Quantitative Assessment of Geographical Based Load Forecast Technique at Eskom Distribution: Forecast Error and Impact on Infrastructure Execution

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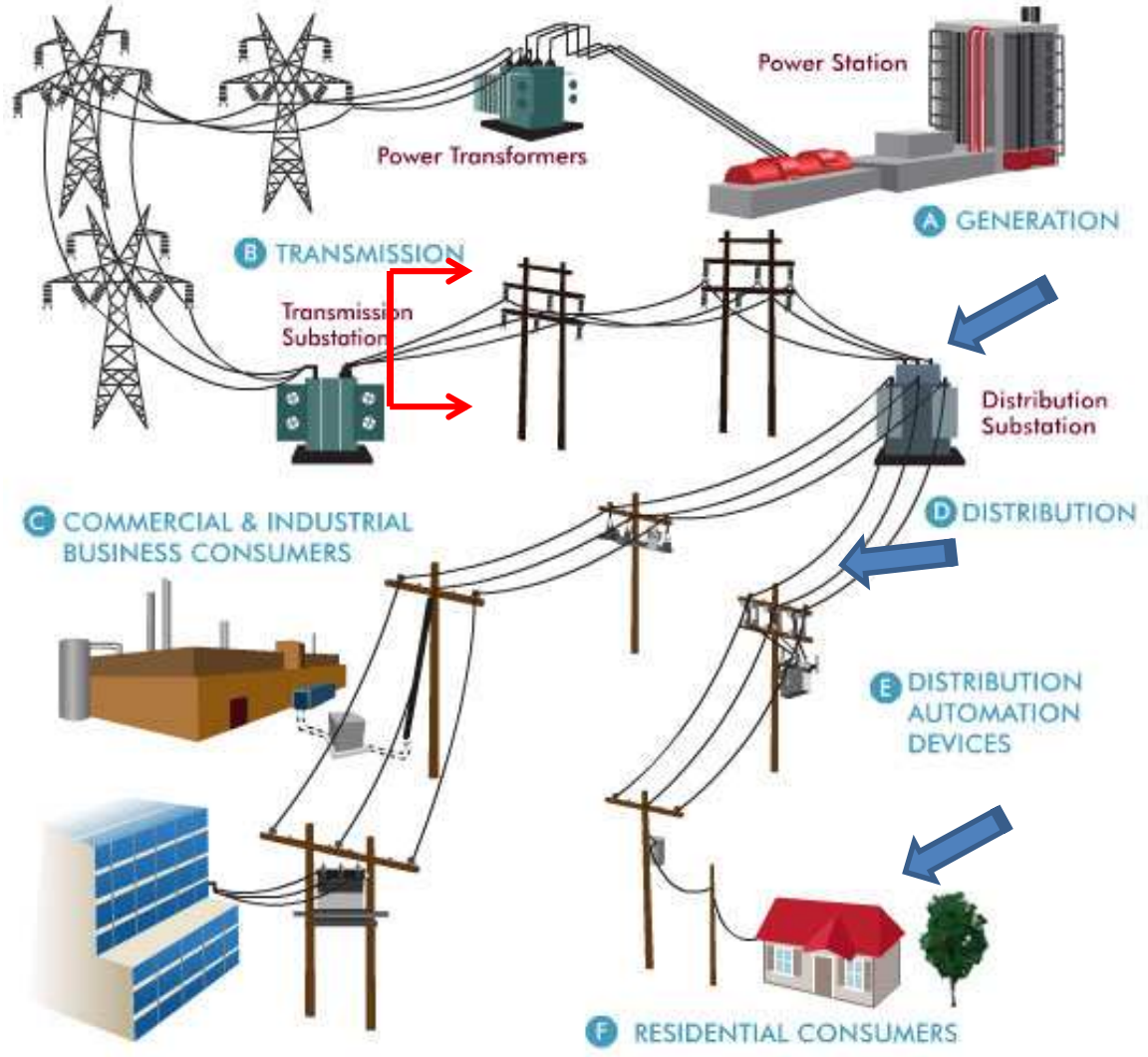
Introduction - Context



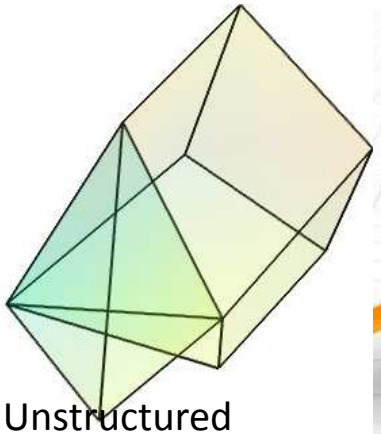
Distribution System Voltage ≤132kV

Distribution forecast

Source: http://2.bp.blogspot.com/-nUJFk3jMzBU/TwR26BfjJCI/AAAAAAAAAA4/1ciQ5bxCZjw/s640/ps.jpg

Forecasting Method Evolution at Eskom

Prior 2007



Unstructured

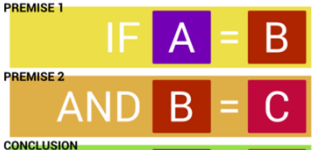
Trend based

Planner's knowledge about the area

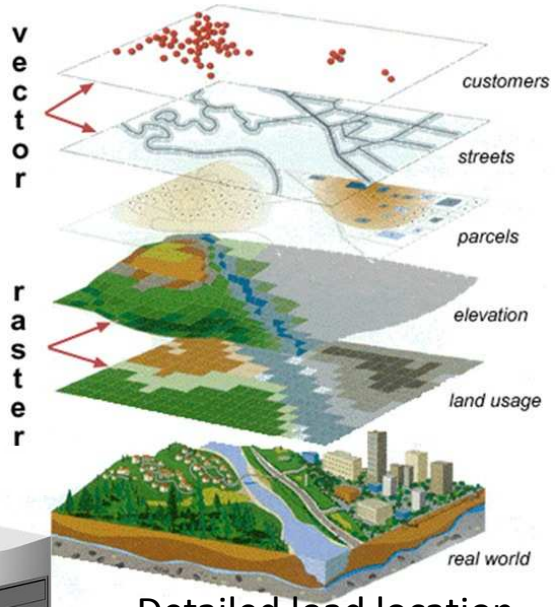
Spread sheets

Network based

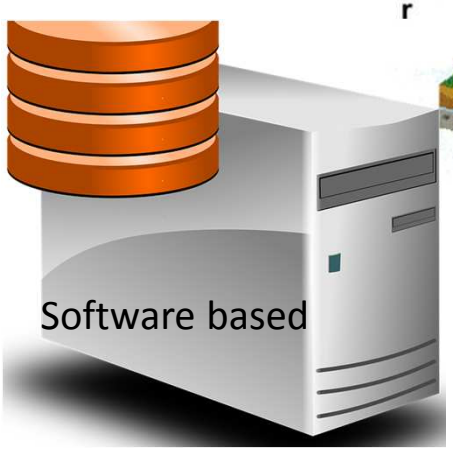
Post 2007



Structured



Detailed load location



Software based

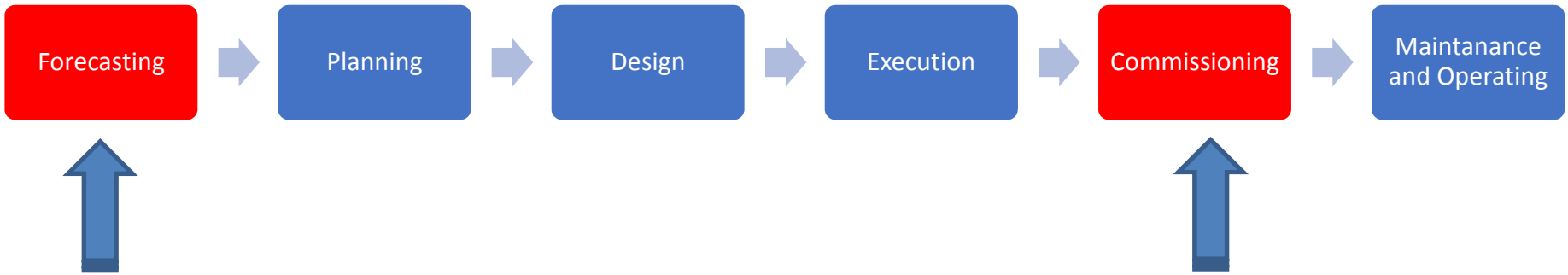
Spatial based

…Thus…

- The GLF Method:
  - Where – load location
  - How much – load magnitude
  - What – load type and characteristic
  - When – expected time of take up
- Legacy Method
  - How much – load magnitude
  - Network – feeder or transformer under forecast
  - When – expected time to take up

Study Objective

- To compare the GLF method to the legacy method on the following aspects:
  - Forecast accuracy
  - Impact on planned infrastructure versus the actual infrastructure



Literature

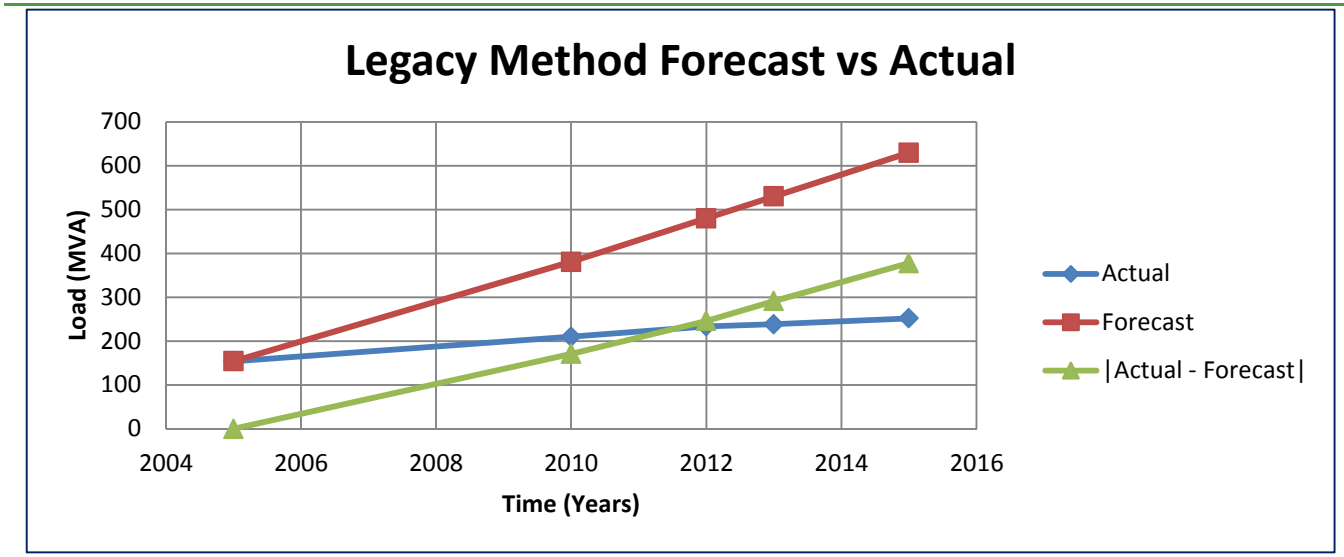
- Comparing spatial forecast methods to trending methods, Willis [1] found:
  - Spatial forecasts show better over all accuracy
  - Trending methods show higher accuracy in short term and high error in long term forecasting
- Impact of forecasts on infrastructure procurement according to Carvallo, *et al* [2]:
  - Overstated forecasts have led to overspending on infrastructure

Method Followed

- The GLF forecast from the Stellenbosch Municipality Master Plan (2006) was compared to the actual load from 2006 – 2016.
- Legacy forecast: Mokopane Area Network Development Plan (2007) used.
- The infrastructure commissioned between 2006/7 and 2016 were compared to the planned infrastructure.

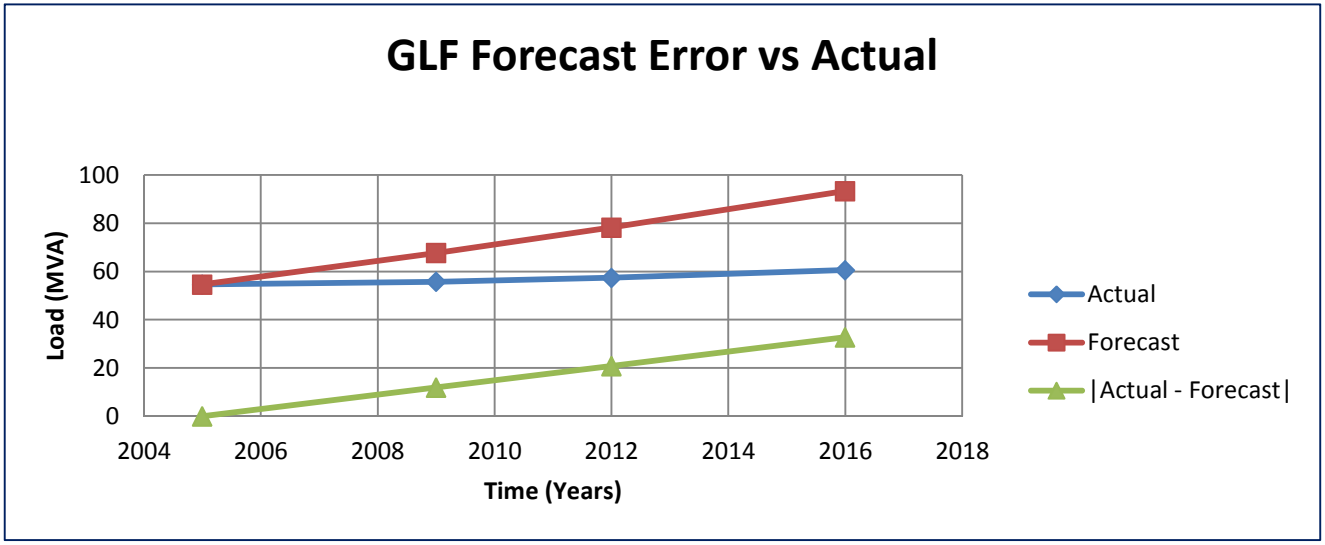
$$MAPE = \frac{\sum |(Actual - Forecast)|}{\sum Actual} \times 100\%$$

Results – Forecast Error



Sum(Actual)	1088.47
Sum(Error)	1086.43
MAPE	**99.81%**
Correlation (Forecast, Actual)	0.99

LM Summary Results



Sum(Actuals)	228.31
Sum(Error)	65.54
MAPE	**28.71%**
Correlation (Forecast, Actual)	0.98

GLF Summary Results

Results – Infrastructure: Actual vs. Planned

a) LM area infrastructure - planned and actual

	Planned Feeder Bays (number)	Planned TRFR Capacity (MVA)	Planned HV Lines (km)	2016 Actual Feeder Bays (number)	2016 Actual TRFR Capacity (MVA)	2016 Actual HV Lines (km)
Totals	11	600	306	4	160	60

$$MAPE = \frac{917 - 224}{224} \times 100\%$$

$$MAPE = 309.4\%$$

b) % Error Per Infrastructure Category		
Feeder Bays	Trfr Capacity	HV Lines
175%	275%	410%

Total Plan = 11+600+306 = 917

Total Commissioned = 4+160+60 = 224

a)GLF area infrastructure - planned and actual

	Planned TRFR Capacity (MVA)	Planned HV Lines (number of lines)	2016 Actual TRFR Capacity (MVA)	2016 Actual HV Lines (number of lines)
Totals	262.5	19	230	17

$$MAPE = \frac{281.5 - 247}{247} \times 100\%$$

$$MAPE = 14\%$$

b) % Error Per Infrastructure Category	
Trfr Capacity	HV Lines
14%	12%

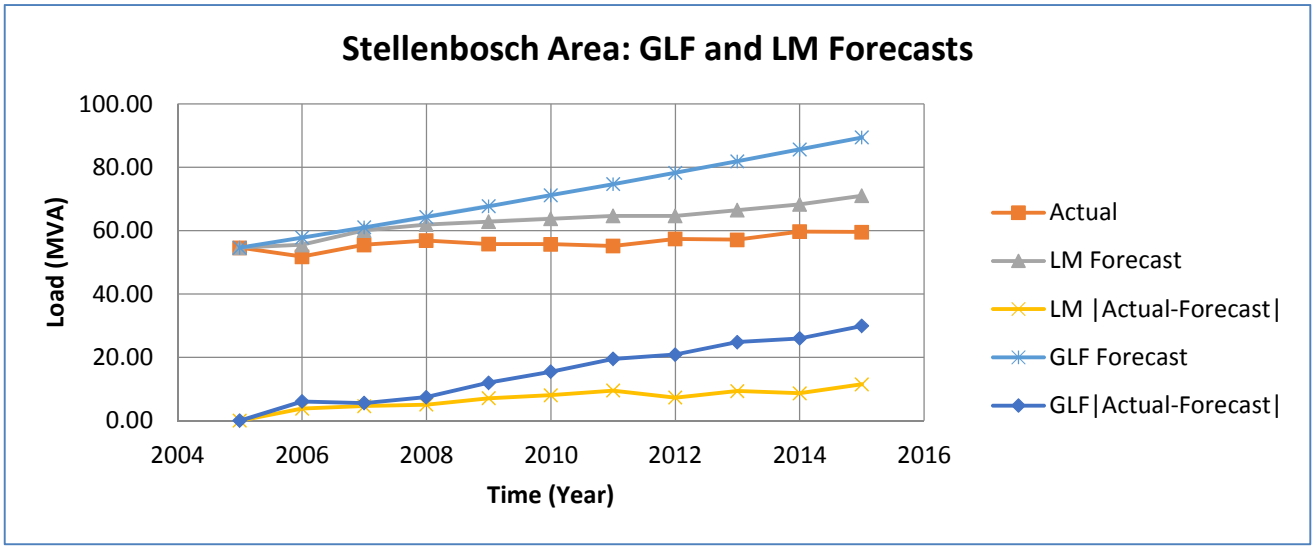
Total Plan = 19+262.5= 281.5

Total Commissioned = 230+17 = 247

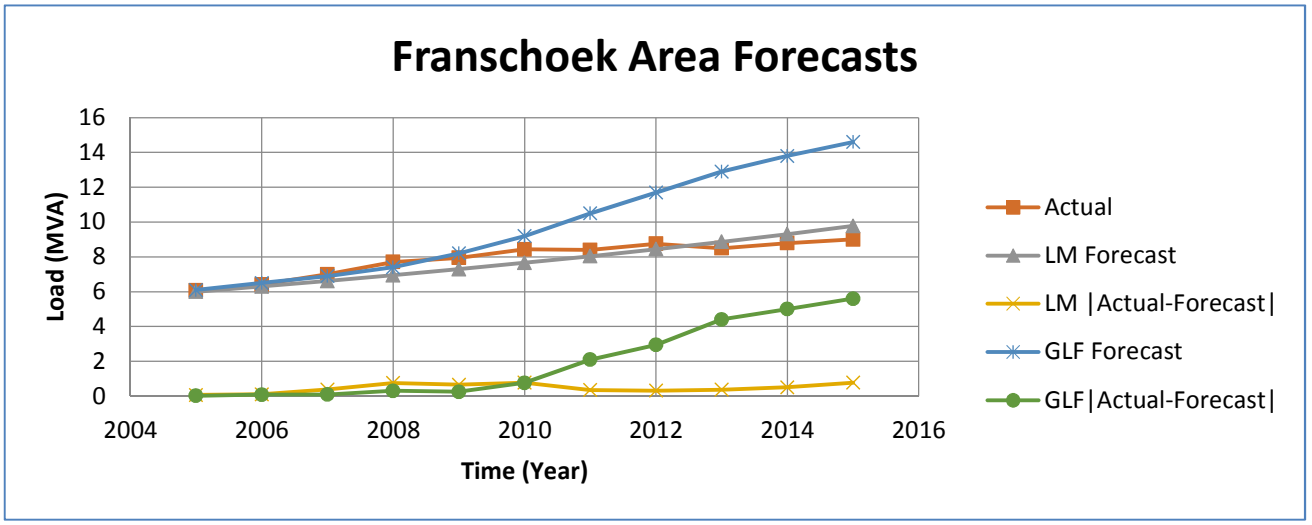
Observations

- Contributing factors to the large error margins in legacy method:
  - Load composition
  - 2008 economic downturn
  - Further downturn in mining sector – 2013
- The GLF area showed to be immune to the economic downturn:
  - University
  - Residential
  - Commercial
  - Farming – vineyards
- Contrary to the suggestion by literature, the following observation was made:
  - $Forecast\ Error \propto Execution\ Error$

Additional Tests Reviled…



MAPE (Legacy Method) = 12.04%
MAPE (GLF) = 27.02%



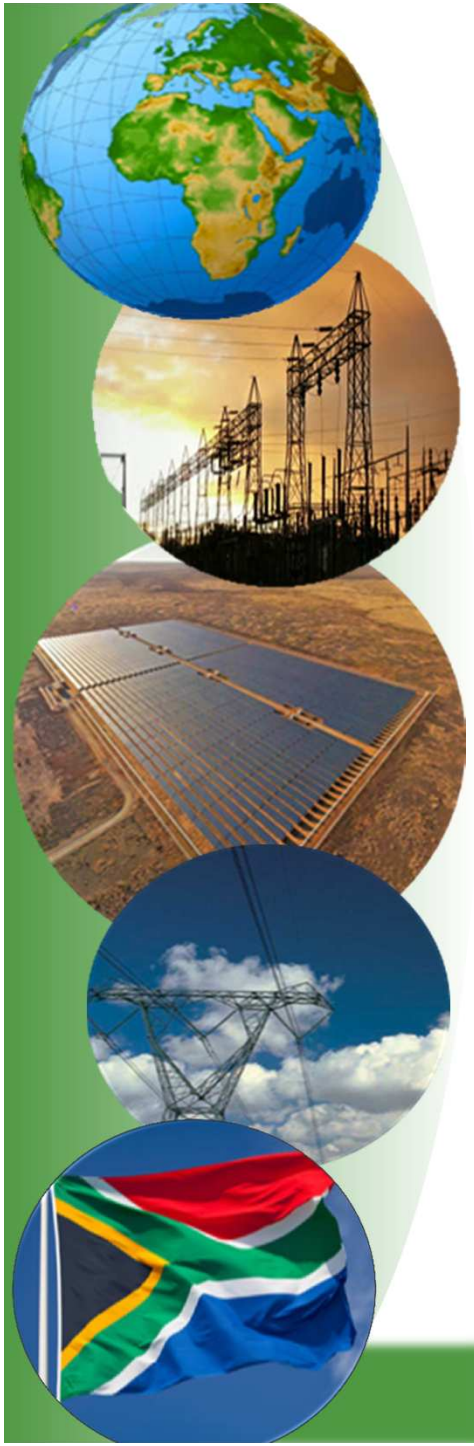
MAPE (Legacy Method) = 5.84%
MAPE (GLF) = 24.83%

Conclusion

- Two out of three case studies showed the legacy method to be more accurate than the GLF method based on MAPE
- The error due to over-forecast did not lead to over-procurement
- The case studies and aspects examined on this study, suggested that the GLF method that was adopted by Eskom did not improve forecasting outputs as was intended

More to be done…

- Possible future work proposed:
  - Evaluate the impact of each method on the planning process and decision making
  - Increase the number of case studies in order to arrive at more generic conclussion
  - GLF and legacy method relevance for forecasting in the current and future power systems (?)



Thank You

References

[1] H. L. Willis, Spatial Electric Load Forecasting, 2nd ed., Raleigh, North Carolina: MARCEL DEKKER, INC., 2002.

[2] J. P. Carvallo, P. Larsen, A. H. Sanstad and C. A. Goldman, "Load Forecasting in Electric Utility Integrated Resource Planning," Berkeley National Laboratory, Berkeley CA, 2016.