

**CAMUNDA  
COMMUNITY  
SUMMIT 2023**

# The Camunda 8 Connector for Carbon-Aware Process Execution

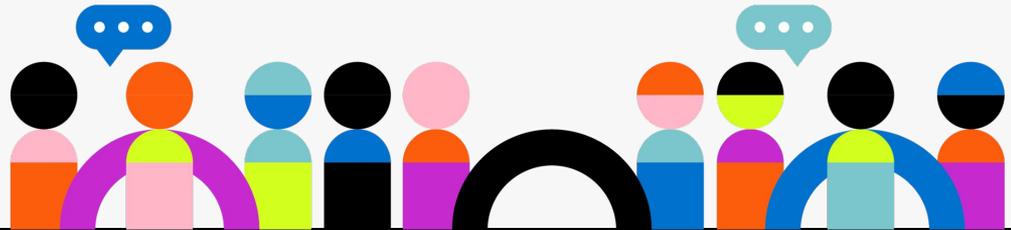
Camunda Carbon Reductor



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# The Camunda 8 Connector for Carbon-Aware Process Execution

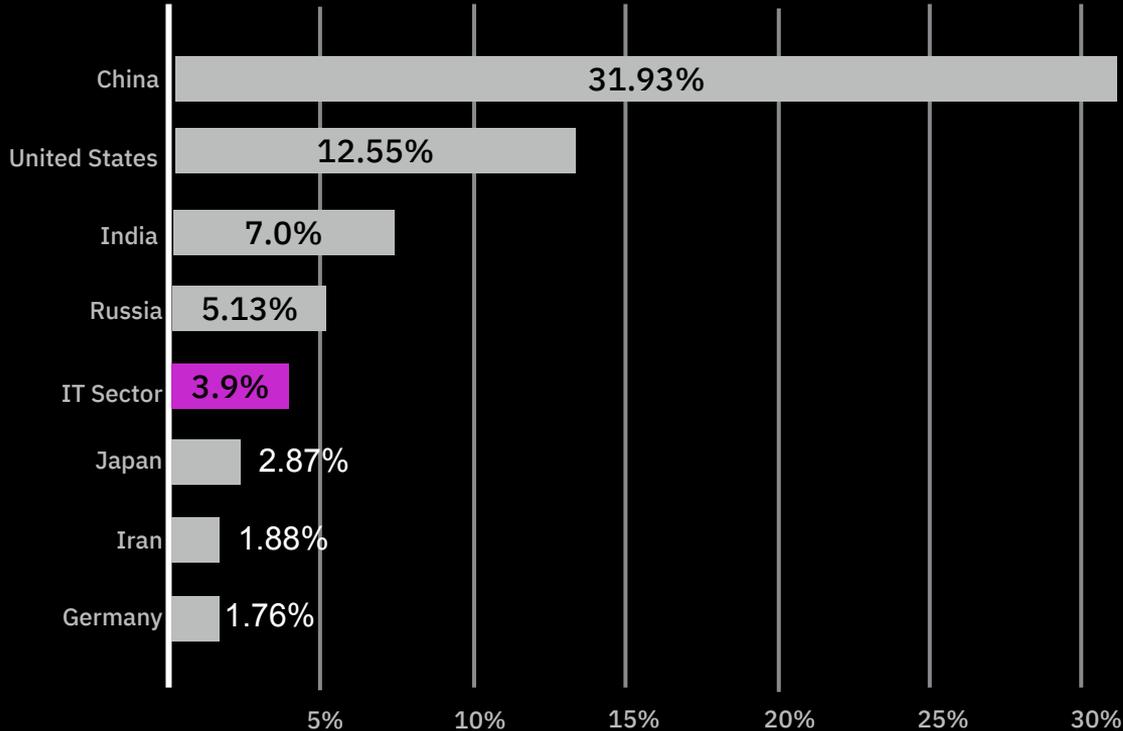
Camunda Carbon Reductor



A close-up photograph of dry, cracked soil. The soil is light brown and shows deep, irregular cracks that have formed due to desiccation. The texture is rough and granular. A semi-transparent teal banner is overlaid at the bottom of the image, containing white text.

global warming of  $\sim 2.8^{\circ}\text{C}$  by the end of  
the century [IPCC]

# Carbon Emissions by Country



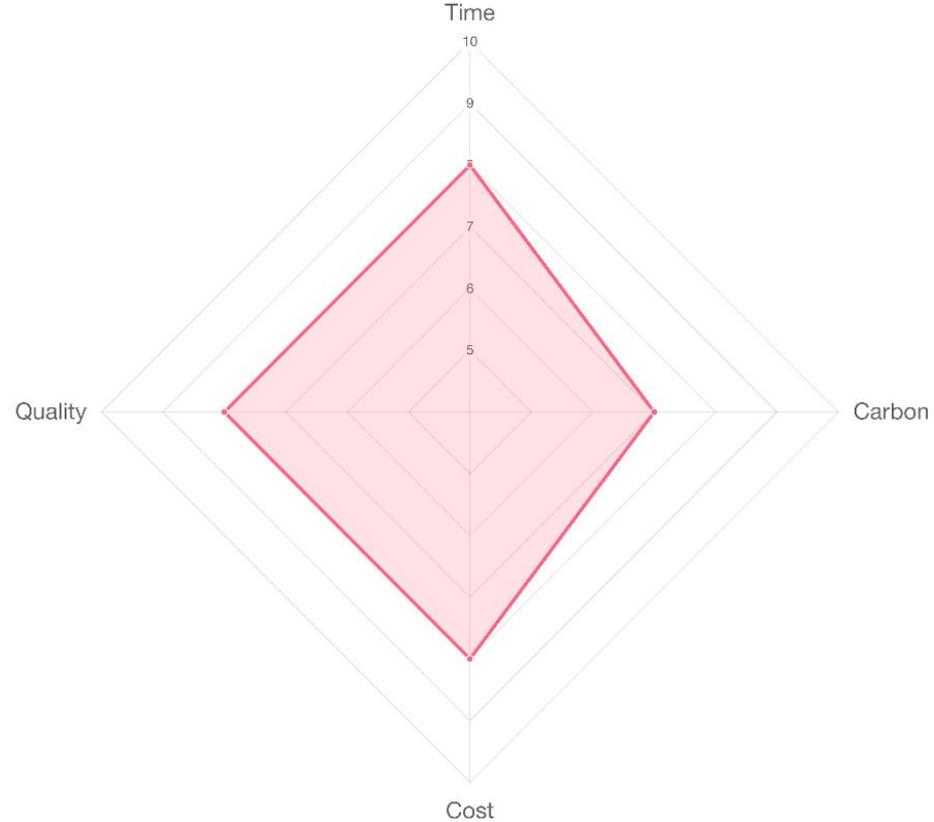
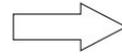
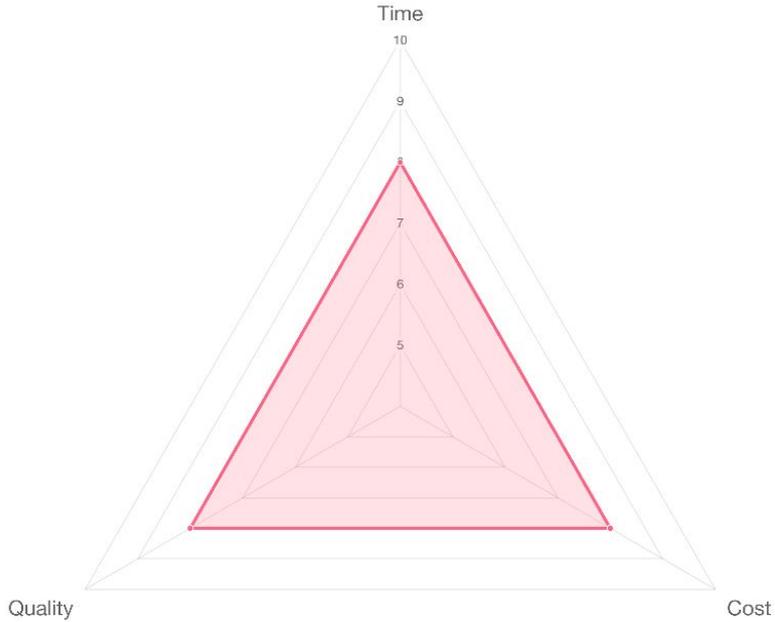
## Sources

European Commission:

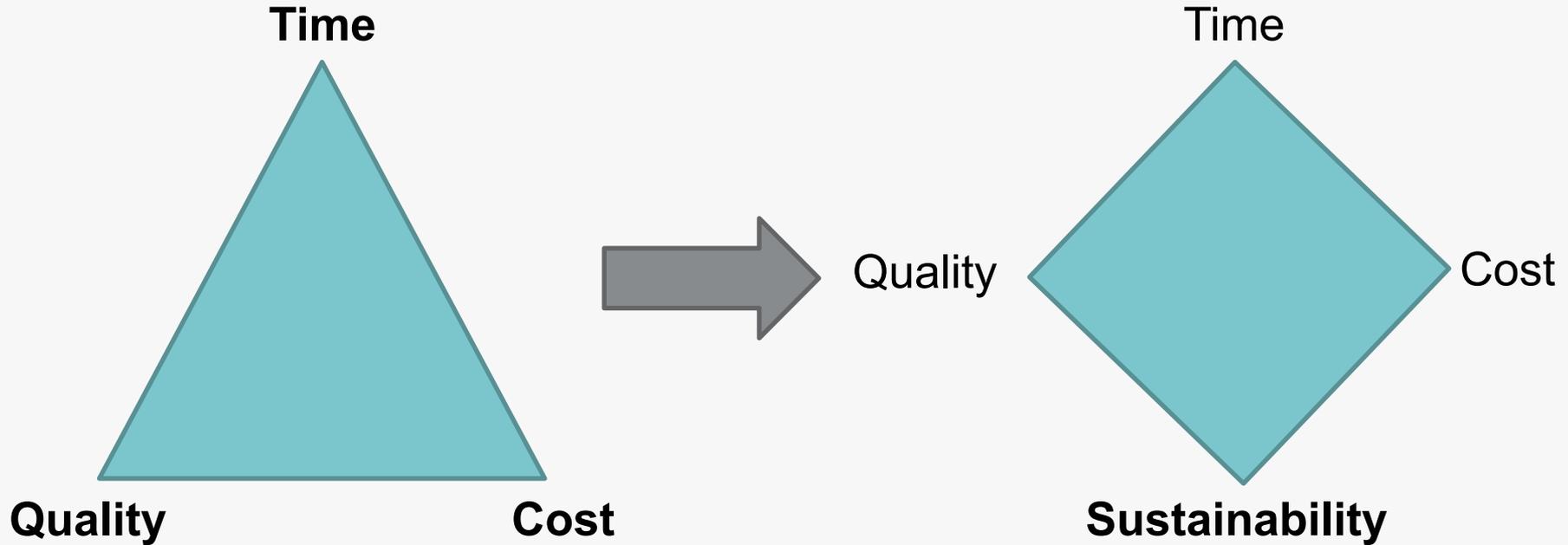
[https://edgar.jrc.ec.europa.eu/report\\_2022](https://edgar.jrc.ec.europa.eu/report_2022)

Freitag, C., et al.: The real climate and transformative impact of ict: A critique of estimates, trends, and regulations. *Patterns* 2(9), 100-140 (2021)

# Performance Dimensions



# Performance Dimensions

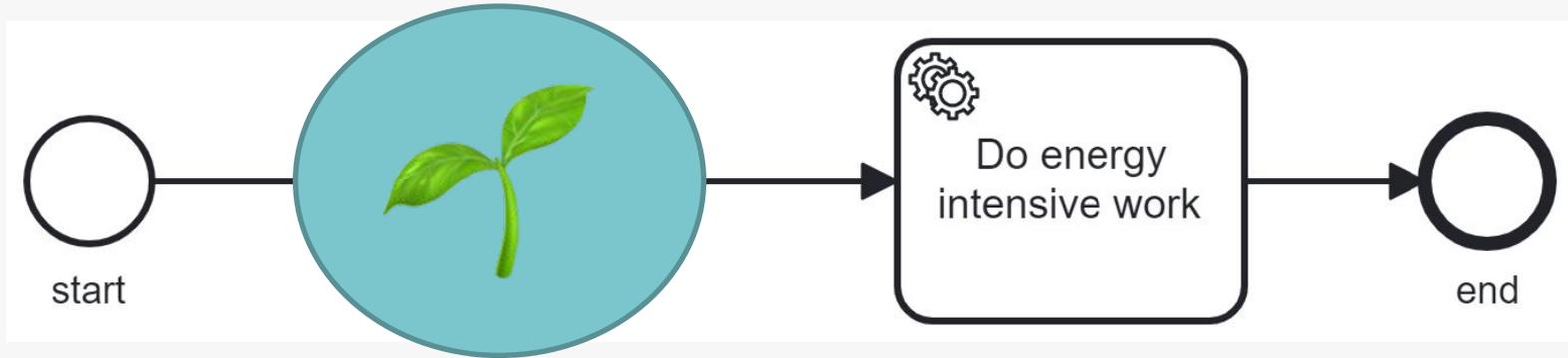


# Sustainability in IT

- Improve Hardware for better energy efficiency
- Choose efficient technology
- Programm efficient source code
  - Algorithms
  - Data structures
- Reduce data transmission over large distances (Caching)
- Take into account carbon-intensity of energy

**little  
Influence/  
already  
considered**

# Goal



# Camunda Carbon Reductor



Modeler | Carbon Aware Proc... X +

https://modeler.cloud.camunda.io/diagrams/9cf6661a-a49a-408c-8997-ed3737abe06b---carbon-aware-process?v=756.284,1

Camunda Modeler Home > Carbon-Aware Project > Carbon Aware Process

Design **Implement**

Deploy Run

```
graph LR; start((start)) --> task1[Make execution greener]; task1 --> task2[Do energy intensive work]; task2 --> end((end));
```

Properties Comments

PROCESS Carbon Aware Process

General >

Documentation >

Extension properties +

Data >

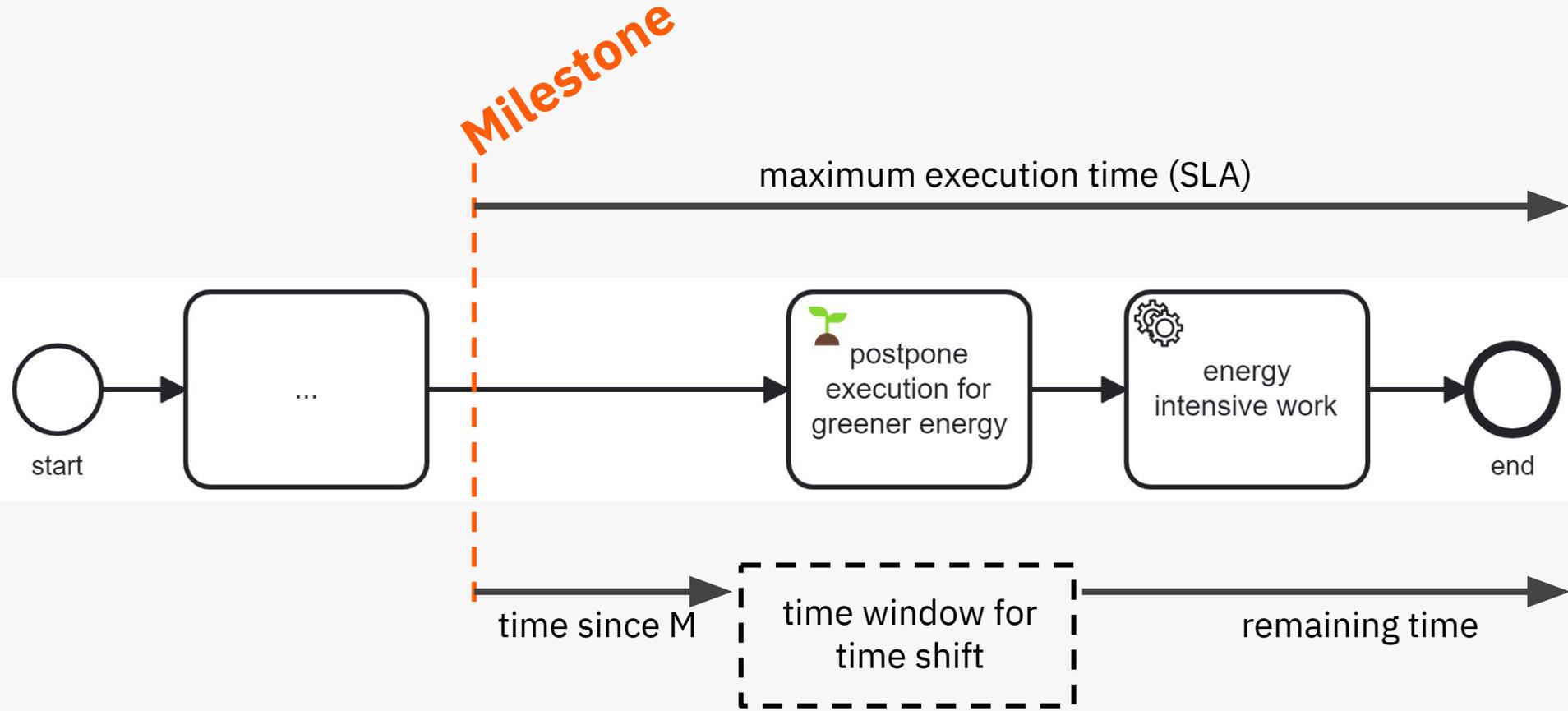
Details

Problems 0

Check problems against: Zeebe 8.2

No problems found. You can deploy your diagram now.

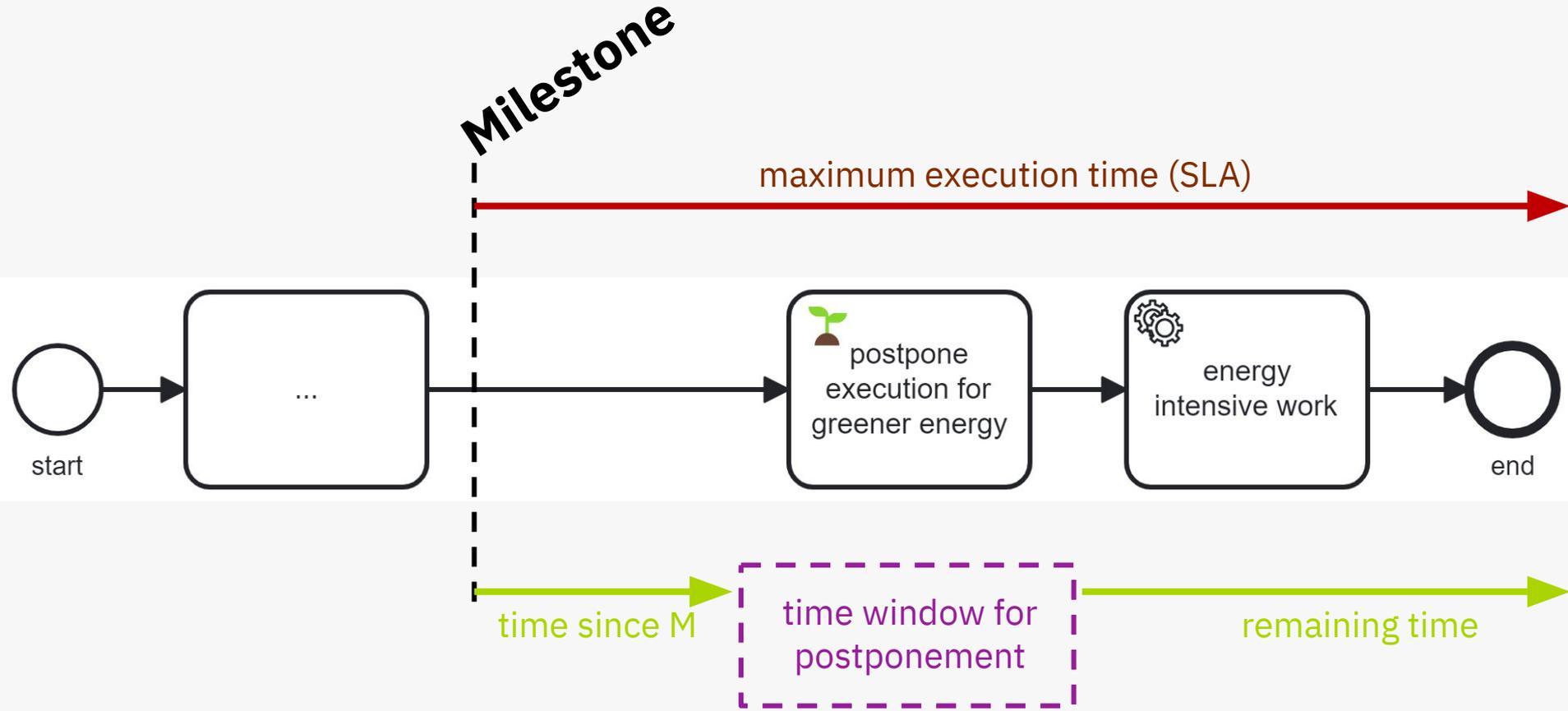
# Find postponement time-window



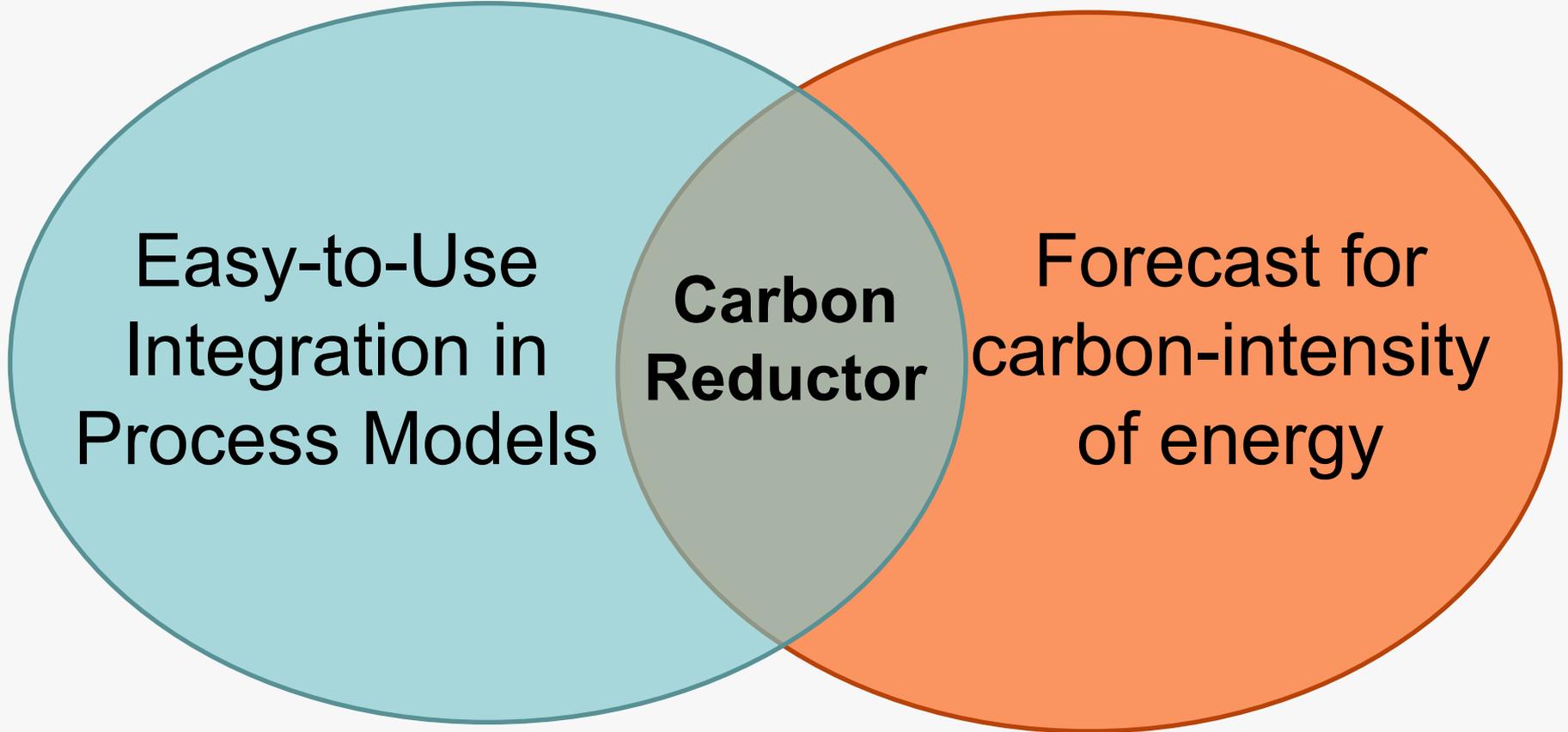
# Find postponement time-window

$$t_{\text{shift}} = t_{\text{max\_execution}} - (t_{\text{milestone}} + t_{\text{remaining}})$$

# Find postponement time-window



# Implementation



# Forecast for carbon-intensity of energy

CCS  
2023



Select a definition

CarbonAware.WebApi v1

## CarbonAware.WebApi 1.0 OAS3

<https://carbon-aware-api.azurewebsites.net/swagger/v1/swagger.json>



### CarbonAware

**GET** `/emissions/bylocations/best` Calculate the best emission data by list of locations for a specified time period.

**GET** `/emissions/bylocations` Calculate the observed emission data by list of locations for a specified time period.

**GET** `/emissions/bylocation` Calculate the best emission data by location for a specified time period.

**GET** `/emissions/forecasts/current` Retrieves the most recent forecasted data and calculates the optimal marginal carbon intensity window.

**POST** `/emissions/forecasts/batch` Given an array of historical forecasts, retrieves the data that contains forecasts metadata, the optimal forecast and a range of forecasts filtered by the attributes [start...end] if provided.

**GET** `/emissions/average-carbon-intensity` Retrieves the measured carbon intensity data between the time boundaries and calculates the average carbon intensity during that period.

**POST** `/emissions/average-carbon-intensity/batch` Given an array of request objects, each with their own location and time boundaries, calculate the average carbon intensity for that location and time period and return an array of carbon intensity objects.

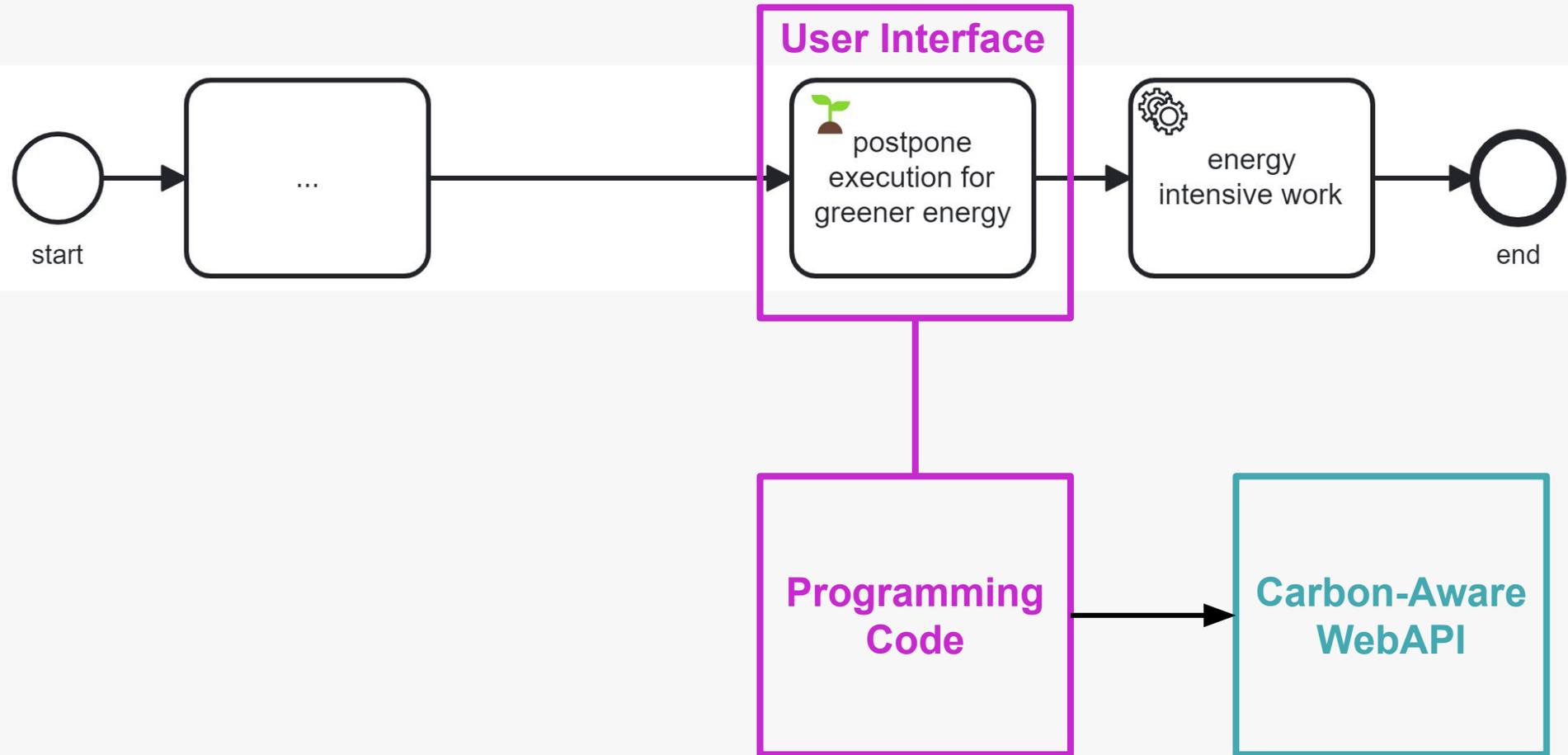
### Locations

# Easy-to-Use Integration in Process Models CCS 2023

“A **Connector** is a reusable building block that performs the integration with an external system and works out of the box.”

[[Camunda Docs](#) >> [Connectors](#) >> [Introduction](#)]

# Connector



# Job Worker vs. Connector

	Connector	Job Worker
small/reusable library		full application
automatic management of C8-specific APIs		
secret management		
access to low-level API		

# Job Worker vs. Connector

“You can also build a Connector-like system using element templates and job workers.”

[\[Camunda Docs >> Connectors >> Introduction\]](#)

# Data required for Carbon Reductor

## Configuration

Milestone

Maximum Execution Time

Remaining Time

Region



## Output

Delay

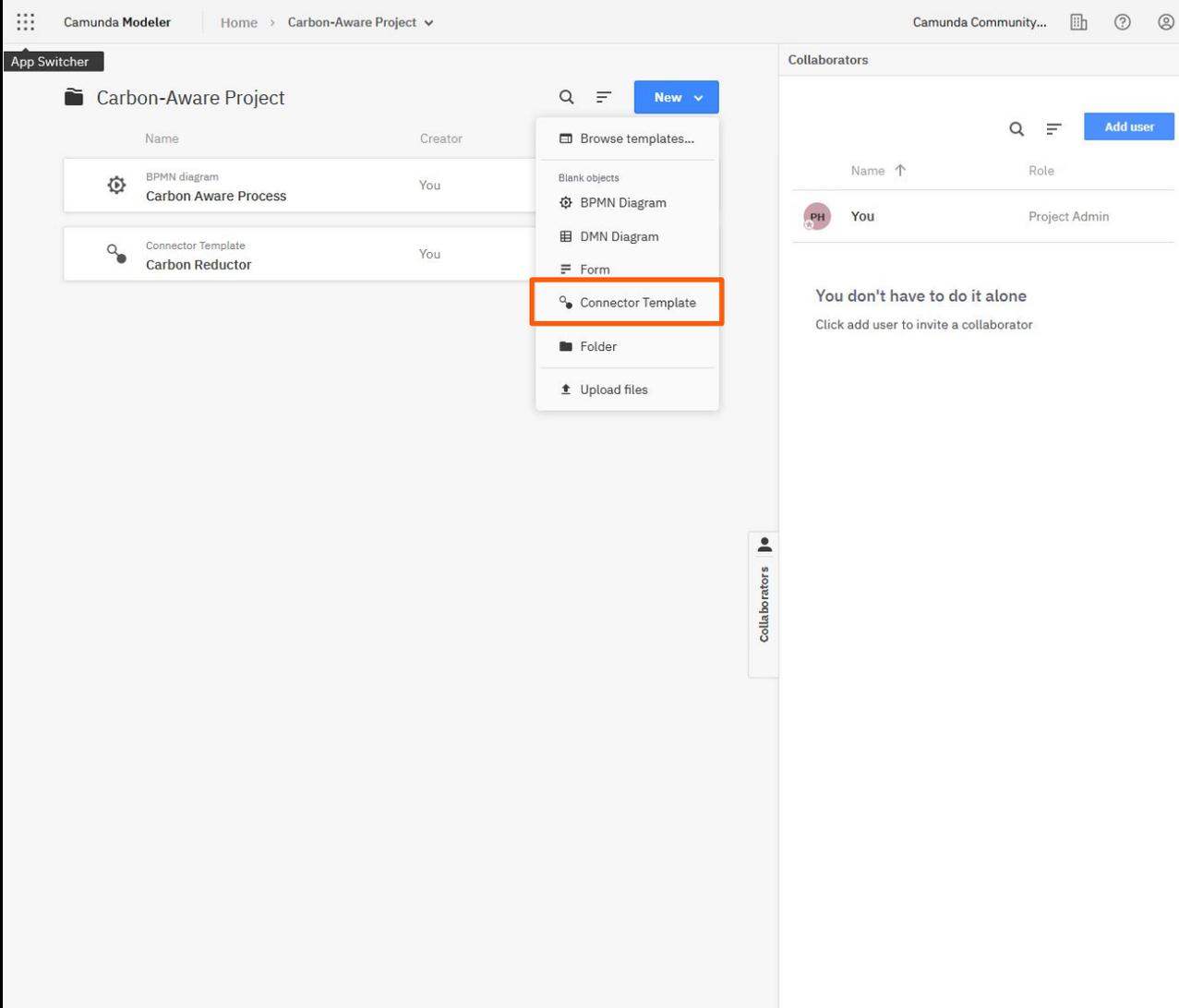
Original carbon emissions

Actual carbon emissions

Saved carbon emissions

# Deep Dive into Implementation

# Element Template



The screenshot displays the Camunda Modeler interface. At the top, the breadcrumb navigation shows 'Home > Carbon-Aware Project'. The main workspace is titled 'Carbon-Aware Project' and contains a table of elements:

Name	Creator
BPMN diagram Carbon Aware Process	You
Connector Template Carbon Reductor	You

A 'New' dropdown menu is open, listing options: 'Browse templates...', 'Blank objects', 'BPMN Diagram', 'DMN Diagram', 'Form', 'Connector Template' (highlighted with an orange border), 'Folder', and 'Upload files'.

On the right, the 'Collaborators' panel shows a table with one entry:

Name	Role
You	Project Admin

Below the table, a message reads: 'You don't have to do it alone. Click add user to invite a collaborator.' A vertical 'Collaborators' sidebar is also visible at the bottom right.

# Element Template

Camunda Modeler Home > Carbon-Aware Project > Carbon Reductor

Upload icon Publish

Raw JSON

```
1 {
2   "$schema": "https://unpkg.com/camunda/zeebe-element-templates-json-schema/resources/schema.json",
3   "name": "Carbon Reductor",
4   "id": "ee472df8-0e91-4740-a234-0452f5313f2e",
5   "icon": {
6     "contents": "data:image/svg+xml,%3Csvg xmlns='http://www.w3.org/2000/svg' viewBox='0 0 100 100'%3E%3Ctext%3C%2Ftext%3E%3C%2Fsvg%3E",
7   },
8   "category": {
9     "id": "connectors",
10    "name": "Connectors"
11  },
12  "appliesTo": [
13    "bpmn:Task"
14  ],
15  "elementType": {
16    "value": "bpmn:ServiceTask"
17  },
18  "groups": [
19    {
20      "id": "commonConfiguration",
21      "label": "Common Configuration"
22    },
23    {
24      "id": "slaBasedConfiguration",
25      "label": "SLA based configuration"
26    },
27    {
28      "id": "outputMapping",
29      "label": "Output Mapping"
30    }
31  ],
32  "properties": [
33    {
34      "type": "Hidden",
35      "value": "de.envite.greenbpm.carbonreductorconnector.carbonreductortask:1",
36      "binding": {
37        "type": "zeebe:taskDefinition:type"
38      }
39    },
40    {
41      "label": "Location",
42      "group": "commonConfiguration",
43      "id": "location",
44      "description": "The location where the process is running",
45      "type": "Dropdown",
46      "choices": [
47        {
48          "name": "Europe North",
```

Visual Preview

 CARBON REDUCTOR ServiceTask

General

Template

Common Configuration

Location

The location where the process is running

SLA based or absolute duration

Defines how to calculate the time window for the timeshift

Duration of remaining process tasks

PT6H

The duration of the remaining tasks after the Carbon Reductor as ISO 8601 duration

Milestone

= now()

Timestamp of the chosen milestone. The milestone builds the starting point for the SLA based duration calculation: milestone + max. process duration = latest process completion date

SLA based configuration

Maximum process duration from milestone to finish

PT12H

The maximum duration the process is allowed to run as ISO 8601 duration

Output Mapping

Result Expression

```
= {
  "wasExecutionDelayed": response.execu
  "delayedByInMs": response.delayedBy,
  "originalCarbon": response.originalCa
  "actualCarbon": response.actualCarbon
  "savedCarbonPct": response.savedCarbo
  "reducedCarbon": response.reducedCarb
}
```

Expression to map the response into process variables

Raw JSON

```

1 {
2   "$schema": "https://unpkg.com/@camunda/zeebe-element-templates-json-schema/resources/schema.json",
3   "name": "Carbon Reductor",
4   "id": "ee472df8-0e91-4740-a234-0452f5313f2e",
5   "icon": {
6     "contents": "data:image/svg+xml,%3Csvg xmlns='http://www.w3.org/2000/svg' viewBox='0 0 100 100'%3E%3Ctext
7   },
8   "category": {
9     "id": "connectors",
10    "name": "Connectors"
11  },
12  "appliesTo": [
13    "bpmn:Task"
14  ],
15  "elementType": {
16    "value": "bpmn:ServiceTask"
17  },
18  "groups": [
19    {
20      "id": "commonConfiguration",
21      "label": "Common Configuration"
22    },
23    {
24      "id": "slaBasedConfiguration",
25      "label": "SLA based configuration"
26    },
27    {
28      "id": "outputMapping",
29      "label": "Output Mapping"
30    }
31  ],
32  "properties": [
33    {
34      "type": "Hidden",

```

Visual Preview


**CARBON REDUCTOR**  
ServiceTask

General • >

Template >

Common Configuration • v

Location v

The location where the process is running

SLA based or absolute duration v

Defines how to calculate the time window for the timeshift

Duration of remaining process tasks ☹

PT6H

The duration of the remaining tasks after the Carbon Reductor as ISO 8601 duration

Milestone ☹

= now()

Timestamp of the chosen milestone. The milestone builds the starting point for the SLA based duration calculation: milestone + max. process duration = latest process completion date

SLA based configuration • v

Maximum process duration from milestone to finish ☹

PT12H

The maximum duration the process is allowed to run as ISO 8601 duration

Raw JSON

```

1 {
2   "$schema": "https://unpkg.com/@camunda/zeebe-element-templates-json-schema/resources/schema.json",
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7   },
8   "category": {
9     "id": "connectors",
10    "name": "Connectors"
11  },
12  "appliesTo": [
13    "bpmn:Task"
14  ],
15  "elementType": {
16    "value": "bpmn:ServiceTask"
17  },
18  "groups": [
19    {
20      "id": "commonConfiguration",
21      "label": "Common Configuration"
22    },
23    {
24      "id": "slaBasedConfiguration",
25      "label": "SLA based configuration"
26    },
27    {
28      "id": "outputMapping",
29      "label": "Output Mapping"
30    }
31  ],
32  "properties": [
33    {
34      "type": "Hidden",
35      "value": "de.envite.greenbpm.carbonreductorconnector.carbonreductortask:1",
36      "binding": {
37        "type": "zeebe:taskDefinition:type"
38      }
39    }
40  ]
41 }

```

Visual Preview



**CARBON REDUCTOR**  
ServiceTask

- General ● >
- Template >
- Common Configuration** ● ▾
- Location ▾

The location where the process is running
- SLA based or absolute duration ▾

Defines how to calculate the time window for the timeshift
- Duration of remaining process tasks ⊖

PT6H

The duration of the remaining tasks after the Carbon Reductor as ISO 8601 duration
- Milestone ⊖

= now()

Timestamp of the chosen milestone. The milestone builds the starting point for the SLA based duration calculation: milestone + max. process duration = latest process completion date
- SLA based configuration** ● ▾

Maximum process duration from milestone to finish ⊖

PT12H

The maximum duration the process is allowed to run as ISO 8601 duration
- Output Mapping** ● ▾

Result Expression ⊕

```
31 ],
32 "properties": [
33   {
34     "type": "Hidden",
35     "value": "de.envite.greenbpm.carbonreductorconnector.carbonreductortask:1",
36     "binding": {
37       "type": "zeebe:taskDefinition:type"
38     }
39   },
40   {
41     "label": "Location",
42     "group": "commonConfiguration",
43     "id": "location",
44     "description": "The location where the process is running",
45     "type": "Dropdown",
46     "choices": [
47       {
48         "name": "Europe North",
49         "value": "northeurope"
50       },
51       {
52         "name": "Europe West",
53         "value": "westeurope"
54       },
55       {
56         "name": "France Central",
57         "value": "francecentral"
58       },
59       {
60         "name": "France South",
61         "value": "francesouth"
62       },
63       {
64         "name": "Germany North",
65         "value": "germanyouth"
```

CARBON REDUCTOR  
ServiceTask

General ● &gt;

Template &gt;

Common Configuration ● ▾

Location

Europe West ▾

The location where the process is running

SLA based or absolute duration

Defines how to calculate the time window for the timeshift

Duration of remaining process tasks ☹

PT6H

The duration of the remaining tasks after the Carbon Reductor as ISO 8601 duration

Milestone ☹

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Timestamp of the chosen milestone. The milestone builds the starting point for the SLA based duration calculation: milestone + max. process duration = latest process completion date

SLA based configuration ● ▾

Maximum process duration from milestone to finish ☹

PT12H

The maximum duration the process is allowed to run as ISO 8601 duration

```
31 ],
32 "properties": [
33   {
34     "type": "Hidden",
35     "value": "de.envite.greenbpm.carbonreductorconnector.carbonreductortask:1",
36     "binding": {
37       "type": "zeebe:taskDefinition:type"
38     }
39   },
40   {
41     "label": "Location",
42     "group": "commonConfiguration",
43     "id": "location",
44     "description": "The location where the process is running",
45     "type": "Dropdown",
46     "choices": [
47       {
48         "name": "Europe North",
49         "value": "northeurope"
50       },
51       {
52         "name": "Europe West",
53         "value": "westeurope"
54       },
55       {
56         "name": "France Central",
57         "value": "francecentral"
58       },
59       {
60         "name": "France South",
61         "value": "francesouth"
62       },
63       {
64         "name": "Germany North",
65         "value": "germanynorth"
66       }
67     ]
68   }
69 ],
```

CARBON REDUCTOR  
ServiceTask

General

Template

Common Configuration

Location

Europe West

The location where the process is running

SLA based or absolute duration

Defines how to calculate the time window for the timeshift

Duration of remaining process tasks ☹

PT6H

The duration of the remaining tasks after the Carbon Reductor as ISO 8601 duration

Milestone ☹

= now()

Timestamp of the chosen milestone. The milestone builds the starting point for the SLA based duration calculation: milestone + max. process duration = latest process completion date

SLA based configuration

Maximum process duration from milestone to finish ☹

PT12H

The maximum duration the process is allowed to run as ISO 8601 duration

# Job Worker

```
@Component
public class CarbonReductorWorker {
    ...
    @JobWorker (type = "de.envite.greenbpm.carbonreductorconnector.carbonreductortask:1" )
    public void execute (ActivatedJob job) throws Exception {

        if (!alreadyTimeshifted (job)) {

            Forecast forecast = getForecast (job);
            Delay delay = calculateDelay (forecast);
            writeToProcessInstance (job, forecast, delay);

            if (delay) {
                failJob (job, delay);
            } else {
                completeJob (job);
            }

        } else {
            completeJob (job);
        }
    }
    ...
}
```

# Demo

# Reporting

## Filter Report data

Instance Start Date:  location:  savedCarbon:  [Reset all](#)

### Instance Count

**173**

Process Instance Count

### Success Rate (Instances Saved more than 10% Carbon)



### Carbon Reduction Overall [gCO2/kWh]

**17,9 thousand**

carbonReduction - Sum

### Saved gCO2/kWh [%]

**23,2**

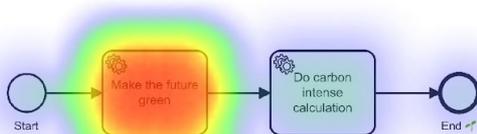
savedCarbon - Avg

### Carbon Reduction [gCO2/kWh]

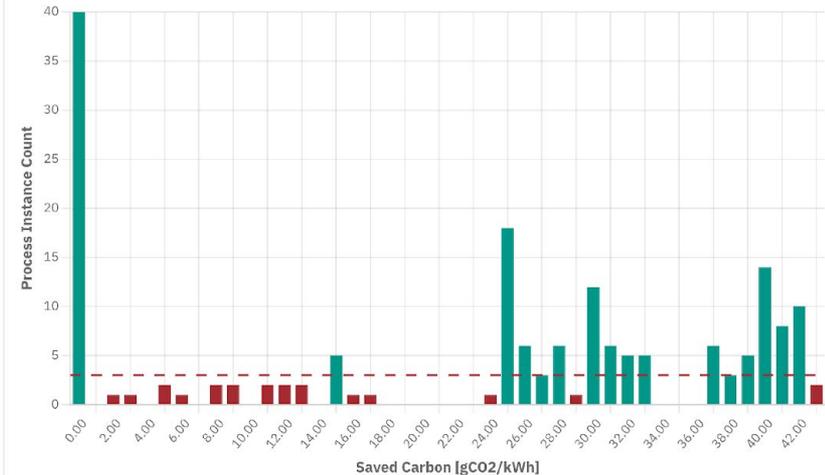
**103,4**

carbonReduction - Avg

### How long does every process take?



### Saved Carbon per Carbon Reductor Execution



# Where do I find the Carbon Reductor?

## Partner Connectors

Connector runtimes provided by Camunda partners:

Connector	Partner	JAR with dependencies	Code repository	Documentation	License	
MySQL	Infosys		<a href="#">GitHub</a>	<a href="#">Documentation</a>	MIT	Lifecycle Stable
Oracle	Infosys		<a href="#">GitHub</a>	<a href="#">Documentation</a>	MIT	Lifecycle Stable
PostgreSQL	Infosys		<a href="#">GitHub</a>	<a href="#">Documentation</a>	MIT	Lifecycle Stable
MSSQL	Infosys		<a href="#">GitHub</a>	<a href="#">Documentation</a>	MIT	Lifecycle Stable
Camunda Carbon Reductor	envite consulting GmbH		<a href="#">GitHub</a>	<a href="#">Documentation</a>	MIT	Lifecycle Stable
SMTP	Infosys		<a href="#">GitHub</a>	<a href="#">Documentation</a>	License	Lifecycle Stable
IMAP	Infosys		<a href="#">GitHub</a>	<a href="#">Documentation</a>	License	Lifecycle Stable
POP3	Infosys		<a href="#">GitHub</a>	<a href="#">Documentation</a>	License	Lifecycle Stable

<https://github.com/camunda-community-hub/camunda-8-connectors>

# Thank You



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<https://envite.de/>