

BIS | Department for Business
Innovation & Skills

**STRENGTHENING UK SUPPLY
CHAINS: PUBLIC PROCUREMENT**

Tunnelling: A Capability Analysis

APRIL 2012



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Introduction

The Vision

Working in partnership with industry, we will grow and sustain UK capabilities in sectors which are influenced by public sector procurement. In doing so we will increase the opportunity for UK based firms to win public sector contracts.

Public Procurement: Setting The Scene

1. The UK public sector spends around £238bn each year on the procurement of goods, works, and services, which accounts, as a share of total spending, for around a third of overall public sector expenditure¹.
2. The way in which the public sector conducts its procurements and engages with the supply base can have a significant impact on economic growth and firms' investment decisions. Although public sector demand is only around 15% of total UK demand, in certain sectors it accounts for a large proportion or majority of demand (e.g. defence, health, transport). Furthermore, even in sectors where the public sector is not necessarily the primary customer, it can still have a significant impact on the activities and behaviours of firms.
3. Impacts can occur in a number of different ways. For example, procurement decisions and processes can positively or negatively influence the degree of competition in a sector, which in turn has important implications for value for money. Public sector procurement can also support innovation, by being a lead customer or by creating new markets, for example driving environmentally-friendly construction techniques², or the development of low carbon vehicles by procuring them for public sector fleets³. In doing so public procurement can influence firms' future investment decisions in equipment, jobs and training.
4. To put the importance of public sector procurement in context further, the total value of UK exports stands at around £230bn, which is around the same magnitude as UK public sector procurement.
5. We naturally therefore have an interest in understanding how public sector procurement affects UK-based supply chains, and whether there is more that could be done to improve the opportunity for UK based firms to bid for public sector contracts. At the same time, we are conscious of the various policy tensions and

¹ Gross Procurement as a share of Total Managed Expenditure (TME), source Public Expenditure Statistical Analyses (PESA).

² NESTA Policy Briefing, 'Driving innovation through public procurement' (February 2007).

³ BIS Economics Paper No 1. Towards a Low Carbon Economy.

trade offs between delivering multiple government objectives and the achievement of value for money in public procurement.

6. We believe strong UK based supply chains are important not only for UK competitiveness but also to maintain the UK's reputation as an open and attractive place to do business. We recognise that Government may have an important role to play in helping to remove barriers to growth, for example where there are skills shortages, underinvestment in innovation, a lack of competition, or problems with access to finance. For many sectors, this is about delivering stable macroeconomic conditions and a business environment which supports growth and enterprise. There may also be areas where more targeted action to address market failures could be taken to strengthen the UK supply base.
7. Improving the public sector's understanding of supply chains will also enable it to have better strategic dialogue with industry over the long term - being clear about the outcomes needed and whether the market can deliver them.
8. In November, we announced a package of measures to support business and promote growth through the way that the public sector does business⁴. This work follows on from that announcement and our desire to develop a more strategic relationship with our supply chain, identifying capability gaps that need to be addressed.

“.....identifying capability gaps in the supply chain that need to be addressed to meet future demand and taking action to remove barriers to growth”

Autumn Statement 2011

9. Our intention is that this will help secure the best value for the taxpayer, and also ensure that the UK has strong supply chains able to compete effectively for public sector contracts, as well as act as a beacon for foreign investment.

Action We Are Taking

10. This April, we are publishing details on future potential public sector demand in a range of sectors. These build on the procurement pipelines that we published in November 2011 for the construction and infrastructure sectors.
11. These forward plans will provide transparency of future public sector demand, giving industry a clearer picture of what the future market developments will be, enabling them to plan investments accordingly.
12. Our ambition is to go a step further and, using this information, to work with industry to evaluate the strengths and weaknesses of UK-based supply chains and

⁴ http://cdn.hm-treasury.gov.uk/autumn_statement.pdf

understand how well equipped they are in their own right to compete for these future contracts. We want to understand the skills, technologies, materials and other capabilities that are needed to meet our projected future demand.

13. This will help us ensure smooth delivery of what we want to procure, and ultimately increase value for the taxpayer, but also understand where there are opportunities for the UK-based supply chain within that. Based on this analysis, we will work with industry to identify appropriate actions to strengthen UK based supply chains. Partnership between the public sector and industry will be vital looking forward.
14. We will also look across sectors to highlight common gaps and opportunities, as this can help us understand where action should be taken to address barriers to growth.
15. In practice this may mean that the public sector will change the way it procures. For example, standardising aspects of procurement across projects to realise cost savings, procuring less bespoke solutions which our suppliers find easier to export, or smoothing demand in order to avoid 'famine or feast' cycles.
16. In practice this may mean that the public sector changes what it procures or when it procures. For example, standardising aspects of procurement to realise cost savings, procuring products which our suppliers find easier to export, or smoothing demand in order to avoid cycles of 'feast or famine'.
17. It could mean aligning other areas of government policy with procurement strategy, for example, updating our skills policy to ensure our workforce is properly equipped to meet future demand.
18. This document focuses on the capabilities required in tunnelling, within the wider context of construction and infrastructure, to illustrate some of the actions we are able to take to strengthen the UK supply base in sectors which are influenced by public sector procurement.

What Does This Mean For Business And The Public Sector

19. The tunnelling sub-sector illustrates some of the potential benefits of taking a coordinated approach and analysing pipeline requirements. It has improved our understanding of where there are capability gaps and capacity issues within supply chains, as well as identified opportunities that businesses could take advantage of.
 - **Training opportunities for apprentices and existing workers:** Greater visibility of pipelines has provided a view of aggregate demand. This has helped identify capacity issues in tunnelling. New tunnelling projects could support new apprentices in underground construction to build the skills base.
 - **Manufacturing:** Manufacturing opportunities may be developed on key components such as tunnel segments.

- Managing a better **flow of demand** between projects to ensure that the investment in skills and capability is not lost through a 'famine and feast' pipeline.
- Capitalising on **increased opportunities to export tunnelling skills as a consequence of greater** urbanisation in the developing world.
- Opportunities for making savings as a consequence of **economies of scale** which may accrue on purchasing of key components of tunnelling plant and equipment.

Tunnelling: A Capability Analysis

Introduction

1. Tunnelling has been identified by industry and Government, through the Infrastructure Cost Review, as a key area to address to ensure that a number of the significant infrastructure projects which were outlined in the National Infrastructure Plan 2011⁵ are delivered.
2. This section firstly reviews tunnelling as a sub-sector of construction, to understand the wider supply chain issues therein. It then examines the capability of the supply chain to meet future demand, identifies capability gaps, proposes actions to address them, and explores potential benefits for UK firms.

The Construction Supply Chain

3. According to the Office for National Statistics (ONS), the value of construction output in 2011 was around £122 billion.
4. This comprises of three main sub-sectors:
 - Commercial, industrial and social (£55 billion, of which £19 billion is public).
 - Residential, including repair and maintenance (£44 billion, of which £12 billion is public).
 - Infrastructure, including repair and maintenance (£23 billion). The value of new infrastructure in 2011 was £15 billion, of which £5 billion was public.
5. The construction supply chain encompasses an extremely wide range of activities, from quarrying through to civil engineering and associated professional services. It is a highly fragmented industry with supply chains dominated by small firms, with very little vertical integration. This, together with the inherently project based nature of the market, has profound implications for the way construction supply chains operate. Sub-contracting is used extensively, which in turn has consequences for the composition of the workforce. Unreliable rates of profitability have repercussions on the supply chain's approach to investing in areas such as training and innovation⁶.
6. Looking at the construction supply chain holistically (rather than considering specific markets e.g. tunnelling), recent studies⁷ highlight a number of key barriers to growth

⁵ http://www.hm-treasury.gov.uk/national_infrastructure_plan2011.htm

⁶ Construction Matters, House of Commons Business and Enterprise Committee, 2008

⁷ Review of Education Capital, Department for Education, 2011

The Plan for Growth, HM Treasury and the Department for Business Innovation and Skills, 2011

Never Waste a Good Crisis, Constructing Excellence, 2010

Infrastructure Cost Review, HM Treasury, 2010 [formatting issue, this should be on the previous page yes?]

and efficient operation. There is broad consensus across the industry that construction supply chains underperform in terms of their capacity to deliver value, and that there has been a lack of investment in construction efficiency and growth opportunities.

7. The principal barriers to growth are a lack of visibility and confidence around the forward pipeline and the lack of integration in supply chains. This has been exacerbated by poor and inconsistent public procurement practices, compounded by a lack of standardisation and repetition in the product production (e.g. fragmented and unpredictable demand) and by relative protection from overseas competition. The Specialist Engineering Alliance concluded⁸ that delivery processes that are fragmented, hierarchical and adversarial stand in the way of progress. More integrated and collaborative approaches are required where specialists with the requisite knowledge are brought in at the early stages of a project.
8. The Report, 'Never Waste a Good Crisis'⁹ identified five themes for future action which are fundamental to the development of supply chain capabilities and the creation of new market opportunities. We built on this in the Plan for Growth (March 2011), and identified three key themes which government and industry should take forward together:
 - Maximising the opportunities for the sector and for the UK from the shift to a low carbon economy, building on the Low Carbon Construction Innovation and Growth Team Report and the work of the Green Construction Board.
 - Ensuring public procurement drives growth in the sector, building on the Government Construction Strategy.
 - Building on the UK's global reputation for excellence in engineering and architecture to develop low carbon business opportunities overseas.
9. We are addressing these capability issues in construction supply chains in three ways:
 - *The Government Construction Strategy*¹⁰. This is led by a Board of key public sector construction clients and is chaired by Paul Morrell, the Government's Chief Construction Adviser. It will ensure that the public sector will become a better client for the industry – more informed and better co-ordinated when its requirements are specified, designed and procured.
 - *The Green Construction Board*. This is co-chaired by the Minister of State for Business and Enterprise and Dan Labbad, Chief Executive of Lend Lease EMEA. This Board looks specifically at new opportunities for growth across the public and private sectors arising from the shift to "greener" construction and in making sure that the policy landscape supports those opportunities.

⁸ Sustainable Buildings Need Integrated Teams, Specialist Engineering Alliance, 2009

⁹ Never Waste a Good Crisis, Constructing Excellence, 2010

¹⁰ Government Construction Strategy, Cabinet Office, 2011

- *The Infrastructure Cost Review*. This looks at how to reduce the costs of delivery of economic infrastructure being delivered by public, private and regulated clients. The first annual progress report was published on 23 April¹¹.
10. At the heart of these three streams of work is the consideration of the skills, technologies and materials needed, and how these could be met by developing UK capability.
 11. The Infrastructure Cost Review has used the increased visibility provided by the construction and infrastructure pipelines to identify tunnelling as a capability gap. As mentioned, this gap may impact on the ability of supply chains to deliver key infrastructure projects.

Tunnelling: A Gap Identified

12. The National Infrastructure Plan (NIP) 2011¹² sets out a vision for each sector of economic infrastructure, supported by an investment pipeline of major projects and programmes. NIP 2011 identified 40 priority projects and programmes crucial for growth. As a consequence of this commitment, there is potential for growth in the tunnelling sector in the future.
13. Following publication of the infrastructure investment pipeline alongside NIP 2011, industry and government have begun to develop understanding of both the requirements of the projects and programmes in the pipeline and the current capability and capacity within the delivery supply chain. From these discussions and the analysis of the pipeline, it has been recognised that there are a number of priority projects that contain significant elements of tunnelling. These include:
 - **High Speed 2** (Tunnel Boring Machine (TBM) drives).
 - **Crossrail** (TBM drives, plus sprayed concrete linings).
 - **Thames Tideway Tunnel** (TBM drives).
 - **Northern Line Extension** to Battersea (TBM drives).
 - **London Underground capital programme** (containing significant amounts of sprayed concrete linings on projects such as Tottenham Court Road and Bank Station).
 - **National Grid cable tunnels** (as part of the electricity and gas transmission and distribution investment programme).
 - **New nuclear programme** (for example, EDF's Hinkley Point C projects requires TBM drives for new tunnels for cooling water intake and outflow).

¹¹ http://www.hm-treasury.gov.uk/iuk_cost_review_index.htm

¹² http://www.hm-treasury.gov.uk/national_infrastructure_plan2011.htm

14. These seven projects and programmes are spread over six different contracting authorities, a mixture of public, private and regulated clients and sit under the policy lead of three departments (DECC, DEFRA and DfT). In addition to the projects identified in NIP 2011, there are a number of other strategically important tunnelling projects planned in the UK, including the Geological Disposal Facility for the UK's high and intermediate level nuclear waste.
15. Crossrail, High Speed 2, Thames Water, National Grid, London Underground and EDF have discussed with us the broad tunnelling requirements of their projects. Furthermore, we have explored with the Institution of Civil Engineers, Civil Engineering Contractors Association, Construction Products Association, Association for Consulting and Engineering, Construction Skills and the British Tunnelling Society the current capability and capacity for tunnelling in the UK.
16. Industry has welcomed the proactive co-ordinated approach to building competence in the supply chains, but is sensitive to the risks of investing in employing and training a new tunnelling workforce ahead of any contract award. There is, however, an opportunity here for industry to invest in UK supply chain capability and ensure that it is best placed to take advantage of future contracts. A purely reactive approach could potentially lead to pinch points in capacity which may not be addressed and threaten effective project delivery.

Capacity and Requirement

17. The pipeline of tunnelling projects contains those currently under construction (e.g. Crossrail) and others with construction some years away (e.g. High Speed 2). Each project has differing skills requirements, timescales and resource levels and combines different tunnelling techniques and underground construction activities.
18. These projects will provide significant employment during construction - for example, Crossrail is anticipated to employ around 14,000 people at peak and Thames Tideway around 4,000. This will include roles in design, engineering and project management as well as traditional construction activities. Of the 18,000 jobs required for these two projects for construction, resources required for direct tunnelling and underground work will rise to a peak of around 4,000 per annum by 2015/16 across the priority projects and programmes. It is anticipated that there will be an overall tunnelling resource requirement of over 14,500 man years on these projects over the next five years.
19. To illustrate a resource profile for major tunnelling project, figure 1 below indicates the *labour only* project resource profile for Crossrail which includes the tunnelling and underground construction trades, and indicates a peak labour resource of just under 3000.

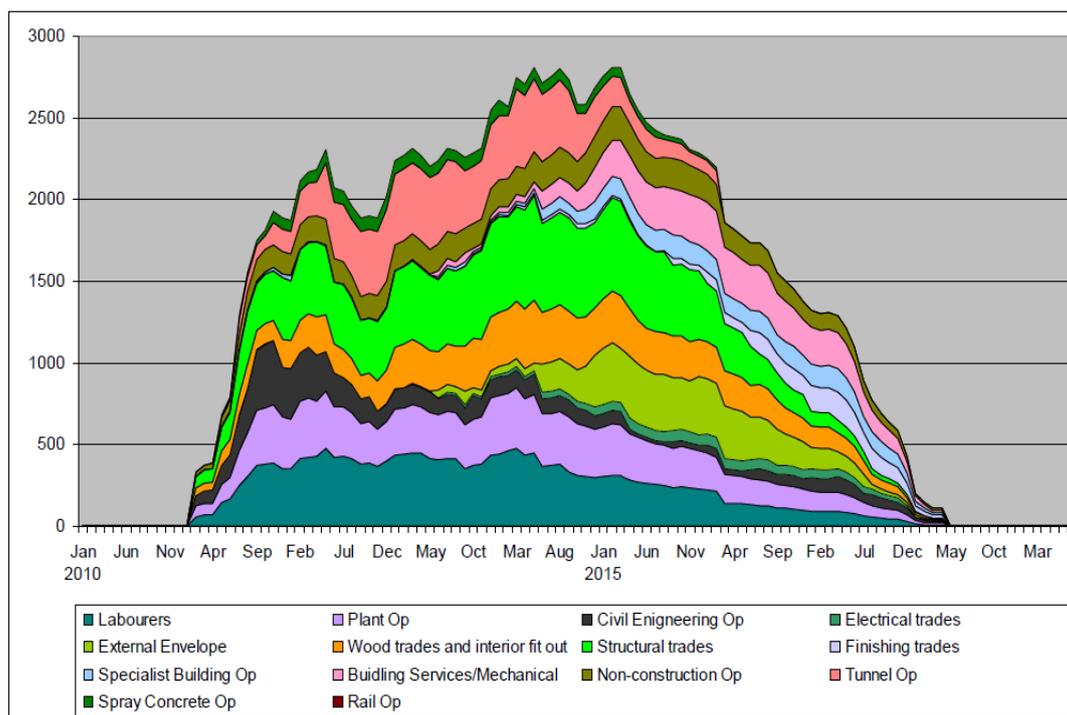


Figure 1: Labour only project resource profile for Crossrail

20. Estimates of current capacity from the British Tunnelling Society (BTS) indicate that future demand from these projects will outstrip current supply by around 2015/16. Therefore, there is a requirement to invest in developing a newly skilled labour force to meet the demand, particularly to address shortages and skills gaps of young people and new entrants to the industry.
21. However, the historic lack of visibility and certainty of a forward pipeline of tunnelling projects has led to fragmentation of the industry as a lack of continuity of work has limited industry's confidence to invest in training new workers ahead of contracts being placed. Whilst the industry has been able to solve capacity shortfalls reactively, this carries an increased risk of inflationary pressures and potential delays.
22. This increase in the scale of tunnelling projects in the UK coincides with increasing worldwide demand, as megacities expand and require metro systems and underground infrastructure to support their development. BTS's own analysis of the global market shows increasing worldwide demand for skills in tunnelling and underground construction. This increasing global demand will reduce opportunities for UK projects to address capability gaps cost effectively by importing worldwide tunnelling expertise. If we (industry and Public Sector) can take action to increase tunnelling capacity and improve capability in the UK, we will be able to meet our own future demand and improve opportunities for UK based companies to export this capability into overseas markets.

Current Capability

23. Whilst the UK tunnelling industry currently has access to sufficient skills and resources from UK and international suppliers to meet current demand, the requirements identified in the forward pipeline mean that investment in building capability is necessary to ensure that future projects can be delivered to time and budget.
24. The UK is well placed to achieve this by capitalising on existing strengths. The UK has world-renowned engineering skills in tunnel design and many of our major consultants are already achieving success in international markets.
25. The UK is also already a world leader in specialist technology and research of underground construction, and our universities, including Birmingham and Cambridge, have established preeminent positions in specialist technologies associated with tunnelling.
26. For example, the University of Cambridge has been at the forefront of the development of world leading technologies to monitor the performance of both underground structures, such as tunnels, basements, piles and retaining walls, and above ground structures, such as bridges, using smart sensor technologies including fibre optics, micro-electromechanical sensors (MEMS) and wireless sensor networks. This research has already resulted in deployments in tunnels in the London Underground and also Prague, Madrid and Barcelona metro systems. This technology enables infrastructure owners to monitor the behaviour of structures during construction and operation as well as providing the opportunity to validate existing design assumptions, offering the opportunity for substantial savings by providing the data on which more refined models can be developed.
27. In addition, a £17m Government – industry investment, through the Engineering and Physical Sciences Research Council (EPSRC)/Technology Strategy Board (TSB) Innovation & Knowledge Centre (IKC) in Smart Infrastructure and Construction, supports the UK in its ambition to maintain its world-leading position in this field, delivering high value technology solutions to projects in the UK and worldwide. Global businesses such as Arup, GE Aviation and IBM are involved in the IKC; this is enabling a transfer and sharing of knowledge about research on sensor and data management, coupled with emerging best practice in the form of the latest manufacturing and supply chain management approaches applied to construction and infrastructure. It aims to develop completely new markets and achieve breakthroughs in performance.

Potential Benefits Of A Co-ordinated Approach

28. Government and industry have started the analysis of the pipeline requirements across infrastructure and construction projects. In doing so we have identified a number of key benefits of taking a joined up approach:

- **Training opportunities for apprentices and existing workers:** The work done to produce forward pipelines has provided a view of aggregate demand. This has helped identify capacity issues in tunnelling. New tunnelling projects could support new apprentices in underground construction to build capacity and the skills base to meet the pipeline needs.
- **Manufacturing:** There may be opportunities to manufacture key components such as tunnel segments. Whilst pre-cast segment manufacturing is often sited locally to the project (to minimise transport costs and carbon), standard or demountable components could be developed that would open up opportunities for sustainable local manufacturing opportunities. As a longer term ambition, a strong forward order book may encourage investment in capability for manufacture of TBMs (currently expertise is centred in Germany, Canada and the Far East). In the UK alone there are currently around 20 TBMs working or about to commence work and a similar number on Sprayed Concrete Lining (SCL) faces. Whilst this represents an increase over the past five years, the industry has been characterised by significant volatility from stop-start investment. A more medium term ambition may be to develop the capability to manufacture key elements of the plant and equipment that supports tunnelling. For example, Clayton Equipment Ltd, based in Burton, Staffordshire recently won a contract to deliver 14 mining locomotives for the National Grid's London Power Tunnels project. A key deciding factor was the ability of Clayton to offer a bespoke manufacturing and design capability to enable a match with the project's detailed requirements.
- **Exports:** Greater urbanisation in the developing world is likely to drive up demand for tunnelling skills to support transport, waste and utility requirements. This will potentially create export opportunities for UK-based firms. By investing in increasing tunnelling capacity and improving capability in the UK, UK based firms are likely to be in a position to export skills, products and solutions. Similarly, research into leading edge technology, such as underground mapping and real time data from tunnelling, will enhance the value proposition for UK based firms seeking international projects.
- **Demand management:** There may be opportunities to achieve a better flow of demand between projects to ensure that the investment in skills and capability is not lost through a famine and feast pipeline. Furthermore, a greater understanding of the capabilities within the supply chain will help clients ensure that any risk sums held in contingency for potential capability gaps are evidence based and appropriate.
- **Economies of scale:** Economies of scale may accrue on purchasing of key components if consideration is given to re-use and standardisation of elements

of the tunnelling plant and equipment. Whilst many of the specific 'face' components are likely to be bespoke for each project (linked to tunnel diameter and the specific ground conditions), much of the ancillary plant and equipment could be standardised and therefore used across projects if due consideration is given to the flow of projects. Similar savings can be achieved by spares being made available across projects. It is only through strategic consideration across a portfolio of tunnel projects for different clients that such opportunities may be developed.

Actions

29. Industry has set out a clear statement of the issues to meeting forward procurement pipelines. Working in partnership, industry and Government will take action to address these.

Skills

30. **Issue:** Industry expects that, to help bridge the shortfall in capacity for the major tunnelling projects it needs some 450 new apprentices over the next 5 years (90 per annum), and additional skills training for 500 existing underground construction workers.
31. **Actions:** A summit between the industry and Government in Spring 2012 to explore options for training apprentices and existing workers through the new Tunnelling and Underground Construction Academy (TUCA) in East London
32. **Issue:** To build capacity in the numbers of graduate tunnelling engineers in cooperation with the industry, the University of Warwick have started this academic year, a new Masters course in Tunnelling and Underground Space. This course has been established in cooperation with the British Tunnelling Society (BTS). This is an MSc is unique to the UK and one of few dedicated to tunnelling in Europe, and has strong industrial support of teaching. However, the cost of an MSc can be a deterrent for UK students, meaning that many MSc students are from overseas and return the their home country on completion of their course.
33. Sponsorship offers UK students both a cost-neutral option and the security of employment upon completion. An increase in sponsored places will encourage more UK students to consider further study and careers in tunnelling. There is already significant industrial support in sponsoring students (typically £15k per student to cover fees and maintenance). The first year intake is 11 students (8 full time, 3 part time), with students sponsored by industry, with a capacity and plan to increase to 25 students each year.
34. **Action:** Continued industry sponsorship of higher level degree courses will increase the skills and competitiveness of UK firms to compete in domestic and international markets.

Innovation in Manufacturing

35. **Issue:** There are four “deep” stations on the Crossrail project – Whitechapel, Liverpool Street, Tottenham Court Road and Bond Street. Whilst the size and surface layout of these stations differs, the platform interface is the same. Currently, the detailed design and construction of each of these stations is out for tender or awarded and is possible that four different contractors may be appointed for the four stations. The project delivery programme requires these stations to be constructed at different times (linked to the progress of the associated tunnel drives), which can limit the ability to drive innovative standardised solutions. Through Imperial College, Crossrail wish to investigate opportunities to find standardised manufactured units for the station platforms that are made off-site and can be installed at lower cost and to higher safety and quality standards. The economics of such an approach are unlikely to be feasible on a single station project, but combining the approach across the four deep stations may offer a cost saving, and act as a test case to prove the benefits of a standardised, manufactured solution for complex underground construction.
36. **Action:** Building on from Crossrail’s partnership with Imperial College to develop innovative solutions to standardise manufactured units for station platforms, Government and industry will examine what further support is needed to develop this type of manufacturing capability in the UK.

Technology

37. **Opportunity:** We have already stated that we are world leading in developing specialist technology and research of infrastructure and underground construction. This is an opportunity we are leveraging globally. Building on the investment we have made we announced in the Budget 2012 that we will establish a Future Cities Catapult in 2013 which will enable businesses to develop innovative solutions to infrastructure and construction problems of developing cities for the future.
38. **Action:** The market opportunity for integrated city systems is estimated to be worth £200bn a year by 2030. A key action that Government is focused on is how the capability developed in the UK can be exported.

Summary

39. This is the beginning of a dialogue between the public sector and industry about ensuring Britain’s supply base has the skills and capacity to meet the challenges of the future.
40. By publishing a forward procurement pipeline and adopting a strategic approach to procurement, we can help UK businesses – whether in tunnelling or elsewhere - become more competitive.
41. It is vital that the public sector and industry work in partnership on this long-term programme to grow and sustain UK capabilities that are influenced by public sector procurement.

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