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SPEEDBUMP PRESENTATION

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Agenda

Part 1: Introduction & executive summary

Part 2: Results & testing

Part 3: Benefit analysis

Part 4: Basic business plan

Executive summary

Prototype a system that utilizes the basic functions of a speed bump for the purpose of energy capture

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Decision matrix

- decided this approach with decision matrix

- final design with professors' help

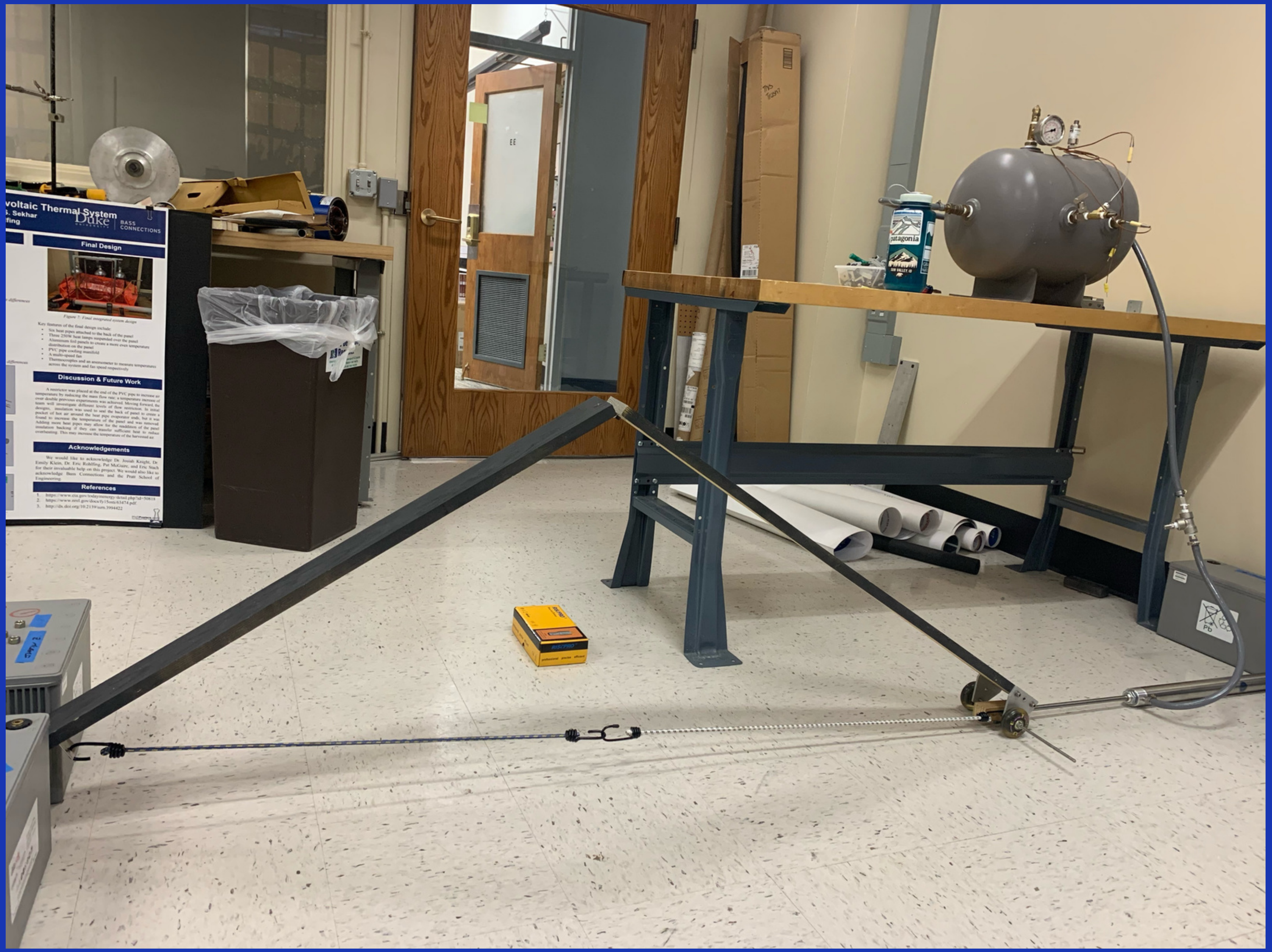
	Cost	Technical Complexity	Power output/capacity/efficiency	Safety	Environmental impact	Maintenance	Total
Weight	0.2	0.25	0.2	0.15	0.15	0.05	1
Hydraulic	4	2	4	2	3	3	3
Compressed gases: Open loop (air)	4	5	4	3	4	4	4.1
Compressed gases: Closed loop (other gas)	3	2	5	1	4	2	2.95
Piezoelectric	1	1	1	4	4	1	1.9
Combination piezoelectric and hydraulic	2	1	5	3	2	1	2.45
Mechanical (axel and generator)	5	5	3	3	4	4	4.1

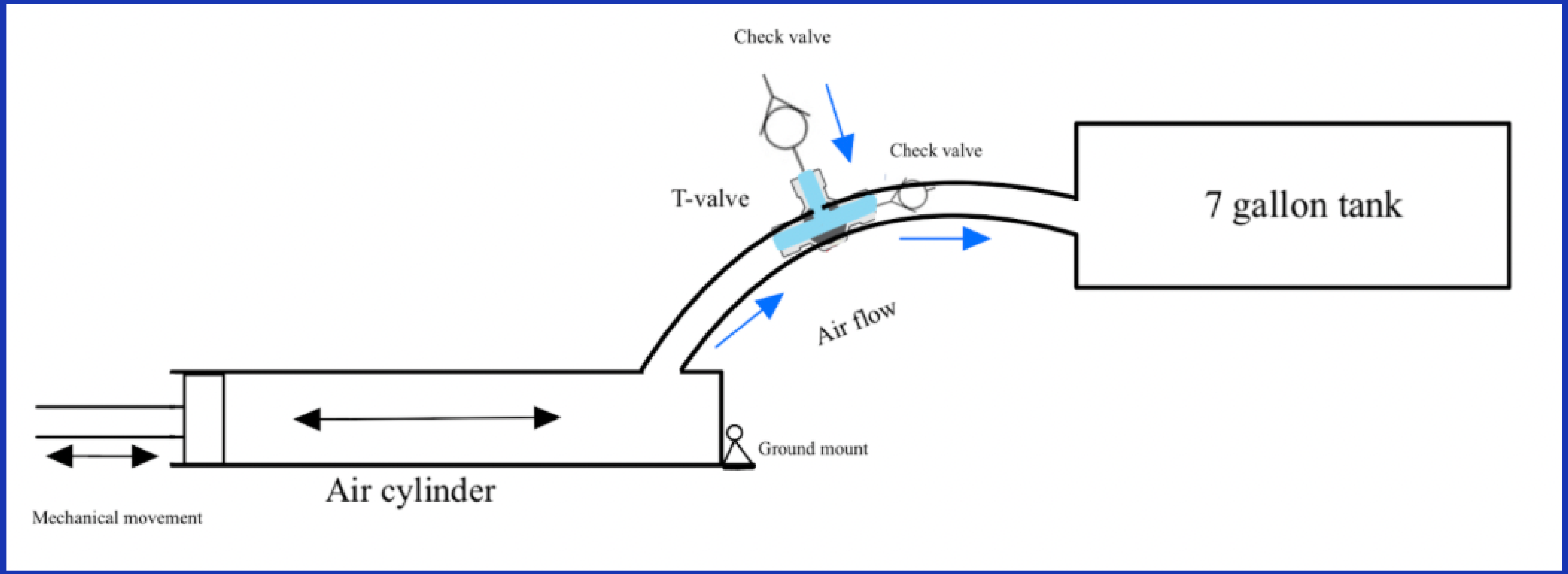
Analysis of Design

Justification of:

- Tank
- Pump
- Hinging mechanism

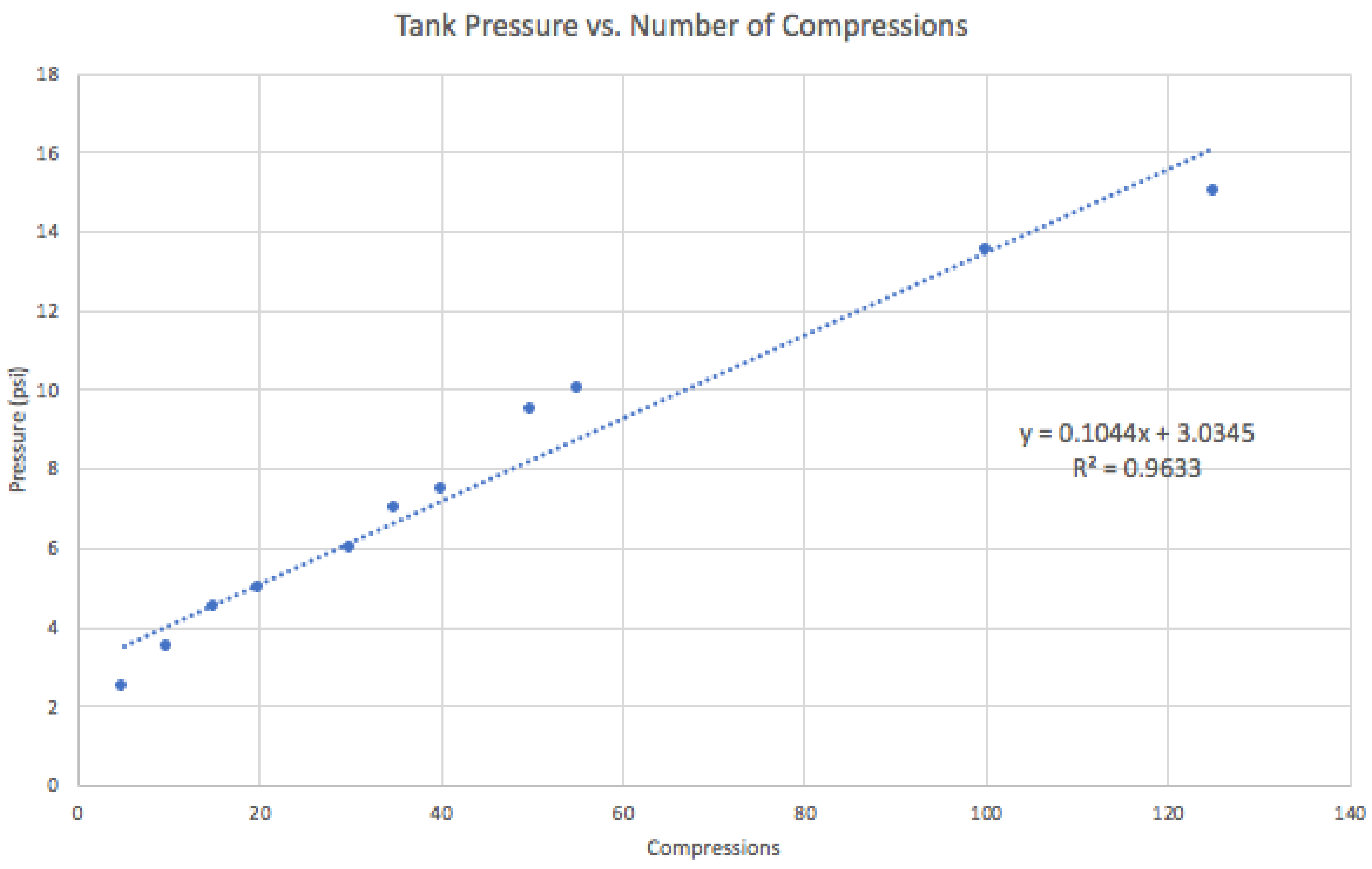
McMaster as main site for supplies




Check valve
Check valve
T-valve
7 gallon tank
Air flow
Ground mount
Air cylinder
Mechanical movement

Testing

- Pump was manually compressed 125 times
- Tank pressure was noted 11 times during pumping process
- Relationship between tank pressure and # of compressions was plotted
- To fill tank (max 160 psi), approximately 1500 compressions needed!



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DEMO

Results

- Estimated energy stored in our prototype tank (7 gallon, 160 psi):

$$m = 0.0326\ \text{kg}$$

$$V/V_o = 14$$

$$C = mRT = 2810\text{J}$$

$$W = 14000\text{J} = \text{approximately } 0.04\ \text{kWh}$$

- Estimated energy stored in a 500 gallon tank with 2000 psi capacity:

$$W = 1.4\text{e}8\text{J} = \text{approximately } 39\ \text{kWh}$$

- Like our prototype, many compressions would be required to fill this tank, but a scaled-up version could power an entire single family home for a day or two

Social benefit analysis

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Increased pedestrian safety	Increased traffic and vehicle safety	Awareness of environmental conservation	Individual empowerment for environmental activism
Assessed via community surveys of pedestrian satisfaction and collision data	Assessed via traffic safety data and driver satisfaction metrics	Provides opportunity for education on environmental issues	Example of individual action taken by students towards tangible environmental benefit

Environmental benefit analysis

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Reduced emissions associated with roadside devices
- for 100 bumps: 118.4 lbs CO_2/day

Reduced energy consumption on college campuses
- for 100 bumps: 139.3 kWh/day

Reduced energy costs for universities
- for 100 bumps: 13.13 $/day

All calculations assume 2000 PSI, 500 gallon tanks w/ same pump as prototype - 100 installed on campus

Less reliance on fossil fuels for energy generation on campus

Wasted mechanical energy --> pressurized air --> energy production

Passive form of clean energy generation = reduced energy generation costs

Each filled in 2 weeks

Target market

Colleges and Universities seeking to increase reliance on clean energy

Vehicle Operators on high-traffic campus roads

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Basic Business Plan

Understanding our market & business model

- Cost structure
- Revenue streams
- Payback period

Overall, existing market landscape and cost-benefit ratio present a *challenging path* to market

Estimating cost on a $/speed bump basis

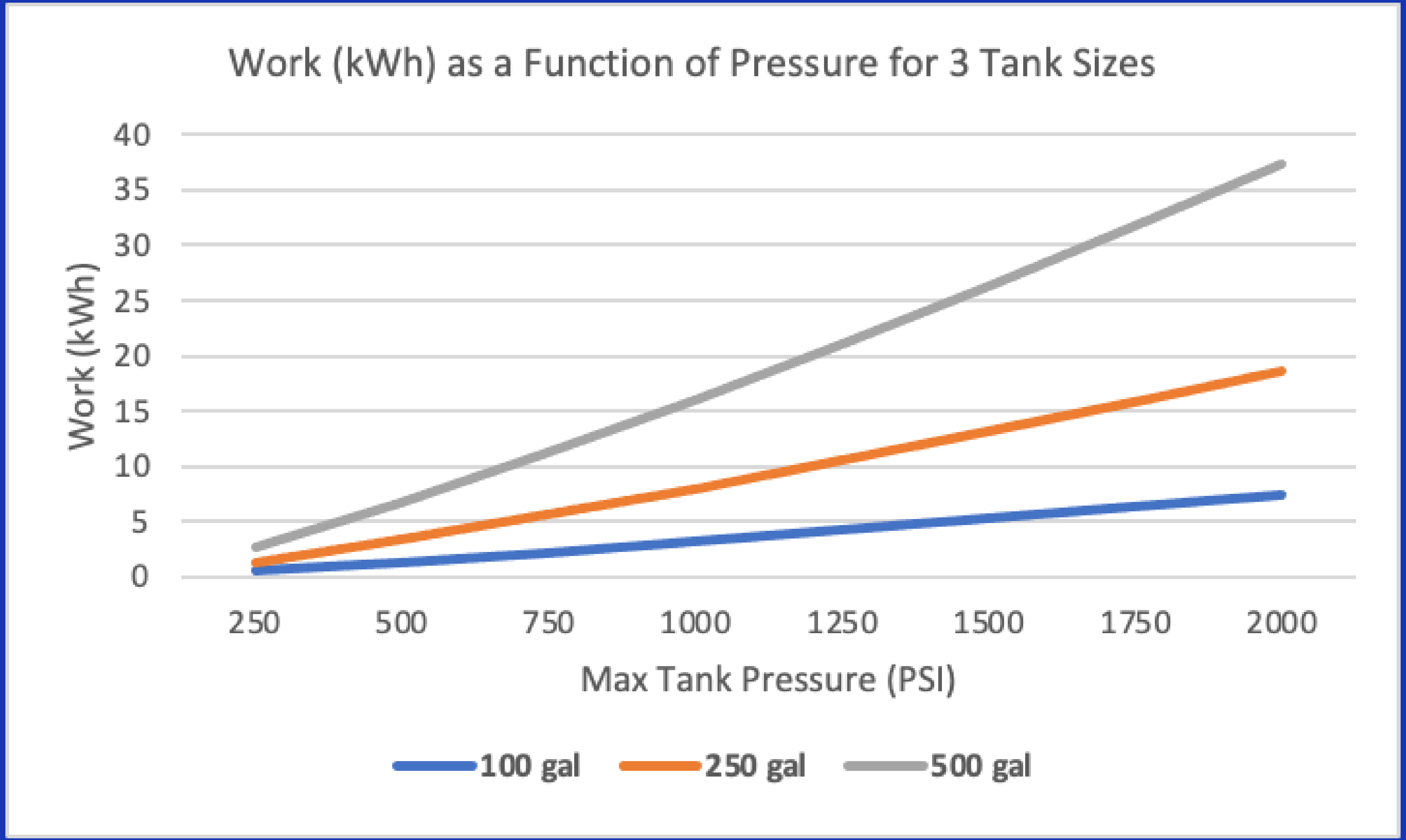
- Approx. *full-scale system*
- Based on discounted retail prices & assumptions on manufacturing, maintenance, CapEx
- Contracts, partnerships, economies of scale to further reduce costs

Scaled System - 250-500 gallon tank @ Max 1000-2000 PSI Estimated Lifetime Cost ($ / speed bump)		
Pumps (2 - 8 total)	$	500
Tubing (10 ft. total)	$	50
Misc. Hardware	$	50
Tank (300-500 gallons)	$	2,000
Turbine & Generator	$	1,000
Manufacturing/Assembly	$	150
Labor	$	150
Planning & Installation	$	1,000
Lifetime maintenance	$	400
CapEx ($ per Unit)	$	500
Total	$	5,800.00

Revenue & Value-Add

- Electricity output ($/kWh)
  - NC - 11.5 cents/kWh
- Safety value
  - University target market
- CO_2 abatement & env. benefits
- Long-term energy storage option

Assume WTP of $.15 / kWh from customers



Estimated Payback Period

<u>Assumptions</u>:

Lifetime, all-inclusive cost est. $5800/unit

Revenue of $.15/kWh

50% "power-to-power" efficiency

- (kWh electricity) = (1/2) (kWh work)

System sized to reach max P once/day

- ~50L pump stroke volume
- ~1200 compressions (600 cars)

250 gallons @ 2000 PSI = 19 kWh work

Corresponds to payback period of roughly 11 years

...

Seek opportunities to *reduce costs* and *increase system capacity*

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What incentives are the government offering to help us roll out our product?

Government Incentives

- Purchasing Tax Credit (PTC) & Investment Tax Credit (ITC)
- Federal R&D Tax Credit.
- SBIR & STTR Grants through the DOE.
- Chapel Hill Silver LEED Requirement.

Thank you!

Any questions?