

Smart Micro Grids

South African Smart Microgrids

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Grids**

**Eskom Research Testing &
Development**

Powering your world



- Generation Capacity 41,995MW from 27 power stations.
- Generation Mix : 35,726MW of Coal fired(85.07%), 1,860MW Nuclear(4.43%), 2,409 Gas fired(5.75%), 2,000MW Hydro and Pumped storage(4.76%) and 3MW of Wind farms(0.01%).
- Eskom customers
 - Breakdown: 800 Municipalities, 3,000 Industrial customers, 1,000 Mining customers, 50,000 Commercial customers, 84,000 Agricultural customers and more than 5,1 million Residential customers.
- Sold 217,903 GWh in 2013/14 financial year.
- Electrified 4.5million households since 1991.
- Non-electrified households 3.2 million(from DoE)
- Forecasted generation to increase by 17,384MW by 2019/2020
- Employees : 46,919
- 1076MW of renewable IPPs connected to the grid
- 359,726km of Power Lines, Substations with a cumulative capacity of 232,179 MVA



What is a MicroGrid?

A MicroGrid has the following Characteristics:

1. Must have an associated distributed generation resource/s .
2. Must have an associated load, close to the generation resource.
3. Must be able to operate as part of the national grid as a whole, as well as having the ability to island itself and operate completely independently.
4. Must have some form of control to manage the grid connection as well as the distributed resource.

What the Smart MicroGrid Pilot?

The Smart MicroGrid Pilot aims to build on the MicroGrid described above by incorporating additional control to achieve:

1. Seamless integration, control and switching of multiple different resources connected to it.
2. Load control and load limiting to minimize the generation capacity required.
3. Create a modular system which can be expanded and to meet each community's needs without redesign of the system.
4. To provide load data on each load connected to it as well as each generation resource connected for accurate load forecasting and capacity estimation.
5. Information and communication to gauge the performance and health of the system as well as aiding maintenance scheduling.

- Smart MicroGrids can actively contribute to all market segments and need to be designed on a needs basis. The Living Standards Measure (LSM) start from the very low LSM 1-4 to the highest LSM 8-10.
- When designing a MicroGrid to cater for the different LSM Groups , a Fit for Purpose/Need must be addressed in the conceptual and design Phases, accompanied by Stakeholder engagements and customer buy-in and ownership.
- “Technology is the easy part, Making it Work for the customer and keeping it working is the hard Part”

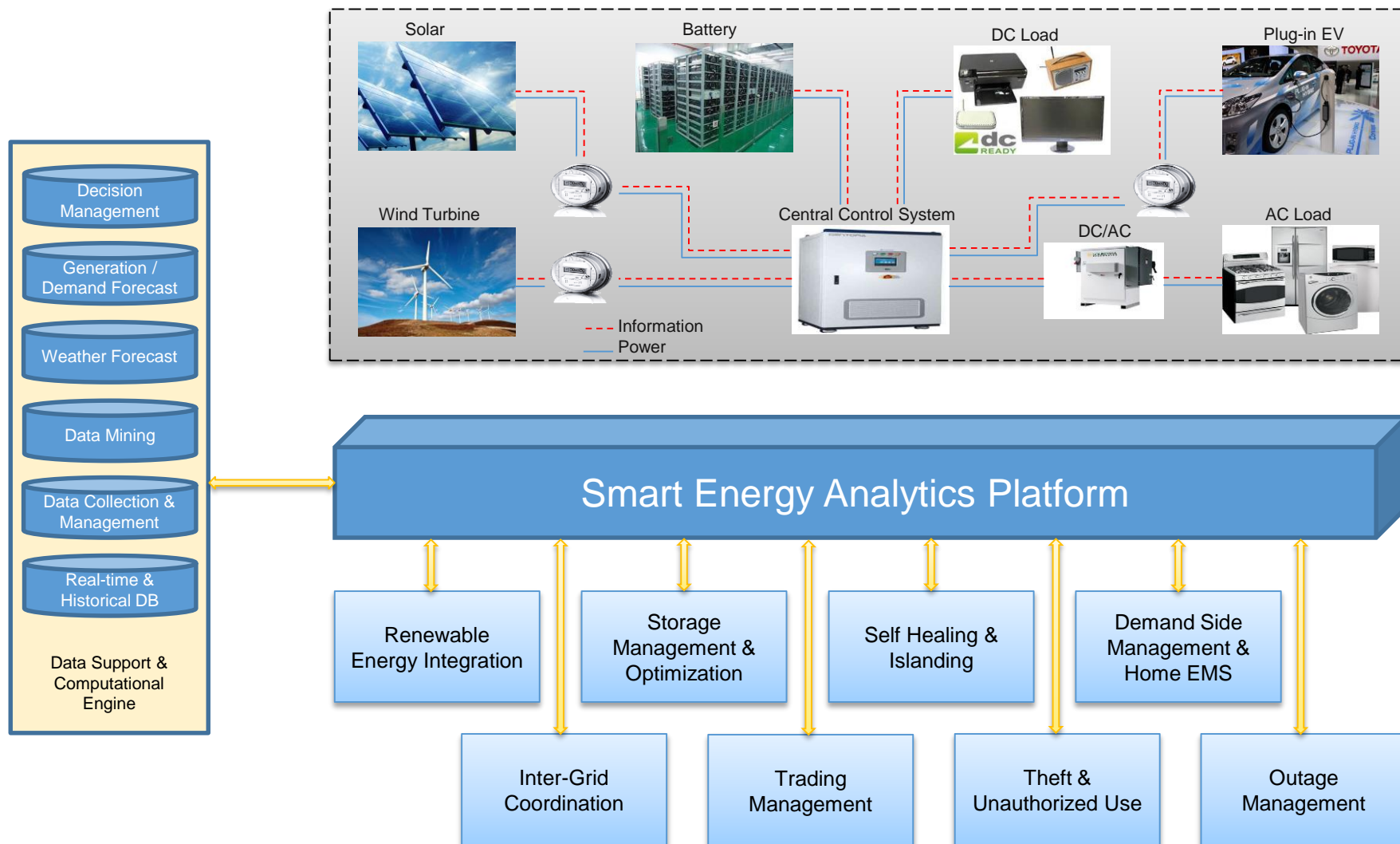
Living Standards Measure (LSM) Groups (South Africa)

LSM Groups	Detail		Requirements
LSM 1-4	<ul style="list-style-type: none"> Income Energy Usage per Month 	: R 400 – R 1'500 : 62 – 94 kWh	<ul style="list-style-type: none"> Off grid Renewable resources Scalable plant size Smart resource control 2-4 days autonomy Load limiting Easy to install, maintain Low cost
LSM 5-7	<ul style="list-style-type: none"> Income Energy Usage per Month 	: R 1500 – R 5'500 : 177 – 320 kWh	<ul style="list-style-type: none"> Grid tied Centralised renewable plant Smart resource control 1-2 days autonomy Load limiting Home Energy Management
LSM 8-10	<ul style="list-style-type: none"> Income Energy Usage per Month 	: R 12'000 – R 24'000 : 412 - 624 kWh	<ul style="list-style-type: none"> Grid tied Distributed Energy Resources Smart resource control Few hours of autonomy Load limiting Home Energy Management

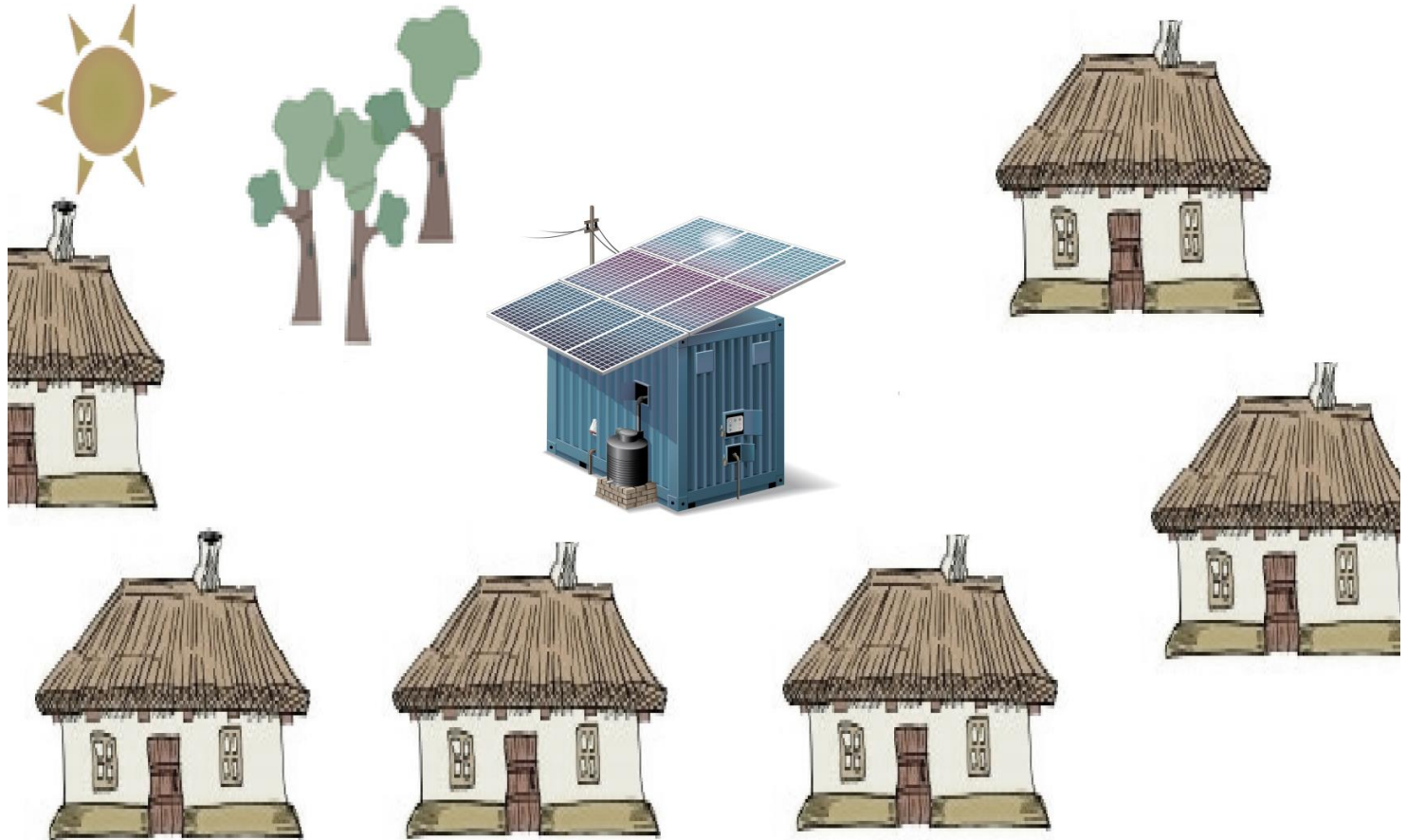
What technology will be deployed within this Smart MicroGrid.

An **Active Microgrid Network Management** system, that will dynamically control all system components and integrate them via a Nerve center to other MicroGrids and interconnections to the national supply grid. The AMNM system will integrate to the following systems:

1. Renewable Energy Sources e.g. PV, Wind, Hydro.
2. Distributed generation e.g. Diesel generators, Hydrogen fuel Cells
3. Storage systems e.g. Battery, Pump storage, Mass flywheels
4. AC and DC reticulation systems and Loads
5. Revenue management, Theft and energy balancing
6. IOT - Real Time monitoring, Mesh Telecommunication network, RF, PLC, Big data Management and analytics
7. Smart Transformers & Smart Inverters
8. Self healing, Islanding
9. Outage management and workforce deployment
10. Home Energy Management, Trading management , EV integration
11. Grid Situational Awareness and Response, integrating Weather, Fire, Lightning, Solar and Environmental Data



LSM 1- 4

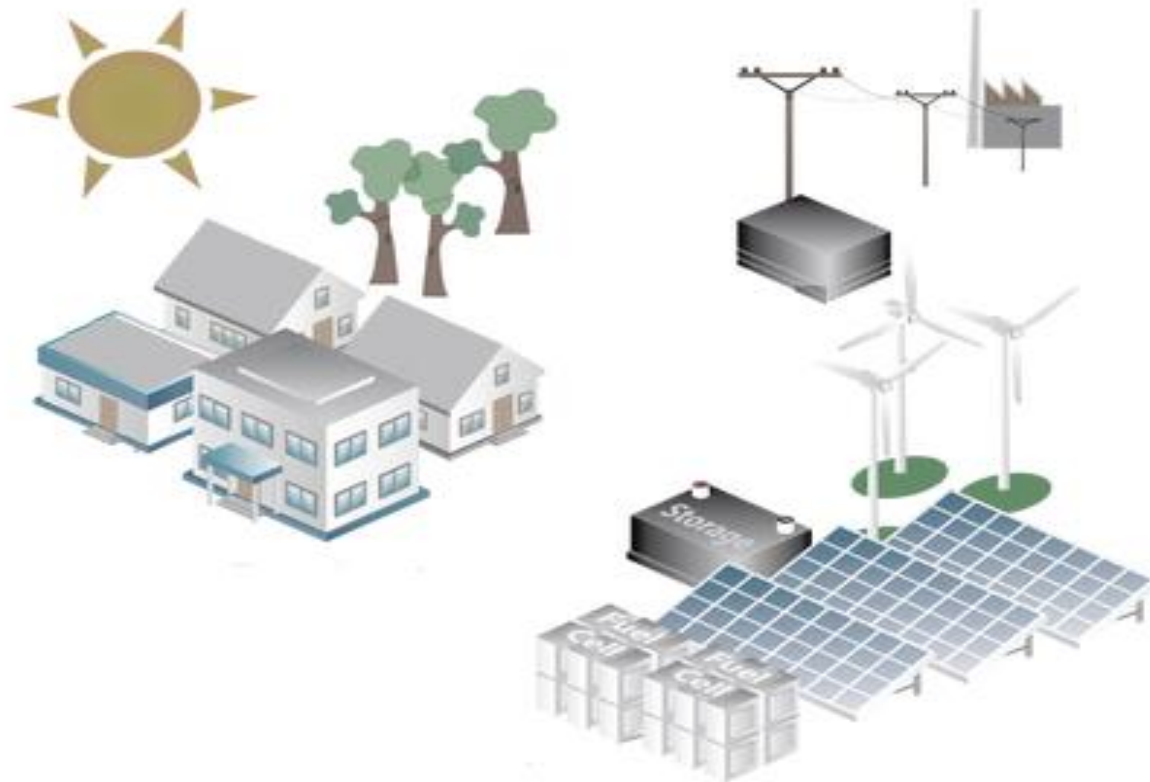


LSM 1-4 Total Electricity Consumption

Total Customers	Total kWh used per Month				
2 798 551	LSM Groups				
Appliances	1	2	3	4	LSM 1-4
Washing Machine	0 kWh	0 kWh	0 kWh	18 kWh	18 kWh
Polisher	0 kWh	0 kWh	19 kWh	47 kWh	66 kWh
DVD	0 kWh	0 kWh	18 kWh	120 kWh	138 kWh
Twin Tub	0 kWh	0 kWh	0 kWh	141 kWh	141 kWh
HTS	0 kWh	67 kWh	104 kWh	851 kWh	1 022 kWh
Other	445 kWh	1 744 kWh	294 kWh	162 kWh	2 645 kWh
Freezer	0 kWh	266 kWh	601 kWh	5 446 kWh	6 313 kWh
Microwave	0 kWh	150 kWh	171 kWh	6 578 kWh	6 899 kWh
Geyser	0 kWh	0 kWh	0 kWh	14 933 kWh	14 933 kWh
TV	0 kWh	4 182 kWh	6 369 kWh	35 930 kWh	46 481 kWh
Hi-fi	579 kWh	5 344 kWh	5 431 kWh	35 777 kWh	47 131 kWh
Stove	0 kWh	113 kWh	3 765 kWh	79 494 kWh	83 372 kWh
Fridge/Freezer	0 kWh	2 596 kWh	17 829 kWh	121 232 kWh	141 657 kWh
Hotplate	3 508 kWh	28 749 kWh	30 900 kWh	128 344 kWh	191 501 kWh
Lightiing	1 824 kWh	16 218 kWh	28 850 kWh	201 306 kWh	248 198 kWh
			Total Usage KWh		790 515 kWh
			Total usage per Customer		282 kWh

- Rural access to electricity and all of the associated social and economic benefits.
- Providing electricity to non-electrified communities without adding additional strain on the currently strained grid.
- Islanded systems will be unaffected by the main grids performance as well as by other MicroGrids.
- The MicroGrids may be able to electrify communities well before the grid electrification program reaches them.
- Provide remote communities with power without the need for large infrastructure.

LSM 5 - 7



LSM 5-7 Total Electricity Consumption

Total Customers	Total kWh used per Month			
7 581 970	LSM Groups			
Appliances	5	6	7	LSM 5-7
VCR	3 kWh	10 kWh	12 kWh	26 kWh
Tumble Dryer	2 kWh	11 kWh	31 kWh	44 kWh
Laptop	10 kWh	59 kWh	152 kWh	221 kWh
Desktop Computer	15 kWh	67 kWh	172 kWh	254 kWh
Vacuum	1 kWh	46 kWh	209 kWh	256 kWh
DVD	131 kWh	152 kWh	129 kWh	412 kWh
Polisher	93 kWh	130 kWh	209 kWh	432 kWh
Dishwasher	0 kWh	136 kWh	354 kWh	490 kWh
Aircon	54 kWh	439 kWh	1 367 kWh	1 860 kWh
Fron Loading Washing	152 kWh	1 088 kWh	2 030 kWh	3 271 kWh
Top Loading Washing	258 kWh	1 333 kWh	2 823 kWh	4 413 kWh
Pool	1 427 kWh	727 kWh	2 573 kWh	4 728 kWh
HTS	1 020 kWh	2 178 kWh	2 173 kWh	5 372 kWh
Twin Tub	654 kWh	2 663 kWh	2 106 kWh	5 423 kWh
Freezer	4 693 kWh	8 762 kWh	15 890 kWh	29 345 kWh
Microwave	12 863 kWh	22 623 kWh	18 558 kWh	54 044 kWh
TV	28 423 kWh	29 895 kWh	21 641 kWh	79 959 kWh
Hi-fi	26 714 kWh	31 951 kWh	26 336 kWh	85 000 kWh
Hotplate	65 161 kWh	28 571 kWh	10 323 kWh	104 055 kWh
Fridge/Freezer	104 953 kWh	117 068 kWh	84 969 kWh	306 989 kWh
Stove	125 894 kWh	208 327 kWh	168 471 kWh	502 691 kWh
Lightiing	196 613 kWh	248 803 kWh	178 726 kWh	624 142 kWh
Geyser	67 949 kWh	367 531 kWh	582 589 kWh	1 018 069 kWh
		Total Usage KWh		2 829 MWh
		Total usage per Customer		373 kWh

- Load control and limiting of a grid connected system can help with demand management and help reduce the strain on the system.
- Integration of small scale renewables plants onto the grid.
- With the smart control and metering of the MicroGrid, more accurate load forecasting and capacity can be achieved.
- The MicroGrid can provide end of line strengthening.
- The communities are not as dependent on the grid and can be load shed for days at a time if necessary.

LSM 8-10



Powering your world



Powering your world



LSM 8-10 Total Electricity Consumption

Total Customers	Total kWh used per Month			
3 536 914	LSM Groups			
Appliances	8	9	10	LSM 8-10
Sewing Machine	5 kWh	11 kWh	15 kWh	31 kWh
Blu Ray	3 kWh	11 kWh	32 kWh	46 kWh
VCR	15 kWh	28 kWh	44 kWh	87 kWh
DVD	111 kWh	150 kWh	172 kWh	433 kWh
Tumble Dryer	52 kWh	117 kWh	296 kWh	464 kWh
Laptop	251 kWh	485 kWh	893 kWh	1 629 kWh
Polisher	253 kWh	571 kWh	1 156 kWh	1 981 kWh
Desktop Computer	346 kWh	766 kWh	1 129 kWh	2 241 kWh
Vacuum	355 kWh	794 kWh	1 207 kWh	2 357 kWh
Twin Tub	1 335 kWh	1 020 kWh	677 kWh	3 031 kWh
Fron Loading Washing	2 092 kWh	3 300 kWh	4 995 kWh	10 387 kWh
HTS	2 150 kWh	3 513 kWh	5 007 kWh	10 670 kWh
Top Loading Washing	2 950 kWh	4 400 kWh	4 898 kWh	12 248 kWh
Hotplate	7 839 kWh	10 809 kWh	15 236 kWh	33 885 kWh
Dishwasher	1 063 kWh	5 372 kWh	32 745 kWh	39 180 kWh
Aircon	2 768 kWh	10 488 kWh	41 072 kWh	54 328 kWh
Microwave	15 231 kWh	19 584 kWh	22 363 kWh	57 179 kWh
TV	17 348 kWh	22 174 kWh	25 266 kWh	64 788 kWh
Hi-fi	22 910 kWh	30 500 kWh	37 097 kWh	90 507 kWh
Freezer	19 068 kWh	34 444 kWh	51 657 kWh	105 169 kWh
Pool	5 434 kWh	27 572 kWh	122 347 kWh	155 353 kWh
Fridge/Freezer	68 667 kWh	87 723 kWh	100 854 kWh	257 244 kWh
Stove	136 946 kWh	175 606 kWh	198 374 kWh	510 926 kWh
Lightiing	171 023 kWh	250 901 kWh	324 330 kWh	746 253 kWh
Geyser	565 394 kWh	750 545 kWh	867 708 kWh	2 183 647 kWh
		Total Usage KWh		4 344 MWh
		Total usage per Customer		1 228 kWh

- Load control and limiting of a grid connected system can help with demand management and help reduce the strain on the system.
- Integration and control of Small scale renewables onto the grid.
- Facilitate selling energy back to the grid when excess is produced.
- With the smart control and metering of the MicroGrid, more accurate load forecasting and capacity can be achieved by means of DR techniques and energy balancing..
- The MicroGrid can provide end of line strengthening of long transmission Networks , where voltage drop sand power quality is an issue.

Benefit Realisations & Eskoms Strategic initiative

Benefit Realisations

Benefit 1

- Identifying the social challenges as well as benefits associated with the installation of a MicroGrid in a community as well as providing electricity to previously electrified areas.
- This benefit is aligned with the Universal Access to electricity
- Communities too far away from the grid may not be electrified if not included in the 5 year electrification plan or electrified at all.

Benefit 2

- The determination of an optimal distributed MicroGrid generation mix for least cost options.
- This benefit is reducing Eskom's environmental footprint and pursuing low-carbon growth.

Benefit 3

- MicroGrids could become a viable method of socio-economic upliftment and universal access.
- This benefit is in line with RD&T's mandate of Choosing the optimum future technologies.

Benefit 4

- Gaining an understanding of the technical requirements of MicroGrids.
- This benefit is in line with RD&T's mandate of Choosing the optimum future technologies, understanding the future technologies, accelerate implementation and developing and securing future technology options.

- Detailed information will be provided for each site the Region, Electrification Plan, Total Customers, Distance, Latitude and Longitude. The sites will also be plotted on a South African map to provide a visual clarification. The following provinces have been considered:
- KwaZulu-Natal (KZN),
- North West (NW),
- Free State (FS),
- Limpopo,
- Eastern Cape (EC).

Geographical Location from Grid

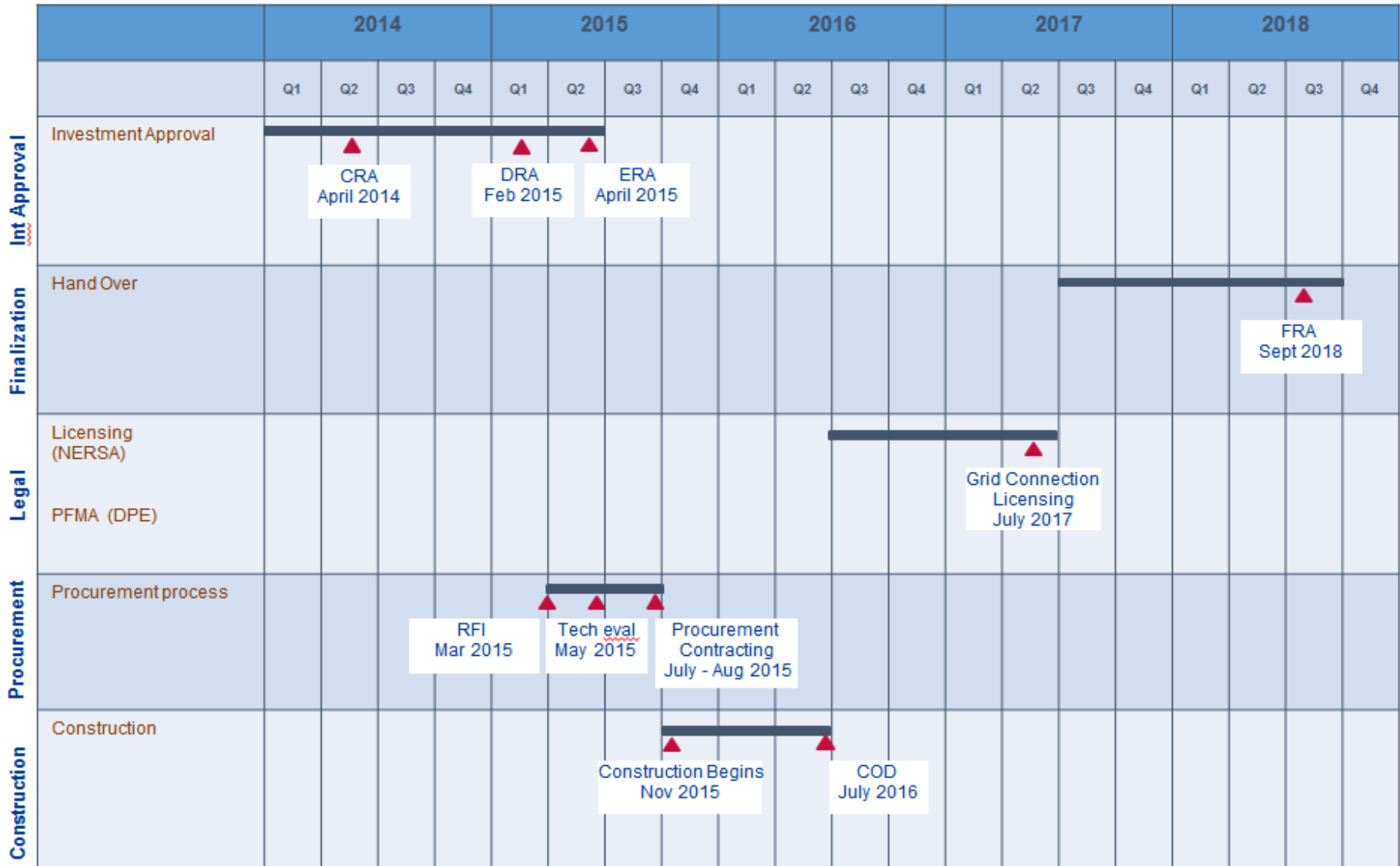
	Region	Electrification Plan	Total Customers	Distance(km) - Joburg	Latitude_Y	Longitude_X
1	Bergville CNC	Schedule 6	42	350	-28.718468	29.087137
2	Volkstrust CNC	Schedule 6	38	256	-27.446498	29.869567
3	Vryheid CNC	18_19	30	449	-27.641662	31.191011
	Region	Electrification Plan	Total Customers	Distance(km) - Durban	Latitude_Y	Longitude_X
4	Bizana CNC	19_20	37	206	-31.042705	30.151156
5	Bizana CNC	19_20	55	237	-30.875227	29.970341
6	Dundee CNC	17_18	38	168	-28.730732	30.622805
7	Hluhluwe CNC	17_18	40	279	-27.894143	32.447126
8	Jozini CNC	17_18	33	339	-27.617558	32.353626
9	Jozini CNC	17_18	41	352	-27.539117	32.54427
10	Jozini CNC	17_18	45	426	-26.989006	32.765791
11	Jozini CNC	17_18	50	426	-26.976264	32.755294
12	Jozini CNC	17_18	51	393	-27.159427	32.54523
13	Jozini CNC	17_18	53	412	-27.00031	32.326704
14	Kranskop CNC	17_18	39	116	-29.028429	30.980202
15	Ladysmith CNC	17_18	37	234	-28.418808	30.205701
16	Mandini CNC	17_18	55	90	-29.142909	31.337726
17	Marina Beach CNC	18_19	48	199	-30.847229	30.164288
18	Mt Ayliff CNC	18_19	33	364	-30.684337	29.05732
19	Mt Ayliff CNC	18_19	37	365	-30.74445	29.04259
20	Mt Ayliff CNC	18_19	47	357	-31.059711	29.226136
21	Nongoma CNC	Schedule 6	52	237	-28.151656	31.85008
22	Pongola CNC	18_19	56	299	-27.633892	31.722709
23	Pongola CNC	18_19	56	312	-27.531741	31.878336
24	Pongola CNC	18_19	60	321	-27.619573	31.60247
25	Vryheid CNC	18_19	55	342	-27.511274	31.428195

Satellite Photos of Deep rural un-electrified sites



Smart MicroGrid Project Schedule

Overview of project schedule





Thank you

Questions?

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