San Diego Gas & Electric MicroGrid Performance Simulation

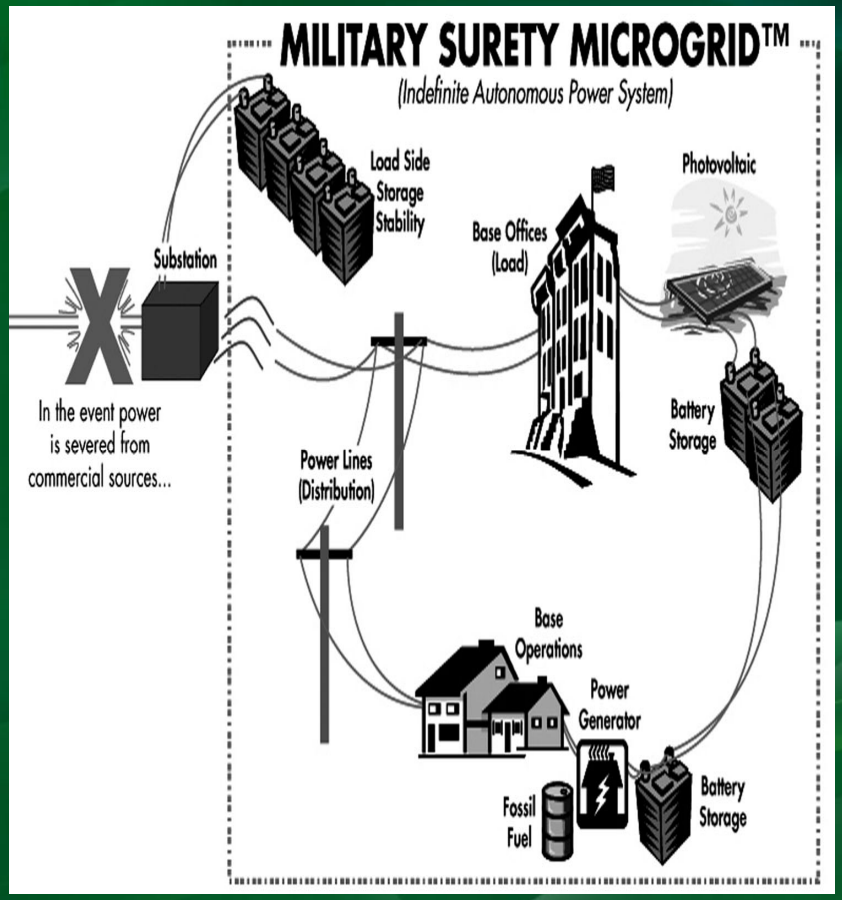
Team SMART

Christina Cheek
Mulugeta Damamo
D'Angelo Woods

Overview

- Background: What is Microgrid?
- Problem Formulation
  - Design Requirements
- Current Status of Art: What Can We Learn?
- Solution Approach
- Tasks and Project Management
- Deliverables
- Cost and Resources
- Conclusion

Background: What is a Microgrid?



- Modern, small-scale version of power grid
- Can generate, distribute, and regulate electricity to customers using RERs
- Can operate independently of power grid when/if necessary

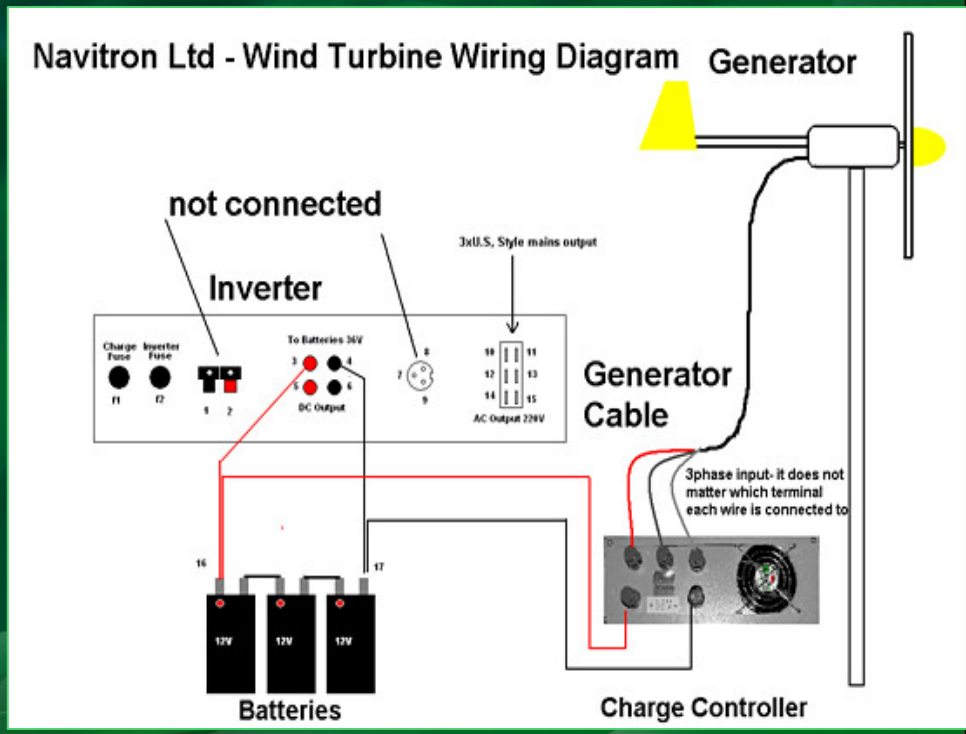
Source: http://www.sandia.gov/news/resources/releases/2006/microgrid.html

Problem Formulation

- Proof-of-Concept
  - Does the microgrid work?
  - How can it be modeled?
- Cost/Benefit Analysis
  - If concept works, how much will it cost to design and implement?
  - What are the benefits to SDG&E and its customers?
- Emissions Analysis
  - Can microgrid contribute to reduced emission?
  - How much emission (in tons) is produced by microgrid?

Problem Formulation: Example Mathematical Model

- Wind Turbine Modeling
  - ρ=air density
  - A-area
  - C_d=drag coefficient



$$P_d = \mathbf{F}_d \cdot \mathbf{v} = \frac{1}{2}\rho v^3 A C_d$$

Source: Woods, D. Renewable Energy and Influences of Climate Change

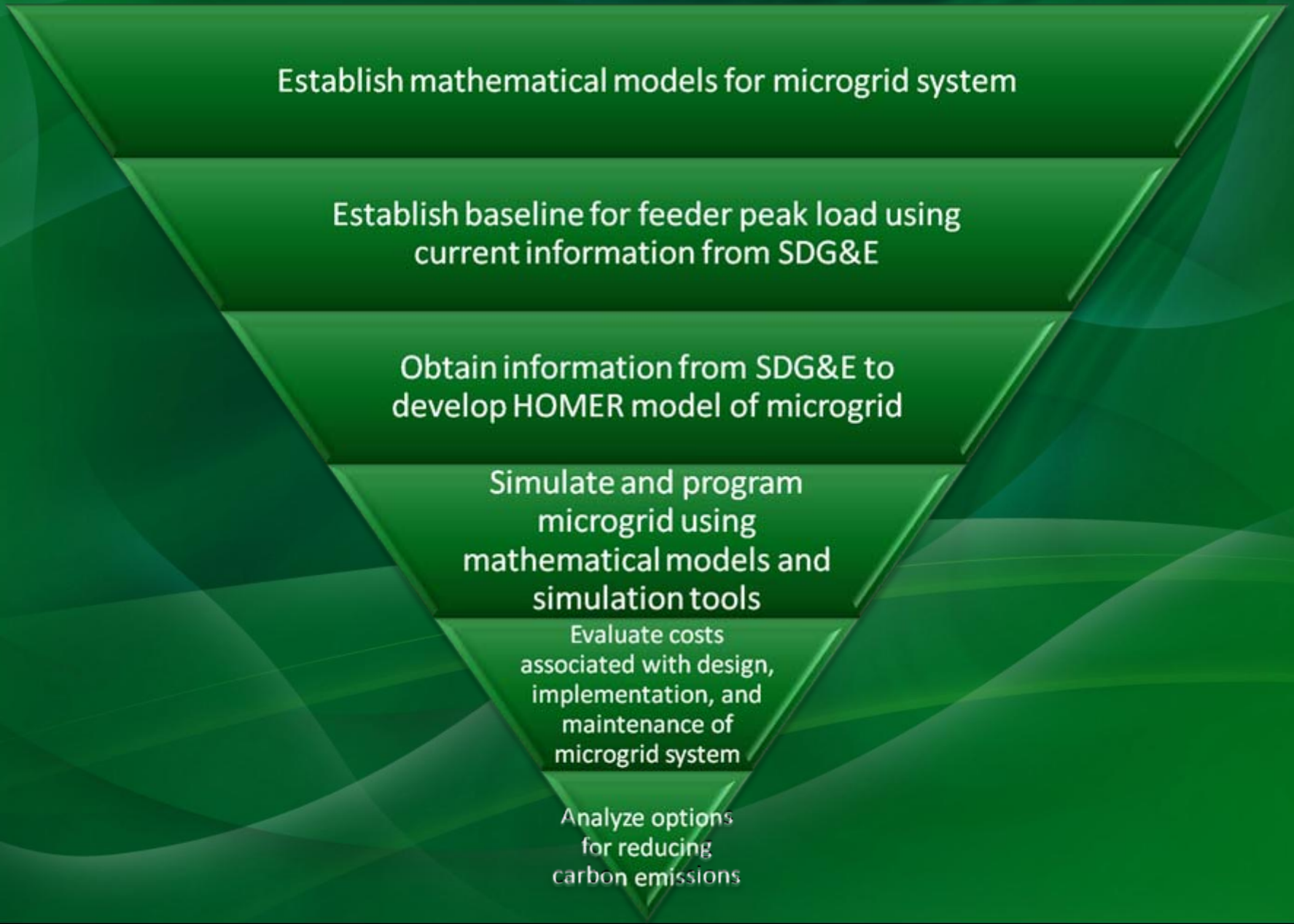
Design Requirements

- Constraints
  - More information will be provided from external advisor(s)
  - Minimize costs associated with design, implementation, and maintenance of microgrid system for customer and SDG&E
  - Achieve >15% reduction in feeder peak load
- Relevant Coursework
- Compliance/Regulations
  - Several on-going projects
  - IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems

Current Status of Art
What We Can Learn

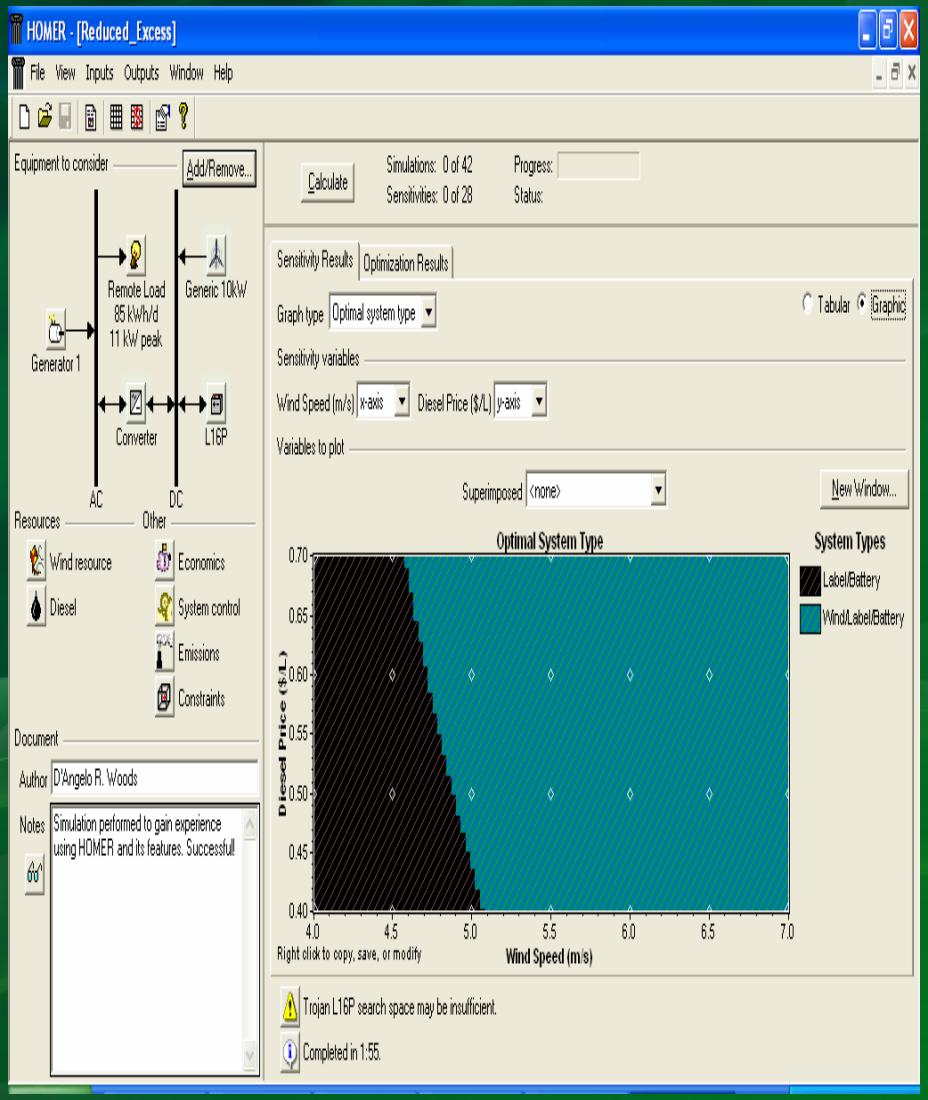
- CEC/DOE Energy Storage Collaboration
  - Energy Storage System that maintains electric grid stability during brief power system variations and momentary power interruptions
- CERTS Microgrid Test Bed Demonstration with AEP
  - Significantly reduce level of custom field engineering needed to operate microgrid consisting of small generating sources thus reducing associated costs
- SDG&E Beach Cities Microgrid Project
  - 3-year pilot scale “proof-of-concept” test in San Diego
  - Application of technologies that will improve security and reliability of electricity supply and lower costs to consumers

Solution Approach



Preliminary Schematic

- Simulated six designs
  - 2 Wind Turbines
  - 1 Diesel Generator
  - 1 Battery Quantity
  - 3 Converters
- Reduced excess electricity from 18% to 1.65%
- Sensitivity analysis: Variations in annual wind speed and diesel fuel prices affect optimal design



Task and Project Management

Team Assignments

- Christina Cheek will develop and prepare our mathematical models for simulations
- Mulugeta Damamo will perform our carbon emissions analysis
- D'Angelo Woods will obtain information from SDG&E for component specifications and to establish feeder peak load baseline
- All team members will conduct research of microgrid concept and use simulation tools to acquire data

Task and Project Management

- Proposal Presentation
  November 13, 2009
- Written Proposals: Version II
  November 18, 2009
- Final Proposals
  November 30, 2009
- Final Proposals, Team Evaluations, Peer Evaluations, Binder
  December 2, 2009
- Design Selection
  December 14, 2009
- Begin Simulation and Testing Phase
  January 18, 2010
- Final Design
  February 15, 2010
- Final Testing
  March 13, 2010

Deliverables

Deliverables

- Microgrid Model
- Report on Microgrid Operation Under Normal/Faulted Conditions
- Microsoft Excel Spreadsheet of Cost/Benefit Analysis
- Emissions Analysis Report

Cost and Resources

Matlab/Simulink Student Version	$99.00
Hybrid Optimization Model for Electric Renewables	$0.00
SimPowerSystems Toolbox	$59.00
Power Systems Analysis Toolbox	$0.00
Miscellaneous	$200.00
Total Cost	$358.00

Conclusion

- Why Microgrid Project?
- Benefits to SDG&E and Customers
- Next Steps for Team SMART

Source: http://certs.lbl.gov/certs-derkey-mgtb.html

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Questions?