OPPORTUNITY 15

SCOPE TRANSITIONAL

UNCERTAINTIES

Technology, Nature

MEGATRENDS

Materials Revolution

TRENDS

Biomaterials
Food-water-energy nexus
Mobilising Innovation
Nanotechnology

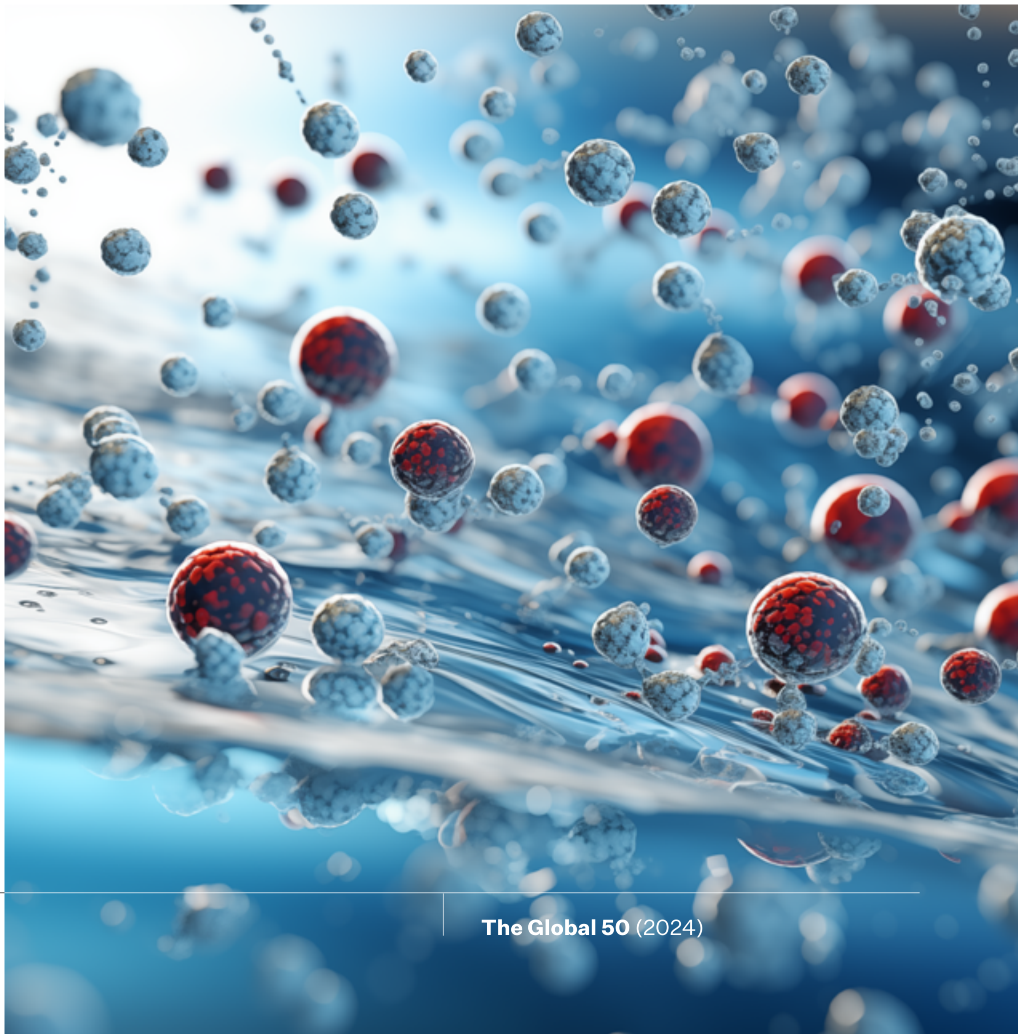
SECTORS IMPACTED

Agriculture & Food
Automotive, Aerospace & Aviation
Chemicals & Petrochemicals
Consumer Goods, Services & Retail
Energy, Oil, Gas & Renewables
Government Services
Health & Healthcare
Infrastructure & Construction
Materials & Biotechnology
Metals & Mining
Utilities

What if carbon nanomaterials ensured global access to clean water?

CARBON FOR WATER

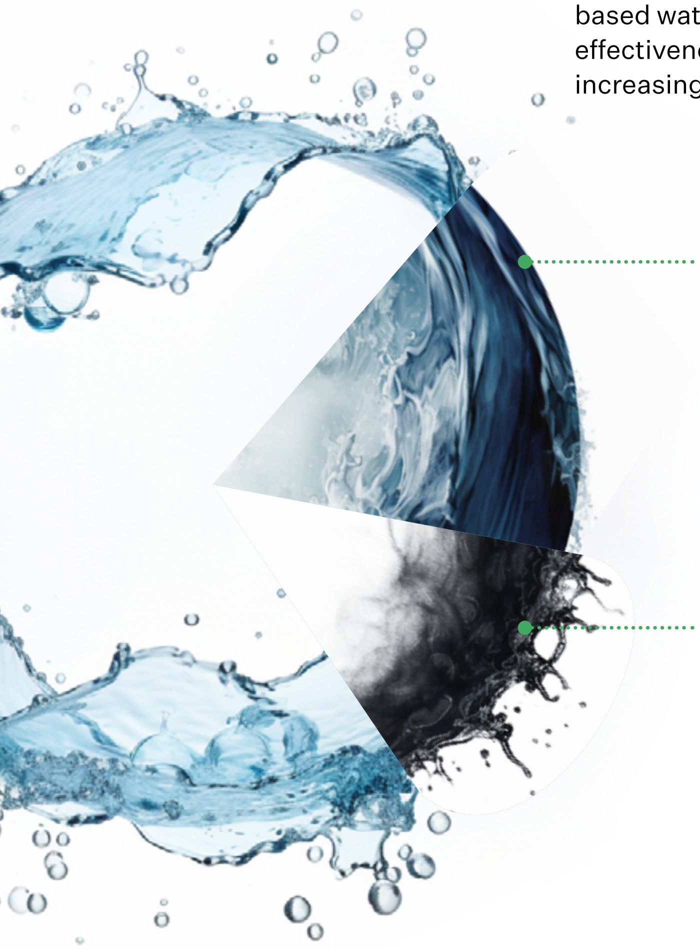
Carbon-based nanomaterials transform global access to potable water through their ability to effectively remove pollutants at the nanometre scale, in both small and large volumes, allowing for point-of-use applications and larger scale operations, reducing the cost and environmental impact of desalination processes.



WHY IT MATTERS TODAY

In 2020, 74% of the world's population had access to safe drinking water compared with 62% twenty years earlier.[429] But water scarcity continues to be a global challenge.[430] In 2021, 2.3 billion people lived in water-stressed countries,[431] and, in 2022, over 1.7 billion drank from contaminated water sources.[432] Just over half a million people die each year from diarrhoea as a result of unsafe drinking water, sanitation, and hand hygiene.[433] As demands grow for clean, safe water, the global market for water purification is forecast to rise from $30.62 billion in 2022 to $54.48 billion by 2030, with a CAGR of 7.6%.[434]

Almost 50% of educational institutions in sub-Saharan Africa and one in every four healthcare facilities worldwide are without basic water services.[435] In medium- to low-income nations, efforts to enhance clean water access face hurdles because of recontamination occurring between the point of collection and where it is used.[436] As a result, point-of-use or home water treatment technologies, which purify drinking water at the household level before consumption, address contamination risks both at the source and during transportation.[437] However, membrane-based water filtration and chlorine disinfectants are being used whose effectiveness is subject of debate because of toxic by-products and increasing pathogen resistance.[438]



2.3 billion people

lived in water-stressed countries in 2021

1.7 billion people

drank from contaminated water sources in 2022

1 in 2

of educational institutions in sub-Saharan Africa

and

1 in 4

healthcare facilities worldwide are without basic water services

OPPORTUNITY

Carbon-based nanomaterials transform access to potable water worldwide as they function at the scale of 1:100 nanometres (i.e. one billionth of a metre), making them effective at selectively capturing and removing heavy metals, organic compounds, and other pollutants.[439] From carbon nanotubes and graphene to carbon quantum dots and fullerenes, carbon-based nanomaterials hold particular promise in water filtration[440] and desalination, as they reduce the cost and environmental impact of desalination processes today.[441]

While carbon-based materials have been used for wastewater treatment,[442] they have not been scalable for water purification because of concerns regarding toxicity and environmental impacts.[443] At nanometre scale and with advances in materials science, advanced machine intelligence and computational modelling simulate and study the effect of physical and chemical particle characteristics[444] on toxicity patterns and recyclability.[445]

BENEFITS

In previously water-stressed regions, abundant clean water resources greatly enhance health, rejuvenate economies, and prevent disease. Reduce the cost and environmental impacts of desalination processes.

RISKS

Unintended consequences arise from incomplete knowledge about toxicity and the impact on human health and the environment. Damaged carbon nanomaterial filters or processes can cause nanotubes or nanofibres to pollute water supplies, leading to adverse health outcomes and lack of water purification.

The global market for water purification is forecast to rise to

$50.66 Billion

by 2029

$30.62 Billion

in 2022