Changes to the 18-Month Outlook

Forecasts and Assessments Standing Committee Meeting

April 20, 2006

Meeting Agenda

Coffee and Muffins 8:30

1. Introduction – Greg Hine 9:00
2. Demand Forecast Normalization
   – Andrew Trachsell 9:15
3. Hydroelectric Capability Forecasts
   – Greg Hine 10:15

Break 11:00

4. Impacts of Changes on Reserve Above Requirements
   – Greg Hine 11:15
5. Required Reserve Calculation – Dan Rochester 11:30
6. Next Steps - Anne Barr

   Adjourn 12:00

Stakeholder Engagement (SE-19)

- Changes to 18-Month Outlook (SE-19)
  The challenges to maintain reliability of Ontario's bulk power system during the summer of 2005 that were related to high demands and lower hydroelectric generation have prompted changes to the calculation of supply adequacy for the purposes of reliability assessments.
- Specifically, the IESO is adjusting its forecasts for peak demand and hydroelectric capability to more accurately align with expected circumstances, particularly over peak periods, and to allow plans to be developed to ensure Ontario is better prepared.
- The impact these changes will have on the calculation of supply adequacy is illustrated in the 18-Month Outlook reliability assessment published on March 24, 2006.

Stakeholder Engagement

III. Stakeholder Engagement Goals and Objectives

Goal

To educate stakeholders on the changes made in the 18-month outlook and to solicit feedback on the impact of those changes to stakeholders.

IV. Stakeholder Engagement Approach and Methods

The stakeholder approach will be to present the information at the Forecasts and Assessments Standing Committee meeting with a request for written feedback on the different methodologies applied.

This is a public consultation and information supplied will be posted on the IESO website including identification of the participant.

Stakeholder Engagement Schedule

Activity	Target Date
1. Issue 18-Month Outlook demonstrating both methodologies.	March 24
2. Post stakeholder plan.	April 7
3. Open stakeholder session at FASC Meeting. Session will provide stakeholders with rationale for change and will invite stakeholder feedback via e-mail.	April 20
4. Deadline for feedback from stakeholders.	May 4
5. Posting IESO response to stakeholder input	May 18
6. Potential IESO Market Manual change process.	May/ June

- The perfect forecast?
- The perfect Outlook?

Demand Forecasting

Reliability Standards & Assessments
Andrew Trachsell

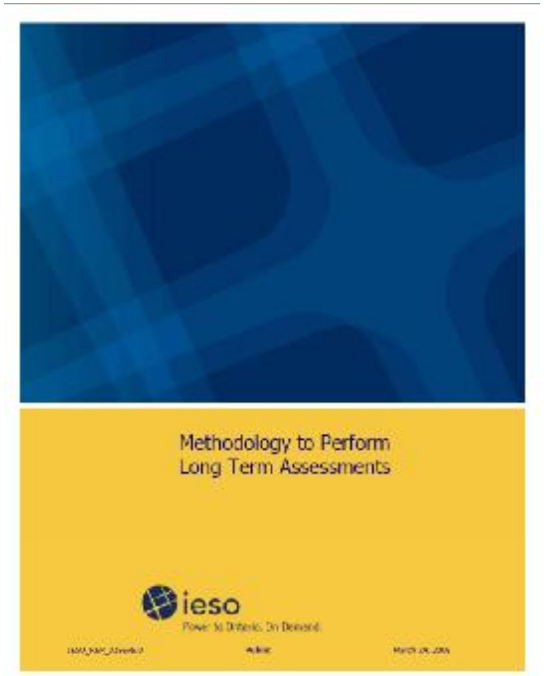
Demand Forecasting

- Demand Forecasting
  - Form and drivers
  - Forecast of drivers (Calendar, Growth, Weather)
- Weather Scenarios
  - Weather Impact
  - Generating Scenarios
  - Mapping
- Results
  - Summer
  - Winter
  - Uncertainty

Methodology

Methodology to Perform Long Term Assessments

- http://www.ieso.ca/imoweb/pubs/marketReports/Methodology_RTAA_2006mar.pdf



Ontario Demand Forecast

- http://www.ieso.ca/imoweb/pubs/marketReports/18Month_ODF_2006mar.pdf

Demand Equations

$$Y_t = \alpha + \beta_t X_t$$

- Actual Demand
  - Hourly
  - Daily Peak
  - Daily Energy

- Calendar
- Growth
- Actual Weather

Independent Variables

- Calendar
  - Days of the week
  - Daylight savings time
  - Sunrise and sunset by location (London, North Bay, St. Catharines, Thunder Bay, Toronto & Windsor)
  - Holidays & Fuzzy Holidays
- Growth
  - Economic activity (Employment)
  - Demographics (Housing stock)
  - Both can be estimated at the zonal level
- Weather
  - Six weather stations (Kapuskasing, North Bay, Ottawa, Thunder Bay, Toronto & Windsor)
  - Four weather elements (Temperature, dew point, cloud cover and wind speed)

Models

- Daily energy models
  - For system and 10 zones
- Daily peak models
  - For system and 2 zones
- Hourly demand models
  - For system and 10 zones

Forecast Drivers

- Calendar
  - Pretty easy to forecast
    - Have updated changes to Daylight Savings Time
- Growth
  - Consensus forecast
    - Employment and housing starts
    - For next 2 years
  - Population Projections
    - Proxy employment and housing stock growth based on Ministry of Finance population projections
- Weather Scenarios

Demand Forecasting

- Demand Forecasting
  - Form and drivers
  - Forecast of drivers (Calendar, Growth, Weather)
- Weather Scenarios
  - Weather Impact
  - Generating Scenarios
  - Mapping
- Results
  - Summer
  - Winter
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Weather Scenarios Methodology

- Methodology is the same regardless of the normalization period (week, month or season)
- We use weather history from January 1st, 1970 to the present
- For each day in history the weather is given a "weather impact" based on the conditions of that day
- For example
  - January 14th, 1988
    - Afternoon high of (-14.3) °C
    - Wind speed of 10 km/hr
    - Cloudy periods
    - Combined for a weather impact of 4,830 MW

Demand Model

Demand = *f* (weather, calendar, economic)

Demand = *f* (temperature, humidity, cloud cover, wind speed, calendar, economic)

$$Demand_t = \alpha + \beta_1 * Temp_t + \beta_2 * Humidity_t + \beta_3 * Wind_t + \beta_4 * Cloud_t + ... + \varepsilon_\tau$$

$$Demand_t = 9854 + 113 * Temp_t + 41 * Humidity_t + 11 * Wind_t + 68 * Cloud_t + ... + \varepsilon_\tau$$

$$Weather\ Impact_t = 113 * Temp_t + 41 * Humidity_t + 11 * Wind_t + 68 * Cloud_t$$

Use the model to quantify the “weather impact”

Weather Impact

- Combine weather observations with weather coefficients from the model

- January 14th, 1988
  - 4,522 MW from the temperature (-14.3 °C)
  - 108 MW from the wind (10 km/hr)
  - 200 MW from cloud (partly cloudy)
  - 4,830 MW of combined weather impacts

Generating Normal Weather

1. Within the normalization period the weather impacts are ranked from highest to lowest
2. We then take the median values across the years
3. The median value of the highest ranked weather impact becomes the first day in the normalized weather
4. The median value of the second highest ranked weather impacts becomes the second day in the normalized weather
5. This is repeated until you have normal value for each day in the normalization period.

Monthly Example for January

	1975	1976		1981	1982		1987	1988		1999	2000		2004	2005		Normal
1	4,561	5,696	-	5,599	5,874	-	4,720	**4,830**	-	5,627	5,049	-	5,418	5,291	→	4,830
2	3,953	5,202	-	5,588	5,804	-	4,188	4,482	-	4,786	4,816	-	5,125	5,121		4,639
3	3,828	5,102	-	5,367	5,296	-	4,071	4,310	-	4,597	4,609	-	5,081	4,776		4,587
4	3,716	5,101	-	4,648	4,858	-	3,947	4,202	-	4,581	4,430	-	4,856	4,731		4,376
5	3,710	4,804	-	4,598	4,755	-	3,849	4,050	-	4,514	4,399	-	4,760	4,667		4,326
6	3,647	4,477	-	4,541	4,713	-	3,839	3,966	-	4,497	4,225	-	4,726	4,583		4,230
7	3,637	4,294	-	4,464	4,532	-	3,737	3,908	-	4,262	4,220	-	4,591	4,229		4,087
8	3,593	4,193	-	4,301	4,504	-	3,628	3,794	-	4,203	4,124	-	4,538	4,008		3,954
9	3,475	4,187	-	4,209	4,459	-	3,399	3,620	-	4,086	4,038	-	4,523	3,926		3,885
10	3,326	4,144	-	4,203	4,290	-	3,345	3,569	-	4,003	3,905	-	4,522	3,912		3,861
11	3,314	4,124	-	4,082	4,284	-	3,205	3,556	-	3,979	3,901	-	4,300	3,885		3,825
12	3,190	4,119	-	4,024	4,208	-	3,152	3,484	-	3,794	3,836	-	4,261	3,868		3,782
13	3,158	4,105	-	3,990	4,208	-	3,106	3,406	-	3,715	**3,611**	-	4,188	3,648		3,611
14	2,974	4,080	-	3,857	4,192	-	2,977	3,301	-	3,579	**3,456**	-	4,142	3,584		3,456
15	2,925	4,051	-	3,837	4,189	-	2,953	3,293	-	3,434	**3,428**	-	4,102	3,557		3,428
16	2,910	3,880	-	3,742	4,115	-	2,928	3,289	-	3,277	3,354	-	4,090	3,509		3,353
17	2,896	3,510	-	3,676	4,083	-	2,915	3,228	-	3,191	3,173	-	4,079	3,439		3,261
18	2,807	3,445	-	3,660	4,059	-	2,896	**3,186**	-	2,958	2,948	-	3,994	3,188	→	3,186
19	2,702	3,445	-	3,406	3,845	-	2,833	2,915	-	2,921	2,931	-	3,946	3,156		3,025
20	2,626	3,433	-	3,390	3,739	-	2,770	2,848	-	2,848	2,848	-	3,940	3,070		2,973
21	2,623	3,405	-	3,313	3,597	-	2,712	2,817	-	2,785	2,827	-	3,931	3,017		2,928
22	2,592	3,386	-	3,075	3,445	-	2,580	2,602	-	2,651	2,714	-	3,824	2,700		2,794
23	2,560	3,144	-	3,067	3,331	-	2,578	2,507	-	2,640	2,701	-	3,646	2,666		2,755
24	2,506	3,045	-	3,042	3,218	-	2,567	2,316	-	2,635	2,503	-	3,570	2,643		2,686
25	2,417	3,038	-	3,035	3,144	-	2,560	2,303	-	2,535	2,388	-	3,319	2,636		2,652
26	2,389	3,024	-	2,923	2,886	-	**2,559**	2,141	-	2,420	2,321	-	3,164	2,535		2,559
27	2,287	2,974	-	2,863	2,886	-	**2,427**	1,967	-	2,341	2,233	-	2,926	2,527		2,427
28	2,158	2,955	-	2,854	2,862	-	2,377	1,961	-	2,224	1,988	-	2,785	2,509		2,306
29	2,089	2,946	-	2,765	2,853	-	2,309	1,798	-	2,215	1,976	-	2,336	2,449		2,262
30	1,902	2,787	-	2,452	2,576	-	2,174	1,792	-	2,010	1,809	-	**2,108**	2,215	→	2,108
31	1,515	2,131	-	1,779	2,413	-	1,998	1,263	-	1,509	1,784	-	1,389	811		1,844

Monthly Example for January

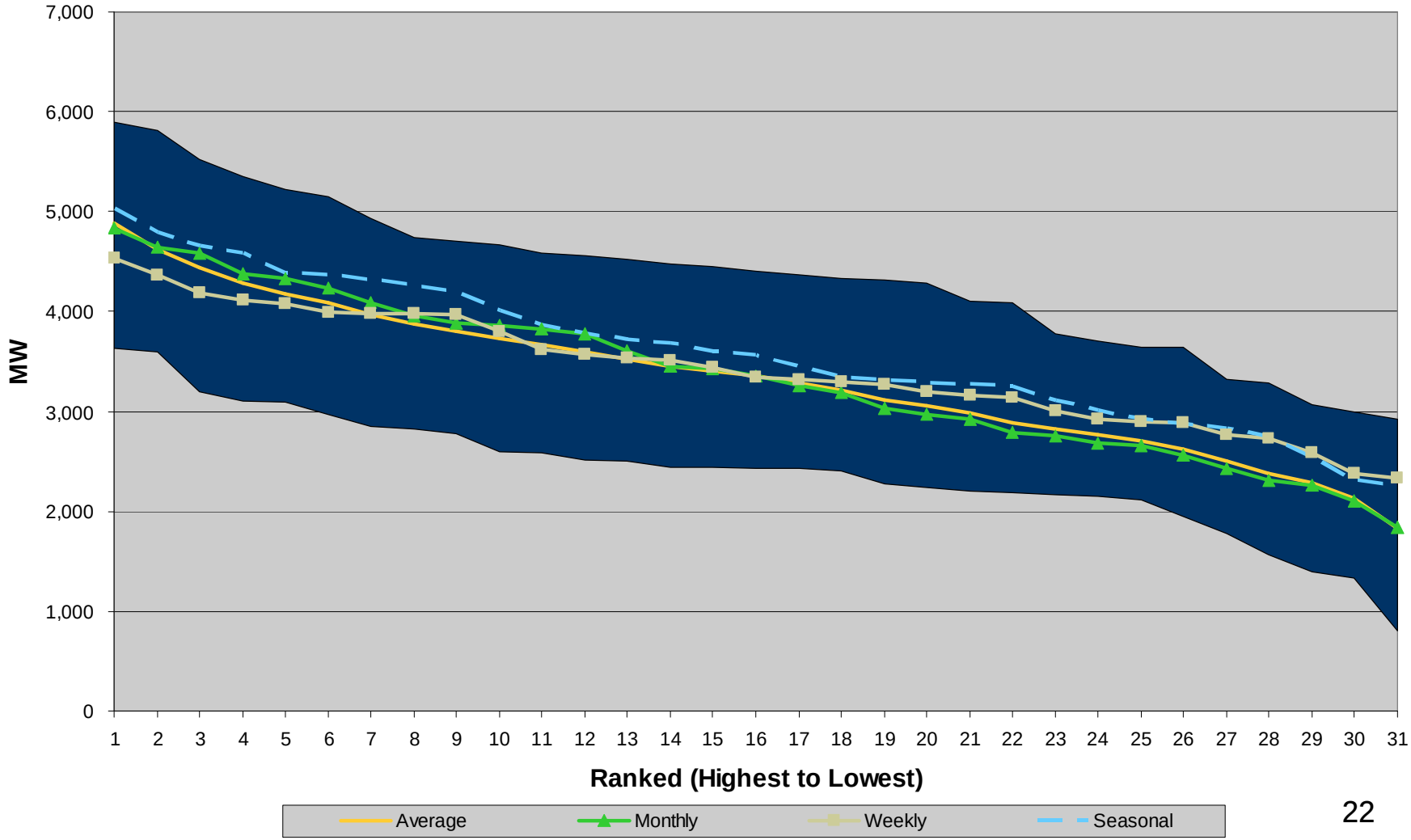
- Each day of the normal weather is represented by a weather from a day in history
- This enables consistency across the province
- Each zone will have a distinct set of weather conditions based on January 14th , 1988

Normal		Normal
4,830	→	14-Jan-88
4,639		05-Jan-96
4,587		14-Jan-78
4,376		16-Jan-85
4,326		30-Jan-97
4,230		17-Jan-92
4,087		26-Jan-03
3,954		11-Jan-97
3,885		12-Jan-97
3,861		01-Jan-97
3,825		17-Jan-85
3,782		31-Jan-79
3,611		19-Jan-00
3,456		15-Jan-00
3,428		24-Jan-00
3,353		31-Jan-86
3,261		07-Jan-80
3,186	→	22-Jan-88
3,025		13-Jan-80
2,973		21-Jan-80
2,928		22-Jan-80
2,794		06-Jan-93
2,755		26-Jan-86
2,686		10-Jan-86
2,652		16-Jan-80
2,559		12-Jan-87
2,427		06-Jan-87
2,306		23-Jan-96
2,262		24-Jan-83
2,108	→	02-Jan-04
1,844		11-Jan-80

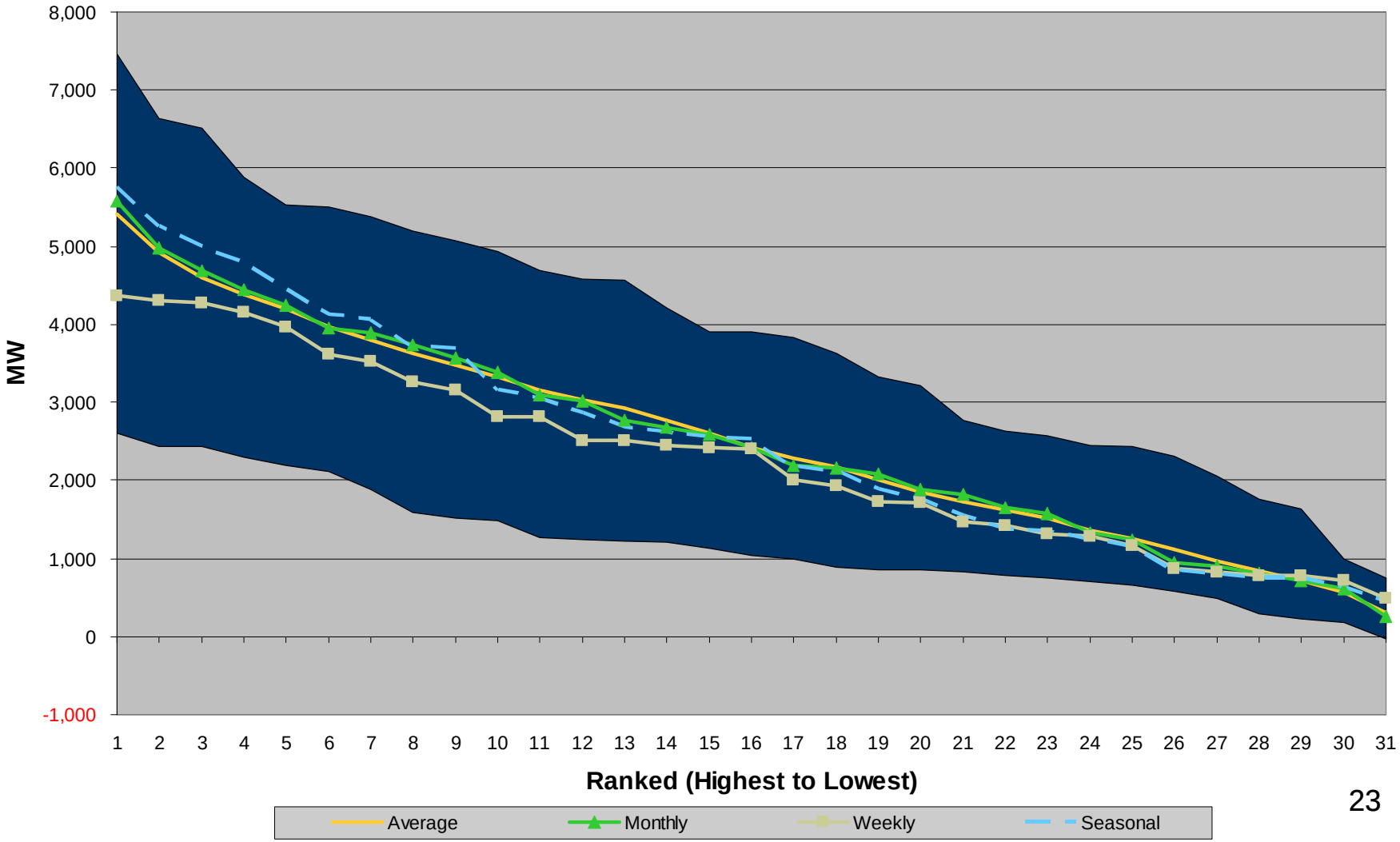
Changes in Weather Scenarios

- Summer & Winter
  - Moved from weekly to monthly normalization
- Given a larger normalization period (or sample size) the rank and sort approach
  - Higher peaks & Lower minimums
  - Weekly < Monthly < Seasonal
    - Weekly Summer Peak - July 4, 2005 (4,369 MW)
    - Monthly Summer Peak - July 6, 1993 (5,584 MW)
    - Seasonal Summer Peak - June 25, 2003 (5,759 MW)

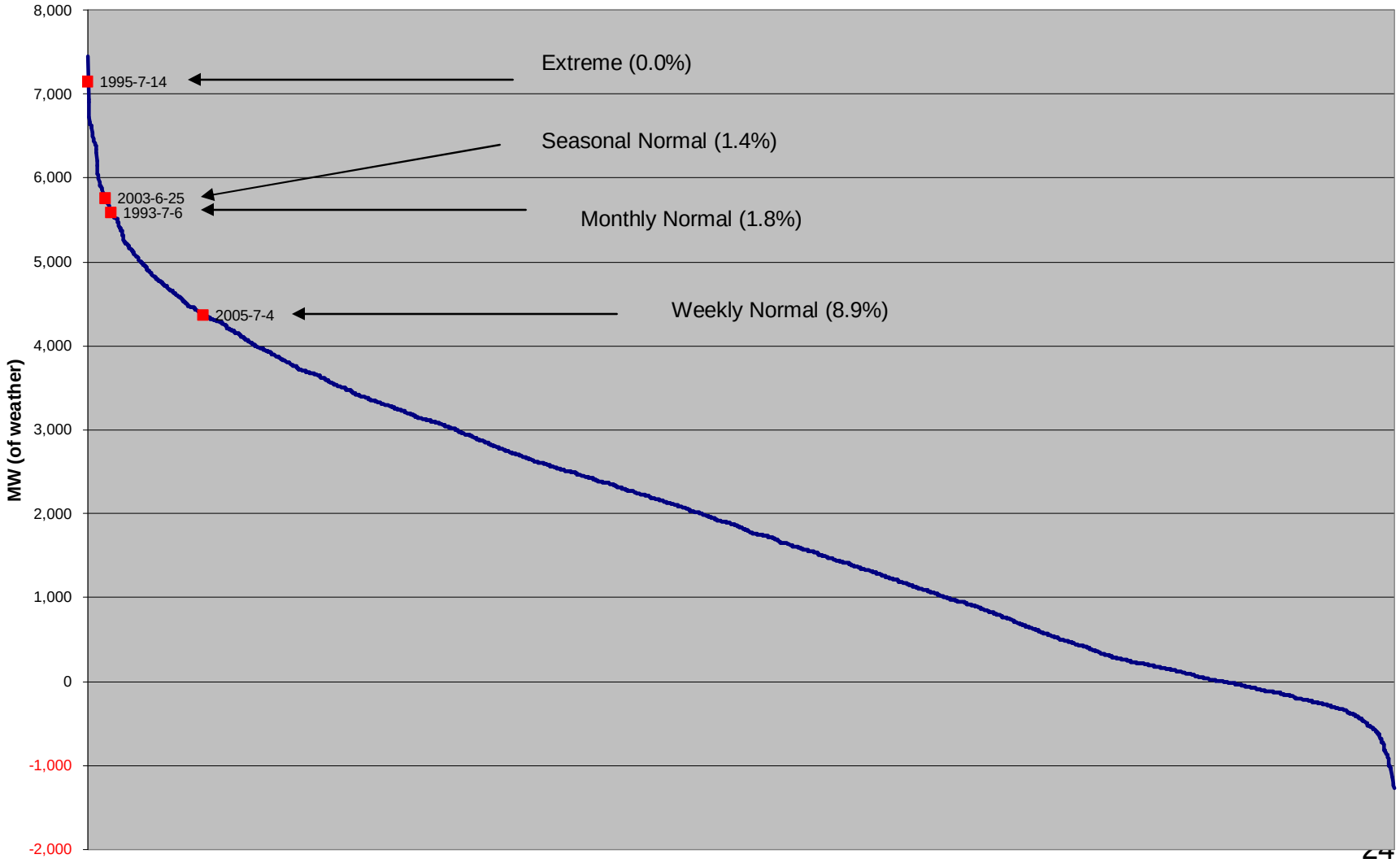
Daily Peak Weather Factor - January



Daily Peak Weather Factor - July



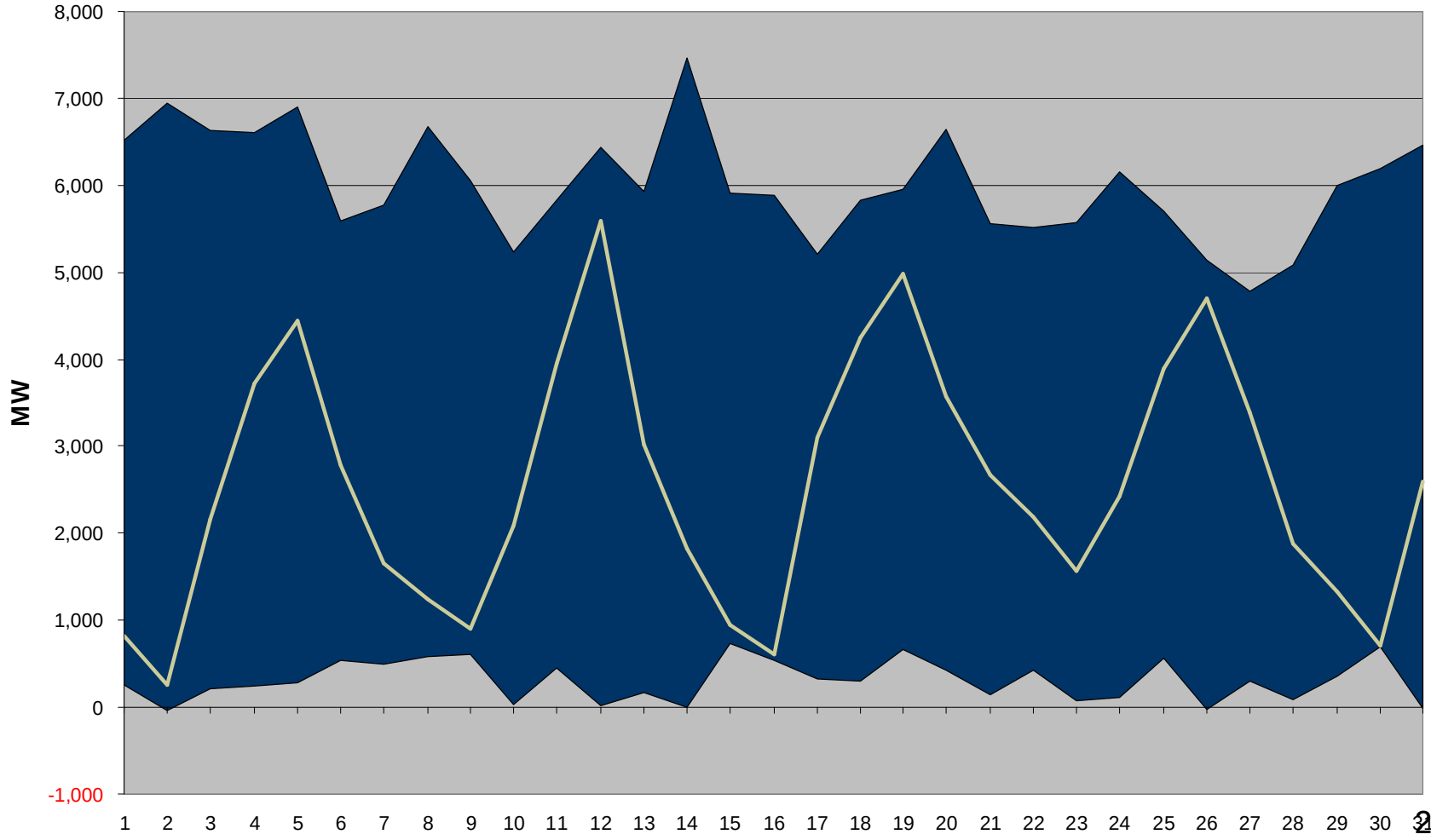
Summer Weather Impacts



Mapping Weather to Days

- Daily weather in each scenario has to be mapped to the calendar
- Weeks are mapped so that the biggest weather impact occurs on Wednesday
  - Conservative approach to avoid weekends and holidays
- Monthly and Seasonal weather is mapped based on the ranking of the weekly weather

Mapping for July 2006



Variety of Weather Scenarios

- Normalization period
  - Daily, weekly, monthly & seasonal
- Type
  - Median (Normal), extreme & mild
- History
  - All history, 30, 10 or 5 years
- Load Forecast Uncertainty
  - Measure of the volatility in demand due to fluctuations in weather
  - Represents normal weather plus one standard deviation in demand
- Historic Years
  - Certain historic years are of interest – 2002 & 2005

- Each scenario serves a specific purpose

Demand Forecasting

- Demand Forecasting
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  - Forecast of drivers (Calendar, Growth, Weather)
- Weather Scenarios
  - Weather Impact
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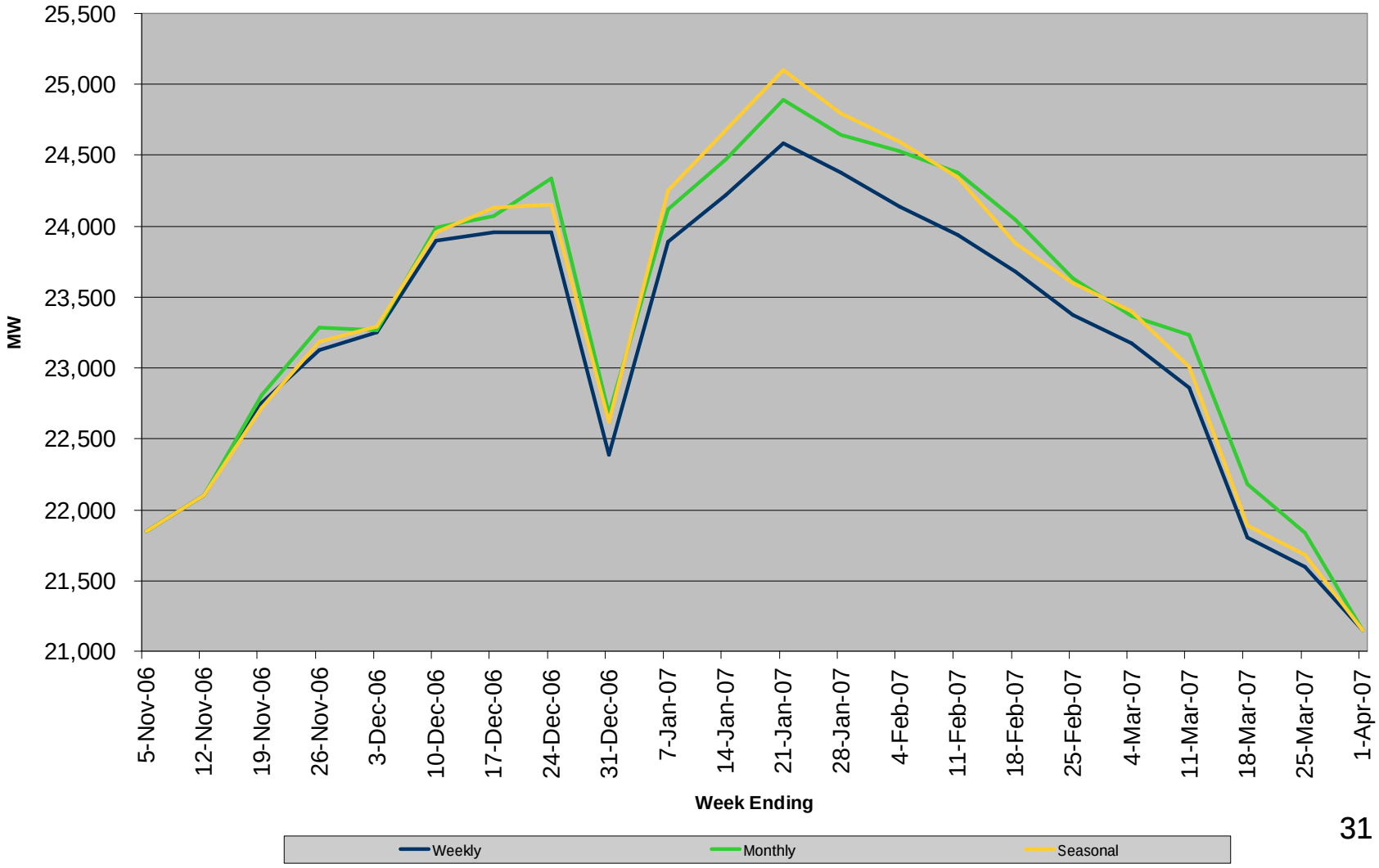
Results

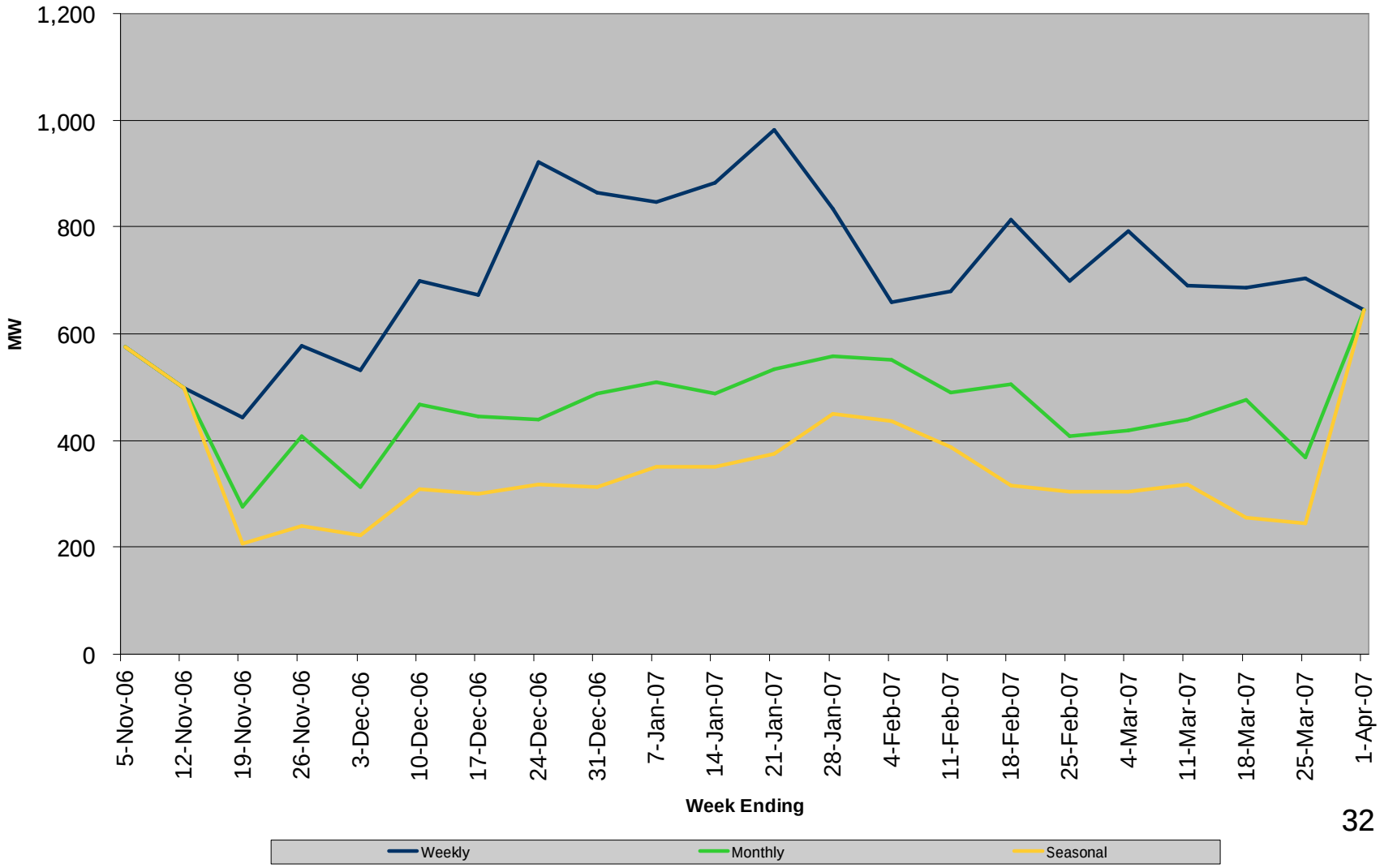
- Generate demand forecasts based on:
  - Weekly normalized – Normal, LFU & Extreme
  - Monthly normalized – Normal & LFU
  - Seasonally normalized - Normal

Weekly Peak Demand – Summer 2006

Weekly Peak Demand
Winter 2006-07



Weekly Load Forecast Uncertainty
Winter 2006-07



Demand Forecasting

Questions?

Hydroelectric Capability Forecasts

Reliability Standards & Assessments
Greg Hine

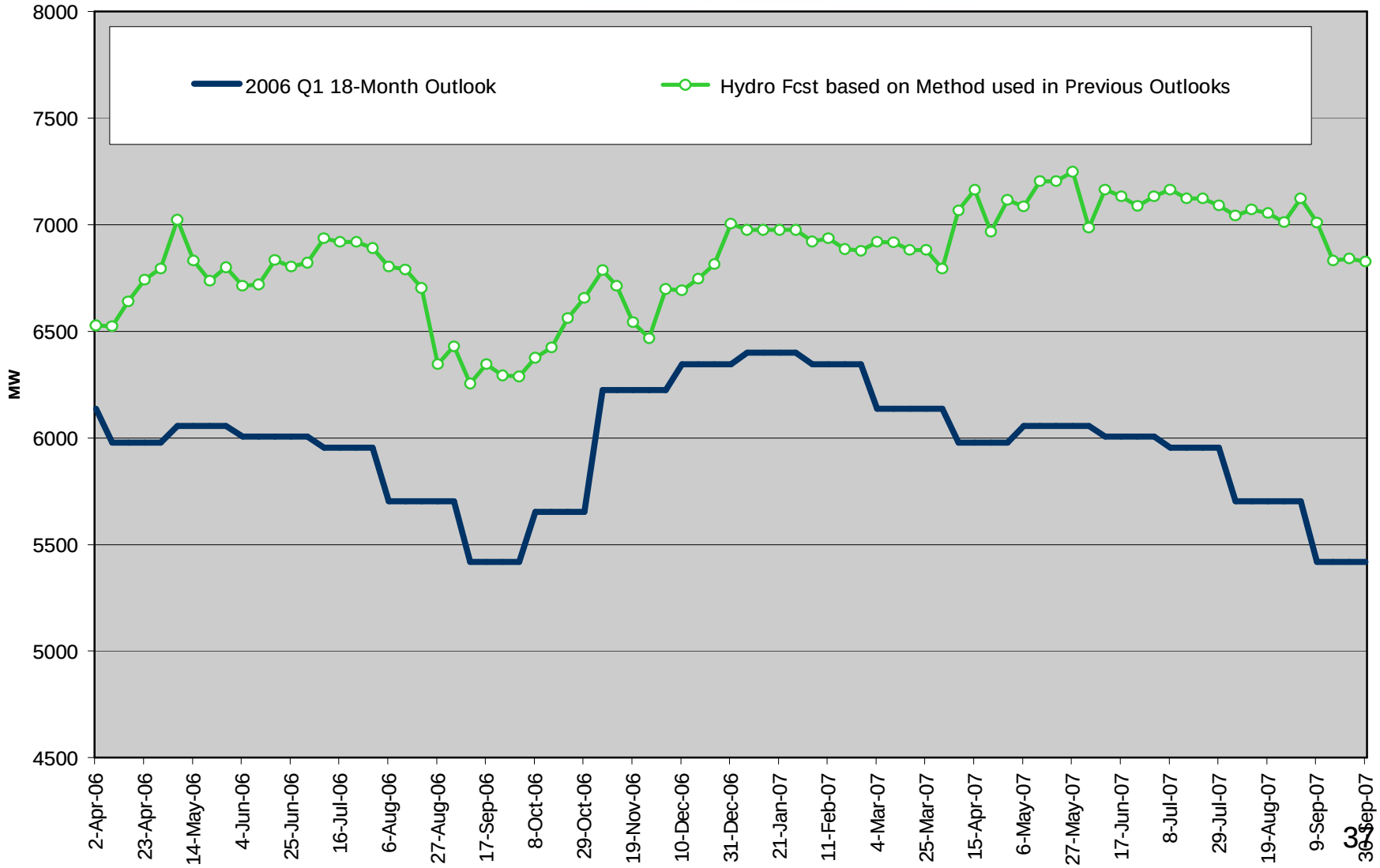
Hydro Resource Scenario
Why Review Modelling Assumptions?

- Previous L&C input: MP estimate of net maximum generation output that can be sustained for one hour or more, 5 days a week (Form 1230)
- In most cases, this estimate is equivalent to the station MCR which does not consider the coincident capability of all hydro units & stations
  - This results in potential overstating of hydroelectric capability at the time of system peak

New Methodology

- Using historical values corresponding to the 1-hr peak on weekdays since market opening, the IESO determined monthly median values of:
  - Hydroelectric production, and
  - Operating reserve (OR) offers accepted from hydro units.
- For the summer months of June, July, and August,
  - Monthly median hydroelectric production values range from 4500 MW to 5200 MW, and
  - Monthly median accepted OR offers from hydro units range from 700 MW to 900 MW.
- New hydro forecast equals monthly median hydroelectric production plus accepted OR offers from hydro units.

New Hydro Capability Forecast (1)



New Hydro Capability Forecast (2)

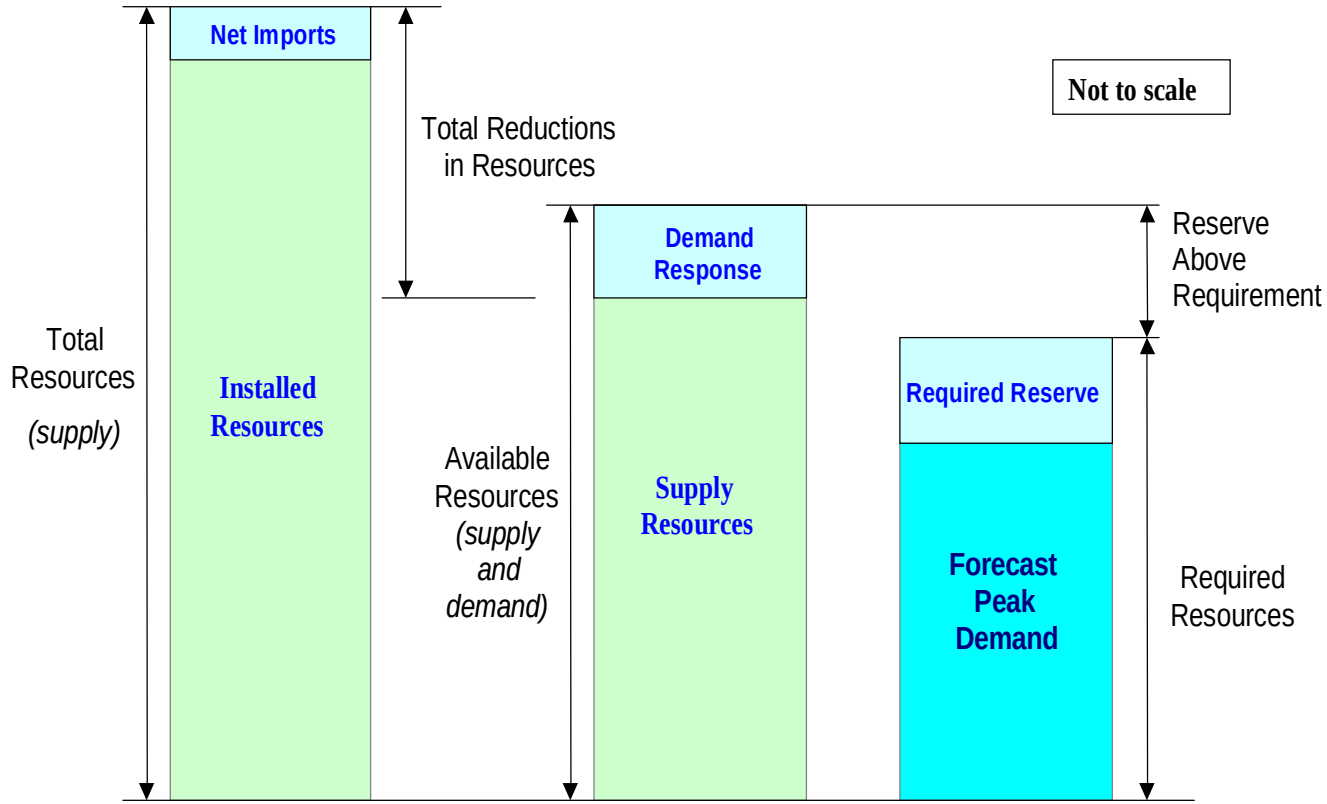
- For each week in the study period, the new hydroelectric forecasts are less than the hydroelectric forecasts based on the methodology used in previous Outlooks.
- On average for the 18-month period, the difference between the forecasts is approximately 900 MW.
- Differences are larger during the summer and winter peak weeks
- New hydroelectric forecast methodology is a first step towards a more accurate representation of hydroelectric capacity during peak periods
  - IESO welcomes suggestions on ways to further improve hydroelectric capability forecasts

Impacts of Changes on Reserves Above Requirement (RAR)

Reliability Standards & Assessments
Greg Hine

Reserve Above Requirement

- Reserve Above Requirement (RAR) is the difference between Available Resources and Required Reserves



Impact of Changes on RAR

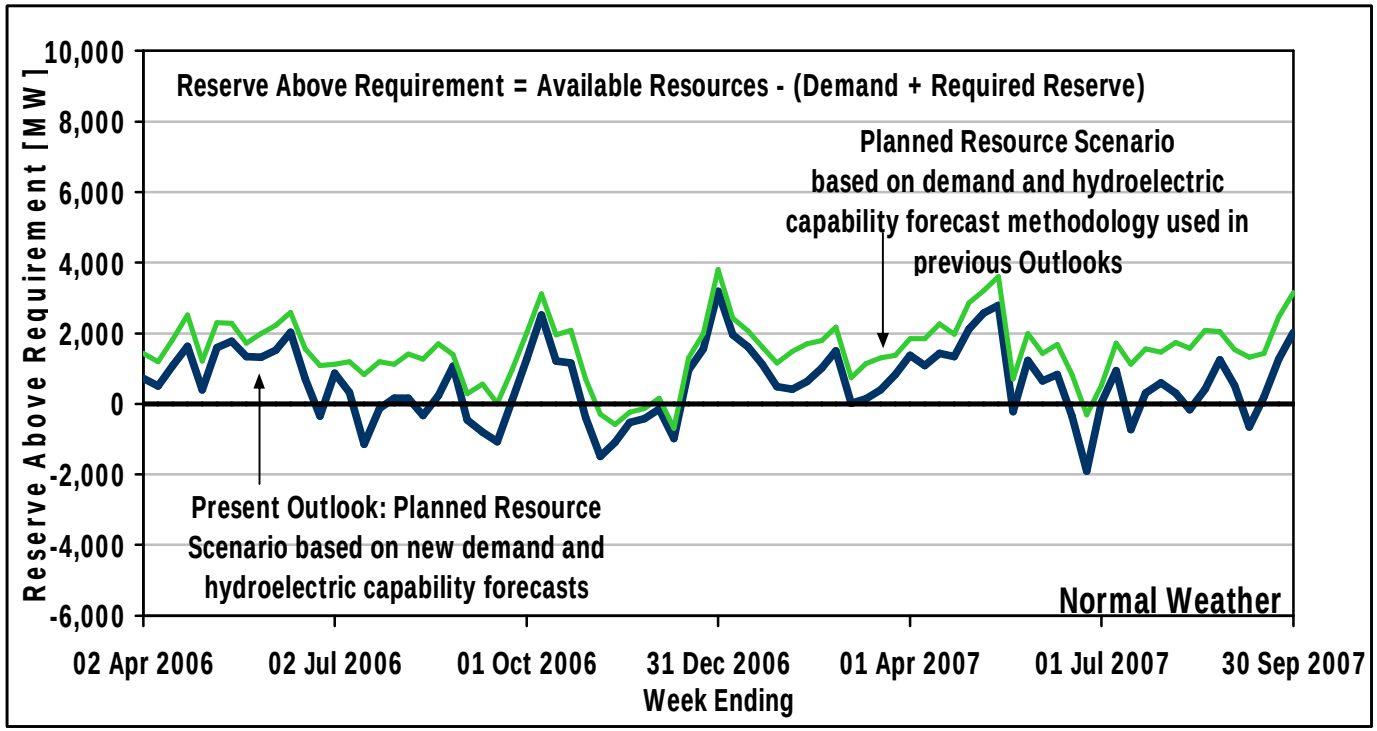
Example: Forecast Summer 2006 Peak – week ending July 16, 2006

	MW Change
1) Change in Demand Forecast: Weekly Normal Peak minus Monthly Normal Peak	- 1218
2) Change in Hydroelectric Capability Forecast: New minus Old	- 1369
(1) + (2)	- 2587
Change in RAR	- 1995

- Note that the impact of the changes on RAR is not equal to the sum of the MW changes in the demand forecast and hydro forecasts.
- The change in RAR is smaller because the increase in the demand forecast is somewhat offset by the reduction in load forecast uncertainty

Change in Reserve Above Requirement

- RAR values are, on average for the 18-Month Study period, approximately 900 MW lower than RAR values based on the demand and hydroelectric capacity forecasting methodologies used in previous Outlooks.



Summary of MW Changes Resulting from New Forecasts

	Average MW Change During the 18-Month Study Period	Average MW Change during the Summer (Jun-Aug)	Average MW Change during the Winter (Dec-Feb)
1) Change in Demand Forecast: Weekly Normal Peak minus Monthly Normal Peak	- 273	- 598	- 203
2) Change in Hydroelectric Capability Forecast: New minus Old	- 878	- 1057	- 536
(1) + (2)	- 1151	- 1655	- 829
Change in RAR	- 920	- 1147	- 690

Required Reserve

Reliability Standards & Assessments
Dan Rochester

Required Reserve (1)

- How we calculate required reserve (RR) in the 18-Month Outlook
  - load uncertainty distribution convolved with generator forced outage probability.
  - Weekly RR value determined equivalent to an annual LOLP of 0.1 day/year
- Capacity planning by OPA.
  - want simpler RR
  - expressed as a percent of demand
  - have initially selected 18% for supply mix report

Required Reserve (2)

- RR range in previous Outlooks – 13 to 20%
  - majority in 16-17% range
- RR range in current Outlook – 13 to 18%
  - majority in 15-16% range
- Simpler approach has appeal – math is easier to do and easier to understand
- requirement at time of annual peak could be determined using a variety of models, not just the present unsupported model

Required Reserve (3)

- IESO longer term decisions need to be made consistent with approach of OPA
- Options
  1. determine annual peak RR as percentage with associated LOLP (not less than 0.1 day/year), apply same LOLP to all weeks of the year
  2. determine annual peak RR as percentage, apply same percentage to all weeks of the year (1% change = 200MW approx.)
  3. use separate approaches for 18-Month Outlook and the Ontario Reliability Outlook
  4. other?

Required Reserve (4)

- Deadline for IESO decision – mid-May
- Stakeholder input (you talk, we listen)
  - Questions
  - Pros,
  - Cons,
  - Comments,
  - Suggestions

Next Steps

Stakeholder Engagement

Anne Barr

Stakeholder Engagement Schedule

Activity	Target Date
1. Issue 18-Month Outlook demonstrating both methodologies.	March 24
2. Post stakeholder plan.	April 7
3. Open stakeholder session at FASC Meeting. Session will provide stakeholders with rationale for change and will invite stakeholder feedback via e-mail.	April 20
4. Deadline for feedback from stakeholders. E-mail responses to stakeholder.engagement@ieso.ca	May 4
5. Posting IESO response to stakeholder input.	May 18
6. Potential IESO Market Manual change process.	May/ June