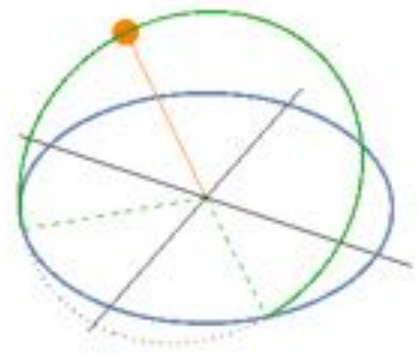
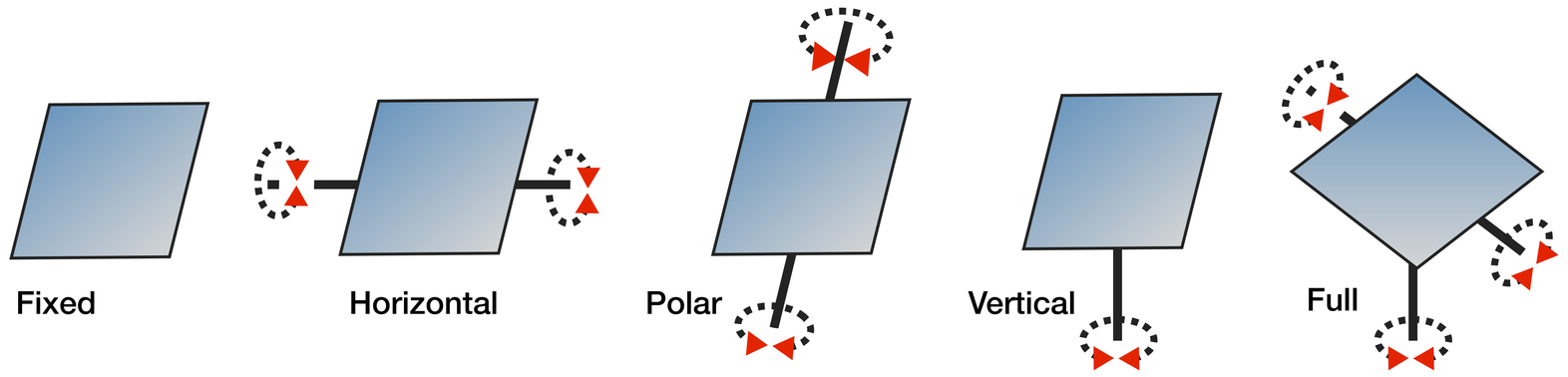
ECOSMART™ dedicated to solar energy

TRACKING THE SUN

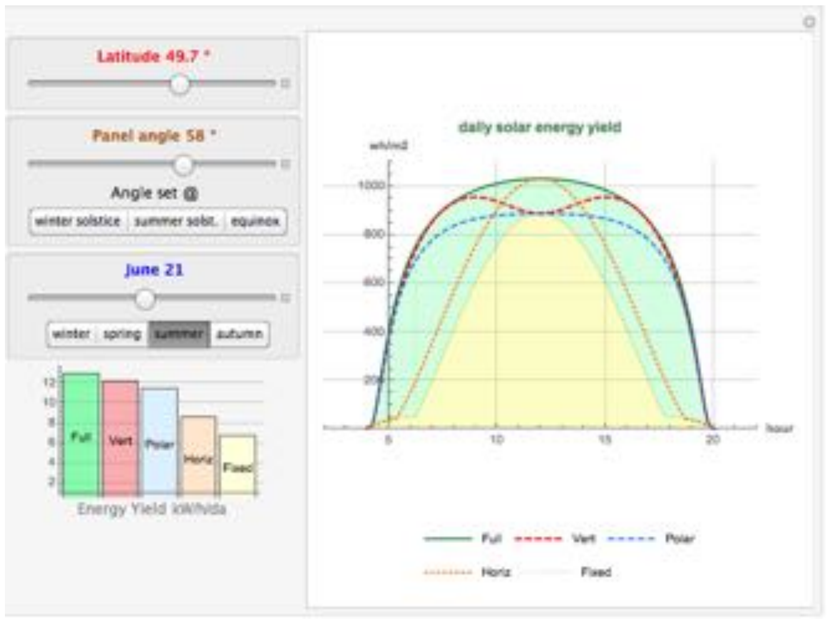
what is the most effective solution ?





The position of the sun changes according to hours and seasons. PV modules receive maximum solar energy when facing directly the sun. It is a simple geometric result. The energy received from direct radiation is proportional to the cosine of the angle between the sun ray and a perpendicular to the panel, i.e when the sun is at 45° to the panel the energy received will be cos(45°) =~ 70% of the solar energy available. If the panel is perpendicular to the sun, cos(0°)=1 and the energy received is maximum. If the panel is parallel to the sun, the direct energy received is null as cos (90°)=0 . Regardless of its orientation, a PV modules will still receive some of the diffuse solar energy, scattered by the atmosphere.

EcoSmart has developed an interactive simulation to visualize the solar energy yield from five different mounting systems: **Fixed**, Horizontal Axis Tracker (**HAT**), **Polar** tracker, Vertical Axis Tracker (**VAT**), Two-axis (**Full** tracking).



Energy Simulation by EcoSmart

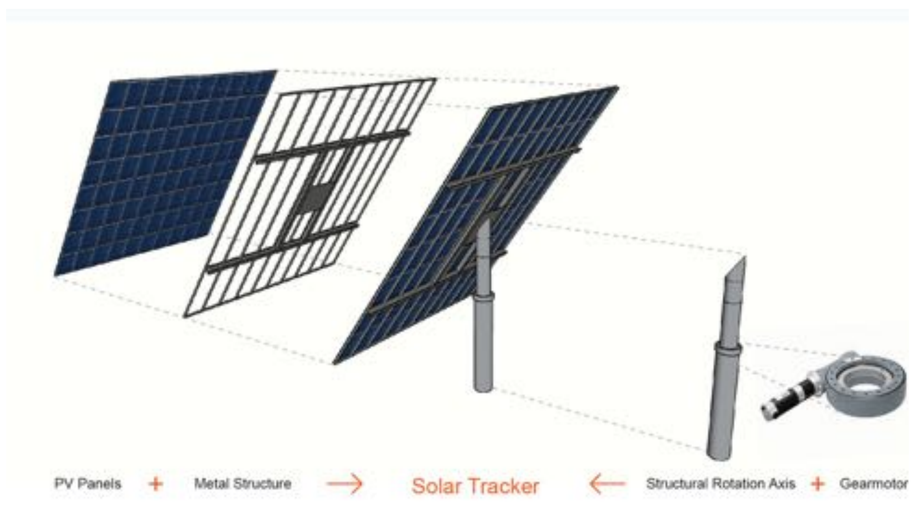
Mounting systems compared

The simulation calculates the solar energy received by a PV panel as function of the angle of incidence of the sun. In this case presented here, the location is Kimberley, in Canada, where EcoSmart helps building the first ground-mounted large scale solar project in Western Canada.
At that location, the optimum angle for maximum annual yield in 58°.
The graphs shows the daily energy yield on June 21 for each mounting system : **Fixed**, **HAT**, **Polar**, **VAT**, **Full**.

- The **full** tracker produces almost twice as much as the **fixed** system.
- The performance from a **VAT** is close to the **full** tracker by a few %
- The **Polar** system is close to **VAT**
- The **HAT** and **Fixed** are much less efficient.

Some key findings:

- **Full tracking** has no significant advantage over **VAT**. The increase in complexity and cost of 2 tracking mechanisms is not justified by the marginal gain in energy.
- A **fixed** system misses a large amount of energy, (green area), at hours when electricity tariff are often higher. In high latitudes, such as in the Northern US states or in Canada, most of the solar energy is produced during the long summer days making a fixed system very inefficient.
- Surprisingly, the **HAT** - a system widely used - is only marginally better than the **fixed** mounting.
- The daily energy profile from a **full, VAT or polar** system is rectangular compared to the sinusoidal shape of the **HAT and fixed** output. Fixed systems typically clip the power curve with the inverter (the overbuilt technique) to create a flatter daily profile The same profile is achieved naturally by the Full / VAT / Polar systems without any energy penalty.



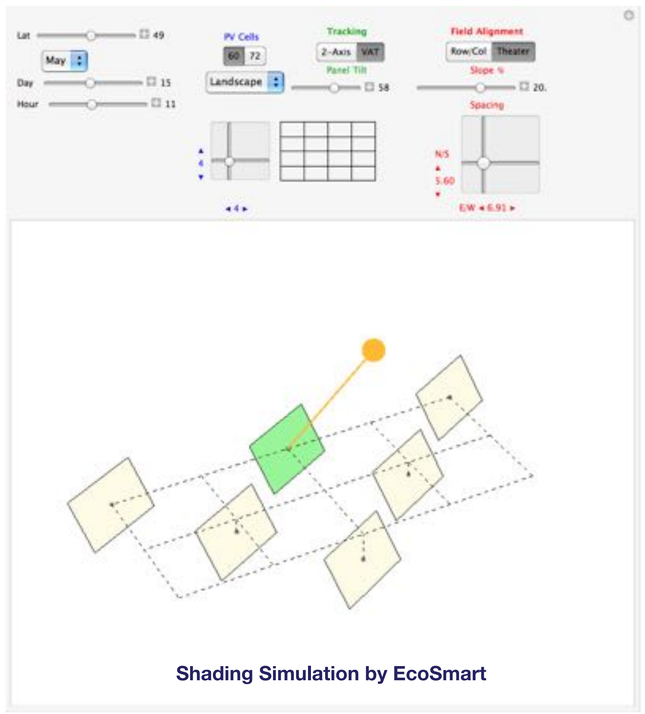
… and the winner is …

The **Vertical Axis Tracker (VAT)** is the most cost-effective system. It has an energy performance close to the maximum and can be build with simple, widely available components:

- a rack to fix the modules
- a structural frame to support the rack
- a heavy pipe connecting the frame to the mechanism
- a slewing drive that rotates the frame according to the sun azimuth.
- a small motor and control mechanism for the slewing drive
- a ground pile attached to the bottom of the slewing drive.

Recommendations

- The rotation of the tracker can be controlled by software using astronomical formula rather than photo cells. Is it simpler, cheaper and more reliable.
- A large sloped panel acts as a plane wing and may have significant drag and lift forces. Trackers require in-depth wind load analysis using aeronautical formula or wind tunnel testing.
- Unlike fixed mounting, VAT are subject to lateral (East/West) shading. VAT solar farm needs a minimum of 5 Ha/MW (12.5 acres/MW) to minimize lateral shading. The space between the trackers can be used however for traditional farming activities , such as sheep raising.



Shading Simulation by EcoSmart

Conclusions

1. Trackers significantly improve solar system performances.
2. Tracker benefits are greater in Northern solar projects.
3. Not all trackers are equal.
4. HAT (horizontal) are less efficient than the other systems.
5. VAT (vertical) is the most cost-effective system.
6. VAT can be built with simple, off-the-shelf components.
7. The tracker position can be controlled simply by software rather than by photo-cells
8. Trackers produce a rectangular daily energy profile and do not need DC overbuild (i.e. power clipping by the inverter)
9. Wind load on trackers can be important.
10. Trackers need more space around them.
11. … that's good for sheep and wildlife ! …

See more at EcoSmartSun.com

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