IEMA Transforming the world to sustainability

Cross-sector insights: The role of smart solutions in the transition to sustainability

By the IEMA Fellows Working Group on
Disruptive Technologies & the Digital Economy

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Executive summary

Viewed as the defining global health crisis of our time[1], the COVID-19 crisis has added to the perfect storm of issues impacting on organisations, economic prosperity, communities, and health and wellbeing[2]. In parallel to this, the pandemic has also been referred to as the digital accelerant of the decade enabling collaborations at a scale never seen before. Indeed, advances in technology, combined with the mRNA vaccine platform technology, have proven a game changer as researchers have streamlined data-recording to produce a vaccine against the COVID-19 pandemic in less than a year[3].

The cross-sector collaborations (with tech companies) that we have lived through during this pandemic have proven that when the data is available, smart solutions such as online health care could provide a blueprint for how technology can create positive environmental and social impact in support of sustainable outcomes.

Taking note of this potential, this document sets out practical recommendations extracted from case studies submitted by IEMA members and technology experts working to ensure disruptive technologies can support a transformation towards sustainability.

The recommendations seek to illustrate how professionals can carry out the seven key actions set out in the 2019 IEMA Thought Piece on Disruptive Technologies & Sustainability[4]. Highlights from some of the recommendations in the case studies are included below as mapped against the key actions:

Key action 1: Thinking about your business strategy (key market drivers in your industry and where the main opportunities and risks lie)

Recommendation: align strategic and sustainability goals

Telecoms – OneWeb (space-based global communications network) case study:

- *Sustainability benefits of smart solutions that originate from greater connectivity can be wide ranging, extending to health and wellbeing, and the natural environment. There is a need to align sustainability goals with the overall business strategy, including required collaborations.*
- *Organisations should explore the Sustainable Development Goals (SDG) and the associated targets that a given technology can benefit by mapping these pathways to their operations. This will help avoid using the tech as a 'bolt-on' to the mission, bringing about sustainable change and exploration of innovative ways of using technology for good.*

Key action 2: Developing a clear short-term plan for upskilling management and board level professionals

Recommendation: enhance training plans

Health – NHS Digital/Built Environment – Leeds City Council, Qualis Flow case studies:

- *To prevent building in additional negative environmental and social impact, sustainability professionals within different organisations should develop clear plans for upskilling management and board members with enhanced technology and sustainability skills. This will enable organisations to integrate relevant digital systems and new collaborative business models so that technology solutions support multiple teams within organisations, all working towards this common goal.*

Key action 3: Creating or participating in forums with other stakeholders and technology providers to learn, discuss and explore new opportunities offered by disruptive technologies and innovators within your industry/sector.

Recommendation: collaborate in support of knowledge sharing

Transport – Brighton & Hove Buses; Sopra Steria case studies:

- *Professionals and/or organisations should support knowledge sharing from the tech projects they have led, be it through multi-stakeholder discussions with local authorities or in workshops with other regions (e.g. Brighton & Hove, Sopra Steria case studies) so as to maximise the opportunities for replicating the project in other sectors and upscaling sustainable outcomes.*

Key action 4: Using your sustainability expertise to engage in multi-stakeholder debates with technology companies, finance professionals and your government representatives to ensure the setup of a suitable infrastructure for a sustainable digital economy.

Recommendation: collaborate across sectors to finance sustainable infrastructure

Transport – Brighton & Hove Buses; Sopra Steria case studies:

- *Bus operators such as Brighton & Hove Buses are working with councils across Sussex, facilitating vehicle manufacturers and finance providers to influence policy makers in support of a sustainable digital economy. Sustainability professionals should encourage their organisations to seek out opportunities to engage in discussions and partnerships as these can be a key factor in the organisation securing year-on-year patronage for technology solutions.*

Key action 5: Adopting a 'circular economy approach and whole systems thinking' when engaging in your organisation with new technology

Recommendation: embed flexible processes to support a circular approach

Energy – Siemens / Built Environment – Qualis Flow case studies:

- *Multi-stakeholder development projects that integrate disruptive technologies are complex. To achieve the desired sustainable outcomes, sustainability professionals should agree upfront with all critical stakeholders the objective vision for application of the technology. At the same time, they should secure agreement on an agile and dynamic approach to cater for any required changes in planning and technology design that accommodate improvements and enhanced resource management.*

Key action 6: Encouraging/investing in the use of data analytics and more open and collaborative cross-sector data exchange models within your sector and establishing the sustainability value of disruptive technologies.

Recommendation: actively support standardisation and harmonisation of data

Agriculture – Mondra & Agriculture and Horticulture Development Board (AHDB) case study:

- *Accessing the data of digital technologies used in the energy, built environment and transport sectors will be crucial to ensuring a successful journey towards net zero, but also a more resilient and sustainable society. Mondra and AHDB are actively working with stakeholders in the agriculture sector to encourage the harmonisation of data and standardisation of environmental footprinting. Sustainability professionals should encourage senior management in their own organisations to follow suit and sign up to data standardisation initiatives that incentivise the use of digital tools that support net zero targets.*

Key action 7: Supporting a 'cyber security culture' that extends beyond information exchange when using technology

Recommendation: implement clear data governance processes that enable data sharing for sustainability

Transport (Rail sector) – Yumuv (Trafi) case study:

- *Building trust in technology is a key challenge as exemplified by Yumuv and its Mobility-as-a-Service application. To ensure the technology continues to support sustainable transformation and avoid* ***data protection*** *concerns by all key stakeholders, sustainability professionals should establish clear data governance processes and transparency rules from the start of the project. This will enable greater levels of data sharing between organisations in support of sustainable outcomes.*

IEMA will continue to support the profession through this transition to a sustainable digital economy by providing accessible training, practical and skills-based webinars, regular updates and member insights on the impact of tech for sustainability, and the marketing of relevant external opportunities for further tech training.

In the meantime, we hope that the recommendations set out in this thought piece, will provide readers with further practical guidance on how to better engage with smart solutions in their own organisations.

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Contents

Introduction

Since 2019 and the release of the IEMA Thought Piece on Disruptive Technologies & Sustainability[5], the world has been hit by the COVID-19 pandemic. Viewed as the defining global health crisis of our time[6], this pandemic has added to the perfect storm of issues impacting on organisations, economic prosperity, communities, and health and wellbeing[7]. It has radically changed the way we live and brought about collaborations between organisations at a pace that would have been considered unachievable only a few months before[8].

COVID-19 has since been referred to as the digital accelerant of the decade, further enabling the transition to a digital economy[9]. An example of this has been the increase in remote working, companies having moved 40 times more quickly during the crisis than they thought possible before (it took 11 days instead of the 1-year pre-crisis estimate)[10].

The cross-sector collaborations (with tech companies) that we have lived through during this pandemic has proven that when the data is available, the application of smart tools in the fight against COVID-19 (e.g. online health care) could provide a blueprint for how technology can create positive environmental and social impact in support of sustainable outcomes and the fight against climate change.

While cities, regions and countries plan their recovery from this pandemic, organisations in the public and the private sector (including IEMA members such as NHS or Siemens) continue to come forward with their commitments to a net zero-carbon footprint and ambitious sustainability strategies. In the tech sector, Microsoft itself has committed itself to become carbon negative, through a plan to reduce and ultimately remove Microsoft's carbon footprint[11]. This presents a unique opportunity for sustainability professionals to ensure the adoption of the best technology to ensure a sustainable transition to a digital economy.

The 2019 IEMA thought piece identifies seven key action areas that can be integrated by a professional or their organisation to support the transition to a digital economy including:

1. thinking about business strategy (key market drivers in your industry and where the main opportunities and risks lie);
2. developing a clear short-term plan for upskilling management and board level professionals with enhanced technology and sustainability skills to help integrate relevant disruptive technologies and new collaborative business models within your organisation;
3. creating or participating in forums with other stakeholders and technology providers to learn, discuss and explore new opportunities offered by disruptive technologies and innovators within your industry/sector;
4. using your sustainability expertise to engage in multi-stakeholder debates with technology companies, finance professionals and your government representatives to ensure the setup of a suitable infrastructure for a sustainable digital economy;
5. adopting a 'circular economy approach and whole systems thinking' when engaging in your organisation with new technology;
6. encouraging/investing in the use of data analytics and more open and collaborative
7. cross-sector data exchange models within your sector, and establishing the sustainability value of disruptive technologies;
8. supporting a 'cyber security culture' that extends beyond information exchange when using technology.

Following positive response to this initial thought piece by IEMA members and a call for further practitioner case studies, the IEMA Fellows Working Group on Disruptive Technologies and the Digital Economy has produced this second thought piece. The document includes a range of case study insights on the challenges and benefits of integrating smart solutions in different sectors including public health, transport, energy, agriculture and the built environment.

The examples in this thought piece, which focus mainly on developed countries (which have the heaviest carbon footprint) showcase some of the key challenges in ensuring that smart solutions drive sustainable outcomes. While digital may deliver many sustainability benefits, the technology itself is often not inherently green. These technologies, and the resources required to build them, substantially affect the natural environment on which humanity depends. Such impact therefore becomes even more critical as the use and demand of digital devices, data access, storage and artificial intelligence (AI) increases[12].

As emphasised in some of the transferrable lessons of the case studies, there will be an increased need for standardisation and interoperability. This translates as a balancing act between harmonisation of the sustainable management of these solutions and the need to foster technical diversity. We will see that each smart solution may serve a different purpose. Some will combine with other technologies to provide additional efficiencies (e.g. autonomous vehicles contain a combination of sensors, cameras, radar and AI), others will replace existing technologies and services completely (e.g. additive manufacturing such as 3D printing replacing traditional manufacturing) and some will become additional to what is already there (e.g. big data and the transition to smart agriculture supported by 5G).

It should be noted that the case studies in this document are a small group of examples put together by the IEMA Fellows to further illustrate the capability of technology to create positive environmental and social impact in support of sustainable outcomes and the fight against climate change. A recent report by the Royal Society focusing specifically on how technologies can help to achieve net zero targets in the UK offers more detailed insight at a national level of how the various technologies available can help to achieve net zero emissions across multiple sectors and industries[13]. This extensive account of the different technologies available at the national level goes beyond the scope of this paper, but we invite the reader to access it should they wish to find out more about more solutions in other sectors.

The role of collaboration is also explored in greater detail in the IEMA Fellows network thought piece on the Value of Collaboration for Corporate Sustainability Outcomes[14].

We hope that the recommendations set out in this thought piece will provide readers with further practical guidance on how to engage better with smart solutions to increase the resiliency of their organisations.

COVID-19 tech-related solutions

a blueprint to inform our transition to a sustainable digital economy

Technology solutions such as big data and AI helped facilitate COVID-19 preparedness and the tracking of people, so mitigating the spread of infection in several countries. In Sweden, the government developed a platform for health care workers to report real-time data on volumes of patients with COVID-19, ventilator usage and other resource information[15]. Advances in technology, combined with the mRNA vaccine platform technology (which teach our cells how to make a protein—or even just a piece of a protein—that triggers an immune response inside our bodies[16]), have also proven a game changer as researchers have streamlined data-recording to produce several vaccines against the COVID-19 pandemic in less than a year[17].

Such cross-sector collaborations have proven that when the data is available, the application of smart tools in the fight against COVID-19 could provide a blueprint for how technology can create positive environmental and social impact in support of sustainable outcomes.

The annual Lancet Countdown on Health and Climate Change[18] made it clear that the climate crisis is creating conditions leading to the spread of numerous deadly infectious diseases such as dengue fever and malaria. Between 2015 to 2019, suitability for malaria transmission in highland areas was 38·7% higher in the African region compared with a 1950s baseline[19]. As these patterns continue to grow, climate change and associated environmental issues widen existing health inequalities between and within countries. Looking to tackle this issue, the COVID-19 Marmot Review identified an urgent need to 'Build Back Fairer' and do things differently, based on principles of social justice; to build a wellbeing economy that puts achievement of health and wellbeing at the heart of government strategy; to build a society that responds to the climate crisis at the same time as achieving greater health equity[20].

The opportunities offered by proper integration of technology stand to transform the environment profession. A recent journal by the IEMA Impact Assessment network highlighted how the integration of innovation and technology within the impact assessment discipline will help translate to a greater use of online content. The journal found that virtual reality, visualisations, infographics and interactive maps in a web-based format could effectively communicate aspects relating to health in prospective development projects. This could include mapping existing health inequalities to illustrate sensitive communities, visualising the diversion of a popular footway, or hearing the noise levels of a passing train at a given noise-sensitive receiver. The report observed that having relevant data more accessible and ready to interrogate could allow greater focus on the key health issues and save time. In doing so, it noted this would allow impact assessment professionals to better demonstrate where there are perceived health impacts and help reduce public anxiety over a project[21].

Connectivity for all supporting health equity and sustainability outcomes

Despite the current progress in roll out of smart solutions, there are obstacles to the widespread implementation of technologies. This is particularly the case in developing countries where there is a strong risk that governments will, in the name of combatting the COVID-19 disease, expand their use of surveillance technologies to track individuals and even entire populations, with a view to later restricting their rights further. The UN High Commissioner for Human Rights has highlighted this threat calling on countries to close the digital divide as fast as possible, one option being to ensure secure and affordable Internet access[22].

Digital health initiatives can amplify socio-economic inequalities and contribute to health care disparities. To effectively implement digital technology at a global scale, each intervention therefore needs to be tailored to the target regions. This includes providing better access to connectivity everywhere, be it through subsidies or public access solutions such as free Wi-Fi hotspots at a regional level[23].

Case study: OneWeb

Global communications company OneWeb is working at the heart of this issue, putting together a large-scale mass-produced satellite system, that will provide a global communications network in space. With three billion people across the planet lacking access to the Internet, a disparity known as the digital divide, OneWeb is working to deliver high-speed services capable of providing fibre-speed Internet to communities in previously unreachable regions of the planet. OneWeb views this as critical piece of the 'green' infrastructure needed for the sustainable recovery from COVID-19 and achieving the aims of the Paris Agreement and the UN Global Goals.

Cognisant of the sustainability challenges of rising levels of space waste and efforts to minimise these[24], the organisation has in parallel developed its own commitment to Responsible Space, to ensure it doesn't add to debris and protect the space environment, designing it satellites with enough fuel to de-orbit at the end of life, and being fitted with a future-proof grappling hook.

On the topic of health and wellbeing, the organisation sees wider connectivity as being an enabler of video-consultations and remote patient-monitoring, whilst continuing to build on the advances highlighted in this section so that AI-systems can predict future pandemics and allow scientists to share data to combat them, enabling warning systems for communities in high-risk regions to mitigate future outbreaks. It should be noted that connectivity also plays a key role as a driver of smart solutions across all pillars of sustainability. Enhanced connectivity has numerous applications to support environmental stewardship, from greater resolution environmental monitoring to the reduction of greenhouse gas emissions.

"With three billion unable to access connectivity – a social-economic disparity which has only been widened by the COVID-19 pandemic – providing connectivity to everyone, everywhere will be critical for sustainable recovery, and it is therefore important that we build our OneWeb system in a responsible manner. To this end, we aim to not only reduce our own impact – via our Sustainability Strategy and Responsible Space Programmes – but also use our technology to create positive opportunity. OneWeb is a future-thinking organisation, and its innovative satellites are an example of this. Built with a grappling hook, this will enable future debris-removal systems to de-orbit the satellite at the end of its lifecycle, leaving no trace in space."

(Ben Knight – MIEMA, Facilities Manager & Head of Sustainability, OneWeb)

Other stakeholders in this space, seeking to provide connectivity for all, include: Starlink, Facebook Connectivity and the World Bank. To find out more about OneWeb, please read the OneWeb case study **here**.

Extracted recommendations for sustainability professionals:

- Sustainable Development Goals (SDG) mapping: As can be seen from the case study, sustainability benefits of smart solutions in a given sector can be wide ranging, from health and wellbeing to the natural environment. Organisations should identify the SDGs and their targets that a given technology can benefit. Mapping these pathways will help identify how to go beyond compliance and create a positive impact on the natural world and society.

- Collaboration requires communication: There is a need to align sustainability goals with the overall business strategy, including required collaborations, as some areas are easy to change, whilst others are not. Collaborating both internally and externally at an early stage will avoid using the tech as a 'bolt-on' to the mission, bringing about sustainable change and exploration of innovative ways of using technology for good.

Using digitalisation to alleviate the health sector's carbon footprint

With health care giving rise to more than 5% of the national environmental impact in the largest economies, the sector is an important contributor to carbon emissions after the heaviest polluting industries. This statistic reveals the potential to make key improvements that not only cut emissions, but also help to enhance public health[25]. With an ageing and growing population, this energy intensive sector is expected to grow further[26] and with it, its emissions will grow as well.

As noted above, the wave of uptake in smart solutions to recover from the COVID-19 pandemic cannot be disassociated from the fight against climate change and environmental degradation. COVID-19 has further exposed and deepened entrenched inequalities, and could undermine our progress on climate, nature and SDGs if recovery measures do not take into account climate, nature and development goals. Fortunately, we have noted that organisations in the public health sector itself, including the English and Scottish National Health Service branches, are recognising the impact of their sector and have shown sector leadership[27] by issuing commitments to achieve net zero emissions before the middle of the century.

Case study: NHS Digital

Data and its supporting infrastructure are increasingly championed as key components of any solution to the global climate crisis and associated targets and goals. However, the sustainability impact of digital is still not fully understood. The UK National Data Strategy[28] has shown that while demand for data centre services increased by more than 500% between 2010 and 2018, the amount of energy consumed by data centres only increased by 6% over the same period thanks in part to efficiency gains.

But there is still a lack of transparency from providers in specific areas relating to the services they offer. End users are largely unaware of the impacts of digital consumption on energy use and wider sustainability issues. Poor data management and culture can lead to a growing risk of data duplication, unnecessary data retention, migration and processing that contributes to carbon use.

NHS Digital is the national information and technology partner to the UK health and social care system. It supports the NHS carbon neutrality targets by making sure environmental and social sustainability is core to the design of new healthcare technology. Supporting the standardisation of digital health systems, the organisation views digitalisation as an opportunity to maximise efficiencies not only in terms of sustainability but also access to health care services.

Recognising the environmental benefit of such a transition within the health care sector, NHS Digital is adopting more public cloud-based services as part of a

'Cloud First' approach as well as optimising on-premise data centre consumption through the co-location and modernisation of services. The approach involved selecting platforms which offer efficient cooling, use of renewable electricity and Power Usage Efficiency (PUE). Overall, the case study notes that transition to this approach has represented a huge saving by the NHS of circa 4,000 tonnes CO2e[29].

NHS Digital recognises that organisations need to fully support an efficient use of technology services, in addition to the beneficial impacts they can bring. As it looks to support the transition to sustainable ICT services beyond the UK health sector, the organisation is currently developing a set of transferrable lessons for wider application on key issue areas ranging from standardisation and interoperability to the integration of circular economy principles. Valuing the importance of collaboration for sustainability outcomes, NHS Digital has also partnered with the UK government Sustainable Technology Advice & Reporting (STAR) Team (of which IEMA is a member)[30], to help ensure that government ICT services are designed, delivered and operated with sustainable principles at their core. (To find out more please read the ***NHS Digital case study.***)

"There are many challenges that we and all public-sector bodies encounter at the interface of sustainability and digitalisation in health care. One critical challenge exists around balancing local, autonomous decision-making on digital solutions that meet the unique needs of the population they serve with a standardised, central approach that promotes sustainable benefits, both environmental and human. Improving our sustainability will require a concerted effort to tackle these types of challenges and to remain flexible in how we are going to achieve a truly sustainable system, that can be patterned across the health tech space. By embedding a 'sustainable by design' culture throughout our organisation and encouraging our suppliers to do the same, we can start to shift towards a brighter, more sustainable future."

(Ben Tongue – MIEMA, Sustainability Lead, NHS Digital)

Extracted recommendations for sustainability professionals:

- Where appropriate, professionals should guide organisations to use cloud services to migrate existing legacy workloads into the cloud to further reduce data centre footprint.
- When creating digital systems, an organisation should ensure that it considers sustainability risk/ resilience issues such as extreme weather, energy security, supply chain security and digital inclusion (equality linkage).

Mobility and smart solutions

Perhaps in no other energy-demand sector are the impacts of the COVID-19 response more readily apparent than in transport. They have transformed personal mobility in and outside cities, as well as demand for domestic and international flights, and global supply chains from raw materials to consumer products. Remaining one of the highest-emitting sectors, transport emissions primarily involve road (the largest emitter), rail, air and marine transportation. In 2016, they accounted for over 24% of global CO2 emissions and they are expected to grow at a faster rate than that from any other sector[31], posing a major challenge to efforts to reduce emissions in line with the Paris Agreement and the SDGs.

At the height of the pandemic, however, emissions from surface transport fell by approximately half. Analysis in October 2020 found that global ground transport emissions had been cut by 841 MtCO2 compared to the same period in 2019[32]. The necessity for social distancing has provided the opportunity for society to re-shape urban transport and the way we look at mobility. In several regions and cities, the impact of the COVID-19 pandemic is already evident, as the dominance of the car is being seriously challenged for the first time in decades. While the Dutch 'bike revolution' was brought about following an economic and social crisis in the seventies, the pandemic may become a catalyst for the growth of sustainable mobility in many polluted urban areas[33].

But encouraging modal shift to public transport, decarbonising public transport itself and encouraging zero-carbon travel such as walking and cycling will not solve the problem. Pop-up bike lanes will not be sufficient if local governments do not combine pop-up infrastructure with long-term goals. Each lockdown period has brought its own spikes in demand from an initial lack of bike supplies resulting from mass uptake in cycling to increased road traffic resulting from fear of contamination on public transport. Signs of positive transformations should not mask the fact that global emissions are continuing to rise and the message from the authors of the latest report by the Global Carbon Project is that a drop in emissions in a single year will simply not slow the pace of global warming[34]. However, there is an opportunity to secure long-term emission cuts by following an economic recovery that is not only aligned with tackling climate change but enhanced by existing and additional smart solutions. Removing the need for journeys through better urban planning, supporting better balance between work, living and recreational spaces and the use of technology are all-important long-term drivers that will contribute to a more efficient and relevant transport system

AI and data analytics in mobility to support economic recovery

As regions look to implement their recovery plans, the role of tech in supporting sustainable mobility and resilience features highly. AI is being applied to understand how vehicles are moving around city centres, and in places has helped improve congestion prediction by 50% compared with traditional modelling approaches[35]. In London, the Mayor of London, Sadiq Khan, launched the first part of London's Green New Deal fund with investments of £10 million aiming to boost green jobs, tackle climate change and address inequalities[36]. The list of priorities includes green transport and the public realm: seeking to encourage active transportation and electric vehicles, while improving access to green spaces.

Smart sensors and Internet of Things (IoT) devices won't only be used by city planners to monitor the impact of policy measures linked to the pandemic; over the long term they will also be key to the recovery of local businesses, as policy makers start identifying where people work, shop, eat out or go for drinks.

Case study: Brighton & Hove and Metrobus – RTPI

Within the public transport sector, regional operators such as Brighton & Hove and Metrobus along with their local government partners in Brighton & Hove, East Sussex, West Sussex and Surrey have one of the longest-established on-street real-time passenger information (RTPI) systems in the United Kingdom. This consists of on-street, digital, flag-style signage which display next bus route numbers, end destinations and minutes until the bus is due at that stop. The integration of AI solutions at a local level helps to reinforce positive travel behaviour choices. As the technology develops, this has permitted the operators to upgrade on-bus next stop display screens to include railway RTPI, so that the efficiency of the passenger experience is maximised. For more information about the Brighton & Hove and Metrobus RTPI case study, please see below in the list of case studies.

"In developing an Energy Strategy for West Sussex, I've recognised that it is vital that sustainability professionals understand the importance of cross-sector collaboration and the part they can play in enabling the transition we need. Not everyone will be a technical expert but we will all need to be literate in technologies relevant to the work we are doing, in the same way we all need know-how to use computers. A great example is how bus operators such as Metrobus are working with councils across Sussex, facilitating vehicle manufacturers and finance providers to influence policy makers. This illustrates the interconnectivity between stakeholders that need to be considered. When we use relatable and common language, we can accelerate the process. It's for all of us to individually embrace these opportunities to develop our skills whether we are writing strategies or designing the code behind a system."

(Sandra Norval – FIEMA, Director, Bluedotaug Ltd, Member of the IEMA Fellows Working Group on Disruptive Technologies & the Digital Economy)

Extracted recommendation for sustainability professionals:

Sustainability professionals should encourage their organisations to seek out opportunities to engage in discussions and partnerships as these can be a key factor in the organisation securing year-on-year patronage for technology solutions.

Environmental benefits of tech in mobility

Digital mobility services, such as sharing concepts, can improve the performance not only of public transport but also be a driver of more general digitalisation. By using these services, the goal would be to achieve a collaborative form of mobility, which closes the gaps between active mobility, motorised private transport and public transport[37]. As noted in the introduction to this section, the popularity of smart mobility programmes has taken off in many countries, including the Netherlands, which is leading work on the topic, from bike sharing to the Hyperloop[38]. Acting as a connector of bundled transport services, smart solutions would allow for better distribution of passengers on the various modes of transport, enabling greater environmental and health benefits. Collaborations at a regional level have already started supporting this transition.

Case study: Sopra Steria and city commuting

Sopra Steria, a European consultancy providing digital services and software development, provides an example of this engagement through the COMMUTE project. The collaboration in the city of Toulouse in France offers a digital platform that aggregates many technologies including cloud, big data, cybersecurity and data visualisation AI. It is dedicated to the collection of data to develop a new and common understanding of employee mobility. Traffic congestion in the airport and aeronautical area of Toulouse has incurred enormous costs including time lost, accidents and air pollution. Working with local authorities and businesses, Sopra Steria reduced congestion and implemented new mobility solutions in the region, that included car-pooling, car-sharing and

other means of active transport, such as cycling, by enabling cross-referencing of public and private data.

Between 2017 and 2019, through a 5% reduction in the use of private vehicles, the project achieved an estimated emissions reduction of around 1.3 tCO_2e per day[39] or about 6,400 car days of emissions saved each day in Toulouse. The success of this project underscores how digital transformation can offer an opportunity to address the challenges of mobility. This project provided the opportunity to implement a new strategy for an improved approach for managing mobility that involved reduced environmental impacts and an opportunity to reduce costs required for the maintenance of transport infrastructure. For more information about the Sopra Steria case study, please see below in the list of case studies.

"Fifteen per cent of emissions reductions needed within the UK between 2021 and 2030 can be enabled by digital technology that can already be deployed. Digital technologies therefore have a vital role to play in supporting the transition of other sectors to net zero. Mobility – intelligent traffic systems – represent a significant opportunity area for driving down emissions. Different technologies will need to come together – the application of connectivity with big data and AI with IoT devices, monitoring and tracking what is going on. One particular technology will not provide the silver bullet – we need a whole suite of solutions, technologies and, beyond that, we need policies and finance to be lined up."

(Avinash Lunj – PIEMA, Environment Manager UK, Sopra Steria)

Extracted recommendation for sustainability professionals:

Use your experience with the technology to create or participate in forums with other stakeholders to learn, discuss and explore new opportunities offered by this solution within your industry/sector. This can be done in multiples ways: be it actively working with local partners to deploy the initiative/technology in new economic areas, leading knowledge exchange workshops with other regions to define which good practices to transfer, or even collaborating with a national standards body to offer learnings from the project to inform a new industry standard using this solution to promote sustainable outcomes.

Case study: Yumuv (Trafi)

Across the border from France, in Switzerland, another international case study submitted by IEMA Member Lucie Anderton of International Union of Railways focuses on Yumuv, a digital 'Mobility-as-a-Service' platform. Trafi technology which underpins the platform, brings together public and shared mobility into a single Mobility-as-a-Service package. The platform looks to stimulate sustainable urban mobility in Switzerland by consolidating existing urban mobility options, strengthening public transport, and making the use of shared mobility hassle-free. Lucie notes a marked reduction in the number of individuals in England today possessing a driver's license in England because of the demand for consumer 'Mobility-as-a-Service' as an alternative to ownership. She stresses that the transformative technology and disruptive collaborative partnerships this platform supports will allow for significant shifts in sustainable travel choices. She sees them as providing people with confidence to move away from private ownership of vehicles and support the take up of shared mobility and the use of rail as the backbone of the journey. Identifying multiple associated sustainable benefits, Lucie sees this behaviour change as an opportunity to bring about benefits for air quality and freeing up space and congestion.

For more information about the Yumuv case study, please see below in the list of case studies.

Extracted recommendation for sustainability professionals:

Build trust in the technology: Technology platforms or smart solutions with sustainable outcomes (such as shared mobility applications) which function based on deep collaborative agreements will require professionals/ organisations to ensure there are clear governance processes and transparency on use of data set up at the outset. If there is no confidence in the use of information across actors (e.g. data protection concerns) or the arrangements are not inclusive, then the partnership may fail.

Food and smart agriculture

Issues such as climate change, biodiversity and environmental impacts resulting from intensive farming practices increase the need for changes in food production. Together with globalisation, the food and agricultural industry is left to reflect how to double food production by 2050 with less land available every year. Internet of Things (IoT) Systems could enable food production to be increased by 70%[40], according to Beecham Research. Data and analytics have many benefits, and agriculture has more data than almost any other industry.

With more than 570 million farms producing food in almost all the world's climates and soils, it is difficult to put forward solutions that are effective across the large and diverse range of producers that characterise the agricultural sector. The best way forward appears to be an approach where producers monitor their own impacts, flexibly meet environmental targets by choosing from multiple practices, and communicate their impacts to consumers with the help of IoT sensors[41].

Free online tools such as the Cool Farm Tool, developed by Anthesis for the Cool Farm Alliance, are available to support organisations in reaching their goals. The tool offers an online greenhouse gas, water and biodiversity calculator for farming, used in more than 100 countries by more than 50 major industry players such as Unilever and Danone etc. Taking just 10 to 15 minutes to get a rough estimate, the calculations support farmers to manage costs, productivity and soil health. Allowing farmers to find out how their fields respond to the management options of interest, the tool helps stimulate thinking about management, by showing hotspots and helping to develop action plans[42].

The Agriculture and Horticulture Development Board (AHDB) is a UK levy board funded by farmers, growers and other parts of the agriculture supply chain. The organisation aims to act as a trusted source of environmental information to help UK farmers understand how to improve their footprint. As the sector begins to make progress in its transition to net zero, AHDB believes it is important to ensure that the focus is not just on carbon emissions but achieves a balance to ensure that the right incentives are in place for stakeholders to do the right thing. For this reason, AHDB have put forward Mondra as an external case study of an organisation that is enabling the digitalisation of the sector in support of sustainable outcomes.

Case study: Mondra

A growing company, Mondra, seeks to integrate all impacts in its assessment of farming operations, to help farmers do the right thing. It labels itself as a 'data-driven insights platform that supports food system players to meet their carbon neutrality goals, communicate their performance and drive planet-positive profits'[43]. Mondra is working with key stakeholders in the agricultural sector to enable environmental accountability through radical transparency and traceability.

Mondra's digital platform therefore operates on three levels, seeking to empower farmers to monitor, improve and communicate product environmental impacts to their customers.

An effective monitoring tool, the platform captures environmental impacts including: greenhouse gas emissions, water usage and biodiversity loss. As a resource that helps producers improve their impact, the platform provides performance benchmarks and improvement insights. Mondra also issues an auditable record and certificate of product achievements and best-in-class food labels for commercial use together with a traffic light grading system to support consumers in making quick decisions about one product over another based on eco-impact.

In this case study example, Mondra has worked with a leading plant-based milk brand helping to improve the environmental footprint of their milk range. Following a detailed lifecycle analysis of its product range, Mondra enabled the client to improve identified hotspots, and reformulate its sourcing strategy to bring about an

estimated 22% reduction in supply chain greenhouse gas emissions. Furthermore, through improved production practices brought about through the digital platform, Mondra has enabled the client to achieve a 12% reduction in water use (For more information about the Mondra case study, please see below in the list of case studies).

Despite the positive impact driven by this database, Mondra and AHDB shared an overriding concern regarding the lack of primary farm data from the client's actual supply chain to calculate environmental impact of operations. This meant that a modelling approach was needed for farm-level ingredients. Moving forward, both organisations support radical improvement and standardisation of the way environmental footprinting is done in farms and specifically at 'yield-level' to make it easier for farmers to certify positive environmental impact.

AI-enabled platforms also give smallholder farmers the information they need to connect directly to buyers of their produce, reducing food waste and increasing farm income. In Kenya, Twiga Foods' platform aggregates market participants, facilitating a more efficient matching of buyers and sellers in Africa's large but fragmented fruit and vegetable market. For farmers, the platform enables access to a fairly priced, transparent, mobile marketplace. For vendors, the benefit is increased reliability in sourcing high-quality produce. Twiga's system has reduced post-harvest losses to 5%, compared to 30% in informal markets where farmers typically sell produce[44].

In the UK, while Defra (Department for Environment, Farming and Rural Affairs) and the NFU (National Farmers' Union) are supporting their own initiatives, AHDB is seeking to develop a standardised agricultural footprinting model. Through the online Farm Excellence platform[45], AHDB has drawn together a network of inspirational farmers who are seeking to promote best practices, by learning, sharing and creating new ideas to drive innovation and increase productivity. Seeking to drive better environmental impact by the sector, AHDB has launched its first wave of on-farm carbon footprinting[46], to better identify and quantify all activities or inputs on-farm that come with a carbon footprint. The results of these assessments will be used to calculate the carbon-to-output ratio[47] which will be benchmarked to determine where savings lie, and a bespoke plan created. Working closely with farmers and in support of local economies, AHDB's online tools such as Farmbench[48] play a vital role in enabling the digitalisation of the agricultural sector. This digitalisation will help farmers to not only improve efficiency but increase profits to ensure a sustainable livelihood and a more secure and self-sustaining industry.

Extracted recommendations for sustainability professionals:

- Support standards development: Given the lack of standardisation in the way that environmental footprinting is done on-farm within the sector, sustainability professionals working in this sector should support further collaborations with technology providers, including current initiatives led by AHDB, DEFRA and the National Farmers' Union to develop standard footprinting models.

- Encourage/invest in the use of data analytics and more open and collaborative cross-sector data exchange models within your sector: professionals working in this space should support collaboration towards a comprehensive audit of available agricultural primary data sources (e.g. farm monitoring systems, earth observation data, agricultural audit bodies). By harmonising and processing existing data feeds, we can reduce the effort required of farmers to certify their yields for eco-impact, bringing down a further barrier to adoption and taking the sector one step closer to its net zero ambitions.

The energy transition

Cities are huge consumers of power, using up to two-thirds of the world's energy and producing a similar proportion of global carbon emissions[49]. As urban hubs look to redefine the energy mix and distribution systems, technology has helped to evolve the energy system and unlock further options on the route to decarbonisation and sustainability.

Governments across the globe, including the UK, are now seeking to boost investment in green technology and invest in increased offshore and onshore wind power capacity. Within the UK the boost in investment could translate to an increase from 30GW to 40GW by 2030, thereby creating an additional 9,000 jobs and boosting the country's ability to reach its net zero targets[50].

Investment in renewables alone will not be sufficient to meet carbon neutrality targets. Smart solutions at the local level also need to ensure that society can transition from being a consumer of energy to becoming a prosumer of energy (where it both produces and consumes energy). Energy models are currently changing, and supply and demand needs to become more dynamic to meet environmental targets. Power Transition is an example of such a company supporting energy prosumers. It enables individuals and organisations to take control of their energy, supporting collaboration and local energy sharing through a software platform that enables tracking of energy in real-time[51]. A recent TechUK report confirms that, for data centres, advances in battery technologies mean that data centre operators may, in due course, be able to make stored capacity available without compromising business continuity and thereby significantly reduce its reliance on grid power. The centre operators would therefore shift their status from large energy customers to energy prosumers, supplying the majority of their own power requirements themselves[52].

Case study: Keele University – Siemens Smart Energy Network Demonstrator

At Keele University, Siemens (an IEMA Corporate Partner) are making advances through their demonstrator site for the organisation to realise its own vision of decarbonisation at the local (small town) level, to reduce energy consumption by firstly understanding what energy consumption is, analysing it and then balancing it, based on key core tech applications developed and delivered from the Siemens Smart infrastructure portfolio. The aim of this local project is to control, coordinate and manage energy loads across the university facility that will enable, clear visibility and orchestrated control of the network assets, to achieve the functional requirements of the Smart Energy Network Demonstrator.

Working in collaboration with government, academia and with a direct linkage to dozens of SME businesses in Staffordshire and further afield, the project is seeking to showcase the potential of connectivity and interoperability of technology solutions for achieving sustainable outcomes. To do this, the project is looking to mimic 'real world' infrastructures in the UK with a mix of technologies from different suppliers, while also creating tools, mechanisms and expertise for developing continuous 'plug-n-play' capabilities in the future for interested parties, including SMEs.

The flexible nature of the energy infrastructure, enabled by the mix of tech on-site, provides extensive sustainability benefits including renewable generation with the capacity to save over 4,000t of CO2 per annum, balanced with cost savings estimated at 15%[53] and incentivised utilisation of energy to promote the shift to lower-carbon transportation systems.

For more information about the **Siemens energy case study**, please see below in the list of case studies.

The current main sources of renewable electricity (such as wind and solar energy) feed into energy networks only intermittently, meaning production risks not always matching demand if storage, interconnectors or other back-up power plant capacity are not developed. At the local level, energy providers are starting to use technologies such as AI and digital twinning to help integrate intermittent renewable energy sources into the electricity grid[54]. These providers have plans to implement Active Network Management, which continually monitors all the constraints on an area of the network, in real-time, and allocate the maximum amount of capacity available to customers in that area based on the date their connection was accepted. Smart solutions therefore further support the integration of wind power over the long term and help to overcome issues of public trust in terms of the reliability of energy supply offered by renewables.

Smart Electrical Energy Storage Systems (EESS)[55] are also beginning to deliver value to clients, not just by ensuring power to buildings and infrastructure, but by becoming an active digital component of the wider electricity network (e.g. enabling grid flexibility).

While traditionally EESS has been deployed to make better use of renewable energy (e.g. solar PV), careful initial design can also help EESS to reduce client connection costs by avoiding excessive systems specification though the provision of 'peak shaving' (covering short periods of additional energy demand that would otherwise require additional capacity). Digital Time of Use tariffs and 'Virtual' Power Plants are further increasing the versatility of EESS, essentially enabling the commercial exploitation of variable energy tariffs.

Extracted recommendation for sustainability professionals:

Adopt a 'circular economy approach and whole systems thinking' when engaging your organisation with new technology: Given the complexity of multi-stakeholder projects that integrate disruptive technologies, ensure that you agree upfront the objective vision with the customers and critical stakeholders, but securing agreement on an agile and dynamic approach to accommodate any required changes in planning and design that link back to the technology itself to maximise efficiency and energy saving.

Case study: Brighton & Hove and Metrobus – Hydrogen Fuel Cell Bus fleets

In public transport, the promising introduction of energy sources, such as hydrogen, albeit at a still low level, has highlighted the cross-sectoral interconnections of smart solutions in the transformation to sustainability. In this second case study example from Brighton & Hove Buses, the advancements brought about to its fleet of 100 buses through local collaborations are creating a positive knock-on effect to other initiatives such as RTPI (referenced above in the mobility section) and the integration of smart solutions in traditional bus shelters known as 'Superhubs'[56]. The aim of the ongoing project is to replace its current fleet with a Hydrogen Fuel Cell Bus Fleet to achieve a zero emission regional fleet by 2030. A testament to IEMA's recent guidance on the Value of Collaboration for Corporate Sustainability Outcomes[57], the project is a multi-stakeholder partnership between Metrobus, the EU's FCH JU Jive Project, UK Gov Ultra Low Emission Bus Scheme, Gatwick Airport and a local government partner. Across the deployment phases of the project, over 100 buses will move to zero emission. Supporting the dissemination of knowledge behind of hydrogen power to smaller local fleets, Brighton & Hove Buses will support further collaboration and enable wider decarbonisation, beyond sustainable mobility, to include development of the local economy.

It should be noted that hydrogen buses are currently priced at twice that of conventional diesel buses[58]. As demand increases, and they become mass produced, the price will decrease. However, EU and national subsidies will be necessary to fund these to prevent fare rises and for future hydrogen bus fleets to grow in popularity.

"Fuel cell buses are not only an area in which Brighton & Hove Buses are leading their industry peers, but also working as a vehicle for unlocking many other sustainability benefits including Superhubs and expansions in Real-Time Passenger Information Systems."

(Patrick Warner – Head of Innovation Strategy, Brighton & Hove Buses)

For more information about the Brighton & Hove Buses case study on Hydrogen Fuel Cell Bus Fleets, please see below in the list of case studies.

Extract recommendations for sustainability professionals:

- Think about your business strategy when considering new technologies, assess the key market drivers in your industry and where the main opportunities and risks lie: By embracing hydrogen fuel as a new clean energy source and using their strengths to share the technology with smaller local fleets, Brighton & Hove Buses is strengthening its value as a local partner and enabler of wider decarbonisation;

- Participate in discussion forums with other stakeholders and technology providers to explore new opportunities offered by disruptive technologies and innovators within your industry/sector: Uptake in hydrogen fuel by Brighton & Hove Buses has encouraged match funding investment by highway authorities by delivering bus priority measures alongside zero emission bus fleet deployments, this in turn has led to the company's involvement in multi-agency regeneration projects within the region, which is unlocking further transport improvements.

Smart tools for a sustainable built environment

Together, building and construction are responsible for around 39% of all carbon emissions in the world, with operational emissions (from energy used to heat, cool and light buildings) accounting for 28% of that amount[59]. Newly constructed buildings are more energy efficient, but 80% of building stock which will exist in 2050 has already been built, so a major priority of climate policy should go to decarbonising existing stock[60]. The role of smart solutions, particularly within urban landscapes, will play a huge role in holding organisations and local governments to account on their commitments to reducing emissions.

Scope and impact of smart solutions at city level

Case study: EBRD

Since 2016, the European Bank for Reconstruction and Development (EBRD), through its €1.5 billion flagship Green Cities programme, has brought together 45 cities that want to upgrade their infrastructure for the 21st century with the aim of having 100 cities on board by 2024.

As noted in the section on mobility, cities have also been at the forefront of the COVID-19 pandemic, and city budgets for the integration of smart and digital applications are expected to climb. As part of their efforts to build back better and greener, EBRD has made a commitment to ensure it utilises a Smart Maturity Assessment tool to benchmark the readiness of cities to become Green Cities against a maturity scale that EBRD has developed. The organisation notes that city governments are starting to think about building smart solutions into urban infrastructure in one of two ways: either they are led towards smart integration by public-sector champions with experience or visions of city and community benefit, or they gain direct experience of how smart technologies make life more efficient simply through the private sector 'leapfrogging' through the introduction of new commercial digital applications.

While EBRD is currently working to embed the project into its Green Cities programme, the smart integration process will not only include recommendations on how green projects will benefit from smart technology but will also evaluate the maturity of the city municipal government to adopt smart technology to ensure that sustainable outcomes are maximised by each infrastructure investment. Looking at key parameters such as smart leadership and governance, stakeholder engagement and integrated ICT infrastructure, EBRD will conduct a more detailed smart needs assessment leading to any necessary policy development and capacity-building programmes to support sustainable outcomes.

Smart solutions can play a vital role in achieving international commitments under the Paris Agreement on Climate Change and the SDGs. Technologies can help cities make significant progress toward 70% of the SDGs. Focusing on the environmental impact alone, integrating smart solutions to urban infrastructure could result in as much as 10–15% greenhouse gas emissions savings. Recognising this fact and the opportunities created by its Smart Maturity Assessment tool, EBRD has shared the same with the World Bank, the G20, the OECD and the Global Infrastructure Hub looking to promote best practices in the integration of smart solutions for sustainability. For more information about the **EBRD case study,** please see below in the list of case studies.

Extracted recommendation for sustainability professionals:

Enhancing accountability to maintain trust in smart solutions: Support the development of (or sign up to) industry standards or benchmarking tools (e.g. EBRD's prototype Smart Maturity Assessment tool) which are simple and intuitive to test against smart solutions in different projects. This will help to maintain a high degree of accountability and continued investment in smart technology that supports sustainable outcomes.

Case study: Leeds City Council

Recognising the modularity of smart solutions and how they can be used to support sustainable outcomes, Leeds City Region is transforming modern life through the development and implementation of smart technologies for the 21st century and beyond.

Leeds City Council is currently developing a project which will consist of approximately 15 Concentrator/ Gateways that will cover the whole city. The network server will be built using Open Standards enabling data sharing with others where applicable for further projects that could support climate adaptation and waste reduction measures.

The initial application of this project will be for street lighting control, targeting 97,000 streetlights across the city, with a rollout period beginning in 2021. Building data sharing into this lighting infrastructure retrofit project will enable the council to add on further sensors and functionalities; to support other uses, in addition to efficient lighting, such as social housing monitoring and road temperature monitoring, and to support greater efficiencies and maintenance costs. Ultimately, in the next phase, a partnership with Leeds Beckett University will allow the council to monitor the urban heat island effect and the impact of green infrastructure, building upon Leeds Beckett University's understanding of thermal performance in the built environment and underscoring the value of collaboration for sustainable outcomes.

Looking ahead, the council has secured funding to develop a prototype dashboard for this project covering a multitude of additional uses, including flooding, air quality and carbon emissions. As the project is further rolled out, it has the potential to benefit numerous communities and stakeholders in the region including schools, academics, service managers and decision-makers. For more information about the Leeds City Council case study, please see below in the list of case studies.

"In a sustainable city or society, the economy is delivering social benefits while remaining within environmental limits. Innovative smart sensor technologies are allowing sustainability professionals to monitor environmental quality and resource flows with greater accuracy and often in real-time. This allows us to take a systems-based perspective of sustainability, using data to engage with other professionals in order to optimise economic, social and environmental outcomes. Sustainability professionals need to grasp this opportunity to ensure that future smart cities and societies are sustainable ones as well."

(Dr Tom Knowland (FIEMA) – Head of Sustainable Energy & Climate Change at Leeds City Council)

Extracted recommendation for sustainability professionals:

Encouraging/invest in the use of data analytics and more open and collaborative cross-sector data exchange models within your sector: By using open data protocols where possible as part of their project's sustainability, professionals will not be tied to any one technology supplier. This means that the network can effectively be used by any organisation or business interested in developing sensors and other technologies to support more sustainable outcomes.

Waste infrastructure and smart solutions

As noted in the Leeds City Council case study, through open exchange of information, digital technology and smart solutions such as sensors have the potential to support numerous sustainable outcomes from climate adaptation measures to air quality control.

Plans to build the world's first commercial-scale plastic recycling plant in Teesside (UK) using innovative hydrothermal upgrading technology is a good example of that potential. Using a ground-breaking advanced recycling process called HydroPRS™ (Hydrothermal Plastic Recycling Solution), the project aims to see a one million tonne global, annual recycling capacity in

operation or development by 2025. Through the use of this technology, the new site will recycle 80,000 tonnes of plastic waste annually, currently considered 'unrecyclable'[61].

From the perspective of transitioning to a circular economy, smart solutions can also make it possible to identify, track and trade materials for re-use. In terms of waste management, digital tools can ensure that all waste movements are easily recorded, checked and tracked through the waste management chain, leading to more effective waste regulation and policy, and helping drive improved business productivity and investment.

During the June 2020 IEMA webinar on digital waste tracking, DEFRA presented the progress that the UK is making on the topic of smart waste tracking, helping to put in place the fundamental building blocks of data gathering and analysis to ensure it knows the types, amounts and quality of waste, and where it is generated and ends up. Highlighting four key benefits of the transition to an online tracking system it noted that this would support the Government's Resources & Waste Strategy for England in: reducing costs; reducing waste crime; enhancing visibility of the waste hierarchy; and supporting investment and innovation in waste management. Anthesis, one of the two companies to have been shortlisted to trial a pilot project for this new system, has developed the Vastum proposal focused around two rules: collecting data against a common data standard and ensuring that every waste movement is accompanied by a unique transaction ID. Offering a practical example of a digital solution for national waste tracking, the organisation hopes that the implementation of the tool will generate the high-quality and granular data needed for further environmental protection, policy and investment in support of a circular economy[62].

Case study: Qualis Flow – Digital materials tracking for the built environment

Qflow is an AI-enabled sustainability start-up[63] that facilitates construction companies to be more sustainable and more profitable. The company's solution tracks all materials arriving on-site and all waste leaving. Its technology is based on a hybrid model, applying Optical Character Recognition (OCR) and a series of machine-learning-based algorithms to digitise and extract data from delivery and waste tickets. In essence, the company aims to help the construction industry become more sustainable by automating processes that rely on manual data input and are at risk of human error.

Qflow was deployed by Skanska to support the delivery of its £350m Oxfordshire Highways Project, the data capture achieved with Qflow was improved by over 70%, enabling the Skanska sustainability team to deliver better forecasts of waste transfers whilst reducing risk of non-compliance. The Qflow data science team are using the data to identify opportunities to not only improve productivity but also to reduce waste generation all together. Polly Gourlay of QFlow notes in her submission the potential of technology and smart solutions which can greatly support and empower environmental professionals. Commenting on the scalability of the technology she notes that better tracking of waste data enables movements to be optimised. Specific examples include using closer waste facilities to reduce carbon emissions, or selecting waste facilities to reduce carbon emissions, or selecting facilities that perform better against the waste hierarchy. For more information about the Qflow case study, please see below in the list of case studies.

Extracted recommendation for sustainability professionals:

Technology should support the profession: Environment and sustainability professionals can and should use technology to empower the work that they do. They should therefore re-evaluate any process or software that doesn't make the task easier or quicker.

Conclusion

In summary, progress is being achieved across sectors, but we need further acceleration and integration of digital technology, in line with sustainability targets, to support a transition to a sustainable digital economy.

The 2019 IEMA Fellows Thought Piece on Disruptive Technologies & Sustainability set out key actions for sustainability professionals to ensure disruptive technologies can support a transformation towards sustainability. The cross-sector insights collected from IEMA members and technology experts in this follow-up project further illustrate how members can carry out those actions as we continue to move towards decentralisation as part of a peer-to-peer digital economy.

Some of the key topics touched upon through the recommendations are detailed below:

On the topic of SDG Mapping: The OneWeb case study on connectivity has highlighted that sustainability benefits of smart solutions can often be wide ranging, extending from health to the natural environment. Sustainability professionals should work with their organisations to align their sustainability targets with their business strategy, using the SDGs and its targets as a way of **mapping potential pathways** for the use of technology. This will help identify how to go beyond compliance and create a positive impact.

On the topic of data use: Greater visibility of what is happening across sectors is needed increasingly close to real-time to enable effective operational decision-making. This requires access to the right data and for that data to be analysed in operational timescales – which opens up opportunities for sensors, intelligent edge devices, and connectivity to transport the data from where it is generated to where it is needed and where it will be analysed. Accessing the data of digital technologies used in the energy, built environment and transport sectors will therefore be crucial to ensuring a successful journey towards net zero and also a more resilient and sustainable society. Mondra and AHDB are actively working with stakeholders in the agriculture sector to encourage the **harmonisation of data** and standardisation of environmental footprinting. Sustainability professionals should encourage senior management in their own organisations to follow suit and sign up to data standardisation initiatives that incentivise the use of digital tools that support net zero targets.

On the topic of collaboration: Professionals should support knowledge sharing from tech projects they have led for organisations, be it through multi-stakeholder discussions with local authorities or in workshops with other regions (e.g. Brighton & Hove, Sopra Steria) so as to maximise the opportunities for replicating the project in other sectors and **upscaling** sustainable outcomes. This approach enables further collaborations with other organisations in line with the findings of the IEMA Thought Piece on The Value of Collaboration for Corporate Sustainability Outcomes[64].

On the topic of data sharing: Applying the **data sharing approach** set out by Leeds City Council in its infrastructure developments, professionals should where possible use open data protocols so that they are not tied to one technology supplier. Similar to the NHS Digital approach, they should seek to maximise **interoperability** of technologies and digital systems to ensure they support sustainable transformation.

On the topic of accountability: Building on the data-sharing approach, professionals should engage in dialogue and collaboration with key stakeholders in their sector to support the development of (or sign up to) **benchmarking tools** (e.g. EBRD's prototype Smart Maturity Assessment tool) that measure the degree of positive impact created by smart solutions. This will help to maintain a high degree of accountability and continued **investment** in smart technology that supports sustainable outcomes.

On the topic of transparency: Current barriers for adoption include **access to data** as people need to have confidence that when they're adopting technologies that those technologies are going to be secure. Clarity over how consumer data will be used will enhance public confidence, while at the same time it will highlight the benefits the public will get back from the use of that data. Building trust in technology is therefore a key challenge as exemplified by Yumuv and its Mobility-as-a-Service application. To ensure the technology continues to support sustainable outcomes and avoid **data protection** concerns by all key stakeholders, sustainability professionals should establish clear data governance processes and transparency rules from the start of the project.

On the topic of circularity and whole systems thinking: Multi-stakeholder development projects that integrate disruptive technologies are complex (e.g. Siemens, Qualis Flow case studies). To achieve the desired sustainable outcomes, sustainability professionals should agree upfront with all critical stakeholders the objective vision for application of the technology. At the same time, they should secure agreement on **an agile and dynamic approach** to cater for any required changes in planning and technology design that accommodate improvements and enhanced resource management.

On the topic of training: Over the past year, the COVID-19 pandemic has been a digital accelerant, leading many organisations to move several years ahead in their technology journey. Faced with diminishing levels of minerals which are needed for the development of key digital technologies (e.g. cobalt shortages and the global battery market), the sustainability profession will increasingly **need to upskill on tech** to provide strategic advice on how organisations should adapt to these challenges.

Supporting collaborations and building dialogue between stakeholders will be a key part of the guidance offered by professionals. An example of this is the SoS MinErals research initiative by NERC, which seeks to develop the best practices and processes needed to guarantee the security of supply of strategic minerals in a digital economy[65]. To prevent building in additional negative environmental and social impact (e.g. NHS Digital, Leeds City Council, Qualis Flow), sustainability professionals within different organisations should develop clear plans for upskilling management and board members with enhanced technology and sustainability skills to help integrate relevant digital systems and new collaborative business models within their organisation, alongside sustainability targets. This may involve some sustainability professionals undergoing additional training across a variety of disciplines as well as widening and strengthening the numbers of people undertaking some form of training in sustainability and related disciplines. Taking such steps will ensure that technology solutions support multiple teams within organisations, all working towards this common goal.

IEMA will continue to support the profession through this transition by providing accessible training, practical and skills-based webinars, regular updates and member insights on the impact of tech for sustainability, and the marketing of relevant external opportunities for further tech training.

Table of case studies

Name of the organisation	**Brighton & Hove Buses and Metrobus – RTPI**
Description of the core tech	Real-Time Passenger Information Systems (RTPI)
Nature of the project and who the key partners are and their contribution/role	Brighton & Hove and Metrobus along with their local government partners in Brighton & Hove, East Sussex, West Sussex and Surrey have one of the longest-established on-street real-time information systems in the country. Within the Brighton & Hove and East Sussex operating area, this consists of on-street, digital, flag-style signage which display next bus route numbers, end destinations and minutes until the bus is due at that stop. In West Sussex and Surrey, this tends to be slightly more discrete signage within bus shelters. In such areas where bus services are very frequent, this promotes the convenience and attractiveness of the bus as a travel choice. The councils own the system and fund the signage and our bus companies provide a data feed and maintain the reliability of that data. This partnership has been a key factor in our year-on-year patronage growth at a time when many areas of the country have experienced declining bus use. In areas like ours where buses are every few minutes, it re-enforces all the positives about bus travel and very often means that passengers don't ever need to study a timetable.
Sustainability benefits achieved	Re-enforces positive travel behaviour choices and, in more recent years, our on-bus next stop display screens in the Metrobus area have been upgraded to include railway RTPI so that as our buses approach a railway station, our passengers see what the next trains are before they get off the bus, enabling a leisurely stroll to the platform or a more relaxed pace and the chance to grab a coffee if delays have been encountered. Partnership working across sectors like this improves the convenience and ease of using public transport and helps contribute to less traffic congestion from cars.
Business rationale	Our input is relatively low other than a small team of people to maintain the systems and the on-bus equipment, but the partnership approach to delivering these benefits is as above.
Transferable lessons learnt	Our upgraded inclusion of rail real-time information is setting a new standard that some other operators are looking to replicate. Recently we learned that our main rail service provider, Southern, is looking to incorporate a similar 'next buses' real-time information section on the approach to stations served by frequent buses as part of their refurbishment programme of the Electrostar type of train, which is the most commonly used rolling stock type on the entire Southern network.

Name of the organisation	**Brighton & Hove Buses and Metrobus – Hydrogen Buses**
Description of the core tech	Hydrogen Fuel Cell Bus Fleet Replacement to achieve a zero emission regional fleet by 2030
Nature of the project and who the key partners are and their contribution/role	Phase 1) deployment of the first commercially led application of fuel cell bus technology in the bus industry in Crawley with Europe's largest deployment (54 buses) to date going into service in 2022. Funded in partnership between Metrobus, the EU's FCH JU Jive Project, UK Gov Ultra Low Emission Bus Scheme, Gatwick Airport and a local government partner (to be named in due course). Phase 2) deployment of a further circa 50 fuel cell buses at Brighton & Hove Buses' Newhaven Depot, providing a world-first full depot conversion to fuel cell tech in partnership with Lewes & Eastbourne councils, who will convert their refuse collection vehicle fleet to fuel cell power at the same time and benefit from shared refuelling station facilities and our big group ownership buying power for the hydrogen. Bus Manufacturer: Wrightbus Hydrogen Fuel Supplier: Ryse UK
Sustainability benefits achieved	Across the two deployment phases, over 100 buses will move to zero emission and a cascade of other buses in the fleet will see the ultra-low emission Euro six diesel buses on existing routes moved to other routes, enabling the retirement of ageing Euro 3, 4 and 5 emission-rated buses from the fleet along with a similar impact on around 40–50 dustcarts.
Business rationale	Enabling our regional fleet to become fit for the future and continue to exceed all local emission regulations whilst, in the longer term, matching improved environmental performance with eventual fuel cost reductions.
Transferable lessons learnt	By embracing this important new clean energy source and using our strengths to share the technology with smaller local fleets, we strengthen our value as a local partner and enabler of wider decarbonisation way beyond simply moving large numbers of local people around efficiently and contributing to the local economy. So far this is unlocking a number of benefits such as encouraging match funding investment by highway authorities by delivering bus priority measures alongside zero emission bus fleet deployments (this will slash bus journey times, turning around a decade-long period of damage to buses, trigger business growth, enable wider modal shift from car to bus, improve local air quality and challenge established public health outcomes). It is also enabling our involvement in multi-agency regeneration projects within the region which is unlocking further transport improvements.

Name of the organisation	EBRD
Description of the core tech	**Smart systems and the EBRD Smart Maturity Assessment tool** The European Bank for Reconstruction and Development (EBRD) is a multilateral development bank that operates in 38 countries across Central Europe, Central Asia and North Africa. EBRD made the decision in 2019 to integrate 'smart' into its flagship Green Cities urban sustainability programme. This will include the utilisation of a new Smart Maturity Assessment tool to benchmark the readiness of cities to become a green city against a maturity scale that EBRD has developed.
Nature of the project and who the key partners are and their contribution/role	**Integrating 'smart' into the EBRD flagship Green Cities urban sustainability programme** Kyiv, the capital of Ukraine, and Novi Sad, in Serbia, are the first two EBRD Green Cities that will have smart assessments built into their Green City Action Plan (GCAP) from the start. However, simply advising EBRD cities of the advantages of smart component and application integration into Green City actions is the easy part. To be truly successful, EBRD cities must fully embrace smart digital innovation citywide but rarely do they have the knowledge or capacity to do this and, in some cases, still need to be 'switched on' the importance of data. EBRD experience to date has found that cities start to think about building smart solutions into urban infrastructure in one of two ways, either: 1. they are led towards smart integration by public-sector champions with experience or visions of city and community benefit; or 2. they gain direct experience of how smart makes life more efficient simply through the private sector 'leapfrogging' through the introduction of new commercial digital applications (apps).
Sustainability benefits achieved	EBRD smart integration will not only include recommendations on how green projects will benefit from smart technology but will also evaluate the maturity of the city municipal government to adopt smart technology. This is to ensure that any smart applications that are specified for new infrastructure projects will be of true benefit for the city and their communities and value for money will be achieved. This Smart Maturity Assessment will benchmark the readiness of cities against a maturity scale that EBRD has developed. Where gaps are identified, EBRD will conduct a more detailed smart needs assessment leading to necessary policy development and capacity-building programmes. The maturity assessment will specifically consider: • Smart leadership and governance: - Does this currently exist and, if so, what are the responsibilities and organisational structures? - What investment is planned for further maturity and benefit? - Does this include partner collaboration or open-source availability of data for private sector smart development?

	• Stakeholder engagement:
	  - How have stakeholders been engaged with to determine how best smart inclusion can provide benefit?
	  - Is there a citizen, community or even an environmental/green benefit focus and, if so, what are the intended benefits?
	• Data and integrated ICT infrastructure:
	  - Is data captured and, if so, how?
	  - Does the necessary ICT infrastructure exist to transfer and utilise the data?
	  - What is the capacity, and can this be enhanced?
	  - Does the city have the competency and capacity to fully utilise the data available and the ICT infrastructure?

Business rationale	Since 2016, the EBRD Green Cities urban sustainability programme (a €1.5 billion flagship programme) has brought together 45 cities that want to upgrade their infrastructure for the 21st century with the aim of having 100 cities on board by 2024. The EBRD helps each one with both municipal investments and technical support to develop tailor-made programmes of green infrastructure projects. McKinsey estimated in their Smart Cities report of 2018 that integrating smart solutions to urban infrastructure could result in as much as 10–15% greenhouse gas emissions savings. This is a key reason for the European Bank for Reconstruction and Development's (EBRD) recent decision to integrate 'smart' into its flagship Green Cities urban sustainability programme. EBRD also wants to ensure that its cities and their communities obtain optimised value and benefit from the infrastructure solutions EBRD invest in. Where this can be improved through digital components and applications then it seeks to ensure that these are integrated or at least the city is advised of the potential advantages.
Transferable lessons learnt	This is just the start of the integration of smart and digital technology innovation across EBRD. The new bank strategy for 2021 to 2025 has the incorporation of digital technology as one of its three core pillars along with gender and inclusivity and green economy transition. Consequently, the incorporation of smart into Green Cities is a pathfinder for EBRD, but given the enthusiasm for this already received from EBRD cities, this is timely and genuinely needed. Smart has now been formally integrated into the GCAP methodology for all future EBRD Green Cities. The ambition is for EBRD to have 100 of these by 2024. Retrospective smart assessments are also now being conducted for those cities with completed GCAPs, so none of the EBRD Green Cities will be left out. EBRD conducted a thorough global review of smart knowledge including engagement with the public and private sector smart experts to determine if there was a Smart Maturity Assessment for cities already in existence that could be used. They drew a blank on this, however, and so developed their own. The maturity assessment is simple and intuitive and has drawn a positive response from all external to the bank so far that have reviewed it. Hence, the Smart Maturity Assessment is transferrable and has already been shared with the World Bank, the G20, the OECD and the Global Infrastructure Hub.

Name of the organisation	Leeds City Council
Description of the core tech	**Internet of Things/Sensor network** Leeds is developing a project which will consist of approx. 15 Concentrator/Gateways which will cover the whole the city. The network server will be built using Open Standards enabling data sharing where applicable. The initial application will be street lighting control (97,000 street lights) and the gateway deployment will follow the locations for that rollout starting in 2021.
Nature of the project and who the key partners are and their contribution/role	The network will allow other sensors/applications to be deployed, including Social Housing monitoring and Road Temperature. So, after the core elements are in place, sensors and applications can easily be added to the network. Leeds Beckett University is interested in developing a proposal relating to monitoring the Urban Heat Island effect and the impact of green infrastructure, building upon Leeds Beckett University's understanding of thermal performance in the built environment. University of Leeds is interested in deploying air quality sensors and extending monitoring beyond the campus.
Sustainability benefits achieved	The city council has secured funding to deliver a prototype dashboard of environmental issues in the city including flooding, air quality, carbon emissions, waste, biodiversity and local weather conditions (drawing on the extensive network of weather data captured by both universities and the council but not publicly available to date). The benefits of data publication via dashboards has been demonstrated during the COVID pandemic. There is a significant network of potential users for dashboards including the general public, schools, decision-makers, public service managers and academics. In addition, Leeds has an active community of data scientists and is host to the Leeds Open Data Institute created to explore and deliver the potential of open innovation with data at city scale.
Business rationale	Using open data protocols means that Leeds is not tied to any one technology supplier. This means that the network can effectively be used by any organisation or business interested in developing sensor and other technologies and data applications..
Transferable lessons learnt	TBC

Name of the organisation	**Mondra Global Limited (t/a Mondra)**
Challenge	More than one-fifth of the world's greenhouse gas emissions stem from agriculture, over half from animal farming. Unless these emissions are actively addressed, they will probably increase by 15–20% by 2050 as the earth's population rises and the need for food continues to grow. Limiting the impact of climate change will require shifts in what we eat, how much we waste, and how we farm and use our land [1].
Description of the core tech	We are building the digital platforms and tools for a sustainable food system, enabling a step-change in environmental accountability through radical transparency and traceability. Driven by tightening regulation and consumer demand, we are creating a new competitive marketplace; one where producers are empowered to monitor, improve and communicate product environmental impacts to their customers based on a scientific, standardised and comparable environmental accounting and certification method. Based on years of scientific research (Poore & Nemecek, 2018), Mondra enables farmers and processors to measure and certify product greenhouse gas emissions, water usage, water pollution and biodiversity loss. Certificates for interrelated food products are connected on the Mondra platform and culminate in a consumer-facing product label to surface farm-to-fork environmental impacts and inspire planet-positive food choices. Mondra delivers the commercial incentives for food producers to certify and label their produce: • understand and benchmark environmental performance • know how to improve environmental performance • enhance brand loyalty, customer satisfaction, win market share • accelerate emission reduction and reduce regulatory risk • access forthcoming agricultural subsidies (farmers) Certificates are updated year on year, driving continuous improvement and a competitive marketplace based on a standardised, scientific approach to measuring and communicating environmental impacts in the food system. TRANSPARENCY TOOLS Monitor – Using latest scientific research (Poore & Nemecek 2018), the platform captures environmental impacts including: greenhouse gas emissions, water usage, water pollution, biodiversity loss. Mondra enables self-service product Life Cycle Assessment (LCA). Data acquisition is largely automated by integrations with farm and production management systems, supplemented by earth observation and secondary data sources. Machine learning algorithms fill data gaps, anomaly detection verifies accuracy and in-person checks (delivered through partnerships with existing audit bodies) provides added fraud protection. Improve – Mondra provides performance benchmarks and improvement insights. Producers understand their relative performance in the market and identify improvement hotspots, albeit a change in production practice or sourcing arrangements.

	Communicate – Mondra provides an auditable record and certificate of product achievements and best-in-class food labels for commercial use. Mondra's traffic light grading system supports consumers to make quick decisions about one product over another based on eco-impact. Mondra also delivers a digital certificate with online learning centre plus an enriched e-commerce experience. **TRACEABILITY PLATFORM** Product certificates are structured in a food system graph to show the relationships between products in complex supply chains, delivering unparalleled traceability from farm to fork. Products are assessed annually and any changes to individual performance automatically cascade throughout the chain to those who are impacted. Blockchain technology guarantees integrity.
Nature of the project and who the key partners are and their contribution/role	**Project Partners:** Mondra (project ownership, digital tools and platform), Oxford University (Underlying Science for calculating eco-performance, Poore & Nemecek, 2018, project support) **Project Overview:** We worked with a leading plant-based milk brand who wanted to understand, improve and communicate the environmental performance of their milk range. Using Mondra's platform, the client was able to comprehend greenhouse gas, water, and biodiversity impacts across their entire supply chain including farm-level produce, distribution, packaging, processing and retail. To arrive at these insights the client invited suppliers to participate on Mondra's platform and, where data was not available, Mondra's gap-filling algorithms were able to complete the process by modelling against Poore & Nemecek and other secondary data sources. Mondra delivered a comprehensive product LCA, surfacing environmental impacts at each stage of supply. Improvement hotspots were identified, and action taken, including a reformulated sourcing strategy to reduce carbon emissions of key ingredients, practices and packaging choices. Once the product composition and production cycle were optimised for environmental impact and cost, the client certified their product on the Mondra platform (ISO14044 and GHG protocol compliant) and proceeded to label their packaging to inform consumer choice and drive brand loyalty
Sustainability benefits achieved	Mondra provided the client with the means to optimise ingredient composition, sourcing arrangements, processing practices and packaging choices for environmental impact, balancing the need to guard margins. Estimated reduction in supply chain greenhouse gas emissions of 22% through new sourcing strategy. 12% reduction in water use through improved production practices

Business rationale

For the first time in history, political, social and commercial drivers are converging to create the circumstances for a new food system; one where sustainable production wins commercially.

COVID-19 is driving 'mindful consumption'[2] and grocery retailers are making net zero pledges that include scope of three supply chain emissions[3]. Coupled with increasing environmental regulation[4], this is driving food manufacturers to consider the ecological performance of their products[5] by sourcing more sustainable ingredients. In turn, this impacts the competitive landscape of UK farming. Meanwhile, NFU has laid out a 3-pillar strategy[6] (smart farming, bio-economy, re-use of land for carbon sequestration) to achieve farmer net zero by 2040 with forthcoming subsidy reform promising to reward sustainable farming practices[7].

With the political and commercial drivers in place, we have a golden opportunity to enable a step-change in Environmental Transparency and Traceability – establishing a system where producers monitor and communicate their environmental impacts – in order to better appeal to their customer and outrun tightening environmental regulation.

Transferable lessons learnt

Though encouraged by the outcomes of the project, lack of primary farm data from the client's actual supply chain meant that a modelling approach was needed for farm-level ingredients. This undermines accuracy and the value of the insight to inform farm-level improvement and processor sourcing decisions. Key takeaways:

'Top down' approach to data acquisition needs to be complemented by a 'bottom up', farmer-specific proposition to drive engagement. We need to radically improve and standardise the way that environmental footprinting is done on-farm and specifically at 'yield-level'.

There are a number of high-profile initiatives working towards a standardised agricultural footprinting model (AHDB, DEFRA, NFU). Beyond defining a standard, we need to unlock the commercial incentives to drive adoption by UK farmers and growers. Forthcoming subsidy reform will only go so far in achieving net zero targets. There is an urgent need to pilot new supply chain economic incentive models to make it commercially feasible for farmers to improve performance year on year.

We need a comprehensive audit of available agricultural primary data sources (e.g. farm monitoring systems, earth observation data, agricultural audit bodies) – and a strategy to create win-win commercial outcomes for owners to share their data openly. By harmonising and processing existing data feeds, we can reduce the effort required of farmers to certify their yields for eco-impact, bringing down a further barrier to adoption.

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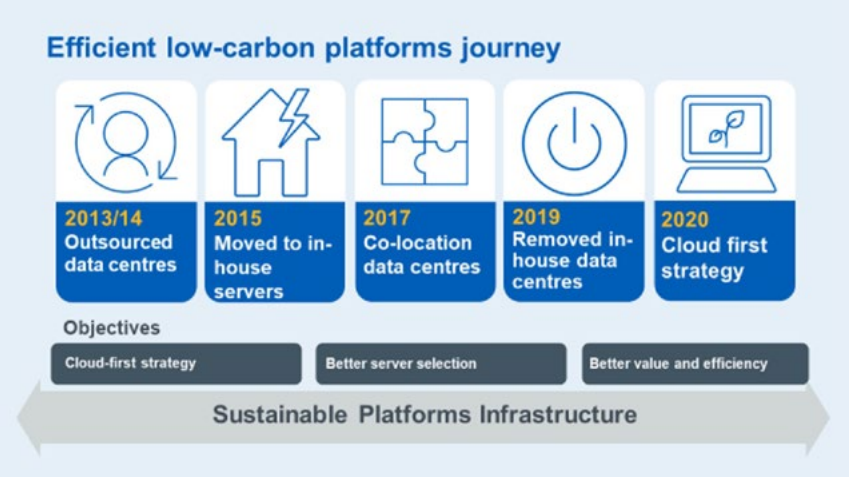
Name of the organisation	NHS Digital
Description of the core tech	**Cloud-based services** One of the most critical contributions to sustainability is made by more efficient and effective use of our technology infrastructure services. The NHS has made progress in optimising on-premise data centre consumption by migrating to more efficient alternatives and also by adopting more **public cloud-based services** through the 'Cloud First' approach.
Nature of the project and who the key partners are and their contribution/role	**Adoption of cloud-based services to enable carbon savings across both NHS Digital's own delivery and now to the wider health system.** A revised sustainability effort is being mobilised from NHS Digital working with partners and our technology suppliers, in order to mobilise a strategy and plan that further contributes to their goals. In the coming year, NHS Digital will take a more strategic stance in optimising the use of both local organisations' infrastructure and their cloud-based solutions. Major public cloud suppliers are showing ambition in greening their offers and progress is being made in data provision. We are therefore developing a target to only use platforms which operate on 100% renewable electricity by 2025. Alongside our advances in adopting a 'Cloud First' approach and therefore realising sustainability benefits as part of our overall strategy for infrastructure services, we are also continually improving our adoption of contemporary cloud and infrastructure tools and processes, which includes considerations of developing our software and products in a similarly more efficient way to reduce infrastructure costs. In the coming year, we will take a more strategic stance in optimising the use of both local organisations' infrastructure and their cloud-based solutions. We will work with other NHS partners to drive the optimisation of infrastructure consumption and efficiency across the health and social care technology arena.
Sustainability benefits achieved	The NHS's low-carbon platforms journey has highlighted a need to select green platforms to power our digital health services and server provisioning. This involves selecting platforms which offer efficient cooling, use of renewable electricity and Power Usage Efficiency (PUE). The journey outlined in the below represents a huge saving of circa 4,000 tonnes CO2e. Early benefits of these changes commenced nearly 10 years ago but has accelerated over the last few years to alternative 'co-located' hosting services and with the adoption of modern cloud services through the 'Cloud First' agenda and developing strategies.

Numerous technical interventions have been used to achieve efficiencies including:

- Consolidating and decommissioning 'legacy' data centre cabinets that are no longer required and planning for further reductions in the future. 20 cabinets have been decommissioned in HM Land Registry facilities with 39 more by the end of March 2021.
- Commissioning more efficient data centre services such as through the Crown Hosting agreement.
- Using cloud services where appropriate and migrating existing legacy workloads into the cloud to further reduce data centre footprint. There are now 58 services on native cloud reducing the need for additional data centre capacity and 1,350 virtual machines migrated from co-located data centre to cloud.



(Source: https://files.digital.nhs.uk/25/AAFD74/Sustainability%20Annual%20Report%202019-20.pdf)

Business rationale

In order, to further enhance the efficiency of a cloud-based approach, we have procured and implemented cloud management systems and tools to help the organisation optimise our cloud environments.

These tools and systems work across multi-cloud environments and enable NHS Digital to tag resources, alert on cloud consumption and identify areas for optimisation and cloud rightsizing. It also helps us to identify opportunities to buy and reserve capacity to optimise costs.

Transferable lessons learnt

We have learnt and are developing the following transferable lessons:

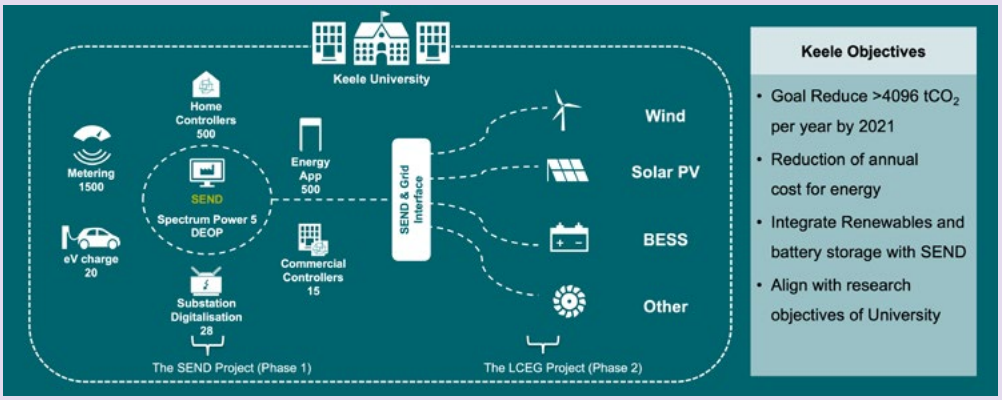
- technical best practice expertise in data centre architecture and cloud migration
- developed a prototype sustainable digital system design checklist
- building a toolset to allow integrated decision-making for digital system design (e.g. factoring in environmental and social externalities into design/business case decisions)
- consideration of sustainability risk/resilience issues for digital systems e.g. extreme weather, energy security, supply chain security, digital inclusion (equality linkage)
- thought leadership on key low-impact digital system interventions, e.g. data resolution and retention, single low-energy user device, circular economy, interoperability etc

Name of the organisation	OneWeb
Description of the core tech	**Space-based global communications network** At OneWeb, we are building the world's first global communications network in space to deliver high-throughput, high-speed services capable of connecting everywhere, to everyone. Using the world's first large-scale mass-produced satellite system – orbiting at an altitude of 1,200km at 8,000 metres per second – in conjunction with a network of ground stations across the globe, we will be able to provide fibre-speed Internet to previously unreachable regions of the planet.
Nature of the project and who the key partners are and their contribution/role	**Collaborative communications project supporting connectivity access everywhere** The OneWeb system is being built in conjunction with various partners, including OneWeb Satellites (a partnership with Airbus) and launch provider Arianespace.
Sustainability benefits achieved	The benefits of improving connectivity (not just via the OneWeb system) will be a critical piece of the 'green' infrastructure needed for the sustainable recovery from COVID-19, and achieving the aims of the Paris Agreement and UN Global Goals. The pandemic has highlighted our reliance on connectivity as the world has migrated more than ever to the online domain. However, three billion people across the planet do not have access to the Internet, a disparity known as the digital divide. In a period where we depend on the Internet for work, education, shopping and healthcare; communities who are underserved are facing difficulties in adapting, with COVID-19 only accentuating the disparity between those who are able to access the Internet, and those who cannot. However, improving connectivity and reducing the digital divide can enable the responsible stewardship of our natural environment whilst bringing about the socio-economic change creating opportunities across all the Global Goals. For our health and wellbeing, wider connectivity can enable video consultations and remote patient monitoring, whilst connected AI systems can predict future pandemics and allow scientists to share data to combat them. Communication networks are critical for responding to disasters and coordinating relief efforts while enabling warning systems for communities in high-risk regions. For our natural environment, wider connectivity can strengthen the sustainability of water systems whilst being a key driver of smart technology; from connecting Smart Cities and Smart Homes to driving Smart Energy Grids and empowering smart agriculture. A connected world will improve efficiencies whilst reducing emissions and waste. Indeed, reducing the need to travel is the most obvious benefit to the environment from connectivity as less travel equates to less greenhouse gas emissions. Connectivity will also enable better monitoring of vital ecosystems, helping to protect biodiversity across the globe. With 617 million children and adolescents not reaching the required educational standards, providing access to information and learning resources across the globe will be critical for driving sustainable development. Improving education will, in turn, prepare children and adults alike for their roles as citizens and allow them to create opportunities in their communities.

	For the economy, the United Nations estimates that for every $1 invested in connectivity could yield $5 in GDP growth by 2025. Whilst we are all familiar with online-entrepreneur success stories, empowering the three billion unconnected people to create their own businesses and thereby diversify the global marketplace will drive sustainable economic growth across the world. Connectivity enables people across the world to drive positive changes, from global movements such as the four million people who – inspired by Greta Thunberg – joined the Climate Strikes, to the human rights advocate Malala Yousafzai – who gained 1.1 million signatories in an online petition to improve education for the world's poorest girls. However, the Telecommunications industry consumes 3% of global energy – with the data centres used to power digital services contributing to 2% of global greenhouse gas emissions – an environmental impact on-par with the aviation sector. With all the benefits that can come from connectivity, it is vital that the sector looks to not only reduce its own impact, but also actively seek opportunities for using its technology for positive change for both the natural environment and wider society, itself becoming part of the innovative green technology needed for the sustainable recovery from COVID-19.
Business rationale	With such wide-reaching implications for sustainable development, it is key that the OneWeb system is itself sustainably developed. In space, we are committed to Responsible Space, to ensure we do not add to debris and protect the space environment. Our satellites are designed with enough fuel to de-orbit at the end of life and are fitted with a future-proof grappling hook. The constellation itself utilises solar technology for propulsion and system operations, whilst launching large numbers of satellites at a time (approx. 34) greatly reduces the number of launches needed, and the associated logistical emissions. Back on earth, just as the system will enable others to work towards a zero-carbon world, we are also designing our own net zero strategy, whilst seeking opportunities to use our technology for positive effect on the natural environment and society.
Transferable lessons learnt	Through building our sustainability strategy, we have started to fully appreciate the value of our technology beyond just reducing our own impact. By exploring areas that our technology can benefit across the Global Goals, we have started to map pathways in which we can go beyond compliance and begin to have a positive impact on the natural world and society. It is important of course to align our sustainability goals with the overall business strategy, as some areas are easy to change, whilst others are not. But, engaging with teams across the business certainly produces opportunities, sometimes previously unimagined. It has been valuable to work across the business at an early stage, so that we can build in sustainability at the heart of what we do, rather than having it as a 'bolt-on' to the mission. Furthermore, exploring sustainability benefits can lead to wider – and previously unconsidered – business opportunities. The key learning so far is therefore the necessity of wide (and early) collaboration – both internally and externally – to bring about sustainable change and explore innovative ways of using technology for good.

Name of the organisation	**Qualis Flow (Qflow) – Skanska Project (client)**
Description of the core tech	Qflow is an AI-enabled sustainability start-up that facilitates construction companies to be more sustainable and more profitable. Automated evidence-based data collection, flexible data aggregation and enriched datasets free professions from overwhelming bureaucracy and empowers them to act: to find commercial savings, to reduce carbon impacts and to avoid environmental risk. At its core, Qflow tracks all materials arriving on-site and all waste leaving. The technology is based on a hybrid model, applying Optical Character Recognition (OCR) and a series of machine learning based algorithms to digitise and extract data from delivery and waste tickets. This data is then enriched using a variety of data science approaches to normalise and fill any gaps. The clean, normalised and comprehensive dataset is then analysed for any environmental or commercial insights, such as opportunities for improvement in supply chain performance, material efficiencies and carbon mitigation. Qflow's mission is to help the construction industry become more sustainable by automating processes that rely on manual data input and are at risk of human error. Qflow's verified data source provides an auditable chain of custody, driving efficiency through digital innovation and data insights and embedding data-driven decision-making within the organisations it works with.
Nature of the project and who the key partners are and their contribution/role	Qflow was deployed by Skanska UK in 2019 on the £350m Oxfordshire Highways Project. The overarching client was Oxfordshire County Council and the principal contractor being Skanska UK. The contract covers over 2,800 miles of highway maintenance works and 1,000 structures. Due to the nature of the works, the contract generates a large amount of waste that needs to be tracked and verified for compliance and management. Qflow worked closely with Skanska's Senior Environmental Advisor Oliver Beech to deploy the Qflow app across the project for a three-month trial. The construction industry in the UK alone produces upwards of 120 million tonnes of waste every year, accounting for 32% of all the waste in national landfills. Skanska's Infrastructure Services division, responsible for carrying out the highway maintenance contracts, produces over 150,000 tonnes of waste every year. Innovative solutions such as Qflow are crucial to support them to minimise their impact.
Sustainability benefits achieved	Over the three-month trial, over 400 non-conformances and issues were raised alerting the team to risks in waste movements that they could address before they created problems such as programme delays or compliance risk. Data capture was improved by over 70%, enabling the sustainability team to deliver better forecasts of waste transfers whilst reducing risk of non-compliance. The Qflow data science team are using the data to identify opportunities to not only improve productivity but also to reduce waste generation all together. Better tracking of waste data also allowed opportunities to be explored for optimising movements in different regions, and new developments within the Qflow analytics team have since been able to map out cumulative waste volumes and disposal locations to identify alternative end destinations closer to site and reduce embodied carbon associated with transport. From one central London development, it was calculated that moving waste movements to closer facilities alone could save 6,775kg CO_2e per year.

Business rationale	Over £295,000 indirect commercial gains were identified. This incorporates reduced risk and efficiencies in the management of these processes, by automating the data and having real-time alerts. The ability for Qflow's software to verify the data via its three-step QA system means the Skanska team saved countless hours inputting and auditing data and increased the accuracy of the data by over 70%. The Qflow software picked up various non-conformances that were missed by manual checks.
Transferable lessons learnt	Technology can and should be used to empower environmental professionals. Any process or software that doesn't make the task easier or quicker should be re-evaluated. It should be noted that the new product deliveries module allows for the software to be applied to non-environmental purposes, such as fire safety and quality (as an example). There is no reason why the Qflow software cannot be applied in other sectors, the focus on construction has arisen from our background and the magnitude of impact we believe this can have on the industry. In terms of scalability, we use a cloud-based infrastructure ensuring we can handle a never-ending number of projects, companies and data-points. People are more important than technology. Engagement and encouragement ensure that the potential of technology projects succeed. Engage everyone with what you are trying to achieve and why it is important. Complete and enriched datasets facilitate insights, resulting in risk being mitigated and opportunities to improve identified. Data accuracy needs to be increased to mitigate risk to compliance and programme. In terms of industry averages, we are finding from the data some interesting and valuable trends. • 15% of timber delivered to site is non-complaint (not sustainably sourced/FSC or PEFC). • 27% of waste transfer notes (WTN) are not compliant and missing waste duty of care information. When these numbers are correlated into risk in terms of programme delays and re-work, the commercial and sustainability impact could be severe. These numbers give us an indication of the opportunities available from data insights and the impact we can have increasing profitability whilst reducing waste and material use and decreasing our overall carbon impact.

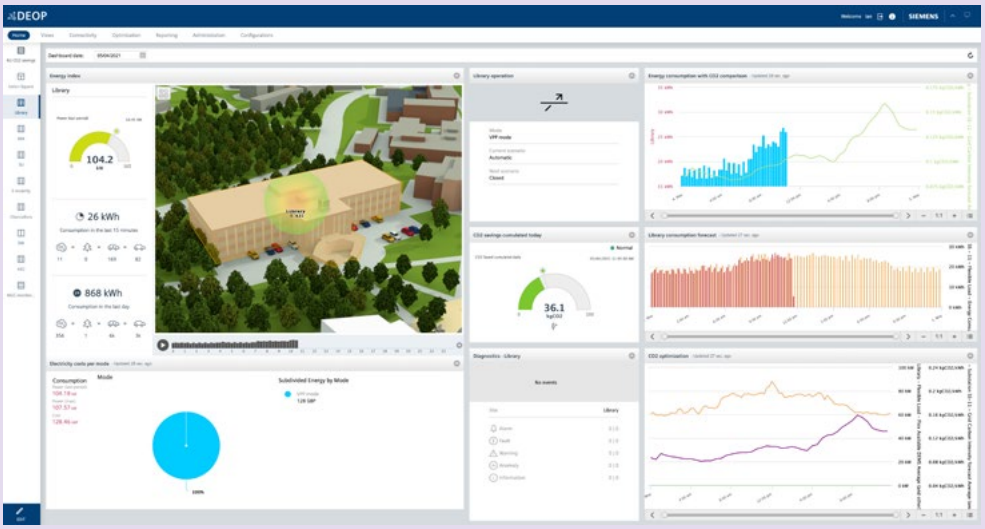
Name of the organisation	**Siemens PLC** Submission by Ian Lloyd, Head of Microgrid Solutions Siemens PLC, Smart infrastructure. Keele University Smart Energy Network Demonstrator
Description of the core tech	Our technical solution is based around key core applications that have been developed and delivered from the Siemens Smart infrastructure portfolio that have evolved over a number of years in smart grid development that will integrate with the entire range of the existing campus infrastructure and the future-proposed conventional demand, storage and generation opportunities that play a part in the Keele University development. Integration of our Spectrum Distribution Management System (DMS), our Distributed Energy Optimisation System (DEOP) and legacy Decentralised Energy Management System (DEMS) to control, coordinate and manage energy loads across the University facility, will enable clear visibility and orchestrated control of the network assets to flex and balance that will achieve the functional requirements of the Smart Energy Network Demonstrator. Keele is a demonstrator site for Siemens solutions, thought leadership, engineering expertise and ability. And on the back of that to be able to scale this project to another town, another city, another county and, lastly, another country to promote advanced control engineering that can be used to decarbonise society  Siemens link to reference case: https://new.siemens.com/global/en/products/energy/references/send-keele-university-smart-energy-management.html Link to advisory video overview: https://new.siemens.com/global/en/products/energy/references/send-keele-university-smart-energy-management.html Link to Augmented Reality reveal of the technology solution: https://www.youtube.com/watch?v=SnyiydwEn_Q

Nature of the project and who the key partners are and their contribution/role	On the campus at Keele University in Staffordshire, we are realising the vision of decarbonisation on the scale of a small town to reduce energy consumption – by firstly understanding what energy consumption is, analyse it and then balance it. The development of a decarbonisation solution that promotes a modified intelligent network, the digitalisation and integration of new and old systems, and its value to the stakeholder groups from regulation down to curriculum. The core objectives are aligned to the funding bodies of UK Government and the ERDF, the needs of the operational resources at the University, the research academics that will access and evaluate the data, and a direct linkage to dozens of SME businesses in Staffordshire and further afield, The core objectives are: • to harness the University's infrastructure attributes to facilitate the development and testing of renewable and smart energy technologies by business and academia • to create a demonstrator that is as close as possible a representation of 'real world' infrastructures in the UK with a mix of technologies from different suppliers • to demonstrate maximum technical sophistication, i.e., implementing the rollout of smart meters, load controllers and other intelligent devices commensurate with the scale of this delivery on a 'full campus' basis • to showcase technology connectivity, interoperability and feasibility in a world-class demonstrator • to create tools, mechanisms and expertise for developing continuous 'plug-n-play' capabilities in the future for interested parties, i.e., small to medium-sized enterprises • to enable the integration of relatively high levels of on-site local renewable sources of generation, i.e., 15–30% of total annual energy consumption from renewable energy • to significantly reduce the carbon footprint of the campus, i.e., 25% reduction in carbon footprint over the 1990 baseline and 35% of current carbon footprint • to promote research and innovation in, and adoption of, low-carbon technologies.

Sustainability benefits achieved

Coordination of assets and the inclusion of renewable generation to save over 4,000t of CO2 per annum, balanced with cost savings estimated at 15% and incentivised utilisation of energy to promote the shift to lower-carbon transportation systems.

The completed development will result in more than 28 substations digitalised, microgrid and building controls in place across the network hundreds of smart meters being installed, and over 8MW of renewable energy capacity being added across the campus to the existing network.



(Source: https://new.siemens.com/global/en/products/energy/references/send-keele-university-smart-energy-management.html)

Business rationale	Demonstrator to enable carbon control, linked to marketplaces for energy and carbon to maximise sustainable environment, but to remain within or reduce existing budget costs for energy consumption. A world-leading location to advise, educate, promote, test and scale an architectural schema that is replicable and transferrable to other locations in the UK and globally.
Transferable lessons learnt	Among the many lessons learnt about technology and its integration, the key learning from the project is spilt amongst those that relate to a relationship developed for success between the suppliers and stakeholders and the method of programme delivery with agility in mind. **Relationship building** • Clear objective vision agreed with the customer and the critical stakeholders • Early identification of the points of pain and pleasure for the current site/town operation • Early definition and agreement of success criteria for each element of programme initiatives documented • Clear dissemination of progress to retain engagement **Programme and technical solutions** • Agreement of an agile and dynamic approach for suitable planning and designs • Acceptance from the customer and Siemens for a 'sprint and soak' approach • Quick implementation of 'no regrets' measures to generate programme momentum • Future-proof designs to cater for likely changes in technology and market activity • System security and cybersecurity built into architecture design

Name of the organisation	**Sopra Steria Group** Submission by Ian Lloyd, Head of Microgrid Solutions Siemens PLC, Smart infrastructure. Keele University Smart Energy Network Demonstrator
Description of the core tech	**Collaborative Governance platform using an aggregate of all the digital technologies (cloud, big data, cybersecurity, privacy, user experience, social network, data visualisation AI, APIs (Application Programming Interfaces are a software intermediary that allow two applications to talk to each other) Open Data, data sharing, DevOps) to support sustainable mobility** Sopra Steria has brought its expertise in Smart Cities, its know-how in complex IT platforms and its mastery of Agile methodologies to the COMMUTE project to provide a digital, multi-actor platform based on an innovative digital concept, Colibry. This platform supports a collaborative governance based on a public and private partnership involving local authorities and big enterprises. Its aim is to share data between partners to define a common strategy to reduce the impact of the 'car usage and single occupant journeys' shift the commuting to new mobility (car-sharing, bicycle, ...) and new ways of working (home working). The digital platform is an aggregate of all the digital technologies (cloud, big data, cybersecurity, privacy, user experience, social network, data visualisation AI, API, Open Data, data sharing, DevOps) dedicated to the collection of heterogeneous data able to integrate with agility information required to develop a new and common understanding of employees mobility. This is an assistance for a collaborative decision-making process.
Nature of the project and who the key partners are and their contribution/role	**Multi-stakeholder project seeking to reduce congestion on major urban roads while increasing mobility, and using data and digital tools to influence behaviours.** Composed of 115 municipalities and more than one million inhabitants, the metropolitan area of Toulouse is a territory with a strong demographic and economic growth. By 2030, the area is expected to host an additional 250,000 people, 140,000 jobs and 200,000 to 230,000 homes in the large urban centre of Toulouse (compared to the situation in 2008). This growth will affect mobility. In the large urban centre, the number of daily journeys, all modes combined, will be around 4.5 million by 2025. The chosen territory for the deployment of the COMMUTE project is integrated into a wider perimeter, the north-western mobility area. This area is highly attractive due to the presence of the aeronautical industry, major economic territory of the Toulouse conurbation comprising more than 71,000 jobs and possesses an international flagship facility: Toulouse-Blagnac airport. Traffic congestion in the airport and aeronautical area of Toulouse has enormous costs including time lost, accidents and air pollution. Future growth will make it worse. The urban authority, Toulouse Métropole, is tackling this congestion with the COMMUTE (Collaborative Mobility Management for Urban Traffic and Emissions reduction) project, which engages local employers in developing a collaborative system for mobility management, aiming to change commuters' habits. The COMMUTE project in the airport area of Toulouse provides a case study of an opportunity in the migration to lower-carbon transport infrastructure. Part of the Smart City Master Plan managed by Toulouse Métropole and TISSEO Collectivités, it has two primary goals: reducing congestion on major urban roads while increasing mobility, and using data and digital tools to influence behaviours.

	The project aims to reduce the solo use of private vehicles in favour of new mobility solutions (car-pooling, car-sharing, cycling, etc.), through collaboration between the local authority and businesses in cross-referencing public and private data. In order to accomplish these objectives, several initiatives have been taken: 1) Reduction of the use of solo occupant private vehicles: for example, reserved spaces for company car-poolers and setting up a fleet of shared vehicles available to employees 2) Usage of public transport: for example, evaluation of the effect on the potential usability of public transport of actions accompanying the changes 3) Develop alternative means of mobility: for example, improvement of access to businesses for pedestrians and cyclists 4) Limitation of commuting: for example, development of teleworking within the company In partnership with Sopra Steria, the City of Toulouse in France has developed projects such as COMMUTE with the aim of providing accessible and sustainable transport systems to its citizens, together with innovation and technological investment in infrastructure in order to foster more resilient and sustainable industrial development The high-level objectives of these projects are closely linked to the UN Sustainable Developments Goals (SDGs), in particular: - SDG9 Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation. - SDG11 Make cities and human settlements inclusive, safe, resilient and sustainable.
Sustainability benefits achieved	The project began late in 2017 and will ended in 01/2021. A reduction of 5% in the use of private vehicles between 2017 and 2019 reduced emissions by an estimated 1.3 tCO_2e per day. Mass deployment of car-pooling enabled 100,000 car-shares during the period 2018 – 2020. In 2019, the digital platform allowed this collaborative governance system to visualise the potential impact of cycling habits by 27,000 employees. As a result of this, it decided to design and deploy a specific action on cycling effective as of October 2020.
Business rationale	Facing the soaring metropolisation and the increasing expectations around sustainability, digital transformation offered an opportunity to address the challenges of mobility. This project provided the opportunity to implement a new strategy for an improved approach for managing mobility that involved reduced environmental impacts and an opportunity to reduce costs required for the maintenance of transport infrastructure. COMMUTE demonstrates that a collaborative management of mobility involving local authorities, companies and employees using digital technology to share data and a common action plan has a positive impact on mobility practices and optimising the use of infrastructure – that is fit for purpose, today and in the future.
Transferable lessons learnt	The technology developed by Sopra Steria is scalable and reproducible in any area where public authorities and private companies want to collaborate to be more effective for the employees' mobility. The European Commission with Urban Innovation Action (UIA) fund the COMMUTE project. We are working with the local authorities to deploy the initiative on new economic areas of the city and we have workshops with other European cities of UIA programme to define the good practices to transfer. In the COMMUTE Project, the AFNOR (French standardisation organisation) elaborates a dedicated deliverable to prepare a future Mobility Management Standard.

Name of the organisation	**Yumuv (Trafi)**
Description of the core tech	Digital 'Mobility-as-a-Service' platform. Trafi technology brings together public and shared mobility into a single Mobility-as-a-Service package.
Nature of the project and who the key partners are and their contribution/role	Yumuv's purpose is to stimulate sustainable urban mobility in Switzerland by consolidating existing urban mobility options, strengthening public transport and making the use of shared mobility, hassle-free. Cooperation between Trafi, Swiss Federal Railways SBB CFF FFS, and PTOs of Verkehrsbetriebe Zürich, Basler Verkehrs-Betriebe BVB, and BERNMOBIL. Yumuv is one app, one account, that works everywhere in Switzerland, with one-time registration which unlocks access to all Yumuv services across Zurich, Basel and Bern. Yumuv riders can plan trips, purchase public transport tickets, book and pay for e-bikes, e-scooters and soon – car-sharing Trafi also powers the world's largest MaaS in Berlin — Jelbi.
Sustainability benefits achieved	Transport has continued to increase in greenhouse gas emissions globally, radical change is needed in our travel behaviours to make the necessary urgent shift away from the internal combustion engine and the private car. One of the key challenges preventing significant modal shift to public and shared mobility is widely considered to be the problem of the last mile, with the perception of complexity or difficulty of getting to and from a transport hub. Digital platforms and the Mobility-as-a-Service apps that they enable provide a way for different sustainable modes of transport to better work together and provide a better door-to-door service. The platforms allow for real-time information, as well as combined ticketing and payment across modes and operators. These apps provide a place for the modes to work together rather than in competition, they complement each other, providing a full A to B journey between them and make it easier for the passenger. UK Department for Transport figures show the percentage of men in England aged 17–20 with a full UK driver's licence has fallen from 51% in the mid-1990s to just 29% in 2017 (and from 81% to 69% for men aged 21–29) (Department for Transport National Travel Survey, 26 July 2018). These shifts can be partly attributed to the demand for consumer 'Mobility-as-a-Service' as an alternative to ownership. This transformative technology and the disruptive collaborative partnerships it supports will allow for significant shifts in sustainable travel choices. They will build confidence for people to move away from private ownership of vehicles and support the take up of shared mobility and the use of rail as the backbone of the journey. This behaviour change can, in turn, bring about benefits for air quality and free up space and congestion.
Business rationale	For many traditional public transport actors, COVID-19 has meant that public confidence has taken a big hit. They must innovate and transform to win back passengers and achieve the modal shift needed to decarbonise. MaaS platforms enhance customer experience and keep rail and other public transport modes relevant and linked into the multimodal sustainable mobility system.
Transferable lessons learnt	MaaS only works when there is a deep collaborative agreement across different organisation types and sizes. It requires clear governance and transparency on use of data. MaaS can fail if there is no confidence in the use of information across actors and where the arrangements are not inclusive.

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