Energy Storage Licensing and Regulation

Meeting with NERSA

and

SAESA Policy and Regulation sub-committee

4 September 2019

SAESA South African Energy Storage Association

Our Association

The South African Energy Storage Association (SAESA) was constituted in March, 2018, to advocate and advance the development of an energy storage industry in Southern Africa. The membership includes manufacturers, suppliers, electricity utilities, municipal distributors, financiers and end-users of such systems. SAESA's function is to ensure that business plays a constructive role in the country's economic growth, development and energy transformation and to create an environment in which it supports the Just Energy Transition so that all sectors can thrive, expand and be competitive.

Storage technologies are rapidly maturing and costs are falling…..

Energy storage systems provide a wide array of technological approaches to managing our power supply in order to create a more resilient energy infrastructure and bring cost savings to utilities and consumers

Diverse approaches are currently being deployed around the world, there are seven main technologies:

- Solid State Batteries - a range of electrochemical storage solutions, including advanced chemistry batteries and capacitors
- Flow Batteries - batteries where the energy is stored directly in the electrolyte solution for longer cycle life, and quick response times
- Gravitational Energy Storage Systems - Mechanical crane and mass stacking systems
- Flywheels - mechanical devices that harness rotational energy to deliver instantaneous electricity
- Compressed Air Energy Storage - utilizing compressed air to create a potent energy reserve
- Thermal - capturing heat and cold to create energy on demand
- Pumped Hydro-Power - creating large-scale reservoirs of energy with water

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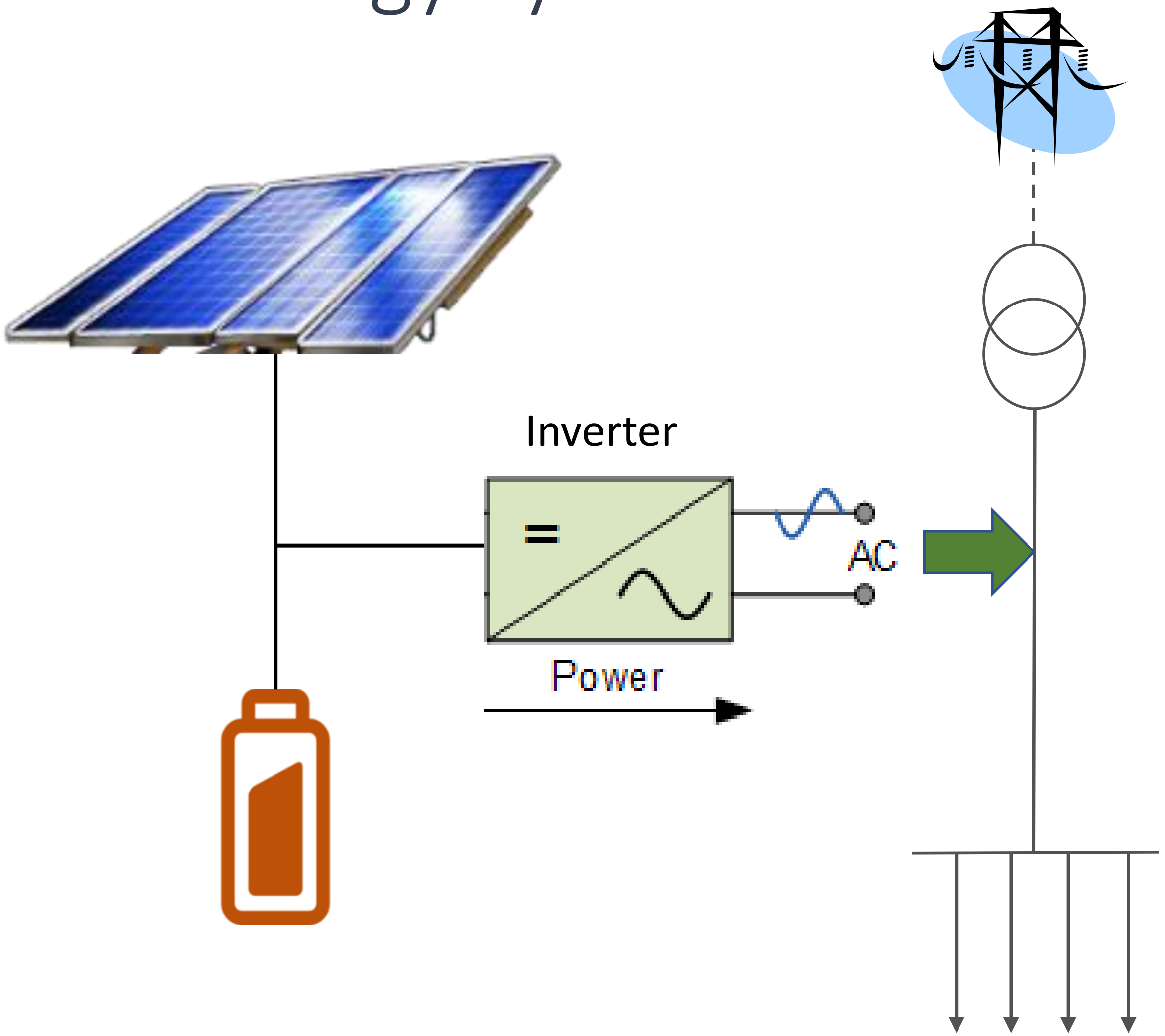
Use Cases for Energy Storage

Energy Storage as an integral part of a Renewable Energy System

Energy Storage can be included as an integral part of a renewable energy system:

- Stores surplus energy for use at a later period to match the renewable energy production to the load profile
- It effectively improves the capacity factor of the generating system
- *In this case the installation can be defined as generation, subject to generation registration and licensing requirements*



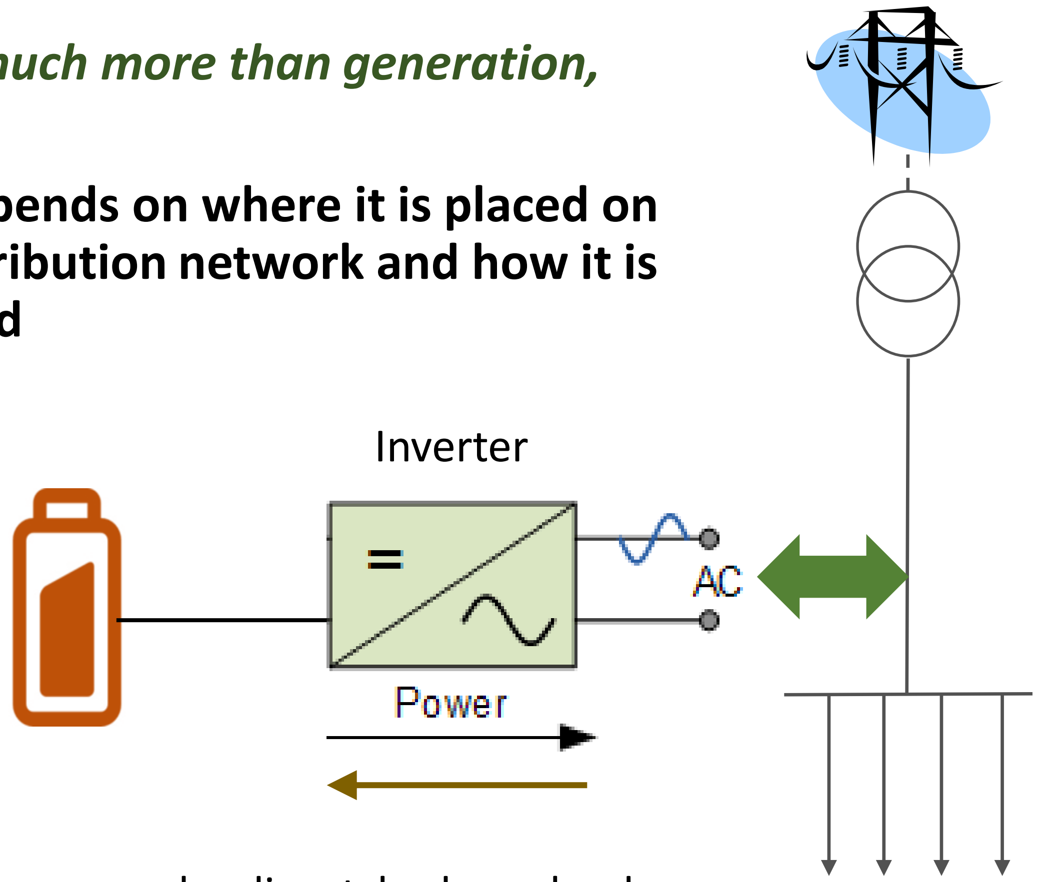
On its Own, Energy Storage is a powerful grid management tool

Energy Storage can be applied to:

- Optimizing energy procurement costs
- Protecting the Economy
- Preserving overloaded distribution infrastructure
- Unlocking property development
- Supporting densification
- Optimizing Investment in renewable energy systems
- Providing basic energy services

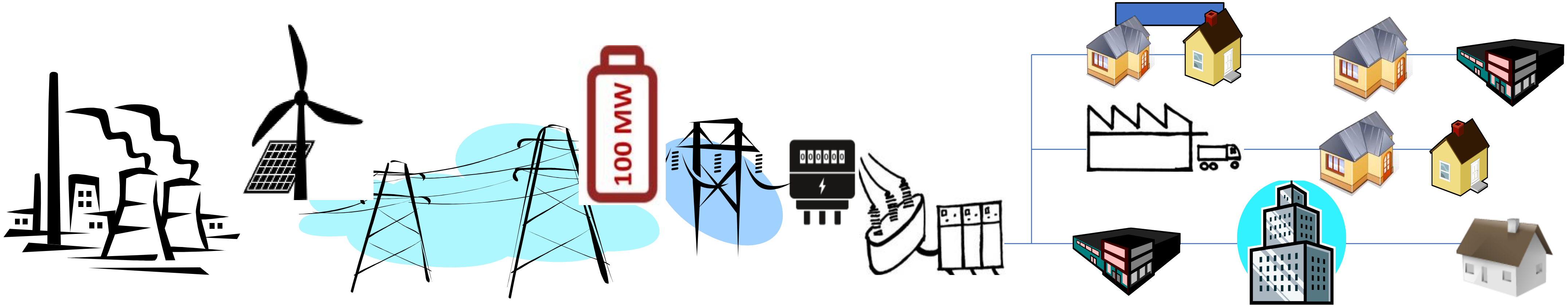
This is much more than generation, and ~

It all depends on where it is placed on the distribution network and how it is operated



Storage can be dispatched as a load and as a generation asset

Value of Storage connected at Tx level



- Consider what a 100 MWh storage system placed at a point on Eskom's high voltage transmission network can provide:
  - A means to store surplus renewable energy at a national level,
  - Avoid transmission network bottlenecks and
  - Provide frequency support (reserve margin) for the national generation industry

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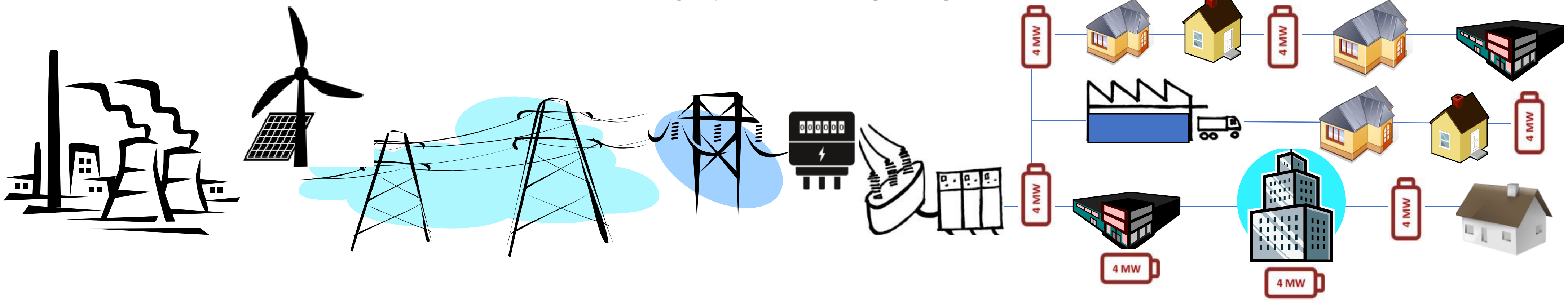
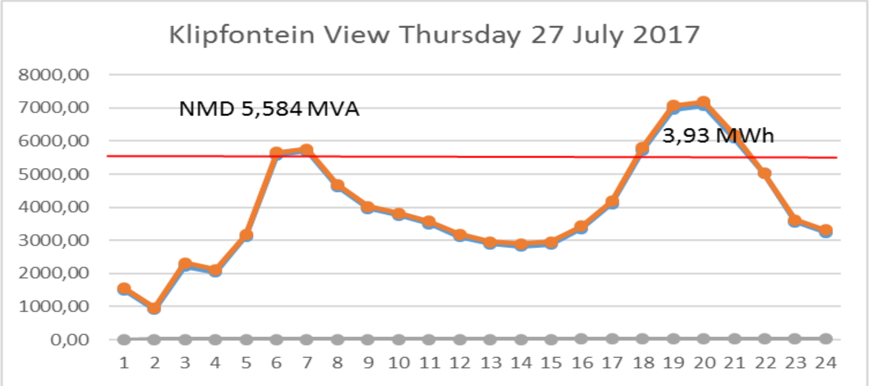
Stacked value when connected at Dx level



- **If the same storage capacity of 100 MWh was deployed by strategically placing twenty-five smaller 4 MWh systems further downstream on the medium voltage distribution networks, the systems would still realize Tx benefits and add further value through:**
  - Energy purchasing arbitrage (Routinely, over the life of the storage system)
  - The alleviation of distribution network bottlenecks and overloads
  - The avoidance of Eskom Notified Maximum Demand Charge penalties,
  - The deferment of network refurbishment or network upgrade capital expenditure
  - Improvement of the power factor over the entire transmission and distribution networks
  - Realizing a significant improvement in the security of supply for customers.
  - Providing a measure of standby power to end customers (alternative to diesel power)

Load that is the Least Cost to Supply

- Peaky loads cost a lot to service
- As a grid operator, we do benefit from the diversity that the community connected to the grid demands
- However, the more peaky the load of our own customers is, the more costly it becomes for a distributor to both source the power and to deliver it.
- **The ideal load – a flat line – is a constant demand and a predictable quantity of energy to be delivered**
- In reality very few loads are flat –
- Whatever can be done to remove the kinks in the load curve, will reduce costs of both cost drivers
- The supplier of last resort – this will likely be Eskom's new role – will be the price setter, and will become more and more costly over time.



Tariff: Nightsave Urban kVa.
NMD: 5,584 MVA.
Exceedance in July 2017: 2,161 MVA
Excess NMD charge per kVA in July (8 events): 8 X R 21,36 = R 170.88 per kVA
Total paid in Excess NMD Charges for 2017/2018: R2 609 637,18

Energy Storage is a powerful DSM tool to clip the peaks and fill the valleys

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Storage earns it’s daily keep on Municipal Distribution Networks

- Time of use tariffs are designed to change the behavior of the loads serviced
- These tariffs are also the foundation of the business case for energy storage systems
- TOU tariffs have expensive periods, typically when loads are high that stress the generators and distribution networks
- The cheaper periods are when the load subsides and things calm down – typically overnight
- Arbitrage is the practice of storing cheap period energy for use in a future, expensive energy period
- The base business case for storage is to do this every day, and this is how it ‘earns its daily keep’ and pays for itself

Optimizing energy procurement costs

Megaflex tariff - Local authority

Voltage	Active energy charge [c/kWh]											
	High demand season [Jun - Aug]						**Low demand season** [Sep - Ma					
	Peak		**Standard**		**Off Peak**		**Peak**		**Standard**		**k**	
		VAT incl		*VAT incl*		*VAT incl*		*VAT incl*		*VAT incl*		*VAT incl*
< 500V	**300,18**	*345,21*	**91,34**	*105,04*	**49,84**	*57,32*	**98,28**	*113,02*	**67,83**	*78,00*	**43,23**	*49,71*
≥ 500V & < 66kV	**295,45**	*339,77*	**89,52**	*102,95*	**48,61**	*55,90*	**96,38**	*110,84*	**66,33**	*76,28*	**42,09**	*48,40*
≥ 66kV & ≤ 132kV	**286,13**	*329,05*	**86,67**	*99,67*	**47,07**	*54,13*	**93,34**	*107,34*	**64,25**	*73,89*	**40,75**	*46,86*
> 132kV*	**269,66**	*310,11*	**81,69**	*93,94*	**44,36**	*51,01*	**87,96**	*101,15*	**60,54**	*69,62*	**38,41**	*44,17*

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Arbitrage Break-even Cost Point

Analysis of break-even point of energy storage cost vs. maximum arbitrage potential of the Local Government Megaflex Tariff

1kWh Storage used for 6 days of the week, one shot per day, to shift 1kWh from peak to off-peak, all year round

Plant Parameters

Technology Aspects	Units	Value
Total Installed Cost of Storage System	$/kWh	400
Storage System Specified Cycle Life	Number	7000
Efficiency of Charge and Discharge cycle	%	85%
Capital Aspects	Units	Value
Rand to Dollar Exchange Rate	Ratio	14,4
Local cost of Storage	R/kWh	5760
Capital loan interest rate	%pa	5,5%
Capital Loan Term	Years	10
Cost of Finance	R/kWh	-1741
Total financed plant cost	R/kWh	7501
Theoretical Plant Life, 6 days p/week, 1 cycle/day	Years	22,4
Storage Plant Expected Life	Years	15
Charge / Discharge Cycles required	Number	4693
Total Savings from 1 kWh daily arbitrage over the life of the equipment	Rand	7395,34
LCOE over expected plant life, 1 shot per day	c/kWh	159,85

Megaflex Tariff Application

11kV Intake point

Operational Aspects Energy	Units	Value
HV Distribution System Losses	%	4,00%
MV / LV Distribution	%	3,00%
Value of Winter Evening Energy Arbitrage	c/kWh	246,84
Value of summer Evening Energy Arbitrage	c/kWh	54,29
Loss-less average value of daily arbitrage	c/kWh	102,43
Average daily rate to re-charge system	c/KWh	43,72
Cycle cost to overcome system recharging losses	c/kWh	8,14
Cycle savings due shift of losses out of peak	c/kWh	3,07
Net average value of daily energy arbitrage	c/kWh	97,36
Operational Aspects Network and Demand costs	Units	Value
Peak Period Duration	hours	2
Demand reduction potential per kWh of storage	kVA	0,5
Monthly network charge per kW	r/kVA	7,63
Monthly demand charge per kW	r/kVA	28,99
Daily network and demand charge savings potential	c/kWh	60,23
* This savings is subject to the system being in operation during the annual half hour peak.		
Total potential daily arbitrage value of 1kWh storage	c/kWh	157,59

DSM on steroids – load shifting and peak lopping

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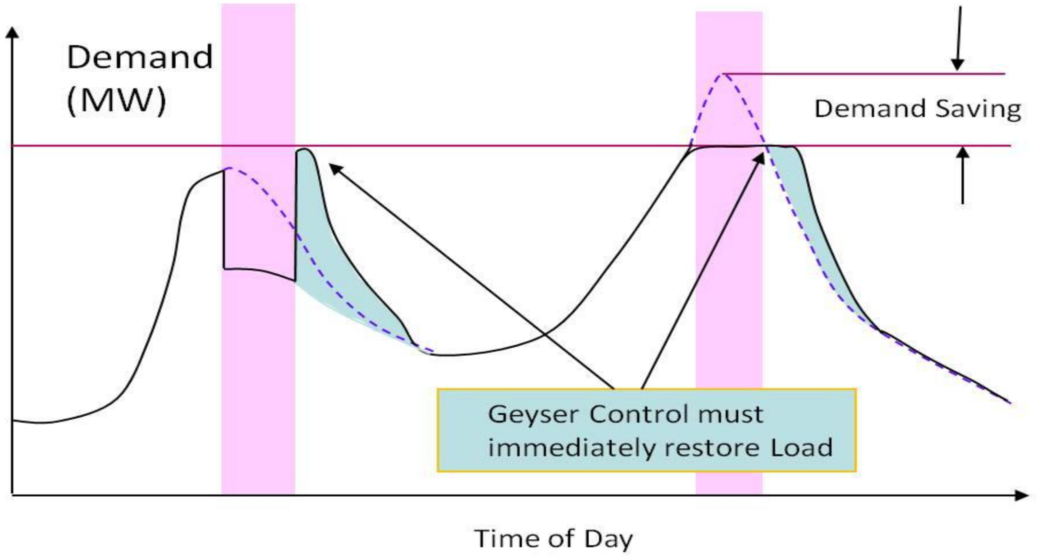
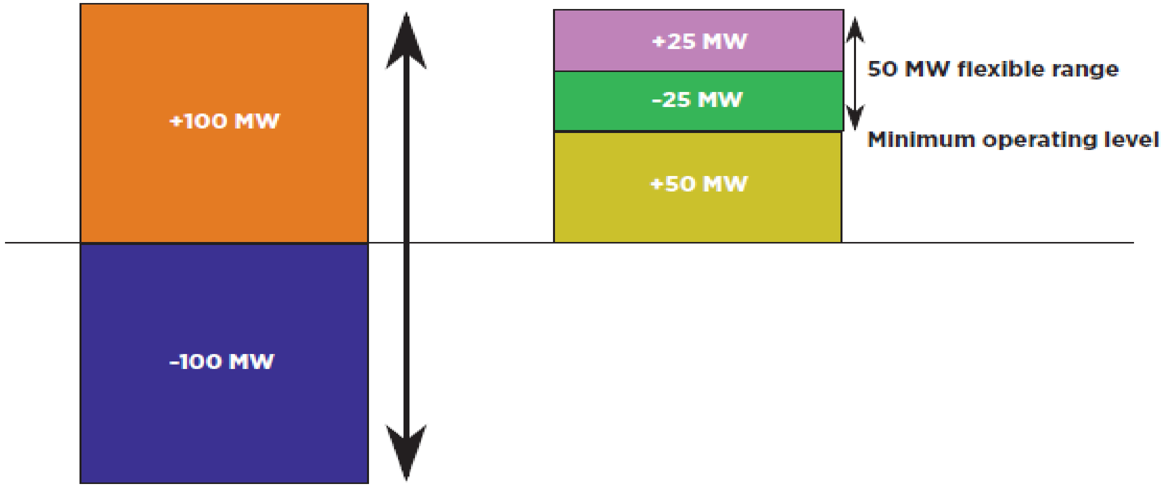
- Energy storage can behave as a load as well as a generator
- Unlike a load reducing geyser control system there are no time constraints on when the system needs to be re-charged – a geyser control system must restore load within an hour or so after the peak period, to avoid cold water complaints
- Gas peaking plant can only reduce the peak equivalent of its generating capacity.
- A storage system can reduce the peak by its inverter capacity as well as fill in the valleys in its recharge mode – it has twice the control swing



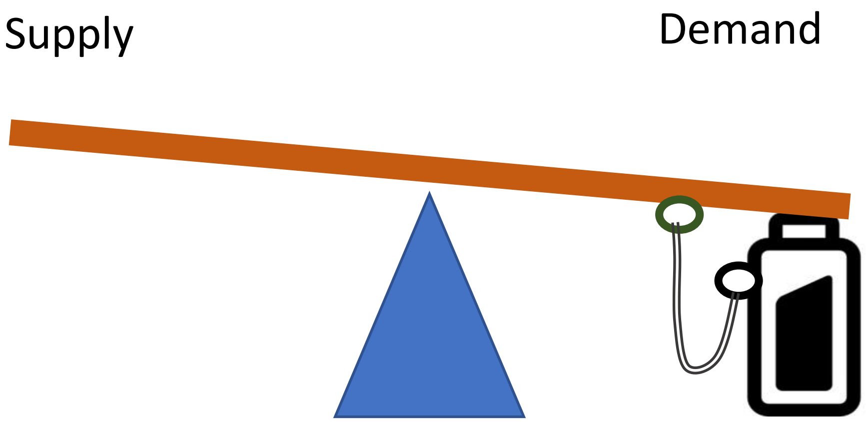


Optimizing energy procurement costs

The highest value in the medium term ?

Protecting the Economy

- Storage is an antidote to load shedding -
- Direct cost of unserved energy- estimated to be R17 per kWh (planned outages)
- Indirect costs- can be as high as R87 per kWh (figure from IRP 2019 Update)
- Those companies that have UPS units (storage systems) to ride through power interruptions are already reaping the benefits of storage
- The benefit is proportional to the frequency of load shedding – how much can we expect over the next few years?
- Under continuous Stage 1 conditions, the system may pay for itself in <1 year?



Stage 1 applied during business hours – 08h00 to 16h00 translates to 16 hours without power over a month. The additional value over the month for each kWh of storage available may be anywhere from R272 to R1392.

For stage 2, the value is twice this, for stage 3, 3 times, etc.etc.

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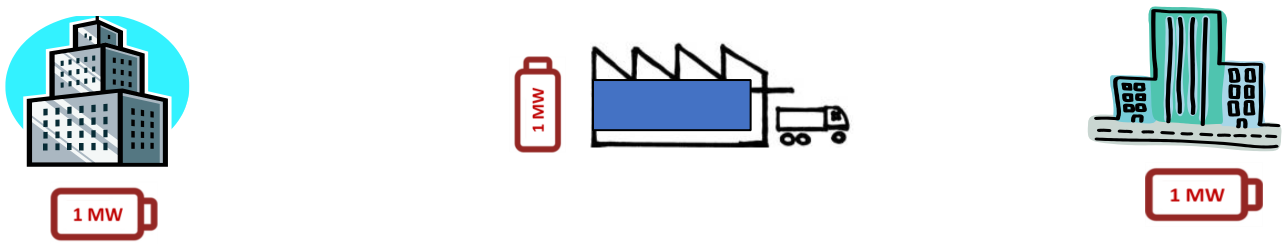
Avoiding Un-served Energy Costs

- **The best location for SA's energy storage assets is on the customer's premises and to run their sites as power islands during grid outages or load shedding.**
- Can be implemented by the distributor (VAS) or by the customer (TOU tariff response)
- This will keep the economy going and at the same time maintain revenues for the distributors as they restore their grids or comply to load shedding calls.
- Eskom previously initiated power 'buy-back' initiatives, in effect paying large industrial customers not to consume power to reduce the load.
- It was not a well supported Demand Response scheme as it shut down a portion of the economy as those businesses simply 'closed shop' in responding.
- If those businesses were to have substantial storage systems, they could participate in a DR program that will have the same effect yet allow economic activity to continue as normal.



Protecting the Economy

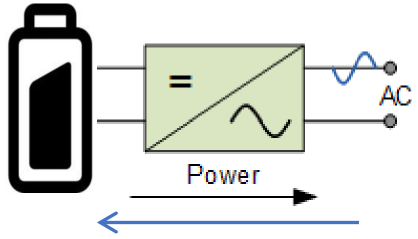
Investment comparison – Diesel vs. Storage

Diesel Generator

1. Expensive Fuel – R5,70 /kWh
2. Generator only Used in an emergency
3. Sunk cost, only 'pays back' when an emergency applies
4. Complicated parallel operation, supply interruption at grid failure and grid restoration
5. Spinning plant fault current issues
6. Complicated, high maintenance machinery
7. Must be regularly 'preparedness tested'

Energy Storage System

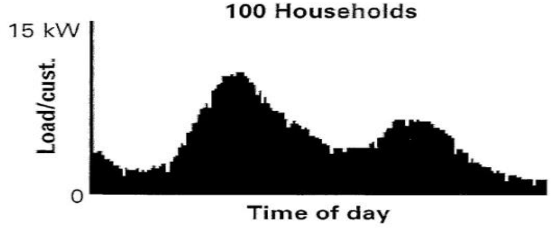
1. Recharges with cheapest energy available, including renewable options. R 0,43 to R 0,49 / kWh
2. Used everyday and in emergencies
3. Payback certainty through daily arbitrage duty
4. Easy inverter based parallel grid integration, seamless load transfers
5. No fault current issues
6. Reliable machinery
7. Daily use, routine daily functional testing

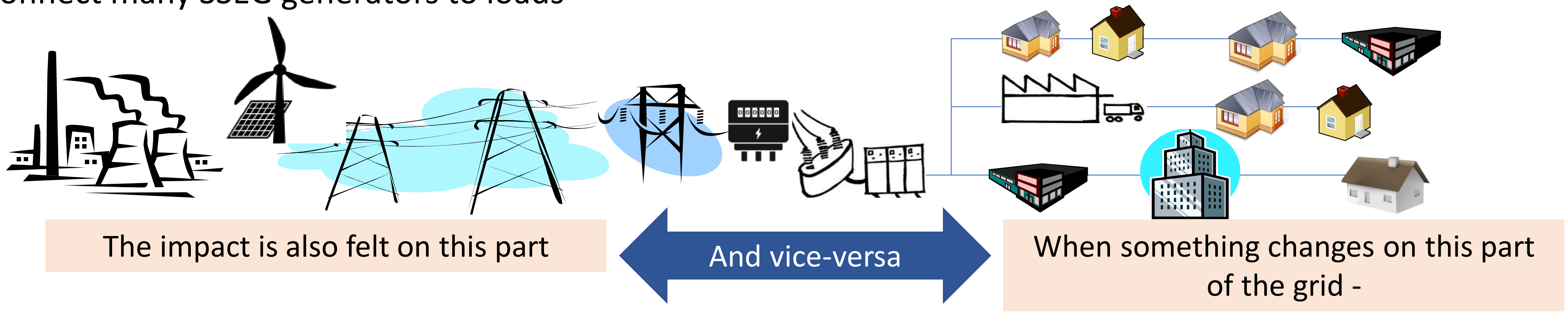


Activity of Generation operations
Vs.
Activity of Energy Storage operations

Key Properties of the Grid

- We often take the grid for granted – we do not properly acknowledge its properties and expect it is simply an infinite source of electricity
- It is *the* classic network – it connects everything together, very similar to the WWW
- What happens at one node of the grid has an impact on other nodes at locations both above and below that point
- Grids allow us to take full advantage of diversity
- Those connected to it form part of a community
- It is no longer a one-to-many kind of network, it naturally has the ability to connect many SSEG generators to loads





Generation and ES activities – the same but different

System Operator activities associated with Generation

1. Load forecasting
2. Generation scheduling
3. Economic dispatch
4. Reserve margin maintenance

Top-down, unidirectional control of energy across the networks

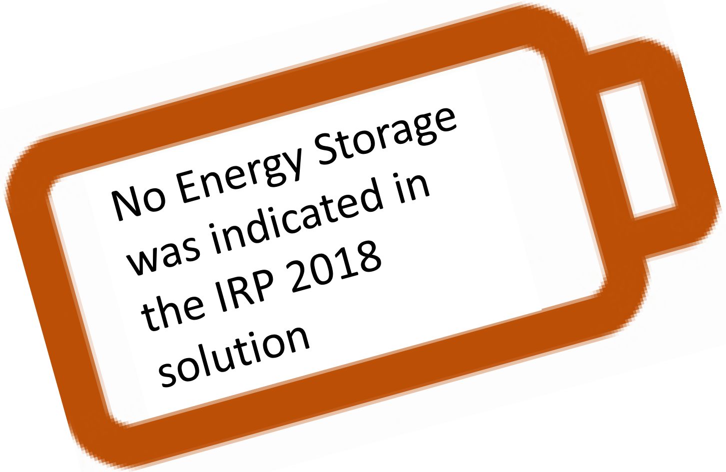
Activities associated with Energy Storage systems

1. Storage charge and discharge co-ordination
2. Opportunistic storage of renewable energy surpluses
3. Least cost re-charge management
4. Management of a new, swift component of the reserve margin
5. Demand Response co-ordination

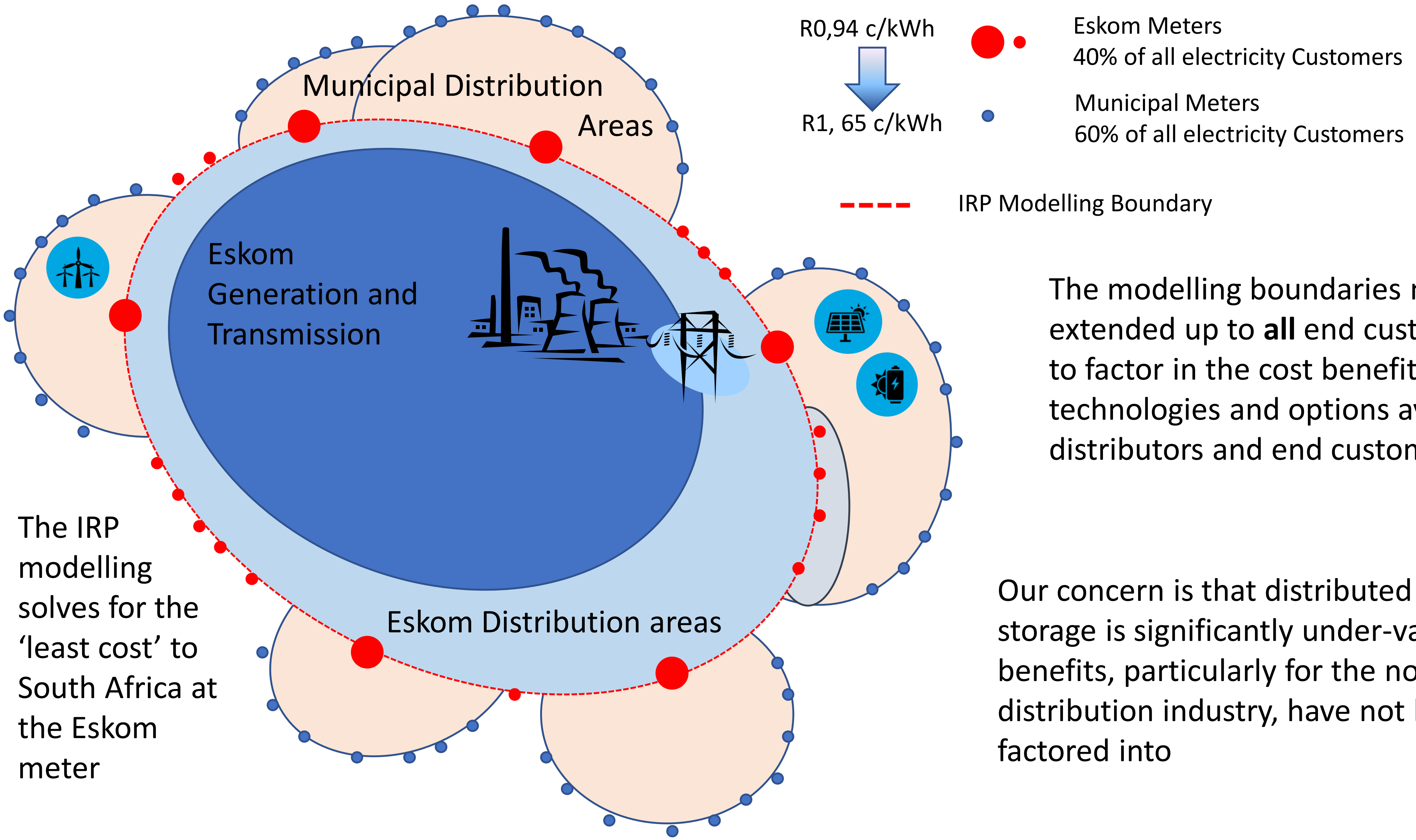
IRP Treatment of Energy Storage

Energy Storage and the IRP Modelling

- IRP is the most important policy instrument for determining the optimal mix of energy and technologies to deliver the lowest cost energy solution
- Transmission connected battery storage was included, however a static, non declining cost was used.
- Only the associated reserve margin value was recognized
- There are 30 or so parameters defined as inputs to the IRP modelling
- The following subset are influenced by distributed energy storage - all positively:
  - Distribution Infrastructure; Expansion and Refurbishment
  - Price Cone
  - Cost of Unserved Energy
  - Demand and Consumption Forecast
  - Demand Side Management
  - Generation Location
  - Own Generation
  - Renewables
  - Reserve Margin



IRP modelling Boundary



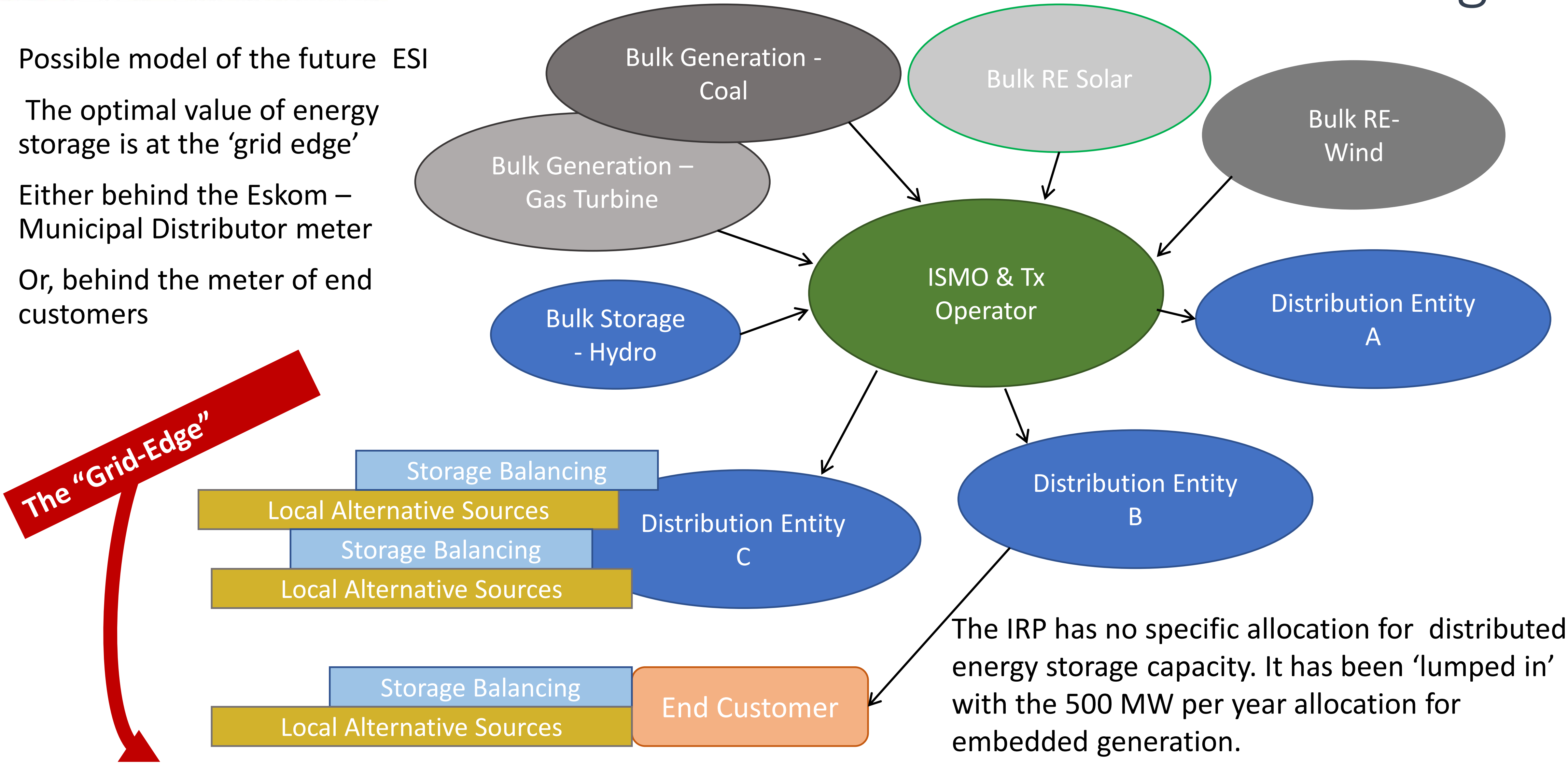
The IRP modelling solves for the 'least cost' to South Africa at the Eskom meter

The modelling boundaries need to be extended up to **all** end customer meters, to factor in the cost benefits of new technologies and options available to distributors and end customers

Our concern is that distributed energy storage is significantly under-valued if the benefits, particularly for the non-Eskom distribution industry, have not been properly factored into

Allow Storage to find its best value at the 'Grid Edge'

- Possible model of the future ESI
- The optimal value of energy storage is at the 'grid edge'
- Either behind the Eskom – Municipal Distributor meter
- Or, behind the meter of end customers



The IRP has no specific allocation for distributed energy storage capacity. It has been 'lumped in' with the 500 MW per year allocation for embedded generation.

Review of SSEG Landscape

SSEG Regulatory Uncertainty

Regulatory rules on small scale embedded generation. First issued in September 2011, are still not properly in place

The Delay in the promulgation of new regulations is causing problems –

Delayed by:

- Energy source not properly considered in the IRP2010
- On again and off again amendments to Schedule 2 of the ERA
- Uncertainty at the DoE and NERSA of possible impacts

Resulting in:

- Under the radar, unsafe connection to the grid
- Potential grid stability issues
- The stifling of a valuable new industry
- Investment uncertainty

We want to avoid the same fate for Energy Storage systems

ERA Intentions and things that need to be regulated

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ERA Objective

2. The objects of this Act are to—

(a) achieve the efficient, effective, sustainable and orderly development and operation of electricity supply infrastructure in South Africa;

(b) ensure that the interests and needs of present and future electricity customers and end users are safeguarded and met, having regard to the governance, efficiency. effectiveness and long-term sustainability of the electricity supply industry within the broader context of economic energy regulation in the Republic:

(c) facilitate investment in the electricity supply industry;

(d) facilitate universal access to electricity;

(e) promote the use of diverse energy sources and energy efficiency;

(f) promote competitiveness and customer and end user choice; and

(g) facilitate a fair balance between the interests of customers and end users, licensees, investors in the electricity **supply** industry and the public.

4. The Regulator—

(a) must—

(i) consider applications for licenses and may issue licences for—

(aa) the operation of generation, transmission and distribution facilities;

(bb) the import and export of electricity;

(cc) trading;

THE ACT DOES NOT INCLUDE THE ACTIVITY OF ENERGY STORAGE

Do we need an amendment to the Act?

Regulation of Tariffs and Charges

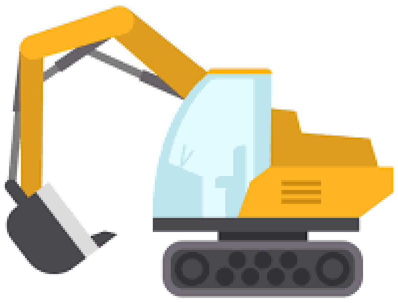
- The deployment of energy storage systems at various points along the generation, transmission, distribution and retail value chain will have a direct bearing on the regulated environment of tariffs and charges
- Energy Storage systems support Demand Response programs that are not destructive to the economy, as was the case with Eskom power 'buy-back' proposals. DR tariffs require regulation
- New dynamic as opposed to static Time of Use Tariff structures will be needed
- It is the municipal distribution industry that holds the bulk of the 'peaky' residential loads in the country, and as from 2020, it is most likely that all municipalities that purchase Eskom power for on-selling, will only be able to purchase such power on a time of use basis
- In addition to a high exposure to peak energy prices, many municipal distributors are being heavily penalized by Notified Maximum Demand (NMD) charges that could be reduced (or even avoided) where sufficient energy storage can be installed on their networks, downstream of the Eskom bulk supply meter
- The arbitrage value and business case for Energy Storage systems on non-Eskom distribution networks depends heavily on tariff structures and the Regulator is needed to oversee any changes in these structures.
- Tariffs and charges for Electric Vehicle charging as a schedulable load will be required

Own Generation – RE plus storage

- Shopping centres, office parks and hospitals are making investments in rooftop PV to reduce energy costs - good for the economy as a whole.
- PV works well with loads such as air conditioning that correlate well with production. Self-consumption is maximized, the full benefit of the investment is realized.
- Where correlation is poor, an energy storage system can be used to optimize the investor’s self-consumption.
- Compliance to an appropriate time of use tariff that signals the investor when to self-consume the stored energy to benefit the local distributor, brings financial reward. This is a win-win situation.
- The energy storage plant can be offered to the utility to both locate and dispatch, to manage network loading.
- **There is a growing international trend (California and China for example), where investment in renewable energy systems is conditional to a corresponding investment in energy storage to flatten the Duck Curve.**
- This may be one of the policy options we as South Africa would like to consider - now is the time to act on it.

Distribution Infrastructure - Expansion and Refurbishment

- We have a 70 billion Rand backlog in distribution infrastructure maintenance.
- It is estimated a third (R23 billion) of this is for distribution network strengthening, often needed for only short duration peak loads.
- Upgrade work involves the physical replacement of existing distribution infrastructure plant and cabling, an expensive and disruptive activity.
- This problem is constraining property development in municipal areas also affecting economic development.
- The life of aging distribution infrastructure is extended where the networks can be de-stressed through peak load reduction.



- **Well-placed energy storage can permanently avoid or solve a fair share of these problems – particularly since it already pays for itself from daily arbitrage savings.**

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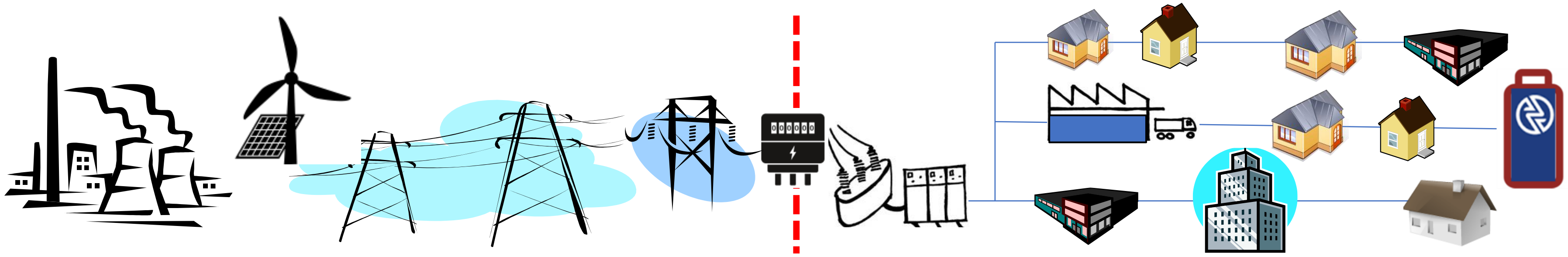
Generation Location



- Eskom currently finds itself in a position where as part of a World Bank loan condition for their new build coal stations, they are required to invest in around 600 MWh of energy storage in support of Renewable Energy
- These storage assets will most likely be placed on the Eskom networks. They could be of greater national benefit if they were placed on ailing Municipal distribution networks to give some financial relief to Local Government.
- **This can be done by creating a 'virtual Eskom intake point' on the municipal network, that can avoid NMD penalties and still create peak energy revenues for Eskom.**
- If strategically placed, the virtual intake points could also unlock stalled development which would increase energy demand, which Eskom wants.
- This investment is not mentioned at all in the draft IRP2018 and would have maximum impact if placed on the weakest municipal networks and maintained with Eskom expertise.

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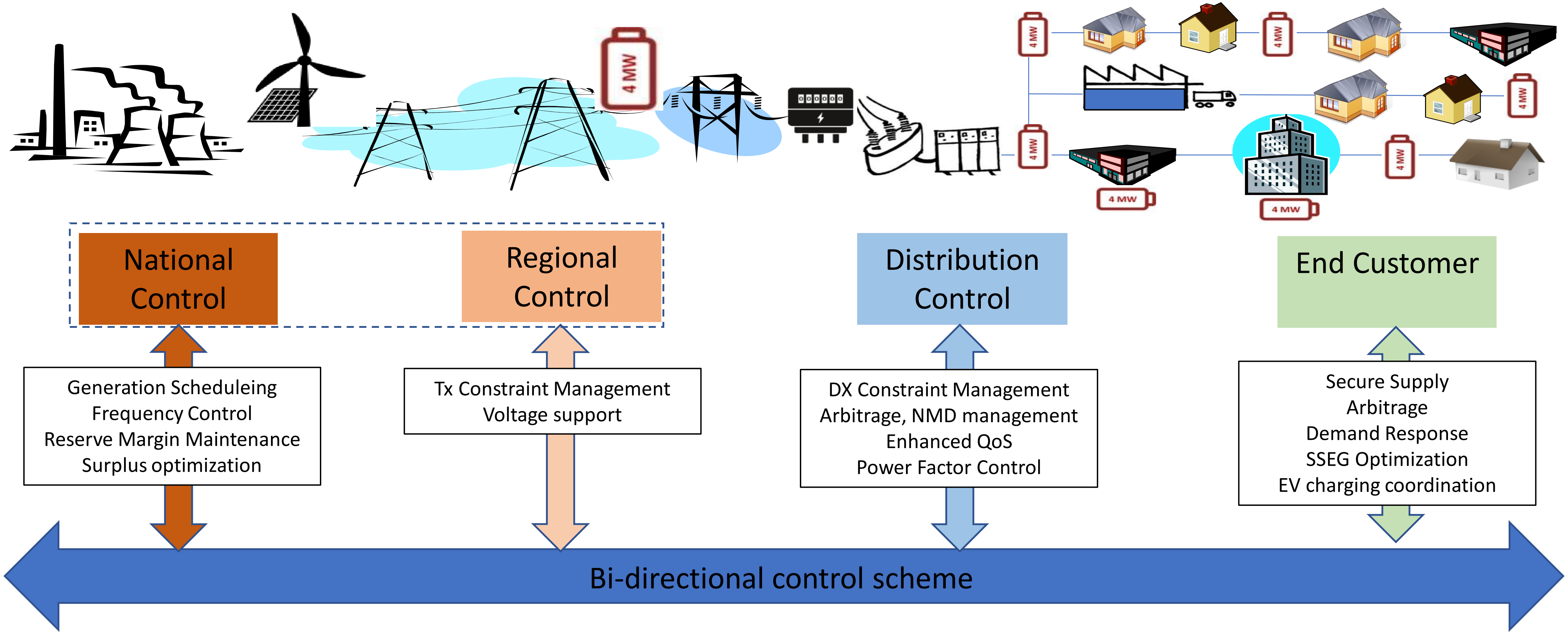
Regulation of operational control of Energy Storage Assets

Enabling ‘the stack’ – combining technologies



- New bi-directional control infrastructure is required to manage when energy storage assets should be deployed in their power generation mode and when they should be in their ‘flexible load’ mode.
- The control system should inform National Control of what stored energy is available to count as a contribution to the reserve margin (4th IR and SG aspects)
- The rules of engagement to co-ordinate the use of all energy storage assets are required – industry regulation
- There will be a need for new real-time, dynamic TOU tariffs to support Demand Response programs

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Way forward and how can SAESA help with the process?

Finale

As an association, we value the opportunity to give our comments and contribute to improving the country's energy system. We firmly believe in the Just Energy Transition path and Energy Transformation.

We support an IRP for electricity that is a rational, mechanistic, techno-economic planning process that determines the optimal mix of generation technologies and capacities, at the least cost to the economy, necessary to meet the projected demand for electricity in the years ahead, with adequate security of supply, while also meeting government policy and socio-economic requirements and constraints.

Such constraints may include: meeting carbon emission reduction commitments; meeting applicable environmental laws and regulations; minimisation of water usage; maximisation of job creation.

In an uncertain world where electricity demand cannot be accurately predicted in the years ahead, and where disruptive new technologies are emerging, the IRP is also about enabling flexible planning decisions of least regret