


SIGMA ENERGY SOLUTIONS

PRESENTATION TO

cibo

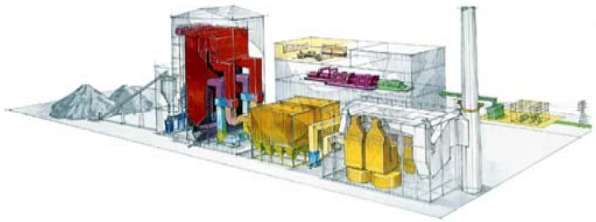
Energy Efficiency Options for Industrial Plants



Why Energy Efficiency?

IBO's can get ahead of curve

- Emissions compliance
  - degrades efficiency/increases auxiliary loads
- GHG Regulations
  - Efficiency/Process/Equipment Performance Improvements
  - Boiler tuning/furnace exit gas heat recovery
- CO2 Registries
  - Identifies potential regulatory/environmental targets
- DOE
  - Efficiency is cheapest way to reduce CO2 emissions
- Efficiency 1-10%; MA: Efficiency/Renewable offsets



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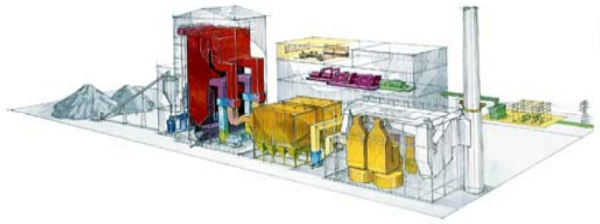
Efficiency Improvement
The Process

- Define Objectives
- Review Design Basis
- Establish Baseline
- Assess Condition
- Interview Plant Personnel
- Benchmark & Evaluate
- Identify Improvements
- Rank Economically
- Plan & Implement
- Validate & Verify
- Monitor & Follow-up



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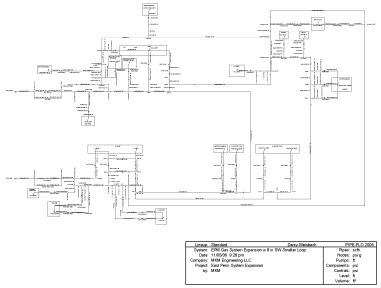
Where do we start?

Review Design Basis/Establish Baseline

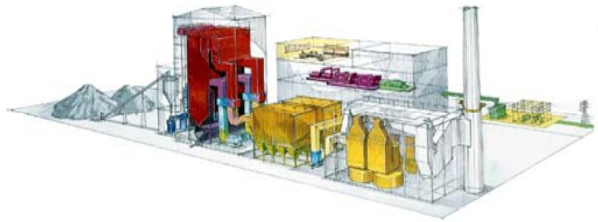
Engineering Evaluation



- Plants operating for many years with staff turnover
- Plant modifications may not have been integrated
- Current operations to be optimized with design
- Plant configuration control brought up to date
- New perspectives bring potential energy savings

Unit Performance Testing

- VWO Test with Senior Consultant in Control Room
- Move unit to determine equipment constraints
- Identify suspect instruments by closing heat balance



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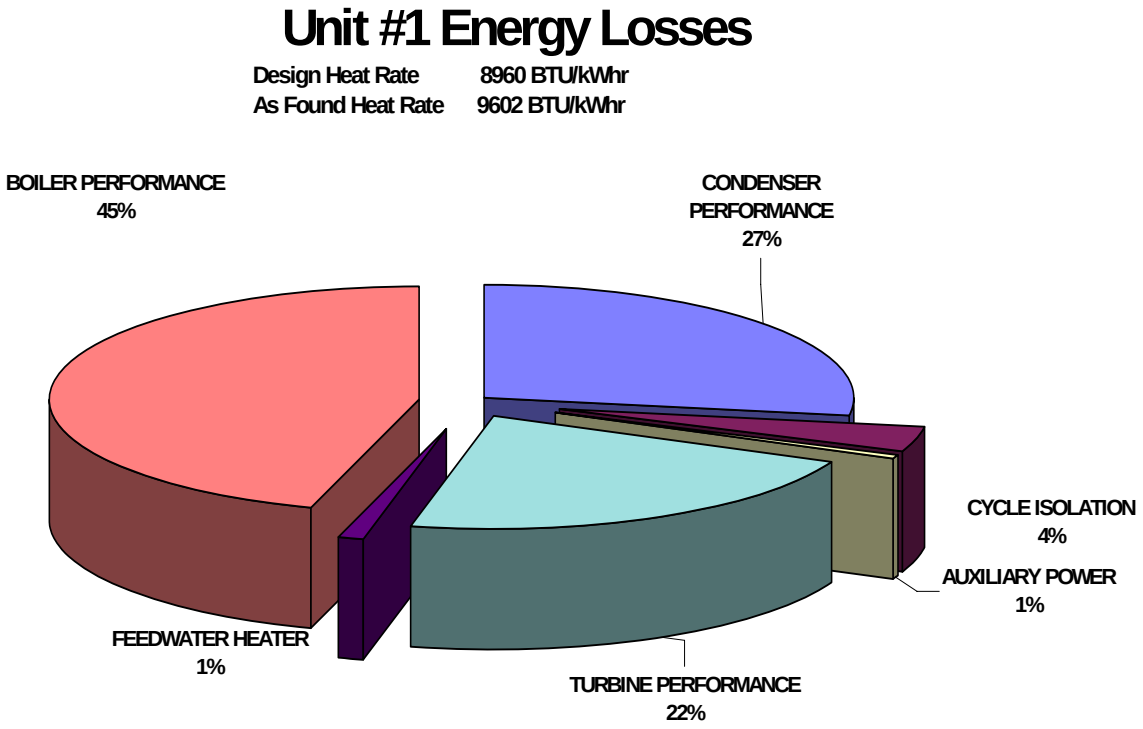
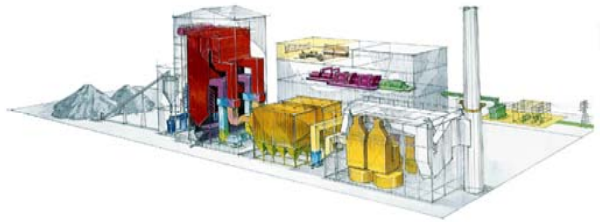
Where are we now?

Energy Assessment

- Engineering/Economic Evaluation
- Determine Major Equipment Constraints
- As-Found vs. Design Heat Balance comparison





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BOP CCR: Capacity Constraint Release
(current configuration)

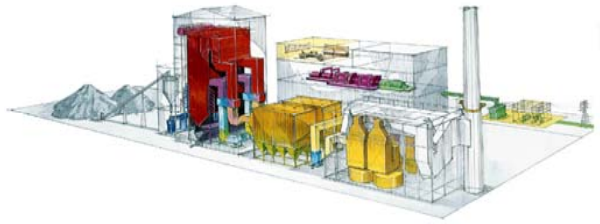
Step 1: Identify Low Hanging Fruit

- Collect VWO Operating Data, Power Uprate Heat Balance
- Interview plant management & operations staff
- Establish current baseline & model systems
- Lighting/HVAC/Motor/VSD/automation efficiency upgrades

Step 2: Mitigate Capacity Constraints

- Heat Rate conclusions (quantifies cost of production impacts)
- Develop solutions to unlock constraints
- Identify cost reduction opportunities
- Develop budgetary costs/predicted MW regains

Result: Actionable NPV specific recommendations



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BOP LF: Limiting Factors

(support of prime mover uprate)

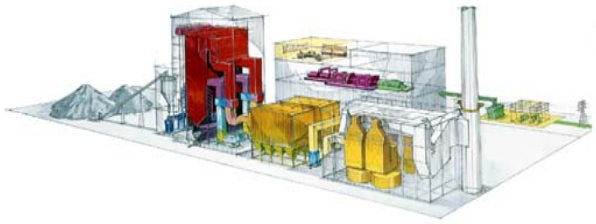
Step 1: Assessment of Current Operating Performance

- Collect VWO Operating Data, Power Uprate Heat Balance
- Interview plant management & operations staff
- Establish Current Baseline
- Model mechanical and electrical systems

Step 2: Assessment & Release of BOP Limiting Factors

- Identify equipment/systems that prevent achieving full uprate
- Develop solutions to unlock constraints
- Develop budgetary costs/predicted MW regains

Result: Actionable NPV specific recommendations



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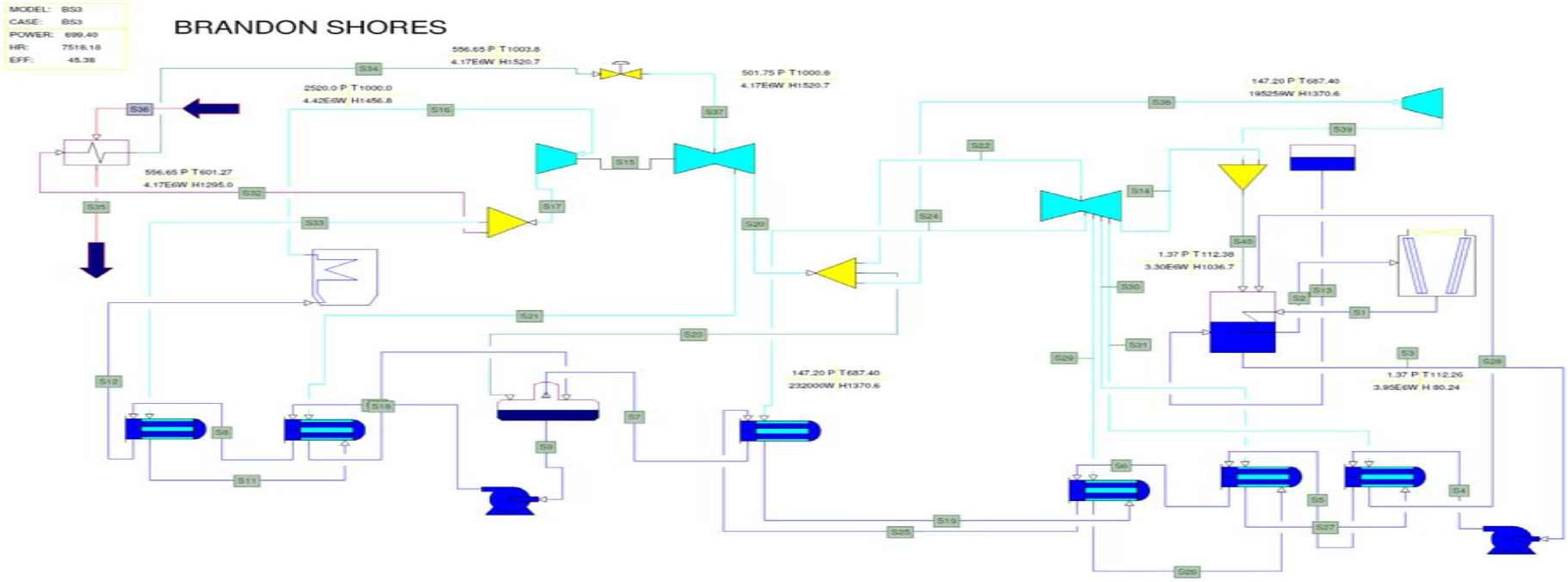
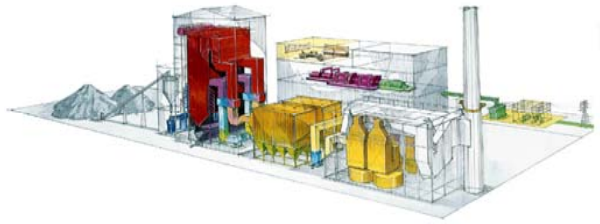
BOP CCR/LF Analysis

- **Thermal Cycle Modeled in Gate Cycle**
  - **Establish New Flow/Pressure/Temp Conditions at Components**





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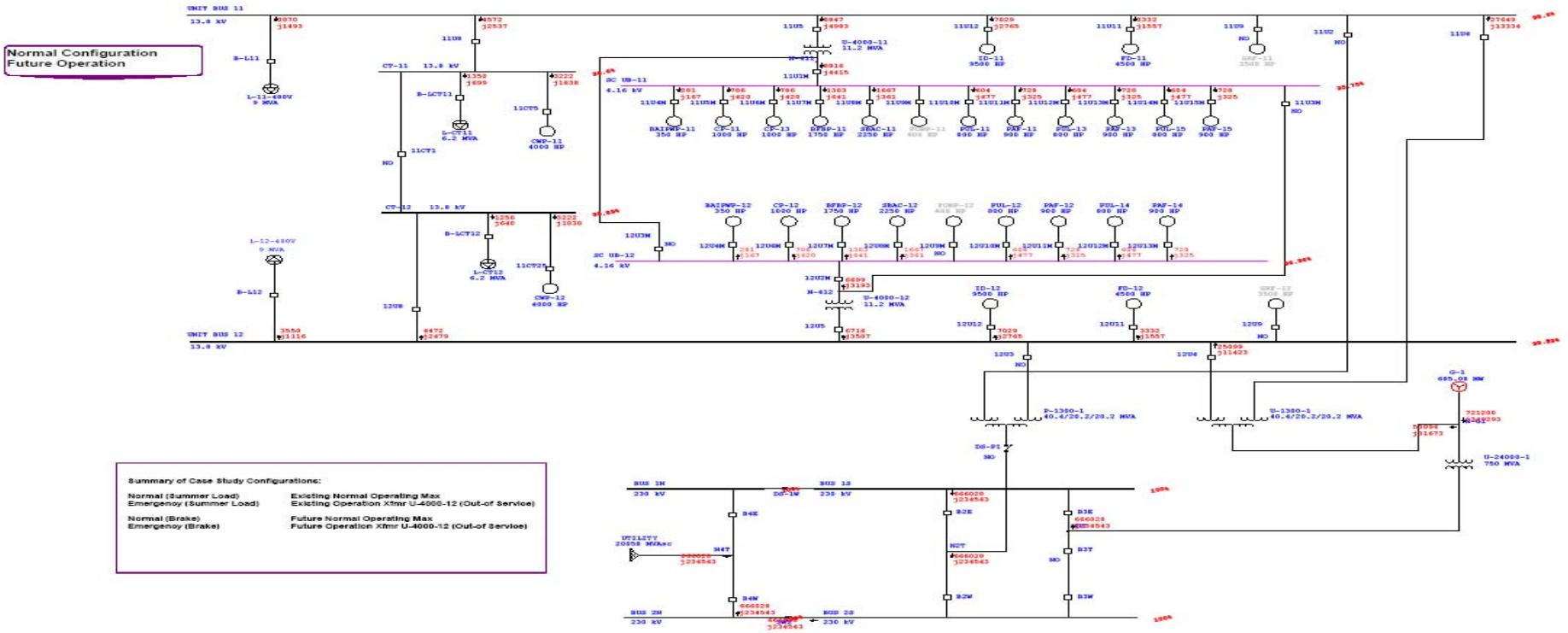
BOP CCR/LF Analysis

- **Electrical System Modeled in ETAP**
  - **Load Flow Analysis**

One-Line Diagram - Brandon Shores Unit 1 R1 (Load Flow Analysis)



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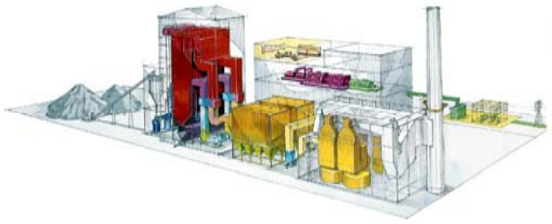

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Asset Optimization Improve Performance

Midwestern Industrial Power Facility

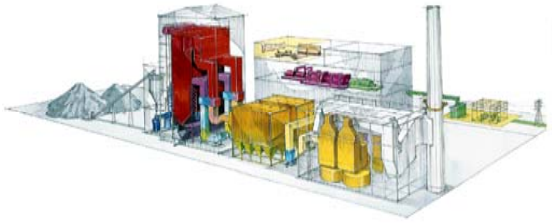
- Installing APCS for SOx Reduction
- Requests Boiler/Turbine/BOP optimization study to determine uprate capacity for three existing 144MW units

The SAVE™ Solution:

- Optimized Plant Retrofit (OPR) Study addresses uprating of boiler and turbine
- Debottlenecking approach analyzes BOP system and equipment constraints

Results:

- 20% uprate (w/HP retro) and 10% uprate (w/o HP retro)
- BOP constraints identified and mitigation plan developed



SIGMA ENERGY SOLUTIONS

Asset Optimization
Improve Performance

Industrial Power Facility

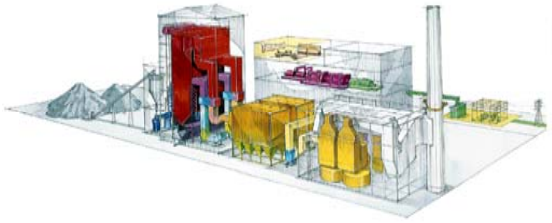
- Plant exhibiting high reliability
- Identified need to improve heat rate
- Target underperforming equipment/systems

The SAVE™ Solution:

- Integrated steam plant analysis
- Identify, assess and mitigate BOP system and equipment constraints

Results:

- Small capital recommendations generated $2.2M NPV
- Included installing condensate return system, FWH



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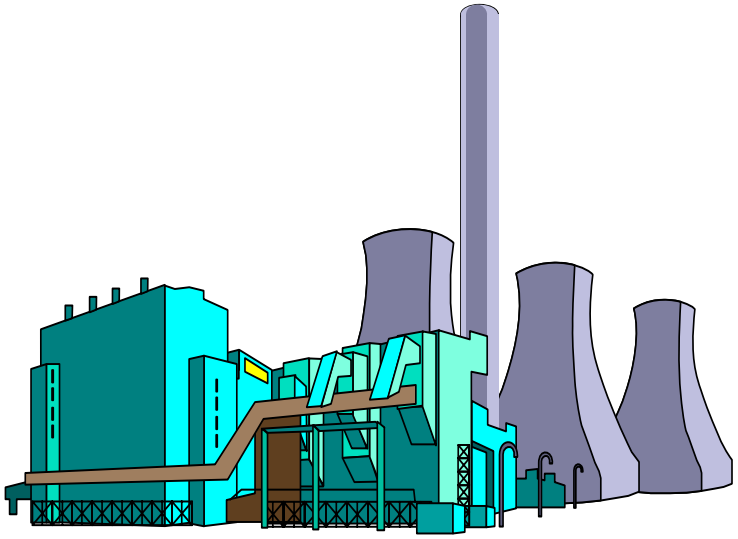


Industrial Power Facility

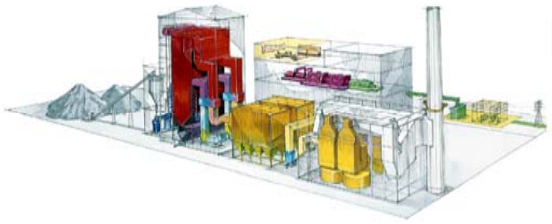
- Combined cycle generation
- Identified need to improve heat rate
- Focus on power block

The SAVE™ Solution:

- Integrated plant analysis
- Assessed third party financial contracts

Results:

- Recommendations identified ~$4.5M in annual savings
- Included installing unit controls and plant-wide EMS



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Asset Optimization
Improve Performance

AES Warrior Run (180MW CFB)

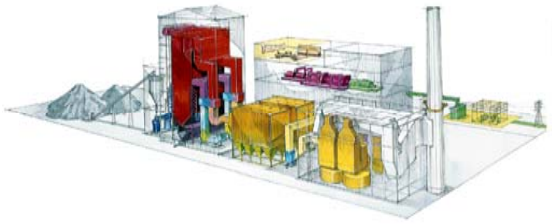
- Client requested assistance in recovering 600 BTU/kWh degradation from initial as commissioned plant heat rate

The SAVE™ Solution:

- Energy Assessment Approach
- Evaluated current VWO performance against design basis
- Generated Operational, Maintenance and Capital project recommendations

Results:

- 40-60% of heat rate degradation recovered
- Capital project: condensate to dry limestone < 2yr payback



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Asset Optimization
Improve Performance

Eastern Supercritical PC Units

- Slated for divestiture, investments lagged
- Older plant beyond original design life

The SAVE™ Solution:

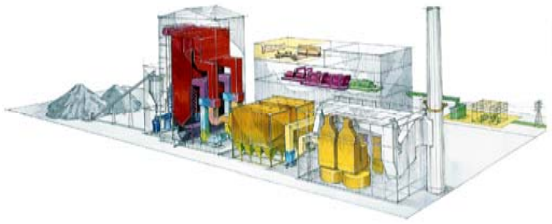
- Integrated Reliability/Efficiency Assessment

Recommendations:

- Cycle analysis estimated 1000BTU pick-up
- Recover > 100,000MWH of lost availability
- Developed critical systems equipment plan
- Identified key programmatic issues

Results:

- $21M NPV in Efficiency Improvements
- $3M in Annual Availability Recovery



SIGMA ENERGY SOLUTIONS

Asset Optimization
Improve Performance

MidAmerican Energy Louisa 1 (758MW)

- Installing APCS for SOx Reduction
- Requests IP/LP Retrofit and Boiler/BOP optimization study to recover aux load

The SAVE™ Solution:

- IP/LP retrofit
- Enhanced Optimized Plant Retrofit (OPR) Study addresses boiler issues and upgrades
- BOP analysis identifies CT/CW limitations and back-pressure improvements

Results:

- Total uplift predicted to be ~50-59MW depending upon season
- Enhanced OPR added ~30-40MW to the IP/LP only case

THANK YOU FOR YOUR TIME AND ATTENTION!

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