Green Cloud Computing

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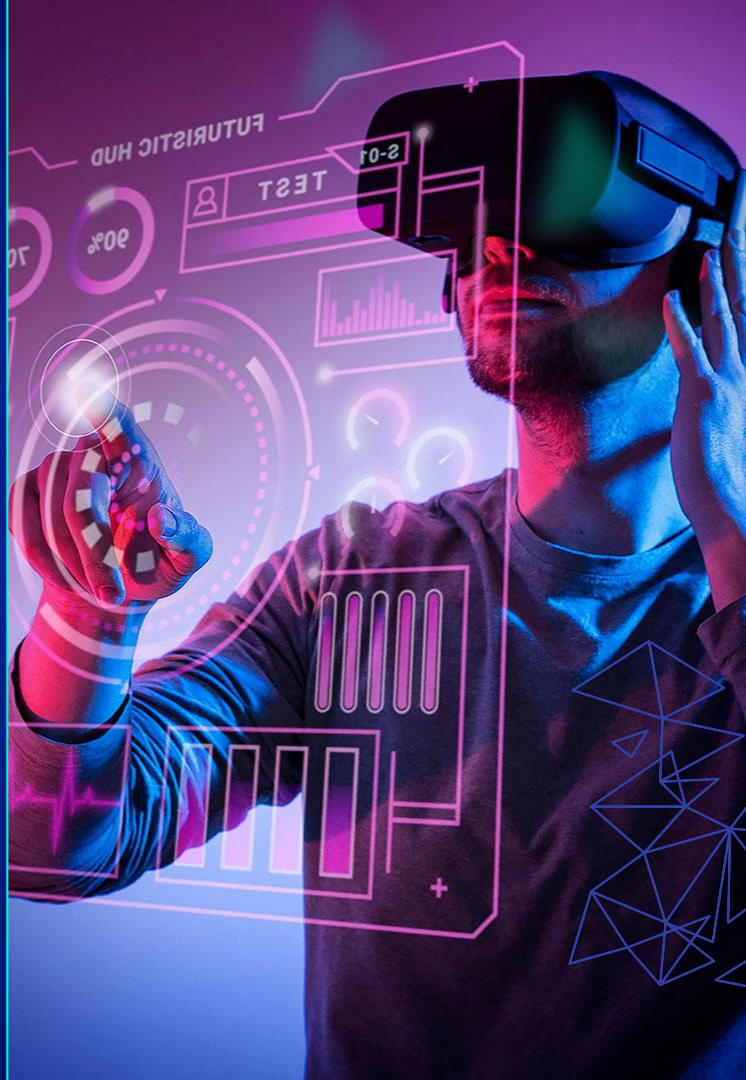
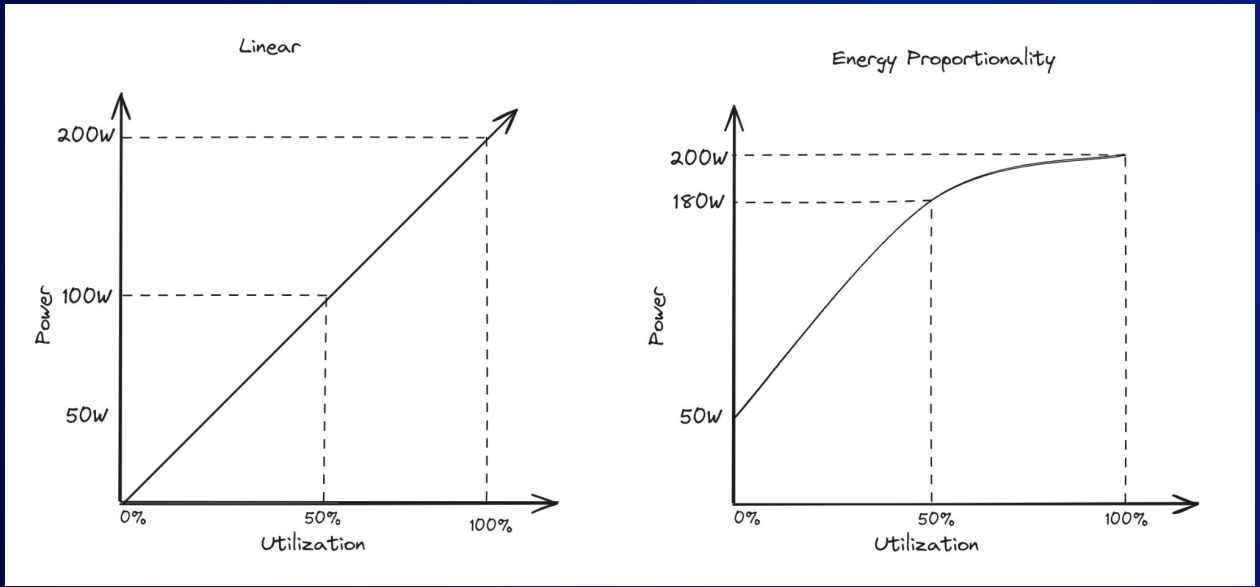
Why cloud platforms are/can be the key?



Energy Proportionality



The more compute resources you consume the more energy efficient it becomes.

In other words: if you don't use your resources at maximum you are harmful to the environment.

So, who would be the best candidate to do this?
YOU👊!

REDUCE

REMOVE

REPLACE

REFACTOR

REPLATFORM

RELOCATE

Maximize the Consumption and Utilization

Cut down everything existing as much as we can

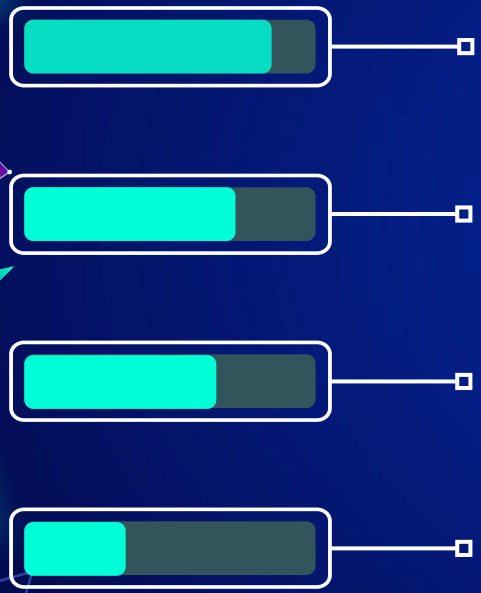
- Identify anything overprovisioned
- Shutdown idle items
- Remove any obsolete node
- Provide better infrastructure
- etc.

Increase the utilization of what we have to its best performance

- Improve density per node
- Become highly flexible and a tetris master
- Share resources if not needed
- etc.

All of it is a home turf of platforms

Optimization Strategies



Scale, reduce & rightsize

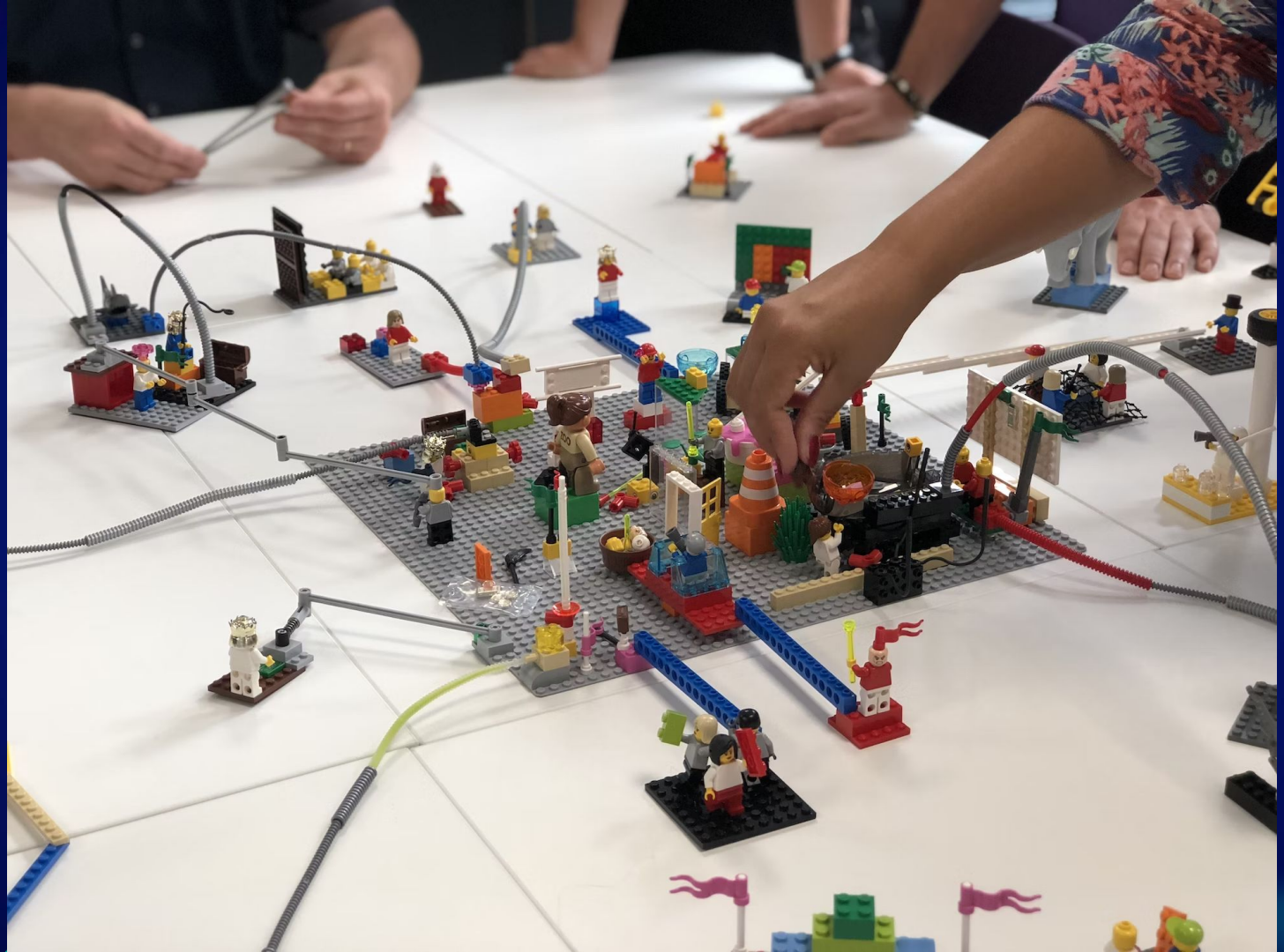
Change hardware, cloud & location

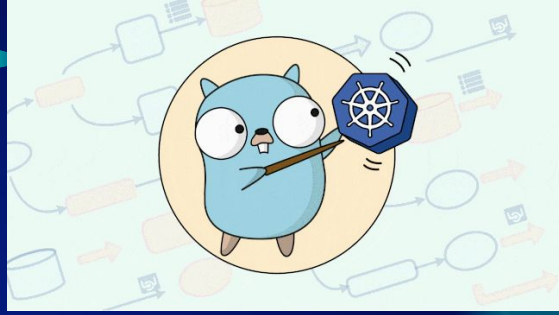
Adjust systems architecture

Optimize Software & build process


MAERSK


THIS IS NOT
KUBERNETES





Kubernetes provides a unified approach to integrate various solutions and to make them act on each other.*

*yes, we still need better data at the node level, beyond this, only the creativity is a limit

Cloud Provider Insights

Item	SCOPE \ (relative to provider)	AZURE	GCP	AWS
Life cycle stage				
Extraction	3	YES	YES	NO
Manufacture	3	YES	YES	NO
Usage	1 & 2	YES	YES	YES
End of life	3	YES	NO	NO
Item				
Building	3	NO	YES	NO
IT Equipment	2 & 3	YES	YES	YES
Overhead	2 & 3	YES	YES	?
Employee commutes	3	NO	YES	NO
Fugitive emissions from HVAC system coolants.	1	?	NO	?
Impacts of IP traffic	Depending on the type of infra	YES	NO	?
On-site combustible fossil energy source	1	?	YES	YES
Idle Resource Impacts	2 & 3	YES	YES	?
Impacts of internal services	2 & 3	YES	YES	?
Methodology of the carbon intensity of electricity				
Line loss	2	?	NO	?
Manufacture of energy infrastructure	2	?	YES	?
Location Based	2	Indirectly	YES	NO
Market Based	2	YES	YES	YES

Source: https://boavizta.org/en/blog/calculettes-carbone-clouds-providers

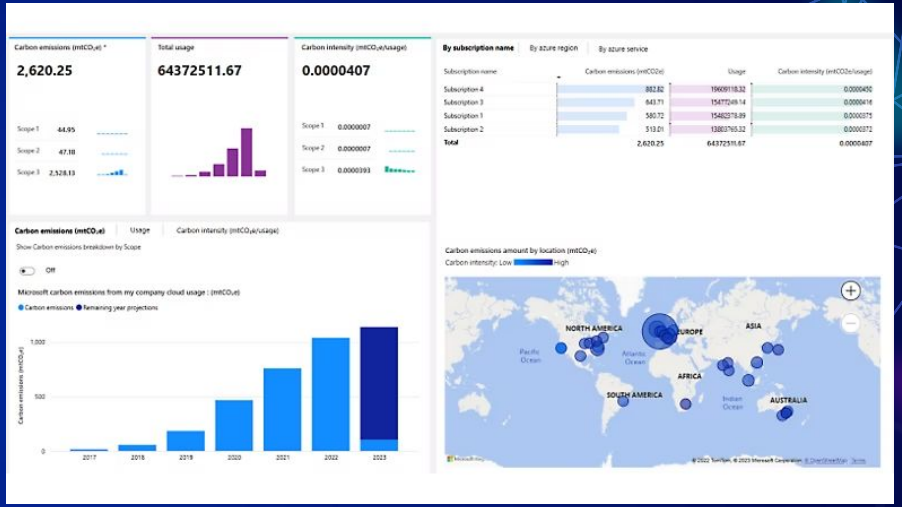
- **Location-based**: The location-based method calculates the emissions related to electricity consumption according to the electricity mix of the region where consumption takes place.
- **Market-based**: The market-based method calculates the emissions related to electricity consumption based on the electricity purchased by the consumer. Some players propose a dual reporting - location-based & market-based.

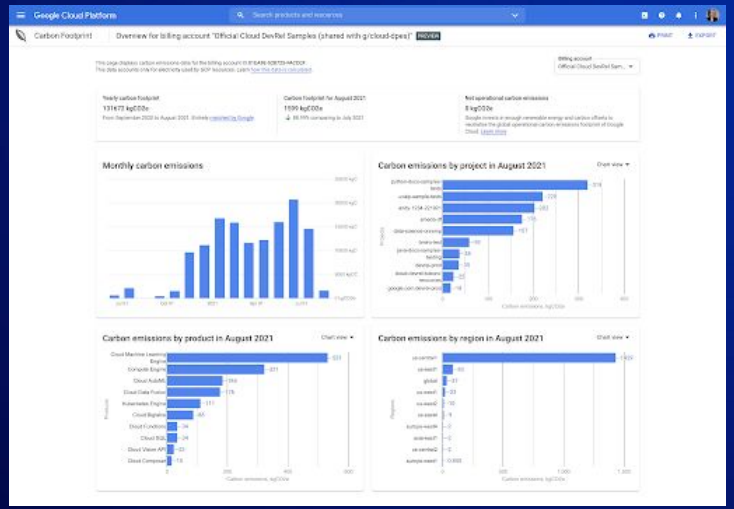
Always prefer **location-based** methods. When both figures are reported, those evaluated with a location-based method must be given precedence.

Cloud Provider Insights

CSP dashboards are good to know but often using data from previous years as a base and mix it with current power consumption.

Should be used to report overall CO2e output and to optimize in the long run.

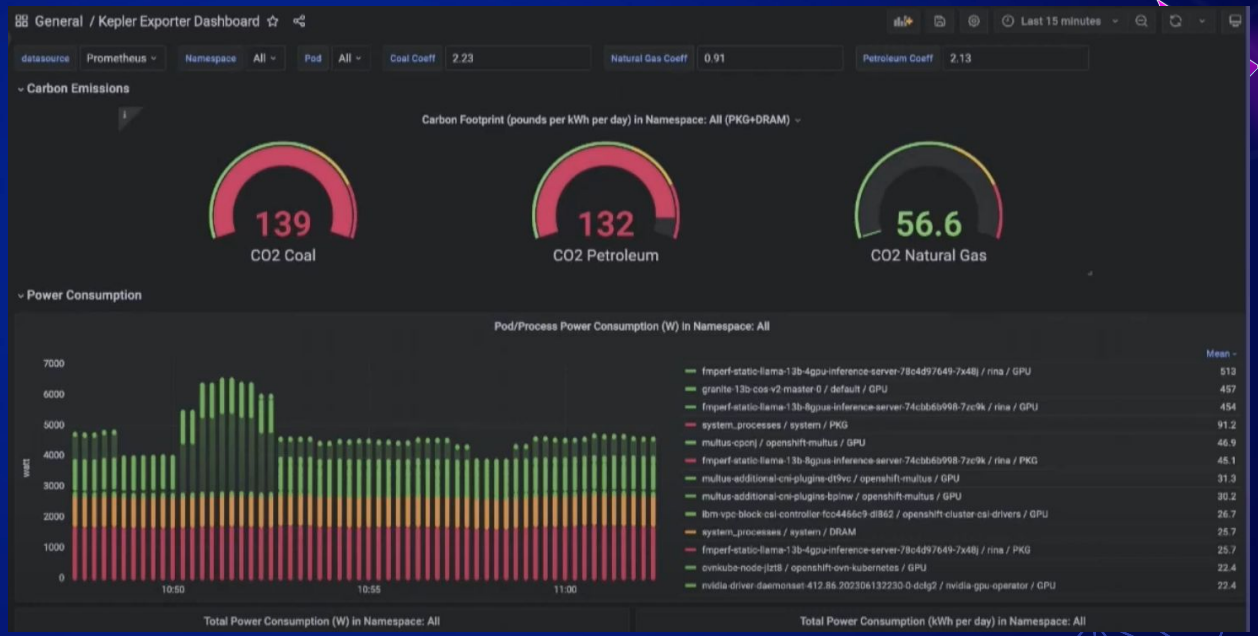




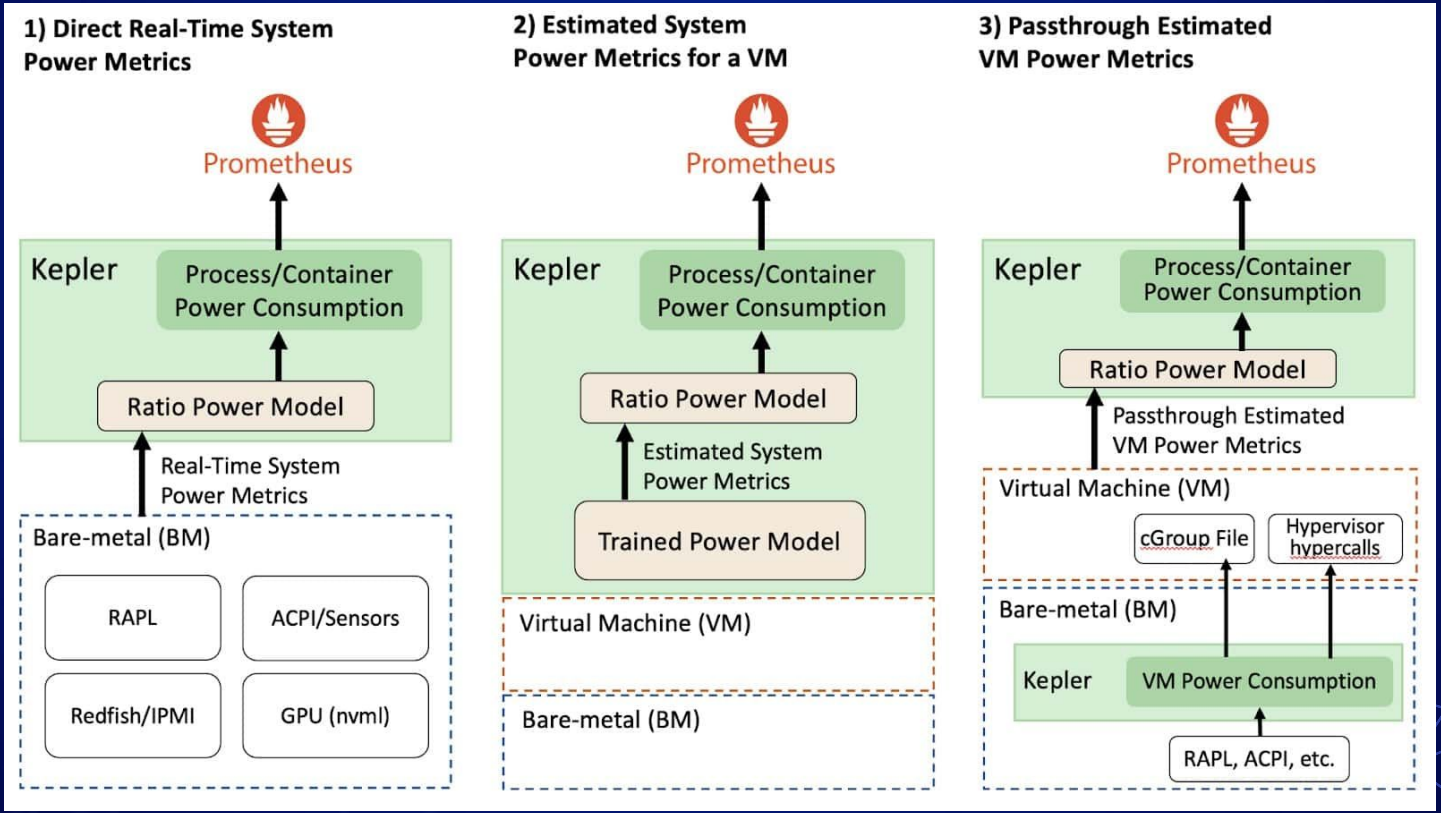
Kepler & co

Kepler (Kubernetes-based Efficient Power Level Exporter) is a Prometheus exporter. It uses eBPF to probe CPU performance counters and Linux kernel tracepoints.

These data and stats from cgroup and sysfs can then be fed into ML models to estimate energy consumption by Pods.



Kepler Deep Dive



CNCF TAG Environmental Sustainability

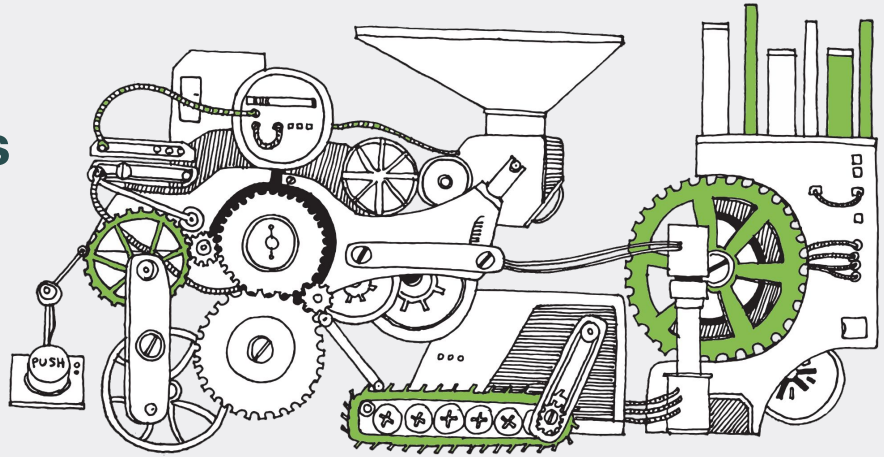
Working Group Green Reviews

Pipeline

- Equinix infrastructure
- GitOps (CAPI, Ansible)
- GitHub Actions with tests
- k6 benchmark tests

Collaboration with CNCF Projects

- Falco



Metrics

- Standard metrics
- Energy metrics (Kepler)
- GSF's Software Carbon Intensity specification

How to focus on the sustainability enablement of the users?

Create Opportunities

Efficient Infrastructure

Provide options in hosting, e.g. with Kubernetes to provide different node groups.
ARM tend to be better in performance, price and energy consumption.

Dynamic App Management

Apps should scale by default, but often require the right surrounding.

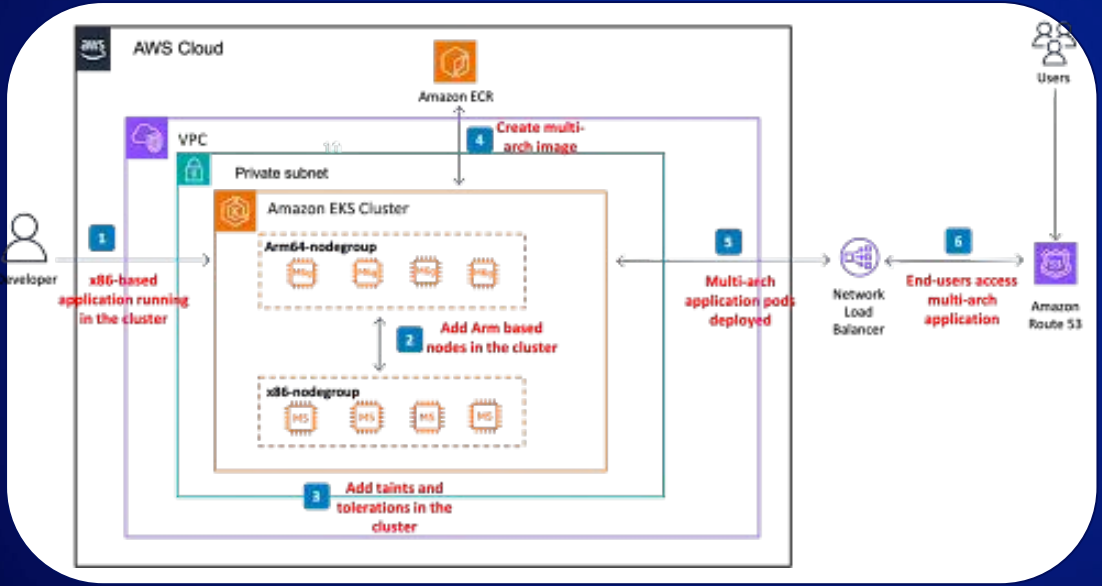
Serverless platforms, event driven autoscaling, de-scheduling and reduction are needed implementations.

“Better” Locations

Enable other regions and countries, document their CO2e efficiency and guide users to those options.

Efficient Infrastructure

Multi Architecture Infrastructure




```
apiVersion: eksctl.io/v1alpha5
kind: ClusterConfig

metadata:
  name: multi-arch-cluster
  region: us-east-1

nodeGroups:
  - name: x86-node-group
    instanceType: m5.large
    desiredCapacity: 2
    volumeSize: 80
  - name: arm64-node-group
    instanceType: m6g.large
    desiredCapacity: 2
    volumeSize: 80
```

Efficient Infrastructure

Multi Architecture Deployment

```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: arm-deployment
  labels:
    app: hello
spec:
  replicas: 1
  selector:
    matchLabels:
      app: hello
      tier: web
  template:
    metadata:
      labels:
        app: hello
        tier: web
    spec:
      containers:
      - name: hello
        image: <your-docker-repo-path>/multi-arch-demo:arm64
        imagePullPolicy: Always
        ports:
          - containerPort: 8080
        env:
          - name: NODE_NAME
            valueFrom:
              fieldRef:
                fieldPath: spec.nodeName
          - name: POD_NAME
            valueFrom:
              fieldRef:
                fieldPath: metadata.name
        resources:
          requests:
            cpu: 300m
      nodeSelector:
        kubernetes.io/arch: arm64
```

```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: multi-arch-deployment
  labels:
    app: hello
spec:
  replicas: 6
  selector:
    matchLabels:
      app: hello
      tier: web
  template:
    metadata:
      labels:
        app: hello
        tier: web
    spec:
      containers:
      - name: hello
        image: <your-docker-repo-path>/multi-arch:latest
        imagePullPolicy: Always
        ports:
          - containerPort: 8080
        env:
          - name: NODE_NAME
            valueFrom:
              fieldRef:
                fieldPath: spec.nodeName
          - name: POD_NAME
            valueFrom:
              fieldRef:
                fieldPath: metadata.name
        resources:
          requests:
            cpu: 300m
```

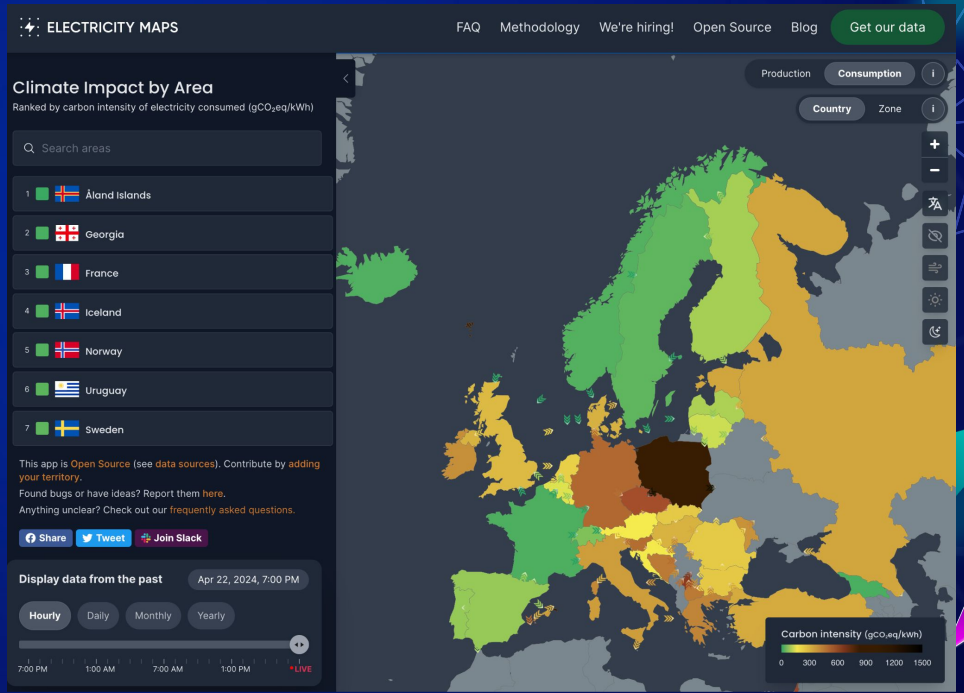
Better Locations

Let's have a look!

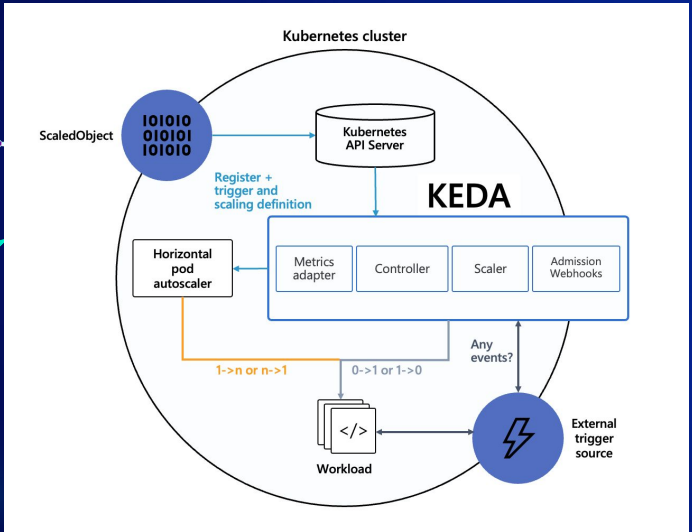
Deliver platforms in areas that tend to be greener:

1. Norway, Iceland
2. Sweden, Switzerland, Spain, Portugal, France
3. Netherlands, Belgium, Austria

Difference:
Germany 466g vs Sweden 36g **-92%**
Netherlands 266g vs France 31g **-88%**
Ireland 384g vs Switzerland 65g **-83%**



Event Driven Auto Scaler



With Keda your users are enabled to scale up and down their workload based on events.

This is especially useful when you are in a market where the demand also changes over time.

The less resources you use and the more often you increase density per node the better is your utilization.

An alternative is the combination of kube-green & karpenter. KG shuts down pods time based, while karpenter removes empty nodes.

A Keda + karpenter combination is possible too.

Event Driven Auto Scaler on CO2e steroids


```yaml
apiVersion: carbonaware.kubernetes.azure.com/v1alpha1
kind: CarbonAwareKedaScaler
metadata:
  name: carbon-aware-word-processor-scaler
spec:
  kedaTarget: scaledobjects.keda.sh        # can be used for ScaledObjects & ScaledJobs
  kedaTargetRef:
    name: word-processor-scaler
    namespace: default
  carbonIntensityForecastDataSource:       # carbon intensity forecast data source
    mockCarbonForecast: false              # [OPTIONAL] use mock carbon forecast data
    localConfigMap:                        # [OPTIONAL] use configmap for carbon forecast data
      name: carbon-intensity
      namespace: kube-system
      key: data
  maxReplicasByCarbonIntensity:            # array of carbon intensity values in ascending ord
    - carbonIntensityThreshold: 437        # when carbon intensity is 437 or below
      maxReplicas: 110                     # do more
    - carbonIntensityThreshold: 504        # when carbon intensity is >437 and <=504
      maxReplicas: 60
    - carbonIntensityThreshold: 571        # when carbon intensity is >504 and <=571 (and beyo
      maxReplicas: 10                      # do less
  ecoModeOff:                              # [OPTIONAL] settings to override carbon awareness;
    maxReplicas: 100                       # when carbon awareness is disabled, use this value
    carbonIntensityDuration:               # [OPTIONAL] disable carbon awareness when carbon i
      carbonIntensityThreshold: 555        # when carbon intensity is equal to or above this v
      overrideEcoAfterDurationInMins: 45   # if carbon intensity is high for this many hours d
    customSchedule:                        # [OPTIONAL] disable carbon awareness during specif
      - startTime: "2023-04-28T16:45:00Z"  # start time in UTC
        endTime: "2023-04-28T17:00:59Z"    # end time in UTC
    recurringSchedule:                     # [OPTIONAL] disable carbon awareness during specif
      - "* 23 * * 1-5"                     # disable every weekday from 11pm to 12am UTC
```

Other options?

Serverless

Suitable but only if your underlying infrastructure is fast too.

Difficulties in optimizing the utilization except you include it into steady workload to fill up the last 10% of capacity.

WASM

Reduces the footprint in size and speed of startup.

Doesn't have an effect on compute efficiency.

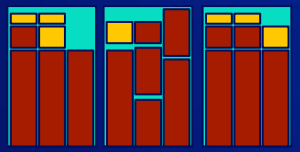
Self Service

Provide a service catalog of optimized deployments with guides that have sustainability in mind.

Users tend to use the default, so make the default great!

Strategic Approach to “Fill-up-the-Gaps”

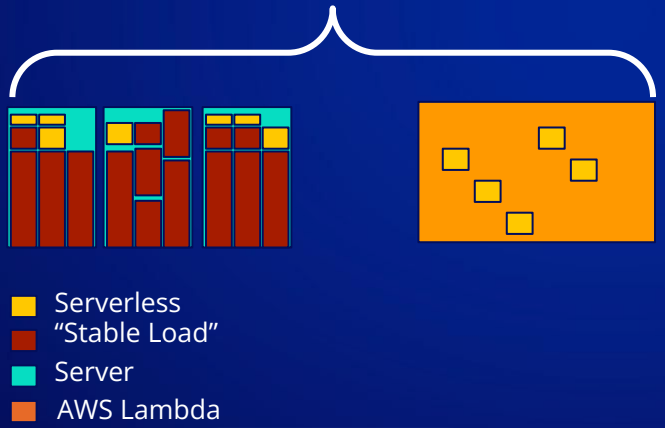
OpenFaaS running in cluster



Serverless
“Stable Load”
Server

Strategic Approach to “Fill-up-the-Gaps”

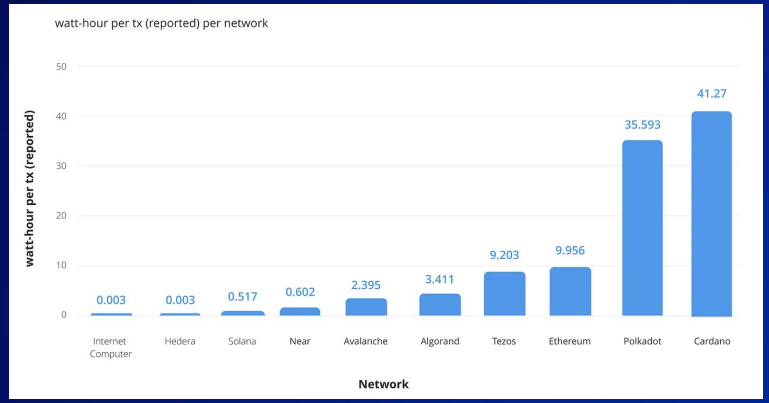
OpenFaaS running in cluster and cluster

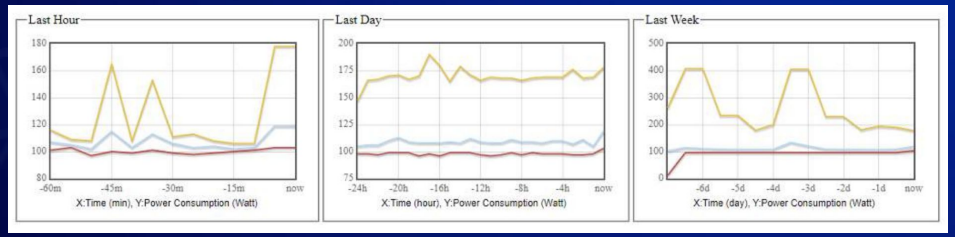


OpenFaas for example provides the capability to run the same workload within K8s and AWS Lambda.

That means, if your cluster runs out of resources due to high utilization, you can fall back to AWS

Cloud is so 2000, let's do Web3!





Yellow: max., Red: min., Blue: Average.

It's difficult to compare Web3 to classic computing.

Don't forget protocols as ICP are tamper proof, encrypted, and generally very secure computing.

Without heavy utilization of such protocols the computation is same inefficient as non optimized workload.

On the other hand, protocols as ICP allow other computing concepts as DeepGreen or Edge Computing to be implemented very easy.

The Power of Platform Engineering

Transparency

Opportunities

Show the effectiveness of the actions taken.

Making changes visible.

Enable the self-driven activities to find the right options.

Correlate a change with an effect.

Education = Awareness

Create Awareness

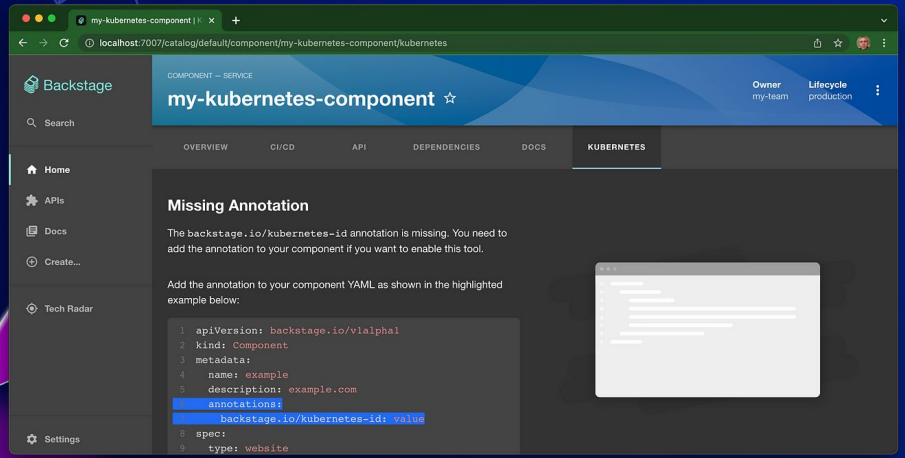
It’s on us to share and build an understanding of why we shouldn’t treat cloud resources as infinite.

Educate Actively

Provide demos and best practices that are already with a sustainable architecture and configuration in mind.

As Platform Engineers we have the opportunity to share this knowledge and enforce it into the community.

Use Backstage as Multiplicator



Backstage is a perfect multiplication gainer through its integrated documentation and references.

Provided templates might be used more often then self developed stand alone items.

Green Cloud Computing

Reducing Data

Est. >90% stored data is untouched

Increase Utilization

Only at max. Used servers are good servers (old or new)

Optimize Processes

(I'm not sorry, but) you are not Google. Spotify or co

Define Sustainable Architecture

More lightweight, flexible, polyglot, robust and humanity friendly

Have a strategy & no blind optimization

Don't swap your compute randomly around

Provide Platforms to ease things

You have to implement the possibilities to make one use them

Thank You For Your Time

Max Körbächer

Founder & Cloud Native Advisor
CNCF Ambassador, LF Europe Advisory Board

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LIQUID

Let’s connect, LinkedIn →