Annexures

Global Perspectives on Rooftop Solar Energy

A Deep Dive on How Leading Economies Advance Rooftop Solar Energy Adoption

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Annexure 1: Major challenges of the *Golden Sun Programme* in China

- Developers delayed project commencement to reduce costs; in many cases, delays in grid integration became a challenge.
- The tariff from solar projects was connected to benchmark prices of local desulphurisation coal fire power plants – however, only two provinces, Zheijiang and Jingsu, developed tariff policies for the programme. Due to a lack of clarity regarding tariffs in many provinces, programme implementation was challenging.
- The policy did not establish an upper limit (in terms of bidding capacity) for projects to claim incentives. There was policy design–related issues concerning the non-availability of the upper limit for the bidding capacity for which the incentives were applicable. Additionally, subsidy support was not linked to cost reduction due to market competition; this resulted in excessive subsidies being provided under the programme.
- From the user perspective, the policy did not provide clarity on the use of solar generation, which created challenges in grid infrastructure planning and grid integration–related challenges for solar systems.
- The high cost of monitoring, and a lack of capacity on the part of local authorities to monitor a large number of projects, resulted in substandard installation in many places. Additionally, many developers used solar PV equipment that had been discarded in European countries to gain high margins.

Annexure 2: Business models of the *Solar Energy for Poverty Alleviation Programme* in China

- Projects were developed through 100 per cent government subsidy.
- The government, solar developers, and beneficiaries developed projects through an equal financial contribution. However, the government provided zero-cost financing to beneficiaries from economically disadvantaged families who could not contribute their share. Beneficiaries repaid the loan through the income generated by selling the electricity to the grid.
- Joint-level solar installation (community-level solar installation) was adopted under the policy to reduce the challenges associated with scattered installation. Under this model, the project was jointly financed by the government, the solar developer, and beneficiaries. Beneficiaries were required to contribute CNY 5,000 (USD 693), and they could get zero-cost financing from local banks for this. Beneficiaries repaid the loan from their income from selling electricity to the grid. In this model, the county government owned the solar project, and the net revenue generated after paying the land lease fee and operation and maintenance cost was distributed among the beneficiaries.

Annexure 3: Business models of China's *Whole County PV* programme

- Building owners self-finance, the project and sell electricity to the developer.
- Commercial and industrial consumers can lease rooftop space, and solar developers can install and carry out the O&M of the solar plant. They can also sign two power-selling contracts – one with the roof owner and one with the local utility – through which they sell power to the property owner and the excess power to the grid.
- Residential consumers can lease their rooftops to a solar developer. The developer pays the rent for the roof space. The solar developer is responsible for the installation and O&M of the solar system. They then sell 100 per cent of the generation from the rooftop system to the grid.

Annexure 4: Key energy institutions in Germany

- The Federal Ministry for Economic Affairs and Climate Action (BMWK) is a federal ministry of Germany tasked with designing the country's energy transition.
- The Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway (BNetzA) is one of the agencies under the BMWK. It regulates these sectors to ensure that access to various networks is non-discriminatory.
- Market Master Data Register (MaStR) is an official register of electricity and gas market data managed by the Federal Network Agency.
- The German Cooperative and Raiffeisen Confederation (DGRV) is the federation for German cooperatives.

Annexure 5: Key institutions in the US involved in designing RTS interventions

- Department of Energy (DOE) is a federal government department responsible for addressing challenges related to energy policy and production, the environment, and research and development of nuclear energy in the US.
- Solar Energy Technologies Office (SETO) is part of the Office of Energy Efficiency and Renewable Energy (EERE) under the DOE. SETO provides research, development, demonstration, and deployment assistance for solar energy.
- The Energy Information Administration (EIA) is a statistical and analytical agency within the DOE that provides independent and impartial energy data for the US.
- Environmental Protection Agency (EPA) is a US government agency with a mission to protect human health and the environment. The agency also provides funding opportunities such as Solar for All.
- The US Department of the Treasury is the executive agency tasked with promoting economic prosperity and ensuring financing security in the US. The department created an *Inflation Reduction Act* (IRA) Programme Office to partner with other Treasury offices, the IRS, and the White House. The US Internal Revenue Service (IRS) is a statutory authority and plays a crucial role in implementing the IRA of 2022.
- Public Utilities Commissions in the US (e.g., California CPUC) are governing bodies that regulate the rates and services of public utilities such as electricity.
- National research labs such as NREL and LBNL.

Annexure 6: Evolution of the clean energy tax credits in the US

Table A1 Clean energy tax credit programmes have been a consistent driver of increased residential RTS adoption in the US over the past decade

Segment	Residential	C&I		Key act introduced
Instrument type	Clean energy credit (Tax code 25D)	ITC (Tax code 48, 48E)	PTC in ct/kWh (Tax code 45, 45Y)	
2006–2007	30%	30%	-	The *Energy Policy Act of 2005* created the 30% tax credit for residential and commercial; The Tax Relief and Health Care Act of 2006 extended the tax credit for one additional year.
2008–2014	30%	30%	-	*The Emergency Economic Stabilisation Act of 2008* extended tax credits till 2016.
2015	30%	30%	-	The Protecting Americans from Tax Hikes Act (PATH) of 2015 extended 25D till 2021; The *Consolidated Appropriations Act of 2015* included a multi-year extension of residential and commercial tax credits with the phase-out on 2020–2021 defined.
2016	30%	30%	-	
2017–2019	30%	30%	-	*The Tax Cuts and Jobs Act* 2017 maintained the residential and commercial ITC.
2020	26%	26%	-	
2021	22%	22%	-	
2022	30%	30%	1.5 ct	The *Inflation Reduction Act* of 2022.
2023–2032	30%	30%	1.5 ct [1]	

2033	26%	26%	0%[2]	
2034	22%	22%	0%	
2035	0%	0%	0%	

Source: Authors' analysis based on data from IRS 2024a, SETO 2023b, The White House 2023, and SEIA 2023

Note: 1. Amount is adjusted for inflation; 2. Phase down of PTC is linked to the applicable year, i.e., the year in which the annual GHG emissions from electricity production in the US are equal to or less than 25 per cent of the emission from 2022.

Annexure 7: Difference between US NEM 1.0, NEM 2.0, and NBT

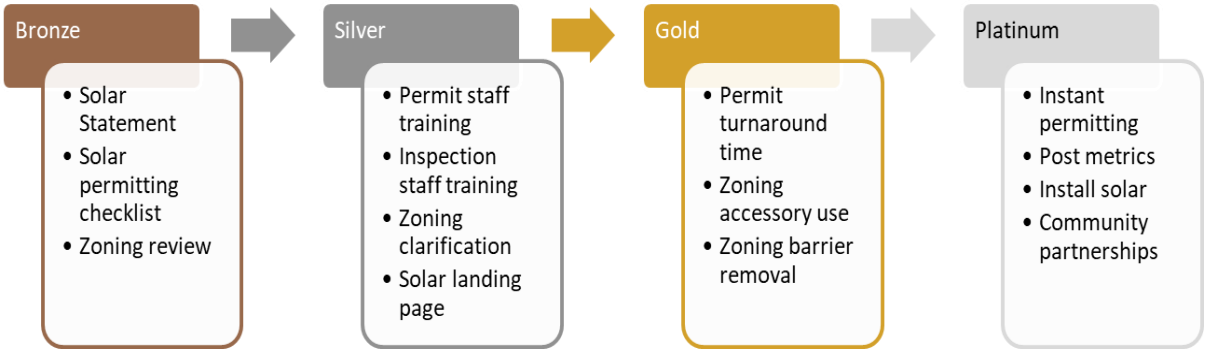
Table A2 The US is transitioning from net energy metering to a net billing tariff with a higher installation limit

Criteria	NEM 1.0	NEM 2.0	NBT
Eligible import rate schedule	Any	Time of use (TOU) rates	Specific 'electrification' TOU rates
On-site use of generated energy avoids energy imports	Yes	Yes	Yes
Basis of credits for retail energy exports before true-up	Import rates	Import rates	CPUC avoided cost calculator values (usually < import rates)
Basis of credits for net surplus energy at true-up	Wholesale price of energy	Wholesale price of energy	Wholesale price of energy
Interconnection fee	None	USD 94–145	USD 94–145
Billing and true-up period	Annual billing, annual true-up (Both charges and credits roll over for 12 months)	Annual billing, annual true-up (Both charges and credits roll over for 12 months)	Monthly billing (pay monthly), annual true-up (credits roll over for 12 months)
Installation size limit	Consumer's annual electric load with limited exceptions; capped at 1 MW	Consumer's annual electric load with limited exceptions	Consumer's annual electric load with an additional limit of up to 50% if the customer attests to need

Source: Authors' compilation based on data from CPUC. 2023. "Net Energy Metering and Net Billing." California Public Utilities Commission. https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/customer-generation/net-energy-metering-and-net-billing

Annexure 8: Details of the *SolSmart* programme

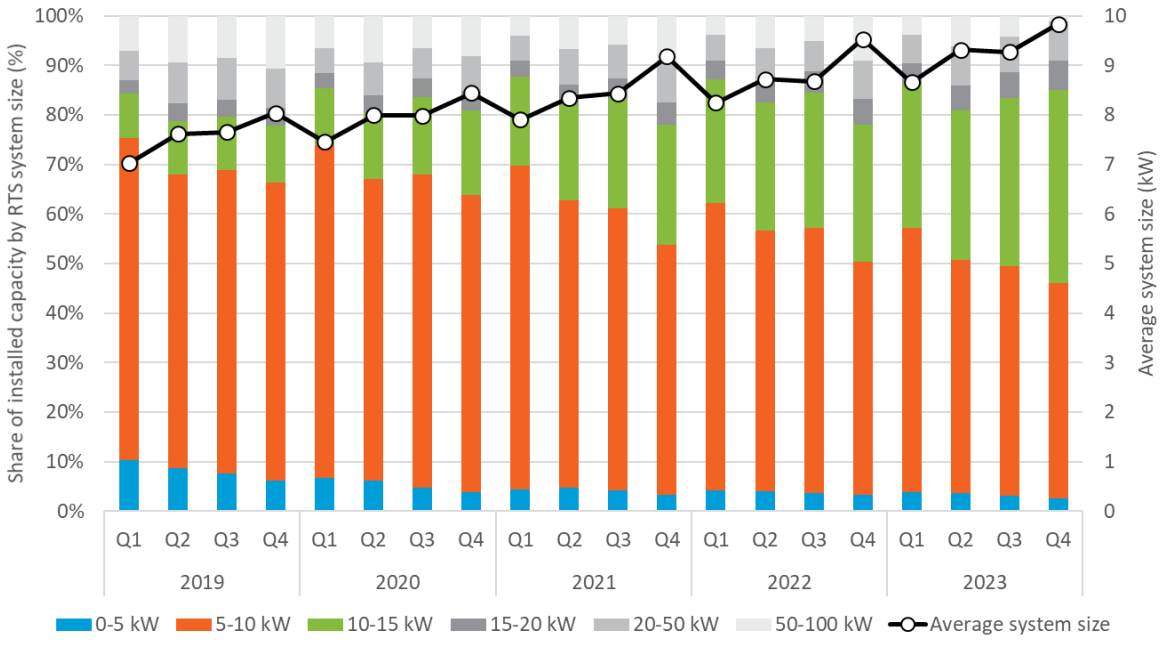
Figure A1 *SolSmart* designations are based on prerequisite criteria



Source: Authors' compilation based on data from SolSmart. n.d. "Introducing SolSmart." https://solsmart.org/why-solsmart.

Annexure 9: The average RTS system size in Australia

Figure A2 The average RTS system size in Australia increased from 7 kW to 10 kW between 2019 and 2023



Source: Authors' compilation based on data from Clean Energy Regulator. 2023. "Quarterly Carbon Market Report (December 2023)." https://cer.gov.au/markets/reports-and-data/quarterly-carbon-market-reports/quarterly-carbon-market-report-december-quarter-2023

Annexure 10: Three key components in the implementation of the SRES in Australia

- **Creation and issuance of *small-scale technology certificates* (STCs) -** STCs are issued when the RTS[1] system is installed. The prosumer can choose to get the issued certificates or, as is more prevalent, sign away their STCs to a registered agent in exchange for an upfront discount on the system. The CER does not regulate the quantum of upfront discount and depends on the agent's expectation of the value of STCs. Similar to RECs, each STC represents 1 MWh of electricity. The quantity of STCs represents the expected generation[2] from the system. Until 2016, the certificates were awarded for a 15-year generation, whereas, since then, the issued certificates correspond to generation until 2030. Thus, each year, there will be a decrease in the energy corresponding to which the certificates will be issued.

- **Obligation to procure STCs -** The government sets a small-scale technology percentage (STP) each year on the advice of the CER. Obligated entities, principally electricity retailers and open-access consumers, are mandated to procure STCs equivalent to the STP share of the electricity they sell. For instance, if the STP is 12 per cent and the retailer sells 20,000 MWh of electricity that year, the retailer must procure 24 certificates (12 per cent x 20,000 MWh = 24 MWh; 1 STC = 1 MWh). As opposed to the RET and the LRET, SRES is not designed to achieve an increasing level of deployment. Instead, the SRES aims to reduce the mismatch between supply and demand of STCs in the market. Accordingly, the STP is set annually based on four parameters:
    - Estimated creation of STCs (i.e., estimated installation of small-scale RE systems)
    - Total expected electricity sales (or consumption, for open access)
    - Cumulative surplus of STCs
    - Exempted electricity consumption (i.e., electricity consumed by businesses that are exempt from RE obligations to ensure their competitiveness)

  The STP is calculated as STP = (P1 + P3)/(P2 - P4). For 2024, the STP is 21.24 per cent.

- **Exchange of STCs -** The STCs can be traded between the obligated entities and the agent (or the prosumer) through bilateral transactions in the open market or through the CER-maintained clearing house at a fixed price of AUD 40/STC (USD 26 /STC). If there is an undersupply of certificates in the clearing house, obligated entities can obtain a CER-created STC at the same price – effectively establishing the clearing house price as the price ceiling for STCs. The penalty for not procuring the required amount of STCs is AUD 65/STC (USD 42 /STC). The significant difference between the price and the penalty incentivises obligated entities to procure STCs.

  While the actual benefit from the SRES to an individual prosumer varies based on market conditions and system characteristics, it typically amounts to one-third of the upfront cost of the RTS system (Clean Energy Regulator 2023).

[1] While the SRES scheme covers multiple technologies, in this section, focus is on RTS.

[2] In order to calculate the expected generation, the country is divided into four zones based on levels of insolation, with a higher insolation zone receiving a larger multiplier.

Annexure 11: Key features of Italy's *Super Bonus 110%* Scheme

- The policy provides 110 per cent tax relief to customers over a period of four years on their expenditure. Eventually, the cost of installation will be free for beneficiaries. For example, if a household had spent EUR 10,000 (USD 10,792) on installing a solar system, then the household is eligible to get a tax benefit of EUR 11,000 (USD 11,871) during the four-year period. Hence, the tax credit benefit for the household is EUR 2,750 (USD 2976) a year. This tax amount is deducted from the total tax liability of the beneficiary in a financial year.
- Beneficiaries whose taxable amount is not high and who cannot take full benefit of the policy can transfer the tax credit to the contractor/vendor or supplier of the solar plant. The contractor can deduct the tax credit amount from the installation cost. The contractor can claim the tax credit from the government or can sell the tax credit to banks.
- The scheme provided tax relief for new solar plant installation and tax relief to homeowners for renovating and modernising old solar plants

Annexure 12: Amendment to the *Decreto Aiuti* Quarter scheme in Italy

- House owners can benefit from the old 110 per cent *Super Bonus* policy until 31 March 2023 as long as they complete at least 30 per cent of the installation work by 30 September 2022.
- House owners who own a property and use it as their main home can benefit from the amended policy if the owner's income is not more than EUR 15,000 (USD 1,618) per year.

Annexure 13: Other policy initiatives in Italy to support RTS adoption

Table A3 Increased installation limits along with technology-based pricing policies have led to a surge in solar adoption in Italy

Policy details	Capacity limit	Policy framework	Impact
Scambio Sul Posto	● 20 KW for systems installed before 31 December 2007. ● 200 KW for systems installed after 31 December 2007. ● 500 KW for systems installed after 1 January 2015.	● GSE, the leading utility of the country, collected the data related to energy fed to and withdrawn from the grid. ● Calculate the cost of electricity supplied (COE) by distributed generator by deducting the costs related to grid service. ● Calculate the value of electricity (VOE) fed concerning the hourly zonal electricity price.	● With the increase in the limit of solar system installation, the capacity addition in the solar sector has increased in the past couple of years. ● As the policy is framed to link the technology-based market price for solar generation, this results in transparency in cost recovery to generators. This encourages solar generators to adopt new technologies, such as PV systems with storage in the future.

		• Pay the lesser value between COE & VOE to the solar generator.	
DL Energia, 2022 (Dentons 2022)	• Rooftop solar installation up to 200 KW	• Under the policy, the government has planned to simplify the permit and EIA assessment process in all municipality areas of the country. • Permits are no longer needed to install and upgrade RTS plants. • Only projects placed in buildings of aesthetic, traditional, or historical importance need to obtain a permit.	• The simplified process for RTS installation has reduced the bureaucratic red tape and sped up the project approval and installation process.

Source: Authors' analysis based on data from Toxiri GSE 2014, Dentons 2022

Annexure 14: Comparison of billing mechanism and minimum payable amount to discoms in Brazil

$B_1=(E_C-E_i)*(TE+TUSD)$ (1)

$B_{min}=E_{min}*(TE+TUSD)$ (2)

$B_{net}=Max(B_1,B_{min})$

Where B_1 is the bill for the positive difference between the energy consumed and injected into the grid, E_c is the energy consumed from the grid, E_i is the energy injected into the grid, TE is the energy tariff, TUSD is the distribution system use tariff, B_{min} is the billing for the minimum amount of energy according to the connection, E_{min} is the minimum amount of energy billed, and B_{net} is the charged bill by the discom.

$B_2=(E_C-E_i)*(TED)+(E_C+E_i)*(TUSD\ FioB)$ (3)

$B_{min}=E_{min}*(TE+TUSD)$ (4)

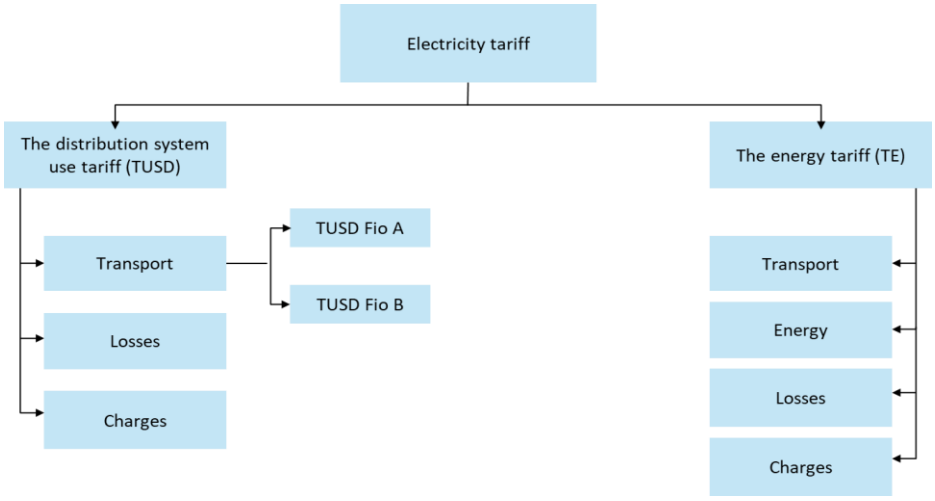
$B_{net}=Max(B_2,B_{min})$

Where B_2 is the billing amount for the positive difference between the energy consumed and injected into the grid, TED is the energy tariff and the distribution system use tariff excluding the TUSD-FioB, and TUSD-FioB is the tariff for the use of the distribution system without contemplating system losses, the use of the transmission system, and government contribution. From 2029 or 2031 onwards, all other TUSD components would also no longer be compensated. At the end of each month, consumers must pay either the net billing amount or the minimum payable amount to discom, whichever is higher.

Annexure 15: Brazil's electricity tariff component structure

The current net metering rule allows full compensation for surplus power generation for all tariff components, such as the distribution system use tariff (TUSD) sub-divided into TUSD Wire A – Transmission, TUSD Wire B – Distribution, TUSD Charges and TUSD Losses, and Energy Tariff (TE) (ANEEL 2020) (Figure A3). Currently, consumers with distributed generation do not pay for using the distribution grid and sectorial charges concerning their credits, which other customers bear. The new regulation ends this cross-subsidy and determines that the compensation for excess power shall apply exclusively to the energy tariff (TE). All consumers have to pay for grid availability and usage costs.

Figure A3 Electricity tariff components of Brazil



Source: Authors' analysis based on data from ANEEL 2020. https://www2.aneel.gov.br/cedoc/aren20231060_2_1.pdf

Annexure 16: New compensation mechanism in Brazil under its revised net-metering scheme

Table A4 Brazil gradually transitioning to the new metering scheme ensuring equal benefits for new and existing consumers

For consumers requested access to the distribution network between 8 February 2023 and 7 July 2023								
Year	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2031 onwards**
TUSD-FioB component percentage	15%	30%	45%	60%	75%	90%	100%	100%
All other TUSD components	0%	0%	0%	0%	0%	0%	0%	100%
For consumers requested access to the distribution network onwards 8 July 2023								

Year	2023	2024	2025	2026	2027	2028	2029 onwards
TUSD-Fio B component percentage	15%	30%	45%	60%	75%	90%	100%
All other TUSD components	0%	0%	0%	0%	0%	0%	100%

Source: Authors' compilation based on data from Tauil Chequer and Mayer Brown. 2022. "Brazil Energy Journal." Brazil Energy Journal 4 (June). https://www.mayerbrown.com/-/media/files/perspectives-events/publications/2022/06/brazil-energy-journal--june--power-distributed-generation.pdf

Annexure 17: State-level interventions for RTS adoption in India

Table A5 Central initiatives to promote RTS adoption are well supported by several state level policy and regulatory interventions

State-level measures	Current scenario
System capacity restrictions	83% of states limit the minimum size of the system to 1 kW, restricting low-consumption consumers. Hence, there is a negative impact on deployments.
Metering regimes and compensations	Net-metering is the most common regime. Nine states offer virtual net-metering options, providing flexibility to the beneficiaries. Nineteen states also have gross-metering regulations.
Proactiveness in policy notifications	Only nine states/UTs notified policies during the 2012–2016 period, and 46% of states have notified policies after that. Two-thirds of the states have clear time-bound targets, making the impact measurable.
Monetary incentives	Seven states provide capital subsidy incentives. Delhi and Kerala also provide generation-based incentives. Very few states have extended the subsidy to C&I sectors.
Financing mechanisms	Payment security mechanisms, green solar funds, community solar, and peer-to-peer energy trading are a few business models across states. SNAs in a few states are also tasked with end-used financing options.
Ease of access	Twenty-two states provide single-window clearance for RTS processes. Very few states require the discoms to maintain a database of net-metering applications and their status.

Source: Authors' analysis

In Gujarat, an innovative rent-a-roof programme was initiated to boost RTS adoption. Gujarat has the largest deployments and contributes to nearly 30 per cent of all the RTS installations throughout the country. The state has a detailed solar policy: the *Surya Gujarat* scheme (2019). The incentives are uniform up to 3 kW, unlike the present central financial assistance. The state also has defined targets under the scheme to benefit 8 lakh consumers by 2022.

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