



Contact:

Nancy Crist

Public Relations Specialist

J.W.Morton & Associates

Office (319) 378-1081, x22

Cell (319) 693-3138

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World's First Tractor to Run on Two Renewable Fuels With Zero Carbon Emissions Debuts on Iowa Farm

BLAIRSTOWN, Iowa—April 27, 2015—The world's first tractor to run on two renewable fuels was introduced at a news conference April 27 at Pinehurst Farm in Blairstown, Iowa. The tractor runs on hydrogen gas or on ammonia (combined with a small amount of hydrogen). Hydrogen is fed to the tractor's 150 horsepower internal combustion engine from four 10-foot-long hydrogen tanks mounted above the cab. The ammonia tank sits above the cab at the front of the tractor.

The hydrogen and ammonia fuels are collected and stored on-site through nine interrelated subsystems of the Raphael Schmuecker Memorial Solar Hydrogen System. This is the first known system to make ammonia using solar energy. No carbon emissions result from the system's generation of the two fuels or the consumption of hydrogen as a fuel and ammonia as a fuel or fertilizer. The innovative endeavor is being led and funded by a private citizen, Jay Schmuecker, who worked at Caltech's NASA Jet Propulsion Laboratory for over 50 years. "In the Jet Propulsion Lab we were constantly challenged to do what had never been done before," said Schmuecker, who was responsible for the mechanical assembly of Mariner II, the first spacecraft to fly by another planet, Venus, in 1962. He also managed the engineers who built most of the spacecraft that visited other planets in our solar system and beyond. "That training has served me well over the last six years as I worked to make hydrogen gas and fuel a tractor with it."

Schmuecker has caught the attention of the U.S. Department of Agriculture (USDA). "Jay's system is innovative, cutting edge and renewable," said Chris Cassidy, national renewable energy advisor, USDA. "This is the type of emerging technology the USDA wants to take to rural communities so that agriculture producers and rural businesses can deploy it." According to Cassidy, a farmer, rural business, or cooperative wanting to replicate Schmuecker's commercially available renewable hydrogen technology can apply for financial assistance through the USDA's Rural Energy for America Program.

The System's Inspiration

Schmuecker's system is named for his father, Raphael, who lived in Arizona and was a staunch advocate of using hydrogen to replace fossil fuels. He died in 2005 at the age of 92. A few years later, Jay Schmuecker began to consider the idea of installing a hydrogen system on his family's farmland in Eastern Iowa. Back when Schmuecker's grandfathers farmed in the early 1900s, crops were raised and fed to horses that powered the farm's implements. Over time, horses were

replaced by fossil fuels to power farm equipment. Schmuecker wanted to show that renewable fuels offer farms the chance to once again be self-sustaining without harming the environment.

Schmuecker's system is located at Pinehurst Farm where his father was born and raised. The 320-acre farm, which Schmuecker owns with his three children, Jayne, Matt and Amy, raises soybeans and corn. "I thought it was great that Dad wanted to honor our grandfather," said Amy. "My grandfather was promoting hydrogen as an alternative fuel source back in the '60s. My dad was able to make my grandfather's dream a reality. That's pretty special."

Her sister Jayne agrees this is an important endeavor. "I like the idea of exploring other energy resources and am proud that my dad stepped out to make this a reality," she said. "Dad would not have undertaken this project unless he truly felt there was a long-term benefit in demonstrating that solar-hydrogen energy is worthy of larger exploration." With initial specs and drawings in hand, Schmuecker's next step was to recruit top-notch leads to guide his development team.

Building the Team

David Toyne is a custom design engineer in Tujunga, Calif., whose 40 years of experience has been a valuable asset to Schmuecker's team. Toyne is responsible for the controls and instrumentation subsystem that directs the operation of the electrolyzer, nitrogen generator, air compressors, hydrogen fuel dispenser, hydrogen and ammonia pumps, and ammonia storage. He is also responsible for the design and development of the hydrogen and air piping of the project.

Toyne's other engineering feats include designing the prototype motion base system for the \$60 million "Back to the Future" ride and the Earthquake ride system and special effects for Universal Studios Florida. He was also on the management team responsible for the exterior renovation of the MGM Grand Hotel and Casino in Las Vegas. Toyne enjoys his role in developing a unique use of renewable energy through Schmuecker's solar-hydrogen system. "With any technology, the first step is to show it can be done," he said.

Tom Hurd is founder/owner of Spatial Designs in Mason City, Iowa, a company that specializes in incorporating renewable energy into architectural design. Hurd says a lot of people stop in his office to talk about including renewable energy in their lives, but don't follow through. "Jay was different," said Hurd. "Once I learned he was a NASA engineer, I knew he was serious."

Hurd anticipates Schmuecker's project may arouse fear over hydrogen's volatility. "Gasoline is just as volatile as hydrogen," said Hurd. "But car companies said long ago you need gas to run your car and it's safe to use, so people accepted it. We have cars and buses that run on hydrogen, but hydrogen has not taken off as a renewable fuel because people resist change." He believes the solar-hydrogen system is the perfect "poster child" for hydrogen as a clean and renewable alternative to fossil fuels.

Schmuecker's pursuit of a hydrogen engine to fuel a tractor led him to his third team lead, Ted Hollinger, founder and CEO of Hydrogen Engine Center (HEC) in Algona, Iowa. Hollinger agreed to provide a modified 460 cu. in. Ford V-8 engine design and install it in a John Deere 7810 tractor, which Schmuecker purchased. Schmuecker's goal from the beginning was to develop a working tractor that could be used by Dennis Crow, who farms the Schmuecker land, rather than a trophy tractor that is only driven in parades.

HEC has a strong history of involvement in innovative energy projects. Hollinger was attracted to Schmuecker's project because it was groundbreaking. "This technology doesn't exist anywhere else," he said. "This is the first time a vehicle has been developed to store and run on hydrogen and ammonia gases. It's also the largest hydrogen engine in the world and the first time an individual has built their own hydrogen refueling system."

Although Schmuecker originally intended to use ammonia as the tractor's backup fuel, he revised his plan when it was discovered the fuel boosted the tractor's power. As a result, the tractor is started on hydrogen gas and then switched to ammonia combined with a small amount of hydrogen. The combination adds more power than hydrogen alone.

Once Schmuecker decided to use ammonia as a tractor fuel he began to explore the possibility of making ammonia on the farm. This led him to his fourth team lead, Doug Carpenter, founder and president of Sustainable Fuels in Tustin, Calif. Carpenter agreed to develop a method for using solar energy to make ammonia for fuel. Ammonia generation was the ninth subsystem of the Raphael Schmuecker Memorial Solar-Hydrogen System.

Knowledge Shared

From the beginning, Schmuecker's intent was to honor his father and create awareness among the public, especially farmers, that the cost of fossil fuels will increase as the supply continues to be depleted; it is time to look for renewable fuels to replace them. Financial reward was never the goal of this Iowa native, who turns 80 this year. In fact, he spent a sizeable amount of his Caltech retirement fund to bring his dream of a hydrogen-fueled tractor to life. The details of the system can be found, free of charge, at solarhydrogensystem.com and farm tours of the system will be offered beginning this summer.

"While Jay's system benefits our rural communities, it is also of extreme importance to the U.S. Military," said Cassidy. He explained that Schmuecker's solar-hydrogen system is needed by our troops on the front line because it uses readily available natural elements like sun and wind to make fuel. "Jay's technology, when applied to military and humanitarian development use, can be deployed as a smaller system that is modular and mobile," he said. "The smaller system is efficient, affordable, economical and less likely to attract adversarial attention, which is a problem currently with tankers and generators. Jay's system is built by Americans and it will benefit Americans and our strategic partners."

For more information on the Raphael Schmuecker Memorial Solar-Hydrogen System, visit www.solarhydrogensystem.com.

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