Energy Efficiency Frontier—Lean and Green Refining

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What is Focus on Energy?

Wisconsin utilities’ statewide program for energy efficiency and renewable energy
Presentation Topics

• Energy intensity
• Best practices in refining
• Wisconsin case studies
• Emerging technology—currently in progress
• Energy efficiency support
• Q&A
Energy Intensity

- Energy intensity = energy input per unit through
- Typical metrics and ranges of refining energy intensity:
  - Kilowatt-hour per tonne: 40 to 100 kWh/t
  - Horsepower-day per Ton: 2 to 5 hp-d/T
  - Refer to this as “direct” refining energy
- Push this lower to realize direct refiner energy savings
- Indirect energy savings realized by optimizing refining:
  - From reduced scrap (fewer breaks, improved first sheet quality)
  - Due to getting on a new grade in less time
  - Due to better sheet drainage
  - Both thermal and electrical energy savings
Refining Energy Intensity Challenge

• Can PM refining energy intensity be reduced from present:
  10%  17%  31%  More?

• Benefits beyond direct refiner electricity reduction
  - Better formation and sheet dewatering (energy, cost, quality)
  - Optimized drying energy (energy, cost)
  - Lower refiner maintenance (reliability, cost)
  - Longer refiner component life, e.g., plates (uptime, cost)
  - Fewer press breaks (uptime/production, cost)
  - Other benefits?

• Imagine the potential energy savings: locally, nationally, globally
Best Practices in Refining

- Reduce “no-load” and “wide spot in the pipe” refiners
- Run low intensity plate designs, especially on hardwood
- Check refiner mechanical condition regularly
- Refine each pulp type separately, if possible
- Shut down tickler refiners when possible
- Operate in design hydraulic flow ranges
- Upgrade double disk refiners with splined rotors
- Consider modern energy-efficient designs when replacing refiners (including duo-flo mode)
- Minimize stock flow through deflakers
Refining Best Practices to Improve Energy Efficiency—Low-cost approaches

• Add recirculation control with standpipe, respond to machine needs
• Downsizing plates within existing refiner
Case Study—Shawano Specialty Mill: Mono-To Duo-Flo Mode Conversion

Mono-flow mode:

Diagram courtesy of GL&V
Case Study—Shawano Specialty Mill: Mono-To Duo-Flo Mode Conversion

Duo-flow mode:

Diagram courtesy of GL&V
Case Study—Shawano Specialty Mill: Mono-To Duo-Flo Mode Conversion

• Two 508-mm (20-inch) refiners operated side by side
  - One in duo-flo mode
  - One in mono-flo mode (considered for conversion)

• Focus measurement and verification (M&V)
  - Controlled, steady-state conditions
  - Stock samples taken throughout trials conducted
  - Power metering equipment on each refiner motor switchgear
  - Flow and pressure measurements
  - M&V results documented in a written report

• Expectation: up to 20% less energy use in duo-flo mode
• Actual: 18.5% energy reduction, associated cost savings
• Simple payback range: 2.5 years to less than 10 months
Case Study—Shawano Specialty Mill: Project Implementation Results

<table>
<thead>
<tr>
<th>Location</th>
<th>Demand Reduction Observed</th>
<th>Hours of Operation</th>
<th>Calculated Energy Use Reduction</th>
<th>Blended Utility Rate</th>
<th>Total Cost Savings</th>
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<tbody>
<tr>
<td>Little Rapids Corp.</td>
<td>18.5%</td>
<td>8,350</td>
<td>&gt; 250 MWh/yr</td>
<td>Confidential</td>
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<td>Shawano Specialty</td>
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Payback ~ 2 years

Energy efficiency incentive applied based on energy savings, project cost
Case Study—Wausau Paper: Splined Rotor Refiner Upgrade

• Two (2) 700-hp refiners
  - Converted from mono-flo to duo-flo mode
  - Splined rotor upgrade implemented
• Power metering before and after project
• Employed data logging equipment on refiner motor switchgear
• Energy savings:
  - Expected 25%
  - Actual 31% decrease in kW demand
  - Annualized electrical energy savings ~ 25% (~ 3.1 million kWh/year)
  - Cost ~ $161k  Savings ~ $184k/yr  Payback ~ 11 months
Case Study—Wausau Paper: Splined Rotor Refiner Upgrade

Photo courtesy of GL&V, for illustration purposes
Case Study—Wausau Paper: Splined Rotor Refiner Upgrade

Ports located in the hub

Photo courtesy of GL&V, for illustration purposes
Case Study—BPM Inc., Peshtigo, Wisconsin: Brief Mill Background

• 2006 paper mill restart after bankruptcy purchase
  - Restarted as non-integrated mill (sulfite pulp mill shuttered)
  - Two paper machines – specialty papers, MG, waxing grades
• 2007 formed mill-wide energy team
• 2009 Co-recipient Statewide/Wisconsin Paper Council award for energy efficiency based upon 2008 efficiency improvements
• 2009 pledged US-DOE Save Energy Now LEADER program
  - Voluntary 25% reduction in energy intensity in 10 years vs. baseline
  - Tapped into technical assistance such as energy assessments
  - Exceeding voluntary reduction commitment
Case Study—BPM Inc., Peshtigo, Wisconsin: Energy Team Formed (2007)

• General manager, paper mill manager, technical manager, plant engineer, and invited guests participate and contribute
• Focus energy advisor and energy specialist part of team
• WPS (energy supplier) account executive part of team
• Monthly meetings on site – minutes and action items recorded
• Energy efficiency ideas, studies, and projects implemented
• Assigned engineer to energy efficiency project management
• Currently in fifth year of aggressive energy efficiency pursuit
• Mill energy team process led to refining optimization project
E-team identified refining as offering significant energy reduction potential:

- No bypass between machine chest and #1 PM stuff box
- Recycle furnish required pumping through entire refiner train
- Over-refining suspected of causing other problems
Case History #3 BPM Inc., Peshtigo, Wisconsin: Physical changes and refining optimization

Modifications to refiners and process flow:

• Bypass around each DD refiner (piping and valves)
• R1 dedicated to virgin pulp via process flow change
• R1 addition of recirculation control and standpipe, based on machine needs
• R4 retrofit with 584-mm (23-in) plates, from 660-mm (26-in)
Case Study—BPM Inc., Peshtigo, Wisconsin: Refining Optimization and Emerging Technology

- Began with interest in controlling freeness
- Discovered fiber morphology analyzer using optical sensing
- Introduced technology to a mill willing to trial as beta site
- Developed project
- Ran trials in mode simulating full project implementation
- On single grade, made the same quality paper:
  - Using 151.4 kW less demand (one refiner instead of three)
  - Annualized energy savings over 1 million kWh/year
- Developing control algorithms presently
- Pursuing emerging technology deployment financing
- Focus offering technical services and eligible efficiency incentive
Case Study—BPM Inc., Peshtigo, Wisconsin: Refining Optimization and Emerging Technology

- Project name: Fiber Stream Optimization
  - Vetted the fiber morphology analyzer technology 2-3 years ago
  - Reconnected with the maturing tech at TAPPI PaperCon 2010
- BPM predicted energy savings:
  - >150 kW at refiner, > 1 million kWh/year direct at refiner
  - Indirect energy savings could surpass direct (scrap, on-grade, etc.)
- More mills interested in beta site case study so far
- First four (4) interested mills larger, much higher refining capacity:
  - 4.8 MW of predicted electrical demand reduction possible
  - 41 million kWh/year of estimated electrical energy reduction
  - Yet-to-be-quantified thermal energy savings
Energy Efficiency Guidance and Assistance

- The most cost-effective “new” energy source: energy efficiency
- Wisconsin industrial energy efficiency resources:
  - Focus on Energy statewide program
  - Utility companies and respective account executives
- USA energy efficiency resources:
  - US-Department of Energy, Industrial Technologies Program, EERE
  - DSIRE (database of state incentives for renewables and efficiency)
  - US-EPA Energy STAR in Pulp and Paper
  - US-EPA CHP Partnership
- ACEEE – American Council for an Energy-Efficient Economy
- TAPPI:
  - National and regional/local chapters
  - Standards and TIPs
- Vendors and consultants can be excellent resources
Lean and Green Refining: Conclusions

• We can reduce energy intensity in refining
• Establish goals/targets for energy intensity reduction
  - Mill or paper machine level energy reduction targets
  - Individual process energy intensity reduction targets
• Seek technical and financial assistance
• Implement best practices for efficiency first
• Seek new developments and new technologies:
  - Refining processes
  - Refining equipment
• Seek financial incentives if available/eligible to implement:
  - Best practices projects
  - Emerging technologies