# *The Switcheroo In The Retail Electricity Market — Questioning Net Metering Regressiveness*

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*January 29, 2021*

**Net metered restaurant customers** $\sim$ A monopolist delivery-only restaurant sells meal $x$ with price $\pi$ per meal, which includes the delivery charges. Occasionally, some customers cook their own $x$, and they cook even more $x+$, sometimes. If the restaurant agrees to buy the extra $x$, how much it should be? Who should pay for the delivery cost? If more people cooked $x$ and sold it to the restaurant, at times, what will happen to the restaurant, and to people who do not cook?

## *The Switcheroo*

For many years, electric utilities have been blessed with the unidirectionality of money and energy in the distribution network. In a deregulated market, the utility meets its population demand by purchasing energy from the wholesale market, and selling it back to its customers at the retail rate, thus hedging the inelastic consumers from facing the spiky wholesale price. In a competitive retail market, the regulated utilities submit their estimated rate, with justification, to the public utility commission (PUC), which then takes the decision of accepting or revising the projected rate. The rate usually bundles utility's fixed, variable and capacity costs, which are recovered through a volumetric charge. To raise revenue, some utilities rely on a fixed connection charge levied on end-users, exploiting their small income effects compared to their substitution effects.

The introduction of behind the meter (BTM) distributed generation (DG) thoroughly altered the retail electricity market paradigm. DG adopters are more dynamic and price-elastic customers with the ability to bidirectionally transact energy and money with the utility. Under net energy metering (NEM), this transaction is valued at the retail rate[1].

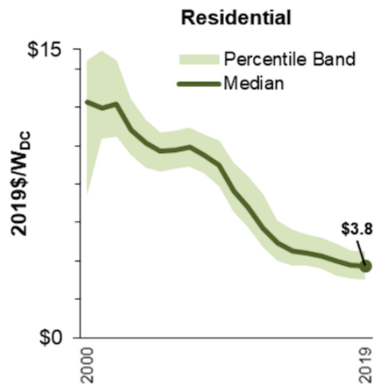
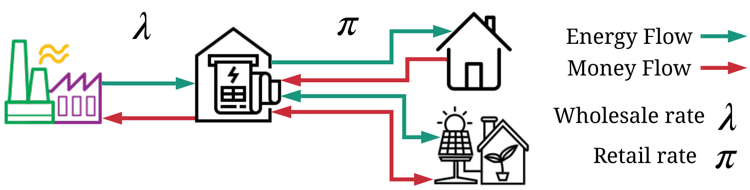



Figure 1: Residential PV prices trend between 2000 and 2019. Credit: Berkeley Laboratory.

[1] For the rest of the article, I will use `retail rate`, and `sell-rate` to refer to the prices of buying from and selling to the utility, respectively.




Although NEM roots back to the 1990s, the boom in BTM DG adoption only occurred when the costs of residential rooftop solar panels installation significantly dropped from approximately \$14000/kWDC in 2000 to \$3800/kWDC in 2019[2], which justifies why the cumulative capacity of rooftop solar in California alone, tripled over the course of the last five years[3]. Although the market value created by NEM has always been controversial, as of October

[2] Galen Barbose and Naïm Darghouth. Tracking the sun. `https://emp.lbl.gov/tracking-the-sun`, October 2019

[3] California Distributed Generation Statistics. Nem solar pv. `https://www.californiadgstats.ca.gov/charts/`

2019 more than 39 states mandated NEM[4]. While NEM customers and the solar industry emphasize the pivotal environmental benefits brought by solar PV, utilities argue that the retail rate compensation under NEM enables adopters to avoid paying toward the utility's fixed costs, which is persistent even when customers adopt PV. The revenue deficit created by adopters forces utilities to further increase the retail rate[5]; a move that directly impacts non-adopters as they have no option but to pay the new retail rate. DG adopters will mostly gain more benefit when the retail rate increase, as their system's payback time will be shorter due to the increased bill savings.

[4] *Detailed NEM Summary Map*. Database of State Incentives for Renewables & Efficiency (DSIRE). URL `https://www.dsireusa.org/resources/detailed-summary-maps/`

[5] The practice of retail rate increase is due to the fact that utility rate design is almost purely volumetric, bundling the variable, fixed and demand costs faced by the utility.

Three main issues result from the retail rate compensation under NEM:

1. Cost shifts from DG adopters to non-adopters.
2. Utility death spirals.
3. Inequities due to the tendency of wealthier customers to adopt the relatively costly new technology.

The issue of cost-shifts is highly correlated with the existence of utility death spirals, as they are both a result of the utility's struggle to recover its fixed costs. The inequity issue is expected to diminish with the falling rooftop solar costs. To comment on the efficiency of NEM, we first need to closely scrutinize the utility rate structure and sell-rate design.

> "I am not sure exactly how the incentives for renewable adoption should be structured, But I can tell you that they don't involve paying households retail rates for power injected into the system, as net metering policies currently do. And they don't involve maintaining retail rates that are many times higher than avoided costs. "
> — Severin Borenstein[6]

[6] Severin Borenstein. Is the future of electricity generation really distributed? `https://bit.ly/2KVvDMP`, May 2015

## *Is Net Metering Regressive?*

Net metering itself is not regressive, the policy depends crucially on the utility rate design and the sell-rate mechanism. There has to be a balance between the benefits given to adopters, and the revenue adequacy off the retailer, while offering a reasonable rate for non-adopters, which can only be granted if the rate design and the selling mechanism are well established.

An example of an incongruous tariff design is the combined adoption of a one-part tariff in California, and the full retail-rate compensation, which has led to the high price markup between the retail and wholesale rates. Higher price markup exacerbates subsidy levels between adopters and non-adopters, as the difference between the retail rate and the utility's avoided-cost rate expands[7]. Therefore, one-part tariff with retail rate compensation produces a regressive NEM in the long run, where adopters gain exaggerated bill savings at the cost of non-adopters, who are usually poorer customers.

Besides the tariff, the utility rate design can lead to a regressive NEM. Adopters under an inclining block rate (IBR), for example, gain a twofold benefit. The first is the energy consumption reduction and retail rate compensation due to the onsite generation. The second benefit is the avoidance of climbing to the pricey blocks.

In both cases above, the utility rate design, the tariff, and the full retail rate compensation contributed to the perverse incentive to adopters. In my opinion, the current retail electricity market structure has led to the consequence that the extra bill savings achieved by adopters are an extra bill payment by non-adopters, given the fact that utilities are constrained by a revenue adequacy condition.

If no fundamental changes are implemented to the preceding policies, the decline of PV costs and the increased PV penetration would further swell the problem.

However, and call me over-optimistic on this, I strongly believe that the cost-shifts and death spirals issues with NEM are solvable,

[7] Severin Borenstein. Can net metering reform fix the rooftop solar cost shift? https://bit.ly/3t31HiZ, January 2021

and by different tools.
It is therefore essential that utilities develop rigorous mathematical models to investigate the efficiency, and practicality of each solution.

> "Net metering by itself is not regressive, but the design of the utility rate structure and the compensation mechanism are the key driving elements in determining the level of incentives to adopters, and hence the efficiency of the net metering policy."

In the monopolist restaurant case stated above, the main questions were; a) should the restaurant pay $\pi$ to get $x$?, b) since the customers in the case of excess $x$ are the sellers, should the restaurant continue to pay the delivery charges?, c) what will happen to non-cookers. If we apply the current net metering policy exercised in most US states, the restaurant will pay $\pi$ to get $x$, where $\pi$ already include the delivery charge. But, if the restaurant was the party responsible for delivery and its costs, shouldn't it pay $(\pi - \text{delivery cost})$ to get $x$? On the third question, non-cookers will face higher prices as the restaurant will increase $\pi$ in order to survive, which creates the cost-shift and death spiral issues.

Therefore, the question is, under this policy that enables customers to locally generate and sell back excess electricity, will the utility survive? and how?

## *Towards an effective and equitable net metering*

The primary goal of policymakers is to design a net metering policy that grants steady solar adoption, without compromising the welfare of non-adopting customers, while maintaining a revenue adequate utility that ensures network reliability and resiliency. Although feed-in tariff (FiT) is widely adopted, particularly in Europe, and is a good candidate to replace net metering, but I will only present solutions under the net metering framework. The possible effective ways to realize efficient net metering programs are:

A) Sell-rate reduction.
To force adopters to pay their share of the fixed costs, the utility can compensate customers' net excess generation with the avoided cost-rate instead of the retail rate, or at least a price that is below the retail rate. This, however, would solve the subsidies and revenue deficit created due to net export, but self-consumed solar generation is still virtually compensated at the retail rate, which I think is a limitation for this method. Frankly, self-consumption is the backbone feature of net metering, so I believe that the adoption would still grow even if energy exportation is discouraged. The sell-rate reduction will alter adopters' consumption patterns by discouraging sell back, which in turn ushers self-consumption and hence solar+storage solutions.

B) Connection charges (Fixed charges).
Connection charges (two-part tariff) are very effective in reducing the price markup, thus controlling adoption growth. The utility under this solution will rely on the fixed charge part to meet the revenue requirement, which will reduce the gap between the retail and wholesale prices, and hence reducing the bill savings achieved by adopters. Connection charges can be uniform or discriminatory. While uniform connection charges are adopted by many utilities in the US and worldwide, discriminatory connection charges are arguably more effective, but harder to justify and implement.

- Uniform:
Simply, uniform connection charges are lump sum taxes that are independent of consumption, and are usually levied to reflect the costs of energy delivery, metering, and customer service. Inflating connection charges is a robust tool to reduce the price markup, and stabilize the DG adoption. In fact, if the utility completely secures its revenue for cost recovery through volumetric charges, the DG adoption will be most probably stalled.

- Discriminatory:
  Discrimination in fixed charges can be based on income, technology adoption, or temporal and locational factors, among others. Income-based connection charges have been already proposed as a solution to mitigate cost shifts[8].
  Moreover, an example of a discriminative technology-based fixed charge is the recent VDER policy mandated by the New York Public Service Commission (NYPSC), which requires adopters to pay a customer benefit charge (CBC) that depends on the capacity of their DG system. Aside from the legislative controversy, this policy can be very effective in addressing cost shifts. CBC especially outperforms when the adoption increases, as increased DG penetration means more revenue from CBC. The NYPSC can control the adoption and ensure healthy utility operation by periodically adjusting the charge. The good thing about CBC is that unlike uniform connection charges, non-adopters do not pay any of this, possibly increasing charge.
  The temporal and locational discrimination, involve charges levied on adopters based on temporal factors such as sunrise and sunset times, and locational factors, such as elevation, temperature, and irradiance. The hardest part of implementing this solution is the classification and justification of the charge.

[8] Severin Borenstein. Reinventing fixed charges? https://bit.ly/3pq7IUP, November 2020

C) Billing period shortening.
The notion of billing period becomes important, once the retail and sell-rates are differentiated. A shorter billing period means that adopters will have less time to bank their credits. If the billing period is instantaneous, the adopters always face the sell-rate when they are net-producing. This approach and the sell-rate reduction are a good combination to control adopters' bill savings.

D) Time-of-use rate.
One of the most effective, but intricate tools to control the adoption, is through time-of-use (ToU) rates. The so-called California NEM2.0 policy, mandated adopters to enroll in ToU rates[9]. The PV generation profile in California peaks shortly afternoon. Therefore a late peak period would mean that adopters will avoid, or get compensated by the off-peak price, and when they become net-consumers (late in the day), they face the peak price. The peak ratio is another tool to devalue the net excess generation, and then charge adopters with a high peak price when they net-consume. As non-NEM customers are not obliged to enroll in ToU, the effect of high peak price will mostly only impact the adopters.

E) Combination of the above.
It might be more efficient and equitable to combine two or more solutions to design an equitable and efficient net metering policy.

[9] Net energy metering (nem) 2.0 evaulation. URL `https://www.cpuc.ca.gov/General.aspx?id=6442463430`

I did not list retail rate discrimination as a solution, not because it is hard to disentangle adopters and non-adopters into two different customer classes, but because I believe that doing so will not help in controlling adopters' bill savings, or utility revenue adequacy. If the utility secures a lower retail rate for non-adopters, the adopters would still benefit from the higher retail rate. Doing such action is as if the utility accepts absorbing the shifted costs. rather than shifting it to the non-adopters.

In conclusion, although net metering programs promoted sustainability and lower electricity generation footprints, it is not clear under the current retail electricity market paradigm, if net metering creates any value in the market. Under net metering, there is always a tradeoff between DG adopters' bill savings and cost-shifts, retailer surplus, and adopters surplus. While the proposed solutions may solve the longstanding issues of net metering such as cost-shifts and utility revenue deficit, I can not draw a conclusion on which option is best, or how these options will perform when the deployment of energy storage devices proliferates. But what is guaranteed, is that with the continuously falling PV costs, the diffusion of residential based generation will grow, maybe in some form of grid-independent households.

## *References*

*Detailed NEM Summary Map*. Database of State Incentives for Renewables & Efficiency (DSIRE). URL https://www.dsireusa.org/resources/detailed-summary-maps/.

Net energy metering (nem) 2.0 evaulation. URL https://www.cpuc.ca.gov/General.aspx?id=6442463430.

Galen Barbose and Naïm Darghouth. Tracking the sun. https://emp.lbl.gov/tracking-the-sun, October 2019.

Severin Borenstein. Is the future of electricity generation really distributed? https://bit.ly/2KVvDMP, May 2015.

Severin Borenstein. Reinventing fixed charges? https://bit.ly/3pq7IUP, November 2020.

Severin Borenstein. Can net metering reform fix the rooftop solar cost shift? https://bit.ly/3t31HiZ, January 2021.

California Distributed Generation Statistics. Nem solar pv. https://www.californiadgstats.ca.gov/charts/.