Renewable Energy and the Net Feed-in Tariff Concept

Presentation at the ERLN conference

CSIR Energy Centre

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Background

The South African power system is currently under severe constraints, with several controlled load shedding events in late 2014 and in the first months of 2015

Embedded PV fulfils key requirements in three dimensions to address the current crisis

Cheap: 0.8-0.9 R/kWh

- Significant cost reduction for PV combined with a world-class solar resource in South Africa makes solar PV cost competitive to alternative new-build options → no subsidy required anymore

Fast: many projects ready to go

- South African PV industry geared up to start implementing very quickly

Subsidy: building something that is more expensive than alternative new-build options

Large: 500-1 000 MW/yr

- Granularity of embedded PV allows very fast ramp up of new capacity

Plus: adding PV to the grid fully aligned with long-term capacity-expansion plan (IRP)

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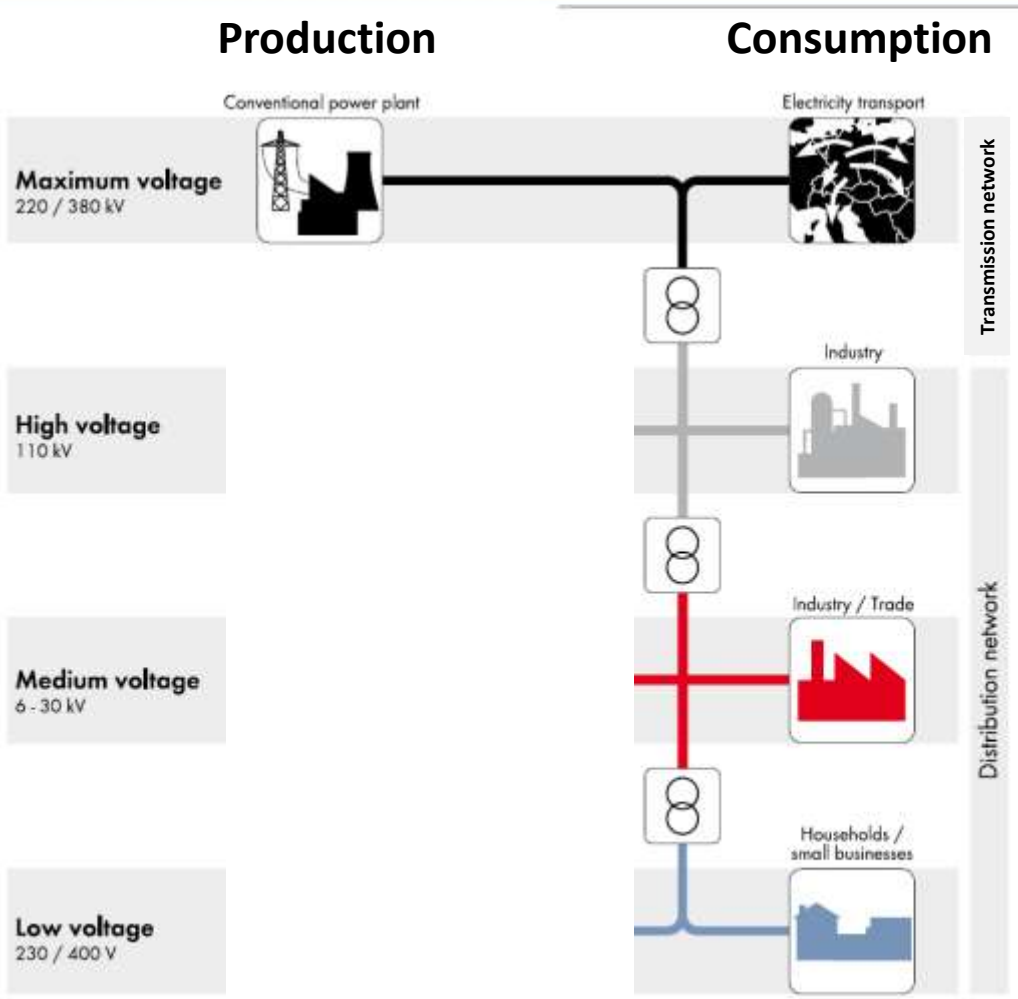
Sources: CSIR Energy Centre analysis

Today: production and balancing of supply/demand happens centrally



Balancing of supply/demand on central system level

One-directional power flow

On end-consumer level mostly no generation, no storage/balancing capabilities, no manageable load

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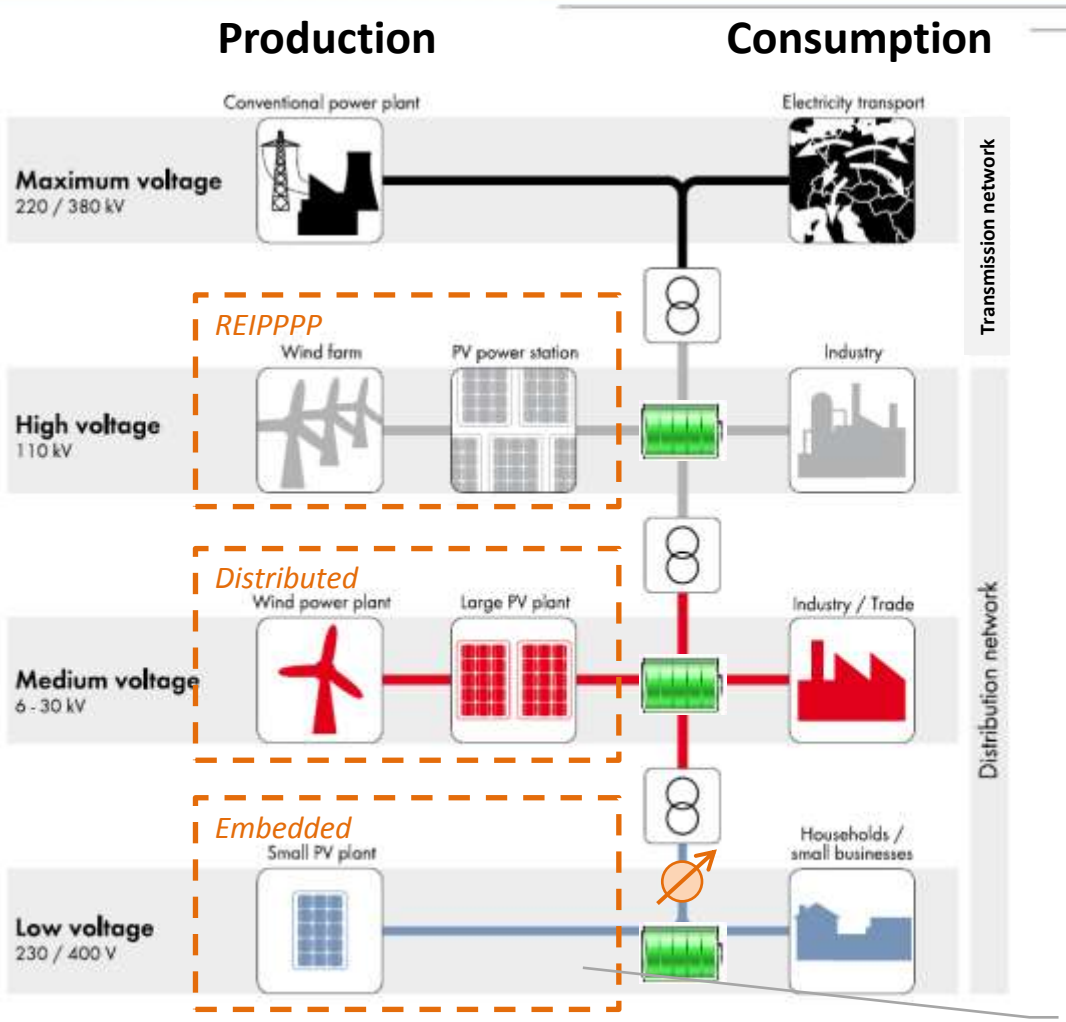
Sources: SMA; CSIR Energy Centre analysis

Future: Production and consumption occurs on all levels, power flows are bi-directional, an ICT layer is required on top of the energy layer



Storage

(production at times and consumption at other times)

1. 75…100 MW and more
2. < 1…30 MW
3. 1…1,000 kW

Biogas, single wind turbines, small hydro, etc. can potentially also be embedded, i.e. behind a customer's meter

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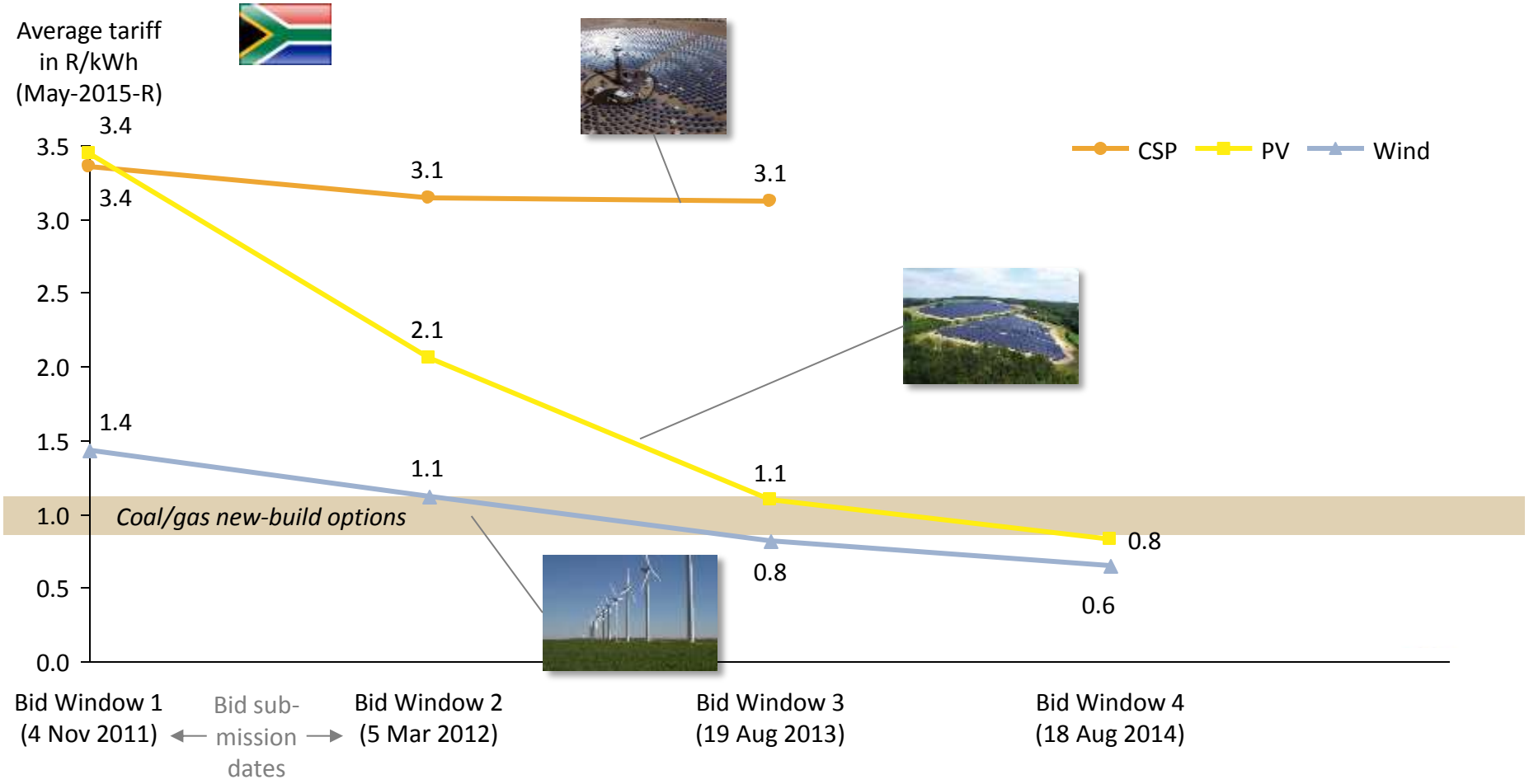
Sources: SMA; CSIR Energy Centre analysis

Actual results: PV and wind in South Africa are cost competitive today

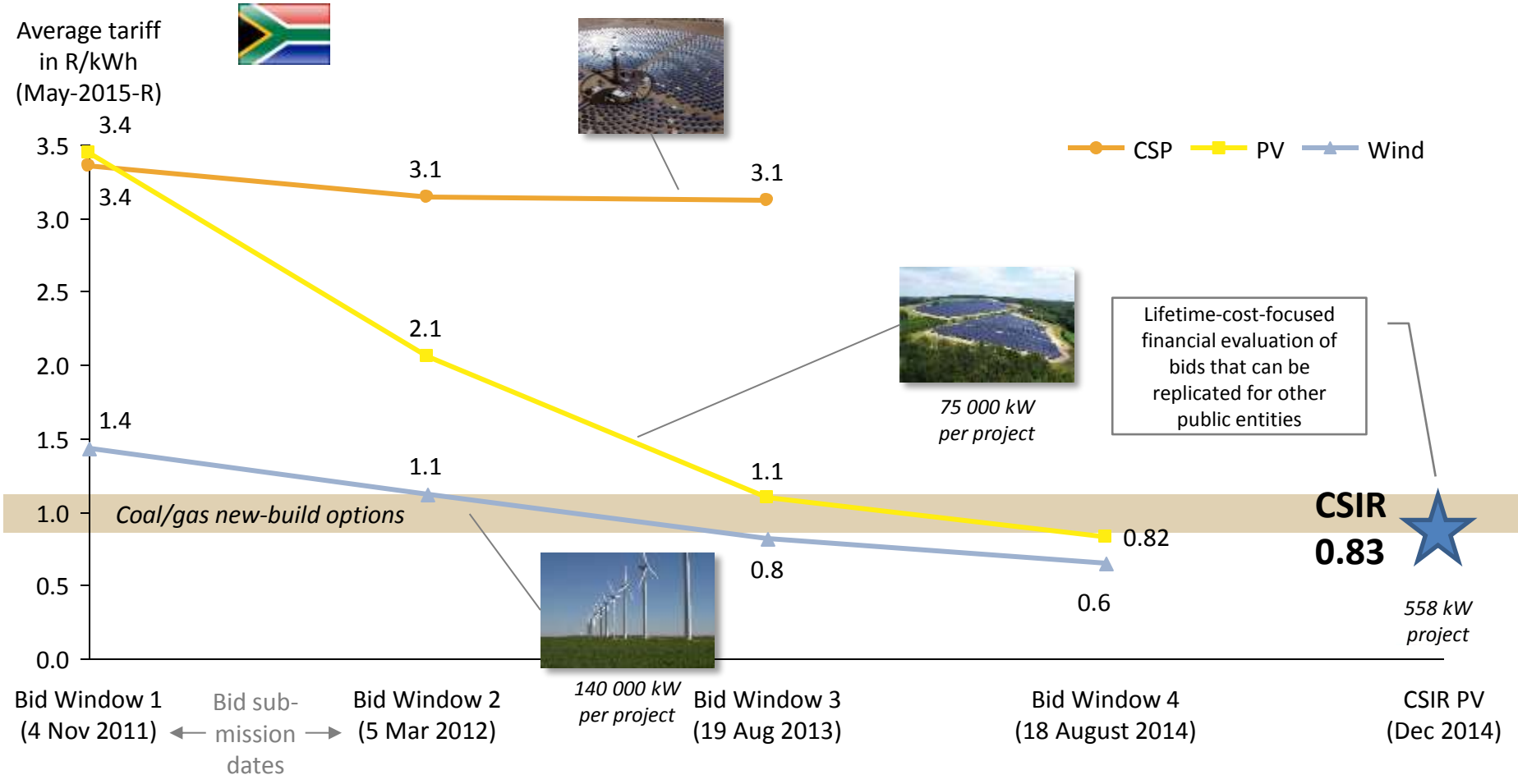
First four bid windows' results of Department of Energy's RE IPP Procurement Programme (REIPPPP)



Notes: For CSP Bid Window 3, the weighted average of base and peak tariff is indicated, assuming 50% annual load factor Sources: StatsSA on CPI; Department of Energy's publications on results of first four bid windows http://www.energy.gov.za/IPP/List-of-IPP-Preferred-Bidders-Window-three-04Nov2013.pdf; www.ipprenewables.co.za/gong/widget/file/download/id/279; http://www.energy.gov.za/IPP/Renewables_IPP_ProcurementProgram_WindowTwoAnnouncement_21May2012.pptx; CSIR Energy Centre analysis

PV makes sense across South Africa: CSIR's first 560 kW PV system in Pretoria can compete with 75 000 kW PV systems in the Northern Cape

Four bid windows' results of Department of Energy's IPP Procurement Programme and CSIR's first own PV



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The Status Quo

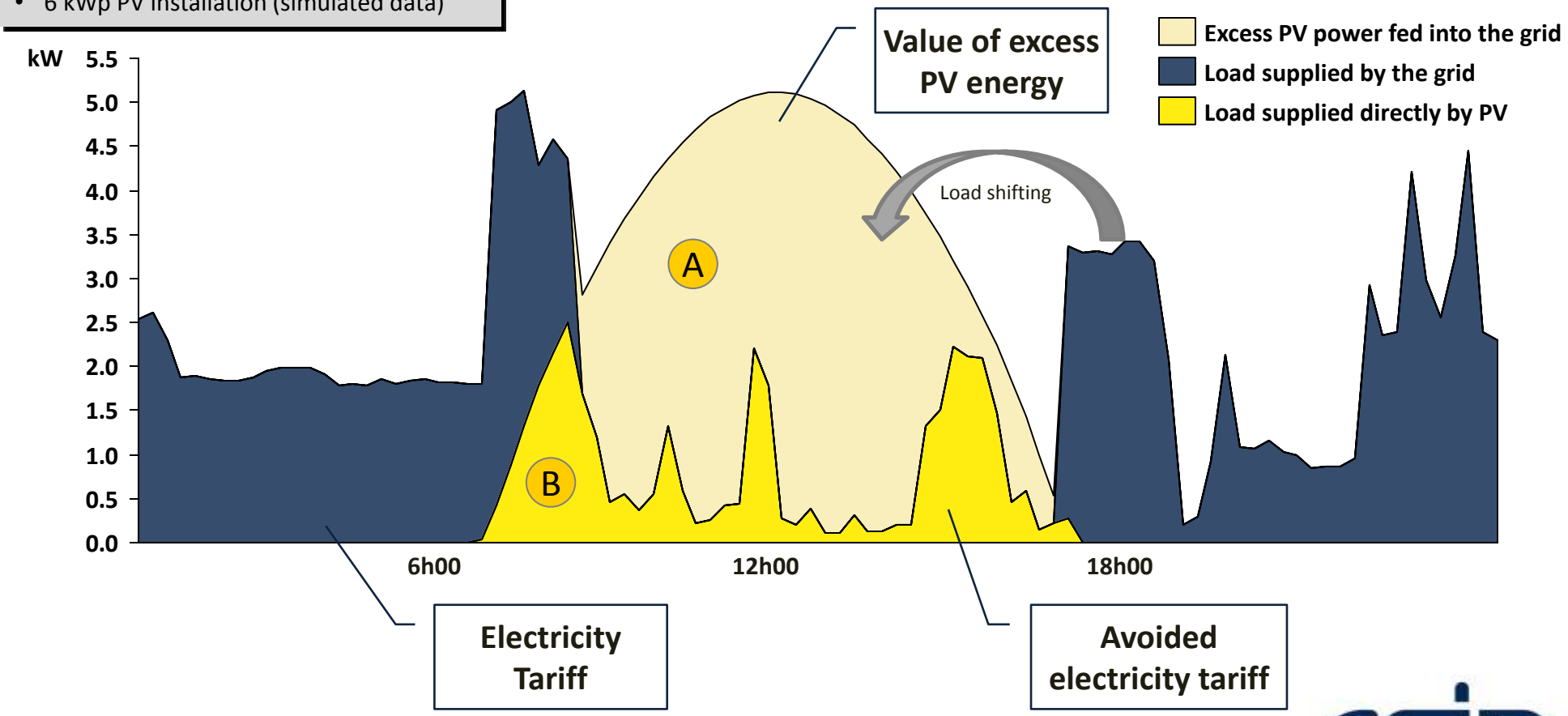
- Business Case for a Residential Embedded PV Installation
- Financial Threat for Municipalities from Embedded PV

Proposal: Regulatory Approach to Embedded PV Installations

Effects of the Proposed Regulatory Approach

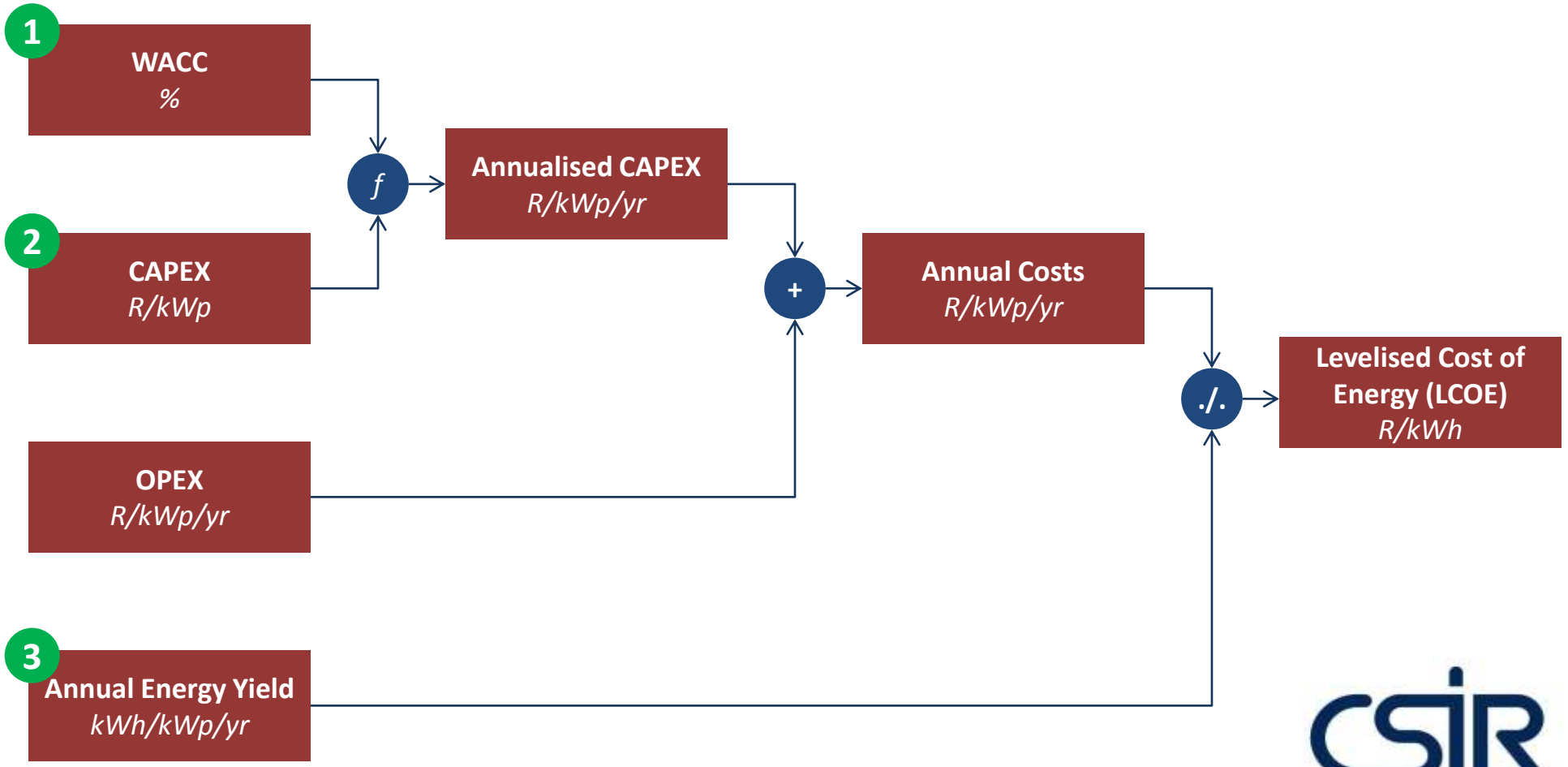
Residential electricity demand and PV supply generally do not match

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



Sources: CSIR Energy Centre analysis

PV has three main cost drivers – LCOE locked in over lifetime of asset

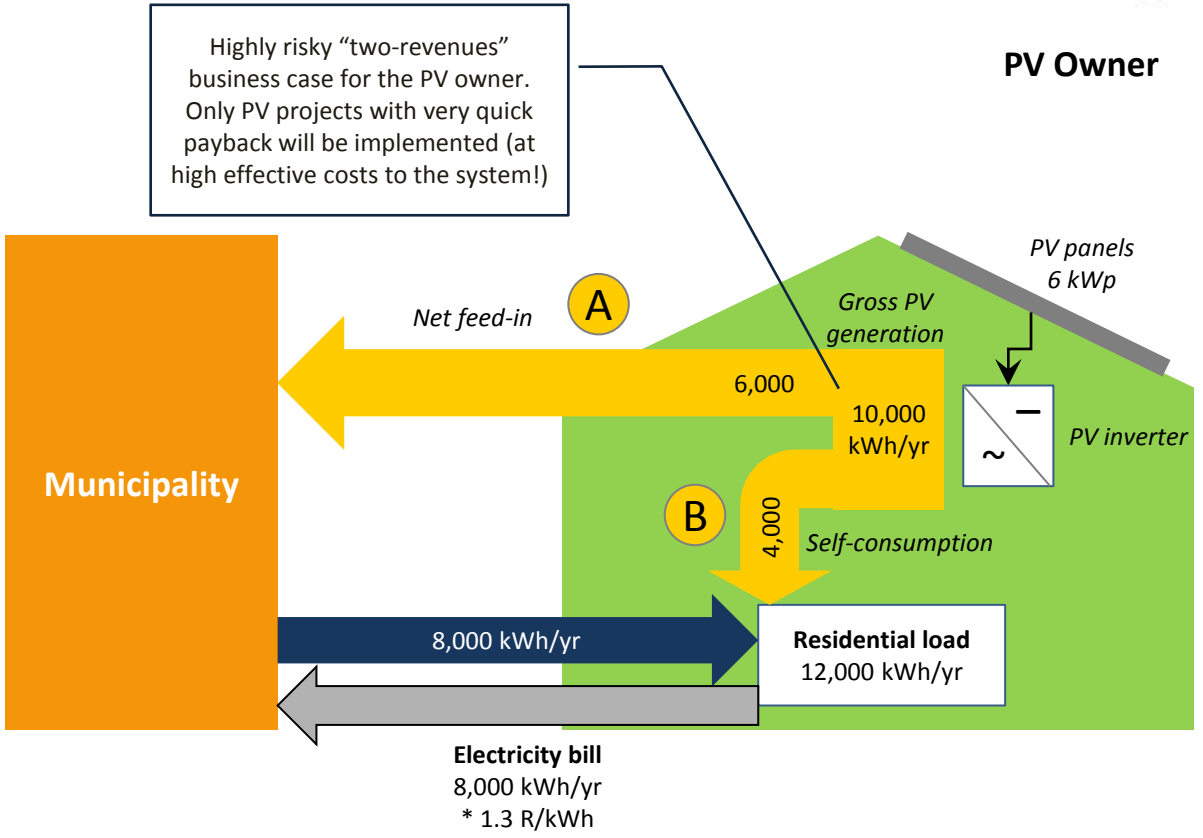


Note: Without inflation, i.e. In real terms; LCOE = Levelised Cost of Energy = discounted total lifetime cost of the PV installation divided by discounted total lifetime energy yield of PV installation

Sources: CSIR Energy Centre 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

Effective tariff = weighted average of value of energy A and B

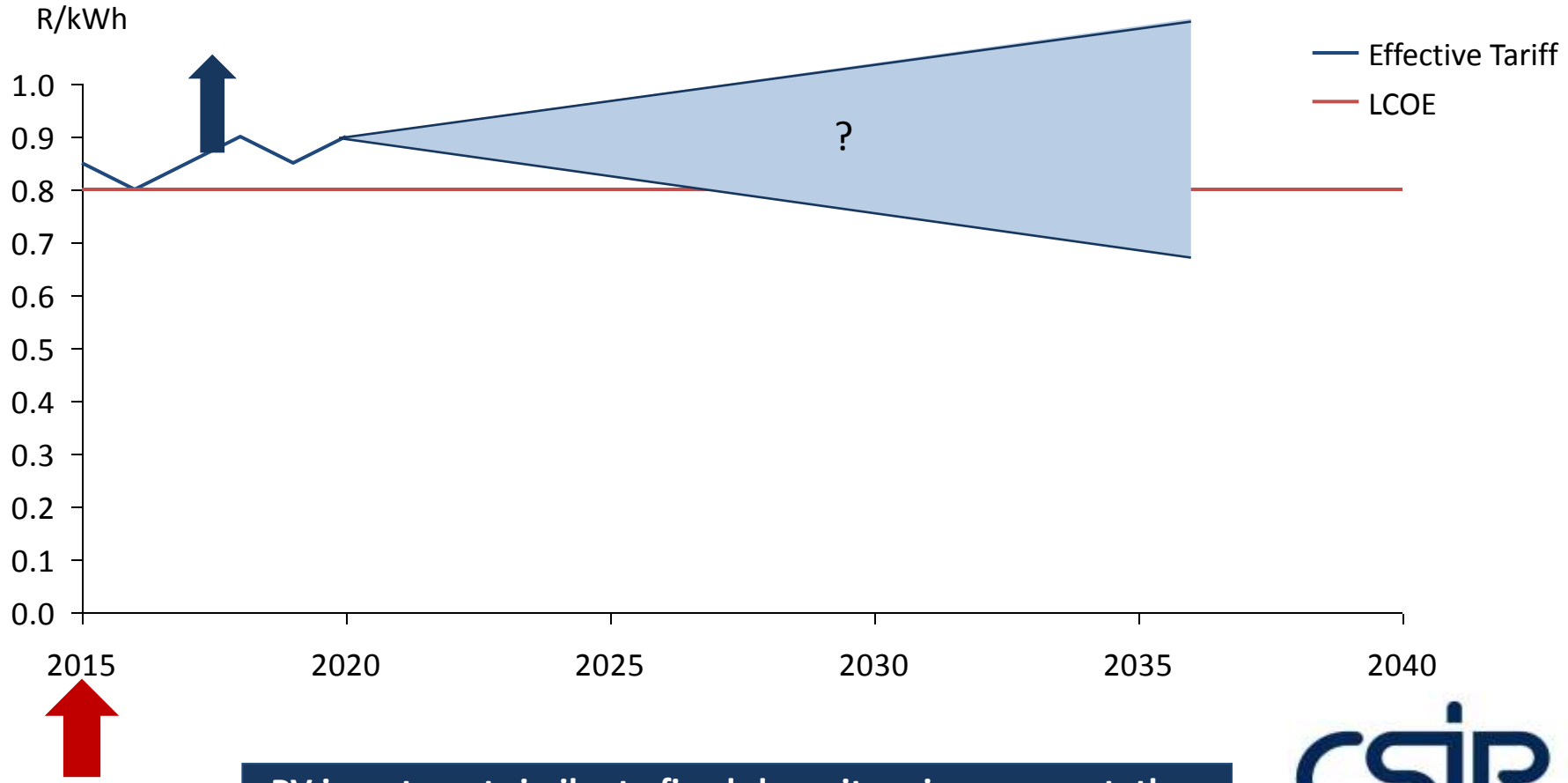


Sum of energy stream A and B equals the total amount of PV energy

Grid energy
Solar energy
Payments

Source: CSIR Energy Centre analysis

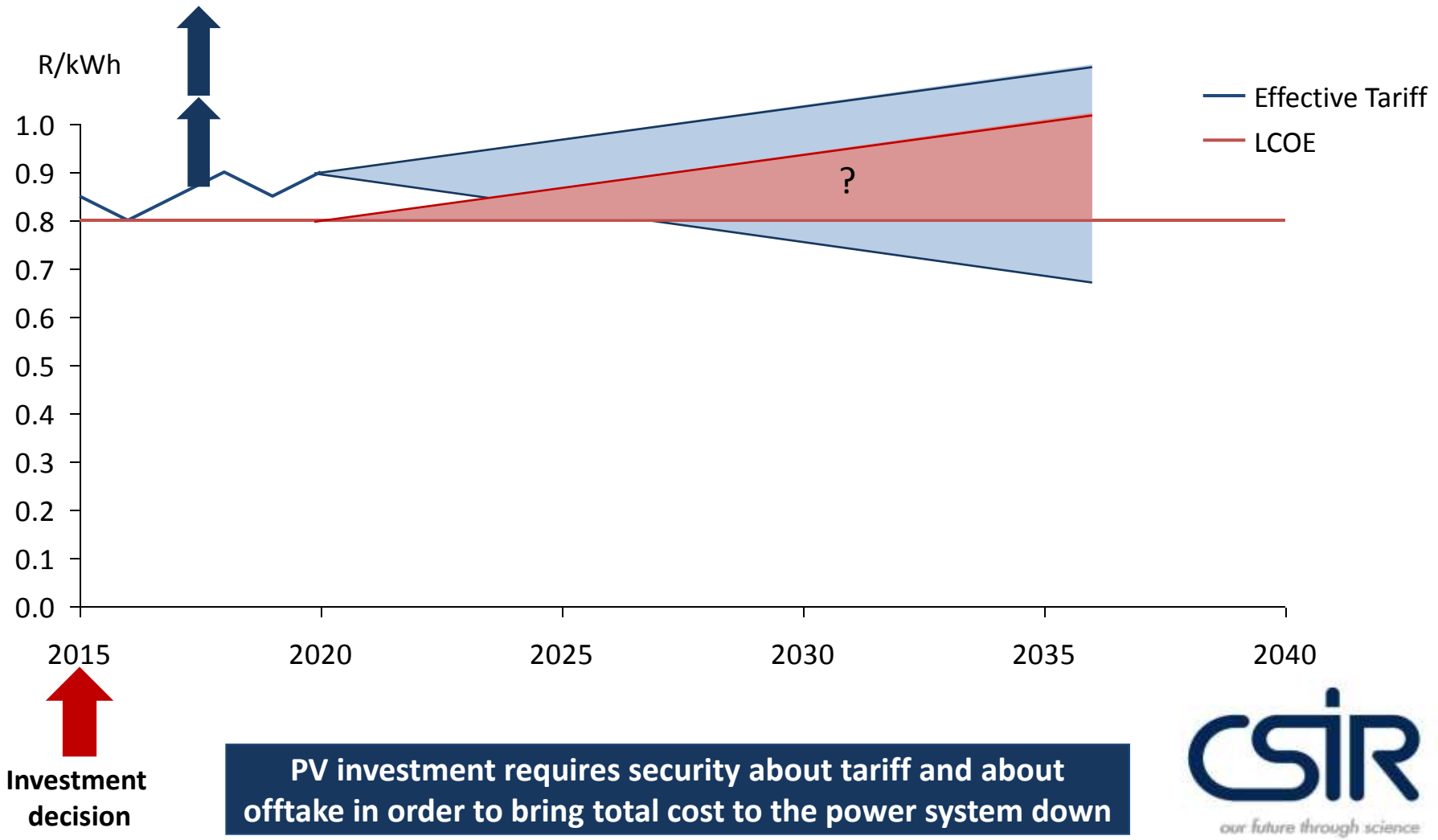
Uncertainty about future tariff makes investor require higher initial tariff – with potential subsequent windfall profits



PV investment similar to fixed-deposit savings account, thus requires the same investment certainty, to bring costs down

Note: Without inflation, i.e. In real terms; LCOE = Levelised Cost of Energy = discounted total lifetime cost of the PV installation divided by discounted total lifetime energy yield of PV installation
Sources: CSIR Energy Centre analysis

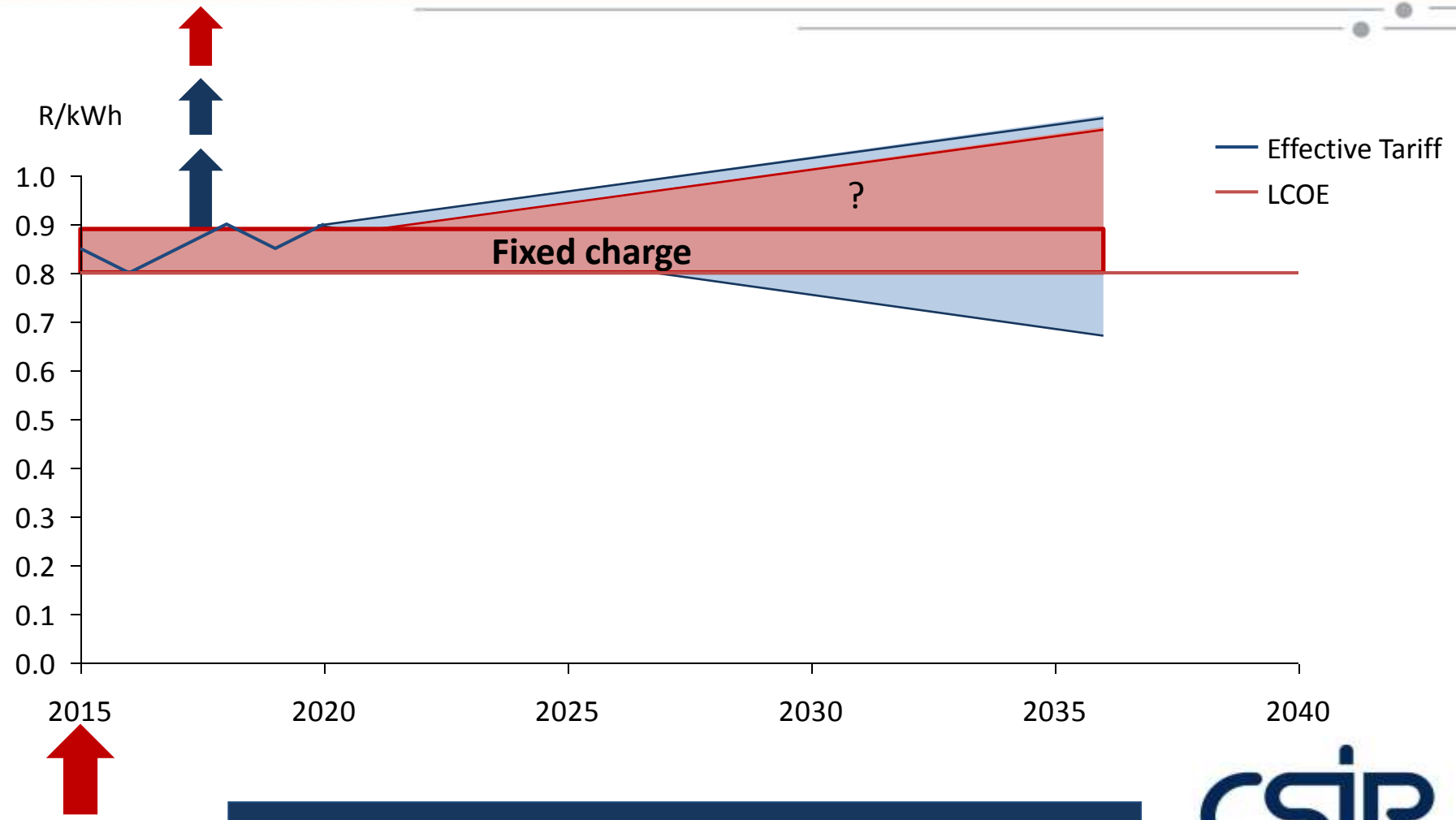
Uncertainty about future offtake increases LCOE, which pushes required initial tariff additionally up – with subsequent windfall profits



PV investment requires security about tariff and about offtake in order to bring total cost to the power system down

Note: Without inflation, i.e. In real terms; LCOE = Levelised Cost of Energy = discounted total lifetime cost of the PV installation divided by discounted total lifetime energy yield of PV installation
Sources: CSIR Energy Centre analysis

Introduction of a fixed charge increases the required effective tariff by exactly the amount of the fixed charge in order to trigger the invest



A fixed charge reduces number of viable PV projects

Note: Without inflation, i.e. In real terms; LCOE = Levelised Cost of Energy = discounted total lifetime cost of the PV installation divided by discounted total lifetime energy yield of PV installation

Sources: CSIR Energy Centre analysis

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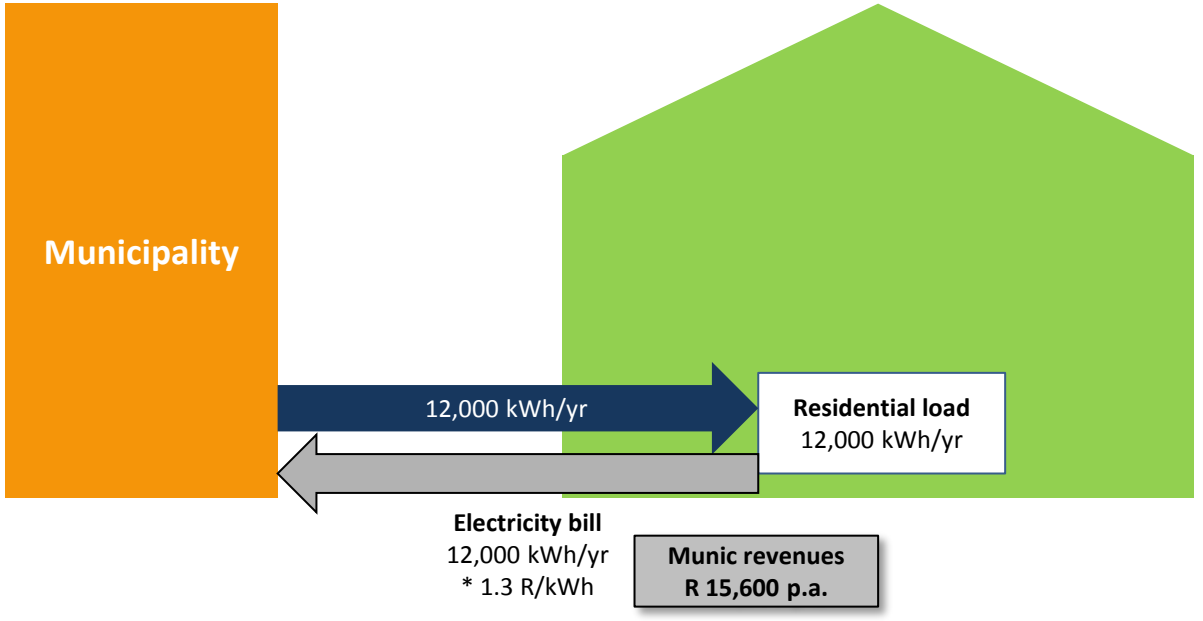
Proposal: Regulatory Approach to Embedded PV Installations

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

All numbers without VAT!

Munic revenues **R 15,600 p.a.**



Source: CSIR Energy Centre analysis

Status today: municipality buys electricity from Eskom Wholesaler and pays R 8,400 p.a. for it – therefore makes a surplus of R 7,200 p.a.

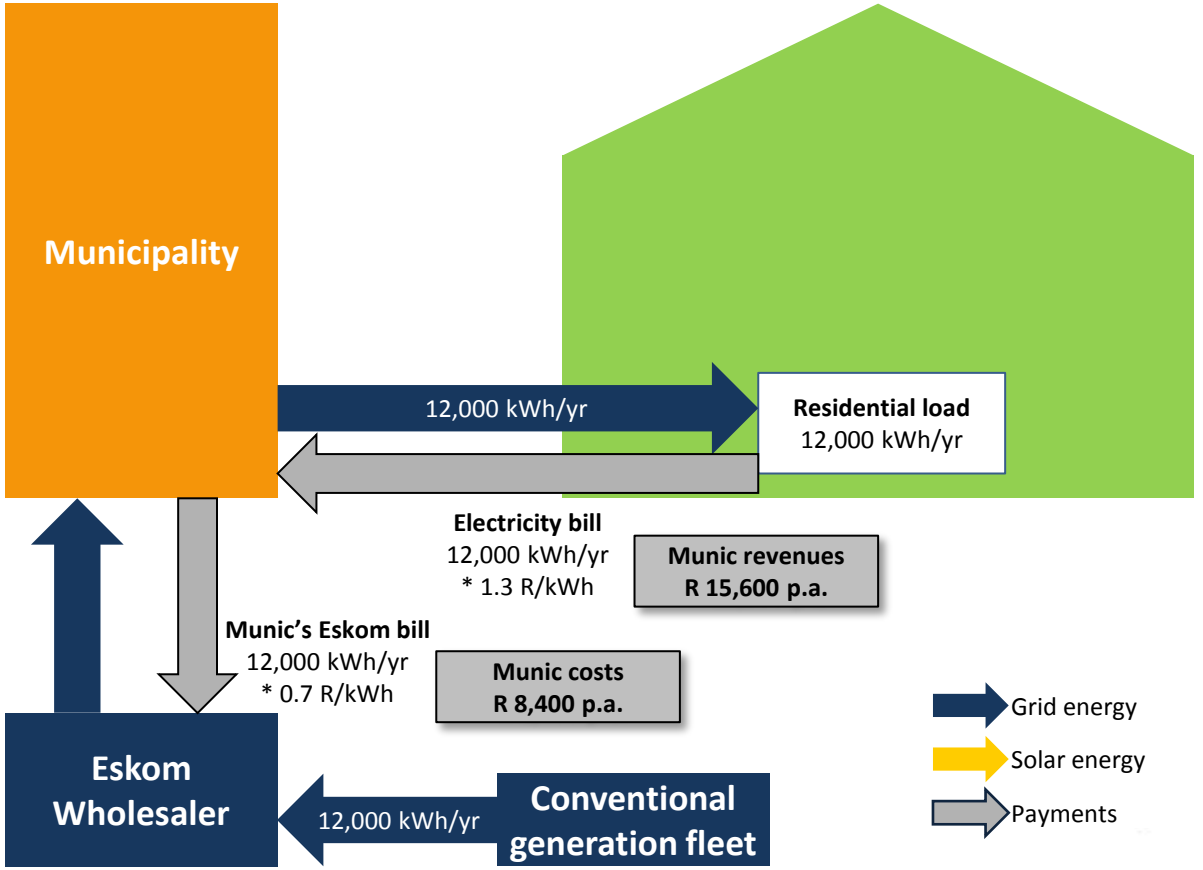
Munic revenues **R 15,600 p.a.**

Munic costs of goods sold **R 8,400 p.a.**

==========

Munic surplus **R 7,200 p.a.**
(on that specific customer)

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

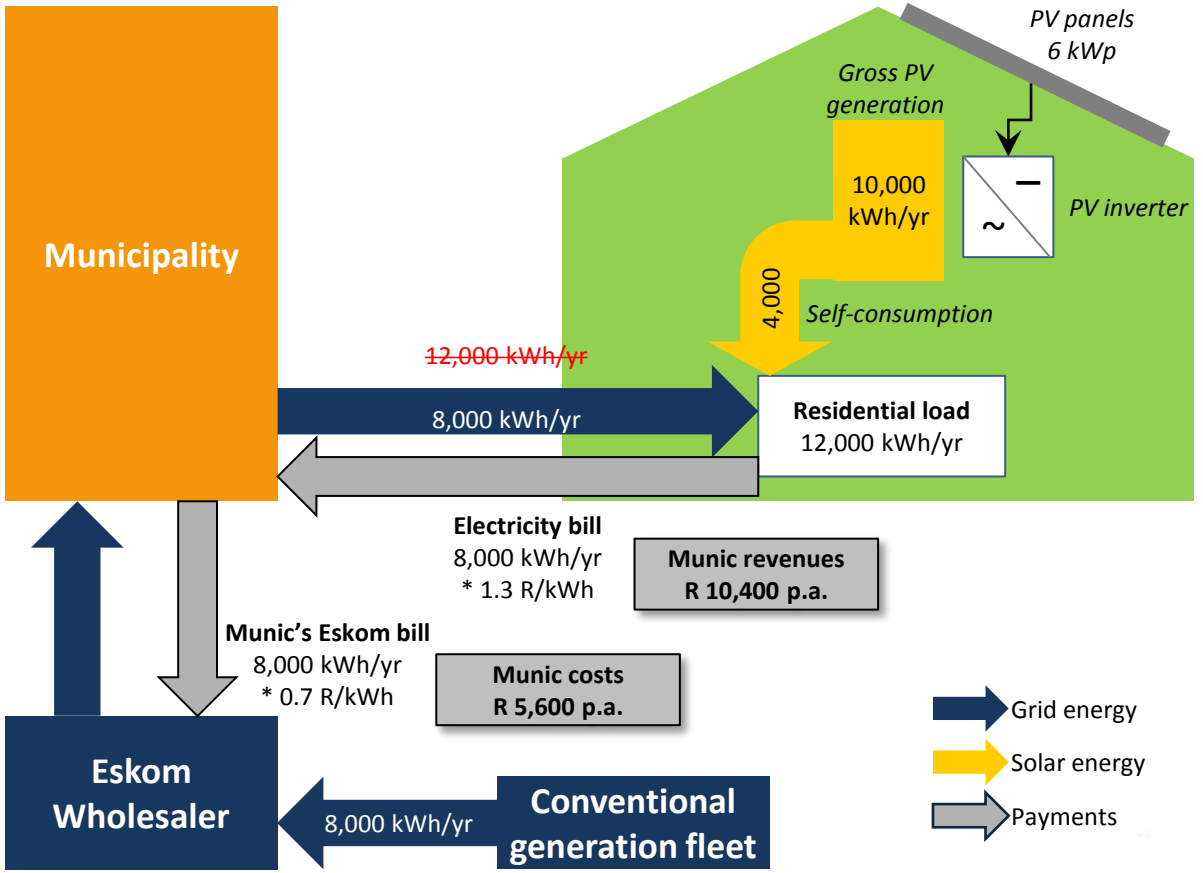


Source: CSIR Energy Centre analysis

Status today: An embedded PV generator with 40% of the PV energy being self-consumed on site reduces municipality sales & surplus

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.**
==========	
Munic surplus *(on that specific customer)*	~~**R 7,200 p.a.**~~ **R 4,800 p.a.**

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



Source: CSIR Energy Centre analysis

Status today: None of the key stakeholders' concerns is addressed with respect to embedded PV generators

Player	Concern	Add-ressed?
Munics	• Municipalities will go bankrupt (loose out on surplus 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 Manu-facturers	• 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	✗

Sources: CSIR Energy Centre analysis

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

Create a "Central Power Purchasing Agency" (CPPA) as a national aggregator with two roles

A **Net Feed-in Tariff to the PV Owner**
CPPA buys other part of the energy from embedded PV that is <u>not</u> self-consumed (fed back into grid) from the PV owner at a guaranteed tariff (20 years, predefined tariff path)

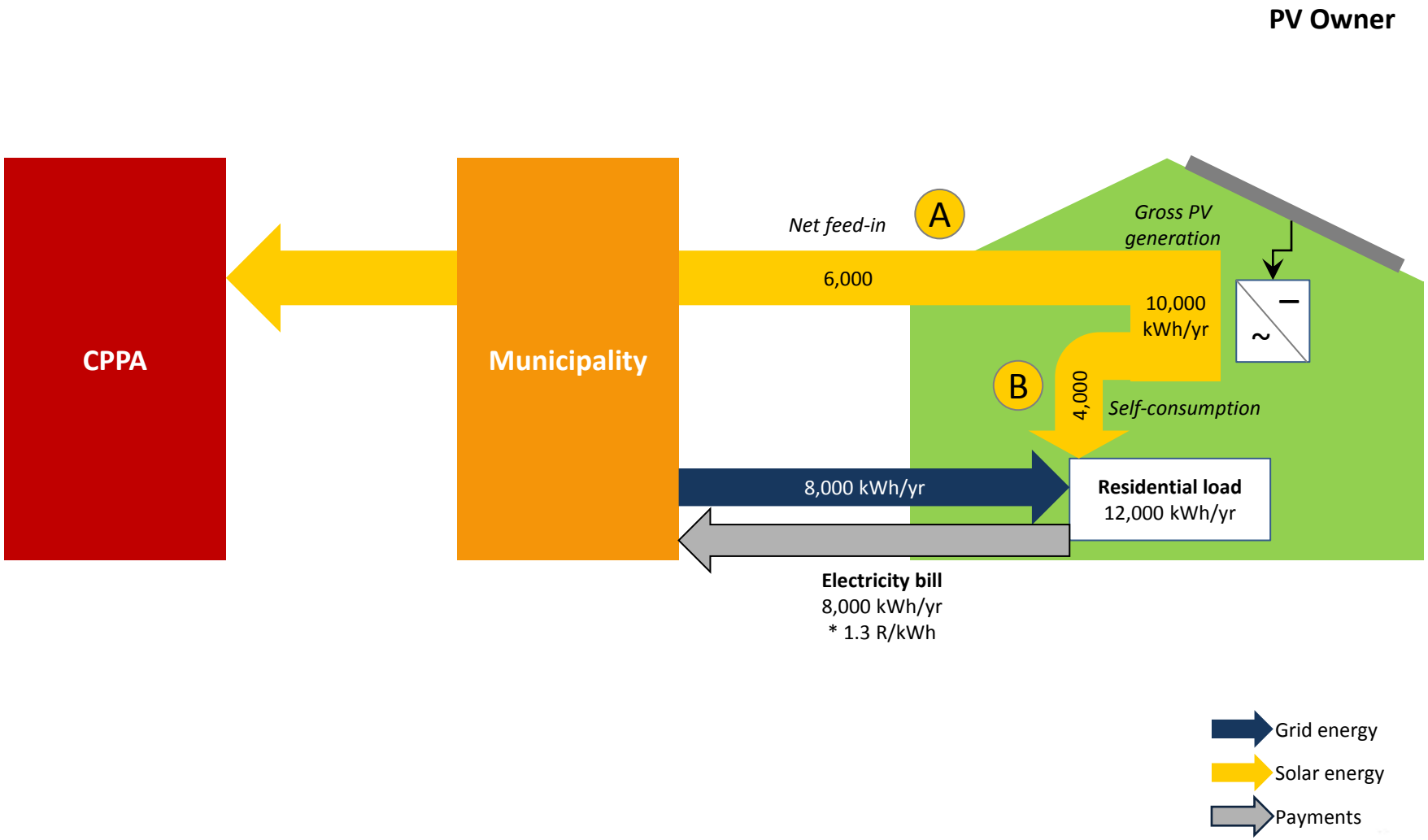
B **Financial compensation to the municipality**
CPPA compensates the electricity distributor (municipality or Eskom Distribution) financially for lost surplus due to onsite self-consumed energy from embedded PV generators

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

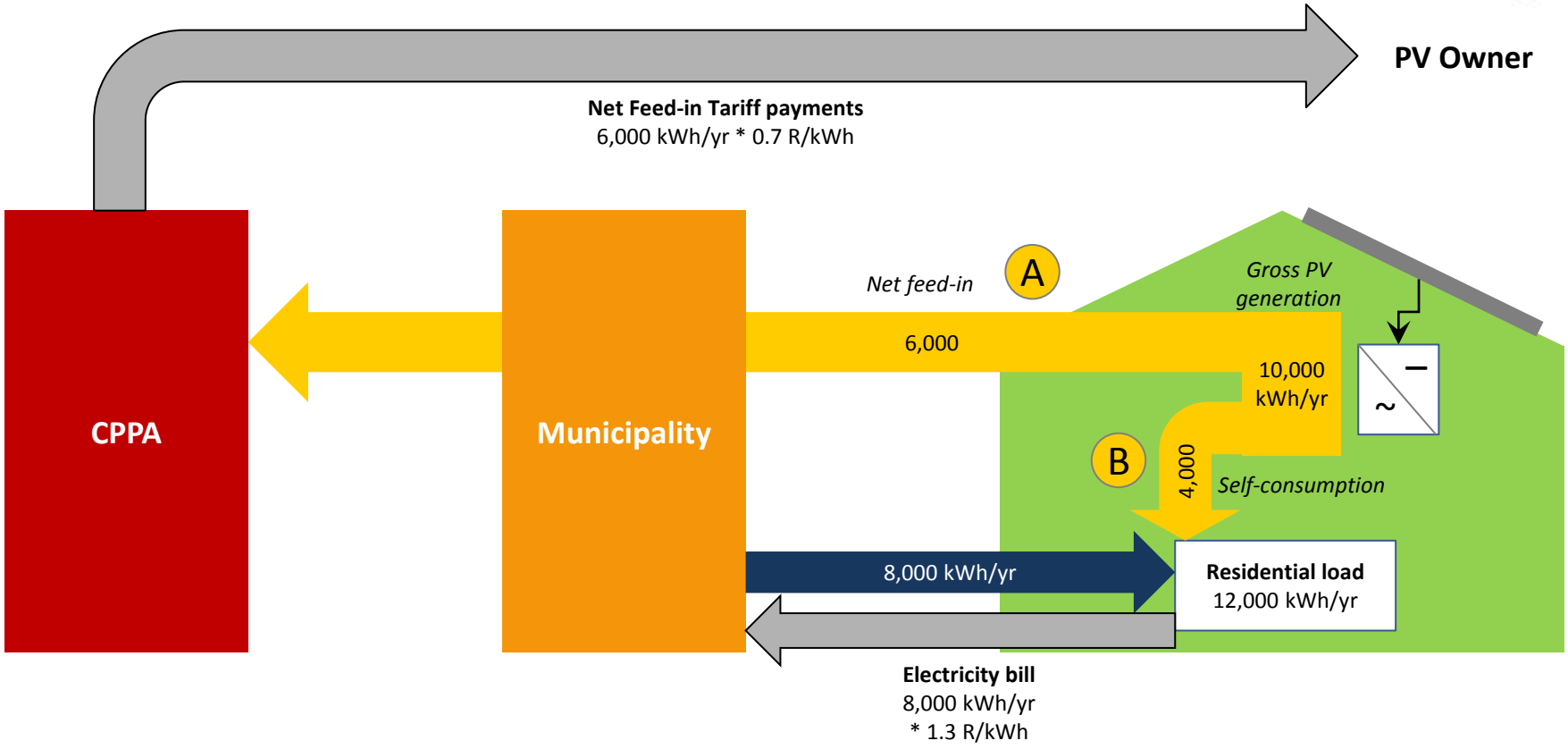
Sources: CSIR Energy Centre analysis

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 Energy Centre 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

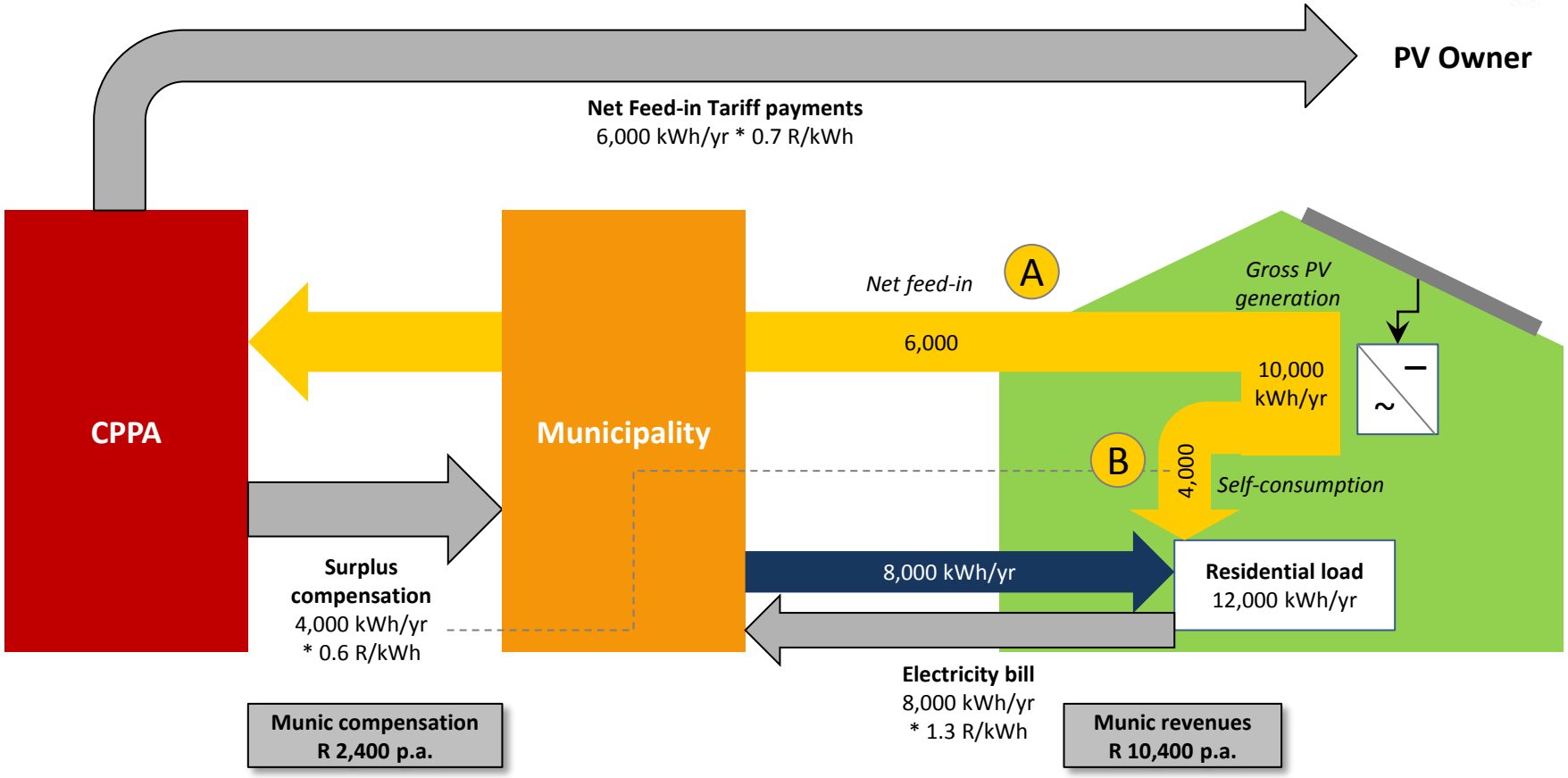


The guaranteed CPPA payment de-risks the PV business case and makes it bankable

Grid energy
Solar energy
Payments

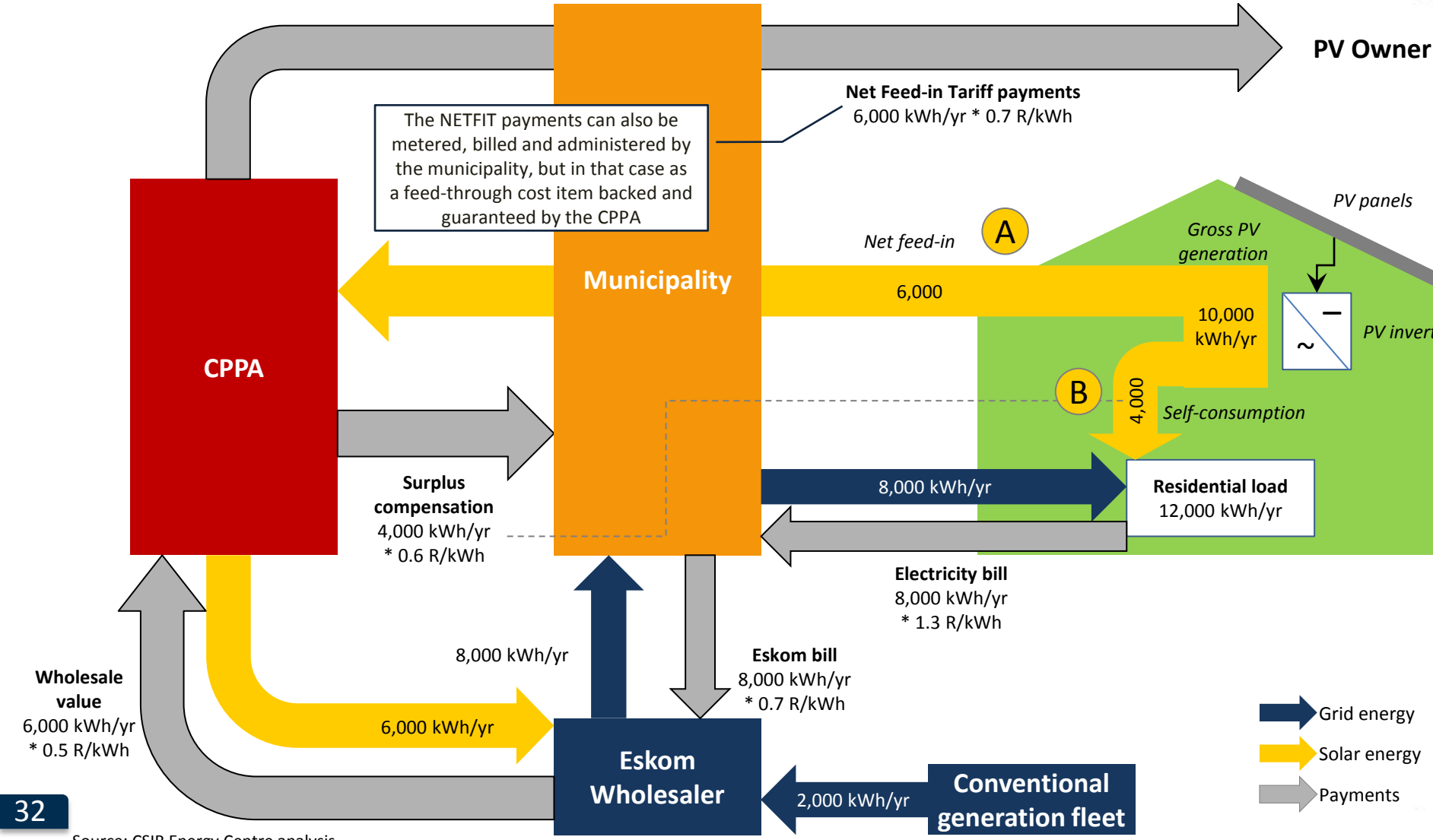
Source: CSIR Energy Centre analysis

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



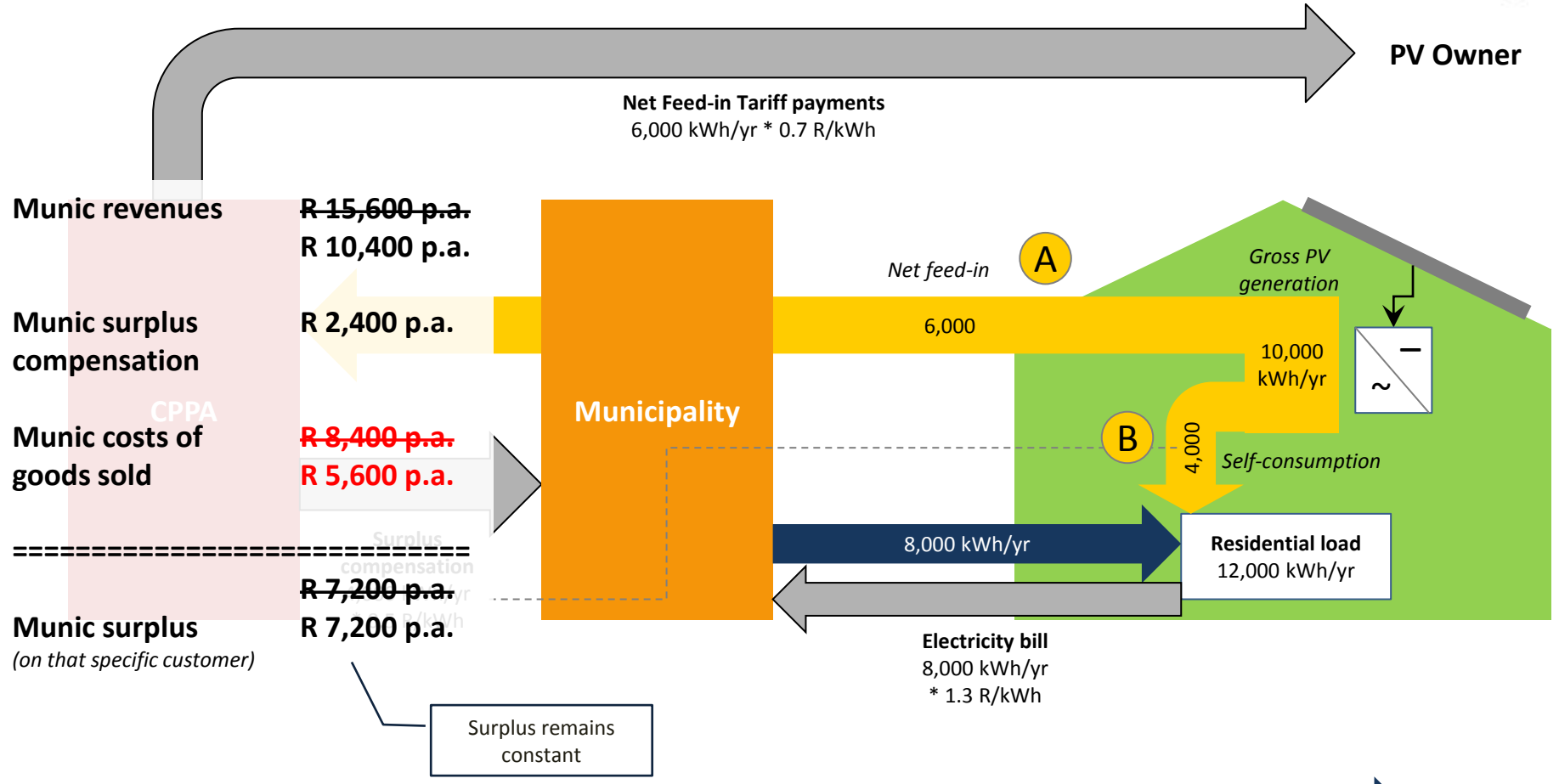
Source: CSIR Energy Centre analysis

“Central Power Purchasing Agency” (CPPA) is aggregator for embedded PV, de-risks the PV business case & makes munic financially indifferent



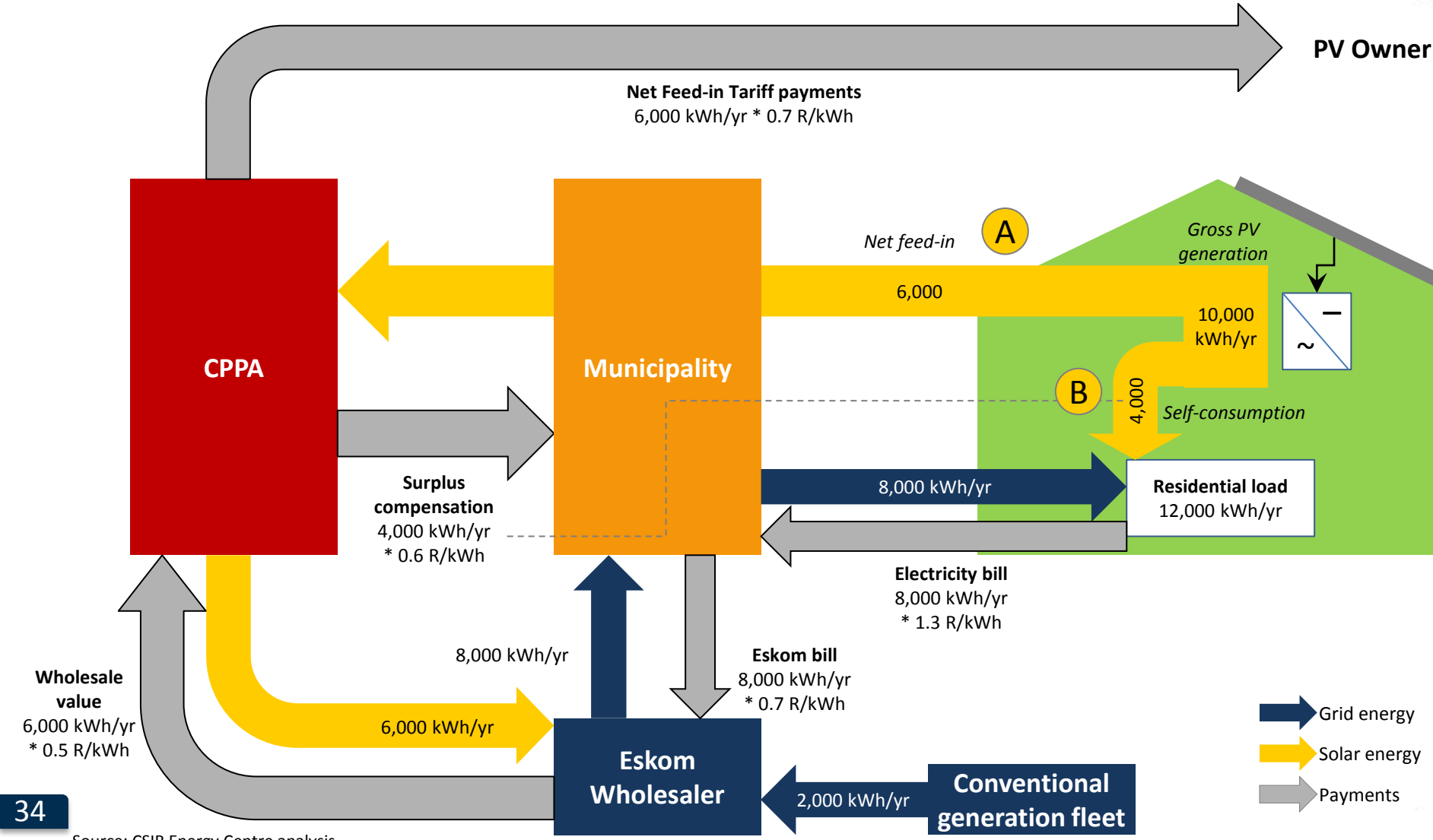
Source: CSIR Energy Centre analysis

Proposal: Surplus compensation makes municipality not better & not worse off, it simply makes it financially indifferent to embedded PV



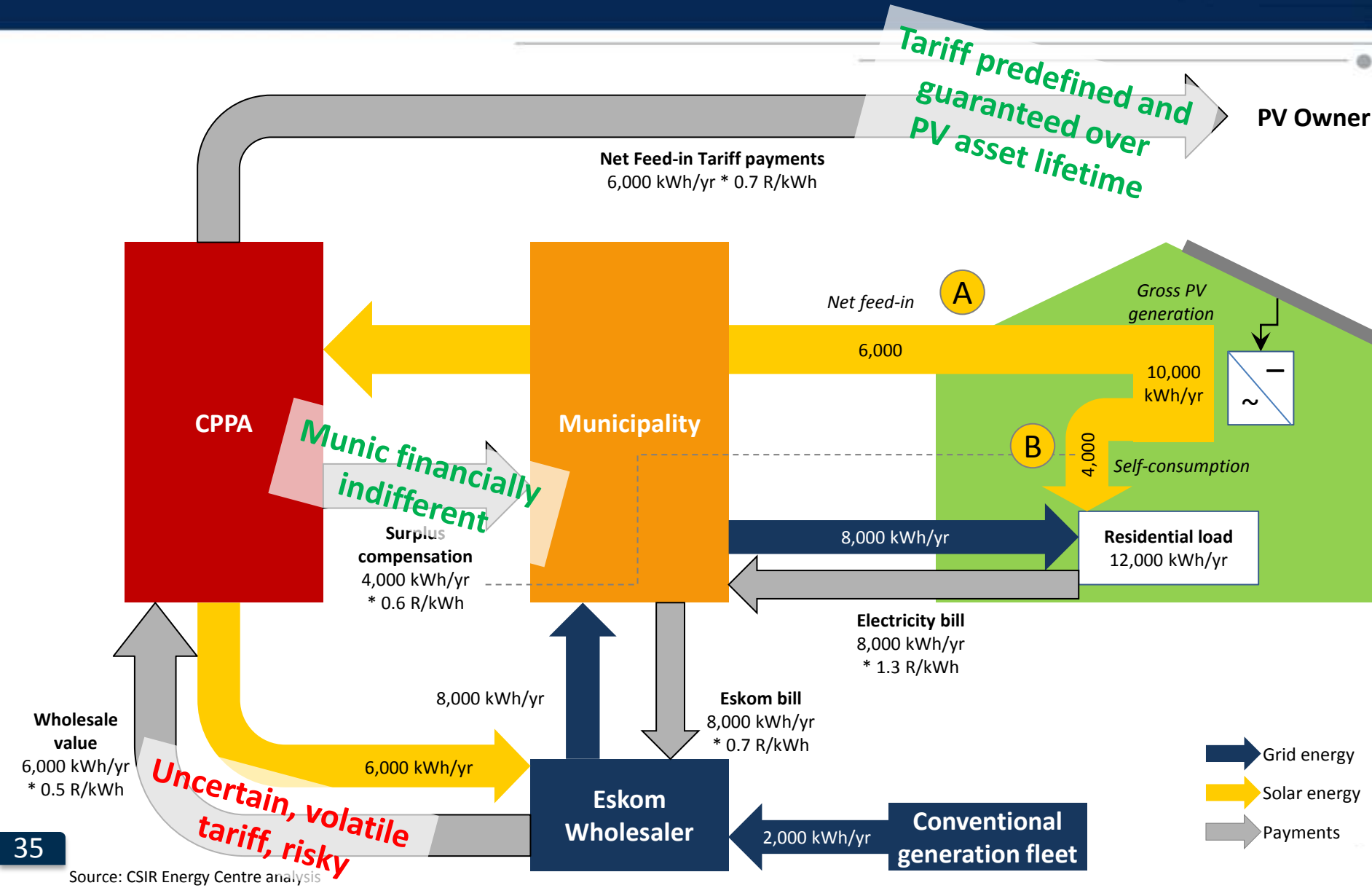
Source: CSIR Energy Centre analysis

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



Source: CSIR Energy Centre analysis

CPPA de-risks business case for PV owner – which brings costs down – and makes the municipality financially indifferent to embedded PV



Source: CSIR Energy Centre analysis

How does the NETFIT differ from a net-metering scheme?

	Approach 1: Net Metering (potential "first step")	Approach 2: Net Feed-in Tariff with central off-taker (end state?)
Power Flows	Bi-directional: importing and exporting of energy allowed	Bi-directional: importing and exporting of energy allowed
Tariff Structure	Tariff for import and export can be different (e.g., export tariff lower than import tariff)	Tariff for import and export can be different (e.g., export tariff lower than import tariff)
PV Investment Security	Both import and export tariff uncertain over lifetime of the PV asset; fixed charge add. risk	Export tariff is guaranteed over the lifetime of the PV asset; no fixed charge introduced
Energy Balance	Must be a net energy consumer over an energy-balancing cycle (typically one year)	Net energy consumer or **producer** over an energy-balancing cycle (typically one year)
Financial Balance	Must be a net payer over a billing cycle (i.e. no cash payments back to the customer)	Can be **net receiver** of payments over a billing cycle (→ **PV as a micro-utility business**)
Off-taker	Local authority (i.e. municipality or Eskom Distribution)	**Nationwide central off-taker**
Funding	From municipalities' bottom line	Nationwide funding scheme **outside** of the municipalities' financial system

Proposal in this document

Source: M.P.E. GmbH proposal on net metering; Eskom Pricing proposal on net metering; NETFIT proposal by CSIR Energy Centre analysis

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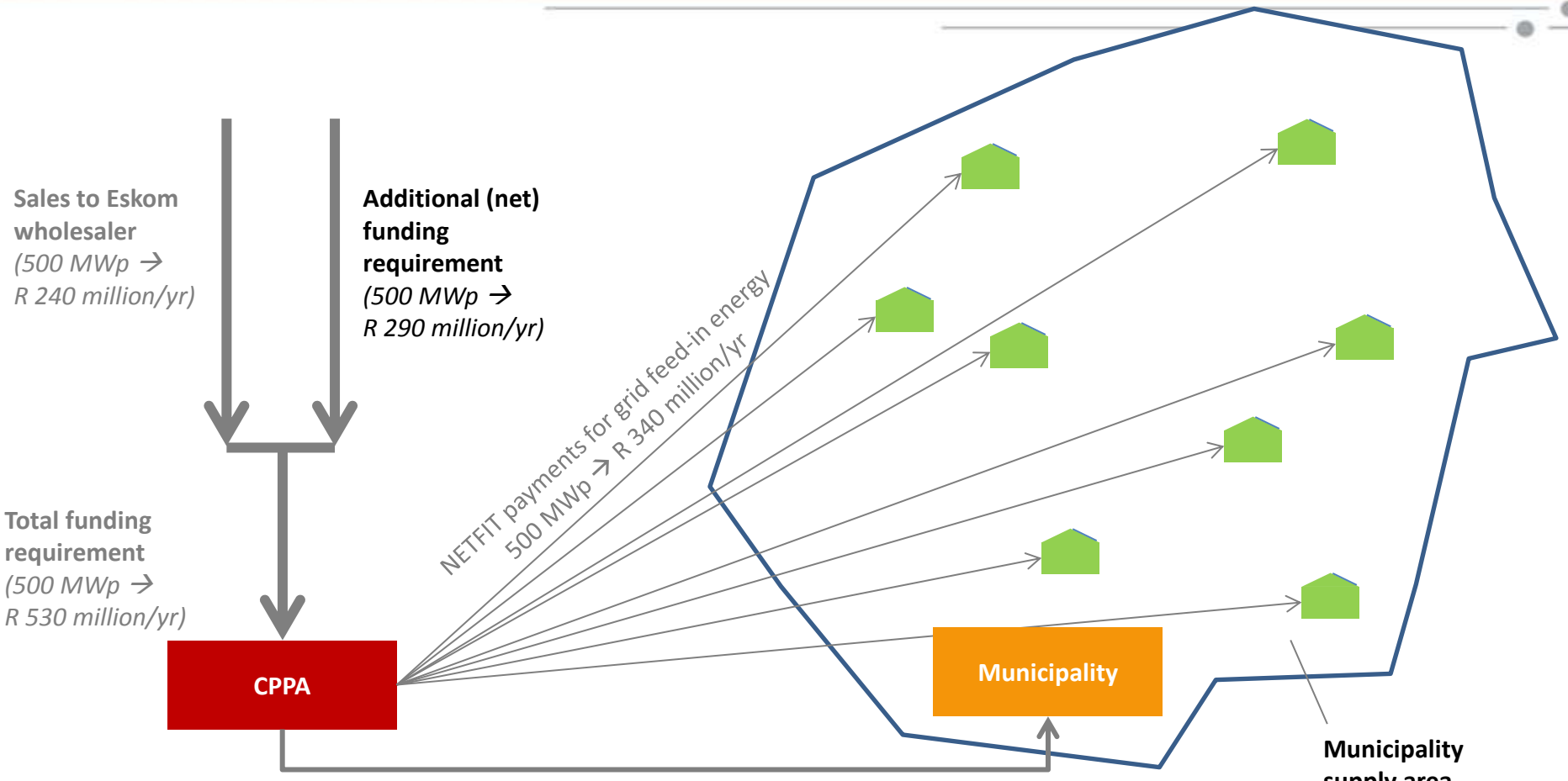
Funding requirement for CPPA would be approx. R 290 million/yr for every 500 MWp of installed PV capacity (plus CPPA staff & processes)



Assumptions: 1,600 kWh/kWp/yr; self-consumption ratio of 40%; NETFIT of 0.7 R/kWh; surplus compensation of 0.6 R/kWh; wholesale value of PV energy of 0.5 R/kWh Source: CSIR analysis

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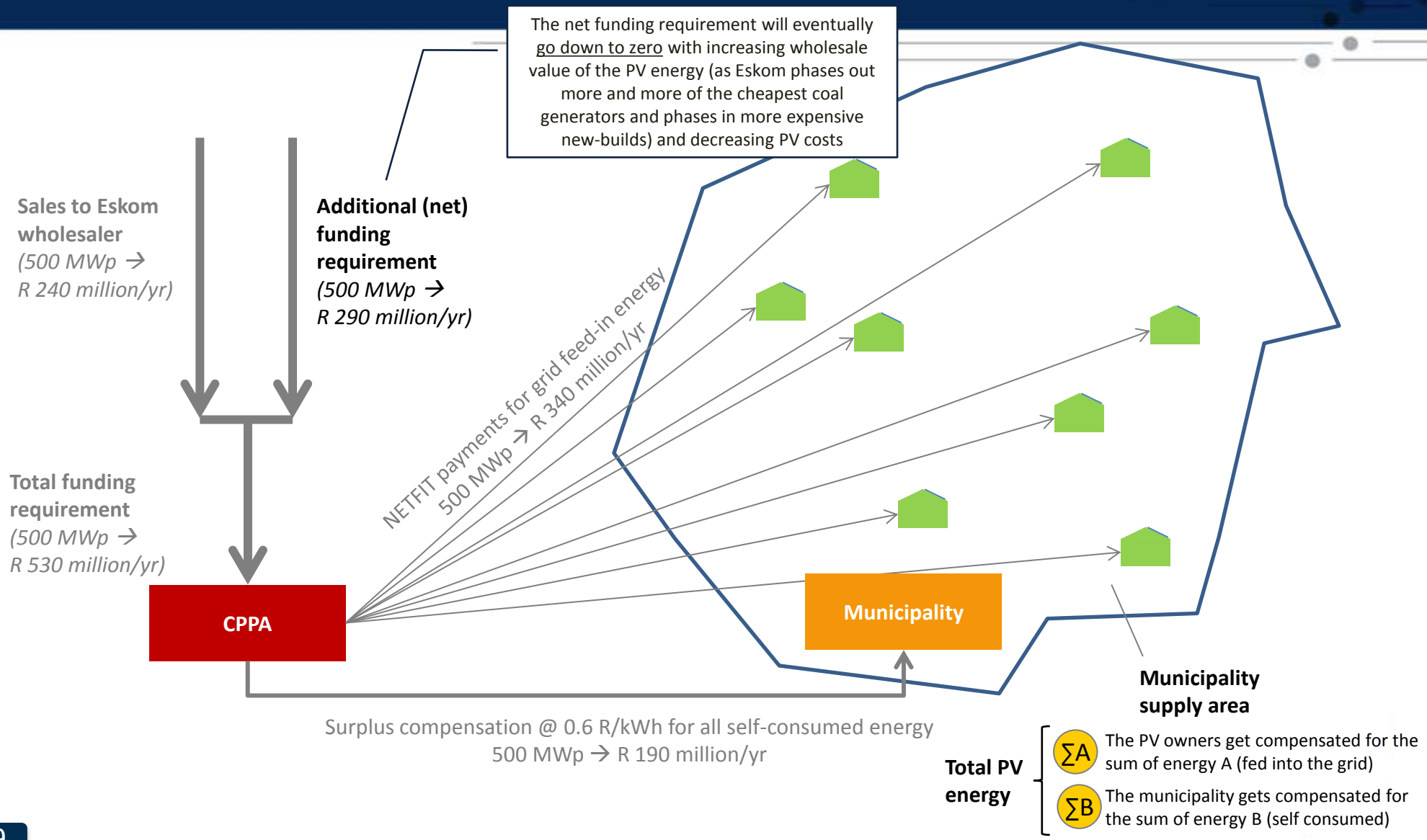

Assumptions: 1,600 kWh/kWp/yr; self-consumption ratio of 40%; NETFIT of 0.7 R/kWh; surplus compensation of 0.6 R/kWh; wholesale value of PV energy of 0.5 R/kWh Source: CSIR analysis

Concerns of all key stakeholders are addressed via the NETFIT with financial compensation for municipalities

Player	Concern	Add-ressed?
Munics	• Cannot afford to loose out on surplus from electricity sales • Administrative burden managing large-scale uptake of embedded PV	Financially neutral ✓
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	Business case has good risk-return profile, similar to fixed-deposit ✓
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	Secured work to install 100,000s of PV systems & micro-utility business ✓
PV Manu-facturers	• REIPPP Programme very well run, but the demand is too "spiky" in order trigger significant investments into local production of modules/inverter • Rooftop PV market attractive (it is very fragmented & provides continuous demand that is supplied through wholesaler channels), but not existing	Secured off-take and FIT premium stimulate local manufacturing ✓
Electricity Ratepayers	• Only PV systems with very short payback are currently implemented • That means customers with a) high tariffs and b) high demand implemen they therefore opt out of the cross-subsidisation mechanism, which means higher tariffs for all other customers	De-risking PV business case & broadening ownership base keeps tariff low ✓

Source: CSIR Energy Centre 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

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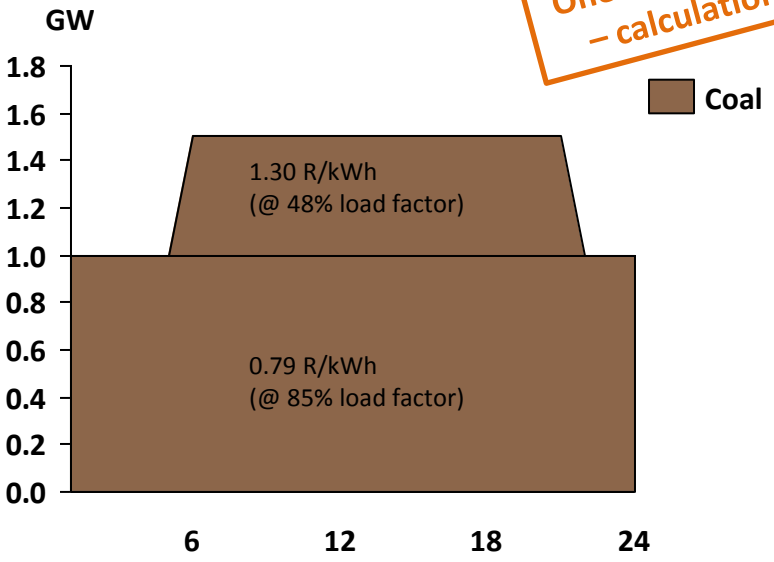
Source: CSIR Energy Centre analysis

By 2020, mix of PV, wind & flexible gas is cheaper than coal, even without any value given to excess wind/PV energy

One illustrative winter day in display – calculations done for a full year

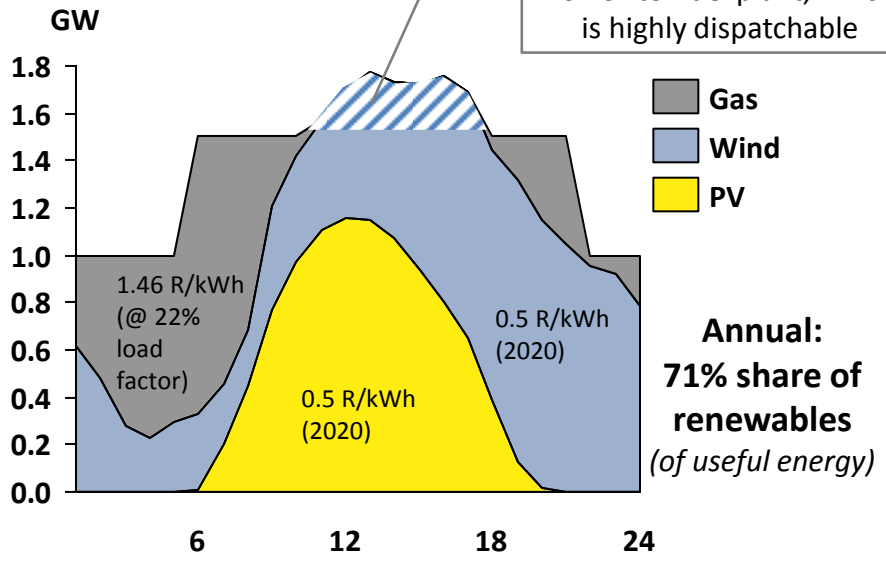


Technology: Coal base / coal mid-merit
Size: 1.18 / 0.56 GW
Energy: 11.1 TWh/yr

Weighted cost: **0.90 R/kWh**

CO2: ~0.95 kg/kWh

Curtailment of excess wind energy → could supply a Power-to-Fuel plant, which is highly dispatchable



Annual: 71% share of renewables *(of useful energy)*

Technology: PV / wind / gas
Size: 1.8 / 2.0 / 1.61 GW
Energy (useful): 11.1 TWh/yr
Energy (total): 3.6 / 5.3 / 3.2 TWh/yr = 12.1 TWh/yr

Weighted cost: **0.82 R/kWh**
(per useful energy, i.e. no value given to excess)

CO2: ~0.18 kg/kWh (per useful energy)

Thank you!