

Forecasts developed for the IRP 2015/6

*Using regression models developed by the CSIR for predicting
future patterns within electricity demand sectors*

**Presentation by CSIR forecasting team
during IRP Public Consultation Workshops
Dec 2016 / Jan 2017**



Background

The CSIR forecasting team has developed a methodology for long-term forecasting of annual national electricity demand

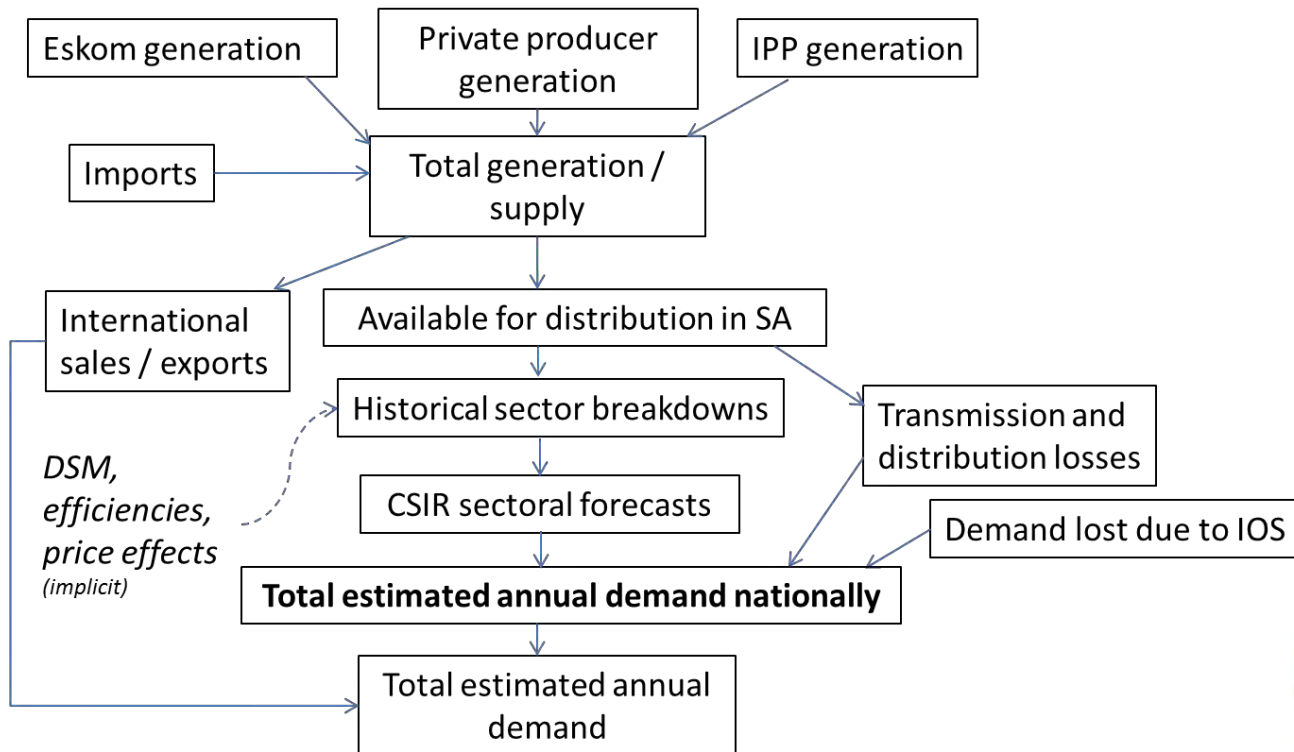
- The methodology was first developed in collaboration with BHP Billiton in 2003, and subsequently re-used and refined
 - Details regarding methodological aspects and the process of developing the methodology were published in the Journal of Energy in Southern Africa (JESA), November 2014 issue
- It has been used for providing additional forecasts in the previous IRP and its revision, and has now been used to provide a new set of forecasts for the 2016 IRP

This presentation briefly describes the following (for more details refer to the report on the IRP website):

- Methodology and assumptions used
- Forecasts produced

Key assumptions with regard to electricity patterns

- The forecasts were designed to determine estimated demand (which may not equal consumption) for electricity *without* considering supply constraints
 - Intended for use in strategic planning
- The forecasts cover the **total** requirement for electricity to be generated annually in order to meet the needs of South Africa



Key methodological considerations

- The forecasts are based on statistical models
 - Data-driven and based on historical quantitative patterns / relationships
 - *Use data that is as up-to-date as possible so that recent patterns are also reflected*
 - Assumption that the relationships will continue into the future
 - Using such models have advantages and disadvantages
 - *The advantage is that one can quickly re-do forecasts for different scenarios*
 - *The disadvantage is the constraints imposed by available data*
- Forecasts were developed in such a way that key parameters (“drivers”) could be fed into the forecasting process
 - Future values of such “drivers” were based on scenarios

Overall methodology followed

- In developing the methodology, the CSIR approach was to collect historical data on electricity consumption from various sources in the public domain
 - Maintained overall consistency between sources by ensuring sector breakdowns correspond to Statistics SA total
- Total demand was broken down into usage sectors, as far as the data allowed
 - Investigation showed that better models were obtained by modelling sectoral demand rather than total
 - “CSIR Recommended” historical sector breakdowns (in time series format) were developed from a combination of data sources
- Regression models were developed per sector
- Scenario forecasts for “drivers” were fed into the sectoral models
- Sectoral totals were aggregated and adjusted for losses to obtain total forecasted values
 - Some adjustments could be made to totals, e.g. adding exports

Statistical forecasting methodology chosen

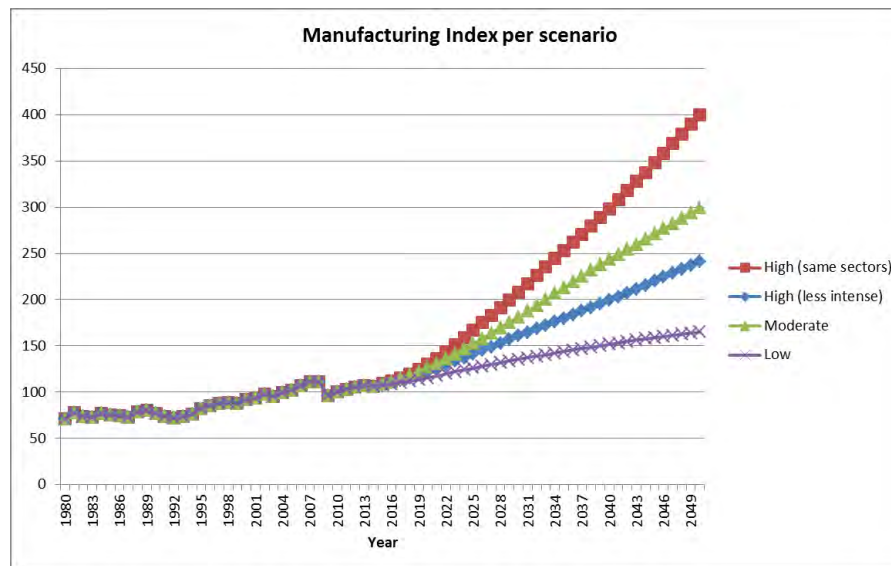
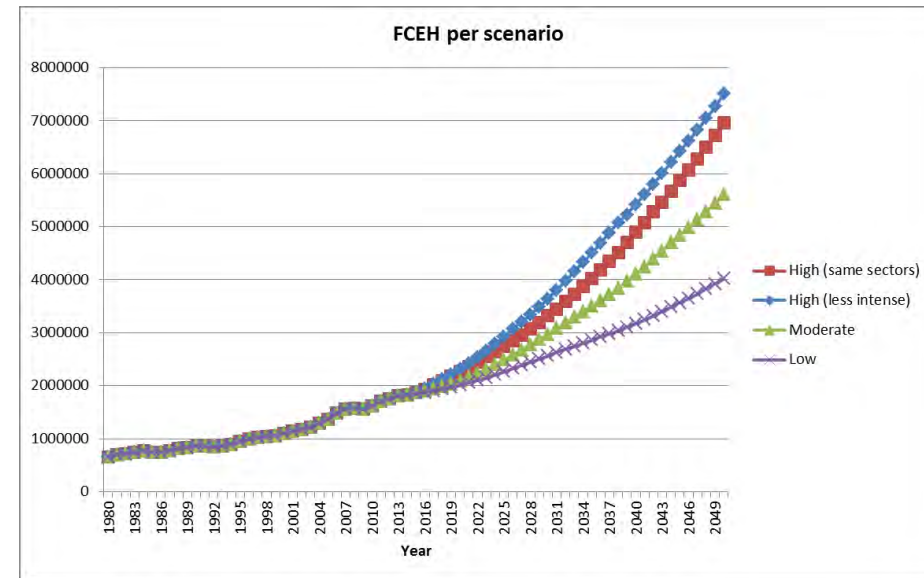
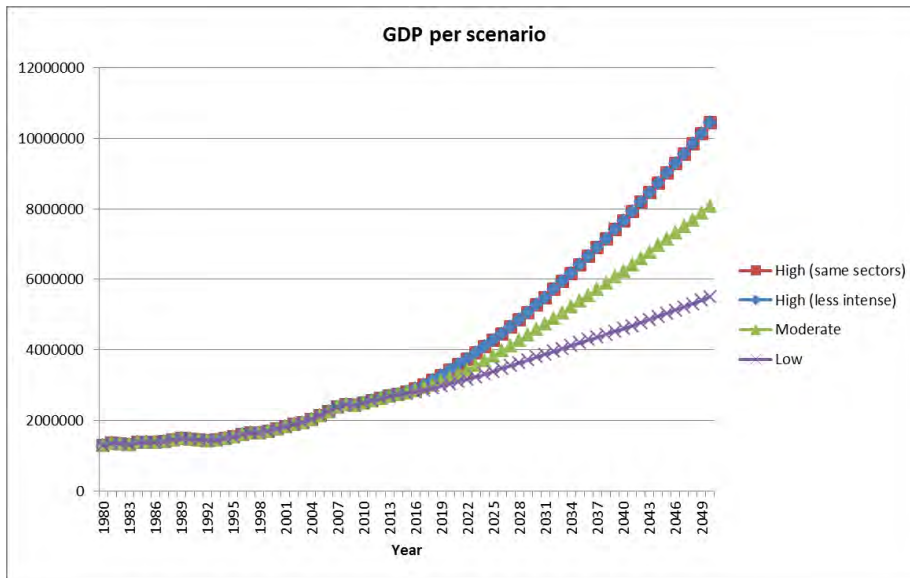
- Explanatory Forecasting: Multiple regression models used
 - In order to translate changes in the “driver” variables in scenarios into electricity changes, not just unchanged extrapolations
 - NOTE: care must be taken not to over-interpret “drivers”
 - Predictors are not necessarily “causes” of consumption
- Criteria used to assess models:
 - Statistical goodness-of-fit statistics: adjusted R^2 , RMSE, residual patterns
 - Residual patterns acceptable and coefficients statistically significant
 - Logical set of “forecast drivers”
 - Measures of multi-collinearity: condition index < 30
 - Stability with regard to scenario predictions

Sector regression models

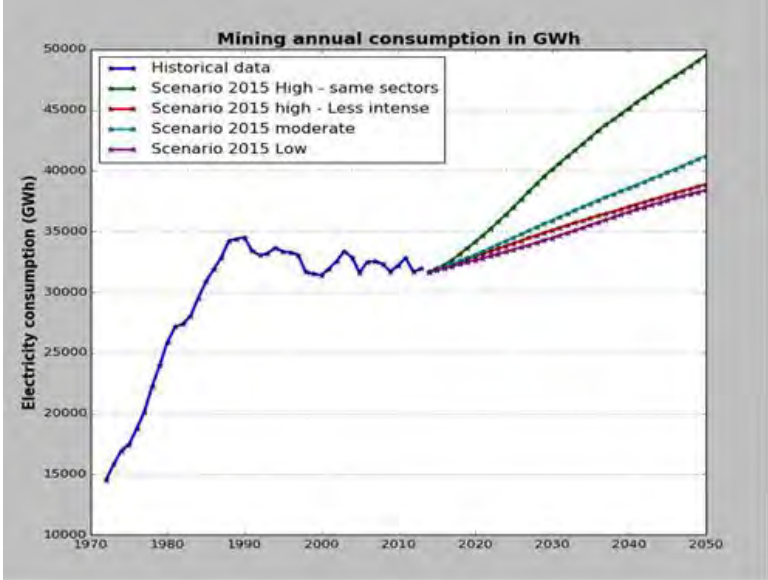
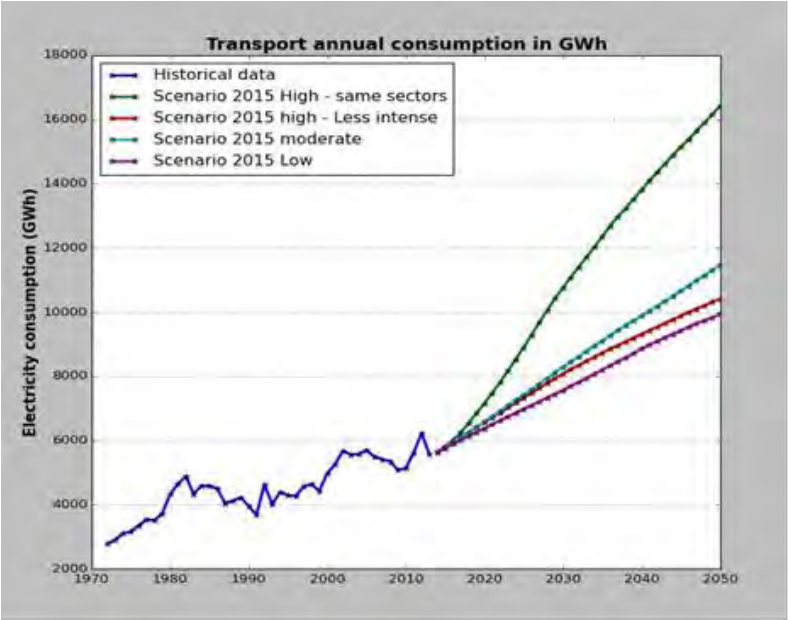
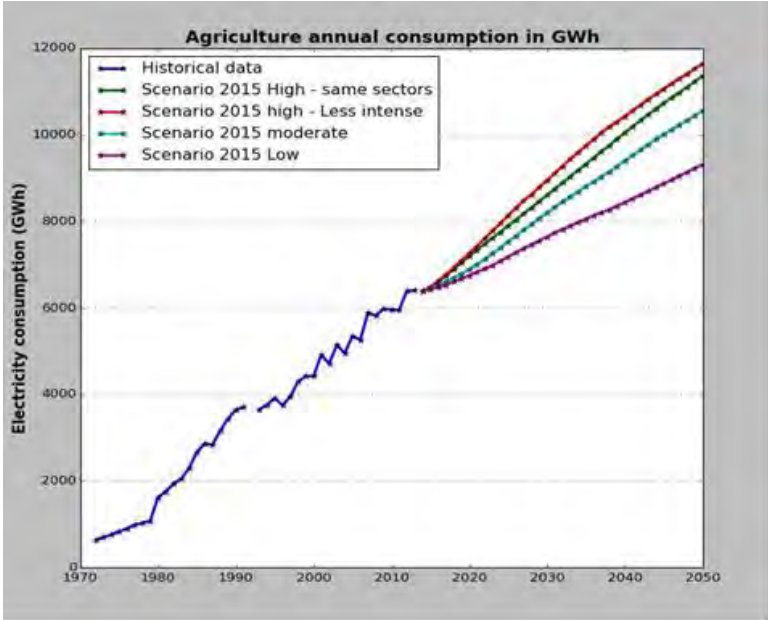
- Sectoral regression models used for IRP 2015/6 forecasts:

Electricity sector	Model used (<i>Note: the “predictor variables” indicated in bold in each model</i>)	Adjusted R ²	Condition index
Agriculture	$-47339 + 3725.82 \times \ln(\mathbf{FCEH})$	Adjusted R ² = 0.97	N/A if only 1 variable in model
Transport	$975.24 + 45.61 \times \mathbf{mining\ index\ excluding\ gold}$	Adjusted R ² = 0.74	N/A if only 1 variable in model
Domestic	$-410694 + 31840 \times \ln(\mathbf{FCEH}) + 2339.48 \times \mathbf{recession}$	Adjusted R ² = 0.97	CI = 1.4
Commerce & manufacturing	$11000 + 0.02259 \times \mathbf{FCEH} + 687.14368 \times \mathbf{manufacturing\ index} \times \mathbf{correction\ factor}$	Adjusted R ² = 0.9691	CI = 21.27
Mining	$21784 + 75.868 \times \mathbf{mining\ production\ index\ (excl.\ gold)} + 0.05268 \times \mathbf{gold\ ore\ treated}$	Adjusted R ² = 0.55	CI = 6.3

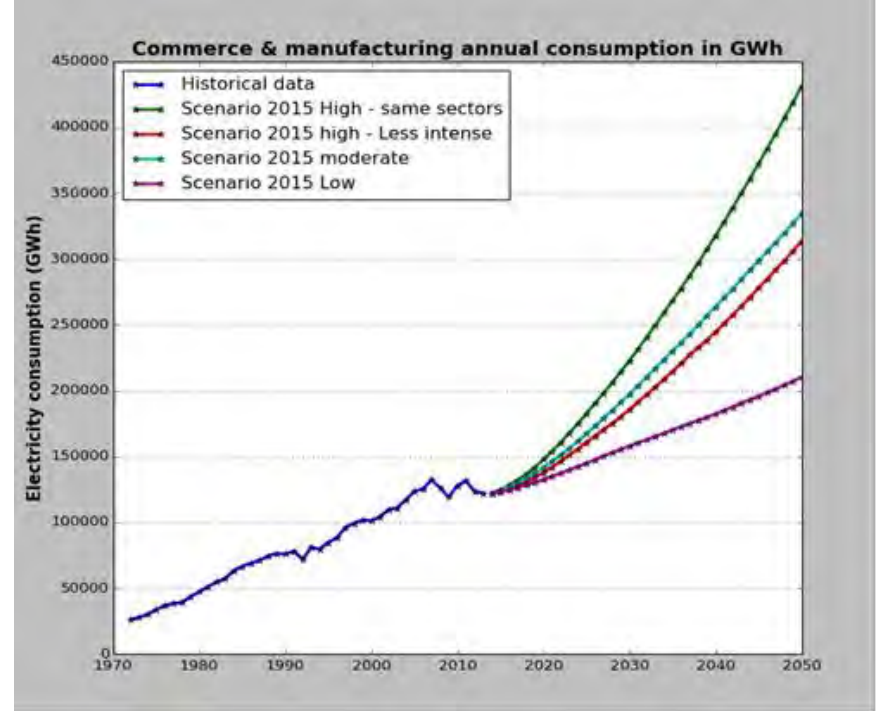
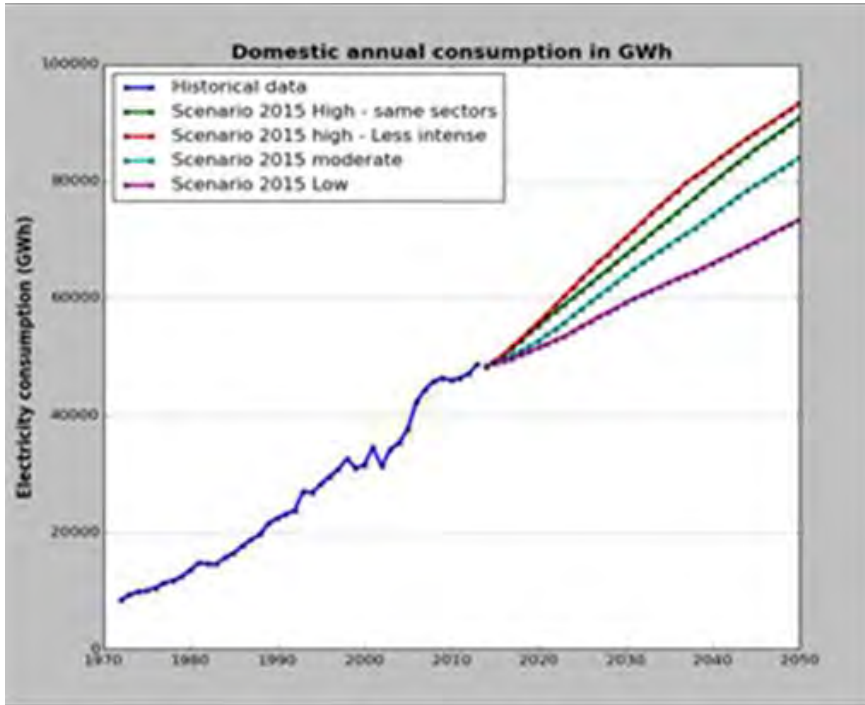
Four economic scenarios used as “driver” inputs



Sector forecasts obtained from regression models

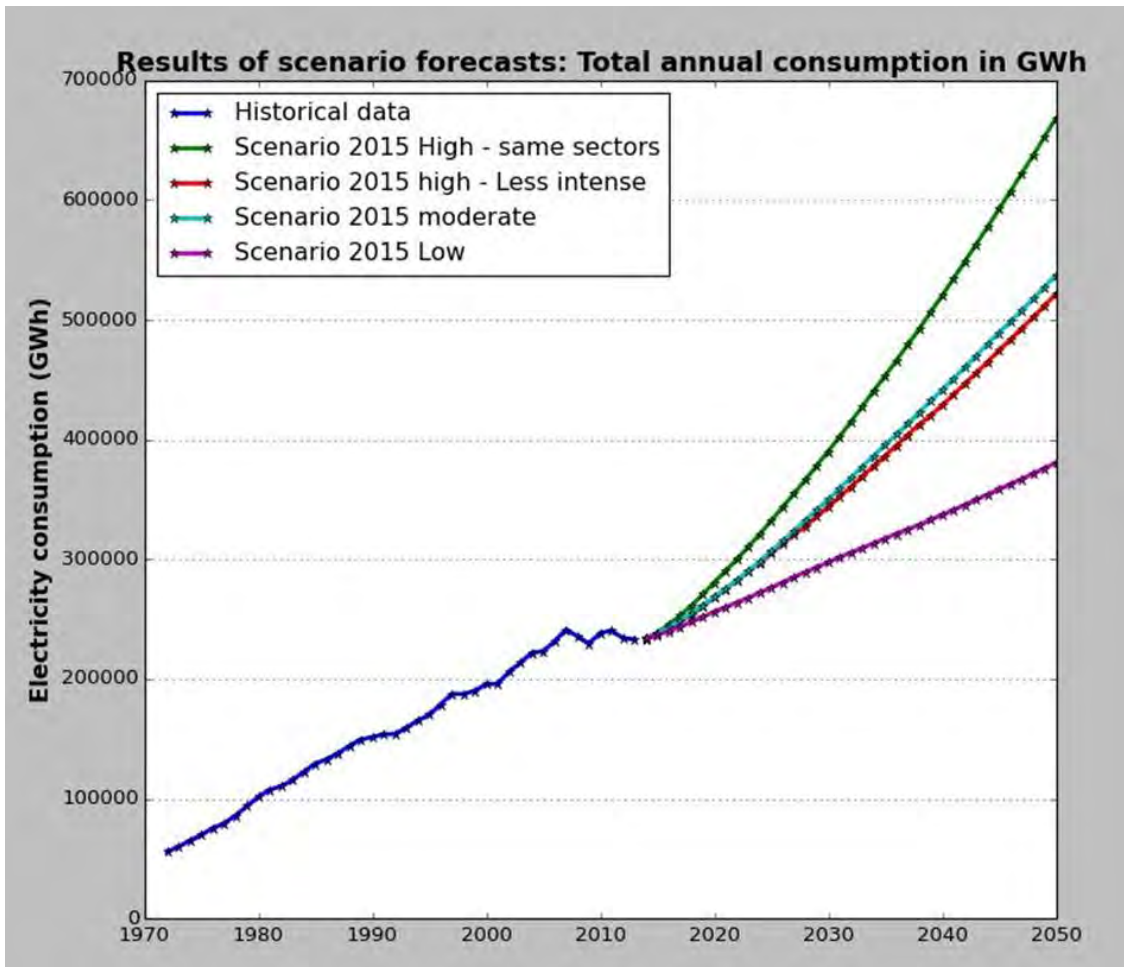


Sector Forecasts (...2)



National forecasts

- Total consumption forecasted by adding up consumption of all 5 sectors and adjusting for losses



Scenario:	Overall growth (2014 to 2050)	Avg year-on-year growth
Low scenario	62.8%	1.7%
Moderate scenario	129.9%	3.6%
High (same sectors) scenario	185.9%	5.2%
High (less intense scenario)	123.9%	3.4%

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