

Smart infrastructure

Better decisions, faster and cheaper.
Giving better outcomes and value for money.



Long live the digital revolution

The march of technology has touched almost every aspect of our lives. It's time for infrastructure to catch up, writes Nabil Abou-Rahme.

With smart phones in our pockets, we have access to data and services that were undreamed of a generation ago. In manufacturing and increasingly in the professions, humans stand side by side with machines in the workplace.

'Smart infrastructure' is about enhancing physical infrastructure with digital technology. It holds the potential to meet the mounting challenges from population growth, greater consumer expectations, tighter budgets and finite natural resources. And it can assist with pressing issues such as carbon reduction, constrained service capacity, service reliability and operational resilience.

In this publication you'll find insight and analysis from thought leaders spanning each of the major infrastructure sectors – water, power and transport – setting out the anatomy of smart infrastructure and some of the benefits it can bring.



Enhancing physical infrastructure with digital technology holds the potential to meet the mounting challenges from population growth, greater consumer expectations, tighter budgets and finite natural resources.

Cutting through the hype

If you scan through the hype about the latest smart technology, there's one descriptor you won't read very often. 'Appropriate'. Not exactly sexy, is it? Where's the glitz of life-altering innovation? Where's the revolutionary vision of the future?

In too many cases, solutions are developed simply because they can be, and not to solve specific problems. "I think, therefore I app." But when you work with infrastructure, 'appropriate' gets the pulse racing quicker than the latest here-today-gone-tomorrow gadgetry and start-ups that promise plenty, and then disappoint. Consultancy and systems should help infrastructure clients to deliver basic needs and more advanced services to their end users – commuters, homeowners, businesses, taxpayers – you and me.

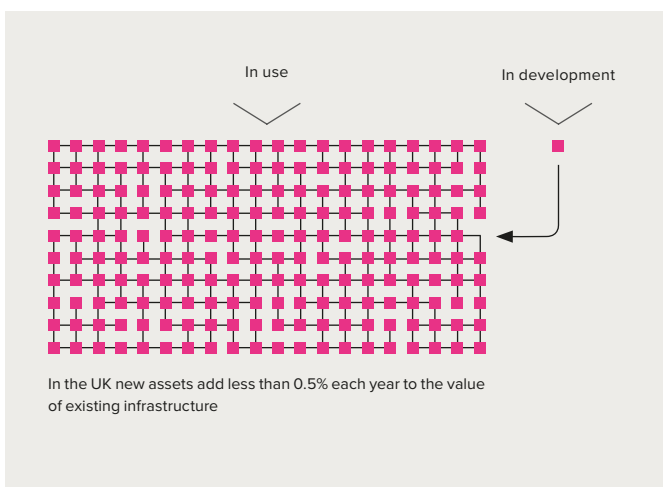
But smart infrastructure also demands that consultancy and systems can accommodate, and even enable, bottom-up innovation. Customers and third party players have an increasingly important role to play in problem-solving and manipulating data to add value, for themselves, infrastructure owners, and operators alike.

Simply, wherever the solutions come from, 'appropriate' involves doing the real stuff well.

Dr Nabil Abou-Rahme is head of smart infrastructure at Mott MacDonald



Why now?



Infrastructure in use and development

Construction of new assets increases the total value of UK infrastructure by just 0.5% a year. As an example, existing UK water infrastructure is valued at £350bn. Annual expenditure on new water assets is £1.8bn.

The world is in the throes of a fourth industrial revolution, characterised by the rapid development of technologies such as robotics, artificial intelligence and 3D printing.

**Infrastructure maturity**

In most mature economies the value of 'infrastructure in use' is substantially greater than the value of 'infrastructure in development'. In the UK, the addition of new assets adds less than 0.5% each year to the value of existing infrastructure. The key concerns are therefore to maximise customer service and value by getting more from the operational asset base.

Digital abundance

The rapid and ongoing reduction in the unit cost of collecting, communicating, processing and storing information is leading to a state of 'digital abundance' – the volume of published data/information/knowledge is mushrooming.

Innovation explosion

This has been accompanied by a rapid increase of ideas/innovations that could benefit infrastructure.

Eight things you need to know about smart infrastructure

1.

Smart infrastructure is the result of combining physical infrastructure with digital infrastructure, providing improved information to enable better decision making, faster and cheaper.

2.

Smart infrastructure will change how infrastructure is delivered, managed and used. This will affect traditional roles, business models and measures of value.

3.

Smart infrastructure will allow owners and operators to increase capacity, efficiency, reliability and resilience. Globally, efficiencies gained could be worth up to £4.8trn.

4.

By getting more from existing assets, owners and operators will be able to enhance service provision despite constraints on finance, resources and greenfield sites.

5.

Owners will be able to gather data from existing infrastructure and their customers to target investment for greatest benefit and to manage demand, so reducing the need for new construction.

6.

Some smart technologies have the potential to unleash third party innovation benefiting infrastructure owners and customers alike – for example, the creation of new products and services.

7.

In the longer term, the development of smart infrastructure will enable better and more-informed whole-life investment decisions based on outcome per pound for the ultimate customers: end-users, fare- and tax-payers, and voters – us.

8.

Smart infrastructure provides opportunity for the transformation of consumers' relationship with infrastructure – for example with personalised dynamic journey planning, the opportunity to trade energy directly with peers, or to optimise personal carbon budgets.

All change!

Smart infrastructure is the sum of all the possible value adding digital enhancements to infrastructure, says Mark Enzer.

As digital enhancements are more cost-effective than traditional physical enhancements, the core value proposition is that smart infrastructure delivers better outcomes for the ultimate customers: fare- bill- and tax-payers and voters.

At the root, this added value comes from:

Improving decisions – enabling ‘better decisions, faster and cheaper.’

Improving intelligence – providing better information to users and operators.

Empowering users – making consumers part of the infrastructure system, able to add value through their actions, and benefit or be rewarded for doing so.

Harnessing the power of innovation – opening the world of infrastructure to the world of consumer innovation, bringing much enhanced agility in a fast changing world.

In the face of ongoing investment constraint, smart infrastructure offers better whole-life value for the customer and society; in other words, ‘increased outcome per pound’.

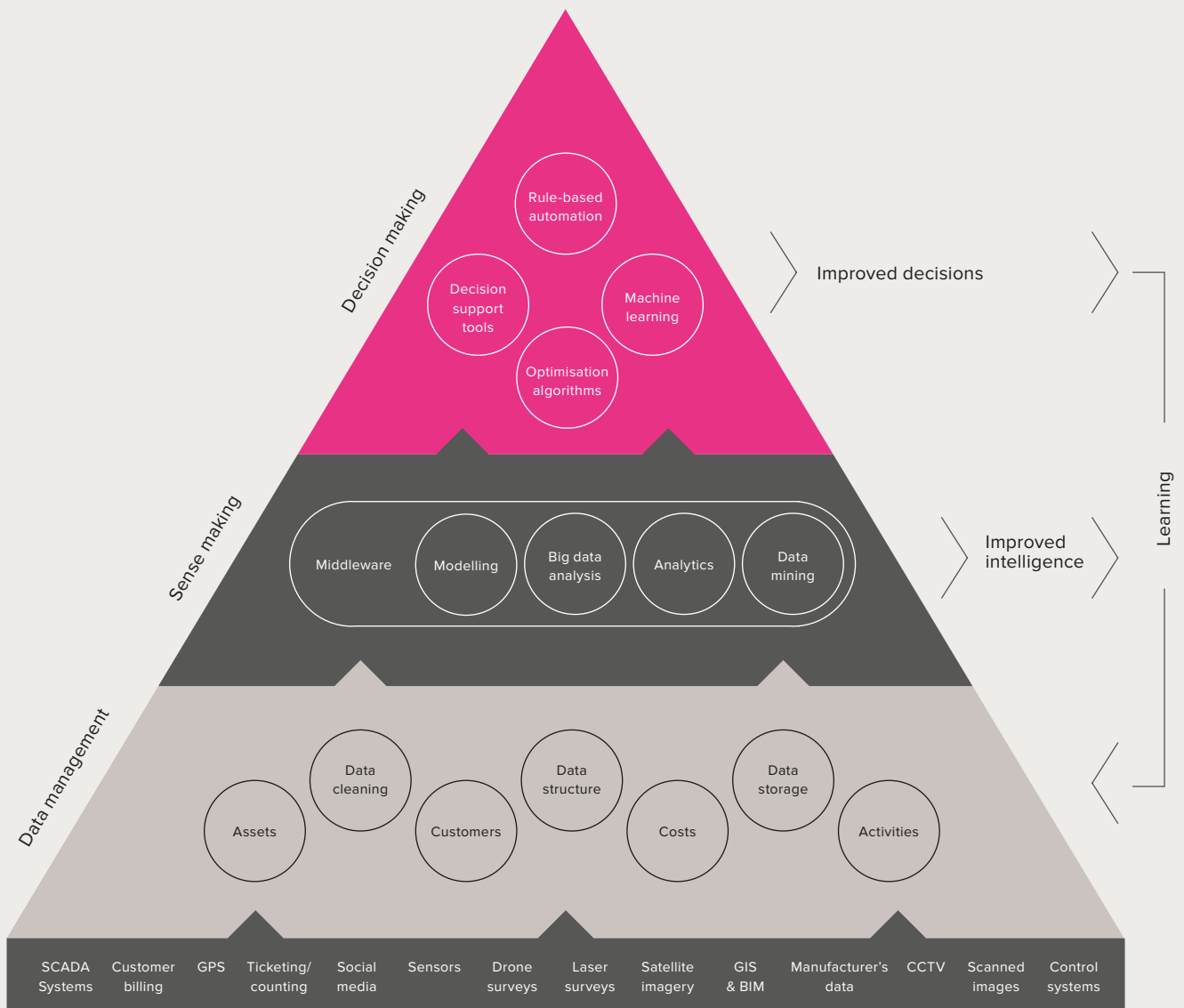
The rise of smart infrastructure will disrupt asset delivery, operation and management. Infrastructure use patterns are likely to change. Our working patterns and the skills we need will have to be reassessed, again and again.

Smart infrastructure is already transforming our industry. The question for all of us is: how fast can we change?

Mark Enzer is Mott MacDonald’s global sector leader for water and environment, lead author of the UK Government’s Infrastructure Carbon Review, and a leading thinker in the smart infrastructure space

The anatomy of smart infrastructure

Smart infrastructure may vary from sector to sector, but its anatomy is always the same, made up of three basic layers connected by communications. All components found in smart infrastructure systems have a place in this simple model.



Data management

Smart infrastructure begins with data, which needs to be harvested, cleansed and structured. In this layer sits data capture from any source, data cleansing and data structuring.

Sense making

Value is added by making sense of the basic data using middleware, data mining, big data analysis and analytics. Intelligence gained can be used by operators and users to see and understand what's going on. Alternatively, this intelligence can be fed into decision making.

Decision making

Better decisions, faster and cheaper enable asset performance to be optimised and efficiency maximised. Decision making is assisted by decision support tools, optimisation algorithms and machine learning.

Communication

Communication connects all layers to each other while providing an interface with the outside world. This includes all machine-to-machine communications (such as the internet of things) and all machine-to-human communications.

Becoming the brand next door



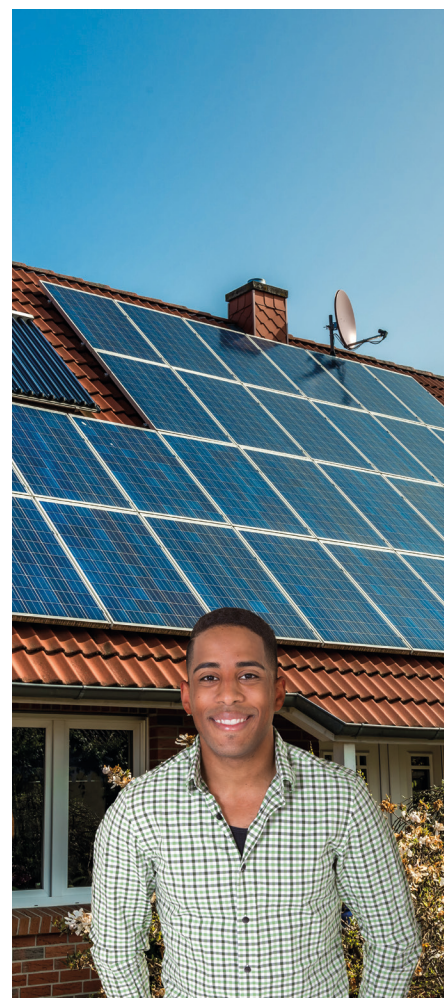
The traditional business model for energy producers – operating large power plants far from the consumer – has already been destabilised by digital technology, says Simon Harrison.



Consumers are no longer passive recipients of electricity, but empowered decision makers at the centre of the generating process. The emergence of devices like smart meters, the NEST thermostat, as well as electric vehicles and domestic-scale storage, are challenging traditional players and market structures. The new competitors want to learn about our lifestyles, use that knowledge to provide a better service, and also to create new money-making opportunities. They're more agile. And they enjoy greater consumer trust than power utilities and governments, so they are currently in a stronger position to set the pace and lead a consumer-centric agenda.

The challenge for established energy providers: to transform from 'ivory towers' into the brand next door, that understands how consumers tick and what they need tomorrow.

Dr Simon Harrison is Mott MacDonald's strategic development manager and chairman of the Institution of Engineering & Technology's Energy Policy Panel



Unlocking hidden capacity

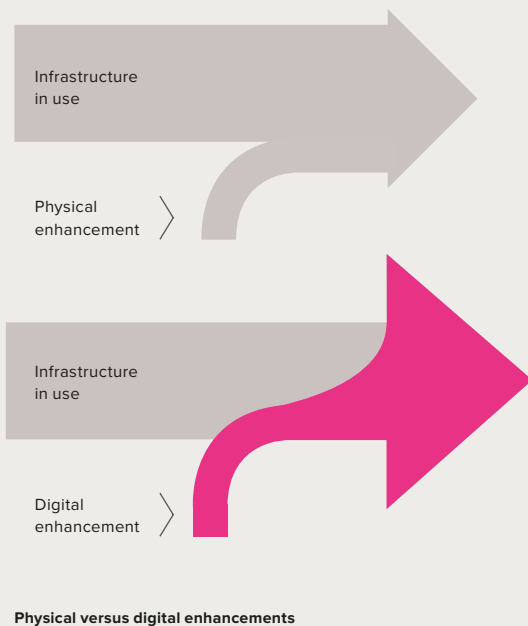


Faced with spiralling city populations and busier transport networks, the challenge of meeting public expectations is increasingly tough, says Fraser Macdonald.

On average UK motorists spend over 100 hours a year stuck in traffic jams –they're not impressed and it's hurting the national economy. Yet capacity is already at breaking point, and regional authorities are grappling with austerity and budget cuts.

Something has to give. Or, to put it in a more optimistic light, something needs to help. The good news is that breakthroughs in mobile, in-vehicle, consumer, automotive and environmental technology – alongside big data analytics – are increasingly helping decision makers meet the city needs of tomorrow.

Creating value with smart infrastructure



Infrastructure value

It is more cost-effective to add to the overall value of mature infrastructure via digital enhancements than by physical enhancements.

Customer value

Better value for money, measured in terms of improved customer service/experience.

Information value

Information itself has value, and loss of information represents a loss of value. Information value is created by increasing connectivity (the network effect) and increasing integration (reducing information loss at interfaces).

Integration value

Value is enhanced through integration and data sharing across:

- The infrastructure process (use, operation, maintenance, investment planning, feasibility, design, manufacture, logistics, assembly).
- The value chain (clients, asset managers, operators, contractors, consultants, suppliers, manufacturers).
- Sectors (communications, energy, transport, waste and water, but also health, education, policy).

Often, it's the marginal gains that make all the difference. If we can make a commuter's day a few per cent more pleasant, then replicate those small improvements across many millions of commuters, five days a week, it can make a meaningful change to a city's wellbeing.

All roads lead to digital

Mott MacDonald's proprietary Osprey traffic management system provides road network managers with a comprehensive view of traffic conditions, enabling them to take action to combat congestion. It pulls in data on flow and congestion information from traffic detectors, and journey time data from sources such as automatic number plate recognition and GPS data. Urban traffic control systems can provide further input, while CCTV images allow operators to visually check network conditions.

Based on a geographic information system (GIS) map, Osprey can also be linked to environmental data to allow pollution levels to influence traffic management decisions, while weather data allows for pre-emptive, targeted interventions to improve safety. Network managers can use Osprey to inform action, or automatic responses to pre-defined scenarios can be programmed, leading to immediate responses to manage sources of congestion on the roads.

Osprey is now in use in 14 local authorities around the UK, supporting congestion management in some of the UK's largest cities. With improved traffic management, people now spend less time on gridlocked roads and more time doing the things they want to do.

Dr Fraser Macdonald is manager of transport technology systems at Mott MacDonald

Getting under infrastructure's skin

Smart infrastructure solutions squeeze more value out of existing assets, and nowhere is this more important than in our water and wastewater infrastructure, says Tom Joseph.

When water and wastewater assets fail, we tend to find out when the taps run dry or when the sewers overflow. Establishing what the fault is and its exact location using physical evidence above ground takes time, especially where much of the infrastructure is buried, leading to unacceptable loss of service. However, by applying data-based systems we can get a much better idea about how water assets are performing.

We developed a smart infrastructure system which visualises the performance of water assets, enabling optimisation and focused maintenance. H₂knOw-how comprises sensors installed at critical points of the water or wastewater network, collecting real-time information on flow rates, water levels and pressures. This is combined with core asset information and performance data sourced from BIM and GIS models, asset management systems, hydraulic models and external sources such as SCADA.

To see is to understand

Fed into a powerful middleware application, the data is scrubbed, analysed and cross-referenced, creating an accurate visualisation of how the water asset is performing in real time. Asset managers are automatically notified of any anomalies in performance, and H₂knOw-how can facilitate automated responses such as pipe closures or redirection for pre-defined incident scenarios.

So far, 12 local authorities use H₂knOw-how to actively monitor their water and wastewater assets, optimising performance and providing a better and cheaper service to end users.

20% efficiency gain

In Auckland, the city council manages over NZ\$5bn of stormwater assets, but depended on a paper-based system as well as audits of thousands of as-built drawings and CCTV videos in order to design renewal plans. H₂knOw-how was brought in to digitise the entire management system and is now driving over NZ\$10M in critical asset renewal projects. Real-time asset data provides an understanding of current performance, while data storage provides access to historic data, replacing the paper-based tracking system.

Our smart infrastructure solution has brought cost savings of over 20% through efficiency gains, and has minimised the need for external project management, bringing extra transparency to the work of Auckland City Council and giving residents confidence that their money is being spent where needed.

Supporting disaster response

H₂knOw-how also aids asset recovery in the event of a natural disaster.

This was the case in Christchurch following the devastating earthquake in 2011 which destroyed a quarter of all city centre buildings and irreparably damaged up to 10,000 homes. The wastewater network suffered numerous ruptures.

Five years earlier we had set up H₂knOw-how on the city's wastewater network. Post-quake, this helped to identify breakages by comparing before and after data, immediately highlighting anomalies. Faults were easily located, and data analysis enabled us to measure the level of damage sustained, differentiating between severed pipes and those which had suffered less extensive damage, and allowing action to be prioritised.

Although it took physical action to fix damage, smart infrastructure proved indispensable and saved valuable time, money and resources.

Tom Joseph, leader, planning and needs analysis, at Mott MacDonald New Zealand and developer of H₂knOw-how

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**Opening opportunities
with connected thinking.**