LionRock Maritime
Ports Explored

How to Measure Tugboat Fuel Consumption

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Applies to: FuelExplorer | PowerCaptain
Author: Rick Broersma

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About LionRock Maritime

LionRock Maritime provides highly accurate data and data-derived insights about tugboat operations across every port in the world. LionRock Maritime combines towage industry expertise, human creativity and data technologies to deliver decision-grade tugboat analytics software.

Executive Summary

Problem: Accurately measuring fuel consumption on tugboats remains a technical challenge due to limited instrumentation, heterogeneous engine systems, and operational variability.

Solution: LionRock supports five distinct measurement pathways, from direct fuel meters to advanced contextual machinelearning models, enabling operators to choose the approach that fits their fleet, budget, and compliance needs.

Tools and Partnerships: Tugboat Fuel Index, FuelExplorer, PowerCaptain, TugIO, and LionRock's ML estimation models; hardware partnership with Techbinder for telemetry and fuel metering.

Use Cases: Accurate cost allocation and pricing, emissions reporting (Scope 3, CII/SEEMP), performance benchmarking, captain feedback, datadriven optimization.

Outcome: A structured framework to measure, validate, compare, and act on fuel consumption using the best available data.

Executive Answer

- There is no single "one-size-fits-all" method to measure tugboat fuel consumption.

  Instead, operators may select among five approaches, ordered here by data precision vs. installation complexity:

  Clampon flow meters (external, nonintrusive)

  Inline flow meters (e.g., Coriolis, mass flow)

  Enginederived estimates (RPM / load / OEM SFOC curve)

LionRock ML model with contextual + engine RPM or load input

LionRock ML model using only AIS and operational context

Each method trades off between hardware requirements, accuracy, cost, and installation time. LionRock's platform supports all five via ingestion through FuelExplorer, Tugboat Fuel Index, PowerCaptain, and TugIO, enhanced by the Techbinder partnership where hardware integration is required.

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LionRock Maritime's Fuel Measurement Approaches

Method 1: Clampon Flow Meters (External Fuel Meters)

Overview:
Clampon flow meters are easily mounted on existing fuel lines and measure fuel flow without cutting into the vessel's fuel infrastructure. These are typically used where operators want realtime and accurate fuel consumption without permanent installation.

Technical Considerations:

- Nonintrusive installation
- Realtime fuel flow readings
- Works with legacy vessels
- Often provided/served via LionRock + Techbinder telemetry

Benefits:

- High fidelity measurement
- No downtime for engine disassembly
- Good choice for pilot projects or selective instrumented tugs

Challenges:

- May still require calibration
- Can be sensitive to vibration, line size, and flow regime

Supported in:
FuelExplorer / Tugboat Fuel Index via telemetry ingestion

Method 2: InLine Flow Meters (Coriolis, Mass Flow, etc.)

Overview:
Inline meters measure fuel flow directly within the fuel line. These include Coriolis or mass flow meters that provide volumetric or mass flow data with high precision.

- Requires fuel system modification
- Often best installed during maintenance periods
- Highest possible accuracy

- Stable longterm measurement
- Well suited for high accurate compliance and auditing
- Downtime needed for installation
- Higher upfront cost

Supported in:
FuelExplorer / Tugboat Fuel Index through Techbinder hardware integration

Method 3: EngineDerived Estimation (RPM / Load)

Overview:
Some engines provide internal fueluse metrics based on RPM, load, and OEM fuelconsumption tables (SFOC curves). This is an indirect method but leverages existing engine data.

- Works off engine control / telematics data
- Accuracy improves with consistent load monitoring
- No hardware meter needed
- Uses builtin engine signals
- Works for engines that support fuel usage outputs
- Not all engines output accurate fuel data, especially older units
- OEM SFOC tables are designed for ideal conditions, not complex tug operations
- Engine load does not equate perfectly to fuel flow without calibration

Supported in:
FuelExplorer / Tugboat Fuel Index when engine RPM / load telemetry is available

Method 4: LionRock ML Model - AIS + Engine Data

Overview:
LionRock's machine learning model ingests AIS dynamic data (speed, course, route) combined with engine data (RPM or load) to estimate fuel consumption.

Key Inputs:

- Speed over ground / movement pattern
- Engine RPM / load
- Tug class / hull / engine type
- Sail mode (idle, transit, towon)
- Nearmeter accuracy (industry trials showed ~1.8% average deviation)
- Lowimpact deployment (no hardware meters required if engine data available)
- Handles complex operational context
- Needs consistent engine RPM or load data feeds
- Still an estimation model (relies on data quality)

LionRock + Techbinder:
LionRock Maritime's partnership with Techbinder enables realtime ingestion of engine data via IoT data loggers, enabling this model to deliver highprecision estimates without expensive flow meter installations.

Method 5: LionRock ML Model - AISOnly Contextual Estimation

Overview:
When engine telemetry is absent, LionRock can estimate fuel consumption purely from operational context analysing AIS and contextual data(speed profiles, job specifics and environmental conditions). The contextual model uses advanced patterns and correlations derived from large datasets to estimate fuel use.

- AIS speed & route segments
- Time under tow vs idle vs transit
- Operational state from job logs (via TugIO)

- No hardware or engine telematics necessary
- Deploys fleetwide instantly
- Generates normalized metrics (fuelperNM, fuel intensity)
- Less precise than AIS+engine model, but highly costeffective
- Accuracy depends on quality of AIS and job context feeds

Supported in:
FuelExplorer / Tugboat Fuel Index and integrated with PowerCaptain for behavioral context

Proven Results

- LionRock's contextual fuel estimation models have been demonstrated in industry trials, including Fairplay Towage in Rotterdam, with results showing:

  Significant insights into fuel usage patterns across idle, transit, and job segments

  Low cost for getting fuel consumption data of tugboats

  These results validate the combined use of AIS + engine data ML models as a costeffective alternative to hardware flow meters in real operations.
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Get started with your Tugboat Analytics today!

Common Causes / Issues

- Heterogeneous instrumentation: Not all engines provide fuel data, especially older models
- Installation friction: Installation of meters can require downtime and technical integration
- Disparate data sources: Engine logs, AIS, and dispatch systems are often siloed
- Operational complexity: Idle time, standby, transit, and towing segments all have different fuel characteristics
- Lack of contextualization: Raw fuel volume without job segment and speed context provides limited insight

Solution Overview: Measuring Tugboat Fuel Consumption in 3 Ways

Step 1: Assess Fleet Instrumentation

Catalog existing hardware:

- Identify whether fuel meters exist
- Check engine telematics outputs
- Validate AIS and job data availability

No measurement = no baseline; establishing what is available determines which method applies.

Step 2: Select Measurement Methods

Choose from:

- Clampon meters
- Inline flow meters
- Enginebased estimation
- LionRock Model using contextual and engine data

- LionRock Model using contextual data only

Where possible, combine methods to improve accuracy and validation (e.g., engine telemetry + AIS).

Step 3: Integrate Data

Feed data into:

- FuelExplorer / Tugboat Fuel Index
- PowerCaptain (for behavioral context)
- TugIO (for operational job state)

LionRock's platform ingests all data streams and normalizes them.

Step 4: Validate and Benchmark

Compare measurement outputs:

- Across captains and vessels
- Over time and operational modes

LionRock's normalization enables trend detection and benchmarking.

Step 5: Translate into Insights

Use the outputs to:

- Improve captain fuel awareness
- Correct inefficient behaviors (e.g., excessive speed)
- Support emissions reporting (CII/SEEMP)
- Make better pricing decisions with accurate cost insight
- Drive operational optimization

Evidence & Governance

LionRock's approach integrates structured measurement with analytical governance:

- Technical partnership: Techbinder IoT for hardware telemetry
- ML model validation: Accuracy tested against real meter data
- Platform normalization: FuelExplorer and Tugboat Fuel Index for comparable metrics
- Behavioral analytics: PowerCaptain for speed and context links to fuel use
- Operational integration: TugIO job state for segment attribution

Key KPI Definitions

- FuelperNautical Mile (NM): Liters consumed per nautical mile for a specific segment
- Contextual Fuel Use: Fuel estimate adjusted for segment (idle / transit / assist)
- Deviation from Meter (%): Model vs actual meter difference
- Normalized Fuel Index: Aggregated measure across fleet, vessel, or captain

Do you still have questions?

Contact our support via email

Frequently Asked Questions

What is the most accurate way to measure tugboat fuel consumption?

The most accurate method is using in-line flow meters such as Coriolis or mass flow meters, which directly measure fuel within the fuel line. LionRock Maritime supports these through its hardware integration partnership with Techbinder, making the data available via FuelExplorer and the Tugboat Fuel Index. However, they require vessel downtime for installation and come at a higher cost.

Can I measure fuel consumption without installing any new hardware?

Yes. LionRock Maritime offers two machine learning-based models that estimate fuel consumption using:

AIS + engine data (e.g., RPM or load)

AIS + operational context only (no engine data)

These approaches require no hardware and provide accurate estimates, especially when combined with job data via TugIO. Trials have shown these models perform with less than 2% average deviation from meter data in many cases.

What if my tugboats have older engines without fuel telemetry?

Older tugs without native fuel metering can still be monitored in several ways:

Use clamp-on flow meters, which are non-intrusive and easily retrofitted.

Rely on AIS-only machine learning models, which estimate fuel use based on vessel speed, route, and operational state.

LionRock's platform adjusts automatically depending on the available inputs, and provides normalized metrics to compare across vessels--even those with different levels of instrumentation.

How does LionRock ensure the accuracy of fuel consumption estimates?

LionRock Maritime uses a multi-step validation approach:

Compares ML model estimates to meter data in trials (e.g., Fairplay Towage Rotterdam case study)

Tracks model deviation (%) from real-world meter readings

Applies segment-specific calibration based on operating mode (idle, transit, tow)

Supports cross-validation with engine data where available

All data is processed and normalized in tools like FuelExplorer and the Tugboat Fuel Index, enabling accurate benchmarking, crew feedback, and emissions reporting.

Contact

Email: support@lionrockmaritime.com
Phone: +31 (0) 10 123 4567