



# Meeting refinery wastewater challenges - membrane based biological treatment and an asset sustainability program

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# Overview

- Delivering value to refineries, key solutions
- Refinery Water Balance
- Typical Refinery Wastewater Treatment
- Membrane Bio Reactor and wastewater treatment
- Uses of Recycled Water
- Supplemental supplies and mobile water
- BAPCO Refinery integrated water and wastewater
- Bashneft Refinery, Russia
- Digital Internet-of-Things: Asset Performance Management
- Conclusions and recommendations

# Delivering Value to Refineries

**Process  
Optimization**

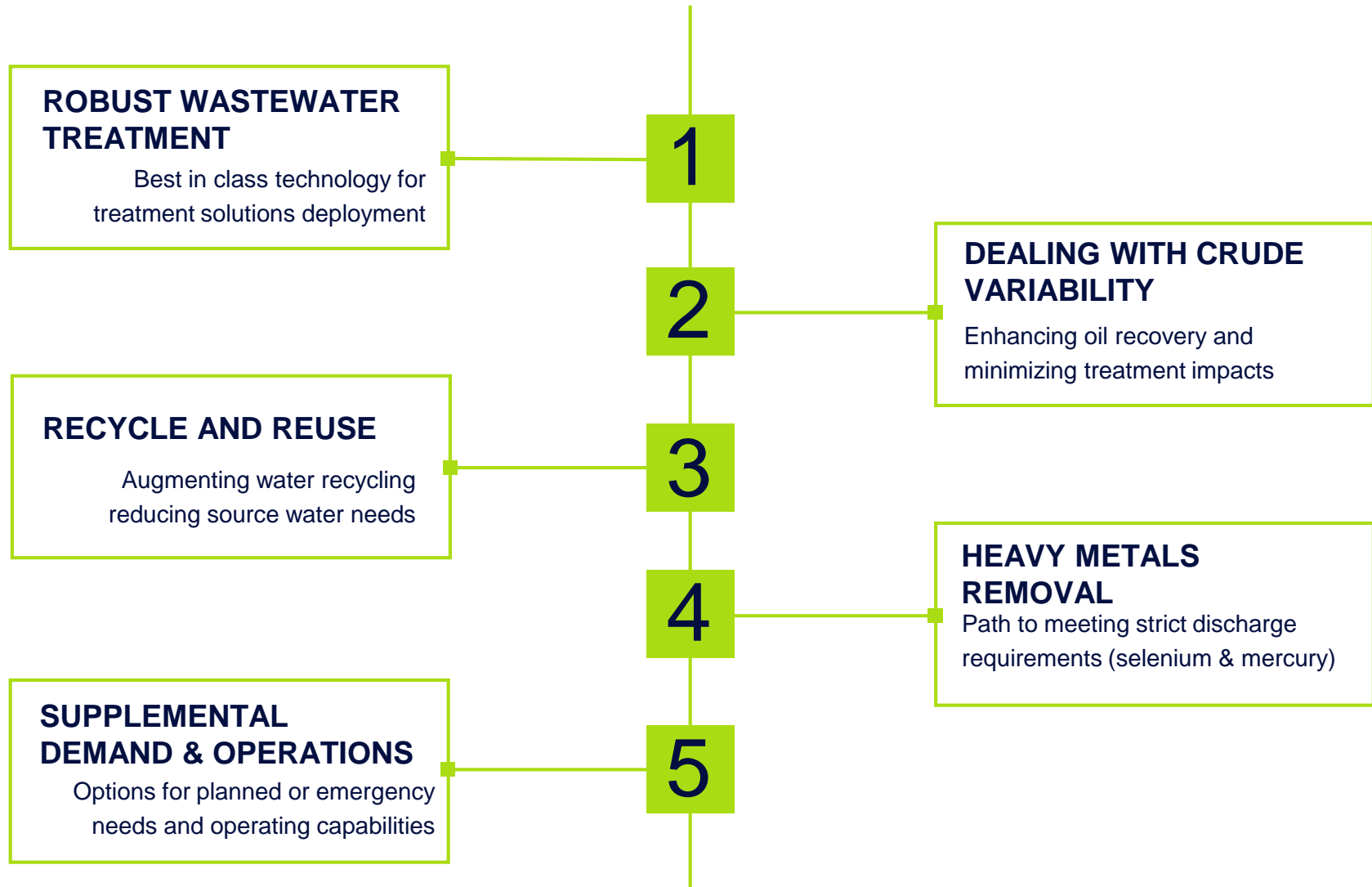
**Make-up  
Water**

**Wastewater  
Treatment**



Industry needs to curtail potable water and meet its water demand through reuse

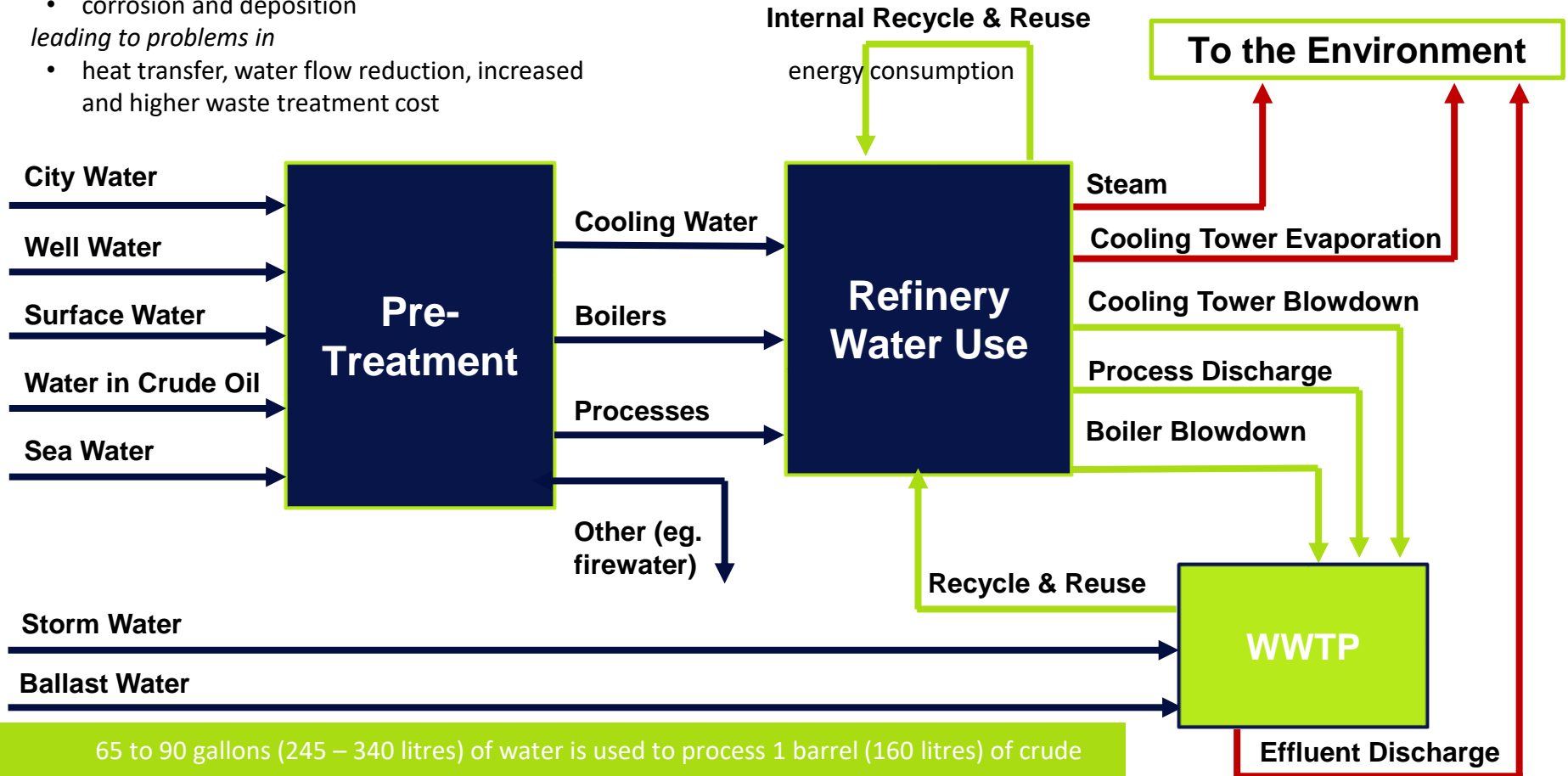
# Key Solutions to Wastewater Challenges



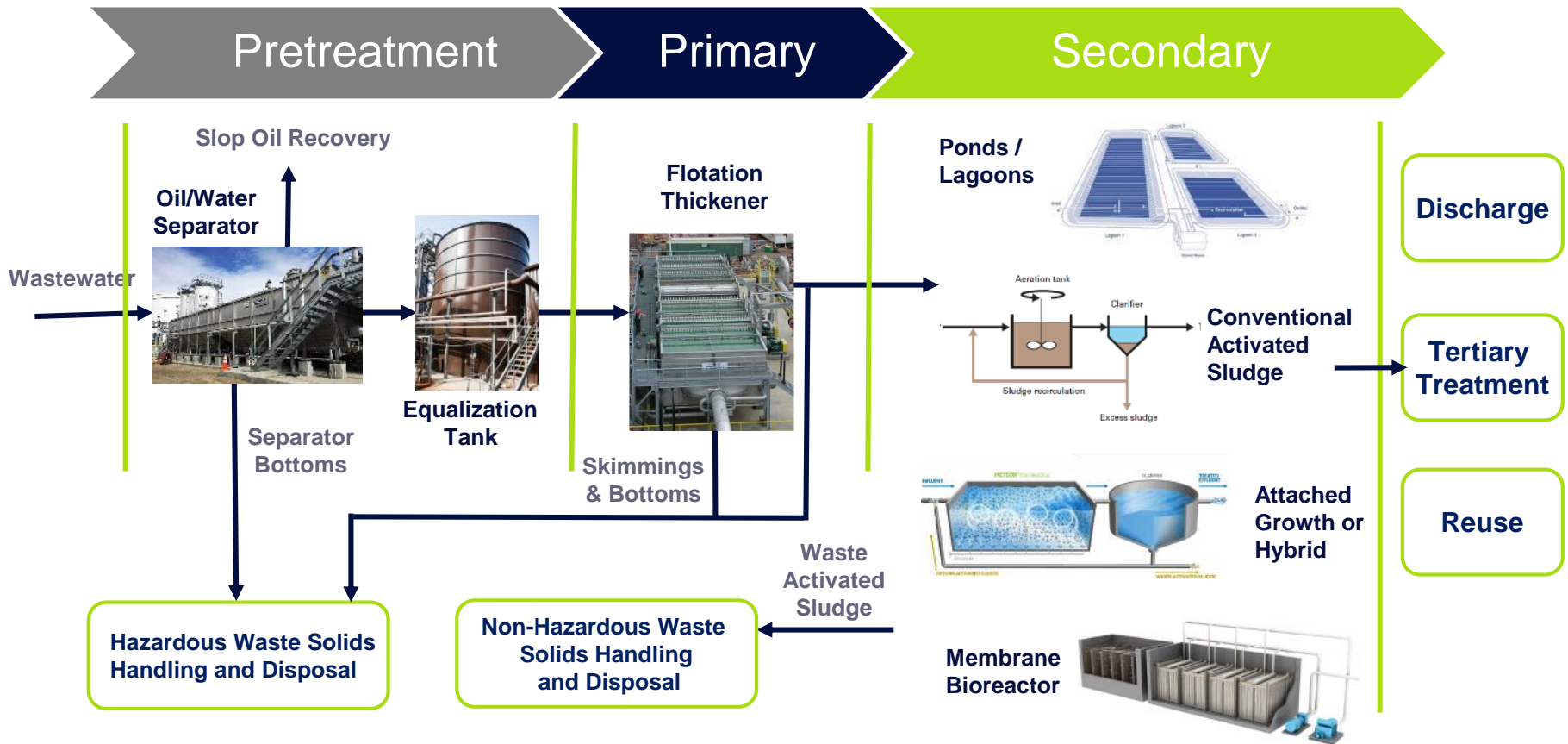
# Refinery Water Balance

If the process water used is not properly treated

- the soluble minerals, suspended solids and inorganic contaminants could affect the processing equipment by means of
  - corrosion and deposition
- leading to problems in
  - heat transfer, water flow reduction, increased and higher waste treatment cost



# Typical Refinery Wastewater Treatment

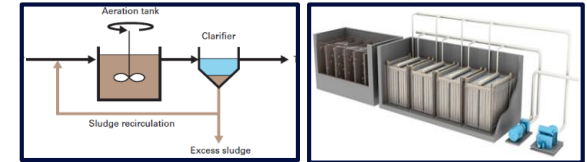


Water is critical to refinery health

# Membrane Bio Reactor & wastewater treatment

## Reinforced Membranes Critical to Reliability

- Hollow fiber configuration
- Billions of microscopic pores on the surface
- Pores are barrier to impurities but allow water molecules to pass
- Membrane layer integrated with support braid providing unmatched ruggedness



	Conventional	MBR
Organics Removal (BOD)	< 20 mg/L	< 2 mg/L
Solids Removal (TSS)	< 20 mg/L	< 2 mg/L
Nutrient Reduction (TN)	< 10 mg/L	< 3 mg/L
Reuse Quality	☹️	😊
Load Variations	☹️	😊
Toxicity Impacts	😊	😊
Process Stability	😊	😊
Retrofit / Upgrades	☹️	😊
Footprint	☹️	😊
Ease of Operation	😊	😊
OPEX	😊	☹️

# Introduction

- Augmented organics removal - recalcitrant COD & toxic compounds
- Additional process stability
- Improved effluent quality for discharge or reuse
- Proven & robust solution
- Lowest cost of ownership

Achieves secondary and tertiary treatment in one compact step



**Footprint**

**Reliability**

**Cost**

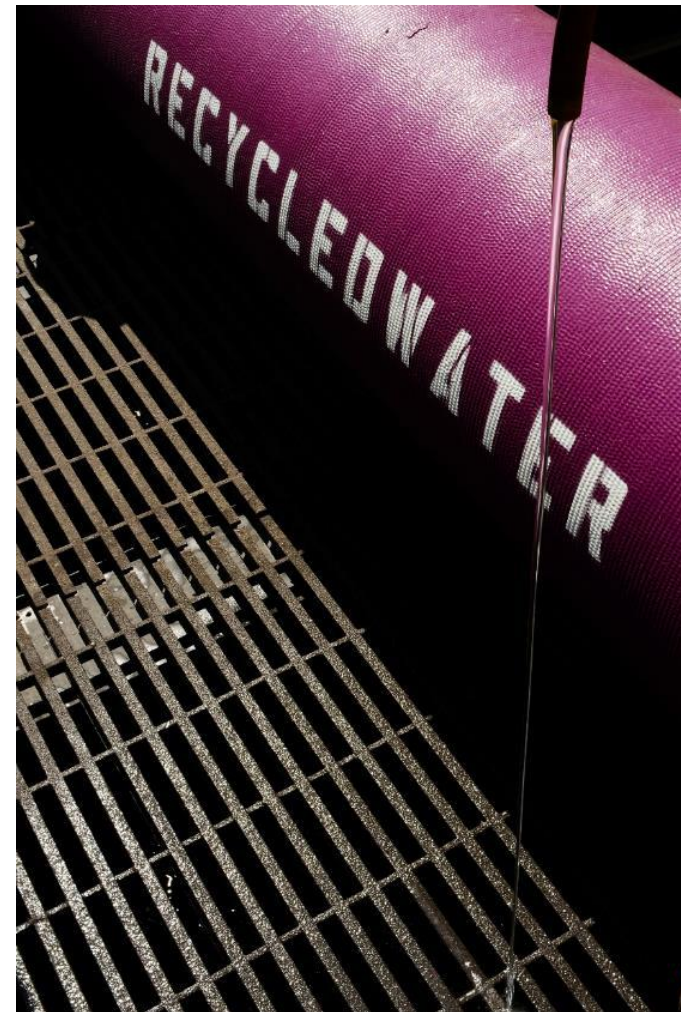
**Effluent Quality**





# Uses of Recycled Water

- Process Water
  - Desalter makeup
  - HCU/HTU wash-waters
  - Coker quench water & cutting water
  - FCC wash-waters
  - Flare seal drum
- Boiler Feedwater Makeup
- Cooling Water Makeup
- Fire & Utility Water



# Supplemental supplies and mobile water

## Short, medium and long term rental solutions

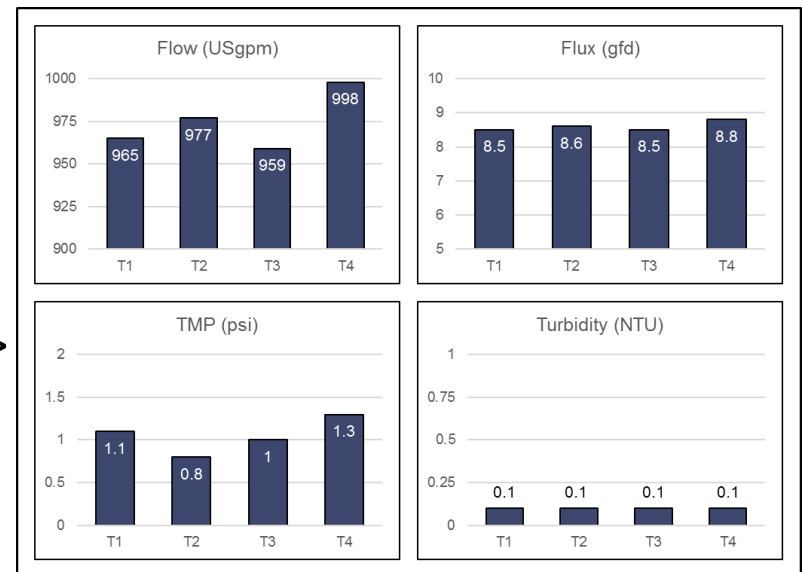
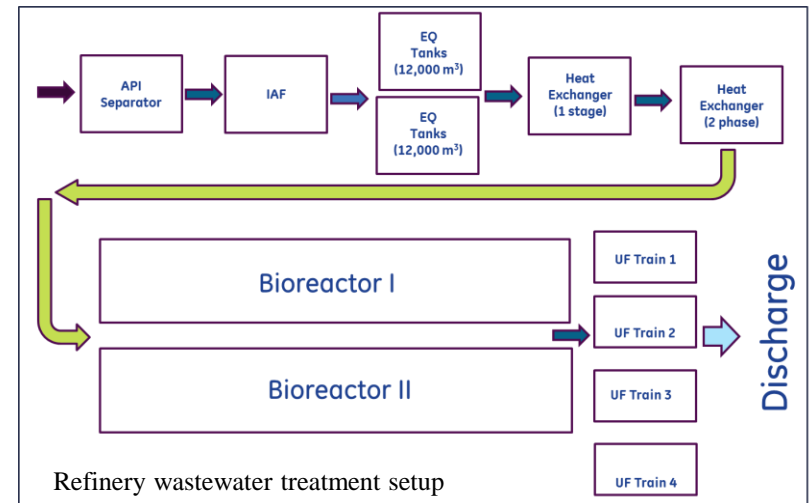
- Emergency
- Planned outages
- Incremental supplies
- Delayed Capex
- Build-Own-Operate Options



Offers a water availability solution literally on demand

# BAPCO Refinery integrated water and wastewater

- BAPCO decided to upgrade its existing WWTP to comply with stricter discharge requirements using the best available technology: MBR
- The MBR system now takes care of Ammonia, Nitrate, Suspended Solids, Sulfides, Phenols, BOD, COD etc., present in the refinery effluent.
- BAPCO effluent from Refinery is unique with high salinity (i.e. TDS > 30,000 ppm and high temperature (> 45 °C)).



Pilot test results

The UF system has consistently met all effluent quality parameters, incl. TSS and turbidity

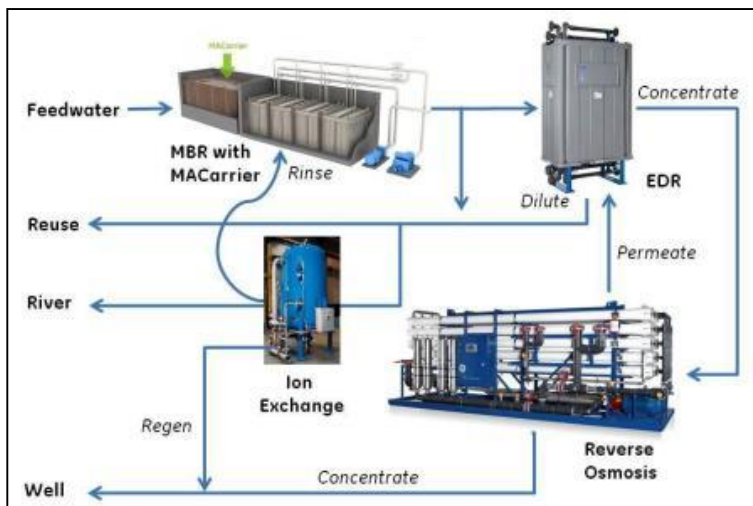
# Bashneft Refinery, Russia

## Customer challenges

- Treat refinery wastewater, 84,000 m<sup>3</sup>/d average, 144,000 m<sup>3</sup>/d max day
- Meet stringent water quality requirements for river discharge (COD < 30 mg/L, phenols < 0.001 mg/L, heavy metal limits)
- Produce treated water for industrial reuse

## SUEZ solutions

- ZeeWeed MBR with MACarrier + EDR (reuse) + IX (heavy metal removal for river discharge) + RO (EDR brine concentration)
- System performance allows water reuse & meets stringent discharge requirements
- Commercial operating date - 2016



Parameter	Raw Feedwater Quality	River Discharge Quality
COD, mg/l	450	30
BOD <sub>5</sub> , mg/l	135	3
Phenols, mg/l	7.0	0.001
NH <sub>4</sub> -N, mg/l	40	0.5
TP, mg/l	0.2	0.13
TSS, mg/l	50	6.4
Oil, mg/l	25	0.05

# Digital Internet-of-Things: Asset Performance Management

- Using InSight™ Remote Data Monitoring & Analytics
  - ensures assets – like boilers, cooling towers, reverse osmosis and ultrafiltration membranes and other key components operate at optimal levels
- Reduce Operational Risk ... by driving reliability and availability of equipment
- Minimize Total Cost of Ownership ... through optimized process operations
- Early detection is a key goal, detecting emerging problems, so that action can be taken now, before a failure is experienced in the future



# Conclusions and recommendations

- The MBR system successfully passed all Performance Test conditions.
- The MBR system met all the treatment capacity requirements while keeping TMP values well below maximum limit of 8 psig.
- The performance 6 months after the completion of the Performance Test continued to be excellent.
- A water reuse target in refineries can help with the economics of their water bill and with suitable polishing technologies, applications towards cooling and boiler water needs can be met.
- **A review of the water balance at each industrial site is recommended to fully understand the economic and operational setting to achieve full results.**