Architecting for Sustainability

Andrew Morrow (he/him)
Senior Solutions Architect
ndmorro@amazon.co.uk
Agenda

Sustainability Use Cases

Architecture Best Practices

Metrics

Getting Started
Sustainability Use Cases
Environmental Sustainability Use Cases

- Carbon Footprint
- Architecting for Sustainability
- Sustainability Data Sources
- Sustainability Transformation
The GHG Protocol defines how to convert greenhouse gases to CO$_2$ equivalent, and the three scopes of carbon footprint.

Scope 1: Fuel consumed

Counted by whoever owns the fuel when it burns

Electrify everything to take Scope 1 to zero
Change grid mix to renewable power and store renewable energy in batteries to reduce Scope 2.
Scope 3: everything else

Scope 3 depends a lot on what kind of business you are in.
AWS Customer Carbon Footprint Tool

- Date range
- Carbon data
- Savings
Carbon reduction opportunity

AWS can lower the carbon footprint of average on-premises data center workloads by nearly 80% today and up to 96% once AWS is powered with 100% renewable energy.

**US**
3.6 times more energy efficient

**Europe**
Up to 5 times more energy efficient

**Asia Pacific**
5 times more energy efficient

Find all the reports on [aws.amazon.com/sustainability/resources/](http://aws.amazon.com/sustainability/resources/)
Sustainability Data on AWS

Sustainability Data Sets

Open Data Program

Amazon Sustainability Data Initiative

AWS Data Exchange
Architecture Best Practices
Are you Well-Architected?

**Business need**
Time to value for feature delivery of sustainable products

The six well-architected pillars

Operational excellence
Security
Reliability
Performance efficiency
Cost optimization
Sustainability
Sustainability Pillar

- Shared Responsibility Model
- Design Principles
- Improvement Process
- Trade Offs
- Best Practices
Shared Responsibility Model

Customer is responsible for sustainability in the cloud

AWS is responsible for sustainability of the cloud

- Data design & usage
  - Software application design
  - Platform deployments and scaling
- Data storage
- Code efficiency
- Utilization & scaling
- Servers
- Cooling
- Water
- Waste
- AWS Global Infrastructure
  - Data centers
  - Electricity supply
- Building materials

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Every Team Should Own Sustainability Goals

Senior Leader
Sustainability Specialist

Architect
Developer

Developer
DevOps

Report Carbon Data
Design for Sustainability
Optimize for Efficiency
Architecture Patterns

- Region Selection
- User behavior
- Software and architecture
- Data
- Hardware
- Development and deployment
Choose Regions where you will implement your workloads based on both your business requirements and sustainability goals.

274 RENEWABLE ENERGY PROJECTS WORLDWIDE

https://sustainability.aboutamazon.com/about/around-the-globe?energyType=true
User Behaviour Patterns

- Scale infrastructure with user load
- Align SLAs with sustainability goals
- Eliminate creation and maintenance of unused assets
- Optimize geographic placement of workloads for user locations
- Optimize team member resources for activities performed
Align SLAs with Sustainability Goals

NEGOTIATE IMPACT-FRIENDLY SLAS

- May reduce cost
- Small adjustment
- Reduction in overall impact
Optimize Team Member Resources

Do complex processing in the cloud

Data Transformation
- AWS Glue

Data Visualization
- Amazon QuickSight

Virtual Desktops
- Amazon WorkSpaces

Virtual Production
- Amazon Nimble Studio
Software and Architecture Patterns

- Optimize software and architecture for asynchronous and scheduled jobs
- Remove or refactor workload components with low or no use
- Optimize the areas of your code that consume the most time or resources
- Optimize impact on customer devices and equipment
- Use software patterns and architectures that best support your data access and storage patterns
Sustainable scheduling – Reduce peaks

Impact depends on total provisioned capacity, not average utilization
Sustainable scheduling – Reduce peaks

Impact depends on total provisioned capacity, not average utilization
Asynchronous and Scheduled Jobs

Queues and buffering

Buffer messages until resources are available to process
Data patterns

- Implement a data classification policy
- Use technologies that best support your data access and storage patterns
- Use lifecycle policies to automatically delete unnecessary data
- Minimize overprovisioning in block storage
- Remove unneeded or redundant data
- Use shared file systems or object storage to access common data
- Minimize data movement across networks
- Only backup data when it would be more impactful, or impossible, to recreate
Data Classification and Lifecycle Policies

Remove unneeded or redundant data
Lifecyle policies: data classification is the foundation

S3 Standard → S3 Glacier Flexible Retrieval (successor to S3 Glacier) → S3 Glacier Deep Archive → S3 Intelligent-Tiering
Data Access and Storage Patterns

Use technologies that best support your data access and storage patterns

Data Formats
- Parquet
- Orc
- Avro

Data Stores
- Purpose Built Databases
- Block storage
- Shared Filesystem
- Object Storage
Hardware patterns

Use the minimum amount of hardware to meet your needs

Use the instance types that meet your requirements with the least impact

Use managed services

Optimize your use of GPUs
Instance Types

Graviton2

- R6g instance
- T4g instance
- Is4gen instance
- G5g instance

Graviton3 (Preview)

- C7g instance

https://github.com/aws/aws-graviton-getting-started
AWS Services Supporting Graviton

- AWS Cloud9
- AWS CodeCommit
- AWS CodeDeploy
- Amazon EMR
- AWS CodePipeline
- AWS CodeBuild
- Amazon FSx for Lustre

- AWS Elastic Beanstalk
- Amazon Aurora
- AWS Systems Manager
- Amazon RDS
- AWS Lambda
- AWS Fargate

- Amazon EKS
- Amazon ECR
- Amazon ECS
- Amazon MemoryDB for Redis
- AWS CodeBuild
- Amazon OpenSearch Service (successor to Amazon Elasticsearch Service)

- Amazon ElastiCache
- Amazon Inspector
- Amazon Neptune
- Amazon DocumentDB (with MongoDB compatibility)
Use Managed Services

- Amazon Elastic Kubernetes Service (Amazon EKS)
- Amazon EMR
- Amazon Elastic File System (Amazon EFS)
- Amazon Personalize
Development and Deployment

- Adopt methods that can rapidly introduce sustainability improvements
- Keep your workload up to date
- Increase utilization of build environments
- Use managed device farms for testing
AWS SDK for JavaScript

Adopt methods that can rapidly introduce sustainability improvements

AWS SDK for JavaScript is used by browsers and npm applications to consume AWS services

Version 3 introduced modular packages per service client

Modular packaging allows reduction of bundle size by ~75%

Further optimization reduced install & publish size by ~50%
People, Process and Technology

Make sustainability part of your processes

Concept    Design    Implementation    Beta/Staging    Production

WA Review
Make sustainability part of your processes

Use a sustainability "Left Shift"

Concept  Design  Implementation  Beta/Staging  Production

Sustainability
Make sustainability part of your processes

Build sustainability into your processes *from the start*

![Diagram showing sustainability at each stage: Concept, Design, Implementation, Beta/Staging, Production.](#)
Proxy Metrics
Measuring Improvements

Where can I find detailed data?

Cost & Usage Report
Usage Data

Itemized Usage

CloudWatch Metrics

Select a relevant usage metric for your workload
Proxy Metrics

Workload metric = \frac{\text{AWS usage metric}}{\text{Unit of work}}
Proxy Metric Example
Best Practice for Metrics

Metric = Main resource usage / Workload KPI

Scaling

Design factors for capacity
Getting Started
Foundational Steps

- Implement a data classification policy
- Use lifecycle policies to archive or remove unneeded data
- Scale infrastructure with user load
- Use the minimum amount of hardware to meet your needs
- Use managed services

View the Customer Carbon Footprint Tool
Tools to Analyze Your Workloads

Metrics
- Amazon CloudWatch
- S3 Storage Lens

Recommendations
- AWS Trusted Advisor
- AWS Compute Optimizer

Review
- AWS Well-Architected Tool
Build Your Skills

Well-Architected Sustainability Pillar
Well-Architected Labs
Sustainability GameDay
AWS Blogs – Category “Sustainability”

https://aws.amazon.com/architecture/well-architected/
https://wellarchitectedlabs.com/
Summary
Summary

Sustainability Use Cases
Carbon Footprint
Well-Architected Sustainability Pillar
Architecture Patterns
Workload Metrics
Next Steps
“Renewables should not replace energy efficiency as a design principle”

Shane Miller
Chairwoman - Rust Foundation
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Thank you!

Andrew Morrow
ndorro@amazon.co.uk
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