One thing we have learnt this week – new types of solar cells

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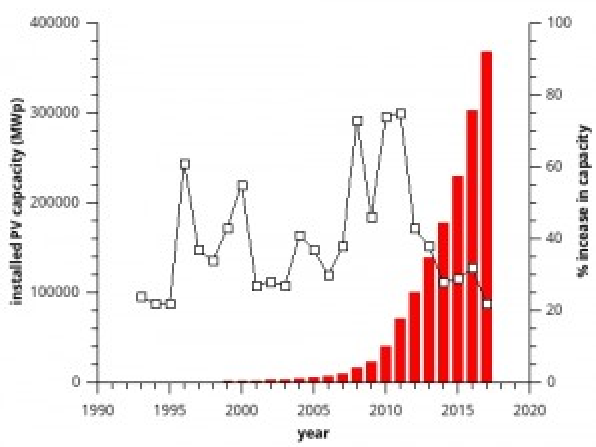
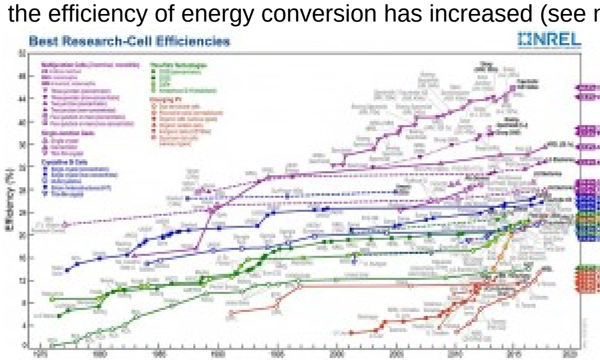
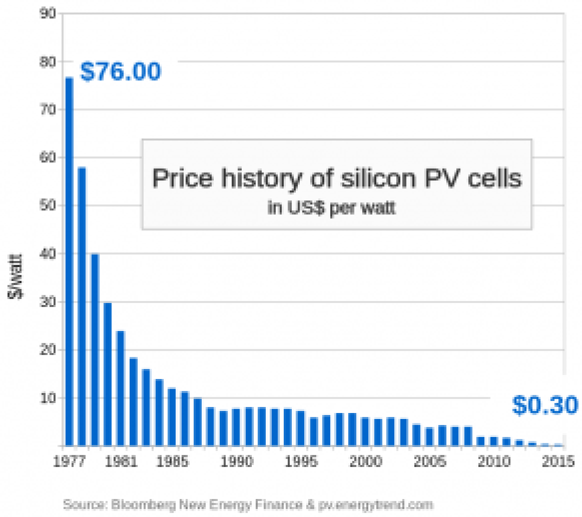
I read a very interesting article in the Guardian this week that got me thinking about types of solar cells. The main article was that silicon solar cost reductions were falling away and this opened the door for new types of solar namely Perovskite types. Reviewing the different types and how they work before we get to this new potential type. **How do they work.** A very simple explanation which applies to all types, the materials maybe the different but the underlying physics is the same. Taking silicon types. Edmund Bequerel discovered the photo electric effect in 1839 and Einstein got a Nobel prize for his explanation of it. Certain materials (and there are quite a range of them) when exposed to light the photons cause electrons to be freed from the material (e.g. silicon). In a pure material this is useless since the electron is recaptured easily. However you can change the behaviour by doping the silicon. Silicon has 4 electrons in outer orbital by adding small amounts of phosphorous with 5 electrons in its outer shell you give it one electron with nothing to do which can be liberated by light and move around. This is known as N-type. By doping with boron you do the opposite there is a shortage of electrons and a positive charge can move (P-type). Both can be liberated by light and are laid on top of one another (a semiconductor). The charges liberated by light have desire to move from one side to the other to equalise charges. This is a current which can be used. All types work in the same way. The light has to be pretty specific wavelengths (just the right energy) do this for specific materials. These main types are. (Note many have been combined which raises efficiency). **Silicon**. The most common type in the world today. The graph below shows this success. In 2004 when we got our first system we were thought of as eccentric and there was barely 4GWp worldwide now the total is over 300GWp (source various) and you cannot go anywhere without seeing a roof covered in modules.



The a number of disadvantages to this technology. The first is it takes a lot of energy to make the cells. The raw silicon must be purified by heating to a molten state. This has led to the incorrect rumour that these cells never return the energy used to make them. This is not true. In actual fact the energy return has improved and the efficiency of energy conversion has increased (see next graph below). The theoretical maximum is about 29%.



One major disadvantage is that convert at the red end of the spectrum and so require bright sunlight. Another is the cells have to be cut very thin which is not easy. There are two types monocrystalline and polycrystalline. Mono are more efficient and more expensive and work slightly more cross spectrum. One major advantage is their longevity. Both have 25 year guarantees. Also they can be recycled into new cells. **Thin film**. This includes a raft of technologies including one silicon and the phrase relates to the fact that the layers are far thinner.   Lots of these are transition metal based such as copper indium gallium diselenide. They have a number of advantages in that they use less material and energy to make. They can also be rolled out into thin layers so could be used on walls windows etc. They have never really caught on and make up about 15% of the market. **Amorphous silicon.** This is a silicon based technology that is thin film with lower purity silicon. The advantages are it uses recycled materials from the electronics industry. They also work far more cross spectrum. This means that they work as well on a cloudy day as a sunny day. The disadvantages are they are less efficient with shorter guarantees. They have been failure issues particularly in hot countries. **Organic.** Organic molecules can absorb photons and liberate them as a semiconductor. Lots of different types are under development. The advantages are those of thin film. The disadvantage is that the efficiencies and life are lower. **Perovskite types.** Technically a thin film (as you see there is overlap between the different types). Perovskite is a mineral but this is not used to make the cells. The word relates to the 3D arrangement of atoms not the materials used. The advantages are as thin film. The disadvantages are that getting large sheets of this material are challenging. New types of solar cells are being worked on all the time but silicon is very dominant that its difficult for new technologies to break through. Are argument in the article was that new types of solar cells are required since the cost reductions in silicon are slowing down. Is this really true?



The pace is lower but looking at the graph these reductions are still huge in % terms and certainly many believe these reductions will continue (such as the Fraunhofer institute). New types of solar cells will still find it difficult to break through. In addition many new types of solar cells are best combined with silicon anyway. Neil

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