What if we let consumer electricity prices fluctuate?

Allowing consumer electricity prices to fluctuate from one time of the day to another could help accelerate the transition towards renewable energies and drive down the costs of this transition. Electricity production from renewable sources, such as wind and solar energy, is expanding rapidly in Europe and around the world. However, integrating these fluctuating sources into the grid is becoming increasingly challenging for grid operators that need to match electricity supply with demand. Switching over to a new electricity market system, in which demand would better adapt to supply, could be crucial for the success of the transition towards a low-carbon society.

The amount of electricity that we consume varies significantly over the course of the day. Consumption generally goes up in the early morning hours and reaches a peak in the late afternoon. Up to now, utility companies essentially respond to intra-day differences in electricity demand by adapting the production of electricity accordingly. With fossil-fuel power plants, this can be done quite easily, provided that sufficient capacity is in place to cover the peaks in demand.

© Galaxy67 / Fotolia.

With the rapid increase of electricity production from fluctuating energy sources such as wind and sun, this picture is becoming significantly more complicated. On windy or sunny days, there can be an oversupply of energy that needs to be absorbed by the power grid, while on calmer and cloudy days, the electricity production rate drops sharply. In order to balance out supply and demand, utility companies need to either maintain expensive fossil fuel plants to cover occasional peak loads, or find ways to store electricity locally or redistribute it over longer distances. In the end, the increasingly high cost of storing or redistributing electricity is beginning to counterbalance the decreasing cost of renewable electricity production.

This is increasingly a problem not only for consumers and utility companies, but also for renewable electricity producers. Wind turbines, for instance, produce most of their electricity exactly at those times when all the other neighbouring wind turbines also produce at maximum rates, pushing down wholesale electricity prices. This is making it more difficult for wind energy to become economically viable without relying on government support.

The introduction of smart electricity meters now offers an opportunity to redesign our energy market system. Smart meters would allow operators to charge consumers variable rates throughout the day, which would follow the evolution of electricity wholesale prices. How would that affect the overall system?

Author: Christian Kurrer

PE 624.275 – January 2018

Potential impacts and developments

At first, the change would perhaps not yet be dramatic: electricity would become cheaper for some hours of the day, but more expensive at other times. Most consumers would not necessarily check the current price of electricity before switching on the coffee machine or the hair dryer, just to possibly save a couple of cents. However, new, more adaptive smart electrical devices could start to appear on the market that would monitor electricity prices for us, optimise the way we use energy overall and lower our utilities bill. Examples could include washing machines or dryers that select for us the best time of the day to finish their job; freezers that lower their temperature when electricity is cheap to save electricity when it is more expensive; charging systems for electric cars that take advantage of the cheapest periods of the night to recharge their batteries; or stand-alone battery systems that would 'buy' cheap electricity from the grid when prices are low, and deliver it to the consumer when prices are higher.

The greatest potential might however be in the area of building heating systems: most domestic heating systems today rely on fossil fuels to heat water, because oil or gas is (still) cheaper than the (average) price of electricity. However, if the price of electricity fluctuated sufficiently, it might become cheaper to switch to heating water electrically during certain periods of the day. This would not only allow heating bill reductions, but would also gradually replace oil and gas with electricity generated from renewable sources. Moreover, the storage tank for warm water, present in many households, could be heated electrically whenever prices are low, further reducing the need for fossil fuels at other times of the day.

In this way, fluctuating consumer electricity prices could not only lower our electricity bills, they could also reduce the amount of oil or gas we need for heating, as well as help push the decarbonisation of the transport sector. At the same time, the additional electricity used by these smart systems at times when wind and solar energy is most abundant would help stabilise electricity prices during these times and therefore boost the economic attractiveness of investing in more wind and solar power. The resulting positive feedback loop would therefore mean smart consumers would not only benefit from fluctuating electricity prices, but would also increase the economic viability of further investments in fluctuating renewable energy production.

Anticipatory policy-making

As wind and solar energy becomes an increasingly prevalent part of our energy production capacity, we need to fundamentally transform our consumer electricity market system to become more responsive to short-term fluctuations in electricity production rates.

This would require smart meters that adapt the prices of electricity to the supply, and at the same time, smart consumer devices such as heating systems that switch over to electricity whenever the fluctuating price of electricity falls below a certain level.

From the technical point of view, smart meters and/or smart heaters are quite straightforward to develop, but initially, one without the other makes only limited sense. Political leadership, industrial coordination, financial incentives and the setting of common standards will be important for setting this transition in motion.

Eventually, this would also require a different approach to the energy-efficiency labelling system. A smart freezer that could modulate its temperature according to electricity prices would perhaps use slightly more energy than one that maintains a constant temperature, but the cost of the electricity would be lower, and it would make more use of fluctuating wind and solar energy, and thereby help reduce carbon emissions.