

Next Generation Distribution System Planning

Challenges and Opportunities for South Africa

Dr Prathaban Moodley

BSc(Eng), MEng, PhD (Wits)

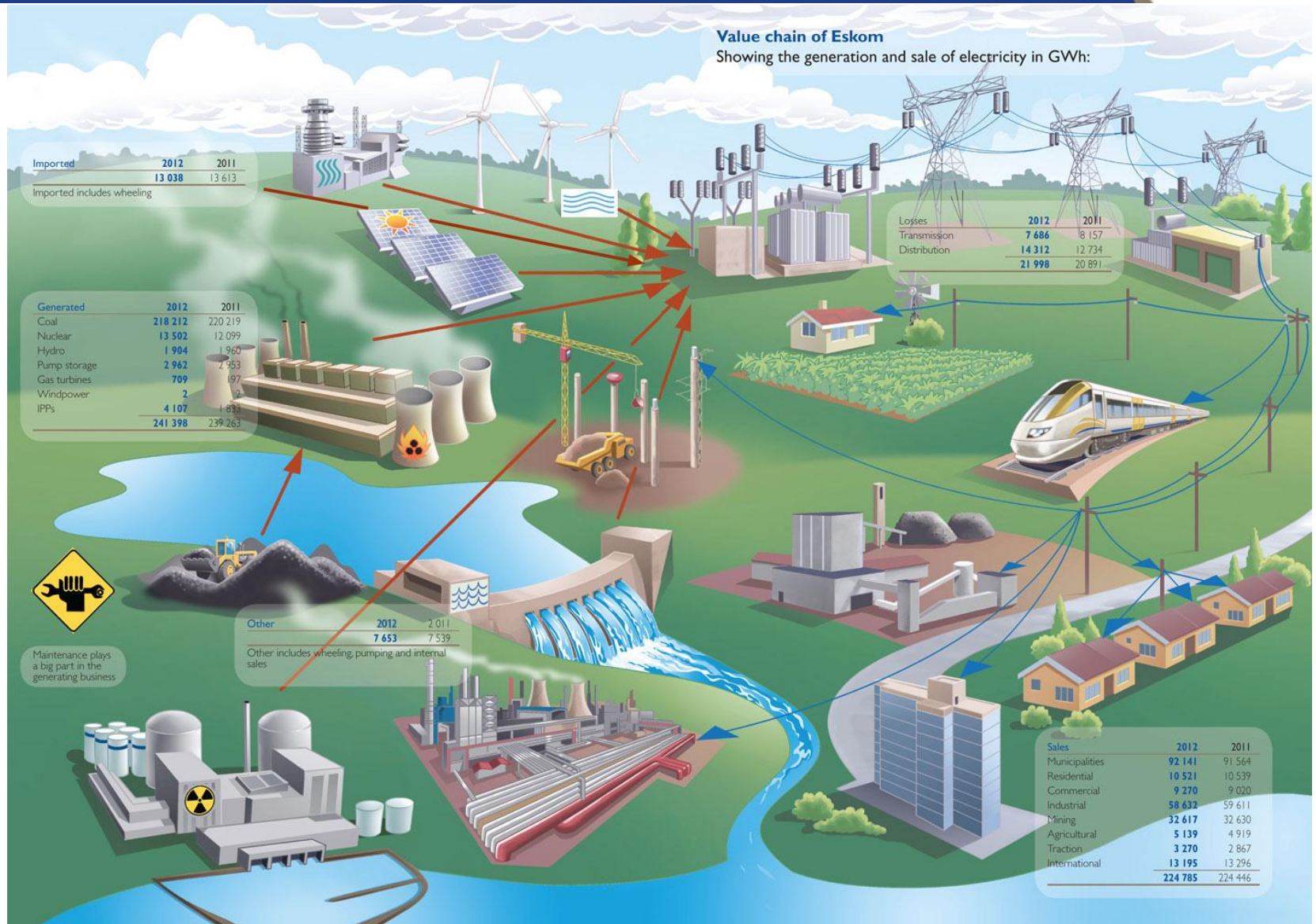
**Technology Strategy & Planning Manager
Eskom RT&D**



Is the Utility Business Model broken?



100 Year Business Model





Source: 3M

Technology Game Changers



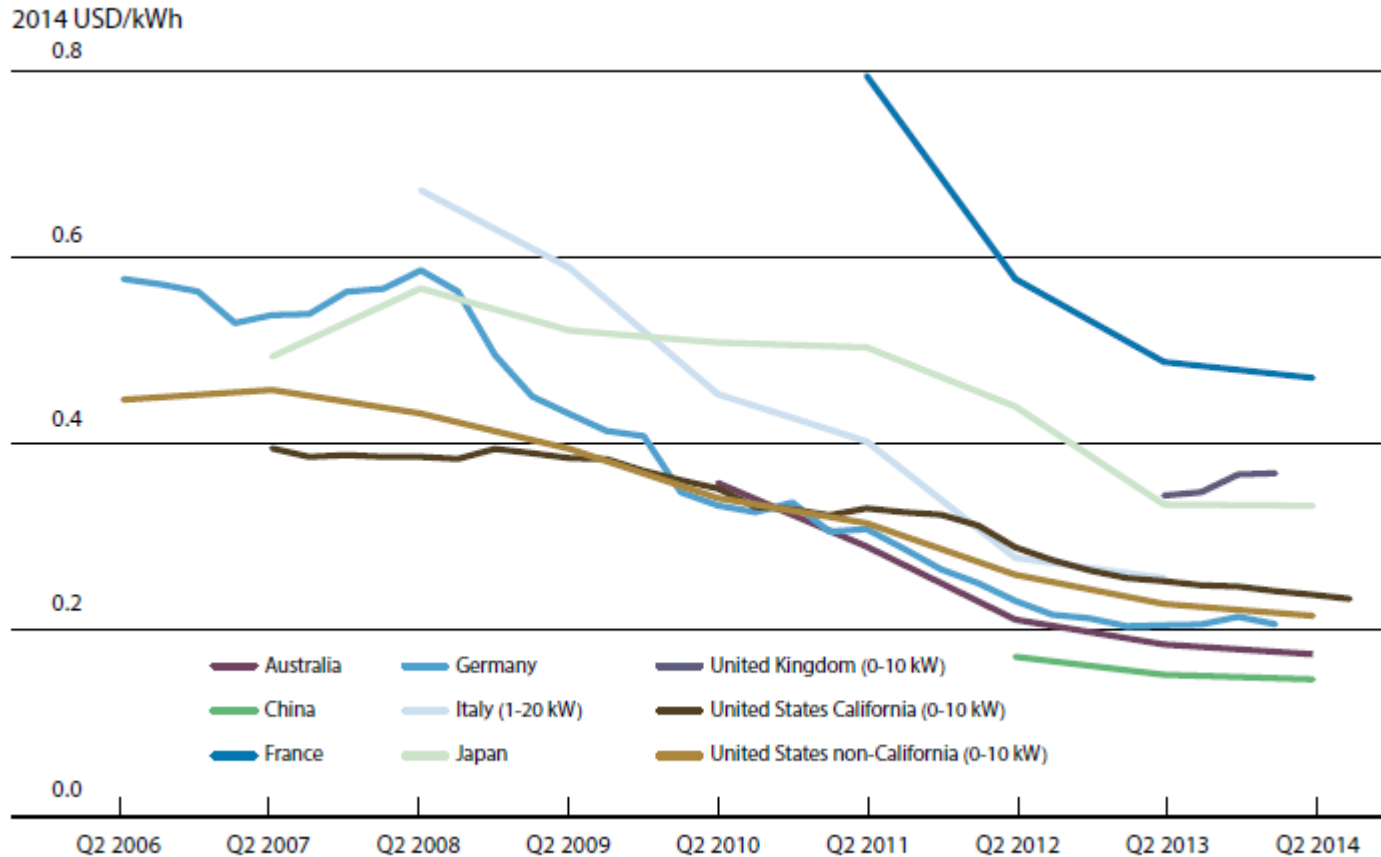
Technology Game Changers

- Solar Photovoltaic
- Storage
- Electric Vehicles
- Energy Efficiency
- Demand Response
- Smart Grids
- Internet of Things
- Big Data & Analytics



Residential PV Prices have dropped by 50%

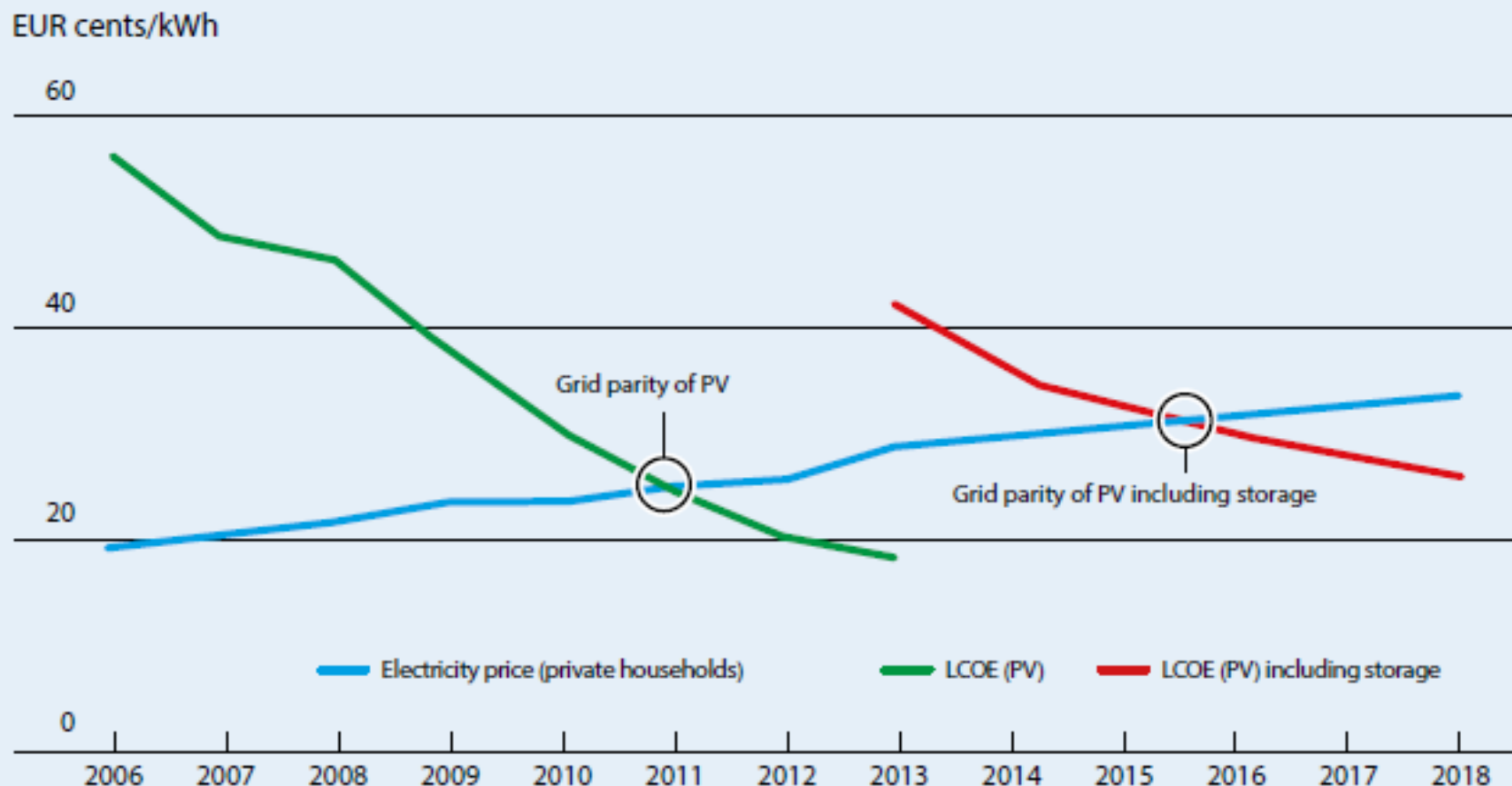
FIGURE 5.16: LEVELISED COST OF ELECTRICITY OF RESIDENTIAL SOLAR PHOTOVOLTAIC SYSTEMS BY COUNTRY, 2006 TO 2014



Source: IRENA Renewable Cost Database; BSW, 2014; CPUC, 2014; GSE, 2014; LBNL, 2014; and Photon Consulting, 2014.

Residential PV with Storage will reach Grid Parity – Lessons from Germany

FIGURE 5.17: GRID PARITY OF PV-STORAGE IN GERMANY



Source: EuPD Research/ BDEW 2013.

Revenue Problem

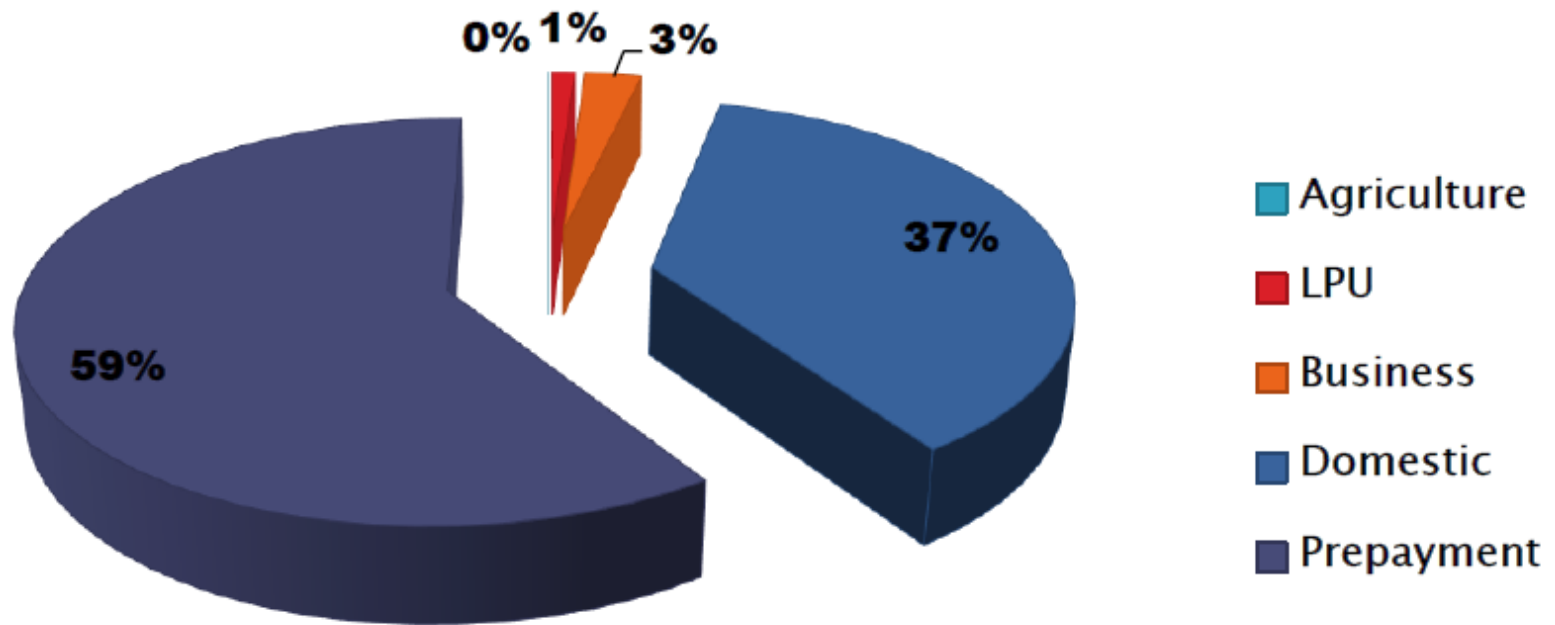
Data sourced from City of Johannesburg & City Power



	2014		2013	
	Actual	%	Actual	%
Service Charges comprise				
Sale of electricity	12 397 510	61%	12 262 284	63%
Sale of water	4 129 926	20%	3 960 971	21%
Surcharges: Electricity	116 919	1%	6 835	0%
Surcharges: Water	35 162	0%	25 847	0%
Surcharges: refuse	3 620	0%	2 787	0%
Refuse removal	1 131 479	6%	974 894	5%
Sewerage and sanitation charges	2 292 731	11%	1 893 020	10%
Other services	252 866	1%	187 262	1%
	20 360 213	100%	19 313 900	100%

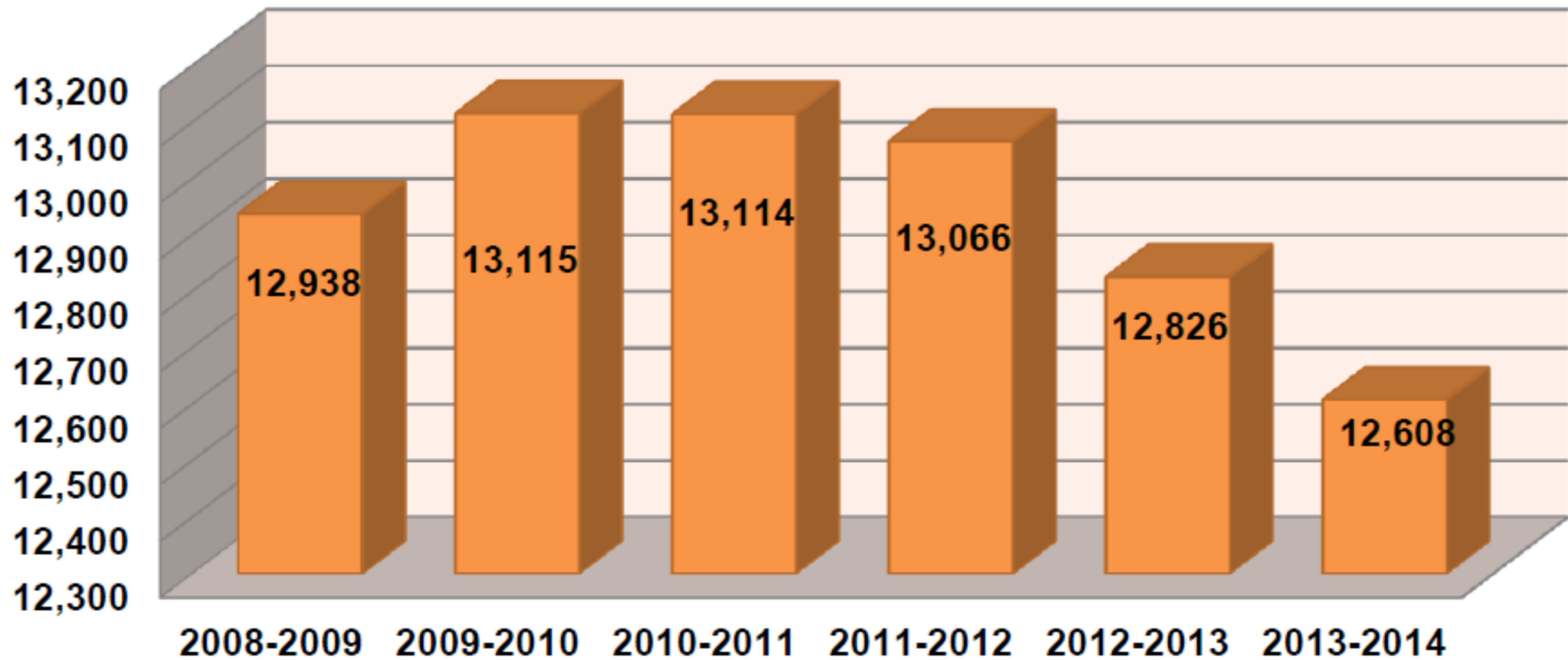
Source: City of Johannesburg Annual Report 2013/14

Customer Categories

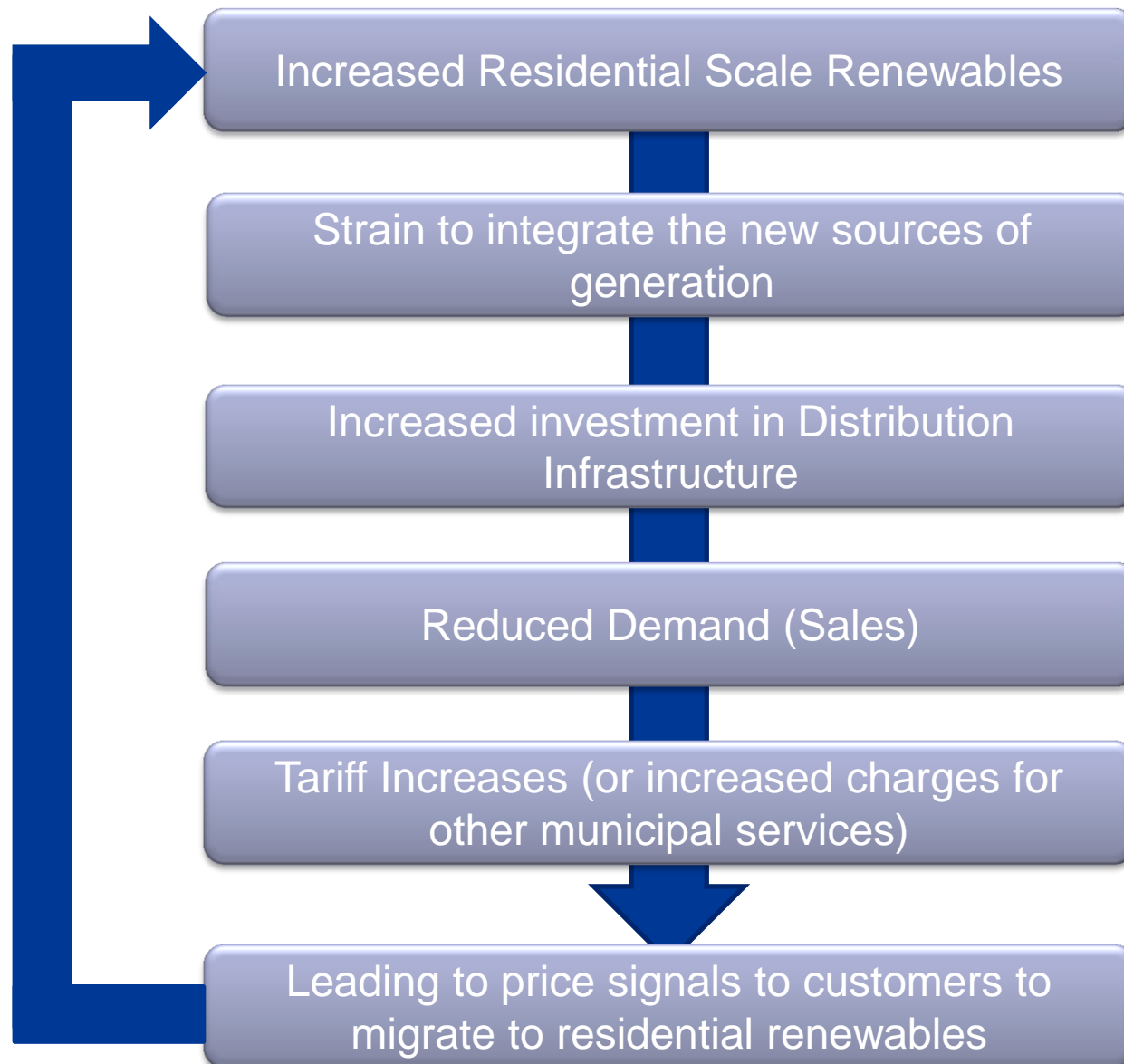


Source: City Power Annual Report 2013/14

Year on Year Volumes - GWh



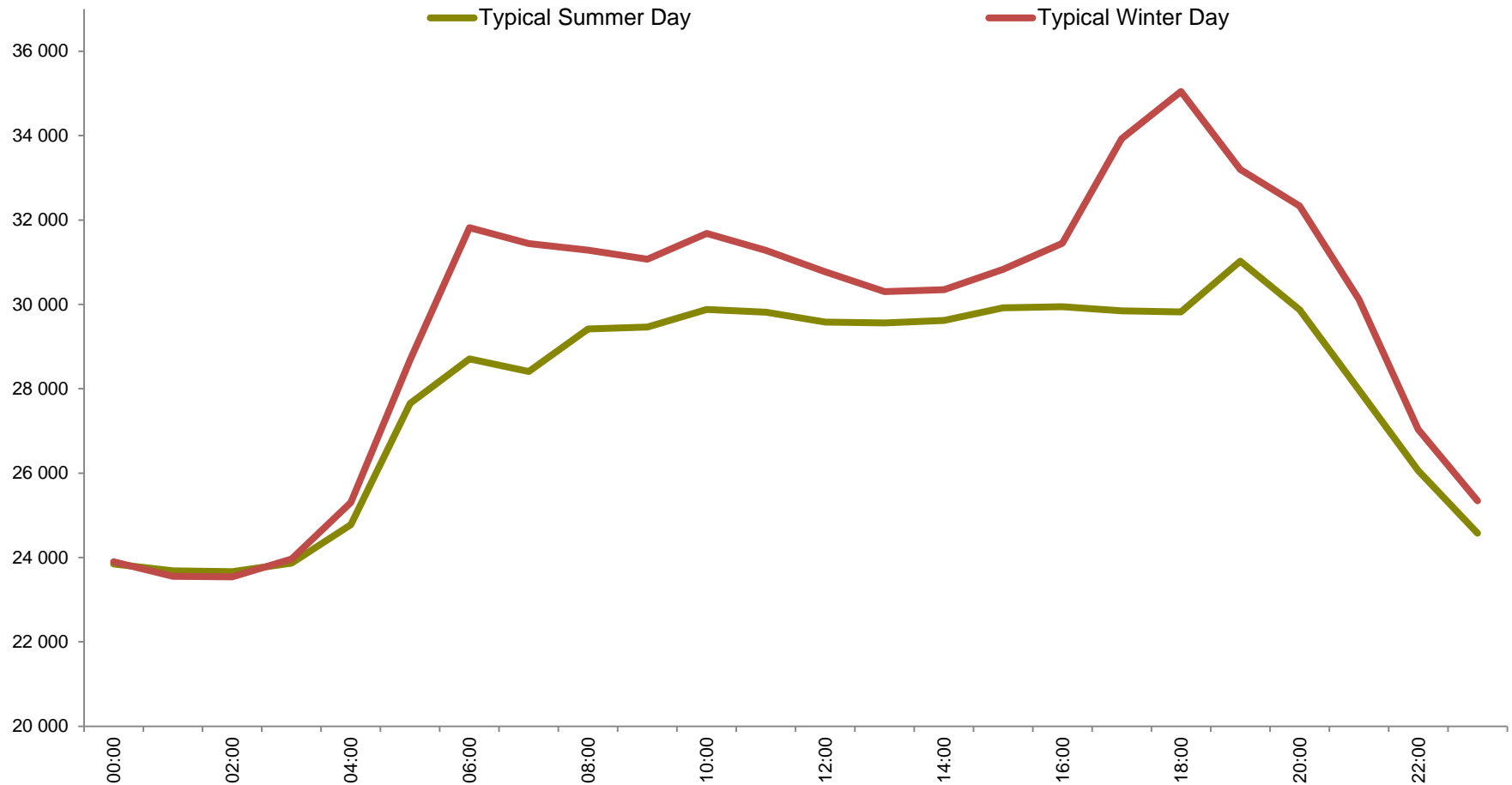
Source: City Power Annual Report 2013/14



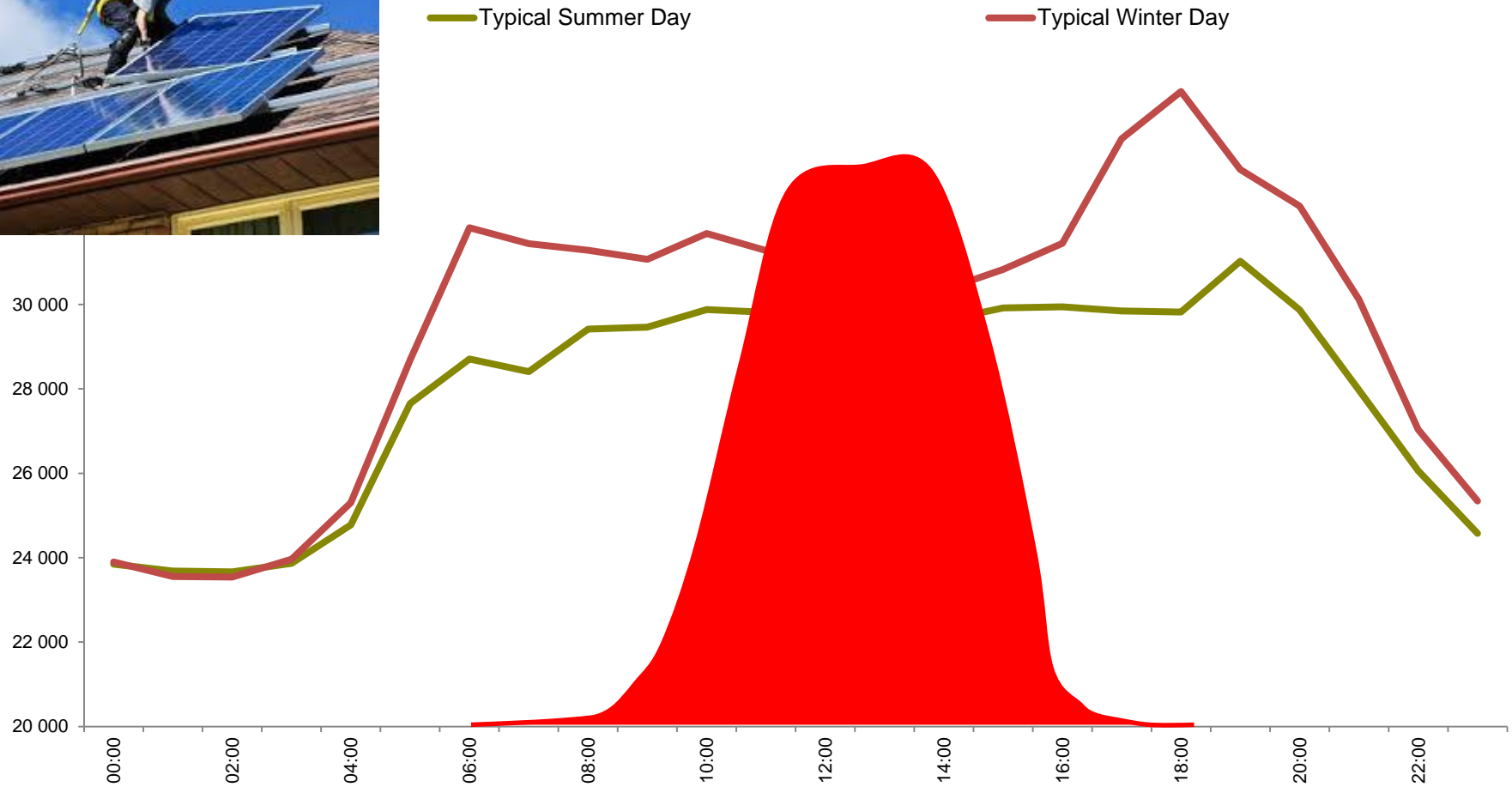
Impact on Load Profile



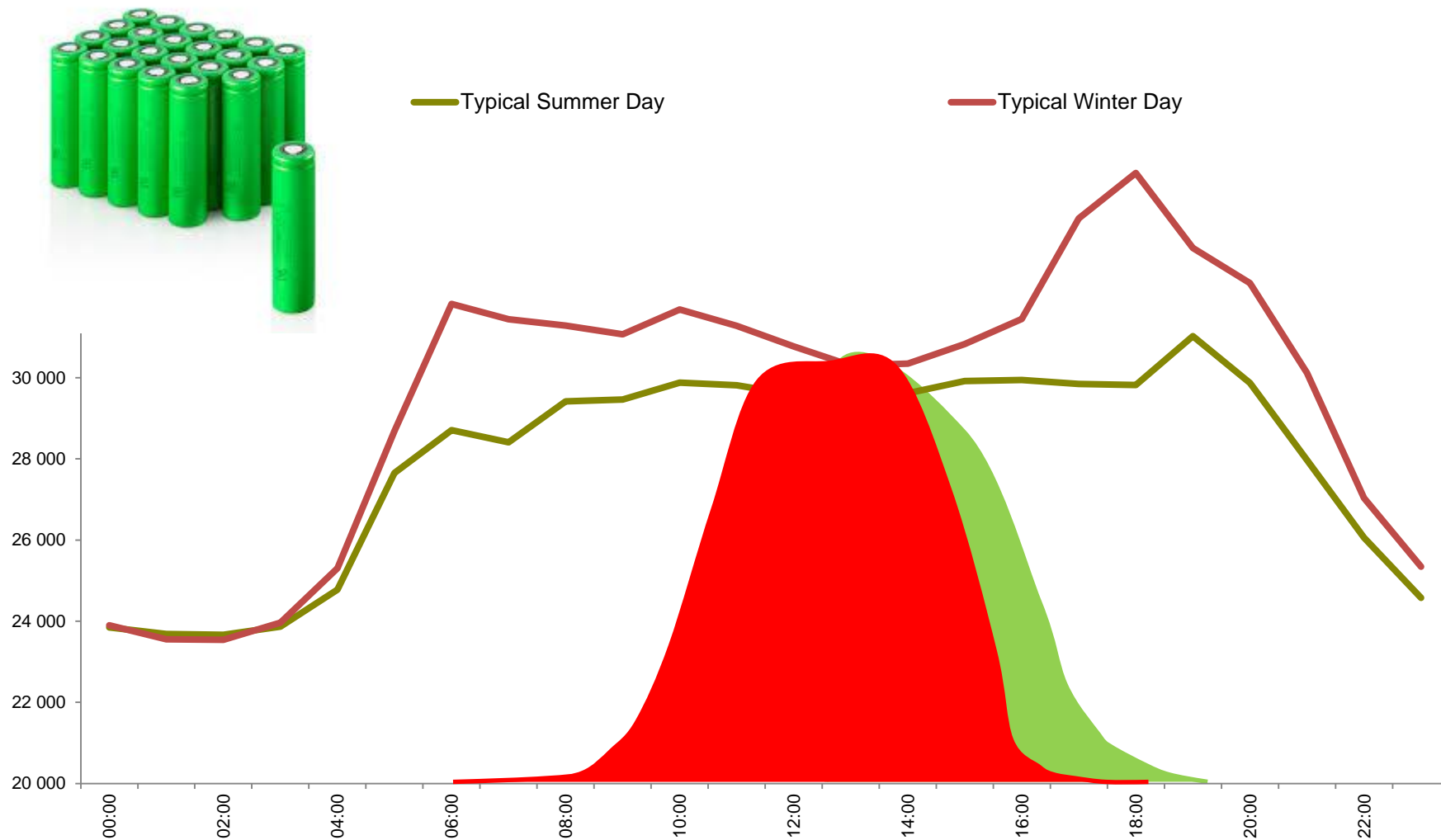
Typical Load Profile



Impact of PV



Impact of Storage

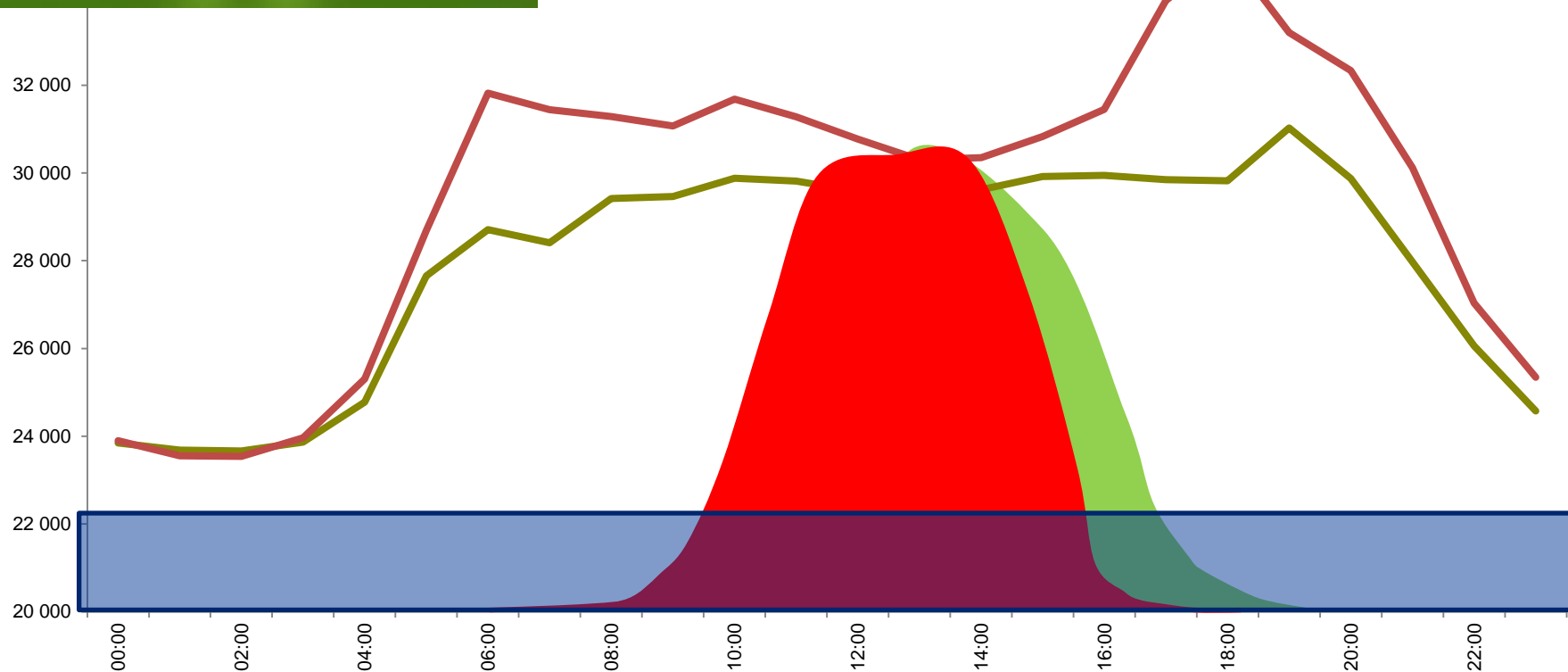


Impact of Energy Efficiency

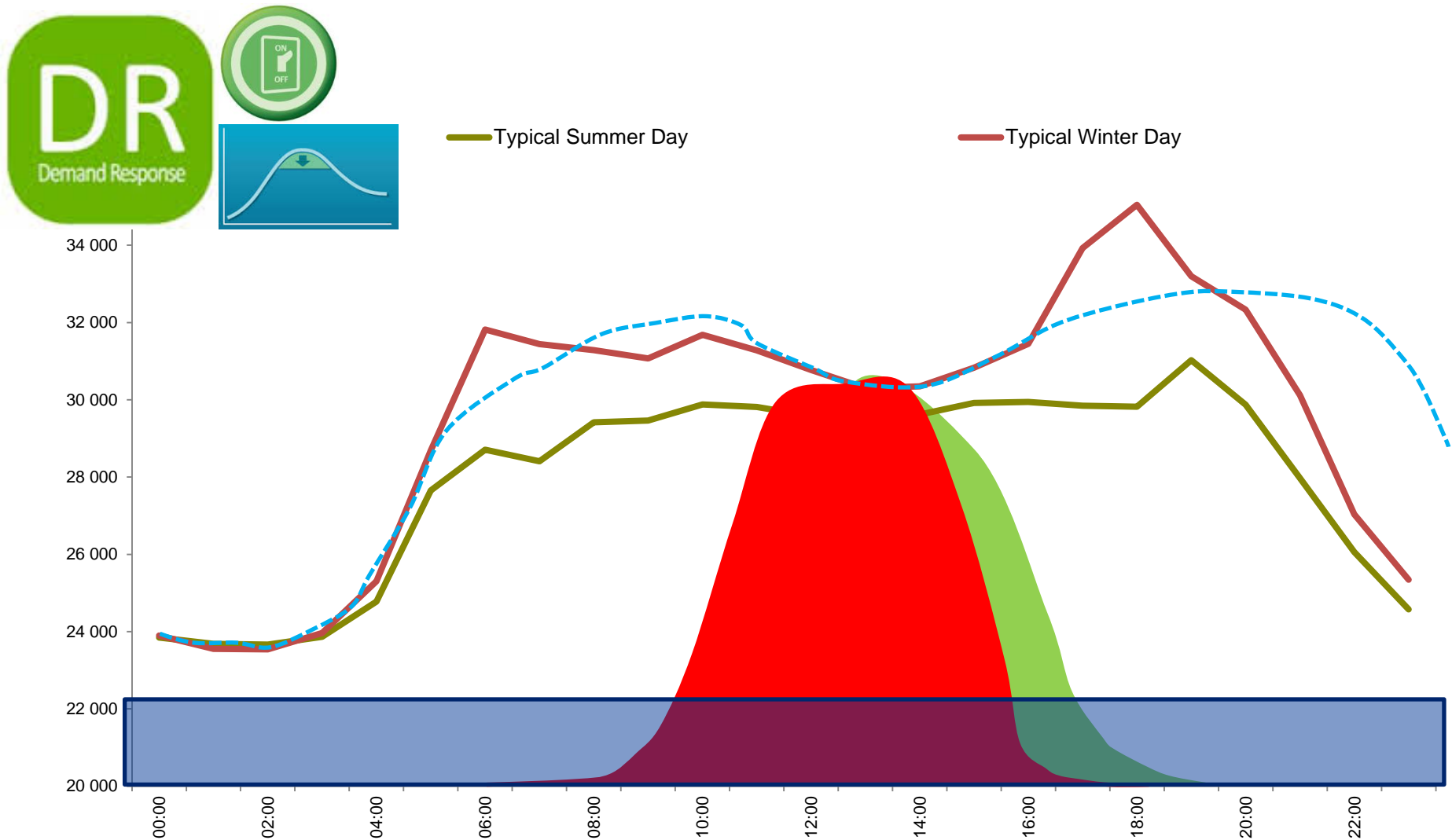


Typical Summer Day

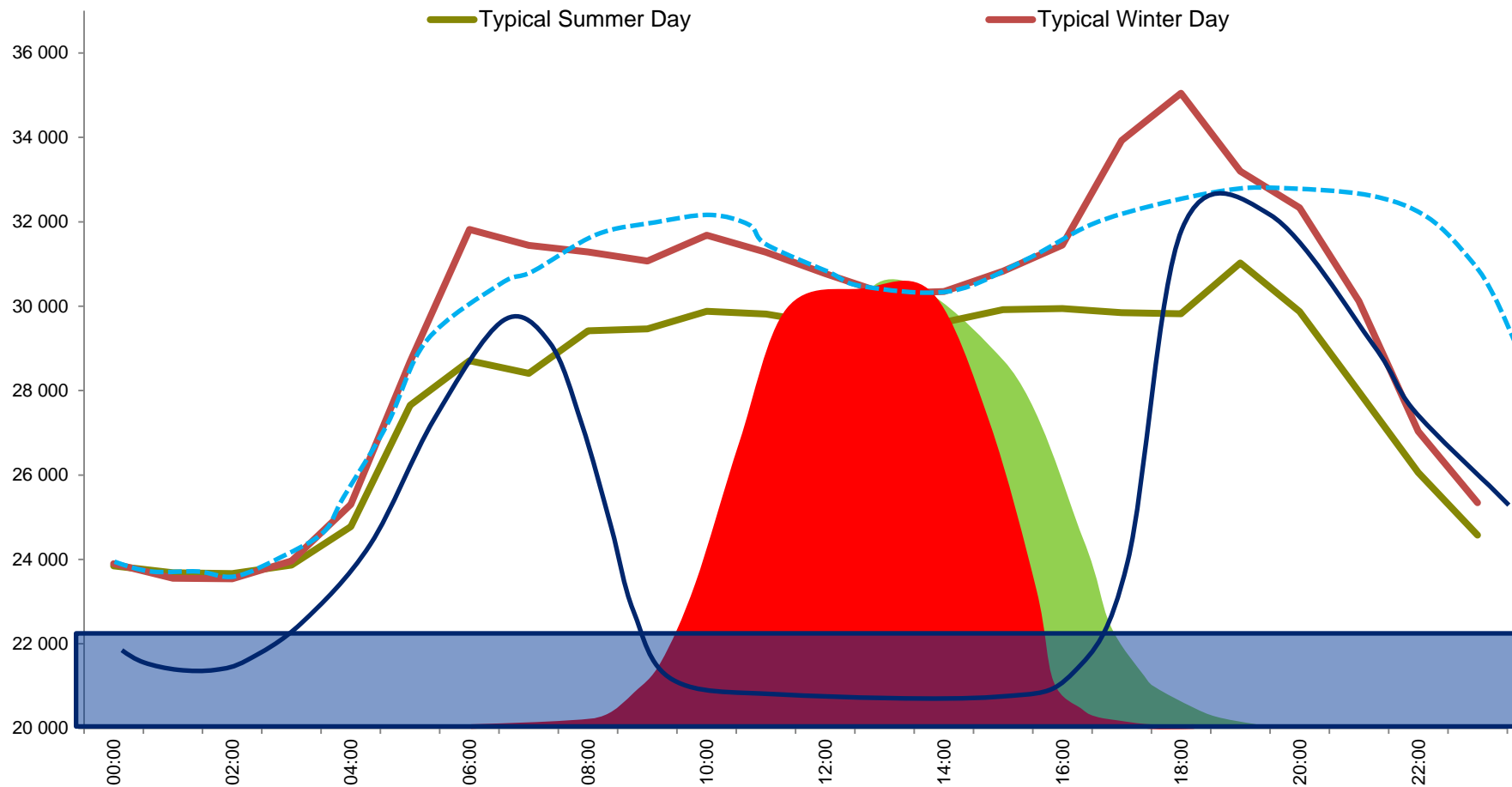
Typical Winter Day



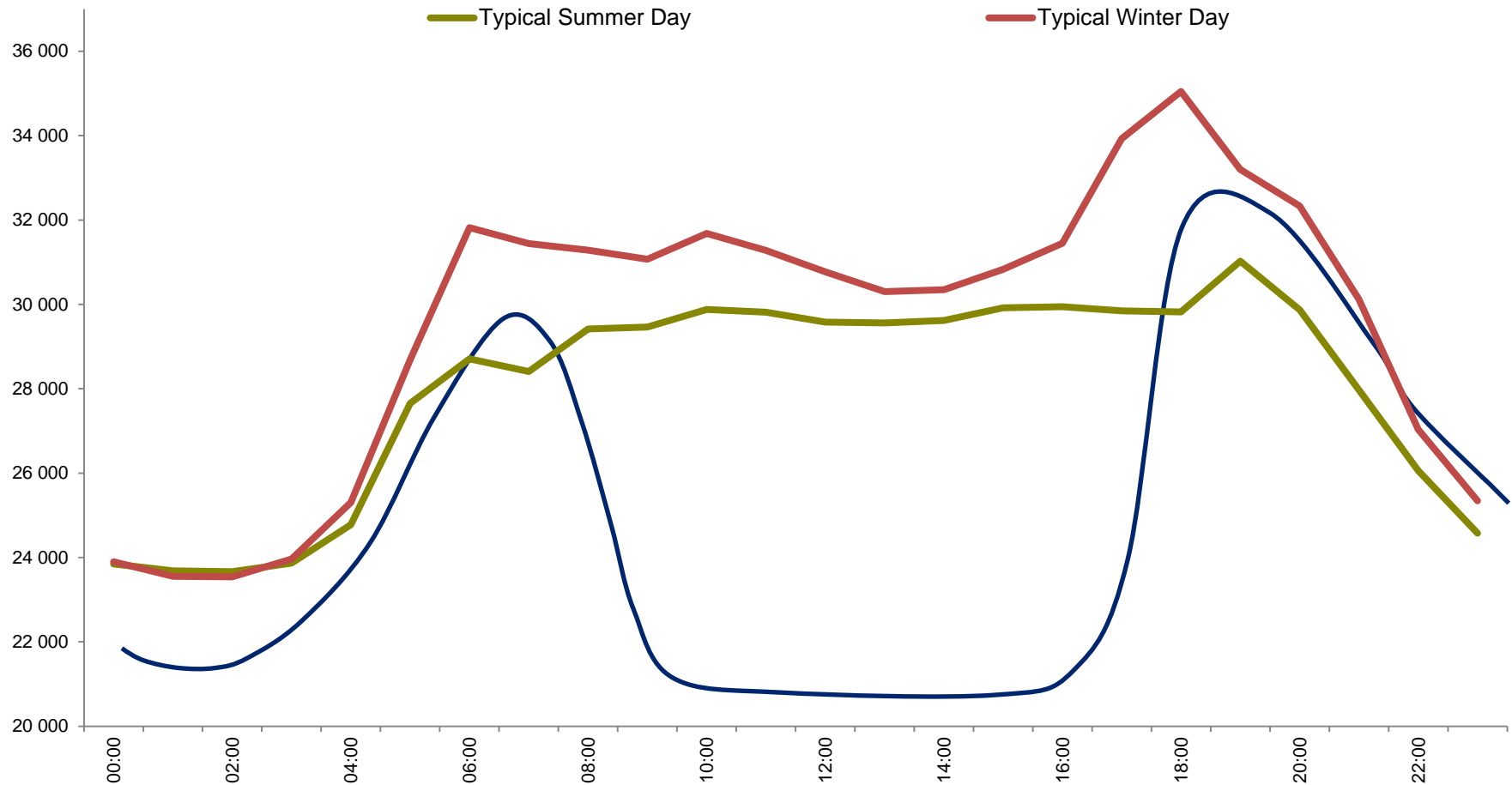
Impact of Demand Response



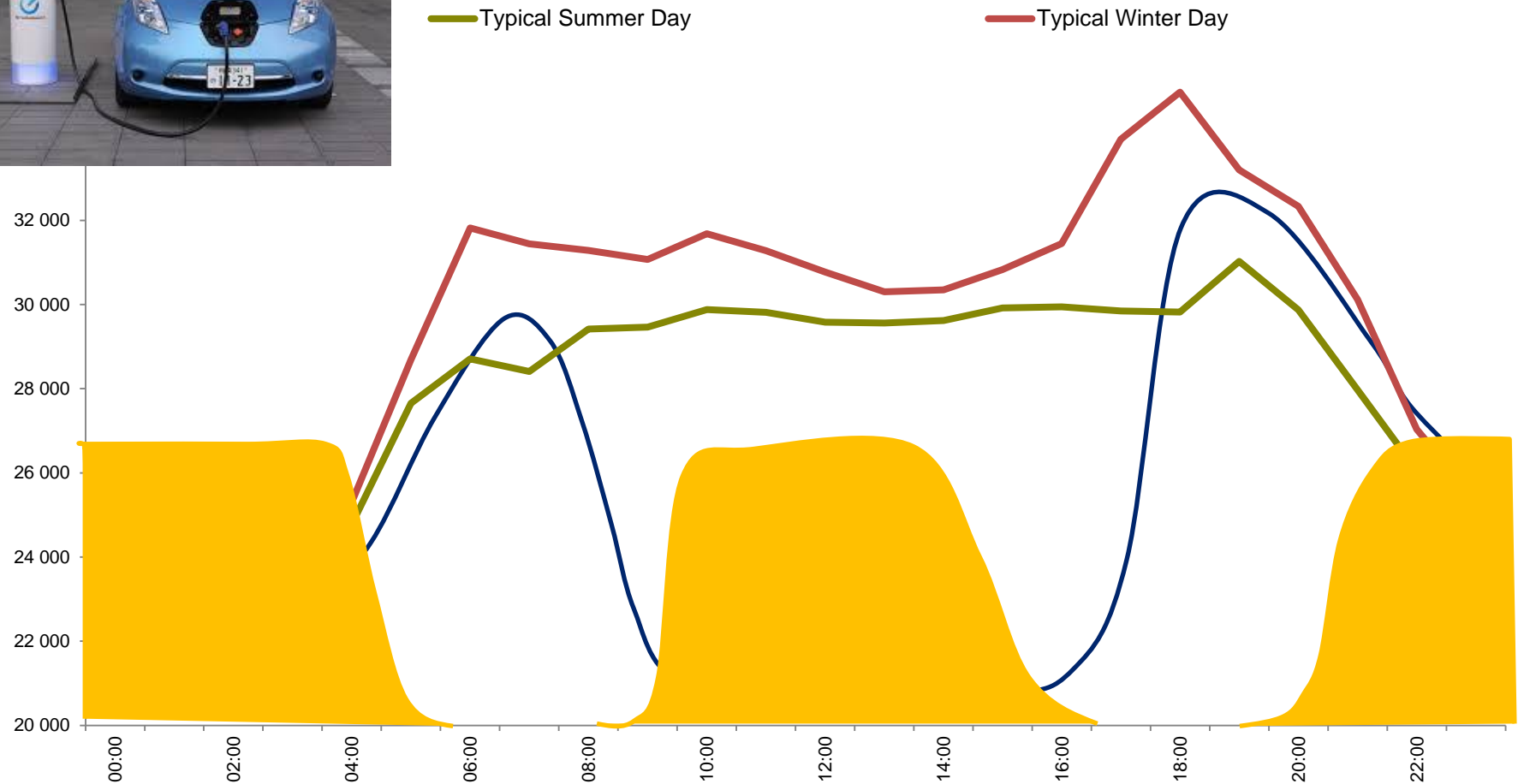
Impact of Demand Response



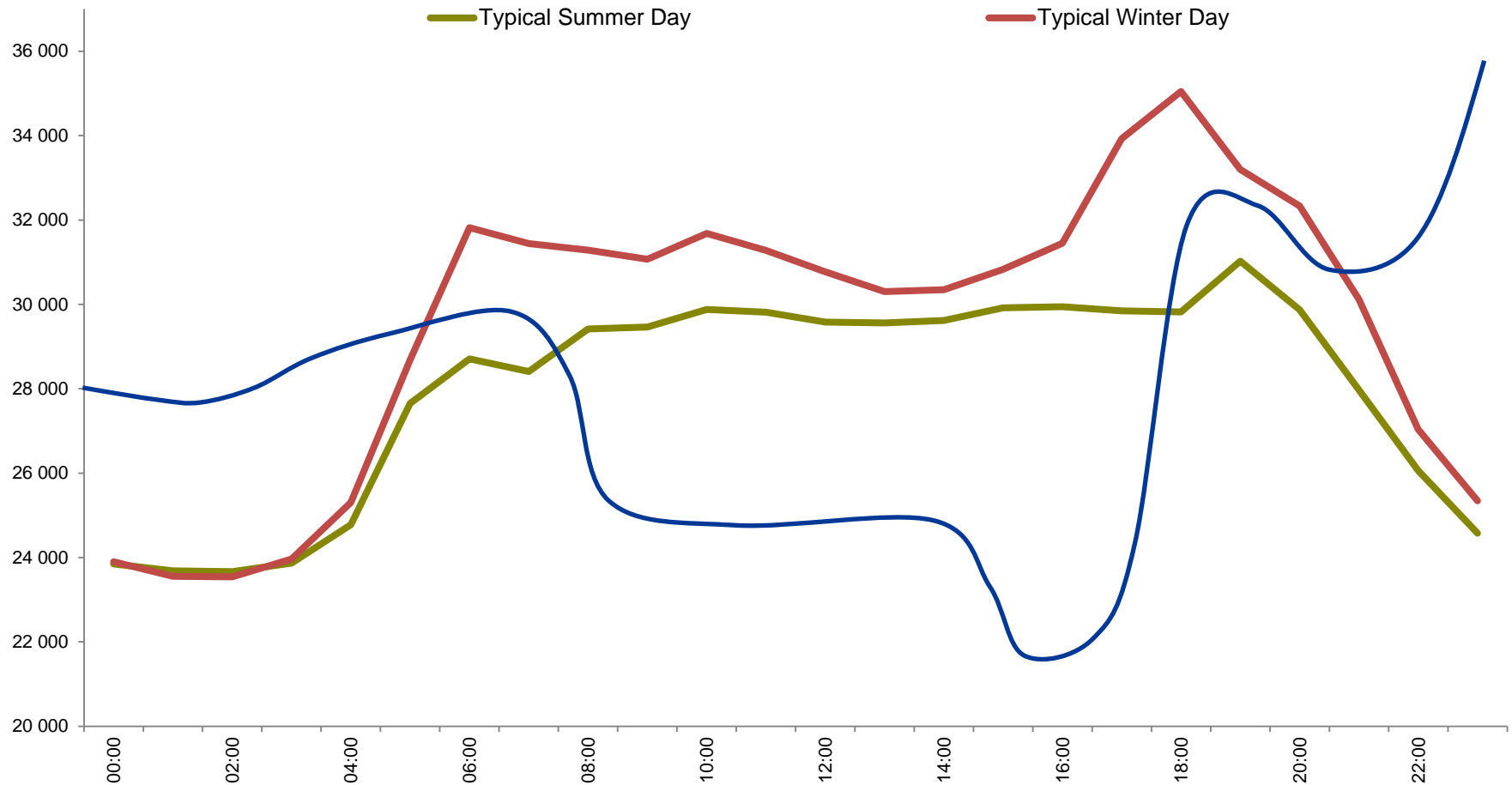
Impact of PV, Storage & DR



Impact of Electric Vehicles



Future Demand Profile - Residential

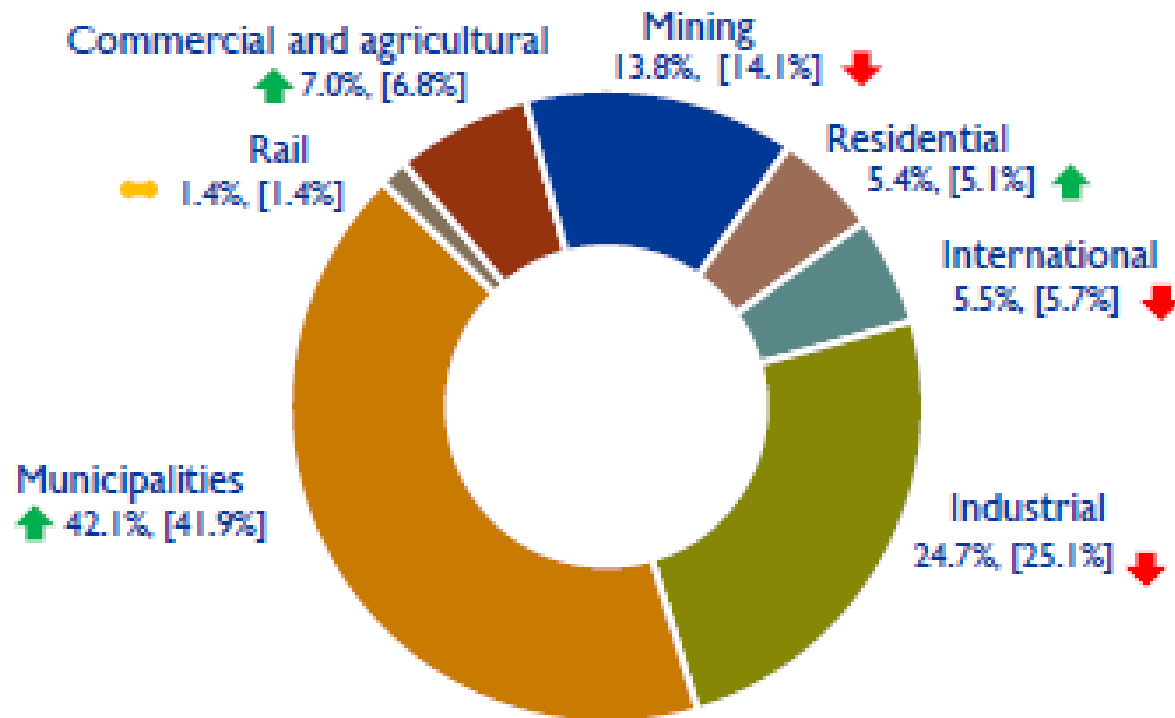


Customer Segments



Which customer segments do you serve?

Electricity volumes by customer type¹



Future Customer

Customer Segment

- Who are the customers
- Light Commercial
- Residential
- Where are they
- How much do they pay?
- How much are they willing to pay?
- Insurance Issues?
- Safety issues?
- Do they value green?

Finance

- Financial Model to pay back the technology
- Build and Operation Costs
- Lifespan of the technology
- Financing Costs
- Market analysis and competition
- Risk evaluation and

Technology Management

- PV technology
- PV Prices
- Storage technology
- Inverter technology
- Energy Efficiency
- Warranties
- Life expectancy
- Construction
- Commissioning
- Regulation
- Strategic Partnerships
- Safety and risk

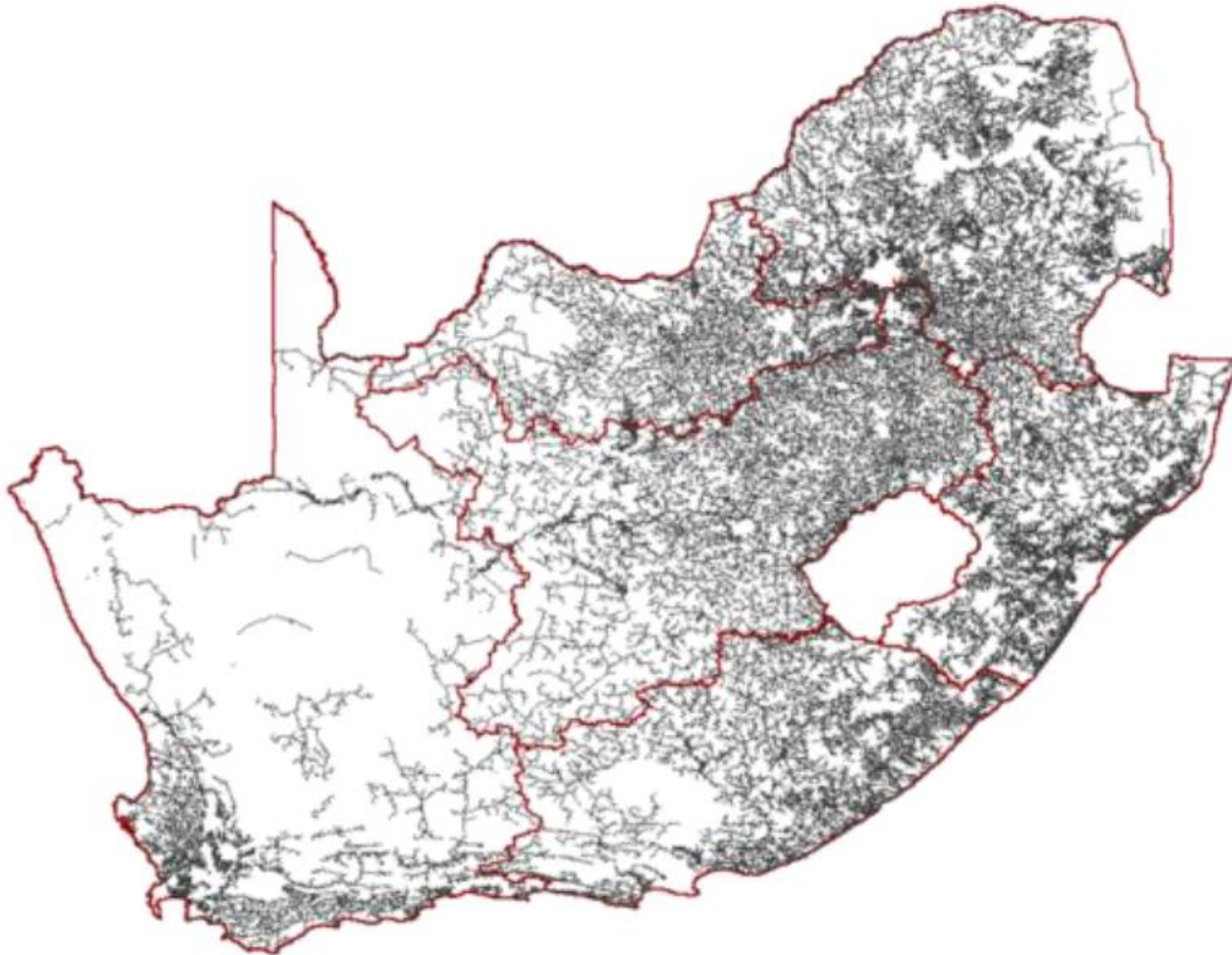
Utility Competencies

- Location of Customers
- Spares
- Skills
- Working in roofs?
- Response times
- Insurance

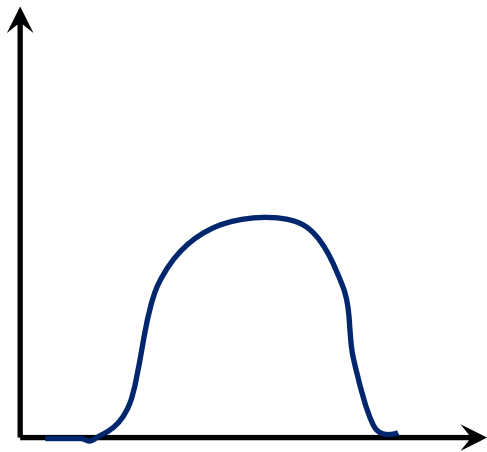
Strategic Partnerships

- Suppliers of the technology
- Installation
- Support
- Warranties

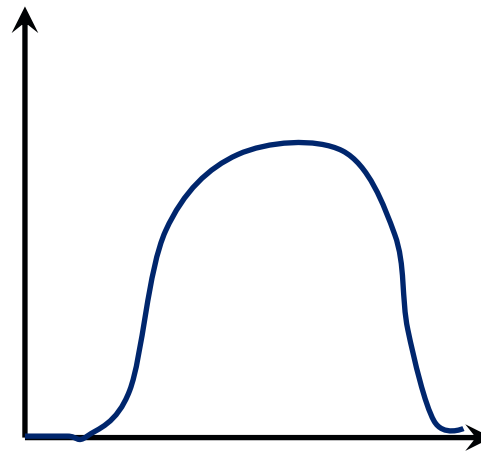
CHALLENGE : Formulate affordable value added, business products and services for Eskom's existing and new customers based on an integrated, smart, green localised and energy efficient technologies in the next 3 years.



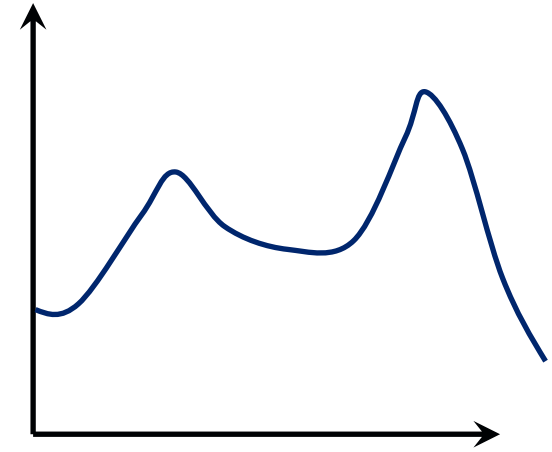
Source: Dr C Carter-Brown, (AMEU Paper)



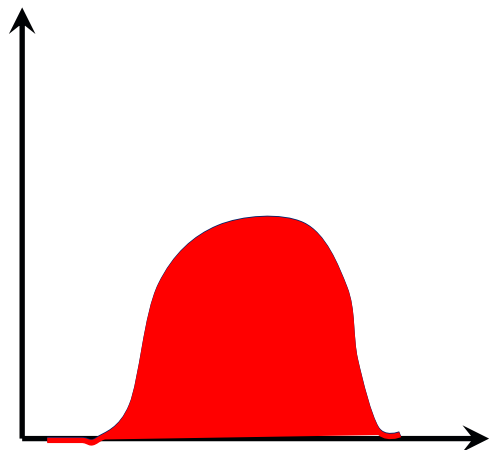
Light Commercial



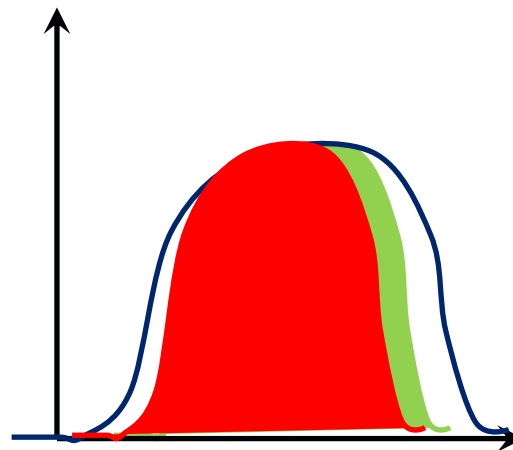
Agricultural (Irrigation)



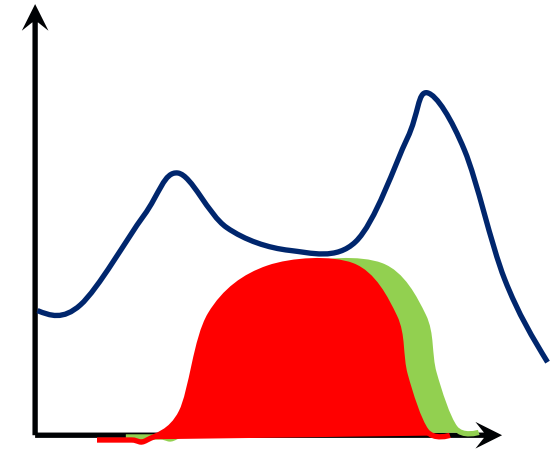
Residential



Light Commercial



Agricultural (Irrigation)



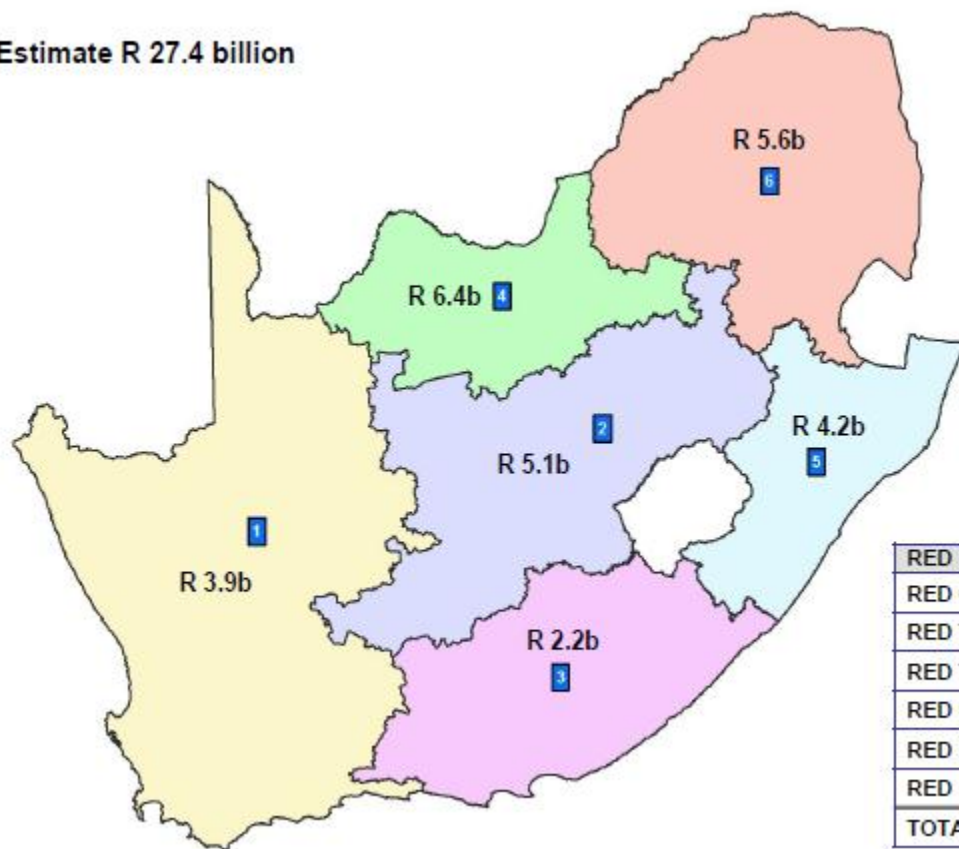
Residential

State of the Distribution Infrastructure



Approach to Asset Distribution Management (ADAM)

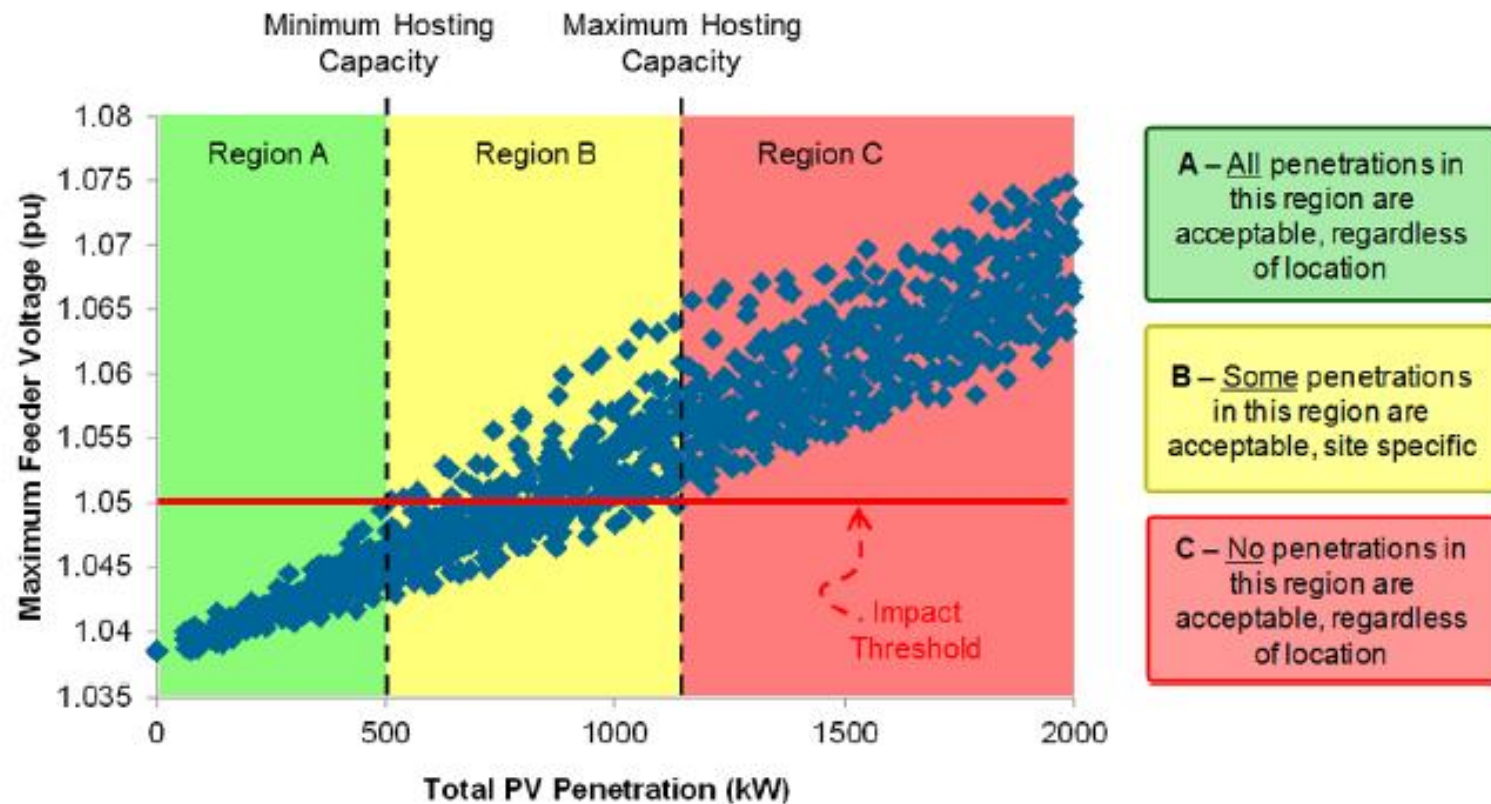
Total Estimate R 27.4 billion



Backlog now R35 billion

RED	Total Backlog
RED ONE	R 3,851,578,245
RED TWO	R 5,132,373,764
RED THREE	R 2,186,296,025
RED FOUR	R 6,413,148,398
RED FIVE	R 4,158,350,649
RED SIX	R 5,627,399,914
TOTAL	R 27,369,146,995

Source: Prof Anton Eberhard (SALGA), May 2013

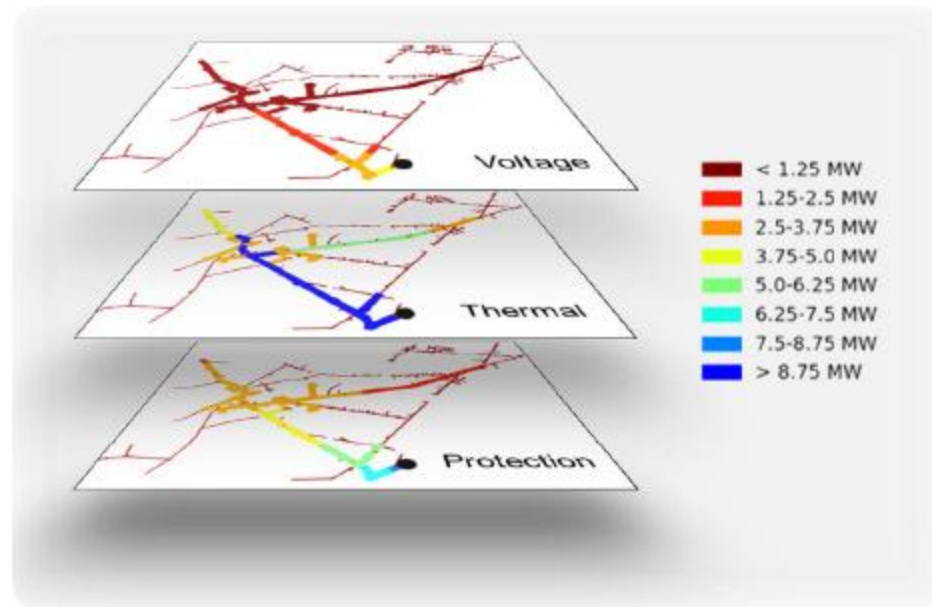


Source: EPRI, 2016

Hosting Capacity – What it Encompasses

Impacts Considered

- Voltage
 - Primary overvoltage
 - Primary voltage change (flicker)
 - LTC/Regulator tapping
 - Secondary overvoltages/voltage change
- Loading/thermal
 - Thermal loading (lines, transformers)
- Protection
 - Reverse power flow
 - Total fault current
 - Breaker reduction of reach
 - Sympathetic tripping
 - Fuse coordination



Source: EPRI, 2016

Other Considerations



- Load Forecasting and using alternative methods
- Comeback Loads
- Operations of the Network
- Distribution System Operator
- Move to probabilistic or stochastic grid-based approaches
- The future distribution system will be affected by many risks.
- Planning tools should be multi-faceted
- Consider move to meshed or ring network topologies
- Plans should also be based on smart metering data.
- Consider reliability assessment in all network planning aspects.
- Review protection systems
- Constantly updating Grid Codes
- Communication systems to support data exchange
- Safety

Stepping Stone for Africa to Leap Frog

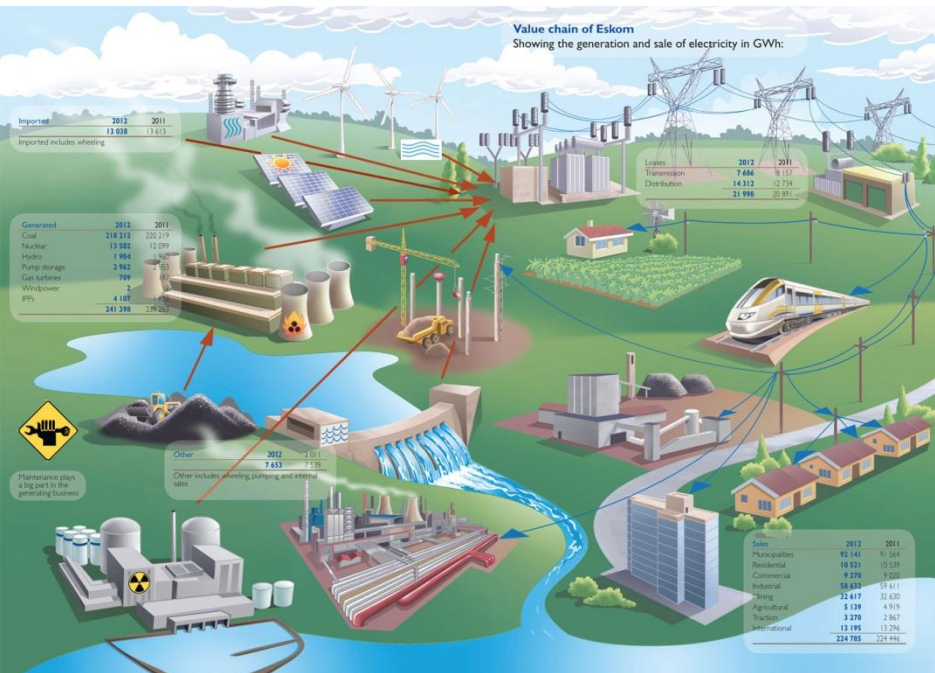


Electric Lighting was solved over 100 years ago



Source: NASA

Conventional Grid vs MicroGrid



Components: 1. PV array, 2. SUPPLY BUS, 3. SUPPLY CABLE, 4. Recharge, 5. Diesel generator, 6. Wind turbine system



Invent the Future

Dr Prathaban Moodley BSc(Eng), MEng, PhD(Wits)
Technology Strategy & Planning Manager (Acting)
Research, Testing and Demonstration
Eskom Holdings Limited
Tel +27 11 629 5251
Email prathaban.moodley@eskom.co.za