Kingston Energy

Waste-to-Energy Management Platform

Version 1.0 | Technical Documentation

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System Overview

The Kingston Energy Tracking System is a comprehensive web application designed to monitor and optimize waste-to-energy operations in Kingston, Jamaica. The platform provides real-time tracking of garbage collection trucks, energy production statistics, and AI-powered operational insights.

Key Objectives

* Real-time monitoring of waste collection operations
* Energy production tracking and analytics
* Route optimisation and efficiency analysis
* Multi-role access control system
* AI-driven predictive maintenance

Target Users

* System Administrators - Full system control and configuration
* Operations Managers - Daily operational oversight
* Resident Users - Local area status and collection information

Features

🔐 Authentication & Security

Multi-tier Role System

* Administrator: Full system access
* Manager: Operational oversight
* User: Basic information access

Demo Accounts

* Admin: `admin` / `admin123`
* Manager: `manager` / `manager123`
* User: `user` / `user123`

🗺️ Interactive Mapping System

Real-time Geographic Visualisation

* Leaflet.js powered interactive maps
* Kingston-centered coordinate system (17.9970, -76.7936)
* Major road network overlay
* Collection zone boundaries

Live Asset Tracking

* Colour-coded truck status indicators
* Real-time position updates
* Route visualisation and optimisation

🚛 Intelligent Truck Management

Status Monitoring

* 🟢 Collecting: Active waste collection
* 🟡 Enroute to Disposal: Transporting to facilities
* 🔴 Disposing: At energy plant
* 🔵 Returning: Heading back to zones

Performance Metrics

* Load capacity tracking (0-100%)
* Collection rate monitoring (kg/min)
* Speed optimisation controls
* Route efficiency analysis

⚡ Energy Production Analytics

Real-time Statistics

* Steam energy generation (kWh)
* Carbon offset calculations (kg CO₂)
* Waste processing metrics (tons)
* Homes powered equivalents

Facility Monitoring

* Power plant capacity utilisation
* Output efficiency tracking
* Load distribution analysis

🤖 AI-Powered Intelligence

Virtual Assistant

* Natural language processing
* Real-time system queries
* Operational insights
* Predictive analytics

Smart Alert System

* Priority-based notifications (Critical, High, Medium, Low)
* Predictive maintenance alerts
* Route optimization suggestions
* Capacity warnings
* Weather alerts

🔍 Advanced Search & Analytics

Real-time Search

* Truck ID-based filtering
* Visual result highlighting
* Map auto-navigation

Location Services

* User-area status monitoring
* Proximity-based alerts
* Collection schedule information

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Technical Architecture

|  |  |  |
| --- | --- | --- |
| Technology | Version | Purpose |
| HTML5 | Latest | Semantic structure & accessibility |
| CSS3 | Latest | Responsive design & animations |
| JavaScript | ES6+ | Client logic & state management |
| Leaflet.jsLeafl | 1.9.4 | Interactive mapping |

System Components

Core Data Structures

```javascript

// User Management

const users = [

    {

        username: 'admin',

        password: 'admin123',

        role: 'admin',

        name: 'System Administrator'

    }

];

// Geographic Data

const KINGSTON\_CENTER = [17.9970, -76.7936];

const KINGSTON\_ROADS = [...]; // Road network definitions

const COLLECTION\_ZONES = [...]; // Service areas

// Asset Management

const trucks = [

    {

        id: 'KGN-1234',

        position: { lat, lng },

        status: 'collecting',

        load: 2500,

        capacity: 12000,

        metrics: {...}

    }

];

```

AI Alert System Architecture

```javascript

const ALERT\_TYPES = {

    MAINTENANCE: {

        title: "Maintenance Required",

        source: "AI Predictive Maintenance",

        icon: "🔧",

        priority: "high"

    },

    EFFICIENCY: {

        title: "Efficiency Alert",

        source: "AI Performance Monitor",

        icon: "📊",

        priority: "medium"

    }

    // ... additional alert types

};

```

Performance Optimisation

Efficient Rendering

* Dynamic marker management
* Optimised route calculations
* Debounced user inputs

Memory Management

* Alert system limits (50 alerts max)
* Efficient garbage collection
* Optimised event listeners

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Installation Guide

System Requirements

* Web Browser: Chrome 70+, Firefox 65+, Safari 12+, Edge 79+
* Internet Connection: Required for map tiles and CDN resources
* JavaScript: Must be enabled
* Screen Resolution: 1280x720 minimum recommended

Quick Installation

1.File Preparation

* Download all project files to a single directory
* Ensure file structure integrity:

   ```

   project-folder/

   ├── index.html

   ├── style.css

   └── app.js

   ```

2. Deployment

* Open `index.html` in a web browser
* No server configuration required (runs client-side)

3. Initial Setup

* Use demo credentials for login
* Explore different user roles
* Verify map loading and functionality

Network Configuration

CDN Dependencies:

* Leaflet.js (maps)
* OpenStreetMap (tile server)

Firewall Considerations:

* Allow access to `\*.tile.openstreetmap.org`
* Enable `unpkg.com` for Leaflet CDN

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User Guide

Administrator Role

Truck Management

1. Add New Trucks

* Click "+ Add New Truck" in controls section
* System auto-generates ID and position
* Configure initial settings

2. Modify Existing Trucks

* Edit Location: Update GPS coordinates
* Edit ID: Change truck identification
* Adjust Settings: Speed, capacity, collection rate

3. Performance Monitoring

* Real-time load tracking
* Route efficiency analysis
* Maintenance scheduling

System Configuration

* Alert threshold settings
* User management
* Performance benchmarks

Manager Role

Operational Oversight

* Real-time status dashboard
* Alert acknowledgment and management
* Performance reporting
* Resource allocation

Analytics Access

* Energy production trends
* Route optimisation suggestions
* Capacity planning insights

User Role

Resident Services

* Local area status
* Collection schedule information
* Proximity-based truck tracking
* Service notifications

Search Functionality

* Truck ID search
* Location-based filtering
* Status querying

AI Assistant Usage

Natural Language Queries

```

"Show me trucks near downtown"

"What's our energy production?"

"Any maintenance alerts?"

"Truck status for KGN-1234"

```

Supported Query Types

* Truck locations and status
* Route information
* Energy production stats
* Waste management data
* System performance

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API Documentation

Data Models

Truck Object Specification

```javascript

{

    id: "String (KGN-XXXX)",

    lat: "Number (17.8-18.2)",

    lng: "Number (-77.0 - -76.6)",

    load: "Number (kg)",

    capacity: "Number (kg)",

    status: "Enum: collecting, enroute-to-disposal, disposing, returning",

    speed: "Number (multiplier)",

    collectionRate: "Number (kg/min)",

    currentRoad: "String",

    collectionZone: "String",

    routePath: "Array[Coordinates]",

    metrics: {...}

}

```

Alert Object Specification

```javascript

{

    id: "String (ALT-timestamp-random)",

    type: "Enum: MAINTENANCE, EFFICIENCY, ROUTE, SAFETY, CAPACITY, WEATHER",

    title: "String",

    message: "String",

    priority: "Enum: critical, high, medium, low",

    source: "String",

    icon: "String (emoji)",

    timestamp: "Date",

    acknowledged: "Boolean",

    context: {...}

}

```

Event System

User Interface Events

* `login()`: Authentication handler
* `searchTrucks()`: Real-time search
* `toggleChat()`: AI assistant control
* `updateTruckSetting()`: Admin modifications

Simulation Events

* `updateTruckLoadsRealTime()`: Load calculations
* `moveTruckAlongRoute()`: Position updates
* `checkForAlerts()`: AI monitoring
* `updateStats()`: Metrics recalculation

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Technical Specifications

Geographic System

* Latitude: 17.8° to 18.2°
* Longitude: -77.0° to -76.6°
* Road Network: 5 major arteries with detailed paths
* Collection Zones: 6 defined service areas with radius 1.1-1.6km

Performance Metrics

Update Frequency

* Truck positions: 2 seconds
* Load calculations: 1 second
* Alert checks: 10 seconds

Data Limits

* Maximum alerts: 50
* Search results: Unlimited
* Route points: Dynamic calculation

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Troubleshooting

Common Issues & Solutions

Map Display Problems

* Symptom: Blank or gray map are
* Solution:
* Check internet connection
* Verify Leaflet CDN accessibility
* Clear browser cache
* Check browser console for errors

Performance Issues

* Symptom: Slow response or lagging interface
* Solution:
* Reduce number of active trucks
* Close other browser tabs
* Check system memory usage
* Update browser to latest version

Search Functionality

* Symptom: No results or incorrect matches
* Solution:
* Verify truck ID format (KGN-XXXX)
* Check for exact case matching
* Clear search input and retry
* Verify truck exists in system

Login Problems

* Symptom: Authentication failures
* Solution:
* Use exact demo credentials
* Check username/password case sensitivity
* Clear browser storage
* Try different user role

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Future Enhancements

Planned Features

1. Database Integration

* Persistent data storage
* Historical analytics
* User session management

2. Mobile Application

* iOS and Android native apps
* Push notifications
* Offline functionality

3. Advanced Analytics

* Machine learning predictions
* Seasonal trend analysis
* Cost optimisation algorithms

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Support & Maintenance

Technical Support

* Documentation: This technical guide
* Demo System: Fully functional prototype
* Code Comments: Comprehensive inline documentation

Maintenance Procedures

* Regular browser compatibility testing
* Performance optimisation reviews
* Security vulnerability assessments
* Feature enhancement evaluations

System Limitations

* Current: Client-side simulation only
* Data Persistence: Session-based only
* Scale: Designed for demonstration purposes
* Integration: No external system connections

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