



Isbell Residence Vinton, IA



- Project Cost:** \$38,848
- AERLP:** \$18,858
- Loan Term:** 15 yrs.
- Lender:** Farmers Savings Bank,
Vinton, IA
- Lender share:** \$19,900
- Annual O & M Cost:** \$0
- Est. Payback:** 42.4 yrs.
- Installation Date:** December 1999

Two days before the year 2000, the Isbell family of Vinton flipped the switch on their new renewable energy system and became virtually energy independent.

Dan Isbell says that concerns about possible Y2K catastrophes helped motivate the radical transformation in his family’s energy habits. But the roots of his interest came from his years teaching Vinton middle school students about renewable energy during an annual environmental issues course.

“I was about 50 and was tired of hearing myself telling these kids how to do things,” he says. “I decided it was time to put up or shut up. Then when Y2K came along I took advantage of the fact that there was a serious enough chance that things would shut down that I was able to turn to my wife Kim and say ‘there’s a way out of this.’”

Dan wanted to make full use of all available energy resources at their property on the bank of the Cedar River, with wind, sun, water, and wood all contributing to generate their electricity, warm their water, and heat their home. But first they needed to cut back on their consumption.

Energy Conservation

In 1998, the Isbells used more than 45 kWh of electricity per day on average. Throughout 1999 they made significant changes, cutting their daily use to less than 3.5 kWh without sacrificing modern conveniences.

First they replaced 45 incandescent light bulbs with compact fluorescent bulbs. Then they squelched all “ghost loads” by installing switches on electronic devices that use electricity even when turned off, such as TVs, VCRs, and microwaves. These measures cut about one-third of their electricity use.

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Hybrid System Technical Specifications

PV	Inverter/Batteries	Heat Producing Appliances
10 - 120 W Astropower 1206 photovoltaic panels Zomeworks U2000 Tracker Rack	Trace SW 4024 Inverter 2 - Trace C-40 Charge Controllers 12 - 2V GNB Absolyte II P 6-90A -15 Batteries	80 gallon Solahart 302 K solar water heater Hearthstone Mansfield soapstone woodstove
Wind	Hydro	225 W Zomeworks Solar Max solar cooker
1500 W Bergey 1500 Wind Turbine 80 ft. Rohn SSB light-duty tower	100 W Aquair UW submersible hydro generator	

Next they traded in their electric dryer and range for propane models, eschewing hidden electric features such as the glow bar used in most gas ovens to modulate baking temperatures. More significantly, they replaced their 70-gallon electric water heater with a tankless propane unit that heats water on demand.

These appliance changes lopped another 80 percent from their electricity bill to the East Central Iowa Rural Electric Co-op. Dan notes with humor that the REC came out to replace their “faulty” electric meter when they saw the dramatic drop in consumption.

“It wouldn’t have made sense to invest in solar anything without making the changes we did in conservation,” he says.

The Isbells also had a super-efficient, DC-powered Sunfrost refrigerator ready for the moment their solar panels began operating. And they bought a front-loading washer, efficient ceiling fans, and other small improvements. In total, their energy efficiency investments cost between \$8-10,000.

None of these improvements were paid for by the Alternative Energy Revolving Loan Program (AERLP) since these funds are reserved for renewable energy production efforts. But the Isbells did fund almost half the cost of their electricity and heat generating improvements through the AERLP. Dan says their AERLP loan not only gave them necessary capital while saving money in interest, but also helped them secure additional financing through a local bank.

“I cannot think of a better way to get local banks involved in lending money to finance renewable energy projects,” he says. “The combination of technical oversight by the engineers at the Iowa Energy Center and financial oversight by the local banks is bound to leave everyone involved feeling assured that the investment is a sound one.”

Electricity Production

Dan scaled the electricity generation system to produce an average of about 13 kWh of electricity per day, with seven kWh coming from a small wind turbine, four kWh from photovoltaic (PV) panels, and two kWh from a hydro-powered micro-turbine that would operate during the eight months when the river was not frozen.

Ten Astropower PV panels, totaling 1200 W and mounted on a Zomeworks passive-tracking rack, have performed admirably, generating about 3.6 kWh per day on average.

The total cost for these units was \$8200, including shipping and wiring.

“You don’t have to be in Albuquerque to make solar work,” Dan says. “You really can count on solar power right here in Iowa.”

Initially, Dan manually adjusted the panels for winter and summer angles. He later discovered that the panels perform better in all seasons at the steeper winter angle, probably because a great deal of reflected light comes from the river. He also believes this angle lessens the risk of hail damage.

The Isbell’s wind turbine has not proven as successful. It generates only about 1.1 kWh per day on average – 15 percent of what Isbell expected -- and cost \$1800 more than the PV panels. Included in this figure was a charge Dan didn’t anticipate: \$1274 to ship the turbine tower from Oklahoma to his home.

Dan selected a Bergey 1500 turbine for its proven reliability and sturdy tower. The Isbell’s property is too small for a tilt-down tower, and



the Bergey’s few moving parts and promise of maintenance-free operation appealed to him.

But the Bergey achieves its rated output in 28 mph wind, and doesn’t spin at all with winds below 8 mph. And the Isbell’s property presented distinct siting challenges.

Their wind tower rests between a flood plain and the base of an 80-foot bluff to the northeast. The Isbell’s garage is just feet away, and their home not much farther. Dan had hoped that the prevailing winds moving up and down the river would be sufficient, but such has not been the case on most days.

Project Performance

Year	PV (kWh)	Wind Use (kWh)	Production Total (kWh)	Home Use (kWh)	Production/Use (%)	PV Value (\$)	Wind Value (\$)	Total Value (\$)
2000	817	280	1,097	1,233	89.0	96	33	128
2001	902	341	1,244	1,392	89.4	106	40	146
2002	862	365	1,227	1,308	93.8	101	43	144
2003	1,039	330	1,369	1,508	90.8	122	39	160
2004 ¹	1,101	394	1,495	1,296	115.4	117	34	152
2005	1,372	354	1,726	1,495	115.5	147	28	175
2006	1,279	406	1,685	1,541	109.3	141	39	180
totals	7,372	2,470	9,843	9,773		\$830	\$256	\$1,085
avg.	1,053	353	1,406	1,396	100.4	\$118	\$37	\$155

¹ Net Metering began 5/16/04. Prior to net metering, PV & Wind output limited by actual use

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The experiment in hydropower proved even more disappointing. Their Aquair UW submersible generator produced no electricity at all, and was returned to Real Goods for a full refund.

But even though the 4.7 kWh of electricity they produce each day on average is only a third of the output they’d planned for, the Isbell’s still produce all the electricity they need most of the time. And while solar power has proven the star performer at their location, Dan still believes wind fits well into the equation.

“It’s really neat to see the patterns,” he says. “Usually it’s either sunny or it’s windy. I truly recommend the mix.”

Batteries and Net Metering

Dan adds that the mix of wind and solar power is especially important when relying on battery-backup power as they did until 2004. The Isbells still use their batteries, though Dan is not sure he would replace them if they failed.

Dan invested almost \$5000 in a 24-volt stack of Absolyte fiberglass-mat batteries. The industrial-grade batteries, typically used in remote applications such as utility substations, are maintenance-free and rated at 25 years.

With a 610 amp-hour capacity, the Isbells can run their home from battery power alone for about two and a half days while drawing down only 50 percent of the battery charge. The batteries do not release gases as lead-acid batteries do, allowing the Isbells to house them in their main living space.

The Isbells signed an interconnect agreement with their rural electric cooperative in 2004, making the batteries less important except for emergency backup power. Their net-metering agreement gives them full production credit at their retail purchase rate of 11.7¢ per kWh, but only as a way to offset their \$17 monthly facility charge. The Isbells sell a net of about 0.5 kWh per day which saves them a few dollars each month, but they were also forced to pay for the installation of a \$700 meter.

For Dan the main motivation was simply to see all his generated electricity



measured and put to good use. Without the interconnection, their charge controllers turn away excess energy whenever the batteries are full.

Heat Generation

The Isbells also invested in three heat-producing appliances that use renewable fuel sources: a Solahart solar water heater, a Hearthstone Mansfield soapstone woodstove, and a Zomeworks solar oven.

The solar water heater relies on a passive, closed-loop system to heat an 80-gallon outdoor tank that feeds their indoor tankless water heater. The system performs well and saves propane, but Dan has struggled to insulate the water pipes leading into the house to prevent them from freezing on very cold days.

He also moved the system from his roof to a platform connected to his house, both to maximize the sun angle and to avoid potential damage to his roof from hot water. He says that he will probably choose a model using vacuum-tube collectors and a PV-powered pump in the future to achieve better performance while minimizing potential problems.

The soapstone woodstove provided a long-lasting heat as advertised, and its clean-burning design meant the pipes needed to be cleaned far less often. But the Isbells found that it didn’t heat their home as quickly or thoroughly as the steel stove they had used for 17 years. It also arrived slightly damaged, and in 2001 they traded it in for a Jotul Firelight cast-iron stove which they find strikes a good balance between

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the fast-heating of steel and the lasting heat of soapstone.

The open-air solar cooker relies on parabolic reflectors, and the Isbells have found that it allows them to forgo electricity or propane for cooking, even in the winter. The couple uses it less than they expected, however, because meals take so long to cook.

Summary

Completing all of these projects simultaneously was no easy feat, but Dan believes it allowed all pieces of the puzzle to mesh seamlessly from the start. He completed much of the work himself, relying on experts for key operations such as erecting the wind tower and making the final electrical connections.

He notes that Benton County has no zoning rules at all, so there were no permitting hurdles to clear during construction and installation. His biggest surprise came during shipping, with several items arriving damaged and charges running much higher than anticipated.

At a total cost of about \$48,000 for their energy conservation and energy production investments, the Isbells face a lengthy payback period. But Dan rejects the concept of a payback period altogether.

"I don't buy a refrigerator to pay itself back, or a car, or a washing machine or anything else," he says. "I buy a refrigerator because I want cold food, a washing machine because I want clean clothes, and a car because I want to go places.

"Our renewable energy system provides light, heat, security, recreation, comfort, etc. It's doing all the things we ask of it -- why should it also pay for itself?"

He designed the system to be nearly maintenance free, and it has proven very reliable. The Isbells do, however, have to stay close to home in the winter to keep the wood stove burning. And on three occasions the \$10 pop-off relief valve on their solar tank has blown when left unused too long during hot summer days.

Dan and Kim extend their passion for teaching by sharing their experiences with others. They frequently give presentations to energy expo audiences, college classes, and civic groups, and have shown their system to many visitors.

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The Iowa Energy Center's Alternate Energy Revolving Loan Program (AERLP) plays a supporting role in stimulating renewable energy development within the state. Since its inception in 1996, the AERLP has supported numerous wind, biomass, solar, hydro, and hybrid projects.

Successful applicants receive a low-interest loan from a combination of Energy Center and lender funds. The Energy Center provides loan funds equal to 50% of the projects financed cost (up to \$250,000) at 0% interest. Matching financing must be obtained from a lender of the applicant's choice. The maximum loan term for the Energy Center's funds is 20 years.

The lending institutions are responsible for financially qualifying the borrower, while

the energy center assists in technically qualifying the borrower. By partnering with expertise from lending institutions the Energy Center is able to cost-effectively process the loans in a timely manner and maximize the impact of the loan program.

Eligibility

The AERLP is open to all individuals and groups who want to build renewable energy production facilities in Iowa. Utilities that are not required to be rate-regulated are not eligible. AERLP loan funds may not be used to refinance an existing loan or be applied to existing alternate energy facilities.

Application Deadlines

January 31, April 30,
July 31, October 31

For more information

Contact the Iowa Energy Center,
(515) 294-8819
www.energy.iastate.edu

The Iowa Energy Center is dedicated to improving Iowa's energy efficiency and use of renewable energy through research, demonstration, and education.

