Global Clean Water Desalination Alliance

“H_20 minus CO_2”

CONCEPT PAPER

1st December 2015

GLOBAL CLEAN WATER DESALINATION ALLIANCE

Water desalination enables the production of water from different water sources that would otherwise not be fit for human consumption or for use in industrial processes. There are several proven and well established water desalination technologies. These technologies provide water for populations in regions lacking sufficient access to fresh water sources, as well as for industrial activities that rely on clean water. It is estimated that currently there are more than 18,000 desalination plants in operation worldwide, with a maximum production capacity of around 90 million m^3 of water every day (IDA Desalination Yearbook 2015-2016).

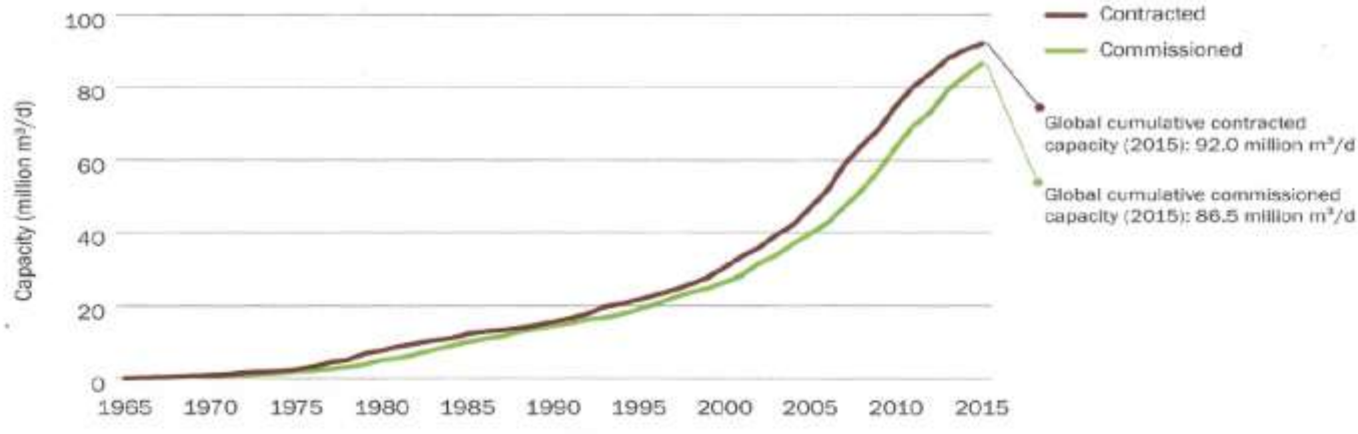


Figure 1 - Global cumulative installed contracted and commissioned desalination capacity, 1965 - 2015 [Source: GWI Desaldata / IDA, 2015]

Water desalination is typically an energy intensive process and largely powered by fossil fuel sources. As a result the CO_2 emissions associated with water desalination are considerable.

It is estimated that the currently installed and operational desalination plants worldwide emit around 76 million tonnes of CO_2 per year (Masdar, 2015).

As access to potable water becomes an increasing issue for a quarter of humanity one can expect an increase of use of desalinisation to satisfy this basic dire need for survival of large parts of the population.

With this trend emissions are expected to grow at least to around 218 million tons of CO_2 per year in 2040 if no actions are undertaken (see Figure 2).

Clean energy is regarded as an alternative energy source for water desalination technologies but is not widely used at this stage. Application of clean energy sources for water desalination can lead to a significant reduction of CO2 emissions, if the actions as stated in this initiative are implemented worldwide. Appendix 1 shows different scenarios of varying targets and the resulting impact on CO_2 emissions.

Several factors explain that use of clean energy has stayed very limited for desalinisation. The upfront cost of research, development and demonstration of improved, new and clean energy powered water desalination technologies can be significant. Furthermore, there is strict regulation on water quality to ensure public health and there are significant barriers to overcome to adopt and implement new technologies. This has led to a relatively slow development and uptake of new technologies and concepts in the desalination industry.

The Global Clean Water Desalination Alliance ("the Alliance") aims to bring together key water desalination and clean energy stakeholders with the goal to reduce the CO_2 emissions of the world's water desalination plants. Collaborative action is essential to overcome the barriers to accelerate development and uptake of more environmentally friendly water desalination technologies. Commitment for change by major stakeholders is essential to trigger tangible change in the sector.

Water desalination belongs at the forefront of today's global water, energy, and climate debate. The Alliance advocates actions to reduce CO_2 emissions stemming from water desalination by:

- Powering new water desalination plants by clean energy sources;
- Replacing fossil fuel based energy sources of existing water desalination plants with clean energy sources;
- Retrofitting existing water desalination plants with more energy efficient technologies; and
- Attracting investments in the water desalination sector for CO_2 emission reduction purposes.

BACKGROUND

Water desalination is an important solution to the shortage of freshwater resources. About 25% of the world's population encounters fresh water scarcity (UN OCHA, 2010). In response to the increasing water demand, desalination has become the most important source of water for drinking and agriculture in some regions, especially the Middle East and North Africa (MENA), and some of the Caribbean Islands, where fresh water is particularly scarce. China, India and a number of industrialized countries, including the US, are now turning towards desalinisation as the solution for additional sources of potable water.

The global water supply is already highly critical, and the Organisation for Economic Co-operation and Development (OECD) considers that, in 2030, 3.9 billon people (47% of the global population) will be subject to water stress (OECD, 2008). To avoid this, more desalination plants will be required, leading to additional CO_2 emissions unless advanced and alternative technology solutions are applied. Such advanced and alternative solutions are already under development and deployment, however only on a small scale. At present pace the desalination production growth rate is already above 10% per year, and higher growth rates are most probable.

Climate change and water stress are interdependent. Climate change is likely to exacerbate regional and global water scarcity considerably. A global warming of 2 °C above present will confront an additional approximate 15% of the global population with a severe decrease in water resources and will increase the number of people living under absolute water scarcity by at least 40% compared with the effect of population growth alone (Schewe et al, 2014).

Opportunities for CO_2 reduction

Increased Energy Efficiency

The desalination of water is an energy intensive process. Increasing the efficiency of this process will reduce its energy consumption and thereby its CO_2 emissions. Water desalination processes require electricity and for certain technologies also heat. New and improved technologies are available that can enhance the energy efficiency of water desalination. Examples are desalination technologies with high recovery rate, low energy reverse osmosis membranes, improved energy recovery devices, highly energy efficient pumps and optimized pretreatment systems.

Retrofitting existing plants with more energy efficient technologies will reduce the energy consumption, and thereby CO_2 emissions. Existing plants can be upgraded in efficiency and capacity, a strategy allowing the utilization of already installed capital intensive infrastructure (e.g. using existing water intakes and outfall) through installing more up to date and energy efficient innovative technologies and equipment. Examples are integrated hybrid thermal-membrane solutions, new solutions to couple wastewater treatment with desalination, use of forward osmosis and membrane distillation for brine treatment to allow higher water recovery. Equipment retrofit options include pumps, electric motors, and energy recovery devices. Furthermore, the practice of replacing faulty components with more energy efficient components instead of identical components can lead to energy savings.

Systems Integration and Demand Response

Systems integration issues are a key challenge that planners and operators of desalination plants must address. A system design that balances the interacting and interdependent requirements of power, water, and grid systems is likely to lead to a more efficient and cost effective design for the integrated system which will help to reduce overall CO_2 emissions.

System integration issues include:

- Demand response capabilities for desalination facilities;

- Integrating on-site energy generation from desalination facilities into electric grid operations;
- Managing for the variability of renewable energy technology generation;
- Use of curtailed renewable electricity generation to power desalination facilities;
- Design and integrated planning of desalination facilities in the context of energy planning.

Demand response capabilities allow a grid-connected desalination plant to respond to critical load situations on the electric grid by temporarily reducing its power consumption. This obviates the grid operator to add supply from peaking power plants, which tends to be very carbon intensive. Desalination plants can also absorb high peak supplies of renewable energy by producing and storing additional potable water using wind or solar energy that would otherwise be curtailed by grid operators. Demand response capabilities are particularly important to smaller, more isolated power grids that often struggle with high degrees of variable sources of renewable power. These isolated locations are often the locations that depend most heavily on desalinization for drinking water supplies.

Clean Energy

Water desalination is powered by electricity and for several technologies also by heat. Both electricity and heat can be supplied by clean energy sources. Electricity can be supplied by photovoltaic systems, wind, hydro, ocean energies, biomass, or geothermal. The required heat is typically of a low to medium temperature (e.g. 80-130 °C), which can be supplied by renewable sources such as solar thermal, geothermal, waste incineration and biomass. Clean energy can also be utilized to upgrade any unutilized low grade heat source that might be available. An example is the upgrading of low temperature heat to more useful higher temperatures by applying heat pumps that run on clean electricity.

One possible approach is to power the water desalination plant entirely with clean energy sources using a dedicated energy delivery infrastructure. This approach is likely to be most suitable for small to medium sized plants in remote locations. Another approach is to locate the water desalination plant and the clean energy plant in different locations, using existing energy transmission infrastructure for the energy delivery. In many cases this approach is likely to be more cost effective than a dedicated energy supply and transmission infrastructure and also allows balancing any supply-demand mismatches that may be present in case of energy supply by variable clean energy sources. Hybrid plants may be a cost-effective interim solution whereby a certain portion of the energy supply of the desalination plant is produced by clean energy sources and the remainder by fossil fuels.

Encouraging the parallel or tied development of new water desalinisation plants with clean energy plants is essential to avoid additional CO_2 emission in the near and long-term future. An example of such an encouragement is to require project developers to include at least one clean energy powered desalination scenario in the technical and financial due diligence.

Although sustainable development is the scope of this Initiative, the means to accomplish it is by cost reductions. The energy cost is the major constituent of the operating cost and inexpensive solar energy, for example, makes desalination increasingly the most affordable option for providing fresh water in arid areas. The PV industry has accomplished phenomenal cost reductions through improving efficiency in the stages of manufacturing and deployment. The prices of photovoltaic electricity have been drastically reduced over the last five years to levels in parity with unsubsidized electricity rates in areas of high solar irradiation in the Middle East and other arid regions that need to expand the capacity of water desalination. Substantial cost reductions have also been achieved in the wind energy industry.

When both the direct costs and those of the fuel subsidies are considered, powering reverse osmosis desalination plants via PV results in significant cost savings. The wholesale cost of electricity from photovoltaics is currently in the range of 6-10 US cents/kWh in areas of high irradiation. Photovoltaic electricity is cost-competitive in the Cooperation Council for the Arab States of the Gulf (GCC) based on direct costs (levelized cost of electricity) and is significantly cheaper than fossil fuel based electricity on full cost accounting for resource (fuel and water) depletion, and environmental impacts.

Research, Development and Demonstration

Research, development and demonstration of water desalination technologies with the potential to achieve CO_2 reductions should be supported to a larger extent. In particular, the testing, demonstration and verification of new or improved technologies should be facilitated more in order to better support the commercialization of CO_2 reducing technologies for water desalination. Research, development and demonstration activities shall also focus on systems integration aspects, especially those of variable clean energy technologies linked with desalination facilities.

The demonstration of novel technologies is of high importance for water desalination. Feed water quality for desalination plants not only differs from location to location but also shows variations over the seasons, and can be altered due to short-term impacts such as higher temperatures, higher salinity and algae blooms. Moreover, with fresh water as a basic requirement for life, results from actual demonstration are vital to ensure public health.

It is expected that increased support to research, development and demonstration will allow innovation to access the market.

Education, Training and Outreach

It is important to disseminate information on carbon dioxide emissions in the desalination sector. Currently, there are no detailed studies available on this topic. Outreach activities shall inform the investors and public decision makers about on-going activities in the desalination sector to increase the sustainability of the industry. Education and professional training programs will guarantee that all players in the desalination industry are aware about the increasingly available options to reduce the carbon dioxide emissions.

Target Setting

The growth of water desalination capacity worldwide and the approaching end-of-life of a significant number of desalination plants in the Middle East imply that targets on a minimum share of clean energy in the energy supply for desalination plants can have both a short- and long-term impact. These targets can be applied to new and retrofitted plants only, a country’s entire water supply infrastructure, or anything in between.

Challenges for CO_2 reduction

Adoption of Advanced Water Desalination Technologies

Water utilities need to pay utmost attention on avoiding any possible health impact of the produced water. Furthermore, like in the power sector, reliability and robustness is of high importance. Unplanned plant shutdowns leading to water shortages are not accepted by end-users and may imply significant financial penalties. This requirement evidently leads to a high degree of risk consciousness of utilities, extending throughout the value chain, including consultants that write specifications for new and retrofitted plants and technology suppliers that are expected to offer extensive guarantees on reliability.

Moreover, utilities typically require a long proven track record of the applied technologies and the responsible suppliers. This results in developers and technology providers responding to their clients with more conservative solutions to make sure the high demand on reliability will be met. Consequently, the adoption of innovative or advanced technology with CO_2 saving potential is slow.

Powering of Water Desalination by Clean Energy

The source and supply of energy for the water desalination process is typically not included in a request to develop a new water desalination plant. This leads to a situation where energy efficiency remains important, but where any technical and commercial implications of powering a water desalination plant with clean energy are not considered. This does not stimulate the development of business models or technical solutions for clean energy powered water desalination. A design that balances the interacting and interdependent requirements of power, water, and grid systems is likely to lead to a more efficient and cost effective designs for the integrated system. Furthermore, in many cases, fossil fuel based energy is heavily subsidized, hampering the application and competitiveness of clean energy sources. By including both the water desalination and clean energy component in a single request to develop a new desalination plant, the developer and the entire value chain are forced to consider the commercial and technical integration of both.

Cost Implications

The competitiveness of clean energy with conventional fossil fuels has recently dramatically improved to levels where the cost of clean energy is on par or in some cases even less expensive than conventional alternatives. If however externalized costs, such as the impacts of CO_2 emissions on the climate, were factored in, the benefits of clean energy would become even more apparent. So far they are not reflected into the cost of water desalination and not necessarily borne by those relying on water desalination.

The incomplete cost of energy used for water desalination processes distorts the development of technology and business models for water desalination. This distortion hampers the development of truly sustainable water desalination business models and technologies that reduce CO_2 emission or can achieve CO_2 neutrality. Enforcing clean energy, energy efficiency and CO_2 reduction targets for desalination plants can internalize the true cost of conventional energy into the cost of water desalination.

OBJECTIVE

The overall objective of the Alliance is to stimulate a reduction of CO_2 emissions from water desalination through committed actions and policies.

In this regard the Alliance calls on governments, industry, non-governmental organizations, utilities and other stakeholders to support efforts towards achieving CO_2 emission reductions in the water desalination sector.

The members of the Alliance pledge to contribute to the following specific actions:

1. **Requirement for clean energy supply**

   Existing desalination plants[1]

   - By 2030: Supply at least 10% of the annual energy demand of existing water desalination plants, which have been operational in 2015, from newly installed clean energy sources.

   Future desalination plants[1]

   - For new desalination plants commencing operation between 2020 and 2025: Supply at least 20% of the annual energy demand from newly installed clean energy sources.
   - For new desalination plants commencing operation between 2026 and 2030: Supply at least 40% of the annual energy demand from newly installed clean energy sources.
   - For new desalination plants commencing operation between 2031 and 2035: Supply at least 60% of the annual energy demand from newly installed clean energy sources.
   - For new desalination plants commencing operation after 2035: Supply at least 80% of the annual energy demand from newly installed clean energy sources.

2. **Incentives of enhanced energy efficiency, system integration and demand response**

   Members joining the Alliance encourage the implementation of financial incentives for owners of existing desalination plants and developers of new plants to reduce the energy intensity, work on system integration issues and introduce demand response measures. Such demand response measures will allow desalination plants to better follow the load on the electric grid and to be better synchronized with the grid. These incentives can unlock benefits such as water desalination plants shedding load during peak times and absorbing load during high renewable energy generation times. There are significant opportunities for the improvement of the overall grid health, rendering the combination of renewable power and water desalination a grid infrastructure advancement opportunity and not just a water desalination technology advancement opportunity.

   Incentives can be tax credits, rebates, special tariff structures, etc.

[1] In all cases, preference shall be given to clean energy plants located as close as possible to the water desalination plant. If this is not viable, a new clean energy plant shall be built elsewhere whereby the produced clean energy shall offset the consumed energy from the desalination plant on an annual basis, but not necessarily at each point in time (e.g. during times when a variable clean energy source is not available). In all grid connected cases, the desalination plant shall pay an electricity tariff reflecting the cost of the newly installed clean energy supply and the use of the transmission and distribution system and also considering the benefits of potential ancillary grid services provided by the desalination plant.

3. **Investment in additional research, development and demonstration (RD&D)**

   Members joining the Alliance commit to put in place from 2017 onwards an additional investment in the amount of USD 100 million per year (all members together) on solutions driven RD&D activities to increase the energy efficiency of desalination technologies and to improve the suitability of desalination processes to be powered by clean energy sources. Each member shall be free to select the amount of committed investment. The investment can be in cash or in kind, e.g. in form of infrastructure, equipment, etc. RD&D activities shall also cover systems integration aspects, including demand response capabilities. In addition, RD&D efforts shall include the development and improvement of off-grid renewable powered desalination systems. The RD&D investment budget and activities shall be managed by one or more internationally reputable research administrators.

   Particular attention shall be paid to fund pilot and demonstration projects validating the reliability and commercial viability of new solutions. This will accelerate the market adoption of advanced desalination technologies and help to overcome the so called "valley of death" between R&D and commercialization. Sponsored pilot and demonstration projects shall be obligated to disseminate the key results and lessons learned of the project.

4. **Investment in education, training and outreach**

   Members joining the Alliance will support the dissemination of information on carbon dioxide emissions in the desalination sector. Currently, there are no detailed studies available on this topic. A detailed inventory analysis shall be undertaken to document the carbon dioxide emissions in the sector.

   Outreach activities shall inform the public about on-going activities in the desalination sector to increase the sustainability of the industry. Education and professional training programs shall guarantee that all players in the desalination industry are aware about the available options to reduce the carbon dioxide emissions.

DESCRIPTION OF THE GLOBAL CLEAN WATER DESALINATION ALLIANCE

The Alliance is an inclusive multi-stakeholder platform that will stimulate actions to reduce CO_2 emissions in water desalination.

The Alliance will formulate and implement its work program taking into consideration and coordinating closely with existing structures, programs and facilities sharing the common objective of promoting the development and deployment of CO_2 emissions reducing solutions for water desalination.

Members

The Alliance seeks to create an inclusive and neutral multi-stakeholder platform that brings together public, industrial, governmental and non-governmental actors that share a common vision of environmentally friendly water desalination with low or no CO_2 emissions and are ready to commit publicly to contribute to or participate in the activities undertaken.

A list of current members that have helped to establish the Alliance is provided in Annex A.

Scope of Activities

Members intend to formulate a work program to be implemented in the following four areas of activities:

1. Platform for dialogue, co-operation and coordination

The Alliance plans to develop a dialogue within its constituency and coordinate the efforts in relevant areas, including, enabling frameworks for investment; financing and risk mitigation schemes; business models for clean energy powered water desalination; research, development and deployment roadmaps; and frameworks for technology demonstrations.

2. Knowledge platform

The Knowledge Platform shall map the water demand and the potential for renewable energy sources to power desalination plants to meet the demand. The platform shall also collect and share information about proven and new desalination and renewable energy technologies enabling cost-effective implementation of renewable energy powered desalination plants. The Knowledge Platform shall be hosted at IRENA.

3. Promotion of enabling mechanisms to reduce CO_2 emissions in desalination

The Alliance plans to work with Members to implement enabling mechanisms to support the development and deployment of solutions that can reduce CO_2 emissions in water desalination. The activities will focus on areas such as:

- Implement support mechanisms allowing a transition toward water desalination plants that emit less CO_2;
- Demonstration, scale-up and/or adaptation of successful technologies, business schemes, financing instruments, and risk mitigation instruments;
- Formulation of national CO_2 emission reduction policies, strategies and targets for water desalination;
- Streamlining of processes for the financial and/or technical integration of clean energy and water desalination.

4. Capacity building

The Alliance plans to facilitate the development of institutional and human capacities in policy, regulation, technology and finance to support the development and deployment of water desalination solutions with low or no CO_2 emissions.

5. Outreach and raising awareness

The Alliance plans to support outreach activities to raise awareness of the problem and possible solutions.

- Organize and conduct joint advocacy events to engage the public and private sector;
- Create and maintain a web-based portal for the sharing and dissemination of information;
- Dissemination of communication materials such as newsletters.

Administrative Aspects

Operational Principles

Neutrality and transparency will be the guiding values, ensuring no particular region, country, technology or scheme gets preferential treatment. The Alliance will act independently from national agendas. It will coordinate its work with existing structures, programs and facilities on the ground to avoid duplication.

Governance

The Alliance will be governed by a Committee formed of representatives of the Alliance constituency. The Committee will meet each year and communicate as often as required. Meetings will review the achievements, status of collaboration, potential activity opportunities and progress in implementing the work program alongside any other relevant issues. Chairmanship of the Committee will be on a rotational basis between Members. The chair will host the Committee and will be responsible for the administrative and logistical arrangements of the meeting. The Committee may decide on the establishment of dedicated working groups.

Secretariat

The secretariat will be hosted in the soon-to-be-launched Abu Dhabi Water Hub which will be a ‘one-stop-shop’ for players in the global water industry and academia interested in solving the most pressing water challenges with Abu Dhabi’s water sector. The overlap and synergies between the Alliance’s and Abu Dhabi Water Hub’s activities and networks will be leveraged to increase the impact of the Alliance’s advocacy and activities. The Alliance plans to work with IRENA especially on international topics.

Communication

The Alliance will communicate through various channels such as email groups, audio and video conferencing, as needed.

Funding

Actions can only be undertaken based on a coalition of in-kind or voluntary funding. Actions can also be organized complementarily by the members clearly identified, individually or in partnership.

REFERENCES

Masdar 2015, *Global CO_2 Emissions of Water Desalination Plants*, Internal Report.

OECD 2008, *OECD Environmental Outlook to 2030*, OECD Publishing, Paris.

Schewe, Jacob et al. 2014 "Multimodel assessment of water scarcity under climate change," *Proceedings of the National Academy of Sciences of the United States of America (PNAS),* vol. 111, no. 9, pp. 3245–3250.

UN OCHA 2010, United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA), Annual Report 2010.

ANNEX A – LIST OF MEMBERS

Members - As of December 1st, 2015 - 69 members

Australia		
1. National Centre of Excellence in Desalination	Neil Palmer	Chief Executive Officer CEO
Belgium		
2. BESIX SA	Ghassan Ejjeh	Senior VP
3. Engie Labs Laborelec	Guy Dreessen	International Sales Director
China		
4. Harbin ROPV Industry Development Center	Li Youqing	Chief Executive Officer CEO
5. Tianjin Institute of Seawater Desalination and Multipurpose Utilization, State Oceanic Administration	Prof. DrRuan Guoling	Chief Engineer, Represents MIAC
6. Tianjin University	prof. ShiChang Wang	Professor
France		
7. Atoll Energy	Elena Barbizet	CEO
8. ENGIE	Raphaël Schoentgen	Excom member - Research & Technologies Director
9. Mascara	Marc VERGNET	President
10. Suez Degrémont	Marc Chevrel	Innovation & Partnerships Director
11. Veolia Middle East	Xavier Joseph	CEO Veolia Middle East
12. Veolia Water	Johnny Obeid	Vice President Middle East
13. Veolia/SIDEM SA	Gérard CANTON,	Deputy General Manager
Germany		
14. Fraunhofer-Institute for Solar Energy Systems ISE	Dr.-Ing. Joachim Koschikowski	Head of Group "Water Treatment and Separation"
15. QiDO Energy Development GmbH	MARTINA DABO	Managing Director, Chief Technology Officer
Greece		
16. Consolidated Contractors Company CCC	Samer S. Khoury	President Engineering & Construction
India		
17. Bhabha Atomic Research Centre (BARC)	PK Teweri	Head, Desalination Division, President of the Indian Desalination Association (InDA)
Indonesia		
18. Suez Supreme Energy Co- Geothermal	Dr.Victor Van der Mast	CEO Chief Executive Officer

Israel			
19.	IDE Technologies	Avshalom Felber	CEO Chief Executive Officer
20.	Technion - Israel Institute of Technology	Professor Raphael Semiat	Dean Of the Wolfson Faculty of Chemical Engineering, President of the Israel Desalination Society (IDS)
21.	Technion-Israel Institute of Technology	Professor/EM David Hasson	GWRI Rabin Desalination Laboratory
Italy			
22.	Fisia Italimpianti S.p.A	Dr Roberto Borsani	Consultant on behalf
23.	TM.P. S.p.A - Termomeccanica Pompe	Edoardo Garibotti	Managing Director
24.	United4Water Consultants LLC	Shannon McCarthy	Partner and Co-Founder
25.	University of Calabria	prof.Enrico Drioli	Professor
Japan			
26.	Retired	Isao Takekoh	Former Director of IDA
27.	Toray Industries Inc.	Dr Masaru Kurihara	President Asia Pacific Desalination Association (APDA), Senior Scientific Director of "Mega-ton Water System", Fellow
28.	Toyobo	Dr. Nobuya Fujiwara	
Korea			
29.	Gwangju Institute of Science & Technology (GIST)	Prof Dr. In S. Kim	School of Environmental Science & Engineering, President of Korean Desalination Plant Association (KDPA).
Pakistan			
30.	Pakistan Desalination Association	Fayyaz Muddassir Mubeen	President of the Pakistan Desalination Association (PakDA) IDA Director
Palai			
31.	Palau Energy Office	Mr Greg Decherong	
Saudi Arabia			
32.	ACWA POWER	Paddy Padmanathan	President & Chief Executive Officer
33.	King Saud University	Prof. Ibrahim S. Al-Mutaz	Chemical Engineering Dept.
34.	Moya Bushnak	Dr Adil Bushnak	Chairman
35.	National Power Company	Dr Fareed AlYagout	President
Singapore			
36.	Hyflux/ Singapore Water Association SWA	Foo Hee Kiang	Advisor to CEO on behalf SWA

37. Nanyang Technological University	Prof Anthony G Fane,	Director Mentor Singapore Membrane Technology Centre
38. Public Utilities Board PUB	Maurice Neo	Deputy Director International/Industry Relations
39. Singapore Water Association	FOO Hee Kiang	Vice-President, General Affairs
Spain		
40. Abengoa	Patxo Bernaola	Technology and innovation director
41. Aqualia Gruppo FCC	Frank Rogalla	Innovation & Technology Manager
42. Dow Chemical Ibérica, S.L. -	Antonio Casañas	Key Account Manager Dow Water & Process Solutions
43. Sacyr Environment USA	Gary Crisp	Director Business Development and IDA Director
The Netherlands		
44. UNESCO-IHE Institute for Water Education	Prof. Maria Kennedy, PhD	Professor of Water Treatment Technology
United Arab Emirates		
45. MASDAR	Ahmad Belhoul	CEO
46. Dubai Electricity and Water Authority	Nasser Lootah	EVP-Generation, (Power&Water)
47. Abu Dhabi Executive Authority	Alham Al Marzouqi	
48. First Solar	Dr Raed Ahmad Bkayrat	VP of Business Development for Saudi Arabia and ME
49. Future Pipe Industries	Mounib Hatab	Regional Vice President, Sales and Marketing – GCC
50. ILF Consulting Engineers	Dr. Corrado Sommariva	Managing Director Generation Middle East
51. Metito Overseas Ltd	Fady Juez	Managing Director
United Kingdom		
52. Genesys International Limited	Ursula Annunizata	Director, President European Desalinatiom Sociaty
53. Heriot-Watt University	Prof. Gareth Pender	Chair Institute for Infrastructure and Environment
54. Swansea University	Professor Nidal Hilal	Director, Centre for Water Advanced Technologies and Environmental Research (CWATER)
United States of America		
55. AMTA	Greg Wetterau	Vice President

56.	Avista Technologies, Inc	Doug Eisberg	Director of Business Development
57.	Columbia University	Prof. Vasilis Fthenakis	Director, Center for Life Cycle Analysis Earth and Environmental Engineering
58.	Desalitech	Nadav Efraty	CEO Chief Executive Officer
59.	Energy Recovery Inc (ERI).	Juan Miguel Pinto	Sales Manager, Desalination Americas, Director ALADYR - Asociación Latinoamericana de Desalación y Reuso del Agua
60.	H2OProfessionals	Shawn Meyer-Steele	Managing Director and Director Caribbean Desalination Association
61.	IDA Desalination Academy, Leading Edge Technology	Leon Awerbuch	Dean, President& Chief Technology Officer
62.	IDA Energy & Environment Committee, Desalitech	Dr Rick Stover	Chairman, Executive VP of Desalitech
63.	International Desalination Association	Patricia Burke	Secretary General
64.	Liberation Capital LLC	Earl H Jones	Partner
65.	MASSACHUSETTS INSTITUTE OF TECHNOLOGY	Professor John H. Lienhard V	Director, Center for Clean Water and Clean Energy at MIT and KFUPM, Director Abdul Latif Jameel World Water and Food Security Lab.
66.	New England Water Innovation Network	Earl Jones	Managing Partner
67.	The Renewables 100 Policy Institute	Angelina Galiteva	Founding Board Chair
68.	University of Pensylvania	Professor Noam Lior	Professor and Past Chief Editor ENERGY ¬ The International Journal , and Advances in Water Desalination
69.	Water Globe Consulting, LLC	Nikolay Voutchov	President

ANNEX B – GLOBAL CLEAN WATER DESALINATION ALLIANCE JOINT STATEMENT DURING COP21, DECEMBER 2015

On the occasion of the 2015 United Nations Climate Change Conference COP21, we, [TBD], together with [TBD]:

- Note that water desalination is typically an energy intensive process and largely powered by fossil fuel sources. As a result the CO_2 emissions associated with water desalination are considerable. It is estimated that the currently installed and operational desalination plants worldwide emit around 76 million tonnes of CO_2 per year. The emissions are expected to grow to around 218 million tons of CO_2 per year in 2040, if no actions are undertaken.
- Clean energy is regarded as an alternative energy source for water desalination technologies but is not widely used. Application of clean energy sources for water desalination can lead to a reduction of 83 million tonnes of CO_2 per year in 2040, if the actions as stated in this initiative are implemented worldwide.
- Recognize that the adoption of CO_2 emission reducing or clean energy powered water desalination technologies is hampered by the lack of a holistic and integrated approach on water desalination using clean energies, insufficient support mechanisms enabling the adaption of cleaner desalination technologies, and incomplete accounting of external costs of energy in the cost of desalinated water. This presents a significant challenge in the development and deployment of water desalination solutions that can reduce or avoid CO_2 emissions.
- Understand that the Global Clean Water Desalination Alliance offers a partnership platform among [TBD] to promote the development and deployment of advanced water desalination solutions that can lead to significant reductions in CO_2 emissions.

Therefore, we, the members of the Global Clean Water Desalination Alliance, announce the launch of the Global Clean Water Desalination Alliance to serve as a platform for dialogue and knowledge-sharing among its members and other stakeholders as well as a coalition for action to accelerate the worldwide development and deployment of water desalination solutions that can reduce or avoid CO_2 emissions.

Members of the Global Clean Water Desalination Alliance: [TBD]

ACTION PLAN

The Challenge

Water desalination is typically an energy intensive process and largely powered by fossil fuel sources. As a result the CO_2 emissions associated with water desalination are considerable. Clean energy is regarded as an alternative energy source for water desalination technologies but is not widely used.

The upfront cost of research, development and demonstration of improved, new and clean energy powered water desalination technologies can be significant. Furthermore, there is strict regulation on water quality to ensure public health and there are significant barriers to overcome to adopt and implement new technologies. This has led to a relatively slow development and uptake of new technologies and concepts in the desalination industry.

The Response

The Global Clean Water Desalination Alliance offers a platform for effective communication among key stakeholders with a view to help to identify opportunities and to advocate for support mechanisms to foster the transition to a less carbon intensive desalination industry. The Alliance will bring together stakeholders in water desalination including governments, financing institutions, industry, non-governmental organizations and research organizations to co-operate on the transition to a cleaner water desalination industry, focusing on areas such as: coordination of industry and research activities, promotion of enabling mechanisms to reduce CO_2 emissions in desalination, capacity building and outreach.

The Commitment to Action

Water desalination is a vital solution in many parts of the world to ensure water supply for human consumption and industries. We the members of the Global Clean Water Desalination Alliance undertake to support this coalition for action, the Global Clean Water Desalination Alliance, and to develop its detailed work plan by April 2016 to ensure a rapid reduction in the CO_2 emissions from the water desalination industry.

We the members of the Global Clean Water Desalination Alliance pledge to contribute to global actions to reduce CO_2 emissions through the following specific actions:

1. **Requirement for clean energy supply**

   Existing desalination plants[2]

   - By 2030: Supply at least 10% of the annual energy demand of existing water desalination plants, which have been operational in 2015, from newly installed clean energy sources.

   Future desalination plants[2]

   - For new desalination plants commencing operation between 2020 and 2025: Supply at least 20% of the annual energy demand from newly installed clean energy sources.
   - For new desalination plants commencing operation between 2026 and 2030: Supply at least 40% of the annual energy demand from newly installed clean energy sources.
   - For new desalination plants commencing operation between 2031 and 2035: Supply at least 60% of the annual energy demand from newly installed clean energy sources.
   - For new desalination plants commencing operation after 2035: Supply at least 80% of the annual energy demand from newly installed clean energy sources.

2. **Incentives of enhanced energy efficiency, system integration and demand response**

   Members joining the Alliance encourage the implementation of financial incentives for owners of existing desalination plants and developers of new plants to reduce the energy intensity, work on system integration issues and introduce demand response measures. Such demand response measures will allow desalination plants to better follow the load on the electric grid and to be better synchronized with the grid. These incentives can unlock benefits such as water desalination plants shedding load during peak times and absorbing load during high renewable energy generation times. There are significant opportunities for the improvement of the overall grid health, rendering the combination of renewable power and water desalination a grid

[2] In all cases, preference shall be given to clean energy plants located as close as possible to the water desalination plant. If this is not viable, a new clean energy plant shall be built elsewhere whereby the produced clean energy shall offset the consumed energy from the desalination plant on an annual basis, but not necessarily at each point in time (e.g. during times when a variable clean energy source is not available). In all grid connected cases, the desalination plant shall pay an electricity tariff reflecting the cost of the newly installed clean energy supply and the use of the transmission and distribution system and also considering the benefits of potential ancillary grid services provided by the desalination plant.

infrastructure advancement opportunity and not just a water desalination technology advancement opportunity.

Incentives can be tax credits, rebates, special tariff structures, etc.

3. Investment in additional research, development and demonstration (RD&D)

Members joining the Alliance commit to put in place from 2017 onwards an additional investment in the amount of USD 100 million per year (all members together) on solutions driven RD&D activities to increase the energy efficiency of desalination technologies and to improve the suitability of desalination processes to be powered by clean energy sources. Each member shall be free to select the amount of committed investment. The investment can be in cash or in kind, e.g. in form of infrastructure, equipment, etc. RD&D activities shall also cover systems integration aspects, including demand response capabilities. In addition, RD&D efforts shall include the development and improvement of off-grid renewable powered desalination systems. The RD&D investment budget and activities shall be managed by one or more internationally reputable research administrators.

Particular attention shall be paid to fund pilot and demonstration projects validating the reliability and commercial viability of new solutions. This will accelerate the market adoption of advanced desalination technologies and help to overcome the so called “valley of death" between R&D and commercialization. Sponsored pilot and demonstration projects shall be obligated to disseminate the key results and lessons learned of the project.

4. Investment in education, training and outreach

Members joining the Alliance will support the dissemination of information on carbon dioxide emissions in the desalination sector. Currently, there are no detailed studies available on this topic. A detailed inventory analysis shall be undertaken to document the carbon dioxide emissions in the sector.

Outreach activities shall inform the public about on-going activities in the desalination sector to increase the sustainability of the industry. Education and professional training programs shall guarantee that all players in the desalination industry are aware about the available options to reduce the carbon dioxide emissions.

Appendix 1

Analysis of Different Scenarios With Respect to Desalination Growth Rates and Clean Energy Targets

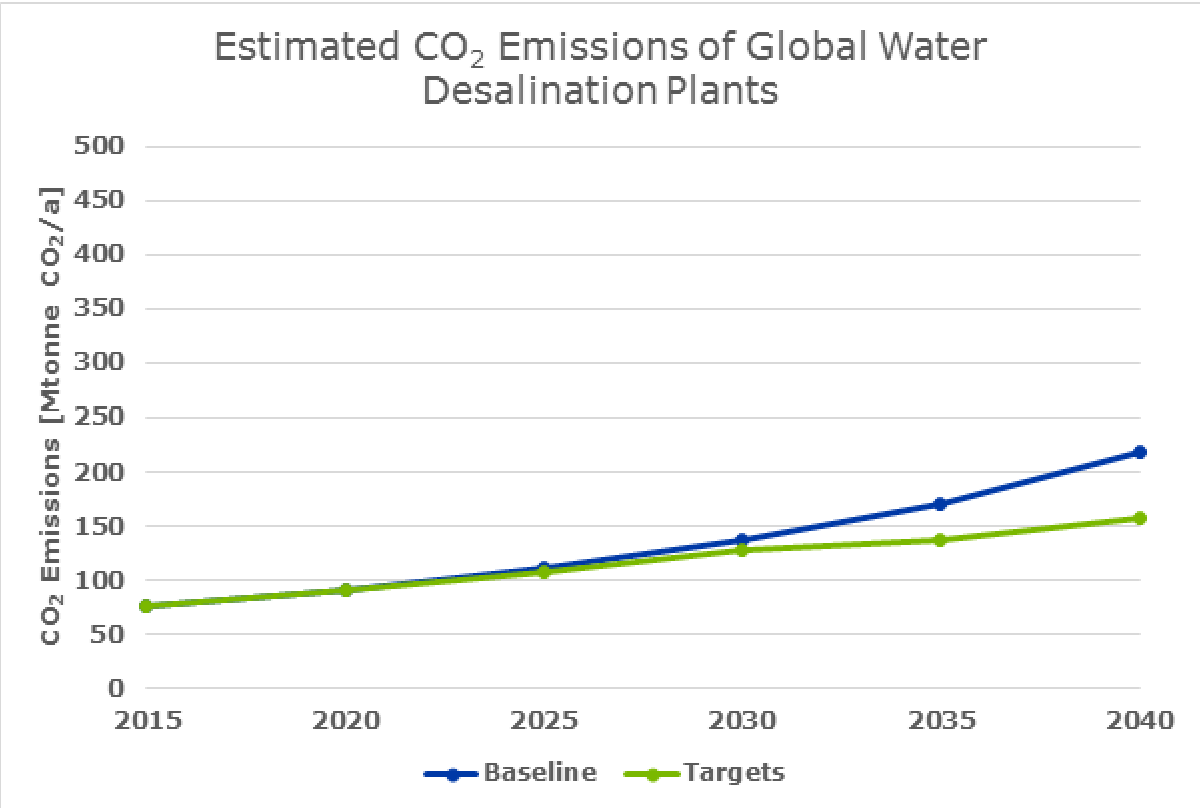
The methodology used to create the scenario analysis is described in Masdar (2015).

SCENARIO 1A (MODERATE TARGETS, BUSINESS-AS-USUAL GROWTH RATE)

Clean energy targets for water desalination plants commencing operation (new plants) or already in operation (existing plants) in the following timeframes.

	2020-2025	2026-2030	2031-2035	2036-2040
Targets NEW PLANTS	10%	30%	50%	70%
Targets EXISTING PLANTS	0%	0%	10%	10%

Assumed compounded growth rate of water desalination of 6.1% per year

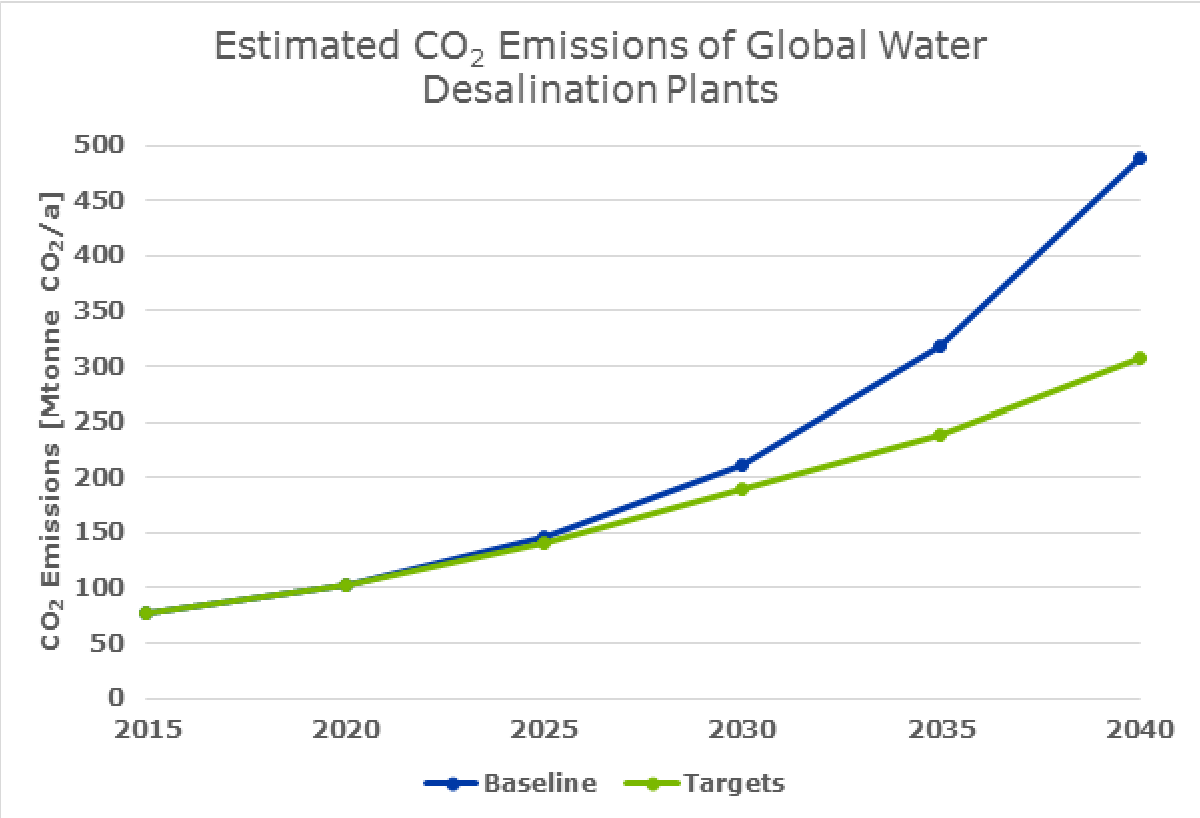


SCENARIO 1B (MODERATE TARGETS, HIGH GROWTH RATE)

Clean energy targets for water desalination plants commencing operation (new plants) or already in operation (existing plants) in the following timeframes.

	2020-2025	2026-2030	2031-2035	2036-2040
Targets NEW PLANTS	10%	30%	50%	70%
Targets EXISTING PLANTS	0%	0%	10%	10%

Assumed compounded growth rate of water desalination of 10 % per year

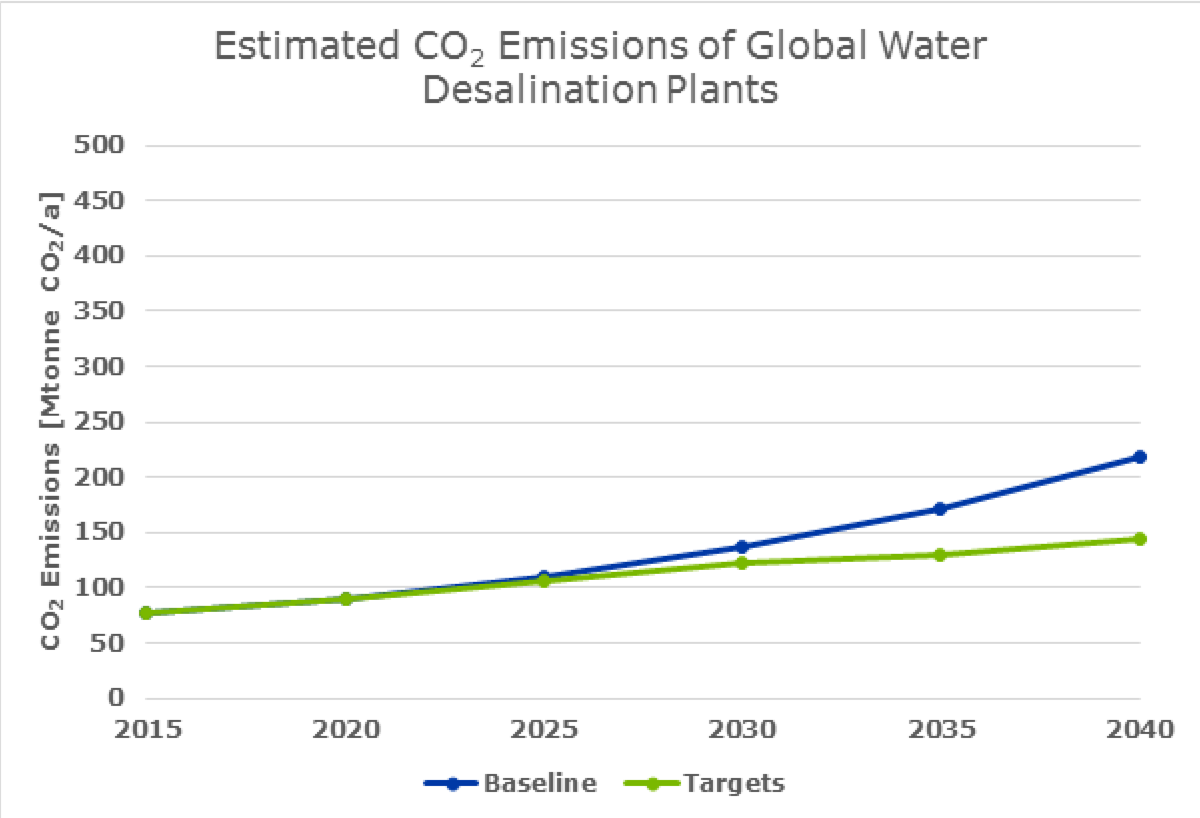


SCENARIO 2A (BALANCED TARGETS, BUSINESS-AS-USUAL GROWTH RATE)

Clean energy targets for water desalination plants commencing operation (new plants) or already in operation (existing plants) in the following timeframes.

	2020-2025	2026-2030	2031-2035	2036-2040
Targets NEW PLANTS	20%	40%	60%	80%
Targets EXISTING PLANTS	0%	0%	10%	10%

Assumed compounded growth rate of water desalination of 6.1% per year

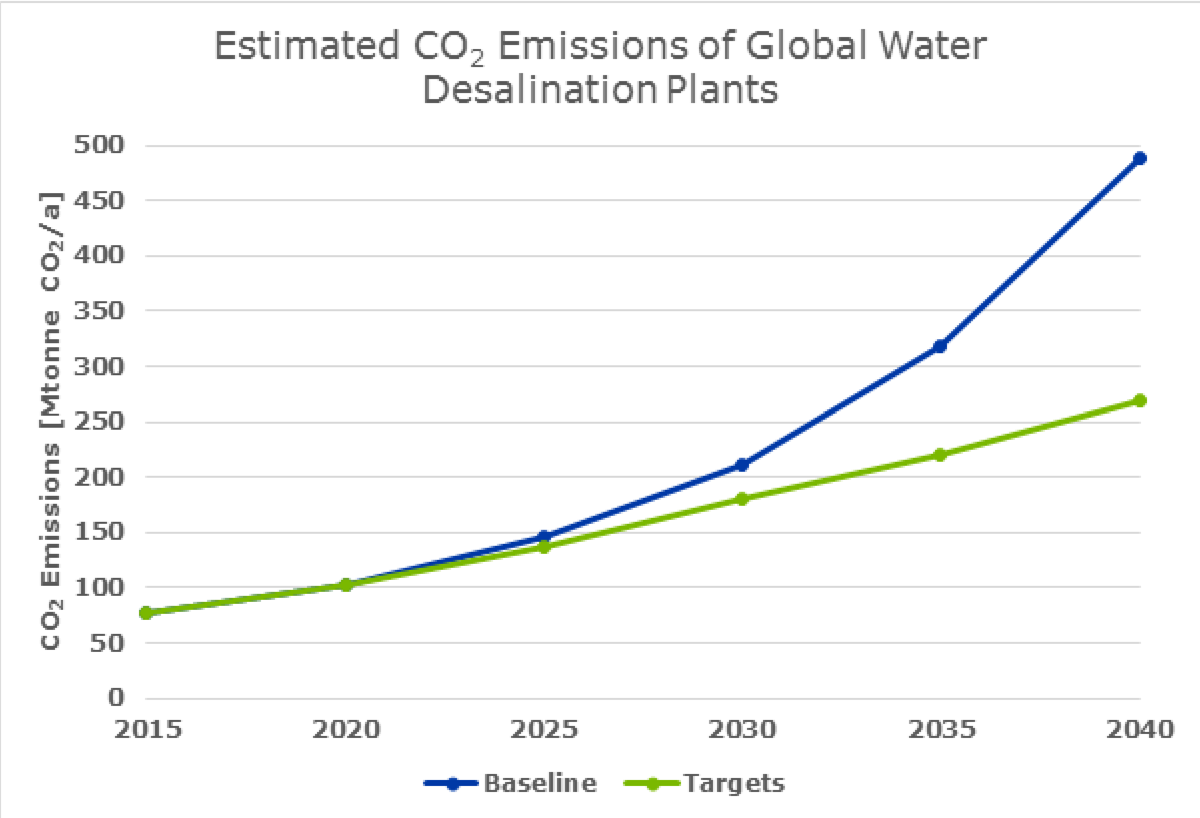


SCENARIO 2B (BALANCED TARGETS, HIGH GROWTH RATE)

Clean energy targets for water desalination plants commencing operation (new plants) or already in operation (existing plants) in the following timeframes.

	2020-2025	2026-2030	2031-2035	2036-2040
Targets NEW PLANTS	20%	40%	60%	80%
Targets EXISTING PLANTS	0%	0%	10%	10%

Assumed compounded growth rate of water desalination of 10% per year

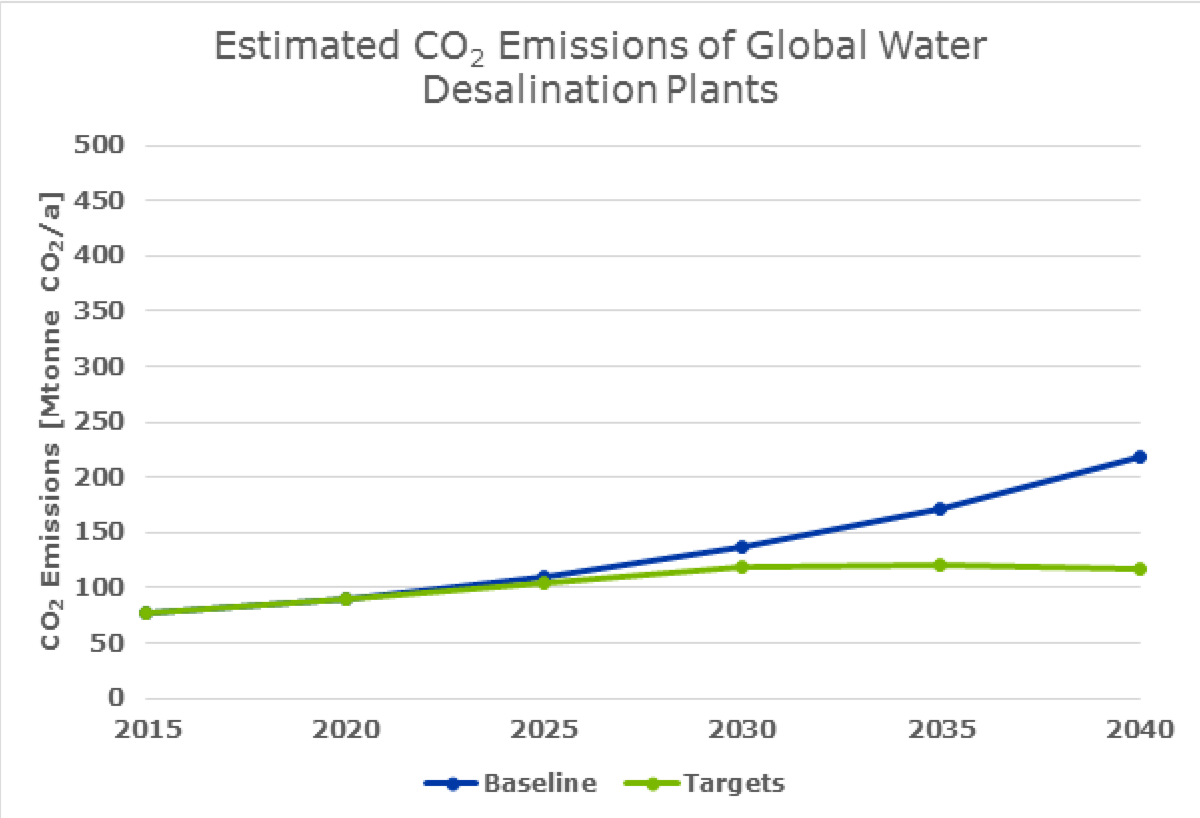


SCENARIO 3A (AMBITIOUS TARGETS, BUSINESS-AS-USUAL GROWTH RATE)

Clean energy targets for water desalination plants commencing operation (new plants) or already in operation (existing plants) in the following timeframes.

	2020-2025	2026-2030	2031-2035	2036-2040
Targets NEW PLANTS	25%	50%	75%	100%
Targets EXISTING PLANTS	0%	0%	10%	10%

Assumed compounded growth rate of water desalination of 6.1% per year



SCENARIO 3B (AMBITIOUS TARGETS, HIGH GROWTH RATE)

Clean energy targets for water desalination plants commencing operation (new plants) or already in operation (existing plants) in the following timeframes.

	2020-2025	2026-2030	2031-2035	2036-2040
Targets NEW PLANTS	25%	50%	75%	100%
Targets EXISTING PLANTS	0%	0%	10%	10%

Assumed compounded growth rate of water desalination of 10% per year