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Retail Electricity Price Plans for A Zero Emission Energy Future

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Traditional retail electricity price plans have been developed to recover the cost of services to firm loads. Firm loads cannot have their power interrupted by the utility except during power system emergencies. Electricity service has three major categories of costs:

(1) Costs that are fixed regardless of the amount of power (kW) or energy (kWh) used. An example is the cost of distribution system equipment and labor serving each building. Once the electrical service connection size is installed, the resulting costs do not vary with either the amount of peak power demand or electric energy used within the capacity limit of that service connection.
(2) Costs that are associated with the amount of peak power (peak kW) used. An example is the cost of transmission and generation equipment and labor required to supply the annual peak power demand of consumers.
(3) Costs that are associated with the amount of electrical energy (kWh) used. An example is the cost of fuel to produce the electricity. High emission generation typically has high fuel costs. Low emission generation typically has low fuel costs.

Unfortunately, various social and political goals have resulted in retail electricity rates that are not precisely aligned with those 3 cost categories above. For small consumers like residential service, the electricity rates are often based on either an energy consumption rate only or a combination of a small monthly fixed charge and an energy consumption rate. Larger consumers have more complex rate structures but those structures also do not align perfectly with the 3 cost categories listed above.

With traditional uses of electricity, the electricity rate structure can be flexible. However, if we want to encourage electrification of transportation and heating applications in order to lower CO_2 emissions, then the cost of heating with electric energy must be competitive with the cost of heating with the fossil fuels currently being used. Similarly, the system cost of using electricity-based methods to replace liquid fossil fuels in the transportation sector must also be comparable.

Because of the way energy is currently sold, most fossil fuel costs are combined into a volumetric rate ($/gallon, $/ton, $/cubic foot, etc.). Natural gas is a special case because it is supplied to buildings via dedicated pipelines so that fixed monthly and peak demand charges can also be included in the rate structure much like we see with electricity for larger business consumers.

However, from a consumer's perspective, energy can come from any source that meets the consumer's affordability limit. If zero emission electricity were available from time-to-time at rates lower than the cost of fossil fuels, that consumer could switch fuels to take advantage of the lower cost fuel when it is available. The only pre-requisite is for that consumer to have a dual fuel capability for their appliances. For a typical residential consumer that would be a dual fuel furnace for space heating in the winter and a dual fuel hot water tank for year-round use.

Most people do not appreciate that as an electric power system approaches zero emissions, the installed generating capacity will be able to produce, at little additional cost, more zero emission electricity than the consumer is able to consume. When this point is reached, the surplus zero emission energy can be sold to neighbouring jurisdictions, and/or the surplus can be curtailed (turned off or effectively wasted).

Short duration surplus electricity is not dependable. It can be sold as an interruptible source of energy at the marginal cost of production (effectively the fuel cost) by agreement among electricity wholesale markets. Selling zero emission surplus electricity on an interruptible basis is therefore not a profit-making operation. Curtailing the surplus is even worse because both the economic and environmental value of that zero-emission energy is lost.

The surplus zero emission electricity can be used to displace fossil fuels in other sectors of the economy if its marginal cost of production is lower than the volumetric cost of the fossil fuel it is displacing. Fortunately, that is almost always true because zero emission electricity has a very low marginal cost of production (little/no fuel cost).

So how do we reform our retail electricity rates to facilitate the use of zero emission electricity to displace of fossil fuels across our entire economy?

One method is to reform our retail electricity price plans so they exactly match the cost of service in the 3 categories listed above. Unfortunately, that will undo many years of rate design intended to achieve a number of social and political goals. Also, it will create dissatisfied electricity consumers who currently pay little for their electricity services. These consumers will likely become very angry with the reform and lobby their elected officials to block the reform.

An alternative is to develop new electricity rate plans that have a marginal cost of energy that matches the wholesale market energy price whenever surplus zero emission energy is being sold to other jurisdictions or being curtailed. Consumers can install dual fuelled appliances and voluntarily subscribe to these new price plans. They can then take advantage of the low prices for surplus zero emission electricity to reduce their fossil fuel use and emissions. There is no cost to the electricity system because the retail consumer will be paying the same price that adjoining jurisdictions would pay for that same energy.

Small residential consumers with smart meters can have a very simple price plan with a very low time-of-use rate, say between midnight and 6 am. That is typically when most of the surplus zero emission electricity is available in a low emission power system. The rate can be set to a fixed value equal to the average wholesale market price in the previous 6-month or 1-year period and periodically adjusted to recover any under or over charges.

Larger industrial consumers can have more sophisticated communication capability with the electricity market operator to take advantage of surplus periods at any hour of the day including daytime hours when we can have maximum production from wind and solar generation.

Zero emission electrical systems that are optimally designed will typically be capable of supplying over 15% of total production that is surplus to the needs of traditional electrically powered equipment. If the voluntary retail electricity rate plans are properly structured, that surplus can be used to charge electric vehicles at night, displace fossil fuels for space and water heating and make green hydrogen and ammonia to decarbonize more challenging industrial and transportation processes. These voluntary price plans will facilitate achieving a zero emission energy future at a lower total cost.