Disconnecting an existing house from the grid

A design project for a disabled woman who may not tolerate a smart meter

Introduction

Mechanical utility meters are being replaced with digital meters which usually communicate wirelessly or by injecting signals onto the power line (PLC) and the household wires. Case reports have shown that these technologies affect a small number of people, sometimes to the point that they cannot continue to live in their home.

One option is to disconnect a house from the electrical grid, so there is none of these "smart" meters and there is no *dirty electricity* coming in from the meters on nearby residences.

The owner of a 774 sq ft (80 m^2) home located in the high desert of northeastern Arizona contacted the author to find out how to take her house off the grid, if she had to. The house is located in an area with several other people who are also disabled with electrical sensitivities. The houses are placed on large lots of 20 acres or more.

The local climate is characterized by moderate summers and harsh winter nights.

Based on the homeowners' health restrictions, two options are suggested:

- Full disconnect from the grid
- Hybrid system / partial disconnect

A ballpark cost estimate of the two options arrived at a total price of $27,000 to $35,000.

Special consideration

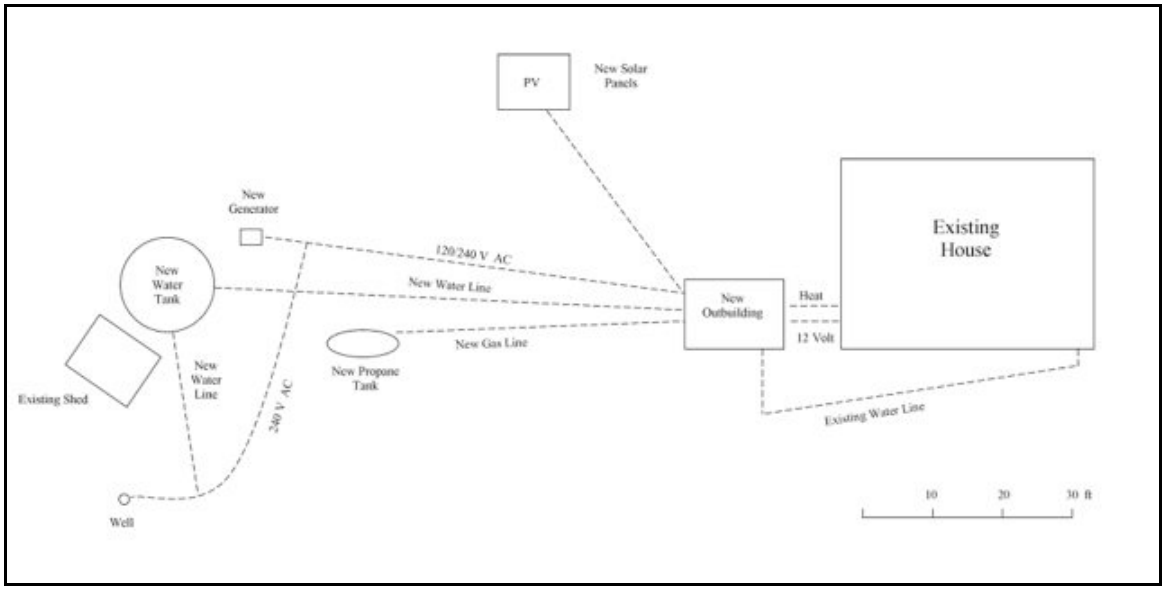
The homeowner has a number of health conditions and disabilities which make this design a challenge. The specific issues include:

- air quality
- electromagnetic radiation
- dirty electricity
- repetitive noise

These restrictions limit the use of several standard technologies used in off-grid housing, such as heating with woodstoves and most propane heating systems. Inverters, modern pulsing solar chargers and DC motors are also problematic technologies. The noise restriction is an issue for the pumps and generator.

These restrictions are not insurmountable. There are already off-grid houses in the area which employ technical solutions to all these issues. The only exception is that they were built from the start to be off the grid, and use in-floor radiant heat.

Option 1: Full disconnect



The first option is to fully disconnect the property from the electrical grid. This means that there will be no live wires closer than about 800 ft (250 meters) from the house.

This is the costlier of the two options, but also the one offering the best protection.

The house will use 12 volt DC solar power for lighting. The refrigerator is powered by propane gas and is located in a new outbuilding. The house is heated by a propane boiler located outside the house also in the new outbuilding.

A generator is used once or twice a week to pump water from the well to a holding tank. At the same time, the generator also powers the washer and dryer.

Cooking will take place on the porch, using a portable propane stove and a barbecue grill.

Extensive modifications of the home are needed to install a hot water heating system and 12 volt wiring.

See the appendix for specific details and considerations.

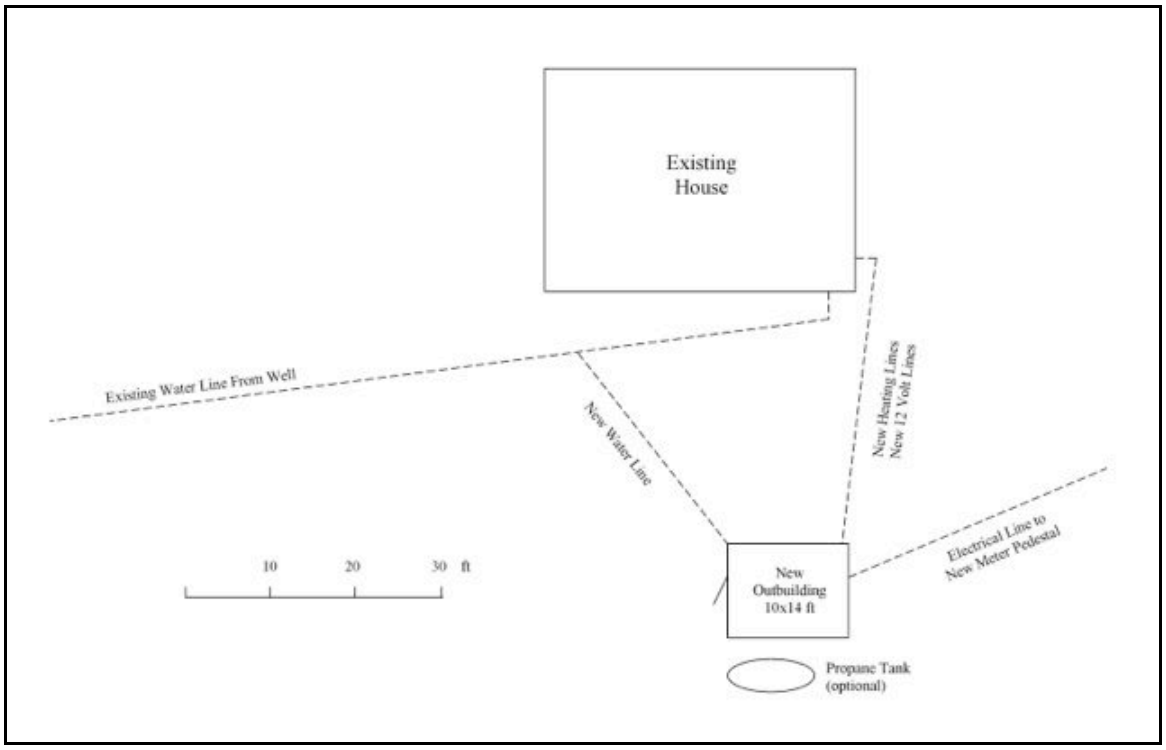
Option 1: Full disconnect —Financial estimate

The following estimate is broad and based on a similar system built in 2008. It should only be used as a guideline for the cost. The listed cost of the heating system is particularly variable.

Solar system: 600 watt PV, 660 Ah battery, controllers, mounting, etc.	$ 4,000
Well system: tank, piping, pump	$ 3,000
Electrical system: rewiring, new lights, etc.	$ 3,000
Appliances: fridge, water heater, stove, barbecue	$ 2,500
Generator: propane, low-noise, reliable model	$ 4,000
Utility shed: heated, insulated, 8x8 ft	$ 8,000
Heating: in-floor retrofit or hydronic radiators	$10,000
Propane system: line (tank is rented)	$ 600
	$35,100

The above estimates include labor cost.

Option 2: Hybrid system



The second option is a hybrid, where the house is fully disconnected from the electrical grid, while a new outbuilding and the well are grid connected. This option is cheaper and more comfortable, but then grid power will be as close as about 40-50 ft from the house. The smart meter will be about 80 ft (25 m) away.

In this scenario, the house itself is also powered by 12 volt DC solar power and it has the same hot water heating system as the first scenario. Both of these will require extensive modifications of the house.

Cooking may take place on the porch, using propane stove and barbecue, or it can be in the grid-connected outbuilding.

The grid-connected outbuilding will contain the electric washer, dryer and refrigerator. It will also contain the water heater and boiler, which can be propane or electric.

The well will be virtually unchanged, except its power and control will come from the outbuilding. There will be no need for a storage tank or generator.

The electrical meter is moved from the house to a pedestal next to the transformer, about 80 ft (25 m) from the house.

The hybrid system will provide more flexibility and convenience than the fully disconnected system. Having regular, unlimited power available for projects, appliances, electronics, etc. is a considerable convenience.

For details, see the appendix.

Option 2: Hybrid — Financial estimate

The following estimate is broad and based on a similar system built in 2008. The cost of the heating system is a gross estimate.

Solar system: 500 watt PV, 660 Ah battery, controllers, mounting, etc.	$ 3,500
Electrical system 12v: rewiring, new lights, etc.	$ 3,000
Moving electrical meter to pedestal	$ 1,000
Appliances: stove, barbecue	$ 200
Utility building: heated, insulated, 10x14 ft	$11,000
Heating: in-floor retrofit or hydronic radiators	$10,000
	$27,700

The above cost estimates include local labor.

Further information

The appendix contains details about the options, including the new outbuilding and the electrical systems.

For more general information about suitable technologies for this type of off-grid or hybrid homes, see http://www.eiwellspring.org/offgrid.html.

Appendix

Utility building

The utility building contains equipment and appliances that cannot be kept in the house. This is because of their size, the fumes, noise and/or electrical emissions (dirty electricity/EMF).

Winter nights may occasionally go below –10ºF (–24ºC) so the utility building must be heated and insulated to protect the pipes and batteries. The cooler return water from the house heating system can be used in an in-floor heating system with an insulated slab.

Due to the danger of explosive hydrogen gas, the batteries must be housed in a separate room from any gas appliances.

The pressure pump is noisy and cannot be placed in the house or even in a closet on the side of the house. In a mild climate, it could have been placed in an unheated garden shed, allowing the option 1 utility building to be built as a closet on the side of the house instead.

It is best to move the washer and dryer to the outbuilding in both scenarios. Generator power has a lot of harmonics in it and is not as tolerable as regular grid power, so it is best to not have generator power in the house, even just for an hour or two a week. Alternatively, the occupant could go for a walk or wait in her car, while the washer/dryer is running.

To minimize problems with dirty electricity inside the outbuilding, the wires should be twisted.

The utility building is located differently in the two scenarios:

In option 1 (full disconnect) the building is located about 20 ft from the east side of the house, to provide convenient access to the refrigerator.

In option 2 (hybrid), the outbuilding will need to be connected to the existing transformer, and possibly the septic system. It is here located about 40 ft from the front door, i.e. to the north or northwest of the house.

For option 1, the building can be made smaller, with direct access from the outside to the content. There will be a special door for the refrigerator, one for the battery

bank and a double door for the rest. The person would stand outside while accessing the equipment.

	Option 1 **Full Disconnect**	**Option 2** **Hybrid**
size	8 x 8 or 10 x 14 ft	10 x 14 ft
content	solar controller battery bank water heater boiler circulation ump refrigerator washer (optional) dryer (optional) iron filter water softener pressure pump n/a	solar controller battery bank water heater boiler circulation ump refrigerator washer (optional) dryer (optional) iron filter water softener n/a well controller
lines to house	cold water hot water heat (2 lines) power (12 volt)	cold water hot water heat (2 lines) power (12 volt)
other lines	n/a water from tank propane septic or gray water (optional)	120/240 V AC water from tank propane (optional) septic or gray water

Heating system

The house is presently heated by wall-mounted electric heaters that are selected and installed to have minimal electromagnetic emissions. These cannot be used in an off-grid house.

The common choices, such as wood stove, pellet stove, direct vent gas heaters, etc. cannot be used, due to air quality issues.

With an existing home with a slab floor, one option is to install a hydronic radiator system with hot water piped in from a boiler located outside the building. All boilers require 120 volt AC for their control system, and are usually designed for much larger buildings. It may be necessary to use a propane water heater instead. A water heater cannot deliver as high a water temperature as a boiler so there will be a need for larger radiator surfaces in the house.

A second option is to install a retrofit in-floor heating system by adding a new floor on top of the existing slab. Rigid foam boards (minimum one inch thick) would be placed on the existing concrete floor. PEX tubing would then be mounted and encased in 1½ inch of concrete poured over the foam boards. Floor tiles could be laid on top, if desired.

The retrofit in-floor system would raise the floor from 2½ to 3 inches (65 to 75 mm), which would require modification of the doors in the house. Such a system uses a lower water temperature than radiators, and will work well with a regular propane water heater.

The in-floor heating retrofit appears to be the better choice in this case.

Solar system

A solar electric system works very well in the Arizona climate. There are hundreds of houses in the area which are powered by the sun. A small wind generator could also be used, except that the noise is a particular problem here.

Based on local experience, 500 to 600 watts of solar panels are estimated, together with a 660 amp-hour battery bank. A larger system may be needed.

The solar panels will be mounted on a rack, while the battery bank is housed in the new outbuilding.

About 100 watts of the solar panels should be dedicated to the two pumps (water pressure and circulation pump) to ensure reliability. In the hybrid option, there is no pressure group.

Care must be taken to choose charge controllers which do not produce problematic transients on the building wiring. This rules out models with features such as PWM and MPPT.

Electrical system

Off-grid houses of today use alternating current like regular houses. However, the inverter that produces it will not be tolerable.

A 12 volt direct-current (DC) system will be needed. Such systems were standard for off-grid homes until 1990 and are a well-established technology.

The household wiring must be modified to work well with 12 volt DC. This includes

- thicker wiring in the walls (where needed)
- new electrical switches (possibly)
- new receptacles (outlets)

The existing fixtures can be retained in most cases, with new 12 volt bulbs installed. A few outdoor light fixtures will need to be replaced with LED flood lights.

Existing appliances, such as the refrigerator, and electric water heater, must be replaced for the "fully disconnected" scenario.

As DC motors have greater electromagnetic emissions than AC motors, the refrigerator may need to be a gas model. In either case, the refrigerator must be relocated to an outbuilding.

There is an iron water filter and a water softening system, which both need electricity to control their backflush cycle. These may be run manually, or modified to run on the solar system. The well water has a very high mineral content, making these systems necessary.

The television must be replaced with a 12 volt model.

The existing washer and dryer are retained. In the fully disconnected option, they will be powered by a generator. In the hybrid option, they will be run by grid power.

They can be kept in the house or moved to the new outbuilding. If kept in the house, a kill switch can be used to disconnect power when not needed.

Using a generator to power the house on a full-time basis is not possible. The cost, noise and "dirty electricity" are all prohibitive issues.

The well

There is a well, with a 240 volt pump located at the bottom of the well hole. The pump is presently run at brief intervals throughout the day when the water pressure becomes low in the pressure tank.

The standard well system in off-grid houses uses a storage tank, which is either filled slowly by a solar or wind driven pump, or about once a week using a regular 240 volt well pump powered by a generator.

It is here assumed that the existing well pump is retained and run by a 240/120 volt generator, which is also used to run the washer/dryer.

A storage tank of at least 1500 gallons is needed for efficient use of generator time, and supply reliability in case of mechanical breakdown.

A new DC powered pressure pump takes water from the holding tank and fills the existing pressure tank as needed.

These small pressure pumps are very noisy and should not be placed inside the house. People with neurological conditions are sometimes greatly troubled by such noise, making it essential to locate elsewhere, in this case.

An alternative is to leave the well system on the grid, while disconnecting the house. In that case, there will only be minimal changes to the well system.

Cooking

The homeowner presently uses a portable electrical hot plate for cooking. It is not realistic to cook using 12 volt DC solar. Instead, a portable propane gas stove can be used on the porch, possibly also a propane barbecue. These cannot be used inside, due to fumes.

Air conditioning

The house is located at 5900 ft (1900 meters) elevation in a climate with rather mild summers. Off-grid houses in the area rarely have air conditioning and one is not designed for this house.

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