Urban Runoff and Energy Recovery

Opportunity and Significance

- Average annual rainfall in Detroit is 30.97 inches
- Total building area of Detroit is roughly 15.75 mi^2
- A water volume of 12,838 Olympic size swimming pools per year falling from buildings.

Limitation: Small amounts of electricity—Water storage

Opportunity: Remote sensors can be powered through runoff—Improved residential rainwater systems

Technical Objectives

- Can microturbines operate with low flow (~0.024 gal/sec) and low head (1-6 ft)?
- How much power can microturbines generate under these conditions?

Method

- Compare commercially available low cost microturbines (12 V).
- Replicate reservoir system with 5 gallon bucket.
- Wire turbine to load (10,000 Ω).
- Drain bucket to test power generation.
- Test three different turbine heights.

Next Steps for Testing and Development

- Determine best turbine type for low fluid conditions.
- Test same volume reservoir with smaller area. This should simultaneously increase head and flow.
- Power sensors on campus with microturbines.
- Pair with micro wind turbines and/or solar cell.
- Model more efficient microturbines for 3D printing.

Results

- Average Watts vs Height
- Flow of water decreased along with water level in bucket.
- Velocity of water related to height of water level from bucket outlet.

Commercialization Plan

- Store water as a battery on elevated surfaces.
- Charge sensors without wired power using micro hydro/wind/solar.
- 3D print microturbines
- Use collected water for irrigation or outdoor use.
- Reduce residential water consumption.

References

https://www.usclimatedata.com/climate/detroit/michigan/united-states/usmi0229
https://maps-semcog.opendata.arcgis.com/datasets/buildings-detroit

Related Work and State of Practice

Sponsored by WSU College of Engineering through the Research Opportunities for Engineering Undergraduates program.