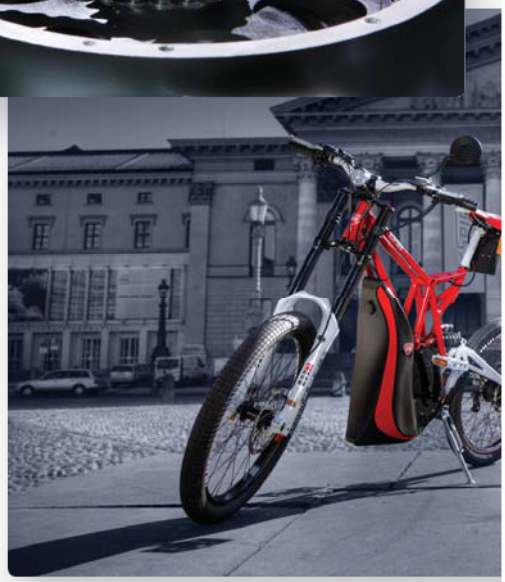
Chain drive boosts e-bike efficiency

A new chain drive promises to improve the efficiency of electric bikes and extend their range. The drive was jointly developed by **iwis Drive Systems** and **Clean Mobile**, a firm that makes electric drives for two-wheeled vehicles. Both companies are based in Munich, Germany. The hybrid unit combines electric and human power to reportedly deliver effortless acceleration and excellent range both on and off-road.

Clean Mobile's designers began with a small, 1,200-W electric motor that delivers 150 N-m of torque. Initial plans were to mount the motor near the pedals and run the motor at high speeds, even at slow riding speeds. It quickly became clear this setup couldn't transmit power to the rear wheel *and* meet efficiency targets with conventional reduction gearing.

The company approached engineers at iwis, who recommended splitting the gearing into a primary and secondary transmission. Primary gearing would handle speed reduction at the pedal crank and use standard components for secondary power transmission to the wheel.

The iwis chain cascade in Clean Mobile's direct dual drive gives a 1:38 reduction ratio. It operates across a wide speed range with about 80% efficiency.



The result is the direct dual drive (DDD), which uses three chains and sprockets to connect the pedal crank and adjacent motor shaft, together yielding a 1:38 reduction ratio. Engineers selected chains with the required strength and fatigue life based on forces on the teeth of each sprocket and the resulting overall transmission ratio. The three-chain arrangement reduces motor speed from 3,600 rpm down to pedaling speed. A freewheel hub ensures that force exerted by the rider on the pedals goes only to the wheel, not the motor, should the battery ever fail. A second idle

The DDD in Third Element's eSpire electric bike mounts above the pedal crank and behind the Li-ion battery pack.

Third Element's eSpire electric bicycle placed first at last year's E-bike world championship.

mechanism disengages the pedals from the rear wheel, as on conventional bicycles.

The chains are major contributors to the drive's overall efficiency, explains Michael Frank, new business development project manager at iwis, because they only transmit tensile forces in the direction of travel. A spur wheel with helical gearing, in contrast, would induce additional, lateral forces and thereby reduce overall efficiency, says Frank.

Tests on the DDD by the Department of Drive, Control, and Actuator Technology at the German armed forces university (**Universität der Bundeswehr München**) in Neubiberg, near Munich, showed an efficiency of approximately 80% across a broad operating range. In contrast, typical electric bikes have efficiencies ranging from 25 to 50%, according to Clean Mobile officials.

An eSpire bicycle equipped with DDD, built by Munich cycleworks **Third Element**, won the first official E-bike world championship at last year's Intermot in Cologne, Germany — the world's largest bicycle and motorcycle show. Its electronic controls and torque sensors manage energy flow from the Li-ion batteries to the wheel, further enhancing efficiency. It has a top speed of 45 km/hr.

iwis is developing more-powerful units, as well as lower-rated versions that use plastic parts, to satisfy demand from builders of two, three, and four-wheel vehicles, says Frank. **MD**

Resources:

Clean Mobile, *www.clean-mobile.com*

iwis Drive Systems, *www.iwisusa.com*

Third Element, *www.3-element.com/en-us*