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# On-line Training of SAARC Professionals on Power Purchase Agreements of Renewable Energy Projects



## Different models of RPPA and strategies for the design and regulation of RPPAs

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# Content

- What are renewable power purchase agreements (RPPAs)?
- PPAs for large renewable generation projects
- PPAs for distributed renewable generation projects
- Cross-border trading of electricity
- Design considerations for RPPAs

# **What are PPAs and RPPAs?**

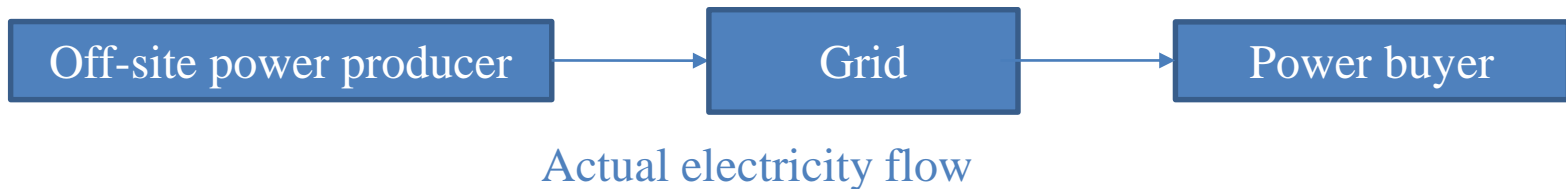
# What are PPAs?

- PPA is an agreement to buy and sell electricity between two parties
  - Often for long-term
- Physical or Financial/Synthetic
- Most often for long-term
- Can take several forms

# Physical or Financial – What does this mean?



- Large industrial/commercial customers with onsite generation space
- Customer avoids generation O&M headache
- Power producer can sell more than the contracted amount



- Actual electricity flow but through the grid
- Customer may pay for both capacity and energy generated
- Power producer can be anywhere...grid management charges apply

Price > \$10/MWh (P pays C difference)

Price < \$10/MWh (C pays P difference)

P – Producer; C- Consumer

- Actual electricity generation is not important...the contracted amount is
- Financial contract to pay for difference in price of electricity purchased and sold up to a MW value (contract for differences model)
- Possible in deregulated markets

# Renewable PPAs or RPPAs

- Renewable PPAs or RPPAs are PPAs for buying and selling of renewably generated electricity
- Differ from traditional PPAs as these are from projects that are *yet to be built*
- Increasingly popular with large corporate customers
  - Google's 140 MW PPA w/ Candela Renewables
  - GE's 5 MW solar PPAs with Tata Power Renewable Energy
  - Apple's 50 MW solar PPA for its Denmark data center

# Advantages and Disadvantages of PPAs

- **Advantages**

- Long-term price security (to both producer and consumer)
- Help producer secure financing...especially useful for renewable projects where public financing may be unavailable

- **Disadvantages**

- Long lock-in period for prices results in opportunity cost
  - Consumer may have purchased cheaper electricity
  - Producer may have sold electricity at higher prices
- e.g., Coal PPAs are a challenge for India's DISCOMs
  - They need to pay for capacity...but lot of solar means they don't need as much coal generation

# **RPPA Models for Large-scale Renewable Generation**



# Feed-in-Tariff (FIT) Structure

- FIT involves buying electricity based on cost of renewable energy production through long-term (15-25 years) contracts
  - One of the earliest forms of RPPA
  - Pioneered by the US since 1978
- FIT typically pays a fixed amount for each unit of electricity generated
- Can be an important instrument for supporting deployment of renewable energy technologies that are not yet competitive in the market
- FIT responsible for establishing the lead for US and Europe in renewable energy deployment

# Payment Approaches for FIT

- **Approach 1:** Levelized Cost of Generation + Some Return
- **Approach 2:** Estimating value of renewable generation
- **Approach 3:** Fixed price incentive
- **Approach 4:** Auction-based approaches

**Most effective approaches ensure coverage of project costs and some profit**

# Implementation Considerations for FIT

- Eligibility criteria for entities
- Role of the electric utility
- Duration of contract
- Consideration of caps on program or project size
- Forecasting requirement to address variability and uncertainty
- Resolving grid access issues

# Considerations for Funding FIT

- Adding costs into the rate base
- Using tax revenue
- Combination of the two
- Carbon auctions
- Utility tax credits
- Costs should be shared...minimize/eliminate “free-riders”

# Competitive-Bidding or Auctions

- Call for tenders is issued to procure specified amount of capacity or energy from renewable generation
- Developers submit their bid with price/unit
- Auctioneers evaluates bids and signs the PPA with successful bidder
  - Evaluation based on price and other criteria (e.g., amount of locally manufactured content)

# Advantages and Disadvantages

- Real price discovery – Regulators do not need all project details to determine reasonable price of electricity
- Certainty in prices and quantity of renewable generation purchased
- Commitments and liabilities of the parties are clear
- Auction participation and organizing costs may be high...
- Aggressive bids may over promise and under deliver

# Elements for Effective Auction Design

- Increasing competition
- Incorporating rules to ensure high realization rates of projects of successful bidders
- Minimum qualifications to ensure realization of auction objectives
- Clear and transparent winner selection process

# Wheeling Policies for Renewable Projects (USA)

- Renewable generators pay same transmission rates as others
- Based on FERC's principle that transmission charges should be economical and equitable
- Special transmission corridors have been built for accessing renewable generation. E.g., CREZ in Texas
- States typically allow renewable energy to be purchased from other states within the ISO/RTO
- Some states have no or minimal limitations on where to import renewable energy from (e.g., Colorado)



# Wheeling Policies for Renewable Projects (USA)

- Four transmission rates used – Pancaked, Postage Stamp, Licensed-Plate, and Distance-sensitive
- Postage stamp favorable for generators located far from load centers (e.g., wind)
- Example of wind PPA and its wheeling provisions provided in an NREL report
  - Between Alabama Power Company and 202 MW Chisholm View wind farm

# Wheeling Policies for Renewable Projects (USA) – An Example

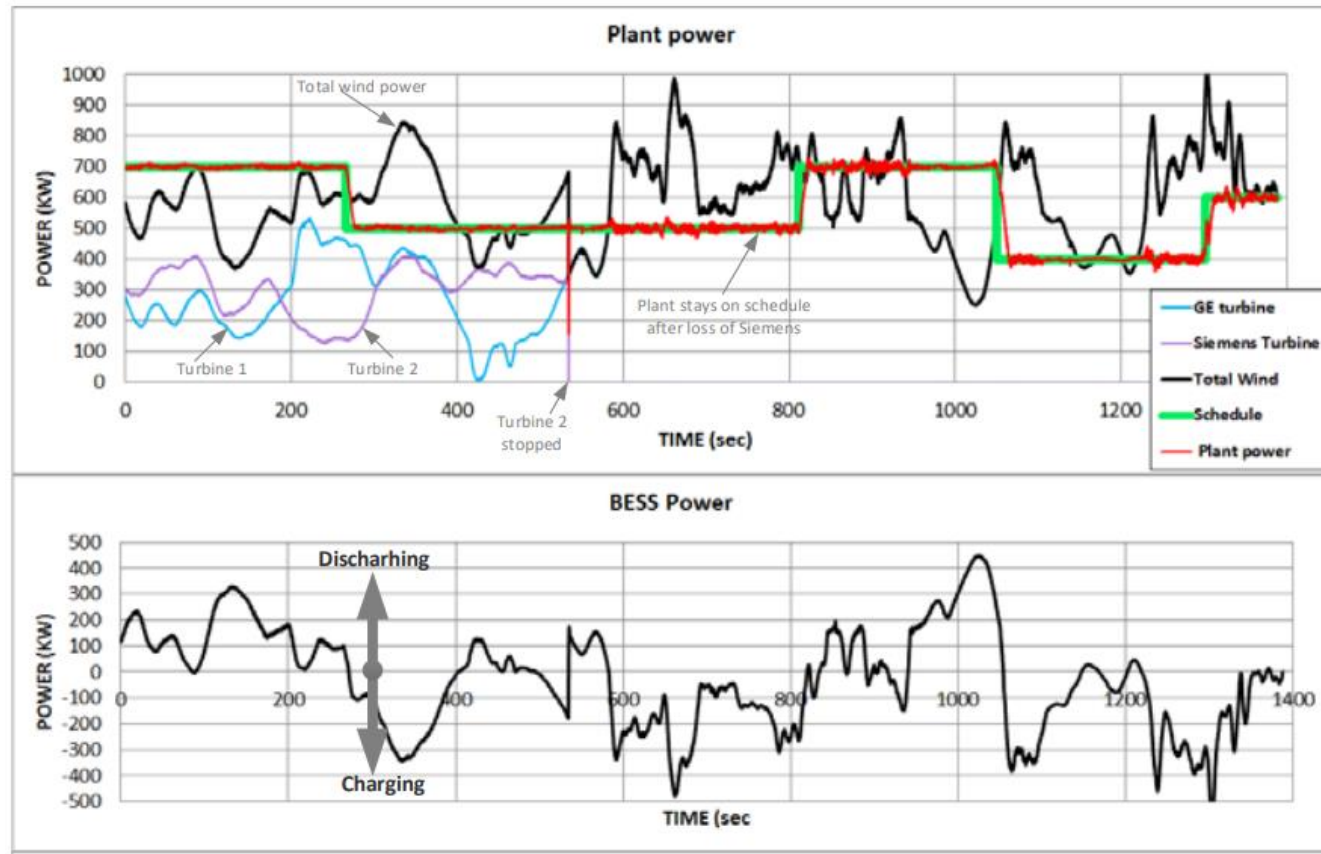
- Wind developer was responsible for securing all firm transmission rights; pay for firm transmission services; pay for interconnection charges
- Contract void if the above conditions were not met
- The utility would gain rights to firm transmission and pay for transmission costs once the project was up and running
- The utility could use the transmission rights as they wished

# Waiver of Transmission Charges for Certain Renewable Projects in India

- No Interstate transmission charge for wind and solar projects commissioned up to 2025
- Waiver also for BESS and Pumped Storage Hydro commissioned up to 2025
  - **Eligibility** - At least 70% of pumping/charging power from wind/solar
- Waiver for transmission charges...**not for losses**

# Better Dispatchability of Hybrid Power Plants

Wind power plant becomes dispatchable with hybridization



**Source:** Gevorgian, Vahan, Rajni Burra, and Mahesh Morjaria. 2018. "Hybrid Utility-Scale PV-Wind Storage Plants for Dispatchability and Reliability Services." Golden, Colorado: National Renewable Energy Laboratory. NREL/PR-5D00-71551. <https://www.nrel.gov/docs/fy18osti/71551.pdf>.

# RPPAs for Hybrid Renewable Energy Plants (India)

- Guidelines for procurement approach released in October, 2020
- Competitive-bidding approach for procuring power
- Applicable only to wind-solar hybrids
  - Storage can be included but only to firm wind-solar power
  - No prescription provided for storage technology

# Hybrid Plants' Competitive-bidding Design (India)

- 50 MW minimum project size
- Rated power of wind or solar resource at least 33% of hybrid resource size
- Solar Energy Corporation of India (SECI) will conduct bidding
  - It will buy from developer and sell to DISCOMs/other consumers
  - PPA will be cancelled if sale agreement not signed withing 6 months of award

# Hybrid Renewable Energy Procurement (USA)

- Policies are state-specific in states without electricity markets (e.g., Oregon and Arizona)
- Competitive-bidding approach adopted in both these states
- Arizona Public Service (utility) entered into a PPA with First Solar for a 65 MW solar, 50 MW/135 MWh battery storage
- Portland General Electric or PGE entered into 30-year PPA with NextEra Energy based on competitive-bidding
  - 300 MW wind + 50 MW solar + 30MW/4 hrs. battery
  - 100 MW wind purchased by PGE for \$160 Million

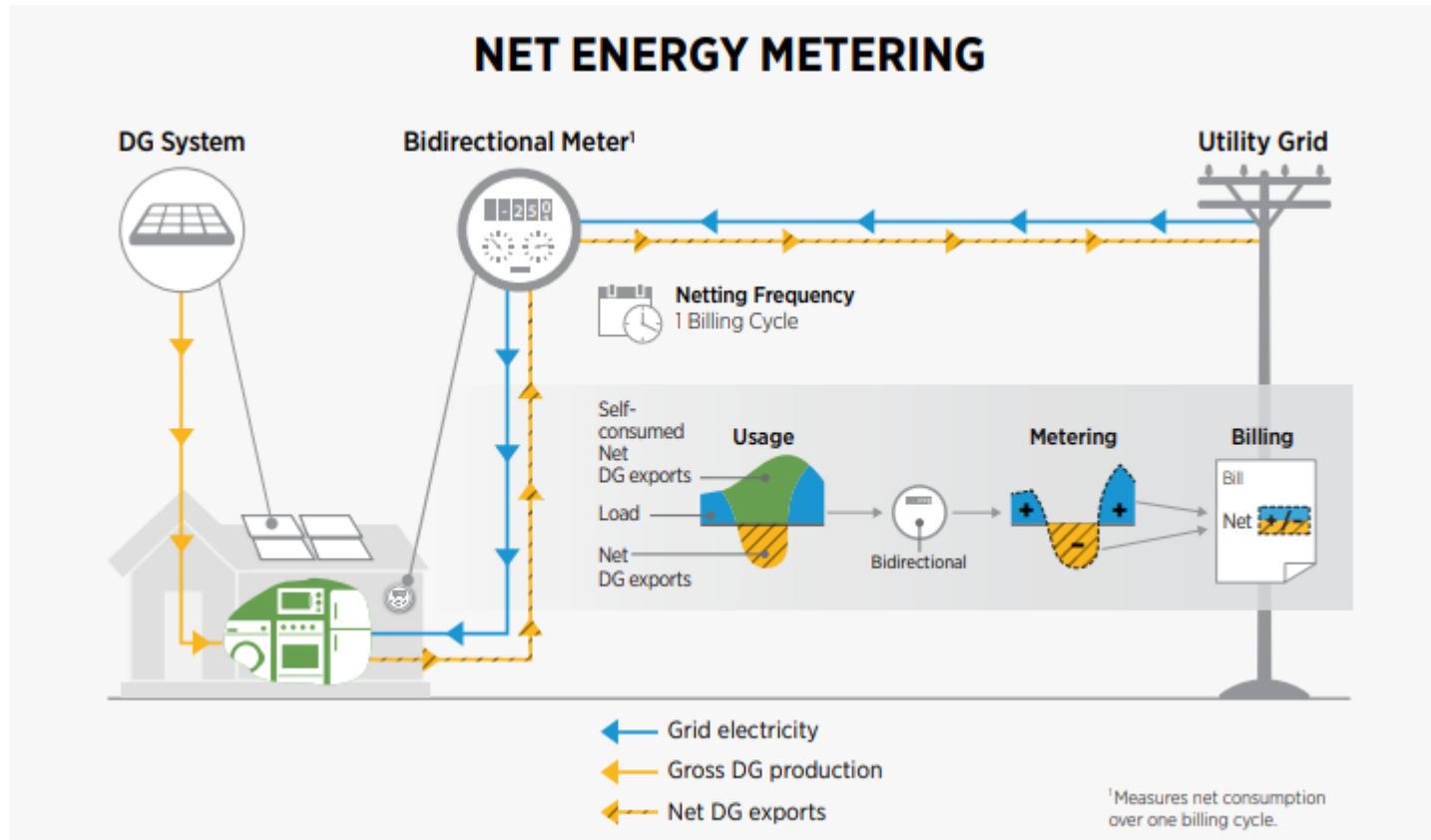
# **RPPA Models for small- scale/Distributed Renewable Generation**



# Various Compensation Options and Components

- Based on metering and billing arrangements
  - Net energy metering
  - Net billing
  - Buy all, sell all
- Sell rate design approach
- Retail rate design approach

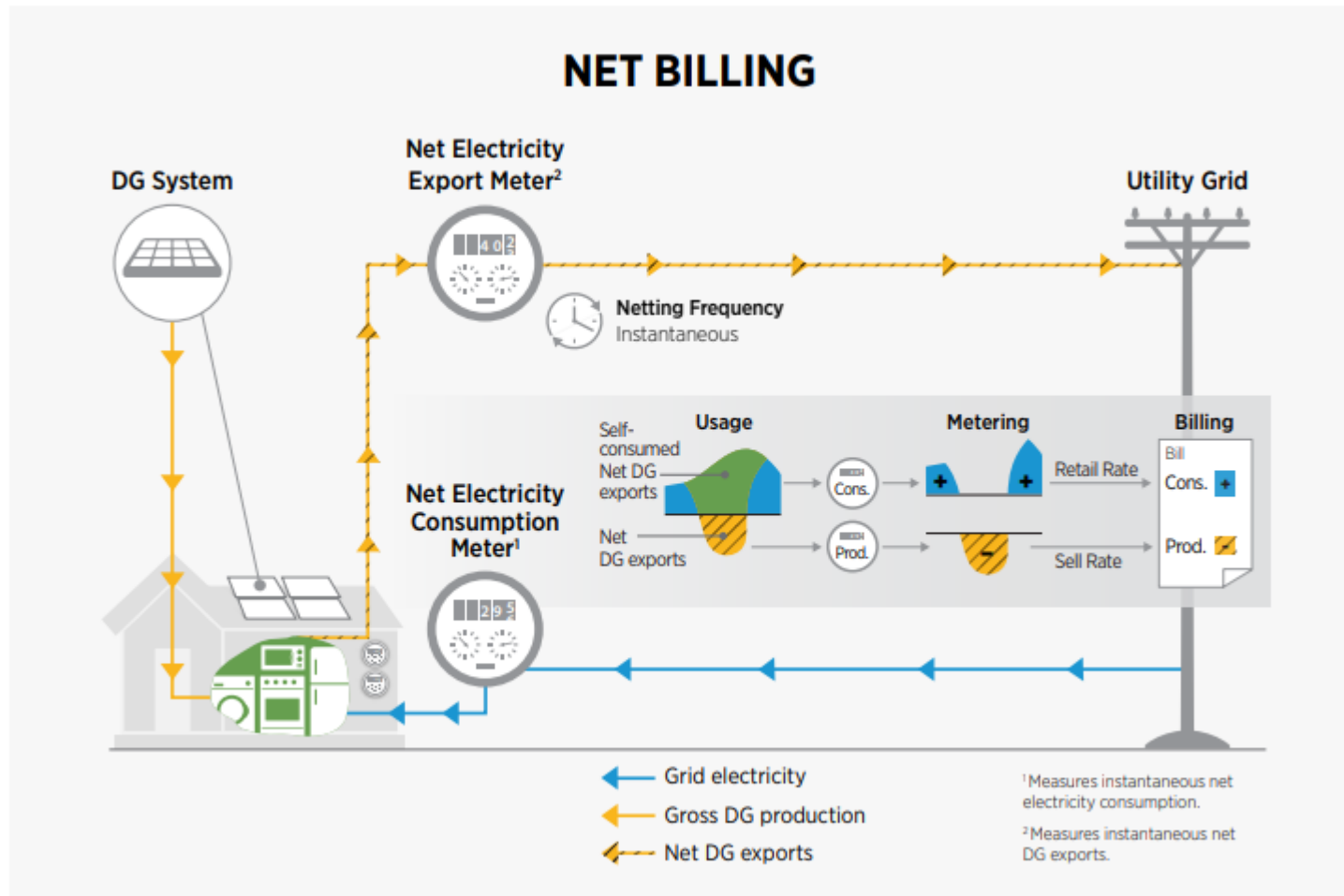
# Net Energy Metering



Source: NREL, USA

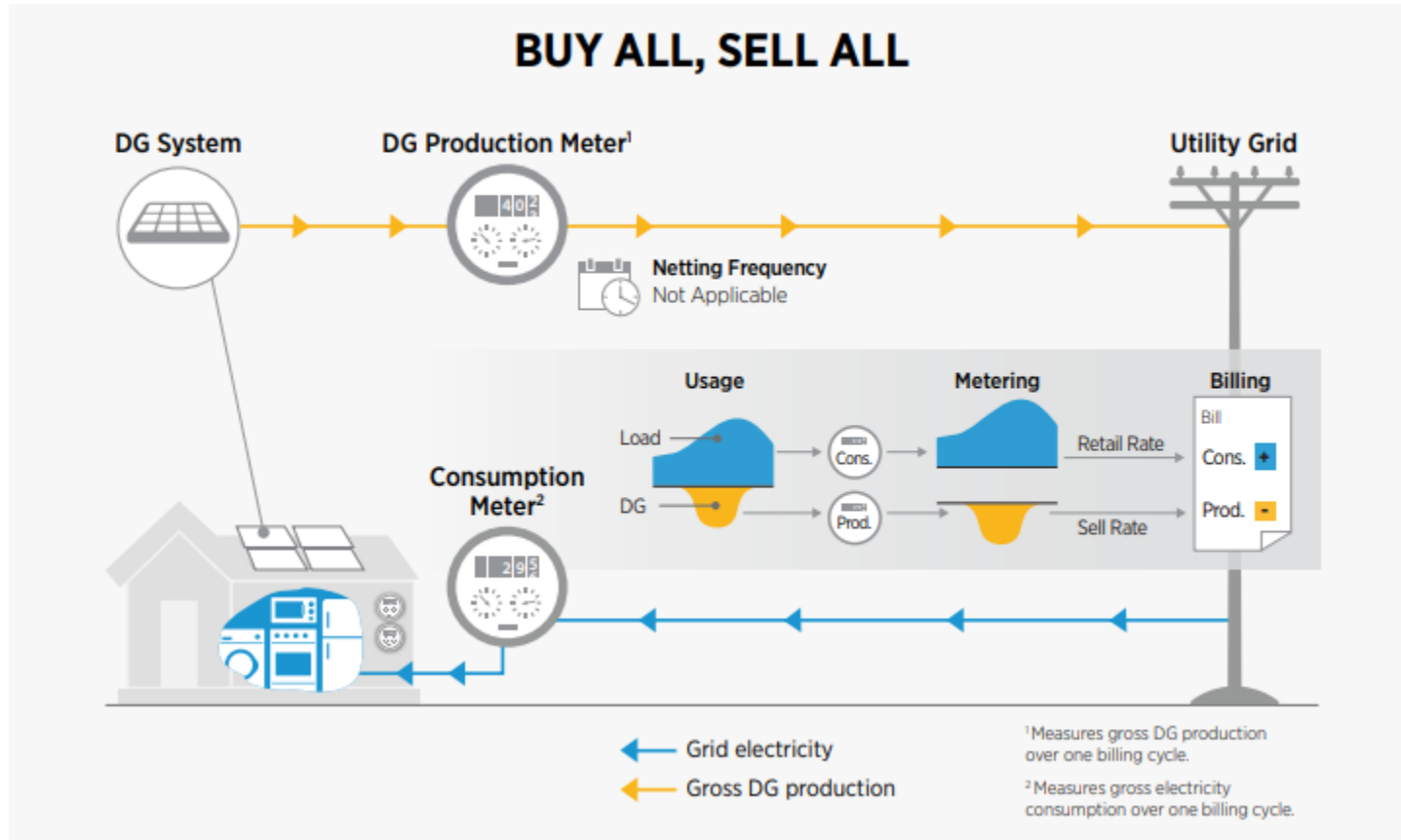
Extra generation is banked within billing cycles and usually banked between billing cycles

# Net Billing



Source: NREL, USA **No banking allowed for extra generation**

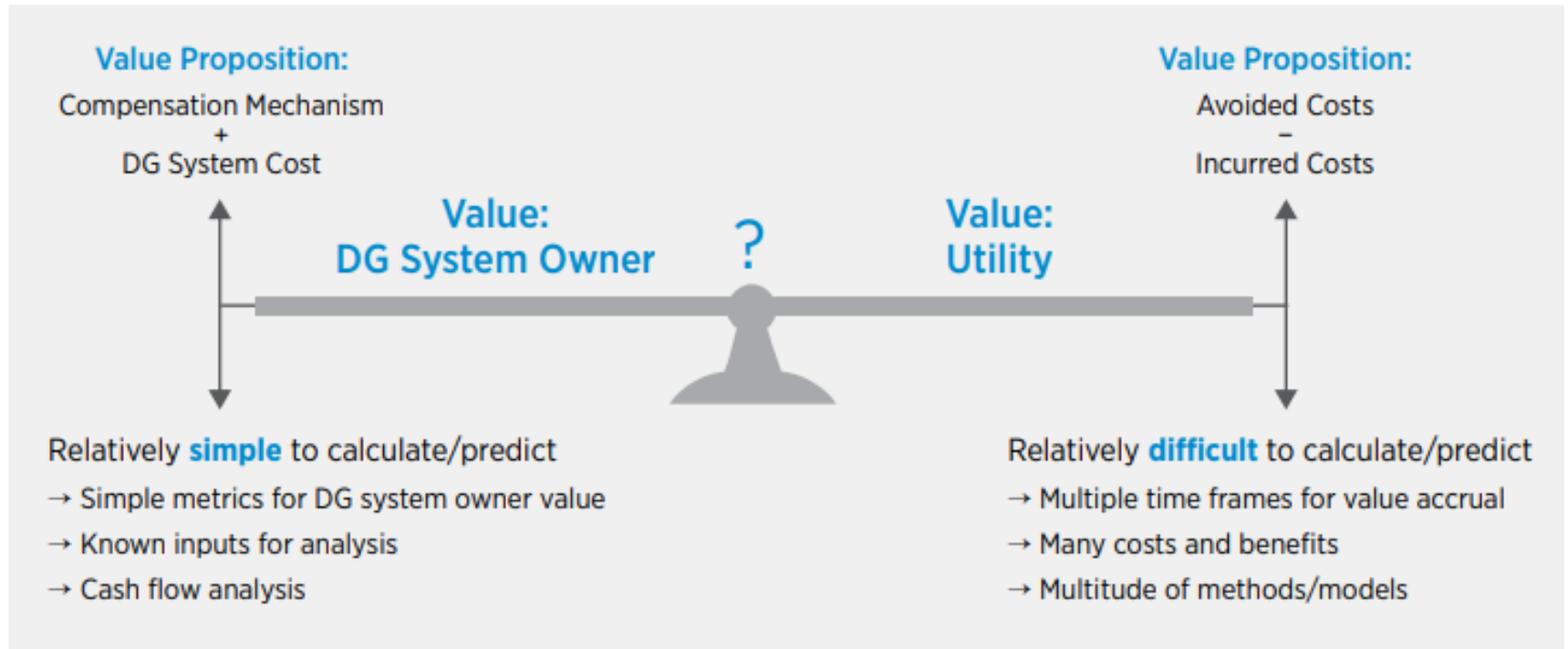
# Buy all, sell all



Source: NREL, USA

**Paid for all generation; charged for all consumption...long-term fixed price typically offered for generation**

# Value of Solar Approach for Sell Rate Design



Source: NREL, USA

Value of Solar (VoS) approach can be used for determining sell rates for compensation **methods** discussed earlier

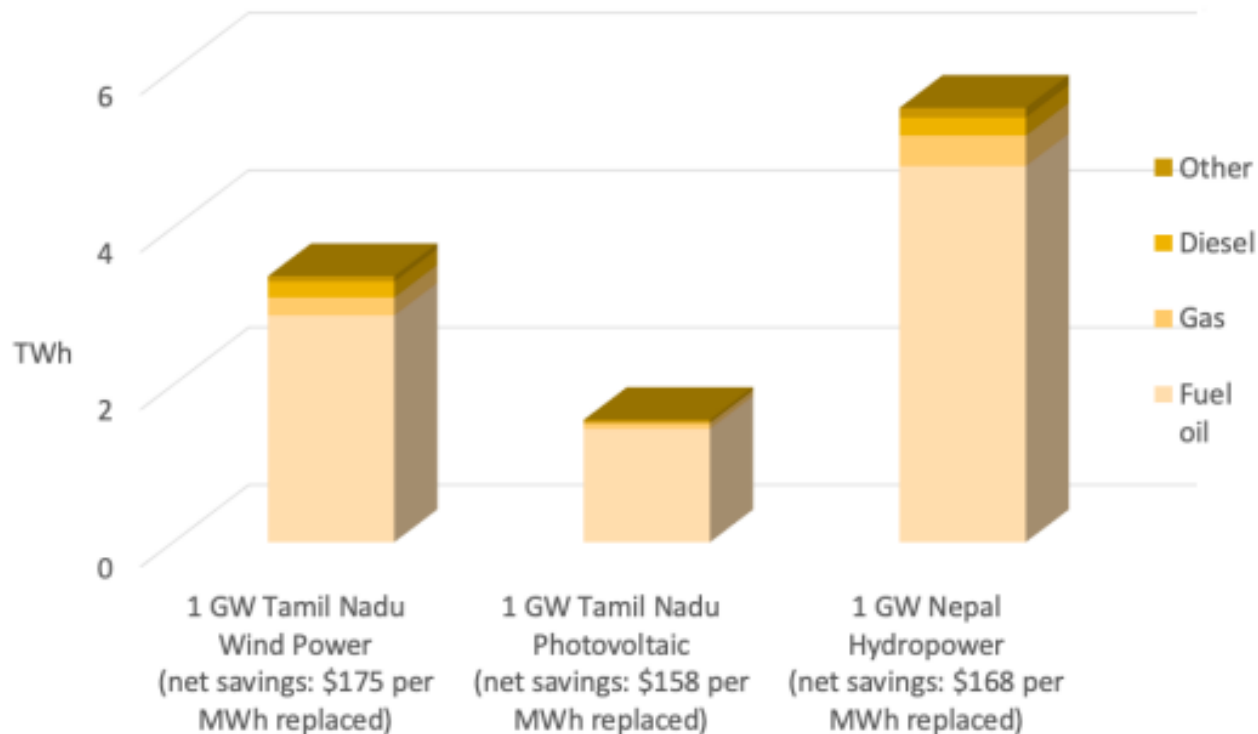
# Value of Solar Study for Gujrat and Jharkhand

	Gujrat		Jharkhand	
	Base Case (Rs/kWh)	MNRE Goals (Rs/kWh)	Base Case (Rs/kWh)	MNRE Goals (Rs/kWh)
<b>With Environmental and Health</b>	10.0–11.8	9.0–10.8	7.6–9.3	7.5–9.3
<b>Without Environmental and Health</b>	4.8	3.8	2.3	2.3

Source: NREL, USA

# **RPPA Associated with Cross-Border Trade of Electricity**

# Benefits to SAARC from Cross-Border Trade of Renewable Energy



## Potential Benefits to Bangladesh

Source: NREL, USA



# Tariff Provisions in India for Cross-Border Electricity Trading

- Regulations issued by CERC in 2019
- Tariff for imports
  - Through competitive-bidding
  - Through mutual agreements between entities of India and the other country
  - Special provision for hydro power imports
  - Transmission or Wheeling charges through Indian grid apply for exports

# Cross Border PPAs in Europe

- Increasing interest in cross border PPAs in the European Single Market
- Corporate buyers are interested...can buy renewable energy outside the electricity market where their load resides
- Both virtual and physical PPAs are possible
- **Benefits** - e.g., Increased choice, avoid regulatory barriers
- **Risks** - e.g., Complex sourcing and contracting, uncertainty of obtaining of interconnector capacity rights

# **RPPA Design & Regulation Strategies**

# Design Strategies – Key Considerations

- Liabilities
- Contract Term
- PPA Price
- Escalator
- Expiration
- Environmental Attributes
- Assignability
- Credit Support
- Performance Terms
- Site Right Agreement
- Tax Equity

Source: dena

# Design Strategies – Facilitating RE Growth

Consider the following in RPPAs

- Voltage and frequency ride-through
- Voltage and power factor support
- Provision of AGC
- Plant forecasts or data to enable forecasting
- Provision of ancillary services
- Reduce impacts of curtailment



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*Thank you*



# References

- PPA definitions - <https://www.next-kraftwerke.com/knowledge/ppa-power-purchase-agreement>
- Synthetic PPA details - <https://www.projectfinance.law/publications/2013/april/synthetic-power-contracts/>
- Traditional vs Renewable PPA: <https://perspectives.se.com/renewable-energy/what-s-the-difference-between-a-traditional-and-renewable-ppa#:~:text=One%20of%20the%20big%20differences,contract%20are%20much%2C%20much%20different.>
- Google Texas PPA: <https://www.environmentalleader.com/2020/09/google-candela-texas-solar-ppa/>
- GE India PPA: <https://www.tatapowersolar.com/press-release/tata-power-renewables-signs-ppa-with-ge-for-5-mw-solar-projects/>
- Apple PPA: <https://www.pv-magazine.com/2020/09/04/apple-data-center-in-denmark-powered-by-50-mw-of-solar/>
- FIT Reference: <https://www.nrel.gov/docs/fy10osti/44849.pdf>
- Competitive bidding: [https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/Jun/IRENA\\_Renewable\\_Energy\\_Auctions\\_A\\_Guide\\_to\\_Design\\_2015.pdf](https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/Jun/IRENA_Renewable_Energy_Auctions_A_Guide_to_Design_2015.pdf)
- Hybrid Resource PPA (India): [https://mnre.gov.in/img/documents/uploads/file\\_s-1602674926052.PDF](https://mnre.gov.in/img/documents/uploads/file_s-1602674926052.PDF)
- Hybrid Resource PPA (USA): <https://www.utilitydive.com/news/solar-wind-storage-developers-gearing-up-as-hybrid-projects-edge-to-m/556480/>
- PPAs for Distributed Generation.: <https://www.usaid.gov/sites/default/files/documents/1865/68469.pdf>
- NREL India VoS study: <https://www.nrel.gov/docs/fy21osti/78442.pdf>
- Potential Cross-Border Renewable Energy Trading Benefits in SAARC – <https://www.nrel.gov/docs/fy20osti/76919.pdf>
- CERC (India) Cross-border Electricity Trading Regulations: <https://cercind.gov.in/2019/regulation/CBTE-Regulations2019.pdf>
- Europe Cross-Border PPAs: <https://www.wbcds.org/contentwbc/download/10878/160801/1>
- Wheeling charge renewable energy: <https://www.nrel.gov/docs/fy16osti/65660.pdf>
- Wheeling charge renewable energy India: [https://powermin.gov.in/sites/default/files/Waiver\\_of\\_inter\\_state\\_transmission\\_charges\\_Order\\_dated\\_21\\_June\\_2021.pdf](https://powermin.gov.in/sites/default/files/Waiver_of_inter_state_transmission_charges_Order_dated_21_June_2021.pdf)
- Designing PPAs : [https://www.dena.de/fileadmin/dena/Publikationen/PDFs/2019/dena-REPORT\\_How\\_to\\_use\\_PPAs\\_for\\_cost-efficient\\_extension\\_of\\_re.pdf](https://www.dena.de/fileadmin/dena/Publikationen/PDFs/2019/dena-REPORT_How_to_use_PPAs_for_cost-efficient_extension_of_re.pdf)
- Designing PPAs: <https://www.nrel.gov/docs/fy16osti/66543.pdf>