

Introduction to AEMO Power System Operations

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OVERVIEW



1. The NEM

2. Power System Operation Functions

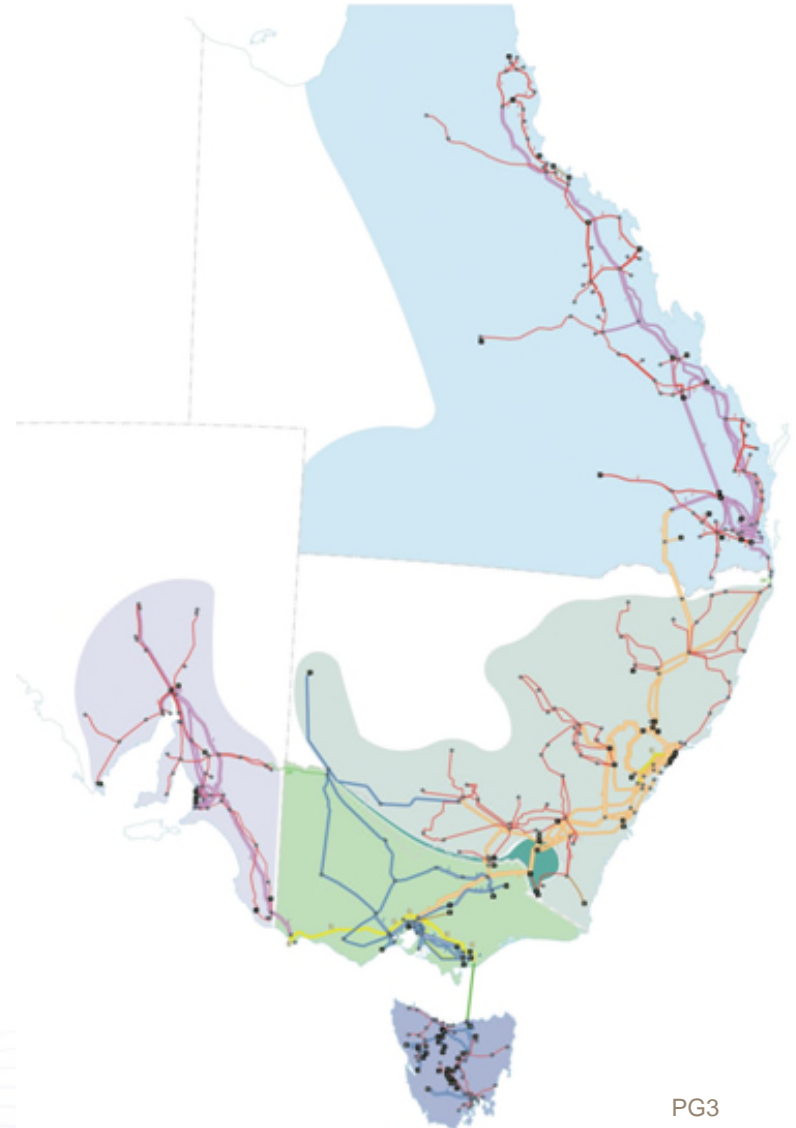
3. Operational Forecasting

4. Changing Nature of Power System Operations

NEM

The National Electricity Market (NEM) is one of the **world's largest** interconnected power systems

- runs for more than 5,000 kms from Port Douglas in Queensland to Port Lincoln in South Australia
- supplies more than \$10 billion electricity annually to meet the demand of more than 8 million end users.



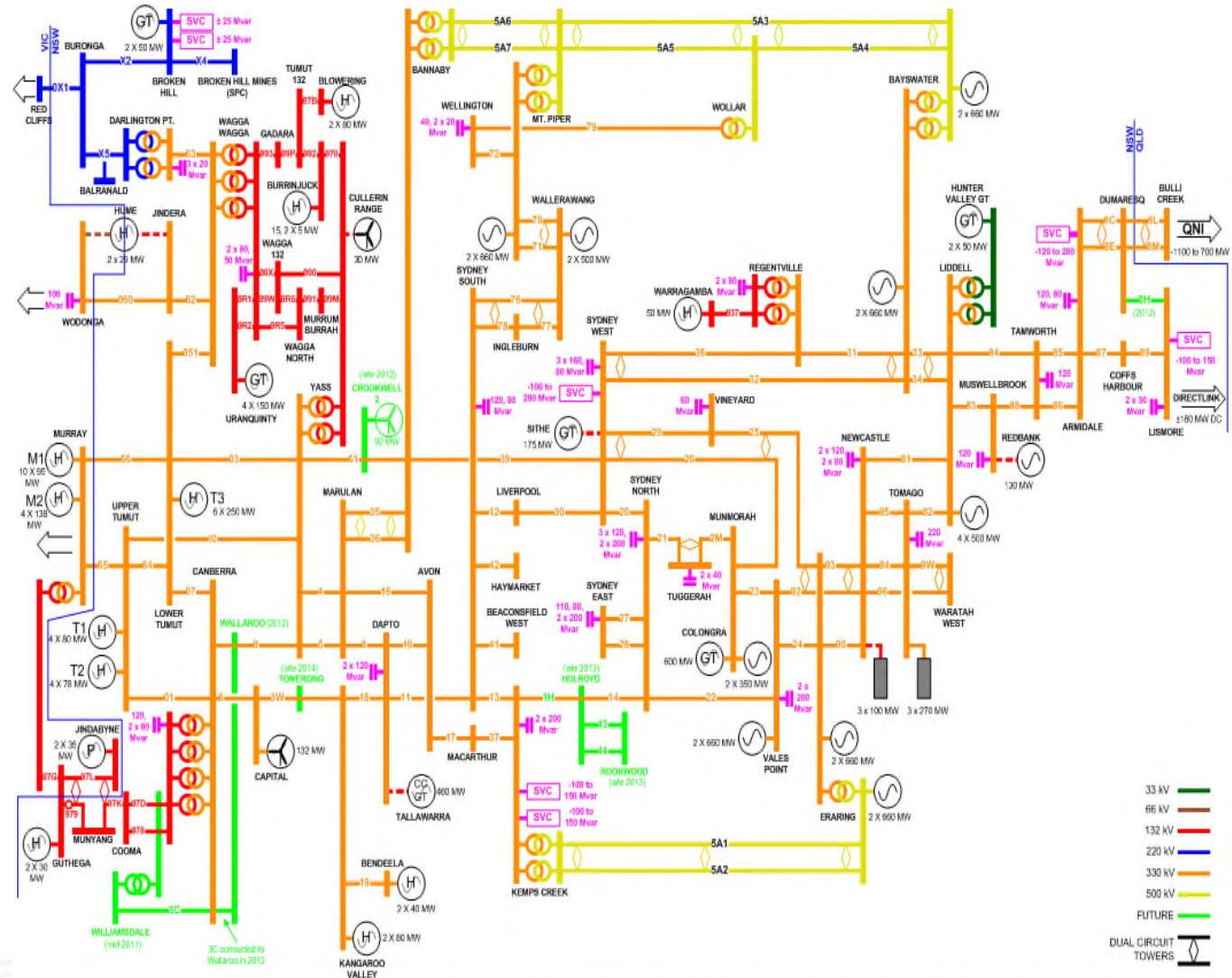
- Characteristics:
 - Geographically long & skinny ~ (5300 kms)
 - Maximum demand ~ 35,600 MW
 - Installed capacity ~ 42,500 MW
 - Energy ~ 190 million MWh pa
 - Market ~ \$10 billion pa
 - Registered generators ~ 70
 - Network service providers ~ 30
 - Wholesale market customers ~ 49
 - Retail customer transfers ~ 1.7 million pa

Power System Operations Functions

POWER SYSTEM OPERATION

Make sure the lights stay on

- System Normal
- Outages of equipment
- Emergencies like bush fires, floods etc



- Two control centres
 - Brisbane
 - Sydney
- Operate as co-primary, as opposed to main and back up
- Staffing – 5 per shift –
 - 2 operators per control centre plus 1 shift manager
 - Planning to move to 4 in 2016
- Duplicate EMS Systems at each site
- Duplicate Market Systems at each site

Core Functions of AEMO

- **MANAGE SYSTEM SECURITY**

- Ensure transmission network can support demand

- Coordinate planned network outages

- Analyse credible events

- Coordinate recovery from major incidents

- **MANAGE MARKET DISPATCH**

- Forecast demand for each Region and forecast wind generation

- NEM Dispatch Engine (NEMDE) runs every 5 minutes

- Sets Dispatch Price (5 min) and Spot Price (30 min)

- Dispatches generating units (5 min) and monitors compliance

MAINTAIN RELIABILITY (RESERVE)

- Forecast Demand
- Determine available Reserve (NER 4.8.4)
 - LOR1 – reserve < 2 largest units
 - LOR2 – reserve < largest unit - load shedding possible for next contingency
 - LOR3 – reserve < 0 - load shedding actual or imminent
 - LRC – available generation < 10% POE demand + reserve intervention threshold level
- Intervention if Required
 - Directions (NER 4.8.9)
 - Reserve Trader (NER 3.20)

- Identify Credible Contingencies
- Determine Risks
- Take Action to maintain or restore a Secure Operating State

Ensure ancillary services requirements met

Planned network outage assessment

Contingency plans

System reconfiguration

Intervention - direct participants

DISPATCH OF GENERATION

- Real Time Demand Forecasting
- Application of network constraints
- Monitoring of Conformance
- Control of Frequency via Automatic Generation Control

- Market Notices for:
 - Lack of Reserve
 - System Security Risks
 - Non Conformances
 - Unusual Conditions
 - Market Failure (Suspension)

For Real Time Dispatch

- In dispatch it forecasts regional demand 5 minutes ahead (i.e. end of the next dispatch run) this in order to determine more accurately the dispatch price and reduce need for frequency regulation
- For this purpose it employs a neural network

For Forecasts of Price and Reserve for Today & Tomorrow

- AEMO uses an automated forecasting system which runs every 30 minutes with automatic in-feeds of weather data to forecast regional demand on 30 minute resolution
- The forecaster employs a variety of models depending upon the time-frame with forecasting for timeframe of 12 hours and less relying more on recent history and relying more on weather based models for longer timeframe
- Changing nature of the load particularly residential PV is creating significant challenges with updates to the models now underway

For Forecasts of Reserve up to a week ahead

- For this purpose AEMO uses the same forecasting application to provide a forecast of regional reserve up to a week ahead on a half hour resolution

For Forecasts of Reserve up to a two years ahead

- For this purpose AEMO uses a different approach which takes the results of the long term forecasts (discussed later) and estimates for each day in the period
 - Expected demand (expected weather conditions) and
 - 10% probability of exceedance demand

Longer term Forecasts up to 10 years ahead

- For planning purposes and regulatory purposes

FORECASTING OF WIND AND LARGE SCALE SOLAR GENERATION



Forecasting of wind generation is becoming increasingly important and AEMO uses separate forecasting systems to provide these forecasts over a similar range of timeframes

- **Real Time** (5 minutes ahead)
- **Today and Tomorrow** (30 min resolution expected output for Pricing forecasts)
- **Up to seven days ahead** (30 min resolution 10% , 50% and 90% POE for reserve calculations)
- **Up to 2 years ahead** (daily resolution 10% , 50% and 90% POE for reserve calculations)

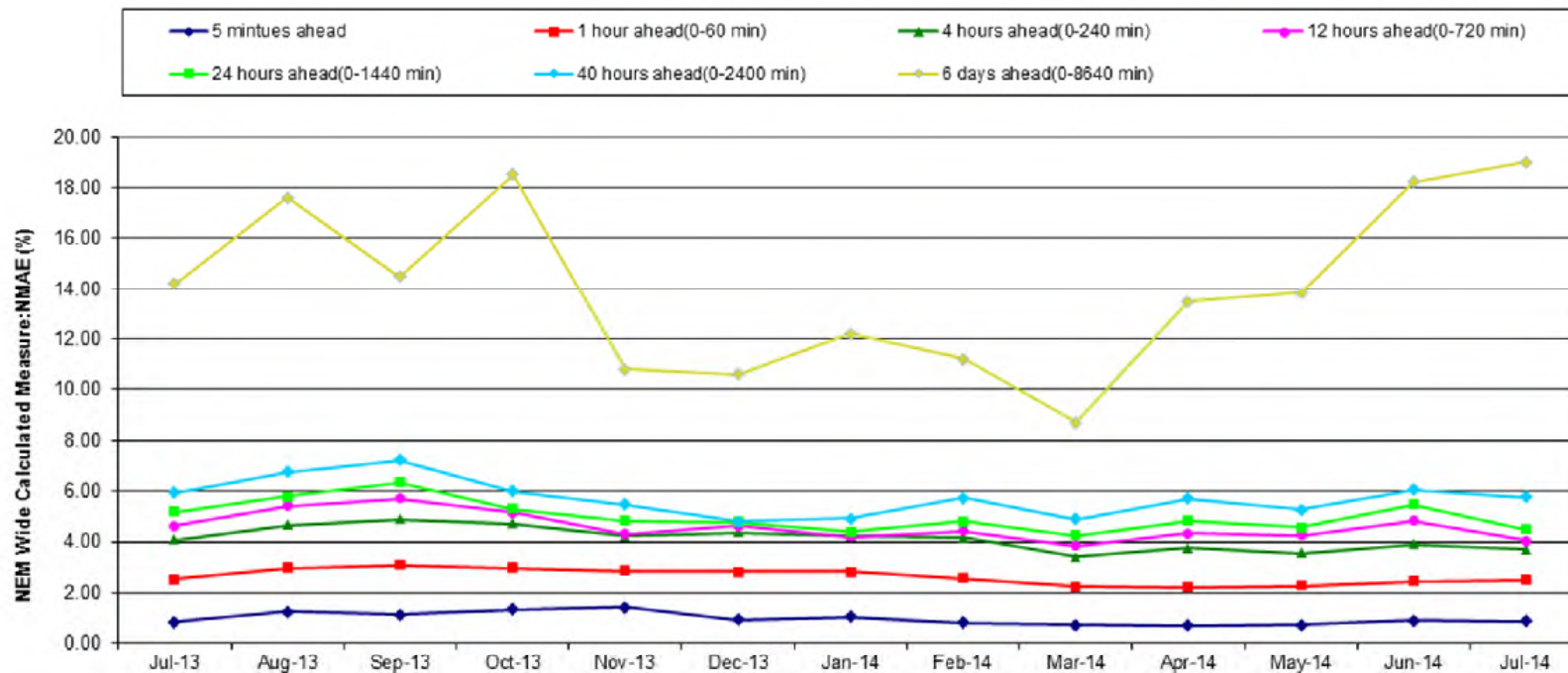
This forecast depends upon

- Detailed weather forecasting model for wind
- Real time data from wind farms
- Technical data related to energy conversion efficiency

Now being extended to large scale solar forecasting

NEM WIND FORECASTING PERFORMANCE

NEM Region Wind Forecasting Performance



	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14
5 minutes ahead	0.85	1.26	1.12	1.33	1.41	0.92	1.05	0.83	0.73	0.69	0.73	0.90	0.87
1 hour ahead(0-60 min)	2.52	2.97	3.09	2.98	2.84	2.81	2.81	2.57	2.24	2.22	2.27	2.44	2.49
4 hours ahead(0-240 min)	4.08	4.65	4.88	4.70	4.22	4.36	4.21	4.16	3.41	3.76	3.55	3.89	3.70
12 hours ahead(0-720 min)	4.62	5.41	5.70	5.14	4.31	4.64	4.18	4.42	3.84	4.33	4.26	4.83	4.05
24 hours ahead(0-1440 min)	5.18	5.80	6.35	5.29	4.82	4.77	4.40	4.80	4.24	4.83	4.56	5.48	4.48
40 hours ahead(0-2400 min)	5.95	6.75	7.22	6.00	5.48	4.80	4.93	5.72	4.88	5.69	5.26	6.05	5.76
6 days ahead(0-8640 min)	14.20	17.60	14.50	18.50	10.80	10.60	12.20	11.20	8.69	13.48	13.82	18.22	19.00

CHANGING NATURE OF POWER SYSTEM OPERATIONS



A number of factors are transforming power system operations

- Growth of renewables and distributed generation
- Reduction in conventional generation
- Rise in demand side response
- Reduction in base load

We are seeing a new range of issues

- Low inertia
- Reduced fault levels
- Reduced availability in ancillary services
- Reduced voltage support in some areas
- Challenges in managing minimum loads
- Less certainty in forecasting reserve conditions

At the same time need to pursue productivity improvements

QUESTIONS

