WattTime

A new technique in sustainability

Over the last two years, cutting-edge research at UC Berkeley, Yale, and Carnegie Mellon has raised the possibility of an entirely new technique in sustainability: using electricity specifically at times when the grid is powered by cleaner energy sources.[1] WattTime is a nonprofit founded by UC Berkeley PhD students that researches, develops, and deploys technology that implements this technique in order to enable organizations to meet sustainability goals.

WattTime's method works in four steps. First, a cloud-based server analyzes the power grid to determine the sources of electricity on the grid in a given time and place. Second, the server sends this information to any electricity-consuming equipment with an Internet-connected control system and an accessible data format, such as automated demand response (ADR) capable equipment. Third, electricity-consuming equipment then uses this signal to determine the optimal timing of its power consumption based on the needs of its users and the desired level of pollution reduction. Finally, the server communicates with energy monitoring systems to quantify and verify the actual amount of carbon saved due to shifts in energy use.

Step 1. Analyzing the power grid

As different power plants turn on and off throughout the day, the mix of fuels on the grid—coal, natural gas, wind, etc.—is constantly changing. A growing number of utilities and grid operators are beginning to provide real-time public data about this mix.[2]

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[1] See, e.g. Spatial and Temporal Heterogeneity of Marginal Emissions: Implications for Electric Cars and Other Electricity-Shifting Policies. Joshua S. Graff Zivin, Matthew Kotchen, Erin T. Mansur. 2012. http://www.nber.org/papers/w18462

[2] See, e.g. ISO New England's guest dashboard

WattTime is unique because it focuses not just on that overall mix, but on what is known as the “marginal” power plant. When a user flips a light switch, the “marginal” plant is the one that actually increases or decreases its power output in response. At WattTime, we believe that means your power is “from” this plant, because it is the one you can actually affect by conserving energy. By shifting energy use to times when the marginal power plant is cleaner, an electricity user can directly reduce emissions from dirtier power plants in real time.

To determine the marginal plant, WattTime applies the latest techniques in electricity market economics. These new methods achieve very high accuracy and reliability by incorporating actual historical pollution monitoring of power plants, rather than engineering assumptions.[3] Our method incorporates hourly pollution data nationwide as reported by the US EPA’s Continuous Emissions Monitoring System (CEMS) against a variety of current market conditions including place, time of day, flows of electricity between regions, and the current level of electricity demand in a region.

WattTime is the first project to implement this technique in real time, by monitoring wholesale electricity markets known as Independent System Operators (ISOs). Currently our method can accurately distinguish between any of 20 different grid situations and associates each situation with a group of power plants that are typically marginal under those conditions. Our precision will also continue to grow over time as we continue to integrate the bleeding edge of ongoing research at UC Berkeley and elsewhere.[4]

Step 2. Connecting with ADR-capable equipment

WattTime’s RD&D is still in its early stages. A basic version of the cloud server went live in March 2014 and we continue to expand its capabilities with new features based on our vision and the needs of our partners. Currently, WattTime is preparing its first pilot project involving automated timing at UC Merced. In that project, WattTime will install and operate new smart plugs that reduce the carbon footprint of electric vehicles through timing when they charge.

The WattTime method has also been explicitly designed for another potential approach: direct integration with existing ADR-capable equipment. Since adjusting the control settings on existing equipment does not require a capital outlay, it is potentially a very

[3] See, e.g. Marginal Emissions Factors for the U.S. Electricity System. Kyle Siler-Evans et al. 2012. *Environmental Science and Technology*. http://pubs.acs.org/doi/abs/10.1021/es300145v

[4] See, e.g. Negawatt or Megawatt? Evaluating marginal impacts of climate change mitigation strategies across space and time. Meredith Fowlie, Duncan Callaway, Gavin McCormick. Forthcoming.

low-cost source of emissions reductions. WattTime is now accepting proposals from partners who can work with us to pilot test retuning their existing ADR-capable equipment.

Step 3. Control and management of ADR-capable equipment

WattTime has identified three broad categories of ADR-capable equipment that are often a good fit for the commercial sector.

- **Building heating, ventilation, and air conditioning (HVAC):** For office buildings with centralized Energy Management Systems (EMS), it is often possible to use the controls system to pre-cool or pre-heat buildings according to times when electricity is relatively dirty or clean. For buildings equipped with variable speed drive (VSD) ventilation, fans can be configured to circulate air at times when energy comes from relatively clean sources.
- **Energy storage:** Grid-connected batteries or industrial chillers can be configured to charge or cool at times when the grid is relatively clean and release energy at times when it is relatively dirty. An early pilot project here could be simply to measure the carbon impact of an existing battery system, and draw up a supply curve of how many additional carbon savings could be achieved at what cost, if any.
- **Other:** This basic strategy can be configured to work with a wide variety of energy end uses, from plug-in electric vehicles to data center cooling. In theory, WattTime's services can increase the environmental benefits of almost any project where control and monitoring systems are already installed, and where the timing of energy use has some flexibility.

Step 4. Quantifying and verifying benefits

WattTime's high-resolution time series data about the environmental impact of electricity consumption can provide a range of benefits in the corporate sustainability space.

When used as an input to an energy control and management system, WattTime's services include quantification and verification of the amount of carbon saved and other environmental benefits. The extent of the benefits will depend on the specifics of the project, including the technology application, scope of the installation, and event frequency. In many cases it is possible to reduce a company's carbon footprint with no increase in energy rates. Thus, WattTime's approach can be a particularly low-cost, high-reward solution when an investment has already been made in control and monitoring systems or other advanced energy technologies.

In addition, many companies already deploy some equipment that shifts electricity timing, but do not count these impacts against their sustainability targets. For example, some buildings use backup batteries to avoid peak demand charges, but do not quantify the implications of these batteries for the carbon intensity of the power grid. In such cases, WattTime can also be used to simply calculate and verify the on-going pollution savings achieved by existing equipment, and to suggest opportunities where it could be operated slightly differently to meet more ambitious sustainability targets.

Conclusion

Carbon-aware electricity timing is a brand-new way to achieve carbon and other emissions reduction targets at relatively low cost. WattTime, a nonprofit with roots in the University of California system, is paving the way for this technique in the field. The method can be compatible with most electrical control systems, but is particularly low-cost where it can be applied to already installed equipment or as a component of a full-service installation project. WattTime seeks partners interested in quantifying the benefits their existing time-shifting equipment already causes, or in methods to further increase the emissions reductions from their existing equipment.