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Advancing Electronic Monitoring in Taiwan's Distant Water Longline Fisheries

AUGUST 2026



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ACRONYMS

AAP	Archipelago Asia Pacific
ABNJ	Areas Beyond National Jurisdiction
AFMA	Australian Fisheries Management Authority
AI	Artificial Intelligence
AUD	Australian Dollar
BET	Bigeye Tuna (Thunnus obesus)
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CCTV	Closed Circuit Television
CMM	Conservation and Management Measure
CSIRO	Commonwealth Scientific and Industrial Research Organization (Australia)
EEZ	Exclusive Economic Zone
E-logbook	Electronic Logbook
EM	Electronic Monitoring
ER&EM IWG	Electronic Reporting and Electronic Monitoring Intersessional Working Group (WCPFC)
ETP	Endangered, Threatened, and Protected
EU	European Union
FAD	Fish Aggregating Device
FAO	United Nations Food and Agriculture Organization
FIP	Fishery Improvement Project
FPS	Frames Per Second
GB	Gigabytes
GBP	British Pound
GPS	Global Positioning System
HD	High Definition
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
IOTC	Indian Ocean Tuna Commission
ISSF	International Seafood Sustainability Foundation
IT	Information Technology
LEO	Low Earth Orbit
LL	Longline
LTLL	Large Tuna Longline
Mbps	Megabytes per second

MCS	Monitoring, Control, and Surveillance
MPI	Ministry for Primary Industries (New Zealand)
MSC	Marine Stewardship Council
NGO	Non-Governmental Organization
NMFS	National Marine Fisheries Service (United States)
NOAA	National Oceanic and Atmospheric Administration (United States)
NTOU	National Taiwan Ocean University
NZD	New Zealand Dollar
OFDC	Overseas Fisheries Development Council (Taiwan)
P&I	Protection and Indemnity (Insurance)
RFMO	Regional Fisheries Management Organization
RFT	Request for Tender
SPRFMO	South Pacific Regional Fisheries Management Organization
STLL	Small Tuna Longline
TFA	Taiwan Fisheries Agency
TTA	Taiwan Tuna Association
TTLA	Taiwan Tuna Longline Association
TWD	New Taiwan Dollar
UPS	Uninterrupted Power Supply
USD	United States Dollar
VMP	Vessel Monitoring Plan
VMS	Vessel Monitoring System
WCPFC	Western and Central Pacific Fisheries Commission

DISCLAIMER

This report is provided for informational purposes only. It is intended to describe the considerations, tradeoffs, and implementation challenges associated with the potential rollout of electronic monitoring in Taiwan's distant water longline fleet, drawing on international experience and stakeholder inputs. It does not constitute policy advice, and it is not an advocacy document. It should not be interpreted as recommending or endorsing any particular regulatory approach, institutional arrangement, or implementation decision by the Taiwanese government. Any references to international models, RFMO standards, or program designs are presented solely to inform understanding of options and risks, not to urge a specific course of action.

Furthermore, throughout this document, "Taiwan" is used as a practical shorthand for ease of reference. In certain international fisheries fora and Regional Fisheries Management Organizations, the relevant member or participating fishing entity is formally referred to as "Chinese Taipei." References in this report to "Taiwan," including in relation to its authorities, fleet, and regulatory system, are intended solely for readability and convenience and do not imply any position on legal status, sovereignty, or international representation.

ACKNOWLEDGEMENTS

This report reflects the contributions of many individuals and organizations whose expertise, collaboration, and commitment helped shape its development.

Ocean Outcomes extends its sincere appreciation to Marine Change for the research and analysis that underpin this report. Roderic Hodges at Marine Change provided the technical expertise, international comparative research, and analysis that were instrumental in developing a practical and comprehensive assessment of electronic monitoring implementation for Taiwan's distant water longline fleet.

We are also grateful to the experts who reviewed the report and provided valuable feedback throughout its development. Their comments strengthened the technical rigor, clarity, and relevance of this publication.

01 EXECUTIVE SUMMARY

With a tuna longline (LL) fleet comprising around 900 vessels operating across the world's oceans, Taiwan is a major distant water fishing flag state. This report assesses the electronic monitoring (EM) landscape for Taiwan's LL fleet, evaluates feasibility, and provides practical recommendations for advancing EM implementation. The analysis focuses on EM technical and operational standards aligned with relevant Regional Fisheries Management Organizations (RFMOs), interoperability with Taiwan's existing fisheries monitoring infrastructure, key considerations for vendor engagement and government capacity, cost implications, funding models, and market incentives for EM adoption.

While these RFMOs have issued interim EM standards and the regulatory trends are clear, they do not yet mandate EM coverage on LL fleets. However, the experience of the relatively few jurisdictions that have implemented EM at scale shows that specific institutional capacities, standard setting, technology integration, and sustainable funding mechanisms take significant time to build even where general institutional capacity is already strong.

Australia began exploring EM in 2005 and only made it mandatory a decade later following years of pilots and trials. In New Zealand, the legal basis was established in 2017 while implementation began in 2023 and proceeded in stages through 2025. In the United States Western Pacific LL tuna fishery, the US case most similar to Taiwan, EM development began in 2009 and was made mandatory in 2025, followed by a phased fleet rollout planned through 2027. Scotland's 2024 EM mandates similarly built on experience using EM in selected fisheries from 2008, with full requirements for the large pelagic fleet coming into force in 2026.

For Taiwan, starting program design early reduces the likelihood of reactive decisions later as RFMO and market expectations tighten and as vendor, data review, and funding systems must be put in place. As Taiwan already competes globally in cutting edge technology, designing a credible, technically sophisticated EM system is an opportunity to extend that comparative advantage into fisheries monitoring.

To protect the human rights of fishers and for other considerations, Taiwan promoted the installation of CCTV systems on tuna LL vessels. This system stores video records on onboard hard drives, which are then manually retrieved. This practice met the policy needs of Taiwan at that time and is fundamentally different from the standards of international electronic observers. Furthermore, the CCTV footage does not contain key metadata such as vessel identification codes, timestamps, or geolocation.

Program Design

Due to the dispersed nature of the fleet and extended times at sea, an effective LL EM program in Taiwan will require routine **satellite transmission** for timely review of fishing events. Data transmission and review architectures are therefore key design considerations. Though the current market leader (Starlink) has not been sanctioned for official use in Taiwan, additional satellite communications arrays are expected to come online in the near term. A provider-agnostic approach allowing EM data transmission to take place across multiple satellite networks may therefore be advantageous.

Sampling rates are a core cost driver as they determine to a significant extent how much data must be transmitted for review. The report highlights a 20% review rate as a defensible scientific benchmark, balancing representativeness with practical feasibility while recognizing diminishing marginal returns at higher coverage levels.

Vendor engagement: Because government fisheries authorities do not possess the in-house technical and operational capacity to deploy large-scale technology systems, effective EM implementation requires collaboration with specialized private-sector vendors. EM vendor services often include two distinct procurement categories: **onboard systems** (hardware and software), and **downstream services** (data management, analytics software, and video review). Governments can contract these either as an integrated package or as individual components.

Internationally, vendor engagement falls into two broad categories, the tradeoffs of which are discussed in detail in the report:

1. A **centralized model** in which a competitive tender is used to select one or more approved EM service providers.
2. A **minimum standards model** in which the regulator defines minimum technical and performance standards for EM systems and authorizes vendors that meet these standards to offer their services to vessel operators. Initial certification and ongoing compliance auditing are conducted by a government-approved entity.

International experience suggests that no single model for engaging EM vendors is universally optimal. Rather, implementing countries have adopted approaches that reflect their own institutional capacity and governance preferences.

The report also outlines three potential **EM data review** models, each with tradeoffs related to assurance, speed of rollout, cost, and the degree of capacity required within government:

1. **Vendor-led** initial review with government quality assurance, audit, and enforcement.
2. End-to-end, **in-house government** review.
3. A **hybrid model** where vendors pre-process and segment footage while government performs formal review and reconciliation.

The Overseas Fisheries Development Council (OFDC) is well positioned to support the Taiwan Fisheries Agency (TFA) in managing core elements of EM data review because it already sits within Taiwan's electronic reporting and verification architecture and has operational involvement in VMS and e-logbook workflows.

As for **data governance and industry acceptance**, resistance to new compliance measures can be mitigated by ensuring vessel operators experience tangible benefits from adoption. Treating EM

outputs as government-owned compliance data while providing video feed access to vessel owners for operational purposes is recommended and consistent with approaches used in other jurisdictions.

Taiwan already has the **legal basis** to collect, store, and use onboard video for compliance purposes. The key operational requirement is to maintain clear chain of custody, which can be strengthened through standardized procedures including tamper-evident metadata and file integrity checks such as digital fingerprints (hashes) for transmitted footage.

Costs and Funding

Public documentation and vendor interviews suggest EM **hardware** costs of approximately USD 8,000-10,000 per vessel, with effective lifetimes commonly in the 3 to 5-year range in harsh marine conditions.

International benchmarks suggest total annual **implementation costs** (excluding hardware) of approximately USD 12,000-14,000 per vessel, with **administration costs** clustering around USD 3,500 per vessel and **data review and storage** accounting for the balance.

Existing programs, however, rely on physical media swaps or terrestrial communication networks rather than satellite transmission. As such, **routine satellite transmission** will be an incremental cost for a Taiwanese EM program. Indicative satellite transmission costs are estimated at USD 500-1,000 per month per vessel (approximately USD 6,000-12,000 per year).

Combined operating costs for EM on Taiwan's LL fleets are estimated at approximately USD 20,000-29,000 per vessel per year, with data review and satellite transmission as the dominant cost drivers, while hardware comprises a comparatively modest share.

For EM hardware, given TFA's history of subsidizing adoption of onboard technologies (including the CCTV systems currently mandated across the fleet), it may be expedient for TFA to subsidize some portion of the upfront hardware costs associated with EM. Taiwan has already taken a modest step in this direction through a limited 2025 EM subsidy program for a small number of distant water LL vessels. Recurring hardware maintenance and replacement costs, including periodic camera replacement due to harsh marine conditions and routine system upgrades, are most

Figure 1: Estimated annual operating costs for EM on Taiwan's LL fleets (USD)

ANNUAL OPERATING COST	LOWER LIMIT	UPPER LIMIT	% OF TOTAL COST
Hardware	2,000	3,300	10-11%
Data transmission	6,000	12,000	30-41%
Data review and storage	8,800	10,300	35-44%
Administration	3,200	3,700	13-16%
Total operating cost	**20,000**	**29,300**	

logically borne by industry, since vessel operators have the most direct ability to protect and manage equipment day to day.

For recurring expenses associated with satellite data transmission, over half [1] of Taiwan-flagged LL vessels already pay for satellite connectivity. It therefore seems reasonable to expect industry to continue bearing some transmission costs, particularly given the operational value of connectivity for fleet management and safety beyond EM.

Non-Regulatory Incentives

While EM is mainly driven by RFMO compliance and enforcement objectives, adoption in Taiwan's LL fleet is more likely to succeed if vessel owners experience clear, direct benefits from participation. Industry consultation through the main LL associations can help translate program design choices into practical operating rules that reduce resistance and increase willingness to pay.

Fleet management is the most immediate incentive. Over half of Taiwanese LL vessels have voluntarily linked their onboard CCTVs to satellite connectivity, and owners report their willingness to pay for this service is tied to their ability to observe operations on demand and communicate more effectively with captains and crew. TFA can build on this foundation by making EM data available for fleet management, not only compliance. Looking ahead, as EM vendors integrate edge computing and additional sensors, onboard systems could support navigation and fuel efficiency improvements, power and freezer load optimization, gear deployment and retrieval optimization, predictive maintenance, and safety and crew welfare functions.

Market access is the second major non-regulatory incentive pathway. Taiwan's LL industry remains heavily exposed to buyer expectations in high value export markets, and in the US and EU in particular, labor risk has become a defining concern in distant water fisheries supply chains. In that context, EM can function as part of a broader credibility and risk management platform, helping Taiwan protect market position and reduce commercial friction as labor, traceability, and sustainability expectations tighten.

Related to market access, **ecolabels and improvement programs** provide an additional incentive for EM adoption. For Taiwanese LL fleets, EM is the most feasible path to meeting the evidence requirements for ecolabel certifications such as the Marine Stewardship Council (MSC). While MSC is not a universal requirement, it is an important certification for access to retail and branded supply chains in the EU and US, and increasingly in Japan.

Insurance is a secondary incentive for EM adoption, primarily by improving access to coverage based on stronger oversight rather than in generating immediate premium reductions. For crew coverage, EM could strengthen evidence in cases involving injury, medical evacuation, or labor disputes. For third-party liability, EM could also help establish causation, verify compliance with procedures, and reduce false claims.

1 Reported in personal communications with the Taiwan Tuna Longline Association (TTLA).

02 INTRODUCTION

Marine Change was engaged by Ocean Outcomes to analyze Taiwan's electronic monitoring (EM) landscape, complete a feasibility assessment, and highlight key considerations for advancing EM in Taiwan's distant water tuna longline (LL) fleet. The scope of this analysis includes:

- → Exploring *Technical & Operational Standards* for EM in distant water LL fisheries, ensuring compliance with Regional Fisheries Management Organization (RFMO) standards, as well as Interoperability & System Integration across fisheries monitoring infrastructure that includes Vessel Monitoring Systems (VMS), electronic reporting platforms (e-logbooks), and national fisheries databases.
- → Identifying the appropriate capacity and a potential entity to undertake EM Data Review, considering best practices while ensuring *Data Security & Access* that includes defining data ownership rights and privacy safeguards that align with international standards.
- → Assessing *Regulatory Compliance & Enforcement* frameworks that facilitate the admissibility of EM data for compliance monitoring, enforcement actions, and fisheries reporting.
- → Conducting a *Cost Analysis* for EM systems including Administrative Costs and workforce requirements for national EM program implementation.
- → Identifying potential cost-sharing *Funding Models* appropriate for EM adoption in Taiwan, drawing from a review of cost recovery programs in other fisheries.
- → Considering *Market Incentives* for vessel operators, including market access and seafood certification programs.

Taiwanese Context

Taiwan is one of the world's major distant water fishing flag states. Since the 1960s, Taiwanese LL vessels have expanded from the South China Sea into the Pacific, Indian and Atlantic Oceans, targeting albacore, bigeye and yellowfin tunas as well as billfish across multiple tuna RFMO convention areas: primarily the Western and Central Pacific Fisheries Commission (WCPFC), the Indian Ocean Tuna Commission (IOTC), the Inter-American Tropical Tuna Commission (IATTC), and the International Commission for the Conservation of Atlantic Tunas (ICCAT).

Taiwanese LL operations today are structured around a significant small-scale fleet (STLL), numbering nearly 700 vessels in the WCPFC convention area alone, and a diminished though still substantial large-scale fleet (LTLL). Across both vessel classes there are currently around 900 Taiwanese LL vessels operating globally. Operationally, Taiwanese LL vessels fish year-round and follow highly migratory tuna stocks across vast areas of the high seas and coastal state exclusive economic zones (EEZs). Many vessels offload catch and are resupplied through at-sea transshipment and crew changes, and some trips have been documented to last up to three years. This combination of global range, long trip duration, and reliance on transshipment makes the fleet operationally efficient but poses significant challenges for traditional monitoring, control and surveillance (MCS) tools.

Regardless of flag state, deploying human observers onto LL vessels is constrained by the need to align vessel and observer schedules, limited berth space on smaller LL vessels, the remoteness of fishing grounds, and the practical difficulty of rotating observers on and off vessels that may not enter port for many months. Safety and welfare concerns for observers further complicate deployment.

In seeking to meet RFMO minimum observer requirements, Taiwan's historical deployment levels have fluctuated due to practical constraints. The figures below show actual observer coverage (as measured by days at sea) in the WCPFC since 2015.

For the Taiwan Fisheries Agency (TFA), this combination of a large, globally dispersed LL fleet, long and remote fishing trips, and relatively low observer coverage creates a structural

Figure 2: Taiwan LL Observer Coverage in WCPFC, by Fleet Segment

LL FLEET SEGMENT	LARGE-SCALE FLEET (LTLL)	SMALL-SCALE FLEET (STLL)
2015	8.5%	2.5%
2017	10.1%	5.8%
2018	8.6%	8.2%
2019	15.0%	7.0%
2022	15.7%	8.0%
2023	11.5%	6.0%

enforcement challenge. It is difficult to verify logbook data, detect problematic practices such as shark finning or unauthorized transshipment, or systematically document interactions with protected species when only a small fraction of fishing sets is independently observed. At the same time, the logistical and welfare constraints described above make it unrealistic to scale human observer coverage to levels that would provide comprehensive monitoring. This context underpins growing interest in EM as a complementary tool to provide a more consistent record of Taiwanese LL operations across oceans and RFMOs, and as a platform on which to build risk-based, data-driven compliance and science programs.

Taiwan has in fact already built a foundation for electronic reporting that EM could plug into.

Electronic logbook (e-logbook) reporting was implemented on LTLL vessels in 2014 and extended to STLL vessels in 2015, with vessels required to transmit fishing data daily. LL vessels are also subject to hourly vessel position reporting via VMS. Together, these systems provide a trip chronology highly complementary to EM: VMS provides a time-stamped movement record, while e-logbook provides a time-stamped operational record that is already used as an input to official catch and effort statistics and compliance checking.

Institutionally, verification is already designed around triangulating multiple data streams. TFA established a 24/7 Fisheries Monitoring Center in 2017 to integrate and cross-check vessel information, vessel positions and catch data. The Overseas Fisheries Development Council (OFDC), a non-profit body funded by public-private contributions to support TFA's management of Taiwan's distant water fleets, certifies VMS installations, receives e-logbook submissions, and monitors signal loss and reporting gaps. Within that architecture, EM can be positioned as an additional evidentiary layer that can be indexed to the same events already visible in VMS tracks, e-logbook entries, and landing/transshipment declarations that Taiwan uses for catch verification and traceability.



Definition and Components of EM

EM systems are often discussed simply as "cameras on boats," but in practice they function more like an end-to-end workflow for producing usable compliance or scientific evidence. An integrated EM system has three linked components: onboard data collection and storage, data transmission, and data review. Weakness in any one of these elements undermines the whole system.

Taiwan's current CCTV program does not meet the standard definition of an integrated EM system. CCTV systems record video to an onboard hard drive that is later physically removed and (sometimes) delivered to authorities, often long after fishing events have occurred. This footage does not include a time stamp or location metadata, greatly limiting the ability to cross check footage with catch reporting data or verify compliance with other fisheries regulations. CCTV supplies post-hoc evidence with long review lags and a higher risk of data gaps or tampering. By contrast, EM enables more timely detection of potential non-compliance, faster feedback to vessels, and risk-based tasking for enforcement.

Onboard data collection and storage

EM data collection relies on a set of onboard devices that automatically record fishing operations. Core components typically include deck-mounted cameras, a central control box, hard drives for data storage, a GPS unit, and a stable power supply. Cameras are positioned to cover key activities such as baiting, setting, hauling, and catch handling. On LL vessels, a common configuration is four cameras: three focused on fish landings and one dedicated to baiting operations.

Sensors may be linked to the control box to detect when fishing gear is deployed or retrieved, generating metadata that synchronize video with vessel activity. These sensors can also trigger video recording, though cameras may also be configured to capture continuous video or still images at set intervals. Each camera must meet minimum standards to ensure that fishing events are clearly captured and species identifiable. Metadata, especially time stamp and GPS position, must be embedded in the video stream to enable authentication and cross-checking with logbooks. Captured video and metadata is stored onboard on physical hard drives.

Transmission of footage for review

Of the few EM systems currently in operation at scale, most rely on local data retrieval through physical hard drive exchange and/or upload via cellular networks. For distant water fleets, however, an EM system based on physical data exchange is impractical. Long intervals between fishing events and video review greatly reduce the value of EM for monitoring and timely enforcement. Transmitting footage from distant water vessels to reviewers in Taiwan in near real time is now technically and economically feasible with current technologies.

In recent years, low-earth orbit (LEO) satellite constellations have emerged as a cost-effective mechanism for transmitting EM data regardless of vessel location, making near real-time verification of fishing activities increasingly feasible even for globally dispersed fleets. This allows for timely review of fishing effort, bait usage, fish size and quantity, discards and releases, transshipments, crew working hours, and other operational data relevant to fisheries managers.

Though transmission costs have fallen sharply and are likely to keep declining, they are still significant. To manage bandwidth requirements, only footage segments that contain relevant fishing activities (such as baiting, gear setting, hauling, discards, and transshipments) can automatically be filtered and transmitted, while the remaining footage is stored onboard for later retrieval if needed. Machine learning and onboard edge computing tools are playing a rapidly expanding role in identifying these activity segments and prioritizing them for upload and review.

Timely review of footage

A persistent challenge for EM programs is the sheer volume of footage generated. Full manual review is generally impractical, leading most programs to rely on targeted or risk-based sampling. Human reviewers, often experienced onboard observers, focus on key fishing events rather than continuous playback. Increasingly, advanced EM-specific software and machine learning algorithms are being used to detect events of interest, classify catch, or flag anomalies, substantially improving the efficiency and consistency of human review.

Third-party vendors

Because government fisheries authorities do not possess the in-house technical and operational capacity to deploy large-scale technology systems, effective EM implementation typically requires collaboration with specialized private sector vendors. In some cases, quasi-governmental agencies and research institutions are also involved.

EM vendor services often include two distinct procurement categories: onboard systems (hardware and software), and downstream services (data management, analytic tooling, and video review). Governments can contract these either as an integrated package or as individual components.

Internationally, vendor engagement has taken two primary forms.

First is a centralized model, where a delegated government agency conducts a competitive tender to select one or more approved EM service providers. These vendors are then contracted to supply, install, and maintain onboard EM systems across the fleet, and potentially to manage data storage and/or review.

Alternatively, the government defines minimum technical and performance standards covering all aspects of EM systems and authorizes vessel operators to procure technology from vendors that meet these standards. Initial certification and ongoing compliance auditing are conducted by a government-approved entity. This minimum standards model can apply either to the full EM system or separately to onboard systems and to review/service providers.

The tradeoffs across centralized versus standards-based approaches are discussed in greater detail later in the report, including implications for cost, rollout speed, quality assurance, vendor lock-in risk, and the degree of capability that is kept inside government.

Advantages and Disadvantages of EM

EM offers several advantages over human observers, particularly in LL fisheries where operations are globally dispersed, onboard space is limited, and safety and logistics are challenging. EM systems provide continuous, objective, and verifiable records of fishing activity across 100% of trips, unaffected by fatigue, bias, cost, or availability constraints that limit human observer coverage. EM data can also be stored indefinitely, re-analyzed, and audited.

By taking on the role of compliance, EM complements onboard observers whose expertise remains essential for collecting scientific data that cameras alone cannot accurately capture: biological sampling, including age, sex, and length-weight measurements.

However, EM is imperfect. Depending on vessel layout, camera placement, and crew behavior, footage may not effectively capture all relevant activities. Some events are obscured or happen too quickly to be reliably identified. With any EM program there is currently an inherent tradeoff between accuracy and the extent of human review: lowering the threshold for human review improves accuracy but increases review time and cost, while higher automation speeds processing at the expense of precision.

Based on interviews with multiple EM vendors, currently even the most advanced AI-based EM data reviewers are reportedly able to achieve accuracy of only about 70-90%, depending on the fishery. Accuracy is almost certain to improve as AI tools progress over time, but human review is still a vital part of an effective EM system.

RFMO EM Landscape

A key driver of EM adoption in Taiwan is compliance with evolving RFMO standards. This research will focus on tuna RFMOs most relevant for Taiwan's LL fleet: WCPFC, IOTC, IATTC, and ICCAT.

The RFMOs are at different stages of advancing EM standards. In 2023, both IOTC and ICCAT formally adopted EM standards that apply to LL fisheries. In 2024, IATTC also adopted interim EM standards covering LL vessels, to be reviewed and potentially updated in 2027. Similarly, in 2024, WCPFC adopted interim EM minimum standards including for LL vessels.

While these RFMOs have now adopted EM standards, EM is not yet mandated for member countries. However, the situation is evolving. Ongoing RFMO joint working groups and technical consultations are building the case for EM adoption, especially to enhance regional observer programs. EM is moving from a voluntary supplement to human observers toward a recognized option for countries to meet observer coverage requirements, and potentially to an operational requirement.

WCPFC

The WCPFC is the most consequential RFMO for Taiwan's distant water LL fleet. Well over half of Taiwan's tuna LL operations fall under its jurisdiction, and the commission's current work on EM is expected to shape compliance norms across other tuna RFMOs. The WCPFC's 2024 adoption of interim EM minimum standards was a foundational step, establishing a common technical baseline for camera systems, image quality, data capture, and secure transfer.

Although EM is not yet mandatory, these standards have created a de facto template that national authorities are now expected to follow when developing domestic EM programs.

At present, LL fleets are still required to maintain at least 5% observer coverage under existing rules, and EM has not yet been formally recognized as equivalent to human observers for the purpose of meeting that requirement. The next stage is the creation of a formal EM conservation and management measure (CMM). This is now under development through the WCPFC Electronic Reporting and Electronic Monitoring Intersessional Working Group (ER&EM IWG), which in 2025 focused on designing an assurance and audit process, standardized reporting templates, and initial EM standards for carrier vessels and transshipment. These are pre-conditions for treating EM as a functional substitute or complement to observers at scale.

At the December 2025 commission meeting, consistent with the adopted workplan, there were no formal decisions on EM coverage. Instead, it marked the start of negotiations on the structure of a future WCPFC EM program. The US tabled a “Consultative Draft Conservation and Management Measure for the WCPFC Electronic Monitoring Program”. The draft is framed as “CMM 2026-xx” clearly indicating an aim of adoption in 2026, but its precise form remains to be negotiated.

For Taiwan, the strategic value of EM extends beyond basic RFMO compliance. Recent WCPFC analyses of data gaps and monitoring performance underscore that LL fisheries remain under-observed relative to purse seine, and that improvements in monitoring coverage are a key lever for strengthening stock assessments and justifying catch limit adjustments. Early adoption of EM could support Taiwan’s case for maintaining or modestly expanding its bigeye tuna quota, provided that improved monitoring demonstrably reduces uncertainty around catch.

The commission’s direction is clear: EM is expected to become an accepted, and perhaps required, component of LL monitoring. The pace of adoption will vary by member, but countries that move early will shape both the technical standards and the compliance benchmarks that follow. For Taiwan, keeping its EM implementation schedule aligned with this WCPFC timeline offers regulatory certainty and a potential competitive edge in quota negotiations and international market perception.

IOTC

The IOTC’s approach to EM is now among the most developed of the tuna RFMOs in terms of formal standards, assurance, and the pathway for recognition of national programs. EM is formally recognized as a tool to contribute to, and in some cases substitute for, human observers when it can be demonstrated that EM meets minimum data standards. This provides a structured way to address the longstanding coverage gap: although large commercial fleets are required to achieve at least 5% observer coverage, overall coverage across IOTC fisheries remains at roughly 2%, with particularly low coverage in LL segments.

Member countries wishing to implement EM must apply to have their national programs accredited, a process that involves technical review by the IOTC secretariat to confirm conformity with minimum standards covering camera specifications, data fields, review procedures, and data security protocols. Recognized

programs are then subject to periodic audits, ensuring that EM data collection and review remain consistent and reliable. Importantly, IOTC allows cross-recognition of EM programs already approved by other RFMOs, which should simplify Taiwan's compliance burden given the global nature of its fleets.

By the 2025 annual meeting, the legal architecture for EM in the IOTC was therefore largely in place, and the focus had shifted to implementation. The IOTC's regional EM program was due to be operational by July 2024, with members beginning to submit Vessel Monitoring Plans (VMPs) and information on EM coverage and data fields. However, the commission did not agree on new binding EM coverage targets or a change in the minimum 5% observer requirement. External observers, including the International Seafood Sustainability Foundation (ISSF), noted that there was no meaningful discussion on these topics despite the newly adopted standards, and characterized it as a missed opportunity to close persistent monitoring gaps. As a result, EM remains voluntary, even though the framework clearly anticipates its use to meet observer obligations.

At the same time, several members have continued to push EM forward through domestic regulations. Seychelles has moved from pilots toward making EM mandatory on parts of its industrial fleet, and the Maldives has announced plans to require EM on vessels when it reopens its LL fishery. These national initiatives, together with the IOTC's accreditation and audit provisions, are likely to shape how EM is used in practice, especially for vessels fishing outside coastal state EEZs. For Taiwan, early participation would send a strong signal of commitment to transparency and may help reduce the risk of friction with coastal states hosting Taiwanese vessels.

ICCAT

ICCAT's adoption of EM minimum standards in 2023 outline how systems should operate and what data should be collected, yet they stop short of requiring member countries to implement EM. However, EM may complement required human observer coverage and may be used to fulfill coverage requirements.

Nevertheless, ICCAT's EM standards have begun to shape national programs in the Atlantic. Several member states have initiated pilot projects, notably on bluefin tuna vessels, focusing on catch and bycatch documentation and compliance verification. The commission's priority now is to standardize reporting templates and ensure compatibility between EM data and their integrated online reporting system.

Following the 2025 ICCAT annual meeting, observer requirements for LL vessels remain at 10% for tropical tuna fisheries and decisions on scaling up EM were deferred to intersessional work in 2026 and beyond.

For Taiwan, whose presence in the Atlantic LL fishery is smaller, adopting EM in these fleets would simplify reporting to ICCAT's compliance committees and reduce the need to rely on scarce human observers, even without a formal mandate.

IATTC

The IATTC's approach to EM is anchored in a 2024 resolution that sets interim minimum standards for the use of EM systems across purse seine and LL vessels. These standards define technical requirements for cameras and gear sensors, VMPs, data fields, review processes, and data submission formats. The resolution designates an EM

working group and the secretariat to coordinate implementation and to provide annual summaries of member progress.

The resolution requires the commission to review the interim standards in 2027 and at least every two years thereafter, using information from member EM programs and technological developments to decide whether and how to revise them. The resolution does not make EM mandatory, nor does it specifically allow EM coverage to substitute for human observers in meeting the longstanding 5% LL observer requirement. IATTC's observer coverage in LL fisheries remains below target, typically 2-3%.

The 2025 IATTC annual meeting left EM and observer rules unchanged. Negotiations focused on a new joint IATTC-WCPFC working group on South Pacific albacore, strengthened shark measures, and FAD management. As a sign of modest progress on EM, the shark measures allow members to meet reporting obligations using data from human observer or EM programs.

For Taiwan, early, voluntary adoption of EM that conforms to the 2024 resolution can strategically position the country to shape the final rules and timelines ahead of the 2027 review.

Member countries implementing EM and using it to submit information to the IATTC must share detailed program descriptions, including VMPs, data review protocols, and governance structures. Annual EM data reports are then submitted alongside regular national reports. Although no audit process yet exists, the IATTC secretariat may develop one by 2027 in coordination with other tuna RFMOs.

Figure 3: Cross-RFMO comparison of EM status

RFMO	EM STATUS	MANDATORY?[2]	AUDIT/ ASSURANCE	IMPLEMENTATION TIMELINE	STRATEGIC RELEVANCE
WCPFC	Interim standards adopted (2024); binding CMM proposed 2026	No	Under development (timing to be decided in 2026)	No fixed schedule	Primary RFMO; directly linked to bigeye quota
IOTC	EM recognized as a tool to meet observer coverage objectives; audits active	Optional but encouraged	Formal audit system in place	No fixed schedule	Key secondary fishery, model for audit design and cross-recognition
ICCAT	Minimum standards adopted (2023); EM recognized as a tool to meet observer coverage objectives	Voluntary	None yet, basic working group review in place	No fixed schedule	Smaller footprint but strategic for transparency, reputation gains
IATTC	Interim standards adopted (2024) but not an option for meeting observer coverage	No	Review planned for 2027	Review and update in 2027	Smaller footprint but strategic for transparency, reputation gains

2 Refers to whether the RFMO currently requires members to implement EM.

Paths Forward for EM on Taiwan's Distant Water LL Fleets

Though (interim) EM standards have been issued and the general direction vis-à-vis EM is clear, the major tuna RFMOs have not yet mandated EM coverage on LL fleets and realistic timelines for doing so remain undefined. The experience of the few countries that have implemented EM at scale (New Zealand, Australia, the US, and Scotland) shows that building institutional capacity, setting standards, engaging vendors, and then normalizing EM in operations is a multi-year process that has typically taken longer than originally anticipated.

Therefore, despite the lack of an imminent compliance need, it is still sensible for Taiwan to begin designing a national framework for EM implementation to avoid rushed, reactive decisions later once RFMO and market expectations tighten. For Taiwan's LL fleet, which is large and currently lacks systematic EM infrastructure, starting that process early buys time to learn, test, and adjust. Given the scale of the challenge, any serious EM program for Taiwan will need to be planned as a phased, long-term effort.

That phased approach should reflect the heterogeneity of Taiwan's LL fleet. Though the basic logic of EM does not differ between LTLL and STLL vessels, LTLL vessels will often have more physical space and a more stable power supply, while STLL vessels are more likely to face tighter deck layouts. Given the diversity of its LL fleets, Taiwan can pursue a single national EM framework while allowing vessel-specific VMPs, phased rollout by fleet segment, and some flexibility in hardware configuration and funding support to achieve monitoring outcomes.

As Taiwanese LL vessels operate globally across RFMO jurisdictions, it would be both efficient and prudent to adopt a unified EM standard that meets the requirements of all major tuna RFMOs. A single, harmonized standard would allow vessels to operate seamlessly across regions without system modifications or compliance confusion, while providing regulators and industry a clear, consistent framework for data collection, review, and reporting. This approach would simplify administration and ensure that Taiwan's EM program remains adaptive as RFMOs continue to align their technical and operational requirements.

This report lays out in detail the key practical considerations for EM implementation, including effective engagement with technology and service providers, the costs and potential funding models associated with implementation, policy considerations, and non-regulatory incentives for industry adoption. With an eye on future compliance requirements, it closes with an in-depth look at the technical requirements for EM among the major tuna RFMOs as they currently stand. And to show what is possible and realistic, it begins with the experiences of the few countries that have operationalized EM at scale.



03 CASE STUDIES: EM LESSONS FROM OTHER FISHERIES

New Zealand

EM scope and timeline

The Fisheries (Electronic Monitoring on Vessels) Regulations 2017 established the legal basis for EM on certain commercial fishing vessels. Building on that framework, in 2021 the Ministry for Primary Industries (MPI) approved a policy initiative to install EM systems on up to 300 vessels across key inshore and high-risk fisheries, including trawl, set net, and LL.

Implementation began in August 2023 and has proceeded in stages. Surface LL vessels became subject to mandatory EM coverage from January 2024, while bottom LL vessels followed in March 2025. Approximately 220 vessels, including around 110 LL vessels, have been equipped with EM systems to date, with footage securely transmitted to MPI for review and compliance analysis.

RFMO compliance

The LL fleet that primarily targets southern bluefin tuna is the New Zealand fishery most shaped by RFMO requirements. As fisheries data are reported to the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) for scientific and compliance purposes, the RFMO's requirements effectively define the minimum data that the EM systems must capture: catch and effort by set, species composition, and detailed information on bycatch. The same vessels also operate under WCPFC CMMs for seabirds and highly migratory species. More broadly, the rollout of New Zealand's EM program has been framed as a means to meeting both domestic and international obligations.

Third-party vendor approach

New Zealand has adopted a hybrid vendor model for EM. For well-established e-logbook and VMS reporting technologies, the government has set minimum standards and approved multiple providers. For higher-level EM systems including cameras, MPI has opted for a centralized model with a single service provider, Spark Business Group, selected through a competitive tendering process.

Though MPI has not stated publicly why it opted for a single vendor model, this process enabled a relatively fast rollout while limiting delivery risk via a fixed price contract, which was particularly useful as budgets for fleet wide EM implementation had already been allocated (discussed in more detail below).

Hardware requirements

With a single technology provider, there is a single, standard EM system across New Zealand's fleets. The core unit comprises a fuse box, voltmeter, onboard EM server (called Yellowfin), isolated voltage converter, a power over ethernet unit (for cameras), digital video cameras, cellular (4G/LTE) antenna, and an 'active/standby' switch. In addition, a 10-inch onboard display allows vessel operators to check the status of the cameras and other hardware.

As the systems are proprietary, key technology specifications have not been made public, including recording resolution and frame rates of video cameras and the size of the hard drive.

In New Zealand, camera number and placement are determined based on the monitoring objectives and the footage required to meet them. At minimum, camera coverage must be sufficient to observe gear setting and hauling, as well as the use of any protected species mitigation equipment or procedures.

Figure 4: Inside New Zealand's Yellowfin EM units



Source: Spark Business Group

Figure 5: 10-inch onboard display connected to New Zealand EM units



Source: Spark Business Group

Data capture, transmission, and on-vessel storage

When switched to 'active' mode, the system captures footage continuously at both low and higher resolution (resolution details are not public) in 1-minute time segments. All footage captured is encrypted and stored securely on the vessel's onboard EM server. After setting the system's switch to 'standby', the cameras stop recording and the display monitor turns off.

Once back within land-based cellular network coverage, the system automatically initiates upload of all the low-resolution footage to the cloud. Even when the system is on 'standby', GPS functionality and data transfer will continue for a maximum of 5 hours while footage uploads to the cloud.

The cloud AI models then analyze each one-minute segment of footage to detect fishing activities. If such activities are detected, the system instructs the onboard EM server to upload the relevant higher resolution footage to the cloud. If the event is selected for review, approved MPI staff are then able to access and review the footage.

Once data is uploaded to the cloud, all previous footage on the vessel's hard drive is overwritten as new footage is collected.

New Zealand's regulations do not indicate a timeline between fishing events and data transmission to MPI. Their fleets also operate relatively close to the coast. As such, there is no public indication that satellite communications are being considered for the EM program.

Data review and centralized storage

Spark Business Group's role is limited to providing the hardware, data transmission, and cloud storage infrastructure. As both the telecom carrier and cloud integrator for New Zealand's EM system, Spark uses its own national cloud and data center infrastructure (located onshore in New Zealand) to host the backend of the EM program.

Once the footage is uploaded to MPI's secure servers, the Ministry's own analysts and compliance officers handle all review, interpretation, and enforcement actions. By September 2025, the onboard camera program had monitored more than 64,000 fishing events since 2023, with in-house video analysts reviewing roughly 31% of those events, or more than 20,000 in total. The footage selected for review is chosen through a combination of random sampling and targeted, risk-based criteria, including protected species risk, analysis of e-logbook and GPS data, and other relevant intelligence

Data access, ownership, and privacy

MPI retains full ownership and custodianship of all material generated under the EM program, including raw video footage, associated metadata, system logs, and analyst annotations. This ensures that EM data are treated as official compliance records held by the government.

Vessel operators may submit formal requests for access, typically limited to annotation summaries, derived data, or supervised on-site viewing, to verify their own fishing activity or resolve disputes. Raw footage is not routinely released, both to protect the privacy of crew and to maintain the integrity of ongoing compliance investigations.

Requests from the public are considered on a case-by-case basis but are frequently declined or heavily redacted where disclosure could compromise commercial sensitivity, individual privacy, or active enforcement work. In practice, all EM footage remains within MPI's secure systems, accessible only to authorized analysts, compliance officers, and technical staff under strict confidentiality and chain of custody protocols.

Costs and funding model

Prior to EM rollout, the government allocated NZD 68 million (USD 39 million) for program design and implementation, including onboard installation of EM systems (executed by a different third-party service provider) that were 100% paid for by public funds.

Ongoing costs for the program are estimated at NZD 8.7 million (USD 4.9 million) annually, of which NZD 4.8 million (USD 2.8 million) comprises the costs of onboard equipment and footage review. Other costs include data transfer, storage and analytics, fisheries compliance and management activities, and hardware-related costs.

For purposes of cross-country comparison, EM program costs have been assigned to one of three categories: Hardware, Implementation (which includes data transmission, storage, and review), and Administration (covering enforcement, system management, and other costs).

Figure 6: Annual operating costs of New Zealand's EM system

COST CATEGORY	DESCRIPTION	COST (NZD MILLION)	COST (USD MILLION)	ASSIGNED CATEGORY
Onboard equipment	Ongoing maintenance and replacement of onboard hardware (including depreciation)	2.48	1.40	Hardware
Submission of footage	Transfer of footage over the cellular network	0.36	0.20	Implementation
Storage of footage	Cloud storage / processing of footage	0.94	0.53	Implementation
Footage review	Human review of footage, creation of annotation data	2.36	1.33	Implementation
Compliance	Fishery Officers: activity associated with enquiries of suspected breaches identified	0.17	0.10	Administration
	Compliance Analysts: analysis required to determine whether a suspected breach requires investigation	0.60	0.34	Implementation
Fisheries & data management, science	Additional MPI resources needed to enable benefits of onboard cameras to be realized	0.46	0.26	Administration
Other	Includes contract management, call center, service support and continuous system improvement	1.30	0.73	Administration
Total		**8.67**	**4.90**	

While upfront costs were publicly funded, New Zealand is now implementing cost recovery, taking a stepwise approach. Over the three-year transition period ending September 2026, industry quota holders are assessed a special levy totaling NZD 8.5 million annually. Following the transition period, it has been proposed (subject to public consultation) that NZD 5 million (USD 2.85 million, covering onboard equipment, footage review, and fishery officers) be recovered annually via additional industry levies.

Of the proposed NZD 5 million levy, NZD 4.8 million (onboard equipment and footage review) is apportioned based on the quota share and species. The remaining NZD 0.2 million (for fishery officers) is via a general levy across all quota owners. For general levies, MPI spreads the cost across all quota owners according to the economic value of each fishery, measured through port-price data, i.e. higher-value fisheries pay a larger share of non-stock-specific costs.

The proposed cost sharing is informed by Transparency, Justifiability, Equity and Efficiency principles in MPI's Cost Recovery Policy Guidance, whereby only reasonable costs that are clearly linked to the service being provided can be recovered from industry.

MPI commissioned a financial analysis (published in 2022) to test the ability to pay for onboard cameras across New Zealand's inshore fleets. It segmented vessels by method, region and size band, profiled recent profitability, and then modeled the incidence of EM costs (installation, equipment/servicing, data transmission, and human review) at the vessel level and as a share of operating margins.

The analysis concluded that cost impacts are uneven: most medium/large vessels can absorb EM costs, but small vessels are at risk of material erosion of profitability. These results underpin the policy decision to stage the rollout, pair it with government funding of the initial expense, and then move to cost recovery.

NZ's approach shows the value of segment-level incidence testing before finalizing who pays. By modeling EM costs against actual margins by fleet cohort, they designed phasing, subsidies, and differentiated levies to avoid unintended exits from the fishery.

Admissibility of EM video evidence for prosecutions

In New Zealand, EM footage collected is treated as potential evidence within existing legal frameworks and there are no evidentiary rules specific to EM. Instead, admissibility depends on the same criteria applied to any surveillance or digital record, principally that it was lawfully obtained, relevant, and reliable. In practice, this means prosecutors must demonstrate an unbroken chain of custody, verifiable metadata integrity (time, location, and source), and tamper-proof storage from vessel to review.

Recent government papers emphasize that camera footage is handled as an official compliance record: it is encrypted at capture, uploaded through secure channels, and accessed only by authorized MPI analysts. This positions EM video on the same footing as other regulated monitoring tools such as geospatial tracking or observer logs rather than as a novel form of evidence requiring its own statute. Courts have so far accepted EM material under standard evidentiary principles, and there is no reported case in which EM footage was ruled inadmissible.

Australia

EM scope and timeline

The Australian Fisheries Management Authority (AFMA) first considered EM as early as 2005 in response to commercial fisheries interactions with Australian sea lions, an endangered species. After seven years of pilots and trials, EM was made mandatory in 2015 on commercial vessels in four fisheries, including LL vessels targeting tunas and billfish. EM is currently in use on around 75 Australian vessels.

AFMA describes EM as a tool for independently checking whether fishers' catch reports accurately reflect the volume and species caught, and for confirming reported interactions with threatened, endangered, and protected species.
RFMO compliance

Australia's pelagic LL fishery operates both in the Australian EEZ and in the adjacent high seas within the WCPFC convention area. Based on public documents, AFMA has calibrated both EM coverage and its data content to satisfy WCPFC monitoring and reporting requirements beyond treating EM as a purely domestic compliance issue.

Similarly, Australia's demersal LL fisheries operating in the high seas area of the South Pacific are under the jurisdiction of the South Pacific Regional Fisheries Management Organization (SPRFMO), a non-tuna RFMO. Reporting documentation here also notes the alignment of Australia's EM systems with RFMO requirements.

Public documents do not indicate that Australia's EM program was conceived solely to meet RFMO obligations, but they do show that in practice RFMO observer and data standards are used as

benchmarks for EM coverage rates and for the minimum information EM must be able to provide, and that AFMA itself presents EM as a key tool for delivering RFMO-compliant monitoring in its LL fleets.

Third-party vendor approach

The initial rollout of EM in Australia (referred to herein as "Phase 1") was conducted through a centralized process. AFMA contracted a single technology and service provider, Archipelago Asia Pacific (AAP), to install and maintain EM systems, review the resulting footage and metadata, and deliver compliance reports to AFMA for enforcement.

In 2020 AFMA initiated a strategic review of the program, and in 2022 announced a shift to a standards-based, multi-vendor model. That reform ("Phase 2") is now being operationalized through a request for tender (RFT) which establishes a type-approval and panel arrangement for the supply of EM equipment and associated support services. Under this model:

- → AFMA defines a national set of technical and fishery-specific standards
- → Vendors whose systems meet those standards are pre-qualified (type-approved)
- → Vessel operators will be free to procure EM systems from any approved provider

AFMA describes this as a "performance- or outcomes-focused" approach designed to support a single EM program adaptable across fisheries while accommodating future developments. Importantly, the RFT confirms a fundamental change in AFMA's delivery model for Phase 2. Under the multi-vendor system, AFMA will own and operate the national EM data repository and review platform, while vendors will be limited to hardware supply, installation, and maintenance.

Hardware requirements

While the detailed specifications of AAP's proprietary EM systems are not available in public documents, the RFT for Phase 2 makes the required system architecture explicit:

- → Control center capable of encrypting and storing all EM data on removable solid-state drives supplied by AFMA, maintaining system-health logs, and allowing remote diagnostics by the EM provider
- → Cameras: minimum full-HD (1080p / 30 fps) with weather-resistant IP66 housings; number and placement determined by fishery-specific requirements (typically 3-6 per vessel).
- → Sensors: hydraulic-pressure and drum-rotation sensors automatically triggering camera activation; continuous logging of gear use integrated with vessel ID, time, and position.
- → Geolocation device recording at least 5-minute intervals; positional accuracy within 100 meters.
- → Communications module capable of hourly transmission of geolocation, sensor, and health data via satellite or cellular network.
- → Encryption: All EM data must be encrypted using government-approved methods, ensuring that video and sensor records cannot be read or altered by anyone outside AFMA. Each vendor provides AFMA with a single, secure "master key" that allows the agency to unlock and process footage from every vessel using that vendor's system.

These standards make the system hardware agnostic and interoperable, allowing vendors to use commercial off the shelf components so long as they meet AFMA's performance benchmarks.

Data capture, transmission, and on-vessel storage

Under the Phase 1 EM system, camera recording is automatically triggered by gear sensors (hydraulic and drum rotation). The onboard control center associates each video segment with timestamped metadata (vessel ID, location, gear activity, and sensor logs) to assist with the review process.

Only low-bandwidth sensor data, including information on EM system health, vessel location, and fishing gear status, is transmitted back to the regulatory authority in real-time via satellite (or mobile network if available). Meanwhile, video footage with associated metadata is stored locally on a removable, encrypted hard drive. Vessel operators must return their drive (via post) to AFMA within 24 hours of the first landing of each month, or earlier if the drive reaches 80% capacity.

This hybrid system minimizes the amount of data transmitted over satellite, a particularly important aspect of a system launched in 2015. As Australia's vessels operate nearshore and regularly return to port, physical hard drive swapping is feasible. Based on the new RFT for Phase 2, data transmission and storage will evolve only incrementally. AFMA staff will decrypt and review EM data, still using physical hard drives, within secure facilities and with no third party permitted to store or process video data.

Data review and centralized storage

Beyond the provision of onboard EM systems, AAP was also contracted in Phase 1 to analyze the video footage and deliver reports (including logbook comparisons) to AFMA, which then uses the outputs for compliance and management. The approach to human review combines random selection and risk-based targeting, with elevated reviews for certain higher-risk operators or unusual catch patterns. The target audit rate for human review is 10%.

Under the new Phase 2 standards, AFMA will bring video analysis and review of EM footage fully in-house, drawing on a mix of its existing fisheries observers and newly designated EM analysts. This approach leverages the observers' operational expertise while expanding their roles into complementary analytical work and creating more diverse career pathways within AFMA. EM review will continue to focus on verifying compliance, detecting protected species interactions, and cross-checking logbooks.

The agency plans to centralize all EM footage from multiple vendor systems within a single review platform. The Phase 2 RFT's emphasis on open, non-proprietary data formats and detailed metadata requirements indicates AFMA's intent to leverage AI tools for review.

To accelerate this shift, AFMA is partnering with the Commonwealth Scientific and Industrial Research Organization (CSIRO) to strengthen its analytical capacity and integrate emerging technologies into the EM program. CSIRO provides technical support in areas such as automated image recognition, species identification, and data architecture design, helping AFMA to trial artificial intelligence and machine learning models on large EM datasets. The collaboration aims to streamline review, improve detection accuracy for protected species and compliance anomalies, and develop scalable digital tools that can be applied across multiple domestic fisheries. Over time, this partnership is expected to form the foundation for a fully integrated, AI-assisted EM review system managed within AFMA's own data infrastructure.

Data access, ownership, and privacy
Since the inception of the EM program, AFMA has retained full ownership and custody of all data collected, including raw video footage, sensor logs, metadata, and analytical outputs. Once retrieved from vessels, footage becomes an official record. Regulatory amendments in 2019 allow license holders to view their own EM footage for co-management purposes.

Access by external parties is tightly controlled. Data requests are assessed individually, but video and associated records are routinely withheld or redacted on grounds of privacy, commercial sensitivity, and potential interference with enforcement proceedings. In practice, all EM footage remains within AFMA's custody, accessible only to authorized agency analysts and compliance officers following established chain of custody and audit protocols.

Under the new EM framework, all data will be decrypted and stored solely within AFMA's secure servers. Vendors will have no access rights beyond equipment diagnostics.

Costs and funding model

During rollout, the initial hardware costs of Australia's EM systems were 100% publicly funded. These costs were not made available in public documentation.

Ongoing administrative and implementation costs transitioned to industry through cost recovery levies beginning in 2016. At that time, industry was also required to pay for their own EM hardware and maintenance. Annual operating costs have totaled AUD 1.5-1.8 million (USD 1.0-1.1 million) historically, of which industry contributes AUD 1.3-1.5 million per year. Individual industry contributions are proportional to their quota shares in each fishery, with levy rates updated annually.

Since cost recovery was initiated, industry has covered 100% of EM implementation costs (data transmission, review, storage/management) and 50% of EM administration costs.

In 2021, as AFMA moved toward a standards-based model, AUD 20.1 million was allocated over four years to build its data management and IT capacity. In 2025 an additional AUD 10 million investment was made to expand and enhance EM, integrating AI and machine learning.

Figure 7: Australia's ongoing EM program costs, including industry and public contributions

COST (IN AUD)	INDUSTRY CONTRIBUTION	GOVERNMENT CONTRIBUTION	TOTAL EM PROGRAM COST
2017-2018	1,488,974	217,338	**1,706,312**
2018-2019	1,363,722	170,379	**1,534,101**
2019-2020	1,365,655	171,637	**1,537,292**
2020-2021	1,444,382	280,703	**1,725,085**
2021-2022	1,391,044	424,329	**1,815,373**
2022-2023	1,379,935	104,654	**1,484,589**
2023-2024	1,261,266	215,123	**1,476,389**
2024-2025	1,354,755	219,474	**1,574,229**
2025-2026	1,356,114	232,300	**1,588,414**

Admissibility of EM video evidence for prosecutions

In Australia, EM footage is treated as potential evidence under existing legal frameworks, with no special rules created specifically for EM data. Admissibility therefore depends on the same foundational tests as for any digital or surveillance record, principally that the footage was lawfully obtained, relevant to the alleged offense, and reliably preserved. For prosecutions, this requires AFMA to demonstrate a clear chain of custody from vessel to review, secure handling of encrypted storage media, and integrity of the metadata linking video to time, location, and fishing activity.

AFMA's documentation and contractual framework emphasize that EM data are official state records managed in accordance with existing legislation and internal evidence handling protocols. This ensures that EM material is treated on the same footing as VMS data, observer logs, or physical inspection reports, rather than as a distinct class requiring bespoke legislation. To date, there are no reported cases in which EM footage has been ruled inadmissible in Australian courts. The system's strength derives from procedural safeguards (encryption, documented custody, and authenticated metadata) rather than any statute unique to EM.

United States

EM scope and timeline

The United States has regulated EM programs covering six disparate fisheries operating in federal and international waters, including Hawaii and Pacific Islands (Western Central Pacific) pelagic LL, Alaska (North Pacific) groundfish fixed-gear and trawl, West Coast (Pacific) groundfish trawl, Northeast (New England) groundfish, and Atlantic highly migratory species pelagic LL. In each of these fisheries, EM is authorized as an alternative to human observers but is not necessarily mandated. Most relevant to the Taiwanese context is the Western Central Pacific pelagic LL fishery, which is the primary focus here due to its intersection with RFMO requirements. Lessons and examples from other US fisheries are considered as well.

US Western Central Pacific LL vessels operate out of the state of Hawaii (150 vessels) and the territory of American Samoa (10 vessels). Development of EM in the fishery started in 2009, with approximately 20 Hawaii LL vessels voluntarily participating in EM research and development projects. Electronic catch reporting was made mandatory in this fishery starting in 2021.

In June 2025, the Western Pacific Council, the regional policy-setting body working alongside the National Marine Fisheries Service (NMFS), part of the National Oceanic and Atmospheric Administration (NOAA), approved mandatory EM for these vessels, initiating a phased rollout for the full 160-vessel LL fleet in 2025-2027.

Figure 8: Proposed EM implementation timeline for US Western Central Pacific LL

2025	→ Begin outreach to the Hawaii LL fleet (April) informing vessel owners and operators on the use of EM and transition from observers to EM → Begin deployment of the first 50 EM systems (late 2025) → Establish the database and data management infrastructure.
2026	→ Begin EM data review → Deploy another 50 EM systems → Initiate engagement with the American Samoa LL fleet
2027	→ Continue EM data review → Deploy another 50 EM systems, including in the American Samoa LL fleet

Compliance with the Endangered Species Act and Marine Mammal Protection Act are among the US Western Central Pacific LL EM program's primary objectives, as well as alignment with RFMO requirements, particularly WCPFC and IATTC. In this fishery, justification for the transition from human observers to EM is clear: "Given the decline in the use of human observers to date and anticipated in the future due to increasing costs of the program and decreasing funding, there is a need to incorporate EM into a more efficient program to address monitoring needs of LL fisheries in the Western Pacific."[3]

RFMO compliance

Hawaii's pelagic LL fisheries operate in the US EEZ and on the high seas within the WCPFC and IATTC convention areas. NOAA's region-specific EM implementation plans present EM as one component of a mixed monitoring strategy that helps the US continue to meet RFMO catch and bycatch reporting obligations while managing costs and logistical constraints on observers.

In the Atlantic, EM on pelagic LL vessels has been developed in the context of ICCAT conservation and monitoring requirements, particularly for bluefin tuna. NOAA documents describe EM as part of a broader package of electronic technologies used to independently verify logbook and VMS data, monitor catch and discards, and support compliance with RFMO-related quota and catch documentation obligations. The same EM systems are also used to monitor shark catch and bycatch, in line with domestic regulations that implement ICCAT decisions.

Third-party vendor approach

The US follows a standards-based, multi-vendor EM model. NMFS defines the performance and data standards, certifies providers that can meet them, and retains full control of the resulting monitoring data for compliance and scientific purposes.

NMFS maintains public lists of approved EM vendors across Alaska fixed-gear, West Coast groundfish, and Northeast groundfish. For Western

3 Western Pacific Regional Fishery Management Council. 2025. Council Action: Draft Electronic Monitoring Implementation. Prepared for the 203rd Council Meeting, June 2025. Version 05.27.25.

Central Pacific LL, NMFS has not yet published an approved provider list while rulemaking proceeds.

Each US fishery (except Western Central Pacific LL) also has an Electronic Monitoring Program Manual laying out the specific requirements for both vessels and service providers. For example, in the West Coast groundfish fishery, the EM provider must:

- → Install and certify a vessel's onboard EM system
- → Provide information for the vessel owner/operator to complete the vessel monitoring plan (including hardware and software specifications)
- → Provide technical (remote and field) services for the EM system and EM data
- → Provide hard drives (or other approved media) for transferring data from the vessel to the EM service provider
- → Receive and store raw EM data recorded by the EM system
- → Receive and store vessel logbook data submitted by the vessel captain
- → Review raw EM data and create annotations
- → Submit EM summary data to NMFS for at-sea discards
- → Give feedback to the vessel operator post-review
- → Submit to an NMFS secondary review as requested.

Hardware requirements

The Western Central Pacific LL EM program will most likely follow NMFS' outcome-based approach rather than prescriptive hardware rules. Draft operational standards require video quality sufficient to identify species, estimate size, and determine catch disposition, without specifying fixed resolution or frame rates. Recording in other NMFS EM programs is sensor triggered during gear deployment and retrieval, with buffer periods before and after activity.

Data capture, transmission, and on-vessel storage

Under the West Coast Groundfish Electronic Monitoring Program Manual (2023):

- → Video must be of sufficient quality and resolution to allow NMFS reviewers to identify species, estimate catch, and verify compliance with retention/discard rules.
- → Providers must maintain minimum pixel clarity and field of view adequate for clear viewing under normal lighting and weather conditions.
- → Systems must record continuous video of all fishing and catch handling activity, and data must be timestamped and georeferenced.

Drives are mailed to the selected service provider after each trip.

Data review and centralized storage

In US EM programs, initial review is undertaken by the service provider, with summary and derivative data provided to NMFS for catch, at-sea discards, and non-compliance. In each of the six US EM programs, data must be retained by vendors for a minimum of 12 months after catch data are finalized for the fishing year. Cloud storage is allowed for EM providers but not required. EM data received by NMFS are federal records and must be stored for 3-7 years based on government rules.

Data access, ownership, and privacy

NMFS considers information collected by an EM system as confidential from the point of collection, regardless of whether it is in NMFS or an EM service provider's possession. EM service

providers are expected to maintain safeguards that keep vessel EM data confidential while the data are under their control. The data is technically considered to be under NMFS ownership, with EM providers as data custodians.

The public may request records created or obtained by NMFS and under its control at the time of the request. NMFS may release information in aggregate and may release still imagery (not video) provided there are no identifiable features that violate confidentiality provisions. EM data held by an EM service provider is not subject to freedom of information rules.

Costs and funding model

NMFS policy directives identify two broad cost categories:

1. Administrative costs, which include program administration and support (e.g. setting program standards), certification of EM providers, monitoring program performance, and data analysis and the storage of federal records
2. Sampling costs, which include EM equipment purchases and installation, equipment servicing and maintenance, vessel monitoring plan development, trainings for industry, data transmittal, video review and storage, and service provider fees and overhead.

The policy directive recommends that administrative costs are categorized as NMFS responsibility, whereas sampling costs are categorized as the responsibility of the fishing industry. However, the policy directive also states that when NOAA Fisheries determines EM is needed to meet legal obligations, such as Endangered Species Act requirements, and sufficient appropriated funds are available, NMFS may choose as a policy matter to pay the sampling costs of those programs.

For the Western Central Pacific LL fishery, under a model sampling rate of 25% of LL sets reviewed, annual sampling costs are estimated at USD 1.93 million (including EM hardware) and administrative costs estimated at USD 519,000 per year, or a total of USD 2.5 million per year.

Depending on the availability of public financing, three cost sharing alternatives are under consideration for EM rollout:

Alternative A: NMFS would cover all program costs, both administrative and sampling, on the rationale that EM's primary purpose is monitoring protected species interactions.

Alternative B: NMFS would fund administration and most sampling, while industry covers future camera/system replacement costs, estimated at USD 10,000 per system over an assumed three-year life, totaling USD 0.53 million annually across 160 vessels (USD 3,300 per vessel annually).

Alternative C: To illustrate a maximum industry burden scenario, the draft presents industry paying 100% of sampling costs (USD 1.93 million/year, or USD 12,000 per vessel), with NMFS continuing to fund administration (USD 0.52 million/year) under its cost allocation policy.

Under alternative C, individual vessel owners would be responsible for contracting with an NMFS-approved EM service provider and paying them directly for hardware replacement, data handling, and video review. This mirrors how other US EM programs work.

Figure 9: Impact estimates on Western Central Pacific LL fishery economic performance

	ALTERNATIVE A	ALTERNATIVE B	ALTERNATIVE C
Industry pays for:	n/a	EM system replacement	Sampling costs, EM system replacement
Annual average cost per vessel (USD)	0	3,300	12,000
Average vessel profit and % reduction of profit margin	44,000	40,100 (-7.6%)	32,000 (-27.4%)

Under alternatives A and B, vessels would still select an approved provider and develop a vessel monitoring plan with them. Under alternative A, NMFS would pay program sampling costs, while under B, industry covers replacement hardware and NMFS continues paying the rest of sampling.

Based on the latest public information, NMFS has secured funding to install EM systems and cover administrative and sampling costs through 2027, but has not committed to funding the program beyond that period.

Admissibility of EM video evidence for prosecutions

In the US, EM footage is treated under the same framework as any other form of digital or documentary evidence collected for fisheries enforcement. Admissibility in court is governed by federal rules, particularly the requirements that evidence be relevant, authentic, and not misleading. In practice, that means prosecutors must show the video was lawfully obtained, accurately depicts the events in question, and was maintained under a reliable chain of custody from the vessel to NMFS.

NOAA's enforcement procedures and regional EM program manuals require that all EM data be encrypted at capture, transferred under documented protocols, and stored on secure servers managed either by NMFS or an approved service provider acting on NMFS's behalf. This ensures metadata integrity, i.e. time, location, vessel ID, and sensor linkage can all be verified during investigation or litigation.

In administrative enforcement, EM video is routinely accepted as primary evidence, provided authenticity and chain of custody are documented. In federal criminal prosecutions, EM footage is admissible on the same basis as body camera or surveillance video and no case to date has excluded it on technical grounds.



Scotland

EM scope and timeline

In Scotland, EM was mandated for pelagic and scallop dredge fisheries fleets in 2024. For the scallop fleet, comprising around 70-80 vessels, the new EM obligations began in June 2024. For the large pelagic fleet (greater than 12 meters in length) of 20 vessels targeting mackerel, herring, and blue whiting, EM requirements came into force in March 2026.

These mandates build on more than a decade of Scottish experience using EM in its demersal trawl fisheries, where systems have been installed on a rotating group of vessels under the "Cod Conservation Credits" and related schemes since 2008. In those programs, EM was used on selected vessels for discard estimation, activity mapping, and gear selectivity studies, providing practical experience with the technologies and data that informed the later decision to expand the EM mandate.

RFMO compliance

Scotland's EM rollout has been framed primarily in terms of domestic management goals rather than as a direct response to any single RFMO obligation. At the same time, Scotland's pelagic fleets target shared stocks that are jointly managed with other coastal states (UK, Norway, EU, Faroe Islands, etc.) and are subject to international control measures. In that sense, EM is consistent with emerging international expectations for transparent, fully documented pelagic fisheries, but public Scottish documents present it as a domestic policy choice that also supports those shared-stock arrangements.

Third-party vendor approach

Like the US, Scotland has taken a standards-based, multi-vendor approach in which the government sets technical and data requirements and vessel owners are free to contract with any EM supplier that can meet those specifications.

Data governance documents clarify the respective roles of vessel owners, vendors and government.

Vessel owners must:

- → Install an EM system that meets the technical specifications (cameras, GPS, winch sensors, control box)
- → Keep it fully functional on all relevant trips
- → Ensure personal details (identity/contact/vessel data) submitted to government are accurate and kept up to date

Vendors will:

- → Supply and install the EM hardware and software
- → Operate or host the data storage system that receives automatic uploads of GPS, winch-sensor and video data
- → Collect, process, and store EM data on behalf of the vessel owner

Hardware requirements, including data capture

For both scallop and pelagic vessels, Scotland defines specific hardware requirements in technical specification documents issued under the 2024 EM regulations. In both cases, an EM system must include:

- → Control/storage box capable of housing the software and storing video from digital cameras, winch sensor data, and vessel position data
- → Winch sensors connected to the gear handling winches and activated whenever those winches are operated
- → GPS device that records vessel identity, position, speed, course and fix accuracy at least once every 10 seconds, with a maximum position error of 10 meters.

On scallop vessels, the EM system must include at least one digital camera whose field of view captures fishing and related operations, including gear setting and hauling, with each camera required to record at a minimum of 5 fps and produce video of at least 2 megapixels per frame (i.e. 1920p × 1080p). Cameras must have infrared capability that is automatically enabled for low light conditions and must meet at least an IP66 rating.

For pelagic vessels, the specifications are more demanding. Each camera must automatically begin recording when a winch sensor is first activated on the trip and must be capable of recording at a minimum of 30 fps, again at a minimum of 2 megapixels per frame, with automatic infrared capability and at least an IP66 rating. Cameras must be placed in a series of defined locations so that all fishing activity, including deployment and retrieval of gear, discards, etc. is captured.

Data transmission and on-vessel storage

Government officials must be able to access, extract and review EM video and metadata at any time without cost and all EM systems must support real-time, in-person viewing onboard by a fisheries officer and allow data to be extracted on demand.

For scallop vessels, EM systems must automatically transmit gear sensor and GPS metadata to the vendor's data storage system whenever the vessel has access to an available transmission method. Video footage must be transmitted automatically or after government officials remotely select clips and the vessel next comes within range of a transmission means.

For pelagic vessels, metadata must be automatically transmitted to the vendor's data storage system at least once every 24 hours, in a secure, tamper evident way. For video, the vessel owner can choose off-vessel storage, in which case video must be automatically uploaded within five working days of arrival in port, or onboard storage, whereby video is stored in the control box but must be automatically transmitted to the manufacturer's storage system within five working days of a government request.

Regardless of storage location, EM data and metadata must be available to government authorities for one year following any fishing event.

Data review and centralized storage

Scottish policy documents specify that EM data are reviewed by government alone, not vendors, and that review effort is allocated on a risk basis rather than by a fixed sampling percentage. The proportion of footage reviewed depends on compliance priorities and available staff resources, with machine learning tools mentioned as a possible way to increase future review rates. Examples of EM data review include using spatial data and imagery to validate that gear deployment is within statutory limits or that vessels are not fishing inside of MPAs.

As for data storage and access, vessel owners choose and pay for the storage solution and must ensure that government officials have full access. When EM data are pulled for enforcement or science, they are held on secure government servers with restricted staff access.

Data access, ownership, and privacy

Scottish EM has clear roles for vessel owners, government, and vendors. The vessel owner and the government jointly determine the purposes and means of processing EM data, while the third-party EM provider is a processor acting on behalf of the vessel owner. The vessel owner, with the EM supplier acting as processor, is responsible for gathering, processing, and storing EM data in a vendor hosted system, and data is then shared with the government as required. Within government, access is limited to trained staff with a business need, predominantly in compliance and science roles.

Location and camera feeds are considered as personal data because they can reveal where a named vessel is at a given time, and because crew may occasionally appear in footage. It emphasizes that camera images of individuals are incidental and are not used to identify crew. Any data extracted by the government from the vendor's system are stored on secure in-house systems and kept only as long as they remain valid and the vessel is licensed, or, in the case of footage used in investigations, until the conclusion of enforcement or scientific work.

Costs and funding model

Scottish government documents present EM as a shared cost system in which vessel owners pay for hardware installation and ongoing service, while the government funds its own review and enforcement capacity.

On the public side, a Business and Regulatory Impact Assessment estimates that expanding EM will require some additional government spending on data processing, analysis, storage, and enforcement but treats those staff and IT costs as part of the government's normal compliance and monitoring budget. Remarkably, the assessment expects additional costs to be minimal as enforcement staff will be reassigned to EM review. As of 2023, estimated incremental costs for the public sector included specialist analysis software and server storage at GBP 4,000-30,000 (USD 5,300-40,000) per year and additional staff to review EM data for scientific purposes (especially bycatch and ETP species) estimated at GBP 40,000 (USD 53,000) per year.

For vessel owners, the estimated costs reflect the different requirements for scallop and pelagic vessels and are summarized below:

Figure 10: Estimated EM costs for Scottish vessel owners

FIGURES IN GBP	SCALLOP VESSELS	PELAGIC VESSELS
Hardware cost (5-year expected life)	2,380-6,180	6,590-13,070
Installation	520-1,650	1,940-4,360
Installation - data transfer	n/a	0-2,470
Annual software license	310-420	310-420
Annual data transfer	50-90	700-2,000
Annual data storage	n/a	510-5,310
Annual maintenance (excl labor)	0-310	1,210-3,270
Total: Year 1 and Replacement Years	**3,250-8,320**	**10,050-27,630**
Total: Year 2 Onward	**360-810**	**2,730-11,000**

Data transfer costs, including installation, for pelagic vessels are assumed to be for satellite transmission (Starlink). This is not a requirement, simply an expectation based on the nature of the fishery as the opportunity cost of staying at port to upload data might be greater than the cost of a (one month) satellite data package.

Admissibility of EM video evidence for prosecutions

The EM regulations themselves are anchored in the existing UK fisheries enforcement framework, which already contains rules on evidence in fisheries prosecutions. The Sea Fish (Conservation) Act 1967 provisions on “proceedings for offenses relating to licenses, evidence” and related penalty clauses are expressly applied to EM offenses by the 2024 Scottish EM regulations. That cross-reference means that prosecutions arising from EM rely on the same evidence rules that apply to other fisheries offenses, with EM recordings treated as one form of digital evidence alongside VMS, logbooks, and officer testimony. Legal and academic analyses of Scottish fisheries enforcement note that the government already uses modern technologies, including EM and VMS, to detect potential offenses and that these tools are expected to play an increasing role in building cases, subject to general criminal evidence standards of authenticity and reliability.

Third-Party Vendors: Summary and Lessons Learned Internationally

New Zealand

New Zealand has opted for a centralized single-provider, turnkey contract: the government fully funded the initiative, delivering a closed, automated camera stack across 300 priority vessels. This choice allowed New Zealand to move fast, standardize installs/training, and stand up the data pipeline while the program is still in early implementation.

Australia

In Australia, EM systems were initially implemented via a centralized model, in which a single vendor was contracted to supply, install, maintain, and review EM systems across roughly 75 vessels in key domestic fisheries. This approach (2015-2020) enabled AFMA to roll out standardized systems quickly and at scale while outsourcing most of the technical and analytical burden to the private sector.

Starting in 2022, AFMA began investing in its internal capacity and initiated a transition toward a standards-based, multi-vendor framework designed to end vendor lock-in and create a more flexible, scalable EM system.

Only pre-qualified vendors may install or service EM systems in these fisheries. This creates a controlled vendor pool that guarantees interoperability and security but still allows competition among multiple approved suppliers. This approach ensures strong data governance and consistency while avoiding long-term vendor lock-in. It also positions AFMA to progressively automate review through AI-assisted analytics. However, it requires substantial government capacity for data processing and compliance oversight.

United States

The US follows a more decentralized and regulatory model. NMFS defines national and regional performance-based standards, specifying what must be captured, metadata requirements, delivery timelines, and data security protocols. However, it does not maintain a vendor panel or enter commercial contracts like its Australian counterpart.

Private companies can apply for NMFS provider approval, and once certified, may sell or lease EM systems directly to vessel owners. Operators are free to choose any approved vendor so long as their system meets NMFS standards and the data produced are compatible with the agency's review infrastructure. Oversight is exercised through program specific permitting, audits, and data submission requirements, not through a central procurement mechanism.

This creates a market-driven, outcome-based system: competition drives innovation and cost efficiency, while NMFS focuses on compliance and data integrity. Review and data storage may be handled by NMFS itself or by independent third-party analysts under agency supervision.

Scotland

Scotland has adopted an open-standards, vendor-neutral model. The government sets detailed legal and technical specifications for EM systems covering cameras, GPS, gear sensors, control units, data formats, retention and access, but does not restrict which companies may supply equipment, provided their systems meet those

specifications. Vessel owners are responsible for procuring and installing compliant EM packages and for contracting with third-party providers. Those providers act primarily as data processors and storage/transfer hosts: they install and service hardware, run the off-vessel data storage platforms, and ensure that the government can securely access and extract EM data when required.

Vendors are limited to the technical role of implementing and operating EM systems that conform to specifications while review and enforcement remain with the government. This approach gives Scotland a relatively open vendor ecosystem and avoids long-term lock-in, while ensuring that data standards, access rights, and enforcement decisions stay firmly under government control.

Cross-country comparisons

The examples above show there is a continuum between centralized and standards-based models rather than a binary choice. New Zealand represents the most centralized approach, with a single contracted vendor responsible for supplying, installing, and maintaining EM systems across the fleet under a national concession. Australia occupies a middle position through its type-approved panel model: the government defines detailed technical specifications and centrally procures services from a pre-qualified vendor panel, maintaining control over data standards while allowing limited competition and potential vendor diversification. The US and Scotland, by contrast, follow a fully standards-based model in which the government sets performance and data requirements but authorizes vessel operators to contract directly with any approved provider, fostering competition, innovation, and adaptability. The key difference between the US and Scotland is that the latter executes all data review in-house.

Figure 11: Cross-country comparison of EM vendor approaches and cost sharing

COUNTRY	PROGRAM DESIGN	INITIAL HARDWARE INSTALLATION	HARDWARE REPLACEMENT & MAINTENANCE	IMPLEMENTATION / DATA REVIEW	ADMINISTRATION
New Zealand	Public	Single-provider concession model	Single-provider concession model	Single-provider concession model	Public
Australia Phase 1	Public	Single-provider concession model	Single-provider concession model	Single-provider concession model	Public
Australia Phase 2	Public	n/a	Centralized, type-approved panel model	Public	Public
US Western Central Pacific LL: Scenario A	Public	Open standards, publicly funded	Open standards, publicly funded	Open standards, publicly funded	Public
US Western Central Pacific LL: Scenario B	Public	Open standards, publicly funded	Open standards, privately funded	Open standards, publicly funded	Public
US Western Central Pacific LL: Scenario C	Public	Open standards, publicly funded	Open standards, privately funded	Open standards, privately funded	Public
Scotland	Public	Open standards with specific technology requirements, privately funded	Open standards, privately funded	Data storage: open standards, private funding and execution Data review: public funding and execution	Public

The approaches taken by Australia, the US, and Scotland are quite similar but have some important differences. In effect, Australia's model is a government-curated vendor marketplace, while the US and Scotland are regulated open markets. The Australia and US approaches maintain outcome-based standards, but Australia couples those standards with a contracting framework and internalized data review. By contrast, Scotland has laid out very specific technology requirements while keeping data review in-house.

Figure 12: Comparison of EM multi-vendor approaches in Australia, US, and Scotland

FEATURE	AUSTRALIA	UNITED STATES	SCOTLAND
Legal instrument	Government-run type-approval and commercial panel	Regulatory certification, no central contracting	Regulatory certification, no central contracting
Procurement model	Centralized panel: only pre-qualified vendors may supply	Decentralized: any approved provider can operate	Decentralized: any approved provider can operate
Data management	All data decrypted and reviewed by government in-house	Review may be done by vendors or third-party analysts	All data decrypted and reviewed by government in-house
Market structure	Controlled vendor pool with set pricing and KPIs	Open competitive market driven by vessel demand	Open competitive market driven by vessel demand
Policy emphasis	Government control, data security, interoperability	Innovation, flexibility, and cost competition	All the above

For Taiwan, whose LL fleet is diverse and dispersed, these distinctions are critical: a pre-qualification system ensures security and uniformity, while an US- or Scotland-style open market maximizes flexibility and private-sector innovation with the option to maintain review capacity internally or externally. An optimal approach may combine elements of all the above based on local needs, priorities, and capacity.

Funding Models: Summary and Lessons Learned Internationally

New Zealand

In New Zealand, 100% of upfront costs (NZD 68 million / USD 39 million) to set up its EM systems were shouldered by the state. This included all hardware and vessel installation costs, data transmission, review, and storage. In 2024-26, the government executed a transitional cost recovery program in which 98% of total operational costs (including hardware depreciation, NZD 8.7 million / USD 4.9 million) is covered by industry via an annual vessel levy. A long-term cost recovery framework has been developed to follow that transitional period. Cost recovery is proposed to shift to industry covering 100% of costs (NZD 5 million / USD 2.85 million), associated with maintenance and replacement of EM hardware, footage review, and fishery officers, while the government will cover costs associated with submission and storage of footage, compliance analysts, fisheries management/science, and other execution costs.

Australia

In Australia, 100% of hardware costs to set up its EM systems were covered by the state, while a cost recovery model for EM implementation and administrative costs was introduced the following year. On average, industry contributes AUD 1.4 million (USD 0.9 million, covering 100% of EM implementation and 50% of EM administration) in levies, covering the costs of hardware and associated maintenance. Individual industry contributions are proportional to their quota shares in each fishery, with levy rates updated annually. The government contributes on average AUD 200,000 (USD 130,000, 50% of EM administration).

In 2021, as AFMA moved toward a standards-based model, AUD 20.1 million was allocated over four years to build its data management and IT capacity. In 2025, an additional AUD 10 million investment was made to expand and enhance EM, integrating AI and machine learning.

United States

In the US Western Central Pacific LL fishery, annual sampling costs (including EM equipment purchases and installation, equipment servicing and maintenance, vessel monitoring plan development, trainings for industry, data transmission, video review and storage, and service provider fees and overheads) are estimated at USD 1.93 million annually. Administrative costs (program administration and support, certification of EM providers, monitoring program performance, and data analysis and storage) are estimated at USD 519,000 per year. While EM funding has been secured through 2027, depending on the availability of public financing thereafter, three cost sharing alternatives are under consideration for EM rollout:

- → **Alternative A**: NMFS would cover all program costs, both administrative and sampling, on the rationale that EM's primary purpose is monitoring protected species interactions.
- → **Alternative B**: NMFS would fund administration and most sampling, while industry covers future camera/system replacement costs, estimated at USD 10,000 per system over a three-year life, totaling USD 0.5 million annually across 160 vessels (USD 3,200 per vessel annually).
- → **Alternative C**: In a maximum industry burden scenario, industry would pay 100% of sampling costs (estimated at USD 1.9 million/year, or USD 12,000 per vessel), with NMFS continuing to fund administration (USD 0.5 million/year) under its cost allocation policy.

Scotland

Compared to the other countries surveyed here, the cost sharing mechanism for Scotland's EM is very simple. Vessel owners pay for 100% of hardware installation and maintenance, plus all ongoing services including data storage and transfer (using a multi-vendor model). Meanwhile, the government funds 100% of its own data review and enforcement capacity. These activities are funded out of the Scottish government's core fisheries compliance budget, and there is no EM-specific levy or license surcharge described in the public documents.

Cross-country comparisons

Figure 13: Comparative analysis of EM funding models, program categories

COUNTRY	PROGRAM DESIGN	INITIAL HARDWARE INSTALLATION	HARDWARE REPLACEMENT & MAINTENANCE	OPERATING COSTS, IMPLEMENTATION / SAMPLING	OPERATING COSTS, ADMINISTRATION
New Zealand	Publicly funded	Publicly funded, mostly recouped by levies	100% recouped by levies	100% recouped by levies	Publicly funded
Australia Phase 1	Not disclosed	Publicly funded	100% recouped by levies	100% recouped by levies	50/50 public and industry
Australia Phase 2	Publicly funded	n/a	Private sector	To be determined	To be determined
US Western Central Pacific LL: Scenario A	Not disclosed	Publicly funded	Publicly funded	Publicly funded	Publicly funded
US Western Central Pacific LL: Scenario B	Not disclosed	Publicly funded	Private sector	Publicly funded	Publicly funded
US Western Central Pacific LL: Scenario C	Not disclosed	Publicly funded	Private sector	Private sector	Publicly funded
Scotland	Publicly funded	Private sector	Private sector	Private sector: responsible for data transfer and storage; Data review is publicly funded	Publicly funded

Figure 14: Comparative analysis of EM funding models, government vs industry contributions

COUNTRY	GOVERNMENT CONTRIBUTION	INDUSTRY CONTRIBUTION	INDUSTRY CONTRIBUTION MECHANISM
New Zealand	Upfront: 100% of all costs 3-year transition: 2% of annual operating costs Long-term (proposed): 100% of data submission and storage, compliance analysts, fisheries management/ science, and other execution costs	3-year transition: 98% of annual operating costs, including hardware depreciation Long-term (proposed): 100% of EM hardware/maintenance, footage review, and fishery officers	Stock specific levy (96%): based on quota amount and species-specific EM effort General levy (4%): higher-value fisheries pay a larger share of non-stock-specific costs
Australia	Upfront: 100% of hardware costs Ongoing: 50% of annual EM operating costs Ongoing: enhancements to EM management capacity, including integrating AI	100% of EM vessel hardware/ maintenance 100% of EM implementation costs 50% of EM administration costs	Levies based pro rata to the quantity of access rights held and species-specific EM effort
US Western Central Pacific LL: Scenario A	100% cost coverage, including hardware, sampling, and administrative costs	None	n/a; Industry selects their hardware and review provider
US Western Central Pacific LL: Scenario B	Upfront: 100% of hardware costs Ongoing: 100% of administrative costs All sampling costs excluding hardware	Replacement hardware costs	Industry selects their hardware and review provider and pays for hardware
US Western Central Pacific LL: Scenario C	Upfront: 100% of hardware costs Ongoing: 100% of administrative costs	Replacement hardware costs All other sampling costs	Industry selects and pays their hardware and review provider
Scotland	100% of administrative costs, footage review, and fishery officers	100% of EM vessel hardware/ maintenance, data transmission and storage	Industry selects and pays their hardware and data transmission/ storage provider

Costs: Comparative Analysis and Implications for Taiwan

A cost comparison across these four countries shows clear similarities with some key differences, with gaps in what is available publicly.

Across New Zealand, Australia, and the US, ongoing annual implementation and administration costs per vessel are USD 8,000-10,000 and USD 3,200-3,700, respectively, with total operating costs per vessel ranging from USD 11,700-13,700 annually.

While the above figures are quite similar, it was not possible to assess differences in public sector capacity building costs. As the NMFS has already implemented EM in three other US fisheries, it presumably has already built internal capacity to manage multiple EM vendors and the associated backend systems. Similarly, Scotland does not publish specific administrative and enforcement costs associated with EM, though it reportedly has reassigned enforcement personnel to EM review.

Though Australia's onboard systems costs were not publicly available, annual hardware costs were found to range from USD 3,300-4,700 per vessel across New Zealand, the US, and Scotland (pelagic vessels).

Figure 15: EM cross-country cost comparison I (figures in USD)

COUNTRY	INITIAL ALL-IN COSTS	REGULATOR CAPACITY BUILDING COSTS	VESSELS COVERED	ANNUAL HARDWARE COST	ANNUAL HARDWARE COST PER VESSEL
New Zealand	39 million	n/a	Up to 300	1.4 million	4,700
Australia	n/a	19.6 million	75	n/a	n/a
US Western Central Pacific LL	n/a	n/a	160	0.53 million	3,300[4]
Scotland - pelagic	n/a	n/a	20	0.19 million	3,500[5]
Scotland - scallop	n/a	n/a	80	0.11 million	1,400

4 Assumes a 3-year life.
5 Assumes a 5-year life and includes installation costs.

Figure 16: EM cross-country cost comparison II (figures in USD)

COUNTRY	ANNUAL OPEX: IMPLEMENTATION EXCL HARDWARE	ANNUAL OPEX: ADMIN	ANNUAL IMPLEMENTATION COST PER VESSEL	ANNUAL ADMIN COST PER VESSEL	TOTAL OPEX PER VESSEL EXCL HARDWARE
New Zealand	2.4 million	1.1 million	8,000	3,700	11,700
Australia	0.75 million	0.28 million	10,000	3,700	13,700
US	1.4 million	0.52 million	8,750	3,200	11,950
Scotland	n/a	n/a	n/a	n/a	n/a

Though the data are incomplete, these figures imply all-in costs of scaled EM systems in the range of USD 15,000-18,400 per vessel. Extrapolated to the Taiwanese context, this implies a total cost of USD 13.5-16.6 million per year assuming a 900-vessel LL fleet. These figures exclude satellite transmission costs, which are discussed later in the report.

EM Rollout in the European Union

The EU is in the middle of building what will likely become the largest regulated EM framework in the world, but it has not yet been implemented at scale in the way Australia, New Zealand, the US, or Scotland are today. The revised EU Fisheries Control Regulation is designed to improve the credibility of catch reporting and reduce illegal discarding by targeting the fleet segments where the risk of non-compliance is highest.

The implementation timeline is deliberately long and staged. The revised Control Regulation entered into force in early 2024, but the core EM requirement does not apply until 2028. This multi-year runway reflects how much needs to be designed, negotiated, and operationalized before a technology mandate becomes real at fleet level. For Taiwan stakeholders, the key point is that even in a highly capable regulatory environment with substantial institutional infrastructure, the EU is treating EM as a multi-year transition rather than something that can be rolled out quickly by decree.

At the legal level, the EU has already made several consequential decisions. The risk-based framework potentially covers vessels above 18 meters only and is highly prescriptive about privacy constraints. EM should focus on areas where fishing activity, handling, and discarding can occur, and implementation should avoid identifying individuals to the extent possible. This privacy orientation may shape technical requirements, data workflows, and even vendor offerings in ways that differ from some non-EU EM programs.

In 2025, the European Fisheries Control Agency (EFCA) issued EM guidelines that describe minimum technical expectations and practical considerations for compliant systems, including system integrity, security, auditability, and privacy. These guidelines help translate the regulation's intent into implementable design principles such as secure recording and transfer, tamper resistance, reliable time and position metadata, controlled camera placement, and governance

around configuration changes. They also anticipate pragmatic data handling approaches that limit bandwidth and storage burdens, for example by transmitting smaller activity data routinely while transferring large volumes of video only when requested by the authorities.

What remains unresolved, and will largely determine the cost and effectiveness of the rollout, is the long list of implementation decisions that still need to be finalized. The single most important open question is how “high risk” will be defined in practice and which fleet segments will be brought into scope, since that will determine the size of the required rollout. Beyond that, EU member states must decide what vendor engagement models to adopt (central procurement versus multi-vendor certification, who installs and maintains systems, who holds and secures data), what review model will be used (authority-led, vendor-led, or hybrid), what sampling and audit rates will apply, how long footage must be retained and where, what triggers a request for video, and what service levels apply for retrieval, investigation, and evidentiary use. Even with guidance on minimum technical characteristics, these operational choices are central to determining cost and efficacy.

The broader lesson for Taiwan is that the EU’s approach implicitly acknowledges that EM is as much an institutional build as it is a technology deployment. A legally binding mandate is only the beginning. The hard work is translating that mandate into detailed rules, contracts, workflows, quality assurance systems, privacy protections, and enforcement protocols that can operate day to day across a large fleet of up to 4,000 vessels. The EU’s timeline is therefore a useful benchmark signaling that credible REM at scale typically requires several years of regulatory and operational preparation even before the first installations are mandatory.

04 POLICY CONSIDERATIONS FOR EM IMPLEMENTATION IN TAIWAN

Effective implementation of EM in Taiwan will not be achieved through a single technical decision or regulatory amendment. It is a system change that touches multiple policy domains at once: fisheries management and RFMO compliance, data governance and privacy, vendor oversight and public procurement, and the commercial realities of a diverse, globally dispersed LL fleet. The choices Taiwan makes at the design stage will shape not only how EM functions as a compliance tool, but also how far it can support science, market access, and fleet management over the long term.

It is true that RFMO expectations for EM remain relatively weak, uneven, and subject to change. As such, the first key policy decision is not how to implement EM, but whether to do so. For a fleet of Taiwan's scale and prominence operating across all major tuna RFMOs, the direction is clear: pressure for higher-quality, independently verifiable data will continue to mount, and EM is very likely to become an expected element of fisheries monitoring.

Starting the EM adoption process now, while standards are still evolving, would give Taiwan time to sequence reforms, avoid rushed compliance once rules tighten, and shape RFMO practice rather than reacting to it. Government agencies need a framework that is administratively workable and robust enough to satisfy RFMO standards and domestic legal



requirements. Industry will focus on cost, operational burden, and the extent to which EM data can be used to manage fleets more efficiently rather than simply to penalize them.

Technology providers need predictable rules for vendor approval, performance specifications, and roles and responsibilities. The sheer size of the Taiwanese LL fleet will draw significant attention from EM vendors eager to compete for a new market. Creating this new market requires clear objectives and an explicit view of the tradeoffs between centralized control and market flexibility, between rapid rollout and institutional capacity building, and between minimum RFMO compliance and broader policy ambition.

For a country that already competes globally in cutting edge technology, designing a credible, technically sophisticated EM system is not just a defensive move, it is also an opportunity to extend that comparative advantage into fisheries monitoring, where only a few high-income countries have implemented systems at scale.

Although this report is primarily focused on compliance and implementation, EM also has meaningful scientific value. Where human observer coverage has remained limited, EM can materially improve the evidence base on retained catch composition, discards, shark catch, and interactions with protected species such as seabirds, turtles, and marine mammals. EM does not replace human observers for biological sampling such as tissue collection, age determination, or detailed length-weight measurements, but it can greatly expand the amount of standardized information available to scientists and fisheries managers.

Defining EM Scope

A key first step in implementing EM is defining its scope and the data it is intended to capture. While it is most expedient to align with RFMO requirements, these should be seen as a baseline rather than the full extent of the program's ambition. The government should begin by setting clear and focused objectives, which may include improving the accuracy and timeliness of scientific fisheries data, strengthening compliance and transparency, and maintaining market access. Programs that prioritize a limited set of measurable outcomes tend to perform more effectively.

Equally important is designing the system around a clear operating model that sets out how EM will function in practice: what will be recorded, how data will be transmitted, who will review it, and how it will inform management and enforcement. This requires early alignment of technical design, data governance, and institutional workflows. Because EM distributes roles and responsibilities across government, industry, and technology providers, implementation must also anticipate institutional change and secure buy-in from vessel operators who will ultimately bear much of the operational burden. Finally, EM systems should be designed to be harmonized with RFMO data and audit standards, open to evolving technology, and adaptable to scaling across fleets.

Third-party Vendor Approach

International experience suggests that no single model for engaging EM vendors is universally optimal. Rather, countries have adopted approaches that reflect their own institutional capacity and governance preferences.

Centralized versus standards-based

At one end of the spectrum is the centralized model, where a government contracts directly with one or a small number of vendors to supply and manage EM systems. At the other is the standards-based model, in which a government sets minimum technical and performance requirements, and vessel operators are free to select any vendor meeting those standards.

A centralized approach offers several advantages, particularly for administrations with limited internal technical capacity or when establishing a new program. By engaging a single or limited number of vendors through a turnkey contract, the authority can more easily ensure consistent system architecture, data formats, and review protocols across the fleet. This simplifies troubleshooting and provides a controlled environment for learning and system refinement during rollout. The vendor bears most of the operational and technical burden, including installation, maintenance, and data delivery, allowing the fisheries authority to focus on oversight and developing institutional familiarity with EM workflows. The tradeoff, however, is that dependence on a small number of vendors or having a fixed-term contract can reduce

competition, slow innovation, and create program-wide vulnerability to technical or contractual disruptions.

A standards-based model prioritizes flexibility and competition. The government defines the technical and performance standards, certifies vendors, and allows vessel operators to choose among them. This approach tends to foster innovation, cost discipline, and responsiveness to fleet-specific needs. However, it demands a stronger internal capability within government to design, enforce, and periodically update standards, to accredit and audit multiple vendors, and to ensure interoperability and data comparability across systems. These administrative and technical functions require sustained investment in capacity and expertise, particularly in data governance and IT integration.

Given the size and heterogeneity of Taiwan's LL fleets, a standards-based model might be the better long-run solution as this maximizes flexibility, competition, and innovation, which is particularly important during a time of rapid technological progress. The vendor lock-in associated with a centralized model, while potentially useful in the early years of an EM program, would likely lead to less innovation in the fleet.

However, this is not a binary choice and Australia's experience illustrates how an EM program can evolve as institutional capacity matures. AFMA initially adopted a single-vendor model during rollout, contracting one company to supply, install, and service EM systems across all participating vessels. This approach allowed AFMA to focus on developing procedures for review, storage, and compliance without managing multiple vendors. Once the program stabilized, AFMA decided to invest in

Figure 17: Tradeoffs when considering vendors: centralized vs standards-based

ASPECT	CENTRALIZED MODEL	MINIMUM STANDARD MODEL
Technology Flexibility	Moderate: fleets operate under one or a small number of approved vendor platforms. Consistency is high but flexibility and pace of innovation depend on vendor cooperation	High: vessel operators can choose among qualified vendors, fostering competition on features, pricing, and support; new technologies (e.g. AI-assisted review) can be integrated more quickly
Cost Efficiency	Economies of scale can lower initial costs through bulk procurement and standardized installation, but limited vendor competition may increase long-term service and upgrade fees	Competitive dynamics drive cost efficiency; the size of Taiwan's fleet may still offer vendors economies of scale
Administrative Burden	Lower for government: the vendor can manage installation, maintenance, data transfer, and often even first-level review under a single contract. Oversight focuses on contract compliance rather than technical standard-setting	Higher for government: authorities must establish, enforce, and periodically update standards, accredit multiple vendors, and ensure consistency across systems
Interoperability and Data Standards	Uniform hardware and data protocols simplify system integration and central review	Strong technical standards and rigorous certification are required to ensure interoperability across different vendor systems
Innovation	Slower: system upgrades and new functionalities depend on renegotiated contracts and vendor initiative	Faster: open competition and a dynamic vendor ecosystem accelerate the adoption of new technologies
Risk Concentration	Medium to high: reliance on one or a few vendors increases exposure to technical failure or contract disputes affecting the entire fleet	Lower: a diversified vendor base distributes technical and operational risk across multiple providers

its internal technical capacity. This staged approach demonstrates how a program can begin with a highly centralized rollout and progressively move toward a more open vendor ecosystem.

In-house government capacity

Apart from the considerations of centralized vs standards-based models, international experience also shows that governments have also chosen which specific capacities to keep in-house and where to leverage private vendors. Here it is a continuum between Australia, where AFMA has opted to bring both data storage and review in-house under the second phase of its EM program, and the US, where initial review is undertaken by the service provider, with summary and derivative data provided to NMFS. Both New Zealand and Scotland have kept only data review in-house, though their approach to third-party vendors is very different.

TFA will need to decide which functions to keep in-house and which to contract out, how much vendor concentration risk it is willing to tolerate, whether vessel operators or government will contract and pay vendors directly, and how access and ownership of data will be structured. The optimal pathway will depend on how quickly TFA wishes to scale EM coverage, the pace at which it is prepared to invest in its own technical and legal capability, and the balance it seeks between administrative simplicity, market competition, and control over critical monitoring infrastructure.

Figure 18: Cross-country comparison of EM vendor approaches and government capacity

COUNTRY	HARDWARE INSTALLATION	HARDWARE MAINTENANCE	DATA TRANSMISSION	DATA STORAGE	DATA REVIEW
New Zealand	Single-provider concession model	Single-provider concession model	Single-provider concession model	Single-provider concession model	Government
Australia Phase 1	Single-provider concession model	Single-provider concession model	Hard drive swap	Single-provider concession model	Single-provider concession model
Australia Phase 2	Centralized, type-approved panel model	Centralized, type-approved panel model	Hard drive swap	Government	Government
US Western Central Pacific LL	Open standards, outcome-based	Open standards	Open standards	Open standards	Open standards
Scotland	Open standards with specific technology requirements	Open standards	Open standards	Open standards	Government

Hardware

Leveraging current onboard technologies

As CCTV systems are installed on nearly all Taiwan-flagged LL vessels and over half[6] of the fleet already uses and pays for satellite data transmission (via Starlink), leveraging extant onboard hardware might be an expedient way to transition to EM.

Based on stakeholder interviews, some CCTV systems could be upgraded/retrofitted into an EM setup by introducing additional onboard equipment. At a basic level, this would involve routing the camera feeds into a central control unit that digitizes the video stream (as needed), embeds tamper-evident metadata (time and GPS position, plus vessel and camera identifiers), and then transmits footage for review.

However, the retrofitting process may require technical adjustments, including repositioning cameras to capture fishing activities while avoiding areas where crew privacy is a concern. In addition, many CCTV installations use analog cameras and cabling, so these feeds would need to be converted to a digital format. In discussions with EM vendors, reactions to a retrofit approach were mixed, reflecting these practical complexities and the potential variability of existing CCTV systems across the fleet.

Data Transmission

Although Starlink is the most mature LEO satellite broadband system globally, Taiwan has not sanctioned the technology for government use. Public reporting and commentary indicate two sticking points: Taiwan's preference for strong local control in the provision of critical communications services, and unease about potential geopolitical exposure given Elon Musk's business interests in China.

Instead, Taiwan has pursued a more diversified satellite communications strategy built around Chunghwa Telecom's partnerships with alternative providers, including Eutelsat OneWeb as an LEO service, SES O3b mPOWER as a separate high-capacity satellite network, and Astranis as a newer micro-satellite provider, alongside work on a domestic LEO capability. In that context, relying on Starlink for EM data transmission is not aligned with Taiwan's broader policy direction or its current commercial partnerships.

Over the next few years, additional constellations such as Amazon's Kuiper and Telesat Lightspeed are expected to come online, and Taiwan has indicated interest in engaging with new entrants as they mature. Given this shifting landscape, the practical design choice for EM is a provider-agnostic approach that can operate across multiple satellite networks, with OneWeb or other approved services used as an initial pathway where necessary.



6 Reported in personal communications with the Taiwan Tuna Longline Association (TTLA).

Data Review

The OFDC is well positioned to manage core elements of EM data review because it already sits inside Taiwan's electronic reporting and verification architecture. In its role as the commissioned professional institution supporting TFA's distant water monitoring system, OFDC is involved in the practical administration of VMS and e-logbook reporting workflows, including receipt of transmissions, certification that onboard systems can transmit normally, and management of signal loss events and other reporting disruptions. If Taiwan adopts EM, OFDC could extend this function and serve as a technical support and triage layer for EM data, helping link EM outputs to VMS tracks and e-logbook records and flagging gaps, inconsistencies, or priority events for follow up, while TFA retains enforcement authority and decision-making power over compliance actions.

Alternative implementation options for data review are presented below. Each allocates responsibilities differently between government and service providers, with trade-offs in assurance, speed of rollout, cost, and the degree of capability that sits inside TFA. The comparative experiences below draw on how EM programs have been implemented internationally.

Vendor-led comparison

In this arrangement, certified EM service providers would perform the first-order review of EM data to e-logbooks and produce standardized trip reports and variance summaries for submission to TFA. TFA (and any commissioned support body, e.g. OFDC) would then conduct quality assurance through audits and performance monitoring, and follow up where the reports indicate potential non-compliance or data issues. This is broadly how EM programs in the US and Australia's Phase 1 are structured: third-party service providers review footage, compare against e-logbooks, and submit outputs to the regulator.

Starting with this model offers pragmatic advantages. It can be operationalized relatively quickly by adapting existing international approaches to provider certification, review protocols, and data submission standards, and it limits the immediate need for large new review teams inside government. It also gives TFA early visibility into EM workflows and outputs while allowing capacity to build over time.

However, reliance on vendors for first-order review introduces dependencies that must be actively managed. TFA would need clear performance standards, robust audit procedures, and ongoing oversight of vendor outputs to ensure consistency, data integrity, and defensible results. Where OFDC supports the electronic reporting system, its most natural contribution in this model might be technical coordination and support to quality assurance processes (for example, helping triage reporting disruptions and linking EM outputs to existing trip records), rather than acting as the primary reviewer.

Government in-house review

In this scenario, TFA (or a dedicated government review unit) would conduct its own review of EM data. This approach keeps capacity inside government, but it requires a significant build-out of staff, training, and review platforms. AI could make this model more feasible by reducing the volume of footage requiring full manual review and by helping triage analyst attention toward key events. That matters because reviewer headcount

and operating cost are likely to be among the main constraints on a government-run system.

New Zealand's program sets a centrally designed mix of random and risk-based review, and the ministry reviews selected footage in-house. Scotland's model likewise keeps analysis within government, with internal staff pulling data from vendor-hosted systems and conducting risk-based review themselves. Australia is moving in this direction, aiming to deploy an AI-assisted review system in Phase 2.

If TFA implements an in-house, AI-assisted data review procedure for EM, its existing collaboration with National Taiwan Ocean University (NTOU) could play an important role, mirroring how CSIRO provides AFMA with ongoing technical advice and standards development support.

Hybrid: vendor pre-processing, government review and reconciliation

A practical intermediate option might be for vendors to handle the time-consuming first stage of processing, such as segmenting footage, identifying key fishing events, and producing structured summaries, while TFA would conduct the formal review and reconciliation against logbook entries and other reporting streams. This division of labor would preserve efficiency by using vendor systems for data preparation while keeping the substantive comparison and judgement inside government.

This differs from a vendor-led model as to where the data reconciliation is performed and, therefore, where accountability lies. In a vendor-led model, the service provider conducts the primary review and issues the comparative judgement (for example, trip-level variance findings) that the regulator then audits and acts upon. In a hybrid model, the vendor's role would be limited to pre-processing and summarizing footage, while TFA would perform the formal comparison and reconciliation against the e-logbook and other records.

Sampling rates

Beyond how the review process is structured, another key policy question is the sampling rate for data review. Fisheries scientists at the Marine Stewardship Council (MSC), a prominent, independently governed seafood certification and ecolabeling program, have found 20% monitoring coverage to be a feasible minimum for high seas fisheries and a balanced starting point for improving data quality, while acknowledging that no single percentage is a silver bullet across all contexts. This is also broadly in line with how EM is being operationalized elsewhere, where programs commonly rely on audit or sampling models rather than full review. AFMA audits 10% of fishing events, US Western Central Pacific LL implementation targets 25%, and New Zealand MPI reports review rates of 31%.

This rate should be understood as a baseline rather than a ceiling. Routine review sits on top of a retained EM video record and additional footage is therefore available for targeted follow up where risk indicators, protected species concerns, intelligence, or discrepancies with e-logbook and VMS data justify escalation. This makes sampled EM review stronger than a simple analogy to observer coverage might suggest: a random audit of recorded footage can still create a meaningful deterrent and generate statistically useful information at lower cost than full review.

In that sense, 20% is a defensible middle ground. It is large enough to provide a meaningful statistical and compliance signal, but still low enough to keep review costs and transmission demands from becoming prohibitive. Recent EM optimization analysis shows that rare events, especially ETP species interactions and other low frequency bycatch events, can require materially higher review rates than common catch streams. A sensible EM program would therefore treat 20% as a default baseline, while preserving the ability to increase review rates for higher risk vessels, seasons, or event types.

Economies of scale

A key consideration when engaging vendors is the tradeoff between promoting price competition and capturing whatever economies of scale are available when implementing a national EM program. In an interview, a prominent EM provider estimated that economies of scale afforded by a program-scale contract could reduce costs by approximately 10-20% for both hardware and services. This is significant but relatively modest as EM vendors reportedly have limited bargaining power compared to higher volume, terrestrial technology markets. By contrast, demand uncertainty in a highly competitive market may constrain vendors' ability to lower prices by limiting bargaining power with their suppliers. These claims, plausible though somewhat counterintuitive, could not be independently verified and merit further consideration when TFA assesses vendor engagement models.

If TFA wants to enable scale benefits, its most direct levers are committing to a clear rollout pathway (fleet segment scope and stable multi-year timeline), standardizing data formats and submission requirements to reduce vendor-specific integration work, and implementing contracting structures that reduce vendor uncertainty (e.g. framework agreements with defined service levels).

The same vendor also stated a preference to contract directly with government entities rather than with vessel owners, citing administrative simplicity.

Data Access and Ownership

Resistance to new compliance measures can be mitigated by ensuring that industry experiences tangible benefits from their adoption. When e-logbooks were introduced for Taiwanese LL vessels in 2014 and 2015, the catch reporting and vessel position data captured for compliance purposes was made available to vessel owners, transforming it into a fleet management tool. Similarly, EM data can be leveraged by vessel owners to improve communication with their fleets and provide them greater access to onboard activities at any time. As discussed later in the report, there are also potential operational benefits of having AI-powered EM systems onboard.

The value of this transparency to vessel owners is already apparent, as over half of Taiwan's LL vessel CCTV systems have been voluntarily connected to satellite communications, providing on-demand access to video feeds. In interviews with vessel owners, it was reported that video access is valuable to them because it gives them a direct, unbiased view of vessel operations. In addition, inexpensive satellite communications allow for more frequent and detailed discussions with captains and enables owners to better assist captains with crew management. It is therefore strongly recommended that vessel owners be allowed data access to the video feeds on their vessels, something also stipulated by RFMO rules.

A similar approach should apply to data ownership. Under Taiwan's current e-logbook system, vessel operators are required to transmit operational data to TFA for management and RFMO reporting purposes. In this framework, the Government of Taiwan is the legal owner of the data, while TFA serves as its custodian, responsible for secure storage, verification, and authorized use. Vessel operators, as the generators of the data, may be granted access rights to information originating from their own vessels, but not ownership. This arrangement has worked well because it preserves the government's authority to verify and report fishing activity while allowing operators to retain access to their own data for operational use.

The same model can be extended to EM. Each vessel's EM system generates multiple data streams (e.g. video and metadata) that could be treated as government-owned compliance data while still being made accessible to vessel owners for operational purposes. Under this structure, two distinct but complementary data functions are maintained: (1) an official, tamper-evident copy submitted to TFA for compliance and scientific use, and (2) an owner-accessible copy for operational and fleet management purposes. Allowing vessel owners this level of access is consistent with the intent of Taiwan's 2017 e-logbook reform, which successfully aligned compliance and business incentives.

This mirrors the approach taken by AFMA in Australia and by NMFS in the United States, where the government is the sole owner of EM data collected under statutory authority, but vessel operators are granted controlled data access for operational benefit.

Funding Models

As the case studies above illustrate, EM systems globally are typically funded through a mix of government and industry expenditures. Depending on the model adopted, some incremental government costs (for example, data storage, review capacity, and compliance follow-up) could be recovered through licensing fees, levies, or other cost-recovery mechanisms applied to the fishing industry.

For onboard EM hardware, given TFA's history of subsidizing adoption of onboard technologies (including CCTV), it may be expedient for TFA to subsidize some portion of the upfront hardware costs associated with EM. Taiwan has already taken a step in this direction. In July 2025, the Ministry of Agriculture introduced a subsidy program for distant water LL vessels that reimbursed purchase and installation costs up to TWD 150,000 (USD 4,700) per vessel, supporting up to 10 vessels. Such subsidies are broadly consistent with approaches used in New Zealand, Australia, and the US. In New Zealand, for example, initial support was largely recouped through levies on the fleet.

For recurring expenses associated with satellite data transmission, over half of Taiwan-flagged LL vessels already pay for satellite connectivity. It is therefore reasonable to expect industry to continue bearing some transmission costs, particularly given the operational value of connectivity for fleet management and safety, in addition to EM.

Recurring maintenance and replacement costs, including periodic camera replacement due to

Figure 19: Taiwan Fisheries License Fee Schedule

VESSEL SIZE (GROSS TONNAGE)	TWD	USD
Less than 20	100	3
20-50	200	6
50-100	300	9
100-500	600	19
500-1,000	1,000	32
1,000 and above	1,500	47

harsh marine conditions and routine system upgrades, are also most logically borne by industry, since vessel operators have the most direct ability to protect and manage equipment day to day.

These observations reflect Taiwan's historical practices and the general principle of aligning incentives between industry and government, but the precise mechanism will depend on the vendor model adopted by TFA. Industry might pay EM device and service costs directly (as in the US and Scotland), or costs might be recovered through a levy or fee structure (as in New Zealand and Australia). The same choice of mechanism also applies to other EM-related costs, including data transmission, storage, and review.

Admissibility of EM Video Evidence for Prosecutions

Under its CCTV program, Taiwan already has a clear legal framework to collect, store, and use video from distant water vessels. With clear rules in place, the footage is considered to be collected lawfully and fit for use.

Whether fisheries cases are resolved through administrative penalties or criminal trials, evidence gathered according to law is typically admitted if integrity and authenticity can be proven. Keeping clean records of EM data provenance and chain of custody is therefore essential.

Taiwanese privacy law does not block the use of EM for compliance. The government may process personal data when carrying out statutory duties, but it must respect purpose limits, security, and retention rules. That is consistent with using EM footage for enforcement and science while following documented safeguards.

However, there is room to tighten chain of custody and authenticity standards, especially for satellite transmission. A standard operating procedure document can make provenance clear without new legislation. This can be done by creating a digital fingerprint (file hash) when footage is transmitted. The receiving server verifies that hash on arrival and issues a time-stamped receipt. A secure link from vessel to archive, paired with a simple transmission log noting when the file was created, sent, received, and which unit handled it, could provide a straightforward audit trail. Likewise, keeping a

locked master copy for preservation alongside a separate working copy for analysis could make any later edits clearly visible.

Provenance becomes straightforward when devices share a synchronized clock, cameras have fixed IDs mapped to deck plans, and GPS and system time metadata are embedded in the footage. Because EM can be reviewed as activity segments rather than continuous video, it helps to record how segments were selected, note any gaps or failed transmissions, and enable automatic resubmission.

These are pragmatic refinements that align with mature international EM programs. In the US, program manuals and VMPs make footage routine evidence. New Zealand's camera regulations provide an explicit compliance toolkit built on equipment standards and operator duties. Australia relies on published procedures that connect camera rules to review and enforcement workflows. Scotland's EM regulations likewise assume that camera and sensor data will be used directly in compliance investigations and prosecutions under the existing fisheries enforcement evidence framework, rather than creating a separate admissibility regime.

However, Taiwan's LL fleets are not accustomed to paying significant licensing or registration fees and any additional levies would need to be socialized to avoid industry pushback. See below for the current, remarkably modest fisheries license fee schedule for all Taiwan-flagged vessels regardless of gear type or operating area.

05 NON-REGULATORY INCENTIVES FOR INDUSTRY EM ADOPTION

While RFMO requirements provide an emerging compliance target supporting EM adoption in Taiwan, doing so in consultation with industry is critical to secure buy-in and reduce resistance. The key Taiwanese LL industry associations, the Taiwan Tuna Longline Association (TTLA) and Taiwan Tuna Association (TTA), respectively representing Taiwan's small-scale and large-scale tuna LL vessel fleets, are well positioned to liaise between government and LL vessel owners.

Fleet Management and Optimization

Even if EM is a compliance tool first and foremost, allowing vessel owners the ability to leverage the technology for fleet management is expected to greatly increase their willingness to pay over the long-term. There is strong evidence for this as over half of Taiwanese LL vessels have already opted to link their CCTV systems with satellite communications.

Vessel owners report their current willingness to pay for satellite communications as linked to their ability to observe vessel operations on demand and to better communicate with captain and crew. While these benefits are clear for global fleets that land very infrequently, additional upside may emerge as EM technologies are more widely adopted. Installing EM effectively introduces AI onboard as well, creating possibilities for longer-term operational improvements beyond simple monitoring by compliance officers and owners.

When integrated with additional sensors on key equipment, AI could begin to optimize the vessel as an interconnected system.

Perhaps the most immediate, tangible benefit could be increased fuel efficiency. Drawing data from engine load, vessel position and speed, and sea conditions, AI could suggest navigation adjustments. Even modest gains in fuel efficiency could translate to significant cost savings for distant water vessels.

Similarly, by tracking generator load and freezer compressor cycles, AI could recommend ways to stagger high-energy draws so that power demand is balanced, reducing wear on generators and cutting fuel consumption. Additional sensors on the freezing system, including temperature, pressure, and compressor current, could feed AI models that detect early signs of gas leakage or mechanical failure, allowing preventative maintenance before a costly breakdown at sea.

AI could also help crews optimize gear deployment and retrieval. By linking line-tension sensors, GPS buoys, and EM video, the system could learn which soak times, depths, and environmental conditions yield the best catch composition. Automated retrieval sequencing, i.e. determining which buoys to haul first, could cut transit time and fuel usage during hauling.

Predictive maintenance is another area where AI could pay off. Vibration and temperature sensors on winches, pumps, and hydraulic systems could detect deviations from normal operating patterns

long before mechanical failure occurs. Onboard diagnostic alerts could allow crew to schedule maintenance proactively, lowering unplanned downtime and improving safety.

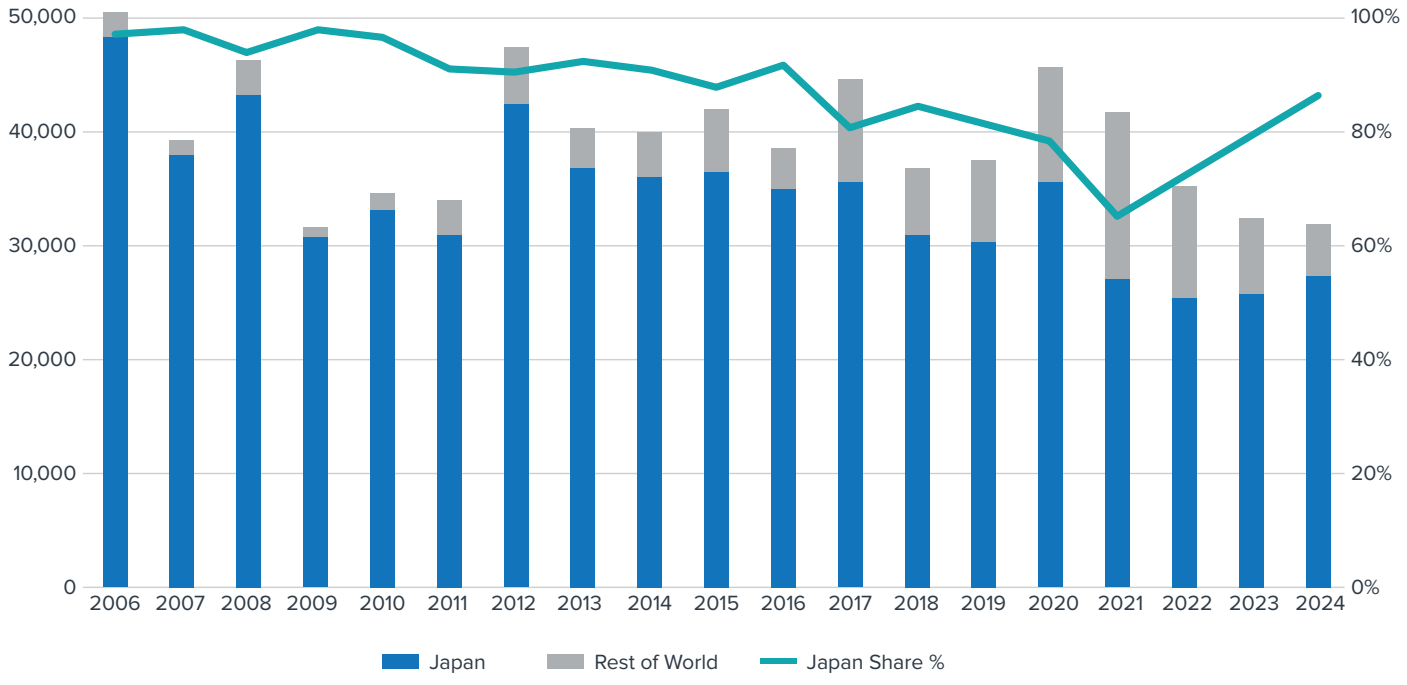
Beyond mechanical systems, AI-enabled EM could also enhance safety and crew welfare. Computer vision models trained on EM video could detect risky behaviors, unsafe deck conditions, or man-overboard events, automatically triggering alarms and marking locations. Environmental sensors could monitor confined-space gases such as carbon monoxide or hydrogen sulfide before crew enter cold rooms. As these capabilities are developed, EM could not only serve as a compliance instrument but also a vessel management and risk-reduction tool.

Some of these advances are already being made in purse seine fisheries. These fleets rely on satellite linked echosounder buoys associated with FADs to generate near continuous biomass information, and buoy manufacturers are integrating AI to improve species classification. A recent vessel digitalization project on tuna purse seiners recorded 209 onboard signals spanning ship operations, fuel systems, and environmental conditions, with those data already feeding fuel prediction, species distribution, and route optimization models used by participating vessels.

Market Access

Historically and continuing to the present day, Japan has been the single largest market for Taiwanese tuna LL, particularly for bigeye tuna (BET). Japan has accounted for over 70% of Taiwan's BET exports in 19 of the last 20 years and frequently accounts for over 80%.

Figure 20: Taiwanese BET Exports to Japan vs Rest of World



Source: ITC Trade Map Data

This dominance is due to the high quality demanded by the Japanese market for sashimi grade tuna and the generally elevated quality standards of LL vessels, including strong fish handling practices during haul-in and onboard freezing at low temperature. While there has been some market diversification over the last several years due to the growing global popularity of sushi, Taiwan's ability to sell in markets beyond Japan has been throttled due to negative perceptions of the LL industry related to both social and environmental impacts.

Taiwanese LL vessels are also a significant supplier of albacore tuna to the US canned tuna market. For US and EU buyers, labor risk is now one of the defining concerns in distant water fisheries supply chains. A single investigative article or NGO report about forced labor or abuse on a vessel can potentially do significant reputational damage and overshadow years of gradual progress on ecolabeling. Against that backdrop, EM offers Taiwan not only a compliance tool, but also a platform to reduce perceived labor risk in its LL fleets.

RFMOs do not require EM systems to monitor social conditions, and in practice cameras will only ever provide partial insight into working hours or treatment of crew. Even so, a well-designed EM program combined with, for example, rules on crew rest and mandatory individual satellite data allocations, would allow Taiwan to demonstrate a higher level of oversight than most competitors. For international buyers, the fact that vessels are under continuous camera and data monitoring, with the possibility of reviewing segments where risk is highest, is itself a powerful signal that labor abuses are less likely to go undetected. That signaling value may be as important commercially as any direct labor-monitoring capability EM can realistically provide.

Ecolabels

Beyond EM, a standard industry framework to boost market access while improving fishery management practices is the fisheries improvement project (FIP). FIPs, which often have the goal of achieving the MSC ecolabel, set specific, timebound targets for data collection on target and non-target species and remediation measures to reduce environmental impacts. FIPs also include social risk assessments for LL fleets, assisting buyers with due diligence in their supply chains. Several FIPs and MSC certifications have been initiated in Taiwan's LL supply chains due to international buyer requirements.

Even with FIPs and MSC certifications in place in certain fleet segments, EM is the most scalable way to strengthen independent verification of onboard practices for the wider Taiwanese LL fleet. In this fishery it is still common practice to remove shark fins at-sea immediately upon landing. MSC's preferred approach is a clear "fins naturally attached" policy, meaning sharks are brought to port intact so there is no doubt that carcasses are retained and finning is not occurring. (Shark finning is also banned by all tuna RFMOs.) If the fleet does not shift to fins naturally attached in practice, MSC requires 20% observer coverage to create an evidence base. As 5% coverage rates have proven challenging with human observers, this gap can most practically be bridged only with EM.

The 20% coverage figure is a defensible, scientific benchmark for the level of independent monitoring needed to create confidence in onboard activities. For Taiwan, it can also serve as a practical reference point when designing an EM program. A 20% sampling rate has been found to ensure that monitoring is representative across vessels, trips, and seasons, while higher coverage levels tend to deliver smaller incremental gains relative to their

cost and operational burden. In other words, 20% is high enough to be taken seriously, but not so high that it becomes unrealistic to implement at fleet scale.

While MSC is not a universal requirement, it is an important certification for access to retail and branded supply chains in the EU and US, and increasingly in Japan. As Taiwanese LL fleets diversify their end markets and face tightening buyer expectations around traceability and sustainability claims, the ability to meet MSC evidence requirements can reduce commercial friction and protect market share. That credibility is very difficult to achieve at scale without EM.

Insurance

Insurance is a secondary but potentially useful incentive for EM adoption. For Taiwanese LL fleets, there are typically least three layers of insurance coverage: crew protection, vessel cover, and third-party liability.

Distant water vessels owners must enroll all crew in labor insurance, plus personal accident, medical, and life insurance. EM could be relevant here, mainly by improving evidence in the event of injury, death, medical evacuation, wage or treatment disputes, or allegations of abuse. That may improve underwriting confidence and claims handling, but it is less likely to lower premiums as crew-related insurance is driven mainly by injury incidence, medical cost, fatigue, safety management, and the operator's labor practices rather than by the mere presence of EM. A more realistic insurance benefit is that EM helps demonstrate stronger oversight and may improve access to coverage for vessels operating in supply chains subject to labor risk.

As for vessel cover, TFA provides annual subsidies of up to NTD 6,000 (USD 190) for 20-50 GT vessels and NTD 8,000 (USD 250) for vessels 50-100 GT. This reduces the potential for EM to create additional savings for STLL owners (defined as under 100 GT), especially if they are only buying minimum cover. For larger, unsubsidized LTLL vessels, the commercial case for premium reductions is somewhat stronger. Hull underwriters usually care most about factors such as vessel type, age, condition, use, maintenance, and casualty history. Hull material matters, but it is only one factor among several, and age and condition are often more important than fiberglass versus steel alone. EM footage could help reconstruct incidents and, if combined with sensors, support better maintenance evidence, but it is less important to the physical risk profile of the vessel than vessel age.

Third-party liability, including shipowner liability or protection and indemnity (P&I) cover, is where EM has the strongest potential to affect insurance pricing. P&I cover typically covers risks such as crew injury or death, pollution, vessel collisions, and wreck removal. In these cases, EM can help establish causation, confirm whether procedures were followed, show the vessel's response after an incident, and reduce the potential for false claims. In certain commercial trucking programs, insurers already offer 5% discounts for P&I customers that enroll to use video data as evidence, adjusting renewal pricing based on driving data. Though fisheries are not yet at that stage and different risk profiles than commercial trucks, this example illustrates the potential of video to lower vessel premiums.

EM can help vessels show that they are better monitored and documented, and less exposed to undisclosed IUU, casualty, or labor-risk issues. That alone may improve insurability and underwriting appetite. Only after insurers accumulate credible claims experience linking certified EM systems to lower loss frequency, faster claims resolution, or better recovery outcomes would meaningful premium reduction become possible.

06 COSTS OF EM IMPLEMENTATION

While the costs of implementing EM in Taiwan will depend on various program design choices, the experiences of four jurisdictions that have deployed EM at scale offer useful guidance for TFA. New Zealand, Australia, the US, and Scotland have different technical requirements and use different mixes of third-party vendors and in-house government capacity, but their programs still reveal broadly comparable cost patterns that can inform Taiwan's planning.

A major difference for Taiwan is that EM for its LL fleets will require routine satellite transmission of EM data, whereas data transfer (mainly done by physical hard drive swaps) is not a core cost driver in the comparison EM programs. Satellite transmission is therefore an incremental cost in addition to more established EM cost categories.

Hardware

Publicly available documentation on EM systems operating at scale, including the US Western Central Pacific LL fleet, and interviews with EM vendors point to very similar pricing for EM hardware of approximately USD 8,000-10,000. Exact costing will of course depend on the technology specifications, but this estimate is based on multiple data points.

A key driver of hardware cost is its effective life in harsh saltwater environments. US regulators assume a useful life of three years when building cost estimates, while Scotland assumes depreciation over five years. According to vendor interviews, actual operating lifetimes of EM systems used in LL fleets range from three to five years.

With TFA funding, NTOU has developed an EM system tailored to Taiwan's LL fleet. The system includes a compact 20 cm^3 central control unit with five removable 16 GB hard drives and can interface with camera arrays (including edge computing), a GPS antenna, and other onboard equipment such as power regulation. Built using off the shelf components, the current version can be produced for about USD 6,000 and is being piloted on 10 Taiwanese LL vessels. A simplified configuration that omits crew entertainment functionality would reduce the unit cost to roughly USD 4,500. NTOU has also established a small team to conduct AI-assisted video review, and these technologies are being commercialized through a startup company called PhaseTech.

Although this system currently trails more mature international EM providers, TFA could leverage the partnership to help build a domestic EM industry, supported by a large LL fleet as an initial customer base.

Data Transmission

Eutelsat OneWeb, a lesser known but fully operational satellite communications provider, has an array of around 650 LEO satellites with near-global coverage. OneWeb can deliver broadband speeds in the same general range as Starlink for many use cases, though real-world user experience depends on network capacity and ground infrastructure, where Starlink maintains a significant advantage. Chunghwa Telecom, Taiwan's largest and partially state-owned telecoms provider, now operates under an exclusive agency agreement with OneWeb.

At 1080p resolution and a minimum frame rate of 5-10 fps generally considered sufficient for effective review, each EM camera generates roughly 40 GB of compressed video per day if recording continuously. In practice, fishing activity and relevant crew movements occur only part of the time. If these dead periods are automatically screened with activity-detection algorithms, the amount of footage requiring transmission could be reduced by about 60%. If the video resolution is reduced from 1080p to 720p, file sizes fall by another 70%. Combined, this results around 5 GB per day per camera, or roughly 20 GB per day for a four-camera EM array. Assuming a Taiwanese LL vessel would need to transmit approximately 20 GB of EM data per day or 600 GB per month over the satellite link, OneWeb could easily handle this. In other words, the bottleneck is not the data transmission speed but how much that capacity costs.

Chunghwa has not yet published retail tariffs for OneWeb service in Taiwan. The table below presents indicative pricing from OneWeb plans that are currently available. In practice, a government buying capacity in bulk via Chunghwa can be expected to secure (significantly) better pricing than retail plans, so these figures should be considered indicative only.

Transmitting 600 GB per month assumes that all recorded footage is uploaded and available for review. In practice, most EM programs apply a defined review rate and sampling strategy. If, as discussed above, 20% of fishing activity is selected for review, the transmission requirement falls to roughly 120 GB per month, which would fit within a 250 GB plan and cost on the order of USD 600-1,000 per month at today's indicative OneWeb tariffs (before any bulk purchase discounts via Chunghwa).

Soon onboard edge computing could reduce transmission needs further by pre-processing video at the point of capture, shifting from sending all active-time video to sending only what matters. The latest EM smart cameras have the capability

Figure 21: Indicative pricing of OneWeb satellite data transmission

MONTHLY DATA ALLOWANCE (COSTS IN USD)	ASIASATELLITE ONEWEB MARITIME	GLOBAL SATELLITE'S ONEWEB MARITIME	LAND / FIXE ONEWEB (NON-MARITIME)	STARLINK
100 GB	295	325	585	350
250 GB	n/a	625	1,025	n/a
500 GB	n/a	1,075	1,500	650
1,000 GB	2,550	1,875	~2,600	1,150

to run basic computer vision models in near real time to identify discrete, reviewable events such as setting and hauling, fish coming aboard, handling and discards, and bycatch interactions. Instead of transmitting continuous footage, the system can send AI-flagged short video clips for review, accompanied by standard metadata such as camera ID, geolocation, and time. The full-resolution record is still stored locally on encrypted drives for a defined period in case regulators need to audit or pull additional footage. Because most active time does not correspond to review-critical moments, event-based onboard processing could materially reduce the volume that needs to be transmitted, with the exact reduction depending on the fishery, camera placement, review rules, and model performance.

Vessel owners are more likely to accept EM if recurring satellite costs are predictable and not obviously out of line with what they already pay for connectivity. The owner of a LL vessel participating in a FIP reports paying around USD 1,100 per month split evenly between 50 GB of Starlink data and EM review fees. That experience sits at the high end of the cost range indicated by the analysis above. It therefore seems realistic to assume that if EM transmission volumes can be kept below the 250 GB/month range through scientific review rates and/or effective edge processing, the additional satellite cost per vessel will be manageable. Based on historical trends and emerging competition, it also seems highly likely that prices of satellite data will continue to fall.

Other Costs: Data Review and Storage, Administration, etc.

Data review and storage costs can vary widely based on sampling rates, technology usage, vendor roles and responsibilities, duration of storage, video resolution, etc. With so many variables in play, technology vendors cannot provide cost estimates with any precision.

Instead, international benchmarks across disparate operating models provides the best, if imperfect, indication of potential costs. As noted in the cross-country comparative analysis earlier in the report, the range of total annual operating cost per vessel excluding hardware is approximately USD 12,000-14,000 per vessel across New Zealand, Australia, the US and Scotland.

Another EM cost category that is known with some certainty is administration cost per vessel. Across New Zealand, Australia, and the US, the range is USD 3,200-3,700 per vessel, a remarkably tight range.

Extrapolating from these figures indicates data review and storage costs ranging from USD 8,800-10,300, with review accounting for most of the cost. Though these figures also include data transmission, the EM programs on which costs are benchmarked use satellite data transmission sparingly if at all, instead relying on physical hard drive swaps. Based on standard postage rates, it is estimated that delivery costs are effectively de minimis.

Indicative satellite transmission costs for Taiwan's LL fleets are between USD 500-1000 per month per vessel, or USD 6,000-12,000 per month. Taken together, these estimates indicate total operating costs of approximately USD 20,000-29,000 per vessel.

Figure 22: Estimated annual operating costs for EM on Taiwan's LL fleets

ANNUAL OPERATING COST	LOWER LIMIT	UPPER LIMIT	% OF TOTAL COST
Hardware	2,000	3,300	10-11%
Data transmission	6,000	12,000	30-41%
Data review and storage	8,800	10,300	35-44%
Administration	3,200	3,700	13-16%
Total operating cost	**20,000**	**29,300**	

These figures illustrate an underappreciated point about EM systems: hardware, even when the assumed useful life is conservative, represents a small portion of the overall cost. Instead, the labor-intensive nature of data review is a significant cost driver, alongside the considerable expense of transmitting video data via satellite. To that point, even if current CCTV systems onboard Taiwan's LL were retrofitted to include EM, some savings would certainly be possible but would be quite modest in the context of a wider EM rollout.

It is also important to note that the underlying benchmarks are not exactly equivalent across jurisdictions. In New Zealand and Australia, EM operating costs are substantially recovered from industry, which has had the practical benefit of forcing a relatively transparent accounting of the full program cost per vessel. However, the figures above do not reflect the significant investments made by AFMA to bring data review in-house in Phase 2. By contrast, in the United States and Scotland, publicly available figures tend to capture only incremental government outlays, while the broader, multi-year capacity building required to stand up EM systems is not separated from wider monitoring and compliance budgets. As a result, cost figures drawn from the US and Scotland should be interpreted as partial and potentially understating full program costs.

Indicative specifications

Interviews with EM vendors provided some indicative requirements for hardware and review capacity. Under a typical EM program that combines standard sampling rates (roughly 10-25% of fishing events) with AI-assisted review, vendors report that a single shore-based reviewer can typically take responsibility for approximately 8-10 LL vessels. For distant water LL fleets that remain at sea for extended periods, vendors also recommend an 8 TB hard drive to store high-resolution footage in case additional review is required. Finally, vendors generally do not view dedicated gear sensors as essential, or even preferred, for LL EM. When video is indexed to VMS and includes speed and bearing, reviewers can infer whether the vessel is setting, hauling, or steaming, which simplifies the system and reduces failure points by avoiding extra devices that can malfunction in harsh marine conditions.

07 CURRENT RFMO TECHNICAL REQUIREMENTS FOR EM IMPLEMENTATION

Data Capture, Storage, and Transmission

The table below compares key elements of data capture, storage, and transmission across the WCPFC, IOTC, IATTC, and ICCAT, i.e. those most relevant to Taiwan's LL operations.

Figure 23: Cross-RFMO Comparison of EM Technical Specifications

EM TECHNICAL SPECIFICATIONS	WCPFC[7]	IOTC	IATTC	ICCAT
VMP	Required per vessel; onboard copy should be maintained	Required per vessel	Required per vessel or vessel group; onboard copy should be maintained	Required per vessel; copy onboard
Camera coverage	No minimum number; sufficient to capture required EM data	No minimum number; tailored by VMP. Most LL need at least 3 cameras; water-view camera recommended	No minimum number; sufficient to capture required EM data	No minimum number but must cover views of setting, hauling, catch handling, and surrounding water area
Event(s) to be recorded	Fishing activities e.g. setting, hauling, catch handling, and discarding	Fishing activities e.g. baiting, setting, hauling, and discarding/release	Fishing activities e.g. baiting, setting, hauling, and discarding	Fishing activities e.g. setting, hauling, catch handling, and discarding
Fishing trip definition	The period between vessel departure from port and return to port, or period between at-sea transshipments	Not formally defined in the EM standards	Not formally defined in current interim standards	Not explicitly defined in EM standards
Transshipment	Fishing vessel transshipment is covered in EM data fields; carrier-vessel standards still under development	Transshipment is not mentioned in current EM standard	Not addressed in current interim standards; carrier-vessel guidance still to be developed	Transshipment is not mentioned in current EM standard
Image quality	For species ID Video: ≥720p resolution and ≥5 fps (frames per second)	Adequate to allow accurate collection of all required data fields; Higher quality/resolution is preferred	For species ID Video: ≥720p resolution and 5-10 fps Still images: ≥2MP, minimum capture interval <1 second	For species ID Video: ≥720p resolution and ≥5–10 fps Still images: ≥2MP

7 WCPFC's Interim EM Minimum Standards include MUST and SHOULD depending on the technical specification. That verbiage is reflected here.

EM TECHNICAL SPECIFICATIONS	WCPFC[7]	IOTC	IATTC	ICCAT
Metadata	EM records must include timestamp, GPS location, vessel identification, and trip ID	EM records must include vessel name and ID, camera ID, trip ID, geolocation, camera recording status, EM equipment status, and sensor data	EM records must include at least vessel name and ID, trip ID, camera number, geolocation data, sensor data, camera recording status, EM system status	Control box must have a GPS sensor to automatically record position, speed and course; digital signature must include date/time stamp, vessel name, vessel registration, and GPS coordinates
Data encryption	EM records must be transmitted, stored, or accessed securely; encryption and firewalls are recommended	EM data should be tamper-resistant/ evident, ideally using encrypted data	Secure transmission required; transmitted data should be properly encrypted, and an encrypted onboard backup kept	Secure storage/ transmission required; encrypted data where required/decided by national authorities
Sensors	May include sensors to detect fishing; should have log files if sensors are used	May include sensors or other automatic devices to trigger recording	May include sensors or other automatic devices to trigger recording	May include sensors or other fishing-activity recognition tools unless cameras record continuously
GPS / geolocation device	Requires geolocation device to record coordinates, date, and time	Requires GPS to monitor position, route, speed, and date/time of fishing activities	Requires GPS to monitor position, and, unless cameras record continuously, vessel speed and course	Requires GPS (or equivalent) to record position and, unless cameras record continuously, speed and course
Control system	Must be tamper-evident/ resistant; login history recommended to analyze tampering attempts	Must be tamper-resistant and tamper-evident	Must be tamper-evident/ resistant; automatic alerts for malfunction or tampering	Must be tamper-evident; control box prohibits unauthorized changes; automatic malfunction alerts
Uninterrupted power supply (UPS)	UPS should be included	Should have own UPS / autonomous power, or connect to vessel backup power	Should have backup power (e.g. 30 min); and be able to save records during longer outages	Requires UPS (~15 minutes) with controlled shutdown; backup storage required
Durability	Requires on-deck components to be sufficiently dust/water resistant (e.g., IP66); higher (IP67/68) where heavy water contact	Requires a robust system that resists harsh at-sea conditions	Requires hardware to be sufficiently dust and water resistant and durable to use on vessels	Recommends IP66 rating or higher for heavy weather
Data retention	Not specified in interim standards; retention to be set by EM audit/ assurance and program requirements	At least one year, or longer if national/ regional EM program requires	No fixed period; flag state must specify where, how, and how long EM records are stored after analysis	Once reviewed, footage kept at least 3 years, except where national retention rules require shorter; longer if needed for enforcement
Data transmission (vessel to data review center)	EM records must be transmitted to the data review center in accordance with agreed national procedures; no fixed deadline specified	Method and frequency set by EM program, e.g. after each trip	Recovery and secure transmission at end of trip where possible; otherwise at earliest opportunity	At end of fishing trip where possible; otherwise stored securely and transmitted at earliest opportunity

Transshipment Coverage: Fishing vs Carrier Vessels

The current requirements on transshipment differ across RFMOs, drawing a distinction between LL fishing vessels transshipping their own catch and carrier vessels receiving catch.

The WCPFC's EM guidelines require LL vessels to record transshipment activities that occur at sea. The EM data fields include whether the vessel transferred or transshipped fish from or to another vessel, along with the name of the receiving vessel and the date, time, and coordinates of the transfer. By contrast, IOTC, IATTC, and ICCAT do not currently require fishing vessels to record transshipments through EM, though both IOTC's EM program and IATTC's interim standards note that EM could be expanded in the future to include transshipment activities.

For carrier vessels, none of the RFMOs have yet adopted binding EM standards. Within the WCPFC, the ER&EM IWG is formally tasked with the development of EM standards for LL transshipment carrier vessels in 2025-2026. The IATTC has recognized EM on carrier vessels as a promising area for experimental work rather than a regulated requirement, with the existing at-sea transshipment program still relying on 100% human observer coverage. IOTC and ICCAT both tightened their general transshipment measures in recent years, focusing on flagging, VMS, observer coverage and reporting by carriers, but neither has adopted carrier-specific EM obligations. EM on carrier or processing vessels remains at the pilot or project stage.

Based on a comparative review of EM technical standards adopted by the key RFMOs, the minimum hardware specifications that collectively satisfy all requirements for onboard equipment are presented below. This table also compares RFMO-compliant specifications to Taiwan's CCTV and EM subsidy programs, highlighting areas where Taiwan's current specifications already meet or exceed regional requirements and identifying where adjustments may be needed to achieve full alignment:

- → Requiring a formal VMP for each vessel.
- → Requiring tamper-evident and tamper-resistant devices.
- → Requiring cameras rated IP67 or higher as heavy water contact is common with LL vessels.
- → Raw EM records and derived data must be encrypted and securely stored



Figure 24: Minimum RFMO Hardware Specifications vs TFA Subsidy Program

EM TECHNICAL SPECIFICATIONS	RECOMMENDED SPECIFICATIONS (CROSS-RFMO)	TAIWAN'S CCTV SUBSIDY	TAIWAN'S EM SUBSIDY
VMP	VMP required per vessel, describing EM camera placement, coverage areas, and configuration	Photographs showing the appearance of each piece of equipment (main unit, camera, UPS, etc.) and configuration details must be provided upon application	No formal vessel-specific VMP is required; however, photographs showing the appearance of each piece of equipment (main unit, camera, UPS, etc.) and configuration details must be provided
Camera coverage	Minimum 4 cameras; Coverage of baiting, setting, hauling, catch and bycatch handling, and surrounding water area	Depending on the fishery type and vessel size, the system must support 3 to 9 cameras, with installation angles ensuring clear footage of fishing operations and crew activity	Must support ≥3 cameras. Camera fronts must be unobstructed and installed at angles that clearly capture activity.
Image quality	Video resolution for species ID: ≥720p, frame rate ≥5-10 fps	Video: ≥2MP resolution (image quality at least "standard") and ≥15 fps; equipped with night vision	Cameras: ≥2 MP resolution and ≥15 fps capable. Video: ≥2 MP, ≥12 fps; equipped with night vision
Metadata	Include UTC date/time, GPS position, vessel ID. Link to camera ID and trip ID. Integrate with sensor data if used.	Does not mention metadata	Must include watermarks indicating UTC time, vessel position in WGS84 format, and vessel ID
Data storage and encryption	EM records must be encrypted and transmitted, stored, or accessed securely. Systems should include encryption and firewalls to prevent unauthorized access.	Does not mention data encryption or storage protocols	No encryption requirement is stated. Storage must be sufficient for > 1 year of video, with at least 16 TB of built-in hard drive capacity
Sensors	Sensors may be used to detect gear deployment and hauling, triggering recording.	Does not mention sensors	Does not mention sensors
GPS / geolocation	Requires GPS to record vessel position, date, time, speed, and course; metadata linked to recorded video.	Does not mention GPS	Requires GPS or integration with an existing vessel positioning device to record real-time vessel positions
Control system	Must be tamper-evident and tamper-resistant. Systems must include physical seals, restricted access to configuration, and automatic alerts/logs when tampering is detected.	Fault diagnosis records not required	The system must store diagnostic logs including startup, planned and unplanned shutdowns, camera connection status, camera failures, and remaining storage.
UPS	Requires UPS or backup power source for at least 30 minutes during outages and allows controlled shutdown. Must save records during outages	Requires UPS securely wired to the main unit to prevent disconnection	Requires UPS securely wired to the main unit to prevent disconnection

EM TECHNICAL SPECIFICATIONS	RECOMMENDED SPECIFICATIONS (CROSS-RFMO)	TAIWAN'S CCTV SUBSIDY	TAIWAN'S EM SUBSIDY
Durability	All exterior components must meet IP66 or higher rating for waterproofing and dust resistance	Requires cameras to IP66 or higher	Requires cameras to IP66 or higher
Data retention	Raw EM records and derived data must be securely stored and retained for at least 3 years, except where national regulations require a shorter period.	Video footage and diagnostic records must be retained for minimum 3 years	Video files and diagnostic logs must be retained for at least 3 years and provided to TFA on request
Data transmission	None required, as soon as practicable after trip completion, in a timely manner	Not specified	Not specified

While all four RFMOs specify technical standards for EM systems, none currently require data transmission by satellite. The minimum technical specifications above allow data retrieval through physical hard drive exchange, Wi-Fi, or mobile networks when vessels return to port.

RFMO Minimum Data Requirements

The minimum data requirements summarized in the table below represent the foundational data fields that each RFMO expects LL EM systems to capture. While there is broad alignment across the four relevant tuna RFMOs, each applies its own scope and level of detail.

The WCPFC list represents the most comprehensive set of minimum data fields for LL EM systems. The structure and content of these EM data fields closely align with the WCPFC's human observer data standards. However, not all data fields presented below are automatically generated by cameras or sensors. Some data fields (such as condition of fish, gear attributes, and compliance indicators) still require analysis by EM review software and/or data analysts. Building on these minimum data requirements, the commission has tasked the ER&EM IWG with reviewing and developing standardized templates for EM program reporting in 2025-2026.

For the IOTC, the list of minimum data requirements below refers only to the information expected to be captured directly via cameras onboard the EM system. The resulting EM data are intended to complement the IOTC's observer program database, which also houses data from human observers. To ensure data integrity, EM-derived records are clearly labeled within the database as collected via EM.

Similarly, the IATTC and ICCAT frameworks treat EM as a complementary data source that enhances observer coverage and strengthens data completeness. Member countries are expected to process and review EM footage at the national level, then report results annually through existing observer data channels. These submissions, as outlined in the next section, typically include information on EM program implementation summaries.

Figure 25: Cross-RFMO comparison of minimum data requirements

DATA FIELD	WCPFC	IOTC	IATTC	ICCAT
Trip and vessel information				
Name of vessel / registration / flag	Y	Y		Y
International Radio Call Sign	Y			
EM trip ID / unique identifier	Y			
Date & time of departure from port	Y		Y	
Port of departure	Y		Y	
Date & time of return to port	Y		Y	
Port of return	Y		Y	
Total number of sets per trip	Y	Y		
Vessel speed and course			Y	Y
Fishing area / grid square		Y		Y
Gear configuration				
Mainline material		Y		
Branchline material / wire trace			Y	
Hook type		Y		Y
Tori line (bird-scaring line)	Y	Y		Y
Side-setting with bird curtain / weights	Y			
Weighted branch lines		Y		Y
Shark lines used	Y	Y	Y	
Blue-dyed bait used	Y		Y	
Bait species / type / ratio	Y	Y		
Number of baskets or floats set	Y	Y	Y	
Hooks per basket / between floats	Y	Y		
Total hooks set	Y	Y	Y	Y
Date/time/position of start of set	Y	Y	Y	Y

DATA FIELD	WCPFC	IOTC	IATTC	ICCAT
Date/time/position of end of set	Y	Y	Y	Y
Date/time/position of start of haul	Y	Y	Y	Y
Date/time/position of end of haul	Y	Y	Y	Y
Haul direction (start-to-end / end-to-start)			Y	
Catch (target species)				
Species code (FAO 3-letter)	Y	Y	Y	Y
Catch quantity (number / weight)		Y		Y
Length / size measurement	Y	Y	Y	Y
Length-measurement code	Y	Y	Y	Y
Sex / gender	Y	Y		Y
Condition when caught	Y	Y	Y	
Fate (retained)	Y	Y	Y	Y
Product form (GG, whole, fillet)				Y
Bycatch				
Bycatch species identification	Y	Y	Y	Y
Bycatch quantity (number / weight)		Y		Y
Fate (retained / released / discarded)	Y	Y	Y	Y
Condition when released	Y	Y	Y	Y
Catch interaction type (hooked internally / entangled)			Y	
Tag recovery information		Y	Y	
Discards				
Discard species identification	Y	Y	Y	Y
Quantity discarded (number / weight)		Y		Y
Condition when discarded	Y	Y	Y	Y
Reason for discard		Y		

DATA FIELD	WCPFC	IOTC	IATTC	ICCAT
Species of Special Interest (SSI)				
Type of interaction (SSI)	Y			
Date & time of interaction	Y			
Position (latitude/longitude) of interaction	Y			
SSI species code	Y			
Length / measurement code (SSI)	Y			
Gender (SSI)	Y			
Condition when landed on deck (SSI)	Y			
Condition when released (SSI)	Y			
Trip Monitoring Summary				
Was an observer onboard (Y/N)	Y			
Interacted with non-target species (Y/N)	Y			
Failed to comply with any CMM (Y/N + details)	Y			
Transferred or transshipped fish (Y/N)	Y			
Lost any fishing gear (Y/N)	Y			
Abandoned any gear (Y/N)	Y			
Disposed metals/plastics/old gear/chemicals (Y/N)	Y			
Discharged any oil (Y/N)	Y			

As part of the broader regional effort to harmonize EM standards across RFMOs, the ISSF, through the Common Oceans ABNJ II Tuna Project led by FAO, is convening two technical consultation workshops. The first workshop, held in December 2024, brought together the tuna RFMOs, technical experts and industry to compare existing EM minimum standards and data requirements across the IATTC, ICCAT, IOTC, and WCPFC, as well as the CCSBT, identify where they already converge, and highlight priority areas for technical harmonization in fields such as core system specifications, minimum data fields and reporting formats.

A second ISSF-convened workshop, planned for 2026, is mandated under the Common Oceans Tuna Project II to focus on implementation aspects of EM, including how RFMOs and flag states can phase in EM, ensure data quality and assurance, and integrate EM into existing observer and compliance frameworks.

The work of the WCPFC's ER&EM IWG has directly referenced the outcomes of the ABNJ Tuna II harmonization workshop.

RFMO Reporting, Assurance, and Audit

Once EM systems are deployed, how data are reported and verified becomes just as important as the technology itself. Each tuna RFMO has established slightly different reporting procedures, but the underlying logic is consistent: member countries must demonstrate that their EM programs are operating to regional standards, that data are being reviewed and stored securely, and that coverage and compliance results are transparently communicated through annual reporting.

For all four relevant RFMOs, the reporting cycle operates on two levels. At the program level, national authorities submit an overview of how their EM systems are designed and implemented. This includes governance arrangements, review processes, data security measures, and overall progress toward observer coverage goals.

At the operational level, EM analysts produce standardized summaries of data such as species composition, catch quantity, condition, and interactions with protected species from the reviewed portion of EM footage. These summaries are then extrapolated to represent total fleet activity and are reported annually to the respective RFMO secretariats, in formats aligned with required minimum EM data fields, as part of members' scientific and compliance data submissions.

Under the WCPFC, members are expected to include EM implementation details in their annual reports, identify EM-equipped vessels in the real-time record of fishing vessels, and provide coverage statistics once national programs are in place. The commission is developing a standardized EM reporting template and audit mechanism with the aim to be adopted with the 2026 EM measure. Until then, members are encouraged to report using the interim structure, emphasizing coverage rates, analysis procedures, and integration with electronic logbooks.

Within the IOTC, the process is more formalized. Members that implement EM must apply for recognition of their national programs. Once approved, these programs are subject to periodic audits conducted by the IOTC secretariat to verify conformity with regional standards. Countries must also submit annual monitoring plans and data-collection tables that explain how observer-scheme data fields are captured through EM.

ICCAT and IATTC are still at earlier stages. Both require members implementing EM to submit program descriptions and annual progress summaries, but neither has yet adopted a formal audit procedure. ICCAT relies on secretariat and working-group review of member submissions, while IATTC requires that an EM program description be submitted before data are transmitted, followed by an annual EM data report and fleet-level monitoring plan each year. Both commissions have signaled that audit or assurance mechanisms will be introduced in their next phase of EM development, likely within the next two years for IATTC and slightly later for ICCAT.

Across these systems, the term "assurance" refers to verifying that EM data and review processes are accurate, secure, and unbiased, while "audit" refers to independent checks of how national programs perform relative to regional standards. The IOTC's model, in which the secretariat periodically evaluates national programs, is currently the most advanced example of EM assurance among the tuna RFMOs. WCPFC's forthcoming model will likely mirror it, using the existing observer program audit structure as a template.

IN SUMMARY

Taiwan's distant water tuna LL fleet presents a challenging operating environment for fisheries monitoring. Vessels operate across multiple oceans and RFMO jurisdictions, remain at sea for extended periods, and rely on transshipment and complex logistics that make traditional observer deployment difficult and expensive.

The main conclusion of this report is not that Taiwan faces an immediate need to deploy EM across its full LL fleet. The major tuna RFMOs have moved meaningfully in that direction, but EM is not mandatory and the timing of future requirements remains uncertain. Instead, the report suggests that Taiwan would benefit from beginning serious program design now, while there is still time to do so deliberately. International experience shows that EM implementation requires extended timelines because the challenge is institutional as much as technical. Standards must be set, vendors engaged, review systems established, data governance rules clarified, and funding arrangements identified before a program can function credibly at scale.

Taiwan already has a foundation of electronic reporting and fisheries monitoring on which EM could be built, including VMS, e-logbooks, and an existing verification architecture involving TFA and OFDC. At the same time, Taiwan's current CCTV system should not be conflated with true EM. A modern EM system requires synchronized metadata, timely review, secure chain of custody, and integration with existing reporting and compliance systems.

The report points toward a phased path forward. A sensible near-term objective might include a unified national EM framework capable of meeting the relevant technical requirements across the major tuna RFMOs. In parallel, Taiwan would need to determine its preferred approach to vendor engagement, data review, and cost sharing. International evidence does not indicate a single best model. What matters more is that the model chosen fits Taiwan's institutional capacity, preserves regulatory oversight, and remains flexible as technology and RFMO requirements continue to evolve. OFDC appears well positioned to support part of this work given its existing operational role within Taiwan's fisheries data and compliance system.

Costs are likely to be material, with significant decisions to be made regarding how these costs are justified and distributed. Taiwan's past use of public support for onboard monitoring technologies suggests there may be a case for public participation in early-stage hardware or pilot deployment, while some recurring costs may more plausibly sit with industry, particularly where vessels already derive operational value from onboard connectivity.

Finally, the prospects for EM adoption in Taiwan are likely to improve if the system is designed not only as a compliance tool, but also as something that can provide practical value to vessel owners and help protect Taiwan's commercial position in export markets. Fleet management benefits, buyer expectations around traceability and labor risk, and the evidentiary needs of ecolabels and FIPs all strengthen the case for EM. Done well, early preparation would reduce the risk of reactive policymaking later and put Taiwan in a stronger position as RFMO requirements, market expectations, and monitoring technologies continue to converge.

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August 2026



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