Technological Developments, Future Scalability, and Innovations in Biomethane & Bio-LNG in the U.S.

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About the American Biogas Council

- **ABC IS:** A national trade association founded in 2010 and headquartered in Washington, DC representing the entire U.S. biogas and renewable natural gas (biomethane) industry
- **WHO WE REPRESENT:** 400+ organizations and 6,500 individuals from across the world
- **OUR MISSION:** Maximize the economic and environmental benefits of biogas while advancing sustainable solutions for energy, agriculture, and waste management
- **FOUNDING MEMBERS OF:** American Biofuels Maritime Initiative (AMBI), Bio-LNG Maritime Coalition (BLMC), United Biogas Association (UBA) and coordinates closely with national/regional/global biogas associations from across the world (WBA, UK, Europe, Brazil, Canada)
- **INDUSTRY PARTNERS/MEMBERS OF:** International Energy Agency (IEA), Society for Gas as a Marine Fuel (SGMF) and works closely with the Global Methane Hub, IPCC, UN, COP, GHG-Protocol, SBTi, Molecule Group, Future Fuels for Maritime, API, IPIECA, and more

ABC Members and Partners

maritime at-a-glance

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PEAKS RENEWABLES

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U.S. Energy a U.S. Venture company

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American Biofuels Maritime Initiative

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summit UTILITIES

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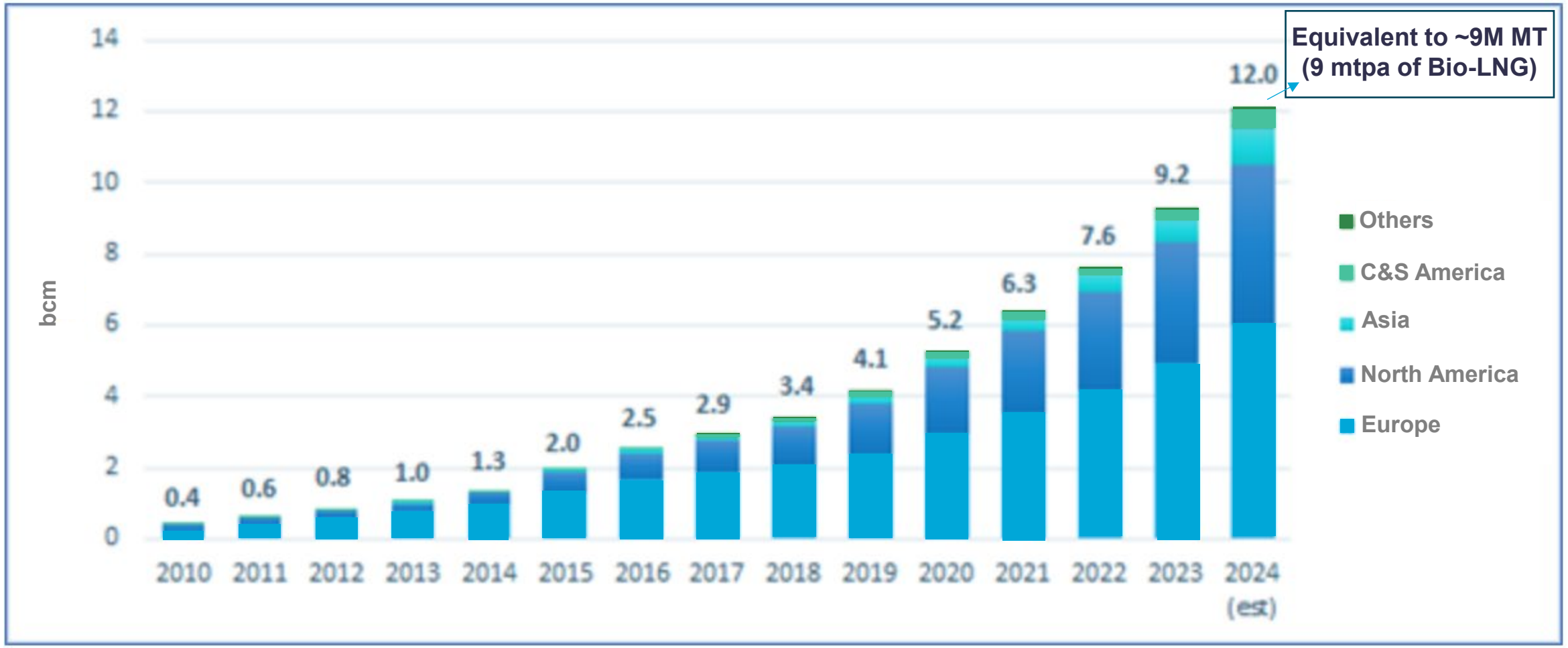
Global Biomethane Picture, 2010-2024

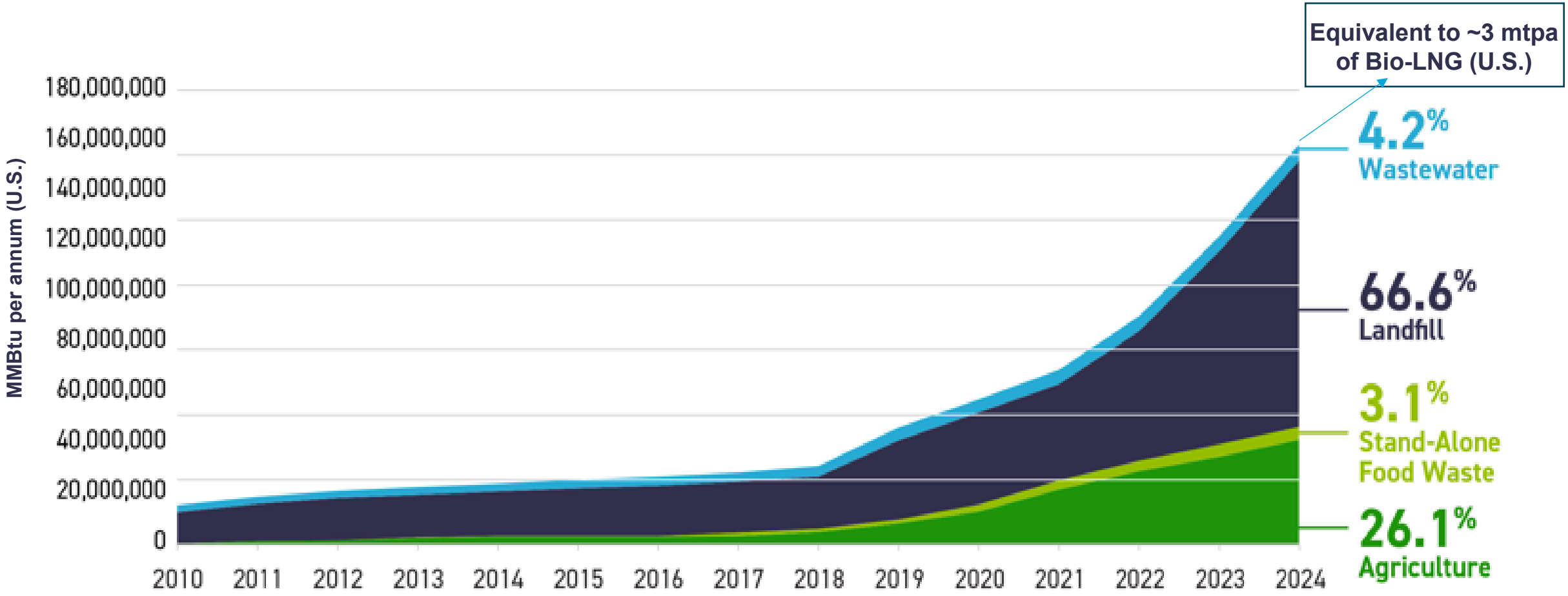


Evolution of global RNG production (2010-2024)

Source: 2025 CEDIGAZ Biomethane Report - Independent business intelligence for the gas industry

U.S. Biomethane Picture, 2010-2024

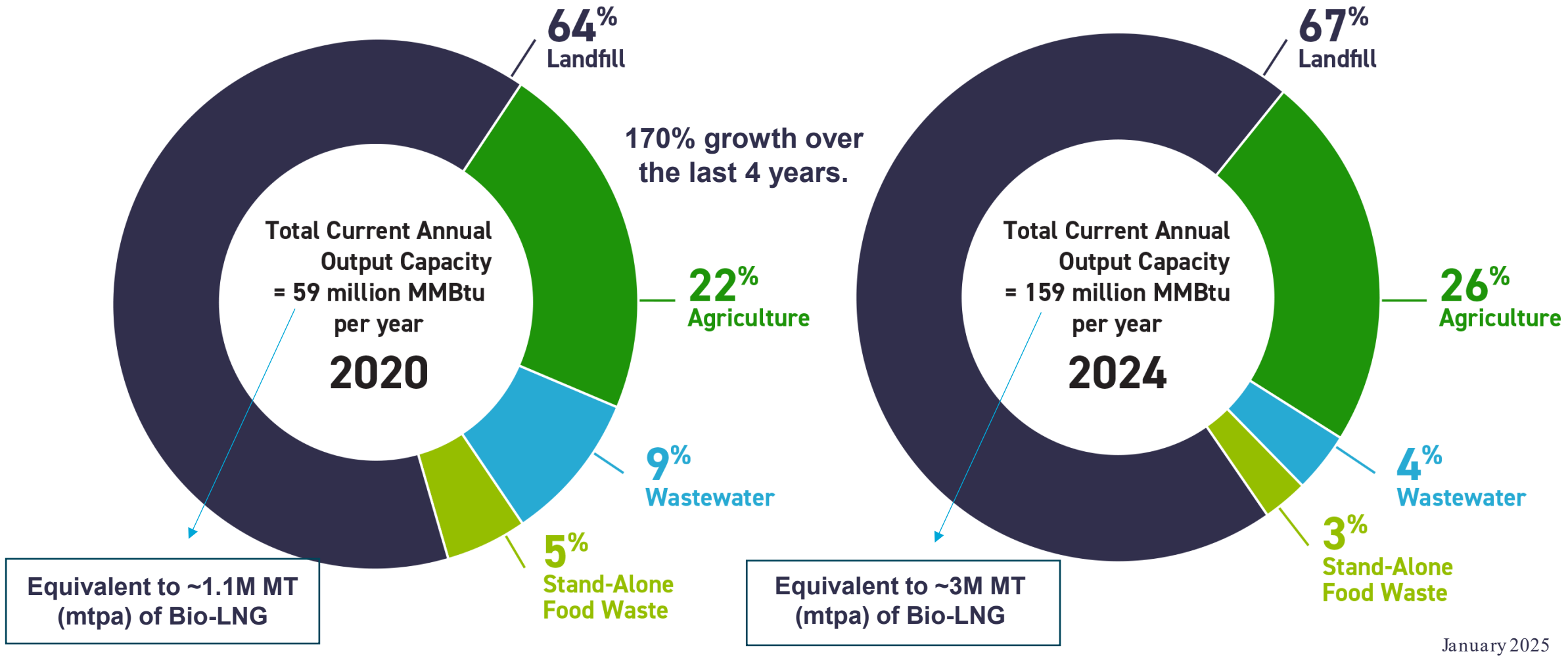
U.S. Production Capacity = ~35% of global supply, 400+ operational projects (2024)[1]



Source: [1]More than 600 biomethane projects operational today in U.S. (2026) - American Biogas Council

U.S. Biomethane Picture, 2020 & 2024

Biomethane Output Capacity by Sector, 2020 & 2024 (MMBtu)



Technological Developments Driving Biomethane Growth

Efficiency & Optimization

- Improved membrane upgrading → Higher methane recovery (>99%)
- Advanced separation media → Nitrogen recovery efficiency gains
- Improved biological monitoring → Higher biogas yields & capture
- Enhanced feedstock pre-treatment → Increased performance / uptime

System Design & Operations

- Increased efficiency through smaller modular systems
- Standardized designs and approaches vs. purely custom
- Improved fugitive emissions detection enabling better sealing and reduced methane losses

Emerging Innovations

- CO_2 recovery enabling sequestration & utilization of carbon dioxide for beneficial use
- Nutrient recovery systems that create organic fertilizers from digestate to displace synthetics
- CNG engine technology advancements that allows for more versatility and power in on-road transportation applications

Why methane capture is vital for overall GHG reductions

Methane = Fastest & Most Impactful Near-term Climate Lever

2018 – 2023

Methane emissions rose FASTER than any time in recorded history[1]

80x

Methane has a GWP 80x HIGHER than CO_2 over 20 years[2]

Manure & enteric fermentation together account for 32% of Global agricultural methane emissions[3]

Manure management contributes approx. 237M MT CO_2e per year[4]

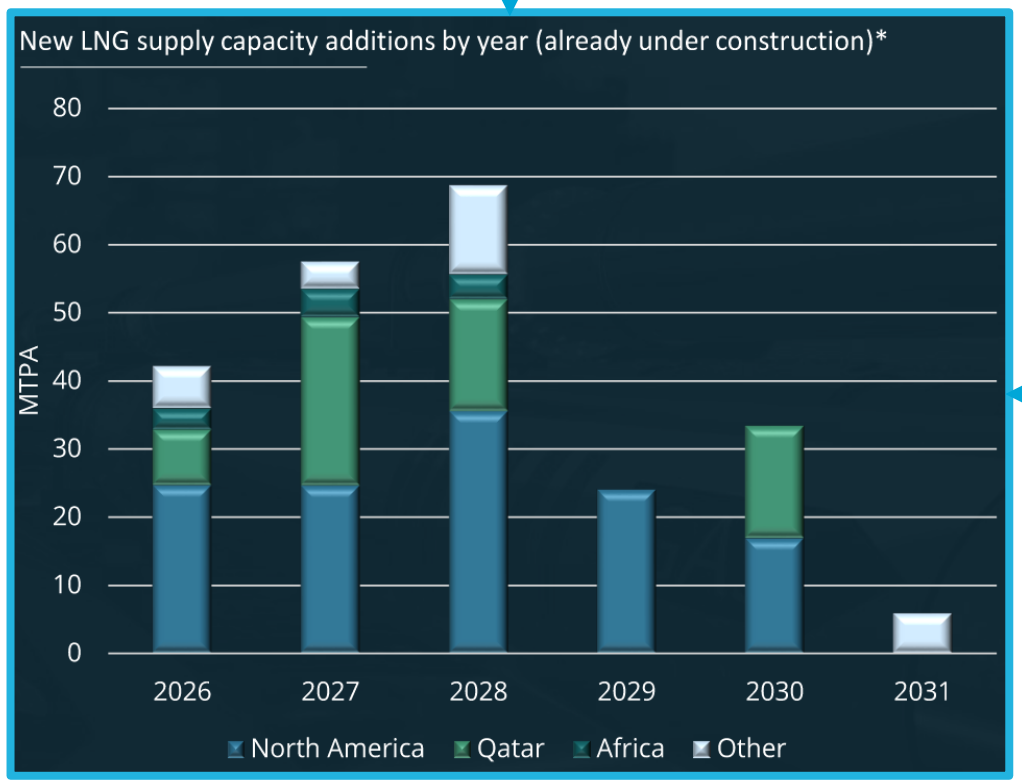
VALUE RECOGNITION

Methane abatement benefits already credited in major frameworks (EU's RED, U.S. RFS & LCFS programs, Canada CFR, etc.)

Sources: [1] *Global Methane Pledge Ministerial Factsheet 2024*. Global Methane Pledge; [2] Raymond, Peter and Steven Hamburg. *Yale Experts Explain Methane Emissions*. Yale Sustainability, 2024; [3] *Food and Agriculture Pathway*. Global Methane Pledge, 2022; [4] *Agricultural Sources and Mitigation Options*. Global Methane Initiative

LNG & Bio-LNG: A critical bridge in the Energy Transition

LNG utilization has grown consistently YOY across ship types reaching 6.7% of reported marine fuels in 2024
(latest data GISIS (MEPC 84/6/1)

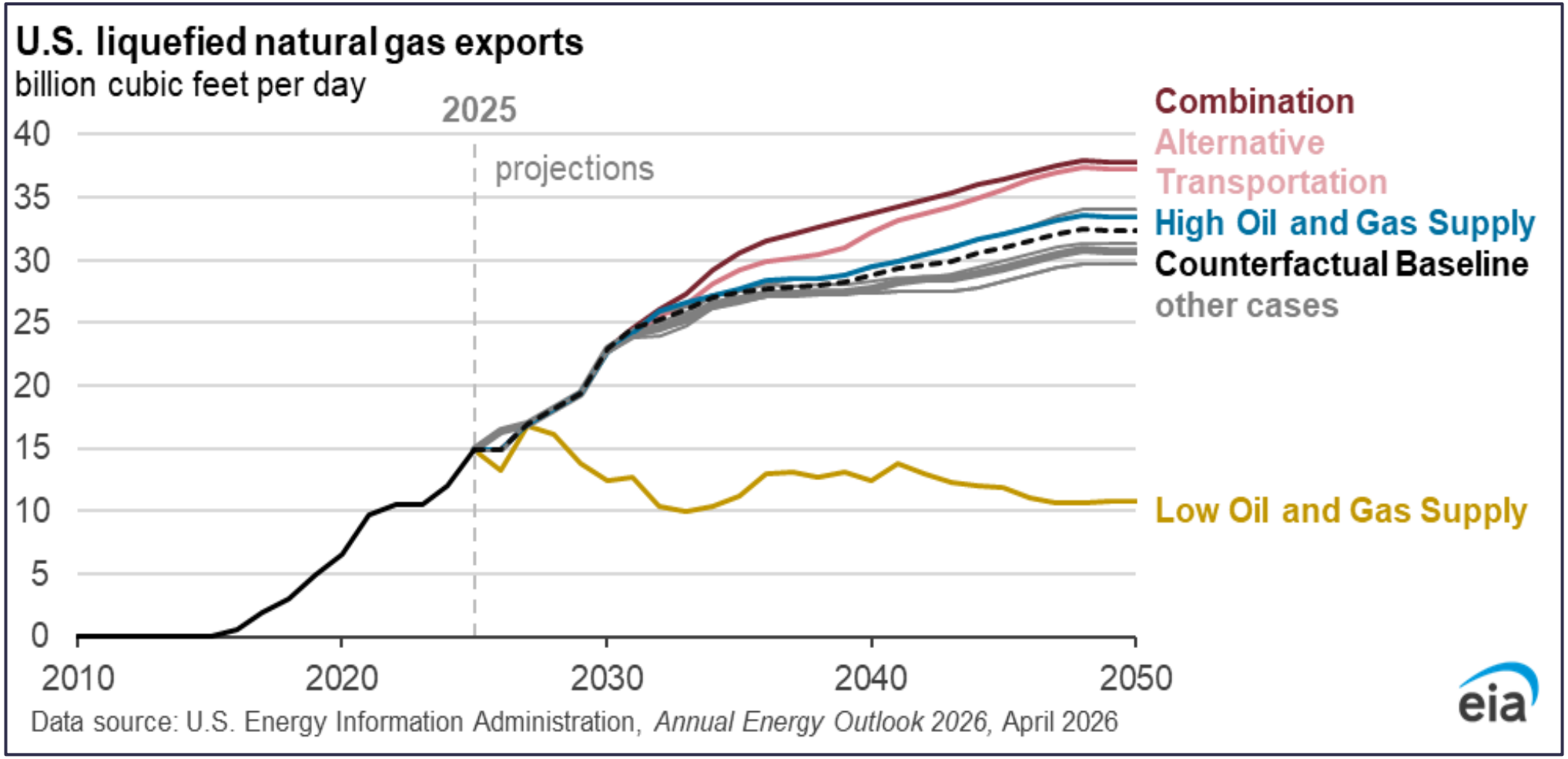


Source: Fearnleys SSLNG Q4 2025 Report

- Allows fleet owners to forgo major vessel retrofits, enabling faster and less capital-intensive adoption
- Improves the intensity and strengthens the energy security potential of the LNG fuel pathway
- Leverages existing and growing LNG investment
- Offers competitive cost trajectories relative to other alternative fuels

>200 mtpa of LNG capacity under construction – reaching commercial operations by 2030

U.S. LNG Export Outlook



U.S. LNG exports are projected to increase from ~150 to ~300 bcm by 2030 according to U.S. EIA data.

(Equivalent to 200+ mtpa)

By 2050, U.S. LNG exports projected to reach 400 bcm

Source: EIA, Annual Energy Outlook, April 2026

Estimated Demand for LNG Bunker Fuel

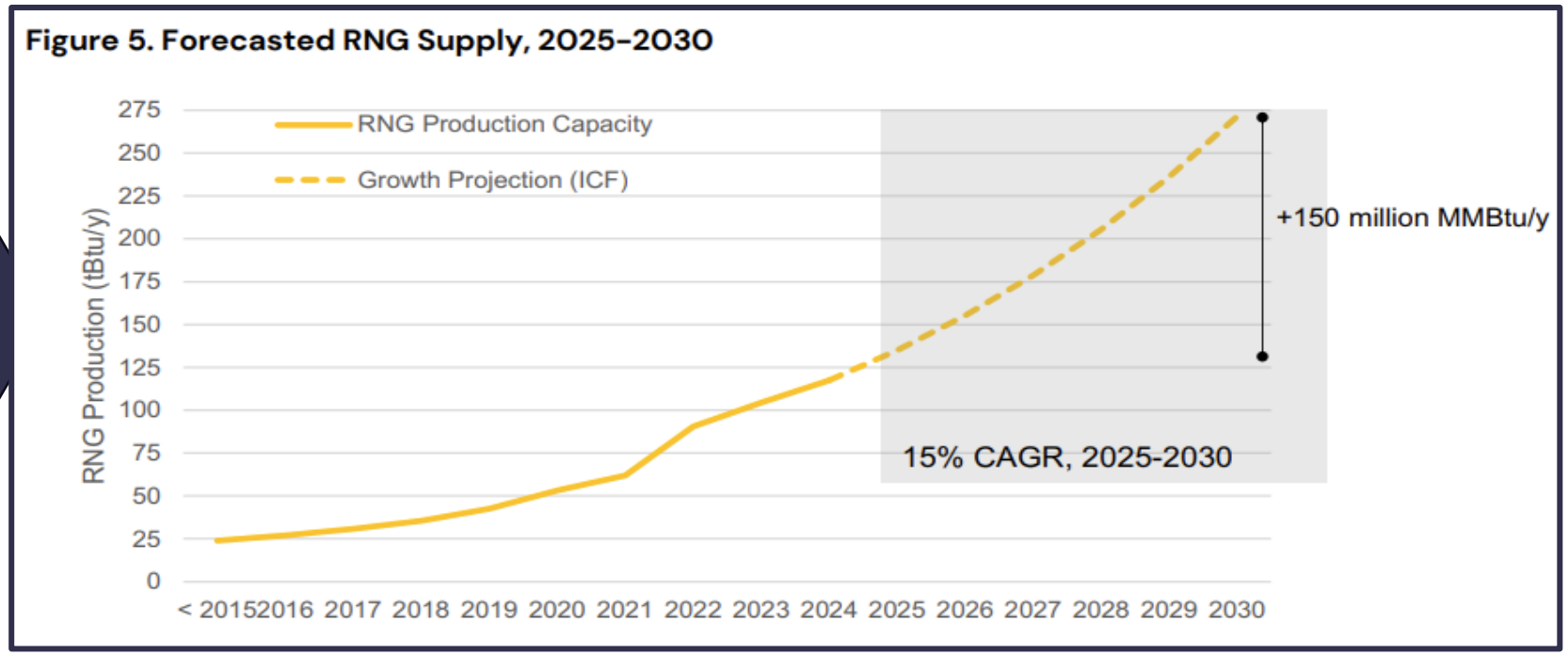
LNG bunker fuel demand is projected to grow from 3.8 mtpa (2025)[1] to 17+ mtpa (2030)[2]

- If Bio-LNG supplies 20% of demand → **3.4 mtpa required of Bio-LNG by 2030** (bunker fuel only)[3]
- Estimated global production will be 14-16 mtpa by 2030 → 21% - 24% of biomethane to maritime
- Estimated U.S. production will be 5-6 mtpa by 2030

Bio-LNG Forecasted New Capacity (by 2030)

- U.S. production growth at 15% CAGR

= 3 mtpa of Bio-LNG capacity increase

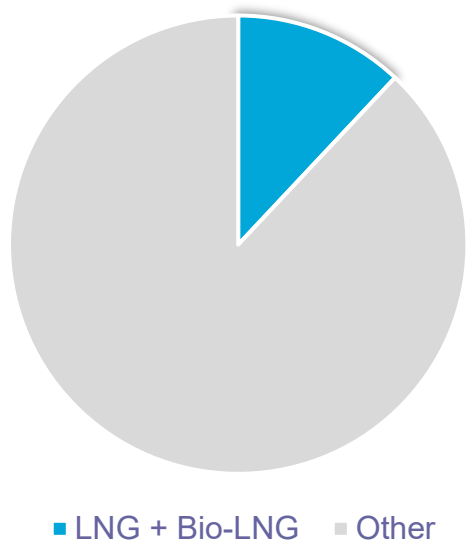


Sources/Notes: [1] Fearnleys SSLNG Q4 2025 Report; [2] Shell The case for the methane pathway (September 2025); [3] Assumes LNG tankers would use mainly fossil LNG through 2030

LNG bunker fuel demand & supply relatively balanced

Market Potential

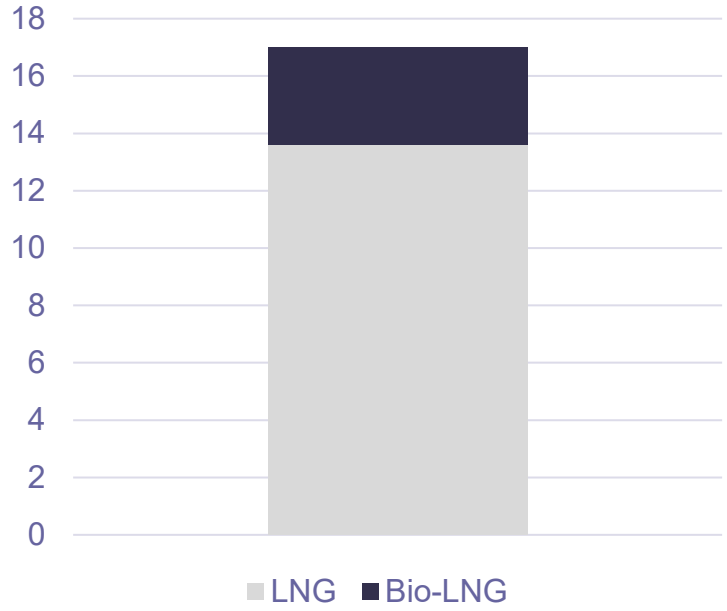
2030 Global Marine Fuel Mix



LNG/Bio-LNG gaining traction globally ~10–12% of marine fuel by 2030

Bunker Fuel Demand

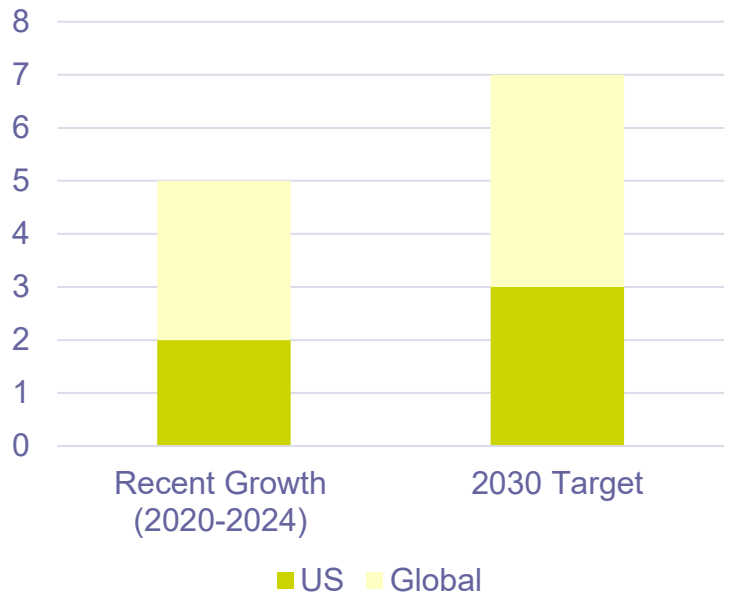
LNG/Bio-LNG Demand (mtpa)



3.4 – 4.0 mtpa Bio-LNG needed by 2030 at 20% Bio-LNG Blend

Supply Reality

New Bio-LNG Capacity



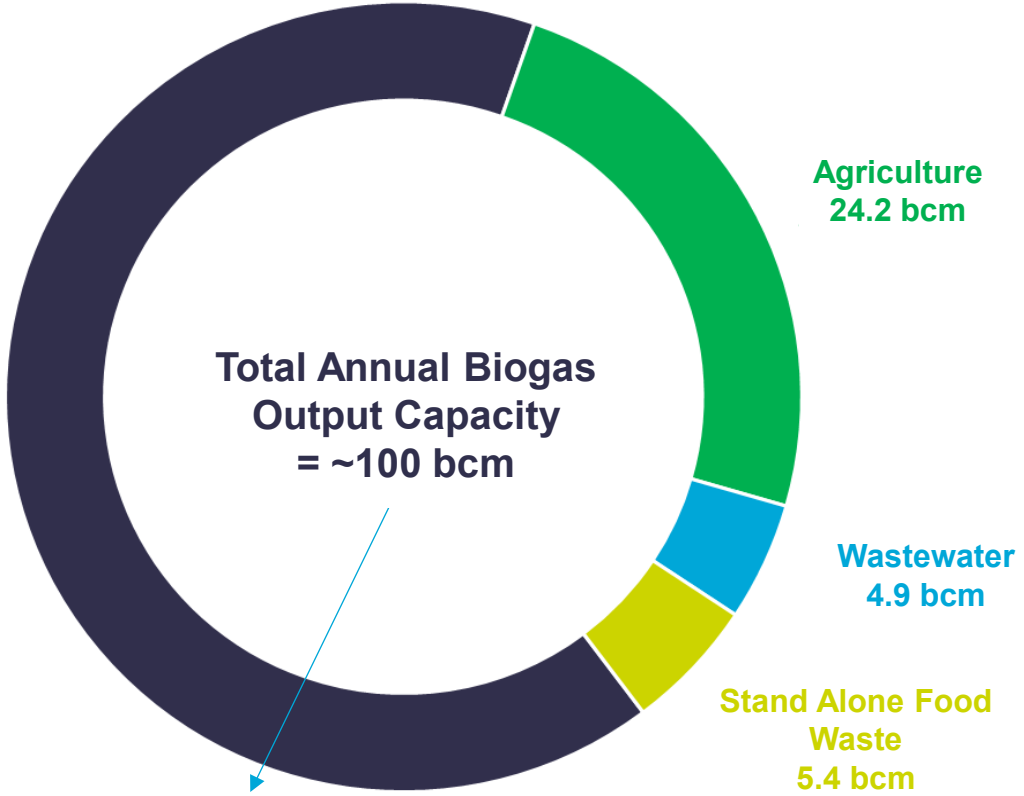
Recent growth proves scalability

The right policy signal unlocks immediate, scalable opportunity for the US and Global Supply

Source: [1] Vanguard Renewables White Paper – How the IMO's Net-Zero Framework Can Power American Industry (2025)

Remaining Potential of U.S. Biomethane Capture Capacity

Using only the four current primary feedstock categories in U.S.



Remaining Potential = 79%	
Landfill	78%
Agriculture	89%
Wastewater	48%
Food Waste	88%

Note: Doesn't include

- Cover crops (sequence crops)
- Agriculture residuals
- Energy crops

Additional 8.4 mtpa of Bio-LNG capacity

Assuming only 20% of the 100 bcm biogas capacity is upgraded to biomethane, and methane content between 55-60%

Pricing: Key factors impacting uptake and pricing

Recognize high-impact pathways to reduce emissions

- Manure-based fuels ≠ standard fuel switching
- Established frameworks already credit avoided methane with verified integrity
- Explicit inclusion of avoided methane crediting

Create a strong demand signal

- Set ambitious GFI targets
- Account for availability, scalability, & affordability of fuels
- Enable overcompliance + credit trading,

Enable Practical Implementation

- Flexible blending
- Pragmatic mass-balancing – Any tracking and certification framework should enable and facilitate mass balance-based delivery through pipeline grid.

IMO framework design choices will determine whether high-impact fuels are fully valued and set up to scale

Pricing at a glance (2030 estimates)

100% LNG Delivered: Est. average range of $11.00 - $14.50/MMBtu[1]

80/20 Bio-LNG Blend Delivered: Est. average range of $16.00 - $26.50/MMBtu[2]

- Emissions reductions from Bio-LNG Blends can be substantial by recognizing avoided emissions
- Result can be significant emissions reductions for fleets at affordable costs and a very minimal cost to the consumer

Notes: [1] Est. range for LNG bunker fuel pricing based on 2025 prices and new global LNG export capacity coming online through 2030;
[2] Est. range for Bio-LNG bunker fuel pricing based on 2025 prices for PoS certificates in EU markets, credit pricing in US road transportation markets, plus other markets

Conclusions

- Methane is already a mainstream bunker fuel today. Careful consideration of its decarbonization options is warranted and key decisions will greatly advance cost efficiency of the program
- LNG and Bio-LNG are mature, scalable solutions that achieve immediate impact by reducing GHGs compared to conventional fuels into abundant energy while benefiting rural economies
- US Bio-LNG is scaling at 15% per year, ready to meet demand under an approved IMO framework
- Current waste-based feedstocks within U.S. can supply maritime with up to 3 mtpa by 2030, 8+ mtpa by 2040, with potential for additional production based on new pathways
- Methane avoidance crediting, flexibility mechanisms, and mass balance-based delivery through the pipeline grid must be firmly recognized by the IMO to reduce compliance costs. Such crediting and flexibility can be implemented with environmental integrity
- Meaningful GFI targets, embedded into a flexible and pragmatic framework that recognizes a mix of solutions would enable development of cost-efficient global value chains and avoid a burdensome and costly alternative of regional frameworks

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