



**LIQUIDPISTON**

**XTS-210**

- Compact and lightweight:  
5x greater power density and specific power vs. piston diesel engines
- Heavy-fuel compatible (Diesel, Jet A, JP-8, kerosene) and Multi-fuel capable (gasoline, propane, hydrogen)
- Optimized for hybrid-electric application

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# X-Engine™ Core Technology Platform

## Creating the ideal engines for direct drive as well as hybrid-electric power systems

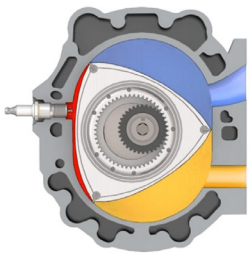
With the X-Engine platform, LiquidPiston is advancing the capabilities of internal combustion engines used in mobile power applications for land, air and sea.

The X-Engine technology platform is inherently scalable and has been demonstrated to-date in engines from 4hp to 70hp. The X-Engine is a novel redesign of the rotary engine that is small, lightweight, and implements portions of LiquidPiston's advanced patented High Efficiency Hybrid thermodynamic Cycle (HEHC).

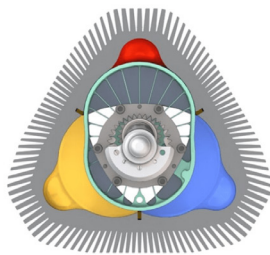


## Reinventing the Rotary Engine

Wankel Engine



LPI X-Engine



X-Engine solves the Wankel rotary engine challenges with sealing, cooling, lubrication, efficiency, emissions and durability.

## Overcoming the challenges of the Wankel in a simple, power-dense design

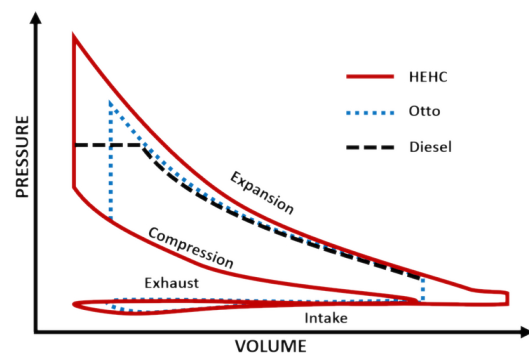
The X-Engine can be likened to an "inverted" Wankel rotary design, having a trochoidal rotor and three-lobed housing. It leverages a stationary combustion chamber, which enables a higher compression ratio with direct injection of fuel, leading to better efficiency and optimized fuel air mixing. Additionally, stationary apex seals reduce blow by and offer direct lubrication, improving efficiency, emissions, and durability.

The X-Engine has few moving parts and either three or six combustion events per rotor revolution, resulting in very high power-density. Except for ancillary parts, there are only two primary moving parts – the shaft and the rotor - making the X-Engine simple and elegant in its implementation.

## Optimizing Thermodynamic Performance

### Increasing fuel efficiency with a patented High Efficiency Hybrid Cycle

LiquidPiston's HEHC is a patented thermodynamic cycle that combines the advantages of Diesel, Otto and Atkinson thermodynamic cycles to improve on efficiency. The cycle incorporates high compression ratio, constant-volume combustion, and over-expansion.



Comparison of 4 stroke air standard ideals for HEHC, Otto and Diesel cycles



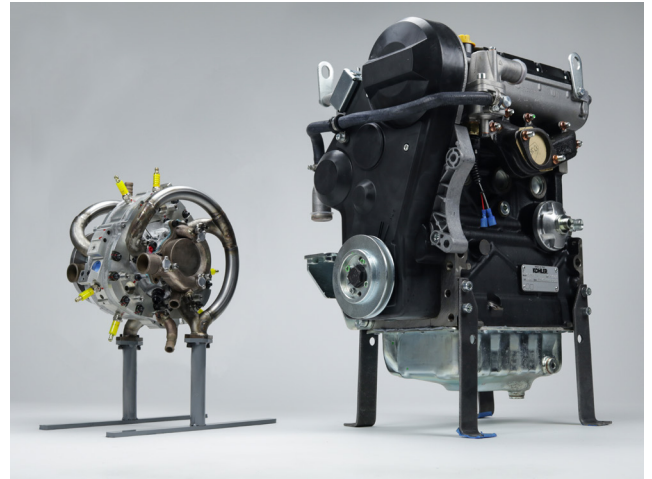
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# The XTS-210: For Power on the Move

The XTS-210 is a 25 horsepower, two-stroke, supercharged, liquid-cooled 210cc X-Engine variant currently under development that reduces size and weight by nearly 80% over diesel engines with comparable power output while targeting an SFC of under 350 g/kwh at maturity.

The XTS supercharger adds up to 1 bar boost while operating on a 2-stroke cycle, producing 6 combustion events per revolution of the rotor, to deliver smooth power from a miniscule package.

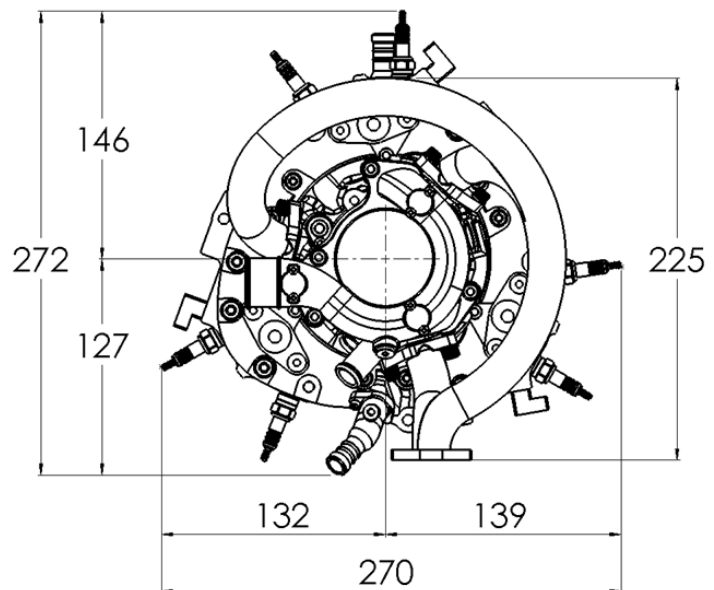
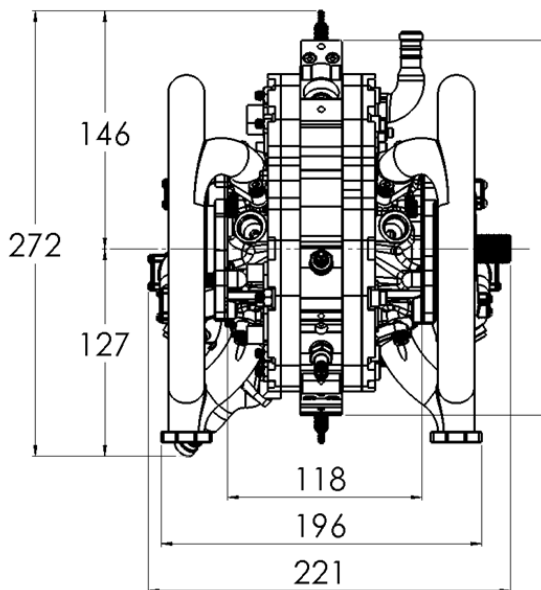
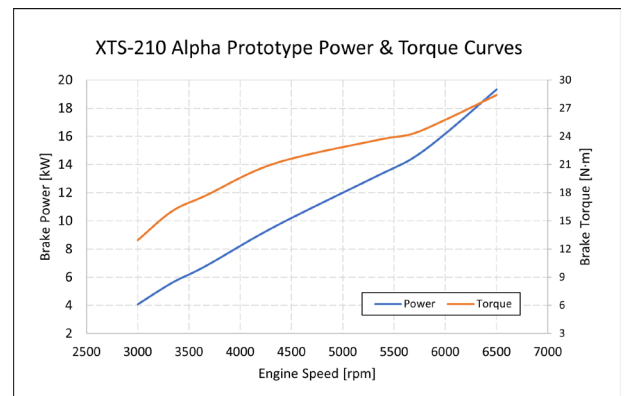
Right: XTS-210 engine core compared to 25 hp Kohler KDW1003. Not shown on the XTS (as the engine is still in its preliminary "Alpha" development stage) – are ancillary systems such as fuel pump, water pump, and oil system.



## Technical Comparison

| Metric  | XTS-210 Alpha               | XTS-210 Mature Target*      | Kohler KDW1003 E536A         |
|---|-----------------------------|-----------------------------|------------------------------|
| Max Power kW (hp)@rpm                           | 19.3 (25.89) @ 6500         | 20 (26.8) @ 6500            | 18.8 (25.2) @ 3600           |
| Max Torque N-m @rpm                             | 28.4 @ 6500                 | 29.4 @ 6500                 | 63.0 @2300                   |
| Displacement cm <sup>3</sup> (ft <sup>3</sup> ) | 210 (.007)                  | 210 (.007)                  | 1028 (.036)                  |
| Dry Weight kg (lbs)                             | 21.2 (46.74)                | 19 (41.88)                  | 85 (187.3)                   |
| Dimensions LxWxH mm (in)                        | 221x270x272 (8.7x10.6x10.7) | 221x270x272 (8.7x10.6x10.7) | 516x412x519 (20.3x16.2x20.4) |
| Compression Ratio                               | 7.0:1                       | 8.0:1                       | 22.8:1                       |

\*Target values - these may change slightly depending on final delivery.



All Dimensions are in MM



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# LIQUIDPISTON - POWER REIMAGINED

## Applications

The XTS is being designed to meet demanding commercial and military heavy-fueled applications, including mobile electric power generation, primary or hybrid-electric propulsive power for vehicles including vertical take-off and landing aircraft (VTOL) and small unmanned aircraft systems (sUAS), as well as auxiliary power units.



## Generators

- Capable of being lifted by a 4-man team
- 10kW Genset design target is roughly one quarter the size and weight of the 10kW AMMPS, MEP 1040 - at 9.2ft<sup>3</sup> and 210 lbs versus 36.7 ft<sup>3</sup> and 985 lbs.



## UAVs

- Up to 60% longer flight duration
- Quiet operating mode (electric-only "silent" cruise)
- Running on JP-8, other jet fuels
- Transition from electric cruise back to engine power with engine restart in-air
- Near-zero vibration

## Company Expertise

LiquidPiston's technology and product development builds on over a decade of prior research and advanced development with more than \$60 million (including government funding and customer-funded programs) invested. We have 82 patents issued or pending globally and a rich innovation pipeline.

LiquidPiston is seeking strategic partners to co-develop engines targeted for specific end markets as well as licensing opportunities for manufacture and use.

LiquidPiston's technical team has decades of combined experience in engine design, engine testing and program management, with technical backgrounds in physics, mechanical design, modeling and optimization.



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