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Welcome

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GPU Benchmarking for Performance and NetZero at IRIS

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Agenda

1 The Case for a GPU Benchmarking Suite at IRIS: Why It's Essential

2 Project Aims

3 Collecting Results

4 Benchmark Results

5 Future work

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The Case for a GPU Benchmarking Suite at IRIS: Why It's Essential

- Most existing benchmarks are not **open-source or tailored to IRIS**
- **Understand Resource Usage**
- **Evaluate GPU performance** for IRIS workloads
- **To track CO2 emissions**
- **Informed Purchasing**

Project Aims

- **GPU benchmarking suite** tailored to IRIS workloads.
- **To assess different GPU performance and CO2 emissions**.

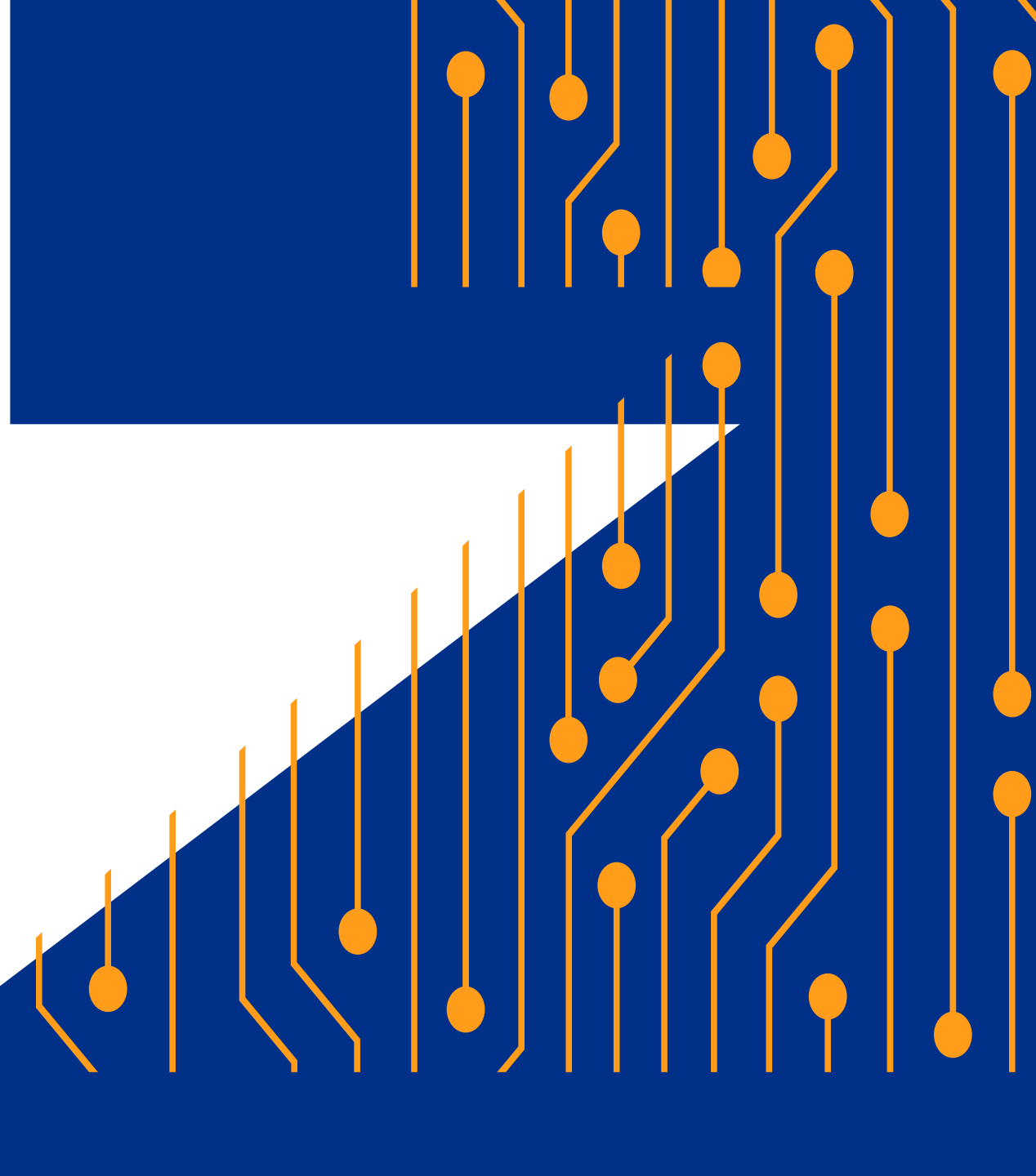
Accomplishments And Progress

- **Prototype GPU Benchmarking Suite** with integrated Mantid, SciML benchmarks.
- **Performance and CO2 Emission Tracking**: The suite assesses GPU performance (nvidia-smi) and tracks CO2 emissions (NESO API).
- **Grafana Dashboard**: To visualize and analysising benchmark performance data.

GitHub Repo and Documentation

IRIS Bench Repository: Access the benchmark suite.

Documentation: Includes installation, Docker files/Habor, command-line interface, and more.



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Collecting Results

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Running a Benchmark on IRIS Bench

GPU and Carbon Performance Results

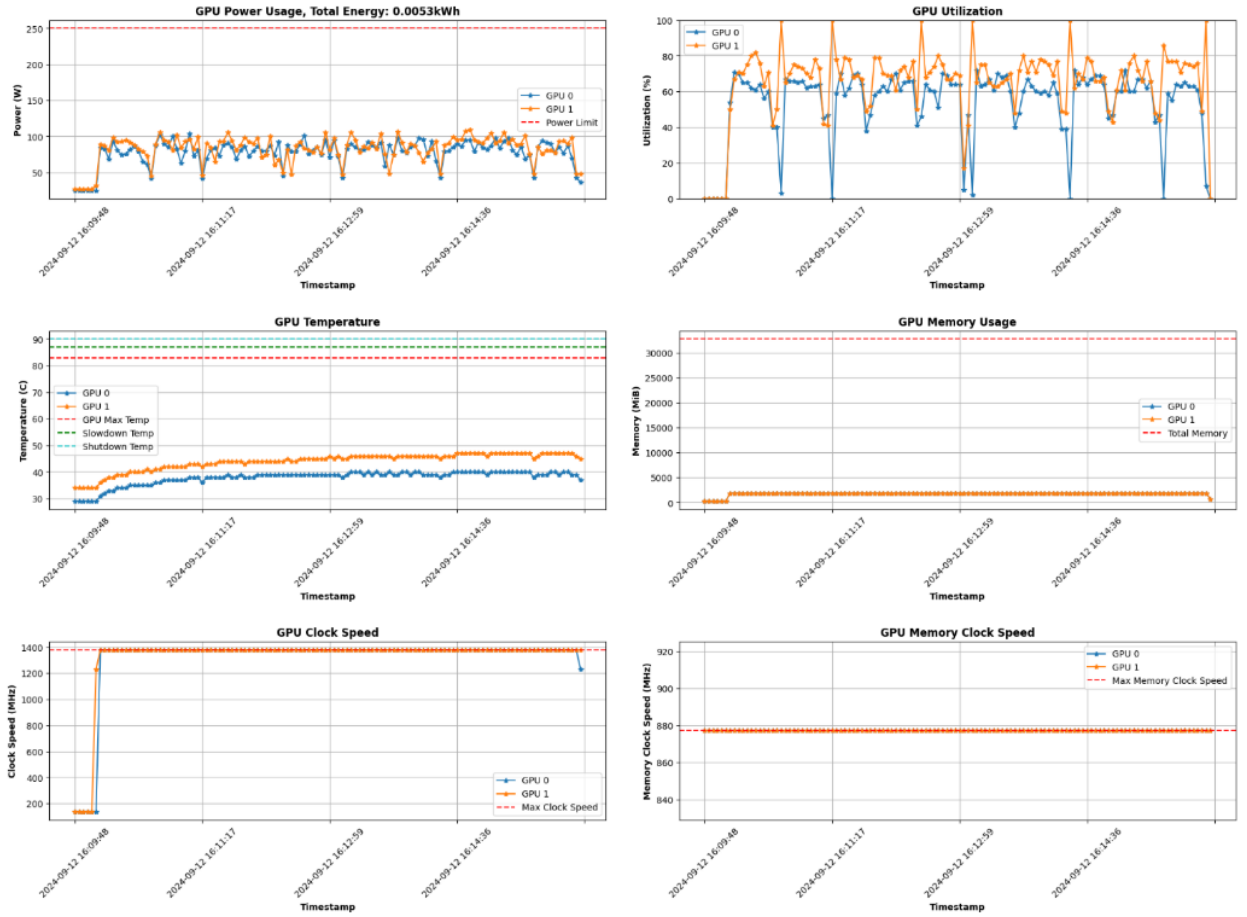
Metric	Value
Benchmark:	stemdl_classification
Benchmark Score (s)	1053.29596
Elapsed Monitor Time (s)	1202.78311
Total GPU Energy Consumed (kWh)	0.00561
Total GPU Carbon Emissions (gCO2)	0.54695

Carbon Information

Metric	Value
Average Carbon Forecast (gCO2/kWh)	97.5
Carbon Forecast Start Time	2024-09-11 14:25:55
Carbon Forecast End Time	2024-09-11 14:45:58

GPU Information

Metric	Value
GPU Type	Tesla V100-PCIE-32GB
No. of GPUs	2
Average GPU Utilization (for >0.00% GPU Util.) (%)	43.03604
Average GPU Power (for >0.00% GPU Util.) (W)	65.31081 (Power Limit: 250)
Average GPU Temperature (for >0.00% GPU Util.) (°C)	38.58559
Temperature Threshold - Slowdown (°C)	87.00
Average GPU Memory (for >0.00% GPU Util.) (MiB)	1877.58896 (Total Memory: 32768.0)
Average Clock Speed (MHz)	1340.87 (Max: 1380.00)
Average Memory Clock Speed (MHz)	877.00 (Max: 877.00)



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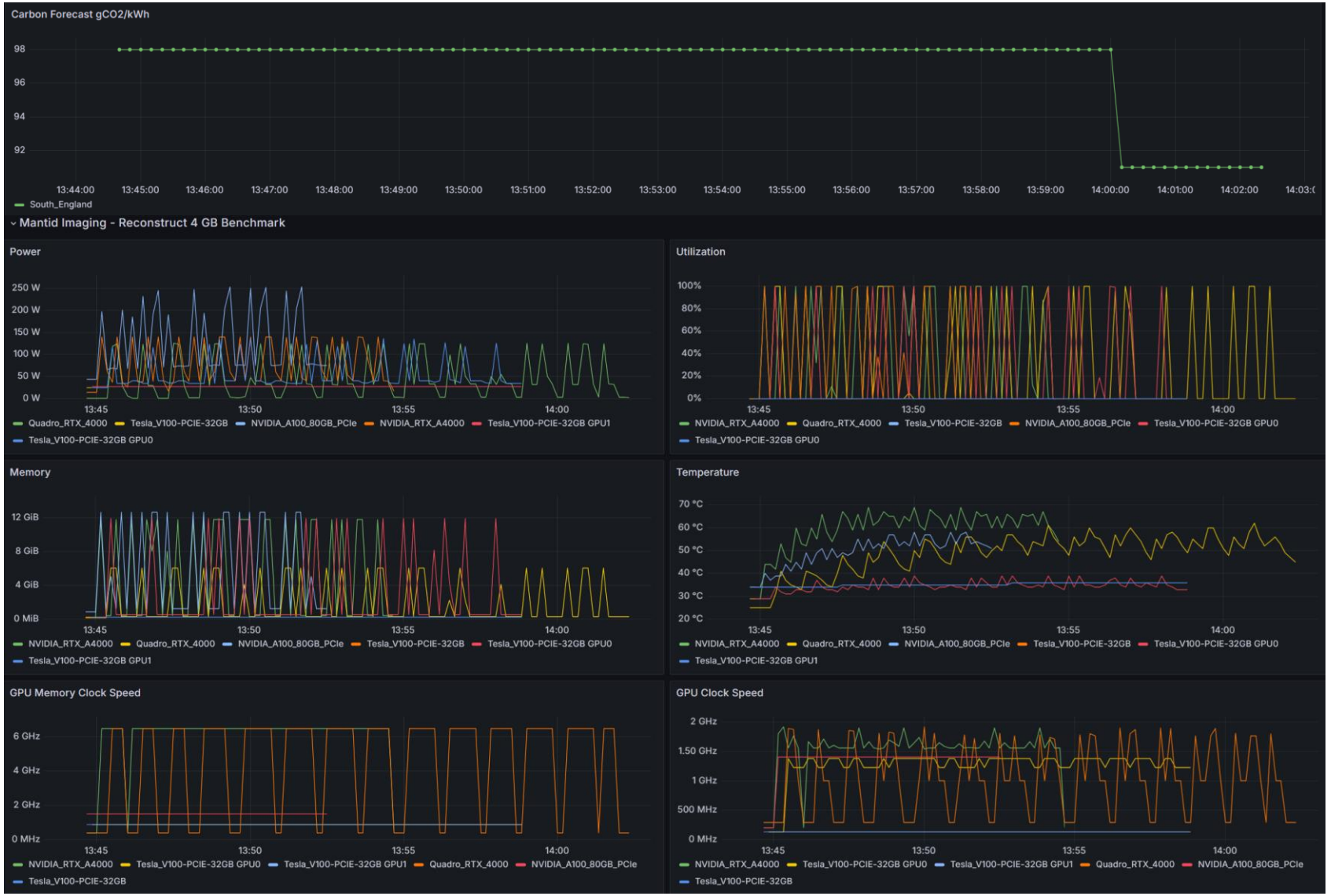
Grafana Dashboard for Performance Analysis and Comparison

Benchmark Results

Time	GPU Type	Number of GPUs	Benchmark Score
2024-09-11 14:02:30	Quadro_RTX_4000	1	1037.06005
2024-09-11 13:45:00	Tesla_V100-PCIE-32GB	1	
2024-09-11 13:59:00	Tesla_V100-PCIE-32GB	2	812.68094
2024-09-11 13:52:30	NVIDIA_A100_80GB_PCIe	1	444.46629
2024-09-11 13:54:50	NVIDIA_RTX_A4000	1	576.91544



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SciML Bench and MANTID Benchmark Results Examples

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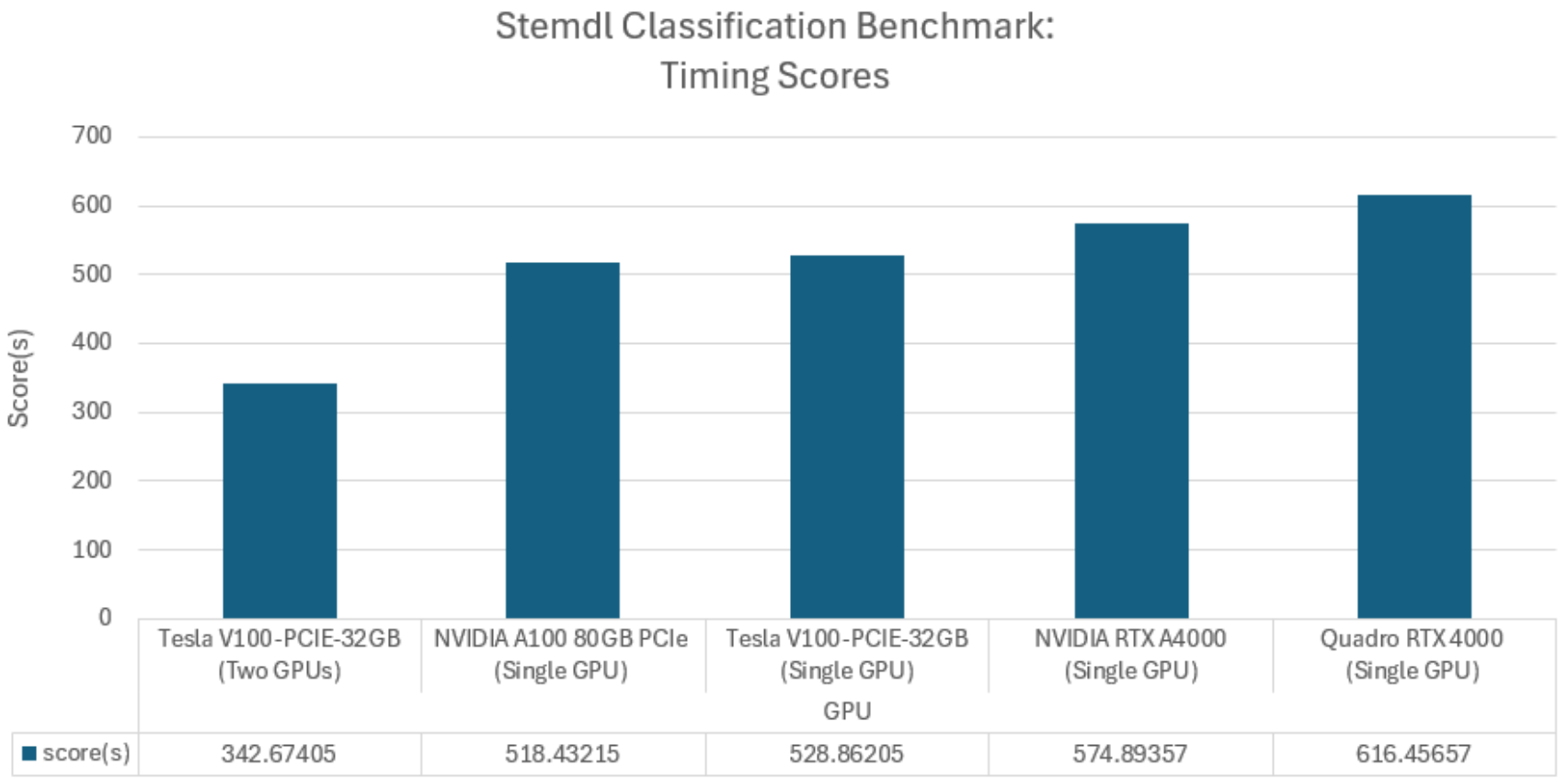
SciML Bench - StemdlClassification



[SciML Benchmark Repo]

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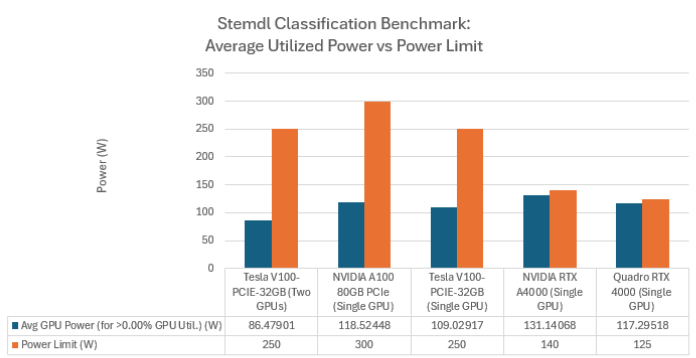
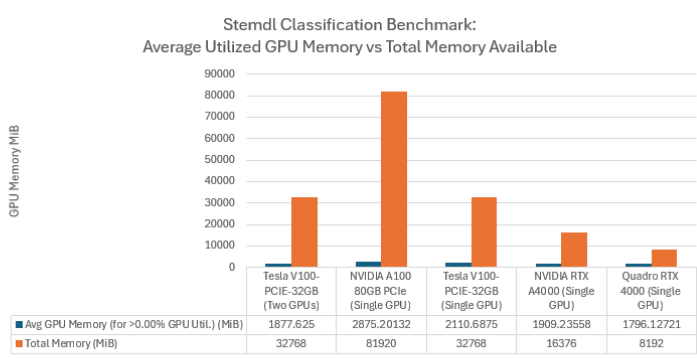
SciML Benchmarks

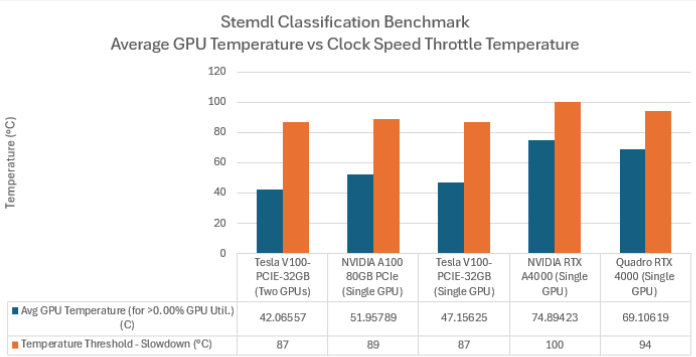
SciML Bench - StemdlClassification



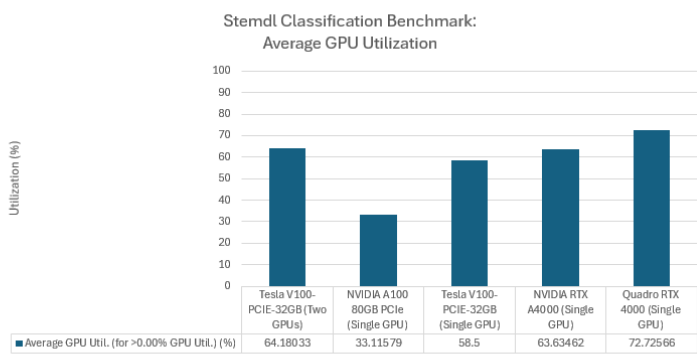
	Tesla V100-PCIE-32GB (Two GPUs)	NVIDIA A100 80GB PCIe (Single GPU)	Tesla V100-PCIE-32GB (Single GPU)	NVIDIA RTX A4000 (Single GPU)	Quadro RTX 4000 (Single GPU)
Avg GPU Power (for >0.00% GPU Util.) (W)	86.47901	118.52448	109.02917	131.14068	117.29518
Power Limit (W)	250	300	250	140	125



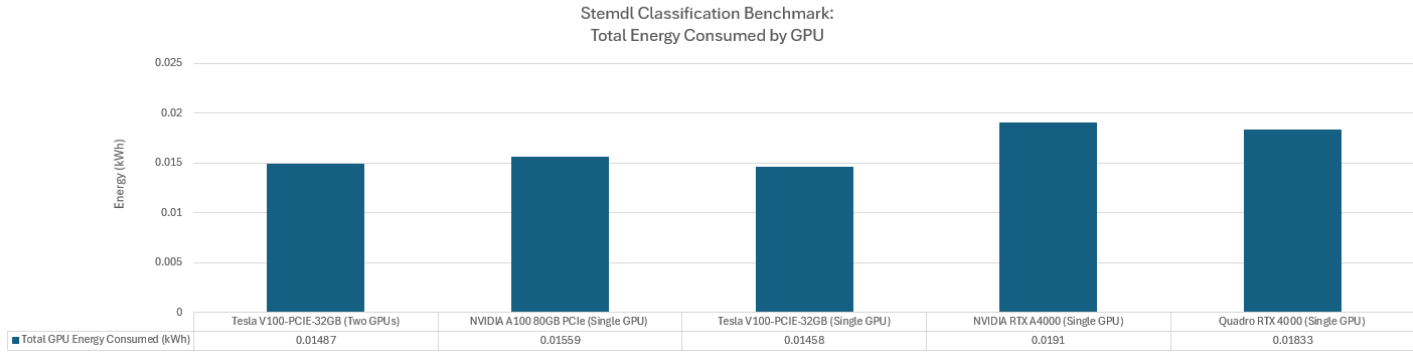
	Tesla V100-PCIE-32GB (Two GPUs)	NVIDIA A100 80GB PCIe (Single GPU)	Tesla V100-PCIE-32GB (Single GPU)	NVIDIA RTX A4000 (Single GPU)	Quadro RTX 4000 (Single GPU)
Avg GPU Memory (for >0.00% GPU Util.) (MiB)	1877.625	2875.20132	2110.6875	1909.23558	1796.12721
Total Memory (MiB)	32768	81920	32768	16376	8192



	Tesla V100-PCIE-32GB (Two GPUs)	NVIDIA A100 80GB PCIe (Single GPU)	Tesla V100-PCIE-32GB (Single GPU)	NVIDIA RTX A4000 (Single GPU)	Quadro RTX 4000 (Single GPU)
Avg GPU Temperature (for >0.00% GPU Util.) (C)	42.06557	51.95789	47.15625	74.89423	69.10619
Temperature Threshold - Slowdown (°C)	87	89	87	100	94



	Tesla V100-PCIE-32GB (Two GPUs)	NVIDIA A100 80GB PCIe (Single GPU)	Tesla V100-PCIE-32GB (Single GPU)	NVIDIA RTX A4000 (Single GPU)	Quadro RTX 4000 (Single GPU)
Average GPU Util. (for >0.00% GPU Util.) (%)	64.18033	33.11579	58.5	63.63462	72.72566



	Tesla V100-PCIE-32GB (Two GPUs)	NVIDIA A100 80GB PCIe (Single GPU)	Tesla V100-PCIE-32GB (Single GPU)	NVIDIA RTX A4000 (Single GPU)	Quadro RTX 4000 (Single GPU)
Total GPU Energy Consumed (kWh)	0.01487	0.01559	0.01458	0.0191	0.01833

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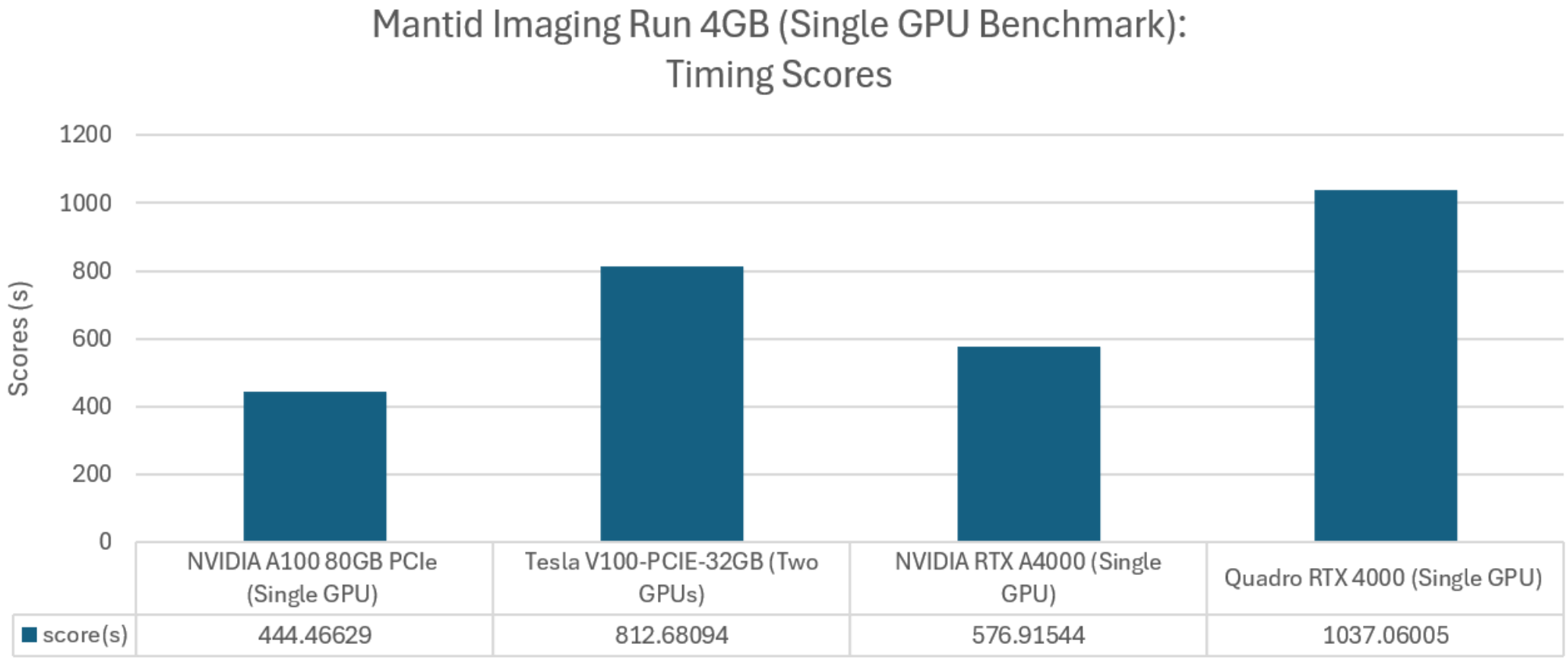
SciML Benchmark Repo

SciML Benchmarks

MANTID Imaging Benchmark 4GB Dataset



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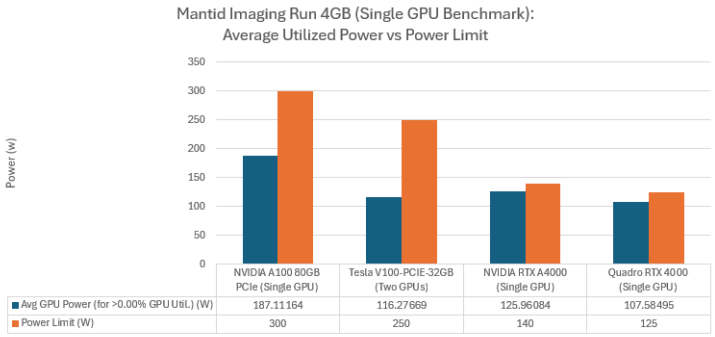
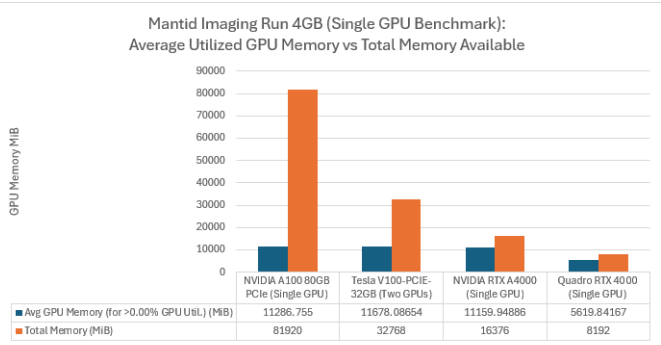
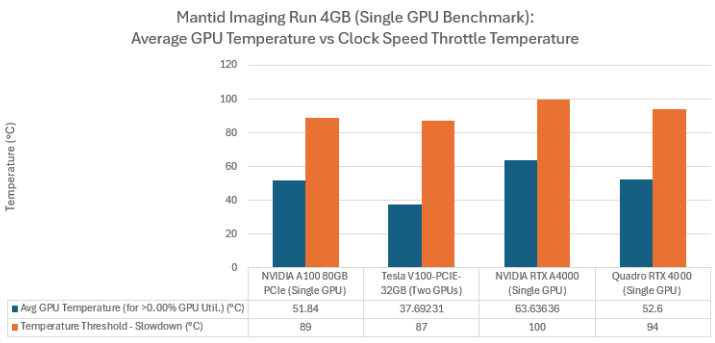
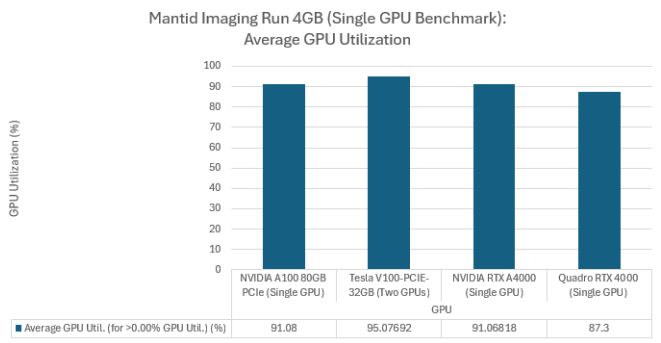
[MANTID Imaging Benchmarks Repo]

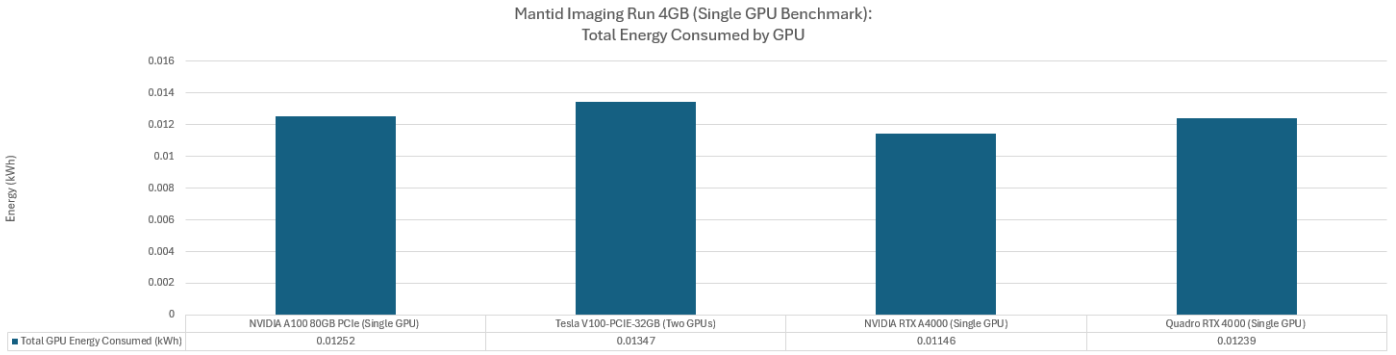
MANTID Imaging Benchmark 4GB Dataset











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[MANTID Imaging Benchmarks Repo]

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Future Work: Improvements to the GPU Benchmarking Suite

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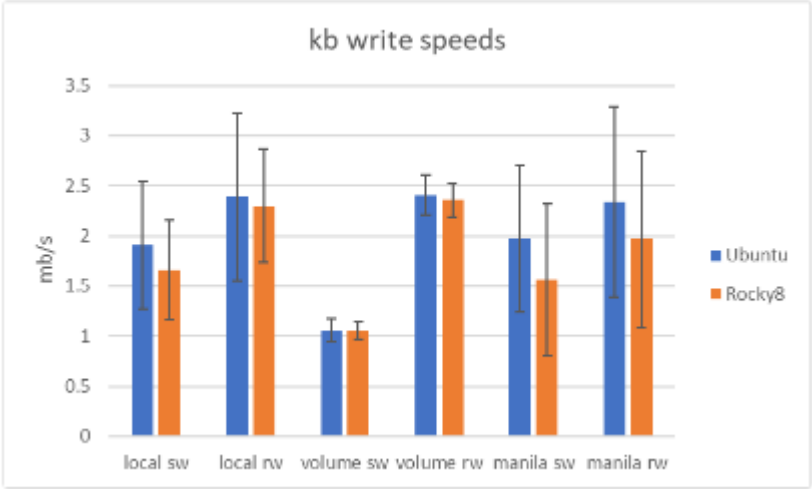
Improvements to the GPU Benchmarking Suite

- **Integrating with Meerkat**
- **Work with IRIS users to integrate more of their benchmarks**
- **Overall Score (Normalize)**
- **FLOP Estimates (+ Efficiency scores)**
- **Integrate CPU, Storage and Memory Benchmarks**
- **Carbon and Cost Forecasting (Next Section)**



Meerkat Storage Benchmark by Chris Green from Cloud Operations Group

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Future Work: Optimizing Energy-Intensive Tasks

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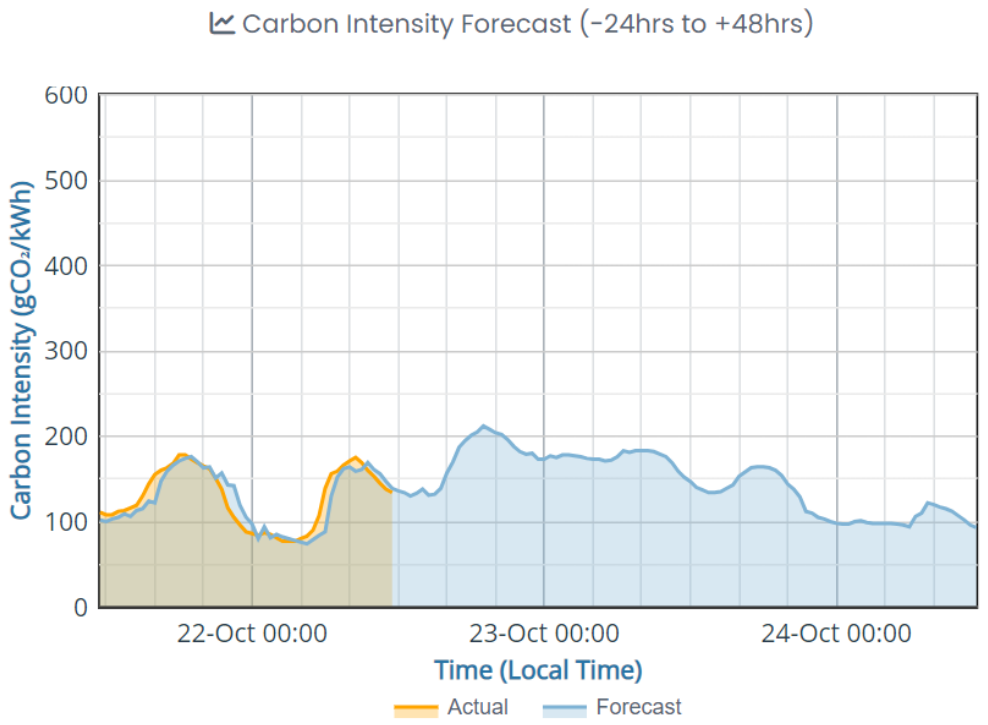
Carbon Emission per kWh Forecasting

- **NESO API**
- **Regional Optimization**: Select times with lower carbon intensity
- **Regional Scheduling**: Select regions with lower carbon intensity (e.g., Daresbury vs. RAL).



Carbon Intensity Forecast from NESO API

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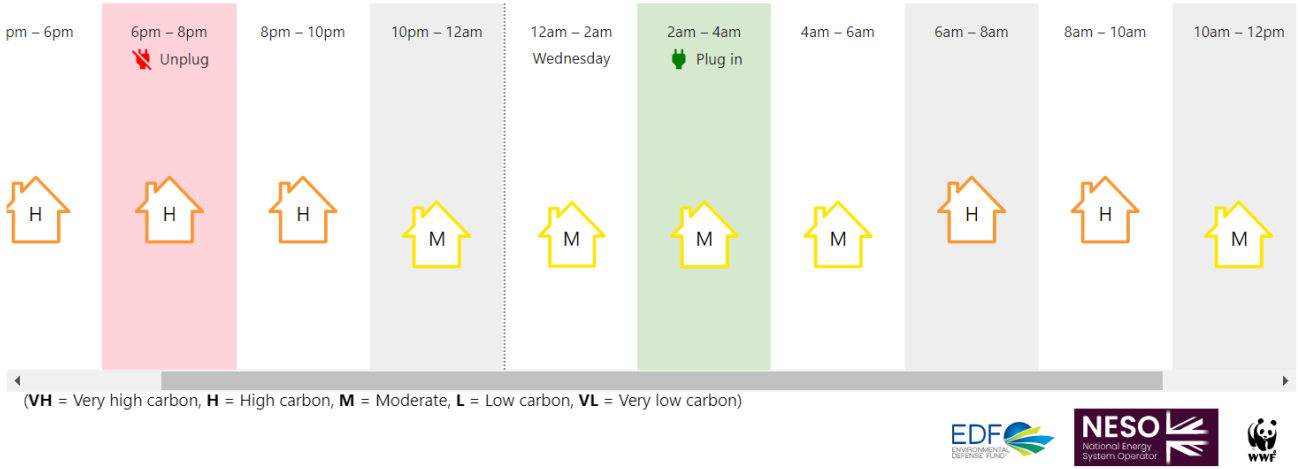
Financial Cost Forecasting

- **Imperial College London API**: Forecast energy costs (pence/kWh)
- Use forecasts to schedule tasks during low-cost periods.

Combining Carbon and Cost Forecasting with IRIS Bench UI

- Displays **runtime with carbon emissions, costs forecasts** for various times and regions (if possible)
- **GPU options with performance** for similar workloads
- (option for **automated scheduling)**



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Additional Carbon, Financial / Ethical Costs (Beyond Power)

- **Fixed Costs**: Includes initial purchase, maintenance, and infrastructure costs, depreciation value
- **Idle Costs**: Value lost when GPUs remain unused but still incur depreciation and infrastructure costs
- **Loss of potential research opportunity** (Idle Cost).
- **Embodied Carbon**: Emissions from GPU manufacturing and delivery.

$$\left(\frac{\text{time used}}{\text{lifetime}} \times \text{total fixed cost of running}\right) - \left(\frac{\text{time idle}}{\text{lifetime}} \times \text{cost of idle time}\right)$$

Want More Information?

- Explore the repo and documentation for detailed guidance.
- Review the IRIS Bench Report for more insights into project research, accuracy considerations, carbon and benchmarking considerations.

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Questions?

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Thank you

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