

# Solar Ready and Passive Solar in Minnesota

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Stacy Miller and  
Rachel Wagner

Wagner Zaun  
ARCHITECTURE



division of  
**energy**  
resources  
Minnesota Department of Commerce

# Overview

- Solar energy options
- Solar ready design principles
- Passive solar design principles
- Resources

# MN Department of Commerce

- Division of Energy Resources
  - State Energy Office
- Providing sound information for 35+ years on:
  - Energy conservation
  - Energy efficiency
  - Renewable technologies



# Expected life of a building

When you design or build a home, how long will it last?

- 10 years?
- 100 years?
- Longer?

2023

2113

2200

# A lot can happen in 100 years!



# What does the next 100 years hold?

- Information technology
- Increasing fuel costs
- Electric vehicles
- More Solar!



# Is solar the next big thing?"



Date: March 22, 1994

Received  
ENERGY UNIT  
MAR 23 1994

To: Executive Directors  
Community Action Agencies

## Re: Electronic Mail (eMail) - A Brief Overview

Recently I have received a number of inquiries into this thing called "eMail." Attached you will find a brief overview of what "eMail" is and what added functionality it can provide to an organization(s). After reviewing the materials please feel free to contact me with any questions.



# Solar Adds Value

- A builder can add value by:
  - Building energy efficient homes that save \$\$ for decades
  - Considering environmental impacts
  - Anticipating future technology options and plan for them today!



# Solar Electricity (Photovoltaics or PV)



Photo Credit: Dennis Schroeder

# Solar Hot Water



Photo credit: Solar Skies

# Solar Air Heat



Photo credit: Rural Renewable Energy Alliance

# Passive Solar Design



Photo credit: Rachel Wagner

# Solar Resource

Solar resource varies by:

- Time of day
- Season
- Local Weather
- **Local Landscape**



Slide credit: Eric Buchanan, UM Morris

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# Solar Resource

## Is There Shading?

- Are there onsite obstructions
- Shading from adjacent land?
- A resource assessment quantifies the current solar resource profile



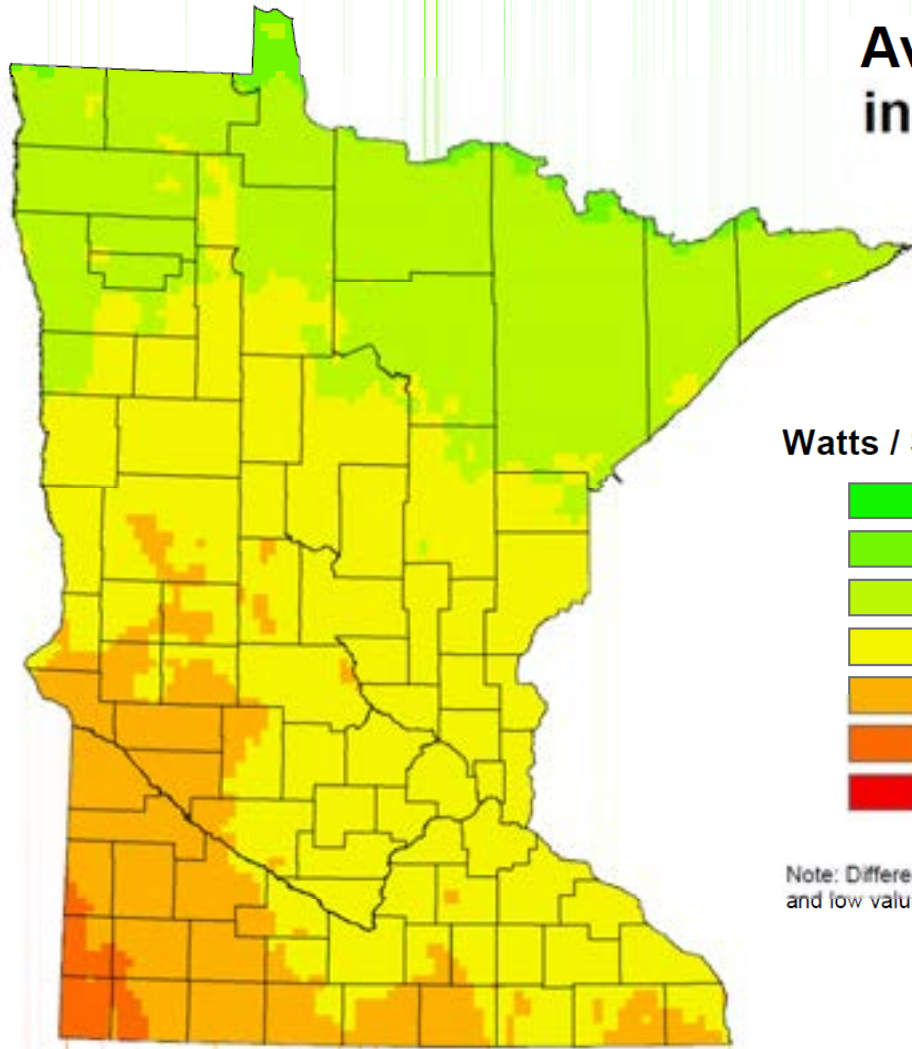
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# Solar Resource in Minnesota

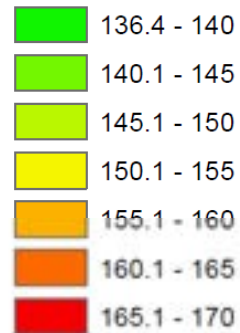
- Solar is a resource for both urban and rural applications
- The resource varies seasonally by a factor of ~2
- There is <15% difference in solar resource statewide

# Solar Resource in Minnesota

## Average Solar Radiation in Minnesota, 1998-2002



### Watts / Square Meter



Note: Differences between high  
and low values are roughly 15%.



# Potential Solar Game Changers

- Electric Vehicles
- Energy Storage
- Falling price of solar
- Rising conventional fuel costs
- Third party ownership

# Solar Electricity in MN

Today...

- 1,100 installations = 13,000 kW
- 70% residential: 15% of capacity
- 30% commercial: 85% of capacity



Photo Credit:  
Westwood Renewables



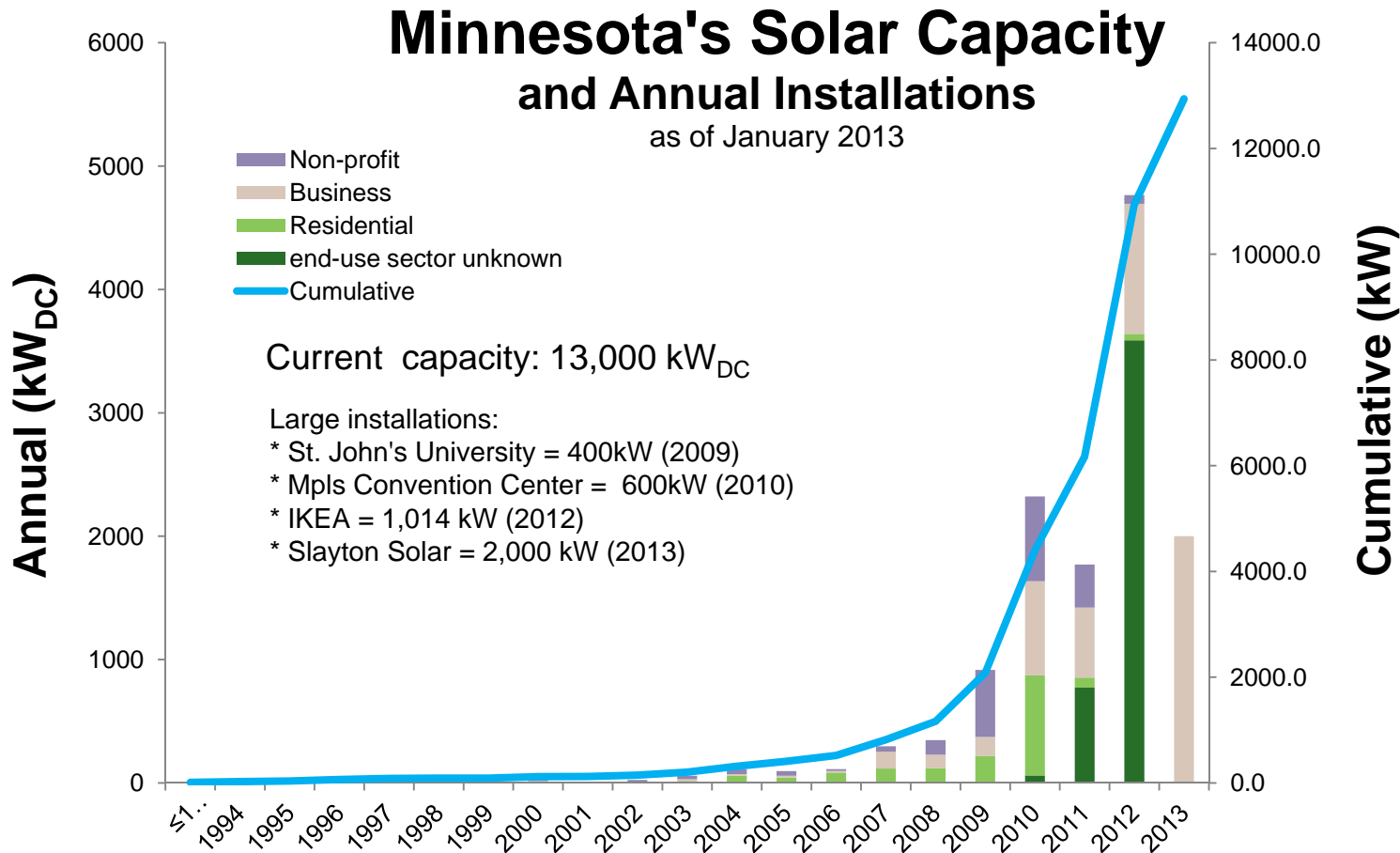
# Solar Electricity in MN

- 13 Megawatts
- 1,100 systems
- 70% residential



Photo Credit: Powerfully Green

# Solar Electricity in MN



# Solar Electricity in MN

## Minneapolis Convention Center

- 600 kW capacity
- 3rd largest PV installation
- City of Minneapolis
- Xcel RDF Fund
- Developer:
  - Best Power Int'l



21  
Photo Credit: City of Minneapolis



# Solar Electricity in MN

## Cherokee Park United Church

- 21 kilowatts
- St. Paul, MN



Photo Credit: SunDial Solar; Silicon Energy

# Electric Vehicle Readiness

- 40 Amp service
- 240 Volt outlet
- Conduit and wiring to the parking area



Photo Credit: [www.dailycamera.com/boulder-county-news](http://www.dailycamera.com/boulder-county-news)

# Electric Vehicle Readiness

- US Dept. of Energy
- **Plug-In Electric Vehicle Handbook for Electrical Contractors**



Photo Credit: MN Dept. of Natural Resources



# Solar Electricity in MN

- Most versatile end use
- Utility incentives widely available



# Solar Water Heating

- Fewer utility incentives
- Small market in MN
- 1897: 1/3 of homes in Pasadena had Solar Water Heating
- 1941: SWH in 1/2 the homes in FL



Photo Credit: Solar Skies



# Solar Water Heating



Photo Credit: Powerfully Green

# Solar Water Heating



Photo credit: Applied Energy Innovations

# Solar Water Heating w/ Space Heat Tie-in



Photo Credit: Conservation Technologies

# Solar Water Heating

- Most efficient
- Most shade tolerant



Photo credit: Solar Skies



Photo credit: Energy Concepts



# Solar Air Heat



Photo credit: Rural Renewable Energy Alliance

# Solar Air Heat

- Least expensive
- Simple to install
- Easy to maintain



Photos credit: Rural Renewable Energy Alliance





# Solar Ready



# Solar Ready



Jean Cazes (jcazes@mediom.qc.ca)

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# Solar Ready-Definition

*Building design and construction that enables straightforward installation of solar energy systems after the building is constructed*

# Solar Ready Design Principles

1. Orient and Design for solar benefit
2. Plan STRUCTURE for future solar equipment
3. Plan SPACE for future solar equipment
4. Make product and location choices to accommodate future solar equipment
5. Design for minimal building energy loads!

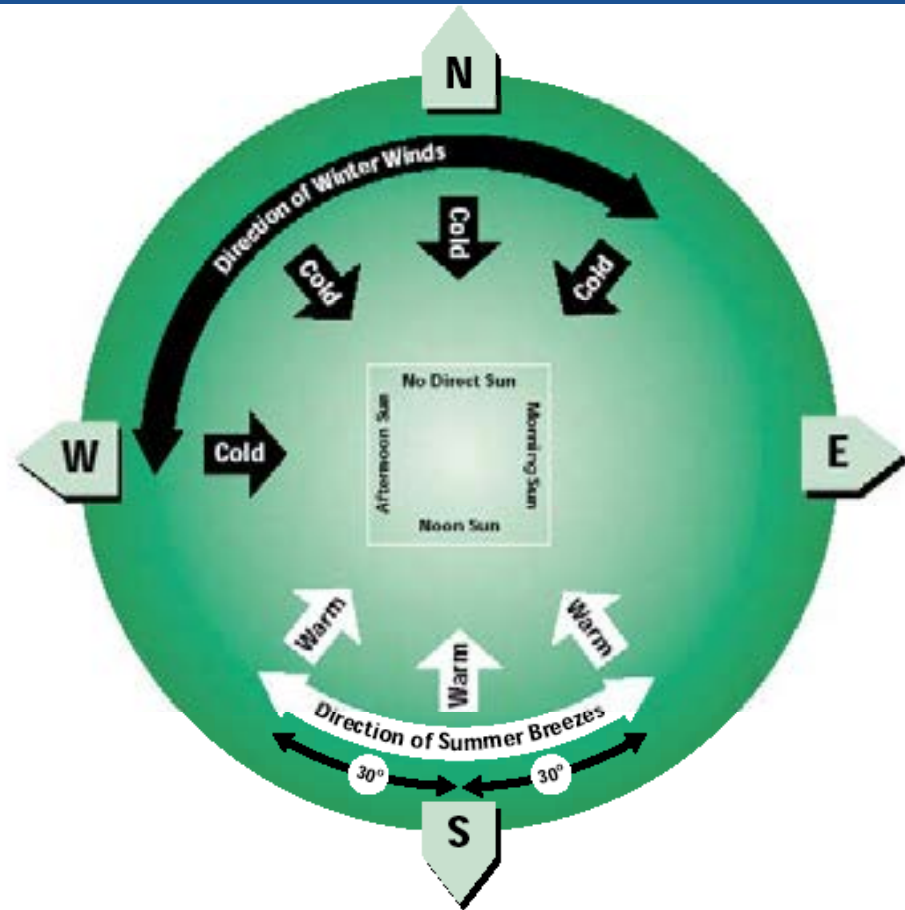
# Solar-Oriented Design

## FACTORS

- Seasons
- Spaces
- Views
- Wind
- Overhangs
- Glare
- Heat Gain
- Heat Loss
- Adjacent features

ENERinfo

[www.gov.ns.ca/natr/meb/energy.htm](http://www.gov.ns.ca/natr/meb/energy.htm)



# Solar Ready Structure

Elements that can support solar:

- Window overhangs
- Deck railings
- Walls
- Roofs



Photo courtesy Mike LeBeau, Conservation Technologies

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# Solar Ready Roof

*Allowable load calculated by an engineer*

- A single plane facing south

# Solar Ready Roof

*Allowable load calculated by an engineer*

- A single plane facing south
- A steep pitch to shed snow and capture sunlight
  - Latitude or rule of thumb 10:12 – 12:12



# Solar Ready Roof

*Allowable load calculated by an engineer*

- A single plane facing south
- A steep pitch to shed snow and capture sunlight
  - Latitude or rule of thumb 10:12 – 12:12
- No roof vents, dormers, chimneys or obstructions that will shade the array

# Solar Ready Roof

*Allowable load calculated by an engineer*

- A single plane facing south
- A steep pitch to shed snow and capture sunlight
  - Latitude or rule of thumb 10:12 – 12:12
- No roof vents, dormers, chimneys or obstructions that will shade the array
- Unshaded by trees or nearby buildings
  - Minimum 60' clear to anything 20' taller than roof

# Solar Ready Mechanical Room

## Leave Space for SWH Equipment

- Mechanical room (min. 100 ft<sup>2</sup>)
- SWH tanks can be quite large
  - 30" – 48" in diameter
  - 48" – 90" tall



# Solar Ready Space

## Chases

- Solar hot water needs space for insulated piping
- Create a path from mechanical space to attic for Solar Hot Water
- Have access to the space for later work

# Solar Ready Space

## Electrical for solar electric

- PV: run  $\frac{3}{4}$ " flexible conduit from attic to terminate near electrical panel
- 2" diam. sleeve through the wall or rim
- Access to electrical panel



Photo credit: Silicon Energy and Blue Horizon

# Solar Ready Equipment

## Plumbing

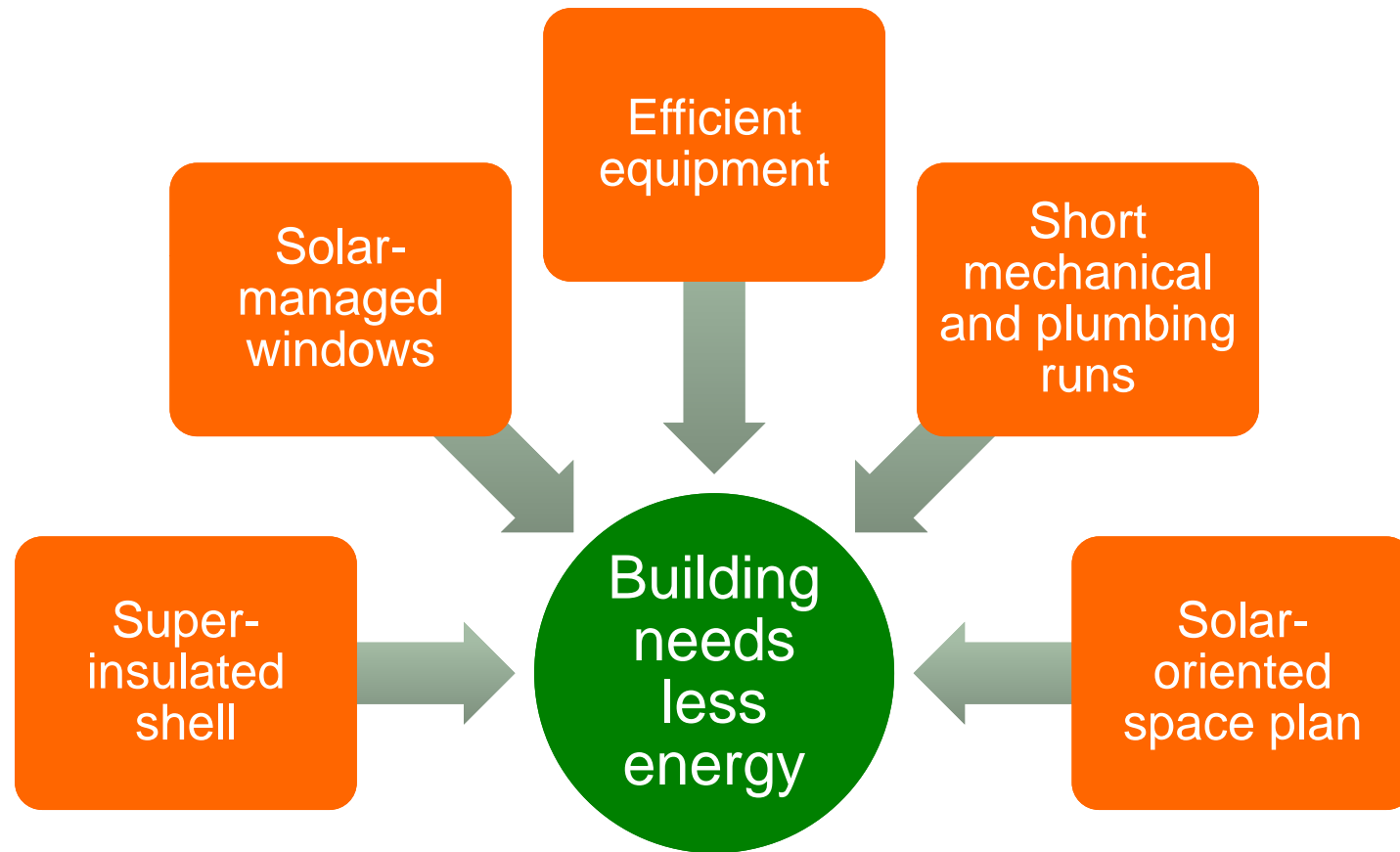
- There are solar-ready water heaters
- “Solar control module” kit
  - an add-on for a tank water heater
- Plan for building penetrations

# Solar Ready Equipment

## Heating

- Hydronic systems are most adaptable
- Boiler can accommodate solar hot water

# Design for low energy loads





# Passive Solar Design



Building form, space plan and construction methods let the sun contribute desired heat, light, and ventilation.

Uses no equipment; very cost effective

# Face it south--or nearly so



Photo credit: Rachel Wagner

**Orient within 30 degrees of south**

## **Considerations:**

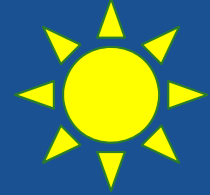
Site constraints

Building  
constraints

Geometric  
constraints

Existing  
obstacles

# Passive Solar Design Principles



- South-facing building facade, within 30 degrees
- Solar-oriented space planning
- Design for super insulated shell
- Window shading & cross ventilation
- Proper window glazing selection
- Design for daylight

# Solar-oriented space planning

- Morning spaces east/southeast
- Daytime spaces south
- Evening spaces west
- Utility spaces north
- Open plan



# Solar-oriented space planning



- Favor open floor plan with living areas to the south
- Allow heat to circulate throughout the living areas

# Windows are the Key to Comfort



- Limited direct sun in summer months
- Ample direct sun in winter months
- Roof overhangs = shading

# Solar-designed overhangs

OVERHANGS allow south windows to admit lower altitude winter sun while shading higher summer sun

Know your solar altitude

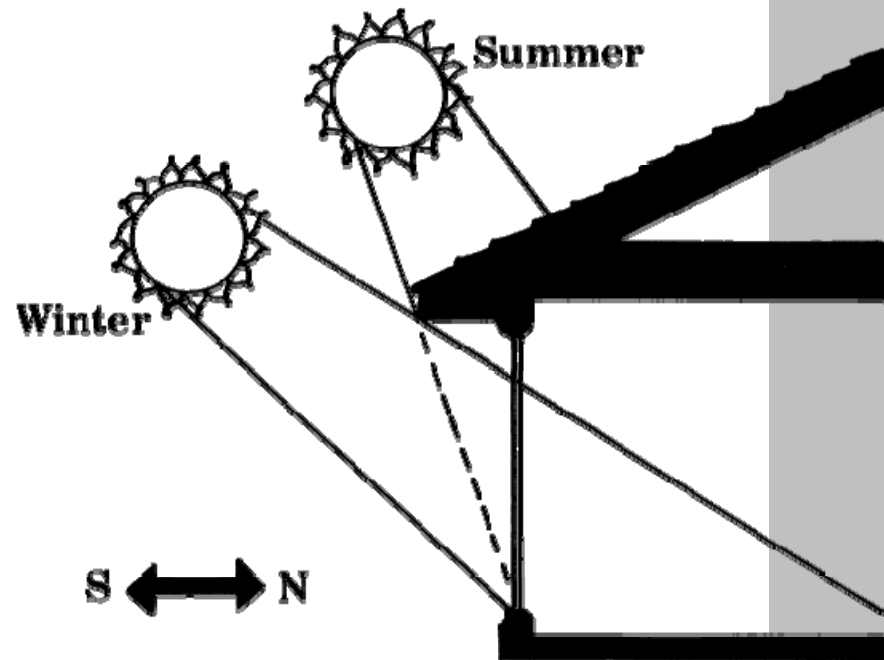
[www.esrl.noaa.gov/gmd/grad/solcalc/](http://www.esrl.noaa.gov/gmd/grad/solcalc/)

Solar altitude in Duluth:

Dec. 21 = 19.5 degrees

Jan. 21 = 23

June 21 = 66.5



<http://www.nesea.org/buildings/passive.html>

# Solar-designed overhangs



Many options:

- Integral Roof Overhangs
- Trellis or pergola elements
- Sun-shades (awnings)
- Decks



# Window glazing for solar gain

- Calculated south facing glass: usually 9-12% of floor area
- High SHGC  $> 0.4$
- Low U-value  $< 0.3$
- Usually, in our climate, triple pane glazing
- Be careful with west-facing glass



# Light and comfort from the sun



Designed for natural daylight  
Reduced use of artificial lighting

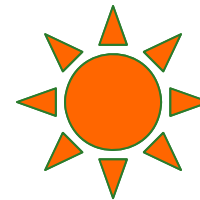
Proper shading & cross ventilation eliminate need for AC

# Solar-Integrated Design



Brought to you (in this house) by the SUN:  
Space Heat....Light....Ventilation....Electricity....Hot Water

Using what the SUN can provide



# Solar Manufacturing in MN

- Rural Renewable Energy Alliance, Pine River
- Solar Skies, Alexandria
- tenKsolar, Bloomington
- Silicon Energy, Mountain Iron
- SolarPod, Eagan
- And others (3M, Silent Power, Back Up Power Systems, Despatch, Northfield Automation, Cardinal Glass, etc...)

# MN Solar Ready Resources

## 1. Solar Ready Building Design Guidelines

[mn.gov/commerce/energy/images/Solar-Ready-Building.pdf](http://mn.gov/commerce/energy/images/Solar-Ready-Building.pdf)

## 2. Solar Ready Construction Specification Report

[mn.gov/commerce/energy/images/Solar-Ready-Construction.pdf](http://mn.gov/commerce/energy/images/Solar-Ready-Construction.pdf)



# Solar Ready Resources from ENERGY STAR

1. ENERGY STAR Solar Ready Photovoltaic (PV) Specification
2. Solar Water Heating (SWH) Specification

# Questions?



Stacy Miller

(651) 282-5091

Rachel Wagner

(218) 733-0690

Wagner Zaun  
ARCHITECTURE 

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