

GREENING FERTILIZER

Building a path to sustainable agriculture

The third agricultural revolution of the mid 1900s paved the way for tremendous increases in agricultural productivity throughout the world, but these practices are not sustainable. The chemical fertilizers that fueled widespread growth are manufactured from non-renewable resources and their production has a high carbon footprint, exacerbating climate change. Yet without ready access to fertilizer, many countries will have a hard time meeting the growing demand for food, especially in the developing world.

Is there a path to more sustainable agricultural practices, starting with greener approaches to fertilizer? Promising innovations are clearing the way.

Dig deeper and find a comprehensive reference list by reading "Sustainable agriculture: Innovations in fertilizer production" at cas.org/sustainable-ag-report

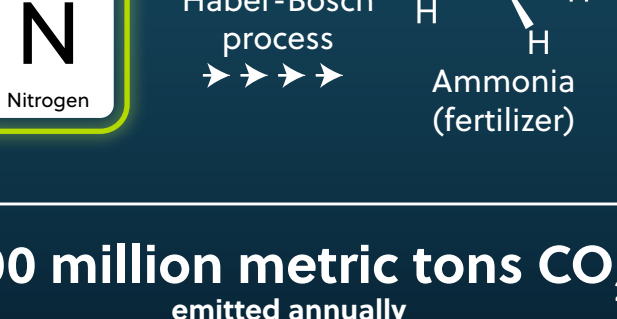


MAJOR NUTRIENTS IN FERTILIZERS

SYNTHETIC FERTILIZERS ARE NOT ECO-FRIENDLY

- Nitrogen**
Extracted from atmosphere
- Phosphorus**
Mined from rock
- Potassium**
Mined from potash ore

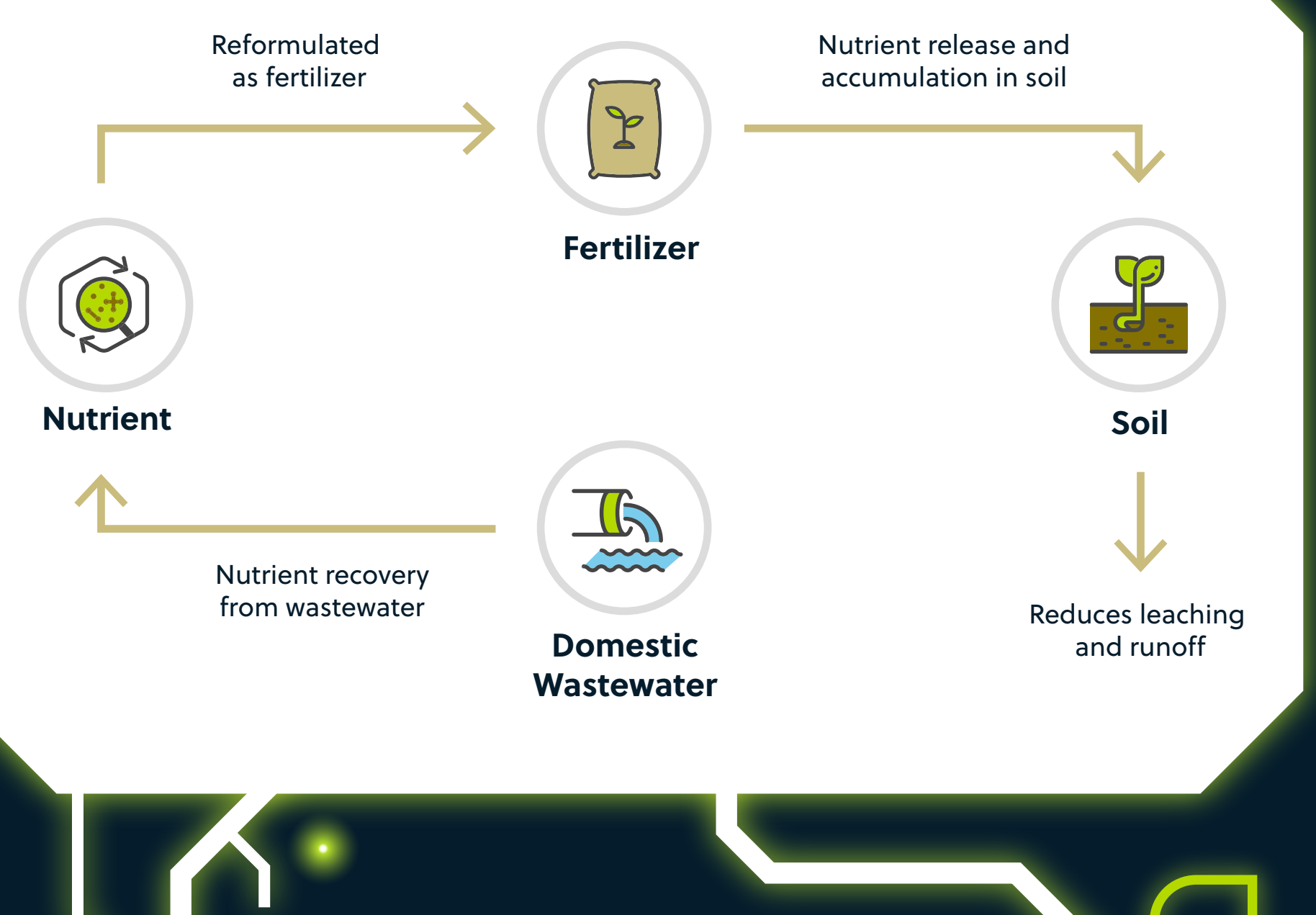
AMMONIA PRODUCTION IS CARBON-INTENSIVE



500 million metric tons CO₂ emitted annually

ORGANIC FERTILIZERS ALSO HAVE CHALLENGES

- Alfalfa meal
 - Manure
 - Wood ash
 - Fish meal
 - Wastewater/sewage
 - Blood meal
- Expensive to**
- Treat
 - Transport
 - Dispose



PROMISING TECHNOLOGIES IMPROVE NUTRIENT RECOVERY FROM WASTE

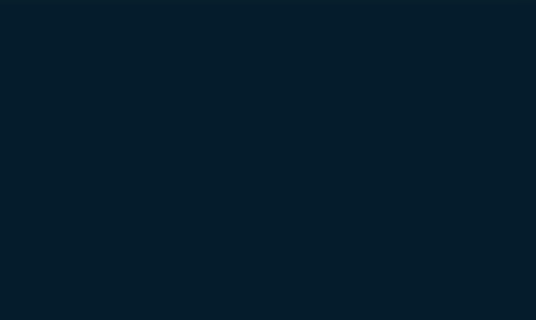
ECO-FRIENDLY

- Composting
- Composting with biochar
- Anaerobic digestion
- Vermicomposting
- Pyrolysis with green energy

SMART NANO-FERTILIZERS

- Nanotechnology
- Controlled nutrient release
- Degradable delivery systems

BIOREFINERIES



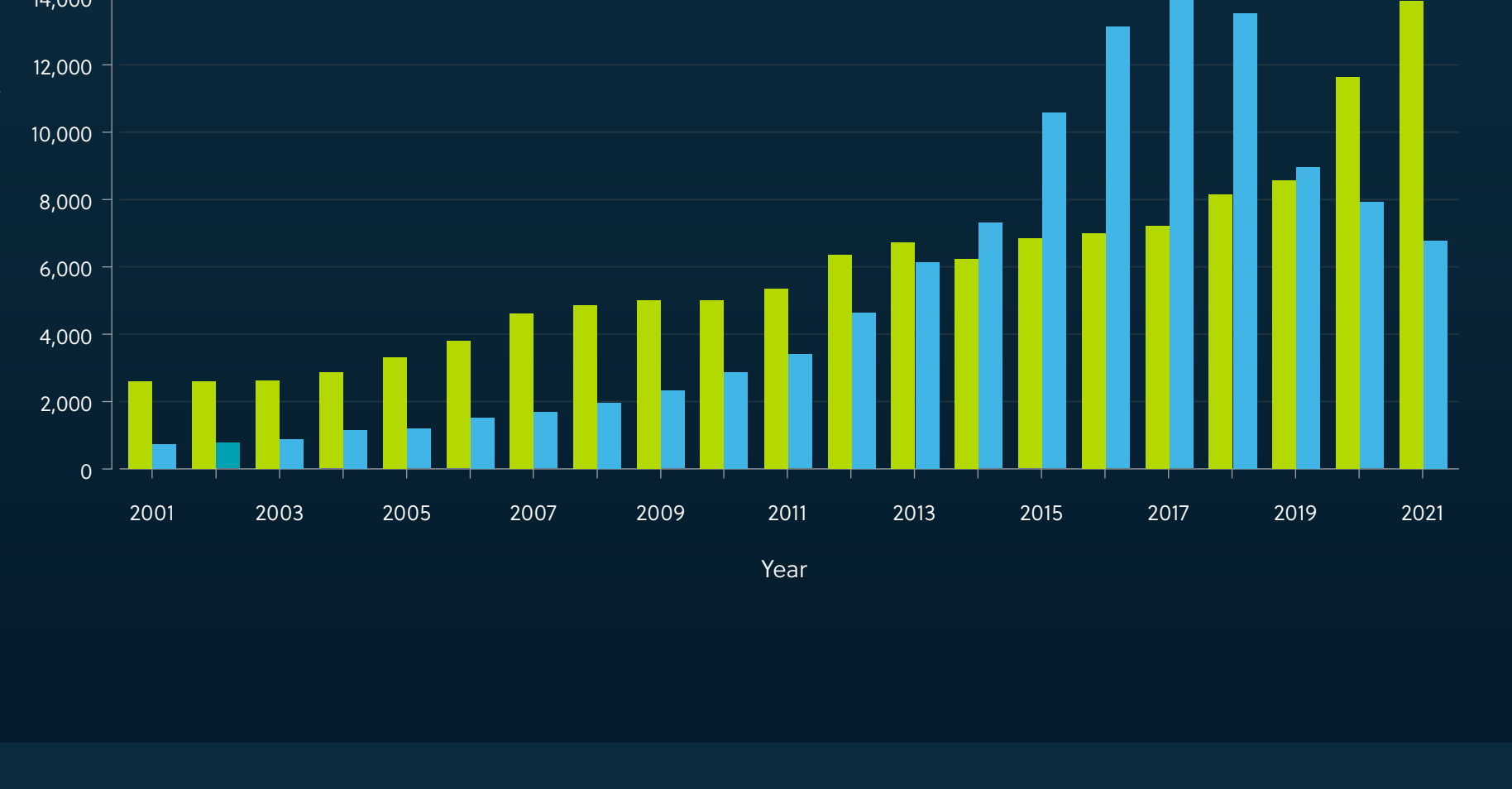
INNOVATIONS

- Electrolysis
- Forward osmosis
- Wastewater treatment

STRUVITE (MgNH₄PO₄)

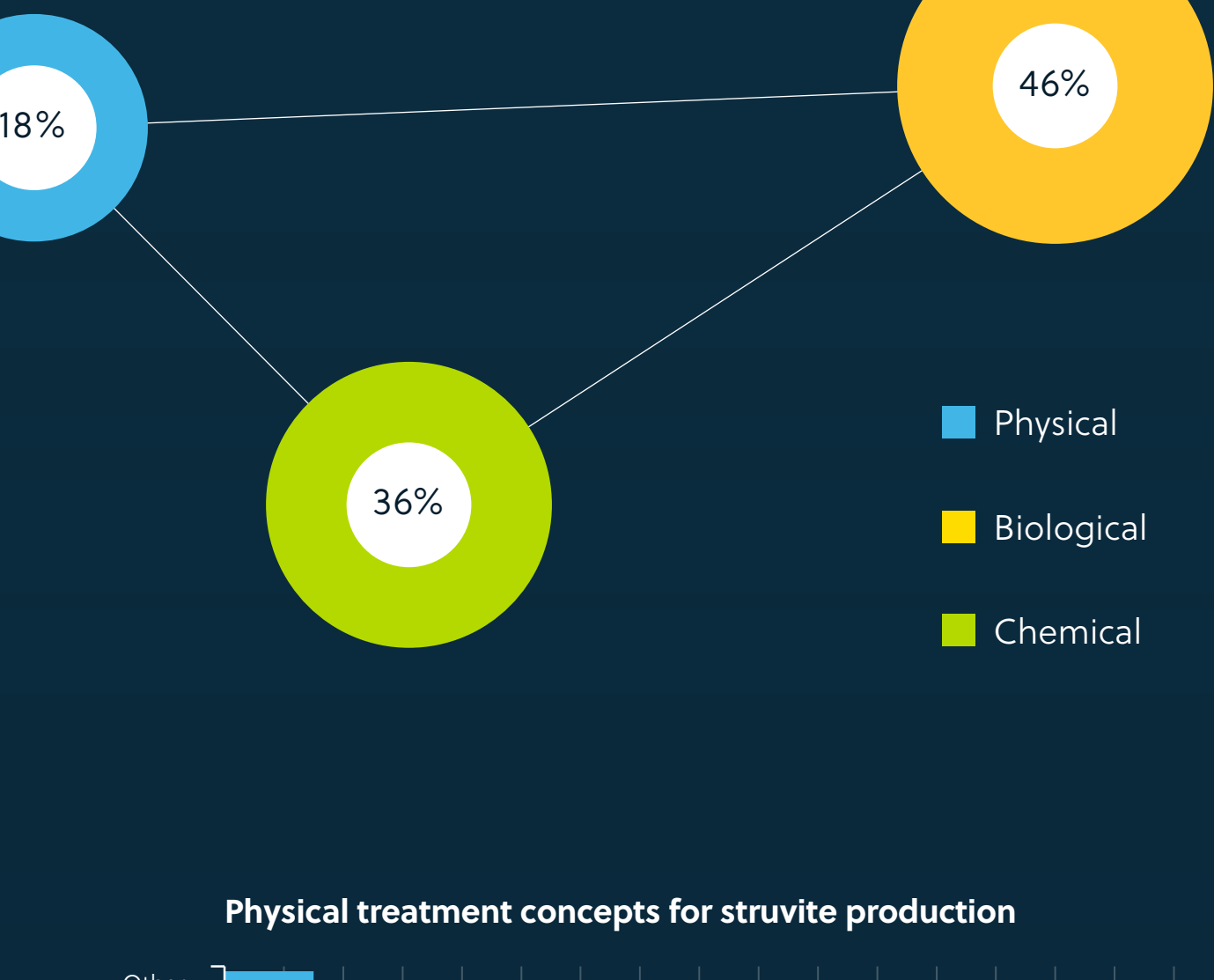
Adequate nutrient source recovered from wastewater

INCREASING NUMBER OF PUBLICATIONS BROADLY RELATED TO SUSTAINABLE FERTILIZERS

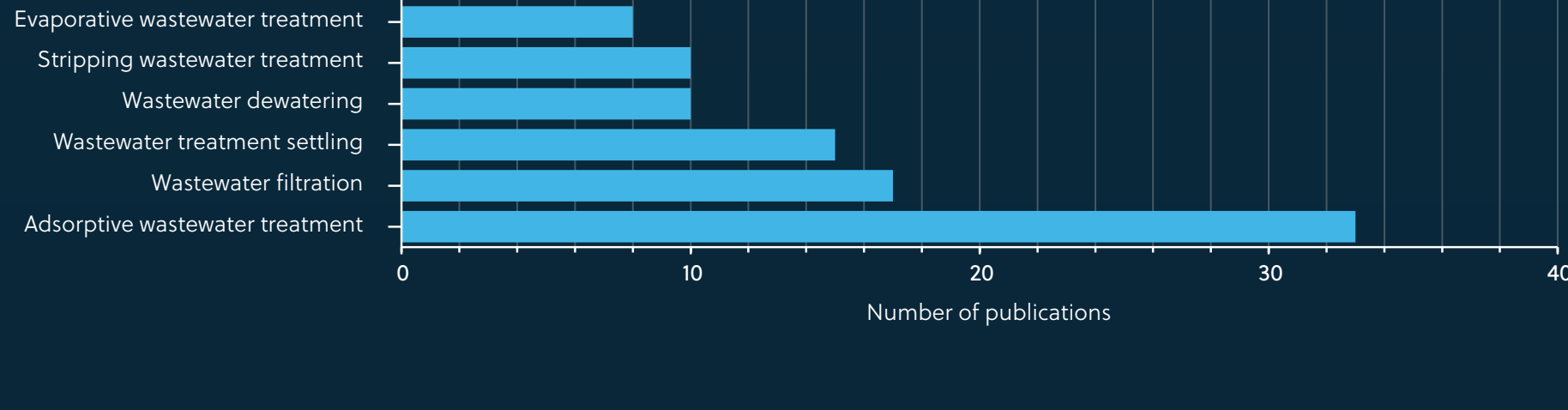


PUBLICATIONS RELATED TO STRUVITE

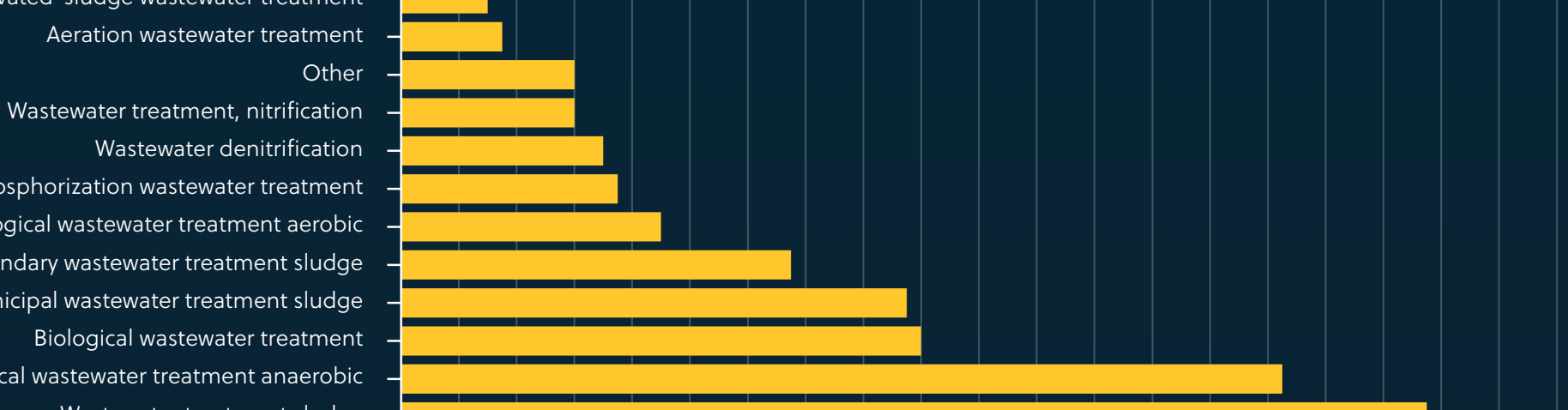
Publications on biological, chemical, and physical methods associated with wastewater treatment and struvite precipitation



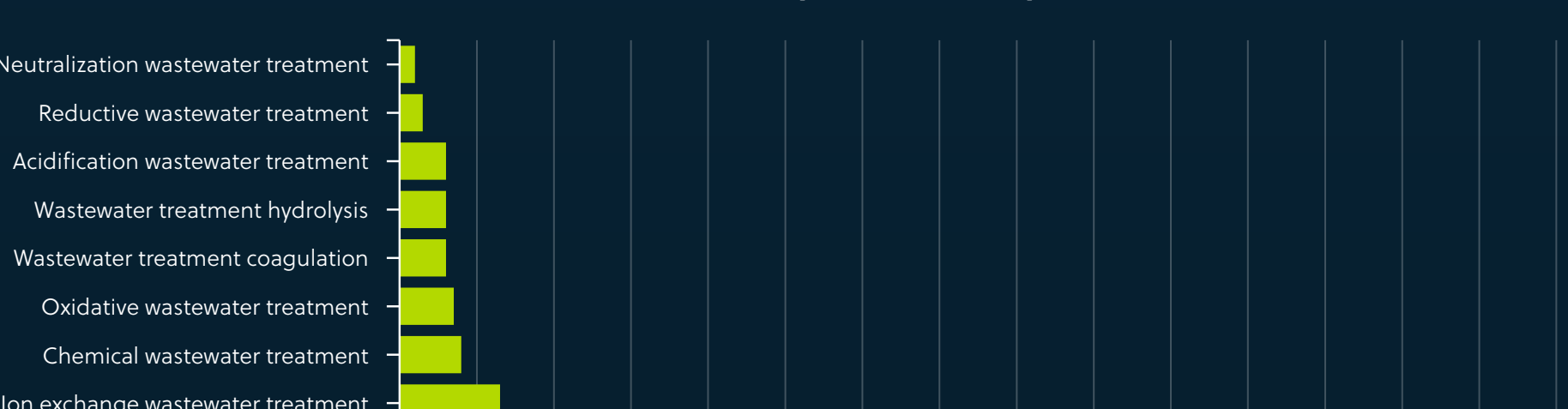
Physical treatment concepts for struvite production



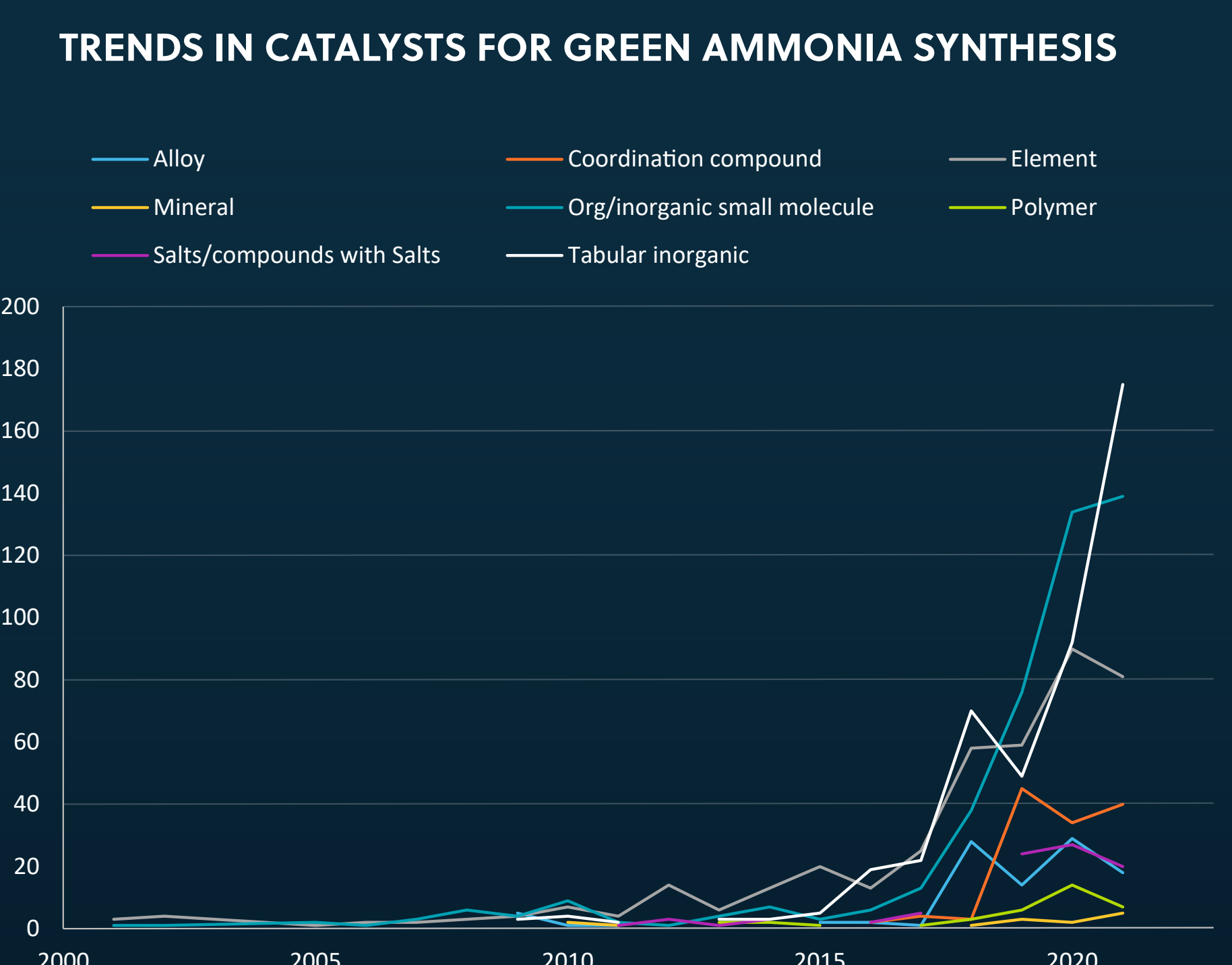
Biological treatment concepts for struvite production



Chemical treatment concepts for struvite production



TRENDS IN CATALYSTS FOR GREEN AMMONIA SYNTHESIS



Learn more at cas.org/insights

