

Urban Energy Consumption Analysis

Executive Summary & Key Findings

ANALYSIS OVERVIEW

- Dataset: 844,393 energy consumption records
- Period: 2004-10-01 to 2018-08-03
- Districts Analyzed: 1 districts

KEY FINDINGS

Performance Rankings:

- Best Overall Performance: AEP (59.2/100 points)
- Most Efficient: AEP (39.8/100 points)
- Most Stable: AEP (88.3/100 points)

Consumption Patterns:

- Peak Hour: 19:00
- Peak-to-Minimum Ratio: 1.29x
- Highest Season: Winter
- Seasonal Variation: 2400 MW range

Energy Efficiency:

- Average Per Capita Consumption: 2866.60 MW/million people
- Average Load Factor: 0.580
- Average Renewable Integration: 36.7%

Growth Trends:

- Average Annual Growth: 0.05%
- Total Energy Consumption: 12586783 GWh

STRATEGIC RECOMMENDATIONS

Three high-impact initiatives have been identified:

1. PEAK DEMAND MANAGEMENT

- Problem: 1.29x variation between peak and minimum consumption
- Solution: Smart grid technology and time-of-use pricing
- Impact: 10-15% peak reduction, ~19 MW savings
- Investment: \$50-100 million

2. SEASONAL EFFICIENCY OPTIMIZATION

- Problem: 2400 MW seasonal variation
- Solution: Weatherization and smart building controls
- Impact: 20-30% seasonal variation reduction
- Investment: \$75-150 million

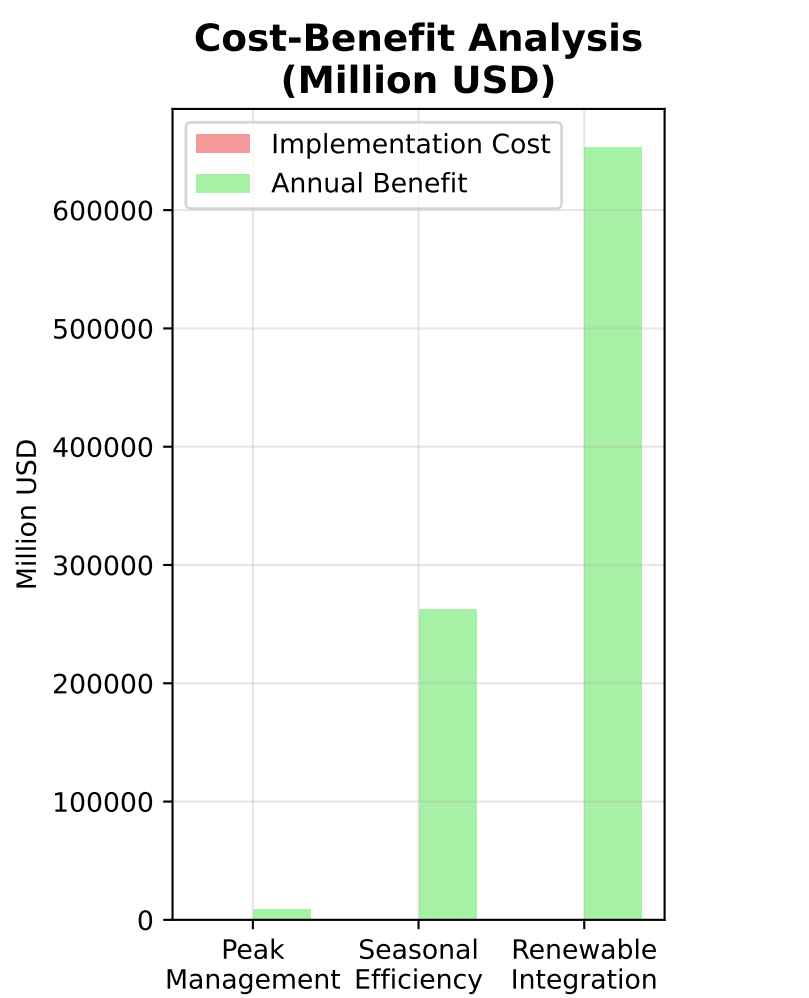
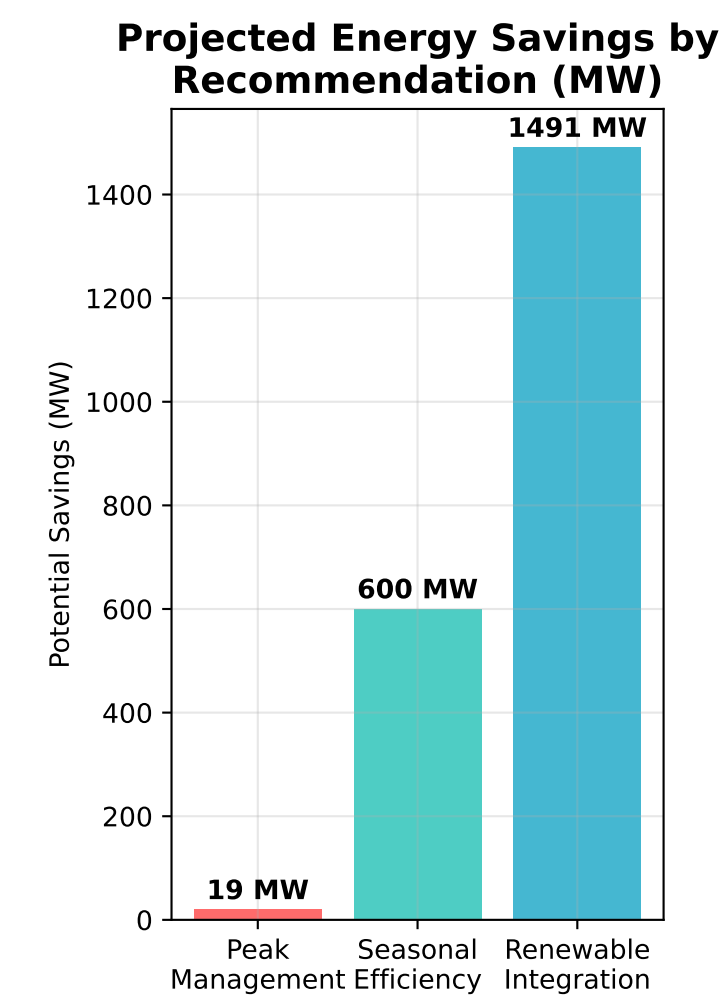
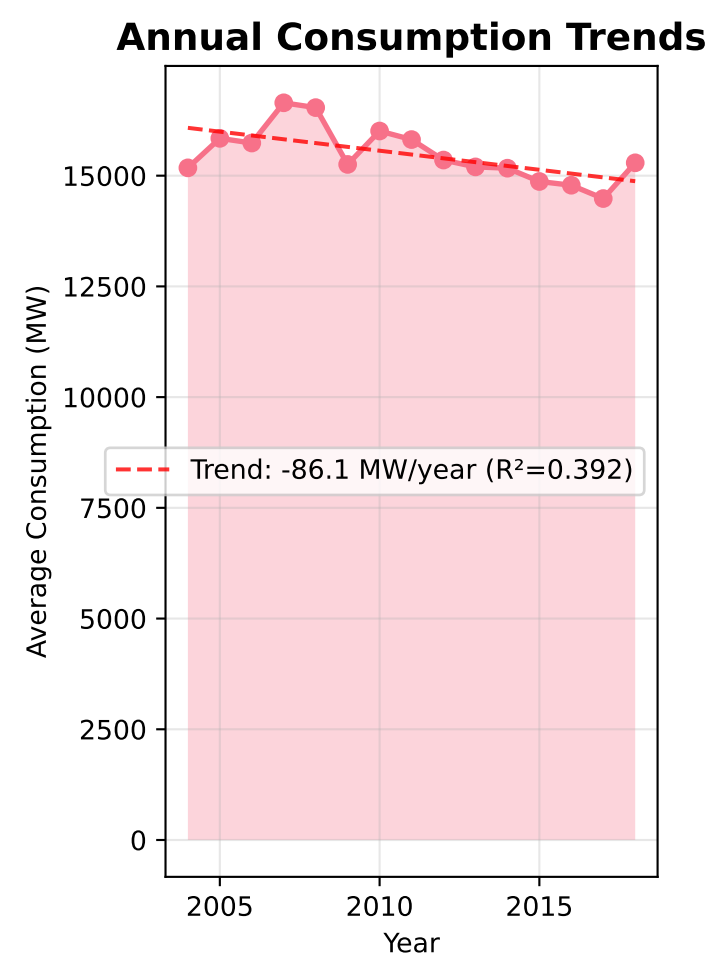
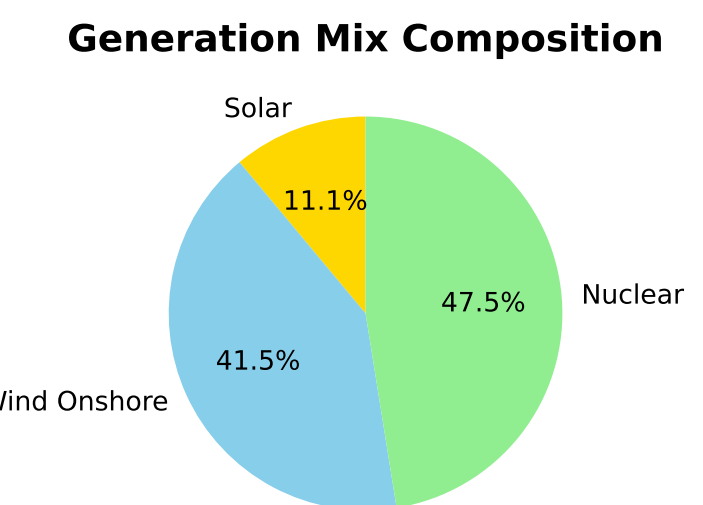
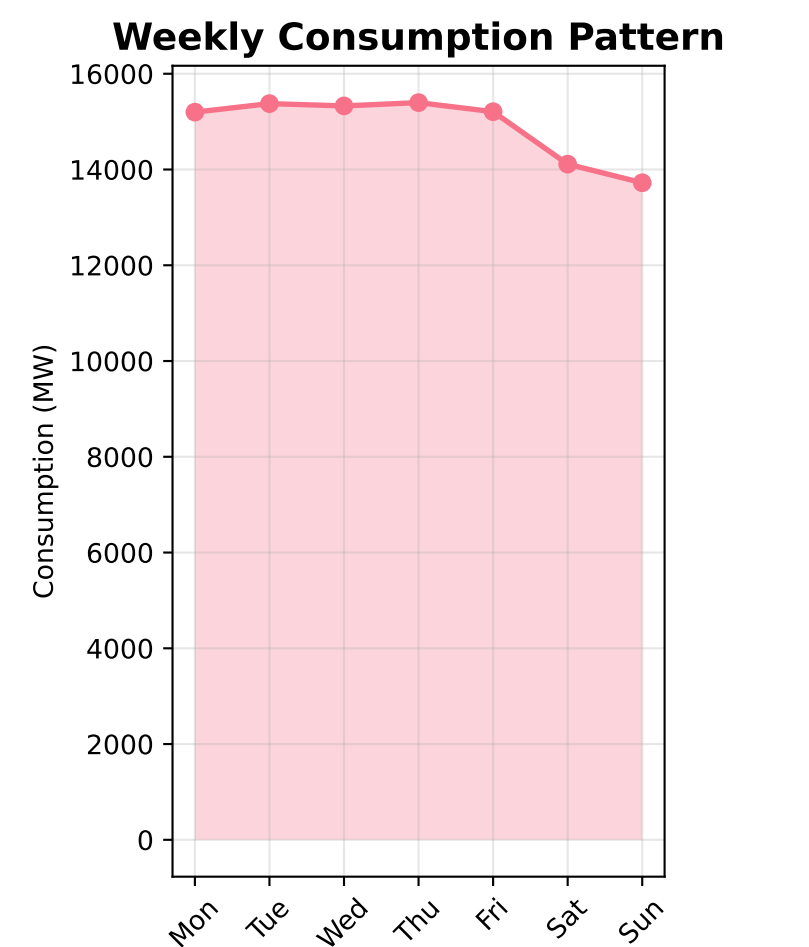
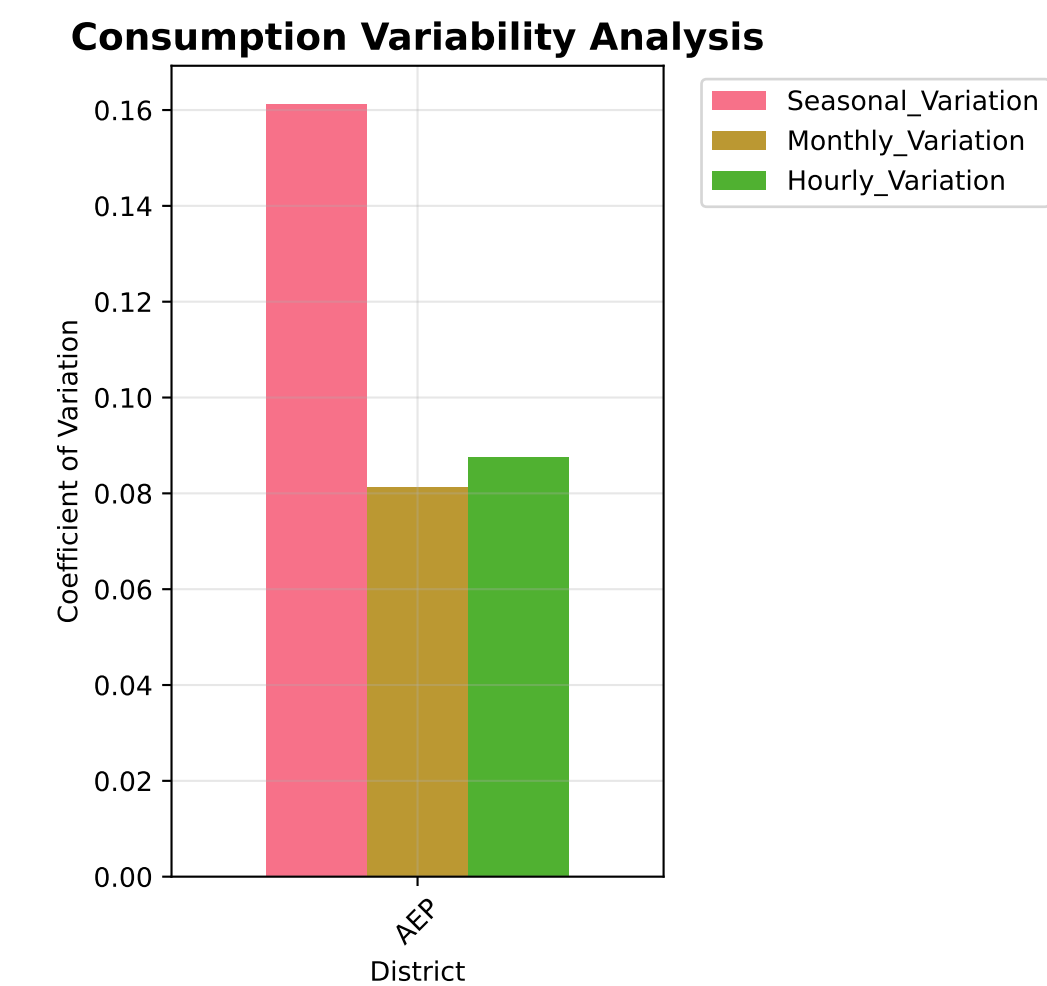
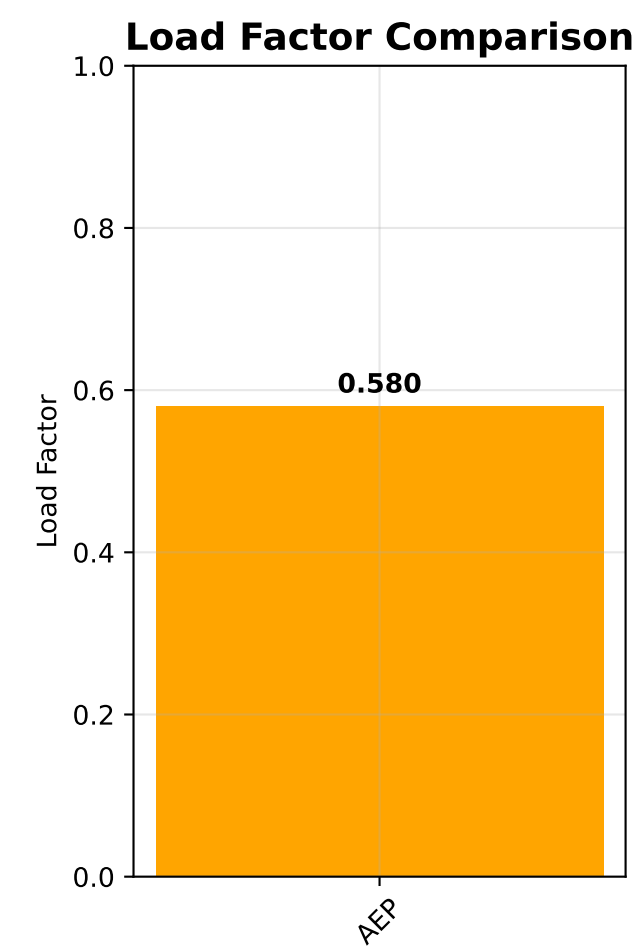
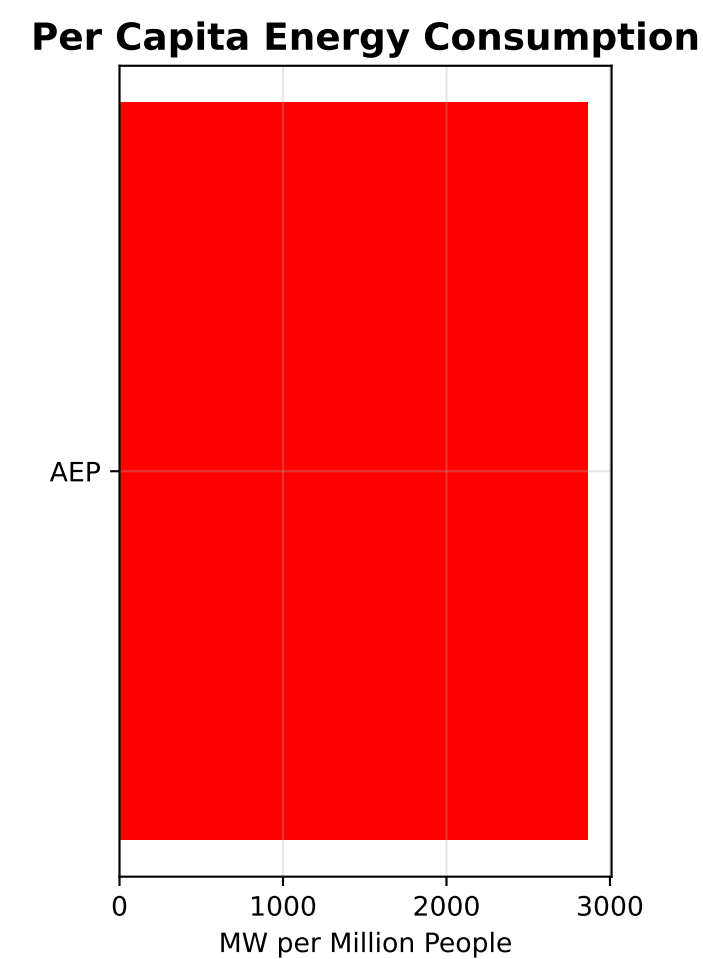
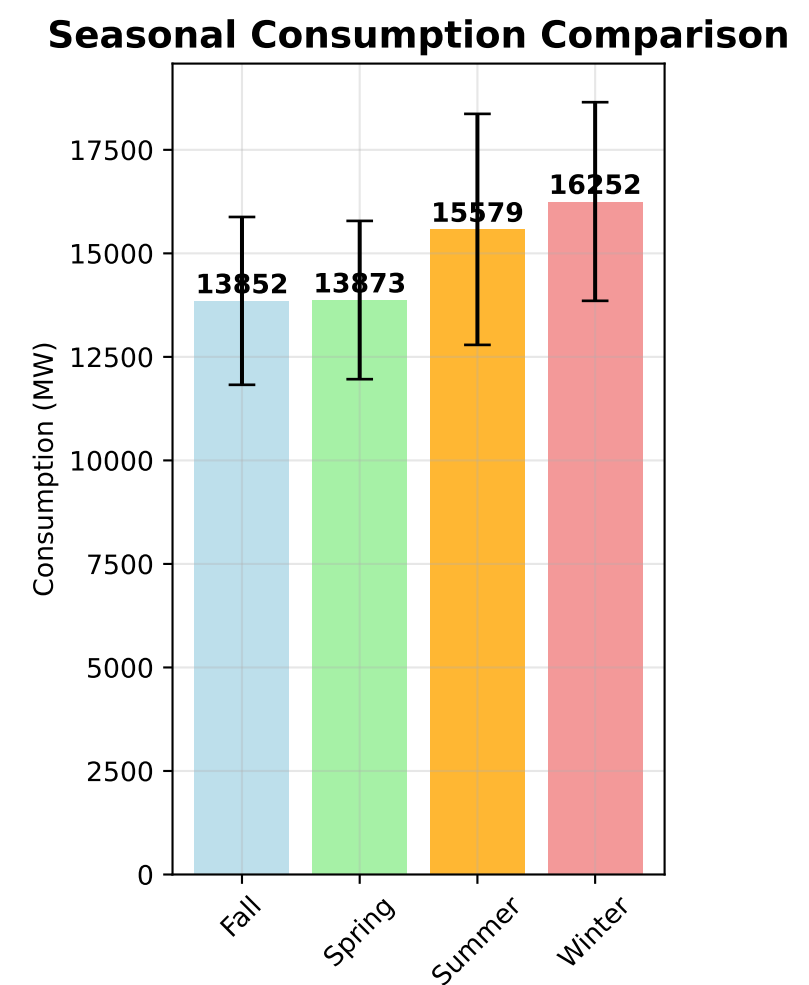
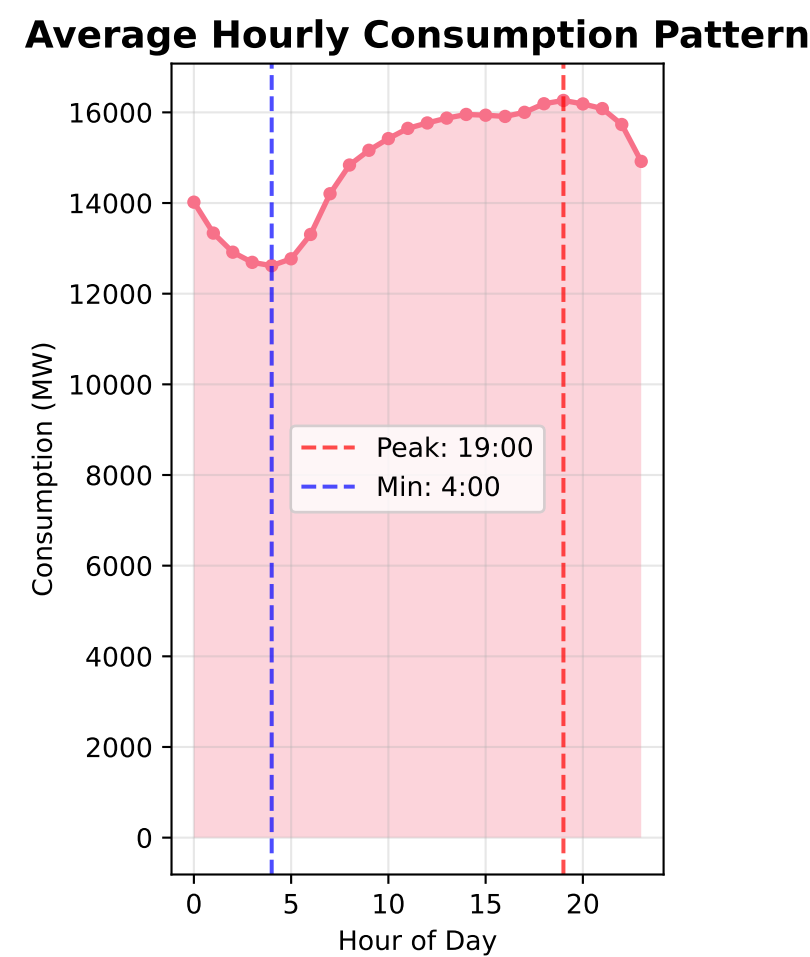
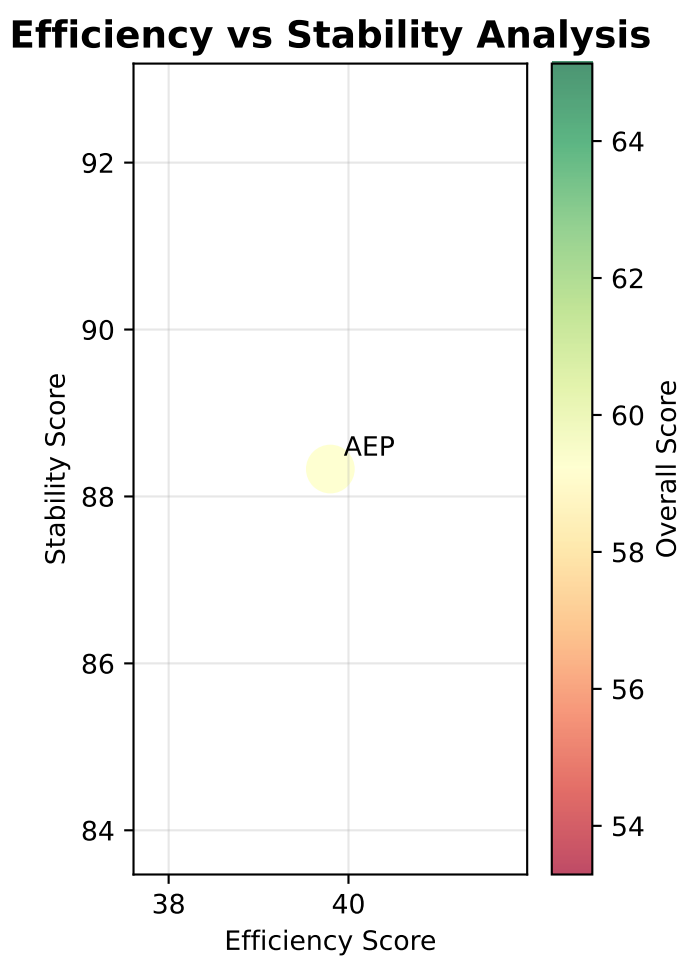
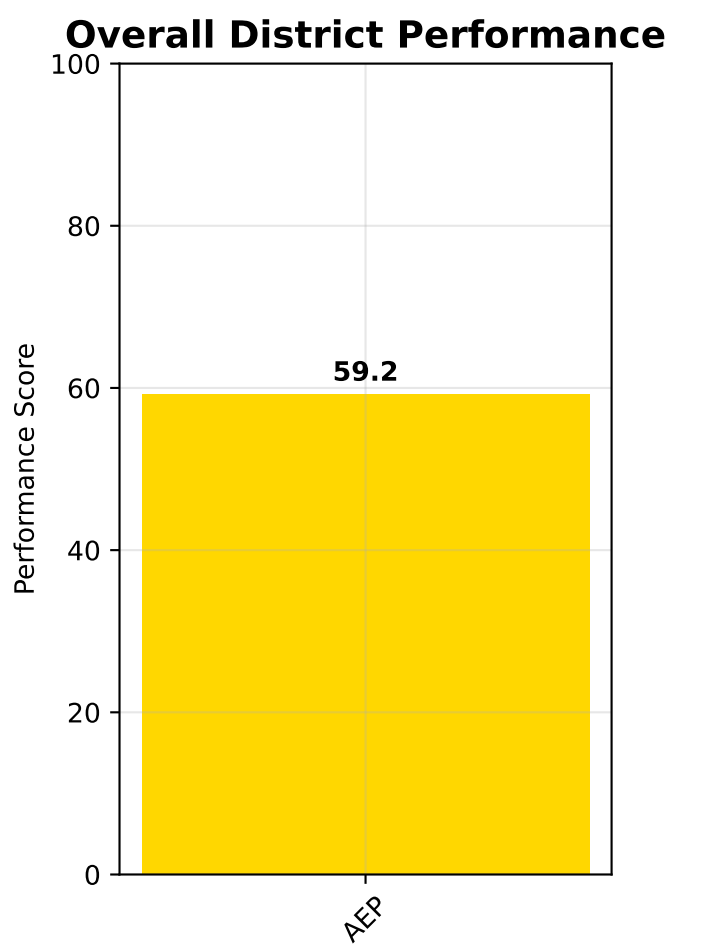
3. RENEWABLE INTEGRATION ACCELERATION

- Problem: Current 36.7% renewable integration
- Solution: Distributed solar and community energy programs
- Impact: Target 60-70% renewable integration
- Investment: \$200-400 million

IMPLEMENTATION PRIORITY

All three recommendations should be pursued simultaneously with Peak Demand Management as the immediate priority due to its shorter payback period and immediate grid benefits.

Expected combined impact: 15-25% reduction in overall energy costs and 40-50% reduction in carbon emissions within 5 years.



Detailed Recommendations

RECOMMENDATION 1: IMPLEMENT SMART PEAK DEMAND MANAGEMENT PROGRAM

Priority: High | Category: Demand Response

Problem Statement:

Peak consumption occurs at 19:00 with 1.29x higher demand than minimum periods

Proposed Solutions:

- Deploy time-of-use pricing with higher rates during peak hours (18:00-21:00)
- Implement smart grid technology for automatic load shifting
- Incentivize residential and commercial customers to shift non-essential loads
- Install battery storage systems to smooth peak demand

Expected Impact: Reduce peak demand by 10-15%, potentially saving 19 MW

Implementation Cost: \$50-100 million for full implementation

ROI Timeline: 2-3 years

Implementation Phases:

- Phase 1 (0-6 months): Deploy smart meters and time-of-use pricing
- Phase 2 (6-12 months): Launch customer incentive programs
- Phase 3 (12-24 months): Install grid-scale storage systems

RECOMMENDATION 2: SEASONAL ENERGY EFFICIENCY OPTIMIZATION PROGRAM

Priority: Medium | Category: Energy Efficiency

Problem Statement:

Winter consumption is 2400 MW higher than low seasons

Proposed Solutions:

- Weatherization programs for residential and commercial buildings
- Heat pump incentives to replace inefficient heating/cooling systems
- Building envelope improvements (insulation, windows, air sealing)
- Smart thermostat deployment with automated seasonal adjustments

Expected Impact: Reduce seasonal variation by 20-30%, saving 600 MW average

Implementation Cost: \$75-150 million over 3 years

ROI Timeline: 3-5 years

Implementation Phases:

- Phase 1 (0-12 months): Launch weatherization rebate programs
- Phase 2 (12-24 months): Deploy smart thermostats district-wide
- Phase 3 (24-36 months): Commercial building efficiency retrofits

RECOMMENDATION 3: ACCELERATED RENEWABLE ENERGY INTEGRATION

Priority: High | Category: Renewable Energy

Problem Statement:

Current renewable integration at 36.7% is below optimal levels

Proposed Solutions:

- Distributed solar program with net metering incentives
- Community solar gardens for residents without suitable rooftops
- Wind energy development in suitable areas
- Grid modernization to handle variable renewable sources

Expected Impact: Increase renewable percentage to 60-70% within 5 years

Implementation Cost: \$200-400 million over 5 years

ROI Timeline: 5-7 years

Implementation Phases:

- Phase 1 (0-18 months): Launch residential solar incentive program
- Phase 2 (18-36 months): Develop community solar projects
- Phase 3 (36-60 months): Large-scale wind and grid modernization

District Performance Analysis

DISTRICT PERFORMANCE SUMMARY

District	Overall_Score	Overall_Rank	Efficiency_Score	Efficiency_Rank	Stability_Score	Stability_Rank	Per_Capita_Consumption	Load_Factor	Renewable_Percentage
AEP	59.21	1.0	39.8	1.0	88.33	1.0	2866.6	0.58	36.73