



# ENVIRONMENTAL PROTECTION IN ANAEROBIC DIGESTION

How implementation of a renewable  
technology can lead to greater risk of  
environmental harm

# AN INTRODUCTION

## → Myself

- 4 years AD management
  - Plant located at distillery with over 1M liters of ethanol storage
- Joined SLR in 2016 and do most of the Process Safety work at SLR UK
- Led several AD HAZOP studies in the UK and beyond

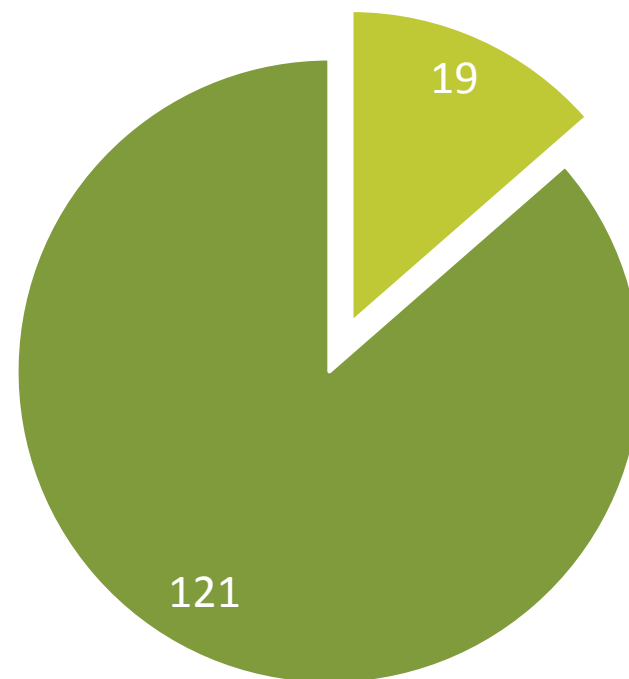
## → My company

SLR delivers global **environmental** and **advisory** solutions



# BENEFITS OF AD PLANTS

- As much as 10 millions tonnes of food waste generated annually in the UK<sup>1</sup>
- 60% of this waste could be avoided, and 2.5 million tonnes of waste is generated after purchase by UK households<sup>1</sup>
- Avoidable food waste leads to 19 million tonnes CO<sub>2</sub>e of greenhouse gas release<sup>1,2</sup> – 16% of the GHG of transport

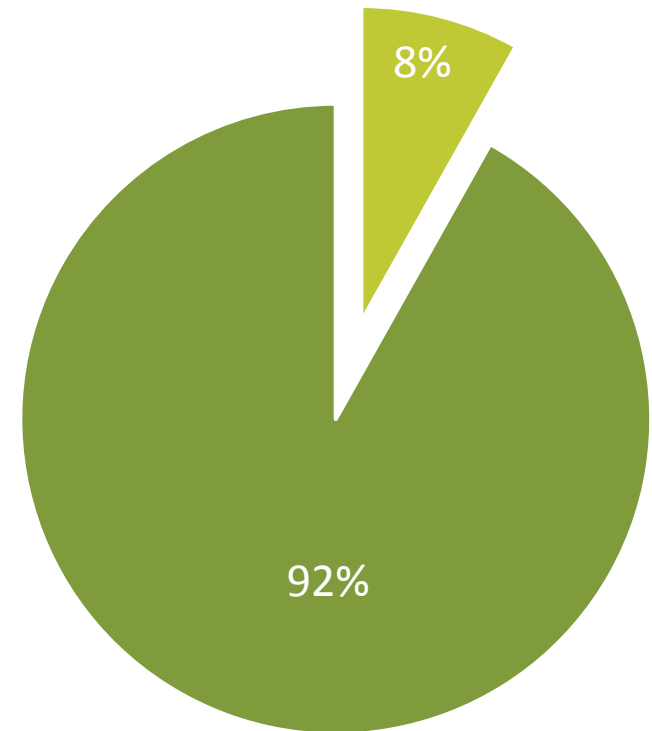


■ Food Waste GHG (Mt CO<sub>2</sub>)  
■ Transport GHG (Mt CO<sub>2</sub>)

1. Waste and Resources Action Programme (WRAP), [Estimates of Food Surplus and Waste Arisings in the UK](#), 2017
2. National Statistics, [2018 UK Greenhouse Gas Emissions - Provisional Figures](#), 2019

# BENEFITS / AD IN THE UK

- Generates a base load of electricity that is not always the case for renewables
- There are over 600 AD plants operating in the UK<sup>3</sup> generating just under 1 GWe equivalent<sup>4</sup>
- In idealised policy setting, AD could generate 78 TWh of renewable gas – compared to 879 TWh of UK gas demand<sup>5,6</sup>



■ "Idealised" Biomethane generation

■ 2018 UK natural gas use

3. Anaerobic Digestion and Bioresources Association (ADBA). [AD Plant Map](#), 2019

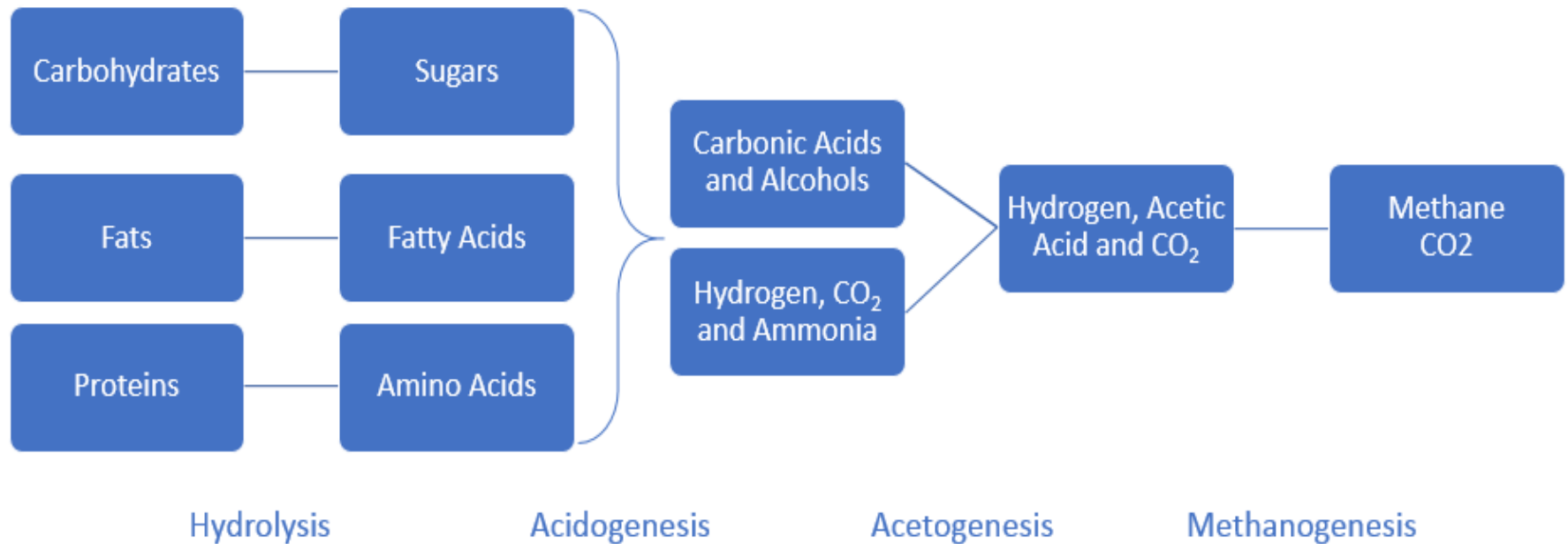
4. ADBA [Market Report](#), July 2018

5. CIWM Journal, [Using Waste to Green the Gas Grid](#), 2018

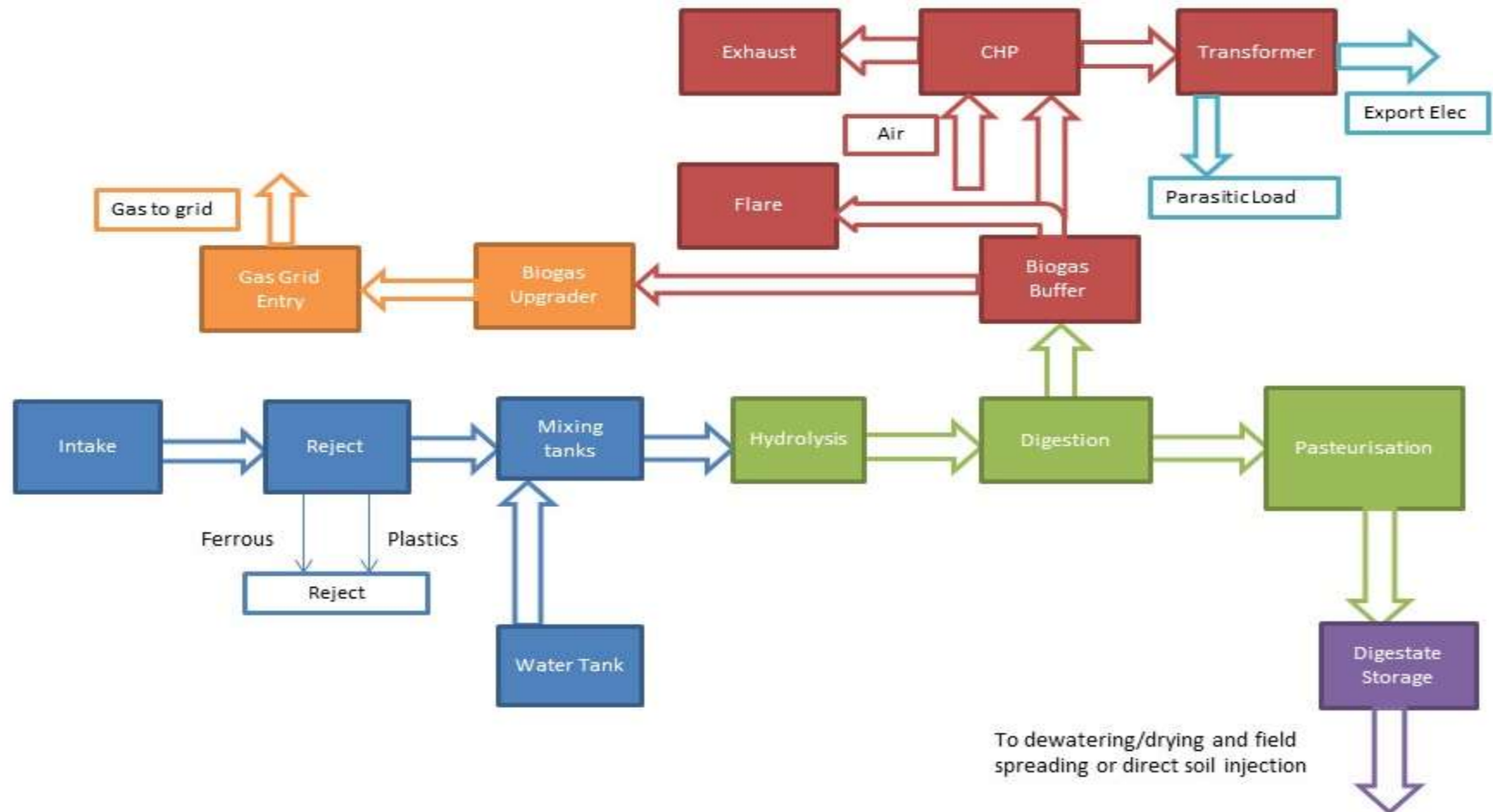
6. National Statistics, [DUKES: natural gas](#), 2017

# THE AD PROCESS

- Anaerobic Digestion is a biological process that converts digestible organic material into methane and carbon dioxide



# A “TYPICAL” WET AD PLANT



# AD FEEDSTOCK



Feedstock management is one of the hardest parts of running AD plants





# A BRIEF INTRODUCTION TO AD



- Digesters store up substrate with up to 60 days residence time
- After digestion this may require pasteurisation



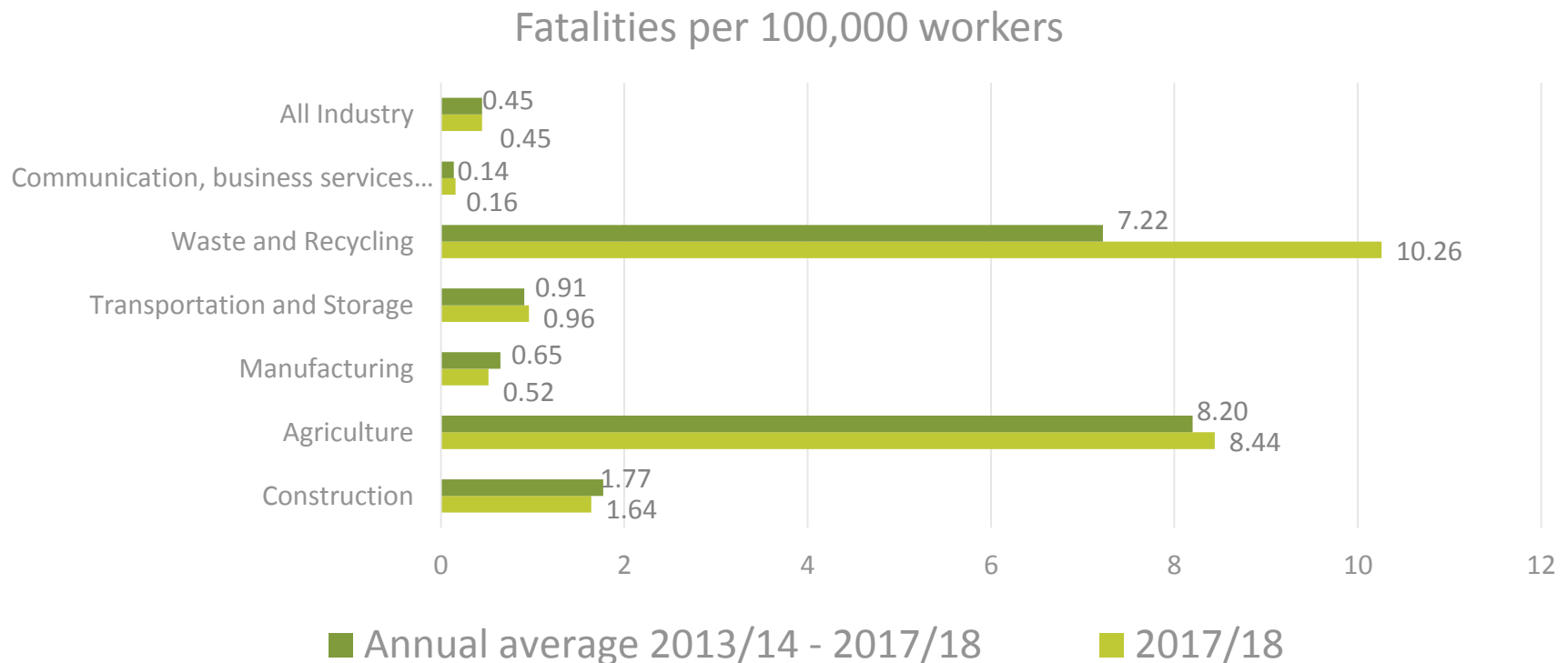


# AD MAJOR ACCIDENT HAZARDS

- Fire and explosion from methane
- Storage of compressed propane at biomethane sites
- Presence of toxic gases for example hydrogen sulphide and ammonia
- Asphyxiation from biogas
- Storage thousands of cubic meters of substrate and digestate - loss of containment
- High COD content of the substrate, in the tens of thousand milligrams per litre
- Biological pathogens – particularly in facilities processing food waste

# UK AD PLANT PERFORMANCE

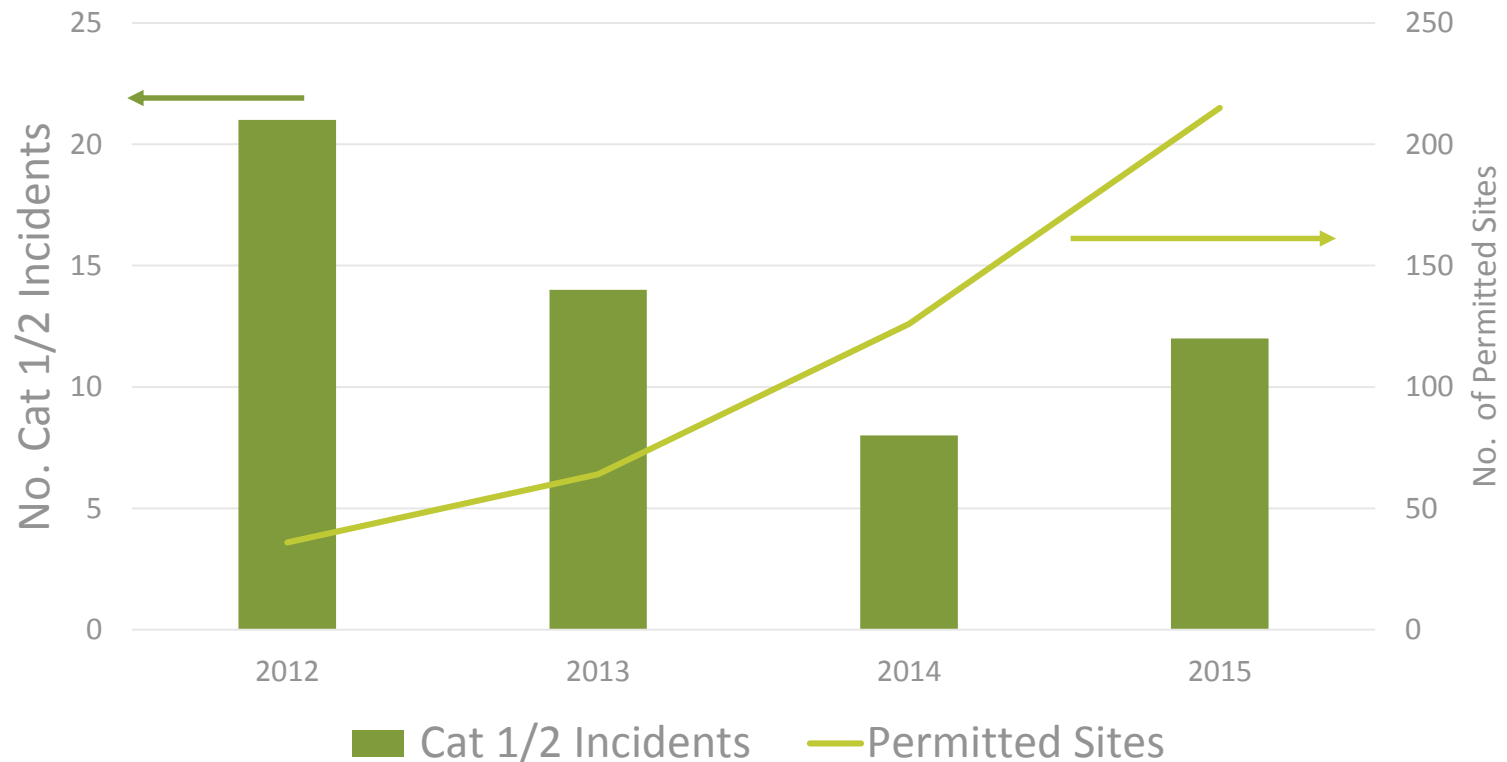
- Unfortunately don't have specific safety states for AD<sup>7</sup> but have HSE data per industry sector



7. HSE. (2018, July 4th). [Workplace fatal injuries in Great Britain in 2018](#).

# ENVIRONMENTAL PERFORMANCE

- Thanks to the EA we have specific data for environmental incidents at AD plants<sup>8</sup>

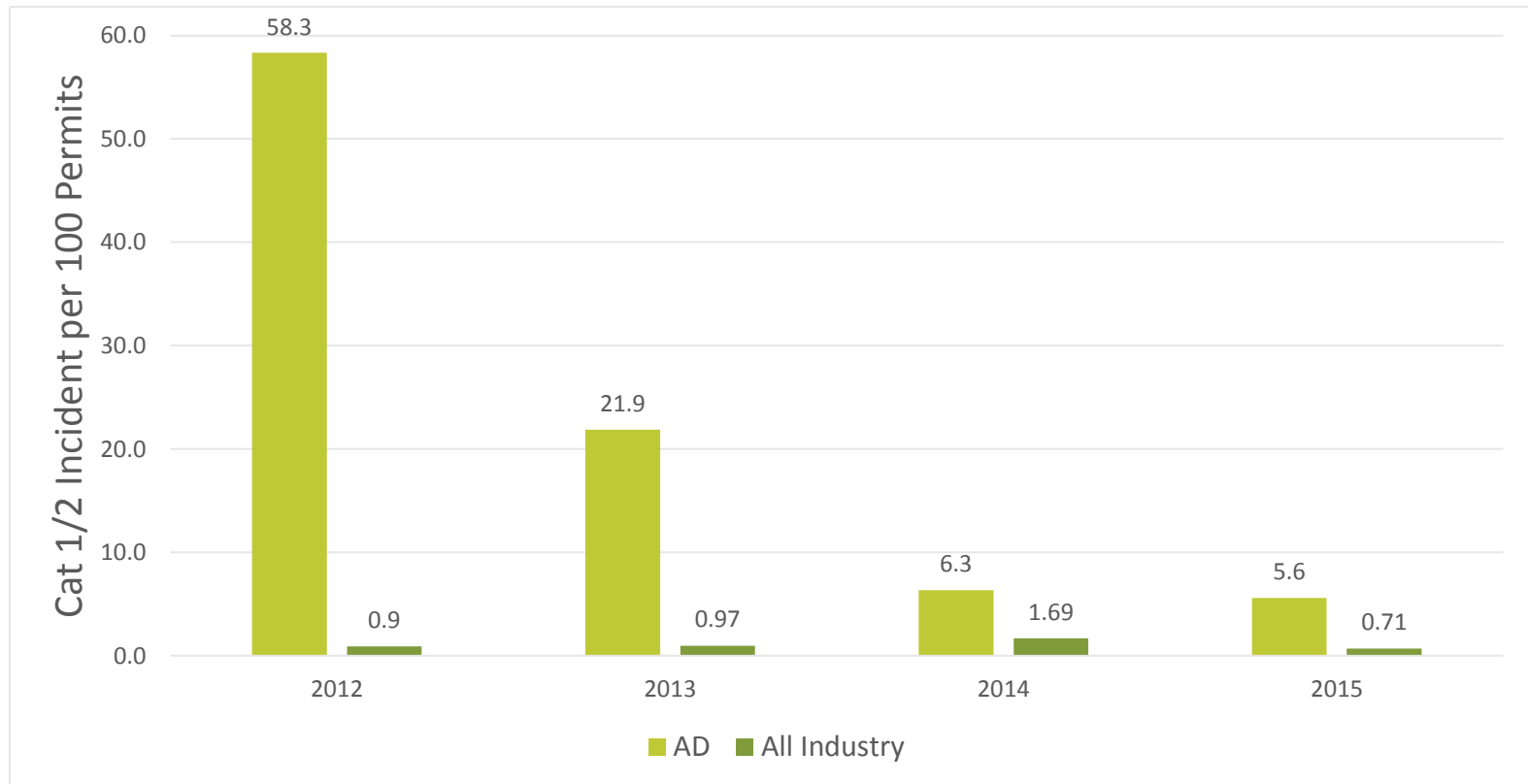


8. Environment Agency. (2016, September). [Pollution Incidents: 2015 Evidence Summary](#).

global environmental and advisory solutions

# ENVIRONMENTAL PERFORMANCE

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# CASE STUDY – LIGHTNING STRIKE

- Food waste AD plant which was struck by lightning
- The damage also led to loss of containment from the digesters
- The plant did not have lightning protection



# CASE STUDY – TANK EXPLOSION

- Maintenance of buffer tank at AD plant led to explosion
- Tank was lifted 10 ft into the air
- Two workers were seriously injured – including one requiring leg amputation





# CASE STUDY – LoC CAUSED BY EXPLOSION

- AD plant at a University processing food waste
- Overpressure led to an explosion and tank failure
- Some substrate flowed into local watercourses
- The site did not have secondary containment



# SOME FINAL CASE STUDIES

- Overflow
  - An operator was pumping digestate into a storage tank
  - The tank had no high-level switches and the operator left the pump on overnight, in error
  - 300 m<sup>3</sup> of digestate overflowed, 10 m<sup>3</sup> escaped the site
- Asphyxiation
  - Two operators repairing damaged biogas roof
  - Both were overcome by H<sub>2</sub>S during the activity
  - One worker died, neither were wearing gas monitors
  - Biogas roof had been damaged multiple times

ONE LAST  
IMAGE





# THE BRIGHTSIDE

- AD is a good technology, but the process and hazards are complex
- There are safety leaders within AD sector pushing to improve
- The EA is in a better position to manage the environmental risk of these plants
- The sector could use its own specific safety statistics to measure its own performance, wider Waste and Recycling sector isn't necessarily appropriate
- Environmental performance is definitely improving
  - Number of plants has increased rapidly, and these plants are now in continuous operation

# THANK YOU FOR LISTENING

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