How to stimulate the South African rooftop PV market without putting municipalities’ financial stability at risk
A “Net Feed-in Tariff” proposal

CSIR Energy Centre
Status: 21 January 2015
Disclaimer

All numbers used in this presentation are either market data to the best of the author’s knowledge (e.g. cost and performance of PV) or they are indicative for demonstration purposes only (e.g. the level of the proposed NETFIT).

The business case mentioned in the presentation is a typical business case based on high-level assumptions. It does not recommend any investment into PV and should not be used as a basis for any decisions with respect to investments into PV or other renewables in South Africa.
Embedded Photovoltaic (PV) generators are at retail grid parity in South Africa today and are even cost-competitive to alternative new-builds

- PV is a cost-competitive supplement to the main electricity supply for many electricity customers in South Africa today
- A combination of drastically reduced prices for Photovoltaic (PV) systems (minus 70-80%) and significantly increased retail electricity tariffs (plus 130%-150%) over the last five years is the reason for this PV cost competitiveness
- The total lifetime costs of a residential PV system today are between 0.8-0.9 R/kWh, whereas residential electricity tariffs range from 1.1-1.4 R/kWh (both excl. VAT), which highlights again the cost-competitive nature of PV; alternative new-build options cost 0.8-1.0 R/kWh

Doing nothing is not an option!

- This would lead to an uncontrollable “under the radar” market for embedded PV, with potentially unsafe practices
- It would furthermore lead to bankruptcy of many electricity distributors, due to lost sales & margins because of self-consumed PV energy
- And South Africa would forgo an immense opportunity for quick, inexpensive ramp-up of significant amounts of energy-supply sources

The CSIR therefore developed a Net Feed-in Tariff concept in which electricity distributors are made financially indifferent to embedded PV, and in which the business case for the PV owner is de-risked at the same time

- Create a “Central Power Purchasing Agency” (CPPA) as a government entity with nationwide reach
- CPPA compensates municipalities financially for all lost gross margins due to energy from embedded PV that is self-consumed on site
- CPPA makes a standard offer to the PV owner to pay a guaranteed Feed-in Tariff (FIT) of 0.7 R/kWh for the net PV energy that fed into the grid (a “NETFIT”) for a period of 20 years, at a predefined escalation path – this tariff is the guaranteed safety net for the PV business case
- A higher NETFIT can be paid, depending on the level of local components used (up to 0.85 R/kWh)
- The NETFIT can be adjusted for new installations to steer the size of the embedded PV market towards a target

Size of the embedded PV market could quickly reach 500 MW – 1 GW p.a., contributing significantly to the current power-supply shortage

Any new-build option increases average tariff! But a 3 GW fleet of embedded PV is one of the cheapest, adds < 2 ct/kWh (< 3%) to the tariff
Agenda

The Status Quo

Proposal: Regulatory Approach to Embedded PV Installations

Effects of the Proposed Regulatory Approach
Status today: Without embedded PV, the residential customer consumes 12,000 kWh p.a. and pays R 15,600 p.a. to the municipality.

Munic revenues: R 15,600 p.a.

Electricity bill: 12,000 kWh/yr $1.3 R/kWh

Municipal revenues: R 15,600 p.a.

Source: CSIR analysis

All numbers without VAT!
Status today: municipality buys electricity from Eskom Wholesaler and pays R 8,400 p.a. for it – therefore makes a gross margin of R 7,200 p.a.

- **Munic revenues**: R 15,600 p.a.
- **Munic costs of goods sold**: R 8,400 p.a.

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**Munic gross margin**: R 7,200 p.a. (on that specific customer)

The gross margin must cover all municipality costs other than bulk electricity purchases from Eskom (e.g. grid costs, staff, meter reading, billing, etc.).

Source: CSIR analysis
Utility-scale: PV in South Africa is cost competitive today
First three bidding windows’ results of the Department of Energy’s IPP Procurement Programme

Real-world price example: Residential-sized PV is a cost-competitive alternative to other new-build options for the power system today!

Current offer on the RSA market for a large residential PV system, high-quality components... 

- Cost of financing: 9%
- Inflation: 6%
- Lifetime: 25 yrs
- Replacem.(year 10): R 31,000 (10% of initial CAPEX)
- O&M: 200 R/kWp/yr → 3,600 R/yr
- Energy yield: 1,600 kWh/kWp/yr (very conservative) → 28,800 kWh/yr
- Module degredation: 0.8%/yr (very conservative)

0.81 R/kWh (excl. VAT) 
(today, here and now!)

- Goes down to 0.7 R/kWh at good site (1,800 kWh/kWp/yr)
- Alternative new-build options:
  - > 0.8 R/kWh (Medupi and Kusile)
  - 0.7-0.8 R/kWh for the pure fuel component of gas-fired power stations run on very cheap gas (IRP data)
- Residential tariffs are 1.1-1.4 R/kWh (excl. VAT)
- Cheapest commercial time-of-use tariffs are on average (load-profile-weighted) 0.8-0.9 R/kWh

Sources: CSIR analysis
Plus, new products appear whose implementation is not preventable

Plug-and-play PV systems on the European market, micro-inverter included

Simply plugs into the standard wall socket → that’s the grid connection

EUR 1,570 per 1 kWp (excl. VAT) → 22 R/Wp

1 kWp → approx. 1,600 kWh/yr for 25 years

→ LCOE < 1 R/kWh (@ 9% financing cost)

Implementation of such products might not be allowed/desired, but it is simply not preventable!


Thus, better embrace the development as an opportunity for the power system to get low-cost additional energy quickly
Status today: An embedded PV generator with 40% of the PV energy being self-consumed on site reduces municipality sales & gross margin

Munic revenues
- R 15,600 p.a.
- R 10,400 p.a.

Munic costs of goods sold
- R 8,400 p.a.
- R 5,600 p.a.
- R 7,200 p.a.

Munic gross margin
- R 4,800 p.a.

The gross margin on this specific customer reduces by R 2,400 p.a.
100,000 customers → R 240 million gross-margin reduction!!!

Source: CSIR analysis
Status today: Excess PV energy that cannot be consumed on site by the customer is fed into the grid with no/too little/too risky compensation.

- **Residential load**: 12,000 kWh/yr
- **PV Owner**:
  - **Gross PV generation**: 10,000 kWh/yr
  - **Self-consumption**: 4,000 kWh/yr
  - **Net feed-in**: 6,000 kWh/yr
  - **Payments**
    - **Electricity bill**: 8,000 kWh/yr
      * 1.3 R/kWh

**Highly risky “two-revenues” business case for the PV owner. Only PV projects with very quick payback will be implemented (at high effective costs to the system!)**

**Sum of energy stream A and B equals the total amount of PV energy**

Source: CSIR analysis
Status today: None of the key stakeholders’ concerns is addressed with respect to embedded PV generators

<table>
<thead>
<tr>
<th>Player</th>
<th>Concern</th>
<th>Addressed?</th>
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</table>
| Munics                | • Municipalities will go bankrupt (loose out on gross margin from electricity sales) if no compensation mechanism for self-consumed PV energy is implemented  
                        • Administrative burden managing large-scale uptake of embedded PV                                                                                                                                     | ✗          |
| PV Owner              | • Business case not attractive if excess energy has to be curtailed or is not financially compensated  
                        • Business case too risky if feeding back into the grid is compensated, but not adequately or at unpredictable rates over the asset lifetime                                                                 | ✗          |
| SMMEs                 | • Utility-scale PV projects are not made for SMMEs as owners/suppliers  
                        • Rooftop PV market is ideal for SMMEs, but without continuous workflow, small companies are not willing to invest into manpower and skills                                                                 | ✗          |
| PV Manufacturers      | • REIPPP Programme very well run, but the demand is too “spiky” in order to trigger significant investments into local production of modules/inverters  
                        • Rooftop PV market attractive (it is very fragmented & provides continuous demand that is supplied through wholesaler channels), but not existing                                                                 | ✗          |
| Electricity Ratepayers| • Only PV systems with very short payback are currently implemented  
                        • That means customers with a) high tariffs and b) high demand implement PV → they therefore opt out of the cross-subsidisation mechanism, which means higher tariffs for all other customers | ✗          |

Source: CSIR analysis
Agenda

The Status Quo

Proposal: Regulatory Approach to Embedded PV Installations

Effects of the Proposed Regulatory Approach
Proposal: Create a “Central Power Purchasing Agency” (CPPA) that is the sole off-taker in South Africa of any percentage of excess PV energy.

Source: CSIR analysis
Proposal: CPPA pays the PV owner 0.7 R/kWh for the excess energy (A) at a predefined escalation path, guaranteed for 20 years.

 CPPA

Municipality

PV Owner

Net Feed-in Tariff payments
6,000 kWh/yr * 0.7 R/kWh

Net feed-in

A

PV panels

PV inverter

Residential load
12,000 kWh/yr

10,000 kWh/yr

Self-consumption

B

8,000 kWh/yr

8,000 kWh/yr

Electricity bill

* 1.3 R/kWh

6,000 kWh/yr

The guaranteed CPPA payment de-risks the PV business case and makes it bankable.

Source: CSIR analysis
Proposal: CPPA pays municipality a financial compensation, linked to amount of self-consumed PV energy (B), measured on aggregated level.

- **Net Feed-in Tariff payments**
  - 6,000 kWh/yr * 0.7 R/kWh

- **Gross-margin compensation**
  - 4,000 kWh/yr * 0.6 R/kWh

- **Net feed-in**
  - A

- **Gross PV generation**
  - 10,000 kWh/yr

- **Self-consumption**
  - B

- **Residential load**
  - 12,000 kWh/yr

- **Electricity bill**
  - 8,000 kWh/yr * 1.3 R/kWh

- **Municipal compensation**
  - R 2,400 p.a.

- **Municipal revenues**
  - R 10,400 p.a.

**Source:** CSIR analysis
Proposal: Gross-margin compensation makes municipality not better & not worse off, it simply makes it financially indifferent to embedded PV

Municipalities revenues
- R 15,600 p.a.
- R 10,400 p.a.

Municipal gross-margin compensation
- R 2,400 p.a.

Municipal costs of goods sold
- R 8,400 p.a.
- R 5,600 p.a.

Municipal gross margin (on that specific customer)
- R 7,200 p.a.

Net Feed-in Tariff payments
- 6,000 kWh/yr * 0.7 R/kWh

Self-consumption
- 4,000 kWh/yr

Electricity bill
- 8,000 kWh/yr
- * 1.3 R/kWh

Gross margin remains constant

Source: CSIR analysis
Proposal: Finally, CPPA transfers the PV energy to Eskom wholesaler, where it is blended with the energy from all other power sources.

- **PV Owner**
- **Municipality**
- **Eskom Wholesaler**
- **Conventional generation fleet**

**PV panels**

**PV inverter**

**Net Feed-in Tariff payments**
- 6,000 kWh/yr * 0.7 R/kWh

**Gross-margin compensation**
- 4,000 kWh/yr * 0.6 R/kWh

**Wholesale value**
- 6,000 kWh/yr * 0.5 R/kWh

**Residential load**
- 12,000 kWh/yr

**Eskom bill**
- 8,000 kWh/yr * 1.3 R/kWh

**Self-consumption**
- 4,000 kWh/yr

**Net feed-in**
- A

**Gross PV generation**
- 10,000 kWh/yr

**Conventional generation fleet**
- 2,000 kWh/yr

Source: CSIR analysis
Agenda

The Status Quo

Proposal: Regulatory Approach to Embedded PV Installations

Effects of the Proposed Regulatory Approach
Effects of the proposal: lowest costs and fast ramp-up of capacity

“Central Power Purchasing Agency” (CPPA) is aggregator for embedded PV, it de-risks business case for the PV owner – which brings costs down – and makes the municipality financially indifferent to embedded PV

The embedded PV capacity additions could very quickly reach 500 MW p.a., adding 2-3 GW to the constrained grid by 2020

The average tariff would increase by less than 2 R-cents/kWh or < 3% to fund a fleet of 3 GW of PV under worst-case assumptions – any alternative new-build would increase the tariff at least in same magnitude

Funding requirements for CPPA would be ~ R 300 million p.a. for every 500 MW of embedded PV

With a gas fleet existing in the future, for which the fuel costs are significantly higher than for coal, the tariff effect could even be negative, meaning that installing PV would save the power system money

Because costs of PV are now so low, it is a no-regret move for South Africa to implement a standard offer for embedded PV
Funding requirement for CPPA would be approx. R 290 million/yr for every 500 MWp of installed PV capacity (plus CPPA staff & processes)

The net funding requirement will eventually go down to zero with increasing wholesale value of the PV energy (as Eskom phases out more and more of the cheapest coal generators and phases in more expensive new-builds) and decreasing PV costs.

Assumptions: 1,600 kWh/kWp/yr; self-consumption ratio of 40%; NETFIT of 0.7 R/kWh; gross-margin compensation of 0.6 R/kWh; wholesale value of PV energy of 0.5 R/kWh.

Source: CSIR analysis.
Concerns of all key stakeholders are addressed via the NETFIT with financial compensation for municipalities

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| Munics         | • Cannot afford to lose out on gross margin from electricity sales  
• Administrative burden managing large-scale uptake of embedded PV                                                                                     | ✓          |
| PV Owner       | • Business case not attractive if excess energy has to be curtailed or is not financially compensated  
• Business case too risky if feeding back into the grid is compensated, but not adequately or at unpredictable rates over the asset lifetime | ✓          |
| SMMEs          | • Utility-scale PV projects are not made for SMMEs as owners/suppliers  
• Rooftop PV market is ideal for SMMEs, but without continuous workflow, companies are not willing to invest into manpower and skills | ✓          |
| PV Manufacturers | • REIPPP Programme very well run, but the demand is too “spiky” in order to trigger significant investments into local production of modules/inverters  
• Rooftop PV market attractive (it is very fragmented & provides continuous demand that is supplied through wholesaler channels), but not existing | ✓          |
| Electricity Ratepayers | • Only PV systems with very short payback are currently implemented  
• That means customers with a) high tariffs and b) high demand implement, they therefore opt out of the cross-subsidisation mechanism, which means higher tariffs for all other customers | ✓          |

Source: CSIR analysis
Further advantages of a NETFIT-based scheme for residential PV

**Transparency & Safety**
- All embedded PV generators would be centrally registered: because no registration → no NETFIT money
- Distribution grid operators are fully aware of all embedded PV generators, which increases maintenance safety

**Job creation & local content**
- Potential for rural enterprises to run a “micro-utility business” with small-scale PV generators → wherever there is a grid, there is a PV business opportunity!
- Huge potential for SMMEs in PV design, installation & verification for residential & commercial customers
- A NETFIT premium payment (e.g. up to +0.15 R/kWh on top of the 0.7 R/kWh) could be linked to high local content

**Reduced grid losses and system costs**
- Embedded PV is close to the load, i.e. grid losses are low (saves add. up to 5% of costs)
- Generally only very little grid strengthening and no grid extension required (PV follows the grid)
- Lower export than import tariff incentivises load-shifting & peak-shaving to better match PV supply and onsite demand; good for the system: matching onsite supply & demand reduces grid losses & need for peaking power
- Aggregated supply profile of spatially distributed embedded PV generators is very smooth and highly predictable

**Reduced transaction costs**
- Project development costs, legal fees, environmental assessment, etc. are all reduced or non existent for embedded PV as compared to large PV installations

**Funding easier due to granularity (small project size, R 100,000 to few millions)**
- With a proper standard offer and NETFIT defined, rooftop PV installation would become bankable
- Banks could put the asset into the home loan (with residual NETFIT revenues as collateral) for easy financing
- NETFIT payments are linked to the asset, not to the PV owner → roof-lease business models become viable

Source: CSIR analysis
How does the NETFIT differ from a pure net-metering scheme?

<table>
<thead>
<tr>
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<tbody>
<tr>
<td></td>
<td>Bi-directional: importing and exporting of energy allowed</td>
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<tr>
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<td>Tariff for import and export can be different (e.g., export tariff lower than import tariff)</td>
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</tr>
<tr>
<td></td>
<td>Both import and export tariff uncertain over lifetime of the PV asset; fixed charge add. risk</td>
<td>Export tariff is <strong>guaranteed</strong> over the lifetime of the PV asset; no fixed charge introduced</td>
</tr>
<tr>
<td></td>
<td>Must be a net energy consumer over an energy-balancing cycle (typically one year)</td>
<td>Must be a net energy consumer or <strong>producer</strong> over an energy-balancing cycle (typically one year)</td>
</tr>
<tr>
<td></td>
<td>Must be a net payer over a billing cycle (i.e. no cash payments back to the customer)</td>
<td>Can be a <strong>net receiver</strong> of payments over a billing cycle (<strong>PV as a micro-utility business</strong>)</td>
</tr>
<tr>
<td></td>
<td>Local authority (i.e. municipality or Eskom Distribution)</td>
<td><strong>Nationwide central off-taker</strong></td>
</tr>
<tr>
<td></td>
<td>From municipalities’ bottom line</td>
<td>Nationwide funding scheme <strong>outside</strong> of the municipalities’ financial system</td>
</tr>
</tbody>
</table>

Source: M.P.E. GmbH proposal on net metering; Eskom Pricing proposal on net metering; NETFIT proposal by CSIR analysis
Key difference between Net Metering & NETFIT: suboptimal risk-return profile for PV Owner in Net Metering, which increases total costs

Net Metering is similar to NETFIT in the sense that it also attaches a certain value to the excess PV energy (part “A” of the total PV energy production) and it allows self-consumption (part “B” of the total PV energy production)

The fundamental differences between net metering and net feed-in tariff however are:

1. Net Metering limits the amount of money that can be accrued on the "excess/fed-in energy" account in a year to the value of the customer’s annual electricity bill, because the financial compensation of excess energy works through a reduction/rebate of/on the electricity bill. NETFIT doesn't do that. The compensation of excess energy is completely separate from the electricity bill (real cash payments into the bank account of the PV Owner that are not related with the electricity bill). NETFIT in that sense separates generation from consumption
2. Net Metering limits the amount of excess energy fed back into the grid to the energy consumption on site (not instantaneously, but over an annual balancing cycle). NETFIT doesn't do that. No limits on the energy fed back into the grid
3. In Net Metering, the level of the tariff for the excess energy fed back into the grid is not guaranteed over the lifetime of the PV asset (20 years). In the NETFIT concept it is

These three aspects might sound small, but they make all the difference for the PV investor. They will push the required effective tariff compensation for the PV investment up (in the net metering case), and therefore increase the total system cost of PV

Suboptimal risk-return profile in the Net Metering case
- In the NETFIT concept part A of the business case is risk free (but at a low tariff), while part B is riskier (but at a higher tariff)
- In net metering, both part A and part B are similarly risky

Mindset of PV Owner: demand-side management measure (Net Metering) vs. micro-utility (NETFIT)
- In NETFIT, the PV Owner becomes a micro-utility or micro IPP that just happens to generate power behind a customer’s meter and can therefore optimise the business case by selling part of the power into the grid (A) and by “selling” the other (typically higher value) part (B) to the customer (if PV Owner and electricity customer are the same entity, like in the residential case, one would not call it "selling")
- In the Net Metering case, the electricity customer reduces his/her net load by installing PV that matches the size of the load. The mindset is that of energy efficiency/demand-side management. It’s a fundamentally different mindset as compared to NETFIT, where the PV installation is a power generator that actively contributes to the grid supply

A Net Metering (which some municipalities have already introduced) could work as the immediate solution, while in parallel the NETFIT concept is prepared for implementation. Once NETFIT is available, all net metering can then be migrated into the NETFIT concept
Renewables very capital intensive → cost of financing needs to come down → this happens if uncertainties are reduced

<table>
<thead>
<tr>
<th>Risk</th>
<th>Who should own the risk?</th>
<th>Net metering</th>
<th>NETFIT (CPI-linked tariff)</th>
<th>NETFIT (pre-defined tariff path)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar insulation</td>
<td>PV asset owner</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Technology performance</td>
<td>PV asset owner</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Tariff (i.e. financial compensation per kWh)</td>
<td>Electricity System</td>
<td>✗</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Off-take</td>
<td>Electricity System</td>
<td>✗</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Inflation</td>
<td>Electricity System</td>
<td>✗</td>
<td>✗</td>
<td>✔</td>
</tr>
</tbody>
</table>

Guiding principle: A risk should always be owned by the entity that can best control it. This way the risk allocation will lead to lowest total cost to the system.

A predefined tariff path leads to lowest uncertainties, hence lowest cost of financing, and hence to lowest LCOE / costs to the system.

Cost of financing → LCOE

Risk allocation leads to lowest macroeconomic costs
Risk allocation not optimal → higher macroeconomic costs
Guiding principle must be to de-risk the PV investment in order to reduce overall costs

Many would say in order to stimulate the market, PV needs to be more profitable with a payback of 5-7 years

But, an analogy: What payback does a private individual require when putting money into a fixed deposit bank account? > 10 years?

The perception of the asset class of PV has to change. It is not a short-term consumable good, but rather an infrastructure-type of investment (like a house/road). Infrastructure investments never give <10 years payback. PV is very similar from a cash-flow perspective to a fixed-deposit

Reducing the payback period of a PV investment by giving it a very high NETFIT will create windfall profits

- The lifetime costs of PV and their nature need to be considered: PV has >20 years lifetime and a cost structure that is almost purely capital (running costs during the asset’s life are very low)
- That means that if the NETFIT was high enough to give a 5-7 years payback, from year 7 onwards the PV investor would make windfall profits until the end of life of the asset. The situation would then be:
  - PV asset is paid off, and the running costs are very low
  - PV owner still gets the tariffs and/or the benefits of avoided energy charges without facing cost items that counter-balance the benefits

Hence, attractiveness of an investment into PV should be increased by de-risking it during the full lifetime, rather than giving high (and potentially too high) upfront incentives in form of high NETFIT and/or CAPEX subsidies

- NETFIT path needs to be defined upfront for the full 20 years & guaranteed/backed by government guarantees
- Government banks could offer loans with subsidised interest rates and/or very long terms to fund the PV assets
- Keep in mind: If NETFIT turns out to be too low, the feedback loop will allow an increase for new installations
A NETFIT meter would be installed in addition to the consumption (import) meter to measure net electricity exported from the premise.

- **NETFIT meter**
  - 6,000 kWh/yr @ 0.7 R/kWh
  - Installed to measure net electricity exported from the premise.

- **Consumption meter**
  - 12,000 kWh/yr (import)
  - 8,000 kWh/yr (export)
  - @ 1.3 R/kWh

- **PV panels** (6 kWp)
  - Owned by PV owner (in many cases the same entity as the electricity customer)

- **Residential load**
  - 12,000 kWh/yr
  - Owned by electricity customer

- **PV generation**
  - 10,000 kWh/yr

- **Self consumption**
  - 4,000 kWh/yr

- **Feed-in**
  - 6,000 kWh/yr @ 60%

- **Net Feed-in Tariff (FIT)**
  - Net FIT meter
  - 6,000 kWh/yr

Source: CSIR analysis
Proposal: Net Feed-in Tariff with central off-taker and financial compensation for munics

Create a “Central Power Purchasing Agency” (CPPA) as nation-wide sole off-taker for energy from embedded PV generators fed back into the grid, with two roles

1. **Financial compensation for self-consumed energy**  
   CPPA compensates the electricity distributor (municipality or Eskom Distribution) financially for lost gross margins due to onsite self-consumed energy from embedded PV generators

2. **Feed-in Tariff for not self-consumed energy**  
   CPPA buys the energy from embedded PV generators that is not self-consumed and thus fed back into the grid from the PV owner at a guaranteed tariff (20 years, predefined tariff path)

Define an annual target (e.g. 500 MWp/yr) for embedded PV and steer the market size via the level of the FIT for new PV installations under the regime

Give a FIT premium to PV systems that use locally manufactured/assembled modules and/or inverter to promote local manufacturing

Source: CSIR analysis
CPPA makes two standard offers: one to the electricity distributor, and one to PV owners in the supply area of the distributor (1/2)

Standard offer from CPPA to the electricity distributor

CPPA makes a standard offer to all holders of an electricity distribution license (municipalities & Eskom) that will make the electricity distributor indifferent to embedded PV generators from a pure financial perspective

Offer: financial compensation for lost gross margins

• CPPA guarantees the distributor financial compensation for lost gross-margins due to energy from embedded PV generators that is self-consumed on the customer’s site (behind the distributor’s meter)
• The level of financial compensation in R/kWh will be determined in a transparent manner and will be the same for all distributors

Terms and conditions

CPPA attaches Terms and Conditions to this offer, which will include:

• Requirement on the distributor to have safe practices in place for embedded generators
• Requirement on the distributor to not impose a different tariff / tariff structure to their customers whether they have a PV system or not

Source: CSIR analysis
CPPA makes two standard offers: one to the electricity distributor, and one to PV owners in the supply area of the distributor (2/2)

Standard offer from CPPA to the PV owner

CPPA makes a standard offer to all customers that are in supply areas of distributors that have signed up to the “standard offer from CPPA to the electricity distributor”. This standard offer will provide very high investment security to the PV owner. The financial return for the PV owner will be relatively low if all PV energy is sold to CPPA (no self-consumption). The CPPA essentially provides the safety-net for the business case of the PV owner and makes it bankable.

Offer: secured off-take of net PV energy fed back into the grid (NETFIT)

- CPPA guarantees to off-take any percentage (between 0% to 100%) of the energy from the embedded PV generator that the PV owner decides to feed back into the grid.
- CPPA guarantees the PV owner a predefined tariff at a predefined annual escalation rate for the energy that is fed back into the grid for a period of 20 years. This “Net Feed-in Tariff” will be substantially below today’s residential end-customer electricity tariffs.

Terms and conditions

CPPA attaches Terms and Conditions to this offer, which will include:

- Requirement on the PV owner to only use PV inverters that are compliant to the grid requirements (CPPA could publish a shortlist on its website of allowed PV inverters).
- Requirement on the PV owner to have a Certificate of Compliance by a certified electrician that certifies the correct installation and grid connection of the PV system according to all relevant norms and standards.

Source: CSIR analysis
Difference between average retail and wholesale tariffs determines one gross-margin compensation level that applies for all municipalities.

Retail tariffs

Wholesale (Eskom) tariffs

Gross-margin compensation = 0.6 R/kWh

$\phi = 0.7 \text{ R/kWh}$

$\phi = 1.3 \text{ R/kWh}$

Source: CSIR analysis
Once NETFIT mechanism is in place, it can be utilised to control size of embedded PV market

**Target**
Set by DoE; for example: 500 MW of new embedded PV installations per year

**Compare**
target & actuals

**Adjust**
NETFIT quarterly

**Actuals**
New installations in the South African rooftop PV market in MW per year

Adjustment of NETFIT for new installations only! Existing installations are guaranteed the NETFIT that was valid at the time of commissioning for 20 years.

**Measure**
via Net-FIT registry

Feedback loop

Source: CSIR analysis
Three tiers of NETFIT premiums could reward the use of local products

CPPA publishes list of eligible modules / inverters on its website

<table>
<thead>
<tr>
<th>Tier 1 Net FIT</th>
<th>Tier 2 Net FIT</th>
<th>Tier 3 Net FIT (maximum achievable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tariff in R/kWh</td>
<td>Tariff in R/kWh</td>
<td>Tariff in R/kWh</td>
</tr>
<tr>
<td>0.70</td>
<td>0.75</td>
<td>0.80</td>
</tr>
</tbody>
</table>

Locally made modules: X
Locally made inverters: X
Locally assembled modules: ✓

OR

CPPA publishes list of eligible modules / inverters on its website.
The average tariff would increase by less than 3 R-cents/kWh or < 5% to fund a fleet of 6 GWp of PV under worst-case assumptions

Assumptions (simplified, but “worst case”)

- 230 TWh/yr total electricity sales in RSA
- 10 TWh/yr from embedded PV (approx. 6 GWp capacity), of which
  - 40% (4 TWh/yr) supply self-consumption
  - 60% (6 TWh/yr) are compensated via the NETFIT
- NETFIT @ 0.7 R/kWh
- Electricity tariff @ 1.3 R/kWh
- Marginal variable costs of the power system @ 0.3 R/kWh (i.e., how much money is saved from not burning conventional fuels thanks to one kWh from PV?)

Results: 6 GWp embedded PV → less than 3 R-cents/kWh tariff increase

- The power system as a whole loses 40% * 10 TWh/yr * 1.3 R/kWh = R 5.2 billion in revenues per year due to self-consumed PV energy
- The power system compensates all PV owners with 60% * 10 TWh/yr * 0.7 R/kWh = R 4.2 billion per year for PV energy fed back into grid
- The power system saves 10 TWh/yr * 0.3 R/kWh = R 3 billion from not burning conventional fuel
- The total costs to the power system to have 6 GWp of embedded PV installed and compensated via the NETFIT scheme are therefore R 5.2 billion + R 4.2 billion − R 3 billion = R 6.4 billion
- Distributing these R 6.4 billion across all remaining kWh sales (230 TWh/yr − 40% * 10 TWh/yr = 226 TWh/yr) results in an increase of the average tariff of 2.8 R-cents/kWh
- Hence, installing 6 GWp of embedded PV increases the average tariff by less than 3 R-cents/kWh (or < 5% of today’s average tariff), assuming a) no further cost reductions on the PV side, b) no increase in conventional fuel costs, c) no increase in electricity demand

This result is very conservative based on worst-case assumptions. With a gas fleet existing in the future, for which the fuel costs are significantly higher than for coal, the tariff effect could even be negative, meaning that installing PV would save the power system money.

Source: CSIR analysis
Lower Net Feed-in than Electricity Tariff makes electricity customer shift loads from peak into day-times to increase PV self-consumption.

One-family residential house
- 12,000 kWh annual demand (actual data)
- 6 kWp PV installation (simulated data)

The load-shifting effect of NETFIT is very beneficial for the overall power system, as it reduces net demand on the grid.

Source: CSIR analysis
Example CityPower: Even with a small “under the radar” uptake of embedded PV, municipalities’ financial stability will still be at risk!

Today (actuals from CityPower 2012/13)

- Revenues from Electricity Sales: 12.4 billion R
- Gross Margin: 4.0 billion R
- Direct Cost of Bulk Electricity Purchases (from Eskom): 8.4 billion R

Must cover all costs other than bulk electricity purchases

Hypothetical implications for CityPower’s financials

CityPower made a gross margin from electricity sales of R 4.0 billion in the financial year 2012/13

This gross margin must cover all costs other than bulk electricity purchases from Eskom

CityPower has approx. 400,000 residential and 10,000 business customers

Assumptions:
- 10% of residential customers (40,000) install 6-kWp-PV systems each “under the radar” and consume 4,000 kWh/yr of the PV energy themselves
- 10% of business customers (1,000) install 200-kWp-PV systems each “under the radar” and consume 300,000 kWh/yr of the PV energy themselves

This would reduce electricity sales by 0.46 TWh/yr or 4.7%

It would reduce the gross margin by R 290 million or 7.3%

Source: CityPower 2012/13 annual report; CSIR analysis
Steepest positive 2-hour ramp in 2013/2014 occurred on 19 August 2013 with an increase in demand of 7.5 GW between 4h00-6h00

Actual South African system load on the 19 August 2013

Sources: Eskom; CSIR analysis
This steep ramp in demand was supplied and followed by the coal fleet.

Actual South African system load and supply structure on the 19 August 2013.

Sources: Eskom; CSIR analysis.
Only once a PV fleet of 7 GW is installed will the steepest ramp of the residual load be as high as 7.5 GW (now afternoon instead of morning).

Actual South African system load on the 20 July 2014 with a simulated PV fleet of 7.0 GWp

Sources: Eskom; CSIR analysis
This steep ramp would have been supplied & followed by the coal fleet

Actual South African system load & simulated supply structure on the 20 July 2014 assuming 7.0 GWp of PV

Supply Sources
- PV
- Wind
- OCGTs (Diesel)
- Coal
- Hydro, Pumped Storage
- Imports, Other
- Nuclear

Sources: Eskom; CSIR analysis
Thank you!