operator to work with less stress and fatigue, thus, they can work comfortably.

3.2 Workability

3.2.1 Being equipped with a large-capacity lithium-ion battery

To be operated for long hours, PC138E-11 is equipped with a large-capacity lithium-ion battery of 225.6 kWh. If the battery is charged during the lunch break at their worksites, it reassures more the operators to work all day without worrying about running out of battery.

As shown in **Fig. 4**, the inverter and electric motor are driven by the electric power supplied from the lithium-ion battery, and the power is transferred to the hydraulic pump. The hydraulic pressure components follow PC138US-11 as the base machine; and realized the controllability and workability which are popular with engine powered machines, as well as the long-hour operation.

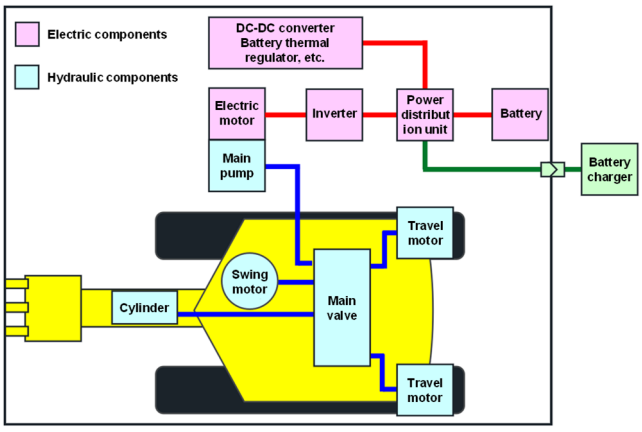


Fig. 4 PC138E-11 System configuration

3.2.2 Temperature adjustment system for batteries

PC138E-11 is equipped with the Battery Thermal Management System (BTMS) that controls the temperature of batteries. BTMS controls the battery temperature to be within the appropriate range so that the batteries can keep operating safely and efficiently. High battery temperature accelerates their deterioration over time and will cause a risk in safety. On the other hand, low battery temperature decreases the battery capacity and charge/discharge performance.

BTMS adjusts the temperature while the batteries are charged as well as they are in operation; so, the temperature of the battery cells is always kept optimum.

3.2.3 Semi short tail

BTMS installed on PC138E-11 can cool down the other electric components as well as lithium-ion battery using the same water circuit (**Fig. 5**); so, the radiators for cooling down the devices like an electric motor can be removed, and the space required for mounting such a radiator is saved. Accordingly, PC138E-11 equipped with a large-capacity lithium-ion battery can operate for long hours even with a small machine body.

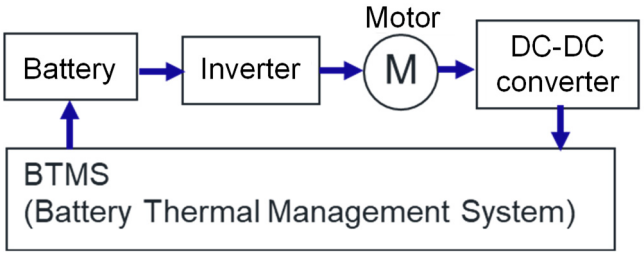


Fig. 5 Cooling circuit

Operation in a small and narrow worksite can be performed more safely because the above-mentioned cooling system is adopted, and the components are arranged in the optimum manner; which allows to have the tail swing radius significantly smaller compared to the standard square type hydraulic excavators, although the rear radius is larger than that of rear ultra-small turning type hydraulic excavators.

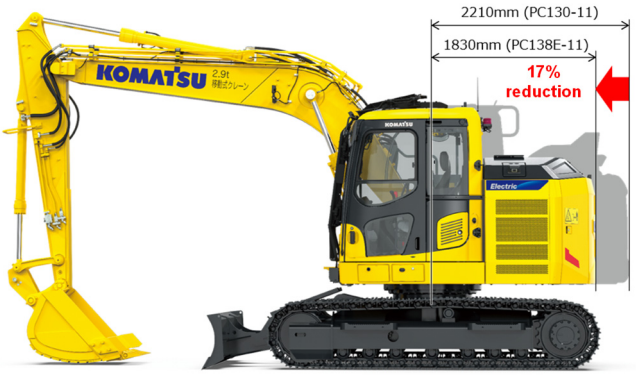


Fig. 6 Tail swing radius of PC138E-11

3.2.4 EU Charging standard CCS Type-2

CCS Type-2, which is widely used in Europe, is adopted for charging, and batteries are charged using a fast charger. A charging port is located at the rear of the machine body and charged by a 3-phase 400 V stationary charger in Europe and by a 3-phase 200 V stationary charger in Japan.

Charge the battery using the charging port provided at the rear side of the machine body. The charging plug is electromagnetically locked during charging and cannot be pulled out, which allows customers to use it with safely (**Fig. 7**).

Fig. 7 Charging port

3.3 Safety

3.3.1 KomVision (all-round machine monitoring camera system)

The machine is equipped with the KomVision system which uses four cameras installed on the sides and rear of the machine (**Fig. 8**) to display an image of the vehicle's peripheral vision on a monitor by combining the images from each camera around the machine (**Fig. 9**). The right screen of the monitor can be switched to the right side, right front, left side, and rear by a switch on the monitor.

Fig. 8 Cameras installed on the surroundings of the machine body

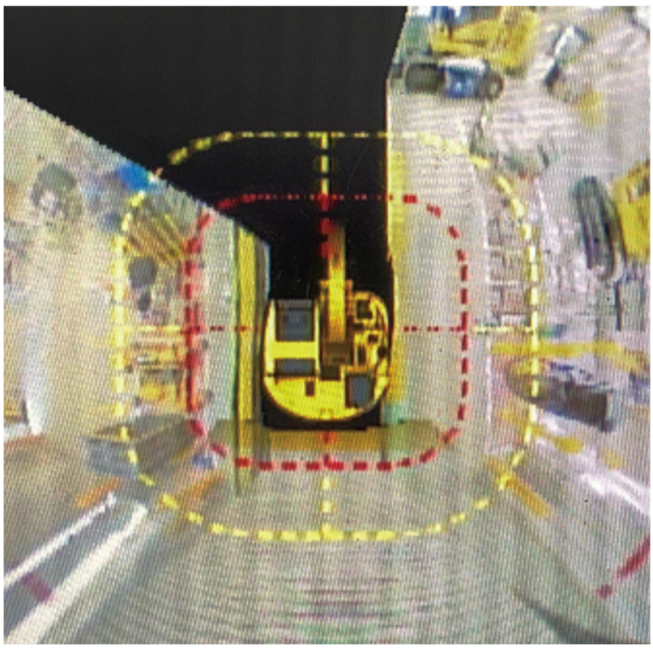


Fig. 9 KomVision

3.3.2 Motor-in-operation revolving lamp

When the electric motor is in operation, the motor-in-operation revolving lamp *1 installed on the upper part of the operator's seat lights up to let the people around the machine recognize it. When using an engine-powered machine, the people around the construction machine can judge whether the machine is in operation or not by the existence of engine sound. However, electric machines do not carry an engine and the exterior noise generated during idling decreased significantly; which makes it difficult for the people to judge whether the machine is in operation or not. The lamp is installed to compensate it.

*1 The color of the operation indicator lamp is purple for Japanese specifications.

Fig. 10 Operation indicator lamp

3.3.3 Compliant with ROPS & OPG Top Guard Standards

ROPS cab with an operator-protective structure (conforming to ISO 12117-2) is provided in case for the tipping over of the hydraulic excavator. It has high shock absorption and outstanding durability and impact resistance. It conforms to the OPG Top Guard Level I (ISO 10262) against falling objects and the head guard standard under the Industrial Safety and Health Law. Together with wearing a retractable seatbelt, it firmly protects the operator from tipping over and falling objects.

3.3.4 Lock lever auto-lock function

The lock lever auto-lock function is provided the same as engine-powered machines. The lock lever auto-lock function prevents the unwanted operation of the work equipment or machine when the lock lever is released while the work equipment control lever, travel lever, or attachment control pedal is operated.

Fig. 11 Monitor display when the lock lever auto-locking function in operation

3.3.5 Motor stop secondary switch

Like the engine shutdown secondary switch on engine-powered machinery, a motor stop secondary switch is installed at the bottom of the seat. The machine can be stopped without sitting on the operator's seat.

Fig. 12 Motor stop secondary switch

3.4 Maintainability

3.4.1 Reduction of maintenance items

Along with the disuse of engine, checking on the engine or fuel related items is not required anymore; so, the items to be checked under daily inspection and periodic maintenance are significantly reduced.

3.5 ICT

3.5.1 Remote monitoring of the daily operating status by Komtrax

Using Komtrax, PC138E-11 can obtain the information on the machine operating condition including its operating hours, power consumption, average amount of electric power, and drive battery temperature, as well as location information.

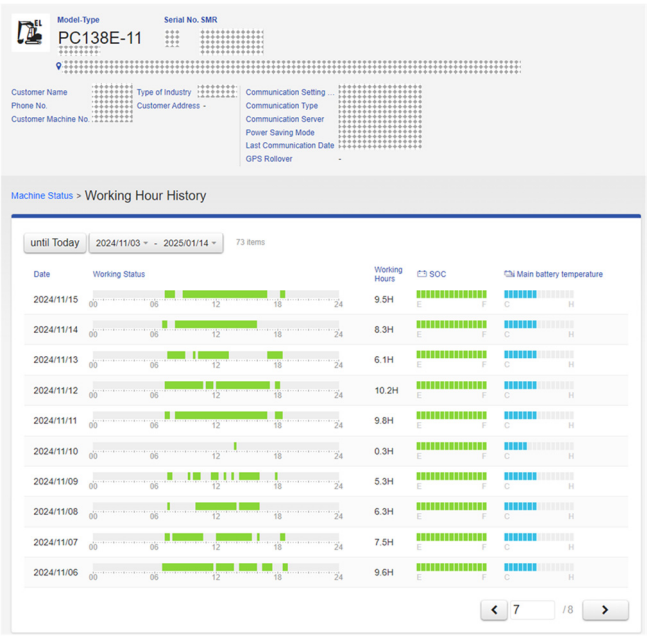
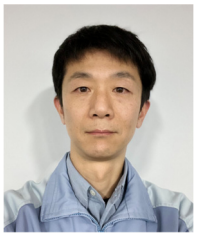


Fig. 13 Komtrax screen

4 Conclusion

In this paper, PC138E-11 is introduced, which was press released in November 2023 and launched at the Japanese market in 2024. With this machinery, we hope establishment of the electrified-machinery market will progress through cultivating much broader market needs towards the target carbon neutrality in 2050.

Introduction of the authors



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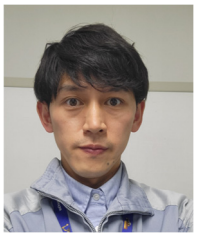

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[A comment from the authors]

We are so proud of being involved in the development of zero-emission construction machinery as part of our effort to realize the ideal “develop safe, highly productive, smart and clean workplaces of the future with customers.” We are grateful to have this valuable experience. Since this is a new technology, we gained a lot of new findings. On the other hand, we also found anew the mature technology using engine rational in many ways. It presented a good opportunity to think about what is ideal for each customer. We would like to continue proceeding with the development of products that meet our customers’ needs.