Enhancing Sustainability In The Sports Stadium: A Techno-Economic Analysis Of Off-Grid Renewable Energy And Electric Vehicle Charging Station.

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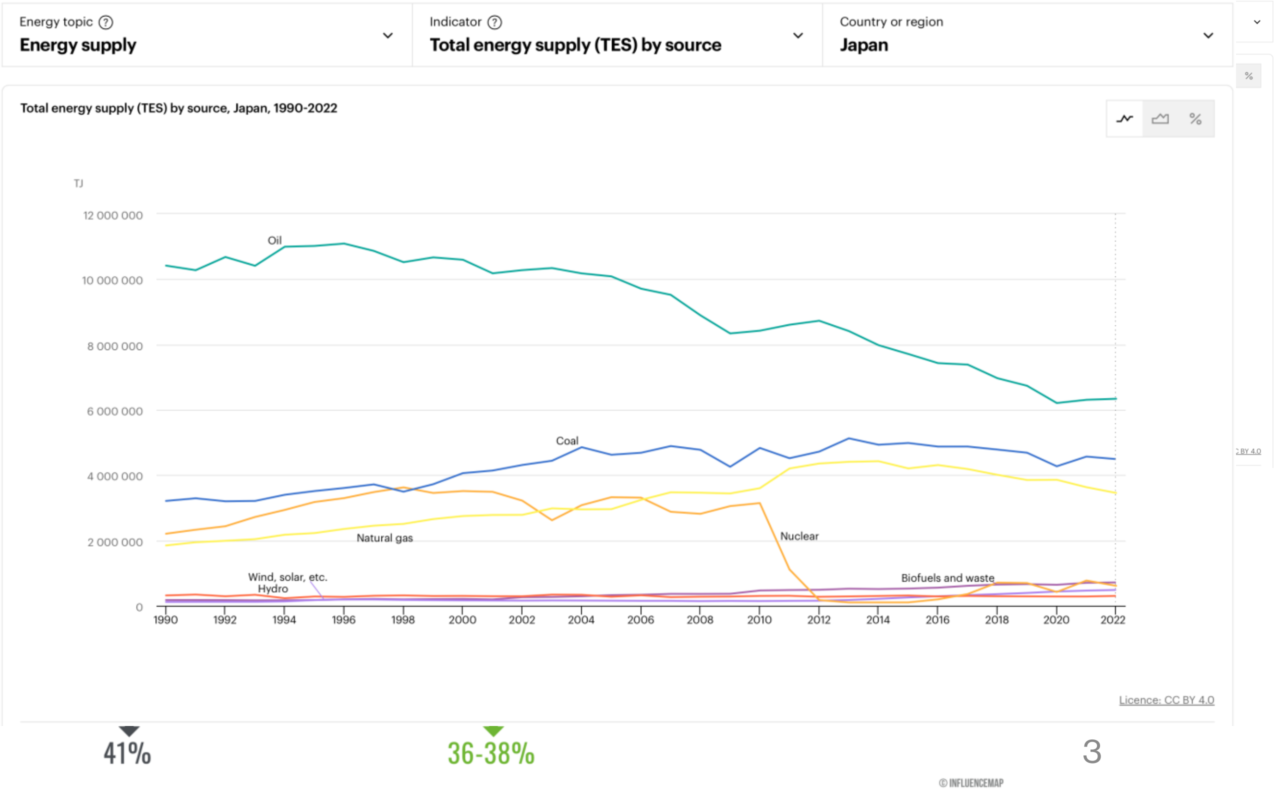
Outline

- Introduction
- Background
- Case study
- Future directions

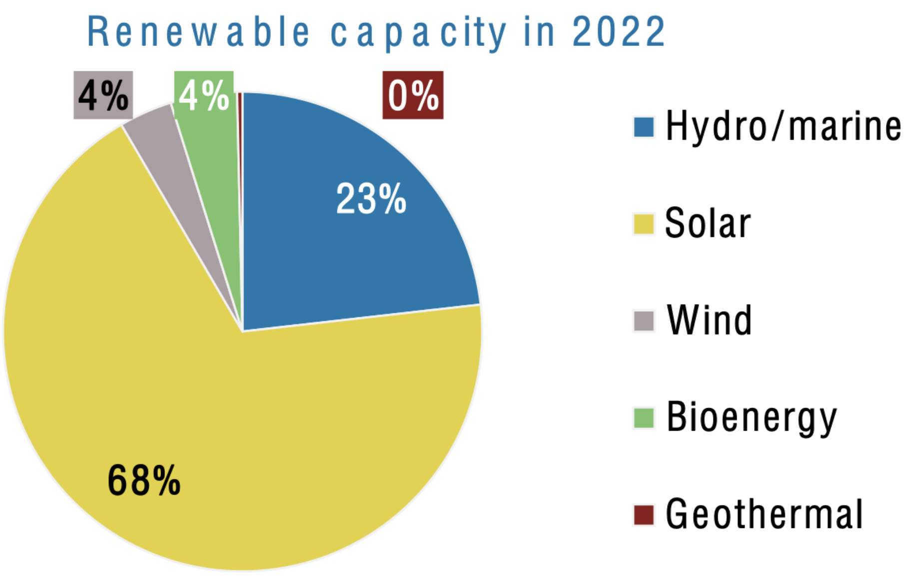
Introduction

- **Energy transition**
  - COP 2023: transition away from fossil fuels in energy systems, in a just, orderly and equitable manner, with developed countries continuing to take the lead.
  - Japan's vision:
    - Reduce greenhouse gas emissions by 46% by 2030
    - The 6th Strategic Energy plan

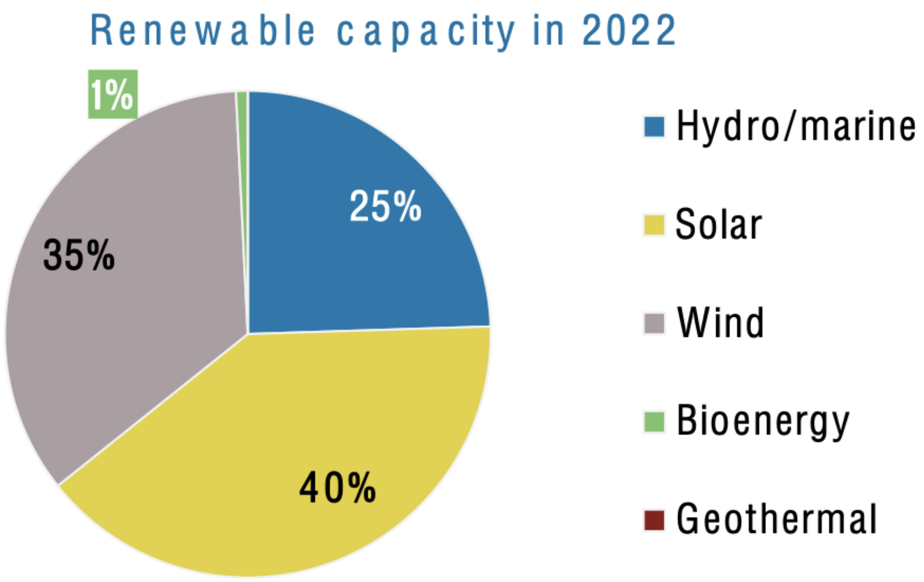
- **Sustainability in the stadium**
  - Energy consumption in stadiums
    - More than 4,000 stadiums exploit up to 40 TWh/year
    - Responsible for around 10% of the annual energy con
  - Solutions for sustainability
    - Energy efficiency
    - Waste management
    - Renewables integration



Introduction



Japan (34%)



Greece (59%)

Introduction

Our objectives:

- ➢ Renewable Energy Components
- ➢ Energy Production and Consumption
- ➢ Economic Viability
- ➢ Environmental Impact

To achieve zero emissions in the stadium within the Japanese context by integrating renewable energy sources, while balancing the goal of zero emissions with economic considerations.

Background

- **Renewable energy system**
  - World
    - US: Golden 1 Arena (world's first arena 100% solar powered); Lincoln Financial Field (11,000 solar panels & 14 micro wind turbines); Allegiant Stadium (100% renewable sources powered)
    - Ashton Gate Stadium (UK), Schwarzwald-Stadion (Germany), Bankwest Stadium (Australia), Stadio della Roma (Italy), Antalya Stadium (Turkey), Taiwan National Stadium
  - Japan
    - Tokyo Olympic Stadium (solar-powered)
    - Hiroshima Soccer Stadium (solar-powered)
    - J. League Climate Action
    - Panasonic Stadium Suita
  - Mode
    - On-site (self-owned, rented)
    - Off-site (power purchase agreement)
- **Renewable energy systems in EV charging stations**
  - Bilal et al. 2022, Ekren et al. 2021
- **Methodology**
  - Artificial techniques (Yoshida et al. 2020, Lian et al. 2019, Al-falahi et al. 2017): Particle swarm optimization
  - Software tools (Thirunavukkarasu et al. 2023, Li et al. 2022, Sinha et al. 2014): Hybrid Optimization of Multiple Energy Resources (**HOMER**)

Case study – Imabari Satoyama Stadium

LOCATION

GENERAL INFORMATION

METEOROLOGICAL DATA

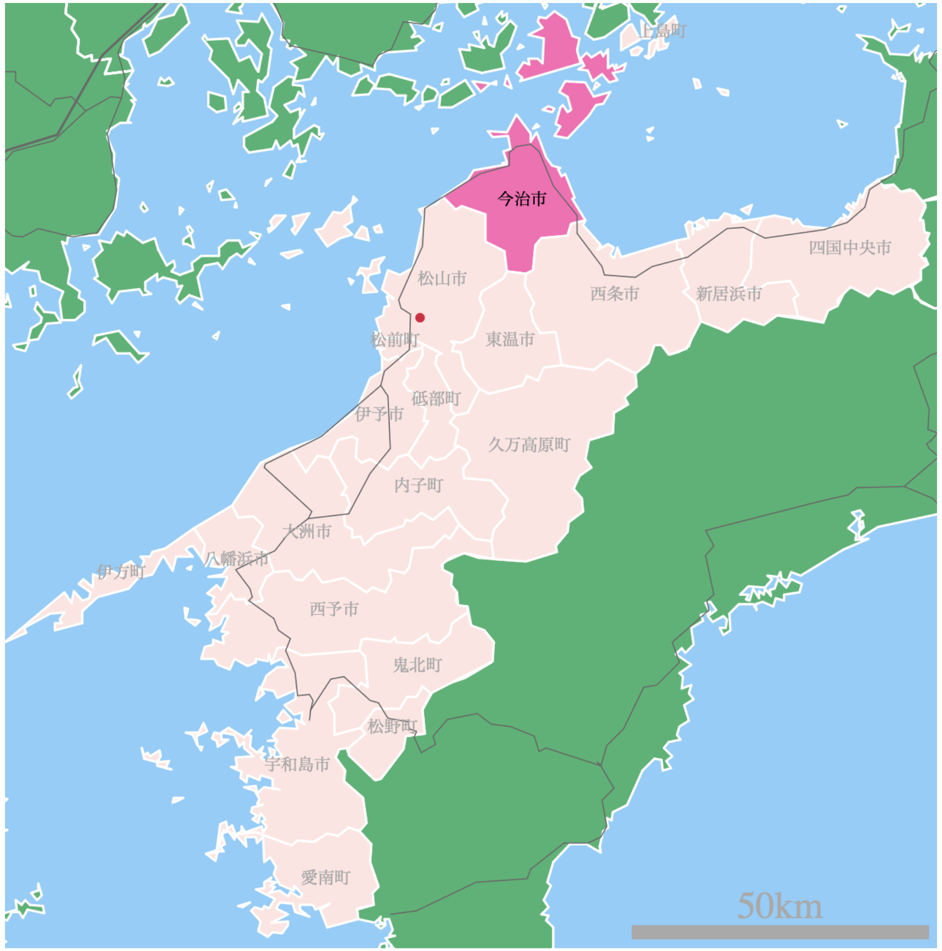
GRID

HOMER

OTHER POTENTIAL

Imabari Satoyama Stadium

- Location



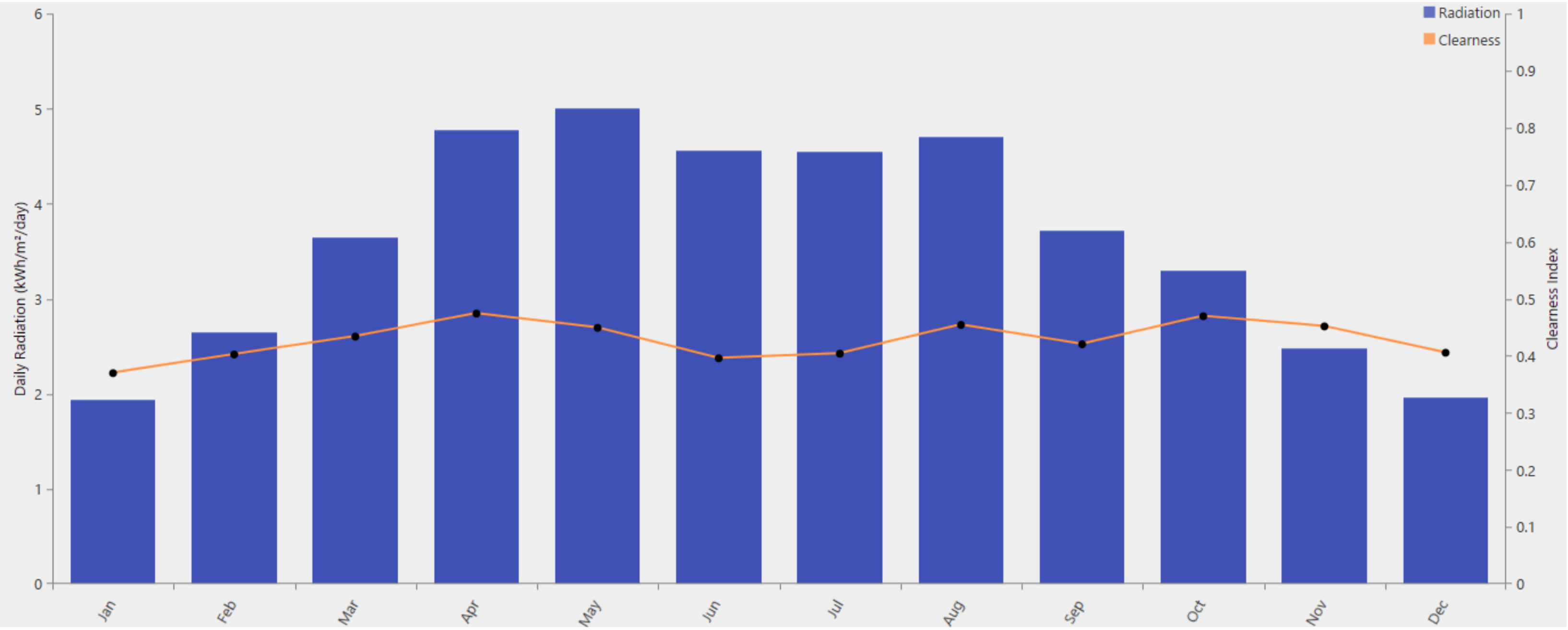
Imabari Satoyama Stadium

Imabari Satoyama Stadium

- **General info**
  - The third di
  - Opened: Ja
  - Capacity: 5

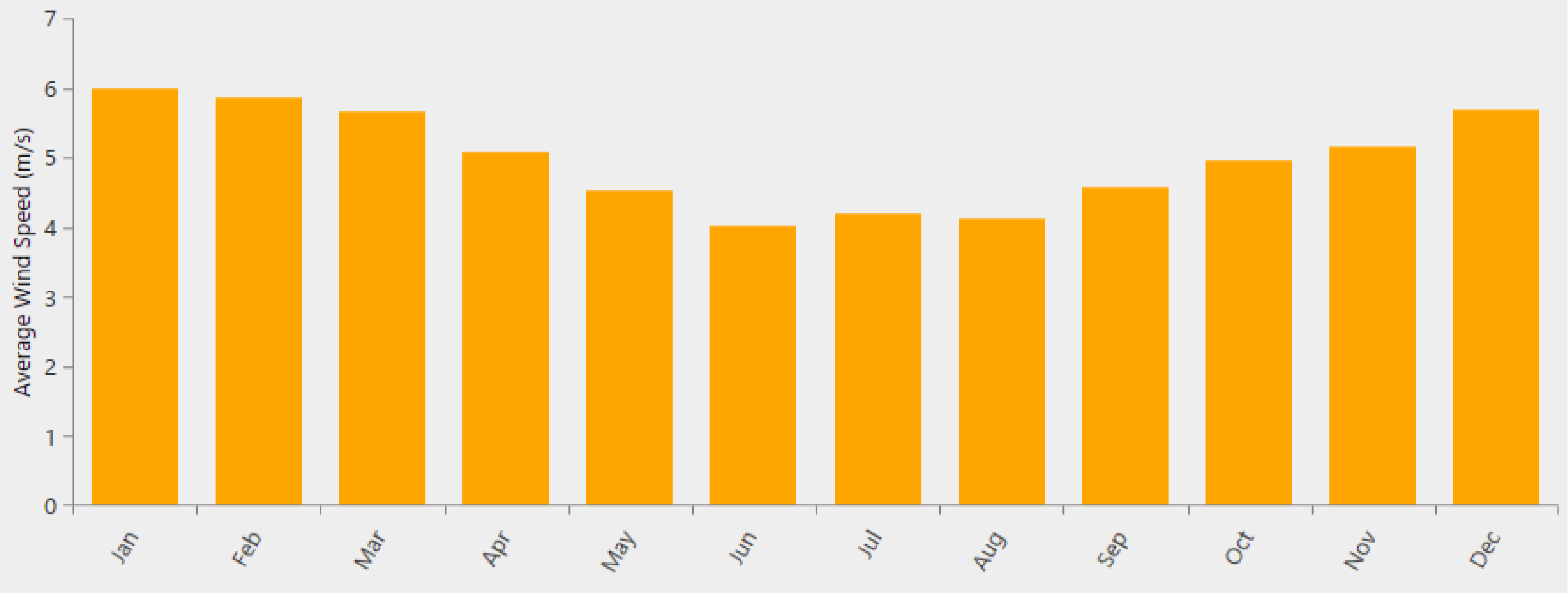
Imabari Satoyama Stadium

- **Meteorological data**
  - Solar: The average solar is around 3.6kWh/m²/day.



Imabari Satoyama Stadium

- **Meteorological data**
  - Wind: The average solar is around 4.98m/s.

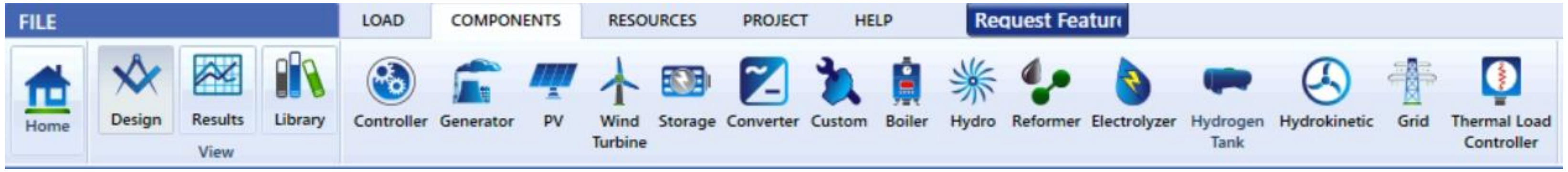


Imabari Satoyama Stadium

- **Grid**
  - Shikoku Electric Power Company
  - Monthly electricity expenses: 800,000 yen/month (~4,720 euro/month)

Imabari Satoyama Stadium

- **HOMER**
  - Commonly used for least-cost optimization in different **stand-alone** or **grid-connected** microgrids
  - Can model different microgrid configurations as it includes **various generation resources**, such as fossil fuel generators, PV, wind, biomass, and hydro systems. It also contains multiple **energy storage technologies**, such as battery storage, hydrogen storage, and supercapacitors.
  - Indicators
    - Cost of Electricity generation (**COE**)
    - Net present cost (**NPC**)
    - **CO2** emission intensity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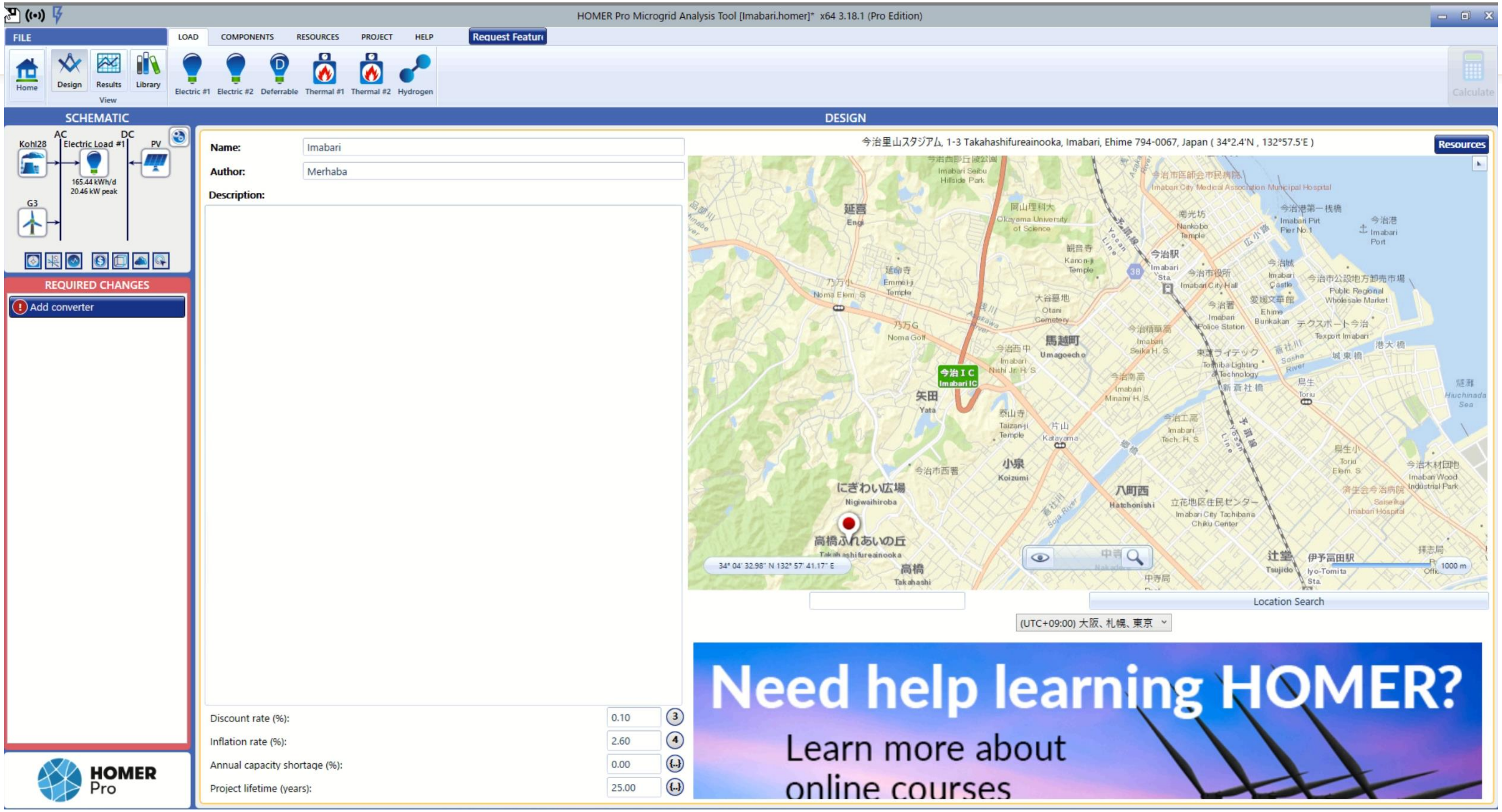
Thermal Load Controller


HOMER Pro Microgrid Analysis Tool [Imabari.homer]* x64 3.18.1 (Pro Edition)
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Electric #2
Deferrable
Thermal #1
Thermal #2
Hydrogen
Calculate
SCHEMATIC
DESIGN
AC
DC
Kohl28
Electric Load #1
PV
165.44 kWh/d
20.46 kW peak
G3
REQUIRED CHANGES
Add converter
Name: Imabari
Author: Merhaba
Description:
今治里山スタジアム, 1-3 Takahashifureainooka, Imabari, Ehime 794-0067, Japan (34°2.4'N , 132°57.5'E)
Resources
Location Search
(UTC+09:00) 大阪、札幌、東京
Discount rate (%): 0.10
Inflation rate (%): 2.60
Annual capacity shortage (%): 0.00
Project lifetime (years): 25.00
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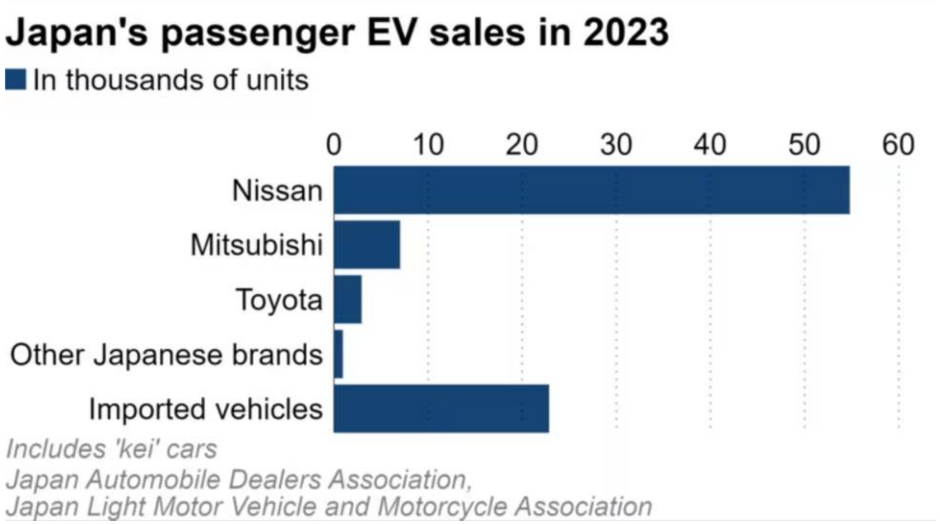
Other potential

- Electric vehicles
  - In Japan, the market share for xEVs is approximately 30%.

- Electric vehicle charging facilities
  - 300,000 public charging ports by 2030
  - Current spots nationwide: 21,378
  - Imabari city: 29



Future directions

EV charging station

Other potential consumptions of excess generated electricity

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