# SOLAR ENERGY FOR A MINNESOTA HOMEOWNER

By: Peter Hamel Advisors: Dr. Thoms and Dr. Storlien Course: Senior Thesis 395

## Introduction

Continual improvements in solar energy technologies have resulted in a growing interest to invest in such systems. As the interest in solar energy grows more and more people must choose a system that fits their needs and goals, which can be quite a difficult and confusing process. This project attempts to provide a complete analysis of several different types of solar energy systems and present the information in a consumer guide that simplifies this process. Comparisons between each type of solar energy system were made based on efficiency, cost, durability, practicality, and maintenance. Solar thermal proved to be the most efficient systems while photovoltaic panels tended to be less expensive.

Research Question: **What is the best solar energy system for a homeowner in Minnesota to invest in?**

## Methods

In order to determine the best solar energy system for a Minnesota homeowner to invest in I needed to become familiar with the mechanics of each system and how they operated. Understanding the operations of photovoltaic cells required a lot of scientific research about the properties of radiant energy and how it interacts with various semiconductors. Understanding the operations of solar thermal systems required further research about conduction and how these systems transfer heat energy.

The second and most important part of research involved an analytical comparison between each system. For this section I had to research the cost, durability, efficiency, and practicality of each system along with the amount of maintenance they required. Once this data was gathered I was able to come up with some advantages and disadvantages offered by each system and display them in a simple chart.

## Conclusion

Generally speaking the larger the investment the greater the system's efficiency will be. The cost and efficiency of a system are very important to consider when investing in solar energy. However these should not be the only considerations for a home owner in Minnesota. The local climate, cost of maintenance, and longevity of the system should also be considered. When I consider all of these factors at once there is not a single system that stands out as being the overall best system for homeowners in Minnesota.

## Photovoltaic Panels

Picture of the waffled monocrystalline solar panel.

Picture of the squared polycrystalline solar panel.

## Solar Thermal Systems

Picture of an evacuated tube solar thermal system.

Picture of a flat plate solar thermal system.

## Passive Solar Designs

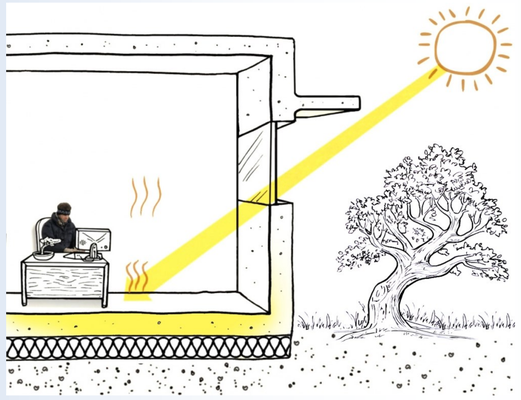

Illustration of a direct gain passive solar design.

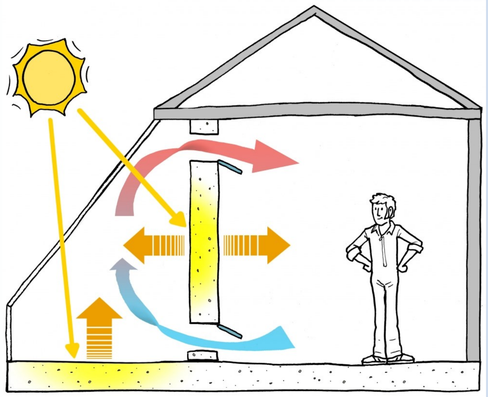

Illustration of an indirect passive solar design.

### Monocrystalline Cells:

- Extremely pure silicon results in a highly efficient system.
- These cells last longer and have warranties up to 25 years.
- Finally these cells perform better in low-light conditions making them a good fit for Minnesota weather.

### Polycrystalline Cells:

- Lower grade silicon results in a much lower upfront cost.
- These cells have a lower heat tolerance making them ideal for the longer cold season in Minnesota.
- Production process results in much less waste compared to monocrystalline panels.

### Evacuated Tube Thermal System:

- Cylindrical tubes collect light throughout the entire day.
- Tubes are well insulated and extremely efficient.
- These systems are light in weight and extremely easy to install.

### Flat Plate Thermal Systems:

- The flat plate feature of this panel increases the surface area for heat absorption.
- Highly resistant to temperature, which means that it will perform well in Minnesota's hot summers and cold winters.
- Although this system is not the most efficient thermal system, it is significantly cheaper than other thermal designs.

### Direct Passive Solar Gain:

- These designs can be extremely efficient utilizing up to 75% of the radiant energy striking the window.
- One downfall is that these designs are not very aesthetically pleasing.

### Indirect Passive Solar Gain:

- These designs are also very efficient and can utilize up to 45% of the radiant energy striking the thermal mass structure.
- Depending on the structure these designs can cost more.

### General:

- Passive solar designs work really well in cooler climates, which is good for Minnesota winters.
- One disadvantage is that these designs often require some sort of remodeling, which can be expensive.