Smart Solutions

Improving Water Supply Reliability

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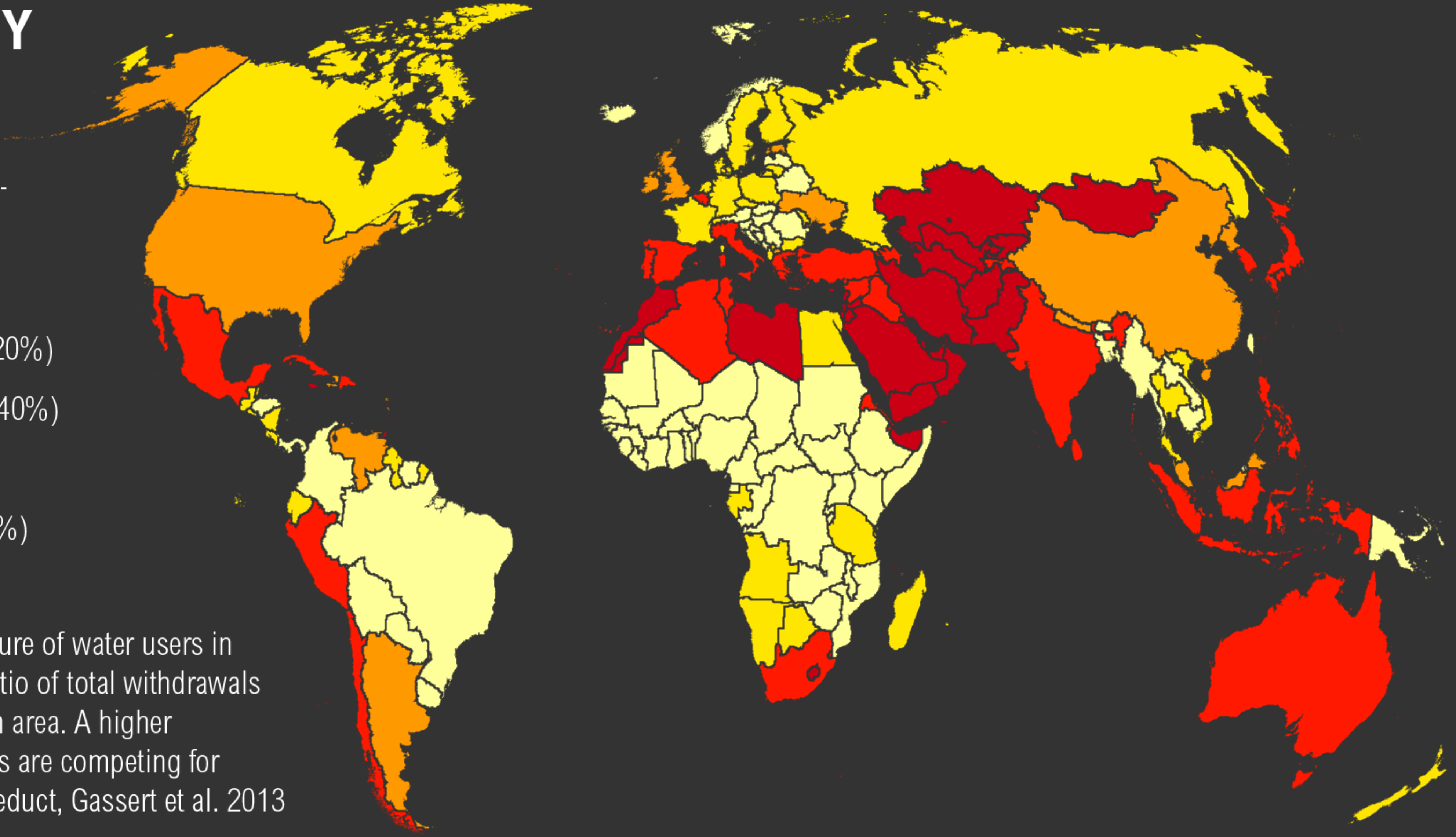
Water
Solutions

DUPONT™

WATER STRESS BY COUNTRY

ratio of withdrawals to supply

- Low stress (< 10%)
- Low to medium stress (10-20%)
- Medium to high stress (20-40%)
- High stress (40-80%)
- Extremely high stress (> 80%)



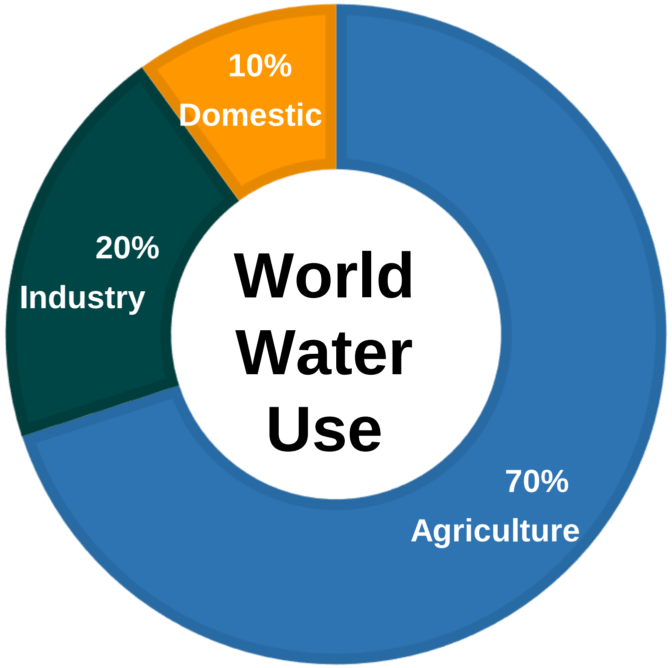
This map shows the average exposure of water users in each country to water stress, the ratio of total withdrawals to total renewable supply in a given area. A higher percentage means more water users are competing for limited supplies. Source: WRI Aqueduct, Gassert et al. 2013

AQUEDUCT

WORLD RESOURCES INSTITUTE

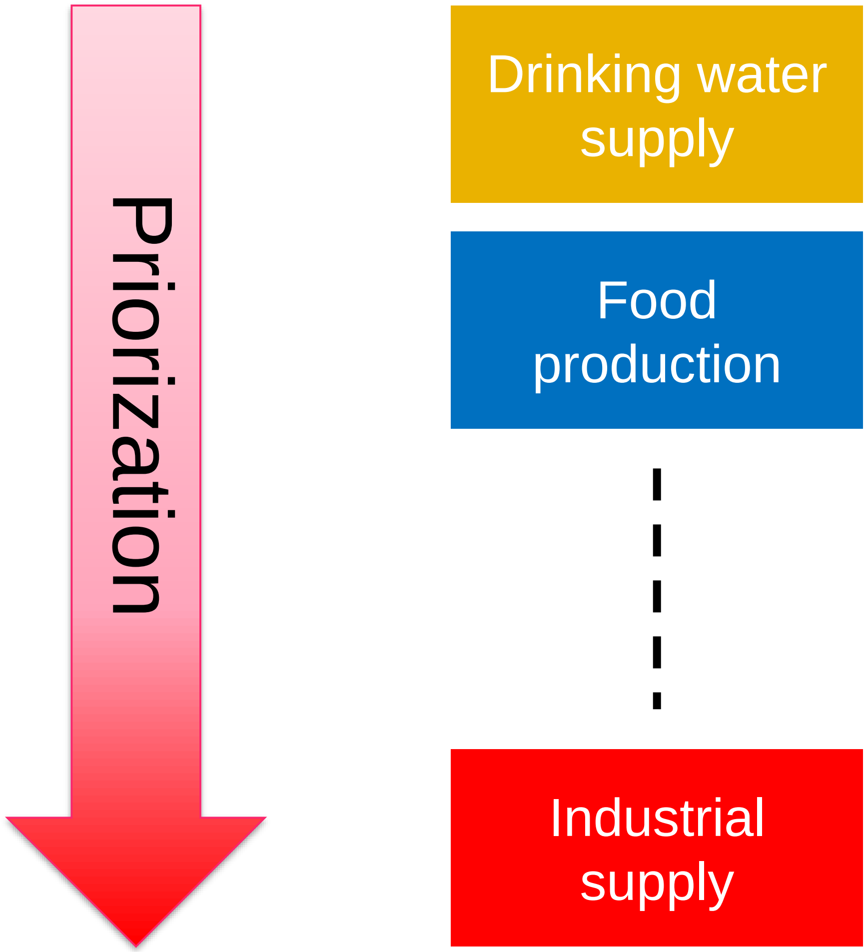
source: http://www.wri.org/resources/charts-graphs/water-stress-country

Water use and priorization



UN WATER

Source: The United Nations World Water Development Report 2018
http://unesdoc.unesco.org



How to anticipate…?

Switch to alternative water source

Change concept to ZLD/MLD

Smart Solutions : maximize what you have now

Common factor

Think and Talk “SOLUTIONS”

Smart Solutions
The value of cooperation

Hellenic Petroleum S.A.
ASPROPYRGOS REFINERY

Athens, Greece.

(Photo courtesy of Hellenic Petroleum SA.)

Existing plant specification – Ion Exchange Technology

Existing plant	
System history	39 years old (1980)
Installed technology	Air holddown system
Regeneration	Counter current
Flowrate	2 * 60 m^3/h
Runlength	2500 - 2700 m^3 / cycle
H_2SO_4 consumption	750 kg 100%
NaOH consumption	1240 kg 100%

What Listening tells you – Key Takeaways

Product based question:

“I need new resins”

listening

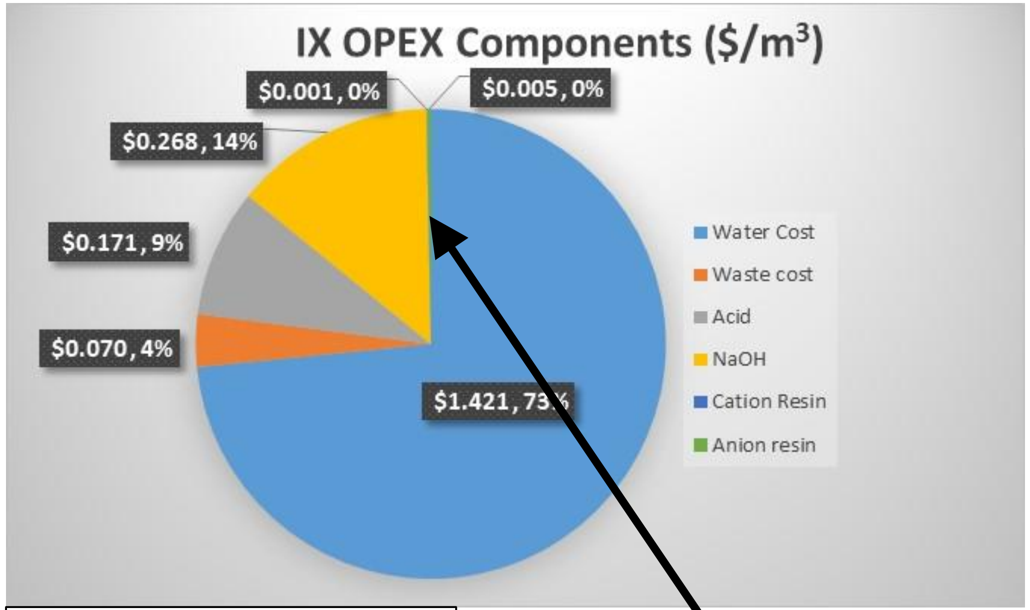
Solution based need:

1. Higher supply reliability
2. More water
3. Better quality
4. Less regenerations

But No investment…

Question ≠ What you hear

Solution vs Product



- 2-bed (cat-anion) system
- 10 meq/l ionic load
- Co-Flow regenerated
- HCl / NaOH
- Global avg. chemical, water & discharge prices
- Anion = 3 yrs.
- Cation = 4 yrs.

Resin replacement cost <1% total OPEX cost !

A “*component*” impacts

< 1% of the cost

A “*solution*” impacts

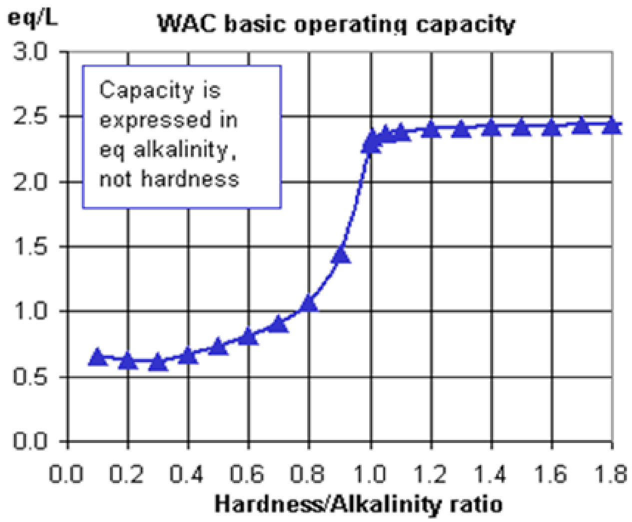
>80% of the cost

Typical Plan

1. Understanding the true needs
2. On site technical discussion & data gathering
3. Technical evaluation of existing equipement
4. Assessment of the water composition
5. Assessment of the vessel, piping etc.
6. Recalculation of the system using sophisticated WAVE software
7. Economical assessment
8. Proposal presentation & technical recommendation
9. Support, training & implementation
10. On site evaluation of results

Assessment of the feedwater

Table 1. Feed water composition				
Cations	Design		Anions	Design
Ca	2.6		Cl	0.11
Mg	0.5		NO_3	0.2
Na	0.21		SO_4	0.5
K	—		HCO_3	2.5
—	—		Silica	0.08
Total Cations	3.31		Total Anions	3.31



Result:

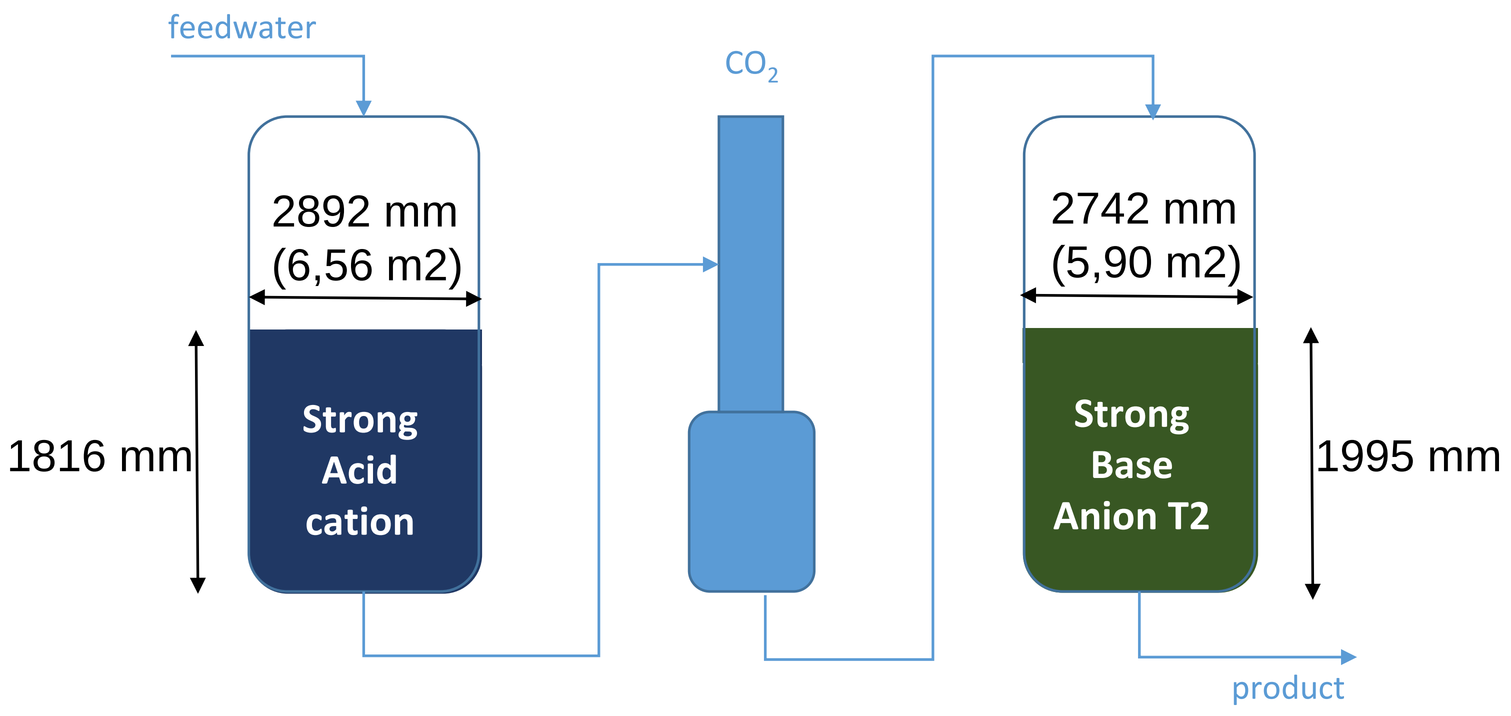
Favourable hardness to alkalinity ratio

Use of a weak acid cation resin is beneficial

Favourable % FMA of total anions

Use of a weak base anion is beneficial

Assessment of the equipment



Result:

- Vessel lifetime could be extended
- Sufficient bedheight available
- Increase of flowrate is possible

Resin configuration <u>Cation</u> - Upgrading the system to a layered bed

WAC* : AMBERLITE™ HPR8300 H:

- Excellent separation for layered bed
- Increased capacity → scope
- Low chemical consumption → scope
- Light color for color distinct

SAC* : AMBERLITE™ HPR1300 H:

- High density for excellent separation
- High capacity
- Low Na leakage = better quality → scope
- Dark color for visible separation

Amberlite™ HPR8300 H

Amberlite™ HPR1300 H

* WAC = Weak Acid Cation resin
  SAC = Strong Acid Cation resin

Resin configuration <u>Anion</u> - Upgrading the system to a layered bed

WBA*: AMBERLITE™ HPR9600:

- Excellent separation for layered bed
- Increased capacity → scope
- Low chemical consumption → scope
- Light color for color distinct

SBA*: AMBERLITE™ HPR4200 Cl:

- Excellent physical strength
- High capacity
- Low silica leakage = better quality → scope
- Darker color for visible separation

Amberlite™ HPR9600

Amberlite™ HPR4200 Cl

* WBA = Weak Bae Anion resin
SBA = Strong Base Anion resin

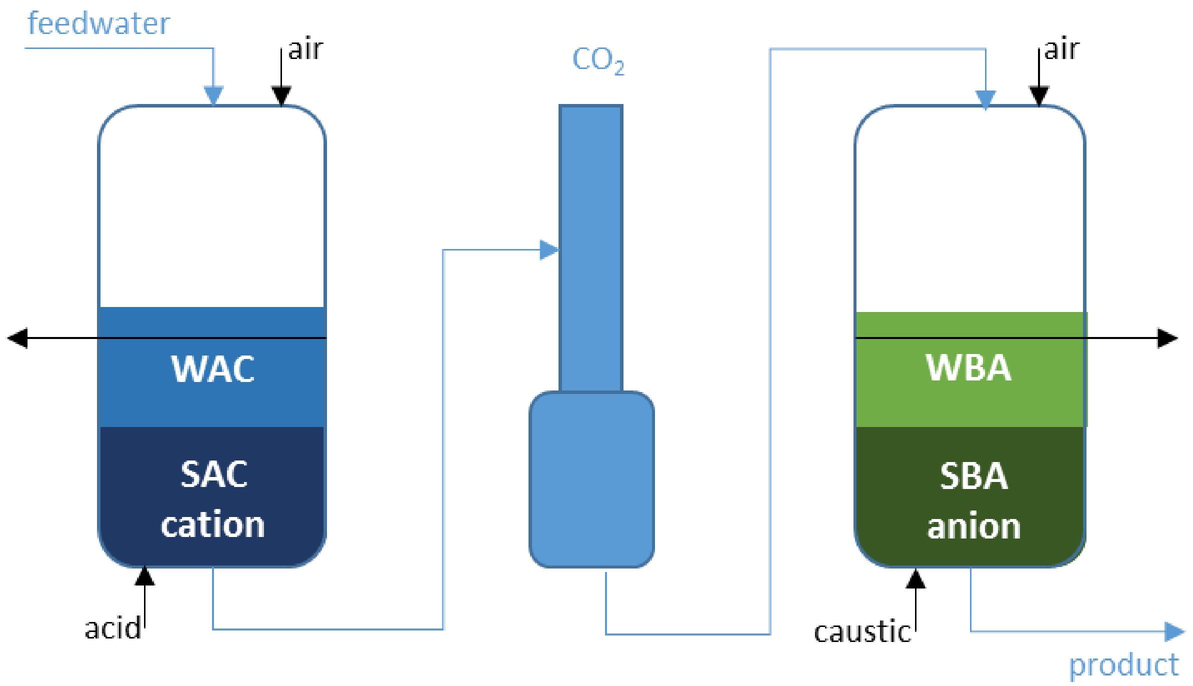
USING WAVE – Water Application Value Engine

CALCULATION OF THE EXCHANGERS

Resin choice	AMBERLITE HPR **8300**	AMBERLITE HPR **1300 H**	AMBERLITE HPR **9600**	AMBERLITE HPR **4200 Cl**
Resin volume [litres]	7000	7000	6000	6000
Reference ionic form for calculation	H	Na	Free base	Cl
Volume to purchase [L]		**7525**		
Potential running time [h]	**52,3**	**52,9**	**52,3**	**52,3**
Gross throughput [m^3]	6276	6347	6279	6277
Ionic load [eq]	15220	5553	4923	2191
Organic load [g/L R as $KMnO_4$]			2,1	0,8
Operating capacity [eq/l R]	2,17	0,79	0,82	0,37
Flow-rate [BV/h]	17,1	17,1	20,0	20,0
Mode of regeneration	Stratabed	Stratabed	Stratabed	Stratabed
Leakage (overrun) [%]	3		2	
Regenerant type		H_2SO_4		NaOH (25°C)
Concentration [%]	0,7	0,7		3,5
Regenerant ratio [% theory]	118	423	142	420
Regenerant Level [g/L R]		164		61
Total regen. [kg 100%]		1150		368

Water Solutions

Solution Proposal & Performance Promise



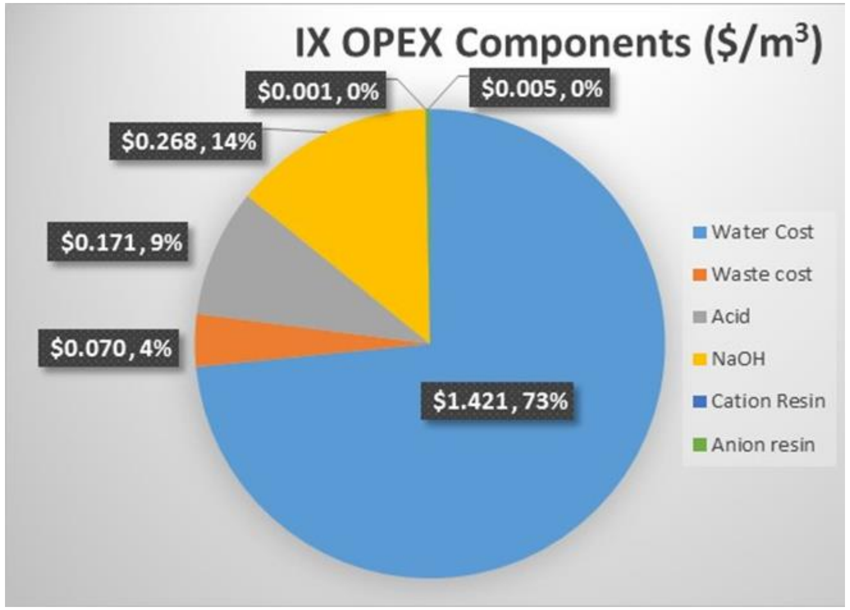
Solution Proposal

- Rebed the system
- Adjust regeneration settings
- Replace nozzles
- Enlarge feedpump

Performance promise

- Double the throughput
  Double the flowrate
- Less chemicals
- Higher quality

Evaluation of the Solution – Multiple WIN



	Old resin	New resin
Throughput (m^3)	~2500	>5000
Number of regenerations/y	~195	~106
H_2SO_4 consumption (tons 100% / year)	146.2	121.9
NaOH consumption (tons 100% / year)	146.2	45.1
NaOH for neutralization (tons 100% / year)	95	5.3
Waste water / year (m_3/year)	37537	15900

OUR SOLUTION:
Impacted effectively the significant part of the cost pie

Key learnings

Great results were achieved by cooperating with a dedicated Aspropyrgos Refinery Utilities team, managing various implementation difficulties:

- Limited options to change the regneration protocol were challenging.
- Resin blocking with air needed carefull adjustment by the operational team
- Regeneration flow control needed carefull control to prevent $CaSO_4$ precipitation

Effective cooperation results in value creation

We delivered what we promised with our solution: All targets were met

Additional overall cost saving of >50% OPEX - Our solution is a pay back for the resin replacement

The value of a solution exceeds by far the product it self

Hellenic Petroleum S.A.

ASPROPYRGOS REFINERY

Special thanks to the refinery operator team and in particular Mr Y. Liberopoulos

(Photo courtesy of Hellenic Petroleum SA.)