The Potential for Small Scale Hydropower Development in the U.S.

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Concerns about global climate change have led to increased interest in renewable energy supplies as well as RPS legislation.

This paper focuses on one specific type of renewable: small scale hydropower.
Small scale hydropower: 30 MW or less

- “small” = 30 MW ≥ P ≥ 1 MW
- “mini” = 1 MW ≥ P ≥ 100 kW
- “micro” = 100 kW ≥ P

→ such small scales have few negative riverine impacts
Diagram of a typical small scale hydropower facility:
Small scale hydropower presents a win-win situation:

*** no carbon emissions and a negligible local environmental footprint ***

(plus, small scale hydropower offers relief from other negative externalities, such as grid instability, centralization of power supply, and dependence on foreign imports)
In an earlier paper (Kosnik, 2008) it was found that potentially developable small scale hydropower sites existed in every state in the country, capable of satisfying RPS strictures beyond 2020.

But are these sites cost-effective?

That is the focus of this current paper.
Empirical Analysis:

- Utilizes a 2006 Department of Energy database → nearly 500,000 viable sites identified
- Scaled this down to only the most environmentally friendly sites
- Expanded the dataset with additional parameters
- Ran the observations through three different costing algorithms, for robustness
Important parameters utilized:

\[ P = \alpha HQ \]

\( P \) = power produced
\( H \) = head
\( Q \) = flow
number of frost days at site
turbine type
penstock length
transmission line length
road construction length
The three costing methods:

- RETScreen International (Canada)
- Norwegian Macro (Norway)
- Interpolation (Britain, Scotland, US)
## RETScreen International - Summary Results

(per kW)

<table>
<thead>
<tr>
<th>Type</th>
<th>n</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Small&quot; Hydro</td>
<td>5,427</td>
<td>$638</td>
<td>$1,243,745</td>
<td>$8,332</td>
<td>$4,989</td>
</tr>
<tr>
<td>&quot;Mini&quot; Hydro</td>
<td>28,616</td>
<td>$1,366</td>
<td>$6,103,161</td>
<td>$18,155</td>
<td>$11,637</td>
</tr>
<tr>
<td>&quot;Micro&quot; Hydro</td>
<td>1,691</td>
<td>$3,939</td>
<td>$267,250</td>
<td>$59,528</td>
<td>$49,015</td>
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</tbody>
</table>
Norwegian Macro - Summary Results

(per kw)

<table>
<thead>
<tr>
<th></th>
<th>&quot;Small&quot; Hydro</th>
<th>&quot;Mini&quot; Hydro</th>
<th>&quot;Micro&quot; Hydro</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>30 MW ≥ P ≥ 1 MW</strong></td>
<td>n = 5,427</td>
<td>n = 28,616</td>
<td>n = 1,691</td>
</tr>
<tr>
<td>Min</td>
<td>$57</td>
<td>$755</td>
<td>$3,114</td>
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<tr>
<td>Max</td>
<td>$169,487</td>
<td>$423,843</td>
<td>$308,668</td>
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<tr>
<td>Mean</td>
<td>$2,618</td>
<td>$6,912</td>
<td>$59,318</td>
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<tr>
<td>Median</td>
<td>$1,896</td>
<td>$5,615</td>
<td>$37,576</td>
</tr>
</tbody>
</table>

1 MW > P > 100 kW
Minimum & Median Cost Figures - Small Hydro - RETScreen International
(per kW)
Conclusions:

- Small scale hydro construction subject to nonlinear economies of scale
- Average cost of construction ($\approx 5,000\ kW$) is high. However,
- Hundreds of cost-effective sites ($\approx 2,000\ kW$), all over the country, still exist.
Conclusions II:

- Small scale hydropower will never be the panacea to U.S. energy issues
- However, it is a useful part of a portfolio of energy solutions
  - Input materials abundant and companies exist
  - Sites identified and could be constructed now (though regulatory reform would help)
  - Many other benefits too (decentralized nature, stability to grid, reduction of foreign imports, etc.)