

EXECUTIVE SUMMARY

The Lux Research 2022 Foresight Report

We help our clients by illuminating and analyzing the future of novel sciences and technologies that support a sustainable global economy.

November 2021



INTRODUCTION

What technologies do you believe will be most impactful in 2022 and beyond? What are their impacts and implications? What should Lux clients do?

Great innovations occur when technologies collide. Collisions happen when different, disparate technologies suddenly find themselves connected through an enabling connector. Connections manifest due to the forceful function of a dominant question. **Connected computation is that enabler, and sustainability is that question.** More and more devices are being computationally connected to create ever-more novel combinations of data, and more and more issues like recycling, healthcare, climate change, and empowered consumerism are being connected via the thread of sustainability. We asked our analysts and thought leaders what they think of emerging new technologies, the status of existing technologies, and potential scenarios that might unfold in 2022 to create new winners and losers.



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Lux Research by the Numbers

250+ Clients

Including multinational corporations, investors, and governments

on

5 Continents

>80%
of the largest
chemical
companies

>75%
of the largest
CPG
companies

>60%
of the largest
oil & gas
companies

>50%
of the largest
electronics
and **IT**
companies

>45%
of the largest
diversified
industrial
companies

Lux Research by the Numbers

150+ Employees
in
5 Offices

Boston

New York

Amsterdam

Singapore

Tokyo

The Lux Sustainable Innovation Model



Climate Tech

Enabling the elimination and remediation of greenhouse gas emissions

Lux Recommends

Your innovation strategy needs to leverage technologies and sectors powering the energy transition as well as figure how to directly reduce emissions and evolve your business models to reach your enterprise's sustainability goals.

Focus Areas

- Decarbonizing industrial processes
- Renewable grid integration
- Energy storage
- Carbon capture, utilization, and storage
- Hydrogen economy
- Electric vehicle charging
- Synthetic fuels



Circular Tech

Enabling the elimination and remediation of waste as well as the regeneration of natural systems

Lux Recommends

Your innovation strategy needs to have a compelling vision, clear business models, and proof that the circular economy practices deliver on their promise of product performance and resource efficiency to build circular supply chains.

Focus Areas

- Plastic waste
- Food and agricultural waste
- Building and construction waste
- Textile circularity
- Circular design tools
- Tracking and traceability
- Synthetic biology
- Chemical recycling



Future Consumer Tech

Enabling nutrition and wellness for the world's population

Lux Recommends

Your innovation strategy needs to strike the right balance between sustainability outcomes (health, safety, and transparency) while delivering on performance, cost, and ease of access to capitalize on the rapidly evolving needs of the future consumer.

Focus Areas

- Alternative food production systems
- Alternative proteins and food ingredients
- Nutraceuticals
- Microbiome
- Digital biomarkers and therapeutics
- Digital sales platforms
- Personalization

2021 in Passing: Hindsight, Surprises, and Signposts



Climate Tech

Carbon capture becoming a business

Building on Tesla and others selling carbon credits for revenue, Exxon takes the next step in building a first-of-its-kind business around carbon itself, which will further stimulate capture and utilization technology development.

Signposts

- COP26 accelerates and converges government policymaking around the globe
- The U.K. announces a 2023 experiment to swap H₂ into its NG infrastructure, setting the pace
- Initial windfarms reach their end of life, prompting renewed focus on large-scale recycling technologies



Circular Tech

Chemicals embrace DSPs in a bigger way

In a sign of decreased dependency on volumetric sales models, companies like BASF embrace just-in-time sales through partnerships with data and analytics companies, signaling a fundamental shift in overall business strategies.

Signposts

- COP26 drives further carbon policy formation and stimulates technology development
- Stock prices of oil and gas and chemical and materials companies do not bounce back to pre-COVID levels without strong ESG programs
- Companies add policy, trend spotting, and NGO understanding to their tech scouting activities



Future Consumer Tech

Cellular meat receives market approval

Intense consumer interest drives rapid market development of alternative proteins. Singapore leads with first market approval of a cell-cultured product. Sustainability concerns by empowered consumers create new perceptions, rapid policy shifts, and novel product opportunities.

Signposts

- Global replication of Land O'Lakes' TruTerra consortium model of analytics-to-the-acre, solving for yield, profitability, and consumer preference
- The U.S. and EU follow Singapore, enacting bioengineering policy, including food safety and provenance
- Companies spend more on innovation scouting in response to the increasingly complex environment



Digital Trends

COVID drives D2C and further shortens last mile of supply chain and "everything on the edge" thinking

Signposts

- Incumbent CPGs accelerate acquisition of purpose-built companies
- Rapid rise of NFT saps energy and value from ecosystems
- Supply chain systematizes the meshing of sensors to create intelligent systems
- Telemedicine rolls back with COVID subsiding, but digital biomarkers go big



Climate Tech

The Lux Top Technologies for 2022

Signals and Signposts

Compressed air energy storage

Market need for cheaper, multiplexed, distributed energy management from surging renewable input energy sources

High-temperature heat pumps

Linking disparate industrial processes together to harness waste heat; heat distribution and management become a monetized service

Flow batteries

Intensive academic research; breakthroughs in organic materials; claims of achievable \$25/kWh makes flow batteries competitive to lithium

Implications

Harbinger of dynamic grid management, renewables, and new business models; on-demand energy management is a proxy for the goods and services delivered

Sustainability drives renewal of mechanical systems with new, connected balance-of-system configurations to drive sustainability

Claims of superior cost to lithium and balance of system plus a smaller form factor lead to increased flexible deployments



Circular Tech

The Lux Top Technologies for 2022

Signals and Signposts

Advanced pyrolysis

Increasing focus on improved economics, recovery, and restreaming of core materials; watch this and the chemical looping spaces for advances and the addition of electrolysis to the balance of system

Production electrochemistry

Green hydrogen interest drives electrolysis systems development, creating viable scaled pathways for new electrochemical reactions

Implications

Part of waste ecosystem platform development driven by circular economy strategy and will drive robotic sorting, balance-of-system efficiencies, and new downstream markets for recovered materials

Accelerated research and discovery targeting replacement of all combustion chemical reactions



Future Consumer Tech

The Lux Top Technologies for 2022

Signals and Signposts

Cell-based meat

Singapore's approval of the world's first laboratory-grown meat source paves the way for global competition

Novel seed treatment

Continued exponential growth in IP around non-genetic seed treatments and CRISPR; partnerships and acquisitions increase as Corteva, BASF, Syngenta invest

Cell-free biosynthesis

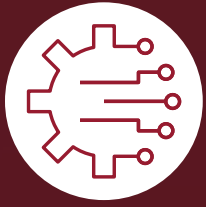
Increased range of created molecules; design on demand

Implications

New methods for bioreactor technology and economic growth media required to cost-effectively scale; new policies needed for food safety

Drive for yield with fewer chemicals propels controlled environment farming using purpose-built and treated seeds per each growth condition

Biomufacturing enables plug and play of enzyme cascades into traditional chemistries to create new synthetic pathways



Digital Trends

The Lux Top Technologies for 2022

Signals and Signposts

Digital biomarkers

Continued rise in digital biomarker companies targeting mobile health and health-at-home market development

Ultra wideband sensors

Very low energy, high bandwidth communications for local sensor data gathering, tracking, and precision location; expect continued smartphone UWB support developments

Implications

Increasing range of mix and match noninvasive data gives rise to new applications in physiologic monitoring

Continued evolution of IIOT and Industry 4.0; supporting acceleration of edge computing and increased smart environments with real-time asset management

Our (Un)popular Predictions for 2022

- 1** No recovery of pre-COVID share prices for O&G and C&M companies
- 2** CCS and H₂ investments cross the tipping point
- 3** COP26 drives boosting of aid to poorer countries
- 4** Plane tickets will be 2–3× more expensive; Germany to close its coal fired plants in 2045 and not 2038 as planned
- 5** Digital hits a wall, slowing ML and AI market penetration and digital transformation
- 6** Proprietary data are dead and increasingly difficult and worthwhile to protect
- 7** Insurance and actuarial companies emerge as winning sectors
- 8** EU overtakes China in green hydrogen and electrolyzer development and deployment
- 9** DSPs continue to grow in importance for chemicals and materials and extend into other industries such as trading of green metals
- 10** Edge computing, computing at the edge, accelerates
- 11** Synbio slows down
- 12** Digital data on the farm accelerate consortia building
- 13** Telemedicine slows down, segmented by demographic adoption
- 14** A massive, unprecedented security breach occurs
- 15** Soil and regenerative practices start fast, then slow down



Thank You

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