Comparison of IRP assumptions with actual IPP tariffs

A feed-back loop between planning assumptions & actuals

CSIR Energy Centre

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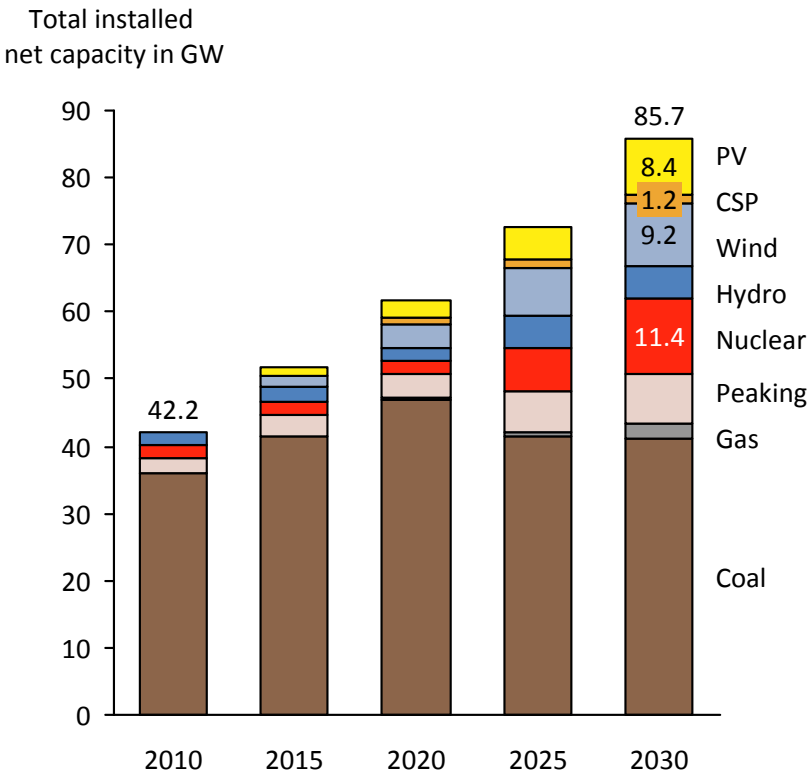
IRP 2010 and actual IPP tariffs in South Africa

IRP LCOE vs IPP Tariff

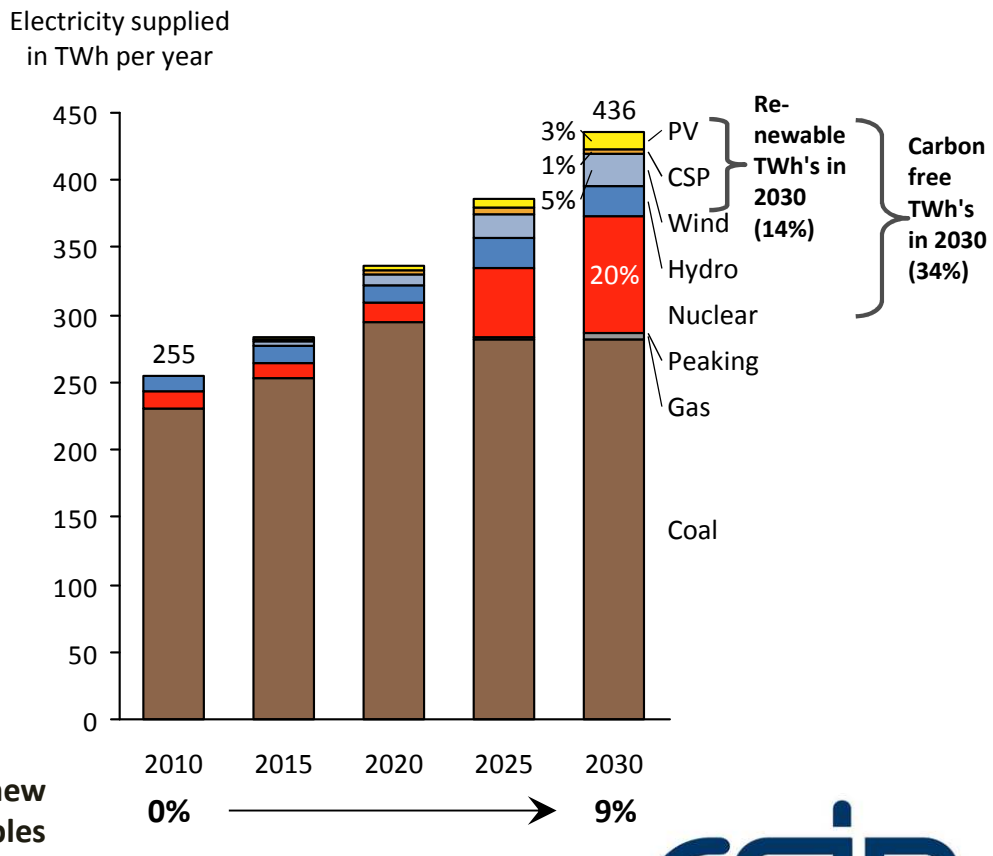
Comparison of IRP assumptions and actuals

Integrated Resource Plan 2010 (IRP 2010): Plan of the power generation mix for South Africa until 2030

Installed capacity



Energy mix



Share new renewables

0% → **9%**

Implementation of the IRP is done by Department of Energy through competitive tenders ("REIPPPP" for renewables)

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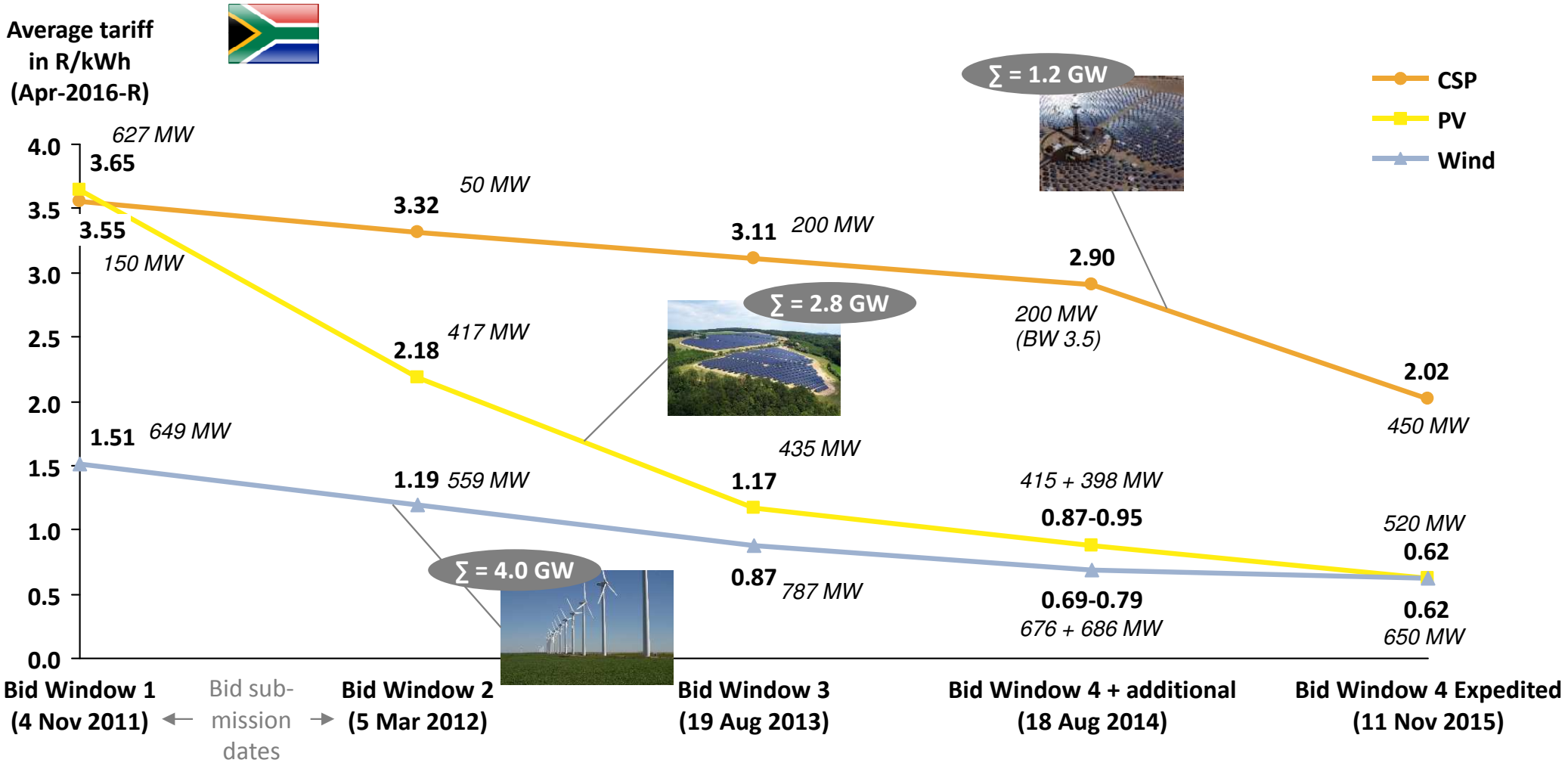
Source: Integrated Resource Plan 2010, as promulgated in 2011; CSIR Energy Centre analysis

Actual tariffs: new renewables projects much cheaper than first ones

First four Bid Windows' results of Department of Energy's RE IPP Procurement Programme (REIPPPP)



Notes: For CSP Bid Window 3, 3.5 and 4 Expedited, the weighted average of base and peak tariff is indicated, assuming 64%/36% split between base and peak tariff; BW = Bid Window; Sources: Department of Energy's publications on results of first four bidding windows http://www.energy.gov.za/files/renewable-energy-status-report/Market-Overview-and-Current-Levels-of-Renewable-Energy-Deployment-NERSA.pdf; IPP Office on BW4 Expedited; StatsSA on CPI; CSIR analysis

The average coal IPP tariff is 1.03 R/kWh in April-2016-Rand

On 10 October 2016, the Department of Energy announced the results of Coal IPP Bid Window 1

- 1 Qualification Tariff per project and 1 Evaluation Tariff per project
- These tariffs are quoted in April-2014-Rand

The announced tariffs cover a different scope than the typical Renewables IPP tariff

- The Qualification Tariff does not include the so-called shallow grid connection costs, the Evaluation Tariff includes them, but in addition the Evaluation Tariff also includes cost of CO2 (@ 120 R/t)
- The coal cost component of the tariff will be escalated with a basket index that is currently CPI + 1%-point, all other components of the tariff will be escalated with CPI
- Renewables IPP projects include the shallow grid connections costs and the tariffs are inflated with CPI

Hence, the announced coal Evaluation Tariff can be made comparable to Renewables IPP tariffs by

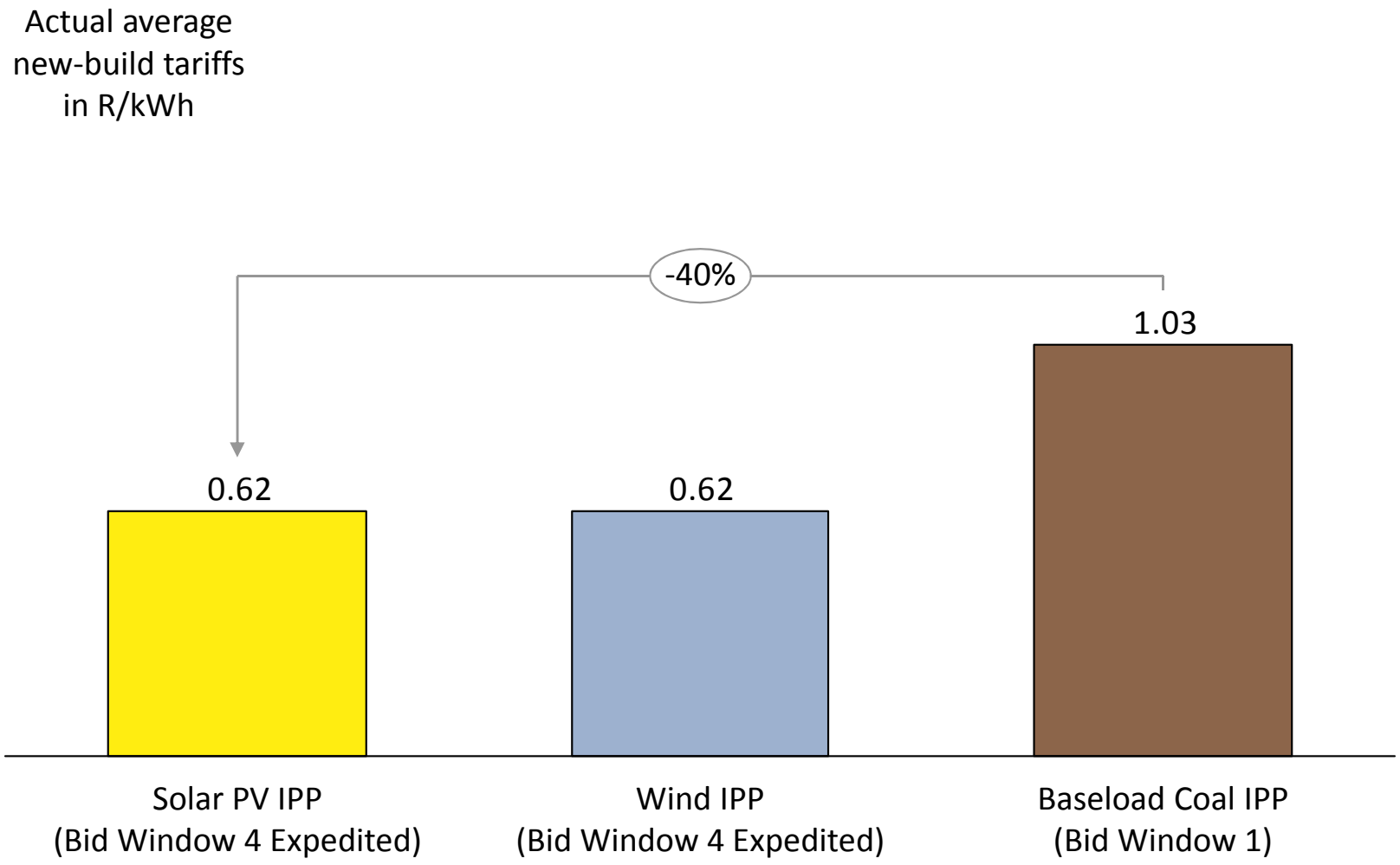
1. Inflating it into today's money (from Apr-2014-Rand → Apr-2016-Rand)
2. Calculating the present-value-equivalent of a fully CPI-indexed coal-cost component to CPI+1%-point
3. Subtracting the cost of CO2 emissions (@ 120 R/t) from the evaluation tariff

With these adjustments, the average coal IPP tariff (incl. grid, excl. CO2) is 1.03 R/kWh (in Apr-2016-Rand)

Sources: http://www.energy.gov.za/files/media/pr/2016/Coal-IPP-factsheet.pdf; CSIR analysis

Actual tariffs of RE Bid Window 4 Expedited and Coal Bid Window 1: new solar PV and wind is 40% cheaper than new baseload coal

Results of South African Department of Energy's RE/Coal IPP Procurement Programme (REIPPPP/Coal IPPPP)



Notes: All numbers in April-2016-Rand

Sources: South African Department of Energy IPP Office's publications on results of IPP Bid Windows; IPP Office on Bid Window 4 expedited; StatsSA on CPI; CSIR analysis

Link between planning and real world needs to be established

In-principle process of IRP planning and implementation

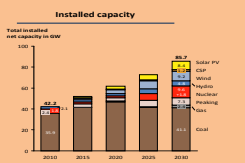
Currently, no feedback loop from procurement results to IRP planning assumptions institutionalised

Planning / simulation world

Inputs
- Demand forecast
- Technology costs **assumptions (LCOE)**
- CO2 limits
- Etc.

IRP model
(least-cost optimisation)

Output
- Capacity expansion plan



Actuals / real world

Inputs
- Ministerial Determinations based on capacity expansion plan

Procurement
(competitive tender e.g. REIPPPP, coal IPPPP)

Outcomes
- Preferred bidders
- MW allocation
- Technology costs **actuals (Ø Tariffs)**

Sources: CSIR analysis

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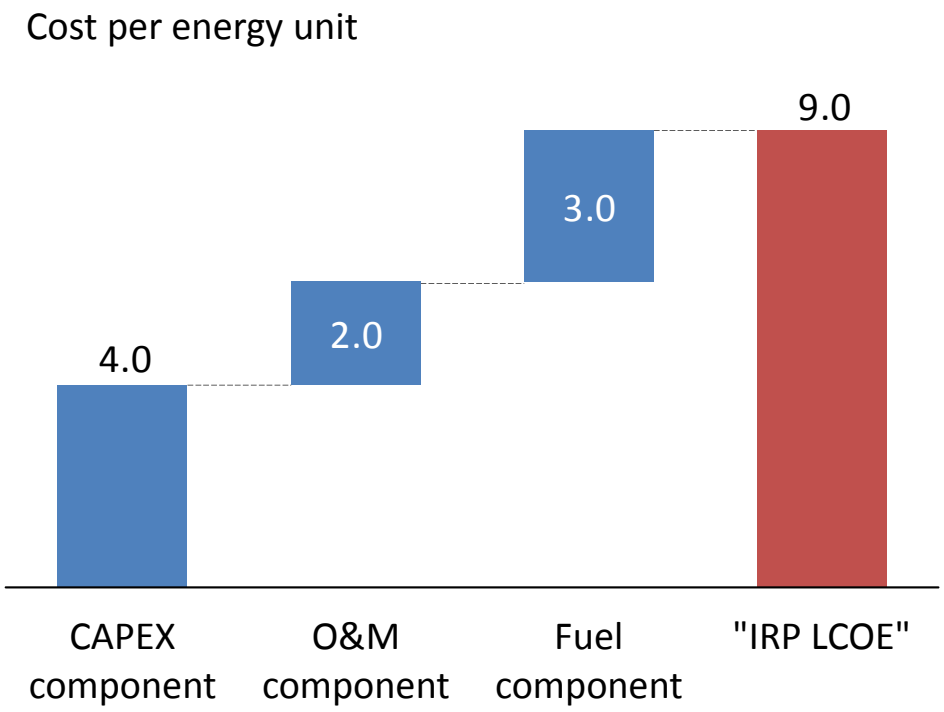
IRP LCOE vs IPP Tariff

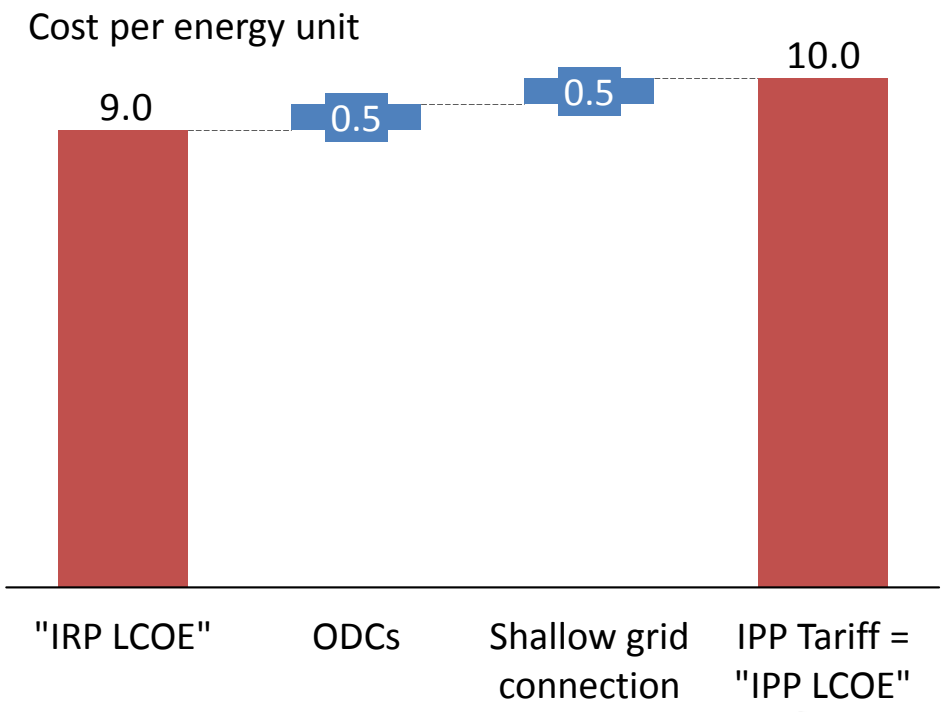
Comparison of IRP assumptions and actuals

IPP tariffs not directly comparable to IRP LCOE, because they cover additional costs such as Owner's Development Cost & grid connection

IRP assumptions: "IRP LCOE" World



IPP results: IPP Tariff = "IPP LCOE" World



Assumption: IRP LCOE = 90% * IPP Tariff

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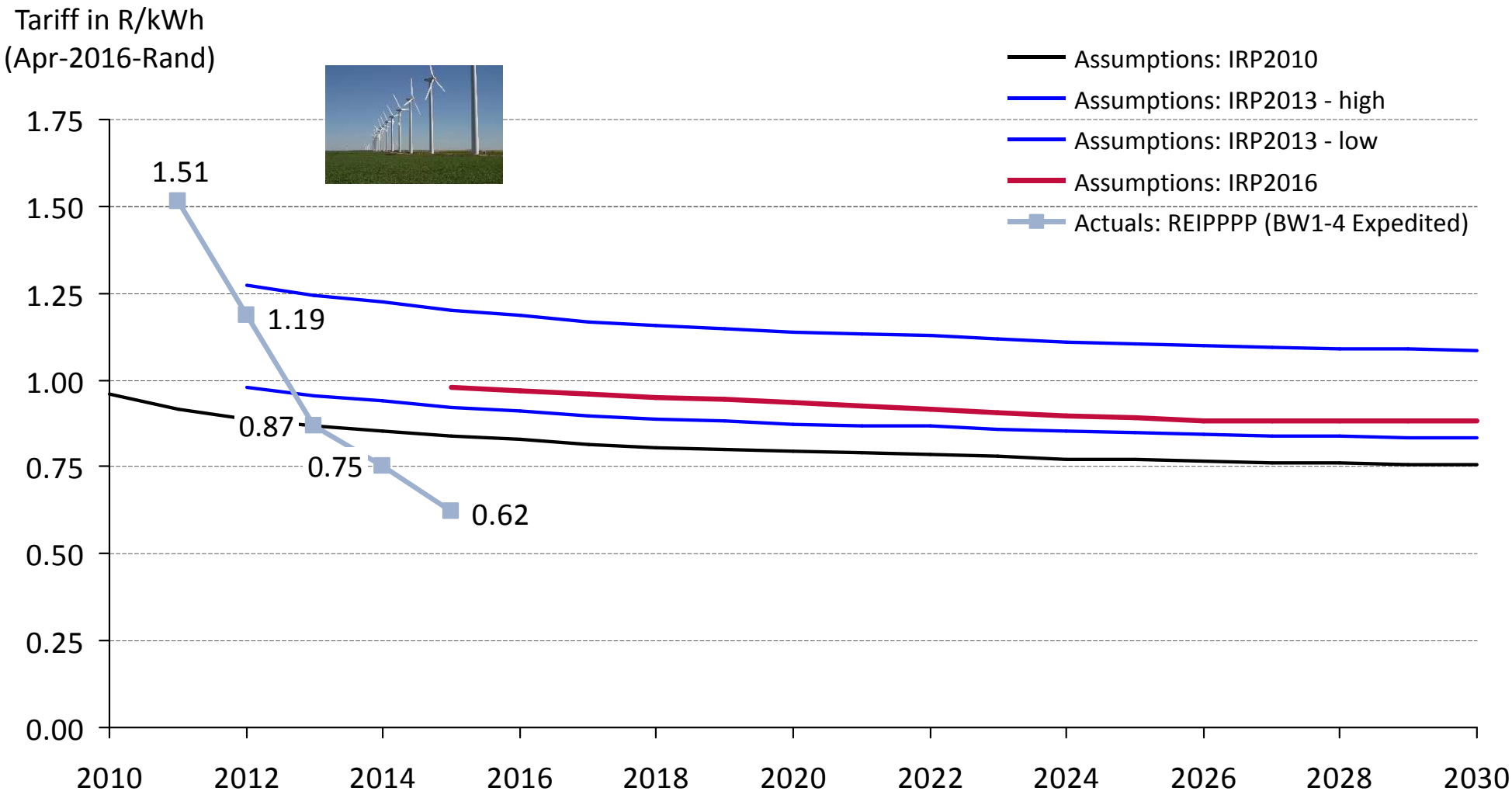
Comparison of IRP assumptions and actuals

Actual coal tariff of Bid Window 1 is significantly above IRP 2010 assumptions and almost exactly on the Coal PF assumption of IRP 2016

Assumptions: CPI used for normalisation to Apr-2016-Rand; LCOE calculated for IRP 2010 and 2013 with 8% discount rate (real), 30 yrs lifetime, cost and load factor assumptions as per relevant IRP document; LCOE for IRP 2016 straight from IRP document; "IRP Tariff" then calculated assuming 90% of total tariff to be LCOE EPC costs, i.e. divide the LCOE by 0.9 to derive at the "IRP Tariff"
Sources: IRP 2010; IRP 2013; IRP 2016 draft as of November 2016; https://www.ipp-projects.co.za/Home/GetPressRelease?fileid=228bdd35-e18e-e611-9455-2c59e59ac9cd&fileName=PressRelease-Coal-based-Independent-Power-Producer-programme-announcement-10Oct2016.pdf; CSIR analysis

Actual wind tariffs in bid window four were below the level that was assumed for 2030 in IRP 2010, BW 4 Expedited is significantly below



Assumptions: CPI used for normalisation to Apr-2016-Rand; LCOE calculated for IRP 2010 and 2013 with 8% discount rate (real), 20 yrs lifetime, cost and load factor assumptions as per relevant IRP document; LCOE for IRP 2016 straight from IRP document; "IRP Tariff" then calculated assuming 90% of total tariff to be LCOE EPC costs, i.e. divide the LCOE by 0.9 to derive at the "IRP Tariff"
Sources: IRP 2010; IRP 2013; IRP 2016 draft as of November 2016; http://www.energy.gov.za/files/renewable-energy-status-report/Market-Overview-and-Current-Levels-of-Renewable-Energy-Deployment-NERSA.pdf; CSIR analysis

Actual solar PV tariffs quickly approached IRP 2010 assumptions in first four bid windows and are now well below cost assumption funnel

Assumptions: CPI used for normalisation to Apr-2016-Rand; LCOE calculated for IRP 2010 and 2013 with 8% discount rate (real), 25 yrs lifetime, cost and load factor assumptions as per relevant IRP document; LCOE for IRP 2016 straight from IRP document; "IRP Tariff" then calculated assuming 90% of total tariff to be LCOE EPC costs, i.e. divide the LCOE by 0.9 to derive at the "IRP Tariff"
Sources: IRP 2010; IRP 2013; IRP 2016 draft as of November 2016; http://www.energy.gov.za/files/renewable-energy-status-report/Market-Overview-and-Current-Levels-of-Renewable-Energy-Deployment-NERSA.pdf; CSIR analysis

Actual CSP tariffs are declining from bid window 1 to 4 Expedited, and are now close to the upper boundary of IRP 2013 cost assumptions

Assumptions: CPI used for normalisation to Apr-2016-Rand; LCOE calculated for IRP 2010 and 2013 with 8% discount rate (real), 30 yrs lifetime, cost and load factor assumptions as per relevant IRP document; LCOE for IRP 2016 straight from IRP document; "IRP Tariff" then calculated assuming 90% of total tariff to be LCOE EPC costs, i.e. divide the LCOE by 0.9 to derive at the "IRP Tariff"
Sources: IRP 2010; IRP 2013; IRP 2016 draft as of November 2016; http://www.energy.gov.za/files/renewable-energy-status-report/Market-Overview-and-Current-Levels-of-Renewable-Energy-Deployment-NERSA.pdf; CSIR analysis

Logic to derive “IRP Tariff” curves

Calculate the IRP LCOE path for each technology based on

- Cost development path for CAPEX in R/kW and for O&M in R/kW/yr as per IRP 2010 / IRP 2013
- Discount rate of 8%
- Lifetime of 25/20/30 years for PV/wind/CSP
- Load factors as per the profiles used in IRP 2010 / IRP 2013
- For IRP 2016, use straight the reported LCOE (i.e. without own LCOE calculation)

Adjust all resulting IRP LCOE numbers to Apr 2016 via CPI table

- http://www.statssa.gov.za/keyindicators/CPI/CPIHistory.pdf

Translate all Apr-2016-based IRP LCOE numbers into an “IRP Tariff”

- The IRP-assumed costs (CAPEX and O&M) reflect only the costs within the battery limit of the EPC contract. Owner’s development costs (ODCs) and grid connection costs are not considered
- Assume that for an IPP the pure EPC CAPEX plus O&M stands for 90% of the total costs that lead to the tariff
- Therefore, divide “IRP LCOE” numbers by 90% to derive at the “IRP Tariff”
- This tariff is logically comparable to the tariffs that IPPs bid for in the REIPPPP

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Re a leboha

Ha Khensa

Enkosi

Siyathokoza

Thank you

Re a leboga

Ro livhuha

Dankie

Siyabonga

Note: “Thank you” in all official languages of the Republic of South Africa