PART 2 - TECHNOLOGICAL INNOVATIONS FOR THE EARTH
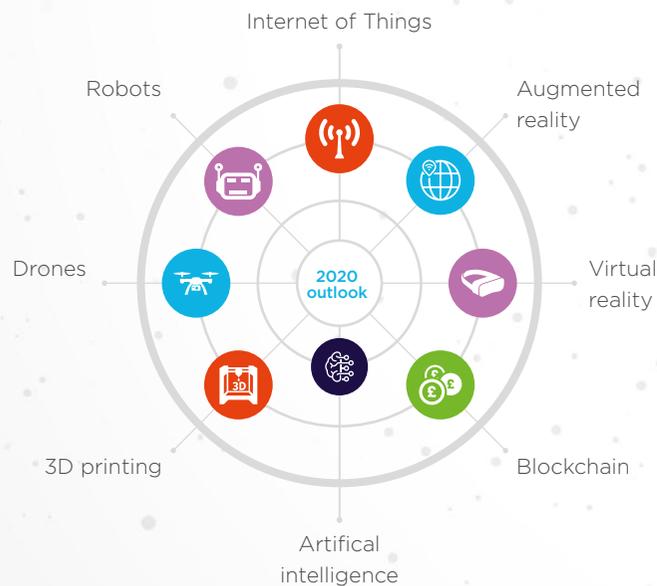
Continuing edie's series of thought-leadership articles on the global impact of megatrends, PwC's sustainability and climate change partner *Celine Herweijer* explores how green innovations and technological breakthroughs are driving the fourth Industrial Revolution.

The essential eight technologies

Internet of Things

Augmented reality

Virtual reality

Blockchain

Artifical intelligence

3D printing

Drones

Robots

2020 outlook

Source: PwC

While the earth has remained relatively stable for 10,000 years, scientists believe that in just a short space of time, we've crossed four out of the earth's nine 'planetary boundaries' – climate, biodiversity, land-system change and biogeochemical cycles.

Meanwhile, in parallel, we are witnessing an era of unprecedented technological change, with the fourth Industrial Revolution ('4IR', as defined by the World Economic Forum) now underway. This is underpinned by rapid advances in artificial intelligence (AI), robotics, and the internet of things (IoT) to name a few.

Using our Emerging Tech Focus tool – and criteria such as speed of take-up, scale of public and private investment, and industry relevance in more than one sector – we charted the 'essential eight' emerging technologies that reflect the development of increasingly autonomous, adaptive and connected machines, and the blurring of the physical and virtual world.
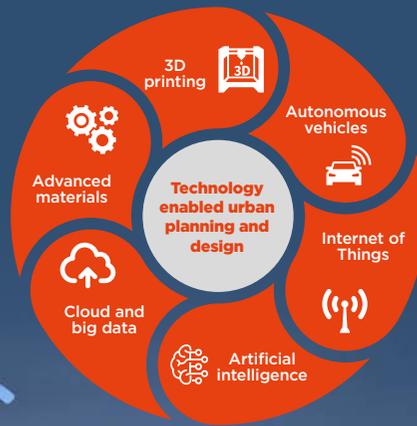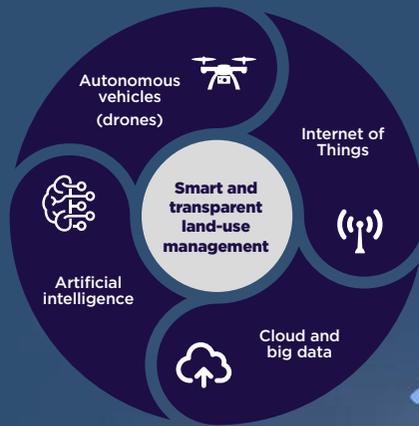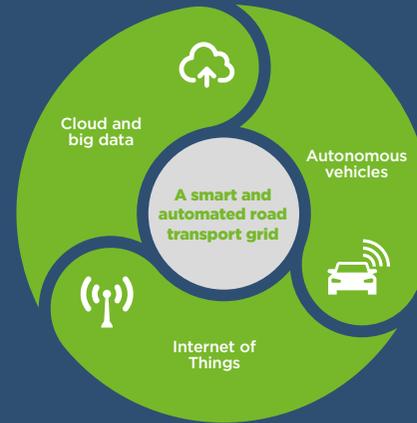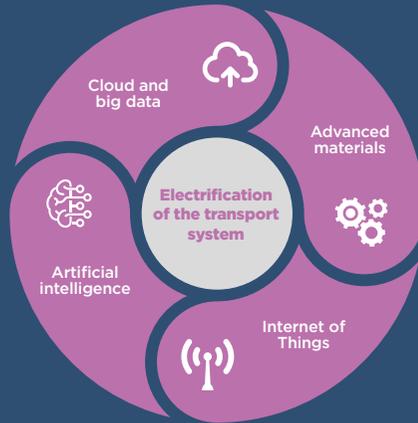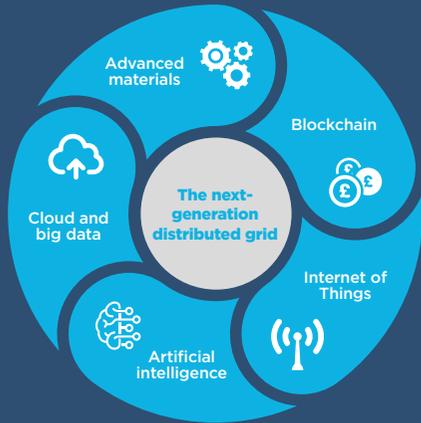
Against this rapidly-changing backdrop, we also wondered if these breakthrough technologies could be used to address our five climate levers: clean power, smart transport systems, sustainable production and consumption, sustainable land use, and smart cities and homes?

In our Innovation for the Earth report, we expanded the essential eight into 10 of the most influential breakthrough 4IR solutions – from advanced materials and synthetic biology to 3D printing. We then looked at the potential to combine these into game changing innovations with potential to drive low-carbon applications across sectors.

Crucially, we found there are multiple ways in which each of these technologies could be harnessed to reduce emissions, potentially rapidly, in our cities, across our transport networks, and through our power distribution and storage networks. ▶

Innovation for the Earth
Emerging game-changing climate solutions building on multiple 4IR technologies

The next-generation distributed grid
- Advanced materials
- Blockchain
- Cloud and big data
- Artificial intelligence
- Internet of Things

Electrification of the transport system
- Cloud and big data
- Advanced materials
- Artificial intelligence
- Internet of Things

A smart and automated road transport grid
- Cloud and big data
- Autonomous vehicles
- Internet of Things

Smart and transparent land-use management
- Autonomous vehicles (drones)
- Internet of Things
- Artificial intelligence
- Cloud and big data

Technology enabled urban planning and design
- 3D printing
- Autonomous vehicles
- Advanced materials
- Internet of Things
- Cloud and big data
- Artificial intelligence

Source: PwC

For example, advanced materials including graphene and nano-quick-charging, energy-dense batteries with the potential to make electric cars both performance and cost-competitive. Then, there is 'Industrial IoT' which is rapidly being adopted across manufacturing, combining smart machines, smart materials, and smart products to create gains in energy efficiency, waste management, and resource productivity.

Innovating to unlock new 4IR solutions is only part of the challenge, however. A number of mainstream 4IR advances could themselves have unintended consequences on the planet, if not designed and scaled in a smart and sustainable way. The energy intensity and energy consumption of blockchain – which facilitates secure online transactions – and IoT are two examples of potential negative impacts.

It is clear that 4IR offers unparalleled opportunities for innovation but it must be enabled by a supportive policy and regulatory environment. The challenge for investors, innovators and governments is not just to help unlock technology breakthroughs for challenges like climate change, but to mainstream the environmental and social impact considerations into wider technological advances – maximising the positive impacts on both people and the planet.

The Essential Eight technologies that matter now

1. **Artificial intelligence (AI):** Software algorithms that are capable of performing tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and language translation. AI is an "umbrella" concept that is made up of numerous subfields such as machine learning, which focuses on the development of programs that can teach themselves to learn, understand, reason, plan, and act (i.e. become more "intelligent") when exposed to new data in the right quantities. ▶

2. **Augmented reality (AR):** Addition of information or visuals to the physical world, via a graphics and/or audio overlay, to improve the user experience for a task or a product. This "augmentation" of the real world is achieved via supplemental devices that render and display said information. AR is distinct from virtual reality (VR); the latter being designed and used to re-create reality within a confined experience.

3. **Blockchain:** Distributed electronic ledger that uses software algorithms to record and confirm transactions with reliability and anonymity. The record of events is shared between many parties and information once entered cannot be altered, as the downstream chain reinforces upstream transactions.

4. **Drones:** Air or water-based devices and vehicles, for example Unmanned Aerial Vehicles (UAV), that fly or move without an on-board human pilot. Drones can operate autonomously (via on-board computers) on a predefined flight plan or be controlled remotely. (Note: This category is distinct from autonomous land-based vehicles.)

5. **Internet of Things (IoT):** Network of objects — devices, vehicles, etc. — embedded with sensors, software, network connectivity, and compute capability, that can collect and exchange data over the Internet. IoT enables devices to be connected and remotely monitored or controlled. The term IoT has come to represent any device that is now "connected" and accessible via a network connection. The Industrial IoT (IIoT) is a subset of IoT and refers to its use in manufacturing and industrial sectors.

6. **Robots:** Electro-mechanical machines or virtual agents that automate, augment or assist human activities, autonomously or according to set instructions — often a computer program. (Note: Drones are also robots, but we list them as a separate technology.)

7. **Virtual reality (VR):** Computer-generated simulation of a three-dimensional image or a complete environment, within a defined and contained space (unlike AR), that viewers can interact with in realistic ways. VR is intended to be an immersive experience and typically requires equipment, most commonly a helmet/headset.

8. **3D printing:** Additive manufacturing techniques used to create three-dimensional objects based on digital models by layering or "printing" successive layers of materials. 3D printing relies on innovative "inks" including plastic, metal, and more recently, glass and wood. ■

Sustainability megatrends at edie Live 2017

This new series of thought-leadership pieces will provide an overview of the environmental and social impacts of the world's megatrends; exploring how they are helping to shape the low-carbon, resource-efficient business of the future.

The series will culminate with a high-level discussion focused on megatrends at the Strategy and Innovation conference on day 2 of edie Live at the NEC Birmingham, 24 May 2017. From climate change and resource scarcity to socio-economics and technology as an enabler, this half day addresses the top level trends that answer the question 'Why act and what happens if we don't?

Find out more about edie Live 2017 and get your free two-day pass here.

edieLIVE
Energy/Sustainability/Resource Efficiency

23-24 May 2017 / NEC Birmingham

Celine Herweijer is a partner in PwC's sustainability and climate change department, and also co-leads the firm's climate change and international development business, along with its work on climate resilience.

Celine has extensive expertise of climate finance, climate policy, climate risk assessment, resilience and disaster risk reduction, private sector development, insurance and sustainable land use and has acted as a key advisor to a number of global organisations including the G20 and World Economic Forum.