Scaling-up Distributed Solar PV in the South East European Region

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BRIEF PROFILE:

Toby Couture is Founder and Director of E3 Analytics, an international renewable energy consultancy based in Berlin that focuses on renewable energy markets, policy, and finance. He has worked with over forty countries around the world on the economic, financial, and policy aspects of renewable energy development, including in Asia, the Pacific region, the Middle East, Africa, and the Americas.

He specializes in policies and tariff setting for distributed solar PV.

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www.e3analytics.eu

Outline

Part 1: Impacts of EVs on RES-T Targets

Part 2: Distributed PV Policy

1. Impact of Electricity Rate Structure
2. Net Metering
3. Net Billing
4. NET-FIT
5. Special Topics: Design Issues

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Part 1: Impact of Electric Vehicles on Transport Sector RES Targets

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Transport Sector Targets at EU Level

- 14% target proposed for RES-T by 2030
- Share of ”first generation” biofuels to be capped at 7%
- Focus increasingly to be on advanced biofuels, biogas, biofuels from wastes, and from non-food crops
- What about the role of Electric Vehicles?

https://www.europarl.europa.eu/news/en/press-room/20180614IPR05810/energy-new-target-of-32-from-renewables-by-2030-agreed-by-meps-and-ministers

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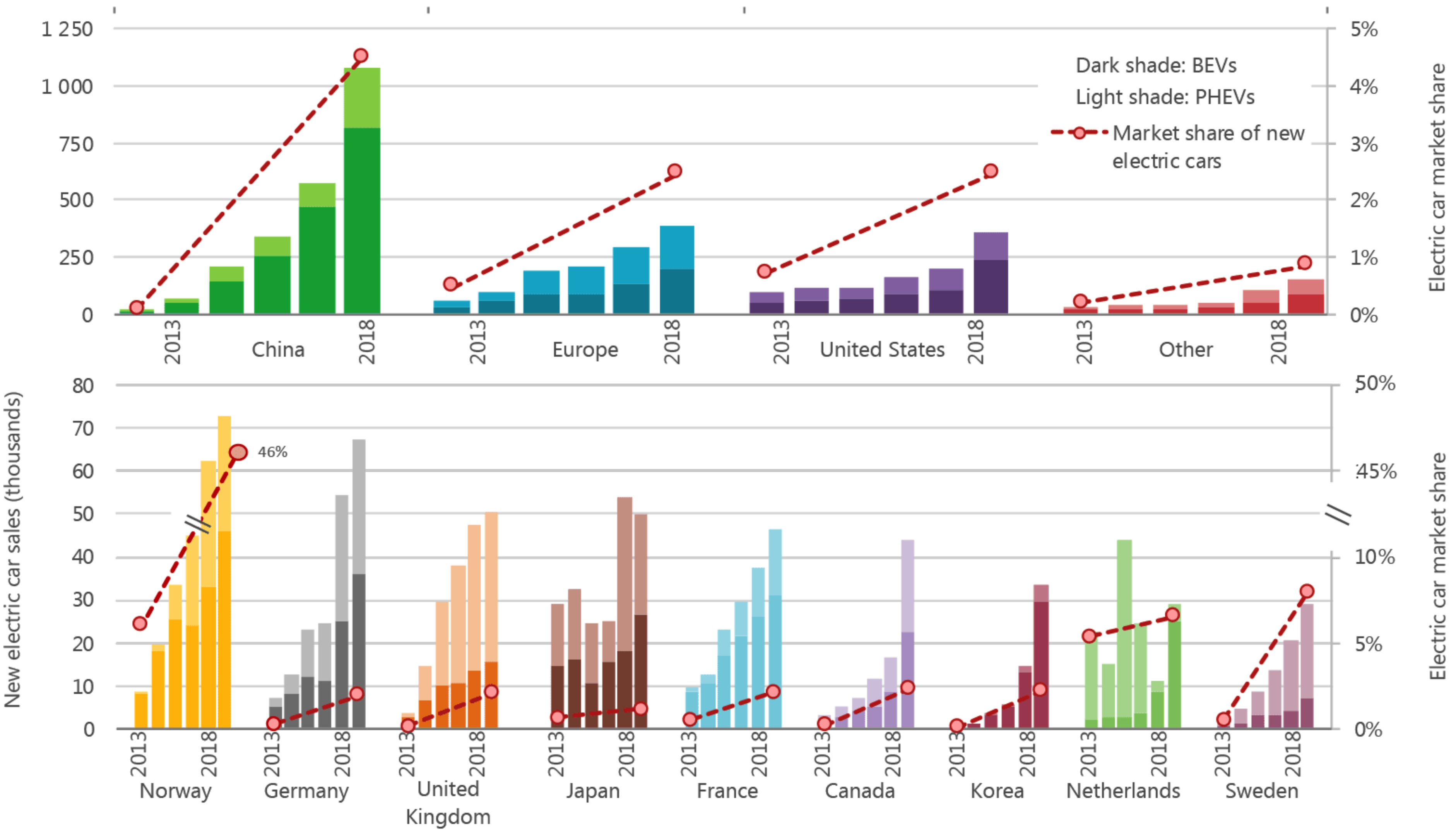
Electric Vehicles are on the Rise



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Source: IEA 2019 Global EV Outlook

RES and the Role of Electric Mobility

- **Rising share of EVs worldwide:**

Vehicle Type	Number on the road (end 2018)
Two-wheelers	260 million
Three-wheelers	40 million
Electric cars	5.1 million
Electric buses	460,000 (ca. 95% of which in China)
Electric Metros	In 181 cities
Electric trams/ light rail	In 411 cities

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Source: REN21 GSR 2019

Transport Sector + RES + Electric Mobility

The rise of electric vehicles has several important effects:

1. Increases electricity demand, but (paradoxically!):

2. *Decreases* Total Final Energy Consumption (TFEC) (because EVs are more *energy efficient*)

Since most countries have a higher % of RES-E in the power mix than RES-T in the fuel mix, increasing EVs increases RES shares.

This should make it easier for countries to achieve RES-T targets

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Economics: Electric Vehicles

Since electricity prices are relatively low in the SEE region (EUR 0.06 – 0.10), the cost-per-km-travelled of EVs is better than in other European countries

Transport sector targets have largely been ignored in the region

This presents an opportunity

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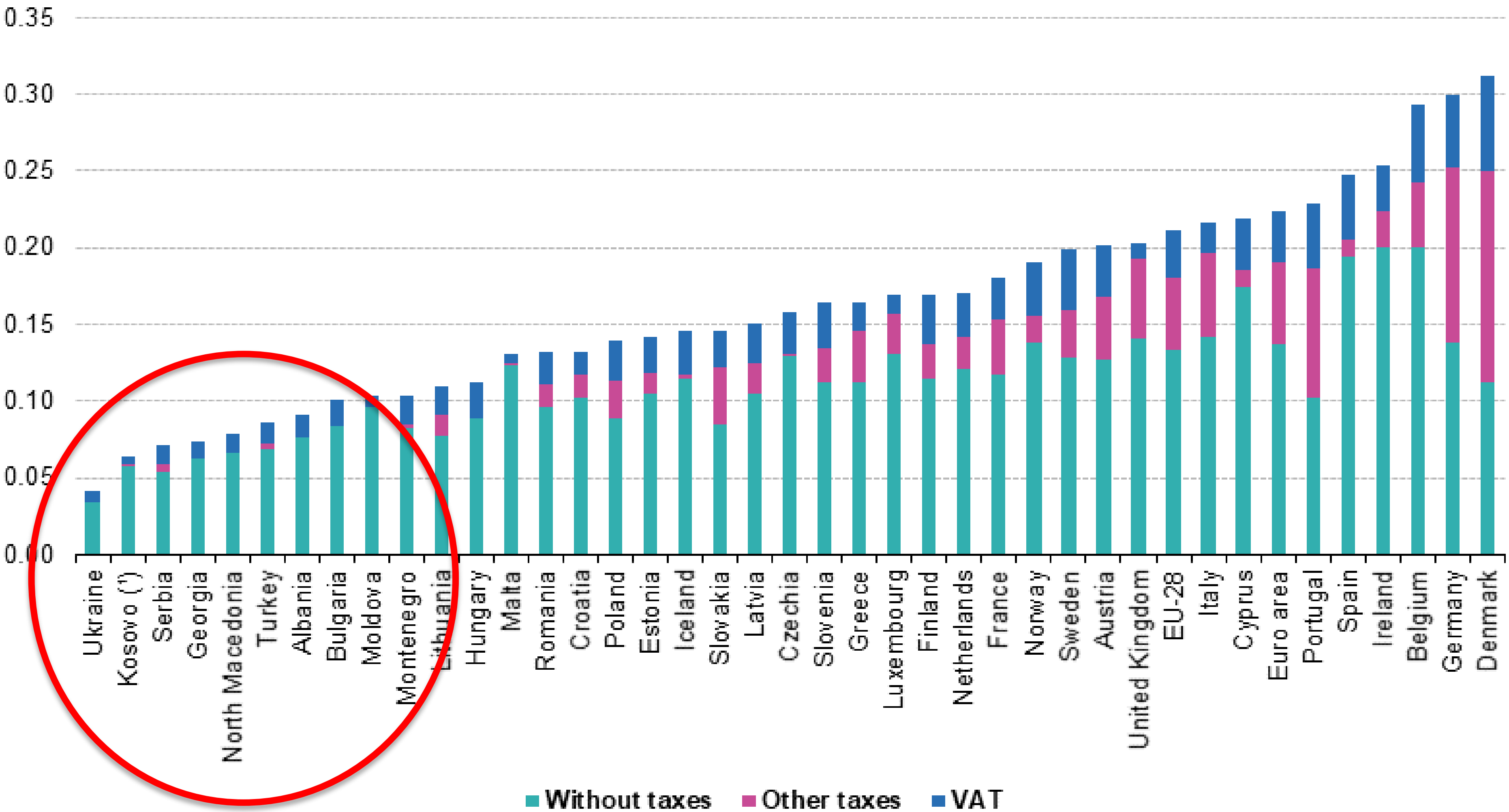
Electricity prices for household consumers, second half 2018

(EUR per kWh)



(¹) This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo Declaration of Independence.

Source: Eurostat (online data codes: nrg_pc_204)

eurostat

Prices Range from roughly EUR 0.80 – 1.40

Energy Community Average = EUR 1.15

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Economics: Electric Vehicles

Comparing the cost of EVs vs. petrol vehicles requires creating a common basis of comparison

First, there is vehicle cost: EVs currently more expensive (10-40% more)

This analysis compares cost of driving 100km

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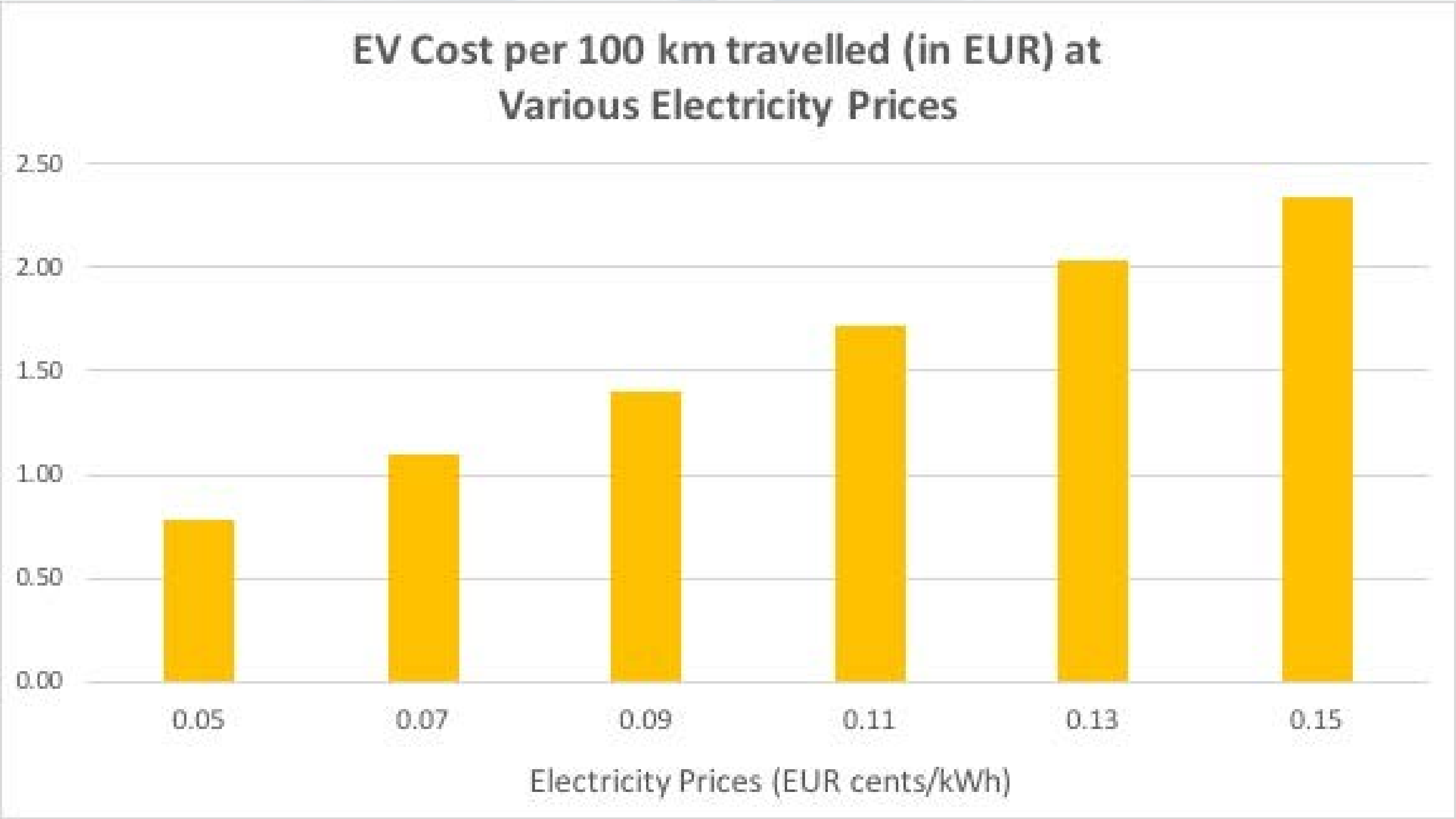

Roughly EUR 1.50

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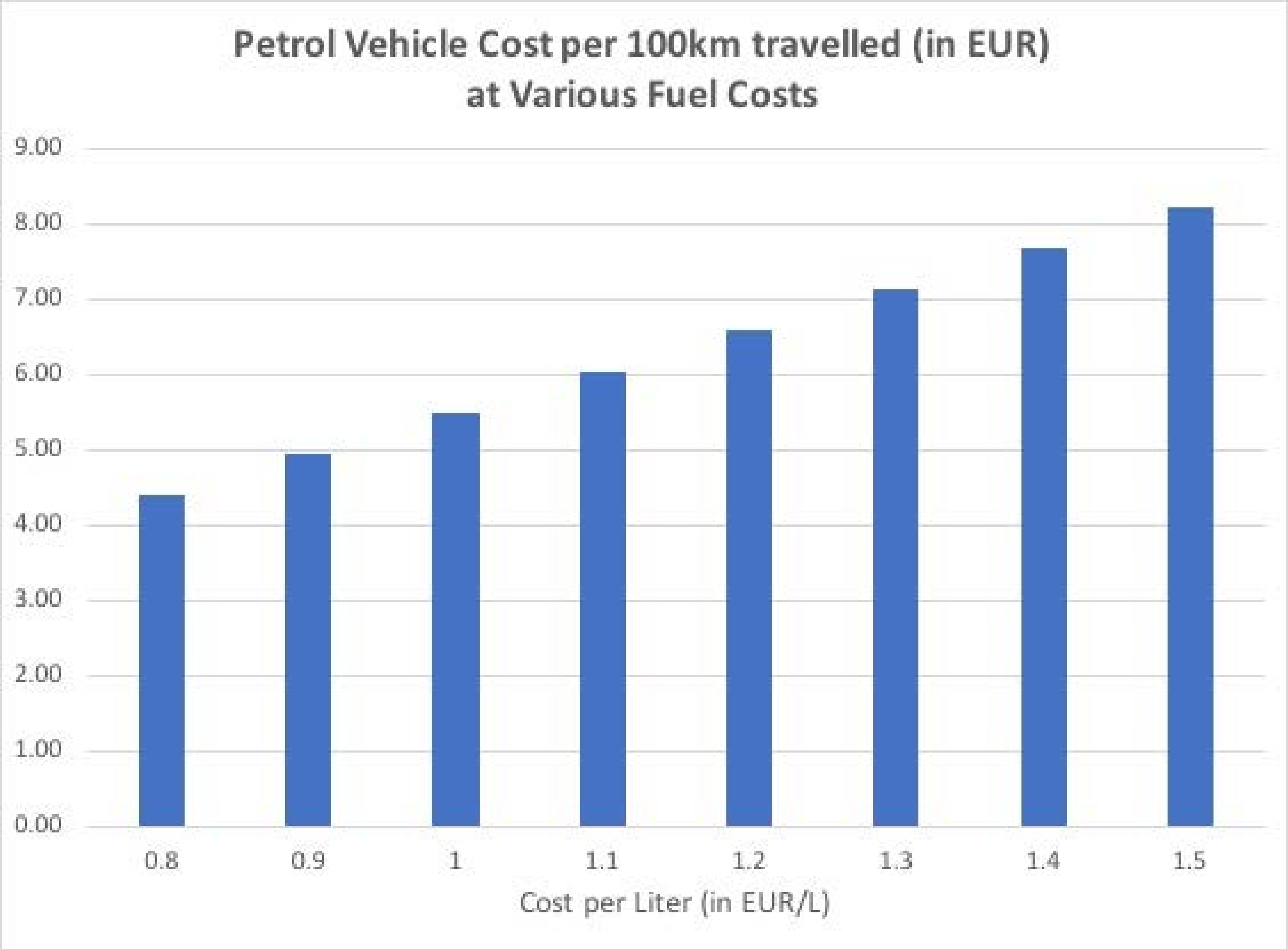
Assumption: New EV Efficiency = 6.4km/kWh



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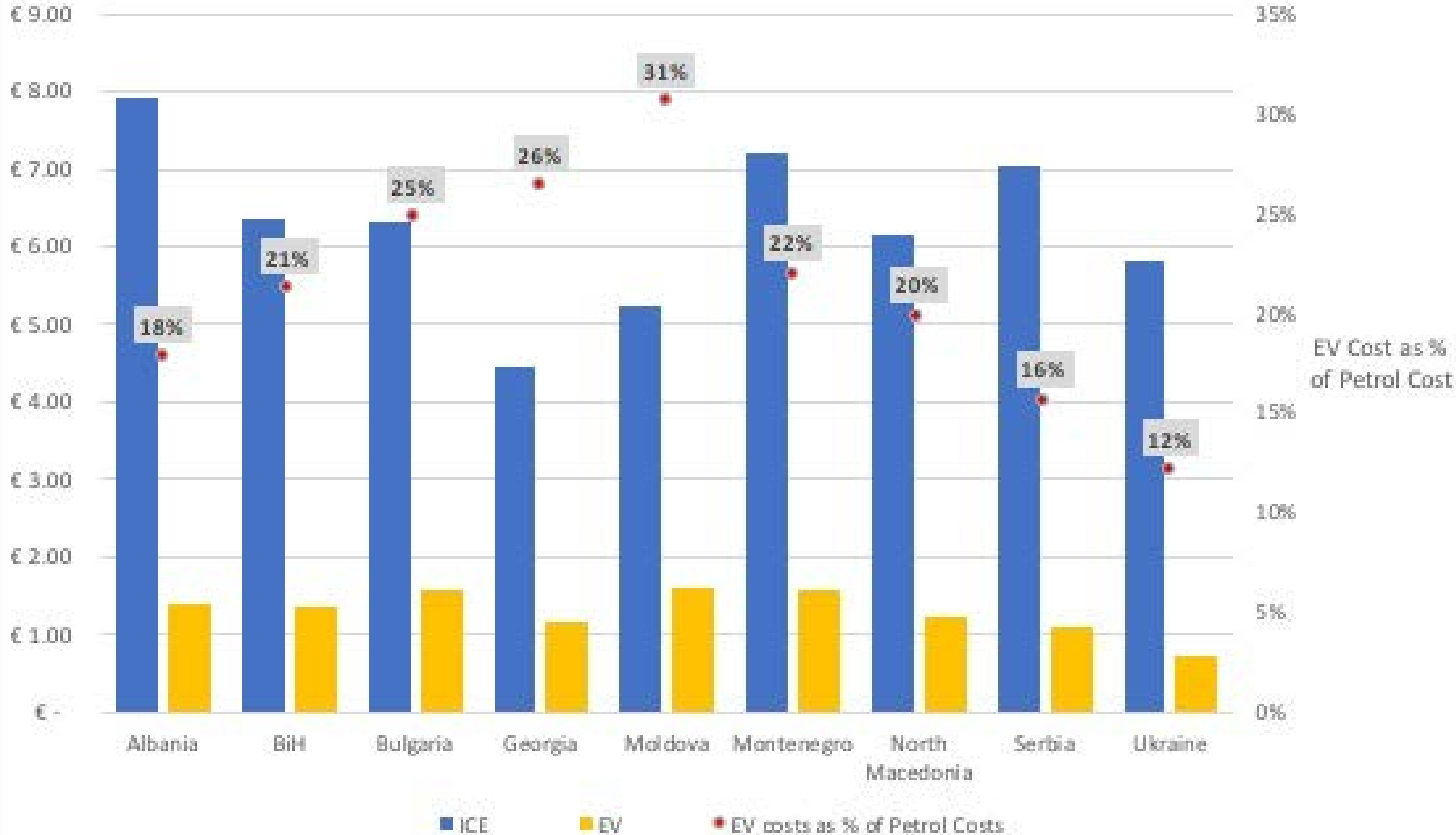
Roughly EUR 6.00

Assumption: New ICE Vehicle Efficiency = 18.2km/Liter

Cost to Travel 100km with Electric vs. Petrol Vehicle

Selection from the SEE Region



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Data Table

	Gasoline Price by Selected Country (Nov 2019)	Cost per 100km	Residential Electricity Price by Country (H1:2019)	Cost per 100km
Albania	€ 1.44	€ 7.91	€ 0.09	€ 1.41
BiH	€ 1.16	€ 6.37	€ 0.09	€ 1.35
Bulgaria	€ 1.15	€ 6.32	€ 0.10	€ 1.56
Georgia	€ 0.81	€ 4.45	€ 0.08	€ 1.17
Moldova	€ 0.95	€ 5.22	€ 0.10	€ 1.59
Montenegro	€ 1.31	€ 7.20	€ 0.10	€ 1.58
North Macedonia	€ 1.12	€ 6.15	€ 0.08	€ 1.22
Serbia	€ 1.28	€ 7.03	€ 0.07	€ 1.09
Ukraine	€ 1.06	€ 5.82	€ 0.05	€ 0.70

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What about the impacts on electricity demand?

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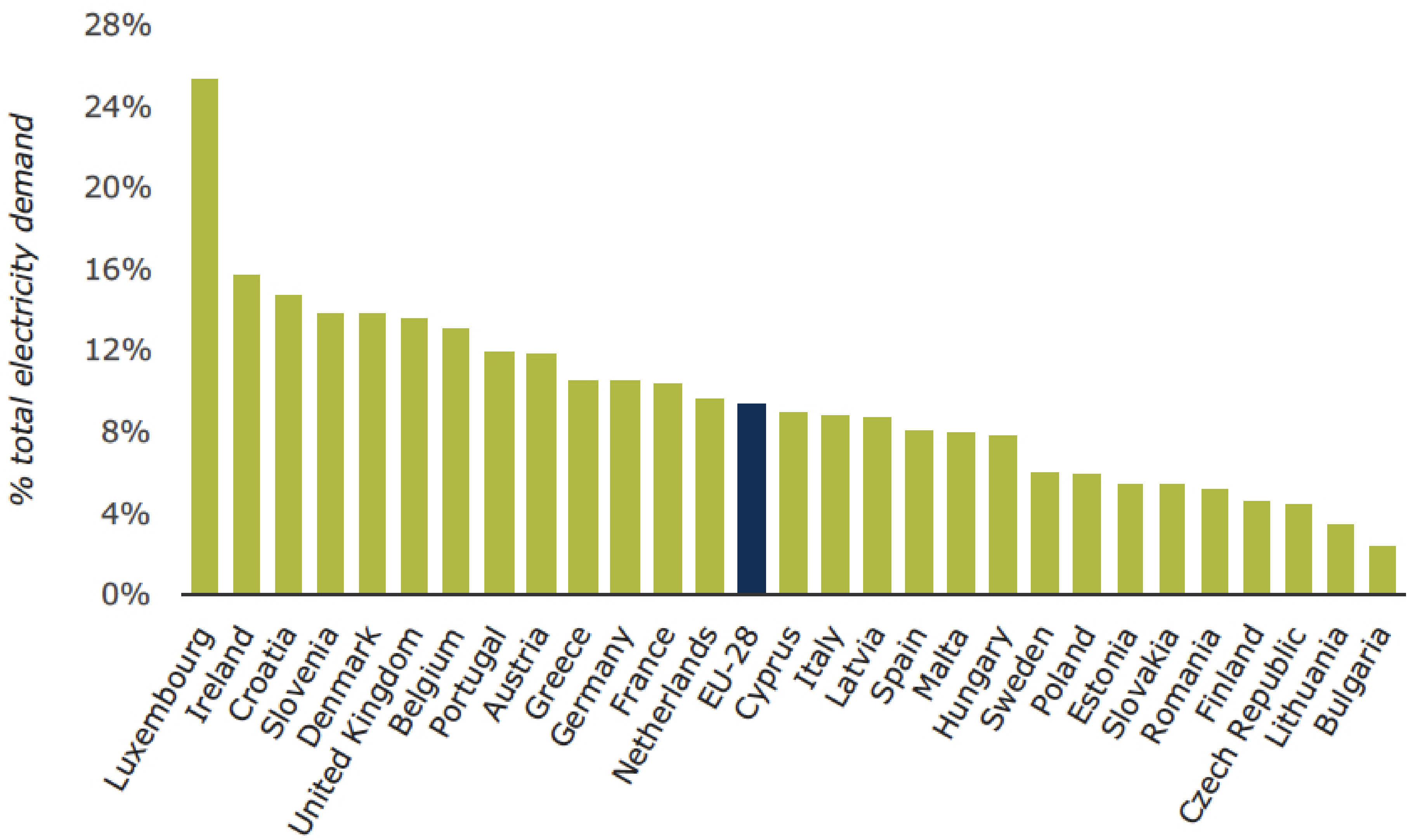
Assuming an 80% share of EVs on the road by 2050 in the EU

Figure 1: Electric vehicle energy demand as a percentage of total electricity demand in 2050



Source: EEA 2019

Analysis from EEA suggests an additional 150GW of new electrical capacity will be needed.

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Source: EEA 2019

What does the policy toolkit for RES-T look like?

Policy Tool	How it works
Upfront cash incentives	Direct cash incentives offered for the purchase of an electric vehicle, or a plug-in hybrid. Such upfront cash incentives can help to bridge the cost gap between EVs and conventional vehicles and drive consumer adoption.
Fiscal incentives	This approach uses the tax code to tilt the playing field toward greater adoption of EVs. This includes measures like increasing the taxes on conventional, or fossil-fuel powered vehicles, or reducing the levies on EVs.
Sweeteners	This category covers the broad array of policies including free access to "fast track" lanes in traffic, free parking, free use of public transit such as ferries. Another sweetener common in many places is **free charging**, where users do not have to pay to dock their car and fill up, along with free passage through road tolls.

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What does the policy toolkit for RES-T look like?

Policy Tool	How it works
Mandates	Mandates involve imposing an obligation, either on car manufacturers or auto retailers (e.g. dealerships) to sell a certain volume of EVs by a certain date, or to reach certain sales targets as a percentage of overall sales. Mandates could also be used to require that certain establishments (grocery stores, shopping centers) be required to offer charging facilities on the premises, or to be ”EV-ready”.
Direct Investment	This approach involves investing directly in the sector either through procurement policies that favor EVs, or by investing public funds in charging infrastructure.
Bans and phase-outs	This approach involves limiting or restricting the ability of conventional vehicles to enter into urban centers, or to be sold. For instance, Mexico, London, and Paris have all already introduced various forms of bans and restrictions on diesel vehicles.
RD&D	Investment in RD&D remain important, including in advanced battery technologies, advanced materials, and improved charging platforms.

“Smart charging” of EVs another critical policy tool

1. Allows more effective peak shaving
2. Reduces the necessary grid investments
3. Allows a reshaping of the load curve to optimize generation cost (shifting demand from peak to base-load generation).
4. Improves the integration of VRE (wind and solar): e.g. by ”dispatching” EV charging at times of high solar and wind generation and throttling it down at moments of low renewables production
5. Can provide demand-response and other system services (e.g. frequency-response)

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Part 2: Distributed PV Policy

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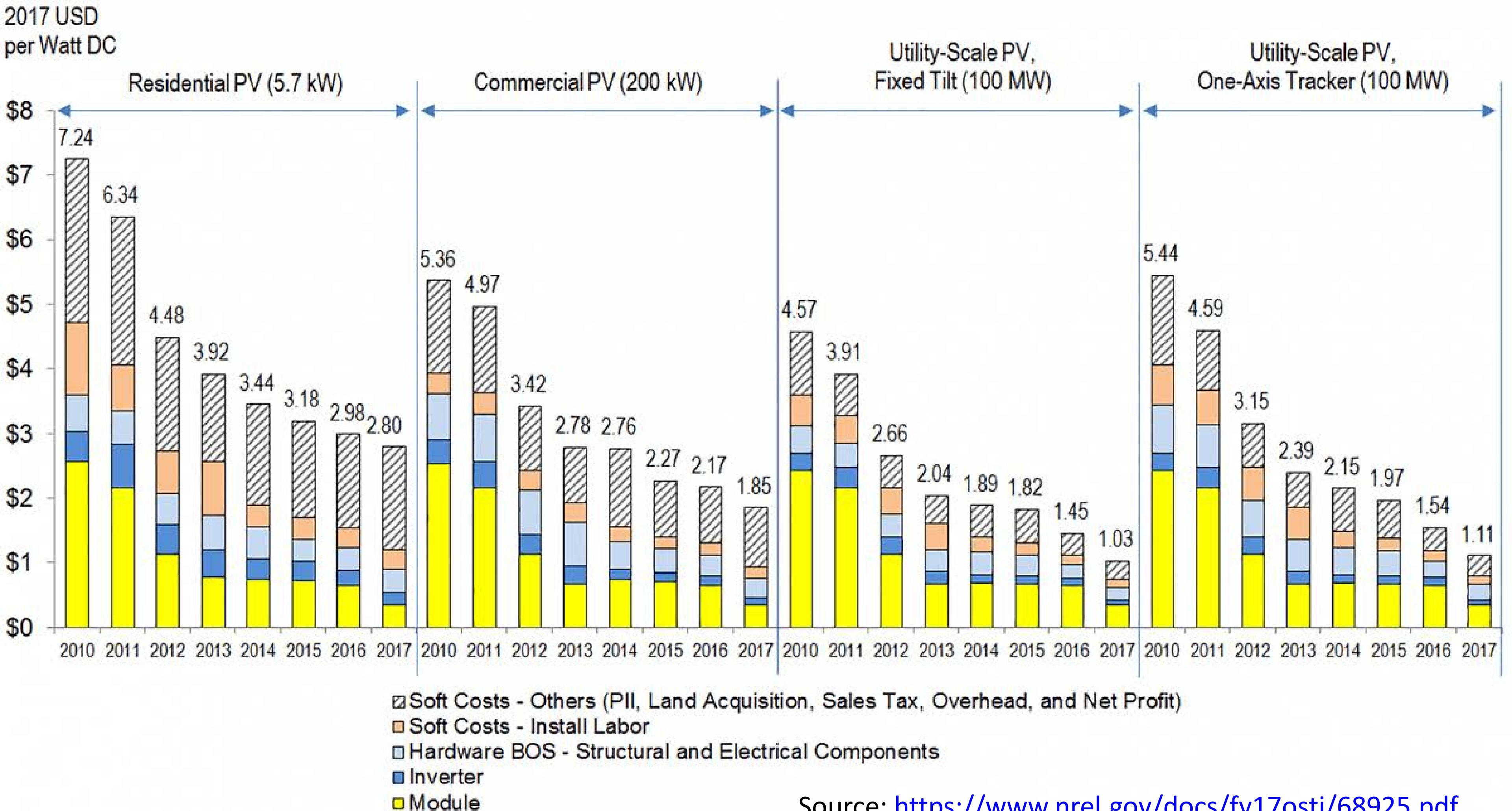
Costs of Solar



Source: https://www.nrel.gov/docs/fy17osti/68925.pdf

Many jurisdictions well beyond "grid parity"

Country	Current Retail Rate (EUR/kWh)	Approximate LCOE of customer-sited solar PV (EUR/kWh)	PV LCOE as a Percentage of Retail Rate
Germany	0.30/kWh	0.8/kWh	~27%
Hawaii	0.33/kWh	0.6/kWh	~20%
Australia	0.20/kWh	0.5/kWh	~25%
New York (U.S.)	0.18/kWh	0.8/kWh	~44%
Cape Verde	0.27/kWh	0.11/kWh	~41%

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Source: E3 Analytics 2019

Historical Context

In jurisdictions with Feed-in Tariffs (e.g. Germany), the majority of households and businesses were exporting **100%** of their output

Projects received a fixed, long-term price for their output: **no self-consumption**

Customers continued to buy 100% from their local utility

Customers in effect became "**mini-IPPs**", not real "prosumers"

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Historical Context

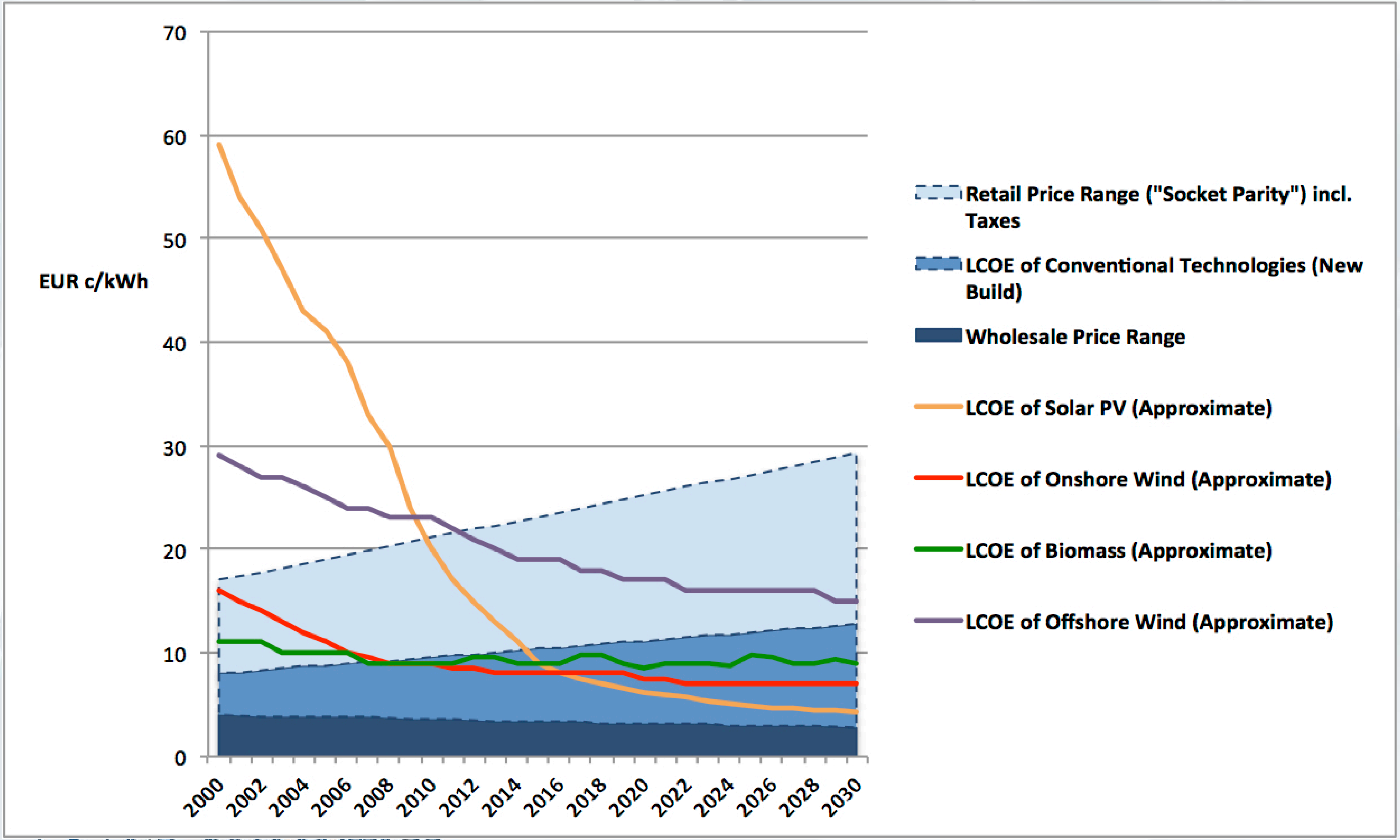
This started to change as retail prices went up, and solar PV costs went down

As a result, **it started to make economic sense to ”self-consume”**

New rooftop PV projects started to be configured for self-consumption first, only injecting their surplus generation to the grid

Feed-in tariffs became, in effect, ”NET-FITs”

Solar PV is now entering the wholesale price range



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Overview of Distributed PV Policies

Policy Mechanism	Relation to the Retail Rate	Possibility of Cash Payment (Y/N)
Net Metering	***At*** the retail rate	No
Net Billing	***Below*** the retail rate	Typically not
NET-FIT	***Below*** the retail rate	Yes
"Classic" FIT	No relation to the retail rate: **Set at the LCOE of each technology**	Yes

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The Rise of Distributed Solar

- In some regions, residential solar surpasses 200% of maximum daytime load (e.g. Hawaii)

- Germany has an estimated 1.70 million individual solar systems

- Australia = 2.2 million

- Japan = 1.9 million

- United States = 2 million

-Bangladesh (!) = **5 million**

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Key Distinction

Compensation Mechanism for **Surplus Generation**

- Bill Credits
- Cash Payment

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Cash payment vs. Bill credits

One of the most fundamental distinctions is whether the customer ever can receive **a cash payment** for their excess generation

In most Net Metering policies, 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 even stipulate: "no negative bills": i.e. no cash payments to customers

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Cash payment vs. Bill credits

However, restricting the compensation to bill credits makes Net Metering **less investable**, and less **bankable** (i.e. harder to get bank loans)

And one of the biggest challenges for other Net Metering markets in the region (Greece, Turkey, Croatia, Hungary, Romania, etc.) is **access to finance**

Without financing, projects have to be paid in **cash**

Result = solar is only for the wealthy(ier) & larger businesses

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Distributed PV generates many more jobs than large, ground-mounted projects

Residential: 11x more jobs per MW

Commercial: 7x more jobs per MW

INSTALLATION AND PROJECT DEVELOPMENT JOBS PER MW INSTALLED

	Jobs Per MW
Industry Total	14.0
Residential	38.7
Non-residential	21.9
Utility-scale	3.3

Source: SEIA 2019: US Solar Jobs Census
https://www.seia.org/research-resources/solar-jobs-census-2018

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1: Net Metering

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Net Metering

- First introduced in the U.S. in the early 1980s

- Targets small system sizes (typically <2MW)

- As of the end of 2019, **over 60 countries around the world have adopted some form of Net Metering**

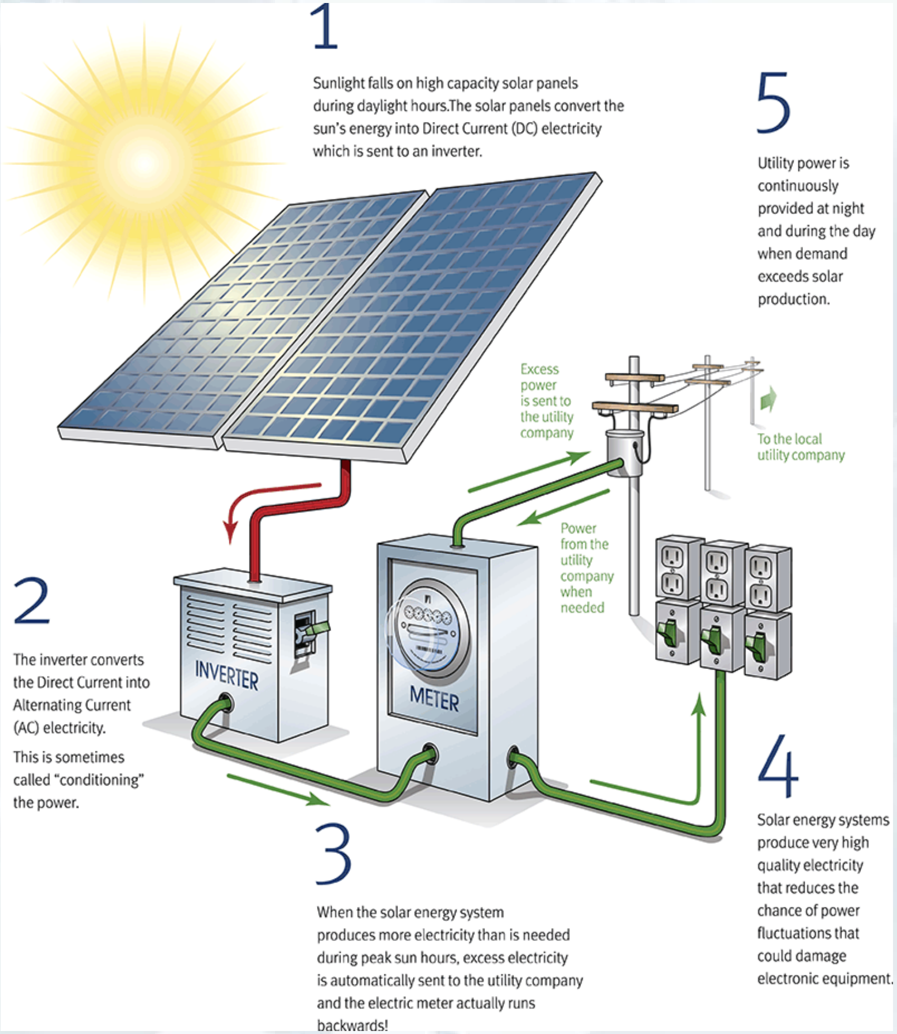
- Allows individuals or businesses with customer-sited generation to connect to the grid and be **credited** for the excess power they fed into the system

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**

Compensation = savings on power bill



Source: SolarCraft.com

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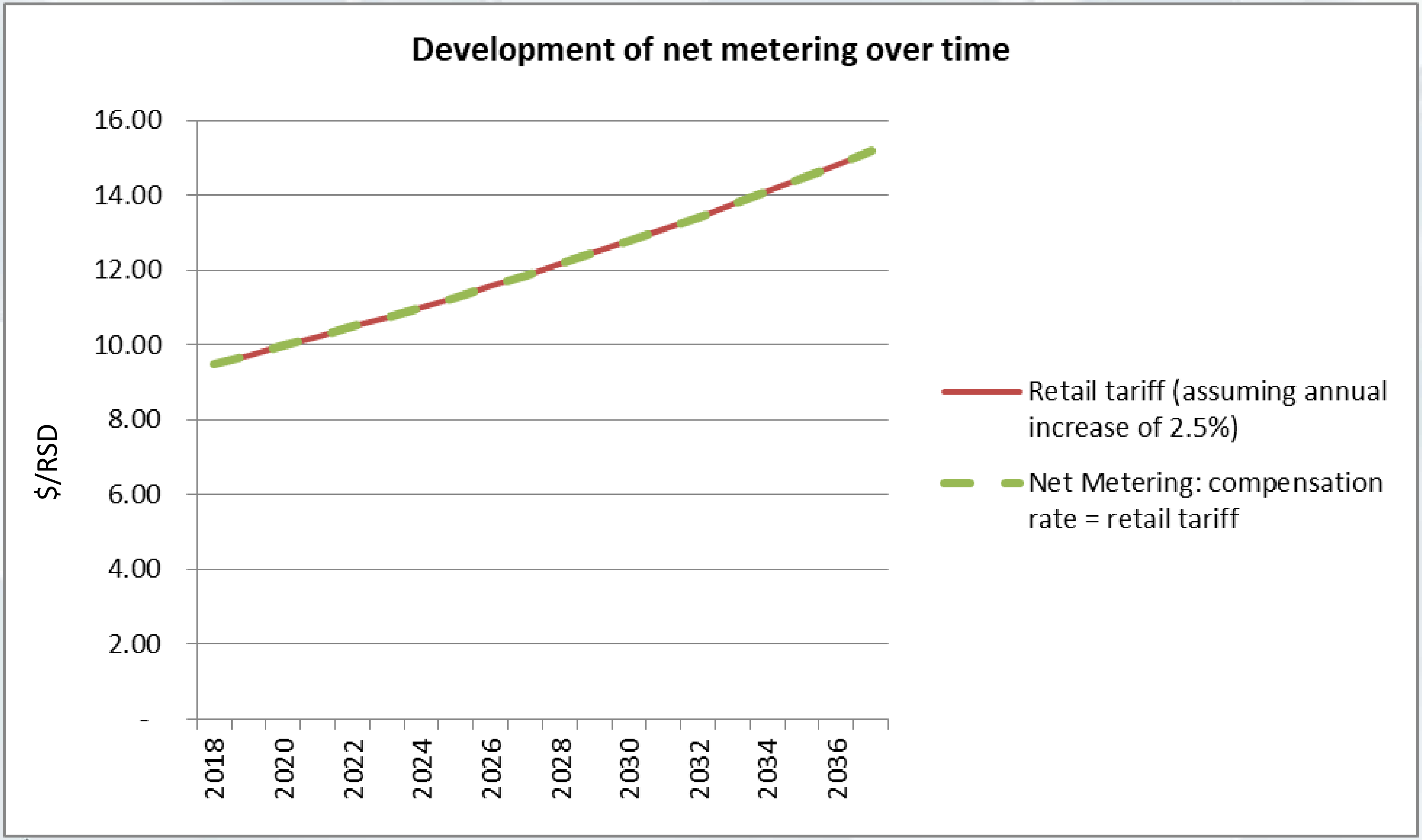
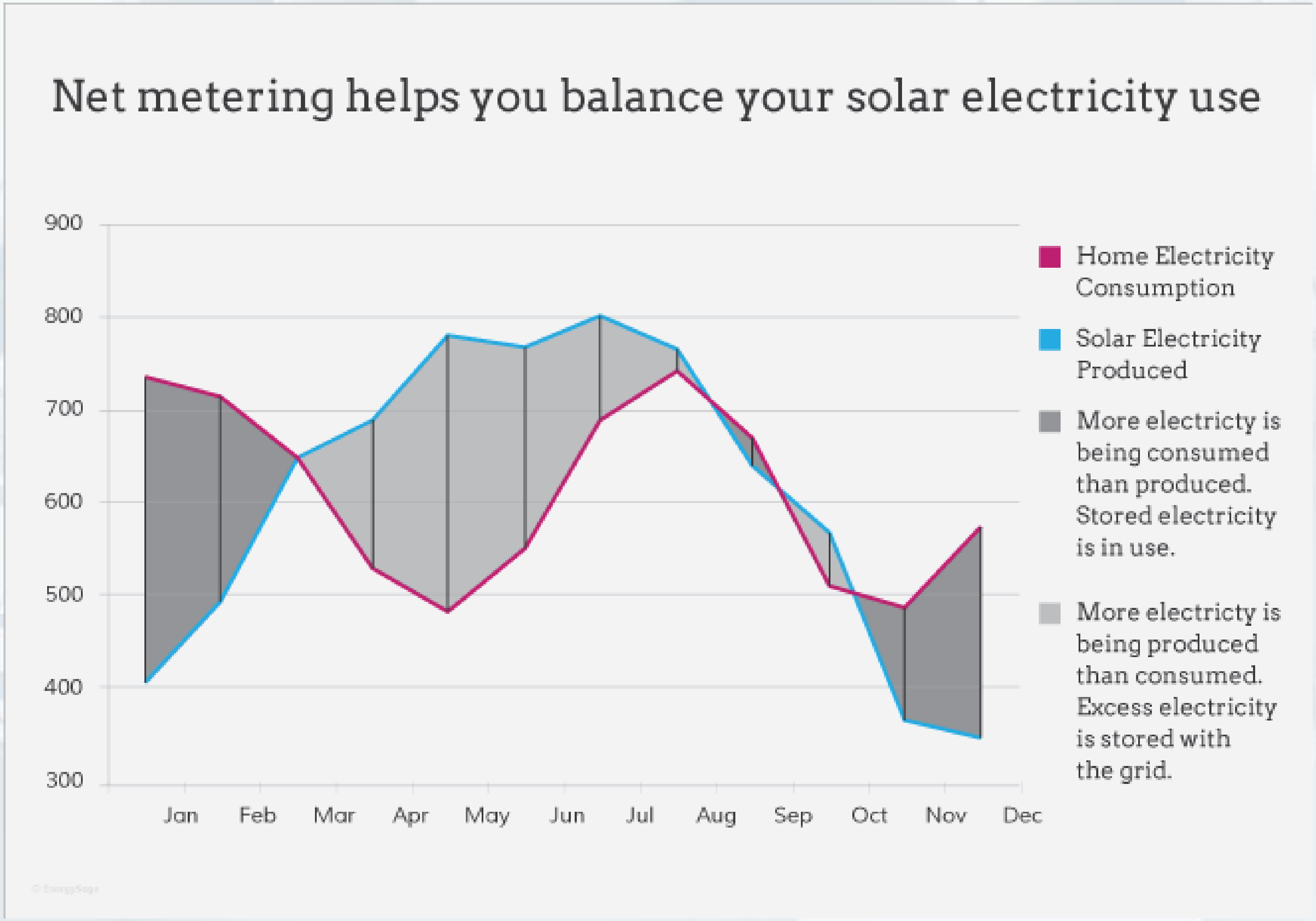
The *value* of customer-sited generation increases over time as retail prices rise



E3 Analytics 2019: *Illustrative*

Net Metering



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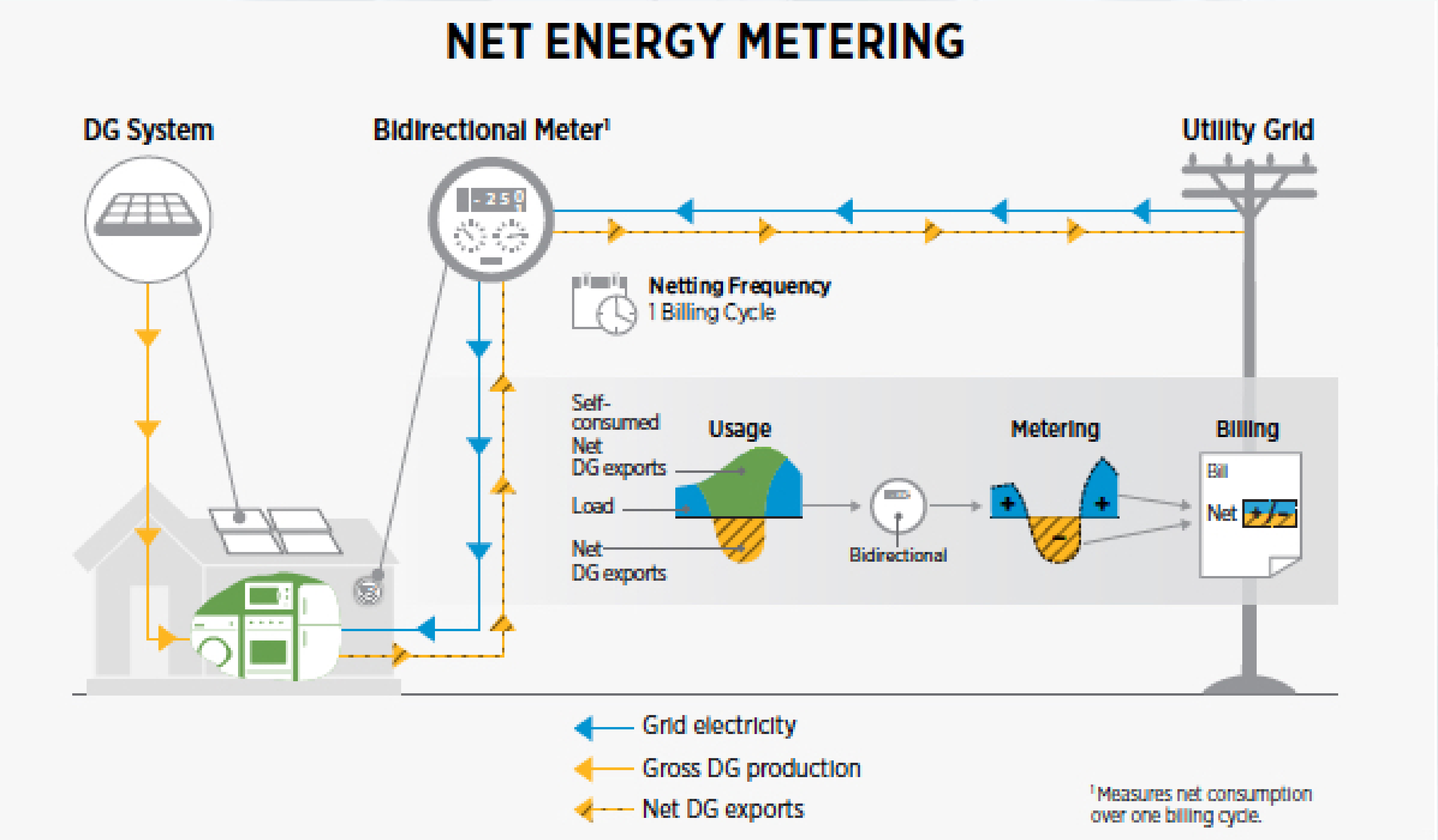
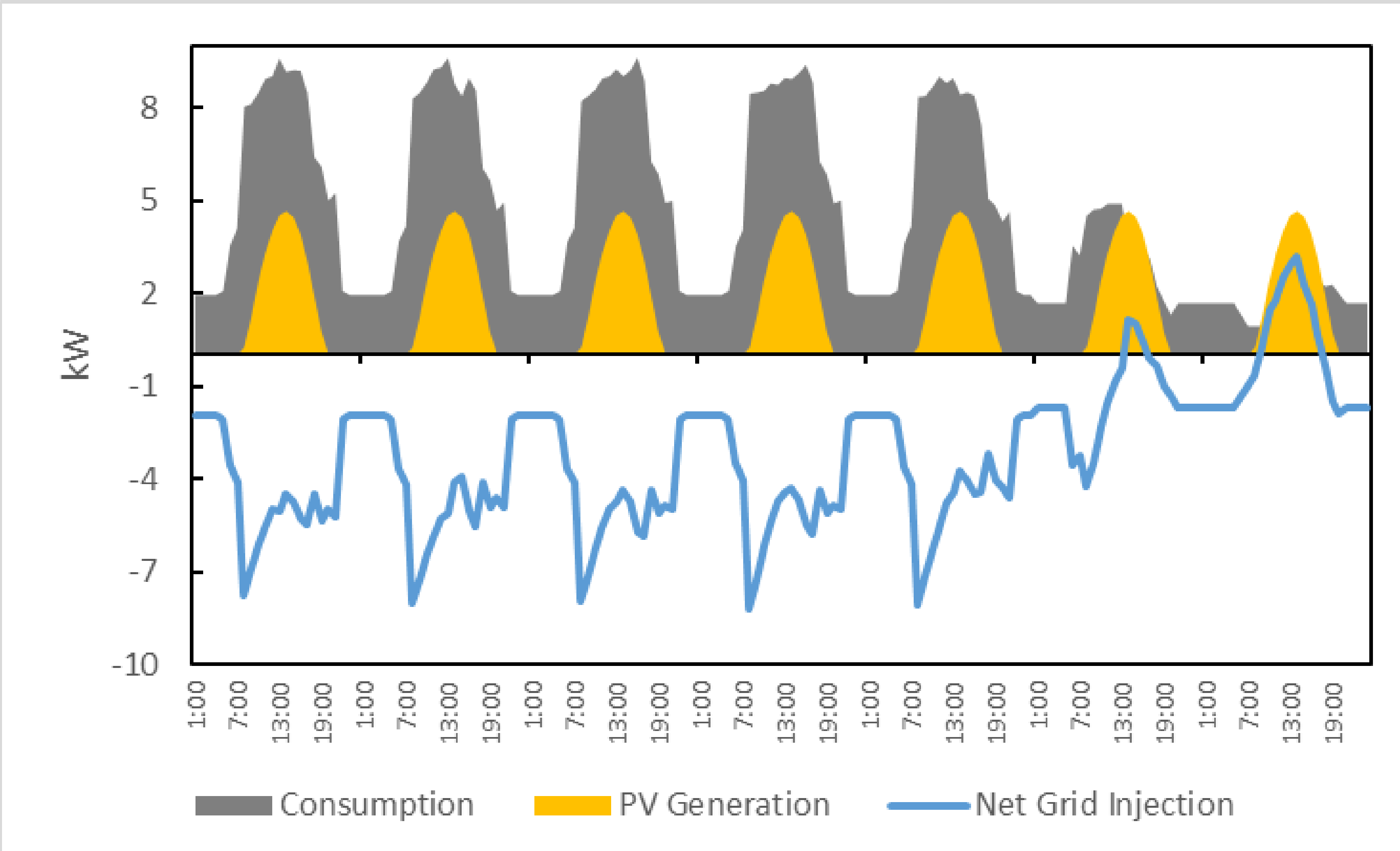
Source: https://www.energysage.com/solar/101/net-metering-for-home-solar-panels/



https://www.nrel.gov/docs/fy18osti/68469.pdf

Office Building Load Curve: 7.5kW Solar PV Array

*Case: **Small surplus** injected into the grid (weekends)*



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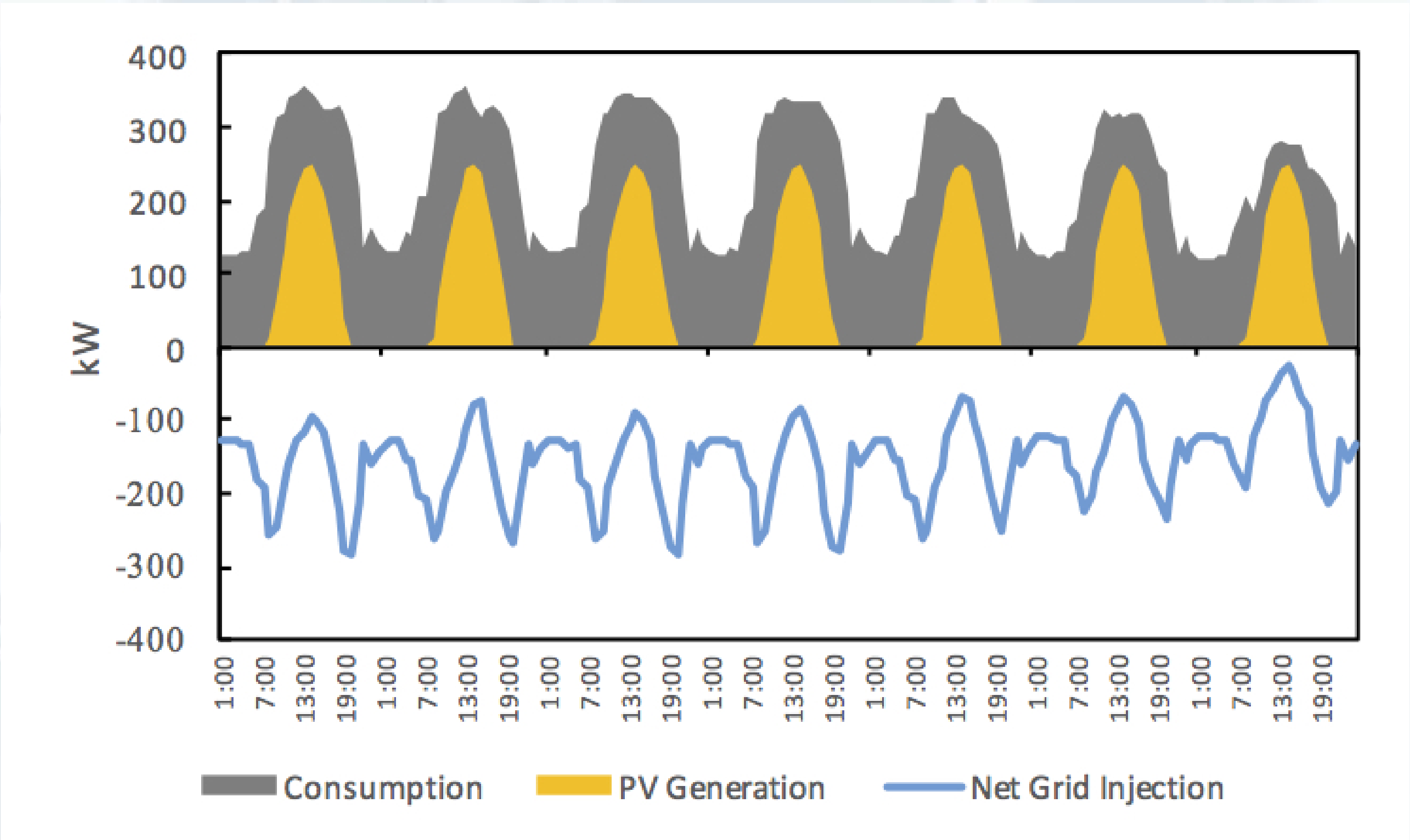
Source: E3 Analytics 2018

Supermarket Load Curve: 300kW Solar PV Array

Case: ***No net surplus*** *injected into the grid*



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Source: E3 Analytics 2018

Issues with Traditional Net Metering

→ In some cases, traditional net metering may lead to **over-compensation**

→ Net metering most attractive to large electricity consumers (incl. large households): i.e. **erodes revenue** from the most profitable customers first

→ Traditional net metering compensation rate is **arbitrary**: varies based on customer class

→ Raises issues of **cross-subsidies** between customers

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DPV Policy: Key Decision Points

1. Does the same rate apply both to self-consumption and exported generation?
2. Which technologies are eligible?
3. Which customer types are eligible?
4. What are the project size categories?
5. Is there a cap on the total allowable capacity?
6. What is the length of the NM agreement?
7. Do existing projects qualify?
8. Are there any additional charges or fees?
9. Are any bill components "ring-fenced" (i.e. non-erasable)?
10. What about taxes (e.g. VAT)?

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2: Net Billing

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2. Net Billing

- More recent policy innovation: first emerges in the late 2000s in island regions

- **Similar to Net Metering:** customers export their excess generation to the grid and receive a compensation on their future bills

- Main difference is that **the rate at which customer-sited generation is credited is different from the retail rate that customers pay**

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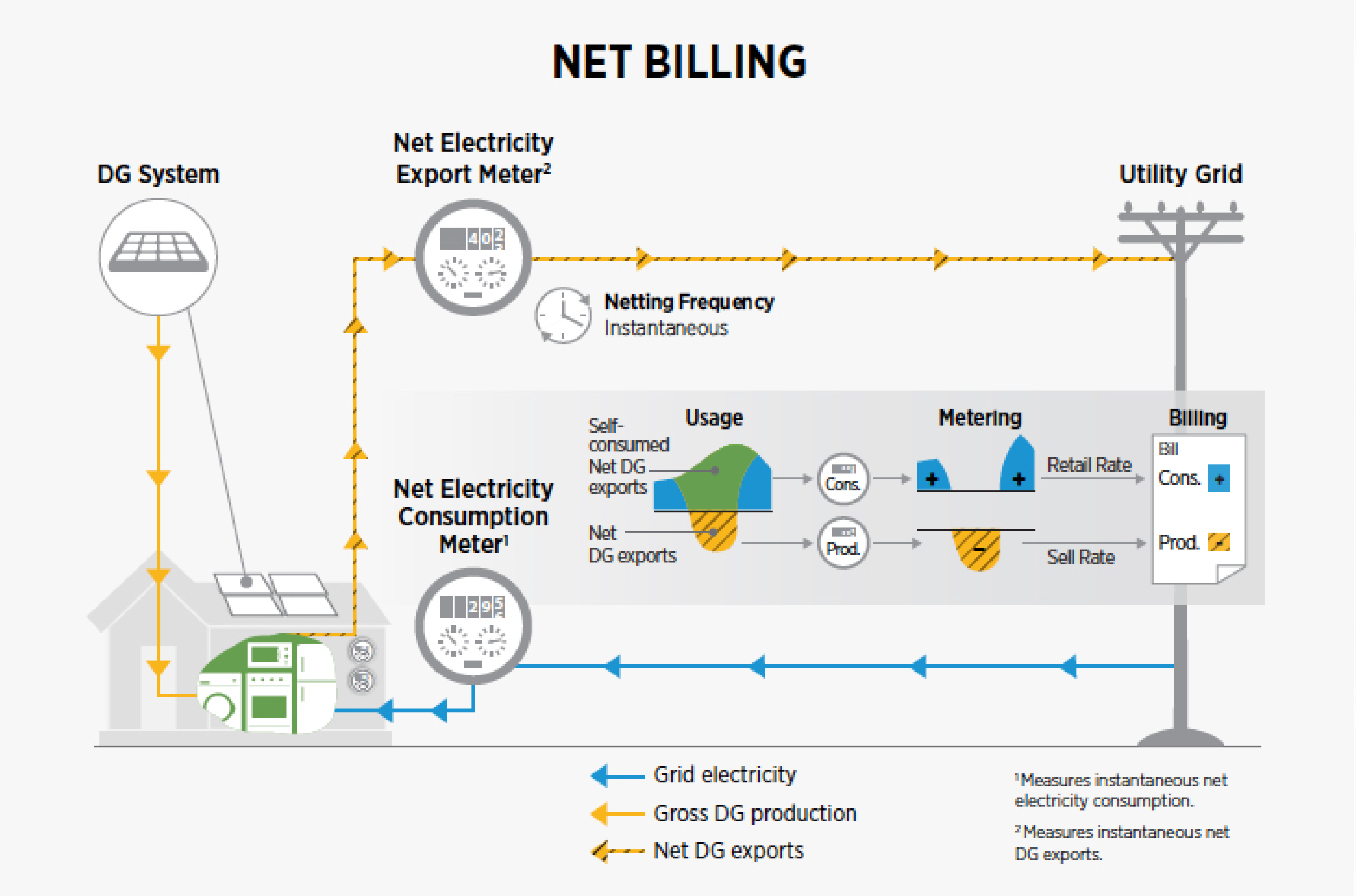
2. Net Billing



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2. Net Billing

Formula for Net Billing:

Compensation rate = A separate pre-determined rate

Surplus electricity injected into the grid ***offsets*** the customer's bill at a predetermined rate

Net Billing does **not** involve a cash payment for net excess generation (if it did, it would be called a **NET-FIT**)

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2. Net Billing

The Net Billing rate is simply an accounting mechanism: it refers to the rate at which a customer can offset their bill

e.g. 1 kWh of Net Excess Generation = USD $0.07

Net Billing severs the relationship between the value of a kWh consumed from the grid and the value of a kWh injected into the grid

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2. Net Billing

Net Billing can also be structured even more conservatively:

Example:

The full output of the PV system is injected into the grid (no self-consumption). The Net Billing rate is the rate at which the electricity injected into the grid offsets the customer's bill (e.g. 1kWh = USD $0.07)

2. Net Billing

Additional restrictions can be added:

- For instance, the regulator can limit which components of the power bill can actually be erased

- "**Ring-fencing**": certain components of the bill are protected, and cannot be erased via self-consumption

- Protects against **revenue erosion**

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The net billing rate can be defined 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

The Net Billing rate is typically lower than the retail rate paid by the customer.

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Net Billing: Advantages (1)

- Net Billing recognizes that the cost of rooftop solar is increasingly below the retail price that customers pay: Net Billing can therefore provide a fairer compensation structure

- Decouples solar compensation from the customer class : all owners of solar PV systems of the same size category can receive the same Net Billing rate, regardless of which customer rate category they happen to be in

Net Billing: Advantages (2)

- Allows utilities to avoid cross-subsidies between different customer classes (and between those with solar PV systems and those without)

- Makes it easier to adjust the compensation rate, since the Net Billing rate is not linked to the retail price

- Net Billing offers more flexibility in terms of setting the value of distributed generation to the system

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3: NET-FIT

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3. NET-FITs

Formula for NET-FITs:

Payment for net excess generation = A specific cash payment (in $/kWh), typically determined by the utility or regulator

Excess electricity injected into the grid results in a cash payment ($/kWh)

The customer receives both a bill, and a check

3. NET-FITs

Policy Mechanism	Relation to the Retail Rate	Possibility of Cash Payment (Y/N)
Net Metering	***At*** the retail rate	No
Net Billing	***Below*** the retail rate	Typically not
NET-FIT	**Typically *below* the retail rate**	**Yes**
"Classic" FIT	No relation to the retail rate: **Set at the LCOE of each technology**	Yes

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NET-FITs in Australia

Customers are provided with the choice:

1. Remain at a fixed, flat rate of 9.9 cents/kWh

2. Adopt TOU pricing at the rates agreed below

	Weekdays	Weekends	NET-FIT Rate (in AUD $/kWh)
Off-Peak	10PM – 7AM	10AM – 7AM	7.1 cents/kWh
Shoulder	7AM – 3PM, 9PM – 10PM	7AM-10PM	10.3 cents/kWh
On-Peak	3PM – 9PM	N/A	29.0 cents/kWh

https://www.solarchoice.net.au/blog/news/victoria-regulator-variable-feed-in-tariffs

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NET-FITs in Senegal differentiated by customer class, technology, and voltage level

	Customer Class	NET-FIT (in FCFA)	NET-FIT (USD/kWh)
Solar PV	Small Domestic	75	0.130/kWh
	Medium Domestic	70	0.121/kWh
	Large Domestic	60	0.104/kWh
	Small Commercial	65	0.113/kWh
	Medium Commercial	60	0.104/kWh
	Large Commercial	50	0.087/kWh
	Medium Voltage Customers	50	0.087/kWh

http://www.crse.sn/sites/default/files/2018-11/D%C3%A9cision%20n%C2%B02018-09.pdf

NET-FITs: Advantages (1)

- NET-FITs recognize that the cost of rooftop solar is increasingly below the retail price that customers pay: paying for this net excess generation (rather than simply compensating it) can therefore be a **”win-win” for both utilities and customers**

- **NET-FITs are more bankable** than either Net Metering or Net Billing: possibility of a cash payment provides a price floor for banks (a ”worse case”)

- **NET-FIT rate can be differentiated** by project size, location, and time of day if desired

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NET-FITs: Advantages (2)

- **NET-FIT rate can be linked to independent benchmarks** (e.g. wholesale market prices, utility avoided costs), removing the appearance of ”subsidies”

- **Fewer issues with cross-subsidization** between customer classes

- **Easier to adjust the compensation rate**, since the NET-FIT rate is not linked to the retail price

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4: Impact of Electricity Tariff Structure

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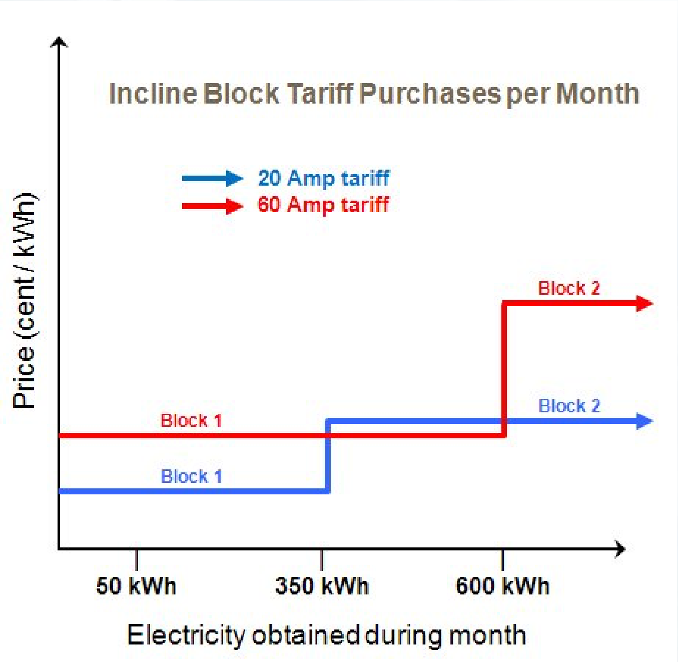
Impact of Electricity Tariff Structure

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



- Higher blocks of consumption are erased first

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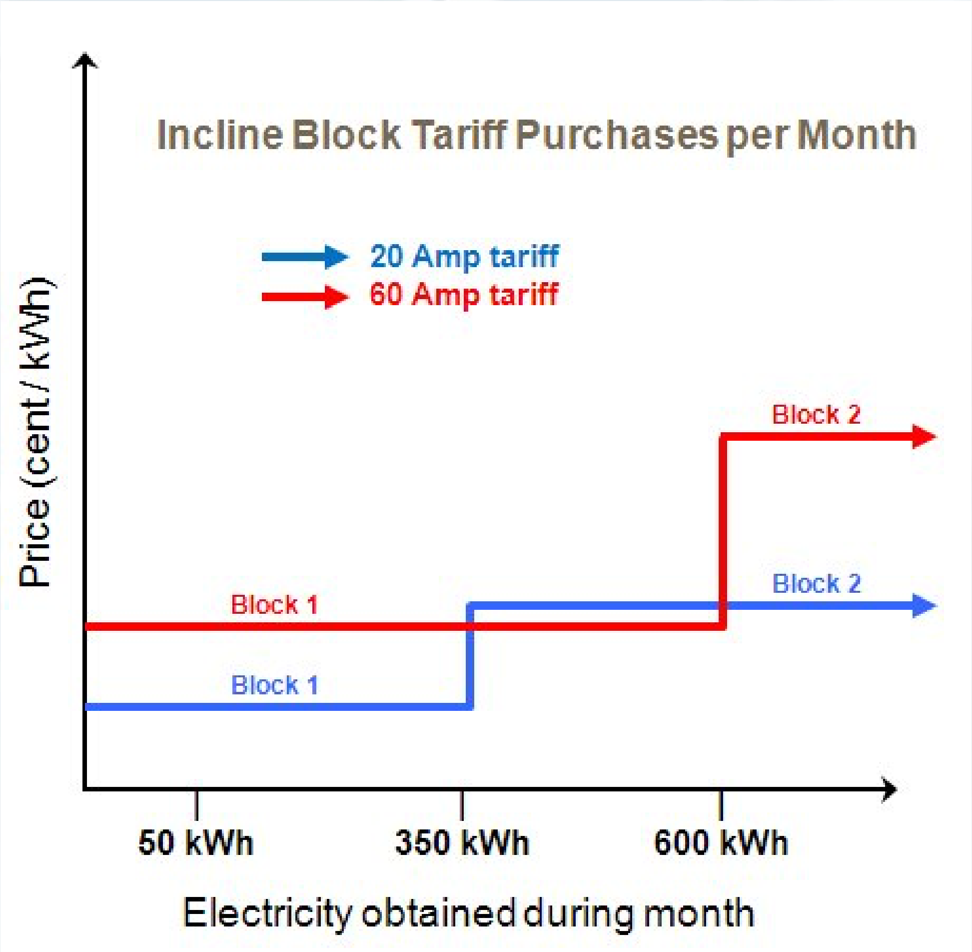
Impact of Electricity Tariff Structure

Wealthier households may find it particularly attractive to self-consume their way out of the higher tariff categories

- Quicker **pay-back**



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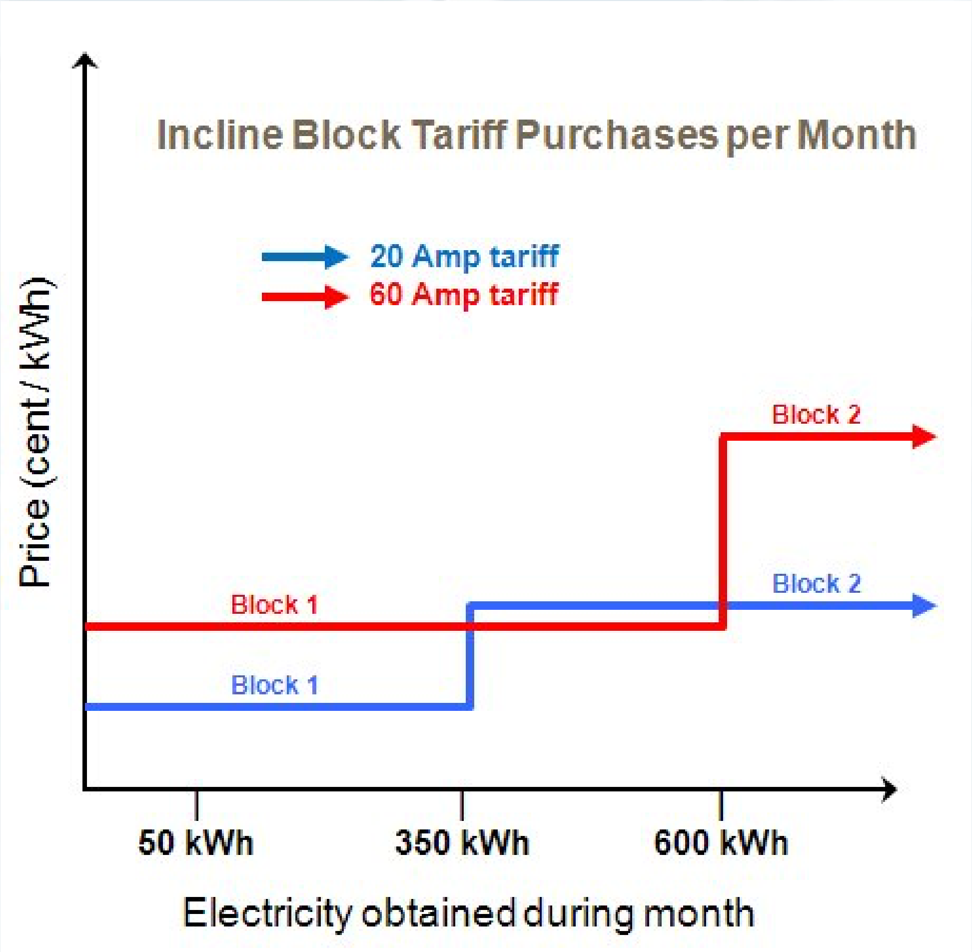
Impact of Electricity Tariff Structure

- However, in some cases, this leads to a situation where wealthier households can self-consume so much that they are able to benefit from the **subsidized tariffs** offered to low-income households

Result = political backlash



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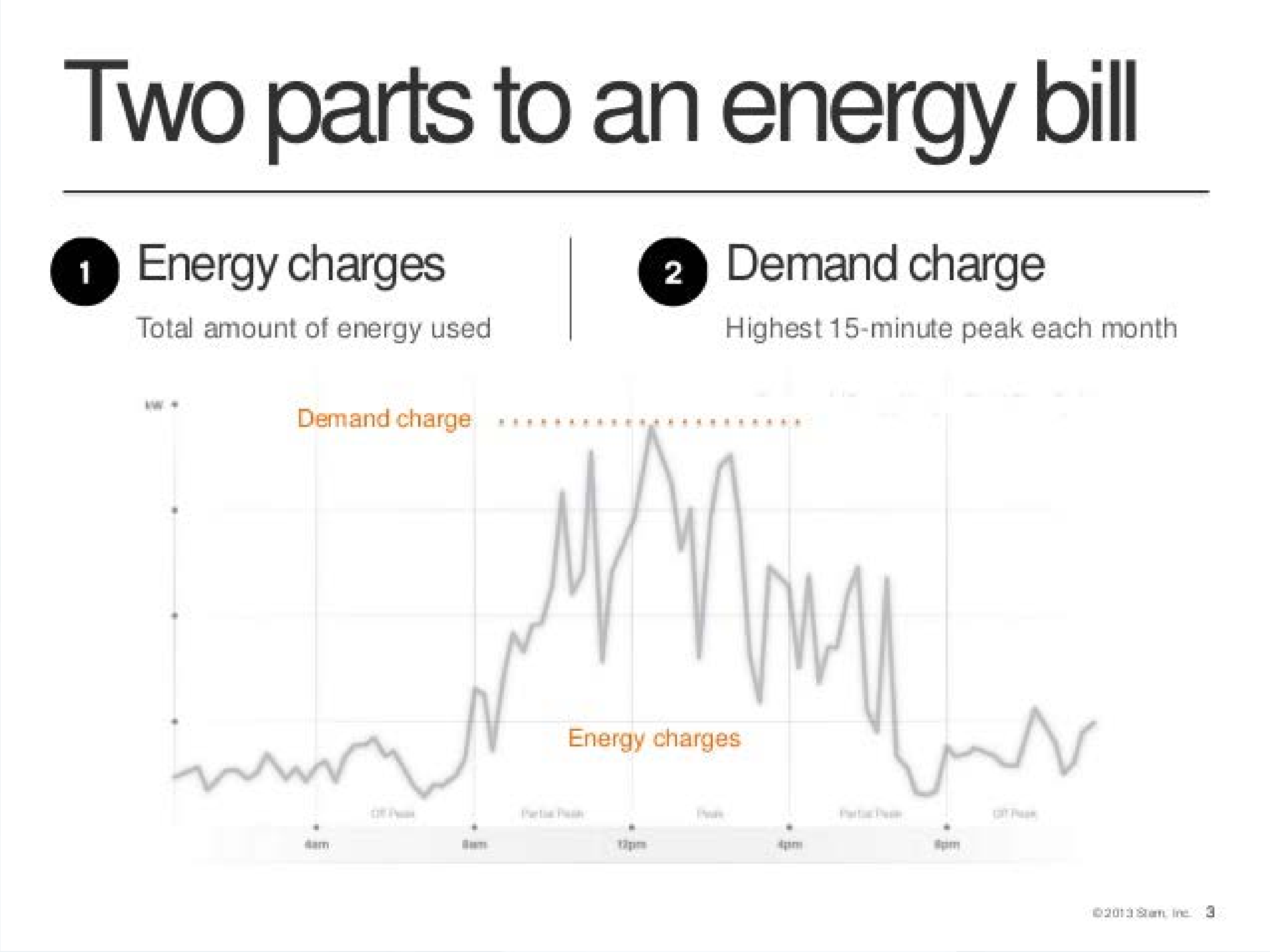
Impact of Demand Charges

Same applies to the introduction of **demand charges**

Demand charges are imposed based on the **peak capacity that a customer reaches during the month**



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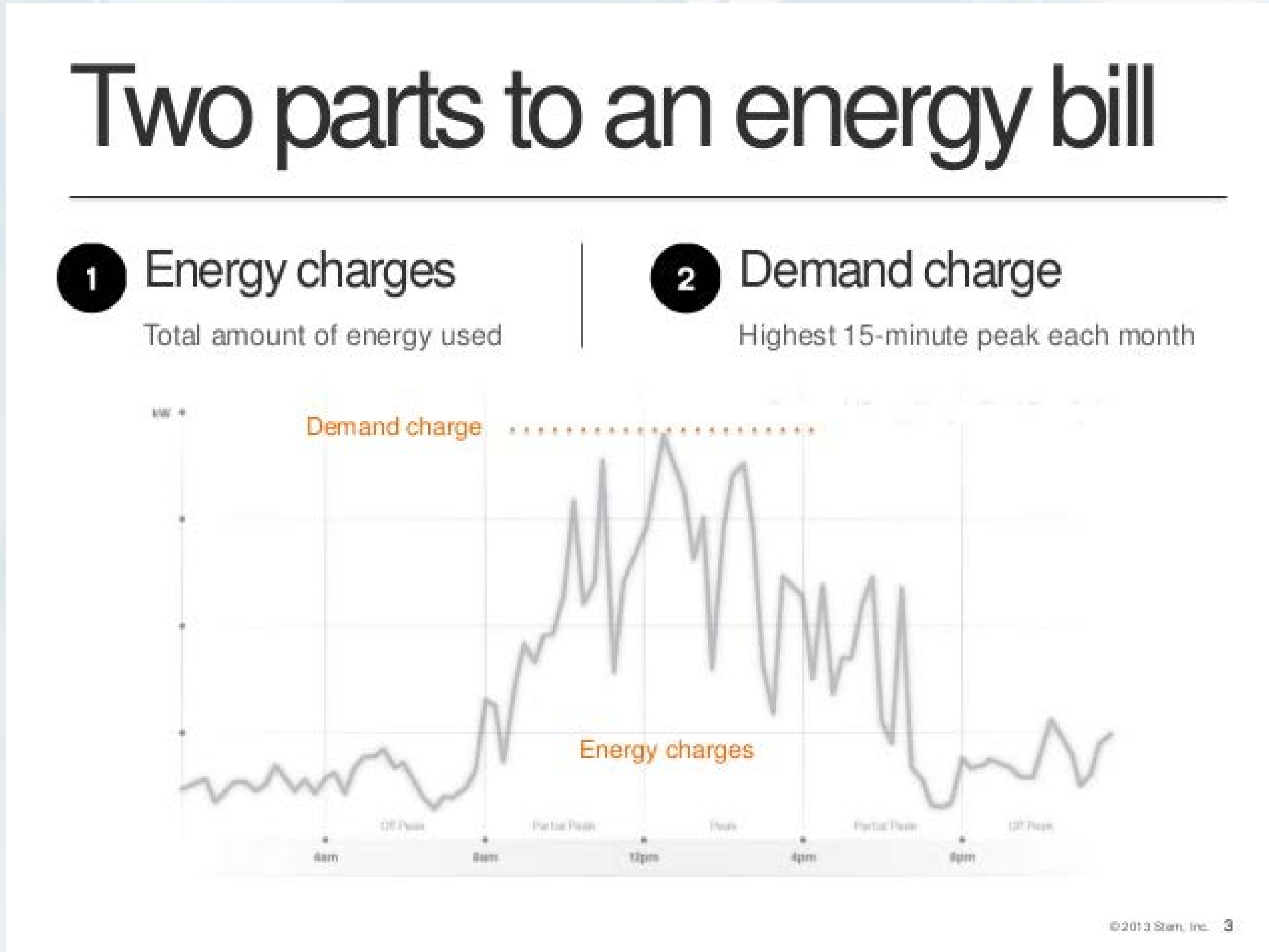
Impact of Demand Charges

Typically only applied to commercial and industrial customers

Some utilities proposing demand charges for residential customers too



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Impact of Demand Charges

Utilities often argue that prosumers are using the existing electricity grid as a storage unit and not paying their fair share:

- They argue that Net Metering customers 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**

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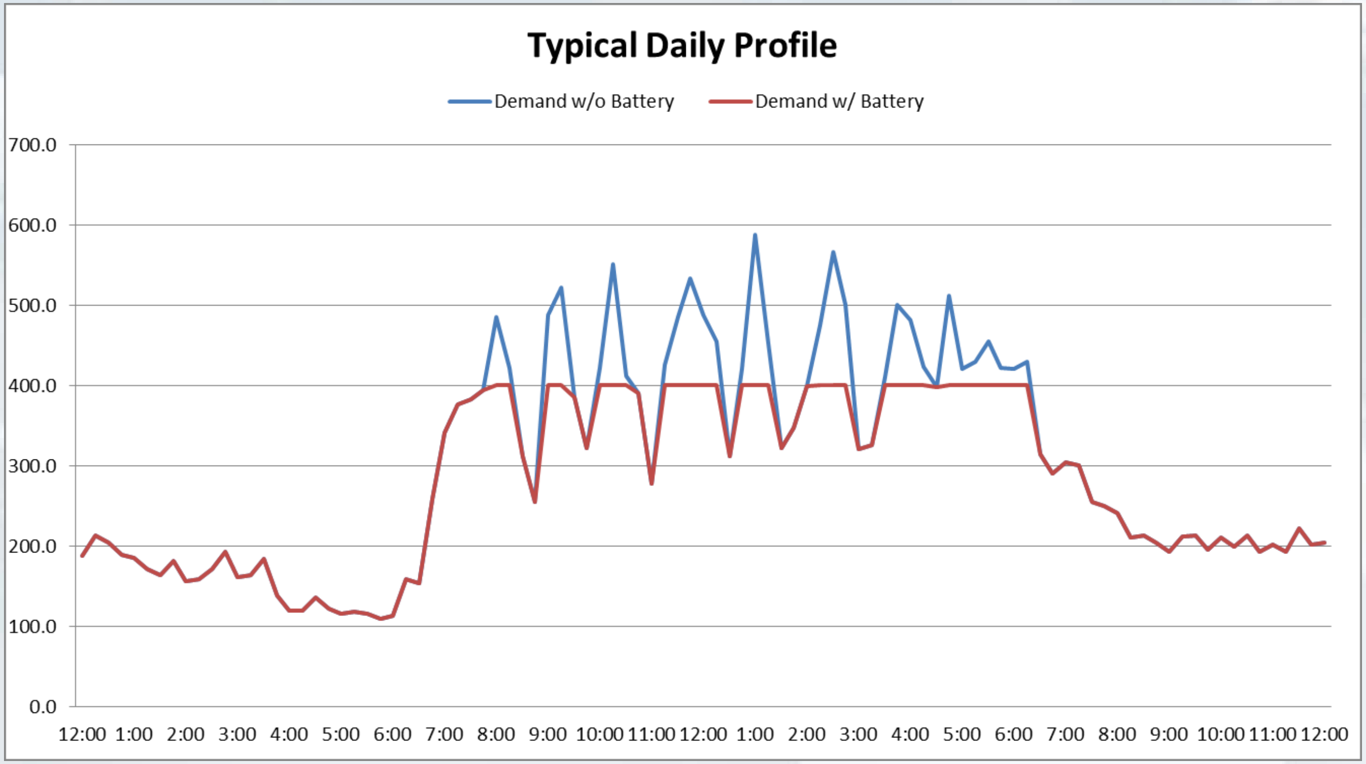
Impact of Demand Charges

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



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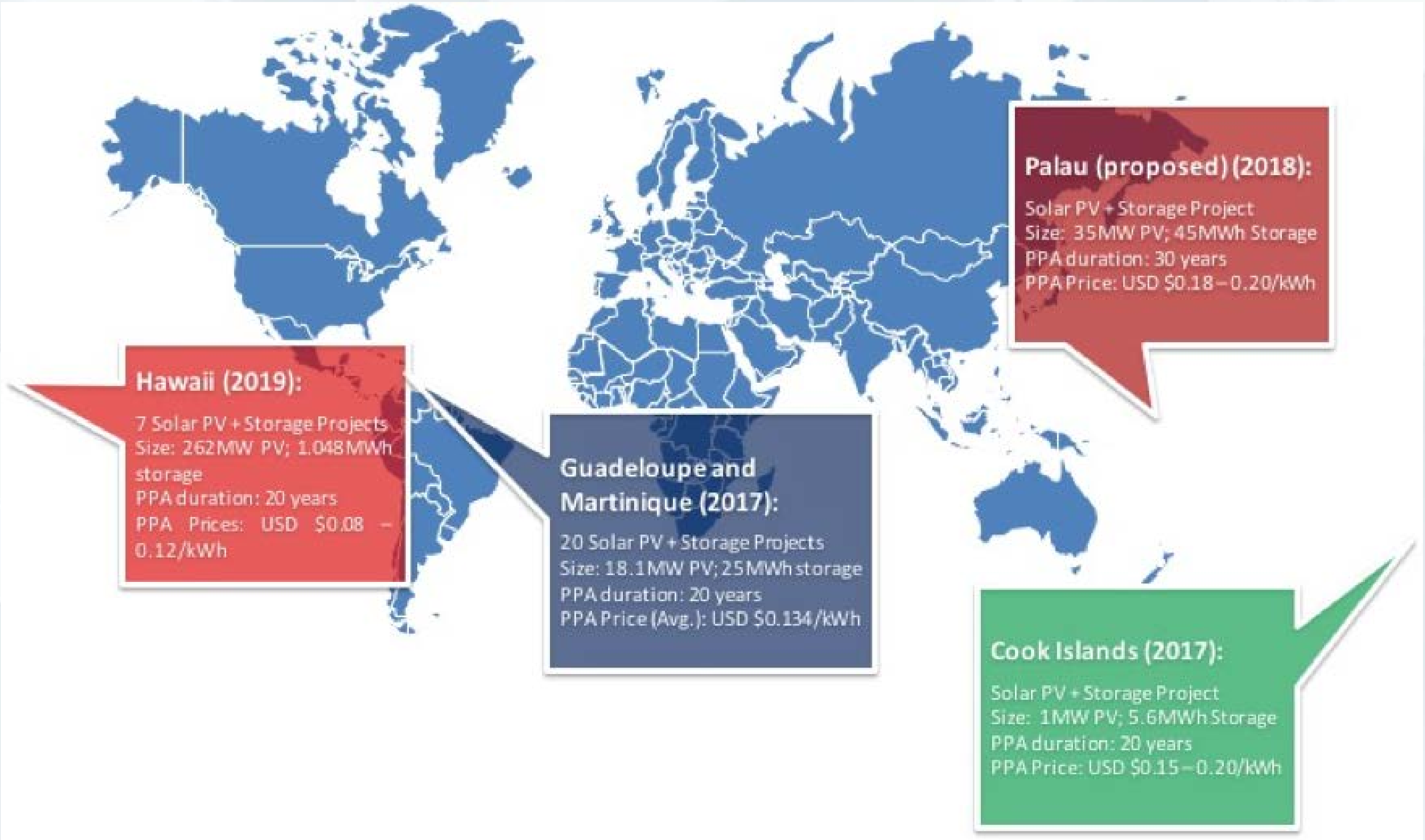
Solar + Storage is increasingly economic



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Source: E3 Analytics 2019

5. Special Topics: Design Issues

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Ring-Fencing

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.

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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

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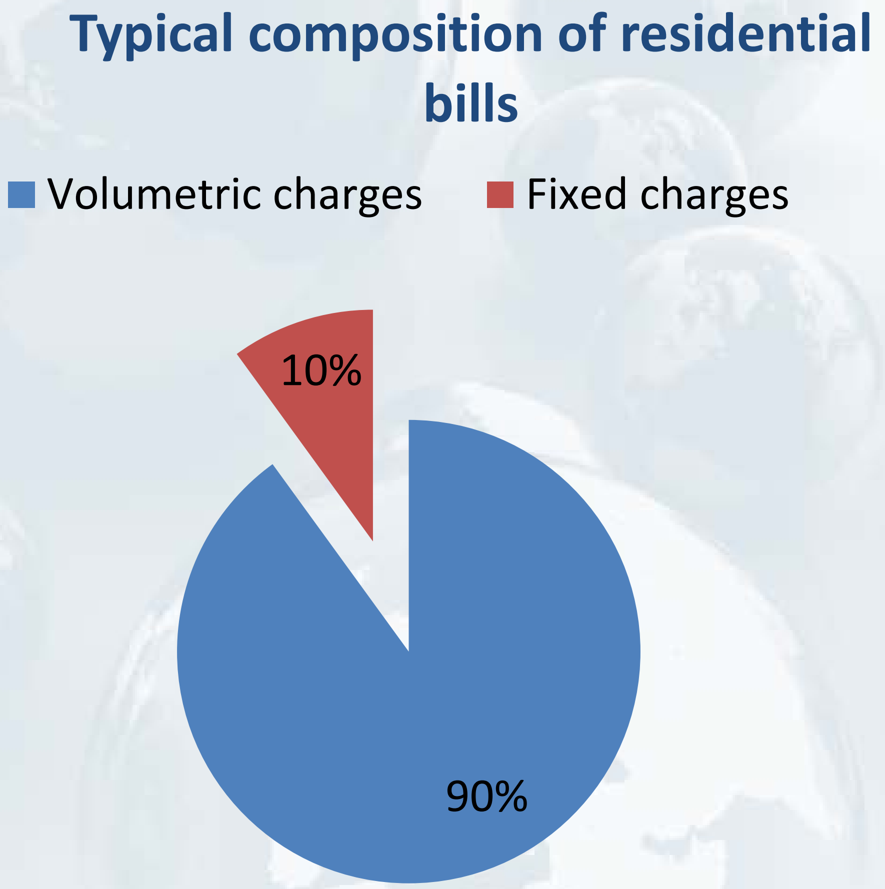
Ring-Fencing

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



Roll-Over Period

- 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

Roll-Over Period

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

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

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Roll-Over Period

- 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

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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

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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)

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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"

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Thank you!

Questions?

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