PROMOD Economic Analysis

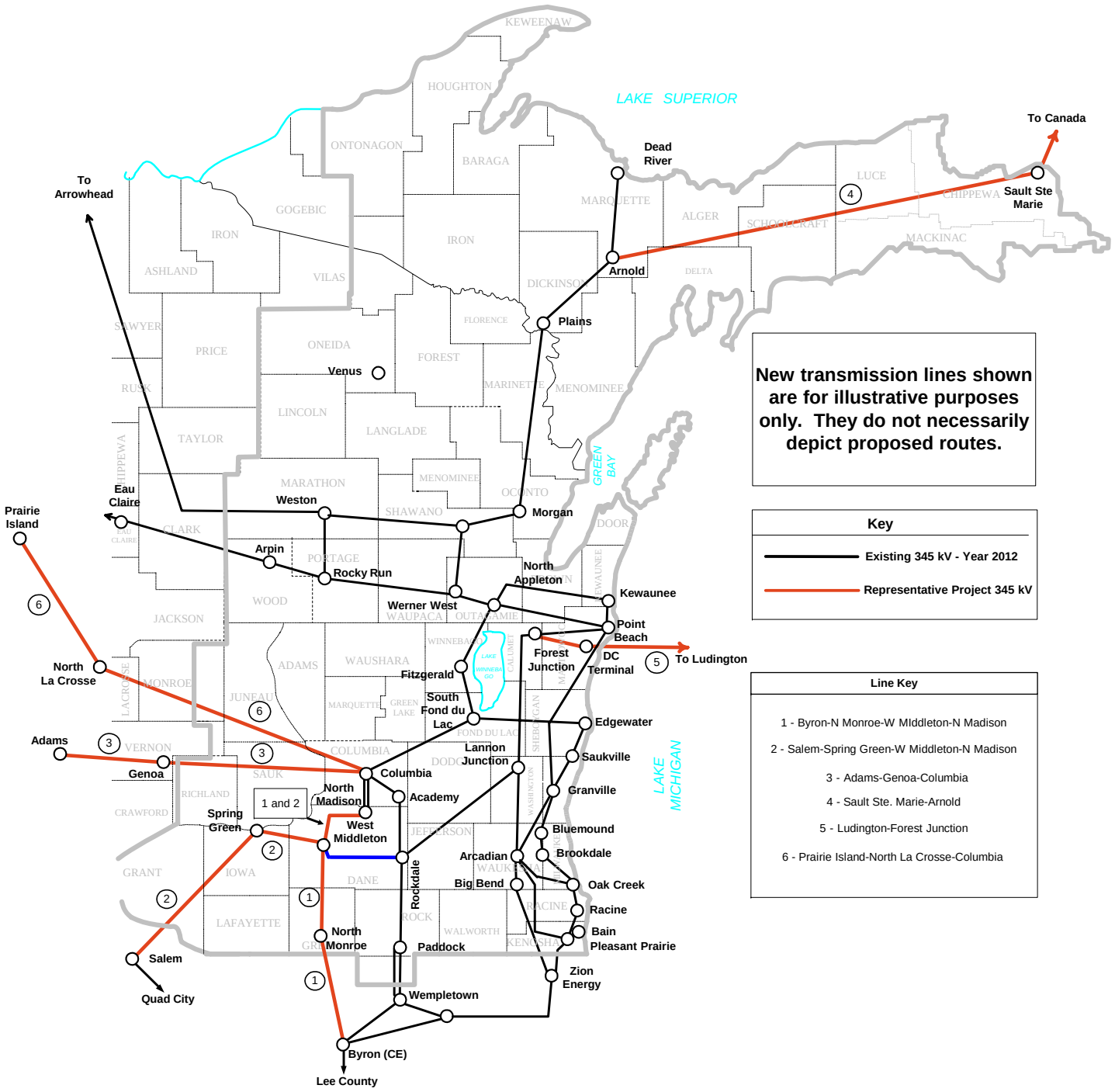
Latest Results & New Case Study
September 1, 2004

Chris Hagman

Transmission Planning Engineer

Introduction

- Alternatives studied with PROMOD:
  - Base Case
  - Base Case Plus Two Fixes (to relieve the 2 most limiting constraints).
  - South: Byron-North Madison
  - Southwest: Salem-North Madison
  - West: Adams-Columbia
  - West: Prairie Island-Columbia (New)
  - Base Case Plus 3 Low Voltage Tie Lines (New)


LAKE SUPERIOR
LAKE MICHIGAN
GREEN BAY
To Arrowhead
To Canada
Dead River
Sault Ste Marie
Arnold
Plains
Venus
Eau Claire
Weston
Morgan
Prairie Island
Arpin
Rocky Run
North Appleton
Kewaunee
Werner West
Point Beach
DC Terminal
Forest Junction
To Ludington
Fitzgerald
South Fond du Lac
Edgewater
North La Crosse
Adams
Genoa
Columbia
Lannon Junction
Saukville
North Madison
Academy
Granville
Spring Green
West Middleton
Bluemound
Arcadian
Brookdale
Rockdale
Big Bend
Oak Creek
Racine
Bain
Pleasant Prairie
North Monroe
Paddock
Zion Energy
Salem
Quad City
Wempletown
Byron (CE)
Lee County
1 and 2
KEWEENAW
HOUGHTON
ONTONAGON
BARAGA
GOGEBIC
IRON
ASHLAND
VILAS
MARQUETTE
ALGER
LUCE
CHIPPEWA
SCHOOLCRAFT
MACKINAC
DELTA
DICKINSON
FLORENCE
SAWYER
PRICE
ONEIDA
FOREST
MARINETTE
MENOMINEE
RUSK
LINCOLN
LANGLADE
TAYLOR
MARATHON
MENOMINEE
OCONTO
SHAWANO
DOOR
CLARK
PORTAGE
WOOD
JACKSON
WAUPACA
OUTAGAMIE
WINNEBAGO
CALUMET
MANITOWOC
KEWAUNEE
ADAMS
WAUSHARA
MONROE
LACROSSE
JUNEAU
MARQUETTE
GREEN LAKE
FOND DU LAC
SHEBOYGAN
VERNON
COLUMBIA
DODGE
SAUK
WASHINGTON
RICHLAND
CRAWFORD
JEFFERSON
GRANT
IOWA
DANE
WAUKESHA
LAFAYETTE
ROCK
WALWORTH
RACINE
KENOSHA
LAKE WINNEBAGO
1
2
3
4
5
6
New transmission lines shown are for illustrative purposes only. They do not necessarily depict proposed routes.
Key
Existing 345 kV - Year 2012
Representative Project 345 kV
Line Key
1 - Byron-N Monroe-W MIddleton-N Madison
2 - Salem-Spring Green-W Middleton-N Madison
3 - Adams-Genoa-Columbia
4 - Sault Ste. Marie-Arnold
5 - Ludington-Forest Junction
6 - Prairie Island-North La Crosse-Columbia

Introduction

- Have come a long ways…
  - June 2nd
    - Intro to PROMOD & cost analysis methodology
    - Analyzed the reasonableness of tie line flows
    - Started looking at flowgates and shadow prices
    - Iterative process

Introduction

- July 7th
  - Biggest bang for buck
    - Comparison between “production cost” savings and capital costs
  - Fixes:
    - Base Case setup, load mapping–CWL error and WPPI update, etc.
  - Case study:
    - High shadow price–North Monroe 138/69 kV transformer
    - Second transformer (~$1 million) saves about $10 million per year for Byron-NMA
  - Scenario:
    - Low internal generation
  - LOLE:
    - Base Case-sufficient import capability to meet LOLE

Introduction

- August 3rd
  - All directions studied
    - East and Northeast alternatives—highest costs & least benefits—dropped by consensus
  - More Fixes/Updates:
    - Added 5 short transmission lines in Illinois to provide generator outlets, additional flowgates
  - Case study:
    - High shadow price on West Middleton-Blackhawk 69 kV cable
    - Relieved by North Madison-Blount 138 kV reliability project
    - Additional benefit–lower LMPs in downtown Madison
  - Scenarios:
    - High wind development, low & high internal generation

Introduction

- September 1st
  - Customer-supplied generator data updates
    - EIA 860 “emergency” capacities can be higher than normal capacities
  - Transmission topology updates in PROMOD:
    - Rockdale-West Middleton 345 kV project
    - Upper Peninsula of MI model updates and corrections
    - Arrowhead-Weston 345 kV reactive requirements
    - NSP/DPC North La Crosse 161 kV project
  - Prairie Island-Columbia & Base Case Plus 3 Low Voltage Ties
  - LMP discussion–reduction in LMP spreads
  - Case study:
    - LMP drivers
  - Scenarios:
    - Low & high natural gas costs

Latest Baseline Results

- Compare the carrying costs for each alternative to the "production cost" savings from PROMOD.

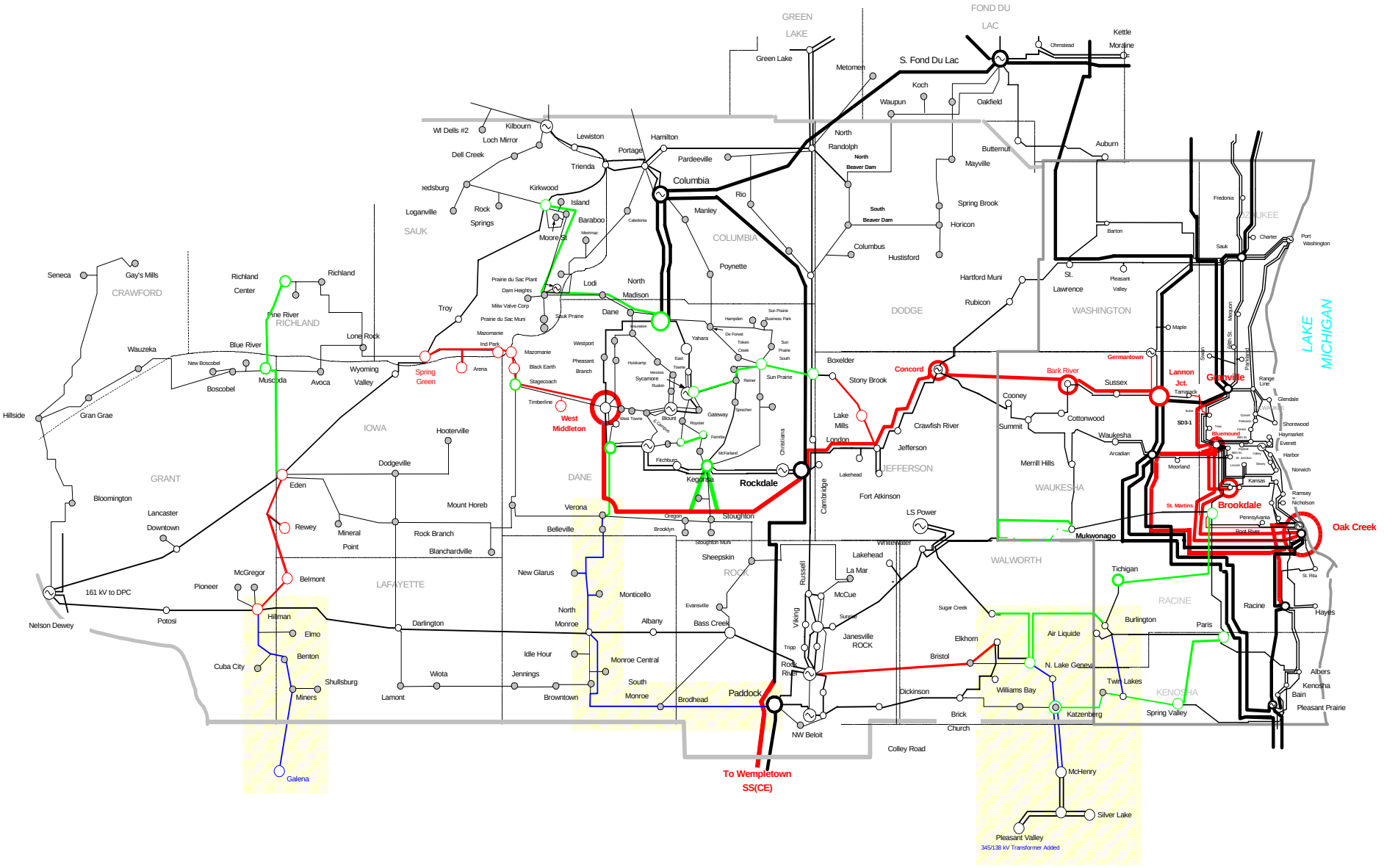
Costs for each Representative Project–Baseline Results

Project	Total Capital Costs (2003$ Mil.)	Approximate Annual Carrying Cost (2003$ Mil.)	"Production Cost" Savings Relative to the Base Case[1] (2003$ Mil.)	Net Imports Relative to the Base Case (GWH)
Base Case	$0	N/A	0	0
Base Case Plus 2 Fixes	$30	$2.7	$6.9 (+$0.6)	381 (-232)
South: Byron–NMA	$143	$12.9	$37.1 (+$22.0)	4,107 (+2,827)
Southwest: Salem–NMA	$223	$20.1	$33.6 (+$16.9)	3,962 (+2,909)
West: Prairie Island–Columbia[2]	> $244	> $22.0	$8.5	585
Base Case Plus 3 LV Ties	?	?	$14.7	934

[1] The values in parentheses show the change in results relative to the August 3rd Baseline results, e.g. the production cost savings for the "Base Case Plus 2 Fixes" increased by $0.6 million relative to the previous results.

[2] Prairie Island-North La Crosse-Columbia is a longer distance than Adams–Genoa-Columbia so the cost of Prairie Island-Columbia would likely be somewhat higher than that for Adams-Columbia.

Base Case Plus 3 Low Voltage Ties



Base Case Plus 3 Low Voltage Ties

Facilities

IL Border WEST - Galena-Hillman 138kV (33 mi.) with 161/138kV.

IL Border CENTRAL - Paddock-N.Monroe-Verona (66 mi.) 69 to 138kV conversion, and additional 345/138 at Paddock

IL Border EAST - McHenry (IL)-Katzenburg 138kV (13 mi.) with additional 345/138 at Pleasant Valley (IL), 69 to 138kV conversion of Katzenburg-N.Lk Geneva (13.8 mi), and Twin Lk-Burlington 138kV (13 mi.)

Stages/Expansion: Projects can be phased and expanded to further include NOM-Lancaster (IL) 138kV, and second line north to Madison (Bass Cr-Verona-WMD?)

Benefits

Parallels Lore-Turkey River-Cassville-NED limits. Project is complimented with TYA plan for Hilman-Eden 138kV.

Paddock-Brodhead 69kV (15.7 mi) already built for 138kV. The project will add voltage support to N. Monroe vicinity, and adds source diversity to west Madison. Project is complimented by TYA plan for a Verona-Cross Country 138kV line and 138/69 transformer.

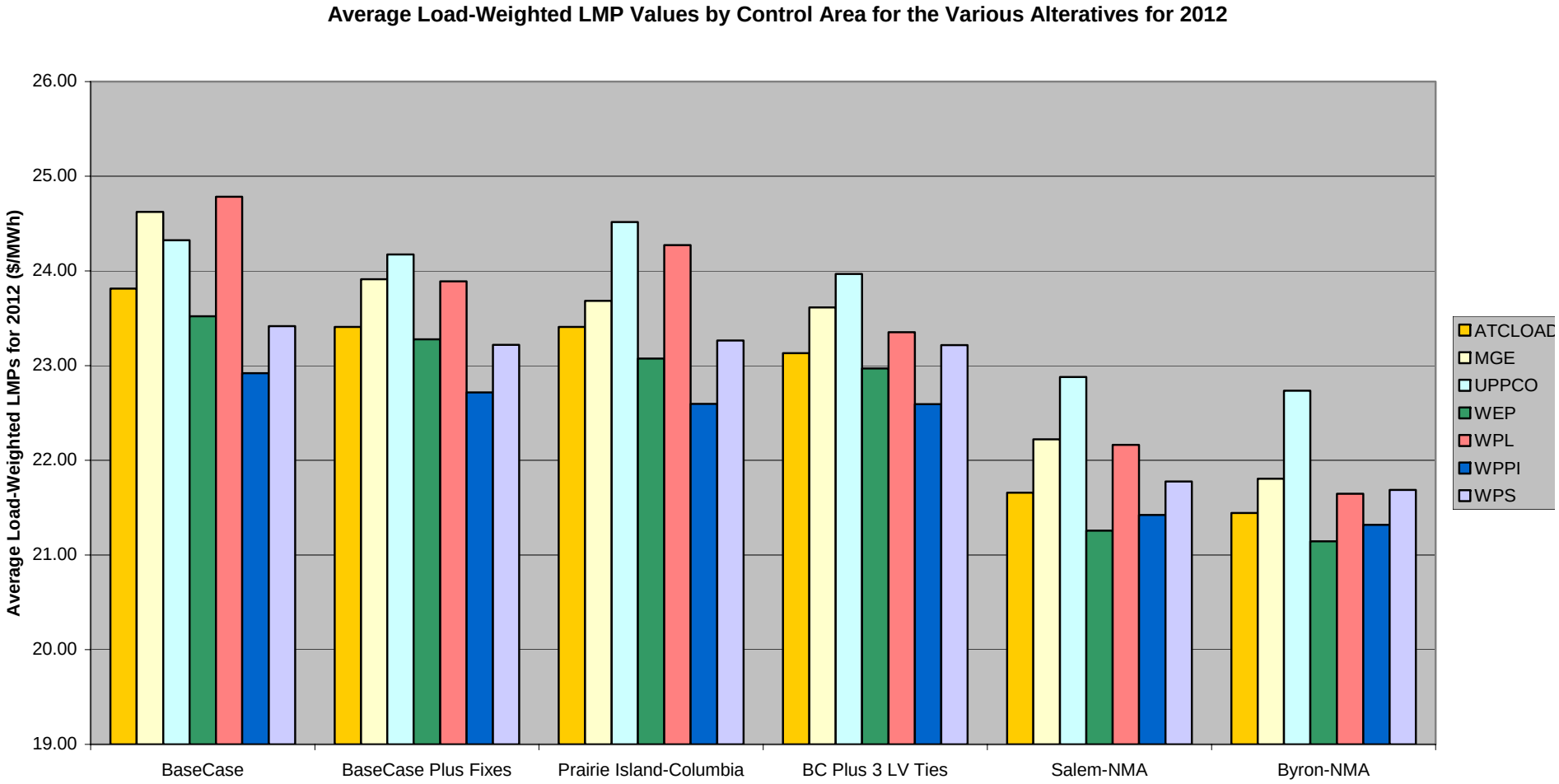
Adds 2 new ties to IL. McHenry lines have a SE rating of 383 MVA, additional transformers will provide 138kV push, especially under 345kV contingencies. Project is complimented with TYA plan for Paris-Spring Valley-Katzenburg 138kV and Tichigan-St Martins 138kV. Tie line effects further enhanced with Twin Lake-Burlington 138kV and 69 to 138 conversion of Katzenburg-N. lake Geneva.

Various project parts may be implemented on a more expedited time schedule.

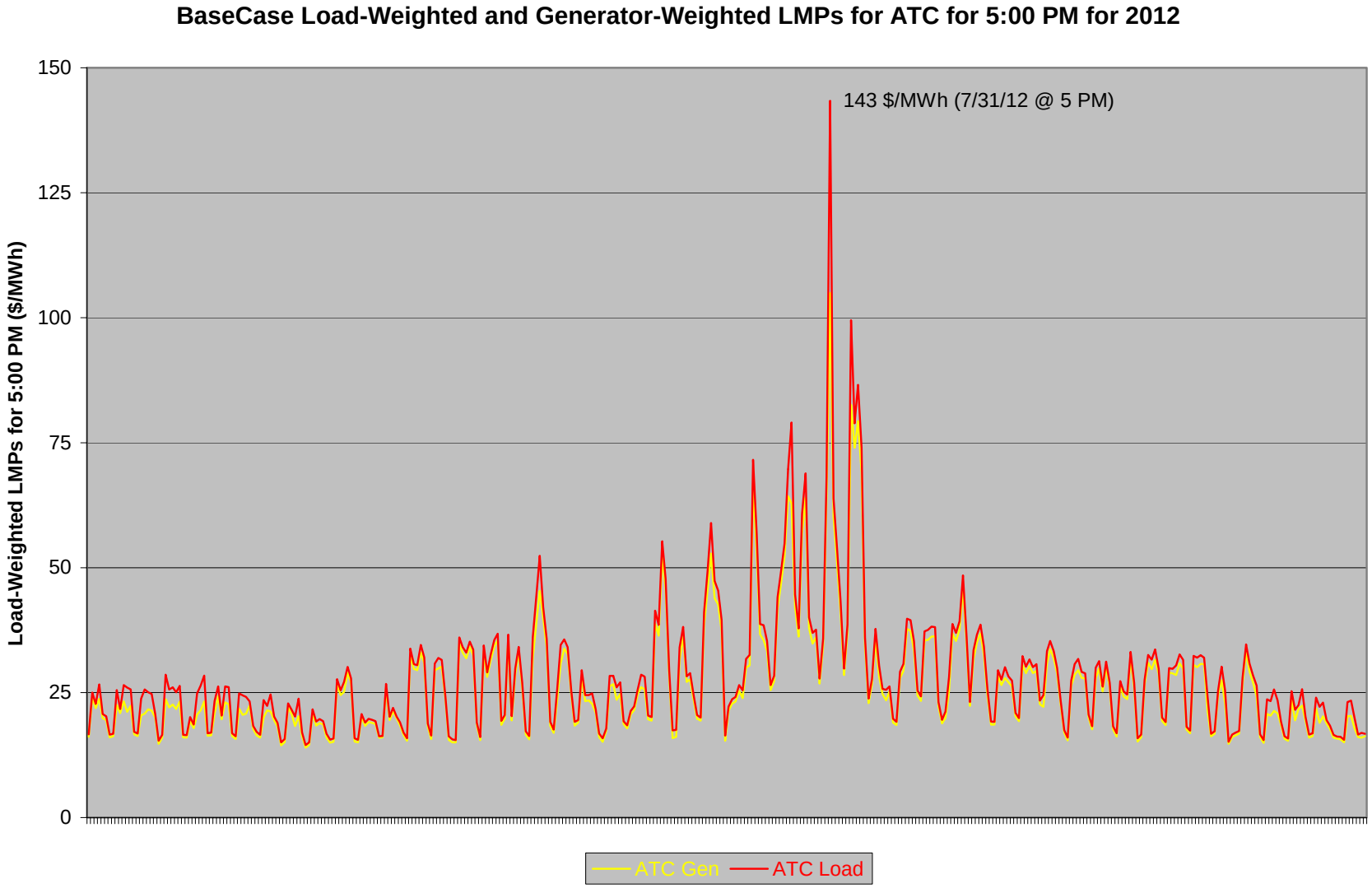
LMP Values

- How do the average load-weighted Locational Marginal Prices (LMPs) vary amongst the various transmission alternatives?
- How do these LMP values differ amongst the control areas?
- ALTE and MGE have the highest LMP values in the Base Case.
- How would you expect Byron-NMA and Salem-NMA to affect these values?
- Comparability

LMP Values, Cont.



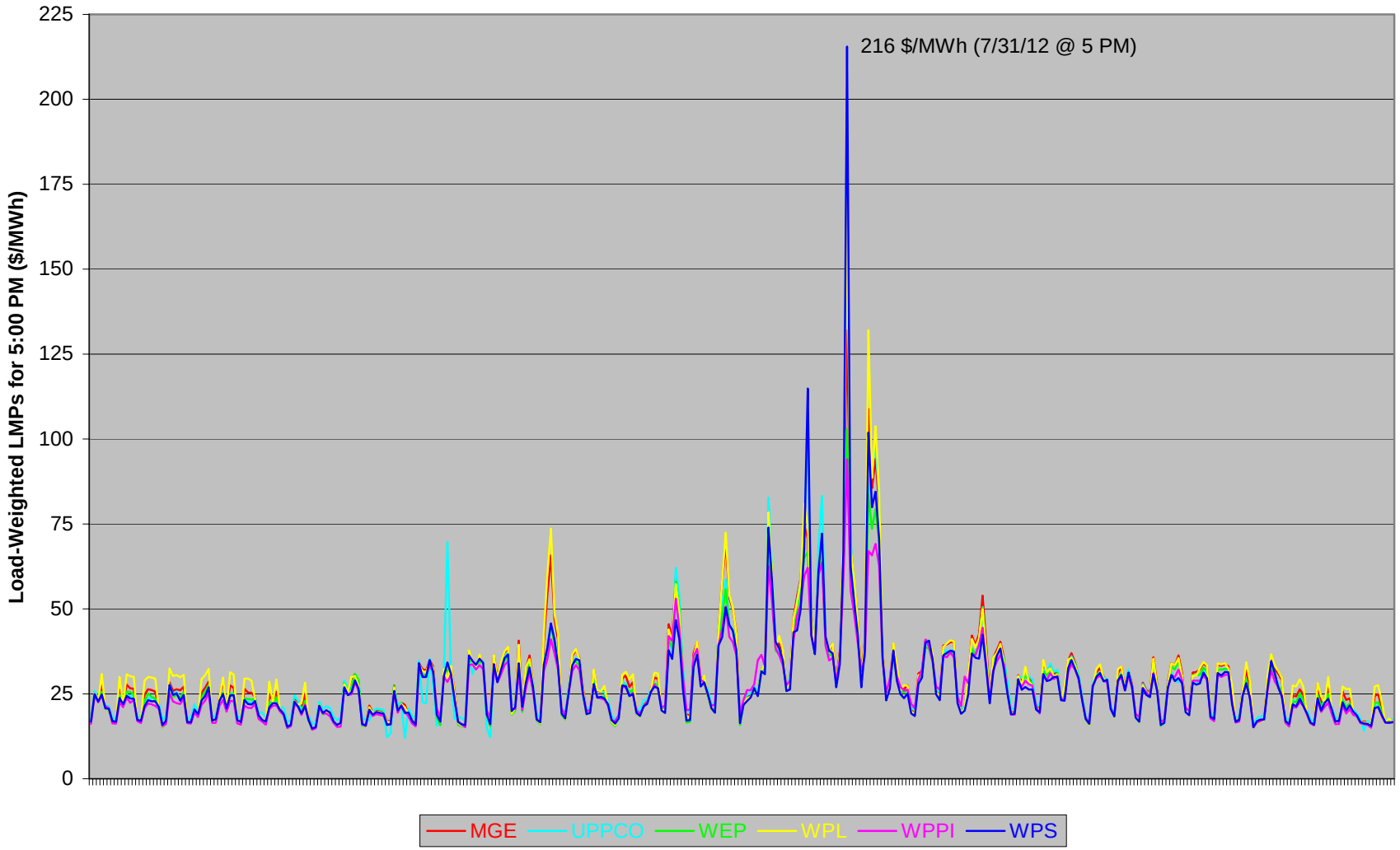
Case Study


BaseCase Load-Weighted and Generator-Weighted LMPs for ATC for 5:00 PM for 2012
Load-Weighted LMPs for 5:00 PM ($/MWh)
150
125
100
75
50
25
0
143 $/MWh (7/31/12 @ 5 PM)
ATC Gen
ATC Load

Case Study, Cont.

- Observations:
  - Load-weighted LMPs greater than generator-weighted LMPs
  - Differ by congestion and loss components of the LMP
  - Nearly identical values during low load periods

Case Study, Cont.



Case Study, Cont.

- What is causing the load-weighted LMP values for the control areas, and especially WPS, to spike on 7/31/12 at 5 PM?
  - Is the load high?
  - Are there key generator outages?
  - Are there transmission outages?

Case Study, Cont.

- July 31, 2012 at 5:00 PM
  - WPS is at its peak load
  - ATC system is very close to its peak
  - ~ 800 MW of generation within the ATC footprint forced off-line (based on gen. forced outage rates)
  - ~ 350 MW of generation in/near the WPS control area forced off-line
    - Pulliam 4 and 7
    - Fox Energy
  - Total generation within ATC footprint reduced somewhat based on customer capacity updates

Sensitivity Analyses

Natural Gas Scenarios-Production Cost Savings Relative to the Base Case

Project	Baseline "Production Cost" Savings Relative to the Corresponding Base Case (2003$ Mil.)	10% Decrease in Natural Gas Prices- "Production Cost" Savings Relative to the Corresponding Base Case (2003$ Mil.)	20% Increase in Natural Gas Prices- "Production Cost" Savings Relative to the Corresponding Base Case (2003$ Mil.)
Base Case	0	0	0
South: Byron–NMA	$37.1	$36.5	$55.4

- Cost savings for Byron-NMA does not change much for the "10% Decrease in Natural Gas" scenario relative to the "Baseline".
- Cost savings for Byron-NMA increases by $18.3 million for the "20% Increase in Natural Gas" scenario relative to the "Baseline".

What's Next?

- Agree on a reduced list of alternatives for further analysis.
- Refine capital cost data for the remaining alternatives.
- Review geographic distribution of LMP values using MapAgent.