Introduction

Quality energy management is the goal of Barb and Jerry Trochinski. Barb and Jerry purchased the family farm in 2007. The farm has been in Jerry's family since 1854. The barn that hosts the PV Solar system was **moved by Jerry's grandfather in 1924 from his grandfather's parent's farm next door. The farm house was** moved from Waukau in 1924—the home had served as the local doctor's office and home. The new home **was built in 2008 and occupies a space that had been a pasture. The following is a summary of 1) 12 KW** PV solar electric generation system located on the remodeled dairy barn, 2) solar hot water system located **on the new home, 3) integrated in-floor heating and high pressure HVAC with fresh air heat exchanger, 4)** Poor Man's garage floor energy efficient, 5) remodel of the farm house to improve energy efficiency and **extend life span of home.**

12 PV Solar Electric Generation System

Due to a collapse of part of the dairy barn from a tremendous snow load in 2007, the decision was made to remodel and repurpose the existing structure. The south wall was removed to the foundation and the **north wall was extended 4 feet to create a wall with the maximum solar angle of approximately 45^0 with a** one directional southern slope. The reconstruction was complete by the installation of the 12 PV [Photo **Voltaic] electrical system panels by STONE CONSTRUCTION COMPANY (Ken Stone and Andy Soull) with** electrical work by DKAL (Dan Kallas, Master Electrician). The 12 KW PV solar electric equipment and **technical assistance was supplied by WERNER ELECTRIC.**

The 48 panels are arranged in two 24 unit pairs that generate 12 volt DC current that is then converted by a DC to AC converter to standard AC synchronized with Alliant Energy (Wisconsin Power and . electrical supplier. Alliant Energy assisted with the necessary permits and TIME OF USE BILLING PLAN (day time from 8 AM until 8 PM Peak Energy Cost/Payment of 20¢ per Kilo Watt **and night time from 8 PM until 8 AM** Off Peak Cost/Payment of 5¢ per KW.

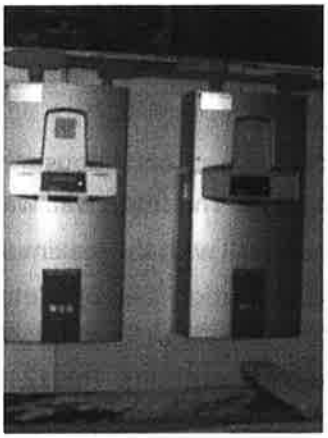
FUNDING

The panels generated 1808 KW from May 21 to June 18; 2021 KW from June 19 to July 19; and 1801 KW from July 19 to August 20 for a total of 5630 KW. KW Peak Energy [3805 X .20 = $760]

KW OFF Peak Energy [1825 X .5 = $ 91.25] for a total payment from the Electric Company of $885.68.

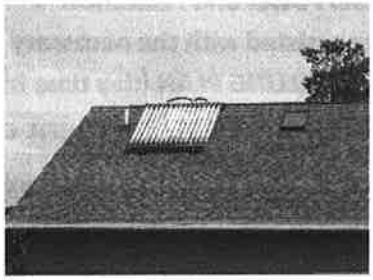
The cost of the materials and labor for the PV electrical generation system was $31,000. The return on investment for the three months was 3%. The expected total payback period is 6 years because the winter

generation will be less than summer and there will be a 30% tax credit incentive. However, we already paid 5% sales tax therefore the net tax credit is 25%. The system is warranted for 25 years and the insurance cost is offset by the deduction for a metal roof. The metal roof is a light color to reduce the heat in the summer because as heat has a negative effect on solar PV production. The maximum production is expected during the early afternoon hours on a bright, sunny, cold winter day. The PV [photo voltaic] system works by collecting energy from the rays of the sun and not the heat provided by the sun. The solar cell [black part of the panel] separates the – (negative) charge from the + (positive) charge and generates electricity similar to car battery [DC]. The inverter changes electricity to AC and in our system adds the AC power into the power grid. You can a system as a small power generating station. The power going to the power company is metered using an electric meter that runs backwards, thus causing the power company to pay us for electricity generated.



More information can be gained by emailing Jerry at farmthesun@gmail.com

Solar Hot Water System



The solar hot water system provided and installed by GRP Mechanical (Greg Peters) gathers the heat from the sun [the most efficient way of capturing the sun's energy]. The panel is constructed of a series of vacuum tubes that have a collector of aluminum and copper. With the copper transferring the heat at the top of the panel to an antifreeze solution that is circulated [see below] to a heat exchanger (that is) located in the hot water tank (located) in the home's utility room [see below]. The typical summer (time) temperature of the hot water tank is 127° and the typical winter temperature is 110°. However, on a cloudy winter day or if the panel becomes covered with (some) snow the temperature may only be 60°. An interesting fact is that the hottest fluid coming in from the solar panel in the winter was 185°. [The system has a "fail system" that will add cold water if the temperature approaches boiling].

The hot water storage tank has two heat coils. The lower coil is heated by the solar panel and the upper tank is heated by the only heat source for the house: the MUNCKIN FURNACE [see below]. If the water temperature is below what is being called for, the MUNCHKIN FURNACE also functions as an 'on demand' hot water heater (see below).

FUNDING for Solar Hot Water

The funding for the Solar Hot Water was aided by a 30% energy cash grant and a 30% tax incentive. The solar panel is expected to generate 75% of the hot water used in the home. The payback period is approximately 10 years. NOTE: We considered a larger solar system that would assist with heating the home. However the payback was extended and the pumps for the larger system were determined to be less reliable because of the high demand for in-ground geothermal systems,—the same reason we choose to not use geothermal as a heat source.

HVAC SYSTEM

The heat system for the home is an in- floor system ([the warmth rises from the floor) [no more warm ceilings and cold floor] with three zones: 1) main living area, 2) master suite, and 3) the second story. Note: The home was built on grade without a basement because of high water table, even though the home is located on a hillside. The MUNCKIN FURNACE provides heat from high pressure natural gas from a main pipeline located next to HWY 91. The MUNCKIN provided by GRP Mechanical has sufficient capacity to maintain the home temperature on the coldest winter day with ease and functions as the "on demand" hot water heater. By zoning the home and using programmable thermostats, we have good temperature control. There is also a gas fire place for viewing and occasional warmth. (When it is not cold enough to want to heat the house and want a little warmth in the morning.)

The air conditioning system is served from a condenser located in the attic and an 18 SEER compressor. The distribution of cooled air is via an insulated 4 inch tube served from an insulated central trunk line that delivers the cooled air at the ceiling level [the most efficient place to added cooled air to the home] because cooled air falls.

An air exchange unit [sometimes referred to as April Aire] provides continuous air exchange to the home to keep the interior air fresh throughout the year.

INSULATION

The large east and south facing window take advantage of solar heat gain on sunny winter days. Insulated window treatments are closed in the evening during heating season and are also used on sunny summer days minimize the sun warming the home's interior. High efficiency windows are paired with a super pack ceiling insulation and R-56 blown insulation, bib and blown insulation in the 6 inch walls and closed cell foam insulation in the box sills. The wall exposure to the west and north are minimized and the placement of the garage buffers the cold north wind. The floor system rests on high density foam insulation and a thermo break of high density insulation separates the concrete floors from the foundation walls. The foundation walls are insulated on the inside with 1" foam and on the outside with 2" high density foam covered by a breaker board that looks like concrete. The garage walls and garage doors are also insulated.

POOR MAN's GARAGE FLOOR Heat System

A 1000 foot PEX* loop is buried 10 feet deep adjacent the home and connects the closed loop PEX coils poured into the concrete [similar to an in floor heating system]. When the temperature drops below 20°, the circulating pump is turned on and circulates the fluid in the close loop system thus bringing the warmth from underground to keep the garage floor at a minimum of 45°. The only energy expended to keep the garage above freezing is the small circulation pump. A much larger underground loop would be necessary to keep the floor temperature up if it were not for the fact that the PEX tube is buried 10 feet deep, below the water table. The warmth is collected from wet soil rather than dry soil. *PEX is the trade name for plastic pipe.

Energy Costs for the 1800 square foot home including both natural gas and electricity before the installation of the PV electric generation panels averaged $104.00 per month.

Farm house Remodel for energy efficiency and to prolong the home's life span

The farm house was built before insulation and thermo windows – some of the nails in the original structure were square hand forged. The original home had minimal energy savings upgrades including 2 inches of vermiculite insulation and three insulated windows—the 19662 addition had 2X4" bat insulated walls with R 18 in the ceiling. The remodel included adding 15 inches of blown insulation to the entire attic, 2" high density foam insulation 2' deep on the exterior walls, energy star windows throughout, insulated doors and storm doors, and spray foam insulation[DIY provided by OMRO BUILDING CENTER] sprayed into the full 4 inch wall cavity. An additional inch of foam insulation was added to the 19662 addition to better insulate the exterior walls. The new siding was incorporated using azec board to aid in incorporating the foundation insulation. The forced air heat system uses exposed piping in the basement therefore the warmth escaping from the basement walls was significant –future insulation may include adding interior high density foam to the basement walls. A roof venting system was installed in conjunction with the roof replacement. The steel roof system installed by STONE CONSTRUCTION provides a permanent type roof and qualifies for an insurance discount. The energy upgrades were completed in the spring of 2012 therefore the energy cost savings are unknown at this time. The hope is that the heating cost will be reduced by 1/3.