The Economics of Downtime

Energy Recovery Inc

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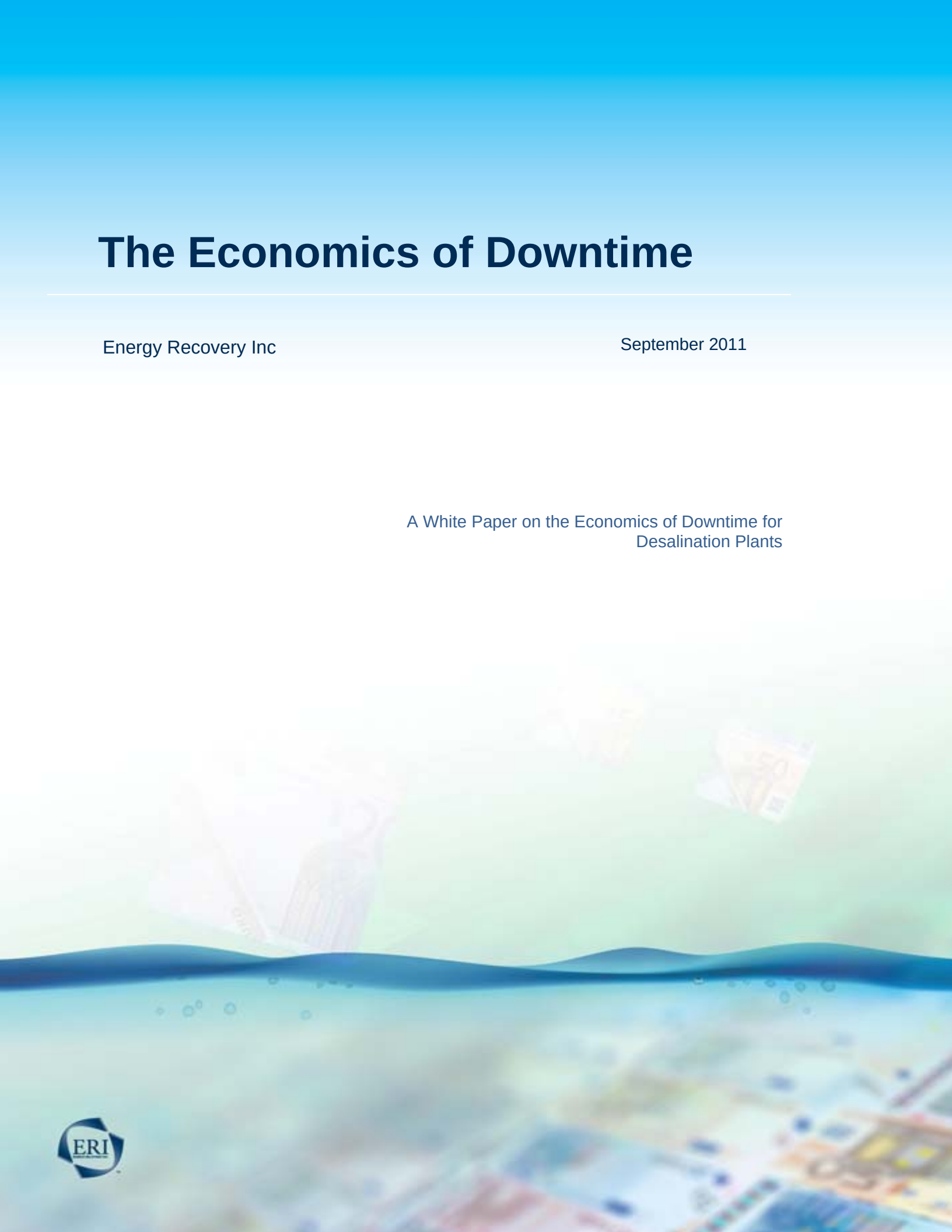
A White Paper on the Economics of Downtime for Desalination Plants



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Executive Summary

➔ Overview

A key cost that is seldom estimated during evaluation of various technologies in seawater reverse osmosis (SWRO) projects is the cost of downtime – both planned and unplanned. This paper will prove that these downtime costs are significant to both the investors and the operators of the plant. Therefore plant availability must be a primary factor to be considered in the design phase. Plant availability is even more critical in evaluating the energy recovery technologies as they can cripple production if they break down often and require high maintenance.

Energy recovery devices (ERD) cost less than 2% of initial capital costs but could cost twice that due to lost margin and capital costs. Due to large initial capital expenses, long project life, and criticality of water for end-users, every component should be designed for longevity and robustness along with highest performance. As many plant operators have to pay for liquidated damages when missing the minimum production requirements, it is imperative that the plant is designed for the highest availability possible.

The Economics of Downtime

Historically, an evaluation of a SWRO project includes many factors such as initial capital costs (CAPEX), specific energy consumption (SEC), water margin, base and variable costs. The one key driver that is unfortunately too often overlooked from the equation is the cost of downtime. It is not realistic to expect a plant to run 24/7/365, but every minute that a plant is not producing water, there is an economic loss to the project owner and operator.

Downtime can be sub categorized into planned and unplanned downtime. All facilities plan for a certain amount of downtime to perform maintenance of various systems. To allow for this downtime, large storage tanks are built and put into place. These storage tanks also help allow the plant to maintain steady production (supply) while demand fluctuates. A facility with minimal downtime could help save the capital cost of a large storage tank and generate significant returns to both its owners and operators.

Unplanned downtime, by definition, is much harder to predict and therefore causes many supply disruptions. Some of the common reasons that require a plant to be shut down include pump and energy recovery device (ERD) failures. All other failures, such as pressure vessels and membranes can be repaired by isolating the particular section, and do not cause plant-wide interruptions. Newer plant designs have a built in spare for high pressure pumps that minimizes the unplanned shut downs.

A common fallacy in plant design is to pick the ERD system solely on its efficiency and initial capital cost. However, a failed ERD system, which only costs about 2% of CAPEX, could completely shut down the operation. Therefore it is imperative to look at the availability (or uptime) of ERD solutions implemented in a SWRO project. ERI's PX™ technology has proven to be available over 99.8% due to advanced design, ceramic components, and a single rotating part. Additionally, this technology has a proven efficiency of 98% and a guaranteed efficiency of up to 97.2% making it the most economic ERD solution for a SWRO plant.

Cost of Downtime

When a plant is down (planned or unplanned), it impacts two groups financially. There is an economic impact to the initial investor who pays interest (cost of capital) on the invested capital; and the operator who benefits from the revenue generated. In many cases, these two parties can be different and therefore both need to be aware of the economic cost of downtime. The discussion below evaluates both of these costs using some examples. A critical aspect to note is that in both cases, the cost of downtime is significant and must be considered during the design phase of the project to minimize them.

➔ Capital costs

SWRO plants are large investment projects for which actual cost depends on location, plant size, distance to distribution centers and many other geographic and economic factors. It is not uncommon to see a 100,000 m3/day plant require an initial capital in excess of US $250 million. Plants are generally designed for a 25-year life and financed by a typical deal comprised of 80% debt and 20% equity. An average of 8% weighted average cost of capital (WACC) is a reasonably conservative estimate.

The daily average interest carrying cost for a project of $250 million over 25 years is around $54,800. Therefore, a plant designed to have one day of downtime per year costs approximately $585,000 over the life of the plant.

The net present value (NPV) of this one day of downtime per year over 25 years (at 8% WACC) is approximately $585,000.

A conservative estimate of just <u>one day per month</u> of unplanned downtime will cost the above plant owner <u>$7 million in return on capital</u> over the life of the plant.

ERI's PX™ technology has a proven availability of 99.8% - the highest of any ERD in the industry – and therefore is the best economic option that assures plant uptime. Alternative technology has multiple moving parts and is well known in the industry for its failure and low availability.

➔ Operating costs

In the case of an operator, the revenue generation depends on making water. Assuming that there are no demand side constraints, the more water a plant makes, the more revenue (profits) it generates. Staying with the theme of a 100,000 m3/day plant with 25 year life cycle and 8% interest, one can estimate the cost of lost margin due to downtime. At a sale price of $0.60 per m3 and margin of $0.25 per m3, a day of downtime results in a NPV of $640,000 of lost revenue and **$267,000 of lost gross margin.** A one day per month of unplanned downtime will cost the above **plant operator $3.2 million** in lost margin over the life of the plant.

Summary

Uptime, or plant availability, *must* be one of the key drivers in a SWRO plant design process. It impacts both investors and operators of the plant over the long life of the project. Energy recovery systems are extremely crucial to the plant uptime as they can potentially cripple water production should they fail or require high maintenance. Selecting the wrong ERD technology can cost the owner and/or the operator of a SWRO plant more than twice the initial capital expenditure for the ERD solution.

A prudent investor or operator must insist on the best economic ERD solution for their plant – the ERI PX™ Technology.

An example of the total lifecycle cost comparison of PX devices and competing technologies are provided in the next section. More information and a downtime costs calculator to help estimate the options is available on ERI's website at www.energyrecovery.com/downtimecostcalculator.

Capital Cost Analysis

Daily Downtime Capital Cost			
Overall Facility Capital Cost			$250 million USD
Life of Plant			25 years
Facility Cost of Capital			8%
Average Daily Return on Capital			**$54,795** USD per day
NPV of 1 Day Downtime			**$584,919** USD/project life
Overall Cost of Unplanned ERD Downtime			
Cost of ERD	1.50%	of Capital Cost	$3.75 million USD
# of UNPLANNED Downtime Days due to ERD per Year			**12** days per year
Downtime Capital Cost due to ERD Failure			**$657,534** USD per year
NPV of Downtime			**$7,019,031** million USD per project life
Breakeven (Cost of ERD = Cost of Downtime)			**6.41** days per year

Sensitivity Analysis

Cost of Capital	Life of Plant (Years)				
	20.0	22.5	25.0	27.5	30.0
6%	$7.54	$8.01	$8.41	$8.75	$9.05
7%	$6.97	$7.34	$7.66	$7.93	$8.16
8%	$6.46	$6.76	**$7.02**	$7.23	$7.40
9%	$6.00	$6.25	$6.46	$6.62	$6.76
10%	$5.60	$5.81	$5.97	$6.10	$6.20

Cost of Downtime in Million USD

Operating Cost Analysis

Daily Downtime Operating Cost	
Life of Plant (Years)	25 Yrs
Interest Rate	8%
Baseline (Plant Size)	100,000 m^3/day
Overall Water Price	\$0.60 USD/m^3
Specific Energy Consumption	3.50 kWh/m^3
Energy Cost	\$0.10\$/kWh
Operating Expenses (Cost to Produce)	\$0.35 USD/m^3
Gross Profit from Water Sales	\$0.25 USD/m^3
Gross Margin	41.67%
Gross Profit per Day	**\$25,000** USD/day
NPV of 1 Day Downtime	**\$266,869** USD/Project Life

COST COMPARISIONS - ERI vs. Competing Isobaric Technologies		
	ERI	**COMPETITION**
CAPEX		
Average CAPEX of ERD per 100,000 m^3/d	\$1.80	\$1.50 million USD
Cost of ERD for Current Plant	\$1.80	\$1.50 million USD
UNPLANNED DOWNTIME COST		
Average Downtime*	0.7	12.0 days/year
Lost Gross Profit due to Downtime	\$17,500	\$300,000 USD/year
NPV of Unplanned Downtime Cost	**\$186,809**	**\$3,202,433** USD/Proj Life
** ERI's PX Technology has a proven availability of 99.8% and zero planned downtime*		
MAINTENANCE COST		
Yearly Maintenance as % of Total ERD Cost*	0.50%	2.00%
Annual Maintenance Cost	\$9,000	\$30,000 USD/year
Maintenance Cost - Life of Plant	\$225,000	\$750,000 USD
NPV (Life of Plant) - Maintenance Cost	**\$96,073**	**\$320,243** USD

*Note: ERI's PX unit has zero required maintenance. A 0.5% provision has been included as a conservative estimate. The 2% for competitive technology is from published data of a leading competitor

Life Cycle Cost Summary			
	ERI	**Competition**	
CAPEX	$1,800,000	$1,500,000	USD
Unplanned Downtime	$186,809	$3,202,433	USD
Maintenance Cost	$96,073	$320,243	USD
Total	**$2,082,882**	**$5,022,676**	USD
Additional cost of competing technology vs. PX™ technology	**$2,939,795**		

Break Even Analysis	
NEW PROJECT	
# excess unplanned downtime days to make PX technology the most economic solution	
	0.98 days
EXISTING PROJECT	
No of unplanned downtime days that justify retrofitting the plant with a new PX Technology	
Competition unplanned downtime days = Capex for PX	**6.74** days
Remaining life cycle cost of Competition = Life cycle cost of PX	**6.60** days
(Competition Maint + Downtime = PX CAPEX, Downtime, Maint.)	

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More Information

For the latest information about our product and services, please visit our website: www.energyrecovery.com

Downtime Cost Calculator

A calculation tool to estimate the downtime costs of a plant is available on ERI's website at www.energyrecovery.com/downtimecostcalculator.

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