CLEAN ENERGY SOLUTIONS CENTER
ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

INTERNATIONAL SOLAR ALLIANCE

International Solar Alliance Expert Training Course: Session 3

DPV Compensation Mechanisms

In partnership with the Clean Energy Solutions Center (CESC)

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INTERNATIONAL SOLAR ALLIANCE

CLEAN ENERGY SOLUTIONS CENTER

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Overview of Training Course Modules

This Training is part of Module 1, and focuses on providing an Overview of Distribtued Generation Compensation Mechanisms

Eight Modules

1. Policies for Distributed PV
2. Policies for Large-Scale PV
3. The Future of Solar Policy
4. Technical Integration of Solar
5. Market Integration
6. Socio-Economic Aspects
7. Off-grid Solar
8. Solar Heating & Cooling

Expert Content and Analysis

Up-to-date Market Insights

Overview of the Presentation

1. **Introduction: Learning Objective**
2. **Historical Context: Understanding Compensation Mechanisms**
3. **Main body of presentation:**
    1. Dealing with Excess Generation
    2. Roll-over Provisions
    3. The Settlement Period
    4. Impact of Electricity Tariff Structure
    5. Impact of Demand Charges
    6. Ring-fencing
    7. Time-of-Use Tariffs
4. **Concluding Remarks**
5. **Further Reading**
6. **Knowledge Check: Multiple-Choice Questions**

1. Introduction: Learning Objective

Learning Objectives

- Understand DPV compensation mechanisms
- Understand the various aspects that influence the compensation for distributed solar projects
- Understand the role of fixed charges, fees, and rising retail prices
- Understand how to adapt compensation mechanisms to better balance overall system costs

2. Historical Context

Historical Context

- Net Metering policies first emerge in the U.S. in the 1980s
- Since then, Net Metering has evolved into a wide range of different forms (Net Billing, NET-FITs, etc)
- Onsite power generation becoming increasingly attractive for a growing number of consumers
- As the share of prosumers continues to grow (e.g. Australia, California, Hawaii, South Africa), the impacts are becoming more significant

Historical Context

- As the number of prosumers has grown, the importance of **compensation mechanisms** has entered the spotlight
- In several parts of Australia, 75% of individual households have solar PV on their roof
- Similar levels of uptake can be seen in certain parts of Hawaii, California, and southern Germany

https://arena.gov.au/blog/climatecouncil/

Net Metering: Review

- Allows individuals or businesses with customer-sited generation to connect to the grid and be **<u>credited</u>** for the excess power they fed into the system

- The meter rolls backward when onsite generation exceeds onsite consumption

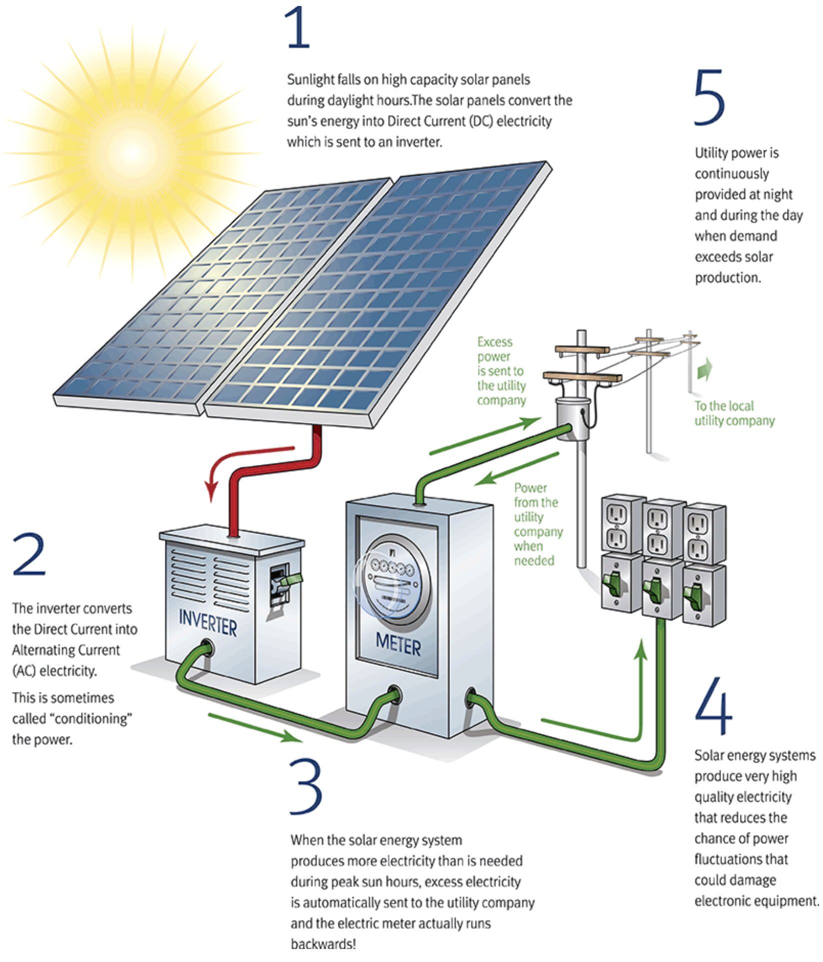
- Bill “credits” are typically granted in kWh: customers can ”bank” their excess kWh and use them to offset their future consumption

Net Metering: Review

Formula:

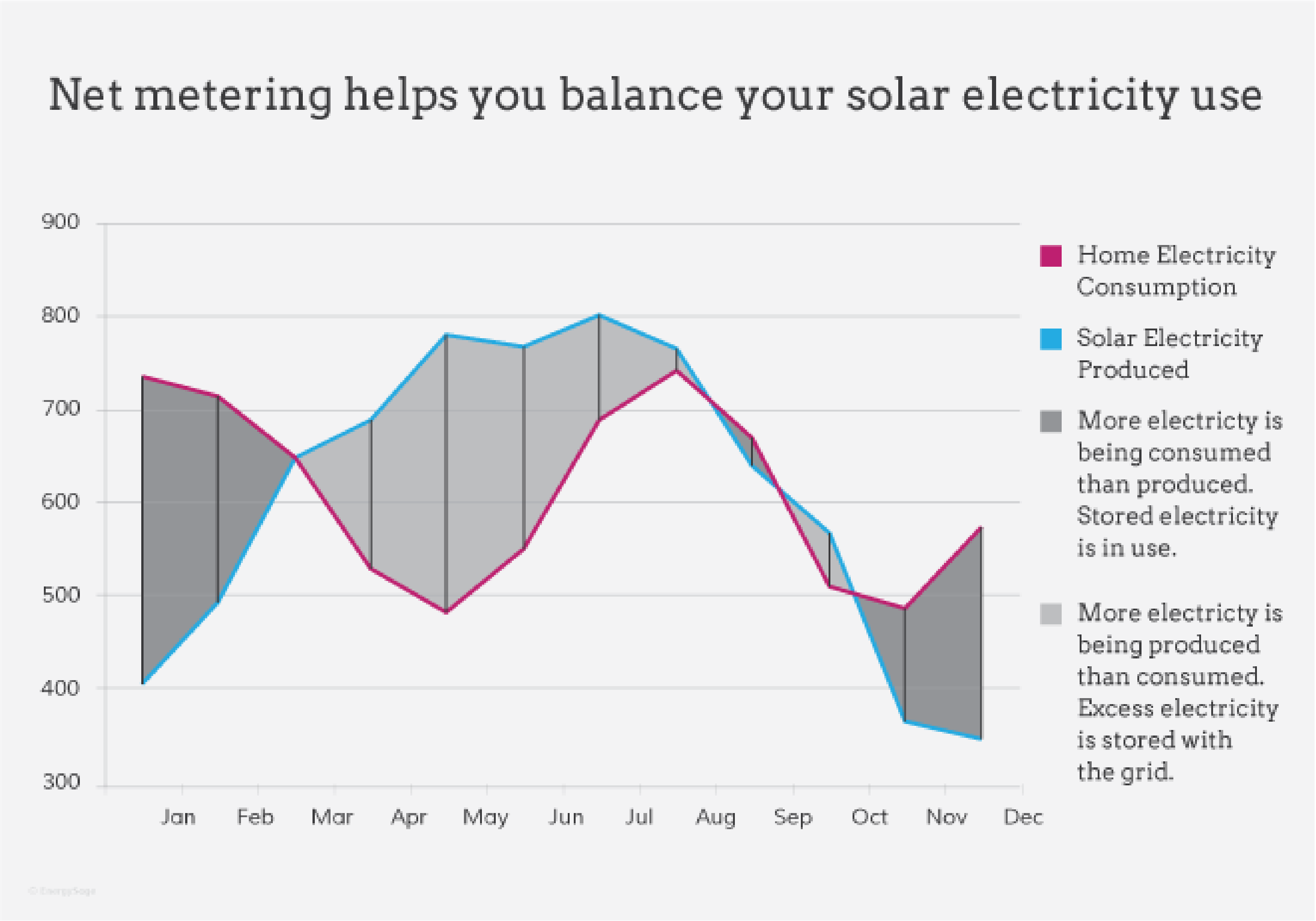
Compensation rate = Retail rate

"Traditional" net metering does <u>not</u> result in a cash payment: **it simply *credits* customer-sited generation at a rate equivalent to the retail rate**



- Source: SolarCraft.com

Net Metering: Review



Source: https://www.energysage.com/solar/101/net-metering-for-home-solar-panels/

Historical Context

- In jurisdictions with FITs pre-2013 (e.g. Germany), the majority of households and businesses adopting solar were exporting 100% of their output
- Projects received a fixed, long-term price for their output: **no self-consumption**
- This meant that customers continued to buy 100% of their supply from their local utility
- Customers in effect became “mini-IPPs”,* not real “prosumers”

*IPPs = Independent Power Producers

Historical Context

- In jurisdictions like the U.S. and Australia, most customers with solar PV developed their projects under Net Metering, or NET-FITs (see Training Sessions on FITs, Net Metering and NET-FITs)
- This means that they self-consumed their own solar PV generation onsite, and **exported their surplus**
- Since FIT costs were often largely passed on to ratepayers, utilities were more indifferent: didn't impact their bottom line
- Local utilities in the U.S. and Australia, by contrast, experienced revenue loss much earlier and more directly

Historical Context

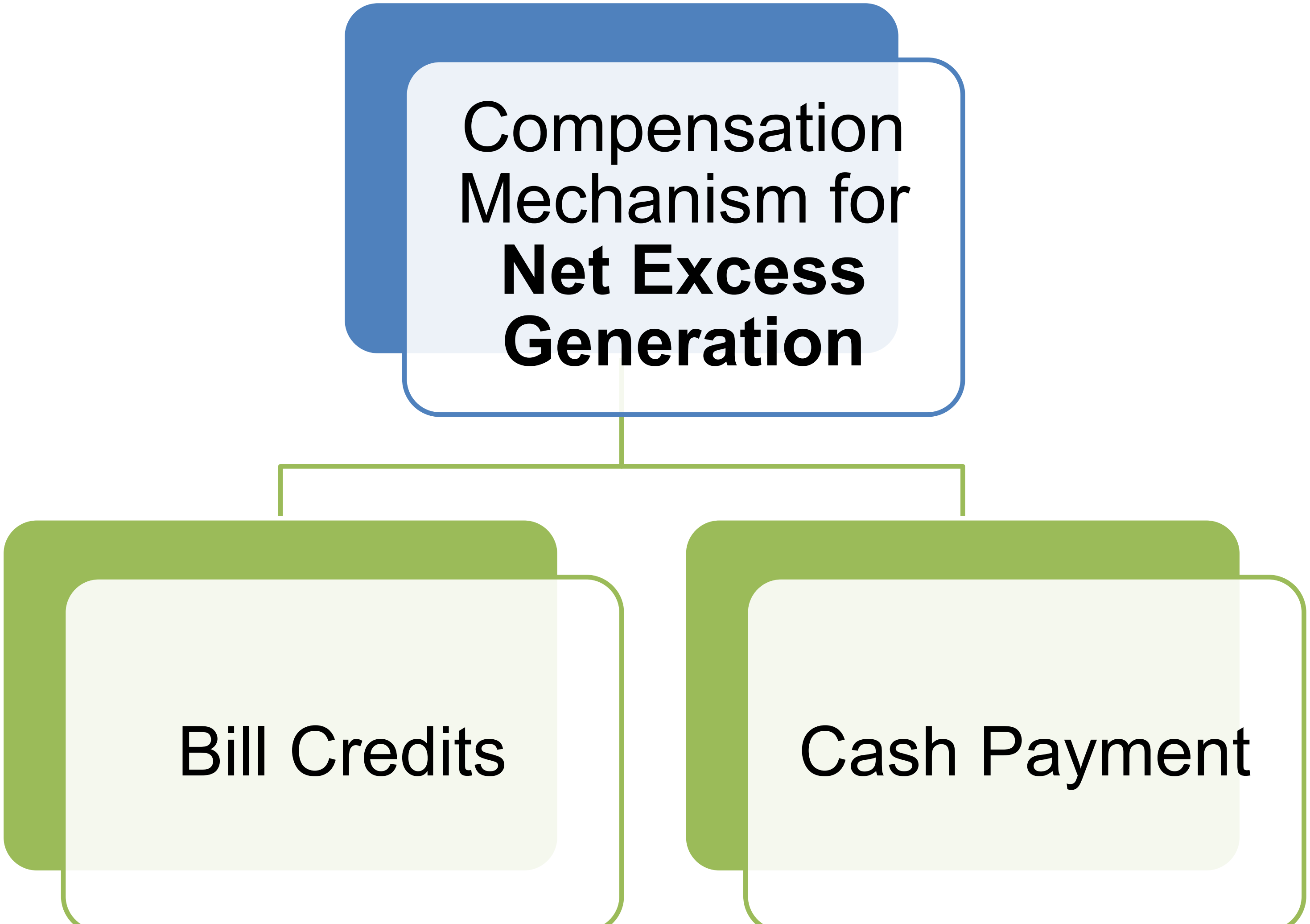
- With utilities increasingly concerned about **load defection and revenue loss**, they have started to **tighten the screws on the compensation mechanisms** offered to distributed generation projects, including solar PV

- More fixed charges, demand charges, etc.

These changes directly impact **the economics of distributed solar**

2.1. Understanding Compensation Mechanisms

Compensation Mechanisms: Key Distinction



Payment and Compensation Fundamentals

- One of the most fundamental distinctions is whether the customer ever can receive **a cash payment** for their excess generation
- In most cases, excess generation for distributed generation projects is settled in the form of **bill credits:** a specific, per-kWh credit that get applied to future bills
- Some jurisdictions (e.g. Vanuatu) even stipulate: "no negative bills"
- Restricting the compensation to bill credits makes Net Metering **less investable**, and less **bankable** (i.e. harder to get bank loans)

Payment and Compensation Fundamentals

Being "compensated" for net excess generation is fundamentally different from receiving a cash payment for that power supply

Lenders (banks) are often reluctant to issue loans for projects under net metering/net billing: the "value stream" of future bill credits is less bankable

As a result, net metering projects (without cash payments, only bill credits) are often developed by larger commercial and residential customers who can self-finance them

This means that **fewer customers can participate:** reinforces the perception that "solar is only for the wealthy"

Payment and Compensation Fundamentals

The value of a distributed solar project is composed of a few different value streams:

Value of a Solar System = A + B – C*

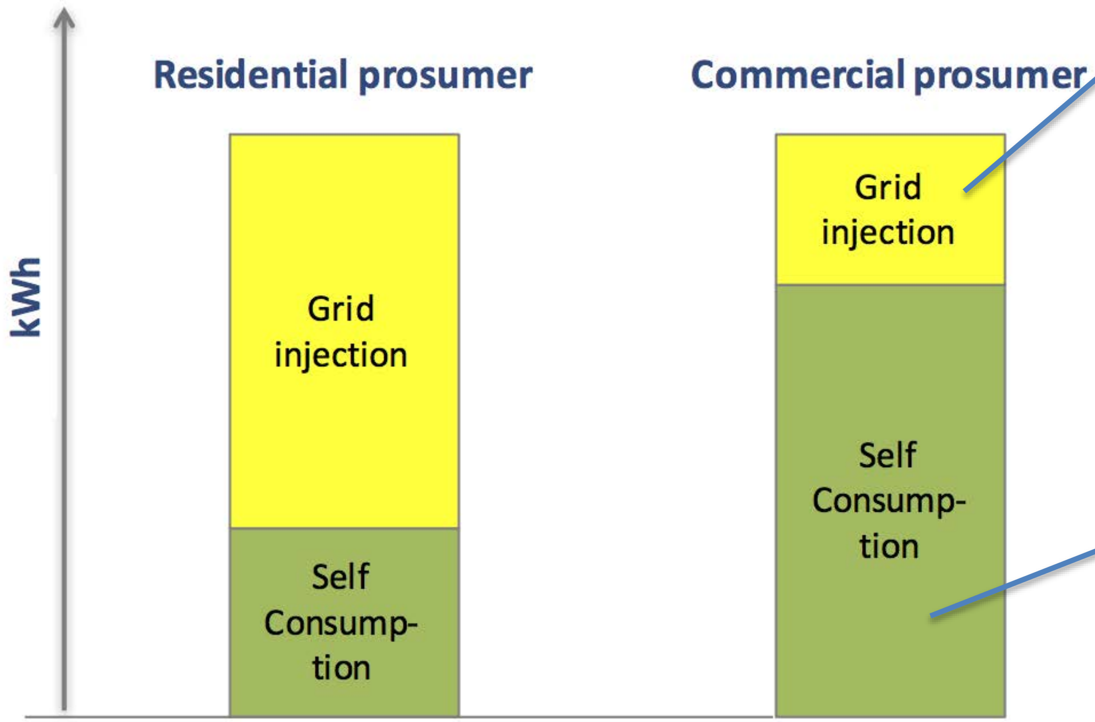
A = The value of the self-consumed electricity

B = The value of the exported (injected) electricity

C = Any fixed charges/fees/taxes that apply

* Plus expectations about future changes in A & B & C

Comparing Cases



For Grid Injection:
Can be compensated @ the full retail rate

Or

Can be compensated at a separate rate

For Self-Consumption:
Can offset @ the full retail rate:

Or

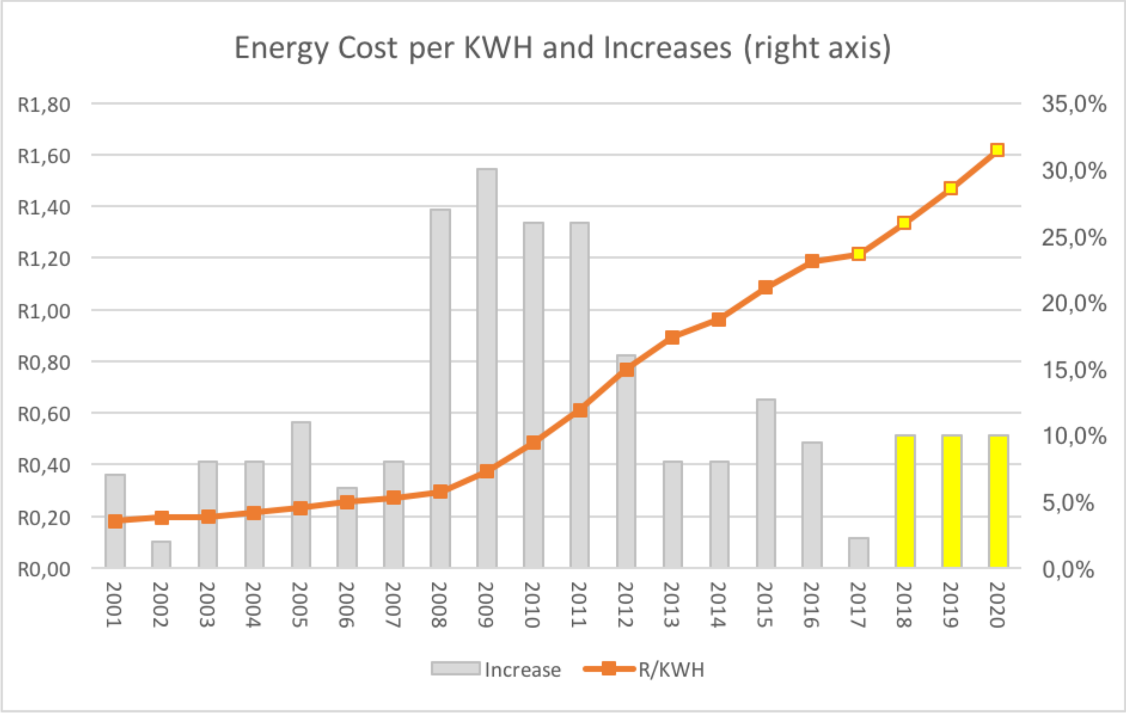
Can offset one's bill at a separate rate

See Training Session on Net Billing

Payment and Compensation Fundamentals

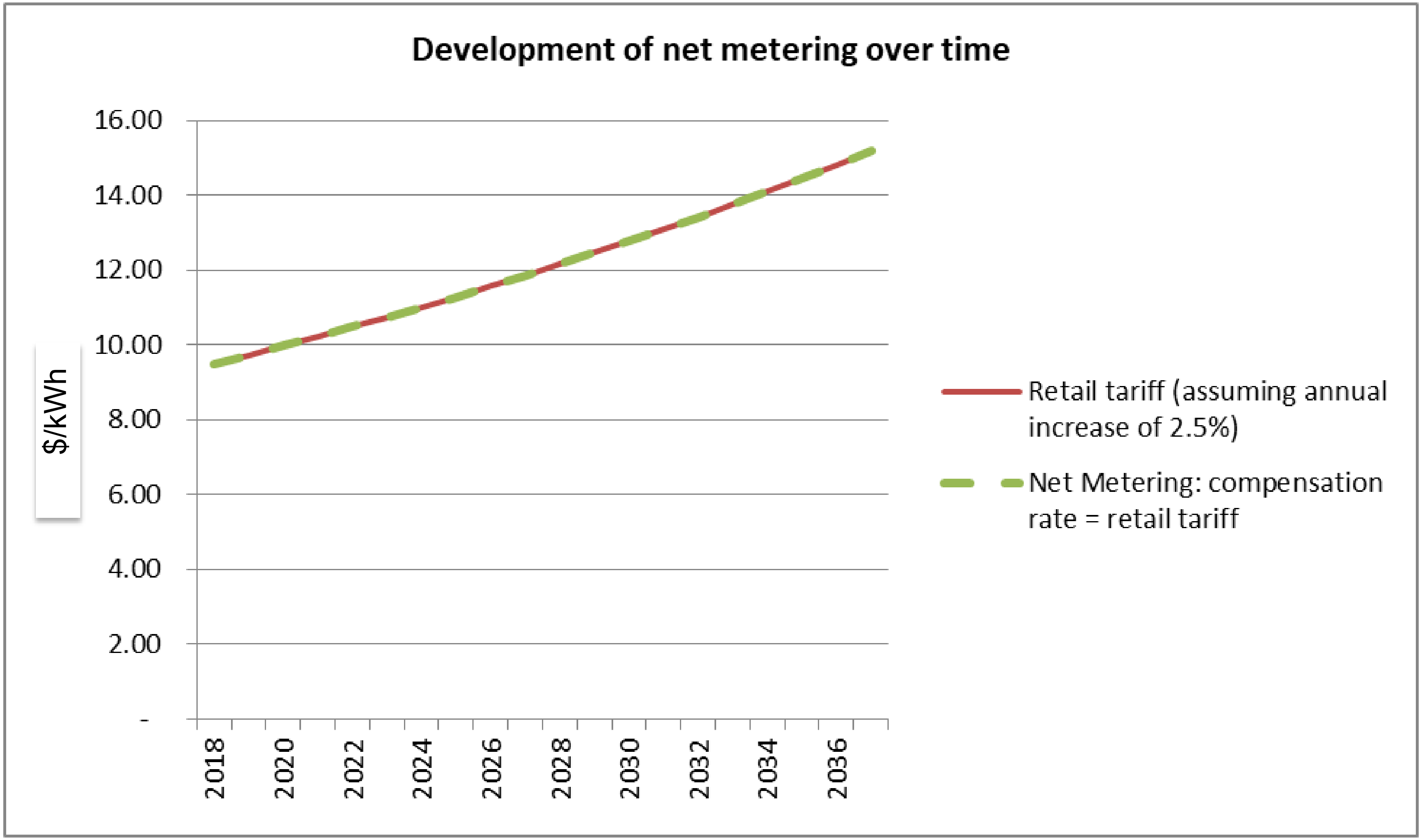
Example: if electricity prices are growing rapidly and are expected to continue to rise, home owners and businesses are much more likely to consider investing in a solar PV system, and will increasingly consider adding storage

South Africa has seen a **363% increase** in electricity rates in the last 10 years



https://energy-led.co.za/about/

The *value* of self-consumption increases progressively over time as retail prices rise



Payment and Compensation Fundamentals

- But **it's not just about the compensation rate**
- Other aspects of the design, structure, metering, and taxation of self-consumption have a significant impact on the overall attractiveness of investing in solar PV for one's own use

Compensation Issues by Topic

1. Dealing with excess generation
2. Roll-over Provisions
3. The Settlement Period
4. Impact of Electricity Tariff Structure
5. Impact of Demand Charges
6. Ring-fencing
7. Time-of-Use Tariffs

1. Dealing with Excess Generation

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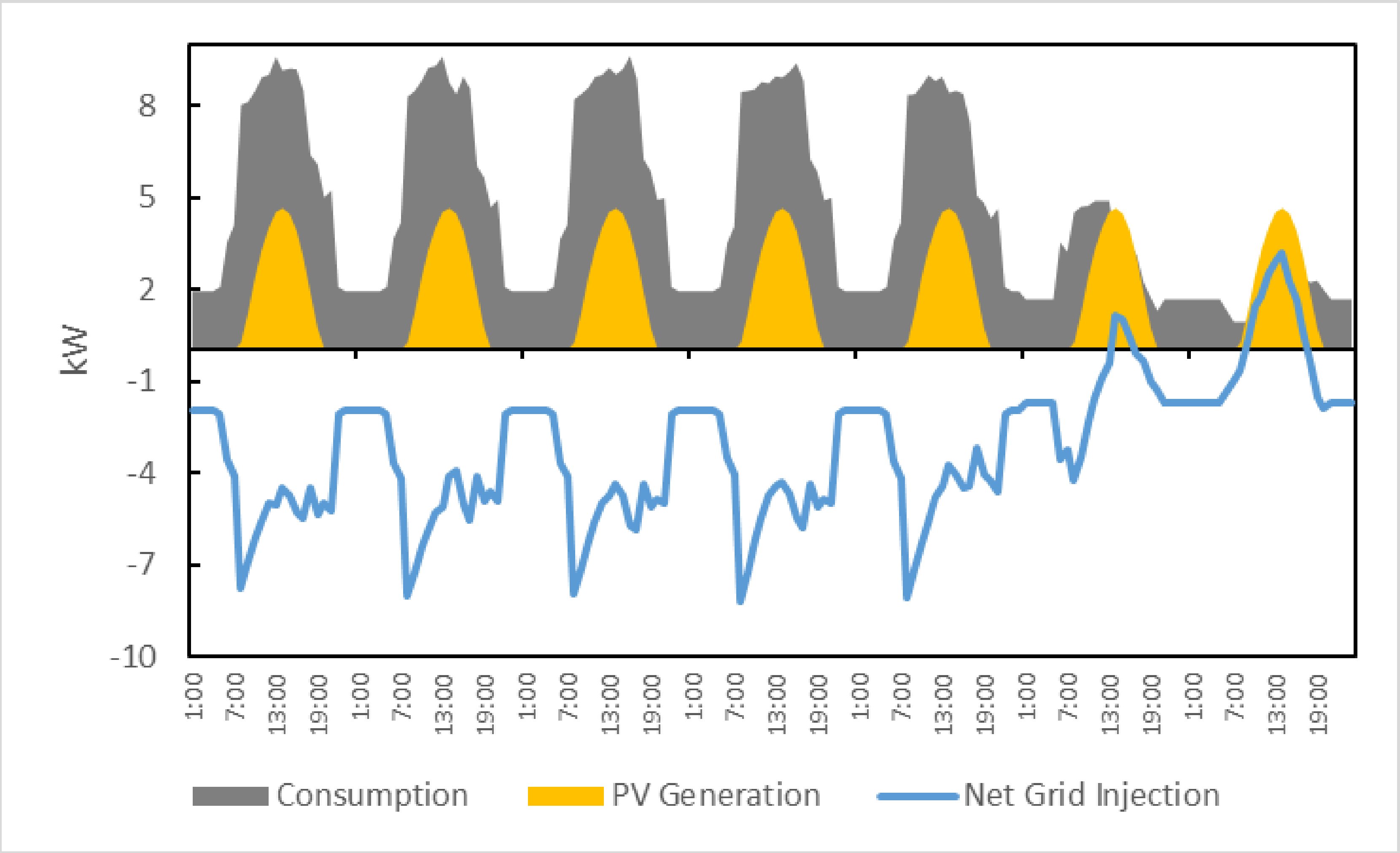


Source; E3 Analytics 2018

1. Dealing with Excess Generation

- Having excess generation during a few hours of the week, or month, is not enough to translate into a bill credit
- Under most net metering policies, the customer would only have a "bill credit" that carries over into subsequent billing cycles if they produced more than they consumed in total over the month
- Small differences are netted out automatically by one's own consumption ***within that same billing cycle***
- It is only larger amounts of net excess generation (beyond one's consumption) that translate into bill credits getting carried over into future billing cycles

1. Dealing with Excess Generation

- In some cases, as under certain **Net Billing** policies, all ***instantaneous*** net excess generation is automatically "credited" at some specified rate: all injected electricity is automatically converted into a monetary credit (e.g. USD 10 cents/kWh) and applied to your bill

- This removes the risk of customer's being "compensated" at a higher future retail rate: e.g. using bill credits "saved up" in year 1 to settle them in year 3 when retail prices are higher

- This risk is also mitigated by introducing a clear **settlement period**

1. Dealing with Excess Generation

Net excess generation can be settled in a range of different ways:

1. **The wholesale market rate**
2. **The "time of use" rate**
3. **The avoided cost rate**
4. **The "value of solar" rate**
5. **Some other rate as set by the regulator (including zero!)**

1. Dealing with Excess Generation

How excess generation is compensated has important impacts on the attractiveness of investing in solar PV

Key Questions

- If the compensation rate is set at the retail rate (i.e. the meter rolls backwards, crediting the customer the same "rate" as the full electricity price they pay per kWh, as under Net Metering), a number of further questions arise:

1. Why do some customers receive a higher compensation "rate" than others (e.g. residential vs. comm vs. industrial)
2. What about taxes?
3. What if retail rates continue increasing in the years ahead?
4. What if retail prices are quite high (e.g. on islands)?
5. What about the possibility of over-compensation?

Key Questions (con't)

- If prosumers are provided with a payment that is set below the retail rate (e.g. a Net Billing rate), is it fixed over time?
- How is this Net Billing rate determined?
- Is it differentiated by customer class? By consumption level?

Key Questions (con't)

- Does net excess generation generate bill credits in "real time", or only if the total meter reading for the month is negative?

- Can these bill credits be carried over into subsequent billing cycles, or are they cancelled out?

- Is there an annual (or monthly) "settling" of net excess generation credits?

- Can the customer ever receive a **cash payment**?

2. Roll-over provisions

2. Roll-over Provisions

- The roll-over period refers to the duration over which the cumulative net excess generation is banked and calculated, typically one billing cycle
- The roll-over period represents the point at which one month's excess generation (for instance) is calculated, and then carried over into the next billing cycle.
- Most Net Metering policies enable the customer to "roll-over" their excess generation up to 12-months

2. Roll-over Provisions

- The roll-over period can vary widely, from one hour, to one year.

Feature	Design Options
Roll-over period	• yearly • monthly • daily • hourly

2. Roll-over Provisions

- A very short roll-over period does not allow the customer as much time to "use up" their net excess generation: i.e. receive the full retail rate for the "value" of their solar generation before it is "settled"

- Excess generation credits can typically be carried over from one billing cycle to another until they reach the **settlement period**: i.e. the point at which any net excess generation credits (or compensation value) is settled definitely and removed from the utilities' books

- In some cases, the roll-over period = the settlement period

3. The Settlement Period

3. The Settlement Period

- After 12 months, for instance (i.e. after the ”settlement period”), the excess credits are then settled (i.e. removed from the utilities’ books)

- The **settlement period** refers to the time at which the net excess generation credits are “trued-up”, and ”settled” from a financial standpoint

3. The Settlement Period

- Main options for dealing with net excess generation after 12-month period:

  a) Excess generation is ***forfeited*** (Net Metering)

  b) Excess generation ***credited*** at some rate (e.g. wholesale rate, or the avoided cost rate)

  c) Excess generation ***remunerated*** at some rate (e.g. avoided costs): i.e. receives a cash payment (NET-FIT)

3. The Settlement Period

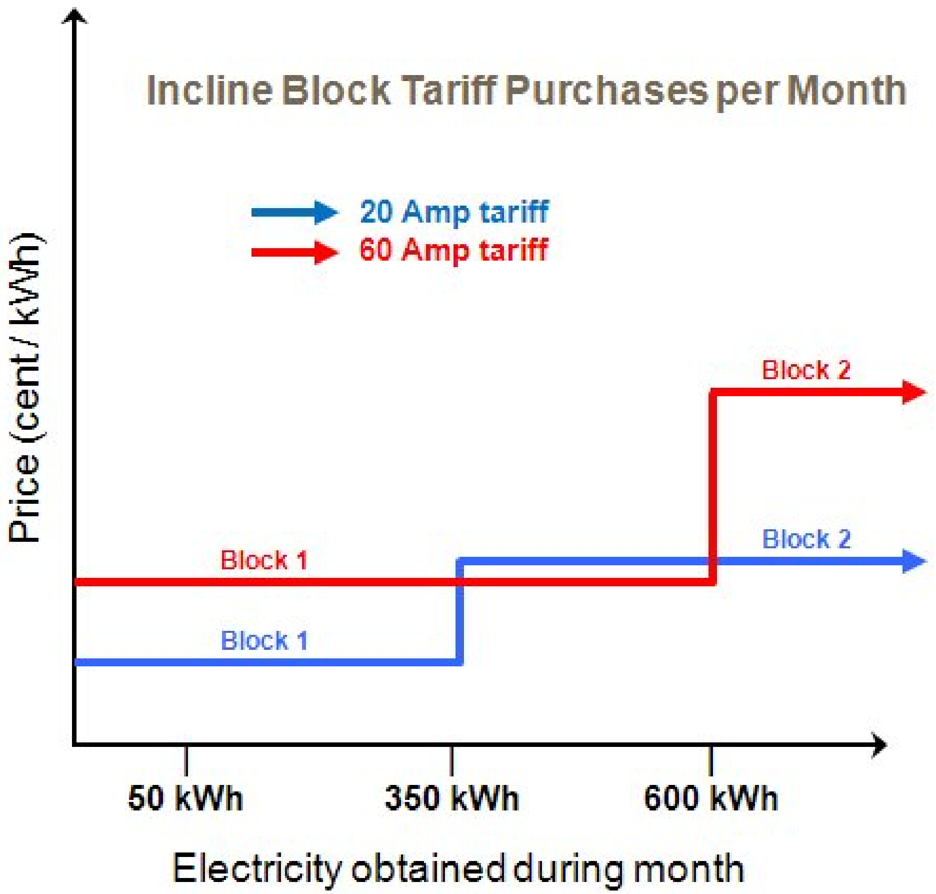
Different settlement periods have a fundamental impact on the attractiveness of investing in a DG project

The primary goal of the settlement period is typically to encourage “right-sizing”

4. Impact of Electricity Tariff Structure

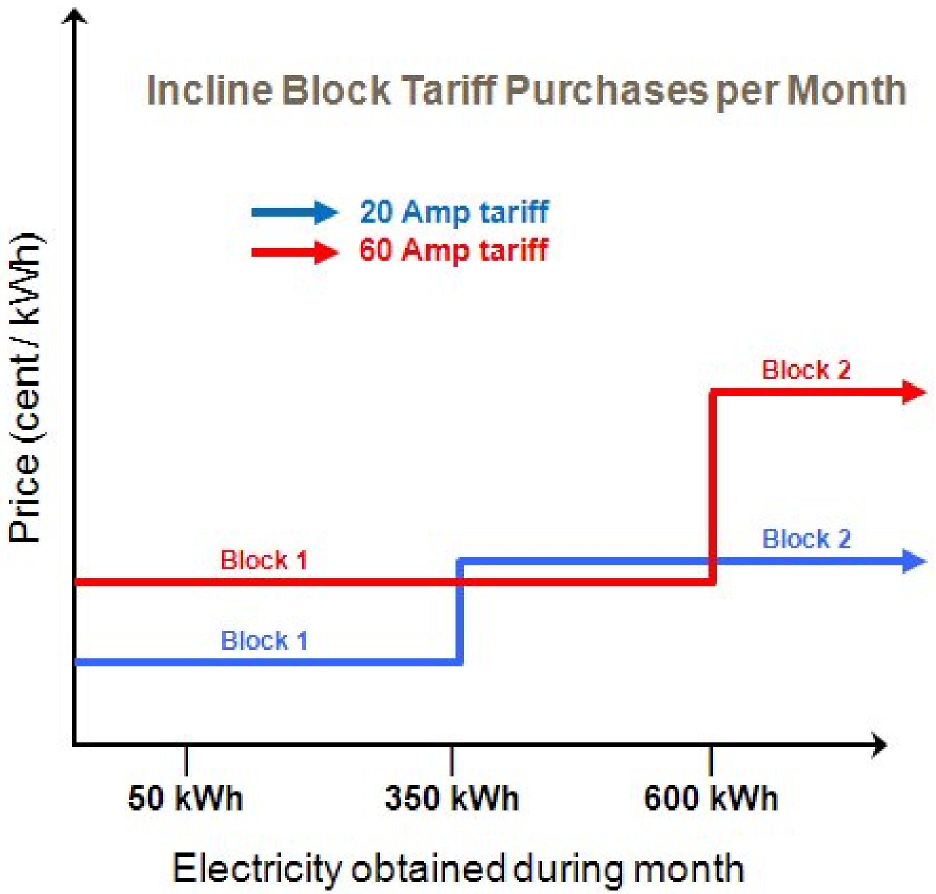
4. Impact of Electricity Tariff Structure

- Another important issue is the underlying structure of the retail prices
- Under **inclining block rates**, wealthier households may find it particularly attractive to self-consume their way out of the higher tariff categories: quicker pay-back



4. Impact of Electricity Tariff Structure

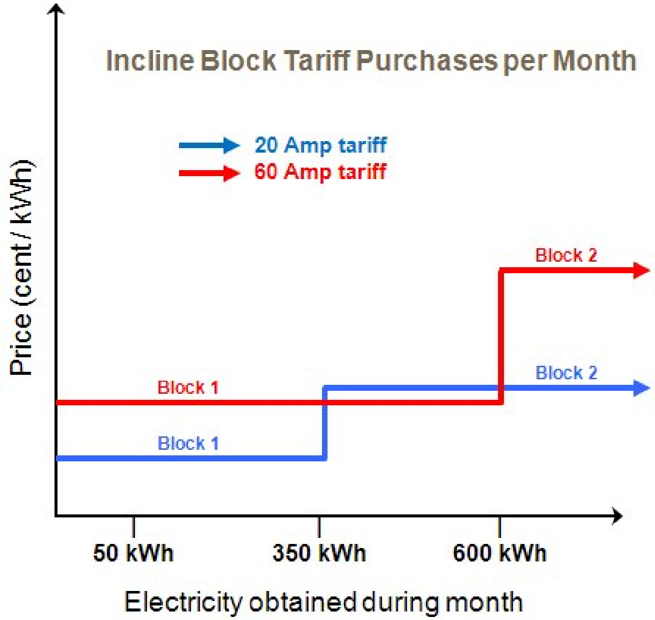
- However, in some cases (e.g. in the Philippines), this led to a few cases in 2016-2017 where wealthier households were able to self-consume so much that they were able to benefit from the subsidized tariffs offered to low-income households



4. Impact of Electricity Tariff Structure

The retail rate structure matters:

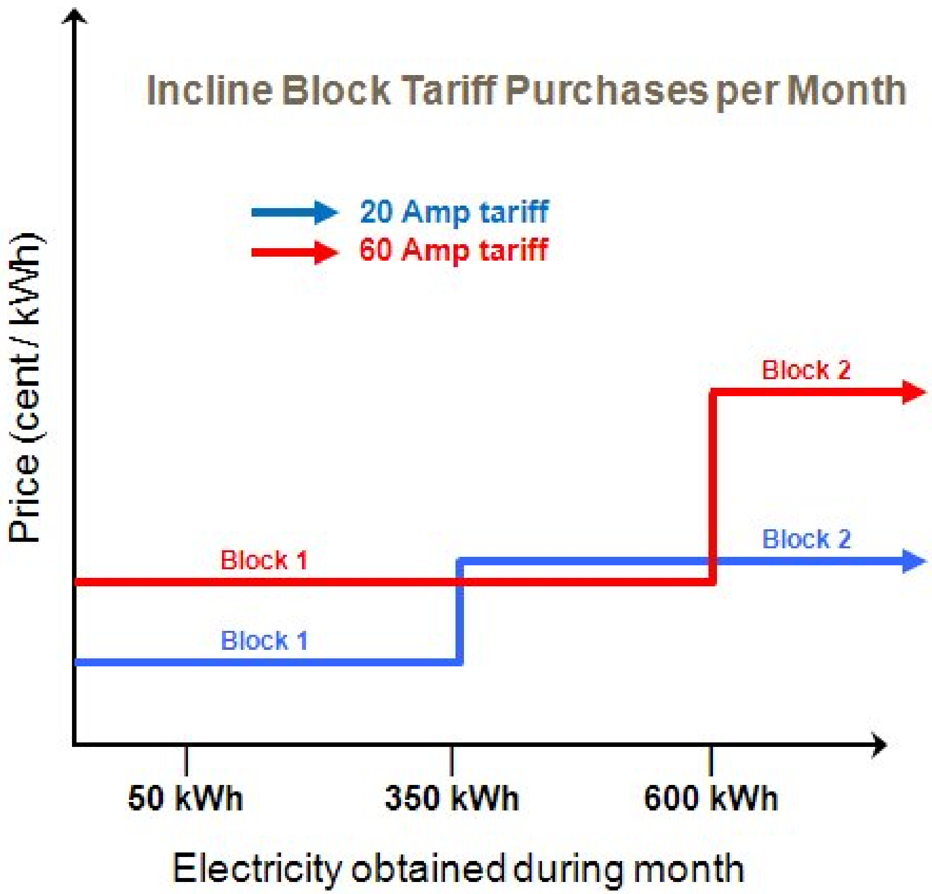
- Inclining block rates : e.g.
  - 0-100kWh = x/kWh
  - 100-300kWh = y/kWh
  - 300 – 1000kWh = z/kWh



- Higher blocks of consumption are erased first

4. Impact of Electricity Tariff Structure

- **Inclining block rates** make self-consumption particularly attractive
- They therefore inherently (inadvertently!) make solar PV more attractive for households who consume more electricity



5. Impact of Demand Charges

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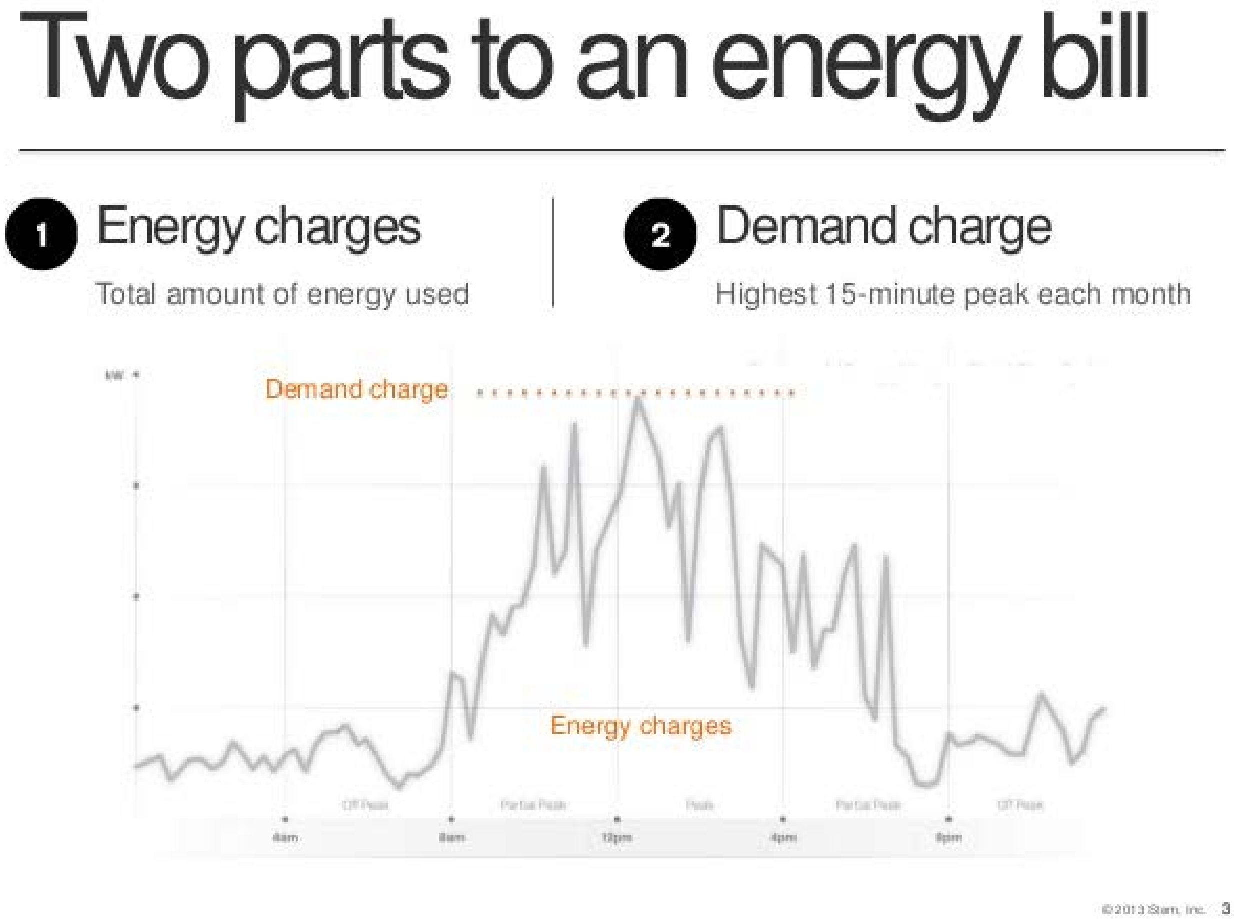
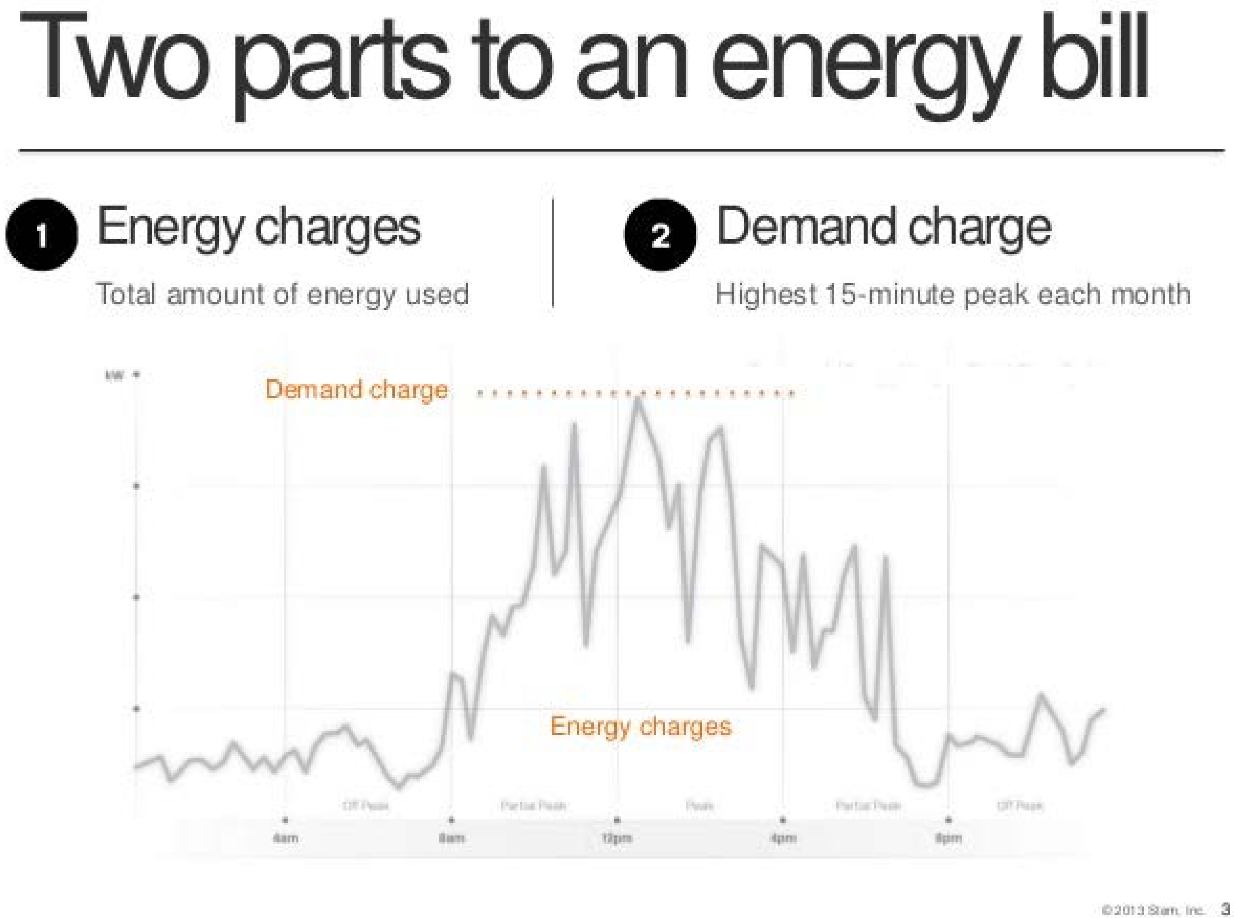
- Same applies to the introduction of **demand charges**
- Demand charges are imposed based on the **peak capacity that a customer reaches during the month**



5. Impact of Demand Charges

- Typically only applied to commercial and industrial customers

- Some utilities proposing them for residential customers



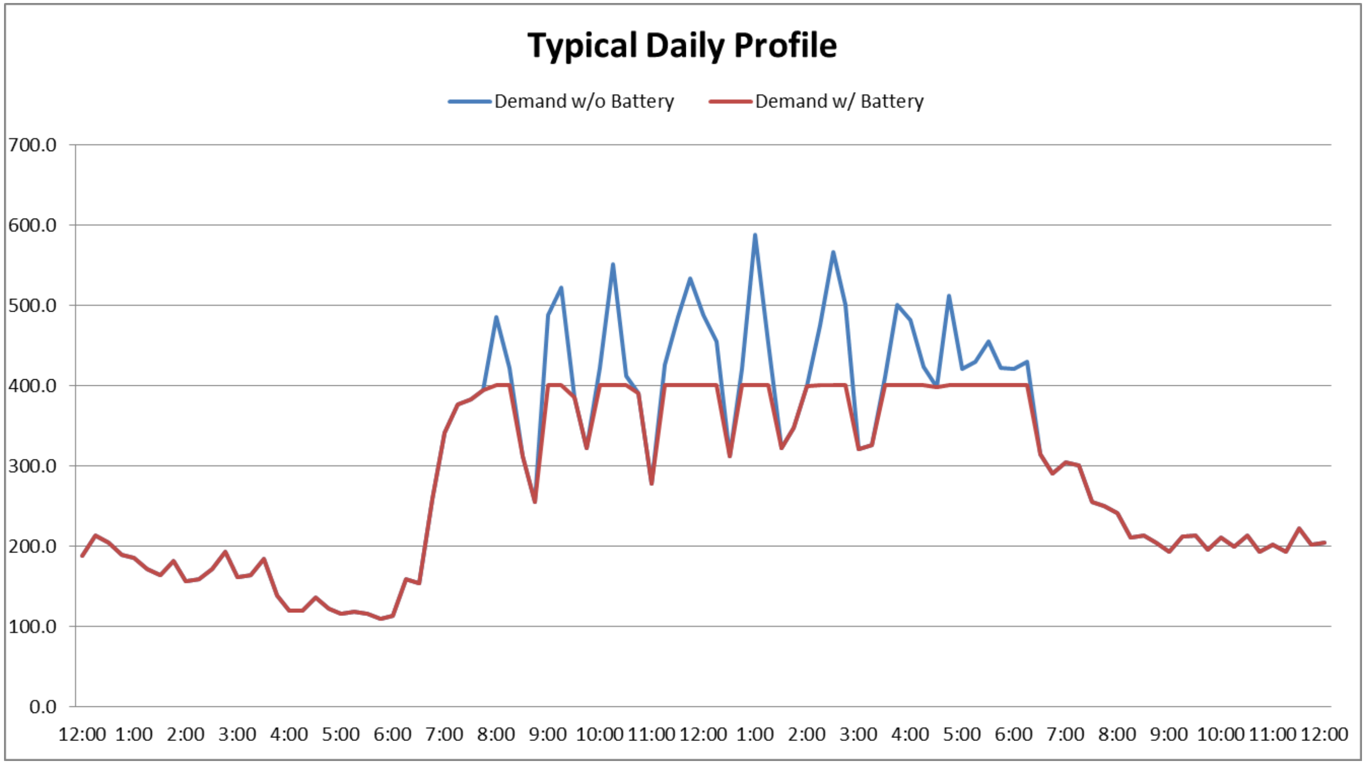
5. Impact of Demand Charges

- Utilities argue that prosumers are using the existing electricity grid as a storage unit and not paying their fair share:
  - Argue that they should also contribute to supporting the overall costs of maintaining the electricity network infrastructure

- Demand charges can, however, have unintended consequences: they create powerful incentives to invest in **onsite energy storage**

5. Impact of Demand Charges

Example: The commercial battery storage market in the U.S. for instance is heavily driven by **demand charge avoidance**



6. Ring-fencing

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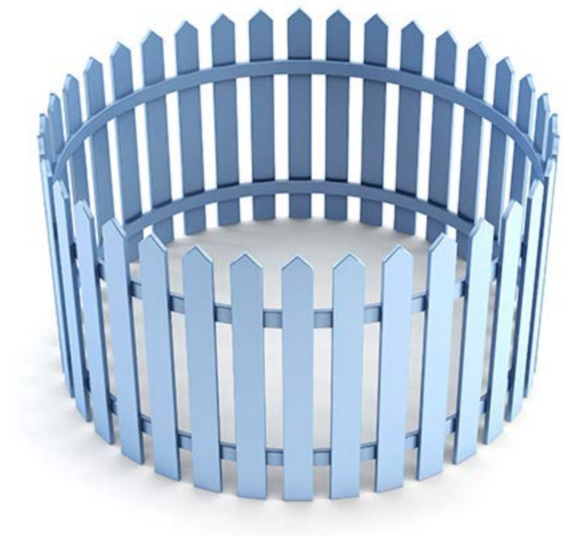
Key issue is also whether a prosumer can offset all components of their bill, or only certain components: In other words, whether they can erase all grid fees and taxes with their net excess generation

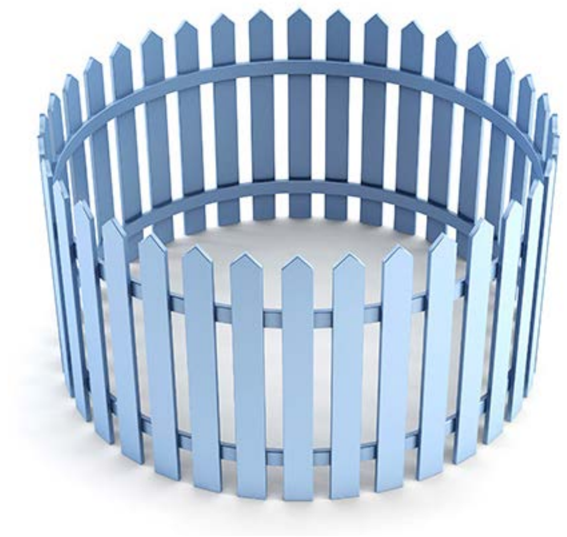
- In jurisdictions with fully volumetric tariffs (e.g. where all the costs of power distribution and supply are bundled into a simple per-kWh rate), offsetting the full rate is often possible: no restrictions.



https://knowledge.wharton.upenn.edu/article/can-the-bank-of-englands-new-ring-fencing-rules-work/

6. Ring-fencing

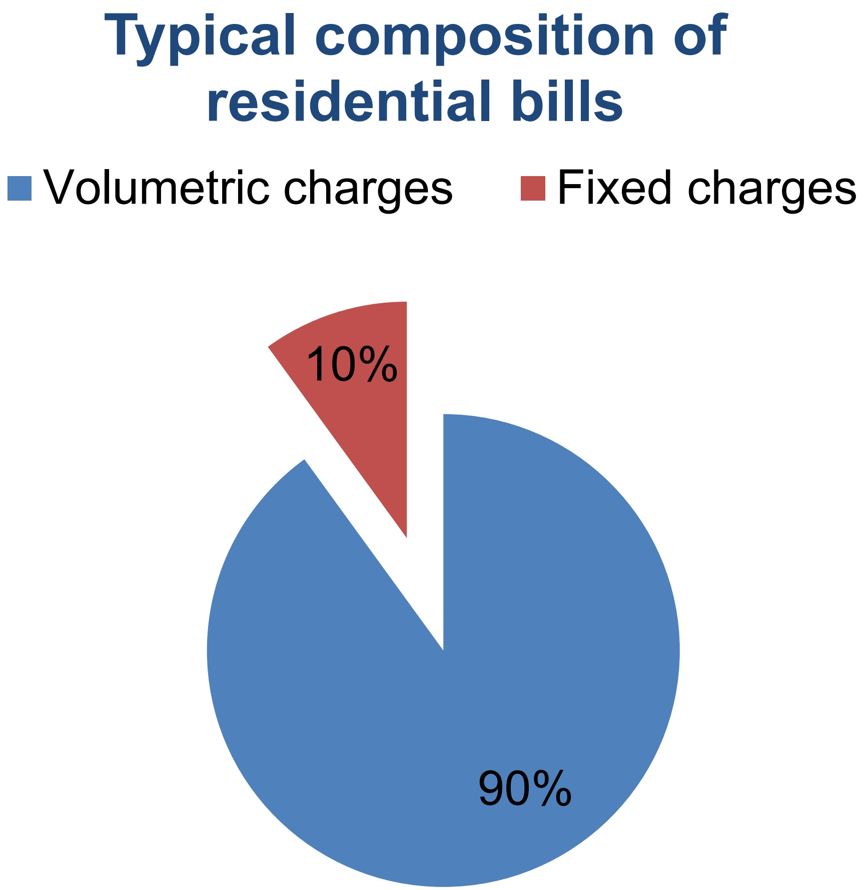
- In jurisdictions where taxes and fees are accounted for separately, it is often not: **one can only erase the energy-related components of the bill**
- Other bill components are **“ring-fenced”**
- This can fundamentally alter the attractiveness of self-consumption



https://knowledge.wharton.upenn.edu/article/can-the-bank-of-englands-new-ring-fencing-rules-work/

6. Ring-fencing

- The share of fixed charges in electricity bills is growing in many jurisdictions (sometimes over 40%)



https://knowledge.wharton.upenn.edu/article/can-the-bank-of-englands-new-ring-fencing-rules-work/

6. Ring-fencing

- Another question is whether customers have to contribute to **renewable energy support costs** (e.g. RE surcharges), or other subsidy categories in the bill (e.g. low-income residents, energy efficiency programs, etc.)

- In a growing number of cases, these different charges are starting to be **ring-fenced: i.e. they cannot be erased via self-consumption**

6. Ring-fencing

Sample Case: all non-energy charges are ring-fenced

Case shows a difference of USD 410 per year vs. classic Net Metering!

Base Data	
Total PV Output in that Month	700kWh
Total Household Demand	500kWh
Total Self-consumed Electricity	300kWh
Net Consumption from the Utility	200kWh
Net Excess Electricity Injected into the Grid	200kWh

Customer Charge	Rate	Without Net Metering, No Solar PV	Classic Net Metering	Net Metering with Ring-fencing of all non-energy charges
Net Electricity Demand from the Utility (200kWh); (Total demand of 500kWh)	USD 0.10/kWh	USD $50	USD $20	USD $20
Distribution Charge	USD 0.05/kWh	USD $25	USD $10	USD $25
Transmission Charge	USD 0.02/kWh	USD $10	USD $4	USD $10
Customer Service Charge	USD 0.01/kWh	USD $5	USD $2	USD $5
Subsidy Charge (low income customers)	USD 0.01/kWh	USD $5	USD $2	USD $5
Other charges	USD 0.01/kWh	USD $5	USD $2	USD $5
Subtotal		USD $100	USD $40	USD $70
Taxes (VAT)	14%	USD $14	$5.60	USD $9.80
TOTAL		USD $114.00	**USD $45.60**	**USD $79.80**
Bill credits to carryover to subsequent month (in kWh)		0 kWh	200kWh	200kWh
Total Remaining Bill, with taxes + remaining bill credits to carry over to the next month		**USD $114**	**USD $45.60 + 200kWh of credits**	**USD $79.80 + 200kWh of bill credits**

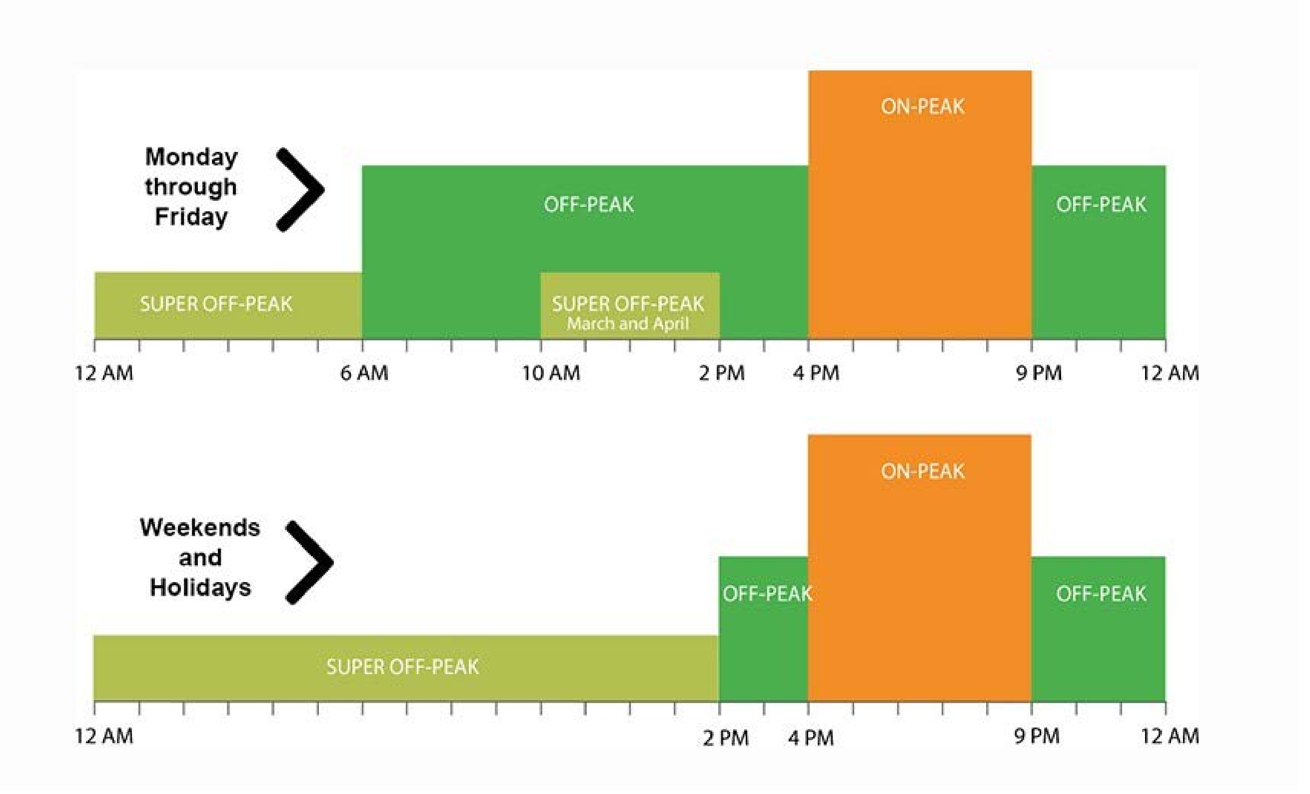
Source: E3 Analytics 2019

7. Time of Use Rates

7. Time-of-Use Rates

In some jurisdictions, customers with solar are being given the option, or being required, to have their compensation rate linked to **time-of-use rates**

Early-evening peak



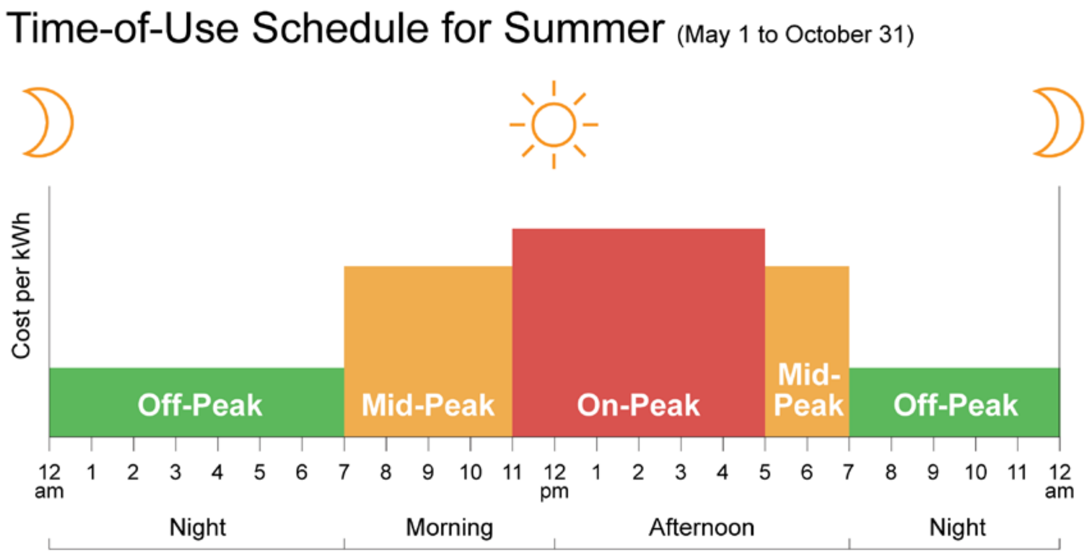
https://www.sullivansolarpower.com/about/blog/what-does-sdge-time-of-use-rate-mean-for-you

7. Time-of-Use Rates

Time-of-use rates can make it more attractive to invest in solar PV, or less attractive, depending on the structure (time of day)

Typically positive for DPV investment

Midday peak



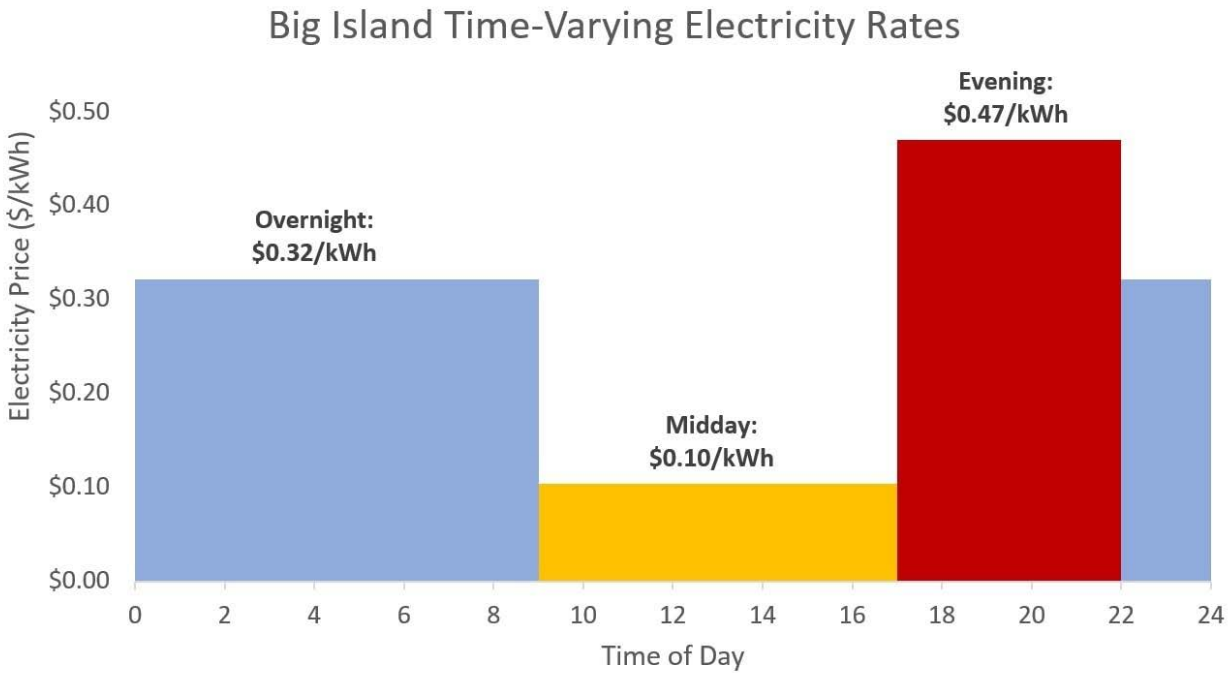
https://hydroottawa.com/accounts-and-billing/residential/time-of-use

7. Time-of-Use Rates

A low daytime TOU tariff can make customer-sited solar less attractive

Can also drive adoption of customer-sited **storage**

Daytime trough in Hawaii



Clean Energy Group, 2017

7. Time-of-Use Rates

Time-of-Use rates required new metering technology to monitor not only grid injection, but also real time consumption: e.g. **AMI meters (Advanced Metering Infrastructure)**

8. Concluding Remarks

Trends in DPV Policies

- Distinction emerging between the self-consumption rate and the export rate
- Trend toward compensation being set below the retail rate (i.e. Net Billing)
- Movement toward offering a cash settlement of Net Excess Generation (instead of simply bill credits)
- Ring-fencing is becoming more common: i.e. making certain bill components “non-bypassable” or “non-erasable” via self-consumption to protect against utility revenue erosion
- Time-based rates (TOU) starting to emerge for DPV excess generation

The Genie is out of the bottle

- The cost of solar is now below the retail price that customers pay in a wide number of markets (Hawaii, California, Massachusetts, South Africa, Germany, Philippines, etc.)

- **Governing the growth of distributed or "customer-sited" solar is poised to become one of the main challenges for electricity systems in the years ahead**

9. Further Reading

Further Reading

- Jacobs, D., Couture, T.D., Zinaman, O., Cochran, J., (2016). “RE-TRANSITION: Transitioning to Policy Frameworks for Cost-Competitive Renewables,” IEA-RETD, Paris. Available at: http://iea-retd.org/wp-content/uploads/2016/03/IEA-RETD_RE-TRANSITION.pdf

- Rickerson, W., Koo, J., Crowe, J., Couture, T., (2016). “Tapping the Potential of Commercial Prosumers: Drivers and Policy Options,” IEA-RETD, Paris. Available at: http://iea-retd.org/wp-content/uploads/2016/04/RE-COM-PROSUMERS-Report.pdf

- Zinaman et al. (2018). Distributed Generation Compensation Mechanisms (2018): https://www.nrel.gov/docs/fy18osti/68469.pdf

Further Reading

- Couture, T., Jacobs, J., Rickerson, W., Healey, V., (2015). "The Next Generation of Renewable Electricity Policies: How Rapid Change is Breaking Down Conventional Policy Categories," Clean Energy Solutions Center, in collaboration with the National Renewable Energy Laboratory, Available at: http://www.nrel.gov/docs/fy15osti/63149.pdf

- Rickerson, W., Couture, T., Barbose, G., Jacobs, D., Parkinson, G., Belden, A., Becker-Birck, C., Chessin, E., (2014). "A Study on the Effects of a Large Uptake of Non-Incentivised Residential PV (RE-PROSUMERS)", IEA-RETD: Paris, France. Available at: http://iea-retd.org/wp-content/uploads/2014/06/RE-PROSUMERS_IEA-RETD_2014.pdf

- EU Study on Prosumers in the EU: https://ec.europa.eu/commission/sites/beta-political/files/study-residential-prosumers-energy-union_en.pdf

Thank you for your time!

E3 ANALYTICS

isa INTERNATIONAL SOLAR ALLIANCE

IET International Energy Transition

Factor
Ideas for change

CLEAN ENERGY
SOLUTIONS CENTER
ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

10. Knowledge Checkpoint: Multiple Choice Questions