FlowSense™

Intelligent Flow Meter Uncertainty & Compliance AI Platform

Upstream Flow Meter Uncertainty Audit & Analysis Platform using AI Agents

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How **FlowSense™** works

- Master Data of Meters with the Field Locations Fed into the System
- Generate Field Survey details as part of the Meter Audit Templates
- Push the audit templates to a collaborative Portal
- Use a AI Agent to perform Uncertainty Analysis and calculate Adjusted Production
- Auto Generates Site Assessment Report – Field level summary, Compliance gaps, Key findings
- Auto Generates risk scoring & anomaly detection with a Predictive Compliance Report

System Setup

Portal Scope

AI Agent Scope

How **FlowSense™** supports NDR & NPMS

Aligns with NPMS & NUPRC Regulations
Automates flow rate validation for accurate production reporting.
Ensures compliance with API, ISO, & NUPRC metering standards.
Centralized Data & Analytics for NDR
Stores flow meter uncertainty trends for historical insights.
Enables root cause analysis & performance tracking.
AI-Powered Predictive Analytics
Anomaly detection to flag faulty meters before failure.
Predictive maintenance to reduce downtime & losses.
Improves Custody Transfer & Revenue Assurance
Enhances allocation accuracy to prevent hydrocarbon losses.
Detects underreporting risks in production volumes.
Strengthens Nigeria's Energy Data Governance
Provides real-time metering insights for policymakers.
Increases transparency & accountability in the upstream sector.

NDR: National Data Repository
NPMS: National Production Monitoring System

FlowSense™ - Uncertainty Analysis Input Parameters

Typical Site/Field Information

Parameter	Description
Production Site Name	Name of the production location where meters are installed.
Location (Latitude/Longitude)	Geographic coordinates for the production site.
Operator	Name of the oil and gas company operating the site.
Field Name	Name of the oil or gas field (e.g., OML, OPL, or PPL).
Ambient Temperature Range (Min/Max)	Minimum and maximum site temperature.
Atmospheric Pressure	Baseline atmospheric pressure of the site.
Regulatory Standards to Meet	Compliance guidelines (e.g., API, ISO 5167).

Typical Flow Meter Specifications

Parameter	Description
Meter ID	Unique identifier for each flow meter.
Location in Process	Specifies where the meter is installed (e.g., wellhead, pipeline).
Flow Meter Type	Type of meter (Ultrasonic, Coriolis, Turbine, Differential Pressure, etc.).
Manufacturer & Model	Brand and model of the flow meter.
Size (inches)	Physical diameter of the meter.
Flow Rate (Min/Max/Nominal)	Minimum, maximum, and nominal flow rate in m^3/h.
Fluid Type	Type of fluid being measured (Oil, Gas, Water).
Fluid Density (kg/m^3)	Fluid's density at operating conditions.
Fluid Viscosity (cP)	Viscosity of the fluid.
Operating Temperature (°C)	Temperature of the fluid during measurement.
Operating Pressure (bar)	Pressure at which the fluid is being measured.
Pipe Diameter (inches)	Pipe size where the meter is installed.
Upstream Straight Pipe Length	Length of straight pipe before the meter.
Downstream Straight Pipe Length	Length of straight pipe after the meter.
Installation Orientation	Whether the meter is installed horizontally or vertically.

FlowSense™ - Uncertainty Analysis Input Parameters

Typical Calibration & Measurement Uncertainty

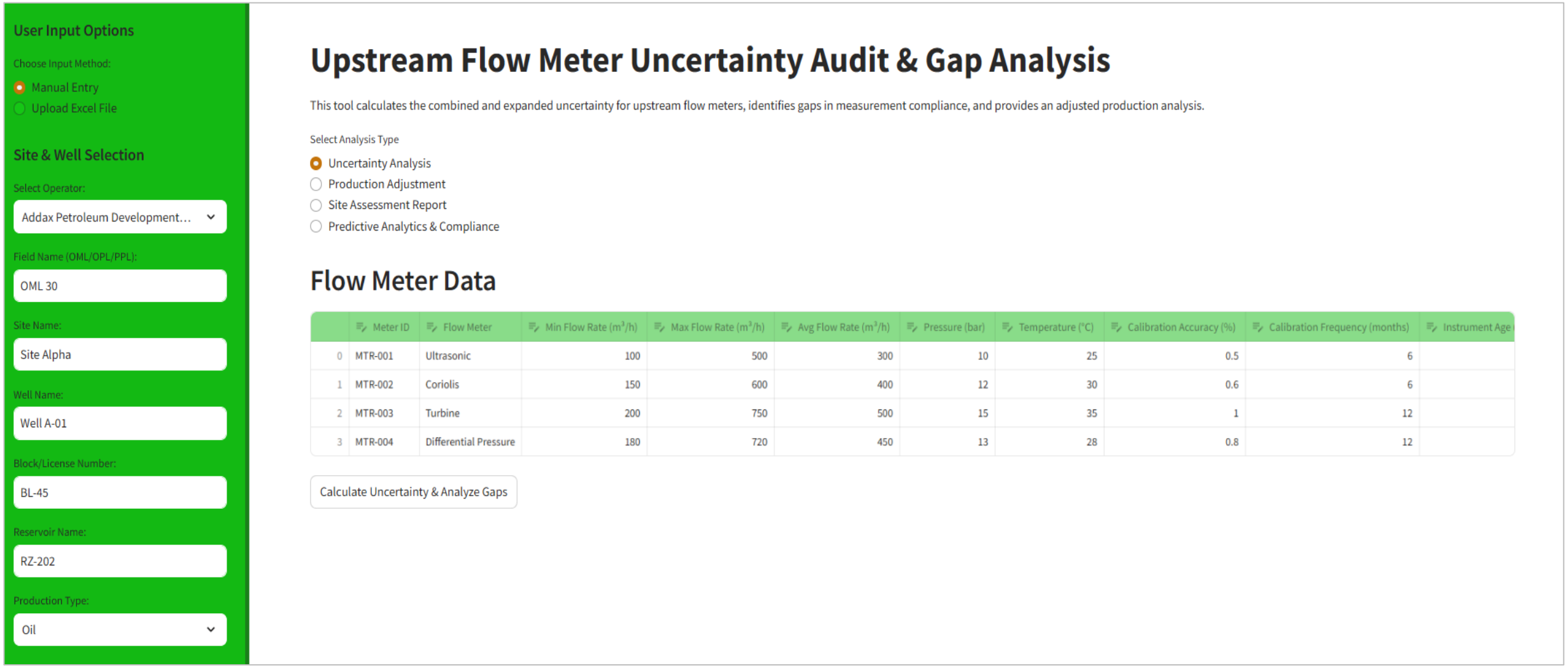
Parameter	Description
Calibration Method	How the meter was calibrated (e.g., Flow Lab, In-Situ).
Calibration Date	Last calibration date of the meter.
Number of Calibration Points	Number of points used for calibration.
Calibration Uncertainty (%)	Uncertainty in calibration results.
Flow Meter Uncertainty (%)	Accuracy of the flow meter under test conditions.
Temperature Measurement Uncertainty (°C)	Error margin in temperature measurement.
Pressure Measurement Uncertainty (%)	Error margin in pressure measurement.
Density Measurement Uncertainty (%)	Error margin in fluid density measurement.
Installation Effects Uncertainty (%)	Impact of improper installation on measurement accuracy.

Typical Operational & Economic Data

Parameter	Description
Vibration Level	Impact of vibrations on meter accuracy.
Measurement Duration	Time for which measurements were taken.
Sampling Rate	Frequency at which meter readings are collected.
Integration Method for Batch Calculations	Algorithm used for averaging batch calculations (e.g., Trapezoidal).
Uncertainty Propagation Method	How uncertainty is calculated across multiple parameters (e.g., GUM).
Required Measurement Accuracy	Regulatory measurement accuracy requirement.
Product Price ($/unit)	Price of oil/gas per unit for economic loss estimation.
Daily Production Volume (bbl/day)	Volume of production recorded per day.

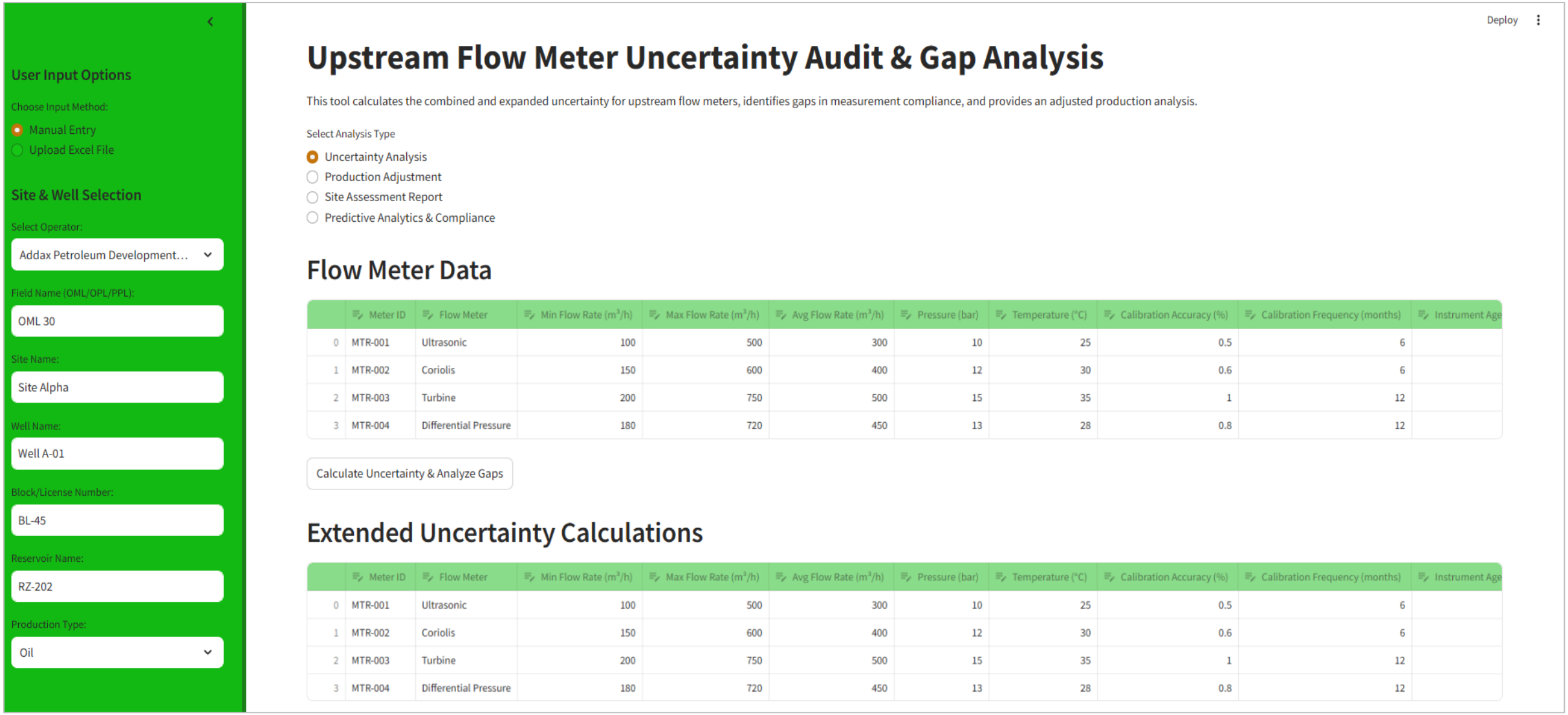
FlowSense™ Demo Screens

FlowSense™ - Uncertainty Analysis Input Screen



	Meter ID	Flow Meter	Min Flow Rate (m³/h)	Max Flow Rate (m³/h)	Avg Flow Rate (m³/h)	Pressure (bar)	Temperature (°C)	Calibration Accuracy (%)	Calibration Frequency (months)	Instrument Age
0	MTR-001	Ultrasonic	100	500	300	10	25	0.5	6	
1	MTR-002	Coriolis	150	600	400	12	30	0.6	6	
2	MTR-003	Turbine	200	750	500	15	35	1	12	
3	MTR-004	Differential Pressure	180	720	450	13	28	0.8	12	

FlowSense™ - Extended Uncertainty Calculations



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FlowSense™ - Adjusted Production Calculation

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User Input Options

Choose Input Method:

- (•) Manual Entry
- ( ) Upload Excel File

Site & Well Selection

Select Operator: Addax Petroleum Development…

Field Name (OML/OPL/PPL): OML 30

Site Name: Site Alpha

Well Name: Well A-01

Block/License Number: BL-45

Reservoir Name: RZ-202

Production Type: Oil

Upstream Flow Meter Uncertainty Audit & Gap Analysis

This tool calculates the combined and expanded uncertainty for upstream flow meters, identifies gaps in measurement compliance, and provides an adjusted production analysis.

Select Analysis Type

- ( ) Uncertainty Analysis
- (•) Production Adjustment
- ( ) Site Assessment Report
- ( ) Predictive Analytics & Compliance

Adjusted Production Calculation

	Meter ID	Flow Meter	Min Flow Rate (m^3/h)	Max Flow Rate (m^3/h)	Avg Flow Rate (m^3/h)	Pressure (bar)	Temperature (°C)	Calibration Accuracy (%)	Calibration Frequency (months)	Instrument Age
0	MTR-001	Ultrasonic	100	500	300	10	25	0.5	6	
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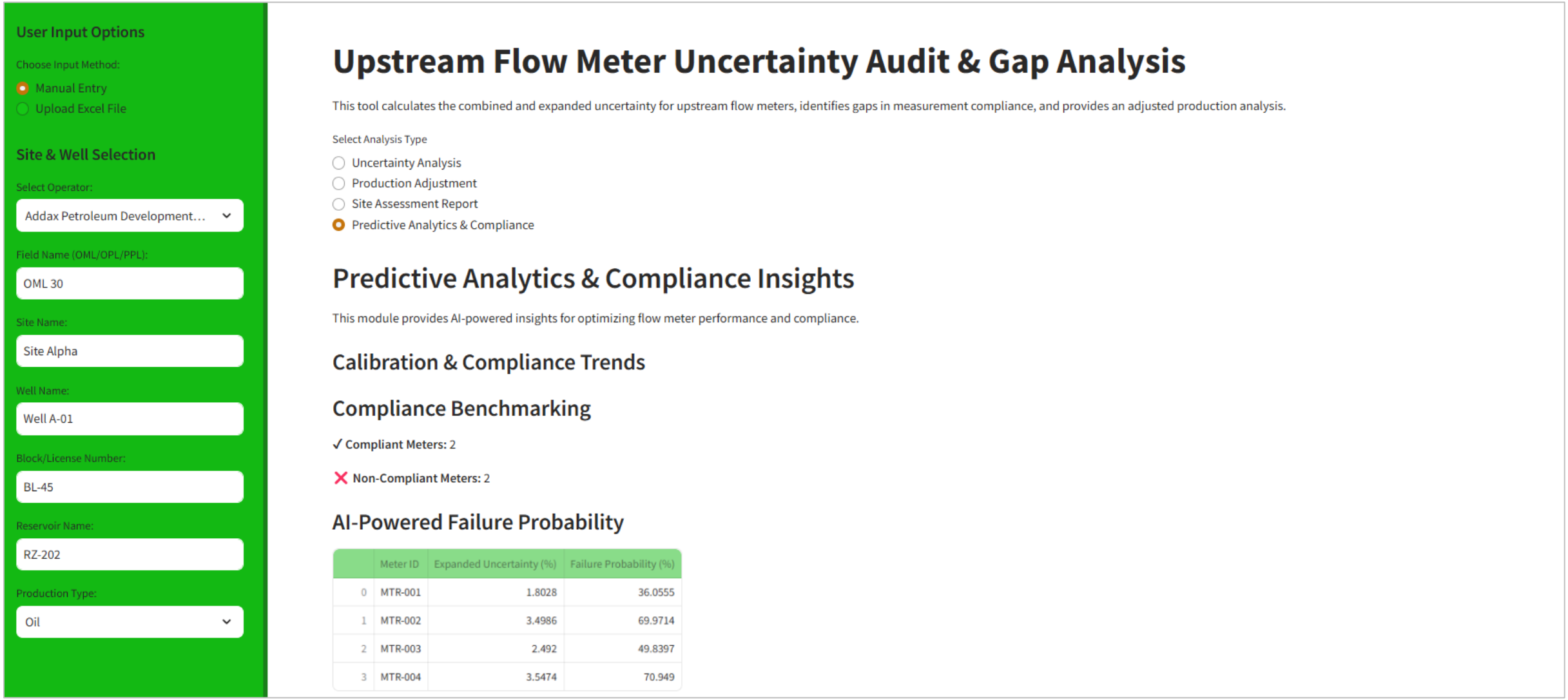
2	MTR-003	Turbine	200	750	500	15	35	1	12	
3	MTR-004	Differential Pressure	180	720	450	13	28	0.8	12	

Download Production Adjustment Report

FlowSense™ - Predictive Analytics & Compliance Insights



FlowSense™ - Predictive Analytics & Compliance Insights

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User Input Options

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Site & Well Selection

Select Operator: Addax Petroleum Development…

Field Name (OML/OPL/PPL): OML 30

Site Name: Site Alpha

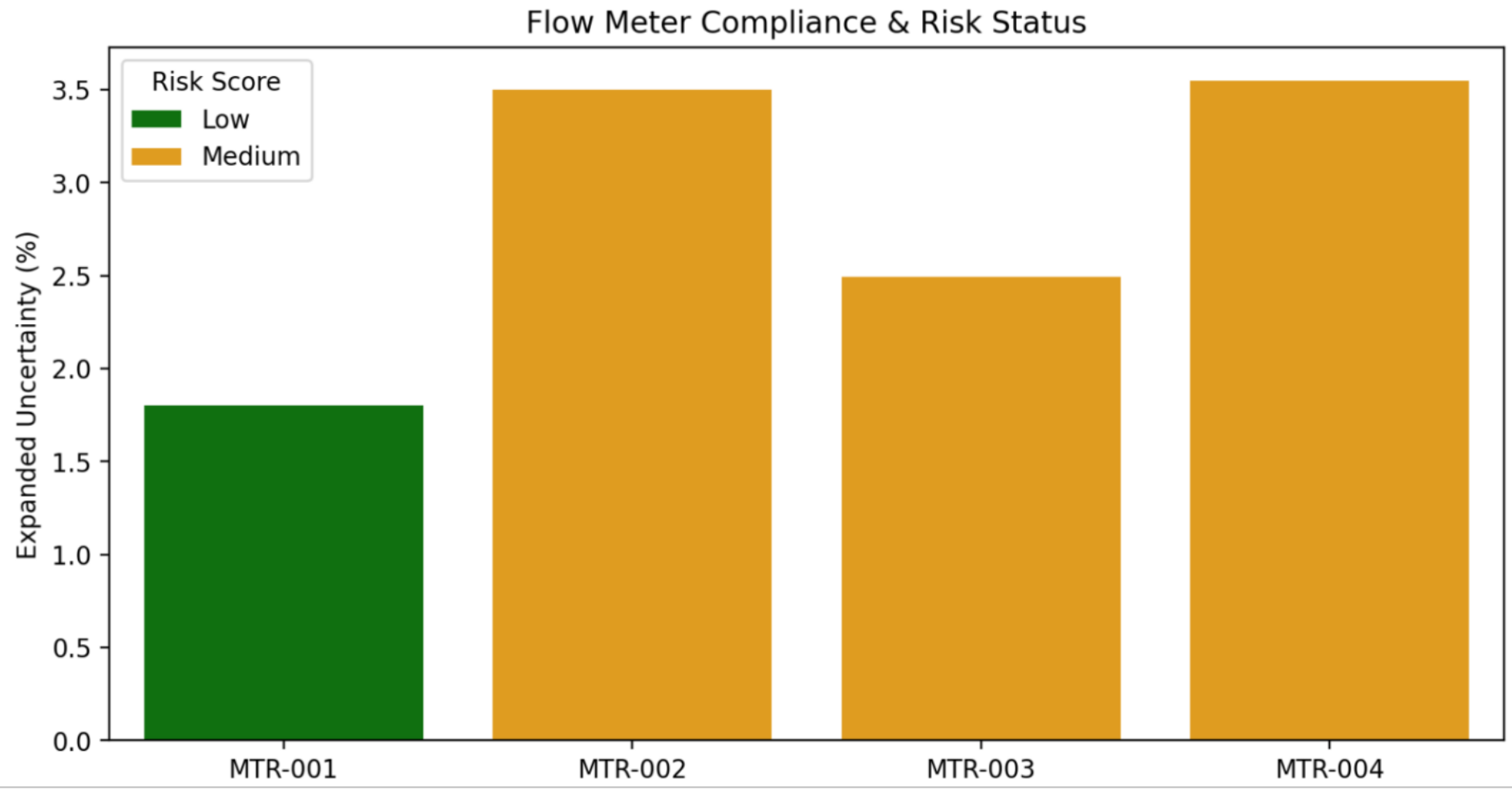
Well Name: Well A-01

Block/License Number: BL-45

Reservoir Name: RZ-202

Production Type: Oil

Risk Scoring & Anomaly Detection



FlowSense™ - Reports

Report Name	Description	Auto Generates	Format	Data Model Availability for the Report to be pushed to a PostgreSQL Table
Uncertainty Report	Contains detailed meter-wise expanded uncertainty calculations, with breakdowns per parameter.	Yes	Excel (.xlsx)	Yes
Production Adjustment Report	Provides Adjusted Production Calculations using Weighted Root Sum of Squares (RSS).	Yes	Excel (.xlsx)	Yes
Site Assessment Report	Includes detailed site-level summary, meter performance evaluation, key findings, and recommendations.	Yes	Document (.docx)	Yes
Predictive Compliance Report	AI-driven risk scoring, failure predictions, and compliance forecasting trends.	Yes	Document (.docx)	Yes

FlowSense™ - Reports

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Uncertainty Report	Contains detailed meter-wise expanded uncertainty calculations, with breakdowns per parameter.
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Meter ID	MTR-001	MTR-002	MTR-003	MTR-004
Flow Meter	Ultrasonic	Coriolis	Turbine	Differential Pressure
Min Flow Rate (m^3/h)	150	200	200	180
Max Flow Rate (m^3/h)	500	600	750	720
Avg Flow Rate (m^3/h)	300	400	500	450
Pressure (bar)	10	12	15	13
Temperature (°C)	25	30	35	28
Calibration Accuracy (%)	0.5	0.6	1	0.8
Calibration Frequency (months)	6	6	12	12
Instrument Age (Years)	3	5	7	4
Production (bbl/day)	3000	2500	1500	3000
Measurement Compliance	Compliant	Non-Compliant	Compliant	Non-Compliant
Fluid Composition	Gas	Liquid	Gas	Gas
Piping Configuration	Straight Run	Bends Present	Valves Nearby	Straight Run
Installation Status	Proper	Improper	Proper	Improper
Calibration Uncertainty	0.25	0.3	0.5	0.4
Temperature Uncertainty	0.5	0.6	0.7	0.56
Pressure Uncertainty	0.5	0.6	0.75	0.65
Measurement Compliance Uncertainty	0.5	1.5	0.5	1.5
Expanded Uncertainty (%)	1.802775638	3.498571137	2.491987159	3.547449788

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Flow Meter	Ultrasonic	Coriolis	Turbine	Differential Pressure
Min Flow Rate (m^3/h)	150	200	200	180
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Pressure (bar)	10	12	15	13
Temperature (°C)	25	30	35	28
Calibration Accuracy (%)	0.5	0.6	1	0.8
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Instrument Age (Years)	3	5	7	4
Production (bbl/day)	3000	2500	1500	3000
Measurement Compliance	Compliant	Non-Compliant	Compliant	Non-Compliant
Fluid Composition	Gas	Liquid	Gas	Gas
Piping Configuration	Straight Run	Bends Present	Valves Nearby	Straight Run
Installation Status	Proper	Improper	Proper	Improper
Calibration Uncertainty	0.25	0.3	0.5	0.4
Temperature Uncertainty	0.5	0.6	0.7	0.56
Pressure Uncertainty	0.5	0.6	0.75	0.65
Measurement Compliance Uncertainty	0.5	1.5	0.5	1.5
Expanded Uncertainty (%)	1.802775638	3.498571137	2.491987159	3.547449788
Weight Factor	0.3	0.25	0.15	0.3
Weighted Uncertainty	0.540832691	0.874642784	0.373798074	1.064234936
Adjusted Production	2945.916731	2412.535722	1462.620193	2893.576506

FlowSense™ - Reports

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Comprehensive Site Assessment Report

Operator: Aiteo Eastern E&P Company Limited
Field Name: OML 128
Site Name: Site Alpha
Well Name: Well A-01

Meter-Level Summary

Meter ID	Flow Meter Type	Expanded Uncertainty (%)	Compliance Status	Calibration Status
MTR-001	Ultrasonic	1.80%	Compliant	6 months
MTR-002	Coriolis	3.50%	Non-Compliant	6 months
MTR-003	Turbine	2.49%	Compliant	12 months
MTR-004	Differential Pressure	3.55%	Non-Compliant	12 months

Operational KPIs

Total Production: 10000 bbl/day
Adjusted Production: 9714.65 bbl/day
Site-Level Uncertainty Factor: 1.53%

Key Findings & Root Cause Analysis

- Meter MTR-002 exceeds uncertainty threshold (Uncertainty: 3.50%).
- Meter MTR-002 is non-compliant and requires corrective action.
- Meter MTR-004 exceeds uncertainty threshold (Uncertainty: 3.55%).
- Meter MTR-004 is non-compliant and requires corrective action.

Recommendations

- Implement regular calibration schedules to maintain accuracy.
- Upgrade outdated or non-compliant meters to improve compliance.
- Enhance real-time monitoring to reduce operational errors.

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Predictive Compliance Report	AI-driven risk scoring, failure predictions, and compliance forecasting trends.

Predictive Compliance Report

This report provides AI-powered insights for optimizing flow meter uncertainty and improving compliance.

Risk Assessment

Meter MTR-001 - Risk Level: Low - Expanded Uncertainty: 1.80%

Meter MTR-002 - Risk Level: Medium - Expanded Uncertainty: 3.50%

Meter MTR-003 - Risk Level: Medium - Expanded Uncertainty: 2.49%

Meter MTR-004 - Risk Level: Medium - Expanded Uncertainty: 3.55%

AI-Powered Failure Probability

Meter MTR-001 - Failure Probability: 36.1%

Meter MTR-002 - Failure Probability: 70.0%

Meter MTR-003 - Failure Probability: 49.8%

Meter MTR-004 - Failure Probability: 70.9%

Key Recommendations

✓ Implement predictive maintenance schedules based on risk levels.

✓ Conduct real-time anomaly detection to monitor meter uncertainty.

✓ Align measurement uncertainty within API / ISO compliance guidelines.

FlowSense™ – Technology Stack

Data Ingestion

Meter Auditors upload data:

→ Uncertainty, Calibration, Flow Rate, Production) via SharePoint Portal.

→ Data is automatically ingested into FlowSense AI using ETL scripts.

FlowSense™ AI Engine

Calculates & Auto generates Reports:

→ Expanded Uncertainty (%) for each meter.

→ Site-Level Uncertainty Factor using the Weighted Root Sum of Squares (RSS) method.

→ Production Adjustment Calculation for final production estimates.

Data Storage

Structured storage of:

→Raw Inputs (Uploaded meter audit data).

→Processed Uncertainty & Production Data.

→Compliance Reports & AI Risk Scores.

API Integration

FlowSense exposes secure APIs for:

→ Power BI Dashboards (Regulatory & Operational Reporting).

→ KNIME AI Models (Anomaly Detection & Predictive Maintenance).

→ Other ERP/SCADA Integrations if required.

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Technology Stack

- Data Ingestion: SharePoint ETL
- Processing Engine: FlowSense™
- Storage: PostgreSQL
- BI & AI Workbench: Power BI, KNIME
- APIs: Secure REST APIs for External Integration

Actionable Insights & Compliance

- Operators & Regulators use Power BI for visual trends & KPIs
- Data Scientists leverage KNIME for predictive maintenance & anomaly detection
- FlowSense™ continuously improves uncertainty models using machine learning

Program Outcomes

- Better Measurement Accuracy
- Regulatory Compliance
- Optimized Production

At Greenojo, we are leading the next wave of Industrial AI, Agentic AI, & Generative AI, transforming industries with autonomous, intelligent, and scalable AI-driven solutions.

THANK YOU

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Greenojo Consulting Private Ltd