Project tile: Spatial Suitability for battery Infrastructure in Worcester County - Massachusetts.

1. **Goal : Identify feasible ground-based locations for battery energy storage systems (BESS).**

2. **Methodology**

The battery storage suitability analysis was conducted using a Multi-Criteria Evaluation (MCE) framework in QGIS. The goal was to identify spatially optimal locations for Battery Energy Storage Systems (BESS) based on accessibility, infrastructure proximity, and environmental constraints. The methodology consisted of four main stages: data preparation, spatial processing, scoring of criteria, and final suitability classification.

3. **Data Preparation**

All datasets were projected into a common coordinate reference system (e.g., EPSG:26986 – NAD83 / Massachusetts Mainland) to ensure spatial consistency. Spatial indexes were created for each layer to improve processing speed. The layers were clipped to the study area boundary to focus the analysis on the relevant geographic extent.

4. **Spatial Analysis Steps**

Step 1 – Proximity to Roads

A distance-to-road raster or vector field was generated using QGIS' *Distance Matrix* or *Distance to Nearest Hub* tool. This identifies how accessible each candidate site is for construction, maintenance, and emergency response.

Step 2 – Proximity to Transmission Lines

Similarly, a distance-to-transmission-line field was generated to evaluate the feasibility of grid interconnection; one of the most important technical criteria for BESS installation.

Step 3 – Population Density Integration

Population density values were joined to the candidate sites to account for demand, energy consumption patterns, and potential benefits to local communities. Population density also captures the socio-economic relevance of placing storage infrastructure near areas where grid support may be most needed.

Step 4 – Scoring Using Multi-Criteria Evaluation (MCE)
Each factor was normalized into a 0–100 score using **scale_linear ()** in QGIS:

- Closer to roads → higher score
- Closer to transmission lines → higher score
- Higher population density → higher score

The general formula was:
score = scale_linear("distance_field", max_distance, min_distance, 0, 100)

Combined suitability was computed as the average:
suitability = ("score_road" + "score_transmission" + "pop_score") / 3

Step 5 – Reclassification into 5 Suitability Classes
The final suitability field was reclassified into: Very Low – Low – Moderate – High and Very High

Using Natural Breaks (Jenks) or Equal Interval classification.
percentage = (count_of_class / total_features) * 100

Step 6 – Percentage Calculation
The percentage of features in each suitability class was calculated as:
percentage = (count_of_class / total_features) * 100

5. RESULTS

Battery Storage Suitability Classes

Your battery storage suitability model distributes the study area into **five suitability classes**, each representing how favorable a location is for future battery energy storage system (BESS) placement. The percentage distribution is as follows:

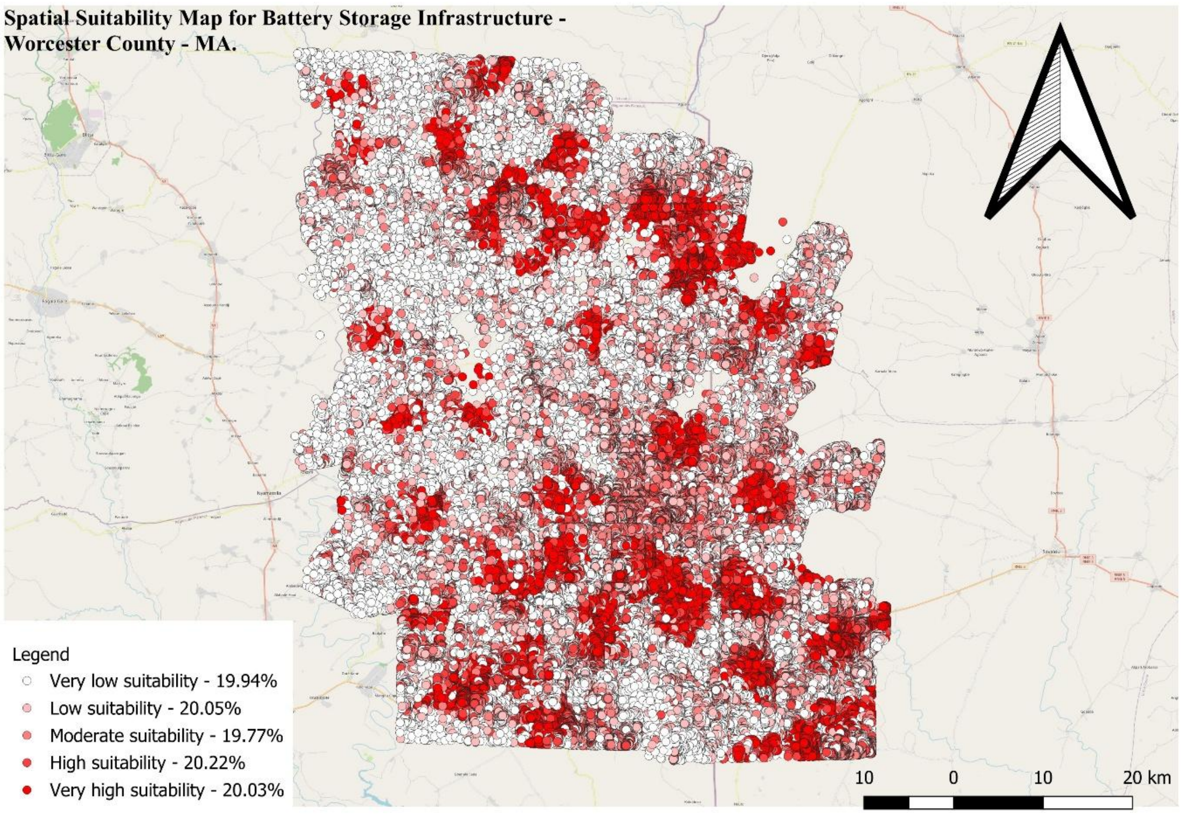

Figure 1- Battery Storay Suitability Map

Interpretation

5.1. Very Low Suitability – 19.94%

Approximately **20%** of the study area is characterized as **very low suitability**. These locations likely present one or more limiting conditions such as:

- large distance from transmission lines or roads
- limited access for construction
- low technical feasibility
- environmental or land-use restrictions

These areas should be **excluded from priority planning** unless future upgrades change local constraints.

5.2. Low Suitability – 20.05%

About 20% of the area falls into the low suitability range. These zones may have partial accessibility, but still lack favorable conditions for battery storage deployment. They represent secondary areas where BESS development is possible but not optimal.

5.3.Moderate Suitability – 19.77%

Nearly 19.8% of the territory exhibits moderate suitability. This class includes areas where most criteria are acceptable, but not strong. Moderate areas serve as flexible alternatives for expansion once high-suitability areas are utilized.

5.4.High Suitability – 20.22%

The highest share of land—20.22%—falls under the high suitability category. These locations generally meet most technical, environmental, and infrastructural criteria:

- relatively close to transmission lines
- road access suitable for equipment transport
- no major environmental constraints

This class contains strong candidate sites for near-term BESS development.

5.5.Very High Suitability – 20.03%

Approximately 20.03% of the study area is categorized as very highly suitable. These locations present the optimal combination of all factors, such as:

- minimal distance to the grid
- good access for construction and maintenance
- favorable land characteristics
- minimal exposure to flood hazards or environmental conflicts

These are the top-priority areas where battery storage infrastructure can be deployed with maximum technical, economic, and operational efficiency.

6. Conclusion

The distribution of suitability classes is remarkably balanced, with each class representing roughly 20% of the study area. This indicates that:

- The model treats all criteria evenly,
- Suitability varies smoothly across the landscape,
- There are sufficient high and very high suitability areas (40.25% combined) to support significant BESS deployment.

This balance also suggests that additional constraints (e.g., land cost, zoning, grid capacity) could further differentiate the highest-performing locations in a next phase.