Harvesting Energy from Pipe Flow

Problem

Every year, the United States **loses a trillion gallons of water** due to leaks in households. These leaks **often cause property damage** requiring tens of thousands of dollars per household of maintenance. With several states already struggling through a drought, wasting a trillion gallons of water **presents both an environmental and economic risk.**

Opportunity

Sensors can be deployed throughout water networks to gather data. The **data can be made actionable and inform on predictive maintenance on plumbing networks, water quality monitoring, and leak detection.**

However, data loggers that would be installed **require electrical power to run**, and **electricity and water mains are rarely co-located.**

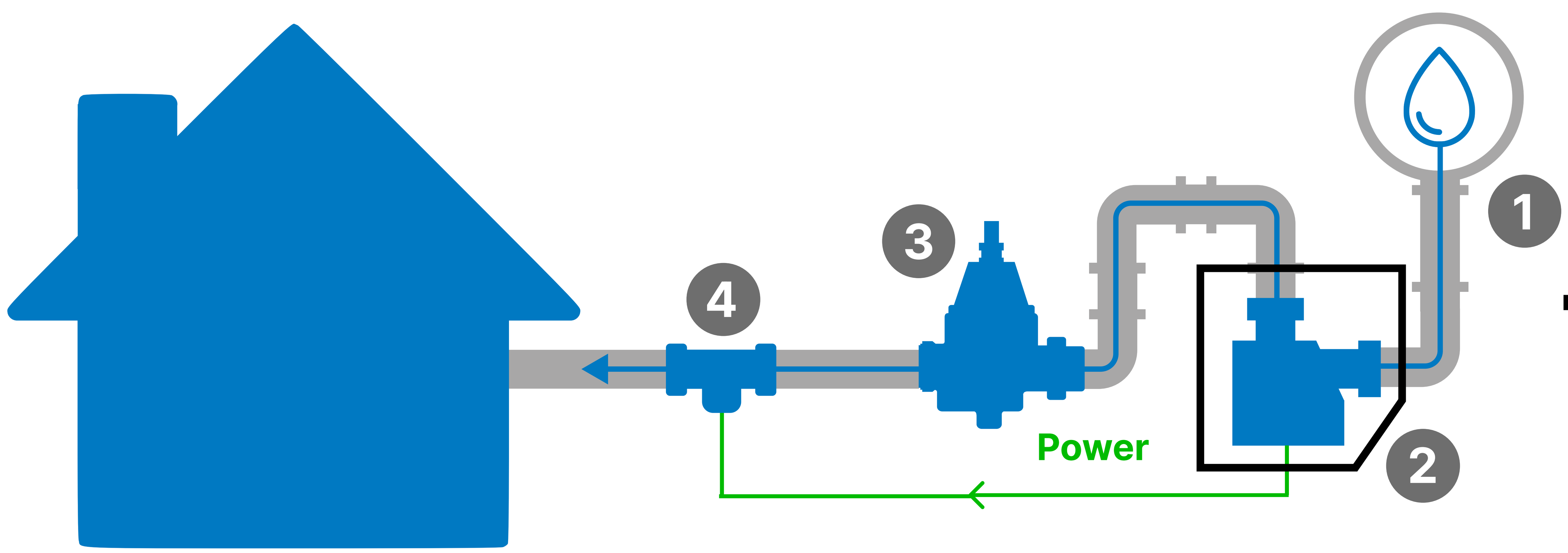
Installation of a data logger for water sensors that runs off of the electrical grid **would require both a plumber and an electrician, generally increasing installation cost & time.**

That being said, Pressure-reducing valves exist in almost all residential water systems. These devices drop water pressure from up to around 80PSI to 60PSI.

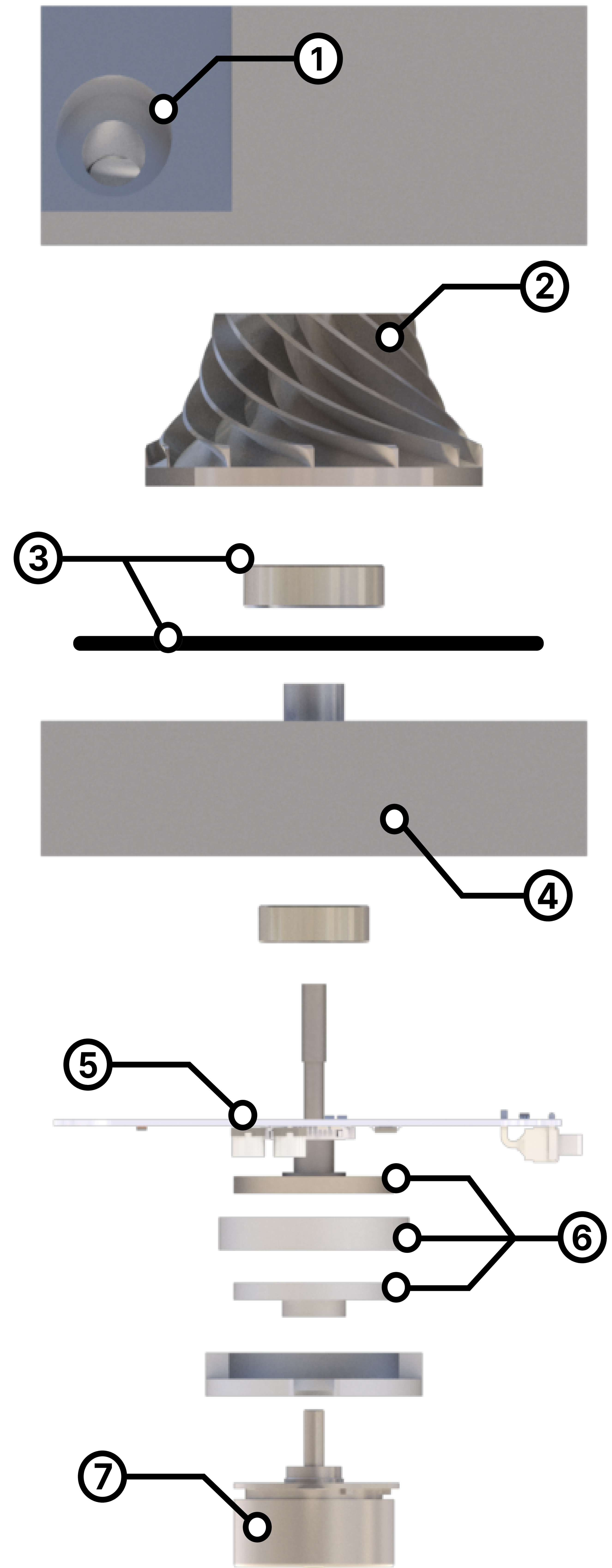
With the flow rates this system would see, that means **about 600mW of power are currently going unused and being lost** as heat and noise at the valve.

Goal

Our mission is to capture and make use of the power lost when water is depressurized for residential use.



1. ***Water is diverted from the municipal supply to a house.***
2. ***Our prototype converts energy from water flow into usable electricity.***
3. ***A valve reduces the water pressure to a level suitable for household use.***
4. ***Sensing tools record relevant water data and relay it "upstream".***



1. **Custom Machined Housing**
Inlet of housing connects to 3/4" water line, standard size for residential units. The system is configured such that water enters radially & exits axially.

2. **3D Printed Turbine**
Testing was done to sweep parameters of custom designed turbines. Plastic additive manufacturing was chosen due to its benefits in dealing with complex geometry, its low cost per part, and its fast turnover time compared to traditional flank milling methods.

3. **COTS Seal & Bearings**
The system uses plastic bearings that performed well and exhibited no corrosion over the duration of the project. The clamped O-ring was successful in preventing leakage in the flow / pressure regime seen in operation of the device.

4. **"Easy - Swapping" Base-plate**
To allow for ease of swapping turbines for testing, the housing features a hub for our turbines to mount to. This allows for rapid and consistent turbine swapping.

5. **Custom PCB**
Creation of a custom board allows for easier integration & lowered packaging constraints given the mechanical system. This is crucial to the systems goal of being "plug and play"

6. **Magnetic Coupling & Water Sealing**
In order to keep the motor safe from contact with water, a magnetic coupling was used to transfer torque from the turbine spindle to the motor shaft. Not relying on waterproof motors allows for a larger and cheaper motor selection, getting rid of limitations for the electrical system.

7. **Off-The-Shelf Motor**
A brushless DC motor was used to convert rotational kinetic energy to electrical energy, like a regenerative braking system in an electric car. A higher-voltage motor was selected to provide more electric potential at lower flow rates.

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