



# The circular economy, IoTs, digital markets

## Google case study demonstrates circular economy approach at scale

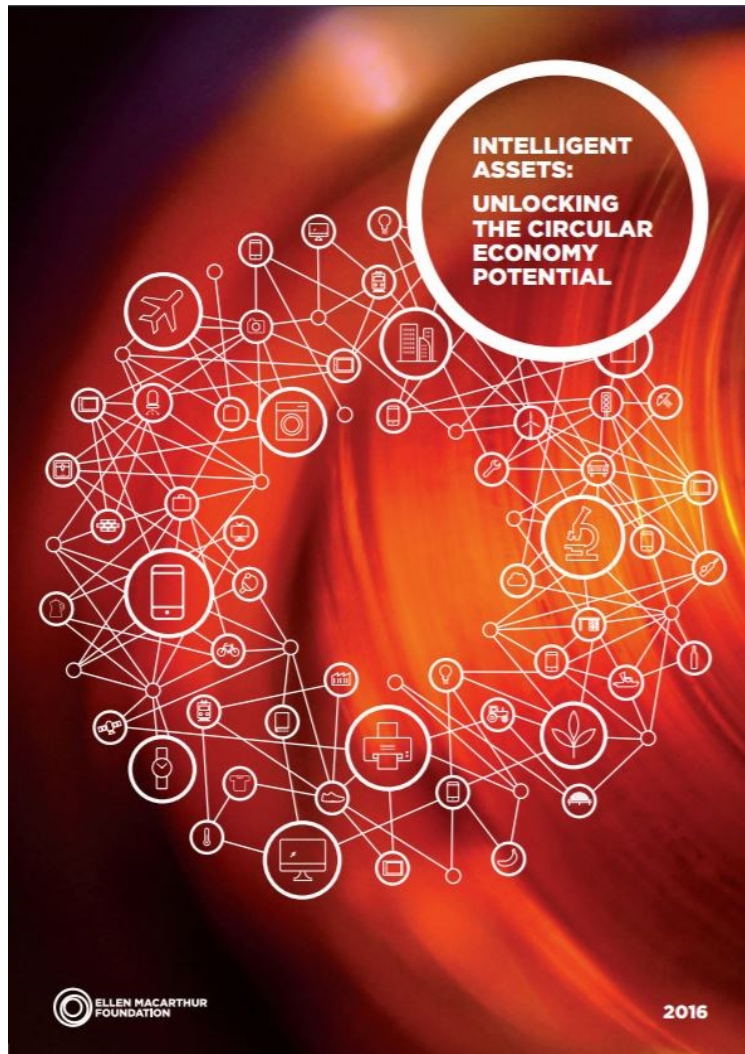
SEPTEMBER 14, 2016



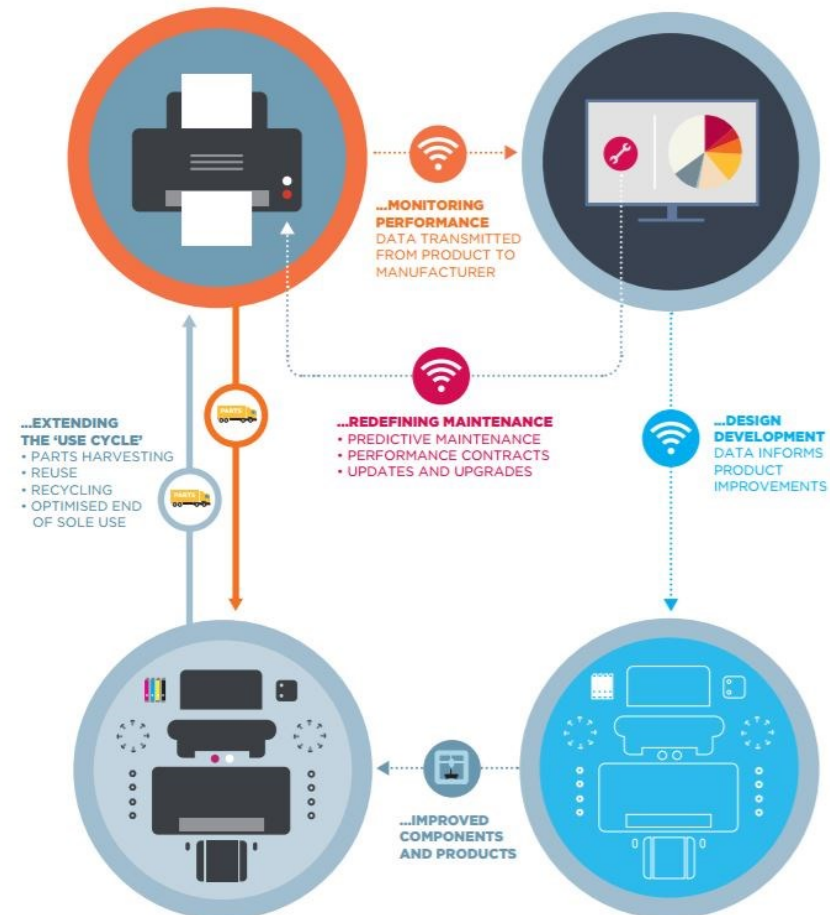
Google, in partnership with the Ellen MacArthur Foundation, today published a case study sharing the results of applying circular economy approaches to its business operations.



# The circular economy, IoTs, digital markets



**INTELLIGENT ASSETS  
TRANSFORMS THE WAY  
WE MAKE, USE, AND  
REUSE STUFF BY...**

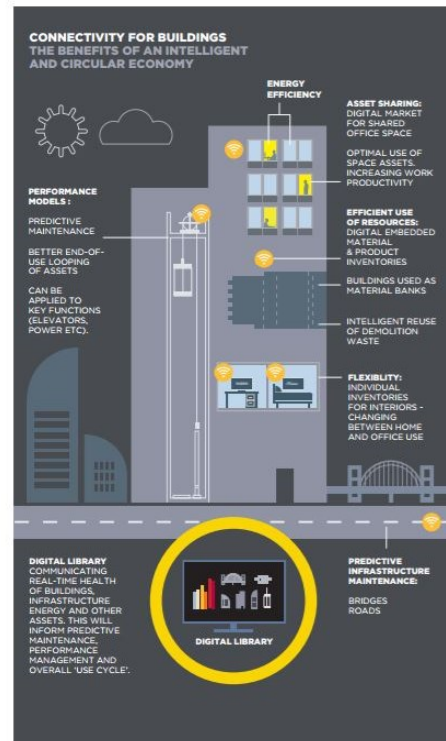




# Example: the built environment

## BUILT ENVIRONMENT AND INFRASTRUCTURE

### BUILDING CONSTRUCTIONS THAT REMEMBER & COMMUNICATE



The incorporation of intelligent assets into the built environment goes beyond improving energy efficiency. It is reshaping both asset utilisation and material management within the sector. Connected buildings and building components are starting to enable the wider use of performance contracts and predictive maintenance schemes, while at the same time dramatically increasing the potential for improved asset utilisation through sharing. The future is likely to entail a built environment that is flexible and modifiable and which, through its interconnectivity, can feed the wider system (the city or the traffic grid) with information that enhances both traffic management and urban planning.

Imagine a world in which all roads, bridges, public spaces, sports facilities, office buildings and private homes represent the biggest valuable materials deposit for the built environment. In this world these assets are connected to a digital library, revealing up-to-date condition of the assets' components to not only enable predictive maintenance and performance models, but also to be a platform for a secondary materials market. Imagine how the connectivity of constructions could pave the way for closing the material loops for the largest source of waste in modern society.

The construction process is fragmented with misaligned incentives among contractors and can create up to 15% by volume.<sup>62</sup> Based on 2009 data, an estimated 54% of demolition waste in Europe is landfilled<sup>63</sup> and most recycling occurs in low-value applications.

A key reason for the value degradation of building material is the lack of knowledge of material composition or value. In addition, the utilisation of buildings is poor, resulting in inefficient resource use.

<sup>62</sup> Ellen MacArthur Foundation, SUV and McKinsey Center for Business and Environment, Growth Within: A Circular Economy Vision for a Competitive Europe (2015).

<sup>63</sup> European Commission, Service contract on management of construction and demolition waste (2010).

<sup>64</sup> Norm Miller, Workplace Trends in Office Space: Implications for Future Office Demand (University of San Diego, 2014); GSA, Office of Government-wide Policy, Workspace Utilization and Allocation Benchmark (2015).

<sup>65</sup> Land dedicated to streets and roads, parking, service stations, driveways, signals, and traffic signs. See S. Heck and H. Rogers, Resource revolution: How to capture the biggest business opportunity in a century (Hechter Media, 2014).

<sup>66</sup> Centre d'études sur les réseaux, les transports, l'urbanisme et les constructions publiques (CERTU), <http://www.certu.fr>

<sup>67</sup> See <https://buildingsolutions.honeywell.com/en-us/solutions/>, [http://www.johnsoncontrols.com/content/us/en/products/building\\_efficiency/case\\_studies.html](http://www.johnsoncontrols.com/content/us/en/products/building_efficiency/case_studies.html)

<sup>68</sup> As a side effect, this design choice avoided demolishing the existing 50-year-old Firth Road bridge, which could instead be repurposed for lighter traffic (thereby avoiding the need for a resource-intensive new bridge). Future installations of monitoring devices on the old bridge could potentially enable predictive maintenance that would extend its lifetime even further.

An estimated 55-65% of total office space is not used even during office hours.<sup>64</sup>

Structural waste is prominent also in infrastructure; every instance of unplanned maintenance for roads, bridges and other important infrastructure constructions causes large disruption and, despite road infrastructure being hugely oversized, congestion occurs regularly.

The road system is taking up 50% of the built environment space while peak traffic only covers 10% of the roads.<sup>66</sup>

Intelligent assets have begun to be incorporated into the built environment. Building service providers and construction companies are already using IoT to optimise the energy efficiency of buildings and larger communal systems (such as street lighting). Large building service providers, such as Johnson Controls and Honeywell, use IoT to help the tenants of their buildings to reduce the cost of their energy bills, while enabling utilities providers to better plan their energy production and avoid wasteful peaks.<sup>67</sup>

#### CHANGING HOW MATERIALS ARE MAINTAINED AND REUSED

In a more novel approach, intelligent assets are now increasingly being deployed to address the sources of waste and resource inefficiencies at several stages across an asset's use cycle. Knowing the location of building components

as well as their condition gives asset owners unprecedented monitoring capabilities, enabling both new business and financial models. These models enable extended use cycles of buildings as well as improved potential to loop or cascade building components and materials in new use cycles at the end of the building's (or component's) use. For example, the automatic embedded product inventories generated by Dutch company BAM's building information management software allows multiple stakeholders to treat the constructions as a 'resource bank', enabling the assets to be returned when a building is decommissioned. IBM and Delta Development are collaborating on incorporating connected sensors into the new Schiphol Trade Park, which will provide an extremely rich flow of data that can be used to optimise resource use, predictive maintenance, reuse and functional design.

The infrastructure space is also seeing the introduction of connected sensor devices. Arup, for example, has supported the installation of an intelligent monitoring system in Hong Kong to enable predictive maintenance for roads and other key infrastructure constructions. Moreover, Arup recently projected a new bridge for heavy traffic over the Firth of Forth, Scotland, which will be equipped with more than 1,000 sensors to monitor its condition through a simple-to-operate, advanced and fully integrated structural health monitoring system.<sup>68</sup> Cisco and the Hamburg Port Authority have recently launched the 'smartROAD' proof of concept study, a pilot