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

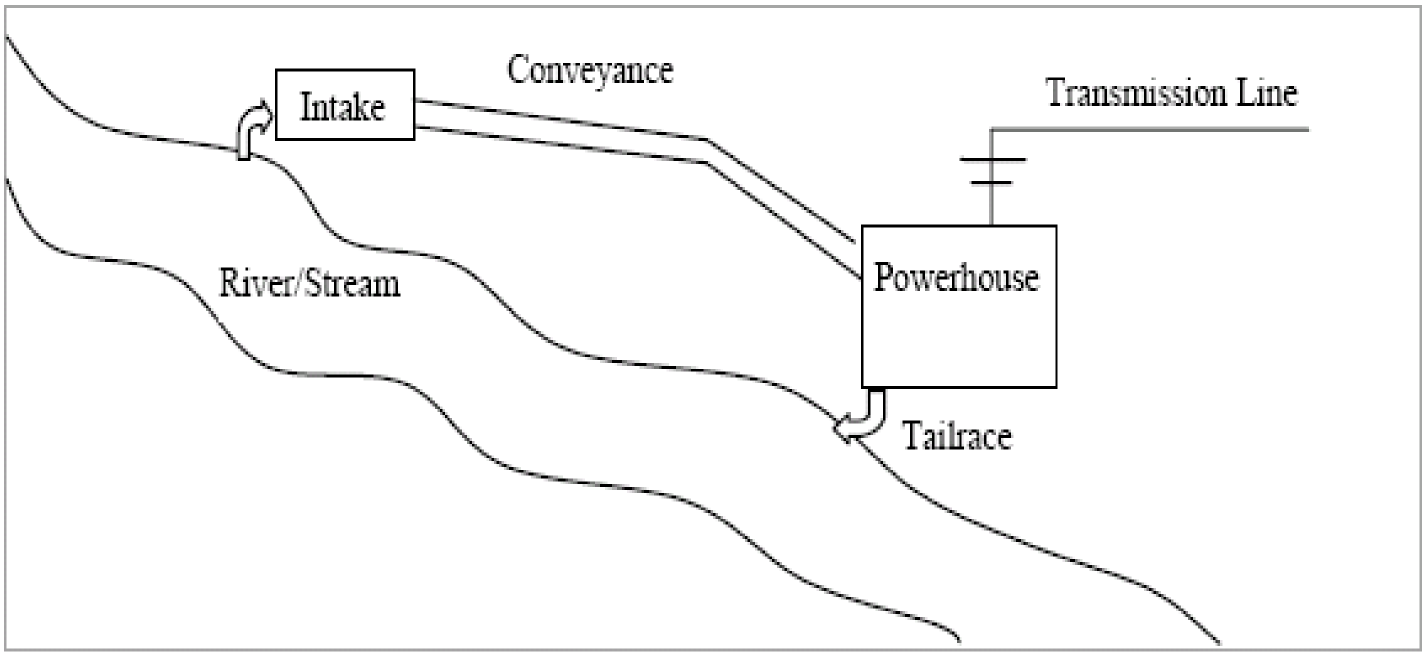
This paper focuses on one specific type of renewable: <u>small scale</u> hydropower

Small scale hydropower: 30 MW or less

- "small" = 30 MW $\geq P \geq$ 1 MW
- "mini" = 1 MW $\geq P \geq$ 100 kW
- "micro" = 100 kW $\geq P$

$\rightarrow$ 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

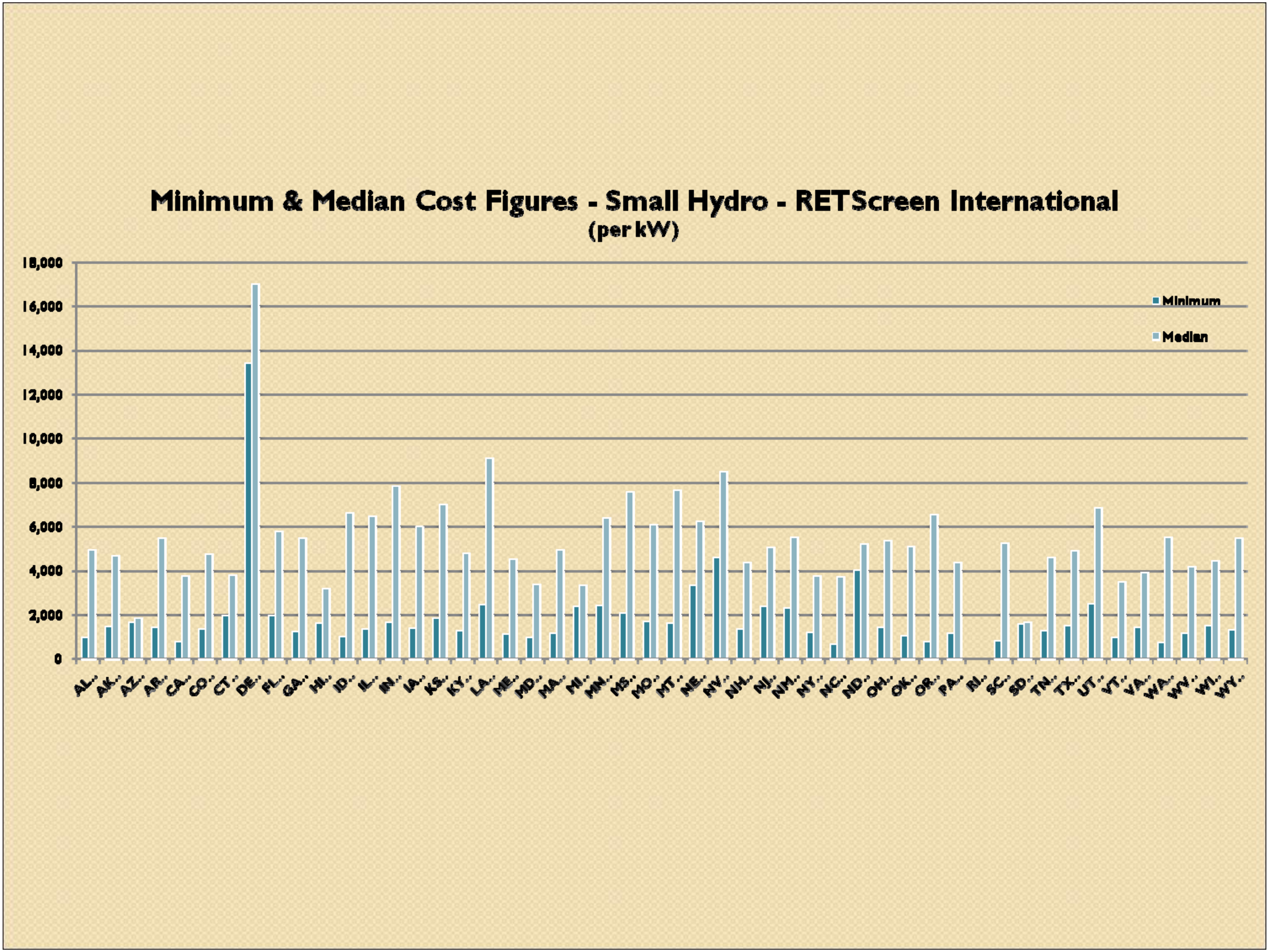
(per kw)

"Small" Hydro 30 MW ≥ P ≥ 1 MW	"Mini" Hydro 1 MW > P > 100 kW	"Micro" Hydro 100 kW ≥ P
n = 5,427	n = 28,616	n = 1,691
Min = $638	Min = $1,366	Min = $3,939
Max = $1,243,745	Max = $6,103,161	Max = $267,250
Mean = $8,332	Mean = $18,155	Mean = $59,528
Median = $4,989	Median = $11,637	Median = $49,015

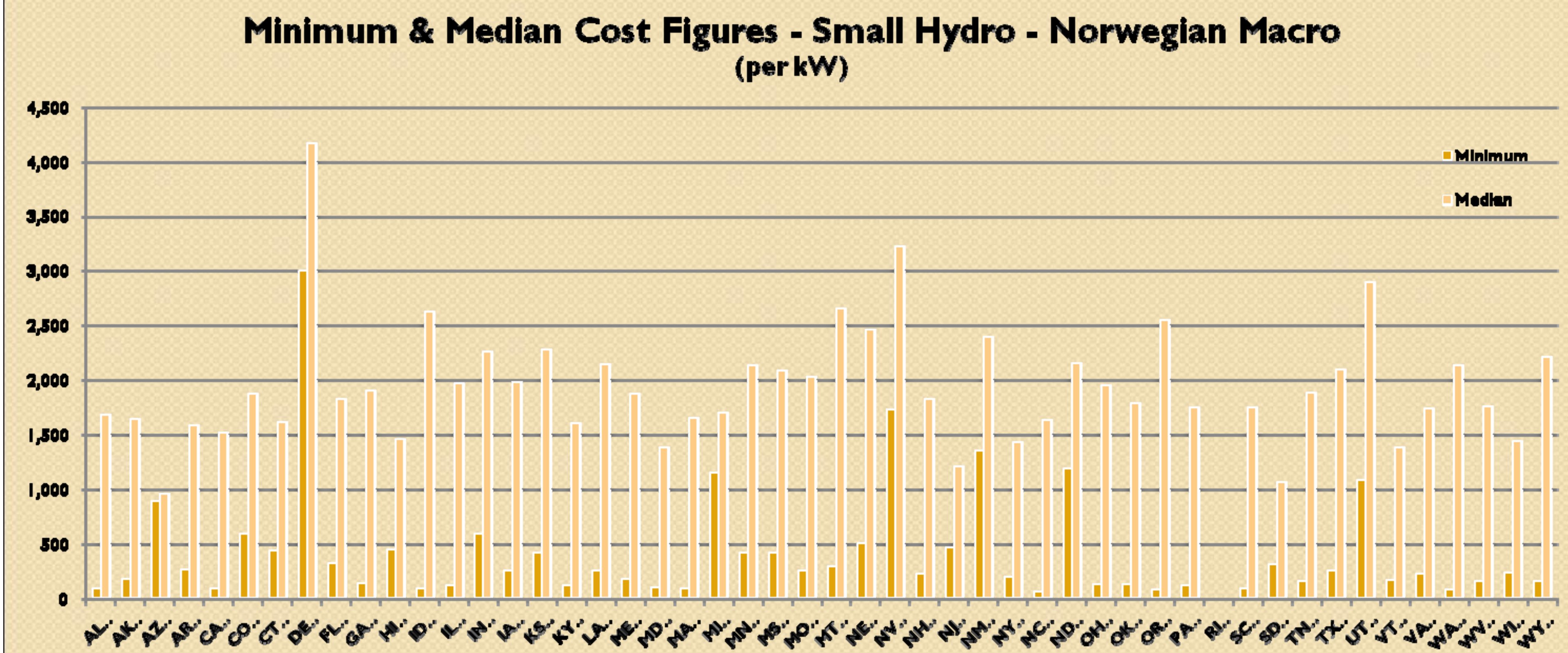
Norwegian Macro - Summary Results

(per kw)

"Small" Hydro 30 MW ≥ P ≥ 1 MW	"Mini" Hydro 1 MW > P > 100 kW	"Micro" Hydro 100 kW ≥ P
n = 5,427	n = 28,616	n = 1,691
Min = $57	Min = $755	Min = $3,114
Max = $169,487	Max = $423,843	Max = $308,668
Mean = $2,618	Mean = $6,912	Mean = $59,318
Median = $1,896	Median = $5,615	Median = $37,576



Minimum & Median Cost Figures - Small Hydro - RETScreen International
(per kW)
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Minimum
Median
AL.. AK.. AZ.. AR.. CA.. CO.. CT.. DE.. FL.. GA.. HI.. ID.. IL.. IN.. IA.. KS.. KY.. LA.. ME.. MD.. MA.. MI.. MN.. MS.. MO.. MT.. NE.. NV.. NH.. NJ.. NM.. NY.. NC.. ND.. OH.. OK.. OR.. PA.. RI.. SC.. SD.. TN.. TX.. UT.. VT.. VA.. WA.. WV.. WI.. WY..


Minimum & Median Cost Figures - Small Hydro - Norwegian Macro
(per kW)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Minimum
Median
AL.. AK.. AZ.. AR.. CA.. CO.. CT.. DE.. FL.. GA.. HI.. ID.. IL.. IN.. IA.. KS.. KY.. LA.. ME.. MD.. MA.. MI.. MN.. MS.. MO.. MT.. NE.. NV.. NH.. NJ.. NM.. NY.. NC.. ND.. OH.. OK.. OR.. PA.. RI.. SC.. SD.. TN.. TX.. UT.. VT.. VA.. WA.. WV.. WI.. WY..

Conclusions:

- Small scale hydro construction subject to nonlinear economies of scale
- Average cost of construction (≈ \$5,000 kW) is high. However,
- Hundreds of cost-effective sites (≈ \$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.)