

Sundownloaders: what and where and when, and how and why and who?

T.R.C. Boyle

tom.boyle@sundownloader.com

Attempted here is the obviously-very-simple task of explaining a completely new and subtle technology, briefly, in plain language, no technicalities; in such a way that everyone still gets the point - gardeners, astronomers, householders, physicists, biologists, chemists, architects, solar-energy engineers, climate-change activists, businessmen, even politicians. So please excuse me if some things are dealt with by reference to other writings. The first and truly obvious thing to grasp is that, if the sun is in the sky, light can be redirected to where you want it; the second and trickier was finding how to do this with non-moving mirrors, which have to be of very special, never-seen-before shapes. It *is* new; they *are* patented.

At sunrise and sunset, sunlight is horizontal so will be reflected straight down by a mirror angled at 45°. Go anywhere in the world, look in any direction; we can quite easily calculate what are the highest and lowest possible solar altitudes on every day of the year - telling us in turn what mirror angles will reflect some light straight down whenever the sun is above the horizon. Now we can design an overall mirror shape to suit that latitude and place. It may be of constant curvature but varying height because we don't want to pay for mirror surface that isn't useful (Type 1A), or if we choose mirror height for other reasons, curvature will vary around the compass (Type 1B). [Both Types exist and they work.](#)

Reflection straight down by a single, wide, sweeping mirror surface is good; obliquely down by a composite (small mirrors mounted on a frame) may be better, offering advantages in ease of manufacture, adaptability to local conditions, lighter weight, less wind resistance, etc. - we call this 'Type 2', and it will likely be commercially-dominant; as assumed in the following discussion which begins, however, with mention of what we are *not* trying to do before turning to real-life applications.

Solar radiation is essential for life on Earth and also already used in ingenious devices for varied, sophisticated engineering purposes. Often light is focussed or 'concentrated' - even greenhouses at high latitudes (US Patent 8,578,650 B2)! But sometimes increased light intensity is either useless or positively harmful, which is where sundownloaders come in: their purpose is to provide more, natural light, better directed, for longer hours; but *not* focussed, *not* intended to give a local intensity greater than full sun - and whichever Type is used the effect overall is that of a convex mirror, *not* concave.

That's something about *what and why*.

When? Answer: as quick as we can. And now let's look at *where, who* and *how*.

Readers of this magazine know what's coming. Few food or garden plants can handle even 50% of full sun intensity, even for a short time; most prosper at 10 - 20%. An old-fashioned greenhouse succeeds primarily because of protecting plants against bad weather. Low sun and obstructions from the structure and objects inside the house often reduce light to the extent that electrical light is added, even during the day, and reflective surfaces are placed to ensure that best use is made of what does come through the glass (transmission is best at incidence angles near 90°); yet on the other hand mid-day sun intensity is excessive; screens are standard industry practice; have been for many years. So, light levels are critical. Though commonly said that 1% extra light means 1% more product, it is also quite clear that this refers to extra light at low-light times of day and year.

What can be wrong with a device that i] sends in natural sunlight (but not too much), ii] well angled, iii] especially when the sun is low in the sky, iv] often from opposite the sun, v] provides a little shading when the sun is high, vi] is inexpensive to install, vii] requires near zero maintenance, viii] no electricity and ix] no fuel of any kind.

In short, greenhouses were waiting for sundownloaders to be invented.

And that gives us ideas about where else sundownloaders will be used and by whom. Solar electricity is already important and will become much more so. Our concern is neither thermal generation nor the efficiency of photovoltaic cells but the inescapable facts that solar radiation striking the Earth's surface is intermittent and varies with season and time of day. Those using direct solar energy must either be intermittent users or provide for the bad times by purchasing back-up power (generated elsewhere) and costly storage facilities (batteries, pumped water, hydrogen, etc.). Anything which reduces that dependence even a little is worthy of consideration.

First, the small domestic unit, with or without grid connection: in such cases, one or a few sundownloaders installed beside and above a solar panel array will bring in some light that would have fallen elsewhere and also direct low level sunlight advantageously: there seems no doubt that the owner would benefit by way of increased total electricity output as well as by distributing that output better over the day. The performance of solar panels is highest at angle of incidence 90° , falls off either side.

Commercial-scale solar units are typically arranged with panels facing North or South, to maximise total output. There are a few exceptions, usually in places where the site itself suggests doing things differently. When considering a large enough area of flat land there is no opportunity to bring in more than a tiny proportion of extra total light, so we are concerned chiefly with redirecting of light to improve angle of incidence. That it can be done is certain. Whether it can be done with sufficient economic advantage to justify the investment required - that is a truly important question and well worthy of research.

We believe that 10% extra output over the day is within reach and because that will be mostly early and late in the day (when demand is highest) it will be worth more. At present and in most places, at least domestic electricity tariffs are constant over the 24 hours. That may change. 'Smart meters' allow differential charging: since it is costly to provide the additional generating capacity required at peak times it is only reasonable that electricity should cost more then. With or without that effect, any kind of generating unit which improves output at peak times is in a strong business position.

Where and who? The greatest proportional benefit will be in the poorest countries and to the little guy in Asia and Africa, who can provide himself with more electricity over longer periods of the day and grow more food for himself and his family. The greatest absolute benefit will fall to business concerns in both the horticultural and solar energy sectors. Natural prejudice inclines most people to think of temperate climates and moderate latitudes, but we are actually in process of seeking research grant support to study tropical/equatorial countries, which have just as many sunset and sunrises, and a lot more poor people.

Returning to *why*; a major motivation, naturally, will be making or saving money. It is worth pointing out, however, that anything that reduces the needs for fossil fuels or massive

engineering work, helps turn solar radiation into food, economises on the use of land for that purpose, and reflects a little sunlight back into space - is also helping with environmental protection, climate change and the provision of what will be needed to feed a rapidly increasing world population. Greenpeace, Greta and all you others, we are on your side!

And finally, *how*? Something about manufacture and deployment of Sundownloaders may be worthwhile, though none of this is rigidly determined. We anticipate making the small mirrors required by a metal-stamping process and then assembly into the units by hand for special situations or mass-production methods for designs of wide application. Installation will require moderately-skilled and specially-trained personnel and new kinds of tools so that inclination and direction can be accurate within about one degree, creating a whole new industry. Sundownloaders will need to be cleaned, say annually, like every other outdoor machine. In some places it will be advantageous to re-orient sundownloaders 2 - 4 times per year, but of course only if definite benefit and/or profit will result

How includes placement. Described here is one possibility: the principles are readily extended to other applications. Consider a greenhouse with multiple roofs at high latitude, where East-West orientation is appropriate - and in the Northern hemisphere:-

Then sundownloaders will be installed over the valleys between roofs and in winter will be directed generally South (but varying between themselves), inclined so as to direct light downwards at about 60° through the North-facing roof panels. Then plants and internal-reflective-surfaces will receive light from both South and North, the latter at near-ideal angle. The sundownloaders cast shadows, but the design is such that each will illuminate about 10 sq.m for each sq.m of mirror surface. In balance, at worst, we lose a little light that is coming in from the South (at too low an angle, less useful anyway, excessive shadowing, poor transmission through glass) and gain the same amount coming in from the ordinarily shaded side, at ideal angle and ideal intensity of ~10% of full sun.

In summer the sundownloaders would be reoriented to make best use of sun coming in from North-Easterly and North-Westerly directions early and late in the day when it is of insufficient height to be fully effective. Redirected light will enter the South aspect of each roof, advantages as before.

Vertical farming is not discussed here, for want of space: yes it must be done: no as presently understood it cannot provide all the food needed for the world if only because the costs are far too high: yes sundownloaders will help: think on:-

<https://trcboyde.net/downloading-the-sun.html>

Finally, back to *who*. Yes that little guy if he gets the chance will gladly make use of sundownloaders and many varieties of scientists, businessmen and engineers should be interested because this involves them all. Climate activists too: we cannot just shut down economic activity, or if we do that will mean the deaths of billions; the great alternative is to minimise damage, maximise use of solar radiation, give us all time to plan rationally for the huge changes that must occur in the way society and countries are run if the human species is to survive. Politicians *must* take note. Kneejerk reactions and the recitation of outdated political and religious nostrums will not help. The future is now, or tomorrow at latest.

And, have we used Kipling's six honest serving-men to best effect, have we answered all your questions? - if not, please ask me some more.