

International Solar Alliance Expert Training Course: Session 16

Virtual Net Metering and Wheeling

In partnership with the Clean Energy Solutions Center (CESC)

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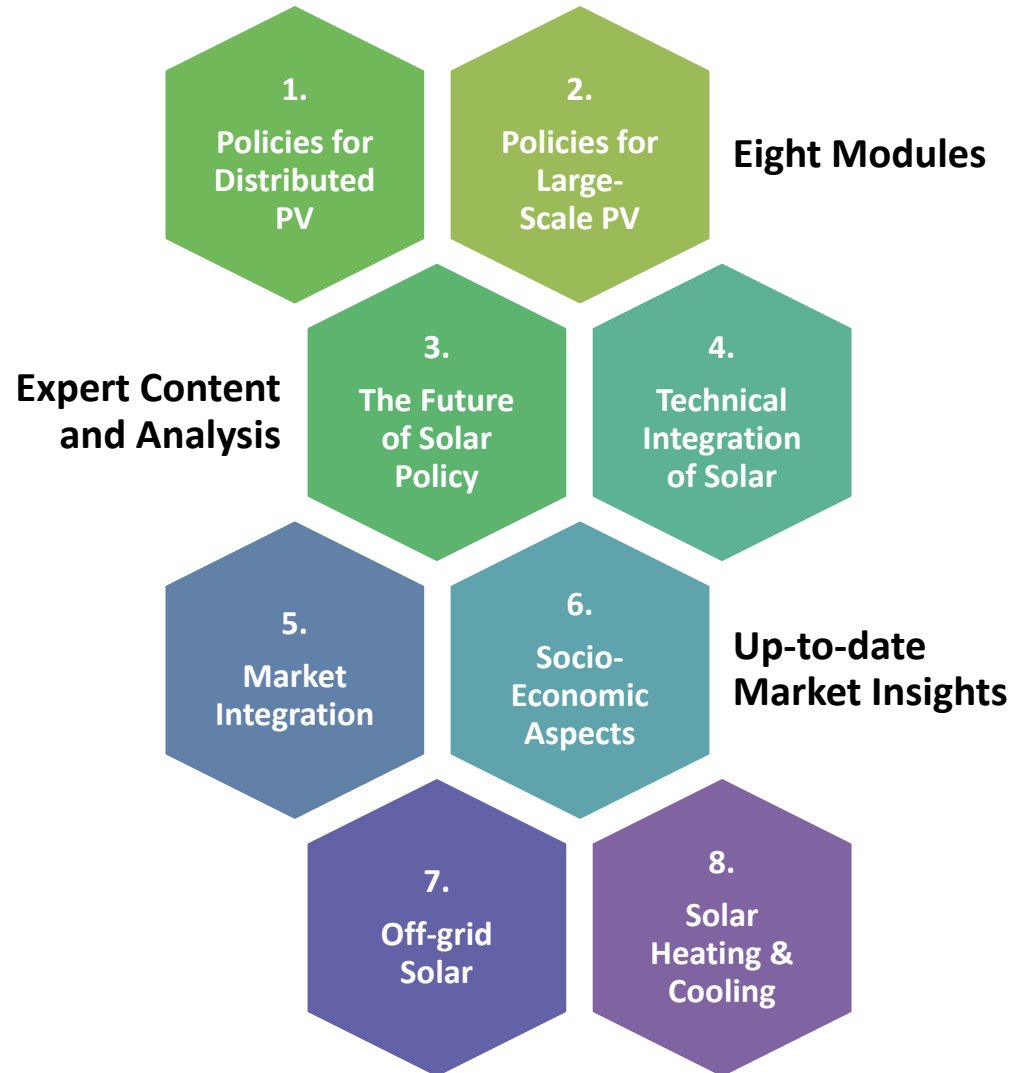
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ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

Overview of Training Course Modules

This Training is part of Module 3, and focuses on the issue of **The Future of Solar Policy**



Overview of the Presentation

- 1. Introduction: Learning Objective**
- 2. What is Net Metering and Wheeling?**
- 3. Virtual Net Metering and Power Plants**
- 4. Costs of Net Metering and Wheeling**
- 5. Advantages and Challenges**
- 6. Case Studies**
- 7. Concluding Remarks**
- 8. Further Reading**
- 9. Knowledge Check: Multiple-Choice Questions**

1. Introduction: Learning Objective

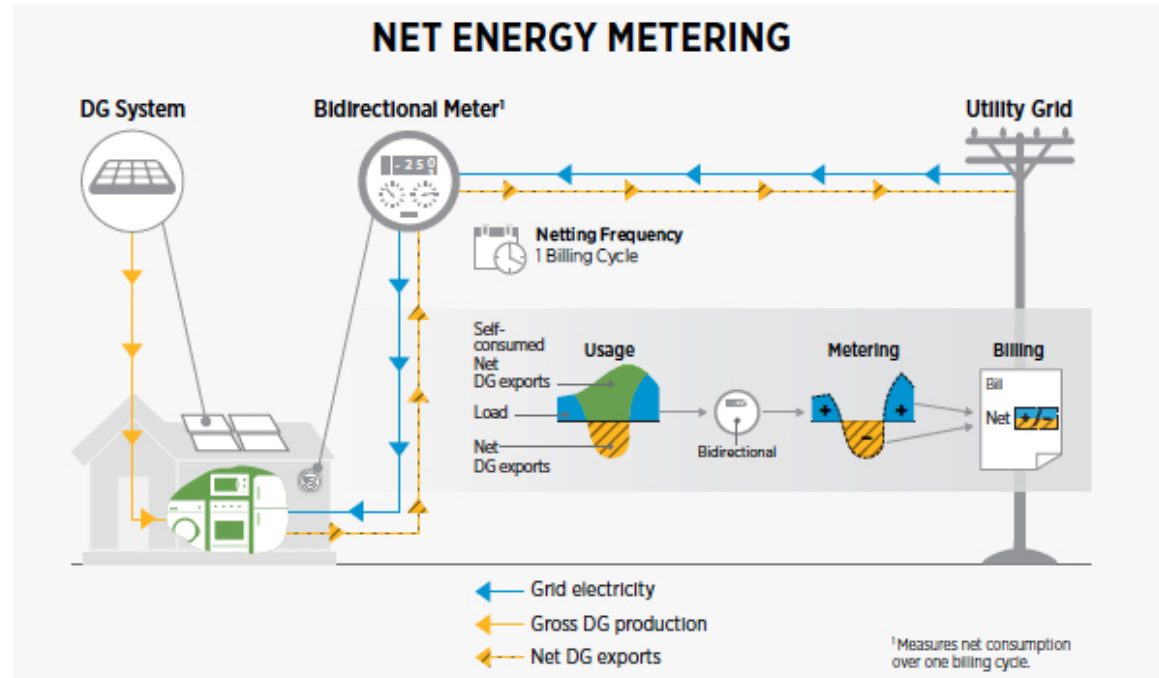
Learning Objectives

- ❖ **Understand how virtual net metering and wheeling technologies work in the context of energy networks**
- ❖ **Understand the benefits of such technologies and applications in supporting the growth of solar PV**
- ❖ **Understand challenges facing more widespread uptake of such applications**
- ❖ **Learn from case studies demonstrating the current state of play**

2. What is Net Metering and Wheeling?

What are Net Metering and Wheeling?

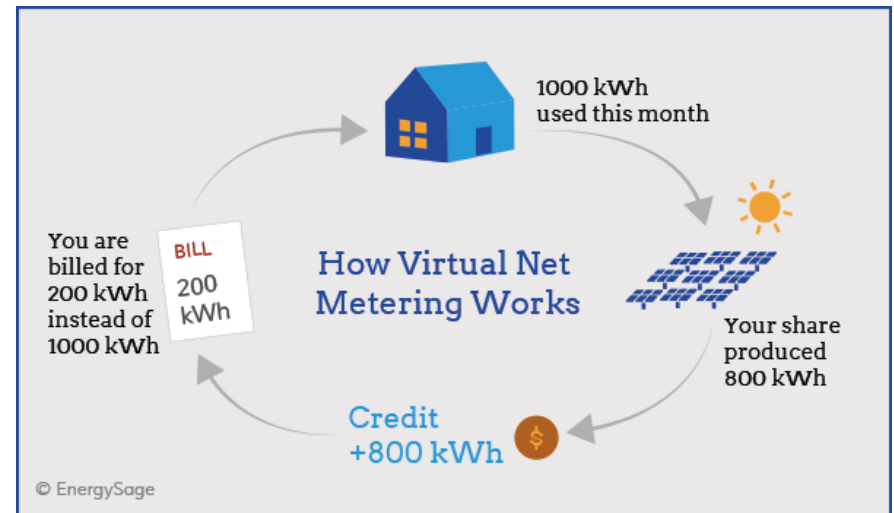
- Net metering is a policy allowing customers to self-supply and export their excess generation to the grid, receiving a credit on their bill rather than a cash payment (See CESC-ISA Session on Net Metering)
- Wheeling allows power to be produced at one location, transmitted over the wires, and delivered to meet self-consumption needs somewhere else on the network



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

What are Net Metering and Wheeling?

- A number of jurisdictions such as Brazil, Jamaica, Jordan, Pakistan, and parts of the U.S. enable owners of embedded generation to wheel their power from one site to another, typically paying grid access fees along the way.
- Helps enable “community solar”, where groups of customers get together to invest in a community project located in the area



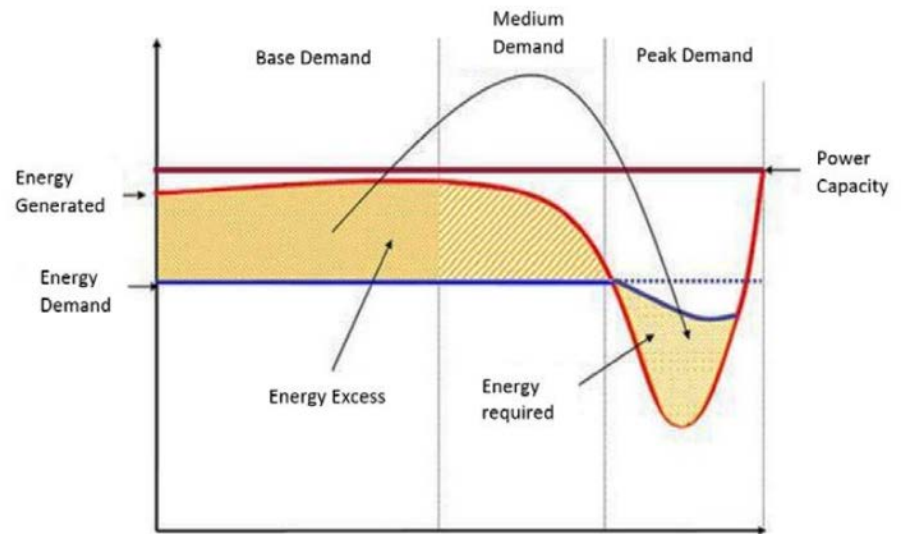
Virtual Net Metering

Sources:

- <http://www.saarcenergy.org/wp-content/uploads/2016/12/Net-Metering-Final-Report.pdf>
- <https://www.mset.gov.jm/sites/default/files/pdf/Electric%20Power%20Wheeling%20-%20Fact%20Sheet.pdf>
- <https://news.energysage.com/virtual-net-metering-what-is-it-how-does-it-work/>

What are Net Metering and Wheeling?

- Net metering describes the act of measuring how much power is generated at one location and comparing it to how much power is consumed at another location.
- Wheeling describes the act of 'transferring' power from generating power at one location and consuming power at another



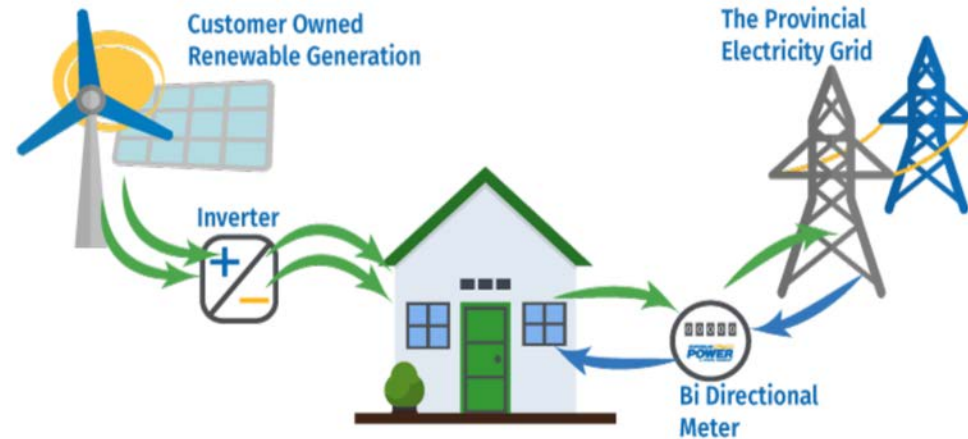
Energy Compensation in the Energy Banking Model

Sources:

<https://www.nrel.gov/docs/fy16osti/65660.pdf>
<http://www.saarcenergy.org/wp-content/uploads/2016/12/Net-Metering-Final-Report.pdf>
<https://www.mset.gov.jm/sites/default/files/pdf/Electric%20Power%20Wheeling%20-%20Fact%20Sheet.pdf>
<https://www.lexology.com/library/detail.aspx?q=e28ab9d7-7b99-4d82-87f7-dee1321cde40>

What are Net Metering and Wheeling?

- Wheeling of electricity is particularly important for technologies like wind and hydro power, where the locations are often more remote and distant from the customer or owner's load. Also increasingly important for solar PV, especially in urban areas.
- In such cases, allowing customers to engage in wheeling can enable them to invest in new generation assets that are not on their own premises while still benefiting from being able to offset their power consumption from the utility.



Sources:

<http://www.saarcenergy.org/wp-content/uploads/2016/12/Net-Metering-Final-Report.pdf>
<https://www.mset.gov.jm/sites/default/files/pdf/Electric%20Power%20Wheeling%20-%20Fact%20Sheet.pdf>
<https://www.lexology.com/library/detail.aspx?g=e28ab9d7-7b99-4d82-87f7-dee1321cde40>

Varieties of Net Metering

SINGLE OWNER

NET METERING



- Solar* on a single property
- One meter on-site
- *Example: Home*

BASIC METER AGGREGATION



- Solar on same or adjacent property
- Multiple meters on-site
- *Example: Farm*

MULTI-SITE AGGREGATION



- Solar on multiple properties
- Multiple meters on-site
- *Example: City-owned buildings*

MULTIPLE OWNERS

TENANT AGGREGATION



- One owner, many renters
- Savings spread through tenants
- *Example: Apartment building*

VIRTUAL/COMMUNITY SOLAR



- Solar offsite, multiple properties
- Savings spread through subscribers
- *Example: Community buy-in*



*Net metering applies to many technologies including wind, anaerobic digesters, etc., but solar is the most common.

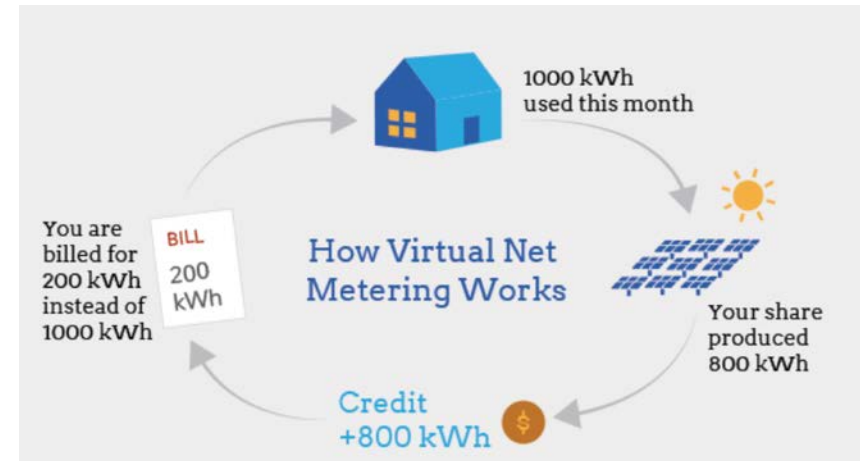


Sources:
<https://ilsr.org/rule/net-metering/updated-states-supporting-virtual-net-metering/>

3. Virtual Net Metering and Power Plants

Virtual Net Metering and Power Plants

- Some communities live in multi-unit housing where the rooftop space is insufficient to host a system large enough to make a meaningful impact on the building's power consumption.
- In such cases, some form of allocation agreement is typically required that breaks down which household has which share of power output based on their financial share in the system.
- This enables each household's electricity consumption to be offset based on their share of the community solar project.



Sources:

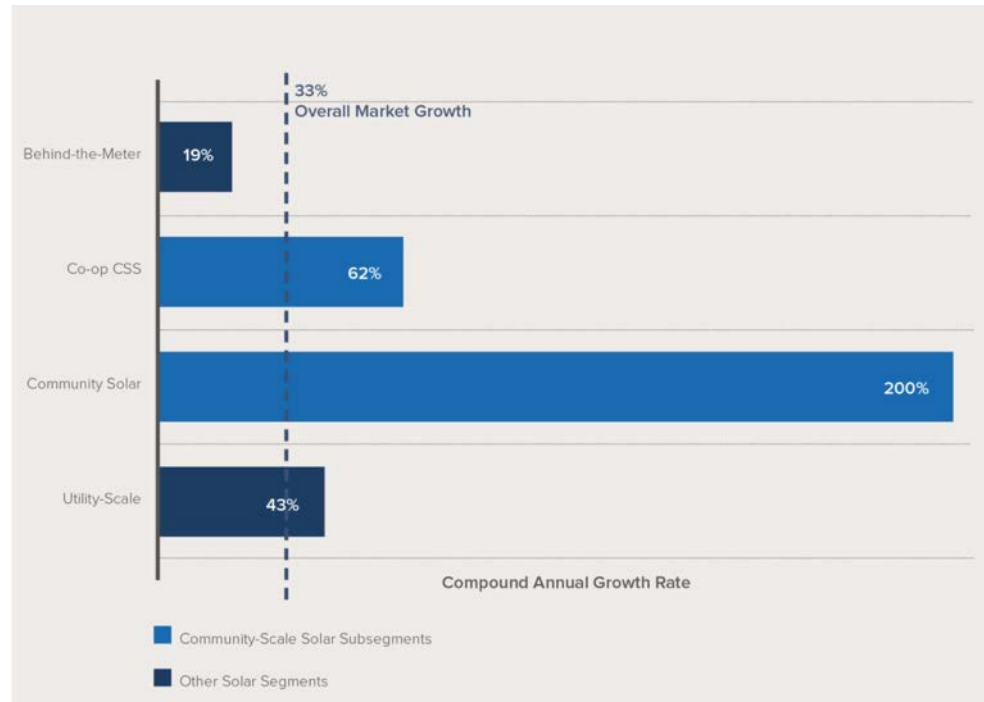
<https://news.energysage.com/virtual-net-metering-what-is-it-how-does-it-work/>

https://rmi.org/wp-content/uploads/2017/04/Sustainable_Finance_Financing_Community_Scale_Solar_2017.pdf

<https://rmi.org/insight/progress-potential-community-scale-solar/>

Virtual Net Metering and Power Plants

- In recent years, a growing number of cities and communities across the U.S. have started using Virtual Net Metering
- These cities and communities develop “community solar” projects that operate on this principle, developing a wide range of different billing and metering arrangements depending on the utility.



Sources:
<https://rmi.org/insight/progress-potential-community-scale-solar/>

Virtual Net Metering and Power Plants

- Virtual Power Plants use software controls to provide energy on short notice to the to the electricity system.
- Demand-response (DR) aggregators manage flexibility of industrial energy users.
- Virtual Power Plants typically control generation units.
- The business model consists primarily of pooling and marketing generation facilities, flexible consumers and storage systems.

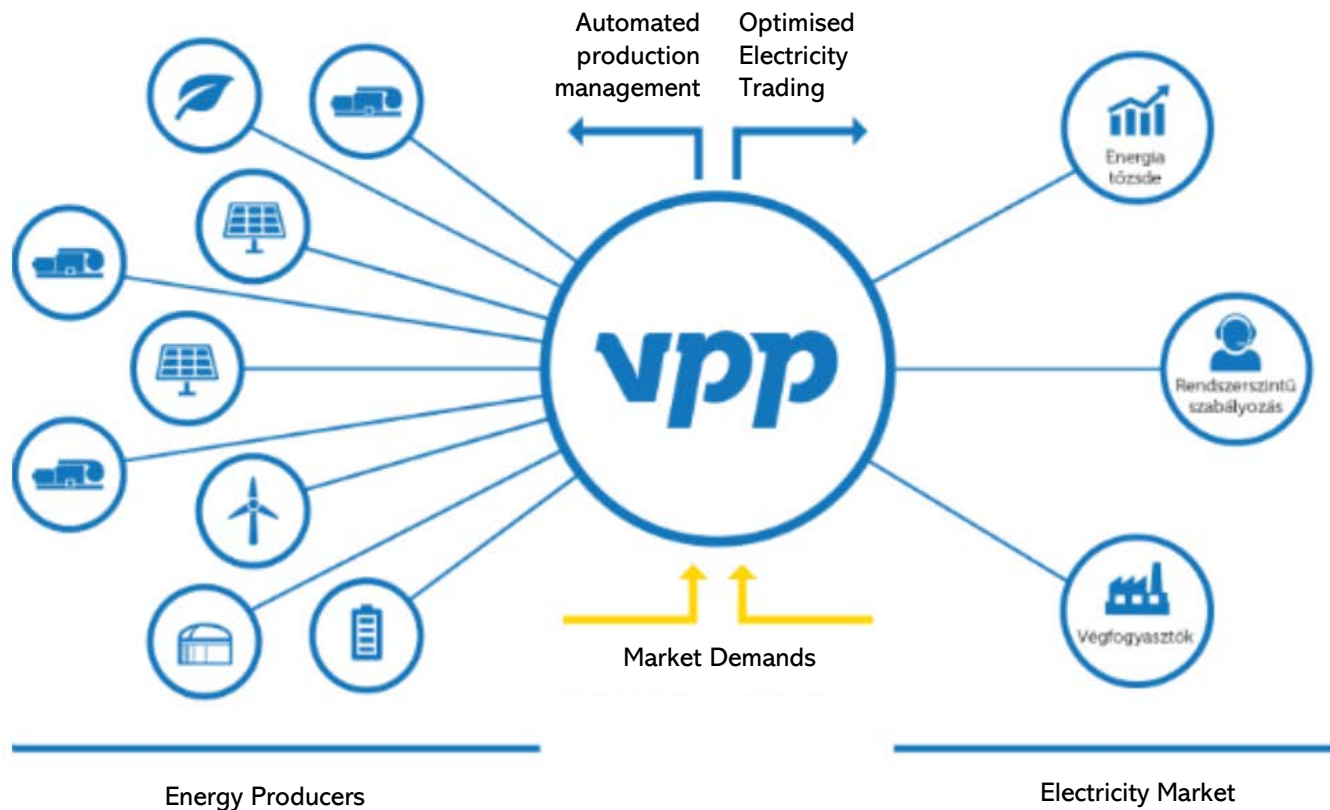


Sources:

"Virtual power plants: a story of market rules and smart grids, Eric Marx, March 14, 2019": <https://energypost.eu/virtual-power-plants-a-story-of-market-rules-and-smartgrids/>

Virtual Net Metering and Power Plants

Virtual Power Plants - Visualisation



Sources:

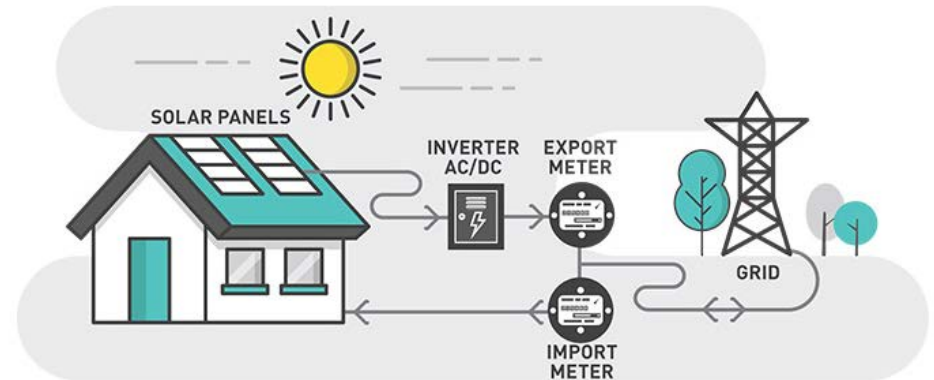
"Virtual power plants: a story of market rules and smart grids, Eric Marx, March 14, 2019": <https://energypost.eu/virtual-power-plants-a-story-of-market-rules-and-smartgrids/>

4. Costs of Net Metering and Wheeling

Costs of Net Metering and Wheeling

What are the costs?

- Owners of transmission and distribution infrastructure typically apply wheeling charges to embedded generators.
- The principles that underpin these charges are to promote efficiency, to allow for cost recovery, to ensure the process of wheeling is non-discriminatory and transparent.



Sources:

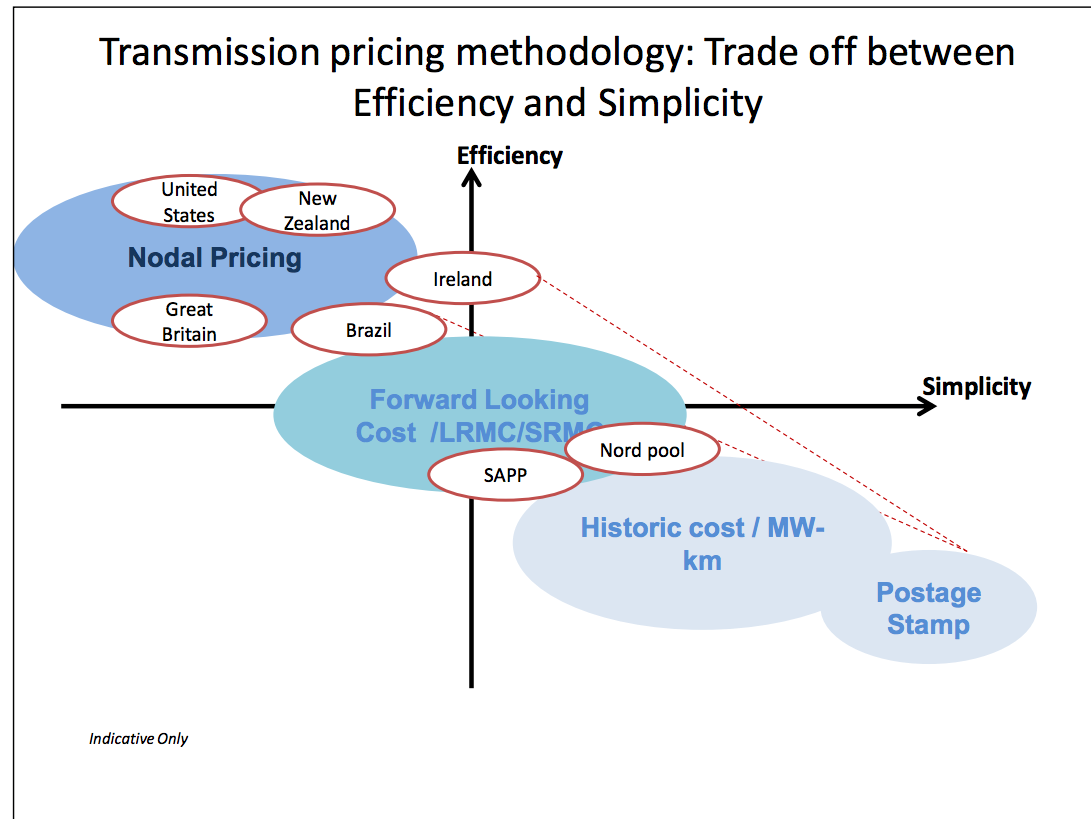
<http://www.proteustechologies.co/insights/kb/articles/energy/solar-pv-understanding-net-metering-gross-metering-and-feed-in-tariffs/>

http://www.our.org.jm/ourweb/sites/default/files/documents/sector_documents/electricity_wheeling_methodologies_-_consultation_document.pdf

Costs of Net Metering and Wheeling

There are four main approaches for establishing wheeling charges:

1. Postage Stamp model
2. Contract Paths approach
3. Distance based approach (MW-km)
4. Load Flow based approach (MW-km)



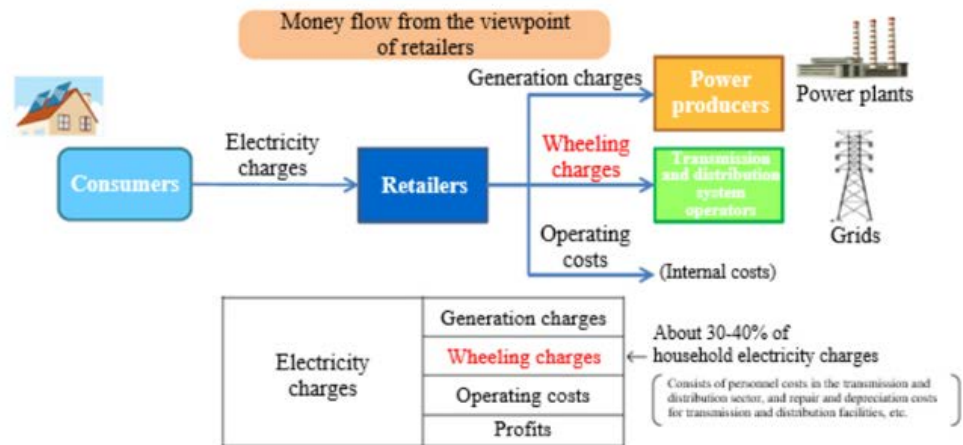
Sources:

http://www.our.org.jm/ourweb/sites/default/files/documents/sector_documents/electricity_wheeling_methodologies_-_consultation_document.pdf

Costs of Net Metering and Wheeling

Postage Stamp model

- In most cases, the wheeling charges are priced based on the “postage stamp” model.
- Under this approach, the methodology allocates the costs between users based on their share of the total peak load on the system.
- This results in a flat transmission charge per kWh that is equal to the total transmission costs, divided by the system’s peak load.



Sources:

https://www.renewable-ei.org/en/column/column_20170113_01.php

http://www.our.org/jm/ourweb/sites/default/files/documents/sector_documents/electricity_wheeling_methodologies_-_consultation_document.pdf

5. Advantages and Challenges

Advantages and Challenges

Advantages

- Allows a wider share of participants to participate (including multi-unit residential housing, and businesses without sufficient roof space, or with too much shading, etc.)
- Can help reduce power costs in the system by allowing excess supply to reach demand.
- Allows better project siting to take advantage of better resource potential.
- Allows embedded generators to develop their generation assets in areas with better land-access conditions, or closer to the substation.



Sources:
<https://www.solar-estimate.org/news/2019-02-12-what-is-virtual-net-metering-and-who-is-it-for>

Advantages and Challenges

Challenges

- Can be difficult to determine the value of transmitted power.
- Is the price static, or dynamic?
- Could reduce reliability if too many IPPs engage in wheeling at the same time, on the same feeders.
- Wheeling charges may not be dynamic enough to reflect real-time issues such as congestion.

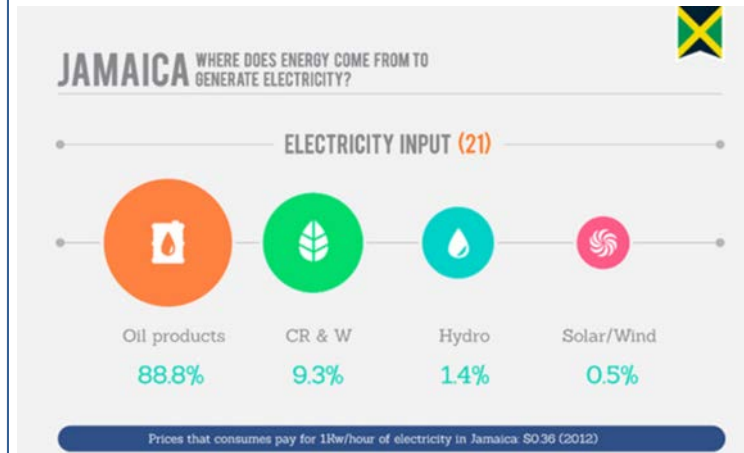


Sources:
<https://blog.ucsusa.org/laura-wisland/caiso-study-solar-grid-reliability>

6. Case Studies

Jamaica

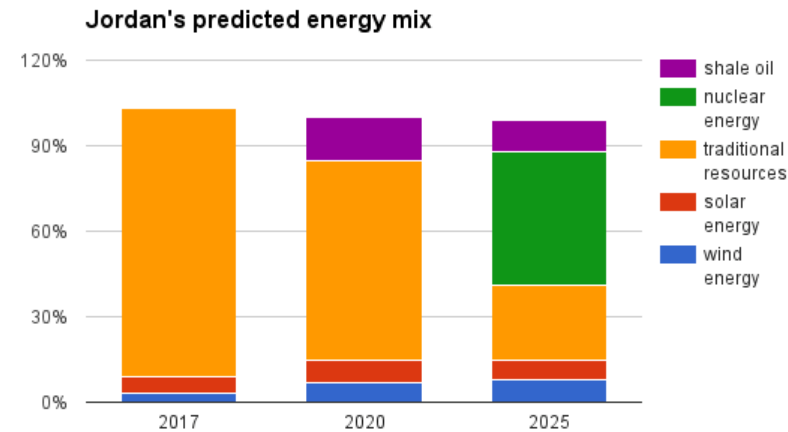
- A detailed analysis was undertaken in Jamaica.
- A 'Load Flow' based approach was chosen as it provided transparency, better assurance of cost recovery, locational price signals to future generators interested in wheeling, as well as a better recognition of actual network flows in order to measure the utilization of assets.
- Under a Load Flow approach, the methodology is based on a power flow model: as such, pricing arguably provides a better reflection of each user's proportion of overall system use.



Sources:
<https://www.mset.gov.jm/sites/default/files/pdf/Electric%20Power%20Wheeling%20-%20Fact%20Sheet.pdf>
<https://blogs.iadb.org/caribbean-dev-trends/en/jamaicas-energy-market/>

Jordan

- In Jordan, the regulations allow an embedded generator to produce power at one site and to transmit that electricity to another site that is either owned, or leased, by the same customer or legal entity.
- In order to do so, the embedded generator simply has to pay a small fee.
- The power provided can then either be consumed by that customer in real time, or can be net metered as part of the country's net metering policy.



Sources:

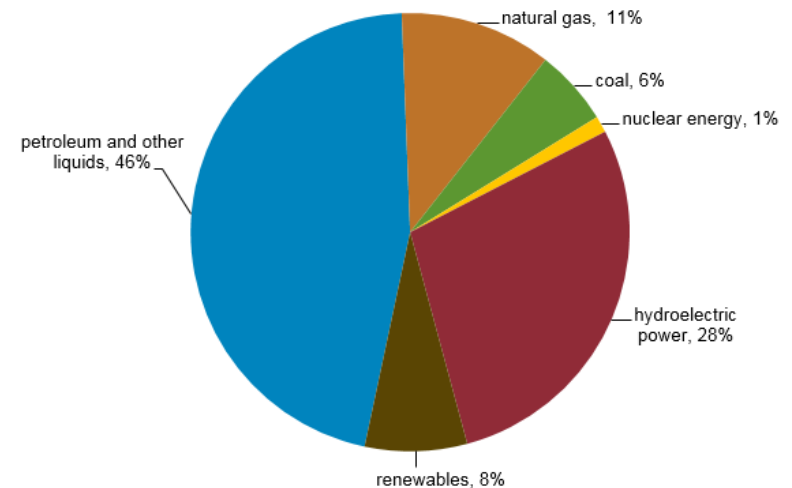
<https://www.wamda.com/memakersge/2016/11/300-days-sunlight-year-look-jordans-solar-sector>

<https://www.projectfinance.law/publications/2016/October/jordan-turbocharges-distributed-solar>

Brazil

- In Brazil, the wheeling rules also allow a customer to sell their net excess generation to another customer on the network.
- It does not have to supply the same legal entity as, for example, the case study shown in Jordan.
- A so-called “use of system” charge is applied as a wheeling fee for each unit of electricity so transported.

Figure 1. Total primary energy consumption in Brazil by fuel type, 2017



eia Source: BP Statistical Review of Energy, 2018

Sources:

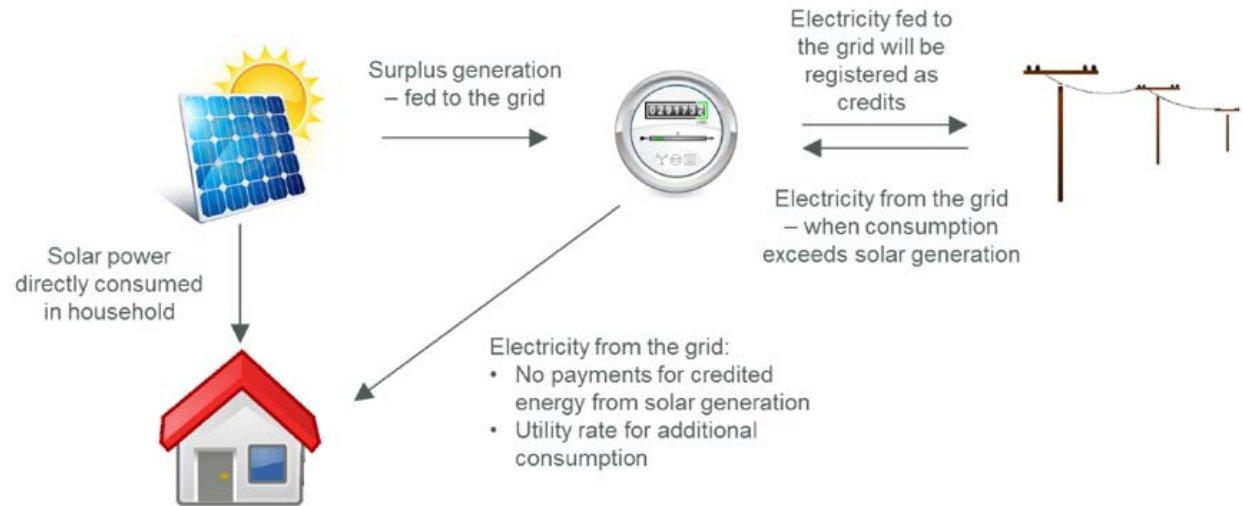
<http://www.saarcenergy.org/wp-content/uploads/2016/12/Net-Metering-Final-Report.pdf>

<https://www.eia.gov/beta/international/analysis.php?iso=BRA>

Brazil

“Use of System” Charge

- This is applied as a wheeling fee for each unit of electricity so transported.
- Two meters are used: one to meter the electricity output at the point of injection and another to meter the import of power at the point of consumption.



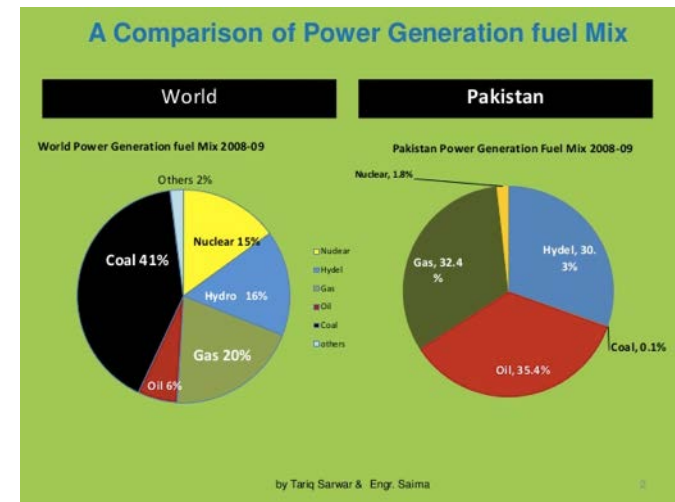
Sources:

<http://www.saarcenergy.org/wp-content/uploads/2016/12/Net-Metering-Final-Report.pdf>

<https://www.apricum-group.com/improved-access-to-public-finance-for-solar-may-unlock-potential-in-distributed-generation/>

Pakistan

- In Pakistan, rules adopted in 2016 allow licensed generators to sell power to other bulk power consumers on the network.
- Bulk power generators are defined as those with a capacity greater than 1MW.
- The generator simply has to pay a wheeling charge for the use of the system, whether the transmission lines, the distribution lines, or both.
- These moves are seen as important parts of opening up the market and introducing more competition.



Sources:

<https://www.lexology.com/library/detail.aspx?g=e28ab9d7-7b99-4d82-87f7-dee1321cde40>

<https://www.skyscrapercity.com/showthread.php?t=480755&page=175>

USA

As of 2019, there were 16 U.S. states that offered some form of virtual net metering.

State	Eligibility
California	Multi-tenant properties, local governments
Connecticut	Municipal, state, or ag. customers only
Dist. of Columbia	All customers
Maine	All customers
Maryland	Allowed for agricultural customers, non-profit organizations, and municipal governments or their affiliates
Massachusetts	All customers
New Hampshire	All customers
Pennsylvania	All customers, within 2 miles
Rhode Island	Local and state governments
Vermont	All customers
SOLAR ONLY	
Colorado	IOU customers; solar only
Delaware	All customers; solar only
Minnesota	Xcel Energy customers only
New York	Launched October 2015
Wisconsin	NSP customers only
OPTIONAL	
Illinois	Utility choice to offer

Sources:

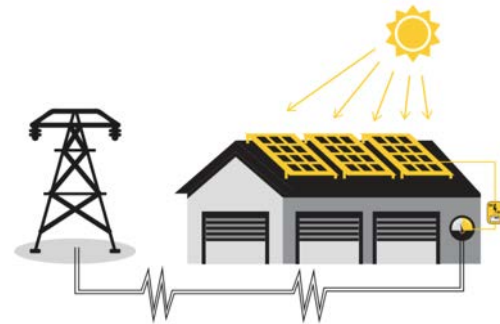
<https://ilsr.org/rule/net-metering/updated-states-supporting-virtual-net-metering/>

<https://www.nrel.gov/docs/fy16osti/65660.pdf>

7. Concluding Remarks

Concluding Remarks

- Net metering and wheeling offers a new solution to the financial complexities of power generators selling to power consumers.
- These systems offer many qualitative benefits including allowing larger numbers of potential generators to make business cases for investment in assets, improving network efficiencies and maximising the potential of existing assets.
- Challenges remain in that although most technical complexities have been tackled, regulation still has to catch up.
- If such systems are widely adopted, it would pave the way for a faster uptake of other smart energy technologies.



Sources:

<https://www.yellowdoorenergy.com/net-metering>

8. Further Reading

Further Reading

- **Introduction to net metering and wheeling with video content**
<https://www.energysage.com/solar/101/net-metering-for-home-solar-panels/>
- **Summary piece on Virtual Net Metering**
<https://news.energysage.com/virtual-net-metering-what-is-it-how-does-it-work/>
- **Balancing advantages against remaining challenges regarding wheeling**
<https://www.nrel.gov/state-local-tribal/blog/posts/weighing-the-costs-and-benefits-of-net-metering-and-distributed-solar.html>

Thank you for your time!



ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

9. Knowledge Checkpoint: Multiple Choice Questions