



What if algae-powered air purification made indoor air cleaner and healthier?

06

Alg-Air Purifier

UNCERTAINTIES

Nature, Technology

MEGATREND (Most significant)

Evolving Ecosystems

TRENDS

Biomaterials
Carbon Capture & Storage
Tackling Air Pollution

TECHNOLOGIES

Biotechnology
Climate Tech
Internet of Things (IoT)

SECTORS IMPACTED

Agriculture & Food
Chemicals & Petrochemicals
Health & Healthcare
Infrastructure & Construction
Materials & Biotechnology
Real Estate

KEYWORDS

Algal Photobioreactors
Indoor Air Quality
Sustainable Architecture
Urban Design
Urban Pollution

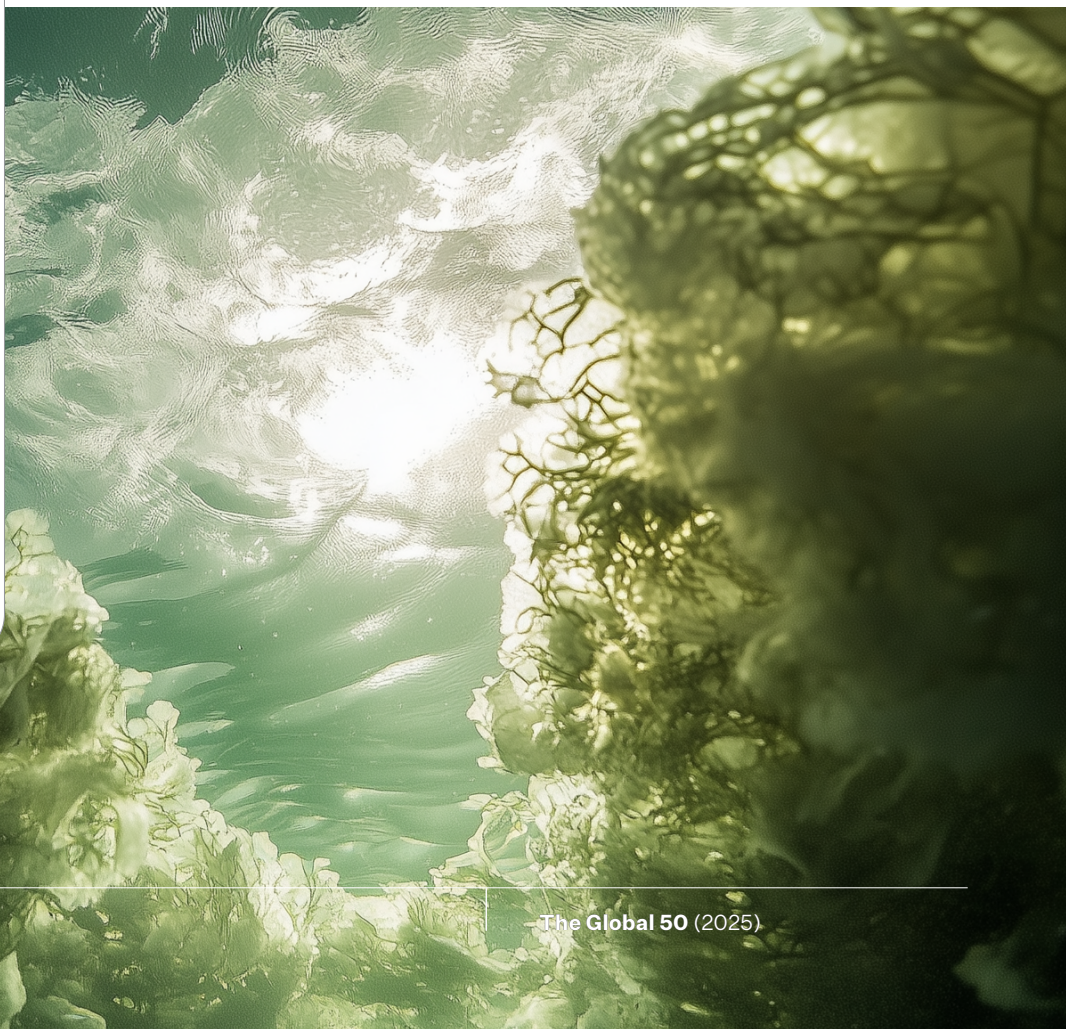
Within Reach

Transitional

Visionary

As we spend more of our lives indoors,^k powered by the Sun's rays or LED lighting, algal bioreactors regulate and purify indoor air, removing microorganisms and reducing respiratory issues.

^k The scenario presented here is one of many possible futures and does not advocate for the elimination of outdoor experiences or discount the value of experiences in nature.





We spend

90%

of our time indoors, where the **levels of pollutants** can be up to

5x

higher than outdoors



WHY IT MATTERS TODAY

Indoor air quality has become increasingly important as green spaces are not always available or accessible, particularly in urban areas, and as activities increasingly take place indoors. In high-income countries, people spend up to 90% of their time indoors,⁵⁶⁸ where the levels of pollutants can be up to five times higher than outdoors.⁵⁶⁹ Rising temperatures, humidity and rainfall due to global warming are expected to increase fungal (e.g. mould) and bacterial growth,⁵⁷⁰ with inadequate ventilation and poor maintenance making the problem worse.⁵⁷¹ In addition, rising indoor temperatures increase pollutant emissions from building materials themselves.⁵⁷²

Poor indoor air quality can negatively impact physical health, cognitive performance, and productivity. Indoor pollution can trigger various health concerns, from asthma⁵⁷³ to heart disease and cancer.⁵⁷⁴ Research published in 2020 shows that reducing carbon dioxide (CO₂) inside classrooms by more than half can lead to students working faster (12%) and learning better (5%).⁵⁷⁵

Various regulatory frameworks and green building certification programmes, such as LEED (Leadership in Energy and Environmental Design) and BREEAM (Building Research Establishment Environmental Assessment Method) set out robust standards for indoor air quality.⁵⁷⁶ In addition, the World Health Organization has guidelines for indoor air quality,⁵⁷⁷ Sustainable Development Goal Indicator 7.1.2 calls for reliance on clean fuel,⁵⁷⁸ and the American Lung Association is one example of an organisation that is running a campaign to improve indoor air quality.⁵⁷⁹ The National Air Quality Agenda 2031 in the United Arab Emirates provides a framework for the government and private sector to improve air quality.⁵⁸⁰



THE OPPORTUNITY



BENEFITS

Better indoor air quality; fewer respiratory issues; nature-based solution; sustainable solution that meets indoor green building certification requirements.



RISKS

Inadequate conditions (light, temperature and nutrient management) to ensure optimal algal growth; improper maintenance leading to suboptimal performance; algal contamination and biological hazards; potential toxicity and pathogenic infection.

Algal bioreactors work through algae's ability to absorb CO₂ and other pollutants through photosynthesis.⁵⁸¹ Integrated algal systems could reduce levels of CO₂ by 13% in 200-person buildings, capturing 16 kg of CO₂ daily.⁵⁸² Integrated into architectural elements, such as façades, artificial trees, and amenities,⁵⁸³ a distributed network of algal air purifiers can be adapted and scaled to meet specific building and urban city needs.⁵⁸⁴ These living façades create dynamic exteriors and healthier indoor environments.⁵⁸⁵

Powered by the Sun's rays or LED lighting for optimal algal growth,⁵⁸⁶ these systems are self-sustaining and environmentally friendly. Through urban-wide analytics and monitoring in smart cities, high-pollution areas can be identified and provided with algal bioreactor units. Units can also be installed as part of building HVAC (heating, ventilation and air conditioning) systems to absorb pollutants and provide clean air indoors.⁵⁸⁷



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