AQUERA

EMPOWERING EVERY DROP, ENRICHING EVERY LIFE.

Project Title : A Community-Driven Affordable Water Access Platform for Safe and Affordable Drinking Water.

Team Name : AQUERA

College Name : Anurag University

Chosen SDG Target :

SDG 6: By 2030, achieve universal and equitable access to safe and affordable drinking water for all.

SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.

6 CLEAN WATER AND SANITATION

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Problem Statement: Access to safe, affordable drinking water remains out of reach for many due to unreliable centralized systems, high costs and infrastructure gaps, harming community health and equity.

Abstract:

Access to safe, affordable drinking water remains a major challenge, especially in low-income and rural areas, where centralized water systems often fail due to infrastructure gaps, high transport costs, and governance issues. As a result, communities depend on expensive bottled water, unsafe local sources, or inconsistent tankers, straining household finances and health.

Despite initiatives like India's Jal Jeevan Mission, universal and equitable water access by 2030 remains out of reach, partly because current models lack community ownership, involve high logistics costs, and fail to use modern technologies for transparency and accountability.

AQUERA addresses this by creating a decentralized, community-operated water treatment and distribution system, supported by an easy-to-use digital platform. Its affordable, modular technologies empower communities to manage their own water systems with transparent pricing and local participation, reducing transport costs and building resilience.

Globally, centralized water supply faces aging infrastructure, high leakage (up to 20–40%), high energy use, and climate risks, making it hard to meet rising demand. Decentralized, community-centered solutions like AQUERA can close this gap, aligning with SDG 6 (clean water and sanitation) and SDG 9 (industry, innovation, and infrastructure)

Why does this issue matter?

Decentralized water systems boost local water security, cut losses, lower environmental impact, and empower communities through ownership and faster repairs. They offer flexible, inclusive solutions for both rich and poor areas, enhancing resilience amid climate change and urban growth. AQUERA's affordable, community-driven, digitally transparent model transforms water management by reducing dependence on centralized networks, building trust, and supporting equitable access. With strong partnerships, achieving universal, sustainable water access by 2030 is challenging but achievable, complementing global goals like SDG 6 and SDG 9.

Proposed Solution:

AQUERA is a fully off-grid, decentralized water treatment and distribution system designed to deliver safe, affordable drinking water to underserved rural and low-income urban communities. By deploying local, community-managed treatment plants, AQUERA cuts water losses (often 20–40%) and reduces energy consumption from long-distance pumping.

Solar-powered and energy-independent, AQUERA ensures continuous operation even during power cuts. Its modular, low-cost technology stack — including biosand filters, ceramic filters, solar disinfection (SODIS), gravity purification, and RO units — adapts to different water needs and income levels, from basic affordable solutions to premium, advanced systems.

A user-friendly mobile app supports plant registration, transparent pricing, prepaid water cards, order management, and real-time water quality monitoring, building trust and accountability.

By promoting community ownership, skills development, and local job creation, AQUERA enables faster repairs and reliable operation. Educational programs for rainwater harvesting and groundwater recharge further strengthen long-term sustainability, delivering not just clean water today but a healthier, more secure water future for all.

Decentralized Community-Based Water Management System:

Key Concept

- A decentralized water treatment and management system supported by a **community-based application**
- Users register on the app, gain a personal dashboard, and can:
    - monitor their treated water quality and usage
    - sell surplus treated water to neighbors, accelerating ROI (similar to solar net metering)
    - maintain full control over their water resources
- Marketplace approach: connect individuals, engineers, and third-party providers to offer affordable, modular water treatment setups
- Collaborate with government subsidy programs to keep initial costs low

- Treated clean drinking water is prioritized, while any remaining treated water (residue) can be safely blended into the normal water tank for non-potable uses
- Reduces distance between **clean water supply** and people in need, enhancing equity and sustainability

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Target Segments

1️⃣Urban Households

- App-based dashboard to manage water quality, sell surplus water
- Easy plug-and-play installation for apartments, societies, or gated communities
- Government-backed subsidies to reduce CapEx
- Less stress on centralized urban infrastructure
- Higher resilience during water cuts or supply rationing

2️⃣Rural Households

- Compact, robust systems with offline features (low-connectivity areas)
- Community registration via app or local kiosk
- Collective ownership models (e.g., village committees) to share costs and resources
- Potential for drinking water entrepreneurships → villagers can sell surplus water to neighbors
- Easy maintenance supported by local third-party service providers
- Strong alignment with rural development schemes and water security initiatives

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3️⃣Industries

- Modular treatment plants for process water and greywater recycling
- Industry-specific water dashboards to track consumption, quality, and reuse
- Marketplace platform to connect industries with verified engineering vendors
- Possibility to sell treated surplus water for non-potable uses (construction, landscaping)
- Supports ESG (environmental, social, governance) and CSR (corporate social responsibility) goals
- Reduces reliance on freshwater, lowering industrial water footprints

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Vision

- Empower communities with **clean, local water**
- Enable cost recovery by creating a water-sharing marketplace
  Tie up with engineers + third-party technology providers under government-supported schemes
- Transform water security through smart, scalable, and community-driven solutions

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Objectives:

- **Universal Access:** Ensure equitable, affordable safe drinking water for marginalized communities by 2030, advancing SDG 6.
- **Decentralization & Resilience:** Deploy decentralized treatment units to cut losses, energy use, and climate vulnerability, boosting local water security.
- **Community Empowerment:** Train local residents to operate and maintain plants, creating jobs, ownership, and rapid response capacity.
- **Technology Integration:** Provide a digital platform for transparent pricing, orders, and real-time quality monitoring to build trust and efficiency.
- **Cost Reduction:** Lower water delivery costs by reducing transport needs and optimizing treatment, making clean water affordable for low-income users.

- **Scalability & Adaptability:** Use a modular design that scales and adapts across diverse socio-economic and geographic settings.
- **Sustainability & Conservation:** Educate communities on rainwater harvesting and borewell recharge to protect and replenish groundwater.
- **Renewable Energy Use:** Power the system with solar energy to reduce carbon emissions and improve reliability.
- **Policy Alignment:** Support government initiatives like the Jal Jeevan Mission by bridging last-mile gaps and ensuring effective fund use.

Detailed Explanation of the Solution:

1. Technical / Design Details

Modular Water Treatment Technology Stack:
AQUERA employs a flexible, modular approach to water treatment, combining multiple purification methods tailored to local water quality and community needs:

- **Biosand Filters:** Simple, low-maintenance biological filtration ideal for removing pathogens and suspended solids.
- **Ceramic Filtration:** Fine filtration to remove bacteria and protozoa, with reusable filter elements.
- **Solar Disinfection (SODIS):** UV radiation from sunlight used to kill microbes in transparent containers, a low-energy method for smaller-scale use.
- **Gravity-Based Purification Systems:** Passive filtration using gravity to reduce energy consumption.
- **Reverse Osmosis (RO):** Advanced filtration for removing dissolved salts, heavy metals, and chemical contaminants, used where water quality requires it.

Each treatment module can be combined or scaled independently to suit water source characteristics, population size, and economic factors.

Renewable Energy Integration:
Solar photovoltaic (PV) panels power the water treatment units and pumping mechanisms, ensuring energy independence and minimizing operational carbon footprint.

Digital Platform:

AQUERA's mobile application and backend platform provide:

- **Plant Registration & Management:** Tracking location, capacity, and operator details.
- **Transparent Pricing & Prepaid Cards:** Allowing consumers to buy water credits, reducing cash handling and ensuring affordability.
- **Order & Delivery Management:** Scheduling pickup or delivery options where applicable.
- **Real-Time Water Quality Monitoring:** Using IoT sensors to track parameters like turbidity, pH, and chlorine levels, with alerts for anomalies.
- **Maintenance Alerts & Reporting:** Facilitating preventive maintenance and rapid issue resolution.

2. Workflow / Architecture

Basic Workflow:

1. **Water Source Input:** Local groundwater, surface water, or collected rainwater fed into a treatment plant.
2. **Pre-Treatment:** Initial filtration and sediment removal (e.g., screens or settling tanks).
3. **Core Treatment:** Combination of modules (biosand, ceramic, SODIS, RO) depending on contamination levels.
4. **Storage:** Treated water stored in hygienic tanks ready for consumption.
5. **Distribution:** Water dispensed via community taps, water ATMs, or delivery services.
6. **User Access:** Consumers purchase prepaid credits via mobile app or cards to access water.
7. **Monitoring & Maintenance:** Continuous sensor data streams to platform; operators receive maintenance prompts.

3. Interdisciplinary Elements

- **Engineering:** Water treatment technology design, renewable energy integration, IoT sensor deployment.
- **Computer Science:** Mobile app and backend platform development, data analytics for water quality and usage, secure payment systems.
- **Environmental Science:** Assessment of local water sources, sustainability practices, rainwater harvesting integration.
- **Social Sciences:** Community engagement, training, capacity building, behavioral change communication for water conservation.
- **Economics & Business:** Developing affordable pricing models, partnerships with government/NGOs, financial sustainability.
- **Public Health:** Ensuring safe drinking water standards, monitoring impact on community health.

4. Design Thinking Application

AQUERA's development applies Design Thinking principles:

- **Empathize:** Understanding the water access challenges, economic constraints, and cultural context of target communities through field research and stakeholder interviews.
- **Define:** Clearly articulating problems such as high water costs, unreliable quality, and lack of local control.
- **Ideate:** Brainstorming multiple treatment and delivery models tailored for different user groups and economic tiers.
- **Prototype:** Building pilot modular treatment units combined with the digital platform for user testing.
- **Test:** Gathering community feedback on usability, affordability, and maintenance, iterating based on real-world performance and user experience.

This human-centered iterative approach ensures AQUERA meets actual community needs, is easy to use, and sustainable over time.

Prototype Description

AQUERA's proof-of-concept prototype is a fully off-grid, decentralized water treatment unit sized for small communities. The system processes approximately 500 liters per day, using a modular treatment chain: sedimentation, multi-stage filtration (sand and activated carbon), solar disinfection (SODIS), and UV/RO options depending on water quality needs. An automated microcontroller manages valves and flow based on sensor data, ensuring reliable, low-maintenance operation.

Technologies Used

- Sedimentation and sand filtration tanks
- Ceramic and activated carbon filters
- Solar disinfection (SODIS) module
- UV/RO treatment add-ons for advanced purification
- Automated solenoid valves with Arduino-based control
- Turbidity, pH, and chlorine sensors
- Solar photovoltaic panels for energy independence
- Custom dashboard (Python + Arduino IDE) for real-time monitoring

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Results from Initial Testing

- Reduced turbidity from 15 NTU to under 1 NTU
- Achieved 99.9% pathogen reduction after UV/SODIS treatment
- Maintained continuous 72-hour operation with stable water quality
- Power consumption measured at ~5 kWh per 1000 liters, fully offset by solar
- Local users reported improved taste, clarity, and acceptability of treated water
- Successfully validated modular design's adaptability across different water sources

Expected Outcomes

Short-term Benefits

- Improved access to safe, affordable drinking water in underserved communities
- Reduced water loss and energy consumption through localized treatment
- Increased community engagement and ownership, leading to faster maintenance and repairs

  Transparent pricing and reliable service via digital platform

Long-term Benefits

- Sustainable, resilient water supply systems adaptable to climate change and population growth
- Enhanced groundwater conservation through rainwater harvesting and recharge education
- Job creation and skill development within local communities
- Lower carbon footprint from reduced transportation and solar-powered operations
- Strengthened alignment with SDG 6 (Clean Water & Sanitation) and SDG 9 (Industry, Innovation & Infrastructure)

Environmental, Social, and Economic Impact

- Environmental: Decreased water wastage and pollution, improved groundwater sustainability, reduced greenhouse gas emissions
- Social: Greater equity in water access, empowered communities, improved public health
- Economic: Lower household water costs, local employment opportunities, reduced strain on centralized infrastructure

Resources Required

Materials & Equipment

- Water treatment components: sedimentation tanks, sand filters, activated carbon filters, ceramic filters, UV lamps, RO units
  Sensors: turbidity, pH, chlorine, flow meters
- Automation: Arduino/microcontrollers, solenoid valves, control panels
- Energy: Solar panels, batteries, wiring
- IT infrastructure: Mobile app development tools, cloud hosting, monitoring dashboard

Technologies

- Water treatment and purification (biosand, SODIS, RO)
- IoT and automation for real-time monitoring and control
- Mobile and web app platforms

Mentorship / Expertise Needed

- Water treatment engineering and quality assurance
- IoT and automation systems
- Software development (mobile and cloud)
- Community engagement and social impact
- Fundraising, project management, and policy navigation

Team Details

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