



CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

STEENBRAS PUMPED-STORAGE POWER STATION

GENERATION

Making progress possible. **Together.**

HISTORY OF ELECTRICITY GENERATION IN CAPE TOWN

- Steenbras Power Station
- Initially planned for Table Mountain, but due to being a national monument it was dropped
- Named after the Steenbras river – popular endemic South African fish
- Commissioned in 1979 with a rated capacity of 180 000 kW (180 MW)
- First hydroelectric pumped-storage scheme on the continent of Africa



Steenbras power station



Hydroelectric Pumped-Storage Scheme

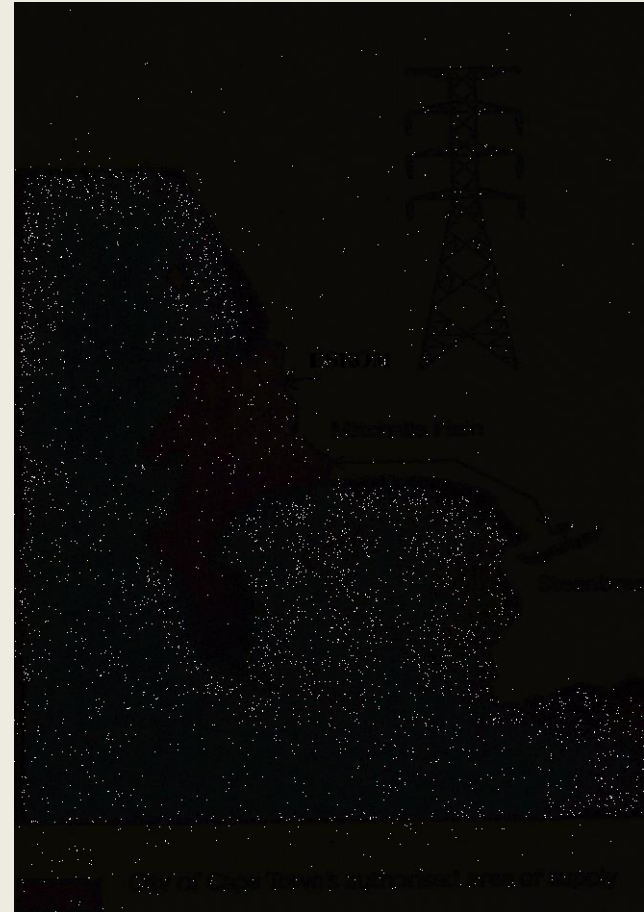
- Not a Hydro Power Station
- Consist of two separate reservoirs upper and lower
- Water is reused instead of re-entering river
- Generate-Mode – use stored water in upper dam to generate electricity during peak periods
- Pump-Mode - Pump water back to upper dam during off-peak period
- Round Trip Efficiency typically between 70% to 80%
- Can generate quickly
- No pollution or waste
- Cannot be used again until water is pumped back up.

PLANT DATA - STEENBRAS

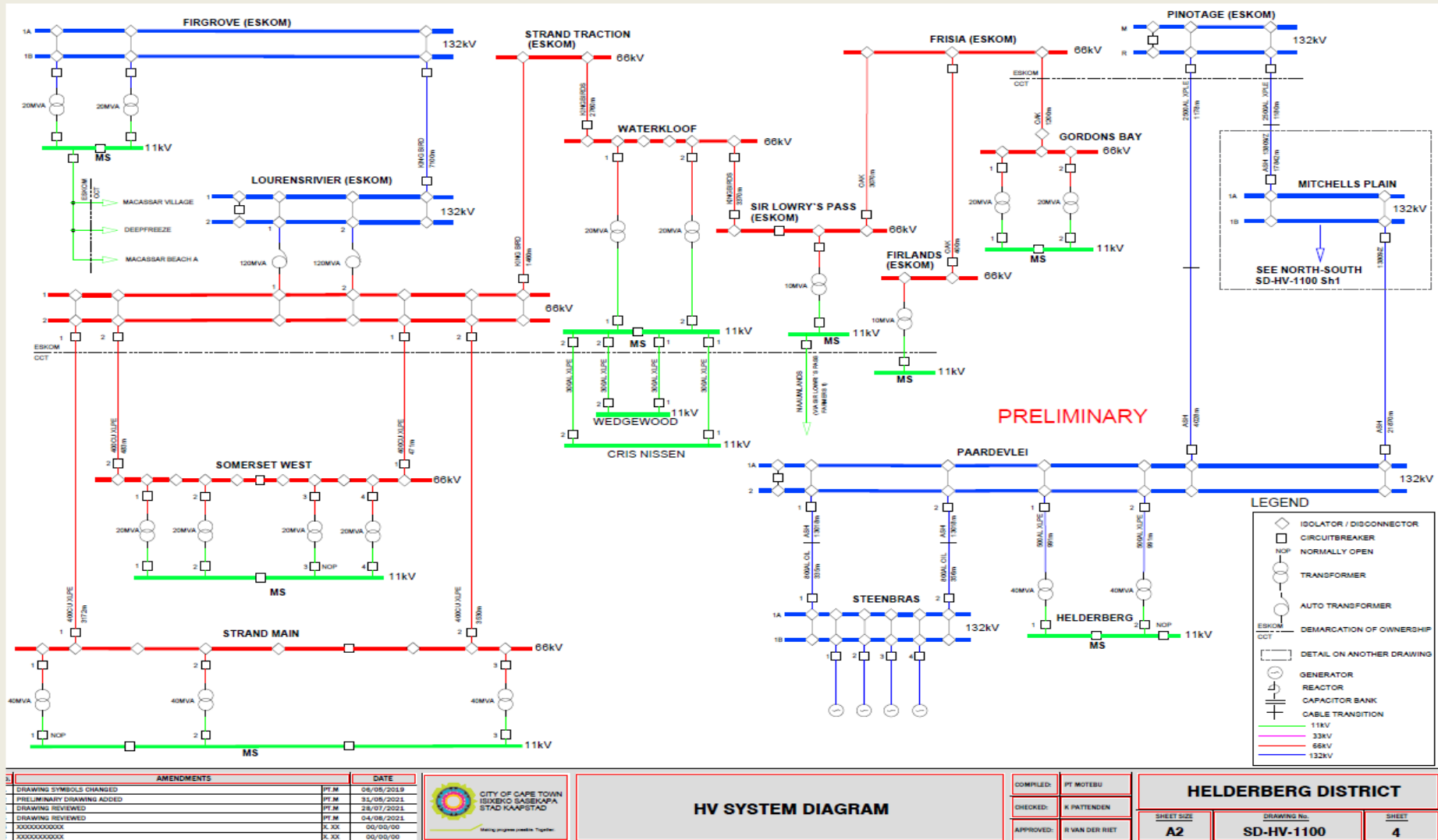
Function	Pumped Storage
Number of Units	4
Output per Unit	45 MW
Speed of Units	600 rpm
Maximum Head	294.5 m
Make of Generators	Siemens (KWU) (Ger)
Make of Turbines	Escher Wyss Ltd (Aus)
Stored Energy	2213 MWh
Dam Capacity	$2.92 \times 10^6 \text{ m}^3$

ESKOM AND CITY OF CAPE TOWN ELECTRICITY GRIDS

- Security of supply – can be started at short notice
- 12.5 hours of supply at full load
- Steenbras and associated generation accommodates for roughly 30% of the City of Cape Towns demand



Network recent upgrades – Paardevlei switching station

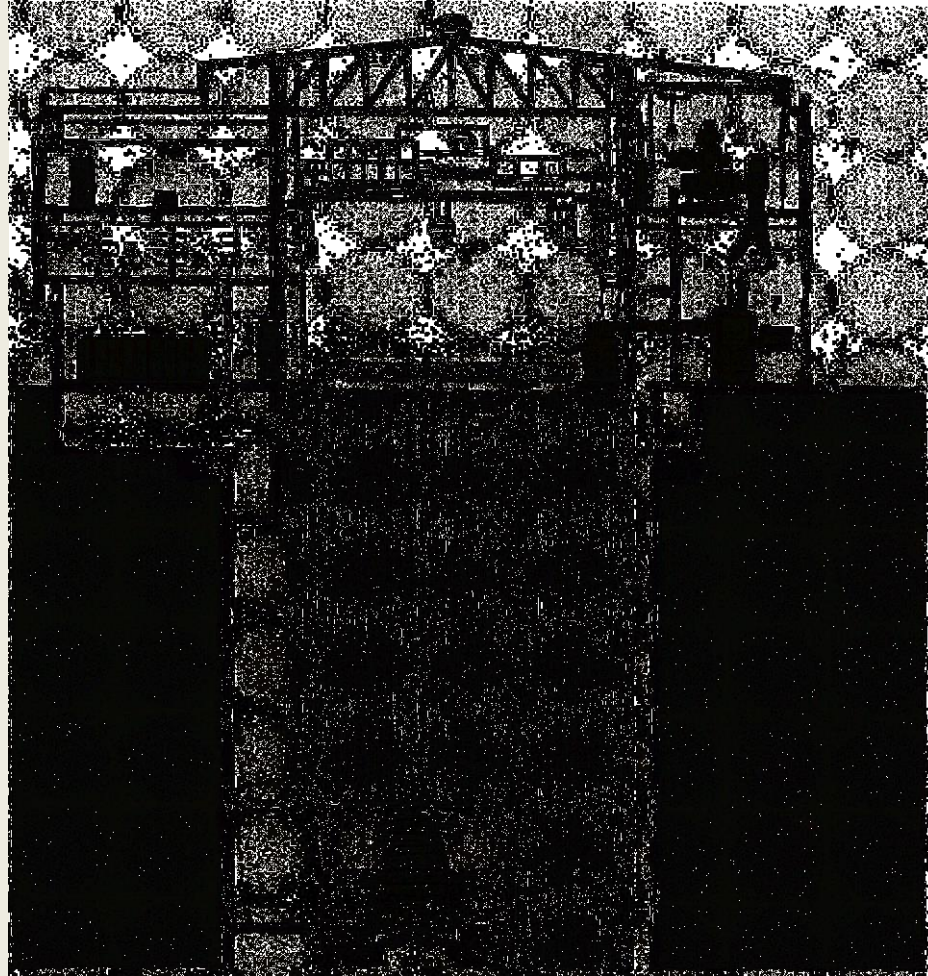


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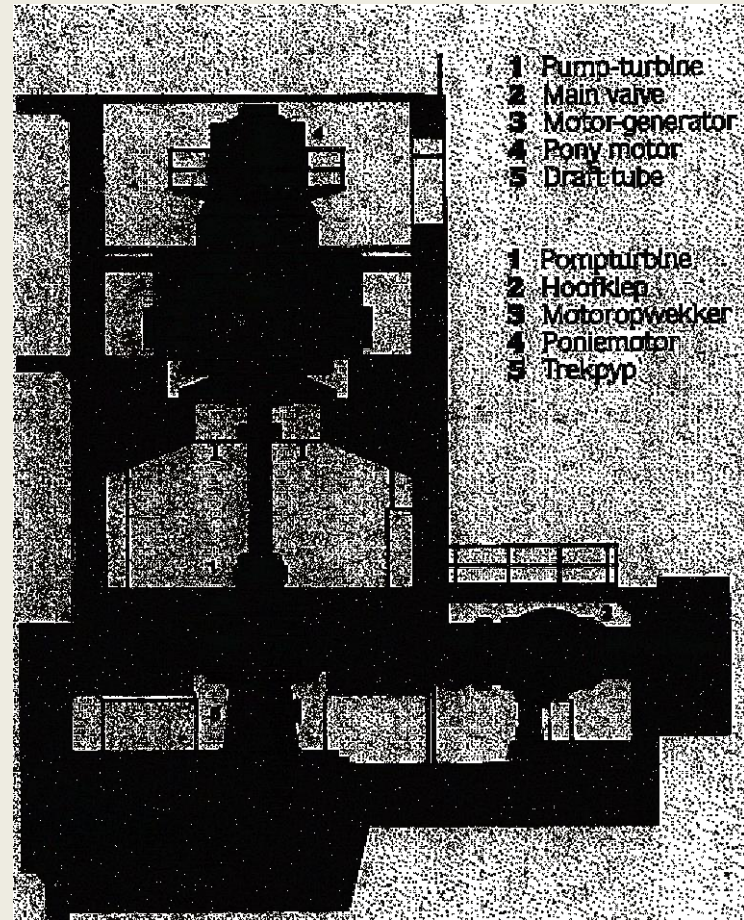
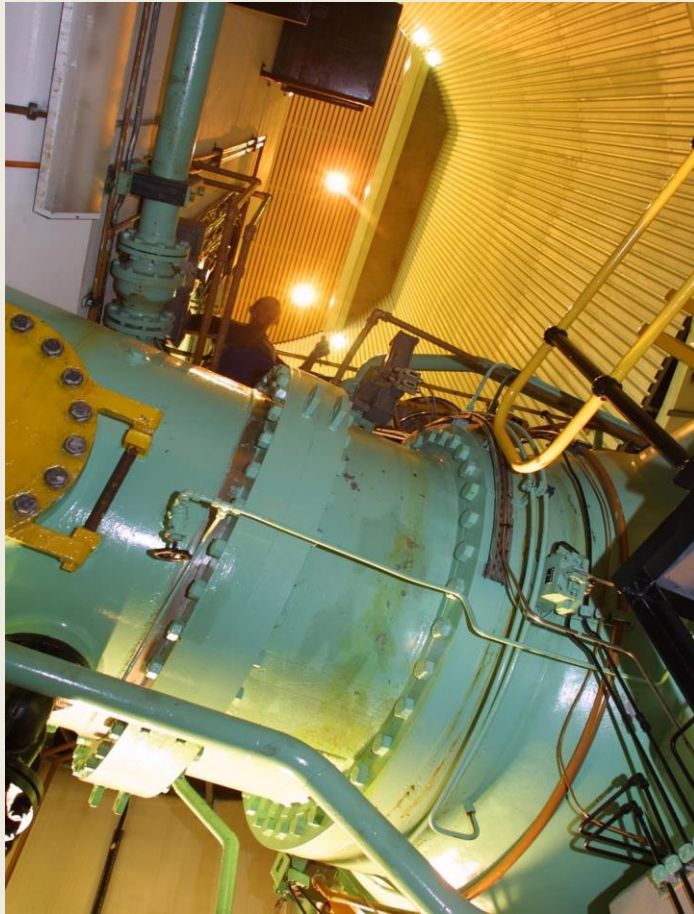
STEENBRAS POWER STATION PROFILE



POWER STATION CROSS SECTION



SECTION OF MACHINE SET



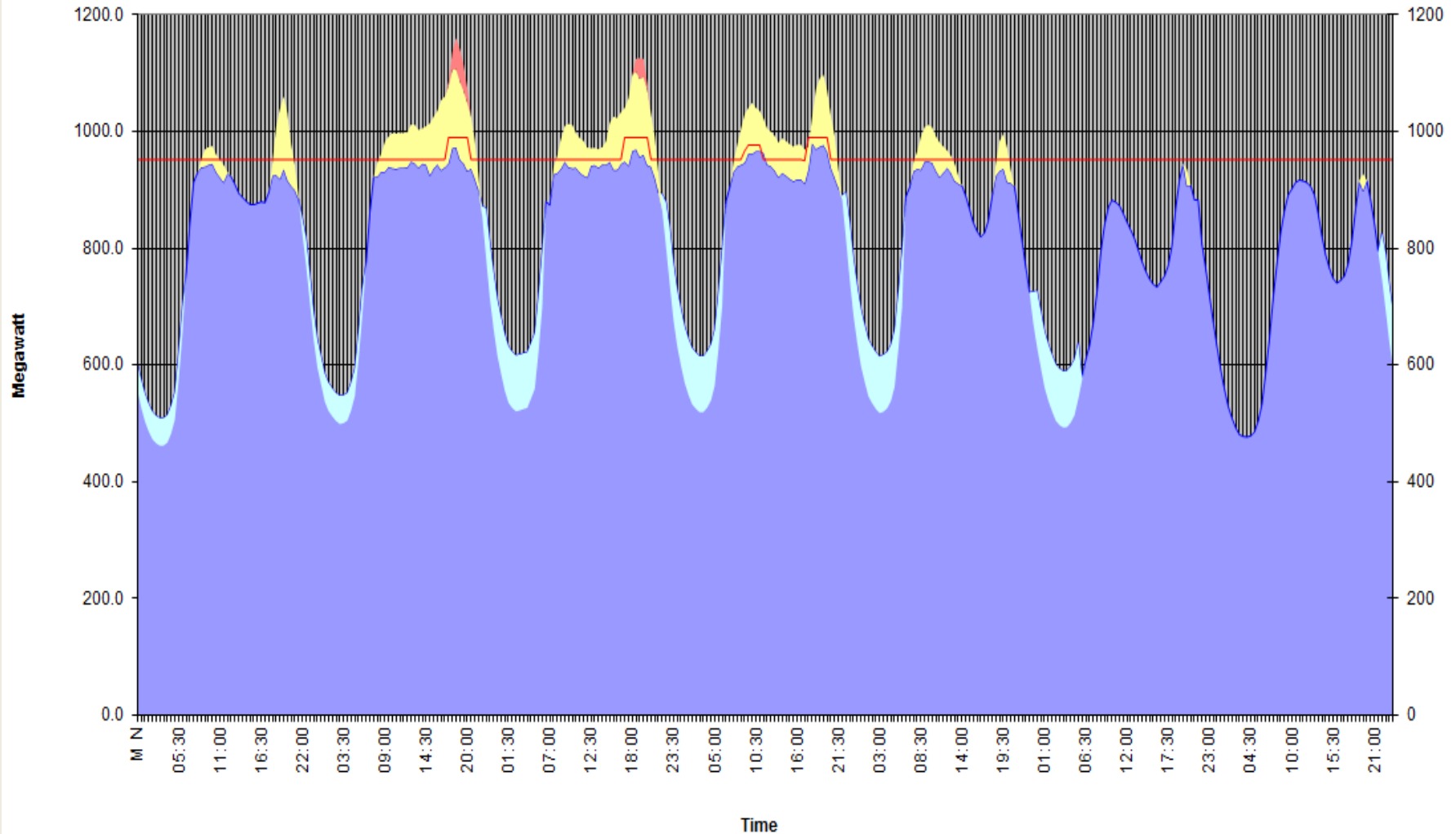
PUMP TURBINE LEVEL



Typical Week load cycle

“Target” import = 952MW, system max=1160.4MW

Cape Town Bulk Supply (Week/day)



Athlone GAS Turbine



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GENERATION GENERAL

- Staff Structure (5 sub-divisions)
 - Mechanical Maintenance
 - Electrical Maintenance
 - Plant Operations
 - Projects
 - Admin
 - Total staff - 50
 - for Gas Turbine and Pumped Hydro
- Load shedding mitigation

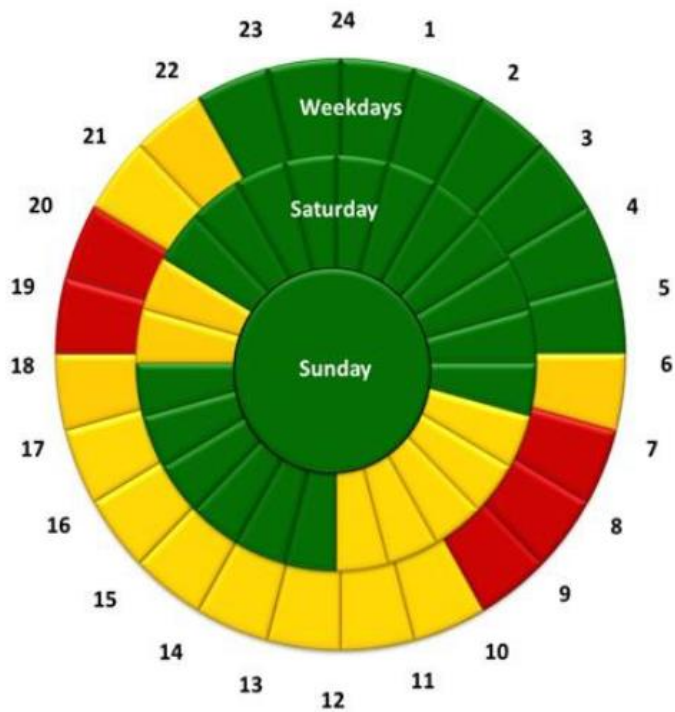
Network Control - Steenbras Pump Storage

Dispatch for peak load shifting and Load shedding mitigation

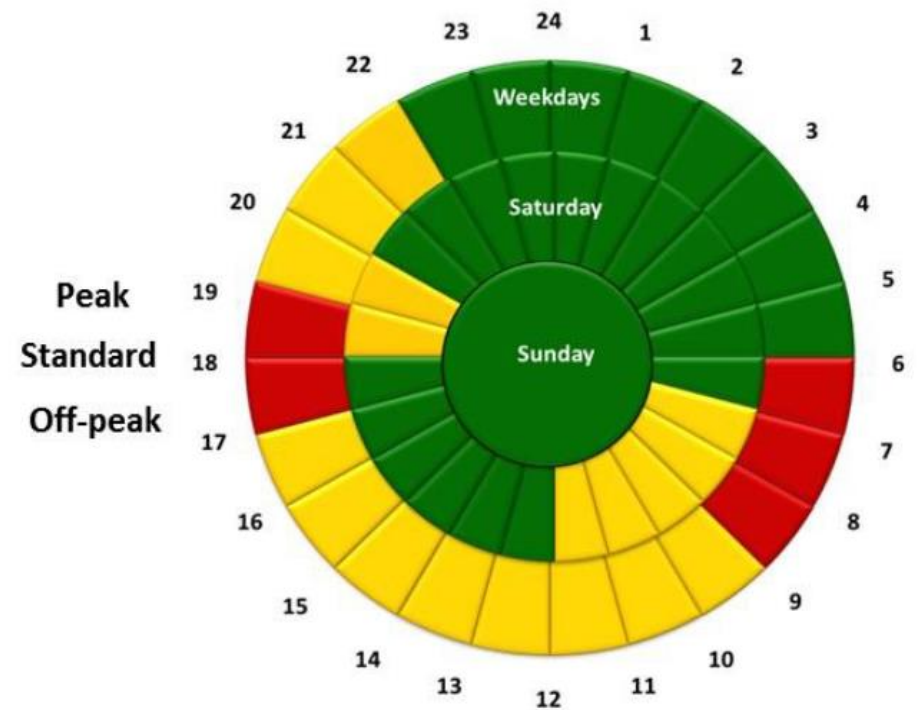
- Eskom Time of Use Tariff
- Energy shift and System Profile
- Station cycle, Daily and weekly, summer and winter

Eskom Tariff Time of Use periods

Low demand season



High demand season



		Active energy charge [c/kWh]												Transmission network charges [R/kVA/m]	
Transmission zone	Voltage	High demand season [Jun - Aug]						Low demand season [Sep - May]							
		Peak	Standard		Off Peak		Peak	Standard		Off Peak					
		VAT incl	VAT incl	VAT incl		VAT incl	VAT incl	VAT incl	VAT incl	VAT incl	VAT incl	VAT incl		VAT incl	
≤ 300km	< 500V	474.73	545.94	144.46	166.13	78.83	90.65	155.42	178.73	107.26	123.35	68.37	78.63	R 13.23	R 15.21
	≥ 500V & < 66kV	467.25	537.34	141.57	162.81	76.89	88.42	152.42	175.28	104.90	120.64	66.57	76.56	R 12.07	R 13.88
	≥ 66kV & ≤ 132kV	452.51	520.39	137.08	157.64	74.45	85.62	147.62	169.76	101.62	116.86	64.45	74.12	R 11.74	R 13.50
	> 132kV*	426.46	490.43	129.19	148.57	70.15	80.67	139.11	159.98	95.74	110.10	60.73	69.84	R 14.87	R 17.10
> 300km and ≤ 600km	< 500V	478.61	550.40	144.98	166.73	78.72	90.53	156.13	179.55	107.48	123.60	68.19	78.42	R 13.28	R 15.27
	≥ 500V & < 66kV	471.92	542.71	142.96	164.40	77.63	89.27	153.97	177.07	105.96	121.85	67.21	77.29	R 12.21	R 14.04
	≥ 66kV & ≤ 132kV	456.93	525.47	138.41	159.17	75.16	86.43	149.06	171.42	102.58	117.97	65.06	74.82	R 11.84	R 13.62
	> 132kV*	430.71	495.32	130.51	150.09	70.85	81.48	140.48	161.55	96.72	111.23	61.33	70.53	R 15.01	R 17.26
> 600km and ≤ 900km	< 500V	483.38	555.89	146.44	168.41	79.50	91.43	157.66	181.31	108.54	124.82	68.86	79.19	R 13.46	R 15.48
	≥ 500V & < 66kV	476.68	548.18	144.39	166.05	78.42	90.18	155.53	178.86	106.97	123.02	67.90	78.09	R 12.28	R 14.12
	≥ 66kV & ≤ 132kV	461.59	530.83	139.80	160.77	75.91	87.30	150.52	173.10	103.60	119.14	65.70	75.56	R 11.93	R 13.72
	> 132kV*	435.03	500.28	131.81	151.58	71.56	82.29	141.93	163.22	97.67	112.32	61.96	71.25	R 15.22	R 17.50
> 900km	< 500V	488.22	561.45	147.92	170.11	80.32	92.37	159.28	183.17	109.61	126.05	69.55	79.98	R 13.52	R 15.55
	≥ 500V & < 66kV	481.44	553.66	145.83	167.70	79.21	91.09	157.03	180.58	108.08	124.29	68.54	78.82	R 12.42	R 14.28
	≥ 66kV & ≤ 132kV	466.23	536.16	141.25	162.44	76.70	88.21	152.08	174.89	104.65	120.35	66.39	76.35	R 12.02	R 13.82
	> 132kV*	439.32	505.22	133.14	153.11	72.36	83.21	143.38	164.89	98.69	113.49	62.64	72.04	R 15.31	R 17.61

* 132 kV or Transmission connected

Distribution network charges						
Voltage	Network capacity charge [R/kVA/m]		Network demand charge [R/kVA/m]		Urban low voltage subsidy charge [R/kVA/m]	
	VAT incl		VAT incl		VAT incl	
< 500V	R 26.38	R 30.34	R 49.98	R 57.48	R 0.00	R 0.00
≥ 500V & < 66kV	R 24.18	R 27.81	R 45.84	R 52.72	R 0.00	R 0.00
≥ 66kV & ≤ 132kV	R 8.65	R 9.95	R 16.00	R 18.40	R 21.18	R 24.36
> 132kV*	R 0.00	R 0.00	R 0.00	R 0.00	R 21.18	R 24.36

* 132 kV or Transmission connected

Voltage	Ancillary service charge [c/kWh]	
	VAT incl	
< 500V	0.62	0.71
≥ 500V & < 66kV	0.60	0.69
≥ 66kV & ≤ 132kV	0.55	0.63
> 132kV*	0.52	0.60

* 132 kV or Transmission connected

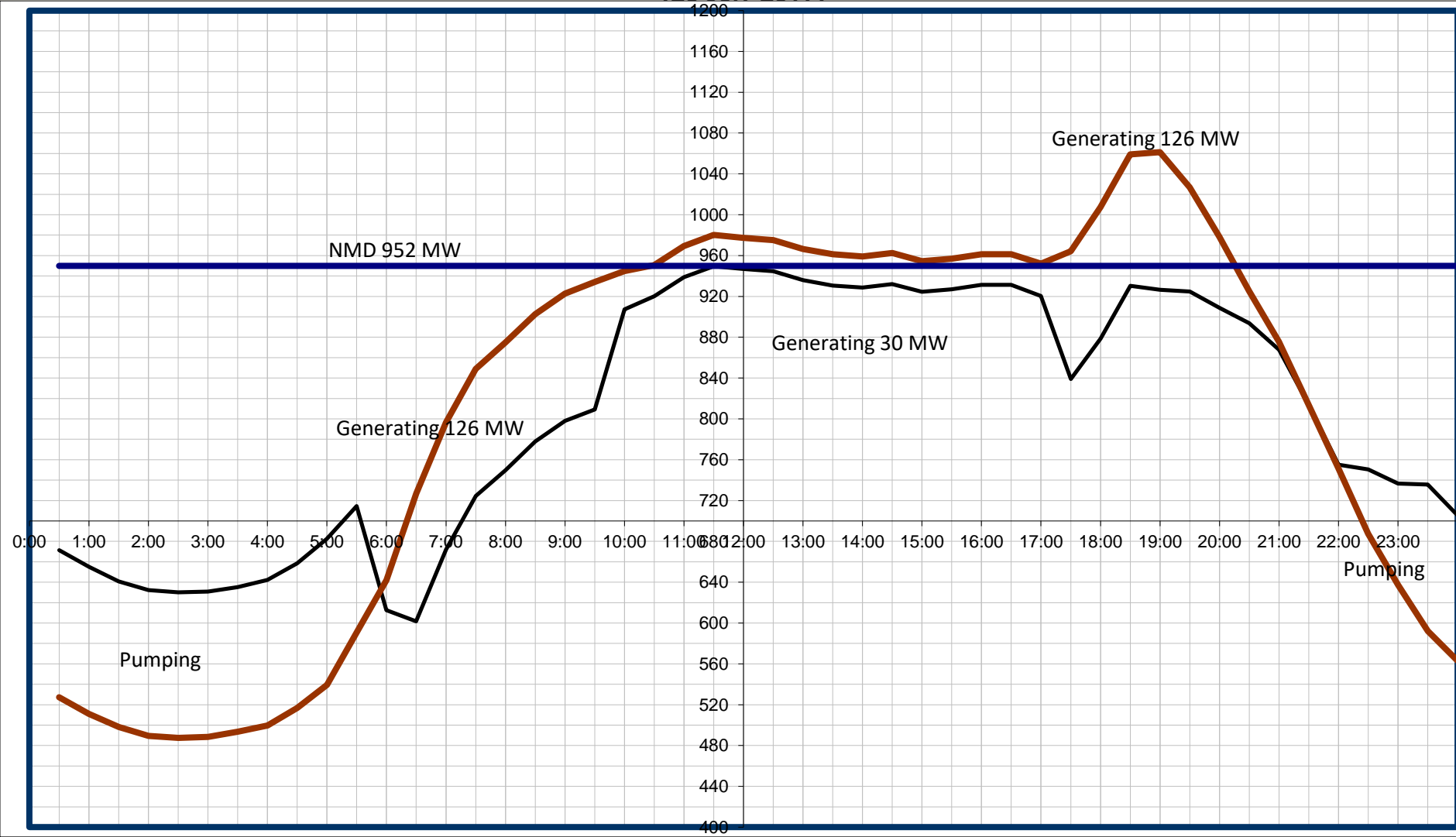
Customer categories	Service charge [R/account/day]		Administration charge [R/POD/day]	
	VAT incl		VAT incl	
> 1 MVA	R 301.23	R 346.41	R 135.78	R 156.15
Key customers	R 5 902.88	R 6 788.31	R 188.51	R 216.79

Reactive energy charge [c/kVArh]			
High season		Low season	
VAT incl		VAT incl	
21.19	24.37	0.00	0.00

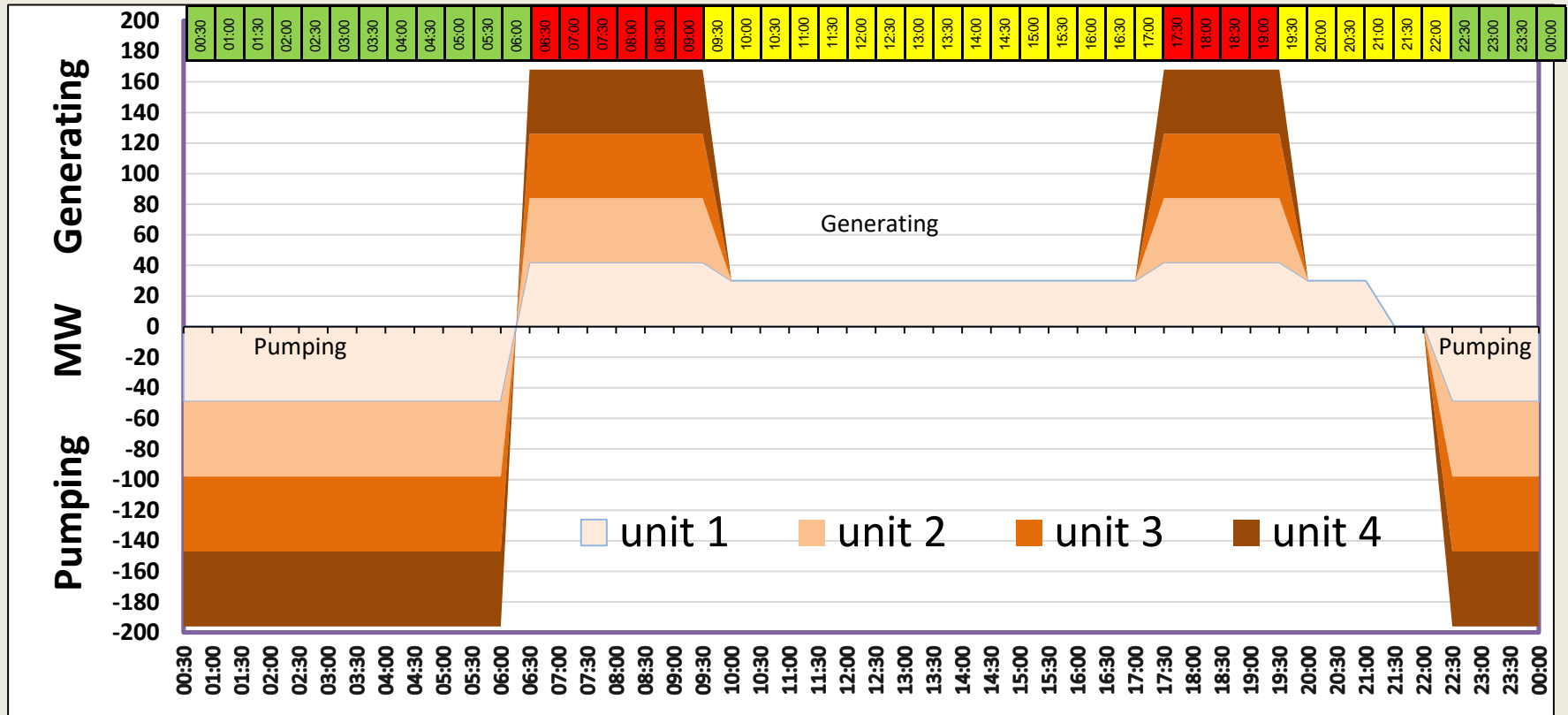
Electrification and rural network subsidy charge [c/kWh]	
VAT incl	
11.73	13.49

Main account load profile and Eskom supply

(23 July 2019)

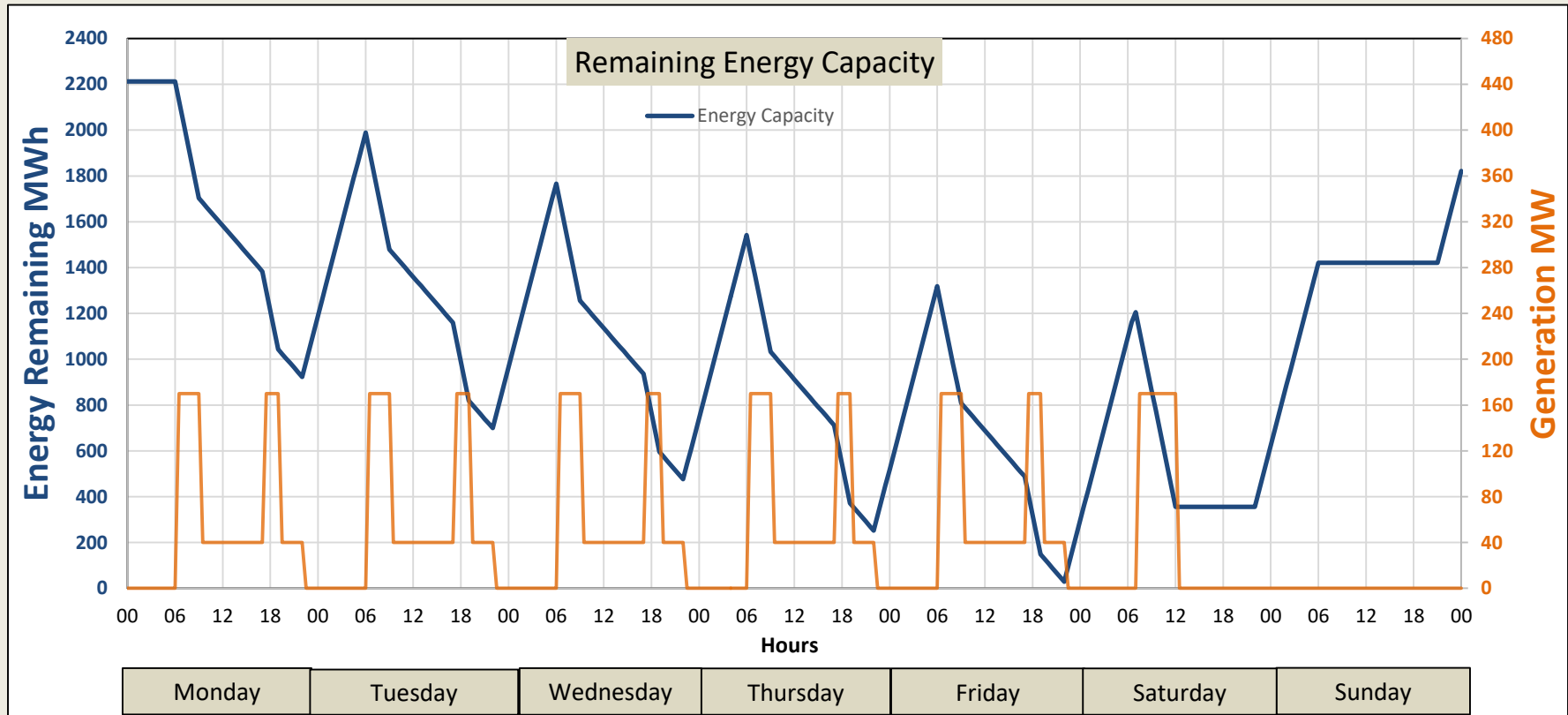


Operating strategy - Daily Pump Gen Cycle in Winter under the TOU tariff



- Time to bring the station from:
- Pump to standstill 15min
 - Standstill to Gen 5min
 - Gen to standstill 5 min
 - Standstill to pump 30 min

Weekly Cycle with 4 machines in winter



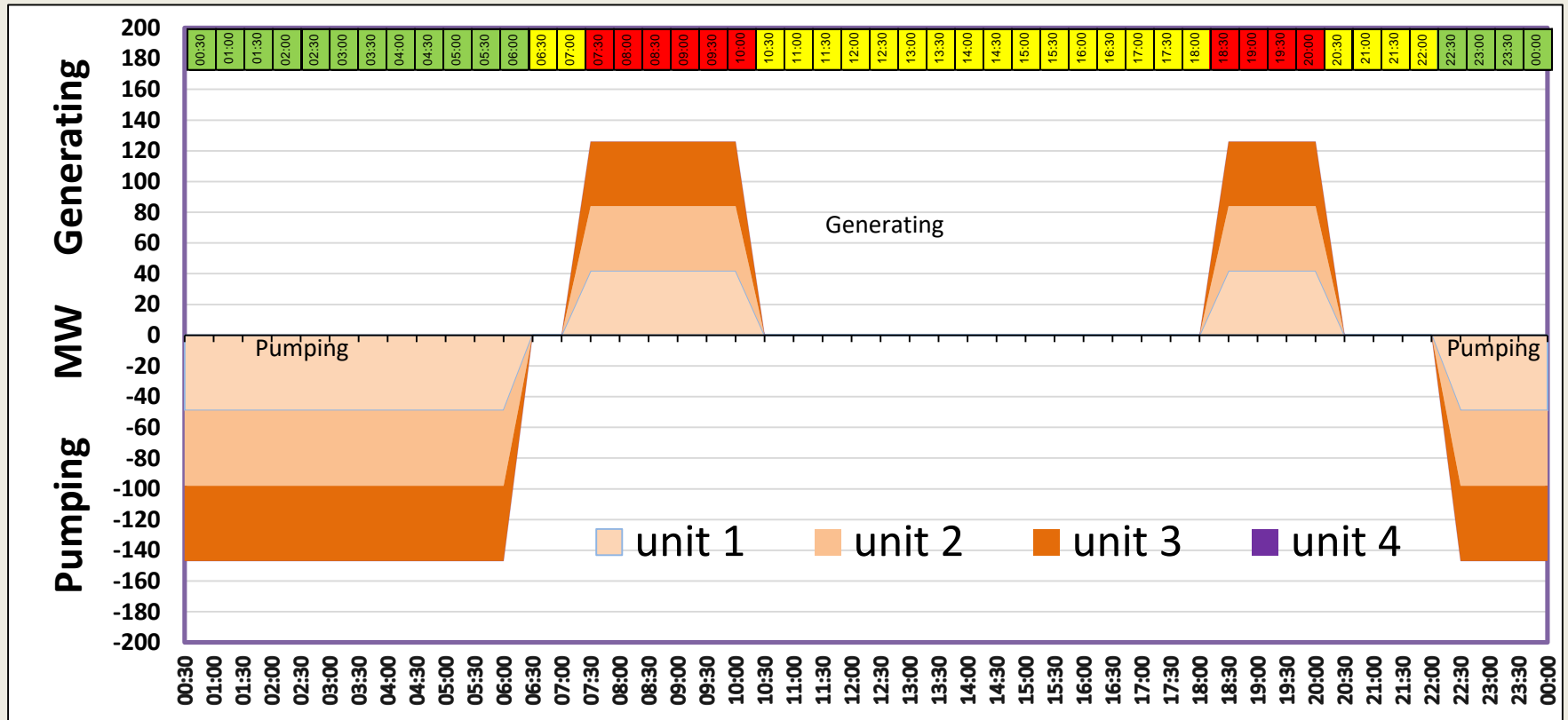
40 MW during Standard period.

Sending out 1300 MWh during the day and recharging by pumping 1100MWh at night.
(550 45ft Tesla mega batteries)



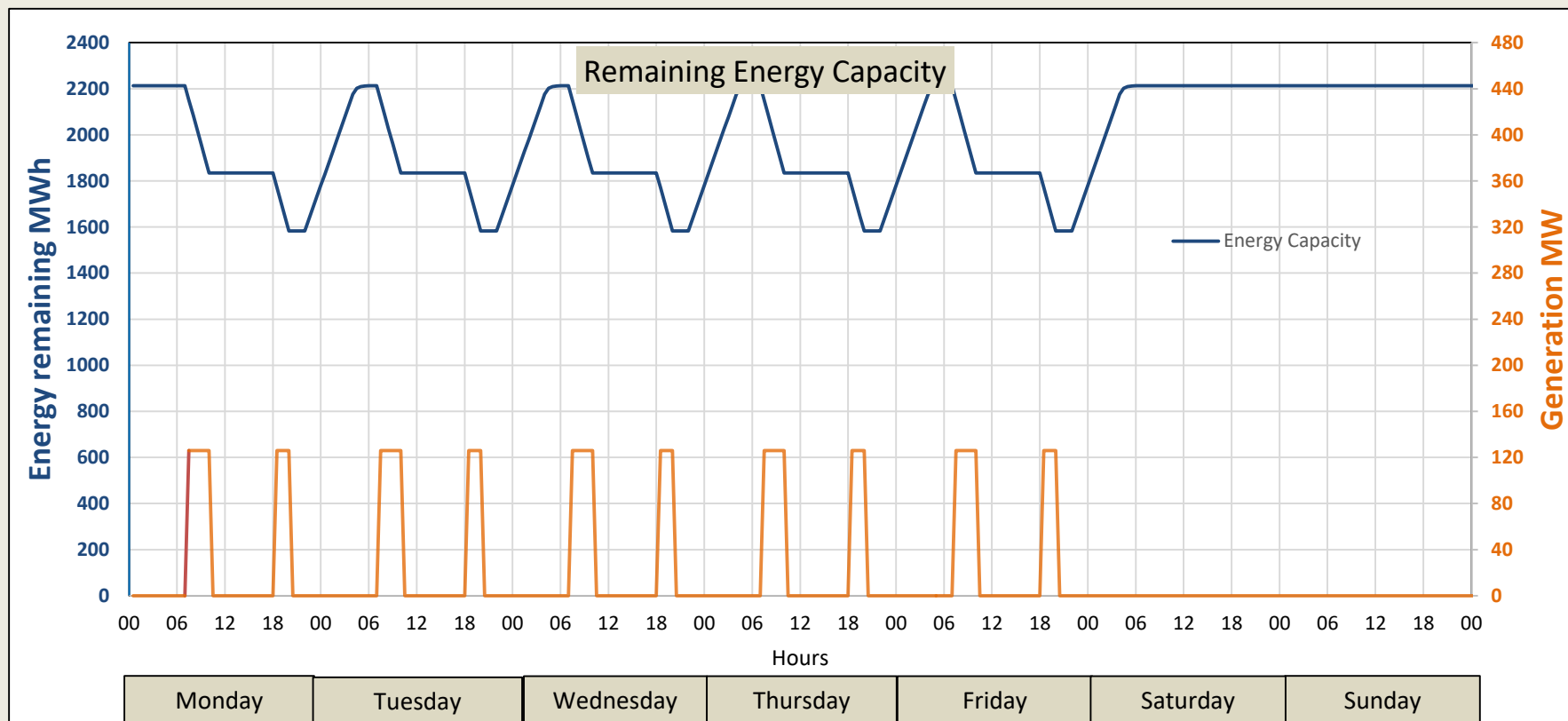
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Operating strategy - Daily Pump Gen Cycle in Summer under the TOU tariff



Weekly cycle with 3 units and no standard period generation

This is the appropriate strategy for summer generation



Steenbras Pump Storage to Mitigate

In Summer/ Low Season:

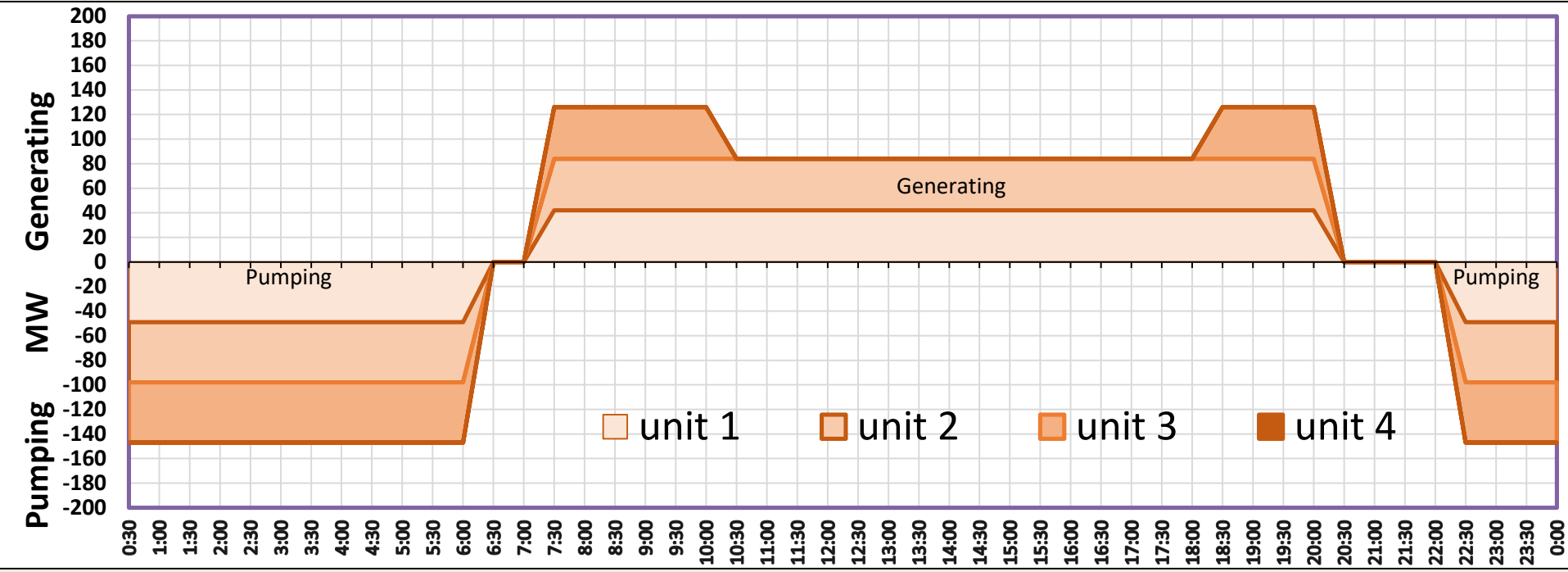
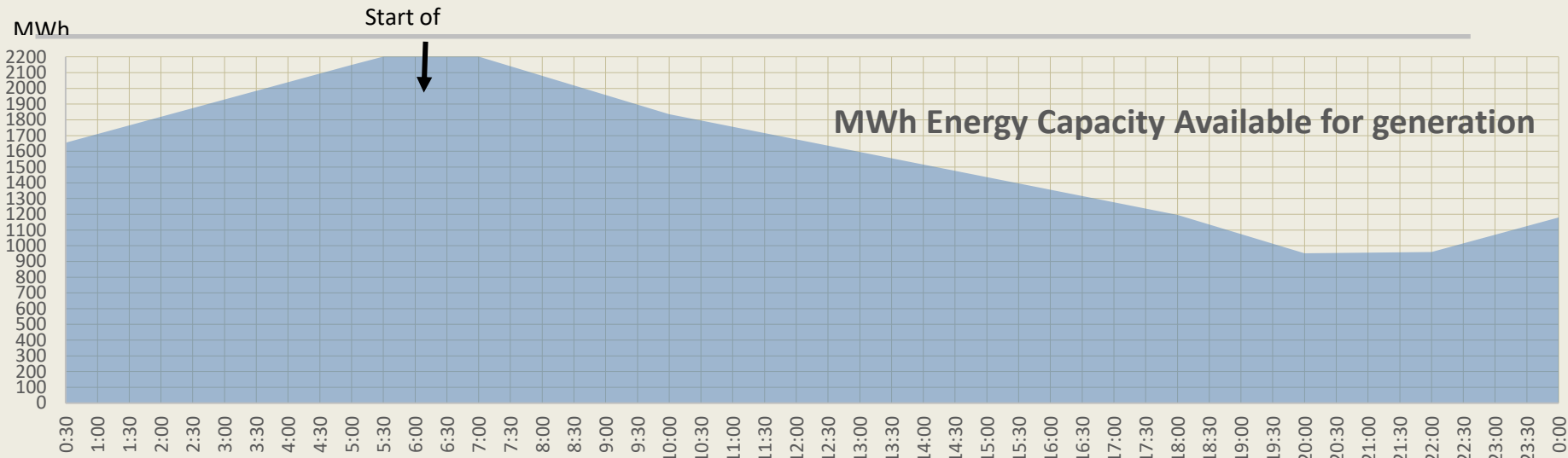
2 units are reserved for load shedding:

1 unit is out on maintenance and 1 unit
Performs the peak load shifting operation.

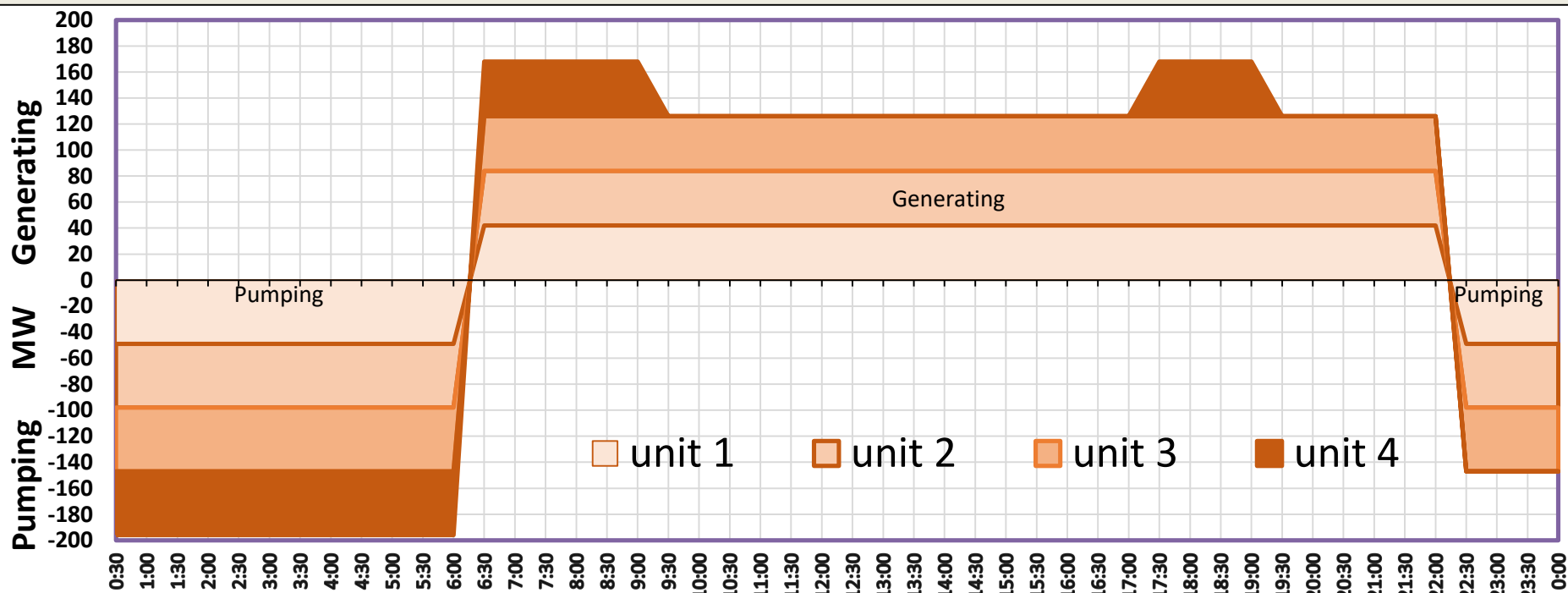
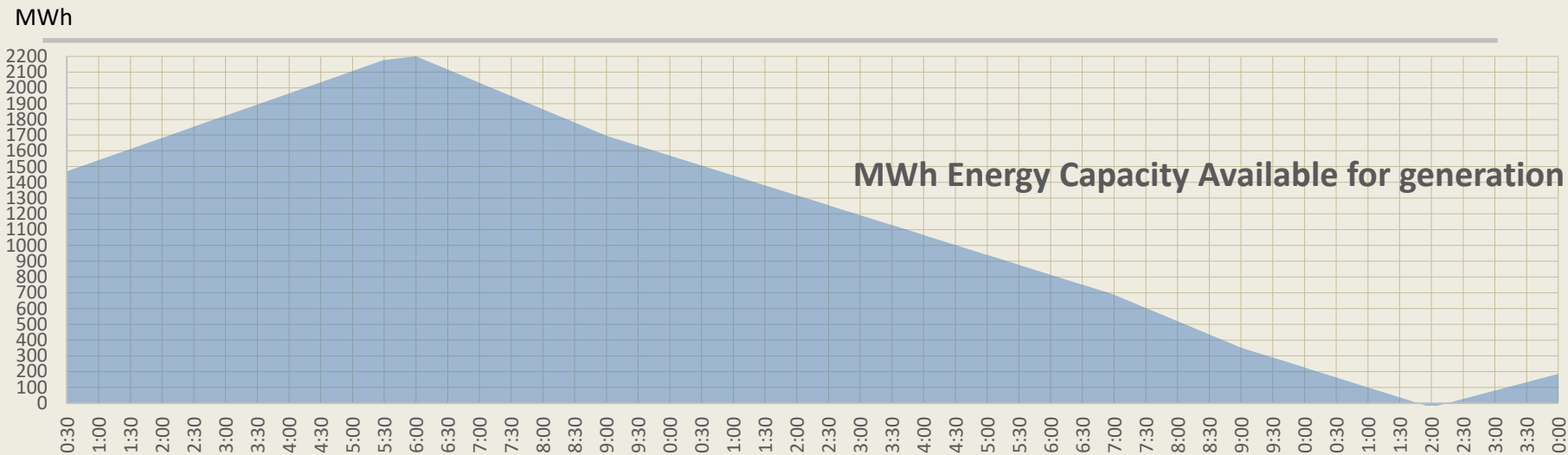
In Winter/ High Season:

1 unit is reserved for load shedding and no maintenance
is planned to take place during the working days Mon. to Fri.
3 units perform the peak load shifting function

Summer load shifting plus Mitigation



Winter Load shifting plus Mitigation



Summary

- Electricity for the City is bought from Eskom at the **TOU tariff**
- Steenbras Pump Storage shifts load from peak time to off peak time with **daily and weekly cycles**.
- Plant is reserved for load shedding mitigation.



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THANK YOU

GENERATION

Making progress possible. **Together.**