



NOVEMBER 2022

CIP Energy Savings

Piedmont



DISTRIBUTOR SUMMIT
NOVEMBER 13-17, 2022

Introduction



RO Energy Requirements

Osmotic Pressure

$$\pi = i \cdot c \cdot R_g \cdot T \text{ (in kPa)}$$

c : molar concentration (mol/L)

R_g : universal gas constant (8.31 Nm/mol.K)

T : temperature (K)

i : number of osmotically active particles in the solution
 $i = 1 + \alpha(v - 1)$

α : degree of dissociation

v : stoichiometric coefficient of dissociation reaction

For NaCl : $\alpha = 1$ & $v = 2 \Rightarrow i = 2$

For SW

RO Feed : TDS 35-40 g/l $\Rightarrow \pi = \sim 27\text{-}30$ bars @ 25°C

RO Brine : TDS 65-70 g/l $\Rightarrow \pi = \sim 50\text{-}53$ bars @ 25°C

Dead Sea : TDS > 350 g/l $\Rightarrow \pi > 300$ bars



SWRO Energy Consumption

Energy Consumption Breakdown

- Intake + Pre-treatment 20%
- RO process 70% - HP pump mainly
- Post-treatment & Distribution 10%

HP pump yield = hydraulic efficiency x motor efficiency

- hydraulic efficiency : 80 to 90%
 - motor efficiency : 90 to 95%
- ⇒ **Overall pumping efficiency** : ~80%



DID YOU PAY ATTENTION ?

What percentage of the total
SWRO energy consumption
does the RO process represent ?



HP Pump Electrical Consumption

HP pump :

- TDS : 35 g/l
- Temperature : 20°C
- Recovery : 45%

⇒ 2.0 - 3.0 kWh/m³ average

- Energy needs :**
- **increase with TDS** [+ 1.5% per g/l]
 - **decrease with T°** [- 0.5% per °C]



Energy Requirements

Fouling = Feed P + ΔP increase



Power + CO₂ emissions increase



CIP required



DID YOU PAY ATTENTION ?

What is the average
Specific Energy Consumption
(in kWh/m³ of permeate)
of an SWRO HP pump ?



CIP Assessment

Measure CIP efficiency



Data required



Normalize Data + Quantify Results



Data Normalisation

Quality (minimum required) :

- Pressure : Feed + Permeate + Concentrate
- Flow : Feed + Permeate
- Conductivity / TDS : Feed + Permeate
- Temperature : Feed

Quantity :

- Values over at least 20 days :

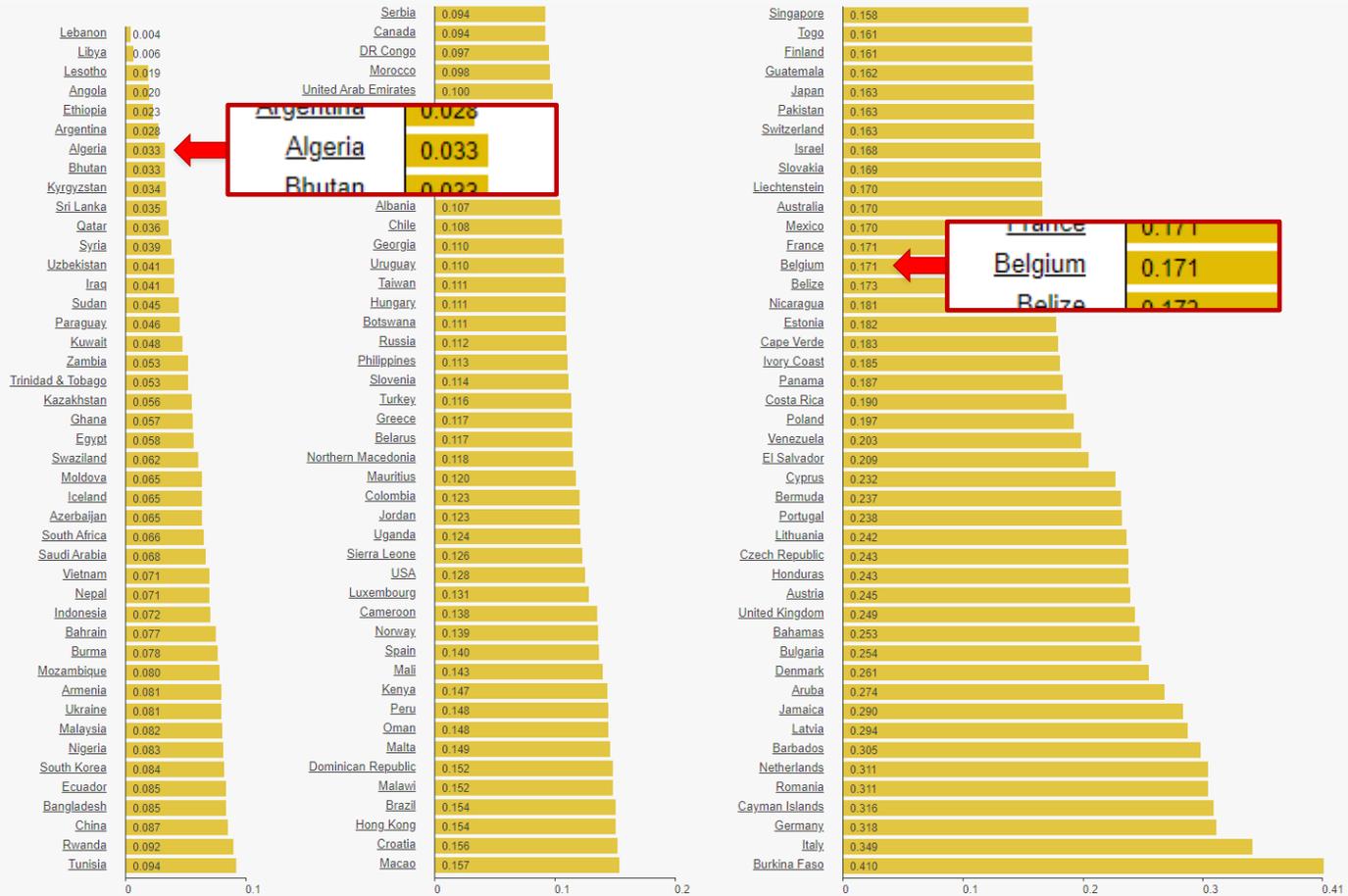
“The value of normalised data lies in trends over time” [Hydranautics]



Electricity Prices (USD / kWh)

Electricity prices for business, March 2022
(kWh, U.S. Dollar)

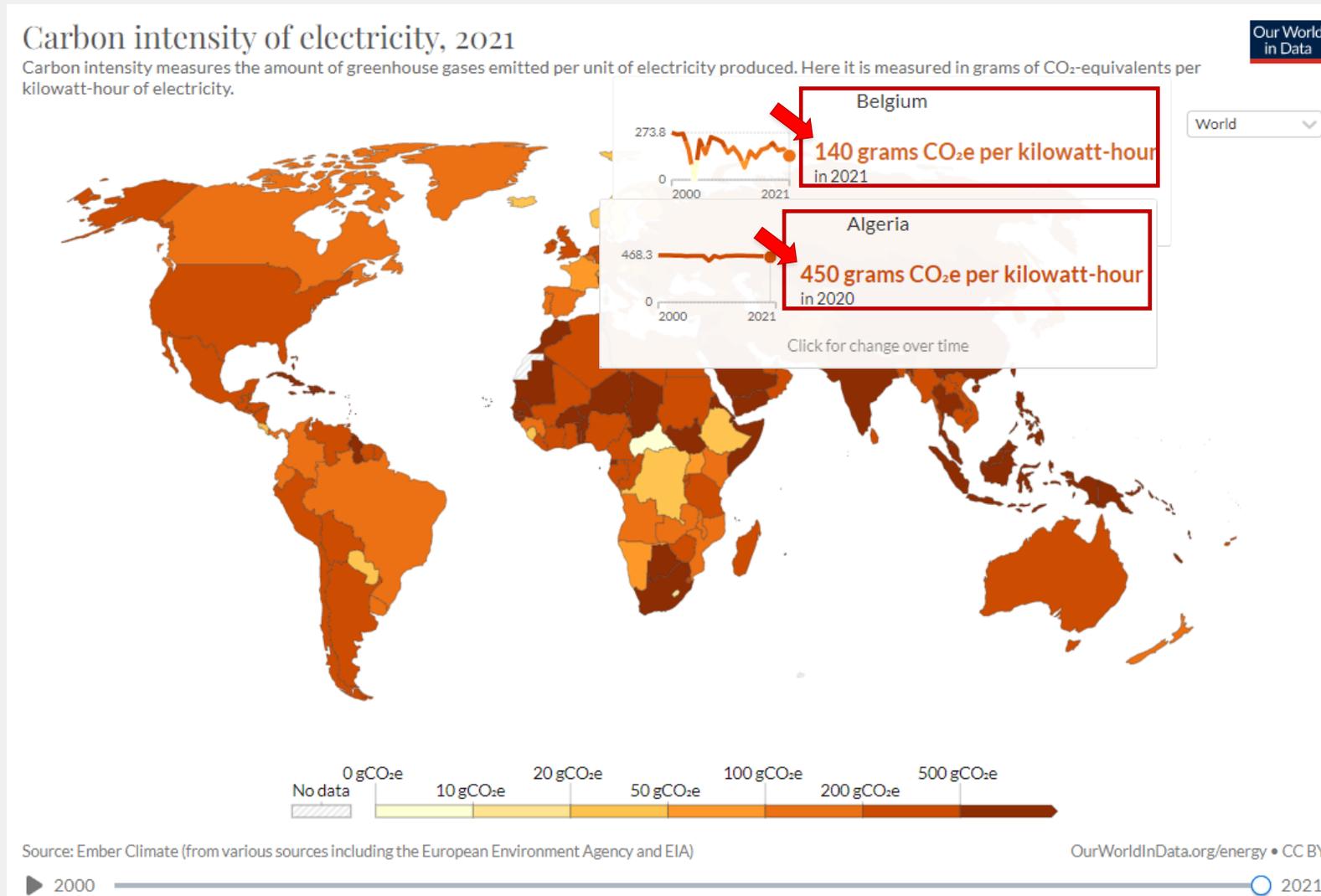
GlobalPetrolPrices.com



Source : GlobalPetrolPrices.com /electricity_prices/



Electricity Carbon Intensity (g CO₂ / kWh)



Practical Examples in SW & BW



Large SWRO's - Western Algeria

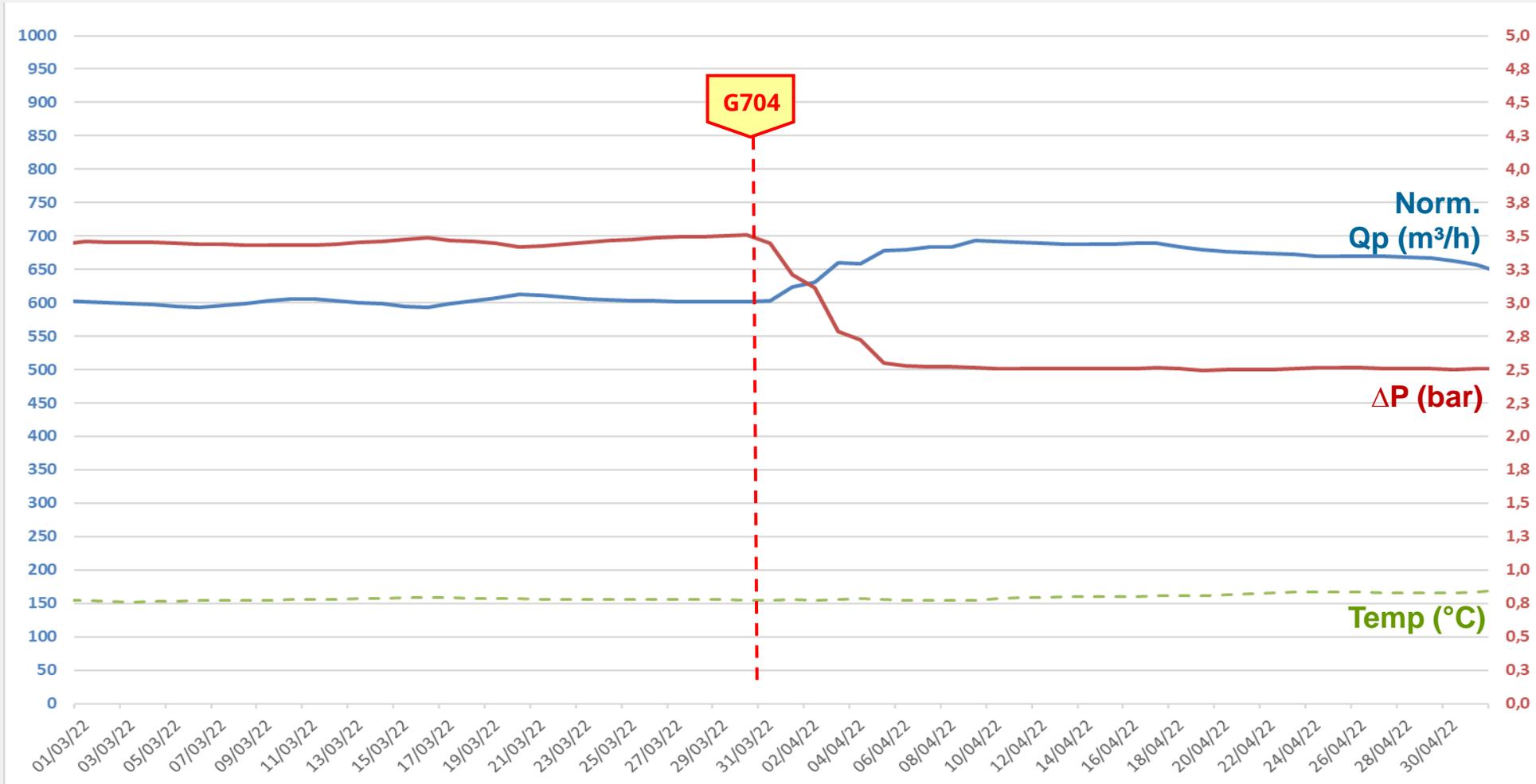


A - SWRO details

Design data	Max output	200 000 m ³ /d
	Recovery	45%
	RO units	12
	Perm. flow per unit	695 m³/h
	PV per train	197
	Membrane type	Toray TM-720
CIP system	Tank capacity	2 x 100 m ³
	Total CIP volume	~115 m ³
	CIP pumps	2 x duty / 1 x standby Q = 1,200 m ³ /h @ 3.0 bars
Main foulants	Organics & aluminosilicates	



A - Genesol 704 CIP results



C11T



A - CIP results (for 1 unit)

	<i>before CIP</i>	<i>after CIP</i>	
Feed Pressure	: 65.0 bar	⇒ 64.4 bar	
Recovery	: 44.7 %	⇒ 44.7 %	
Normalized Perm. flow	: 603 m ³ /h	⇒ 687 m ³ /h	= + 84 m ³ /h i.e. +13.9%
Differential Pressure	: 3.48 bar	⇒ 2.51 bar	= - 0.97 bar i.e. - 27.9%
SEC* (per m ³ permeate)	: 2.39 kWh	⇒ 2.37 kWh	= - 0.02 kWh i.e. - 0.9%
SAVINGS	: - 66 400 kWh / year		
	⇒ - 2 200 USD / year	or	30 Tons CO₂ / year
	[0.033 USD / kWh]		[450 g CO ₂ / kWh]

* SEC = Specific Energy Consumption

C11T

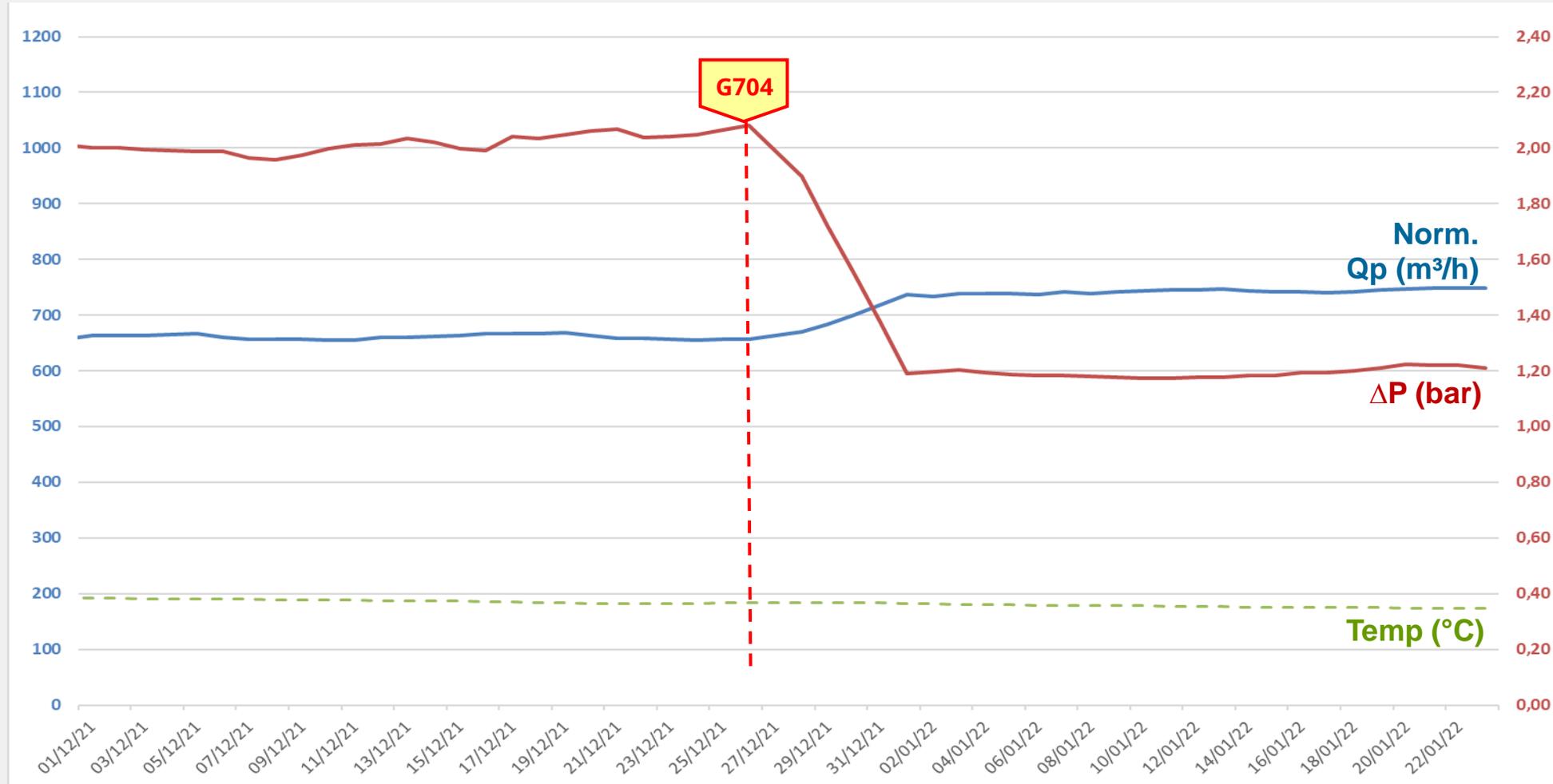


B - SWRO details

Design data	Max output	200 000 m ³ /d
	Recovery	46%
	RO units	10
	Perm. flow per unit	871 m³/h
	PV per train	222
	Membrane type	Hydranautics SWC5-Max
CIP system	Tank capacity	2 x 100 m ³
	Total CIP volume	~185 m ³
	CIP pumps	2 x duty / 1 x standby Q = 1,000 m ³ /h @ 4.1 bars
Main foulants	Organics & aluminosilicates	



B - Genesol 704 CIP results



C06H



B - CIP results (for 1 unit)

	<i>before CIP</i>	<i>after CIP</i>	
Feed Pressure	: 68.7 bar	⇒ 66.8 bar	
Recovery	: 44.5 %	⇒ 44.8 %	
Normalized Perm. flow	: 661 m ³ /h	⇒ 742 m ³ /h	= + 81 m ³ /h i.e. +12.2%
Differential Pressure	: 2.02 bar	⇒ 1.19 bar	= - 0.83 bar i.e. - 41.0%
SEC (per m³ permeate)	: 2.53 kWh	⇒ 2.46 kWh	= - 0.07 kWh i.e. - 2.8%
SAVINGS	: - 227 000 kWh / year		
	⇒ - 7 500 USD / year	or	102 Tons CO₂ / year
	[0.033 USD / kWh]		[450 g CO ₂ / kWh]

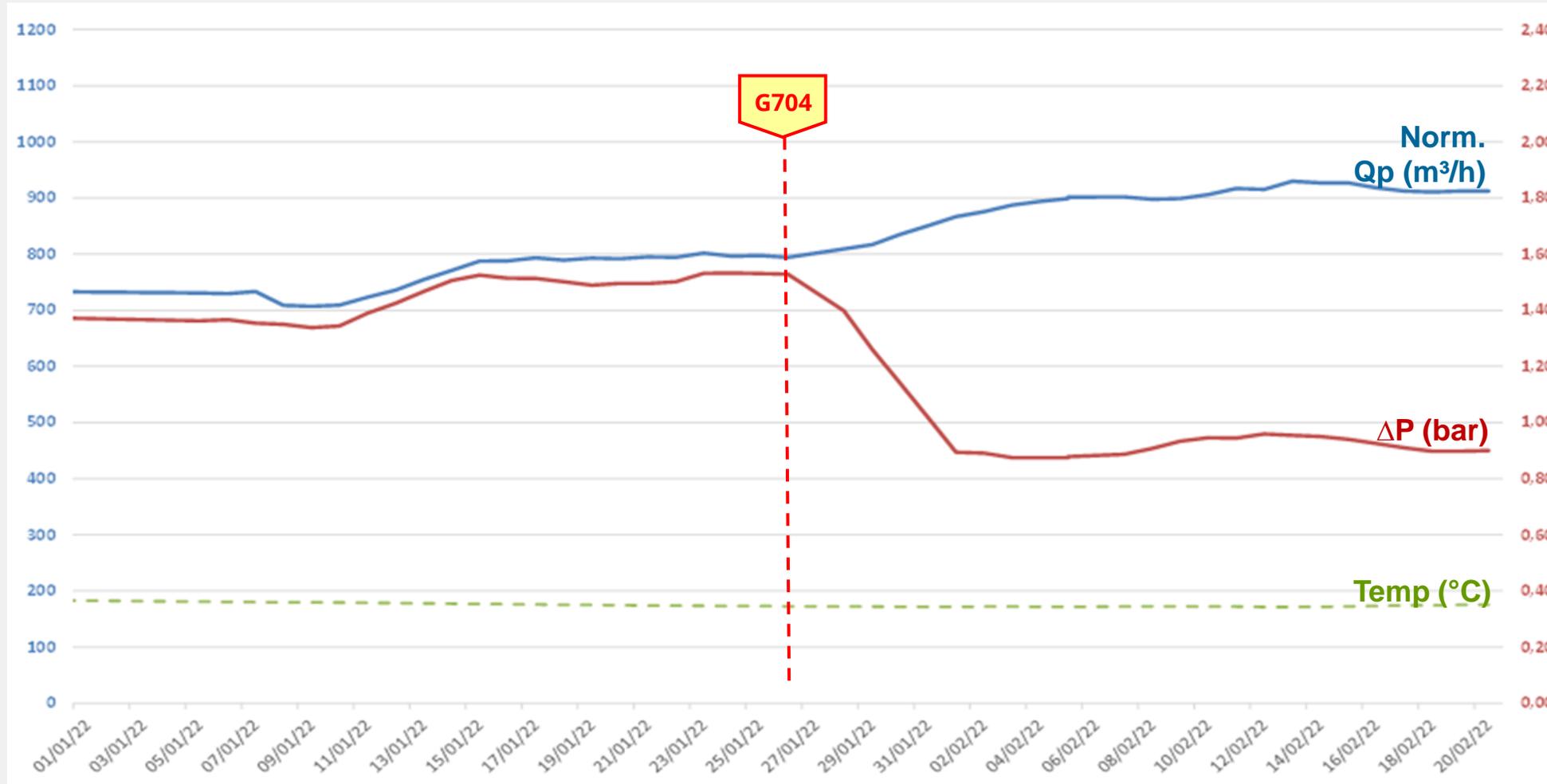


C - SWRO details

Design data	Max output	200 000 m ³ /d
	Recovery	46%
	RO units	10
	Perm. flow per unit	871 m³/h
	PV per train	222
	Membrane type	Hydranautics SWC5-Max
CIP system	Tank capacity	2 x 100 m ³
	Total CIP volume	~185 m ³
	CIP pumps	2 x duty / 1 x standby Q = 1,000 m ³ /h @ 4.1 bars
Main foulants	Organics & aluminosilicates	



C - Genesol 704 CIP results



C09H



C - CIP results (for 1 unit)

	<i>before CIP</i>	<i>after CIP</i>	
Feed Pressure	: 67.0 bar	⇒ 63.0 bar	
Recovery	: 41.7 %	⇒ 41.4 %	
Normalized Perm. flow	: 794 m ³ /h	⇒ 893 m ³ /h	= + 99 m ³ /h i.e. +12.5%
Differential Pressure	: 1.51 bar	⇒ 0.96 bar	= - 0.55 bar i.e. - 36.4%
SEC (per m³ permeate)	: 2.47 kWh	⇒ 2.32 kWh	= - 0.15 kWh i.e. - 6.0%
SAVINGS	: - 575 000 kWh / year		
	⇒ - 19 000 USD / year	or	260 Tons CO ₂ / year
	[0.033 USD / kWh]		[450 g CO ₂ / kWh]



Small BWRO - Belgium

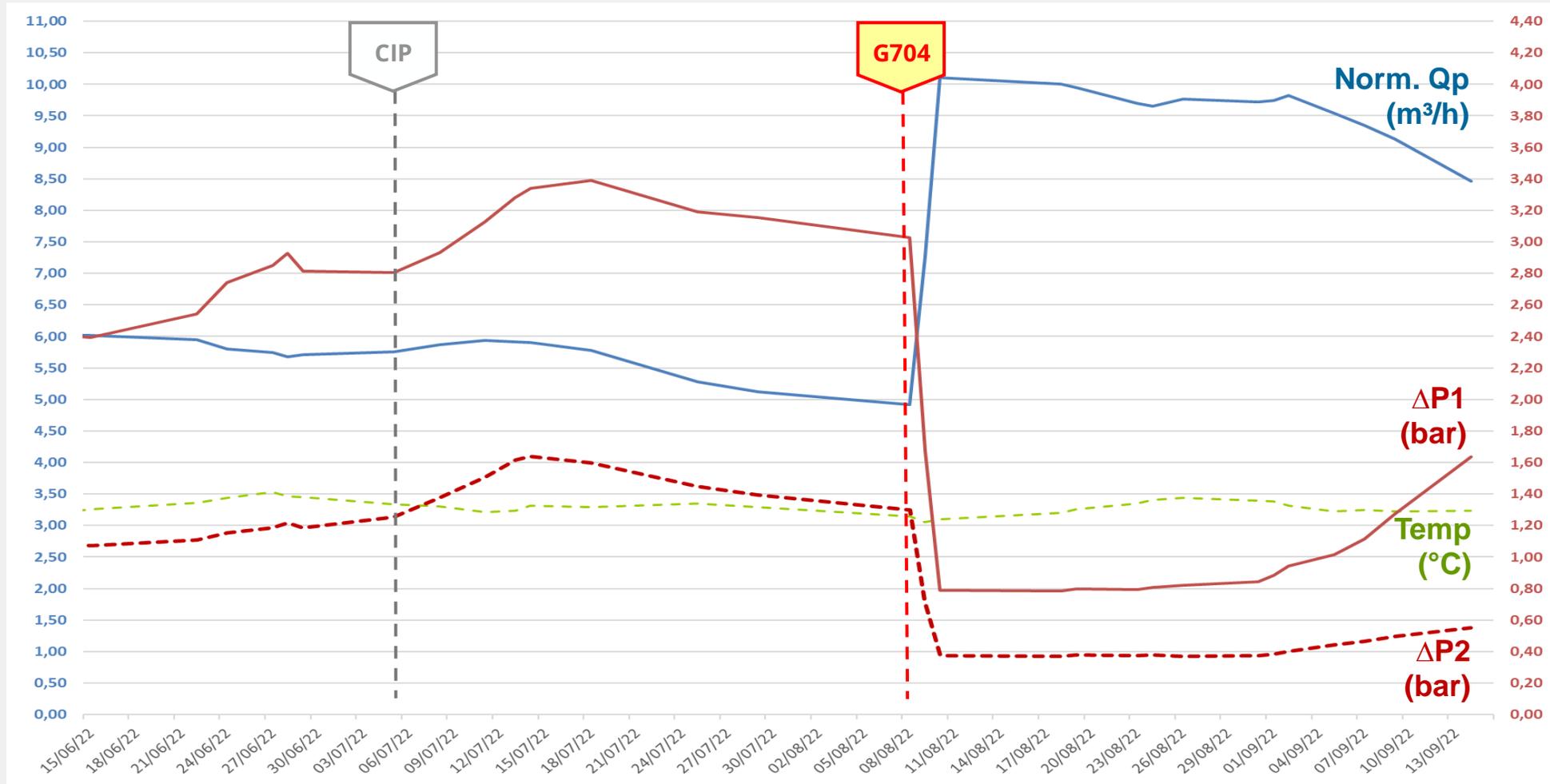


D - BWRO details

Design data	Max output	171 m ³ /d
	Recovery	70%
	RO units	1
	Perm. flow per unit	7.1 m³/h
	PV per train	2 + 2
	Membrane type	-
CIP system	Tank capacity	- m ³
	Total CIP volume	- m ³
	CIP pumps	1 x duty
		Q = - m ³ /h @ 4.0 bars
Main foulants	Biofilm & organics (food tank cleaning facility)	



D - Genesol 704 CIP results



C01B

D - CIP results (for 1 unit)

	<i>before CIP</i>	<i>after CIP</i>	
Feed Pressure	: 8.40 bar	⇒ 6.12 bar	
Recovery	: 70.0 %	⇒ 70.0 %	
Normalized Perm. flow	: 5.82 m ³ /h	⇒ 9.81 m ³ /h	= + 4.0 m ³ /h i.e. +68.6%
Differential Pressure 1	: 3.38 bar	⇒ 0.86 bar	= - 2.52 bar i.e. - 74.6%
Differential Pressure 2	: 1.63 bar	⇒ 0.39 bar	= - 1.24 bar i.e. - 76.1%
SEC (per m³ permeate)	: 0.409 kWh	⇒ 0.298 kWh	= - 0.11 kWh i.e. - 27.1%
SAVINGS	: - 4 767 kWh / year		
	⇒ - 815 USD / year	or 670 kg CO ₂ / year	
	[0.171 USD / kWh]	[140 g CO ₂ / kWh]	



Conclusion

RO : Energy Intensive Process (esp. SW)



Efficient Clean = Energy Savings



**Quantifiable Reduction of
Power & CO₂ Emissions**



Perspective



Algeria Desalination

Current situation

11 large SW desal plants
~2.2 Million m³/d
17% of potable water



45 Tons of Genesol 704 in 2022

Near Future

+ 5 new plants of 300 Km³/d
+ 1.5 Million m³/d (+68%)
42% of potable water



Outlook

Cleaners = Entry Point to new site



**Any SWRO prospect
worth investing our time ?**



EventMobi



h₂O innovation[®]

Piedmont  PWT[™]

WATER COMPANY
OF THE YEAR 2020

