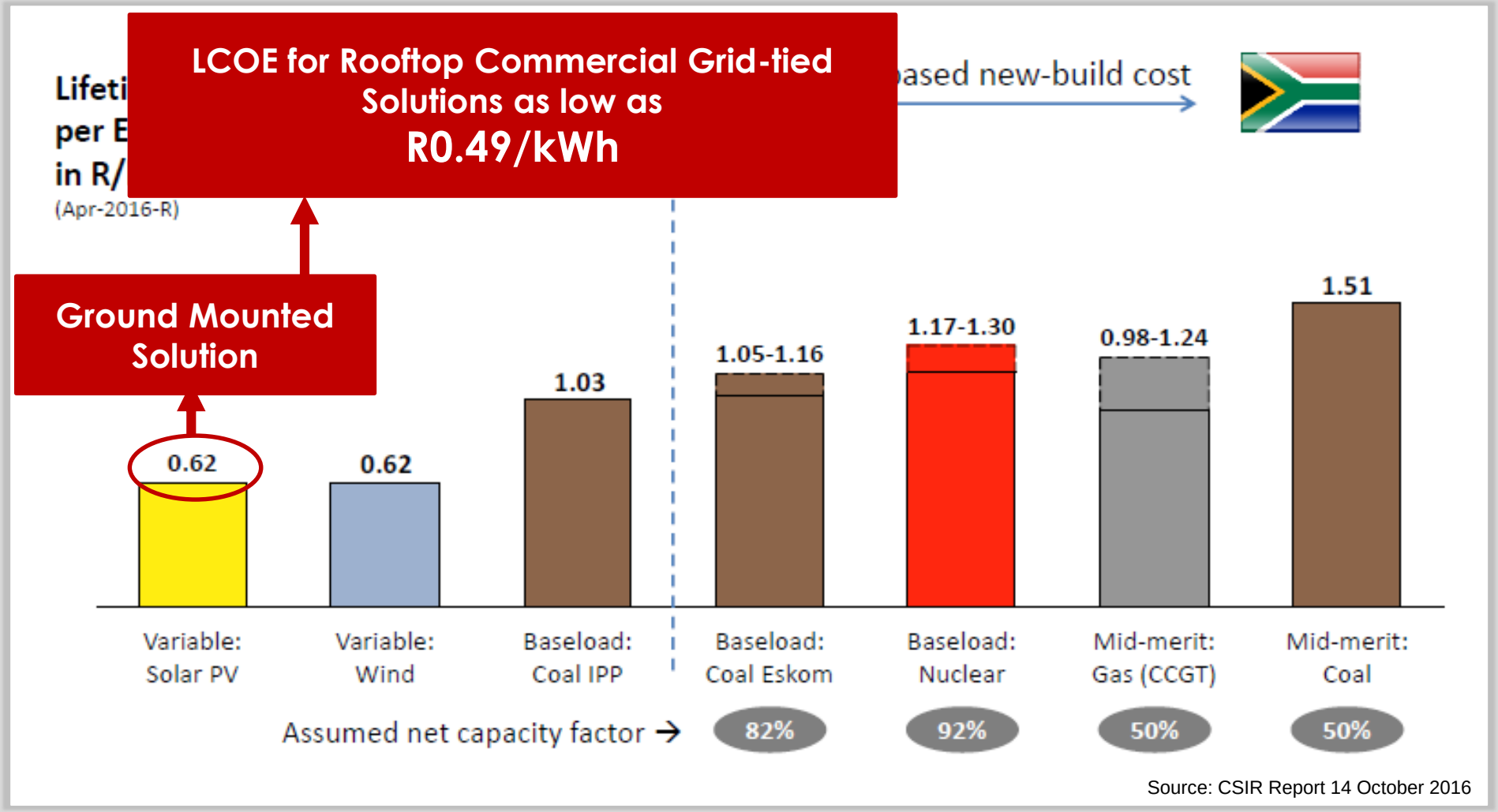
DeVilliers Botha

Energy Storage - Technology Changing the Energy Landscape

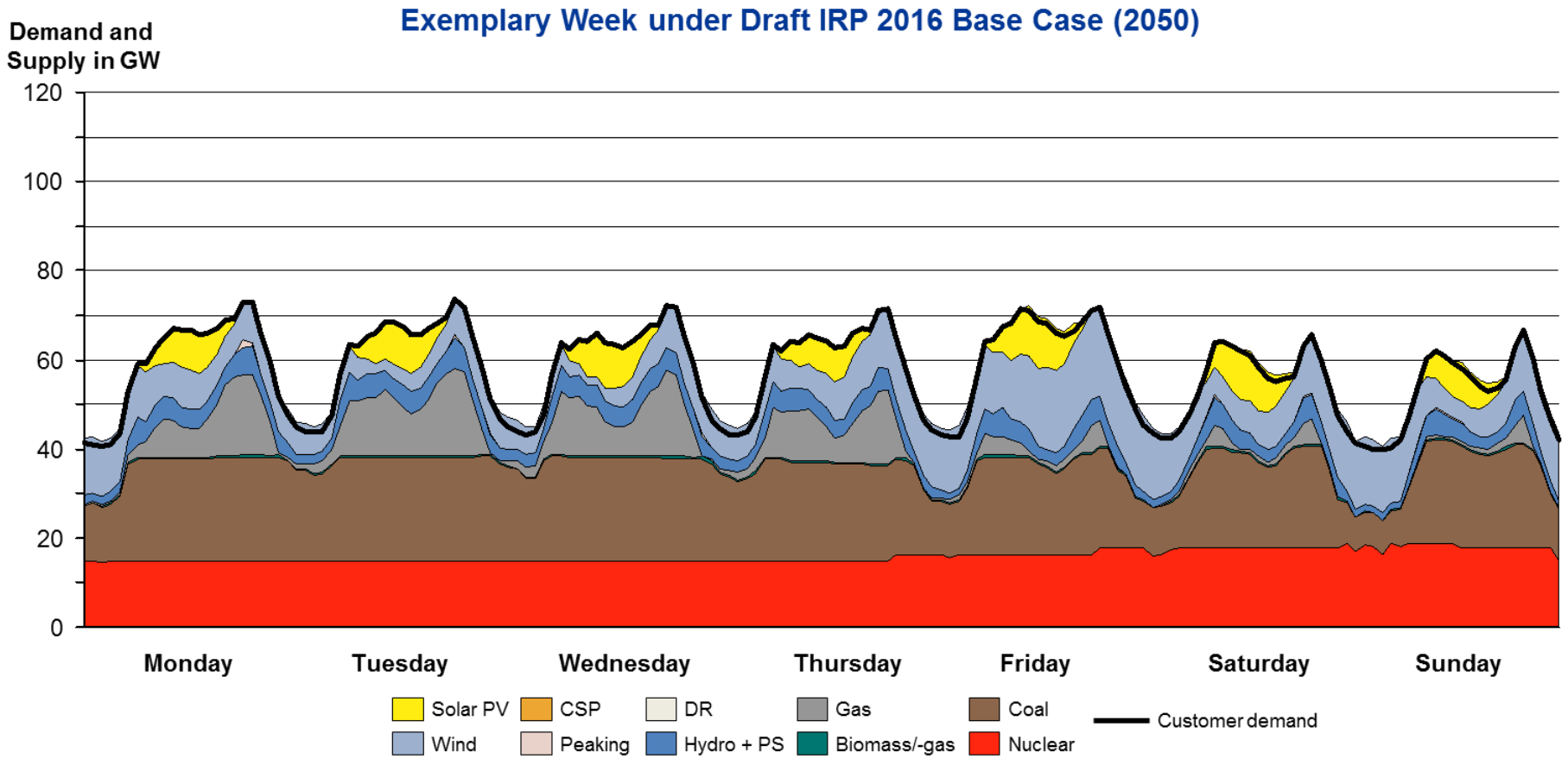
Cost of New Power Generators in SA



Source: CSIR Report 14 October 2016

Draft IRP 2016 Base Case

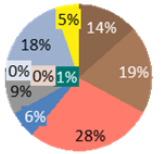
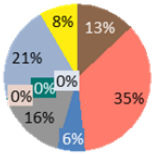
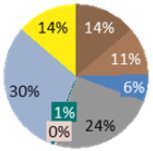
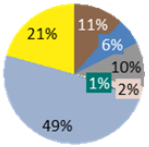
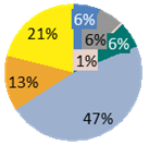
Nuclear and coal dominate the supply mix in 2050



Sources: CSIR analysis, based on DoE's Draft IRP 2016

Least Cost Energy Mix

Least Cost is R60-75 billion/yr cheaper than Draft IRP 2016 by 2050

		As per Draft IRP 2016		As per DoE		
2050		**IRP 2016 Base Case**	**IRP 2016 Carbon Budget**	**Unconstrained Base Case**	**Least Cost**	**Decarbonised**
Energy Mix in 2050	Demand: 522 TWh					
Cost in 2050	Total system cost[1] (R-billion/yr)	700	688	658	627	675
	Average tariff (R/kWh)	1.34	1.32	1.26	1.20	1.29
Environment in 2050	CO_2 emissions (Mt/yr)	187	99	174	86	10
	Water usage (billion-litres/yr)	41	18	33	15	10
Jobs[2] in 2050	Direct & supplier ('000)	252-295	235-253	248-281	310-325	331

Because of lack of data, zero jobs for biomass/-gas assumed (affects Decarbonised)

Coal | Coal (new) | Nuclear | Nuclear (new) | Hydro + PS | Gas | Peaking | Biomass/-gas | Other storage | Wind | CSP | Solar PV

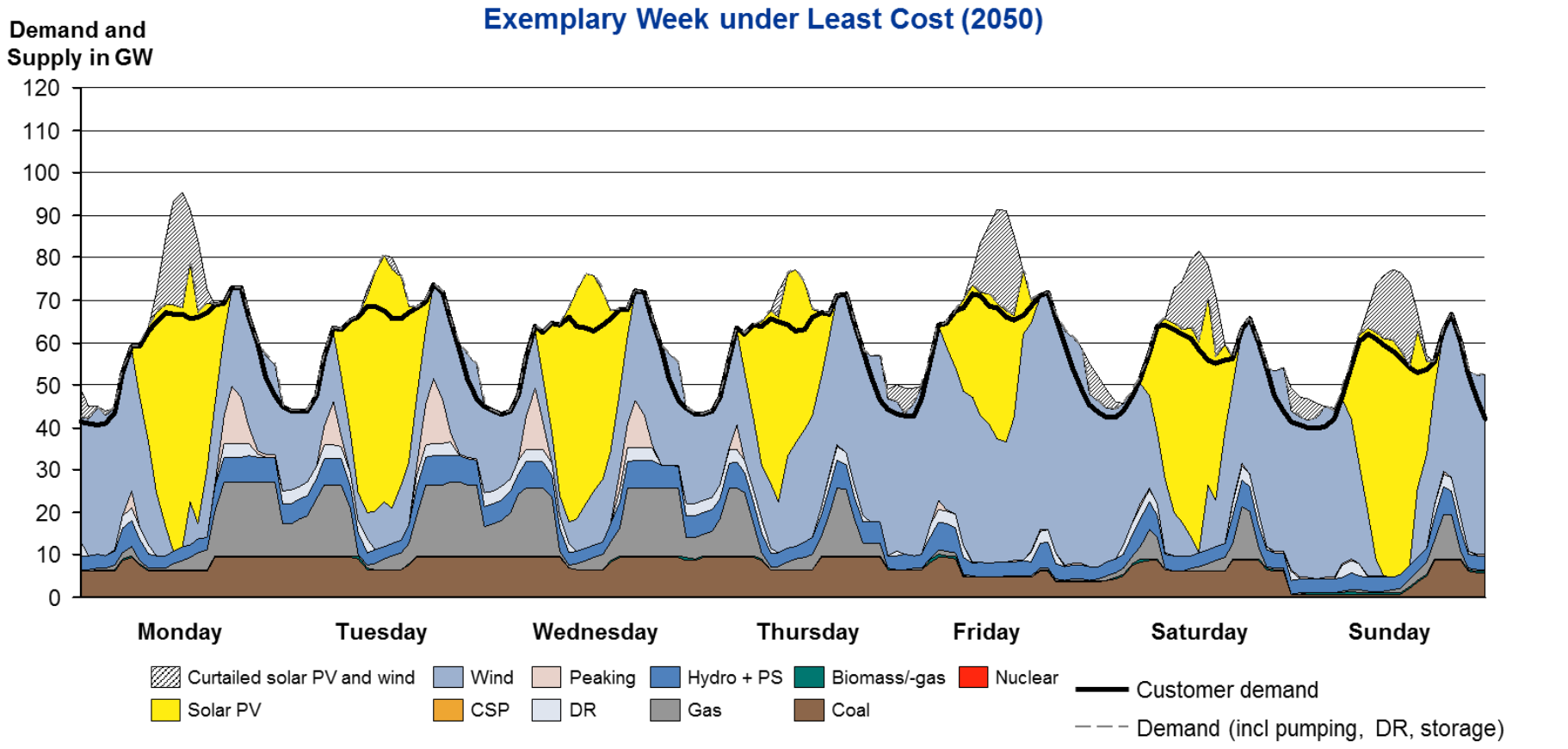
[1] Only power generation (Gx) is optimised while cost of transmission (Tx), distribution (Dx) and customer services is assumed as ≈0.30 R/kWh (today's average cost for these items)

[2] Lower value based on McKinsey study (appendix of IEP), higher value based on CSIR assumption with more jobs in the coal industry; Sources: Eskom on Tx, Dx cost; CSIR analysis; flaticon.com

Source: CSIR

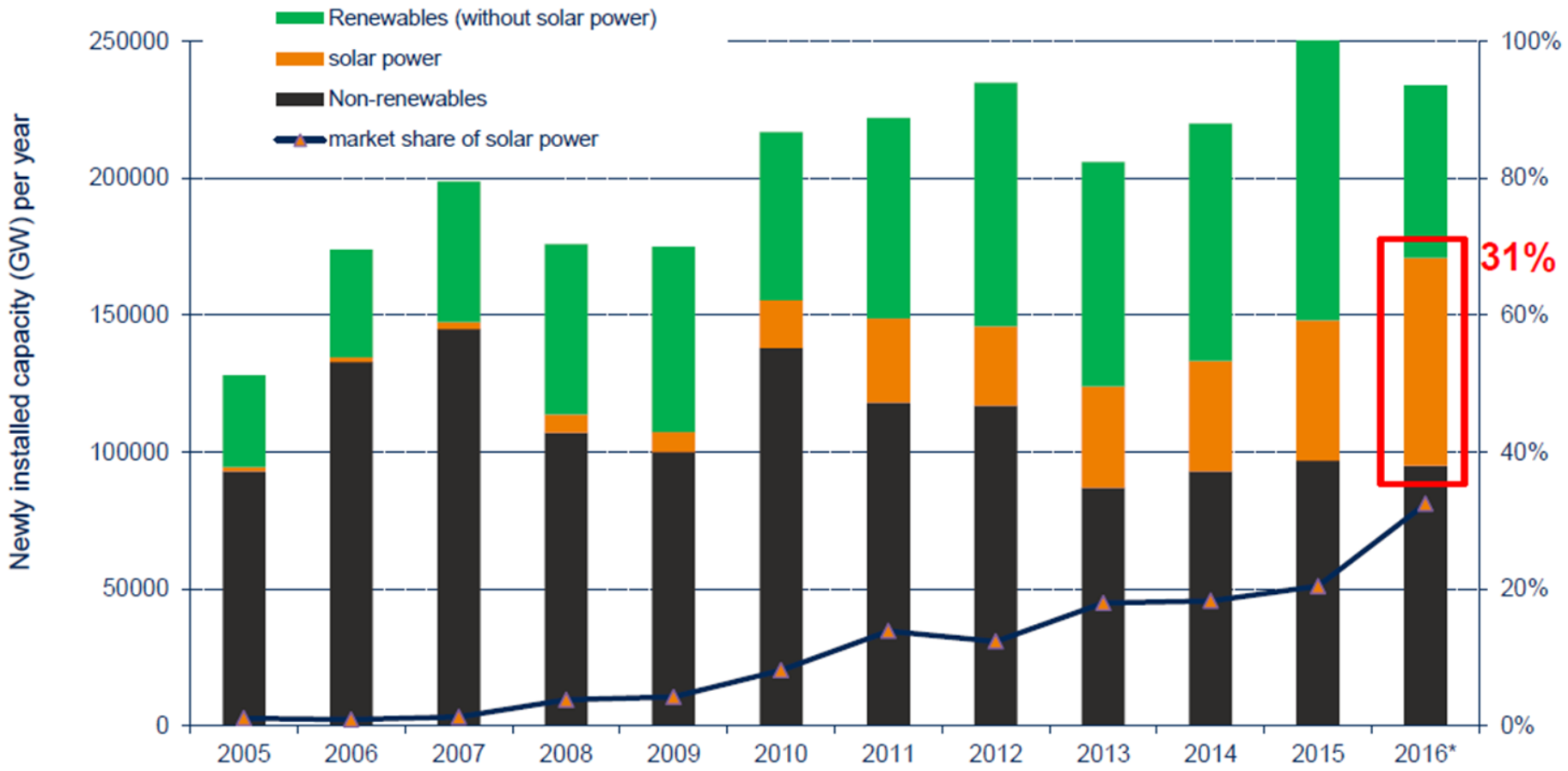
Scenario: Least Cost

Solar PV and wind dominate supply mix in 2050, with curtailment and variability managed by flexible gas



Source: CSIR analysis

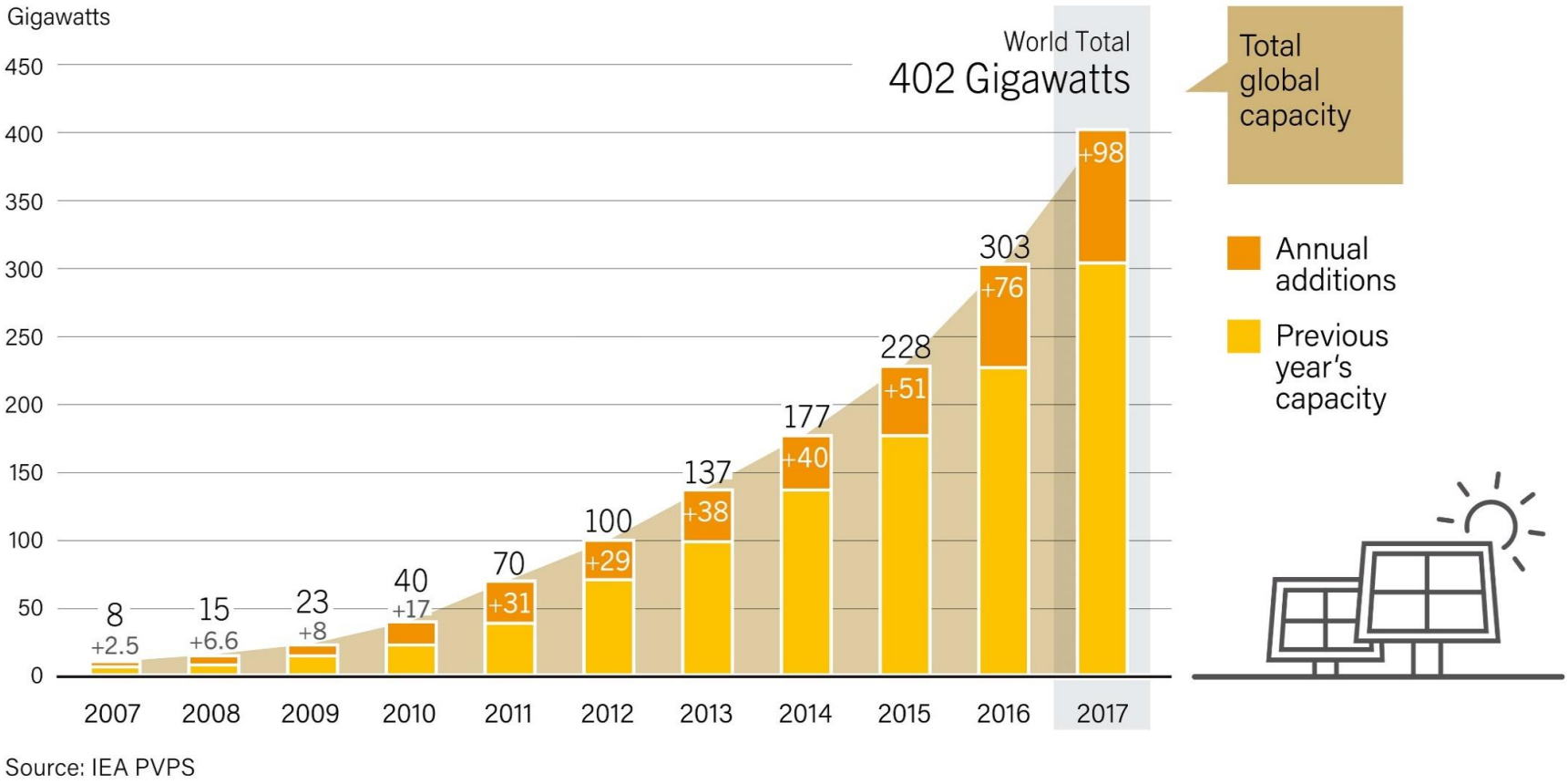
New Build Generation



* preliminary, estimation BSW-Solar e.V.

Sources: IRENA 2016 and BSW-Solar

Global Solar PV Capacity



Source: REN21 - Renewables 2018 Global Status Report

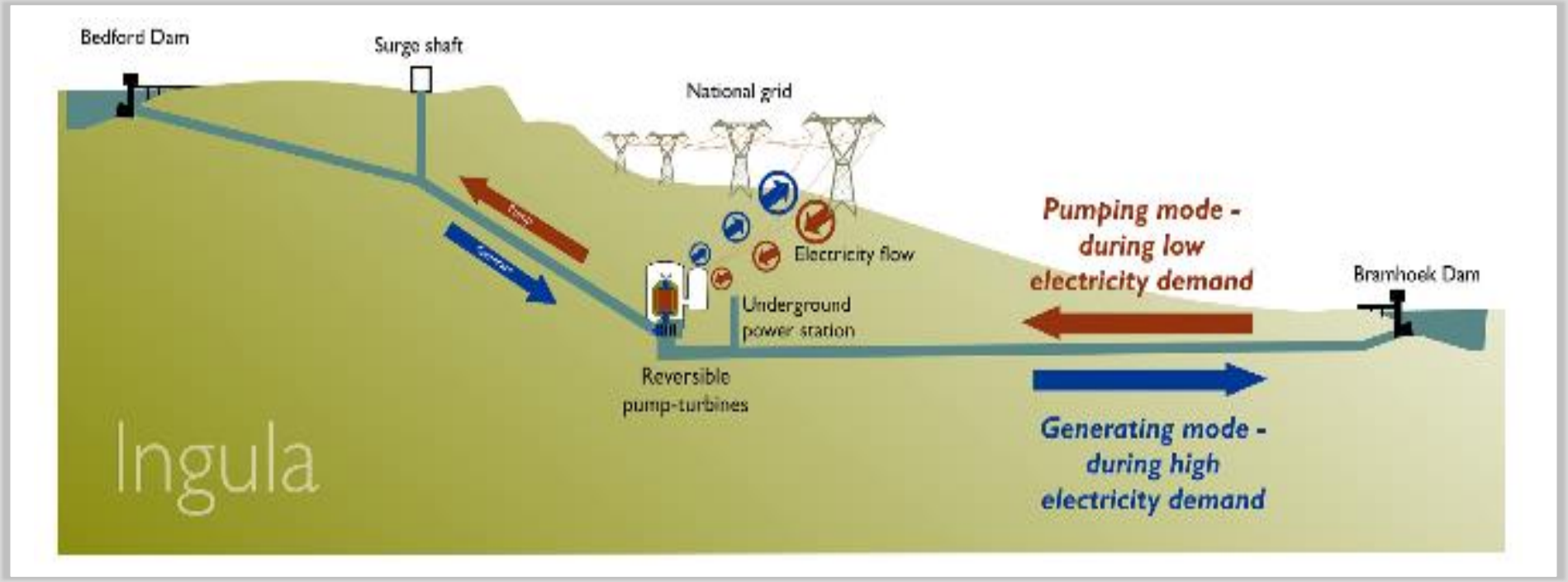
Grid of the Future

Source: 3M

Storage Technologies

- Chemical Battery (Li-ion; Flow; Lead Acid)
- Pumped Storage
- Compressed Air
- Flywheel
- Thermal

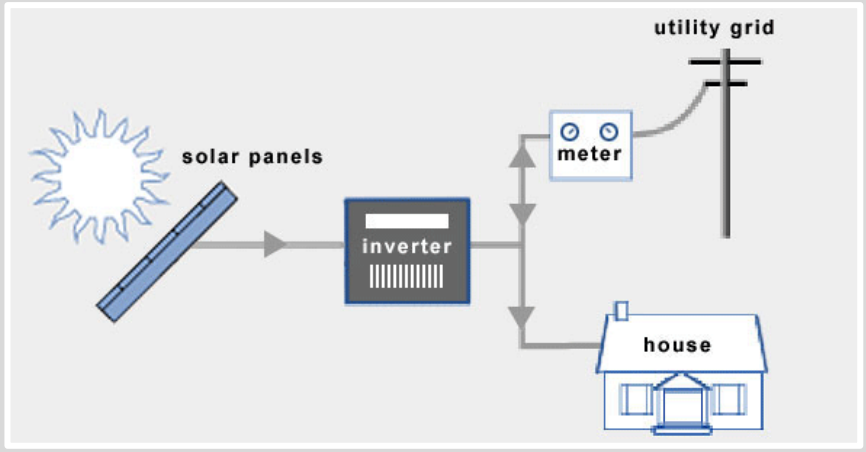
Ingula Pumped Storage



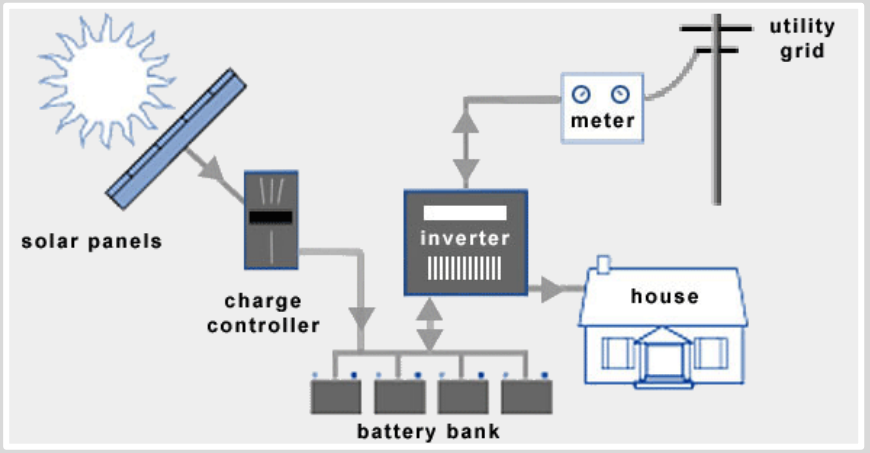
- Ingula Pumped Storage – 1332MW
  - Peaking Plant
  - Cost R30billion (R22.5m/MW)
  - Initial budget R8b
- LCOE – Intricate sum due to reverse pump consumption

Solar Solution Types

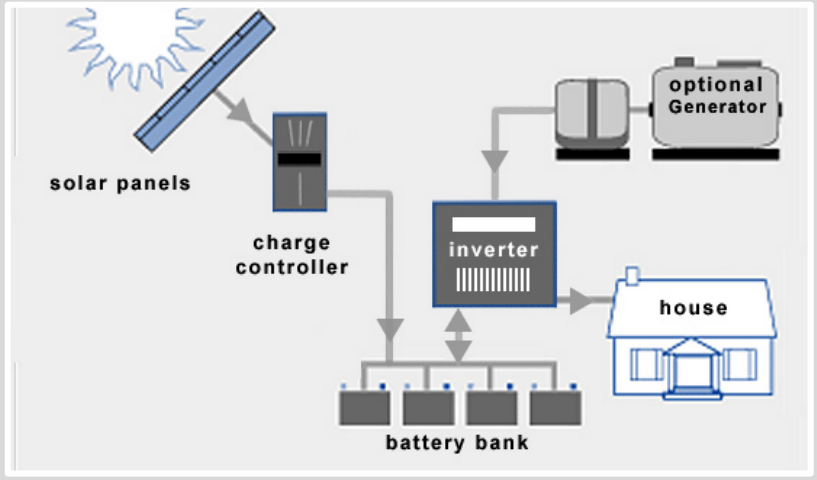
Grid Tied Solution



Grid Interactive Solution



Off-Grid Solution



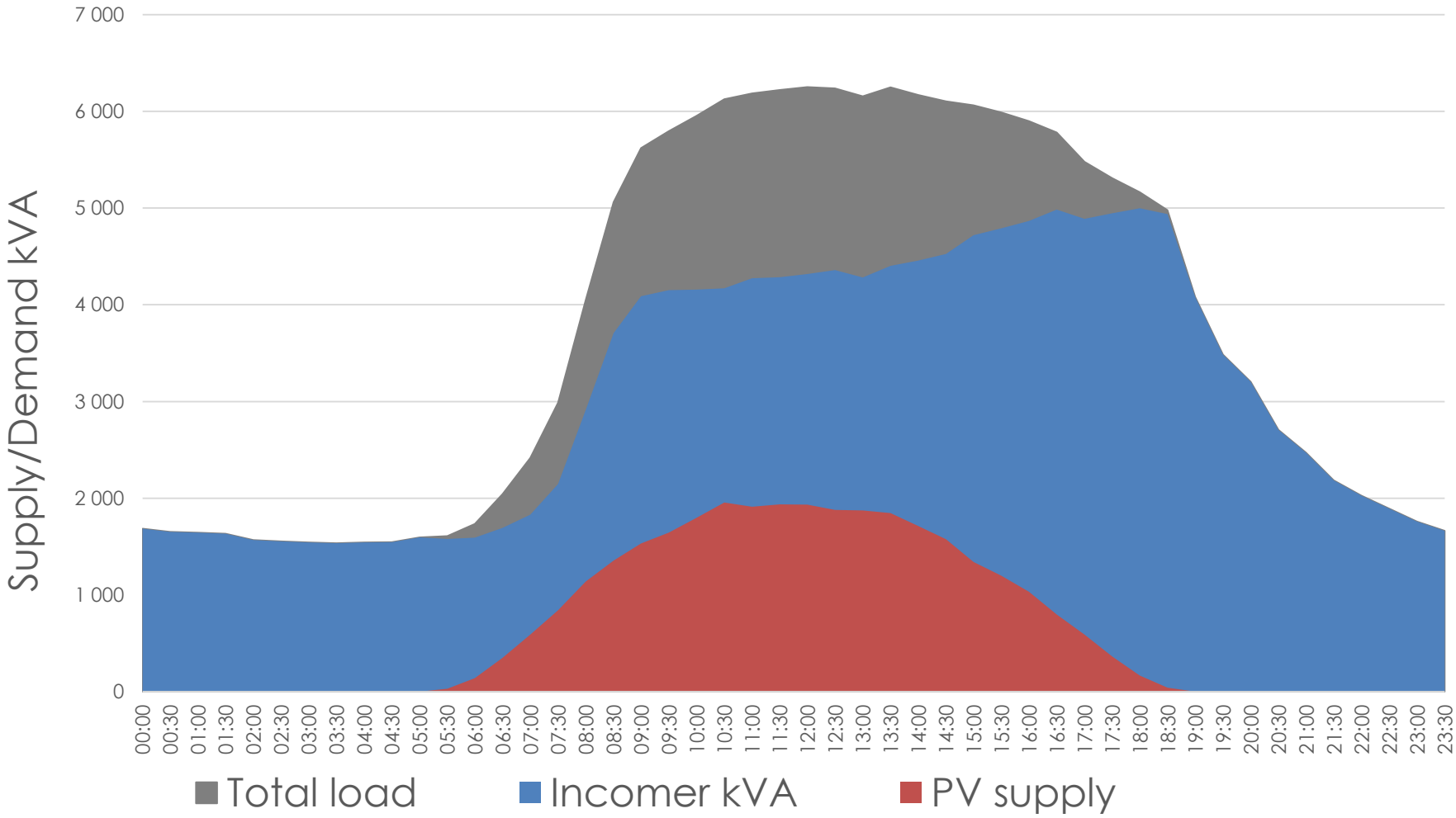
Case Study – Grid Tied Solar System

Unlocking Grid Capacity

- Client could not expand mall due to municipal supply shortage

- Two aspects:
  - Air Conditioning Load match
  - Tropical Cooling Effect
- Result:
  - Mall could add GLA
  - >Rates & Taxes
  - >Night-time consumption at high TOU tariff
- Phased approach

Mall Load Post Installation



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Environmental Impact

552.35 Trees
saved

3,467 Barrels
Oil saved

18.33 kg
Reduced nuclear waste

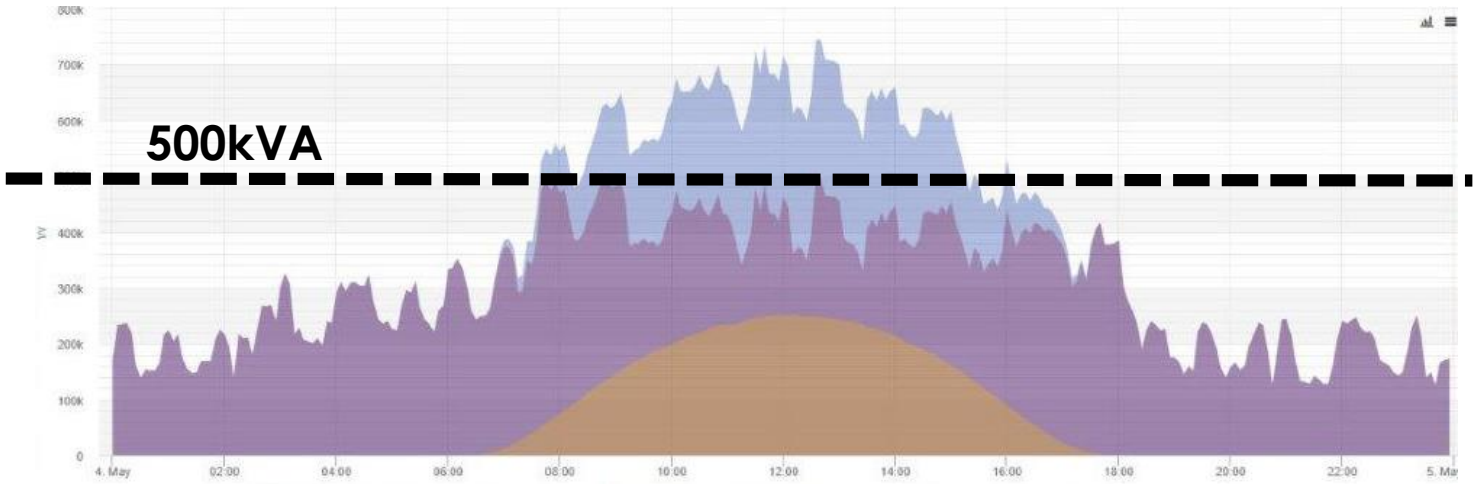
638.27
Households
Energy needs for 4 people

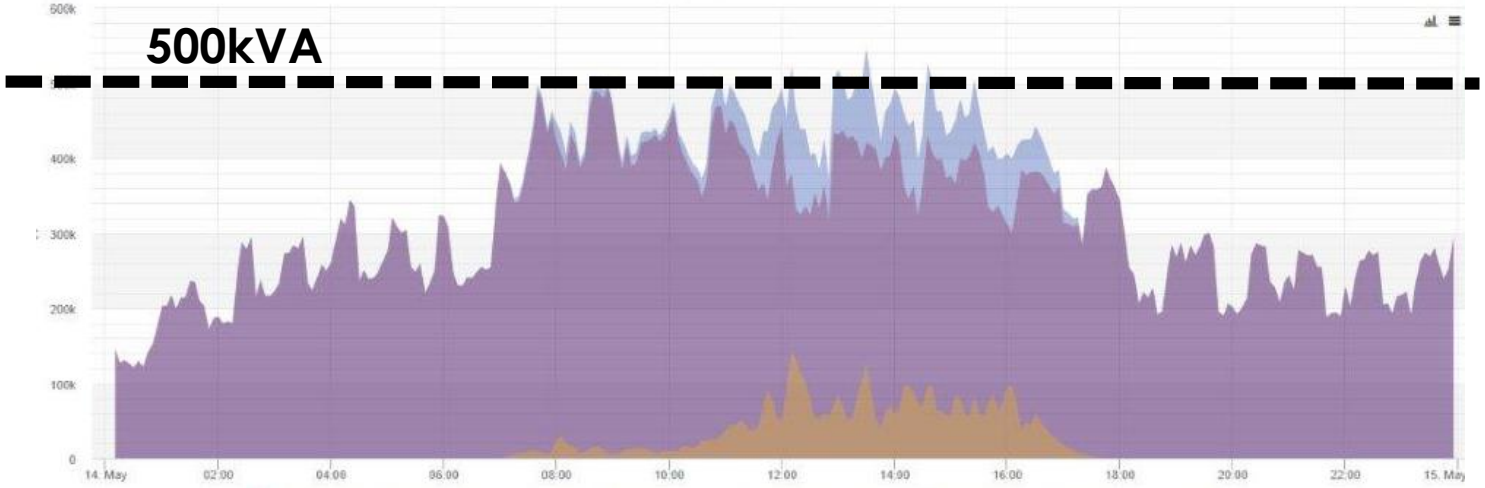
119.0 M mi.
Trip with a Segway

Saving 2 867 tons
of coal
&
avoiding more than
5 021 tons of carbon
emissions per annum

28.1 M mi.
Trip with an electric car

Aircon Effect





Case Study – Solar System with Storage

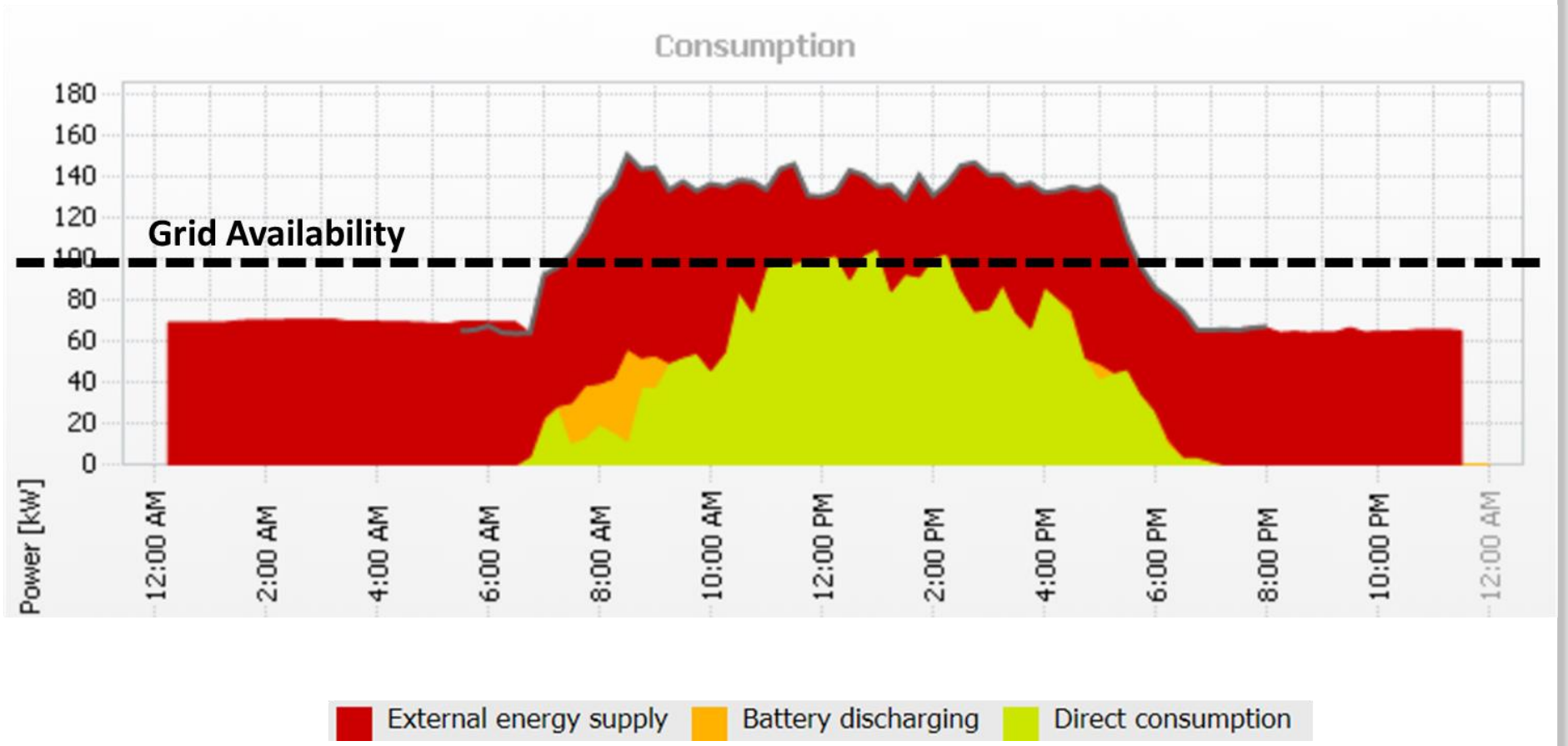
Unlocking Grid Capacity

- Grid capacity was very limited
- Grid Interactive solution
- Without this PV solution, there would have been no township establishment

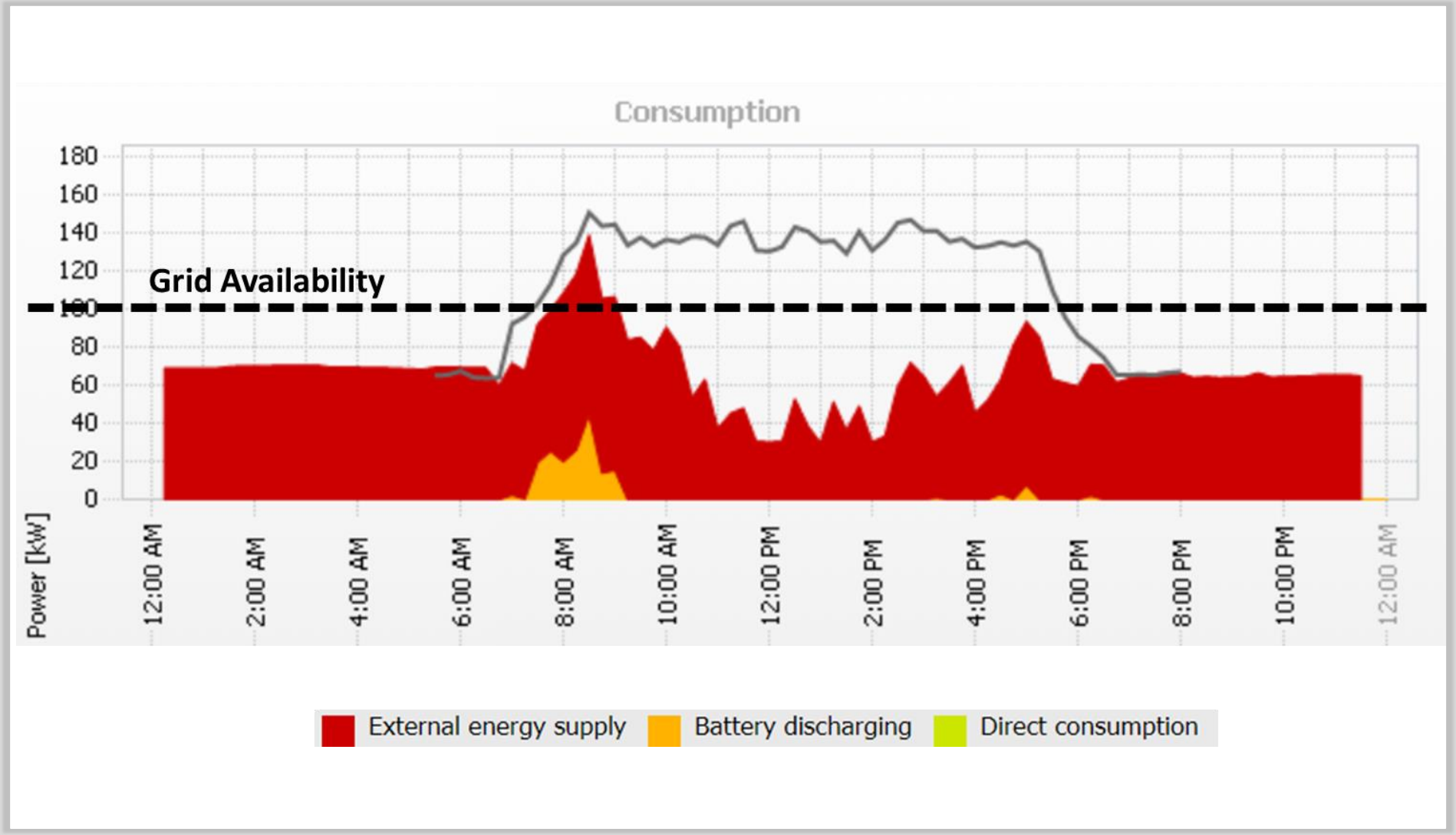
- System Cost: ~R3.8m
- Development Cost: ~R300m

Solareff

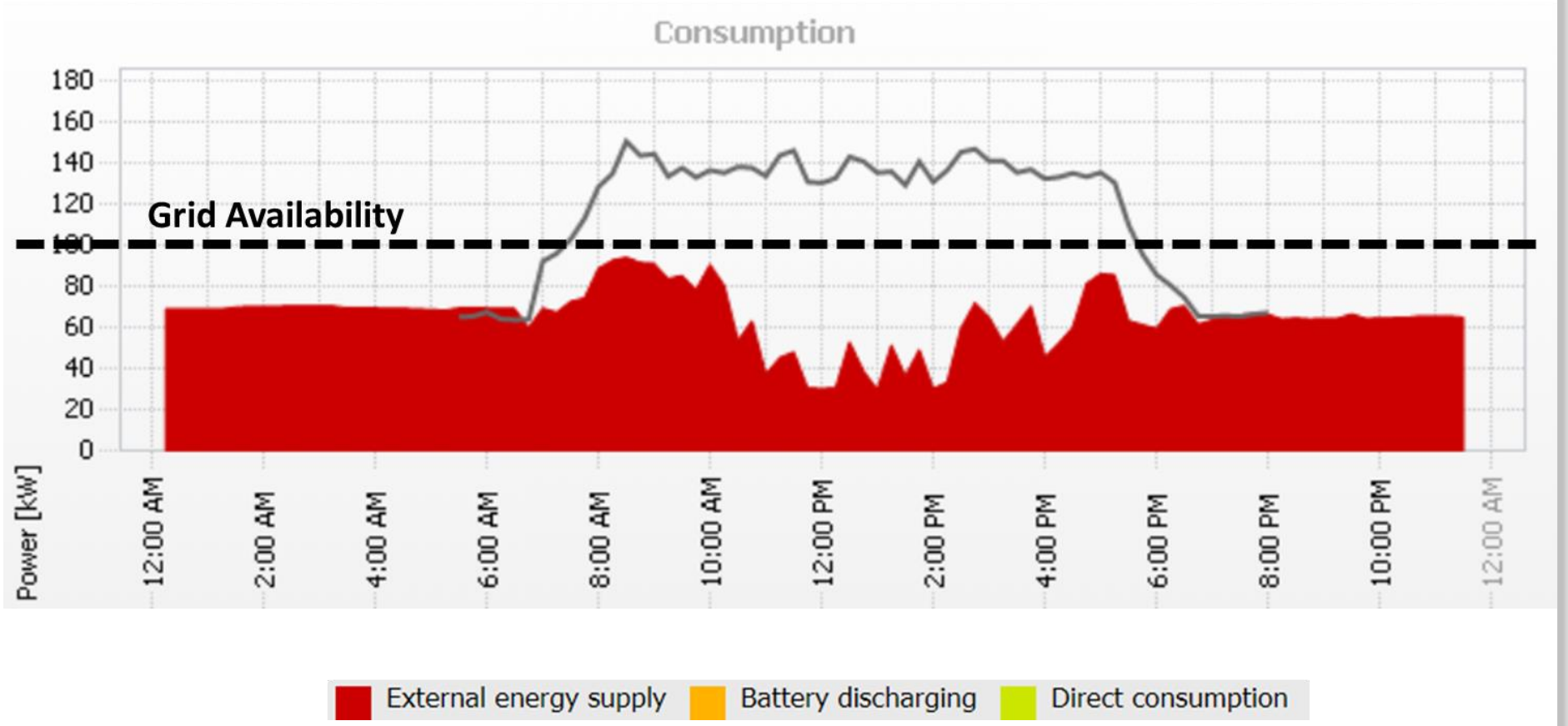
Case Study



Case Study


Consumption
180
160
140
120
100
80
60
40
20
0
Grid Availability
Power [kW]
12:00 AM
2:00 AM
4:00 AM
6:00 AM
8:00 AM
10:00 AM
12:00 PM
2:00 PM
4:00 PM
6:00 PM
8:00 PM
10:00 PM
12:00 AM
External energy supply
Battery discharging
Direct consumption

Case Study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180
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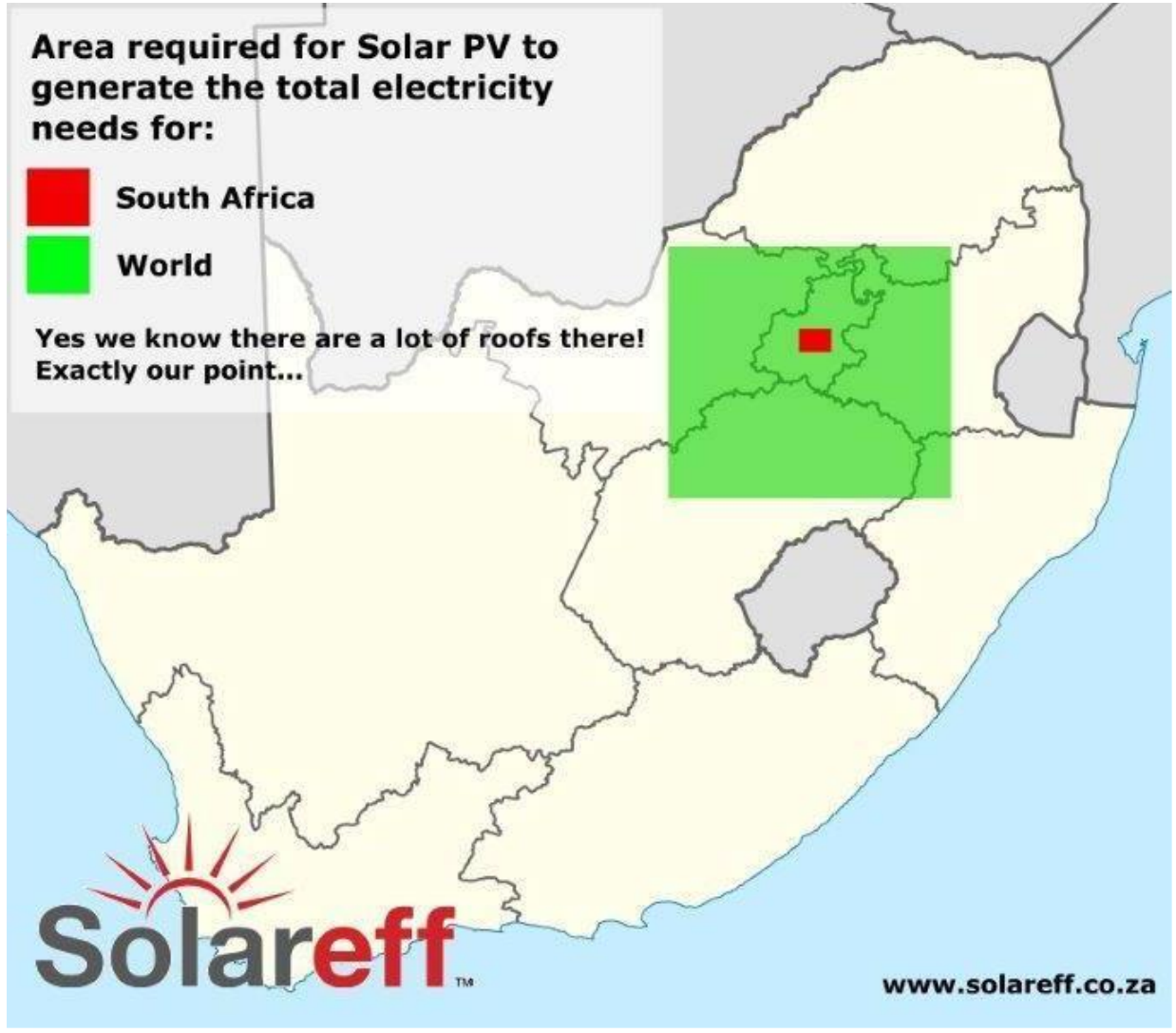
4:00 AM
6:00 AM
8:00 AM
10:00 AM
12:00 PM
2:00 PM
4:00 PM
6:00 PM
8:00 PM
10:00 PM
12:00 AM
External energy supply
Battery discharging
Direct consumption

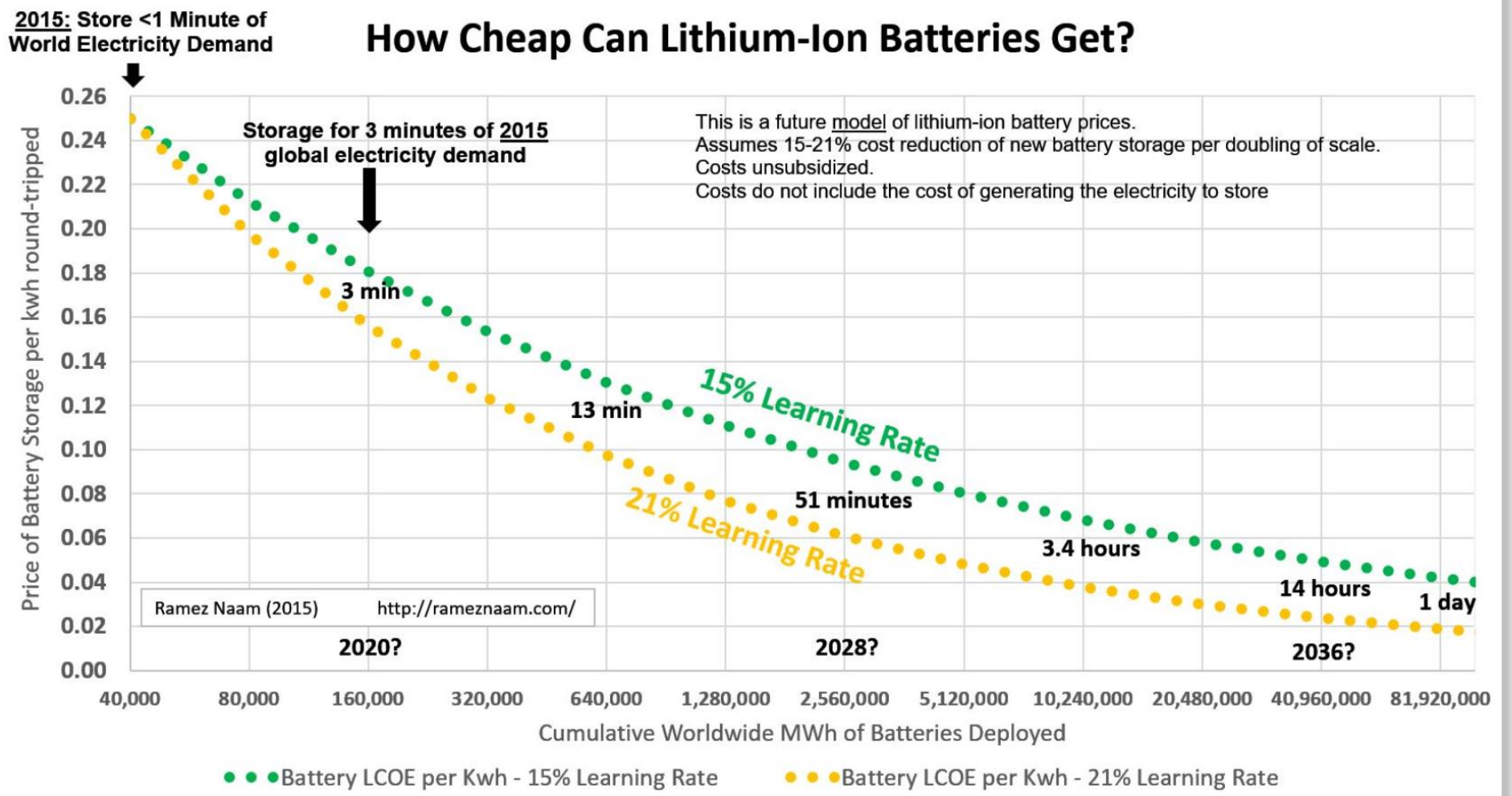
Where We are Today – South Africa

- Grid parity reached for grid tied solar systems 3 years ago
- Grid parity being reached at most locations for solar systems with storage

Potential of Solar PV



Storage Trends



Source: IDTechEx

Electric Mobility

BMWi3 consumption
= 12,9kWh/100km

=

R15.50/100km
1L/100km

Solar carports means no strain on national grid

How Green is your EV?

It all depends on how you charge it!

Solar = 0

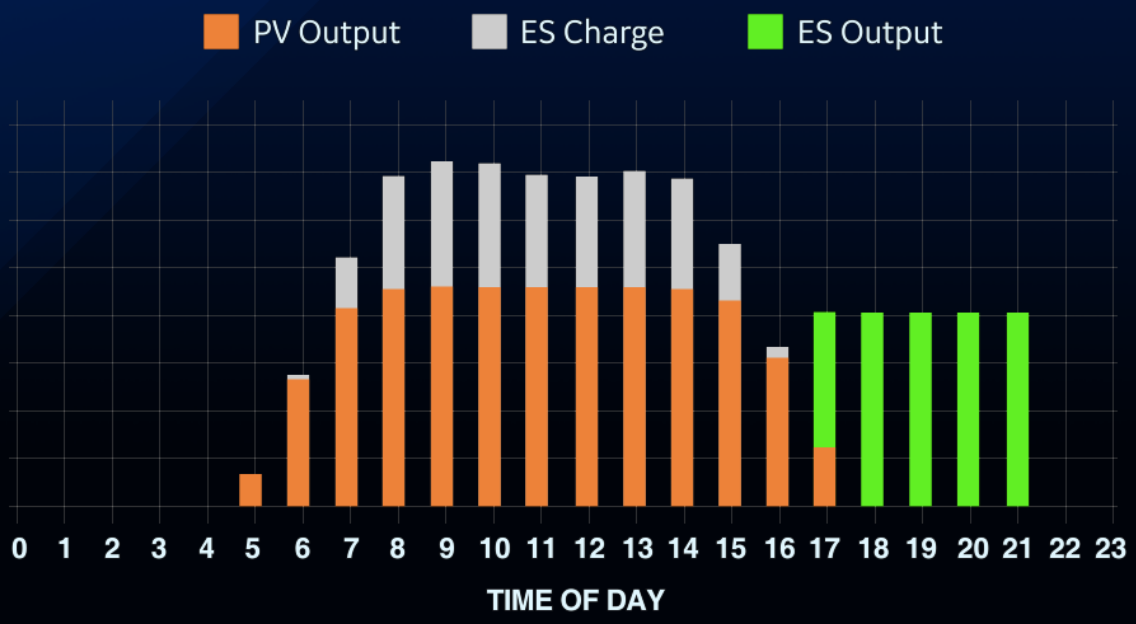
Carbon emissions (tons) over 10 years

Grid electricity (coal generated) = 7.75

Utility Scale Storage

Curtailment Avoidance

Curtailed energy captured by storage provides flexibile management of oversupply and constrained grid system capacity or avoids negative power prices. By avoiding curtailment, storage has a direct impact on the revenue stream optimization from generated energy by increasing the load factor.



Service Class:
Energy

Value Type:
Revenue
$/MWh (Delta)

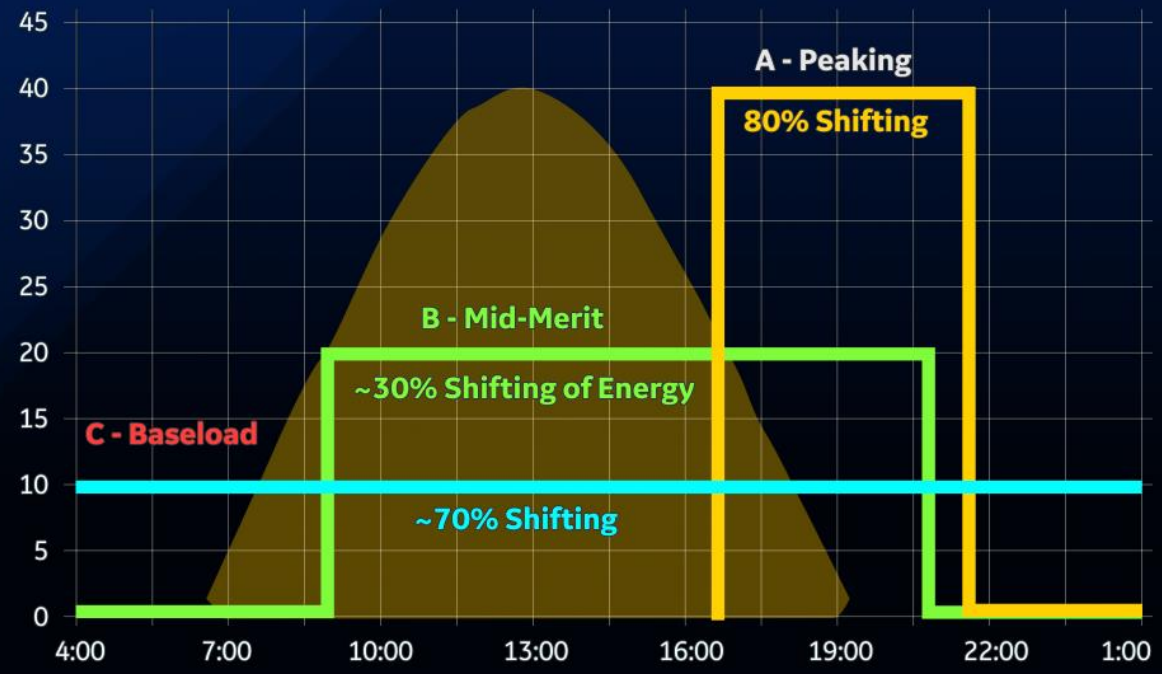
Periodicity:
Daily

Duration:
Long

Utility Scale Storage

Dispatchable

Dispatchable generators can be turned can adjust their power output at the request of power grid operators. Non-dispatchable renewable sources, such as solar PV, cannot typically be controlled by operators. Combining Solar with storage enables dispatch capabilities that can be used to serve peak demand periods and follow loads.



Service Class:
Energy

Value Type:
Revenue
$/MWh (Delta)

Periodicity:
Daily

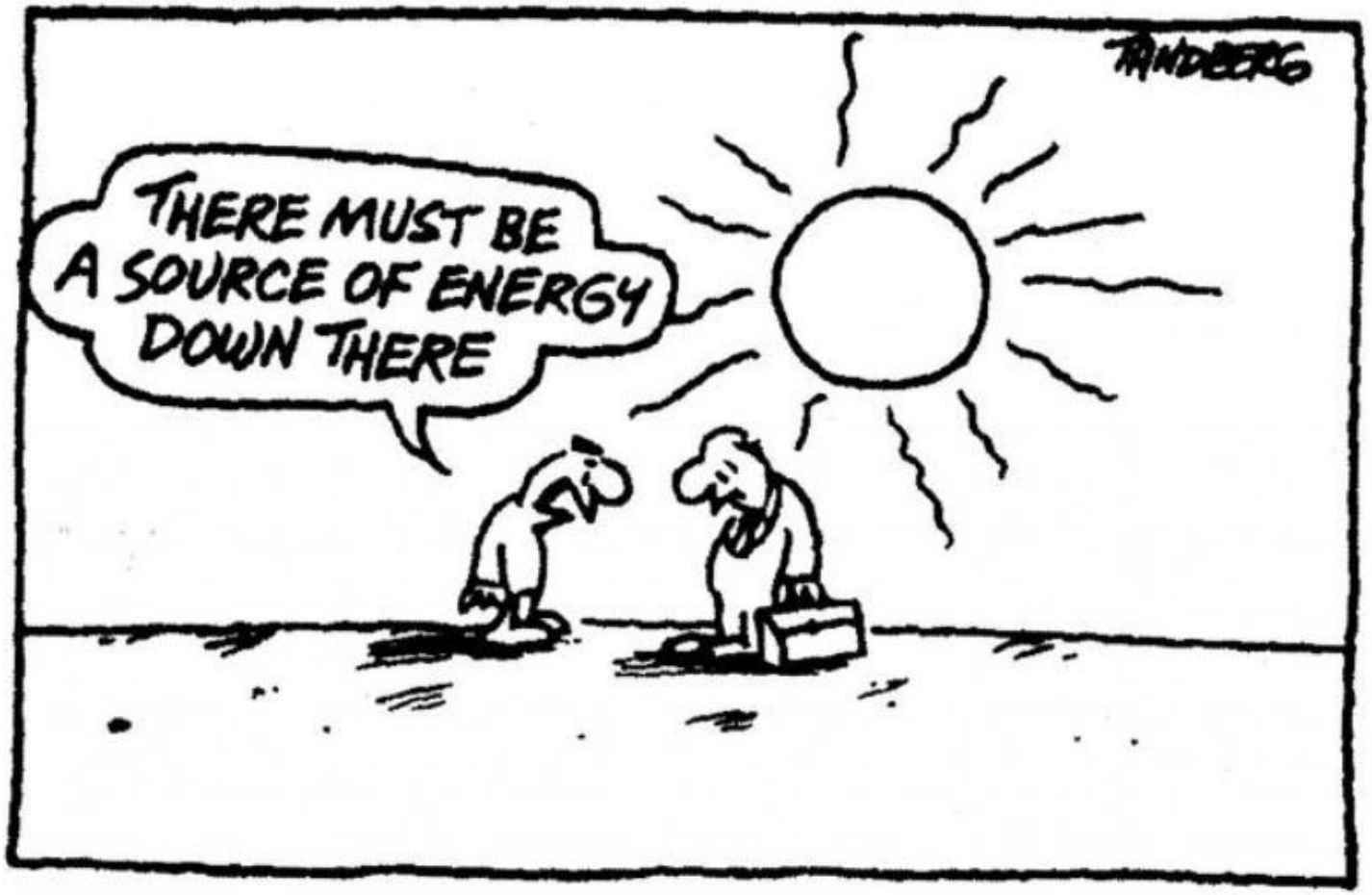
Duration:
Long

Take Aways

- Storage is much more than "batteries"
- Mixture of technologies required
- Moving to a Decentralised System
- Choice of Tech – Cost / Resource driven
- Demand Response is also "storage"
- Fuel in your car is in "storage" – why not use it!

- "Disruption is defined by those that are slow to change, other see it as opportunity"

Questions



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Thank you

info@solareff.co.za | www.solareff.co.za