20 FOR 20

The technologies with the greatest potential to transform the world over the next decade

Lux Research
INTRODUCTION
What technologies will you be following this year that have the greatest potential to transform the world over the next decade?

Each year, we ask our analysts this question. We also investigate the same question using the Lux Intelligence Engine data platform. This report highlights our findings and provides a jumping-off point into much more in-depth information on the Lux member site via dedicated Tech Pages and other research.

In 2020, we continue to see a lot of changes and new technologies making the list. We take a step back to think about the significance of this group of 20 technologies topping our rankings, exploring the key themes from the list. We also check in on techs that dropped off the list from 2019 and take a data-driven look at what’s more overhyped right now. We hope you enjoy, and let us know what you think!

Michael Holman, Ph.D.
VP of Research
michael.holman@luxresearchinc.com

Cosmin Laslau, Ph.D.
Director of Research Products
cosmin.laslau@luxresearchinc.com
### The Top 20 Transformational Technologies for 2020

<table>
<thead>
<tr>
<th>Rank</th>
<th>Technology</th>
<th>Change from 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5G Networks</td>
<td>Up 12 spots</td>
</tr>
<tr>
<td>2</td>
<td>Shared Mobility</td>
<td>New to leaderboard</td>
</tr>
<tr>
<td>3</td>
<td>Advanced Plastic Recycling</td>
<td>New to leaderboard</td>
</tr>
<tr>
<td>4</td>
<td>Solid-State Batteries</td>
<td>Up 7 spots</td>
</tr>
<tr>
<td>5</td>
<td>Protein Production</td>
<td>New to leaderboard</td>
</tr>
<tr>
<td>6</td>
<td>Commercial Vehicle Automation</td>
<td>New to leaderboard</td>
</tr>
<tr>
<td>7</td>
<td>Point-of-Use Sensing</td>
<td>New to leaderboard</td>
</tr>
<tr>
<td>8</td>
<td>3D Printing</td>
<td>Down 7 spots</td>
</tr>
<tr>
<td>9</td>
<td>Energy Trading Platforms</td>
<td>New to leaderboard</td>
</tr>
<tr>
<td>10</td>
<td>Natural Language Processing</td>
<td>Up 6 spots</td>
</tr>
<tr>
<td>11</td>
<td>Hydrogen &amp; Fuel Cells</td>
<td>New to leaderboard</td>
</tr>
<tr>
<td>12</td>
<td>Materials Informatics</td>
<td>Up 2 spots</td>
</tr>
<tr>
<td>13</td>
<td>Quantum Computing</td>
<td>New to leaderboard</td>
</tr>
<tr>
<td>14</td>
<td>Last-Mile Delivery</td>
<td>Up 4 spots</td>
</tr>
<tr>
<td>15</td>
<td>Blockchain</td>
<td>Up 4 spots</td>
</tr>
<tr>
<td>16</td>
<td>Battery Fast Charging</td>
<td>Down 10 spots</td>
</tr>
<tr>
<td>17</td>
<td>Omics</td>
<td>New to leaderboard</td>
</tr>
<tr>
<td>18</td>
<td>2D Materials</td>
<td>Down 9 spots</td>
</tr>
<tr>
<td>19</td>
<td>Flow Batteries</td>
<td>New to leaderboard</td>
</tr>
<tr>
<td>20</td>
<td>Vertical Farming</td>
<td>New to leaderboard</td>
</tr>
</tbody>
</table>
Key themes from the 20 for 20

The 20 technologies we identified are all compelling individually, particularly for companies in industries that are closely aligned to developing and deploying them, or affected by their impact. However, just as important can be the stories they tell as a group. In looking at the 20 for 20, we identified three key common themes among these innovation dynamos – explained in detail on the following pages.

- Renaissance technologies
- Platform technologies
- Breakthrough technologies
Renaissance technologies are newly relevant

Some technologies on our list aren’t necessarily new, but are newly relevant. They have been around for a while in some form – some have even gone for a ride or two on the hype cycle in the past; others have just been regarded as stodgy fields not really associated with cutting-edge innovation. But a combination of megatrends, market demand, and new innovations has thrust them into strategic prominence.

Artificial intelligence has been an aspiration of computer scientists, and preoccupation of sci-fi writers, for decades. Innovation interest has gone through past surges followed by “AI winters,” but in the past five years, new approaches like deep learning combined with the growth of data collection and compute power have made AI a business imperative.

Protein production has been part of human economic activity for millennia, but it is seeing an innovation renaissance in response to food security and climate impact concerns. Trendy alternative proteins like plant-based patties from likes of Beyond Meat and Impossible Foods are just the tip of the iceberg, as everything from precision livestock farming to novel fish meal is on the move.

Calysta’s fermentation tech converts methane into single-cell protein feed. Avoiding the land, water, and resource demands of plant protein, it’s scaling a viable alternative aquaculture feed along with strong corporate partners.
KEY THEME
Platform technologies’ impact is in what they enable

These technologies are growing and will create opportunities for those directly involved in building their infrastructure – but they are of interest not so much for what they do on their own as for how other innovations can piggyback off them. They become the foundation of a new generation business ideas and an enabler for new technologies that leverage this innovation to build even greater capabilities.

PAST EXAMPLE

Smartphones have been the most important platform of the past decade-plus. They’ve been big business for manufacturers like Apple and Samsung, as well as driving growth for mobile network operators. Their greatest impact, however, has been enabling an all-star list of growth companies, from Uber and Grab to Instagram and Tencent.

#12 MATERIALS INFORMATICS CASE STUDY

Materials informatics applies machine learning to structure and property data of chemicals and materials, allowing it to recommend new compositions, formulations, and processing. Chemical and material companies, and their customers, can use these capabilities to streamline R&D and create new impactful products – but also to build new business models.

WHO’S CAPITALIZING?
Evonik’s Coatino platform taps into an extensive database on paints and coatings and applies machine learning to make targeted recommendations for additives and formulations, facilitating sales and boosting customer relationships.
KEY THEME

Breakthrough technologies are creation with unclear impact

Some technologies are pure bursts of tech innovation brilliance. It might not be entirely clear what all the applications will be, but the surge of innovation interest and the way they’ve captured the imaginations of entrepreneurs and visionaries around the world makes them impossible to ignore. The risk is that they are just “tech push” without market pull, but when they can align to an unmet need or demand, the result is explosive.

PAST EXAMPLE

Wearable electronics came onto the scene as a novelty, with experiments like the Pebble watch Kickstarter campaign prompting early adopters to begin experimenting. Now, valuable practical applications are being established for both consumers, such as providing critical health alerts, and industrial users, such as worker safety and productivity boosts.

#15 BLOCKCHAIN CASE STUDY

Blockchain followed the rise of bitcoin’s price to prominence, along with a predictable array of half-baked ideas and outright scams. However, large companies and serious tech developers are exploring how the concept of a distributed ledger can enable legitimate new businesses. It’s not certain yet which approaches and applications will work out, but some will likely go on to have great impact.

WHO’S CAPITALIZING?

U.K. utility Centrica has created a “local energy market” (LEM) in Cornwall, allowing solar and other distributed asset owners to engage in peer-to-peer energy trading – including “power hedges” on LO3 Energy’s blockchain platform.
# 5G NETWORKS

Fifth-generation mobile network technology, with higher bandwidth, more connections, lower latency, and longer battery life.

LUX TAKE

Why it’s important: 5G will be critical for internet of things (IoT), enabling applications in fields from robotic surgery to connected cars. 5G devices will also demand enabling tech from advanced substrates to novel creations like metamaterials.

What you should do: 5G will provide greater data collection, increasing transparency into operations, enabling autonomy, and creating new business models like flexible manufacturing. Clients should take care to align timing to 5G’s staged rollout, where different capabilities will emerge from different components of 5G that mature at different times.

DATA HIGHLIGHTS

2,200

Patents trailed academic publications until 2018 – but patents have shot past and are set to top 2,200 in 2019.
## 5G NETWORKS

### Materials
- Rogers Corporation
- Isola
- Laird
- Apple
- Kenwood
- Kuraray
- Murata
- AGC
- HRAI
- JFE

### Chip Makers
- Qualcomm
- Intel
- Skyworks
- Broadcom
- Qorvo
- Xilinx
- Huawei
- MediaTek
- Samsung
- Unisoc

### Network Gear
- Nokia
- Huawei
- Ericsson
- Samsung
- ZTE

### Mobile Network Operators
- Verizon
- AT&T
- T-Mobile
- Sprint
- Vodafone
- China Telecom
- China Unicom
- China Mobile
- SK Telecom
- KT
- LGU
- SoftBank
- docomo
- Orange
- T

### Device Makers
- Apple
- Samsung
- LG
- Oppo
- Xiaomi
- HTC
- Sony
- Microsoft
- Google

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**Details**
For key player analysis, full data, case studies, and more, see our 5G Networks Tech Page.

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Innovations in mobility outside of conventional ownership, such as car-sharing, ride-hailing, autonomous taxis, and other business models.

**LUX TAKE**

**Why it’s important:** Megatrends like urbanization and a rising global middle class mean urban mobility is increasingly important, but conventional car ownership models are failing to meet this growing need. In their place, new companies and ideas are emerging in the automotive value chain to make mobility cheaper, more convenient, and more efficient.

**What you should do:** While the ride-hailing space is fiercely competitive, there are a huge number of possible business models that stand to disrupt traditional sales, including car subscriptions and microtransit services.

**DATA HIGHLIGHTS**

$10 billion

Amount of funding being poured into the shared mobility space *each year*, including in 2017, 2018, and 2019.
1. **RIDE HAILING**
   - Taxi alternatives, enabled by mobile applications
   - UBER
   - DiDi
   - Grab
   - lyft
   - gojek
   - Gett
   - cabify
   - Via
   - Bolt
   - Blacklane
   - Hertz
   - Wheely
   - Zipcar
   - СитиМобил

2. **BIKE AND SCOOTER SHARING**
   - Two-wheeled mobility for rides, delivery, and more
   - ofo
   - mobike
   - smarthee
   - BIRD
   - 哈啰出行
   - Yellow
   - grin
   - Cityscoot
   - Tier
   - Zygler

3. **CAR SHARING**
   - Alternatives to car rentals, like peer-to-peer sharing of vehicles
   - Turo
   - SOCAR
   - 瓜子
   - Citybee

4. **MOBILITY-AS-A-SERVICE (MAAS)**
   - Transportation that spans across multiple vehicle types
   - ViaVan
   - Gotcha
   - Moovit
   - ReachNow
   - Skipr

5. **OTHER SHARED TRANSPORTATION**
   - Shared mobility for trucks, boats, and more
   - 运满满
   - Wheels Up
   - Outdoorsy
   - DOFT
ADVANCED PLASTIC RECYCLING

Innovations that can convert plastic waste into a variety of valuable products, enabling a circular economy and avoiding pollution.

LUX TAKE

Why it’s important: Regulations like single-use plastic bans and waste reduction commitments from brands are shaking up the plastics value chain. Plastic waste recycling is becoming mission-critical for companies from CPGs to chemicals.

What you should do: Companies need to develop waste collection and sorting and help scale up conversion technologies like pyrolysis and chemical recycling. Look for those collecting and converting to present new competition for oil, chemicals, and materials companies in the new circular value chain.

DATA HIGHLIGHTS

55%

China’s taken a commanding lead in IP activity, with more than half of global patents since 2015.
## ADVANCED PLASTIC RECYCLING

### 1. PYROLYSIS
Waste to oil

<table>
<thead>
<tr>
<th>Plastic Energy</th>
<th>nexus Fuels</th>
<th>Pyroll</th>
<th>Recycling Technologies</th>
<th>RESPolyFLOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>VADXX</td>
<td>REVelity</td>
<td>Polytech</td>
<td>Pyrowave</td>
<td>Arqite</td>
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<tr>
<td>RENEWLOGY</td>
<td>QUBE Energy</td>
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<td>urjas</td>
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### 2. CHEMICAL RECYCLING
Waste to chemicals

<table>
<thead>
<tr>
<th>ionica</th>
<th>carbios</th>
<th>Enovia</th>
<th>QCP</th>
<th>CUMAPOL</th>
<th>LOOP</th>
</tr>
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<tbody>
<tr>
<td>QP</td>
<td>PrT</td>
<td>Garbo</td>
<td></td>
<td></td>
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<tr>
<td>PET Refine</td>
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<tr>
<td>Technology Co.</td>
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</table>

### 3. MECHANICAL AND SOLVENT-BASED RECYCLING
Waste to materials

<table>
<thead>
<tr>
<th>APK</th>
<th>Purecycle</th>
<th>SADAKO</th>
<th>saperatec</th>
<th>ZenRobotics</th>
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</thead>
<tbody>
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</tbody>
</table>

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For key player analysis, full data, case studies, and more, see our Plastic Recycling Tech Page.
What happened to the dropouts – the technologies that were on the 19 for 2019 but no longer appear here?

Technologies that dropped off the 2019 list aren’t suddenly losers or busts – they’re just not quite suitable for selection to the top 20.

Tech innovation is dynamic and rapidly changing, with many closely matched technologies vying for commercial impact. The reality is that there are dozens more transformational technologies that can be (depending on your industry and role) worth following closely. The exercise of highlighting the top 20 hardly means that others are unimportant.

Generally, technologies that dropped from the list did so in one of three ways, as laid out at right, with slightly different implications for executives planning their innovation strategies. The following slide takes a look at each.

**WENT MAINSTREAM**
- Machine learning, microbiome, cybersecurity
  - Some techs have become such standard practice in relevant industries that there’s less value and relevance to including here

**CHANGED FORM**
- Wearable electronics, genome editing, precision medicine
  - Other techs are related to or form one component of bigger-picture technologies that are still included in the 20 for 20 this year

**FELL – RELATIVELY**
- AR/VR, drones, perovskite solar, generative design
  - These techs are still relevant and even growing in innovation interest, but are no longer growing as rapidly as those on the list
Comparing hard innovation data versus social trends’ additional signals

Most of this report focuses on “hard innovation data” sources, specifically patent grants and applications, academic papers and conference proceedings, venture capital funding, and government grants. We also include subject matter experts’ reports and insights.

However, another potential source of innovation data is social data, which ranges from social platforms like Twitter and Facebook to search engines like Google. Many of these datasets are not publicly available due to privacy concerns and controversies like the Cambridge Analytica scandal, making social trends difficult to analyze.

Our team nonetheless was able to programmatically analyze thousands of technologies on the Google Trends platform: On the next slides, we highlight technologies that are trending on the world’s largest search engine and provide our take and additional data on these innovations.
**MILD HYBRIDS**

Cars that use improved small batteries alongside conventional internal combustion engines to bump up fuel economy slightly.

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**LUX TAKE**

**Is the social signal relevant?** Not for innovation purposes. Mild hybrids have been covered by Lux Research for more than a decade as an incremental step on the road to vehicle electrification. Much of the innovation has already been done. Now, carmakers are instead turning their innovation attention to full electrification – although the Google Trends data indicates that consumers may finally be coming around to interest in mild hybrids.

**What you should do:** Note the gap between technical innovation (green curve) and customer interest (yellow curve) – this is typical of many hard innovation problems associated with long product development times like cars.
ALIGNING YOUR INNOVATION STRATEGY

How active should your organization be in pursuing each of these 20 transformational technologies?

For most companies, aggressively pursuing all these technologies won’t make sense. But which to focus on? Each company has its own innovation approach and risk appetite, and technologies have different consequences for different industries – so there’s no one-size-fits all strategy.

However, as a guide, clients can align the 20 for 20 to their industry based on two factors:

1) **Maturity** – How close the innovation is to broad adoption in their industry

2) **Impact** – Whether the results of adoption of this innovation in their industry will be marginal, major, or truly disruptive

Clearly, disruptive technologies that are near or past market launch should be a priority for everyone, but each company can evaluate how far it should go in pursuing innovations that are less mature or that will have less momentous impact. How does this look for your company? Contact us to see how we can help with your roadmap.

Sample alignment of some of the 20 for 20 to the automotive industry

<table>
<thead>
<tr>
<th>Maturity</th>
<th>Impact</th>
<th>Initial testing</th>
<th>Product creation</th>
<th>Market launch</th>
<th>Broad adoption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disruptive</td>
<td>Major</td>
<td>Protein production</td>
<td>Advanced plastic recycling</td>
<td>Point-of-use sensing</td>
<td>2D materials</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5G networks</td>
<td>Hydrogen</td>
<td>Commercial vehicle automation</td>
<td>Shared mobility</td>
</tr>
</tbody>
</table>
What to look for beyond the top 20 – and what to expect going forward

1. **Have data-driven as well as expert-led monitoring in place.** As the renaissance technologies show, innovation areas that seem to have fizzled can return to prominence – so it’s not enough to assess an area once. Ongoing monitoring is essential, and data science approaches can be particularly useful for areas where past disappointments might bias individuals against them.

2. **Cast a wide net to catch enabling platform tech.** The next great innovation to impact your industry might come from well outside it – but if it provides a tech platform on which to build high-value applications for your company, it’s vital not to miss. Most innovation organizations are fairly adept at monitoring and surface innovations from within the industry, but a wider view is critical as well.

3. **Be prepared to think imaginatively about breakthroughs.** When a new technology comes onto the scene, the impacts often aren’t immediately obvious – not least because many of the initial proposed uses are foolish and doomed to fail. Maintain a realistic view of the technical limitations but don’t dismiss possibilities too easily – and rely on data to help keep grounded, without getting swept up in the hype or deflected by naysayers.
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