



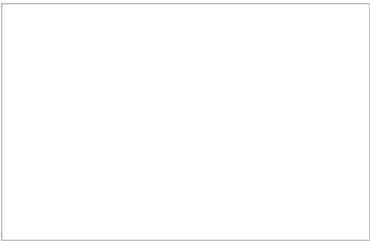
GreenTech Maturity Assessment

Analysis Report

Assessment Details :

<i>Date of Assessment</i>	<i>27 December 2024</i>
<i>Project Name</i>	<i>Platform Engineering</i>
<i>Company Name</i>	<i>Tata Consultancy Services (TCS)</i>
<i>Version</i>	<i>1.0</i>
<i>Cloud Provider</i>	<i>AWS</i>

Current Maturity Level :



Processes are standardized, documented, well understood and reviewed.

GreenTech Maturity Levels :

<i>Maturity Levels</i>	<i>Score</i>	<i>Description</i>

<i>Level 1</i>	<i>1</i>	<i>Processes are unpredictable, poorly controlled, and reactive at best.</i>
<i>Level 2</i>	<i>2</i>	<i>Per-project processes. Often still reactive.</i>
<i>Level 3</i>	<i>3</i>	<i>Processes are standardized, documented, well understood and reviewed.</i>
<i>Level 4</i>	<i>4</i>	<i>Processes are measured and controlled.</i>
<i>Level 5</i>	<i>5</i>	<i>Continuous improvement occurs based on quantitative feedback.</i>

Areas Implemented :

<i>Phases</i>	<i>Count</i>
<i>Development</i>	<i>4 of 24</i>
<i>Network</i>	<i>1 of 2</i>
<i>Deployment</i>	<i>7 of 19</i>
<i>Design</i>	<i>0 of 31</i>
<i>Storage</i>	<i>0 of 5</i>
<i>Quality</i>	<i>0 of 8</i>
<i>Operations</i>	<i>0 of 12</i>

Recommendations :

Development:

1. Optimize source code for energy and carbon emissions using static code analysis

<i>Issue Type</i>	<i>Count</i>
<i>Avoid usage of static collections.</i>	<i>87</i>
<i>Avoid multiple if-else statement</i>	<i>61</i>
<i>Do not call a function when declaring a for-type loop</i>	<i>54</i>
<i>Use ++i instead of i++</i>	<i>43</i>
<i>String Builder</i>	<i>29</i>

<i>Avoid getting the size of the collection in the loop</i>	<i>23</i>
<i>Avoid creating and starting threads directly</i>	<i>17</i>
<i>Avoid using <code>Pattern.compile()</code> in a non-static context</i>	<i>11</i>
<i>Free Resources</i>	<i>2</i>
<i>Use <code>System.arraycopy</code> to copy arrays</i>	<i>1</i>

2. Memory and energy utilization of docker and multi-stage docker files

<i>Metrics</i>	<i>Single-Stage Docker File</i>	<i>Multi-Stage Docker File</i>
<i>Energy Usage</i>	<i>High</i>	<i>Low</i>
<i>Build Time</i>	<i>5 minutes</i>	<i>6 minutes</i>
<i>Layer Count</i>	<i>12 layers</i>	<i>8 layers</i>
<i>Image Size</i>	<i>2.06 GB</i>	<i>2.01 GB</i>
<i>Cache Efficiency</i>	<i>Low</i>	<i>High</i>
<i>CI/CD Impact</i>	<i>High resource usage</i>	<i>Optimized resource usage</i>

Adopt Multi-Stage Docker Files :

- Reduce memory and energy consumption during build and runtime.
- Smaller image sizes lead to faster deployments and lower storage needs.

Optimize Base Images :

- Use official, slim, or alpine versions of base images to minimize size.
- Periodically review and update base images to leverage newer, more efficient versions.

Minimize Dependency Installation :

- Only install necessary dependencies to reduce build and runtime resource usage.
- Use tools like pip-compile to manage dependencies efficiently.

Leverage Caching :

- Utilize Docker's build cache to skip unchanged layers during rebuilds.
- Implement caching for dependencies (e.g., using a proxy server for pip dependencies).

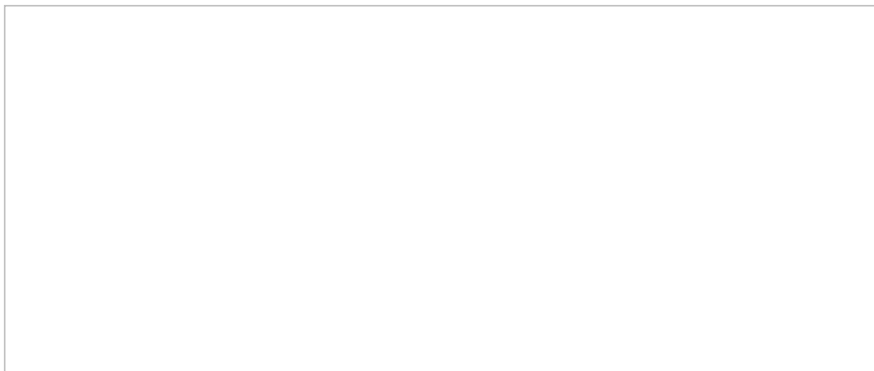
Monitor and Analyze Resource Usage :

- Employ tools (e.g., Docker Stats, Prometheus, Grafana) to monitor container resource utilization.
- Analyze findings to identify optimization opportunities.

3. Energy metrics for application using Intel RAPL, Kepler, Schaphandre

<i>CPU Model</i>	<i>Intel(R) Xeon(R) Platinum 8259CL CPU @ 2.50GHz</i>		
<i>CPU Count</i>	<i>2</i>		
<i>GPU Model</i>	<i>N/A</i>		
<i>GPU Count</i>	<i>N/A</i>		
<i>RAM</i>	<i>3.74 GB</i>		
<i>OS</i>	<i>Linux</i>		
<i>Country</i>	<i>United States</i>		
<i>Region</i>	<i>Virginia</i>		

<i>Duration</i>	<i>Energy Consumed</i>	<i>Emissions</i>	<i>Emissions Rate</i>
<i>44.28 Seconds</i>	<i>0.001309 Kwh</i>	<i>0.000483 kg</i>	<i>0.00001091 kg/s</i>



Monitor and Optimize : Regularly collect energy metrics to identify optimization opportunities in your application.

Set Sustainability Goals : Establish targets for your Sustainability Score (SS) or individual energy metrics to drive improvement.

Energy-Aware Scheduling : Utilize Kepler to schedule workflow tasks during periods of low energy demand or when renewable energy sources are available.

Continuously Update and Refine : Collaborate with hardware teams to optimize system configurations for improved energy efficiency.

Hardware/Software Co-Optimization : As new energy-efficient technologies and methodologies emerge, incorporate them into your application and workflows.

4. Energy consumption of ML job, Model training

Optimize Model Architecture:

- Use efficient neural network architectures (e.g., MobileNet, SqueezeNet, EfficientNet) that require less

computational resources.

- Apply model pruning, knowledge distillation, or quantization to reduce model size and computational requirements.

Select Energy-Efficient Hardware :

- Utilize GPU accelerators with high performance-per-watt ratios (e.g., NVIDIA Ampere or AMD CDNA).
- Consider TPU (Tensor Processing Unit)-based solutions for large-scale ML workloads.
- Explore FPGA (Field-Programmable Gate Array)-based accelerators for customized, energy-efficient computations.

Efficient Training Methodologies :

- Employ transfer learning to fine-tune pre-trained models, reducing training time and energy.
- Use early stopping techniques to halt training when satisfactory performance is achieved.
- Apply distributed training with optimized parallelization to minimize overall training time.

Data Efficiency:

- Use smaller, representative datasets for training, reducing computational requirements.
- Apply data augmentation to artificially increase dataset size without adding new samples.

Hyperparameter Tuning and Automation :

- Utilize hyperparameter tuning tools (e.g., Hyperopt, Optuna) to quickly identify optimal configurations.
- Implement automated ML (AutoML) pipelines to streamline the training process and minimize unnecessary computations.

Network :

1. Energy efficiency for synchronous (REST vs gRPC) and Asynchronous (Kafka vs RabbitMQ) messaging between microservices

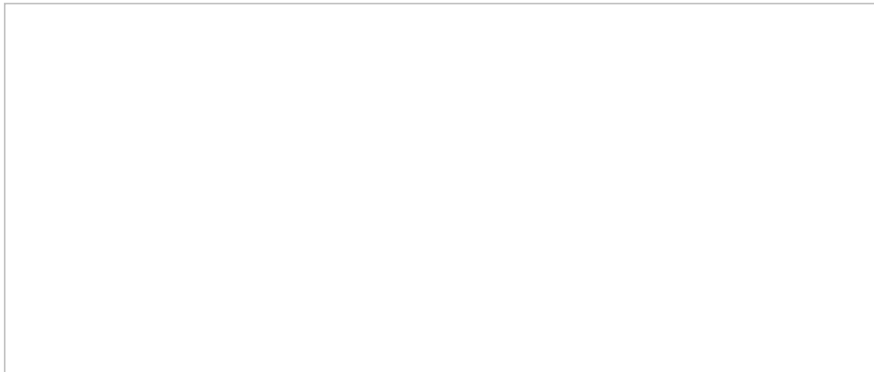
Synchronous Communication Protocols

Metrics	gRPC	Rest
Energy Usage	18.1 W	8.2 W
Peak Memory	4.45 MB	8 MB
Time Taken	3 Minutes	4 Min 50 Sec
Requests	500K	500K
Peak CPU	10%	4%

Asynchronous Communication Protocols

Metrics	Kafka	RabbitMQ
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<i>Energy Usage</i>	<i>19.2 W</i>	<i>10.68 W</i>
<i>Peak Memory</i>	<i>1024 MB</i>	<i>512 MB</i>
<i>Message Rate</i>	<i>1M msg/s</i>	<i>50K msg/s</i>
<i>Latency</i>	<i>10ms</i>	<i>5ms</i>
<i>CPU Usage</i>	<i>55%</i>	<i>35%</i>



For Synchronous Messaging (REST/gRPC)

Use gRPC for New Developments :

- *Leverage its inherent efficiency advantages, especially for microservices with high inter-service communication.*

Migrate REST to HTTP/2 :

- *If moving to gRPC isn't feasible, ensure REST services use HTTP/2 for some efficiency gains.*

Optimize Payloads :

- *Use efficient serialization formats (e.g., protobuf for gRPC, consider alternatives for REST).*
- *Implement compression (if not already done).*

Service Discovery and Load Balancing :

- *Ensure efficient routing to reduce unnecessary network hops.*

For Asynchronous Messaging (Kafka/RabbitMQ)

Use gRPC for New Developments :

- *Leverage its inherent efficiency advantages, especially for microservices with high inter-service communication.*

Migrate REST to HTTP/2 :

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Optimize Payloads :

- Use efficient serialization formats (e.g., protobuf for gRPC, consider alternatives for REST).
- Implement compression (if not already done).

Service Discovery and Load Balancing :

- Ensure efficient routing to reduce unnecessary network hops.

Deployment:

1. Tagging of resources to track usage

Mandatory Tags :

- Owner (e.g., team, department, individual)
- Environment (e.g., dev, staging, prod)
- Project/Service (e.g., project name, service identifier)
- Cost Center (e.g., budget code, department ID)

Optional Tags (as needed) :

- Application
- Component
- Lifecycle (e.g., temporary, permanent)
- Compliance (e.g., PCI, HIPAA)

Tagging Best Practices :

- Use Meaningful Names: Clearly indicate the tag's purpose.
- Keep it Concise: Short tag names (< 20 characters) for easier management.
- Avoid Duplication: Use a single tag for a specific attribute (e.g., don't use both Env and Environment).
- Use Consistent Formatting: Establish a standard for tag values (e.g., all lowercase, separated by hyphens).

Tagging Structure (Hierarchy) :

- Flat Structure: Simple, straightforward (e.g., Owner: JohnDoe, Environment: Prod)
- Hierarchical Structure: Organized with categories (e.g., Project:MyApp/Environment:Dev, CostCenter:IT/Department:DevOps)

Instances without Tags:

Instance Name	Instance Name	Instance Type
marvel-windows-jumboxtest	i-07a7a6794367ded49	t3.medium
marvel-eshawindows-jumpbox-01	i-0378700bcf2ef68e7	t3.large
marvel-rapl-amd	i-0c43a18a046c87984	t3a.large
marvel-sustain	i-0571933e06349edd6	t2.medium
marvel-autoscaler-3	i-0c86e5cbdc6ef48e9	t2.medium

<i>marvel-esha-windows-jumpbox-03</i>	<i>i-01b006bb7ceefd989</i>	<i>t3.large</i>
<i>marvel-docker-registry</i>	<i>i-0121edc6357368099</i>	<i>t3.micro</i>
<i>marvel-git-perforce</i>	<i>i-0361799692abc3dc4</i>	<i>t2.medium</i>
<i>marvel-esha-windows-jumpbox-03</i>	<i>i-01b006bb7ceefd989</i>	<i>t3.large</i>
<i>marvel-Prometheus</i>	<i>i-00f4b18e0c7615802</i>	<i>t2.micro</i>
<i>marvel-slurm-testing-slurmctl</i>	<i>i-02028574274244586</i>	<i>t3a.small</i>
<i>marvel-slurm-testing-slurm-00</i>	<i>i-02028574274244586</i>	<i>t2.micro</i>
<i>marvel-slurm-testing-gw</i>	<i>i-01528621d1601b22d</i>	<i>t3a.small</i>
<i>marvel-slurm-testing-slurmdb</i>	<i>i-0361799692abc3dc4</i>	<i>t2.medium</i>

2. Calculate energy utilization for provisioned resources and show recommendations to deployment teams

(Legend: R denotes Recommendation Rank)

Under-Provisioned

<i>Instance ID</i>	<i>Instance Type</i>	<i>R1</i>	<i>R2</i>	<i>R3</i>
<i>i-0011eee5f9bfa37d5</i>	<i>t3.large</i>	<i>m7i-flex.large</i>	<i>m6i.large</i>	<i>m7i.large</i>
<i>i-01e2bba24c61139a5</i>	<i>t3.large</i>	<i>m7i-flex.large</i>	<i>m6i.large</i>	<i>m7i.large</i>
<i>i-0378700bcf2ef68e7</i>	<i>t3.large</i>	<i>m7i-flex.large</i>	<i>m6i.large</i>	<i>m7i.large</i>
<i>i-061783c19995cf461</i>	<i>t3.large</i>	<i>m7i-flex.large</i>	<i>m6i.large</i>	<i>m7i.large</i>
<i>i-06b0d1885c8bfb73a</i>	<i>t2.medium</i>	<i>c7i-flex.large</i>	<i>c6i.large</i>	<i>c5.large</i>
<i>i-07d971daf49d26ba6</i>	<i>t3.large</i>	<i>m7i-flex.large</i>	<i>m6i.large</i>	<i>m7i.large</i>
<i>i-07fc1239a8432b1ff</i>	<i>t2.nano</i>	<i>t3.small</i>	<i>t3.medium</i>	<i>t3.large</i>
<i>i-0803db063f7902be8</i>	<i>t3.small</i>	<i>t3.medium</i>	<i>m6i.large</i>	<i>t3.large</i>
<i>i-0a30bd8f427568294</i>	<i>t2.large</i>	<i>m7i.large</i>	<i>r7i.large</i>	<i>c7i-flex.xlarge</i>
<i>i-0bcac5f25c482c094</i>	<i>t3.large</i>	<i>m7i-flex.large</i>	<i>m6i.large</i>	<i>m7i.large</i>
<i>i-0e7f58282fba77a57</i>	<i>t3.xlarge</i>	<i>m7i-flex.xlarge</i>	<i>m6i.xlarge</i>	<i>m7i.xlarge</i>

Over-Provisioned

<i>Instance ID</i>	<i>Instance Type</i>	<i>R1</i>	<i>R2</i>	<i>R3</i>
<i>i-07a7a6794367ded49</i>	<i>t3.xlarge</i>	<i>r7i.large</i>	<i>t3.xlarge</i>	-
<i>i-0f6c16ceb8ea482c2</i>	<i>t3.2xlarge</i>	<i>r6i.xlarge</i>	<i>r7i.xlarge</i>	<i>t3.2xlarge</i>
<i>i-0f97772fef03977df</i>	<i>t3.xlarge</i>	<i>r6i.large</i>	<i>r7i.large</i>	<i>t3.xlarge</i>
<i>i-0fda6069f43c06dfl</i>	<i>t3.xlarge</i>	<i>r7i.large</i>	<i>t3.xlarge</i>	-

3. Identify Unused Resources

Unused EC2 Resources

<i>Instance Name</i>	<i>Instance ID</i>	<i>Instance Type</i>	<i>Unused Days</i>
<i>marvel-GenAI-partha</i>	<i>i-0a1748bca3199a63f</i>	<i>t3.medium</i>	<i>274</i>
<i>marvel-LLM-test</i>	<i>i-0b43ba541b65fcd8f</i>	<i>t3.2xlarge</i>	<i>175</i>
<i>marvel-mddp-devsecops</i>	<i>i-0c73c29f8e5d01576</i>	<i>t3.xlarge</i>	<i>162</i>
<i>marvel-EEaaS-Kubernetes</i>	<i>i-0ced2e371b3425fe5</i>	<i>t3.large</i>	<i>142</i>
<i>marvel-TEaaS-openstack-kolla</i>	<i>i-0842262e5bb3e2915</i>	<i>t3.xlarge</i>	<i>141</i>
<i>marvel-awx-ansible</i>	<i>i-0d5da5ba883efcf5b</i>	<i>t3.xlarge</i>	<i>127</i>
<i>marvel-Neureda-registry</i>	<i>i-0dc340b462af4ed74</i>	<i>t3.medium</i>	<i>125</i>
<i>marvel-windows-jumboxtest</i>	<i>i-07a7a6794367ded49</i>	<i>t3.medium</i>	<i>122</i>
<i>marvel-PlatformEng-Keycloak</i>	<i>i-0161cf03311390911</i>	<i>t3.medium</i>	<i>121</i>
<i>marvel-PE-mddp-k8s-1</i>	<i>i-0bfe201057f0db5f9</i>	<i>t3.2xlarge</i>	<i>121</i>
<i>marvel-Prometheus</i>	<i>i-00f4b18e0c7615802</i>	<i>t2.micro</i>	<i>120</i>
<i>marvel-slurm-testing-slurmctl</i>	<i>i-02028574274244586</i>	<i>t3a.small</i>	<i>120</i>
<i>marvel-slurm-testing-slurm-00</i>	<i>i-0c10cab3a673568a5</i>	<i>t3a.small</i>	<i>120</i>
<i>marvel-slurm-testing-gw</i>	<i>i-01528621d1601b22d</i>	<i>t3a.small</i>	<i>120</i>
<i>marvel-slurm-testing-slurmdb</i>	<i>i-04cf6faf1252ba6a7</i>	<i>t3a.small</i>	<i>120</i>

<i>mfdm_qual_dd_pg</i>	<i>i-03b6cc42f6ee8679a</i>	<i>t2.medium</i>	<i>116</i>
<i>tcsnxgnmfdmins5</i>	<i>i-054d01dc2082a9968</i>	<i>t3.large</i>	<i>114</i>
<i>mfdm_qual_dd_pg</i>	<i>i-03b6cc42f6ee8679a</i>	<i>t2.medium</i>	<i>116</i>
<i>tcsnxgnmfdmins5</i>	<i>i-054d01dc2082a9968</i>	<i>t3.large</i>	<i>114</i>
<i>tcsnxgnpemonobs01</i>	<i>i-0a30bd8f427568294</i>	<i>t2.large</i>	<i>114</i>
<i>tcsnxgnpemonobs02</i>	<i>i-0644a1225a61cfad0</i>	<i>t3.medium</i>	<i>114</i>
<i>tcsnxgnpemonobs03</i>	<i>i-0f4a538834c7f8379</i>	<i>t2.large</i>	<i>114</i>
<i>tcsnxgnmfdmins1</i>	<i>i-06f35320739d13110</i>	<i>t3.medium</i>	<i>113</i>
<i>tcsnxgnmfdmins3</i>	<i>i-0dd30488163388001</i>	<i>t3.medium</i>	<i>113</i>
<i>tcsnxgnmfdmins2</i>	<i>i-030fdebbe195c6d05</i>	<i>t3.medium</i>	<i>113</i>

4. Turn off workloads and node pools outside of business hours

Automate Shutdown/Startup :

What It Is: Scripted automatic shutdown/startup of workloads outside business hours.

Sustainability Benefits :

- Reduced energy consumption
- Lower greenhouse gas emissions
- Decreased e-waste from prolonged hardware lifespan

Identify Non-Essential Workloads :

What It Is: Analyzing workloads to determine which can be safely turned off during non-business hours.

Sustainability Benefits :

- Targeted energy reduction
- Minimized unnecessary resource utilization
- Enhanced overall efficiency

Autoscaling Configuration (Node Pools) :

What It Is: Configuring node pools to autoscale down to 0 nodes during non-business hours.

Sustainability Benefits :

- *Dynamic energy consumption adjustment*
- *Significant reduction in idle resource energy waste*
- *Enhanced environmental responsiveness*

Scheduled Node Pool Management :

What It Is: Scheduling node pool shutdowns/startups using platform-specific features or tools.

Sustainability Benefits :

- *Predictable energy savings*
- *Reduced operational carbon emissions*
- *Improved resource utilization efficiency*

Node Pool Sizing Optimization :

What It Is: Regular review to optimize node pool sizing.

Sustainability Benefits :

- *Continuous energy efficiency improvement*
- *Reduced e-waste through minimized node replacements*
- *Lower environmental impact*

5. Show energy efficient resource provisioning options during provisioning

Please refer to this [link](#) for a guide on how to implement this.

6. Implement pre-checks for common issues in CI/CD pipeline to avoid failures in different stages of pipeline

Please refer to this [link](#) for a guide on how to implement this.

Details :

1. Development (4/24)

Areas Implemented :

- *Energy metrics for application using Intel RAPL, Kepler, Schaphandre*
- *Energy consumption of ML job, Model training*
- *Optimize source code for energy and carbon emissions using static code analysis*
- *Compare memory and energy utilization of docker and multi-stage docker files*

Areas to be Implemented :

- *Simplicity and Efficiency Trade-offs while developing algorithms*
- *Efficient Software Algorithms and data structures*

- *Efficient integration and delivery pipelines (Dev, Test, CI env)*
- *On demand development environments*
- *Minimizing unnecessary code execution*
- *Utilizing lazy loading*
- *Optimize energy consumption for Python and Java applications*
- *Leverage LLMs to suggest energy efficient algorithms for Java / Python applications in IDE*
- *Provide configurable deployment of applications with selected features to minimize resource utilization*
- *Calculate energy utilization at function level*
- *Optimize energy utilization of applications using AI/ML*
- *Memory optimization for applications*
- *Rightsizing containers and VM's based on resource utilization*
- *Compare and suggest open-source tools which are energy efficient*
- *Train models with custom rules for optimization of code*
- *Suggest optimized version of built-in functions which are energy efficient in IDE / static analyzer*
- *Code splitting - Convert code to smaller files which can be loaded on-demand*
- *Tree shaking: This technique helps reduce the overall application size by removing unused code from the final build, thus optimizing the web product and minimizing resource consumption*
- *Split large code repositories*
- *Remove dead code and unused data from application*

2. Network (1/2)

Areas Implemented :

- *Compare energy efficiency for synchronous (REST vs gRPC) and Asynchronous (Kafka vs RabbitMQ) messaging between microservices*

Areas to be Implemented :

- *Optimize data transfer (Implement local data processing, aggregation and compression techniques to avoid transfer of frequent, large amounts of data)*

3. Deployment (7/19)

Areas Implemented :

- *Tagging of resources to track usage*
- *Calculate energy utilization for provisioned resources and show recommendations to deployment teams*
- *Identify and share report on unused resources*
- *Turn off workloads and node pools outside of business hours*

- *Show energy efficient resource provisioning options during provisioning*
- *Implement pre-checks for common issues in CI/CD pipeline to avoid failures indifferent stages of pipeline*
- *Workload allocation on energy efficient servers, VMs*

Areas to be Implemented :

- *Deploy application in a region that is closest to users*
- *Deploy in regions that are powered by renewables or energy efficient resources*
- *Energy efficient workload scheduling*
- *CPU frequency optimization for non-critical workloads*
- *Alerts during resource provisioning (to avoid over provisioning) about energy consumption and energy efficient options*
- *Calculate and minimize energy utilization per transaction*
- *Implement automated decision between horizontal vs vertical scaling of applications*
- *Set up minimal artifacts – Reduce disk, memory and processing demands by considering the software for a given purpose*
- *Schedule resource intensive tasks to execute when renewable energy source is available*
- *Consolidate application workloads to maximize server utilization and move idle servers to low power mode*
- *Measure (Idle/Normal/Peak) energy consumption of resources and identify scope for optimizations (Get power consumption per CPU core information from processor type)*
- *Identify unused resources in K8s using KOR tool*

4. Design (0/31)

Areas Implemented :

No Areas Implemented

Areas to be Implemented :

- *Sustainability as NFR*
- *Minimal Architecture (i.e. Developing minimal software for value)*
- *Replace long-running service with a simple Function as a Service*
- *Asynchronous processing and event-driven architectures*
- *API Design: protocol (TCP, UDP, custom wire protocols)*
- *API Design: data format used for request/response of your APIs: Protobuf/gRPC is better compared to JSON, XML*
- *API Design: Avro schemas instead of JSON for data serialization*
- *Reusable APIs vs P2P Integrations*

- *Choice of programming language: Go, Rust over Python, Java; Java 17 is better with respect to memory optimization*
- *Public cloud, choice of provider, and region*
- *Platform as a Service (PaaS) and Serverless (e.g., Function as a Service (FaaS))*
- *Containers and Kubernetes – Adopting energy efficient architectures such as containers or serverless*
- *Scheduling and batch vs. real-time – Demand Shaping*
- *Carbon awareness into the Kubernetes Scheduler*
- *Cost and Sustainability: Reducing operational costs and sustainability are aligned*
- *Enforce Quotas and Rate Limiting*
- *Reduce the Network Footprint*
- *Identify energy utilization of applications across different design choices*
- *Optimize data generation of applications*
- *Create reusable modules to minimize development and maintenance efforts*
- *Enable parallel processing using distributed computing and minimize energy consumption*
- *Measure KPIs on the features used by customers and remove unused features*
- *Energy saving mode for applications, system processes during periods of low load*
- *Energy budgets for applications*
- *Create Energy profile for application (Core Vs Non-core tasks – Logging, Monitoring, Audit, Redundancy etc...)*
- *Improve resilience of equipment to minimize redundancy (Ensure legacy hardware can support at least core features of software)*
- *Shared libraries for applications*
- *Server-side rendering (SSR): With SSR, a web page's HTML is generated on the server and sent to the client, resulting in quicker initial load times and improved search engine optimization*
- *React frameworks: Next.js as a framework has many built-in features for energy optimization*
- *Progressive Web Applications (Hybrid of native and web apps) are more energy efficient*
- *Optimize availability and scalability needs for application*

5. Storage (0/5)

Areas Implemented :

No Areas Implemented

Areas to be Implemented :

- *Dynamic provisioning of volumes for EC2 instance / Pod to automatically scale the storage size*
- *Identify and remove unused data and resources in cloud*

- *Implementing data retention, archival and deletion policies*
- *Utilize caching to store frequently used data*
- *Optimize log and metrics collection*

6. Quality (0/8)

Areas Implemented :

No Areas Implemented

Areas to be Implemented :

- *Code and design review for sustainability*
- *Document decisions using Key Design Decisions (KDDs) or Architectural Decision Records (ADRs)*
- *Profiling tools and static analysis – Code profiling and optimization tools*
- *Upgrade Runtimes and Modules*
- *Change aware testing*
- *Test Case Optimization*
- *Risk Based Testing*
- *On-demand and scalable Test Environments*

7. Operations (0/12)

Areas Implemented :

No Areas Implemented

Areas to be Implemented :

- *Automated sustainability maturity assessment for applications*
- *Observability and CarbonOps*
- *Automation*
- *Switching instances to chipsets that offer the same processing power at lower levels of energy consumption*
- *Sustainable DevOps practices integrate sustainability into the software delivery process*
- *Optimize resource allocation using ML*
- *Maximize utilization of resources*
- *Spot Instances*
- *Setup sustainability goals for infrastructure, development and applications and monitor them using dashboards and reports*
- *Reduce the cooling requirements of servers by ensuring that applications (servers) run in optimal*

temperature range

- *Identify zombie workloads that consume resources (e.g., Application not running within container / VM)*
- *Dashboard for resource utilization at cluster, node, and pod level and grouped by applications in Kubernetes*