Green Giraffe
The renewable energy financial advisors

Funding Energy From Waste (EFW) projects

The 5 building blocks of a fundable project

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Funding energy from waste

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A specialist advisory firm focused on renewable energy

We get deals done

Deep roots in renewable energy finance

- Launched in 2010 by experienced finance specialists with a **strong and proven track record** in renewable energy
- 100 professionals with offices in Boston (USA), Cape Town (South Africa), Hamburg (Germany), London (UK), Paris (France) and Utrecht (the Netherlands)
- Multi-disciplinary skillset including **project & corporate finance, M&A, tendering, contracting, and legal** expertise

High-quality, specialised advisory services

- Focus on projects where we can actually add value
- We can provide a holistic approach and are able to include sector-specific tasks in addition to traditional debt or M&A advisory (such as contracting, tender advice, strategic advisory, and development services)
- Widening geographical reach beyond Europe, with a growing presence in the Americas, Africa, and Asia
- Priority given to **getting the deal done!**

More than **EUR 25 billion** funding raised for renewable energy projects in **10 years**

100 professionals in **6 countries** on 3 continents

Involved in over **170 renewable energy transactions or projects** with a total capacity of circa **50 GW**

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2. The waste market

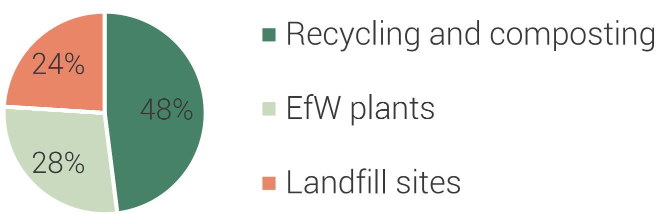
Key producing countries in Europe (2016)

Country	Inhabitants (mil)	Waste produced (Mtpa)	Amount to EfW	Amount to landfill	EfW plants	A.D. plants
	84	411.5	6.3%	16.9%	121	> 9,500
	67	343.9	4.2%	36.0%	129	250
	17	97.8	7.9%	2.2%	13	108
	66	222.9	5.2%	24.4%	41	315

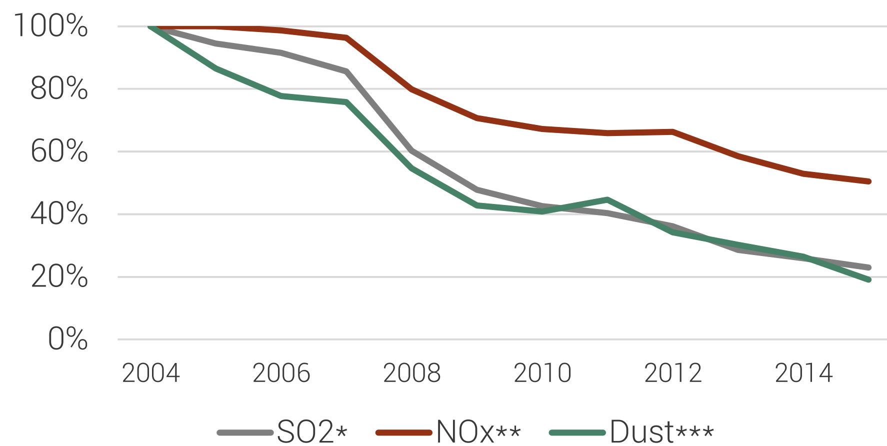
Trends in the EU

- EfW capacity has doubled in the last years
- Incinerator emissions have been reduced by up to 81%

Municipal solid waste treatment in the EU in 2017



Incinerator emissions relative to 2004 base level



*Product of burning fossil fuels, causes acid rain
**Poisonous, removed by urea/ammonia
***Affects view, removed by electrostatic precipitators

Source: EEA, Cewep, Tolvik

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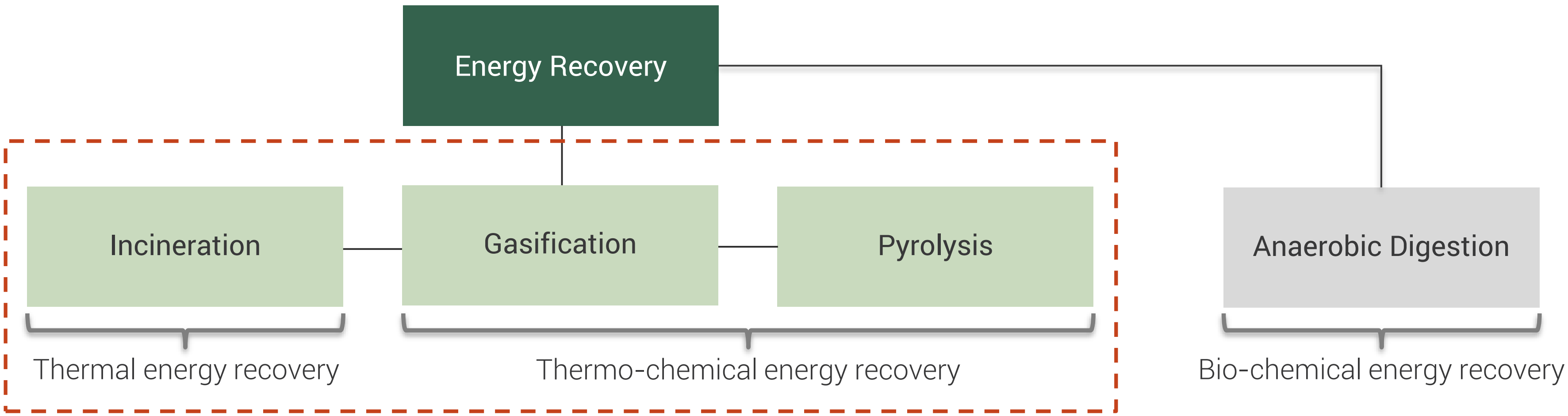
3. Technologies

Methods of energy recovery



3. Technologies

EFW is generating energy in the form of electricity and heat from the destruction of waste

Types in ascending order of complexity

- Mass burn incineration
- Gasification
- Waste to oil
- Pyrolysis
- Plasma arc gasification

EFW in the UK

- UK produces 223 M tons of waste increasing by 2-3% annually
- 104 M tons are recycled
- 97 M tons are landfilled
- 18 M tons of refuse derived fuel (RDF) are processed in 42 EFW plants producing 6 GWh
- 3 M tons of RDF are exported
- 20 plants in construction or development at a cost of GBP 6-8 M /MW

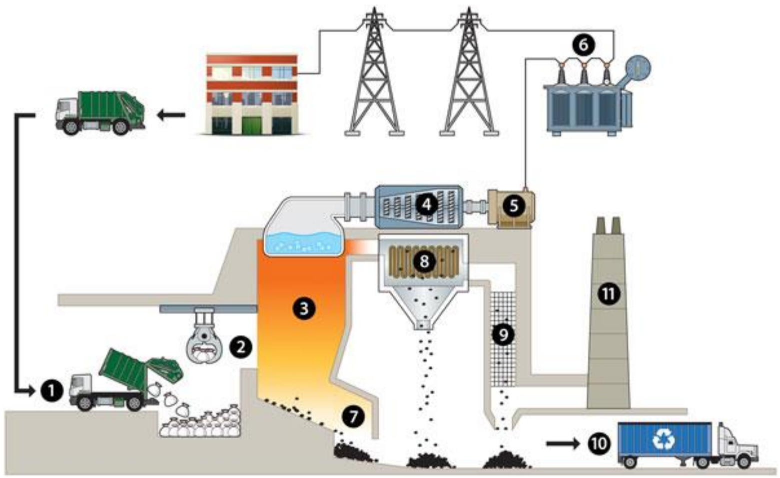
97 M tons of waste being sent to landfill means significantly more energy from waste (EFW) plants required in the next 10 years

3. Technologies

Thermal energy recovery – incineration

Technological aspects

- Main energy product is high temperature heat
- Can process a broad range of waste types
- High plant availability (>90%)
- Waste burnt on a grate, at 850 to 950 degrees centrigrade
- Volume of waste decreased by 95%
- Flue gas treatment and ash disposal required



An incineration plant
Source: Fmanet

Economic aspects

- Most common technology on the market –approx 90% of installations
- Average capex per MW: GBP 7.3 M
- For a medium sized plant (150-350 ktpa), upfront installation cost is on average GBP 200 M
- Lower cost of finance compared to gasification/pyrolysis due to proven technology

3. Technologies

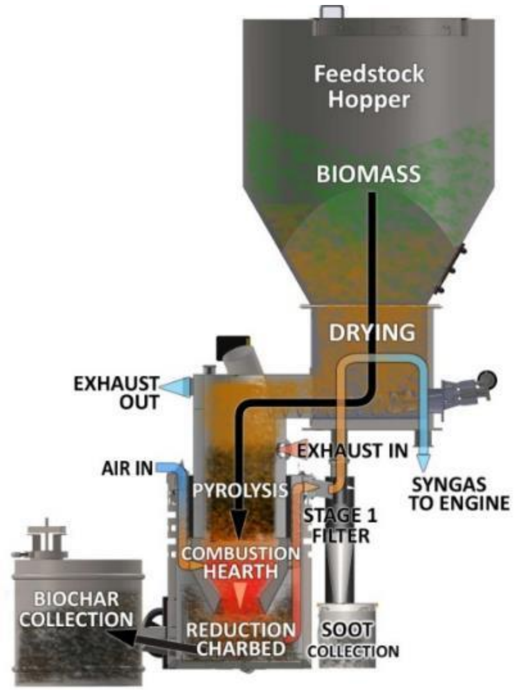
Thermo-chemical energy recovery – gasification

Technological aspects

- Main gasification product is syngas, a fuel gas mixture of hydrogen and carbon monoxide
- Processes refuse derived fuel (RDF) which is waste processed into pellet form but more projects on waste wood are emerging due to higher fuel consistency
- Estimated 75% to 85% of plant availability
- Syngas obtained by reacting at >700 degrees centigrade without complete combustion
- Syngas run through gas clean-up, resulting in pure hydrogen and carbon monoxide
- Can either be cleanly combusted or converted into natural gas

Economical aspects

- In UK only two fully operational commercial scale facilities (15 MW and 7.7 MW)
- Average capex per MW: up to GBP 8.3 M
- Higher upfront installation cost due to more complex technology
- High risk investment (many failed projects) – difficult to obtain funding for gasification projects



A gasification plant
Source: Allpowerlabs

3. Technologies

AD is the process of generating bio gas (methane and hydrogen) from organic materials

4 main types of AD by feedstock

- Food waste
- Crop based
- Slurry based
- Sewage based

By power type

- Gas to grid
- Gas to engines
- Gas to fuel

AD in the UK

- 315 AD plants in the UK (compared to 7,000 in Germany)
- 10.3 M tons of feedstock
- 251 MW of capacity
- UK sent more than 7 M tons of biodegradable waste to landfill in 2017

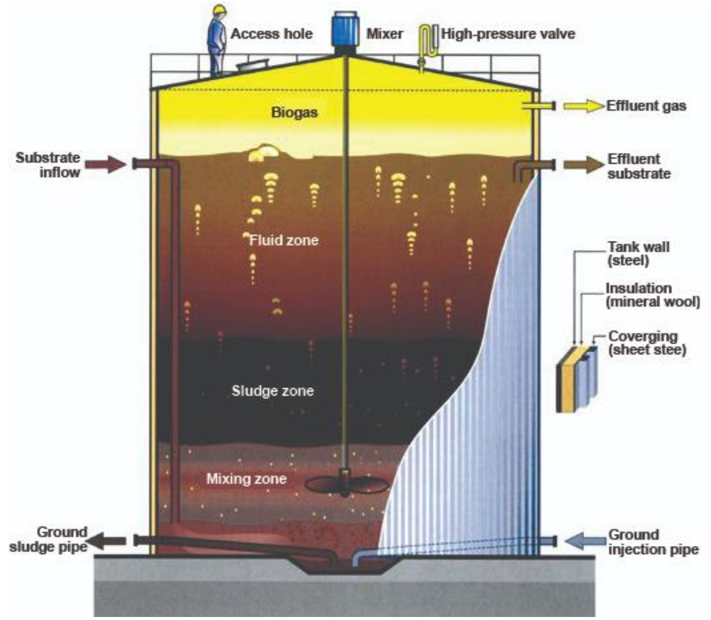
Potential for significantly more AD plants in the next 10 years

3. Technologies

Bio-chemical energy recovery – anaerobic digestion

Technological aspects

- Main product is methane
- Processes MSW or organic waste
- Always available as long as feedstock is provided
- AD breaks down organic waste in an oxygen-free environment
- Result is a gas that can be combusted for energy recovery
- By-products used as fertilisers or soil conditioners



An anaerobic digestion plant
Source: Infograph

Economical aspects

- Technology is proven and mature
- Average capex per MW: GBP 5.1 M
- Initial investment high for commercially scaled projects
- Long-term contracts for biogas and new guidelines for amount of renewable fossil fuel in the UK: 10% by 2020

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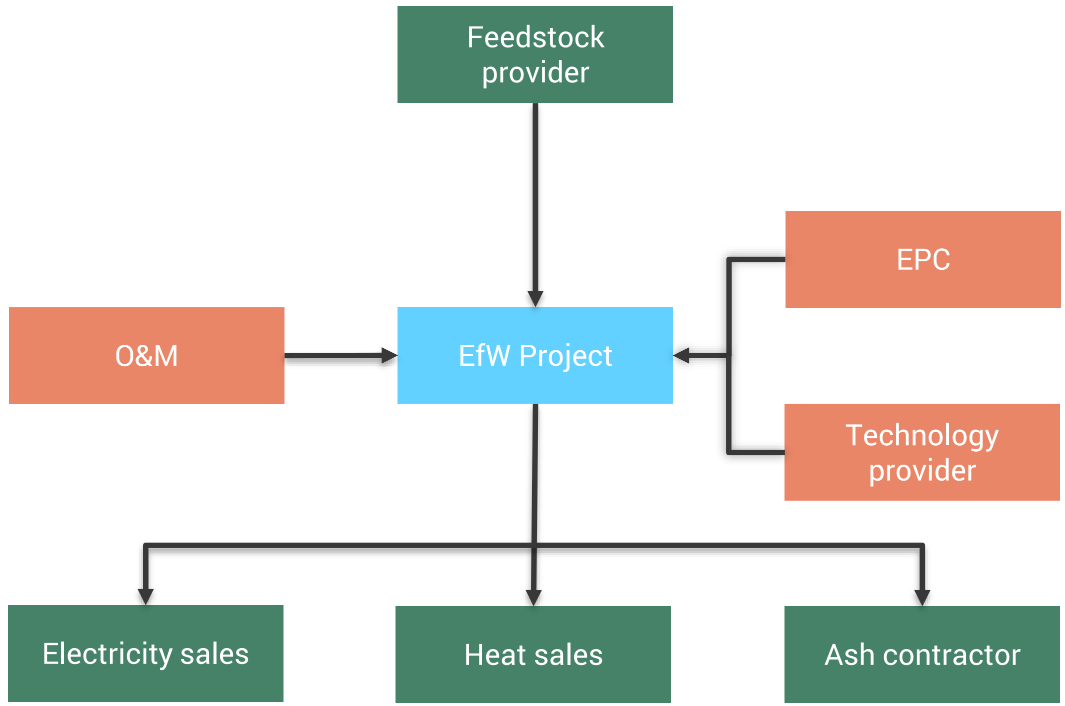
4. The 5 components of a bankable deal..

1. Have you got the waste ?
   - Long term contract ?
   - Realistic gate fee ?
   - Are you an island in a big sea of waste ?
2. Will the technology work ?
   - Proven track record at scale ?
   - EPC wrap
   - Price GBP 7M – 10M per MW
3. Have you got planning ?
   - Section 73 variation or new application ?
   - Local support ?
4. Who will maintain it
   - Fixed price O/M or linked to output ?
5. Does it make enough money ?
   - Project IRR > 12% ?

4. The 5 components of a bankable deal..

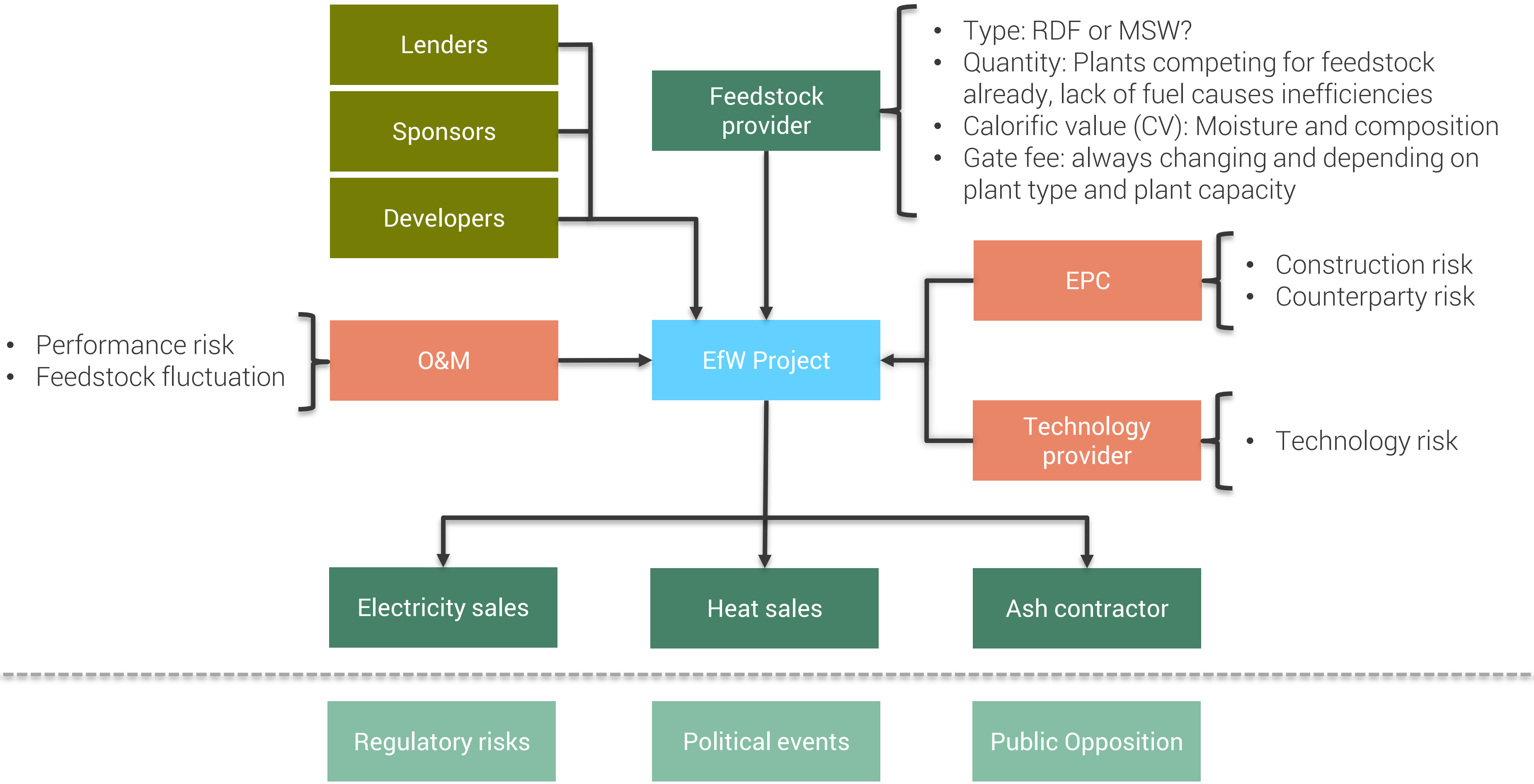
Contractual structure of an EfW project



Costs Revenues

4. The 5 components of a bankable deal..

Risk structure of a EfW project



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5. Conclusion

Waste is a growing opportunity for project finance

I	UK produces 222.9 million tonnes of waste per annum and 25% goes to landfill
II	41 energy from waste plants compared to 121 in Germany. 97m tons pa sent to landfill
III	However, advanced waste to energy technology has had a troubled history in the UK
IV	Banks are retreating to funding proven technologies with 5 required criteria
V	20 projects in construction or development but 20 more needed in the next 10 years

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