

# What exactly is the **Digital Displacement**<sup>®</sup> pump?

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The Digital Displacement hydraulic pump can be easily integrated into standard diesel, hybrid and fully-electric off-highway machines. It enables direct, real-time control of each cylinder within the pump, with software in the controller used to determine the best possible function for every activity a machine or vehicle needs to perform. Additionally, the pump contains sensors that provide data on outlet pressure, shaft speed and crankcase temperature. The controller then turns these insights and demand from the machine user into a stream of valve actuation pulses.

The multi-outlet, digitally-enabled pump offers multiple benefits compared to traditional pumps, such as improved productivity and control, better fuel consumption and the potential to downsize engines or battery packs.

**90%**

Efficient across  
a wide range  
of displacement

## **Bringing the digital excavator to life**

Danfoss Power Solutions envisages that Digital Displacement pumps will be suitable for all construction, agriculture and other off-highway vehicle markets. However, the company has found that the technology can significantly impact excavators in particular, with research showing that hydraulics systems on excavators can achieve fuel savings of 30% by installing Digital Displacement pumps. Furthermore, Danfoss Power Solutions has already identified a pathway in which these savings can be increased to 50% in the future.

Hydraulics are at the heart of most excavators. However, due to the growing demand for electric solutions, they are coming under more and more scrutiny as they cause high amounts of system-related losses. Digital Displacement directly tackles losses linked to the pump and brings new capabilities to the way hydraulic power is reducing losses at a system level.

**There are four main benefits that the Digital Displacement pump offers that improve the efficiency of hydraulics systems, as well as the overall performance of excavators.**

**30%**

**Saving on fuel  
by installing a  
Digital Displacement<sup>®</sup>  
pump**



# The four main benefits of the Digital Displacement® pump

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## Improved System Efficiency

The Digital Displacement pump has been designed with multiple independent fluid outlets all contained within a single body. However, they can all do different things and can change their functions in real-time. For instance, one outlet could be handling pressure control while another performs another type of control action. A single controller manages all possible processes with a master torque limit.

Additionally, it is possible to combine the outlets with digital valves, allowing flow to be allocated where needed in the hydraulics system of an excavator. This functionality helps remove throttling in the system and guarantees that flow is utilized efficiently.

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## Better Pump Efficiency

Danfoss Power Solutions has benchmarked its Digital Displacement pump against axial piston pumps. The company has found that the technology performs very efficiently when operating over a wide range of loads, offering an overall efficiency greater than 90% even when running down to 20% displacement. This results in less energy loss as the system generates less heat. Furthermore, machine functions, user experience and operator interface are all unaffected, while the Digital Displacement pump also fits into the same space as traditional axial piston models. This means that OEMs don't need to make any adjustments to size or space when designing excavators.



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## Pathway to Efficient Energy Recovery

Excavators lose energy that could be recovered and reused when operating, such as lowering or swinging the machine's boom. During extensive testing, Danfoss Power Solutions has found that the Digital Displacement pump motor can save 87% of the energy used when going through the entire cycle of moving the excavator boom and put it back into excavator operational use. A saving of this scale is new territory in hydraulics, with the company excited about the potential this offers for fuel savings and productivity improvements. By combining Digital Displacement technology with similar system architectures such as electric motors, Danfoss Power Solutions believes it can get to above 50% fuel savings and improve productivity by upwards of 25%.

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## Digital Control



**The software behind the Digital Displacement<sup>®</sup> pump also connects several global megatrends.**

The parameters of the Digital Displacement pump are set using software, meaning there is no need for this to be performed manually using screws, orifice and springs as you would expect with traditional pumps. This digital control allows design changes to be implemented quickly, speeding up the entire delivery process. Being entirely software-controlled also means that all pump functions can be changed and configured for specific applications. At the same time, it can also rapidly and accurately limit its input torque, maximizing the power that's delivered by the engine of an excavator. Having the choice of multiple control functions and the ability to change the function of individual outputs offers system engineers the chance to use the Digital Displacement pump functions in different ways and various duty cycle modes.

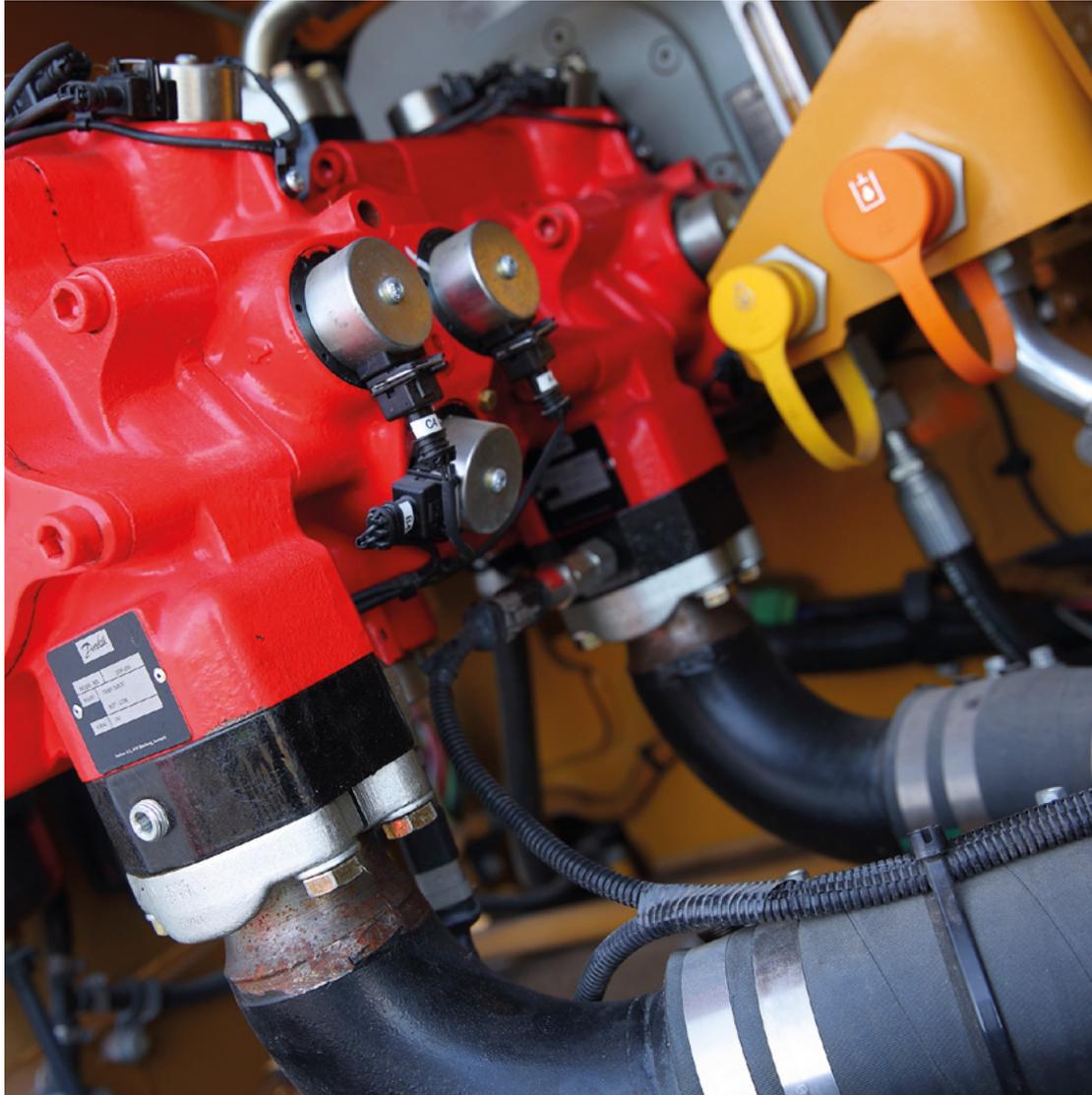
The software behind the Digital Displacement pump also connects several global megatrends. For example, the pump's quick response rate – which is nearly an order of magnitude better than most traditional hydraulic pumps – can be

synchronized with other system activities. As electric motors and inverters are also software-driven, a combination of the Digital Displacement pump and an electric drivetrain means that all system parameters can be precisely controlled, enabling extremely efficient system architectures. This increased control is something that can transform the construction market as more OEMs switch to electrification.

Digital Displacement technology can also play an influential role with autonomous vehicles, with the software's deterministic and accurate output being highly beneficial for control systems. Moreover, the built-in software modules of the pump can be easily configured to connect and communicate with controllers, offering further benefits to OEMs. These advantages include the ability to utilize model-based design and generating data for system monitoring.

# Where next for Digital Displacement®?

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Danfoss Power Solutions is currently bringing all of these benefits together and developing a portfolio of Digital Displacement pumps, commercialized for the mobile machinery market.

**Danfoss Power Solutions is also in the process of testing a modular range of pumps to take Digital Displacement into new market areas.**

**Delivering solutions that meet the challenges faced by major OEMs in the construction market.**

Danfoss Power Solutions will revolutionize the excavator market through a combination of leading technologies. Through its innovative Digital Displacement technology and Danfoss Editron electric drivetrain systems, the company is delivering solutions that meet the challenges faced by major OEMs in the construction market and driving the industry towards net-zero emissions.

# 2021

**Will mark the first Digital Displacement® pump to market**