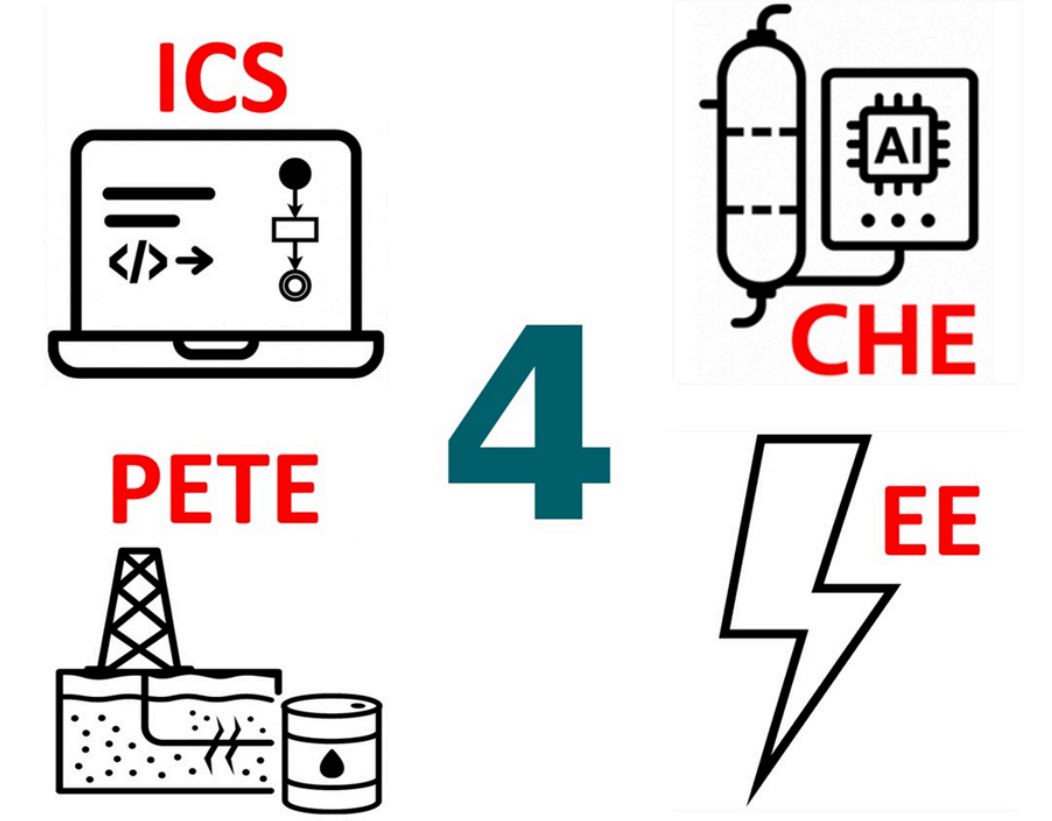


# Smart Wastewater Reuse & Renewable Energy Generation via MFC for Petroleum Applications

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## The Problem

Petroleum operations produce large amounts of wastewater that is **expensive and energy-consuming to treat**. At the same time, these operations need high-quality water for industrial use. This highlights a major problem: **the lack of an integrated system that allows for safe water reuse and renewable energy recovery** under real-world conditions.

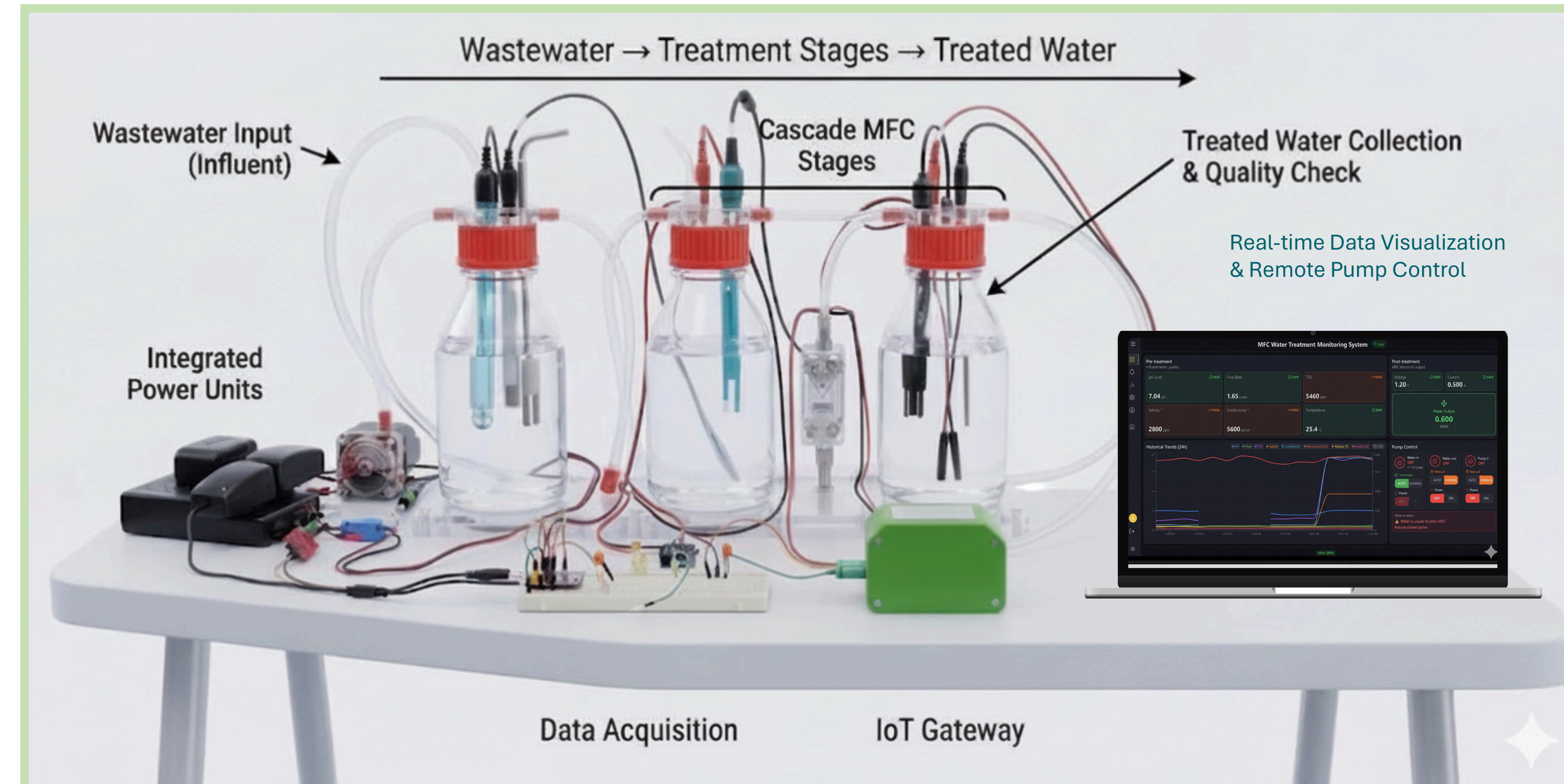
## Our Solution

This project proposes a **smart, cascaded Microbial Fuel Cell (MFC) system** that integrates petroleum wastewater treatment with renewable energy generation through a multi-stage modular bioreactor design.

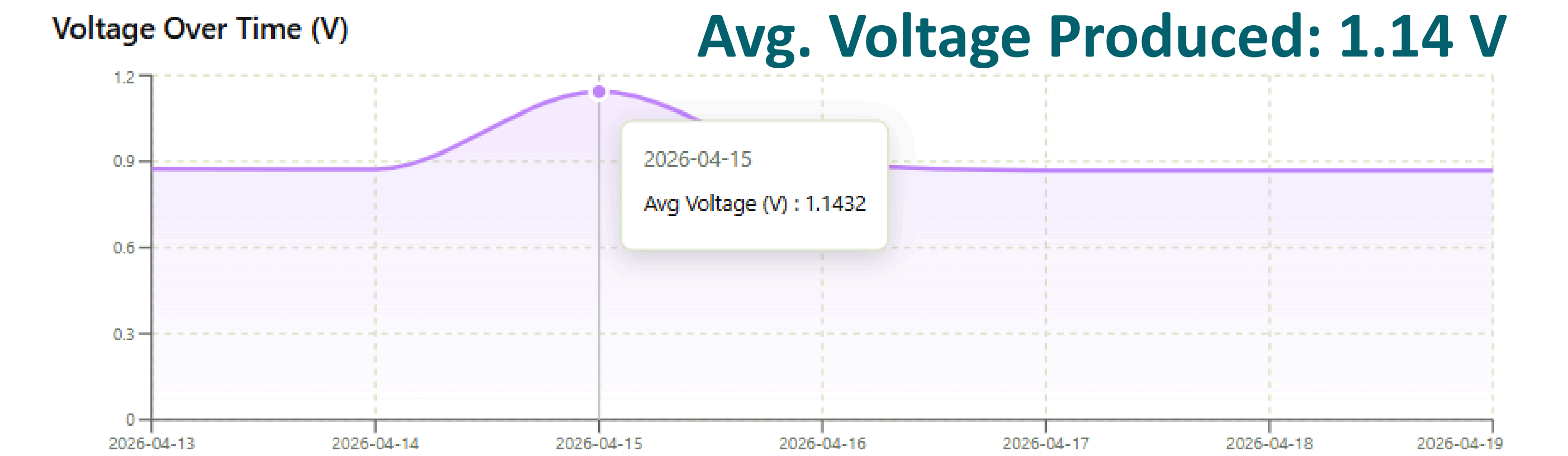
**HOW?** Through a **bio-electrochemical process that degrades organic contaminants while generating electrical energy**. Real-time monitoring is achieved using IoT sensors while a water pump controller maintains optimal MFC feeding rates.

**WHY?** The system is designed to **produce treated water with improved compatibility for Enhanced Oil Recovery (EOR)**, including reduced scaling potential & better oil displacement performance.

## Prototype



## Testing & Results



Water Parameters	Before MFC Treatment	After MFC Treatment	Assessment paramtrs	Before MFC Treatment	After MFC Treatment	Improvement
TOC (mg/L)	136.5	21.24 ↓	Permeability (mD)	4.2	5.2	10.1% ↑
Salinity (ppm)	66,264.78	3687.254 ↓	SI (50:50)	-0.8	-0.34	57.5% ↓
pH	7.7	6.5 ↓	RF (%)	67.44	79.65	12.21% ↑

## Specifications

MFC open-circuit voltage: 0.2–0.7 V

System power consumption: ≤ 35 W (full load)

System response time: ≤ 5 s (API + actuator execution)

Activated carbon pretreatment: 1 L/run capacity

Treated water pH: 6.5–8.5 (EOR suitable)

Oil recovery improvement: ≥ 5%

Scaling index reduction: ≥ 20%

## Constraints

System Limits: Off-the-shelf hardware, lab-scale MFC, ≤1 L/day.

Process Limits: Adsorption/precipitation and simplified simulations only.

Data Control: Reject invalid or delayed (>5 s) data.

Software: ≤3-click UI with automatic EOR compliance reports.

## Conclusion & Future Work

The cascaded MFC system demonstrates **effective petroleum wastewater treatment & energy generation**, with improved voltage output (1.14 Vol) & overall water quality.

**FUTURE WORK** will focus on scaling the system to pilot-level deployment & maximizing performance through optimized cascade configuration, advanced electrode materials, & targeted bacterial selection.

Integration with desalination or polishing units **will enable full compliance with injection standards**, while advanced control strategies will ensure stable operation under real field conditions.