Methane Reduction Roadmap for Federated States of Micronesia, 2026-2035

CLIMATE & CLEAN AIR COALITION
TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS
a UNEP convened initiative

IGES
Institute for Global Environmental Strategies

Methane Reduction Roadmap for Federated States of Micronesia, 2026-2035

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A message from President of FSM

The President
Palikir, Pohnpei
Federated States of Micronesia

I am pleased to present the **Methane Reduction Roadmap for the Federated States of Micronesia (FSM)**. This document represents a significant milestone in our collective efforts to address one of the most potent, short-lived climate pollutants (SLCPs) contributing to climate change. Methane is a critical focus for FSM, not only because of its impact on global warming, but also due to its close links with public health, waste management, energy security, and sustainable development.

The Roadmap has been developed through an inclusive and evidence-based process, involving extensive consultations with state governments, municipalities, civil society, and technical partners. This participatory approach and on-site observation have ensured that the Roadmap reflects the realities of FSM's unique governance structure, socio-economic conditions, and cultural practices.

This Roadmap will also serve as an important input to FSM's **Third Nationally Determined Contribution (NDC 3.0)**, which is currently submitted to the UNFCCC. By integrating methane-reduction target and mitigation measures into NDC 3.0, FSM reaffirms its commitment to the Paris Agreement and the Global Methane Pledge. At the same time, we recognize that effective methane mitigation delivers multiple co-benefits—safer water, cleaner air, healthier communities, more resilient ecosystems, and stronger energy security.

As we move from planning to implementation, we must ensure that the strategies outlined here are matched with strong institutional frameworks, sustainable financing, and continued stakeholder engagement. The success of this Roadmap will depend on our ability to work together—national and state governments, civil society, development partners, and communities alike—to turn these commitments into action.

I call on all stakeholders to support the implementation of this Roadmap. By doing so, we not only contribute to global climate goals but also secure a safer, healthier, and more resilient future for the people of the Federated States of Micronesia.

Wesley W. Simina
President
Federated States of Micronesia

A Message from the CCAC Secretariat

The Climate and Clean Air Coalition (CCAC) is proud to have supported the Federated States of Micronesia (FSM) in developing this Methane Reduction Roadmap, 2026-2035, an ambitious and forward-looking plan that reflects the country's deep commitment to protecting people, nature, and the climate.

Methane is more than 80 times more powerful than carbon dioxide over a 20-year period, stays in the atmosphere for about 12 years and is a precursor to health and plant growth harming tropospheric ozone. Solutions are proven, and many are low-cost. This makes cutting methane a fast and cost-effective way to slow global warming, improve air quality, and strengthen food security.

FSM contributes less than 0.01 percent of global greenhouse gas emissions, and as small-island developing state (SIDS) is among the world's most climate-vulnerable nations. Recognizing the urgency of reducing super pollutants, FSM has for decades been a driving force in international climate action, from its groundbreaking proposal under the Montreal Protocol to phase down hydrofluorocarbons (HFCs), to its decision to step forward as a Global Methane Pledge Champion and bring methane to the Pacific Islands Forum agenda. FSM's continued leadership shows how national action, when guided by clear priorities and strong commitment, can both unlock local benefits and contribute meaningfully to global climate progress.

This roadmap is a clear demonstration of leadership in action. By tackling the country's main methane sources, including solid waste disposal, wastewater, and manure management, FSM is charting a pathway that will deliver wide-ranging benefits in addition to emissions reduction: improving public health and advancing a circular economy, unlocking climate finance. These actions will not only help cut methane but also create jobs, prevent pollution, and strengthen the resilience of communities on the frontlines of climate change.

We stand alongside FSM as it turns ambition into action. This roadmap underlines the urgency to act and shows the world that methane mitigation is both achievable and transformative, delivering rapid climate benefits while driving sustainable development. FSM's leadership continues to light the way toward a safer, healthier, and more resilient future for all.

Martina Otto
Head of Secretariat, Climate and Clean Air Coalition (CCAC)
United Nations Environment Programme

Acknowledgements

The development of the National Methane Reduction Roadmap, 2026-2035 for the Federated States of Micronesia (FSM) was made possible through the generous technical support and guidance of the Institute for Global Environmental Strategies (IGES). We sincerely appreciate their expertise in data analysis, scenario modelling, and the formulation of practical mitigation strategies across key sectors.

We also gratefully acknowledge the financial support provided by the Climate and Clean Air Coalition (CCAC), convened by the United Nations Environment Programme (UNEP). Their commitment to advancing sustainable waste management, methane reduction, and climate action has been instrumental in enabling this initiative.

Our gratitude further extends to the government agencies, local authorities, and community stakeholders who contributed their time, knowledge, and insights throughout the Roadmap development process. Their active engagement ensured that the Roadmap aligns with national priorities, reflects local realities, and offers actionable solutions. We would also like to recognise Palikir Consulting Services for their invaluable role in facilitating local-level data collection and coordination.

The collective efforts of IGES, UNEP-CCAC, and national and local partners have been essential in shaping a comprehensive, science-based, and implementable strategy. Their support has been vital in advancing FSM's commitment to reducing methane emissions, improving public health, promoting circular economy practices, and strengthening climate resilience.

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Abbreviations and Acronyms

AD: Anaerobic Digester

ADB: Asian Development Bank

AFOLU: Agriculture, Forestry, and Other Land Use

BAU: Business-As-Usual

BOD: Biochemical Oxygen Demand

CCAC: Climate and Clean Air Coalition

CCSDC: Climate Change and Sustainable Development Council

CDL: Container Deposit Legislation

CE: Circular Economy

CH_4: Methane

CO_2: Carbon Dioxide

CO_2e: Carbon Dioxide Equivalent

COFA: Compact of Free Association

COP27: 27th Conference of the Parties

CPUC: Chuuk Public Utility Corporation

DECEM: Department of Environment, Climate Change, and Emergency Management

DEWATS: Decentralised Wastewater Treatment System

DOC: Degradable Organic Carbon

DoFA: Department of Finance and Administration

DPW&T: Department of Public Works & Transportation

DR&D: Department of Resources and Development

DRR: Disaster Risk Reduction

DT&I: Department of Transport & Infrastructure

DTCI: Department of Transportation, Communications and Infrastructure

DTPW: Department of Transportation, Communication & Public Works

EEZ: Exclusive Economic Zone

EFDB: Emission Factor Database

EMP: Energy Master Plan

EPA: Environmental Protection Agency

FAD: Fish Aggregating Devices

FBD: Food-Borne Diseases

FESRIP: Framework for Energy Security and Resilience in the Pacific

FIB: Fecal Indicator Bacteria

FOD: First Order Decay

FRDP: Framework for Resilient Development in the Pacific

FSM: Federated States of Micronesia

GCF: Green Climate Fund

GEF: Global Environmental Facility

GHG: Greenhouse Gas

GMP: Global Methane Pledge

GPG: Good Practice Guidance

HFCs: Hydrofluorocarbons

HIES: Household Income and Expenditure Survey

IDP: Infrastructure Development Plan

IGES: Institute for Global Environmental Strategies

INC: Initial National Communication

INDC: Intended Nationally Determined Contribution

IPCC: Intergovernmental Panel on Climate Change

IPPU: Industrial Processes and Product Use

JICA: Japan International Cooperation Agency

JSAPs: Joint State Action Plans

KIRMA: Kosrae Island Resource Management Authority

MCF: Methane Correction Factor

MEF: Methane Emission Factor

MRV: Monitoring, Reporting, and Verification

MSW: Municipal Solid Waste

NCCCT: National Climate Change Country Team

NDC: Nationally Determined Contributions

NEMS: National Environmental Management Strategy

ODS: Ozone-Depleting Substances

PCCP: Pacific Climate Change Portal

PICTs: Pacific Island Countries and Territories

POPs: Persistent Organic Pollutants

ppb: Parts Per Billion

PUC: Pohnpei Utility Corporation

PW&T: Public Works & Transport

PWMS: Pohnpei Waste Management Services

RE: Renewable Energy

S.A.M.O.A: Small Islands Developing States Accelerated Modalities of Action

SDGs: Sustainable Development Goals

SIDS: Small Island Developing State

SLCP: Short-Lived Climate Pollutant

SMEs: Small Enterprises

SNC: Second National Communication

SPC: Pacific Community

SPREP: Secretariat of the Pacific Regional Environment Programme

SWMS: State-level Waste Management Strategies

TJ: Terajoule

TNC: Third National Communication

UNEP: United Nations Environment Programme

UNFCCC: United Nations Framework Convention on Climate Change

VBD: Vector-Borne Diseases

WB: World Bank

WBD: Water-Borne Diseases

WHO: World Health Organisation

YSPSC: Yap State Public Service Corporation

Executive Summary

The Methane Reduction Roadmap for the Federated States of Micronesia (FSM) outlines the nation's strategy to address methane (CH_4) emissions, a potent short-lived climate pollutant (SLCP) for the period 2026-2035. As a Global Methane Pledge (GMP) Champion, FSM is committed to reducing methane emissions. This initiative delivers rapid climate benefits, strengthens food security, improves public health, promotes circular economy practices, and opens opportunities for climate finance.

FSM's methane emissions profile, based on 2018 data from the Third National Communication, underpins the Roadmap's targeted interventions. Total methane emissions in 2018 were estimated at 1.72 Gg, reflecting an overall 14% decrease from 2001; however, emissions have increased since 2014. The waste sector, primarily solid waste disposal and domestic wastewater treatment, accounts for approximately 54% of total methane emissions, while agriculture, mainly manure management, contributes 46%. Emissions from the energy and transport sectors are negligible.

The Roadmap identifies practical mitigation measures across key sectors, focusing primarily on solid waste management due to its significant share of emissions and data availability. Under a Business-As-Usual scenario, methane emissions from waste management are projected to rise by 35.9% by 2035 compared to 2020, driven by deteriorating landfill management and increasing waste generation. Based on the science-based scenario analysis, the roadmap sets specific methane reduction targets: national 12.4%, Pohnpei 15.6%, Chuuk 10.9%, Yap 8.0%, and Kosrae 10.2%. These targets will be achieved by improving landfill management in four states, new landfill construction in Chuuk, diversion of organic waste through composting and mulching, and waste reduction via enhanced circular economy policies.

While future targets for wastewater and manure management will be set as more reliable data become available, interventions for wastewater treatment and manure management offer co-benefits. Decentralised wastewater treatment systems (DEWATS) and anaerobic digesters (AD) can not only reduce methane, but also prevent water pollution in rivers and streams and enhance public health. The energy sector, though a minor source, adds value through increased renewable deployment and improved energy efficiency.

It is important to highlight that successful implementation depends on enablers including technical capacity, public awareness, resource mobilisation, knowledge sharing, inter-institutional coordination, gender inclusion, and a supportive regulatory framework. A robust Monitoring, Reporting, and Verification (MRV) system, led by the Department of Environment, Climate Change, and Emergency Management (DECEM), is under development to improve data management, support evidence-based decision-making and reporting for international obligations, and climate finance access. Through this integrated approach, FSM aims to achieve measurable methane reductions, strengthen resilience, and generate sustainable benefits for communities and the environment.

1 Context

1.1. Importance of Methane Mitigation

Methane (CH_4) is a short-lived climate pollutant (SLCP) and the second most abundant anthropogenic greenhouse gas (GHG) (UNEP and CCAC, 2021). Global warming potential far exceeds that of carbon dioxide (CO_2), being 86 higher over a 20-year period and 34 times higher over a 100-year period (Monaco et al., 2021).

The atmospheric concentration of methane has been rapidly accelerating worldwide since the 1980s and reached 1,889 parts per billion (ppb) in 2020 (Figure 1-1), which is a 260% increase compared to pre-industrial levels (before the 1750s) (UNEP and CCAC, 2021).

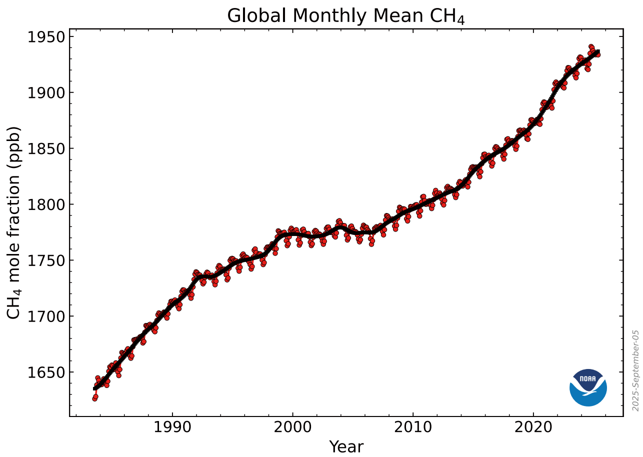

Figure 1-1: Global mean methane amount, 1984-2019 (Ed Dlugokencky, NOAA/ ESRL[1])

The Intergovernmental Panel on Climate Change (IPCC)'s 2018 Special Report identified that achieving a sustainable mitigation pathway to limit global warming to 1.5°C requires deep and simultaneous reductions of non-carbon dioxide climate-forcing emissions, including SLCPs. The UNEP-CCAC Global Methane Assessment (2021) shows that increased methane abundances are a key contributor to the gap between actual and ideal decarbonisation/SLCP mitigation pathways. (Figure 1-2).

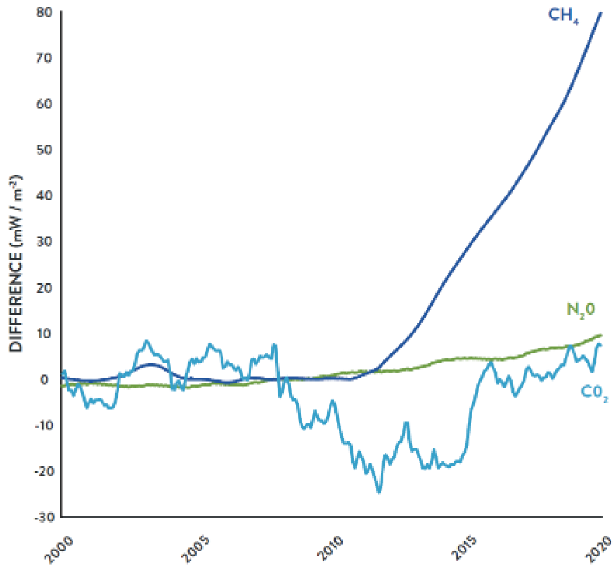

Figure 1-2: Value for the difference between actual global mean annual average radiative forcing from major GHGs and values under Representative Concentration Pathway

In pathways to 1.5°C, global anthropogenic methane emissions need to fall by an average of 45% by 2040; in other words, an overall decrease of 30–65% relative to 2010 (Figure 1-3). These trajectories imply an approx. 2% annual decrease in methane emissions over the next 20 years, which contrasts sharply with the current path of approx. 0.5% per year. The current path could lead to methane abundance, which corresponds to scenarios of approximately 3–5ºC of warming by 2100 (Nisbet et al. 2020).

1 https://gml.noaa.gov/ccgg/trends_ch4/ (visited in June 2025)

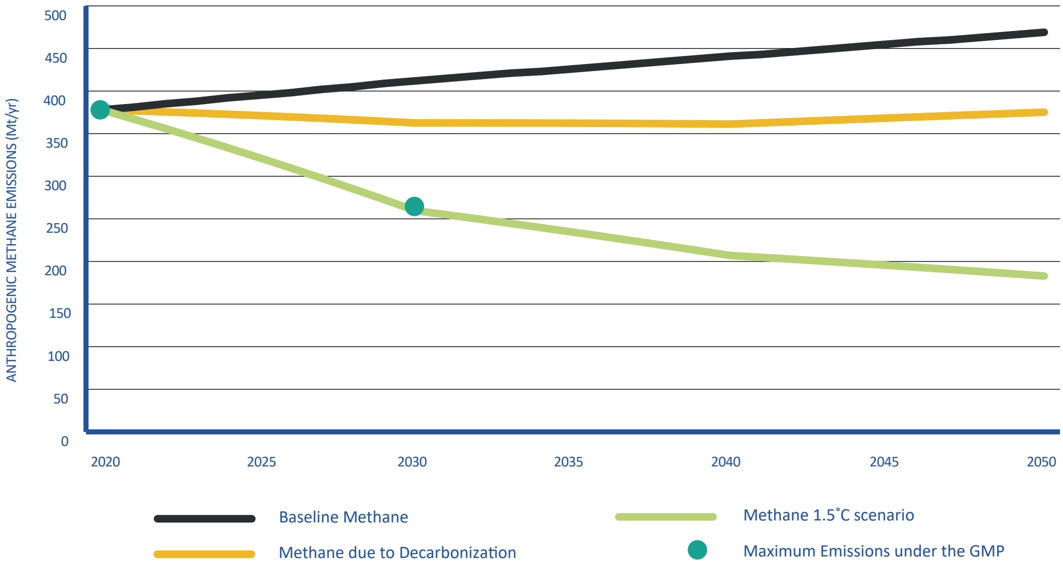

Figure 1-3: Methane emissions under the best estimate baseline projections (UNEP, 2022)

Approximately 60% of total global methane emissions come from anthropogenic sources (UNEP and CCAC, 2021). Of these sources, over 90% originate from three sectors: fossil fuels (35%), agriculture (40%), and waste (20%). Methane not only has a warming effect—it also acts as a precursor for the toxic air pollutant, tropospheric ozone, when it reacts with other chemicals like nitrogen oxides in sunlight. Therefore, quick action would help limit dangerous climate feedback loops, while simultaneously delivering important health, environmental, and economic benefits (BOX below).

BOX : Methane Impacts (CCAC)

Climate Impacts: Methane is second only to CO_2 in driving climate change. As carbon dioxide has a long atmospheric lifetime, the results of action on carbon dioxide will take longer to realise. This means reducing methane is a priority to dampen the rate of warming and limit dangerous climate feedback loops such as the melting of the polar ice caps and sea level rise.

Health Impacts: Methane is a key precursor gas of the harmful air pollutant, tropospheric ozone. Globally, increased methane emissions are responsible for half of the observed rise in tropospheric ozone levels. While methane does not cause direct harm to human health or crop production, ozone is responsible for about one million premature respiratory deaths globally.

Agriculture Impacts: Through its contribution to tropospheric ozone generation, as well as rising atmospheric temperatures, methane leads to staple crop losses of up to 15% per year.

Economic Impacts: Methane's impacts on climate change and public health result in a yearly loss of roughly 400 million person hours globally due to extreme heat. Interestingly, however, the majority of identified methane abatement controls cost less than the societal benefits - estimated as a benefit of 4,300 USD per tonne of methane.
(source: https://www.ccacoalition.org/short-lived-climate-pollutants/methane)

The Federated States of Micronesia (FSM), being a small island developing state (SIDS), has long been a global leader in efforts to reduce Short-Lived Climate Pollutants (SLCPs), which have impacts on acute vulnerabilities exacerbated by near-term climate change—rising sea levels, extreme weather events, and ecosystem degradation—and which threaten the nation's environment, economy, and way of life. FSM's leadership dates back to 2009, when its delegation, led by Ambassador Asterio Takesy, proposed a ground-breaking initiative during the Montreal Protocol negotiations to address SLCPs. Since then, FSM has consistently advanced international action, including playing a pivotal role in promoting the Kigali Amendment to phase-out hydrofluorocarbons (HFCs). This legacy of climate leadership naturally led FSM to ratify the Paris Agreement in 2016, followed by joining the Global Methane Pledge (GMP) in 2021 during COP26 in Glasgow, aiming to cut methane emissions by at least 30% from 2020 levels by 2030.

Addressing methane emissions is seen as both a moral responsibility and a practical necessity for FSM, as shown in the table below (Table 1-1).

Table 1-1: Contribution of methane mitigation efforts in FSM

Contribution to	Description
Supporting FSM's Climate Goals	- Methane reductions deliver fast climate benefits, helping limit global temperature rise and slowing sea level rise—critical for the protection of low-lying islands. - Reducing methane builds long-term resilience and aligns closely with FSM's commitments under the Paris Agreement and Global Methane Pledge. - Strong methane reduction commitments can attract additional climate financing opportunities. - Strengthens FSM's position as a leader in SLCP mitigation within regional and global forums.
Advancing Innovation in Circular Economy	- Creates new industries around methane recovery (e.g., biogas production, composting, and biochar manufacturing). - Encourages private-sector investment in low-emission technologies; creates more jobs in energy, waste and wastewater management. - Clean, well-managed environment improves quality of life, attracts tourism, and supports broader economic development.
Enhancing Food Security through proper waste management	- Improved management of organic waste such as kitchen waste and green waste through composting and mulching enhances soil fertility and supports local agricultural productivity, while also diverting biodegradable materials from disposal sites where anaerobic decomposition would otherwise generate methane emissions.
Improving Human Health through proper pollution control	- Reducing methane emissions through proper manure management in small-scale pig farming and wastewater treatment helps prevent soil and water contamination. - Lower methane emissions mean lower ground-level ozone, a pollutant linked to respiratory diseases, particularly affecting vulnerable populations such as children and the elderly. - Reducing open dumping and burning of biomass residues such as coconut shells as fuel, a common practice in many Pacific communities, leads to emission reductions of methane and black carbon, cleaner air and less exposure to toxic smoke.
Promoting alternative renewable energy	- Utilizing coconut shells for biogas or biochar production and implementing anaerobic digestion of animal manure, human faeces and wastewater to generate methane gas offer renewable energy alternatives that can replace fossil fuels.
Promoting Sustainable Development Goals (SDGs)	- Methane reduction measures contribute to multiple SDGs, including climate action (SDG 13), zero hunger (SDG 2), and good health and well-being (SDG 3).

Source: Developed by the author

1.2. National Context

i. Background and Objective of Methane Reduction Roadmap

In the same year FSM joined the Global Methane Pledge (GMP), 2021, FSM also became a member state of Climate and Clean Air Coalition (CCAC), reinforcing its commitment to reducing SLCPs such as methane, black carbon, and hydrofluorocarbons (HFCs). This partnership supports FSM's broader climate strategy, including its commitments under the Paris Agreement and participation in the GMP. In 2023, FSM further demonstrated its commitment by becoming a GMP Champion, joining countries like Canada, Germany, Japan, Nigeria, and the European Union. As a Champion, FSM advocates accelerated methane mitigation both domestically and internationally.

FSM has consistently demonstrated its commitment to global climate action by integrating GHG mitigation—including methane—into its national development and climate policy frameworks. According to its "Second National Communication (SNC) and Intended Nationally Determined Contribution (INDC)", submitted on 15 September 2016, FSM pledged to formulate strategies, national policies, and best practices aimed at reducing GHG emissions. This commitment is closely tied to FSM's objective of increasing the share of renewable energy in its national energy mix, while aligning GHG abatement with broader social, environmental, and economic development priorities.

In November 2022, at the 27th Conference of the Parties (COP27) in Sharm el-Sheikh, Egypt, FSM formally launched its "Updated Nationally Determined Contributions (NDC)". The updated NDC explicitly recognises the necessity of achieving net-zero global emissions by 2050 to limit the global temperature rise in line with the Paris Agreement's long-term goals—an imperative for the survival of FSM's islands, people, cultural identity, and unique biodiversity.

Crucially, the updated NDC acknowledges the important co-benefits of reducing SLCPs, including improvements in air quality, public health, food security, and sustainable livelihoods. It also underscores FSM's intent to integrate methane mitigation strategies into national climate planning, particularly in sectors such as solid waste and wastewater management.

The Updated NDC (2022) outlines a series of cross-cutting mitigation and adaptation measures that extend beyond the initial 2025 target year, reflecting a more integrated and long-term vision to 2030. As part of the Updated NDC, FSM has committed to undertaking a national methane inventory and assessment of methane abatement opportunities. This initiative formed a foundational step toward development of this Methane Reduction Roadmap, 2026-2035. The objective is to identify practical methane mitigation actions and opportunities across key sectors such as solid waste disposal and wastewater management, which will not only contribute to FSM's emission reduction goals but also deliver significant co-benefits in public health and sustainable development. The Annex shows the step-by-step process in developing the roadmap.

This effort reflects FSM's strategic integration of methane mitigation into national climate policy, aligning with its role as a Global Methane Pledge Champion and climate goals, and reinforcing its long-standing leadership in addressing short-lived climate pollutants (SLCPs).

ii. Policies and Regulations at National and State Levels

Before ratifying the Paris Agreement in 2016, the Federated States of Micronesia (FSM) had already demonstrated its commitment to climate action by adopting the Nationwide Climate Change Policy in 2009. This policy was later revised and integrated into the Nation-Wide Integrated Disaster Risk Management and Climate Change Policy (2013), aligning with the Strategic Development Plan 2004–2023. The overarching goal of this policy is to promote sustainable development by proactively integrating disaster risk management with climate change adaptation and mitigation across critical sectors such as economic resilience, food, water and energy security, infrastructure, waste management and sanitation, health, and education.

Complementing this framework is FSM's National Energy Policy, which served as the foundation for the development of the Energy Master Plan. Given that the energy sector is the country's primary source of GHG emissions, the policy was updated for the period 2024–2050 to set strategic goals focused on expanding energy access and affordability through a transition from fossil fuels to renewable energy sources and improved energy efficiency. These national policies were subsequently translated into state-level frameworks, with each state developing its own master plan. Likewise, the National Solid Waste Management Strategy was translated into state level strategy, based on which each state carries out activities under the authority of the respective state governments.

The Annex shows the policy and regulations related to climate change and relevant sectors at national and state levels.

iii. Governance and Legal System

The Federated States of Micronesia (FSM) is an independent sovereign state in a Compact of Free Association (COFA) with the United States of America. It comprises 607 islands, 65 of which are inhabited, making up the four states of Yap, Chuuk, Pohnpei, and Kosrae, which serve as the country's primary administrative divisions. The population is approximately 100,000 (2024 UNFPA estimate). Chuuk State, comprising seven major island groups, and Pohnpei State, the site of the national capital Palikir, have large populations of almost 50,000 and 37,000, respectively, together accounting for more than 80% of FSM's total population. There are smaller populations in Yap State, comprising four large islands and seven small islands and atolls, and Kosrae State, a single high island.

Table 1-2: General information about four states in FSM

State	Population[2] (2025 projection)	Capital	Land Area (km²)
Pohnpei	37,154	Kolonia	346
Chuuk	49,942	Weno	127
Yap	11,678	Colonia	118
Kosrae	6,791	Tofol	110

2 FY25 population projection based on the 2010 census (https://stats.gov.fm/)

The four island groups became the Federated States of Micronesia in 1979, adopting a constitution. In 1986, FSM achieved independence under COFA, which was renewed in 2003 and in 2023. Under the COFA, the USA is responsible for defence and also provides financial aid for economic development. In 1990, FSM's independence as a matter of international law was confirmed when the United Nations ended the country's Trusteeship status pursuant to Security Council Resolution 683.

Each state comprises a group of islands and operates with a high degree of autonomy under its own constitution, with an elected legislature and governor overseeing local governance. These state governments are responsible for providing essential public services such as education, healthcare, and utilities, while the national government, based in Palikir, Pohnpei, retains authority over matters of national significance, including foreign policy, defence (in cooperation with the United States), and inter-state coordination.

Therefore, implementing national policies across FSM requires careful intergovernmental coordination, given the country's decentralised federal structure and the cultural and geographic diversity of its states. As such, policy implementation must be both flexible and participatory, ensuring that national priorities are effectively translated into state-specific actions that reflect local contexts, needs, and capacities.

iv. Economy

The economy of FSM is largely based on subsistence farming and fishing, with a significant portion of the population engaged in small-scale agriculture and coastal fisheries for daily sustenance. Commercial fishing, particularly longline tuna fishing, plays a vital role in the economy, with foreign fleets operating in its Exclusive Economic Zone—especially from countries like China—operating under licensing agreements. This sector contributes significantly to government revenue through fishing access fees. Despite FSM's natural beauty and cultural heritage, its tourism industry remains underdeveloped due to geographic isolation, limited transportation links, and inadequate infrastructure.

The backbone of FSM's economy, however, is financial assistance from the United States, provided under COFA, which remains the cornerstone of public sector financing. Historically, COFA assistance has accounted for more than 50% of total public revenue in FSM, making it the single largest contributor to national and state-level budgets.

Under the current structure, national budget distribution is governed by a combination of constitutional provisions, legislative appropriations, and negotiated agreements. In practice, the majority of Compact funds are directed to FSM's four states—Yap, Chuuk, Pohnpei, and Kosrae—reflecting the country's decentralised governance model. As outlined in the Amended Compact (2004–2023) and continuing through the Compact Trust Fund arrangements post-2023, approximately 90–93% of annual COFA sector grants are allocated directly to the states, with only 7–10% directed to the national government. This funding supports state-level services such as education, health, and infrastructure, while the national government manages coordination, oversight, and national-level obligations.

In 2023, a renewed 20-year COFA economic assistance agreement was signed between FSM and the United States for fiscal years 2024–2043[3]. This agreement commits approximately 3.3 billion USD over 20 years—or around 165 million USD annually—to FSM. While the detailed implementation breakdown is under negotiation, the structure is expected to retain the state-focused distribution model.

Although some remittances are sent from citizens abroad, they are relatively modest; most Micronesians who migrate to the United States under COFA provisions tend to relocate permanently with their families, which could contribute to population loss and a growing 'brain drain'. This migration, particularly among youth and skilled workers, could pose challenges for the country's long-term economic development and human resource capacity.

v. Institutional Framework

The institutions involved in climate change mitigation, which are coordinated under a decentralised structure, are summarised in Table 1-3. At the national level, the Department of Environment, Climate Change, and Emergency Management (DECEM) serves as the lead agency responsible for the development and integration of climate change and disaster risk management policies. This institutional structure positions DECEM as the central authority for coordinating FSM's climate change efforts, including those targeting methane emission reduction. However, inter-agency coordination is limited, leading to fragmented efforts, overlapping responsibilities, and gaps in accountability. For example, climate resilience and waste management may fall under the mandates of different agencies, resulting in minimal collaboration and undermining the implementation of integrated approaches. Another fundamental barrier to effective enforcement is the lack of technical and human resource capacity. FSM's geographically dispersed structure—comprising four states spread over hundreds of islands—poses additional challenges for coordination, monitoring, and enforcement of climate actions.

While national agencies provide strategic direction and ensure compliance with international commitments, implementation is largely the responsibility of state-level governments. FSM's political system grants significant autonomy to its four states—Pohnpei, Yap, Chuuk, and Kosrae—each of which operates with its own administrative systems and environmental priorities. This decentralised governance model means that methane mitigation efforts, particularly those related to waste management, manure management, and wastewater management, vary considerably between states.

Coordination between national and state institutions is essential but often shaped by the distinct socio-economic and environmental conditions of each state. FSM must prioritise institutional strengthening. This includes building capacity at the state and municipal levels through training programmes for local officials, improving data collection and reporting systems, and fostering community engagement through education and participatory processes. Establishing clear and practical implementation roadmaps with defined roles, timelines, and budgets will help close the gap between national policy and local action. Furthermore, creating a centralised mechanism for the monitoring and evaluation of climate-related initiatives would enhance transparency, accountability, and adaptive management. Addressing these systemic gaps is essential not only for FSM to meet its international climate commitments but also

3 https://www.congress.gov/crs-product/IF12194 (visited in June 2025)

to protect its communities from the escalating risks posed by climate change.

The better coordination is also essential for the climate financing and negotiation. Table 1-4 provides an overview of some of the government institutions and their associated roles in climate finance. Despite moving towards an integrated approach in the policy and technical aspects, it is evident that climate financing has been split across a number of national organisations.

Table 1-3: Institutional setting for climate change (technical)

Institution		Mandate and role
Department of Environment, Climate Change, and Emergency Management (DECEM)		- Responsible for developing and mainstreaming climate change and disaster management policies and ensures alignment with international commitments.
	Division of Environment and Sustainable Development	- Develops and enforces policies, programmes and laws for environmental protection, biodiversity, and natural resources. - Ensures environmental quality and promotes sustainable development practices across sectors.
	Division of Emergency Management	- Focuses on resilience planning and Disaster Risk Reduction (DRR) frameworks; it leads the implementation of the framework and oversees early warning systems and risk reduction strategies.
	Division of Climate Change	- Serves as the national focal point for the UNFCCC. - Oversees the implementation of FSM's Nationally Determined Contributions (NDCs), develops and manages climate policy, and adaptation projects in collaboration with states and international partners; coordinates awareness campaigns, community engagement, and public information and supports capacity development for national and state agencies
Department of Transportation, Communications and Infrastructure (DTCI)		- Oversees transportation and infrastructure development, including disposal site construction and management, with a focus on low-emission technologies and resilient infrastructure. - Works in tandem with DECEM and DR&D to integrate GHG mitigation considerations into infrastructure planning. - All states have a DTCI office, each with a slightly different mandate.
Department of Resources and Development (DR&D)		- Leads national programmes on renewable energy, energy efficiency, and sustainable agriculture and forestry with a focus on food security with agriculture division. - Works on implementing the FSM's Energy Master Plan and ensuring alignment with NDC mitigation goals.
State Governments (Pohnpei, Chuuk, Kosrae, Yap)		- Responsible for developing climate change and disaster management regulations and implementing relevant projects.
State Utility Corporation		- Provides public services by operating and maintaining infrastructure for water, power, and wastewater. - Bills and collects fees from customers.
State Environmental Protection Agency (EPA) (Pohnpei State EPA, Chuuk State EPA, Yap State EPA, Kosrae Island Resource Management Authority (KIRMA))		- Creates and enforces state-level environmental laws and regulations. - Issues permits and licenses, and oversees environmental monitoring. - Plays a critical role in solid waste, water, and wastewater management.
Civil Society, Academia, and the Private Sector		- NGOs, community groups, and educational institutions participate in ground-level implementation.
International Partners and Donors		- FSM implements mitigation and adaptation projects in cooperation with development partners such as WB, ADB, UNDP, SPREP, FAO and bilateral donors such as GIZ and JICA. - Capacity building, infrastructure, and innovation supported through GCF, GEF, AF funding and other mechanisms.

Source: Developed by the author and confirmed by DECEM

Table 1-4: Institutional setting for climate change (finance and administration)

Institutions	Role
Department of Foreign Affairs	- Manages FSM's diplomatic relations and foreign policy for formal engagement with regional organisations and bilateral partners supporting climate projects and programmes
Department of Environment, Climate Change, and Emergency Management (DECEM)	- Technical Focal Point for UNFCCC - Operational Focal Point for Global Environmental Facility (GEF)
Department of Finance and Administration (DoFA)	- Coordinates with DECEM to manage climate financing and administration - Focal point for multilateral banks (ADB, IMF, WB) - National Designated Authority for GCF

Source: Developed by the author and confirmed by DECEM

1.3. International Context

FSM is a party to several international conventions and regional agreements related to climate change such as UNFCCC, the Paris Agreement, and Global Methane Pledge that shape its national policies on climate change, energy, agriculture, and waste management—sectors closely linked to methane emissions. By aligning with these frameworks, FSM has committed to reducing its GHG emissions, including methane, and improving environmental management across multiple sectors.

Regionally, FSM is a member of the Pacific Islands Forum and participates in initiatives like the Framework for Resilient Development in the Pacific (FRDP) and the Pacific Regional Waste and Pollution Management Strategy (Cleaner Pacific 2025). These frameworks promote integrated approaches to climate resilience, disaster risk reduction, and waste management—all of which are essential to methane mitigation. FSM also collaborates through the Secretariat of the Pacific Regional Environment Programme (SPREP), which provides technical assistance on environmental governance, including methane-related sectors.

Through these international and regional engagements (Table 1-5), FSM has established a legal and institutional foundation. These commitments influence national policies, inform project development, and shape technical and financial partnerships aimed at reducing methane emissions across the country's critical sectors.

Table 1-5: International Conventions and Regional Agreements that FSM has joined

International Convention and Agreement	
Stockholm Convention	In effect since May 22, 2001 It aims to eliminate or restrict the production and use of persistent organic pollutants (POPs) which are toxic chemicals that remain in the environment for long periods, accumulate in living organisms, and travel long distances.
Basel Convention	In effect since December 5, 1995 It controls the transboundary movements of hazardous wastes especially from developed to developing countries, and ensure their environmentally sound management, including disposal.
Montreal Protocol	In effect since September 6, 1995 It aims to phase out the production and consumption of ozone-depleting substances (ODS) like CFCs, halons, and HCFCs.
The Sendai Framework for Disaster Risk Reduction 2015-2030	It aims to achieve substantial reduction of disaster risks and losses in lives, livelihoods, and health and in the economic, physical, social, cultural, and environmental assets of persons, businesses, communities, and countries over the next 15 years.
Climate and Clean Air Coalition (CCAC)	FSM joined the CCAC in 2021, reinforcing its commitment to reducing short-lived climate pollutants (SLCPs) such as methane, black carbon, and hydrofluorocarbons (HFCs).
Regional (Pacific Islands) Agreement and Strategy	
The Small Islands Developing States Accelerated Modalities of Action (S.A.M.O.A) Pathway 2014	It recognises that dependence on imported fossil fuels has been a major source of economic vulnerability and a key challenge for Small Island Developing States (SIDS) for many decades. It also recognises that sustainable energy, including enhanced accessibility to modern energy services, energy efficiency, and use of economically viable and environmentally sound technology plays a critical role in enabling the sustainable development of SIDS.
The Framework for Resilient Development in the Pacific (FRDP) 2017-2030	Goal 2: More efficient end-use energy consumption, reduced carbon intensity of development processes, increased conservation of terrestrial and marine ecosystems and increased resilience of energy infrastructure
Pacific Climate Change Portal (PCCP)	FSM utilises this regional knowledge-sharing platform to access and share information on climate change policies, projects, and data, facilitating collaboration and knowledge exchange among Pacific Island countries.
Framework for Energy Security and Resilience in the Pacific (FESRIP) 2021–2030	The regional policy framework developed by the Pacific Community (SPC), in partnership with Pacific Island Countries and Territories (PICTs), guides sustainable, resilient, and inclusive energy sector development across the region. FESRIP supports: - Expanding renewable energy systems (e.g., solar mini grids) - Reducing reliance on diesel imports - Enhancing the resilience of energy infrastructure in outer islands - Improving electricity access and affordability
2050 Strategy for the Blue Pacific Continent and First Implementation Plan	The 2050 Strategy frames regional cooperation and broader action around seven key thematic areas: Political Leadership and Regionalism, People-Centred Development, Peace and Security, Resource and Economic Development, Climate Change and Disasters, Ocean and Environment, and Technology and Connectivity.
Micronesia Challenge	Launched in 2006, this regional initiative aims to conserve 30% of nearshore marine resources and 20% of terrestrial resources by 2020. FSM, along with Palau, the Marshall Islands, Guam, and the Northern Mariana Islands, collaborates to achieve these conservation goals. In July 2019, the leaders set new ambitious targets that build upon the Micronesia Challenge commitment to effectively manage 50% of marine resources and 30% of terrestrial resources by 2030.
Waigani Convention	In effect since May 23, 1997 A regional treaty for Pacific Island countries, prohibiting the importation of hazardous and radioactive wastes into Pacific Islands Forum countries and controlling the transboundary movement of hazardous wastes within the South Pacific region.
Agreement Establishing the Secretariat of the Pacific Regional Environment Programme (SPREP)	SPREP serves as the primary intergovernmental organisation for environmental protection in the Pacific region. SPREP supports member countries in addressing environmental challenges through capacity building, policy development, and technical assistance.
Pacific Regional Waste and Pollution Management Strategy 2016–2025 (Cleaner Pacific 2025)	A comprehensive, long-term strategy for waste management and pollution control in the Pacific region comprising four strategic goals and 15 strategic actions to address priority waste and pollution issues.

Source: Developed by the author based on each convention and agreement

2 GHG Emissions Inventory (2001–2018)

The FSM's Third National Communication (TNC) presents a comprehensive description of anthropogenic Greenhouse Gas (GHGs) emissions and removals from FSM for the year 2018 (also includes the period 2001–2017) in accordance with the 2006 IPCC Guidelines for Greenhouse Gas Inventories and its 2019 Refinement as well as IPCC Good Practice Guidance (GPG). The GHG inventories have been prepared using the Tier1 approach. NOx, CO, NMVOC, SO_2 are not estimated and reported due to the lack of detailed activity data and associated uncertainty in their estimation.

In 2018, the FSM's total GHG emissions (excluding removals) were 174.19 Gg CO_2e (in comparison to 184.63 Gg CO_2e estimated for year 1994 under the initial national communication (INC) and 173.52 Gg CO_2e estimated for year 2000 under the second national communication (SNC)). This comprises direct CO_2 emissions of 118.52 Gg, CH_4 emissions of 1.72 Gg and N_2O emissions of 0.028 Gg during 2018. In absolute terms, FSM's total GHG (CO_2e) emissions were around 0.0000031% of the total global GHG emissions for year 2018.

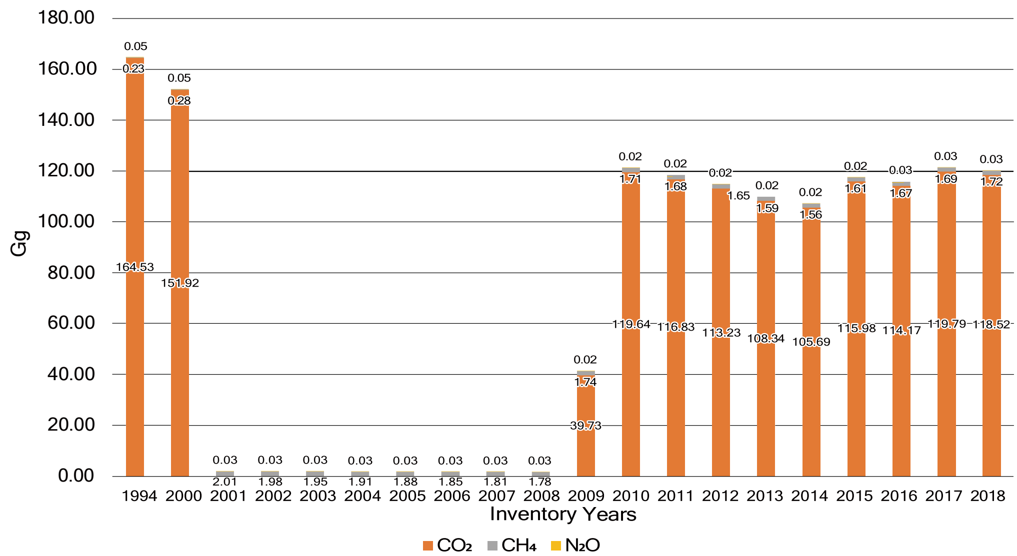

Figure 2-1: FSM's GHGs emission by type of gas (1994–2018) in TNC (FSM, 2021)

Analysis of the trend in CO_2 emissions in FSM indicates a drop to 118.52 Gg from 164.53 Gg during the period 1994 to 2018, or an approx. 28% reduction.

The energy sector is the main sector contributing to FSM's total GHG emissions, accounting for 118.52 Gg CO_2e in 2018, or about 68% of total GHG emissions in the country. The emission level rose from 39.73 Gg CO_2e in 2009 to 119.64 Gg CO_2e in 2010 and dropped thereafter until 2014. This period of lower emissions (2010–2014) is mainly attributed to the slower economic growth experienced. Emissions rose from 2015 onwards, followed by a marginal dip in 2016.

3 Methane Emission Sources

3.1. Methane Emissions Trends and Inventory Methodologies

The FSM's Second National Communication (SNC), submitted in 2015 and based on 2000 data (Table 3-1), estimated total methane emissions at 0.28 Gg, the country's second most significant GHG, accounting for approximately 3% of total GHG emissions in CO_2-equivalent terms after carbon dioxide. In the SNC, the energy sector was identified as the largest source of methane emissions, followed by waste and agriculture-related sub-sectors. In this report, CH_4 emissions from the waste and agriculture sectors was not captured fully due to the absence of data.

Building upon this, the Third National Communication (TNC) (Table 3-2) presents updated estimates and sectoral breakdowns. Based on more recent data, the TNC estimates total methane emissions of 1.72 Gg CH_4. The dominant sources of methane in the TNC are livestock, solid waste disposal, and wastewater treatment and discharge sub-sectors (Figure 3-1). Notably, CH_4 emissions from the energy sector were not estimated in the TNC, contrary to the SNC.

The differences in methane emission levels and sectoral sources between the SNC and the TNC highlight the evolution in data quality, availability, and methodological approaches used in each report. These inventory findings show both progress and gaps in methane emissions data across sectors, underscoring the need for enhanced data collection systems, particularly for agriculture and waste, and the importance of transitioning toward sector-specific mitigation strategies in FSM's climate policy and Nationally Determined Contributions (NDCs).

Table 3-1: Sectoral Total GHG Inventory, 2000 [Gg] in Second National Communication

Categories	CO_2-eq	CO_2	CH_4	N_2O
1. Energy	158.19	151.92	0.19	0.0037
2. Industrial Processes and Product Use (IPPU)	0.071	0.071	-	-
3. Agriculture, Forestry, and Other Land Use (AFOLU)	0.77	-	0.027	-
4. Waste	14.5	-	0.062	0.048
Total GHG Emissions, excl. Removals (2000)	**173.53**	**151.99**	**0.28**	**0.05**
Total GHG Emissions, excl. Removals (1994)	184.63	164.54	0.23	0.051

Source: Second National Communication to the UNFCCC (2010)

Table 3-2: Sectoral Total GHG Inventory, 2018 [Gg] in Third National Communication

Categories	CO_2-eq	CO_2	CH_4	N_2O
1. Energy	118.52	118.52	–	–
2. Industrial Processes and Product Use (IPPU)	NE	NE	NE	NE
3. Agriculture, Forestry, and Other Land Use (AFOLU)	28.43	–	0.80	0.0229
4. Waste	27.24	–	0.93	0.0051
Total GHG Emissions, excl. Removals (2000)	**174.11**	**118.52**	**1.72**	**0.028**

Source: Third National Communication and First Biennial Update Report to the UNFCCC (2023)

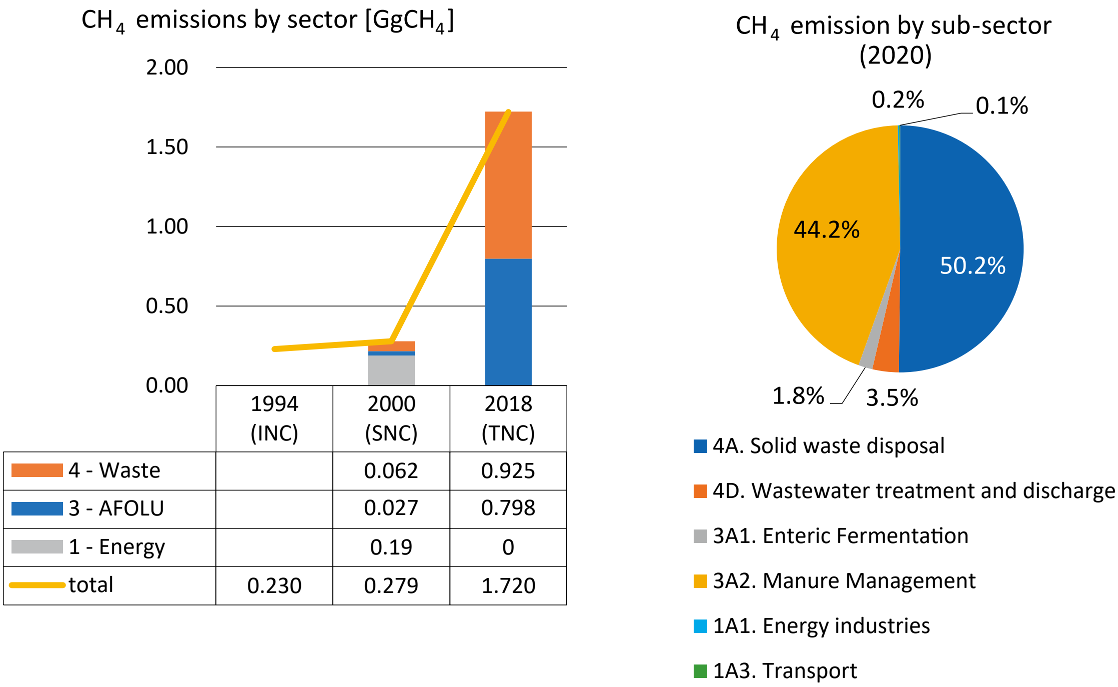

Figure 3-1: Methane emission estimates reported in INC, SNC, and TNC (Left) and source of methane emissions in TNC (Right)

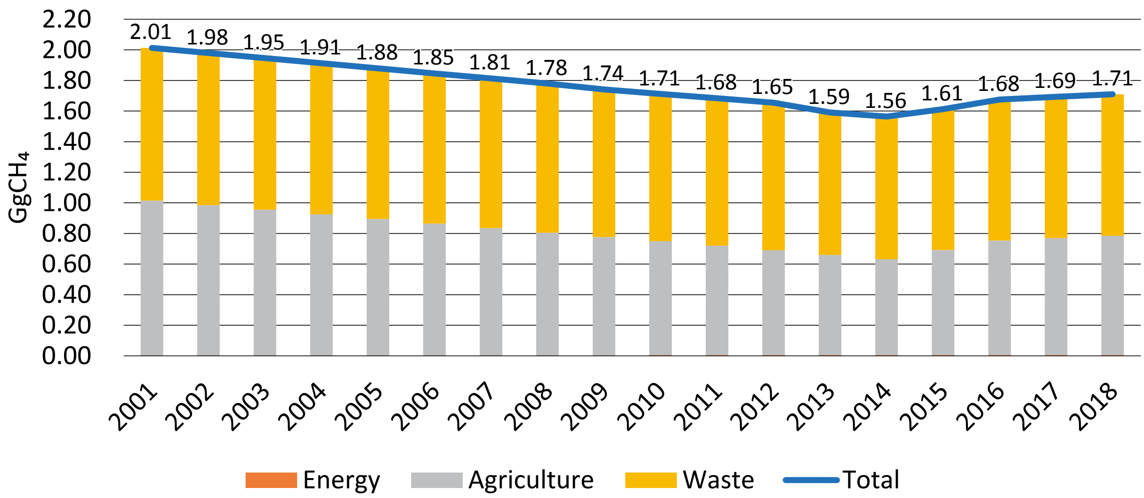

Figure 3-2: Historical trend of methane emissions by sector (National Total)

Source: Developed by the author based on the TNC

According to the TNC, methane emissions exhibited a declining trend until 2014, after which it started to rise until 2018. Estimated emissions declined to 1.71 Gg in 2018 from 2.01 Gg in 2001, representing a 14% decrease during the inventory period. The main methane emissions (about 54%) in FSM come from the waste sector (solid waste disposal and domestic wastewater treatment), with the remaining 46% attributed to the agriculture sector, mainly livestock—manure management.

3.2. Energy Sector

In the SNC, methane emissions were estimated using the reference (top-down) approach using data from Mobil Oil, the only importer of fossil fuel into FSM in 2000. In contrast, the TNC adopted the sectoral approach for estimating emissions from 2009 to 2018. Due to data limitations, emissions for the years 2001 to 2008 were not estimated. The reference approach relies on national energy supply data to estimate GHG emissions from fossil fuel combustion but does not allow for sub-sectoral differentiation within the energy sector (e.g., electricity generation, transport, residential, commercial, etc.). Therefore, only aggregate emissions under IPCC Category 1A (Fuel Combustion) are reported.

Methane emissions from the energy sector primarily arise from the incomplete combustion of fossil fuels, particularly diesel. An additional small fraction of methane may be produced through the incomplete combustion of biomass or organic waste, such as coconuts as firewood, as well as from anaerobic decomposition in biomass storage, especially when used as a renewable energy source and not properly managed. Available evidence suggests that these methane emissions are minimal in comparison to emissions of carbon dioxide (CO_2). According to the IPCC Emission Factor Database (EFDB) (Chapter 2) for example, the default CH_4 emission factor for off-road diesel-fuelled equipment is approximately 5 kg CH_4 per terajoule (TJ) of energy consumed. In contrast, the default CO_2 emission factor for diesel combustion is significantly higher, at approximately 74,100 kg CO_2 per TJ. This stark contrast between CH_4 and CO_2 emission factors illustrates that methane emissions from diesel combustion constitute only a small fraction of total emissions from the energy sector, though the precise proportion varies depending on factors such as engine type, operating conditions, and the presence or absence of emission control technologies.

3.3. Industrial Processes and Product Use (IPPU)

The TNC reported no emissions from the IPPU sector, consistent with national circumstances. FSM has no industrial processes using GHGs and no non-energy use of fossil fuels, making emissions from this sector negligible or zero.

3.4. Agriculture Sector

While in the SNC data limitations prevented the calculation of methane emissions from livestock, the TNC identified emissions within the AFOLU sector. Only Category 3A – Livestock (3A1. Enteric Fermentation and 3A2 Manure Management) was considered as a source of methane emissions, of which manure management is the primary source, though comprehensive data remained limited (Figure 3-3). Emissions from rice cultivation and liming were excluded, as these practices are not present in FSM. Furthermore, emissions from field burning of agricultural residues, urea application, and synthetic fertiliser use were not estimated for the 2001–2018 inventory period due to the absence of reliable data.

In 2018, the AFOLU sector was estimated to emit 0.78 $GgCH_4$, of which the emissions from manure management were 0.75 $GgCH_4$, accounting for 96% of total emissions from the sector, with only 4% coming from enteric fermentation. Between 2001 and 2014, methane emissions from livestock dropped from 0.74 $GgCH_4$ to 0.60 $GgCH_4$, a reduction of approximately 19%, primarily due to a drop in the livestock population. However, emissions showed an upward trend after 2014, attributed to extrapolated projections of a rise in the number of livestock from 2014 to 2016.

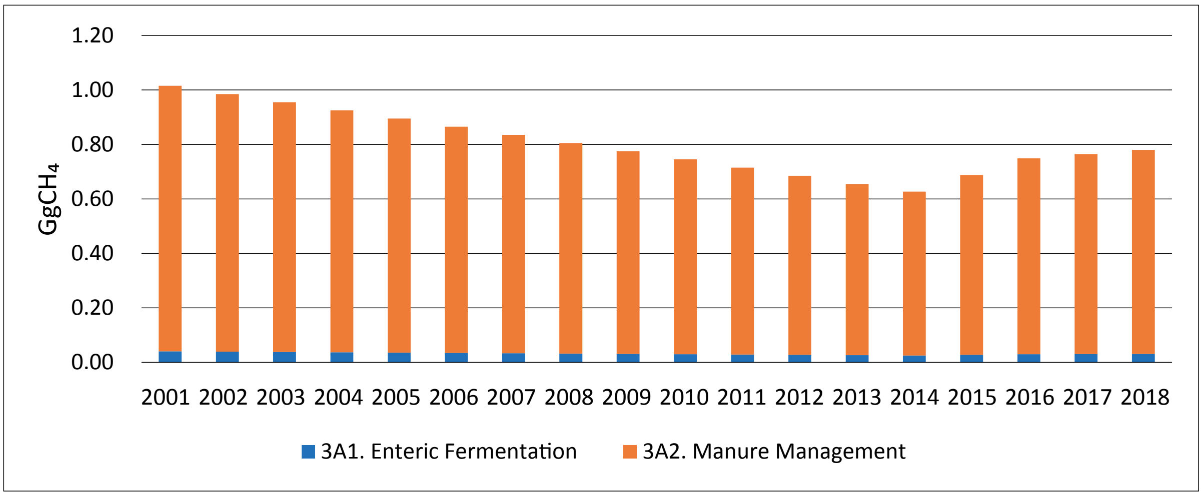

Figure 3-3: Historical trend of methane emissions (Agriculture Sector)

Source: Developed by the author based on the TNC

3.5. Waste Sector

Although the SNC characterised the waste sector as a minor contributor to national GHG emissions, the TNC indicated that the waste sector accounted for approximately 54% of national methane emissions, primarily from "4.A solid waste disposal", followed by "4.D wastewater treatment and discharge". The sudden drop in emissions in 2013 onwards is attributed to rehabilitation and upgrading of several dumpsites, transitioning them from unmanaged to semi-aerobic landfill systems (Fukuoka method), which reduce anaerobic methane generation.

Sewage systems can be found in the urban centre, Kolonia, in Pohnpei, Chuuk and Yap, although the population covered by the system is very limited. In Pohnpei for example, more than 90% of the population in Kolonia have access to the system, although Kolonia's population is estimated at only 5,000, less than 14% of the total population in Pohnpei. In Yap, a sewage treatment facility to replace the existing one has been constructed, while in Chuuk, a wastewater treatment system was rehabilitated in 2024 and the number of households connected to it rose from 500 in 2020 to 624 in 2024, according to an interview with the EPA in Chuuk.

Nevertheless, a significant proportion of the population continues to rely on non-networked sanitation systems such as pit latrines and poorly maintained septic tanks. These systems create anaerobic conditions that facilitate the decomposition of organic matter, thereby increasing methane emissions. Compared to sewer areas where controlled treatment processes can mitigate emissions, non-sewer areas are likely to contribute more substantially to methane release.

In addition to methane emissions, significant environmental and public health challenges across the country persist. A study conducted by Glen K. Fukumoto et al. (2016) assessed pig farming practices and freshwater quality on the island of Pohnpei. The survey, which included 40 rivers and streams, found that 68.3% were unsafe for recreational use, while none met the standards for drinking water. Elevated levels of bacteria, nutrients, and sediments were detected across the sampled sites.

Similarly, a comprehensive nearshore water quality assessment conducted around Pohnpei in 2018–2019 identified

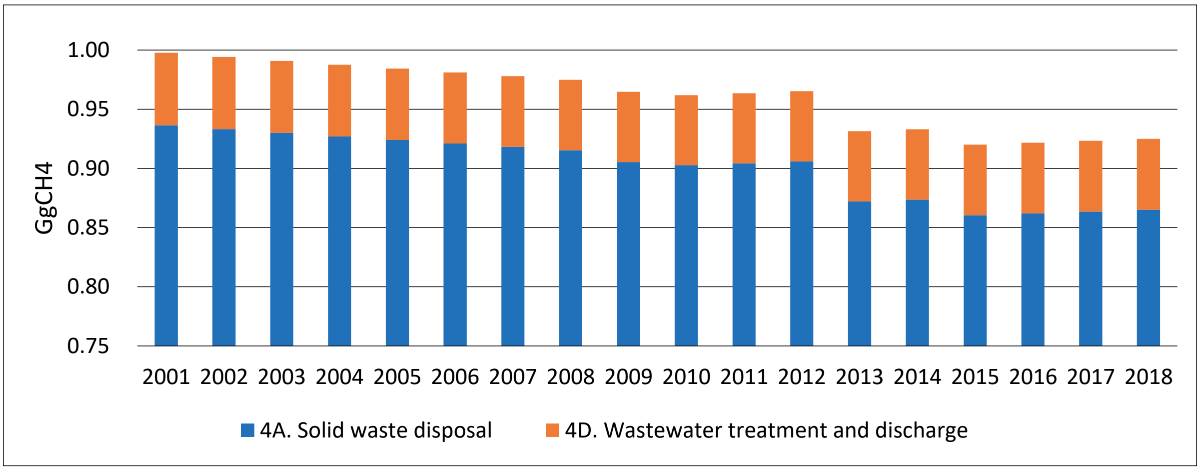

Figure 3-4: Historical trend of methane emissions (Waste Sector)

Source: Developed by the author based on the TNC

sewage contamination hotspots. The study measured faecal indicator bacteria (FIB, Enterococcus spp.), nutrient concentrations (NH_4^+, $NO_3^- + NO_2^-$, PO_4^{3-}, and H_4SiO_4), and stable nitrogen isotopes ($\delta^{15}N$) in macroalgae and nitrate nutrients, alongside physicochemical parameters such as turbidity, salinity, and temperature. Findings confirmed substantial sewage runoff from domestic wastewater systems and piggeries into both coastal waters and rivers, the latter serving as the primary drinking water source for many communities. This pollution poses serious public health risks, including the spread of waterborne diseases such as E. coli infections, cholera, and leptospirosis. The EPA is responsible for the monitoring of water quality for drinking purpose but the quality of wastewater has not been monitored on a regular basis since then due to the absence of equipment and skilled staff.

3.6. Key Category Analysis

According to the TNC, FSM has identified the most important sources of GHG emissions through a process known as key category analysis. This process helps the country understand which sources contribute the most to its total emissions and where it should focus its efforts to reduce them.

FSM used a method called Approach 1 to do this analysis. This is a standard method recommended by IPCC that involves listing all emission sources by size and adding them up until they reach around 95% of total emissions. The idea is that a small number of major sources are responsible for most emissions. These top sources are called key categories because they have the greatest impact on the country's total emissions and are therefore the most important to track and manage.

For FSM's 2018 data, the key categories responsible for methane emissions were identified as:

- Solid Waste Disposal
- Wastewater Treatment and Discharge
- Manure Management (from livestock)

While the methane emission analysis in this roadmap focuses on the above three sub-sectors, emissions from the energy sector have been taken into consideration from a co-benefit perspective.

4 Analysis and Mitigation Measure Assessment

4.1. Solid Waste Disposal

i. Future Projection of Methane Emissions

To establish a realistic and evidence-based methane reduction target for the solid waste disposal sub-sector, this section presents a comparative scenario analysis based on two distinct pathways: a Business-As-Usual (BAU) Scenario and a Mitigation Scenario.

The BAU Scenario assumes the continuation of current waste management practices without the implementation of new policies, measures, or infrastructure investments. It projects future methane emissions to 2035 based on existing disposal methods and management conditions. This scenario is informed by historical emission data from the Third National Communication (TNC), with adjustments requested by DECEM during the June 2025 technical review meeting to better reflect observed conditions. Adjustments include (details are described in the Annex):

- Use of Kosrae's waste composition data for Yap due to the uncertainty of the organic waste fraction in Yap studied in 2017.
- Incorporating non-household waste into per capita generation rates, which were omitted in the TNC.
- Updating the Methane Correction Factor (MCF) based on the deteriorated disposal site management conditions in Pohnpei and Yap.
- Revising the equation for Degradable Organic Carbon (DOC).

The Mitigation Scenario models the impact of implementing following interventions; 1) improvement of landfill site management in all states and construction of a new landfill site in Chuuk, 2) diversion of organic waste from landfill site, and 3) implementation of 5% waste reduction per year for ten years from 2026. The intervention 1) is one of agreed actions outlined in the state-level waste management strategies (SWMS). The SWMS was issued between 2018-2020 depending on a state, many of the agreed actions remain unfulfilled as of 2025. It is necessary to re-affirm and re-set the state targets.

Table 4-1 presents the key indicators used for estimating both scenarios. Detailed explanations of the adjustments and assumptions can be found in the Annex. The following assumptions are applied:

- Population growth is estimated by linear extrapolation using the trend during 2010-2018.
- Municipal solid waste (MSW) generation per capita is estimated in the same way as was done in the SWMS for the BAU scenario (It is associated with GDP growth).
- The waste generation at source will be reduced by 5% per year for 10 years from 2026 for the Mitigation scenario.
- The composition of waste disposed at landfill sites in all four states will shift to resemble that of Kosrae, characterised by lower proportions of organic, paper, and textile wastes.

Table 4-1: Indicators used for scenario analysis

Indicator	Pohnpei			Chuuk			Yap			Kosrae		
	2020	2035 (BAU)	2035 (Mitigation)	2020	2035 (BAU)	2035 (Mitigation)	2020	2035 (BAU)	2035 (Mitigation)	2020	2035 (BAU)	2035 (Mitigation)
Population (a)	36,831	37,784	37,784	49,508	50,788	50,788	11,577	11,877	11,877	6,732	6,907	6,907
MSW generation per capita (b) (kg/day/person)	1.171	1.319	0.827	0.932	1.050	0.658	1.325	1.330	0.834	1.157	1.161	0.728
Amount generated (tonnes/day) (c)=(a) x(b)	43.1	49.8	31.2	46.1	53.3	33.4	15.3	15.8	9.9	7.8	8.0	5.0
% disposed to landfill site	49.8%	49.8%	64.8%	0%	0%	62.3%	59.8%	59.8%	65.6%	55.4%	55.4%	67.9%
Organic waste fraction[4] (%)	34.9	34.9	23.2	34.9	34.9	23.2	23.2	23.2	23.2	23.2	23.2	23.2
Paper waste fraction (%)	20.3	20.3	17.5	20.3	20.3	17.5	17.5	17.5	17.5	17.5	17.5	17.5
Textile waste fraction (%)	3.6	3.6	3.4	3.6	3.6	3.4	3.4	3.4	3.4	3.4	3.4	3.4

Source: Developed by the author using data from the National Solid Waste Management Strategy[5], FSM, Country profile, J-PRISM/JICA

4 Amount of organic waste (= kitchen and garden waste) out of total amount discharged
5 Pohnpei (2020-2029), Chuuk (2019-2028), Yap (2018-2027), Kosrae (2018-2027)

The proposed waste reduction target—from an estimated 0.96 (Chuuk)–1.35 (Yap) kg/day in 2025 to 0.66–0.83 kg/day by 2035—may seem ambitious. However, considering that the global average is 0.74 kg/day (Kaza et al., 2018), this target is both realistic and achievable. Comparing emissions under both scenarios offers a solid foundation for establishing practical methane reduction targets at the national and state levels.

<BAU Scenario>

Methane emissions from FSM's disposal sites are relatively low compared to other countries at similar economic level. The following reasons are assumed.

- Low organic waste disposal—cultural practices such as feeding food scraps to pigs and dogs divert organics from landfills.
- Semi-aerobic landfill systems—installed in three states with JICA support, which contributes to the avoidance of the methane generation.

However, under the BAU scenario, emissions are projected to rise from 0.734 $GgCH_4$ in 2020 towards 0.998 $GgCH_4$ in 2035, representing a 36% increase (Figure 4-1). This jump is driven by deteriorating landfill management in Pohnpei and Yap, where formerly well-managed semi-aerobic systems have reverted to poorly managed open dumping, increasing the Methane Correction Factor (MCF) from 0.5 to 0.7 since 2025. (see detail explanation in Annex). The improper landfill site management was confirmed at the technical review meeting with key stakeholders.

State-level projections (Figure 4-2) show the highest emissions in Pohnpei due to population size, with a marked spike since 2025, as explained above. Kosrae maintains the lowest emissions, benefitting from small waste generation, effective landfill operations and consistent monitoring.

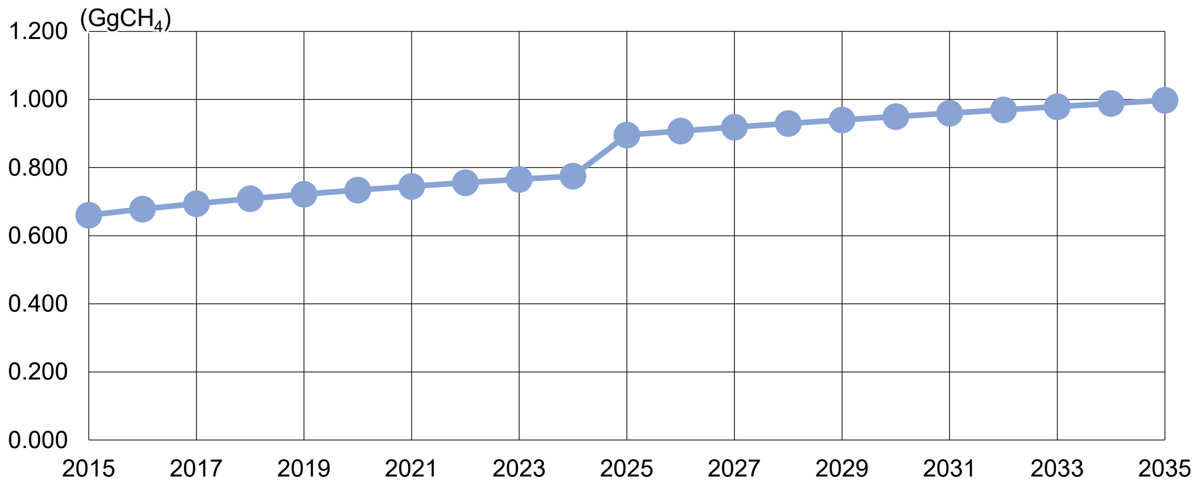

Figure 4-1: Projected methane emissions ($GgCH_4$) in FSM (BAU Scenario: 2015-2035)

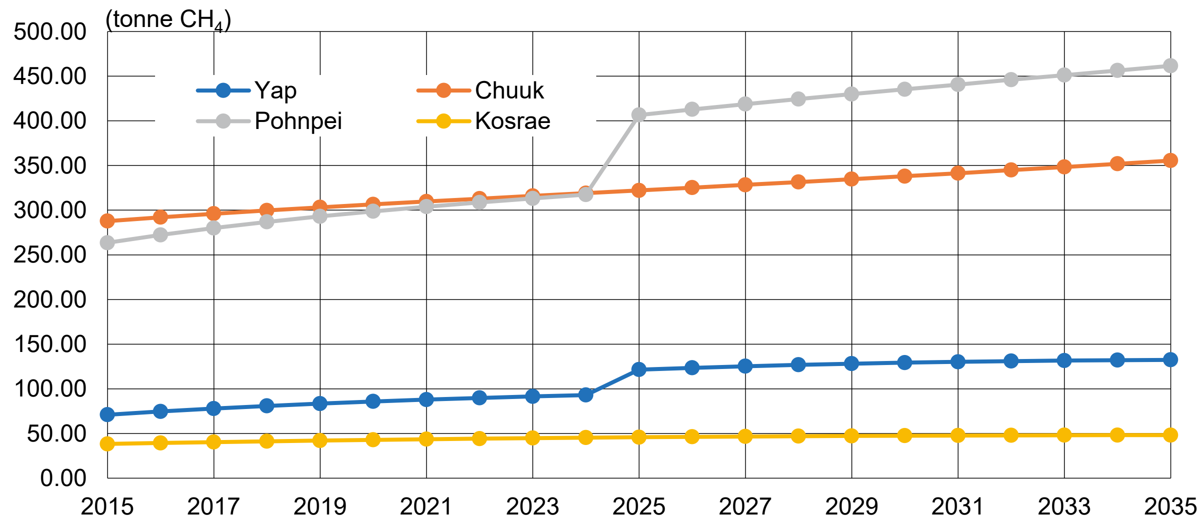

Figure 4-2: Projected methane emissions (tonnes CH_4) in each state (BAU Scenario: 2015-2035)

<Mitigation Scenario>

As shown in Figure 4-3, if the measures outlined in 4.a.i "Future Projection of Methane Emissions" are implemented from 2026, the methane emissions will decline after peaking at 0.789 $GgCH_4$ to 0.643 $GgCH_4$ by 2035—a 12.4% reduction from the 2020 level (0.734 $GgCH_4$).

At the state level shown in Figure 4-4, the largest reductions are expected in Pohnpei and Chuuk, where improved landfill operations and new landfill site construction are projected to have the greatest impact. By contrast, Yap and Kosrae are expected to see gradual increases, reflecting smaller waste volumes due to small population.

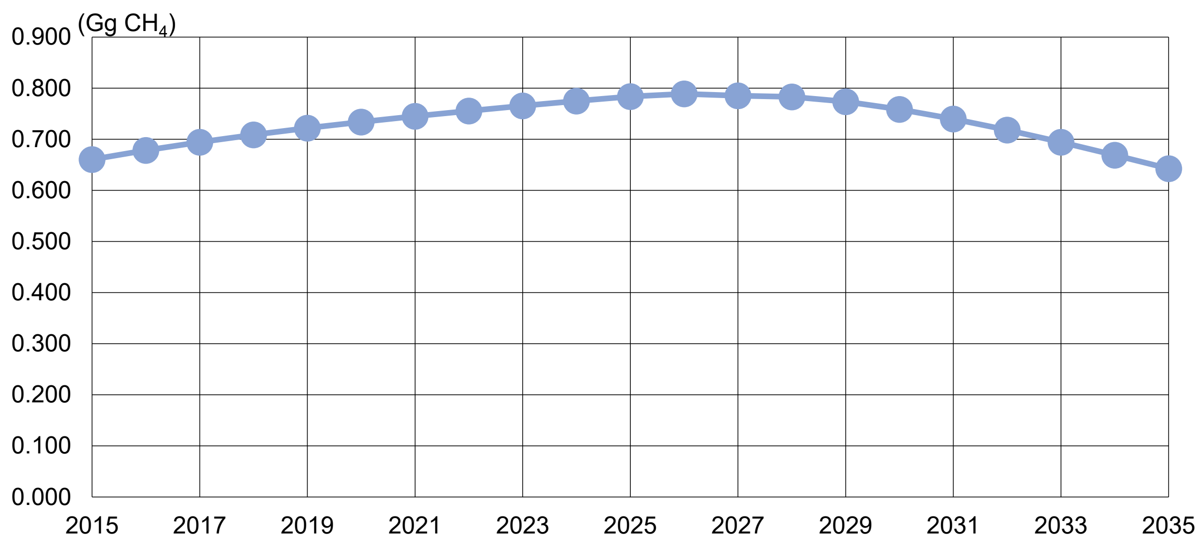

Figure 4-3: Projected methane emissions ($GgCH_4$) in FSM (Mitigation Scenario: 2015-2035)

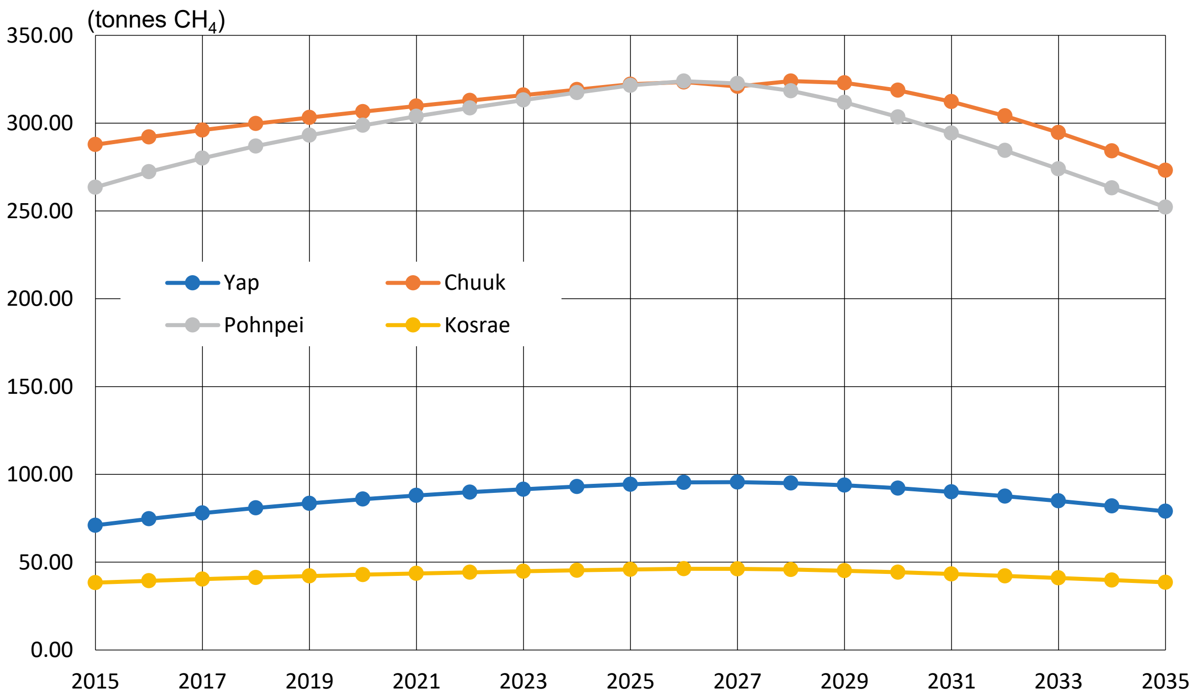

Figure 4-4: Projected methane emissions (tonnes CH_4) in each state (Mitigation Scenario: 2015-2035)

<Comparative Scenario Analysis>

Figure 4-5 shows the comparison between the two scenarios of methane emissions at the national level; Figures 4-6 to 4-9 illustrate these projections by state.

National Level

Under the BAU scenario, methane emissions are projected to increase by 36% compared to 2020 levels, reaching 0.998 Gg by 2035. The sharp increase in BAU emissions in 2025 is attributed to the deterioration of landfill management in Pohnpei and Yap, despite the installation of semi-aerobic systems. After this spike, BAU emissions continue rising in line with the projected population growth.

In contrast, with implementation of the targeted measures shown below, emissions in 2035 could be reduced by 55% relative to the BAU projection. This would bring methane emissions down to 0.643 Gg, representing a 12% reduction from the 2020 baseline of 0.734 Gg. These results demonstrate that the proposed measures can make a substantial contribution to achieving methane reduction.

Pohnpei State

Although the existing facility is a semi-aerobic landfill based on the Fukuoka method, inadequate operation and management have led to rising methane emissions since 2025, with a continued slight increase linked to population growth. Under the BAU scenario, emissions are projected to reach 0.462 Gg by 2035, representing a 55% increase from 2020. With mitigation measures, however, emissions are expected to decline to 0.252 Gg by 2035, equivalent to a 15.6% reduction from the 2020 baseline.

Chuuk State

At present, municipal waste from Weno is openly dumped at a temporary disposal site. If this continues, methane emissions are projected to reach 0.356 Gg by 2035. Assuming a new landfill is constructed in 2028 and operated appropriately, the initial thin waste layers would remain relatively aerobic, limiting methane generation. Under this scenario, 2035 emissions are projected at 0.273 $GgCH_4$, representing an 10.9% decrease from 2020 levels.

Yap State

Yap has a smaller population, which results in lower overall waste volumes compared to Pohnpei and Chuuk. Consequently, methane emissions in Yap State are about 30% of those in Pohnpei and Chuuk States. With mitigation measures in place and with waste composition in 2035 assumed to remain the same as in 2020, emissions are projected to decrease by 0.007 $GgCH_4$ by 2035 compared to 2020 levels, representing an 8.0% reduction. This corresponds to a potential 68% reduction relative to the 2035 BAU scenario.

Kosrae State

Kosrae State emits approximately half the methane of Yap. With the implementation of mitigation measures, emissions are projected to decrease by 0.004 $GgCH_4$ by 2035 relative to 2020 levels, representing a 10.2% reduction. Although Kosrae has a smaller population and lower waste generation than Yap, its methane reduction rate in 2035—relative to 2020—is 10.2%, exceeding Yap's 8.0%. The primary reason is that, while mitigation measures are scheduled to commence in 2026, Yap's emissions increase between 2020 and 2026. Therefore, even if identical mitigation measures are implemented in both states, the relative reduction rate, when evaluated against the 2020 baseline, is calculated to be higher for Kosrae.

Table 4-2: Result of Comparative Scenario Analysis

	FSM total ($GgCH_4$)			Pohnpei ($GgCH_4$)			Chuuk ($GgCH_4$)			Yap ($GgCH_4$)			Kosrae ($GgCH_4$)		
Year	2020	2035	gap	2020	2035	gap	2020	2035	gap	2020	2035	gap	2020	2035	gap
BAU scenario	0.734	0.998	35.9%	0.299	0.462	54.5%	0.307	0.356	16.0%	0.086	0.132	54.2%	0.043	0.048	12.3%
Mitigation scenario	0.734	0.643	▼12.4%	0.299	0.252	▼15.6%	0.307	0.273	▼10.9%	0.086	0.079	▼8.0%	0.043	0.039	▼10.2%
Gap		0.355			0.209			0.082			0.053			0.010	

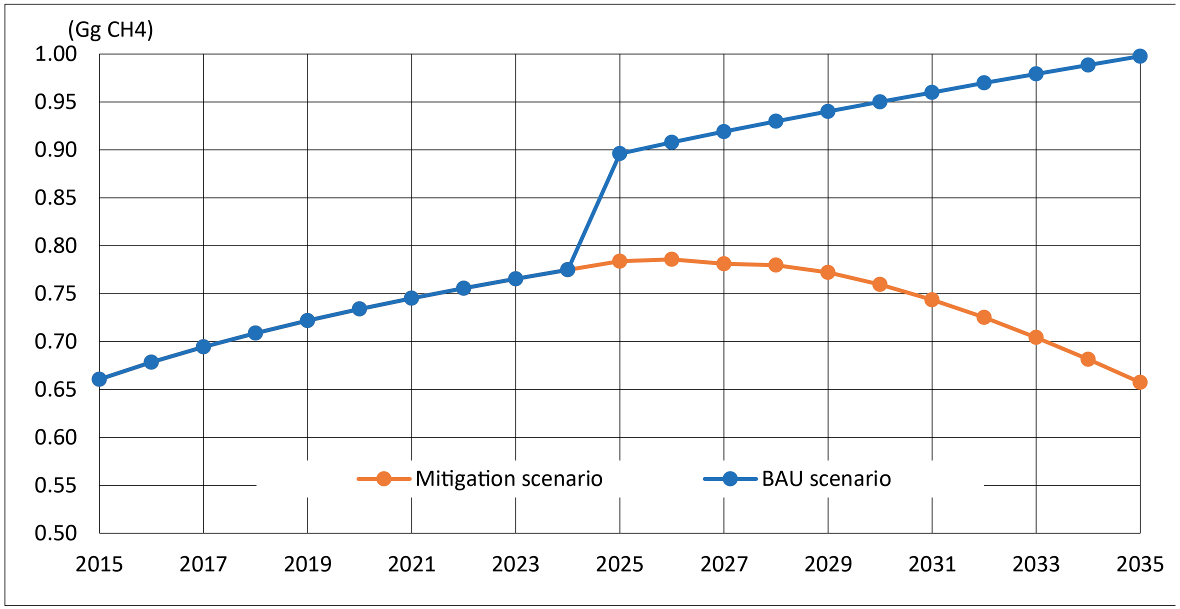

Figure 4-5: Comparison of projected methane emissions in FSM (2015-2035)

With the implementation of the targeted measures shown below, emissions in 2035 could be reduced by 0.355 GgCH4, or 55.2% relative to the BAU projection. This would enable a 0.091 GgCH4 reduction, representing a 12.4% reduction from the 2020 baseline if mitigation measures are taken from 2026. These results demonstrate that the proposed measures can make a substantial contribution to achieving methane reduction.

Suggested Mitigation Measures

1. Improvement of landfill management in all states and construction of a new landfill site in Chuuk
2. Diversion of organic waste from landfill sites
3. 5% waste reduction at source per year from 2026

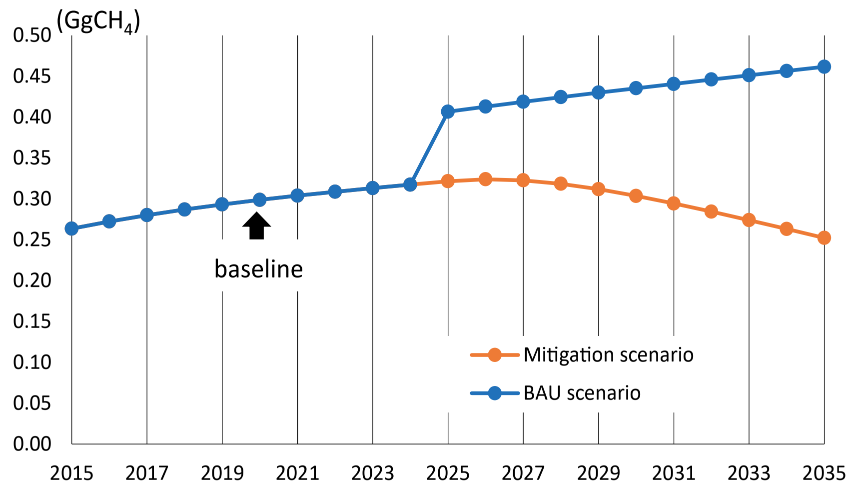

Figure 4-6: Comparison of projected methane emissions in Pohnpei (2015-2035)

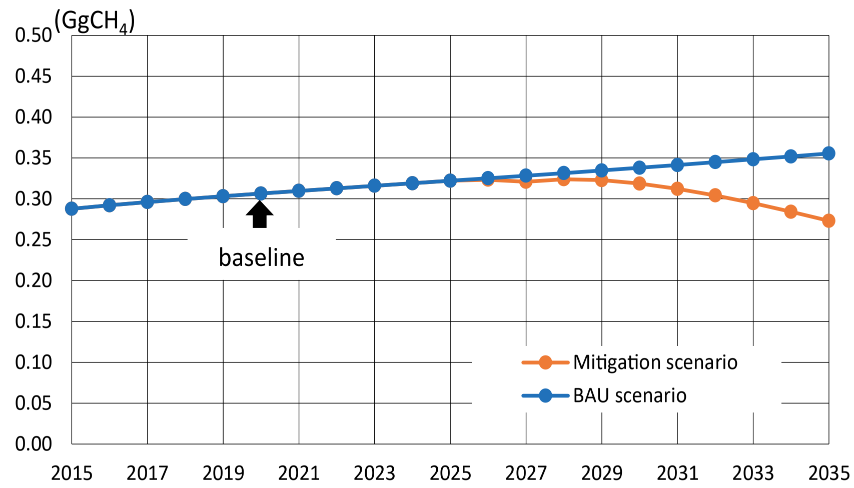

Figure 4-7: Comparison of projected methane emissions in Chuuk (2015-2035)

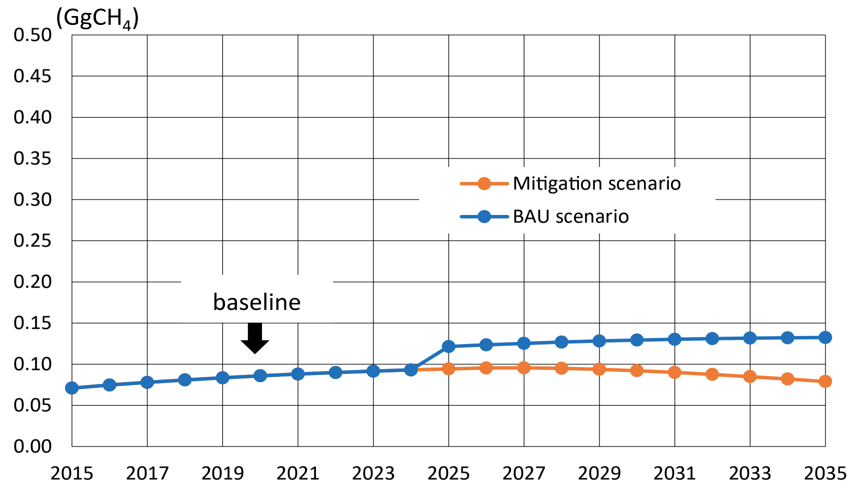

Figure 4-8: Comparison of projected methane emissions in Yap (2015-2035)

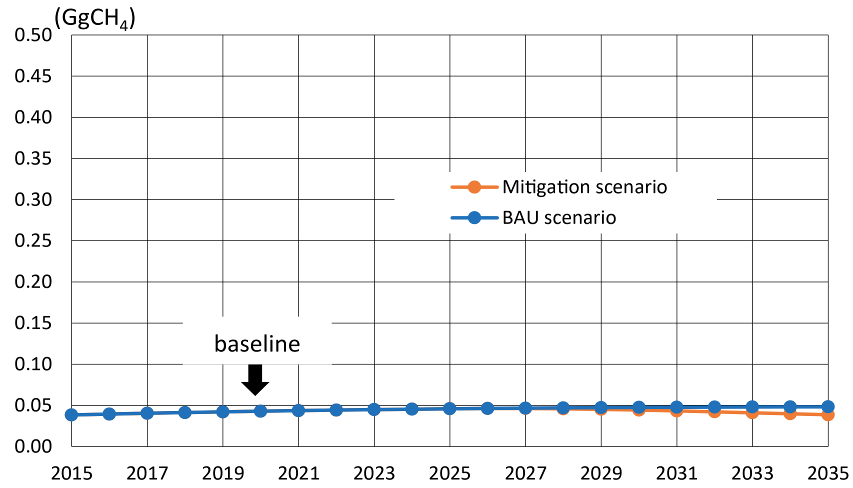

Figure 4-9: Comparison of projected methane emissions in Kosrae (2015-2035)

ii. Policies and measures supporting reduction of methane emissions

Based on the analysis presented in the previous section, improvement of landfill management, further diversion of organic waste, and waste reduction efforts (5% reduction every year) would realise a methane emissions reduction of least 12% below 2020 levels by 2035. While achieving a 30% reduction, the collective target of the Global Methane Pledge, would require efforts beyond the measures outlined above, a 12% reduction by 2035 is considered ambitious yet achievable. Further mitigation in Small Island Developing States (SIDS) like FSM is more challenging, given their relatively small contribution to CH_4 emissions.

These measures are aligned with national policies and development plans that provide the framework for solid waste management in FSM. Key guiding documents include:

- FSM National Strategic Development Plan (2024–2043)
- Infrastructure Development Plan (2024–2034)
- National Solid Waste Management Strategy (2015–2020)
- Code of Law at national and state levels
- Constitution at national and state levels

The SWMS prioritises the improvement of landfill management through the closure and rehabilitation of existing sites, the construction of a new landfill in Chuuk. These interventions are expected to reduce methane emissions from landfill sites. The strategy also discourages direct waste disposal by individuals, as such practices compromise oversight and effective site operations. Furthermore, if green waste is prohibited from being disposed of at landfill sites across all states and instead managed through mulching or composting at the household or community level, methane emissions from landfills could be significantly reduced.

The SWMS also emphasises expanding waste collection coverage with waste segregation at source and establishing sustainable financing mechanisms. Proposed measures in the SWMS include the introduction of Container Deposit Legislation (CDL) and a tax on imported vehicles, with revenues dedicated to the removal of abandoned vehicles. While increased recycling activities may not directly reduce methane emissions, they are expected to enhance landfill management and extend the operational lifespan of landfill sites

Table 4-3 presents the estimated costs associated with each component outlined in the SWMS.

Table 4-3: Actions suggested and Estimate cost for five years

Unit: million USD

Component	Pohnpei	Chuuk	Yap	Kosrae
Strategy period (original)	2020-2024	2019-2023	2018-2022	2018-2022
1. Proper management of final disposal site	1.39 Privatisation + expansion	1.19 Rehabilitation + safe closure + EIA for new landfill	0.10	0.20 New landfill preparation
2. Improvement of CDL system	0.66	0.72	0.70	0.06
3. Improvement of waste collection	0.22 Collection by the local governments	-	0.08 (Kolonia) + 0.21 (outside of Kolonia)	0.13
4. Green waste recycling	-	-	0.03 composting	-
5. Proper management of oil and tires	-	-	0.06	0.15
6. Enhancement of human capacities		0.17	-	
Total Estimate Cost	**2.27**	**2.08**	**1.18**	**0.55**

Source: National Solid Waste Management Strategy, Action Plan, FSM, Country profile, J-PRISM/JICA

Though the SWMS was developed and approved in each state during 2018-2020, limited progress has been made in implementing most of its components. This was evident during the author's field visits to Pohnpei, Chuuk, and Yap in January 2025 and further confirmed during the technical review meeting in June 2025.

A landfill development project in Chuuk is scheduled to commence with financial support from the World Bank, according to Chuuk EPA (January 2025). In addition, Chuuk launched a composting initiative under the PacWastePlus programme to divert organic waste from landfills, even though this activity is not explicitly outlined in the SWMS.

The omission of organic waste management in the SWMS may be partly due to the FSM's long-standing habitual practices of feeding food waste to pigs and dogs, which already helps divert organic waste from disposal sites and reduces methane generation. While organic waste disposed at landfill sites is a significant source of methane in general, its share in the waste composition across all four states is around 35% at maximum—relatively low compared to over 50% in many developing countries. Nevertheless, additional measures such as composting and mulching at the household or community level are recommended to strengthen organic waste diversion from open dumping areas and public disposal facilities, to further mitigate methane emissions.

At the state level, regulatory oversight of landfilling operations is typically carried out by designated agencies such as EPA, while service delivery is often managed by separate entities such as the Department of Transportation and Public Works, which may enter contractual arrangements with private service providers to fulfil their responsibilities. In Pohnpei state however, as of February 2025, disposal site operations were managed directly by the State Government, since the end of a contract with the Waste Management Service Company previously engaged in collection, transportation and disposal site management. Currently, waste collection in Pohnpei is handled by municipalities with limited capacity.

To properly monitor the impact on the environment, clear demarcation with a written agreement is needed among the related stakeholders. Such agreements should define roles and responsibilities for oversight, inspections, and data collection—covering waste disposal by type and environmental parameters such as leachate quality and landfill air emissions. A detailed overview of institutional roles and responsibilities is presented in Table 4-4.

Table 4-4: Institutional setting for Solid Waste Management in FSM

State	Regulatory agency	Operation of disposal site management	Collection and Transportation
Pohnpei	Pohnpei EPA	Until 2024, Department of Transport & Infrastructure (DT&I) contracted out to Pohnpei Waste Management Services (PWMS). As of Feb. 2025, it is operated directly by the State.	PWMS operated until 2024. As of Feb. 2025, Municipalities collect waste with limited capacity.
Chuuk	- Chuuk EPA - Public Safety	Department of Transportation, Communication & Public Works (DTPW)	DTPW operates only in Weno.
Yap	Yap EPA	Department of Public Works & Transportation (DPW&T)	Private companies contracted by DPW&T collect mainly from households, public institutions and commercial sectors.
Kosrae	Kosrae Island Resource Management Authority (KIRMA)	Department of Transportation & Infrastructure (DT&I)	Municipalities

Developed by the author based on National Solid Waste Management Strategy[6], FSM, Country profile, J-PRISM/JICA and interviews with relevant agencies

Photos taken by the author: Fishing nets disposed of at a designated area in the landfill (left) and an incinerator for medical waste (right) in Pohnpei

6 Pohnpei (2020-2029), Chuuk (2019-2028), Yap (2018-2027), Kosrae (2018-2027)

4.2. Wastewater Treatment

i. Future Projection of Methane Emissions

Accurately projecting future methane emissions from the wastewater treatment sub-sector in FSM remains challenging due to the absence of reliable, disaggregated data on wastewater treatment systems. Between 2001 and 2020, methane emissions from this sub-sector have remained relatively constant at approximately 0.06 $GgCH_4$ per year, based on the IPCC Tier 1 methodology. In the absence of updated and detailed data, it is assumed that this trend will continue into the near future.

Using the Tier 1 method, reliant on default emission factors and regional assumptions, results in a relatively low contribution from the wastewater treatment sub-sector compared to emissions from the solid waste disposal sub-sector, which dominates methane emissions within the broader waste sector. As a result, the wastewater component is often seen as negligible in the national GHG inventory under the current calculation approaches.

However, if methane emissions from the widespread use of septic tanks and pit latrines particularly prevalent in rural and peri-urban areas are more accurately captured to reflect actual conditions, the estimated emissions from this sub-sector may be higher than currently reported. Furthermore, these conventional sanitation methods pose significant risks to groundwater quality, coastal ecosystems, and marine biodiversity. Although such environmental impacts may appear minimal in sparsely populated areas, their cumulative effects on environmental health and community well-being are substantial and should not be overlooked.

To enhance both the accuracy of national GHG inventories and the effectiveness of climate mitigation strategies, it is critical to undertake comprehensive data collection on:

- The operation of centralised sewage systems and treatment of sludge
- The prevalence and condition of septic tanks, pit latrines and other on-site systems
- Regional variations in wastewater treatment practices

Such data will enable FSM to move beyond default assumptions and develop more representative, context-specific emission estimates. In doing so, the country can better identify mitigation opportunities in the wastewater treatment sub-sector, contributing not only to climate targets, but also to public health improvements and the protection of sensitive ecosystems in a quantitative manner.

ii. Policies and measures supporting reduction of methane emissions

While methane emissions from the wastewater treatment sub-sector have not been explicitly addressed in FSM's policy framework, existing regulations related to wastewater treatment and water quality primarily focus on natural resource management and pollution control. The regulatory framework consists of a combination of national standards and state-level implementation. The national government is responsible for establishing overarching policies and standards, while state governments are tasked with developing and enforcing regulations within their respective jurisdictions.

The National Environmental Management Strategy 2019-2023 (NEMS) outlines FSM's approach to environmental management, emphasizing the need for sustainable use of natural resources. It highlights the importance of addressing environmental challenges, including waste management and water quality, through coordinated efforts between national and state governments. One of the core objectives is: "All human-generated wastes are effectively managed to prevent or minimise environmental degradation". To achieve this, NEMS sets out milestones specific to wastewater management under the activity "Improve sewer infrastructure in urban areas". These include: resource allocated, green alternatives investigated, pass and enforce appropriate wastewater standards/quality regulations, plan and design developed, and infrastructure improved by 2020. This policy has been implemented only in the urban centres—Kolonia in Pohnpei and Yap, and Weno in Chuuk. The sewage system has expanded in these urban areas, while much of the population outside these centres continues to rely on latrines and septic tanks.

At the state level, Pohnpei issued "Marine and Freshwater Quality Standards Regulations" in 1986. These regulations align with the national NEMS and define the designated uses for FSM's water bodies, establish water quality standards[7], and mandate the maintenance of those standards to safeguard public health and the environment. The other states have their own sets of regulations and laws regarding wastewater treatment and water quality.

It is important to note that wastewater management in FSM is often approached primarily from a public health perspective, particularly regarding the prevention of waterborne diseases. Although the Updated Nationally Determined Contribution (Updated NDC) for FSM does not explicitly mention methane reduction in the public health sector, it includes targets that are indirectly supportive. One such target is:

"By 2030, establish a surveillance system, including a laboratory facility, to detect and monitor vector-borne diseases (VBD), water-borne diseases (WBD), and food-borne diseases (FBD), to enable rapid response and control of outbreaks."

While this goal is primarily health-focused, the implementation of actions can contribute to climate mitigation—specifically methane reduction—through improvement of wastewater treatment and manure management (which is discussed in the next section). These improvements help remove organic contaminants from waterways, which not only reduces the risk of disease outbreaks but also minimises the methane formation in anaerobic conditions, such as those found in poorly maintained septic tanks. Although the extent of methane leakage from these sources is currently unquantified due to data limitations, reducing such emissions remains a relevant co-benefit.

The adoption of anaerobic biodigesters for wastewater treatment presents a valuable opportunity. Methane generated through bio-digestion can be captured and used as a renewable energy source, substituting for fossil fuel consumption and contributing to a reduction in overall CO_2 emissions. This offers a triple benefit: climate mitigation, improved public health, and enhanced energy security.

7 Maximum allowable E. coli level of 0 MPN/100 mL for drinking water and <576 MPN/100 mL for recreational waters

Therefore, targeted policies and measures—such as expanding centralised wastewater infrastructure, promoting safe and sustainable on-site sanitation, improving sludge management, and integrating renewable energy solutions like biodigesters—are effective for mitigating methane emissions.

4.3. Manure Management

i. Future Projection of Methane Emissions

Like the wastewater treatment sub-sector, it is challenging to accurately project future methane emissions from the manure management sub-sector in FSM due to the lack of current and reliable data. Key data gaps include:

- updated livestock population figures,
- details on manure management practices, and
- the proportion of waste treated under anaerobic versus aerobic conditions.

The current methane emissions estimates rely on Tier 1 default methods from the IPCC, which assume a generalised emission factor and manure treatment system. However, the author's field observations and interviews suggest that many households clean pig pens by washing manure into open ground or waterways—practices that tend to favor aerobic decomposition, possibly resulting in very low methane emissions. If these habitual practices are more widespread than previously assumed in the TNC, methane emissions could be negligible as the methane correction factor under these conditions is likely close to zero, meaning current estimates in the TNC may significantly overstate actual emissions.

Without accurate and up-to-date information, it is not possible to estimate current emissions, nor make realistic future projections. Once this information is collected, such as through systematic interviews or regular census, the national GHGs inventory could be corrected and better aligned with local realities, ensuring more accurate reporting and supporting better-targeted methane mitigation efforts from this sub-sector.

ii. Policies and measures supporting reduction of methane emissions

Although manure management is under the AFOLU sector according to IPCC, methane emissions from manure management in FSM are closely linked to environmental pollution and public health risks, similar to the impact of the wastewater treatment. This is because most pigs in FSM are not raised for agricultural purposes, but rather raised at individual houses for cultural activities, especially in Chuuk, Yap and Kosrae. It is common across FSM for pig manure to be washed away with water, leading to contamination of waterways. This practice significantly heightens the risk of waterborne diseases, including salmonellosis and leptospirosis,

In the late 2000s, Pohnpei experienced significant water pollution in its rivers, largely attributed to traditional pig manure management practices. In response, dry litter piggery systems were introduced as a mitigation measure. These systems employ absorbent materials, such as wood chips, to capture and manage pig waste, thereby minimising water usage and preventing the direct discharge of waste into nearby water bodies. However, the measure failed to scale due to high upfront costs and greater labour- and time-intensity than conventional cleaning methods, according to interviews conducted by the author.

Both wastewater and manure management in FSM is typically addressed from a public health perspective, with a focus on preventing disease transmission. While FSM's Updated NDC does not explicitly target methane reductions within the public health or agriculture sectors, it includes indirectly supportive objectives. Notably, the NDC sets a goal to:

"By 2030, establish a surveillance system, including a laboratory facility, to detect and monitor vector-borne diseases (VBD), water-borne diseases (WBD), and food-borne diseases (FBD), to enable rapid response and control of outbreaks."

Pohnpei state addresses these challenges by establishing the *Marine and Fresh Water Quality Standard Regulations* (1995), which set water quality benchmarks, including a maximum allowable E. coli level of 0 MPN/100 mL for drinking water and <576 MPN/100 mL for recreational waters. The Pohnpei Environmental Protection Agency (EPA) is responsible for enforcing these standards through regular water quality monitoring.

Moreover, a recent milestone in addressing both food system sustainability and environmental concerns is the Pohnpei State Food Security Policy, released in 2025. This policy sets a framework for building a resilient, self-sustaining local food system and includes specific provisions to tackle manure management, such as:

- Promoting waste management practices that support a circular economy and environmental protection;
- Encouraging local feed production, composting, and the use of livestock waste as soil amendments to reduce nutrient runoff;
- Capturing and safely using animal waste to prevent waterway pollution and maintain healthier ecosystems.

These measures align with broader goals of reducing methane emissions by:

- Preventing anaerobic waste decomposition in unmanaged systems (e.g., open pits or waterways),
- Encouraging the adoption of biogas systems, which capture methane for clean energy use (e.g., cooking or lighting), thereby replacing fossil fuel consumption,
- Supporting practices that turn waste into a resource, minimising both emissions and pollution.

Improved manure management has multi-benefits. It reduces methane emissions, improves water quality, protects public health, and contributes to clean energy goals. Policies that link pollution control and climate mitigation offer a holistic pathway toward sustainable development and resilience in FSM.

Photos taken by the author: A pigpen connected to a biodigester in Pohnpei (left) and a traditional pigpen in Yap (right)

4.4. Energy

i. Future Projection of Methane Emissions

The energy sector contributes negligibly to methane emissions in FSM, as explained in *1.f Key Category Analysis,* though the GHG emissions from this sector are significant. Therefore, quantitative analysis of methane emissions from the energy sector has been omitted from this roadmap though it is technically possible to estimate if reliable data is available.

ii. Policies and measures supporting reduction of methane emissions

FSM's National Energy Policy outlines strategic goals focused on expanding energy access and affordability through a transition from fossil fuels to renewable energy sources and improved energy efficiency. This policy direction is reinforced in FSM's Updated NDC for 2030, which includes clear commitments such as:

- *"By 2030, increase electricity generation from renewable energy to more than 70% of total generation."*
- *"By 2030, reduce black carbon and methane emissions related to diesel electric generation by more than 65% below 2000 levels."*

These targets reflect the government's recognition of the importance of decarbonising the energy sector not only to reduce carbon dioxide emissions but also to limit SLCPs, including black carbon and methane. Although methane reduction would not be significant, the measures such as replacing fossil fuel with renewable energy, upgrading diesel generators, improving fuel storage and handling systems, and phasing out outdated infrastructure contribute to methane mitigation.

In this way, even though the methane reduction potential from the energy sector is limited in quantitative terms, the policy alignment and transition to cleaner energy sources provide important co-benefits. These efforts complement the broader methane mitigation strategy outlined in this roadmap and support FSM's commitment to climate resilience, energy security, and sustainable development.

5 Target Setting for Methane Reduction

This section outlines a methane-specific reduction target to be achieved in FSM. Setting such a target is critical, as it provides a clear benchmark for measuring progress, informs policy and investment decisions, and strengthens accountability in achieving both methane reduction and broader climate resilience objectives. However, targets are only meaningful if progress toward them can be measured. Without consistent data collection and regular monitoring of key indicators, it becomes impossible to track achievements, identify implementation gaps, or revise strategies effectively—ultimately undermining the purpose of the target. Reliable data gathering on a regular basis is essential to ensuring transparency, supporting adaptive management, and enabling evidence-based decision-making.

Given the considerable uncertainty in methane emissions data from the wastewater treatment and manure management sub-sectors presented in the Third National Communication (TNC), and the relatively stronger availability of baseline data in the solid waste disposal sub-sector, this roadmap sets a methane reduction target solely based on the projection of emissions in the solid waste management sector.

As detailed in 4.a.i *Future Projection of Methane Emissions*, two scenarios were analysed comparatively. According to the findings, implementation of the actions outlined in the SWMS, diversion of organic waste, and waste reduction effort could achieve the following methane reduction targets by 2035 compared to 2020 levels:

Methane Reduction Target for 2035 (vs 2020 baseline)
National Target: 12.4% reduction
State Target
- **Pohnpei: 15.6% reduction**
- **Chuuk: 10.9% reduction**
- **Yap: 8.0% reduction**
- **Kosrae: 10.2% reduction**

This methane reduction target should be formally incorporated into the FSM's forthcoming Nationally Determined Contribution (NDC). If waste generation decreases—whether due to population decline or reduced waste generation per capita —the resulting reduction in methane emissions by 2035 will be greater. Therefore, when accurate and reliable data, such as from population censuses or more recent waste data at landfill sites, become available, the methane emission estimates should be updated accordingly.

Target-setting for the methane emissions from wastewater and manure management sub-sectors may be considered in the future, once reliable, ground-level data become available to support accurate emissions estimates. In the meantime, monitoring indicators related to wastewater quality or public health impacts could be established as a non-GHG indicator, drawing on the model of the Marine and Freshwater Quality Standards Regulations already adopted in Pohnpei and existing national frameworks such as the NDC or sector-specific policies. Following this approach, once national targets are translated into state-level targets, a responsible agency at state level should be mandated to regularly monitor water / wastewater quality or number of people infected with VBD, WBD and FBD. Monitoring these indicators will ensure that water resources are adequately protected, thereby supporting public health and ecological sustainability.

6 Implementing Pathways

Key potential mitigation measures have been identified through the analysis of existing policy, governance structure and regulatory framework, and assessment of methane emission reduction potentials from three sub-sectors discussed in the previous sections. On the other hand, when evaluating technology options to mitigate methane emissions, it is essential to consider enablers because technology alone does not guarantee sustained results. The success and long-term effectiveness of any mitigation measure depend mainly on these enablers: institutional, technical, social, financial, collaborative and inclusive conditions that support its implementation.

- Technical and Operational capacity: Even if a methane mitigation technology is technically proven, it may fail in practice if local institutions do not have qualified staff who can operate, maintain, and monitor it. To translate technical designs into effective solutions, training with clear operational guidelines and regulatory frameworks is indispensable.
- Awareness raising and behavioural change: Methane mitigation often requires changes in practices—whether in waste handling, livestock management, or energy production. Awareness-raising activities foster understanding among communities, policymakers, and private actors about the benefits, risks, and co-benefits of new technologies, increasing the likelihood of public buy-in and adoption.
- Sustainable financing and resources: Some methane mitigation technologies require high upfront investment. Also, in FSM's island context, ensuring spare parts availability or using products with low replacement or repair needs is crucial to minimise O&M costs. Resource mobilisation through climate finance, public–private partnerships, and budget allocation is key to scaling deployment and sustaining systems over their lifecycle.
- Knowledge sharing and local adaptation: FSM's diverse island contexts mean that technologies must often be adapted to local conditions. Knowledge sharing—both domestically and through regional networks—helps replicate successes, avoid repeating mistakes, and adapt designs to environmental and logistical realities.
- Coordination and Partnership: Methane emissions sources often fall under multiple sectors (e.g., waste, agriculture, energy). Inter-institutional coordination ensures that roles and responsibilities are clearly defined, overlaps are avoided, and synergies are leveraged—leading to more efficient and coherent implementation.
- Inclusivity and equity: The social impact of technologies can vary across gender, age, and socio-economic groups. Incorporating diversity and gender considerations ensures that mitigation efforts are equitable, inclusive, and benefit all segments of society, which in turn strengthens community ownership and long-term sustainability.
- Regulatory framework: A robust and coherent regulatory framework is a critical enabler, providing the legal basis for enforcement, setting technical standards, and ensuring compliance across sectors and states.

In this section, the identified enablers have been considered for each technology option. Following the explanation of each option, the implementation pathway of the overall roadmap is also discussed from the enablers point of view.

6.1. Technical mitigation measures

Table 6-1 presents specific actions aimed at reducing methane emissions. To achieve the mitigation target in an effective and efficient manner, the primary focus will be on emission reduction in the waste sector, which is the largest source of methane emissions in FSM. Measures in other sectors are recommended from a co-benefit perspective, as their reduction potential may be currently limited or difficult to estimate accurately due to the lack of data.

Table 6-1: Methane mitigation measures with reduction level and co-benefits

Sub- Sector	Actions	CH_4 reduction level	Co-Benefit
Solid waste disposal	Improvement of landfill site management (e.g., controlled landfilling)	◎ (High)	Improves public health; prevents nuisance, odour, air and water pollution from open burning and unmanaged disposal.
	Organic waste management (composting and mulching) + improved waste collection	◎ (High)	Diverts organic waste from landfill; reduces methane emissions and leachate pollutants; compost and mulch as output to improve soil quality and support agriculture.
	Reduction of waste generation through circular economy approach	◎ (High)	Lowers demand for raw materials and energy; decreases GHG emissions from production and disposal; reduces pressure on landfill capacity.
Domestic Wastewater treatment	Decentralised wastewater treatment systems	○ (moderate)	Reduces groundwater contamination; lowers water-borne disease risks.
	Dry litter piggery system	△ (low)	Utilises wood chips from green waste (waste as resource); reduces water pollution; produces manure for agricultural use.
	Anaerobic digesters replacing septic tanks to produce biogas	○ (moderate)	Prevents water pollution; replaces fossil fuel use; Risk: methane leakage if poorly maintained.
Manure management	Anaerobic digesters to produce biogas from livestock manure	○ (moderate)	Prevents water pollution; reduces odour; produces biogas for cooking/lighting; Risk: methane leakage if poorly maintained.
Energy	Conversion of coconut to syngas or biochar	△ (low)	Produces renewable energy or value-added product; reduces air pollution from open burning; contributes to CO_2 reduction.
	Shift electricity generation from fossil fuels to renewable energy sources	△ (low)	Cuts fuel imports; increases energy security; lowers CO_2 emissions.
	Upgrade or replace inefficient diesel generators	△ (low)	Improves fuel efficiency; lowers maintenance costs; reduces NO_x, PM emissions.
	Hybridisation with solar PV + battery storage	△ (low)	Cuts fuel imports; increases energy security; lowers CO_2 emissions.
Transport	Ban or phase-out of high-emission, two-stroke engines	△ (low)	Improves fuel efficiency; reduces black carbon.

Source: Developed by the author

i. Improvement of landfill site management (Controlled Landfilling)

FSM has taken strong measures to address solid waste issues, with each state developing its own Solid Waste Management Strategy (SWMS) and action plan. Across all four states, the SWMS identifies landfill site management as a critical element for improving solid waste management outcomes.

In Pohnpei, Yap, and Kosrae, semi-aerobic landfill sites have been established. The semi-aerobic landfilling method contributes not only to methane emission avoidance but also provide multiple additional benefits, including:

- **Faster waste stabilisation:** Organic matter breaks down more quickly with oxygen (aerobic decomposition), reducing the active lifespan of the landfill.
- **Leachate quality improvement:** As aerobic conditions promote microbial activity that helps degrade pollutants, leachate has lower biochemical oxygen demand (BOD) and less toxicity, consequently reducing treatment costs.
- **Odour reduction:** Aerobic decomposition suppresses the production of odorous gases such as hydrogen sulphide, which are typically generated in anaerobic conditions.
- **Reduced risk of explosion or fire:** Lower methane accumulation decreases the likelihood of spontaneous combustion within the landfill.
- **Low-cost operation:** Lower operational costs and less energy demand than fully mechanical aerobic landfills as it relies on passive or minimal aeration.

However, if the landfill sites are not managed consistently or operated properly, the landfills may not function effectively, resulting in increased methane emissions and negating the intended environmental benefits. Table 6-2 shows the operational checklist and Table 6-3 shows a list of actions to ensure the enabling conditions.

Table 6-2: Checklist of proper operation of semi-aerobic landfill site

Category	Items
1. Leachate and Gas Vent System Maintenance	• Conduct regular and post-rainfall inspection of clean leachate collection pipes (usually perforated pipes at the base). • Remove blockages from gas vents and leachate drains to ensure passive air circulation. • Ensure leachate drains are sloped correctly to allow free flow (no waterlogging).
2. Waste Layering and Compaction	• Spread waste in thin layers (usually less than 60 cm thick). • Compact each layer properly to eliminate large air pockets (avoiding over-compaction, which collapses air paths).
3. Controlled Soil Covering	• Apply daily soil cover (10–20 cm) to control odour, flies, and moisture. • Use intermediate covers during heavy rain or between filling phases to prevent water seepage.
4. Site Drainage Management	• Ensure the landfill has surface water drainage channels to prevent rainfall from entering waste. • Maintain a gentle slope (2-5%) to divert rainwater away from the active cell.
5. Monitoring and Recordkeeping	• Leachate levels and quality monitoring (monthly monitoring recommended: pH, EC, temperature, BOD, COD, ammonia, E.coli; bi-annually: heavy metals, VOCs, and others) • Gas venting (CH_4, CO_2, temperature) • Settlement and erosion • Keep records of waste quantities (by vehicle), maintenance schedules, and any pipe clean-outs or blockages found.
6. Staff Training	• Train landfill operators on mechanism and benefit of semi-aerobic method, and the way to identify and fix system failures. • Control access to prevent uncontrolled dumping and burning.
7. Community Engagement / awareness raising	• Educate nearby residents about: ◦ Keeping out hazardous waste ◦ Benefits of improved landfill management ◦ Potential for waste separation and recycling

Source: SPREP & JICA, 2010 edited by the author

Table 6-3: Enabling activities ensuring sustainable operation of landfill site management

Category	Responsible Agency	Activity
Technical Capacity	Dep. of Public Works and Transport, State government, EPA	- Develop operational manual (or guideline) for semi-aerobic / engineering landfill site management. - Develop a tender document template with work specifications for outsourcing of waste management services (collection, transportation, and disposal). - Develop a digital platform such as KoboTool for easy monitoring and recording. - Train disposal site operators (DPW) and inspectors (EPA) on how to collect monitoring data with digital tools.
Awareness raising	Municipalities, NGOs	Inform communities of the importance of proper waste segregation, health risks from open dumping/burning, and benefits of controlled landfills.
Resource mobilisation	Dep. of Public Works and Transport, State government	Secure funding for landfill upgrades, necessary vehicles, machines and O&M costs, and monitoring equipment from local tax, national budget, donors, or multilateral climate funds.
Knowledge sharing	Dep. of Public Works and Transport, EPA, DECEM	Share best practices among states and with regional peers in the Pacific Island countries, including case studies of successful controlled landfills.
Coordination and partnership	Dep. of Public Works and Transport, EPA, State government	Ensure collaboration between EPA, state government, Dep. of public works, and State Government for integrated landfill site management.
Inclusivity and equity	Women's Associations, Youth Groups, waste collectors	- Promote participation of women, youth, and marginalised groups in planning and decision-making for integrated solid waste management - Ensure training and capacity-building activities are accessible and inclusive, addressing diverse needs and barriers
Regulation	EPAs	Regulate the standard and methodology for environmental monitoring (leachate quality, gas).

Source: Developed by the author

ii. Organic Waste Management (Composting / Mulching)

The proportion of organic waste in the total waste disposed of at FSM's landfill sites is relatively small compared to countries of similar economic levels. This is largely due to the long-standing cultural practice of feeding food waste and kitchen waste to pigs and dogs, which has substantially reduced methane emissions from landfill sites at the national scale.

While maintaining this cultural habit, further diversion of organic waste, especially green waste, should still be pursued. In FSM's tropical environment, substantial volumes of garden waste—such as leaves, branches, and other vegetative materials—are generated year-round, placing a significant burden on the limited space available at landfill sites. In some areas, green waste is openly burned to reduce volume or used as firewood. Open burning produces black carbon, another SLCP, and should be regulated or prohibited.

The most appropriate methods for managing green waste in FSM must be consistent with the country's island geography, limited land availability, humid tropical climate, and predominantly low-income rural context. Priority should be given to low-tech and sustainable approaches.

- Composting

  Decentralised composting is one of the low-cost and easy to adopt methane mitigation methods that can be implemented at the household, community or school level. It helps reduce the volume of waste going to landfill sites and produces compost that improves soil fertility.

- Mulching

  Shredded green waste produced by wood chippers can be repurposed as mulch for landscaping, erosion control, or livestock bedding. This practice reduces the need for imported fertilisers, prevents weed growth, and eliminates the occurrence of open burning. In addition, it enhances soil water retention, supporting healthier vegetation. The approach is particularly well-suited to rural and outer island settings, where mobile chippers could be deployed to serve multiple communities on a rotational basis.

PacWastePlus Programme funded by the European Union and implemented by the Secretariat of the Pacific Regional Environment Programme (SPREP) in Chuuk and Yap

The project aims to enhance organic waste management by diverting organic materials from landfills to composting facilities by implementing composting programmes. In Chuuk, a largescale composting facility is planned for construction at the Neauo Landifll in Weno. Supported by Chuuk EPA and the Ministry of Agriculture. The project expects to reduce CH_4 emissions and leachate production, and compost as outputs will be utilised to improve soil quality and support agricultural activities within the community.

Source: https://library.sprep.org/sites/default/files/2021-11/FSM-Poject-Profile-Snapshot.pdf

Table 6-4: Enabling activities ensuring sustainable operation of composting and mulching

Category	Responsible Agency	Activity
Technical Capacity	EPAs, State Public Works & Transport (PW&T), College of Micronesia	- Train municipal staff, school eco-clubs, and community groups on composting and mulching techniques. - Develop simple technical manuals for household/community-level use. - Provide training on operation and maintenance of wood chippers and composting equipment.
Awareness raising	Dep. of Agri., EPAs	- Community campaigns on the benefits of compost and mulch for agriculture and soil health. - Demonstration in schools and community gardens. - Use traditional and church networks for outreach.
Resource mobilisation	NGOs, private sector, state government	- Access climate finance (GEF small grants) for pilot compost/mulching projects. - Promote public–private partnerships for compost sales and landscaping services. - Integrate compost and mulch into agriculture support schemes.
Knowledge sharing	Dep. of Agri., state government	- Document and share lessons from pilot projects. - Create a platform for state-to-state exchange of experiences. - Discuss composting/mulching practices in regional workshops.
Coordination and partnership	State Government	- Coordinate across states for mobile shredder deployment. - Establish partnerships between green waste collectors, farmers, and schools. - Integrate into state waste management strategies.
Inclusivity and equity	Women's Associations, Youth Groups	- Involve women and youth in community composting / mulching activities. - Create income-generating opportunities (compost sales, landscaping services). - Ensure accessibility in outer islands.
Regulation	EPAs	- Develop and enforce regulations against open burning of green waste. - Introduce guidelines/standards for compost quality and safe use (in case of commercial use). - Integrate into state waste management strategies.

Source: Developed by the author

iii. Reduction of Waste Generation through Circular Economy

Reducing waste generation through a circular economy (CE) in FSM involves rethinking how resources are produced, used, and managed to minimise waste and maximise value. Table 6-5 shows keyways to increase the value of materials while reducing waste generation. Examples include enhancement of the container deposit system (CDL) and organic waste management outlined in the previous section.

Table 6-5: Reduction of waste generation and Circular Economy (CE)

CE method	Action	Description	Co-benefit
Promote Extended Lifespan through Reuse and Repair	Repair and refurbishment	Encourage local repair businesses for electronics, appliances, and furniture to extend product life.	Less waste to landfills, reduced import demand, cost savings for households.
	Second-hand markets	Establish community-based platforms for exchanging or selling used goods, reducing the demand for new products.	
	Durable product design	Incentivise suppliers and importers to provide durable, repairable, and modular products.	
Enhance Recycling and Material Recovery	Segregated collection	Implement source-separated collection for plastics, metals, paper, and e-waste.	Conserves resources, reduces GHG emissions from raw material production, and generates economic opportunities
	Recycling initiatives like CDL	For bottles, cans, or batteries, incentivise return and reuse.	
	Partnerships with regional recyclers	Export recyclable materials to larger facilities in the region for processing.	
Encourage Sustainable Consumption	Awareness campaigns	Educate residents on reducing single-use items and choosing sustainable products.	Reduces overall waste generation, lessens environmental pollution, and fosters community engagement.
	Incentives for low-waste lifestyles	Encourage businesses to adopt refill stations, bulk packaging, and reusable products.	

Source: Developed by the author

iv. Decentralised Wastewater Treatment System (DEWATS)

DEWATS[8] is a gravity-based wastewater treatment system suitable for schools, clinics and small villages with limited infrastructure and dispersed settlement patterns. DEWATS provides treatment for wastewater flows from 1-1,000 m^3 per day and does not require sophisticated maintenance.

DEWATS consists of three components; sedimentation and floatation in the primary treatment, baffled upstream reactors or anaerobic filters in the secondary treatment, and constructed wetlands or polishing ponds as tertiary aerobic treatment in sub-surface flow filters. By replacing septic tanks or pit latrines with DWATS in rural areas, methane emissions can be reduced and wastewater can be treated, which improve sanitation and public health at the same time.

Advantages of DEWATS:

- Energy efficient treatment as the system relies on gravity and biological processes
- Suitable for daily wastewater flows up to 1,000 m^3/day
- Modular design of all components allows gradual expansion to suit community size
- Treated water can support irrigation or landscaping; sludge usable as compost or soil conditioner
- Reliable and long-lasting construction design
- Expensive and sophisticated maintenance not required, particularly suitable for remote or low-income settings

8 https://www.unescap.org/sites/default/files/6.%20Singh-UNHABITAT.pdf
https://www.unescap.org/sites/default/files/Session%202.7_%20JSC%20-%20What%20is%20essential%20for%20the%20decentralized%20waste%20water%20management%20150327.pdf

Limitations of DEWATS:

- Large area with access to water is required
- Wetland treatment may be economical relative to other options only where land is available and affordable.

Table 6-6: Enabling activities ensuring sustainable operation of DEWATS

Category	Responsible Agency	Activity
Technical Capacity	Utility Corporation, EPAs	- Train utility staff and technicians on design, operation, and maintenance of DEWATS (e.g., construction of wetlands and small-scale plants). - Develop FSM-specific technical guidelines.
Awareness raising	EPAs, NGOs, Municipalities	- Conduct campaigns on the health, sanitation, and climate benefits of DEWATS. - Promote community ownership. - Showcase success stories from pilot projects.
Resource mobilisation	Utility Corporation	- Secure funding for pilot installations. - Explore subsidies for rural households/communities and encourage private contractors for construction and O&M services.
Knowledge sharing	Utility Corporation College of Micronesia, Regional network	- Document lessons from existing small-scale wastewater treatment pilots. - Exchange knowledge among states and with other Pacific island countries implementing DEWATS.
Coordination and partnership	Utility Corporation, EPAs, NGOs	- Establish coordination mechanisms between environment, health, and utilities sectors. - Integrate DEWATS into state wastewater and sanitation plans. - Partner with NGOs and community organisations for implementation and monitoring.
Inclusivity and equity	Women's Associations, Health NGOs, Community Leaders	- Ensure women, youth, and vulnerable groups are included in consultations on siting and design. - Engage women's groups in community hygiene promotion. - Provide equitable access to DEWATS facilities in rural and outer island communities.
Regulation	EPAs	- Develop standards for effluent quality and system performance. - Integrate DEWATS into building codes and municipal sanitation bylaws.

Source: Developed by the author

v. Anaerobic Digesters to Produce Biogas (methane)

Anaerobic digestion is a microbial process in which bacteria decompose organic matter, such as manure, in the absence of oxygen. This process produces biogas, which is a mixture primarily composed of methane and carbon dioxide. Methane, being an energy-rich biogas, can be captured and converted into electricity or upgraded to "renewable biogas" for applications such as cooking and heating.

The feedstock for anaerobic biodigesters can include animal manure, human faeces, and a variety of organic waste materials, such as kitchen waste and green waste. As a result, this mitigation technology offers a cross-cutting solution that can serve multiple sub-sectors, including solid waste management, manure management, and wastewater treatment.

To ensure efficient methane generation and sustainable system performance as well as social acceptance of mixing these feedstocks, a comprehensive feasibility study should be conducted. This study should analyse the composition and availability of each feedstock component, and assess their respective contribution to biogas production. Understanding the proportion of animal waste, human waste, and organic solid waste is essential for optimising digester size, location, operational requirements, and financial viability.

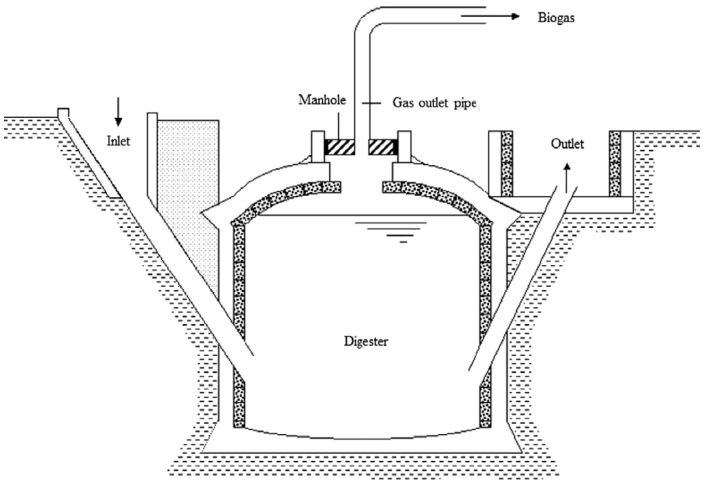

Figure 6-1: Fixed dome (Chinese type) digester (adopted from Gunnerson and Stuckey)

Among the various types of biodigesters, the fixed dome biodigester (Figure 6-1) is considered particularly suitable for FSM due to its durability—often exceeding 20 years—and low operational costs. This system is a closed, dome-shaped structure designed to anaerobically digest organic inputs such as animal manure, human excreta, kitchen waste, and green waste.

In several Pacific Island countries, fixed dome biodigester projects have been implemented with encouraging outcomes (see the boxes below).

BOX. Cases in Pacific Island Countries

- **Samoa:** Demonstration projects have showcased the viability of fixed dome digesters for managing piggery waste and producing biogas for cooking. (**Fixed dome (Chinese type) digester (adopted from Gunnerson and Stuckey** (Surendra K.C., et. al., 2014))
- **Fiji:** Research initiatives have explored the integration of biodigesters into circular food-energy systems, emphasizing their role in climate adaptation and sustainable agriculture. (**Scoping the governance and co-benefits of circular food-energy ...**)
- **Tuvalu:** Feasibility studies have considered biodigesters as a means to reduce dependence on imported fuels and improve waste management practices. (**Use of Biogas as an Alternative Energy Source' Cost-Benefit Analysis (PPCR)**)

The project in Pohnpei, continuously supported by China since 2009, has successfully demonstrated this concept by converting pig manure into methane gas, which is then used as a renewable cooking fuel at individual houses or small commercial entities, replacing fossil fuel consumption (LPG or firewood). This system also indirectly contributes to mitigation of water pollution by redirecting waste away from natural water bodies into a controlled digestion tank.

BOX. Case in FSM

Since 2009, China has assisted FSM in implementing a biodigester project, notably establishing a biogas system at the Ohwa Christian High School in Madolenihmw, Pohnpei. This system utilises pig manure from the school's piggery to produce biogas for cooking, demonstrating a practical application of waste-to-energy technology in a local setting.

Source: https://china.aiddata.org/projects/63835/

As of 2024, when the author conducted an interview, a total of 59 biodigester units have been installed. Building on this progress, the project plans to install an additional 12 units in 2025, each with a diameter of 16 feet. According to an engineer from the Department of Agriculture, the cost of a single biodigester unit—including labour and utilities—is estimated at 7,000 to 8,000 USD.

The benefits of this initiative are already being realised at the community level. One beneficiary, a woman who operates a local restaurant, shared her experience with the author. By using methane gas captured from her biodigester for daily cooking, she has significantly reduced her reliance on LPG. This shift has not only lowered her operational expenses but has also contributed to the reduction of GHG emissions, demonstrating the tangible economic and environmental advantages of biodigester adoption.

<Proposed business model for sustainable operation>

While this approach has proven effective at small scales, scaling it up with sustainable operation requires careful consideration of technical, financial, and operational factors (Table 6-6). High initial capital costs present a significant barrier to adoption, particularly in rural or low-income communities. Moreover, proper maintenance of anaerobic digesters is critical to prevent methane leakage. This maintenance often necessitates specialised technical support, which may not be readily available in remote areas.

To facilitate broader adoption and sustainable operation, involvement of the private sector is essential—particularly private entities that can provide long-term maintenance services. Financial institutions have a key role to play by offering revolving funds or microcredit schemes to reduce the upfront cost burden while ensuring the payment from users. It could also be feasible to develop a leasing-based business model. In this approach, the biodigester facility remains the property of a private company or service provider, while users pay a monthly fee for the service, which includes installation, operation, maintenance, and repairs. Additionally, supportive policy frameworks and financial incentives, such as subsidies for green businesses or feed-in tariffs for larger-scale facilities, would help accelerate the deployment of anaerobic digestion systems as part of a broader strategy for renewable energy development and climate change mitigation.

Table 6-7: Enabling activities ensuring sustainable operation of Anaerobic Digester

Category	Responsible Agency	Activity
Technical Capacity	Utility Corporation., EPAs, Dep. of R&D, Dep. of Agri.	- Train local technicians on installation, safe operation, and maintenance of biodigesters. - Develop user manuals in local languages. - Provide training on leak prevention, detection and repair. - Develop a leasing-based business model where private sector will do repair and maintenance.
Awareness raising	Utility Corporation, NGOs, EPAs, Municipalities	- Conduct outreach on the benefits of biodigesters (clean cooking fuel, reduced odour, water pollution control). - Showcase pilot projects in communities and schools.
Resource mobilisation	Utility Corporation Public-Private Partnership	- Secure donor grants for demonstration projects. - Promote subsidies or low-interest loans for households or entrepreneurs who install and operate biodigesters. - Encourage private companies to supply equipment and services.
Knowledge sharing	Utility Corporation, Dep. of R&D, College of Micronesia, regional network	- Document lessons from pilot biodigester installations. - Exchange knowledge among states and with other Pacific island countries through regional bodies such as SPREP.
Coordination and partnership	Utility Corporation, EPAs, NGOs, private sector	- Foster partnerships between potential local service providers, utility corporations, NGOs and EPAs.
Inclusivity and equity	Women's Associations, Youth Groups, Community Leaders	- Involve women and youth in decision-making and training (as they are often primary users of cooking fuel). - Support income-generating opportunities (e.g., selling surplus biogas or slurry as fertiliser). - Ensure inclusion of rural and outer island households.
Regulation	EPAs	- Develop safety and technical standards for biodigesters. - Regulate methane leakage and effluent management. - Incorporate biodigesters into state-level sanitation and wastewater management plans.

Source: Developed by the author

vi. Dry Litter Piggery System

The dry litter piggery system functions similarly to mulching (see ii. Organic Waste Management (Composting / Mulching)), where shredded green waste produced by wood chippers is repurposed as mulch for livestock bedding. In 2012, the Government of Japan supported the "Project for Dry Litter Piggery in Pohnpei State" to address severe water pollution in Pohnpei's rivers. As part of this initiative, wood chipper machines were provided to facilitate the conversion of pig waste into compost and part of green waste into mulch. The compost and mulch were intended for use in agricultural activities, thereby closing the nutrient loop between livestock and crop production.

While the initiative successfully demonstrated improvements in water quality and environmental health, widespread adoption of the dry litter piggery system was limited. The primary barriers include the labour-intensive nature of the system and the need for initial infrastructure investments for pigpens. These challenges underscore the importance of potential financial incentives backed up by policy to scale up such environmentally beneficial practices across FSM.

vii. Conversion of Coconut to Syngas and Biochar

As the FSM moves to implement its NDC target of increasing coconut production by 2030 to enhance biofuel production and food system resilience, a parallel opportunity arises to utilise coconut by-products—particularly coconut shells—for biogas and biochar production. If producing biofuel from coconut oil were to become a large-scale industry, enough coconut shells as biomass waste could be generated to justify commercial biomass combustion or gasification to produce heat, electricity[9] or biochar.

Traditionally, coconut shells are often openly burned, releasing harmful black carbon, which is a SLCP. Alternatively, converting coconut shells into syngas through gasification technology or producing biochar can offer a cleaner, more sustainable solution. Table 6-8 shows the comparison of characteristics between gasification and biochar production from coconut shells.

Gasification is a thermochemical process that converts organic or carbonaceous materials into a combustible gas mixture—commonly called syngas (composed mainly of carbon monoxide, hydrogen, and methane)—by reacting the feedstock at high temperatures (700–1200°C) with a controlled amount of oxygen or steam. This syngas can be used to generate electricity, heat, or further refined into liquid fuels. To effectively implement gasification using coconut shells, several technical and logistical conditions must be met:

- Feedstock preparation: Coconut shells must be dried and crushed to a uniform size to ensure consistent combustion.
- Reliable supply chain: Continuous and sufficient volumes of coconut shells must be available to make the operation viable.
- Technical capacity: Skilled labour is needed to operate, maintain, and troubleshoot gasifier units with careful control of temperature, feedstock flow, and gas clean-up.
- Infrastructure: Equipment costs, feedstock processing, and safety infrastructure can be capital-intensive. Proper installation is required to ensure safety and efficiency of gasifier systems.
- Market viability: Commercial viability depends on having an end-use market for the energy produced and policies or incentives to support renewable energy adoption.

Biochar production presents a second viable pathway for utilizing coconut shells in FSM, which is different from gasification in process, output, and suitability. Biochar is a stable, carbon-rich product produced through pyrolysis, the thermal decomposition of organic material in the absence (or limited presence) of oxygen. Contrary to gasification, the technology is relatively low-tech and low-maintenance, more suitable for rural settings and units can be small and community-operated, with minimal energy input.

Given FSM's decentralised geography, rural population distribution, limited technical capacity, and agricultural co-benefits, biochar production is likely the more suitable and scalable option for most parts of FSM—particularly in outer islands and small communities.

9 U.S. Department of the Interior, Office of Insular Affairs. (2006)

However, gasification could still be strategically deployed in more urbanised centres like Pohnpei or in partnership with industries or institutions that can ensure consistent operation and market use for the produced energy. A feasibility assessment or a pilot project at the local level is essential for informed decision-making and resource allocation. Table 6-8 presents the key enablers required to operationalise the syngas/pyrolysis project using coconut shells in FSM.

Table 6-8: Comparison of characteristics between gasification and biochar production from coconut shells

Factor	Gasification	Biochar Production
Technical complexity	High Gasification: 700-1200°C with controlled oxygen/air or steam	Low to moderate Pyrolysis: 300-700°C under limited oxygen
Initial cost	High	Low to moderate
Output	Syngas (energy)	Biochar (soil amendment, carbon sink)
Operational need	Skilled labour, steady maintenance	Simpler equipment, community-based
Climate benefit	Energy + methane/SLCP reduction from waste	Carbon sequestration + soil benefits
Scale	Better at large facilities	Adaptable to household/community use

Source: Developed by the author

Table 6-9: Enabling activities ensuring sustainable operation of Coconut to Syngas or Biochar

Category	Responsible Agency	Activity
Technical Capacity	Dep. of Agri., Dep. of R&D,	- Build technical expertise on small-scale gasification/pyrolysis systems. - Train operators on safe use, maintenance, and handling of syngas and biochar. - Develop local guidelines for installation and performance.
Awareness raising	Dep. of Agri.	- Raise awareness among communities, coconut processors, and farmers on benefits of syngas (renewable energy) and biochar (soil fertility, carbon sequestration). - Promote demonstrations in pilot sites.
Resource mobilisation	DECEM, Dept. of Finance & Administration, Private Sector	- Mobilise climate finance and donor support for pilot gasification/pyrolysis units. - Explore public–private partnerships with coconut industry and energy industry. - Incentivise small enterprises (SMEs) involved in green business.
Knowledge sharing	Dep. of Agri., Dep. Of R&D, Regional network	- Document pilot project results (yields, energy performance, soil benefits). - Facilitate knowledge-sharing across FSM states and beyond the country through existing regional networks such as SPREP.
Coordination and partnership	Dep. of Agri., Utility Corporation, State governments	- Link coconut producers, local energy providers and distributors, and coconut farmer cooperatives. - Integrate syngas/biochar systems into renewable energy and agricultural strategies. - Coordinate logistics for biomass collection and transport.
Inclusivity and equity	Farmer Groups, Youth Entrepreneurs	- Promote community-led enterprises for biochar production, distribution, and application. - Encourage youth and women to participate in green business. - Ensure equitable access to technology in rural and outer islands.
Regulation	State EPAs, Dept. of Agri.	- Develop environmental standards for syngas units. - Regulate emissions and workplace safety. - Establish quality standards for biochar use in soils.

Source: Developed by the author

By creating a closed-loop system—where increased coconut production supports both food security and the potential to create a low-emission, locally-driven energy source—FSM can reduce its reliance on imported fossil fuels, lower

GHGs and SLCPs emissions, and promote circular economy practices that align with climate and energy goals. This integrated strategy offers a high-impact co-benefit pathway for climate mitigation, organic waste management, and energy resilience.

6.2. Enablers for sustainable operation

Effective methane mitigation in FSM requires both the careful selection of technology options and the enabling conditions that make their implementation viable. These enablers such as technical skills, awareness raising, financing mechanisms, coordination with different agencies and regulatory reform, etc. must be fully considered when choosing mitigation measures. Without them, even the most promising technologies may fail to deliver their intended impacts.

At the same time, the Methane Reduction Roadmap cannot be applied uniformly across FSM. The country's decentralised governance means that Pohnpei, Yap, Chuuk, and Kosrae each operate with distinct socio-economic profiles, infrastructure availability, and environmental conditions. Factors such as population distribution, livestock density, waste management infrastructure, and wastewater coverage vary widely, influencing both emission profiles and the feasibility of different mitigation options.

For this reason, national targets in the roadmap must be translated into tailored state-level strategies. Aligning state sectoral policies with the roadmap ensures that the chosen interventions are context-specific, adequately resourced, and grounded in local ownership. Achieving this alignment requires the active engagement of state governments to set realistic targets, mobilise stakeholders, and secure participation from municipalities, communities, the private sector, academia, and NGOs.

This vertical integration—from national planning to state-level action—strengthens policy coherence, improves access to climate finance, and meets donor requirements for subnational commitment. It also ensures that methane reduction efforts deliver wider co-benefits, including better public health, reduced water pollution, enhanced food security, and increased use of renewable energy.

Table 6-10 summarises the key enablers and possible interventions. Targeted activities to strengthen these enablers will be essential, as they will underpin the successful deployment of selected technology options. The Department of Environment, Climate Change and Emergency Management (DECEM) will lead at the national level showing the direction for methane mitigation, with implementation carried out at the state level by designated supportive agencies.

Table 6-10: Enablers that support implementation of the Methane Reduction Roadmap

Enabler	Importance	Example Interventions	Supportive Agencies
Technical Capacity	- Qualified technical staff and adequate infrastructure in designing, operating, and maintaining systems is crucial. - Dependence on imported equipment and spare parts should be avoided as much as possible because O&M costs become higher.	- Training landfill operators, wastewater technicians. - Developing methane monitoring protocols. - Creating state-specific technical guidelines and standardised procurement and technology selection. - Encourage regional cooperation for spare parts supply and joint technical support.	Dep. of Public Works, Utility Corporation, EPA
Awareness Raising	- Low awareness of methane impacts and co-benefits of mitigation among communities and local leaders hinders the implementation of the roadmap. - Social and cultural acceptance and community participation are critical to adopt new technologies, especially in rural/outer islands with traditional waste/livestock practices.	- Executing public campaigns and media platforms on health, livelihood, economic and climate benefits from methane mitigation. - Engagement with village and religious leaders and school principals for larger impact. - Demonstration projects at community level to showcase success (e.g., composting sites, community biodigesters).	EPA, NGOs, academia
Resource Mobilisation	- High upfront costs for infrastructure hampers implementation. - Long-term O&M requires sustainable funding beyond donor cycles. - Cut full reliance on donor funding and COMPACT, with more domestic financing mechanisms for long-term sustainability.	- Structuring public–private partnerships. (e.g., leasing models for biodigesters or composting facilities). - Introducing cost-recovery mechanisms (user fees, tipping fees, biogas sales, community-based financing for operations). - Mobilising blended financing through government budgets, international climate funds (e.g., GCF, GEF), and concessional loans.	Donor agencies, private sector, EPA,
Knowledge Sharing	- Conditions vary widely between states and islands, thus solutions must be adapted to waste profiles, and environmental and logistical realities.	- Facilitating cross-state workshops or knowledge exchange forums. - Documenting lessons learnt from pilot projects and share through Pacific regional networks.	State governments, academic institutions, regional networks
Coordination & Partnerships	Responsibilities for methane sources spread across multiple agencies; need a harmonised approach.	- Establish or strengthen state–national coordination mechanism for MRV. - Building technical partnerships with NGOs, universities, regional organizations, and donor agencies.	Utility Corporation, Dep. of Public Works, Health, State governments, NGOs, college of Micronesia
Inclusivity and equity	Women and youth often lack access to training/resources though they have different roles in waste handling and household energy use.	- Inclusive consultation for awareness raising, planning, implementation, and monitoring.	Women's associations, youth groups, community-based organisations, NGOs
Regulation	Technical standards and regulations ensure the enforcement and compliance of methane mitigation across states.	- Set standards of water/wastewater quality. - Establish enforcement mechanisms and penalties. - Integrate methane mitigation requirements into permits and licenses.	EPA, Environmental police, municipal government, legislative bodies

Source: Developed by the author

7 Monitoring, Reporting, and Verification (MRV) System

7.1. Importance of MRV and Continuous Data Collection

A robust Measuring, Reporting, and Verification (MRV) system supported by continuous data collection is essential for FSM to successfully implement its Methane Reduction Roadmap. In FSM, the national MRV Policy has been under development with the vision of increasing data completeness and availability in key categories of emissions and removals and to develop the institutional arrangements, technical foundations and tools for systematic, robust national MRV following the UNFCCC and IPCC guidelines[10]. This system serves as the foundation for tracking progress, informing policy, ensuring international transparency, and securing the necessary support. The importance of such a framework is multifaceted:

- **Tracking Progress and Informing Policy:** The primary purpose of an MRV system is to enable FSM to track its progress toward achieving its climate goals, including its Nationally Determined Contributions (NDCs) and commitments under the Global Methane Pledge (GMP). Targets are only meaningful if progress can be measured; without consistent monitoring, it is impossible to track achievements, identify implementation gaps, or revise strategies effectively. Continuous data collection ensures that policymakers have access to quality information to evaluate the effectiveness of mitigation actions, make timely adjustments, and support evidence-based decision-making (CCAC, 2024). This in turn would allow FSM to produce more ambitious and transparent NDCs in the future.

- **Fulfilling International Obligations:** An operational MRV system is critical for FSM to meet its international reporting obligations under the UNFCCC and the Paris Agreement, such as preparing National Communications (NCs) and Biennial Update Reports (BURs). Countries joining the GMP also commit to improving the accuracy and transparency of their national GHG inventories.

- **Enhancing Transparency and Access to Climate Finance:** A reliable MRV system demonstrates transparency to development partners and enhances FSM's climate finance readiness. By clearly understanding and reporting on methane emission sources and mitigation opportunities, FSM can build trust with the international community and more effectively justify and attract the public and private investment needed for mitigation projects, such as anaerobic digesters, composting facilities, or improved wastewater treatment systems.

- **Addressing Data Gaps:** FSM currently faces significant challenges with data availability for its GHG inventories, with data collection often being ad hoc, segregated, and project-specific rather than continuous. A systematic MRV framework is designed to overcome these gaps by establishing protocols for continuous and targeted data collection, thereby improving the accuracy, completeness, and reliability of the national GHG inventory. FSM's Updated NDC explicitly commits to undertaking a national methane inventory, underscoring the political will to address these data

10 National Monitoring, Reporting and Verification Policy 2022-2027 (draft)

gaps.

7.2. GHG and Non-GHG inventory

Methane mitigation measures not only contribute to methane reduction but also deliver significant co-benefits that align with FSM's national development goals, particularly in public health, environmental protection, and sustainable energy. Tracking non-GHG indicators is crucial for quantifying these benefits and building a stronger case for investment. An integrated MRV system should therefore be designed to capture both GHG and non-GHG data. Table 7-1 outlines the recommended data to be collected, along with appropriate data collection methods. Systematically gathering this comprehensive data is essential for accurate reporting, evidence-based policymaking, and demonstrating FSM's climate finance readiness.

Table 7-1: Suggested Data Collection Methods and Responsible Entities for FSM Methane MRV

Sub- Sector	Data	Suggested collection method	Collector
For GHG-inventory			
Solid waste disposal	Landfill types	On-site observation and recording	PW&T
	Waste composition at source	Waste audit (annual)	EPA
	Waste generation per capita	Waste audit (annual)	EPA
	Waste disposal amount and composition at disposal sites/ landfill sites	On-site monitoring	PW&T
	landfill site management	On-site assessment with check list (Table 6-2)	PW&T
	Production of compost (medium-large scale)	Report from implementer	EPA
	Amount of feedstock of organic waste for composting / AD (medium-large scale)	Report from implementer	EPA
Wastewater treatment	Population using septic tanks and its type	Interview and recordings	Utility Corporation
	Population using pit latrines	Interview	Utility Corporation
	Population practicing open defecation	Estimation	Utility Corporation
	Functionality of oxidation sewage plant	Recording	Utility Corporation
Manure Management	Number of AD installed/sold	Report from producer/retailer	Dep. of Agri.
	Feedstock of AD (by type)	Interview	Dep. of Agri.
	Volume of LPG sold	Report from distributor / importer	Company
	Manure management method	Interview, field visits	EPA
	Number of animals per type (pig, poultry)	Interview,	Dep. of Agri
For Non-GHG inventory			
Water quality	river, groundwater, and coastal area (DO, BOD, E-coli, total coliform, etc.)	Sampling and lab analysis	EPA
	leachate at disposal site (BOD, DO)	Sampling and lab analysis	EPA
Public Health	Number of people diagnosed with water-borne disease (WBD)	Report from clinics, hospitals	Dep. of Health
Renewable Energy and Economic Growth	Production of biodiesel from coconut	Report from producer	Utility Corporation
	Amount of coconut supplied for production of biodiesel	Report from producer	Utility Corporation
	Number of people engaged in coconut biodiesel business	Report from producer	Utility Corporation

Source: Developed by the author

7.3. Institutional Framework for Methane Emission Reduction and MRV

The institutional framework for methane mitigation and MRV in FSM operates within the nation's decentralised federal structure, requiring close coordination between national and state-level entities. While national agencies provide strategic direction, implementation is largely the responsibility of FSM's four autonomous state governments—Pohnpei, Chuuk, Yap, and Kosrae.

The proposed institutional arrangement builds on existing climate governance structures to create a coordinated system for tracking methane emissions and reduction efforts (Figure 7-1).

High-Level Governance:

- The Climate Change and Sustainable Development Council (CCSDC), chaired by the Vice President of the FSM, provides high-level political oversight for all climate change actions.
- The National Climate Change Country Team (NCCCT) includes representatives from all states and coordinates activities between sectoral working groups and state governments.

Lead Agency and Coordination:

- DECEM serves as the lead agency and national coordinating entity for all MRV activities.
- A dedicated team within DECEM is responsible for the day-to-day operations of the MRV system. Its key functions include the overall setup and coordination of the system, establishing data-sharing rules (e.g., through Memoranda of Understanding) with data providers, developing technical guidance, creating reporting plans, and ensuring that actions at the state level are captured and reported nationally.

MRV System Structure: An MRV Steering Committee, likely a sub-group of the NCCCT, will oversee the design and implementation of the national MRV system. The framework operates with sector-specific working groups that report to DECEM. For methane mitigation, a dedicated Waste & Co-benefit Working Group is proposed.

- Working Group: This technical group will be responsible for collecting all relevant emissions data from national and state stakeholders, validating the data, and providing high-level interpretation and analysis for the national MRV system.
- Data Providers: A range of national and state-level entities will be responsible for supplying raw data related to both GHG and Non-GHG inventory to the working group. These providers including Department of Health and Social Affairs and Department of Agriculture are crucial for ensuring the inventory reflects on-the-ground realities.

State-Level Implementation and Gaps: State governments and their agencies (e.g., State EPAs, Public Works, Utility Corporations) are the primary implementing bodies for methane mitigation projects and regulations. While this framework outlines a clear structure, a current gap is the lack of a formalised legal mandate for MRV. To be fully effective, these institutional arrangements for the MRV system need to be formalised through legal instruments or official agreements that clearly define roles, responsibilities, and procedures for consistent, long-term data collection and sharing across all levels of government.

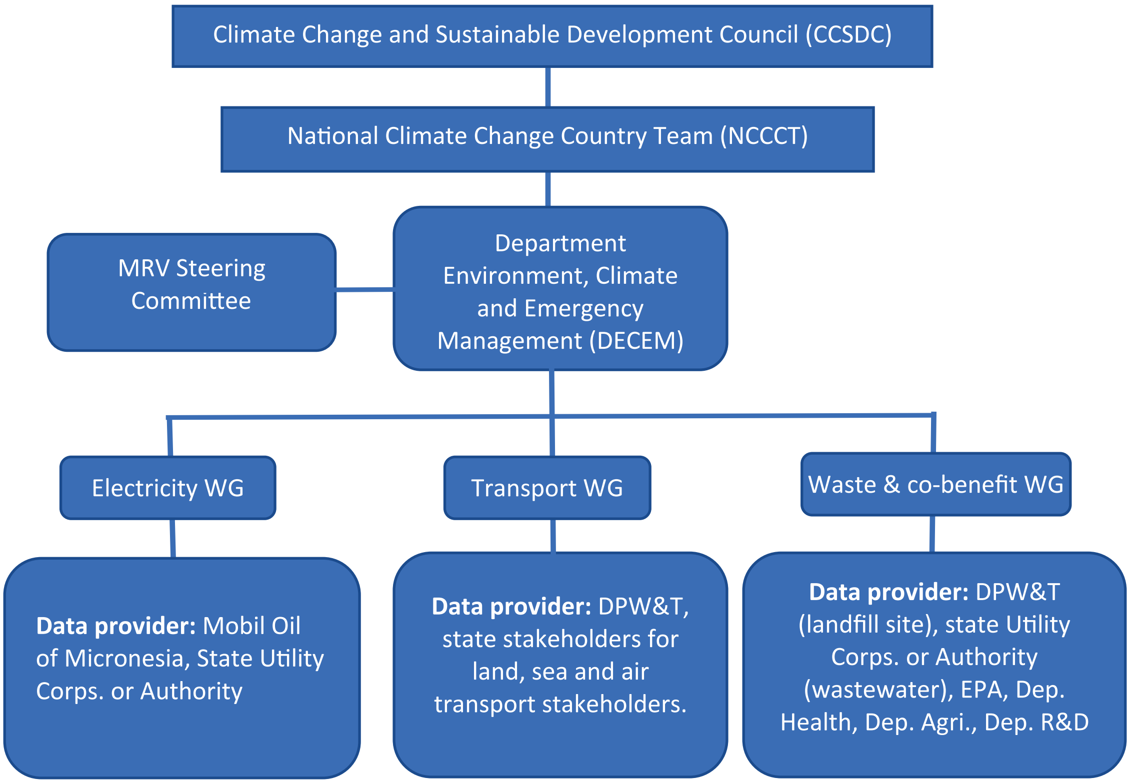

Figure 7-1: Suggested Institutional Arrangement for MRV

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9 Annex

9.1 Process for Roadmap Development

Development of the Methane Reduction Roadmap involves a structured and collaborative approach, ensuring comprehensive stakeholder engagement and evidence-based decision-making. Throughout the development process, continuous stakeholder engagement, transparent communication, and evidence-based decision-making are emphasised. Regular updates and consultations ensure that all stakeholders remain informed and involved. The roadmap aims to not only address methane emissions but also align with broader environmental and economic goals, ensuring sustainable development and climate resilience for FSM. Figure 9-1 outlines the key steps and activities involved in this process:

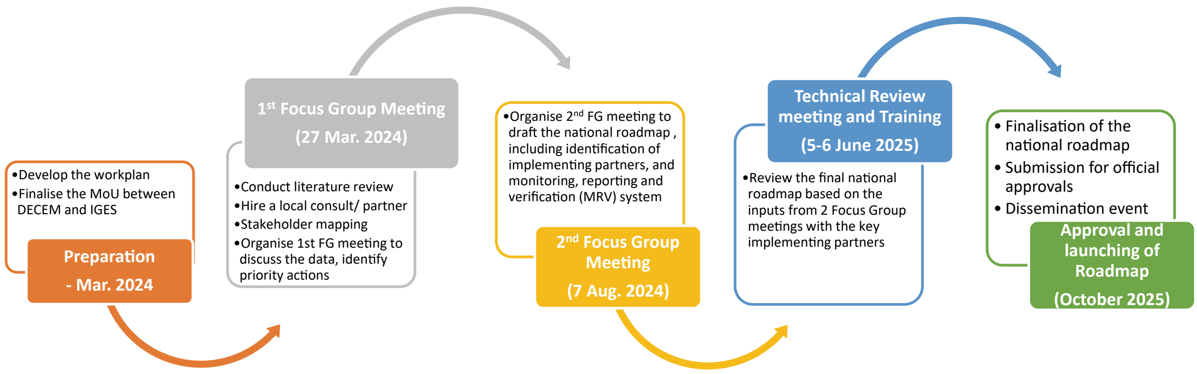

Figure 9-1: Key steps in developing the Methane Reduction Roadmap for FSM

Step 1 - Initial Preparation (Sep. 2023–Mar. 2024)

- **Developing the Workplan:** Establishing a detailed workplan that outlines the timeline, key milestones, and responsibilities of all involved parties. This workplan serves as a blueprint for the entire process, ensuring that all activities are coordinated and deadlines are met.
- **Finalizing the MoU:** Formalising the Memorandum of Understanding (MoU) between the DECEM and the Institute for Global Environmental Strategies (IGES). This MoU sets out the terms of collaboration, roles, and responsibilities, and ensures that all parties are committed to the project's objectives.

Step 2 - Organise 1st Focus Group Meeting (Mar. 27, 2024)

- **Conducting a Literature Review:** Reviewing existing literature to gather relevant data and insights on methane emissions and reduction strategies. This review provides a scientific and technical basis for the roadmap, ensuring that it is grounded in the latest research and best practices.
- **Hiring Local Consultant/Partner:** Engaging a local consultant or partner with expertise in methane reduction and policy development. The consultant provides on-the-ground insights, facilitates stakeholder engagement, and contributes to the technical and strategic aspects of the roadmap.
- **Stakeholder Mapping:** Identifying and mapping key stakeholders who are involved in or affected by the roadmap.

This includes government agencies, industry representatives, NGOs, community groups, and international partners. Effective stakeholder mapping ensures that all relevant voices are heard and considered.

- **First Focus Group Meeting:** This meeting's objective is to bring together all stakeholders, introducing the project overview, its goals, and expected outcomes. It also serves as a platform for stakeholders to voice their expectations and concerns and to discuss the gathered data, identify priority actions, and collect initial feedback from stakeholders to understand the current state of methane emissions and key sources.

Step 3 - Organise 2nd Focus Group Meetings (Aug. 7, 2024)

This meeting is pivotal for developing the roadmap details. This includes discussing implementing measures and the establishment of the Monitoring, Reporting, and Verification (MRV) system.

Step 4 - Prepare for Technical Review Meeting (Aug. 2024-June 2025)

In this phase, the focus shifts to refining the roadmap based on technical reviews on policy interventions required to achieve methane reduction targets.

- **Final Report Preparation:** Developing the final report of the national roadmap, incorporating inputs from the focus group meetings. This report includes detailed action plans, timelines, responsibilities, and expected outcomes. It also addresses any gaps identified during the focus group meetings.
- **Technical Review Meeting with capacity building:** Presenting the final report for the technical review by key implementing partners. This meeting involves a thorough review of the roadmap's technical, financial, and strategic aspects, ensuring that it is feasible, effective, and aligned with national and international goals. This meeting also serves to deepen the participants' understanding about IPCC estimation methodology, the importance of data collection and M&E, in addition to the causes and impacts of methane emissions.

Step 5 - Finalisation and Official Approval (June-July 2025)

- **Finalisation of the Roadmap:** Incorporating any final feedback and making any necessary revisions to the roadmap. This ensures that the document is comprehensive, accurate, and reflects the consensus of all stakeholders.
- **Submission for Official Approvals:** Submitting the finalised roadmap for official government approval. This involves presenting the roadmap to relevant authorities, obtaining the necessary endorsements, and ensuring that it is formally adopted as a national policy.
- **Dissemination Event/Action:** Joining the NDC 3.0 validation meeting to share the roadmap with all relevant stakeholders in order to find synergies between the two policies.

9.2. FSM Updated Nationally Determined Contributions for 2030

Table 9-1: FSM Updated Nationally Determined Contributions for 2030 and its contribution to SDGs and methane reduction

<table>
<tr><th>Contributions for 2030</th><th>Conditions</th><th>Climate Change Co-Benefits</th><th>SDGs</th><th>Methane reduction</th></tr>
<tr><td colspan="5">Energy Security</td></tr>
<tr><td>By 2030, increase access to electricity to 100% nationwide.</td><td>Conditional</td><td rowspan="3">Adaptation Co-benefits
– Distributed renewable energy increases the resilience of the energy system to sea-level rise and extreme weather events.
– Domestically produced renewable energy is less vulnerable than imported fossil fuels to climate change-induced disruption of global supply chains.
Mitigation Co-benefits
– Reduced emissions of carbon dioxide.
– Reduced demand for, and use and transport of, diesel fuel.
– Reduced emissions of SLCPs such as black carbon and methane.</td><td rowspan="3">5, 7, 8, 9, 13, 17</td><td>-</td></tr>
<tr><td>By 2030, increase electricity generation from renewable energy to more than 70% of total generation.</td><td>Conditional</td><td>○ By reducing reliance on and upgrading fossil fuel-derived generators</td></tr>
<tr><td>By 2030, reduce carbon dioxide emissions from electricity generation by more than 65% below 2000 levels.</td><td>Conditional</td><td></td></tr>
<tr><td colspan="5">Food Security</td></tr>
<tr><td>By 2030, establish and/ or strengthen farmer cooperatives across all four FSM States.</td><td>Unconditional</td><td rowspan="4">Adaptation Co-benefits
• Increased resilience to climate change impacts on local food production, including sea-level rise, saltwater and changes in precipitation patterns.
• Increased resilience to price spikes and shortages of key food imports caused by climate change impacts on the global food system.
Mitigation Co-benefits
• Reduced shipping emissions due to a decreased reliance on food imports.
• Potential for increased production of coconut- derived biofuels to replace certain uses of fossil fuels.</td><td rowspan="4">2, 3, 8, 13, 17</td><td>-</td></tr>
<tr><td>By 2030, establish and support state-level farmer associations to provide training in climate-smart agriculture practices, and establish local seed banks.</td><td>Unconditional</td><td>-</td></tr>
<tr><td>By 2030, improve market access for farmers by facilitating development of commercial agreements with local purchasers.</td><td>Unconditional</td><td>-</td></tr>
<tr><td>By 2030, increase annual production of coconuts and coconut-based products to improve resilience of the food system to climate change impacts.</td><td>Conditional</td><td>△ By utilising coconut shells as residues for biogas or biochar production</td></tr>
<tr><td colspan="5">Water Security</td></tr>
<tr><td>By 2030, provide universal access to clean drinking water through refurbishment of existing water infrastructure and extension of network to unserved and underserved areas.</td><td>Conditional</td><td>Adaptation Co-benefits
• Increased resilience of the local water supply to climate change impacts, including sea-level rise, storm surge, saltwater intrusion, and more severe droughts.</td><td>3, 6, 13, 17</td><td>○ By reducing pig manure that are decomposed under anaerobic condition (such as anaerobic lagoons and septic tanks)</td></tr>
<tr><td colspan="5">Short-Lived Climate Pollutants</td></tr>
<tr><td>Meet Kigali Amendment HFC phase down commitments (in advance of schedule if possible).</td><td>Conditional</td><td>Mitigation Co-benefits
• Reduced emissions of black carbon.
• Reduced emissions of HFCs.
• Reduced emissions of methane.</td><td>3, 7, 9, 12, 13, 17</td><td>-</td></tr>
</table>

Contributions for 2030	Conditions	Climate Change Co-Benefits	SDGs	Methane reduction
By 2030, reduce black carbon and methane emissions related to diesel electric generation by more than 65% below 2000 levels.	Conditional			◎ Primary target for methane reduction
Undertake a national methane inventory and assessment of methane abatement opportunities.	Conditional			◎ Methane reduction roadmap
Ecosystems Management: Marine, Terrestrial and Coastal				
By 2030, effectively manage 50% of marine resources and 30% of terrestrial resources, including restricting commercial fishing in up to 30% of the FSM marine environment.	Unconditional	**Adaptation Co-benefits** • Increased resilience of fisheries to climate change impacts by improving sustainability, reducing by- catch, reducing IUU fishing, and providing protected areas for stocks to recover. • Preservation of ecosystems services and livelihoods. • Preservation of food supply/ security. • Improved capacity of governments and communities to respond to climate change impacts on coastal and marine ecosystems. • Improved climate-resilience of livelihoods and businesses reliant on coastal and marine ecosystems. • Improved flood resilience through protection of mangroves and implementation of other nature-based solutions. • Reduction of coastal erosion. • Improved resilience to more extreme droughts through water conservation / groundwater protection. • Increased resilience of coral reefs, mangrove forests, and wetlands to climate change impacts. **Mitigation Co-benefits** • Reduced emissions from fishing fuel. • Less disturbance of land and ocean-based carbon sinks.	1, 2, 3, 8, 13, 14, 15, 17	○ By diverting organic waste from the disposal sites
By 2030, develop non-entangling and biodegradable Fish Aggregating Devices (FAD) to be used by all purse seine flag vessels in the FSM EEZ.	Unconditional			-
By 2023, achieve full tuna fishery transparency, through electronic monitoring of all FSM-flagged longline fishing vessels.	Unconditional			-
By 2030, develop Integrated Land Management Plans and Shoreline Development Plans to effectively protect and sustain terrestrial and coastal ecosystems	Conditional			-
By 2030, expand the number of Protected Areas and their coordination through Protected Area Networks.	Conditional			-
Resilient Transport Systems				
By 2030, climate-proof all major island ring roads, airport access roads, and arterial roads.	Conditional	**Adaptation Co-benefits** • Resilience to flooding from sea-level rise and king tides. • Maintenance of public and commercial services during weather-related emergencies. **Mitigation Co-benefits** • Reduction of emissions from idling vessels by reducing time spent waiting to dock. • Reduction of emissions from large transportation idling vessels waiting to dock by incorporating renewable energy technology for powering their auxiliary equipment.	8 10 11 13 17	
By 2030, complete climate-proofing of major ports (larger and more resilient docks meeting ISPS standards).	Conditional			

Contributions for 2030	Conditions	Climate Change Co-Benefits	SDGs	Methane reduction
Public Health				
By 2030, establish a surveillance system, including a laboratory facility, to detect and monitor VBD, WBD, and FBD to enable rapid response and control of outbreaks.	Conditional	**Adaptation Co-benefits** • Improved preparedness of the public health system to respond to VBD, WBD, and FBD outbreaks, which are projected to increase due to climate change.	3. 13. 17	△ By improving management of organic matter
By 2030, provide training in the detection and treatment of VBD, WBD, and FBD to all medical personnel and public health officials.	Conditional			
By 2030, equip all hospitals and other relevant medical facilities to receive and effectively treat patients suffering from VBD, WBD, and FBD.	Conditional			
Emergency Management & Response				
By 2025, complete an update of the National Disaster Response Plan.	Unconditional	**Adaptation Co-benefits** • Enhancement of emergency management and disaster response to extreme weather events, including improved delivery of essential supplies and services (e.g., food, water, medical, transportation). • Improved monitoring of coastal erosion, sea level-rise, groundwater supplies, and other natural resources. **Mitigation Co-benefits** • Reduction of carbon dioxide emissions from emergency response vessels.	3	
By 2030 complete comprehensive nationwide GIS mapping.	Conditional			
By 2030, update vessels and/or secure additional vessels for inter-state transportation and emergency response operations, incorporating renewable energy technology.	Conditional			

◎ : direct contribution, ○ : indirect contribution, △ : potential contribution (co-benefit)
(Source: FSM NDC, 2022 edited by the author)

9.3. National and State policy and regulations

Table 9-2: National policy and regulations

Policy	Description
Overarching policy	
Strategic Development Plan (2004–2023)	This long-term plan emphasises mainstreaming environmental considerations, including climate change, into national policy and economic development activities. The plan emphasised: • Sustainable land and waste management. • Improved agricultural practices and food security. • Protection of water resources and ecosystems vulnerable to climate change. • Reduce energy use, convert to RE sources, and minimise emission of greenhouse gases. These priorities have directly influenced FSM's subsequent climate strategies, including its Updated NDC
Strategic Development Plan (2024–2043)	Adopted in January 2025, the SDP enables national and state governments to prioritise their plans and budgets in targeted sectors and industries, develop infrastructure, and attract investments. The nine thematic areas are: 1) Cultural heritage, 2) Education and human capital, 3) Health and well-being, 4) Gender Equality and Social Inclusion, 5) Governance and Institutional Strengthening, 6) Peace and Security, 7) Sustainable Economic Development, 8) Environment Sustainability and Climate Change; and 9) Infrastructure Development and Sustainability.
Infrastructure Development Plan (IDP) 2016–2025	The IDP is envisioned to guide the FSM's development needs and ensure that public infrastructure assets meet the current and future demands of our communities, including transportation, energy, water and sanitation, public facilities, and marine, agriculture and coastal protection. Wastewater systems and solid waste management are key sectors discussed throughout the report.
Infrastructure Development Plan (IDP) 2024–2034	The IDP prioritises critical infrastructure projects and investments that emphasises sustainable and climate-resilient infrastructure, while also ensures that the IDP aligns with the nation's environmental and development policies.
Environmental Protection Act (2014)	The Act aims to prevent pollution, protect the environment, and promote sustainable resource use. It is a framework for environmental protection.
Nationwide Climate Change Policy (2009)	The focus of this Policy is to mitigate climate change especially at the international level, and adaptation at the national, state and community levels to reduce FSM's vulnerability to climate change adverse impacts. This policy has six goals: mitigation, adaptation, technology transfer, finance, capacity building and training, and education and public awareness.
Nationwide Integrated Disaster Risk Management and Climate Change Policy (2013)	This policy supersedes the Nationwide Climate Change Policy (2009) and supports Strategic Development Plan 2004–2023. The goal of the policy is to promote development that proactively integrates disaster risk management with climate change adaptation and mitigation efforts across sectors such as economic resilience, food, water and energy security, infrastructure, waste management and sanitation, health, and education. Joint State Act on Plans (JSAPs) for disaster risk management and climate change adaptation addressed at State levels.
Climate Change Act (2013)	The Act provides a legal framework mandating national departments and agencies to develop and implement climate-related plans in line with the Climate Change Policy 2013. It instructs government offices and departments to prepare plans and policies consistent with the Climate Change Policy; it also includes an obligation on the President to report to Congress on the progress of implementation of the Climate Change Policy, and for the budget request to include one or more lines on the implementation of the Climate Change Policy.
Updated Nationally Determined Contribution (NDC) under the Paris Agreement (2022)	The updated NDC outlines a series of cross-cutting mitigation and adaptation contributions with a long-term vision through 2030. It covers the policy areas of (i) energy security, (ii) food security, (iii) water security, (iv) SLCPs, (v) fisheries and marine conservation, (vi) resilient transport systems, (vii) public health, and (viii) emergency management and response.

Policy	Description
Energy	
Energy Office Act 2010	Amendments were made to establish a National Energy Office and for other purposes.
National Energy Policy 2012	This policy aimed to improve the lives of FSM citizens by providing affordable, reliable, and environmentally sound energy. It focused on reducing dependence on imported fossil fuels and promoting renewable energy sources.
National Energy Policy 2024–2050	Building upon the 2012 policy, this updated framework sets strategic goals to prioritise energy access and affordability for all citizens. It addresses institutional, power, petroleum, and renewable energy sectors.
Fossil Fuel Non-Proliferation Treaty Endorsement (2024)	FSM became the 14th nation to endorse the proposed Fossil Fuel Non-Proliferation Treaty, advocating for a global agreement to phase out fossil fuels and transition to renewable energy sources.
Energy Master Plan (EMP) 2018	This Plan consists of national master plan and state master plan for four states. At the national level by 2037, the EMP seeks to achieve (i) an electrification rate approaching 100%, (ii) 84% of electricity generated from RE sources, (iii) diesel consumption decreasing from 4.2 million in 2018 to 1.5 million gallons, and (iv) GHG emissions from electricity generation reducing from 43,000 tonnes in 2018 to 16,000 tonnes.
Waste management	
National Solid Waste Management Strategy 2010–2014	The overall goal of the strategy is to develop, implement, and maintain a system of integrated solid waste management that deals with the solid waste stream and minimises the negative impacts on the health of FSM's population and environment. Seven thematic areas are discussed: (1) Policy and Legislation, (2) Planning, (3) Sustainable Financing, (4) Integrated Solid Waste Management, (5) Medical Waste, (6) Capacity Building, and (7) Awareness.
National Solid Waste Management Strategy 2015–2020	Building upon the previous strategy, the 2015–2020 plan continued to focus on sustainable waste management practices. (Not publicly available online.)
Biodiversity Strategy and Action Plan 2018	Waste management and pollution identified as a threat to biodiversity.
Agriculture	
National Agriculture Policy 2012–2016	It emphasises revitalizing domestic food production and enhancing food self-sufficiency. The policy serves as a framework for coordinating investments from various sources, including national budgets and international aid, to support the agriculture sector.
Air quality	
Ozone Layer Protection Act 2010 (Amended in 2014)	The Ozone Layer Protection Act and associated regulations implement Vanuatu's obligations as a party to the Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer.
Public Health	
National Climate Change and Health Action Plan (2012)	The plan developed in collaboration with the World Health Organisation (WHO) serves as a strategic framework to address the health impacts of climate change across FSM's four states[17].

17 https://www.fsmgov.org/press/pr090611.htm

Table 9-3: State policy and regulations (Pohnpei)

Policy	Description
Overarching policy	
Constitution of the State of Pohnpei	- Article 7 (Responsibilities of the Government of Pohnpei) states, under s 1, that the Governor shall establish and execute comprehensive plans for the conservation of natural resources and the protection of the environment. - s 2(2) of Article 13 requires the Legislature to provide by statute for the strict control of harmful substances, limiting their introduction, storage, use, and disposal within Pohnpei to activities necessary for the enhancement of public health, public safety, and economic development.
Environmental Protection Act of 1992 (amended in 1993) State Law No 3L-26-92	- Established an independent governmental agency, known as the Pohnpei Environmental Protection Agency (EPA). - The EPA shall have the power and duty to protect the environment, human health, welfare, and safety and to abate, control, and prohibit pollution or contamination of air, land, and water
Joint State Action Plan for Disaster Risk Management and Climate Change (Pohnpei) 2016	- Coordinated by the Pohnpei Department of Public Safety, this plan provides a comprehensive approach to disaster risk management and climate change, highlighting the state's strengths and areas for improvement. - Objective 6.6 under Objective 6 Infrastructure is to improve management of solid waste, on p. 79. Solid waste management is discussed on p. 28.
Energy	
Energy Master Plan (EMP) 2018 for Pohnpei	Pohnpei will need to invest 114.0 m USD in new and replacement electricity infrastructure over the next 20 years from 2018. New infrastructure includes adding RE generation capacity and grid connections on Pohnpei Proper, and developing three mini-girds and 177 stand-alone solar system across 11 islands. The Master Plan would provide all households in Pohnpei with electricity access from 2025. From 2019 onwards, the share of RE in Pohnpei's electricity generation would be over 50%.
Act to reform the power generation and distribution in Pohnpei	Amending various provisions of Title 34 and Title 11 of the Pohnpei Code with respect to providing for power purchase agreements between PUC and large-scale generators of electrical power.
Waste management	
State Law No. 6L-66-06 Litter Abatement Regulations	- It provides for litter abatement and solid waste disposal, shipping container and motor vehicle waste disposal fees. - It established the Environmental Quality Fund (designed to collect fees associated with waste disposal and environmental protection activities. The collected fees are allocated to support environmental programmes and initiatives within the state). - It established the Litter Reward Fund (all fines collected by the state of Pohnpei shall be collected; the money may be used by the EPA to reward (25.00 USD) persons who provide information or evidence which leads to a conviction of persons who violate these regulations).
State Law No. 3L-26-92 Solid Waste Regulations, 1995 under the EPA Act	- All solid wastes shall be stored in such a manner that they do not constitute a fire, health, or safety hazard or provide food or harbourage for vectors, and shall be contained or bundled so as not to result in spillage. - The aesthetic, non-hazardous and sanitary storage of solid waste is the responsibility of the person owning, operating or managing the property, premise, business establishment or industry where the solid waste is accumulated.
Solid Waste Management Action Plan (Pohnpei) 2020–2024	Strategic priorities include improvement of the CDL system, proper management of final disposal site, and improvement of waste collection system by local governments.
Biodiversity Strategy and Action Plan (Pohnpei) 2018	Waste management and pollution identified as a threat to biodiversity on p. 8. Objective 5 includes to increase awareness of proper waste disposal and recycling and pollution control.
Marine and Fresh Water Quality Standard Regulations, 1995 State Law No. 3L-26-92	The regulations aim to maintain and protect the quality of Pohnpei's marine and freshwater bodies, ensuring they are safe for various uses, including drinking, recreation, and supporting aquatic life. Specific standards are established for various water uses. For instance, the acceptable level of *Escherichia coli* (E. coli) bacteria is set at **0 MPN/100 mL** for drinking water and **less than 576 MPN/100 mL** for recreational or bathing waters. The Pohnpei EPA is responsible for monitoring water quality and enforcing these standards.

Policy	Description
Agriculture	
Pohnpei State Food Security Policy and Food Production Master Plan (2025)	Key goals include: 1) Increasing local food production by 50% within five years and reducing reliance on imports, 2) Developing sustainable agriculture and aquaculture, and 3) Improving health and nutrition through promotion of the consumption of locally produced, nutritious foods.
Air quality	
Air Pollution Control Standards and Regulations, 1995	The regulations aim to maintain and protect the quality of Pohnpei's air, ensuring it is safe for various uses, including public health, agriculture, and overall environmental well-being. Specific standards are established for various air pollutants to prevent health hazards, damage to agriculture, and deterioration of property. These standards are designed to be at levels where air pollutants are not expected to produce adverse effects. The Pohnpei EPA is responsible for monitoring air quality and enforcing these standards.

Table 9-4: State policy and regulations (Chuuk)

Policy	Description
Overarching policy	
Constitution of the State of Chuuk	Section 1 of art. XI (land and the environment) states the legislature shall provide by law for the development and enforcement of standards of environmental quality, and for the establishment of an independent state agency vested with responsibility for environmental matters.
Chuuk State Clean Environment Act of 2018	- Regulates phasing out of single-use plastic shopping bags and expanded polystyrene (Styrofoam). - Prohibits any person or business to import, possess, sell or distribute single-use plastic shopping bags after December 31, 2020. - Prohibits any person or business to import, posses, sell or distribute expanded polystyrene (Styrofoam) after December 31, 2021. - Enforcers shall issue a written citation for the violation with a penalty of First Offense: 500 USD fine and confiscation of the subject stocks. Second Offense: 1,000 USD and confiscation of the subject stocks. Third and subsequent Offense: 5,000 USD fine and confiscation of the subject stocks. - Also establishes the Chuuk State EPA, and gives the Agency powers of subpoena and quasi-judicial powers of contempt, issuance of orders, and enforcement of the provisions of the Act. - Allows the EPA to undertake enforcement actions, including (1) up to 100,000 USD civil penalty per day of violation; (2) civil action in Court; and (3) criminal action, in addition to civil action, with a maximum ten years' imprisonment or 500,000 USD fine or both.
Joint State Action Plan for Disaster Risk Management and Climate Change (Chuuk) 2017	This plan addresses Chuuk's vulnerabilities and proposes actions to enhance disaster preparedness and climate resilience across the state's islands. Objectives include to improve waste management and promote environmentally friendly recycling, and increased environmentally friendly sanitation coverage. Identifies poor sanitation and waste management as human-induced vulnerabilities to biodiversity.
Energy	
Energy Master Plan (EMP) 2018 for Chuuk	Chuuk will need to invest 86 m USD in new and replacement electricity infrastructure over the next 20 years from 2018. New infrastructure includes adding renewable generation capacity and grid connections in Weno, and developing electricity infrastructure in other regions of Chuuk. Chuuk's RE generation target is 30 %.
The Chuuk Public Utility Corporation (CPUC) Act of 1996	Establishes CPUC to be responsible for providing reliable electricity and water at reasonable cost to its customers and the public corporation shall be responsive to the needs and concerns of the people of Chuuk.
Waste management	
Littering Act 1991 (Littering Law CSL- 191-33)	- Became unlawful for any person, establishment, corporation, or firm to throw, discard, scatter or abandon any waste materials, garbage or other debris in any form or substance upon any public road, street, easement, land or body of water other than a public dumping ground. - It requires businesses to have a sufficient number of garbage receptacles, and to securely contain all garbage resulting from business operations. - It requires the EPA to designate a sanitary dump site after an Environment Impact Statement, to be maintained by the Department of Public Works. - It sets penalties and enforcement allowing the Division of Public Safety to use any enforcement methods it sees fit.
Environmental Improvement Tax and Truk Environmental Action Agency 1979 (Recycling Law of *aluminium cans*)	- Section 1 imposes a 0.05 USD tax per metal can. - Section 4 requires the Chuuk Visitors Bureau to operate a refund and processing programme for the return of such cans at 0.02 USD per can. - Section 6 provides for taxes not paid to be subject to a penalty of 20% per month on unpaid taxes.

Policy	Description
Code Title 21: Health & Sanitation, Ch 13: Sanitation (as of 2001)	- Requires latrines or toilets to conform to public health regulation standards and prohibits depositing faeces within 500 yards of a dwelling. - Prohibits accumulation of rubbish and states a person who fails to remove such accumulation within a reasonable time after notice in writing by a Department of Health Services representative shall be deemed to have violated the Section. - Establishes September as the annual Sanitation Month. - States the penalty for violation is a maximum of 500 USD, or maximum one-year imprisonment, or both.
Chuuk Public Utility Corporation Act of 1996 (CSL 3-97-05)	- The Chuuk Public Utility Corporation has the power and duty to provide sewerage systems.
Solid Waste Management Action Plan (Chuuk) 2019–2023	Strategic priorities include proper management of landfill sites, introduction of the CDL system, and enhancement of human capacities: learning from experiences of other states and countries.
Biodiversity Strategy and Action Plan (Chuuk) 2018	Waste management and pollution identified as a threat to biodiversity, but also not emphasised within Plan as falls under EPA responsibility.

Table 9-5: State policy and regulations (Yap)

Policy	Description
Overarching policy	
Constitution of the State of Yap	Article XIII relates to the Conservation and Development of Resources. s1 allows the State Government to provide for the protection, conservation and sustainable development of agricultural, marine, mineral, forest, water, land and other natural resources.
Code Title 18: Conservation and Resources, Division 4: Environmental Quality Protection Act	- Establishes the Yap State Environmental Protection Agency (Yap State EPA) - Yap State EPA has the power and duty to control and prohibit pollution of air, land and water - Grants the Agency right of entry for various purposes. - Requires a person who (A) discharges pollutants to air, water or land in violation of this chapter or a permit; or (B) intentionally or negligently causes a pollutant to be discharged to air, water or land to clean up the pollutant or abate its effects on the order of the EAP. - Provides for persons who violate any provision of the chapter to be liable to a civil penalty of between 100 and 10,000 USD for each day of violation.
Joint State Action Plan for Disaster Risk Management and Climate Change (Yap) 2015	Led by the Yap State Office of Planning and Budget, this plan focuses on integrating disaster risk management and climate change adaptation into state planning processes. It emphasises the importance of traditional knowledge and community involvement in building resilience. Objective 3.4 under Objective 3 Resources and Development and Environment is to address and improve management of solid waste, sanitation and hazardous waste, on pp. 45 and 50.
Energy	
Energy Master Plan (EMP) 2018 for Yap	Yap will need to invest 58.9 m USD in new and replacement electricity infrastructure over the next 20 years from 2018. New infrastructure includes adding renewable generation capacity and grid connections on Yap proper, and developing two new mini- grids, seven enhanced mini-grids, 226 stand-alone solar systems and 36 other systems across eight islands. The Master Plan would provide all households in Yap with electricity access from 2025. From 2019 onwards, the share of RE in Yap's electricity generation would be about 50% or above.
Waste management	
Plastic Bag Prohibition Regulations of 2014	Prohibits retailers from distributing non-biodegradable plastic bags, with enforcement measures including a 100 USD fine for violations.
Code Title 11: Crimes and Punishment (Littering)	- Grants 50% of any fine collected to the person who reported the offence to the police. The remaining portion is to be deposited in a Clean-up Activities Account, to be used for cleaning and beautification programmes and activities organised by the Yap Government. - Imposes an imprisonment term between two days and six months, or a fine between 25 and 500 USD, or both, for littering of non-biodegradable material. - Imposes an imprisonment term between one day and six months, or a fine between 15 and 500 USD, or both, for littering of biodegradable material.
Recycling Programme Law of 2008 Container Deposit Legislation (CDL)	Consumers pay a deposit fee of 6 cents per container (glass, PET, aluminium, cooking oil containers) at the point of purchase. Upon returning the empty containers to designated recycling centres, consumers receive a refund of 5 cents per container, while the remaining 1 cent covers operational costs
Yap State Law 8-45 Recycling Finance Law 2009	Under CDL, a deposit fee is imposed on specific recyclable materials upon importation into Yap State.
Yap State Solid Waste Management Strategy 2018–2022	Action plan components include expansion of waste collection services to areas outside of Colonia; privatisation of waste collection service provided in Colonia; enhancement of container deposit system (CDL); proper management of public disposal site; green waste recycling; and proper management of inappropriate waste disposal such as waste oil and tires.
Biodiversity Strategy and Action Plan (Yap) 2018	Waste management and pollution identified as a threat to biodiversity on p 7. Objective 5 (pp. 10, 20, and vi of Annex 1) refers to managing pollution.

Table 9-6: State policy and regulations (Kosrae)

Policy	Description
Overarching policy	
Constitution of the State of Kosrae	s 1 of art XI (land and the environment) states that a person has the right to a healthful, clean, and stable environment. While providing for the orderly development and use of natural resources, the State Government shall by law protect the State's environment, ecology, and natural resources from impairment in the public interest.
Title 19: environmental protection and management	- Kosrae Island Resource Management Authority (KIRMA) was formally established. - Grants KIRMA the authority to develop and enforce regulations and a permit aimed at environmental protection (water, air, land, pollution control) and sustainable resource management within the state.
Joint State Action Plan for Disaster Risk Management and Climate Change (Kosrae) 2015	Developed to address Kosrae's specific risks related to climate change and natural disasters, this plan outlines strategies for sustainable development and environmental protection. Objective 3.6 is to strengthen waste management, and includes actions, sub actions, sources of actions and lead/supporting agencies.
Energy	
Energy Master Plan (EMP) 2018 for Kosrae	Kosrae will need to invest 37.3 m USD in new and replacement electricity infrastructure over the next 20 years from 2018. New infrastructure includes adding RE generation capacity and grid connections on to the main grid and developing a mini grid in Walung. The share of RE in Kosrae's electricity generation would be above 80% from 2019 onwards.
Waste management	
Control of Plastic Wastes Act of 2017 (amended in 2018)	- Amended Act 11-174 prohibits provision of plastic grocery bags by wholesale business or retailer, including shops, restaurants and salespeople. - The ban shall not apply to (1) original plastic packaging; (2) use for chilled or frozen merchandise; (4) reusable bags; (5) fresh produce bags; (6) freezer or snap-lock bags; and (7) garbage bags not distributed individually. - Became effective April 30, 2019 - Imposes a maximum 100 USD fine for each offence
Title 9: Taxation & Revenue Sharing, Ch 22: Recycling Deposits	- Imposes a refundable recycling fee of 5 cents per container on all aluminium beverage containers. - Contracts the Kosrae Community Action Programme as the State's recycling agent to administer the scheme.
Title 13: Offenses and Penalties (Littering and Pollution)	- Prohibits littering on public or private property without consent as a category three misdemeanour. - Defines polluting as wilfully or negligently discharging pollutants in violation of Chapter 4 of Title 7. Polluting is a category 1 misdemeanour.
Solid Waste Management Strategy (Kosrae) 2018–2022	Action plan components include improvement of waste collection system; improvement of container deposit system; proper management of public landfill site; and proper treatment of waste oil.
Biodiversity Strategy and Action Plan (Kosrae) 2018	Waste management and pollution identified as a threat to biodiversity. Strategy and action plan include minimising waste contributing to environmental pollution.

9.4. Revision of methane estimation in Third National Communication (TNC)

i. Solid Waste Disposal

In 2018, estimated methane emissions from the solid waste disposal sub-sector amounted to approximately 0.865 Gg CH_4. Future methane emissions in this sector are expected to vary depending on several key factors, including population growth, waste composition, waste generation per capita, the methods employed for waste treatment and the Methane Correction Factor (MCF), reflecting the type and condition of the disposal site, a critical parameter in emission estimation.

Methane emissions are estimated using the Tier 1 methodology under the IPCC First Order Decay (FOD) approach. Due to the lack of consistent, locally monitored data in FSM, default activity data and parameters are applied in the estimation process. Key data inputs required include, but are not limited to:

- Population size
- Waste generation rate (waste generation per capita)
- Amount of waste disposed at both managed and unmanaged sites
- Waste treatment method (composting, anaerobic digestion, open burning, etc.)
- Waste composition at the point of disposal
- MCF based on the type and condition of the disposal site.

<Methane Correction Factor (MCF)>

The MCF reflects the degree of anaerobic conditions at a waste disposal site and is a pivotal factor under the Tier 1 approach. According to IPCC default values:

- Semi-aerobic landfills (e.g., Fukuoka method) managed: MCF = 0.5
- Unmanaged shallow dumpsites (<5m depth): MCF = 0.4

Methane is produced when organic waste decomposes under anaerobic conditions. Deep, poorly ventilated, or unmanaged landfills provide favourable environments for such decomposition. In contrast, semi-aerobic systems—such as those introduced in Pohnpei, Yap, and Kosrae—facilitate oxygen infiltration into waste layers, thereby promoting aerobic conditions and reducing methane generation.

For the TNC, an MCF of 0.5 was applied to semi-aerobic sites and 0.4 to unmanaged shallow dumps, covering estimates up to 2018. Comparative studies indicate that the Fukuoka method, a well-established semi-aerobic landfill approach, can reduce GHG emissions by 37–40% compared to open dumping.

However, the effectiveness of semi-aerobic systems depends heavily on proper maintenance of gas venting infrastructure. When pipes are clogged, compaction is inadequate, or soil cover is lacking, anaerobic conditions may re-emerge, leading to higher-than-expected MCF values and increased methane emissions. Based on findings from the technical review meeting and field observations at semi-aerobic landfill sites in Pohnpei and Yap, it has been confirmed that neither systematic landfill management nor monitoring is currently in place. Consequently, an MCF value of 0.7, 0.2 higher than that assumed for well-managed semi-aerobic landfills, has been applied in the BAU scenario beginning in 2025 and extending through 2030.

- Semi-aerobic landfills (e.g., Fukuoka method) poorly managed: MCF=0.7

<Waste Composition (organic waste fraction)>

According to the IPCC methodology, waste composition should be assessed at the point of disposal, as methane generation primarily results from the anaerobic decomposition of organic waste. Waste composition data varies significantly among FSM states. For instance:

- Yap reported an organic waste fraction of 64%, substantially higher than other states, which reported 20–35%.
- The national average of organic waste fraction reported in the 2021 FSM Waste Audit (supported by PacWastePlus) was 17.84%. (Figure 9-2).
- At the technical review meeting, a representative from Yap confirmed that bringing green waste to the landfill site is prohibited.

Given the notable difference in the organic waste fraction observed in Yap, which might be caused due to methodological differences in data collection (i.e., before or after the self-treatment of organic waste at household level), the same waste composition for Kosrae has been used for Yap for the years 2018 and 2019.

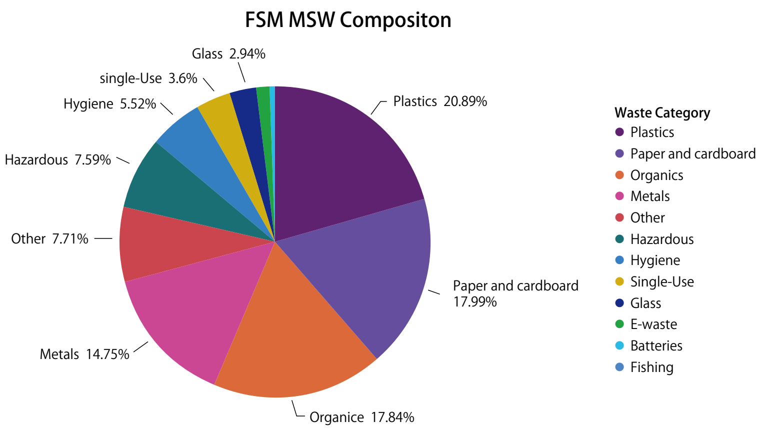

Figure 9-2: FSM municipal solid waste composition (% by weight)[18]

<Waste Generation per Capita>

Waste generation per capita is a core metric in calculating total waste volume. In the TNC, only household waste generation per capita derived from the State-level Waste Management Strategies was considered to calculate waste generation per capita. In the revised calculation, the sum of household and non-household waste has been considered because non-householder waste which comes from commercial entities, offices, and schools also contributes to methane emissions.

18 Source: Federated States of Micronesia National Waste Audit Analysis Report 2023

<Calculation of Degradable Organic Carbon (DOC)>

Degradable Organic Carbon (DOC) refers to the portion of organic carbon in waste that can decompose biologically under anaerobic conditions in landfills, potentially generating methane. In the revised calculation, DOC which was applied to "metals" in the TNC has been removed because metals do not contain organic carbon. Moreover, the formula itself has been modified in such a way as to follow the IPCC methodology.

ii. Wastewater Treatment

Methane emissions from wastewater in FSM primarily originate from the treatment and discharge of domestic and commercial wastewater (sewage). Given the minimal presence of industrial activity within FSM, emissions from industrial wastewater are not considered significant and are therefore excluded from the national inventory.

As with the solid waste disposal sub-sector, the lack of comprehensive monitoring systems and localised emissions data necessitates the use of default methodologies. FSM's greenhouse gas (GHG) inventory applies the IPCC Tier 1 methodology, utilising default parameters for the Oceania region, as outlined in the 2006 IPCC Guidelines and the 2019 Refinement.

To estimate methane emissions from domestic and commercial wastewater, several critical data inputs are required:

- Total population
- Amount of wastewater generated or treated
- Per capita Biochemical Oxygen Demand (BOD)[19] generation rate (g/person/day)
- Fraction of population connected to sewer systems or discharging to various treatment pathways
- Maximum methane-producing capacity (Bo) — default: 0.6 kg CH_4/kg BOD
- Methane Correction Factor (MCF) — default values are shown below:
    - Aerobic treatment systems: 0.0
    - Anaerobic lagoons: 0.8
    - Septic tanks: 0.5
    - Uncollected or open defecation: 0.0
    - Discharge to water bodies (sea, river, lake): 0.1 (untreated)

According to the TNC, the entire population of FSM is considered to discharge wastewater to untreated systems—namely, direct discharge into coastal waters, rivers, or lakes. This pathway is assigned a default MCF of 0.1, reflecting minimal anaerobic conditions and thus lower methane generation compared to conventional anaerobic treatment systems.

<Wastewater Treatment Situation>

Access to centralised sewage systems across the states of FSM is concentrated in Kolonia in each state. While comprehensive and current statistical data remain limited, interviews were conducted by the author with representatives from utility corporations in Pohnpei, Chuuk, and Yap indicates. The results are summarised in Table 9-7.

19 Biochemical Oxygen Demand

Table 9-7: Summary of wastewater treatment status

State	Current Situation
Pohnpei	The Pohnpei Utility Corporation (PUC) is responsible for sewage services in Pohnpei. As of December 2024, the sewerage system serves approximately 856 units, covering around 5,000 residents or 90% of Kolonia's population. Plans are underway to achieve full coverage. Outside Kolonia, however, most households rely on decentralised systems, including septic tanks, pit latrines, or other on-site sanitation methods, which may contribute to methane emissions due to anaerobic conditions.
Chuuk	The Chuuk Public Utility Corporation (CPUC) manages wastewater services on Weno Island, where a refurbished wastewater treatment plant, completed in 2016, currently serves 624 households. This equates to service coverage for roughly 20% of Weno's population (estimated at 14,000), or about 6% of Chuuk's total population. The remainder of Weno's residents and those in outer islands rely on septic tanks, pit latrines, or direct discharge into the environment. CPUC regularly monitors wastewater parameters such as dissolved oxygen (DO), ammonia, chlorine, and pH. A wastewater service fee is charged at 7 USD/month for households and 15 USD/month for commercial users. Notably, treated sludge is distributed to community members for use as fertiliser.
Yap	Yap State Public Service Corporation (YSPSC) oversees sewer collection and treatment in Kolonia, where a centralised wastewater treatment plant is operational. A new facility, constructed by GPPC, recently replaced the aging infrastructure. Despite these developments, service coverage remains limited, with only 300 units (approximately 10% of the population). In rural and outer areas, pit latrines remain prevalent. While drinking water quality is monitored for chlorine and turbidity, wastewater quality is not currently tracked.
Kosrae	The systems are owned and managed by the municipalities with technical assistance being provided by the Department of Public Works.

Source: Interviews arranged by the author

This reliance on non-centralised and often inadequately managed systems has important implications for methane emissions, particularly due to the anaerobic conditions associated with septic tanks and poorly maintained latrines. Considering this fact, the methodological approach that is used in TNC provides a conservative baseline for methane emissions from wastewater in FSM, while underscoring the need for improved data collection and infrastructure development to enable more accurate and country-specific estimates in the future.

iii. Manure Management

Methane emissions from manure management occur primarily under anaerobic conditions, where organic matter decomposes in the absence of oxygen—typically in storage systems such as lagoons, anaerobic digesters, or open channels. In contrast, aerobic or minimally managed systems, where manure is exposed to air or dispersed into the environment, tend to produce significantly lower methane emissions.

The TNC uses the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 4, Chapter 10: Emissions from Livestock and Manure Management), applying the Tier 1 approach for estimating methane emissions from "Manure Management" of the Livestock sub-sector. This method relies on default emission factors and general assumptions suited to regional contexts where country-specific data are limited.

The formula used is:

CH_4 (Gg/year) = N(T) × MEF(T) × 10^{-6}

where N(T) is the number of animals of type T, and MEF(T) is the methane emission factor (kg/head/year).

Livestock population data were sourced from the 2013–2014 Household Income and Expenditure Survey (HIES) and the 2016 FSM Integrated Agriculture Census. For years beyond 2016, pig populations were extrapolated using trendlines based on observed data. Since the pig population increased from 2014 to 2016, the emission estimates also rise accordingly under the assumption that all other parameters remain constant.

The methane emission factor (MEF) applied is 24 kg CH_4/head/year, the Tier 1 default for breeding pigs in Oceania under warm (>25°C) conditions. This value assumes that 50% of manure is managed in anaerobic conditions, such as lagoons—a standard assumption when detailed local data are unavailable.

<Manure Management Situation>

Traditionally in FSM, pigs have been an integral part of family life and cultural practices. Most households raised pigs for ceremonial and communal purposes. This subsistence-based agrarian system, rooted in social obligations, underpins the widespread presence of piggeries across the islands.

According to interviews conducted in 2025 by the author, the cultural importance of pigs varies among the states. In Pohnpei, pigs are particularly valued as symbols of family status. Consequently, households in Pohnpei tend to raise more pigs than those in other states. Pigs are commonly slaughtered for various social events beyond holidays, such as weddings and funerals. In contrast, pig consumption in Yap is typically associated with Christmas celebrations.

Across FSM, the small-scale pig pens typically use water-based cleaning practices, flushing pig waste directly out of pens onto the ground or into adjacent waterways. These systems are unlikely to create sustained anaerobic conditions, especially in well-drained or shallow environments, and would therefore result in substantially lower methane emissions than anaerobic lagoon systems.

Therefore, the reliability of these estimates is significantly undermined by the absence of updated data post-2016, particularly regarding:

- Actual livestock numbers, and
- Manure management practices at the household or community level.

To improve methane emission estimates from manure management and ensure they reflect real practices in FSM, it is critical to:

1. Update livestock census data, especially pig populations, on a regular basis.
2. Conduct surveys or case studies to understand typical manure disposal methods in each state.
3. Differentiate emission factors based on actual manure handling—e.g., distinguish between flushing into soil, open drainage, composting, or lagoon storage.

4. Ensure that assumptions about aerobic conditions are validated, from the point that manure does not accumulate in water-logged or enclosed pits, and that manure disposal sites are not obstructed in ways that would foster anaerobic decomposition.

In conclusion, without updated, field-based data on manure management practices, methane emissions from this sub-sector will remain highly uncertain. Addressing these data gaps is essential for developing targeted climate mitigation strategies and aligning inventory estimates with on-the-ground realities.

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