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IDEAS THAT WORK

8-9 October 2015 | CSIR ICC

**Financial benefits of solar and wind
power in South Africa in 2015**

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Background

South Africa's power system is currently under severe constraints

- Power generators meant to be the “barely-ever-used” safety net for the system (diesel-fired gas turbines) running at > 30% average load factor in the first half of 2015
- Load shedding occurred during 82 days in the first half of 2015 (out of 181 days)

At the same time, Department of Energy is procuring new generation capacity and has already allocated a total of 8.1 GW of renewables (mainly wind & PV) for procurement from Independent Power Producers

- ... of this, 6.3 GW have achieved preferred bidder status
- ... of this, 4.0 GW have financially closed and signed the Power Purchase Agreements with Eskom
- ... of this, ~1.8 GW are operational and feed energy into the grid as of end of June 2015

The CSIR conducted a study on the financial benefits of the first renewables in South Africa in 2014

- Fuel cost savings by reducing the utilisation of diesel-fired gas turbines and of the expensive part of the coal fleet were assessed, as well as the amount of “unserved energy” that renewables avoided
- The study found that renewables in 2014 generated R0.8 billion net benefit to the economy

A continuation of this financial benefit study was conducted for the first 6 months of 2015

Agenda

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Actuals: South African power system in 2015

Methodology: illustrative explanation

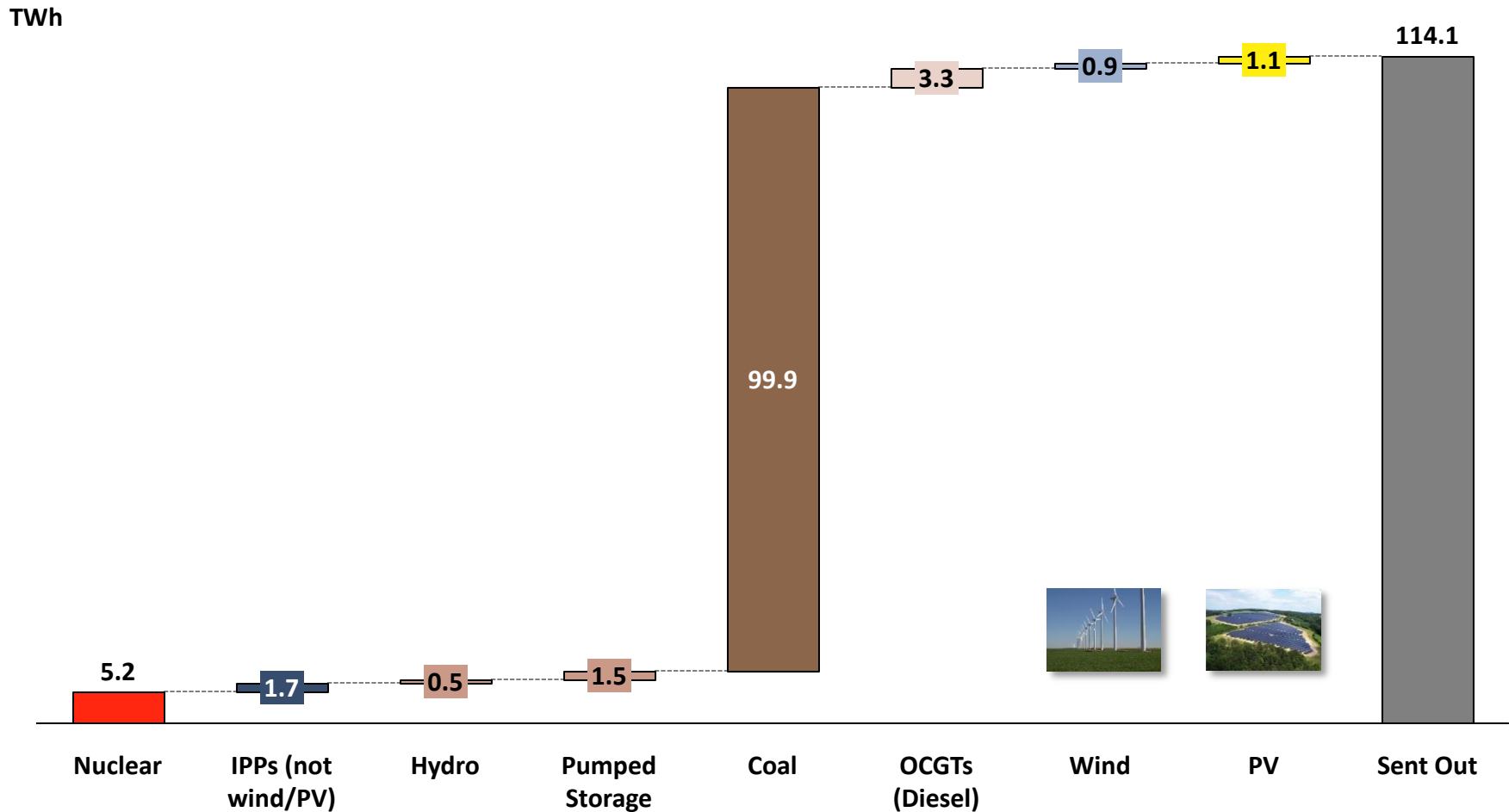
Results: financial benefits of renewables in 2015

Next steps

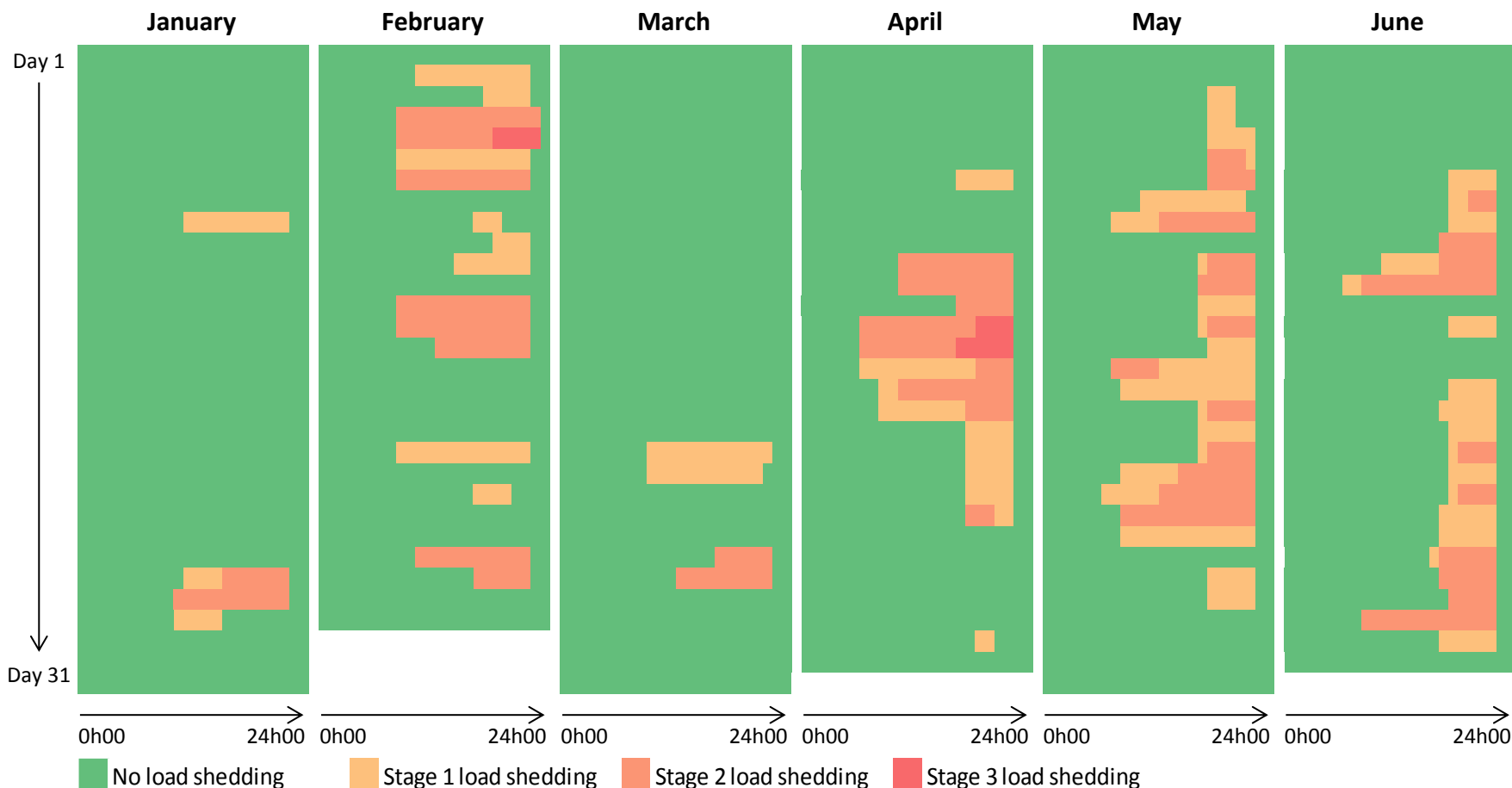
Wind and PV stand for 2% of the electricity sent out to the South African grid from Jan-Jun 2015

Actual energy captured in wholesale market from Jan-Jun 2015

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Hourly distribution of actual load shedding in the South African power system from Jan to Jun 2015



Notes: Load shedding assumed to have taken place for the full hours in which it was implemented, in reality load shedding (and the Stage) may occasionally change/end during a particular hour. Total GWh calculated assuming Stage 1 = 1 000 MW, Stage 2 = 2 000 MW, Stage 3 = 3 000 MW

Sources: Eskom Twitter account; CSIR Energy Centre analysis

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CSIR-defined methodology: In any hour, wind/PV can have one of three effects on the existing fleet

Applicable if ...

A Saving coal fuel

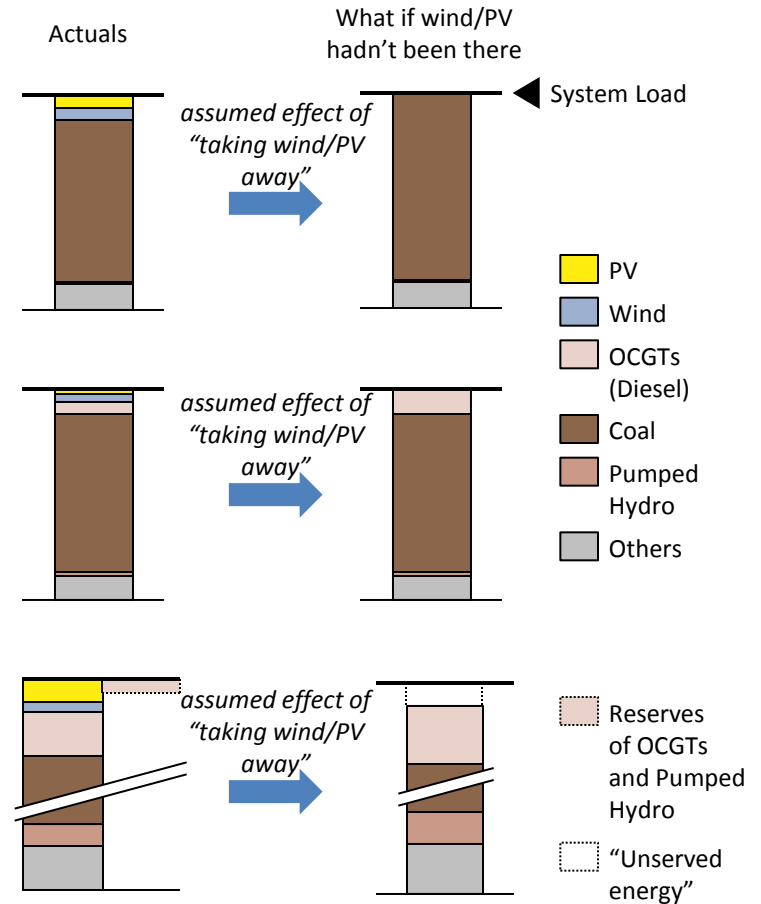
... output from OCGTs = 0 MWh

B Saving diesel fuel

... output from OCGTs > 0 MWh

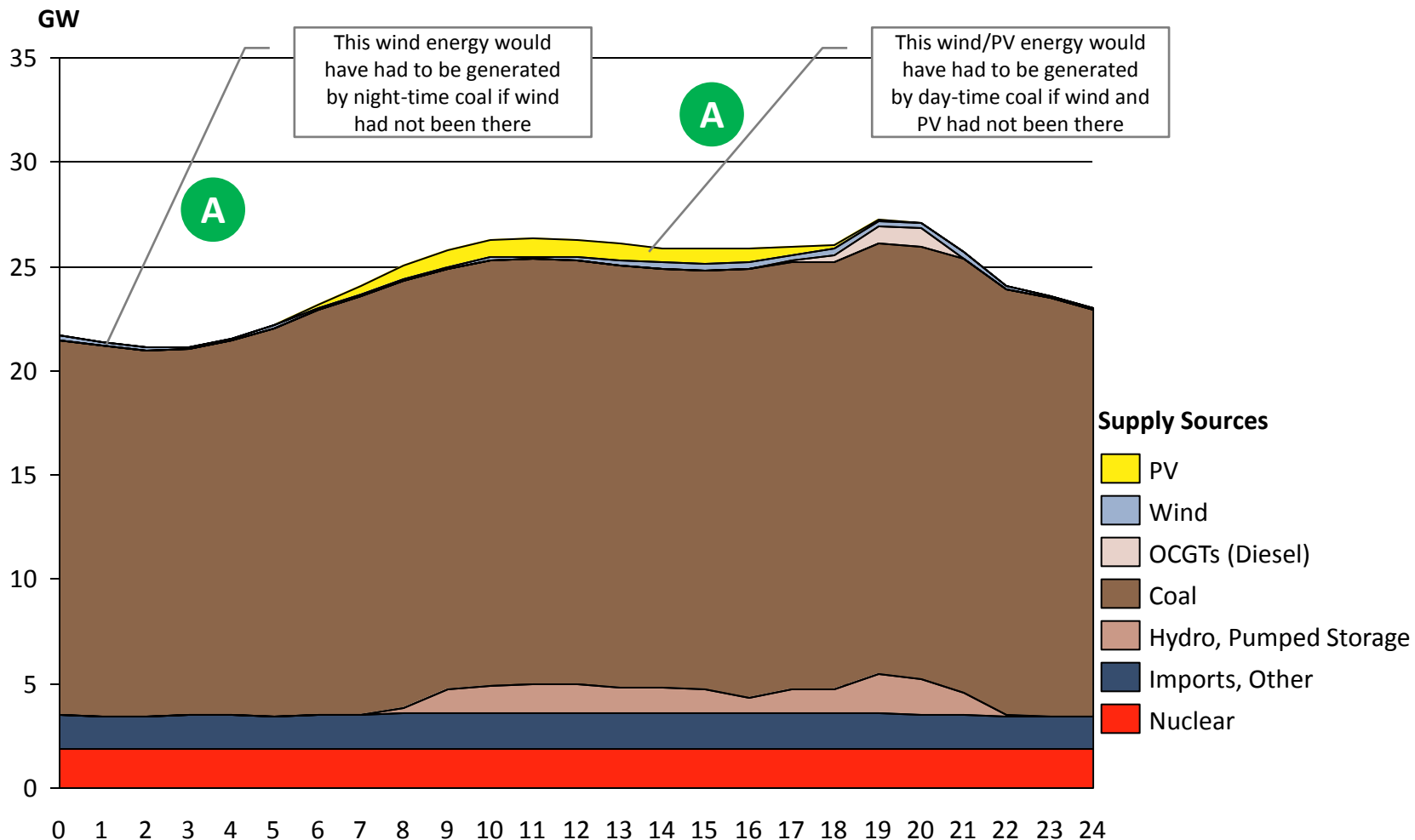
C Avoiding “unserved energy”

... output from OCGTs > 0 MWh and (reserves of OCGTs and Pumped Hydro) < (wind and PV)



On an unconstrained day, wind and solar PV replace mainly coal fuel

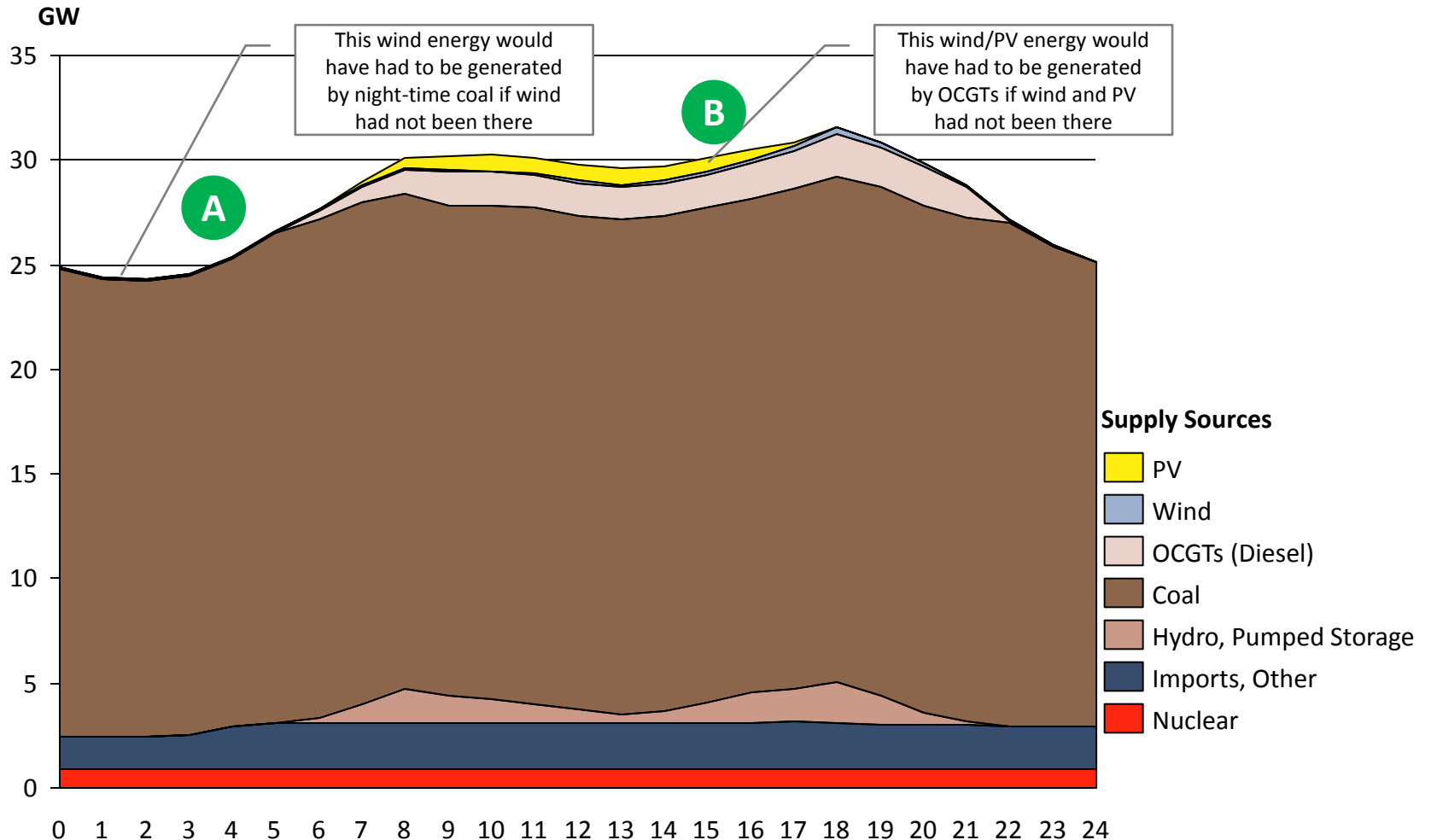
Actual South African supply structure for a summer day, 2 January 2015 (Friday)



Sources: Eskom; CSIR Energy Centre analysis

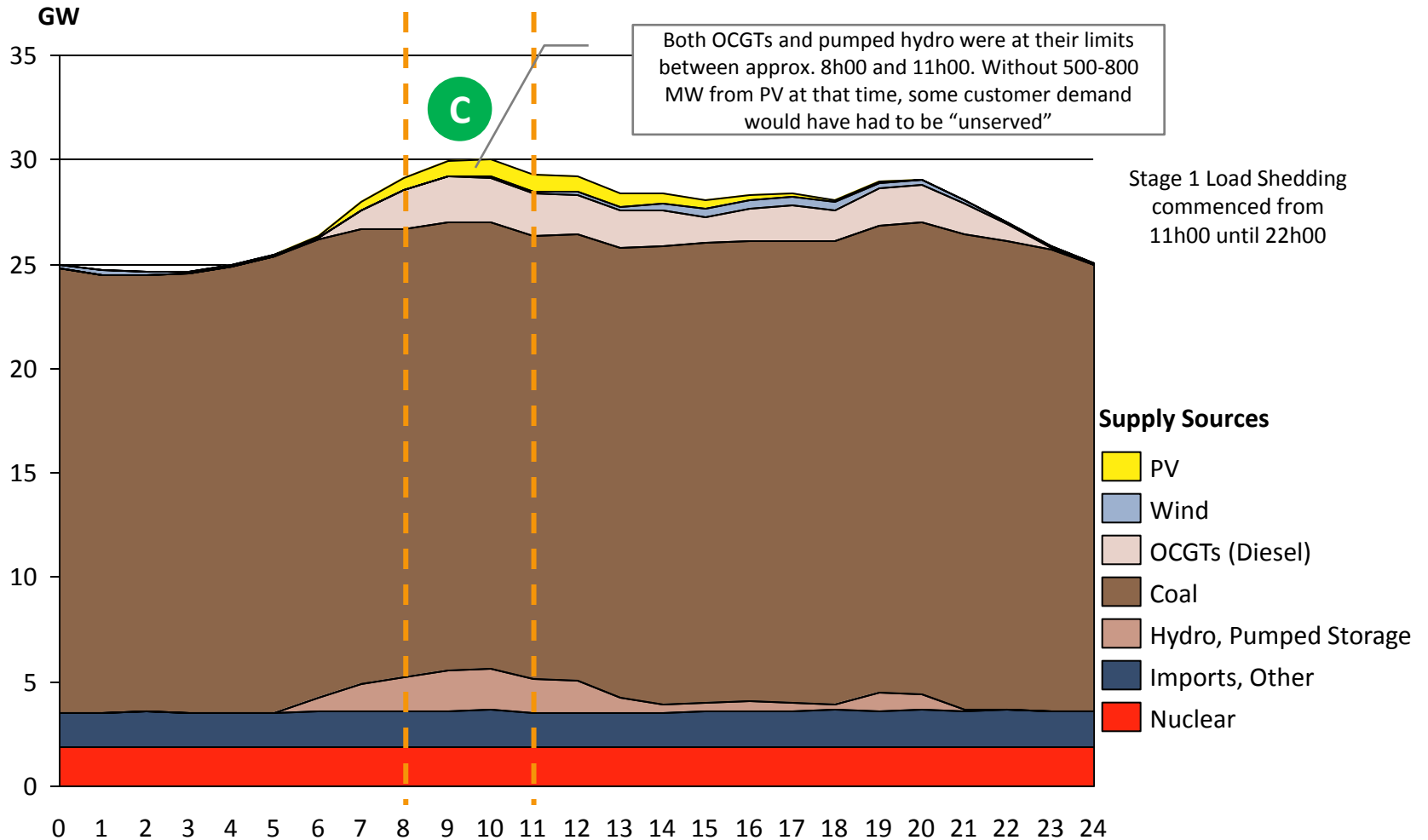
On a constrained day, both wind and solar PV replace mainly diesel fuel

Actual South African supply structure for an autumn day, 9 April 2015 (Thursday)



On 9 January, PV even prevented “unserved energy” between 8h-11h00

Actual South African supply structure for a summer day, the 9 January 2015 (Friday)



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Renewables replaced 0.5 TWh from coal and 1.5 TWh from diesel from Jan-Jun 2015

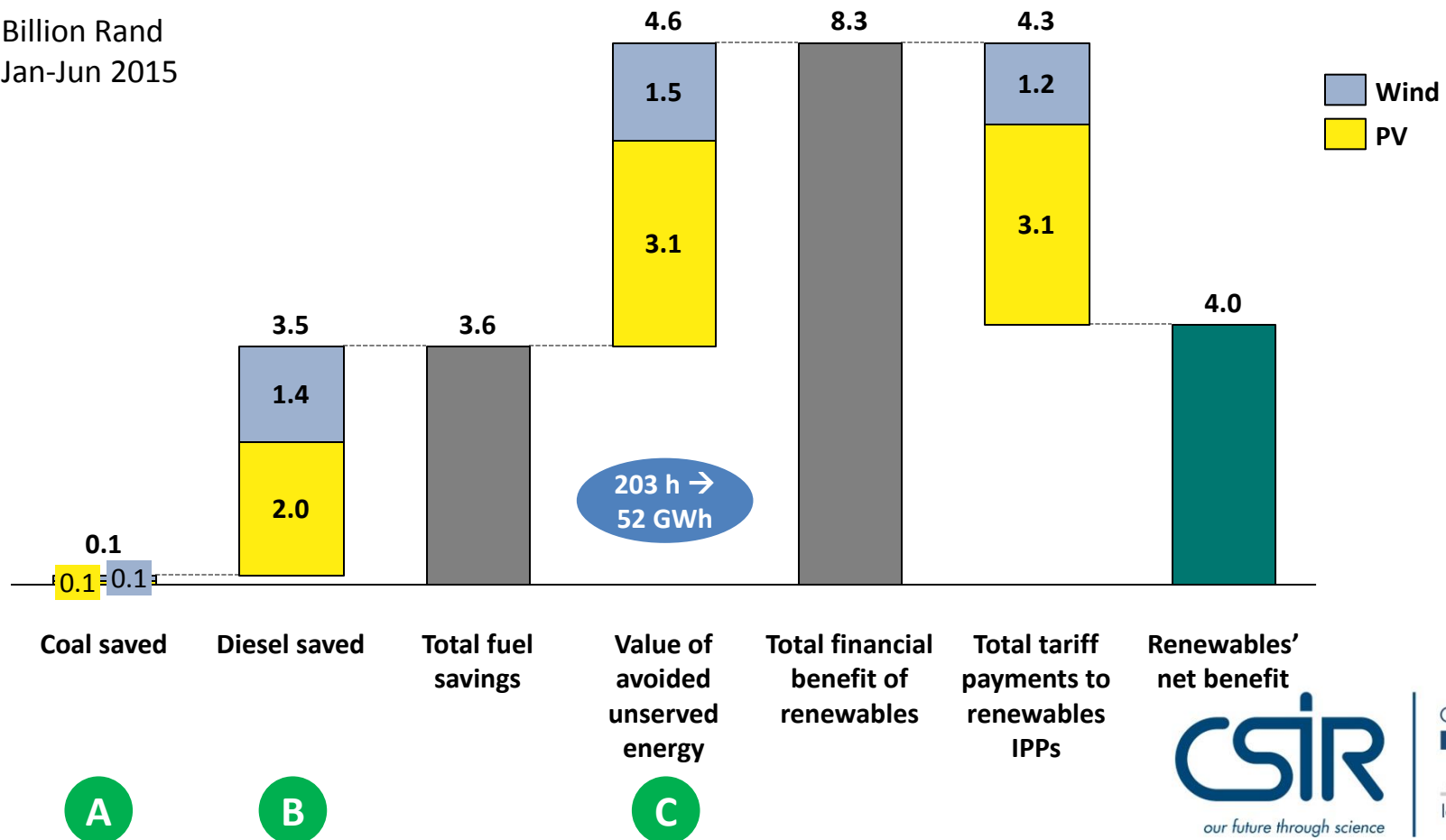
Coal/diesel replacement in GWh for Jan-Jun 2015 due to wind and solar PV

<i>in GWh</i>	A ... electricity from coal	B ... electricity from diesel	C ... unserved energy	Total
 Wind replaced/avoided...	305	603	17	925
 PV replaced/avoided...	176	852	35	1 063
Total	481	1 455	52	1 988

Results for Jan-Jun 2015 from applying CSIR-defined methodology on actual hourly production data

In summary (Jan-Jun 2015): Renewables generated a net benefit for the economy of up to R4.0 billion

Billion Rand
 Jan-Jun 2015



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Methodology: illustrative explanation

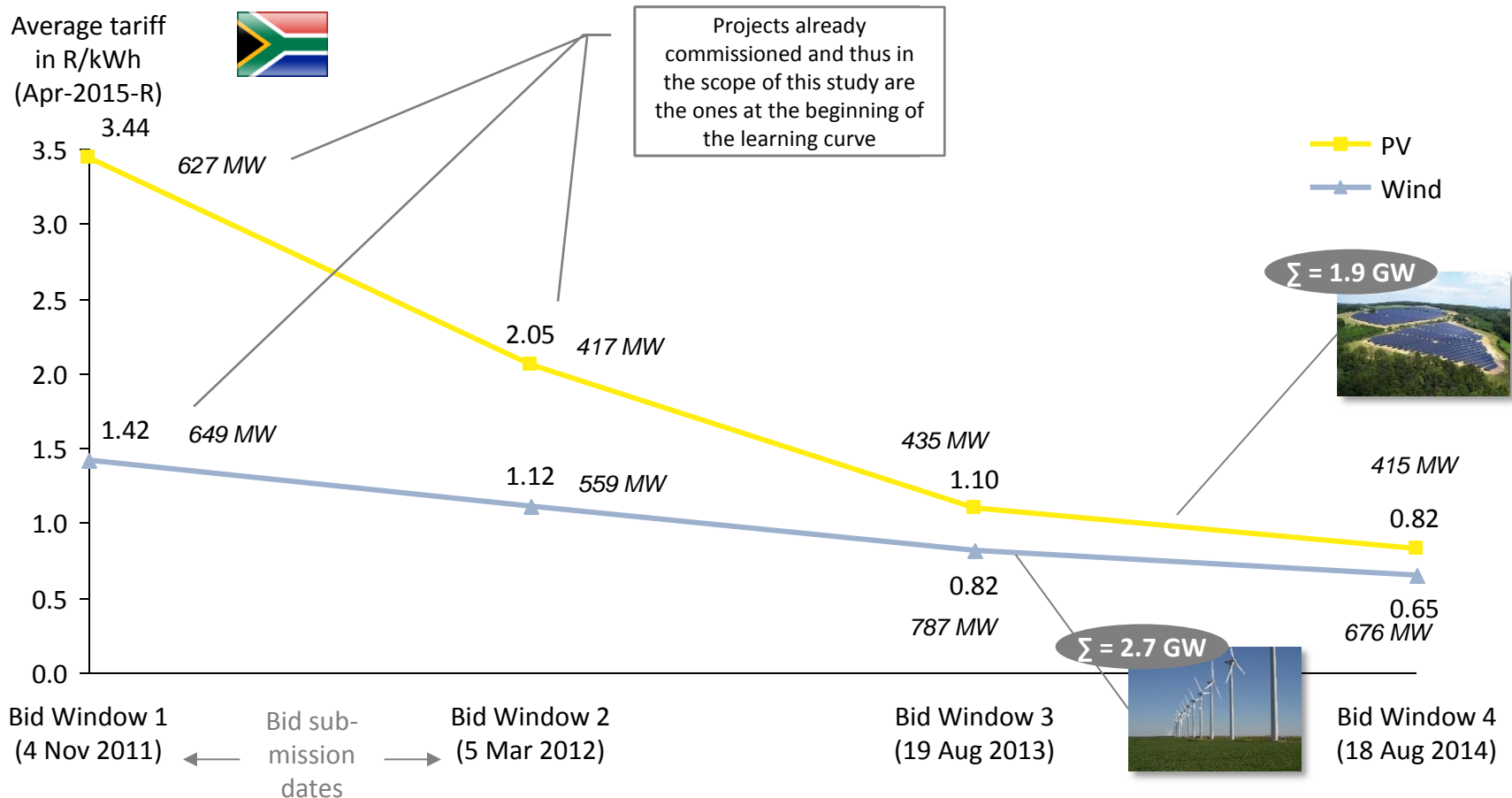
Results: financial benefits of renewables in 2015

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Actual results:

New projects much cheaper than first ones

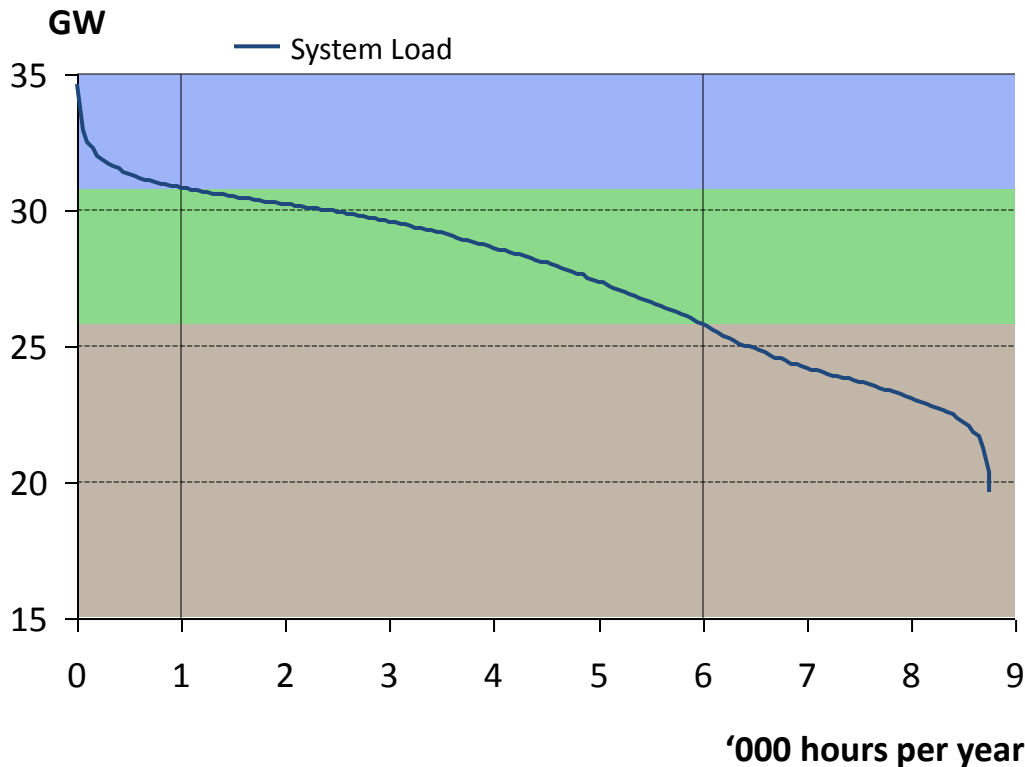
First four bid windows' results of Department of Energy's renewables programme



Note: BW = Bid Window; Sources: Department of Energy's publications on results of first three bidding windows <http://www.energy.gov.za/IPP/List-of-IPP-Preferred-Bidders-Window-three-04Nov2013.pdf>; http://www.energy.gov.za/IPP/Renewables_IPP_ProcurementProgram_WindowTwoAnnouncement_21May2012.pptx; StatsSA on CPI; CSIR Energy Centre analysis

The system had a peaking demand of 3.8 GW, mid-merit of 5.0 GW, and base of 25.8 GW

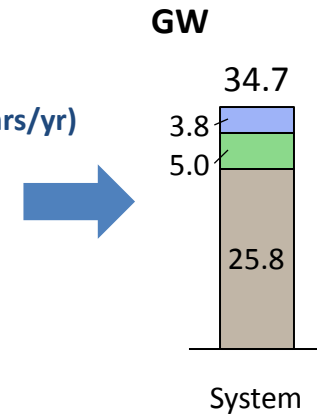
Load Duration Curve for Aug 2014 to Jul 2015 as per actual data



Peak-load
(< 1 000 hrs/yr)

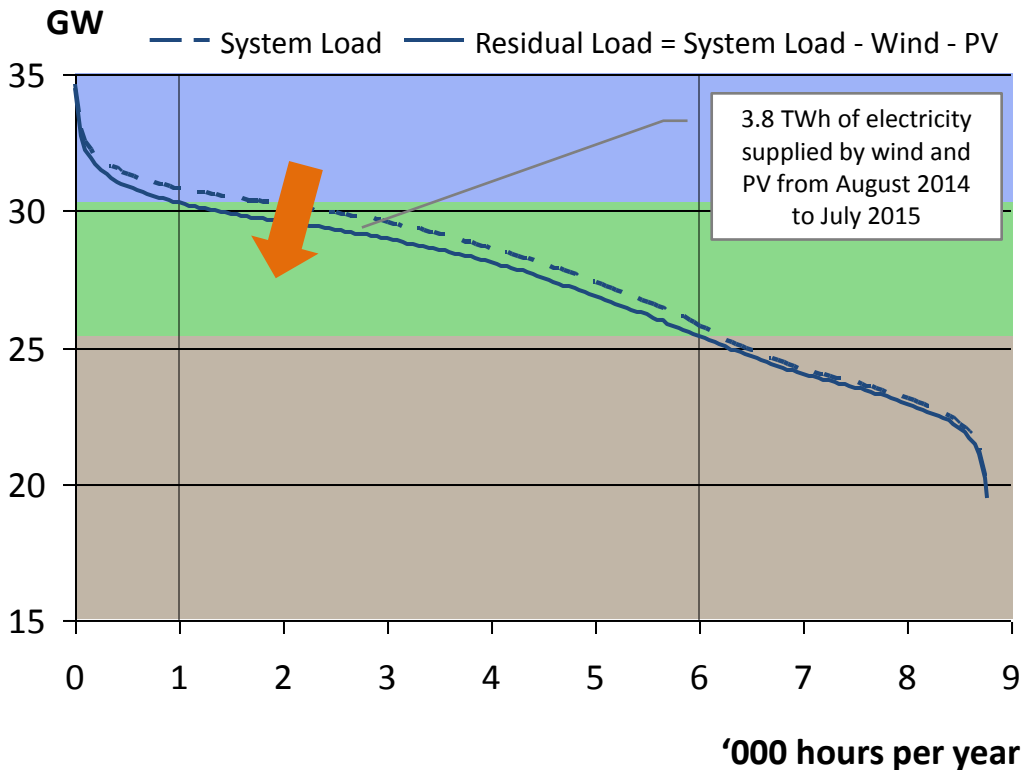
Mid-merit load
(> 1 000 & < 6 000 hrs/yr)

Base-load
(> 6 000 hrs/yr)



Wind/PV changed the shape of residual load: mid-merit & base down to 4.9/25.4 GW, peaking up

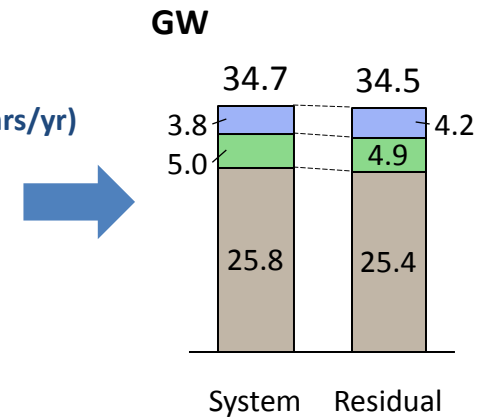
Load Duration Curve for Aug 2014 to Jul 2015 as per actual data



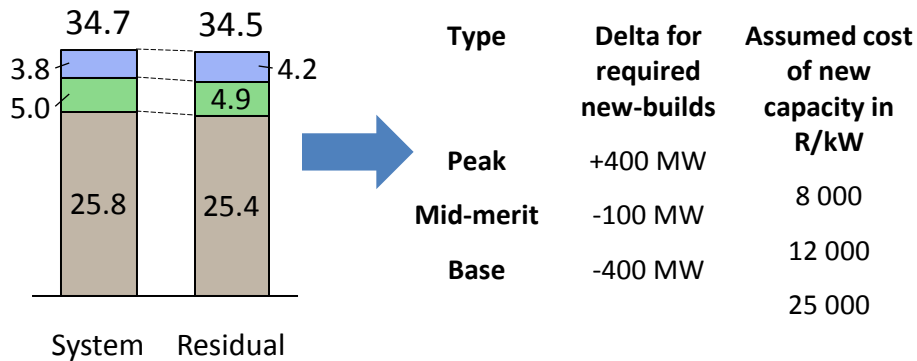
Peak-load
(< 1 000 hrs/yr)

Mid-merit load
(> 1 000 & < 6 000 hrs/yr)

Base-load
(> 6 000 hrs/yr)



Additional effect CAPEX savings: Wind & solar PV change shape of load & allow for cheaper new-builds



Last year, wind and PV changed the residual load such that cheaper new conventional power stations can be built: Annualised R9 billion CAPEX savings translates into additional value of R0.2 per kWh of renewable energy

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Thank you

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