**Throughout the history of human civilisation, we’ve enjoyed what we believed to be effectively unlimited energy and resources in our global playground, enabling us to do more or less whatever ever we wanted wherever and whenever it suited us without any concern for the consequences.**

**And when there were only a few hundred million of us scattered around the earth, that philosophy was probably quite valid. But there’s nearly eight billion of us now, and we’ll be more than ten billion by mid-century, so the old mind set of ‘nature’s infinite bounty’, doesn’t hold true anymore and we’ve reached a point where our earth systems are really creaking at the seams to cope with our rapacious demands.**

**Most rationally minded people have at least recognised that the major causes of our current predicament are over consumption and the burning of fossil fuels. Our policymakers all know very well that we need to very rapidly move to low carbon sources of power like wind and solar in what will become a much more electrified future. But that paradigm shift will ask an awful lot of our electricity grids in the coming years. By 2030 most people who own cars will be driving models powered by batteries not hydrocarbons. Millions of homes around the world will be running electric heat pumps instead of gas boilers. Significant additional strain will be put on our grids by more and more data centres to feed our insatiable addiction to social media and digital information, and all of that will be exacerbated by things like cryptocurrency mining facilities and the rapid increase in air conditioning systems.**

**So, I think it’s probably fair to say we no longer have the luxury of being profligate in the way we use the energy and resources available to us on our little blue galactic spaceship.**

**In fact, what we need to do is find really smart ways of optimising the energy we generate so that virtually none of it is wasted and therefore the amount we need to generate in the first place is minimised.**

**Solar panels are great example. The best technology available on the market has a sunlight to electricity conversion factor of about eighteen to twenty percent. That means eighty percent of the energy hitting the panel is simply wasted as heat. And actually, because of physics stuff that we won’t go into here, as that heat builds up on the panel, it reduces the panel’s ability to produce free electrons to make electricity. So, ironically, on a nice hot sunny day in summer, a solar panel rated at twenty percent efficiency may only be achieving about twelve percent. So, here’s an idea straight out of the Edward de Bono school of lateral thinking…why not find a way of capturing that excess heat, drawing it away from the solar panel and doing something useful with it. That way you kill two birds with one stone – you get more efficient solar panels, and you use less energy producing heat somewhere else because you can just use the energy the sun has already provided. Sounds a bit obvious when you say it out loud, but it’s only very recently been developed into a marketable proposition. It’s called photovoltaic thermal or PVT and it could increase the amount of energy your solar panels can harvest by as much as three times. So, let’s take a look.**

**------------------------------INTRO TITLE SEQUENCE---------------------------**

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

**Now you might be thinking, hang on Dave, surely roof top solar heating has been around for decades? And you would of course be quite correct. Jimmy Carter had solar heating panels installed on the roof of the Whitehouse while he was President in the late nineteen seventies, before Ronald Reagan had them removed during his administration. Rooftop solar hot water heaters can achieve sunlight-to-water heat conversion efficiencies as high as fifty percent or more, but they have very low capacity factors. So, what does that mean? Well, a typical system is designed to meet water heating demand even in the depths of winter, but in those colder months it can take most of a day to meet the heat demand of the household water system. On a sunny summer day, the water can get piping hot within an hour or so, which means all the solar energy for the entire rest of the day is completely wasted.**

**By contrast, solar photovoltaic panels generate electricity that can either be used immediately or stored in batteries for later use by the householder. But unless you’ve got a roof the size of a small warehouse, you’re only likely to have one or the other installed for your domestic needs, and because in most parts of the western world natural gas for home heating has, until recently, been so cheap and gas boilers have become so efficient, solar thermal panels have largely lost out to solar photovoltaic panels in the battle for that limited rooftop real estate.**

**But what about that Solar PV panel inefficiency factor?**

**According to this twenty-seventeen analysis paper by the Swiss Federal funding program EnergieSchweiz,**

**“Approximately 10% of the solar irradiation on a crystalline photovoltaic cell is reflected and cannot be utilised. Around 17% of the remaining 90% of the irradiation that is absorbed by the cell can be converted into electricity and 73% is converted into thermal energy. In a photovoltaic module the thermal output remains unused. It raises the temperature of the cell and can thus have a negative effect on the electrical efficiency of the module.”**

**And here's that again in layman’s terms. A typical solar panel is rated for optimal efficiency at a cell temperature of about twenty-five degrees Celsius. That’s not ambient surrounding air temperature, that’s solar cell temperature. For every ten degrees Celsius the solar cell heats up above that level, the panel loses something like five percent of its rated performance. So, a panel at seventy-five degrees Celsius would have lost a quarter of its ability to generate electricity. And on a sunny day in somewhere like Australia, which has the largest proportion of solar PV panels per household in the world, it’s not uncommon for panel temperatures to hit a hundred degrees Celsius.**

**It's almost the definition of irony isn’t it really? A device that relies on the sun, but which gets less effective as the sun heats it up!**

**And the really harmful enemy of solar panels is SUSTAINED heat. According to Professor Martin Green of New South Wales University, who is affectionately known as the Godfather of Solar PV,**

**“A decrease of 10 degrees Celsius in operating temperature could double the lifespan of solar panels and boost their performance every day. “**

**Now, you could stand on your roof with a hose pipe in your hand, spraying all your panels with water during the hottest part of the day. That would certainly cool the panels down and immediately improve their efficiency, but you’d probably get bored, and eventually you’d get heat stroke and fall off the roof. Plus, you’d be using a bunch of water, which is another precious resource you don’t really want to waste.**

**And natural gas isn’t quite as cheap as it once was, is it? Over here in Europe, where bad things are happening, our home heating bills are about to go off the scale. Plus, policymakers in most countries are now looking for ways to urgently reduce the carbon dioxide emissions from their national energy sector, not to mention reduce their reliance on fossil fuel supplies from less than reputable sources! So, if there was a safe and reliable way to cool down solar PV panels to optimise their electrical performance AND divert that recovered heat to do some useful work, then you’d be onto a winner, right?**

**And that’s where PVT technology comes in. It’s actually been in development for a few years. Early designs attempted to combine the design of a solar thermal panel with solar photovoltaic technology by essentially adding liquids in an energy reservoir heat exchanger box bolted to the bottom of a solar PV panel. The liquid was plumbed up to the box from the house and a pump was used to control the flow and outlet temperature. But these early designs came with a few drawbacks. Firstly, the heat exchanger typically had an inlet at one end and an outlet at the other. That meant the cells closest to the inlet were always cooler than the cells closest to the outlet. The difference could be significant across the panel and because of the interdependent way that cells work on a solar panel, that temperature variation meant the performance of the whole panel was only really as good as the hottest cell. And the liquid needed to be in constant contact with the back of the panel to allow the heat to be dissipated away. Industry research showed that even with a small air gap, the heat transfer dropped exponentially with gap size. In colder climates, an anti-freeze like glycol had to be used to prevent the heat exchange liquid from freezing. Leakage from joints was also an issue. And you don’t really want liquid escaping into a confined space with high voltage DC current flowing through it. Add to that the complexity of all that plumbing during installation and the extra difficulty of repairing or removing the plumbed in panels, and you’ve got yourself a bit of a cumbersome solution that could be a difficult sell to the average punter.**

**The alternative is a PVT system using air or gas like this one from an Australian startup company called Sunovate.**

**In a recent webchat, Sunovate’s co-founder and technical director, Glenn Ryan, explained how their system works.**

**An air-tight cassette is created using the same inexpensive stamping machines that make car body panels. The air box is designed to be simple enough that it can either be factory fitted to the underside of a solar PV panel or retrofitted to existing panels on a rooftop in such a way that it doesn’t affect the warranty of the existing panels. At each end of the box is a fan that pushes ambient air in, which then gets heated by the excess panel heat and sent back out of an exit point. So, you’re constantly removing heat energy from the underside of the solar panel, which means its electrical generation capacity is being improved, and you’re harvesting the heat energy to do some useful work.**

 **Sunovate’s research showed that on a typical 25 degree Celsius day, you can easily get 40 degrees Celsius of heat energy from the cassette system, which effectively increases the amount of solar energy being utilised by the panel from about 17 percent, right up to about fifty percent, and increasing the operational lifespan of the panel from about twenty years to something more like fifty years.**

**And, of course once you’ve captured the heat energy, there’s a whole bunch of options for what you can do with it. It can be fed directly into a ducted system to provide direct space heating inside the house. Or it can go through a heat exchanger to supplement your homes hot water system.** **There’s even a company called Stiebl in Germany that makes an interior air source heat pump, which could take the excess heat energy directly from the Sunovate system and use it to provide all of the homes heating and hot water, even on colder days.**

**In hotter regions like Australia and the southern states of America, where your house may not need any heating, these systems could dump heat somewhere else, like into the pool in your garden, which I’m told are a popular choice in those parts of the world. If I had one in my garden here in England it’d probably be more useful as an ice rink to be honest, but the point is you’re still removing heat from a PV system to allow it to operate far more efficiently, and sending that heat into something that would otherwise be using electricity to keep it warm.**

**And as an added bonus, the exact same cassette system can harvest cool air at night time, when the surface of a solar panel is typically about eight degrees Celsius cooler than the surrounding ambient air. That air can then be circulated around the home to provide a more comfortable night time temperature in hot countries.**

**But these PVT systems also have great potential in larger applications.**

**In a** **commercial setting they can be used for all sorts of services like wood drying or supplemental heat for industrial processes.**

**And perhaps one of the most promising opportunities is in district heating systems.** **Sunovate’s plan is to** **integrate their solar PV heat recovery system with glasshouse type structures to create multi-megawatt installations.**

**District heat networks are a closed loop system of pipes typically with a hot supply and a cold return. They’re generally filled with a liquid, either as water or a water-glycol mix. District heat can supply residential homes and public buildings, as well as commercial greenhouses and industrial processes. They can also be connected to large seasonal storage facilities where heat energy can be squirreled away for winter and high demand periods. That’s something that’s already being done in some parts of the world where bore holes are drilled deep into the earth and heated liquid is sent right down to the depths during the hot summer months where it maintains its energy for very long periods of time and then drawn back up during the wintertime when it’s required.** **In Demark they have systems that collect heat during the summer and dump it into huge pit storage systems with insulating foam toppers. And in the Netherlands there are facilities that force hot air into subterranean aquifers for long term storage.**

**All of these existing systems could be greatly enhanced using harvested energy from PVT systems. It’s certainly an ambitious goal, but if it can be achieved then we’d have something that would be making a really tangible difference to our global decarbonisation challenge.**

**Sunovate themselves have a couple of big scaling steps to go through before they can provide commercial scale data for their levelised cost of heat production, but in our webchat Glenn Ryan told me he’s confident that once they reach mass production levels, they’ll be at least competitive with natural gas with an applied carbon price.**

**My YouTube buddy Rosie Barnes visited Sunnovate’s prototype site out in Perth, Australia recently, and she’s produced a fascinating video over at the Engineering with Rosie channel looking at how solar thermal is likely to fit in with the overall renewable energy matrix, and I’ll leave a link to that in the description section below.**

**You may well have direct knowledge of these systems, or perhaps you’re already working in the industry and you can share a few nuggets of insight. If you do, or if you just have views on the subject one way or another, then jump down to the comments section below and share your thoughts there.**

**That’s it for this week, though…etc.**

**A massive thank you to our fantastic Patreon supporters who keep these videos ad-free and completely independent. And there’s just time to give a quick shout out to the folks who’ve joined recently with pledges of ten dollars or more a month. They are**

**David Hailey**

**Peter Kullmann**

**Glenn Matlack**

**Rory Litwin**

**Neil Harmer**

**Greg Goodson**

**Damian Seery**

**Pierre Skier**

**Brian Semmler**

**Neil Hardy**

**Steve White**

**Kreig Leitchze**

**Lee Redden**

**And**

**Garrett Cassar**

**And of course a huge thank you to everyone else who’s joined since last time too.**

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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**