

Light Report

Saving the planet with IoT and Blockchain

New emerging technologies can improve the Environmental, Sustainability, and Governance (ESG) credentials of organisations in many vertical sectors. In this report we discuss the potential impact of IoT (Internet of Things) in Agriculture and Smart Cities and how blockchain can support new emerging business models.

Introduction

Sustainability is one of the defining themes of the decade. Having risen to the top of agendas worldwide due to concerns over climate change, during 2022 yet more emphasis has been placed on sustainability due to ongoing geopolitical disruptions.

For decades, one of the key drivers for the adoption of numerous IoT applications has been to enable the more efficient use of all types of resources for reasons of efficiency, cost reduction and, particularly in a smart cities context, to improve the quality of life of city dwellers. Essentially, each IoT device that is deployed needs to have an associated 'business case' of benefits. Often, and particularly in the case of enterprise IoT and smart city applications, these benefits are based on reduced levels of consumption of (hydrocarbon) fuel, electricity, water, and other resources, or reduced pollution. Smart grids reduce power losses, fleet management makes for more efficient route planning and therefore lower fuel consumption and lower pollution, building management systems can adapt operation of power-hungry devices and therefore reduce electricity use, precision agriculture makes more efficient use of water, and numerous other examples.

Overall, the sustainability impact of IoT will be significant. Based on Transforma Insights granular forecasts of over 250 IoT applications, combined with identified sustainability benefits for each application, we find that in 2030 IoT solutions will result in a reduction of:

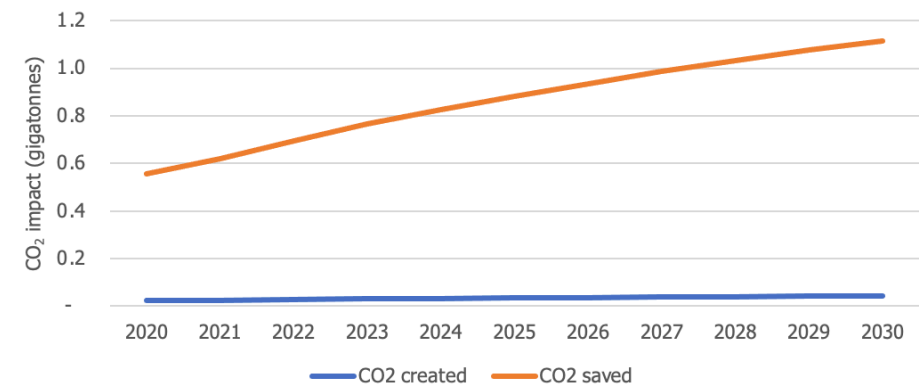
- Over 1.6 petawatt-hours (PWh) of electricity consumption.
- Approaching 3.4 petawatt-hours (PWh) of hydrocarbon fuel consumption.
- Approaching 230 billion cubic meters of water consumption.

The savings listed above all translate to CO2 savings, and after accounting for the sustainability 'costs' of IoT (in terms of manufacturing, distribution, and electricity consumed by IoT-connected devices), the benefits are significant as illustrated in figure *** below. Overall, the deployment of IoT applications will result in a net reduction in CO2 emissions of approaching 1.1 gigatonnes in 2030.

Accordingly, organisations of all kinds have the potential to use IoT technologies to improve both their ESG performance (for instance, by reducing the consumption of resources) and also improve their financial performance (often by consuming less resources) and potentially also quality of life. With almost perfect synergy, IoT applications that help to save the planet generally also save money or improve individuals' quality of life, and IoT applications that save money or improve individuals' quality of life generally also help to save the planet.

In the remainder of this report, we focus on sustainability in two key sectors (Agriculture and Smart Cities) and also how emerging Blockchain technologies can be used to underpin adoption of certain IoT solutions.

CO₂ impact of IoT [Source: Transforma Insights, 2021]



CO₂ impact of IoT
[Source: Transforma Insights, 2021]

IoT and Sustainability in Agriculture

IoT can be used in the Agriculture sector to support many different approaches to monitoring crops, livestock, agricultural land for soil condition, and general local environmental monitoring, along with remotely monitoring farm equipment and processes (such as irrigation). Many crop monitoring applications incorporate the use of granular monitoring techniques to optimise use of resources (seed, fertilizers, water) and quickly react to threats (weeds, pests, fungi). Livestock monitoring applications often include location tracking and behaviour monitoring of livestock to tailor feed mix and detect any illness in advance. All these solutions improve the efficiency of farming methods resulting in better utilisation of resources and energy often along with a decrease in usage of fertilizers and chemicals and a decrease in water pollution due to runoff of chemicals and other pollutants.

Specifically, granular monitoring of crops and livestock can generally increase yield by 15-20%, so reducing electricity, hydrocarbon fuel, and water consumption for a given output by 9-12%. Additional fuel savings can be made due to a reduced need to visit and inspect assets that are monitored with IoT solutions.

The impact of IoT in Agriculture is most significant in terms of water consumption, where irrigation management and soil monitoring solutions can reduce water consumption by 25-30%. The potential impact is illustrated by an automated irrigation project in

Sardinia, Italy, supported by Libelium and deployed for the Agribio cooperative. The solution improves the growth of crops and limits the environmental impact of production by ensuring the responsible use of water, energy and other natural resources. It also improves soil fertility and helps to maintain water quality.

The benefits of IoT deployed to support food production are not limited to land-based scenarios and can extend to aquaculture. For example, Libelium also supports a solution to enable the more efficient operations of Westpac Mussels mussel farming in New Zealand, by collecting accurate measurement of salinity at mussel farming locations. In another example, also in New Zealand, underwater cameras are used to monitor the appetite and activity of salmon during feeding. Again, salinity sensors are used, deployed alongside dissolved oxygen sensors placed at depths of 25 and 50 meters deep. In combination, these sensors are used to ensure the production of high-quality fish.

Smart livestock management helps to reduce pollution and optimise livestock production

Libelium Plug & Sense! devices have been deployed to monitor temperature, humidity, particulate matter and gases (including NO_x, CO_x, CH₄, NH₃) generated by livestock on a farm in Romania. Sensors are connected using LoRaWAN and Wi-Fi and data is sent to the cloud to support decision making to optimise farm operations by simulating farm performance and animal development in different scenarios. A particular focus is the provision of recommendations to stakeholders to make management decisions to reduce greenhouse gas emissions. Additionally, the solution supports a blockchain-based smart contract transaction network, so that customers know the gas emissions associated with each cow or calf sourced from the farm, supported by an immutable record and auditable provenance.

IoT and Sustainability in Smart Cities

IoT in Smart Cities includes a range of solutions that enhance the sustainability and infrastructure of cities (and other urban areas, and also campus areas like seaports, airports, train stations, and university campuses), while also enhancing the convenience for citizens. Relevant IoT applications include smart streetlights, traffic monitoring and control systems and parking space monitoring technologies, all of which help authorities to adjust the environment and movement of vehicles and people and reduce the energy consumed in cities and improve the quality of life of citizens.

Specific examples include smart parking solutions that can decrease the extra miles travelled, fuel consumed, and pollution generated looking for a vacant parking space by 30-40%. Road traffic management solutions can decrease the fuel consumed whilst idling at traffic signals by 40% and smart public space lighting has the potential to reduce electricity consumption by 20%.

Pollution management is also a critical aspect of city development, with high levels of pollution often holding back the development of a city either by preventing investment in further infrastructure or by reducing the attractiveness of a city location to potential new businesses and residents. Conversely, the effective monitoring and management of pollution levels (and traffic, public transport, and so on) in a city can accelerate the development of urban areas, and,

crucially, increase economic activity and so the tax revenues of local authorities. This dynamic is neatly illustrated by a project to provide environmental monitoring for the construction of the Bilbao Metropolitan South Bypass to measure and control the environmental impact (noise, dust, air quality) during construction to minimise disturbance to nearby residents.

Alternatively, air quality monitoring can be deployed to ensure that established operations can maintain their growth trajectory whilst also complying with increasingly strict regulations as they grow. An example of such a solution is located at the Port of Gdansk, Poland, focussing on the detection of hazardous chemical pollutants in the air and supporting prediction of the spreading of monitored chemical compounds.

Air quality monitoring helps ensure compliance with air quality regulations

Libelium Plug & Sense! devices were installed in Porto Antico, Genoa, to monitor weather conditions and air pollutants. The initiative is part of a broader programme to test the potential of new 5G communication standards to support advanced digital services. A particular focus is the monitoring and management of fine particulates, nitrogen oxides, and ozone, each of which is known to have a significant impact on human health. A critical aspect of the project has been to understand the interplay between atmospheric conditions and pollutant levels, with prolonged periods of stagnant air clearly resulting in the accumulation of atmospheric pollutants.

The need for certainty

Both sectors discussed above have highlighted another emerging trend in IoT: the need to share accurate and auditable information. This is a natural evolutionary step for many different kinds of IoT application. Historically, information related to devices (such as monitoring readings) has predominantly been of use to, and used by, the organisation that deployed the device in question, or a network of partners. In such cases, the provenance of IoT data is known, reliability is understood, and systems are available to provide historical information, as required.

However, as IoT-derived data become more critical so it becomes necessary to share it with a wider community of users and so necessary to associate key data with an immutable record that can support an audit process. Specifically in the livestock monitoring case described above, blockchain technologies are used to support an immutable record of gas emissions associated with an individual animal and in a way that supports an

audit process. The digital record so created supports a framework of smart contracts that ensure that the best prices are offered for livestock with the lowest associated greenhouse gas emissions. In other cases, such as those related to pollution monitoring, a robust, immutable, auditable, record of readings from any specific sensor could be invaluable to provide proof that environmental regulations have been adhered to.

Beyond the verticals discussed in this report, blockchain-enabled auditability will have application along all kinds of supply chains, particularly food supply chains and supply chains that cross borders where CO₂-based (or other environmental) taxes are levied. The technology will also be deployed to support servitised propositions (where capital assets are offered to customers as-as-service), providing an auditable record of asset usage, condition, and maintenance status and maintenance records. There are clearly many situations in which the insurance sector can make use of this kind

of auditable information which can be used to prove the condition of an asset at a certain time (even potentially including the certification of CCTV monitoring feeds), and so assist in establishing liability in the case of breakdown or malfunction, or some other loss event. And there is particular opportunity for new insurance products to be extended to the agriculture sector, supported by blockchain-auditable information sourced from crop, livestock, and environmental monitoring sensors.

Blockchain is (or, more accurately, distributed ledger technologies are) particularly well-suited to these exact scenarios. The technology can be used to provide an abstracted layer of certification and auditability across diverse networks of participants to support an emerging decentralised economy. As such, blockchain will become a critical feature of data sharing between diverse parties in certain scenarios.

Conclusion

There is significant potential for IoT to be deployed in a way that can help organisations to enhance their ESG credentials and to meet sustainability targets. Indeed, particularly in an enterprise context, there is often a near-perfect synergy between the deployment of IoT to increase efficiency (and so reduce consumption of natural resources) and the potential for those same IoT solutions to improve ESG performance and enhance overall sustainability.

In certain scenarios, particularly where data is exchanged within diverse groups of participants, blockchain (or distributed ledger) technologies will become key enablers supporting trustworthy and auditable data exchange, ushering in new decentralised value chains.