The city of Annapolis, Md., continues to gain attention for its environmental initiatives, particularly those related to the health of Chesapeake Bay. So it was no surprise when the city's harbormaster walked away with an Environmental Award at the 2011 International WorkBoat Show.

The award was for the conversion of its harbor patrol boat to the first solar/diesel/electric hybrid vessel of its kind. Capt. J.P. "Flip" Walters, the harbormaster who worked for nearly five years on the project, said it wasn't easy to be green and even harder to be first. But Walters is very pleased with the project, which started with a request for a jet drive.

"It was a strange sequence of events that brought us here," he said.

In 2001, Kingston, Ontario-based MetalCraft Marine delivered a 23'x8'6"x3'6" patrol boat to the Annapolis harbormaster. A six-cylinder Mercruiser 220 diesel outdrive powered the vessel. It was a better than average patrol boat, according to Walters.

"Then, in 2005, MetalCraft delivered a pump-out boat to the city, this time it had jet drives," said Walters. "We were unfamiliar with the drives, and a number of us operators really did not like the boat, but we had no training either. So once we were able to operate it correctly and take advantage of the incredible maneuverability it offers, we were converted."

Walters, who was assistant harbormaster at the time, proposed converting the patrol boat to waterjets. Like many municipalities, Annapolis had no funding for such a project, so Walters began to look for money in other places. He discovered..."
that the EPA Clean Diesel Act might be a source if the vessel was converted to a hybrid electric system with a solar array. The project was too small for an EPA grant, but the Mid-Atlantic Regional Air Management Association awarded a $300,000 grant to convert both the patrol boat and the pump-out boat to hybrid.

“The catch was we were awarded the grant, but it only covered 75 percent of the project so we needed to get the remaining funds from somewhere else,” said Walters. MetalCraft’s president Tom Wroe obtained a $120,000 research grant from the Canadian government and the project was finally fully funded.

“That is my favorite part of the story. Here we are in Annapolis, and we have Her Majesty the Queen to thank for making this boat possible,” said Walters.

**RETOFIT ENGINEERING**

Retrofitting Patrol Boat One with a new engine system, battery pack and solar array required careful engineering, according to MetalCraft Marine’s Bob Clark.

“Every electric boat has its own profile,” Clark said. There is not a “one-size-fits-all” solution. First, that profile must be defined.

The Annapolis boats operate within an area that encompasses several creeks in the Severn River. The city’s waterways equal 18 linear miles, which makes for an excellent application of the hybrid system. While patrolling the harbor and visiting moorings, the boats are in a 6-mph speed zone, which is ideal for electric propulsion. Moving between these areas, there is opportunity to run the diesel engine and recharge batteries.

**Steyr Motors North America.**

Panama City, Fla., provided the complete power package. The Steyr HDS (hybrid drive system) is a compact marine hybrid system that combines an electric motor and a small diesel engine. The HDS won the National Marine Manufacturers Association’s IBEX Award for Innovation in 2008 when it was introduced.

Nestled neatly aft of the wheelhouse, the hybrid drive electric motor is attached to the MO306H43 300-hp, turbocharged, in-line, six-cylinder diesel.

Rich Alley, Steyr Motors North American general manager, said the diesel and electric motors work together seamlessly.

“You can start the diesel off the electric motor. While the diesel is propelling the boat, the electric motor is its generator, and when the diesel accelerates, the electric motor can add a boost,” said Alley. “For low-speed operations or operations within environmentally sensitive areas, the hybrid system makes perfect sense, you can just shut the diesel off while the boat is within these areas.”

“You should see the boaters’ faces as they watch us approach without a sound,” said Assistant Harbormaster Bill Brookes. “We used to have to turn off the diesel so they could hear us.”

When running in electric mode,
the motor delivers 7 kW or about 10 hp running on 48 volts (VDC). Fully charged, the boat can operate in electric mode for about three hours. A bank of lead-acid, gel-cell batteries are stowed forward of the wheelhouse. The batteries weigh about 1,000 lbs. They rest in a cradle system and can be lifted by the boat’s davit. The weight of the batteries was a consideration from the start, since the boat itself weighs just over 6,000 lbs. Walters said that there is a pending enhancement for the project, which will allow the city to upgrade the batteries to state-of-the-art lithium ions, which will weigh only about 200 lbs. and deliver three times the endurance.

A water-cooled hybrid control unit monitors the flow of electricity to the motor. A touchscreen display in the wheelhouse gives real-time information to the operator about usage, charge levels and fuel consumption.

Switching between the diesel and the electric motor is as simple as a flick of a switch.

“The electronically controlled clutch or spline is operated by an electronic linear actuator. This clutch mechanism disengages the diesel so that the electric motor only powers the jet drive,” said Walters.

Because this is the first North American application of the Steyr system in a waterjet propulsion boat, there were several issues to iron out. “We basically had to do an awful lot of reverse engineering,” said MetalCraft’s Clark.

It was the desire to convert Patrol Boat One to waterjet propulsion that began the switch to hybrid technology. MetalCraft specified a HamiltonJet 274 unit to deliver the thrust needed to make 30 knots under diesel power. Since MetalCraft had built the hull, they were able to measure hull efficiencies and create a reverse power curve.
that optimized the efficiencies for the
propeller of the Hamilton waterjet. A
F 63 marine gear was selected to
achieve the optimized efficiency.

**SOLAR PANELS**
In addition to the hybrid system, the
conversion included the installation
of four 130-watt solar panels on the
wheelhouse roof. The panels augment
the charge of the eight 225-amp hour
tables that supply the 48-volt system.
Brookes said the boat performs well,
iving the operators the maneuver-
ability they wanted with the jet, a green
boat, and the added savings for the
city’s operations budget.

“I had no trouble with the boat oper-
ing in electric mode in up to 30 knots
of wind,” said Brookes, who also towed
fireworks barge from the headwaters
of the Severn with the boat.

As for the savings, since the city
did not have to pay for the conversion,
very penny now saved is real. Walters
now estimates that there will be a 50
percent reduction in fuel consumption
and engine wear and tear, thereby
extending the life of the boats. According
to Annapolis Mayor Josh Cohen, the
savings are more than fiscal. “As part
of the city’s Clean & Green Initiative,
this project addressed the need for re-
sources on the water directly affecting
the health of the bay,” he said.

The hybrid pump-out boat is cur-
rently being converted and will be
delivered in time for the spring boating
season. Walters said it would be identi-
cal to Patrol Boat One in all ways,
except the smell.