



# TEES VALLEY PROCESS INDUSTRY (TVPI) HIGH LEVEL ANALYSIS

## REPORT TO STAKEHOLDERS

Report compiled by TVPI Project Team  
on behalf of the TVPI Steering Group

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**MPI** Materials  
Processing  
Institute



**Tees Valley**  
*Unlimited*





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## EXECUTIVE SUMMARY

The global petrochemicals and petroleum derivatives market has changed markedly since 2009 and is still in a state of constant evolution. The impact that this has had on the investment conditions in the Tees Valley region must be recognised if UK plc is seriously committed to attracting foreign direct investment (FDI) in the future.

In order to compile an accurate description of TVPI commencing in Q4 2015 a survey questionnaire was developed and circulated to all the major chemical, material and allied value chain operators in the Tees Valley. The key objectives of this high level analysis were an attempt to identify existing synergies that might help future investment opportunities for the Tees Valley and also examine potential cost saving opportunities for existing operations. A total of 46 companies responded to the survey which included all of the major operating companies.

Review of the high level study, its responses and analysis has generated a series of findings. Over 160 potential opportunities were identified ranging from small-scale, resource sharing projects or requests for contact details to potential suppliers/customers, through to major investment prospects that have the potential to generate widespread growth through an extended supply chain.

The short term opportunities that exist can be categorised under industrial symbiosis, waste value enhancement, asset, product, service maximisation, supply and consumption of surplus heat/steam, purchasing/operational/safety/environmental excellence and Infrastructure. Some of these identified opportunities can be progressed by TVPI members collaborating together.

In the medium to longer term, opportunities include unconventional gas as a feedstock for low carbon process industry and manufacturing growth, quantifying the opportunity presented by exploitation of significant local raw material and mineral resources, developing a Hydrogen economy and the Teesside Collective industrial carbon capture, storage and utilisation project. These identified opportunities will require external assistance in order to be developed.

This report summarises the findings of the analysis and presents the “Asks of the UK Government” and how local and national agencies can help to support TVPI in the short, medium and long term in its aim of building a dynamic future for Teesside.

## 1.0 PROJECT INTRODUCTION

TVPI, incorporating chemicals and allied process and materials operators, comprises 58% of the UK Chemicals industry [source: CIA, TVU]. The region provides £12Bn GVA to the UK Economy, of which 14% is in the manufacturing sector against a UK average of 10%.

The North East region is one of only two in the United Kingdom that generates a trade surplus which is over £4Bn per annum [source: TVU]. Workforce productivity is very high in a world where that of our competitors (e.g. US) is falling. In addition, the region is recognised as a centre of excellence for innovation, as well as being home to numerous high quality technical services providers.

Maintaining and building on this strong economic position should be seen as vital to the success of a number of strategic UK Government initiatives, most notably "The Northern Powerhouse" and "The UK Chemistry Growth Partnership".

Project partners NEPIC (North East Process Industry Cluster), MPI (Materials Processing Institute) and TVU (Tees Valley Unlimited) are looking to identify ways to re-invigorate the chemicals, materials and allied process industries in the Tees Valley over the short, medium and longer term. In order to achieve this strategic goal, they have combined their resources to undertake a high level analysis of TVPI's assets in the chemicals, allied process and materials industries.

Project governance has been delivered by an industrial steering group incorporating members from across a number of TVPI manufacturing areas including; Wilton, Billingham, North Tees, Seal Sands and Teesport.

Jacobs Consultancy has been commissioned by the project partners to provide insight into the investment conditions in different geographies throughout the globe and also to provide experience of the configuration of different process industry clusters including the leverage that these clusters have through their approach to attracting investment.

## 2.0 PROJECT OBJECTIVES

The objectives were categorised into opportunities that have the potential to have an impact on the economy of the region and beyond in the short, medium and longer term.

In the short term:

- Identify opportunities for existing operations to improve their competitiveness.
- Identify opportunities for industrial symbiosis including gaps in the current TVPI value chain.
- Identify the tools and mechanisms that are deployed by Tees Valley major competitors such as Antwerp and Port of Rotterdam.

Looking to the medium and longer term:

- Identify future investment opportunities for TVPI where conditions are favourable based on the existing sector capabilities.
- Gain an understanding of global market and technology trends in order to identify major investments that would act as enablers facilitating large scale growth in TVPI.

## 3.0 THE DATA

To compile an accurate description of TVPI from Q4 2015, a survey questionnaire was developed by the project partners in conjunction with the project steering group and then circulated to all the major chemical, material and allied value chain operators in the Tees Valley. A total of 46 companies responded to the survey with all of the major operating companies contributing.

Within the questionnaire, contributors were asked to provide a summary of their Tees Valley assets in the context of their overall business. Appreciating the potential for individual company sensitivity and confidentiality, the request was made to provide process flow diagrams, a list of key raw materials, utilities, products, process intermediates, bi-products and any wastes generated from the process. Furthermore, each contributor was asked to provide their own thoughts, opinions and examples of opportunities and barriers that they believe existed for them in the medium term (5 years) both within their own operational field/sector and also beyond in the wider regional arena.

Face-to-face meetings were held with as many of the contributors as possible and a comprehensive set of site reports were generated as a result.

The information provided via the survey process was of a very high standard and has enabled a comprehensive definition of TVPI to be developed as well as a robust list of recommendations to be drawn up. Contributors frequently went beyond the initial simple request to provide a thorough description of their operations and the consumption and production levels of their Tees Valley facilities.

The success of the data acquisition phase clearly demonstrated that throughout TVPI there exists a consistent desire to develop opportunities for collaboration that could lead to greater competitiveness and sustainable economic growth within the region and beyond. This demonstrates clear alignment between the strategic aim of the project and TVPI.

Once acquired the survey outputs were reviewed to develop a holistic understanding of TVPI. Data analysis then focussed on identifying the short, medium and longer term opportunities that could be developed. These include the potential for symbiotic relationships through shared infrastructure, asset maximisation, waste value enhancement and in the longer term, identifying raw materials and process industry feedstocks that have the potential to improve global competitiveness and reinforce security of supply options for multiple sectors. The data was also interrogated with the aim of identifying common barriers to growth that TVPI companies faced.

A broader aspect of the data review was to compare TVPI with some counterpart clusters in Europe, notably Antwerp and the Port of Rotterdam with the aim of identifying positive aspects that the Tees Valley has over competitors and aspects of other clusters that TVPI could learn from in order to help attract further investment.

## 4.0 GLOBAL PERSPECTIVE

The global petrochemicals and petroleum derivatives market has changed markedly since 2009 and is still in a state of constant evolution. The impact that this has had on the investment conditions in the Tees Valley region must be recognised if UK plc is seriously committed to attracting foreign direct investment in the future.

Evidence of this dramatic shift in global investment conditions is most obviously represented by the current economic resurgence in the United States. Abundant natural gas derived from shale has transformed the United States' chemical industry from the world's high-cost producer five years ago to among the lowest-cost producers today [source: American Chemical Council]. The US now enjoys a decisive competitive feedstock advantage for the production of basic petrochemicals, the building blocks for multiple value chain manufacturing processes. Companies from around the world are investing in new U.S. production capacity, leading to industry revival and new jobs.

Natural gas liquids are key to the cost advantage that is being enjoyed in the US. Ethane, a natural gas liquid derived from shale gas is used as a feedstock for producing ethylene which goes into a huge array of manufacturing products. Competitively priced natural gas and ethane are enabling chemical companies to build new plants, expand, or improve their facilities in the United States.

A recently published report by the American Chemistry Council (ACC) identified 264 completed, in progress or announced chemical industry projects as of April 2016; the majority involve foreign investors. Combined, these projects account for \$164 billion in new capital investment and an estimated additional 426,000 direct and indirect jobs created by 2023.

Of significant note is the fact that the ACC report acknowledged that the US will only fully realise the huge potential for growth that exists in this sector by aligning Government policy priorities to the investment opportunities. This is significant as this point has repeatedly been made by TVPI - it is having a critical role in achieving growth in the region.

While the US has witnessed massive expansion in chemical industry investment, the same cannot be said for other regions at this time. The Middle East no longer holds the competitive feedstock advantage when compared to the US. When this is added to the regional instability, investors tend to shift to alternatives.

Growth in the EU, Canada and China has stagnated reflecting global supply and demand pressures with the UK being widely acknowledged as one of the only major global economies to deliver sustained growth albeit at relatively low rate.

### 4.1 European competition

An aspect of this high level analysis was to establish the approach that is applied by other Western European chemical and process sector clusters, and identify advantages that TVPI may have over some of its competitors. Lessons that TVPI can learn from, in particular Antwerp in Belgium and Port of Rotterdam in the Netherlands were also investigated.

The Port of Rotterdam is an impressive hub for supply and logistics associated with refinery and fossil fuels, bio feedstocks, food, grains and minerals. Antwerp is a manufacturing hub for downstream development, such as car components, plastics moulders and consumer goods. The site is home to approximately 20 of the major process and chemistry sector multinationals. However, TVPI has as many, if not more

favourable factors that support the development of a successful process industry cluster.

Feedstock is currently fed directly to the Tees Valley from the North Sea oil and gas pipelines, while the two EU clusters import feedstocks from deep sea sources. The opportunity in the medium to longer term for unconventional gas and mineral resources to be accessed locally should be recognised and exploited. Industrial Carbon Capture Utilisation/Storage potential has been proven possible through the Teesside Collective project, thus providing the potential for a low carbon route to manufacturing and production.

Downstream market resource as defined by the UK Government as The Northern Powerhouse, provides access to a similar hinterland of downstream manufacturing opportunities and end users. TVPI has access to port facilities that are on a par with Antwerp and even Rotterdam.

Academic and innovation capability such as CPI (Centre For Process Innovation), MPI, Durham and Teesside Universities are available to provide research and development support which can match the professional investment assistance services offered by Antwerp and Rotterdam.

## 5.0 FINDINGS

Review of the high level study, its responses and analysis as described previously has generated a series of findings. Over 160 potential opportunities were identified ranging from small-scale, resource sharing projects or requests for contact details to potential suppliers/customers, through to major investment prospects that have the potential to generate widespread jobs and economic growth through an extended supply chain.

These findings have been collated into short, medium and long term prospects in line with the objectives of the study.

### 5.1 Short term opportunities exist under the following categories:

For the purposes of this report, short term opportunities are those that have the potential to bring about improvements in competitiveness and cost savings for existing operators without the need for major capital investment.

#### 5.1.1 Industrial Symbiosis

Defined as: *an association between two or more industrial facilities or companies in which the wastes or bi-products of one become the raw materials for another*

A number of companies who took part expressed a desire to collaborate/exchange information with a view to maximising value from waste streams/bi-products. One example of this, is a company that produces pyrolysis oil from waste plastic streams. A number of operators have the potential to supply the feedstock to this process.

#### 5.1.2 Waste Value Enhancement

This category includes local TVPI companies capable of supporting initiatives that can reduce costs, improve sustainability by dealing with problematic product streams. TVPI includes specialist providers of bespoke solvent recovery and extraction solutions that could be applied directly to increase yield and reduce disposal costs for other operators.

#### 5.1.3 Asset, Product, Service Maximisation

This field includes individual opportunities to share and promote assets (such as pipelines), products and services. Land availability across the existing Tees Valley Chemical Parks is one obvious example however more subtle examples also exist. Closure of facilities on the Wilton International site has left individual operators with redundant capacity in effluent infrastructure that could be shared with other operators to mutual benefit with considerable sustainability enhancement.

#### 5.1.4 Supply and Consumption of Surplus Heat/Steam

Numerous companies demonstrated a desire to be involved in projects relating to the supply of so-called waste or low grade heat. A study, funded by TVU in their capacity as Local Enterprise Partnership, to develop conceptual models for low grade heat networks both north and south of the River Tees is currently ongoing to which the TVPI findings will be shared.

#### 5.1.5 Purchasing / Operational / Safety / Environmental Excellence

A wide range of sectors and services are represented within TVPI. Factors that influence performance will vary from site to site leading to individual manufacturers holding expertise in fields where others have limited knowledge. The sharing of best practice has recently been exemplified

through the BASME initiative managed by NEPIC and further initiatives that increase the knowledge capacity of operators will lead to improved competitiveness.

### 5.1.6 Infrastructure

Maximising the use of existing assets has been discussed earlier however a further area that was frequently identified by contributors was the need for infrastructure bottlenecks to be alleviated. Some rail and road networks in the Tees Valley are near capacity and would benefit from investment. Improved infrastructure for new technology initiatives such as hydrogen networks is also an area that has the potential to benefit multiple operators.

### 5.1.7 Delivering in the short term

In order to realise the opportunities that have been identified through this high level analysis and bring the savings and increased competitiveness to TVPI in the immediate and short term, a further delivery roadmap must be established. Unlike larger opportunities that will be discussed later, the short term projects are not reliant on obtaining direct funding. The support that is needed to progress these opportunities is in the development of resources that facilitates sharing of information through marketing, company brokerage, laboratory testing and concept and front end engineering support.

TVPI has demonstrated throughout this study, a desire to work collaboratively to realise the opportunities. The only gap in the process is a defined entity with responsibility and resources to facilitate the opportunities that exist.

## 5.2 Medium term opportunities

Medium term opportunities are defined as those that have a synergistic link to existing TVPI assets and/or production streams and which could give the TVPI a sustained competitive advantage over other international sites. Such opportunities would still need significant study prior to initiating an implementation campaign; however international investors are known to be looking at these opportunities and value chains due to decarbonisation and employment benefits.

This list is not intended to be definitive however taking a high level view of TVPI and applying a global investment perspective the following opportunities warrant further investigation. The list is presented alphabetically.

Opportunity	Downstream Benefit Potential	Constraint / Mitigation / Action
Acrylic Acid and Acrylates production	Acrylic Acid to Esters for Paints and Coatings Acrylic Acid to Super adsorbent polymer for consumer, plant media medical and (emerging) industrial good	Proprietary technologies from Asia but derivatives markets mentioned have good growth. Needs low cost propylene as feedstock
Acrylonitrile (AN) from PDH or Naphtha	Acrylonitrile to AN Butadiene Styrene Copolymer / Styrene AN Acrylonitrile to Poly AN to Carbon Fibre. Lightweight high strength materials for use in cars, trucks, bridges, aerospace, sports and medical equipment	Unfashionable but derivatives markets mentioned have good growth. Needs propylene as feedstock
Ammonium carbonate and bicarbonate	Local ammonia plus local waste CO <sub>2</sub> . There are customer blending opportunities	Investor required

Opportunity	Downstream Benefit Potential	Constraint / Mitigation / Action
Animal feed production	Related to previous example. There are existing and potential resources within TVPI, e.g. minerals and bio-based	Mostly small size but high value trace materials plus some general bio-waste beneficiation
Cellulosic ethanol (CE), Bio-based materials and Sugars e.g. Citral and Dibasic Acids	Historically sugar based chemistry for ethanol but CE is more attractive for making green ethylene. Niche demand exists today and will grow Sugars can provide specialities and many intermediates e.g. FDCA as a PTA replacement	Major long term technical issues remain. Some progress from Scandinavian and Italian innovators.
Chloralkali e.g. NaOH + Cl <sub>2</sub> + H <sub>2</sub> (pure) KOH + Cl <sub>2</sub> + H <sub>2</sub>	An enabler for Chlorine derivatives e.g. TiO <sub>2</sub> and other minerals; shale via HCl; esterification of biomaterial. Chlorinated isocyanurates option. Possibly target KOH rather than NaOH	Sustainability and safety enhanced by avoiding Chlorine shipment for water treatment - Trans Pennines KCl in TVPI
Coal chemistry	Pitch feedstock is basis to make advanced specialty high value materials to be converted locally e.g. Pitch carbon fibre, specialist phenols. Large global speciality materials company has wider for plans Coal to Ethanol for refinery mandate.	Intellectual Property (IP) innovation and ownership Affordable power is an enabler. Optimisation studies required
Ethylene specialities <ul style="list-style-type: none"> <li>EO derivatives</li> <li>Linear Alpha Olefins</li> <li>Alpha MMA</li> </ul>	Provides basis for revival of fine chemical using EO as a building block. Several ethylene LAO technologies available. MMA via ethylene - many downstream markets	Commit to ethylene cracker expansion. Active lobby programme
Fertiliser - Blending and Exports	Expand on the Mineral base with cheap local power to build unique cost competitive business	Real advantages over Rotterdam & Antwerp need to be publicised
Mineral Beneficiation	As with fertiliser, real local resources mean this is a strategic opportunity.	Build on existing project which are largely based on non-UK firms. Needs UK Plc approach
Post-consumer waste beneficiation	Numerous TVPI chemistries based in Innovation Parks and local know-how for fillers for rubbers and plastics	Intellectual Property (IP) innovation and ownership Affordable power is an enabler. Optimisation studies required
Poly-tunnel and Algal Pool Uses for CO <sub>2</sub>	Land availability, CO <sub>2</sub> (and H <sub>2</sub> ) plus waste heat to make highly effective plant growth media.	Studies ongoing Intellectual Property (IP) innovation and ownership Build on sugar to biochemical knowhow.

Opportunity	Downstream Benefit Potential	Constraint / Mitigation / Action
Special salts e.g. MgCl <sub>2</sub> to Mg metal from Seawater	Historically magnesium and aluminium production was within TVPI (Alcan in Lynemouth) but no longer, predominantly due to high power costs. Lithium and magnesium are used in the production of light-weighting in cars, plus aerospace and interruptible power.	Power resources are required for long term solutions. Derivatives markets mentioned have good growth.
Surface chemistry	EU Framework Programme (F8) based innovation e.g. graphene and PVD (Physical Vapour Deposition) and CVD (Chemical Vapour Deposition) services	Lack of entrepreneurial spirit in University portion of F8 participants
Waste Stream Recovery from Industry – Multiple Options	There are existing immediate opportunities from the survey and potential new concepts, e.g. Scandium and other rare earth elements from TiO <sub>2</sub> and fuel ash mining	Mostly small size but early returns. Plus with innovation funding some high value metals and some general plastics valorisation prospects

### 5.3 Long term opportunities

Long term opportunities are those that will require investment in new technologies, proof of concept or pilot scale testing, or facilities and infrastructure that will lead to a sustained process and manufacturing industry in the Tees Valley region and beyond.

#### 5.3.1 Unconventional Gas as a feedstock for low carbon process industry and manufacturing growth

Access to local feedstock and affordable energy are the biggest differentiators in establishing a sustainable process, chemical and manufacturing sector. This is most obviously represented by the growth in US chemical sector described in section 4. The potential exists for TVPI to exploit similar feedstock advantages as those witnessed in the USA - however more work is needed to quantify the opportunity. The ultimate aim of attracting FDI that would add significant value to the UK and the Tees Valley economy is possible, however more evidence is needed to support the claim.

British Coal Board and British Geological Survey Data show that there are 10 Trillion Tonnes of coal under the UK section of the North Sea (note 1 tonne Coal = 5.5 Barrels of oil). Furthermore there are now several modern extraction techniques that do not require traditional mining to access this huge carbon and energy resource. Modern techniques for extraction, used around the world today, also allow the carbon dioxide released in using the gas produced to be returned to the rock structures from which it is extracted; turning this into a low carbon opportunity matching climate change objectives.

The latest technologies include underground coal bed gasification, enhanced methane and ethane recovery from underground coal and enzymatic conversion of coal to alkanes. Accessing these reserves depending on which technologies are used will convert the coal to alkanes (mixtures of methane and ethane etc.) or syngas, all of which are used extensively in the process industries, and are currently used as feedstock for a number of TVPI companies. These materials are also important in the production of electricity.

Current North Sea licenses give access to approximately 25 billion tonnes. It is estimated that current UK demand (Tees Valley, Humberside, Grangemouth and Runcorn) for accessing this coal, in terms of syngas is 70 million tonnes per year (70 million tonnes syngas = 70 million tonnes coal). From this it is clear that the mineral resource is huge and with the appropriate technology application it could fuel the whole of the UK industrial and domestic energy and raw material demand for thousands (1000's) of years. As well as the benefits of industrial feedstock, the output of the processes has the potential to displace the huge volumes of gas that the UK currently imports.

Conceptual development in this area has reached a point where pilot facilities testing technologies are urgently needed to clarify uncertainties relating to the UK geology, the quality and composition of gas produced and also to firm up on the costs of extraction. In addition the necessary supply pipelines and factory conversions to use the new materials needs to be engineered and estimated.

This opportunity when linked to industrial carbon capture and storage (ICCS) has the potential to revolutionise UK industry as all other industrial sectors lie downstream of the chemical processing sector. There can be no question that there is industrial demand for syngas.

#### 5.3.2 **Quantify the opportunity presented by exploitation of significant local raw material and mineral resources**

The Tees Valley has another raw material advantage over Antwerp and Rotterdam in the form of minerals that are mined and processed locally and then shipped worldwide where they are used in the agriculture and process industries. A project that is currently in the final stages of obtaining development consent will expand the scale of operations in this sector in the Tees Valley. This project could be viewed as a cluster development opportunity rather than purely commodity export project. Complementary processes and logistics infrastructure combined with land availability all combine to suggest that the building blocks are all in place for TVPI to maximise the potential for this sector.

Downstream opportunities exist in the value chain of both the agribusiness sector and also other inorganic materials sectors however the full potential is still to be quantified.

Competitor clusters such as Antwerp and the Port of Rotterdam provide technical and advisory resources to target and support inward investment, a concept that could be mirrored here in the Tees Valley.

#### 5.3.3 **Hydrogen economy**

The concept of a Hydrogen economy is often considered critical to achieving decarbonisation of the UK energy sector. TVPI is home to the UK's largest producer of Hydrogen whilst pipeline facilities are in place to supply the gas to users at different locations in the area.

Demonstration projects are needed to confirm the concept and to clarify integration (and export of technology) potential with other low carbon energy systems including wind and solar.

#### 5.3.4 **Teesside Collective Industrial Carbon Capture, Storage and Utilisation**

Teesside Collective [www.teessidecollective.co.uk](http://www.teessidecollective.co.uk) is a pioneering infrastructure project offering a compelling opportunity to progress the UK's industrial and environmental interest's hand-in-hand. Publishing a technically viable, end-to-

end blueprint for a shared Industrial Carbon Capture and Storage (CCS) network in July 2015, Teesside Collective set out the economic and environmental benefits the project could bring to Tees Valley and the wider UK.

Integration of the Teesside Collective findings into the other initiatives proposed in this report is a way towards achieving a low carbon industrial future in the UK.

## 6.0 BARRIERS TO DEPLOYMENT

The final list of findings presented, is the barriers to growth that TVPI contributors identified through the survey.

### 6.1 Policy leadership

This was identified as an issue at many different levels. Lack of clarity surrounding policy instruments such as renewable fuel targets has had a direct impact on operators while the more general energy policy of Government has created a situation where the levels of uncertainty are currently too high to attract investors. Other examples where a lack of leadership and direction has led to investment stagnation include:

Energy Pricing	Continually identified as one of the most important factors in attracting investment.
Carbon reduction taxation and policy	Growth is far more likely to be achieved by incentivising the drive towards a low carbon economy through industry transition support rather than the standard approach of providing more support to innovation
HSE regulations	Increasing pressure to business particularly in relation to more stringent emission standards.
Northern Powerhouse	Concept generally popular however there is a lack in understanding of what the specific role of this initiative is. Potential to improve Infrastructure and transport links through the Northern Powerhouse. Remove rail bottlenecks, expand A19 capacity including the Tees crossing.

Policy and subsequent legislation is most appropriate when key stakeholders are able to contribute. TVPI requires assistance towards brokerage of issues with Government and Government Departments.

### 6.2 Decisions made offshore

Since the break-up of ICI, the vast majority of ownership in TVPI has transferred overseas leaving the UK as a home to many small-scale operations that form part of much larger multinational organisations. Key business and investment decisions are made offshore and are decided on global economic issues rather than UK centric factors. This is also highlighted within the UK Steel Industry citing SSI corporate decision to exit the UK in 2015 and now Tata Steel in 2016 announcing their intention to sell off its remaining UK assets.

Government involvement could correct this deficiency by leveraging the UK's influence with multinationals on tax and incentives.

### 6.3 Legislation and regulation

TVPI operators are well aware of the need to minimise environmental impact that results from their operations. However tighter emission standards that are being driven by Europe (in the interests of non UK investors) are adding a further barrier to investment in what is already a highly competitive and difficult trading arena.

### 6.4 Transport links

As previously referenced, there are common and recurring issues relating to the region's accessibility for logistics. These focus on road and rail infrastructure that are seen as hindering growth.

## 7.0 RECOMMENDATIONS

A significant development relating to the UK devolution agenda occurred whilst this high level analysis was being undertaken. Former deputy Prime Minister, Lord Heseltine, was appointed chair of a Government committee tasked with regeneration of Northern Industrial areas including Tees Valley through the creation of a Mayoral Development Corporation. As part of this review, a series of work streams were developed setting a vision and supporting the Strategic Economic Plan for the Tees Valley.

The findings and recommendations of this TVPI high level analysis have been fed directly into the Tees Valley Innovation Submission in support of the Tees Valley Vision (strategic economic plan). The recommendations based on the findings presented in this report are as follows:

### 7.1 Creation of a resourced entity with responsibility for Marketing and Development of the Tees Valley Process Industry

Based on the model used in Antwerp and the Port of Rotterdam, such a body would be given the responsibility to raise the global awareness of TVPI, both supporting existing companies to grow and attracting new investors world-wide to the region. Funding a resource should be constantly made available so that TVPI opportunities can be consistently marketed to the relevant parties.

Representation of TVPI should be made at all major process industry exhibitions and conferences as is the case for competing clusters. The body with responsibility for delivery should also be in a place to provide technical resource to respond to all enquiries received and maintain contact with potential investors. E.g. at Antwerp the City claims that it supports companies has a high level of credibility - <http://www.ondernemenantwerpen.be/en>

Estimated Funding Requirement	£500,000 per annum
Potential value to UK economy	In 2013, the chemicals industry in Antwerp provided an estimated gross added value of 8.1 billion euros to the Belgian economy <a href="http://www.investinlanders.be/en/Sector/Chemicals/chapter/Facts-and-Figures">http://www.investinlanders.be/en/Sector/Chemicals/chapter/Facts-and-Figures</a>

### 7.2 Fund Scoping and Business Plan Prospectus for medium and long term opportunities identified

Funding should be made available for front-end engineering, scoping and or concept studies and development of a Business Plan and prospectus for each medium and long term opportunity that have been identified within this report. As well as the potential opportunities listed in section 5.2 These include Unconventional Gas as a feedstock for low carbon process industry and manufacturing growth, quantifying the opportunity presented by exploitation of significant local raw material and mineral resources, developing a Hydrogen economy and exploiting work already undertaken on Teesside Collective Industrial Carbon Capture Storage and Utilisation.

Market each opportunity through existing bodies with knowledge and network such as NEPIC, and provide support through the UKTI Account Management Approach to attracting investment.

Estimated Funding Requirement	£500,000 initial project
Potential value to UK economy	Estimated at 100 times the initial scoping and/or concept study outlay. <a href="https://dspace.lboro.ac.uk/dspace-jspui/bitstream/2134/11165/1/Thesis-1997-Petley.pdf">https://dspace.lboro.ac.uk/dspace-jspui/bitstream/2134/11165/1/Thesis-1997-Petley.pdf</a> (p31).

### 7.3 Fund Raw Materials, Feedstock and Minerals Studies Pilot facilities

Funding of detailed studies into the feedstock and raw materials opportunities identified in the study is necessary to quantify the full potential for these opportunities in the medium and long term.

Pilot facilities are necessary to prove a number of conceptual opportunities that have the potential to expand the TVPI manufacturing supply chain. These include:

- Enhanced Oil Recovery
- Underground Coal Bed Gasification
- Enhanced Methane and Ethane recovery from Underground Coal
- Shale Gas
- Enzymatic Conversion of Coal
- Algae Manufactured Fuels
- Polycarbonate fluids and plastics
- New minerals

In addition to the concept development and pilot testing that is necessary, funding should also be directed towards the development of business propositions using the data that is accrued from the original steps.

Following the UK Government decision to cease support for power sector CCS, better understanding is needed to link Carbon Dioxide Capture, Utilisation and Storage to the opportunities listed for upstream and downstream manufacturing potential.

Estimated Funding Requirement	£50M including <i>ca</i> £1M for initial concept and pre-FEED phases of study followed by support for pilot in the event of positive conclusions
Potential value to UK economy	£2Bn of Foreign Direct Investment

### 7.4 Incentivise Symbiotic materials and energy opportunities identified

The majority of companies who contributed to the high level analysis do not have local developmental laboratory resource. Following identification of over 160 opportunities, resources are required to broker each opportunity to the companies concerned and to facilitate sharing of information through marketing, laboratory testing and concept and front end engineering support. TVPI companies expressed a keenness to take these opportunities forward therefore support should be limited to cover small development projects (where needed) at local universities or through Centres of Excellence (COE's).

Estimated Funding Requirement	£500,000 to cover facilitation, brokerage and any resultant lab work or engineering study
Potential value to UK economy	£10's of millions generated via improved competitiveness, reinforcing of market position, downstream services supply

### 7.5 Support to direct industry toward policy makers

Government policies must be consistent and stable in order to maintain and drive business growth and investment into TVPI and UK. Estimated funding requirements are unknown but support through policy is essential if the recommendations provided in this report are to succeed.

## 8.0 CONCLUSIONS

The report authors are extremely grateful to all contributors who freely gave of their time and expertise in order to describe their processes in detail and in so doing, aided the project partners in their key objectives of attempting to identify future investment opportunities for the Tees Valley and also examine cost saving opportunities for existing operations.

Whilst there is no guarantee of further work occurring, it is hoped that through the findings of this report and its recommendations, positive steps can be taken in order to realise the key objectives of this Tees Valley Process Industry High Level Analysis.