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ETI Waste Gasification Project

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Agenda

- Energy Technologies Institute
- ETI flexible research project to inform project design
- Why Gasification of Waste
- Waste Gasification Phase 1 Project Aims
- Waste Gasification FEED Study Outcomes and Value
- Waste Gasification project Timelines



What is the ETI?

- The Energy Technologies Institute (ETI) is a public-private partnership between global industries and UK Government

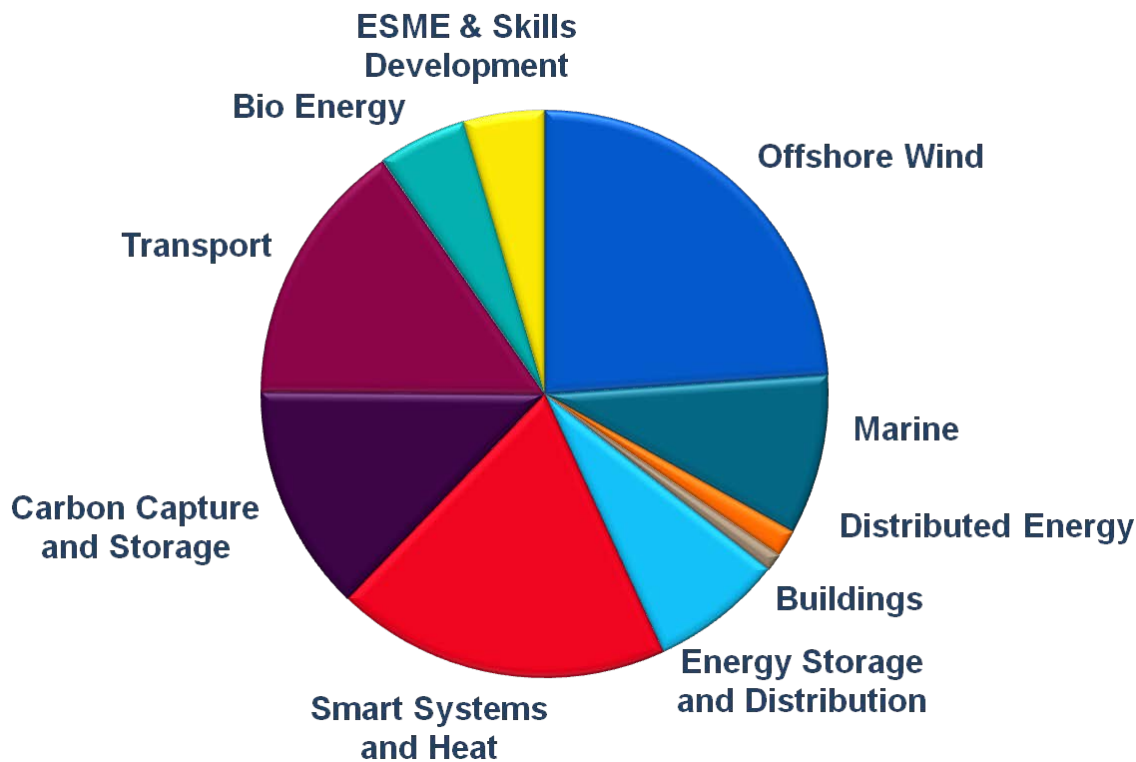
Delivering...

- Targeted development, demonstration and de-risking of new technologies for affordable and secure energy
- Shared risk





ETI Invests time in 9 Technology Programme areas

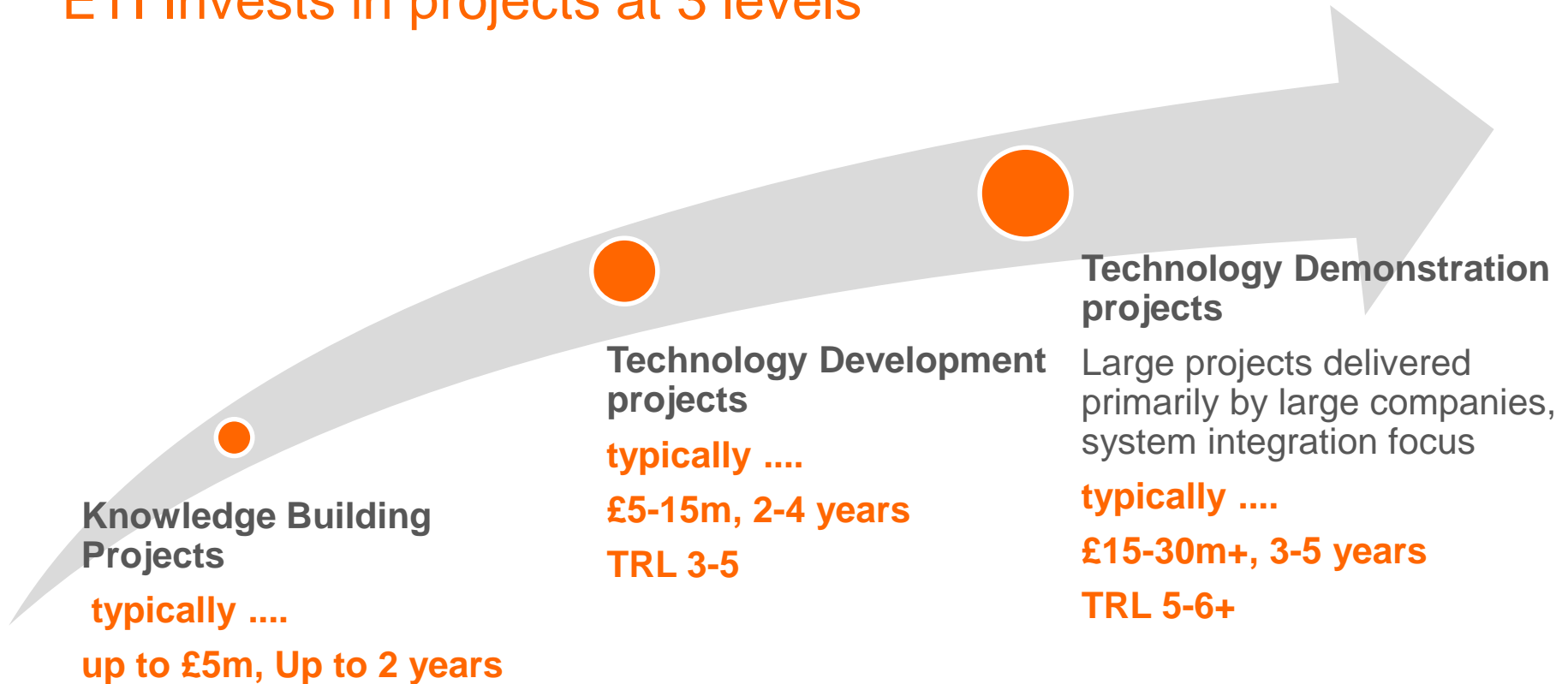


Delivering...

- New knowledge
- Technology development
- Technology demonstration
- Reduced risk



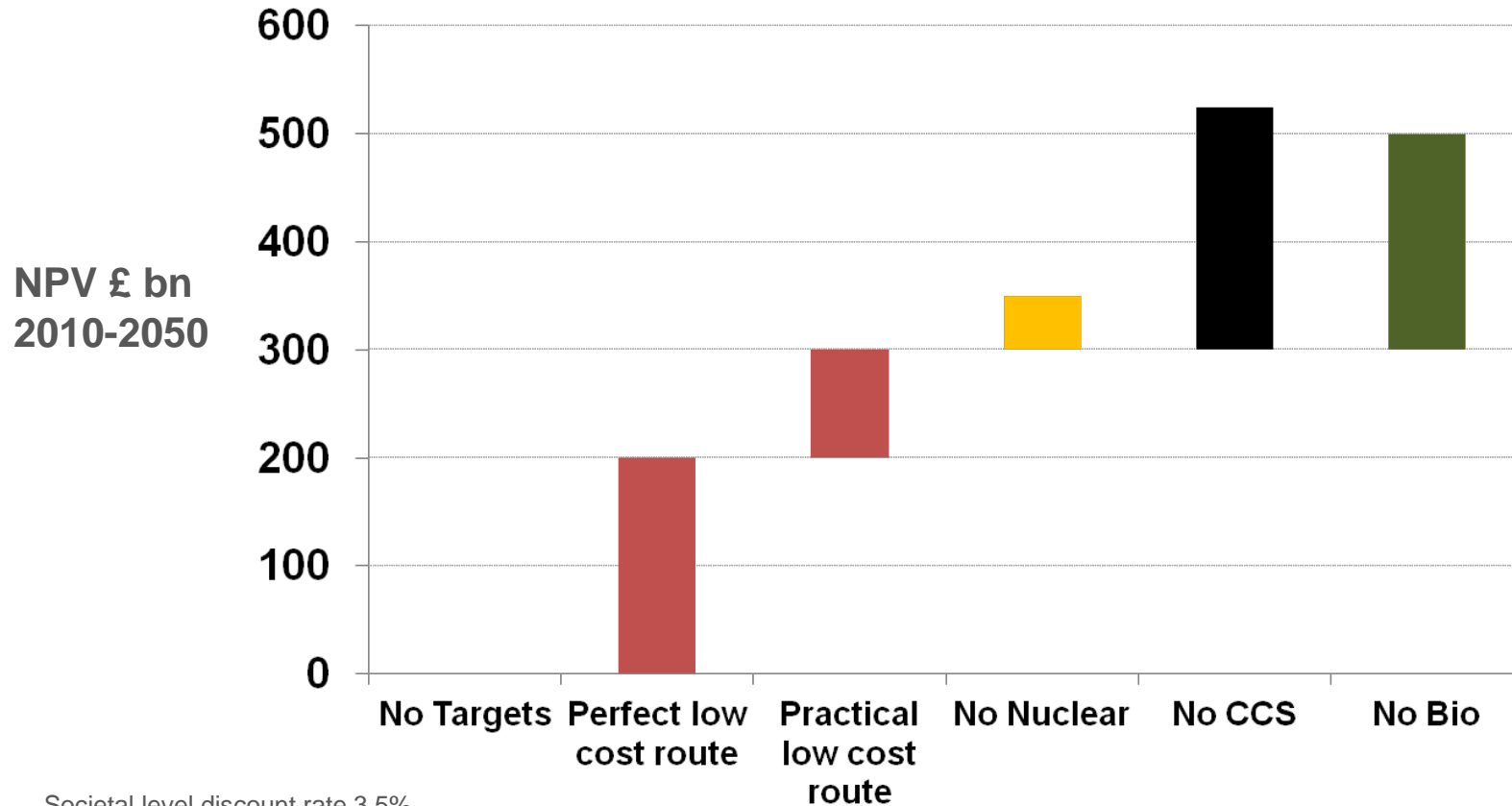
ETI Invests in projects at 3 levels





Getting the UK energy system to 2050

Incremental 2010-2050 cost of delivering national energy system which meets CO2 targets



Societal level discount rate 3.5%



Bioenergy

A key lever – particularly with CCS

Requires sustainable supplies – imports and indigenous

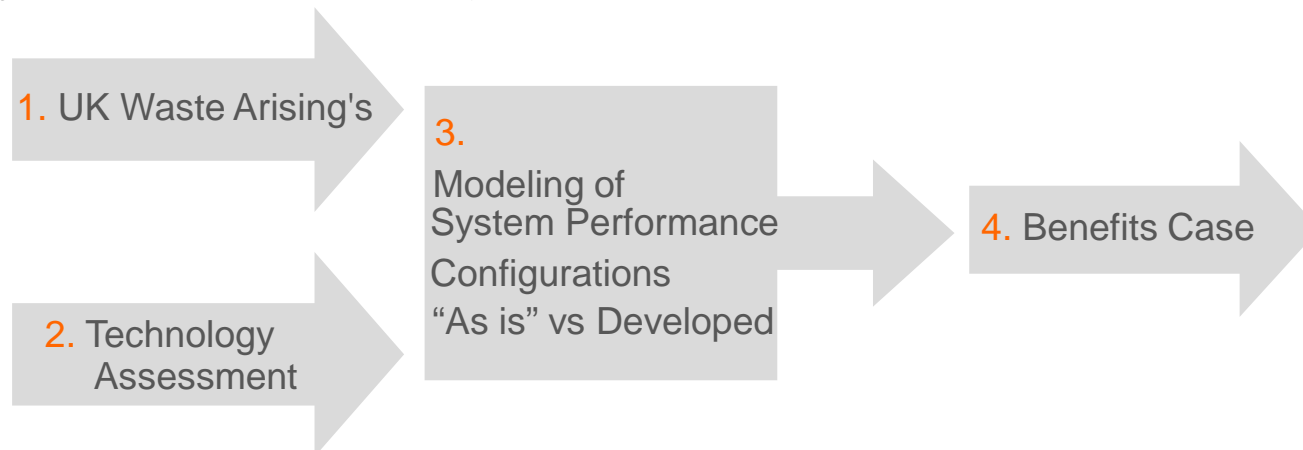


- Major potential for creating ‘negative emissions’ via CCS
- Could support a range of conversion and utilisation routes
 - Hydrogen
 - SNG
 - Heat
- ETI investing in soil science, logistics and value chain models
- Informing decisions
 - “what do we grow ?”
 - “where do we grow it ?”
 - “how do we handle it ?”



Why energy from waste

- Drivers to use waste as a fuel
 - Reduce waste sector emissions – 3.2% of UK GHG emissions in 2009
 - Landfill diversion – landfill tax and landfill diversion targets
 - UK commitments
 - Reduction of UK emissions by 80% by 2050
 - To supply 15% of energy from renewable sources by 2020
- Energy from Waste FRP project





Waste system analysis

- About 90MT of UK waste is energy bearing
- Key waste streams are MSW and C&I – C&D is about 70% non combustible
- C&I contains more paper and card than MSW – due to different recycling targets
 - Both contain large percentages of thin film plastics with high CV
- Plastics contribute significantly to waste CV – economically favourable to extract energy from these providing efficiency is high enough
- Waste streams will always contain some recyclable materials as these can't be continuously recycled

	England	Wales	Scotland	Northern Ireland	Total
MSW	29.1	1.8	2.1	1.1	34.1
C&I waste	58.7	3.6	8.1	1.6	72.0
C&D waste	89.6	12.2	11.8	1.7	115.3
Total	177.4	17.6	22.0	4.4	221.4



Improve definition of the opportunity for electricity & heat generation (& other products) from wastes, now & in the future

- Technology overview & testing program
- FB gasification most suitable technology
 - Dwindraft possibly suitable at smaller scales
- Strong focus on fuel feeding and syngas gas cleaning needed
 - Feedstock pre-treatment may be necessary to homogenise
- Total system design is essential
- Gasification & pyrolysis technologies tested were able to process mixed wastes of widely varying composition
- Operating engines on syngas shown to be feasible
- Integrated AD / gasification set up is an opportunity



Opportunity assessment - component value add & technology combination option identification

- Most UK communities don't produce enough MSW to be economically viable for current scale technologies (e.g. incineration).
 - Town scale is a major development opportunity,
 - benefits in efficiency and reductions in transport impacts including costs
 - High efficiency local plants (with heat use) - strongest impact on emissions reductions from energy from wastes
- EFW technologies must be able to cope with waste variabilities (including shape and moisture content) - drives towards medium and high temperature thermal processes
 - Changes in recycling are leading to reducing MSW and C&I availabilities and changing compositions
 - Elemental composition is relatively stable
 - Opportunity to develop waste pre-treatment technologies to homogenise
- Limited range of options for wet wastes garden waste and food waste
 - AD appears most attractive.
 - AD efficiency is low for the size of plant – work needed to improved process intensities
- Gasification* is preferred to liquefaction by pyrolysis for MSW & C&I
 - Liquefaction by pyrolysis more suited to consistent quality feedstock streams such as tyres

*including Pyrolysis/Gasification combinations and gasification by pyrolysis.



Develop a UK benefits case for development & deployment of the identified technologies

- Identify the potential for energy from waste to deliver GHG reductions, provide energy security, to provide affordable energy, to be robust, and where ETI can add value
- Financial assessment modelling carried out at four scales to understand waste availabilities out to 2030

City

34% of UK population live in cities
500k people taken as scenario scale
UK has 5 cities over 500k people and 26 between 200k and 500k
Mixed economy of residential, industrial and service
No agricultural

Village

21% of UK population live in villages
5k people taken as scenario scale
Residential, little commercial

Town

43% of UK population live in towns
50k people taken as scenario scale
Residential and commercial (with surrounding agricultural).

Rural Agricultural

2% of UK population live in a rural setting
500 people taken as scenario scale
Mainly farming and light industrial (arable or livestock)



Benefits Case Outcomes

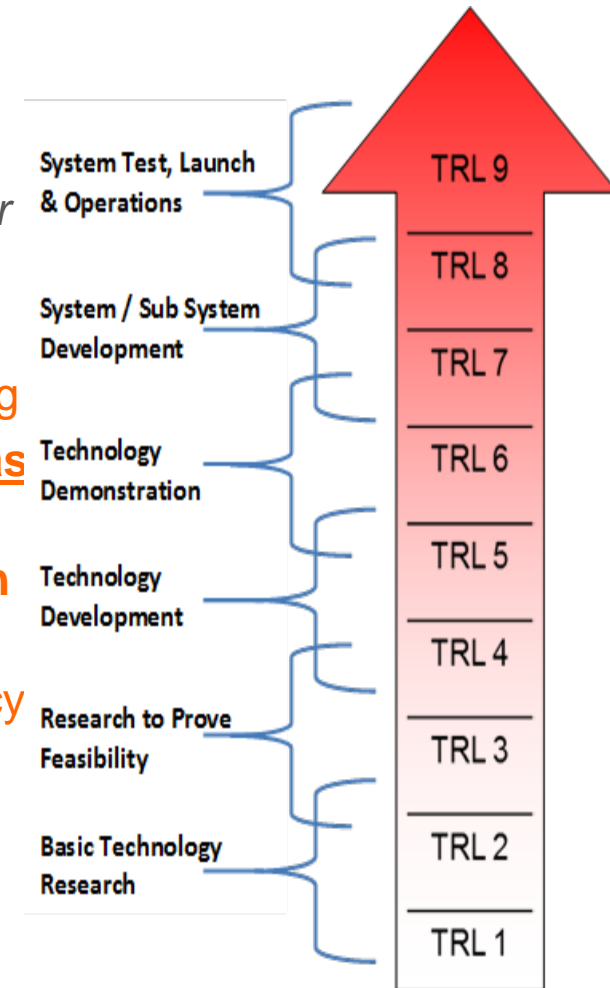
- Projected achievable electrical generation is approximately **25TWh** per year
 - Equivalent to 5-8% of UK electricity demand
- Advanced EFW technologies can potentially contribute to a net decrease 5 to 10 MTCO₂e/year at midpoint technology conversion and waste arisings scenarios
- High total conversion efficiency technologies drive highest GHG savings
- Focus on town and village scale technologies, especially gasification/pyrolysis
 - City scale well served by incineration
 - Cost effective syngas clean-up is essential for community scale systems
- Integrating thermal and AD technologies would maximise resource efficiencies
 - Requirement for higher efficiency, low cost, AD plants that can be integrated

	City	Town	Village	Rural
Av Population	500,000	50,000	5,000	500
% UK Popn.	34%	43%	21%	2%
Waste kT/yr (Mwe)	500 (75)	50 (8)	5 (0.8)	0.5 (0.1)
Number of plants	76	946	4,544	4,544



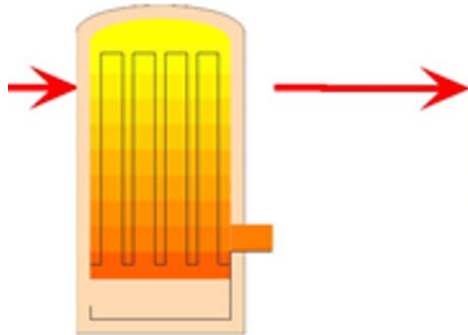
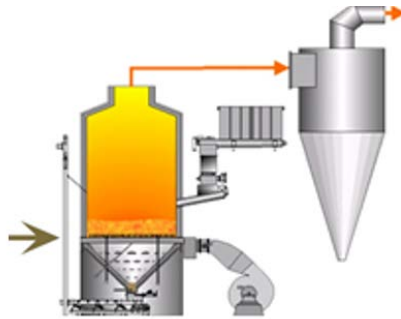
Technology Choices

- Incineration and Anaerobic Digestion TRL 9
- Pyrolysis and Gasification TRL5 (*Laboratory scale, similar system validation in relevant environment*)
- But, Gasification;
 - Can handle a wider range of waste without pre-sorting
 - **Provides great energy sector flexibility (power, gas liquids)**
 - **Is future proof, as an intermediate and destination technology**
 - Greatest potential for ETI to deliver LCOE and efficacy improvements
- Coupling of key elements (Sorting, gasification, gas clean up, gas utilisation) of the system are vital





Waste Gasification Project Phase 1



Aim: To design an economically and commercially viable, efficient energy from waste gasification demonstrator plant in the 5-20 MWe scale range.

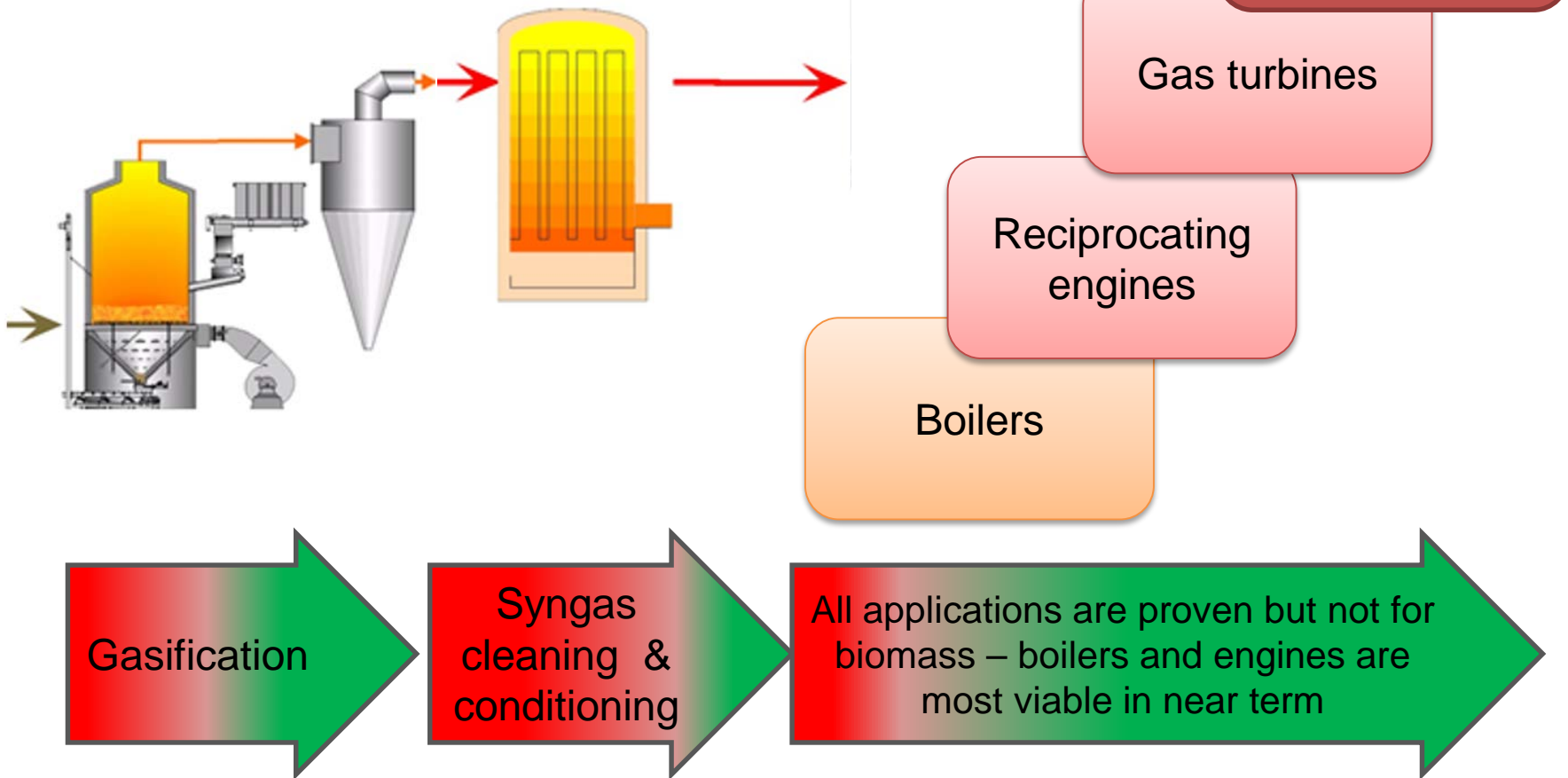
- Three companies commissioned to deliver their design
- Designs supported with a combination of laboratory and pilot scale testing on different feedstocks and through process modelling
- £2.8 million over 1 year



Outcome: Delivery of the process (de-risked) designs, site identification, Planning and Permitting



ETI focus on power with CCS but with recognition of value of flexibility

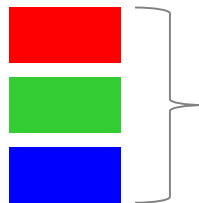




£2.8 million Waste Gasification (WG) project launched in April 2012



Phase 1
Design study



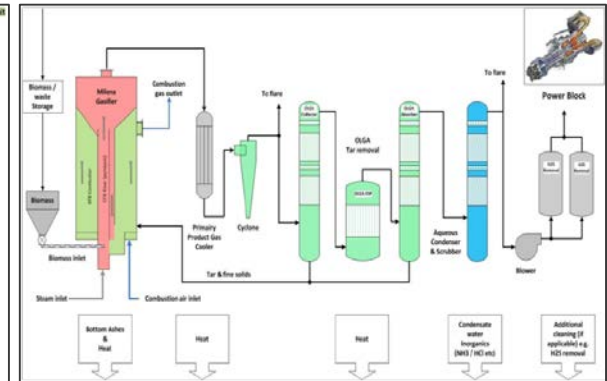
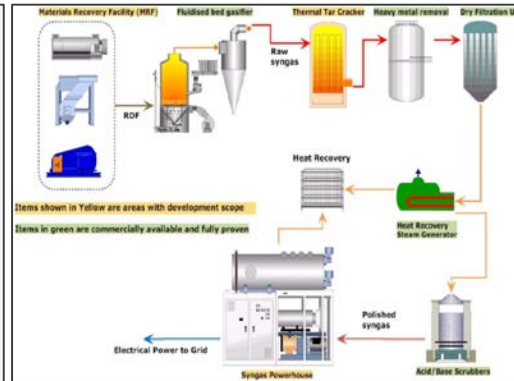
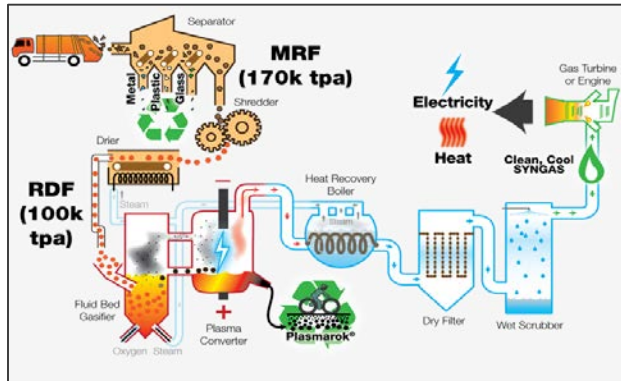
- Integrated system (MRF – engine)
- > 25% electrical efficiency
- > 80% availability

Phase 2
Build and
operate





Advanced Plasma Power, Broadcrown and Royal Dahlman



- Site location: West Midlands (Tyseley)
- ≈ 5MWe reciprocating engines
- Novelty of design: plasma torch tar cracking

- Site Location: West Midlands (Wednesbury)
- ≈ 3MWe reciprocating engines
- Novelty of design: thermal tar cracking

- Site location: NE Lincs (Grimsby)
- ≈ 7MWe Combined cycle gas turbine plant
- Novelty of design: indirect gasifier, turbine and chemical washing



Selection Process

- **Project Review meetings:-** 26-27th February 2014
 - Structured technical review of the final deliverables
 - Technology (Confidence it can work as defined)
 - Deliverability (Confidence the teams can deliver the project goals)
 - Exploitation (Confidence the team understand how to maximise the benefits)
- **Selection panel:-** 5th March 2014
 - Pre meeting scoring process
 - Formal sessions assessing and comparing the projects in three key areas
 - Technology
 - Deliverability
 - Exploitation
 - Final recommendation to ETI Executive Board 7th March 2014
- **Phase 2 contract negotiations**
 - March-December 2014
- **Phase 2 contract announcement**
 - December / January 2015

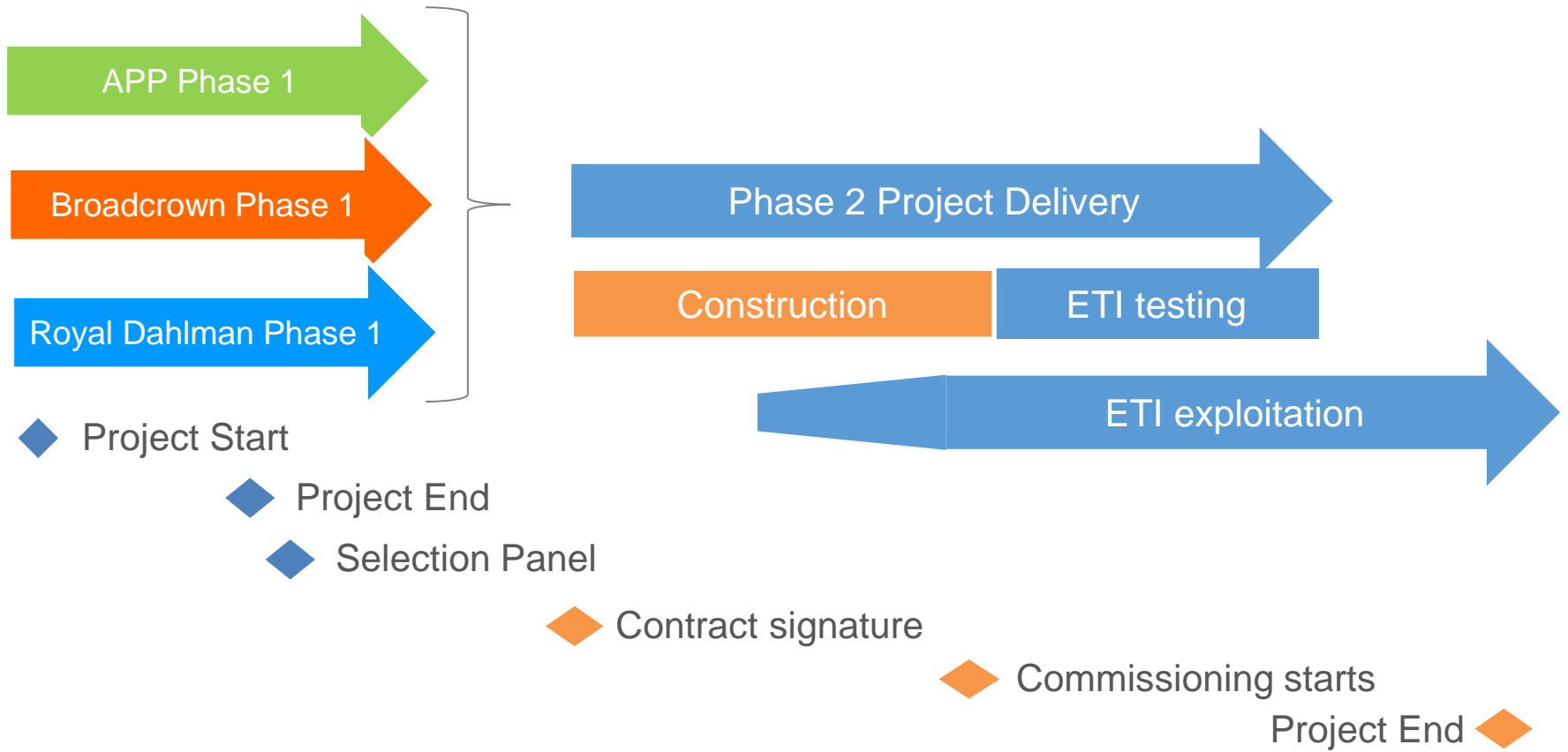


What did we find during our due diligence

- By paying for a FEED study the following areas were clarified and hence reduce the risks in delivery
 - Greater cost certainty
 - Provides clearer risk analysis
 - The value of claims made was established
- Feedstock handling, while not difficult, is a key challenge
 - Different approaches taken to maximise system availability
- There is limited whole system operating experience
- Tars is a complex subject – good understanding of control is essential
- Key understanding of waste properties and how they vary is needed
- Investors are finding it challenging to take on new designs of gasification system due to lack of operational experience and evidence



Forward look



Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
2013			2014				2015				2016				2017			



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