

LESOTHO HIGHLANDS POWER PROJECT

Developer: **BREEZE POWER (Pty) Ltd**

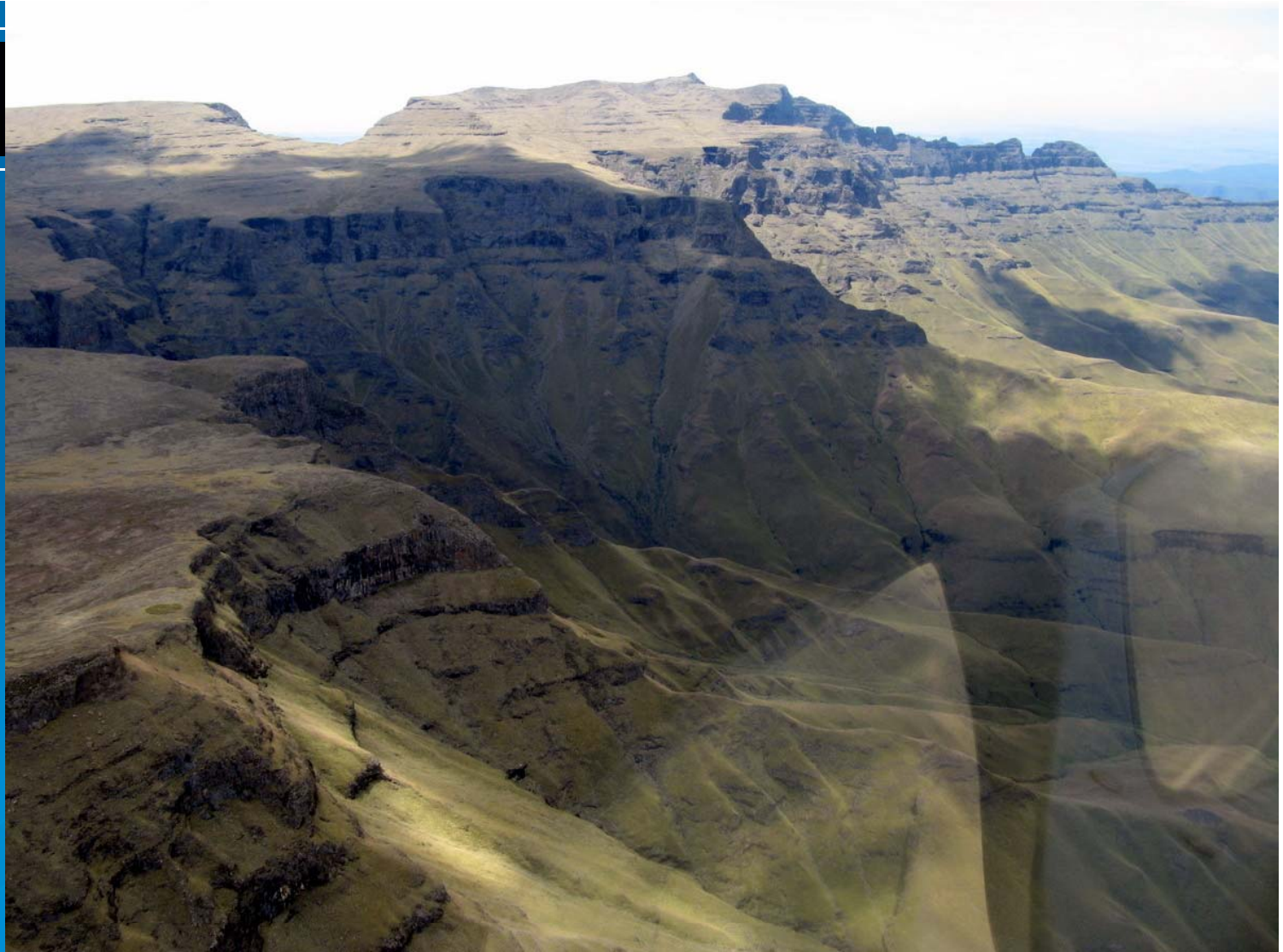
Dieter Matzner – Hatch Africa



Integration of Wind Power and Pumped Storage to provide peaking and mid-merit power supply

Project Introduction

- The Project Developer is Breeze Power (Pty) Ltd jointly owned by the Lesotho Government and Harrison & White.
- The intention is to develop and integrate Pumped Storage with up to 6000 MW Wind Power to provide green firm/scheduled mid-merit and peaking power to Lesotho and South Africa.
- The project will be developed over the next 10 to 15 years and will be of a similar scale and scope to the Lesotho Highlands Water Project and construction start of phase 1 is expected in 2012.
- The overall project value is estimated to be between \$15 to 20 billion



Lesotho Highlands – Example of typical rough terrain





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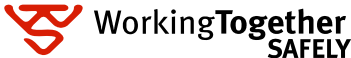


Existing major infrastructure: Katse Dam





Existing major infrastructure: Mohale Dam reservoir



Current Status

- A meso-scale study of Lesotho has been carried out identifying the most suitable sites/regions to develop up to 6000 MW wind power capacity, which was followed by first order constructability review by multiple physical site inspections and helicopter flyovers.
- 18 wind measuring masts on various sites across Lesotho are being erected (12 already installed).
- 1st Phase will maximize utilization of existing Lesotho grid and it is expected to develop at least 150MW initially.
- Follow on phases will require new transmission infrastructure in Lesotho and South Africa.
- In parallel a master plan is being developed to establish the requirements to roll out of the integrated 6000 MW wind power facility and



Breeze Power met mast at Site 1

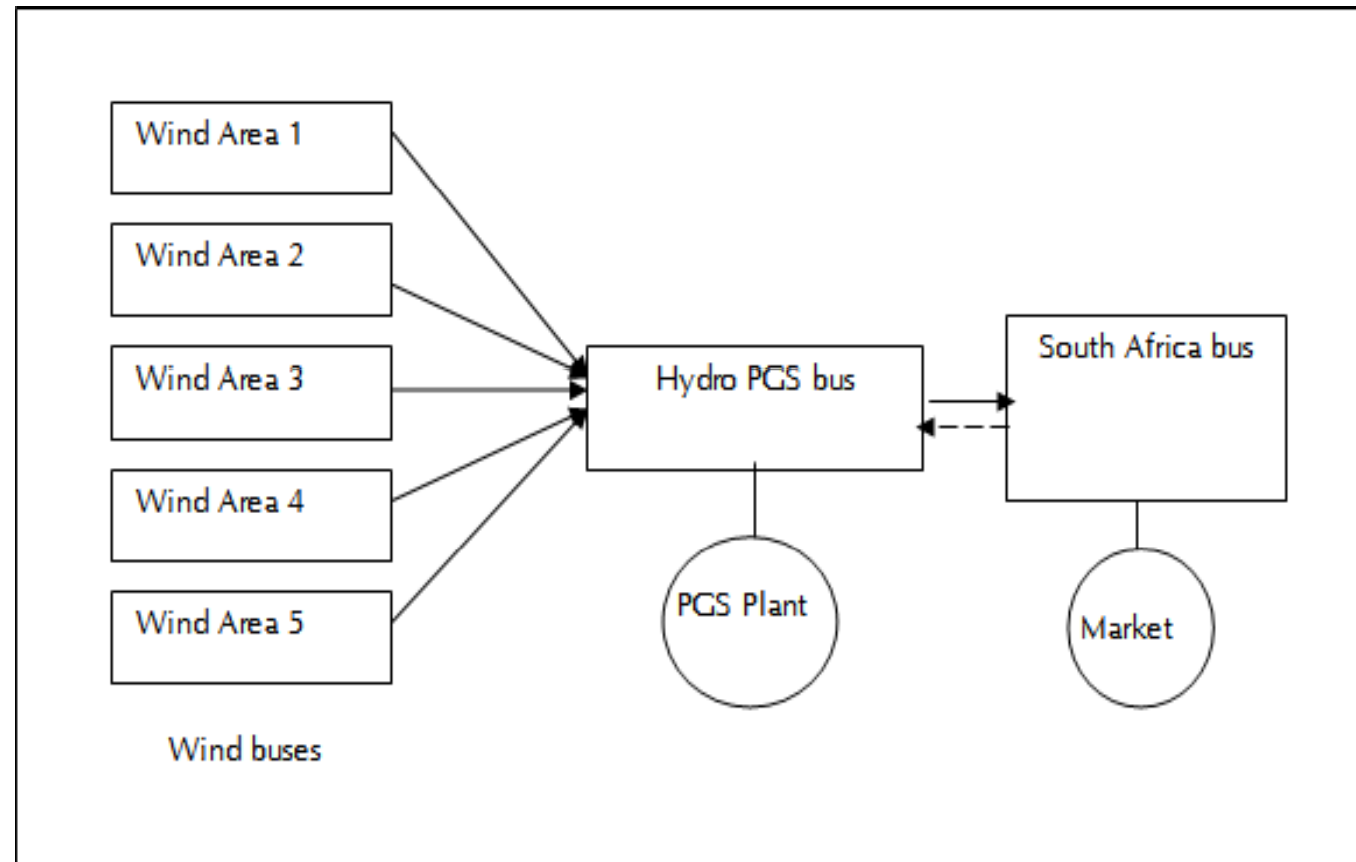
Approach to Power Planning Studies

- Traditional methods....lump energy sources together
- Ideally...evaluate the change in “hourly...yearly operations” before and after
- Have a system that “acts” like the operator and “makes decisions” based on forecasts and current system status...not simulation
- Within Hatch...use the Vista DSS software
- Tool which is used by system operators and dispatchers to guide operations typically for the upcoming week...Operations Modeling
- But....The model/tool is also used for planning studies.

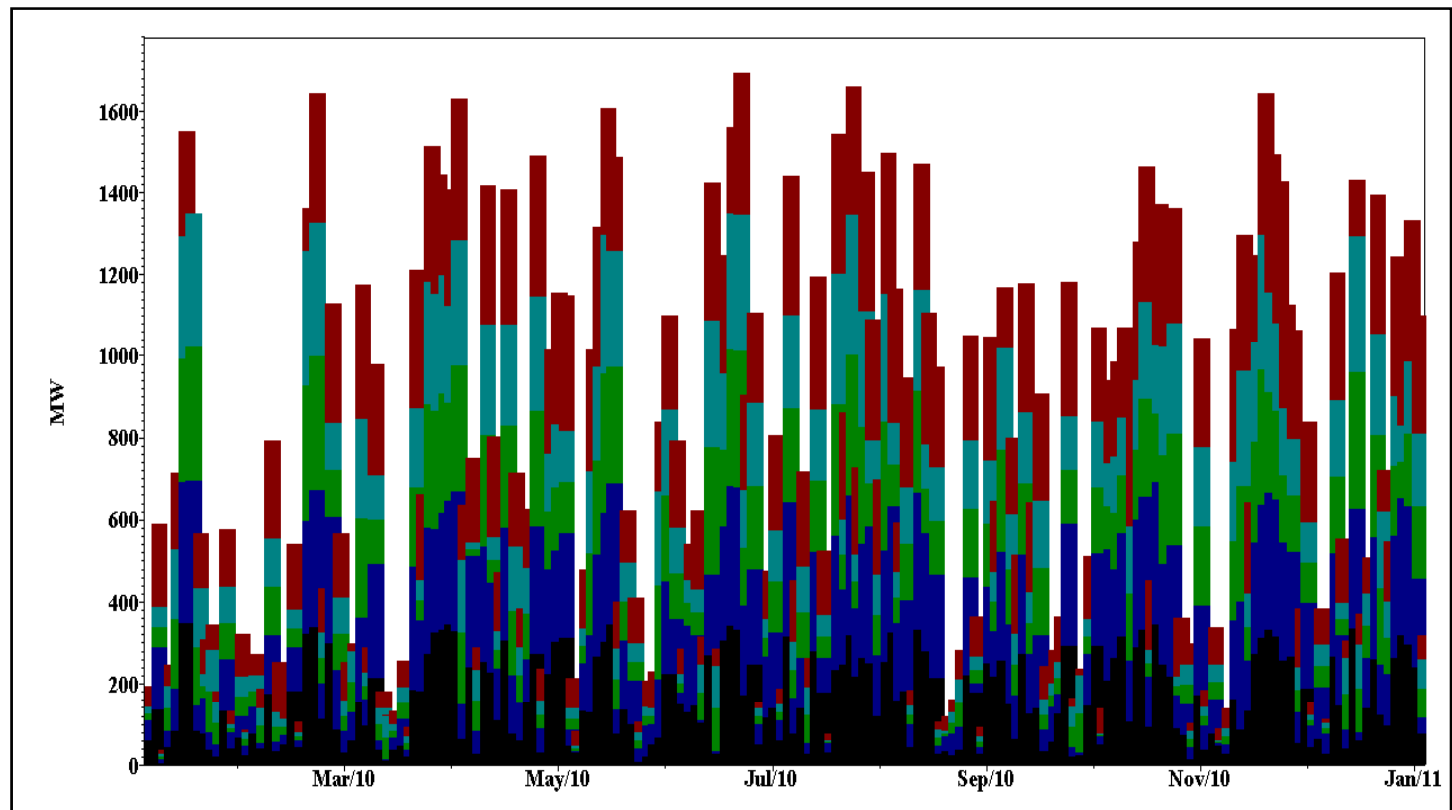
Study Objectives

- Treat the PSS/Wind hybrid system as stand-alone
- Only export energy (not importing in the off-peak and selling in the on-peak)
- Objectives are
 - To assist in understanding the framework of the PPA (reliability and asking price)
 - Seek an understanding of the reservoir usage/operations
 - Determine the magnitude and probability of shortfalls
 - Evaluate the export of secondary energy (unscheduled wind power)
 - Evaluate various on-peak delivery options, 25-30-35 hrs/week in terms of wind required to support various reliability levels (87 hrs/week also studied)
 - Determine reliability of firm energy delivery during project staging

Electrical Concept Diagram



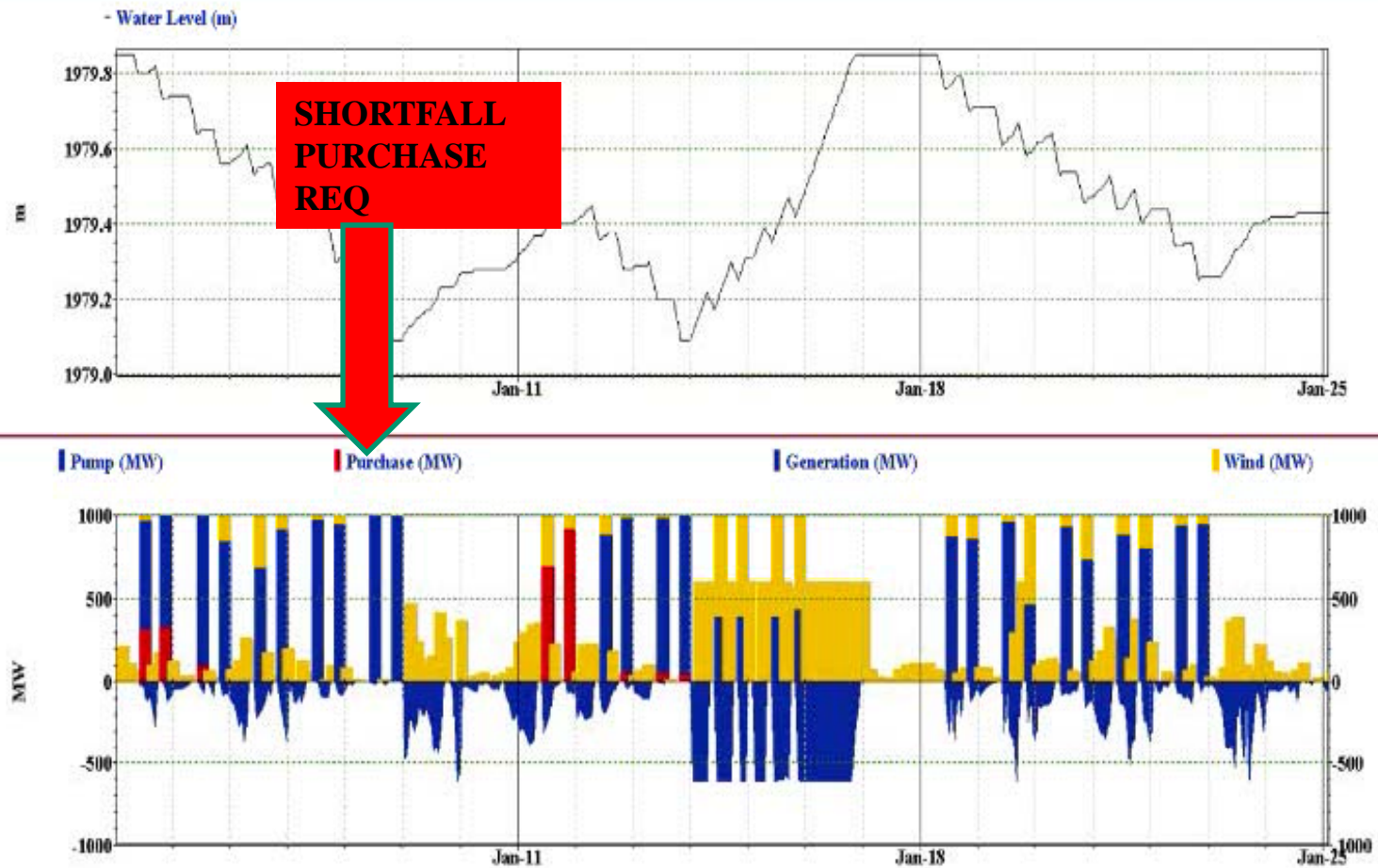
Daily Wind Profile over one Year



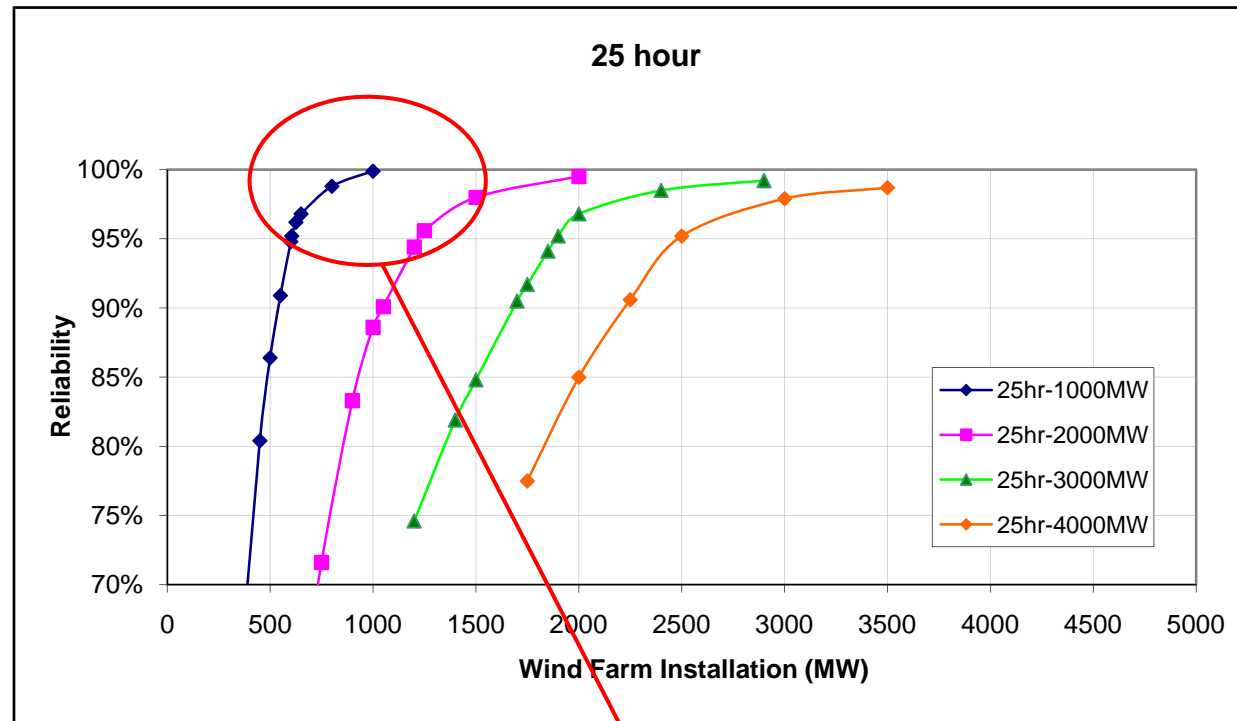
Operations Strategy

- In the off-peak
 - Use wind to pump water into the upper reservoirs
 - At FSL the wind is exported as secondary energy
- In the on-peak
 - Use wind to supply firm energy contractual requirements
 - Use hydro generation to supplement on peak supply only when required

Generation & Pumping Cycles for 25 hrs/week

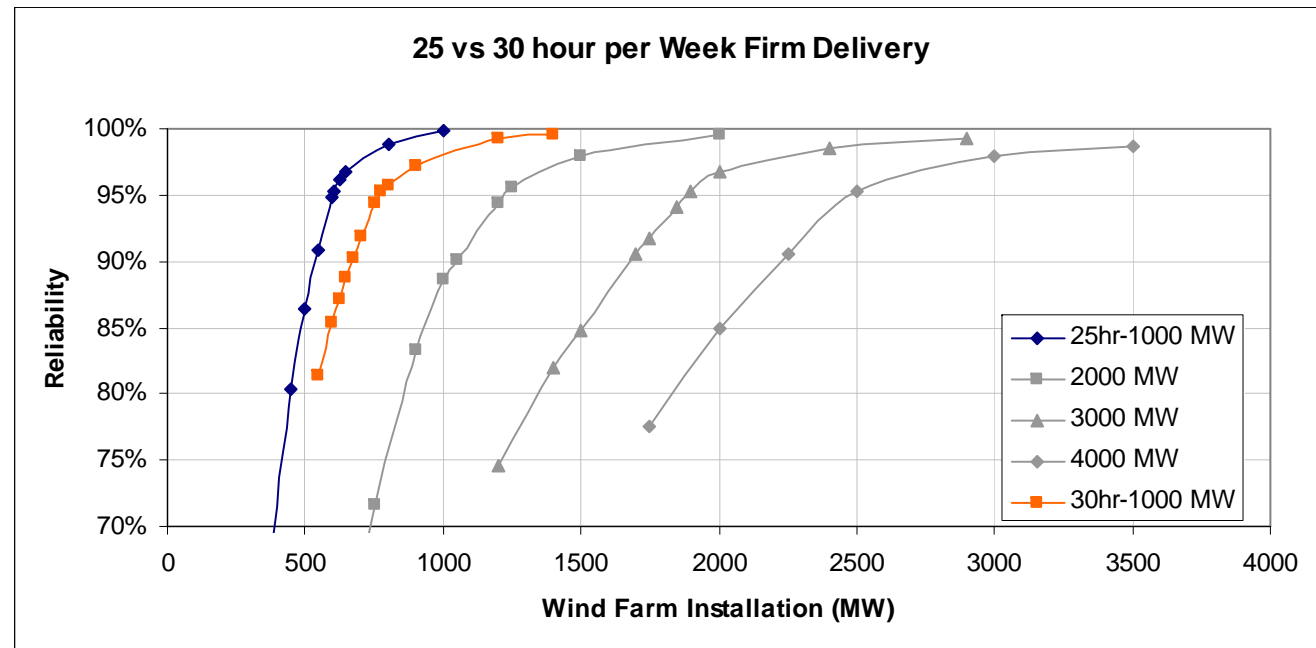


Reliability of Supply vs Installed Wind Power Capacity

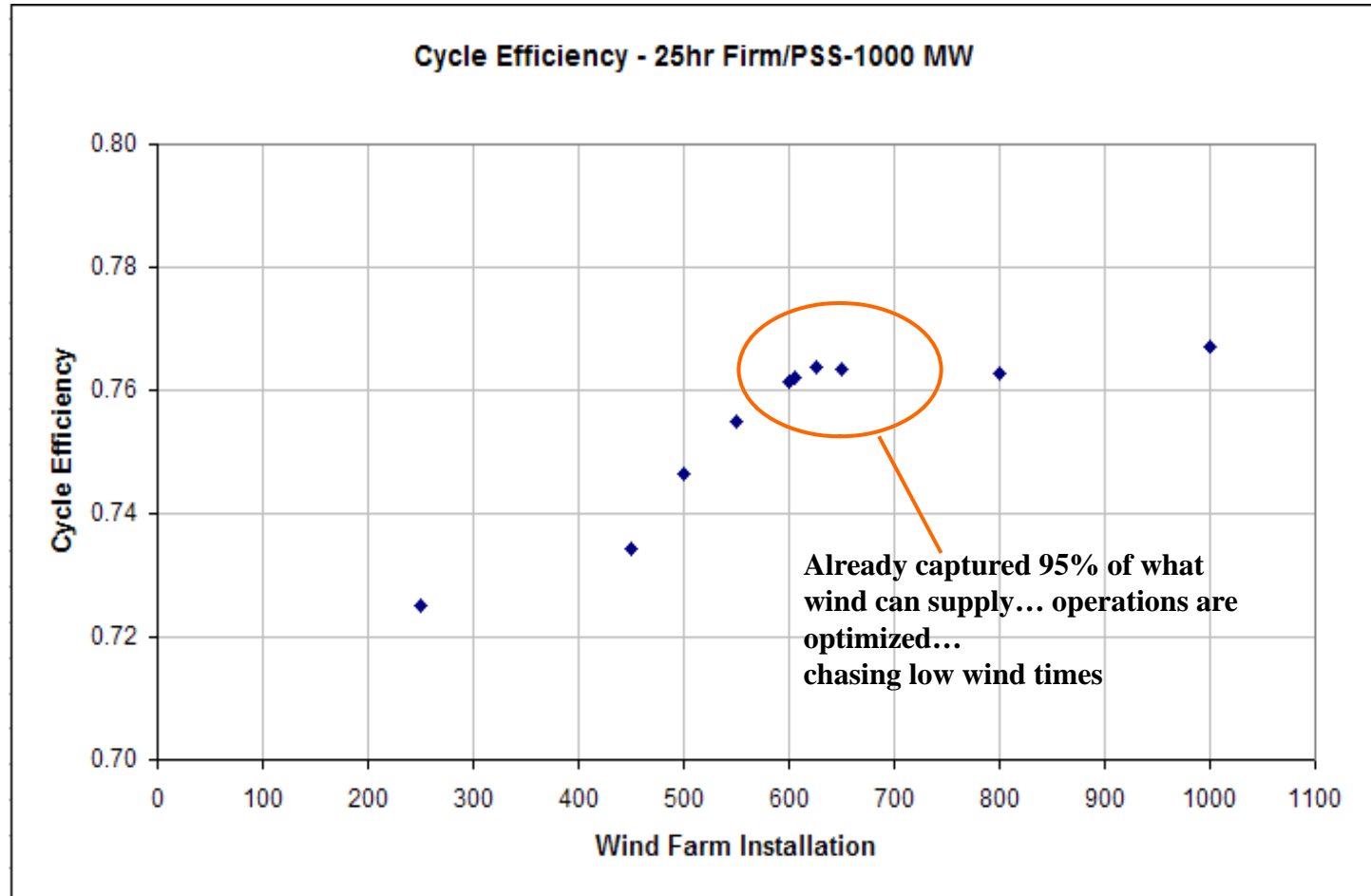


- Specific periods of the year where wind is very low and reservoir is empty.
- Large installed wind capacity required to supply this.

Longer Generation Times vs Installed Wind Power Capacity



Cycle Efficiency vs Installed Wind Power Capacity



Firm Capacity/Generation Times/Reliability/Installed Capacity

PSS/Firm MW	25 Hour			30 Hour			35 Hour		
	80%	90%	95%	80%	90%	95%	80%	90%	95%
1000	450	550	650	550	700	800	650	850	1000
2000	850	1050	1250	1050	1450	1650	1350	1750	2050
3000	1350	1700	1900	1700	2150	2400	2000	2550	3200
4000	1850	2250	2500	2250	2900	3450	2750	3650	4550

Firm 4000 MW - 35hr, 4550 MW Wind Power, 95.1% Reliability

	Number of days	Hours		Wind MW		Generation MW		Pumping MW		Secondary MW		Shortfall	
		On Peak	Off Peak	On Peak	Off Peak	On Peak	Off Peak	On Peak	Off Peak	On Peak	Off Peak	On Peak	Off P
January	30	140	580	99,006	530,478	381,342	0	0	394,307	0	136,372	79,576	
February	28	140	532	214,627	730,314	267,176	0	0	410,705	0	319,812	78,119	
March	31	161	583	227,231	855,368	367,908	0	0	471,061	0	384,460	48,785	
April	30	154	566	202,244	741,326	413,623	0	0	513,958	0	227,754	0	
May	31	147	597	169,142	692,880	347,657	0	0	382,608	0	310,398	71,133	
June	30	154	566	217,978	782,192	388,108	0	0	476,626	0	305,864	9,811	
July	31	154	590	212,741	986,929	391,218	0	0	543,592	0	443,686	11,932	
August	31	154	590	218,026	683,048	364,506	0	0	453,808	0	229,464	33,394	
September	30	154	566	178,998	658,528	429,361	0	0	472,142	0	186,705	7,533	
October	31	147	597	211,193	863,479	376,677	0	0	507,530	0	356,355	0	
November	30	154	566	226,333	879,383	374,126	0	0	447,596	0	432,056	15,444	
December	31	161	583	209,516	976,057	434,334	0	0	570,757	3.67	405,708	0	

Most Likely System Concept

- 87 hrs/week of Firm Scheduled Power of up to 2000 to 3000MW during May to Dec. and 1000 to 1500 MW during Jan. to April (Peak + Standard - Megaflex)
- 6000MW of installed wind power capacity
- Utilization of 1200MW Pumped Storage provides 80% reliability of supply; with limited off-peak power imports from SA achieve 100% supply reliability
- Good match with SA winter power demand profile

Special Challenges

- Lesotho Environmental Conditions
 - Elevations
 - Highest Lightning strike rate in the world
 - Temperatures reach minus 20 degrees C
 - High wind speeds/gusts
- Transportation of heavy equipment to sites
- Construction of Transmission Infrastructure in Lesotho
- Long time scales in South Africa for grid connection servitudes and approvals
- Regulatory Environment, Government Agreements, etc.



**Key passes to access the highlands:
Moteng Pass (to Sites 1 and 2)**





**Key passes to
access the
highlands:
Mafika Liziu Pass
(potential route to
Sites 1, 2 and 9)**

Helicopter Blade Transportation



Special Equipment for Roads Transportation



Tower Sections Transportation



Questions?