

SCOTLAND'S WAY AHEAD

The Case for Low Carbon Infrastructure in Scotland



A REPORT TO THE LOW CARBON INFRASTRUCTURE TASK FORCE

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Green Alliance

Green Alliance is a charity and independent think tank, focused on ambitious leadership for the environment. With a track record of over 35 years, Green Alliance has worked with the most influential leaders from the NGO and business communities. Green Alliance's work generates new thinking and dialogue, and has increased political action and support for environmental solutions in the UK.

CONTENTS

Exe	ecutive summary	5
1	Introduction	. 12
2	The infrastructure landscape	.14
3	Benefits of low carbon infrastructure	. 19
4	Infrastructure sectors: low carbon targets and opportunities	. 23
5	Deciding on priority projects: assessment criteria	. 28
6	Making it happen: evaluating deliverability	. 30
7	Conclusion	. 38



CHAIR'S INTRODUCTION

Scotland's infrastructure is essential to our quality of life. How we heat and bring water to our homes, dispose of waste, travel around and communicate today is determined by infrastructure investment decisions made in the past.

Scotland's ambitious climate change targets mean that the time is right to plan new, and adapt existing, infrastructure to enable Scotland's transition towards a low carbon economy.

Determining future infrastructure priorities requires strong leadership from government. Capital investment and a clear policy framework are vital ingredients in unlocking the necessary private funding.

This report restates the case for low carbon infrastructure, and illustrates how it can deliver real value for money – with economic, environmental and social benefits. New forms of energy capture and storage, public transport, energy efficiency, and digital networks are just a few of the opportunities for investment in a low carbon future.

The report was commissioned by the Low Carbon Infrastructure Task Force, which seeks to inform government thinking on funding and facilitating low carbon infrastructure. It brings together key figures across the infrastructure lifecycle in Scotland, from construction and finance industries, public and private sectors, the engineering sector, and academia.

Climate change is one of the biggest challenges of our generation and we hope this report is a useful contribution to the debate. We have a duty to build infrastructure that will meet the needs of our grandchildren, make it easier to live in a world less dependent on fossil fuels and more resilient and able to adapt to the changes that climate change will bring.

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EXECUTIVE SUMMARY

Low carbon infrastructure is central to Scotland's ability to meet its climate change objectives. People interact with infrastructure constantly, using it to talk to friends and family, to commute to and from work, to travel for leisure, to heat and light their homes, when turning on the tap or when recycling or disposing of waste. As the costs and impacts of climate change become more apparent, it is essential that the infrastructure underpinning our lives helps to deliver a low carbon transition.

Failing to invest in low carbon infrastructure will lock in high emissions and vulnerability to the multiple impacts of climate change, leaving a legacy of buildings, roads, energy generation and more which will be expensive to adapt in the future. Instead, Scotland can seize the opportunity now to increase investment in low carbon infrastructure, gaining the benefits in terms of climate change, but also economic progress and social welfare for years to come.

Reflecting this potential, the Low Carbon Infrastructure Task Force defines low carbon infrastructure as "infrastructure that will enable Scotland's people and businesses to thrive and prosper in a low carbon society for many generations, in line with the requirements of the Climate Change (Scotland) Act."

REALISING THE LOW CARBON TRANSITION

The Scottish Government is well aware of the challenge in addressing climate change and has an ambitious set of low carbon targets in place. These include:



80% reduction in greenhouse gas emissions by 2050

Largely decarbonised electricity sector by 2030



decarbonisation

of road transport

by 2050, with

significant

Largely decarbonised heat

sector by 2050,

with significant progress by 2030

Zero waste economy by 2050

progress by 2030 The UK Climate Change Committee remains optimistic about overall progress towards the 2020 and 2050 targets, and Scotland is making faster progress on cutting emissions than the UK as a whole. However, the Scottish Government has failed to meet its first four annual targets and this does not demonstrate a trajectory of strong and consistent progress across the range of sectors critical in the transition to a low carbon society.



Alongside these targets, Scotland's infrastructure investment pipeline sets out relevant investments and ambitions across economic and social infrastructure sectors. Examining these in tandem with low carbon ambitions reveals a mixed picture. Strong progress is evident in some areas, such as renewables, while significant challenges lie ahead in areas such as heat, transport and energy efficiency. All of these may be areas for transformative new low carbon infrastructure projects. Overall, critical weaknesses are evident in Scotland's current approach to infrastructure planning and its ability to support a low carbon transition.

AIMING FOR A LOW CARBON INVESTMENT SCENARIO

International comparisons suggest that a global low carbon investment scenario which is aligned with the goal of keeping global warming below 2 degrees C would require a minimum of 72% of public infrastructure investment directed at low carbon projects.¹ A good portion of this is achieved through regular investment cycles for home and industry, refitting to much higher energy efficiency standards. According to the analysis in this report, 52% of Scotland's current infrastructure pipeline is already allocated to low carbon projects, which suggests this proportion should increase by a minimum of 20 percentage points in order to align with this global average level of low carbon investment scenario. However, it would be expected that Scotland, as with other developed countries, should achieve a higher proportion of low carbon investment that is consistent with its climate change goal.

While this may sound like an achievable increase, it points to the key challenge facing Scotland. Achieving a low carbon transition will not just involve increasing investment for low carbon infrastructure projects; it will mean decreasing spend on neutral and high carbon projects. This requires a fundamental shift to reorient all investment decisions towards a low carbon future.

BENEFITS OF LOW CARBON INFRASTRUCTURE

Playing our part in a global effort to prevent dangerous climate change requires a fundamental shift to reorient all investment decisions towards a low carbon future.



Emissions reduction potential is central to making the case for low carbon infrastructure. Indeed, the overarching strength of low carbon infrastructure is that it builds in long term resilience to the growing impacts of climate change and avoids unsustainable lock-in to high carbon pathways and their associated economic, environmental and social impacts. However, it is also important to recognise the wider economic, social and environment benefits that low carbon infrastructure can offer. Low carbon infrastructure:

- Contributes to economic progress and resilience by providing the opportunity to leverage additional rather than displaced investment, and offering the possibility of long term returns to investors.²
- Creates demand for domestic industry, because construction necessarily takes place in situ. Many low carbon technologies are still developing, and successful innovation and demonstration in Scotland will boost local businesses.
- Provides for greater energy security, which in turn improves economic stability.
- Results in improvements to environmental quality in air, land and water.
- Enables people to behave in low carbon ways. It can also play an important role in changing norms through its visibility.
- Provide health benefits through improved air quality, encouraging active travel, and through reducing fuel poverty.
 - Offers opportunities for community ownership, which can foster closer ties among local residents, as well as bring in revenue which can be invested in local amenities.

A NEW APPROACH TO INFRASTRUCTURE PLANNING

Scotland's current sectoral approach to infrastructure planning is at risk of being unable to support the shift at the scale and speed needed. This approach compartmentalises low carbon objectives in just a few areas, namely energy, transport and housing (energy efficiency) infrastructure, with only cursory mention in relation to other sectors.

Instead, a meaningful commitment to low carbon infrastructure should be manifest in all sectors, informing the design of programmes across society and the economy. This will build overall resilience to climate shocks as well as harnessing the multiple benefits that a low carbon approach can deliver.

In its current form, Scottish infrastructure planning is failing to support ambitious progress on a number of critical low carbon priorities or to afford them the prominence, coherence of approach and security of funding that established infrastructure sectors benefit from. These include:

Energy efficiency

Efforts to tackle energy efficiency remain fragmented with current plans only including domestic energy efficiency in infrastructure planning. Progress remains slow, even with multiple support programmes in place. The recent introduction of a national infrastructure priority for energy efficiency should provide a context for a single, coherent programme that aggregates support and combines efforts to tackle domestic, business and public sector energy efficiency.

Demand side approaches to infrastructure

Reducing demand for infrastructure, for example via domestic energy efficiency, shifting peak energy demand, or public transport schemes, avoids the need for investment in new capacity whilst securing the same outcomes for society and the economy. But consideration of such approaches does not fit naturally into existing infrastructure planning, with the risk that their opportunities will get missed.

A systems approach to renewable heat

Low carbon infrastructure challenges such as renewable heat and the development, funding and delivery of district heating are multi-faceted and require more than a project by project approach. Treating Scotland's heat provision as an infrastructure system in need of co-ordinated planning and funding would support more rapid progress on deployment and delivery at scale.

Addressing emerging needs

As low carbon infrastructure becomes more widespread, related issues, such as the need for energy storage, emerge. This is acknowledged and some exploratory work is being done. But current approaches to infrastructure planning make it difficult for emerging issues like this to get the recognition, focus and level of funding needed, despite solutions to them being integral to infrastructure ambitions as a whole.

The planning process should take a holistic approach as to how best low carbon infrastructure can support positive outcomes across a range of policy objectives, sectors and activities, providing a framework for greater ambition and financial support. The result should be a national infrastructure plan which aligns with the requirements of the Climate Change (Scotland) Act.

Low carbon infrastructure results in improvements to environmental quality – in air, land and water.

THE PUBLIC SECTOR AS INVESTOR AND ENABLER

Most infrastructure is funded by the private sector and this is not expected to change. The public sector's central role is to create the policy stability that will attract private sector investment. The public sector in Scotland also has unique potential to act as an investor in certain situations. These include investing in:

Enabling infrastructure

Securing the benefits of low carbon infrastructure will depend on enabling infrastructure, such as grid capacity and connections, being in place. This focus is already evident in Scotland's current infrastructure spending plans, which have a focus on interconnections to support renewables' growth.

Emerging infrastructure needs

Public investment is well placed to accelerate the development of emerging technologies, such as energy storage, that will benefit a wide range of low carbon infrastructure projects and technologies but are at risk of failing to secure substantial private sector investment. Investment in such areas maximises the cost effectiveness of public investment and avoids the risk of picking winners.³

Innovation

A number of factors mitigate against private sector investment in low carbon research and development at the scale needed.⁴ Without intervention, evidence suggests that research and development will remain focused on traditional, higher carbon sectors.⁵ Public investment can act as a vital correction to this, helping low carbon technologies become commercial, competitive investment propositions. For example, the Global Commission on the Economy and Climate recommends that major economies triple public investment in energy related R&D by the mid-2020s, aiming to allocate 0.1% of GDP or more.⁶

Demand side approaches to low carbon infrastructure

Demand side approaches to infrastructure can be harder to package as private sector investment opportunities, especially while they are still gaining traction. This highlights another important opportunity for public sector investment, with energy efficiency being a good example.

Investment to leverage private sector funding

Public sector money can create confidence in a sector and leverage additional private sector funding into it. Scotland has a good track record in this area with renewables and to some extent with its domestic energy efficiency programmes. This effort could be increased and extended to other sectors.

Public investment in infrastructure should always be approached with caution. Action to correct market failures can be counter-productive, encouraging rent seeking or crowding out more substantial private funding. But the degree to which the accepted strengths of public investment map onto the low carbon infrastructure challenges in need of support is striking. This indicates the need for increased public investment to enable and stimulate transformational infrastructure projects.

...the degree to which the accepted strengths of public investment map onto the low carbon infrastructure challenges in need of support is striking.



ASSESSING FUTURE PRIORITIES

When considering future investments, it will be important to consider the nature of the low carbon infrastructure that Scotland needs to develop. The overarching objective should be to identify infrastructure that will enable Scotland's people and businesses to thrive and prosper in a low carbon society for many generations, in line with the requirements of the Climate Change (Scotland) Act.

This report sets out the ideal characteristics of any future low carbon infrastructure. Designing projects and approaches that can deliver against these criteria will be a challenge, further complicated by the real world factors that affect deliverability and feasibility of the potential project. The following criteria are suggested as a means to develop a pipeline of projects that can not only reduce emissions, but collectively deliver a range of economic and social benefits.



ADDITIONALITY adds to existing efforts.



PROSPERITY contributes to prosperity of individuals and businesses.



CARBON results in net reduction of consumptionbased carbon emissions.



CO-BENEFITS maximises social benefits, such as health and wellbeing.



ENVIRONMENT furthers environmental quality.



BEHAVIOURS enables low carbon choices for all.

In terms of evaluating deliverability, it is important to explore if the necessary financial, policy and regulatory factors are in place, and if not, what needs to be done to overcome any gaps.



CONCLUSION

Scotland is by no means a laggard in identifying the opportunities that low carbon infrastructure offers its economy and society, and is aware of the challenges involved.

But current approaches are not providing the scale of investment necessary. International comparisons suggest that Scotland's public investment in low carbon infrastructure needs to increase by a minimum ot 20 percentage points just to be in line with average global levels of investment and more if Scotland is to meet its climate change targets.

In addition to reducing emissions, low carbon infrastructure has a vital role to play in securing a sustainable, prosperous and fair future for Scotland. Now is the time to rethink approaches and ensure that its contribution can be fully realised.

This new approach will require not only greater investment in low carbon infrastructure, but a reorientation of all infrastructure to embed low carbon objectives. Current plans consider low carbon aspects for energy, transport, housing and waste. These plans bypass the many opportunities for low carbon infrastructure in other sectors such as water, digital technology, health, schools, culture and heritage, regeneration and justice. Taking this holistic approach, it will be possible to support faster, more ambitious progress.

The establishment of the Low Carbon Infrastructure Task Force provides a timely opportunity to reflect on the bold projects and new approaches that will help achieve this outcome.



SCOTLAND'S WAY AHEAD The Case for Low Carbon Infrastructure in Scotland



INTRODUCTION

Infrastructure is central to Scotland's ability to meet its low carbon objectives. Although often perceived as intangible, people interact with infrastructure constantly, using it to talk to friends and family, to commute to and from work, to travel for leisure, to heat and light their homes, when turning on the tap or when recycling or disposing of waste.

As the costs and impacts of climate change become more apparent, it is essential that the infrastructure underpinning our lives helps to deliver a low carbon transition. Failure in this regard will lock in high carbon trajectories and the associated impacts for decades to come. Infrastructure is built for the long term and re-engineering it to reduce impacts at a later stage is complex and costly.

Reflecting these concerns, the Low Carbon Infrastructure Task Force defines low carbon infrastructure as "infrastructure that will enable Scotland's people and businesses to thrive and prosper in a low carbon society for many generations, in line with the requirements of the Climate Change (Scotland) Act."

The Scottish Government is well aware of the challenge in addressing climate change and has a comprehensive suite of low carbon targets in place. Though these targets outstrip the ambition and progress evident at a UK level, in several areas they have been missed. The targets include:

- 80% reduction in greenhouse gas emissions by 2050.
- Largely decarbonised electricity sector by 2030.
- Almost complete decarbonisation of road transport by 2050, with significant progress by 2030.
- Largely decarbonised heat sector by 2050, with significant progress by 2030.
- Zero waste economy by 2050.

This report explores the critical role of infrastructure in meeting these targets. Progress in some of the better established sectors, such as renewables, is strong. But substantial challenges remain in many areas, such as energy efficiency and heat, with a step change in progress urgently needed.

Chapter 2's analysis of the Scottish Government's approach to infrastructure finds that it is unable to effectively address emerging issues or realise the value of demand side approaches. Current approaches also make it difficult to embed low carbon objectives across all infrastructure.

Addressing these challenges and maximising the economic, social and environmental benefits of all infrastructure is essential to accelerating progress. This is the focus for chapter 3. Incremental change will remain the norm if obstacles to more rapid deployment are not addressed. Some key opportunities for progress are highlighted in chapter 4.



Future low carbon infrastructure projects and approaches should support prosperity, improve environmental outcomes, support low carbon behaviours and provide social benefits, as well as delivering carbon reductions. Chapter 5 sets out the desired characteristics of future low carbon infrastructure projects, providing a framework for assessing their value and potential.

In addition, multiple real-world factors will affect the deliverability of new low carbon infrastructure. Chapter 6 explores these, looking in particular at the role of the public sector as enabler and investor.

Accelerated progress on the low carbon transition is needed as some milestones and targets have already been missed, and more challenging deadlines approach. Low carbon infrastructure has a vital role to play and this report identifies key ways of ensuring its contribution can be fully realised.

The Low Carbon Infrastructure Task Force defines low carbon infrastructure as **"infrastructure that will enable Scotland's people and businesses to thrive and prosper in a low carbon society for many generations, in line with the requirements of the Climate Change (Scotland) Act."**

THE INFRASTRUCTURE LANDSCAPE

2.1 INFRASTRUCTURE AMBITIONS

The Scottish Government's 2011 *Infrastructure Investment Plan*, and its subsequent updates provide the foundation for Scotland's infrastructure ambitions and investment plans. Although infrastructure's ability to deliver societal benefits is acknowledged in the plan, it is largely framed as a growth enabler. The government has identified the following as the key components of faster growth and it positions infrastructure as helping to achieve all of them:

- Productivity, competitiveness and resource efficiency: enhanced digital and transport networks are featured as central to this, but energy, water and waste infrastructure should also have a role to play.
- Participation in the labour market: infrastructure investment can create jobs and support greater access to the labour market.
- Population growth: via supporting and creating communities in which people want to live and work.⁷

In the three years to 2015-16 the Scottish Government will have invested £11 billion in infrastructure. The government's intention is that infrastructure investment supports all areas of the country and is able to deliver against each of the government's desired characteristics of growth: solidarity, cohesion and sustainability.⁸

2.2 THE PUBLIC SECTOR ROLE

Although infrastructure funding has shifted from the public sector to mainly private sources over the past 30 years, public investment continues to play an important and often unique role by:⁹

- Developing long-term enabling infrastructure, such as transport and digital networks.
- Supporting emerging infrastructure needs such as energy storage.
- Investing in innovative low carbon technologies.
- Leveraging additional private sector investment.
- Addressing market failures.
- Supporting wider strategic and social objectives, e.g. on health, education and housing.¹⁰

In addition, the public sector can create the policy and regulatory stability that attracts private finance. It can also provide the strategic planning context to promote the low carbon transition. The government can also act as a project broker and facilitator, to help new technologies to become market ready and develop the key skills and capacity in public sector agencies and the private sector.

2.3 WHAT DOES THE SCOTTISH GOVERNMENT MEAN BY INFRASTRUCTURE?

The Scottish Government breaks infrastructure down into the following sectors:



The 2011 Infrastructure Investment Plan focuses on the growth and investment that economic infrastructure can support, but also argues that social infrastructure is key to "creating a more successful country, with opportunities for all of Scotland to flourish".¹¹ This helps to move the debate beyond seeing infrastructure simply as 'kit' that helps to grow the economy, to the more nuanced recognition that infrastructure only has merits if it also delivers outcomes of value to society, such as a strong education and health system and the transition to a low carbon economy.

The Scottish Government's most recent economic strategy maintains this approach. It positions infrastructure investment as vital because of what it enables, namely high value public services, boosted connectivity and improved access to the labour market, and notes that investment must be prioritised to capture "the opportunities offered by the transition to a more resource efficient, lower carbon economy".¹²

The Task Force's definition of low carbon infrastructure also focuses on social and economic outcomes, and does not view economic growth as an end in itself. In the absence of a common definition of low carbon infrastructure, the Task Force's definition provided in section 2.1 is a valuable starting point from which to consider potential new infrastructure projects. Chapters 3 and 4 explore the wider benefits and opportunities of low carbon infrastructure in more detail.

2.4 CURRENT INVESTMENT IN LOW CARBON INFRASTRUCTURE

Scotland's infrastructure investment pipeline sets out proposed investments, both private and public capital, for the next 10 to 20 years. The Scottish Government acknowledges that the pipeline is uncertain beyond the short term, and that it is dependent on overall funding, borrowing powers and the balance between capital and revenue budgets. However, a simple analysis of the pipeline's low carbon, high carbon, and carbon neutral content provides a general indication of the Scottish Government's priorities.

In this report's analysis, projects have been categorised based on their thematic consistency with the transition to a low carbon economy:¹³ These categories and the allocation of infrastructure projects within them are based on Green Alliance's analysis of the UK infrastructure pipeline in 2013 and subsequent updates to it.

- Low carbon: seen as necessary to the low carbon transition.
- Neutral: do not represent substantial carbon efficiency gains in their own right but are consistent with low carbon ambitions.
 - High carbon: relatively carbon intensive.

The allocation of projects within these categories will be open to debate as it is, by necessity, a top line analysis rather than a full life-cycle assessment of each project within the infrastructure pipeline. Certain nuances are challenging to reflect, for example, some aspects of gas-related infrastructure are needed for the low carbon transition, but such activity is classed as high carbon overall. And, for example, classing much of the social infrastructure spend as neutral does not mean that such activities have no carbon impact, or that they could not embed low carbon design features. It is a relative judgement made in comparison to the higher carbon impacts of road building or airport expansion. Broadly, the categories include the following types of infrastructure:

Category	Examples	
Low carbon	Transport – rail and ferry	
	Energy – all renewables and electricity transmission and distribution	
	Rural affairs and the environment - waste	
	Housing – energy efficiency programmes	
Neutral	Rural affairs and the environment - all non-waste	
	Housing – all non-energy efficiency	
	Water	
	Digital	
	Health	
	Schools	
	Culture and heritage	
	Regeneration	
	Justice	
High carbon	Transport – roads and airports	
	Energy - fossil fuel generation	

Categorising projects in Scotland's infrastructure pipeline using this approach reveals the following breakdown:¹⁴

Category of infrastructure investment	Capital value (billions)	%	
Low carbon	£21.72	52.26%	
Neutral	£11.56	27.82%	
High carbon	£8.28	19.92%	
Total	£41.56	100.00%	

The only infrastructure projects to fall in the high carbon category are roads, with the bulk of the capital value coming from the Forth replacement road bridge. The neutral category includes the largest number of individual projects, mostly schools and healthcare facilities, but also some projects from the digital, culture, and justice sectors. The low carbon category includes projects from the energy, transport, and housing sectors, such as fuel poverty and energy efficiency programmes, electricity grid upgrades and rail expenditure.

2.5 HOW DOES SCOTLAND COMPARE?



will be spent globally in the next 15 years on new roads. railways and airports, energy generation assets, telecoms and equipment for our homes and workplaces. International comparisons of infrastructure spend are hampered by varied national approaches to infrastructure planning. National models are driven by their own economic growth, spatial planning or fiscal governance objectives and definitions of infrastructure and coverage of public and private projects varies widely. Although national long term planning processes increasingly recognise the role of infrastructure in supporting a transition to a low carbon economy, few national or regional analyses provide sufficient detail to assess the proportion of low and high carbon spend.

The influential New Climate Economy (NCE) report from the Global Commission on the Economy and Climate, with an economics panel chaired by Lord Stern, is therefore a valuable resource. It focuses on infrastructure spending as a driver of the low carbon transition, providing a unique benchmark and opportunity to develop an international comparison. US\$90 trillion (£58 trillion) will be spent globally in the next 15 years on new roads, railways and airports, energy generation assets, telecoms and equipment for our homes and workplaces. The NCE report's analysis suggests that a less than 5% increase in spending could repurpose this investment as low carbon.¹⁵

The NCE report presents current projected global spend on infrastructure as the 'base case', alongside a low carbon scenario. It is possible to classify the global infrastructure spend set out in these two scenarios into the same low, neutral and high carbon categories used above, which then enables an international comparison.

NEW CLIMATE ECONOMY SCENARIOS BREAKDOWN: I.

Category of infrastructure	Base		Low carbon	
investment in US\$ trillions	Case		scenario	
Low carbon	7.49	8%	64.81	72%
Neutral	57.34	65%	4.72	5%
High carbon	23.78	27%	20.05	23%
Total	88.61	100%	89.58	100%

T

The NCE global base case for infrastructure investment is revealed to have little dedicated low carbon investment, with the majority of spend in areas of neutral or high carbon infrastructure. The low carbon scenario sets out the balance of global infrastructure spend that would ensure that global warming is limited to 2°C. A high proportion of neutral expenditure turns into low carbon expenditure, primarily by delivering the regular investment cycle of home and industry refitting to much higher energy efficiency standards.

The graph on the next page compares the low, neutral and high carbon infrastructure investment in NCE's base case, their low carbon scenario and Scotland's projected investment.

International comparison: NCE scenarios and Scotland's pipeline



While Scotland already has significantly more low carbon investment planned than the global base case, it is still some way off having the level necessary to play its part in limiting global warming to 2°C. It should, therefore, be aiming to increase its low carbon infrastructure spend by at least 20 percentage points, if it is to align with the NCE global low carbon investment scenario and the global 2°C goal that Scotland's targets are geared towards meeting. However, it would be expected that Scotland, as with other developed countries, should achieve an even higher proportion of low carbon investment that is consistent with its climate change goals

While this may sound like an achievable increase, it masks the significant challenge of reorienting policy and investment decisions towards a low carbon future. To some degree, the higher capital costs of low carbon technologies will be offset by lower energy costs due to efficiency savings. But achieving NCE's low carbon scenario requires reductions in fossil fuel investment, as well as smarter, more compact approaches to urban development – in sum decreasing spend on neutral and high carbon projects.

Going further still, it requires that all infrastructure investment has low carbon considerations at its heart, rather than just some infrastructure sectors featuring low carbon projects while the remainder continue to be undertaken on a business as usual basis. Scotland is making progress on low carbon infrastructure in some sectors, but it still has a long way to go before low carbon objectives are central to all its infrastructure decisions. While this report presents a high level breakdown of current infrastructure spend, going forward, the Scottish Government will need to develop a more rigorous analysis to assess progress towards achieving a higher proportion of low carbon infrastructure investment.

BENEFITS OF LOW CARBON INFRASTRUCTURE

Emissions reduction potential is central to making the case for low carbon infrastructure, but this alone is too narrow a frame. A meaningful commitment to low carbon infrastructure should be manifest across all sectors, informing the design of programmes across society and the economy.

This broader view requires an understanding of the economic, social and environment benefits that low carbon infrastructure can offer, as explored in detail below. For example, in addition to the benefits of emissions reduction, low carbon public transport can reduce congestion and fuel costs, stimulate economic performance, improve air quality, reduce road accidents and improve quality of life for residents.¹⁶

Not all of these benefits are specific to low carbon infrastructure. For example, high carbon road building could enable greater connectivity between communities and improved access to the labour market. And low carbon infrastructure will not be without the risk of potentially negative impacts. Tidal power, high speed rail and offshore renewables have all raised environmental impact concerns and the low carbon transition will entail job losses in higher carbon sectors. But the overarching strength of low carbon infrastructure is that it builds in long term resilience to the growing impacts of climate change and avoids unsustainable lock-in to high carbon pathways and their associated economic, environmental and social impacts.

ronmental benefits	Social benefits
ces carbon emissions	Health benefits
oves air quality	Reduces fuel poverty
orts low carbon	Strengthens local
viour change	communities
	ironmental benefits ces carbon emissions oves air quality orts low carbon viour change

3.1 ECONOMIC BENEFITS

Any future low carbon infrastructure projects should deliver against broad measures of economic progress. This aspiration is reflected in the assessment criteria for potential projects set out in chapter 5. Debate about expanding Scotland's measures of economic progress beyond GDP can inform this, as well as the focus on reducing inequality in Scotland's economic strategy.

Economic progress and resilience

The low carbon economy, of which infrastructure is a key part, is not only growing, it has also proved resilient to recession, providing over a third of UK economic growth during 2011-12.¹⁷ From 2010 to 2013, turnover increased by 7.6%, and gross value added (GVA) rose by 8.7%.¹⁸ Total GVA was £26.2 billion in 2013, roughly the same as that of the food and drink sector, and five times larger than aerospace, increasing to £44.9 billion when the supply chain is included.¹⁹

Infrastructure investment has a strong multiplier effect, driving further growth. Standard & Poor's have estimated that each additional pound spent on infrastructure in one year would lift real GDP by £1.90 over a three year period: a multiplier effect of 1.9.²⁰ Low carbon infrastructure investment can offer similar benefits. It promotes economic growth by providing the opportunity to leverage additional rather than displaced investment, and offering the possibility of long term returns to investors.²¹ Government investment in low carbon infrastructure also has the potential to correct market failures preventing development, as explored in chapter 6.

According to the Scottish Government, investing £223 million in port and landside infrastructure to support the offshore wind sector could create an annual economic impact of £295 million per year.²² By 2020, large scale offshore wind development could generate up to £7 billion for the economy, while the renewable heat industry could be turning over a further £2.7 billion.^{23, 24} Digesting all the food waste in Scotland would save £23 million in avoided landfill costs, and generate electricity worth £27 million.²⁵

Job creation and skills development

As the low carbon sector grows, so does the number of people that it employs. Across the UK, more than 11,000 businesses were directly engaged in the sector by 2013, with more than a quarter of a million people employed in low carbon activities and a further 190,000 employed within the supply chain.²⁶

Scotland's low carbon economy is expected to support 60,000 new jobs by 2020,²⁷ with analysis suggesting that every £100 million spent on energy efficiency measures supports approximately 1,300 full time jobs.²⁸ The Scottish Government anticipates that maximum investment in key offshore renewables infrastructure could create more than 28,000 direct jobs and 20,000 indirect jobs by 2020.²⁹ Circular economy activity has the potential to create over 200,000 gross jobs in the UK and reduce unemployment by about 54,000 by 2030.³⁰

These jobs can and must support the creation of new skills bases. For example, improving energy efficiency requires modern construction methods and multi-skilling to retrofit buildings, as well as preserving specialist skills for older and historic buildings.³¹ The transition to increased investment in low carbon infrastructure may also lead to job losses in higher carbon sectors. Strategies for a 'just transition' will be needed to manage this, supporting displaced workers with retraining and efforts to redeploy labour in growing low carbon sectors. The aspiration for future low carbon infrastructure jobs to be decent, secure and paid at least a living wage is reflected in the assessment criteria in chapter 5.

The low carbon economy, of which infrastructure is a key part, is not only growing, it has also proved resilient to recession, providing over a third of UK economic growth during 2011-12.



Support for domestic industry and innovation

Infrastructure is well placed to create demand for domestic industry, because construction necessarily takes place in situ. Many low carbon technologies are still developing, and successful innovation and demonstration in Scotland will boost local businesses. Scotland has the largest offshore renewables resources in the EU and is in a strong position to capitalise on the benefits they can offer the economy.³² For example, the Scottish Government estimates that Scotland could provide a third of the UK's offshore wind supply chain, at a value of £30 billion.³³ It also estimates that demonstration of carbon capture and storage in Scotland over the next decade could create up to 5,000 jobs and be worth £3.5 billion to its economy.³⁴ Infrastructure renewal also offers opportunities for Scottish business. Modelling suggests that between 2010 and 2050 £100 billion of heat infrastructure will be replaced. Much of this will need to be low carbon if relevant targets are to be met, providing a growth opportunity.³⁵

In terms of innovation, the Scottish Government aims to capitalise on its unique advantages in wave and tidal technology, hosting the European Marine Energy Centre to support international research as well as developing domestic expertise. Scotland is already home to the world's largest planned tidal energy project, in the inner Pentland Firth, which could deliver nearly 400MW of renewable electricity.³⁶

Energy security

Low carbon infrastructure reduces reliance on foreign energy imports and, depending on the nature of the infrastructure, can reduce reliance on the grid altogether by enabling communities to become more energy self-sufficient. Analysis by Cambridge Econometrics suggests the value of the estimated coal and gas imports displaced by wind energy in the UK during 2013 was £579.5 million.³⁷ Energy security also improves economic stability. Reduced reliance on imported fossil fuels decreases exposure to energy market fluctuations, which contribute significantly to macroeconomic volatility, particularly in relation to inflation.³⁸

3.2 ENVIRONMENTAL BENEFITS

Carbon emissions reduction

Low carbon infrastructure lowers Scotland's dependence on fossil fuels, reducing emissions compared with higher carbon alternatives. Focusing infrastructure development on low carbon options will ensure progress towards Scotland's targets to reduce greenhouse gas emissions by 80% by 2050 and 42% by 2020. This would demonstrate Scotland's commitment to playing its part in international efforts to tackle climate change, and to the United Nations' stated goal of limiting global temperatures to 2°C above pre-industrial levels.

Improved air quality

Infrastructure that supports lower emission vehicles or reduces the need for fossil fuel power plants will reduce harmful emissions other than carbon, such as sulphur dioxide, nitrogen oxides, and soot.³⁹ For example, in Scotland's business as usual scenarios, transport emissions are projected to increase by 11% between 2013 and 2027.



The Scottish Government estimates Scotland could provide a third of the UK's offshore wind supply chain, at a value of £30billion

Low carbon behaviour change

Low carbon infrastructure can be central to enabling people to behave in low carbon ways. The Scottish Government's approach to influencing behaviour recognises the importance of infrastructure in supporting behaviour change (see section 6.3). For example, a greater density of electric vehicle charging points increases the reliability of electric cars, making them a better choice for consumers. Better recycling provision supports people in changing their waste habits. Low carbon infrastructure can also play an important role in changing norms through its visibility. For example, greater deployment of locally owned energy infrastructure has been found to increase awareness of climate change and improve acceptance of renewable energy.⁴⁰

3.3 SOCIAL BENEFITS

Health benefits

As described above, low carbon infrastructure can improve air quality. This benefits people's health as well as the environment: sulphate and black carbon (soot) are significant risk factors for cardiovascular problems.⁴¹ At the EU level, analysis suggests that 5,000 premature deaths can be avoided by 2030 via action to mitigate climate change compared to a business as usual scenario.⁴²

Infrastructure that encourages people to walk or cycle rather than take the car is likely to reduce the rate of multiple health problems: obesity, chronic diseases caused by physical inactivity, and the effects of air pollution. It should also reduce casualties by improving road safety for pedestrians and cyclists. A study found that, in London, more active travel could reduce heart disease and stroke by 10-20%, reduce breast cancer by 12-13%, dementia by 8%, and depression by 5%.⁴³

Reducing fuel poverty

Fuel poverty is a persistent problem in Scotland, rising to 39% of households in 2013.⁴⁴ Energy efficiency improvements can reduce fuel poverty, by reducing home heating costs. District heating can also offer significant assistance with fuel poverty. A network serving tower blocks in Aberdeen has reduced typical fuel costs by up to 50% for residents, 70% of whom were fuel poor.⁴⁵ Local and community energy generation projects can also contribute to reducing fuel poverty, when benefits are channelled to nearby residents.

Stronger local communities

New infrastructure offers opportunities for community ownership, which can foster closer ties among local residents, as well as bring in revenue which can be invested in local amenities. If Scotland meets its target of 500 MW of electricity in local or community ownership by 2020, this could result in £225 million a year going directly to local communities.⁴⁶





INFRASTRUCTURE SECTORS: LOW CARBON TARGETS AND OPPORTUNITIES

The Scottish Government categorises infrastructure under two headings: economic infrastructure and social infrastructure. This is alongside its extensive suite of policies aimed at tackling climate change and enabling the transition to a low carbon economy, many of which rely on infrastructure for success.

4.1 TARGETS

Below, we go through each of the infrastructure sectors set out in the government's framework (see section 2.3) to explore the low carbon aspects and challenges ahead.

Overall target

TRANSPORT

Almost complete decarbonisation of road transport by 2050

The overall target is supported through targets or goals for 2030 on decarbonisation of road, rail and maritime transport, as well as modal shift to public transport and active travel. Vehicle efficiency has been improving due to European legislation, but the gains have been offset by increased car use and active travel remains static.⁴⁷ The shift to electric vehicles (EVs) is currently the primary focus in the Scottish Government's efforts to decarbonise transport, al-though other technologies will have a role. Behaviour change is critical to successfully achieving the transport targets but investment in this area is not yet commensurate with the scale of change needed.

Scotland's overall targets

ENERGY

12% fall in energy consumption by 2020 Largely decarbonised electricity sector by 2030 Largely decarbonised heat sector by 2050 with significant progress by 2030

The Scottish Government supports these aims through specific targets on renewables, heat, local and community energy and carbon capture and storage (CCS).⁴⁸



RENEWABLES

100% of electricity demand from renewables by 2020 30% of all energy demand from renewables by 2020 50% of electricity from renewables by 2015

Renewable sources provided 49.6% of Scotland's electricity consumption in 2014, which means that the 2015 50% renewable electricity target has nearly been met a year ahead of schedule.⁴⁹ But the pace of deployment will need to more than double if the 2020 target is to be met. And while the pipeline of projects is strong, there is a high degree of uncertainty about whether projects that gain planning consent will actually get built and become operational due to the difficulties of securing finance. In terms of the project pipeline and increasing connection requirements, the pathway to 2050 and beyond is less clear.



HEAT

11% of heat demand from renewable sources by 2020 Largely decarbonised heat sector by 2050 with significant progress by 2030

In 2011 renewable heat only supplied 2.6% of Scotland's non-electrical heat demand.⁵⁰ Current capacity, plus the building of all consented projects (which is unlikely), would still only result in renewable heat providing 9.5% of heat demand by 2020.⁵¹ So the 11% target by 2020 remains challenging. District heating is a key focus for development as well as exploring the potential for geothermal and anaerobic digestion.

Skills and knowledge gaps in local authorities and housing associations will need to be addressed and questions answered about how expanding renewable heat fits into Scotland's existing energy infrastructure, as well as energy efficiency and fuel poverty programmes.



LOCAL AND COMMUNITY ENERGY

500MW of local and community ownership of renewable energy by 2020

Including capacity currently in development, Scotland is set to exceed its 2020 target.⁵² Community and locally owned renewables are well placed to support wider low carbon behaviour change and awareness-raising, and offer benefits beyond clean energy. As a complement to 'big kit' renewables, the government and other organisations have been exploring local energy systems that take an integrated approach to community energy, renewable heat and mobility challenges.

Obtaining grid connections for this increased capacity and overcoming the high capital costs of getting projects underway are barriers to further deployment.



CARBON CAPTURE AND STORAGE (CCS)

Demonstrate CCS at commercial scale by 2020 Full CCS retrofit of conventional power stations by 2025-30

CCS technology features prominently in the Scottish Government's plans, as its application will allow new power stations run on traditional fossil fuels to be built. A project is underway in Peterhead, but the likelihood of CCS operating economically and at scale in the near future remains uncertain due to delays in the UK's CCS deployment programme.⁵³ This leaves Scotland's goal of full CCS retrofit of all conventional power stations by 2030 looking increasingly over-optimistic.

WASTE

By 2025:

Targets

Target

70% of household waste recycled/composted/reused 70% of all waste (including commercial and industrial waste) recycled reducing the proportion of total waste sent to landfill to a maximum of 5% of all waste

By 2050:

Aim to achieve a zero waste Scotland

Scotland's plans to move to a zero waste, circular economy are central to its low carbon ambitions. It is estimated that a more circular Scottish economy could reduce territorial emissions by 11 million tonnes CO2e per year by 2050, compared to a business-as-usual scenario.⁵⁴ There is still a long way to go on the target of sending only 5% of waste to landfill, as this was 40% in 2012. Emissions from the waste sector have fallen by 59% from 1990 levels, largely due to reductions in the volume of waste going to landfill.⁵⁵

In infrastructure terms, valuing waste as an economic resource and reprocessing it to extract value will require new investment in facilities that support reprocessing, more sophisticated material sorting and energy recovery from non-recyclable materials.⁵⁶

WATER

Water infrastructure plans do not have clear low carbon objectives, though the sector is relevant. Water treatment uses a significant amount of energy, with Scottish Water using around 450GW per year. The company is committed to reducing its emissions and, by 2018, should be enabling more energy generation than it consumes.⁵⁷ Tackling leakage is also relevant. Between 2006 and 2010, 400 million litres of water were saved per day, which could save 20,000 tonnes of carbon dioxide per year.⁵⁸ Water infrastructure also plays a key role in managing flood risk and abstraction effectively, and is central to ensuring resilience to climate change.

DIGITAL

The digital strategy and infrastructure pipeline note that greater connectivity will enable the transition to a low carbon society, with reference to people being more able to work at home and travel less. But there are no indications that the carbon implications of such a shift (e.g. increased use of domestic energy by home-workers) have been explored in depth. As Scotland invests in its digital infrastructure, it will be important to embed low carbon objectives.



ENERGY EFFICIENCY - HOUSING



Energy efficiency designated a national infrastructure priority - all buildings to achieve a good energy rating by 2030-2035⁵⁹

Additional ambitions in Scotland's Sustainable Housing Strategy[®]: Make sure that no-one in Scotland has to live in fuel poverty, as far as practicable, by 2016 Deliver a step change in the provision of energy efficient homes to 2030 through retrofit of existing housing and improved building regulations for new build homes

The Scottish Government classes housing as a social infrastructure sector that contributes to economic recovery, growth, the transition to a low carbon economy and the tackling of fuel poverty. The average energy performance of Scotland's housing stock has improved, though residential emissions are not falling at the rate required to meet climate change plans.⁶¹ Fuel poverty, in particular, remains a significant challenge with 39% of households living in fuel poverty in 2013.⁶²

Overall, Scotland's current investment in energy efficiency is expected to provide savings of £2.4 billion on energy bills between 2013 and 2027, compared to business as usual. Beyond 2027, savings are estimated to continue at £289 million a year.⁶³ The recent introduction of a national infrastructure priority for energy efficiency could provide for a greater scale of investment.

4.2 ANALYSIS: THE LOW CARBON INFRASTRUCTURE OPPORTUNITIES AHEAD

Reviewing the Scottish Government's infrastructure sectors reveals strong progress in some low carbon areas, such as renewables, but significant challenges in others. Transport, heat and domestic energy efficiency stand out as examples of the latter, due to the level of ambition compared to progress so far. All of these may be areas for transformative new low carbon infrastructure projects. More fundamentally, this examination highlights some critical weaknesses of Scotland's current approach to infrastructure planning and its ability to support a low carbon transition.

Sectoral approach is limiting

The government takes a sectoral approach to infrastructure. As set out above, low carbon objectives and related infrastructure requirements feature prominently in discussions of energy and transport infrastructure, and domestic energy efficiency features as an aspect of housing infrastructure. There is also a strong connection between low carbon objectives and waste infrastructure. Beyond that, low carbon receives only cursory mentions in reference to water and digital infrastructure and none at all in reference to the social infrastructure sectors of health, schools, culture and heritage, regeneration and justice. This means that current low carbon infrastructure investment tends to back incremental change in limited areas, rather than the scale of progress that is needed. It also fails to take advantage of the potential synergies between projects which could enhance low carbon ambitions.



Liberating low carbon infrastructure

Rather than seeing low carbon as a specific type of infrastructure, a low carbon approach to all infrastructure should be encouraged. Embedding low carbon objectives in infrastructure that supports the delivery of positive health, education, cultural and regeneration outcomes for Scotland is essential to building resilience to climate shocks and harnessing the multiple benefits it can deliver. At the same time, it remains important that the overall investment in projects that are primarily projects that reduce emissions such as public transport. Meaningful progress towards the low carbon investment scenario discussed in section 2.4 will be difficult to achieve if the practical mechanics of infrastructure policy, planning and funding do not encourage this multi-benefit approach.

Alignment with climate change targets

The result should be a national infrastructure plan which aligns with the requirements of the Climate Change (Scotland) Act. The planning process would take a holistic approach as to how best low carbon infrastructure can support positive outcomes across a range of policy objectives, sectors and activities, providing a framework for greater ambition and financial support.

The designation of energy efficiency as a national infrastructure priority could signal a move in this direction. It could provide the context for a single, coherent programme that brings together policies and budgets focused on domestic, business and public sector action. This would put energy efficiency on a firmer footing with longer term security than annual decision making allows, and aggregated support into more ambitious programmes. Economic modelling of an ambitious proposed UK energy efficiency programme found that every £1 invested by the government could deliver a return of £3.20 in GDP, enabling the programme to pay for itself over time.⁶⁴

This example demonstrates that in some cases, a new understanding of the types of infrastructure that need investment is necessary. These include demand side approaches, cross-sectoral projects, and projects that address emerging needs, for example energy storage. These issues are discussed further in section 6.

In summary, there are evident opportunities in existing infrastructure sectors, but Scotland's low carbon transition will need new approaches to planning and investment that reframe and prioritise the projects that will be central to success.



THE CASE FOR LOW CARBON INFRASTRUCTURE IN SCOTLAND

DECIDING ON PRIORITY PROJECTS: ASSESSMENT CRITERIA

Exploring the current levels of low carbon action in Scotland reveals commendable levels of ambition and a mix of impressive progress in some areas, with significant challenges still ahead in others.

Although some support programmes are in place for low carbon objectives, their range, scale, and narrow focus, combined with the sectoral approach to infrastructure planning, leads to incremental change, rather than bold, ambitious progress.

The remaining sections of this report focus on the future of low carbon infrastructure that Scotland needs to develop, and its nature. The criteria below set out the benefits that future infrastructure projects would be expected to deliver. The real world delivery challenges that projects will face are discussed in chapter 6.

Assessment framework

The framework in section 5.1 below is designed to facilitate a relatively simple evaluation, using a traffic light system to compare different projects rather than requiring a detailed quantitative analysis. The overarching intention is for the assessment to help identify projects and approaches that fit with Task Force aspirations for infrastructure that will "enable Scotland's people and businesses to thrive and prosper in a low carbon society for many generations, in line with the requirements of the Climate Change (Scotland) Act".

When evaluating the strengths of a project, a traffic light can be assigned to each criterion, with green denoting a good score, amber for moderate and red for poor. Infrastructure options will have different strengths, which will become apparent when assessing them using this framework and comparing their results. Any assessment would also have to establish baselines for each criterion to ensure that the infrastructure projects under consideration are able to deliver increased benefit. Some of the criteria, particularly those on prosperity, reflect evolving discussions on how best to measure and value economic progress.

The purpose of the criteria is to enable a structured discussion about the desirability of different types of infrastructure projects and to inform decision making when agreeing priority projects. For example, a project might be judged to be desirable, despite scoring red on one or more criteria, if it performs strongly on others. The assessment process will bring these kinds of potential trade-offs to the surface. It will help to structure discussion around which benefits are ultimately valued more than others, and therefore, which projects should be supported. It will also enable the development of a suite of projects that can collectively deliver the desired range of benefits, even if they are not all able to do so individually.

5.1 KEY CRITERIA FOR ASSESSMENT

Criterion	Description	Indicators
Additionality	Adds to existing efforts, rather than replacing them	 New technology Novel application of an existing technology Scaling up and sustainable deployment of an existing infrastructure Suitable for new public sector infrastructure investment and able to leverage significant new private sector investment
Prosperity	Contributes to the prosperity of Scotland's people and businesses	 Contributes to rising median household incomes Creates and develops decent work (taking into account living wage and job quality and security) Provides a positive return on investment in economic and social terms65 Supports upskilling or reskilling
Carbon	Causes net reduction of consumption-based carbon emissions	 Reduces energy demand Moves the country closer to achieving: 80% reduction in greenhouse gas emissions by 2050 A largely decarbonised electricity sector by 2030 Almost complete decarbonisation of road transport by 2050 A largely decarbonised heat sector by 2050 with significant progress by 2030 A zero waste economy by 2050
Co-benefits	Has social benefits, not only economic and environmental benefits	 Infrastructure design maximises co-benefits Improves people's health and well-being Involves education opportunities Fosters community cohesion Enables community benefit from infrastructure investment Potential for international technology transfer
Environment	Furthers environmental goals other than carbon abatement ⁶⁶	 Goes beyond current legal requirements to further environmental quality of land, air and water. Fits within environmental boundaries
Behaviours	Enables low carbon choices for all	 Involves an interface with the public Includes elements beyond the infrastructure itself to support sustainable use Easy to use

6

MAKING IT HAPPEN: EVALUATING DELIVERABILITY

Once a set of desirable low carbon infrastructure projects have been identified using the criteria, it is important to consider them in a real world context. How deliverable are they? And are the factors needed to support their delivery in place or lacking?

The matrix below is a framework for exploring whether the necessary components are in place, and which would need to be created, strengthened or expanded.

	Non-regulatory	Regulatory
Financial	Suitability for public sector	Policy context, e.g.
	investment	Levy control framework
	Ability to leverage private	Capacity market
	finance	Public transport funding
Non-financial	Project brokering/development	Strategic context
	Behaviour change	Planning context
	Public engagement	Regulations
	Trends	



6.1 NON-REGULATORY, FINANCIAL FACTORS

The public sector's role in low carbon infrastructure - investor and enabler

Financing is central to infrastructure delivery. As discussed in section 2.2, the public sector can help to provide this directly, via investment, as well as providing a context that attracts private finance. Both aspects should be considered when evaluating the delivery challenges that face low carbon infrastructure projects.

Public investment is particularly critical in the following areas:

- **Enabling infrastructure:** securing the benefits of low carbon infrastructure will depend on the presence of enabling infrastructure, such as grid capacity and connections, being in place. The public sector is often best placed to fund such infrastructure and this focus is already evident in Scotland's current infrastructure spending plans, which have a focus on interconnection to support renewables growth.
- Emerging infrastructure needs: Issues such as energy storage have a critical role in supporting wider deployment of low carbon infrastructure and public investment is particularly well placed to accelerate the development of such technologies. The cost effectiveness of public investment is highest when it supports technologies that will benefit a wide range of low carbon infrastructure projects and technologies.⁶⁷ This approach also helps governments avoid attempting to pick winners from among different technologies. At the moment, the infrastructure planning process makes it difficult for emerging needs like this to get the necessary recognition, focus and level of funding commitment, despite them being integral to Scotland's infrastructure ambitions as a whole.
 - Innovation: A number of factors work against the private sector investing in low carbon research and development (R&D) at levels that will accelerate progress.⁶⁸ Without intervention, evidence suggests that R&D will remain focused on traditional, higher carbon sectors.⁶⁹ Public investment can act as a vital correction to this, helping low carbon technologies become commercial, competitive investment propositions. To this end, the Global Commission on the Economy and Climate recommends that major economies triple public investment in energy related R&D by the mid-2020s, aiming to allocate 0.1% of GDP or more.⁷⁰
 - Demand side approaches to low carbon infrastructure: Demand side approaches to infrastructure can be harder to package as private sector investment opportunities, especially while they are still gaining traction. This highlights another important opportunity for public sector investment, with energy efficiency being a good example. Reframed as an infrastructure priority, it could be the focus for ambitious, co-ordinated public investment that delivers revenue for the government. Analysis of an ambitious (proposed) UK scheme found that every £1 invested by the government in energy efficiency would deliver a return of £3.20 in GDP and £1.27 in increased tax revenues.⁷¹

Cross-sectoral approaches: Projects often need to work across sectors and be part of a wider policy initiative. This is particularly true for renewable heat. Efforts to deliver district heating need to be fully integrated into urban planning and take a strategic, rather than a project by project, approach. The co-benefits of heat networks should be maximised, for example their ability to alleviate fuel poverty. Approaching Scotland's heat as an infrastructure system in need of co-ordinated planning and funding would support more rapid progress on deployment and the delivery of district heating at scale.

The co-benefits of heat networks should be maximised, for example their ability to alleviate fuel poverty. **Investment to leverage private sector funding:** Public sector money can create confidence in a sector and leverage additional private sector funding. The Scottish Government has a good track record in this area. Its £70 million National Renewables Infrastructure Fund is expected to help deliver an estimated £7.1 billion in value to Scotland's economy.⁷² The £106.5 million Renewable Energy Investment Fund aimed to lever £50-70 million into renewable energy during the financial year 2014-15,⁷³ and the government aims to lever further energy company investment in energy efficiency with its government-funded energy efficiency and fuel poverty programmes.⁷⁴

The above examples of public investment all aim to correct market failures, an activity that comes with risks. Investments require constant review to ensure that they don't become counter-productive. Critically, it is essential to ensure that public investment doesn't end up crowding out private sector investment, which will ultimately fund infrastructure at a far greater scale. Given these risks, experts see the government's major role on infrastructure as the creation of a supportive context to attract private finance. This includes:

Creating policy and regulatory stability: the importance of this cannot be overstated. A government's key role is to provide what the OECD describes as "investment grade policy certainty" which is invaluable in attracting private sector infrastructure investment.⁷⁵ If the public sector is considering a market intervention, its first goal should be to understand why the failure exists. Often, governments find themselves at fault, having failed to provide an enabling policy context.

Strategic infrastructure planning: in addition to the broader policy context, governments should proactively plan and promote infrastructure. The public sector is unique in being able to take a holistic view of infrastructure needs and to align these with policy goals in order to maximise the economic, environmental and social co-benefits of action.⁷⁶ Scotland's pipeline of projects is a useful reference point, but a comprehensive low carbon infrastructure investment strategy would better enable infrastructure planning that can take a cross sectoral approach and maximise the economic, social and environmental benefits of low carbon infrastructure.

Supporting a Green Investment Bank (GIB): the OECD advocates the creation of GIBs to drive low carbon infrastructure, citing the UK version (which covers Scotland) as a strong example.⁷⁷ To date it has invested £1.8 billion of public money in transactions worth £6.9 billion, mobilising £3 of private capital for every public pound.⁷⁸ The GIB focuses on low risk investments in relatively mature technologies, and its portfolio is currently constrained by EU state aid requirements, which limit the type of projects that it can support. But its money and expertise is making a significant contribution to the de-risking of low carbon infrastructure.

The enabling role of the public sector in securing private infrastructure investment remains central. In addition, public investment can be valuable, if not critical, in certain situations. Many of these relate to the opportunities for future low carbon infrastructure identified in chapter 4, such as ambitious energy efficiency, energy storage and a heat system. It will therefore be worth considering the case for public investment in detail when assessing the deliverability of future low carbon infrastructure projects.



Achieving the low carbon transition will not just require additional funding for low carbon infrastructure. It requires a comprehensive shift that embeds low carbon objectives in all infrastructure.

6.2 REGULATORY, FINANCIAL FACTORS

Policy context

As argued above, the policy context is perhaps the major driver of low carbon infrastructure investment and deployment. UK-level efforts to drive low carbon energy infrastructure delivery have focused on revenue support through contracts for difference and fixed tariffs, all paid for by levies on energy companies, rather than public capital investment. Meanwhile, capacity market contracts are intended to encourage investment in new capacity for the electricity grid, but the first auction supported overwhelmingly high rather than low carbon projects. The progress of low carbon transport options is also strongly informed by political decisions on road, rail and airport expansion, as well as decisions at the local level on the funding allocated to current and future public transport schemes.

Acknowledging the importance of the policy context and using it to advantage, as well as seeking to change it where necessary, will be essential when championing new infrastructure.

6.3 NON-REGULATORY, NON-FINANCIAL FACTORS

Project brokering and development

This is an essential aspect of delivering low carbon infrastructure and is currently a gap. Private sector and GIB infrastructure funding requires projects that are relatively low risk and can demonstrate commercial viability. But a lot of low carbon infrastructure lacks support in the transition from demonstration stage to commercial readiness. District heating and energy supply companies (ESCOs) are good examples, where progress is encouraged but local authorities lack the capacity and technical knowledge to develop networks into market-ready propositions. The Heat Network Partnership for Scotland, the Low Carbon Infrastructure Transition Fund and the enterprise agencies play valuable roles in addressing this, and are examples of the early stage public investment discussed above. Ensuring the deliverability of emerging low carbon infrastructure priorities may require similar approaches.

Behaviour change

Low carbon infrastructure should support people in adopting low carbon lifestyles and behaviours, with this intention built into infrastructure design from the start rather than serving as an add-on. Ensuring that this is understood and the necessary support is in place will be important aspects of deliverability. For example, any reframing of energy efficiency as an infrastructure priority will need to include behaviour change objectives from the start. Delivery of Scotland's electric vehicle infrastructure is already underway, but behaviour change is central to its success and has received far less attention to date.

The Scottish Government's Individual, Social and Material (ISM) approach to influencing behaviour change recognises infrastructure's role in enabling behaviour change.⁷⁹ This is a useful foundation from which to make the case for integrating behaviour change into new low carbon infrastructure projects and programmes. But moving from a theoretical foundation to practical action is proving a challenge to the delivery of new projects.

Public engagement

New infrastructure can have a big impact on communities and landscapes, and public engagement is critical to successful delivery. Exclusion from decision making fosters mistrust, whereas meaningful engagement can create buy-in and improve project design by providing insight into the infrastructure people will value and the most appropriate locations for it.

Designing effective mechanisms for public engagement is a key aspect of low carbon infrastructure delivery. Neglecting it will put projects at risk as anything new, ambitious and unfamiliar may face public opposition, however positive its long term benefits.

Trends

Low carbon infrastructure projects will offer greatest benefit when they anticipate and respond to key national trends. Scotland's infrastructure plans aim to respond to and influence transport and digital trends. Population growth, urbanisation and demographic change will also have an impact.

Scotland's population is expected to increase by an average of 10.2% between 2010 and 2035. Cities will grow even more, with Edinburgh and Aberdeen projected to grow by 28% by 2035.⁸⁰ Population growth places increased burdens on infrastructure, with implications for emissions. This context should inform infrastructure design. In particular it strengthens the case for demand reduction approaches, which mean the needs of more people can be met within existing infrastructure capacity.

Urban population growth offers risks and opportunities. If it results in sprawl then high transport emissions, congestion, poor air quality and higher infrastructure investment requirements get locked in, along with social exclusion. Or, the increased demands can be met in low carbon ways, via public transport, renewable district heating networks, and the energy efficiency benefits of denser domestic and business accommodation.⁸¹ Scotland's urban growth should be managed to take advantage of these opportunities.

Scotland's population is also aging. By 2037, the population over the age of 75 will increase by 86%.⁸² The impacts on energy infrastructure vary, as some older people increase their consumption, while others become even more vulnerable to fuel poverty and associated health problems. Low carbon energy infrastructure can help tackle fuel poverty and lessen the carbon impacts of increased consumption. And regardless of income, older people share an increased vulnerability to climate shocks such as hotter summers, colder winters and extreme weather events. A low carbon approach to meeting Scotland's infrastructure needs will build in resilience to such events and help to insulate an aging population against the social, environmental and economic impacts of climate change.

Low carbon infrastructure will offer greatest benefits when it anticipates and responds to key national trends



to the delivery of low

carbon infrastructure

6.4 REGULATORY, NON-FINANCIAL FACTORS

Strategic context

Strategic commitments are important assets when it comes to delivering low carbon infrastructure. Even where actions may be lacking, they serve as indications of political commitment to the endeavour and provide a valuable hook when making the case for new low carbon infrastructure.

Scotland's economic strategy centres around two key objectives: increasing competitiveness and tackling inequality. But it acknowledges the importance of infrastructure investment and the role it can play in supporting the transition to a low carbon economy. Low carbon also features prominently in the detail of Scotland's infrastructure investment plan. Projects are considered against four criteria, one of which is "managing the transition to a low carbon economy".⁸³

Planning context

A supportive planning context is essential to the delivery of low carbon infrastructure. Top line Scottish planning policy features low carbon objectives prominently, setting out a vision for a Scotland that is: a successful, sustainable place, a low carbon place, a natural, resilient place and a connected place.⁸⁴

But reality can be very different. Administrative capacity in local authorities and the ability of planning officers to engage with newer ideas and technologies is a significant challenge. New approaches to heat and energy efficiency, as well as consideration of new issues like energy storage, would help to maximise the opportunities of low carbon infrastructure. The planning system will have a role to play in supporting this, but it will be a challenge to reflect and act on these opportunities in an already complex planning system that is slow to change. It will also be difficult to deal with unfamiliar infrastructure proposals, regardless of the supportive language at a strategic level, so the impacts on deliverability should not be underestimated.

Regulations

Regulations have the potential to foster or even require low carbon investment, such as minimum standards of energy performance in existing housing and non-domestic properties, building regulations, and congestion charging. Procurement regulations can also be used to promote low carbon purchases – for example electric vehicle fleets.

At the same time, some environmental regulations may have impacts on some technologies, such as offshore renewables or the developing wave and tidal technologies, which will need to be taken into account. In terms of the wider regulatory context, any new infrastructure project will need to take account of all of the Scottish, UK and European regulations that is subject to. A full assessment of this will highlight any potential risks to delivery. In summary, any new low carbon infrastructure should aim to go beyond current regulatory requirements on, for example, environmental protection or air quality.



Scotland is in a good position to seize the opportunity now to increase investment in low carbon infrastructure, gaining the benefits in terms of climate change, but also economic progress and social welfare for years to come.

CONCLUSION

Scotland is in a good position to seize the opportunity now to increase investment in low carbon infrastructure, gaining the benefits in terms of climate change, but also economic progress and social welfare for years to come.

Failing to do so will lock in high emissions and vulnerability to the multiple impacts of climate change, leaving a legacy of buildings, roads, energy generation and more which will be expensive to adapt in the future.

The Scottish Government is well aware of the challenge in addressing climate change and has a comprehensive suite of low carbon targets in place. However, in several areas Scotland is not on track to achieve its low carbon ambitions, and future progress is hindered by current infrastructure.

The key findings of this report are:



Scotland compares relatively well in a global assessment of low carbon infrastructure investment, but it is still some way off having the level estimated as necessary to do its part in limiting global warming to 2°C. To achieve the global low carbon investment scenario, it needs to increase its low carbon infrastructure as a proportion of infrastructure spend by at least 20%. This is a global figure, and it would be expected that Scotland, as with other developed countries, should achieve a higher proportion of low carbon investment that is consistent with its climate change goals. In essence this means a reorientation of all policy and investment decisions towards a low carbon future and decreasing spend on neutral and high carbon projects.

This report identifies the multiple benefits of low carbon infrastructure. Emissions reduction potential is central to making the case for low carbon infrastructure, but it also will 'lock-in' positive health, education, cultural and regeneration outcomes for Scotland, as well as building resilience to climate shocks.



Achieving the low carbon transition will not just require additional funding for low carbon infrastructure. It requires a comprehen sive shift that embeds low carbon objectives in all infrastructure.85 Scotland's current sectoral approach prevents low carbon infrastructure challenges such as energy efficiency and renewable heat from getting the attention and coordinated focus that they require. It also hinders efforts to address emerging issues such as energy storage, and to realise the value of demand-side solutions to infrastructure needs.



The role of the public sector as an investor and enabler is critical to making this shift. Public investment is still seen as essential to fund and stimulate low carbon infrastructure opportunities. There are many areas to accelerate progress such as assisting technologies to become investment ready and exploring low carbon opportunities in social sectors such as health, regeneration, and schools. Overall there is a strong case for greater public investment in low carbon infrastructure, alongside the government's central role in creating a supportive policy context that attracts investment.

The work of the Low Carbon Infrastructure Task Force provides a timely opportunity to reflect on new approaches to achieving low carbon infrastructure in Scotland. This report sets out the ideal characteristics of any future projects and explores the real world factors that affect delivery, and how the public sector can help overcome current barriers to development.



about the outcomes it enables and Scotland has a valuable opportunity to secure positive economic, environmental and social benefits by ambitiously rethinking its approach to low carbon infrastructure.

ENDNOTES

- 1 Global Commission on the Economy and Climate, 2014, New Climate Economy Technical Note: Infrastructure investment needs of a low-carbon scenario
- 2 D Zenghelis, 2012, A strategy for restoring confidence and economic growth through green investment and innovation, London
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