

An aerial photograph of a city skyline, likely Shanghai, featuring numerous skyscrapers and a river. A red text box is overlaid on the top left. The text inside the box reads: "Exploring 4IR-enabled applications for the SDGs".

# Exploring 4IR-enabled applications for the SDGs



Through research, analysis and interviews with a range of stakeholders at the forefront of applying Fourth Industrial Revolution (4IR) technologies across industry, technology firms and research, PwC and the World Economic Forum (WEF) **have mapped 345 technology applications across the Sustainable Development Goals (SDGs)**. This provides both public and private stakeholders with a broad understanding of technology applications that are currently being deployed to tackle the SDGs – helping to guide investment decisions, research and development (R&D) efforts and technology governance. This list of applications is not meant to be exhaustive, but to be representative of the most prominent innovations.

For further details on the methodology, please refer to the insight report<sup>1</sup>.



<sup>1</sup> World Economic Forum, In collaboration with PwC, Unlocking Technology for the Global Goals, [http://www3.weforum.org/docs/Unlocking\\_Technology\\_for\\_the\\_Global\\_Goals.pdf](http://www3.weforum.org/docs/Unlocking_Technology_for_the_Global_Goals.pdf)

**Table 1: Prominent 4IR-enabled applications for Global Goals 1-16, and their maturity**

# 1 No poverty

## High maturity

- Artificial intelligence (AI)-enabled digital footprint for credit/mobile money access
- AI, satellite and drone-enabled disaster risk insurance products (including parametric bonds) and microfinance
- Advanced demographic data analytics
- Blockchain-enabled crowd-finance
- for development projects and charitable organizations
- Inclusion-orientated and community-focused crypto solutions
- Smart pay-as-you-go utilities and shared services

## Medium maturity

- AI-enabled financial market early-warning system
- Transparent and secure land-registry platforms and smallholder identity systems harnessing blockchain
- Transparent and secure records of workers' rights and compensation harnessing blockchain
- Community-distributed marketplaces for goods and services, including peer-to-peer (P2P) trading and smart contracts
- AI- and blockchain-enabled skills matching, access and contracting across global markets
- Blockchain digital identity solutions to enable economic identities, including for refugees

# 2 Zero hunger

## High maturity

- AI, satellite and drone-enabled disaster risk insurance products (including parametric bonds) and microfinance
- Precision agriculture to optimize inputs and returns and early detection of diseases and issues
- Agricultural robotics for harvest and process automation and input-output optimization
- AI- and sensor-enabled prediction to optimize agricultural and food supply and demand prediction
- Low-emission minimum-waste indoor/urbanized farming solutions, including hydroponics and vertical farming
- AI-enabled hyperlocal weather forecasting for agricultural management and prediction
- Low-cost, low-greenhouse gas (GHG) emissions synthetic proteins

## Medium maturity

- Blockchain-based food supply chain traceability and management system
- Crop biotechnology solutions to improve resilience, productivity and nutritional content
- Community-distributed marketplaces for food and agriculture, including P2P trading and smart contracts
- AI-enabled extension services for smallholders to increase productivity
- Low-GHG emissions synthetic fertilizers, including green ammonia and derivative green fertilizers
- AI, sensors and blockchain to eliminate spoilage/loss in food value chain, including smart food storage
- Precision nutrition optimized for individuals and livestock

## Low maturity

- Highly customized, 3D-printed food

# 3 Good health and well-being

## High maturity

- Smart homecare, smart wearables and virtual healthcare assistants
- Monitoring and predicting health metrics and disease, including smart implants, wearables
- Smart hospital management to improve communication, collaboration and performance
- Drones for remote delivery of medicines, medical equipment and samples

## Medium maturity

- AI-prediction of spread of epidemics/pandemics
- AI-enabled analysis of microbial resistance to antibiotics to aid patient care and new antibiotic development
- AI- and sensor-enabled remote monitoring and diagnostics for hard-to-reach communities
- Advanced healthcare learning, e.g. virtual reality (VR) /simulations for virtual patient encounters, AI to form training based on patient results
- Blockchain-powered digital identity for citizens enabling healthcare access
- Secure blockchain-based patient data storage to streamline records
- Smart medical robotics and nanobots to improve surgical performance and access
- AI and digital twins to optimize large-scale, high-speed drug trial simulation
- Emotion recognition for diagnosis and treatment, e.g. diagnose neurodevelopmental disorders and mental health issues

## Low maturity

- 3D printing of medicines and body parts, and lab-grown synthetic organs
- Low-cost personalized medicine (synthetic biology, AI)

# 4 Quality education

## High maturity

- Smart open educational resources to increase affordability and accessibility
- Augmented reality (AR) and virtual reality (VR) training, information and remote learning experiences
- Automating and speeding up teachers' tasks
- 4IR-enabled personalized and adaptive learning, including AI personalized mass online open courses
- AI-driven assessments to enable the delivery of continuous feedback
- AI-designed digital curriculums, teaching plans and content across devices
- Smart tools for school and teacher resource management
- Natural language processing (NLP)-enabled voice assistants and speech to text for inclusive learning support
- AI-based plagiarism detection, e.g. document scans, tests for plagiarism

## Medium maturity

- Algorithms to make informed decisions on student learning and deficit

## Low maturity

- Interactive and multisensory assistive learning to increase student engagement and interaction



## 5 Gender equality

### High maturity

- AI-enabled digital footprint for mobile money access targeted at women consumers and entrepreneurs
- 4IR digital applications supporting women and girls, including those where users can report instances of sexual violence confidentially
- 4IR-enabled educational platforms targeted at girls and women
- AI-enabled remote work platforms to mobilize contingent workforce

### Medium maturity

- Community-distributed marketplaces for goods and services, including P2P trading and smart contracts to facilitate inclusion
- AI to identify and reduce selection bias to support inclusivity
- AI-enabled real-time gender data analytics
- Inclusion-orientated and community-focused cryptocurrency solutions
- Drones for remote delivery of goods, which may free up time in rural communities, especially for women
- AI-enabled cyber abuse detection of sexual and gender harassment
- Open-access gender-equality dashboard at country-wide level
- Blockchain-powered digital identity to enable access to services and finance

## 6 Clean water and sanitation

### High maturity

- Precision and autonomous irrigation and nutrient prescription systems enabled by AI, robotics, sensors, drones and satellite technologies
- Farming technology that minimises water, land and nutrient use, e.g. vertical farming, automated irrigation, aeroponics
- Smart water-infrastructure predictive maintenance
- AI-enhanced scenario modelling for water infrastructure risks and performance

### Medium maturity

- 4IR-enabled traceability to provide consumer transparency on water source
- AI- and Internet of Things (IoT)-enabled real-time water system insights for water suppliers and users including water quality and water availability, and prediction tools
- Blockchain platform to cost-effectively crowd-finance clean water infrastructure development
- Decentralized water systems with smart contract-enabled peer-to-peer water rights trading and dynamic pricing

### Low maturity

- Advanced materials for desalination technology
- Smart nanotechnology and biosynthetic solutions for water desalination, purification and reclamation

## 7 Affordable and clean energy

### High maturity

- 4IR-enabled decentralized and coordinated energy-grid management, including IoT, AI
- Smart infrastructure for operational efficiency and maintenance
- Optimized energy system demand and supply modelling and forecasting harnessing AI and big data
- Alternative energy asset financing mechanisms (e.g. blockchain finance platforms and mobile money)
- AI-enabled virtual power plants to integrate distributed renewable energy sources
- AI- and IoT-enabled predictive maintenance of energy infrastructure

### Medium maturity

- Advanced energy storage (ultra-low cost and high performance)
- Printable renewable assets (e.g. solar coatings)
- 4IR-enabled peer-to-peer renewable energy trading
- Blockchain platform to crowd-finance clean energy infrastructure development

### Low maturity

- Advanced materials for bio-energy carbon capture and storage (BECCS)
- Advanced materials and analytics for next-gen thermal storage (ultra-low cost and high performance)
- Alternative biofuel production: e.g. algae-derived biofuels
- Advanced waste heat capture and conversion

## 8 Decent work and economic growth

### High maturity

- AR/VR training, information and remote-learning experiences
- Robotics for process automation for increased productivity
- AI and big data economic analytics to improve economic forecasting and monetary and fiscal tools
- AI-enabled digital footprint for mobile money access
- AI-enabled transparent inventory management in supply chain for more efficient purchasing power
- AI-enabled digital support hubs for workers
- AI-enabled remote work platforms to mobilize contingent workforce
- AI, cloud, satellite and drone-enabled disaster risk insurance products (including parametric bonds) and microfinance

### Medium maturity

- Community-distributed marketplaces for goods and services, including P2P trading and smart contracts
- AI-enabled supply and demand 'matchmaking' for goods and workers
- Community-growth-focused crypto solutions
- Transparent monitoring, through harnessing blockchain, to help reduce forced labour, modern slavery and human trafficking
- Transparent and secure records of workers' rights and compensation

### Low maturity

- Robotic exoskeletons to assist in manual/physically exhaustive tasks

## 9 Industry, innovation and infrastructure

### High maturity

- Robotics for manufacturing and construction process automation
- Smart IoT-enabled infrastructure for efficiency and maintenance
- Drones and robotics for remote goods delivery and remote infrastructure maintenance
- IoT-enabled tracking and optimization of industrial machinery
- Next-gen satellite, drone and AI-enabled geospatial mapping and AR/VR visualization for infrastructure planning and development

### Medium maturity

- Blockchain-enabled value chain monitoring and provenance tracking of materials
- Automated, 3D-printed buildings and infrastructure
- 3D-printed optimized product design and intelligent packaging
- AI and robotics for precision-strength capabilities and waste prevention
- Blockchain-enabled circularity and sharing business model incentives, e.g. tokenization to encourage collection and recycling of waste
- 4IR-enabled internet connectivity in rural locations (drones, satellites)
- Autonomous and connected mobility solutions for efficiency and systems optimization

### Low maturity

- AI-enabled discovery fuelling industrial R&D and innovation; quantum-enabled discovery
- Advanced materials for sustainable and durable infrastructure

## 10 Reduced inequalities

### High maturity

- AI-enabled digital footprint for mobile money access
- AI and satellite/drone-enabled next-gen disaster risk insurance products (including parametric bonds) and microfinance
- Next-gen demographics data analytics
- AI-enabled platform collating information on social services and policies

### Medium maturity

- AI to identify and reduce selection bias to support inclusivity, e.g. for access to public services
- Community-distributed marketplaces for goods and services, including P2P trading and smart contracts to facilitate inclusion
- Inclusion-orientated and community-focused cryptocurrency solutions (e.g. Brixton pound)
- AI-enabled cyberabuse and diversity and inclusion discrimination detection and mitigation
- Blockchain-enabled digital voting
- Blockchain-powered digital identity to enable access to services, including for refugees
- AI-based real-time tax structures and tax-recovery optimization

### Low maturity

- 4IR improved living conditions for disability groups, e.g. AI sensory augmentation, robotic exoskeletons
- Autonomous cars, built with universal design principles, for people unable to drive

## 11 Sustainable cities and communities

### High maturity

- Sensor-based grid and AI-based urban network management (pollution, waste, water, energy)
- Next-gen satellite, drone and IoT land-use detection and management
- AI-, VR/AR-optimized city design and planning
- 4IR-enabled building-management systems

### Medium maturity

- AI-enabled urban mobility management, including autonomous EVs (e.g. traffic lights, optimal route mapping to relieve congestion/emissions)
- Urban greening infrastructure (e.g. living buildings, pollution sequestration, graphene-based self-cleaning concrete)
- 3D-printed buildings and infrastructure
- AI-enabled supply and demand prediction with blockchain-powered purchasing for logistics
- 4IR-enabled decentralized, peer-to-peer community energy and water grids including AI, IoT and blockchain
- AI-led disaster prediction (automatic thresholds enabling early evacuation warning)
- Drones for remote community goods delivery including disaster relief supplies

### Low maturity

- Advanced construction materials (e.g. low/zero emissions steel and aluminium, zero/negative emissions concrete)
- Building level electricity and thermal storage and conversion via advanced materials (e.g. graphene)

## 12 Responsible consumption and production

### High maturity

- AI-enabled supply chain process optimization and automation
- AI-optimized logistics and distribution networks to minimize costs, emissions and waste
- Digital twins for lifespan performance optimization
- 4IR optimization of industrial machinery, manufacturing and recycling, including robotics for sorting and recycling
- AI- and IoT-enabled consumption and production data analytics

### Medium maturity

- Local 3D-printed products and intelligent packing to minimize distribution-related emissions
- Community-distributed marketplaces for goods and services, including P2P trading and smart contracts
- Advanced biodegradability solutions for products/materials
- AI- and blockchain-enabled data platforms for monitoring and managing sustainable trade
- 4IR technology to eliminate waste in food and fibre value chains
- Blockchain-enabled value chain monitoring and provenance tracking
- AI- and blockchain-enabled life cycle traceability to aid responsible purchasing decisions
- Blockchain-enabled incentive schemes for circular/recycling outcomes
- Advanced materials for low emissions chemicals, steel and aluminium

## 13 Climate action

### High maturity

- Smart and transparent land-use management
- Precision analytics for agricultural management
- Autonomous and connected electric vehicles
- Earth management big data platform e.g. monitoring carbon emissions
- 4IR-enabled building-management systems
- Smart and connected city planning and mobility systems
- Large-scale AI-/drone-enabled precision reforestation
- 4IR-enabled decentralized clean energy grids
- Low-cost, low-GHG synthetic proteins

### Medium maturity

- 4IR technology to eliminate waste in food and fibre value chains
- Advanced battery storage technologies
- Advanced materials for clean energy generation and transmission (e.g. semiconductors, solar coatings)
- 4IR-enabled next-gen weather and climate prediction and response analytics
- Advanced materials for low/zero emissions aluminium, steel and cement
- Technology solutions that reduce the need for travel, e.g. 3D printing of goods and (ultimately) AR/VR experiences

### Low maturity

- Advanced materials for bio-energy carbon capture and storage (BECCS)
- Advanced waste heat capture/conversion

## 14 Life below water

### High maturity

- Habitat monitoring and analytics (e.g. monitoring pH and pollution)
- Marine pollution management technologies
- AR/VR training, information for marine industries (fishing, shipping)

### Medium maturity

- AI-enabled data platforms to monitor and manage fishing activity and compliance
- Robotics for fishery process automation
- Fishery stock forecasting (e.g. automated fish catch thresholds)
- Platform for managing biological assets
- e.g. fishing and shipping, including IoT, AI analytics and blockchain
- Autonomous vessels and connected sensors for automated ocean health mapping
- Alternative financing mechanisms for sustainable fisheries and ocean conservation (e.g. cryptocurrency, mobile money, reward platforms, and microfinance)

### Low maturity

- Coral genome modification to aid resilience (synthetic biology)
- Attracting and removing micropollutants (synthetic biology)
- 3D-printed coral reef structure for marine restoration

## 15 Life on land

### High maturity

- Real-time habitat and land-use mapping, monitoring and detection of illegal or adverse activities
- AI-/drone-enabled precision habitat restoration and precision reforestation
- Autonomous vehicles and drones for planting and feeding
- 4IR-enabled wildlife tracking, monitoring, analytics and pattern forecasting and real-time detection, e.g. disease, animal capture

### Medium maturity

- Earth management big data platform, e.g. endangered species dashboard and rights codification
- AI simulation of animal, plant and habitat interaction
- AI-assisted plant and animal disease identification and detection
- Alternative conservation financing mechanisms, e.g. cryptocurrency, mobile money and microfinance

### Low maturity

- AI-enabled genome sequencing to optimize conservation efforts
- Genetic rescue for endangered and extinct species
- Robotics to control the spread of invasive species, e.g. identify and extract invasive species in a stream

## 16 Peace, justice and strong institutions

### High maturity

- AI-enabled IoT devices for emergency response
- Low-cost biometric identification for the last mile
- AI-enabled digital passport and visas for border security
- AI-enabled identity tax fraud identification (using browsing data, retail data and payments history)
- AI-enabled cybersecurity systems
- Real-time natural language processing to analyse public sentiment to inform policy

### Medium maturity

- AI- and computer vision-enabled public services, e.g. tracking and sentencing of criminals, reducing bias in policing, identification of missing persons
- AI-enabled corruption-reporting platforms
- Traceable and secure record of public spending and supply chains harnessing blockchain
- Blockchain-enabled crowd-finance for litigation, including for SMEs and marginalized groups
- Blockchain and AI-enabled authentication of news and media articles
- Blockchain-enabled digital voting
- AI-enabled cyberabuse and discrimination detection and mitigation
- Blockchain-enabled citizen loyalty and reward platforms

Note: Whilst all of the applications in Table 1 are 'in vivo' in society today, they are at varying levels of maturity, which for simplicity of illustration have been classified into Low (emerging), Medium (improving) and High (mature). In practice, emerging solutions (low maturity) may be more nascent, but over the coming decade to 2030 could still outperform mature solutions (high maturity) in terms of impact, if the enabling environment is supportive and/or the solution itself has a large market and high disruptive capability (e.g. low cost low greenhouse gas synthetic proteins for achieving Climate Action impact).





