White Paper

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Net-metering concept for Small Scale Embedded Generation in South Africa

prepared for

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1 Introduction

1.1 Purpose and Scope

During meetings in the offices of SALGA with AMEU as a reference group on 25. 07. 2013 and 07.11.2013, possible options for a legal and technical framework for the connection of rooftop-PV systems in South Africa have been discussed.

The net-metering concept is proposed on the base of these discussions. The following main aspects should to be considered, by standard conditions for Small Scale Embedded Generators:

- Ensure safety of operating personnel.
- Ensure that impact on power quality in local distribution networks is low.
- Low administrative overhead so that also private customers can participate in it.
- High security of investments into Small Scale Embedded Generators (mainly rooftop PV systems).
- Export tariff that provides sufficient incentive to avoid illegal connection of Small Scale Embedded Generators.
- Export tariff that is sufficiently low for not creating an additional burden to overall electricity costs.
- Tariff that provides an incentive for timely generation of electricity.
- Low overhead costs for additional equipment, such as meters etc.
- Fair coverage of costs of grid usage.

The paper is to be seen as a proposal and not as any binding document.

1.2 Background Net-Metering

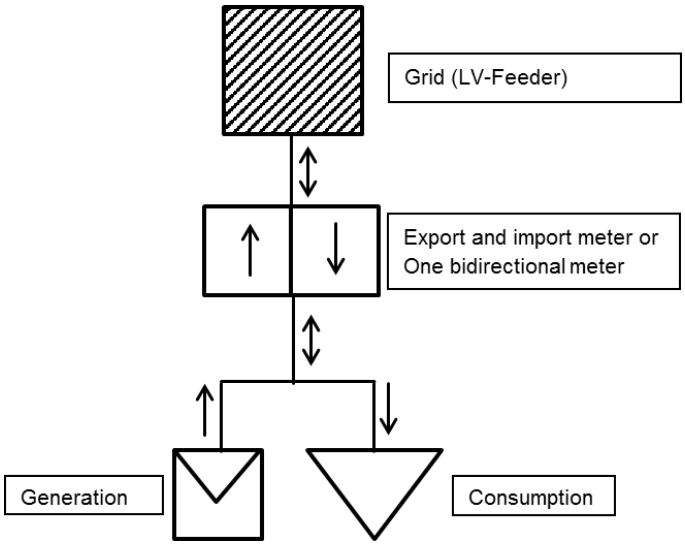

Figure 1 – Bidirectional metering arrangement for net-metering

Net-metering concepts are used widely on international level for remunerating rooftop PV-systems, e.g. in USA, Morocco, Brazil (see also [1]) and the Philippines [2].

Unfortunately, there is no generally applicable definition of the term “net-metering”. Therefore, some definitions are required for explaining the meaning of “net-metering” in this document.

In this document, the term Net-Metering is referred to a tariff scheme having the following characteristics:

- The tariff scheme is applicable to a local generator-load combination only (and not to a generator without load or to configuration where generator and load are installed remotely).
- A net-metering client is still considered to be a consumer and not a generator.
- A net-metering client can export and import electrical energy.
- Tariffs for export and import can either be the same (“classical net-metering”, e.g. USA) or different (example: Philippines, Germany).
- Over a billing cycle (e.g. one year) the remuneration of exported electricity is capped to the value of imported electricity (no net payment possible).

The actual metering arrangement required for implementing a net-metering scheme is depicted in Figure 1. The actual meters can either be realized by one bi-directional meter or by two unidirectional meters. With such a metering arrangement, it is possible to assign individual tariffs for net-export and net-import of energy and hence creating an incentive for timely delivery of electricity.

2 Proposed Concept

A net-metering scheme covering the following aspects is proposed:

- Maximum size for applicability of net-metering is equal to 100kVA.
- Fix import tariff and fix export tariff.
- Costs for grid usage: Based on connection capacity (kVA, import or export).
- Net billing cycle: 1 year.
- Obligation of the grid operator to take the exported energy (under normal operating conditions)
- Guaranteed export tariff for a duration of at least 3 years
- Technical rules for interconnection: No application of the Grid Code for Renewable Generation but introduction of a simple set of rules for the installation of net-metering systems based on NRS 097-2-3.

This list represents at the same time the relevant parameters that must be defined for finalizing the concept. An overview about proposed settings of the relevant parameters are shown in Table 1.

Table 1: Discussion of proposed Net-Metering Scheme

Proposal	Discussion	Ref.
Applicability of net-metering to installations having an installed capacity <100kVA and LV connection.	- Applicability of net-metering must be limited. Actual limit to be discussed. - 100kVA limit seen as an initial limit until initial experience with Small Scale Embedded Generators could be gained. Could be increased afterwards (e.g. up to 1MVA). - Small Scale Embedded Generators having an installed capacity greater than the defined limit will automatically be treated as generators (requiring a NERSA license), irrespective of the associated load.	3.1
Bi-directional (or two unidirectional) meters	- Required for net-metering with different export and import tariffs.	3.2
Fix import and export tariff, Time of Use tariff is possible but cannot be mandatory for net-metering users	- Fix tariffs are simple to apply and don't require special metering equipment. - Return of investment can easily be predicted. - Low administrative overhead - No Smart Meter required	3.3
Export Tariff below import tariff	- Incentive for timely export of electricity (e.g. through storage, timely operation of heating systems etc.) automatically provided. - Export tariff should not be too low because it represents an incentive for legal connection, which could get lost in case of too low tariffs. - Shall be a fair value, e.g. can be defined in-line with the usual purchase price of electricity of the distribution utility.	3.3
Net billing cycle of 1 year	- Net billing cycle should at least be 1 year (across all seasons) for ensuring that electricity generated in summer will be fully remunerated (e.g. high summer production balanced off by lower production in winter) - Net billing cycle >1 year will probably have implications with regard to tax declarations.	3.3
Obligation of the DU to take the exported energy und normal operating conditions	- Investment security (bankability) - Subject to technical feasibility of the installation, which must be evaluated prior to connection, during the application process and must not be withhold unreasonably.	3.6
Guaranteed export tariff for a duration of at least 3 years	- Ideally the guaranteed export tariff should cover the entire pay-back period of the Small Scale Embedded Generator but this is not feasible according to existing legislation. - Long guarantee required for investment security (bankability) - Duration of three years turned out to be the maximum	3.3

Proposal	Discussion	Ref.
	possible guarantee period according to current legislation (to be verified by legal advisors).	
Costs of grid usage should be on kVA basis and should cover network management and administrative services of DU	- Import tariff (kWh) must be reduced correspondingly for not increasing overall cost of electricity. - Total cost of electricity of a User with average consumption must not increase when switching over to a Net-Metering-Tariff (without considering generation). In other words: energy produced by Small Scale Embedded Generator shall always lower electricity bills, even if generation is very small. - Exaggerated fixed charges for grid usage basis would endanger economic viability of most rooftop PV projects. - Exaggerated fixed charges lead to low variable charges (cost of energy/kWh) and therefore create an incentive for high consumption (and reduces the incentive for energy efficiency measures) - Too low fixed charges could endanger the economic viability of DUs. - Grid usage on kWp basis (instead of installed kVA) would create an additional incentive for timely generation/consumption/installation of storage but would require Smart Metering and have therefore not been considered by the working group.	3.4
Technical Rules for Interconnection of Net-Metering Systems	- One document focusing on safe installation, safe operation and avoidance of negative impact on power quality (basis: NRS 097-2-1). - No application of the rules and procedures described in the Grid Code for Renewable Generation, which would be too complex for Small Scale Embedded Generators.	3.4

3 Discussion

3.1 Applicability

An absolute limit of the applicability of net-metering should be foreseen. In any case, only installations having a connection to an LV grid should be entitled to use the net-metering schemes. All other connections should be treated as generators, irrespective of the associated load.

The working group has confirmed 100kVA as reasonable limit, at least during an initial phase until relevant experience with Small Scale Embedded Generators could be gained.

In the medium to long term, this limit could potentially be increased to 1MW/1MVA because this is at the same time the maximum installed capacity with an LV connection (directly at the transformer station).

The limit of 100kVA will probably not allow larger rooftop-PV-installations on commercial buildings, such as offices, hotels or supermarkets to participate in the Net-Metering program. These installations would still require a NERSA generator license. On the other hand, net-metering could be a very interesting option to these users because of their positive correlation between solar generation and consumption.

It is also possible that larger installations will be artificially split for not exceeding the 100kVA limit, which is also not in NERSA's interest.

Additional limitation of the size of a rooftop PV-installation, e.g. limiting the installed capacity to peak demand, as it is practice in other countries (e.g. USA), is not required here, because the fact that export tariffs are below import tariffs will make installations that are much larger than the associated load unprofitable.

3.2 Metering Arrangement

Since the proposed concept for Small Scale Embedded Generation foresees an export-tariff that is different from the end-user/import tariff, the metering setup must explicitly distinguish imported and exported energy according to the following definition:

Import: Local Load ≥ Local PV Generation => Residual Load ≥ 0

Export: Local PV Generation > Local Load => Residual Load < 0

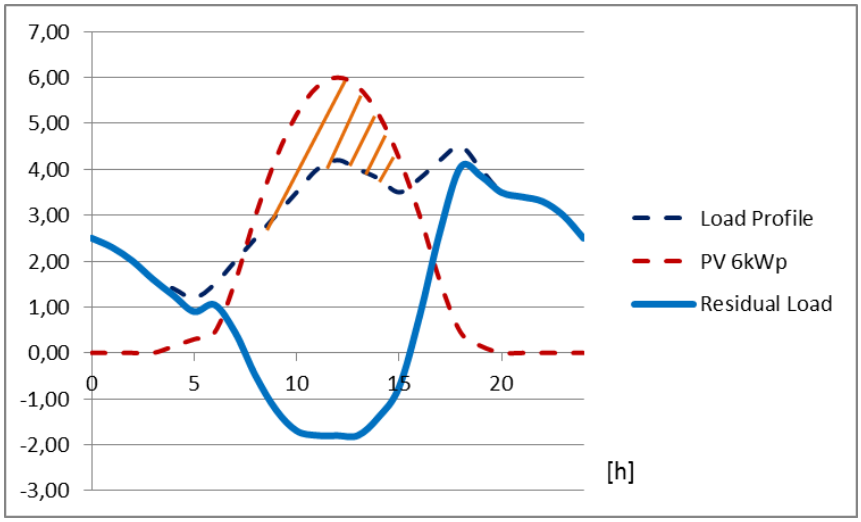

Figure 2: Load, generation and residual load profile

This can be realized either by two unidirectional meters or one bidirectional meter having two separate registers (import and export register) as shown in *Figure 1*.

3.3 Tariff

From a costumer/investor perspective, net-metering in combination with a rooftop PV system is economically viable when there is a return of investment within an acceptable period of time. This depends on investment costs, produced energy, electricity tariff and the tariff considered for exported electricity.

Initial expenditure mainly consists of investment for the PV modules and inverters, with additional cost for its installation.

If the remuneration concept uses an export tariff that is below the end-consumer-tariff, the incremental earnings per kWp will decrease, when the locally generated energy exceeds local consumption during some times of the day. This will basically always happen in the case of residential consumers, whose load can easily drop down to almost zero during mid-day, when nobody is at home. However, in the case of commercial end-users, demand and PV-generation are much better correlated and therefore, a PV system can be sized so that the complete energy produced can be used for self-consumption (at least during working days).

These considerations lead to the following conclusions with regard to the proposed tariff scheme:

- The proposed tariff scheme provides better incentives for commercial end-users than for private users.
- The proposed tariff scheme provides an incentive for timely use of energy (e.g. heating warm water tanks/swimming pools etc. during mid-day and not during evening peak) without the need for special time-of-use tariffs.
- The proposed tariff scheme will automatically limit the size of PV-rooftop installations to the size of the corresponding load, which will automatically reduce or even avoid grid problems relating to situations with high power reversals (e.g. high voltages during high power exports).

Besides the actual value of the export tariff the following aspects should be considered for enabling bankability of rooftop PV-investments:

- Export tariff should ideally be fixed over a period equal to the pay-back period of the Small Scale Embedded Generator.
- The grid operator must be obliged to take and remunerate the exported electrical energy under normal operating conditions during the same period.

Without these two criteria, the required investment security wouldn't be given and the bankability of rooftop PV-systems would be endangered.

3.4 Grid Usage

For residential users, grid usage is usually paid on a kWh basis, even if in reality, grid-dependent costs depend on the installed connection capacity (in kVA) instead of energy lows (in kWh).

A net-metering concept in combination with a kWh-only tariff, every produced kWh of a Small Scale Embedded Generator reduces at the same time costs of grid usage, even if PV-systems (without storage) don't reduce the maximum power consumption (kWp) and hence the required grid capacity.

This obviously justifies a tariff scheme, in which grid usage is paid on a kWp or kVA basis and not on a kWh basis. On the other hand, such a tariff scheme considerably reduces the economic viability of most Small Scale Embedded Generators. Therefore, the connection fee (on kVA basis) must be carefully defined for not endangering the economic viability of Small Scale Embedded Generators.

When deciding on the actual tariff, the following aspects should also be kept in mind:

- Introducing a fixed component in the tariff (kVA basis) requires lowering the variable part (on kWh basis) of the tariff. Otherwise, overall cost of electricity would increase, which could not be justified.
- The tariff for Net-Metering Users (fix/variable charge) should be configured in a way that for a user with average consumption, cost of electricity doesn't increase when switching over to a Net-Metering Tariff (even without any credits for generated electricity).
- The fix tariff component must be sufficiently high for covering the DU's expenses for grid services and administration.
- On the other hand, it has to be considered that high fixed charges lead to lower variable charges, which in turn reduces incentives for investments into increased energy efficiency.

Hence, the decomposition of residential tariffs into fix/variable components require careful balancing and it is recommended that every Net-Metering Tariff will have to be approved by the NERSA.

3.5 Technical Rules for Grid Connection

Currently, there are two standards or guidelines in place that apply to Small Scale Embedded Generation:

- NRS 097-2-1:2013
- NERSA Grid Code for Renewable Generation [3].

From a legal point of view, the NERSA grid code is the much stronger document, because it is legally binding.

However, its applicability to Small Scale Embedded Generators is very low and its technical requirements are not complete (e.g. with regard to safety or protection aspects). Besides this, compliance validation procedures proposed by the NERSA Grid Code for Renewable Generation [3] are by far too complex for Small Scale Embedded Generators and require engineering services that would probably cost more than the entire installation.

For this reason it is proposed to define a separate document named “Technical Rules for the Interconnection of Small Scale Embedded Generators in South Africa”, in which all required technical rules and compliance procedures are described. Such a document should include the following aspects:

- General requirements for electrical installations in South Africa (with reference to the applicable standards)
- Guidelines for the installation of net-metering equipment (arrangement of breakers and disconnectors, protection-related aspects, metering arrangement)
- Voltage and frequency ranges of unrestricted operation
- Power quality aspects

These technical rules should be based on NRS 097-2-1:2013, which are very well elaborated but in some parts not sufficiently specific to the South African situation.

3.6 Investment Security

Experience in other countries has shown that investment security is a key factor to the success of a regulatory framework for renewable energy projects.

For this reason, it is important that:

- It is ensured that a DU cannot decrease the export tariff during a guaranteed period. This period should ideally be in-line with the pay-back period of a rooftop PV-installation.
- The distribution network operator is obliged to take the exported electricity under normal operating conditions during the same period

Without these aspects, the benefits of net-metering would be substantially reduced.

4 Summary

This document proposes a remuneration scheme for Small Scale Embedded Generators <100kVA and LV connection (in particular rooftop PV systems) in South Africa.

It addresses a series of issues that were discussed during meetings of representatives of municipalities, Eskom, AMEU, GIZ and its consultants hosted by SALGA on 25.07.2013 and 07.11.2013 in Pretoria.

The proposed approach is based on an advanced net-metering concept considering different tariffs for net-export and net-import of electrical energy.

The document should provide an input into the decision-making process and indicate possible solutions for the various issues and problems that distribution utilities may face when introducing such a concept.

5 References

[1] ECOFYS, GIZ, *Lessons for South Africa from international experience on support mechanisms for micro-RE generation,* 2013.

[2] M.P.E. GmbH, GIZ GmbH, *Manual for Interconnection - Report for supporting the interconnection of rooftop-PV systems in the Philippines,* 2013.

[3] NERSA South Africa, *Grid Connection Code for Renewable Power Plants (RPPs) Connected to the Electricty Transmission System (TS) or the Distribution System (DS) of South Africa,* 2012.