

Graphene Technologies for a Cleaner World

 $G_2O$ 

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# G<sub>2</sub>O - Applying Graphene Filters

- Proven graphene filter
  technology addressing a \$10Bn
  market and reducing energy
  costs by up to 97%.
- Applications include
  - Desalination of seawater
  - Environmental maritime applications in aquaculture and oil & gas production
  - Drain water and waste water management



### The Water Problem

- The world will face a 40% global shortfall between forecast demand and available supply by 2030
- Within the next 15-20 years, the worsening water security situation risks triggering a global food crisis, with shortfalls of up to 30% in cereal production.
- \* 780 million people still have no access to clean drinking water
- \* Desalination is energy intensive and relatively expensive
  - Existing solutions require high pressures and high membrane areas
  - Membrane fouling increases energy costs and decreases lifetime

### The Environmental Problem

In spite of compliance with increasingly strict public regulations, too much harmful fluids and particles are discharged into the environment by:

- \* Transportation: Road traffic in cities, coastal & ocean shipping, etc.
- \* Energy sector: Coal, oil & gas exploration and production
- \* Industries : Chemicals, semiconductors, foods, pulp & paper, etc.

The large environmental industry, in spite of its R&D efforts, is not yet ready with:

- New materials,
- \* Less energy intensive processes,
- Much better membrane & filtration technologies
- \* More efficient processes to reduce effluence

### G<sub>2</sub>O Contribution to a Cleaner World

#### High throughput graphene oxide filter

- Flux and permeate results 100x greater than existing comparative results
- Increases productivity, decreases operational costs
- Resists fouling (paramount in oil/water separation systems)
- \* Can be quickly regenerated without chemicals
- \* Simple to manufacture
- Brings produced water into regulatory compliance
- Allows for greater volumes of reuse water to be utilized
- \* Can be tailored to a wide variety of applications





## Fouling Is No Longer An Issue

![](_page_6_Figure_1.jpeg)

### Desalination with G<sub>2</sub>O filtration

![](_page_7_Figure_1.jpeg)

Energy (kW) required to desalinate 1 m3 of water with RO compared to membrane filtration

#### Water Desalination

#### Flux Comparisons

Membrane	Manufacturer	Pure Water Flux (l/m2/ hr/bar)
SR3D	Koch	0.35
Filmtec NF270	Dow	13.3
DL	GE Osmonics	3.06
$G_2O$	<i>G</i> <sub>2</sub> <i>O</i>	500 (8000 for ultrafiltration)

Brackish water	Seawater
80%	97%

\*Assumes 10 bar pressure required for brackish water, 70 bar for seawater using current RO membranes and 50% energy recovery

## Technology, IP and Partners

- Licensed a patented (pending) graphene membrane technology already developed at a US University
- Successfully scaled from 3cm to 9cm sheets with no performance degradation
- Collaborations initiated with Aquateam, Oslo (3rd party validation), Norwegian Water and the Centre for Process Innovation, Redcar (development partner)

# G<sub>2</sub>O Summary

- Technology validated by publication in high impact peer reviewed academic journals
- Our team has strong relevant background in filtration, engineering, graphene, technology commercialisation and water treatment
- Our graphene membranes have high throughput and easy regeneration simplifying filter designs
- Relationships with end users allows rapid iteration and reduces development risk