**As you know, I often try to kick off these little weekly musings with a bit of light-hearted repartee, just to get you good folks in the mood for the brain bending technological information download that usually follows.**

**But this week’s program has to do with agriculture and, with the possible exception of some entertaining images of fruit and vegetables that have hilariously taken on the form of male genitalia, I couldn’t really find anything terribly amusing in the data that I was analysing.**

**So, I’ve decided to just give it to you straight**

**(unlike that carrot). Ah, come one??!!...**

**Hello and welcome to Just Have a Think.**

**Our global agricultural systems account for more than a third of all human induced greenhouse gas emissions.**

**They also use a huge amount of water. According to the World Bank, agriculture consumes about seventy percent of all freshwater withdrawals and an even higher share of what’s known as ‘consumptive water use’ as a result of evapotranspiration of crops.**

**Rapid changes in the global climate mean that If we carry on with our current agricultural methods, there’s no way there’ll be enough water even to grow the current level of food production, let alone what we’ll need by 2050.**

**Right now, that system is struggling to feed more than seven point eight billion people. In thirty years’ time that number will be more like nine point eight billion.**

**And as more and more of those people are lifted out of poverty and begin to adopt a heavier, more varied diet, food production will somehow need to double over the next three decades, at a time when the rapidly increasing impacts of climate change are making current farming practices look less and less sustainable as every year goes by.**

**Access to food will need to be drastically improved, so that some of the gross inequities in the world are addressed, and food waste will need to dramatically reduced too. Right now we throw away more than thirty percent of everything we produce.**

**If nothing changes at all then we will quite likely be looking at food shortages, water scarcity, regional conflicts and economic destabilisation.**

**We could just all stop eating meat and switch to plant-based diets of course. That would immediately and sustainably fix the entire problem and provide every human on the planet with all the calories and nutrients they need. I’ve done it, and I love it. And so have hundreds of thousands of other people around the world. But let’s be honest here – it’s unlikely that billions of people, especially in the richer industrialised nations, are going to voluntarily give up the practice of eating dead animals.**

**So, all sorts of agricultural systems are now being developed and promoted all over the world to try a make the whole thing more sustainable, and one of the ideas gaining a lot of interest right now is to combine food production with energy production, in a concept known as Agrophotovoltaics, or Agrivoltaics, or just APV for short.**

**There’s a strong clue in the name, obviously. And sure enough, in very basic terms it means putting solar panels in a field where crops are also grown.**

**So how does it work in practice and what do we gain from doing it?**

**Well, it turns out that there’s a limit to how much sun any individual plant can actually use. It’s something known as the light saturation point. Any extra light received beyond that point makes no difference at all to the plant’s photosynthesis. All it does is make the plant sweat, which makes it more thirsty.**

**So, by strategically placing solar panels directly above a crop growing area, it’s theoretically possible to precisely regulate how much sunlight reaches each plant so that they have the optimum level for maximum growth with minimum water loss.**

**All the excess sunlight that would otherwise be wasted on the plants would then be captured on the upper side of the solar panels to generate energy.**

**And if the panels are raised up high enough above the ground, then livestock, farm workers and even agricultural machinery can all operate very happily in the cool shade beneath the canopy.**

**And it’s not a one-way street either. It’s a mutually beneficial, symbiotic relationship**

**As the plants grow beneath the panels, they help to keep the panels cool. Ironically, solar panels don’t actually like getting hot – it reduces their operating efficiency. So, anything that can draw heat off them will help to make the panels more productive. According to a study by Oregon State University, panels positioned correctly above plants can produce as much as ten percent more electricity.**

**That electrical energy can be used to run the farm with electric tractors and equipment, and to power precision agricultural technology that helps further reduce water usage. All of that obviously reduces the running costs for the farm. And any surplus energy can be stored in battery banks or sent to the grid for consumer use.**

**So, you’re effectively using the sunlight twice, to grow cash crops and to generate a second income stream from the solar power generation.**

**Farmers all over the world are finding it increasingly difficult to make ends meet without huge government subsidies. In the USA that struggle is starting to nudge towards something more like an existential crisis as trade wars, commodity prices and climate change all combine into a perfect storm of economic disaster. Between twenty eleven and twenty eighteen, more than a hundred thousand farms were shut down across America, so the ability to use the land more profitably while still providing crops for the nation, is a potential lifeline that could keep many farmers from going bankrupt.**

**And, the OSU study also calculated that converting just one percent of American farmland to agrivoltaics could meet the entire US national renewable energy target, not to mention saving a significant amount of water and creating a sustainable long-term food production system.**

**But it’s not just happening in America. APV technology is being quite enthusiastically embraced all over the world.**

**Japan implemented six hundred and fifty-four projects between twenty thirteen and twenty eighteen with a peak generating capacity of about a hundred and fifty megawatts.**

**South Korea currently have about two megawatts worth, and of course the mighty China, who, as we’ve learned on so many occasions on this channel, never… ever, do anything on a small scale, installed an estimated four gigawatts of agricultural PV capacity just in the three years between twenty fifteen and twenty eighteen.**

**It’s a system that’s yet to gain significant momentum down in Australia though, despite the huge potential benefits that could be reaped in that country. Competition for land in Oz is pretty fierce. It’s a vast land mass, more or less the same size as the 48 contiguous states of America, but food production is only possible in fairly restricted areas that have enough rainfall, agricultural value and existing infrastructure, especially easy connections to the electricity grid, to make any operation economically viable. That proximity to the grid draws solar PV developers to exactly the same geographical locations and in many cases that’s actually caused a conflict between developers and farmers in those areas.**

**So, Agrivoltaics would seem like a bit of a blindingly obvious solution. There are no legislative barriers to APV in Australia today. The only obstacles, to be honest, are wilful ignorance and an unwillingness on the part of famers and solar developers to cooperate for everyone’s mutual benefit. There is growing media exposure to the idea though, like this superb report by Remi Rauline for the Renew website.**

**And I’ll leave a link to that article in the description section below here.**

**Over here in Europe, according to this report by Agora Energiewende and the British think tank Ember, 2020 marked the first time that the EU generated more power from renewable sources than from fossil fuels. Renewable energies made up thirty eight percent of the European energy mix in 2020, compared with thirty seven percent from oil, gas and coal. So, the potential for agrivoltaics here is huge.**

**France is already getting involved, led by the wine making industry.**

**Sun’Agri, a subsidiary of French solar developer Sun’R has installed a**[**viticulture**](https://www.pv-magazine.com/2019/12/05/french-start-up-ombrea-develops-solar-blinds-made-of-sliding-pv-panels/)**[agrivoltaic](https://www.pv-magazine.com/2020/03/20/european-agrivoltaics/%22%20%5Ct%20%22_blank) system in the wine-growing area of Piolenc, in Hérault, in South Eastern France, as part of a program to test how agrivoltaics perform in specific crop cultures. The project is running in partnership with the local chamber of agriculture as part of a program supported by the French**[**Environment and Energy Management Agency**](https://www.pv-magazine.com/2019/11/28/are-rare-earths-used-in-solar-panels/)

**In a recent interview with PV Magazine, a Sun’Agri spokesperson said**

**“Vines are among the crops most affected by the effects of climate change, so it is essential that they be at the heart of our experiments,”**

**A thousand square metres of vines in the test area were planted with the black grenache, red wine grape. Six hundred square metres were covered by a system of two hundred and eighty panels with a generation capacity of 84 kilowatts. The panels were mounted four point two metres or about fourteen feet above ground and are remotely controlled by an** [**artificial intelligence**](https://www.pv-magazine.com/magazine-archive/the-evolution-of-solar-intelligence/)**algorithm that Sun’Agri have been developing for more than a decade.**

**The algorithm determines the ideal tilt of the panels, based on available sunshine, the water requirements of viticulture, the growth model of the crop, as well as soil quality and weather conditions. And in the event of extreme climatic hazards like drought, heatwave, hail, frost or heavy rain, the system positions the panels to protect the crops.**

**Water demand was reduced by as much as thirty four percent in the PV-sheltered vines thanks to that reduction in evapotranspiration that we looked at earlier. The project is due to move from this demonstration scale to a full commercial phase in 2022, at which point it will expand to include other agrivoltaic projects linked to arboriculture, greenhouse gardening and arable crops across 15 installations.**

**There are some challenges that could stand in the way of widespread use of agrivoltaics though, as this recent research paper by the German Fraunhofer Institute points out, not least of which is the higher initial capital costs compared to conventional ground mounted PV installations. Those costs are mainly due to the much taller support systems used for the modules, as well as the need for site-specific system design. But the report also found that, compared to other renewable energy sources today, APV overall looks quite competitive. The industry comparison standard known as levelised cost of electricity, or LCOE, comes out at seven to twelve euro cents per kWh for agrivoltaics. That is higher than the ground mounted systems, but it’s already cheaper than small rooftop PV systems.**

**And as a bit of a bonus, free-standing APV installations also provide a valuable habitat for other plants and wildlife. With careful management, the extra protection from excess harmful sunlight improves the health of the soil and increases the level of nutrients, creating important ecosystems for plants and insects, which in turn increases the availability of food for field animals, as well as birds and bats.**

**In Germany a group called the Triesdorf Biodiversity Strategy for Free-Standing PV Installations, was recently founded to promote biodiversity in solar parks and increase public acceptance of these installations and the energy transition as a whole.**

**Agrivoltaic technology itself is improving all the time. Panels can now be made translucent to allow finer control of the amount and specific wavelengths of light that are either absorbed by the panel or allowed through to reach the crops. And there are even completely mobile PV systems like this one from US company Tracker Sled, providing plug-and play style modularity and mobility regardless of what type of terrain or topography it’s deployed on.**

**Despite the fact that the basic principles of APV have been known about for over four decades, the industry is still young, and it’s only recently started to evolve. Research is ongoing to find the best ways to adapt the system for producing as many types of fruit and vegetables as possible and clearly more work needs to be done to ensure its economically viable on a global scale, but agrivoltaics do look very promising and the technology could play a major role in defusing the current conflict between agricultural landowners and solar developers, especially in highly populated countries where space is at a premium.**

**Now, I’m hoping there may be some folks watching this who have direct experience of working with one of these systems. If you do, or if you have other comments and observations that you think would be constructive and helpful, then dive down to the comments section below and leave your thoughts there.**

**That’s it for this week though.**

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**As always, thanks very much for watching, have a great week, and remember to Just Have a Think.
See you next week.**