Introduction to Renewable Energy Options

Renewable Energy Vermont (REV)

May 2012

Overview

- About REV
- Vermont's Energy Future
- Technologies
- Costs & Financing Options
- Finding an Installer
- Next Steps
- Q & A

About Renewable Energy Vermont (REV)

Vermont's Energy Future

Steps to a secure, clean energy future:

- Conservation
- Efficiency
- Renewables

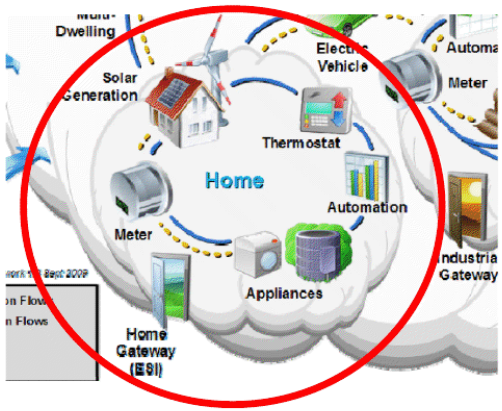
Energy Sectors:

- Power
- Thermal
- Transportation

Re-Envisioning our energy Future: Moving Towards a Smart Grid

Energy in the 21st Century:
Moving towards a Smart Grid

...to a Virtual Power Plant via Smart Grid



5 Types of Renewables

- Solar
- Wind
- Geothermal
- Bio-energy
- Hydro

Renewable Energy

Why Renewables?

- Reduce Carbon Footprint
- Fuel Price Certainty
- Cannot be "used up"
- Economic Development & Security
- National Security

Challenges

- Higher upfront cost and limited funding compared to conventional energy sources
- Aesthetics: "Beauty is in the eye of the beholder"
- Re-envisioning our electric grid

Solar Power

History

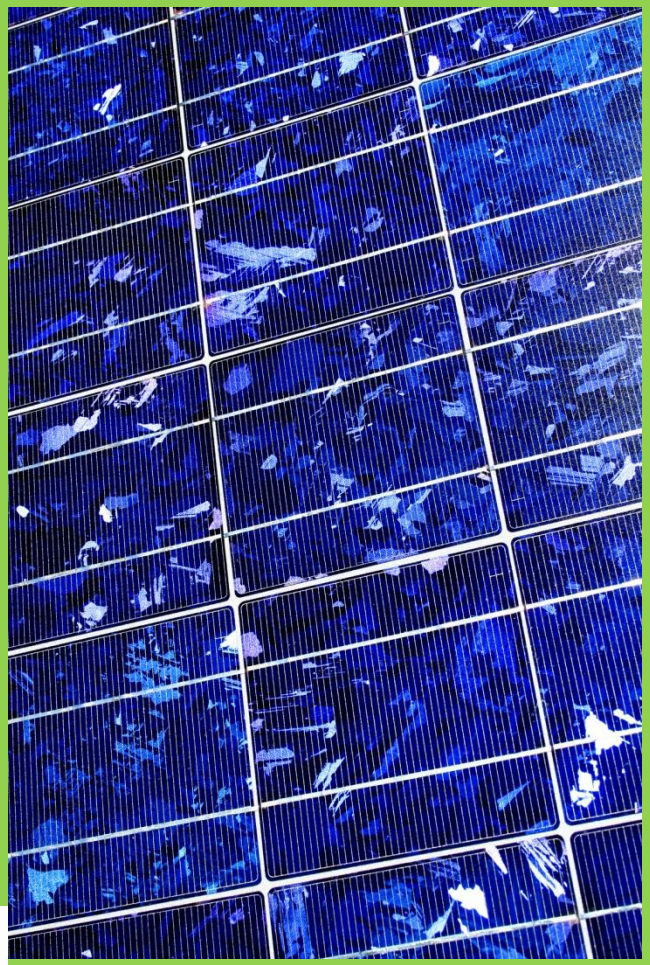
- Edmund Bequerel, 1839
- Albert Einstein, 1905
- Bell Laboratories, 1954
- Satellites in space, 1958

What is Solar Power?

- Electricity and heat generated from sunlight

Renewable Energy Vermont

Anatomy of a Solar Cell



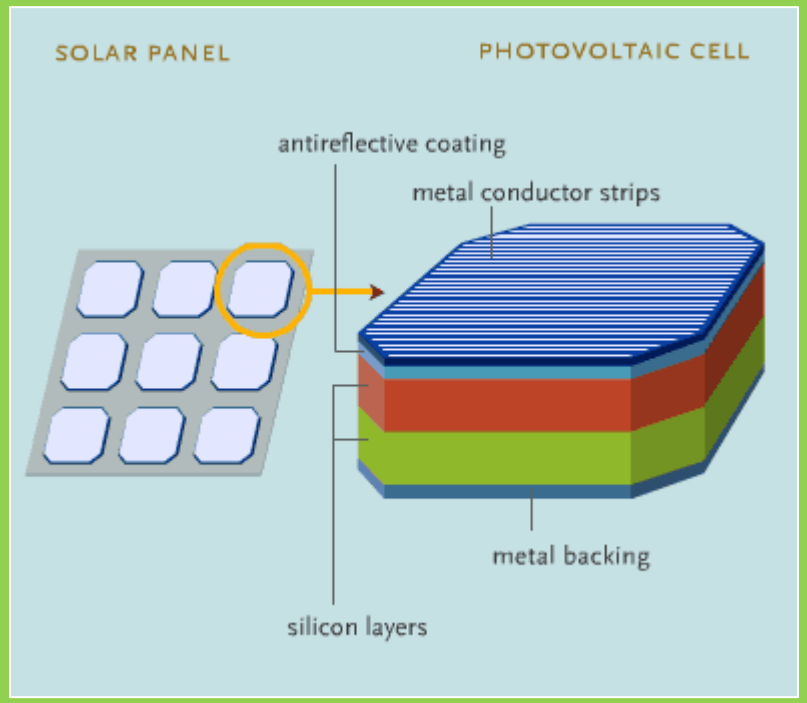
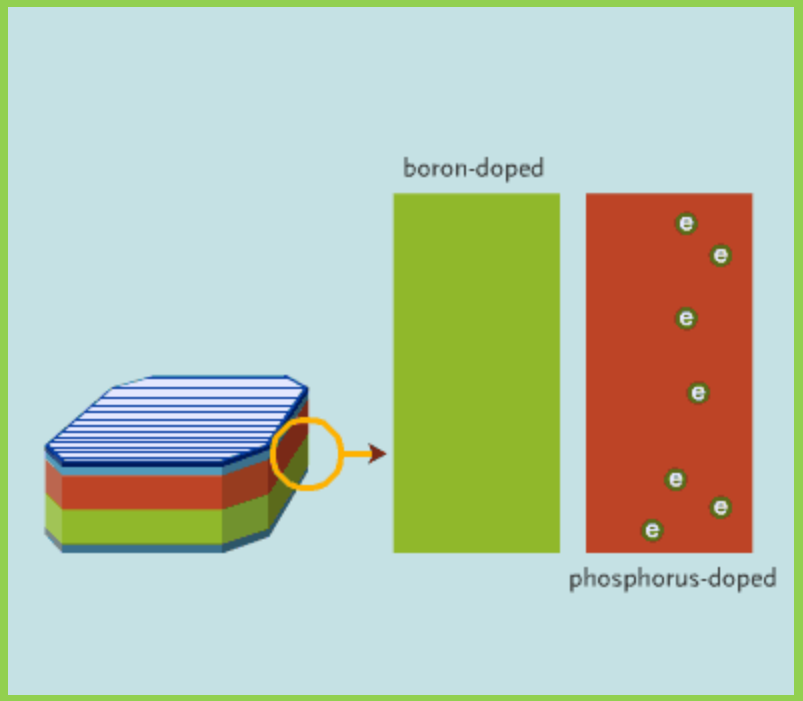


Photo credit: Stephanie Chasteen and Rima Chaddha

Renewable Energy Vermont

How Do Solar Photovoltaics Work?

Silicon Layers



Electric Field

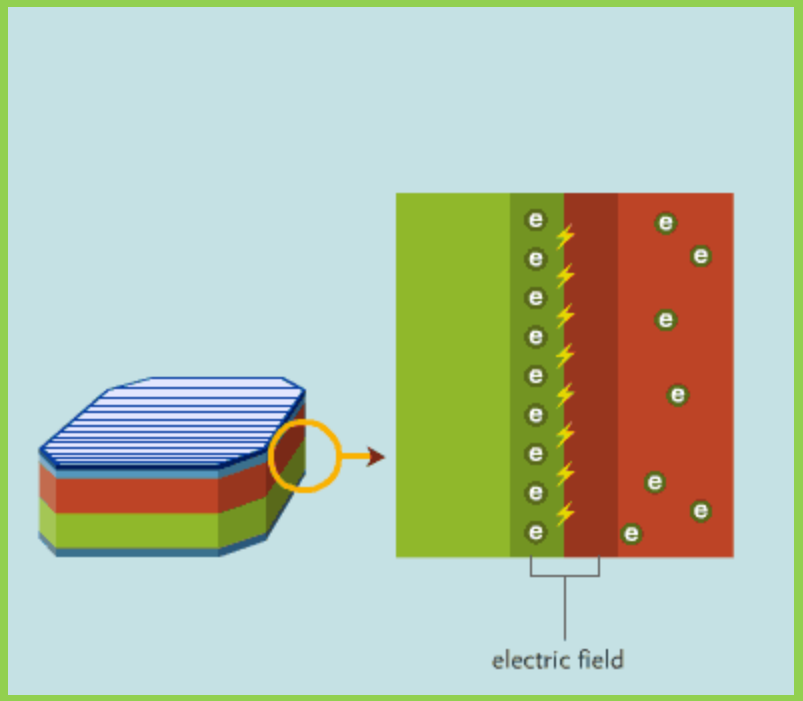
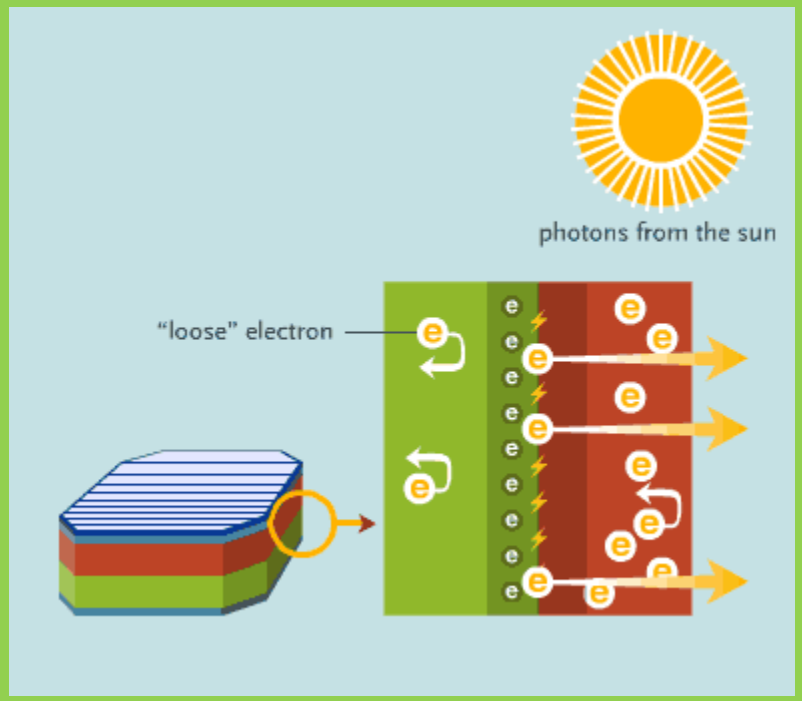


Photo credit: Stephanie Chasteen and Rima Chaddha

Renewable Energy Vermont

How do Solar Photovoltaics Work?

When Sunlight hits a cell



Generating Electricity

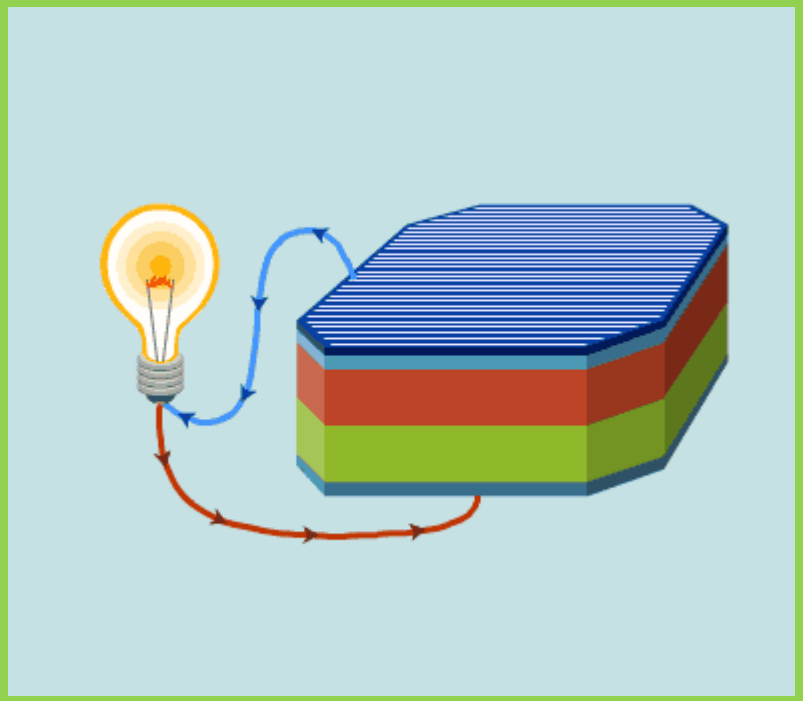


Photo credit: Stephanie Chasteen and Rima Chaddha

Average Residential System Size
5-10 kilowatt (kW)

- Residential: 5-10 kW
  - $25,000 without incentives
- Commercial: 50 kW
  - $190,000 without incentives

1kW=1,000 Watts

Solar Photovoltaics
Things to Consider

- Silent electricity
- Unobtrusive, Take advantage of unused space (rooftops)
- Grid-tied systems can net-meter ("run your meter backwards")
- Lasts ≈ 20 years
- Should be situated in full sunlight, shading can significantly reduce production
- Sun doesn't always shine
- Toxic chemicals used in PV production

Solar Hot Water

Basic Categories of Solar Hot Water Systems

- Passive
- Active
- Indirect
- Direct

Five general types of solar hot water systems

- Integrated collector storage (ICS) (Passive)
- Thermosyphon (Passive)
- Open-Loop Direct (Active)
- **Pressurized Glycol (Active)**
- **Closed-Loop Drainback (Active)**

Solar Hot Water Explained

- The solar collector absorbs sunlight
- A pump moves glycol within a piping loop, where it is heated

Typical Direct Pump System

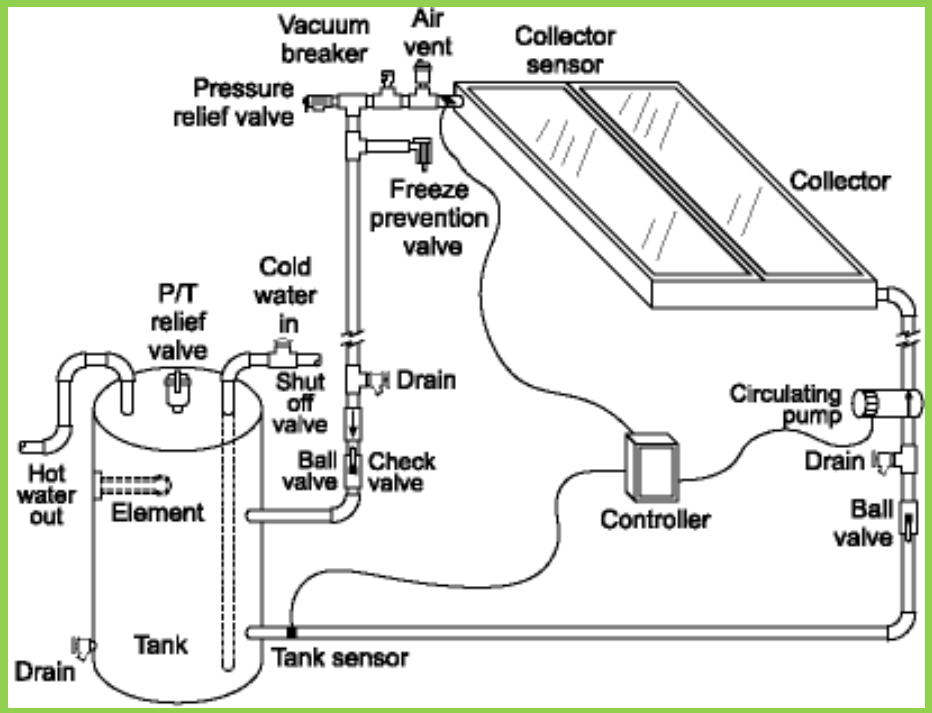


Photo Credit: Florida Solar Energy Center

Solar Hot Water Explained

Photo Credit: Bill Spence

- Heat is transferred to solar hot water tank
- Glycol is pumped back to solar collectors
- Loop repeats until sun sets and pump turns off

Solar Hot Water: Passive Systems

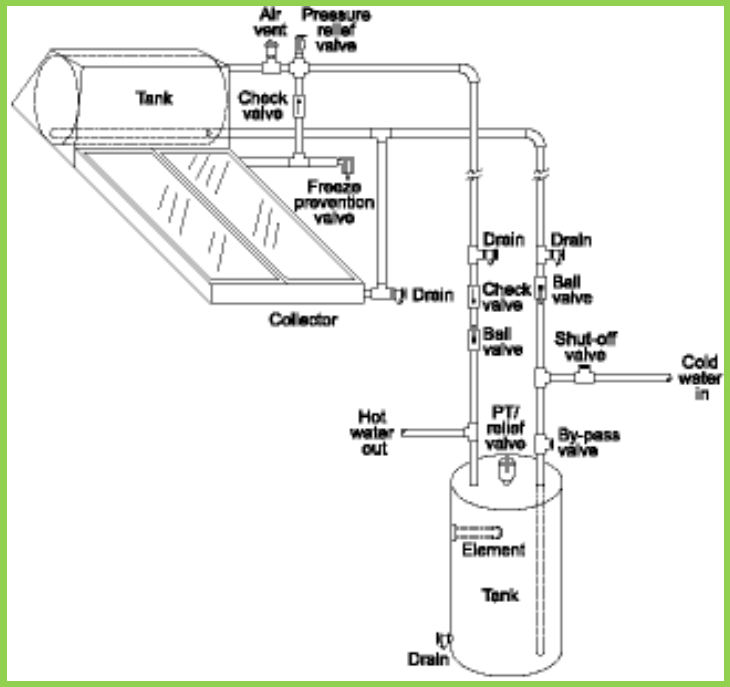


Figure 1. Thermosiphon system

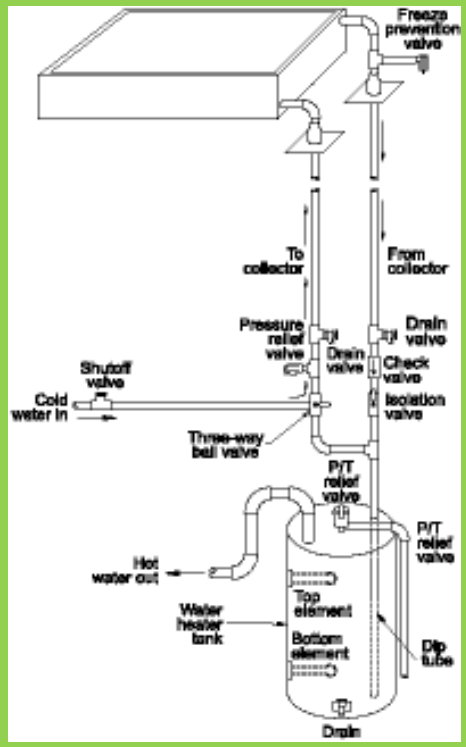


Figure 2. Integral collector storage (ICS) system

Renewable Energy Vermont

Solar Hot Water: Active Systems

Indirect

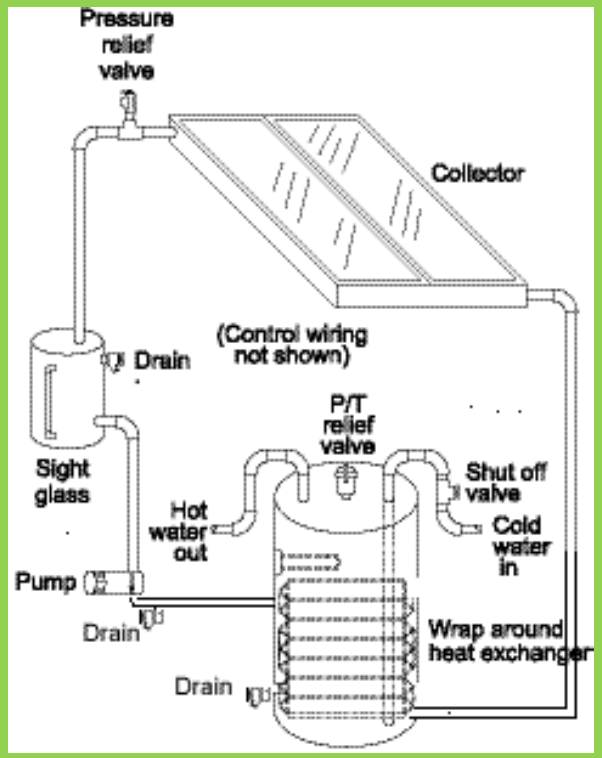


Figure 1. Indirect pumped system

Direct

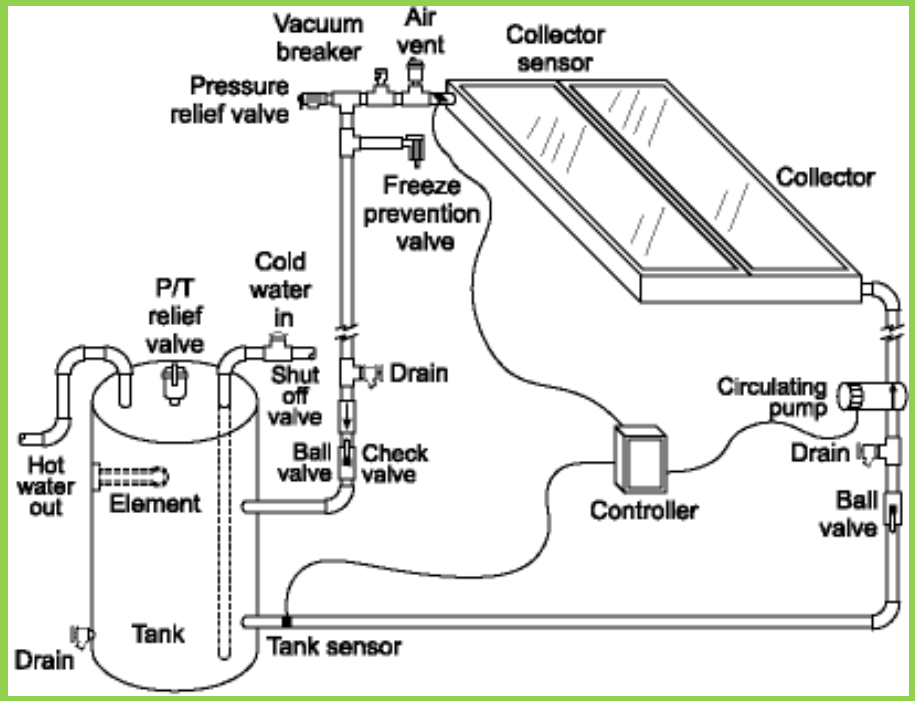


Figure 2. Typical Direct Pump System

Photo credit: Florida Solar Energy Center

Solar Hot Water: System Components

Solar Collector

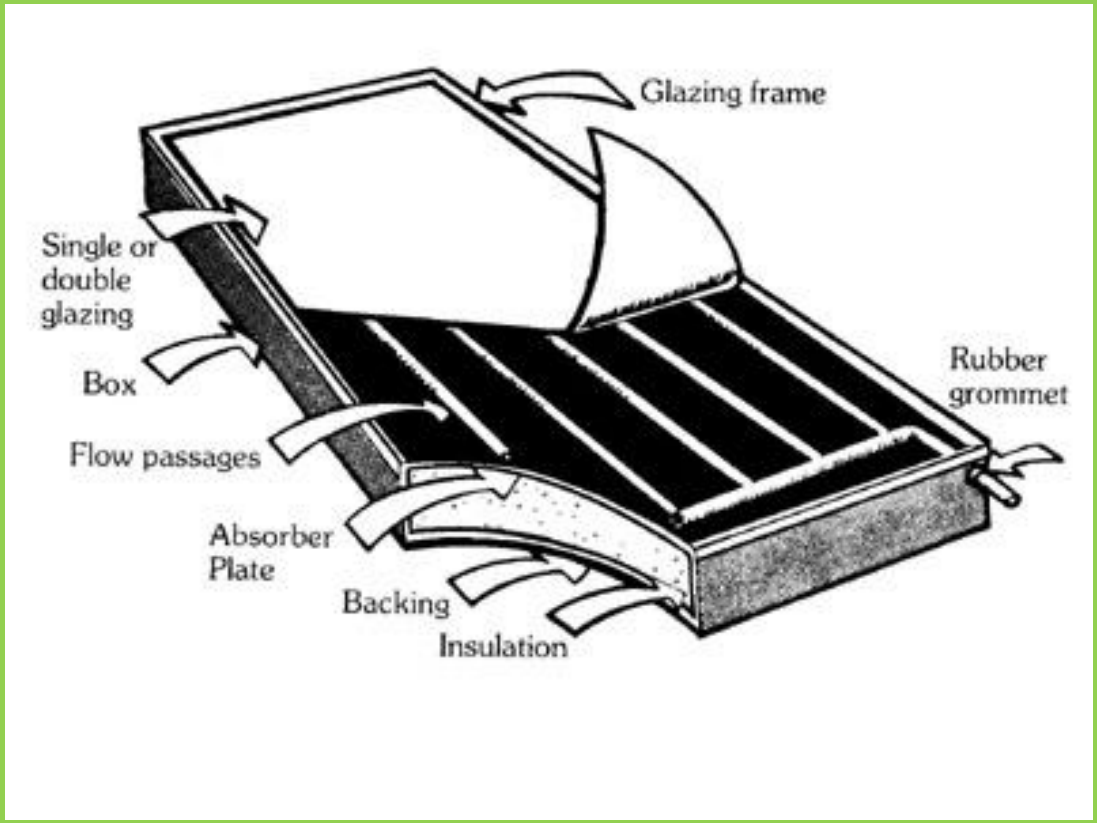


Photo Credit: Missouri Dept. of Natural Resources

Average Solar Hot Water System

- Residential: two 4’ x 8’ collectors yield 60~80 kBTU
  - $7,000~$10,000
- Commercial: 250 kBTU
  - $20,000~ $25,000

35 kBTU = 1~2 person usage

Solar Hot Water
Things to Consider

- If half of all households used solar water heaters, the reduction of CO_2 emissions is the same as doubling the fuel efficiency of cars
- Pay back in 4~8 years
- Last 15~40 years
- Does not account for all of your heating needs
- Still require backup heater

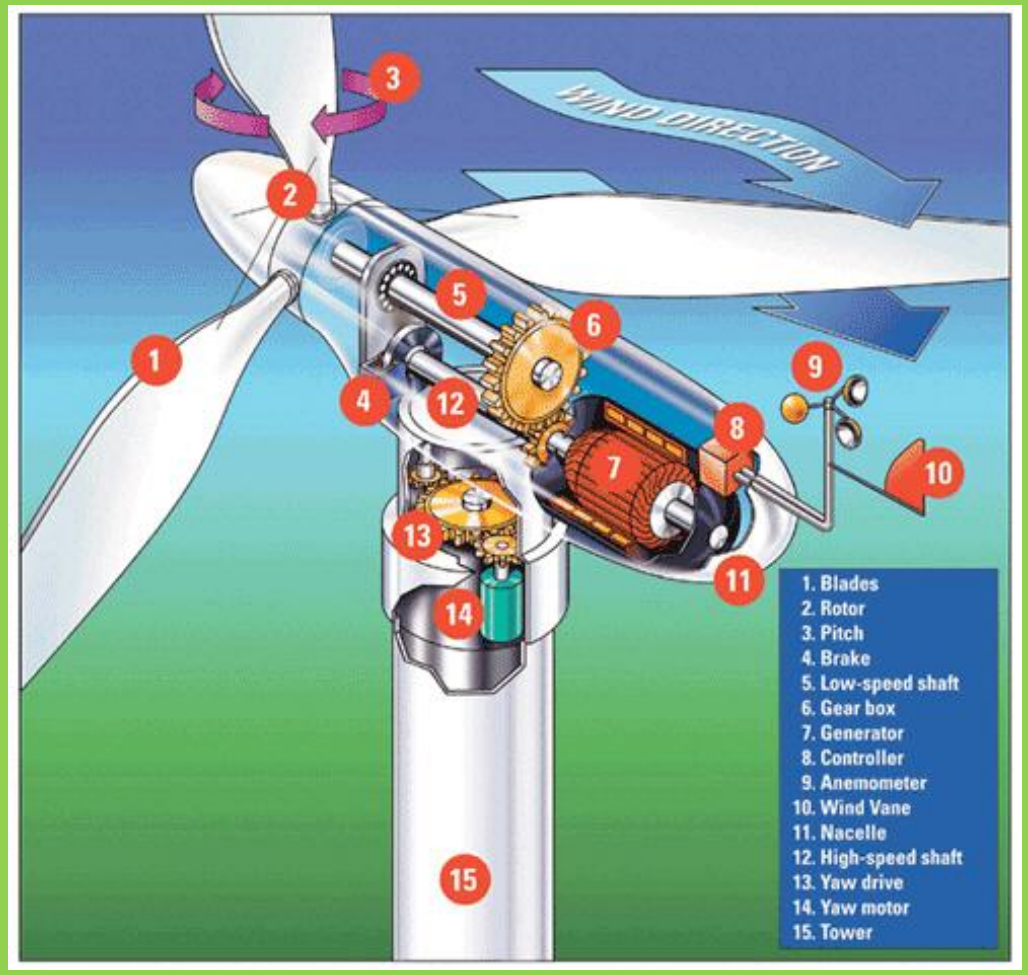
Wind Power Explained

- Form of solar energy
- Convert kinetic energy in wind to mechanical power
- Wind turns blades → spins rotor shaft → series of gears
- Generator converts mechanical power → electricity

October 19, 1941- Grandpa's Knob
Castleton, Vermont

Photo Credit: Rutland Herald

Wind Turbines



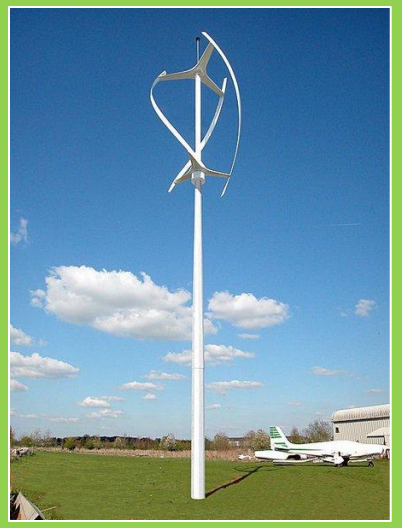
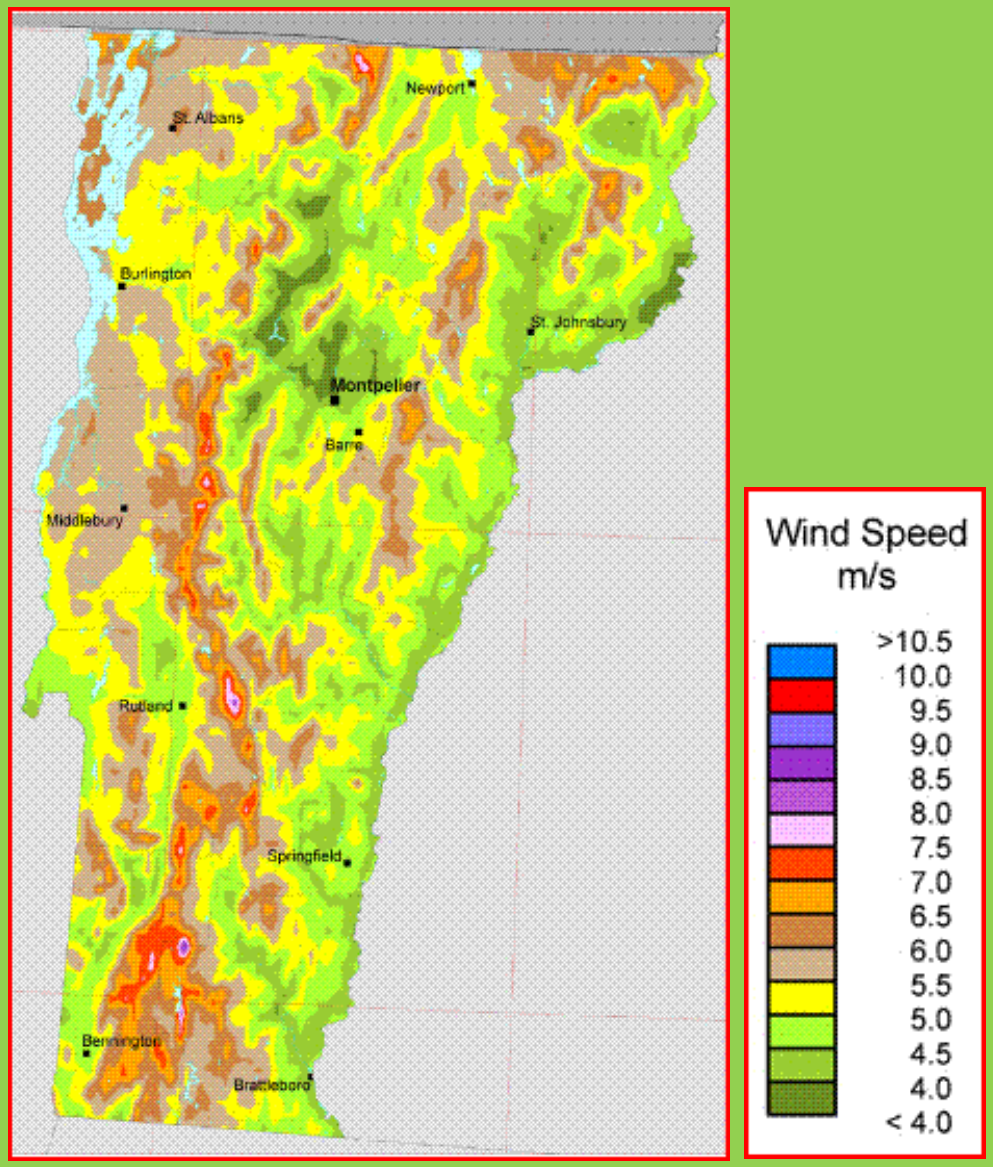


Photo Credit: quietrevolution (QR)

Wind Potential in Vermont



Renewable Energy Vermont

Average System Size

- Residential: 10kW
- Community: 100kW
- Commercial: 2 MW
- 1 megawatt (MW)= 1000 kilowatts

10 kW

Wind
Things to Consider

- Turbines last 20-25 years
- Need steady, consistent wind
- Need to build turbines high enough: 80 ft. tall, wind speeds >10mph
- Commercial scale is one of the lowest-cost renewable energy
  - 4 to 6 cents/ kWh
- Lights on commercial-sized turbines

Geothermal Explained

Most common type of Geothermal in Vermont: Ground Source Heat Pump

How it works

- A heat-transfer fluid circulates through pipes buried in the ground
- Heat from earth warms fluid in pipes
- Warmed fluid is pumped through system to indoor air delivery system
- Process is reversed in summer

Renewable Energy Vermont

Geothermal: Ground Source Heat Pump

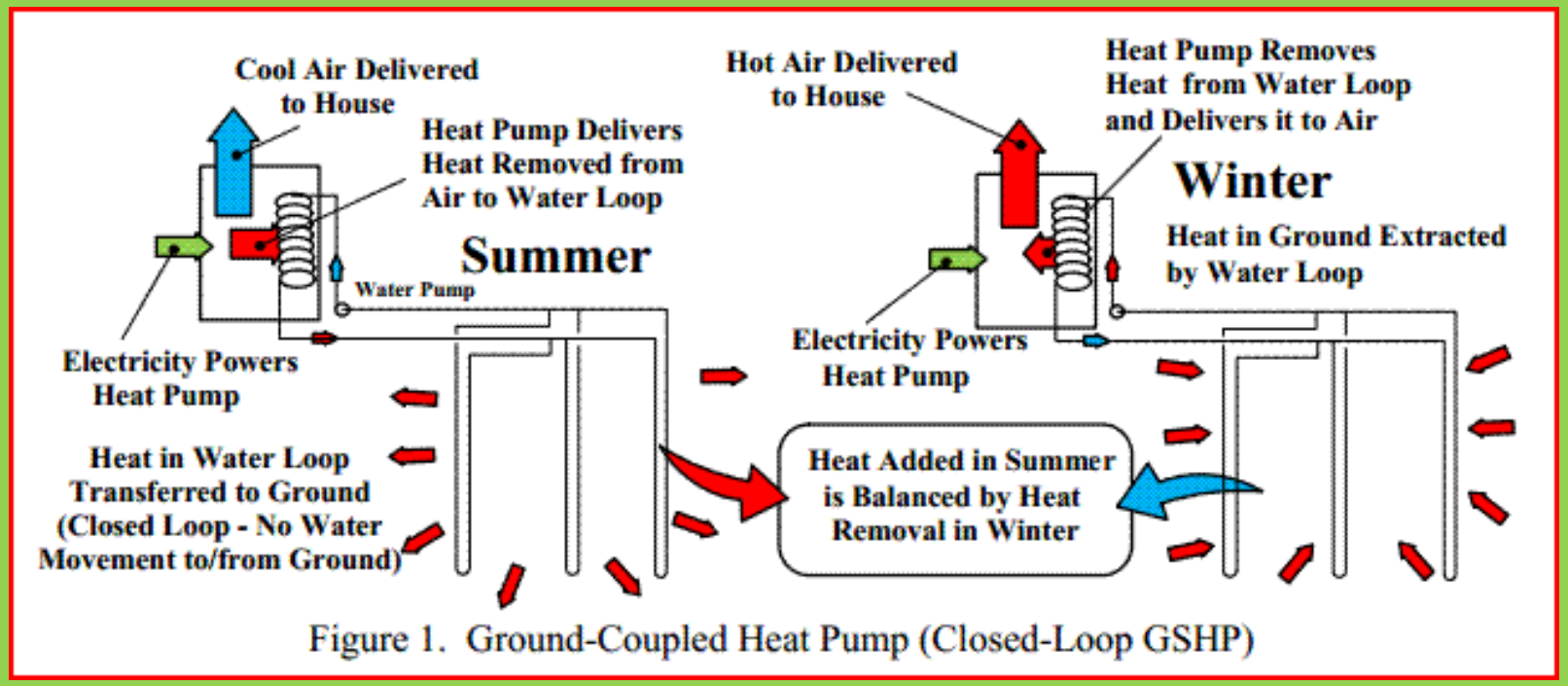
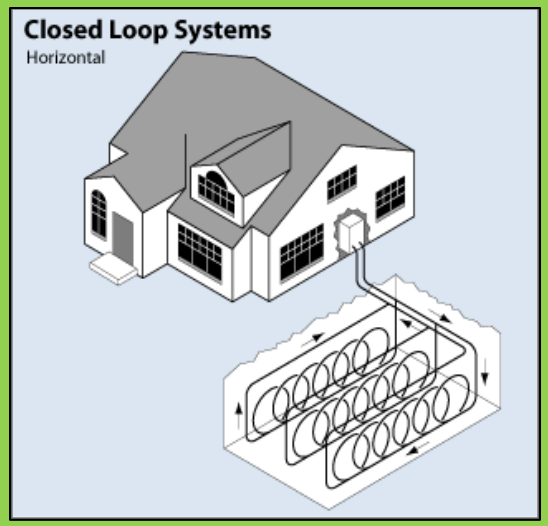
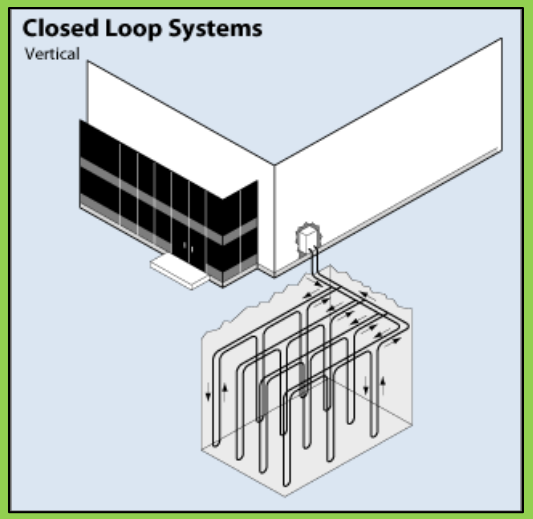
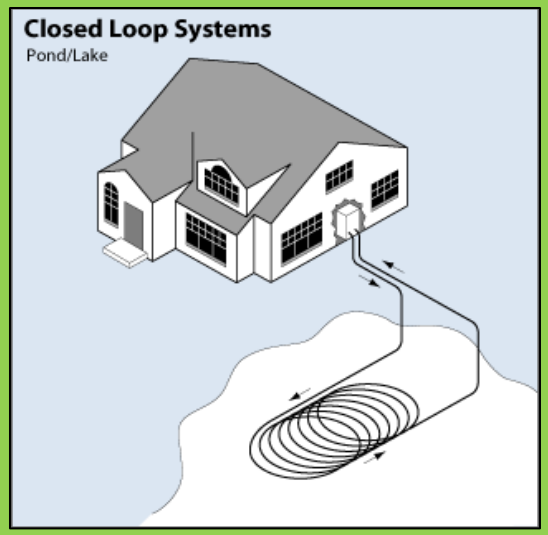


Figure 1. Ground-Coupled Heat Pump (Closed-Loop GSHP)

Geothermal







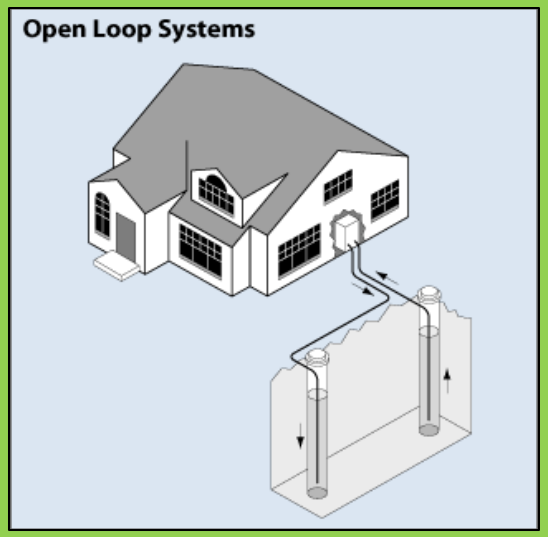


Photo Credit: US Dept. of Energy

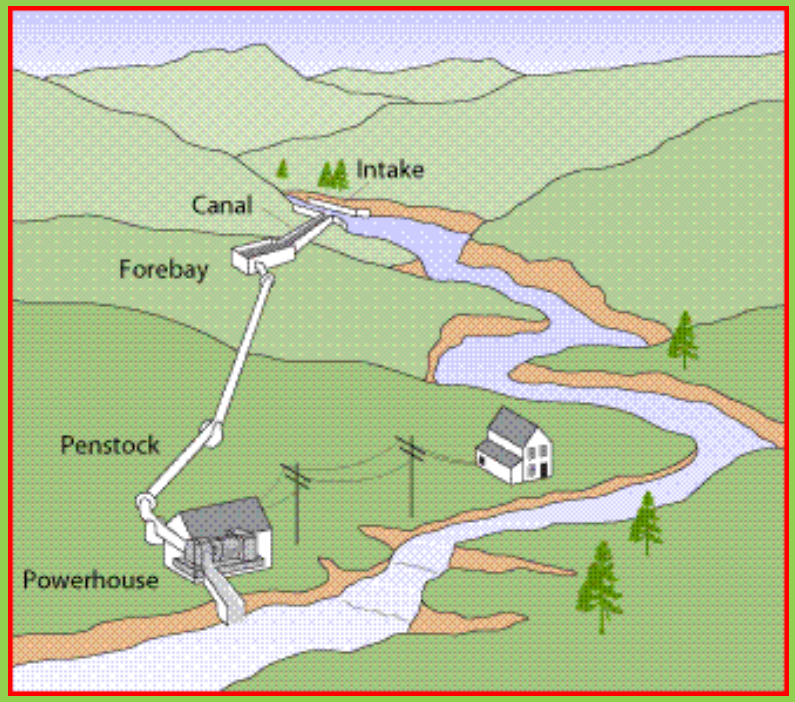
Geothermal
Things to Consider

- Quiet
- Use 25% ~ 50% less electricity than conventional heating/cooling systems
- Reduce emissions up to 40% compared to conventional heating/cooling systems
- Maintain 50% relative indoor humidity
- Can be new or retrofitted
- Piping lasts 25~50 years
- Heat pumps last 20+ years
- Underground pipes not easily accessible
- Need electricity to operate, not zero emissions~ unless combined with solar PV
- Installation requires large trench
- Toxic refrigerants

Renewable Energy Vermont

Hydro Power

- Energy in flowing water
- Run-of-the-river systems
- Water is channeled to turbine/ waterwheel
- Moving water spins a shaft
- Pumps water or powers alternator or generator



Renewable Energy Vermont

Bioenergy

Energy from plants and plant-derived materials

- Biomass
- Biofuels
- Biogas

Average Residential System Cost

	Average Size (kW or kBTU)	Average cost ($)	Average Energy Provided (kWh or kBTU/day)
Solar (Photovoltaic)	5 kW	$25,000	5200 kWh
Solar (Hot Water)	Two 4' x 8' collectors; Each collector with a capacity of 30 kBTU/day (or 8.8 kWh)	$7,000 - $10,000 installed	60-80 kBTU/day per 2-collector system
Wind	5kW 10kW	$45,000 $80,000	4,500 kWh/year 11,000 kWh/year
Geothermal	Min. 3 tons (36,000 BTUs) 10-12 (tons small residential)	Typical 1500 sq ft. house	Depends on size of residence and temperature outside
Biomass	35,000 – 200,000 Btu/hr Pellet Boilers	$15,000 - $40,000	Will heat 1,00 -4,000 square foot home of average construction

Renewable Energy Vermont

Average Non-residential System Cost

	Average Size (kW)	Average cost ($)	Average Energy Provided (kWh)
Solar (Photovoltaic)	50 kW	$190,000	51,000 kWh
Solar (Hot Water)	No Data	No Data	No Data
Wind	100 kW 750 kW	$585,000 $2,500,000	120,000 kWh/year 1,300,000 kWh/year
Geothermal	Small Scale commercial: 10-12 tons (120,000 BTUs-144,000 BTUs)		
Biomass - Pellet	200,000– 2 million Btu/hr	$50,000 - $500,000	20,000 -75,000 square foot school in Vermont climate
Biomass - Woodchips	1 million – 9 million Btu/hr	$1 million - $4 million	50,000 – 500,000 square foot school in Vermont Climate

Renewable Energy Vermont

Financing Options

Property Assessed Clean Energy (PACE)

- Special assessment on property tax
- Only in towns that have elected PACE on Town Meeting Day
- Financing energy improvements for residences
- 15% of assessed value of property or $30,000, whichever is less
- Term of assessment is a maximum of 20 years, or the average measure life of the improvements, whichever is less.

http://pacevermont.wikispaces.com/

VSECU Solar Loans

- .25% discount off current home equity loan rates
- Minimum loan amount is $5,000
- Total maximum amount is $200,000 or 90% of loan-to-value, whichever is less
- Fixed rates as low as 3.74%
- Monthly payment per $1,000 borrowed: $8.57-$18.75
- https://www.vsecu.com/loans/other-loans/solar-loans

Renewable Energy Vermont

Financing Options

Vermont Small Scale Renewable Energy Incentive Program

Solar Photovoltaic and Hot Water Incentive Amounts

Customer Type	Installer	Incentive Amount ($/Watt or 100 Btu/d))	Maximum Incentive
Residential/ Commercial & Industrial	Vermont Solar Partner	Res: $0.65/ W up to 10kW C&!: $0.60/Watt up to 60kW $1.50/100Btu/day	Residential–10kWPV;200kBtu/dSHW $10,500 2 year max C&I – 60kW PV; 1100kBtu/d SHW $52,500 2 year max
Special Customer*	Vermont Solar Partner	$2.25/W up to 10kW; $1.50 from 10kW to 60kW $3.00/100 Btu/day up to 1,500kBtu/day	PV – $97,500 SHW - $45,000 * **or** *50% of installed cost whichever is lesser
Leasing - Residential	Vermont Solar Partner	$0.65/W up to 10kW $1.50/100Btu/day up to 200kBtu/day	$6,500 –PV $3,000 -SHW
Leasing – C&I and Special Customer	Vermont Solar Partner	0.60/ W up to 60kW $1.50/100Btu/day up to 1,100 kBtu/day	$36,000 – PV $16,500 - SHW
Efficiency Adder	Vermont Solar Partner	$0.10/W PV $0.50/100Btu/day SHW	3.5kW Residential PV; 4.5 kW C&I and Special Customer PV 70kBtu/day Residential SHW; 90kBtu/day C&I and Special Customer SHW

Not shown here: Wind Incentive Amounts, Hydro Incentive Amounts

www.rerc-vt.org

Renewable Energy Vermont

Financing Options

USDA REAP Loan

- Agricultural producer or rural small business
- Loan Limits:
  - Up to 75% of project's cost
  - Maximum of $25 million, minimum of $5,000
- Maximum % Guarantee
  - 85% for loan of $600,000 or less
  - 85% for loan of $600,000 or less
  - 80% for loans greater than $600,000 but $5 million or less
  - 70% for loans greater than $5 million up to $10 million
  - 60% for loans greater than $10 millon up to $25 millon

USDA REAP Grant

- Unit of State, tribal, or local government, institutions of higher education, rural electric cooperatives, or a public power entity
- Designed to assist farmers, ranchers and small businesses
- Minimum:
  - $2,500 (system); $1,500 (efficiency); None (feasability study).
- Maximum:
  - $500,000 (system); $250,000 (efficiency); $50,000 (feasability study)

Renewable Energy Vermont

http://www.rurdev.usda.gov/ORreap.html

Financing Options

30% Residential Tax Credit

- Federal, personal tax credit
- Solar (PV & SHW), Wind, Geothermal Heat Pumps, Fuel cells using renewable fuels
- No maximum dollar amount
- Excess credit may be carried forward to next tax year
- Does not have to be principle residence
- http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US37F

For more information visit:
Database of State Incentives for Renewables and Efficiency (DSIRE)
www.dsireusa.org

Renewable Energy Vermont

How To Find an Installer:

Visit www.revermont.org

Renewable Energy Vermont

Building Our Renewable Energy Future:
Clean, Sustainable, Secure

SEARCH

Contact | eNews Sign Up | Join REV

Find | Become a Partner Installer | Technologies | Member Directory | Events | About Us | Jobs / Classifieds | REV Blog | Go Renewable

Find a Partnership Program Installer

Home > Find | Become a Partner Installer > Find a Partnership Program Installer

Reduce your energy costs and protect yourself from rising fuel prices. Going renewable with the help of a Vermont Solar and Wind Partnership Program installer is affordable and easy.

View all Solar & Wind Partner Installers

Go Renewable With a Vermont Solar & Wind Partnership Program Installer

Once you've reviewed the steps to going solar with our **Vermont Solar Consumer Guide**, and taken a look at the **Renewable Energy Atlas of Vermont** (read more below), the next step is to **find a Vermont Solar & Wind Partnership Program installer**.

The Purpose of the Vermont Solar & Wind Partnership Program is to:

1. Provide a benchmark of installation quality and experience for the solar and wind installation industry and its customers.
2. Provide a gateway to the Vermont Small Scale Renewable Energy Incentive Program.

Partner Search

» All REV Partners

SEARCH

SEARCH

Featured Members

Sunward

Biocardel Vermont LLC

Building Energy

VELCO

Questions?

Contact REV

Julie Bellino

Operations Coordinator

(802) 229-0099

julie@revermont.org

Mailing Address:

P.O. Box 1036

Montpelier, VT 05601