A truthful bidding mechanism for micro-hydropower plant removals

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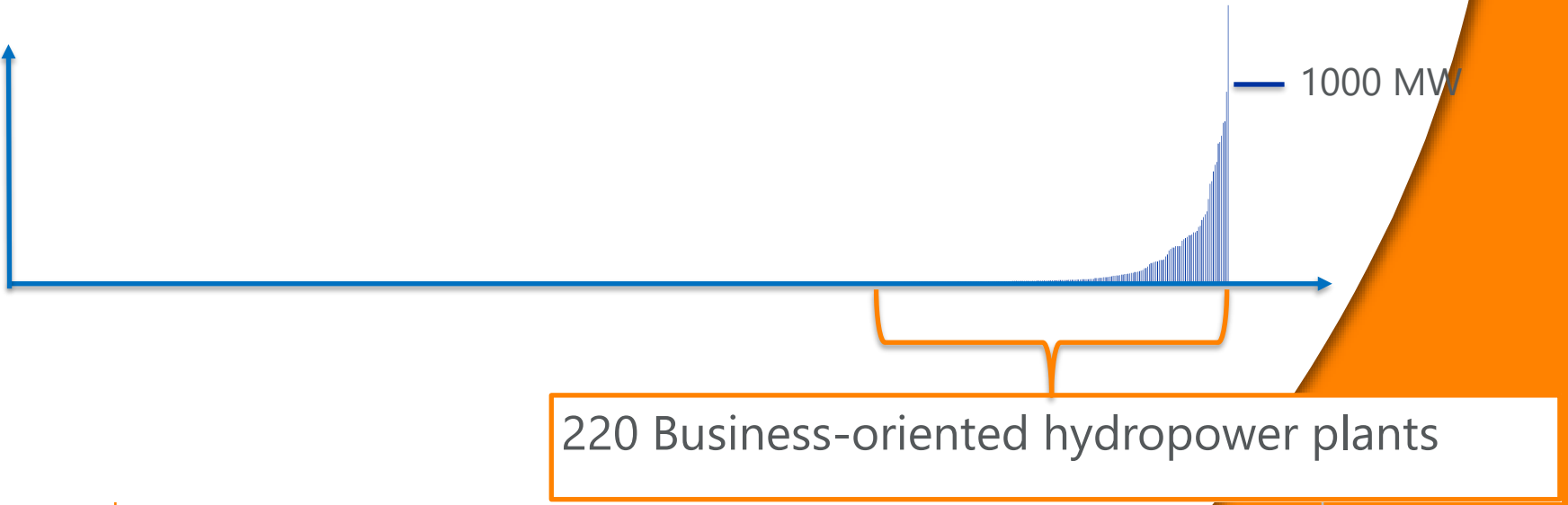
Hydropower plants and dams in Finland

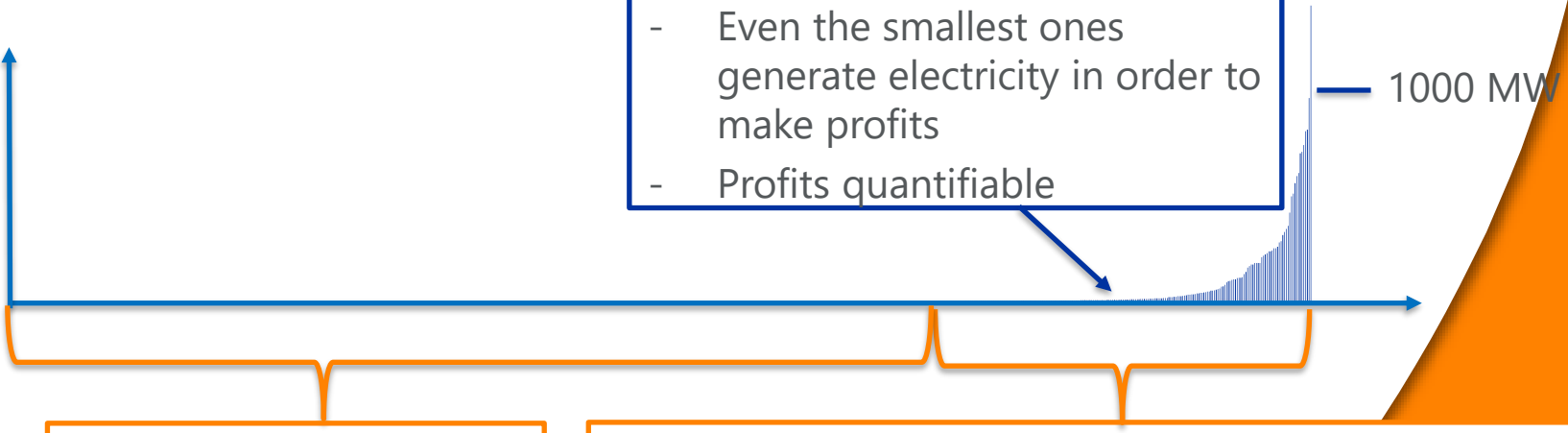


Hydropower plants and dams in Finland

500 household based + 220 Business-oriented hydropower plants

Hydropower plants and dams in Finland

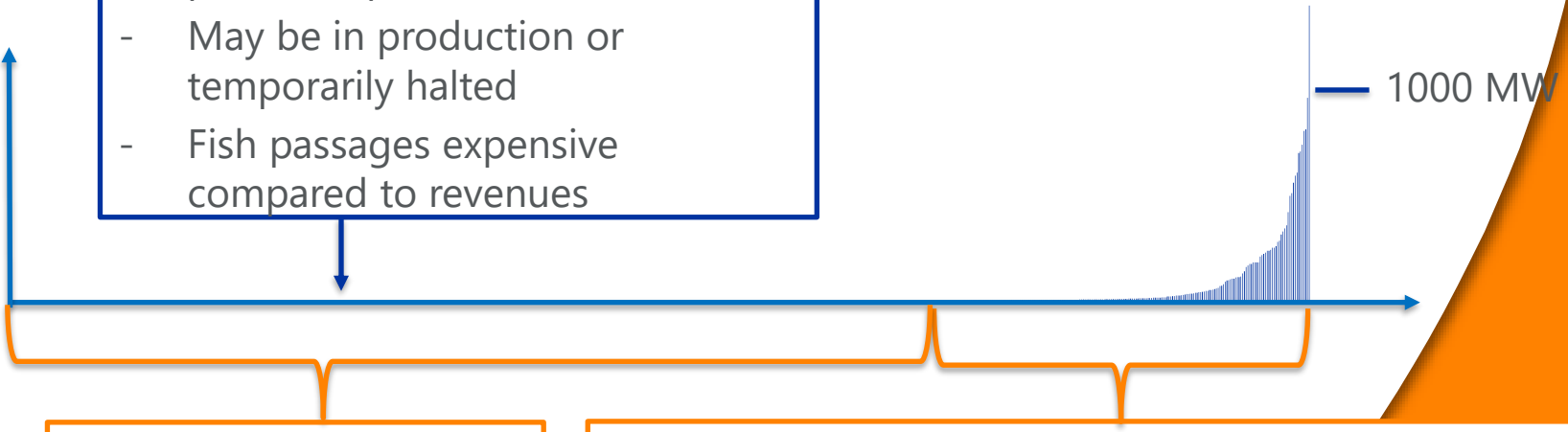
- Environmental regulation focuses on these: permits and permit tightening processes
- Largest ones have their own analysts, lobbyists
- Even the smallest ones generate electricity in order to make profits
- Profits quantifiable



500 household based + 220 Business-oriented hydropower plants

Hydropower plants and dams in Finland

- Ecologically important
- Generate electricity for household or small scale industry use
- Generally old structures with no permit requirements
- May be in production or temporarily halted
- Fish passages expensive compared to revenues



500 household based + 220 Business-oriented hydropower plants

Characteristics of the 500 small ones

- Hard to estimate what the net benefit of the dam is for the owner
  - \+ Electricity for own use (high price)
  - \+ Irrigation
  - \+ Swim after sauna
  - \+ Fishing
  - \+ Rowing
  - \- Not having a rapid (aesthetics, migratory fish)
  - \- Own valuation for freshwater ecology

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Hard to infer from observable characteristics:

How much should we pay for the dam owner to have it removed & river restored?

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Summing up the problem

- Many small dams
- Many of them ecologically harmful
- Ecological characteristics well mapped and known
- Benefits to owners unknown, hard to infer
- Removal ties public resources even if frictionless (permitting, planning, removal, restructuring)
- Removal consumes lot of time and public resources if focusing on difficult cases

1. Where to focus to obtain maximal ecological benefits?
2. How much to pay as compensation for dam owners?

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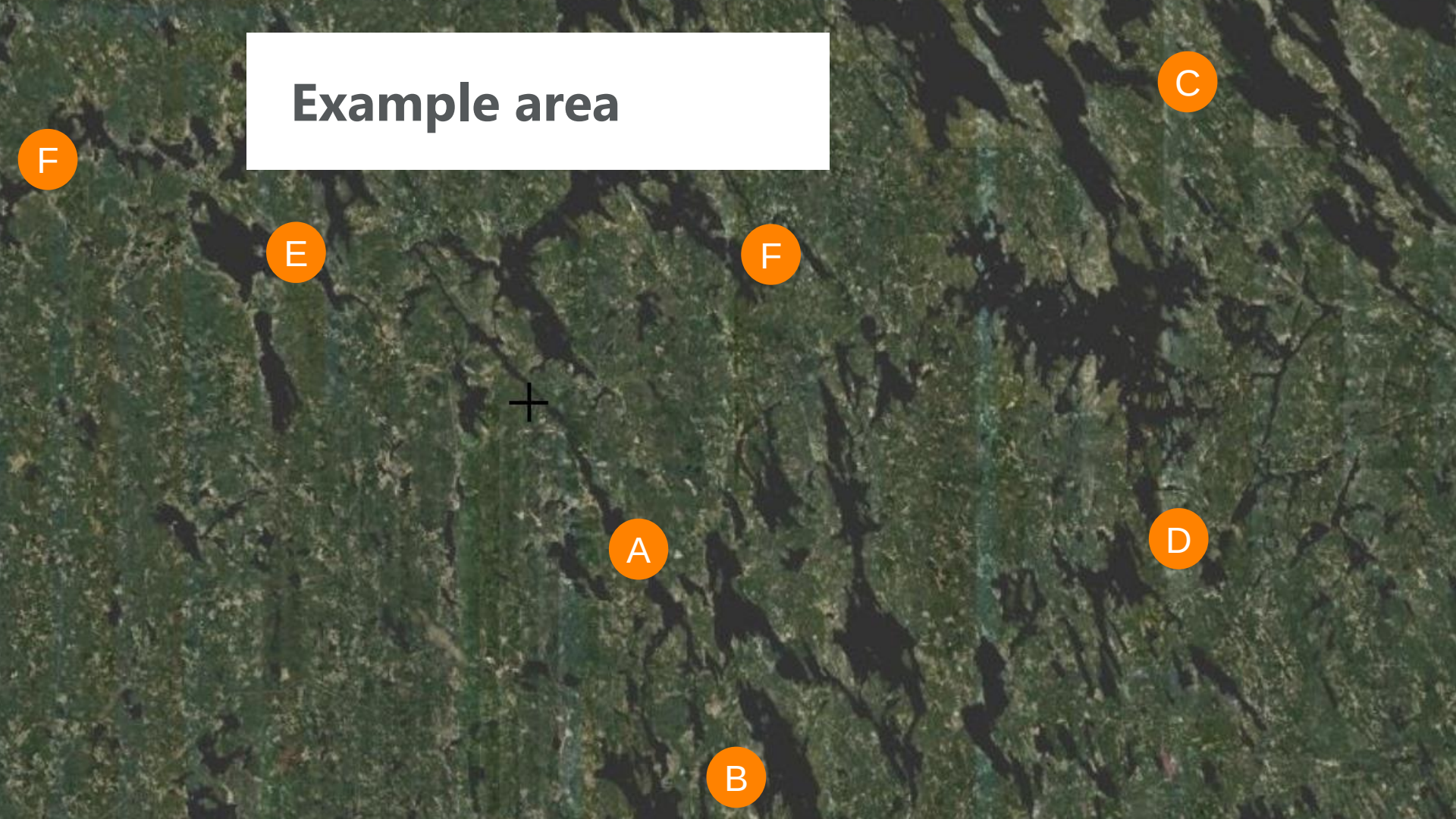
Example area



1. (Simple) Environmental Benefit Index (EBI) & Ecological priorization

Facility	D=Upstream distance (km)	Q=Upstream quality (1-5)	EBI= $Q * \sqrt{D}$	Rank
A	2.4	4	6.2	5
B	25	1	5.0	6
C	13	2	7.2	3
D	50	1	7.1	4
E	3	2	3.5	7
F	10	5	15.8	1
G	10	3	9.5	2

1. EBI & Removal, restoration (RR) costs

Facility	EBI	RR costs (thousand €)	Dam owners values (thousand €)	Rank
A	6.2	20	HIDDEN!	5
B	5.0	21		6
C	7.2	19		3
D	7.1	20		4
E	3.5	20		7
F	15.8	19		1
G	9.5	20		2

1. Ecological priorization, budget 80 000€

Facility	EBI	RR costs (thousand €)	Dam owners values (thousand €)	Rank
A	6.2	20	HIDDEN!	5
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C	7.2	19		3
D	7.1	20		4
E	3.5	20		7
F	15.8	19		1
G	9.5	20		2

1. Ecological priorization, budget 80 000€ → start negotiating with F

Facility	EBI	RR costs (thousand €)	Dam owners values (thousand €)	Rank
A	6.2	20	HIDDEN!	5
B	5.0	21		6
C	7.2	19		3
D	7.1	20		4
E	3.5	20		7
F	15.8	19		1
G	9.5	20		2

After fierce, year-long negotiations, the dam owner says NO! to the offered amount (eventually **61 000€**).

Why?

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1. Ecological priorization, budget 80 000€ → move to negotiate with G

Facility	EBI	RR costs (thousand €)	Dam owners values (thousand €)	Rank
A	6.2	20	HIDDEN!	5
B	5.0	21		6
C	7.2	19		3
D	7.1	20		4
E	3.5	20		7
F	15.8	19		1
G	9.5	20		2

Having learned from negotiations with F, we offer G immediately **61 000€**. G agrees to go on with dam removal. YES!!

But we could have achieved much more. Why?

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- Why don’t we just ask?
- Will they answer honestly?
- With a well-designed auction mechansim they will

- Ask dam owners ”How much you should be compensated to let as remove the dam and restore the river?“
- The answer is honest, if
    - There is competition (enough bidders)
    - There is no coordination
- Weight the EBI that would be achieved with the compensation request
- Rank
- Choose dams until budget exhausted

2. Auction mechanism, budget 80 000€

Facility	EBI	RR costs (thousand €)	Dam owners bids (thousand €)	Total cost (thousand €)	EBI/ €	Rank
A	6.2	20	0	20	0.310	3
B	5.0	21	90	111	0.045	7
C	7.2	19	5	24	0.300	4
D	7.1	20	10	30	0.236	5
E	3.5	20	-10	10	0.346	2
F	15.8	19	80	99	0.160	6
G	9.5	20	´5	25	0.380	1

2. Auction mechanism, budget 80 000€

Facility	EBI	RR costs (thousand €)	Dam owners compensation (thousand €)	Total cost (thousand €)
A	6.2	20	0	20
B	5.0	21	90	111
C	7.2	19	5	24
D	7.1	20	10	30
E	3.5	20	-10	10
F	15.8	19	80	99
G	9.5	20	´5	25

By using an auction, we recieved total environmental benefits equal to EBI=26.4 instead of EBI=9.5 – with the same budget.

Issues

- Joint benefits. Typically more dams in a single river than just one → benefits are interlinked
    - Computational issue
- There are 5200 dams without hydropower in Finland, with ecological effects
    - → these can be included, expect lower EBI, lower bids
    - → increase competition (good)

Auction trial in Finland 2021-2022

- We are planning to conduct an auction pilot on Southern Savonia
- Goals:
    - Attract enough bids out of few hundred targets
    - Identify 10 dams (either w/o hydropower) for removal
    - Act!
- Work in progress, joint work with various governmental organiszations, ministries, WWF, universities

Kiitos –Thank you!

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