The global movement toward cost-reflective tariffs

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Tariffs have always been "an unfailing annoyance" to utilities and customers alike

"There has never been any lack of interest in the subject of electricity tariffs. Like all charges upon the consumer, they are an unfailing source of annoyance to those who pay, and of argument in those who levy them. In fact, so great is the heat aroused whenever they are discussed at institutions or in the technical press, that it has been suggested there should be a "close season" for tariff discussions. Nor does this interest exaggerate their importance. There is general agreement that appropriate tariffs are essential to any rapid development of electricity supply, and there is complete disagreement as to what constitutes an appropriate tariff."

--D.J. Bolton, Costs and Tariffs in Electricity Supply, 1938

The structure of existing tariffs for households does not reflect the structure of costs

For network companies that only provide transmission and distribution services, as well as vertically integrated companies or network companies that also provide regulated supply, they are typically two-part designs, with the first part being a monthly service charge, and the second part being a non-time varying charge

This is out of line with the structure of costs

Five currents are swirling around this existing design, making change inevitable

- **Current 1.** The emergence of distributed generation, which has created inequities among residential customers
- **Current 2**. The realization that the cost-causation principle also applies to residential customers
- **Current 3**. The rollout of smart meters, which makes it relatively easy to offer demand charges
- **Current 4.** The need to improve load factor and clip peaks
- **Current 5.** The recognition that a few U.S., European, and Australian utilities have been offering demand charges for years

The onset of distributed generation has exposed the failings of existing rate design

While network costs are largely fixed, the bulk of the revenues are variable under traditional volumetric tariffs

As growth slows down due to the deployment of distributed generation and “organic” conservation, networks face revenue risks

Ultimately, tariffs are raised for all customers, creating inequities as customers with low kW demand subsidize customers with high kW demand

With no demand charges, customers have no incentive to lower their kW demand, creating inefficiencies in the deployment of scarce capital

The Econ 101 view of rate design

Set rates based on long run social marginal costs

If there is a revenue deficiency, use a fixed charge to make the utility whole

This view is impractical for many reasons:

- It is virtually impossible to measure social costs
- Volatile fixed charges will be a hard sell to customers
- Even stable fixed charges are a hard sell
- Fixed charges do not carry the variation in distribution cost across customers of different sizes
- Nor do they provide customers an incentive to reduce demand

Back to the Future

Year	Author	Contribution
1882	Thomas Edison	• Electric light was priced to match the competitive price from gas light and not based on the cost of generating electricity
1892	John Hopkinson	• Suggested a two–part tariff with the first part based on usage and the second part based on connected kW demand
1894	Arthur Wright	• Modified Hopkinson's proposal so that the second part would be based on actual maximum demand
1897	Williams S. Barstow	• Proposed time-of-day pricing at the 1898 meeting of the AEIC, where his ideas were rejected in favor of the Wright system
1946	Ronald Coase	• Proposed a two-part tariff, where the first part was designed to recover fixed costs and the second part was designed to recover fuel and other costs that vary with the amount of kWh sold
1951	Hendrik S. Houthakker	• Argued that implementing a two-period TOU rate is better than a maximum demand tariff because the latter ignores the demand that is coincident with system peak
1961	James C. Bonbright	• Laid out his famous Ten Principles of Public Utility Rates

Back to the future (concluded)

Year	Author	Contribution
1971	William Vickrey	• Proffered the concept of real-time-pricing (RTP) in *Responsive Pricing of Public Utility Services*
1976	California Legislature	• Added a baseline law to the Public Utilities Code in the *Warren-Miller Energy Lifeline Act*, creating a two-tiered inclining rate
1978	U.S. Congress	• Passed the *Public Utility Regulatory Act (PURPA),* which called on all states to assess the cost-effectiveness of TOU rates
1981	Fred Schweppe	• Described a technology-enabled RTP future in *Homeostatic Control*
2001	California Legislature	• Introduced *AB 1X,* which created the five-tier inclining block rate where the heights of the tiers bore no relationship to costs. By freezing the first two tiers, it ensured that the upper tiers would spiral out of control
2001	California PUC	• Began rapid deployment of California Alternative Rates for Energy (CARE) to assist low-income customers during the energy crisis
2005	U.S. Congress	• Passed the *Energy Policy Act of 2005*, which requires all electric utilities to offer net metering upon request

Bonbright's Ten Commandments

1. Effectiveness in yielding total revenue requirements under the fair-return standard
2. Revenue stability and predictability
3. Stability and predictability of the rates themselves
4. Static efficiency, *i.e.,* discouraging wasteful use of electricity in the aggregate as well as by time of use
5. Reflect all present and future private and social costs in the provision of electricity (*i.e.,* the internalization of all externalities)
6. Fairness in the allocation of costs among customers so that equals are treated equally
7. Avoidance of undue discrimination in rate relationships so as to be, if possible, compensatory (free of subsidies)
8. Dynamic efficiency in promoting innovation and responding to changing demand-supply patterns
9. Simplicity, certainty, convenience of payment, economy in collection, understandability, public acceptability, and feasibility of application
10. Freedom from controversies as to proper interpretation

Is originality necessary?

The vast literature on electricity tariffs shows so many different views that it would be difficult to be original in proposing tariff changes.

-Hendrik Houthakker, 1951

The tariffs for large commercial and industrial customers already embody cost-reflective pricing principles

How some utilities are dealing with the issue

Mandating demand charges for distributed generation customers

- In Arizona, Arizona Public Service (APS) and Salt River Project (SRP) are moving down this path
- Solar City has filed a law suit against SRP

Give distributed generation customers a choice between (a) paying a higher fixed charge or (b) paying standard fixed charge along with a demand charge

- In Kansas, Westar Energy is moving down this path

The theory of tariffs revisited

Tariffs should promote economic efficiency and equity, but changes in tariff regimes should be implemented gradually

- For distribution-only utilities, this translates into a two-part rate, where the first part is a monthly service charge and the second part is a demand charge; for other utilities, into a three-part rate

Such tariffs have been offered to commercial and industrial customers for the better part of the last century, inspired by the writings of Professor John Hopkinson in 1892

- The ideal method of charge then is a fixed charge per quarter proportioned to the greatest rate of supply the consumer will ever take, and a charge by meter for actual consumption

The theory of tariffs (continued)

The Hopkinson tariff contains an explicit demand charge

- E.g., demand charge = $2.50 per month per kW of maximum demand in the month, plus an energy charge of 5 cents per kWh per month

It was followed by the Arthur Wright tariff, which achieves the same objectives without requiring the measurement of demand

- The Wright tariff uses a declining block rate structure where the charge for energy might be 10 cents per kWh for the first 50 hours of use and 5 cents for the next 50 hours of use and so on

The theory of tariffs (concluded)

As Crew and Kleindorfer (1979) put it in their well-known text on public utility economics

- Maximum-demand tariffs, which were to become so popular in the industry over the years were born
- Their original intent was apparently to come to terms with the peak-load problem to the extent that they aimed to improve utilization or load factor

Illinois is considering a law which would mandate demand charges for all residential customers

Demand (or capacity) charges in the U.S.

19 U.S. utilities in 14 states offer them on an opt-in basis

- Included in this category are large utilities such as Duke Energy, Georgia Power, and Xcel Energy
- California is missing in action

With two exceptions, APS and Black Hills Power, where participation rates are in the 8-10% range, the offerings have elicited weak customer enrollment

- The tariffs are often poorly designed, poorly marketed, and offered without advice about load control technologies

The situation will change with the deployment of smart meters, which is nearing 40% of all U.S. households, and the realization that the distribution grid is nearing a point of inflection

Capacity charges in Spain

All customers must select a level of capacity prior to being connected to the grid

- They can base this level on the size of their house, and on whether or not they have electric heating
- An engineering firm will provide a report to the network in order for service to be activated
- Customers may change their mind as often as they want and either increase of reduce the contracted peak demand
- Once they have selected a level of demand, they have to adhere to it
- If they exceed it, they will have a blackout and will have to reset the system

Capacity charges in Spain (concluded)

The tariff includes a capacity charge and an energy charge (based on a pass through of wholesale market prices)

The weight of the capacity charge in the total bill for the average customer has changed with time:

- 10 years ago, when demand was growing fast, the energy charge component was more important than the demand charge component. The target was to incentivize energy savings and efficiency
- When demand started falling after 2008, regulated revenues started falling very quickly, while costs remained stable or still increasing. The government reacted by increasing the share of the demand charge to stabilize revenues

Capacity charges in Italy

The capacity charge is levied on the "size" of the connection to the network

The customer can choose the size of the connection, which then acts as a limit on the power (kW) that can be demanded at any point in time

This approach predates the arrival of smart meters. All households in Italy now have smart meters, and one of the functionalities of the smart meter is that it can limit the maximum power delivered to the house

- That maximum power level can be adjusted remotely on customer request

Capacity charges in Italy (concluded)

Distribution Charges for Various Levels of Consumption

	Fixed Charge (€)	Demand Charge (€)	Variable Charge (€)	Total	% Fixed	% Demand	% Variable	Average Rate (€/kWh)
1.5 kW, 1,800 kWh	6.1	8.6	8.7	23.4	26.1%	36.7%	37.2%	0.013
3 kW, 3,000 kWh	6.1	17.2	73.2	96.5	6.3%	17.8%	75.9%	0.032
4.5 kW, 4,250 kWh	20.7	70.1	211.0	301.8	6.9%	23.2%	69.9%	0.071
6 kW, 10,000 kWh	20.7	93.5	917.6	1,031.7	2.0%	9.1%	88.9%	0.103

Sources and Notes:

D1, D2, and D3 tariffs from http://www.autorita.energia.it/allegati/docs/11/199-11TITtab_new.xls.

Bills with a max demand less than or equal to 3 kW are calculated using the D2 tariff. All other bills are calculated using the D3 tariff.

Capacity charges in France

Going back to the 1950's, all residential customers in France pay a capacity charge

Customers in France can choose their level of power capacity, expressed in kVA's

- The capacity demanded is often based on a consideration of the size of the house, the type of heating system, and the number and frequency of use of electrical appliances
- The standing charge paid by customers depends on the capacity level chosen
- If the customer is using several appliances at once and the amount demanded exceeds the subscribed capacity value, the power will go out and the customers will have to reset the system
- If this happens often, the customer can upgrade the level of supply

Capacity charges in France (continued)

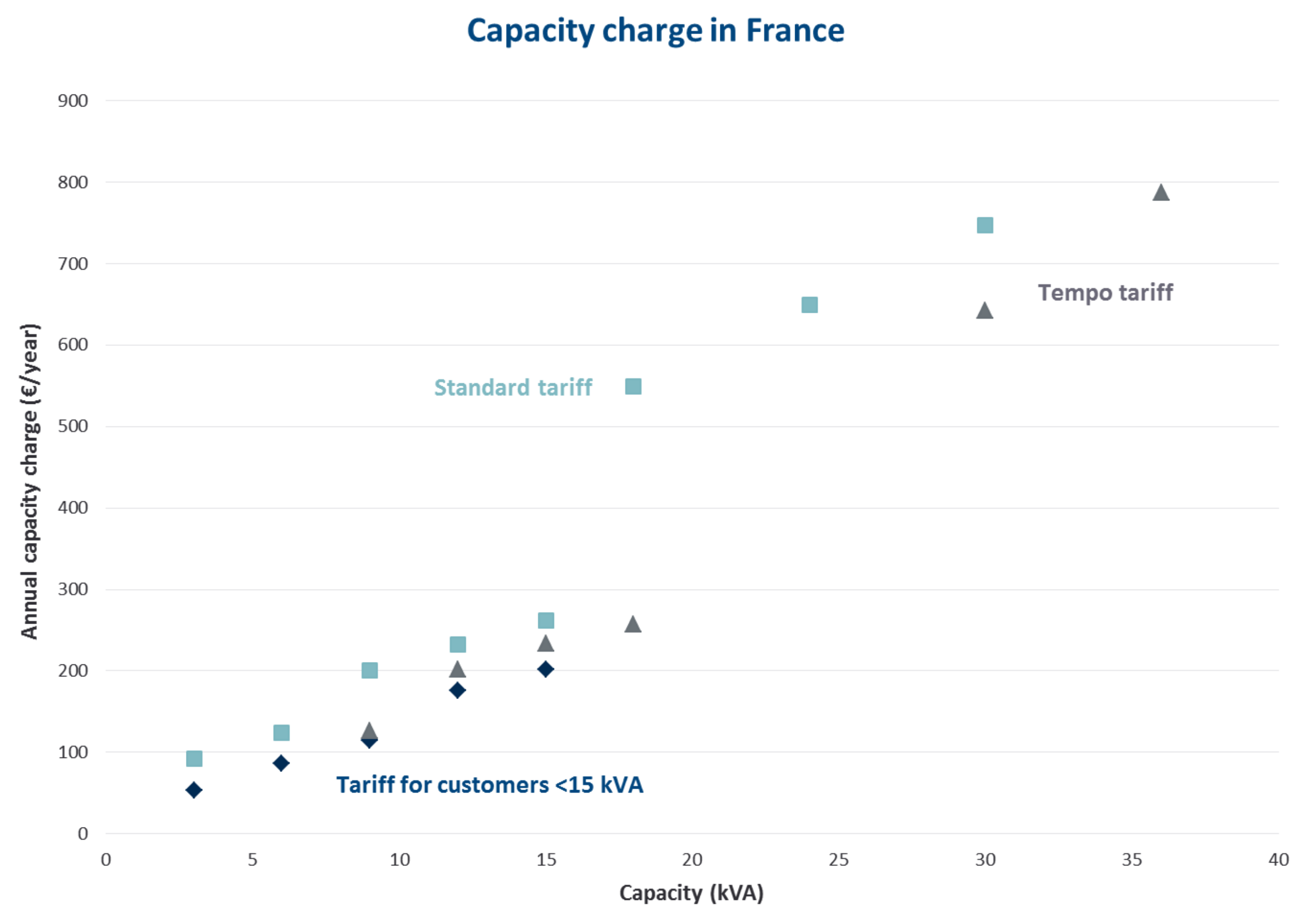
The French government aims at replacing all traditional metering systems with the Linky smart metering system by 2020

- This should better monitor the demand charge needed for a household

Concerning the variable charge, customers can subscribe to a two-period time-varying rate

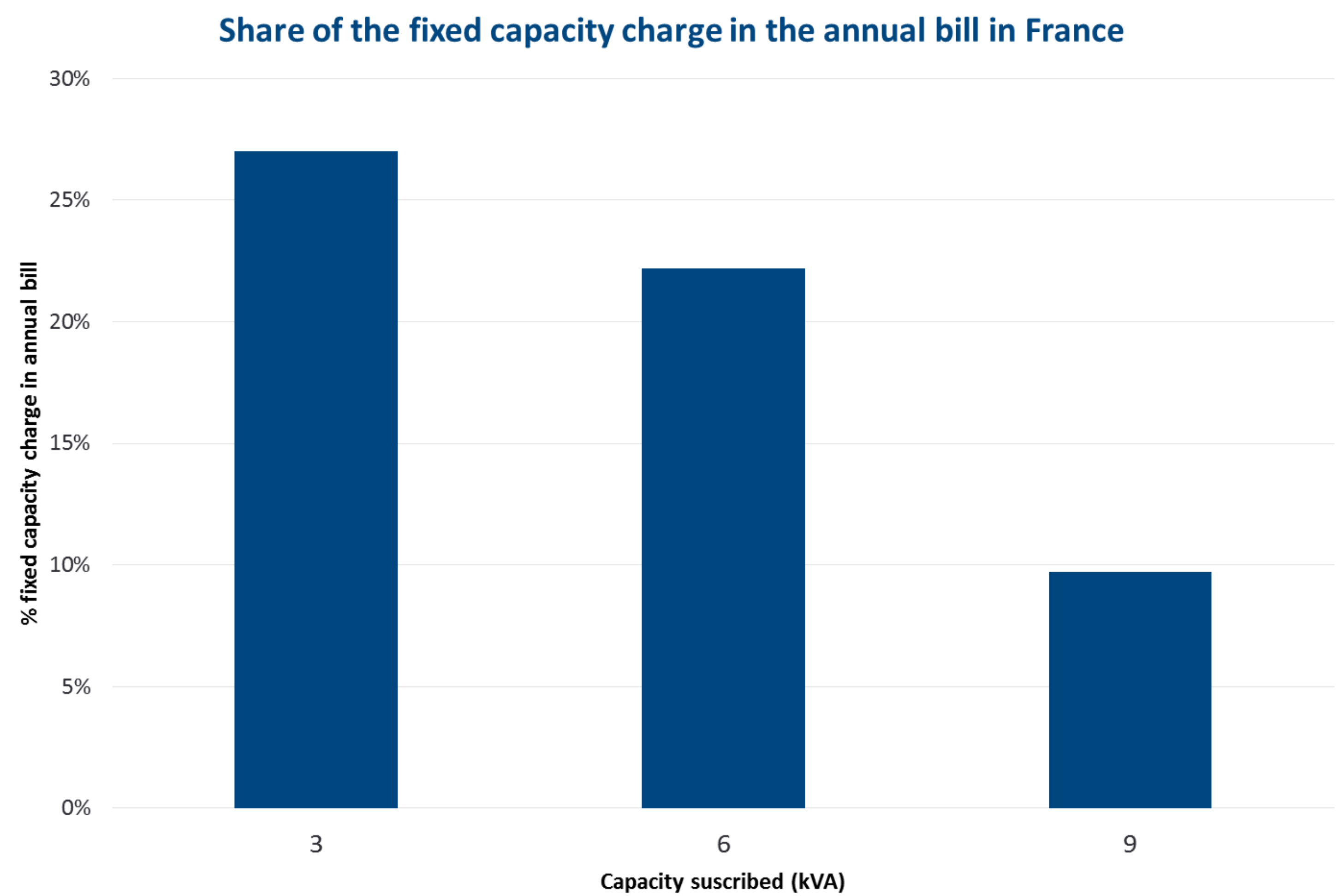
- The variable charge is lower during off peak hours (8 hours during the night) and higher during the rest of the day

EDF offers three tariffs with capacity charges



Source: Residential rates including all taxes - applicable as at 1st January 2015. Standard tariff stands for "Option Heures pleines/Heures creuses" and Tariff for customers <15kVA stands for "Option Base"

The larger the capacity, the smaller the share of the capacity charge in the bill



Note: Illustrative chart computing the Standard tariff for 6 and 9 kVA with a consumption of 2400 kWh/y and 8500 kWh/y, and the tariff for customers <15kVA for 3 kVA with a consumption of 1000 kWh/y.

Demand charges in Australia: United Energy

United Energy is a distribution utility in Melbourne, Victoria, serving 630,000 electric customers

Like all other networks in Victoria, it has deployed smart meters

United Energy is planning to rollout an opt-in rates to its residential customers in July

- Summer charge of $7/kW-month
- Winter charge of $3/kW-month
- kW demand is measured as the customer's maximum demand across all days of the month in the hours between 3 and 9 pm
- There is also a small energy charge of 2.5 cents/kWh

Hugh Gleeson, the chief executive, says that existing tariffs give a "free ride" to those with air conditioners and solar panels

The benefits of demand charges in Australia

Incentivize efficient DER investments, saving customers $17.7 billion by 2034

Eliminate $120 per year of cross subsidies today, rising to $655 per annum in 2034

Lower bills by $250 per year by 2034

Avoid price shocks that would otherwise be 5 times higher

Source: Energeia, Network Pricing and Enabling Metering Analysis, December 2014

Additional insights from Australia

According to the Australian Energy Market Commission, the existing network tariffs gives consumers no incentives to generate or use energy more efficiently; in fact, they encourage consumers to do the opposite

- A consumer using a 5 kW air conditioner will raise network costs by $1,000 a year, yet only pay $300

The Australian Energy Regulator estimates that some 20-30 percent of the $60 billion invested in network capacity lies idle 99 percent of the time

- United Energy spends about $200 million a year to ensure there is sufficient capacity to meet peak demand

Proposed demand charges in Australia: SA Power Networks

SA Power Networks is located in South Australia. Here are some excerpts from a recent report:

- "[B]ecause demand peaks are drivers of network investment, policy makers have been talking about the need to shift to more cost reflective pricing mechanisms."
- "Cost reflective tariffs involve a fundamental change in thinking about how customers are charged, by linking bills to levels of demand, *which is the main driver of network costs*, instead of simply being based on total electricity usage."
- "They also require a shift from 'accumulation' meters to smarter meters that can measure consumption at points in time. This means the speed of introduction of these tariffs will depend on policy decisions regarding how smart meters will be rolled out to the community."

SA Power (concluded)

From July 2015 onwards, SA Power proposes to transition small-market customers to a new cost-reflective network tariff based on maximum demand:

- From July 2015 to July 2017 the tariff will be made available on a limited, predominantly opt-in basis
- From July 2017 the tariff will be mandatory for all new customers and all customers upgrading their supply arrangements (e.g. to install 3-phase power, solar photovoltaic (PV), etc).
- Other customers will be able to access the tariff on an opt-in basis.

Of course, there is that nettlesome issue of how to measure demand (or peak load)

I remember discussing peak load and asking what caused it. I said, "Surely it is the electric cooker in the morning?" I was told that it was not the electric cooker. Then I said, "It must be the immersion heater." But I was told it was not. We went through the whole range of electrical appliances, and I was told that none of them caused the peak load. What is worse, if one listens too long, those people will prove it. I warn the Minister not to listen too long to them…

-The Right Hon. A. Robens, P.C., M.P.:
The House of Commons, 28 Oct. 1952,
(Cited in I.M.D. Little, The Price of Fuel, 1953)

The recommended tariff structure

Networks should use a three-part rate

- Monthly service charge
- Charge for connected load
- Maximum demand charge

Networks that also supply energy should use a five-part rate

- Monthly service charge
- Charge for connected load
- Maximum demand charge
- Charge for generation capacity
- Time-varying energy charge

Conclusions

The five currents of change that are swirling around household rates have made demand charges an inexorable part of future

Utilities will face several challenges when offering the new rate designs:

- How to design them
- How to predict their impacts
- How to protect those customers who would be instant losers

Reversing a century's worth of inequities will take patience and tender loving care

- The best option would be to temporarily reduce the gains to the instant winners and transfer these funds to the instant losers

It will be most important to shield the vulnerable customers

There are several ways in which that can be done:

- Insulate them from demand charges for a limited period of time
- Provide them bill protection, again for a limited period of time
- Give them "energy stamps," akin to food stamps, to defray any increase in bills that would occur due to the demand tariffs

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