27th WORLD GAS CONFERENCE | JUNE 25-29 | WASHINGTON DC | 2018 | IGU

Reinventing the Product and the Product Positioning of Natural Gas

Melissa Stark, Global Renewable Energy Lead

Accenture

Introduction

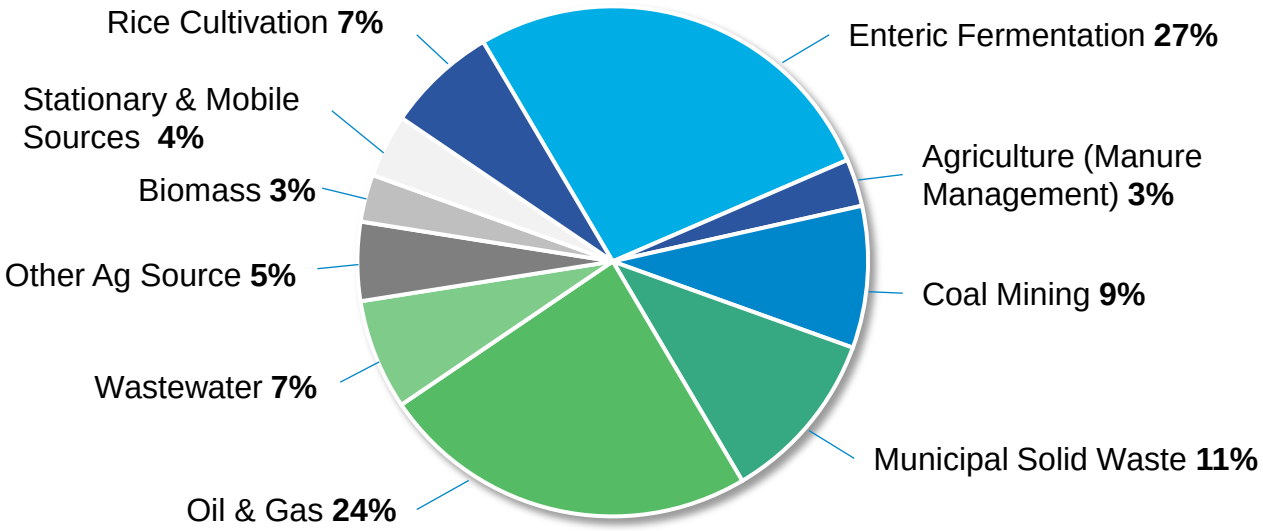
Reposition gas as more than a "complement to renewables" or a "transition fuel" but an integral element of the energy transition

Source: Accenture research paper for WGC, "Reinventing the Product and the Product Positioning of Natural Gas."

Global Methane Emissions

67% of methane emissions come from agriculture, MSW and wastewater, and a significant portion can be abated

Estimated Global Methane Emissions by Source, 2020



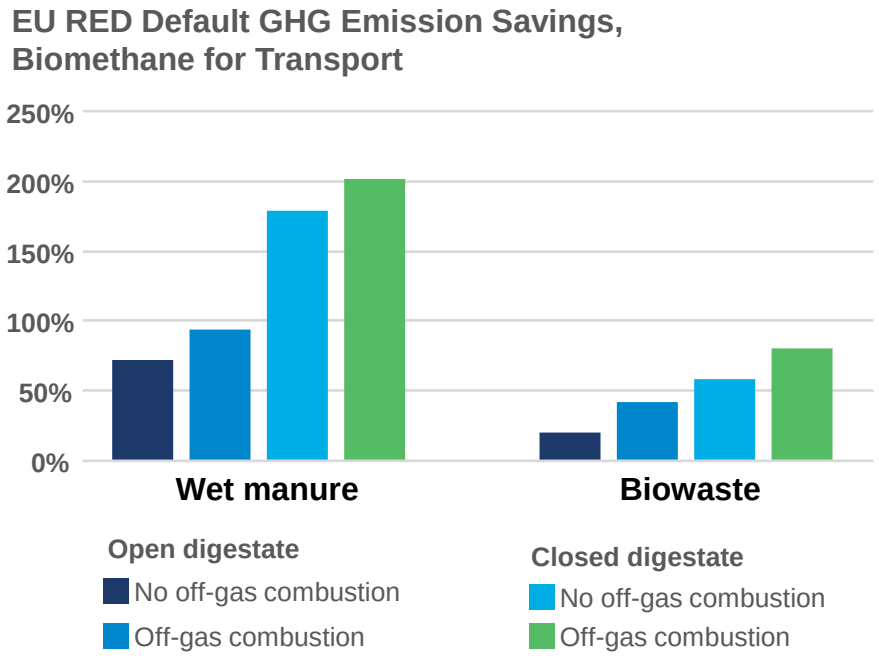
Methane is:

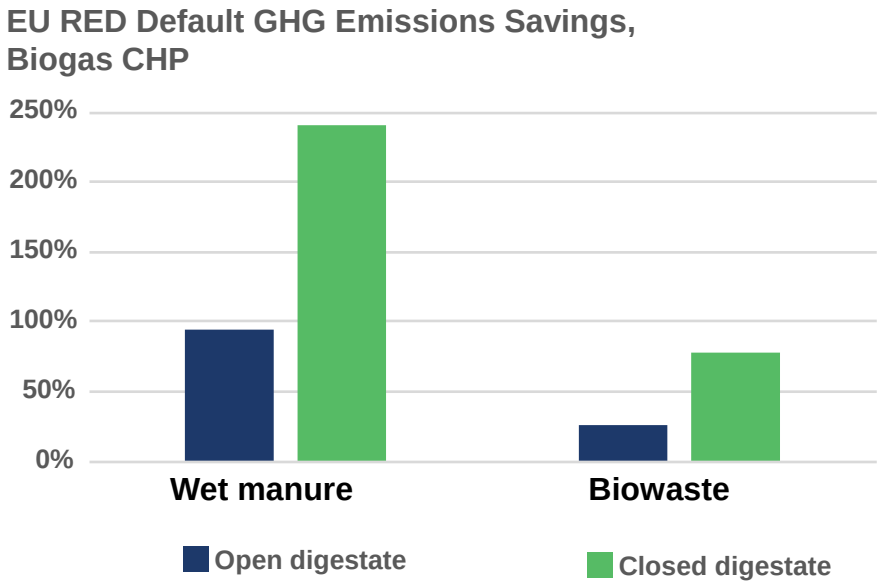
- 2nd most abundant GHG
- 20% global emissions
- 1/3 GHG warming because it can trap heat 28-34x greater than CO_2

Sources: “Global Methane Initiative: An Overview," Global Methane Initiative, 2015, www.globalmethane.org; Accenture research paper for WGC, “Reinventing the Product and the Product Positioning of Natural Gas.”

Biomethane GHG Emissions: Transport and CHP

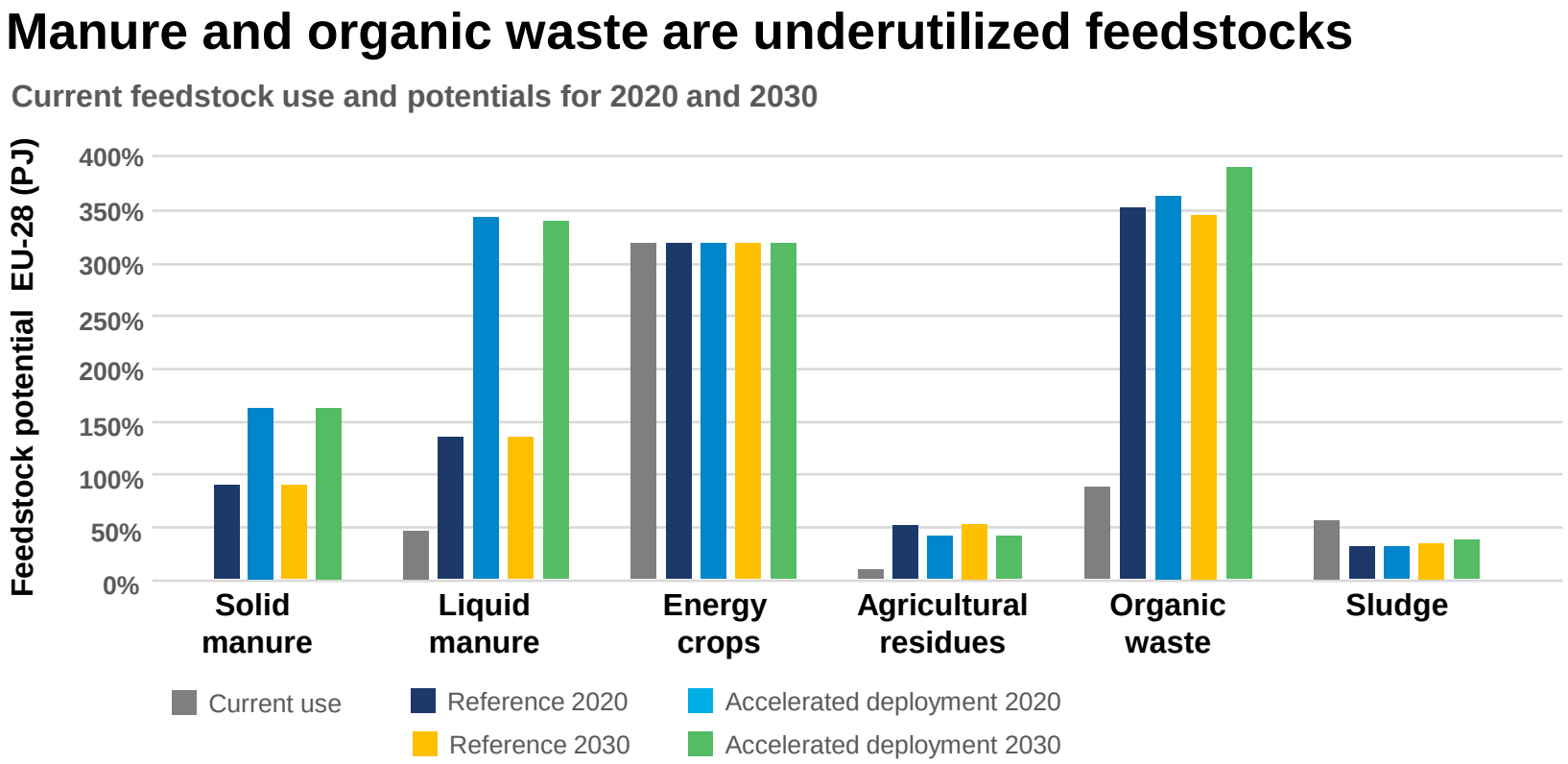
The GHG emissions savings from using wet manure and biowaste are significant





Sources: Council of the European Union, 13 December 2017, http://data.consilium.europa.eu; Accenture research paper for WGC, "Reinventing the Product and the Product Positioning of Natural Gas."

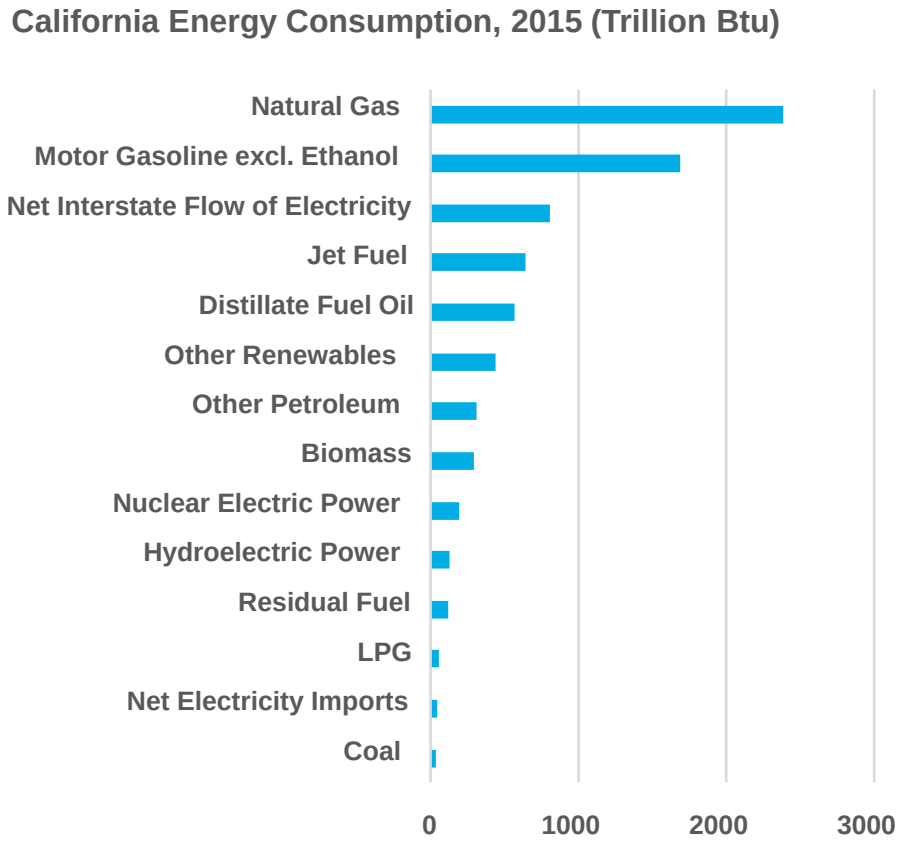
Feedstock Potential: Manure and Organic Waste



Sources: "Optimal use of biogas from waste streams: An assessment of the potential of biogas from digestion in the EU beyond 2020,"European Commission, 2016, https://ec.europa.eu; Accenture research paper for WGC, "Reinventing the Product and the Product Positioning of Natural Gas."

Case Study: California

- Natural Gas largest energy source, imported from other states
- Produces more biogas than any other state with 276 systems (primarily waste water and landfill) and potential for 1,1,87 systems, particularly from agriculture (18 to 960)
- LCFS and RFS make waste gas viable for transport
- SB1383 - Methane regulation
  - Divert 50% (2025) and 75% (2030) of organics from waste stream
  - Reduce dairy and livestock methane emissions by 40% by 2030 (2013)
  - Gas corporations - at least 5 dairy biomethane interconnection projects
  - Biomethane interconnection incentive to cover up to 50% interconnection costs



Sources: California, State Profile and Energy Estimates, Energy Information Administration, www.eia.gov; Accenture research paper for WGC, "Reinventing the Product and the Product Positioning of Natural Gas."

SoCalGas: Market Drivers for Dairy Biogas

- Renewable natural gas (RNG) or biomethane is a key part of SoCalGas' strategy
- Provide education and outreach to biomethane producers on technology, economics and project design
- Cost to upgrade biogas from the dairy sector less than landfill gas, overall project cost is more as dairy digesters need to be built
- Clustering dairy farms and biomethane interconnection incentive to improve economics as some dairy farms not close to connection and do not have the scale to cover capital investment (digester plant, upgrading facility, pipeline connection)

Program	Value	Total Value
Commodity Price of Natural Gas	$3.18/MMBtu*	$3.18/MMBtu
Low-carbon Fuels Standard	LCFS price = ~$92.65/ton CO_2**	~$36.36/MMBtu
Renewable Fuel Standard	RIN price = ~$2.86 RIN***	~$37.14/MMBtu
	Total	**~76.86/MMBtu**

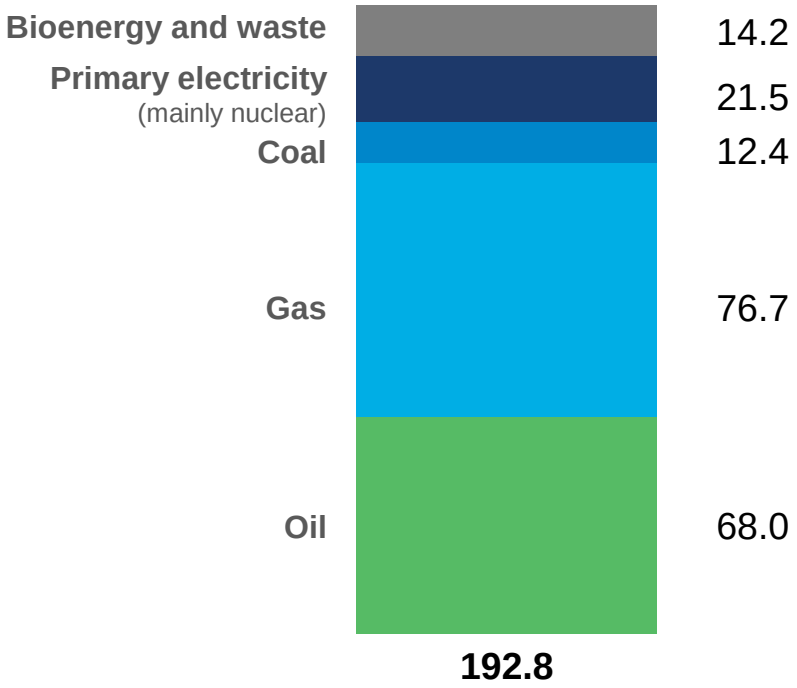
* Jan 2018 Henry Hub price
** Assumes carbon intensity for dairy biogas -276 $gCO_2/MJ3$
*** 2017 Vintage D3 RIN's

Source: Accenture research paper for WGC, "Reinventing the Product and the Product Positioning of Natural Gas"

Case Study: United Kingdom

- Natural Gas largest energy source
- Fast growing market for biomethane-to-grid (BtG) plants with 77 plants. 401 AD plants in total (318 CHP, 77 BtG, 6 cooking/heat only)
- 66% of sewage sludge already treated in anaerobic digestion (AD) plants
- UK produces ~100 mt of organic material that can be used for AD (~10 mt used today)
- Current growth by Renewable Heat Incentive (RHI) interconnection FiT but the Renewables Transport Fuels Obligation (RTFO) will also drive further growth
- Agriculture, largest source of methane (~half UK methane emissions), but no sector-specific methane reduction targets

UK Primary Energy Mix (mtoe)



Sources: "UK Energy in Brief 2017, Department for Business," Energy & Industrial Strategy, July 2017, www.gov.uk; Accenture research paper for WGC, "Reinventing the Product and the Product Positioning of Natural Gas"

UK Renewable Heat Incentive

- Established in 2011, financial incentive to increase the uptake of renewable heat by businesses, public sector and non-profit organisations
- Fixed income (per kWh) for 20 years to generators of renewable heat and producers of renewable biogas and biomethane, including a biomethane injection-to-grid tariff
- Biomethane injection tariff structure 5.35p for first 40,000 MWh; 3.14p for 40,000-80,000 MWh; 2.42p over 80,000 MWh
- Energy Networks Association est. biomethane 10% of UK heat demand by 2020
- Critical is the facilitation by gas distribution companies:
  - Wales and West viewed as leader with a simple process and clearly defined timelines- e.g., inquiry to network analysis in 15 days (no charge), capacity study in 30 days with seasonal and daily demand profiles at the connection point (£771); capacity booking offer attached to the capacity study
  - Northern Gas Networks' "Get Connected" service provides information on available capacity, suitable injection points, equipment, process, costs and regulation

Source: Accenture paper for WGC, "Reinventing the Product and the Product Positioning of Natural Gas"

CNG Fuels: Local Transmission System CNG Station

- RTFO well-established, but first biomethane fed from gas grid in 2016
- RTFO obligation levels rising, crop-cap limiting the use of non-waste feedstocks, and the opportunity to double-count biomethane (2x RTFCs) are increasing the use of biomethane in heavy goods transport
- New CNG trucks can now travel 500 miles without refuelling- e.g., Waitrose has over 50 CNG trucks and planning to replace fleet (600 trucks)
  - Trucks are half a tonne lighter, use carbon fibre fuel tanks 250-bar pressure
  - Trucks cost 50% more but fuel savings £15,000-£20,000 p.a.

Leyland Local Transmission System CNG Station

- Fossil CNG offers well-to-tank emissions reductions of 55% compared to diesel vehicles
- 84 percent well-to-wheel (WTW) CO_2 emissions reduction when using 100 percent biomethane, compared to diesel vehicles
- Monitored CNG trucks achieved a driving distance of 500 km/day or greater
- Payback for LTS station is 6.3 years
- RTFO critical to economics
- Over 90% of potential customers requesting 100 percent biomethane agreements

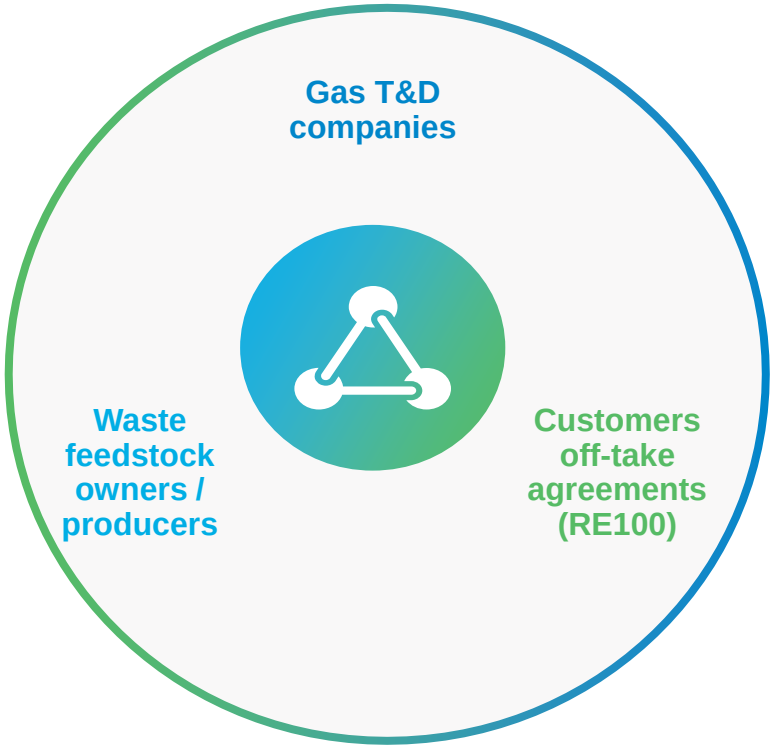
Sources: “Independent assessment of the benefits of supplying gas for road transport from the Local Transmission System”, Element Energy, July 2017, https://cadentgas.com; Accenture research paper for WGC, “Reinventing the Product and the Product Positioning of Natural Gas.”

Conclusion

Aligned Regulatory Targets and Incentives

- Heat
- Transport
- Air quality
- Agriculture
- Waste
- Other…?

Complex Value Chain



New Gas Product

- Lower CO_2
- Methane abatement
- Productive use of waste
- Pathway for future hydrogen solutions and possibly even CCS

Source: Accenture research paper for WGC, “Reinventing the Product and the Product Positioning of Natural Gas.”