



**Passive Solar Use  
in Residential Buildings** 



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**Addressing RDN's Sustainable  
Development Guide.** 

- Checklist Items 1.1:
  - Solar orientation and access,
  - Vegetation,
  - Solar shading,
  - Natural light,
  - Thermal mass.
  
- In 45 minutes!!!

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**Solar Orientation.**

South-facing, vertical windows,  
within about +/-20° of True South  
is the best selection.

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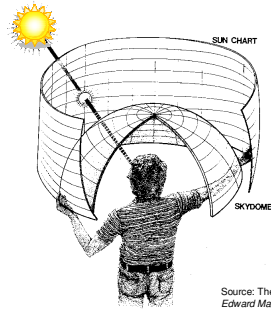
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### 'Sky Dome' Sun Path Chart.



Source: The Passive Solar Energy Book, Edward Mazria.

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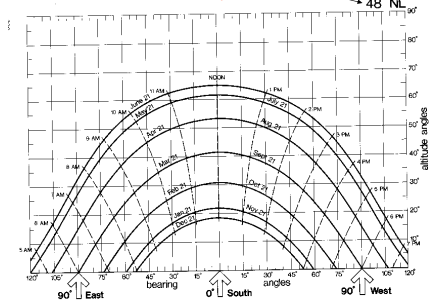
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### Typical Sun Path Chart.

For specific latitudes.



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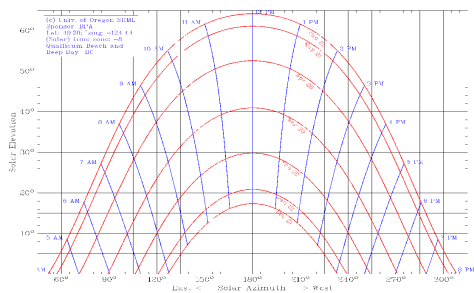
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### Local [49.35°] Sun Path Chart.



Source: University of Oregon web site.

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## BUT, which way is 'South'?

- We're talking about 'true' south, or 'solar' south.
- Use a compass, but make an adjustment.
- 'Magnetic' south [or north].
  - Difference is called Magnetic **Variation**.
  - For Nanaimo, this difference is **18.3° E\***, which is a positive value w.r.t. true north.



\* Correct as of June 18, 2011.

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## Could also use:

- GPS equipment, but it's not very accurate.
  - Usually only indicates each 45° change; i.e. SE, S, SW etc. and you must be moving.
  - OK for estimating road/driveway orientation.
- Modern smart phone with a compass app.
  - But set it for 'true' bearings first.



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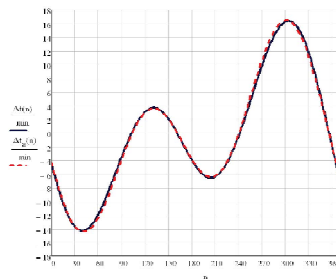
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## Or, use 'solar noon'.

- The sun is not an accurate time-keeper, but has regular, seasonal variations in its rotational speed.
- Simple data records show this variation for the 21<sup>st</sup>. Of each month.



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## Time Zone Adjustment.

- We are in the Pacific time zone, but this is set at 120° W and we are at 124.44°W
- So, the sun takes an additional 4.44 x 4 minutes to reach its zenith here – say 18 minutes.

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## Solar Noon Times at 21<sup>st</sup> day.

| Jan   | Feb   | Mar   | Apr   | May   | Jun   |
|-------|-------|-------|-------|-------|-------|
| 12:29 | 12:31 | 12:25 | 12:17 | 12:15 | 12:19 |

| Jly   | Aug   | Sep   | Oct   | Nov   | Dec   |
|-------|-------|-------|-------|-------|-------|
| 12:26 | 12:21 | 12:12 | 12:03 | 12:04 | 12:16 |

- AND, we must allow for daylight saving time too from March to October. – **add one hour to these clock data.**

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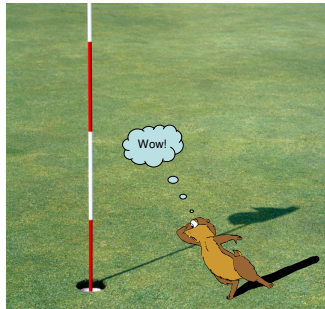
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## Plotting True South.

Place a vertical pole in the ground, in full sunlight.

At Solar Noon, simply plot the direction of its shadow to determine True South/North.



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## Solar Access.

Need to get good solar exposure between 9 am & 3 pm during the winter months [Dec. to Feb.]

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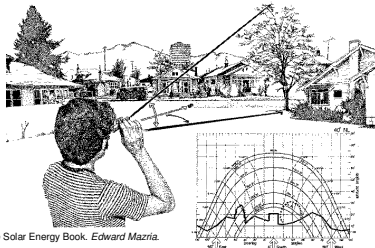
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## Obstructions to sun access

- Plotting the 'Skyline' is more difficult.
  - Requires a compass & an incline gauge.



Source: The Passive Solar Energy Book, Edward Mazria.

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## An Alternative.

- The Solar Pathfinder. <sup>TM</sup>
  - Uses a 'Polar' sun path chart.



Source: [www.solarpathfinder.com](http://www.solarpathfinder.com)

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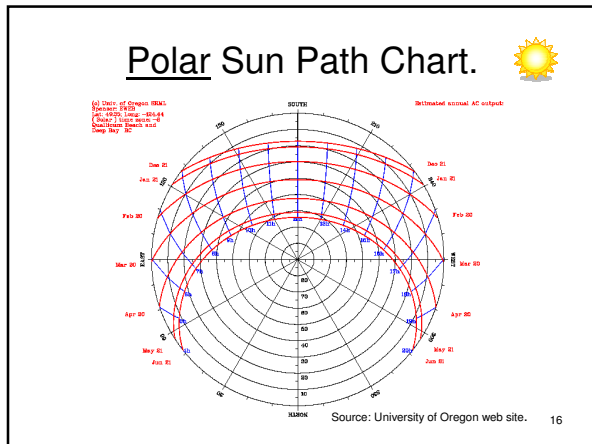
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### But, How Much and What Type of Glazing?

Too much south glazing causes over-heating, especially during the shoulder months.

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### Recommended Percentage for **South** glazing.

- CMHC recommend that regular double glazing be about 8.75% of adjacent open floor area.
- Nebraska Solar Energy recommend between 8 & 12% for energy efficient buildings.
- Higher levels require additional thermal mass to be incorporated into the structure.

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### Other Orientations.

- North, West & East windows should be kept to a reasonable, minimum size because they don't contribute to winter-time solar heating.

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### B.C. Building Code.

- Code requirements must also be met:
  - Section 9.7.1.2 requires a minimum opening window size of 0.35 m<sup>3</sup> [3.77 ft<sup>2</sup>] for fire exit from sleeping areas, with minimum measurement of 380 mm [15"] in one dimension.
  - Section 9.32 requires a minimum opening window size of 0.28 m<sup>3</sup> [3.0 ft<sup>2</sup>] in all 'finished' rooms and 0.09 m<sup>3</sup> [1.0 ft<sup>2</sup>] in bathrooms for natural ventilation.
  - with some exceptions & explanations.

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### And, what type of glazing?

| Component               | South         | East          | West          | North         | Sun Space  |
|-------------------------|---------------|---------------|---------------|---------------|------------|
| <b>Double Glazing</b>   | Yes           | Yes           | Yes           | Yes           | Yes        |
| <b>Argon gas fill</b>   | Yes           | Yes           | Yes           | Yes           | Not needed |
| <b>LowE coating</b>     | Yes<br>Single | Yes<br>Double | Yes<br>Double | Yes<br>Triple | No         |
| <b>Insulated Spacer</b> | Yes           | Yes           | Yes           | Yes           | Yes        |
| <b>Insulated Frames</b> | Yes           | Yes           | Yes           | Yes           | Yes        |

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### And, what type of window?

- Fixed – Best overall Performance.
- Operable:
  - Casement – Lowest air leakage in group.
  - Awning & Hopper – Next Best
  - Horizontal Slider – Becoming More Energy Efficient.
  - Single & Double Hung – Old Style
  - Tilt & Turn – Good, but Most Expensive.

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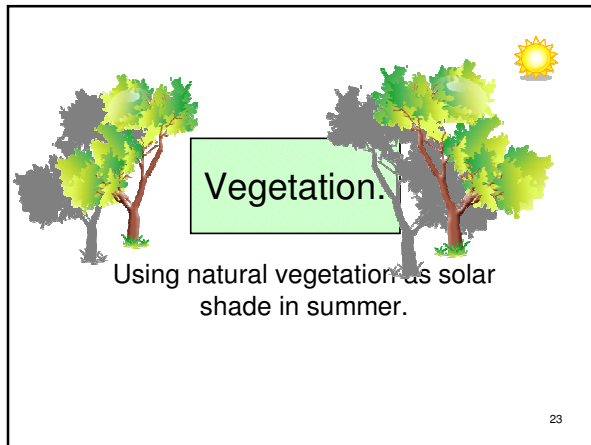
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### Basic Concept.

- Provide tall deciduous trees to the south of the property.
  - Allows solar access in winter, when leaves have fallen.
  - Provides solar shading in summer when leaves have formed.
  - Need VERY tall trees, fairly close to building.
  - Leaf formation/shedding is typically not in synchronization with heating/cooling season.

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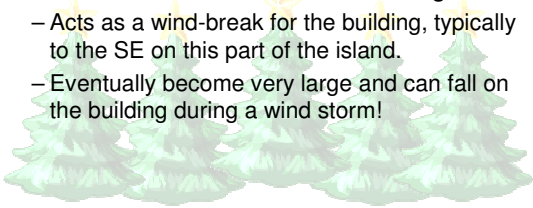
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### Additional Concept

- Provide dense, coniferous trees on the winter, windward side of the building.
  - Acts as a wind-break for the building, typically to the SE on this part of the island.
  - Eventually become very large and can fall on the building during a wind storm!



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### Shading the Windows.



The idea is to get full solar access in winter and to minimize solar heat gain in summer.

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### South Windows. External shade is best option

- Fixed Overhangs.
  - Simple but need careful design.



Full shade by early in May.

2011/04/18

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### South Windows.

External shade is best option

- Fixed Overhangs.
  - Simple but need careful design.

Window too tall.



Overhang too short.

2011/04/18

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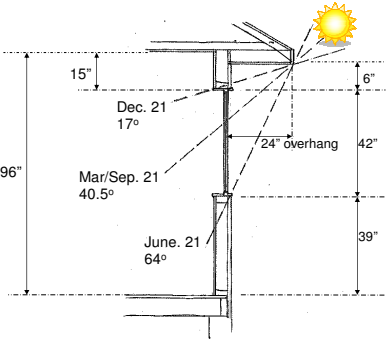
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### Typical Overhang Geometry.



These solar elevations are for Qualicum Beach.

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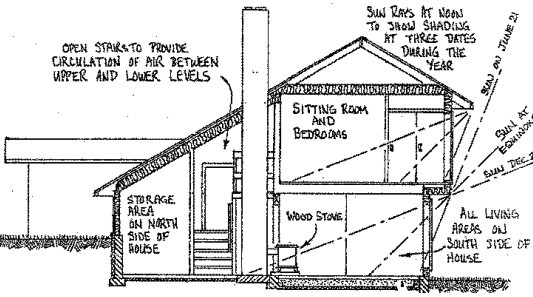
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### Two Storey Overhang Application.



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## External, South windows

- Adjustable Fabric Awnings.
  - Manual/electric operation.
  - UV deterioration.



- Roll-Shutters.
  - Manual/electric operation.
  - Maintenance.



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## South windows, again.

- Internal:
  - Adjustable, horizontal louvers are best here.



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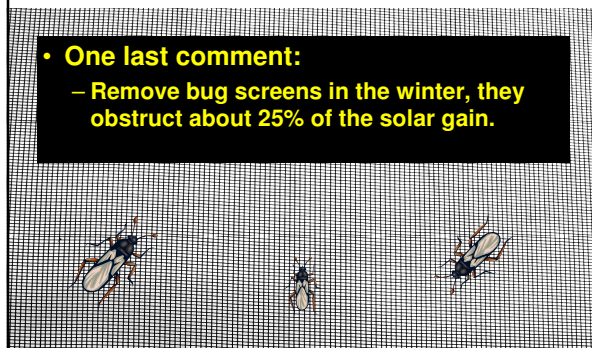
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## South windows, again.

- **One last comment:**
  - **Remove bug screens in the winter, they obstruct about 25% of the solar gain.**



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## East & West windows.

- Important to provide full shade for west in this climate.

– External is best.

– Solar shade cloth is best for internal applications.

– Or **vertical** blinds.



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## Another West Idea.

- Using a Lattice Screen:



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## Natural [Day] Lighting.

Natural [Day] Lighting.

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## Skylights



- Good for adding extra illumination, but
  - The shaft up to the skylight needs lots of additional insulation.
  - An internal screen is essential when on a south or west sloped roof.



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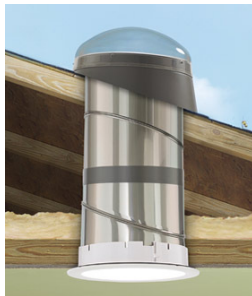
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## Sun Tunnels.



- Easier to install,
- 10" & 14" diameter,
- Can be up to 18 ft. long,
- Rigid tube style is brighter than flexible style,
- No insulation reqd..



Source: [www.velux.ca](http://www.velux.ca)

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## Sun Tunnel in Interior Bathroom.



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## Thermal Mass.

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### Residential Timber Frame Construction.



- Thermal mass best when exposed to direct sunlight.
  - Exposed brickwork such as fireplace,
  - Concrete topping on floor,
  - Quarry, or other tiled floor,
  - Dark colour enhances absorption,
  - Double layer, or thicker drywall,
  - or, 'Phase-change' [PCM] drywall.

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### PCM Drywall.



- Special product from National Gypsum ®,
- Contains paraffin wax granules,
- Changes at 73°F from solid to liquid,
- Must be skim-coated with plaster for fire protection!



Source: [www.thermalcore.info](http://www.thermalcore.info)

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Some Passive Solar Examples.

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Nova Scotia Envirohome 1996  
Front faces SE.



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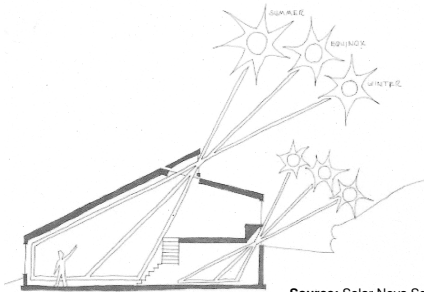
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North-facing Slope Site.



Source: Solar Nova Scotia.

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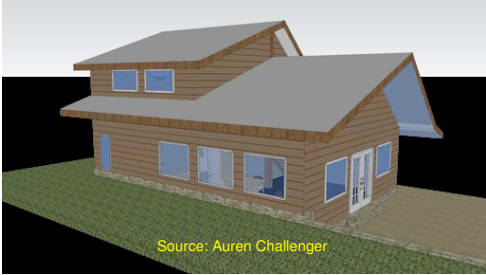
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A Student Submission.  
Gentle North Slope.



Source: Auren Challenger

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Early Canadian Home.



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Brock University – 100 yrs. Later.  
Alumni Passive Solar Greenhouse.



Design: Simon Architects & Planners., Eden Mills, ON.

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### Some Useful Reference Material.



- City of Vancouver Passive Design Toolkit:  
<http://vancouver.ca/sustainability/PassiveDesignGuidelines.htm>
- RDN Sustainable Design Checklist and Guide:  
<http://www.rdn.bc.ca/cms.asp?wpID=2436>
- Build it Solar. Solar Energy projects for DIYers:  
[www.builditsolar.com/index.htm](http://www.builditsolar.com/index.htm) and  
<http://www.builditsolar.com/Projects/SolarHomes/91HomesBook/SolPasPlans91.htm> for house plans.
- Sustainable by Design, Seattle [solar design tools]:  
<http://www.susdesign.com/tools.php>
- David Allen's Solar Home:  
<http://www.allanstime.com/SolarHome/>

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