Winter 2023

How-to: Make your house a battery--How demand-side management will be one key to a greener future, explained for popular audiences.

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A Beginner's Guide to Demand-Side Management (and why it matters)!

Created in conjunction with Western Washington University's Winter 2023 Honors Capstone
March 16th, 2023

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Special thanks to: WWU IES

This little brochure is designed to make the subject of demand-side management (DSM) easier to understand for people without an energy background. I hope this helps you better understand DSM!

Let's start with a short background on electricity demand. At every second of the day, power plants near you are producing the *exact* amount of energy that you need for your everyday activities! Electricity demand is the amount of electricity you and everyone else in your utility's network are using at any point in time. Figure 1 below illustrates the various types of electricity demand for a household in California. A household's demand varies from day to day and season to season, but there are a few consistent trends in electricity demand: morning time (when people wake up to shower and make breakfast) and dinner time (when people get home from work and start turning on their cooktops and TV's) usually have the highest demand, whereas the middle of the night usually has the lowest demand.

The variation in electricity demand depending on the time of day poses a major problem for adding more renewable power plants to supply electric power. The most commonly used renewable generators are relatively unreliable, and they cannot reliably meet demand when people are using electricity. As you can see in Figure 2, wind generation varies unpredictably throughout the day, and solar energy is only generated when the sun is shining- this generation peaks in the early afternoon. Imagine how inconvenient it would be if your lights would only turn on when the wind is blowing or the sun is shining!

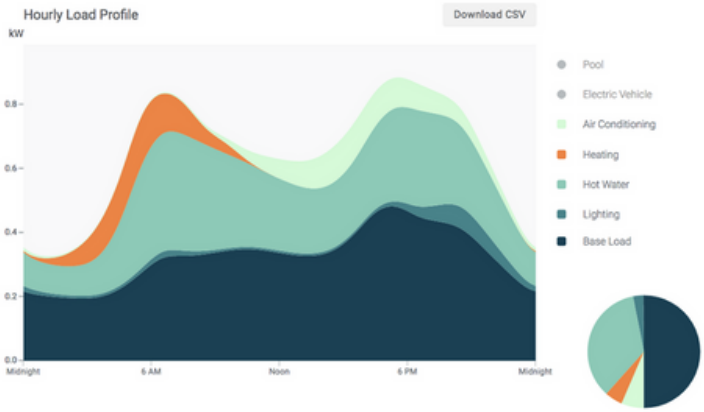

Figure 1: An example of an estimated energy demand in summer for a residential house in Stanford California. Source: Aurora Solar, 2023

When there isn't enough electricity being produced by renewable generators, what happens? To make sure we are producing the exact same amount of electricity that is being demanded at every point in time by houses, factories, and businesses, our electricity supply is supplemented with what are called "peaker generators". These generators are typically oil and natural gas-burning, are expensive, and generate a lot of greenhouse gasses when they are running. However, they can make energy on demand, so they are very useful in making energy as soon as we need it.

Now, how can we increase the amount of green energy in the grid, decrease the need for fossil-fuel generators, and lower the cost of electricity? One option is implementing what we call demand-side management. This includes shifting when we are using electricity so that we can be more aware about which power plants we are using when to meet electricity needs. The main idea is incentivizing people to use electricity less during high-demand times (like in the morning and evening) so that less expensive and polluting "peaker" generators need to be used. Demand-side management has a few different forms, including **demand response**, **energy efficiency**, and **energy storage**.

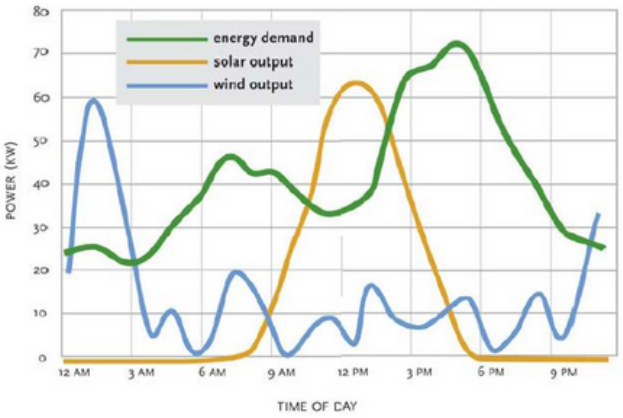

Figure 2: Solar and wind generation in a region compared to the energy demand. Source: Edrisian, 2013

Demand response is a tool used to incentivize people to change what time of day they use electricity. This might include making electricity more expensive at certain times of the day, like during the evening when everyone gets home from work.These price-based programs allow people to choose when and how they want to reduce their energy usage. There are also programs where customers can sign agreements with their utilities so the utility can lower their energy use a few times a year when there is an unusually high demand. This exceptionally high demand tends to happen on the hottest/ coldest days of the year, when people's heaters/ AC's are all running on full blast at the same time. Programs like these are called incentive-based programs and involve signing an agreement with the utility ahead of time giving the utility a little bit of control over their thermostat or water heater in exchange for a discounted energy bill. Demand response aims to increase flexibility of demand, which fits under the "load shifting" diagram in Figure 3.

Energy efficiency is another type of demand-side management. If a heater, AC, or other large appliance runs more efficiently, then there needs to be needs less energy to run, we need to generate less energy in the first place. On a large scale, if a lot of people have more efficient devices and are all demanding a little less energy than normal, then the total amount of energy that needs to be produced can go down by a significant amount! This idea is demonstrated in the "strategic conservation" diagram in Figure 3. Reducing energy consumption is another way we can use peaker generators less often!

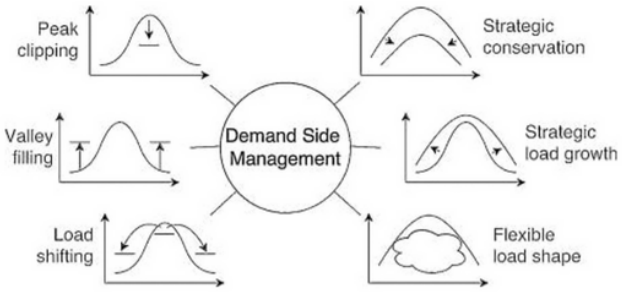

Figure 3: A diagram to visualize demand-side management. Various techniques can be used to re-distribute demand and help reduce the need for peaker generators. Source: Meliani, 2021

Finally, small-scale **energy storage** is another way we can add flexibility to the grid. An example of this small-scale, short-term storage could include hooking up electric vehicles to the grid and charging batteries only during times of low demand, or temporarily discharging their batteries during times of high demand. One other example would be heating water heaters a little hotter than normal during times of low demand, such as the middle of the night, and allowing them to cool down during times of high demand, so energy doesn't have to be used to constantly heat them. In that way, they create more demand during times of normally low demand, doing some "valley filling" as demonstrated in Figure 3.

All these technologies and initiatives have many benefits for you and the world as a whole! Increasing flexibility of energy use means that we are less likely to have blackouts, energy is less expensive as pricey generators are used less, and we can use more renewables. Additionally, higher-polluting generators are avoided, which is better for air and water quality for everyone! All in all, demand-side management will be a very powerful tool in transitioning to more renewable energy and building a more environmentally conscious energy grid. Lots of utilities already have programs like these in place. Our local Puget Sound Energy, for instance, is currently piloting a program for a voluntary incentive-based demand response program on Bainbridge Island and in Duvall. Now that we now know what DSM is, keep an eye out for demand-side management projects near you, whether that be demand response, energy efficiency, or energy storage!

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