

# Cat<sup>®</sup> 336E H Hydraulic Hybrid

Performance without compromise.

## FAQs

### **Q: How does Caterpillar define hybrid?**

The term hybrid can be used or defined in different ways. At Caterpillar, we define a hybrid machine as one that's equipped with devices to collect, store and release energy to perform work during machine operation. That means to be called a hybrid, a machine is not dependent on any particular technology—it doesn't have to be electric. In fact, there are many other ways to store and reuse energy besides electric.

### **Q: Why did Caterpillar go with hydraulic hybrid technology when other OEMs use electric?**

We began researching the feasibility of different hybrid solutions for Cat<sup>®</sup> equipment years ago. In 2009, we began parallel programs to commercialize our hydraulic and electric systems and components for excavator applications. As our development of both systems progressed, it became apparent that, far and away, the best choice for large excavators was hydraulic, not electric. For this size class of large excavators that operate in high-production applications, it was the only solution we tested that proved to lower customers' owning and operating costs. Overall, to meet the needs of our customers today, we find our hydraulic hybrid approach for large excavators is far easier to maintain, less costly and much more efficient than electric. Plus, we have been able to achieve great reductions in fuel, regulated engine emissions and sound while preserving the power, force and speed our customers need to get the job done.

### **Q: Will Caterpillar ever manufacture an electric hybrid?**

We continue to work with electric and other forms of hybrid technologies. In fact, in September 2012, Caterpillar introduced the new Cat 6120B H FS, the largest hydraulic mining shovel ever built. Innovative hybrid technologies in the shovel cut fuel use per ton by an estimated 25 percent through the use of hydra-electric regenerative technologies and a unique energy storage system. We've got the best and the brightest engineers working all around the world to discover and develop the future technologies our customers need to be successful. If that turns out to be electric for certain machines, then we'll be ahead in our development process for an electric hybrid.

### **Q: What performance did you sacrifice on the 336E H to save fuel?**

None. The 336E H hybrid delivers the same industry-leading performance and productivity as our standard 336E, because both machines share many of the same proven hydraulic components. So while the 336E H uses less fuel and reduces regulated engine emissions, it produces the same great lift capacity, digging force, speed, power and performance of the 336E. There is no compromise in performance with the hybrid model.

### **Q: How did you test the fuel savings and performance?**

To validate fuel and productivity, Caterpillar has tested production 336E H machines with operators from all over the world. In a formal production study completed in August 2012, results were impressive, including greater fuel efficiency, and lower cab and spectator noise levels than the 336E and 336D. Customers have also been using field follow machines, which are our first production machines built for customer acceptance testing, to validate fuel burn, controllability, reliability and performance of the 336E H.

### **Q: What is the payback period for the 336E H?**

Precisely when customers will recoup their initial investment in the hybrid capabilities of the 336E H depends on two primary factors: fuel price and application. Assuming today's fuel prices and a high-production application for their respective 336E H, customers can realistically expect to see a return on their added investment for the hybrid features in as little as one year. In comparison, customers that own electric hybrid excavators from other OEMs tell us it takes up to seven years to recoup their investment.

## **Q: How does the hydraulic technology work?**

When the machine stops in a swing cycle, it stores energy. When it accelerates, it reuses the stored energy. The 336E H captures energy during swing braking and stores it in the accumulator. This results in greater fuel efficiency and lower regulated engine emissions for the 336E H versus a standard excavator.

## **Q: What specific or proprietary technology systems achieve the fuel savings?**

To achieve added fuel savings, the design of the 336E H uses three building block technologies that:

- 1) *Conserve fuel* with engine power management via the Cat Electronic Standardized Programmable (ESP) pump, which smoothly transitions between the hydraulic hybrid power sources, engine and accumulator.
- 2) *Optimize performance* using restriction management via the patented Cat Adaptive Control System (ACS) valve, which intelligently manages restrictions and flows to seamlessly control machine motion with no loss of power, and to ensure operators experience no difference in control, hydraulic power or lift capability.
- 3) *Reuse energy* via the hydraulic hybrid swing system, which captures the excavator's upper structure swing brake energy in accumulators, and then releases the energy during swing acceleration.

## **Q: What fuel savings can customers expect with the 336E H?**

The 336E H delivers industry-leading productivity with up to 50 percent greater fuel efficiency, which is measured in tons per liter, over the 336D. Customers can expect the 336E H to use up to 25 percent less fuel compared to a standard 336E, and up to 33 percent less fuel than the 330/336D. All three of the technology building blocks, Conserve, Optimize and Reuse, are integrated together to maximize fuel savings in a variety of applications. Even in low-intensity swing applications, customers will still experience significant fuel savings because of the Conserve and Optimize technologies. (Additional factors, such as operator skill and jobsite conditions, also affect fuel savings.)

## **Q: How many patents do you have on the 336E H?**

Our 336E H exclusive design incorporates over 300-plus filed patents. For example, our patented Adaptive Control System has an industry-first valve. Another patent highlight is the software used by on-board sensors to anticipate engine load, improve response and minimize fuel consumption.

## **Q: What differences will an operator notice in working with the hybrid version of the 336E?**

Even the most experienced 336E operators won't notice any difference working with the hybrid 336E H model. The 336E H uses the same intuitive controls found in other Cat excavators, making it easy for operators to take immediate command of the machine.

## **Q: How will your hybrid differ in power performance from electric hybrids in the marketplace?**

No other OEM makes a larger, more powerful hybrid excavator than the production-oriented Cat 336E H. Competitors that use electric rather than hydraulic as the power source must transform kinetic energy to electric energy and back to hydraulics in order to fully utilize hybrid technology. We eliminate that added step and complexity with our hydraulic hybrid.

## **Q: If the hybrid is the way to go, why continue to offer both a hybrid and the standard 336E?**

Initially, we will offer two models. We think some customers will choose what they know works for them, meaning the standard 336E. We also think some will wait until the simpler, cost-effective technology of the new 336E H establishes itself as an identical performer to the standard 336E—with added fuel savings and reduced regulated engine emissions. Until then, we will offer two models and let customers choose the technology they feel is best for them. We think customers will eventually select the hybrid over the standard model.

## **Q: How many more excavator models will be equipped with hydraulic hybrid technology?**

While we cannot release specific equipment models at this time, the 336E H is the first model and there will be more to come. We can also say we are considering incorporating hybrid technology in other lines of Cat equipment. We'll do so when there is benefit for our customers.

