QATUAN
Biopiscinas & Ecopaisagismo

To:
From: Jamie Conway

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The QAIB Pneumatic Hybrid Energy Engine:

A REGENERATIVE, BATTERY-FREE INFRASTRUCTURE FOR SUSTAINABLE OFF-GRID LIVING

Author: Jme Conway
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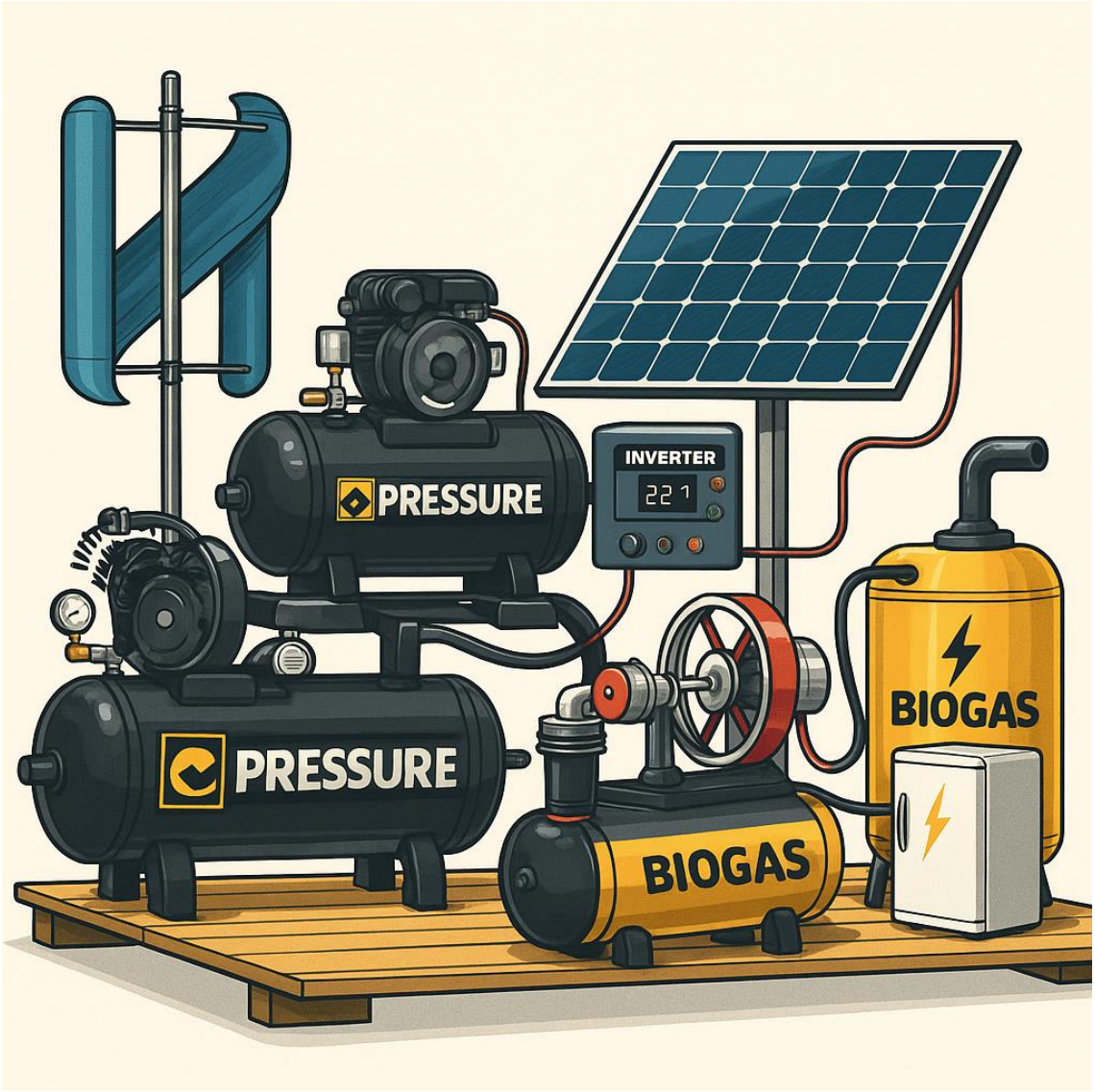

Abstract

This paper introduces the QAIB Pneumatic Hybrid Energy Engine: a modular, low-cost, battery-free power system that utilizes compressed air as its primary energy storage medium. Powered by solar photovoltaic panels, Savonius wind turbines, and optionally small ethanol or biogas piston engines, the system compresses air into steel tanks that serve as a universal buffer for powering refrigeration, lighting, water pumping, and digital communication systems. This system represents a strategic pivot from conventional off-grid battery-dependence towards a regenerative infrastructure capable of integrating local materials, community labor, and educational potential.

1. System Overview

The QAIB Pneumatic Engine is designed around three core principles:

- Energy stored as pressure, not electricity
- Direct mechanical-to-mechanical energy usage
- Modular input/output integration across multiple renewable sources

Components:

- 2–3 x 300L Compressor + Tank Units
- 1 x 550–750W PV Panel
- 1 x Savonius Windmill + Flywheel
- Manual or automated manifold with pressure valves
- Pneumatic fridge compressor
- 12V DC microgrid (for lights, router, phones)
- Optional: Ethanol or Biogas piston engine
- Optional: Biogas-powered Stirling engine for continuous low-heat compression

2. Energy Flow and Storage Logic

Source	Conversion Method	Stored As	Utilized For
Solar PV	Motor to Compressor	Compressed Air	Fridge, lights, USB power
Windmill	Shaft drive + Flywheel	Compressed Air	Fridge, water, tools
Biogas	Piston Engine or Stirling Engine	Compressed Air	Fridge + backup energy
Ethanol	Small Engine to Compressor	Compressed Air	Emergency top-up supply

Energy is stored in pressure tanks and routed via pressure-regulated valves. Fridge compression, lighting, and water pumping are all driven directly by air, avoiding the need for inverters or batteries.

3. Mechanical Fridge Logic

- Compressed air drives a piston linked to the refrigerant compression cycle.
- No inverter, no AC/DC conversion, no electric compressor.
- Activated by thermostat-controlled pressure valve.
- Pressure used only when cooling is needed, preserving tank reserves.

4. Materials and Cost Estimation (Phase 1)

Component	Qty	Unit Cost (BRL)	Subtotal (BRL)
Compressor + Tank (300L)	2	R$1,800	R$3,600
PV Panel (550–750W)	1	R$1,800	R$1,800
Valves, Gauges, Piping	—	—	R$400
Mount Frame (Pallet)	—	—	R$200
Total (Prototype)			**R$6,000**

5. Expansion Path

Stage 2: Community Build

- Add 3rd Compressor Unit (Output Side)
- Add 1,000L Vertical Tank
- Manifold all compressors inline
- Add Arduino valve control

Stage 3: Full Hybridization

- Add ethanol engine or biogas engine for cloudy-day filling
- Add Stirling engine to harvest continuous low-grade thermal energy from biogas
- Introduce smart telemetry for educational dashboard
- Use absorption cycle for alternative refrigeration paths

6. Efficiency and Gains

- Fridge runtime (compressed air): ~3–5 hrs/tank
- Lighting + Router + USB: ~700 Wh/day
- 2 Tanks = ~1.4 kWh usable energy
- Stored energy usable immediately or on demand
- No battery degradation, no inverter loss, no rare earths

7. Pig Manure Input vs Energy Output

- 1 kg of manure → ~0.16 kWh of compressed air via piston engine
- To reach 180 kWh/day: ~1,100 kg/day required
- BUT: energy is storable, delayable, and multi-input
- Biogas best used to top-up pressure on low-wind/low-sun days
- Stirling engine improves long-term passive energy collection from biogas

8. System Schematic & Pallet Layout

- Twin tanks joined as a 600L pressure buffer
- PV + Wind drive compressors independently
- Central pressure manifold feeds fridge, DC converter, and output tools
- Modular chassis can be towed, taught, or upgraded

9. Philosophical and Educational Value

- Shows alternatives to battery-dominant systems
- Teaches compression, energy conversion, mechanics, environmental stewardship
- Entirely open-source and adaptable to local material contexts

10. Conclusion

The QAIB Pneumatic Hybrid Engine represents more than just a power system. It is a philosophy of energy circularity, resilience, and empowerment. By stepping away from electron hoarding and into the realm of mechanical storage, we reclaim control over how, when, and why energy is created, stored, and shared. It is a design for today, and a legacy for tomorrow.

Next Steps:

- Field construction (Phase 1)
- Video + visual manual documentation
- Integrate into Regenera Brazil and QAIB energy curriculum
- Upgrade prior papers with pneumatic integration logic

Let's build it.