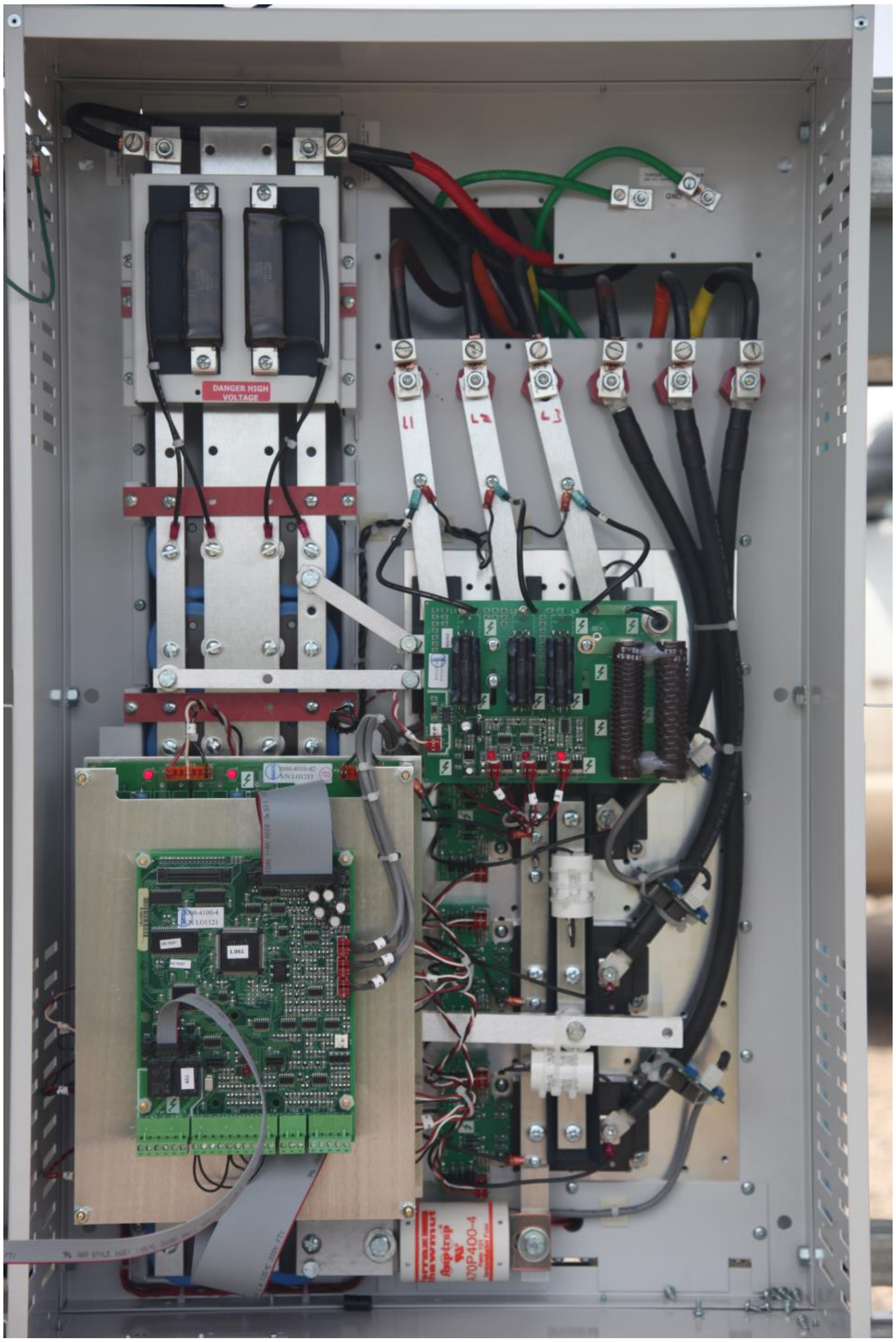
Regenerative Drive Hydro Generation

Using ASR (Aquifer Storage and Recovery) Technology.

On May 24, 2011 3RValve LLC and Madison Farms tested the concept of generating electric power using regenerative drive technology at a shallow well location. The source water was out of a shallow pit supplied by a 40 horse power motor driving a Cornell 4rb40 pump, lifting water 5 feet and delivering 542 GPM at 47 PSI to the inlet of the regenerating pump. This water was metered through an ABB 6 inch duel direction mag flow meter. (See below)

The regenerating pump and line shaft turbine was located in a 20 foot deep shallow well. The regenerating pump was a US motor Holloshaft 75 horse power, 440 volt, 3 phase, 92 amp, 1770 rpm motor set on top of 15 feet of 6 inch column with four 6 inch bowls and a water level 5 feet below ground surface.

We used a US Drives, Inc. AC Line Regenerative Module, model number RG-0400-0060-N1 rated at 50 horse power to capture the DC line voltage created during the regenerative process. (See below)

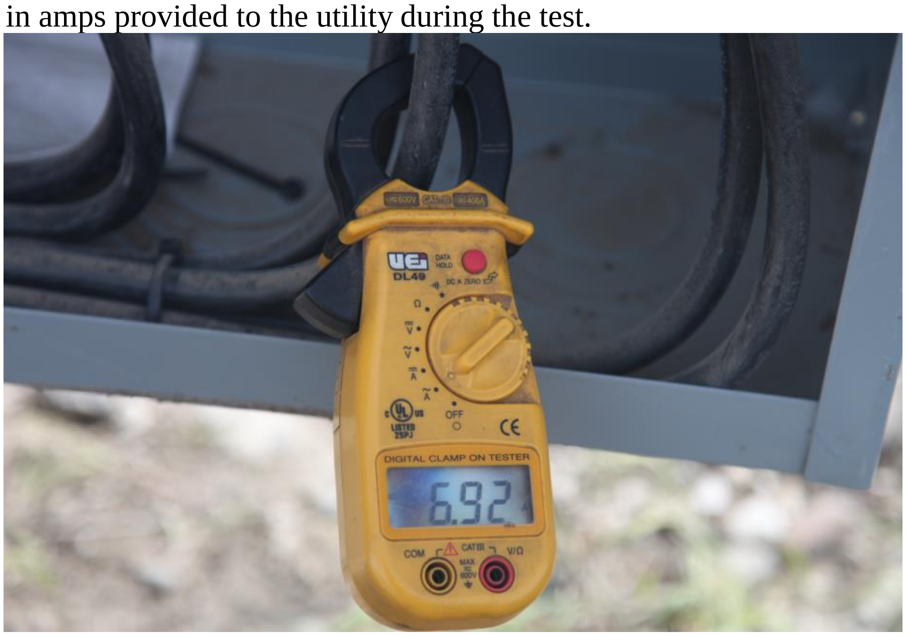


This regenerative module was connected to a 125 horse power US Drives, Inc. Phoenix variable frequency drive (VFD), model number D4-0125-N1 (See below)

The US drive and the 75 horse power line shaft turbine pump where both connected to the local utility service provided by Umatilla Electric Coop.

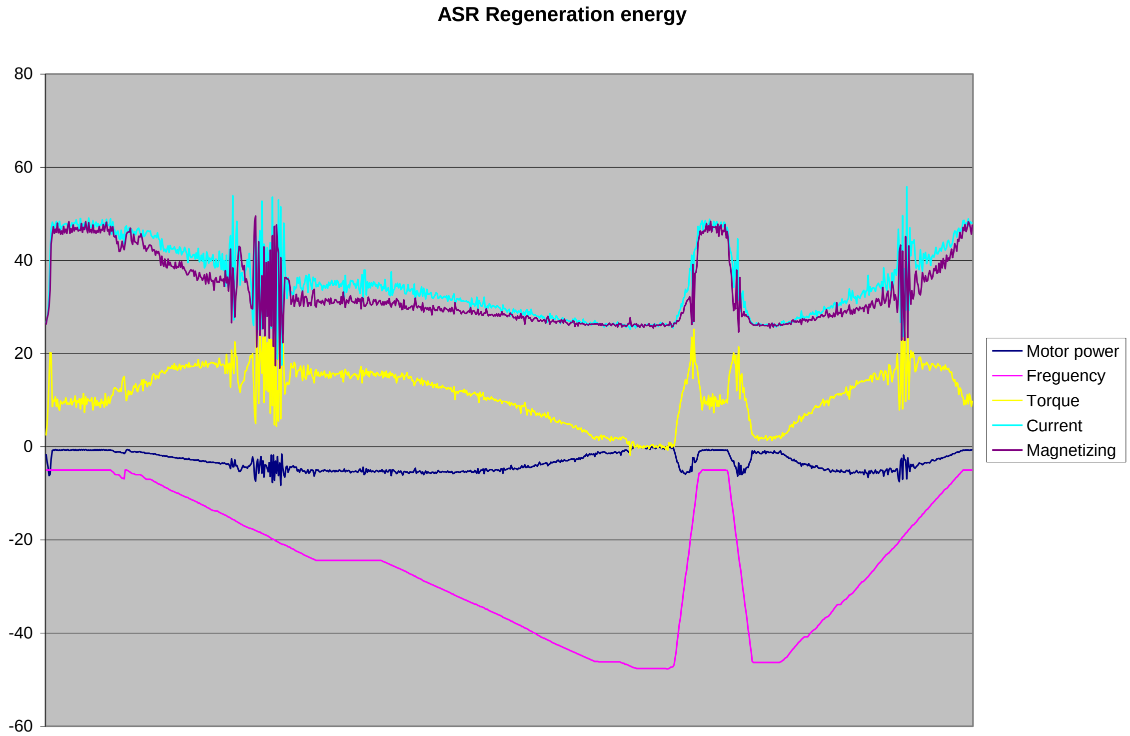
During this test there was also a 100 horse power pump located in the same well as the line shaft turbine that was pumping at a continuous rate into the irrigation system.

This pump was running to provide a net meter location as we did not want to place any power back onto the utility grid. We also placed a clip on amp meter to record the reduction in amps provided to the utility during the test.



The US Drive VFD was capable of recording all the parameters produced by the VFD during the test and recorded the results in excel format.

This graft shows the results of some of those parameters.



The graft above shows the relationship between motor power (blue line) and frequency (pink line). With the water flowing freely through the pump and no braking frequency the rotor of the motor spun at about 46 hertz. The graph also clearly shows the relationship of increased motor power that was produced as we allowed the hertz to increase from 5 hertz up to 46 hertz. At 31.6 hertz we produced the maximum amount of braking energy at 5,800 watts.

During this test we allowed the pump to spin backwards being driven by the 542 gallons per minute of water flow and the 118 feet of head that was available at the pump bowls. We then applied a 5 hertz reverse input to the drive magnetizing the stator causing the rotor of the motor to slow down from 46 hertz to 5 hertz. This electronic braking action caused the DC bus to produce energy that the US drive regenerative module then converted to AC power and supplied back to the utility line at 480 volts 3 phase. During this process we could see a reduction of amps across the 3 legs of the incoming utility power supply. This clearly showed that we where supplying some of the energy that was needed to run the 100 HP pump that was supplying water for our irrigation needs.

If we applied the basic formula of brake horse power = GPM*TDH/3960 we can show that we used 16.1 horse power to deliver the water to the regeneration site by using 542 gpm* 118 TDH /3960.

16.1 horse power * 744 watts per 1 horse power = 12,015 watts, of which we recovered 5,800 watts during regeneration. This would show that we recovered 48% of the energy needed to deliver water to the regeneration site.

If the regeneration source water was from a variable supply like a HVAC unit then I would recommend that a down hole control valve be placed below the pump bowls to keep the well column under positive pressure to ensure that there is no air entrained in the injection water that could plug the receiving aquifer or cause increased cavitations at the pump bowls.

The projects return on investment at 6 percent interest could be a short as 20 months if the power cost from the utility was 7 cents per kilowatt hour and the regenerative energy was used to offset utility energy. I used the following assumptions to come to this conclusion. The actual cost of the regeneration unit was $5,796 and the interest rate on the money to purchase the regeneration unit was 6 percent per year. We produced 5,800 watts of energy and the value of the energy was 7 cents per kilowatt hour (kWh). The system operated 24 hours per day and 365 days per year. This would produce $296 dollars per month of revenue. 5800/1000=5.8 kWh* 24 hours * 365 days =50,808 KW per year * $.07 per kWh = $3,556.56 per year. So if the present value of the investment is $5,796, the interest rate is 6 percent and the annual payment is $3,556.56 then it takes 1.6 years to pay off the investment.

Conclusion of the test:

The use of regenerative drive technology on a line shaft or submersible pump installation that is involved in ASR or the reinjection of HVAC water can be a cost effective investment. To provide a return on investment the head and flow at the injection well may need to be the same or greater then the source water. If the source water is surface water and would require a FERC permit then the added cost of getting the permit may make the return on investment outside any reasonable expectation. If the source water is ground water and exempt from the FERC process, then the return can be quite good. If the system is using a VFD to control the pump then the only added capital would be the regenerative module and it could be sized smaller than the VFD depending on the head and gallons per minute provided to the regenerating bowls.

Special thanks to Gordon's Electric of Hermiston Oregon for the electrical wiring and to Purswell Pump for the use of the Holloshaft pump and motor and to The Energy Trust of Oregon for a R&D grant for the purchase of the regenerative module.
For additional information please contact me Kent Madison at 541 376 8107 or visit my web site at www.3RValve.com