

WHERE TO PLAY:
GAME-CHANGING
TECHNOLOGIES
FOR **AUTOMOTIVE**



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Introduction

The automotive industry is in a period of intense change. The pandemic hit hard in 2020, with vehicle sales retracting significantly. But even as automotive companies begin to recover, there is no returning to business-as-usual. The industry was undergoing transformation even before COVID-19 altered consumer demand, threatened brick-and-mortar dealerships, and disrupted supply chains.

This budding transformation is being paved by sustainability and digitalization. There is no doubt that mounting ESG (environmental, social, and governance) standards will shape the automotive landscape, and that data has become the fuel of the future. We are boldly entering the age of the electric and connected car.

Now, in this period of global reset, leaders in automotive have the opportunity to reposition their organizations; to not only prepare for the so-called “mobility of the future” but to play an active role in shaping it.

However, incumbents—comprising many original equipment manufacturers (OEMs) and tier-one suppliers—are facing fresh competition from new tech-forward players entering the industry. As a result, there is a pressing need to adapt conventional practices, build internal knowledge, form strategic partnerships, and invest in R&D.

This requires that organizations develop and leverage foresight capabilities—beginning with understanding the forces shaping the future of the automotive industry. Through this lens, organizations can identify the trends, technologies, and main players that are driving change in the market. And importantly, which developments hold the greatest potential impact and strategic relevance.

Regarding technological advancement in automotive, the focus is on how to best transition to a low- or zero-emission future in which mobility is smart, connected, and edging toward autonomous. We’re seeing rapid growth in fuel alternatives, new software-based business models, and altered relationships between consumers, automobiles, and cities that call for flexible, integrated, and scalable technology solutions.

This report aims to provide decision-makers in automotive with a view of the technologies that hold the greatest potential for impactful innovation in the industry. These game-changing technologies range from emerging to evolving and present several innovative use cases. The information contained within this report is interlinked with ITONICS end2end innovation management software to help you better connect the dots between these drivers of change, anticipate the most rewarding opportunities for the future, and gain strategic advantage.

An Introduction to Technology Scouting

End2end innovation management begins by asking the fundamental question, **Where to Play**. Answering this question relies on several congruent activities and internal capabilities that primarily fall within the discipline of Foresight and Strategy, as advocated by our distinct **ITONICS COFIM** model. Organizations equipped with strong foresight capabilities can align their strategy with future scenarios and build resilience in an increasingly uncertain and competitive landscape.

Essential in **Foresight and Strategy** is an organization's capacity to scan its business environment comprehensively and continuously—environmental scanning. This is the capability to scan the horizon for weak signals that might indicate larger shifts and influence or disrupt the environment. It begins with the collection of vast amounts of data from which patterns are revealed through sensemaking analysis.

Environmental scanning focuses on control objectives that enhance innovation intelligence, thereby enabling the identification of new opportunities for growth, informing strategic priorities, and shaping future goals. These include capability supervision, competitor watch, trend scouting, and technology scouting.

As the focus of this industry report, **technology scouting** is the process of observing technological shifts and developments by collecting pertinent data, contextualizing change to uncover discernable patterns as weak signals, and identifying emerging technologies that hold both impact and relevance.

Actively screening for shifts in technology adoption, R&D, and patents serves as an early-warning system to help organizations anticipate and respond to changes while also minimizing risk.

Applying an industry lens to the process of technology scouting helps organizations direct their focus and resources more optimally.

And by gaining an understanding of the technological developments and adoption trends that may present future opportunities in their industry, they can equip themselves with the innovation intelligence needed to take decisive, strategic action and ultimately gain a competitive advantage.





The Role of Technologies in Innovation

Emerging, evolving, and disruptive technologies serve as solution drivers, helping innovators connect the dots between their current and future states. These are the tools capable of meeting—and sometimes, creating—new needs, desires, and demands.

Technologies enable new business models, products, and services. They have the potential to meaningfully expand an organization's existing portfolio and transform an entire industry.

The Interplay between Technologies and Trends

Technologies and trends are complementary elements that interact with and influence one another. Trends are expressions of new consumer attitudes, expectations, or behaviors—an indication of market pull; whereas technologies are designed either in response to these shifts or as precursors to nascent demands—representing a market push.

Together this push and pull exert force on the market, driving change forward. It is organizations' ability to pre-empt or respond to this change through innovation that determines their success.

Determining Industry Relevance

Environmental scanning is a divergent exercise; too narrow an approach and important opportunities can easily be missed. And while all elements in the ITONICS portfolio hold relevance—the degree of relevance differs depending on the industry in which your organization operates.

To help provide this industry lens, ITONICS analysts have performed relevance analysis to identify the Technologies and other elements that are most relevant and likely to be game changers in each respective industry.

Our team of analysts monitored the frequency with which each Technology appeared in a given industry. Instances of real-world applications, R&D, patents, and startup activities were tagged with relevant industries through a process combining manual and automated data classification.

This initial mapping of the ITONICS portfolio served as hypotheses of industry relevance. These hypotheses were further validated and enriched through additional quantitative and qualitative industry research to arrive at nine industry packages.

Each industry package, available in ITONICS software, displays the Technologies, Trends, and Inspirations that represent the most relevant—that is, impactful, disruptive, and transformative—areas in which to play.



Technology Scouting with ITONICS

This report provides a starting point from which to embark on your organization's technology scouting. It presents 36 game-changing Technologies for automotive. Through a process of relevance analysis, these have been identified as most relevant and impactful to innovation in the industry.

Each can all be explored on the ITONICS [Teaser Technology Radar](#), filtered for automotive. Additionally, our pick of the industry's top five game-changing Technologies is unpacked in further detail in this report.

How to Read the Technologies

The **Synopsis** gives a brief overview of the Technology, explaining why it is important, what is required to enable it, how it has evolved, and any current limitations and opportunities.

The **Segmentation** of the Technology is indicated corresponding to the relevant categories that appear on the ITONICS Radar: Chemicals & Materials, Energy & Resources, Engineering, Healthcare & Life Sciences, ICT, and Mobility. Listed below, the **Sub-segmentation** provides a more narrow scope as to the area of technological development.



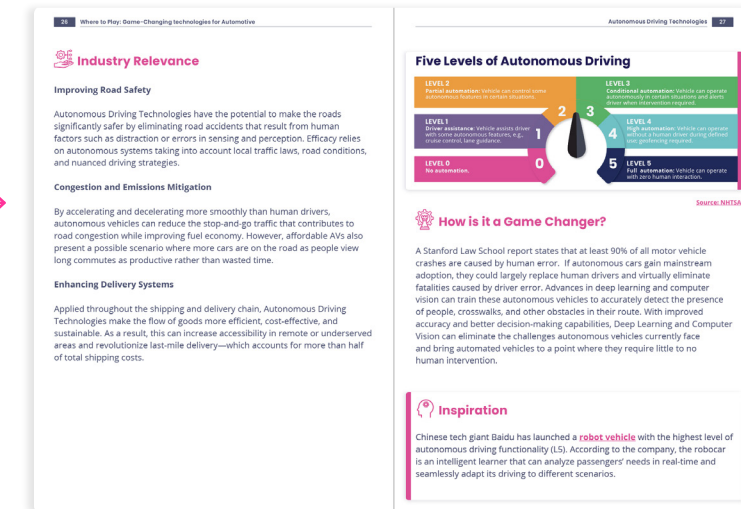
In the **navigation bar**, the  icon will bring you back to the Table of Contents page. The  button will open up the individual element in the ITONICS **Teaser Technology Radar**. Here you can deep dive into the Implications for Innovation associated with the Technology and view the interconnected elements that influence and impact it, including related Trends, Inspirations, and other Technologies.

The **Technology Ratings** look at the parameters of Scope, Potential Impact, Complexity, and Technology Readiness Level (TRL).

Related Trends show the elements that are influenced by and have an influence on the Technology, its development, and adoption. This network provides greater context as to the interplay between elements and points to possible opportunities.

Industry Relevance unpacks the industry-specific applications and potential use-cases that are most prominent with regard to the Technology. Each point looks at the strategic advantage gained through adoption of the Technology and the considerations for its future development.

How is this a Game Changer? elaborates on how the Technology may contribute to or influence possible future scenarios. The relationship between the Technology and nascent demands is explored through a future-oriented lens.

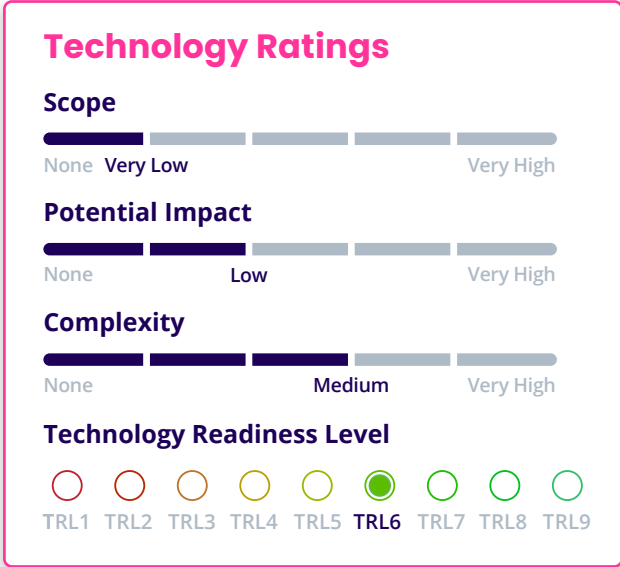


Inspirations provide evidence of how organizations are applying the Technology in the real world. They serve as springboards for ideation, helping innovators look beyond their category, connect information in new ways, and nurture fresh thinking.

ITONICS Ratings

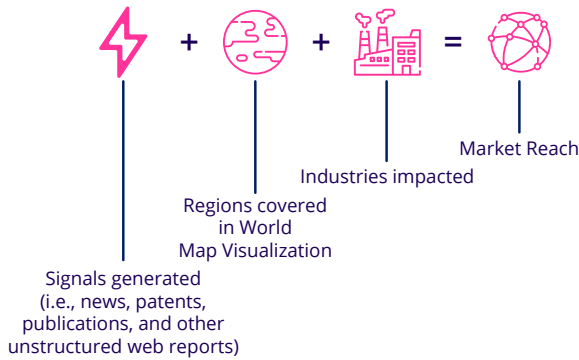
The evaluation of trends or technologies is one of the most important activities in innovation management. The goal is to predict future changes in your industry and whether they are relevant to your organization.

ITONICS Trends and Technologies are presented with ratings that help foresight teams focus their attention and identify relevance based on their unique set of strategic objectives.



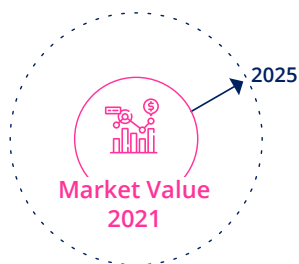
Scope: How far-reaching is the potential influence of this element on this market?

ITONICS Insights tool uses keywords to retrieve data across three dimensions and derive an aggregated mean value to indicate the market reach of each Technology.



Potential Impact: How high is the potential impact of this element on the market?

Market growth data for each Technology is collected from a minimum of 5 verifiable sources, aggregated and extrapolated to 2025.



Scale: Projected market value in 2025 (USD billion):

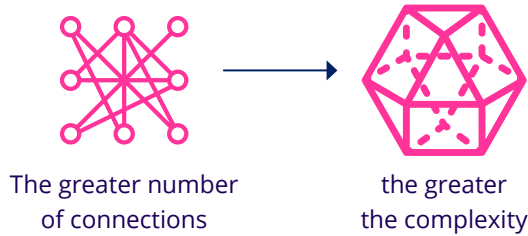
- Very Low: >10 bil.
- Low: 10-50 bil.
- Medium: 50-500 bil.
- High: 500-1,000 bil.
- Very High: >1,000 bil.

Our team of analysts uses advanced query and **ITONICS Insights** to garner the relevant information alongside our research and statistically derive the ratings from quantifiable historical and present data.

Each Technology is rated on Scope, Potential Impact, Complexity, and Technology Readiness Level (TRL) to provide targeted and tailored analysis at your fingertips.

Complexity: How high is the complexity of this element?

A complexity score is derived based on the number of connections each Technology forms with other elements.



Technology Readiness Level (TRL): How mature is this element in the market?

Each Technology is mapped by its Technology Readiness Level (TRL) to determine its relative maturity.

PHASE	TRL	DEFINITION
RESEARCH	1	Basic principles observed
	2	Concept formulated
	3	Experimental proof of concept
DEVELOPMENT	4	Validated in lab
	5	Validated in relevant environment
	6	Demonstrated in relevant environment
DEPLOYMENT	7	System prototype demonstrated in operational environment
	8	System complete and qualified
	9	Actual system proven in operational environment

Exploring the ITONICS Radar

Having the right tools to manage innovations, technologies, projects, and opportunities is vital to act on your organization's innovation strategy in an increasingly uncertain and dynamic world. After all, what you can't manage, you cannot change.

Get started by exploring the ITONICS [Teaser Technology Radar](#) and [Teaser Trend Radar](#) displaying

the elements that are most relevant to your industry. Here you will find a read-only overview of each Technology and Trend.

Beyond what's available in the Teaser, the full content on ITONICS software provides deeper insight into each Technology. It allows users to interact with and configure different elements to derive greater meaning and prompt informed decision-making.

The screenshot displays the ITONICS Radar interface. On the left, a grid of 16 technology cards is shown, each with a title, description, and tags. The cards include: Edge Computing, Unmanned Deliveries, Passenger Drones, Hyperloop, Autonomous Shipping, Autonomous Driving Technologies, Distributed Cloud, Distributed Ledger Technology, Predictive Maintenance, No-touch Payments, Machine Learning, Extended Reality, and others. On the right, an 'Advanced Filtering' sidebar is open, showing 'Saved Filters' (Automotive Industry), 'What element types do you want to show?' (Trend, Technology, Inspiration), 'What do you want to filter by?' (Tags), and sections for 'Trend', 'Technology', and 'Inspiration' with filters set to 'ir automotive'.

ITONICS software provides access to:

- The full portfolio of **175+ Trends and Technologies**, each with detailed explanations of how they have developed, where they are currently having an impact, and how they could evolve into the future.
- **7,000+ Inspirations**, continually updated to illustrate how Trends and Technologies are being activated and brought to life by innovators, businesses, and consumers.
- The ability to set **Internal Ratings** such as Business Relevance, Strategic Fit, Internal Know-How, and Need for Action. Undertaken as a collaborative evaluation exercise within your organization, these ratings help build the consensus and commitment needed in the innovation journey.
- Interactive **Network Graph** visualizations that display first- and second-level relations for a selected element. New relations that hold strategic relevance to your organization can also be added to any network graph.
- Various **Tags** attributed to each element to help users focus their searches. A **Tag Filter** function allows advanced searching by tags and gives suggestions for related tags. To view the Trends, Technologies, and Inspirations that are most relevant to automotive, use **Advanced Filtering** and select the **Saved Filter: Automotive Industry**.

For full access to this content and functionality, register an account on ITONICS Cloud for free today.

REGISTER

Forces Shaping the Future of Automotive

Context of Change

Defining the objectives and scope of environmental scanning activities like technology scouting requires a clear understanding of the context of change in your industry. Context provides a foundation for identifying and assessing the driving forces shaping the future. It points to evidence of where we see change happening in social, technological, economic, environmental, and political spheres and where the change will expand to next. It is the landscape upon which trends and technologies play out; the ability to navigate this landscape is the ability to adequately prepare for possible futures.

Forces Shaping the Future

Around the globe, several driving forces are impacting the automotive industry. Vehicle purchasing habits reflect the need for a variety of flexible options which center on consumers' needs. Sustainability and the move away from carbon-emitting fuel are vital and will need to be baked into businesses' value chains.

Emerging technologies, as well as new players entering the automotive industry, cannot be ignored. Data-led, IoT-infused solutions in manufacturing and mobility reflect a landscape in which both trusted incumbents and cross-category disrupters exploit new business models in the automotive space.

Here we'll discuss some of the forces shaping the future of the automotive industry.

THE EVER-CHANGING CONSUMER

will prompt new business models.

Consumer choice and flexibility will be at the heart of new automotive business models. Mobility-as-a-service (MaaS) and subscription models for vehicles are expected to grow in the coming years. At the same time, dealerships must balance customers' need for in-person due diligence and the rising demand for virtual showrooms and engagement. Remote work and a new generation of consumers are altering perceptions of vehicle ownership, usage, and mobility in general, while preferences trend toward flexible vehicle financing and personalized multimodal journeys.

SUSTAINABILITY REGULATIONS

will galvanize green innovation and ESG investments.

The automotive industry faces increasingly stringent sustainability regulations. Governments will play a vital role in promoting sustainable business practices through both "carrot" and "stick" approaches and time-bound goals linked to international environmental agreements. Independent regulators are likewise setting higher standards for vehicle manufacturers in terms of greenhouse gas (GHG) emissions and fuel economy. In accordance with these mounting sustainability regulations, expect R&D in green innovation and ESG (environmental, social, and governance) investments in the automotive industry to grow.



EMBEDDED CONNECTIVITY

will incite the race for data supremacy.

Connected vehicles are expected to represent about 95% of all new vehicle sales by 2030. This embedded connectivity generates vast amounts of data, enabling, and in some cases compelling, automotive manufacturers to move toward data-driven business models. With new opportunities for data-driven revenue streams and the promise of greater insight into customer behavior, established ICT companies and startups are entering the automotive industry. Incumbents will need to keep pace with enhanced customer-centricity and product optimization by investing in and leveraging their own data science capabilities.



CITIES OF THE FUTURE

will give rise to mobility ecosystems.

Cities of the future will rely on smart mobility infrastructure that reimagines private and public transportation. Advancements in IoT, smart sensors, and edge computing make it possible to collect, process, and share vital data that prioritizes safety and sustainability. Solutions include car- and ride-sharing platforms, autonomous vehicles and unmanned delivery, the rollout of electric vehicle (EV) charging stations, and real-time predictive analytics informing users of traffic, navigation, and multimodal transportation options. Alliance building between governments and business will be critical in implementing seamless mobility ecosystems.



INTELLIGENT MANUFACTURING

will streamline production and build resilience.

The automotive industry is quickly adopting intelligent manufacturing processes that rely on digital supply networks embedded with technologies like industrial IoT, 5G, artificial intelligence, and digital twins. However, many challenges remain, e.g., the high cost of retrofitting older factories, technology skills shortages, security concerns, and cultural resistance associated with job loss arising from automation. While implementing smart factories comes with a high degree of complexity, there are several gains to be made in productivity, customization, response times, energy, and overall cost.



ELECTRO-INVESTMENT

will lay the foundation for wide-scale EV adoption.

Sales of EVs are predicted to overtake internal combustion engine (ICE) vehicles by 2030. While this shift is partly driven by the market pull of government incentives, ESG standards, and consumer demands, the other force propelling EVs forward is investment into technology and infrastructure. Zero-emission fuel alternatives and next-generation batteries promise longer ranges, faster refueling and recharging, and reduced vehicle costs. Simultaneously, cities around the world are deploying electromobility options and infrastructure. Together these changes are making electromobility a sustainable and viable alternative for a growing segment of consumers.



Use this context to help better understand the strategic importance and innovation opportunities associated with the game-changing technologies identified for the automotive industry.

Game-Changing Technologies for Automotive

Technology Navigation

Through a process of qualitative and quantitative industry research, our team of analysts conducted relevance analysis in order to identify the Technologies within our portfolio that are **most relevant and influential in the automotive industry**.

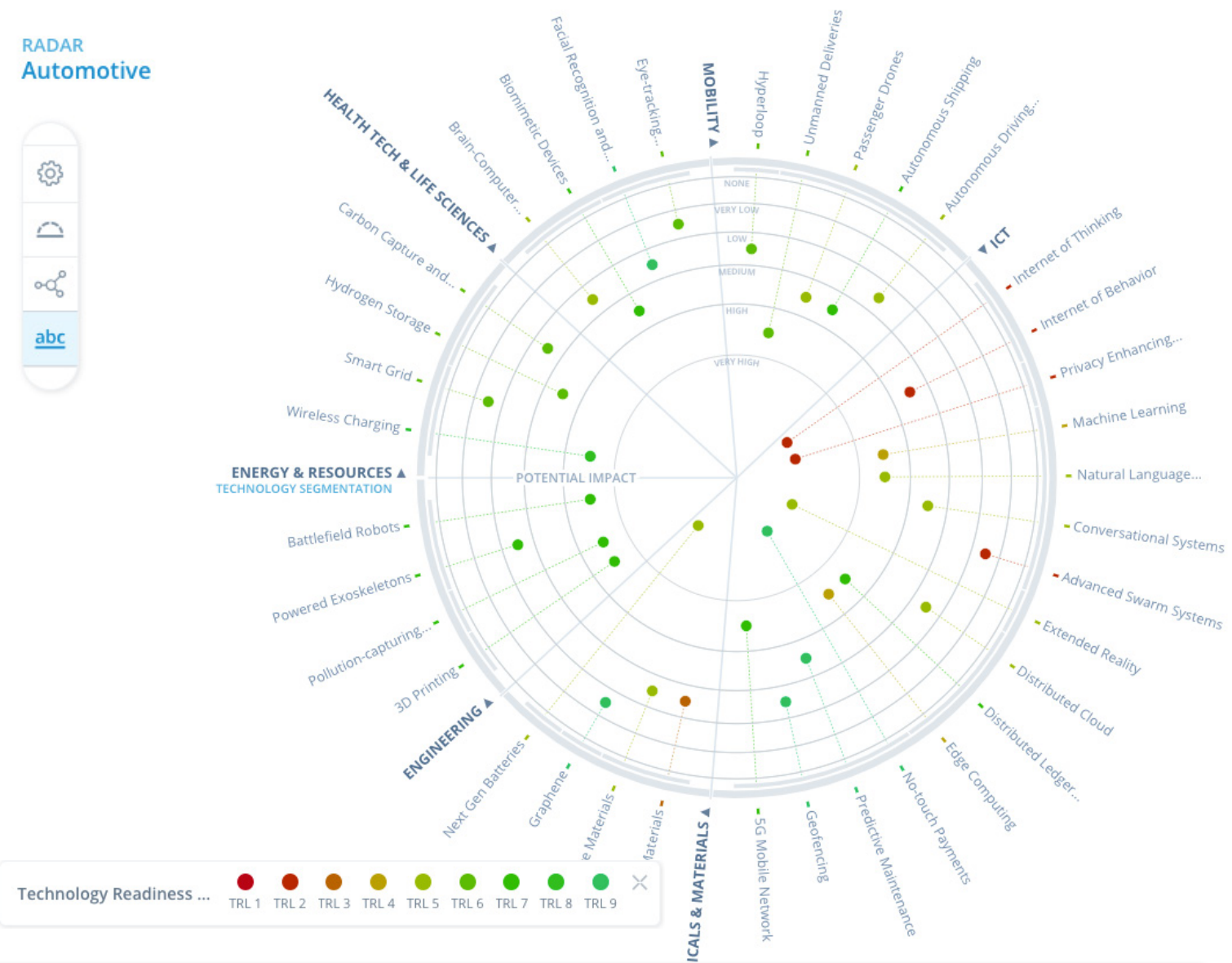
Game-Changing Technologies for Automotive

Explore the selection of Technologies at play in the automotive industry.
Click on the Technology below to view it in the ITONICS

Teaser Technology Radar:

- [3D Printing](#)
- [5G Mobile Network](#)
- [Advanced Swarm Systems](#)
- [Autonomous Driving Technologies*](#)
- [Autonomous Shipping](#)
- [Battlefield Robots](#)
- [Biomimetic Devices](#)
- [Brain-Computer Interfaces](#)
- [Carbon Capture and Storage](#)
- [Conversational Systems](#)
- [Distributed Cloud](#)
- [Distributed Ledger Technology](#)
- [Edge Computing*](#)
- [Extended Reality](#)
- [Eye-tracking Technology](#)
- [Facial Recognition and Biometrics](#)
- [Geofencing](#)
- [Graphene](#)
- [Hydrogen Storage*](#)
- [Hyperloop](#)
- [Internet of Behavior](#)
- [Internet of Thinking](#)
- [Machine Learning](#)
- [Natural Language Processing](#)
- [Next Gen Batteries*](#)
- [No-touch Payments](#)
- [Passenger Drones](#)
- [Pollution-capturing Devices](#)
- [Powered Exoskeletons](#)
- [Predictive Maintenance*](#)
- [Privacy Enhancing Technologies](#)
- [Responsive Materials](#)
- [Self Healing Materials](#)
- [Smart Grid](#)
- [Unmanned Deliveries](#)
- [Wireless Charging](#)

*These Technologies make up ITONICS' pick of the automotive industry's top 5 game-changing Technologies. These are unpacked in further detail in this report.



ITONICS Top 5 Game-Changing Technologies for Automotive

Click below to read more about the industry potential of these Technologies and examples of how organizations are applying them as solutions:

1. Autonomous Driving Technologies
2. Edge Computing
3. Hydrogen Storage
4. Next Gen Batteries
5. Predictive Maintenance

▼ **MOBILITY**
AUTONOMOUS VEHICLE SYSTEMS

Autonomous Driving Technologies

Autonomous Driving Technologies combines two technological disciplines for the benefit of improving the capabilities and safety of autonomous cars.

Deep learning neural networks assist autonomous vehicles (AVs) in detecting obstacles and navigating signals given by other drivers and pedestrians, improving their decision-making capabilities. Deep learning facilitates state-of-the-art solutions to computer-vision problems like image classification, object detection, and facial recognition.

However, training neural networks requires large datasets compared to other AI algorithms, which makes training them a challenge, and gathering sufficient data to train neural networks is very time-consuming.



Technology Ratings

Scope



Potential Impact



Complexity

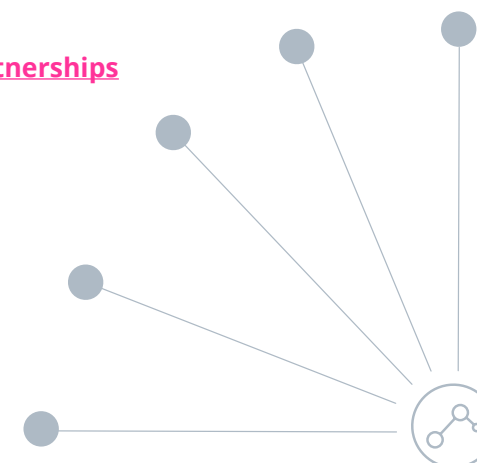


Technology Readiness Level



Related Trends

- [Mobility Ecosystems](#)
- [Road to Autonomy](#)
- [Value Driven Delivery](#)
- [Green and Lean](#)
- [Prosperous Partnerships](#)





Industry Relevance

Improving Road Safety

Autonomous Driving Technologies have the potential to make the roads significantly safer by eliminating road accidents that result from human factors such as distraction or errors in sensing and perception. Efficacy relies on autonomous systems taking into account local traffic laws, road conditions, and nuanced driving strategies.

Congestion and Emissions Mitigation

By accelerating and decelerating more smoothly than human drivers, autonomous vehicles can reduce the stop-and-go traffic that contributes to road congestion while improving fuel economy. However, affordable AVs also present a possible scenario where more cars are on the road as people view long commutes as productive rather than wasted time.

Enhancing Delivery Systems

Applied throughout the shipping and delivery chain, Autonomous Driving Technologies make the flow of goods more efficient, cost-effective, and sustainable. As a result, this can increase accessibility in remote or underserved areas and revolutionize last-mile delivery—which accounts for more than half of total shipping costs.

Five Levels of Autonomous Driving



Source: NHTSA



How is it a Game Changer?

A Stanford Law School report states that at least 90% of all motor vehicle crashes are caused by human error. If autonomous cars gain mainstream adoption, they could largely replace human drivers and virtually eliminate fatalities caused by driver error. Advances in deep learning and computer vision can train these autonomous vehicles to accurately detect the presence of people, crosswalks, and other obstacles in their route. With improved accuracy and better decision-making capabilities, Deep Learning and Computer Vision can eliminate the challenges autonomous vehicles currently face and bring automated vehicles to a point where they require little to no human intervention.



Inspiration

Chinese tech giant Baidu has launched a **robot vehicle** with the highest level of autonomous driving functionality (L5). According to the company, the robocar is an intelligent learner that can analyze passengers' needs in real-time and seamlessly adapt its driving to different scenarios.

Edge Computing

Edge Computing is a computing framework in which data processing occurs closer to the data source—such as IoT devices—instead of in central cloud servers. The shift improves bandwidth availability and reduces latency, speeding up analysis and response times.

Edge Computing is used in smart homes, autonomous vehicles, and communication applications (including gaming) that require low latency and is expected to have further applications in various sectors.

One potential limitation of processing data at the “edge” is that only data deemed as relevant is backed up to the central servers, which could result in the loss of some valuable data.



Technology Ratings

Scope



Potential Impact



Complexity

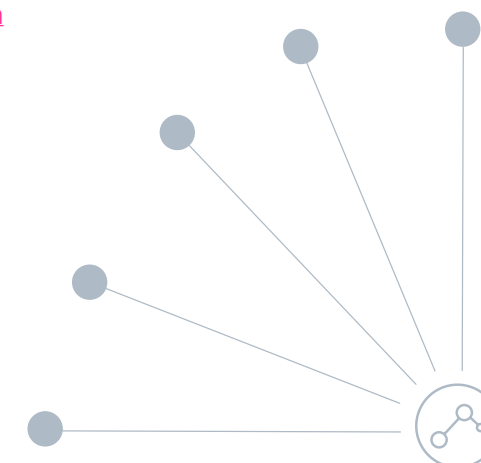


Technology Readiness Level



Related Trends

- [Data Secure by Design](#)
- [Mobility Ecosystems](#)
- [Road to Autonomy](#)
- [Green and Lean](#)
- [Smart Cities](#)



Industry Relevance

Mobility-as-a-Service

With Edge Computing, autonomous and connected vehicles become repositories of data that can underpin mobility-as-a-service offerings. Third parties can use generated data to extend mobility services related to navigation, ride-sharing, and traffic flow guidance. This requires interoperable systems that facilitate the sharing and integration of data between mobility partners and users.

Smarter, Safer Cities

AI-driven traffic management systems (TMS) can analyze traffic patterns and driver behavior, providing valuable and real-time information to city planners and authorities. Edge Computing's ability to transmit and process high volumes of data without the need for costly infrastructure makes it increasingly possible to implement these smart solutions to optimize traffic management and improve road safety.

Privacy in Data Transmission

Together with high-speed connectivity, Edge infrastructure will help maintain data privacy and veracity in connected vehicles, preventing breaches or errors in transmission that could result in road accidents. Edge servers enhance security by meeting the latency and bandwidth requirements for in-vehicle sensors that require real-time authentication between the host and the server.



How is it a Game Changer?

The rapid growth of the IoT is driving the demand for real-time data analysis. Edge Computing can make real-time decision-making a reality by handling the scale and complexity of the vast quantities of data generated by connected sensors and devices. In areas such as autonomous driving and the operation of digital twins—where there is the need for low latency—Edge Computing, aided by 5G communications, will play an essential role.



Inspiration

Texas-based transportation equipment manufacturer Trafficware expands its TidalWave service to nine cities across the US. **TidalWave** is a real-time traffic management solution powered by edge computing and machine learning. Its superior technology provides high resolution and accurate live data for traffic locations, including predictions of future traffic conditions.

▼ ENERGY & RESOURCES STORAGE

Hydrogen Storage

Hydrogen Storage refers to the various methods that are used for storing hydrogen. Some of the current technologies include compressed hydrogen gas tanks, liquid hydrogen tanks, cryogenic compressed hydrogen, metal hydrides, high-surface-area adsorbents, and chemical hydrogen storage materials.

This is the most crucial technology for the development of hydrogen and fuel cells in industries like portable power, transportation, and stationary power.

However, challenges like high cost, high refueling times, high weight and volume resulting in inadequate range in vehicles are yet to be addressed for the technology to fully flourish.



Technology Ratings

Scope



Potential Impact



Complexity

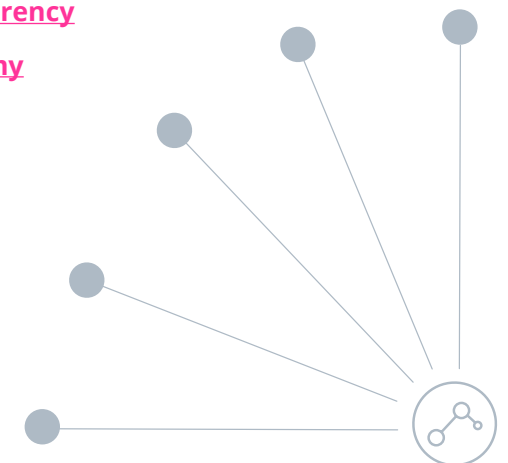


Technology Readiness Level



Related Trends

- [Electromobility](#)
- [Mobility Ecosystems](#)
- [Alternative Energy Transition](#)
- [Carbon as a Currency](#)
- [Circular Economy](#)





Industry Relevance

Net-Zero Compliance

Hydrogen storage can help the automotive industry move toward net-zero. Hydrogen-powered fuel cell electric vehicles (FCEVs) emit only water and warm air, representing a zero-emissions alternative to gasoline and diesel engines. However, the sustainability of FCEVs also depends on the use of green hydrogen produced from renewable energy sources.

Fast Refuelling

FCEVs can be refueled in a matter of minutes—similar to the amount of time it takes to fill an internal combustion engine (ICE) vehicle and significantly faster than charging an all-electric vehicle (AEV) battery. It is, therefore, a good solution for commercial transport vehicles and fleets. However, hydrogen refueling infrastructure remains very limited and is expensive to build.

Extended Range

A full tank of hydrogen can power an FCEV for approximately 300-400 miles. Most AEVs cannot currently match this distance because it would require very large batteries, increasing vehicle weight and charging time. Although, as battery technology continually improves, this range disparity may be narrowed.



The U.S. Department of Energy's Hydrogen Shot Initiative seeks to accelerate breakthroughs to reduce the cost of clean hydrogen by 80% to \$1 per 1 kilogram in 1 decade—overcoming a major threshold to the practical and economic use of hydrogen as an alternative fuel.

Source: DOE, 2021



How is it a Game Changer?

The future will witness hydrogen as an essential energy carrier that has numerous end-uses and is crucial in decarbonizing transportation, building heat and power, and industrial energy. At present, most of the technologies for hydrogen storage are in their prototype or research phase. But with countries like Japan, China, Australia, and South Korea prioritizing and strategizing hydrogen as low emission technology, hydrogen storage, and utilization could potentially disrupt the market within the next ten years.



Inspiration

British automaker **Land Rover** has developed a prototype of its Defender SUV entirely powered by hydrogen. This FCEV model is a part of Land Rover's initiative aimed at exploring alternatively fueled powertrains to deliver on the company's ambitious goal of zero tailpipe emissions by 2036.

▼ **CHEMICALS & MATERIALS**
FUEL CELLS & BATTERY

Next Gen Batteries

Next Gen Batteries is an umbrella term used to describe advances in battery technology that offer greater sustainability, energy efficiency, or lower costs. Factors driving next-gen battery development include the increased demand for sustainable and lightweight rechargeable batteries used in electric vehicles (EVs) and consumer electronics, as well as a growing shortage of rare metals like cobalt and lithium used in current batteries.

New types of batteries, including sodium-ion, aqueous, lithium-sulfur, and metal-air batteries, hold potential. Likewise, solid-state battery technology promises to create safer, more sustainable, and more cost-effective energy storage options. While more investment and R&D are needed, several innovations are showing promise.



Technology Ratings

Scope



Potential Impact



Complexity

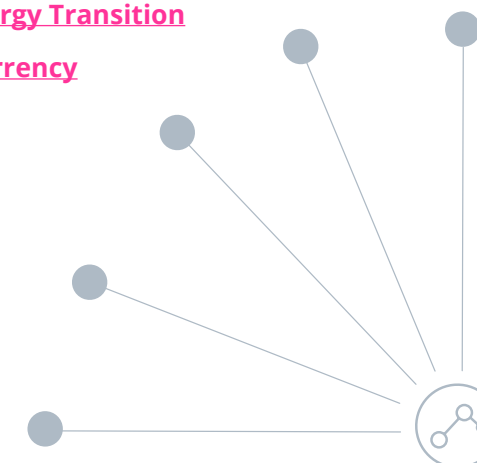


Technology Readiness Level



Related Trends

- [Electromobility](#)
- [Mobility Ecosystems](#)
- [Circular Economy](#)
- [Alternative Energy Transition](#)
- [Carbon as a Currency](#)





Industry Relevance

Widespread EV Adoption

New battery technologies will overcome some of the challenges to widespread EV adoption—such as safety, cost, and charging time. Enhanced battery performance and sustainability, along with pro-EV policies in many countries, will make low- and zero-emission EVs an increasingly attractive and viable alternative to ICE vehicles for consumers and businesses alike.

Alleviating Range Anxiety

While lithium-ion battery technology continues to progress, many consumers still experience range anxiety due to the actual or perceived range limitation and need for frequent charging. However, advancements in Next Gen Batteries such as solid-state and lithium-silicon technologies promise greater energy density that translates to a longer range.

Superlight EVs

Structural batteries, which are efficiently integrated into the chassis structure, provide both energy and mechanical integrity. Whereas conventional battery packs account for a third of the total weight of an EV, structural batteries are a part of the frame itself, and therefore in a sense, massless. They thus allow for the construction of significantly lighter EVs.



“Batteries keep getting better. Average battery energy density is rising at 7% per year and new chemistries are hitting the market faster than ever. Maximum EV charging speeds are also rising.”

Source: Bloomberg, 2021



How is it a Game Changer?

The development of Next Gen Batteries will require innovative mindsets to rethink how energy is stored and transmitted. Batteries that serve as integral structural components in addition to energy and transmission systems will alter product and vehicle design. EV needs will dictate that batteries become safer and more cost-effective, efficient, and sustainable. Alternative materials will gain traction, and the conversion of other types of energies such as biological, mechanical, solar, and thermal energies will increasingly be leveraged to improve energy storage and production.



Inspiration

Chemical company BASF has been selected as the exclusive partner in developing Porsche's **next-generation lithium-ion battery**. BASF's progress in producing high-performance batteries for EVs and closed-loop battery recycling will play an important role in Porsche's aim to achieve carbon neutrality by 2030.

Predictive Maintenance

Predictive Maintenance (PdM) is a system that uses condition-monitoring techniques and predictive analytics to detect anomalies in machine operation and flag issues before they result in failure. This is achieved through the real-time evaluation of data received from smart sensors and IoT-connected machines.

This AI-based predictive model minimizes machine downtime, saving costs and maximizing equipment lifespan. Current challenges to adoption include the high initial investment required and the relative immaturity of IoT technology. Restrictions on data usage, sharing, and privacy concerns may also limit the technology.



Technology Ratings

Scope



Potential Impact



Complexity

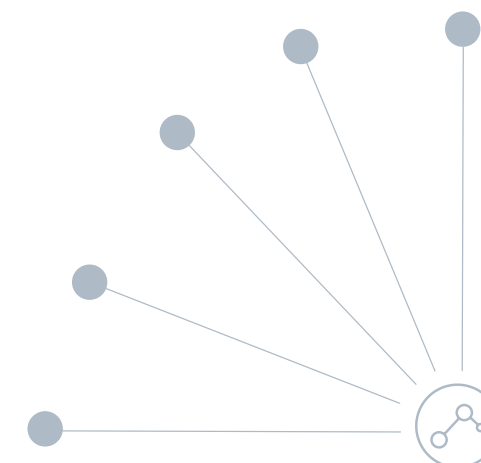


Technology Readiness Level



Related Trends

- [Distributed Manufacturing](#)
- [Green and Lean](#)
- [Automating a Greener World](#)



Industry Relevance

Service Optimization

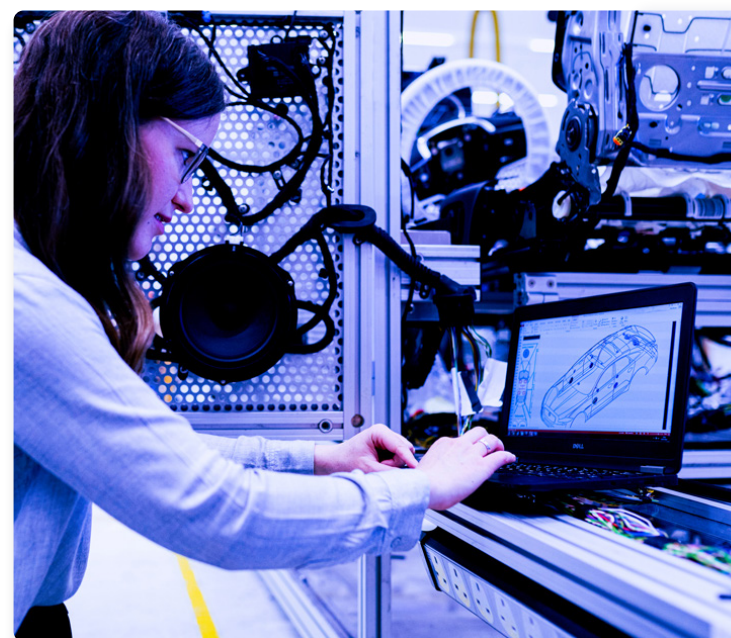
PdM ensures that vehicles are only serviced when required, reducing over-maintenance and no-fault found events. In addition to the cost savings for vehicle owners and fleet operators, this also increases the efficiency of repair and service providers who are able to better manage their time, resources, and spare parts inventories.

Enhancing Service Delivery

Fleet operators and rental companies can use PdM to maximize the uptime of their vehicle assets while creating efficiencies in service delivery for drivers and customers. Real-time data allows for the seamless deployment of road-side assistance, giving service providers the exact location, a pre-emptive understanding of the issue, and the ability to offer remote assistance if feasible.

Insights for Manufacturers

PdM monitors and analyzes a large amount of data from which valuable insights can be derived. Insights related to common parts or systems failures and malfunctions can help manufacturers and suppliers along the entire value chain improve the performance and lifespan of components and systems used in vehicles.



The automotive predictive maintenance market is projected to surpass \$2.7 billion by 2027.

Source: Artesis, 2021



How is it a Game Changer?

The switch from reactive to predictive maintenance will disrupt production, service, and delivery. Cloud-based software and machine learning will expand capabilities to deliver insights that make systems more effective and efficient. With the evolution of 'Industry 4.0' in the manufacturing sector, the integration of IIoT will further enable PdM adoption.

In the automotive sector, companies like Rolls Royce have already started using microbots for vehicle maintenance. In the future, every industry will implement this approach to predict equipment failures and address them proactively.



Inspiration

Singapore-based startup **Carmen** uses predictive analytics to monitor vehicle health. SMS alerts are sent to users via a mobile app or online dashboard to ensure timely service maintenance. This works through a connected in-vehicle Bluetooth dongle that collects diagnostic data and uploads it to the cloud for analysis.

Conclusion

Closing Remarks

The forces shaping the future of the automotive industry are rooted in sustainability and digitalization. These forces are intertwined and multidirectional.

Sustainability sometimes manifests as a market pull—drawn forward by consumer demands, corporate responsibility, and governance. But it is also propelled by technology and green innovation. Developments in Hydrogen Storage and Next Gen Batteries are enabling the rollout of zero-emission vehicles while at the same time intelligent manufacturing and smart supply chain management are increasing transparency, energy and resource efficiency, and overall sustainability.

Meanwhile, digitalization is shifting consumer expectations at every touchpoint—from virtual showrooms with extended reality and in-vehicle interfaces to customized vehicle financing and service delivery through Predictive Maintenance. This enhanced customer engagement is powered by the data generated by each of these touchpoints. Most notably, vehicles themselves are becoming valuable data repositories as embedded connectivity quickly becomes the norm.

Advancements in ICT technologies such as Edge Computing make it possible to transmit, collect, and process a vast amount of data securely and in real-time. This is driving new business models, optimizing production, and enabling autonomous vehicle systems when combined with other Autonomous Driving Technologies like deep learning. While the road to autonomy stretches on, it's clear that the line between automotive and ICT companies will continue to blur as data supremacy emerges as a key differentiator.

Within this context of change, we provide a set of questions for organizations in automotive to consider in the hope of nurturing fresh thinking about the future they wish to be a part of, and play an active role in helping to create.

- What if vehicles become service platforms, compelling OEMs to compete or partner with software companies?
- What if emerging economies can leapfrog internal combustion engine vehicle ownership to clean fuel alternatives and smart shared mobility solutions?
- What if smart city mobility networks and remote working define younger consumer's relationship with vehicle ownership and usage?
- What if consumers are empowered with the choice and flexibility to customize their mobility based on lifestyle?
- What if OEMs embrace intelligent manufacturing and smart supply chain management?
- What if investments in EV technology solve the issues of range anxiety and downtime due to charging?

There are countless questions to be asked about what the future holds for automotive. Finding possible answers to these questions requires a systematic approach and a structured innovation strategy.

The Way Forward

Create a future competitive advantage tomorrow by defining your strategic direction today.

Making better decisions for tomorrow relies on an organization's ability to collect, understand, and act on innovation intelligence—the multitude of building blocks that make up an organization's innovation process.

Scouting the trends, technologies, startups, and other forces of change that are shaping your industry is a crucial first step in this process. But turning this information into innovation intelligence, and subsequently into action, requires additional steps and capabilities that fall within Foresight and Strategy.

Taking Trends & Technologies to Opportunities



1. Discover ITONICS Trends



2. Build Internal Consensus



3. Develop Pictures of the Future

1. Discover ITONICS Trends

Supplement the insights gained in this industry-relevant technology report with an immersion into the trend landscape.

Get started by exploring the ITONICS [Teaser Trend Radar](#) displaying the elements that are most relevant to your industry.

For a full view of the trend landscape, our [Where to Play 2021+ Trend Report](#) contains the complete ITONICS Trend portfolio, presenting 90+ Trends with real-life inspirations and rich analysis.



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2. Build Internal Consensus

In establishing **Where to Play**, it is essential to gain consensus and raise alignment within your organization. This can be achieved through a process of collaborative evaluation. Invite internal stakeholders and experts to participate in rating elements—trends, technologies, scenarios, opportunities, etc.—based on unique industry- and company-specific parameters.

When undertaken in the environmental scanning stage, an internal rating exercise helps empower teams with the consensus needed to ensure strategic relevance, strengthen buy-in, and act decisively.

ITONICS has provided the following internal rating criteria for organizations to consider for trends and technologies:

Technologies

- Technology Attractiveness: How high is the potential value of the technology?
- Internal Know-How: How much internal know-how does your business possess with regard to this element?
- Need for Action: How important is it that your organization take action with regard to this element?

Trends

- Business Relevance: How relevant is this element to your business?
- Strategic Fit: How well does this element fit into your organization's overall strategy?
- Need for Action: How important is it that your organization take action with regard to this element?

The ratings above are pre-set in the ITONICS Showroom. However, organizations can tailor rating criteria to align with their own set of needs and workflows.

3. Develop Pictures of the Future

It's not enough to identify the trends, technologies, disruptive startups, and other drivers of change that are relevant to your industry and organization. To develop an innovation strategy that remains effective beyond the time horizon of key drivers, organizations need to develop realistic and plausible pictures of the future in which these various drivers will unfold. This is done through a process of **scenario planning** and is the basis for discovering future opportunities upon which to act.

Scenario planning is a strategic tool commonly used by key decision-makers, innovation leads, and strategists to find focused foresight, grounded in dependable analysis. This equips them to anticipate exposures appropriately, evaluate innovation opportunities, and inform proactive responses.

What is a scenario?

In the context of business planning and strategy, a scenario is a postulated sequence or combination of events projected to take place that could hold relevance to an organization's future state.

Developing plausible, actionable scenarios requires a systematic approach and organizational participation. It builds on the internal rating exercise, which serves to identify those trends and technologies that hold the greatest strategic relevance and potential. From here, your organization must derive the underlying drivers that are influencing its business environment and extrapolate the different trajectories each driver could take.

Plotting these trajectories against one another and engaging your team's collective and creative input reveals multiple scenario narratives. While each narrative represents a possible future for which your organization may need to prepare, internal consistency and strategic objectives point to those scenarios that should be prioritized.

Your team should prioritize the scenarios they feel hold the most strategic relevance by asking the following two questions:

- Is this a future we hope to play an integral role in creating and shaping?
- Is this a future we hope to mitigate and avoid through thoughtful tactics?

The selected scenarios form a foundational springboard from which your organization can best derive and define clear opportunities—i.e., possible solutions or responses to the various scenario narratives. Use the **ITONICS Roadmap** to plot critical scenario events and develop a timeline of innovation activities required to explore the various opportunities ahead of the horizon in which they are set to occur.

In this way, scenario planning provides organizations with the information required to act on opportunities timeously—as well as the evidence needed to develop appropriate capabilities and assets, actively shape our world, and influence outcomes as they steer towards the future.

To further your innovation journey, all the Trends, Technologies, and Inspirations selected as most relevant to automotive can be found on the ITONICS software using the saved filter: **Automotive Industry**.

The ITONICS solution supports end2end innovation management, from environmental scanning and trend and technology management to building internal consensus and roadmapping.

REGISTER



About ITONICS

We build AI-powered SaaS to innovate, grow, and disrupt.

Our data-driven software platform helps organizations around the globe to identify emerging technologies, trends, and market potentials and translate them into powerful growth strategies.

Supported by artificial intelligence, companies can manage their entire innovation process in a modular software suite to efficiently achieve their business goals and remain future-proof.

Working with global teams to innovate new products, services, and business models, ITONICS professional services inspire, guide, and accompany organizations on their innovation journey. With more than 115 experts on four continents, we support innovation leaders such as adidas, AUDI, CISCO, Intel, Johnson & Johnson, and SAP.

As a strategic partner to key market players across all industries, we systematically advance the topics of innovation, strategy, and digitalization.



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What's Next

Turn Innovation Intelligence into Action

Your digital toolbox for game-changing innovation ▪ Industry-specific Trend and Emerging Technology Radars ▪ Strategic Roadmaps that guide you into the future ▪ Lean Portfolios to manage ideas, technologies, projects, and opportunities	Free access to inspiring insights & content updates ▪ Access to 6 million+ signals to uncover insights at large scale ▪ 90+ Trends, 85+ Emerging Technologies updated annually ▪ 7,000+ freshly curated inspirations maintained	Dependable thought leadership & advisory services ▪ Free innovation maturity assessment ▪ Exclusive access to COFIM Masterclass content ▪ Access to our international innovation community
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You can find us around the globe



ITONICS is a leading SaaS provider of systematic innovation management. The ITONICS Innovation OS combined with a systematic framework to steer innovation efforts helps companies to identify emerging technologies, trends, and market potential and to translate them into customized growth strategies.

With more than 150 experts worldwide, we support innovation leaders such as adidas, AUDI, BMW, CISCO, Intel, Johnson & Johnson, and KPMG.

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