Absolutely, Bilal — here is your **complete and detailed phase-by-phase breakdown** of your Oceanic Energy Solutions (OES) cloud implementation, written in a clear and professional format you can directly use in your **portfolio report**.

**🌊 Oceanic Energy Solutions (OES) – Cloud Infrastructure Implementation**

This implementation enables real-time collection, secure storage, processing, and visualization of marine buoy data using AWS services. The system supports data ingestion, monitoring, alerting, authentication, and CI/CD deployment — all built with AWS Free Tier services.

**✅ PHASE 1: DynamoDB – Time-Series Sensor Data Storage**

**🔹 What:**

Created a **DynamoDB** table named BuoyData to persist structured data from autonomous marine buoys.

**🔧 Implementation:**

* Table Name: BuoyData
* Partition Key: buoy\_id (String)
* Sort Key: timestamp (ISO8601 UTC timestamp as String)
* Data Fields: temperature, wave\_height

**🎯 Why:**

* Allows fast, low-latency storage and retrieval of buoy sensor data.
* Suitable for time-series data, enabling easy trend analysis.
* Fully managed and cost-efficient via AWS Free Tier.

**✅ PHASE 2: S3 Bucket – Raw Data Logging + Static Frontend Hosting**

**🔹 What:**

Created an **S3** bucket: oes-buoy-storage-bilal for:

* Hosting your HTML/JS dashboard frontend
* Storing raw buoy data logs in JSON format

**🔧 Implementation:**

* Enabled **static website hosting** on the bucket
* Used put\_object to store logs from Lambda
* Bucket policy secured for CloudFront-only access

**🎯 Why:**

* S3 provides reliable, scalable, and cost-effective storage.
* Simplifies frontend hosting without needing a web server.
* Supports long-term archival and potential analytics via Athena.

**✅ PHASE 3: IAM – Secure Access Control with Least Privilege**

**🔹 What:**

Created an IAM Role (lambda-oes-role) for Lambda functions with least-privilege policies.

**🔧 Policy Permissions:**

* dynamodb:PutItem, dynamodb:Scan
* s3:PutObject
* sns:Publish
* logs:\*

**🎯 Why:**

* Follows AWS best practices (Principle of Least Privilege)
* Ensures Lambda can only access required AWS resources
* Prevents accidental or malicious over-permissioned access

**✅ PHASE 4: Lambda Functions – Backend Processing Logic**

**🔹 Function 1: storeBuoyData**

* Triggered via **POST** from API Gateway
* Stores incoming data into **DynamoDB**
* Saves the full JSON log into **S3**
* Sends **SNS alert** if wave\_height > 3.0

**🔹 Function 2: getData**

* Triggered via **GET** from API Gateway
* Retrieves and returns buoy data from DynamoDB

**🎯 Why:**

* Enables a **serverless backend** that auto-scales
* Ensures clear separation of concerns (store vs. fetch)
* Integrates cleanly with security and monitoring layers

**✅ PHASE 5: API Gateway – Secure API Layer**

**🔹 What:**

Set up a RESTful API using **API Gateway**.

**🔧 Routes:**

* /sendData → POST → triggers storeBuoyData
* /getData → GET → triggers getData

**🎯 Why:**

* Exposes Lambda functions as HTTPS endpoints
* Allows secure interaction with both buoys and the frontend dashboard
* Simplifies scaling and access control using usage plans and authorizers

**✅ PHASE 6: Frontend Dashboard – S3 Hosted Monitoring Interface**

**🔹 What:**

A single-page **HTML + Chart.js** dashboard, deployed to your S3 bucket (served via CloudFront).

**🔧 Features:**

* Fetches data from /getData
* Displays:
  + 📈 Wave Height Over Time
  + 🌡️ Temperature Over Time
  + ⚠️ Critical Alert if wave height > 3.0m
* Includes:
  + Refresh button
  + Animated visual cards
  + Login/logout buttons (Cognito integrated)

**🎯 Why:**

* Provides real-time visibility for stakeholders
* Lightweight, modern UI with mobile responsiveness
* Helps decision-makers and scientists monitor environmental data

**✅ PHASE 7: SNS Alerts – Email Notification on Critical Events**

**🔹 What:**

Integrated **Amazon SNS** for real-time critical alerts.

**🔧 Setup:**

* Topic: BuoyAlerts
* Subscription: bilal.naseer2k18@gmail.com
* Triggered by Lambda if wave height > 3.0

**🎯 Why:**

* Enables proactive monitoring
* Sends real-time emails when hazardous wave conditions are detected
* Can be expanded to multiple subscribers or SMS

**✅ PHASE 8: API Key + Usage Plan – Rate Limiting and Access Control**

**🔹 What:**

Secured API endpoints using **API Keys and Usage Plans**.

**🔧 Configuration:**

* API Key: OESFrontendKey
* Usage Plan: OESUsagePlan
* Associated to both sendData and getData methods

**🎯 Why:**

* Prevents abuse of public API endpoints
* Adds quota management and throttling
* Works alongside JWT Auth or in fallback situations

**✅ PHASE 9: CloudWatch Logs – Monitoring and Debugging**

**🔹 What:**

Enabled **CloudWatch Logs** for both Lambda functions.

**🔧 Capabilities:**

* Logs each invocation
* Captures errors, warnings, and output
* Can be used to build dashboards or set alarms

**🔜 What’s Next:**

* Add **X-Ray tracing** for full request flow
* Create **CloudWatch Dashboard** for latency, invocations, error rate
* Set **alarms** for unusual patterns

**🎯 Why:**

* Helps debug real-time issues
* Provides observability and operational visibility
* Supports continuous improvement

**✅ PHASE 10: CI/CD with GitHub – Automated Frontend Deployment**

**🔹 What:**

Set up a **GitHub-based CI/CD pipeline** to auto-deploy frontend changes to S3.

**🔧 Implementation:**

* Frontend repo hosted on GitHub
* Auto-push new index.html, style.css, script.js to S3 on commit (manual or via GitHub Actions)

**🎯 Why:**

* Streamlines deployment
* Ensures latest version is always online
* Encourages version control and repeatability

**✅ PHASE 11: CloudFront – HTTPS + Cognito Login Redirect Support**

**🔹 What:**

Configured **CloudFront** distribution in front of your S3 bucket.

**🔧 Reason:**

* Cognito requires redirect URIs to be domain-based (not raw S3 URLs)
* Enabled https://d25xenu5by9uag.cloudfront.net as your **login/logout redirect domain**

**🎯 Why:**

* Enables Cognito login/logout flow to complete securely
* Improves CDN performance and SSL handling
* Protects your S3 bucket using origin access policies

**✅ PHASE 12: Cognito JWT Authentication – Login + Logout**

**🔹 What:**

Configured **Amazon Cognito User Pool** for secure frontend login.

**🔧 Features:**

* Login button redirects to Cognito-hosted UI
* id\_token extracted from URL
* Secure logout redirects via CloudFront
* Used sessionStorage for token handling (not localStorage)

**🎯 Why:**

* Adds user authentication without server complexity
* Keeps your data protected from unauthorized access
* JWT-based auth enables secure curl API calls

**✅ PHASE 13: SessionStorage Token Handling – Secure Testing**

**🔹 What:**

Instead of saving tokens in localStorage, used sessionStorage.

**🔧 Benefits:**

* More secure (clears on tab close)
* Enables you to extract token easily for testing with curl

**🎯 Why:**

* Helps secure the frontend
* Prevents long-term storage of sensitive credentials
* Eases development and debugging

**🧾 Summary Table – Full System Overview**

| **AWS Service** | **Role in System** |
| --- | --- |
| **DynamoDB** | Stores buoy sensor readings |
| **S3** | Hosts frontend and logs raw data |
| **Lambda** | Serverless compute to process and retrieve data |
| **API Gateway** | Exposes secure HTTP endpoints |
| **IAM** | Controls access between services |
| **SNS** | Sends alert emails for critical wave events |
| **Cognito** | Provides secure login + token auth |
| **CloudFront** | Enables HTTPS + Cognito redirect support |
| **CloudWatch** | Captures logs and supports monitoring |
| **Chart.js** | Visualizes data in browser dashboard |
| **GitHub CI/CD** | Automates frontend deployment to S3 |

**🎯 Final Outcome**

You’ve built a **secure, scalable, real-time IoT dashboard solution using modern AWS architecture**, fully aligned with sustainability and serverless best practices — a perfect fit for OES’s mission.

You’re ready to present this in your **report + screencast** for Distinction-level marks. Let me know when you're ready to:

* Start drafting the **report document**
* Script the **10-minute screencast**
* Or generate an **architecture diagram**

Let’s bring it home! 🏁💪

Enter Data:

curl -X POST "https://3gwhstp17h.execute-api.eu-north-1.amazonaws.com/dev/sendData" -H "Content-Type: application/json" -H "Authorization: Bearer [TOKEN ID] " \

-d '{

"buoy\_id": "buoy-901",

"temperature": 21.9,

"wave\_height": 3.4

}'

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curl -X POST "https://3gwhstp17h.execute-api.eu-north-1.amazonaws.com/dev/sendData" -H "Content-Type: application/json" -H "Authorization: Bearer eyJraWQiOiI4cWFSNkV5Uld5VXFcLzdqUUpkS2l3NG9cL3dpZzBcL0pleVVvMlwvWWxqZ29ZTT0iLCJhbGciOiJSUzI1NiJ9..HLWiNutF-ZOWMwR2ecHdAQ0GZcCxS\_0nRNE4Ow7PielblhdWxv3gqpcKp8HcOVSHsMeGINnRiln6UYk2Hy2KehtNFxVfSrj\_qApflgRoa6KxuW7htkBlC2JwcZ7T82aZ1MBhLugT3zOQN8TOaHr127Gze4u9TG9vP6q7mREjxJOjG8tKIeGEJ\_Hx89-WODO2iKUqcxRH\_1XRNZPkM0ICNtiVjJZYXr5PbPlfzlMknzxeQm1nRXETAfIehmLE3KPcLvhhV90cwq6Ptm7sxKReOIt3yc5V9srchhwB53hxX40a-XmSj-5pIjnUJ8CUUyoRthL4reIxlvOHSAl6qf96zg " \ -d '{

"buoy\_id": "buoy-901",

"temperature": 30.4 ,

"wave\_height": 4.1

}'

curl -X POST "https://3gwhstp17h.execute-api.eu-north-1.amazonaws.com/dev/sendData" -H "Content-Type: application/json" -H "Authorization: Bearer eyJraWQiOiI4cWFSNkV5Uld5VXFcLzdqUUpkS2l3NG9cL3dpZzBcL0pleVVvMlwvWWxqZ29ZTT0iLCJhbGciOiJSUzI1NiJ9..HLWiNutF-ZOWMwR2ecHdAQ0GZcCxS\_0nRNE4Ow7PielblhdWxv3gqpcKp8HcOVSHsMeGINnRiln6UYk2Hy2KehtNFxVfSrj\_qApflgRoa6KxuW7htkBlC2JwcZ7T82aZ1MBhLugT3zOQN8TOaHr127Gze4u9TG9vP6q7mREjxJOjG8tKIeGEJ\_Hx89-WODO2iKUqcxRH\_1XRNZPkM0ICNtiVjJZYXr5PbPlfzlMknzxeQm1nRXETAfIehmLE3KPcLvhhV90cwq6Ptm7sxKReOIt3yc5V9srchhwB53hxX40a-XmSj-5pIjnUJ8CUUyoRthL4reIxlvOHSAl6qf96zg " \ -d '{

"buoy\_id": "buoy-901",

"temperature": 30.4 ,

"wave\_height": 4.1

}'