Implementation Models for Distributed Solar in Tamil Nadu

Making Solar A Winning Proposition to all Stakeholders

AurovilleConsulting

Sustainable Energy Transformation Series

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July 2020

Making Solar A Winning Proposition to all Stakeholders

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ACKNOWLEDGMENT

This publication forms part of the Sustainable Energy Transformation, Tamil Nadu (SET-TN) series of documents and activities. SET-TN aims to facilitate higher clean energy deployment in the State by working with all stakeholders in order to find sustainable and equitable solutions. SET-TN is a collaborative initiative by Auroville Consulting (AVC), Citizen consumer and civic Action Group (CAG) and the World Resources Institute India (WRI).

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Suggested Citation: Auroville Consulting (2020).
Implementation Models for Distributed Solar Energy in Tamil Nadu.
Making solar a winning proposition for all stakeholders.
Sustainable Energy Transformation Series. Available at:
www.aurovilleconsulting.com/wp-admin/post.php?post=3053&action=edit

EXECUTIVE SUMMARY

1.ACCOUNTABILITY FOR SOLAR ENERGY TARGETS

The Tamil Nadu Solar Energy Policy 2019 sets a target of 9,000 MW cumulative installed solar energy capacity to be achieved by the year 2023. The overall solar energy target is divided into targets for the utility category solar (5,400 MW) and the consumer category solar (3,600 MW). As of March 2020, Tamil Nadu accounted for a total installed rooftop solar, or consumer category capacity, of 719 MW. In order to achieve the 2023 consumer category solar energy target a total of 2,881 MW of consumer category solar will need to be added. While the Energy Department has the overall responsible for achieving the targets, the implementation of solar energy schemes lies with the Tamil Nadu Energy Development Agency (TEDA) and with the Tamil Nadu Generation and Distribution Corporation (TANGEDCO). TANGEDCO, so far, has focused primarily on the utility category of solar and is, in this context, primarily concerned in meeting its Renewable Energy Purchase Obligations (RPOs). Whereas TEDA's primarily functions as a nodal agency of the Ministry for New and Renewable Energy (MNRE) with a focus on the consumer category solar. A more integrated and coordinated solar scheme development between TEDA and TANGEDCO can help in accelerating deployment of consumer category solar, so can a mid and long-term energy sourcing approach by TANGEDCO, that includes distributed solar energy generation.

2. POLICY AND TARIFF RELATED CHALLENGES

There are a series of policy and regulatory issues in Tamil Nadu, which, if addressed adequately, can accelerate solar energy deployment in the state. High Tension (HT) electricity consumers are currently excluded from the net feed-in mechanism. Paralleling mechanism is currently the only available option for HT consumer to install rooftop solar.[1] Our analysis in Chapter 7 of this paper however shows, that paralleling is the least attractive option for both the HT consumers and TANGEDCO. A second key issue is the current net feed-in tariff of 2.28 INR/kWh, which is below the cost of solar energy generation, resulting in either a negative or moderate return on investment for the consumers. It will be important to introduce capacity-specific feed-in tariffs, as it is unrealistic to assume, that a domestic or commercial rooftop solar system can compete with a MW-scale ground-mounted solar system, in terms of cost per kWh. Our analysis of various implementation models in Chapter 7 also highlights the importance of having multiple metering options available, such as net feed-in, virtual net feed-in and gross feed-in. The Tamil Nadu Solar Energy Policy 2019 provides for net feed-in and gross feed-in while virtual net feed-in is currently not provisioned for.

1 Paralleling means that the solar energy generated needs to be consumed behind-the-meter. If solar energy is exported, it will not be considered towards the adjustment against consumption or payment. In addition, the consumer must pay a parallel operation charges per month for each MW capacity as per TNERC regulation.

3. LEARNING FROM OTHER STATES

A number of Indian States have come up with alternative solar implementation models, in which the utility takes a key role, either as an aggregator-facilitator of demand, or as a guarantor for loan repayment (on bill-financing of solar systems), or as the investor and owner of solar rooftop systems on the consumers premises. Community solar systems, in which the consumers invest into a share of solar system installed at a common rooftop or ground mounted, combined with virtual net-metering mechanism are being promoted by Governments and Utilities in some of the leading countries in terms of distributed solar energy generation. This is a model that maybe adapted to the Tamil Nadu context as well, in particular so for domestic consumers with limited rooftop space available for solar installation, or in cases where the usage right of the rooftop is uncertain, or in the case where the financial viability may only be possible with such an approach (e.g. domestic slab 1 consumers).

4. MAKING DISTRIBUTED SOLAR A WIN-WIN

Distributed solar energy generation has some distinct advantages. Energy generation at the point of consumption has zero distribution and transmission losses. Surplus solar injected into the grid will, in most cases, stay within the local distribution network – reducing distribution losses and avoiding transmission losses. Distribution of generation also means distribution of risks, both financial and technical. For example: If a cloud passes over an ultra-megawatt solar energy system, energy generation will drop suddenly. If the same solar capacity was distributed over thousands of rooftops in different districts and regions, it is unlikely that the same cloud formation will impact solar energy generation in the same manner. The analysis of different implementation models in this report indicates that a tool kit of multiple such models for respective tariff rates and consumer categories has the potential to accelerate deployment of distributed solar energy generation and therefore can contribute to meeting the State's solar energy targets. Furthermore, it can be concluded that distributed solar energy implementation models, if well designed and adapted to the specific context, in terms of electricity tariff rates, have a high potential of resulting into a win-win approach for consumers, TANGEDCO and the State Government. A Utility Facilitated and State Government supported implementation model for the domestic consumers and for LT consumers that are currently subsidized, indicates gains to all stakeholders, even more so if this model is used for community solar systems using a virtual net-metering mechanism. In this model the State Government benefits from phasing out electricity subsidy in exchange for an upfront solar capital subsidy given to the consumer. For most of the LT and HT consumer categories, a Renewable Energy Service Company (RESCo) or Opex model (in which the RESCO sells solar energy generated to the consumer or the Utility), may be the best option, as it results in attractive gains to TANGEDO and healthy gains to the consumers without taking any financial risks. Instead of a programmatic approach, a structural system change, such as a decisive tariff rationalisation towards a single LT and a single HT tariff rate, would not only benefit TANGEDCO, but would at the same time make distributed solar energy attractive to all electricity consumers in the State, without the requirement of capital subsidies.

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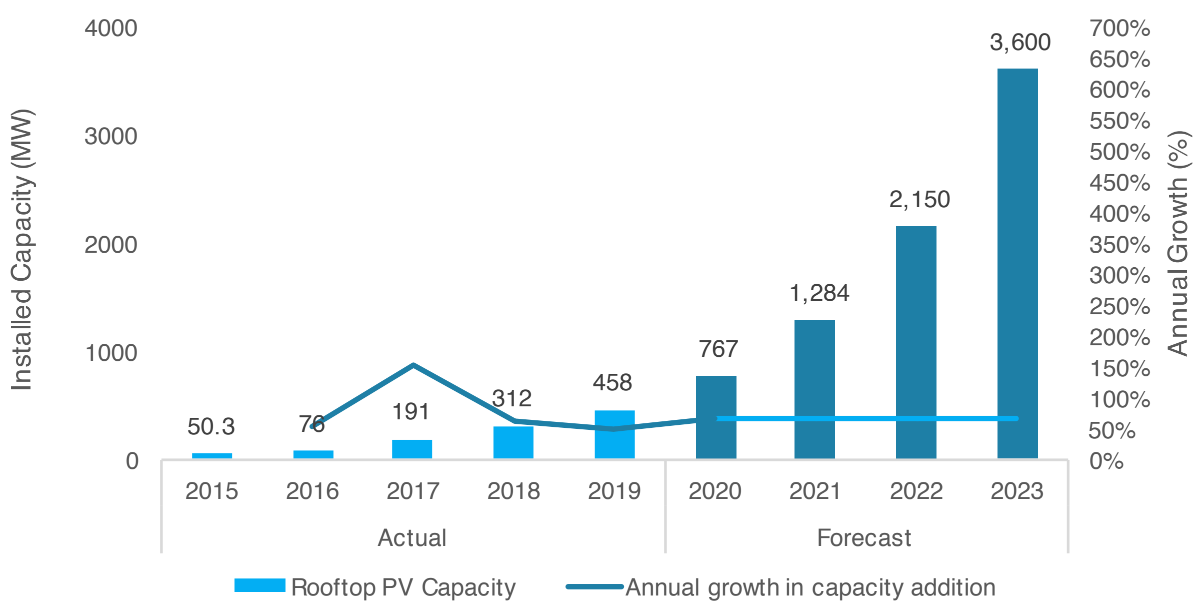
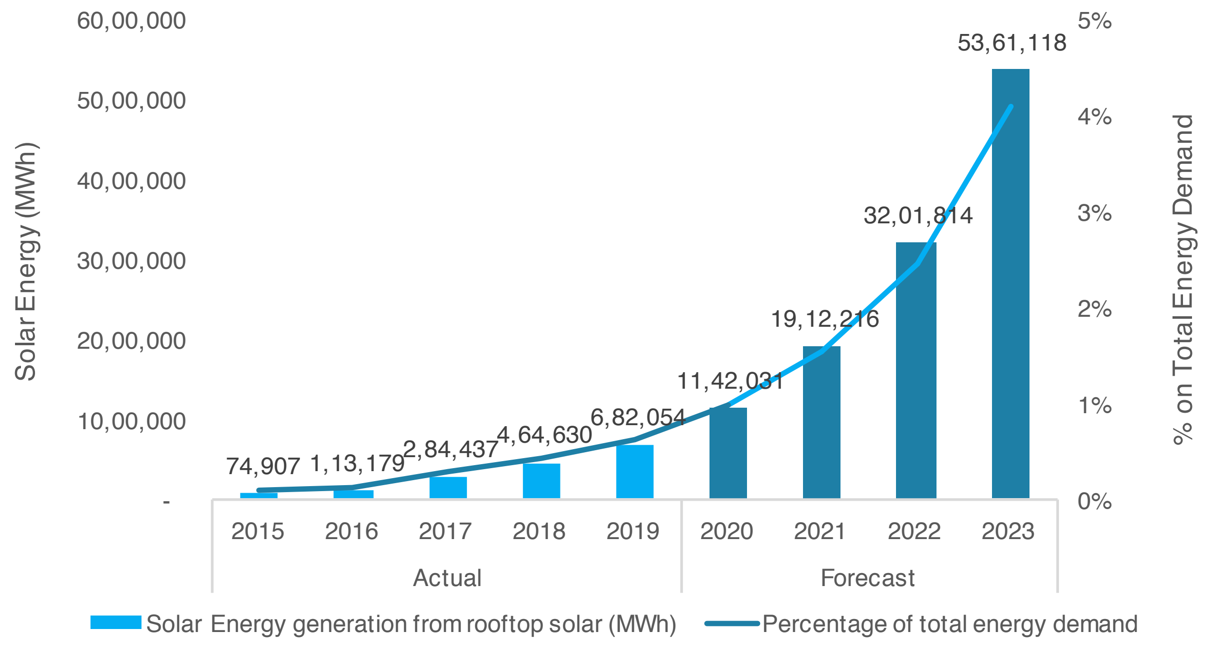
1. INTRODUCTION

With its Solar Energy Policy 2012, Tamil Nadu was among the first Indian States that introduced net metering for rooftop solar. The 2012 Tamil Solar Energy Policy had set a rooftop solar target of 350 MW to be achieved by 2015 (TEDA 2012). As of March 2020, Tamil Nadu has a total rooftop solar capacity of 719 MW (MNRE 2020). Though the 2012 Solar Energy Policy served as a model policy for other Indian States, it had several gaps that contributed to the fact that its rooftop solar target was not achieved. For example, certain consumer categories, for example industrial consumers, were excluded from the net metering mechanisms. In 2019 Tamil Nadu introduced the Tamil Nadu Solar Energy Policy 2019. It introduced a consumer category solar energy target of 3,600 MW by 2023 and it replaced net metering with a net feed-in mechanism (TEDA 2019). Consumer category solar was defined as solar energy generation with the primary purpose as solar self-consumption (behind-the-meter consumption), whereas utility category solar was defined as solar energy generation with the primary purpose of sale of solar energy to the electricity utility or to third parties, regardless of its capacity and interconnection voltage. Based on these two definitions, rooftop solar may fall in either of these two categories, depending on the metering mechanism (e.g. net feed-in vs. gross feed-in). Distributed solar in this report is defined as solar energy generation systems that are interconnected at distribution grid voltage levels below 33 kV (CEA 2013). This definition of distributed solar accommodates any metering mechanism (net metering, net feed-in, gross feed-in etc.) and accommodates both ground-mounted and rooftop-mounted solar systems. Similar to the 2012 policy, the 2019 policy excludes certain consumer categories from the net feed-in mechanism. Consumer categories excluded are all high tensions (HT) consumers.

Figure 1: Rooftop Solar Past trends and forecast





Source: Bridge to India 2016,2016,2017, 2018, 2019

Rooftop capacity addition in the State, till date, has largely been driven by the consumers. The Tamil Nadu Generation and Distribution Corporation (TANGEDCO), so far, has acted more as an observing participant. Its approach appears to be more inclined to restrict the uptake of distributed solar energy, rather than to pro-actively make it a part of its long-term technical and commercial planning strategy. In particular, there are many reported delays by TANGEDCO in providing bi-directional meters to consumers who installed rooftop solar, resulting in financial losses and deep grievances for these consumers. A report, released by the World Resources Institute in 2018, found that 58% of the prosumers who installed rooftop solar experienced delays in processing of the net-metering agreement with TANGEDCO, the majority of which is accounted on non-availability of bi-directional meters. These delays were reported to range from two to six months. This points to a mismatch in the priorities of the electricity utility with the solar ambitions of the state (WRI 2018).

In August 2019, the Ministry for New and Renewable Energy (MNRE), launched Phase 2 of its Rooftop Solar Program, with a country-wide target of 40,000 MW by 2020 (MNRE 2019a). MNRE provides central financial assistance (CFA) to domestic consumers for the installation of rooftop solar in the tune of 40% for system of up to 3 kW and additional 20% for additional capacity from > 3kW to 10 kW. Phase 2 clearly spells out the central role of the Utility in facilitating the growth of rooftop capacity in the respective States, and it provides for performance based financial incentives to the Utility for achieving their respective rooftop targets. For the year 2020 MNRE provisioned a subsidy allocation for 5 MW of domestic rooftop solar for Tamil Nadu (MNRE 2019b). Similarly, MNRE's KUSUM scheme, introduced in July 2019, promotes distributed solar energy generation for agricultural consumers, and allocates a pivotal role to the Utility for the implementation of the scheme (MNRE 2019c). The MNRE subsidy allocation for Tamil Nadu for grid connected solar at agricultural connections is in the tune of 220 MW for the first year (FY 2020-21). The implementation of both these two schemes has not commenced as of May 2020. If implemented, these two schemes may possible be game changers, as it requires utilities to closely look at the financial and technical opportunities of distributed solar energy generation.

The state-specific regulatory and policy environment, in particularly with respect to electricity tariffs and subsidies, has a pivotal role to play in determining if and to what extend various electricity consumer categories consider the installation of distributed solar energy systems. Considering the current tariff structure in the State, there may be limited or no incentive for the subsidized consumer categories to opt for distributed solar via the capex model. Therefore alternative financing and implementation models, bespoke to the various electricity consumer categories, will be required in order for Tamil Nadu to meet its solar energy targets. The aim of this paper therefore is to:

- Outline alternative implementation models for distributed solar energy;
- Evaluate the financial impact of selected implementation models on key stakeholders and,
- Identify key opportunities and win-win situations for consumers, TANGEDCO and the State Government.

2. CHALLENGES IN THE UPTAKE OF DISTRIBUTED SOLAR

Creating an enabling environment for distributed solar, that offers a win-win situation for all stakeholders, utility, the state government, consumers and generators, will need to address some of the current and emerging challenges and it will possibly need a new set of policy, regulatory and market instruments. Distributed solar energy, if well planned, has substantial potential for creating upstream benefits in the grid network for utilities, such as avoiding grid congestion, deferring and avoiding investment in transmission and distribution infrastructure, reducing T&D losses and avoiding investment into additional generation capacity by the utilities. The magnitude of achievable benefits in terms of T&D loss reduction and infrastructure costs deferral depends on the siting of the distributed solar generator within the distribution network. It can be argued that, the closer distributed solar is to the load, the better it is for the overall system. For example, a rooftop solar system may lead to avoided system costs upstream from the metering point. Distributed solar connected anywhere in the LT or HT distribution network may lead to avoided system costs upstream from that interconnection point (Auroville Consulting 2019c, 2020a). Considering these potential advantages of distributed solar a number of current challenges, presented in table 1 below, will need to be addressed first in order to facilitate the growth of distributed solar energy in Tamil Nadu.

Table 1: Challenges for distributed solar in Tamil Nadu

STAKEHOLDER	CHALLENGES
DEVELOPER	• Limited bandwidth to reach a large number of consumers; • Lack of trust by financial institutions to lend for rooftop solar on project financing basis; • High contractual and payment risks for developers; • Installations are often limited to large-scale, highly credit worthy commercial and industry LT customers, limiting the market and excluding a majority of possible customers; • Lack of reliable agencies that can certify installations, to improve customer and lender confidence;
CONSUMER	• Limited bandwidth to evaluate technical and commercial offerings by developers • Financial institutions demand high collaterals for rooftop solar lending, especially so for domestic consumers; • HT consumers are excluded from net feed-in mechanisms; • Delays in finalizing net metering agreement with utilities and in installation of bi-directional meters; • Low net-feed in tariff and electricity consumer tariffs make distributed solar unattractive to a large section of consumers; • Exemption from electricity tax for the consumer category has been retained, but only for two years. • In Tamil Nadu solar energy systems of more than 10kW require a safety certificate issued by the Chief Electrical Inspectorate. Due to shortage of staff this can lead to delays in commissioning of solar PV systems; • TNERC has mandated a second energy meter (in addition to the TANGEDCO bidirectional service connection meter) to record gross generation. This second meter needs to be installed close to the service connection meter. For installations where the service connection point is not near the location of the solar grid inverter (e.g. campuses and multi-storied buildings), this requirement would involve long lengths of cables that may make these systems unviable
UTILITY	• Customers are turning into self-generating pro-sumers; utilities must adapt to the evolving role of the consumer; • Potential loss of high value customers, made possible by the rapidly falling costs of solar energy; • Utilities' staff and management are focused on the conventional distribution model, and awareness of distributed solar within utility staff is minimal; • In the absence of a flexible generation and energy storage fleet and a demand response program the intermittency of solar energy generation can result in grid-integration issues; • Long-term contracts with conventional power generators, often at higher costs than solar and other RE limit the utilities RE uptake.; • Lack in long-term planning of integration of distributed solar.

3. IMPLEMENTATION MODELS

There is a plethora of different implementation or business models available, both in India and elsewhere. A number of case studies are presented in this chapter. For example, the Forum of Regulators (FoR 2019) has laid out six basic consumer-centric and utility-centric implementation models to tackle the challenges holding back fast adoption of rooftop solar. The State Government currently provides electricity subsidy for certain consumer categories including agriculture, domestic consumers and power looms, to name a few. A change in the energy demand from subsidized consumer categories will translate into either an increase or decrease of the electricity subsidy provided by the State Government, therefore the State Government is considered a key stakeholder. For a detailed table of the approved electricity tariff rates refer to Annexure I in this document.

The modest rooftop solar capacity installed in Tamil Nadu, till date, has largely been driven through self-owned projects. Rooftop solar is either financed through Capital Expenditure (CAPEX) model or through a Renewable Energy Service Company (RESCO, or Operating Expenditure, OPEX) model. The majority of installations till date is financed through the CAPEX model but the RESCO model is on the rise (Bridge to India 2017). Most mature rooftop solar markets are primarily driven by financed installations supported by RESCOs. It is expected that over the medium term, Tamil Nadu, too will follow a similar trajectory, and the share of financed, RESCO-based installations will grow (Bridge to India 2019b).

Globally, rooftop solar energy businesses have followed two broad routes for development. The first route has been focused on consumers, who develop small decentralized distributed solar projects, mostly on their rooftops through either CAPEX or RESCO models. Facilitative policies, incentives, tax rebates (electricity tax), capital subsidies, feed-in tariffs and net metering have been key drivers of such implementation models (USAID 2018). A second route for decentralized solar energy involves direct involvement by the Utility, which plays an active role in developing distributed solar projects, including investment, facilitation, aggregation of demand, or development with third party developers. Utilities have an inherent advantage, they are customer facing, and act as the interface between the customer and the grid. Utility-driven implementation models can play a transformative role in development of Tamil Nadu's distributed solar market. Utilities can increase their participation in deployment of distributed solar through facilitation or through direct investment (USAID 2018). Table 2 summarizes both customer-centric and utility-centric implementation models.

Table 2 : Summary Implementation Models

UTILITY-CENTRIC IMPLEMENTATION MODELS	CONSUMER-CENTRIC IMPLEMENTATION MODELS
Utility-owned, on customer or utility premises	Consumer -owned
Community-owned and utility facilitated	RESCO (third party) owned
Utility financed	

Adapted from: USAID (2018)

In the Utility Centric implementation model, the utility either assumes the role of a facilitator or the role of an investor. Both models offer unique benefits to the utility, the consumers and the solar energy industry.

Table 3 Utility centric implementation models: Facilitation Approach and Investment Approach

APPROACH	FACILITATION APPROACH	INVESTMENT APPROACH
ROLE	Utility aggregates and facilitates procurement of systems or services. Under this approach the utility may charge for facilitation services, creating an additional source of revenue for itself.	Utility aggregates projects and invests in developing those projects.
BENEFITS	• Utility aggregates demand from a large number of interested consumers. This allows aggregation of capacity which in-turn allows procuring in large quantities leading to economies of scale. • For large-scale procurement, utilities can standardize components and services as part of bidding documents. These standards can help create benchmarks for consumers and developers, irrespective of their participation in utility procurement programs. • Utilities have technical know-how and capability to monitor the quality and timely execution of projects.	• Utilities are capable of developing and enforcing contracts, reducing risk for consumers, developers as well as financial institutions. Contract developed and used by the utilities can become benchmarks for other consumer and developers. • Utilities, especially government-owned utilities, being large corporations with long track record enjoy confidence of the financial institutions. Improved risk profiles lead to improved bankability of the projects enabling increased participation of the financial institutions in the projects and hence the sector.

Adapted from: USAID (2018)

4. CASE STUDIES

ANDHRA PRADESH I UTILITY FACILITATED

Customer-owned solar rooftop program on net-metering basis with Equal Monthly Instalments (EMI) partly shared by Utility. This model is exclusively for Domestic Category B consumers with monthly electricity consumption between 140 to 200 kWh. Rooftop solar PV systems lie in the range of 1 kW to 1.5 kW. The EMI sharing is such that the consumer pays to the extent where its total electricity billing amount is equal to the amount they paid before the PV system installation. The Utility contributed to the EMI payment with a minimum share of INR 160 (for a rooftop system meeting consumption of 140 kWh/month) up to INR 428 (for a rooftop system meeting consumption of 200 kWh/month). In cases the consumer EMI exceeds the bill amount, the consumers continue to pay the EMI beyond the loan tenure, till the EMI share is neutralised by consumer payments (APERC, 2019).

ANDHRA PRADESH I UTILITY FACILITATED

Utility acts as an aggregator of consumers' demand. The Andhra Pradesh Solar rooftop program follows a gross metering arrangement. The utility drives the vendor selection – through bidding process based on tariff as bid parameter and facilitates in availing necessary clearances for installation. Further the Utility assists in arranging loans for consumer (through Andhra Bank), channels the available capital subsidy by MNRE, and ensures repayment of the EMI through the consumer's electricity bills. (APERC 2019).

KERALA I UTILITY OWNED & UTILITY FACILITATED

As a part of achieving the National goal in renewable energy development, the Kerala State Electricity Board (KSEB) launched the SOURA scheme under the Urja Kerala Mission aimed at developing Solar PV Rooftop/Ground mounted plants aggregating to 1,000 MW within two years. Out of this, 500 MW were to be reached through Rooftop Solar for domestic, public and private buildings including educational institutions, hospitals and commercial establishments. SOURA scheme has three distinct implementation models; (i) utility owned with gross feed-in of solar energy, (ii) Utility as RESCO with sale of gross solar energy generation to the consumer and (iii) an utility facilitated model, in which the consumer owns the system. Surplus solar, if any, for the last two models will be settled at Average Power Purchase Cost (APPC) rate.

CHINA I RESCO

This third-party-owned (RESCO) model operates under power purchase agreement. The power purchase agreement usually lasts 10 to 25 years. The RESCO and the consumers have a long-term contract. Surplus solar not consumed by the domestic consumer is sold by the RESCO to the Utility. (Cai, Xie, Zhang, Xu, & Cheng, 2019).

ARIZONA I UTILITY AS RESCO

Arizona Public Service (APS) is an investor-owned utility. APS launched a Solar Partner Program, that gives domestic electricity consumers a chance to go solar. This is a utility-owned rooftop project where the utility acts as a RESCO. Customers lease their rooftop and receive a monthly credit of USD 30 for 20 years by the utility. The rooftop PV systems size range from 4 kW to 8 kW. The Utility owns and invests on the rooftop solar system and supplies power to the consumer (USAID 2017).

CALIFORNIA I COMMUNITY SOLAR

A collective of tenants in an apartment block invest into a single solar system. Net metering credits are then allocated based on the investment share to individual tenants and for the building's common load. This approach avoids the deployment of separate solar energy systems with a separate solar inverter for each tenant, which considerably reduced the upfront cost of the system. The scheme permits that virtual net metering credits are shared throughout an entire affordable housing property, as long as that property is on contiguous parcels and under common ownership. In California, net metering credits are valued at a fully bundled retail rate, i.e. inclusive of the distribution cost as California's virtual net metering program is available only to occupants of certain types of multi-tenant buildings. Thus, California participants who are located within the same building on the same distribution circuit make the use of the distribution system non-existent or minimal. (California Public Utilities Commission).

CALIFORNIA I COMMUNITY SOLAR

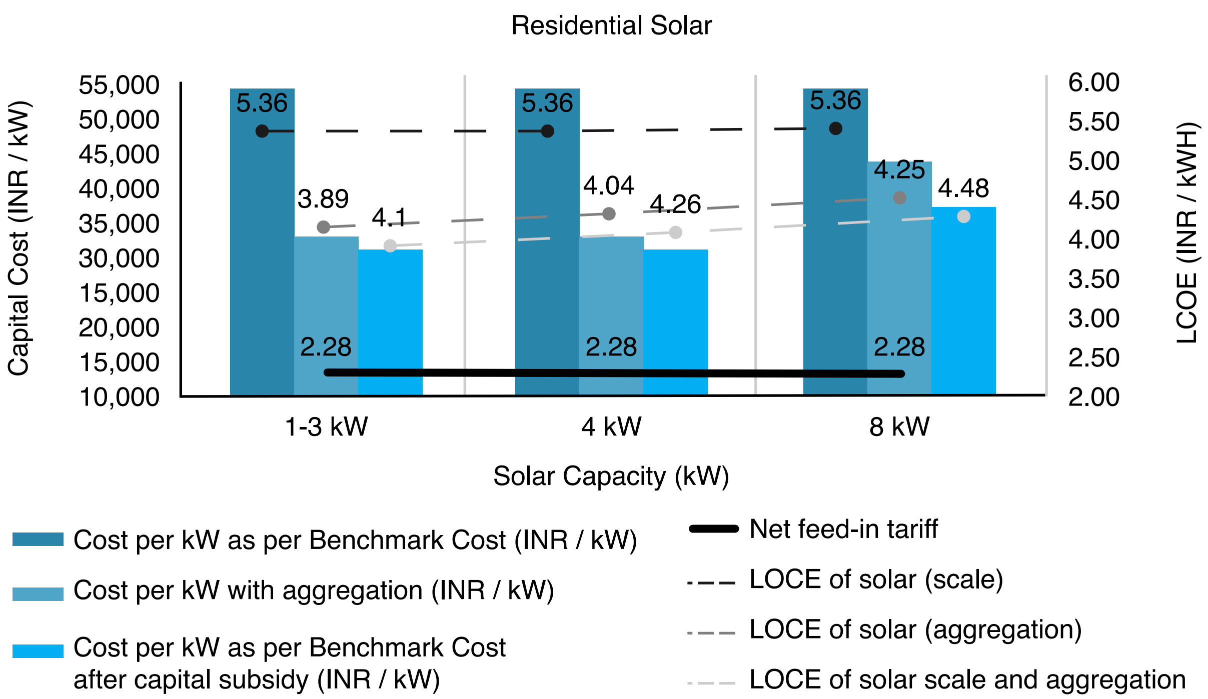
Consumer invests in the community solar program, i.e. buy a share of a local solar project directly from the developer and receive credit for avoided generation costs from the utility. The consumer pays for the electricity drawn from the grid at prevailing tariff rates (Stark 2019).

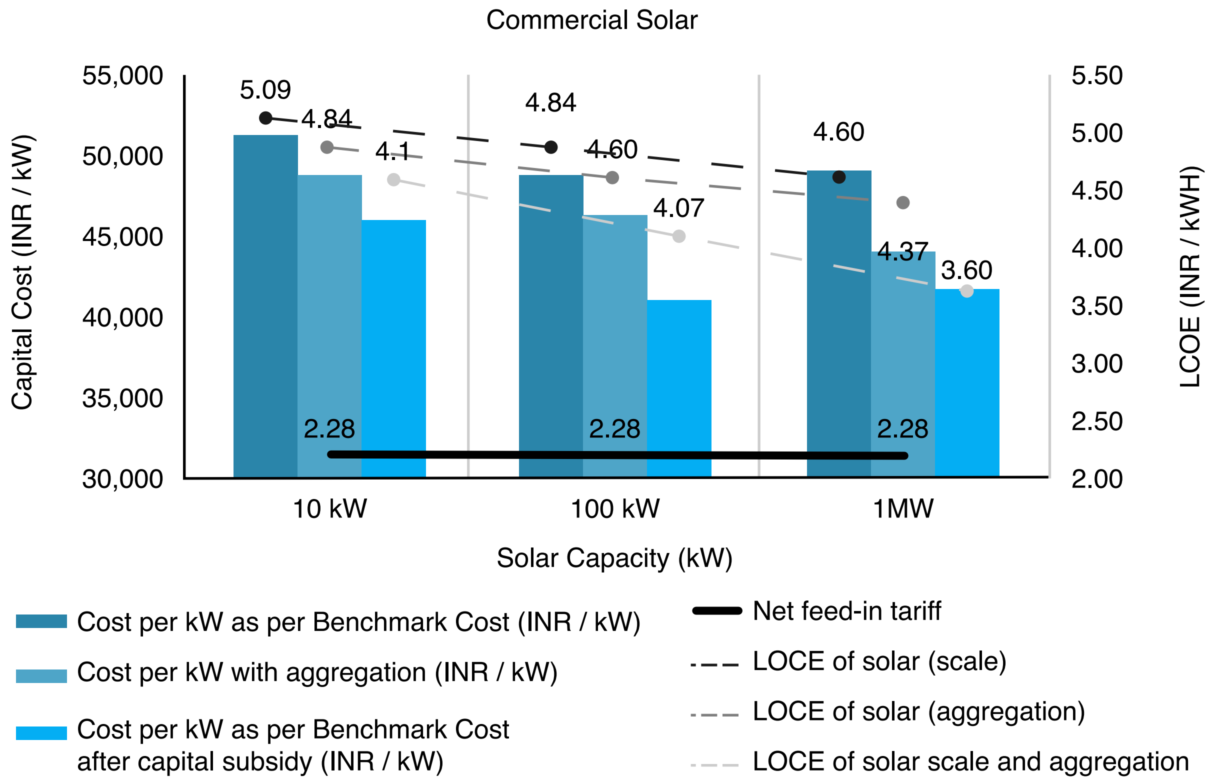
5. AGGREGATION & SCALE AS COST REDUCTION STRATEGY

Growth in the solar energy capacity addition has been driven largely by favorable economics due to economies-of-scale production along the entire supply chain. Global polysilicon production capacity grew more than fourfold this past decade, while the price of polysilicon, the primary feedstock for solar module production, declined from over USD 80 per kg in 2010 to just USD 8.40 per kg in 2019. Similarly, accompanying the steep module price decline was a fivefold increase in the global module production capacity. Wafer and solar cell production capacity also experienced huge growth over the decade. In addition the solar panels and inverters became more efficient, reducing the cost of solar energy. Technological innovation in the near future is expected to further bring down the cost of solar energy (GTM 2019).

Most of the distributed solar energy capacity additions are driven and funded by the end-consumer. In the case of the domestic consumer category, CFA through capital subsidy is available. There is an economic benefit of aggregation of rooftop solar projects either through RESCOs or other entities such at the Utilities or the State Nodal Agencies to MNRE. Aggregation and scale, in terms of solar energy capacity, reduces the capital cost of distributed solar and consequently lowers the levelized cost (LCOE) per unit of solar energy produced. The figure 2 below illustrates the cost reduction potential (for capital cost and LCOE) for the domestic (up to 10 kW) and the commercial (10 kW to 1 MW) distributed solar segments. The capital costs of distributed solar arrived at in figure 2 are used as assumptions for modeling the implementation models in Chapter 7 of this document.

Figure 2 Potential for cost reduction through aggregation and scale





Source for benchmark costs: MNRE 2019d
Assumptions: Cost reduction for scale at 5% per factor 10 increase. Cost reduction for aggregation at 5% per factor 100 increase

Tamil Nadu offers a net feed-in tariff of INR 2.28 per kWh for solar energy exported to the grid (TNERC 2019a). This net feed-in tariff is clearly below the LCOE of distributed solar energy, even in the case of the residential solar sector, where capital subsidy by MNRE is available.

6. LOAD PROFILES & SOLAR SELF-CONSUMPTION POTENTIAL

The financial viability of distributed solar energy for the respective consumer categories is a function of multiple variables including the respective electricity consumer tariffs and their future trends, the solar metering mechanism and solar tariff, capacity sizing of the solar system, changes in future electricity demand , the instantaneous behind-the-meter self-consumption potential, availability of capital subsidy and access to affordable financing. Figure 3 below is an illustrative exploration of the self-consumption potential for selected consumer categories based on an assumed solar capacity and their respective load curves over a 25-year time horizon, the expected life time of the solar generator.

Solar self-consumption potential is defined as the percentage of solar energy that serves the consumer's electricity requirements on the total electricity consumption.

Solar self-consumption potential = solar energy consumed/total electricity consumed

Whereas **solar generation-consumption potential** is defined as the percentage of solar energy consumed on the gross solar energy generation.

Solar generation-consumption potential = solar energy consumed/gross solar energy generated

Both, solar self-consumption potential and solar generation-consumption potential are calculated with instantaneous values. Figure 4 illustrates the solar self-consumption potential for selected consumer categories in relation to various solar capacities in the first year of the solar system operation. It indicates the technical threshold after which the increase in solar capacity has very limited or no impact on the self-consumption potential of the electricity consumer. With every increase in the solar generation capacity the incremental increase in the solar self-consumption potential reduces. This is of particular relevance in context of Tamil Nadu with its net feed-in mechanism, wherein the consumer gets compensated at 2.28 INR/kWh for every unit of solar energy exported to the grid. In this case solar generation capacity will need to be sized to minimize solar energy export over the lifetime of the solar system in order to achieve the highest financial gains for the consumer.

Figure 5 estimates the change in percentage of the solar self-consumption potential (e.g. instantaneous energy served from solar) versus the solar generation-consumption potential (energy consumed on the solar gross generation) over a 25-year period. It shows that, with an estimated increase in annual electricity consumption (5% for domestic consumers and 3% for other consumer categories) and with an annual solar energy gross generation reduction of 1%, the solar self-consumption potential decreases, while the solar generation-consumption potential increases over the years. With a higher daytime electricity consumption, more kWh of solar energy generated will be consumed behind-the-meter. The solar capacity for the domestic consumer slabs are sized such that the expected solar energy generation over 25 years matches the consumers electricity consumption over the same time period. For the selected LT and HT consumer the solar energy capacity was sized such that the 25-year solar energy gross generation is 50% of the 25-year electricity consumption. The computed load curves and solar self-consumption potential of various consumer categories have been used for the financial impact assessment of various implementation models presented in chapter 7 of this report

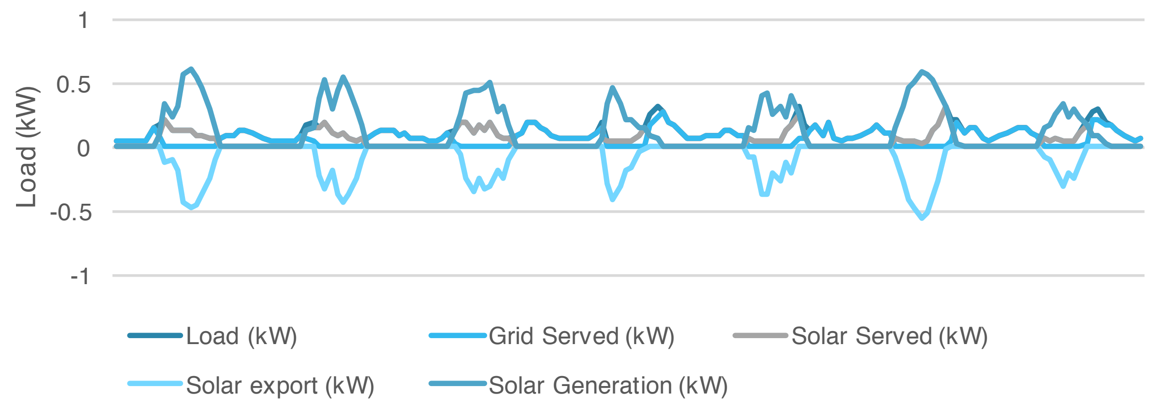
ASSUMPTIONS FOR FIGURES 3,4 & 5

Solar capacity sizing domestic consumers: solar energy production over 25 years is equal to consumers electricity demand over 25 years.
Solar capacity sizing selected LT and HT consumer categories: solar energy production over 25 years is 50% of the consumers electricity demand over 25 years.
Capacity Utilization Factor: 19%
Grid Availability Factor: 97%
Annual solar degradation: 1%
Annual increase in energy consumption for domestic consumers: 5%
Annual increase in energy consumption for selected LT & HT consumer categories: 3%
Load profile for domestic consumer slab 1 and 2 are assumed to be the same
Load profile for domestic consumer slab 2 and 3 and for Bulk supply to domestic colonies are assumed to be the same.
Load profile for industry, power loom and cottages and tiny industries are assumed to be the same.
Load profiles of educational institutions (HT) and Govt. and Govt. aided institutions are assumed to be the same.

Figure 3 Illustrative example of load shapes to determine % of demand served from solar

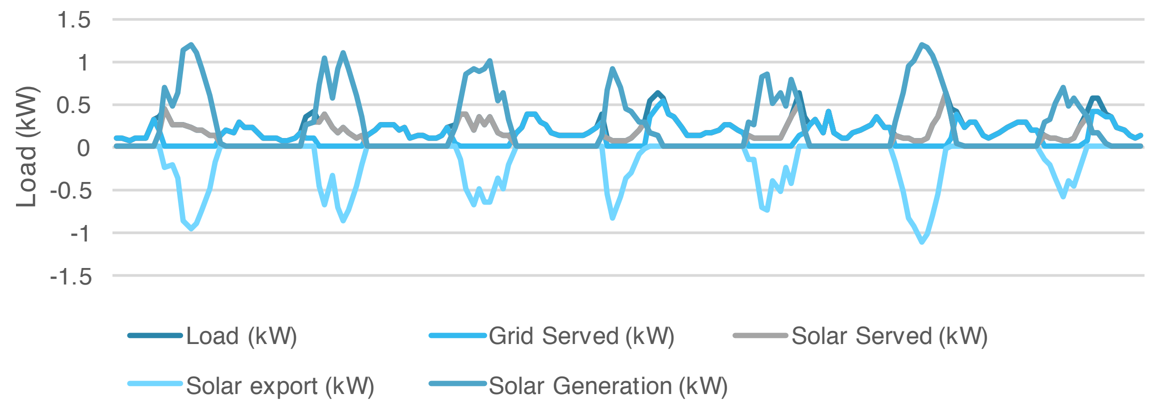
DOMESTIC CONSUMER SLAB 1

	Electricity consumption kWh/ year	Solar capacity (kW)	Solar Energy Generation (kWh/year)	Solar Serving (kWh)	Solar export (kWh)	Solar self-consumption (%)
Year 1	600	0.8	1,292	273	1,019	45%
Year 25	1,935	0.8	1,015	656	360	65%



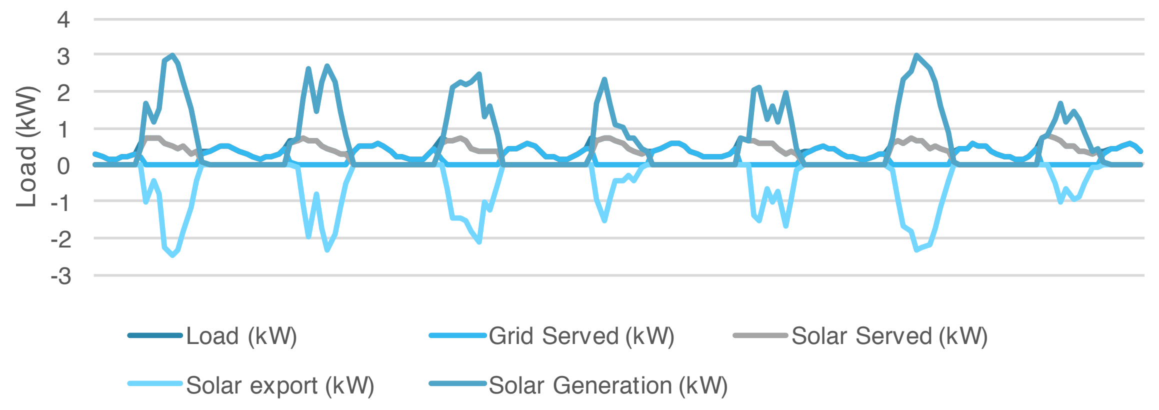
DOMESTIC CONSUMER SLAB 2

	Electricity consumption kWh/ year	Solar capacity (kW)	Solar Energy Generation (kWh/year)	Solar Serving (kWh)	Solar export (kWh)	Solar self-consumption (%)
Year 1	1,200	1.6	2,584	545	2,039	45%
Year 25	3,870	1.6	2,030	1,311	718	34%



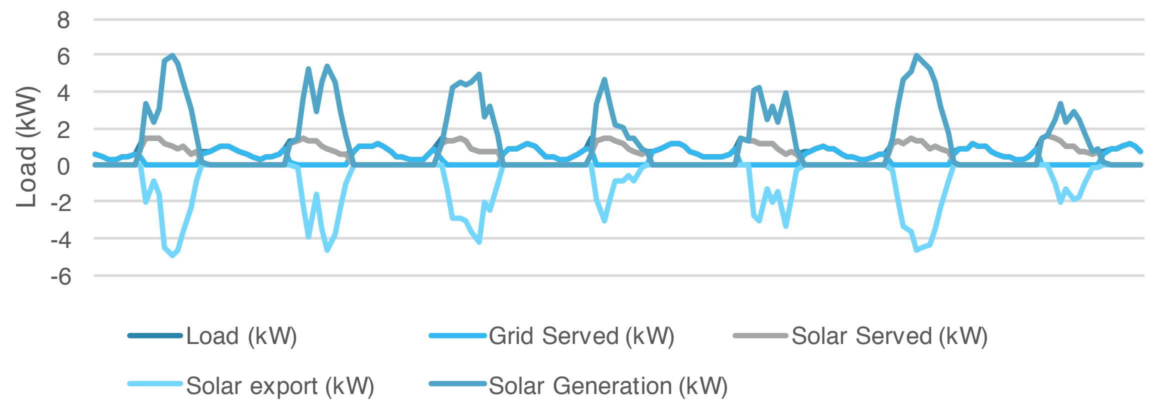
DOMESTIC CONSUMER SLAB 3

	Electricity consumption kWh/ year	Solar capacity (kW)	Solar Energy Generation (kWh/year)	Solar Serving (kWh)	Solar export (kWh)	Solar self-consumption (%)
Year 1	3,000	4	6,458	1,262	5,196	42%
Year 25	9,675	4	5,074	3,086	1,987	32%



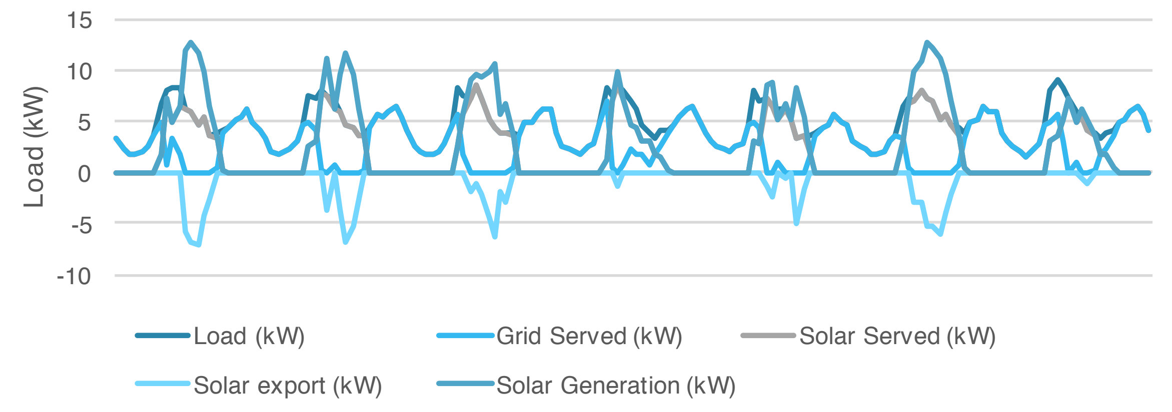
DOMESTIC CONSUMER SLAB 4

	Electricity consumption kWh/ year	Solar capacity (kW)	Solar Energy Generation (kWh/year)	Solar Serving (kWh)	Solar export (kWh)	Solar self-consumption (%)
Year 1	6,000	8	12,916	2,525	10,392	42%
Year 25	19,351	8	10,148	6,173	3,975	32%



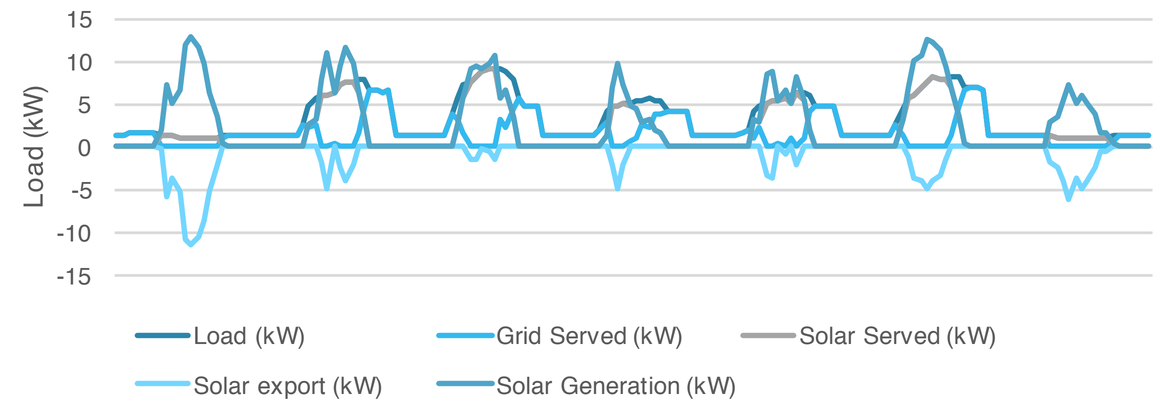
LT BULK SUPPLY TO RESIDENTIAL COLONIES

	Electricity consumption kWh/ year	Solar capacity (kW)	Solar Energy Generation (kWh/year)	Solar Serving (kWh)	Solar export (kWh)	Solar self-consumption (%)
Year 1	33,500	17	27,448	12,238	15,209	37%
Year 25	68,099	17	21,564	16,468	5,096	24%



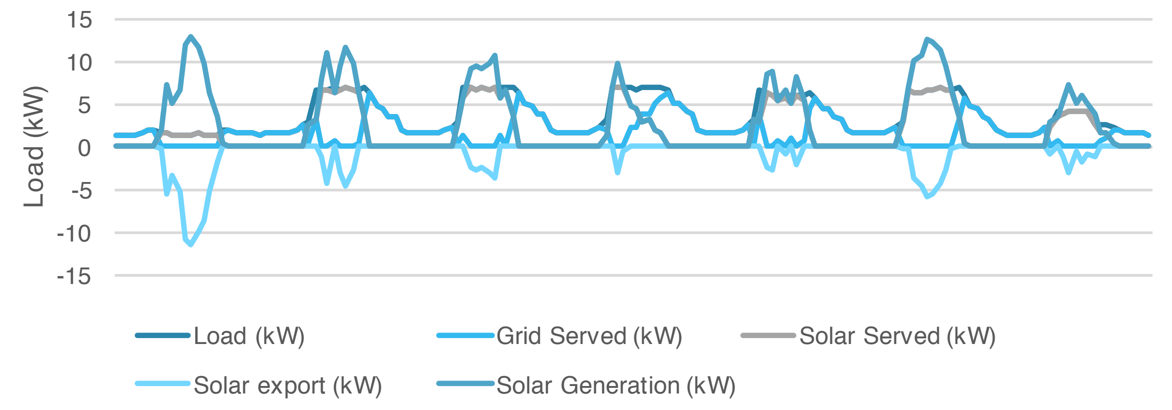
LT GOVT. AND GOVT. AIDED INSTITUTIONS

	Electricity consumption kWh/ year	Solar capacity (kW)	Solar Energy Generation (kWh/year)	Solar Serving (kWh)	Solar export (kWh)	Solar self-consumption (%)
Year 1	33,500	17	27,446	17,091	10,355	51%
Year 25	68,099	17	21,564	18,417	3,146	27%



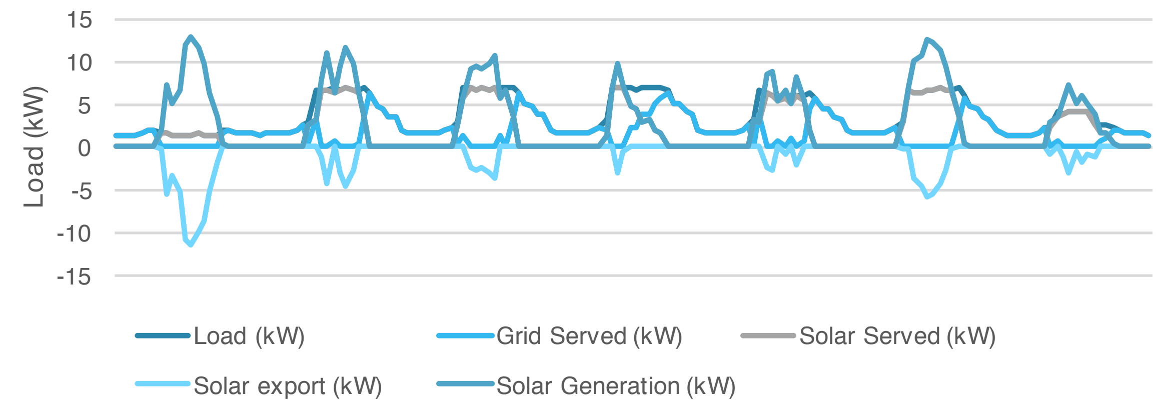
LT COTTAGE INDUSTRIES

	Electricity consumption kWh/ year	Solar capacity (kW)	Solar Energy Generation (kWh/year)	Solar Serving (kWh)	Solar export (kWh)	Solar self-consumption (%)
Year 1	33,500	17	27,446	18,089	9,357	54%
Year 25	68,099	17	21,564	19,772	1,792	29%



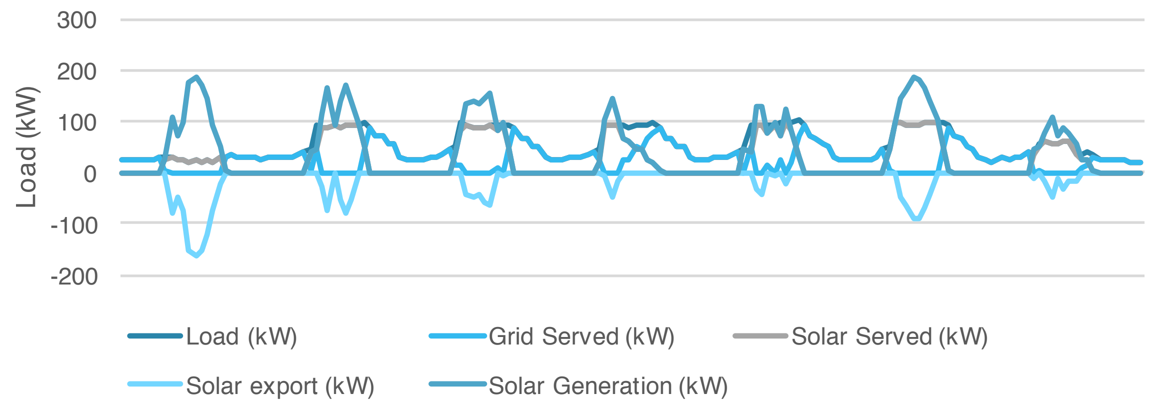
POWER LOOMS

	Electricity consumption kWh/ year	Solar capacity (kW)	Solar Energy Generation (kWh/year)	Solar Serving (kWh)	Solar export (kWh)	Solar self-consumption (%)
Year 1	33,500	17	27,446	18,089	9,357	54%
Year 25	68,099	17	21,564	19,772	1,792	29%



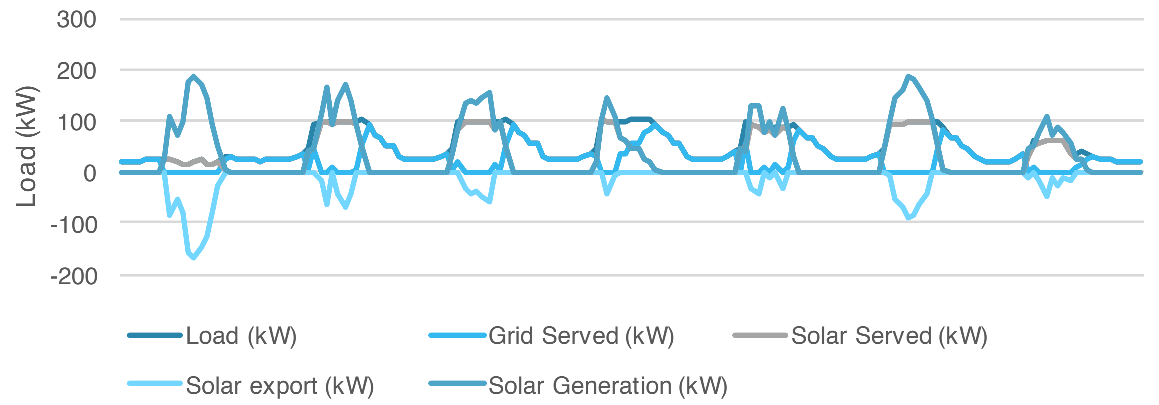
HT COMMERCIAL

	Electricity consumption kWh/year	Solar capacity (kW)	Solar Energy Generation (kWh/year)	Solar Serving (kWh)	Solar export (kWh)	Solar self-consumption (%)
Year 1	4,90,000	250	4,03,617	2,58,711	1,44,906	53%
Year 25	9,96,069	250	3,17,113	2,87,953	29,160	29%



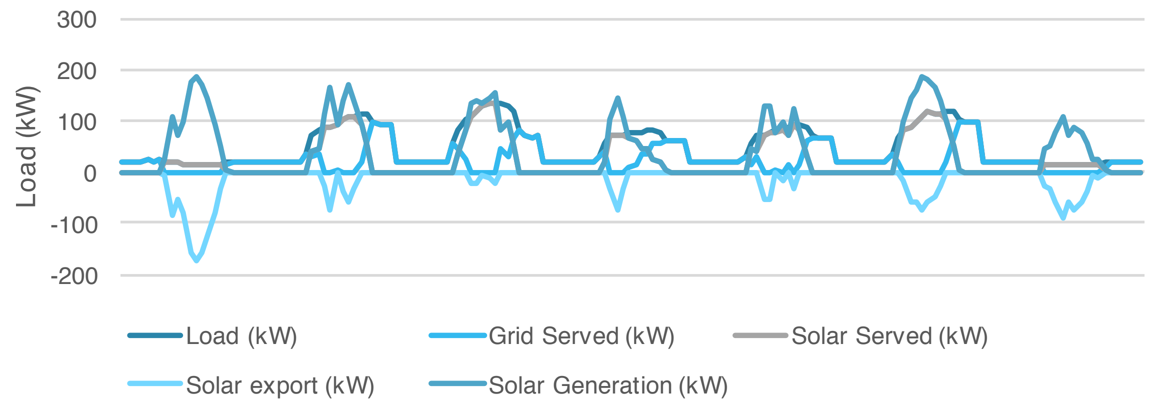
INDUSTRIAL

	Electricity consumption kWh/year	Solar capacity (kW)	Solar Energy Generation (kWh/year)	Solar Serving (kWh)	Solar export (kWh)	Solar self-consumption (%)
Year 1	4,90,000	250	4,03,617	2,65,023	1,38,595	54%
Year 25	9,96,069	250	3,17,113	2,90,577	26,536	29%



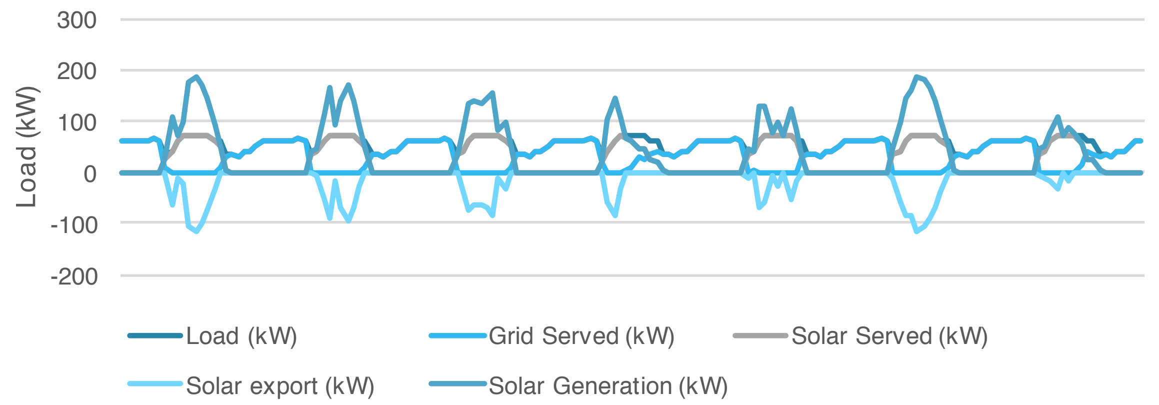
INSTITUTIONAL (EDUCATION)

	Electricity consumption kWh/year	Solar capacity (kW)	Solar Energy Generation (kWh/year)	Solar Serving (kWh)	Solar export (kWh)	Solar self-consumption (%)
Year 1	4,90,000	250	4,03,617	2,50,600	1,53,017	51%
Year 25	9,96,069	250	3,17,113	2,70,618	46,495	27%



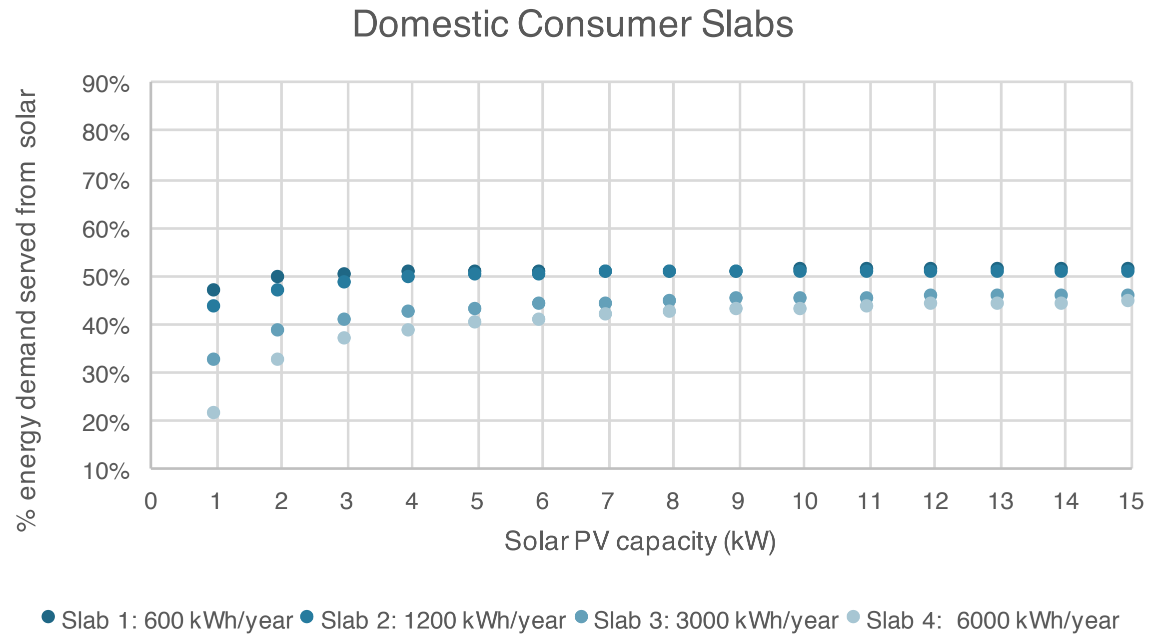
MUNICIPAL (WATER SUPPLY)

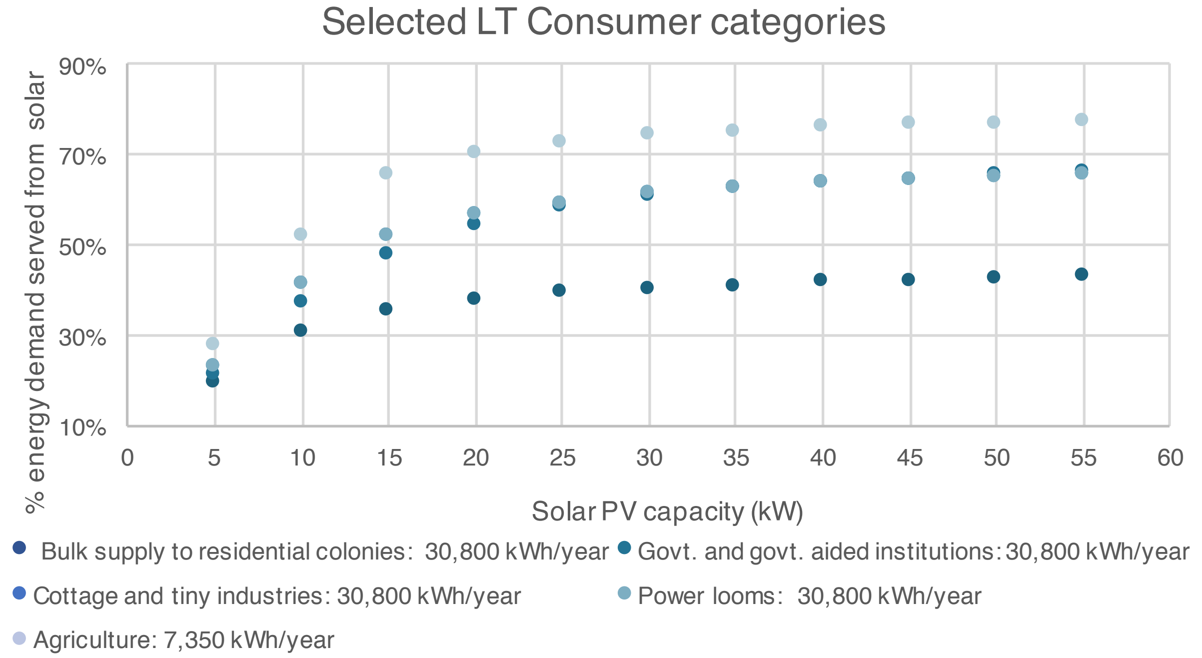
	Electricity consumption kWh/year	Solar capacity (kW)	Solar Energy Generation (kWh/year)	Solar Serving (kWh)	Solar export (kWh)	Solar self-consumption (%)
Year 1	4,90,000	250	4,03,617	2,20,703	1,82,914	45%
Year 25	9,96,069	250	3,17,113	3,16,758	355	32%

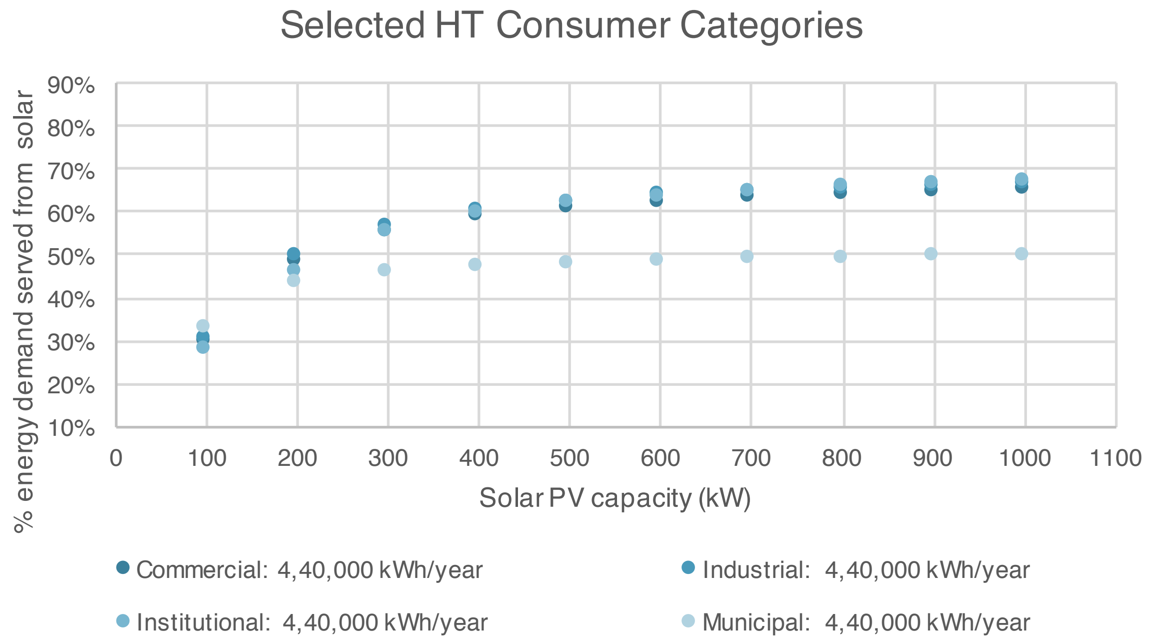


Note: Load shapes displayed illustrate a typical weekly load shape for one week in year 1.

Figure 4 Solar self-consumption potential by electricity consumer categories

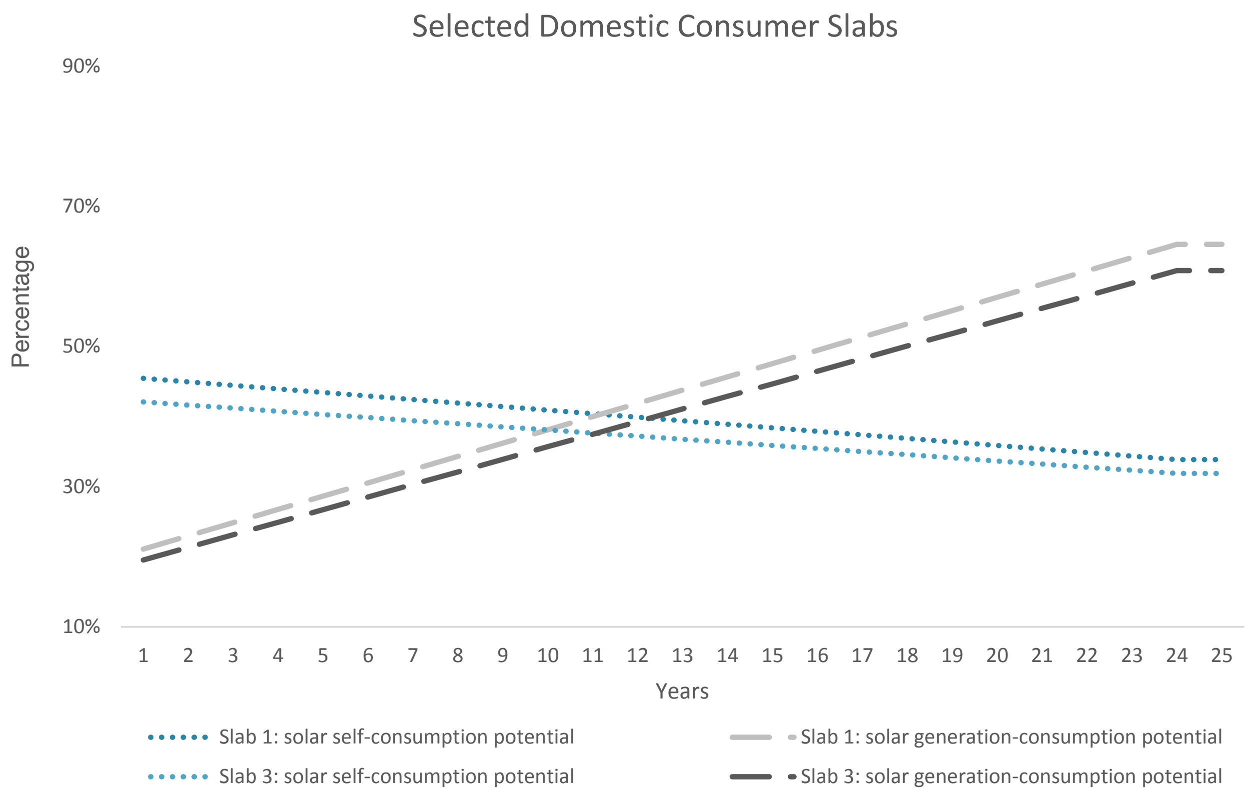


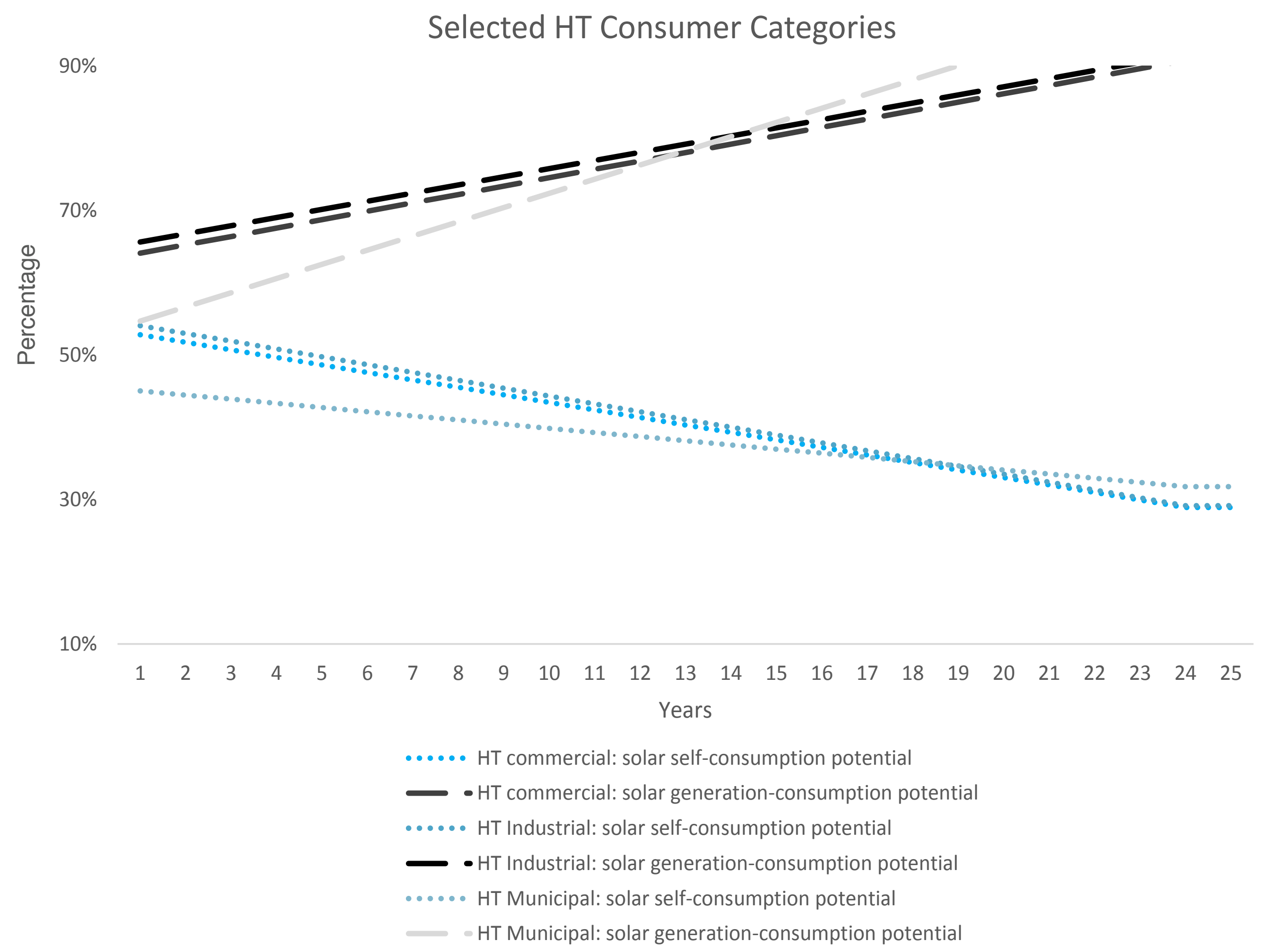


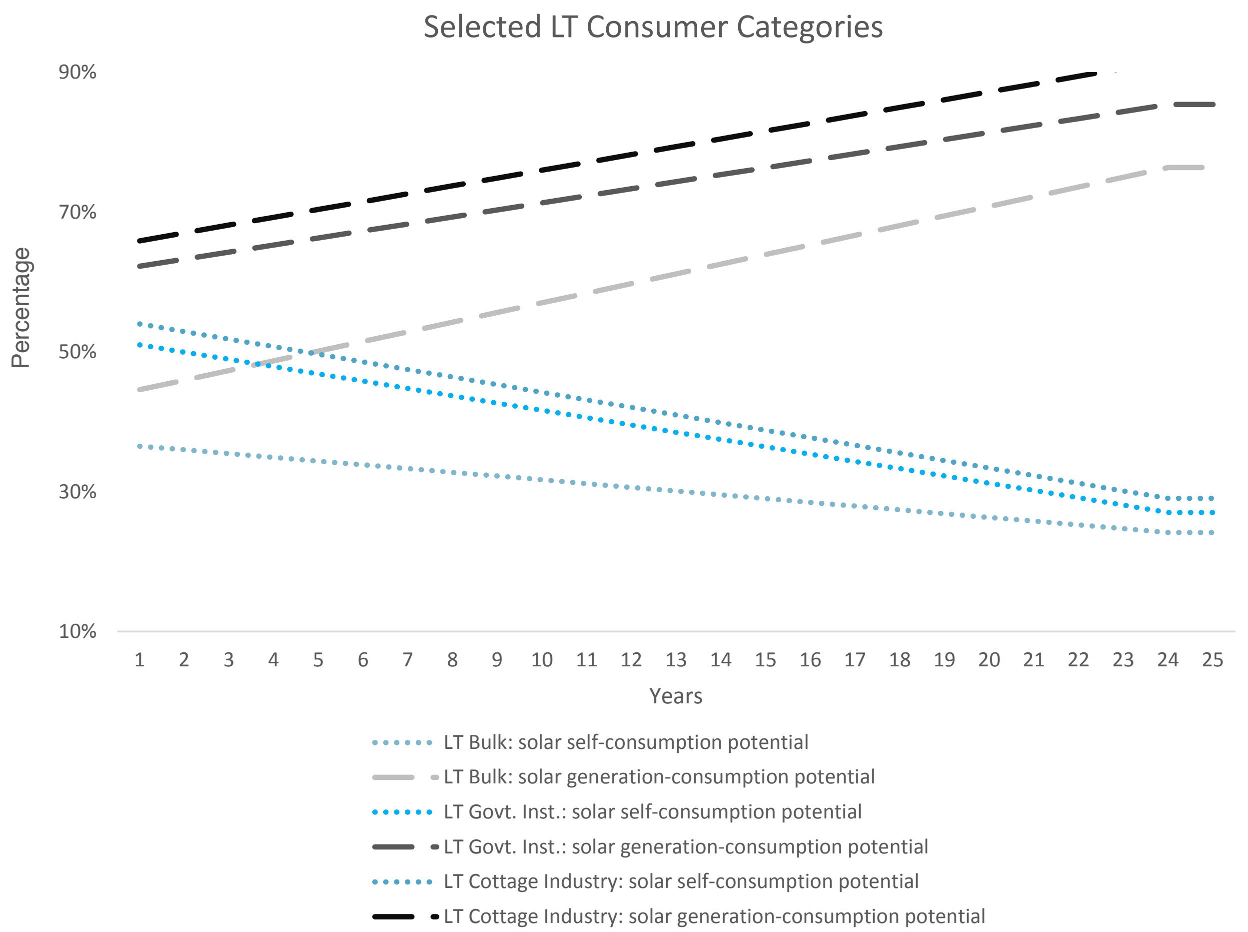


Sources for load shapes:
Domestic: BEE & EDS (2020).
Municipal Water Pump: Grigoras (2014).
Industry: TERI (2012)
Other: NREL (2020)

Figure 5 Trend in solar self-consumption and solar generation-consumption potential over 25 years







Sources for load shapes:
Domestic: BEE & EDS (2020).
Municipal Water Pump: Grigoras (2014).
Industry: TERI (2012)
Other: NREL (2020)

7. PUTTING BUSINESS MODELS TO TEST

The following chapter simulates the financial impact of introducing distributed solar on TANGEDCO, the consumers and, where applicable, on the State Government. Different implementation models are simulated. The financial modeling takes only energy charges (kWh) and not demand charges (kW or KVA) into account. For a detailed listing of input assumptions refer to Annex 2. The objective of this exercise is to identify implementation models that promise to be a win-win solution for all key stakeholders. Implementation models explored in this report are listed in table 4 below.

Table 4 Description of simulated implementation models

IMPLEMENTATION MODEL	DESCRIPTION OF MODEL	DOMESTIC	SELECTED LT CONSUMERS	SELECTED HT CONSUMERS
Consumer Centric	The classical capex model, in which the consumer drives the vendor selection and financing. *Metering mechanism: Net feed-in at INR 2.28 per kWh.*	✓	✓	✓
Consumer Centric (Paralelling)	The consumer centric (capex model), with the limitation, that instantaneous surplus solar cannot be exported to the grid. In addition, TANGEDCO levies paralleling charges in the consumer. *Metering mechanism: Paralleling - no solar-net export*			✓
RESCO 1	In the RESCO model a developer invests into the solar system on a consumer's premises and recovers its investment trough charging a solar energy tariff on the gross generation of solar energy. The consumer benefits from a reduction in electricity bill through self-consumption and through export of solar energy to the grid for which TANGEDO will compensate the consumer with the prevailing net feed-in tariff. *Metering mechanism: Net feed-in at INR 2.28 per kWh.*	✓	✓	✓
RESCO2	RESCO finances and operates rooftop solar system at the consumers premises. All solar energy generated is feed into the grid. The consumer receives a rooftop lease from the RESCO. *Metering mechanism: Gross metering at capacity specific solar gross feed-in tariffs*	✓	✓	✓
RESCO 3	In the RESCO 3 model a developer invests into the solar system on a consumers' premises. The RESCO will have two agreements. A power purchase agreement with the respective consumer, for which a solar energy procurement volume per year and a solar energy tariff, both for a 25-year period are fixed. The second agreement is between the Utility and the RESCO for the surplus solar, that will be injected into the local grid. The RESCO is compensated for every kWh injected with a fixed feed-in tariff over 25 years. The consumer benefits from a reduction in electricity bill through self-consumption. *Metering mechanism: Gross metering at capacity specific solar gross feed-in tariffs. Gross metering for solar energy not absobed by the consumer.*		✓	✓
Utility Facilitated	The Utility acts as an aggregator of demand, manages the tendering and vendor selection process and guarantees repayment of loan through an EMI with on-bill financing mechanism. *Metering mechanism: Net feed-in at INR 2.28 per kWh.*	✓	✓	
Utility Facilitated and State Government Supported	In addition to the Utility Centric model, the State Government provides a capital subsidy for the capital cost of solar, in exchange for phasing out electricity subsidy to consumers. The consumer will pay full electricity tariff as per TANGEDCO tariff schedule from year 1. *Metering mechanism: Net feed-in at INR 2.28 per kWh.*	✓		
Utility Facilitated Community Solar	This is the same implementation framework that for the Utility Centric model, however instead of installing the solar generators at the rooftop of the LT consumers, the LT consumer will own a share of a ground mounted community scale solar system at a different location. This model requires the introduction of a virtual net-metering mechanism. *Metering mechanism: Virtual net feed-in at INR 2.28 per kWh.*	✓	✓	
Utility Facilitated & State Government supported. Community Solar	The Utility Centric & State supported model with community scale solar systems and virtual net feed-in mechanism. *Metering mechanism: Virtual net feed-in at INR 2.28 per kWh.*	✓		

Table 5 Metering mechanism

METERING MECHANISMS	DESCRIPTION
Net Feed-in	The solar energy is used for self-consumption with the surplus, if any, being exported to the grid. The imported energy is debited at the applicable consumer tariff while the exported energy is credited on the basis of a solar energy tariff. The consumer pays the difference between the debit and credit amounts.
Gross Feed-in	The solar energy is fed into the grid for energy sales to the distribution licensee or a third party. The solar energy fed into the grid will be purchased at either the prevailing solar energy tariffs or discovered/negotiated solar energy tariffs.
Virtual Net Feed-in	Virtual net feed-in is a bill crediting system for community solar. It is typically used when solar energy generated from a solar plant is shared among multiple consumers. Electricity consumed during solar generation will be off-set in-kind (kWh) credits on the consumers electricity bill. Surplus solar energy, will be credited in INR to the consumers electricity bill.

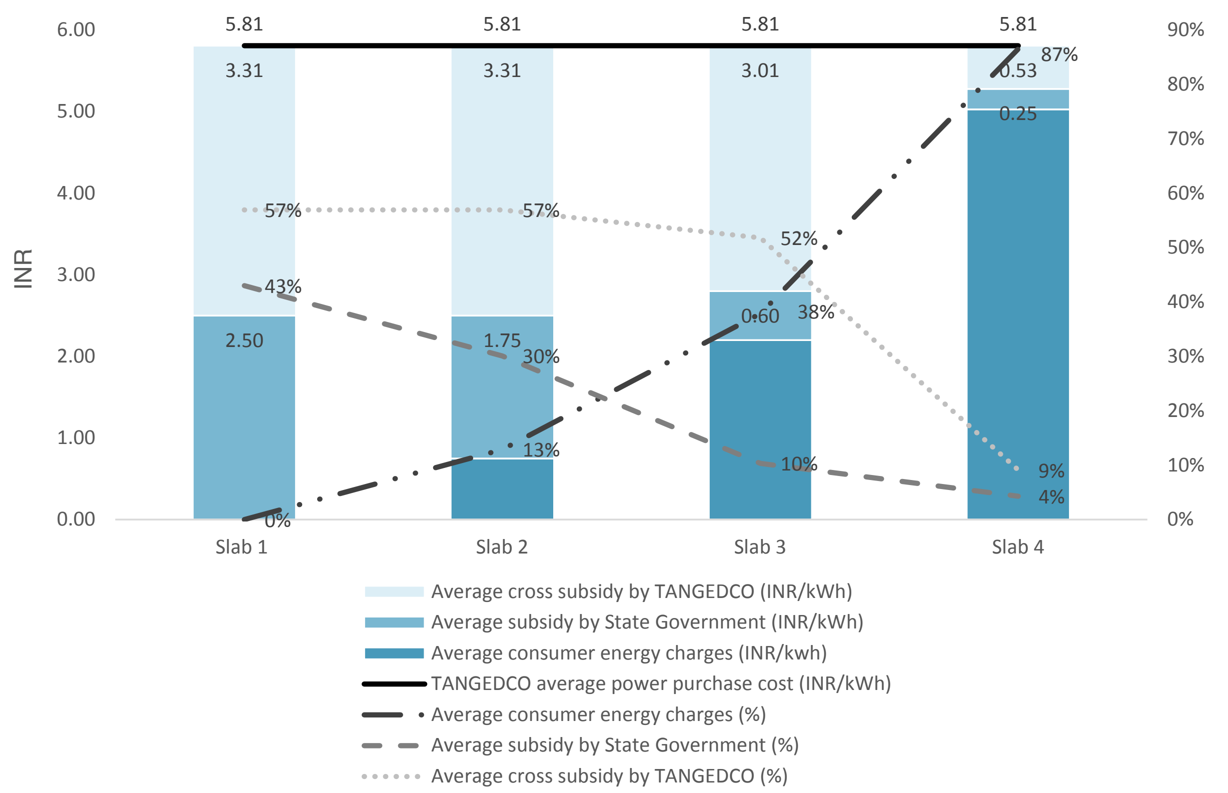
7.1 DOMESTIC CONSUMERS

The domestic consumer category has several specific characteristics, which prove to be of substantial challenge for a financially viable deployment of distributed solar. Some of these are:

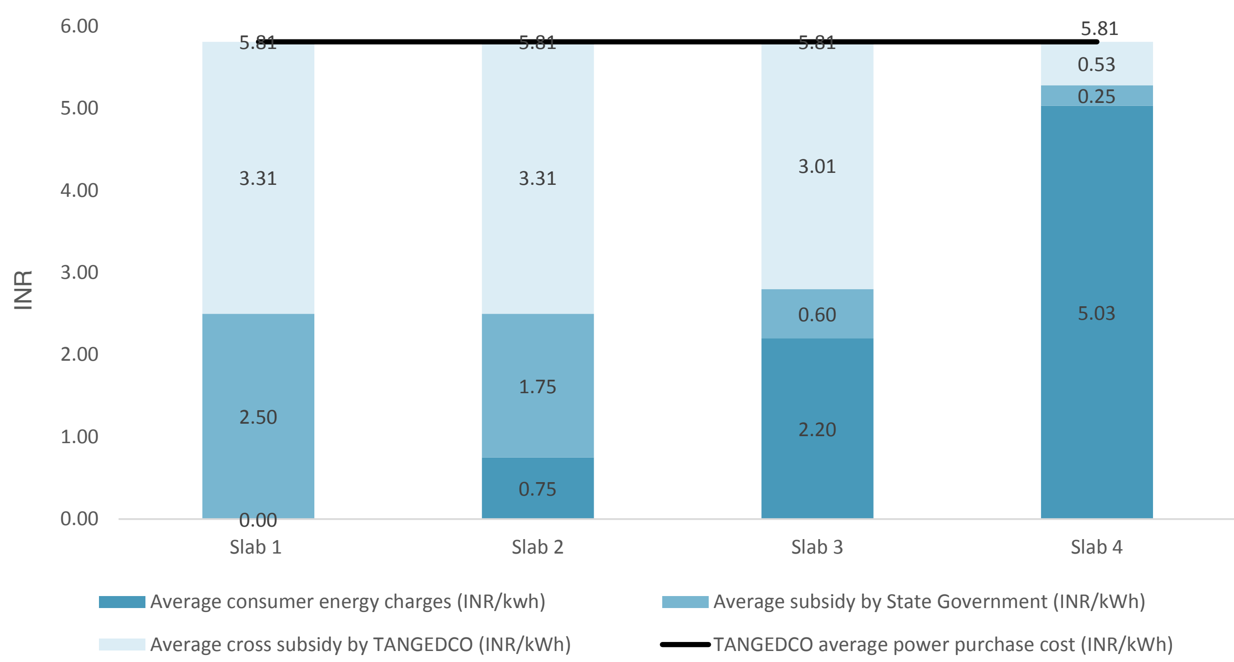
- Highly subsidized electricity rates, subsidized by both the State Government and by TANGEDCO through cross-subsidies;
- Moderate to low day-time electricity consumption, with limited potential for self-consumption of solar energy during sunshine hours (refer to Figure 3). This translates into a high solar export to the grid which is with the current low net feed-in tariff of INR 2.28;
- Requirement of small solar energy generation capacity typically in the range of 0.5 to 10 kW with a higher per kW capital cost due to its smaller scale;
- Possibly a limited rooftop space availability, especially in urban areas, restricting or preventing the installation of rooftop solar;

TANGEDCO serves a total of 21 million domestic service connections, out of which 61% fall into tariff slabs 1 and 2. In the financial year 2019-20, slab 1 and slab 2 account for a combined 25% of the total domestic electricity consumption and for a 54% share of the total subsidy disbursement by the State Government. The per service connection (meter) subsidy disbursement indicates that slab 2 and slab 3 benefit from the highest annual subsidy disbursement of about INR 1,800 per year. Slab 1 receives the lowest subsidy in terms of INR per service connection but benefits from a 100% free electricity altogether (TNERC 2019b). The subsidy disbursal per service connection (meter) benefits consumers with higher energy consumption disproportionally more than consumers with low energy consumption. This may be interpreted as an unsustainable subsidy policy and merits to be reconsidered. Figure 6 further indicates that the cross-subsidy amount per kWh provided by TANGEDCO for the first 3 domestic consumers slabs is higher, than the electricity subsidy contributed by the State Government. Average cross subsidy provided by TANGEDO for the first three slabs is higher than 50%. TANGEDCO literally suffers on account of the prevailing domestic electricity tariff policy, even for the slab 4 consumers cross-subsidy of 4% is still required. Every kWh of avoided supply to domestic consumers therefore results in a financial gain to TANGEDCO, an argument for TANGEDCO to actively promote domestic rooftop solar, in particular so for the lower consumer slabs (1 &2) as solarization of these will reap the highest financial gains to TANGEDCO (refer to figure 7 & 8).

Figure 6 Analysis of domestic consumer tariffs and subsidy disbursement FY 2018-19



Source: As per TANGEDCO



Source: TNERC (2019b)

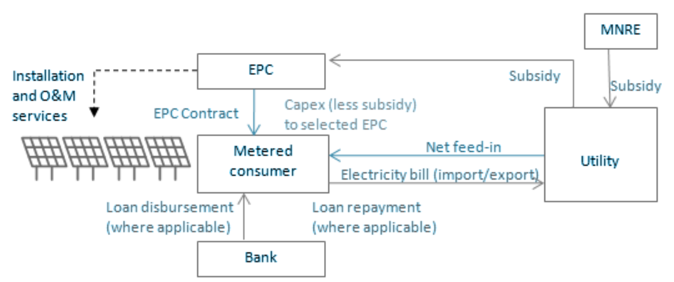
Figure 7 Selected implementation models, distributed solar for domestic consumer slabs and financial impact on key stakeholders

less attractive → more attractive

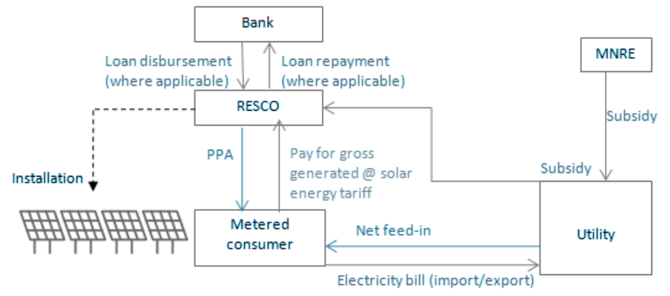
	1 CONSUMER CENTRIC	2 RESCO 1	3 RESCO 2	4 UTILITY FACILITATED	5 UTILITY FACILITATED AND STATE SUPPORTED	6 UTILITY FACILITATED COMMUNITY SOLAR	7 UTILITY FACILITATED & STATE GOVERNMENT SUPPORTED. COMMUNITY SOLAR
DESCRIPTION	The classical capex model, in which the consumer drives the vendor selection and financing.	In the RESCO 1 model a developer invests into the solar system on a consumer's premises and recovers its investment through charging a solar energy tariff on the gross generation of solar energy. The consumer benefits from a reduction in electricity bill through self-consumption and through export of solar energy to the grid for which TANGEDO will compensate the consumer with the prevailing net feed-in tariff.	The RESCO invests into rooftop solar that will be installed at domestic rooftops. The consumer receives a rooftop lease from the RESCO. Solar energy will be fed-into the grid with a gross metering mechanism.	The Utility acts as an aggregator of demand, manages the tendering and vendor selection process and guarantees repayment of loan through an EMI with on-bill financing mechanism. In addition, the Utility contributes a share of the EMI repayment through its cost reduction in order to enable the transition to solar for an increasing number of domestic consumers.	In addition to the Utility Centric model, the State Government provides a capital subsidy for the capital cost of solar, in exchange for phasing out electricity subsidy to consumers. The consumer will pay full electricity tariff as per TANGEDCO tariff schedule from year 1.	This is the same implementation framework that for the Utility Centric model, however instead of installing the solar generators at the rooftop of the domestic consumers, the domestic consumer will own a share of a ground mounted community scale solar system at a different location. This model requires the introduction of a virtual net-metering mechanism.	The Utility Centric & State supported model with community scale solar systems and virtual net feed-in mechanism.
METERING MECHANISM	Net feed-in at INR @ 2.28 INR/kWh	Net feed-in at INR @ 2.28 INR/kWh	Gross metering @ capacity specific tariffs as per RESCO tariffs below	Net feed-in at INR @ 2.28 INR/kWh	Net feed-in at INR @ 2.28 INR/kWh	Virtual Net feed-in @ @ 2.28 INR/kWh	Virtual Net feed-in @ @ 2.28 INR/kWh

IMPLEMENTATION FRAMEWORK

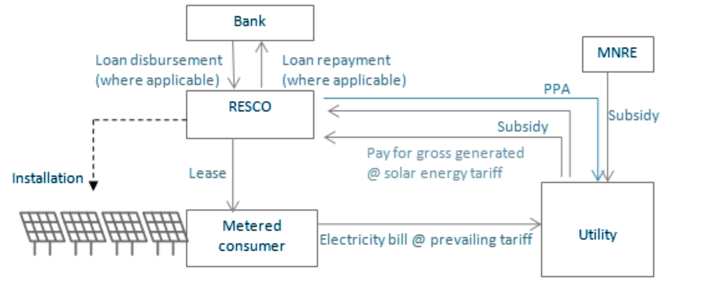
1 CONSUMER CENTRIC



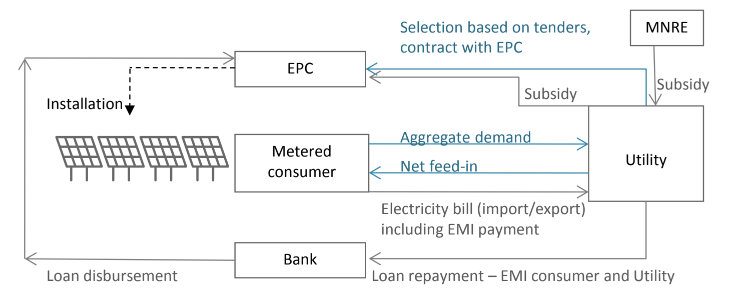
2 RESCO 1



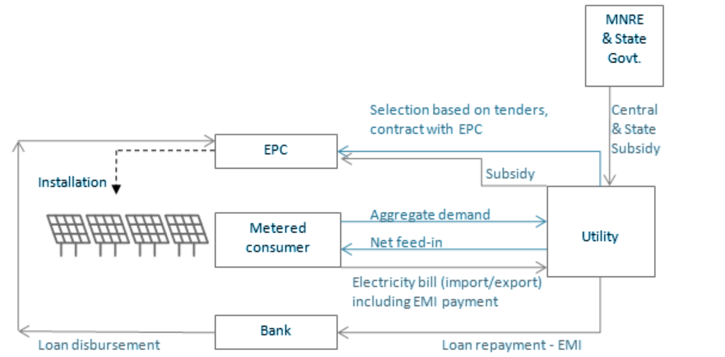
3 RESCO 2



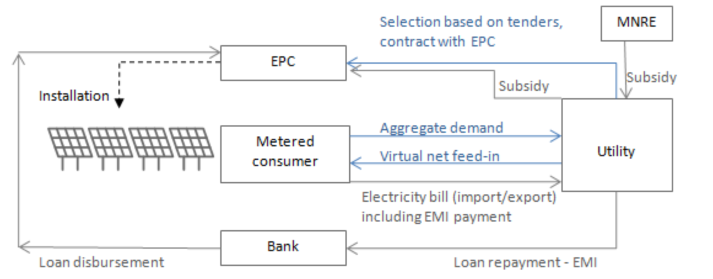
4 UTILITY FACILITATED



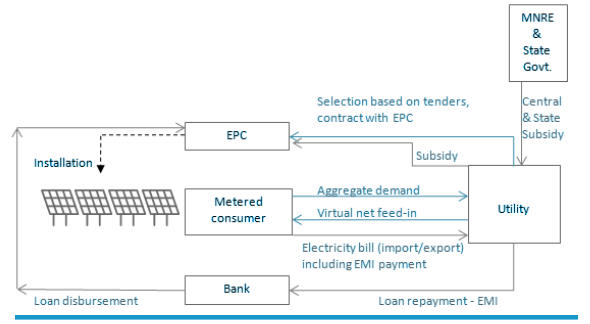
5 UTILITY FACILITATED AND STATE SUPPORTED



6 UTILITY FACILITATED COMMUNITY SOLAR



7 UTILITY FACILITATED & STATE GOVERNMENT SUPPORTED. COMMUNITY SOLAR



COST ECONOMICS

1 CONSUMER CENTRIC

	Slab 1	Slab 2	Slab 3	Slab 4
Cost INR per kW (w/o subsidy)	0	0	0	54,000
RESCO tariff (INR/kWh)	N/A	N/A	N/A	N/A
Solar capacity (kW)	0.80	1.60	4.00	8.00
MNRE Subsidy (%)	40%	40%	35%	28%
State Gov. Subsidy (%)	N/A			
TANGEDCO EMI contribution (%)	N/A			
Debt-equity ratio	70%/30%			
Loan Tenure	10 years/1 year Moratorium			
Interest on loan	11%			
CONSUMER (GAINS/LOSSES) IN INR Year 1	(347)	424	1,484	9,824
25-year	(3,727)	27,688	140,729	241,955
TANGEDCO (GAINS/LOSSES) IN INR Year 1	4,267	8,534	20,703	32,317
25-year	56,694	97,862	149,847	270,371
STATE (GAINS/LOSSES) IN INR Year 1	682	545	0	0
25-year	6,376	(2,890)	(2,299)	0

2 RESCO 1

	Slab 1	Slab 2	Slab 3	Slab 4
Cost INR per kW (w/o subsidy)	0	0	0	51,300
RESCO tariff (INR/kWh)	3.89	3.89	4.04	4.25
Solar capacity (kW)	0.80	1.60	4.00	8.00
MNRE Subsidy (%)	40%	40%	35%	28%
State Gov. Subsidy (%)	N/A			
TANGEDCO EMI contribution (%)	N/A			
Debt-equity ratio	70%/30%			
Loan Tenure	10 years/1 year Moratorium			
Interest on loan	11%			
CONSUMER (GAINS/LOSSES) IN INR Year 1	(2,701)	(4,284)	(6,677)	(14,538)
25-year	(10,652)	17,185	127,514	212,631
TANGEDCO (GAINS/LOSSES) IN INR Year 1	4,267	8,534	20,703	32,317
25-year	56,694	97,862	149,847	270,371
STATE (GAINS/LOSSES) IN INR Year 1	682	545	0	0
25-year	6,376	(2,890)	(2,299)	0

3 RESCO 2

	Slab 1	Slab 2	Slab 3	Slab 4
Cost INR per kW (w/o subsidy)	0	0	0	51,300
RESCO tariff (INR/kWh)	3.89	3.89	4.04	4.25
Solar capacity (kW)	0.80	1.60	4.00	8.00
MNRE Subsidy (%)	40%	40%	35%	28%
State Gov. Subsidy (%)	N/A			
TANGEDCO EMI contribution (%)	N/A			
Debt-equity ratio	70%/30%			
Loan Tenure	10 years/1 year Moratorium			
Interest on loan	11%			
CONSUMER (GAINS/LOSSES) IN INR Year 1	1,446	2,892	7,229	14,458
25-year	19,959	39,917	99,793	199,586
TANGEDCO (GAINS/LOSSES) IN INR Year 1	532	1,063	2,658	5,316
25-year	29,844	59,689	149,221	298,443
STATE (GAINS/LOSSES) IN INR Year 1	0	0	0	0
25-year	0	0	0	0

4 UTILITY FACILITATED

	Slab 1	Slab 2	Slab 3	Slab 4
Cost INR per kW (w/o subsidy)	0	0	0	51,300
RESCO tariff (INR/kWh)	N/A	N/A	N/A	N/A
Solar capacity (kW)	0.80	1.60	4.00	8.00
MNRE Subsidy (%)	40%	40%	35%	28%
State Gov. Subsidy (%)	N/A			
TANGEDCO EMI contribution (%)	30%	30%	5%	5%
Debt-equity ratio	70%/30%			
Loan Tenure	5 years (EMI on bill financing)/no Moratorium			
Interest on loan	11%			
CONSUMER (GAINS/LOSSES) IN INR Year 1	(2,081)	(3,344)	(15,055)	(26,858)
25-year	3,170	41,231	155,721	274,661
TANGEDCO (GAINS/LOSSES) IN INR Year 1	2,687	5,374	17,257	29,157
25-year	51,315	87,104	143,147	259,613
STATE (GAINS/LOSSES) IN INR Year 1	682	545	0	0
25-year	6,376	(2,890)	(2,299)	0

5 UTILITY FACILITATED AND STATE SUPPORTED

	Slab 1	Slab 2	Slab 3	Slab 4
Cost INR per kW (w/o subsidy)	0	0	0	51,300
RESCO tariff (INR/kWh)	N/A	N/A	N/A	N/A
Solar capacity (kW)	0.80	1.60	4.00	8.00
MNRE Subsidy (%)	40%	40%	35%	28%
State Gov. Subsidy (%)	50%	10%	5%	5%
TANGEDCO EMI contribution (%)	30%	30%	5%	5%
Debt-equity ratio	70%/30%			
Loan Tenure	5 years (EMI on bill financings)/Nor Moratorium			
Interest on loan	11%			
CONSUMER (GAINS/LOSSES) IN INR Year 1	172	(3,370)	(14,771)	(24,189)
25-year	(1,514)	21,653	141,912	272,491
TANGEDCO (GAINS/LOSSES) IN INR Year 1	4,004	5,901	19,386	29,377
25-year	55,798	88,897	145,364	260,360
STATE (GAINS/LOSSES) IN INR Year 1	(4,769)	(408)	(1,634)	(4,769)
25-year	12,942	25,403	18,395	7,722

6 UTILITY FACILITATED COMMUNITY SOLAR

	Slab 1	Slab 2	Slab 3	Slab 4
Cost INR per kW (w/o subsidy)	0	0	0	0
RESCO tariff (INR/kWh)	N/A	N/A	N/A	N/A
Solar capacity (kW)	0.80	1.60	4.00	8.00
MNRE Subsidy (%)	40%	40%	35%	28%
State Gov. Subsidy (%)	N/A			
TANGEDCO EMI contribution (%)	30%	30%	5%	5%
Debt-equity ratio	70%/30%			
Loan Tenure	5 years (EMI on bill financing)/no Moratorium			
Interest on loan	11%			
CONSUMER (GAINS/LOSSES) IN INR Year 1	(792)	(466)	(6,071)	(7,181)
25-year	11,129	57,399	204,226	379,285
TANGEDCO (GAINS/LOSSES) IN INR Year 1	3,150	6,299	17,674	30,082
25-year	52,890	90,254	144,569	262,762
STATE (GAINS/LOSSES) IN INR Year 1	682	545	0	0
25-year	6,376	(2,890)	(2,299)	0

7 UTILITY FACILITATED & STATE GOVERNMENT SUPPORTED. COMMUNITY SOLAR

	Slab 1	Slab 2	Slab 3	Slab 4
Cost INR per kW (w/o subsidy)	0	0	0	0
RESCO tariff (INR/kWh)	N/A	N/A	N/A	N/A
Solar capacity (kW)	0.80	1.60	4.00	8.00
MNRE Subsidy (%)	40%	40%	35%	28%
State Gov. Subsidy (%)	50%	10%	5%	5%
TANGEDCO EMI contribution (%)	30%	30%	5%	5%
Debt-equity ratio	70%/30%			
Loan Tenure	5 years (EMI on bill financing)/No Moratorium			
Interest on loan	11%			
CONSUMER (GAINS/LOSSES) IN INR Year 1	562	(1,151)	(6,397)	(5,733)
25-year	2,004	35,795	187,697	371,676
TANGEDCO (GAINS/LOSSES) IN INR Year 1	4,081	6,672	19,772	30,238
25-year	56,060	91,522	146,677	263,290
STATE (GAINS/LOSSES) IN INR Year 1	(2,934)	327	(717)	(2,934)
25-year	19,191	27,902	21,520	13,972

COMMENT

	Comment
1 CONSUMER CENTRIC	With the exception for domestic consumers in slab 1 this model results in short- and long-term gains to the domestic consumers and TANGEDCO. However due to the complexity in the domestic tariff slab system the subsidy burden to the State Government increases for slab 2 and slab 3 consumers. This increase is on account of consumers moving from a higher into a lower consumption slab due reduced grid energy consumption after solar installation.
2 RESCO 1	The classical RESCO 1 model results in slightly more moderate gains to the consumer slabs 2,3 and 4 as compared to the Capex model. For the slab 1 consumer this model shows a loss to the consumer over the 25-year time period. The financial impact on TANGEDCO and the State Government are the same as under the consumer centric model.
3 RESCO 2	The RESCO 2 model, with rooftop lease and gross-feed in results in a healthy benefit to all consumer slabs, on account of the income through the rooftop lease. The financial savings to TANGEDCO are more moderate than in the earlier models. There is no impact on the State Government's subsidy disbursal due to the gross metering mechanism.
4 UTILITY FACILITATED	The Utility Facilitated model results in a higher deficit for all consumer slabs in year 1 on account of a shorter loan tenure, without moratorium. However, taking a 25-year time period into account the financial gains to all consumers slabs shows a clear upward trend as compared to the previous models. This model may also work for slab 1 consumers. The higher gains for the consumer are on account of aggregation and the EMI share by TANGEDCO. TANGEDCO will reap moderately lower financial gains due to its EMI contribution. However, this model may support a higher uptake of rooftop solar by all domestic consumers and in summa summarum can result in higher benefits to TANGEDCO through an increased number of domestic consumers installing rooftop solar. The financial impact on the State Government remains the same as under the Consumers Centric and the RESCO models 1 & 2.
5 UTILITY FACILITATED AND STATE SUPPORTED	This model has the potential to become a win-win approach for all stakeholders. With the exception of the slab 1 consumers, it results in financial gains for all the consumer slabs, for TANGEDCO and for the State Government. The State Government benefits on the long run through phasing out electricity subsidy in exchange for an upfront capital subsidy on the rooftop solar. TANGEDCO and the consumers benefits from a lower EMI share on account of the capital subsidy provided by the State Government.
6 UTILITY FACILITATED COMMUNITY SOLAR	Though the current Tamil Nadu Solar Energy Policy does not provide for virtual net feed-in, this model may present an attractive alternative to rooftop solar. Especially domestic consumers, that have limited or no rooftop space available and consumers in slab 1 may find this an attractive alternative. All consumer slabs and TANGECO would benefit from moderate to high financial gains over 25 years . This is primarily on account of the lower capital cost of solar due to aggregation and scale. However, this model results in an increase in subsidy disbursement to the State Government, similar to the Consumer Centric, RESCO 1 &3, and the Utility Facilitated model.
7 UTILITY FACILITATED & STATE GOVERNMENT SUPPORTED. COMMUNITY SOLAR	A win-win approach for all stakeholders, similar to the Utility Centric & State supported model, with the additional benefits of capital cost reduction through aggregation and scale. In financial terms the most balanced model in terms of gains to the consumer, TANGEDCO and the State Government. The State Government benefits from phasing out of electricity subsidy in exchange for an upfront capital subsidy. Similarly like with the Utility Centric Community Solar model this approach may be selected in particular for slab 1 consumers and consumers with limited or no rooftop space available.

Table 6 Summary: financial impact of implementation models on key stakeholders in %

less attractive — more attractive

NO	BUSINESS MODELS	AGGREGATION	CAPEX (INR/ KW)				METERING MECHANISM	IMPACT ON CONSUMER (25-YEAR GAINS AS % ON ELECTRICITY BILLING AMOUNT)				IMPACT ON TANGEDCO (25-YEAR GAINS AS % OF NET REVENUE BAU)				IMPACT ON STATE GOVERNMENT (SAVINGS 25-YEAR AS % ON SUBSIDY AMOUNT)			
			SLAB 1	SLAB 2	SLAB 3	SLAB 4		Slab 1 (50 kWh/ month)	Slab 2 (100 kWh/ month)	Slab 3 (600 kWh/ month)	Slab 4 (> 600 kWh/ month)	Slab 1 (50 kWh/ month)	Slab 2 (100 kWh/ month)	Slab 3 (600 kWh/ month)	Slab 4 (> 600 kWh/ month)	Slab 1 (50 kWh/ month)	Slab 2 (100 kWh/ month)	Slab 3 (600 kWh/ month)	Slab 4 (> 600 kWh/ month)
1	Consumer Centric	no	54,000	54,000	54,000	54,000	Net feed-in	-18%	27%	27%	20%	181%	279%	124%	67%	19%	-9%	-8%	0%
2	RESCO I	yes	51,300	51,300	51,300	51,300	Net feed-in	-52%	17%	24%	17%	181%	279%	124%	67%	19%	-9%	-8%	0%
3	RESCO II	yes	51,300	51,300	51,300	51,300	Gross feed-in	89%	39%	19%	16%	821%	821%	821%	821%	0%	0%	0%	0%
4	Utility Facilitated	yes	51,300	51,300	51,300	51,300	Net feed-in	15%	40%	30%	22%	164%	248%	116%	65%	19%	-9%	-8%	0%
5	Utility Facilitated & State Government supported	yes	51,300	51,300	51,300	51,300	Net feed-in	-7%	21%	27%	22%	178%	250%	121%	65%	38%	75%	63%	27%
6	Utility Facilitated Community Solar	yes	36,282	36,282	36,282	36,282	Virtual net feed-in	54%	55%	39%	31%	169%	30%	19%	17%	19%	-9%	-8%	0%
7	Ultility Facilitated & State Government supported Community Solar	yes	36,282	36,282	36,282	36,282	Virtual net feed-in	10%	35%	36%	30%	179%	261%	122%	66%	56%	82%	74%	48%

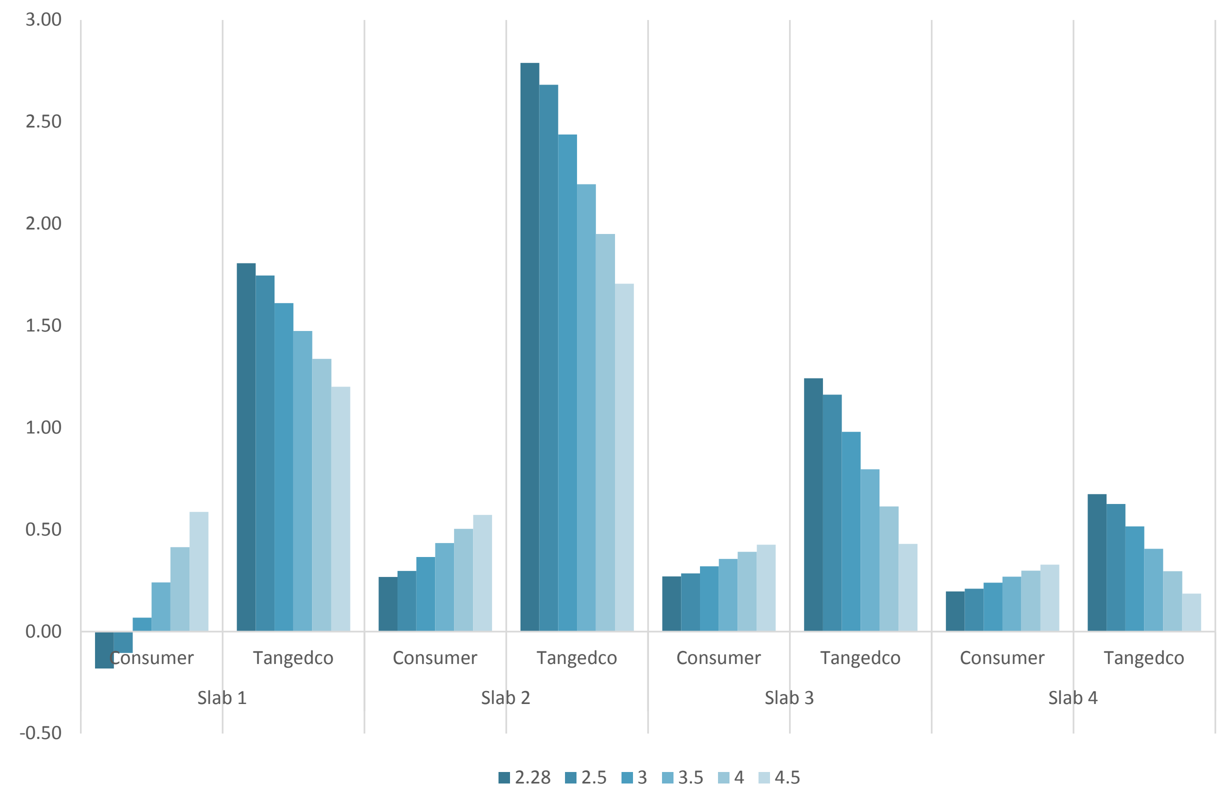
Table 6 above presents, for each of the 7 selected implementation models and the 4 domestic consumer slabs, the potential losses/gains in % value for the consumers, TANGEDCO and for the State Government. It highlights the benefits of aggregation, either by a RESCO or the Utility, as it reduces the capital cost and therefore the levelized cost of solar. With the current capital subsidy provided by MNRE domestic rooftop solar is a viable option for all consumer categories except for the slab 1 consumers. However, it is recommended that TANGEDCO takes an active facilitation role in bringing solar to the domestic consumers, even more so as it has the potential of substantial cost reduction to TANGEDCO. For the slab 1 consumers a more creative implementation models will need to be developed. The Utility Facilitated model, in which TANGEDCO contributes to the loan repayment from its gains on account or reduced cost of electricity supply, or the RESCO 2 model, in which the consumer benefits from an income of roof lease and wherein the RESCO gets compensated by TANGEDCO for the gross solar energy generation, are both financeable viable solutions for slab 1 consumers. The Tamil Nadu Solar Energy Policy 2019 provides for gross feed-in tariffs for all voltage levels, however a tariff order for the same has not been passed yet by TNERC.

The Utility-Facilitated and State-supported model may be considered. For this model an upfront capital subsidy by the State Government is provided in exchange for phasing out electricity subsidy. In addition, the capital subsidy by MNRE and a TANGDCO share on the consumers debt repayment are assumed. This model presents a clear win-win to all stakeholders. It is the only model in which the State Government reaps savings across all 4 domestic tariff slabs. Most of the other models presented result in a subsidy increase for the State Government. This is primarily on account of higher slabs consumers moving, after solar installation, to lower consumer slabs with higher electricity subsidy per kWh. However, in the case of slab 1 consumers and consumers with lack of rooftop capacity a clear case can be made for Model 7, the Utility-Facilitated and State-supported Community Solar. Here the consumer holds a share in MW-scale rooftop or ground mounted solar systems and avails of a virtual net feed-in mechanism.

DEEP-DIVE I IMPACT OF NET FEED-IN TARIFF ON THE FINANCIAL VIABILITY

The current net feed-in tariff Tamil Nadu stands at INR 2.28 /kWh for solar energy fed into the TANGEDCO grid. The current net feed-in tariff is substantially below the real cost of distributed solar energy production (refer to Figure 2). This, combined with the highly subsidized domestic electricity rates, makes it a key variable in developing successful implementation models for domestic solar. Figure 8 below presents a 'what-if' sensitivity analysis of different net feed-in tariffs and their impact on the domestic consumers' and TANGEDCO's losses/gains from installing rooftop solar for the consumer-driven CAPEX model including the capital subsidy available by MNRE. It clearly indicates that higher net feed-in tariffs still result in rooftop solar being beneficial to both TANGEDCO and the domestic consumers

Figure 8 Impact of net feed-in tariff on the financial viability of domestic solar MISSING

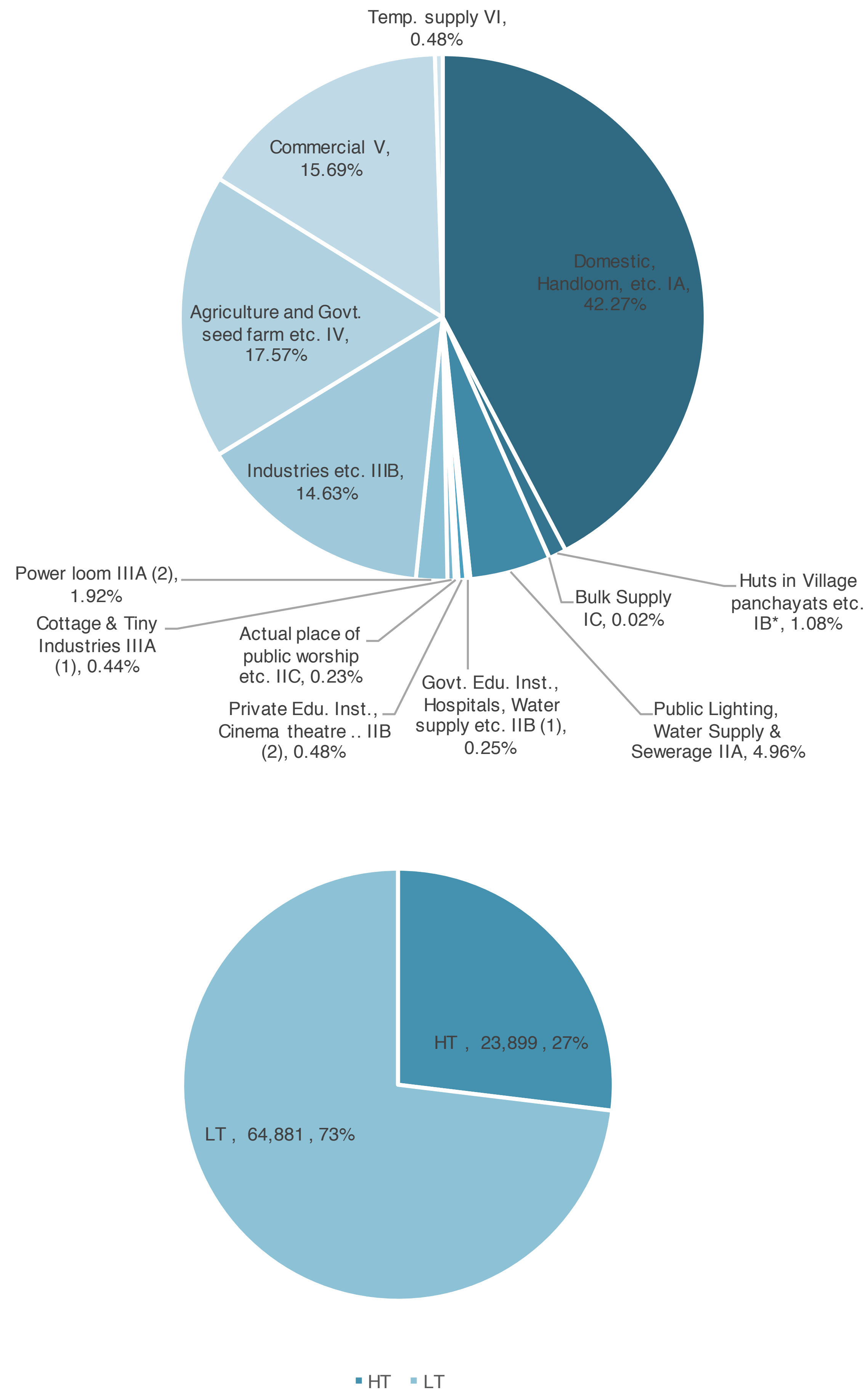


7.2 SELECTED LT CONSUMER CATEGORIES

There are 13 distinct LT electricity tariff categories, including the domestic tariff category, many of which have a slab-wise tariff system and are supported with electricity subsidy by the State Government. The domestic tariff category accounts for more than 42% of the total LT electricity consumption with a complex 4 tier slab system was elaborated upon in detail earlier in this document (TNERC 2017). Agriculture, another major LT consumer, has not been considered in this paper. Earlier reports on the opportunities of introducing distributed solar for Agriculture have elaborated this extensively (Auroville Consulting 2019a, 2019b). The LT commercial, industrial, public lighting and municipal water supply and the private educational institutions tariff categories have the same or very similar tariff rates as their counterparts in the HT categories and have therefore not be analyzed. Insights from the analysis for HT tariffs in Chapter 7.3 can be applied to the LT commercial, industrial, public lighting and municipal water supply and the private educational institutions tariff categories.

The selected LT consumer categories for the financial modeling have been selected on the basis of their relatively speaking low electricity tariff (e.g. electricity tariff is below TANGEDCO's average cost of supply without TANGEDCO's fixed costs). For these tariff categories the benefits of introducing distributed solar to TANGEDCO will be higher and the design of appropriate implementation models for low electricity consumer tariff categories is more challenging. For details on the respective electricity rates refer to Annexure I. Selected LT categories for the financial modeling under this chapter are: (i) Bulk supply to residential colonies, (ii) Cottage and Tiny Industries, (iii) Government or Government Aided Institutions, and (iv) Power Looms. Out of the selected LT consumer categories, Power Looms has a complex 5 tier tariff slab system with the first 750 kWh for free to the consumer on a bi-monthly basis. Implementation models presented are similar than for the domestic consumer category as the challenges and opportunities are similar.

Figure 9 Share of energy consumption of LT consumer categories on total LT energy demand for FY 2018-19 and share of LT & HT consumption on total Tamil Nadu energy demand for FY 2018-19

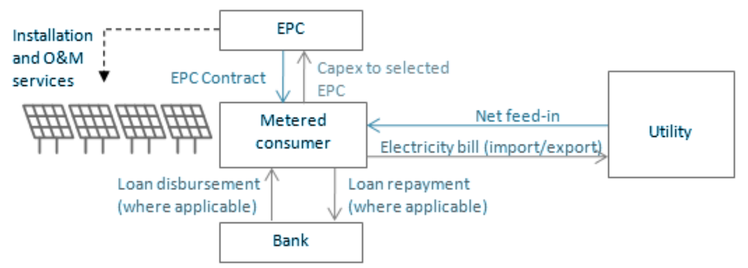


Source: TNERC 2017

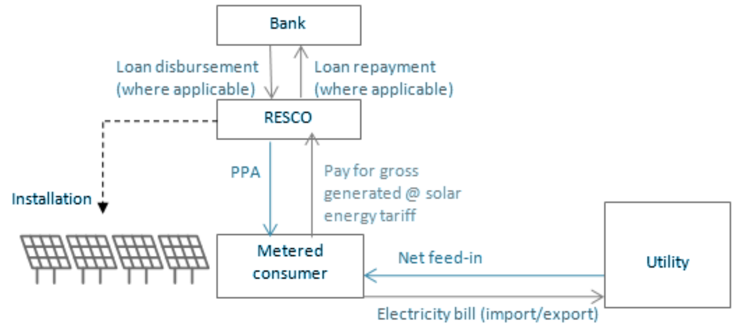
Figure 10 Selected implementation models, distributed solar for selected LT consumer categories and financial impact on key stakeholders

less attractive — more attractive

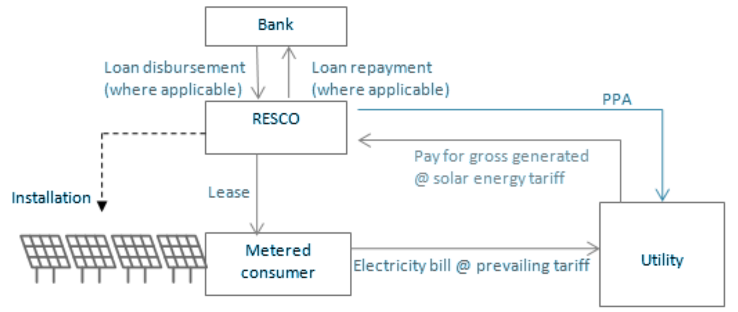
1 CONSUMER CENTRIC

		Bulk Supply	Govt. Inst.	Cottage Ind.	Power Looms
DESCRIPTION		The classical capex model, in which the consumer drives the vendor selection and financing.			
IMPLEMENTATION FRAMEWORK					
METERING MECHANISM		Net feed-in at INR @ 2.28 INR/kWh			
COST ECONOMICS	Cost INR per kW	51,300			
	Solar capacity (kW)	17			
	RESCO tariff (INR/kWh)	N/A			
	Debt-equity ratio	70%/30%			
	Loan Tenure	10 years/1 year Moratorium			
	Interest on loan	11%			
CONSUMER (GAINS/ LOSSES) IN INR	Year 1	11,304	42,217	24,876	21,899
	25-year	368,710	1,318,453	670,666	665,710
TANGEDCO (GAINS/ LOSSES) IN INR	Year 1	65,024	35,217	52,785	31,983
	25-year	538,474	(105,333)	219,291	(208,570)
STATE (GAINS/ LOSSES) IN INR	Year 1	0	0	0	23,779
	25-year	0	0	0	433,290
COMMENT		This model results in healthy short and long-term gains to the selected LT consumer categories. The financial gains are especially attractive for the consumer category Govt. and Govt. aided institutions on account of its higher electricity tariff rate. The financial impact on TANGEDCO shows clear losses for Govt. institutions and Power Looms and on the other hand high gains for Bulks supply to domestic colonies and Cottages and small Industries. Moderate savings for the State Government can be expected in the case of Power Looms, which currently receives electricity subsidy support.			

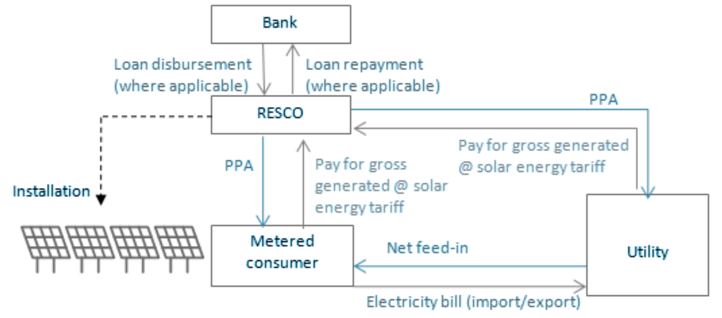
2 RESCO 1

		Bulk Supply	Govt. Inst.	Cottage Ind.	Power Looms
DESCRIPTION		In the RESCO 1 model a developer invests into the solar system on a consumer's premises and recovers its investment through charging a solar energy tariff on the gross generation of solar energy. The consumer benefits from a reduction in electricity bill through self-consumption and through export of solar energy to the grid for which TANGEDO will compensate the consumer with the prevailing net feed-in tariff.			
IMPLEMENTATION FRAMEWORK					
METERING MECHANISM		Net feed-in at INR @ 2.28 INR/ kWh			
COST ECONOMICS	Cost INR per kW	46,035			
	Solar capacity (kW)	17			
	RESCO tariff (INR/kWh)	4.57			
	Debt-equity ratio	70%/30%			
	Loan Tenure	10 years/1 year Moratorium			
	Interest on loan	11%			
CONSUMER (GAINS/ LOSSES) IN INR	Year 1	(34,502)	(3,589)	(20,929)	(23,906)
	25-year	424,138	1,077,113	754,871	749,442
TANGEDCO (GAINS/ LOSSES) IN INR	Year 1	65,024	35,217	52,785	31,983
	25-year	538,474	(105,333)	219,291	(208,570)
STATE (GAINS/ LOSSES) IN INR	Year 1	0	0	0	23,779
	25-year	0	0	0	433,290
COMMENT		The RESCO model results in higher long-term gains to the consumers as compared to the capex model. The financial impact on TANGEDCO and the State Government are the same as under the Capex model.			

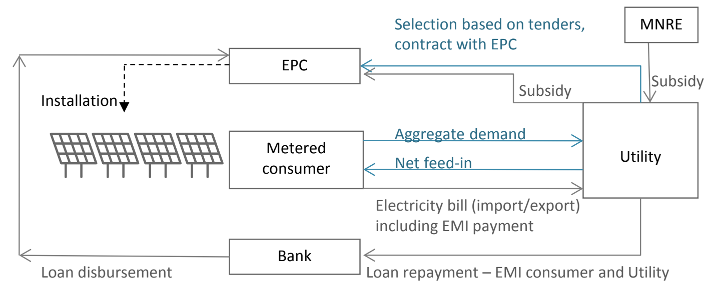
3 RESCO 2

		Bulk Supply	Govt. Inst.	Cottage Ind.	Power Looms
DESCRIPTION		RESCO finances and operates rooftop solar system at the consumers premises. All solar energy generation is feed into the grid. The consumer recieves a rooftop lease from the RESCO			
IMPLEMENTATION FRAMEWORK					
METERING MECHANISM		Gross metering @ INR 4.57/kWh			
COST ECONOMICS	Cost INR per kW	46,035			
	Solar capacity (kW)	17			
	RESCO tariff (INR/kWh)	4.57			
	Debt-equity ratio	70%/30%			
	Loan Tenure	10 years/1 year Moratorium			
	Interest on loan	11%			
CONSUMER (GAINS/ LOSSES) IN INR	Year 1	14,723	14,723	14,723	14,723
	25-year	193,785	193,785	193,785	193,785
TANGEDCO (GAINS/ LOSSES) IN INR	Year 1	(6,719)	(6,719)	(6,719)	(6,719)
	25-year	303,845	303,845	303,845	303,845
STATE (GAINS/ LOSSES) IN INR	Year 1	0	0	0	0
	25-year	0	0	0	0
COMMENT		A possible win-win approach for all selected LT consumer categories and for TANGEDCO. With moderate long-term gains to the consumers and healthy long-term gains to TANGEDCO.			

4 RESCO 3

		Bulk Supply	Govt. Inst.	Cottage Ind.	Power Looms
DESCRIPTION		In the RESCO 3 model a developer invests into the solar system on a consumers' premises. The RESCO will have two agreements. A power purchase agreement with the respective HT consumer, for which a solar energy procurement volume per year and a solar energy tariff, both for a 25-year period are fixed. The second agreement is between the Utility and the RESCO for the surplus solar, that will be injected into the local grid. The RESCO is compensated for every kWh injected with a fixed feed-in tariff over 25 years. The consumer benefits from a reduction in electricity bill through self-consumption.			
IMPLEMENTATION FRAMEWORK					
METERING MECHANISM		Behind the meter & gross metering @ 4.57 INR/kWh			
COST ECONOMICS	Cost INR per kW	46,035			
	Solar capacity (kW)	17			
	RESCO tariff (INR/kWh)	4.57			
	Debt-equity ratio	70%/30%			
	Loan Tenure	5 years (EMI on bill financing)			
	Interest on loan	11%			
CONSUMER (GAINS/ LOSSES) IN INR	Year 1	348	20,140	514	(2,463)
	25-year	564,191	1,168,779	833,882	828,964
TANGEDCO (GAINS/ LOSSES) IN INR	Year 1	26,689	9,115	29,198	8,396
	25-year	366,992	(216,709)	122,482	(280,635)
STATE (GAINS/ LOSSES) IN INR	Year 1	0	0	0	23,779
	25-year	0	0	0	433,290
COMMENT		The RESCO 3 model shows attractive long-term gains to all selected consumer categories. TANGEDCO would benefit from introducing solar for Bulk Supply and Cottage Industries but would, on the other hand see revenue losses for Govt. Institutions and Power Looms. The State Government benefits from a reduction of electricity subsidy disbursal for Power Looms.			

5 UTILITY FACILITATED

		Bulk Supply	Govt. Inst.	Cottage Ind.	Power Looms
DESCRIPTION		The utility acts as an aggregator of demand, manages the tendering and vendor selection process and guarantees repayment of loan through an EMI with on-bill financing mechanism			
IMPLEMENTATION FRAMEWORK					
METERING MECHANISM		Net feed-in at INR @ 2.28 INR/ kWh			
COST ECONOMICS	Cost INR per kW	46,035			
	Solar capacity (kW)	17			
	RESCO tariff (INR/kWh)	N/A			
	Debt-equity ratio	70%/30%			
	Loan Tenure	5 years (EMI on bill financing)			
	Interest on loan	11%			
CONSUMER (GAINS/ LOSSES) IN INR	Year 1	19,480	50,393	33,052	30,075
	25-year	473,342	1,069,503	775,298	770,342
TANGEDCO (GAINS/ LOSSES) IN INR	Year 1	65,024	35,217	52,785	31,983
	25-year	538,474	(105,333)	219,291	(208,570)
STATE (GAINS/ LOSSES) IN INR	Year 1	0	0	0	23,779
	25-year	0	0	0	433,290
COMMENT		This model results in higher gains to all consumer categories on account of the facilitation by TANGEDCO. TANGEDCO would benefit from introducing solar for Bulk Supply and Cottage Industries but would, on the other hand see revenue losses for Govt. Institutions and Power Looms. The State Government benefits from a reduction of electricity subsidy disbursal for Power Looms. TANGEDCO may consider charging a facilitation fees to the consumers to increase its financial benefits from such a scheme.			

6 UTILITY FACILITATED COMMUNITY SOLAR

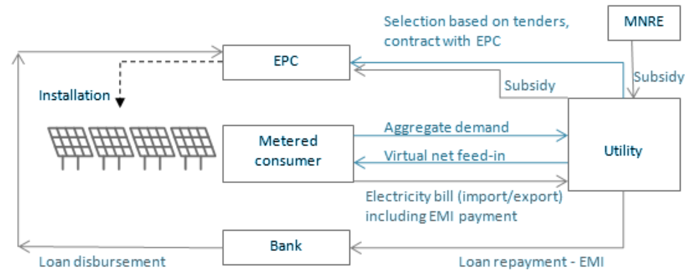
		Bulk Supply	Govt. Inst.	Cottage Ind.	Power Looms
DESCRIPTION		This is the same implementation framework that for the Utility Centric model, however instead of installing the solar generators at the rooftop of the LT consumers, the LT consumer will own a share of a ground mounted community scale solar system at a different location. This model requires the introduction of a virtual net-metering mechanism.			
IMPLEMENTATION FRAMEWORK					
METERING MECHANISM		Virtual Net feed-in @ 2.28 INR/ kWh			
COST ECONOMICS	Cost INR per kW	46,035			
	Solar capacity (kW)	17			
	RESCO tariff (INR/kWh)	N/A			
	Debt-equity ratio	70%/30%			
	Loan Tenure	5 years (EMI on bill financing)			
	Interest on loan	11%			
CONSUMER (GAINS/ LOSSES) IN INR	Year 1	34,627	65,539	48,199	45,222
	25-year	667,173	1,263,333	969,129	964,173
TANGEDCO (GAINS/ LOSSES) IN INR	Year 1	65,024	35,217	52,785	31,983
	25-year	538,474	(105,333)	219,291	(208,570)
STATE (GAINS/ LOSSES) IN INR	Year 1	0	0	0	23,779
	25-year	0	0	0	433,290
COMMENT		The utility centric community solar results in the highest benefit for the selected LT consumer categories. But like in the previous models a loss to TANGEDCO under two of the 4 selected LT consumer categories.			

Table 7 Summary: financial impact of implementation models on key stakeholders in %

less attractive — more attractive

NO	BUSINESS MODELS	AGGREGATION	CAPEX (INR/KW)	METERING MECHANISM		IMPACT ON CONSUMER (25-YEAR GAINS AS % ON ELECTRICITY BILLING AMOUNT)				IMPACT ON TANGEDCO (25-YEAR GAINS AS % OF NET REVENUE BAU)				IMPACT ON STATE GOVERNMENT (SAVINGS 25-YEAR AS % ON SUBSIDY AMOUNT)			
						LT Bulk	LT Govt. Institu-tions	LT Cottage Industry	LT Power Looms	LT Bulk	LT Govt. Institu-tions	LT Cottage Industry	LT Power Looms	LT Bulk	LT Govt. Institu-tions	LT Cottage Industry	LT Power Looms
1	Consumer Centric	no	51,300	Net feed-in		9%	25%	16%	21%	126%	-7%	63%	-15%	0%	0%	0%	21%
2	RESCO 1	yes	46,035	Net feed-in		10%	20%	18%	23%	126%	-7%	63%	-15%	0%	0%	0%	21%
3	RESCO 2	yes	46,035	Gross feed-in		14%	11%	14%	21%	393%	393%	393%	393%	0%	0%	0%	0%
4	RESCO 3	yes	46,035	Fixed units for Self-consumption over 25 years and gross feed-in of surplus solar by TANGEDCO		13%	22%	20%	26%	81%	-14%	34%	-20%	0%	0%	0%	21%
5	Utility Facilitated	yes	46,035	Net feed-in		11%	20%	18%	24%	126%	-7%	63%	-15%	0%	0%	0%	21%
6	Utility Facilitated Community Solar	yes	36,282	Virtual net feed-in		16	24%	23%	30%	126%	-7%	63%	-15%	0%	0%	0%	21%

All implementation models show a viable long-term gain for the selected consumer categories. The financial impact on TANGEDCO comes with mixed results: losses for LT Govt. Institutions and LT Power Looms on account of their higher tariff rates, and gains for LT Bulk and LT Cottage & Industries. As LT Power Looms is the only selected LT consumer category benefiting from an electricity subsidy by the State Government, solarization comes along with a 21% subsidy reduction. A similar approach as the Utility-Facilitated and State Government-supported model, presented under the domestic chapter may be considered for Power Looms. RESCO 3 and Utility Facilitated Community implementation models show the highest gains to the consumers, whereas RESCO 2, with a gross metering arrangement and a rooftop lease income to the consumers, appears to be a win-win for both the LT consumers and TANGEDCO and maybe the most sensible model to promote, provided that availability of rooftop space is not a constraint.

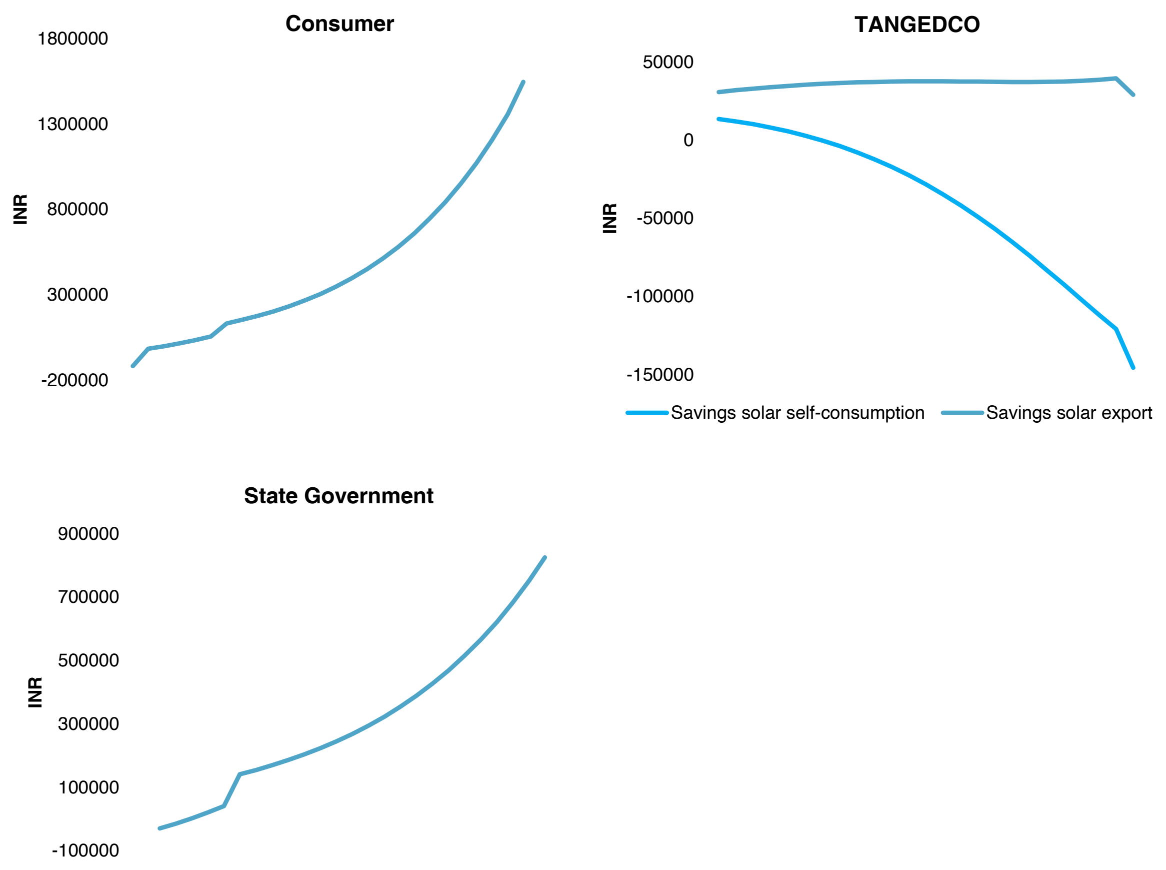
DEEP-DIVE I 'WHAT IF' I TARIFF RATIONALISATION AND CAPITAL SUBSIDY FOR DISTRIBUTED SOLAR

Power Loom accounts for a moderate 1.92% of the total LT electricity demand (TNERC 2017). This consumer category is characterized by a 5 slab tariff rate system and a strong electricity subsidy provided by the State Government for all 5 slabs. Bi-monthly consumption of up to 750 kWh is free of cost for the consumers. An alternative approach to providing electricity subsidy to these consumers, would be that the State Government offers a 50% upfront capital subsidy to the consumer for disturbed solar, in exchange the State Government phases out electricity subsidy disbursement. In addition, the electricity tariff rate for Power Looms could be rationalized from the 5 slab system to a single tariff on par with the industrial consumer categories in order to ensure financial gains to TANGEDCO. Such an approach results in gains to all stakeholders (refer to table 8 and figure 11 below).

Table 8: 25-Years Financial impact by key stakeholders: Utility Facilitated and State Government supported implementation model for Power Looms

	CONSUMER	TANGEDCO	STATE GOVERNMENT
25-Year gains (INR)	20,85,426	1,88,109	16,64,308
25-Year gains (%)	65%	13.25%	80%

Figure 11: 25-Years Financial impact by key stakeholders: Utility Facilitated and State Government supported implementation model for Power Looms MISSING



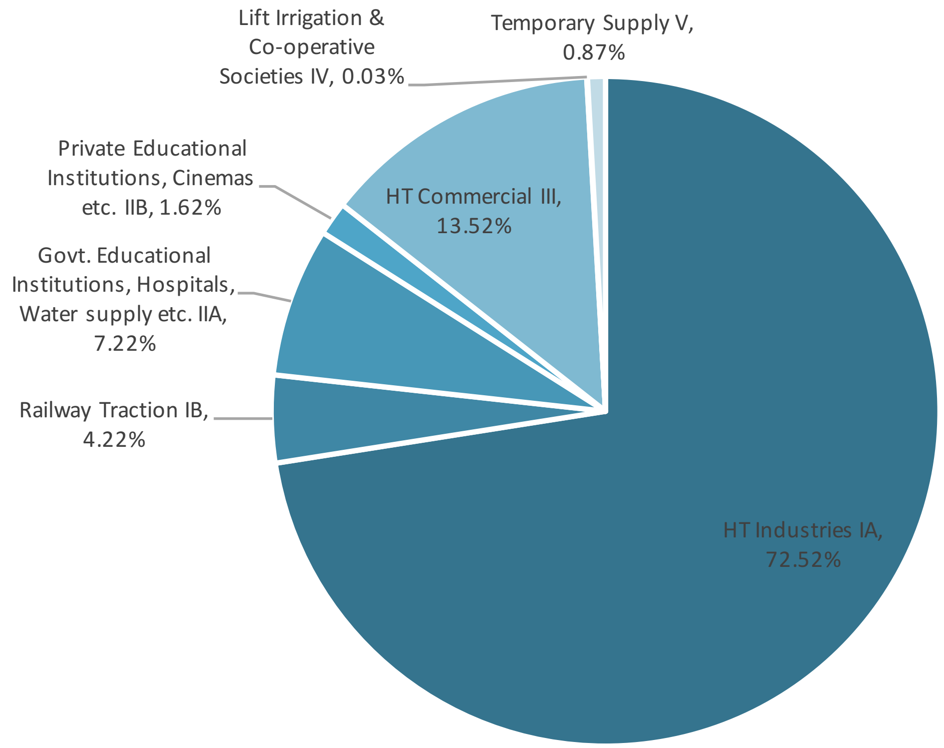
7.3 SELECTED HT CONSUMER CATEGORIES

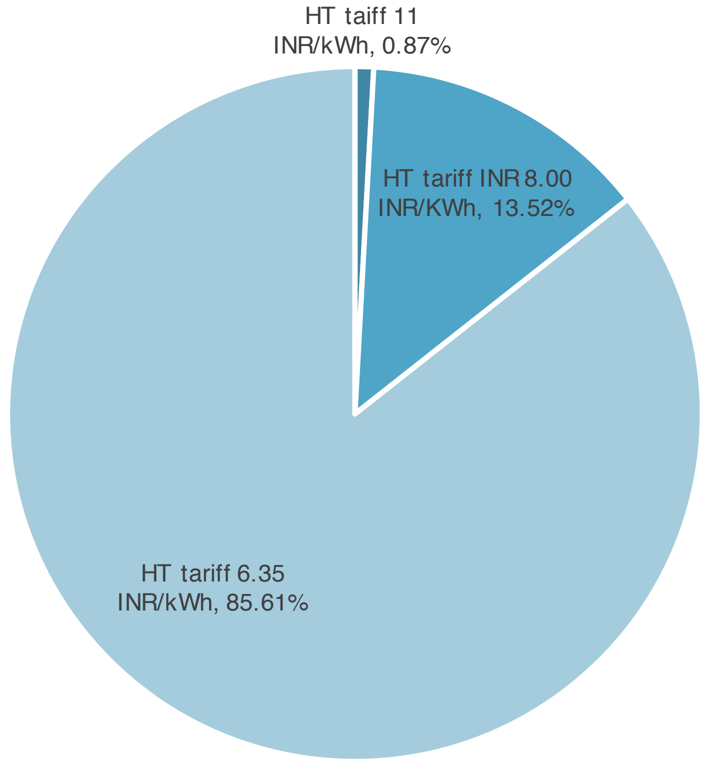
As of April 2020, there are seven HT consumer categories but only two different tariff rates: INR 8.00 /kWh for commercial consumers and INR 6.35/kWh for the remaining six HT consumer categories (excluding temporary supply). One would expect that HT tariffs are lower than LT tariffs since in the case of HT consumers transformer and LT distribution capital costs, maintenance and energy losses are borne by the consumer. But most LT tariffs are lower than the above-mentioned HT tariffs (refer to Annex 1). Some of the characteristics of HT service connections are:

- The HT III (commercial) tariff of INR 8.00 per kWh is at par with the TANGEDCO cost of supply;
- The HT tariff ((I-A, I-B, II-A, II-B, V) of INR 6.35 per kWh is 20% lower than the TANGEDCO cost of supply
- The higher tariff rates result in a higher return of investment on solar installations to the consumers for the solar energy that is self-consumed;
- Higher solar energy self-consumption potential on account of high day-time load;
- Likely good rooftop space availability and therefore a higher solar system capacity potential. But since energy consumption by HT consumers is higher than most LT consumers, solar energy generation as a percentage of consumption may still be small in most cases.

In the FY 2018-19 HT electricity consumption accounted for 27% of the total electricity demand in Tamil Nadu (refer to figure 9). HT commercial (HT III), which has the highest tariff rate, not considering Temporary Supply, accounts for about 14% of the total HT energy demand in the State (refer to figure 12). For the purpose of the financial modeling the following consumer categories were selected: (i) HT Commercial, (ii) HT Industrial, (iii) HT Private Educational Institutions and (iv) HT Water Supply (for municipalities).

Figure 12 Share of energy consumption of HT consumer categories and tariff categories on total HT energy demand and share of LT and HT energy consumption on total energy demand in Tamil Nadu for FY 2018-19

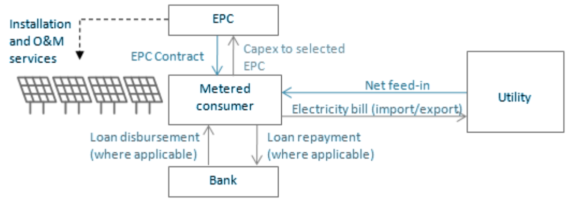
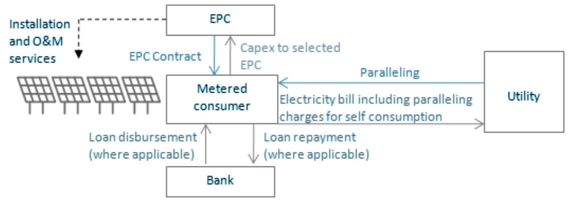
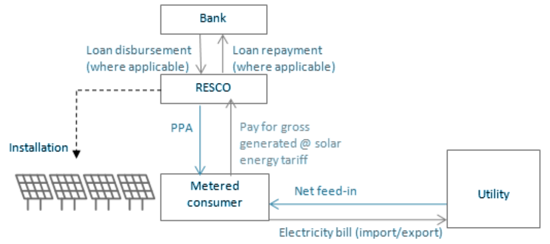
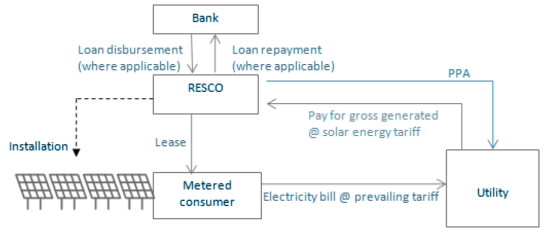
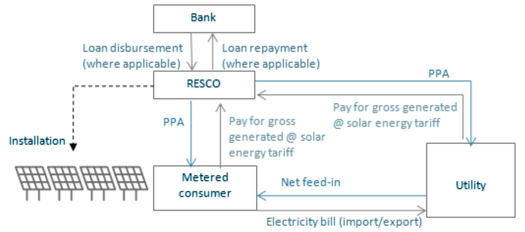




Source: TNERC 2017

Figure 13 Selected implementation models, distributed solar for selected HT consumer categories and financial impact on key stakeholders

less attractive → more attractive

		1	2	3	4	5
		CONSUMER CENTRIC	**CONSUMER CENTRIC (PARALELLING)**	**RESCO 1**	**RESCO 2**	**RESCO 3**
DESCRIPTION		The classical capex model, in which the consumer drives the vendor selection and financing.	The consumer centric (capex model), with the limitation, that instantaneous surplus solar cannot be exported to the grid. In addition, TANGEDCO levies paralleling charges in the consumer.	In the RESCO model a developer invests into the solar system on a consumer's premises and recovers its investment through charging a solar energy tariff on the gross generation of solar energy. The consumer benefits from a reduction in electricity bill through self-consumption and through export of solar energy to the grid for which TANGEDO will compensate the consumer with the prevailing net feed-in tariff.	RESCO finances and operates rooftop solar system at the consumers premises. All solar energy generated is fed into the grid. The consumer receives a rooftop lease from the RESCO.	In the RESCO 3 model a developer invests into the solar system on a consumers' premises. The RESCO will have two agreements. A power purchase agreement with the respective HT consumer, for which a solar energy procurement volume per year and a solar energy tariff, both for a 25-year period are fixed. The second agreement is between the Utility and the RESCO for the surplus solar, that will be injected into the local grid. The RESCO is compensated for every kWh injected with a fixed feed-in tariff over 25 years. The consumer benefits from a reduction in electricity bill through self-consumption.
IMPLEMENTATION FRAME-WORK						
METERING MECHANISM		**Net feed-in at INR @ 2.28 INR/kWh**	**Paralelling (no solar net export)**	**Net feed-in at INR @ 2.28 INR/kWh**	**Gross metering @ 4.07 INR/kWh**	**Behind the meter & gross metering @ 4.07 INR/kWh**
COST ECO-NOMICS	Cost INR per kW	48,735	48,735	41,033	48,735	-
	Solar capacity (kW)	250	250	250	250	250
	RESCO tariff (INR/kWh)	N/A	N/A	4.07	4.07	4.07
	Debt-equity ratio	70%/30%	70%/30%	70%/30%	70%/30%	70%/30%
	Loan Tenure	10 years/1 year Moratorium	10 years/1 year Moratorium	10 years/1 year Moratorium	10 years/1 year Moratorium	10 years/1 year Moratorium
	Interest on loan	11%	11%	11%	11%	11%

		1 Commercial	1 Industrial	1 Institutional	1 Municipal	2 Commercial	2 Indstrial	2 Institutional	2 Municipal	3 Commercial	3 Industrial	3 Institutional	3 Municipal	4 Commercial	4 Industrial	4 Institutional	4 Municipal	5 Commercial	5 Industrial	5 Institutional	5 Municipal
CONSUMER (GAINS/ LOSSES) IN INR	Year 1	1,263,068	825,780	767,080	645,509	609,624	222,832	131,248	31,574	755,397	354,213	295,513	173,943	202,809	202,809	202,809	202,809	1,015,481	602,968	570,154	502,196
	25-year	30,518,169	22,296,355	20,709,315	20,834,067	21,401,258	13,892,026	11,988,716	13,467,892	30,703,762	22,359,198	20,620,912	20,757,553	2,652,469	2,652,469	2,652,469	2,652,469	30,182,425	22,444,694	21,223,240	18,693,570
TANGEDCO (GAINS/ LOSSES) IN INR	Year 1	(88,097)	3,14,526	3,69,938	4,84,698	(4,76,577)	(53,112)	(45,324)	(1,19,194)	(88,097)	3,14,526 WW	3,69,938	4,84,698	(3,33,062)	(3,33,062)	(3,33,062)	(3,33,062)	(88,097)	3,14,526	3,69,938	4,84,698
	25-year	(1,46,39,630)	(62,83,096)	(45,79,451)	(47,42,151)	(1,81,30,546)	(94,66,115)	(87,72,072)	(1,08,51,602)	(1,46,39,630)	(62,83,096)	(45,79,451)	(47,42,151)	38,99,083	38,99,083	38,99,083	38,99,083	(1,21,89,695)	(45,45,079)	(31,10,858)	(1,40,539)
STATE (GAINS/ LOSSES) IN INR	Year 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	25-year	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

	1	2	3	4	5
COMMENT	From the point of the HT consumer one of the financially most lucrative models with health short and long-term gains. However, this model shows significant long-term revenue losses to TANGEDCO. Currently all HT consumers are exempted from availing net feed-in mechanism, but are allowed paralleling operations.	The paralleling model presents the least attractive model for both the consumers and TANGEDCO. Though the selected consumers will see long-term cost reduction on electricity costs, primarily on account of an expected annual increase in electricity demand and tariff rates, the impact on TANGEDCO over a 25-year time period shows significant losses. It is surprising that this is currently to only feed-in model permitted in Tamil Nadu.	The RESCO 1 model results significant short and long-term gains to all selected HT consumer categories, primarily on account of the lower capital expenditures on account of aggregation by the RESCO. TANGEDCO would see short-term gains but significant long-term losses.	The RESCO 2 model is a financially rewarding approach for all selected HT consumer categories. The consumers benefit from an additional income on account of a rooftop space lease. An advantage to the consumer is also the low risk exposure, as the consumer neither invests nor requires a power purchase agreement. This model also promises significant long-term savings for TANGEDDCO and appears to be the only win-win approach among the presented business models for HT consumers as it is the only model that shows long-term savings for both, TANGEDCO and the HT consumers.	RESCO 3 model results in significant short and long-term gains for the selected HT consumer categories. However especially the long-term losses to TANGEDCO are significant.

Table 9 Summary of financial impact of implementation models on key stakeholders in %

less attractive → more attractive

No	Business Models	Aggregation	Capex (INR / KW)	Metering mechanism	Impact on consumer (25-year gains as % on electricity billing amount): Commercial	Industrial	Institutional	Municipal	Impact on TANGEDCO (25-year gains as % of net revenue BAU): Commercial	Industrial	Institutional	Municipal
1	Consumer Centric	no	48,735	Net feed-in	28%	26%	24%	24%	-28%	-21%	-15%	-16%
2	Consumer Centric with Paralelling	no	48,735	Only behind the meter consumption nor net feed-in	20%	16%	14%	16%	-35%	-32%	-29%	-36%
3	RESCO 1	yes	41,033	Net feed-in	28%	26%	24%	24%	-28%	-21%	-15%	-16%
4	RESCO 2	yes	41,033	Gross metering	2%	3%	3%	3%	343%	343%	343%	343%
5	RESCO 3	yes	41,033	"Behind the meter & gross metering	28%	26%	26%	22%	-23%	-15%	-10%	0%

With the exception of the RESCO 2 model, wherein all gross solar energy generated is sold to TANGEDCO and the consumer receives an additional income for the rooftop lease, all other simulated models result in double-digit gains to the selected HT consumers. However, the RESCO 2 model is the only implementation model simulated that shows gains to TANGEDCO. RESCO 2 model assumes that a gross feed-in tariff of 4.07 INR/kWh, that accounts for the real cost of distributed solar energy generation, has been determined by the State Electricity Regulator Commission. The current gross feed-in tariff for solar energy generation has been determined for ground mounted MW-scale solar at INR 3.04, a cost that will be difficult or impossible to meet with 100 kW-scale rooftop solar. Therefore, capacity differential solar gross feed-in tariffs would be required. RESCO 2 model could be turned into a viable win-win situation if the revenue for the HT consumers, through rooftop lease can be increased so that it comes close, or matches the possible revenue, that can be expected from the other implementation models. This could also be done by a rooftop lease contribution from TANGEDCO, from its net revenue gains through this model. It is interesting to note, that the current available solar rooftop model for HT consumer, which is the Paralleling option, in which self-consumption of solar energy by the consumer is permitted but export of surplus solar to the grid is not allowed, is the model in which the financial losses to TANGEDCO are the highest, this is due to loss of energy sales revenue and no benefit of importing low cost solar energy from the consumer.

The real crux of making distributed solar a viable option for the utility and the consumer however is the consumer tariff policy. The current tariff policy is a maze of twenty different tariffs of which some come with a slab system and some benefiting from electricity subsidy by the State Government. Most of the tariffs are below TANGEDCO's cost of supply. This motivates TANGEDCO to prevent high paying consumer categories to go for solar energy, as it is highly depending of the revenue from these consumers. The present tariff structure contributes to a worsening financial health of TANGEDCO. TANGEDCO's aggregated debt stood at INR 1,13,438 crore (provisional) in fiscal year 2019 (CRISIL 2020).

DEEP DIVE I 'WHAT-IF' I TARIFF RATIONALISATION AND DISTRIBUTED SOLAR

This section explores the financial viability of distributed solar for LT and HT consumers with the underlying assumption that a decisive tariff rationalisation has been undertaken, wherein the current tariff system with twenty consumer categories is being reduced to a system with two consumer categories only: a single LT consumer tariff rate and a single HT consumer tariff rate. As in the case of HT consumers the cost, maintenance and energy losses of the transformer and the LT distribution are borne by the consumer, the tariff for HT consumers is assumed to be lower than the LT tariff. The LT and HT tariffs must be fixed such that the cost of supply of TANGEDCO is fully covered with an automatic annual inflation correction. If the Government is of the view that certain consumer categories must be financially supported, such support may take the form of direct benefit transfers rather than Government- subsidized electricity tariffs or tariff-based cross subsidies.

With an average cost of supply of 8.04 INR/kWh (including all fixed costs), an average power purchase cost of 5.18 INR/kWh, an LT tariff of 7.00 INR/kWh, and an HT tariff of 6.85 INR/kWh, adequate demand charges covering all remaining TANGEDCO fixed costs, and net-feed-in solar energy tariff of 2.28 INR/kWh TANGEDCO's finances will become healthy while consumers will be motivated to invest in solar energy systems. The results presented in table 9 show that this is indeed a win-win proposition.

One key take away of this exercise is that a decisive tariff rationalisation would not only improve the finances of TANGEDCO but would motivate TANGEDCO to support and promote distributed solar energy generation. To get more consumers to invest in distributed solar energy systems, net (or gross) feed-in tariffs are needed that at least cover the actual cost of solar energy.

Table 10 Financial Impact of Solar under tariff rationalisation

Consumer category	Electricity Tariff (INR/kWh)	Capex (INR/kW)	Metering Mechanism	Impact on consumer (25 - year gains as % on electricity billing amount)	Impact on TANGEDCO (25 - year gains as % on net revenue BAU)
LT	7.00	51,300	Net feed-in	18.30%	3%
HT	6.85	48,735	Net feed-in	24.05%	11%

8. CONCLUSIONS

TThe case studies presented in this paper and the simulation of multiple consumer tariff specific implementation models clearly highlight the opportunities for TANGEDCO emerging from distributed solar energy. With consumer tariff rationalization as proposed in this paper, the import of solar energy from consumers remains of interest to TANGEDCO as it reduces the average cost of supply while at the same time contributing to the achievement of solar energy targets. With the proposed rationalization of consumer and solar energy feed-in tariffs, consumers will be motivated to promote distributed solar energy

Under the current electricity tariff policy, characterized by state-provided electricity subsidy and tariff cross-subsidy, various solar energy implementation models and metering mechanisms are required in order to meet the State's solar energy targets. It makes sense for both TANGEDCO and the State Government to invest or promote investment in solar energy systems at consumer premises particularly in the case of heavily (cross-) subsidized consumer tariffs.

Aggregation of demand offers an opportunity to reduce the capital cost of solar and therefore achieve a greater installed solar capacity. TANGEDCO itself can act as an aggregator. Meanwhile consumer category-specific solutions and models have to be used as outlined in this paper and as summarized below.

Domestic Consumer Category: It is recommended that TANGEDCO assumes a key role for domestic rooftop solar, as envisioned under Phase 2 of MNRE's rooftop solar program. The Utility-Facilitated and State Government-Supported implementation model presents a unique opportunity with gains to all parties and the additional benefit of phasing out electricity subsidy. The Community Solar Energy Models present themselves as attractive alternatives for domestic consumers with limited rooftop space and for slab 1 consumers, for which the financial returns of rooftop solar would be a detriment otherwise. There is a big opportunity for the State Government to actively promote distributed solar for subsidized electricity consumers such as the agricultural and domestic consumers and for consumers under the Power Loom tariff category. This can be facilitated by providing an upfront capital subsidy for the solar system in exchange for phasing out electricity subsidy to these consumer categories. The analysis of this approach clearly indicates that this benefit all stakeholders involved: the consumer, TANGEDCO and the State Government.

LT consumer categories: For the various LT consumer tariff categories, appropriate solar energy implementation models need to used. The RESCO 2 Model presents a fairly attractive solution across all the LT consumer categories. For LT consumer tariff categories that are subsidized by the State Government, the Utility-Facilitated and State Government-Supported approaches maybe considered.

HT consumer categories: Currently 'paralleling' is the only available solar energy option for HT consumers. As the analysis shows, this implementation model has possibly lower gains to the HT consumers (with a smaller solar capacity sizing higher gains to the consumer can be expected) and the highest revenue reductions to TANGEDCO. It is therefore surprising that TANGECO continues to support this model. In the absence of a decisive and fast paced tariff rationalisation, the RESCO 2 model, with a gross feed-in mechanism, presents the only viable solution with potential gains for both parties, the HT consumers and TANGEDCO. TANGEDCO would be well placed to play a facilitating role in this

Distributed solar will need to become an essential part of TANGEDCO's power procurement and planning strategy. Instead of being considered as a threat, distributed renewable energy generation combined with distributed energy storage may be seen as an opportunity for the transition towards a distributed energy future and a financially healthy distribution company. Tariff rationalisation has shown to be a potential leverage in accelerating the deployment of distributed solar, it would also help in removing some of the current reservations regarding distributed solar energy by TANGEDCO. The tables 10,11 and 12 below summarize the viability of the presented implementation models for the consumersm the State Government and for TANGEDCO.

Table 11 Summary financial viability of implementation models for consumers

	Domestic Consumer Category				Selected LT consumer categories				Selected HT consumer categories			
Implementation model	Slab 1	Slab 2	Slab 3	Slab 4	Bulk	Govt. Inst.	Cottage Ind.	Power Looms	Commercial	Industrial	Institutional	Municipal
Consumer Centric	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Consumer Centric (Paralleling)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	✓	✓	✓	✓
RESCO 1	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
RESCO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
RESCO 3	N/A	N/A	N/A	N/A	✓	✓	✓	✓	✓	✓	✓	✓
Utility Facilitated	✓	✓	✓	✓	✓	✓	✓	✓	N/A	N/A	N/A	N/A
Utility Facilitated and State Government Supported	X	✓	✓	✓	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Utility Facilitated Community Solar	✓	✓	✓	✓	✓	✓	✓	✓	N/A	N/A	N/A	N/A
Utility Facilitated & State Government supported. Community Solar	✓	✓	✓	✓	N/A	N/A	N/A	✓	N/A	N/A	N/A	N/A

Legend	✓	Viable	=	Possibly viable	X	Not viable	N/A	Not applicable e.g. not simulated

Table 12 Summary financial viability of implementation models for TANGEDCO

	Domestic Consumer Category				Selected LT consumer categories				Selected HT consumer categories			
Implementation model	Slab 1	Slab 2	Slab 3	Slab 4	Bulk	Govt. Inst.	Cottage Ind.	Power Looms	Commercial	Industrial	Institutional	Municipal
Consumer Centric	✓	✓	✓	✓	✓	X	✓	X	X	X	X	X
Consumer Centric (Paralleling)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	X	X	X	X
RESCO 1	✓	✓	✓	✓	✓	X	✓	X	X	X	X	X
RESCO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
RESCO 3	N/A	N/A	N/A	N/A	✓	X	✓	X	✓	✓	✓	✓
Utility Facilitated	✓	✓	✓	✓	✓	X	✓	X	X	X	X	=
Utility Facilitated and State Government Supported	✓	✓	✓	✓	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Utility Facilitated Community Solar	✓	✓	✓	✓	✓	✓	✓	✓	N/A	N/A	N/A	N/A
Utility Facilitated & State Government supported. Community Solar	✓	✓	✓	✓	N/A	N/A	N/A	✓	N/A	N/A	N/A	N/A

Legend	✓	Viable	=	Possibly viable	X	Not viable	N/A	Not applicable e.g. not simulated

Table 13 Summary financial viability of implementation models for State Government of Tamil Nadu

	Domestic Consumer Category				Selected LT consumer categories				Selected HT consumer categories			
Implementation model	Slab 1	Slab 2	Slab 3	Slab 4	Bulk	Govt. Inst.	Cottage Ind.	Power Looms	Commercial	Industrial	Institutional	Municipal
Consumer Centric	✓	X	X	=	N/A	N/A	N/A	✓	N/A	N/A	N/A	N/A
Consumer Centric (Paralleling)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
RESCO 1	✓	X	X	=	N/A	N/A	N/A	✓	N/A	N/A	N/A	N/A
RESCO2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
RESCO 3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	✓	N/A	N/A	N/A	N/A
Utility Facilitated	✓	X	X	=	N/A	N/A	N/A	✓	N/A	N/A	N/A	N/A
Utility Facilitated and State Government Supported	✓	✓	✓	✓	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Utility Facilitated Community Solar	✓	X	X	=	N/A	N/A	N/A	✓	N/A	N/A	N/A	N/A
Utility Facilitated & State Government supported. Community Solar	✓	✓	✓	✓	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Legend	✓	Viable	=	Possibly viable	X	Not viable	N/A	Not applicable e.g. not simulated or not relevant as no electricity subsidy is provided

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ANNEXURE I

REVISED TARIFF RATES WITH EFFECT FROM 11.08.2017
APPROVED RATE AND PAYABLE BY THE CONSUMER
(CATEGORY OF CONSUMERS * FULLY / # PARTLY SUBSIDISED BY THE GOVERNMENT)

I - HIGH TENSION SUPPLY

		TARIFF FIXED BY TNERC		TARIFF PAYABLE BY THE CONSUMER	
Tariff	Category of Consumers	Energy Charges (Rs/ unit)	Demand Charges (Rs/ kVA/month)	Energy Charges after Govt's subsidy (Rs/ unit)	Demand Charges after Govt's subsidy (Rs/kVA/ month)
I-A	Industries, Registered factories, Textiles,Tea estates, IT services, start up power provided to generators.etc.,	6.35	350	6.35	350
I-B	Railway Traction	6.35	300	6.35	300
II-A	Govt. and Govt. aided Educational Institutions and hostels, Government Hospitals, Public Lighting and Water supply, Actual places of public worship etc.,	6.35	350	6.35	350
II-B	Private Educational Institutions & Hostels	6.35	350	6.35	350
III	All other categories of consumers not covered under HT-I-A, I-B, II-A, II-B, IV and V	8.00	350	8.00	350
*IV	Lift Irrigation societies for Agriculture registered under Co-op Societies or under any other Act. (Fully subsidised by the Govt.)	6.35	0	0	0
V	HT Temporary Supply for construction and other temporary purposes	11.00	350	11.00	350

II - LOW TENSION SUPPLY

Tariff	Category of Consumers & slabs		Energy Charges (Rs/ unit)	Fixed Charges for two months (Rs)	Energy Charges after Govt's subsidy (Rs/ unit)	Fixed Charges for two months after Govt's subsidy (Rs)
#I-A	Domestic , Handloom, Old age homes, Consulting rooms, Nutritious Meals Centres etc.					
	Consumption upto 100 units bi-monthly					
	(100 units free scheme)	0-100 units	2.50	30/service	0	0
	Consumption above 100 units and upto 200 units bi-monthly					
	(100 units free scheme)	0-100 units	2.50	30/service	0	20/service
	101-200 units				1.50	
	Consumption above 200 units and upto 500 units bi-monthly					
	(100 units free scheme)	0-100 units	2.50	40/service	0	30/service
	101-200 units				2.00	
	201 to 500 units		3.00		3.00	
	Consumption above 500 units bi-monthly					

Tariff	Category of Consumers & slabs		Energy Charges (Rs/ unit)	Fixed Charges for two months (Rs)	Energy Charges after Govt's subsidy (Rs/ unit)	Fixed Charges for two months after Govt's subsidy (Rs)
#I-A	Domestic , Handloom, Old age homes, Consulting rooms, Nutritious Meals Centres etc.					
	(100 units free scheme)	0-100 units	2.50	50/service	0	50/service
	101-200 units		3.50		3.50	
	201 to 500 units		4.60		4.60	
	above 500 units		6.60		6.60	
	For Handlooms in residence, 0 to 200 units bimonthly is free. (Above 200 units bi-monthly, the corresponding slab in the domestic tariff is applicable)					
*I-B	Huts in village panchayats,TAHDCO:- Till installation of meters (Fully subsidised by the Govt.)		0	290/service	0	0
	On installation of meters (Fully subsided by the Govt.)		4.95	0	0	0
I-C	L.T. Bulk supply to residential Colonies of Railway, Defence , Police quarters etc.		4.60	120/service	4.60	120/service
II-A	Public lighting by Govt./Local bodies, Public water supply, Sewerage etc.,		6.35	120/kW	6.35	120/kW
II-B(1)	Govt and Govt. aided Educational Institutions, Govt. Hospitals and Research labs, etc		5.75	120/kW	5.75	120/kW
II-B(2)	Private Educational Institutions & Hostels		7.50	120/kW	7.50	120/kW
#II-C	Actual Places of Public worship(Bi-monthly)	0-120 units	5.75	120/kW	2.85	120/kW
	Above 120 units		5.75	120/kW	5.75	120/kW
III-A(1)	Cottage and Tiny Industries, Agricultural and allied activities, Sericulture, Floriculture, Horticulture and Fish/Prawn culture etc. (contracted load shall not exceed 12 kW) (Bi-monthly)					
	upto 500 units		4.00	40/kW	4.00	40/kW
	above 500 units		4.60		4.60	
#III-A(2)	Power Looms (contracted load shall not exceed 12 kW) incl. Winding etc.(Bi-monthly)					
	(750 units bimonthly is free) upto 500 units		5.20	120/kW	0	0
	501-750 units		5.75		0	0
	751-1000 units		5.75		2.30	70/kW
	1001-1500 units		5.75		3.45	
	above 1500 units		5.75		4.60	
III-B	Industries(Not covered under LT-III-A(1) & III-A(2)) , If the connected load of all industries in LT-III-A(1) & III-A(2)connected load exceeds 12 kW, welding sets and IT		6.35		6.35	70/kW
*IV	Agricultural, sericulture, floriculture, horticulture and fish/prawn culture etc., - Till installation of meters (Fully subsidised by the Govt.)		0	Rs.2875/HP/ Annum	0	0
	On installation of meters (Fully subsidised by the Govt.)		3.22	0	0	0
V	Commercial (Not covered under LT-I-A, I-B, I-C, II-A, II-B(1), II-B(2), II-C, III-A(1), III-A(2), III-B, IV and VI)					
	consumption upto 100 units bi-monthly	0-100 units	5.00	140/kW	5.00	140/kW
	consumption above 100 units bi monthly	(for all units)	8.05	140/kW	8.05	140/kW
VI	For temporary activities, construction of buildings and Lavish illumination, additional construction of beyond 2000 square feet in the premises of an existing consumer.		12.00	690/kW	12.00	690/kW
	Lavish illuminations					

ANNEXURE II

NO.	ASSUMPTIONS		SOURCE
1	Annual tariff rate increase domestic	8.00%	assumed
2	Annual tariff rate increase selected LT consumers	8.00%	assumed
3	Annual tariff rate increase selected HT consumers	5.00%	assumed
4	Annual increase in energy consumption domestic	5.00%	assumed
5	Annual increase in energy consumption selected LT consumers	3.00%	assumed
6	Annual increase in energy consumption selected HT consumers	3.00%	assumed
7	Grid availability factor	97.00%	assumed
8	CUF of solar PV system	19.00%	assumed
9	Annual degradation of solar	1.00%	assumed
10	TANGEDCO APPC (INR/kWh)	5.81	Derived from TANGEDCO P&L 2017-18
11	TANGEDCO average billing rate w/o demand charges (INR/kWh)	4.54	Derived from TNERC tariff order 2017
12	Net feed-in tariff (INR/kWh)	2.28	TNERC order 2019
13	Local distribution losses	10.00%	assumed
14	Operation and Maintenance Expenses in year 1	1.40%	TNERC order 2018
15	Annual increase in Operation and Maintenance Expenses	5.72%	TNERC order 2018
16	Insurance (% of depreciated asset value)	0.35%	TNERC order 2018
17	Depreciation Rate	3.60%	TNERC order 2018
18	Equity	30.00%	TNERC order 2018
19	Debt	70.00%	TNERC order 2018
20	Loan tenure (years)	10	TNERC order 2018
21	Moratorium (years)	1	TNERC order 2018
22	Loan tenure for EMI domestic consumers (years)	5	TNERC order 2018
23	Moratorium for EMI domestic consumers (years)	0	TNERC order 2018
24	Interest on loan	10.55%	TNERC order 2018
25	Interest on working capital	11.55%	TNERC order 2018
26	Inflation rate/annual increase in cost of supply	5.00%	TNERC order 2018
27	Discount rate for NPV	9.53%	TNERC order 2018

July 2020

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