NET METERING IN BRAZIL: SETTING THE SCENE FOR THE REGULATORY FRAMEWORK REVIEW

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ABSTRACT[1]

Many countries have been adopting policy approaches to stimulate small-scale distributed generation. In this scenario, in 2012, the Brazilian Electricity Regulatory Agency published the first regulatory framework on a net metering scheme for small-scale generators. In 2015, a first framework review was finished when new business models for virtual net metering were introduced. Projections then indicated that installed power could reach significant levels by 2019 while accomplished numbers were continuously exceeding estimations. Consequently, a second major review was scheduled. The paper presents the recent developments of small-scale DG in Brazil and its regulatory framework evolution. Motivations for the second general review and an overview of its main aspects are also highlighted.

INTRODUCTION

The Brazilian Electricity Regulatory Agency (ANEEL) was created in 1997 and it is in charge of the regulation and oversight of the electricity sector in a national level encompassing generation, transmission, distribution and commercialization. There are currently 54 electricity distributors in Brazil which are concession holders. They are responsible for the operation and maintenance of the distribution network as well as the commercialization of electricity in the regulated market. Concession areas vary from municipalities to entire states.

In the last years, many countries have adopted policy and regulatory approaches to promote the connection of small-scale distributed generation (DG) into the grid. Their objectives vary from the need to enlarge participation of renewables in the electricity sector to the achievement of technical benefits, such as losses reduction and voltage level improvement in distribution feeders. Following this global trend, in 2012, ANEEL published the first regulatory framework so as to allow small-scale generators to participate in a net metering scheme in Brazil [1]. The main purpose of the regulation was to reduce barriers for the connection of small-scale renewables in the system.

1 The opinions expressed in this paper are those of the authors and do not necessarily reflect the position of the Brazilian Electricity Regulatory Agency.

In Table 1, it is presented the original regulatory eligibility criteria. Basically, a net metering model was designed in which net excess generation from participant consumers injected into the grid creates “electricity credits” which can be used to offset consumption locally or in remote buildings under the same ownership (virtual net metering). Complementary, technical procedures were incorporated to the Brazilian electricity distribution code with details on access to the grid and measuring systems requirements [2].

FIRST GENERAL REVIEW

In 2015, after discussions with stakeholders and a public hearing carried out by ANEEL, a first general review of the framework was completed. Current eligibility conditions are shown in Table 1.

Business models

In the 2015 review, new business models for virtual net metering were introduced. Roughly speaking, it became possible for blocks of flats to share a single on-site generator (aggregated net metering) as well as for different consumers to share a single off-site generation (shared net metering). Thus, the regulatory model created new opportunities for the development of the small-scale renewables market. There are currently four different models by which electricity credits can be used to compensate consumption from participants:

a) Local systems: the most common DG configuration in which consumers install a small-scale power plant and take advantage of the electricity locally produced. This arrangement has the potential to reduce the electricity bill from the facility where the power plant is located;

b) Virtual net metering: consumers which cannot install an on-site generator can receive electricity credits from a remote DG power plant. Net excess generation produced off-site can be used to compensate consumption from several buildings provided the DG power plant and the buildings are associated to the same consumer and connected to the grid of the same electricity distributor;

c) Aggregated net metering: regulation grants the right to multiple premises (stores in shopping malls and blocks of flats, for instance) to install a single on-site DG power plant and share the electricity produced among the various premises;

Table 1 – Net metering criteria [1]

Category	2012 Original Regulation	Current Regulation
Sources	Hydro, photovoltaic, wind, biomass, qualified* CHP	Any renewable and qualified* CHP
Installed power (P)	P ≤ 100kW (micro-generation) 100 kW < P ≤ 1 MW (mini-generation)	P ≤ 75 kW (micro-generation) 75 kW < P ≤ 5 MW (mini-generation)
Location	Installed in premises connected to the distribution network	Installed in premises connected to the distribution network
Electricity credit expiry	36 months	60 months
Net excess generation compensation model	Local Virtual net metering	Local Virtual net metering Aggregated net metering Shared net metering

*In accordance with ANEEL's requirements.

d) Shared net metering: consumers can join together and install an off-site DG power plant which is shared by all participants in the project. Each one owns a percentage of the total electricity generated by the power plant which will be used to offset individual consumptions.

Market data

Net metering models have expanded conditions for investments in DG in Brazil and this section presents information on how market has been responding to the regulatory framework. Electricity distributors are required to periodically inform data on new DG connections which come to integrate the net metering scheme. Information is constantly monitored by ANEEL and publicly available [3]. In this section, data commonly refers to the end of December 2018, but numbers are approximated since information is continuously updated.

The participation of each generation source in terms of installed power and number of systems is presented in Table 2. It is noteworthy the massive predominance of photovoltaic (PV) systems which represent about 83% of total installed capacity and more than 99% of the participants. This trend, also observed in other countries, is mainly due to PV systems' modularity and their simplicity of installation in urban areas.

In regard to types of consumers, in Table 3 it is shown the distribution of total installed power and amount of systems among consumption classes. Commercial consumers account for the majority of the installed power although they are not predominant in terms of number of systems. This evidences that power plants installed by commercial consumers are typically larger than residential generators. In absolute numbers, the majority of installed systems are within the 0-5 kW range, as indicated in Table 4. Despite not being very representative in terms of quantity, the range 30-75 kW accounts for the largest fraction of installed capacity. Considering the mentioned tables, it can be claimed that the two typical types of DG power plants in the net metering scheme are those described in Table 5.

Table 2 – Participation of sources in the scheme by 2018 [3]

Source	Quantity of Systems		Installed Capacity	
	No.	%	MW	%
Solar PV	51,640	99.5	528	83.4
Thermal	131	0.3	37	5.8
Hydro	63	0.1	58	9.2
Wind	57	0.1	10	1.6
Total	**51,891**		**633**	

Table 3 – Participation of classes in the scheme by 2018 [3]

Class	Quantity of Systems		Installed Capacity	
	No.	%	MW	%
Residential	38,939	75.0	189	29.9
Commercial	8,730	16.8	284	44.9
Industrial	1,425	2.8	81	12.8
Rural	2,376	4.6	61	9.6
Others	421	0.8	18	2.8
Total	**51,891**		**633**	

Table 4 – Participation of capacity ranges in the scheme by 2018 [3]

Installed Capacity Band (kW)	Quantity of Systems		Installed Capacity	
	No.	%	MW	%
0-5	32,948	63.5	102	16.1
5-15	11,947	23.0	105	16.6
15-30	3,725	7.2	84	13.3
30-75	2,706	5.2	135	21.3
75-200	383	0.7	43	6.8
200-1000	154	0.3	88	13.9
1000-5000	28	0.1	76	12.0
Total	**51,891**		**633**	

Table 5 – Typical power plants in net metering scheme by 2018 [3]

Category	Source	Class	Average installed power (kW)
Small (micro-generation)	PV	Residential	8.31
Large (mini-generation)	PV	Commercial	366.94

Within the 2015 review, projections were made with regard to the evolution of installed power of generators in the net metering model, as presented in Figure 1. Estimations signalised that total installed capacity would reach significant levels by 2019. Moreover, it was considered that this trend could have potential negative impacts on tariff levels and on the recovery of distribution costs.

Consequently, ANEEL decided to schedule a second general review to happen by the end of 2019 with focus on the model economic case. In other words, discussions would tackle how distribution network costs are allocated among participants. From data periodically informed by distributors, it was possible to observe that accomplished numbers were continuously exceeding 2015 estimations, as highlighted in Figure 1. An evaluation of the amount of installed systems in the past years shows that there was a considerable growth in the number of systems even before changes on the model in 2015. Considering the market opportunities brought by the new business models for electricity compensation in the 2015 review, models can be claimed as part of the reasons for the relatively fast evolution of the number of systems.

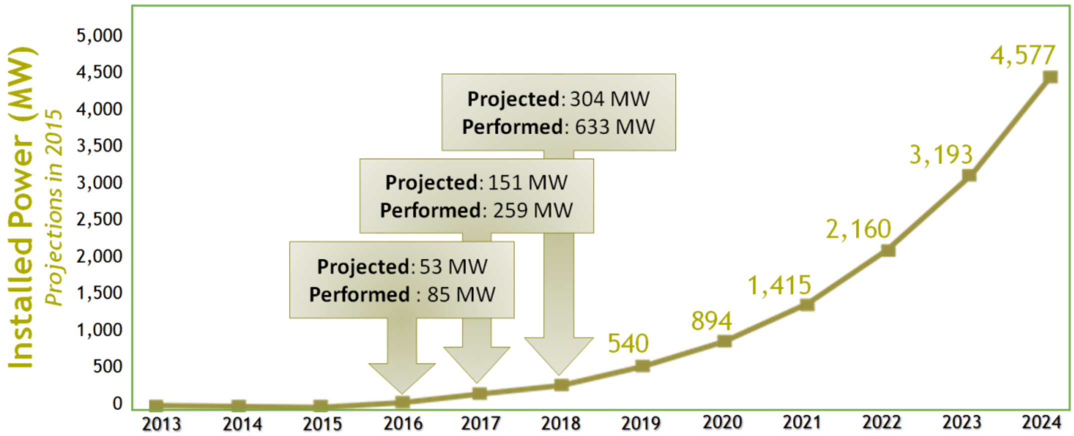

Figure 1 – Estimations and performance of installed power from net metering generators in Brazil [3], [4]

SECOND GENERAL REVIEW

Following the 2015 review, the major problem identified was a potential imbalance between the valuation of net excess generation (according to the 2015 regulatory framework) and the maturity level DG will reach in the short term. In this context, ANEEL decided to investigate the issue through a Regulatory Impact Analysis (RIA), a widespread model which is highly recommended to regulators worldwide by important international bodies such as the Organization for Economic Cooperation and Development (OECD) [5].

The aim of the study is to review the existing regulatory model so as to allow small-scale DG to develop sustainably, taking into account distribution costs which are also covered by other network users. In other words, it is necessary to manage potential economic impacts which may arise from the expected DG market progress and, at the same time, not to restrain the development of small-scale renewables. Following the RIA structure, alternatives to tackle the problem ought to be designed which in this case are based on the distribution tariff components which will be applied in the net metering scheme. For each alternative, impacts are assessed so as to identify correspondent costs and benefits to participants and other consumers.

Building scenarios

Six scenarios were conceived according to different forms of valuing net excess generation injected into the grid by participants. Roughly speaking, distribution tariff is formed by several components and each scenario is characterised by groups of them, as shown in Table 6. In practical terms, in each alternative, net excess generation is valued by the correspondent tariff components and the result is then used to compensate consumption costs in the electricity bill (with consumption valued by the electricity retail tariff).

Scenario 0 is the baseline case in which current status is preserved, which means that net excess generation is valued at retail rate (all tariff components). The other five scenarios estimate different alternatives of valuing net excess generation by eliminating tariff components. In Scenario 1, for instance, tariff share which accounts for the distribution network costs is not considered. This means that 1 kWh injected into the grid would represent less than 1 kWh of electricity credits for billing purposes.

Table 6 – Tariff components in the RIA alternatives

Distribution Tariff Components	Scenarios 0	1	2	3	4	5
Distribution system	✓					
Transmission system	✓	✓				
Charges	✓	✓	✓			
Electricity losses	✓	✓	✓	✓		
Sectoral charges + Others	✓	✓	✓	✓	✓	
Electricity	✓	✓	✓	✓	✓	✓

Assessing impacts

It was established that the impacts brought by each alternative would be assessed from two perspectives: the typical consumer which takes part in the net metering scheme (participant consumer) and the other consumers of the electricity distributor which are not participants (other consumers). The impact analysis of each alternative contemplates three stages:

1) Payback: to assess the payback for a participant consumer according to the chosen alternative and the year of installation (considering market tends to consolidate and DG installation costs to decrease as time goes by);

2) Penetration level: to project the amount of consumers which will join the scheme (and consequently the installed power from DG) using the Bass diffusion model [6] with the payback estimated previously;

3) Impacts: to assess positive and negative impacts for both participant and other consumers according to the penetration level (number of installations and total installed power) from previous step.

The categories of impacts are listed in Table 7. Additionally, some positive externalities which are proportional to the number of DG installations were also considered in the study, such as reduction of greenhouse gases emissions and job creation.

Proposing alternatives

In a nutshell, the RIA seeks a balance between the development of DG market and the consequent benefits to the electricity sector. Thus, the study opted for combining the possible scenarios described in Table 6 so as to create alternatives with the following objectives:
1) in the short run, the alternative should present an attractive payback to consolidate DG market; and
2) in the long run, benefits from the achieved DG penetration level should be captured by the sector.

Table 7 – Impacts considered in the regulatory review

Consumer	Impacts	
Participant	Positive	Reduction in electricity bill
		Reduction in taxes (from electricity bill)
	Negative	Installation costs
		Maintenance and substitution costs
		Additional distribution costs due to network availability and remote use of electricity credits
Others	Positive	Reduction in electricity purchased by distributors from centralised generators
		Reduction in transmission and distribution losses (kWh)
		Reduction in generation capacity (kW) needs to meet system demand requisite
		Extra revenue from additional distribution costs paid by participants to meet distributors revenue needs
	Negative	Reduction in distributors electricity market from where to meet distributors revenue needs

The initial proposal considered that the new regulation would be applied from 2020 while net present value and other calculations for positive and negative impacts used the 2020-2035 horizon. The proposal applied two different approaches depending on the form electricity is compensated in the scheme: local systems (applied to local compensation and aggregated net metering models) and remote systems (virtual and shared net metering models). Moreover, grandfather rights would apply to participants who install systems before the new regulation comes into force. The grandfather provision would last for 10 or 25 years, depending on the system's date of connection.

In regard to local systems, RIA led to the initial perception that maintaining the current net metering model indefinitely can result in relatively high economic impacts and an increase in distribution tariffs to non-participant consumers. Consequently, the recommended approach was to maintain the current status (Scenario 0) until local systems market consolidates with the installation of about 3.36 GW in a national level. As soon as that capacity trigger is reached, it is proposed to shift to Scenario 1, in which new participants start to respond for distribution system costs in electricity compensation. It is worth mentioning that, in practice, each distributor would have an individual capacity trigger which would be determined proportionally to the participation of its DG market nationally. This approach would allow areas with higher penetration levels to shift sooner to the long-term scenario.

In relation to remote systems, RIA has shown that holding existing rules would be even more problematic in terms of economic consequences to non-participants. The study indicated that the adoption of Scenario 3 would be recommended. However, a straight change from current status could possibly curb the intended development of DG market. Thus, the alternative would contemplate a transition period in which there would be two shifts: from Scenario 0 to Scenario 1 when the capacity level of 1.25 GW is reached nationally for remote systems and finally to Scenario 3 when the national capacity of 2.13 GW is achieved for remote systems. As for local systems, individual capacity triggers would be applicable for each electricity distributor.

In case both approaches for local and remote systems are followed, estimations indicate that the evolution of total installed capacity within the net metering scheme would evolve as presented in Figure 2. At the end of the study horizon in 2035, installed power from DG systems in the model would reach around 22 GW.

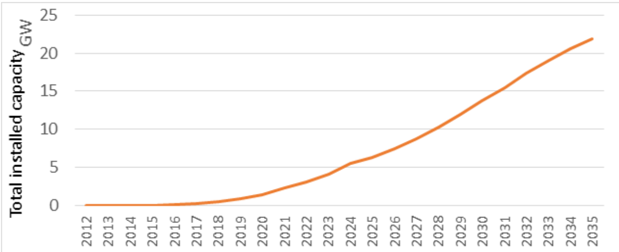

Figure 2 – Projections for total installed capacity according to the scheme review proposal

Future steps

It is worth highlighting that the proposal for the regulatory review presented in this paper represents the most recent RIA at the time of writing but may be subject to modifications. The public hearing to be conducted by ANEEL to discuss the final proposal with stakeholders and society is planned to happen in two stages. Firstly, conclusions of the RIA are expected to be submitted to public comments in early 2019. Afterwards, the alternative defined in the eventually revised RIA will support a draft resolution which will be discussed with society in a second stage. According to ANEEL's agenda, the review should be finished by December 2019.

CONCLUSIONS

In 2012, ANEEL established the first regulation in Brazil encompassing small-scale DG in a net metering scheme. The model underwent a first general review in 2015 when estimations indicated that installed capacity by 2019 could impact on the recovery of distribution costs and a new review was scheduled. Currently, a typical small system in the scheme is residential, photovoltaic and has around 8 kW. Complementary, larger systems are usually photovoltaic, installed by commercial consumers and have about 367 kW. By December 2018, DG systems in the scheme accounted for approximately 633 MW distributed among around 51,891 installed generators. ANEEL decided to tackle the current review using a RIA, an internationally recommended regulatory tool. Six scenarios were designed according to different forms of valuing net excess generation. Subsequently, each scenario was analysed by assessing the payback for participants; estimating the penetration level; and assessing positive and negative impacts for participants and other consumers.

As a result, the study opted for combining scenarios in diverse approaches for local and remote systems. The proposal will be submitted to a public hearing and the review is intended to be finished by 2019. Following the implementation of the new regulation, planned to come into force from 2020, the constant monitoring of the market will allow assessing if intended objectives are achieved. Specifically, the major aim is to promote the development of DG market in the short run so as to gather benefits for the electricity sector in the long term.

REFERENCES

[1] Agência Nacional de Energia Elétrica – ANEEL, 2012, *Resolução Normativa nº 482/2012*, Brazil. Available at: www.aneel.gov.br/cedoc/ren2012482.pdf [Accessed on 14/01/2019].

[2] Agência Nacional de Energia Elétrica – ANEEL, 2017, *Procedimentos de Distribuição de Energia Elétrica no Sistema Elétrico Nacional (PRODIST) – Módulo 3 (Acesso ao Sistema de Distribuição) – Revisão 7*, Brazil. Available at: www.aneel.gov.br/modulo-3 [Accessed on 14/01/2019].

[3] Agência Nacional de Energia Elétrica – ANEEL, *Unidades Consumidoras com Geração Distribuída.* [online] Available at: www.aneel.gov.br/geracao-distribuida [Accessed on 11/01/2019].

[4] Agência Nacional de Energia Elétrica – ANEEL, 2017, *Nota Técnica nº 0056/2017-SRD/ANEEL – Projeções 2017*, Brazil. Available at: www.aneel.gov.br/geracao-distribuida [Accessed on 14/01/2019].

[5] Organization for Economic Cooperation and Development – OECD, 2018, *OECD Regulatory Policy Outlook 2018*, OECD Publishing, Paris, France. Available at: doi.org/10.1787/9789264303072-en [Accessed on 14/01/2019].

[6] KONZEN, G., 2014, *Difusão de sistemas fotovoltaicos residenciais conectados à rede no Brasil: uma simulação via modelo de Bass*, Master's Dissertation, University of São Paulo, São Paulo, Brazil. Available at: www.iee.usp.br/lsf/sites/default/files/Dissertacao_Gabriel_Konzen.pdf [Accessed on 14/01/2019].