ESS Peer Review 2003

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Alaskan Village Modeling and Analysis Project

for the

Department of Energy

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Sandia National Laboratories

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,
for the United States Department of Energy under contract DE-AC04-94AL85000.

Alaska Modeling and Analysis Project

Project Partners

- DOE/ Sandia National Labs
- Alaska Energy Authority
- Lime Village Traditional Council
- McGrath Light and Power
- Sentech Inc.

Alaska Modeling and Analysis Project

Partnership Objectives

- Provide a reliable/cost-effective power system analysis tool for Alaskan Village stakeholders
- Create diesel/battery/PV modeling tool (HYBSIM)
- Validation test-bed for HYBSIM Model at Lime Village
- Support inexpensive capability to remotely monitor,

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History

1999-2001

- Quantified benefits of battery storage for Village systems

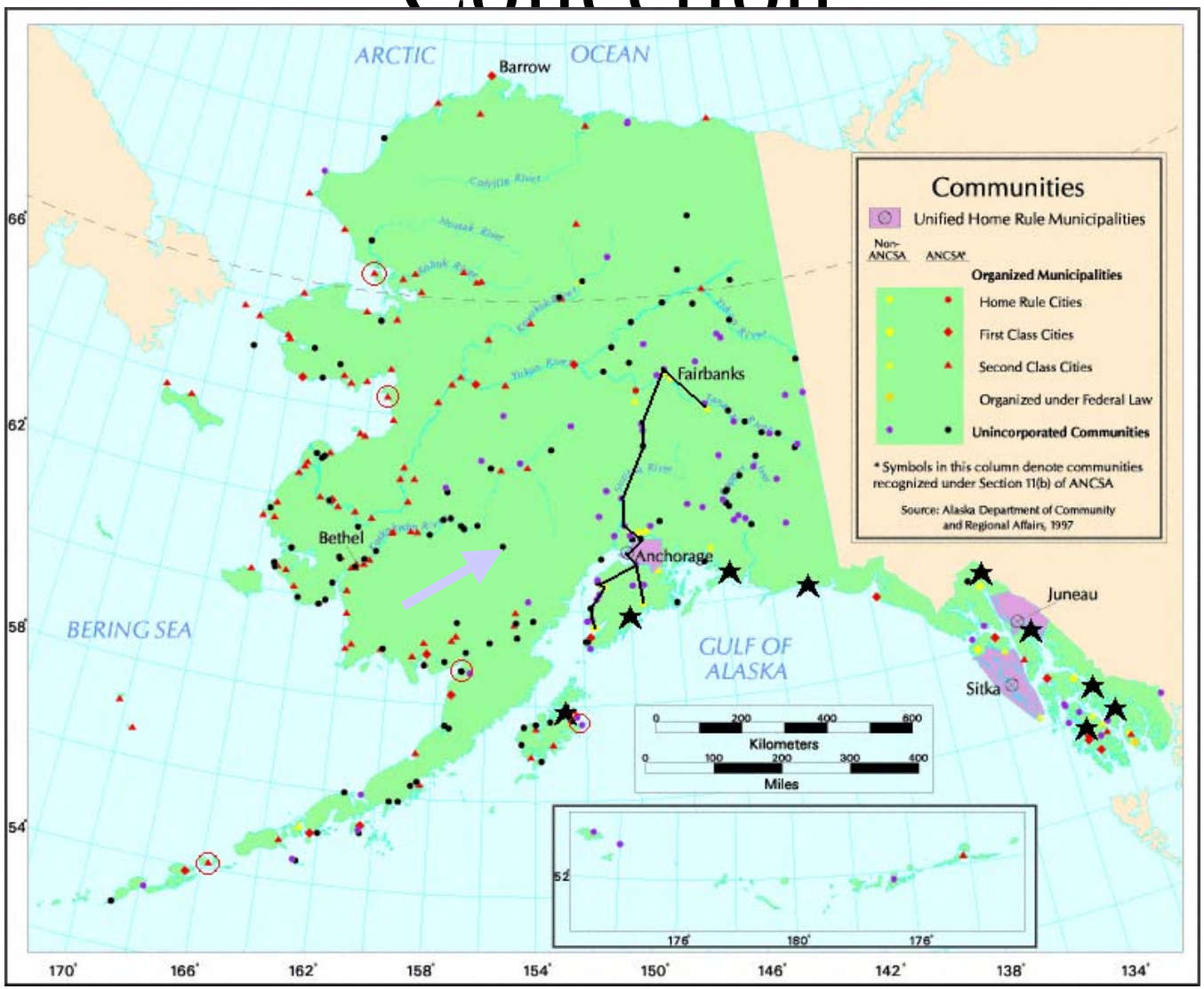
2001-2002

- Enhanced modeling capabilities

2002-2003

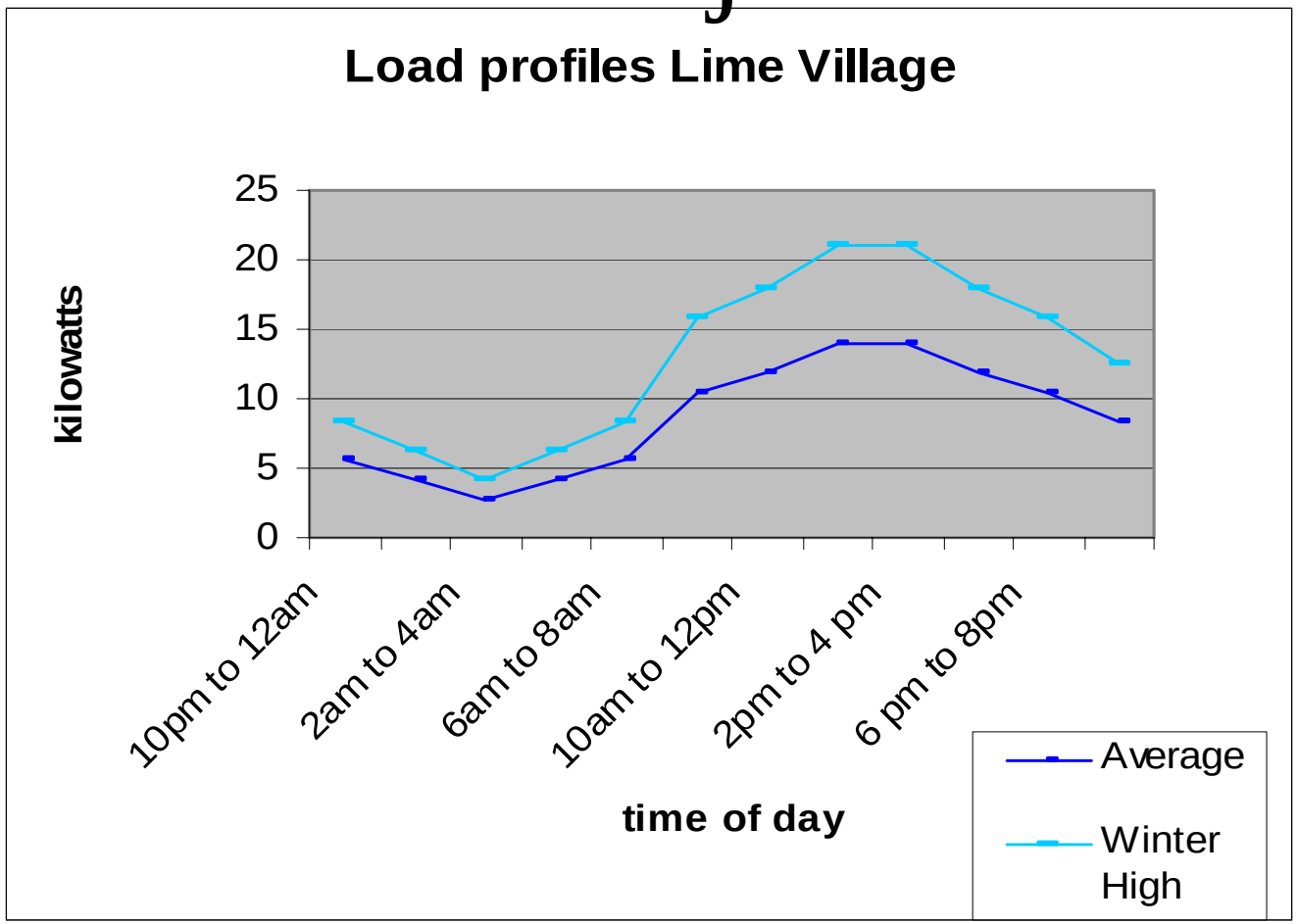
- Test and Validate

Lime Village Test Bed and Data Collection



Lime Village Test Bed and Data Collection

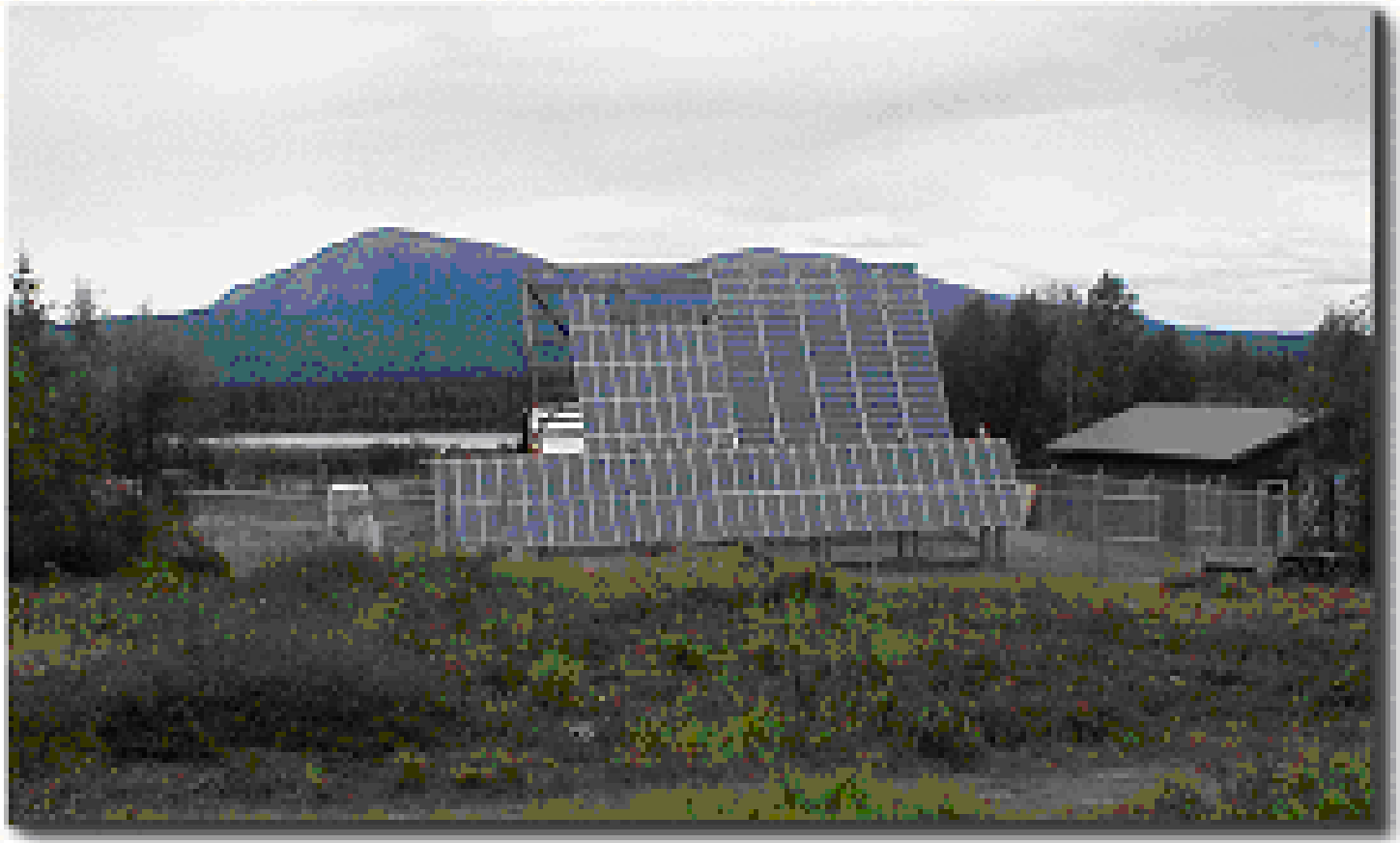
Alaska Modeling and Analysis Project



Lime Village Test Bed and Data Collection

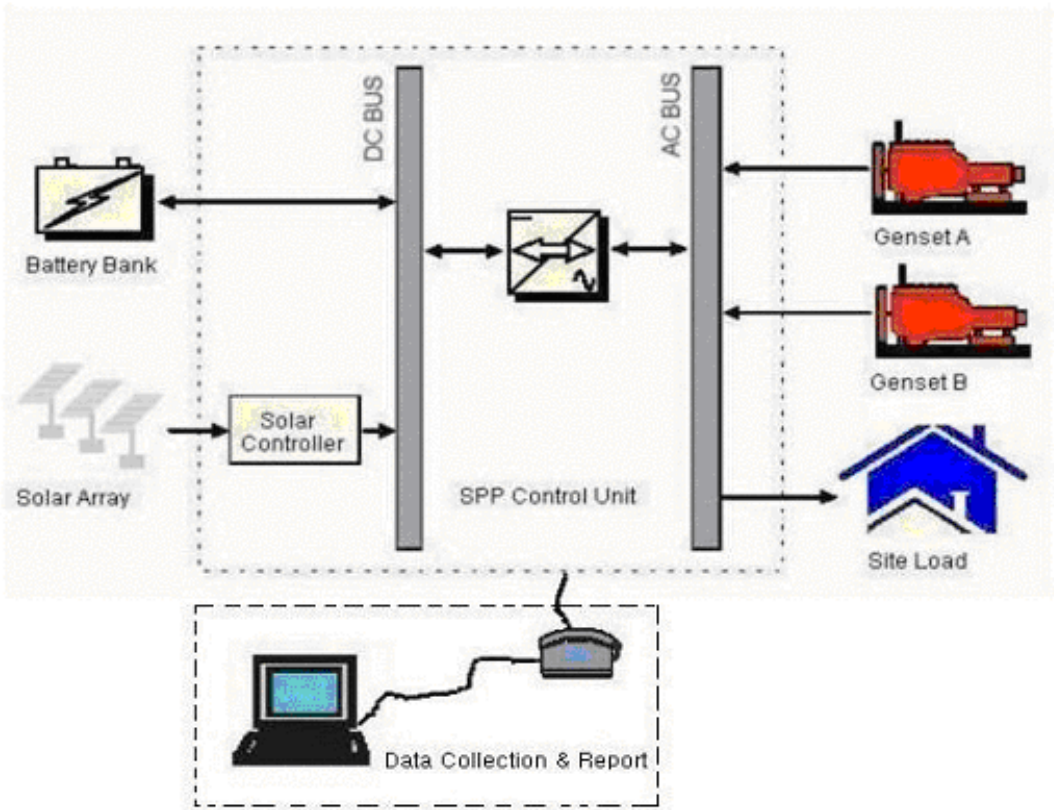
Small generators (21kW and 35kw)

Expanded Solar Array (Siemens, 4kW and Solar BP 8kW)



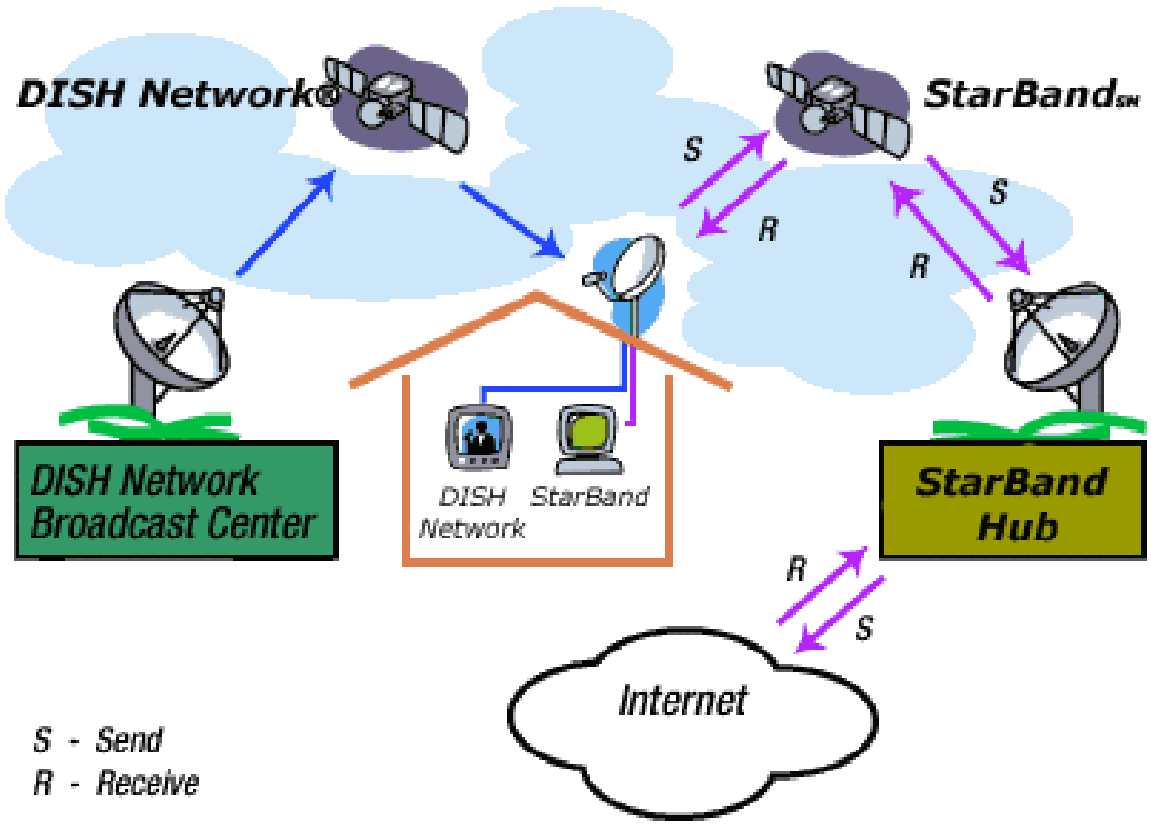
AES 30kW Inverter with AES Link Software and Modem

Solar-Diesel-Battery Diagram



Data Transmission

- Low cost
- Accessible
- Reliable



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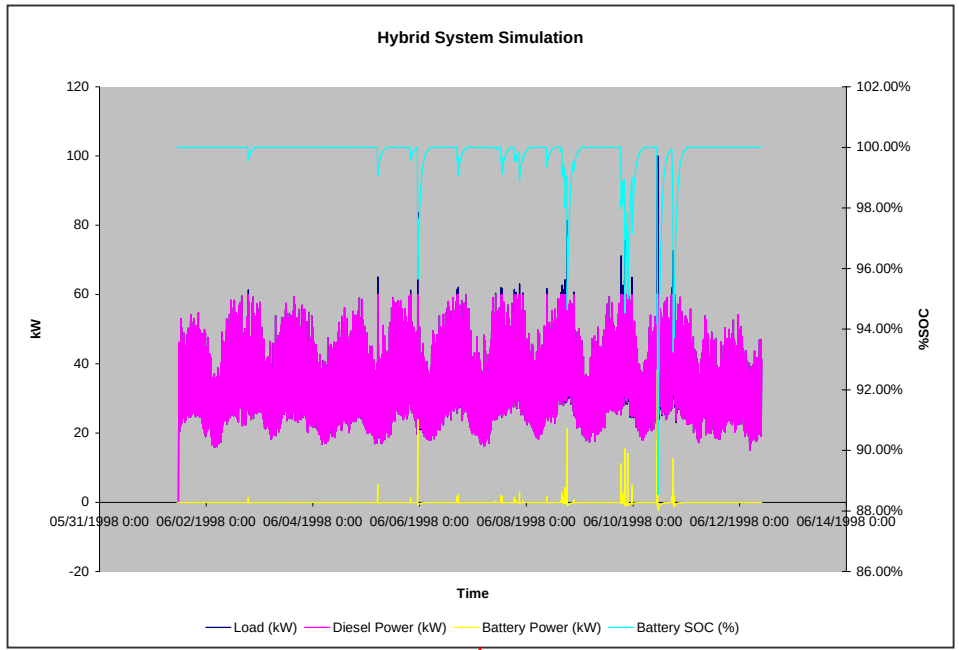
- HybSim Sample Output Report

Summary sheet

Diesel/battery hybrid model output - Summary

Warning: the model detected unmet load during the simulation.

General Parameters		
Dispatch Algorithm	Peak Shave	
Fuel Cost ($/gal)	1.6	
Performance Simulation Length (days)	10.9	
Economic Simulation Time Period (yr)	20	
	Baseline	**Hybridized**
Parameters - Diesels		
Manufacturer	Generic	Generic
Model #	N/A	N/A
Rated Capacity (kW)	100	60
Generator Cost ($)	80000	48000
Nominal Lifetime (yr)	15	15
Existing?	TRUE	TRUE
Age at start of simulation (yr)	5	5
Parameters - Battery		
Manufacturer	---	Generic
Model #	---	N/A
System Voltage (V)	---	240
System Capacity (kWh)	---	19.2
System Cost ($)	---	5760
BOS Cost ($)	---	1000
Lifetime (Ah)	---	19200
Shelf Life (yr)	---	7
Parameters - PCS		
Manufacturer	---	Generic
Model #	---	N/A
Capacity (kW)	---	46.08
Cost ($)	---	4608
Lifetime (yr)	---	10
Summary of Output		
Unmet Load During Simulation (kWh)	0.000	0.112
Instances of Unmet Load During Simulation	0	2
Diesel Assists During Simulation	---	0
Annual Energy Produced (kWh)	252,079	252,079
Annual O&M Costs ($/yr)	$2,001.90	$2,001.90
Annual Fuel Expenses ($/yr)	$44,857.73	$38,046.76
Present Value of Total Capital Investments ($)	$47,351.88	$50,790.68
Annualized Total Expenses ($/yr)	$53,799.56	$46,879.75
Levelized Cost of Energy ($/kWh)	$0.21	$0.19
Annual Fuel Used (gal)	28,036	23,779
Average System Efficiency (gal/kWh)	0.111	0.094
Diesel Annual Hours of Operation (hr)	8,768	8,768
Projected Diesel Life (yr)	15.0	15.0
Battery Annual Charge Throughput (Ah)	---	1,348
Projected Battery Life (yr)	---	7.000
System Comparison		
Annual Fuel Savings (gal)	4,257	
Annual Fuel Savings (%)	15.18%	
Annual Fuel Savings ($)	$6,810.96	
Initial Capital Cost of Hybrid System	$11,368.00	
Simplified Payback Time (yr)	1.67	
Net Annual Savings	$6,919.81	
Payback Time (yr)	1.64	
Annual Avoided Emissions		
NOx (kg)	1,166	
SOx (kg)	77	
CO (kg)	251	
PM-10 (kg)	82	
CO2 (kg)	43,377	



Graph of system performance

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HybSym Workshop, 08/03, Anchorage Alaska

- 15 <u>local</u> participants
- Feedback
  - 100% see value in model
  - 47% willing to beta test
  - 100% will use final model

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Lime Village HybSim Analysis, 2003

- Voltage mismatch between PV and Battery
- Power factor correction, 15kVar capacitor bank to correct to .95
- Lead Acid vs. Nickel Cadmium analysis
- Peak shaving over cycle charging for best cost savings
- 530Ahr battery system will optimize savings

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HybSim Current Development Activities

- Utilization of the new Lime Village Test Bed data for model validation
- Utilization of Grasmere, Idaho Hybrid system data for model validation
- Finalize the integration of PV generation module

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Current Development Activities continued

- Finalize specification libraries for commercially available battery and diesel systems
- Other Upgrades
- Beta Testing with Alaskan Stakeholders
- Commercialization of Software

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Upcoming Plans:

HybSim version 3 to be completed this year

- Specification libraries enhancements
- Additional validation of Lime Village & Grasmere data
- HybSim Test Plan implementation
- Apply model for village analysis with AEA
- Continued commercialization of HybSim
- Training for Alaskan stakeholders

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Summary

- Working Partnership
- Optimizing Lime Village
- Data Collection System
- HYBSIM tool
- Apply model