Electri-City: Energy Management in Public Buildings

Better Buildings Case Competition

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Background of Competition

- **Better Buildings Challenge**
  - **20% more energy efficient by 2020**
- **Provide case studies**
  - **Compete with other teams from various universities**
  - **Find innovative ways of making buildings more energy efficient**
- **Our case study:**
  - **Redesign energy management systems for mid-sized cities**
  - **Target only public buildings**

Deeper into Case Study

Innovative energy efficient investments within cities can be challenging to implement

Causes:

- **Lack of funding and support**
- **Misconception that energy efficient projects are risky investments with little return.**

Deeper into Case Study (cont'd)

To reduce excessive energy consumption, cities must realize their authority over:

- **Planning**
- **purchasing power**
- **the ability to not only motivate their local communities, but also their local markets through reducing energy usage, *starting with public buildings.***

Problem Definition

Design a measurable, sustainable, and replicable energy data tracking and management strategy to achieve reductions in energy consumption within a medium sized city.

Design Requirements

- **The following are required for effective implementation of design:**
  - **Stay within local budget**
  - **Abide by regulations of local government**
  - **Macroscale Solutions to Energy Efficiency in Public Buildings**
  - **Microscale Analysis: Simulation of Howard H. Mackey Building, School of Architecture and Design at Howard University**

Design Requirements (cont'd)

- **Identify key roles and responsibilities across city organization**
- **Discuss how building energy data will be collected and used**
- **Discuss how energy efficiency projects will be discovered, prioritized, and financed**
- **Discuss how to incentivize operations and maintenance staff**

Current Status of Art

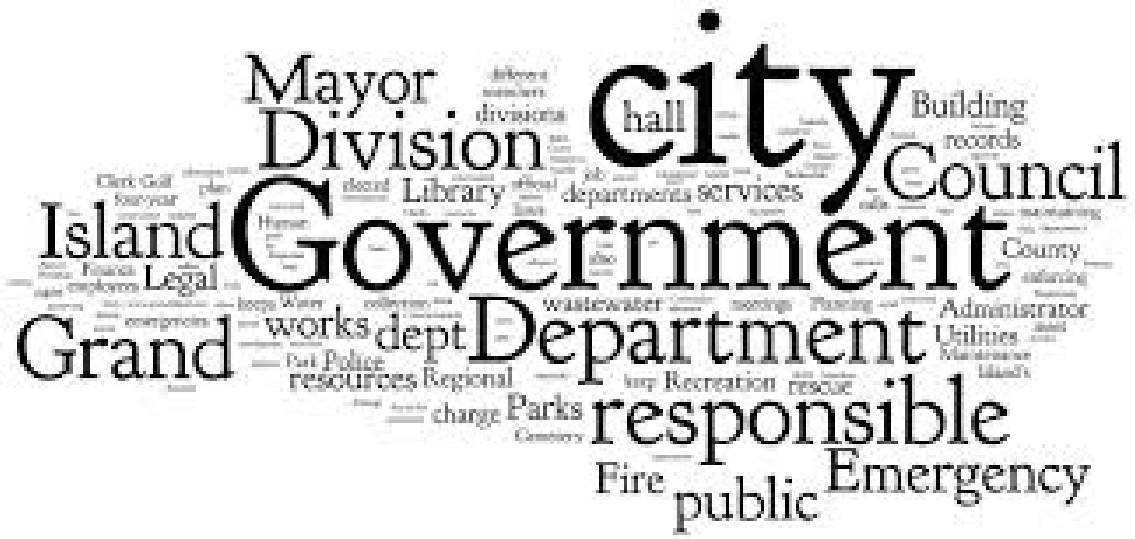
- **There are several aspects that need to address the current status of art:**
  - **Funding**
  - **Government**
  - **Community**

Funding

- **How will these projects get paid for?**
  - **Jackson, Wyoming: Voter passed tax of $3.7 million to fund energy efficiency in public buildings**
  - **Babylon, New York & Pendleton, Washington: Invest Local Government funding & Replenished with renewable and energy savings**
  - **Boulder, Colorado: Voter passed Carbon Tax, $1.8 million on electricity consumption to fund CAP & Energy Efficiency Program**
  - **Bainbridge Island, Washington: Credit Union to finance Energy Efficiency Loan Program**

Government

- **What regulations are followed?**
  - **Plano, Texas: Energy standards for Public Buildings**
  - **Municipally-run Gainesville Regional Utilities (Florida): Implemented feed-in tariff for solar power, making it a world leader in per capita solar installations**

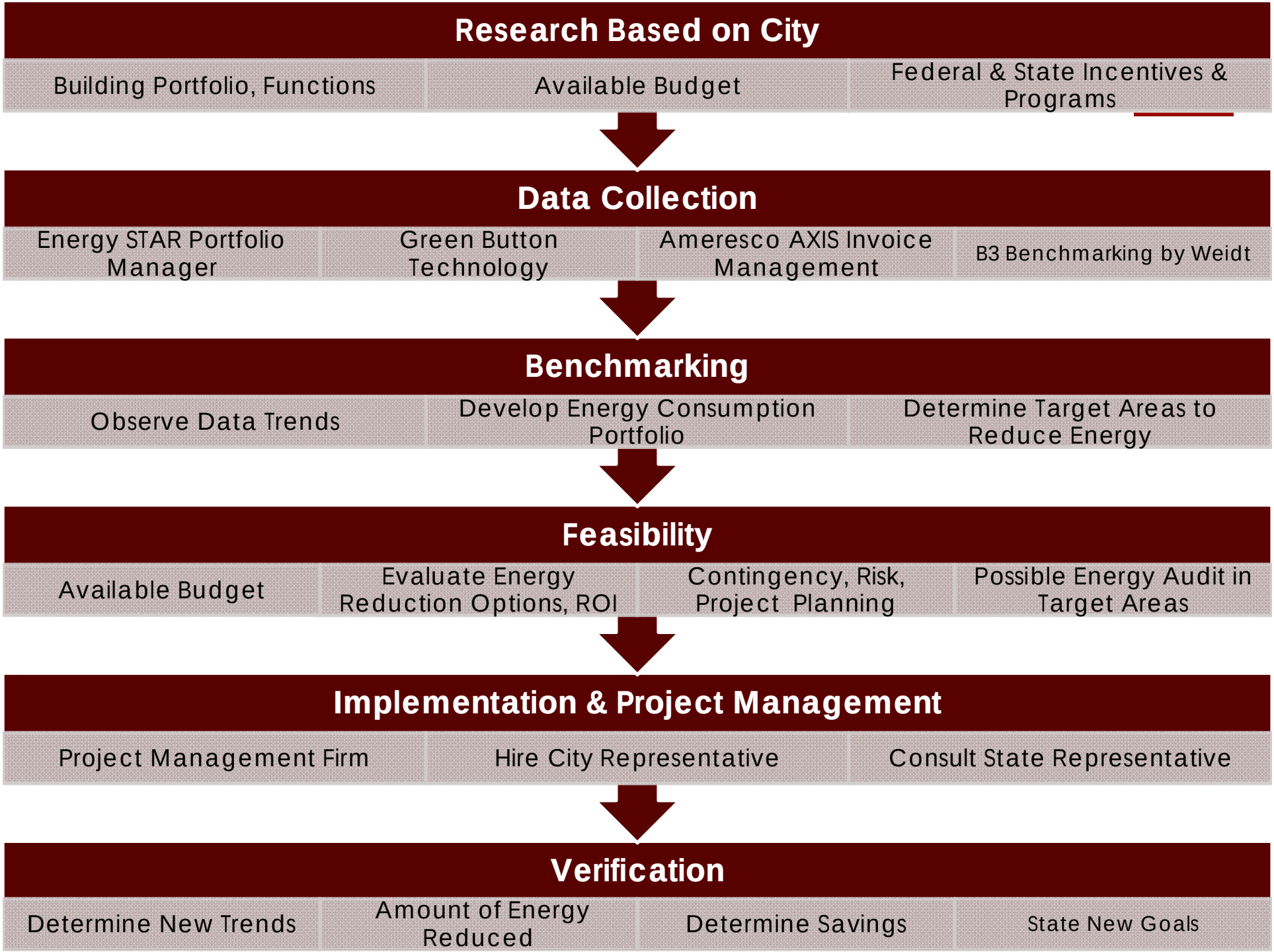


Community

- **How can everyone get involved?**
  - **Salt Lake City, Utah: Social marketing and community networking to promote energy behavior change**
  - **Oberlin, Ohio: Collaboration with educational institutions to develop curricula on energy efficiency and clean energy topics**

Energy Reduction Flow Chart (Solution Approach)

- **The following slide display flow chart**


Research Based on City
Building Portfolio, Functions
Available Budget
Federal & State Incentives & Programs
Data Collection
Energy STAR Portfolio Manager
Green Button Technology
Ameresco AXIS Invoice Management
B3 Benchmarking by Weidt
Benchmarking
Observe Data Trends
Develop Energy Consumption Portfolio
Determine Target Areas to Reduce Energy
Feasibility
Available Budget
Evaluate Energy Reduction Options, ROI
Contingency, Risk, Project Planning
Possible Energy Audit in Target Areas
Implementation & Project Management
Project Management Firm
Hire City Representative
Consult State Representative
Verification
Determine New Trends
Amount of Energy Reduced
Determine Savings
State New Goals

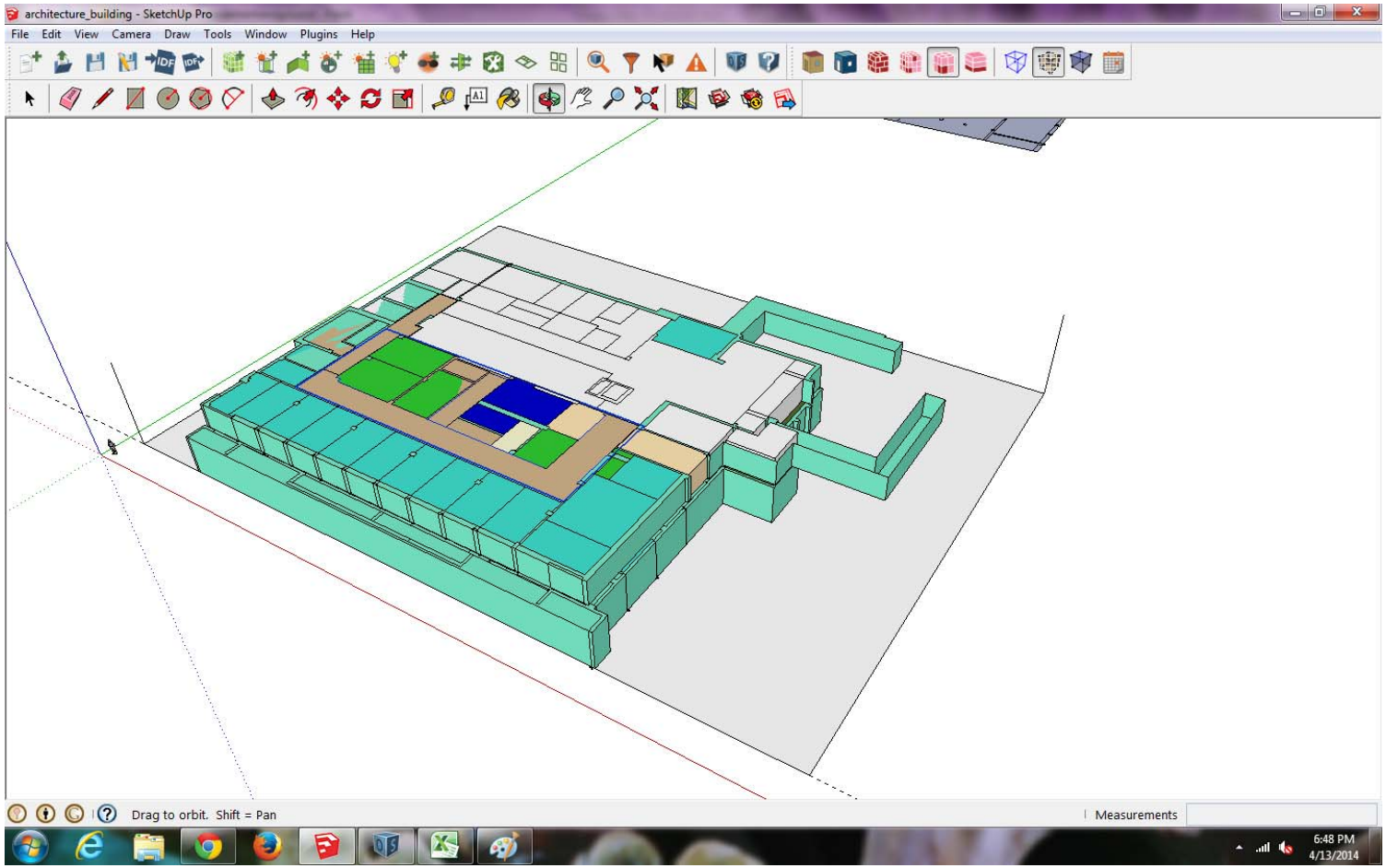
- Building Portfolio
- Available Budget
- Federal, State, and Private Incentive & Rebate Programs

- Energy STAR Portfolio Manager
- Green Button Technology
- B3 Benchmarking developed by Weidt
- Ameresco AXIS Invoice Management
- Johnson Controls Energy Monitoring Software

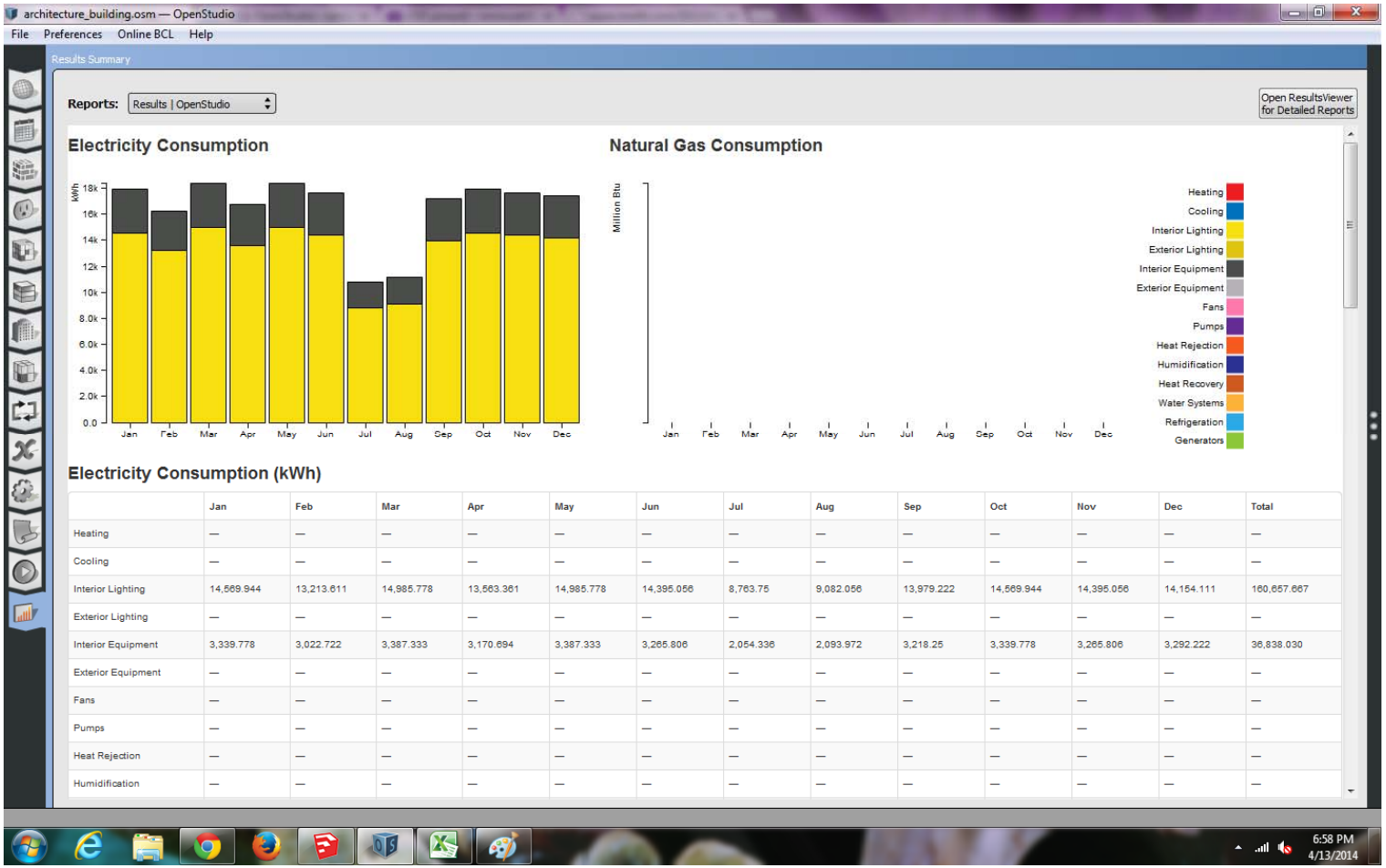
Mackey Data Collection

- Evaluate Energy Performance based on Standard Metric
- Observe Data Trends
  - Seasonally, Hourly, Monthly
- Benchmarking Policies and Programs
- Develop Energy Consumption Portfolio
- Determine Target Areas to Reduce Energy

Energy Consumption Portfolio



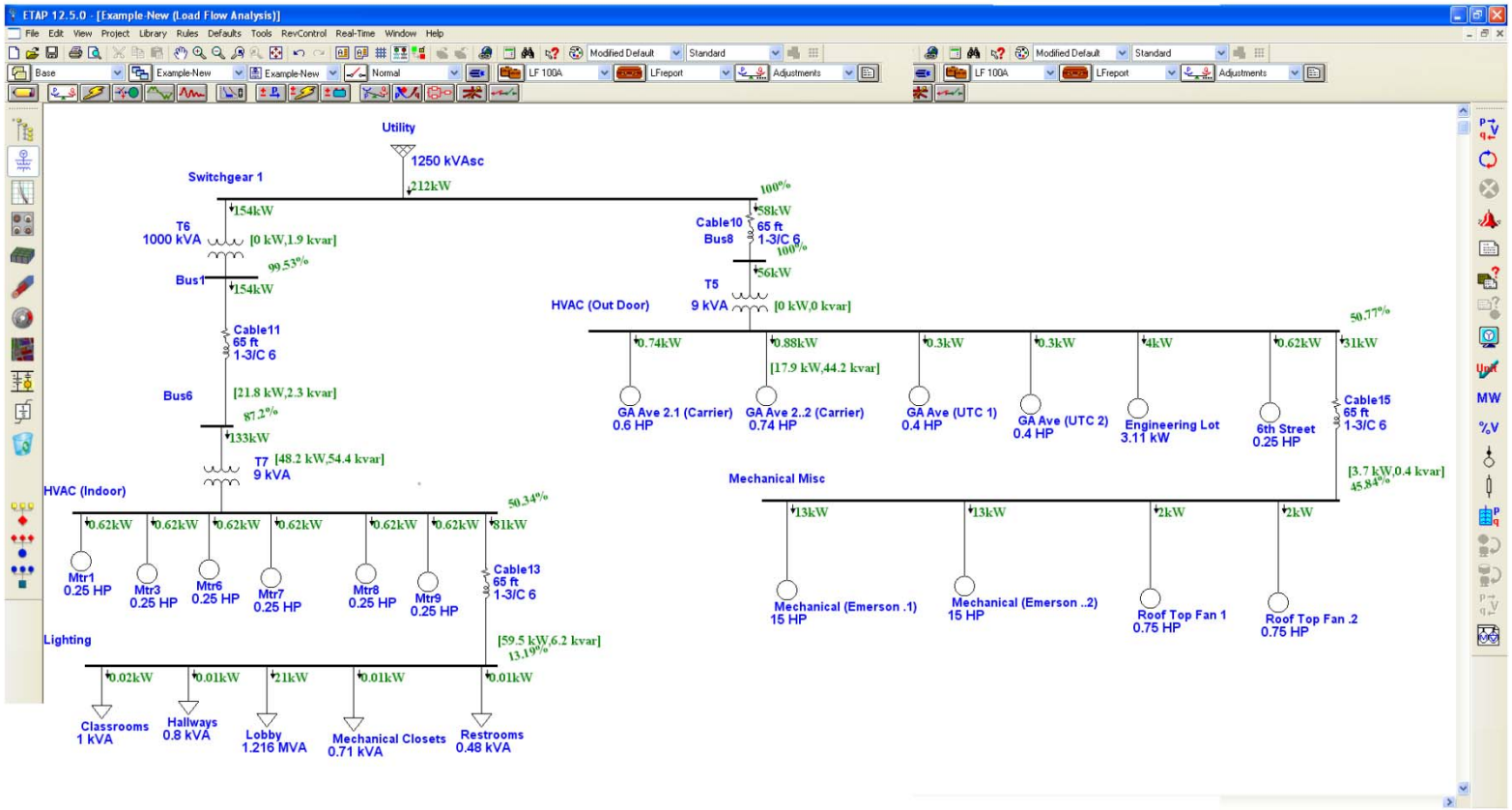
Energy Consumption Portfolio



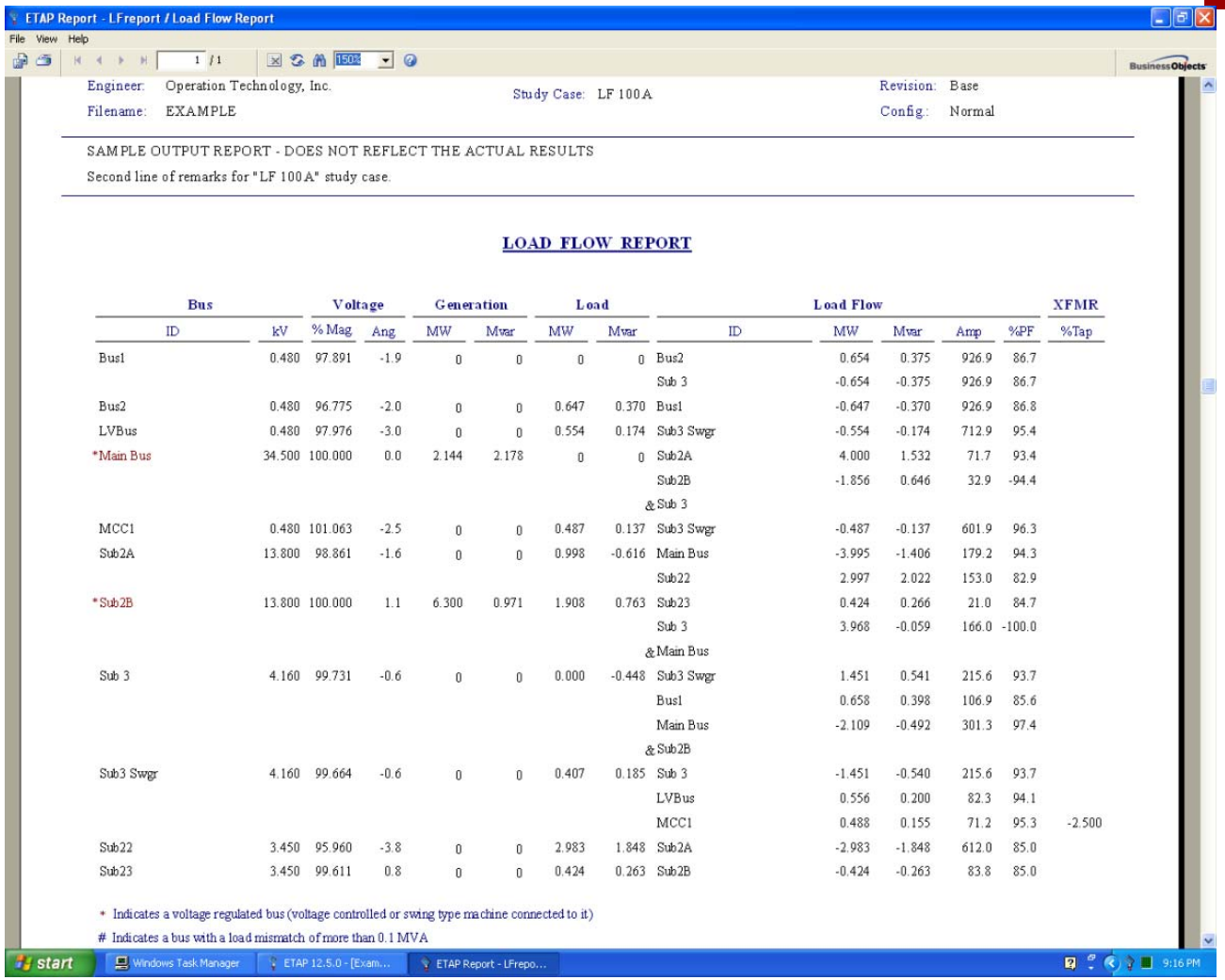
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Heating	—	—	—	—	—	—	—	—	—	—	—	—	—
Cooling	—	—	—	—	—	—	—	—	—	—	—	—	—
Interior Lighting	14,569.944	13,213.611	14,985.778	13,563.361	14,985.778	14,395.056	8,763.75	9,082.056	13,979.222	14,569.944	14,395.056	14,154.111	160,657.667
Exterior Lighting	—	—	—	—	—	—	—	—	—	—	—	—	—
Interior Equipment	3,339.778	3,022.722	3,387.333	3,170.694	3,387.333	3,265.806	2,054.336	2,093.972	3,218.25	3,339.778	3,265.806	3,292.222	36,838.030
Exterior Equipment	—	—	—	—	—	—	—	—	—	—	—	—	—
Fans	—	—	—	—	—	—	—	—	—	—	—	—	—
Pumps	—	—	—	—	—	—	—	—	—	—	—	—	—
Heat Rejection	—	—	—	—	—	—	—	—	—	—	—	—	—
Humidification	—	—	—	—	—	—	—	—	—	—	—	—	—

- Available Budget and Cash Flow Analysis
- Evaluate Energy Reduction Options for Target Areas
- Return on Investment (ROI)
- Life Cycle Cost Analysis
- Contingency, Risk, Project Planning
- Energy Audits where necessary

Simulate Alternative Solution: Normal State



Simulate Alternative Solution: Normal State-Results



ETAP Report - LFreport / Load Flow Report

File View Help

Engineer: Operation Technology, Inc. Study Case: LF 100A Revision: Base

Filename: EXAMPLE Config.: Normal

SAMPLE OUTPUT REPORT - DOES NOT REFLECT THE ACTUAL RESULTS

Second line of remarks for "LF 100A" study case.

LOAD FLOW REPORT

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	% Mag	Ang	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF	%Tap
Bus1	0.480	97.891	-1.9	0	0	0	0	Bus2	0.654	0.375	926.9	86.7	
								Sub 3	-0.654	-0.375	926.9	86.7	
Bus2	0.480	96.775	-2.0	0	0	0.647	0.370	Bus1	-0.647	-0.370	926.9	86.8	
LVBus	0.480	97.976	-3.0	0	0	0.554	0.174	Sub3 Swgr	-0.554	-0.174	712.9	95.4	
*Main Bus	34.500	100.000	0.0	2.144	2.178	0	0	Sub2A	4.000	1.532	71.7	93.4	
								Sub2B	-1.856	0.646	32.9	-94.4	
								& Sub 3					
MCC1	0.480	101.063	-2.5	0	0	0.487	0.137	Sub3 Swgr	-0.487	-0.137	601.9	96.3	
Sub2A	13.800	98.861	-1.6	0	0	0.998	-0.616	Main Bus	-3.995	-1.406	179.2	94.3	
								Sub22	2.997	2.022	153.0	82.9	
*Sub2B	13.800	100.000	1.1	6.300	0.971	1.908	0.763	Sub23	0.424	0.266	21.0	84.7	
								Sub 3	3.968	-0.059	166.0	-100.0	
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Sub 3	4.160	99.731	-0.6	0	0	0.000	-0.448	Sub3 Swgr	1.451	0.541	215.6	93.7	
								Bus1	0.658	0.398	106.9	85.6	
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Sub3 Swgr	4.160	99.664	-0.6	0	0	0.407	0.185	Sub 3	-1.451	-0.540	215.6	93.7	
								LVBus	0.556	0.200	82.3	94.1	
								MCC1	0.488	0.155	71.2	95.3	-2.500
Sub22	3.450	95.960	-3.8	0	0	2.983	1.848	Sub2A	-2.983	-1.848	612.0	85.0	
Sub23	3.450	99.611	0.8	0	0	0.424	0.263	Sub2B	-0.424	-0.263	83.8	85.0	

* Indicates a voltage regulated bus (voltage controlled or swing type machine connected to it)

# Indicates a bus with a load mismatch of more than 0.1 MVA

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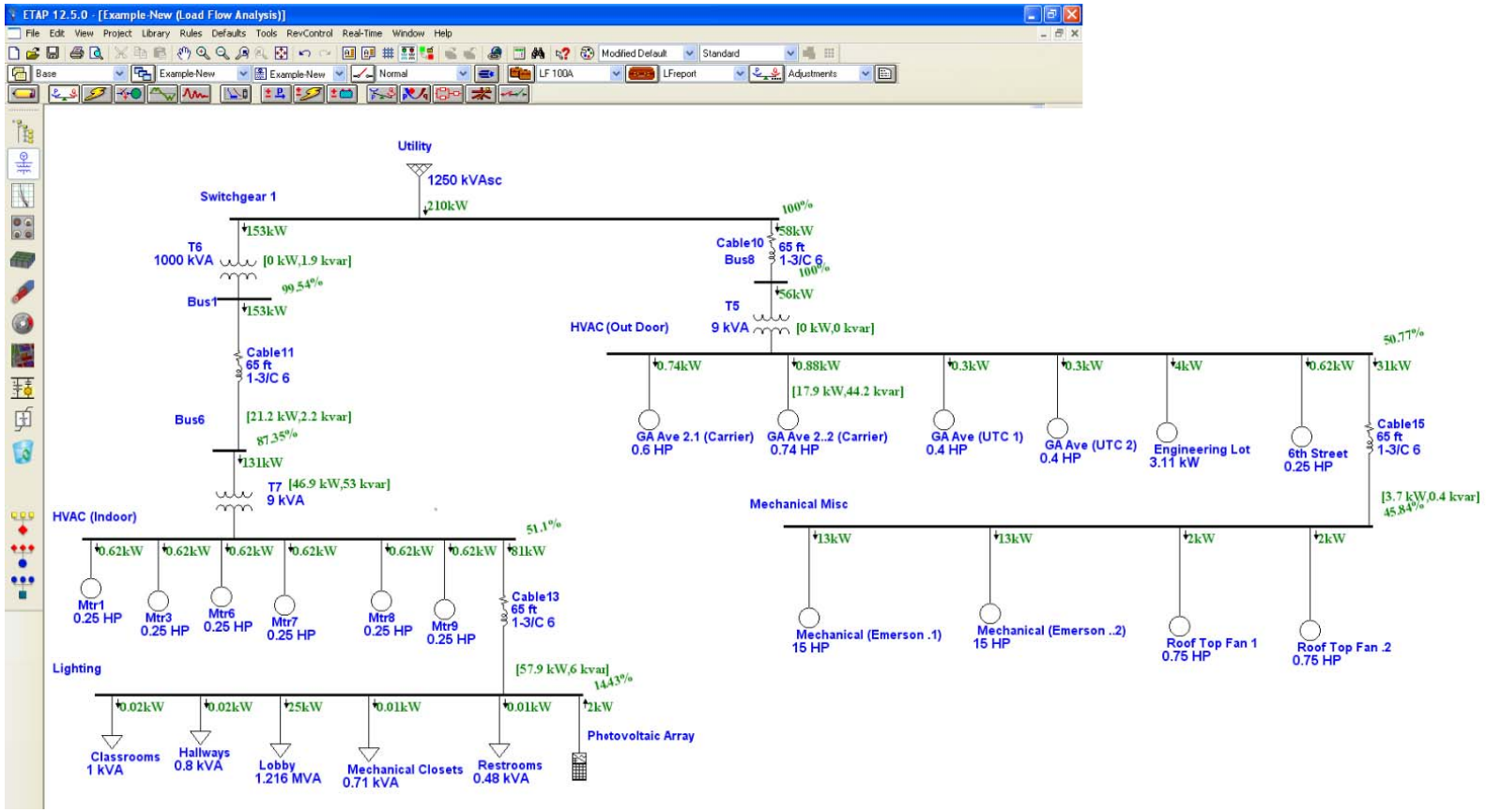
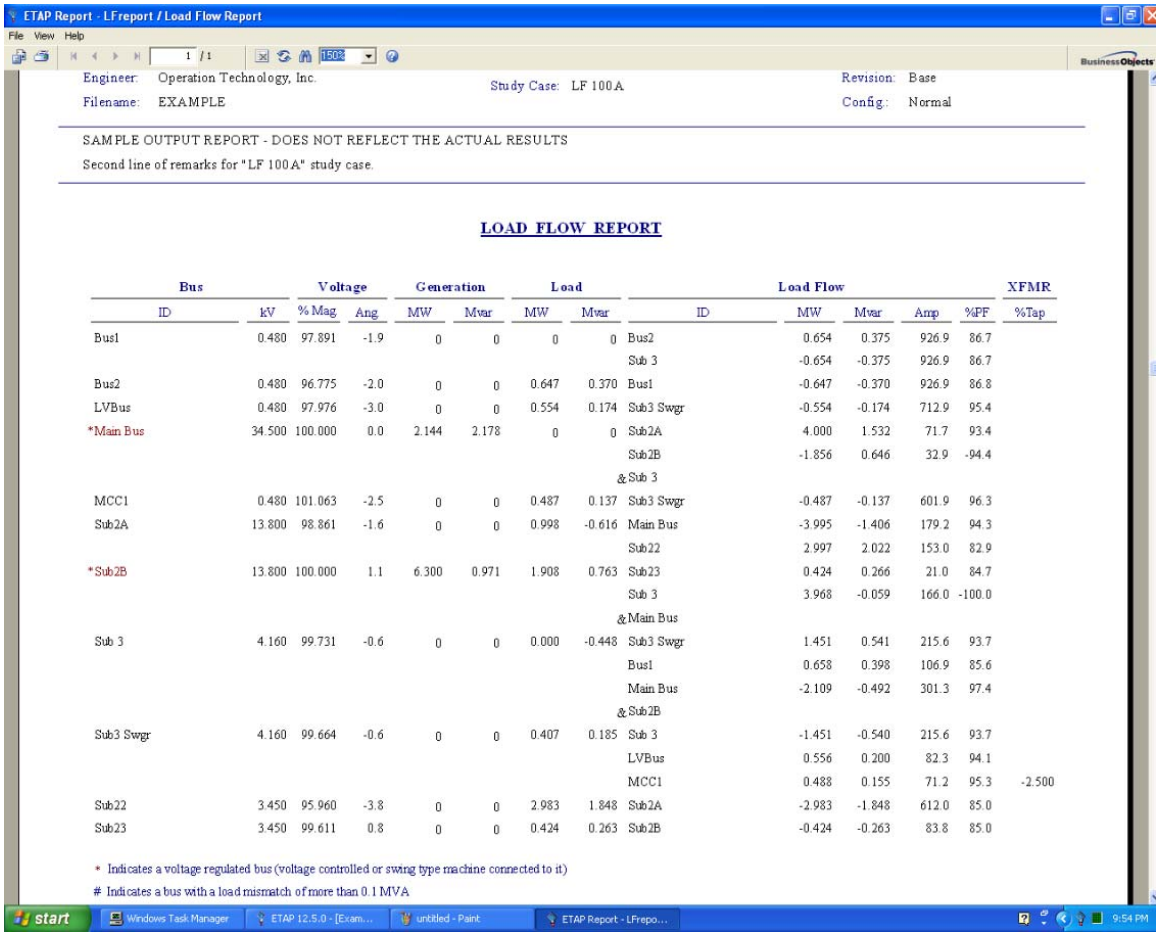
Simulate Alternative Solution: Renewable (15 solar panels)



Simulate Alternative Solution: Results



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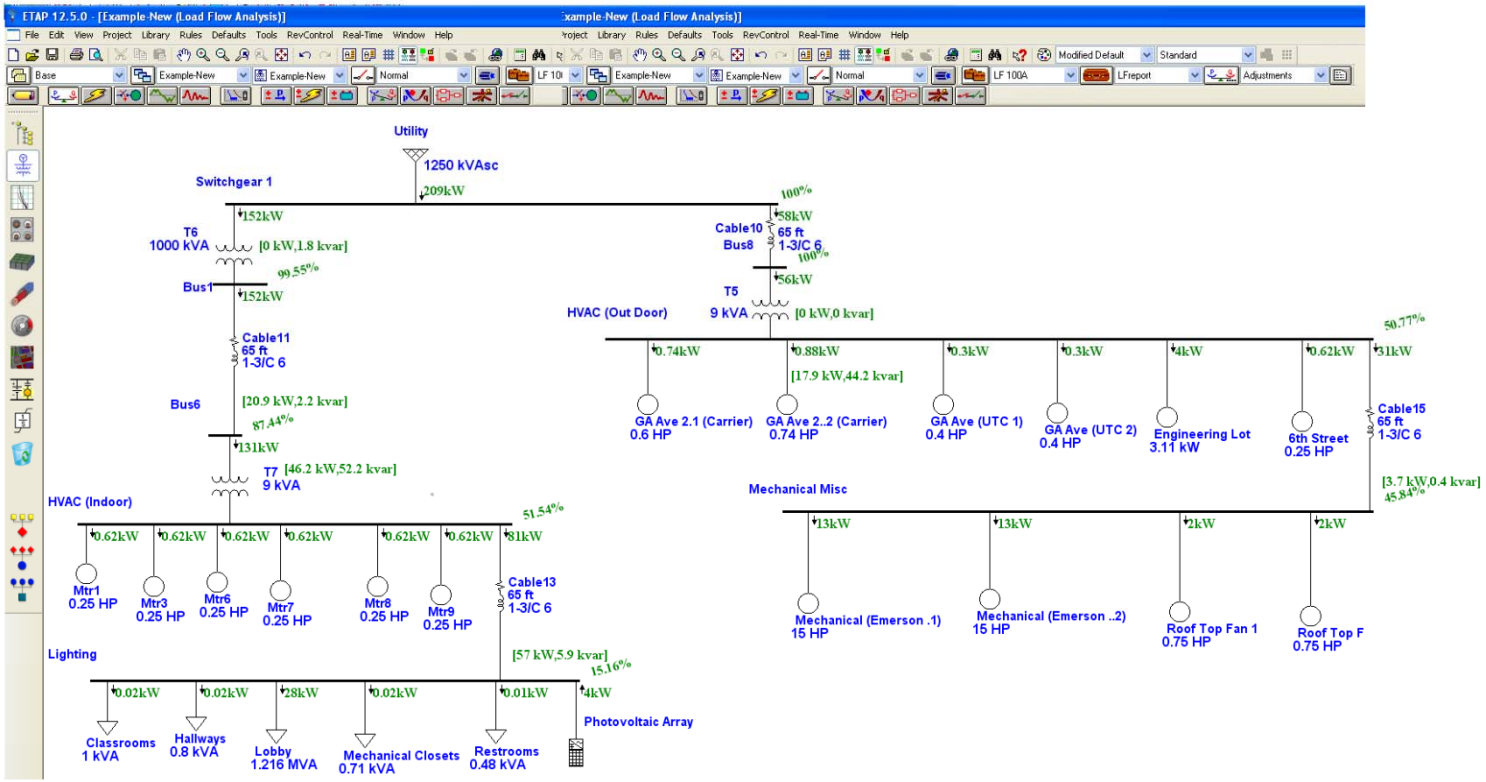
Simulate Alternative Solution: Renewable (25 solar panels)



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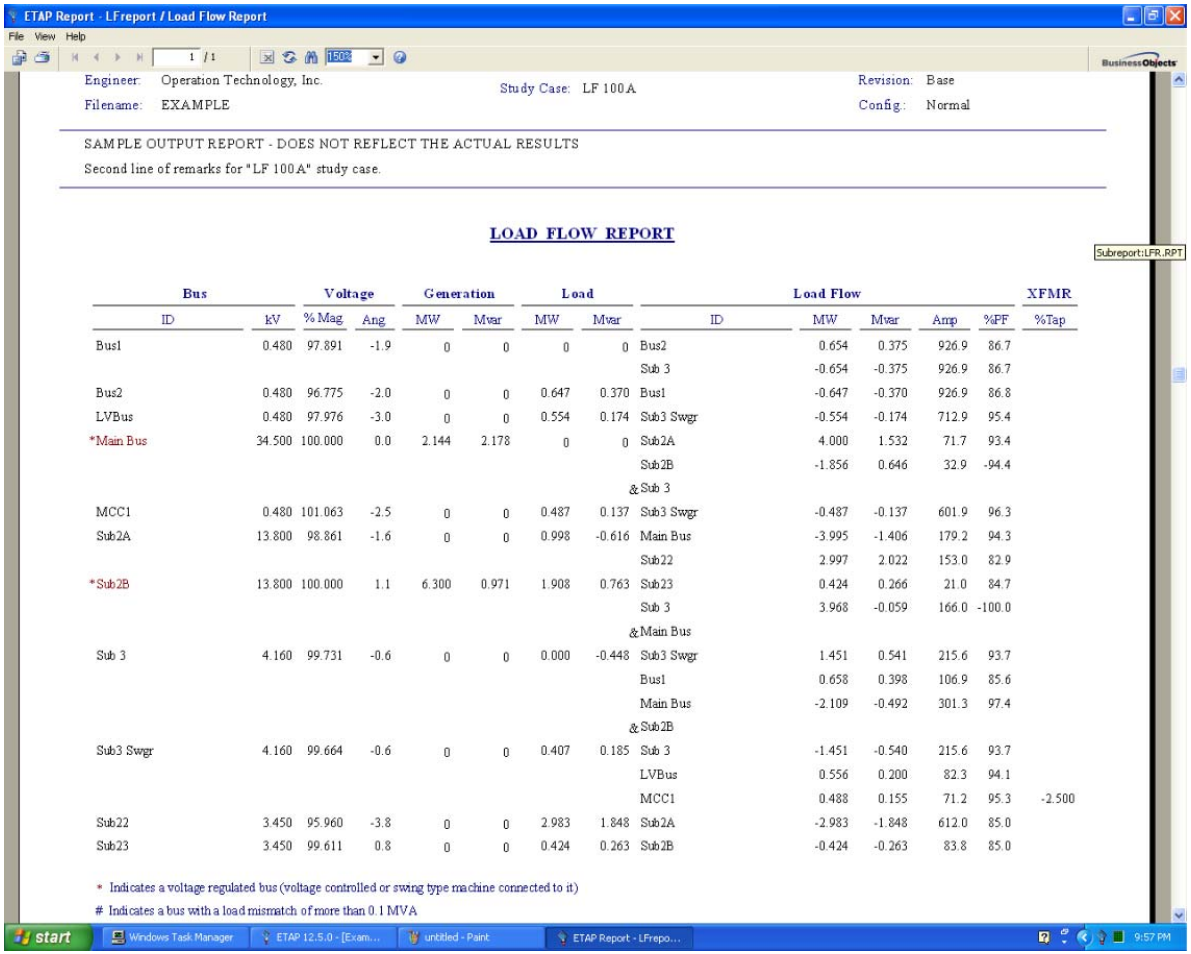

ETAP Report - LFreport / Load Flow Report

File View Help

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Subreport:LFR.RPT

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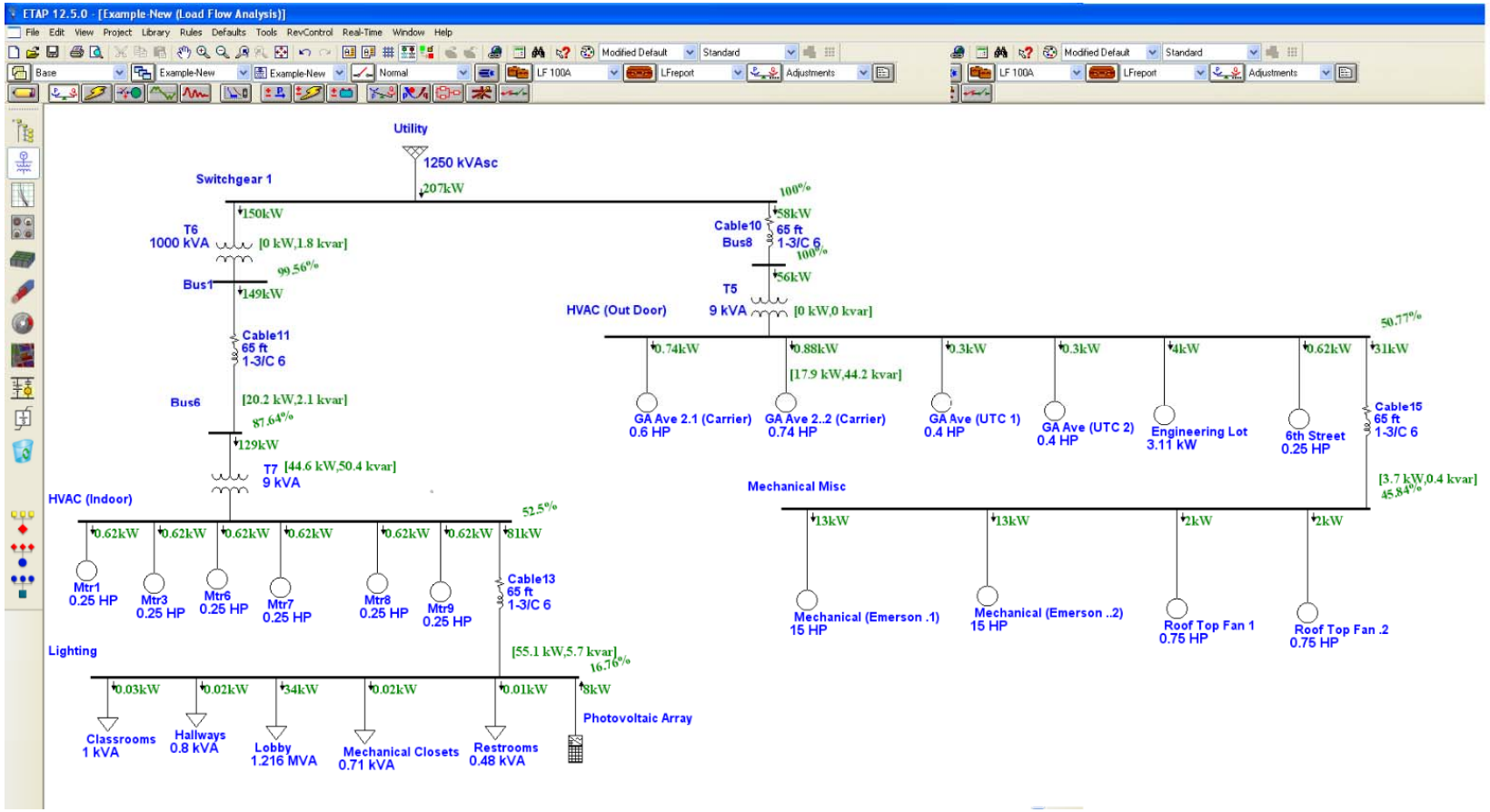
Simulate Alternative Solution: Renewable (50 solar panels)



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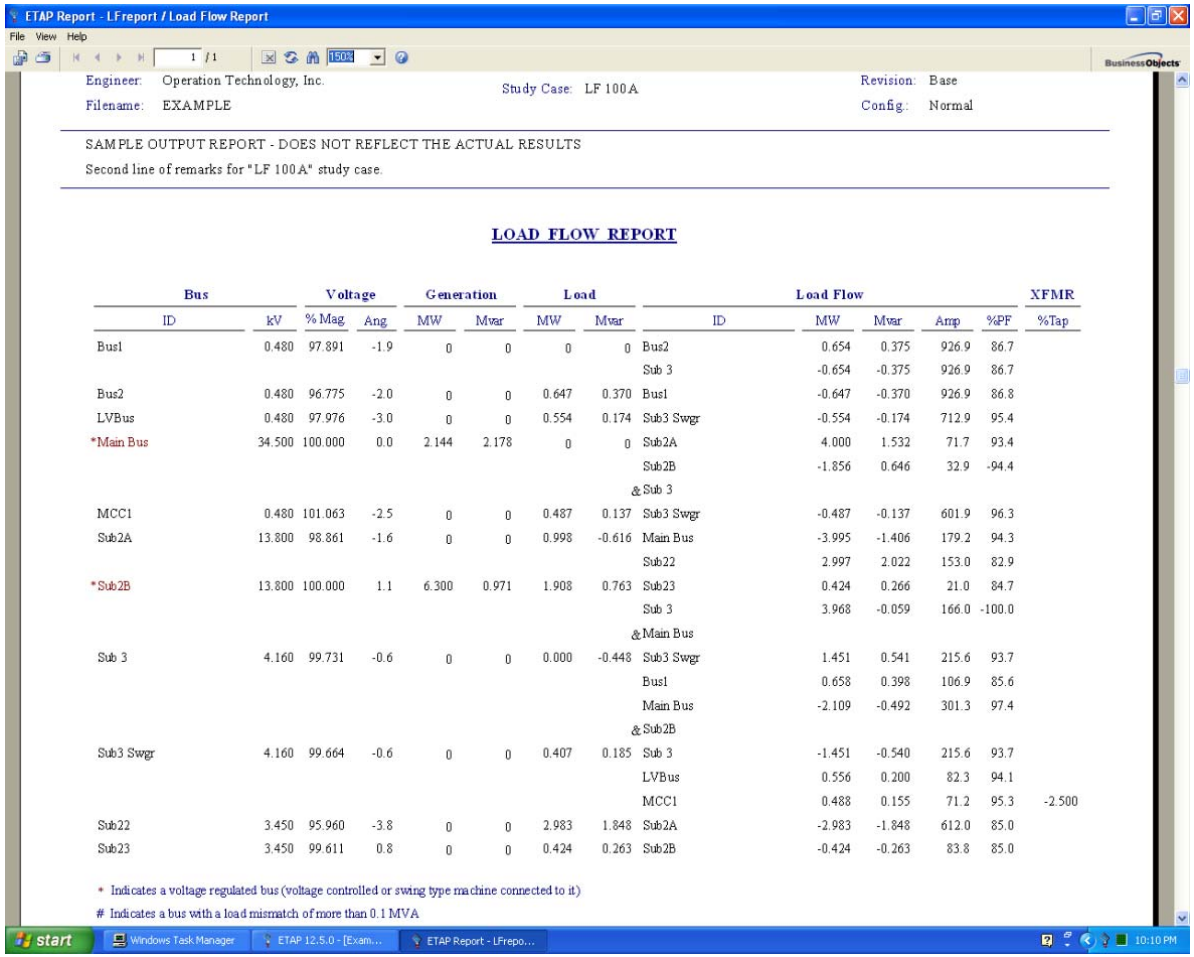

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- Firm Specializing in Project Management Services
- Hire City Representative
- Consult Representative from State Government

- Case Studies
  - Jones Lang LaSalle, Project development Services: Represents state of Michigan in Renovations of historic Cadillac Place; including payment structures, occupancy during construction, coordination among multiple parties, and tight budgets and timeframes.
  - CBRE, Public Institutions and Education Solutions Group: Represents State of Texas, including planning, construction management, and transaction representation.

- Continuation of Benchmarking process
  - New Trends
  - Energy savings
  - Financial Savings
  - Actual ROI compared to Scheduled ROI
- State Achievements & Determine Failures
- State New Goals based on new benchmarks
- Case Studies: Monitor and Document numerical data and compared with stated goals
  - Madison, Wisconsin
  - Bainbridge Island, Washington
  - Salt Lake City, Utah

The Future

- **Higher Property Valuation**
- **Tenant Satisfaction**
- **Reduced Maintenance Expenses**
- **Job Creation & Economic Development**
- **Increased City Budget**
- **Increase Awareness of Energy Efficiency**

Costs and Resources

Resource	Cost
Project Management Firm	$10,100
Solar Panel/Hot Water System	$115,000
Lighting Retrofit	$58,500-$87,000
Max Total	$212,100
ETAP	*Free*
SketchUp Pro 2013	*Free*

- **All costs represent upfront and installation costs.**
- **Students used ETAP and SketchUp as Project Management substitute at no additional cost.**
- **Prices reflect the cost of one building (Architecture Building)**
- **Funding will be provided by city (2% of budget)**

Conclusion

- **Utilization of this system will allow for sufficient data tracking**
  - **Data Consumption Portfolio**
  - **Observation of Data Trends**
- **Tracking data allows city to see where there is a need and appropriately analyze it**
  - **Use of SketchUp and ETAP**
- **Suggested energy alternatives are provided as solutions after analysis is complete**
  - **Use of solar panels**
  - **Lighting retrofit**

Thank You & Questions