Using Single-Phase Electricity And Phase Converters For Irrigation

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It's refreshing these days to see gas prices again less then two bucks a gallon, but with the current volatility you never know what the future may bring. Currently, diesel is about $2.30/gal and propane is about $1.80/gal. Accordingly, diesel prices are actually beginning again to approach parity with electricity prices. The cost for an acre-inch of flood-irrigated water is 85 cents for electricity, while it is a dollar when using diesel. For propane users it's about $1.40 to pump an acre-inch of water of flood water. If one could get natural gas (it is available) the cost would be about $1.20 for an acre inch of water.

The wholesalers tell me they can't provide diesel and propane prices for tomorrow, much less for what they might be this summer. Electricity prices, however, are more long-term in nature due to being largely derived from coal. Surprisingly, there exists a lot of variability among what various irrigators in the Bootheel actually pay per KWH since things like the pump size/land acre ratio or being involved or not in load management greatly affect the actual KWH price. The 85 cent cost for an acre-inch of water using electricity that is quoted above is based on the cost per KWH being 13 cents, but could range from $0.08 to $0.50 per KWH.

The leaked comments of our president-elect prior to the election regarding his future plans to bankrupt coal-generated power plants, however, doesn't bode well for electricity remaining cheap for irrigators in the future. Nevertheless, as it stands now electricity continues to remain the cheapest source of energy to pump water with and it is, of course, the cheapest in terms of initial investment and maintenance costs. In short, electricity still is the best game in town today.

Normally, three-phase electricity is required for irrigation pumping, although single-phase can be used on submersibles 15-horsepower and smaller. For situations calling for more then 15-horsepower, it is still possible, by using a normal 3-phase motor in conjunction with a phase converter, to use single-phase service. Many irrigators in the Bootheel are doing just that.

The phase converter is a piece of equipment that allows single-phase electricity in and three-phase electricity out. The units cost about $3,500 to $4,500. Additionally, a small amount of energy loss (about 3 to 5 percent) occurs in the conversion process. Nonetheless, even when factoring in the added costs, using single-phase is much less expensive then diesel and, most certainly, less then propane at today's fuel costs. What's more, even if you have to pay to bring power lines in, electricity often times will still be found to be the best option.

If you do not currently have electric service at your site but would like to use electricity to run your pumps, there are two options: a) bring in 3-phase or b) bring in single-phase and use phase converters. What is best for you? First, check with your utility to see if they will allow a phase converter[1]; if they won't, 3-phase lines would be the only option, other then using a somewhat expensive type of motor called a written pole motor.

Determining how much you can afford investing in bringing in electrical lines involves several factors. Here are several general rules of thumb to keep in mind concerning the investment in new electrical service:

You can afford to invest more on 3-phase lines then on single-phase lines due to the fact there is less equipment to buy and the operating efficiency will be up to 5 percent higher.

You can afford to invest more for the "typical" pivot (135 acres; 8 inches of water) then with the "typical" flood system (80 acres; 10 inches).

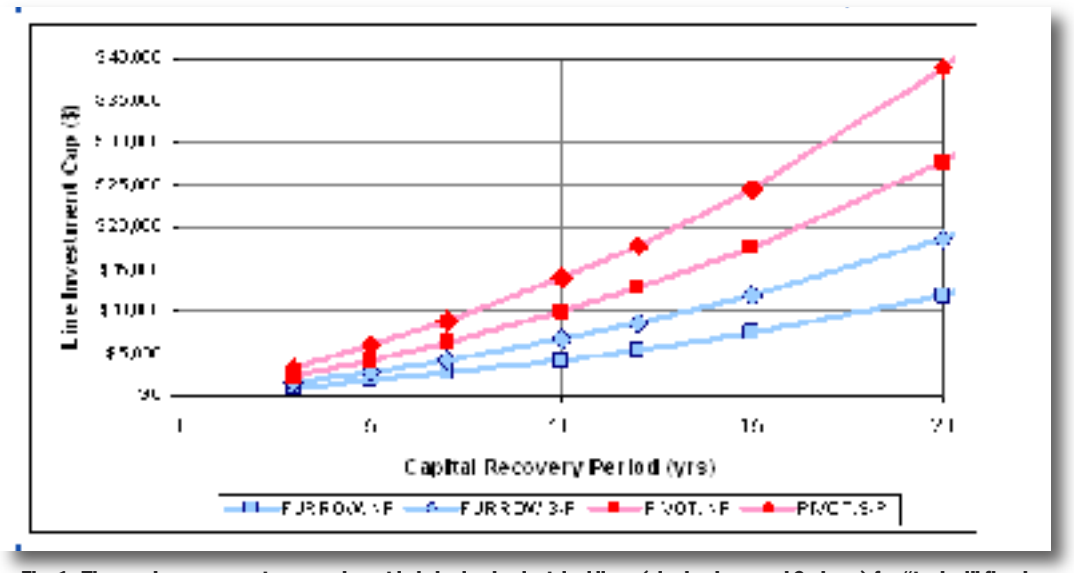

Fig. 1. The maximum amount one can invest in bringing in electrical lines (single-phase and 3-phase) for "typical" flood and pivot systems (based on KWH = $0.13 and gallon of diesel = $2.30) as a function of capital recovery period.

The important factors that need to be evaluated involving investment in new electric lines include the cost of electricity versus the cost of diesel, the initial equipment costs of electrical versus diesel systems, acres involved, inches applied, and operating pressure of the pump. There is also one other big question. How many years do you want to use for calculating the payback? For example, if only three years is used for the capital recovery, a farmer using flood can only invest about a thousand dollars to bring in single-phase. If instead he went to a recovery period of twelve years, he could afford about $5,400 upfront

Figure 1 shows the cap on electrical line investments for both the "typical" flood and pivot situation for both single-phase and 3-phase. As an example, assuming that the farmer/banker decide to use a 12-year capture period, then for a pivot the investment in bringing in line service makes since if is less then about $13,000 for single-phase and $18,000 for 3-phase. If it were a flood system then the values would be about $5,400 for single-phase and $8,500 for 3-phase.

To sum up, electricity still remains the cheapest way to pump when compared against today's $2.30 diesel. If currently not on site, bringing in electrical service could be a viable option. When 3-Phase is not available or too expensive to bring in, using single-phase with a phase converter may also be a viable option, and many local farmers are doing it. Future deviations in fuel cost assumptions from those used here, obviously, change the results. Also, keep in mind the acres involved, inches pumped, and other factors are an important part of this analysis. Therefore, a case-by-case analysis should be made. If you are interested in analyzing your situation contact Joe Henggeler (573-379-5431) or henggelerj@missouri.edu. Δ

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[1] Utilities are wary that phase converters may cause "flicker" on the line, although engineers from phase converter manufacturers claim that this problem could be circumvented by adding a soft start option on the converter.