PortHampton Power

POWER SUPPLY AND TRANSPORT SYSTEM

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Solar

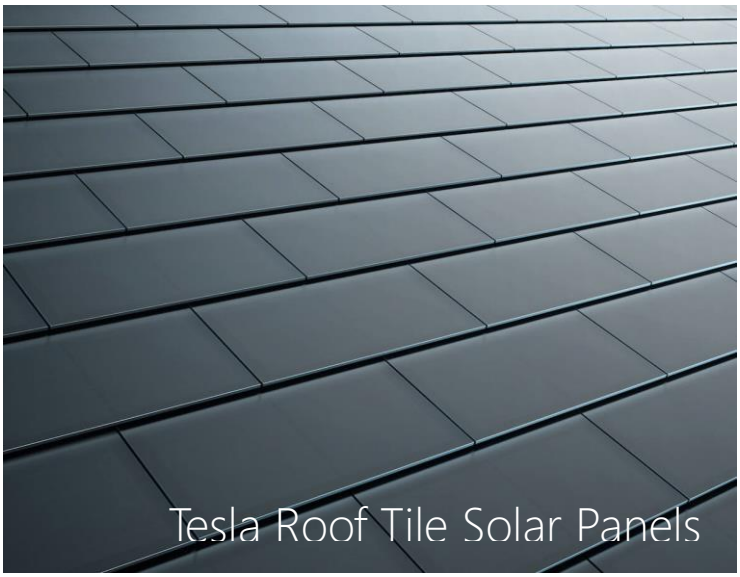
An idea we can take from Tesla's Roof Tile Solar Panels is that it's also used as roofing tiles, saving tiling costs.

An average house roof size is 215 square feet and at Tesla's pricing of £16 per square feet, it will cost a total of 3 billion pounds for the re-roofing of the 850 000 houses required to house 2 million people, with each house containing an average of 2.4 people. Compared to the normal cost of re-roofing of 5500 pounds, using solar panels as roof tiles will actually save 250 million pounds, not counting the energy produced from the solar panels.

Additionally, because traditional solar panels leave 20% of a roof's surface bare due to the lack of space, using solar panel tiles will provide an additional 20% of area totaling 3.2 million square meters which is equivalent to 0.32 giga-watts hour.

Whereas the average efficiency of solar panels in use today is currently 15%, using Solar Thermophotovoltaic cells can increase the efficiency to around 80%. If we combine this technology with roof tiles, we can get an increase of 7 giga watts per hour from domestic alone, which is an efficiency increase of 700%.

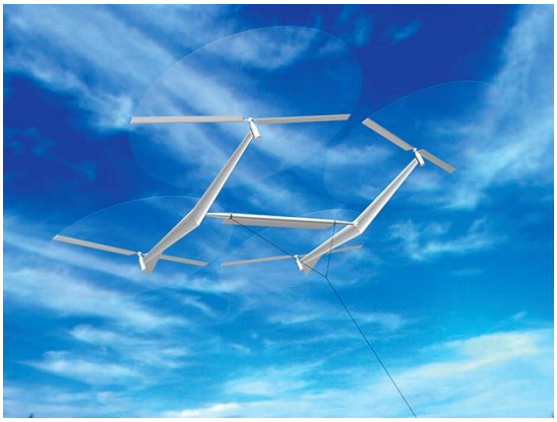
A huge advantage of using Solar Thermophotovoltaic cells is that they absorb wave lengths from infrared to ultraviolet rays and that they can work in damp environments.



Wind

Wind turbines are able to turn because the Kinetic Energy of the wind is transferred to the blades. A faster wind speed means a higher kinetic energy so more energy is transferred to the blades, which produces more electricity. Going off this concept, there are many high-altitude wind turbines designed to operate at around 10,000m above sea level, in the jet stream. The jet stream is a stream of consistent strong wind caused by the Earth's rotation

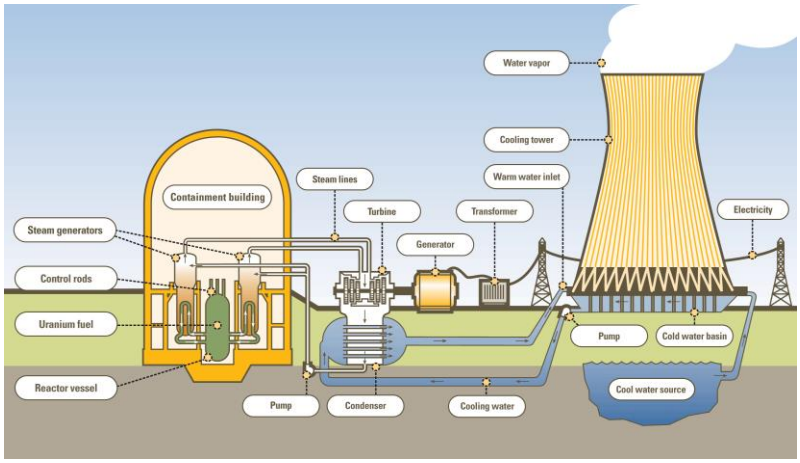
A design we are interested in uses helicopter like rotor blades to take a system into the jet stream, where it uses a portion of the energy produced form the turbines to keep itself airborne. When it has filled its battery capacity, it then flies back to land where its energy is transferred over and the system flies back. This system produces around 0.01 megawatts per hour per square meter at 90% efficiency, which is double that of land-based wind turbines. Variations of this method include kites tethered to the ground or blimp-like airships. The Japanese Aerospace Exploration Agency is researching methods to wirelessly transmit energy, which is a technology that could be implemented into this system in order to increase efficiency (as the system is airborne for longer) or directly transmit the energy to households (reducing energy loss from transport – pylons)



Nuclear

Nuclear power will provide the majority of the city's energy needs. During the energy generation process, there is zero carbon emission. However, there is carbon emission during construction and decommissioning, and other processes like transportation of materials, mining and repair. On average, 66 grams of carbon dioxide is released per kWh of energy, as a result, carbon capture processes need to be performed using other technologies. Nevertheless, using nuclear power instead of other conventional energy production method still prevents a lot of carbon emission. For example, 859 grams/kWh of carbon dioxide emission is avoided by using nuclear power instead of coal, 704 grams/kWh by not using oil and 470grams/kWh by not using natural gas.

However, there are also down sides to using nuclear power. The initial set up cost for a nuclear power plant is quite high, with each costing 6.85 billion pounds on average. Furthermore, power plants need to be decommissioned after 40-60 years of operation due to embrittlement, a process where cracks develop on metal surfaces due to radiation. The decommissioning process takes up to 60 years to complete and costs more than 377.55 million pounds. The first stage of decommissioning is known as safe storage, radioactive substances are allowed to decay into stable elements. The second stage is decontamination, contaminated materials are either decontaminated on site or shipped to a waste disposal facility, and this reduces the radiation level and workers' exposure to radiation, allowing them to dismantle the power plant safely. Another major disadvantage is the need to remove and store nuclear waste safely, which requires lots of resources and has a risk of leakage of radioactive substances.



Nevertheless, taking into account that it is a long-term investment, its advantages compared to other conventional non-renewable energy production method outweighs its disadvantages. It is essential that the energy production method emits as little carbon dioxide as possible while being able to produce sufficient amount of energy to meet the demand of the city.

Biofuel

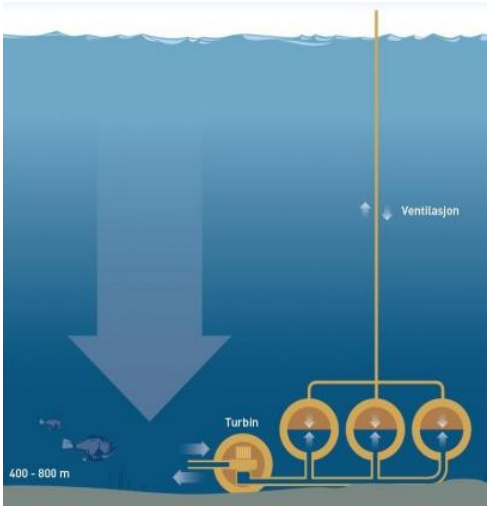
Some of the greatest limitations of biofuel is the use of fertilisers, using agricultural land, monoculture, which is the practice of producing the same crops year after year which will eventually deprive the soil of nutrients for future crops, and its high cost of production.

Scientists from Synthetic Genomics and ExxonMobil have solved this problem by developing a strain of algae that converts carbon into a record amount of energy-rich rat, which can then be processed into biodiesel or burnt to produce steam to spin turbines. 40% of the algae's mass is fat which is over double the fat content of conventional algae.

The fuel emits fewer greenhouse gases than most conventional energy sources, does not stress food production wen produced on an industrial scale and can be cultivated on land unsuitable for other purposes with water that can't be used for food production, which removes the previous limitations. When used as biofuel, each acre of algae yields around 2000 gallons of fuel, compared to 650 gallons per acre for palm oil and 50 gallons per acre for soybean. It can be harvested year-round unlike other food stocks such as corn.

Although this technology is ready for implementation, they are hoping to further increase the algae's ability to convert the sun's energy into biomass to further increase fat production.

Hydro



Renewable technology is not extremely reliable due to the unpredictable weather. Hence we have a few methods to counteract this problem. The main technology we're looking at are underwater tanks producing hydroelectric energy.

By being placed at around 400 to 800m deep, water pressure is 80 times larger than at sea level. This means for the same amount of water, you get a higher efficiency from the turbines. These tanks

work by opening when energy is required. Water flows into the tanks turning a generator as they do so.

Water is then removed through pumps pumping water out or by pumping air in, and so forcing water out so that the system can then be reused. This process has an efficiency ratio of 80% and its many advantages is that it's flexible as any number of tanks can be added and energy is produced on demand

Transport

The system

The public transport system we have chosen to use is one that runs entirely on our revolutionary system of hydrogen energy. As can be seen in the figure on the right, the system consists of two main transport vehicles: Hydrail and the FCBus. With a total costing estimate of £9Bn for 2120 vehicles we believe that as compared to a city such as London that has a total spending of up to £30Bn annually on public transport, we are being cost efficient in our methods. The design will be a hydrail which runs through the city in a straight line in both directions. At the train stops there will be a network of buses that will take people further from the city center. We will use a park and ride system so the system will be carbon neutral

Hydrail

The train features a motor that gains its power from a hydrogen tank and a fuel cell. Stored in a tank large enough to fuel a 497-mile journey, the hydrogen's chemical energy will be converted into electricity by the fuel cell, propelling the train at up to 87 miles per hour. Any energy not used immediately is stored in Lithium batteries attached to the car bottom. Producing nothing but steam as a by-product, the motor will run far more quietly and cleanly than a diesel engine.

FCBus

The fuel cell that powers the bus uses hydrogen and oxygen to generate electricity by an electrochemical process producing only heat and water as a by-product (no harmful emissions). The heat can be used again to warm the passenger compartment, such that as little energy as possible is lost in the process. Other ideas could use ethanol or biofuel.