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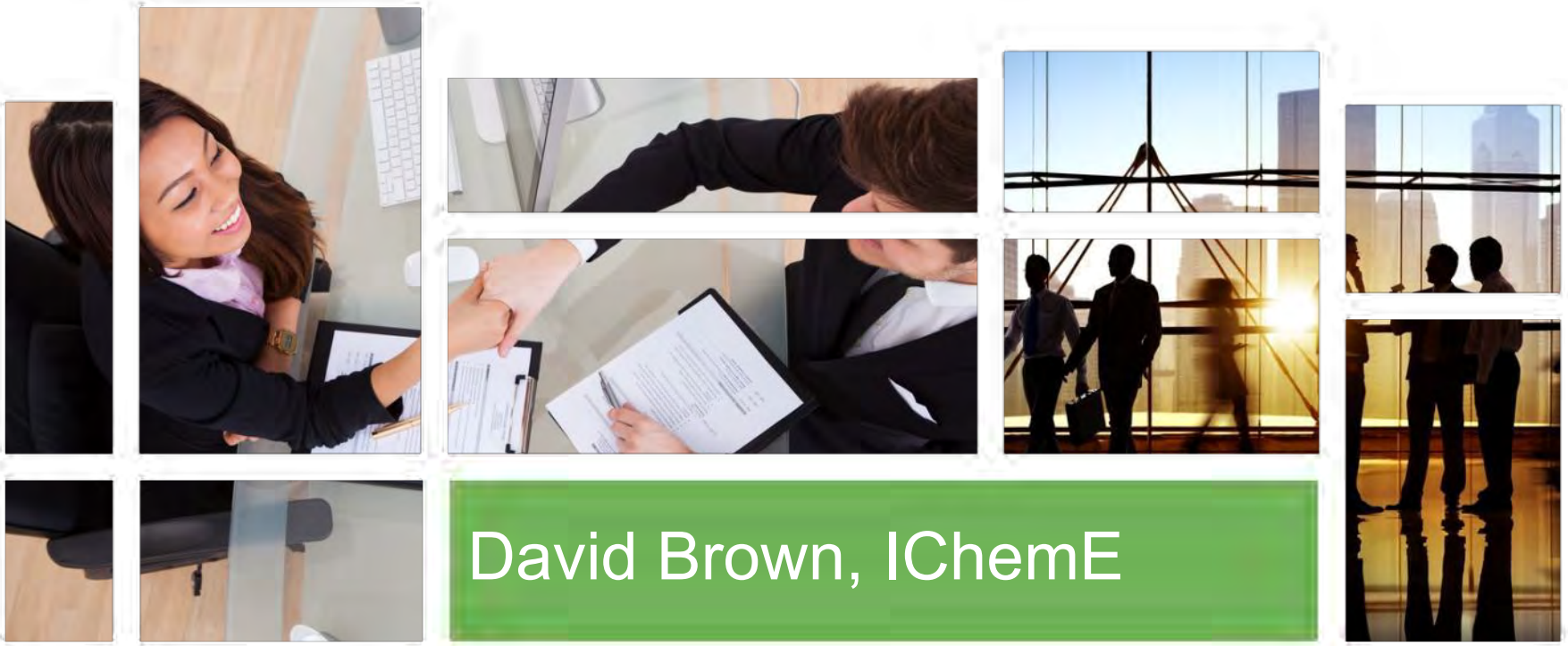
CONFERENCE SESSION TWO

IChemE ADVANCING CHEMICAL ENGINEERING WORLDWIDE

Raising our game

Skills and innovation in the process industries



David Brown, IChemE

UK chemicals and pharmaceuticals

- 158,000 direct jobs
- 500,000 indirect jobs
- 30,000 employed in related R&D
- £12.5 billion p.a. to the UK economy
- £60m a day to the balance of payments
- £24.7 billion chemicals exports
- £20.7 billion pharmaceuticals exports

Source: Chemical Industries Association

Making the case for the process industries

- **Aerospace**
- **Automotive**
- Chemicals….

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Nicola Blackwood to Sajid Javid, 13 May 2016

"Addressing key concerns of the science and innovation community, the Government response should include a refreshed industrial strategy approach for all key research intensive sectors, mirroring the enhanced strategy approach that has been followed for the aerospace and automotive sectors. ……. The Government could put a condition on the sectors that might seek such an enhanced strategy approach that they commit to providing similarly significant investment in research, including in their sectors' supply chains."

Chemistry Growth Partnership

Priorities

- Securing competitive energy and feedstocks
- Rebuilding UK chemistry supply chains
- Accelerating innovation
- Skills
- Climate change solutions

Innovate to survive

Sources; Tata, CSIRO

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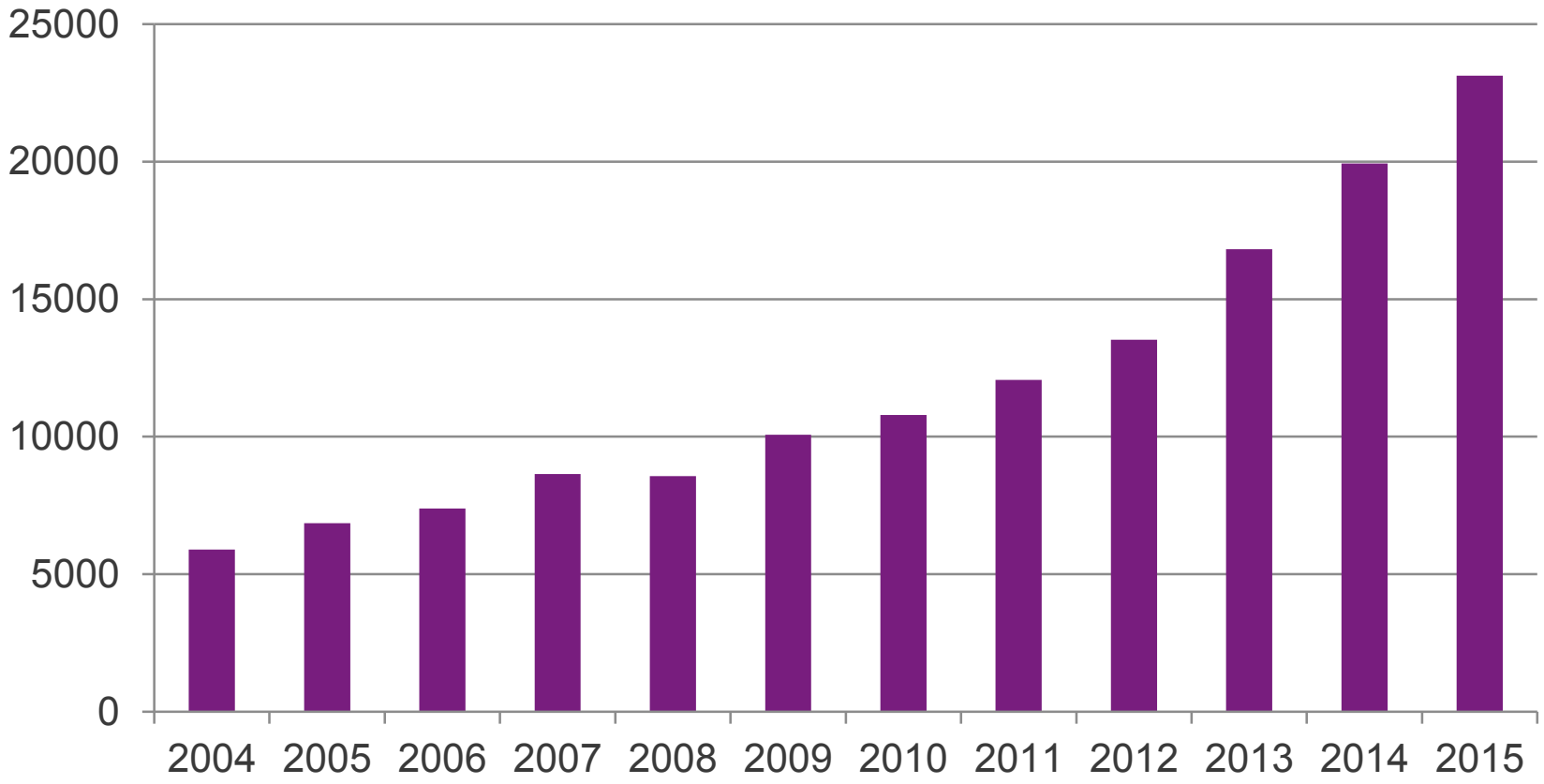
University applications for chemical engineering



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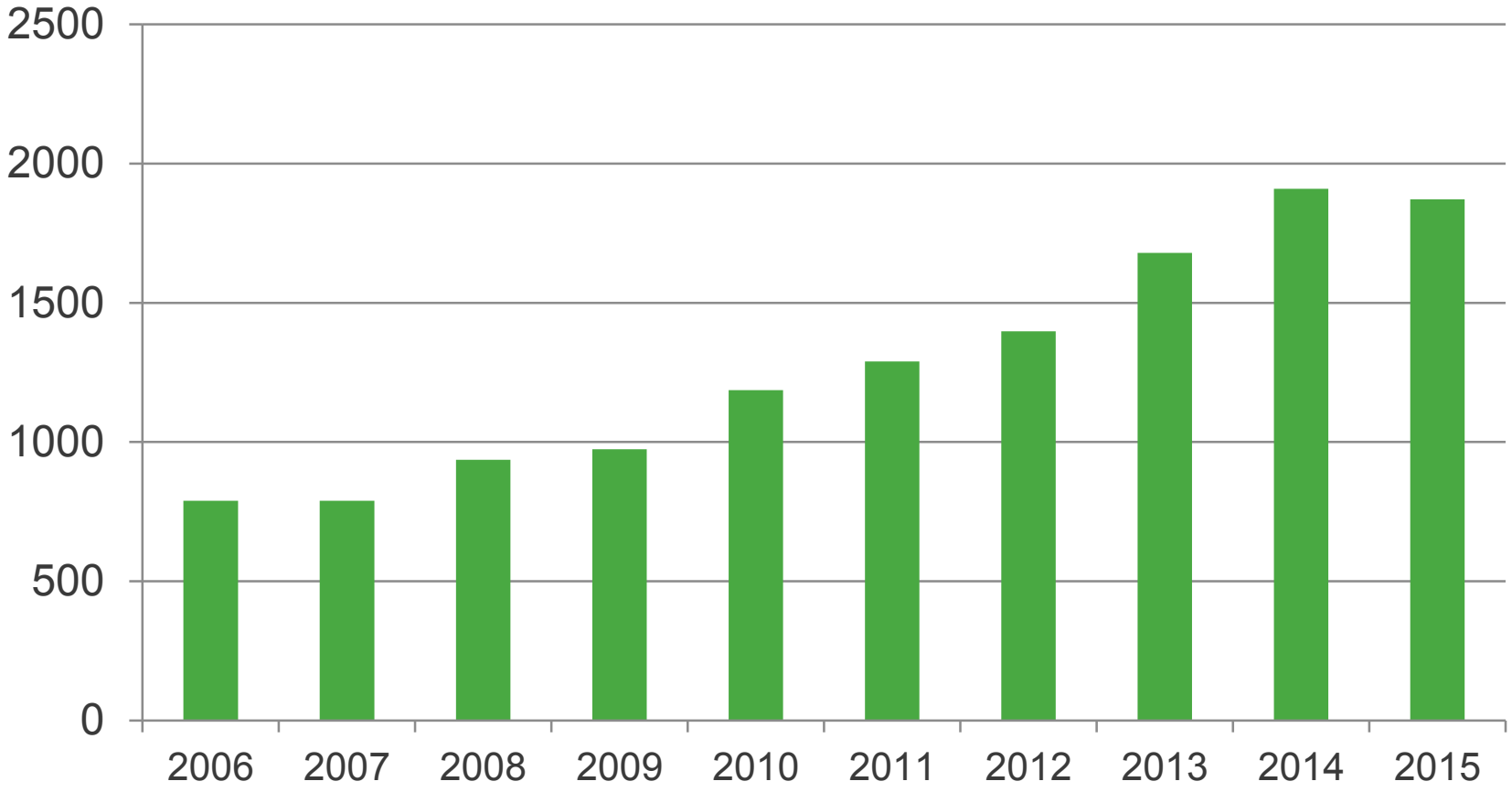
Chemical engineering graduates



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Student placements and internships

Source; Astrazeneca

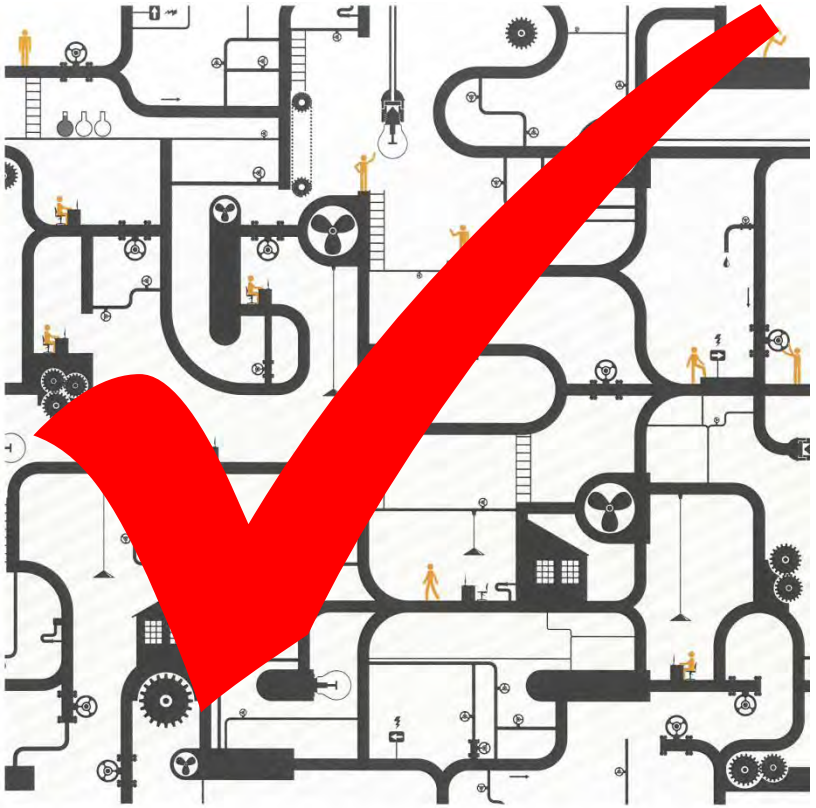
Source; University of Birmingham

Student placements and internships

How not to view placements

"My children, they did internships, they weren't paid and they made coffee"

Associate Professor Jer[illegible] Baker
BBC Radio [illegible]day 7 [illegible]16



Industrial placements in chemical engineering

Guidance and best practice for industry

September 2014

IChemE
Education Special Interest Group

Good placements: what employers say

"Industrial placements provide students with real job responsibility and employers with an excellent opportunity to assess emerging talent through challenging and meaningful assignments, solving real problems in the work place. This is a true win-win scenario and serves to produce high quality engineers with a more rounded perspective… " - John Gunner, Exxon

"We also support industrial placements and often recruit graduates with industrial experience (one year or summer placements) over graduates with purely academic experience. The difference in capability is often obvious from the job interview alone.' - Lee Greenlees, Rolls Royce

"We value our interns - they do useful work, bring a fresh perspective and energise the teams they work with.' - Jane Measures, BP

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"At the heart of the Dutch chemical ecosystem are robust public-private partnerships, cutting-edge open innovation R&D centers and world-class education institutes that encourage intercompany collaboration and innovation." *www.investinholland.com*

In summary

- Speak up for the chemicals and process industries
  - use the Chemistry Growth partnership
- Invest in the next generation for skills and innovation
  - work with universities and innovation centres
- Collaborate!
  - benefit from mutual support in the North East

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07979 658 321

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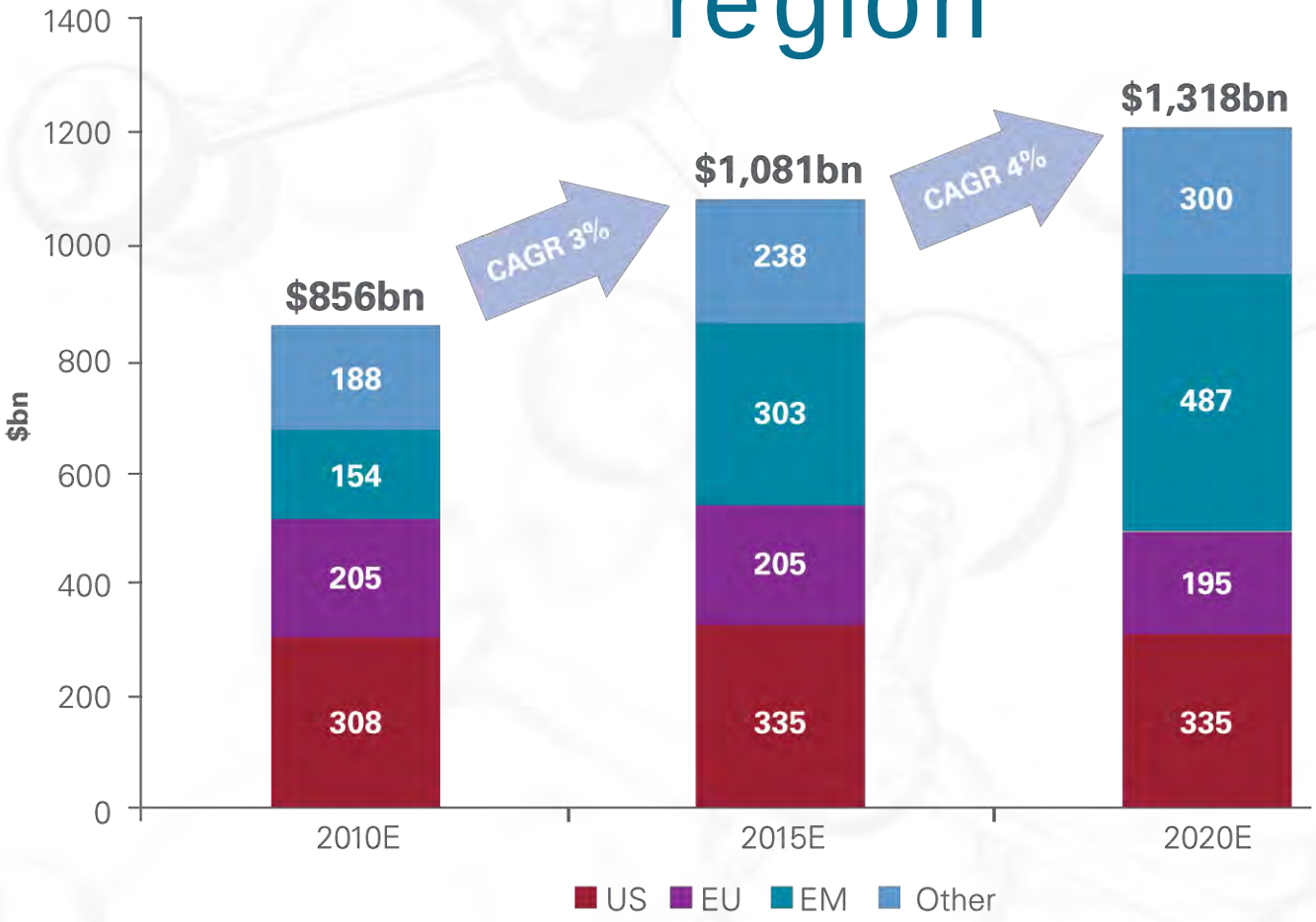
PHARMACEUTICAL PROSPECTS: A SECTOR & COMPANY OVERVIEW

Pharma sales growth to 2020 by region



New product Approvals Forecast to Average 35 Per year

>900 products In the pipeline 2/3 of which are Small molecules

Source: IMS, May 2011 & KPMG, Oct 2011

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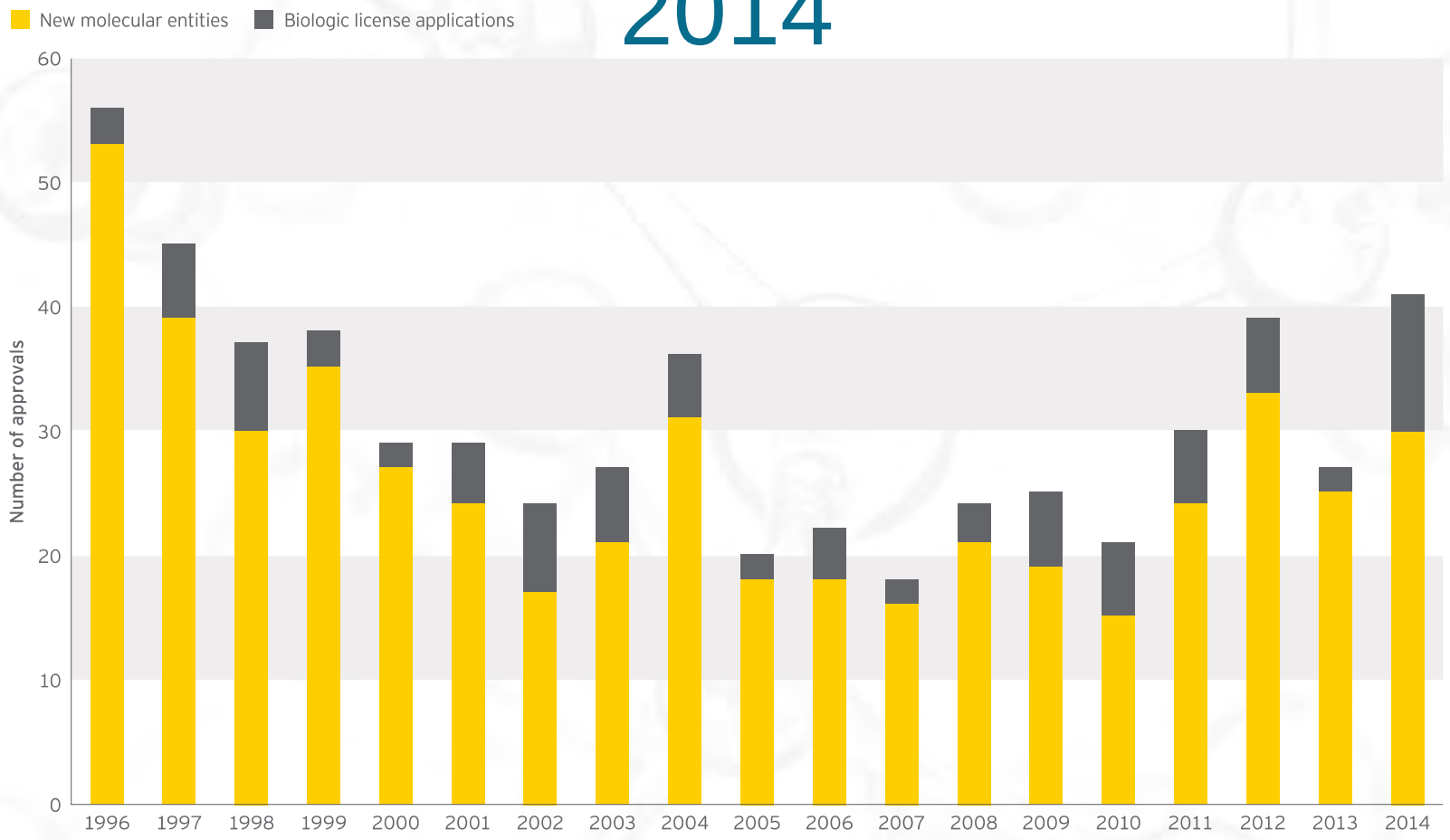
FDA product approvals, 1996–2014



Source: EY, Beyond borders report, 2015

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Small Molecule API Trends

Small Molecules Continue to Drive Pharmaceutical Growth:

- Accounting for 82% of NDA applications in 2014
- 60% of New Chemical Entities
- Can be engineered to deliver small dose effect
  - Economic advantage
  - More amenable to oral formulation
  - Clinical trials can be simpler
  - PR&D can be cheaper
  - Shipment and storage conditions can be easier

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Small Molecule API Trends

Small Molecules Continue to Drive Pharmaceutical Growth:

- Targeted therapeutic trends
- Higher molecular complexity / higher potency
- Smaller batch size
- Projection that in 15 years the ratio of NCE / BIO could still be 60/40

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Small Molecule API Trends

Number of Small-Molecule Drugs, 2013 and Projected for 2010		
Revenues	**2013**	**2020**
Over $1 billion	75	89
$500 million to $1 billion	111	140
$250 million to $500 million	160	227
$100 million to $250 million	345	407
$50 million to $100 million	328	409
Less than $50 million	1991	2180
TOTALS	**3005**	**3552**

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North East Pharma Sector

Strong and Supportive Capability:

- >200 Life Science & Healthcare Companies
- Turnover > £10billion
- 33% Of UK Pharma GDP
- Full Range of Capabilities
  - Preclinical and clinical development
  - Clinical trial management
  - Drug Substance and Drug Product manufacturing

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North East Pharma Sector

Strong and Supportive Capability:

- Strong CMO capacity
- Strong University Presence
- CPI / National Biologics Centre / National Formulations Centre

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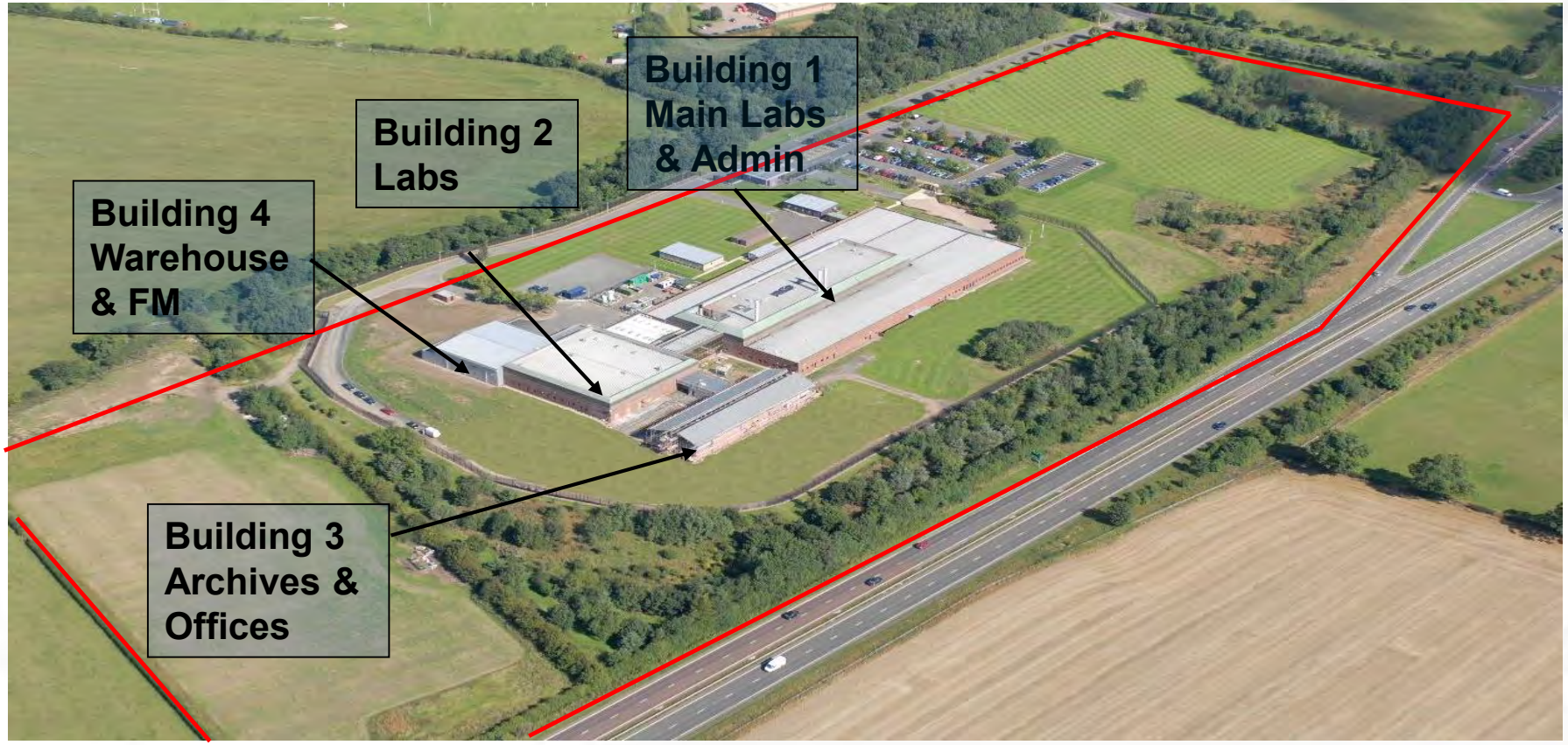
Arcinova

- Site area : ~12.8ha (1 ha = 10,000 m²)
- Total foot print of site buildings ~10,000 m²
  - Of which 2/3 is laboratory space



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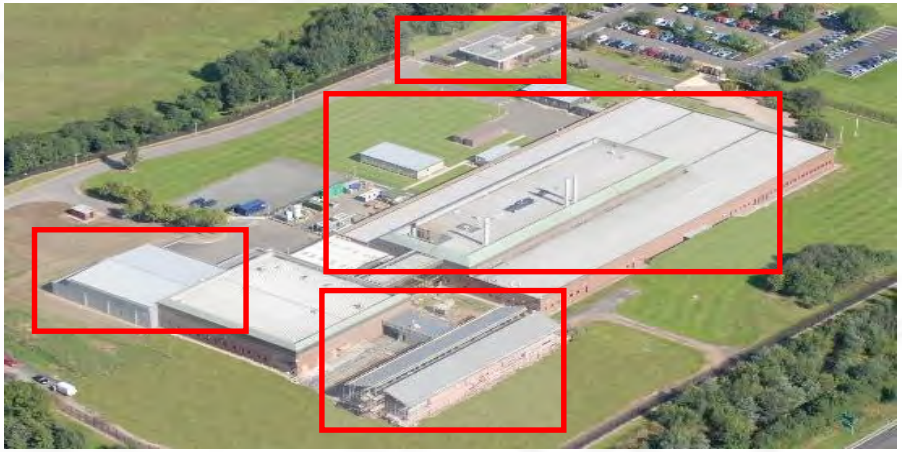
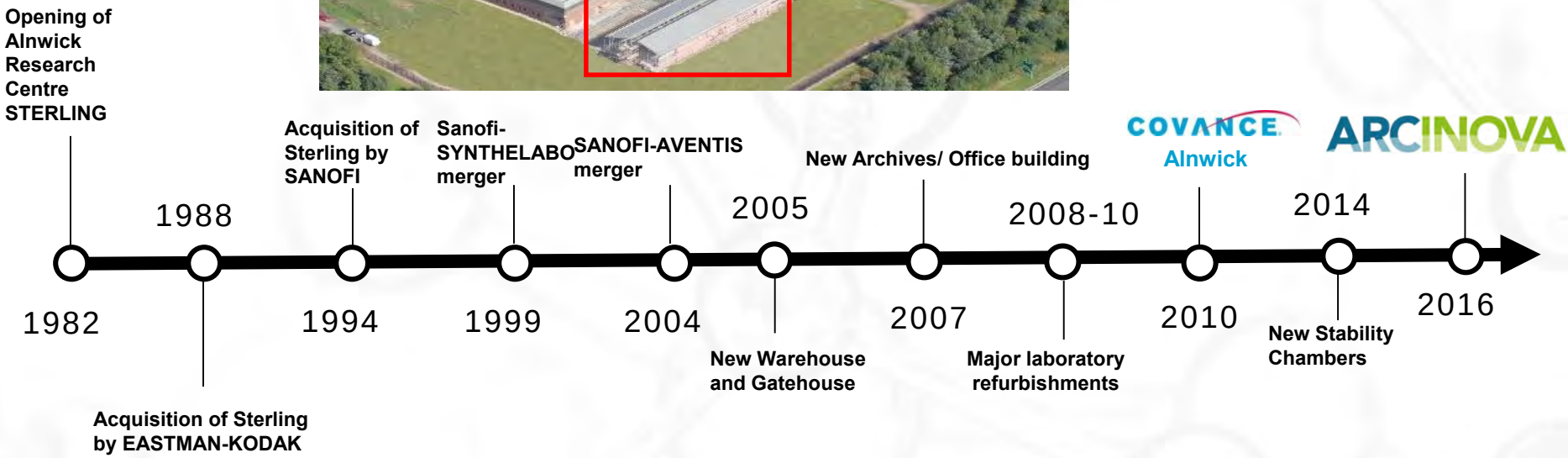
Well-equipped site & rich history





- 60 current customers worldwide
- Biotechs, speciality pharmas, large pharmas

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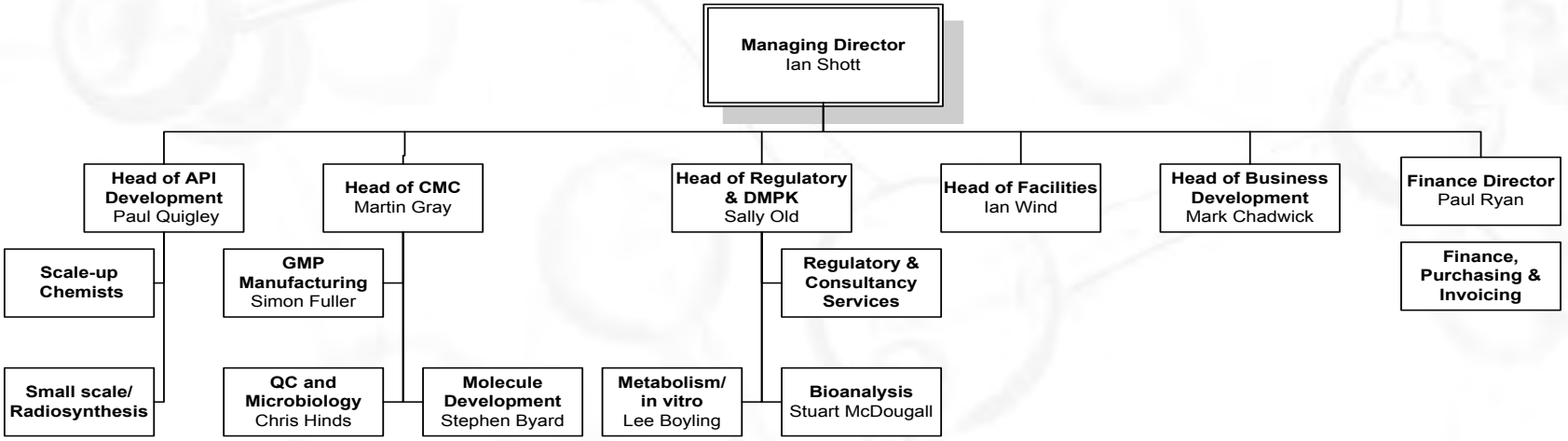
Experienced Team



- Over 50 project staff (chemists, analysts, engineers)
- Average 20 years industry experience

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Small Molecule Capacity

Key Differentiators:

- Strong and established route scouting capabilities
- Established chemistry base
- Extensive Drug Substance / Drug Product development expertise
- Established API analytical capabilities (chemical and physical)
- GMP compliant site
- Well established infrastructure

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Investment – Capability

Building:

- Strong Process Development Expertise
- Range of API development and manufacturing scales
- Alliance partners for further scale up
- Ability to handle multiple API classes
  - Standard
  - Radiolabelled
  - High toxicity / Potency
- Flexibility to introduce new technologies:
  - Synthetic Biology
  - Continuous processing
- Nimbleness, agility and innovative service capabilities

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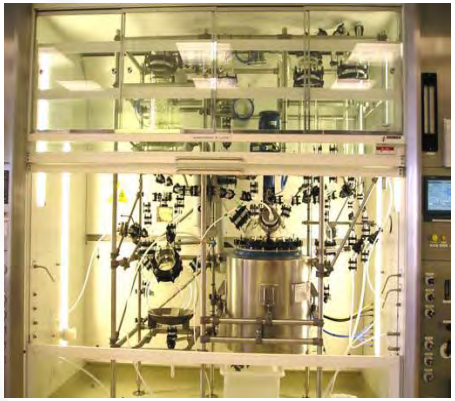
Investment – Infrastucture

- Driving investment from 5lt to 80lt scale
- Integrating with preferred scale up partners
- Tying into design capabilities of established partners (BPE)



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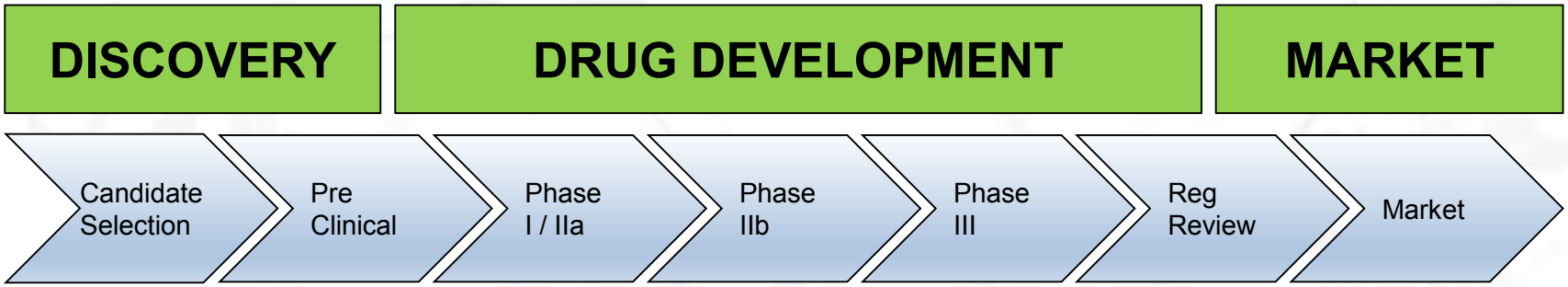
Offerings



Contract Research Services:

Capability for the development of small molecule drug candidates from discovery through pre-clinical and clinical phase I, II and III to launch. These services can also be applied to a range of life sciences applications.

Contract Development Services:

Capability to include Process Research, Development and Scale-Up, drug candidates in both Development and launched to the Market, at relatively small scale using synthetic biology and chemistry.

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Offerings

Efficient, end to end solutions, including:

- Drug substance – synthesis & support – intermediates & APIs
- Isotope synthesis/radiochemistry
- Drug product formulation
- High potency/high hazard materials

- Full bioanalytical support from pre-clinical through clinical trials

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Compliance

- 10 successful MHRA GCP/GLP inspections since 2000
- 10 successful MHRA/FDA GMP inspections since 2005

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Summary - What makes us different?

- Fully integrated provider
  - Pre-clinical through to small scale commercial
  - Cohesive API development, CMC, BioA & metabolism studies
- Big company track record/compliance
  - 34 years successful delivery of projects
- Speed and agility of a small company
  - Responsive team, track record of delivery
- World class facilities and capabilities
  - Modern state of the art research centre

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Strategy

Market segmentation to achieve four key target **customer groups**:

- Emerging Pharma / Biotechs seeking a full service partner
- Midsized pharmaceutical companies seeking strategic suppliers
- Global Pharma seeking trusted low risk and cost effective preferred suppliers of carefully targeted services
- Innovative Life Science companies and organisations (e.g. CPI) requiring professional consultancy and critical service support

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Thank you

UK Medicines Manufacturing Industry Partnership

David Garton
MMIP Project Manager, AstraZeneca UK Operations
NEPIC – 22 June 2016

Contents

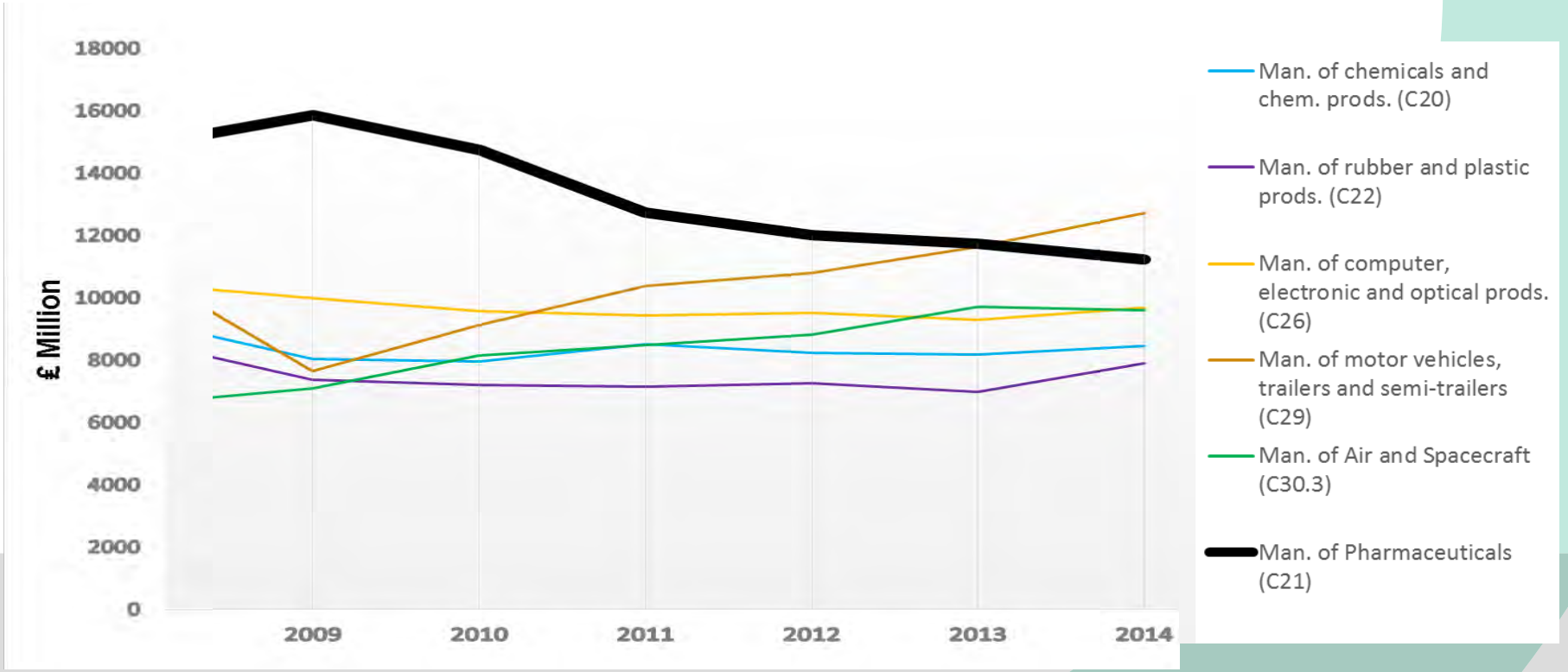
- Medicines Manufacturing
  - Challenges and Opportunities
- UK Medicines Manufacturing Industry Partnership
  - ❑UK Landscape
  - ❑Continuous manufacturing
  - ❑Future supply chain - Advanced Therapies Taskforce
- Conclusions and Acknowledgements

GVA Trend in Manufacture of Pharmaceuticals

MMIP

In 2009 the medicines manufacturing sector had the greatest economic contribution of any high technology research intensive industry providing some £16bn GVA. By 2014 this had declined to £11bn GVA, a 30% reduction.

To reverse this decline the introduction of innovative technologies and a competitive fiscal environment are key.



Change Brings Opportunities
- We have arrived at a Crossroads

MMIP

- Patients becoming partners in their own healthcare
- Continued shift towards personalised medicines
- Regulatory requirements adapting to new technologies
- Impact of “digital” on factory design and operation
- Impact of Intelligent Products (and how we supply)
- Manufacturing technologies and effective supply chains for new product types (ATMPs)
- Availability of skilled people
- Availability of funding (govt and private)
- Infrastructure of national facilities and capabilities to support product and technology development
- Attractiveness of UK tax structure

The Medicines Manufacturing Industry Partnership

MMIP

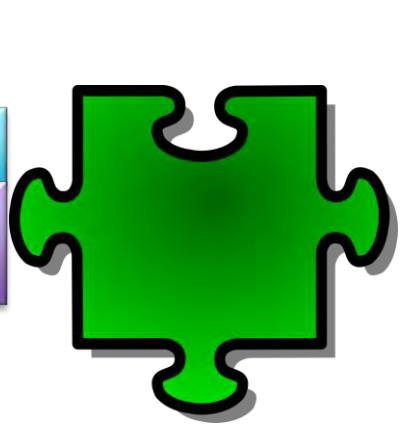
« The manufacture of modern medicines is one of our leading manufacturing sectors, with exports worth over £20bn. MMIP is helping ensure we remain at the forefront of this highly competitive sector, building on the impressive work they have already led in areas like detailed innovation mapping and modern skills investment. »

George Freeman MP,
Minister for Life Sciences

MMIP Objectives & areas of focus

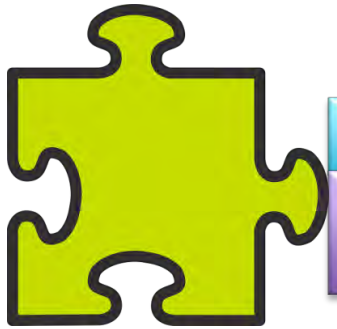
To drive Growth in all areas of the Medicine Manufacturing sector and ***ensure the UK is recognised as an attractive and thriving environment for medicines manufacturing.***

MMIP



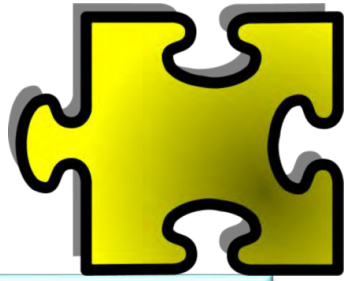
Skills

Workforce with relevant skills



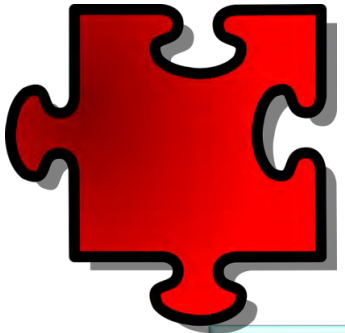
Regulatory

Investment friendly policies



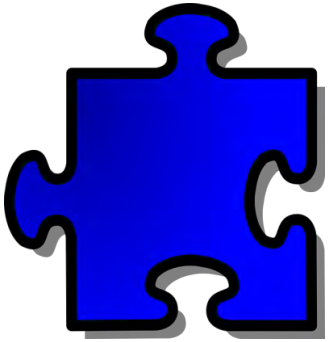
Community & Comms

Aligned medicine manufacturing voice



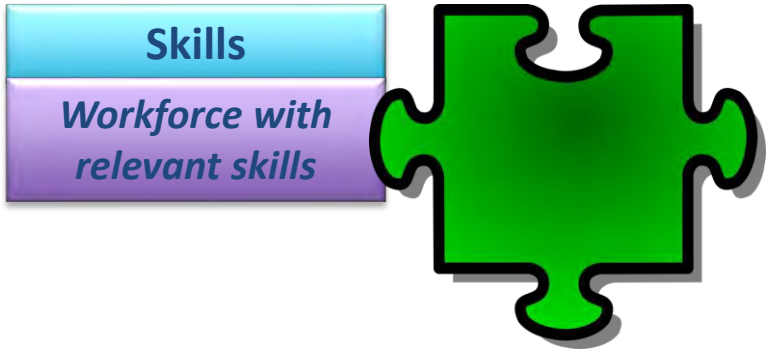
Business Environment

Connective and capable infrastructure



Technology & Innovation

Adaptive manufacturing that meet evolving patient needs



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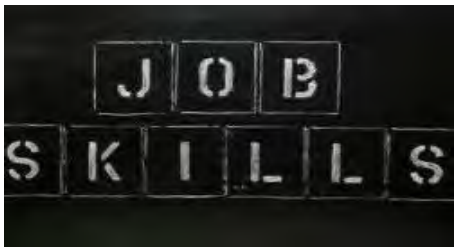
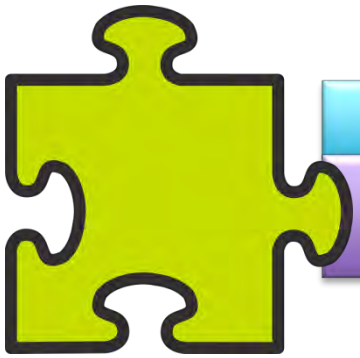
- ✓ **MMIP Conducted an Industry Skills Survey and ABPI skills review**
- ✓ **Science Industry Partnership Skills Strategy**
  - ✓ MMIP has contributed to the SIP Futures Group and Skills Strategy (now issued)



⇨ **Ensuring skills development frameworks and solutions are in place to meet industry needs**

⇨ **Ensuring we have a rich candidate pool for growth and succession**

Published Innovation Office case studies



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MHRA
Regulating Medicines and Medical Devices

Innovation

Early and flexible input from MHRA facilitates successful pharmaceutical site in UK

Winter 2014/15

The issue

In 2007 Eisai, a Japanese pharmaceutical company with no prior manufacturing or packaging capability within Europe, embarked on an aggressive £100M investment plan to develop a European headquarters, research and production site.

The design of the production facility had been undertaken in the UK and involved a cross-functional team including Japanese expatriates, professional services organisations and a newly appointed local team.

Before construction of the site commenced, Eisai wanted to be sure that its concepts and design philosophies would meet the requirements of regulatory authorities.

Making changes later on in the process could cost them both time and money.

"Establishing a presence in Europe was of strategic importance to us. Involving the MHRA Inspectorate early on in the design of our flagship research and production site really helped us to make sure we were developing something that was within the regulatory parameters for this type of site, particularly as we were planning to build in a variety of innovative features. We were able to access guidance and advice quickly and easily as the project developed, helping us to minimise risk and the potential for expensive and time-consuming changes to the site."

Alex Felthouse
Director of Engineering and Production Services, Eisai

How MHRA helped

MHRA worked flexibly with the Eisai team to ensure aspects of compliance were appropriately considered at the beginning of the project, so that comments and suggestions could more easily be taken on board and quickly addressed.

Eisai said that MHRA helped by:

- Attending advisory meetings to facilitate quick decision making
- Reviewing the conceptual approach to make sure it was on the right track
- Providing invaluable feedback at an early stage, helping Eisai to mitigate risk and avoid expensive changes to designs later on in the process
- Working to support Eisai in ensuring compliance.

The outcome

Eisai was able to provide high-level progress updates during the construction, commissioning and qualification period which supported the timely scheduling of Eisai Manufacturing Limited's first MIA inspection.

Moreover, the new facility brought over 100 production-related jobs to the local area and Eisai has announced a further investment in its local production facility.

Eisai are continuing to involve MHRA early in the process in order to ensure ongoing successful development of the project.

"It can be tricky to balance the desire to employ innovative features in site development with the need to meet regulatory requirements. At MHRA, we understand this tension and we work to help companies push the boundaries, but crucially within the parameters of safe and secure regulation. Our Innovation Office is the best way to access the information and guidance you need to save time, money and safeguard your investment in the UK."

Mark Birse, Group Manager Inspectorate, MHRA

The completed facility.

The completed facility.

How can we help you?

Is your organisation developing innovative products or technologies? Get in touch with us at the beginning of your project - we provide access to knowledge, guidance and experience that could help your organisation progress its innovation: innovationoffice@mhra.gsi.gov.uk www.gov.uk/government/groups/mhra-innovation-office

Medicines and Healthcare Products Regulatory Agency

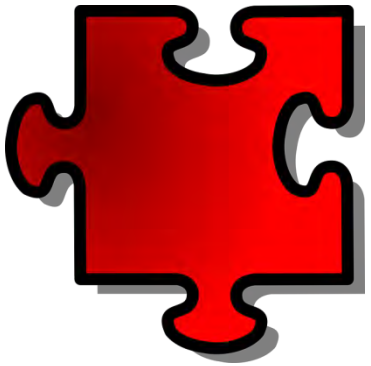
- ✓ **The MHRA, as a progressive regulator, is recognised as an asset for the UK.**
- ✓ The value of the unique MHRA Innovation Office is early collaboration and engagement between Industry and MHRA, this has been actively promoted via multiple case studies.

⇨ **To promote the role of the MHRA Innovation Office and to maximise utilisation of existing flexibility within the current UK regulatory framework.**

⇨ **To understand the long term strategy for Medicines Manufacturing in the UK and to proactively shape the future regulatory framework.**

Business Environment

Connective and capable infrastructure



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- ✓ **Fiscal assessment of the tax treatment of costs to support existing UK manufacturers and enhance the attractiveness of the UK to inward investment.**

- ✓ **MMIP, Office of Health Economics (OHE) and Office of Life Sciences** jointly outlined UK medicine manufacturing measures.

⇨ **Clarify the landscape of tax, patents, capital allowances and regulation**

⇨ **Seeking ways to differentiate the UK and improve attractiveness for investment decisions**

Technology

Adaptive manufacturing that meet evolving patient needs

MMIP

A Strong Base: UK Medicines Manufacture Landscape

- ✓ **Medicines Manufacturing Landscape portal**: mmlandscape.ktn-uk.org

- ✓ Delivered by the Knowledge Transfer Network – the UKs Innovation Organisation
  - outlining the UK capability, funding and infrastructure available to medicines manufacturers to support innovation and identify capability clusters across the value chain for companies.

- ✓ **"One stop shop"** approach to understanding the capabilities, type of businesses and where located / clustered.
  - The tool is not only for UK based business but those international companies that currently operate off-shore and are considering re-shoring/investment to the UK.


KTN
the Knowledge Transfer Network
DETAILED SEARCH
FURTHER INFORMATION
CONTACT US
Search
MEDICINES MANUFACTURING UK LANDSCAPE
Overview
Click a bubble to begin your search
22
FUNDING SOURCES
1328
COMPANIES
195
MANUFACTURING SITES
21
NATIONAL CAPABILITIES
75
ACADEMIC CAPABILITIES
6
CATAPULTS
27
SECTOR ORGANISATIONS
39
UNDERPINNING ORGANISATIONS
FIND BROADER INFO ON THE UK LIFE SCIENCE SECTOR
FIND OUT MORE FROM THE KTN

MMIP

KTN
the Knowledge Transfer Network

DETAILED SEARCH | FURTHER INFORMATION | CONTACT US

Search

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MEDICINES MANUFACTURING UK LANDSCAPE
Overview

MMIP

Detailed search

All | Academic capabilities | Funding sources | Underpinning organisations | Catapults | National capabilities | Sector organisations | Manufacturing sites | Companies

There are 6 entries that match your search.

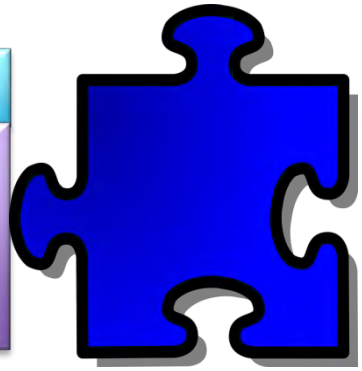
LIST VIEW | MAP VIEW

Start typing to narrow-down the results below | Sort by name A-Z | Show all regions | Reset

Catapults	Cell Therapy Catapult	Visit website	London
Catapults	Digital Catapult	Visit website	London
Catapults	High Value Manufacturing Catapult	Visit website	West Midlands
Catapults	Medicines Technologies Catapult	Visit website	North West England
Catapults	Precision Medicine Catapult	Visit website	East of England
Catapults	Transport Catapult	Visit website	South East England

Technology

Adaptive manufacturing that meet evolving patient needs



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- ✓ **MMIP supported ADDoPT** - advanced digital design of pharmaceutical therapies.
  - Key component of the UK Ecosystem will add world leading capability in the design of and optimisation of small molecules. AMSCI funding December 2015, project will run through 2016/17.
- ✓ **The MMIP supported business case for the Medicines Manufacturing Innovation Centre**

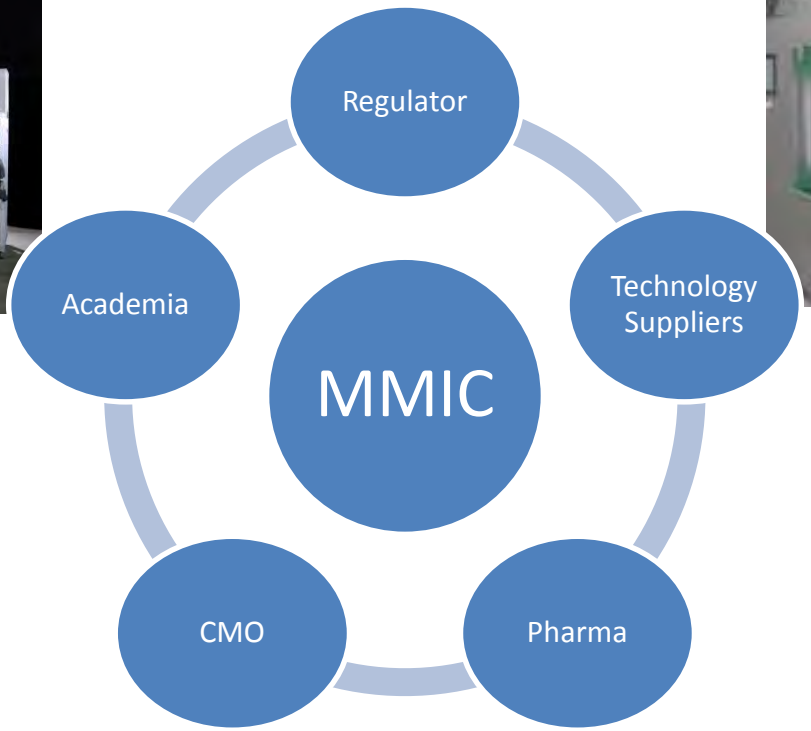
⇨ **Grow a strong knowledge, technology and innovation base**

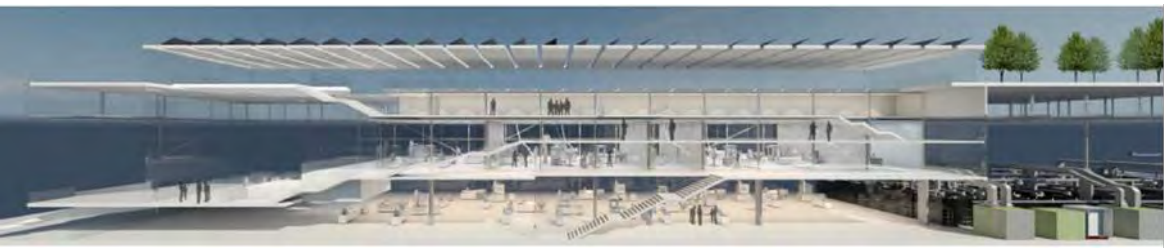
⇨ **Industry needs to move towards higher efficiency with reduced cost of goods. New technology and the drive for more effective and agile supply chains are essential to achieving this.**

Digital

Medicines Manufacturing Innovation Centre

MMIP



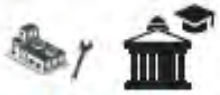


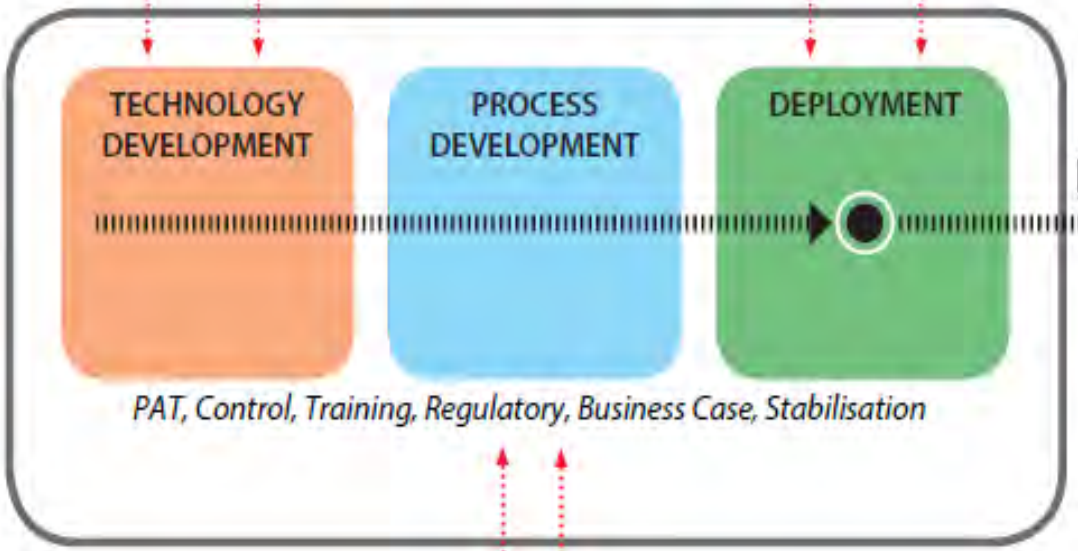
Medicines Manufacturing Innovation Centre

End to End Technology Thinking

Knowledge , technology industry and academia

Knowledge Construction Industry





Knowledge , Molecule Industry

MMIC Joint venture between CPI, University of Strathclyde supported by

Scottish Enterprise and Innovate UK

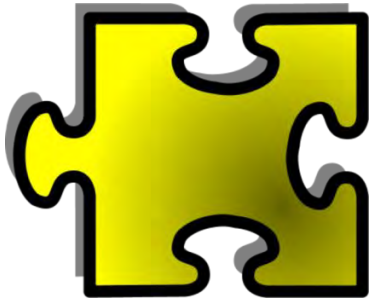
MMIP

Input into the URS development, cost estimate and economic case:

Letters of Support

Community & Comms

Aligned medicine manufacturing voice



MMIP

- ✓ **Joint Government / industry approach to strategy** to invest and utilise the UK's rich technological landscape for medicines, leveraging opportunities available to support translation of innovation to commercialisation.

- ✓ MMIP **community outreach** - MMIP initiatives - work-shops, roundtables and face to face meetings with the medicines manufacturing building "the VOICE of the sector."

- ✓ Strong interest from George Freeman (Minister for Life Sciences) to be personally involved → **Advanced Therapy sector Task Force**

⇨ **Promote existing strong base of medicines manufacturing in the UK.**

⇨ **Potential for inward investments**

⇨ **There is a strong political interest in the potential to expand Medicines Manufacturing and to create more exports.**

Future Supply Chains and MMIP

MMIP

- PRODUCT RESEARCH
- TECHNOLOGY

PROCESS R&D → PLAN → SOURCE → MAKE → MOVE → SELL

Advanced Therapy Medicinal Products

SMALL MOLECULE

LARGE MOLECULE and Vaccines

MEDICINES for Human Health

Community & Comms

Technology

Business Environment

Regulatory

Skills

Edited from press release 23rd March 2016

Government/Industry Taskforce launched - Manufacturing Advanced Therapy medicines in the UK

- Co-chaired by **Minister for Life Sciences George Freeman** and **Ian McCubbin, SVP North America, Japan & Global Pharma Supply**, **GlaxoSmithKline**,
  - Work to anchor advanced therapy manufacturing and the associated supply chain in the UK
  - Complement the work of the Regenerative Medicine Expert Group (RMEG) that is developing an NHS regenerative medicine strategy so that the NHS is fully prepared to deliver these innovative treatments.

- UK leading in development of Advanced Therapies
- Investment in national facilities – Cell and Gene Therapy Manufacturing centre opens 2017
- MHRA and EMA based in London (MHRA Innovation office)
- Licensed 22 GMP facilities

Conclusions

- UK has strong technology base in academia, industry and the emergent national centres
- The MHRA is seen and valued as an asset
- Recognition of the importance of design and manufacture of medicines in UK policy
- Significant ongoing change brings opportunity across a number of therapeutic modalities
  - It is an opportunity to build recognising competition in a global model
  - Advanced technology will be the driver supported by policy enablers
- Further strengthening our industry connectivity, alignment and partnership with government via MMIP
- There is a strong foundation in the UK for turning challenges into opportunities for the pharmaceutical development and manufacturing sector

Thank you

MMIP

Acknowledgements

MMIP is supported by the ABPI, the BioIndustry Association (BIA) and the Knowledge Transfer Network, and includes leadership from Allergan Biologics, AstraZeneca, Eisai, FUJIFILM Diosynth Biotechnologies, GlaxoSmithKline, Pfizer and ReNeuron.

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abpi BIA KTN

HTTP://BIA.me/MMIP_LinkedIn

Contact us: ABPI.org.uk/our-work/MMIP or MMIP@Bioindustry.org

EXPLORING INDUSTRY INTEGRATION AND SYMBIOSIS

John Shipman
Huntsman Polyurethanes

20 April 2016

Tees Valley Process Industry (TVPI) Study

What

- High level study of process industry (Masterplan)
  - Symbiosis opportunities
  - Opportunities to develop the sector
    - New plants / products

How

- 46 Contributors
- All significant companies
- Dealt with confidentiality issue
- Industry led

When

- Started Oct 2015
- Delivered report April 2016

Contributors To The Study

Study Findings

Short term opportunities - not reliant on obtaining direct government funding:

- Industrial Symbiosis
- Waste Value Enhancement
- Asset, Product Service Maximisation
- Supply and consumption of Surplus Energy
- Purchasing / Operational / Safety / Environmental excellence
- Infrastructure

- Delivering in the short term, resources to :
  - facilitate sharing of information through marketing
  - company brokerage
  - laboratory testing
  - concept and front end engineering support

Medium term opportunities - synergistic link to existing TVPI assets and/or production streams and which could give the TVPI a sustained competitive advantage over other international sites.

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_2. 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. **$NaOH + Cl_2 + H_2$ (pure)** **$KOH + Cl_2 + H_2$**	An enabler for Chlorine derivatives e.g. TiO_2 and other minerals; shale via HCl; esterification of biomaterial. Chlorinated isocyanurates option. Target KOH rather than NaOH	Sustainability and safety enhanced by avoiding Chlorine shipment for water treatment - Trans Pennines
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 **•EO derivatives** **•Linear Alpha Olefins** **•Alpha MMA**	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

Opportunity	Downstream Benefit Potential	Constraint / Mitigation / Action
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	IP innovation and ownership Affordable power is an enabler. Optimisation studies required
Poly-tunnel and Algal Pool Uses for CO_2	Land availability, CO2 (and H2) plus waste heat to make highly effective plant growth media.	Studies ongoing IP innovation and ownership Build on sugar to biochemical knowhow.
Special salts e.g. $MgCl_2$ 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_2 and fuel ash mining	Mostly small size but early returns. Plus with innovation funding some high value metals and some general plastics valorisation prospects

Long term opportunities - require investment in new technologies, proof of concept or pilot scale testing

- 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
  - Growth in US Chemical sector
  - Low carbon potential
  - Massive resource

2 Months on ……..

- Study widely praised by various stakeholders
  - BIS
  - UKTI
  - CGP
- Recommendations built into LEP bid to Growth Fund
- Several symbiotic opportunities being developed
- Desire from other process industry clusters to complete a similar study

Shared Energy Opportunities

NEPIC Meet the Members 2016

22nd June 2016

Nick Booth Ltd.

Agenda – am I going to say anything interesting ?

- How you can save money
- Reduce your Carbon Footprint
- Working together – helping other companies
- Working together – helping the local community

NB background

1989 ICI
Graduate C/E Engineer

Wilton Power
Station Manager

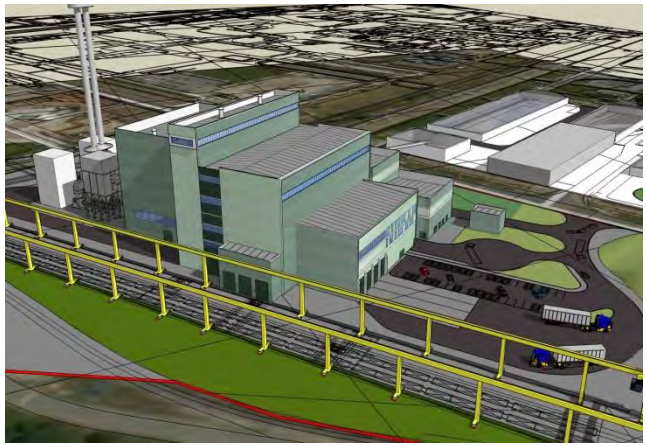
1999 Enron
Business Devt Manager

P&L accountability for UK's largest private wire & industrial heat networks

2003 Sembcorp

Vice President
-Teesside Utilities Business

Senior Vice President
- Group BD



2013 Independent
Consultant

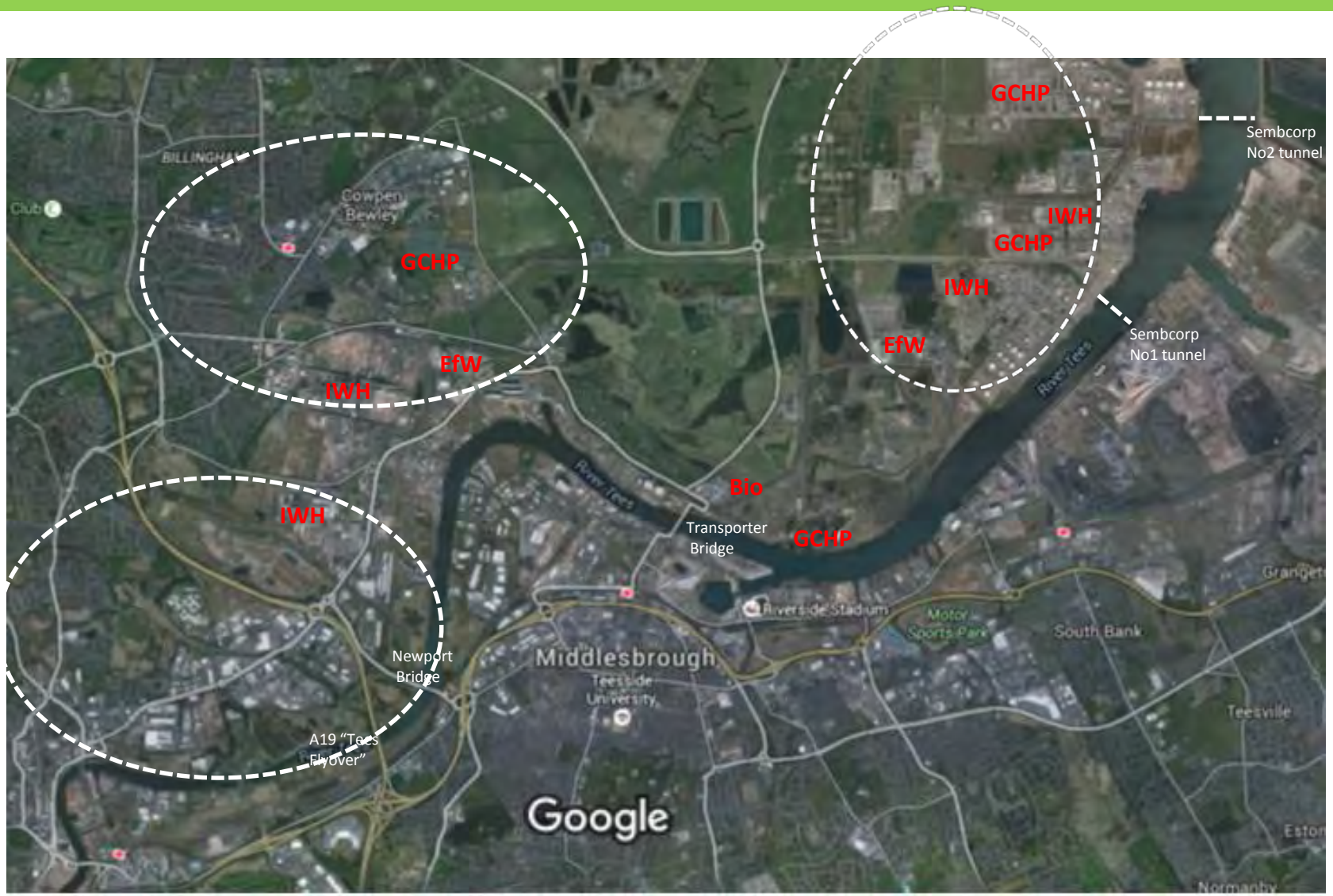
Developed over 200MW / £500M of power plant inc renewables & EfW

Project overview

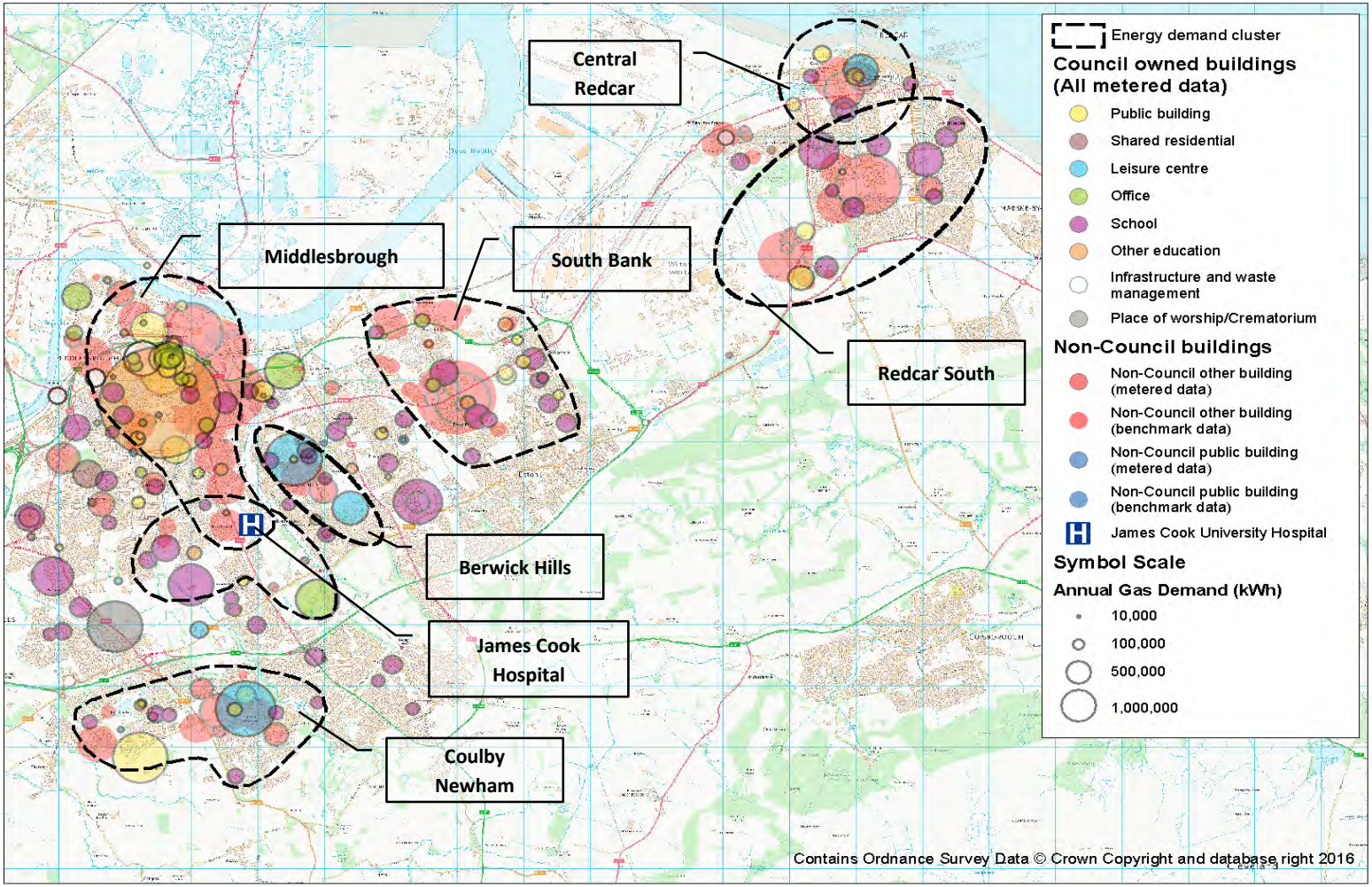
- Two district energy studies underway
  - "North Tees"@ £1.27M budget managed by Stockton Borough Council / N Booth Ltd
  - "South Tees"@ £0.52M managed by TVU / Energis (John Bone) on behalf of R&CBC / MBC
- Overseen by DECC Heat Network Delivery Unit (part of DECC "Heat" Strategy)
- Large CO2 reduction potential given concentration of EII on Teesside
- £20M+ p.a. GVA identified with relatively short leadtime
  - In addition to the CO2 and individual economic benefits the sponsors want to promote synergy between the companies and other stakeholders in the region (i.e. its also about jobs).
- In the longer term the initiative may provide heat to social housing & help address fuel poverty.

North Tees Study Area

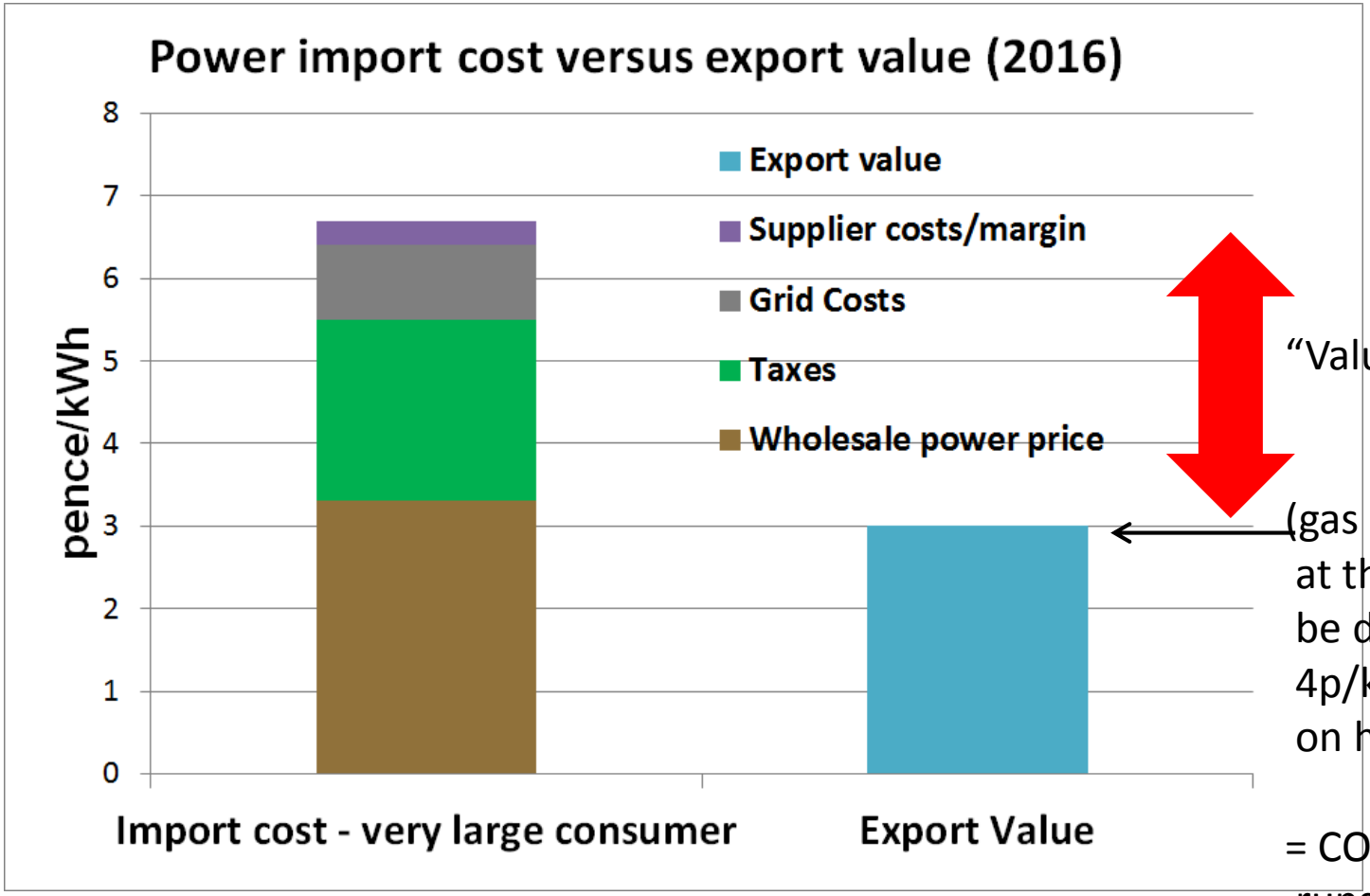
(enough waste heat available to heat every property on Teesside)



South Tees Study Area



Significant value opportunity for local generators & consumers to work together

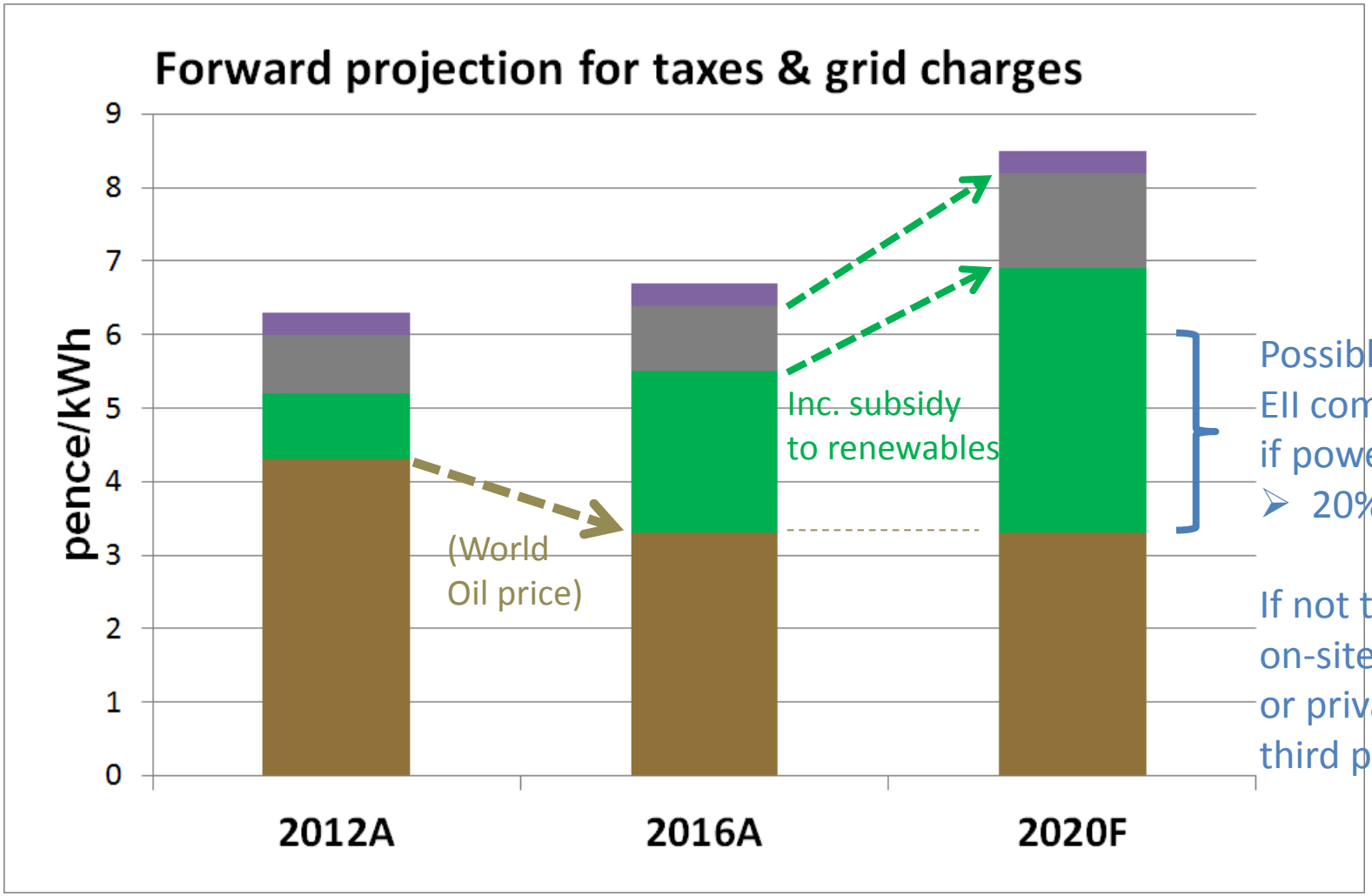


"Value opportunity"

(gas CHP will not run at this price but can be dispatched at say 4p/kWh – depending on heat price)

= CO_2 savings if CHP runs in place of boilers

Opportunity is going to increase



Wilton as a case study

Seal Sands energy integration concept is not new but this time we need to make it happen !!!!!

Joining the dots – where could we end up ? ….

- 100 → 200,000 tpa reduction in CO2 emission at low cost to government
- £50-80M of network investment over next 5-10 years
  - 70%+ of that could be spent in local economy in form of wages
- £15- £25M pa. of economic value created for local companies
  - 1000's of local jobs supported amongst some of biggest companies
  - Business rates from existing companies protected
- Infrastructure to attract future investment & promote further regeneration
- 10-15% reduction in heat costs for municipal buildings now + protection from future rises
- Mechanism to address fuel poverty through lower cost heat (marginal cost very low)

Contacts

North & South Tees project teams interested to talk to all large energy users or generators ……

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Stockton-on-Tees Borough Council

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