

Building Scotland's Future: Infrastructure for a post-pandemic landscape

June 2020

Executive Summary

The Institution of Civil Engineers (ICE) is the independent voice on infrastructure and the leading source of expertise in infrastructure and engineering policy.

ICE Scotland represents over 8,500 members, drawn from across the public, private and academic sectors. Our members design, build and maintain Scotland's critical transport, water, flooding, energy and waste infrastructure. However, we are not a trade body. Our Royal Charter requires that we act in the public interest and the following comments have been developed in this way.

The challenge and tragedy of the Covid-19 pandemic cannot be overstated and lasting effects will be felt for many years to come. As the full impact on Scotland's economy continues to emerge, and we look towards economic recovery, this paper sets out our view on the important role of infrastructure.

Infrastructure is a valuable and efficient economic stimulus. Every £1 of investment in infrastructure generates a potential further £2.70¹ due to economic multiplier effects. Drawing on the unparalleled expertise of our membership, this paper sets out our thinking on how to maximise the role of infrastructure development to support Scotland's economic recovery following the challenges brought on by Covid-19.

Our infrastructure assets, however, are not just economic enablers; they are societal assets. We also consider requirements to ensure infrastructure's social benefits are 'locked-in' and appropriately future-proofed.

Fundamentally, we believe in the short-term:

- A '**Repair, Maintain, and Enhance**' programme offers the best opportunity to offer quick economic stimulus while future-proofing Scotland's infrastructure. This should be declared a national infrastructure priority and be quickly mobilised.
- Scottish Government should commit to working to **remove barriers for industry**, hampering the ability of the infrastructure sector to fully contribute to Scotland's socio-economic recovery.
- Scottish Government should be bold in driving forward the **Fourth Industrial Revolution** – acting now to embrace a future which is **green, digital and inclusive**.

Decisive action on the necessary infrastructure investment, combined with careful stewardship of our infrastructure landscape, and joint working between industry and government, can benefit Scotland's economy and deliver wider social and environmental value – ensuring our infrastructure is fit for today and fit for the future.

¹ Analysis by Oxera for ICE. Further detail can be found here: https://www.ice.org.uk/getattachment/news-and-insight/policy/infrastructure-as-a-stimulus/post-crisis-infrastructure-investment-insight-paper-covid-19.pdf.aspx#_ga=2.179966759.2015985077.1591167730-1129742483.1567513176

The role of infrastructure in economic stimulus

Infrastructure can play a valuable role in economic stimulus, through what is known as ‘multiplier effects’ – the economic value-add created at different stages of an infrastructure project. Due to these effects, analysis conducted for ICE has shown that each £1 spent on infrastructure could generate £2.70.

For quick, low-risk, economic stimulus ICE Scotland recommends Scottish Government rolls out a ‘Repair, Maintain and Enhance’ programme. This would tackle our current maintenance deficit, deliver multiplier effects and future-proof our infrastructure networks – building resiliency into our system.

Covid-19 will leave socio-economic scars. A third of Scotland’s workforce could be unemployed or furloughed² while UK unemployment could rise to 10%, amid a 12.8% fall in GDP in 2020³. On a global scale, the International Monetary Fund (IMF) expects GDP growth for 2020 to be negative, with ‘a recession at least as bad as during the global financial crisis or worse’⁴.

Infrastructure has long been viewed as a valuable economic pump-primer. Analysis by the IMF has shown that, in a sample of advanced economies, a one percentage point of GDP increase in infrastructure investment increases the level of output by 0.4% in the same year and by 1.5% four years after. Infrastructure spending can provide governments with one of the greatest returns on its investments⁵.

Multiplier effects

Infrastructure’s economic stimulus successes are largely driven by multiplier effects. Infrastructure projects create a stimulus effect through activity generated across all stages of an asset’s lifecycle – planning, design, construction, operation & maintenance (and in some cases decommissioning). This creates not just short-term stimulus but long-term value.

Analysis conducted by Oxera on behalf of ICE found that the Office for National Statistics (ONS) estimates of multipliers by infrastructure sector range between 1.5 and 2.7. Therefore, for each £1 spent on infrastructure, there would be an additional £1.50–£2.70 of demand due to multiplier effects⁶.

Infrastructure also generates jobs, both directly through construction and maintenance, and indirectly through wider supply chain activity. Additionally, infrastructure assets themselves improve access to employment and income generating opportunities⁷.

Repair, maintain and enhance

Asset maintenance is a fundamental part of a resilient and productive Scottish infrastructure system and extracting maximum value from our existing infrastructure is essential to Scotland’s economy. Direct replacement costs for all our water and wastewater related assets would cost around £70.5bn⁸. Reconstructing our trunk roads, only 6% of our road

² <https://www.ippr.org/blog/outlook-for-scotlands-workforce-furlough-job-losses>

³ <https://obr.uk/coronavirus-analysis/>

⁴ <https://www.imf.org/en/News/Articles/2020/03/23/pr2098-imf-managing-director-statement-following-a-g20-ministerial-call-on-the-coronavirus-emergency>

⁵ <https://www.imf.org/external/pubs/ft/weo/2014/02/>

⁶ https://www.ice.org.uk/getattachment/news-and-insight/policy/infrastructure-as-a-stimulus/post-crisis-infrastructure-investment-insight-paper-covid-19.pdf.aspx#_ga=2.179966759.2015985077.1591167730-1129742483.1567513176

⁷ https://www.ilo.org/global/docs/WCMS_099513/lang--en/index.htm

⁸ Figures from Scottish Water, provided in 2018.

network, would cost £20bn⁹. Our extant infrastructure represents a sizeable existing investment. Achieving maximum value from this investment is dependent upon appropriately funded, planned and preventative maintenance regimes.

Unplanned and reactive interventions are costly and disruptive. The closure of the Forth Road Bridge for emergency repairs in December 2015 put substantial pressure on alternative road routes, increased journey times, strained rail services, increased carbon emissions and increased costs to commuters¹⁰. The eventual direct cost of remedial work was £16m¹¹. Road hauliers calculated the impact on the freight sector alone at £37m¹².

Scotland's infrastructure is worth billions of pounds but following historic under-investment portions of it are failing to realise their full benefit to the economy as they deteriorate, perform sub-optimally and lose their value. Our infrastructure networks become less resilient, productivity is hindered, and the social value of infrastructure deteriorates; poor infrastructure performance does not create positive places to live and work. Underperforming infrastructure assets can lock out groups of users (e.g. a poorly maintained pavement can prevent appropriate disabled access) hampering inclusivity.

Government commitment to maintenance, both through declaring it a National Infrastructure Priority and through quickly bringing forward a structured maintenance programme, could see this trend reversed.

Moreover, in the context of the post-Covid economic recovery, a focus on asset repair and maintenance offers a low-risk approach to kick-starting construction and catalysing infrastructure's economic multipliers.

Maintenance too can be inherently local, offering a good opportunity for Scottish SMEs, as well as larger contractors, to secure contracts for work. For rural communities with little resiliency, maintenance is even more important.

ICE Scotland is clear that asset maintenance, like any infrastructure investment, must seek to lock-in maximum social, environmental and economic value. Our infrastructure should not necessarily be repaired to the existing baseline but enhanced to deliver better outcomes. New, sustainable materials can be used, prolonging assets' life-spans and increasing their sustainability, new technologies like remote monitoring sensors can be installed to create 'smart infrastructure', deeper inclusivity can be built-in such as adding multi-modal transport options to an existing roadway, and social value delivered such as by considering how the asset can best improve a sense of place. Environmental benefits too can be deeper engrained in our assets, not just through materials but with things like accompanying green infrastructure.

A *Repair, Maintain and Enhance* programme can achieve several objectives: it can optimise our existing assets, deliver economic stimulus and lock-in deeper social-value to Scotland's infrastructure.

Overcoming barriers for industry

Scotland's construction and infrastructure sectors already faced several barriers and new challenges have now emerged as a result of Covid-19. To best ensure industry can step up to deliver an economic recovery, government should adopt a flexible approach to support industry and deliver our collective ambitions.

While infrastructure offers a key opportunity to deliver economic recovery, in the post-Covid landscape industry is facing several challenges.

⁹ <https://www.transport.gov.scot/media/33629/value-of-society-economy-to-trn-final-report-feb-2017.pdf>

¹⁰ <http://eprints.gla.ac.uk/120985/1/120985.pdf>

¹¹ Sunday Post (1 January 2017) Forth Road Bridge closure cost taxpayers £16 million

¹² <https://www.rha.uk.net/news/press-releases/2016-02-february/forth-road-bridge-continues-to-cause-financial-mis-en>

With public health restrictions on 'social distancing' likely to endure across 2020, workforce density on construction sites is limited. At the time of writing we are aware of several sites operating at less than one-third capacity, while others are unable to operate safely at all. The most immediate impact of this change is of course the pace at which projects can be delivered.

We would encourage the Scottish Government to work with industry to implement a flexible approach, for example offering flexibility on working hours and noise restrictions, where appropriate, to enable industry to alter working patterns and better deliver to time and budget.

Public procurement is not working effectively. Local and smaller contractors are often disadvantaged, local supply chains are under-utilised, and larger contractors may not be able to deliver effectively in all cases. More innovative approaches are needed for rural infrastructure and infrastructure procurement, such as the enterprise model 'Project 13' supported by ICE¹³.

Supply restrictions are being felt heavily across construction and infrastructure sectors. With manufacturing and transportation not operating at full capacity, securing physical goods can be challenging and slower than normal. We have particular concerns over the ability of local SME's to withstand an economic downturn and would encourage government to rapidly bring forward packages of supply chain support.

These challenges should be addressed in the short-term, but it is important to remember that they sit in a landscape of pre-existing regulatory and operational challenges across Scottish industry. Scotland's construction and infrastructure sectors are faced with skills and labour shortages, supply chain fragility, and post-Brexit uncertainty.

Delivering the right infrastructure for Scotland cannot be achieved by capital spend on large projects alone. Headline fiscal stimulus must be accompanied by a series of targeted packages – both financial and regulatory - addressing different sectoral challenges, in response to immediate Covid-related impacts and pre-existing concerns.

The Fourth Industrial Revolution: Principles to guide a new age

The Fourth Industrial Revolution is far beyond a digital or information revolution. It refers to a transformation that impacts on all aspects of civil society, governance, economics, manufacturing – and more.

To fully embrace the opportunities this brings, Scottish Government must deliver a post-Covid landscape which is green, digital and inclusive. That will require thinking about infrastructure as a system and creating new finance models.

Government must act early to lock-in value and maximise opportunities this transition brings – and we believe that in doing so three principles should be adhered to, our industrial revolution should be green, digital and inclusive.

Green Infrastructure

Infrastructure developed in support of our post-Covid economic recovery should be aligned to Scotland's net-zero ambitions¹⁴.

¹³ <http://www.p13.org.uk/>

¹⁴ <https://www.gov.scot/policies/climate-change/>

ICE Scotland members are at the forefront of some of the most exciting decarbonisation projects in Scotland¹⁵, and indeed globally, and it will be across the sectors represented within our membership that some of the greatest economic, social and environmental gains are to be made.

Green stimulus packages have been found to offer high economic multipliers¹⁶, and Scotland is uniquely well-positioned to capitalise on existing expertise in several 'green infrastructure' areas, including renewable energy, smart grid management and advanced manufacturing.

ICE Scotland has identified a pressing need to ensure our infrastructure is able to cope with the impacts of climate change – which are already being seen and are set to become more pronounced. Climate change is already resulting in more weather extremes, as was seen with flooding across parts of Scotland in February with Storm Ciara and Storm Dennis¹⁷. These extremes, and their economic, environmental and social impact present an urgent driver for infrastructure investment.

Along with the need for new 'green infrastructure' to be brought forward to deliver both economic multipliers and climate resiliency, our existing infrastructure must be reviewed in the context of changing climate conditions. As part of a 'Repair, Maintain, Enhance' infrastructure programme, it is our view that infrastructure should be improved to build in resiliency against the latest climate change forecasts.

Bringing forward green infrastructure and 'retro-fitting' existing assets will help deliver against climate change targets as well as aiding economic recovery. This type of activity additionally carries social benefits. Green infrastructure, from good public transport provision and local energy systems, to access to green spaces and use of recycled materials, can provide health benefits, contribute to place-making ambitions and support inclusive economic growth¹⁸.

Digital

The mass-roll out and integration of digital technologies into daily lives and working practices signalled the beginning of the *Fourth Industrial Revolution*. The response to Covid-19 has demonstrated the fundamental importance of digital connectivity to Scotland now and in the future.

Digital technologies offer a unique opportunity to make our infrastructure better. We can create and build in different ways, using new, sustainable materials and building with new processes. Through embedding sensors in our assets and developing digital twins¹⁹ we can create 'smart infrastructure' – improving management of our homes, communities and cities while delivering a wealth of data enabling us to learn and continually improve²⁰. Digital technology can tell us when a repair is required, and can enable repairs to be carried out remotely – all reducing costs, creating efficiencies, and making sure infrastructure users are able to extract maximum value from their infrastructure assets.

Along with enabling our infrastructure to perform better, digital assets and digital connectivity deliver for society economically and socially. The digital revolution:

- Enables increased home-working, reducing peak-time traffic flows (improving air quality and place-making) and reducing carbon emissions; while delivering social benefits by allowing people more time at home;

¹⁵ <https://www.ice.org.uk/news-and-insight/the-infrastructure-blog/august-2015/building-better-world-scotlands-low-carbon-future>

¹⁶ <https://www.smithschool.ox.ac.uk/news/articles/200505-building-back-better-net-zero-emissions-recovery.html>

¹⁷ <https://media.sepa.org.uk/statements.aspx>

¹⁸ ICE Scotland is a member of the Climate Emergency Response Group, a pan-economy group of stakeholders delivering a series of recommendations to government on how to meet Scotland's 2045 net-zero target.

¹⁹ <https://www.ice.org.uk/news-and-insight/the-civil-engineer/august-2019/developing-ice-digital-twin-thinking>

²⁰ <https://www.ice.org.uk/news-and-insight/the-civil-engineer/september-2018/dealing-with-big-data-from-smart-infrastructure>

- Creates further opportunities for decarbonisation: digital connectivity is the cornerstone of smart-grid networks and enables consumers to take full advantage of renewable and smart energy technologies at home and in their communities;
- Increases opportunities for remote learning – supporting the skills transitions required across several sectors;
- Underpins social and economic connectivity in rural areas – enabling people to work, live and study in remoter regions productively.

Enhancing our digital infrastructure, particularly by building-out digital connectivity and supporting digital skills and digital literacy, will deliver economic multipliers and can be a key driver of economy recovery. Embracing digital will ensure that Scotland delivers future-proofed infrastructure assets but equally economic competitiveness and social connectivity. Driving forward the digital agenda will be key to ensuring Scotland meaningfully transitions into the *Fourth Industrial Revolution*.

Inclusive Economic Growth

Scotland's infrastructure provision is a key determinant of inclusivity and as we consider the Covid-19 recovery, it will be particularly important to ensure that policy and infrastructure interventions are inclusive and do not leave any groups behind.

Scotland's existing infrastructure systems and networks are not currently as inclusive as they could be. Work must be undertaken to ensure that our existing assets, from our building stock to public transport networks are accessible to all, that place-making does not unintentionally 'lock out' any particular demographic(s), and that infrastructure investment is equally weighted across the requirements of different groups. When new infrastructure assets are brought forward, or existing assets 'repaired, maintained and enhanced', their impact on the inclusive growth agenda should be assessed.

Rural infrastructure provision is especially important under this theme. Early reporting suggests that Scotland's Highlands & Islands will be one of the areas most economically challenged by Covid-19²¹. The area has existing economic resiliency issues, such as a reliance on a small number of sectors, such as Tourism and Food & Drink. Rural areas already lag in infrastructure provision – issues such as ferry disruption, the fragility of air links and the resilience and reliability of strategic roads are having a significant impact on the rural economy. Rural areas often suffer poor broadband connectivity, and lack services such as health and care provision.

There is considerable existing ambition to deliver employment opportunities and boost productivity in rural areas and early indications show increased public desire to live rurally²². For these ambitions to be realised, government must invest in infrastructure – from conventional water, waste and transportation, to digital connectivity.

Demographic shifts are one of the key societal changers Scotland will face in the next few decades, and our infrastructure must be developed accordingly. Catering to urban and rural (and sub-urban) requirements will require different infrastructure approaches. Age demographics will also determine infrastructure provision – as our elderly population increases so must appropriate housing, transport and digital provision, as well as social infrastructure (such as health and social care). Vulnerable groups, such as the disabled, should not be excluded from assessing our basic infrastructure provision – transport networks, housing stock and place-making should be designed and built to accommodate the widest possible set of needs.

The way we use our infrastructure will adjust to reflect the realities of Covid-19 in the medium-term. For example, in the likely scenario that social distancing requirements will exist into the medium term, our key networks like public transport stations, schools, hospitals and social care provision, may need significant re-design. While physical re-design needs in some spaces should be considered in terms of opportunity to deliver economic multipliers and deliver better social value,

²¹ <https://www.pressandjournal.co.uk/fp/news/politics/scottish-politics/2203290/coronavirus-economic-impact-could-be-hardest-in-northern-scotland/>

²² <https://www.homesandproperty.co.uk/property-news/moving-house-after-coronavirus-lockdown-countryside-locations-a138261.html>

the re-imagining of how we use existing spaces and networks is a firm example of the need for infrastructure professionals to design and build assets which can accommodate future uncertainties and minimise barriers to use.

Inclusive infrastructure is about creating an infrastructure landscape that works for us all, now and in the future. We must design and build assets which maximise inclusivity by accommodating uncertainty, designing across demographics and user groups, and embedding strong place-making principles in our infrastructure landscape.

Systems Thinking

Infrastructure is an interconnected system of systems that provides the foundation for our society and our economy. It does more than just provide water, power or transport services; it helps to make cities and rural communities liveable, boosts quality of life and fuels sustainable growth, productivity and prosperity²³.

The principle of infrastructure as a system of systems to support human prosperity will be fundamental to how we design and deliver infrastructure as part of the new normal.

This will require breaking silos, cross-government and cross-industry-working, and altogether conceiving of our infrastructure landscape in a different way, through:

- Recognising interconnectivity between infrastructure networks;
- Understanding societal outcomes enabled by infrastructure (particularly achieving the UN sustainable development goals and inclusivity);
- Considering the long-term sustainability of the system (e.g. maintaining the system to deliver expected benefits);
- Using technology to gain a greater understanding of the system in operation through, for example, establishing a cyber-physical system with a digital twin²⁴.

Infrastructure underpins every aspect of our day to day lives – from energy, water and sewerage provision to housing, transport and digital connectivity. People do not interact with infrastructure in a fragmented basis, but use it in an integrated way.

To maximise the value of our infrastructure assets and embrace the opportunities offered by the *Fourth Industrial Revolution* it is imperative that a systems-led approach to infrastructure is embedded in our thinking.

A systems-thinking approach needs to apply to infrastructure policy decision-making. The widest set of infrastructure demand drivers must be considered in decision making, including economic impact, climate factors, and social benefits. Our infrastructure is used by everybody, and the diversity of users must be reflected in decision-making. Diverse communities of voices (including, but not limited to, age ranges, gender, ethnicity, disabled and carers, geographical representation, economic-circumstance) should be central to shaping our future infrastructure landscape.

New Finance Models

New thinking on infrastructure financing will be required as we look both to economic recovery and to bring forward the next generation of infrastructure. While capital spend will still have a role in bringing forward projects and securing private finance, as our infrastructure landscape modernises, our finance models will too have to change.

There are now emerging instances of Covid-19 immediately impacting the financial health of sectors and their own ability to invest in their assets. For example, the fall in public transport use (widely reported to be around 75%) and associated fares revenues both during and following the easing of lockdown restrictions will impact fleet operator ability to invest, threaten the existing viability of services as well as funding for transport partnerships and authorities. Should unemployment levels increase, homeowner investment in our building stock will likely fall. Local authority budgets are already stretched.

²³ <https://www.cdbb.cam.ac.uk/news/flourishing-systems>

²⁴ <https://www.ifm.eng.cam.ac.uk/research/asset-management/research-projects/infrastructure-digital-twins/>

We would anticipate, and encourage, Scottish Government to bring forward stimulus packages – utilising structures already in place such as the Scottish National Investment Bank, and the Publicly Owned Energy Company – working to kick-start infrastructure investment, attract private capital and deliver economic multipliers.

With the public sector likely a key part of our economic recovery, it must be prepared to take on more risk and evaluate investment approaches differently. A risk-averse approach from the public sector could mean investing in ‘what we’ve always done’ rather than ‘what we can do’. Scotland can act early and lock in the value the *Fourth Industrial Revolution* is beginning to deliver, but only if the public sector is prepared to take a lead and take on more risk to secure a meaningful economic recovery.

ICE has been working with partners to develop a new industry business model – based on an enterprise, not on traditional transactional arrangements – to boost certainty and productivity in infrastructure delivery, improve whole-life outcomes in operation and support a more sustainable, innovative, highly skilled industry²⁵. This initiative, known as Project 13, has received considerable traction to date and industry will look to work with government to further embed these principles into infrastructure delivery post-Covid.

Sectoral Analysis

Delivering a resilient economic recovery while capitalising on the benefits brought forward by the Fourth Industrial Revolution will require a multitude of interventions across different sectors.

We believe sectors should be considered holistically, in line with a systems-led approach, but we have set out specific considerations and interventions in this sectoral analysis.

Transport

Delivering the right transport infrastructure will be a key part of delivering both a sustainable economic recovery and social capital. The right solutions, in the right places can contribute to a range of objectives – including placemaking, health and wellbeing, climate change resilience and productivity. Where delivered correctly, transport systems can promote inclusivity and equality.

Like other aspects of infrastructure, transport solutions cannot be considered in a silo. Transport needs must be integrated into placemaking, new residential infrastructure developments, our planning frameworks, and socio-economic decision-making at all levels.

As we set out in our response to NTS2²⁶ – transport infrastructure and provision is an especially complex policy area. We set out six considerations, which in our view still hold true in the context of economic recovery:

- **Repair, Maintain, Enhance:** A structured and proactive programme of asset maintenance of our existing transport networks is required to ensure assets retain their maximum value and deliver transport solutions at their optimum capacity.
- **Futureproofing:** Our assets and our decision-making should leave enough scope to allow for transformative technologies to come to market and be embedded within our transport networks. Resiliency should be engrained in our system to ensure capacity to deal with climate change effects such as increased instances of landslides, flooding and high winds.

²⁵ <http://www.p13.org.uk/>

²⁶ <https://www.ice.org.uk/about-ice/near-you/uk/scotland/publications/submission-to-scotland-national-transport-strategy>

- **Infrastructure finance:** As the types of transport infrastructure we seek to build changes, and the way we use our transport networks responds to different use-cases, new ways of financing our transport infrastructure are needed.
- **Holistic placemaking:** Transport systems can be a key contributor to places that are enjoyable to live and work in, but this will work best when transport provision is considered as part of a wider set of local challenges. There is an opportunity to address existing transport constraints in the Highlands & Islands, to drive economic recovery, in an area where it will be easier post-Covid for remote and home working with increased staff productivity and health benefits.
- **Integrated networks:** To best deliver for users, transport networks should be easy to use. 'First and Final Mile' links are particularly important to ensure that all Scotland's citizens can travel safely door-to-door.
- **Climate Change:** With the declaration of a Climate Emergency, and Scotland's transport sector a large contributor to Scotland's net emissions, Scotland's transport sector needs to adapt. Careful consideration should be given to barriers to develop clean transport networks and identifying policy solutions to support their delivery. Our networks are already seeing the impacts of a changing climate; support needs to be given too for their adaptation and futureproofing.

ICE Scotland welcomes investment to date in increased active travel infrastructure, and – in the context of the 'green recovery' would support this further going forward. To ensure that we fully decarbonise our transport system, maximise productivity and deliver an inclusive transport network, we would look to Scottish Government to support investment in multi-modal transport infrastructure programmes which include, but go beyond, active travel. Public transport provision, rail electrification, green-hydrogen based solutions and support for Ultra Low Emission Vehicles (ULEV) and associated charging infrastructure will be equally important.

Public transportation providers, often already requiring fleet modernisation and investment, have gone through a turbulent period given dramatically reduced demand (in the region of 75%) through Covid-19. The long-term impacts of loss of fare revenues, and the extent to which public confidence to use public transport will 'bounce back' remain uncertain. We would strongly encourage public sector capital support to ensure we can invest in improving the reach of our public transport network, including first and final mile delivery, and improve the quality of the fleet – both to support emissions reductions through incorporating new technologies, and to deliver against customer experience expectations.

Our road networks, for both car and freight traffic, will continue to be an essential part of Scotland's infrastructure. The decarbonisation of transport can be readily accelerated through government support for deeper penetration of ULEV charging networks coupled with consumer incentives for electric vehicle roll-out. Further rail electrification programmes would be beneficial, both to green our transport fleet but equally in terms of economic multipliers. Similarly, the existing trajectory supporting alternative fuels for freight, ferries and air-travel, such as hydrogen and batteries, should continue apace.

Across all transport modes, an integrated approach across government and industry will be required to identify and deliver the required infrastructure investment to drive decarbonisation, including investment in ports and harbours.

Housing

Housing, much like transport, cannot be effectively delivered in a silo.

The delivery of economic infrastructure to enable and support new housing developments is vital. While there is an accepted need to build more homes (and as we detail above, a need to build more homes to account for our changing demography), there is much scope within the current system to consider infrastructure more strategically²⁷.

Too often we see housing developments lock-in negative societal outcomes. New and existing developments are not always linked with public transport provision. Sites are often built with 'standard' gas and electricity connections, failing to capture the benefits of renewable technologies, or adequately future proof for their use. Energy efficiency is a real problem

²⁷ For fuller analysis of housing, see our 2019 State of the Nation Report <https://www.ice.org.uk/news-and-insight/policy/state-of-the-nation-2019>

within existing housing stock with 'retrofitting' programmes only reaching a small percentage of our built environment²⁸. This can deliver secondary negative impacts, like fuel poverty. Similarly, we recognise that household waste collection is a costly and challenging service for local authorities to operate. Housing development supporting circular economy and waste-reduction principles, could provide an opportunity to implement more sustainable, consumer friendly, and cost-effective waste solutions.

Addressing these issues and rolling out the provision of improved infrastructure in and around our housing developments offers a real opportunity to lock-in positive outcomes, deliver a strong sense of place, and provide economic stimulus as part of a Covid-recovery programme.

Building not just housing developments, but delivering new asset-rich communities, could be a transformative infrastructure programme for Scotland.

Energy

There are various areas across our energy system which are 'low-hanging-fruit' for delivering economically as well as on climate change.

Scotland has a strong pipeline of renewable energy projects, both onshore and offshore, which if delivered could prove a significant economic contributor. Shovel-ready projects exist across a range of technology types, from pumped hydro storage to offshore wind. This potential is underscored by the June 2020 ScotWind offshore leasing round, where Crown Estate Scotland has for the first time in a decade set out new areas of the seabed suitable for offshore wind development. It is estimated that investment in projects coming forward as a result of this round could surpass £8 billion and could deliver enough electricity to power every Scottish household, displacing over 6 million tonnes of CO₂²⁹.

We are also seeing Scottish-based organisations involved in smart-energy management grow, taking a real lead in this internationally. From the *Power Networks Demonstration Centre* in Cumbernauld, to Edinburgh's *Flexitricity* – the industry in Scotland is well placed to take advantage of already world-class positioning in decentralised energy system management – something critical to the *Fourth Industrial Revolution*.

ICE Scotland identifies the delivery of low-carbon heat infrastructure as of particular benefit to both our net-zero ambitions and Scotland's economic recovery. Heat makes up over half of Scotland's energy use³⁰, and will be a critical lever in meeting Scotland's 2030 decarbonisation targets. Renewable heating represented just 6.3% of Scotland's non-electrical heat demand in 2018³¹. Renewable heat has a significant multiplier effect. With gas boilers embedded across our housing stock, their replacement creates significant demand for trained workers to deliver the transition. District heating projects are large-scale infrastructure projects, delivering all the economic multipliers detailed earlier in this response.

We also see a valuable role for Carbon Capture and Storage (CCS). As set out in the latest ICE Insight Paper³² our analysis concludes that the barriers in bringing CCS forward are commercial and regulatory rather than technical. We view the technology as having several clear decarbonisation benefits, but given the infrastructure involved also view CCS as having the potential to contribute meaningfully to Scotland's economic recovery.

²⁸ <https://www.gov.scot/publications/energy-efficient-scotland-strategic-outline-case-proposed-development-national-delivery-mechanism/pages/17/>

²⁹ <https://renews.biz/60869/scots-crown-launches-scotwind-offshore-leasing-round/>

³⁰ <https://www.gov.scot/policies/energy-efficiency/decarbonising-heat/>

³¹ <https://www.scottishrenewables.com/our-industry/statistics#:~:text=The%20growing%20capacity%20of%20renewables.cent%20of%20Scotland's%20electricity%20consumption.>

³² [https://www.ice.org.uk/getattachment/news-and-insight/policy/insights-into-carbon-capture-and-storage/CCS Insights Paper final.pdf.aspx#_ga=2.155295803.1483196288.1591364529-1129742483.1567513176](https://www.ice.org.uk/getattachment/news-and-insight/policy/insights-into-carbon-capture-and-storage/CCS%20Insights%20Paper%20final.pdf.aspx#_ga=2.155295803.1483196288.1591364529-1129742483.1567513176)

Water

Water infrastructure is of course critical to our society. Properly maintaining our water assets is a necessity, but as with other sectors, there is a real opportunity to think differently about our water infrastructure, propelling us into the *Fourth Industrial Revolution* while delivering economic multipliers.

Scottish Water's Delivery and Business Plans set out in some detail how they will respond to challenges and deliver service improvements³³, which we welcome. In our view expenditure should increase on water and waste water asset maintenance which is critical for maintaining service, achieving maximum value from our existing assets and reducing the risk of loss of this vital service to customers³⁴. At the same time, industry should seek to advance its use of data and analytics to support maximum efficiency in delivery, operation and maintenance.

Again, water must be considered as part of a wider infrastructure system. Understanding and making use of interdependencies across sectors can deliver financial and running cost benefits. Scottish Water, one of Scotland's largest energy consumers, has developed a programme of on-site energy generation to drive down its dependency on grid supply, installing a varied portfolio of renewable energy technologies which has also served to lower carbon emissions³⁵. Critical thinking in this area could also increase revenue resilience and reduce the overall demand impact on other sectors. It is vital that both industry and both governments seek measures to identify and exploit these interdependencies where possible.

Water assets have been shown to unlock significant social as well as economic value. Glasgow's 'Smart Canal' scheme combines the 250-year-old Forth and Clyde Canal and 21st century technology to provide surface water drainage, supporting significant regeneration in the north of the city. The North Glasgow Integrated Water Management System is a pioneering surface water drainage system set to unlock a previously unusable 110 hectares of land across the north of the city for investment, regeneration and development, paving the way for more than 3,000 new affordable homes.

The project will see North Glasgow passively absorb, clean and use rainfall. Use of digital technologies means that advanced warning of heavy rainfall will automatically trigger a lowering of the canal water level to create capacity for surface water run-off. Before periods of heavy rain, predicted by sensors and advanced technology, canal water will be moved safely through a network of newly created urban spaces – from sustainable urban drainage ponds to granite channels - that absorb and manage water, creating space for surface water run-off. This solution avoids the requirements to upgrade existing wastewater systems and, through the diversion of surface water, creates additional capacity to enable the development of new communities in areas that were once considered too costly to invest in. In addition, there are significant environmental benefits through the inclusion of green infrastructure and the avoidance of significant excavation and construction activities³⁶.

It is this type of digital-laden, systems-led infrastructure thinking in our water sector and beyond that can unlock real socio-economic benefit for Scotland.

Conclusions

Infrastructure underpins every aspect of Scotland's economy and society, and it's right that it should be at the heart of an integrated economic recovery package. However, we can go further than just 'recover' and instead take an opportunity to rebuild – delivering the right infrastructure for Scotland's future.

³³ <https://www.scottishwater.co.uk/help-and-resources/document-hub/key-publications/delivery-and-business-plans>

³⁴ https://www.ice.org.uk/getattachment/news-and-insight/policy/state-of-the-nation-scotland-2018-infrastructure/State-of-the-Nation-Scotland-2018.pdf.aspx#_ga=2.137187766.783962544.1591785275-1129742483.1567513176

³⁵ <https://www.scottishwater.co.uk/about-us/energy-and-sustainability/renewable-energy-technologies#:~:text=As%20far%20back%20as%20the,heat%20from%20waste%20water%20technology.>

³⁶ <https://www.scottishcanals.co.uk/placemaking/glasgow-canal-project/glasgows-smart-canal/>

Infrastructure delivery will play a critical role in our post-Covid landscape, carrying strong economic multipliers and supporting job creation. An immediate focus on repairing, maintaining and enhancing our existing infrastructure assets would be a low-risk option of stimulating the economy while building resiliency and future-proofing our assets.

While government and Industry must work together to overcome existing barriers, we can maximise the social, environmental and economic value of our infrastructure by thinking in terms of the *Fourth Industrial Revolution*, basing our infrastructure decisions around a green, digital and inclusive vision. This will require investment across a range of sectors, unpicked in our sectoral analysis, and it will ultimately require new thinking – particularly around finance, public and private sector collaboration, and developing infrastructure as a system.

Civil Engineers have always worked to benefit society and it is imperative that in recovering economically from Covid-19 we grasp this opportunity to improve. With decisive action, collaborative working and sound stewardship of our infrastructure assets, Scotland can deliver economic and social value through an infrastructure system that is fit for the future.

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