Subterranean Heat Storage for Greenhouses
The Invermere Experience

“In our every deliberation we must consider the impact of our decisions on the next seven generations”

The Great Law of the Iroquois Confederacy

Presented by

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Groundswell
Invermere, B.C.
Introduction

Why did we build a Subterranean Heat Storage (SHS) greenhouse?

What is a SHS greenhouse?

SHS greenhouse designs

Annualized Geo-Solar heating design

Greenhouse construction

Monitoring results

Our community support

What's next?
Why did we build a Subterranean Heat Storage (SHS) Greenhouse?
Why did we build a Subterranean Heat Storage (SHS) Greenhouse?

Global Warming

Why did we build a Subterranean Heat Storage (SHS) Greenhouse?

Food Security - Healthy Food
Why did we build a Subterranean Heat Storage (SHS) Greenhouse?

Peak Oil
What is a SHS greenhouse?

- Doesn’t use fossil fuels for heating or cooling
- Focuses on storing excess unwanted heat gain
- Uses the subterranean mass for that heat storage
- Glazing oriented to capture winter sun for heating
- All non-south-facing walls are insulated
- Designed to minimize summer heat gain
- Uses passive methods to exhaust excess heat
What is a SHS greenhouse?

Heat Storage Strategies

Passive Heat Storage
• Radiant solar heat transferred to internal mass
• Heat re-radiates into greenhouse during cooler periods
• Inefficient method of heat transfer

Active Heat Storage
• Solar heated air or water used as heat transfer medium
• Heat transfer medium actively distributed through pipes or ducts
• Pipes or ducts placed in the soil below greenhouse
• Heat is then conducted to the surrounding soil
• More efficient storage and transfer method
Our Key Design Considerations

- Partner with school board
- Grow people first
- Grow healthy organic food
- Encourage community involvement
- Demonstrate alternative energy strategies
- Demonstrate rainwater harvesting
- Demonstrate composting
- Fully accessible facility
- Multi-function facility
SHS greenhouse designs

The Victorian Greenhouse
SHS greenhouse designs

The Bubble Greenhouse

[Diagram of the Bubble Greenhouse design, showing typical cross-section of the greenhouse with annotations for different components and processes, such as north roof, south roof, liquid cooling, etc.]
SHS greenhouse designs

The Underground Greenhouse
SHS greenhouse designs

The Solar Cold Climate Greenhouse
SHS greenhouse designs

The Subterranean Heating & Cooling Greenhouse

The Subterranean Heating & Cooling System
SHS greenhouse designs

Annualized Geo-Solar

AGS GREENHOUSE
Annualized Geo-Solar heating design

AGS benefits

- Captures excess greenhouse heat
- Stores more excess heat for cooler periods
- Concrete floors: ease of cleaning
  - fully accessible
  - water recapture
- Demonstrate alternative energy strategies
- Demonstrate rainwater harvesting
- Low cost distribution and storage system
- Low maintenance systems
Greenhouse Construction
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## Monitoring Results

### Average soil temperatures 4 ft below slab

<table>
<thead>
<tr>
<th>Month</th>
<th>Temperature</th>
</tr>
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<tbody>
<tr>
<td>July 2009</td>
<td>13°C</td>
</tr>
<tr>
<td>September 2009</td>
<td>25°C</td>
</tr>
<tr>
<td>January 2010</td>
<td>4°C</td>
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<tr>
<td>September 2010</td>
<td>27°C</td>
</tr>
<tr>
<td>January 2011</td>
<td>6°C</td>
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</tbody>
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### Average soil temperatures 1 ft below slab

<table>
<thead>
<tr>
<th>Month</th>
<th>Temperature</th>
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</thead>
<tbody>
<tr>
<td>July 2009</td>
<td>20°C</td>
</tr>
<tr>
<td>September 2009</td>
<td>29°C</td>
</tr>
<tr>
<td>January 2010</td>
<td>2°C</td>
</tr>
<tr>
<td>September 2010</td>
<td>30°C</td>
</tr>
<tr>
<td>January 2011</td>
<td>4°C</td>
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</tbody>
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### Indoor temps

<table>
<thead>
<tr>
<th>Month</th>
<th>Lows</th>
<th>Highs</th>
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<tbody>
<tr>
<td>July 2009</td>
<td>7°C</td>
<td>29°C</td>
</tr>
<tr>
<td>September 2009</td>
<td>10°C</td>
<td>63°C</td>
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<tr>
<td>January 2010</td>
<td>-12°C</td>
<td>22°C</td>
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<tr>
<td>September 2010</td>
<td>8°C</td>
<td>42°C</td>
</tr>
<tr>
<td>January 2011</td>
<td>-9°C</td>
<td>25°C</td>
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Our Community Support

Google “Invermere Community Greenhouse”

Partnered with SD6 on the project
Almost 300 individuals and businesses helped
Students participated in all phases of the project
K-12 schools use greenhouse to teach horticulture
COTR runs sustainable courses through greenhouse
First Horticulture 101 course to start this year
What’s Next

Greenhouse Improvements

- Seal up exterior glazing envelope
- Build more beds in contact with slab/soil
- Add internal retractable shade cloth system
- Add internal retractable insulation blanket
What’s Next

What we would do different

- Create a more airtight envelope
- Orient glazing to be perpendicular to winter sun
- Insulate side walls
- Build it for half the cost
What’s Next

Resources

www.greenershelter.org
www.sunnyjohn.com (Solar Greenhouses)
www.gardengoddessenterprises.com
Google - Groundswell