Passive Solar Use in Residential Buildings

Addressing RDN’s Sustainable Development Guide.

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

- In 45 minutes!!!

Solar Orientation.

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

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.

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 21st. Of each month.
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.

Solar Noon Times at 21st day.

<table>
<thead>
<tr>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
</table>

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

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.
Solar Access.

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

Obstructions to sun access

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

An Alternative.

- The Solar Pathfinder.™
  - Uses a ‘Polar’ sun path chart.


Source: www.solarpathfinder.com
Polar Sun Path Chart.

Source: University of Oregon web site.

But, How Much and What Type of Glazing?

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

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.
Other Orientations.

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

BUT

B.C. Building Code.

- Code requirements must also be met:
  - Section 9.7.1.2 requires a minimum opening window size of 0.35 m² [3.77 ft²] 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 m² [3.0 ft²] in all ‘finished’ rooms and 0.09 m² [1.0 ft²] in bathrooms for natural ventilation.
  - with some exceptions & explanations.

And, what type of glazing?

<table>
<thead>
<tr>
<th>Component</th>
<th>South</th>
<th>East</th>
<th>West</th>
<th>North</th>
<th>Sun Space</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double Glazing</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Argon gas fill</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Not needed</td>
</tr>
<tr>
<td>LowE coating</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Insulated Spacer</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Insulated Frames</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
And, what type of window? ☀

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

Vegetation.

Using natural vegetation as solar shade in summer.

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.
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!

Shading the Windows.

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

South Windows. External shade is best option

• Fixed Overhangs.
  • Simple but need careful design.

Full shade by early in May.
South Windows. External shade is best option

- Fixed Overhangs.
  - Simple but need careful design.

Typical Overhang Geometry.

![Diagram of overhang geometry](image)

- Dec. 21: 15°, 6" overhang
- Mar/Sep. 21: 40.5°, 42" overhang
- June 21: 64°, 39" overhang

These solar elevations are for Qualicum Beach.

Two Storey Overhang Application.
External, South windows

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

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

South windows, again.

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

South windows, again.

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

Another West Idea.

- Using a Lattice Screen: Shade-cloth improves performance.

Natural [Day] Lighting.
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.

Source: www.velux.ca

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

Sun Tunnel in Interior Bathroom
Thermal Mass.

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.

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
Some Passive Solar Examples.

Nova Scotia Envirohome 1996
Front faces SE.

North-facing Slope Site.

Source: Solar Nova Scotia.
A Student Submission. 
Gentle North Slope. 

Early Canadian Home. 

Brock University – 100 yrs. Later. 

Design: Simon Architects & Planners, Eden Mills, ON.
Some Useful Reference Material.