

Foundation system for sustained distributed water & energy

Overview

A readable, practical technical document that records the childhood proof-of-concept (PoC) idea: a stacked-can, gravity-driven water distribution system (the “baked-bean can fountain”) and how that simple PoC can be evolved into a resilient, community-scale distributed water and micro-energy system.

This document is written so you or a community group can reproduce the experiment, measure its performance, and scale it into a low-tech, low-cost distributed system.

Goals

- Record the original PoC and its working principles.
 - Provide build steps and materials for an experimental prototype.
 - Give basic hydraulic calculations so you can estimate flow and balance the system.
 - Suggest technical upgrades to turn the PoC into a sustainable distributed water/energy solution (micro-hydro, reservoirs, filtration, controls).
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Concept & physical principles

- **Gravity-fed flow:** Water flows from a higher can to a lower can through holes. The driving force is the hydrostatic head (height difference).
 - **Flow control by hole size & head:** Exit velocity follows Torricelli's law: $v = \sqrt{2gh}$. Flow rate through a hole: $Q = A \times v$ where A is the hole area.
 - **Fair distribution by cascading containers:** Each can (or node) receives inflow and releases outflow sized so downstream nodes get their share. The geometry and hole sizes determine per-node distribution.
 - **Potential for energy capture:** If you build a sufficient head and funnel the outflow through a small turbine or water wheel, you can harvest micro-hydro power.
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Materials (prototype)

- Empty metal food cans (baked beans / similar), cleaned and dried — several dozen for an extended cascade.
- Short lengths of rigid plastic straw/tube or small-diameter tubing (to act as flow channels or low-cost nozzle guides).
- Drill or heated nail for making precise holes.
- Sealant / hot-glue / silicone for leak control.
- Small collection basin or reservoir (plastic bin).
- Measuring cup, stopwatch, ruler, marker.

- Optional: small DC turbine or Pelton-style micro turbine (for energy capture), battery and charge controller.
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Prototype build — step by step

1. **Prepare cans:** Clean cans, remove labels as needed. Decide vertical spacing: for a tabletop test, 10–20 cm between levels gives measurable head.
 2. **Make holes:** Choose hole diameters for the outflow. Mark the same position on each can (side, near bottom). Create holes with a nail/drill. File edges.
 3. **Insert short tubes (optional):** Push short straw segments into holes to shape the jet and reduce splash.
 4. **Stacking:** Place cans in stack or staggered cascade so each can drains into one or more downstream cans. Secure with tape if needed.
 5. **Fill & observe:** Pour water into top can and time how long each can takes to pass a liter. Record flow and behavior.
 6. **Adjust:** Increase/decrease hole sizes, change vertical spacing, or add small weirs to balance distribution.
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Example calculation (digit-by-digit) — hole size, head, and flow

Given: head (height of water surface above hole) $h = 0.15$ m (15 cm). Gravity $g = 9.81$ m/s².

1. Compute exit velocity using Torricelli's law: $v = \sqrt{2gh}$.
2. Compute inside: $2gh = 2 \times 9.81 \times 0.15 = 2 \times 9.81 = 19.62$; $19.62 \times 0.15 = 2.943$. So $2gh = 2.943$.
3. Velocity: $v = \sqrt{2.943} = 1.715$ m/s (rounded to three decimals).
4. Hole diameter example: choose $d = 2$ mm = 0.002 m. Radius $r = d/2 = 0.001$ m.
5. Area $A = \pi r^2 = \pi \times (0.001)^2 = \pi \times 1 \times 10^{-6} = 3.14159265 \times 10^{-6}$ m².
6. Flow rate $Q = A \times v = 3.14159265 \times 10^{-6} \times 1.715 = 5.389 \times 10^{-6}$ m³/s.
7. Convert to litres per second: multiply by 1000 => 0.005389 L/s.
8. Convert to litres per minute: multiply by 60 => $0.005389 \times 60 = 0.32334$ L/min.

Interpretation: A single 2 mm hole with a 15 cm head will deliver roughly **0.32 L/min**. For a village node delivering 20 L/min you'd need many parallel holes or larger diameter/nozzles and larger heads. Use this method to size holes for fair distribution.

Tuning distribution

- **Equal shares:** Make hole diameters proportional to desired downstream share. If node A should get twice the flow of node B, make its outlet area twice as large.
- **Head stacking:** Increase vertical spacing to increase head and flow; decrease spacing to reduce.

- **Flow dampers:** Small reservoirs or baffles between stages smooth out short-term pulses and make distribution fairer.
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Upgrades to become a sustainable distributed energy/water system

1. **Reservoir & head control:** Replace top can with a larger reservoir and controlled overflow to maintain steady head.
 2. **Filtration:** Pre-filter at intake (sand/gravel) and a simple cloth screen at each node to keep pipes clean.
 3. **Micro-hydro turbine:** Concentrate outflow through a nozzle to a tiny turbine—ideal for battery charging (expect small watts unless you build larger head/flow).
 4. **Valves & check valves:** Add simple mechanical valves to isolate nodes for maintenance and check valves to prevent backflow.
 5. **Sensors & monitoring:** Low-power flow sensors or float switches plus an MCU (e.g., ESP32) and solar power let you automate and log performance.
 6. **Energy storage & electronics:** Pair with a small battery bank, charge controller and DC loads (lights, phone chargers, sensors).
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Safety, sanitation, and social considerations

- Use food-safe containers and materials if distributing drinking water.
 - Educate users about not contaminating collection points.
 - Provide regular cleaning and inspection schedules.
 - Consider community ownership models and simple maintenance training.
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Scaling and deployment ideas

- **Neighbourhood pilot:** Build a 10–20 can cascade in a community garden to demonstrate fairness and metering.
 - **School project:** Use as an educational tool to teach hydraulics, resource fairness, and appropriate tech.
 - **Micro-hydro pilot:** If you have a natural head (hill, stream), adapt outlet flow into a small turbine to produce tens to hundreds of watts depending on head and flow.
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Next steps / experiments to run

1. Build a 5-stage cascade and measure per-stage volumes with a measuring cup and stopwatch; compare to calculations.
 2. Test different hole diameters (1 mm, 2 mm, 3 mm) and record flows and fairness across nodes.
 3. Add a small storage reservoir and measure how long steady flow lasts.
 4. If energy capture desired, run a bench test of a micro turbine at known head and flow and measure electrical output.
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Appendix: quick reference formulas

- Torricelli: $v = \sqrt{2gh}$.
 - Flow: $Q = Av$ where $A = \pi(d/2)^2$.
 - Power from falling water (ideal): $P = \rho gQH$ where $\rho = 1000 \text{ kg/m}^3$, H is head in meters, and Q is m^3/s . (Real turbine efficiency will be a fraction of that.)
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A note about credit and storytelling

You described building this at 7–9 years old — that’s exactly the sort of original, human ingenuity communities like to celebrate. Keep a clear log (photos, dates, measurements) if you want to present this as a formal PoC or educational exhibit.

If you want, I can now: - Produce a simple diagram (SVG) of the cascade. - Convert this into a one-page flyer for a school or community pilot. - Produce a bill of materials and cost estimate for a 10-node pilot.

Tell me which and I’ll add it next (I’ll do it now if you pick one).