SOLAR AND WIND ASSESSMENTS FOR PIVOTS (SWAP)

A CLOSER LOOK AT THE (IN)FEASIBILITY OF ON-FARM RENEWABLE ENERGY SYSTEMS

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THE OPPORTUNITY FOR ON-FARM RENEWABLES

Use of center pivot irrigation (CPI) on square plots of farmland is commonplace throughout much of the American West. Corners of fields with CPI sprinklers are often unirrigated and left fallow. In fact, the National Renewable Energy Laboratory (NREL) estimates that over 300,000 acres of non-irrigated corners of CPI fields exists in Colorado alone (Roberts, 2011).

Thinking broadly, putting some of this non-irrigated farmland to beneficial use as host sites for renewable energy offers an opportunity for greenhouse gas mitigation, economic development, and agricultural profitability. And the potential is vast: solar photovoltaics (PV) on 71% of Colorado's non-irrigated corners would produce as much electricity as the state currently generates every year (U.S. Energy Information Administration, 2017). Although such massive development isn't feasible for a variety of reasons, investigating the use of select non-irrigated corners to host renewable energy projects for utilities, communities, and individuals is worthwhile.

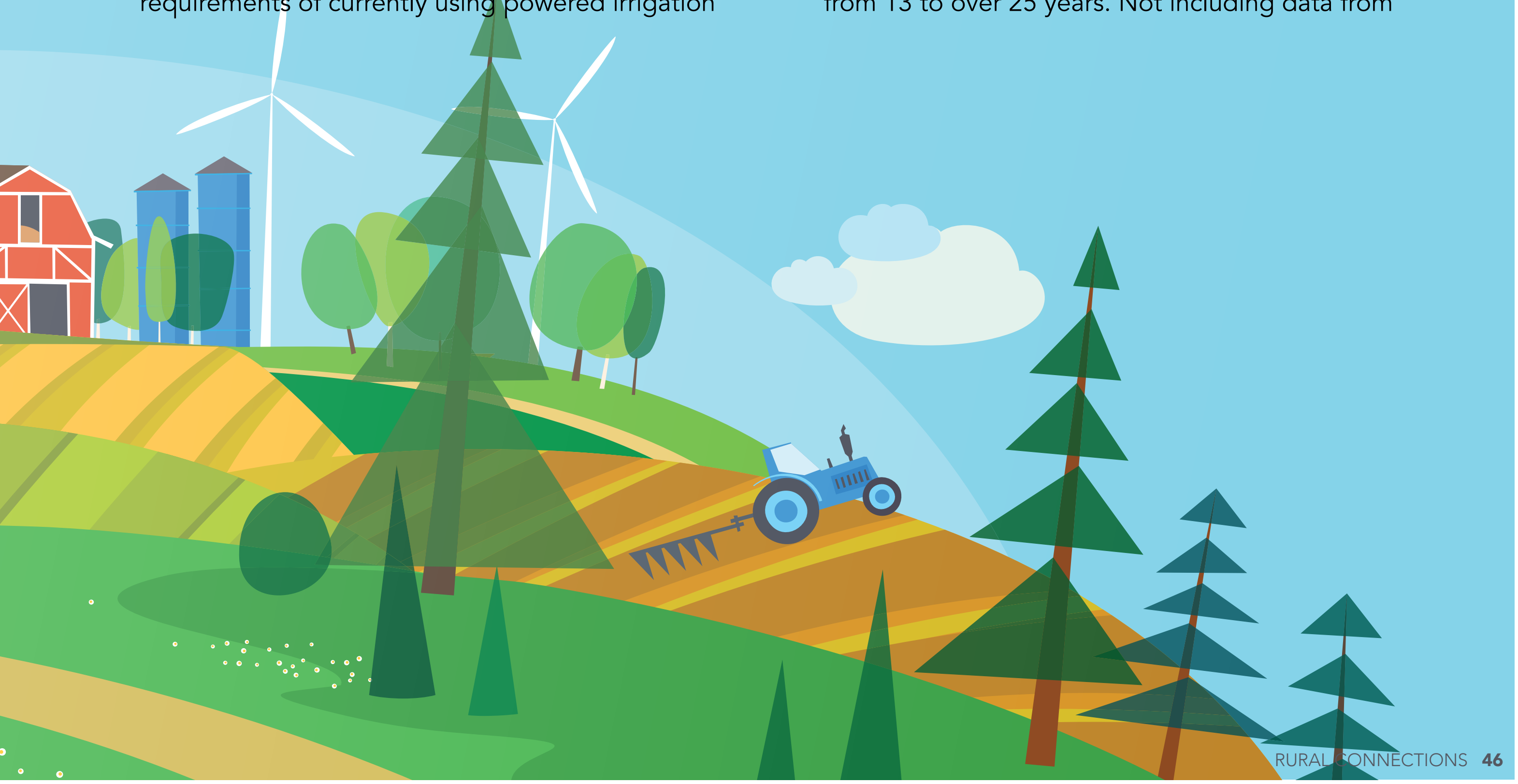
With electricity expenses for pumping water for irrigated agriculture in the West totaling well over $1 billion annually, Colorado State University started exploring the opportunity for individual farmers to utilize renewable energy in non-irrigated field corners (National Agricultural Statistics Service, 2013). From April 2015 through July 2016, a team of two Extension Specialists and a Senior Research Associate in Mechanical Engineering conducted techno-economic feasibility assessments for solar PV or wind energy for 30 farmers on the eastern plains of Colorado. The research was sponsored by a USDA Rural Energy for America Program (REAP) grant and was dubbed 'Solar and Wind Assessments for Pivots' (SWAP).

FEASIBILITY ASSESSMENTS SHINE A LIGHT

The objective of the SWAP project was to provide participants with data such as renewable energy system size, cost, savings, payback period, net present value (NPV), and return on investment (ROI) that would help them make more informed decisions about whether to move forward with investing in a system and/or applying for a grant to install a system. The assessments only considered renewable energy systems that would be tied into the electric grid and used to spin an individual irrigation meter backward. SWAP participants were selected on a first-come, first-served application process as long as they met requirements of currently using powered irrigation and receiving over 50% of gross annual income from agriculture. The CSU team built a spreadsheet tool to conduct assessments using data from electronic surveys and electric bills. The participants spanned six different electric utility service territories, each with different rates and many with different rate structures. Solar assessments were provided for all 30 participants, but wind assessments were only provided upon request and if the participant was located in a Class 2 minimum wind regime.

The mean system size for a solar array was 48 kilowatts (kW), which would offset 81% of electricity used at an irrigation meter. At a cost of $3.16 per watt, the average upfront cost for a PV system totaled over $137,000. A 25% REAP grant and a 30% federal tax credit dropped that to a $71,000 average net cost. Lifetime energy savings averaged $156,000 plus over $23,000 in payments from utilities for "excess generation" at the end of a utility's annual net metering period. Modified accelerated depreciation schedules were provided to participants, but actual financial implications for depreciation were not factored into assessments due to the highly variable tax situation of agricultural producers.

After REAP grants, tax credits, and any available utility incentives, payback periods for solar PV ranged from 13 to over 25 years. Not including data from



participants in one utility service territory for which net metering was not permissible, ROIs for PV averaged 4.7%. Net present values for PV averaged just over $9,100. Wind systems had consistently worse paybacks, ROIs, and NPVs, even in the best wind regimes. One SWAP participant has entered a contract to install a renewable energy system – a 15 kW solar PV array – after applying for a REAP grant.

BARRIERS TO COST-EFFECTIVENESS

Four main barriers to cost-effectiveness for renewable energy systems in the corners of fields with CPI were uncovered. The most significant barrier is low energy charges, which refer to the cost per kilowatt-hour of electricity. This does not include separate demand charges which are typically calculated based on the maximum amount of power needed over any 15-minute period in a month. Because PV and wind systems can only generate electricity when the sun shines or wind blows, they cannot be counted on to reduce demand charges.

Magnifying the impact of low energy charges is the fact that some utilities charge for electricity on an irrigation rate schedule that uses regressive annual tiers. This means that irrigators are charged the most for the first X number of kilowatt-hours (kWh) used in a year, and the least for the last Y number of kWh used in a year. Should an irrigator install a renewable energy system and generate less kWh than is used in a given month, he/she will be charged for the difference of kWh starting from the first, most expensive tier. In essence, this means that the solar or wind energy is offsetting the cheapest electricity first.

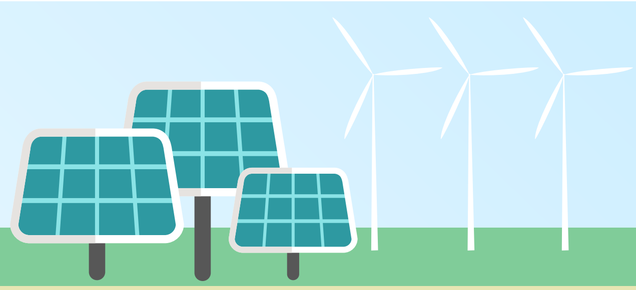
A third barrier to more financially feasible systems is unfavorable utility net metering policies. Net metering refers to one's statutory right to spin the meter backwards when generating renewable energy on a grid-tied system. But this statutory right is only guaranteed for commercial systems up to 25 kW in Colorado rural electric association (REA) service territories, and limiting system sizes can also limit a farmer's financing options. Not only would a farmer gain economies of scale from larger systems, but many renewable energy companies that offer leases or loans at no upfront cost only do so for minimum system sizes of 100 kW.

The other piece of net metering policy that can act as a barrier to financial feasibility is the utility's selection of its 12-month "net metering period" for irrigators. With net metering, an REA member is able to roll over any excess renewable electricity generated in one month to the following month until the end of the net metering period. At that time, all REAs involved in this project would pay the member for any excess generation at their avoided cost of energy, which can be half or less of retail electricity rates. Should irrigation end in September and the net metering period end in March, for example, any electricity generated by the irrigator's renewable energy system in that time frame would be credited at the utility's avoided cost of energy.

The fourth main barrier is the lack of tax liability by many farmers. Without enough tax liability, farmers are not able to take full advantage of tax credits and accelerated depreciation for renewable energy systems.

FOUR MAIN BARRIERS TO COST-EFFECTIVENESS

1. Low energy charges (cost per kilowat-hour).
2. Utilities charge on an irrigation rate schedule using regressive tiers.
3. Unfavorable net metering policies.
4. Lack of tax liability by farmers.



MOVING FORWARD

Interestingly, two of the barriers listed could be removed by a motivated utility. While regressive annual tiers for energy consumption guarantee utilities more revenue earlier in the irrigation season, these rates can also be confusing, discourage conservation, and inhibit cost-effective renewable energy installations. Switching to a flat energy rate or even some type of progressive tier is a viable alternative.

Net metering policy is also under the purview of REAs. An REA could choose to allow renewable energy systems above 25 kW until a certain annual total or other threshold is reached. Eliminating a 12-month net metering period in favor of allowing any excess generation to be rolled over monthly is also possible. In fact, Colorado's largest investor-owned utility allows for customers to make a one-time decision to get paid for excess generation at the end of the calendar year or to roll over any excess. This policy alone could shave four years or more off of a payback period for a typical on-farm renewable energy system (Figure 1).

The other two barriers are less controllable. Low utility energy charges generally reflect the charges a distribution utility (such as an REA) pays to its power provider. Unless a power provider changes its wholesale rate to a more 'energy heavy' rate, it will be difficult for REAs to charge energy heavy rates. Tax liability is always something savvy farmers will be looking to limit, so allowing for tax credits and accelerated depreciation beyond one's liability would take rulemaking at the IRS or an act of Congress.

In conclusion, while the opportunity for renewable energy in the corners of fields with CPI is plentiful, the reality is it will only be cost-effective for farmers in certain situations. Irrigators in utility service territories that charge relatively high energy rates and don't utilize regressive annual tiers could be the target of future assessments. (In California where energy rates are high, solar arrays in field corners are no longer rare.) Partnerships between utilities, universities, and rate consultants can also be formed to address utility revenue concerns while allowing for the growth of renewable energy on irrigated farms. And perhaps small-scale renewable energy costs will continue to fall to the point where they become cost-effective regardless of current barriers.

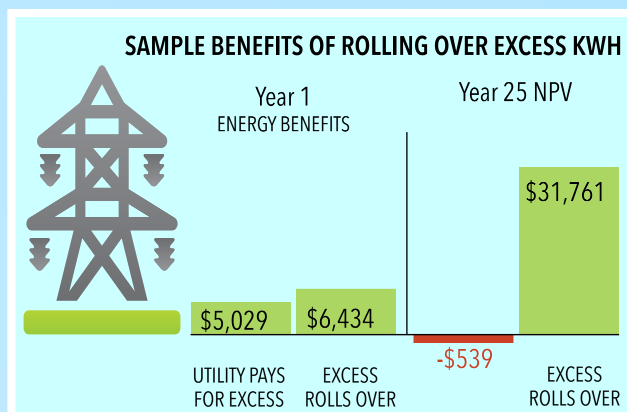


Figure 1. Sample Benefits of Rolling Over Excess kWh.