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NATIONAL PROGRAM FOR ARTIFICIAL INTELLIGENCE

ARTIFICIAL INTELLIGENCE OUTLOOK

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AI REPORT

TABLE OF CONTENTS

The Future of AI – Executive Summary

Throughout each section of this report we can see two Ai development trends at play. Firstly, Ai is becoming:

01 AI is becoming a central part of all future data analytics efforts

02 AI is becoming essential for scaling up industry-level smart solutions more quickly.

Time and again, announcements about the integration of advanced solutions into water, energy, waste management, smart city and environmental sector setups point to the necessity of harnessing the kind of computational muscle that AI can provide. In all of these sectors, understanding the true extent and value of operational data is a primary focus for industry leaders who want to revolutionise the way they do things, which is why we are seeing exponential growth in AI investment, research, large-scale implementations and international collaboration efforts.

In every section's 'looking ahead' summary, there is an unbroken theme of AI practitioners becoming more ambitious and strategic with their deployments. This points to a wider willingness to trial, experiment with and ultimately optimise AI solutions, with a view to achieving more rapid (and impactive) results. This seems to be the case in most sectors even against the backdrop of COVID-19's ongoing presence. Undoubtedly, the global pandemic has caused all manner of businesses to hunker down and remain cautious as they look for the best path towards ensuring both their short and long-term survival. However, what's encouraging is how many sector-leading enterprises are deciding that their answer to the current crisis is to innovate and look for better, smarter ways of operating.

As the decade starts off as one of as one of increased risk and volatility, innovation is already being viewed as a necessary safeguard against the uncertainties of tomorrow – better to be flexible and prepared than reactionary and vulnerable. With this attitude gaining ground amongst pioneering elements in all major sectors, AI is well placed to assume a central role in the digital transformation efforts of global business, infrastructure, politics and society in general. During 2020, forecasts of global revenues for the AI market suggest it will hit $156.5 billion by the year's end. This is a CAGR of 12.3% on last year – lower than it might have been but still remarkably strong in light of COVID's significant undermining of global economies and general commercial confidence. As efforts to contain and cure the virus strengthen, general predictions point towards the AI market making a strong return to form in terms of overall growth over the next two years, then going on to really hit its stride and exceed a value of $300 billion in 2024.

The Future of AI – Executive Summary

Exploring the GCC/MENA Context

AI has been of particular interest to nations throughout the MENA region, especially those whose economic health have traditionally been tied to their natural hydrocarbon-based wealth. With renewables ramping up on a global scale, economic diversification is among the top priorities of GCC governments looking to steer their respective nations safely into a new era. Increasingly, AI is looking like a more reliable steering wheel, with its potential to unlock the true value of the region's plentiful wind and solar resources, solve or at least alleviate its growing crises around pollution and water scarcity, build circular economies in waste management, and generally boost the economic and environmental sustainability of the region for generations to come.

AI is predicted to contribute as much as $15.7 trillion to the global economy by the end of this decade, and the MENA region is poised to make up a sizeable part of that total. The UAE and Saudi Arabia – both nations with long histories of being proactive around AI integration and investment – stand to increase their GDPs by 14% and 12.4% respectively, amounting to hundreds of billions of dollars in created wealth, not to mention the creation of a solid foundation for future AI-related opportunities. Regionally, AI could add $320 billion to the Middle East economy in 2030, a whole 11% of its combined GDP. These predictions, if proven correct, will demonstrate a clear correlation between early investment in AI and the reaping of nigh-on spectacular dividends across all the key sectors explored in this report. Regardless, for the majority of the Middle East, economic diversification is an established political policy and investment trend, one that is already being accelerated by the growing sophistication of AI solutions.

So, from building smart cities to securing sustainable energy supplies, cleaning up our global environment, or providing food and water security for all, AI is embedded into the hopes of every major industry to make our shared future a smarter and more responsible one. Even taking the most conservative of predictions, it's clear that this will be a decade characterised by dynamic growth for the AI market, typified by a growing ratio of headline announcements of large-scale AI deployments and breakthrough innovations.

Transforming the Future of Energy

AI is now firmly in the vanguard of a suite of interconnected technologies that are transforming the most important and impactful global industries. The generation, transportation and delivery of energy is among the most pressing environmental and economic challenges facing our species and the world we share, as urbanisation and economic inclusion drive energy demand ever higher. The global transition to a cleaner and more efficient energy future is not just about steadily switching out hydrocarbons for renewables, improving the sustainability of every part of the industry is essential. This is where AI continues to shine as this decade unfolds.

From the creation of smart grids and microgrids, to the optimisation of major city grids and power generation facilities, AI continues to make headway in reducing the net cost and GHG (Greenhouse Gas) emission rates of providing the power that almost every nation worldwide is hungry to secure for its citizen's daily needs as well as their economic future. AI is being woven into the fabric of our energy future, as innovators use it to unlock higher efficiency rates, greater synergies and better methodologies in their respective energy sectors.

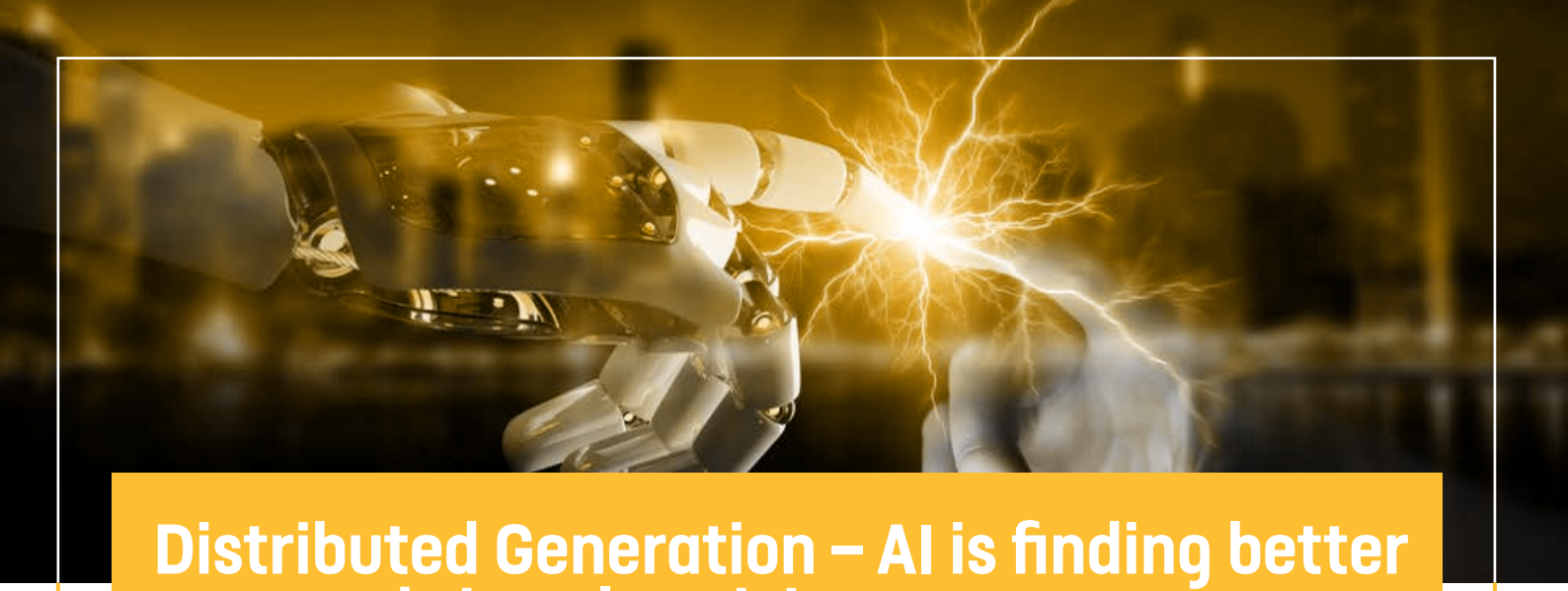
Artificial Intelligence in Energy – Key Areas of Impact:

01 Distributed Generation – AI is finding better ways to bring electricity to everyone

02 Energy Storage – AI is solving a long-standing barrier to renewable energy usage

03 Wind – AI is paving the way for a smarter, more secure and scaled-up industry

04 Solar – AI is breaking new ground each year



Distributed Generation – AI is finding better ways to bring electricity to everyone

The centralised electricity generation and distribution model utilised across North America and Europe throughout the 19th and 20th centuries has served to successfully bring reliable power supplies to hundreds of millions of people. However, the vast amounts of time, money and expertise needed to bring a similar model to parts of the world lacking such infrastructure make it a complete non-starter. Instead, constructing highly capable distributed generation systems – smart grids featuring a higher level of flexible (often renewable-heavy) energy sources along with automated supply chains and emerging innovations such as blockchain, etc – provides a much more sustainable and economical alternative. The rapid development of emerging economies makes extremely fertile ground for this approach, such as Sub-Saharan Africa, where 500 million people will see their per capita income rise faster than the rest of the world, but only 45% of the region's population had reliable access to electricity in 2017. As we see this decade unfold, we can expect the increasingly rapid and widespread deployment of smart grid infrastructure across such regions.

The move away from massive, centralised grids towards smarter, better controlled and supplied distributed models is by no means the purview of the developing world. Leading economies are looking towards technology – with AI in the foreground – to restructure and overhaul their energy sectors to make them future-proofed and fit for purpose in the coming decade. For the Middle East, pivoting away from oil reliance and embracing a new and technologically advanced energy industry setup has been a strategic priority for several decades, with the numerous oil price crashes of recent years bringing the necessity of the move into sharper relief. Demand for energy within the Middle East is anticipated to increase by 20% by 2050, meaning that despite all their improvements in efficiency, renewables cannot hope to cover demand alone. Instead, ramping up renewable capacity alongside industry-wide improvements of existing systems is the way ahead for ME energy providers, with AI at the forefront of respective nations' plans. The UAE, a regional leader in this area, announced in July how its integrated Smart Grid Strategy will involve a series of refinements and new installations with an investment value of almost $2 billion (AED 7 billion) to bring 10 programmes to fruition throughout the 2020s. These AI-empowered programmes involve mass deployment of smart meters, improved asset management, better coordination of big data assets and more.

$2 billion **The projected investment of UAE's integrated Smart Grid Strategy over the next decade.**

A smaller but still highly significant smart grid undertaking is also happening in Egypt, which is indicative of the importance of energy transition to the whole region, not just its leading economies. In mid-July, State-owned Egyptian Electricity Holding Company (EEHC) and French industrial group Schneider Electric signed a $287.5 million contract to construct four new control centres and 12,000 smart ring main units, as well as agreeing on upgrade works for 1,000 distribution points and substations across the nation. The four control centres will become the focal point of the AI-empowered Advanced Distribution Management System, which will be able to monitor, control and reconfigure the entire network with far greater efficiency. Schneider Electric was also keen to point out how the latest cybersecurity tools will be integrated into the system; this is a key area of futureproofing for smart grid infrastructure and it's a topic we will be seeing discussed at great length as more national initiatives get underway.

Energy Storage – AI is solving a long-standing barrier to renewable energy usage

One of the strongest and longest-held criticisms used against scaling up renewable energy solutions is that of the storage difficulties involved. The less reliable power generation levels of wind and solar compared to the 'on/off at the touch of button' benefits of hydrocarbon based power plants means that storing enough energy to make a renewables-based grid consistently reliable has traditionally come at significant cost. AI is changing the landscape here by optimising existing Energy Storage Systems (ESS) for solar and wind facilities, while also regulating consumption and minimising wastage.

Intelligent Storage is an area of great curiosity and rising investment across leading elements of the renewables market, with AI proving ever more crucial in allowing operators to integrate various technologies seamlessly into their existing setup. Moving from a single centralised control setup to a more distributed network of optimised assets is allowing for the creation of much more flexible smart grids that feature advanced utility-scale battery storage, pumped hydro (plus other emerging forms of green hydrogen) and other complementary technologies. Similarly, AI's ability to better understand consumption needs through more accurate analysis of utilities' operational data means that it can allocate supply with far greater efficiency, cutting down on wastage while ultimately stabilising the grid, making it safer and less prone to outages.

Looking towards battery solutions, AI is becoming a tool of choice for researchers and innovators aiming to boost storage capacity and cut down on electric vehicle recharging times with larger and more efficient batteries. In early 2020, a team from Stanford University, the Massachusetts Institute of Technology and the Toyota Research Institute published their findings from battery testing aimed at reducing EV charging times to within 10 minutes. Their results showed how AI can predict the useful life of lithium-ion batteries to within 91% accuracy. Canadian firm GBatteries has already succeeded in building an AI solution capable of recharging a small electric scooter battery within 10 minutes, and claims that through unlocking the AI's potential it will quickly cut that time in half. Also, in June last year a team from Imperial College London demonstrated how their AI solution is speeding up the improvement of designs for the microstructure of fuel cells and lithium-ion batteries by running intensive 3D simulations – an essential outcome for scaling up the transition towards widespread EV and renewable energy usage worldwide.

Wind – AI is paving the way for a smarter, more secure and scaled-up industry

The push to put renewables into the leading spot in various nations' energy mix continues to dominate research and innovation trials across the world, with wind and solar taking the lion's share of the headlines. Wind has been enjoying a litany of good press recently, both in terms of new major investments and efficiency boosts made possible by milestone innovation breakthroughs. Offshore windfarming is of particular interest right now, as the amount of energy it generates has been increasing by almost 30% every year since 2010, but only to the point where it currently generates around 1% of global electricity supplies overall.

The sticking point? Cost-effectiveness. Put simply, placing offshore wind farms further out to sea [Close to 80% of the world's offshore wind resource potential is in waters deeper than 60 metres] allows them to tap into uninterrupted wind flows, but makes them much more expensive as they need to be placed on floating platforms rather than fixed to the seabed. Floating wind farms are still relatively new, and along with the logistical and technical issues around working so far offshore, they are a very expensive prospect to deliver for any kind of large-scale deployment. However, new and planned projects are utilising AI in tandem with other key technologies to overcome this cost-effectiveness barrier. With smart sensors and specialised robots for critical inspection and maintenance works, it is looking increasingly possible for AI solutions to run multiple offshore windfarm installations in a way that is economically viable. Two recent European projects, Windfloat and Hywind off the coasts of Portugal and Scotland respectively, highlight how important this approach will become to the future of wind power this decade, as sector experts have predicted that wind electricity generated from floating platforms should potentially be able to power over 12 million homes in Europe by 2030.

Accurately understanding how much electricity wind farms can generate is another key factor in supporting the growth of the global industry, and this year we are seeing AI help improve turbine output forecasts. Last year, Denmark's Orsted announced it had been overestimating the load factors of its offshore wind farms by underestimating the effect of how wind slows down as it approaches a turbine and after it hits one, known as respectively as "blockage" and "wake" effects. Orsted believes that this is an industry-wide problem and companies are turning to AI to rectify it. Research group DNV GL is one leading organisation reporting high levels of success with using a neural network to improve the modelling of demand forecasting and early-stage detection of performance issues. This is translating into more efficient wind farm setups that can earn greater revenues for their owners – DNV GL's research showed that for an average large offshore wind site, a 1% reduction in load forecast errors could increase its annual revenue by $1.2 million.

As well as helping wind scale up this decade in globally impactive terms, AI is also proving essential for protecting and sustaining wind infrastructure through various challenging scenarios – such as the coronavirus pandemic which is uppermost in everyone's minds this year. Wind turbines and support assets are often constructed in remote locations, even those that are onshore. This makes physical inspection and maintenance extremely difficult, much more so when transport routes and methods are curtailed by unforseen events. This makes the predictive and responsive capabilities of AI all the more attractive as a means of sustaining vital wind assets no matter where they are located.

Solar – AI is breaking new ground each year

Alongside wind, solar is one of the most exiting renewables prospects for the global energy transition. Gratifyingly, the start of this decade has already shown that scaling up solar is proving less difficult than wind, with capacity set to experience continued double-digit growth rates and another 142 GW to be added by the end of this year. Furthermore, capacity is predicted to more than double globally over the next decade, with 125% being added during this period as China leads the way with a massive predicted addition of 285.7GW of new capacity.

However, like wind, the solar industry needs to prove beyond doubt that it can provide reliable, cost-effective electricity generation as it scales up. Doing so will require solar facilities to continue their journey towards being fully 'smart' through the strategic use of emerging technology. To understand how integral this kind of tech-led smart approach is to the solar industry, looking towards Huawei's growing involvement in Middle Eastern solar business provides a telling example. Huawei's substantial R&D investments have yielded highly sought-after AI solutions that are now present in over 1.3 GW of solar PV facilities in the Middle East and Africa, where: "Integrated smart chips have turned the PV plant from a pure power generation facility into a thinking power generation system, similar to the simple-to-smart shift for mobile phones," according to Huawei General Manager, Rui Ma. Already we can see how this approach is unlocking the potential of facilities like the 300MW Sakaka project, Saudi Arabia's first large-scale ground-mount plant, which uses Huawei's 1500V smart PV solution and clocked 13% higher daily output in December 2019 than simulated models.

As well as industrial-level solar facilities, there's promising movement in using AI to upscale interest and investment in putting small-scale solar panels onto the roofs of homes and offices. Flurries of interest in this approach have repeatedly died out over the past two decades, as poor technical capabilities in judging output in an entirely non-standard market (as solar panel power output varies markedly depending on the dimensions of the roof it's placed upon) have led to financial loss and public disillusion. New 'solar calculator' websites and solutions providers are using AI and machine learning to produce consistently an increasingly more accurate predictions of how much any given solar panel might produce when placed on a particular roof. This may not seem like a major breakthrough at first glance, but with a clearer and more accurate picture of cost/benefit ratios, homeowners and businesses can begin to invest in their own solar solutions with greater confidence, potentially leading to millions of new installations within the coming decade.

As well as pure solar energy generation, the applications of AI in using solar energy in other industries have dramatic potential. This was perhaps bet demonstrated late last year when Heliogen, a start-up with backing from Bill Gates, announced that its AI-controlled mirror-based solution can now reflect enough sunlight to generate heat levels above 1000 degree Celsius. This has tremendously exciting implications for industry sectors involved in the manufacture of cement, steel, glass and other essential materials. Instead of using fossil fuels, this technology offers carbon-free sunlight as a fuel source. Given that the manufacture of cement, for example, accounts for 7% of all global CO2 emissions, this technology could represent a world-changing sustainability coup.

Transforming the Future of Water

Along with boosting food security and decreasing air pollution levels, providing enough water of sufficiently high quality for everyone's needs is one of the biggest challenges of the coming decade. As with our combined global energy demand, the desire for more (and better quality) water in residential, municipal, agricultural, commercial and industrial sectors is rising across the board. Sadly, our current water networks are not even capable of satisfying current demand with adequate reliability, with last year's United Nations World Water Development Report estimating that almost half the world's population (3.6 billion people) live in areas that suffer from water scarcity for at least 1 month of the year, every year, and that by 2050, 6 billion people around the world will suffer from a scarcity of clean water. This scarcity is due to a combination of complex and often interconnected factors, ranging from the dwindling of natural water reserves, accelerated by climate change, to mismanagement of existing water network infrastructure.

From manmade problems to naturally-occurring ones, AI is helping us better understand the limitations and inefficiencies of our current water networks, while providing better alternatives that will save and improve water supplies, in quantities that will ultimately save lives and prepare utilities to cope with the rising water demand of future generations.

Artificial Intelligence in Water - Key Areas of Impact:

01 Water Management and Efficiency – AI is plugging the leaks

02 Smart Water – AI is forging a better grid

03 Sustainable Desalination – AI is redressing the water supply imbalance

Water Management and Efficiency – AI is plugging the leaks

While the reduction of available potable water supplies through climate change is a serious concern, one of the critical issues needing to be addressed with all haste is the mismanagement of existing water networks, which is leading to significant waste. A 2017 report from water management services provider Veolia estimated that on average, drinking water networks were only achieving an average efficiency rate of 73.7%, with the remaining 26.3% equating to trillions of litres of water wasted every year. The culprits for water wastage are everywhere, from a leaky showerhead or washing machine in an average home, to burst water mains pipes that go undetected for days, weeks or even months.

This is a global issue, with even world-leading economies suffering from the slow but steady drip of wasted water. In the UK, for example, just under 3 billion litres of water are lost every single day in England and Wales. While this scenario generally results in lost revenue for utility companies and unnecessarily high water bills for consumers, it can also frequently lead to shortages of strategic supplies and resulting periods of water scarcity. For the world's most water scarce regions, this kind of wastage through infrastructural failures is a truly unsustainable situation.

AI is now the driving force behind addressing all manner of water wastage issues, starting with the need to adequately analyse water network data to gain a comprehensive overview of exactly how much water is being lost. Increasingly, water utilities are turning towards more expansive and ambitious deployments of smart meters, sensors, and other IoT hardware to fully understand the extent of what flows through their pipes on a daily basis. This is leading to utilities collecting and storing operational data across millions of devices across multiple applications, requiring them to create platforms that can access everything across the entire data collection setup and react to faults, leaks and other situations with the kind of speed and clarity that will sizeably reduce water wastage rates.

Recent breakthroughs in this area include work done by USAID Global Development Lab and IBM Research Africa using AI and big data analytics to standardise data collection and sharing methods in Southern Africa, with a view to better understanding the true extent of water wastage, contamination and groundwater depletion across the region. Back in the UK, United Utilities, one of the UK's largest water companies, has installed 46,000 of 102,000 sensors planned for integration across its network. This is only an initial stage, as even the planned complement of 102,000 will only cover 10% of the company's entire pipe network. Different types of sensors are being used in concert to detect leaks, with some registering vibrations characteristic of a leak while 'acoustic logger' sensors are designed to pick up a kind of tell-tale humming sound that signifies a leak. The firm's AI system is fed thousands of acoustic recordings and vibration detections every day, allowing it to pinpoint leaks with a reported 90% accuracy level. In Egypt, the Ministry of Agriculture and Land Reclamation is also looking towards AI to completely overhaul the way in which water data is analysed, with particular attention being paid to the rationalisation of water used in irrigation. Their aim is to use more accurate readings of water usage to prompt farmers and landowners to work with them to upgrade the efficiency of their irrigation systems and general water usage habits.

Smart Water – AI is forging a better grid

The combination of sensor networks, data analytics, automation, cloud computing and, of course, AI is leading to the advent of large-scale smart water setups. Whereas twenty years ago a conversation about this kind of water optimisation would have been largely limited to single buildings (a home, a farm, etc) or small, self-contained communities, now we are close to realising the entire overhauling of citywide water grids or the operations of major industrial entities.

1 billion gallons of unbilled water saved by Valencia annually by adopting digital twin technology

The city of Valencia, Spain, provides an encouraging example of what can be achieved in the coming decade. About 1.7 million people in the city (more than half the population) have their water utility services provided by Global Omnium, who have built one of the only "at-scale" digital twins of a citywide water system in the world today, with their AI platform gathering over 6 billion data points per year. A digital twin is a fully realised virtual representation of every single physical asset that makes up a system, which means that Global Omnium can use advanced AI algorithms to run simulations on the digital twin and get a remarkably accurate picture of how any given change would affect the system – from 'what-if' disaster scenarios to planned expansion/upgrade works. Subsequently, they use their findings to improve day-to-day operations as well as long-term planning regarding the system's future upgrades or emergency response protocols. Within the space of a few years of getting the system running, Valencia's water network experienced a 35-40% improvement in network efficiency, a monthly rate of 2,500 leaks reported (many of which would have previously been left undetected) and 1 billion gallons of unbilled water saved annually. In terms of operational efficiency, Global Omnium also enjoyed a 15% reduction in energy costs, maintenance OPEX savings of 20% and generated 2,000 tonnes less in annual CO2 emissions.

Sustainable Desalination – AI is redressing the water supply imbalance

For many parts of the world, the question of their future water supply situation really is one of life or death. Reducing wastage, tracking usage and reducing the environmental costs associated with supplying water are all vital considerations, but the most crucial one for any water-stressed country is whether it can supply its citizens' water needs while maintaining sufficient strategic reserves.

This question has never been so pressing for the MENA region, which now contains many of the most water-scarce places on the planet (with 17 countries below the Water Poverty Line), and has some of the lowest water-availability levels on a per-capita basis. Desalination has been a mainstay in making up the shortfall as naturally occurring water supplies continue to dwindle, but the price tag of high operational costs and resultant carbon emissions remains a major issue for this 'longstanding stop-gap solution'. For example, the Middle East now accounts for more than 60% of the world's total desalination capacity, giving its population vital drinking water supplies but at the same time cutting into hydrocarbon revenues (as fossil fuels power two-thirds of the desalination capacity of the region), increasing CO2 emissions and damaging marine ecosystems by pumping hypersaline brine into the Arabian Gulf and other waterways. Oman alone spent $404 million on government subsidies for electricity generation for desalination plants in 2018, highlighting the ongoing cost of relying on this approach.

Regardless, alternative solutions for supplying potable water at sufficient scale are in short supply, which is leading to a general expansion of desalination capacity in MENA countries, but also a drive to improve the sustainability of such facilities. Desalinated water production in the Middle East alone is expected to grow almost 14-fold by 2040. This is why the need to bring down the cost and environmental impact of desalination has never been stronger. AI is at the heart of this process, with AI and ML algorithms being used to reduce operational expenditure, boost energy efficiency, and aid the rapid digitisation of all desalination plant processes. In all cases, data (and its timely analysis) is essential for predicting when and where maintenance, replacement and upgrade works should take place. Also, as we saw with wind energy generation facilities in the previous section, desalination plants tend to be located in remote, often inhospitable places, making AI-led solutions an attractive alternative to relying on human engineering teams running wholly manual maintenance protocols.

60% of the world's total desalination capacity is in the Middle East

To look at specific use cases of AI in this sector, firms are enjoying increasing success in using AI to predict algal blooms. These are a form of natural phenomena in desalination plants which can cause fouling and blockages of key assets, leading to unplanned downtime and costly repairs. One company, ACCIONA, claimed late last year that its AI algorithm can successfully anticipate algal blooms more than 3 days before they occur, allowing for pre-emptive maintenance to be carried out before the bloom can occur.

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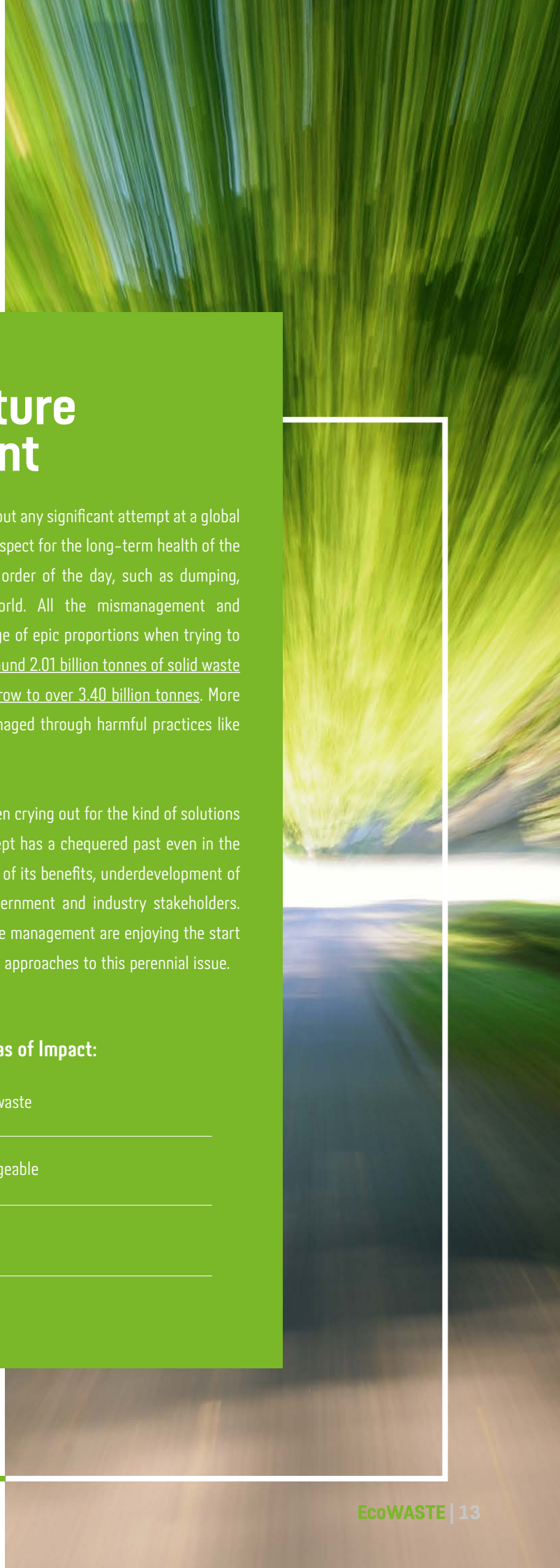


Transforming the Future of Waste Management

Waste is a truly global problem that for far too long has been without any significant attempt at a global solution. Instead of looking for ways to manage our waste with respect for the long-term health of the environment and public health, short-term fixes are often the order of the day, such as dumping, burning or shipping off rubbish to other parts of the world. All the mismanagement and short-sightedness attached to this industry has led to a challenge of epic proportions when trying to establish a better way forward. The World Bank estimates that around 2.01 billion tonnes of solid waste was generated worldwide in 2016 and by 2050 that figure will grow to over 3.40 billion tonnes. More worryingly, at least 33% of all waste generated today is mismanaged through harmful practices like open dumping and burning.

This millennia-old problem of dealing with our own waste has been crying out for the kind of solutions that are both smart and, crucially, scalable. Recycling as a concept has a chequered past even in the most economically developed countries due to overstated claims of its benefits, underdevelopment of facilities and a lack of buy-in from the public and/or key government and industry stakeholders. Fortunately, recycling and other emerging forms of smarter waste management are enjoying the start of a renaissance as technological advances begin to open up new approaches to this perennial issue.

Artificial Intelligence in Waste Management – Key Areas of Impact:

01 The Circular Economy – AI lets us see the big picture on waste

02 Autonomous Sorting – AI can make waste volumes manageable

03 Recycling Ocean Plastic – AI is undoing the damage

The Circular Economy – AI lets us see the big picture on waste

Consumption and waste are intrinsically linked, and both sides of the equation present a big problem for individual countries and the wider world. According to the UN, if we continue in our current consumption patterns, then the resource equivalent of almost three planets would be needed to sustain our predicted 9.6 billion global population in 2050. This is why the term 'circular economy' is being heard more frequently across a wider range of industries. However, moving from 'extract-make-use-dispose' to a 'extract-make-use-recycle/reuse' model is proving a slow and painful process, as economies are up against centuries of ingrained bad habits of consumption dating back to the Industrial Revolution.

$127 billion

The potential value of AI in circular economy setups for food

While creating truly circular economies in any sizeable modern urban area or industrial entity is a highly complicated process, it essentially boils down to having two things – enough data to fully understand the waste situation and enough capacity to deal with it efficiently and sustainably. AI is helping us secure both of these requirements. In terms of data, knowing the type, quantity and quality of waste generated is essential to managing it effectively. AI-empowered platforms can perform analysis on waste flows far better than humans can – and they aren't worried about getting their hands dirty! Already, we are seeing AI solutions greatly impacting on the efficiency of recycling plants – UK-based Greyparrot provides waste recognition software to monitor and sort waste at scale, and claims that AI can bring the industry towards 100% real-time analysis on all waste flows, up from the current 1% global monitoring and auditing rate.

Tech-related circular economy efforts are another key area where AI is providing data-led smart solutions. Microsoft recently reported on the success of its Circular Centre pilot programme for server recycling. In one of its Amsterdam data centres, AI has been integral in reducing the downtime and increasing the accuracy of sorting viable server parts for recycling, while also reducing the cost of transporting and shipping servers processing facilities. Microsoft uses around 5 million servers across its data centres, and each has a lifespan of about five years, making their recycling a sizeable venture in terms of reducing waste and providing parts that can be reused or sold on. Through AI, Microsoft aims to increase its overall reuse rate of server parts by 90% by 2025.

As well as managing the data flows, AI can also optimise circular infrastructure by building and improving setups necessary to "close the loop" by improving processes to sort and disassemble products, remanufacture components, and recycle materials. To take food waste as an example, McKinsey places the potential value of AI in designing and optimising circular economy setups for food at around $127 billion per year in 2030. They see AI being used for a growing range of specific applications at the farming, processing, logistics and consumption stages, such as using image recognition to determine when fruit is ready to pick; matching food supply and demand more effectively; and enhancing the valorisation of food by-products.

Autonomous Sorting – AI can make waste volumes manageable

Once again, scalability is the name of the game when it comes to making a dent in the size of the global waste generation problem. In recent years we've seen leading companies successfully trial and roll out technologies designed to massively speed up the sorting of collected waste; the current phase of the industry's transition is to scale up automated, AI-led sorting solutions so that the benefits of the circular economy can be realised.

The GCC is a key proving ground for this type of autonomous sorting solution, due to its combination of being extremely tech-friendly and forward-thinking on applying said tech to municipal management problems. Efforts to balance the scales are being led by companies like Bee'ah, the region's leading sustainability pioneer, who are aiming to leverage emerging technologies to completely overhaul the business of collecting, transporting, sorting, recovering, recycling and reusing waste. One of Bee'ah's landmark achievements was the launch of WastePro+ in October last year; the end-to-end waste management solution uses AI to coordinate the flow of data of every collection point and truck in the system to ensure that by the time it reaches the sorting and treatment facilities it is ready to be managed in the most efficient and sustainable manner possible. Bee'ah continues to push AI's capabilities in its facilities in Sharjah, the rest of the UAE and other parts of the region with its technology partner Evoteq, with specific efforts now focusing on using robotics to streamline practically every part of the physical sorting of waste.

Outside of the GCC there are plenty of examples that give cause for hope too. In its Geneva facility, Helvetia Environment have deployed a ZenRobotics autonomous sorting solution capable of categorising and sorting up to 8,000 items of medium and heavy waste per hour, allowing the facility to achieve an 80% recycling rate.

While deployments of impressive robotic solutions like this are extremely important for boosting recycling rates and the industry's overall efficiency rates, there is also scope for AI to help improve existing facilities without calling for major infrastructural changes. An AI-powered vision of a sorting plant, using neural networks and modular robotics where necessary, has been proven to create more intelligent and sustainable operations. This approach is gaining ground in the US, Europe and Asia, with operators looking to optimise their existing assets in the short term while also looking towards future upgrades. AMP Robotics is one market exemplar that has enjoyed growing success in installing AI systems designed to monitor current operations, track processing speeds and efficiencies, and analyse accurately the rate and quality of recycling being achieved. In the process, these systems and point out areas for improvement that can be achieved without prohibitive levels of investment. As autonomous systems in recycling and other waste management facilities continue to improve, interim improvements like this will be invaluable in bridging the gap.

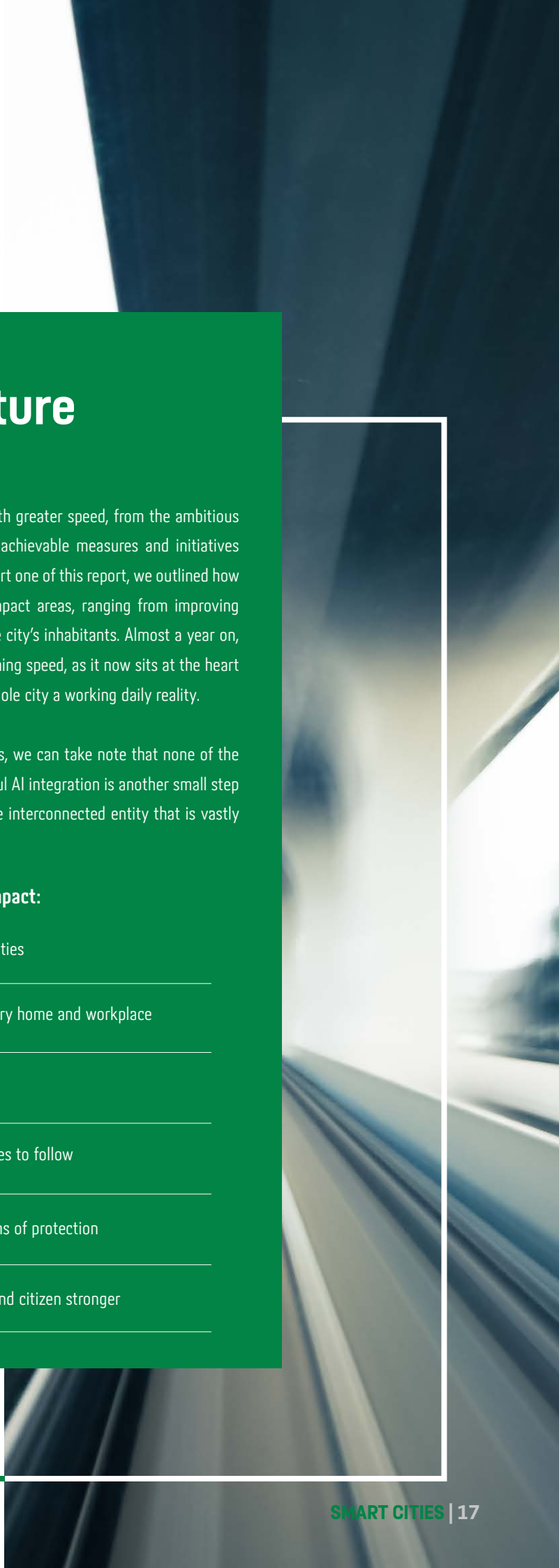
Recycling Ocean Plastic – AI is undoing the damage

The World Economic Forum estimates that the world's oceans now contain at least 86 million tonnes of plastic waste, not to mention vast quantities of chemicals and other pollutant by-products of human activity. Of course, the true figure is impossible to know, as is the extent of the damage being done to marine life and ecosystem across the world's largest bodies of water.

AI is leading the fight to reduce ocean plastic waste levels, as it powers a range of emerging solutions ranging from autonomous ocean-going craft and underwater robots, to coordinating fleets of trash-picking harbour drones and satellites that can detect macroplastics accurately despite being thousands of miles above the Earth's surface.

Autonomous vehicles – drones, mobile robots and aquatic craft – are all proving their growing ability to make tactical, targeted sweeps of areas of either coastal or deep ocean areas and collect plastics from them. Companies are bringing their solutions onto the market in greater numbers with increasing confidence; while most are relatively small in size, their potential lies in their ability to quickly collect plastic to their given capacity, return to a docking bay or similar facility to recharge and disgorge their cargo, and then head straight out again without stopping, all the while without needing human intervention. WasteShark, one water-based drone type launched at the end of 2019 is capable of autonomously collecting 132 pounds of plastic waste at a time, as well as hoovering up biowastes and other waste types before returning to specialised pods to recharge.

Once again though, we return to the question of how best to handle the sheer scale of the ocean plastic waste problem. Faster, bigger and more intelligent robots and drones will be part of the solution, but so will tracking and assessing waste hotspots in such a huge and challenging environment. Satellites are tipped to be increasingly influential in this regard, and recently a research team from Plymouth University successfully used a machine-learning algorithm to train two satellites to map four coastal water areas around the world for concentrations of plastic waste. These were Accra (Ghana), the Gulf Islands (Canada), Da Nang (Vietnam) and Scotland (United Kingdom) and overall the algorithm detected plastic with 86% accuracy, with 100% accuracy for the Gulf Islands tests.



Transforming the Future of Smart Cities

The very concept of 'smart city living' continues to transition with greater speed, from the ambitious daydreams of architects and urban planners towards tangible, achievable measures and initiatives being put in place across the world's leading cities. Last year, in part one of this report, we outlined how AI is impacting the creation of smart cities across six main impact areas, ranging from improving energy efficiency to boosting various forms of security for all the city's inhabitants. Almost a year on, it is plain that the role of AI is continuing to expand with astonishing speed, as it now sits at the heart of platforms designed to make true interconnectivity across a whole city a working daily reality.

As we review the growing impact of AI in the following segments, we can take note that none of the advances explored should be viewed in isolation – each successful AI integration is another small step towards the eventual linking of all citywide systems into a single interconnected entity that is vastly greater than the sum of its parts.

Artificial Intelligence in Smart Cities – Key Areas of Impact:

01 Urban Planning – AI continues to spot gaps and opportunities

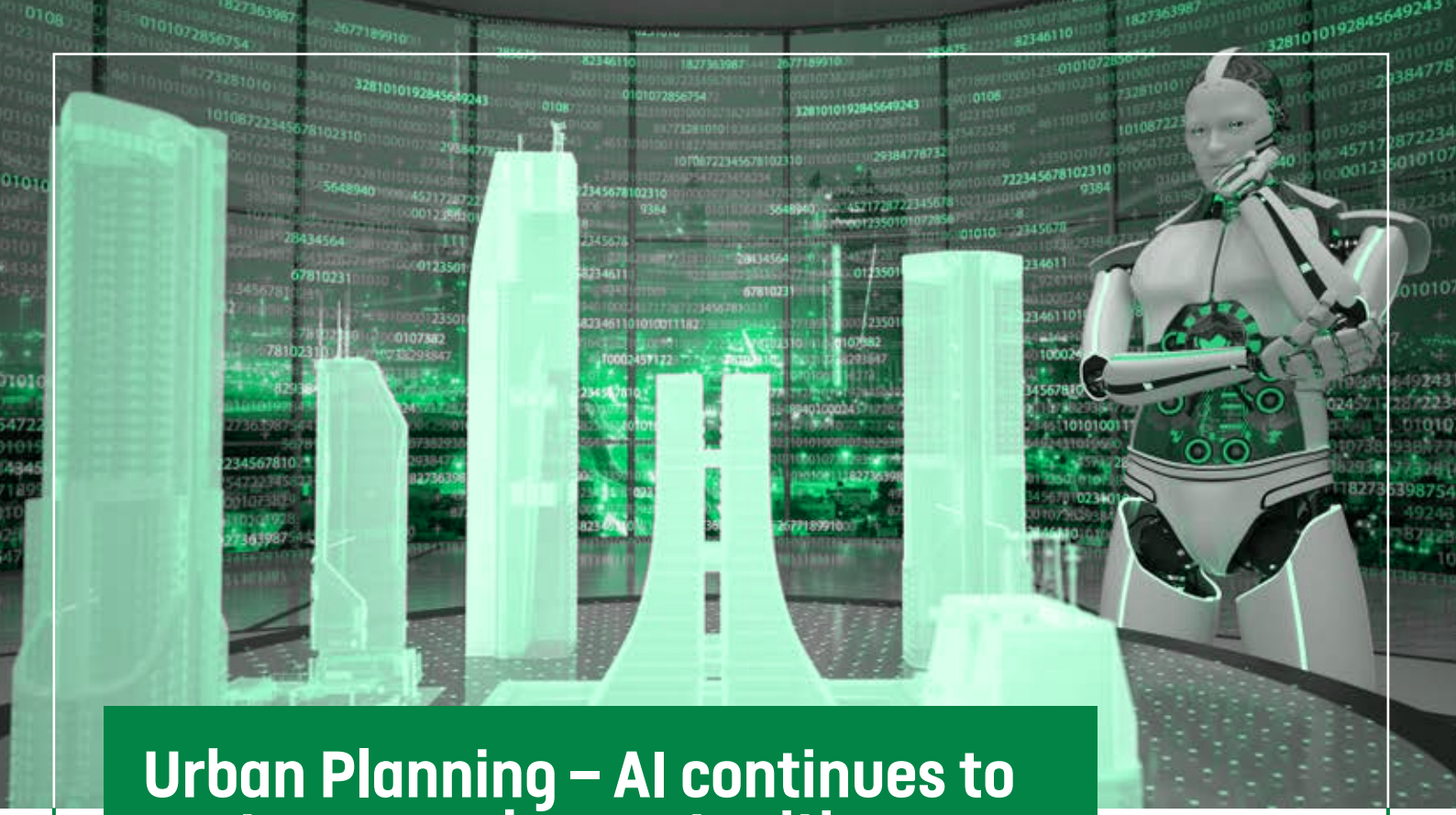
02 Smart Buildings – Using AI to bring sustainability into every home and workplace

03 Smart Health – AI maps a path to healthier city living

04 Transport & Mobility – AI is giving us all better, safer routes to follow

05 Safe Cities – AI is creating more integrated, cohesive forms of protection

06 Smart Services – AI makes the connection between city and citizen stronger



Urban Planning – AI continues to spot gaps and opportunities

Today's big cities are big, complicated beasts with innumerable moving parts. Even the most technologically advanced and economically prosperous cities in the world still wrestle with congestion, crime, utility failures and a thousand other issues on a daily basis. Accordingly, successfully reimagining our entire way of living in cities constitutes a challenge of near-impossible complexity for any human team of urban planners to manage unaided.

While exciting plans to build new smart cities from the ground up are progressing, much of the groundwork for testing smart city concepts is being done in urban areas that have already been built and already have a resident population. For those working in existing cities, the trialling of any new tech-led innovation, any smart city initiative or system, needs to consider myriad factors and challenges present in their target environment. From adhering to established city ordinances and regulations, to minimising disruption to residents, bringing genuinely new and innovative ideas to big city setups is never a simple 'bolt-it-on' operation.

This means that urban planning occupies a crucial place of influence in the success or failure of smart city ambitions, whether they are trying to unlock the full potential of an existing city or are building one from scratch. AI continues to prove its invaluable nature as a means of supporting the vision of urban planners by using data pumped in across the city to spot connections, problems and opportunities with increasing speed and accuracy. From scheduling proactive maintenance work, to undertaking faster, less costly infrastructure assessments in combination with other emerging tech such as drones and IoT-enabled devices, AI is able to optimise existing city assets while helping urban planners better understand how their city should evolve.

As with all things smart city related, data is the critical consideration as AI forges a path ahead into better urban planning. Mistrust issues in light of recent coverage of data privacy scandals and large-scale misuses aside, the understanding of the average city living individual that sharing their data will improve smart city services is starting to take hold. A recent report from Nutanix suggested that most citizens are willing to share data with their government if it will result in creating a smarter city environment for them, with 66% welcoming facial recognition technology as a solution that will do "more good than harm" in the fight against crime.

Data accessibility to improve urban planning is also at the heart of the latest round of decisions announced about the development plan for NEOM, Saudi Arabia's $500 billion smart city dream project. Late July saw Saudi Telecom Company (STC) announce its partnership with NEOM to deliver citywide 5G network infrastructure, which it claims will be one of the most advanced in the world.

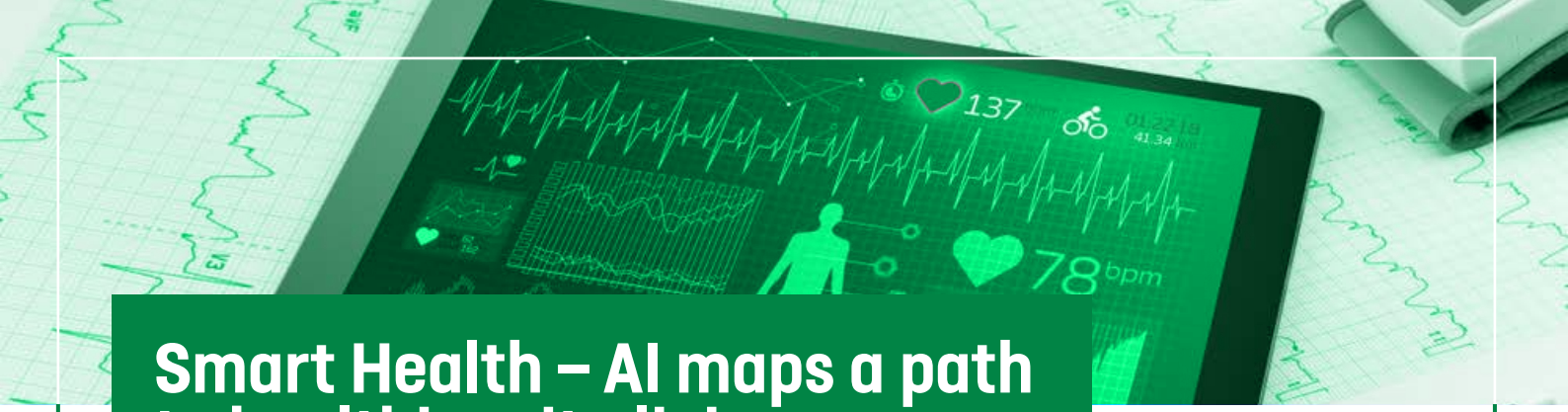
Smart Buildings – Using AI to bring sustainability into every home and workplace

Given that cities are currently estimated to consume over two-thirds of the world's energy and account for more than 70% of global CO2 emissions, bringing down the environmental and economic costs of running every building is one of the highest priorities for smart city idealists. This need is driving both the innovation and the overall growth of the global smart buildings market, which is projected to leap past the $100 billion mark by reaching nearly $110 billion in 2026. Given that 2018 estimates placed the market's value at less than $45 billion at the time, the desire to make buildings smarter is clearly becoming a universal one.

The rising ubiquity of AI in smart building practices, supported by the likes of 5G and edge computing, has led to predictions that such approaches will feature in 75% of all new construction carried out within the next five years. On top of this impressive showing, smart building practices are also being adopted across a widening range of retrofitting activities where legacy buildings need to be brought up to a viable standard of sustainability and safety.

To understand the scale of the potential savings that can be made by making buildings smarter, landmark projects such as the Dubai Silicon Oasis Authority's Integrated Building Management System, IBMS, serve as a useful exemplar. In August, the authority announced that its IBMS now successfully connects almost 60,000 points of control across its 40 different buildings and plants across Dubai. By bringing each building's data and environmental controls together under one state-of-the-art system, DSOA will save $270,000 (AED 1 million) every month, as it markedly reduces wasted energy and unnecessary manpower.

$100 billion The projected growth of the global smart buildings market by 2026



Smart Health – AI maps a path to healthier city living

Understandably, public health is a prime focal point for policymakers and urban planners right now as the world rides the ebb and flow of the current pandemic situation. Looking towards a brighter future, AI is an essential component in ongoing efforts to contain and overcome highly contagious diseases and viral episodes, but also in the broader battle to improve the overall health of everyone as we work making the smart city a healthier, safer living environment for all.

As highlighted in other sections of this report, the advent of 5G networks is making the collection of data in a holistic, citywide manner much more realistic and cost-effective. This has major implications for more strategic use of AI in public health, and accordingly smart cities are investing heavily in video surveillance solutions that use AI to co-ordinate public health responses. With the connectivity issue of bringing together data from across a whole city rapidly diminishing, emerging AI platforms can track and analyse events in real time and formulate responses for situations ranging from disease outbreaks to road accidents or even terrorist attacks.

Looking at diseases once again, tracking the spread of any viral incident or outbreak within a city requires the kind of comprehensive analysis of citywide movements of people and their behaviour. AI can model prospective scenarios and show officials weak spots in their planned responses – this is an approach already being used to good effect in the UAE, where AI modelling is actively informing the country's preparation strategy for potential further waves of COVID-19. AI-backed innovations have also already proven invaluable for limiting face-to-face contact between people as a way of supporting self-isolation and containment strategies across the globe. In Japan, for example, whose government recently passed a 'super cities' bill to speed up the integration of technology into its cities, initiatives are already in place to widen the use of wearables that monitor the condition of viral patients with mild or no symptoms, as well as employing drones for making deliveries of medical items and other necessities to isolated or otherwise vulnerable people.

Looking more specifically at AI in healthcare, the Middle East is proving eager to live up to the claims of its countries' various national strategies and long-term plans for driving systemic public health improvements through technological adoption. AI has become instrumental in creating platforms that bring together blockchain, predictive analytics and the Internet of Medical Things (IoMT) amongst other emerging techs to transform healthcare. Embracing radically innovative thinking is clearly on the rise; the installation of surgical robots has tripled in the region between 2010 and 2019, and within the next five years the sale of surgical robots is predicted to grow by 12% alongside a double-digit rise in robotic surgical procedures being conducted. However, while statistics like these are important in showing the spread of new technology, the time of individual innovations impacting health in an incremental fashion is over; systematic improvements driven by AI-empowered platforms is the new vehicle for transforming the health of whole populations.

AI is also a vital component in the process of speeding up medical research, testing and collaboration between experts and companies around the world. In the UAE, AI has enabled a rapid breakthrough in COVID-19 screening, as Oxford Nanopore Technologies and G42, (a leading UAE-based AI and Cloud Computing company) announced in June that they had successfully developed an unprecedented population-scale technology that rapidly and accurately detects SARS-CoV-2, the virus that causes COVID-19. Once ramped up and in circulation, this mass-screening technology is expected to quickly scale to hundreds of thousands of samples daily, at a far more viable operational cost compared to existing testing methods. This is just one of hundreds of emerging examples worldwide of how AI is greatly reducing the research and discovery cycle, while providing stable, unified platforms for medical researchers to work together effectively no matter where they are in the world.

Transport & Mobility – AI is giving us all better, safer routes to follow

Nothing quite captures the imagination of city inhabitants like the prospect of a future where they can get around more easily, safely and quickly, ideally at a reduced cost to the environment and themselves. Big city traffic and congestion-related pollution are two perennial bugbears that the smart city is determined to abolish for good, and we are seeing steady progress towards the realisation of that lofty ambition.

60% **reduction in monthly traffic violations achieved inYanbu by using a AI-powered Intelligent Traffic Management System**

Now that we have moved on from the concept-proving stage for a number of key smart transportation technologies – such as electric vehicles (EV) and autonomous vehicles – current efforts in leading smart cities are aimed at ramping up the accessibility and reach of said techs. Scalability is the crucial battleground for smart city transport, as any new system needs to fit seamlessly into a transport network serving millions or even tens of millions of inhabitants every day. In the case of EV, even small-scale city projects are repeatedly being held back by the lack of charging infrastructure and worries about the impact of charging stations on the city grid. In the UK, July saw EV charging software-as-a-service (SaaS) provider Electric Miles agree to put 8MW of flexible energy into grids across England and Wales, while also using AI alongside blockchain to optimise the charging capabilities of charge points across these areas. Electric Miles claims that its AI-based solution can create energy savings of 40% per vehicle charge, which will be key in helping the UK transition to the point where mass-EV charging can occur across the country without causing an unmanageable strain on the national grid.

Alongside the sustainability aspect, AI is making it safer than ever to get around cities, whether you drive your own vehicle or use public transport. This is a real target area for improvement, as The World Health Organisation has estimated that about 1.35 million people are killed on roads every year worldwide, with pedestrians, motorcyclists and cyclists making up more than half that figure. To improve road surveillance, safety and policing, cities are turning towards AI solutions that can keep up with the rising volumes of people using urban road systems. Saudi Arabia, a regional forerunner in adopting AI for public services, points towards Yanbu Industrial City as an example of what can be achieved. The city implemented an e-Police system in 2019 that features 256 high-definition cameras all feeding their data into a unified, AI-empowered Intelligent Traffic Management System (ITMS). A year on in its operations, and the system has cut monthly traffic violations by 60%, down to 2,000 from 5,000. This has been achieved thanks to the ITMS's algorithms being able to automatically identify traffic violations and generating query responses much faster than previous systems; it can search over 100,000 data records and formulate a response within seconds.

Safe Cities – AI is creating more integrated, cohesive forms of protection

Keeping millions of people safe while they live together within close proximity presents authorities with an increasingly complex challenge as our cities get bigger and more crowded around premium spaces that are close to the centre of commerce and desirable residential areas.

To take policing as an example, law enforcement agencies have been given a serious upgrade in their hardware as AI creates new tools while improving existing ones. The Dubai Police Force, one of the world's leaders in adopting new technological advances, have adopted a range of innovations this year, such as AI-enabled smart helmets that use facial recognition technology and thermal scanning to seek out individuals with symptoms of COVID-19. This has allowed officers to quickly scan crowds and isolate potential cases while checking them against national databases to run background checks and update records quickly and efficiently. This innovation is being used in conjunction with the capabilities of the Oyoon (Eyes) Project, Dubai's AI smart surveillance network, which is being expanded in light of its instrumental role in facilitating 319 arrests since its inception in 2019. Other additions for Dubai Police include 5G-enabled patrol cars and Police Eye, a secure and confidential online platform for citizens to report crimes and suspicious activities. As one of the few (though the number is growing) police forces who currently use AI extensively and enthusiastically, Dubai Police are confident that their approach is working, to the point where its Commander-In-Chief, Lt General Abdullah Khalifa Al Merri, announced in late July that their goal is to reach a zero crime rate in residential communities in Dubai by the end of the year. Whether this laudable outcome comes to pass or not, the very issuing of such an ambitious target underlines the impact that AI is having on policing.

Safety extends beyond the provision of police protection, of course, and AI is also opening up new approaches for making both public and private areas safer from unseen threats. July saw the Dubai Health Authority announce its launch of a new type of robot capable of performing fast and effective UV sterilisation sweeps of all rooms and corridors in hospitals and health centres where they are deployed. Programmed and controlled by a central AI system, the eight robots currently in operation can perform a complete UV sterilisation of even a large hospital room within 10-15 minutes.

$30.5 billion **The projected growth of the global AI in cybersecurity market – a CAGR of 20.5% between 2020 and 2025.**

Other than physical germs, another unseen viral threat that AI is helping to combat is that of cybercrime. With new and ever more sophisticated cyber threats popping up with worrying speed and regularity, it's clear that spotting such threats unaided is no longer an option. AI is getting better all the time at identifying malware and other forms of malicious code used by cybercriminals by virtue of its ability to spot trends and patterns that a human simply couldn't hope to catch. AI-based network-monitoring tools can track user behaviour for any system, separating out the typical from the suspicious, while also responding to active threats with the kind of speed that, again, a human can't hope to replicate. As a threat modelling, behaviour analysing and threat responding tool, AI is being embedded into cybersecurity setups with growing regularity alongside wider experimentation of its capabilities. Already, this is translating into substantial growth predictions for the global AI in cybersecurity market – in just five years, it will grow from $12 billion to $30.5 billion, a CAGR of 20.5% between 2020 and 2025.

Smart Services – AI makes the connection between city and citizen stronger

The consistent theme throughout each section of area of 'impact' we've discussed so far is one of greater interconnection. AI is creating the right circumstances for building platforms that bring people, data, infrastructure, assets and services closer together, creating higher levels of efficiency and synergy in the process. Nowhere is this more apparent than in smart services – people living in smart cities can look forward to easier access to government services, easier payment of utilities (likely with reduced costs and greater personal control) and more ways to make their opinions and preferences heard regarding the future improvements of these vital services.

In the provision of utilities, AI is not only helping to improve things on the supply side, it's also giving customers added value in terms of greater transparency, control and convenience. The Dubai Electricity and Water Authority (Dewa) is a global exemplar of what can be done with AI in utilities, as the third pillar of its Digital Dewa initiative aims to make Dubai the world's first city to provide fully AI-based electricity and water services. Through extensive testing and expansion of its AI capabilities, DEWA is delivering augmented customer experience, optimised core grid operations and rising levels of productivity across its services. Among its innovations in this area is the growing use of virtual assistants and robots for customer interactions. Rammas, DEWA's smart app virtual employee, has received and responded to over 3.1 million customer requests since its inception in 2017, and with each iteration it becomes capable of dealing autonomously with more complex and detailed requests. DEWA estimated that this innovation alone has saved it almost $10 million (AED 36 million) in operational costs.

Similarly, Abu Dhabi Housing Authority (ADHA) announced in July that due to the implementation of its Robotic Process Automation (RPA) system, it has seen a 88% rise in productivity as the system can process over 4,500 requests per month compared to the average of 2,400 requests manageable by a human employee. This has resulted in greater operational efficiency, a faster cycle of closing transactions and higher levels of customer satisfaction as a result.

Speeding up and simplifying the cycle of receiving, logging, responding to and finally resolving customer requests is of paramount importance for all areas of smart services, as it relates directly to the concept of making smart city inhabitants' lives happier. A July report from Capgemini notes that 57% of citizens believe that smart cities have to provide a better quality of urban services to be truly 'smart', more than a third (36%) are willing to pay for an enriched urban existence and 73% say they are happier with their quality of life in smart cities, dropping to 56% among those who haven't actively used a smart city initiative or smart services.

Transforming the Future of Climate and Environment

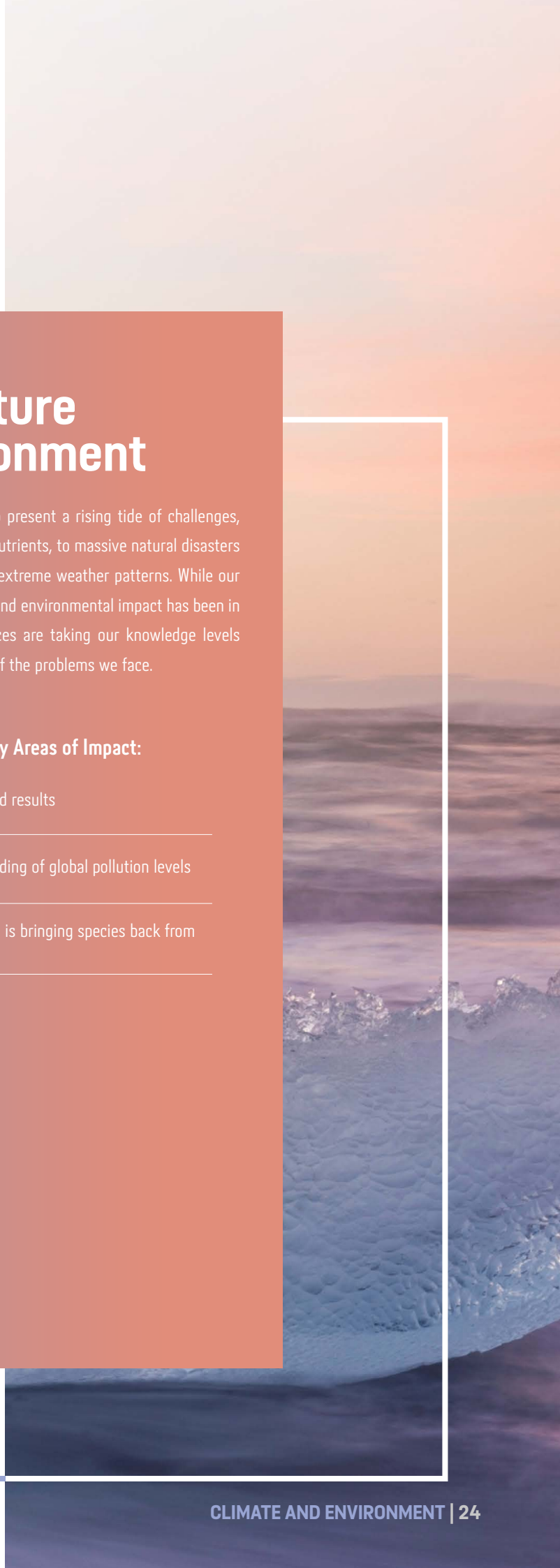
The degradation of our shared global environment continues to present a rising tide of challenges, ranging from depleted natural resources such as water and soil nutrients, to massive natural disasters including unprecedented forest fires and a greater frequency of extreme weather patterns. While our basic understanding of the relationship between human activity and environmental impact has been in place for decades if not centuries, AI-led technological advances are taking our knowledge levels beyond the superficial and delving deeply into the exact nature of the problems we face.

Artificial Intelligence in Climate and Environment – Key Areas of Impact:

01 Food and Agriculture – AI is yielding better predictions and results

02 Air, Water & Soil Pollution – AI is unlocking our understanding of global pollution levels

03 Biodiversity & Ecosystem Conservation & Restoration – AI is bringing species back from the brink



Food and Agriculture – AI is yielding better predictions and results

Farming and agricultural activities are estimated to produce a third of all the world's greenhouse gas emissions, while agriculture takes up around 75% of all global water consumption. There's no getting away from it, putting food on our plates and store shelves carries a huge and unnecessarily high environmental cost. For this essential global industry, massively boosting efficiency and sustainability without sacrificing on the quality or yields of individual crops and livestock is the greatest challenge it currently faces.

As with our other sections, data is a vital resource that is being underutilised in agriculture, and AI is proving similarly useful in harnessing its flow. AI solutions are helping farmers truly understand weather patterns, pest problems, water levels and all manner of essential agricultural factors on a much deeper level. This is allowing them to move from passively reacting to conditions, to proactively predicting key trends and strategising accordingly. Examples coming from across the Middle East – where harsh weather, water shortages and plentiful insects have traditionally conspired to make farming more difficult than more temperate regions – are showing the growing potential of AI to make smart agriculture bloom. For example, the Abu Dhabi Agriculture and Food Safety Authority, ADAFSA, announced in August its first integrated smart algorithm for identifying potential scenarios and risks for the spread of epizootic and zoonotic diseases. Collaborating with other agencies and the United Arab Emirates University, UAEU, ADAFSA's algorithm takes a big data overview of the emirate's livestock and runs simulations regarding the potential spread, infection rates and response scenarios of all manner of animal diseases. This may prove an invaluable means of preparing the UAE for any potential outbreak, improving its containment strategy and boosting food security in the process.

From disaster outbreak scenarios to the daily problem of continuous water waste, Egypt has also turned to AI to boost efficiency in its agriculture sector. In August, the Ministry of Communications and Information Technology and the Ministry of Agriculture and Land Reclamation teamed up to develop a protocol for using AI as a driver of data-led insights into water demand in farming. Between them, the two ministries will be implementing AI systems designed to boost both the overall sector's water efficiency as well as giving individual farmers access to key insights around water demand, through the use of mobile apps and other user-friendly means. This is all part of a wider effort to digitally transform Egyptian agriculture and make it a much more sustainable industry overall.

Air, Water & Soil Pollution – AI is unlocking our understanding of global pollution levels

CO2 emission levels have been used as a key metric by green activists, researchers, governments and news outlets for measuring the vulnerability of our planet's environment for decades, but the pollution of its air, water and soil are equally crucial factors for gauging the world's overall health.

Understanding the full extent of the problem is perhaps not half the battle, but it's certainly a large part of it. One consistent issue with tackling pollution of all types (but particularly air pollution and CO2 emissions) is that it's often a shared global problem but without enough enthusiasm for shared responsibility and response strategies. Without knowing fully where the pollution is coming from, all too often industries are content to pass the buck or drag their feet, claiming that they aren't as responsible as other parties. AI is helping to dispel any such myths when it comes to air pollution, by giving us the means to accurately track exactly where greenhouse gases are coming from. A leading coalition of nine organisations involving former U.S. Vice President Al Gore launched an initiative called Climate Trace in July this year, using AI-based deep-learning models to comb through thousands of images produced daily by satellite networks to achieve accurate global coverage of all fossil-fuel power plant emissions. Starting with CO2 and then moving on to other greenhouse gases, the coalition's goal is to cover 95 percent of man-made GHG emissions in every sector by the middle of next year. Not only will this be a breakthrough in understanding the full extent of our global air pollution and emissions problems, it will also help encourage the biggest offenders to contribute more enthusiastically to solving the issue. In that regard, Climate Trace spokespersons believe that their AI algorithm will also help pinpoint locations where new renewable energy generation facilities should be sited for maximum impact when replacing fossil-fuel plants.

The UAE Space Agency also has plans for bringing AI and satellites together in 2021, by launching a new navigation satellite, followed by an upgraded version in 2022. This marks an important turning point for UAE-based satellite development plans, as the new Satellite Assembly, Integration and Testing Centre in Al Ain (AIT Satellite Centre) is becoming a focal point for using satellites to further the country's digital transformation agenda. Navigation satellites are essential for providing the data necessary for AI platforms need to function effectively in delivering the next generation of smart transportation, smart agriculture, tracking air pollution and much more. With such plans underway, expect to see satellite deployments playing a bigger role in the UAE's overall drive for sustainability through digital transformation.

If you think that water pollution is easy by comparison to track and measure, think again. Rainfall, sunshine levels, storms, soil displacement and, of course, all kinds of human activity mean that pollution levels in any body of water can be unpredictable at the best of times. Using AI to predict and measure water quality is already proving a lifesaver and will continue to boost public health wherever it is intelligently deployed. Globally, contaminated water is responsible for over 1.7 million deaths each year, with more than 90% of the cases occurring in developing countries. With this in mind, AI solutions providers are working fast to make water pollution analysis stronger than ever. Last year, California-based SmartCover Systems used its combination of sensors, satellite communication ability and AI-empowered analytics to create a real-time sewer cleaning optimisation programme in San Antonio, quickly eliminating sanitary sewer overflows, improving the city's water quality and saving $3.4 million within three years.

Biodiversity & Ecosystem Conservation & Restoration – AI is bringing species back from the brink

Cleaning up our air, soil and water will all help provide ideal conditions for life to thrive in all its forms, but certain species and ecosystems need more immediate help right now, as they sit close to the edge of extinction.

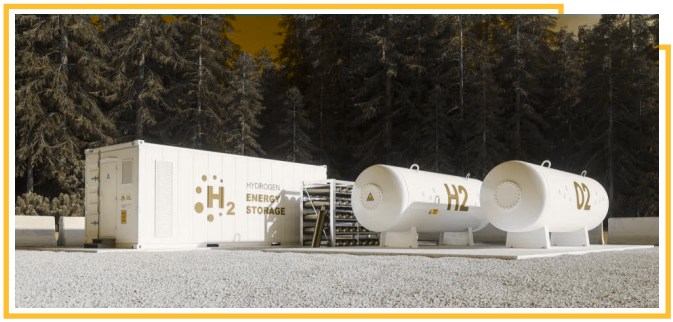
Such conservation efforts are nothing new, even when it comes to large-scale, government-endorsed national programmes, but one of their traditional flaws is that they are frequently carried out without sufficient awareness and knowledge of the size of the problem. From tracking numbers of endangered wildlife, to surveying the extent of situation habitats for conservation and protection, accurate data makes all the difference when battling to save dying species. Major multinationals like Microsoft believe that now is the time to use AI to scale up the availability of data for conservation organisations, allowing them to think and act globally rather than locally. Microsoft's plans for a Planetary Computer platform, unveiled in August, envisage state-of-the-art machine learning tools connecting trillions of data points across the world. By feeding in data collected by sensors, cameras, satellites and experts in the field, the platform will connect and support the efforts of a global community of wildlife biologists and broaden their understanding of all kinds of environmental issues. Initially, Microsoft plans to grant access to leading conservation organisations – over 500 grants in 81 countries – to create an 'AI for Earth' community which will have unprecedented access to critical environmental datasets covering species identification, biodiversity conservation and climate change mitigation, land cover mapping and much more.

Looking towards more nation-specific AI deployments in conservation efforts, in June the Mohammed Bin Rashid Space Centre (MBRSC) announced its planned launch of a scientific interactive platform that will use AI to process imagery and specialised reports from KhalifaSat (the first fully Emirati-built satellite), DubaiSat 1 and DubaiSat. This will give MBRSC the ability to monitor the state of the UAE's soil, air and bodies of water with a previously unmatched level of accuracy and detail. This is going to be a vital supporting pillar of the UAE Government's ongoing efforts to improve environmental conservation throughout the country, by highlighting areas in need of more resources and greater protection. The UAE's total percentage of territory that is now protected as a natural reserve rose to 15.5% on land and over 12% of its marine territory.

Looking ahead Energy

Distributed Generation – AI is finding better ways to bring electricity to everyone

AI technologies are expected to generate between $3.5 trillion and $5.8 trillion annually across the world's energy industries while shaving off as much as 2.2% of all GHG emissions in total. If this potential is realised, AI will make the energy sector the biggest saver of emissions out of all the world's major industries. With more governments committed to hitting ambitious sustainability targets by 2030 and more private enterprises feeling which way the wind is blowing, we can expect predictions on heavy AI investment and implementation to be met or even surpassed.



Energy Storage – AI is solving a long-standing barrier to renewable energy usage

Energy storage is a key battleground for the proponents of a cleaner energy future. Satisfying growing global demand for electricity and personal mobility without sacrificing reliability and affordability will be crucial for accelerating the use of renewables in the global energy mix and the adoption of electric vehicles on our roads. The overall value of AI solutions in the global energy market is expected to hit $7.78 billion by the end of 2024, and its role in improving battery storage systems and Intelligent Storage forms a sizeable part of this valuation.

Wind – AI is paving the way for a smarter, more secure and scaled-up industry

Scalability, security and accuracy of load predictions are all essential for the future health of the wind energy generation industry, and AI factors into all three of these priority targets. While individual innovations around incremental improvements of wind generation efficiency are crucial for proving the economic viability of this rising renewable, what's really exciting from an AI perspective is how we might soon be seeing large-scale windfarms (particularly offshore ones) coming under more direct AI control. From directing operations to organising and executing repair/maintenance works, AI solutions are stepping up to become better holistic control systems that will help make wind farms the secure, cost-effective and sustainable solution needed to satisfy rising global energy demand.

Solar – AI is breaking new ground each year

This is an important year, and indeed, decade, for solar energy development worldwide. By 2029, solar is expected to make up a 6% share of global electricity generation, with masses of new capacity installed and AI leading the way on boosting efficiency as well as creating new opportunities for investment. This jump in market share is being led by a combination of boosted solar efficiency through innovation, rising competition as China and other tech leaders look at solar opportunity hotspots, and finally the sustained trend of growing political motivation to get more renewable capacity into the mix as rapidly as possible. Looking at solar's performance in 2020, it is hard to argue against the idea that these factors have become a virtuous cycle, reinforcing one another as the global energy transition speeds up.

Looking ahead Water

Smart Water – AI is forging a better grid

The political will to reduce nationwide water wastage in many parts of the world is now being met by the technological capability to make meaningful reductions a reality. While potentially daunting for major incumbent utilities who might baulk at investing billions of dollars into replacing aging infrastructure on a large scale, the long-term savings of such an approach are being highlighted and reinforced by emerging examples. Accordingly, the global smart water management market size is expected to grow from $11.7 billion in 2019 to $21.4 billion by the end of 2024, representing a CAGR of 12.9%. We should expect this kind of growth to be maintained and extended as the need to digitalise our most essential utility fully takes hold of the industry. Similarly, the falling cost of key smart water technologies coming to market will drive further deployments, and recent estimates suggest that global water utilities' smart meter installations will experience a 28% cumulative aggregate growth rate to reach nearly 400 million units in 2026.

Water Management and Efficiency – AI is plugging the leaks

A data-driven, technologically sophisticated approach to detecting leaks and infrastructural issues is already proving vastly more cost-effective than relying on laborious manual checks and costly pipe inspection works. With more data being generated and collected across water utility systems, it is inevitable that AI will play a more central role in rationalising and acting upon said data. This will mean more sophisticated deployments of AI-empowered and AI-led solutions being seen across private and public-owned water utilities, especially as more governments are favouring regulatory changes that call for the sizeable reduction of network leaks.

Sustainable Desalination – AI is redressing the water supply imbalance

Right now, only 1% of the world's population depends on desalination for its drinking water. However, as groundwater levels deplete and other freshwater sources are drained while global temperatures rise, this percentage is growing. By 2025, the global water desalination market is estimated to be valued over $32 billion, with AI solutions providing the backbone for the next generation of advanced desalination plants.

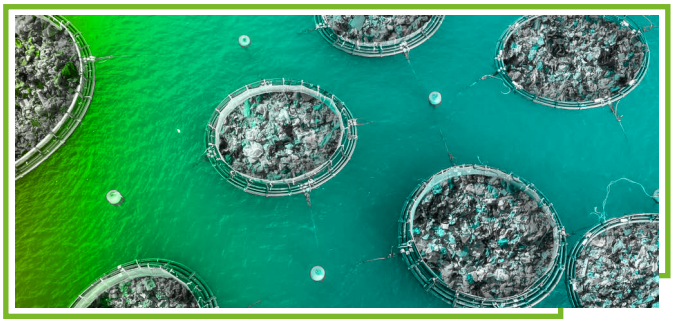
Looking ahead Waste Management

The Circular Economy – AI lets us see the big picture on waste

Moving to a circular economy model has been identified as a $4.5 trillion wealth creation opportunity worldwide, and the GCC region specifically could save $138 billion by 2030 by adopting it. This, alongside the sizeable environmental and public health gains to be made from cleaning up the darker side of waste management, means that there is plenty of incentive for such a transition. Cracking the data side of the problem will likely be the first priority for smart waste management players as the decade unfolds. Getting a truly comprehensive overview of their waste flows is a prerequisite to forming a viable long-term strategy for effectively managing them, so expect to see AI-based data analytics solutions being embedded much more widely across the industry as companies and city municipalities look to move from mass disposal of waste to a programme of recovery, recycling and reuse. The overall smart waste management market is predicted to reach a value of almost $4 billion by 2025, and AI is integral to this steadily increasing valuation.

Autonomous Sorting – AI can make waste volumes manageable

Given that sorting waste by hand is dirty, dangerous and inefficient, it is all but inevitable that human hands will give way to robotic arms with increasing speed across the industry as integration costs fall and efficiency levels rise. The task is simply too complex and problematic to leave to human workers if facilities are going to achieve anything like 100% recycling rates necessary to support a circular economy. The waste-sorting robot market is growing at a CAGR of 16.4% through the forecast years of 2017-2030, and already this is looking like an underestimation as current-day solutions are already demonstrating their marked superiority over a human workforce.



Recycling Ocean Plastic – AI is undoing the damage

Deloitte recently calculated the annual cost of marine plastic pollution to be $6-19 billion a year for coastal communities, not to mention the wider implications of public health and environmental damages and their knock-on effects. However, there are increasingly optimistic reports that with the use of AI and other key technologies, this disastrous trend can start to be reversed within the current decade. Projects like The Ocean Cleanup believe that once their system is rolled out it could remove 50% of the Great Pacific Garbage Patch in just five years.

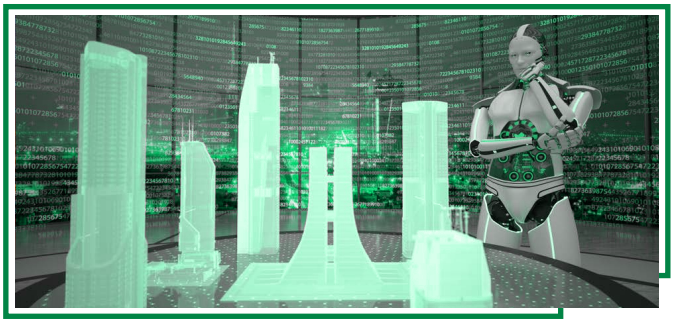
Looking ahead Smart Cities

Smart Health – AI maps a path to healthier city living

As time progresses, we can see how interest in the AI-empowered approach to improving health is being backed with investment – recent predictions on the global smart city artificial intelligence (AI) software market suggest a 700% rise in value between 2019 to 2025, up from $673.8 million to almost $5 billion. This investment drive is due to AI's increasing utility in coordinating a widening range of technological assets that will allow city management branches to understand the reality of public health better than ever before.

Smart Buildings – Using AI to bring sustainability into every home and workplace

While major AI adoptions by large organisations are both impressive and necessary for proving the case for the smart buildings approach to future construction and asset management, what looks really exciting for the technology is the growing potential for its widespread integration into thousands if not millions of ordinary homes. A June report from Frost and Sullivan suggests that over the coming decade, the global AI in homes and buildings market will grow from $610 million to $8.98 billion – a 15-fold increase across the period.



Urban Planning – AI continues to spot gaps and opportunities

As AI continues to build better models of understanding of city environments through smarter collection and interpretation of data, it will subsequently continue to become even more indispensable as an urban planning asset.

Looking ahead Smart Cities

Smart Services – AI makes the connection between city and citizen stronger

Increasingly we're seeing just how big a difference AI can make in delivering outcomes that make smart city citizens happier while reducing operational costs and other forms of strain on city officials and utility companies. Even areas where red tape and frustration were rife are enjoying a leap in efficiency due to AI-based initiatives. As AI platforms for smart utilities and government services become larger, better integrated and more capable, we can expect those efficiencies to compound one another, while bringing in a range of additional benefits to those on both sides of the transaction.

Transport & Mobility – AI is giving us all better, safer routes to follow

While the development of eye-catchingly novel modes of transport (Hyperloop and air taxis spring to mind!) have an important place in the transformation of transportation in cities, AI is unlocking the potential of transport systems that are already in place. Road, rail, even cycle paths and pedestrian walkways – our traditional methods of getting around the city are being aggressively optimised and upgraded under the increasingly watchful eye of AI-based platforms designed to track how a whole city moves, and then make that movement as easy, safe, fast and efficient as possible.

Safe Cities – AI is creating more integrated, cohesive forms of protection

Right alongside better health, providing higher levels of safety and security are hallmarks of the smart city philosophy and, once again, AI is proving itself adept at providing smarter and more informed ways of doing just that. Algorithmic-based insights derived from piecing together thousands if not millions of data points let AI platforms give police, emergency first-responders, government agencies and other authorities a far clearer idea of the problems facing the citizens under their protection, as well as opening up avenues of inquiry for some novel solutions to those problems.

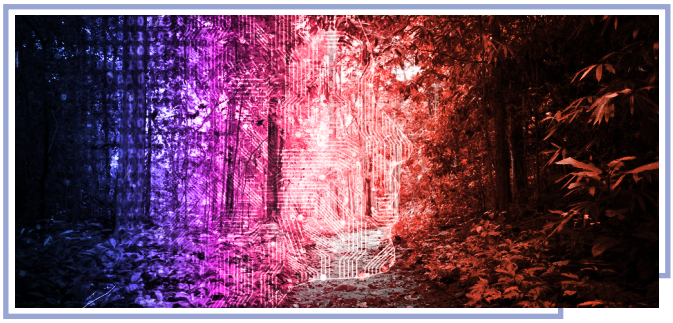
Looking ahead Climate and Environment

Air, Water & Soil Pollution – AI is unlocking our understanding of global pollution levels

AI is central to our future understanding of the severity of various pollution types that are affecting our environment. Collating data from waterways, soil, the atmosphere and even outer space, AI may give us the necessary tools to create a near wholly accurate picture of worldwide pollution by the end of the decade. By understanding and tracking the true extent of the problem, researchers and solutions providers will be much better placed to address and reduce pollution levels across the board. The impact of AI in the satellite market is a particular area of interest to watch, as companies like IBM, Google, SAP, Amazon, and Nvidia continue to collaborate with international space agencies and other private enterprises to integrate cloud computation, machine learning, greater cybersecurity and other AI systems into satellite networks. This is leading to a healthy CAGR of nearly 15% for the global software-defined satellite market, which is projected to reach a value of $3.63 billion by the end of the 2020s.

Food and Agriculture – AI is yielding better predictions and results

Data-led smart farming is the uncontested future of the industry, as farmers in emissions and water-security conscious nations cannot afford to stick to wasteful 'business as usual' practices. From both an economic and regulatory standpoint, this is becoming increasingly unacceptable, requiring farming to pivot towards a more technologically advanced future. This is being reflected in the rising value of the global market for farm management software, which is anticipated to reach $4.2 billion by 2025, representing a CAGR of 17% for 2019-2025. AI is essential for helping farmers to understand the true extent of their options and then maximise their yields by addressing unsustainable practices while planning ahead for more strategic and cost-effective future operations.



Biodiversity & Ecosystem Conservation & Restoration – AI is bringing species back from the brink

The conservation of precious and/or endangered species and ecosystems goes hand in hand with global efforts to tackle air, soil and water pollution. In both instances, data is the key to unlocking successful strategies for limiting the impact of human activity on both local and global environments – and AI is the key to unlocking the data! As the decade unfolds, expect to see more numerous and sophisticated AI integrations into environmental monitoring networks, particularly those using satellites, drones and other airborne technologies.

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