HORIZON-CL5-2022-D3-01-11
Demonstration of innovative forms of storage and their successful operation and integration into innovative energy system and grid architectures

AGiSTIN

Advanced Grid Interfaces for innovative STorage INtegration

Battery Model Insights

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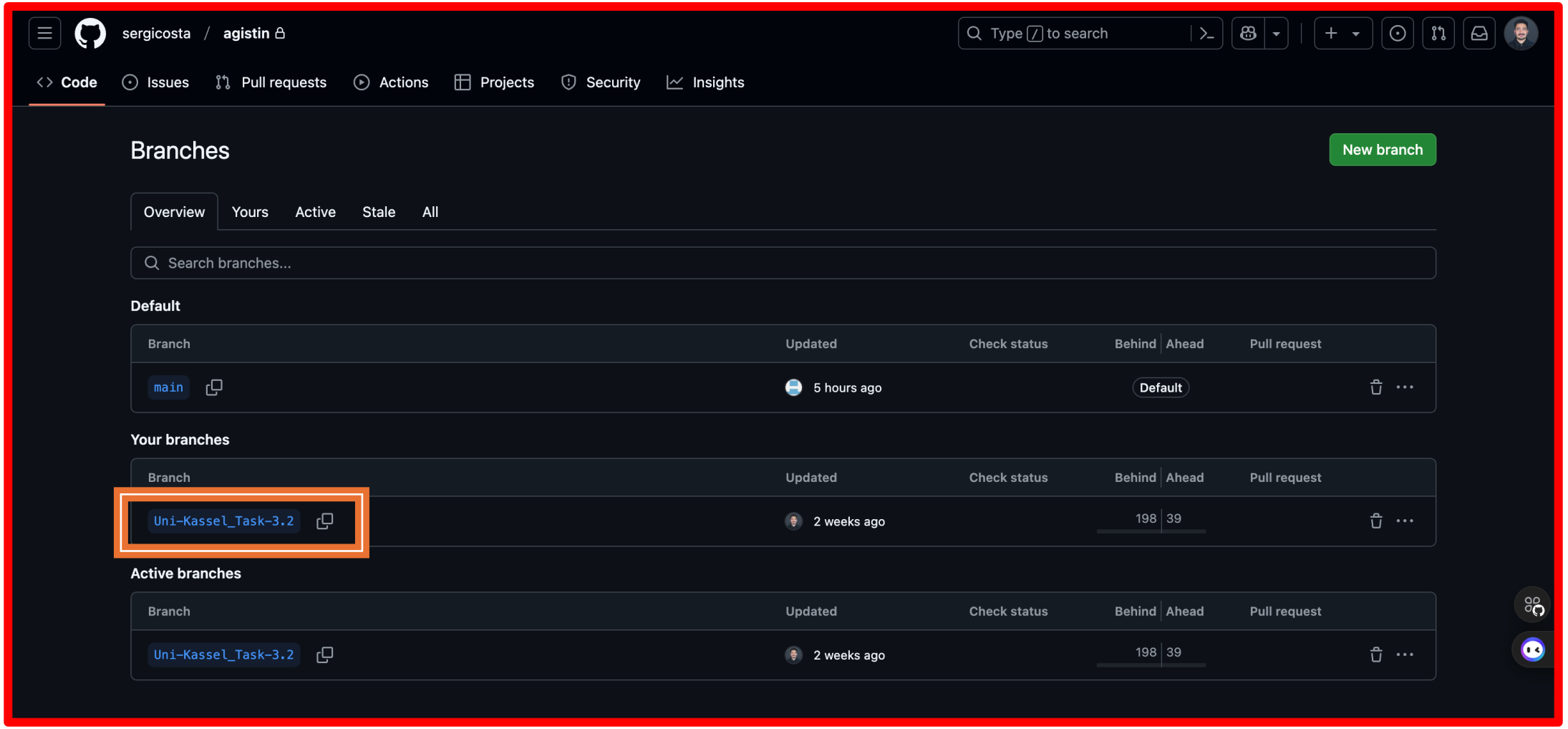
Project Introduction

- **Project Overview:** The Battery Model Project aims to enhance synergy between battery storage, photovoltaic systems, and grid performance.
- **Focus Areas:** Key focus includes optimization techniques for maximizing efficiency in energy storage and generation processes.
- **Integration Importance:** A critical aspect is understanding how optimizing both components leads to improved overall energy management.

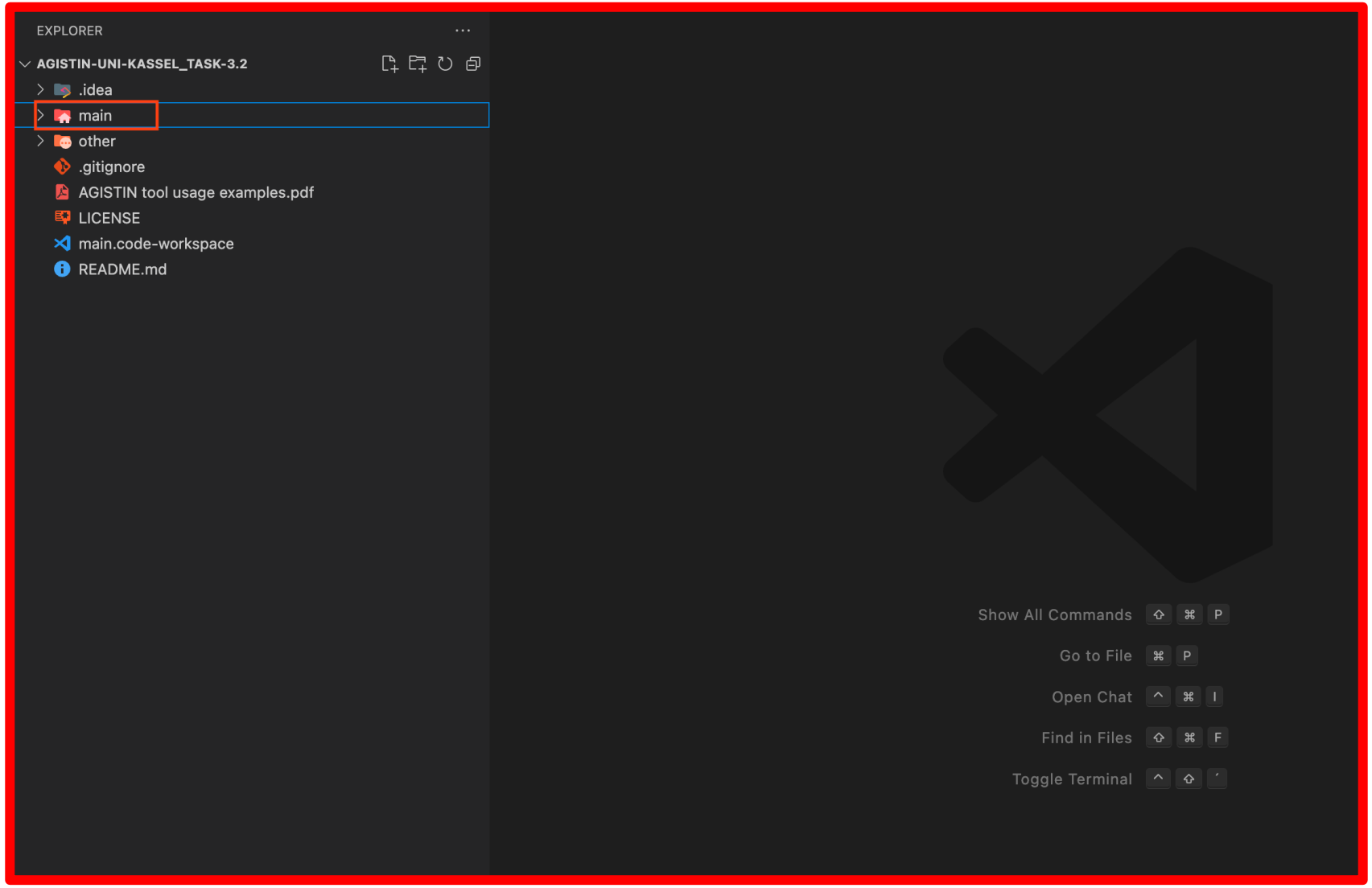
Project Directory Structure

- **Directory Structure:** The directory contains organized folders for efficient project management and accessibility of files.
- **Main Folder:** 'agistin-Uni-Kassel_Task-3.2' serves as the root, centralizing all project-related documentation and substructures.
- **Subfolders Overview:** Subfolders include 'main' for primary files, 'Cases' for data, and 'Devices' for Python scripts.

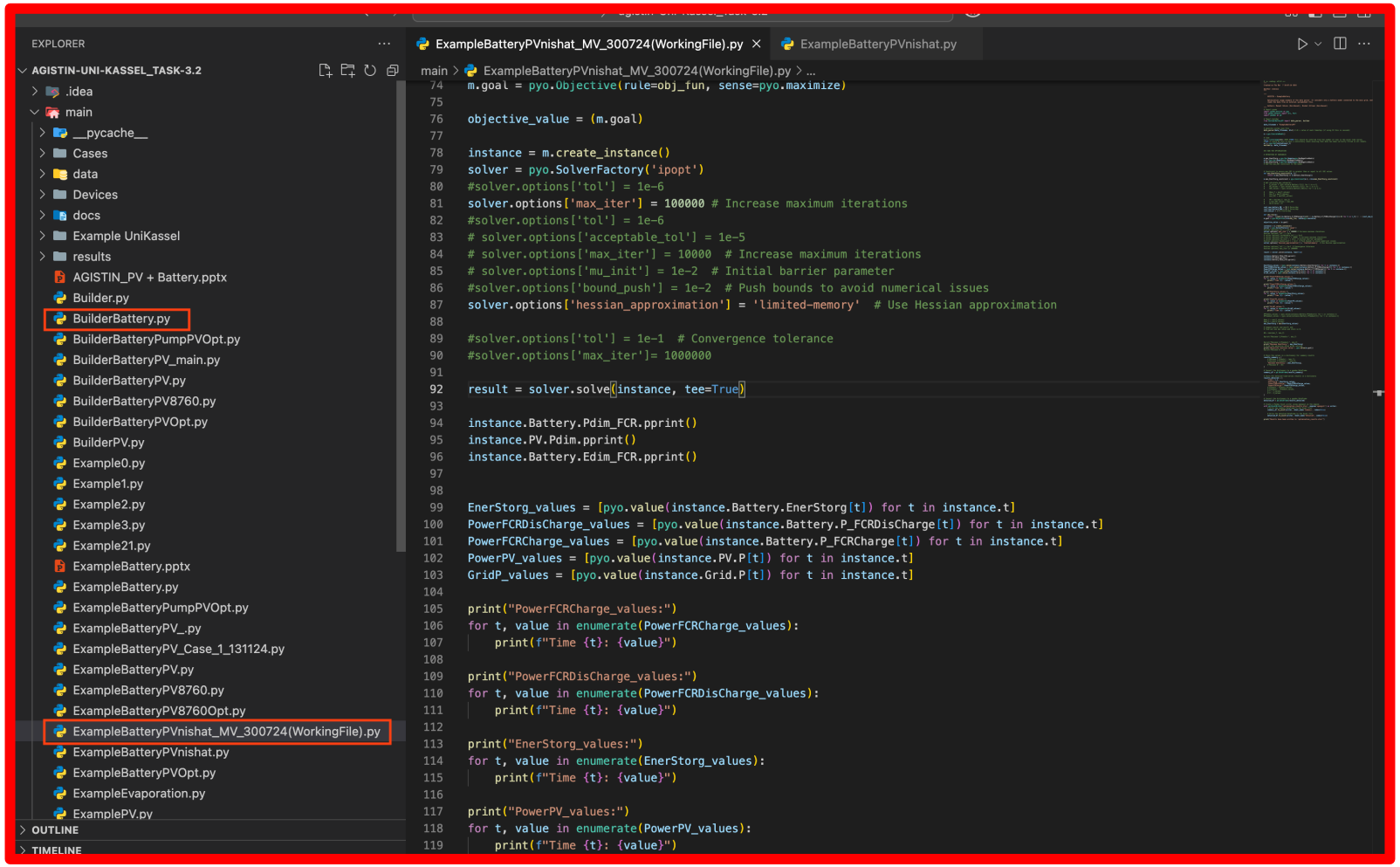
1- This is our GitHub repository.[https://github.com/sergicosta/agistin/branches]
2- It contains a main file where all official work is updated.
3- Additionally, we have a copy of the file where we work, which I have highlighted.



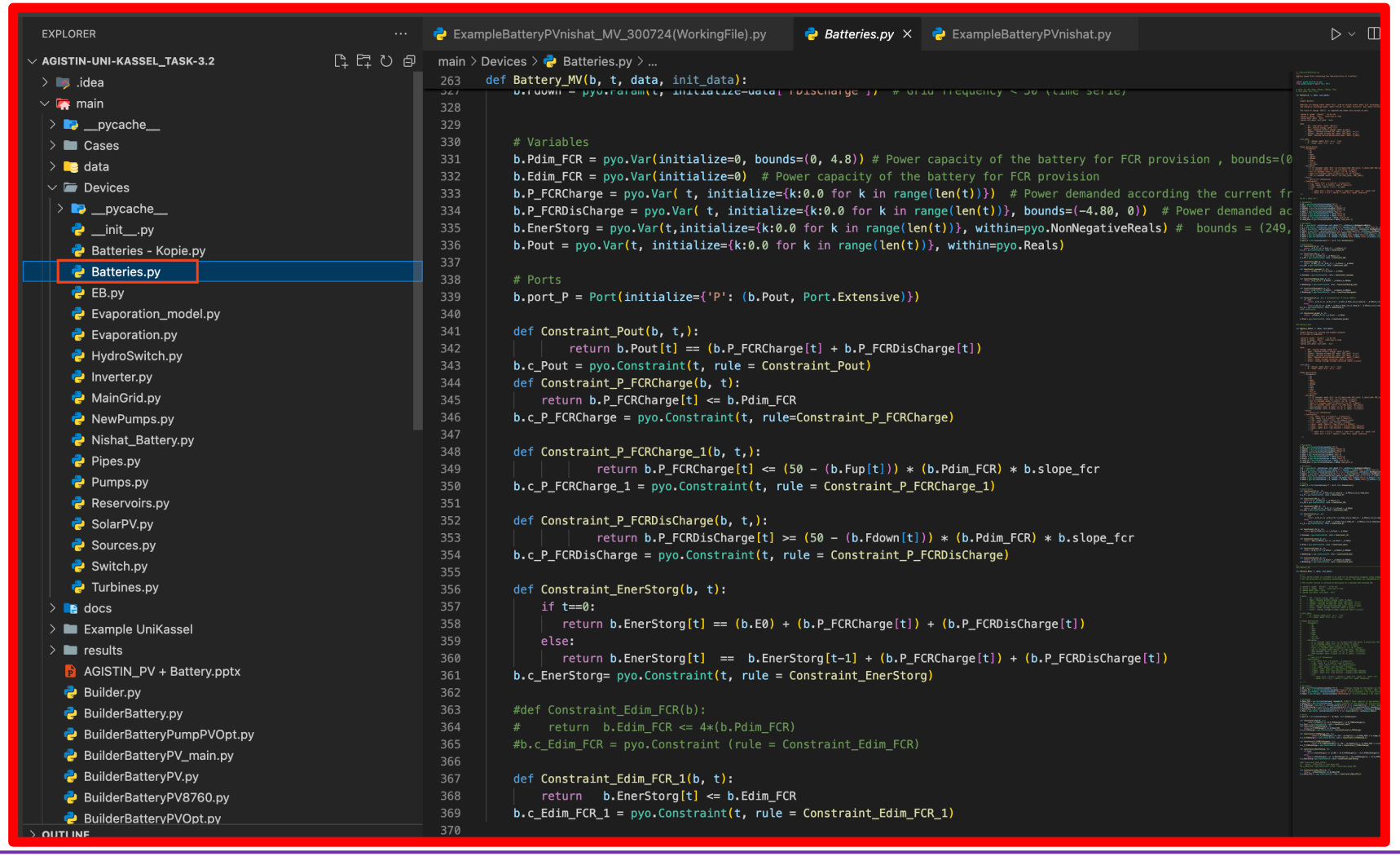
1- In this, we first have a main folder that contains subfolders and files inside it.



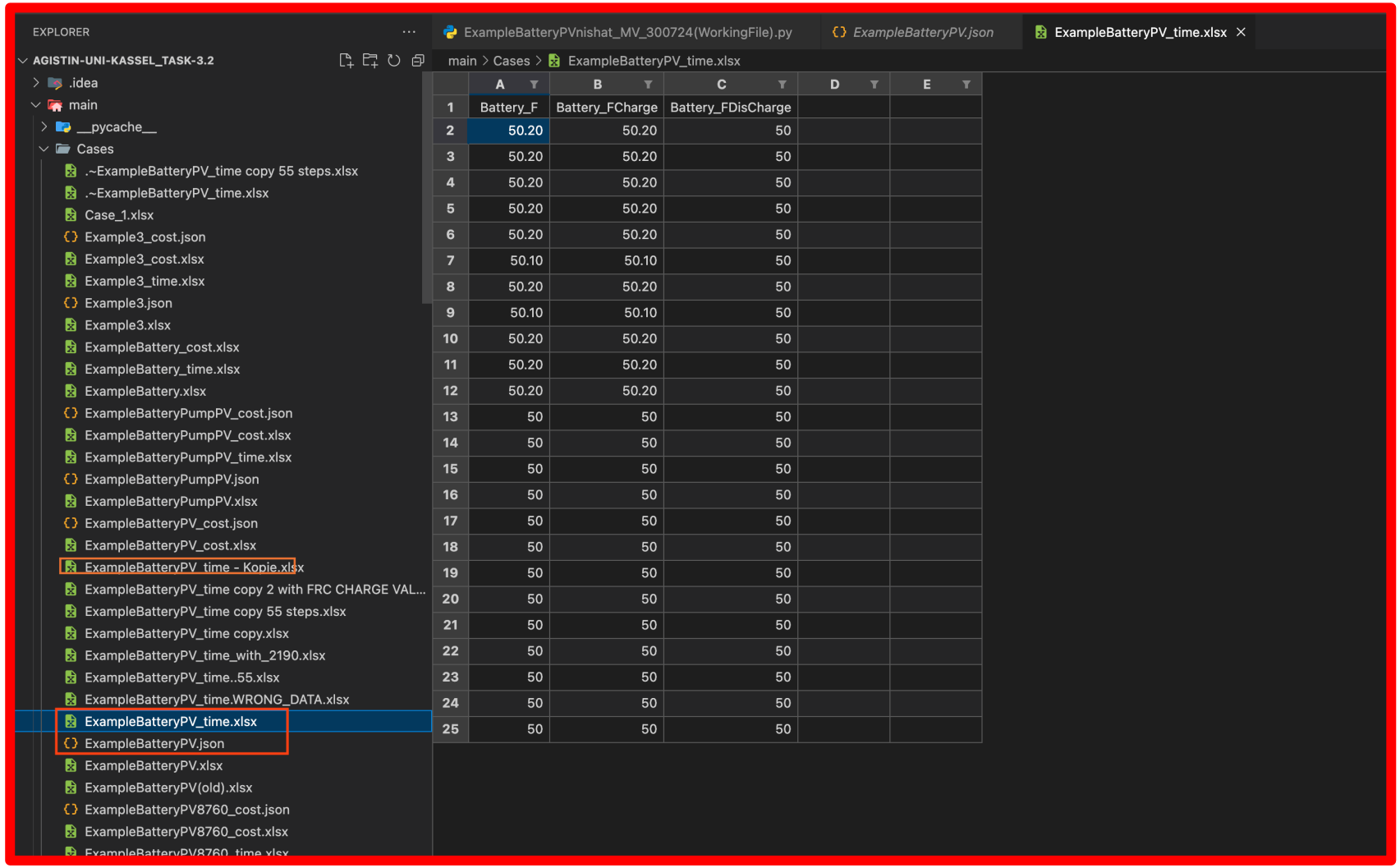
1- In this, we have a main file: **ExampleBatteryPVnishat_MV_300724(WorkingFile)**.
2- This file is where we declare the data points, and we can custom-select the ones present in the Excel file.
3- There's also a **builderbattery.py** file, which helps in calling our JSON and Excel files. We don't make many changes to this file.



1- In this, we have a **devices folder** containing the **batteries.py** file.
2- In this file, we declare different variables, constraints, and functions that we want to print or use.



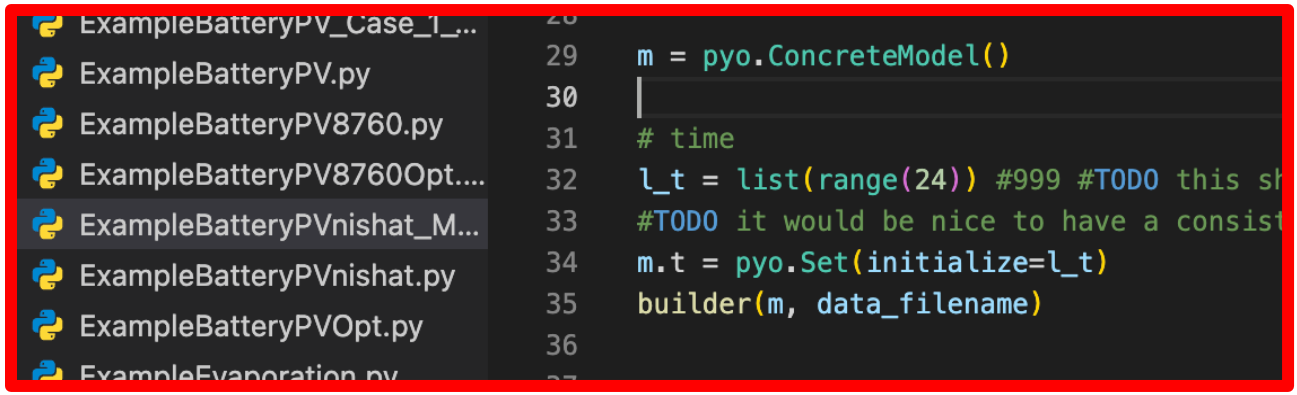
1- In this, we have a **cases folder** that contains 3 files, which are marked.
2- The important file is **examplebatteryPV_time**, where we declare our data points.
3- To run different cases, these 3 files are used.



	A	B	C	D	E
1	Battery_F	Battery_FCharge	Battery_FDisCharge		
2	50.20	50.20	50		
3	50.20	50.20	50		
4	50.20	50.20	50		
5	50.20	50.20	50		
6	50.20	50.20	50		
7	50.10	50.10	50		
8	50.20	50.20	50		
9	50.10	50.10	50		
10	50.20	50.20	50		
11	50.20	50.20	50		
12	50.20	50.20	50		
13	50	50	50		
14	50	50	50		
15	50	50	50		
16	50	50	50		
17	50	50	50		
18	50	50	50		
19	50	50	50		
20	50	50	50		
21	50	50	50		
22	50	50	50		
23	50	50	50		
24	50	50	50		
25	50	50	50		

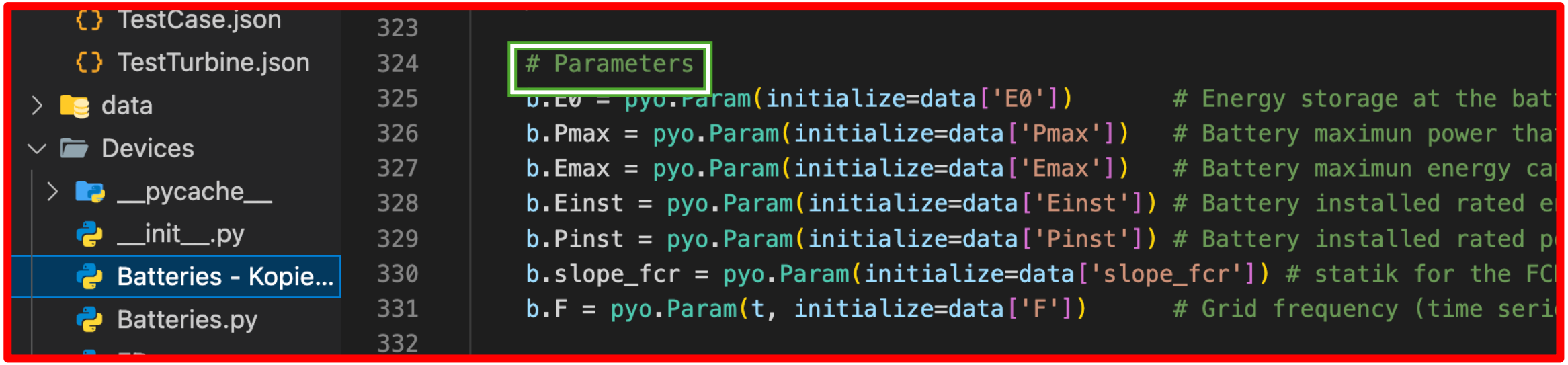
Key Battery Model Files

- **Core Model File:** 'BuilderBatteryPV' is crucial for assembling and developing the comprehensive battery model architecture efficiently.
- **Test Case Definition:** 'ExampleBatteryPVnishat_MV_300724' outlines specific test conditions to ensure model robustness and reliability.
- **File Integration:** Integration of these files enhances project modularity, facilitating easier adjustments and future developments.



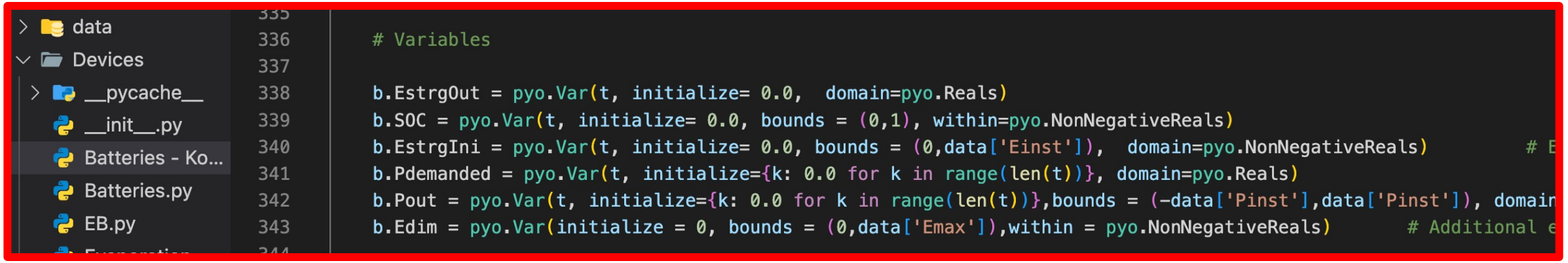
Batteries.py - Parameters

- **Initial Energy Storage:** Parameter b.E0 indicates the initial stored energy within the battery, facilitating mathematical optimization.
- **FCR Performance Slope:** The variable b.slope_fcr represents the effective change in frequency response during charging and discharging phases.
- **Grid Frequency Deviations:** Parameters b.Fup and b.Fdown define acceptable grid frequency thresholds for efficient battery operation management.



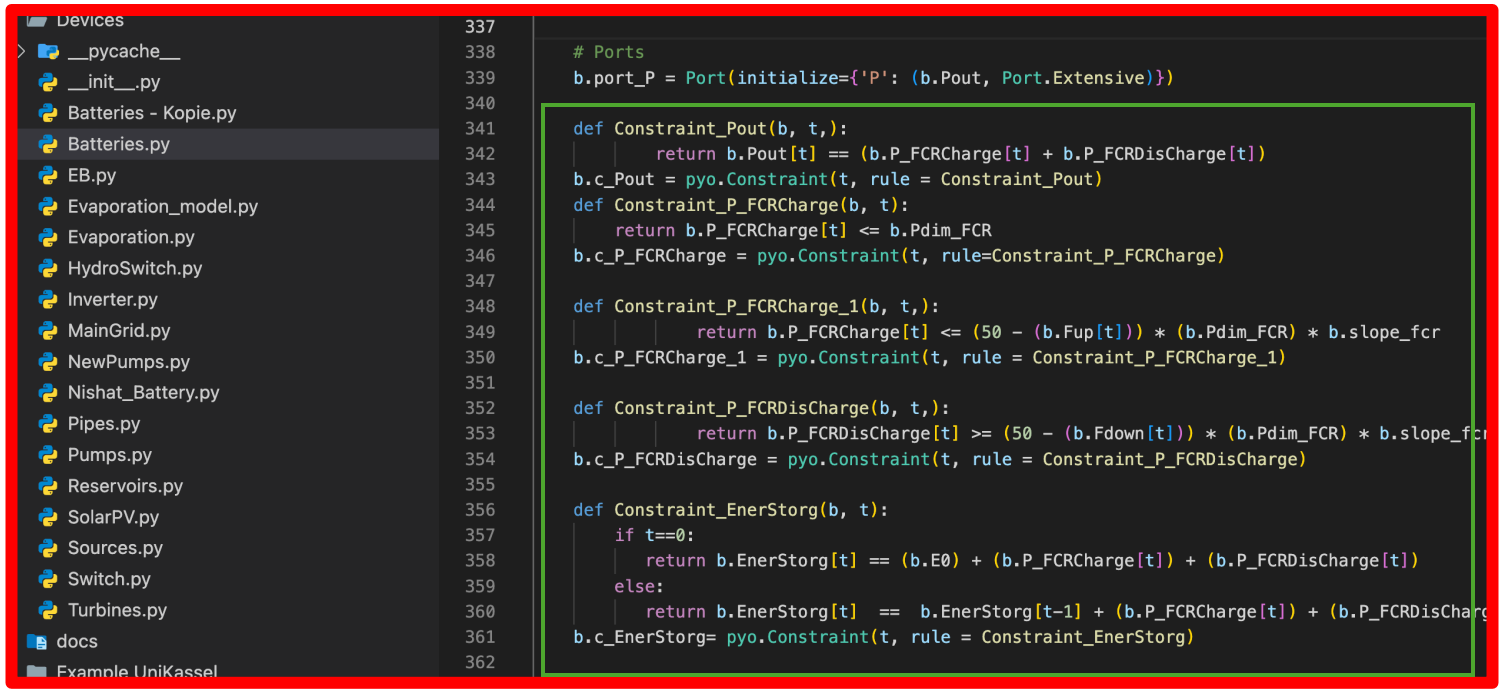
Batteries.py - Variables

- **Max Power Capacity:** Variable b.Pdim_FCR defines the battery's maximum power output during operational scenarios and peak demands.
- **Energy Capacity:** The energy storage capacity, represented by b.Edim_FCR, determines total energy storage available for discharge cycles.
- **Net Battery Output:** b.Pout indicates the actual output power from the battery, factoring in charging and discharging events.



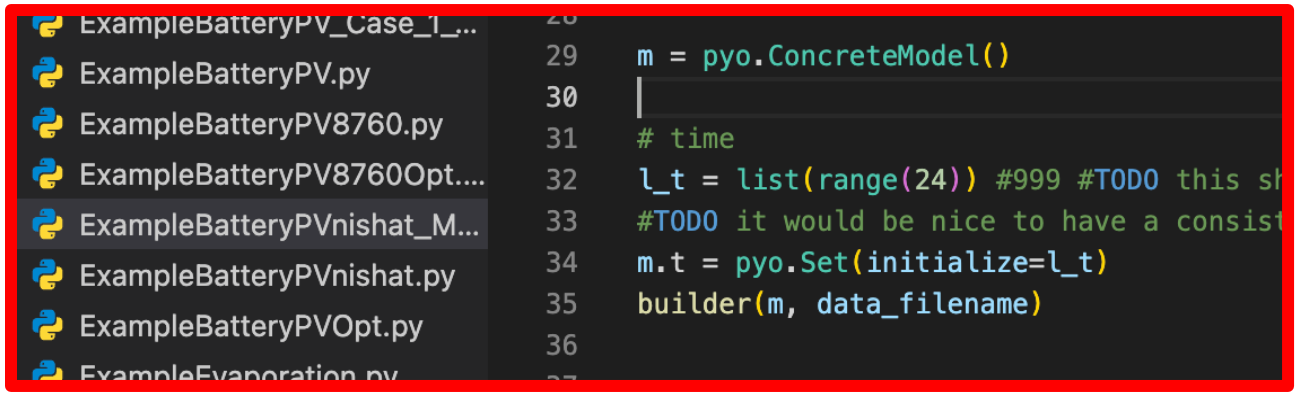
Batteries.py - Constraints

- **Power Output Constraint:** Constraint_Pout ensures balance between charging and discharging power, maintaining operational stability and efficiency.
- **State of Charge Tracking:** Constraint_EnerStorg monitors the State of Charge, aligning with initial energy levels for optimal performance.
- **Energy Capacity Limits:** Constraint_Edim_FCR_1 defines the maximum and minimum energy capacities, ensuring the battery operates within safe thresholds.



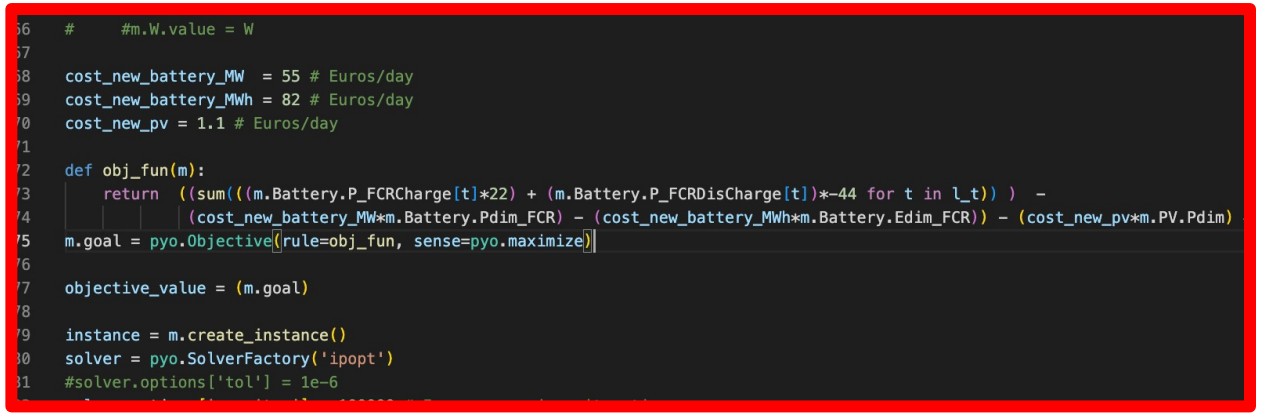
ExampleBatteryPV_Case_1_131124.py

- **Cost Parameters:** Fixed daily costs for capacities are crucial to evaluate financial feasibility of the battery system.
- **Time Steps:** We can customize them in the Excel file, for example, in **ExampleBatteryPV_time**, and then declare them in the main file: **ExampleBatteryPVnishat_MV_300724(Working File)**.
- **Decision Variables:** Key decision variables **Power** and **Energy Capacity** of the battery for optimization.



Optimization Workflow

- **Input Data Parsing:** This initial phase involves organizing and cleansing datasets for accurate model input during optimization.
- **Model Building with Pyomo:** Utilizing Pyomo, models integrate various components, defining relationships crucial for effective energy management solutions.
- **Results Extraction and Analysis:** Post-optimization analysis evaluates outputs, assessing model performance against predefined benchmarks for continuous improvement.



```
#     #m.W.value = W

cost_new_battery_MW  = 55 # Euros/day
cost_new_battery_MWh = 82 # Euros/day
cost_new_pv = 1.1 # Euros/day

def obj_fun(m):
    return  ((sum(((m.Battery.P_FCRCharge[t]*22) + (m.Battery.P_FCRDisCharge[t])*-44 for t in l_t)) )  -
             (cost_new_battery_MW*m.Battery.Pdim_FCR) - (cost_new_battery_MWh*m.Battery.Edim_FCR)) - (cost_new_pv*m.PV.Pdim)
m.goal = pyo.Objective(rule=obj_fun, sense=pyo.maximize)

objective_value = (m.goal)

instance = m.create_instance()
solver = pyo.SolverFactory('ipopt')
#solver.options['tol'] = 1e-6
```

Data Handling & Solver

- **Data Handling Sources:** The project utilizes external JSON files for structured data input, enhancing accessibility and integration.
- **Solver Configuration:** Ipopt settings include customized max iterations.
- **Execution of optimization:** Execute the constraints and the main file.

Conclusion

- **Integrated Model Overview:** The comprehensive framework combines battery storage, PV systems, and grid interaction for optimized energy management.
- **Benefits of Integration:** Enhanced efficiency, cost reduction, and improved reliability are key benefits observed from the integrated model implementation.
- **Next Steps:** Focus on further testing and optimization will ensure sustained improvements in model performance and scalability.

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Thank you for listening