

Thermal / Shade Curtains



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extension
Learning for life

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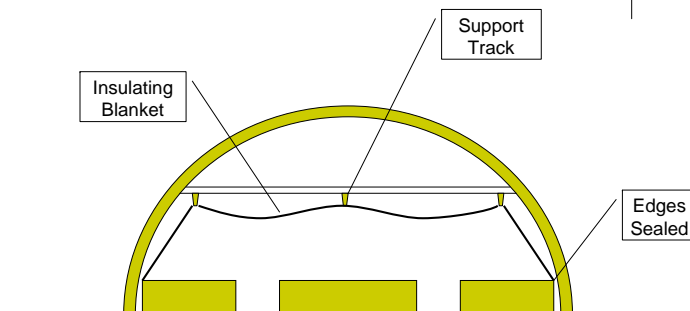
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- Likewise, a lack of mention does not imply that a product is not recommended.
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What are Energy Curtains?



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Thermal / Shade Curtains

- Thermal curtains
 - 80% of greenhouse heating at night
 - Reduces night heating up to 50%
 - Double poly w/ internal thermal blanket
 - 0.4 Btu/hr-F-ft² versus 0.7 Btu/hr-F-ft²
 - Double as summer shade system
- Shade curtains
 - Aluminized shades – 10°F lower air temperatures
 - Internal Shade cloth can be as thermal curtain
- Costs: \$2 to \$4.00 per sq. ft.
- Automated curtains for large greenhouses
- Manual open curtains for hoop houses - Lower cost?

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Potential Energy Savings



- Assumptions
 - 30 x 120 gutter connected 6 bay greenhouse (21,600 sq.ft.)
 - w/ std double poly film
 - Propane cost - \$1.50/ gallon
 - Feb to June growing season, Madison, WI
 - ~ \$20,590 / year

- Thermal curtain
 - 100% roof covered – 52% energy savings
 - ~ \$ 13,435 / year
 - Savings - \$7155 / year (35%)

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Potential Energy Savings



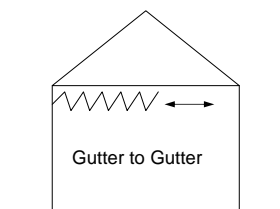
- Assumptions
 - 30 x 96 free standing greenhouse
 - w/ std double poly film
 - Propane cost - \$1.50/ gallon
 - Feb to June growing season, Madison, WI
 - ~ \$3120 / year

- Thermal curtain
 - 90% roof covered & 50% gable ends – 52% energy savings
 - ~ \$ 2130 / year
 - Savings - \$ 1000 / year (32%)

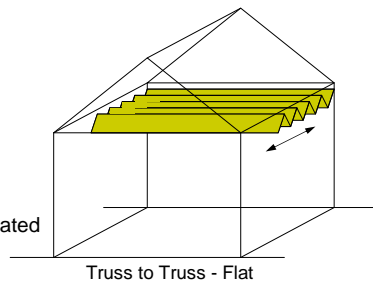
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Types of Curtain Systems



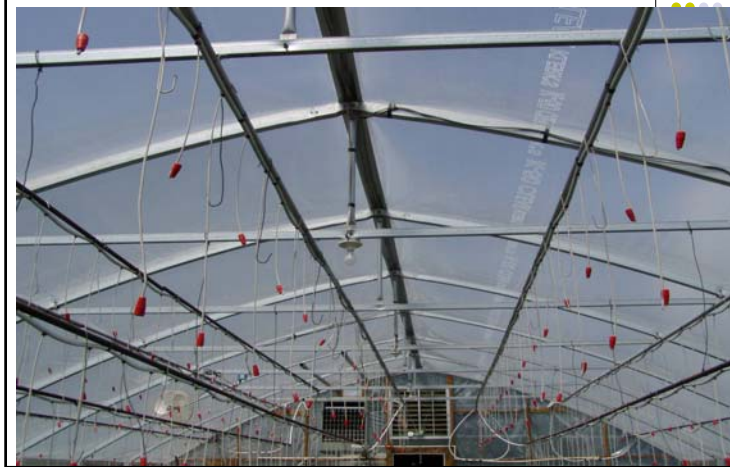
- Curtain at bottom of truss
- Reduces volume of air to be heated
- Lower cost installation



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Issues with curtain installations?



Curtain Installation Issues



- Plants hanging from rafters
- Irrigation hanging from rafters
- LOTS of Things hanging from rafters
- Heating pipes
- Poly tubes
- Heaters – Location & heat distribution

- Gable or roof vents or open roof systems
 - Fully drawn curtain will restrict summer air flow
 - Use porous curtain material

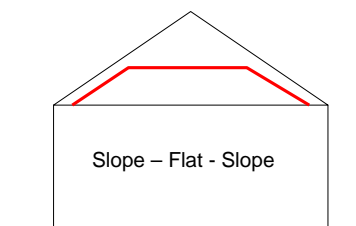
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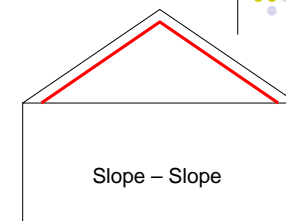
Types of Curtain Systems Truss to Truss



- Follows roof profile part way
- Allow curtain to be installed without moving equipment



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- Follows roof profile
- Minimizes cold air trapped above curtain

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Thermal / Shade Materials

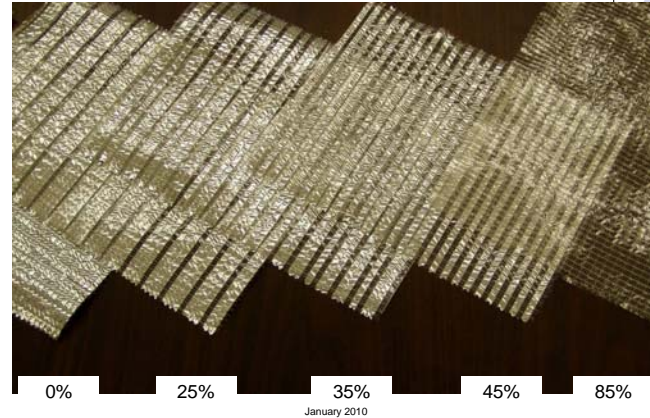
- Non-porous material
 - Highest heat retention
 - Impervious to water and air movement
 - Can fail if water collects on top of curtain
- Semi-porous materials (preferred)
 - Allows moisture to migrate
 - High heat retention – 50 to 75%
- Porous curtains
 - Allows condensate and rain leakage to drain
 - Lower heat retention than nonporous materials – 20 to 30%
- Shade in summer / heat retention
 - Higher shading factor = Higher heat retention
- Curtain life: 8 to 12 years

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Curtain Materials – Semi porous

Aluminized and clear polyethylene woven fabric



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Shading Material Comparison

Type of Screen	Ave Light Transmission(%)	Energy Savings at night (%)
Semi-Porous fabrics	Shading/energy-saving	
XLS 14	55	52
XLS 15	45	57
XLS 16	35	62
XLS 17	25	67
XLS Obscura	< 0.1	75
Porous Construction -	Shading / Ventilation	
XLS 14 F	58	20
XLS 15 F	49	20
XLS 16 F	38	25
XLS 17 F	27	30
Aluminet R -50%	50	20
Aluminet R -70%	30	50

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Which shade factor to choose?

- Heat of summer maximum sunlight (June, July)
 - 10,000 foot-candles
- Most bedding and flowering plants can tolerate 4000 to 5000 foot-candles of light
- Greenhouse glazing light transmission
 - Glass ~ 90%
 - Double Poly ~ 80%
- 10,000 fc x 80% x 55% LT = 4400 foot-candles
 - 45% shading/ 55% light transmission recommended (52% energy savings)

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Other Material parameters

- Flammability
- Roll up, bunch or folding
- Day length control (blackout)

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Curtain Support Systems

- Slide on cables
 - Monofilament line
- Suspended from cables
 - Monofilament line
 - Stainless Steel cables



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Opening Devices

- Motorized
 - Automated opening and closing
- Hand Crank
 - Reduced cost
 - Daily Task
- Hand Pull
 - Low cost for hobby greenhouses
 - Grasp leading edge and pull/push

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Motorized Curtain Opening Cable Drive

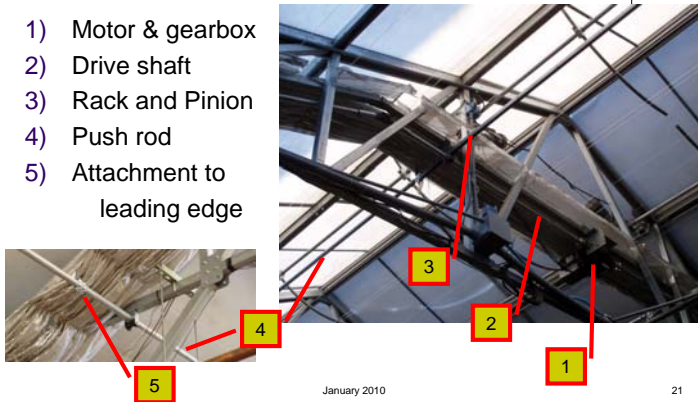


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Motorized Curtain Opening Push Rod Type

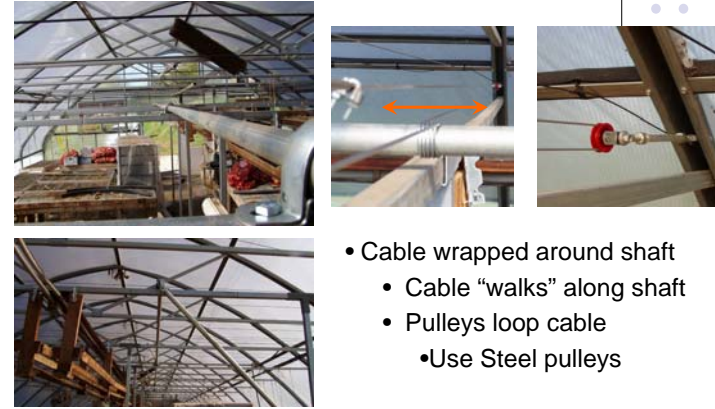
- 1) Motor & gearbox
- 2) Drive shaft
- 3) Rack and Pinion
- 4) Push rod
- 5) Attachment to leading edge



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Hand Crank Opening Device



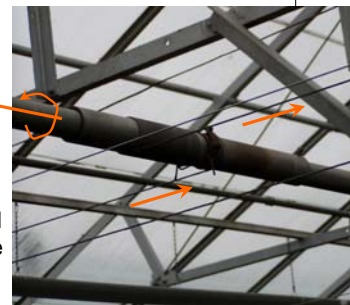
- Cable wrapped around shaft
 - Cable “walks” along shaft
 - Pulleys loop cable
 - Use Steel pulleys

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Cable Winch Drive

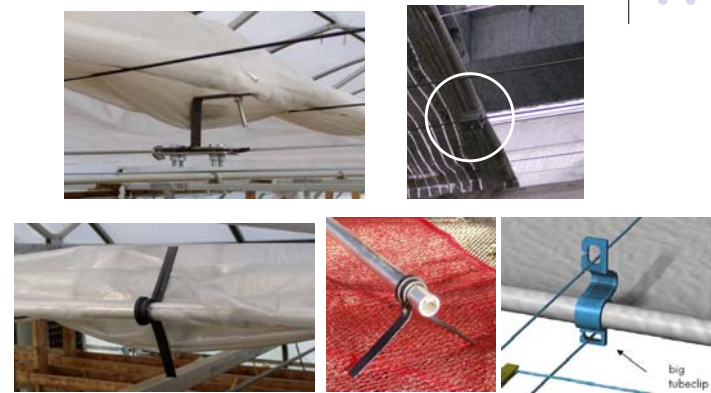
- Spool on / spool off
 - Cable wraps equal curtain travel distance
 - End of cable clamped to drive shaft
 - Cable wrapping up on one side of the spool and unwrapping on other side
 - Larger diameter shaft equals smaller translational distance



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Attaching curtain to opener



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Edge Seals

- “Air tight” from convection / infiltration

Support wires

Fixed Edge

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Edge Seals

- Weighed edge lays on top of curtain

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Support lines and cables

- Additional purlin
 - Anchor for support lines
 - Anchor for drive cables
- Sliding curtain
 - Monofilament line
 - Spacing 12-16 inches
- Suspended Curtain
 - Stainless steel cable
 - Spacing 18 to 48”

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Edge Seals

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Corners – End of Gutter

- “Plug” the end of the gutter
- Staple a piece of cloth in end of gutter
- Ensure curtain seal



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Sealing Truss Sections



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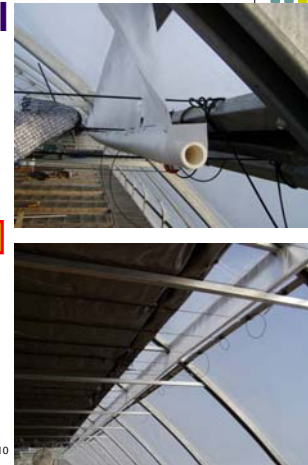
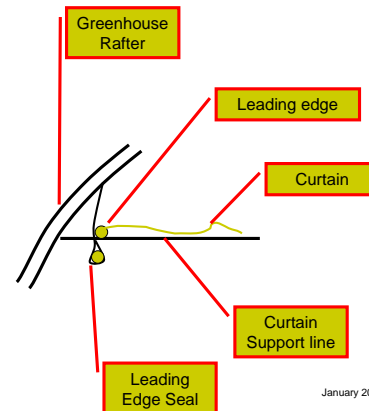
Leading Edge Seal



Support wires

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Leading Edge Seal



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Controllers



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Curtain Management

- Maintain seals
- Leaks – chill plants under leak
- Opening
 - Allow air above curtain to warm up before opening
 - Open in stages
 - Condensation / Ice
- Leave open to melt snow

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Curtain System Costs

- Typical - \$2 - \$4 per square foot
- Variables –
 - Size
 - Type of screen material
 - Number of obstructions
- Easiest to install in
 - Gutter connected greenhouse
 - A-Frame greenhouse

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Manual Curtain Project

- Use off-the-self components
- Make in a shop with vise, welder, drill press



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Support for Hanging Things



Grower Installed Curtain



Curtain System Cost

- Freestanding Gothic greenhouse - 30 x 96
 - Commercial curtain - ~ \$7500 materials
 - Truss to Truss / Slope - Slope
 - Covers ~ 100% of roof area
 - Manual Curtain System
 - Covers bottom cord of truss – about 60% of roof
 - ~ \$ 3500 materials (cover bottom of truss – 23 ft)
 - ~ \$ 2000 for roll-up sides for 100 % roof coverage
 - ~ \$ 5500 total

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Curtain System Suppliers

- VRE Systems
 - www.vresystems.com
- Wadsworth Control Systems
 - www.wadsworthcontrols.com
- Gintec Shade Technologies
 - www.gintec-shade.com

Shade/Thermal Curtain Material

- Ludvig Svensson - www.svenssonamericas.com
- TGU Products – Fiberfil Screen
 - Distributed by United Greenhouse Systems, Edgerton, WI
 - www.unitedgreenhouse.com

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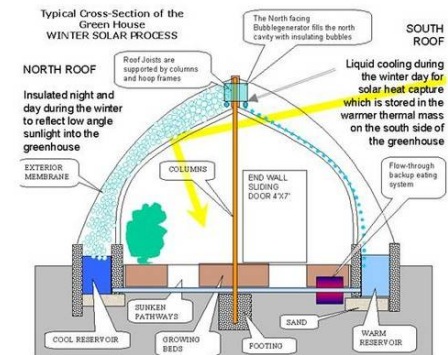
Emerging Technologies

- SunArc –
 - Injects foam between double poly films
 - 50% energy savings claim
 - Foam dissipates by itself
 - Reside washed away after sun-up
 - www.sunarc.ca/english/insulation.html

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Foam bubbles



Source: <http://www.tdc.ca/bubbleinsulation.jpg>

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Foam bubbles



Source: <http://www.tdc.ca/soapbubbles.jpg>

Video: <http://www.solarbubblebuild.com/>

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State/Utility Energy Grants

- Database of State Incentives for Renewables and Efficiency (DSIRE)
 - www.dsireusa.org
 - Grants by state
 - By Renewable Energy or Energy Efficiency
 - By Utility
 - By Residential, business, renewables
 - Federal Grants

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Wisconsin Energy Grants

- Wisconsin Focus on Energy
 - Grants for energy efficiency & renewable energy
 - Grants up to 25% of project cost
 - Utility must be participating
 - Agricultural program provides free audits
 - Unbiased advise (don't sell equipment)
 - Provide estimated energy & cost savings
 - www.focusonenergy.com
 - 1-800-762-7077

Rural Energy for America Program (REAP)

- Part of 2008 farm bill -
- Project Types
 - Renewable Energy
 - Energy Efficiency
 - Feasibility Study
- Grants
 - Cover up to 25% of project costs
 - \$ 10,000 project = \$2500 max grant
 - Grant Minimum / Maximum
 - Renewable energy - \$2500 / \$500,000
 - Energy Efficiency - \$1500 / \$250,000
 - Not for transportation or field equipment
 - Competitive grant process

Rural Energy for America Program (REAP)

- Part of 2002/2008 farm bill -
- Guaranteed Loans
 - Up to 75-85% of project costs
 - Loan Minimum / Maximum
 - \$5000 / \$25,000,000
 - Applications accepted continuously
 - Awards quarterly
 - Application period typically Jan –June
 - \$100 million available for 2010
 - For More Information
 - www.rurdev.usda.gov/rbs/farmbill/
 - www.farmenergy.org

Questions?

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