SMEP | Sustainable Manufacturing and Environmental Pollution Programme

SUSTAINABLE MANUFACTURING AND ENVIRONMENTAL POLLUTION (SMEP) PROGRAMME

Circular Wastewater Solutions in Manufacturing: From Pilots to Practice

Evidence from SMEP pilots in textiles, pharmaceuticals, plastics recycling and tanneries across Kenya, Pakistan and Bangladesh

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£24.6m UK International Development funding

27 pilot projects contracted

11 countries across Sub-Saharan Africa & South Asia

5 intervention areas

50–80% process-water reuse potential shown by water pilots

THE SMEP PROGRAMME

SMEP addresses manufacturing pollution and plastics waste in Sub-Saharan Africa and South Asia. Funded by **UK International Development** and implemented by **UK Foreign, Commonwealth and Development Office (FCDO)** in partnership with **UN Trade and Development (UNCTAD)**, Pegasys/RSK and SouthSouthNorth, the programme supports circular economy and technology-based pilots in textiles, leather, plastics, food processing and used lead acid batteries. These sectors drive economic growth and employment for millions in these regions yet are also among the largest contributors to environmental pollution and human health risks.

SMEP OBJECTIVES

1. To inform and influence policy processes at various levels, from local and national, to Multilateral Environmental Agreements (MEAs).
2. To demonstrate the business case for the wider adoption of technological and circular solutions and improved manufacturing processes.
3. To promote access to new markets, both for new technologies and for new products that can substitute hazardous and polluting alternatives.

WHY IT MATTERS

Wastewater represents a **primary pollution pathway** in these manufacturing sectors. In textile manufacturing, wet processing accounts for a dominant share of pollutant loads, generating **complex chemical effluents**, while plastics recycling contributes to **microplastic leakage**. Across sectors, inadequately treated wastewater often contains high loads of organic pollutants, heavy metals and hazardous compounds that contaminate receiving rivers and downstream users, while also contributing **to greenhouse gas (GHG) emissions** through water- and energy-intensive processes[1, 2, 3].

In many contexts, untreated or partially treated effluent is discharged into receiving environments, posing risks to **ecosystems and human health**, as seen in river systems such as the Nairobi Rivers basin in Kenya. These pressures are compounded by increasing **water stress** and **growing dependence on groundwater abstraction** and the risk of **'water bankruptcy'**, where declining water availability threatens both industrial activity and community access.

Improving wastewater management is therefore critical, not only to reduce pollution and emissions, but to safeguard water resources, industrial productivity and livelihoods – calling for **circular water reuse interventions.**

WASTEWATER COMPLIANCE AS A TRADE IMPERATIVE

Global regulatory expectations are tightening, making environmental performance a condition for trade. Export markets and initiatives such as ZDHC, ZLD/MLD and emerging European Union regulations increasingly require verified effluent control and responsible chemical management for supplier eligibility. These shifts are moving compliance from voluntary to essential to retain market share.

Environmental performance is therefore economically consequential, reflecting an emerging economic-environmental compliance nexus [4] in which investment in wastewater treatment both reduces pollution and secures market access, competitiveness and jobs over time. Suppliers unable to comply, risk exclusion from global value chains, even where production capacity is strong.

ZDHC Zero Discharge of Hazardous Chemicals (brand standard) · **ZLD/MLD** zero / minimum liquid discharge · **EU rules** Ecodesign for Sustainable Products (ESPR)

FIVE WASTEWATER-TREATMENT & REUSE PILOTS, THREE COUNTRIES: PAKISTAN, BANGLADESH, KENYA

PAKISTAN · TEXTILES

SAFECONOMY — reinventing the textile circular economy

WHAT Pilot-scale molecular distortion technique (MDT) wastewater treatment unit that uses electrolysis to break down and oxidise pollutants into simpler compounds, which are then removed as surface scum and settled sludge. The system integrates reaction, filtration and monitoring components under automated control, with treated water reused through solar-assisted heating for industrial processes. Pilot successfully piloted in real-time conditions at Sapphire Textiles Finishing Mill (Lahore, Pakistan).

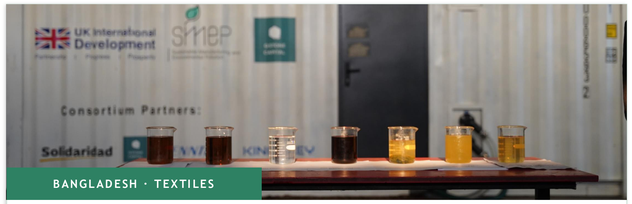
AIM To evaluate the performance of the MDT pilot unit relative to conventional biological wastewater treatment systems, focusing on water quality parameters (BOD, COD, TSS, TDS, Ph, Colour) and compliance with national (Pakistan NQES) and international standards and guidelines (ZDHC). The assessment also examined water recovery and reuse potential, treatment time, energy use (and GHG emission savings) and chemical use and costs.

RESULTS Higher removal efficiencies across all water quality parameters (92%, 90%, 60%, and 95% for BOD, COD, TSS and TDS). Near-complete (98–99%) removal of heavy metals (chromium and arsenic), unlike conventional systems. Enables ~70% water recovery and reduced energy demand (46% less energy) through warmer recovered water, lower groundwater extraction, delivering up to 86% GHG reduction potential. Cost reduction due to lower chemical consumption (71% reduction).

WHO BENEFITS Effective deployment of MDT systems depends on targeting textile segments with the highest technical readiness. In the short term, uptake potential is strongest in export-oriented mills, including denim and wet processing units with complex colour profiles. Sector-wide adoption across Pakistan's textile industry could generate benefits for workers and downstream communities, and significant energy savings.

PROJECT TEAM: NORTHUMBRIA UNIVERSITY (UK) | BAHAUDDIN ZAKARIYA UNIVERSITY (PAKISTAN) | NATIONAL TEXTILE UNIVERSITY (PAKISTAN) | ACCESS ENGINEERING PVT. LTD. | SAPPHIRE TEXTILES FINISHING MILL.

PROJECT PROFILE



BANGLADESH · TEXTILES

Recycling 80% of textile effluent back to production

WHAT Deployment of a *modular pilot-size Minimum Liquid Discharge (MLD) wastewater treatment and reuse system* at two textile factories in Bangladesh to test the efficacy of treating, recovering and reusing wastewater within production, combining advanced treatment (electrocoagulation, ultrafiltration, reverse osmosis and crystallisation) with a circular water management model.

AIM To demonstrate a commercially viable, scalable pathway to near-zero discharge in textile manufacturing, while proving the business case for investment in MLD technologies whilst testing the market's response to a proposed innovative financing model (Avoided Water Pollution tokens/credits, similar to carbon credits) to unlock capital for future adoption.

RESULTS The system achieved high recovery rates (80%+ in denim; 60–70% in dyeing) with consistent water quality (~100 mg/L TDS), reduced energy use at scale (~1.08–2.5 kWh/m³), thus demonstrating strong commercial viability. The denim washing textile segment shows the highest scale-up potential. While high-quality permeate is achievable, managing the concentrated reject stream remains a challenge, with wastewater from reactive dyeing requiring additional polishing beyond standard treatment.

WHO BENEFITS Textile manufacturers through reduced water costs, improved compliance and long-term competitiveness; global brands through more sustainable and traceable supply chains; and communities through reduced pollution and groundwater use. At scale, the combined technology and financing model enables sector-wide transformation, unlocking investment and accelerating circular water adoption across the industry.

PROJECT TEAM: SOLIDARIDAD NETWORK ASIA (BANGLADESH) | QSTONE CAPITAL (NETHERLANDS) | LENTECH ENGINEERING (NETHERLANDS) | KINGSLEY ENGINEERING (BANGLADESH).

PROJECT PROFILE

BANGLADESH · TEXTILES

Optimising textile water reuse and wastewater management

WHAT Panta Rei Water Solutions installed advanced wastewater recovery technologies to complement the existing ETP, now capable of treating and reusing up to 1,200 m³ of water per day at the participating supplier, Fakir Knitwear (Dhaka). The system combines disc filtration, ultrafiltration and reverse osmosis with high-efficiency motors and sensors to reduce energy intensity.

AIM To demonstrate commercially viable, full-scale circular water solutions in textile manufacturing, reducing freshwater use and wastewater discharge while supporting compliance with local and global standards (ZDHC). With leading international brands involved, the project also positions the facility as a best-practice example to showcase the business case for water reuse across mutual supplier networks in Bangladesh.

RESULTS Treated water is recycled back into the facility, reducing freshwater extraction, use (438,000 m³ recovery per year) and wastewater generation by 25–30%, while lowering energy demand and eliminating groundwater softening. Fakir Knitwear is expanding the installation to 50% reuse recovery. It could retain 1.29 million m³ of water in circulation over six years, with a one-year payback and significant cost savings, while avoiding 17–30 kg CO_2e per m³ of treated wastewater.

WHO BENEFITS Manufacturers through cost savings, compliance and supply chain resilience; and workers and communities through reduced groundwater use and pollution, and improved water security. The model is being scaled through the Alliance for Water Reuse and Recycling (A4R), a multi-stakeholder platform convened with support from the *World Bank Group's 2030 Water Resources Group,* to an industrial cluster in Gazipur.

PROJECT TEAM: PANTA REI WATER SOLUTIONS | PRIMARK | H&M | GRUNDFOS | FAKIR KNITWEAR | WATERAID

PROJECT PROFILE

KENYA · NAIROBI RIVERS BASIN

Cleaner production + hybrid membrane treatment + green finance

WHAT Pilot led by the Kenya National Cleaner Production Centre (KNCPC) to address industrial water pollution in the Nairobi Rivers Basin caused by untreated or poorly treated effluent from multiple industries. The project sits within the Nairobi Rivers Basin Commission, supporting wider efforts to restore river systems as critical blue–green infrastructure for improved urban environments and quality of life.

AIM To support businesses operating along the Nairobi Rivers Basin to adopt resource efficiency and cleaner production (RECP) practices that reduce pollution (including the discharge of industrial wastewater), improve resource efficiency, and strengthen environmental compliance. Two targeted sites are used to demonstrate the application of hybrid membrane wastewater treatment.

RESULTS Wastewater assessments on ~3% of the (~4000) businesses operating along the Nairobi Rivers Basin revealed significantly high pollution loads and compliance gaps. A small sample of participating businesses (25) implemented RECP practices across water, energy and waste, investing over USD 1 million and achieving measurable reductions in resource use, emissions and waste generation, alongside increased industrial symbiosis. The project's hybrid membrane wastewater treatment demonstration site, Ultravetis (veterinary supply company), achieved 70% BOD and COD reduction, achieving national and international regulatory compliance for the first time.

WHO BENEFITS Participating manufacturers operating along the Nairobi Rivers Basin achieved cost savings, compliance and productivity gains. Workers benefited through safer jobs and skills development. Operational data provides financiers and regulators clearer evidence and investment pathways. Downstream communities benefit from reduced pollution and improved water quality.

PROJECT TEAM: KENYA CLEANER PRODUCTION CENTRE (KNCPC) | KANKU KENYA LTD. | FINTECH FRONTIERS

PROJECT PROFILE

KENYA · PLASTICS RECYCLING

First-of-its-kind effluent plant for plastics recycling

WHAT A semi-functional 4 m³/h effluent treatment plant was upgraded to 12 m³/h hybrid membrane treatment plant, with capacity to treat 20 000 m³ of wastewater per annum, for a plastic recycling facility in Nairobi (Kenya). At least 80% of the water treated will be used back in the plastic recycling wash lines.

AIM To reduce the release of microplastics and heavy metals into the environment while meeting national and international standards for the release of wastewater into the environment, reducing the extraction of freshwater, decreasing sludge from wastewater treatment and costs associated with the disposal of sludge. The upgrade also catered for the expansion of the plastic recycling capacity from 14 kilotonnes per annum 70 kilotonnes per annum over a 2 year period.

RESULTS The BOD, COD and heavy-metal loads in treated water has been brought down within national and international discharge thresholds. This has contributed to the facility receiving triple international certification ISO 9001 — Quality Management, ISO 14001 — Environmental Management, and ISO 45001 — Occupational Health & Safety. Overall operational costs are reduced by ~30%.

WHO BENEFITS The employees have gained specialized skills for operating a wastewater treatment at a plastic recycling facility. In addition, the successful expansion of the recycling facility incorporating the right environmental protection, supports the expansion of the company's waste-collector network, creating employment and stable income sources, and gaining a replicable ESG-compliant blueprint.

PROJECT TEAM: MR GREEN AFRICA.

PROJECT PROFILE

WHAT WE LEARNED

A. Across SMEP pilots and stakeholder engagements, findings consistently show that the **main barrier** to scaling industrial wastewater treatment & reuse is not technical feasibility, but **access to appropriate, context-specific financing** – which is compounded by weak or absent regulatory incentives (such as water pricing – currently not instituted in Pakistan nor Bangladesh).

B. **Water recovery for production is technically and commercially proven**, with 50-80% recovery across sectors and geographies. Beyond water savings and its environmental gains, it reduces energy, chemical use and GHG emissions. UNCTAD estimated that if the Panta Rei / Fakir model is scaled to 25% of the textile industry in Bangladesh, it could represent 4-7% of the country's 2030 National Determined Contributions target [2].

C. **Industrial wastewater is highly variable**, requiring solutions tailored to specific waste streams rather than industry type. When designed appropriately, these systems deliver **operational benefits and reduced costs**, ensure **compliance** and improve **competitiveness**. But deployment of the most appropriate technology is often constrained by **limited know-how and technical capacity.**

D. While producing clean permeate is achievable, **managing the concentrated waste stream remains the main driver** of cost, complexity and compliance risk. In addition, **upfront investment and space requirements can slow short-term adoption, particularly among small and medium-sized enterprises**.

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