



Open
Geospatial
Consortium




Testbed-18

Building Energy Spatial Data
Interoperability (D125,126)

124th OGC Member Meeting
Steinbeis, Fraunhofer IGD, Concordia



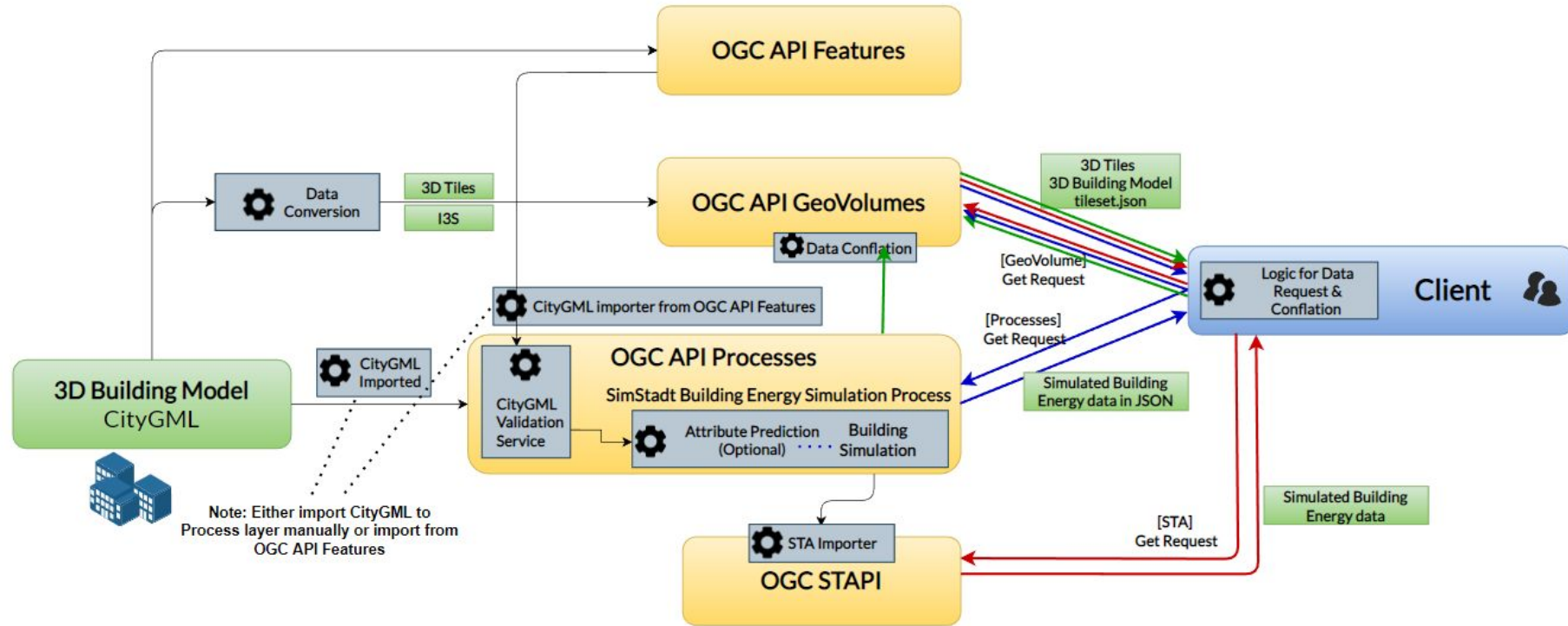
Overview of Our Team


| Organization | Contact Person | Expertise/ Role | Funded |
|--|----------------------|--|--------|
|  Steinbeis @HFT Stuttgart (Germany) | Volker & Joe | Building energy data modeling and simulation | Yes |
|  Fraunhofer IGD (Germany) | Maxim | Spatial data management and visualization | Yes |
|  Concordia University (Canada) | Ursula, Rushi & team | Building energy simulation and energy systems modeling | Yes |

Research and Development Questions

- Evaluation of the Energy Simulation API & OGC standards
- Use of CityGML as a model for the building energy simulation.
- Test the interoperability of the entire workflow.


Overall System Architecture





 Developed Tool/program which automates data operation

 Web Services/ Server  Client/users

 Dataset

 Scenario-A: Building energy data (from STA) is conflated to 3D building model (GeoVolumes) on the client.

 Scenario-B: Building energy data (from OGC API Processes) is conflated to 3D building model (GeoVolumes) on the client.

 Scenario-C: Building energy data (from OGC API Processes) is pre-conflated to 3D building model on the GeoVolumes server.

Data Models

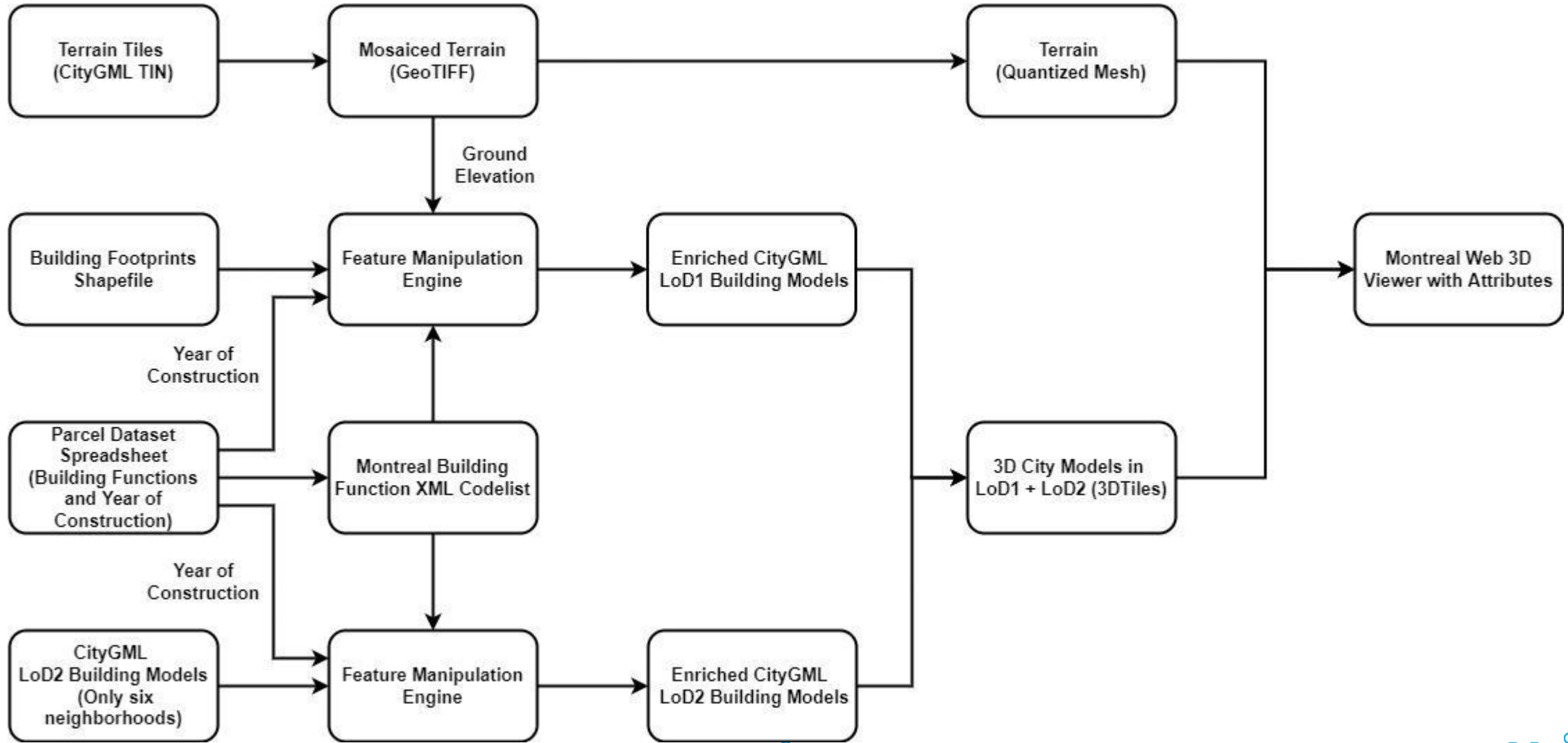
Montreal

- **Building Footprints (includes building heights) - NRCan**
<https://open.canada.ca/data/en/dataset/7a5cda52-c7df-427f-9ced-26f19a8a64d6>
- **Building Parcels (includes parcel function and year of construction) - City of Montreal**
<https://donnees.montreal.ca/ville-de-montreal/unites-evaluation-fonciere>
- **CityGML LoD2 Buildings with Textures ver. 2016 (only for six neighborhoods) - City of Montreal**
<https://donnees.montreal.ca/ville-de-montreal/batiment-3d-2016-maquette-citygml-lod2-avec-textures2>
- **Montreal Admin Boundaries - City of Montreal**
<https://donnees.montreal.ca/ville-de-montreal/polygones-arrondissements>
- **Montreal Terrain (CityGML) - City of Montreal**
<https://donnees.montreal.ca/ville-de-montreal/modele-numerique-de-terrain-mnt>

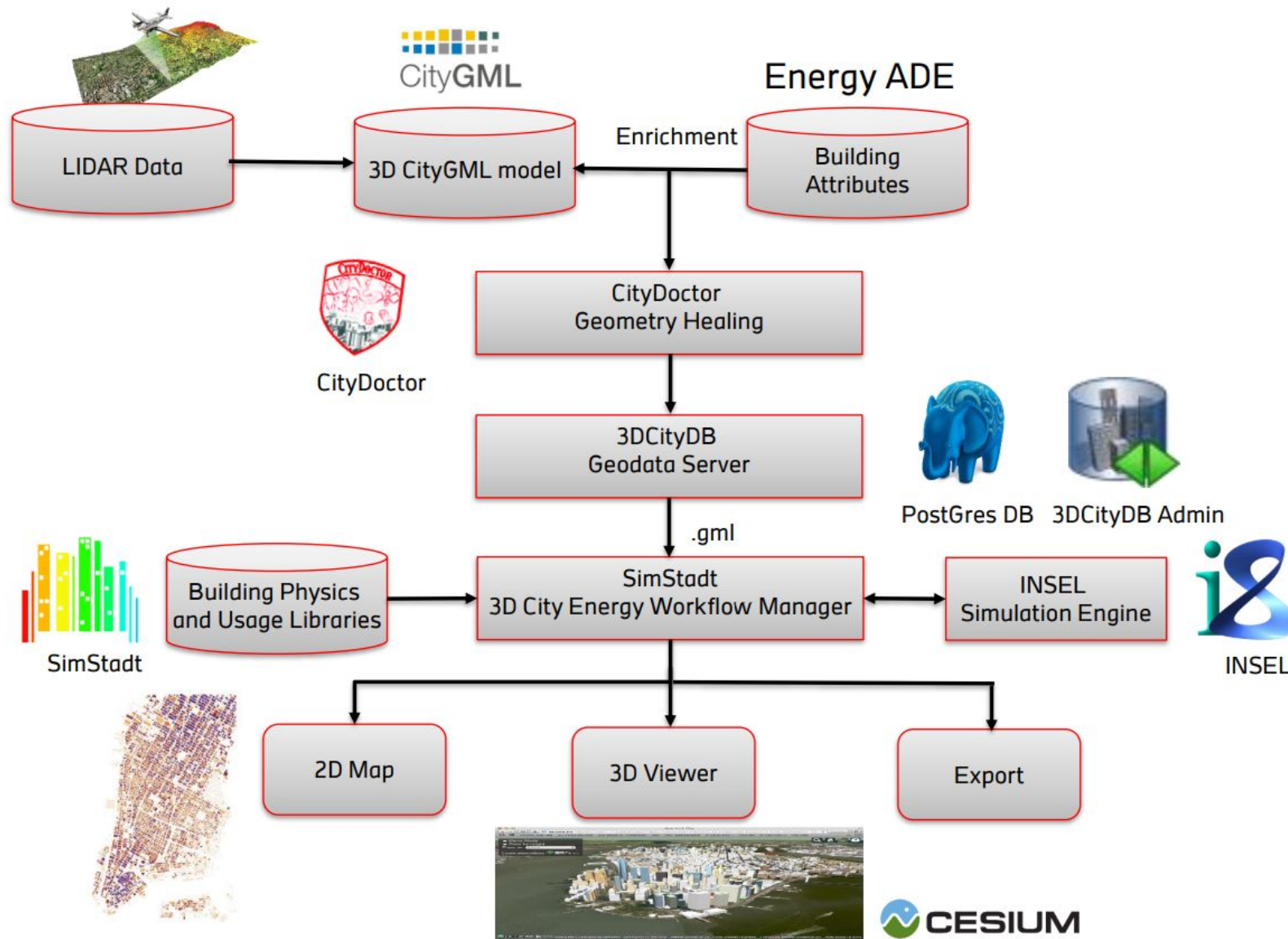
Helsinki

- **Open source 3D CityGML**
https://hri.fi/data/en_GB/dataset/helsinki-3d-kaupunkimalli

Data Curation Flowchart



SimStadt Energy Simulation Tool



Enrich CityGML with Energy ADE

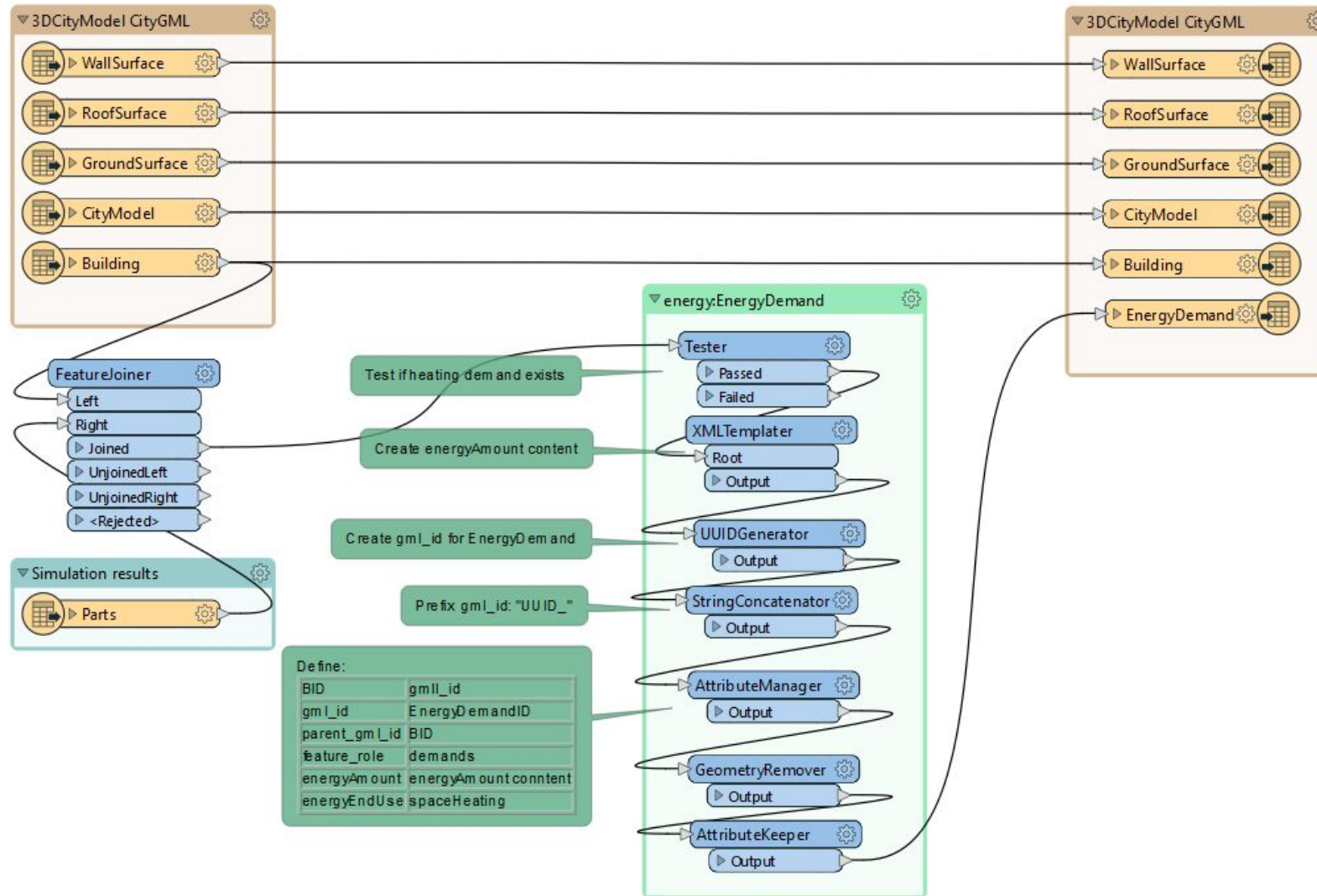
```
<bldg:Building gml:id="uuid_552b17a3-5a84-4601-8bd2-e157896d9877">
  <core:creationDate>2022-06-29</core:creationDate>
  <energy:demands>
    <energy:EnergyDemand gml:id="UUID_7de91d2b-b00d-44e4-b231-9b1f41e75abb">
      <energy:energyAmount>
        <energy:RegularTimeSeries>
          <energy:variableProperties>
            <energy:TimeValuesProperties>
              <energy:acquisitionMethod>simulation</energy:acquisitionMethod>
              <energy:interpolationType>averageInSucceedingInterval</energy:interpolationType>
              <energy:source>SimStadt</energy:source>
              <energy:thematicDescription>Space heating demand</energy:thematicDescription>
            </energy:TimeValuesProperties>
          </energy:variableProperties>
          <energy:temporalExtent>
            <gml:TimePeriod>
              <gml:beginPosition>2022-01-01T00:00:00</gml:beginPosition>
              <gml:endPosition>2022-12-31T23:00:00</gml:endPosition>
            </gml:TimePeriod>
          </energy:temporalExtent>
          <energy:timeInterval unit="day">30</energy:timeInterval>
          <energy:values uom="kWh">8274 6896 5081 2196 237 0 0 0 13 2014 4359 7400</energy:values>
        </energy:RegularTimeSeries>
      </energy:energyAmount>
      <energy:endUse>spaceHeating</energy:endUse>
    </energy:EnergyDemand>
  </energy:demands>
```

EnergyADE

Simulated space heating demand

Monthly heating demand

Enrich CityGML with Energy ADE



OGC API Services

OGC GeoVolumes

Interactive Instruments

- <https://d123.ldproxy.net/montreal/collections>

Ecere

- <https://maps.gnosis.earth/ogcapi/collections/>

Steinbeis@HFT & Fraunhofer IGD

- <https://ogc-testbed-18.igd.fraunhofer.de/3DGeoVolumes/collections>

OGC API - Processes

Steinbeis@HFT & Fraunhofer IGD

<https://Steinbeis-3dps.eu/ogc-api-processes>

OGC Sensorthings API

Steinbeis@HFT & Fraunhofer IGD

<https://Steinbeis-3dps.eu/sta-ogc-tb18>

Web Client 1: Visualizing 3D Building Model

Montreal 3D Viewer ⓘ

Select Neighborhood
Ville-Marie

Montreal 3D Viewer

| | |
|------------------------------------|---|
| Building ID | uuid_5ed069c5-d7da-4bb8-a18a-31f46b5d2b8b |
| Original Building ID | 1340252 |
| Parcel ID | 01037685 |
| Level of Detail | LoD2 |
| Maximum Building Height | 126 m |
| Building Function Code | 6000 |
| Building Function Description (FR) | Immeuble à bureaux |
| Building Function Description (EN) | Office building |
| Building Category | Régulier |
| Year of Construction | 1932 |
| Neighborhood | Ville-Marie |

Office building

Concordia

Hochschule für Technik Stuttgart

st w

Montreal web 3D viewer -

<https://transfer.hft-stuttgart.de/pages/montreal-citygml/web3Dviewer/>

Web Client 2: 3D Building Model + Energy Simulation

OGC Testbed 18 - Building Energy Client

SIW Steinbeis@HFT Fraunhofer IGD

3D GeoVolumes

- > <https://ogc-testbed-18.igd.fraunhofer.de/3DGeoVolumes/collections>
- > <https://d123.ldproxy.net/nunsisland/collections>
- > <https://d123.ldproxy.net/montreal/collections>
- > <https://maps.gnosis.earth/ogcapi/collections>

OGC API – 3D GeoVolumes

Processes

SimStadt API Montreal Nunsisland Helsinki

Urban simulation API for heating demand, PV-potential and other. Supported regions: Montreal and Helsinki

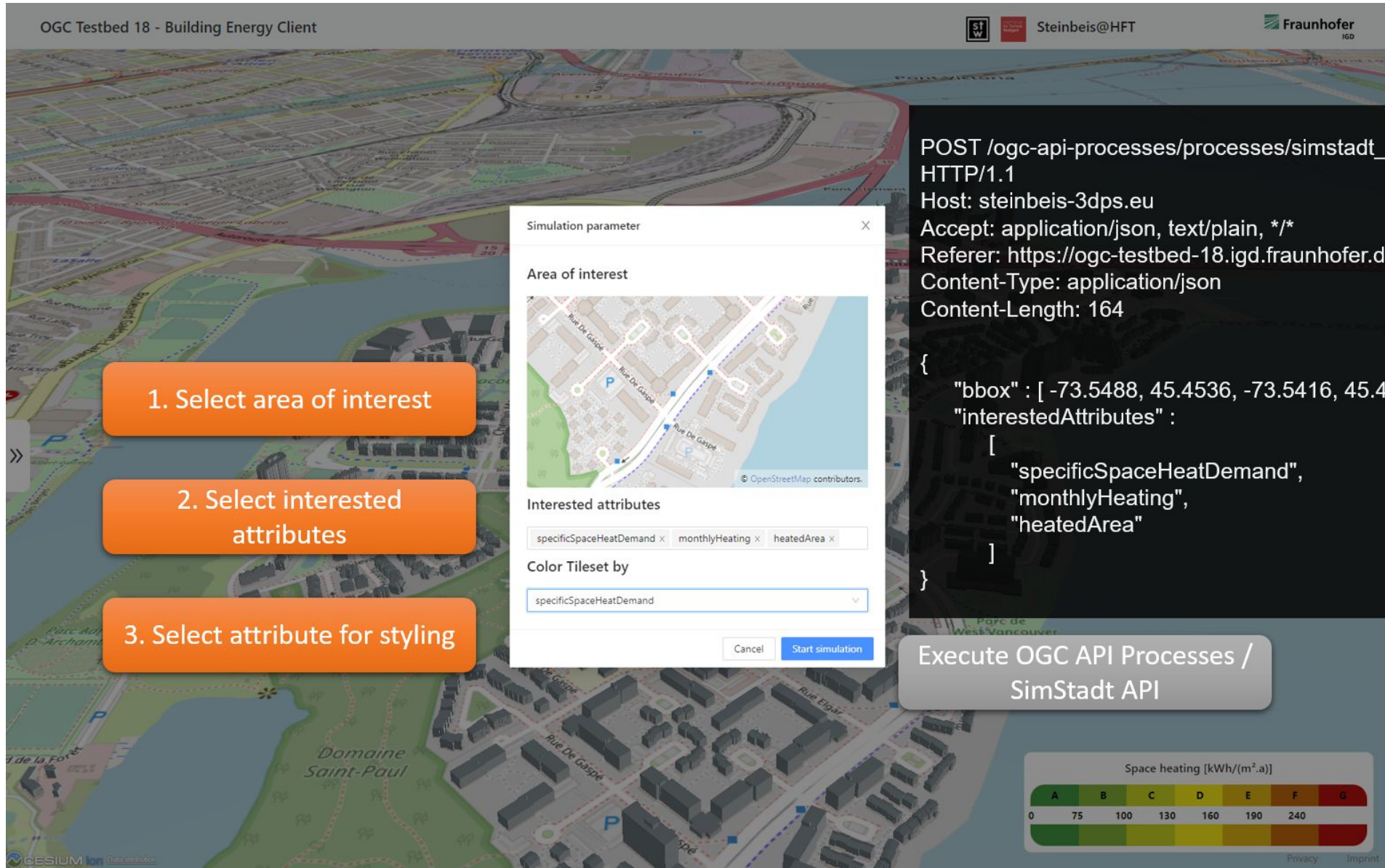
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OGC API – Processes



The main visualization is a 3D city model of a coastal urban area. Buildings are rendered in dark grey, and the terrain is green. Overlaid on the model are various colored lines and shapes representing energy simulation data, such as solar potential (yellow/orange) and heating demand (red/blue). Labels for parks like 'Parc Adrien O. Archaebout', 'Parc Monseigneur A. Richard', 'Parc Maynard-Ferguson', and 'Parc Claude-Vivier' are visible. The map is viewed from an elevated perspective.

Web Client 2: 3D Building Model + Energy Simulation



1. Select area of interest

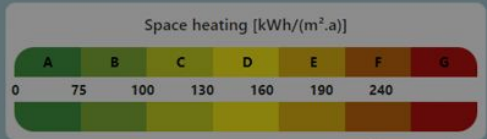
2. Select interested attributes

3. Select attribute for styling

```
POST /ogc-api-processes/processes/simstadt_api/execution
HTTP/1.1
Host: steinbeis-3dps.eu
Accept: application/json, text/plain, */*
Referer: https://ogc-testbed-18.igd.fraunhofer.de/
Content-Type: application/json
Content-Length: 164

{
  "bbox" : [ -73.5488, 45.4536, -73.5416, 45.4564 ],
  "interestedAttributes" :
  [
    "specificSpaceHeatDemand",
    "monthlyHeating",
    "heatedArea"
  ]
}
```

Execute OGC API Processes / SimStadt API



Web Client 2: 3D Building Model + Energy Simulation

OGC Testbed 18 - Building Energy Client

Steinbeis@HFT

Fraunhofer IGD



The image shows a 3D city model with buildings colored according to their energy performance. A central building is highlighted in green, indicating a high energy efficiency rating (A). Other buildings are colored in shades of yellow, orange, and red, indicating lower efficiency ratings (D, E, F, G). The model includes streets, green spaces, and a body of water.

Feature Information

Simulation Results

| Property | Value |
|-------------------------|----------|
| buildingFunction | 1010 |
| heatedVolume | 27159.83 |
| spaceHeating | 1118580 |
| yearOfConstruction | 1968 |
| specificSpaceHeatDemand | 128.7 |

Monthly heating demand [MWh]



The bar chart shows the monthly heating demand in MWh. The y-axis ranges from 0 to 300 MWh. The x-axis shows the months from June to December. The demand is highest in winter months (Dec, Jan, Feb) and lowest in summer months (Jun, Jul, Aug, Sep).

| Month | Monthly heating demand [MWh] |
|-------|------------------------------|
| Jun | 240 |
| Jul | 180 |
| Aug | 120 |
| Sep | 60 |
| Oct | 120 |
| Nov | 180 |
| Dec | 240 |

Feature attributes

| Property | Value |
|--------------------|-----------------|
| id | 128 |
| Function | residential |
| FeatureType | Building |
| CreationDate | 29.06.22, 00:00 |
| YearOfConstruction | 1968 |

Space heating [kWh/(m².a)]

| Rating | Value |
|--------|-------|
| A | 0 |
| B | 75 |
| C | 100 |
| D | 130 |
| E | 160 |
| F | 190 |
| G | 240 |

CESIUM | Data attribution

Privacy | Imprint

Web Client 2: 3D Building Model + Energy Simulation

OGC Testbed 18 - Building Energy Client

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3D GeoVolumes +


- > <https://ogc-testbed-18.igd.fraunhofer.de/3DGeoVolumes/collections>
- > <https://d123.ldproxy.net/nunsisland/collections>
- > <https://d123.ldproxy.net/montreal/collections>
- > <https://maps.gnosis.earth/ogcapi/collections>

Processes

SimStadt API Montreal Nunsisland Helsinki

Urban simulation API for heating demand, PV-potential and other. Supported regions: Montreal and Helsinki

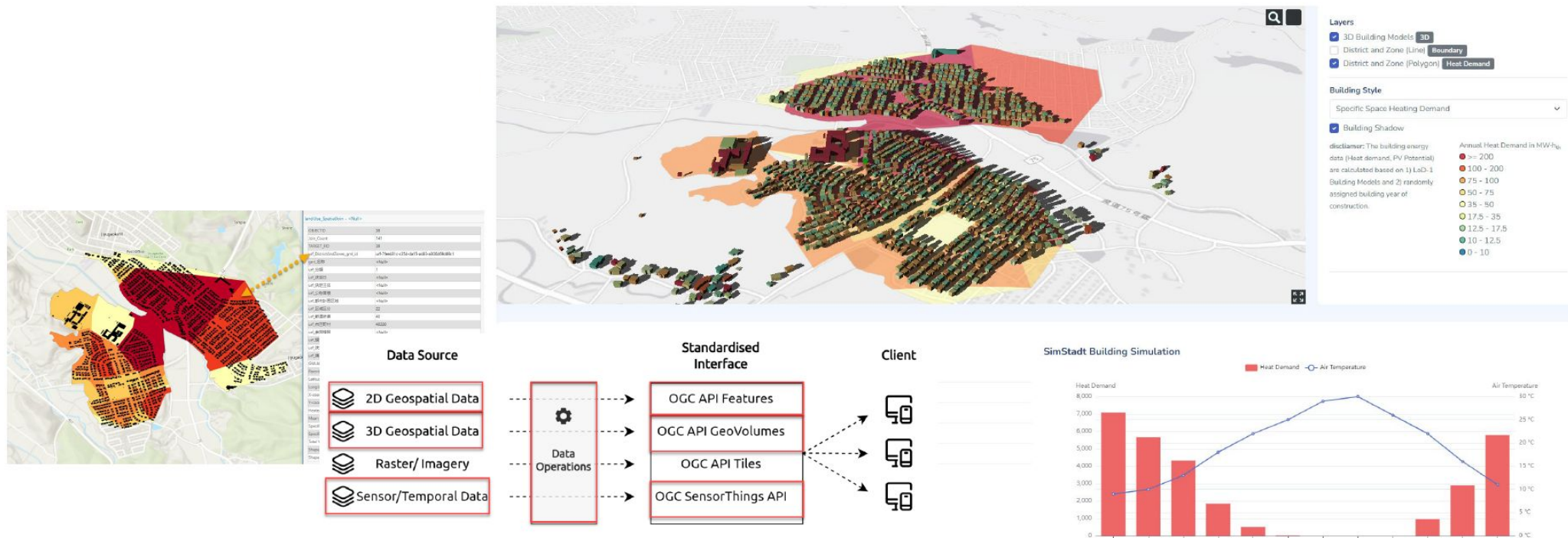
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Privacy Imprint

A similar approach has been used with the Munakata City, Japan in the UDigiT4iCity project
 One sample CityGML model (+ Urban Planning ADE) of Munakata City has been selected as a test dataset. (50305436_bldg_6697_op.gml)

SimStadt Software is used to simulate building energy data (PV Potential, Heat demand, etc.) with the CityGML data input. –
 The building heating demand has been aggregated to district level as defined in der Urban Planning ADE



Q&A