RHEOMEGA

HARNESSING THE POWER OF HEAT

Foam Turbine

ALEXANDER BELL - JULY 2016

Pain Points

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Commercial & industrial users are faced with uncertainty in a fundamental utility: **Electricity**

Power cost is variable & can be expensive

- Time of day & time of year peak demand and energy charges make for complex cost predictions

Power itself can be unstable – interruptions are expensive

- The grid continues to age and is becoming increasingly unstable
- Critical processes at hospitals, data centers, and manufacturing cannot tolerate interruptions
- Power intermittency issues are arising from wind & solar

Old power generation is dirty and inefficient

- Decades-old coal power plants pollute and have T&D losses

Existing Solutions

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For on-site continuous, peak, or backup power:

- Diesel engine generator sets are the norm – cheap, but dirty emissions
- Microturbines & turbines are the clean & flexible alternative, but they're expensive & less efficient

KOHLER 250 KW

CUMMINS 800 KW

CATERPILLAR 2000 KW

Diesel Gensets

C200 Microturbine

Proposed Solution

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The **Foam Turbine** is more efficient and cheaper than turbines

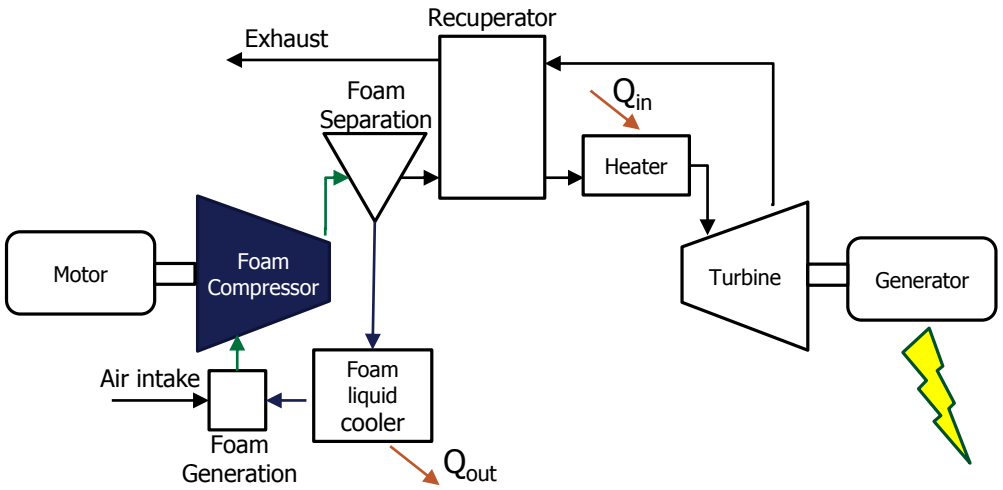
- Poised to outperform diesel gensets

Up to +3% efficiency

Up to +50% greater specific power → improved $/kW

Targeting 500kW module size

Foam Turbine Cycle



Secret Sauce

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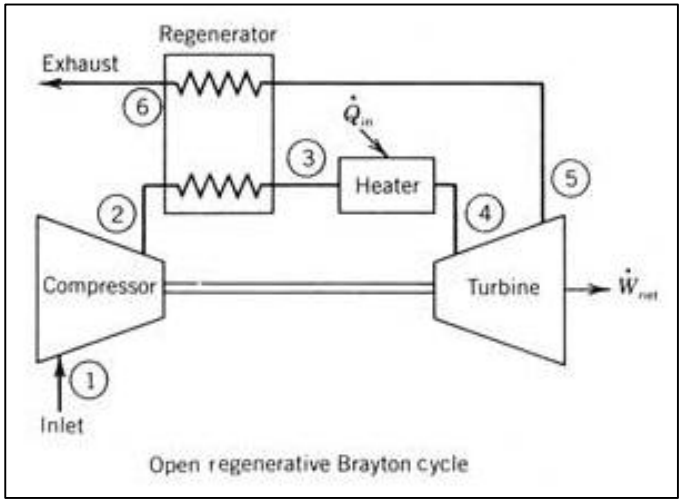
Foam Technology – Isothermal Compression & Expansion

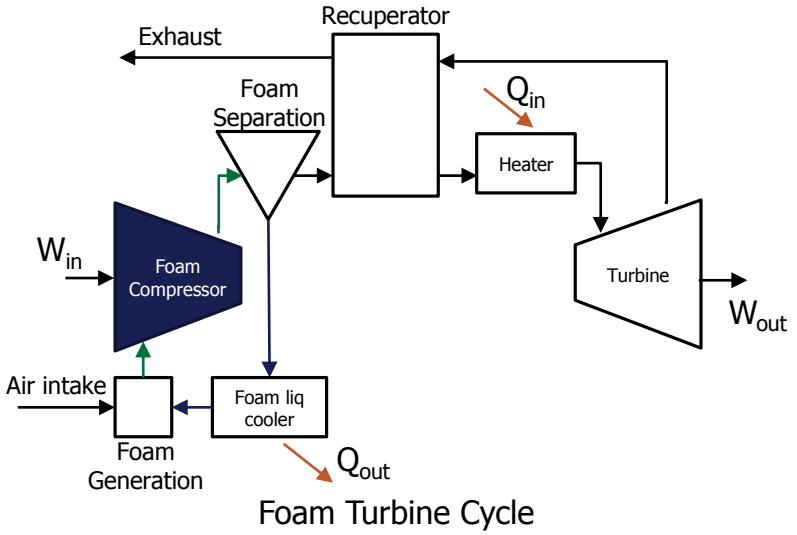
- As demonstrated by SustainX ICAES - Isothermal Compressed Air Energy Storage

Microturbines use a recuperated/regenerated Brayton cycle to generate power

How does the Foam Turbine do it?

- The Foam Compressor (near-isothermal) instead of the adiabatic compressor
- Adiabatic compressor consumes 50% of the turbine's output
- Isothermal compressor consumes 30% less power
- Specific power is increased by 50% → dramatically reduces air flow rate
- Lower flow = smaller expensive hot components – combustor, recuperator & turbine → Cost savings realized





Market

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Distributed Generation, <10 MW

$0.15B microturbines (30kW-1MW)

$1B turbines (1MW+)

$20B diesel engines (500kW+)

Other markets – gas compression & expansion are applicable to many industries

- Turbine uses: Mechanical Drives ($0.15B), Concentrated Solar Power
- Compressor & expander uses: Shop Air compressors ($20B), Air Conditioners & Heat Pumps ($15B), Waste Heat to Power ($15B), Compressed Air Energy Storage ($2B)

Competition

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Distributed Generation (<10 MW):

- 1% microturbines, 5% turbines, 94% diesel engines

Microturbines:

- 55% Capstone, 35% FlexEnergy, 10% Ansaldo

Turbines:

- SolarTurbines (Caterpillar), GE, Siemens, Kawasaki

Diesel engines:

- 30% Caterpillar, 16% Cummins
- 10% Kohler, 6% Generac, 10% Honda, 19% Other

Revenue

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Sell Foam Turbine as capital equipment with gross margin: 20-30%

$300k (500kW) to $1.2M (2MW) per unit

- $600/kW Department of Energy price target for microturbines

Competing with turbines:

- 1's to 10's of units per year
- Annual Revenue ~ $10M-50M

Break into diesel genset market:

- 1000's to 10,000's of units per year
- Annual Revenue ~ $1B to $10B

Timeline & Exit

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Timeline

- Product launch: 3 years
  - R&D needed to adapt Foam Technology to turbines
  - Gov't grants targeted: ARPA-e IDEAS, NSF SBIR

Exit: Acquisition or IPO

- Potential acquirers: Caterpillar, GE, Siemens
- IPO example: Capstone Turbine

Team

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Alex Bell – Founder

"Foam Guy" Senior Research Engineer, R&D Manager – key developer of SustainX's isothermal compression/expansion foam technology – 4 patents

Thayer - MEM

UNH, BS Chemical Engineering

David Perkins – Adviser

CTO – General Compression (Isothermal Compressed Air Energy Storage)

CTO - Active Power (Flywheel & Compressed Air UPSs)

10 patents

University of Texas - BS, MSME