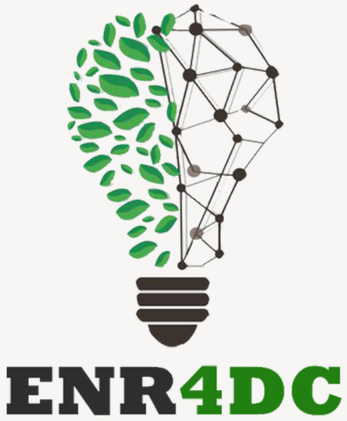
Advanced Project S8

Creation of a workload orchestration solution reducing electrical consumption in Orange datacenters



Introduction

2.7%

Global energy consumption of the **digital sector** of the total global energy consumption (1)

South Africa

Electricity consumption is equivalent to electricity consumption of worldwide datacenters (2)

Orange goals

30%

Reduce CO2 emissions by **2025**

zero

Carbon emission by **2040**

(1) source: Insee - 2019
(2) source : "INTERNATIONAL: ELECTRICITY - CONSUMPTION", U.S. Energy Information Administration

Introduction

Objectives of the project :

- Creating a cluster using **Kubernetes** supervised by **Prometheus**
- Creating a **workload orchestration** solution
- Creating a final **Grafana dashboard**

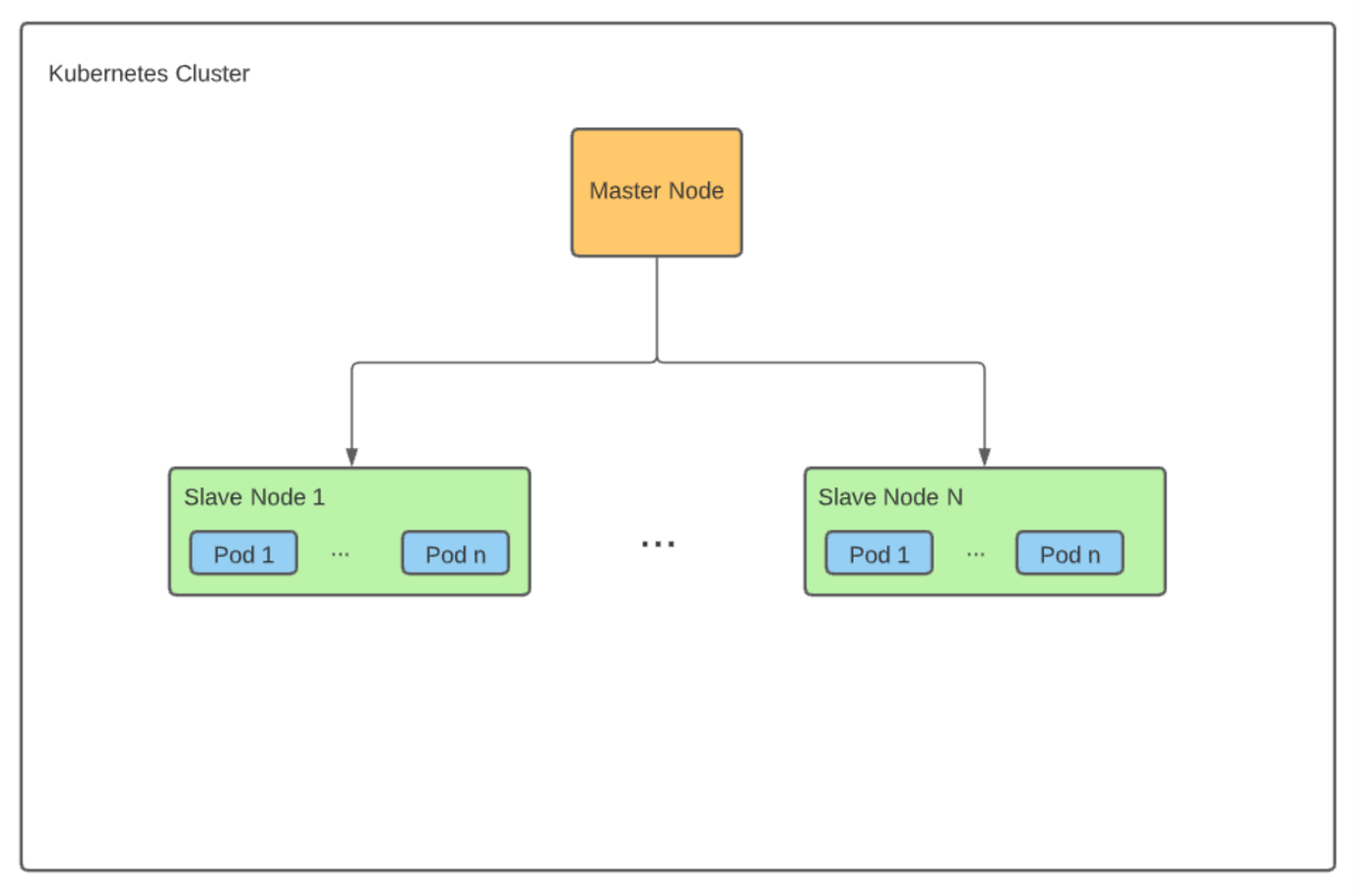
Plan

1. Cluster creation
2. Workload orchestration
3. Results
4. Project management

1. Cluster creation

1. Cluster Creation

Kubernetes cluster



Model

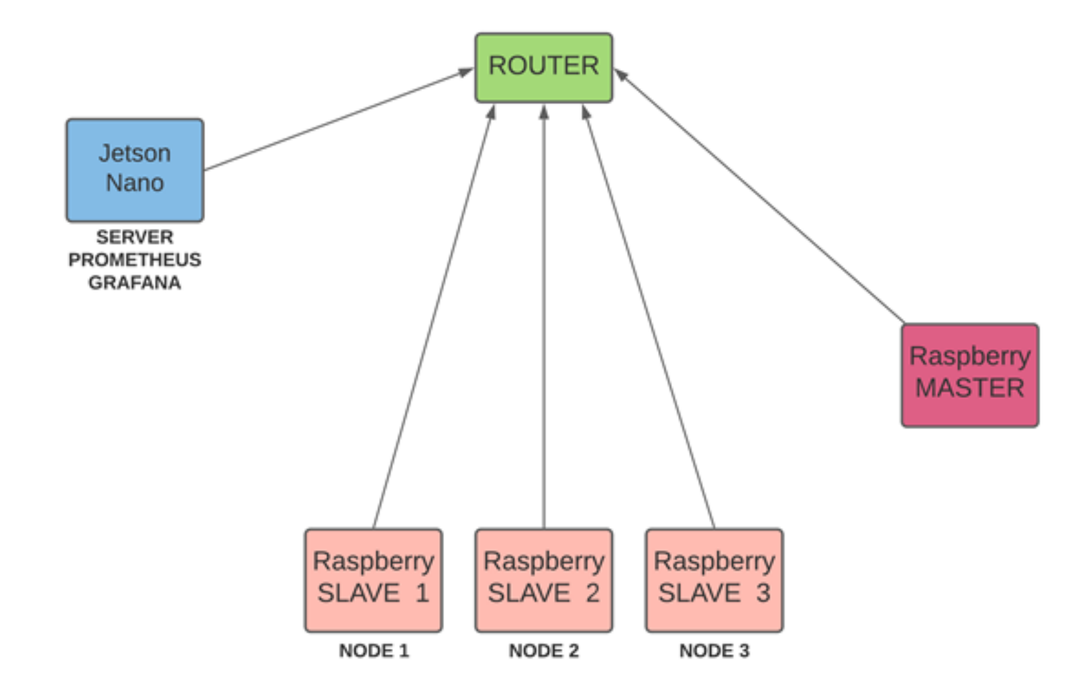
Master Node
Workloads Manager

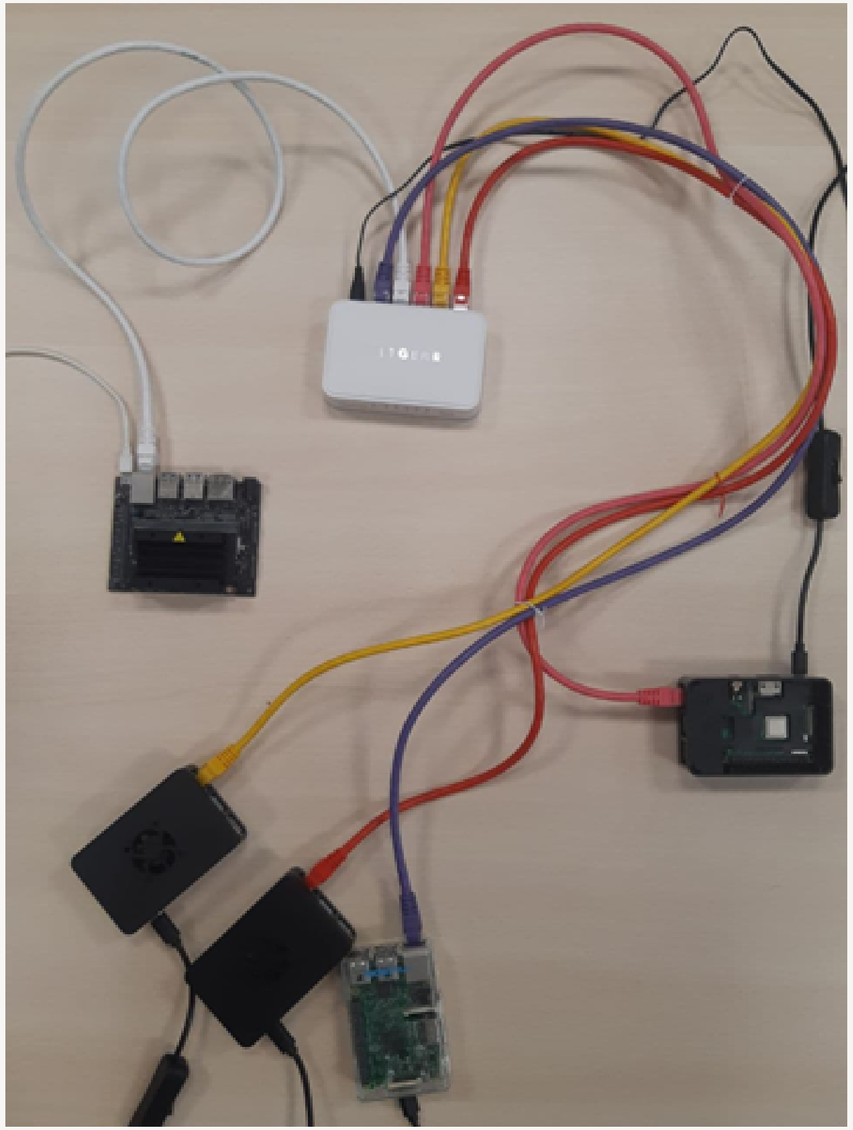
Slave Nodes
Data Centers

Pods
Workloads (Tasks)

1. Cluster Creation

Physical cluster





Kubernetes on Raspberry Pis : Kubeadm

1. Cluster Creation

Physical cluster

Problems encourtered

Incompatibility

Limitation caused by **hardware**

Integration of Prometheus and Grafana

Solution

Kind

A virtual cluster

1. Cluster Creation

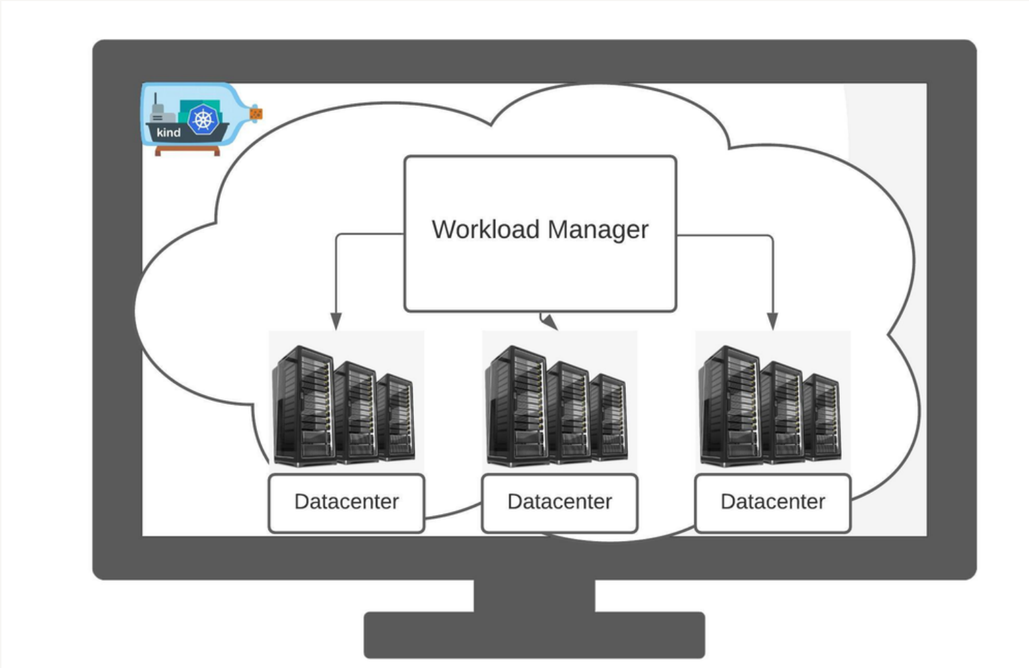
Virtual cluster

Advantages

No material constraint

Easy installation

Prometheus and Grafana supported



Kind

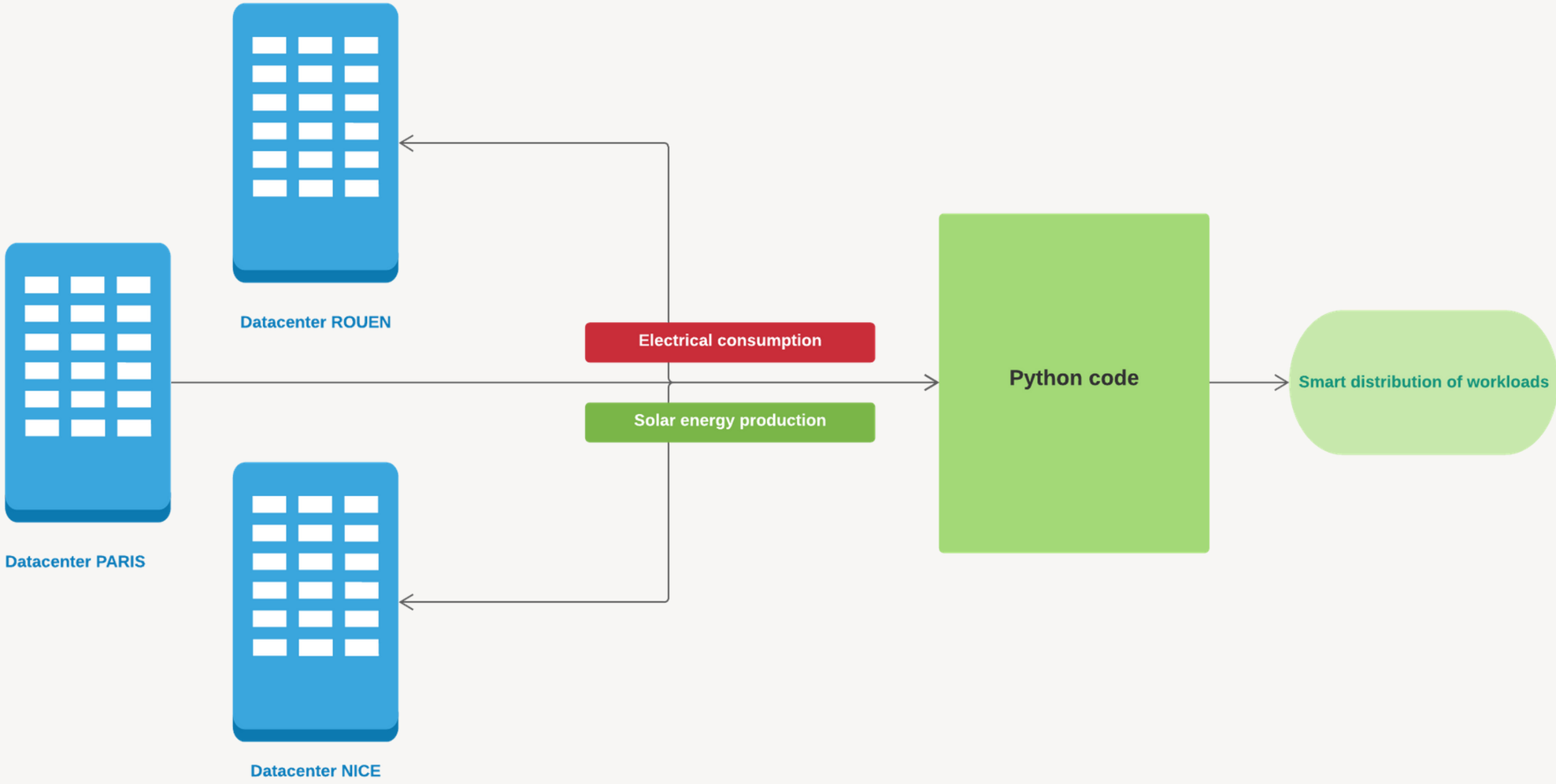
Virtual cluster on a personnal machine

Workload orchestration using Kubernetes

2. Workload Orchestration

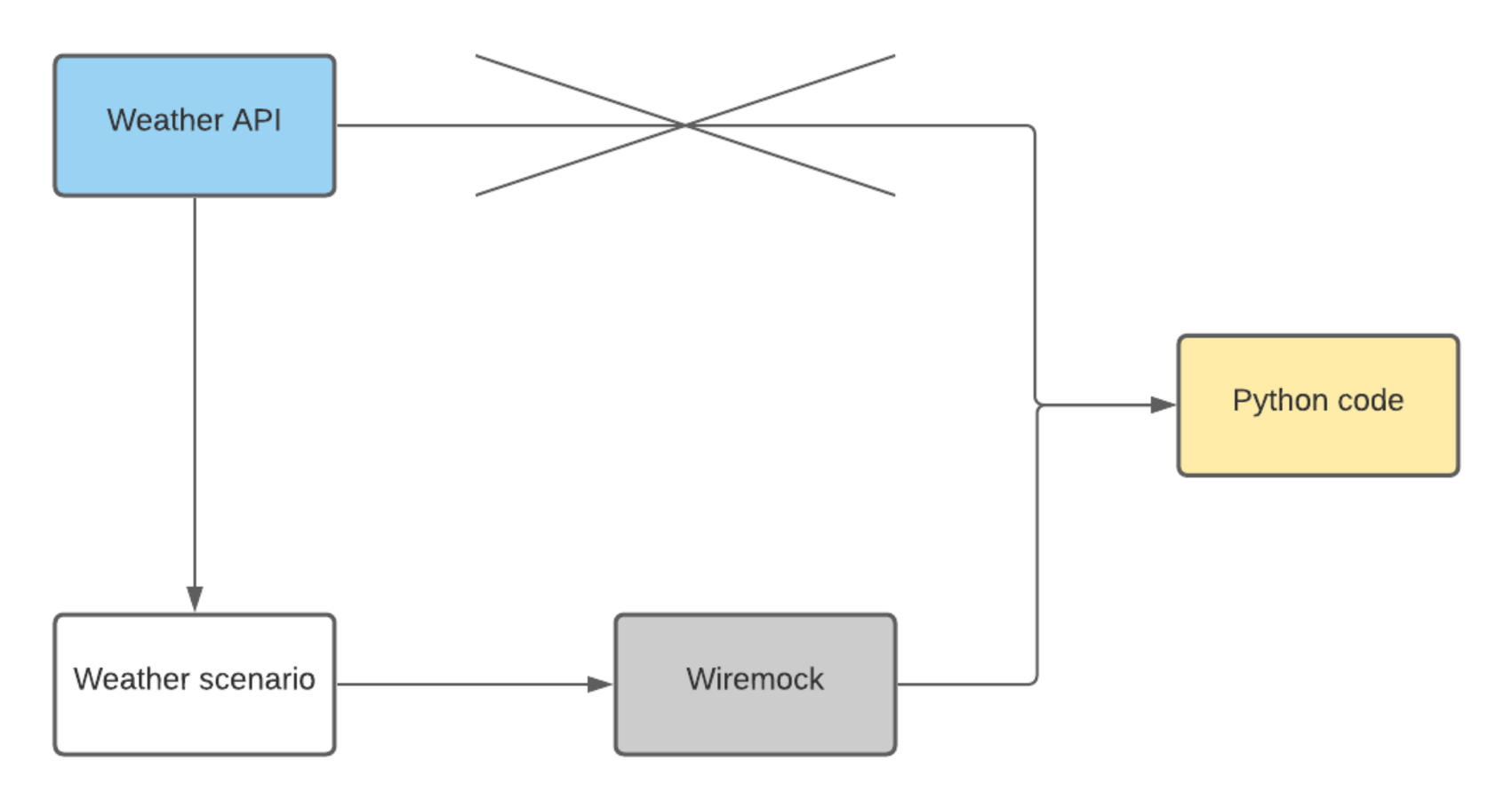
2. Workload orchestration

An innovative idea



2. Workload orchestration

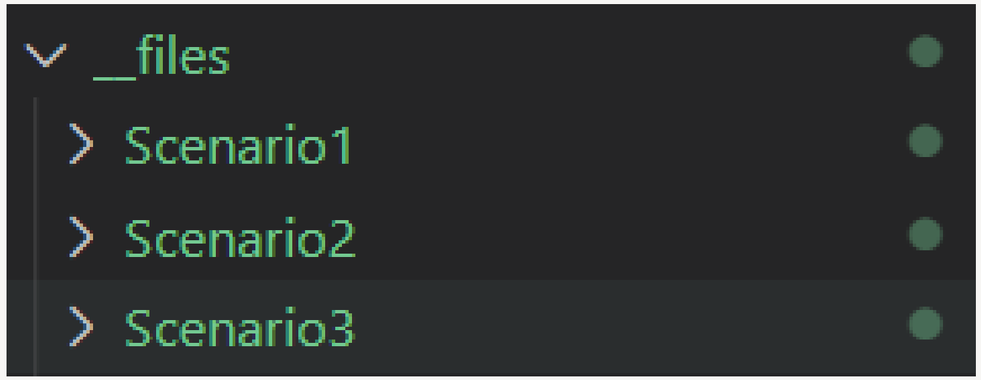
Weather scenarios



2. Workload orchestration

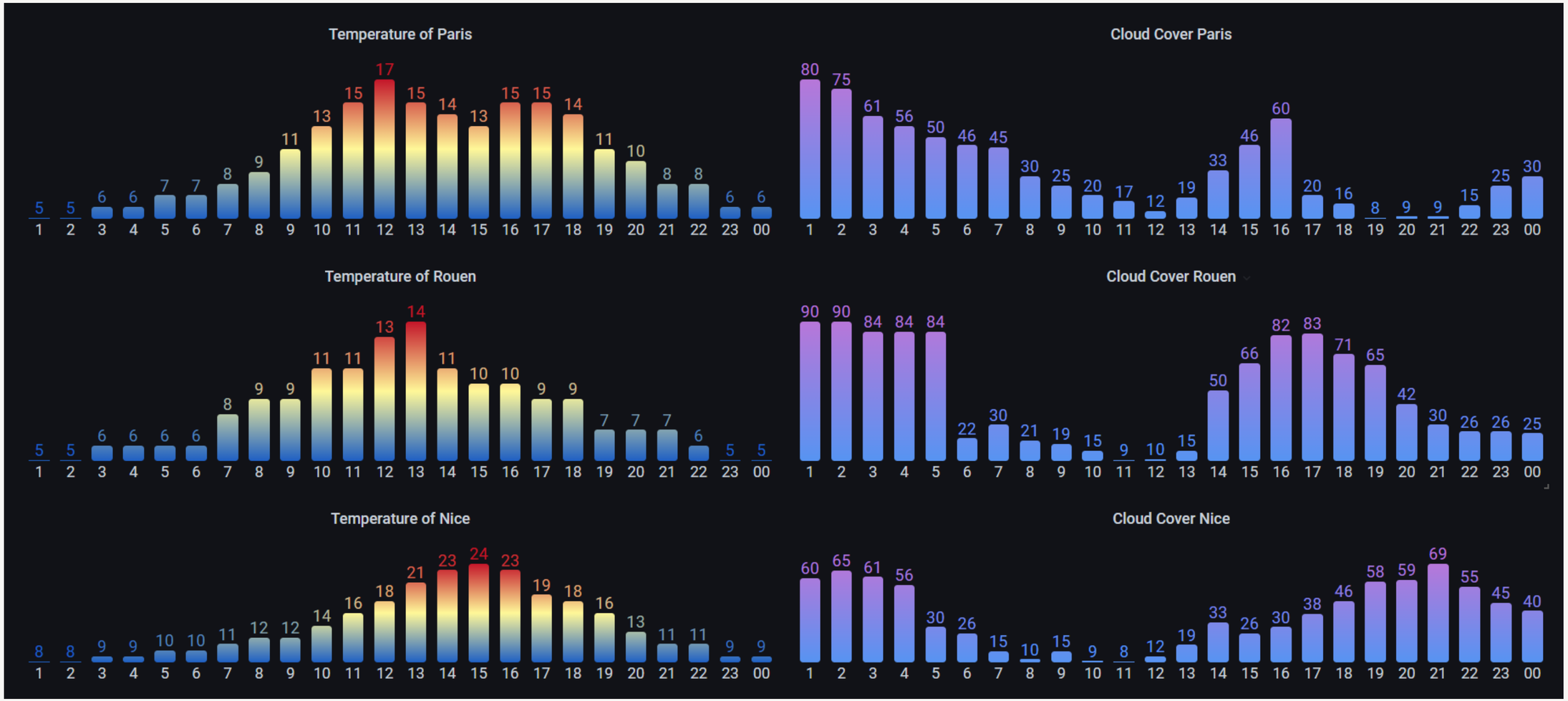
Weather scenarios JSON and Wiremock


```
{"Paris":{"UV index":1,"Temperature":5,"Weather Code":119,"Cloud Cover":80,"Humidity":60},
"Rouen":{"UV index":1,"Temperature":5,"Weather Code":302,"Cloud Cover":90,"Humidity":75},
"Nice":{"UV index":2,"Temperature":8,"Weather Code":119,"Cloud Cover":60,"Humidity":60}}
```

2. Workload orchestration

Weather scenarios with Grafana



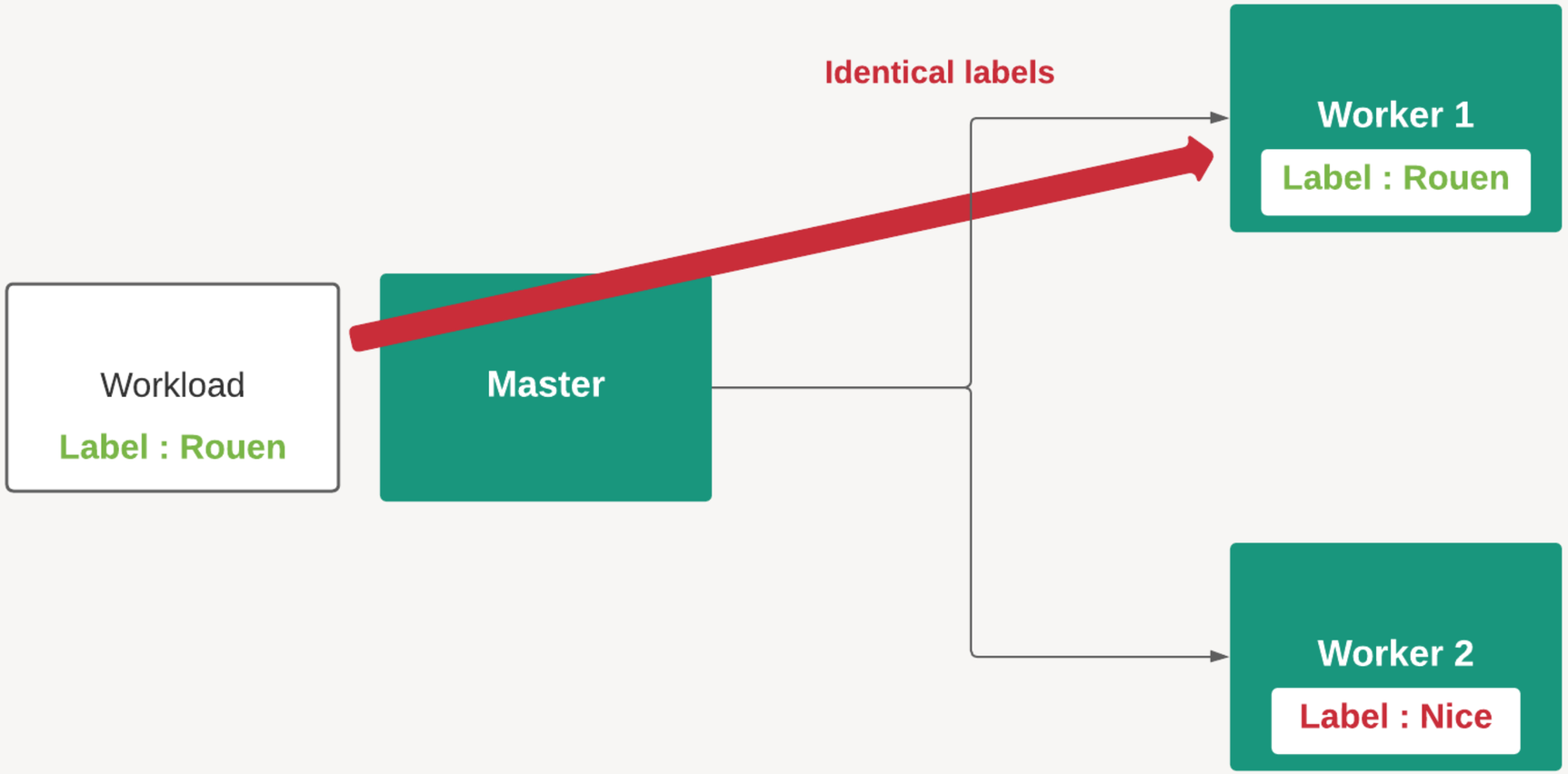
2. Workload orchestration

Ratio computation

- $$E_{available}(t+1) = E_{available}(t) + E_{prod}(t) - E_{cons}(t)$$
- $$R(t) = \frac{E_{available}(t)}{E_{available\_total}(t)}$$

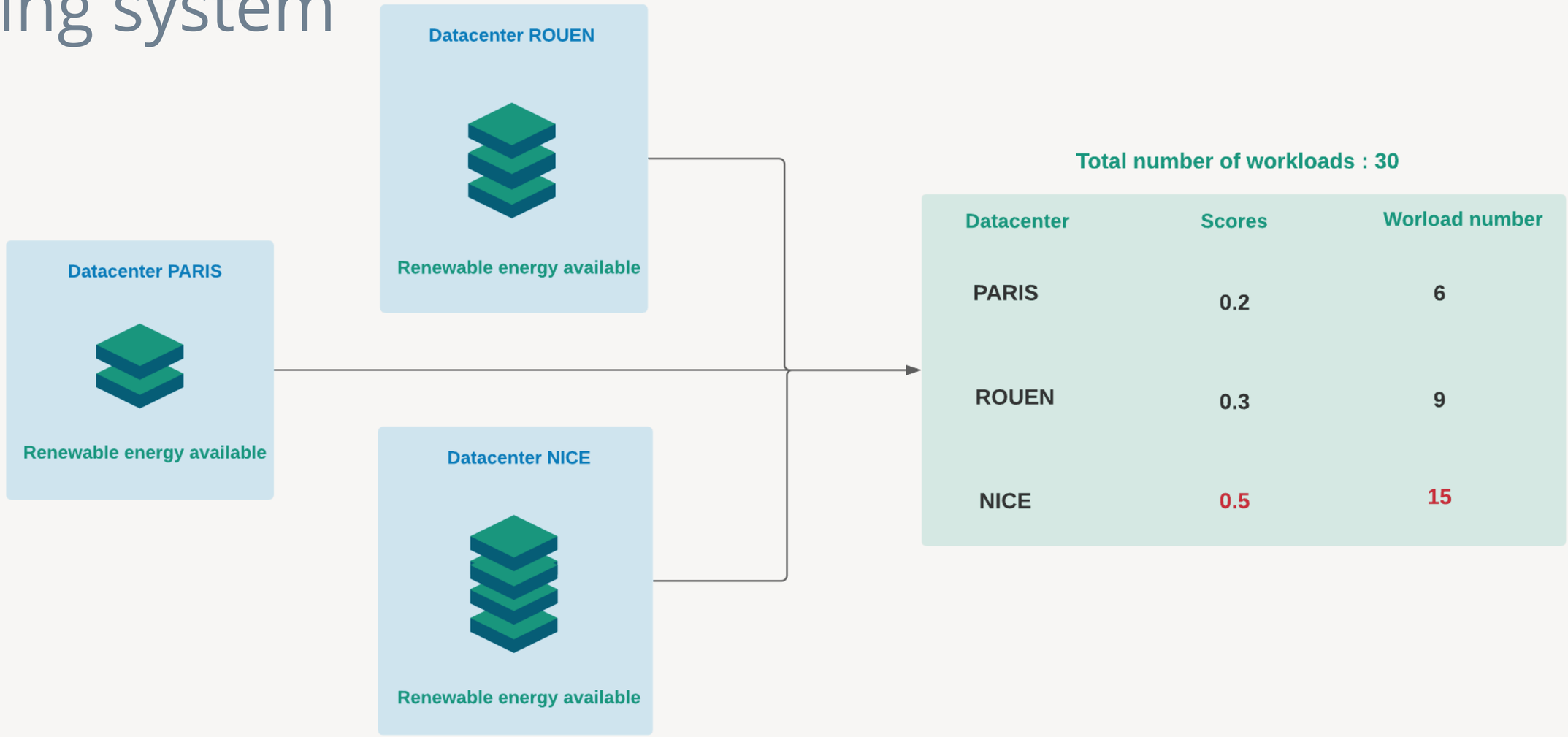
2. Workload orchestration

Labelling



2. Workload orchestration

Scoring system



2. Workload orchestration

Workload redeployment system

t=0

Total number of workloads : 30

t=1

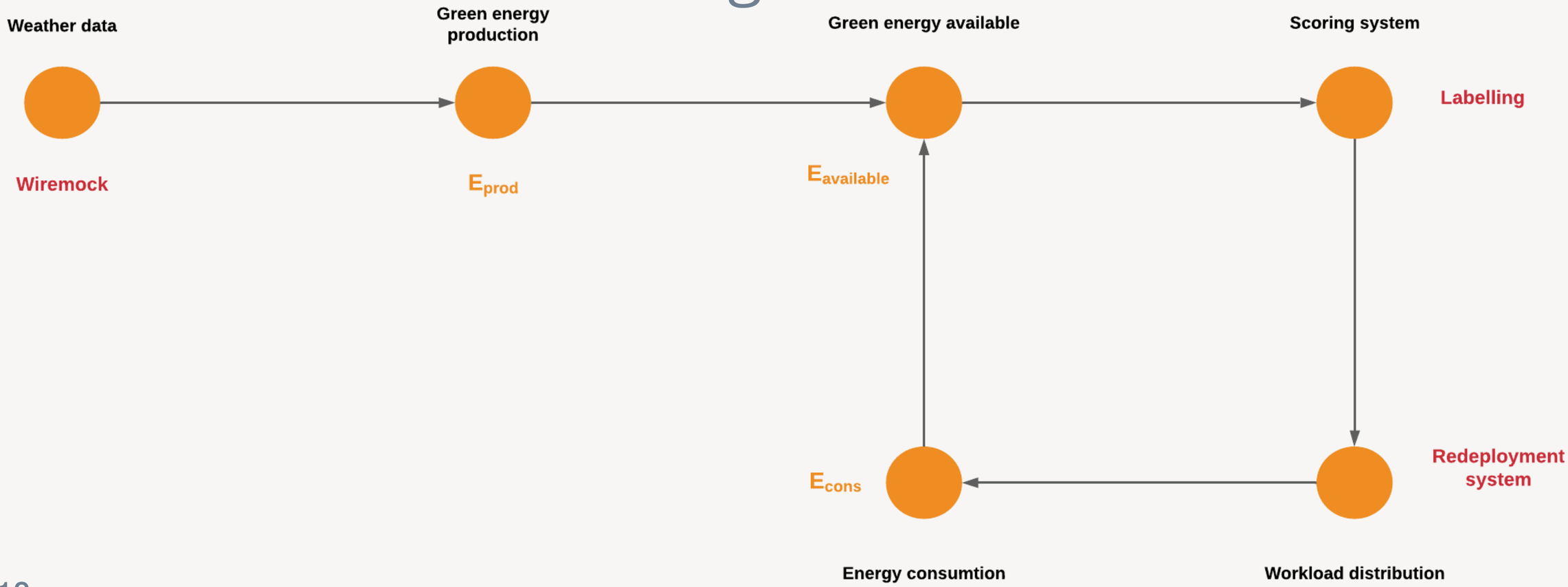
Datacenter	Scores	Worload number
PARIS	0.2	6
ROUEN	0.3	9
NICE	0.5	15

Workload movements

Datacenter	Scores	Worload number
PARIS	0.2	6
ROUEN	0.4	12
NICE	0.4	12

2. Workload orchestration

Global behavior of the algorithm



3. Results

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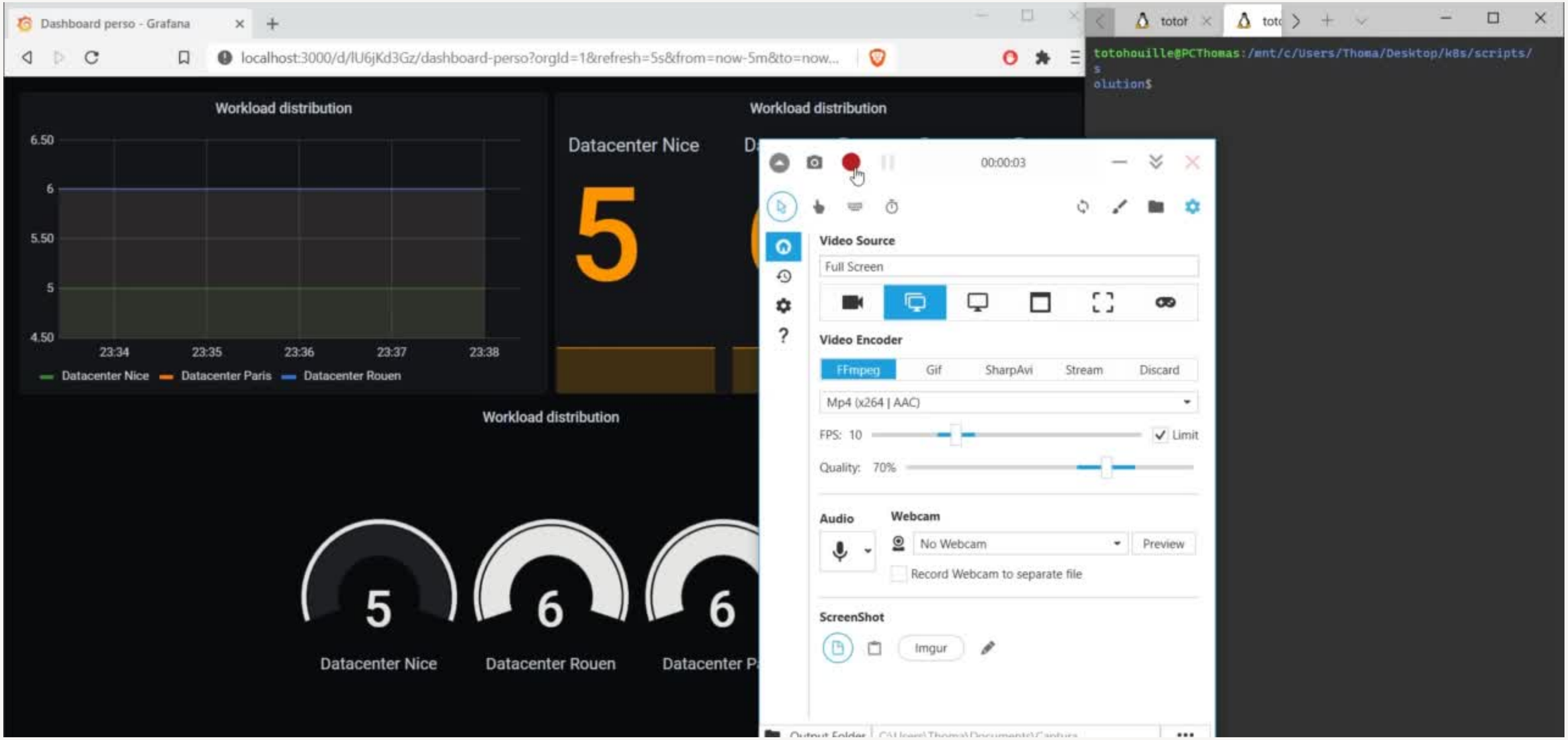

Dashboard perso - Grafana
localhost:3000/d/lU6jKd3Gz/dashboard-perso?orgId=1&refresh=5s&from=now-5m&to=now...
Workload distribution
6.50
6
5.50
5
4.50
23:34
23:35
23:36
23:37
23:38
Datacenter Nice
Datacenter Paris
Datacenter Rouen
Workload distribution
Datacenter Nice
5
Workload distribution
5
Datacenter Nice
6
Datacenter Rouen
6
totohouille@PCThomas:/mnt/c/Users/Thoma/Desktop/k8s/scripts/
olution$
00:00:03
Video Source
Full Screen
Video Encoder
FFmpeg
Gif
SharpAvi
Stream
Discard
Mp4 (x264 | AAC)
FPS: 10
Limit
Quality: 70%
Audio
Webcam
No Webcam
Preview
Record Webcam to separate file
ScreenShot
Imgur

3. Results

Objectives of the project :

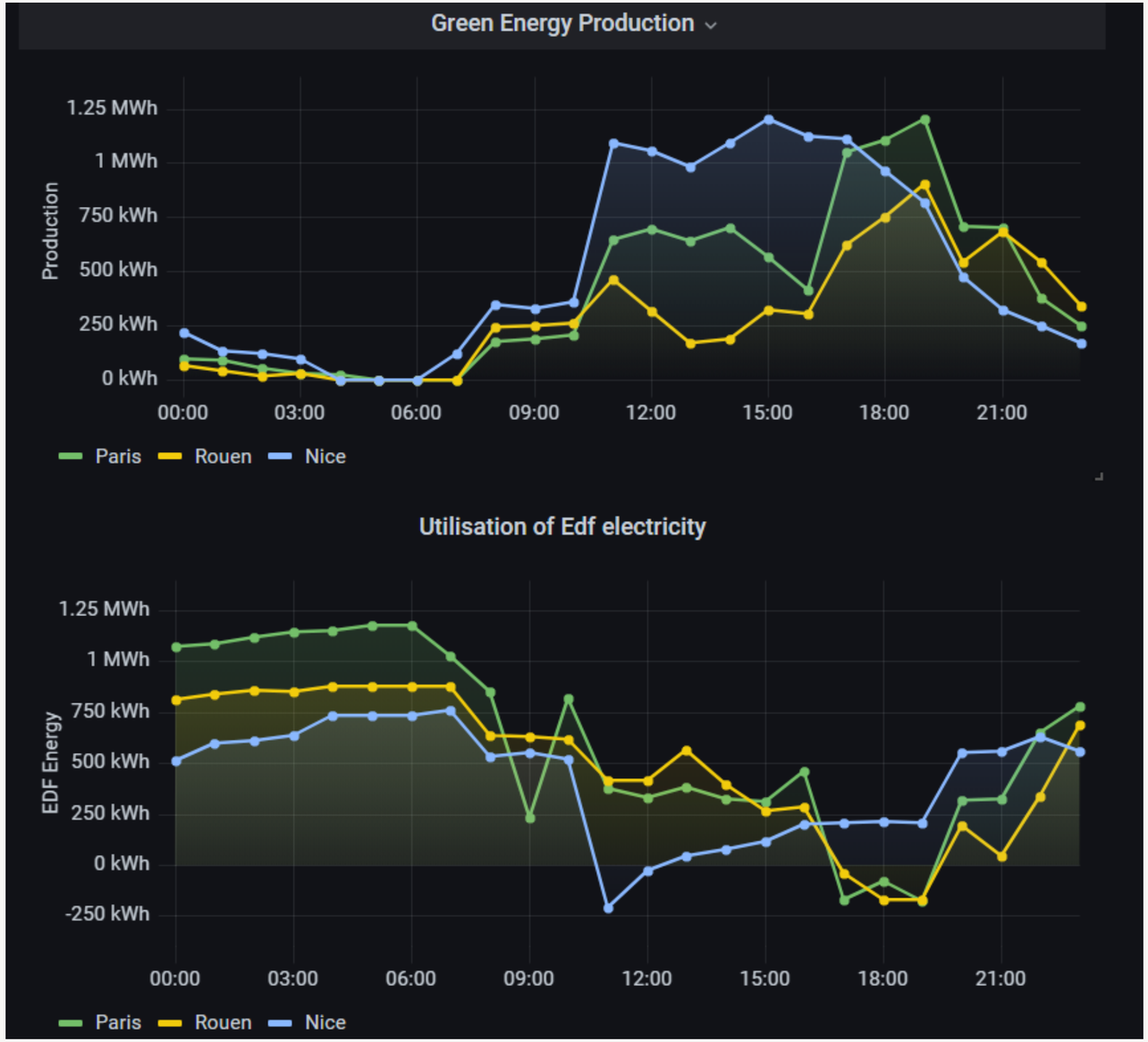
- ✓ Create a cluster using **Kubernetes** supervised by **Prometheus**
- ✓ Create a **workload** orchestration solution
- ➤ Create a final **Grafana dashboard**

3. Results

- Workload **distribution** depending on **ratio**

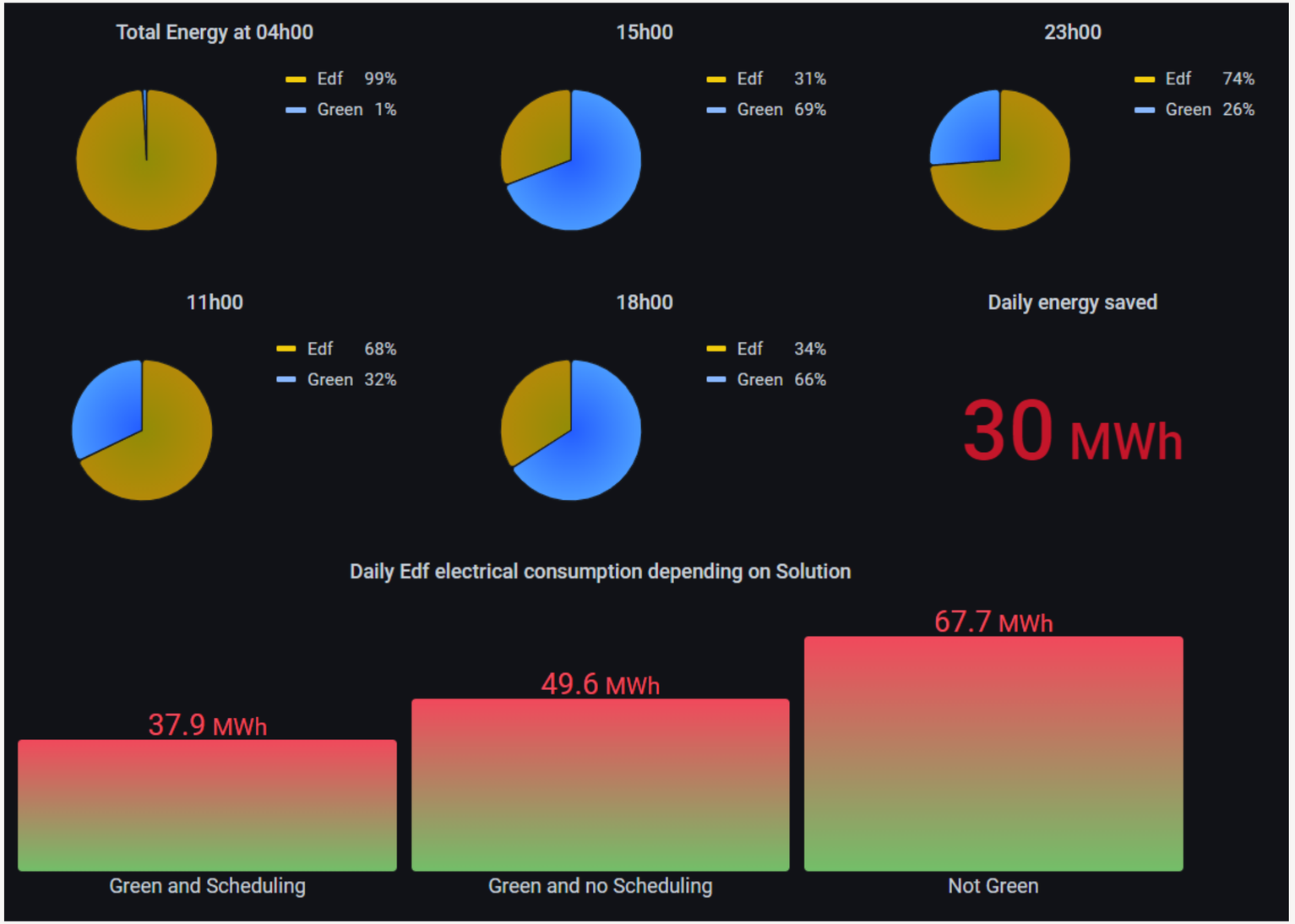
3. Results

- Green energy **production**
- **EDF** energy use

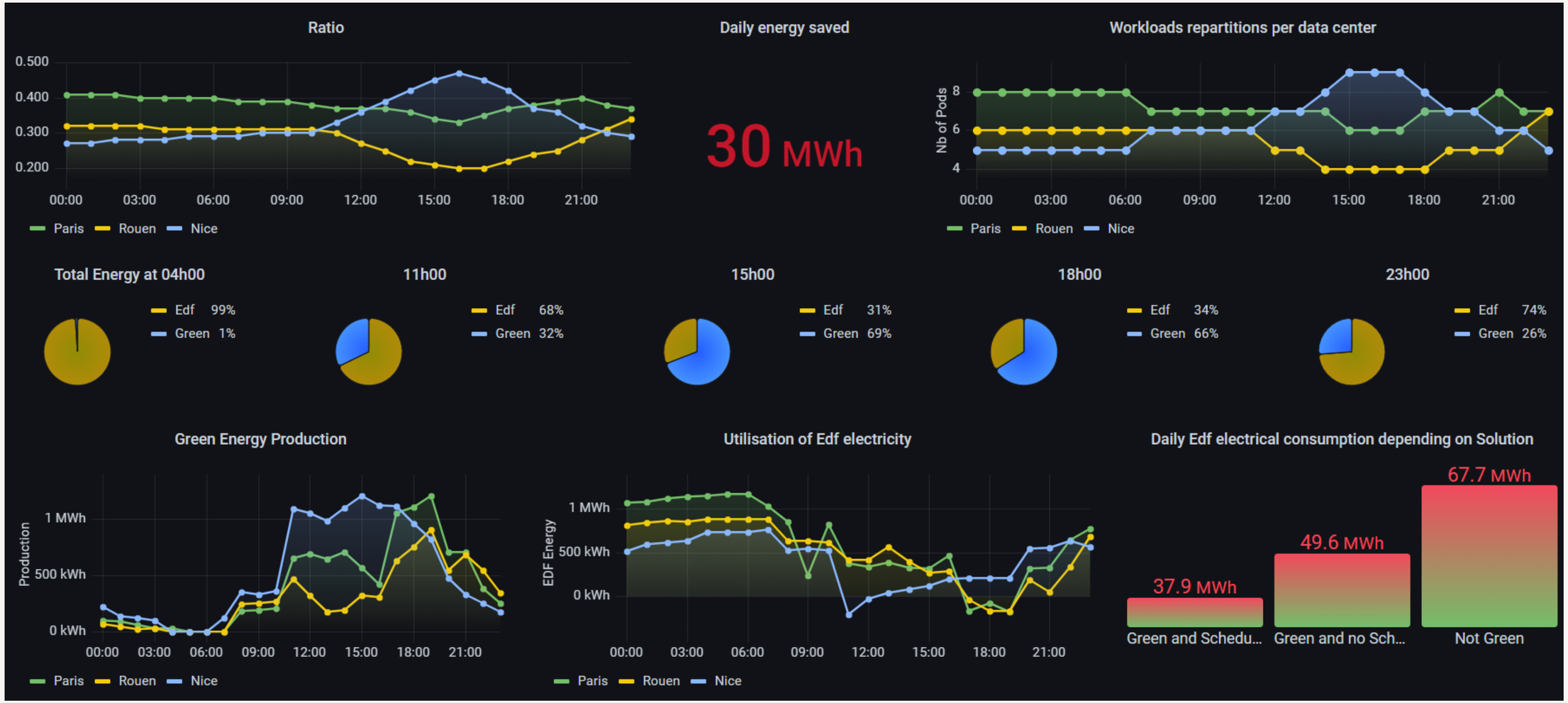


3. Results

- An average **weather scenario**
- An average solar panel **production**
- No **storage** facility for the electricity



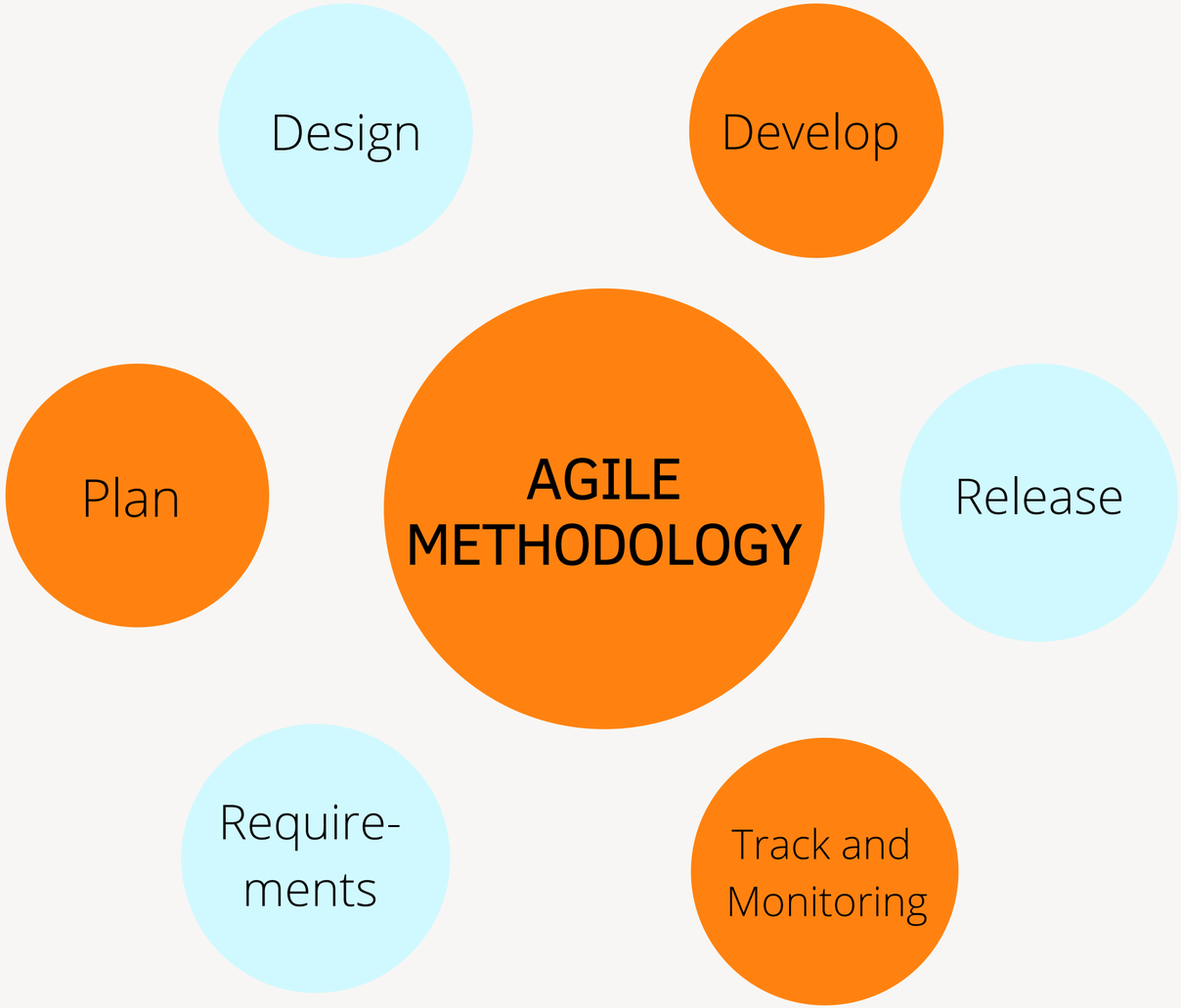
3. Results


Ratio
0.500
0.400
0.300
0.200
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
Paris
Rouen
Nice
Daily energy saved
30 MWh
Workloads repartitions per data center
Nb of Pods
8
6
4
Total Energy at 04h00
Edf 99%
Green 1%
11h00
Edf 68%
Green 32%
15h00
Edf 31%
Green 69%
18h00
Edf 34%
Green 66%
23h00
Edf 74%
Green 26%
Green Energy Production
Production
1 MWh
500 kWh
0 kWh
Utilisation of Edf electricity
EDF Energy
Daily Edf electrical consumption depending on Solution
37.9 MWh
49.6 MWh
67.7 MWh
Green and Schedu...
Green and no Sch...
Not Green

4. Project Management

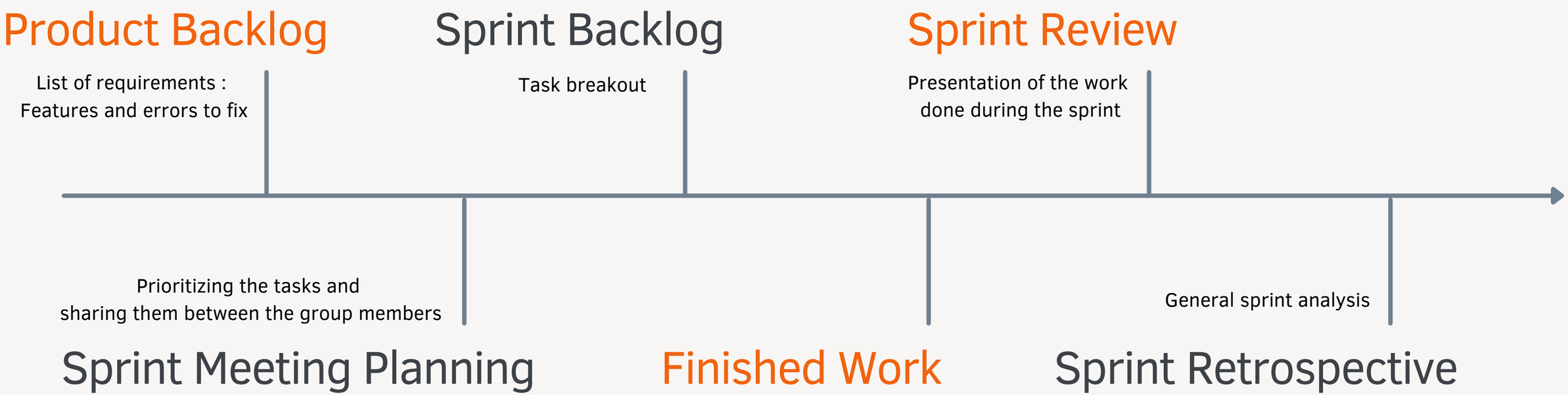
4. Project Management

- Transparency
- Visibility
- Flexibilty



4. Project Management

Agile Methodology



Conclusion

Conclusion

First
on this innovation

An **efficient**
solution

A **starting** point
for the Orange
strategy team

Skills
developpement

What is next ?

Thanks to

Alexis Carrel-Billiard

Frédéric Denis

Questions ?

worker1.yaml

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: pod1
spec:
  nodeName: kind-worker # schedule pod to specific node
  containers:
  - name: nginx
    image: nginx
    imagePullPolicy: IfNotPresent
```