**Smart Home - Energy Sustainability**

**Background**

There are a variety of approaches to making a home more sustainable and improving its green credentials. These range from

* Better insulation including loft, wall, and double glazing to make it more efficient and in so doing reduce its energy needs
* Changing heating and energy from fossil fuel-based sources to more sustainable sources including wind and solar.
* Have the home generate its own heating and energy by using modern infrastructure such as solar, battery storage, air and ground source heat pumps.

Rather than treating each on its own, they should be considered together. A home that is well insulated, generates its own energy and draws from external utility suppliers only when needed will provide the biggest benefits.

**Case Study**

A home is based in Chandlers Ford in Hampshire provides a good example. When the owner moved in the house had single glazed windows, little in the way of loft insulation and all energy and heat was from fossil fuel sources. The aim was to evolve it into a smart, sustainable and energy efficient with two key objectives: -

* To ensure the home is sustainable and plays a small part in reducing climate change
* To provide savings for the owner over the mid to long term

Being a brown field opportunity, the Improvements have evolved over several years

1. Double Glazing
2. Loft Insulation
3. Adding Thermostatic Radiator Valves (TRVs) and smart thermostat to supply heat when the house is occupied at the right level and only to rooms that are occupied.
4. Solar Panels to generate electricity. The benefits are year-round with electricity being generated even on cloudy days. During the lighter less cloudy days the panels generate far more than the house needs with the excess being handed to the grid.
5. Utilise excess generated energy rather than hand it to the grid. When the panels are generating more energy than needed the excess is diverted to the immersion element of the hot water cylinder. Generated energy is now used to heat the water in place of gas.
6. Battery Storage. The solar panels work during daylight hours when the suns radiation can penetrate the clouds. During the evening and night, the house must draw from the grid. With a family that is predominantly not at home during the day this means a lot of generated energy was wasted. The solution was to install a battery that is charged by the solar panels during the day and then released to power the house during the evening.
7. Switch electricity supply to an "economy 7" type tariff. On days when there is not enough sun to charge the battery, it is charged using cheap electricity in the middle of the night. The cheap rate of 5p per kwh makes for a big saving compared to the standard rate of around 13p per kwh.

**Adding a Smart Controller**

Each enhancement has provided benefit to the point that the house is self-sufficient for electricity for around half the year. For the other half, the electricity bill has been cut in half.

Until this stage in the homes evolution each component provided benefit but operated independently of each other. An example of this is the battery control system which is manually configured with the amount of cheap rate electricity to use. During the darker half of the year, it was configured to fully charge the battery overnight. It means the battery is guaranteed to be charged from cheap rate electricity but what if the following day is a pleasant day? If the battery is fully charged overnight any excess energy generated the following day is handed back to the grid rather than being used by the house. What was needed was an intelligent system that could take account of the weather forecast.

The last component added to the house is a *smart controller* that starts integrating the components enabling them to co-operate with each other to improve the benefits and savings.

The smart controller is a computer program running in the home that takes its input from a number of sources: -

* The solar panels
* The battery
* Home energy monitor
* The weather forecast

The smart controller looks at the weather forecast for the following day together with the current battery level. Based on this it determines how much or how little cheap rate electricity is needed to charge the battery and sets the charge point on the battery controller accordingly.

The result is a system that charges the battery just enough to see it through to when the solar panels take over. When the forecast is good no cheap rate electricity is used and the house is self-sufficient. When the forecast is poor the battery is charged 100% from cheap rate electricity or more typically during the darker half of the year it is somewhere in between. .

**The result**

The image below shows a day in the life of the house on the 13th March 2021.

.

Machine generated alternative text:
2021-03-13 
03-13 
CHARGING/DISCHARGING(W) 
02:00 
04:00 
0600 
GENERATION(W) 
1 6:00 
IMPORT(W) 
EXPORT(W) 
22:00 
DEMANDED POWER(W) 
08:00 
10:00 
12:00 
1 4:00 
1 8:00 
20:00 

* The smart controller determined the battery needed to be charged with cheap rate electricity between 12:30 and 02:00
* This weather forecast was accurate as the battery combined with energy generated during the day meant very little (red) energy was pulled from the grid.
* From 08:00 to 16:00 excess electricity was used to top the battery up (black)
* There was heavy energy consumption (green) between 18:00 and 20:00 while the oven and hob were on, all of which was provided by the battery

The "smart controller" is automated, it works 24 by 7, 365 days a year with no intervention. The addition of the smart controller provided additional benefits and savings with little outlay. The smart controller's journey has only just begun, its evolution puts it at the heart of the smart home.