EcoSmart
Comments to
Solar Energy Strategy for NWT

The following notes offers some comments and suggestions to the *NWT solar energy deployment strategy* based on our expertise and recent progress in solar technologies.

NWT solar potential (pg. 3)

The report indicates *"electrical generation of between 800 and 1,200 kilowatt hours per installed kilowatt every year."*

These values could be improved if the solar panels are installed on trackers and follow the sun. As an example, we have done a preliminary analysis for Fort Providence, NT .

The nearest source of solar data available is at the Hay River Airport weather station, located at 116 km radius from Fort Providence. Assuming similar solar energy level, a fixed PV system in Fort Prudence will produce in average 1,355 kWh per kWp per year, while the same system with trackers will produce 1,916 kWh/kWp/yr.

(These values represent the energy received by PV panels at optimum angles and based on our simulation program done on 50 years of solar data from Hay River airport weather station).

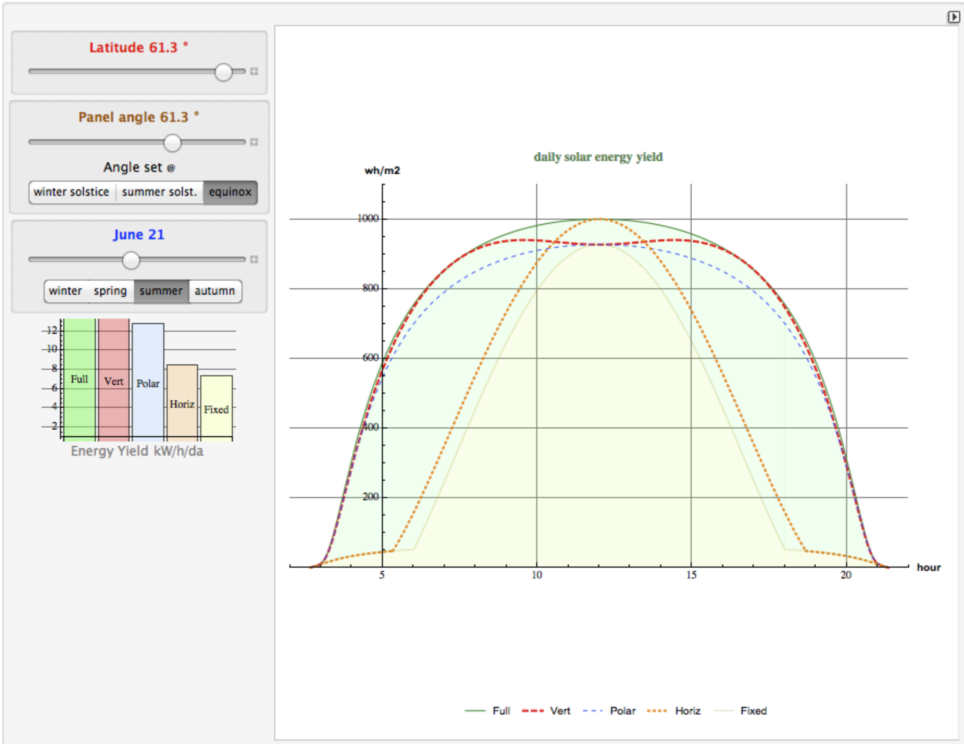

Figure 1: Daily energy yield for various types of trackers at Fort Pridence latitude. Fixed: Light yellow, full tracking: green, vertical axis trackers: red dotted. In the summer, the tracker produces almost twice the amount of energy of a fixed system

With trackers, the annual energy production increases by more than 40%.

One of the main reasons is that, at high latitudes, most of the energy production occurs during the long summer days. If the panels are fixed, the sun will be in the back of the PVs before 6:00 AM and after 6:00 PM and a significant amount of energy will be lost (fig 1 & 2). Trackers at the contrary can harvest the solar energy during longer period of the day.

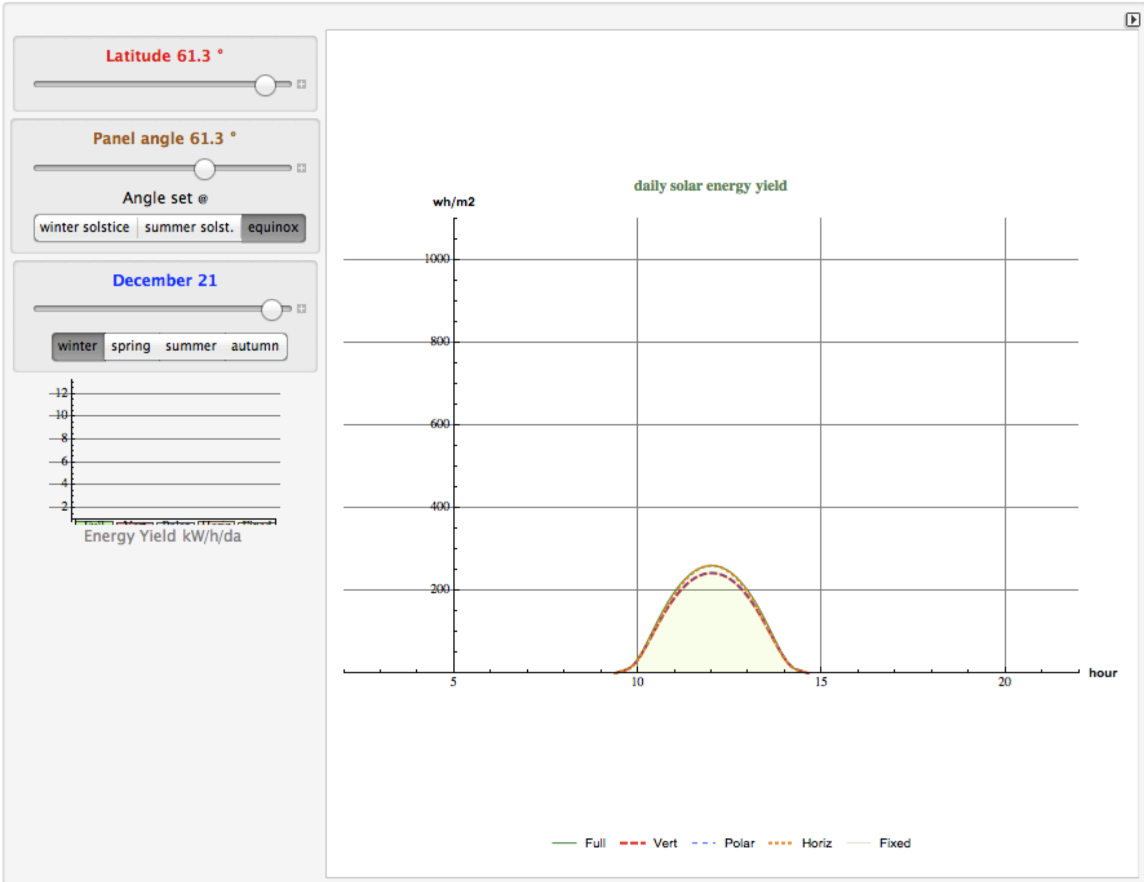

Figure 2: *Same as Fig 1 but in the winter. In high latitudes, there is a large difference of solar energy between summer and winter. Trackers can harvest more solar energy during the long summer days when it is abundant and available.*

Fixed panels have better applications at lower latitude, e.g. California, where the difference in day length and solar energy between summer and winter is much less pronounced.

System costs per watt (pg. 7)

The report states: *An average cost of $12 per installed Watt is expected from connecting solar power into the grid in each of these communities.*

In 2014, a fully installed PV system may cost less than $2/Wp in the US and as low as €1/Wp (C$1.5/Wp) in Germany. Arguably, NWT has higher prices because of remoteness, transportation costs, smaller project size or less experienced workforce. Nevertheless, it is difficult to understand how the costs could jump six-fold from $2 to $12/Wp.

Typical US costs for solar equipment alone are shown in Table 1:

Item	$/Wp (2014)
PV Modules	0.50 ~ 0.70
Inverters	0.15 ~ 0.20
Support	0.10 ~ 0.40 (Trackers)
Cabling, electrical	0.10
Total	**0.85 ~ 1.40**
Notes: These price for large quantities and in the US	

Table 1: PV system typical cost per Watt

Total cost of the main solar equipment of a large solar plant in the US can be as low as 85 cents per watt. As a rule of thumb, equipment is half of the total system cost. Therefore, there is room to reduce costs below $12/Wp, even in remote NWT communities.

For smaller, distributed projects, that are more likely to be build in the NWT, cost saving could be achieved by grouping purchase, creating solar cooperatives or leasing.

20% average power load

The report indicates that:

Solar PV technologies can be used in the current electrical grid if they are below about 20 percent of the average power load for the community. Control systems for solar/diesel hybrid power systems become more complex for anything above 20 percent of average load and battery storage is often required to buffer the intermittent nature of the sun's rays.

- Nowadays, existing on-grid and off-grid applications routinely exceed 20% network load. The rule-of-thumb of 20% is conservative and is no longer a universally accepted limit.
- Although the prices are going down, energy storage is still expensive and adds complexity and maintenance to the system.
- An alternative to storage is to oversize the solar system and dispatch the excess energy. It is a cost-effective solution that takes advantage of the low cost of PVs compared to batteries, and works well in diesel/solar hybrid systems.

Assuming, for example, the annual grid load of Fort Providence is 7,000 MWh/yr powered a 2.8 MW diesel genset system. *(It is a hypothetical cases study extrapolated from another Northern remote community case study)*

In that case, the Levelized Cost of Energy (LCOE - see definition at http://ecosmartsun.com/lcoe-definition/) will be:

- For the diesel-generated electricity: $708/MWh
- For solar electricity : $253/MWh

(Assuming typical costs of diesel genset and the cost of $5/Wp for solar - Calculation details available upon request)

Figure 3 and 4 show the results of simulations done for those parameters.

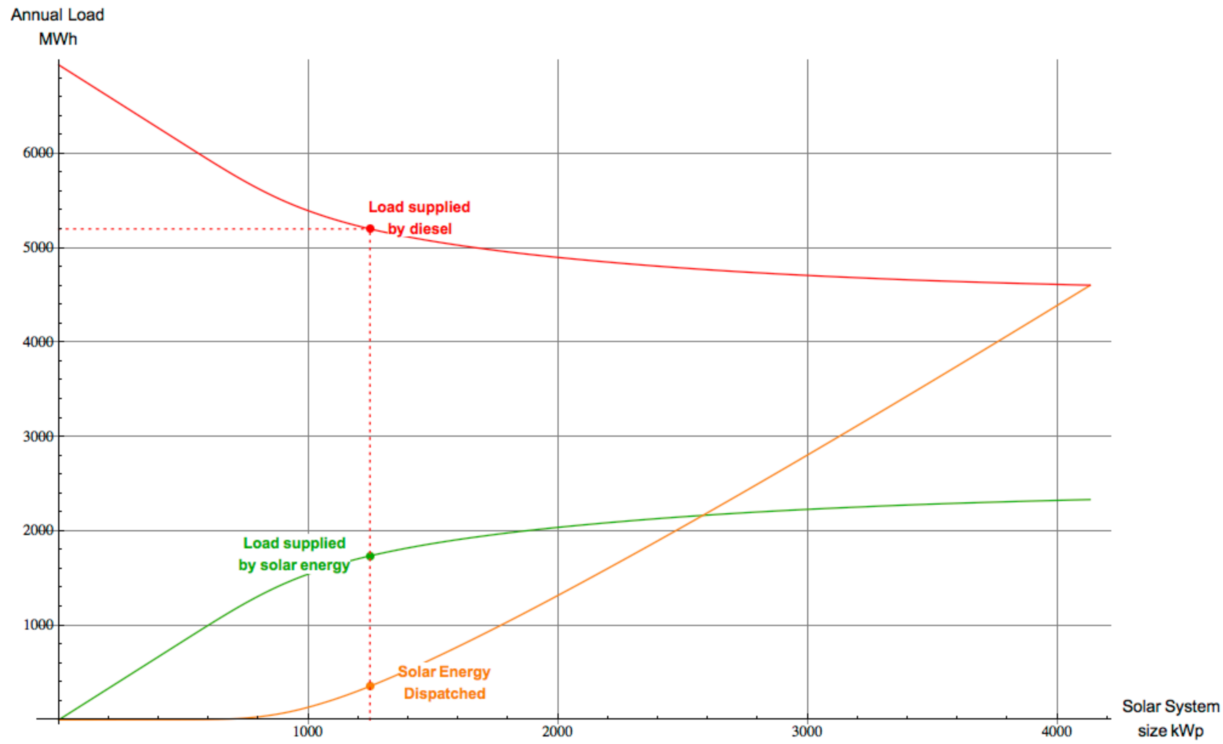

Figure 3: Hybrid Diesel/Solar system load share.

Fig. 3 shows how much diesel is displaced when the size of the solar system is increased. Initially, the reduction of diesel is proportional to the increase of the solar system size. But if the solar system is greater than 1 MWp, part of the solar energy must be dispatched and increasingly less amount of diesel is displaced. The optimum value is shown in Figure 4 that plots the annual energy cost reduction versus the system solar size.

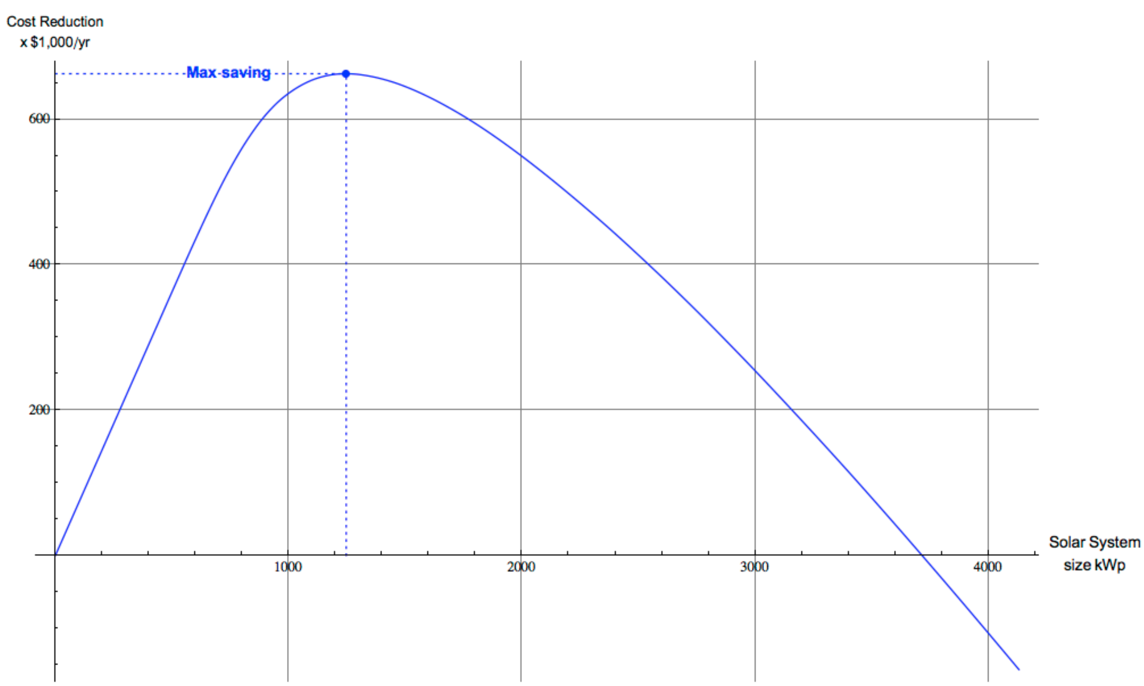

Figure 4: Cost reduction of a diesel/solar hybrid system vs of solar size

In this example, the most cost-effective solar size in a hybrid system would be 1.25 MWp with a cost saving of about $660,000 per year. The full list of results is listed in Table 2

Energy Cost saving $/yr	662,772
Optimum Solar system MWp	1,246
Number years to payback	9.40
Annual load MWh/yr	~7,000
Solar energy used MWh/yr	1,738
Solar energy dispatched MWh/yr	356
Diesel used MWh/yr	5,203
% Load generated by Solar	25.04
% Load by Diesel	74.96
% Solar dispatched	21.20
Litres diesel saved/yr	568,874
Tonne CO2 saved/yr	1,512

Table 2: Main results for 1.25 MW solar hybrid system

These figures and number are for a hypothetical case study, presented only to illustrate that:

1. Significant reduction of diesel consumption can be achieved by adding a solar system -in this case 25%.
2. At that level, no storage is required, only an optimization solar energy dispatching.
3. The cash flow is positive and the solar system reimburses itself in a reasonable amount of time. The payback varies according to the cost of solar installation as shown in Figure 5

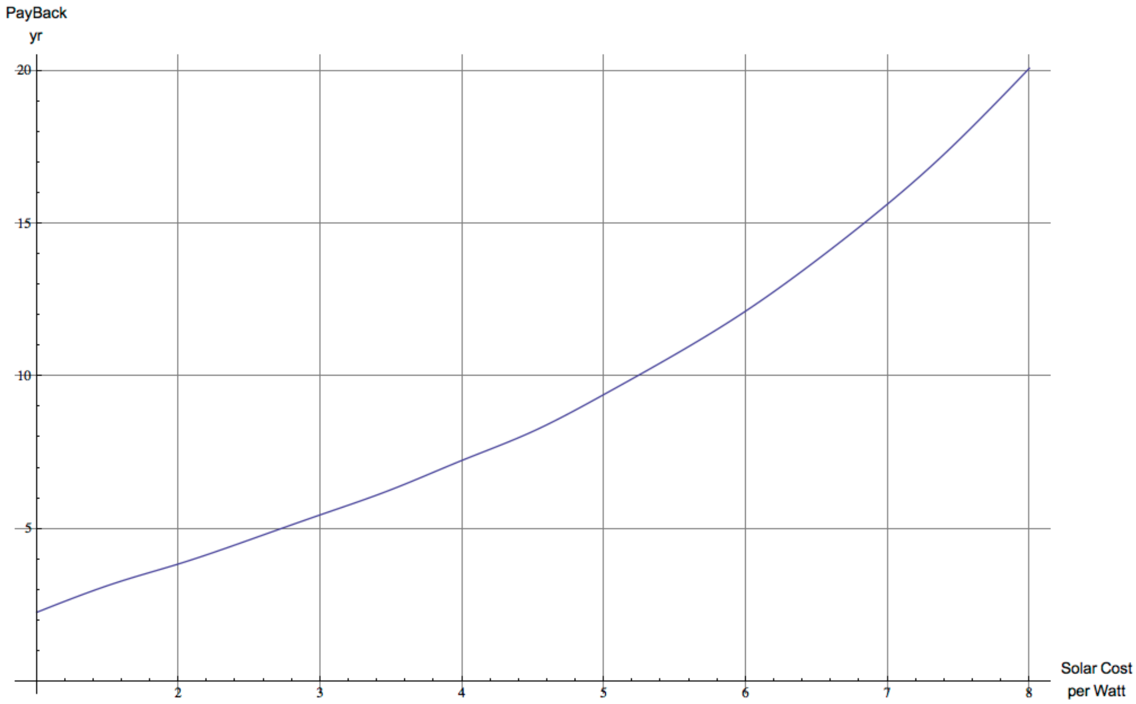

Figure 5: Payback of an optimized hybrid system vs cost per watt of the solar system.

Conclusions

As the NWT Solar Energy Strategy indicates, the region has great solar energy potential. We believe that this potential could be further improved in various ways such as:

1. Using trackers to harvest more solar energy during the long summer days.
2. Bringing down the price of solar equipment to level at par with the world market.
3. Optimizing dispatch of solar energy to achieve greater diesel displacement without using storage.