

Written evidence submitted by the United Kingdom Without Incineration Network (UKWIN)

1. The United Kingdom Without Incineration Network (UKWIN) welcomes this opportunity to respond to BEIS' call for evidence on fuelled and geothermal technologies in the Contracts for Difference scheme.
2. UKWIN is a network of about 100 member groups, and was founded in 2007 to promote sustainable waste management and public participation in environmental decision-making.
3. Through our work we have been directly involved with more than 100 gasification, pyrolysis and conventional incineration schemes. We have tracked many of these from their initial public announcement to the present day. This wealth of relevant experience provides us with a deep understanding of thermal treatment proposals.

Question 1: How should the CFD scheme treat biomass conversion in future?

4. UKWIN supports Biofuelwatch's position that biomass-derived power is neither renewable nor low-carbon, and as such it should not be supported by the UK Government nor promoted as one of the technologies with which to combat climate change.
5. In relation to biomass-derived waste, we would like to call your attention to the Environment, Transport and Regional Affairs Committee's conclusion in 2001 that: "We do not accept that energy from waste incineration is a renewable form of energy. Even if one considers that it meets the technical definition of renewable energy, it utterly fails to meet what might be called a 'common-sense' interpretation. A waste stream is only 'sustainable' in the most twisted definition of the word since sustainable waste management has as its cornerstone the minimisation of waste, and the explicit maintenance of waste streams for the purposes of incineration is in complete contradiction of this principle...There must be no subsidy to the growth of incineration. If fiscal instruments favour the development of incineration, then the result in 20 years time could be a large and overbearing incineration industry which effectively crowds out the more attractive options of minimisation, re-use, recycling and composting".¹
6. We also wish to draw your attention to the October 2015 Eunomia report entitled 'The Potential Contribution of Waste Management to a Low Carbon Economy'.²
7. The Low Carbon Economy report correctly explains that: "...to classify the biomass fraction of waste as a renewable resource is to fly in the face of everything that waste management policies should be seeking to achieve: at the very basic level, it conveys all sorts of wrong messages".

¹ Committee Report on Delivering Sustainable Waste Management. Fifth Report of Session 2000-01, Volume I (published March 2001), Paragraph 149 & Summary recommendation X1 and Paragraph 122 & Summary recommendation A2

² Available from <https://www.zerowasteurope.eu/downloads/the-potential-contribution-of-waste-management-to-a-low-carbon-economy/>

8. Furthermore, UKWIN agrees with that report's highly relevant recommendation that Governments "should immediately discontinue support for all forms of energy from residual waste, including implicit subsidies".
9. The recommendation is supported by the contents of the report itself and its explicit explanation which is that: "Given that part of the rationale for developing renewable sources of energy is to address climate change, it seems counterproductive to maintain support for those which contribute to climate change. The case for supporting measures for the generation of energy from waste on the basis that waste is 'a renewable resource' makes no sense when set against the waste hierarchy. As countries improve in their prevention, reuse, and recycling, so less and less residual waste will be available. It is stretching the definition of 'renewable' beyond what is credible to argue that residual waste could be a source of 'renewable' energy".

Question 6: How can the Government use the CfD scheme to promote the development of innovative ACT projects which will help develop a circular economy using waste as a fuel? Please provide evidence for or against making changes to the support of ACT and set out what you think the impact of making these changes would be.

10. There are good reasons why Government should not use CfD to support the gasification and pyrolysis of waste under the guise of ACT.
11. UKWIN's evidence focuses on the following three grounds for excluding the gasification and pyrolysis of waste from CfD funding: (1) that supporting gasification and pyrolysis will hinder rather than help the circular economy, detracting from resource security (*'Thermal Treatment and the Circular Economy'*); (2) that gasification and pyrolysis cannot be relied upon to provide energy security or to generate energy efficiently (*'The unreliability and inefficiency of gasification and pyrolysis for waste treatment'*); and (3) that supporting the gasification and pyrolysis of waste is not a cost effective means of decarbonising electricity generation (*'Decarbonisation of electricity generation and related matters'*).

12. *Thermal Treatment and the Circular Economy*

13. UKWIN is an enthusiastic advocate for the circular economy, i.e. a 'recycling society' where waste is brought down to an absolute minimum and where there is preservation of material and nutrients for as long as possible through re-use, closed-loop recycling, composting and product re-design.
14. It is widely recognised that thermal treatment (including gasification and pyrolysis, as well as conventional incineration) is a leakage from this circular economy to be minimised, and so the Government should not support gasification and pyrolysis of waste in the name of promoting the circular economy.
15. For example, the European Environment Agency's (EEA's) diagram of the circular economy (see Annex 1, below) clearly shows that incineration (which includes gasification and pyrolysis as per the Industrial Emissions Directive) is a leakage from the circular economy to be 'minimised'.

16. As the EEA's 2016 report, entitled 'Circular economy in Europe: Developing the knowledge base', puts it: "One of the central pillars of a circular economy is feeding materials back into the economy and avoiding waste being sent to landfill or incinerated, thereby capturing the value of the materials as far as possible and reducing losses."³
17. 'Energy recovery' is similarly depicted as a leakage to be minimised in the portrayal of the Circular Economy used by the Ellen MacArthur Foundation and the World Economic Forum.⁴
18. Whilst the image used by the Ellen MacArthur Foundation and the World Economic Forum refers to 'energy recovery', it is worth noting that in practice many gasification and pyrolysis facilities would operate so inefficiently that they would fail to meet the R1 threshold and thus would be classified as 'disposal', a form of waste management located at the bottom of the waste hierarchy alongside landfill, and would therefore not even reach the level of being classed as a form of 'energy recovery'.
19. This situation is recognised by the Government, as reflected in DEFRA's 'Energy from waste: A guide to the debate' (the 'EfW Guide'), which notes at Paragraph 52 that: "The requirement to apply the R1 formula means that lower efficiency municipal energy from waste [thermal treatment] plants are classed as disposal (D10) even if they are generating useable energy" and at Paragraph 74 that: "...Steam generation from gasification is no more efficient than from incineration and due to lower operating temperatures, steam pressure and parasitic loads (i.e. energy required to run the plant) the overall process may be less efficient than conventional incineration".
20. In relation to R1 and the circular economy, UKWIN notes that Paragraph 219 of the Government's EfW Guide states that: "There are four key principles that underpin current thinking on energy from waste and which are expected to remain critical to the development of a sustainable policy into the future" and that Paragraph 235 of the EfW Guide states that: "To be consistent with the principle of energy from waste supporting waste management in line with the hierarchy, key considerations for the long term development or operation of an energy from waste solution are: The ability to at least qualify as recovery in the waste hierarchy".
21. Despite these clear statements of intent, gasification and pyrolysis plants have historically not been required to operate as R1/recovery to qualify for CfD funding for any electricity exported, and some CfD-backed facilities are very inefficient.
22. Whatever the level of efficiency theoretically achievable by gasification and pyrolysis plants, these facilities rely for feedstock on material that could, and arguably should, be recycled or composted.

³ Circular economy in Europe – Developing the knowledge base. European Environment Agency, January 2016. Section 3.6, Page 29. Available from: <http://www.eea.europa.eu/publications/circular-economy-in-europe>

⁴ 'Towards the circular economy: Accelerating the scale-up across global supply chains', World Economic Foundation (prepared in collaboration with the Ellen MacArthur Foundation and McKinsey & Company) January 2014. Available from: <http://reports.weforum.org/toward-the-circular-economy-accelerating-the-scale-up-across-global-supply-chains/view/from-linear-to-circular-accelerating-a-proven-concept/#fig2>

23. Gasification and pyrolysis plants are therefore responsible for reducing resource security, as destroying resources (including fossil-derived materials such as plastics) is central to gasification and pyrolysis processes.
24. As it is relevant to the issue of the adverse impact of gasification and pyrolysis on recycling rates and the circular economy, UKWIN provides excerpts from our evidence to the Environment, Food and Rural Affairs Committee's (EFRACOM's) Fourth Report ('Waste management in England') as Appendix 1.
25. EFRACOM's resulting report (HC 241) notes, at Paragraph 77, that: "UKWIN told us that recycling is harmed by incineration for various reasons, including the presence of incineration capacity and government subsidies for incineration discouraging investment in recycling, the long-term lock-in of money and feedstock to existing and proposed incineration capacity, and the fact that the true costs of incineration are not reflected in the price of treatment. UKWIN also provided us with data showing an apparent correlation between high rates of incineration and low rates of recycling", and at Paragraph 81, that: "When we asked the Minister how the Government ensures that only genuinely residual waste is sent to incinerators, he told us that the key pressure is gate fees - i.e. the charge that must be paid to dispose of waste in an incineration facility. However, we are concerned about the effectiveness of this singular mechanism following evidence we received about 'put or pay contracts' and negative impacts on recycling rates".
26. Far from making a positive contribution to the circular economy, by competing with recycling (and indeed by competing with composting and anaerobic digestion), and by reducing resource security, gasification and pyrolysis act as a break on the circular economy, giving rise to serious and avoidable leakages that certainly do not merit Government subsidy.
27. **The unreliability and inefficiency of gasification and pyrolysis for waste treatment**
28. The case for excluding gasification and pyrolysis projects from CfD is clear and compelling. Despite several decades of research and development, and despite many billions of pounds of investment, gasification and pyrolysis (known by some as 'Advanced Thermal Treatment') remain incapable of reliably delivering energy and therefore should not be relied upon to meet the country's future energy needs.
29. Gasification and pyrolysis projects compete with projects that are capable of delivering genuinely renewable energy, and are therefore responsible for holding back more promising technologies.
30. Air Products' ill-fated Tees Valley gasification project provides one high-profile example of the unnecessary risk that the Government takes when depending on the successful delivery of Advanced Thermal Treatment schemes for our energy security and for our ability to meet renewable energy targets.
31. In April 2014 the Government announced that: "...The new 20 year contract with Air Products, worth 2% of government's energy spend, is expected to deliver £84 million in savings over the life of the contract through an innovative fixed agreement that will provide stability in what the public sector pays for energy...Air Products has longstanding expertise in building and operating large, complex

industrial gas and energy plants ensuring its projects are delivered safely, reliably and cost-effectively".⁵

32. Two years later, in April 2016, Air Products opted to face a \$1bn write-off in preference to carrying on with their doomed gasification project in Tees Valley, and decided to get out of the 'Energy from Waste' business altogether "blaming technical problems and rising costs".⁶
33. Simply put, even a world-class organisation such as Air Products could not get the technology to work, despite devoting years of effort to, and hundreds of millions of pounds on, the Tees Valley gasification project.⁷
34. The MP for Stockton North criticised the Government for relying on gasification, telling the Financial Times that: "The government needs to explain why it signed an exclusive contract to buy electricity generated by unproven technologies and exactly how they propose to fill the gap in their energy needs as these plants are extremely unlikely to come on stream in time..."⁸
35. It was reported in the waste trade press that: "...Tees Valley could be remembered as one of the most expensive waste infrastructure blunders in years. Frustrating for all those involved – and embarrassing for the UK government, which was looking to Air Products to provide power on behalf of its Energy for Growth programme over a 20-year fixed period".⁹
36. UKWIN's submission to BEIS is accompanied by Appendix 2 which is our recently published briefing entitled 'Gasification Failures in the UK: Bankruptcies and Abandonment'. Also see Annex 2 for UKWIN's comments on potentially misleading industry claims regarding gasification.
37. Given the numerous technology failures and bankruptcies across the gasification and pyrolysis sector it seems prudent for the Government to exclude waste gasification and pyrolysis from future rounds of CfD.
38. UKWIN also notes that at present the gasification and pyrolysis facilities being proposed in the UK are largely, if not wholly, focussed on directly burning any syngas that might be produced, rather than converting it into a form suitable for off-site use, e.g. as a transport fuel. Part of the reason for this is the high financial and energy costs of cleaning (removing impurities from) the syngas.
39. Paragraphs 86 and 119 of DEFRA's EfW Guide acknowledge problems with syngas clean-up, noting that: "The greatest challenge [of creating transport fuels from waste] is ensuring the syngas produced is pure enough for the chemical reactions required to make the fuel to work. This purification or 'gas cleanup' step can be energy intensive and reduce the overall efficiency of the process" and that: "The major barrier to this [use of syngas to power gas engines or gas turbines] is that the syngas needs to be 'cleaned up' to remove small amounts of tar and other

⁵ <https://www.gov.uk/government/news/new-energy-deal-to-save-84m-from-government-bill>

⁶ <http://www.ciwm-journal.co.uk/air-products-scrap-teeside-efw-development>

⁷ <http://ukwin.org.uk/2016/04/05/air-products-gives-up-on-gasification>

⁸ <http://www.ft.com/cms/s/0/226c0e34-fb47-11e5-8f41-df5bda8beb40.html>

⁹ <http://www.letsrecycle.com/news/latest-news/air-products-what-happens-now>

chemicals that can damage the engines. This can be technically challenging and/or energy intensive."

40. There are several passages from the recently published Resource Magazine article entitled 'Advanced Conversion Technologies: A Heated Debate' that are directly relevant to BEIS's consideration of the future of CfD for gasification and pyrolysis, and relevant extracts are repeated with commentary below.¹⁰
41. Firstly, the opening paragraph makes clear that, unlike anaerobic digestion, the gasification and pyrolysis of waste failed to emerge from the Government's New Technology Demonstrator Programme as a viable technology.
42. As the Resource Magazine article explains: "For well over a decade now, various forces in the UK have been trying to develop advanced conversion technology (ACT) [i.e. gasification and pyrolysis] for the treatment of residual waste as an alternative to landfill or mass-burn incineration. Way back in 2003, the previous Labour government launched its New Technology Demonstrator Programme with the aim of overcoming the 'real and perceived risks' associated with technologies like anaerobic digestion (AD), mechanical biological treatment (MBT), mechanical heat treatment (MHT), gasification and pyrolysis. And while AD has since gone on to become the government's preferred method of dealing with organic waste...and MBT and MHT are becoming more common, the advanced thermal treatment (ATT) technologies still haven't overcome the hurdles that became evident during the 2003 demonstration programme."
43. In relation to the unreliability of the Air Products Tees Valley gasification technology mentioned above, the Resource Magazine articles cites relevant transcripts of statements made by the CEO of Air Products, for example the CEO's statement that: "We have always said that there is a chance that the technology will not work" and that "There is a still significant outstanding question about if we will ever be able to get it to work on a sustainable basis...The technology is proving to be a lot more difficult than people thought at the beginning".
44. In light of their decision to abandon gasification technology due to "design and operational challenges" (i.e. technology failure) it is clear that Air Products lost faith in gasification technology.
45. Going on to discuss the basis for why gasification can fail, the Resource Magazine notes that: "Putting aside the (perfectly valid) arguments about the technology's potential to destroy valuable materials, I ask him [UKWIN's National Coordinator] what makes the technology so tricky to crack when it comes to the treatment of mixed municipal waste, and he explains: 'My understanding of the wider question of gasification failures is that the more heterogeneous the feedstock, the more likely it is to fail...When you are burning a homogeneous feedstock, you can anticipate its behaviour and you can design around that behaviour. But if you have a mix of materials, you can't be certain that that batch will behave in the same way as your previous batch, because it's based on compositions. So, it becomes unpredictable, like trying to hit a moving dartboard.'"

¹⁰ <http://resource.co/article/advanced-conversion-technologies-heated-debate-11503>

46. UKWIN's perspective is supported in the article by the Chair of PyroPure, a company that uses pyrolysis and gasification on very small batches of niche waste streams.
47. PyroPure's Chair explains how: "Small-scale plants seem to become unmanageable when upsized to large scale – which is necessary for the huge capital costs to be justified. The root cause of most problems is the intrinsic variability of waste feedstocks".
48. Mixed waste (including RDF and SRF) is particularly ill-suited for use as a feedstock for the purpose of producing a syngas for use as a transport fuel because the heterogeneous nature of a mixed waste feedstock results in high levels of impurities in the syngas, adversely affecting the reliability and greatly increasing the likelihood of catastrophic failure of the facility.
49. These problems are inherent with the technology as applied to mixed waste treatment, and cannot be solved through Government subsidies.
50. **Decarbonisation of electricity generation and related matters**
51. UKWIN is aware of the Government's ambitions for decarbonising the power sector. Not only would gasification and pyrolysis hinder efforts to decarbonise, but even if these technologies were to be considered part of a viable pathway towards decarbonisation (and UKWIN believes they are not), then the timescales involved and the history of the waste gasification and pyrolysis industries indicate that these technologies would not be able to contribute to decarbonisation ambitions for 2050, let alone for the 2020 - 2030 period.
52. Furthermore, by the time the waste gasification and pyrolysis technologies could come on-stream the residual waste treatment sector would already be so saturated with treatment capacity that too few gasification and pyrolysis plants would be able to enter the market to make a significant difference.
53. Dominic Hogg is the Founder and Chairman of Eunomia, the research consultancy that maintain BEIS's renewable energy planning database. Eunomia was also cited in the Government's EfW Guide with respect to their work on estimating future domestic residual waste treatment capacity needs.
54. As noted in the article by waste industry expert Dominic Hogg published in the Independent earlier this month: "For the last five years, Eunomia Research & Consulting has closely monitored the amount of residual waste the UK generates, as well as the capacity of the incinerators we have – those in construction, and those being planned – to deal with it. If the whole of the UK was to follow the Welsh approach then, by our estimates, by the end of the decade there will be more incineration capacity than waste suitable to feed them".¹¹
55. This implies that even if gasification could become a 'commercialised' technology by 2020 there would not necessarily be space in the market to accommodate even a small number of gasification plants to be built.

¹¹ <http://www.independent.co.uk/voices/sweden-recycling-rates-revolutionary-dark-truth-behind-uk-wales-incineration-a7471861.html>

56. To the extent that subsidies result in gasification/pyrolysis plants being built where there is no demand for residual waste treatment this inevitably results in the gasification of recyclable and compostable material, hindering wider efforts to combat climate change (see Annex 3).
57. Similar issues can arise where subsidised gasification and pyrolysis capacity is able to undercut recycling gate fees to obtain high levels of recyclable material (that would otherwise be extracted from the RDF/SRF) in order to meet feedstock composition specifications that could favour the inclusion of recyclable plastics, paper, and card for their calorific value, even when it would be environmentally better to recycle (and indeed cheaper to recycle, if not for CfD subsidy).
58. In any event, 2020 is an unfeasibly short time period to anticipate any meaningful level of commercialisation for gasification and pyrolysis, and, as outlined above, it is anticipated that gasification and pyrolysis will never overcome the daunting technical hurdles for treating mixed waste feedstock.
59. One of the most notable features of the gasification and pyrolysis industries is that those involved are extremely tight-lipped about their failures, making it extremely difficult for lessons to be learned when things go wrong.
60. For example, Waste2Tricity/Peel, who helped Air Products find the site for the Tees Valley gasification project, embarked on a project that shared some of the same core gasification technology that failed at Tees Valley. Even so, Waste2Tricity/Peel was unable to find out vital information from Air Products such as: the cause of the technology failure at Tees Valley; how Waste2Tricity's sister plant would be affected; and lessons to be learned (e.g. for design and operation).
61. As Stephen Othen, Technical Director of Fichtner and expert witness for Waste2Tricity/Peel at the Bilsthorpe Planning Inquiry, put it when discussing whether he knew what was going wrong at the 'sister plant' of the proposed gasification plant for which he was advocating: "...Air Products...have no reasons to tell us. I do not know what problems they are having...".
62. Even when given more time by the Secretary of State specifically to try and answer the question of what went wrong at Tees Valley [TV1 and TV2] and how it might affect their Bilsthorpe proposal, Waste2Tricity/Peel were unable to provide an explanation because their business partner was unwilling to be of assistance.
63. As Peel explained to the Secretary of State during the course of the Bilsthorpe planning inquiry: "We also refer the Secretary of State to Air Products' quoted position in the same article where they explicitly state they are: 'unable to go into specifics on the technology'. Thus, on the point as to why or what part of TV1 did not function, the factual position is that Air Products has never released any details." and that "Air Products has released no specific details as to why TV1 would not work. This remains the case".¹²
64. Tees Valley benefitted from a contract for Government investment, and yet the project still failed to help advance the gasification industry.
65. Not only was the project cancelled, but no lessons were learned in the process.

¹² Letter to SoS dated 5th May 2016 for PINS Ref APP/L3055/V/14/3001886

66. This illustrates why pouring Government money, and promises of Government money, into gasification and pyrolysis is a waste of money that brings the UK no closer to achieving our decarbonisation goals.
67. Furthermore, as set out above, wasting time on failed technologies has the effect of actually delaying decarbonisation by focussing businesses and investors on pursuing meritless technologies rather than technologies that can actually support rapid decarbonisation.
68. Paragraph 2.5.38 of DECC's National Policy Statement for Renewable Energy Infrastructure (EN-3) acknowledges that: "CO₂ emissions may be a significant adverse impact of biomass/waste combustion plant" and Paragraph 1.9 of DECC's 2012 UK Bioenergy Strategy acknowledges that: "...it is essential that bioenergy which contributes to our short and medium term targets, such as the 2020 renewable energy targets, also puts the UK in a good place for longer term decarbonisation".
69. It is noted above that gasification and pyrolysis are actually very inefficient technologies for waste treatment.
70. Not all potential feedstocks are capable, via gasification or pyrolysis, of producing syngas that meets the minimal tar contamination levels required in downstream processes for conversion into other fuels or combustion in gas engines.
71. Whilst the alternative of combustion in boiler plant may be less sensitive to contaminants in syngas, the presence of these contaminants still contributes to scheduled and unscheduled downtime and to the unreliability of gasification and pyrolysis technologies when applied to mixed waste treatment.
72. The overall efficiency of thermal treatment processes involving syngas combustion depend very largely on the efficiency of the technologies employed to convert the heat derived from syngas combustion into electrical energy. Utilising the steam arising from gasification and pyrolysis processes to drive a turbine inevitably implies low overall efficiency and, given the parasitic requirements, even lower net efficiency (typically less than 20%). See Annex 4 for technical details including case studies data on design and actual performance, as well as a brief explanation of some of the technical factors limiting the efficiency of gasification).
73. The relatively high waste consumption and relatively poor power output associated with waste gasification and pyrolysis inevitably results in levels of CO₂ per MWh (i.e. emission factors) which are higher than those of a CCGT and much higher than the published DECC's IAG long-term marginal generation emission factors.
74. For example, any energy generated by Waste2Tricity/Peel's gasification plant proposed for Bilsthorpe would have an average fossil carbon intensity of 0.903 tCO₂eq/MWh based on the figures provided by the applicant (see Appendix 3 for UKWIN's carbon calculation evidence as submitted to the Bilsthorpe Inquiry).
75. This fossil carbon intensity is significantly higher than DECC's current Long-run Marginal Emissions Factor (MEF) for 2018 of 0.279 and the CCGT comparator of 0.349 as per Section 2.3.1 of DECC's (December 2015) 'Energy and GHG Appraisal and Evaluation: Background Documentation'.

76. These figures give rise to the conclusion that energy from the gasification technology proposed for Bilsthorpe would have a significantly higher fossil carbon intensity than either the current conventional use of fossil fuel (CCGT) or the long-run marginal energy mix (MEF) as anticipated by DECC.

77. Regarding BEIS' assessment of the 'value for money' of waste gasification and pyrolysis investment it is worth considering that, as with other forms of thermal treatment, DEFRA acknowledge that: "The emissions from waste combustion of non-biogenic material (via any technology including mass-burn incineration) are also not comprehensively reflected in the price of disposal".¹³

78. As such thermal treatment technology is in effect already being subsidised by the Government through the externality of the CO₂ emissions not having been internalised, meaning CfD would in effect be a supplementary subsidy.

LIST OF ANNEXES AND APPENDICES

ANNEXES

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Annex 2 - Commenting On Industry Claims Regarding Gasification

Annex 3 - Comparing Thermal Treatment and Recycling

Annex 4 - Design and Actual Performance of ACT for Mixed Waste

APPENDICES

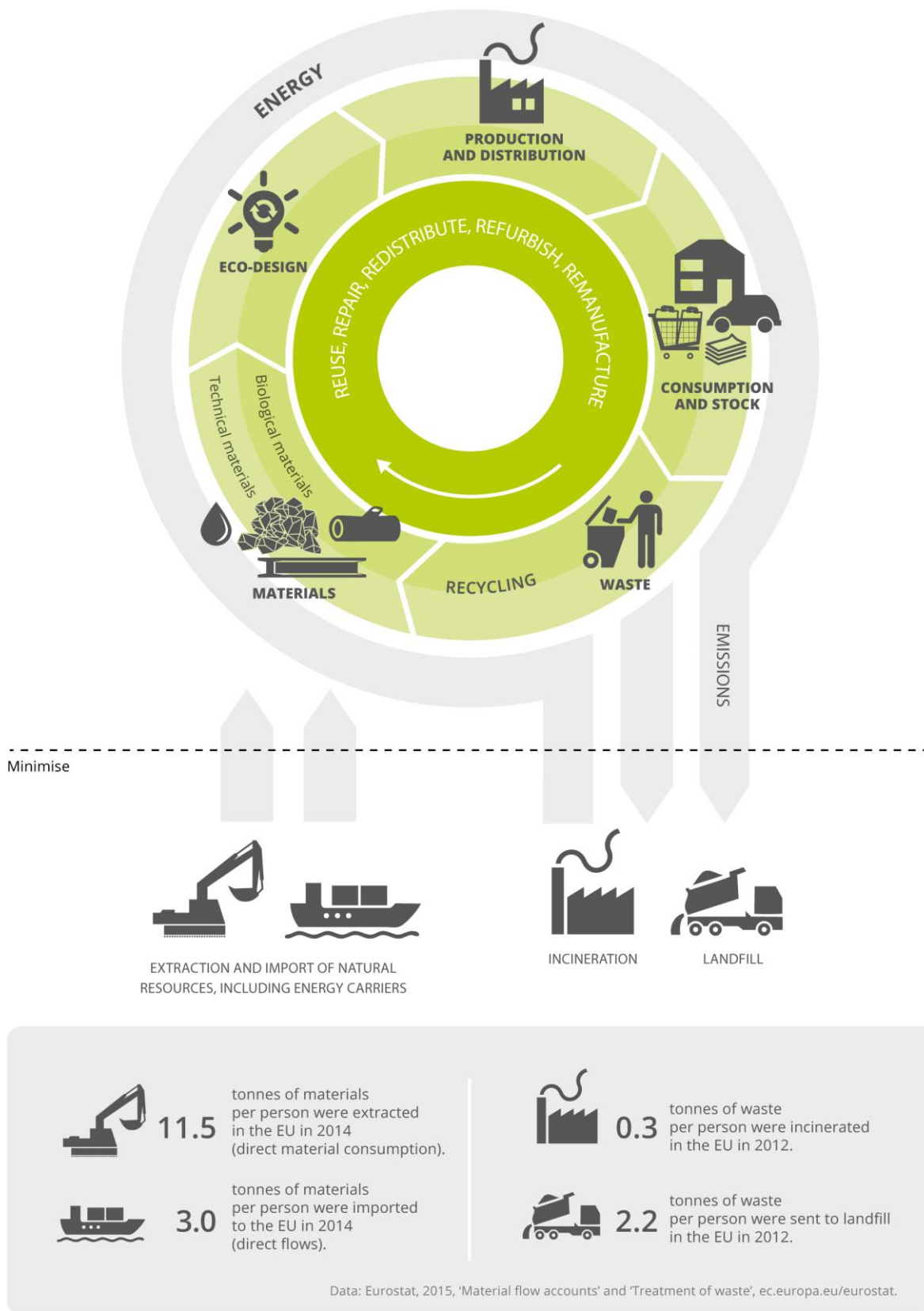
Appendix 1 - Relevant excerpts from UKWIN's EFRACOM evidence

Appendix 2 - UKWIN's Gasification Failures Briefing (November 2016)

Appendix 3 - UKWIN's carbon calculation evidence as submitted to the Bilsthorpe Inquiry

¹³ The Economics of Waste and Waste Policy (Defra, June 2011). Available from:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69500/pb13548-economic-principles-wr110613.pdf

UKWIN ANNEX 1 EUROPEAN ENVIRONMENT AGENCY'S CIRCULAR ECONOMY DIAGRAM



Source: <http://www.eea.europa.eu/media/infographics/circular-economy/view>

UKWIN ANNEX 2 COMMENTING ON INDUSTRY CLAIMS REGARDING GASIFICATION

1. There are a number of claims and speculative statements made by those in the waste industry regarding gasification and pyrolysis that require comment from UKWIN as these third-party comments relate to issues covered UKWIN's submission and may otherwise be relied upon by BEIS without having been supplied with the relevant context.
2. Firstly, we note comments made by Mark Sommerfeld, policy analyst at the Renewable Energy Association (REA).
3. In their press release entitled 'REA response to UKWIN gasification report' (4 November 2016), which we note does not directly dispute the accuracy of UKWIN's evidence, REA quotes Mr. Sommerfeld as stating that: "Gasification Technology is proven, as demonstrated by projects in operation across the globe" and that "The failure of some projects to date are not endemic to the sector".¹⁴
4. On the 7th of November 2016 UKWIN wrote to Mr. Sommerfeld as follows:

"...In your response you state that "Gasification Technology is proven, as demonstrated by projects in operation across the globe" however you do not provide any examples of these gasification projects.

"UKWIN would be grateful if you could provide details of what you would consider to be the most successful operational mixed waste gasification projects in the world...."
5. To date, despite his public proclamations, Mr. Sommerfeld has not been able to provide a single example of a relevant gasification 'success story' anywhere in the world, let alone provide adequate supporting evidence to make good his claim.
6. Mr. Sommerfeld's reluctance to respond with any tangible examples that could be investigated is unsurprising given that, as noted in our well-researched Gasification Failures briefing:

"Promoters of gasification and pyrolysis schemes...regularly make bold claims about the technological, environmental and financial performance of their proposed facilities with a mixed waste feedstock. In reality, where such configurations have been attempted they have either failed to live up to these claims or operators remain suspiciously quiet about reporting actual performance."
7. Moving on, the document entitled 'Investment in Advanced Conversion Technologies: Has the time finally arrived?' (Eunomia, 2016) contains some cautionary advice worth heeding and is far more critical of ACT and its suitability for CfD subsidy than some in the industry may wish BEIS to think, but the report recycles an old rumour about the Tees Valley plant that requires further exploration.¹⁵

¹⁴ <http://www.r-e-a.net/news/rea-response-to-ukwin-gasification-report>

¹⁵ <http://www.eunomia.co.uk/reports-tools/investment-in-advanced-conversion-technologies-act/>

8. The 'Investment in ACT' document states in Section 3.1 that: "While the former Air Products' plant on Teesside recently ceased operations, it is rumoured to be the subject of a takeover that could see it become operational".
9. Firstly, UKWIN notes that the Teesside closure was announced at the beginning of April 2016. As such, it is therefore somewhat misleading to describe the closure 8 months prior as 'recent' within the context of the time-sensitive commercial environment where knowledge capital rapidly diminishes as personnel previously focussed on the gasification project are reassigned to new and unrelated projects.
10. Secondly, the rumours of a potential sale from back in April have gone rather cold.
11. It was noted by Peel in a Planning Inquiry submission regarding their Bilsthorpe gasification plant proposal in May 2016 that: "...there has been information released by Air Products to the effect that due to the terms of their lease the Tees Valley plants may need to be removed. We are unclear how this might interface with the sale process that has also been reported."¹⁶
12. In UKWIN's understanding, more recent rumours regarding staff being removed from the Tees Valley gasification project have further called the sale of the Tees Valley site as anything other than scrap into doubt.
13. The poor prospects for the sale of the Tees Valley gasification plant as a 'going concern' is not surprising given relevant industry comments.
14. Keith Riley is a director of Waste2Tricity, development partner and technology supplier for what Waste2Tricity/Peel described as a 'sister plant' to the Tees Valley project.
15. In a statement to the trade press publication MRW, Mr. Riley called a sale of the Tees Valley plant into question:

"Keith Riley...has told MRW it [the Air Products announcement] was a "great shame" for the industry but he was not surprised by the announcement. He said he could not see another company buying the facilities now as few had as much financial capital as Air Products.

"Even if they gave it away for a pound, the liabilities are pretty high in terms of the investment that you need," he said.

"If they have failed at this point - and bear in mind that Air Products has very deep pockets compared to most other waste companies - so others would struggle."¹⁷
16. As is clear from Mr. Riley's statement, Air Products' decision to give up on gasification was not due to lack of financial resources, as Air Products was one of the wealthiest operators in the sector, but due to their failure (despite substantial investment of finance, expertise, etc.) to have a clear pathway to a viable technology.

¹⁶ PINS ref APP/L3055/V/14/3001886

¹⁷ 'Fears for investor confidence after Air Products withdrawal', 5 April 2016, Rob Preston, MRW. Available from: <https://www.mrw.co.uk/fears-for-investor-confidence-after-air-products-withdrawal/10004939.article>

UKWIN ANNEX 3 COMPARING THERMAL TREATMENT AND RECYCLING

Treating recyclable material through gasification and pyrolysis is a waste of resources that results in avoidable excess emission of CO₂ that hamper wider efforts to combat climate change.

Using DEFRA data from the carbon analysis for thermal treatment¹⁸ and the Scottish metric data for recycling¹⁹ UKWIN calculates the following results:

Plastics

Generating 1 MWh of electricity by thermal treatment of 0.568 tonnes of plastic incurs **0.671 tonnes** of additional CO₂ emissions as compared to recycling the same 0.568 tonnes plastic. This figure is derived as follows:

- a. Generation of 1MWh through thermal treatment of plastics requires 0.568 tonnes of plastic, and is accompanied by the release of 1.08 tonnes CO₂.
- b. This compares unfavourably to 0.365 tonnes CO₂ for 1MWh generated by a Combined Cycle Gas Turbine (CCGT) plant.
- c. Net CO₂ emissions from gasification of plastics compared to generating the same 1 MWh of electricity via CCGT are therefore **0.715** tonnes CO₂/MWh.
- d. Plastics recycling gives rise to carbon dioxide savings (compared to thermal treatment, including gasification) of 0.566 tonnes CO₂/tonne plastic.
- e. Thermal treatment of 1 tonne of plastic at 25% efficiency will result in emissions of 1.90 tonnes CO₂ to produce 1.76 MWh of electricity.
- f. Recycling 0.568 tonnes of plastic will save 0.322 tonnes of CO₂, while the equivalent CCGT generation will incur 0.365 tonnes CO₂. Net emissions can therefore be said to equate to **0.044** tonnes CO₂/MWh.
- g. 0.715 tonnes – 0.044 tonnes = 0.671 additional tonnes of CO₂ released.

¹⁸ 'Energy recovery for residual waste – A carbon based modelling approach' available from: <http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=19019>

¹⁹ 'The Scottish Carbon Metric A national carbon indicator for waste 2013 update to the Technical Report' available from: <http://www.zerowastescotland.org.uk/sites/default/files/2013%20Carbon%20Metric%20-%20Technical%20Report.pdf>

Paper and card

Generating 1 MWh of electricity by thermal treatment of 1.143 tonnes of paper and card incurs **1.5 tonnes** of additional CO₂ emissions as compared to recycling the same 1.143 tonnes paper and card. This figure is derived as follows:

- a. Carbon dioxide savings associated with recycling paper and card are 0.778 tonnes CO₂/tonne paper and card (as per the Scottish Metric).
- b. Thermal treatment of 1 tonne of paper and card at 25% efficiency will give 0.875 MWh for 1.173 tonnes CO₂ if biogenic CO₂ is included.²⁰
- c. The generation of 1MWh through thermal treatment of paper and card requires 1.143 tonnes paper and card and gives rise to emissions of 1.341 Tonnes CO₂/MWh, while theoretically saving 0.365 tonnes CO₂/MWh from CCGT, resulting in net emissions from thermal treatment of paper and card of 0.976 tonnes CO₂/MWh.
- d. Recycling 1.143 tonnes paper and card will save 0.889 tonnes CO₂, whereas the equivalent CCGT generation will result in emissions of 0.365 tonnes of CO₂, meaning a net emissions saving of 0.524 tonnes CO₂/MWh from recycling paper and card when compared to generating the same energy via CCGT.
- e. Generating 1 MWh of electricity through the thermal treatment of 1.143 tonnes of paper and card incurs net additional CO₂ emissions of 0.976 tonnes + 0.524 tonnes = 1.50 additional tonnes of CO₂ released.

²⁰ Note that thermal treatment of 1 tonne of paper and card at 25% efficiency will give 0.875 MWh with 'zero' CO₂ emissions if biogenic CO₂ is asymmetrically ignored, but would still be worse than recycling. If one asymmetrically ignores biogenic CO₂ then the generation of 1MWh requires 1.143 tonnes paper and card, while recycling 1.143 tonnes paper and card would save 0.889 tonnes of CO₂. The equivalent CCGT generation would emit 0.365 tonnes of CO₂. Factoring this in, UKWIN calculates a net emission of 0.524 tonnes of CO₂. So, if one asymmetrically ignores biogenic carbon then the 1 MWh generated by thermal treatment of 1.143 tonnes of paper and card results in 'zero' CO₂ emissions and saves 0.365 tonnes of CO₂ relative to CCGT, whereas recycling the same 0.568 tonnes of paper and card results in savings of 0.524 tonnes of CO₂. Thermal Treatment results in an additional 0.159 tonnes of CO₂ per MWh even if one ignores the direct CO₂ emissions of the thermal treatment. Arguments against 'discounting' (asymmetrically ignoring) biogenic carbon are set out in Eunomia's 'The Potential Contribution of Waste Management to a Low Carbon Economy' and in the Defra-commissioned 'Energy recovery for residual waste – A carbon based modelling approach'.

**UKWIN ANNEX 4
DESIGN AND ACTUAL PERFORMANCE OF ACT FOR MIXED WASTE**

UKWIN notes the statement at Paragraph 3.11 of BEIS' call for evidence that: "Evidence indicates that a significant proportion of ACT capacity currently in the planning system would not help to meet these wider objectives..." and we provide further evidence to support this view, adding weight to the notion that ongoing CFD support for gasification and pyrolysis will not help the Government achieve its objectives.

ACT design performance examples (Derby and Knowsley)

Derby - Energos

(Data extracted from planning application documentation, App. Ref. 05/09/00571)

Parameter	Design Value
Annual operating hours	8410 hours
Net annual electrical output	71,734 MWh
Net Annual Waste Input	140,000 tonnes
(Derived) Input Calorific Value	9.859457 Mj/kg (2.740929 MWh/tonne)
Annual Input Energy from waste	383,730 MWh
Other Annual input energy	10,595 MWh
Net Efficiency	18.19%

Knowsley - Energos

(Data extracted from Environmental Permit Application, Ref. EPR/ZP3339FN)

Parameter	Design value
Annual operating hours	7800
Net annual electrical output	59,080MWh
Net Annual Waste Input	96,000tonnes
Input Calorific Value	11.8 Mj/kg (3.28 MWh/ tonne)
Annual Input Energy from waste	315,000 MWh
Other Annual Input energy	6,226 MWh
Net Efficiency	16.63%

ACT actual performance

Isle of Wight - Energos

(Actual performance data from 2015 annual report, Permit Ref. JP3132LH)

Parameter	Actual value
Annual operating hours	6462 hours
Net annual electrical output	4,941 MWh
Net Annual Waste Input	16,983 tonnes
Input Calorific Value	12.1 Mj/kg (3.36 MWh/tonne)
Annual Input Energy from waste	57,000 MWh
Other Annual Input energy	Not recorded
Net Efficiency	8.7%

CHP / CHP opportunities

UKWIN is not aware of any operational waste to energy CHP plants in the UK to which the ACT description is applied. The unreliability of waste gasification and pyrolysis technologies means it is unlikely that such facilities would be capable of attracting paying heat costumers for any CHP scheme, and the capital investment required to set up a CHP scheme would seem to represent poor value for money.

Effects of the Laws of Thermodynamics on ACT performance

The poor performance of existing and currently planned electricity-only ACT waste to energy plants partially arises, consistent with the laws of thermodynamics, from the relatively low maximum temperatures and pressures achievable in the steam cycles.

The great majority of the energy in the waste is actually dissipated to the environment as heat from the condensers. It would require substantially higher pressures and temperatures, at a significantly increased capital cost, to improve upon the poor level of efficiency of such plants.

At present, gasification facilities are proving to be less efficient than conventional incinerators, and given the parasitic loads involved in cleaning the syngas it can be expected that gasification will always be a poor performer.

GWP implications

As a consequence of the poor energy efficiency of UK ACT plants, CO₂ equivalent emissions per unit of electricity produced are extremely high as compared to those of a CCGT plant, even if the biogenic element is discounted, since ACT plants rely heavily for their meagre output on the energy content (calorific value) of the fossil element (e.g. plastics) in the waste feedstock / RDF.