INTERNATIONAL CONFERENCE ON DESALINATION AND SUSTAINABILITY

1 - 2 March 2012

Energy Recovery Experiences & Future Developments

Ibrahim El Agawany
Energy Recovery Inc

MOR12-013

- Morocco's Water & Energy Needs
- Economic Benefits of Energy Recovery
- Technology Developments: PX™-Q300 Pressure Exchanger Devices
- Perth Durability and Availability Study
- Technical Resources

Morocco's Water & Energy Needs

- Energy costs are high
  - energy cost = ~9 -10 euro cents / kWh
- Brackish RO is frequently required
- Seawater RO is on the fast track
  - Maghreb is developing plants that produce up to100,000 m^3/day

= **$$$$**

Morocco's Water & Energy Needs

- ERI Project Experiences in North Africa (Algeria):

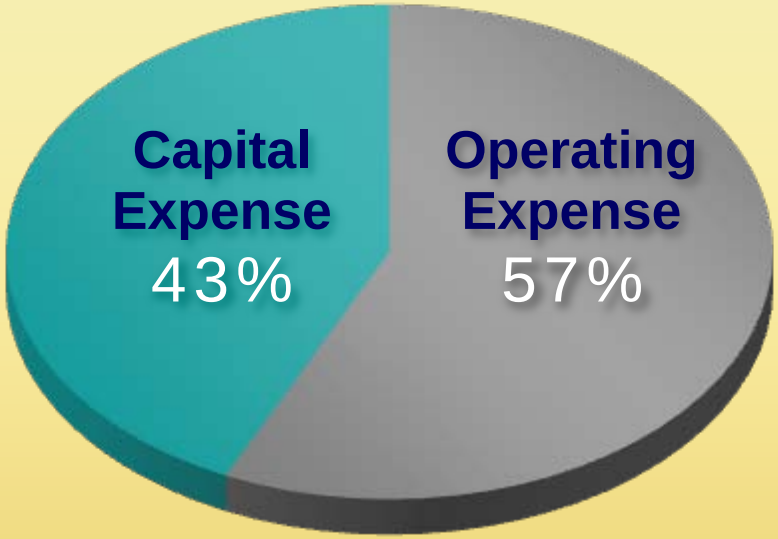
11 Mega Scale - **10:** PX™ ERD + **1:**TurboCharger

USA, Spain, Canada (multi-national construction companies)

100% Algerian plants are using ERI products

Mostaganen, Skikda, Hamma, Fouka, Maagta, Tlemcen, Honaine, Cap Djinet

Desalination Plant Capital & Operating Costs

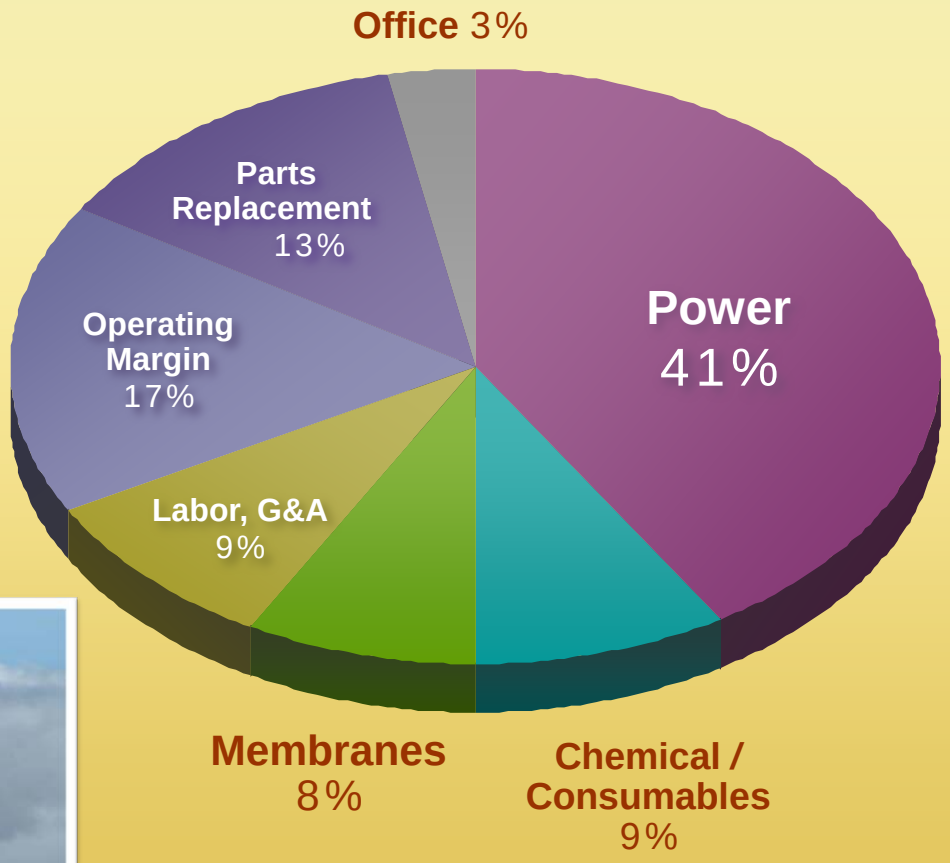


ASSUMPTIONS

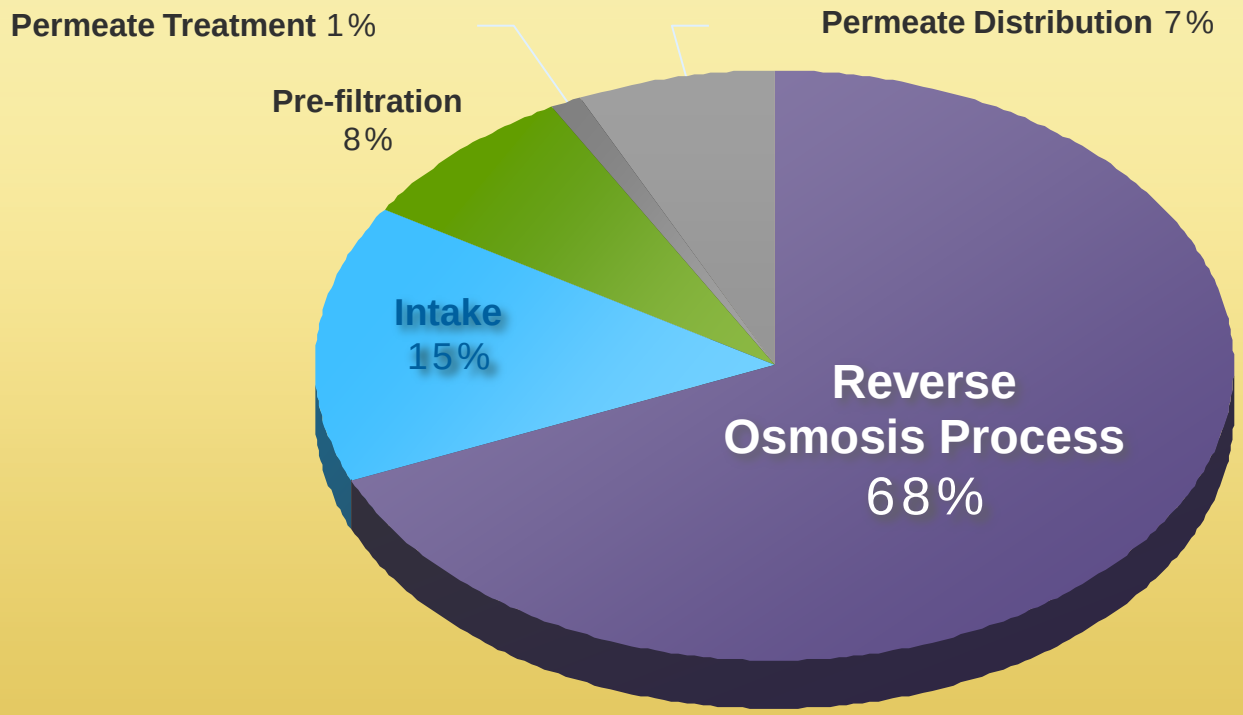
Power Cost USD/kWh	0.09
Debt Equity Ratio	80/20
Debt Interest Rate	8%
Equity ROI	18%

Operating Expenses— Breakdown

Perth Seawater Desalination Plant



Power Use Breakdown (Seawater RO)



RO power consumption = ~20- 45% operating costs

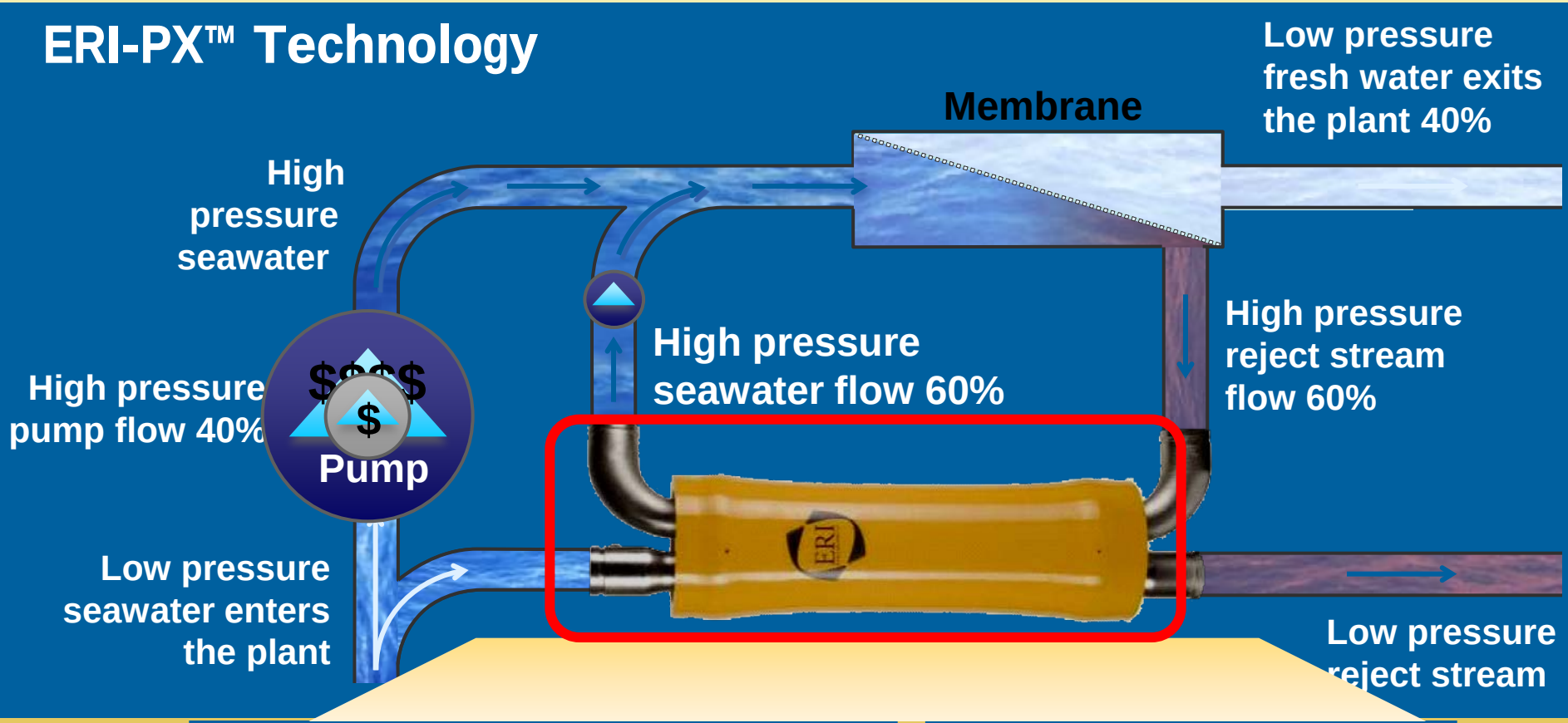
Source: *Affordable Desalination Collaboration*, 2008

Economic Benefits PX™ Technology:

The Best Economic Solution in Energy Recovery. Ever.

Desalination with Energy Recovery

ERI-PX™ Technology



- PX™ Pressure Exchanger™ technology is up to 98% efficient
- Reduces energy consumption by ~60%

Economic Benefits

- **Highest Energy Efficiency**
  - Highest efficiency- guaranteed
  - Performance never degrades over time
  - Saving up to **$1 billion/year** in energy costs alone

- **UpTime: 99.8% Availability Advantage**
  - Zero unplanned downtime can offer average savings of $15 million over the life of a plant*
  - PX devices are highly reliable; they will never be responsible for plant down-time or loss of production

- **Resulting in Lowest Lifecycle Costs**
  - Best Economics: Highest Return on Investment

*Assumption: Plant capacity 100,000 m^3/day

PX Technology Features

- **Durability – Designed for a lifetime**
  - Designed for more than 25 years
    - Robust ceramics- improved formulation
    - Never corrodes, fatigues

- **No Maintenance**

- **Modularity & Flexibility**
  - Scalable (limitless capacity)
  - Flexible operations (recovery/flows)
  - Built-in redundancy
  - Installed in any orientation

PX Technology Features

- **Quickest Start-up**
  - Installation time - Starts up within days
    - 5-6 times faster than other piston-type isobaric ERDs
    - Weeks versus months
  - No hydraulic / PLC controls or wires
  - All devices automatically adjust speed to match flow
  - Lightweight/Small footprint

The PX-Q300 Energy Recovery Device
The Next Generation

The New ERI PX-Q300 ERD

Technology Enhancements

Benefits & Features

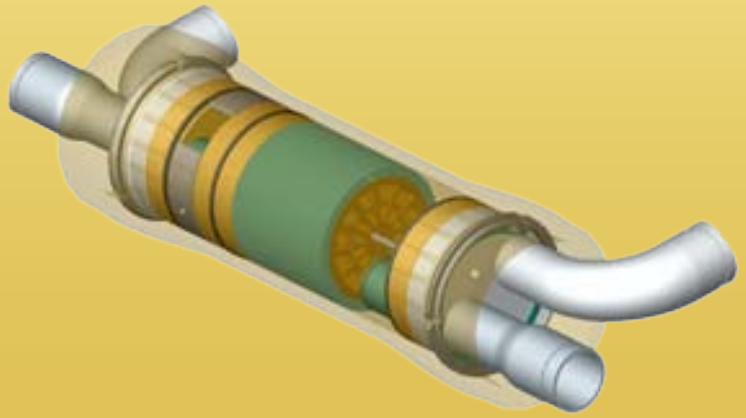
- Highest Efficiency – 97.2% guarantee
- Lowest Lifecycle Costs – Best ROI
- 99.8% Uptime – zero unplanned downtime
- Quietest PX technology – Below 81dB

Perth: 5+ Years
Durability & Availability

An ERD Study

Perth I Desalination Plant Study Results

- Full Plant/ERD system data collection
  - *Mixing and efficiency compared with commissioning data*
- ~15% of the 192 PX-220 devices were disassembled/inspected
  - *All components inspected (housing, piping, seals, ceramics, etc…)*
- 4 ceramic cartridges returned to CA Ceramics Lab
  - *Full material and mechanical analysis was completed*



Sustained ERD Performance

Start-up Performance (April 2006)

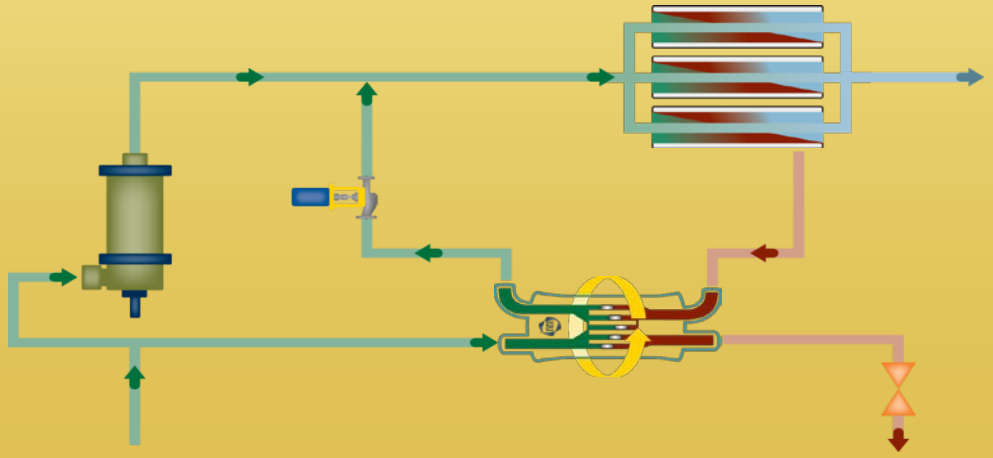
- PX device efficiency averaged 96.5%
- Salinity increase at the membranes was 2.6% at 45% recovery

Mixing normalized for lead flow

~6+ Year Performance (2012)

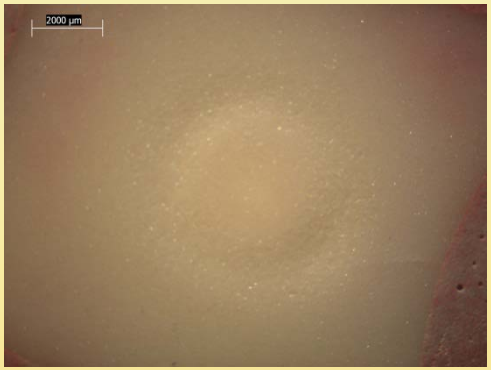
- PX device efficiency averaged 97.2%
- Salinity increase at the membranes was 2.7% at 45% recovery

Mixing normalized for lag flow

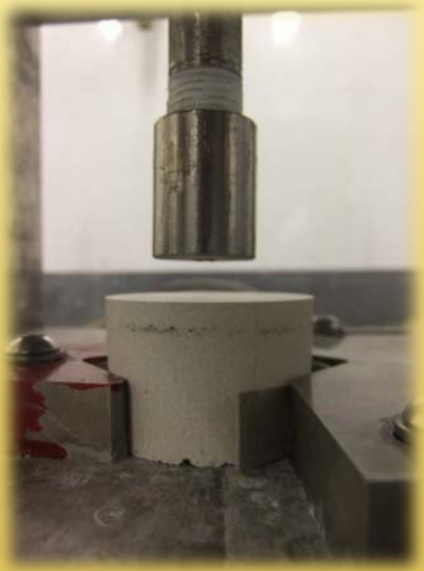


Lifetime Durability

- Ceramics do not fatigue
- Ceramics are non-metallic
- 3X steel hardness
- Projected operating life >***25*** years
- New and improved ceramics developed



200µ scale
8X magnification



Lowest Total Life-Cycle Cost

- Includes purchase of on-site spare cartridges
- Primary spare parts consists of o-rings
- No periodic replacement of parts
- No required maintenance

ERD Life-Cycle Cost < 0.25% of initial cap. Investment / yr

The Importance of Availability

Availability must be the #1 factor in evaluating critical equipment

Typical PX System ~ **99.8%** Availability

Competing devices ~ up to **90%** Max**.** Availability

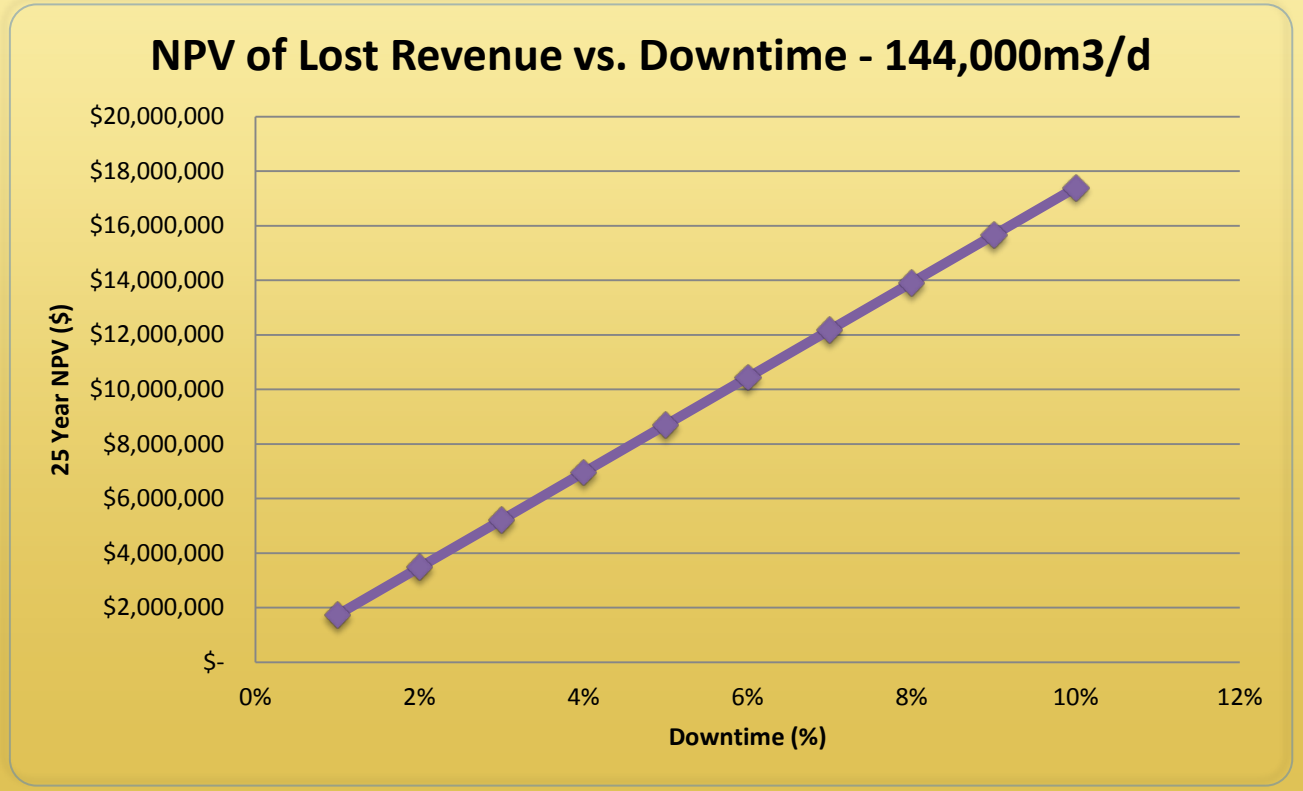
10% reduction in ERD availability translates into ~**$18M** over plant life*

*Assumption: Plant capacity 100,000 m^3/day

ERD System: 99.7% Availability – ***Actual Plant Data***

- Built-in redundancy
- Fail-safe design
- One moving part

$$Availability = \frac{Uptime}{TotalOperatingHours} x100$$



Summary

- Industry leading life-cycle cost advantage
- 99.7% ERD system availability – estimated $18M in possible savings
- The PX devices at Perth meet all performance guarantees after 5+ years of continuous operations
- Min. 25 year projected life out of the ceramic components
- Avg. cost of maintaining ERD system <0.25% of initial cap. investment

Do you know the availability of your ERD system?

Technical Resources

Economic Savings Calculator
for Plant Owners and Operators

Facility Downtime Operating Costs

ERI

Step 1 | Step 2 | Results

Daily Downtime Operating Cost

25	Life of Plant (Years)*	10 %	Interest Rate (Percent)
150,000	Baseline (Plant Size, m3/d)	$0.55	Overall Water Price (USD/m3)
3.50	Specific Energy Consumption (kWh/m3)	$0.10	Energy Cost ($/kWh)
$0.35	Operating Expenses - Cost to Produce (USD/m3)	$0.20	Contribution Profit from Water Sales per m3 (USD/m3)
36.36	Contribution Margin (%)	$30,000	Contribution Profit per Day (USD/d)

$ 272,311 **NPV (Life of Plant) - Cost of 1 day Downtime per Year** (USD/Project Life)

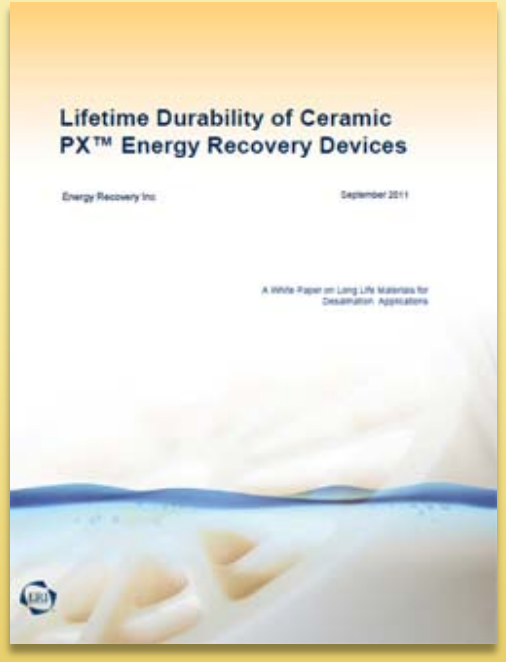
* In case of existing plant, specify remaining life

Calculate This Step

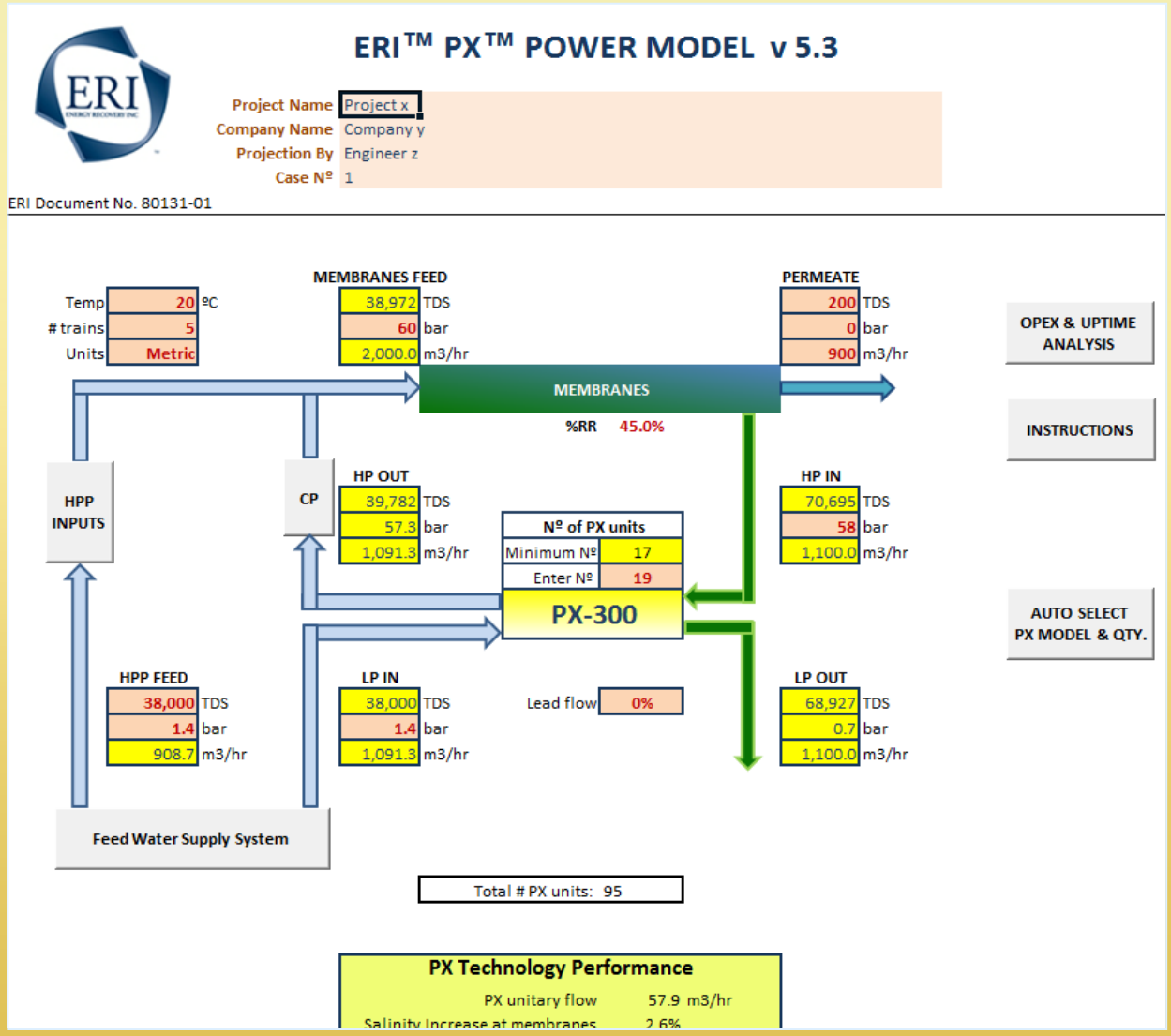
www.energyrecovery.com/downtimecostcalculator_op

White Papers

- **99.8% Availability Advantage**
  Case Examples of availability advantages
- **Efficiency Guaranteed**
  Study on efficiency claims- 96%+ guarantee
- **Lifetime Durability**
  Designed for 25 year lifetime
- **Economics of Downtime**
  Help evaluate planned and unplanned down-time costs over life of plant



Available for Download via the Technology Tab at:
www.energrecovery.com/



www.energyrecovery.com/powermodel