Three Rivers Hydropower – Rye Development

November 19 2019
Hydroelectric Project Portfolio

RYE/FFP NH’s 21 Projects are diversified across geographies (OH, PA, WV, MS, LA)

- Ohio River (3 Projects)
- Monongahela River (6 Projects)
- Allegheny River Lock and Dam #2
- Yazoo River Basin Cluster (4 Projects)
- Yazoo Cluster
- Overton Lock and Dam Project
- Overton – Red River - Louisiana
- Muskingum River Cluster
# Project Data

<table>
<thead>
<tr>
<th>Project</th>
<th>Installed Capacity (Megawatts)</th>
<th>Average Annual Generation (GWh)</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Montgomery Lock and Dam</td>
<td>38.0</td>
<td>195.00</td>
<td>Ohio River</td>
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<tr>
<td>Emsworth Lock and Dam</td>
<td>22.1</td>
<td>112.10</td>
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<td>Maxwell Lock and Dam</td>
<td>13.4</td>
<td>57.14</td>
<td>Monongahela River</td>
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<td>Emsworth Back Channel</td>
<td>11.0</td>
<td>55.42</td>
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<td>Allegheny Lock and Dam No. 2</td>
<td>8.0</td>
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<td>Allegheny River</td>
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<td>Charleroi Lock and Dam</td>
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<td>Grays Landing Lock and Dam</td>
<td>11.6</td>
<td>44.00</td>
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<tr>
<td>Opekiska Lock and Dam</td>
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<td>28.90</td>
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<td>Morgantown Lock and Dam</td>
<td>5.0</td>
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<td>Point Marion Lock and Dam</td>
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<td>15.80</td>
<td>Monongahela River</td>
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<td><strong>Total - 10 Projects</strong></td>
<td><strong>132.4</strong></td>
<td><strong>627.86</strong></td>
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</table>
Development Strategy

• All Projects have FERC License
• Capacity from 5 to 40 MW
• Existing Dams
  • Navigation Systems – Consistent Flows, High Plant Factors, Predictable, Standardized Configuration
• Clusters of Projects When Possible
  • 5% to 25% Projected Cost Savings on Construction and Components
Development Strategy

• Conventional Technology
  • Horizontal Kaplan Pit – 4 M Diameter Range
  • Smaller Projects Modular/Submersible

• Commercial, Governmental, Institutional Customers
  • Pressure to Utilize Renewables
Project Generation - Total 627,857,000 KWH

- Montgomery Lock and Dam: 31%
- Emsworth Lock and Dam: 18%
- Maxwell Lock and Dam: 9%
- Emsworth Back Channel: 9%
- Allegheny Lock and Dam No. 2: 8%
- Charleroi Lock and Dam: 8%
- Grays Landing Lock and Dam: 7%
- Opekiska Lock and Dam: 5%
- Morgantown Lock and Dam: 3%
- Point Marion Lock and Dam: 2%
Average Residential Electricity Use

Pennsylvania
• 857 KWH per month
• 10,284 KWH per year
• 50 % heating costs

Louisiana
• 15,276 KWH/year
• Lowest Electricity Costs

Hawaii
• 6,612 KWH/year
• Highest Electricity Costs
NUMBER OF HOMES SERVED
AVERAGE USE AND GENERATION

Montgomery: 18,961
Emsworth MC: 10,901
Maxwell: 5,556
Emsworth BC: 5,388
Allegheny #2: 5,076
Charleroi: 4,804
Grays Landing: 4,278
Opekiska Lock: 2,810
Morgantown: 1,741
Point Marion: 1,536
Ohio River: Emsworth Locks & Dam

Site Map
Emsworth Locks and Dam
Hydroelectric Project

FERC ID P-13757
Site Map
Emsworth Lock and Dam Project Rendering
Allegheny River – Lock and Dam No. 2
Monongahela River: Grays Landing Lock and Dam
Impacts – Air Quality

Generation in Pennsylvania - 2018

- Nuclear: 39%
- Natural Gas: 35%
- Coal: 21%
- Wind: 2%
- Other Biomass: 2%
- Petroleum: 2%
- Other Gases: 2%
- Wood and Wood Derived Fuels: 2%
- Solar Thermal and Photovoltaic: 2%
- Hydroelectric Conventional: 2%
Impacts – Air Quality

Coal Generation – 44,086,284 MWHR
- CO2 - 31,007,909 Metric Tons
- SO2 – 62,431 Metric Tons
- NOx – 25,709 Metric Tons

Natural Gas generates about 40% CO2 per MWHR as compared to Coal

2018 Data – Energy Information Administration
Impacts – Air Quality

Rye Hydro Projects Generation – 627,857 MWHR (about 1.5%)
  ▪ CO2 Offset – 441,600 Metric Tons
  ▪ SO2 Offset – 900 Metric Tons
  ▪ Nox Offset – 366 Metric Tons

Allegheny #2 Project Generation – 52,200 MWHR
  ▪ CO2 Offset – 36,715 Metric Tons
  ▪ SO2 Offset – 74 Metric Tons
  ▪ NOx Offset – 30 Metric Tons
Impacts - Recreation

Current Bank-Fishing facilities near projects somewhat informal, unimproved, challenging access

All Rye Projects will include improved fishing access, including tailrace platform, pier, or similar, all ADA access compliant
Impacts – Water Quality

- Hydropower Plant discharge must meet current standards
- Seasonal Bypass Flows – 200 to 1000 cfs, as required
- Real-Time Water Quality Monitoring and Reporting
  - Dissolved Oxygen (DO)
  - Temperature
- Generation will be suspended if WQ standards not met
- DO enhancement possible in discharge
Impacts – Aquatic Fauna

Fish Entrainment, Impingement, Mortality
- Licensing Studies - Comprehensive Baseline
- Monitoring During Operation
- Comprehensive Studies after 3-Years of Operation
- Low Approach Velocity – Intake/Trashracks – 2 feet per second
- 5-inch Trash Rack Spacing
- Low-Speed Fish Friendly Turbines

Fish and Freshwater Mussel
Relocation During Construction
Timeline to COD is a Barrier to Investment

- Development stage investors will not get a return on capital for at least 8 years.
- The disparity of development timelines effectively discourages investment in hydropower.
Project Development Process

- Early Stage Development: 5+ years
- Late Stage Development: 2+ years
- Construction: 2+ years
- Operation: 50+ years
Capital Scarce and Expensive – 25% to 30%

- Perceived as binary risk
- Long, uncertain timeline
- Lack of transparency
- Limited data
- Unclear accountability
- Limited Investor experience
**Capital Availability Increased, Still Expensive – 20% to 25%**

- Similar to early stage wind or solar investing
- Relatively high dollars per project due to 408 review requirements
- PPAs negotiated and finalized
Larger Investor Base, Reasonable Capital Cost – 12% to 15%

- Development risk generally mitigated
- Construction risk remains a major concern
- Allows for higher return to Investor than completed projects
- Institutional Investor increased interest due to operating project scarcity
Very Large Investor Base - 8% to 9%

- Scarcity value – Competition for Projects
- Very long asset life: 50 – 75 yrs+
- Predictable cash flows
- Renewable, sustainable
- Stable, reliable energy production
- Fuel and Carbon Hedge
Cost, Risk = f (Excavation Depth^2)
Cost and Risk Mitigation

Alternative Technologies
- Floating or Barge Mounted – Flexible Penstock Connection
- Steel Frame/Plates Anchored to Foundation
- Modular – Assembled on site, float in

Concerns
- Cost – No Significant Advantage
- Stability
- Longevity
- Robustness, Dam Safety
- Operations and Maintenance
Electricity Market

Hourly System Wholesale Price - $/MWH - Duquesne Light

Target Energy Sales Price Range - New Hydro
**Optimization**
- Utilize Existing Resource – Non-Powered Dams
- Benefit Regional Economies
- Maintain Value of Existing Asset – Less Navigation, More Hydro

**Growth**
- Feasible, Credible, Long Term
- Responsible Use of Existing Infrastructure

**Sustainability**
- Minimal Effect on Environment/Resources
- No Change is Water Use or River Flow
- Reliable, Low Impact
Thank You!

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