



Final Deliverable:

E2C Expert Match Tama County, IA

**Microlearning modules on residential
energy efficiency- Module 3**

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U.S. DEPARTMENT
of **ENERGY**

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E2C: Technical Assistance Opportunities

EXPERT MATCH

E2C's Expert Match program connects energy experts with local governments, electric utilities, and community-based organizations to provide technical assistance to inform near-term energy decisions.

Expert Match offers:

- **Access to experts from the U.S. Department of Energy's national lab system.**
- **40–60 hours of support over 3 months from the first kickoff call.**
- **Focus on community-driven challenges or goals.**

For more information, visit:
www.nrel.gov/e2c/expertmatch

Scope

ORNL will develop a set of short microlearning modules to help Montour (Tama County) homeowners better understand and manage household energy use. The work focuses on creating clear, practical, and accessible content that guides residents toward cost-effective improvements and available incentives. Activities in this work may include:

- **Content Development:**
ORNL will prepare seven (agreed upon) modules using plain language, relatable examples, and simple step-by-step guidance covering topics on home energy efficiency improvements.
- **Learning Management System on Website:**
ORNL will use a simple WordPress website of learning management system (LMS) to support hosting the above modules and providing instructions for future updates.

Points of Contact

Community POC

Kent Scheid, CEDI-Tama County

Subject Matter Expert

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Microlearning modules on residential energy efficiency

Module 3. Energy Resilience at Home

Building energy resilience at home means creating systems that can withstand disruptions whilst maintaining essential energy services. This presentation explores key technologies that enable households to generate, store and efficiently use energy. We will explore the basics of :

- Solar energy
- Community solar
- Battery storage
- Heat pumps



Illustrative picture of energy disruption at home

Rooftop/Ground Mount Solar Basics

Solar power systems convert sunlight directly into electricity, providing a renewable energy source right at your home. Let us explore how these systems work and what makes them a popular choice for homeowners.



Solar Power Generation Components

Solar Panels

Photovoltaic (PV) cells in solar panels capture sunlight and convert it to direct current (DC) electricity.

Inverter

The inverter converts DC electricity to alternating current (AC), which is what your home appliances use.

Distribution

Electricity flows to the home's electrical panel, powering the appliances and devices.

Grid Connection

Excess electricity can be exported to the grid, often earning credits through net metering programmes.

Solar Installation Types

Rooftop Solar

- Most common residential installation
- Uses existing roof space
- Typically, less expensive than ground mount
- Installation depends on roof orientation, angle, and shading



Ground Mount Solar

- Ideal when the roof is not suitable
- Can be optimally positioned for maximum sunlight
- Requires available land space
- Easier to access for maintenance



Solar System Costs

Initial Investment

A typical residential solar system (3-10kW) costs between \$8,000 - \$18,000* installed, depending on system size and quality.

Ongoing Costs

Minimal maintenance required. Systems typically have 25+ year warranties with inverters needing replacement after 10-15 years.

Return on Investment

Most systems pay for themselves in 7-12 years through energy bill savings, with additional years of free electricity.

The economics of solar have improved in recent years as equipment costs have fallen while electricity prices have risen.

*Reference: <https://www.ecoflow.com/us/blog/solar-system-price-guide?utm>

Solar Incentives

Federal Solar Investment Tax Credit

Homeowners can claim a 30% federal tax credit on the total cost of installing solar panels (equipment + labor).

Net Metering

Excess electricity generated by your solar system can be sent back to the grid and receive bill credits (credit value depends on your utility provider).

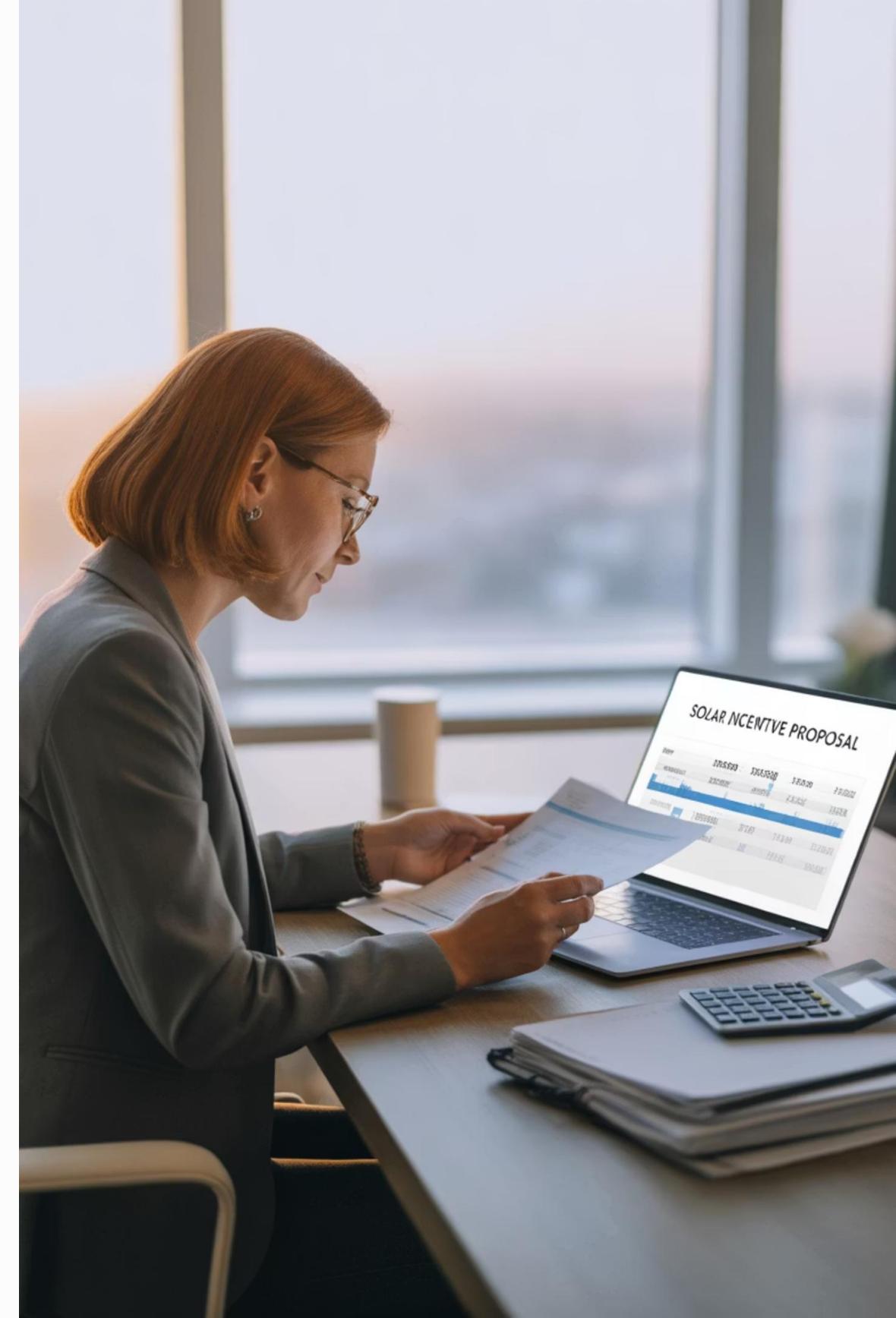
Energy Bill Savings

Immediate reduction in electricity bills by using self-generated power instead of grid electricity.

State and Utility Rebates

Alliant Energy and MidAmerican Energy may offer rebates or performance-based incentives for residential solar installations.

Solar incentives, utility programs and rebates keep evolving. Checking the latest information on utility websites and other offices will be helpful. Example, <https://dsireusa.org>, <https://www.energy.gov/save/solar-tax-credits-and-incentives>





Community Solar

Community solar offers an alternative for those who cannot install solar panels on their own property, allowing multiple households to benefit from a shared solar installation.

What is Community Solar?



Shared Solar Arrays

Large solar installations that serve multiple households or businesses in a community.



Subscription Model

Participants subscribe to a portion of the solar farm's output, receiving credits on their electricity bills.



Accessibility

Makes solar power available to renters, apartment dwellers, and those with unsuitable roofs or limited funds.

How to Join a Community Solar Project?



Research Local Projects

Search for community solar projects in your area through local councils, energy suppliers, or dedicated platforms.



Review Subscription Options

Examine contract terms, subscription costs, expected savings, and commitment period.



Sign Up

Complete subscription agreement and provide your utility account information for billing credits.



Receive Credits

Start receiving credits on your electricity bill based on your share of the solar farm's production.



Benefits of Community Solar

For Participants

- Access to solar with no upfront installation costs
- No maintenance responsibilities
- Typically 5-15% savings on electricity bills
- Support renewable energy without property modifications
- Shorter commitment than rooftop installation

For Communities

- Local job creation during construction and operation
- Strengthened grid reliability
- Productive use of underutilised land
- Inclusive access to energy benefits
- Reduced environmental footprint



Battery Storage for Homes

Battery storage systems allow homeowners to store excess electricity generated by solar panels for use when the sun isn't shining, increasing energy independence and resilience.

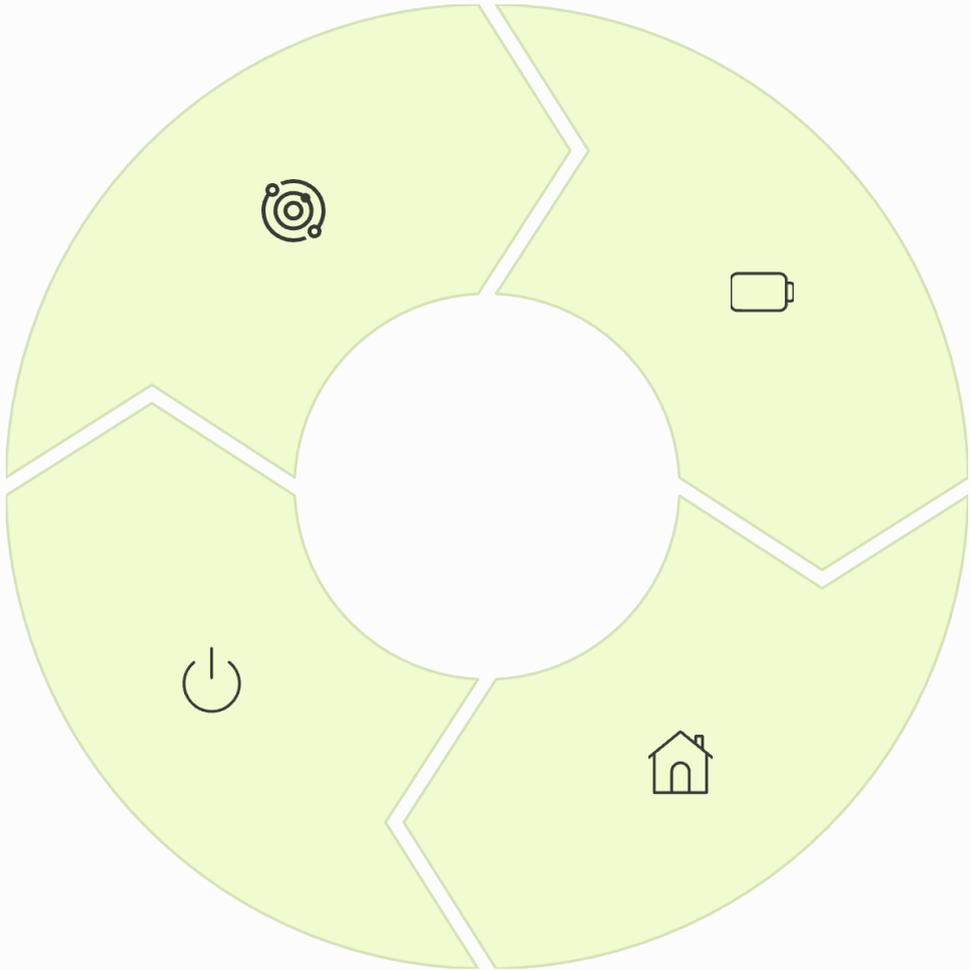
How Home Batteries Work to Provide Electricity?

Generation

Solar panels produce electricity during daylight hours.

Grid Backup

Grid electricity is used only when battery is depleted, minimising purchased energy.



Storage

Excess electricity charges the battery instead of being exported to the grid.

Evening Use

Stored energy powers your home when solar panels aren't producing.

When Battery Storage Makes Sense?

High Electricity Rates

Batteries provide more value when grid electricity is expensive, especially with time-of-use tariffs where evening rates are higher.

Low Export Rates

If you receive minimal compensation for exporting solar electricity to the grid, storing it for self-consumption becomes more attractive.

Power Outage Concerns

Batteries can provide backup power during grid outages, though specific system configuration is required for this functionality.

Energy Independence Goals

For those prioritising self-sufficiency and reduced grid reliance, batteries are a key component despite the additional cost.

Battery Storage Economics

Current Cost Considerations

- Home battery systems typically cost \$9,000 - \$18,000* before incentives
- Payback periods range from 8-15 years depending on usage patterns
- Most systems have 10-year warranties but can last longer
- Economic viability improves with:
 - Larger difference between import and export rates
 - Higher proportion of self-generated electricity used
 - Participation in grid services that pay for battery flexibility

* Reference of battery costs of varying sizes can be found here and similar other websites. The cost vary as per brands, installation cost, type, and efficiency. [https://nrgcleanpower.com/learning-center/solar-battery-cost/#:~:text=Average%20Solar%20Battery%20Costs%20in,range:%20\\$10%2C000%E2%80%93\\$20%2C000%20after%20incentives](https://nrgcleanpower.com/learning-center/solar-battery-cost/#:~:text=Average%20Solar%20Battery%20Costs%20in,range:%20$10%2C000%E2%80%93$20%2C000%20after%20incentives)





Heat Pumps Explained

Heat pumps are highly efficient heating and cooling systems that extract heat from the environment rather than generating it directly, making them an excellent complement to solar power systems for comprehensive home energy resilience.

How Heat Pumps Work for Providing Heat?

Heat Extraction

Heat pumps extract thermal energy from the air, ground, or water outside your home, even in cold weather.

Compression

A compressor increases the temperature of the extracted heat to a level suitable for home heating.

Distribution

The heat is distributed throughout your home via radiators, underfloor heating, or forced air systems.

Efficiency

Heat pumps can deliver 3-4 units of heat for every unit of electricity consumed, making them 300-400% efficient.

Types of Heat Pumps

Air Source Heat Pumps

- Most common and easiest to install
- Extract heat from outdoor air
- Lower installation cost (\$8,000-\$15,000*)
(varies from home size and system type)
- Cold-climate ASHPs available for better efficiency in very cold weather
- Require outdoor space for the unit



Ground Source Heat Pumps

- Extract heat from the ground via buried pipes
- More consistent performance year-round
- Higher installation cost (\$14,000-\$30,000*)
(depends in land, drilling, and system size)
- Require sufficient land for ground loops or drilling
(vertical loops)
- Lower operating costs long-term and higher energy savings



Heat Pumps for Space Heating

Whole-Home Heating

Heat pumps can replace traditional gas or oil boilers, providing heating throughout your home via existing radiators or underfloor heating systems.

Compatibility Considerations

Work best in well-insulated homes. May require larger radiators or underfloor heating as they operate at lower temperatures than conventional boilers.

Running Costs

Typically, lower running costs than gas when properly sized and installed, especially when paired with solar panels that provide free electricity.



Heat Pumps for Water Heating

Dedicated Hot Water Heat Pumps

- Specifically designed for water heating only
- Can replace traditional immersion heaters or work alongside existing systems
- Typically, 2-3 times more efficient than conventional electric water heaters
- Available as integrated units with built-in tanks or split systems
- Provide hot water year-round, independent of space heating needs

Heat pump water heaters extract heat from the surrounding air to heat water efficiently, making them an excellent complement to solar PV systems.



Geothermal Heat Pumps

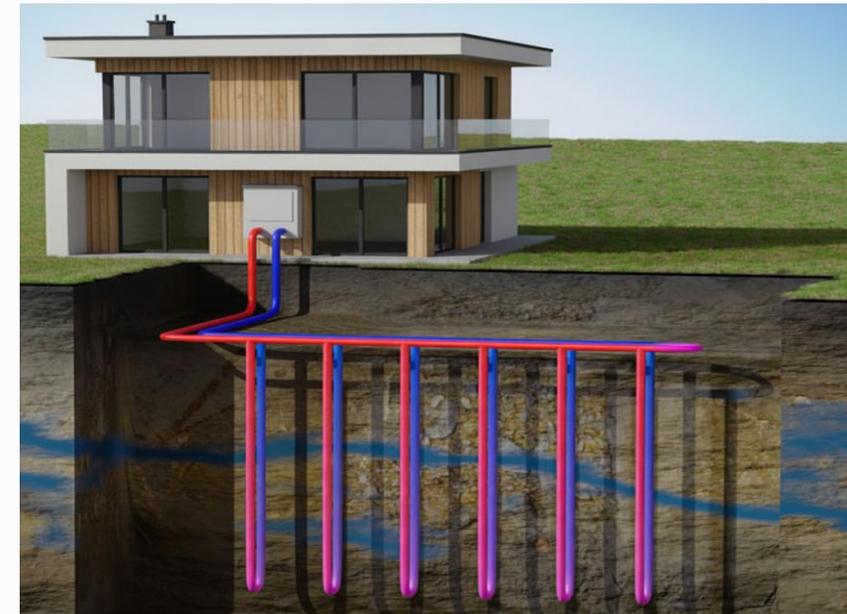
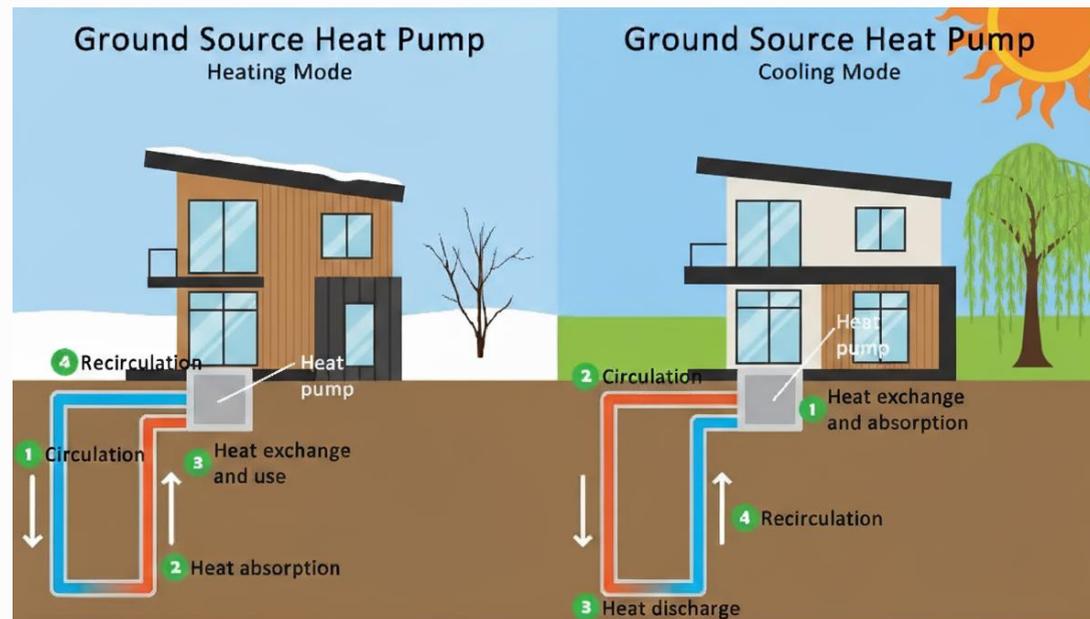
How do they work?

Geothermal heat pumps (GHPs) leverage the stable temperature of the earth to provide efficient climate control year-round.

Geothermal systems transfer heat to and from the earth. In winter, they extract heat from the ground and transfer it into your home. In summer, they reverse the process, moving heat from your home into the cooler ground. This heat exchange process makes them incredibly efficient.

Ideal Conditions for Installation

- Homes seeking significant, long-term energy cost reductions.
- Properties with adequate land for horizontal loops or suitable conditions for vertical drilling.
- Homeowners prioritizing environmental sustainability and consistent indoor comfort.
- New construction or major renovation projects where integration is simpler.



More basic information can be found here- <https://rmi.org/clean-energy-101-geothermal-heat-pumps/>
<https://www.energy.gov/energysaver/geothermal-heat-pumps> , <https://www.energy.gov/eere/geothermal/geothermal-heat-pumps>