White Paper

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SUSTAINABILITY IN NEW AND EMERGING TECHNOLOGIES

EXECUTIVE SUMMARY

In total, new technologies such as Artificial Intelligence and the Internet of Things will save approaching 1.8 PWh*(1)* of electricity in 2030, and an additional 3.5 PWh of (hydrocarbon) fuel use, resulting in total savings of 5.3 PWh of energy. Offset against this benefit is 653TWh of electricity consumption required to power solutions deployed using new technologies.

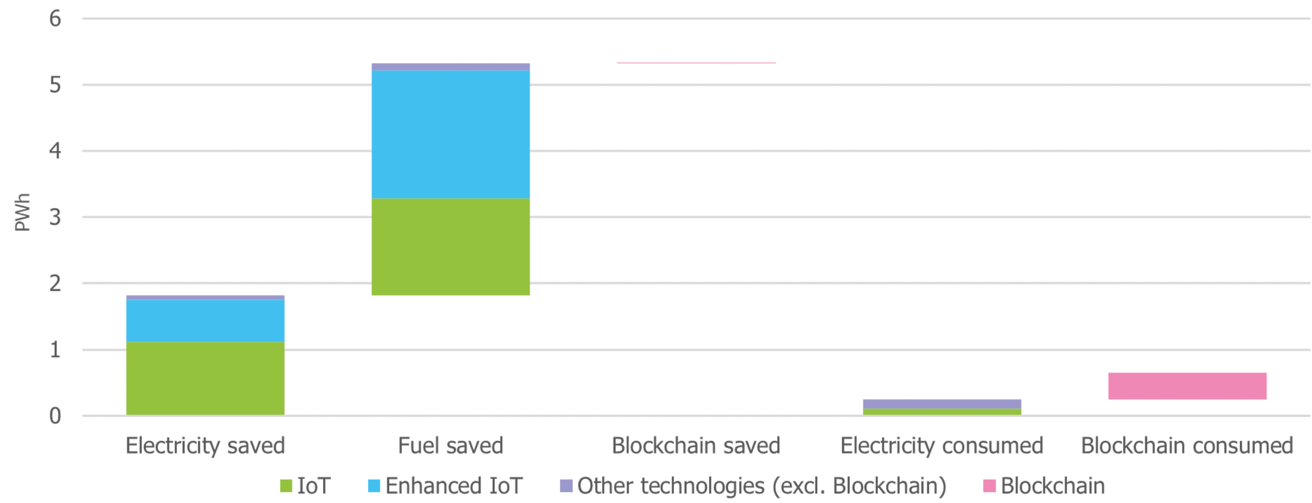
For comparison, the total electricity consumption of the global ICT industry is forecast to increase to around 8 PWh by 2030*(2)*, meaning that together new technologies will generate energy savings equal to around 58% of the total power consumption of the ICT industry.

The vast bulk of the savings are related to IoT-enabled applications, which together account for in excess of 95% of both electricity and fuel saved. This is due to the fact that IoT represents the interface of new technological environments to the 'real world', and it is in the real world where most energy is used and most savings can be made. The most impactful IoT applications include:

- A range of smart grid applications (including Electricity Smart Meters, Grid Operations, and Generation) together accounting for approaching 1.4 PWh of electricity savings in 2030.
- Heating, Ventilation & Air Conditioning (HVAC) systems accounting for approaching 130 TWh of electricity savings in 2030.
- Road Fleet Management, accounting for around 1.25 PWh of fuel savings in 2030.
- Road Traffic Monitoring & Control, accounting for around 290 TWh of fuel savings in 2030.

Figure 1, below, sets out the overall high-level results of the analyses and includes a category of 'Enhanced IoT'

Figure 1: Electricity and Fuel impact* of emerging technologies, by technology, 2030
[Source: Transforma Insights, 2021]



*During live operations, not including manufacturing, distribution, and end-of-life.

applications, intended to capture the overlap between new emerging technologies, i.e. where IoT solutions are themselves significantly dependent on other emerging technologies.

The relationship between new technology and sustainability is complex, with certain solutions such as (IoT-enabled) televisions supporting on-demand content mostly simply contributing to eWaste and power consumption (for local content engines, remote servers, and connectivity), while other solutions such as road vehicle fleet management and heating, ventilation and air-conditioning (HVAC) systems also have associated benefits in terms of fuel and/or electricity consumption. This relationship, illustrated in Figure 2 below, is, with few exceptions, consistent across all new technology deployments: the net impact of new technologies in manufacturing, distribution, and end-of-life phases is generally negative*(3)*, while many solutions generate a net benefit during live operations.

When viewed from this perspective, the difference between consumer and enterprise becomes quickly apparent, with many consumer solutions such as IoT-enabled Audio-Visual devices generally having a negative impact at every step of the process, while many enterprise solutions will result in significant sustainability benefits during their Operation phase.

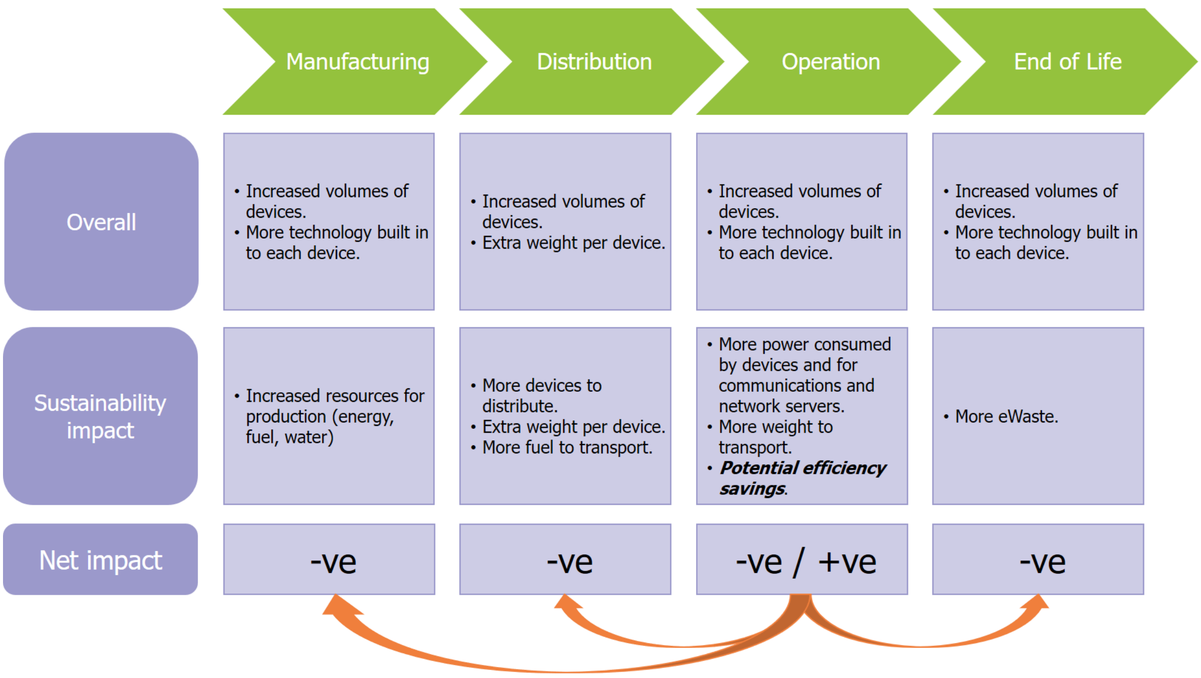
In the case of IoT-enabled solutions, the underlying dynamic is that many consumer devices are intended to deliver an enhanced value proposition to consumers, while enterprise solutions are generally deployed based on a business case analysis and expected net economic benefits. Exceptions to this rule include sophisticated HVAC systems, building automation, and smart lighting, which generate sustainability benefits irrespective of whether they are deployed in a consumer or enterprise context. Given these dynamics, it is not surprising that savings from enterprise account for 95% of electricity savings from all IoT solutions.

Beyond energy savings, water scarcity was listed in 2019 by the World Economic Forum as one of the largest global risks in terms of potential impact over the next decade, and a small number of IoT applications (mostly in the agricultural sector) will result in net savings of 230 billion cubic meters of water in 2030.

The impact of new emerging technology-based solutions that do not include IoT-connected devices is more of a mixed bag than the impact of IoT-enabled solutions. However, two clear groupings emerge when analysing CO_2 impact (which combines both electricity and fuel impact into a single measure).

At the Use Case level, it is the most widely adopted, processing intensive, non IoT-enabled applications that are intended to improve compliance or reduce risk that are most costly in terms of net CO_2 emissions. Use cases like Fraud Detection (accounting for 0.67 megatonnes of net CO_2 emissions in 2030), Risk Analysis (0.29 megatonnes), and Threat Detection (0.24 megatonnes), are all valuable from an end-user perspective, but they are processing-intensive and generally achieve little in the way of tangible results (from a sustainability perspective).

Figure 2: The sustainability impact of technology
[Source: Transfoma Insights, 2021]



Potentially positive impacts from the Operational phase must be offset against the negative impacts from the Manufacturing, Distribution, and End-of-life phases.

Conversely, some applications of (non IoT-enabled) emerging technologies are significantly beneficial in terms of net CO_2 impact, with the most beneficial use cases tending to involve interaction with real-world physical processes. For instance 'x as-a-service' (accounting for 2.6 megatonnes of net CO_2 emissions savings in 2030) includes the proactive and pre-emptive maintenance of assets to ensure that they operate efficiently and do not break down. This saves on remedial maintenance trips, and improved condition monitoring of these assets enables more maintenance to be undertaken during routine service visits. Inventory Management (1.7 megatonnes), Transportation Optimisation (1.1 megatonnes), and Supply Chain Audit (1.0 megatonnes) all include, in some way, improving the efficiency of physical distribution networks, and so reductions in fuel use.

What is particularly interesting is that investment in new technology tends to result in costs in terms of electricity consumption (to power the solution), often offset by some level of savings in terms of electricity consumption but more significantly savings in terms of (hydrocarbon) fuel consumption. This is an important dynamic, since it is much easier to source electricity from sustainable sources than it is to source (hydrocarbon) fuel from sustainable sources: i.e. the simple substitution of hydrocarbon fuel consumption with electricity consumption is beneficial from a sustainability perspective.

SCOPE

This report sets out the sustainability impact of new emerging technologies, including:

- The Internet of Things (IoT)*
- Artificial Intelligence
- Data Sharing
- Distributed Ledger (including Blockchain)
- Human Machine Interface
- Next Generation Product Lifecycle Management

The analyses are based on Transforma Insights' existing granular forecasts of market adoption of these technologies, combined with assessments of the sustainability impact of associated use cases. The scope of the sustainability analysis includes the impact of new technologies on:

- Electricity usage
- Fuel usage
- Water usage
- CO2 emissions
- eWaste

In all cases, our approach has been to analyse the 'incremental' impact of new technologies, by which we mean the net impact of new technology compared to a world without that technology. For example, in the case of a television, the impact of IoT is to connect the device resulting in additional hardware in the television (communications modules and processing power), and incremental communications network and data centre traffic. For certain other applications, the addition of IoT can result in overall either increased sales (e.g. autonomous vacuum cleaners) or reduced sales (e.g. shared vehicle schemes).

Clearly some of the IoT solutions discussed in the Executive Summary (and in more detail in later sections of this report) rely on other emerging technologies (such as, for example, Artificial Intelligence) as part of the solution. Where the emerging technologies analysed later in this report are deployed in association with IoT, their sustainability impact has been included in the IoT analyses, i.e. there is no double-counting between the analyses of the impact of IoT and the impact of other emerging technologies.

The macro-level analyses presented in this report cannot cover the full range of micro-level dynamics that are at play, and do not quantify some of the softer consequences of the deployment of new technologies. In the final section of this report, we discuss a number of the more complex dynamics that take place 'Behind the Scenes', including regional variances, behavioural changes and consumer choice, the wider societal benefits of new technology, and the evolving backdrop for new technology deployment.

*Including the impact of new emerging technologies such as 5G and Low Power Wide Area (LPWA) communications as they relate to IoT connected devices.

SUSTAINABILITY IN IOT

The Internet of Things (IoT) and environmental sustainability are two of the defining themes of our times. In this section, we discuss the relationship between the two. It is a complex relationship, with certain IoT solutions such as on-demand television content mostly simply contributing to eWaste and power consumption (for local content engines, remote servers, and connectivity), while other solutions such as road vehicle fleet management and heating, ventilation and air-conditioning (HVAC) systems also have associated benefits in terms of fuel and/or consumption.

Electricity impact

Overall, we forecast that the adoption of IoT solutions will result in a reduction of electricity consumption of over 1.6 petawatt-hours (PWh) in 2030*(4)*. Figure 3, below, highlights the net electricity saving impact of IoT in 2020 and 2030.

By 2030 the most impactful electricity saving applications will be associated with smart electricity grid operations, HVAC and building automation, whilst the most impactful electricity-consuming IoT solutions worldwide will be CCTV and audio-visual (AV) equipment.

Figure 3: Net electricity savings from IoT
[Source: Transforma Insights, 2021]

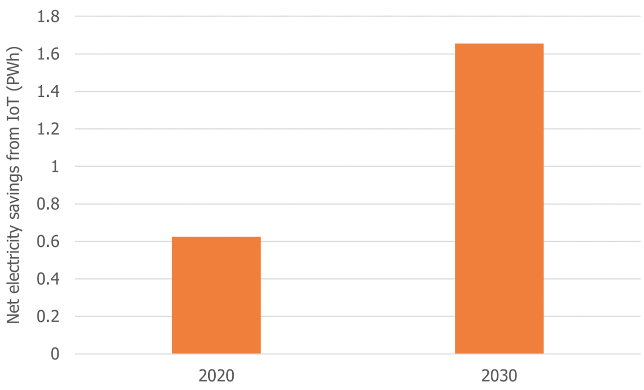
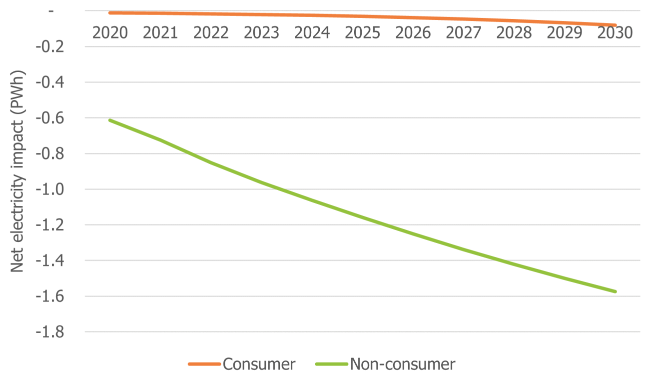


Figure 4: Net electricity impact, Consumer vs Enterprise IoT solutions
[Source: Transforma Insights, 2021]



What is particularly interesting is the difference between consumer IoT solutions and enterprise IoT solutions in terms of their net energy consumption, as illustrated in Figure 4, above. Essentially, IoT capabilities are generally combined with consumer solutions (such as AV devices) in order to improve the functioning and overall services supported by a device. In the enterprise space, on the other hand, IoT capabilities are generally incorporated into a solution if there is a net economic benefit to doing so. Accordingly, enterprise IoT solutions are generally associated with some level of increased efficiency. These efficiency savings could take the form of reduced electricity consumption, or (as we will see later) reduced fuel or water consumption. Such effects could either be direct, where IoT solutions enable tasks to be completed more efficiently, or indirect, where IoT solutions enable the avoidance of costs in related areas. IoT-enabled HVAC is an example of directly enabled electricity savings, whilst an IoT-enabled manufacturing production line machine is an example of indirect savings (due to reduced staffing levels).

Within the consumer sector, the most significant electricity saving IoT solutions are, unsurprisingly, HVAC, Building Automation, and Building Lighting. IoT solutions that exist primarily to support an improved user proposition (such as AV equipment, CCTV, and Personal Assistance Robots*(5)*)

Case Study: Google data centres

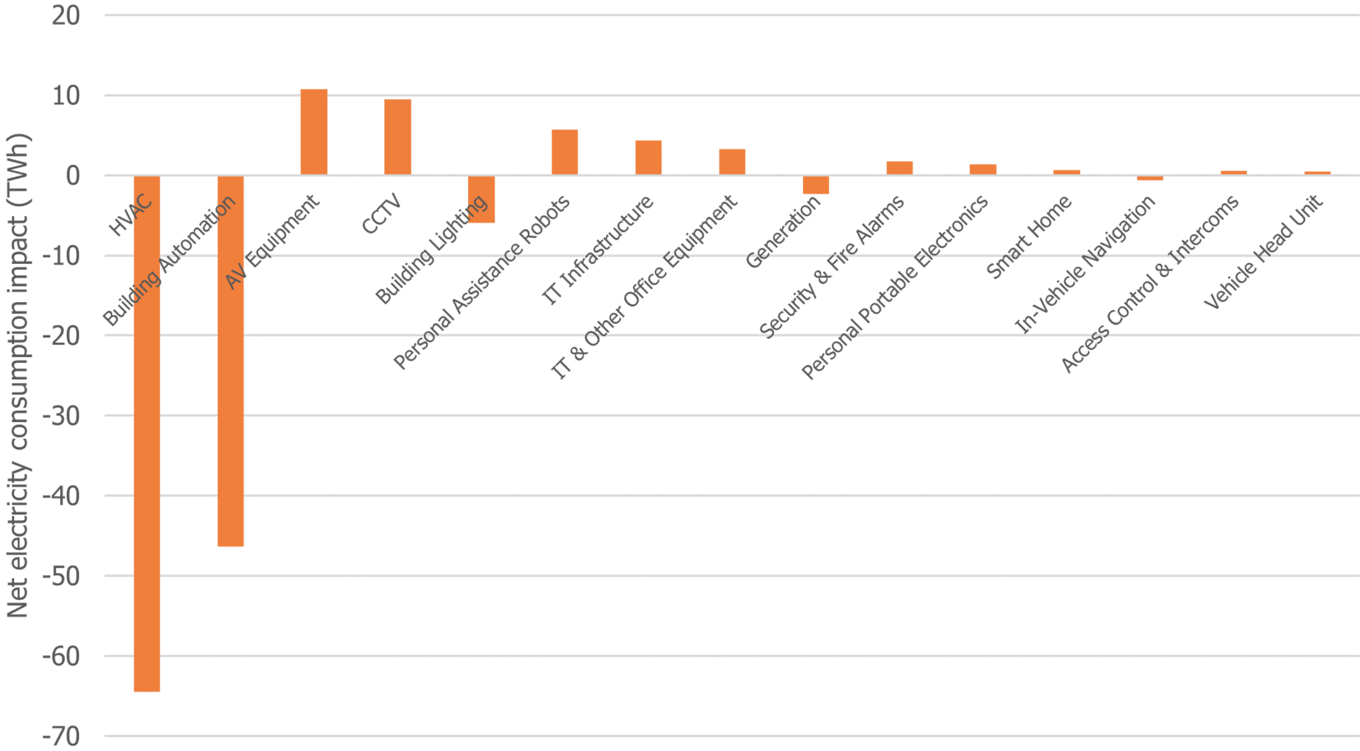
Google applied its own DeepMind machine learning capabilities to its data centres to help manage cooling more efficiently.

Energy optimisation in data centres overall is particularly complex, since equipment and the environment interact in complex, nonlinear ways. Additionally, the overall data centre system has traditionally not been able to react quickly to changes in operating conditions (such as the weather). Initiatives to increase efficiency are particularly challenging due to the fact that each data centre is unique in terms of architecture, environment, and load profile: a tuned model for one system environment may not work well in another 'similar' environment.

Cooling is one of the primary drivers of energy use in data centres, and is typically accomplished via large industrial equipment such as pumps, chillers and cooling towers.

Google's approach used a system of neural networks trained on different operating scenarios and parameters to develop a more efficient and adaptive framework to help manage data centre operations. The result was a reduction in the energy used for cooling of up to 40%.

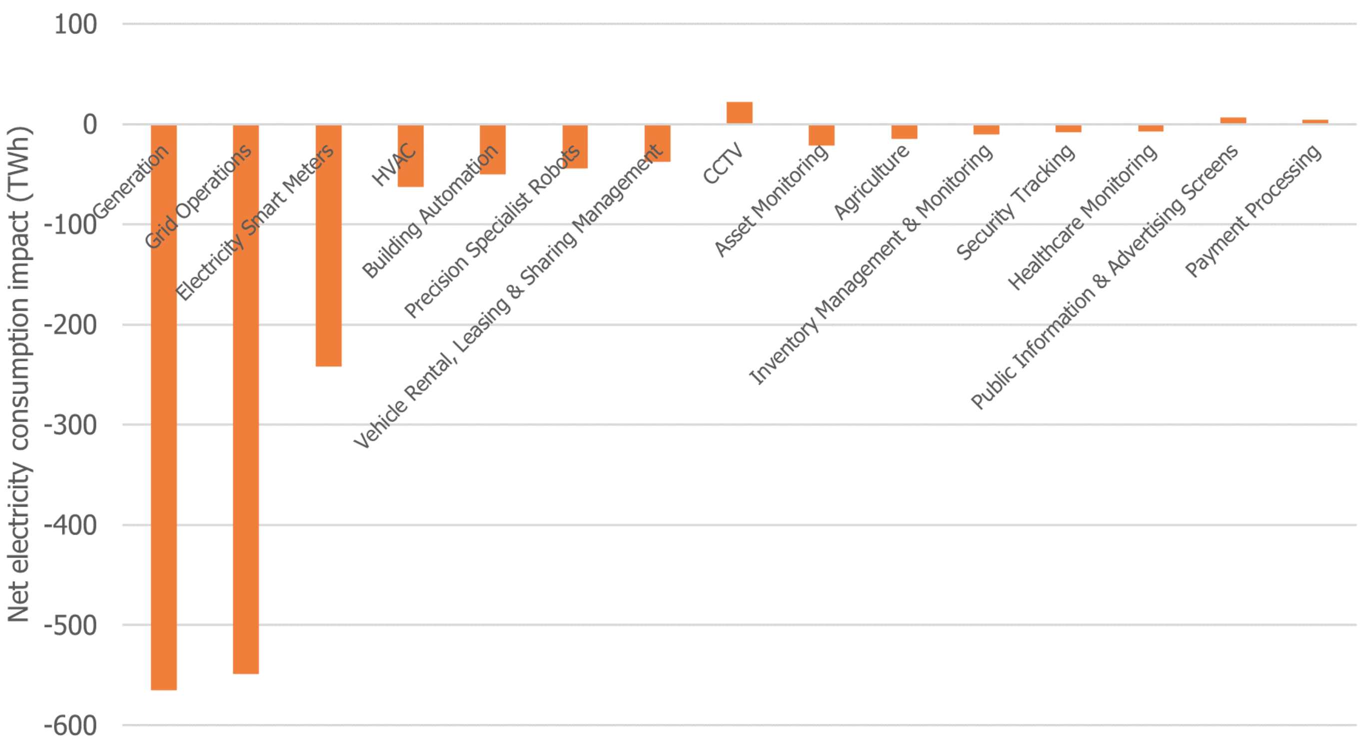
Figure 5: Consumer IoT applications with most net electricity consumption impact, 2030
[Source: Transforma Insights, 2021]



tend to be net electricity consumers. Figure 5, above, illustrates the most impactful consumer sector IoT applications, ordered by total net impact to electricity consumption.

The story is quite different in the enterprise space, with a majority of applications having some significantly net beneficial impact on electricity consumption. Figure 6, below, is again ordered by total net impact to energy consumption and it is clear that all of the most significant IoT solutions in terms of electricity consumption impact in fact have a net impact to reduce electricity consumption.

Figure 6: Enterprise IoT applications with most net electricity consumption impact, 2030
[Source: Transforma Insights, 2021]



Fuel impact

Beyond their impact to electricity consumption, many IoT solutions also impact hydrocarbon fuel consumption (including petrol, diesel, and gas). The net effect on fuel consumption is overwhelmingly positive, since the negative side of the equation (i.e. fuel used) is almost entirely accounted for by the need to transport the additional weight of IoT equipment. The simple fact that a car has IoT vehicle platform (or head end) equipment installed results in an increased weight, and reduced fuel efficiency. However, the overall effect is minor, and the impact of IoT on fuel consumption is significantly positive, as can be seen*(6)* in Figure 7, below.

The most impactful IoT solution in terms of fuel savings will be, unsurprisingly, Road Fleet Management, which enables the significantly more efficient management of road vehicle fleets, and also more efficient routing of delivery vans. Road Fleet Management alone accounts for around 37% of fuel saved by IoT solutions of all kinds. Road Traffic Monitoring & Control allows for more efficient traffic flows, particularly in city-centre and urban environments, and accounts for a further 9% of fuel saved. Inventory Management & Monitoring solutions enable fuel savings (8% of fuel saved) due to the more accurate and timely information that these solutions provide enabling

Figure 7: Fuel impact of IoT applications, 2030
[Source: Transforma Insights, 2021]

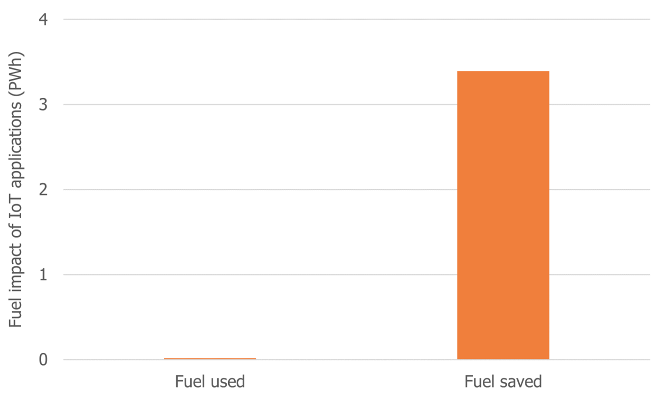
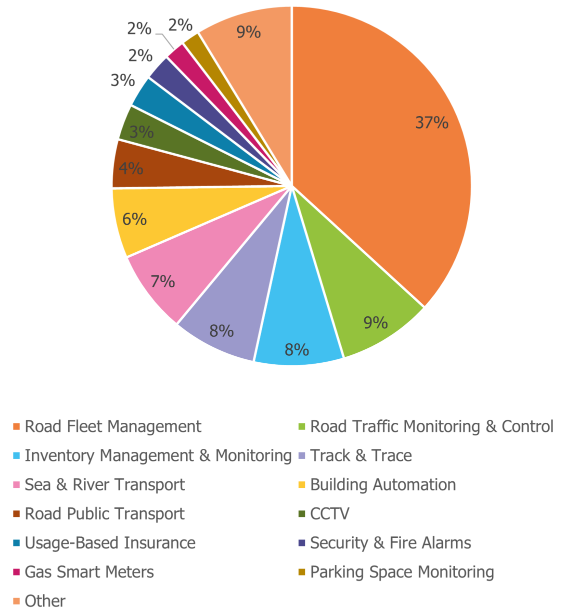


Figure 8: Share of total fuel saved by IoT applications, 2030
[Source: Transforma Insights, 2021]



more efficient transport and distribution systems. Figure 8, above, illustrates the contribution of the most significant IoT applications to total fuel saved by IoT.

Water impact

Water scarcity was listed in 2019 by the World Economic Forum as one of the largest global risks in terms of potential impact over the next decade. Water scarcity can result in partial or no satisfaction of demand, economic competition for water quantity or quality, disputes between users, irreversible depletion of groundwater, and negative impacts on the environment. Two-thirds of the global population (4 billion people) live under conditions of severe water scarcity at least 1 month of the year.

Relatively few IoT solutions have a material impact on water consumption, but those that do can have a very significant impact. In total, IoT solutions will have a

Case Study: West Yorkshire Police, UK

West Yorkshire Police has installed telematics systems into its operational vehicles in an initiative to reduce fuel bills and emissions and ensure that vehicle utilisation is maximised.

The system logs details such as mileage, vehicle speed, acceleration, and engine idling. This information is used to identify vehicles in the fleet that are underutilised, identify best practices for drivers and improve driver performance, and improve overall operational efficiency.

Initially around 600 vehicles were fitted with telematics and new vehicles are fitted with the system as they enter service on fleet.

Analysis of vehicle utilisation levels and identification of optimum fleet size led to the de-fleeting of 120 vehicles. Additionally, there was a significant reduction in the number of miles travelled, together with associated fuel costs and CO2 emissions.

Deployment of the technology also resulted in a reduction in blameworthy collisions by 31%, and informs ongoing driver training programmes targeting those drivers in need of most support.

Case Study: XAG crop-spraying drones

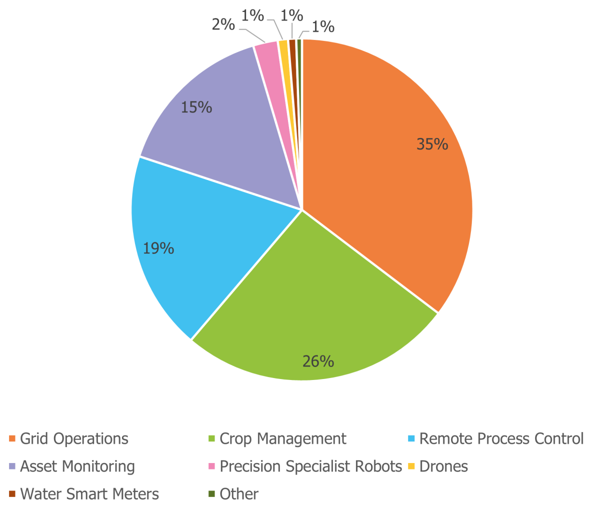
In late 2019, 1,500 drone pilots and 3,000 unmanned aerial system crop spraying drones converged in China to defoliate 1.3 million hectares of cotton fields.

Defoliation is a harvest-aid operation which applies chemicals to accelerate cotton boll opening and encourage cotton leaves to drop from plants within a specific short period of time. It is a necessary process to ensure timely, intensive mechanical harvesting and reduce impurities in cotton fibre.

XAG's P Series Plant Protection UAS is a type of aerial spraying system designed for chemical distribution. It enables users to spray safely and efficiently through simple but intelligent operations. The system can be used on plain fields, orchards, mountains, hills or terraces, and is capable of spraying liquid onto every target crop with uniformity and precision. A single drone is able to cover up to 14 hectares per hour, which the company claims is equivalent to the work of 100 farmland labourers.

Drones can conduct operations on pre-set flight paths to prevent overlaps or misses while automatically avoiding any surrounding obstacles within the croplands. Utilising a patented intelligent rotary atomising spraying system, the P series UAS protects the environment by reducing 30% of pesticide use and 90% of water waste.

Figure 9: Share of water saved by IoT applications, 2030
[Source: Transforma Insights, 2021]



positive impact on water consumption of approaching 230 billion cubic meters in 2030. As illustrated in Figure 9, above, around 35% of this impact will come about as a result of improved smart (water) grid operations. However, overall the majority of water savings as a consequence of IoT will be realised as a result of a range of Agricultural applications, including crop monitoring and management (26%), remote process control (of crop watering equipment, 19%), and improved asset monitoring (of livestock, 15%). The overall profile of water saving as a result of IoT solutions is illustrated in Figure 9, below.

Manufacturing, deployment, and disposal

Any analysis of the sustainability impact of IoT would not be complete without consideration of upstream and downstream resource impact. In this section we consider the incremental resources required to manufacture IoT solutions (including additional hardware per device, and increased (or decreased) levels of device shipments, where relevant).

In the manufacturing phase, the effect of IoT is to increase global electricity use by 34 TWh in 2030, as illustrated in Figure 10, below.

In addition, IoT will result in an increase of fuel used for manufacturing equipment of 3 TWh in 2030, and building IoT enabled solutions will result in an increase of water consumption of around 112 million cubic meters in 2030.

More significantly, the advent of IoT will result in an additional 53 TWh of fuel used for distribution and deployment of solutions, as illustrated in Figure 10 below. This increased fuel use comes about as a result of increased shipment weights for IoT-enabled devices, and also the shipping of an increased number of devices.

Lastly, of course, the advent of IoT will result in the generation of incremental eWaste, including additional hardware per device and increased levels of device shipments, where relevant. The overall impact will be over 657,000 tonnes*(7)* in 2030. For context, the world is forecast to dispose of 74.7 million tonnes of eWaste in 2030*(8)*, meaning that IoT will generate an incremental amount of eWaste in 2030 equivalent to approximately 0.9% of that disposed of in 2030.

Figure 10: Incremental electricity and fuel used to manufacture and distribute IoT solutions, 2020 and 2030
[Source: Transforma Insights, 2021]

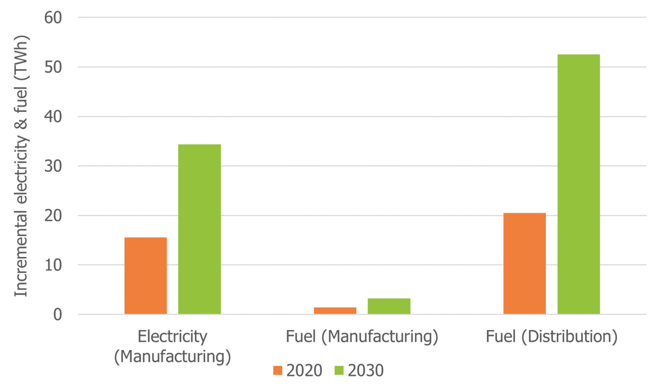
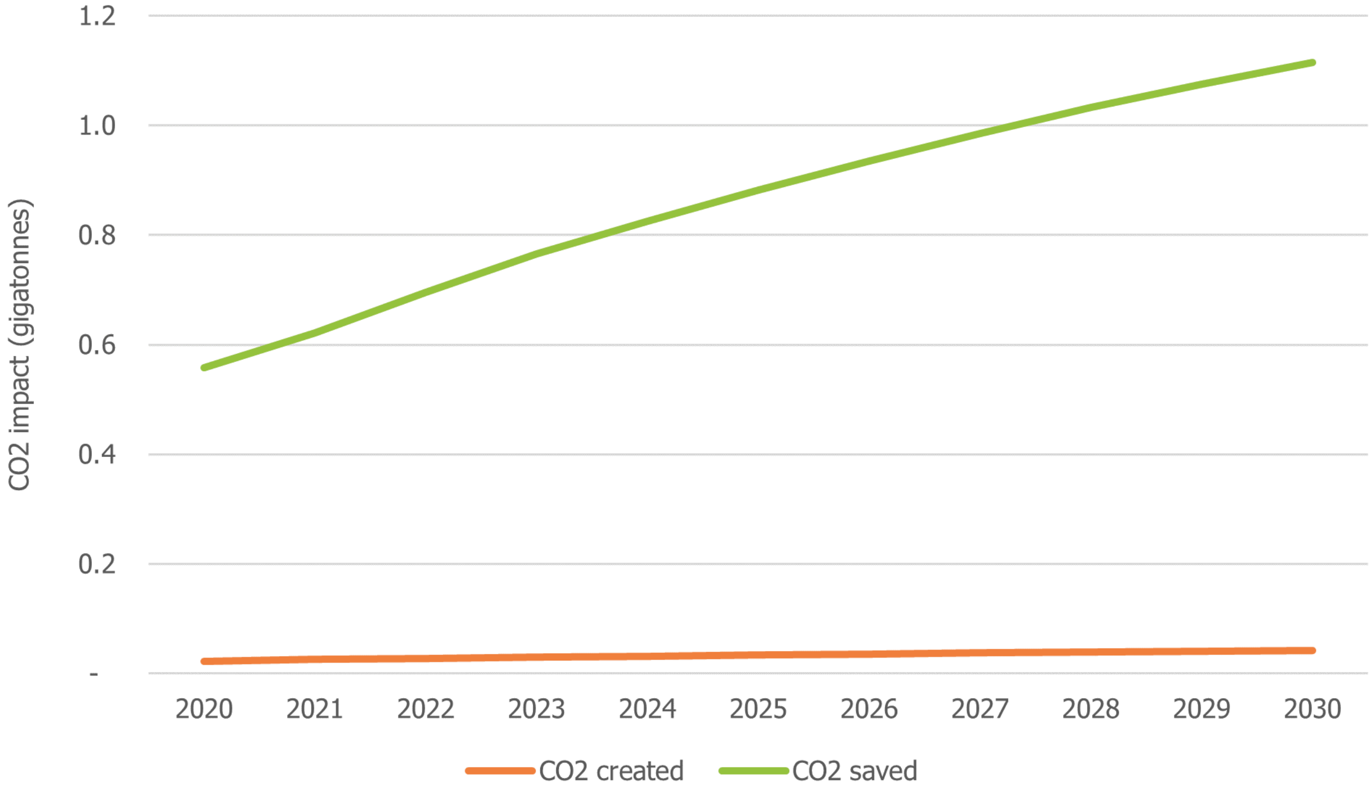


Figure 11: CO_2 impact of IoT
[Source: Transforma Insights, 2021]



CO_2 impact

Forecasts for electricity consumption impact and fuel consumption impact (including in manufacturing, deployment, and operational phases) can be combined to generate forecasts of the impact of IoT solutions on CO_2 emissions. As could be expected from the net impact of IoT solutions on electricity and fuel consumption, the net impact on CO_2 generation is strongly beneficial. By 2030, IoT solutions will collectively enable a net benefit in CO_2 emissions of around 1 gigatonne*(9)*. The overall increases and reductions in the emissions of CO_2 enabled by IoT solutions is illustrated in Figure 11, above.

Figure 12, below, shows the most impactful IoT solution in terms of CO_2 savings. The top rated is Road Fleet Management, accounting for 28% of savings. Grid Operations and Generation account for a further 9% each. Vehicle Rental, Leasing & Sharing and Road Traffic Monitoring account for a further 6% each.

Figure 12: CO_2 impact of major IoT applications, 2030
[Source: Transforma Insights, 2021]

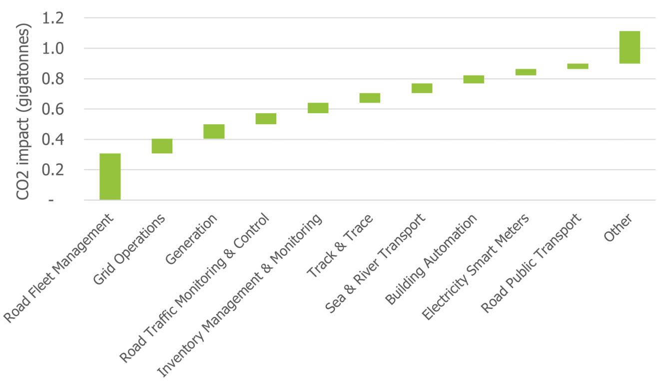
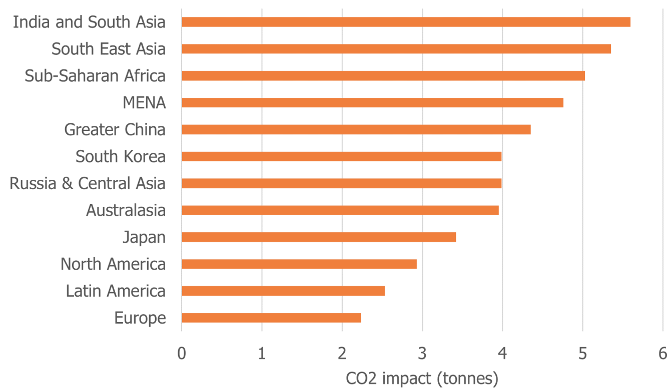


Figure 13: CO2 impact of IoT per smart grid Generation device, by region, 2030
[Source: Transforma Insights, 2021]



It is worth noting that the CO_2 impact of IoT solutions varies significantly around the world, depending on how electricity is generated in a particular country, or region. Figure 13, above, illustrates the impact of IoT-enabled smart grid Generation devices by region. The overall impact on CO_2 emission is lower in regions that have a greater proportion of renewable energy in their generating profile, and higher in those that rely on hydrocarbon-based generation to a greater extent.

SUSTAINABILITY IN OTHER EMERGING TECHNOLOGIES

Besides IoT, there is a range of other emerging technologies that are poised to impact predominantly enterprise end-users in the near future. These include:

- Artificial Intelligence
- Data Sharing
- Distributed Ledger (including Blockchain)
- Human Machine Interface
- Extended Product Lifecycle Management
- Robotic Process Automation

In this section, we analyse the sustainability of these emerging technologies, beyond the impact associated with IoT *(10)*.

Electricity impact

At a first level of analysis, the energy impact of emerging technologies (beyond IoT) is heavily negative. As illustrated in Figure 14, below, the electricity consumed by such technologies is approaching 8.8x the energy saved.

However, this is not the full story. Firstly, the total energy consumed figures include cryptocurrency, and specifically Blockchain. Blockchain is a highly innovative technology, but its operation is predicated on the fact that adding new 'blocks' to the chain is a highly processing-intensive task, and as a result the technology consumes enormous amounts of electricity. We expect that Blockchain will consume in excess of 400 TWh of electricity in 2030, which is equivalent to about 90% of the electricity consumption of France *(11)* today.

Figure 14: Electricity impact of other emerging technologies, 2030
[Source: Transforma Insights, 2021]

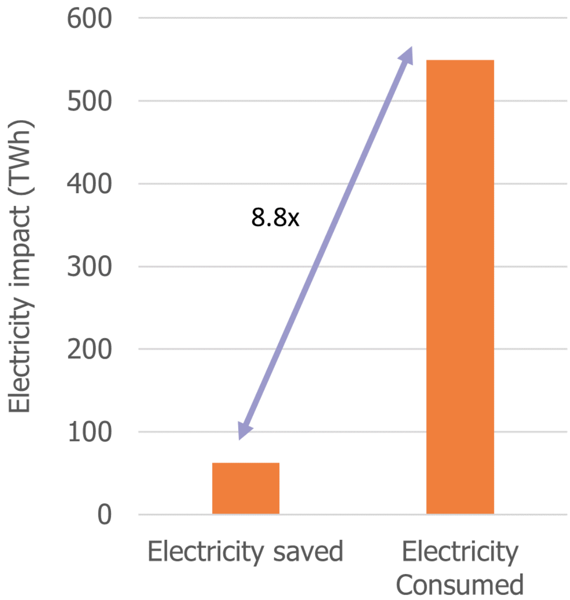
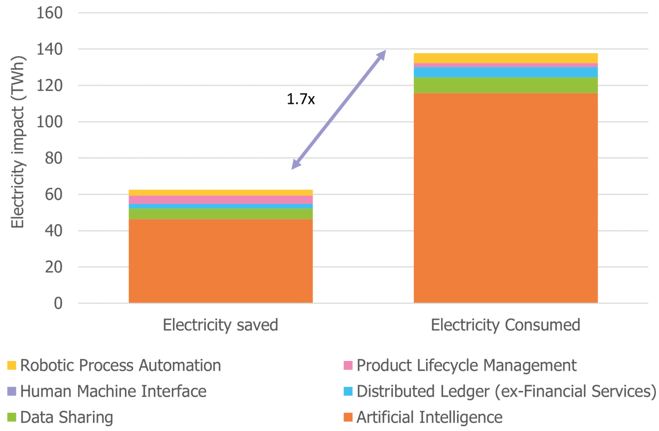


Figure 15: Electricity impact of non-IoT emerging technologies (excluding cryptocurrency), 2030
[Source: Transforma Insights, 2021]

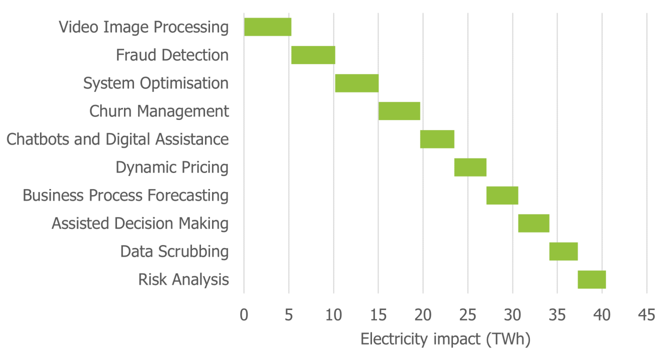


Adjusting to remove Distributed Ledger solutions in Financial Services (including cryptocurrency) results in a far more balanced and representative picture, as illustrated in Figure 15, above. Excluding Financial Services, the energy consumed by non-IoT emerging technologies is around 1.7x the energy saved. Artificial Intelligence is overwhelmingly the most impactful of the technologies.

Overall, it is clear that whilst enterprise deployments of new technology can be expected to be economically beneficial, these expected costs savings do not necessarily translate to direct electricity savings.

At the level of individual Use Cases, the most negatively impactful solutions (i.e. those that make the biggest negative contribution to net electricity consumption) tend to be those that are both processing-intensive and deployed to ensure compliance or to optimise a data-intensive operational process. The net energy impact of the most negatively impactful Use Cases (excluding Blockchain) is illustrated in Figure 16, below.

Figure 16: Top 10 electricity impact of top 10 non-IoT emerging technologies by Use Case (excluding cryptocurrency), ranked by scale of negative impact, 2030
[Source: Transforma Insights, 2021]



Case Study: SOLshare

Bangladesh is considered the market leader of solar home systems. However, most Bangladeshi households still rely on polluting and expensive fuels like kerosene or diesel generators. On the other hand SOLshare claims that more than a billion dollars in solar energy each year is wasted when home battery storage systems connected to solar panels reach capacity and excess solar power generated goes unused.

The company has created a new approach to bring affordable solar electricity to consumers who may not be able to afford their own solar panels. Using the SOLbazaar trading platform, SOLshare interconnects solar home systems and client users into peer-to-peer microgrids, monetising excess solar energy with mobile money. One party earns money, whilst the other gets access to affordable electricity. Clients may both consume and contribute electricity to the network at different times, and any such trades are summarised in a web-based dashboard for each client. SOLshare networks can either operate in isolated 'island mode', or can also connect to national grids to draw power.

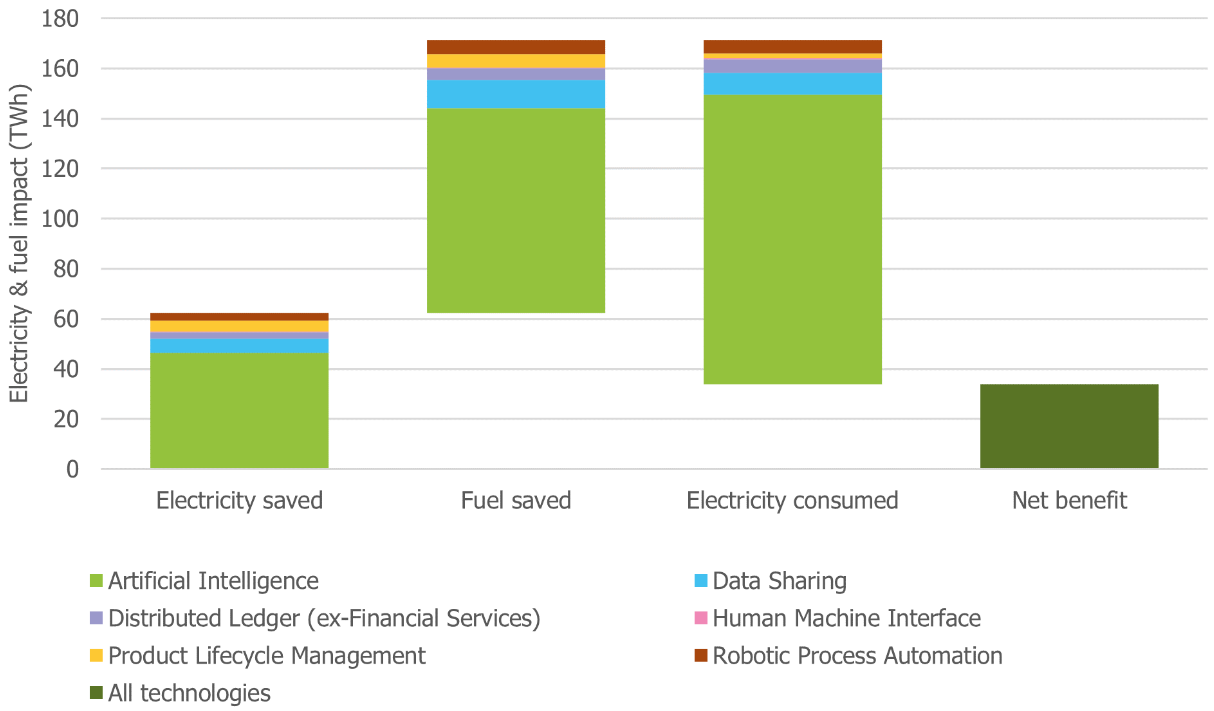
In addition to directly substituting solar electricity in place of diesel powered generator electricity, the solution improves quality of life in underdeveloped areas by making it easier for instance for schoolchildren to study after nightfall.

Fuel impact

The potential of new emerging (non-IoT) technologies to save energy extends beyond electricity to include fuel savings as illustrated in Figure 17, below. As the chart shows, once fuel savings are added to electricity savings the result is a net benefit in terms of the overall energy impact of emerging technologies.

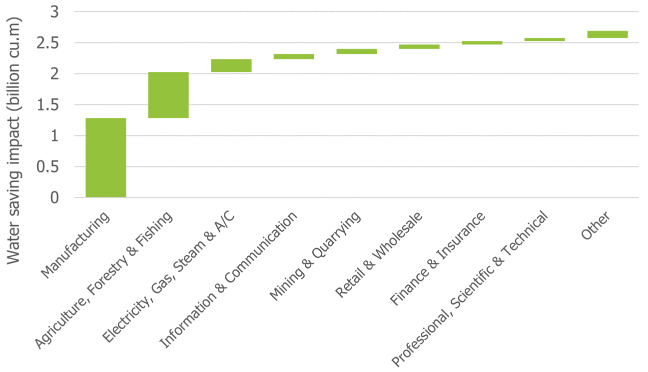
Effectively, the net result of new emerging technologies beyond IoT is to shift a significant amount of what was previously (hydrocarbon) fuel consumption to be replaced by electricity consumption. This in itself is potentially highly beneficial from a sustainability perspective, since electricity can be more readily supplied by renewable sources than can hydrocarbon fuel (or hydrocarbon fuel substitutes). Again, Artificial Intelligence is overwhelmingly the most impactful of the technologies analysed.

Figure 17: Electricity and Fuel impact of other emerging technologies, by technology, excluding Financial Services*, 2030
[Source: Transforma Insights, 2021]



*Excluding Blockchain, other cryptocurrencies and all of Financial Services.

Figure 18: Water saving impact of other emerging technologies by Industry, 2030
[Source: Transforma Insights, 2021]



Water impact

The deployment of new technologies also gives rise to water savings, due to the overall operational efficiency that they enable within end-using organisations. Effectively, investments in technology tend to result in cost savings, reductions in the number of people employed, and a reduced overall sustainability footprint of an end-user (offset, of course, by increased electricity consumption and investment in technical hardware).

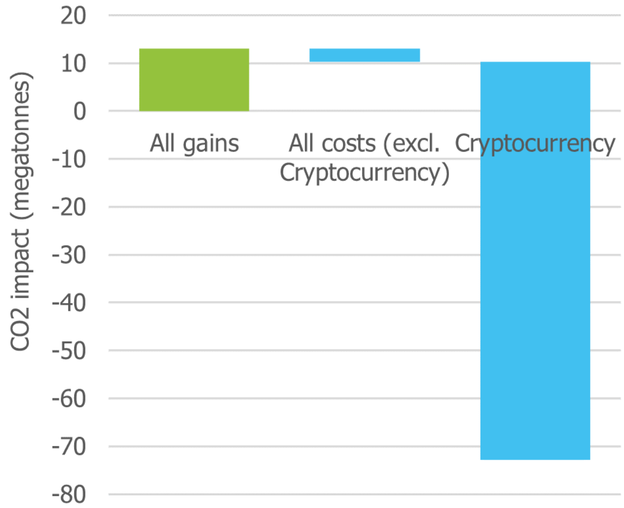
As illustrated in Figure 18, above, the industries that will be most impacted in terms of water consumption include Manufacturing, Agriculture, and Power Generation.

CO_2 impact

An analysis of CO_2 impact*(12)* of (non-IoT) new emerging technologies tells a similar story: when Cryptocurrency is excluded from the analysis, gains outweigh costs by a factor of around 4.7x. The single Cryptocurrency application, however, accounts for a CO_2 cost of the order of around 7x the gains from all other emerging (non-IoT) technologies. These results are illustrated in Figure 19, below.

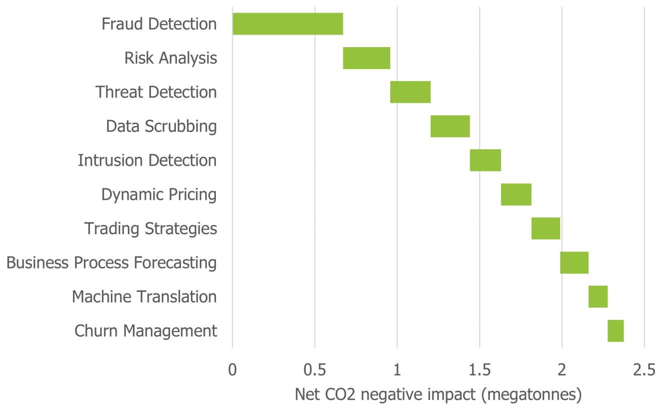
At the Use Case level it is the most widely adopted, processing intensive, applications that are intended to improve compliance or reduce risk that are most costly in terms of net CO_2 emissions. Use cases like fraud detection,

Figure 19: CO2 impact of other emerging technologies by Industry, 2030
[Source: Transforma Insights, 2021]



risk analysis, and threat detection are all valuable from an end-user perspective, but they are processing-intensive and generally achieve little in the way of tangible results (from a sustainability perspective). The most negatively impactful (non-IoT) use cases in terms of CO_2 emissions are illustrated in Figure 20 below.

Figure 20: Significant net negative CO2 impacts of other emerging technologies by use case, 2030
[Source: Transforma Insights, 2021]



Case Study: Mobility Open Blockchain Initiative (MOBI)

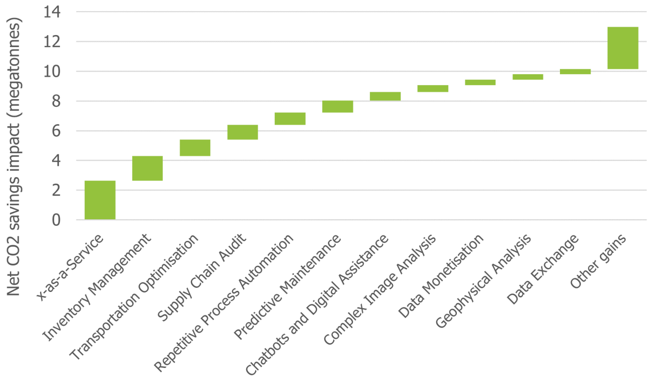
MOBI is member-led consortium working to make transportation greener, more efficient, and more affordable, using blockchain and related technologies.

MOBI's Electric Vehicle Grid Integration (EVGI) group aims to aid the increasing adoption of electric vehicles by creating interoperable systems for governments, utilities, and the mobility industry. The group has defined and launched the automotive industry's first global standard incorporating blockchain technology into a decentralized vehicle charging system.

EVGI's initial focus has been on three core use case areas - Vehicle to Grid (V2G), Peer to Peer (P2P), and Tokenized Carbon Credits (TCC) applications. The standard enables a set of core network data services that enable secure, decentralised communication and immutable recordkeeping between data generating peers. This approach supports data transparency, trust, coordination, and automation among mobility service providers, consumers, utilities, and government stakeholders.

MOBI hopes that applications enabled by this Standard will ultimately help lower carbon emissions, improve road safety, reduce traffic congestion, and support a host of other socially and environmentally beneficial outcomes.

Figure 21: Significant CO2 net savings impacts of other emerging technologies by use case, 2030
[Source: Transforma Insights, 2021]



Some applications of (non-IoT) emerging technologies are significantly beneficial in terms of net CO_2 impact, and these are illustrated in Figure 21 above. The most beneficial use cases tend to involve interaction with real-world physical processes.

For instance, 'x as-a-service' includes the proactive and pre-emptive maintenance of assets to ensure that they operate efficiently and do not break down. This saves on remedial maintenance trips, and improved condition monitoring of these assets enables more maintenance to be undertaken during routine service visits.

Inventory Management, Transportation Optimisation, and Supply Chain Audit all include in some way improving the efficiency of physical distribution networks, and so reductions in fuel use.

BEHIND THE SCENES

The discussion in this document sets out a broad analysis of the sustainability impact of a range of new and emerging technologies. As ever, there are a number of complex dynamics that underlie the top level numbers presented here. In this section we examine some of those underlying dynamics.

Regional variances in impact

There will be significant regional variances between any impacts that the adoption of new technologies might have. These effects are more pervasive, and more interconnected than might immediately be obvious.

Firstly, the impact of many technology-enabled solutions will vary depending on the context into which they are deployed. An example might be an IoT- and AI-enabled crop irrigation system deployed in Iceland compared with a similar system deployed in a Gulf state: clearly by virtue of the extreme difference in climate between these two locations, the water consumption (and so associated technology-enabled savings) associated with these two systems can be expected to be vary greatly. Accordingly, in this instance, the impact of 'new technology' in the Gulf state can be expected to be significantly greater than in Iceland.

Beyond the absolute impact is consideration of how important that impact is. Water stress in locations such as Norway and Iceland is minimal, whilst water stress in locations such as California and the Gulf states is extreme. So even if the expected water savings were to be the same in all locations worldwide, the 'net benefit' of the crop irrigation system will be far greater in certain locations, i.e. those with a high degree of water stress.

Similar dynamics apply across a range of applications for new technology, ranging from the more obvious (for example sophisticated HVAC systems) through to the less obvious (for example traffic management systems deployed in cities with varying levels of congestion).

Impacts in different regions

Another consideration is the global nature of supply chains. A sophisticated HVAC system deployed in Iceland may have been originally manufactured in China, and shipped between the two locations. In this case, over its lifecycle, the HVAC system will have consumed energy and generated emissions both for manufacturing in China, and also for transportation between China and Iceland. The energy savings gained from the operation and ongoing use of the system will, of course, be in Iceland.

However, nearly 100% of electricity in Iceland is generated from renewable sources (mostly hydropower, with significant geothermal generation). Accordingly, even though the deployment of the HVAC system will result in lowered electricity consumption in Iceland, the sustainability benefit of this reduction is near-zero: the energy saved was generated from renewable sources. Meanwhile, the energy consumed to manufacture the system in China (where around 65% of electricity is generated from hydrocarbons), and to transport the system (using hydrocarbon fuel) results in a net 'cost' from the system in question when combined with the 'zero' benefit.

As such, a sophisticated HVAC solution manufactured in Iceland and deployed in China may be significantly more beneficial for the planet than the same system manufactured in China and deployed in Iceland! *(13)*

Time shifting

These regional differences in the sustainability impact of energy consumption can potentially be lessened in the case of devices where energy consumption is not time-critical and can be shifted to times of the day when the renewable proportion of energy generation is greater. For instance, eV batteries could be charged overnight when the wind proportion of electricity generation can be expected to be higher (or during the day, when the solar proportion can be expected to be higher). In Denmark (with lots of wind, but not much sun) it may be best to charge eVs overnight, whilst in the Gulf (with lots of sun, but not much wind) it may be best to charge eVs during the day.

The 'ideal' approach for powering any connected device depends on the degree to which power consumption can be shifted in time without compromising utility, the usage patterns of devices, the mix of generation capacity in any particular location, and how that generation capacity is managed.

Consumer choices

In terms of absolute numbers, connected consumer devices will dominate the IoT. As discussed earlier in this report, most IoT-enabled consumer devices consume more electricity than their non-connected counterparts. So, consumer choices will play a considerable role in the net sustainability impact of new technologies. On one level such choices are binary: a consumer can decide to (or not to) upgrade to an 8K Ultra HD TV. But sustainability-impactful choices are also incremental: with his new TV the consumer can decide to watch a TV programme real time when it is broadcast, or on-demand using a catch-up service. The sustainability impact of the former approach is much less than the latter (which involves dedicated network and server capacity). If the consumer decides to watch a programme on-demand, then they can further decide whether to watch in full 8k Ultra HD quality, or any range of other qualities through to SDTV. Clearly, the lower-quality that the consumer opts for, then the less the sustainability impact of his decision.

Idle hands?

It should be noted that some of the major positive impacts on energy and resource savings are from automating processes that used to be carried out by people, or increasing the efficiency of those processes. But as a complete system, the globe will probably have a growing population for at least the next 40 years. Those people will have to do something. And it will probably involve using resources. Whether it be spending on pottery clay and canvas as people move to three-day weeks and use their spare time becoming artists, or they grab picks and shovels to engage in artificially generated Keynesian work schemes, the population of the Earth will continue to consume as a result of the activities in which they engage. We have not considered these longer-term macro-trends within the scope of this work. However, if the prevailing trend for an under-employed population of 9.7 billion is to retire into a world of ultra-HD virtual reality, the implications will be very different.

Beyond sustainability

Technology can be deployed to support aims beyond sustainability. For instance, implementing solutions that enable the origins of goods to be traced can bring significant benefits, ranging from the simple verification of quality and provenance ("farm to fork") through to tracing the source of raw materials for electronic equipment to ensure that critical elements, such as gold, cobalt, and tantalum, have not been sourced from conflict zones, or mined using child labour, or labour that is subject to some kind of human rights abuse.

In these contexts, it is likely that distributed ledger technologies will prove to be particularly useful, enabling immutable and auditable records to effectively abstract out the systems complexities of individual participants in a supply chain. Extensive adoption of these practices would bridge the responsibility gap between consumers and unethical practices that may occur upstream, disincentivising the purchase of products that have taken advantage of denounced extraction or manufacturing processes.

An evolving backdrop

It is worth noting that the backdrop to any analysis of the sustainability impact of technology is changing. Not only are many technology providers making significant efforts to increase the energy-efficiency of their operations (both in terms of networking, and also data centre operations), but also the deployment of new technology is resulting in changes in human behaviour.

New technologies have enabled multiple human behavioural changes, ranging from home-working (saving energy consumed for commuting, and to operate office buildings) through to video conferencing (in place of potentially international travel). Technologies such as AI-enabled video analysis and remote monitoring of assets have increased the scope of job types that can be undertaken remotely, to include elements of operational management and even remote Quality Assurance.

Case Study: Rice Exchange

Ricex is a blockchain-based rice trading platform. It automates and simplifies the complexity of rice trading, increasing security, transparency, efficiency, traceability and trust for the world's largest agricultural commodity.

Around 48 million tonnes of milled rice are traded every year. Unlike other major grain crops, rice has a wide variety of types and finishes, which makes pricing less homogeneous. Given these intricacies, rice trading has traditionally been - and still is - dominated by a small group of individuals with little transparency.

The Ricex solution supports an active public exchange with private negotiation, real time quotes from service providers, and secure settlement with an immutable audit trail with trade history.

The enhanced traceability and auditability supported by Ricex allows end-users to purchase rice that they know has been sustainably produced and have confidence that they will receive the grade of rice that they have purchased.

Traceability aspects of the platform also support efforts to counter bribery and corruption in the industry and can be used to ensure that rice is not sourced from producers suspected of human rights abuses.

The Covid-19 pandemic of 2020/21 has accelerated these already ongoing changes and is likely to leave permanent shifts in working practices in its wake. The pandemic is also likely to result in the restructuring and diversification of supply chains, and also increased on-shoring of manufacturing. The full impact of Covid is yet to be seen.

Additionally, regulatory and compliance initiatives may further change the dynamics of sustainability. Carbon taxes could effectively become an 'import tax' for low-carbon countries, incentivising further restructuring of supply chains. And Energy, Sustainability, and Corporate Governance (ESG) initiatives will result in companies being further incentivised to focus on sustainability.

Notes:

(1) 1 PWh is equal to 1,000 terawatt-hours (TWh), 1,000,000 gigawatt-hours (GWh), 1,000,000,000 megawatt-hours (MWh), or 1012 kilowatt-hours (KWh).

(2) A. Andrae, T. Edler

(3) Exceptions include, for instance, the advent of shared car schemes resulting in an overall reduced level of vehicle manufacturing.

(4) During the Operation phase, not including Manufacturing and Distribution

(5) Including autonomous vacuum cleaners, and similar devices.

(6) During the Operation phase, not including Manufacturing and Distribution.

(8) Of eWaste created by manufacturing IoT-enabled devices, not disposed of.

(9) Source: ITU Global E-waste monitor 2020.

(10) Gigatonnes. 1 gigatonne is equal to 1,000,000,000 tonnes.

(11) Note: Clearly some IoT solutions rely on other emerging technologies (such as, for example, Artificial Intelligence) as part of the solution. Where the emerging technologies analysed in this section are deployed in association with IoT, their sustainability impact has been included in the IoT analyses, i.e. there is no double-counting between this section and the previous section.

(12) Total electricity consumption of France in 2019 was 449 TWh.

(13) Note: all CO_2 impact charts in this section include manufacturing (of servers, processors, and other hardware), distribution, and also the impact of live operations.

(14) This is a simplified example: it doesn't take into account the effects of transporting raw materials, or building and operating the necessary factories, or climate differences.

ABOUT TRANSFORMA INSIGHTS

Transforma Insights is a research firm focused on the world of Digital Transformation. Led by seasoned technology industry analysts Transforma Insights provides advice, recommendations and decision support tools for organisations seeking to understand how new technologies will change the markets in which they operate.

To address the implications of the technology-driven change, often referred to as Digital Transformation (DX), we examine the intersection of three inter-related areas: New Technologies (which comprises a dozen technology families including concepts such as IoT, AI and distributed ledger), Transformational Use Cases, and Enterprise Change Management.

In order to support our clients' as they navigate this intersection of these three areas, we provide a set of research tools. The Best Practice & Vendor Selection Database offers unrivalled information on current and historic DX deployments, comprising thousands of Case Studies providing would-be adopters with critical understanding of project prioritisation, best practice, key success factors, and the leading vendors with which they should be working. The Database links seamlessly to our new Vendor Connect platform, a mechanism for connecting technology vendors and would-be technology adopters.

Based on our detailed understanding of the strengths and weaknesses of supporting vendors, we provide competitive benchmarks in the form of our Peer Benchmarking. These tools help vendors understand how they are positioned relative to their peers in these emerging markets. Our TAM Forecasts are quantitative guides to the market opportunity, covering each of twelve technology families, looking at hundreds of use cases across 20 vertical sectors and covering 200 countries. Finally, our Insight Reports provide a qualitative guide to the dynamics and impact of the twelve technology families upon which we focus. These are updated annually.

Learn more at transformainsights.com or email us: enquiries@transformainsights.com.

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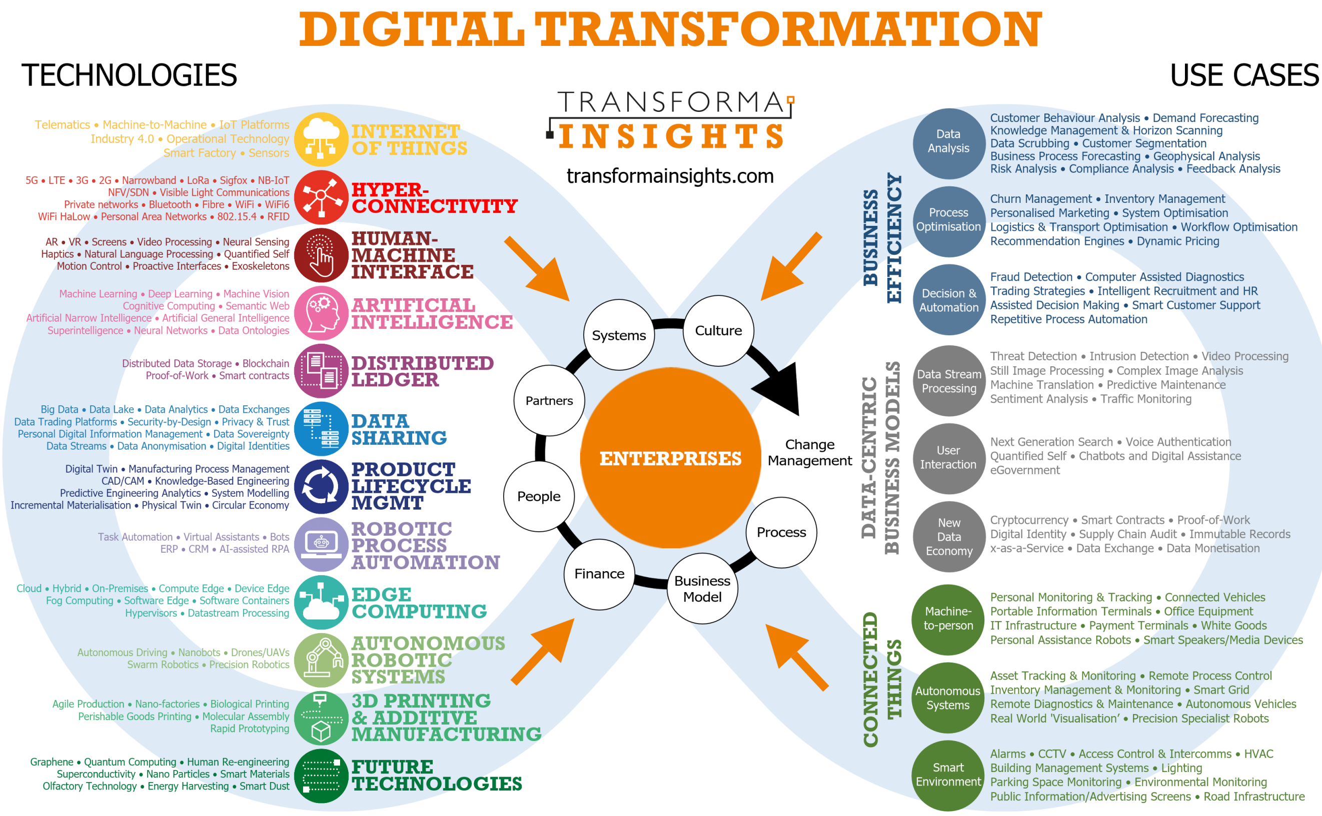

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