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EECE401 Senior Design I
Howard University
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Integration of Distributed Generation to Power Grid

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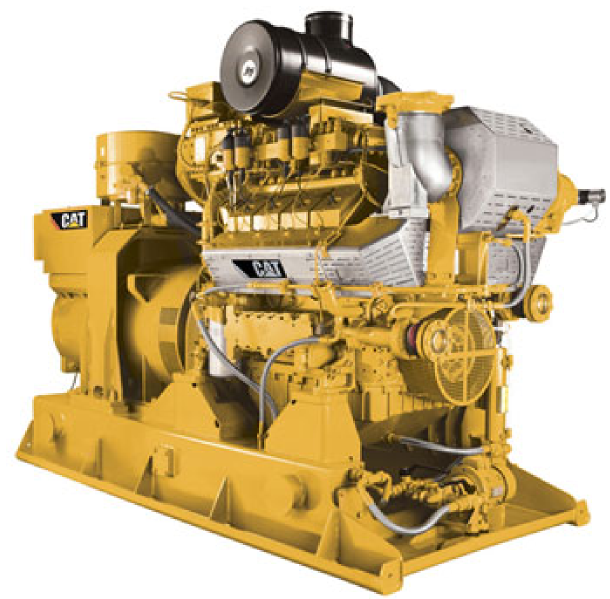
Background

- Utility consumers have generally been subject to considerable costs for electric service.
- Central generation: electrical power production by central station power plants that provide bulk power.
- Price of electricity increases due to the cost of transmission and distributed services.



Background

- Distributed generation (DG): employing small-scale technologies to produce electricity close to the end users of power.
- Requires fewer transport services of the transmission and distribution networks.
- Eliminates the cost, complexity, and inefficiencies associated with T&D.
- Consumers do not know of the best DG technology that can be used to meet their needs.

Problem Definition

"To design a Microsoft Excel model that will take customer and utility data, and use it to determine the best method for distributed generation that will provide a higher return on the investment compared to the grid, while meeting the customer's electricity needs."

Objective

– *Provide the best Distributed Generation solution for the customer, including the system size, cost analysis and the available commercial products.*

Inputs

1) **Customer information** (kW, kWh)
2) **Utility Rate Structure** ($/kWh, $/kW, Peak/Off, Summer, etc.)
3) **Technology Info** (Equipment Cost, Fuel, Heat Available, etc.)

→ **Model** →

Outputs

1) **The technology**
2) **System Size**
3) **Avoided Cost (Utility)**
4) **Return on the Investment.**

Design Requirements

- 1) The Generator size will be optimized by the maximum profit and will meet about 80% of the annual energy load (kWh);

- 2) The Generator will cover about 60% of the Max demand peak (kW).

- 3) The Generator will be subject to constraints pertaining to the resources available to the customer.

Current Status of Art

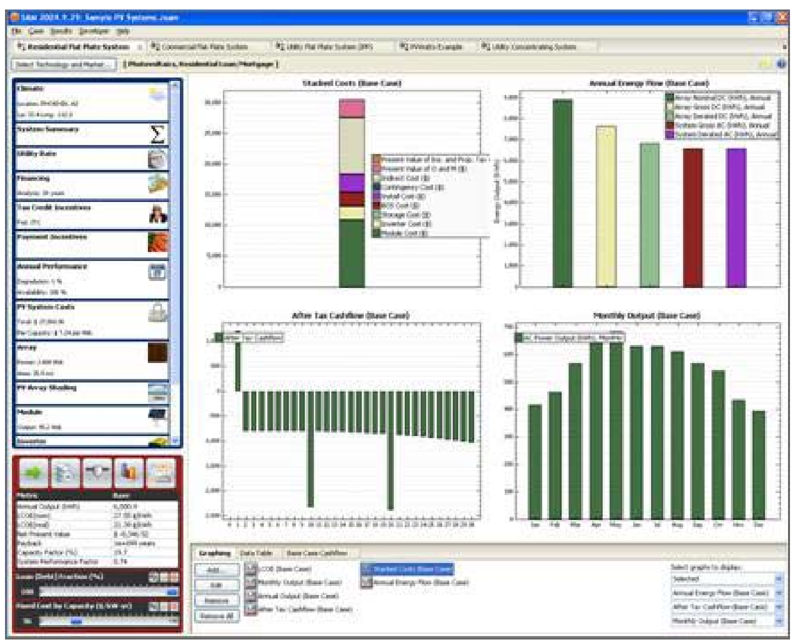
- Homer : Simulation and Optimization for grid tied and off-grid systems.

  - Operate the system by a hourly dispatch model, reducing the costs.
  - Perform sensitivity analysis for uncertain inputs.

Weakness: Do not account for State Incentives (rebates, depreciation, etc.) and cannot model the Net Metering policy.

Current Status of Art

- SAM (System Advisor Model): Performance and financial model for renewable energy resources.
  - PV, Wind, Biomass, Geothermal.

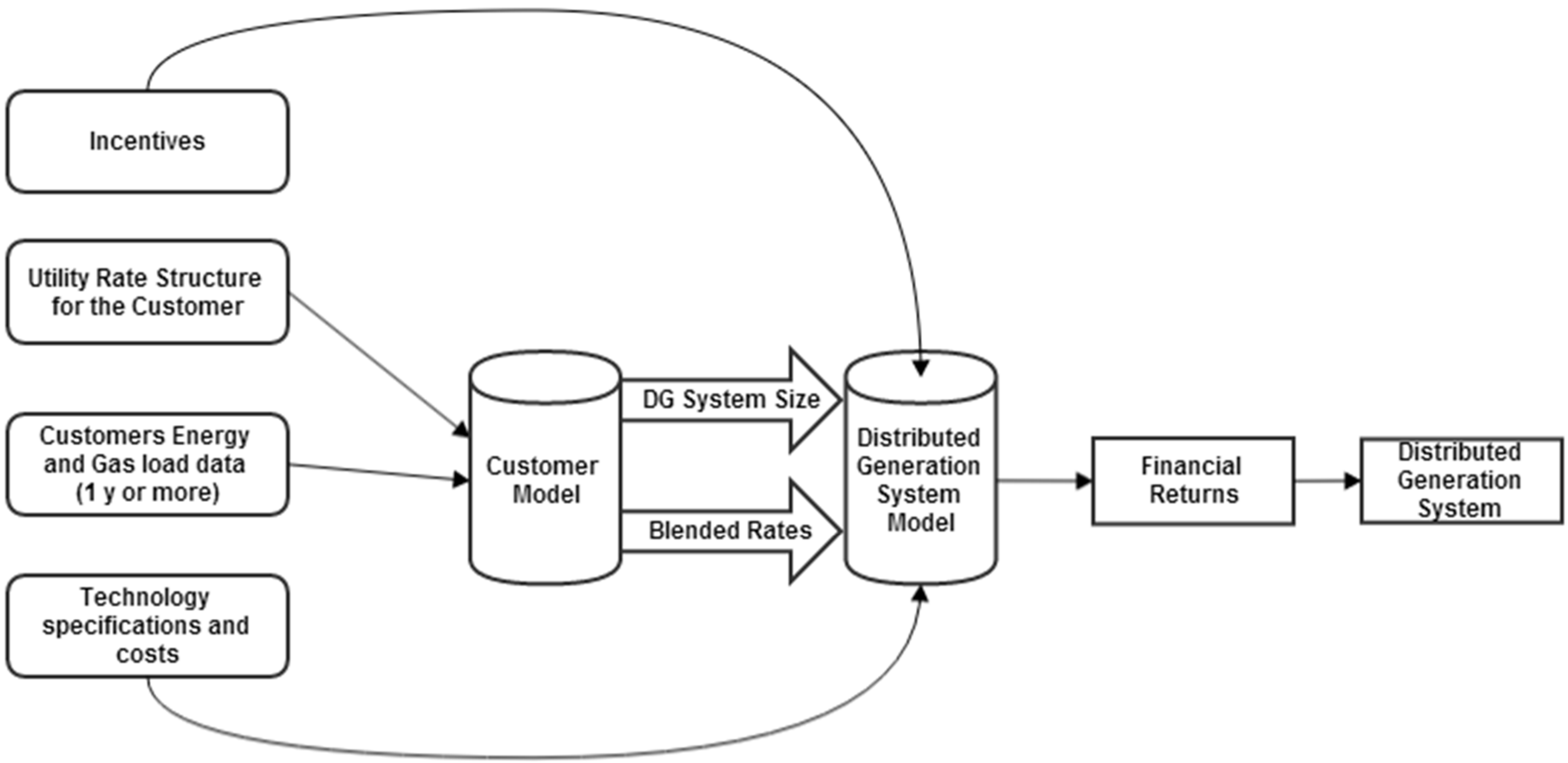


NREL
NATIONAL RENEWABLE ENERGY LABORATORY

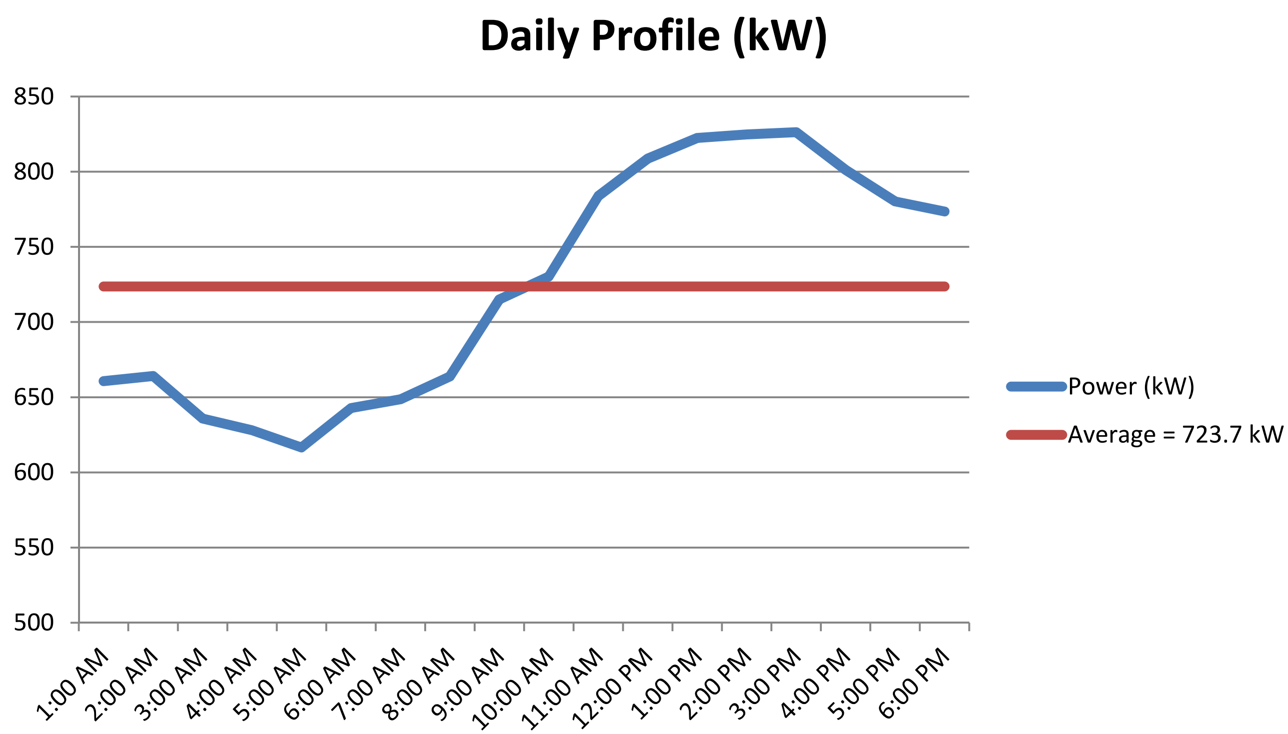
Solution Approach

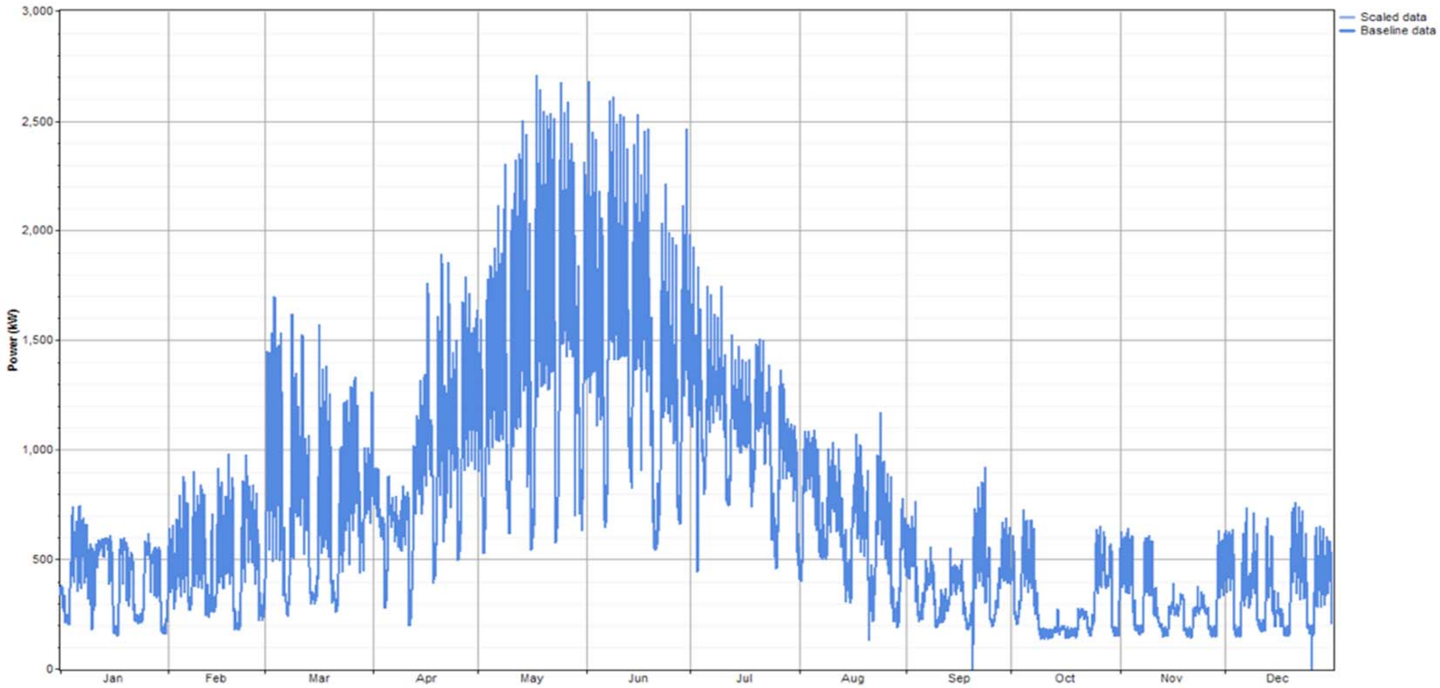
- Design a model capable of:
  1) Simulate the system hour-by-hour;
  2) Compute the avoided cost;
  3) Construct the cash flow with the Expenses and Revenues;
  4) Analyze the Net Present Value, Rate of Return, PayBack, Levelized Energy Cost, etc.

Solution Approach

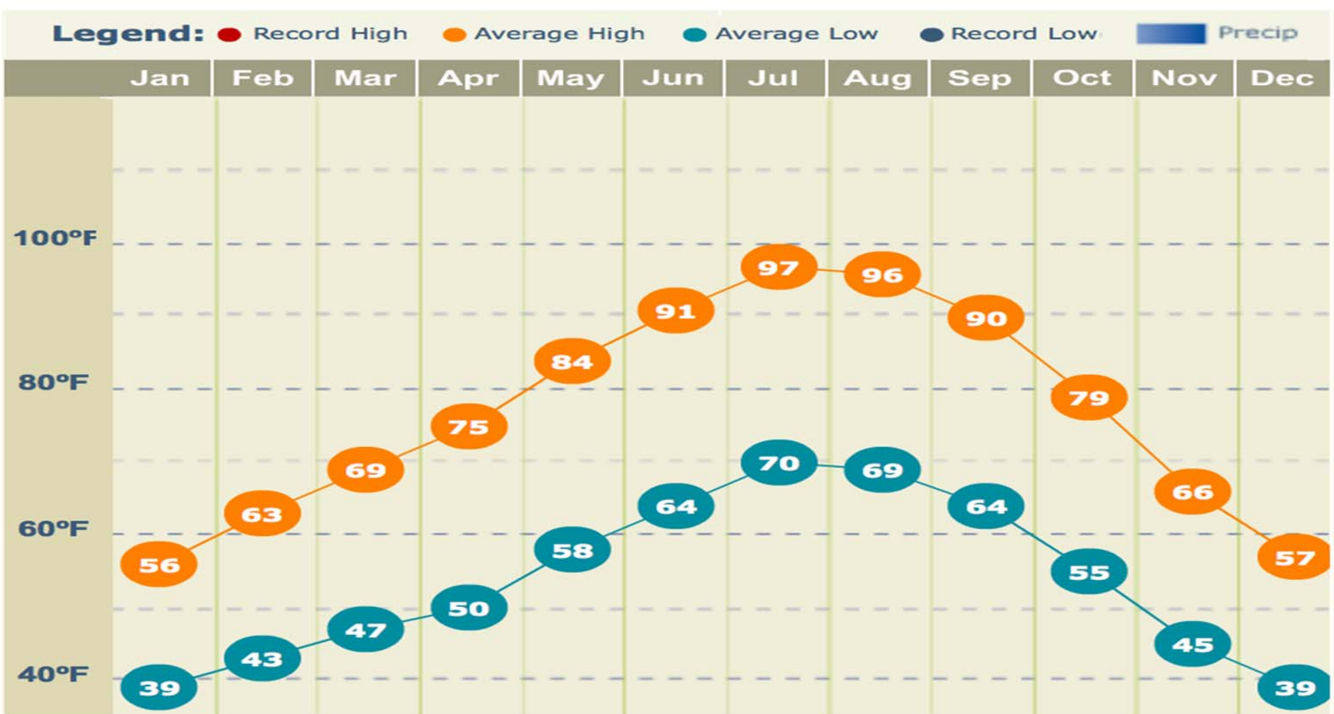


Customer: Cold Storage/Food Processing	
Project Type	Onsite DG Offset, NEM (if available), +PV Potential
Site Location	Bakersfield, CA
Utility Area	PG&E
Off-site Rate Tariff	AG5C (Primary)
Main Service Voltage	480/277V
Main Service Ampacity	12.4kVA
Available Fuel/Feedstock	Natural Gas – PG&E





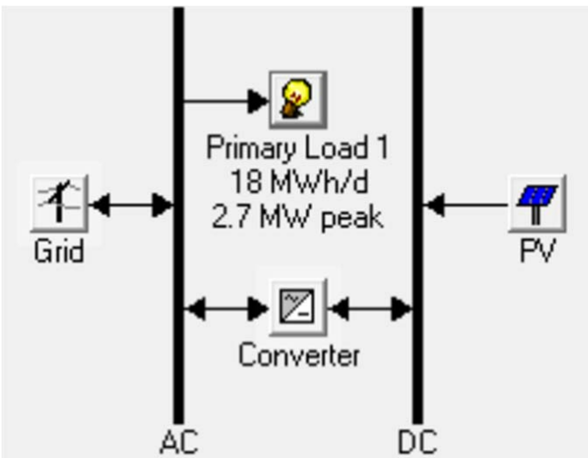
3,000
2,500
2,000
1,500
1,000
500
0
Power (kW)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Scaled data
Baseline data

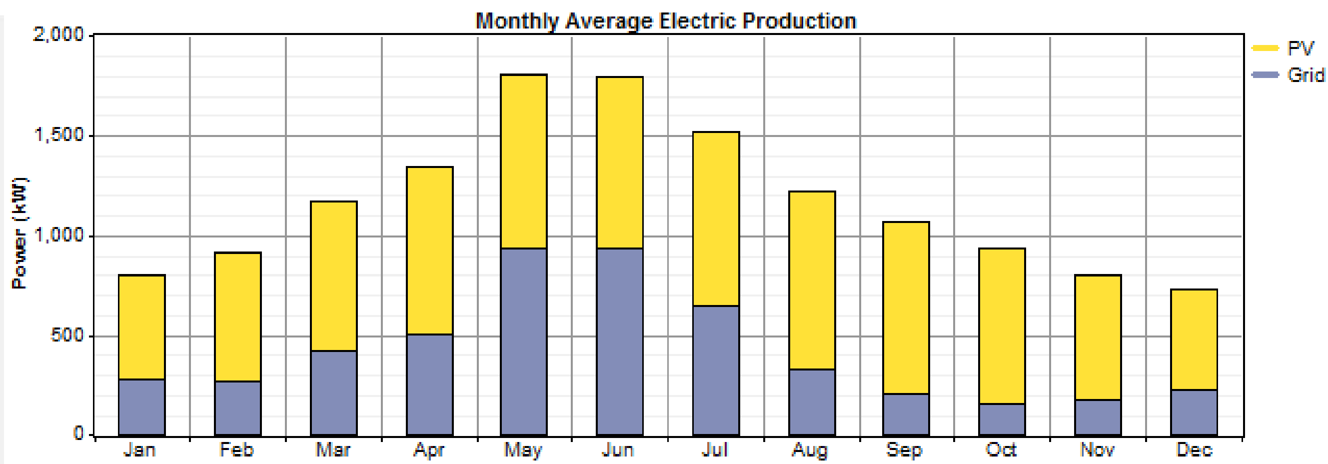


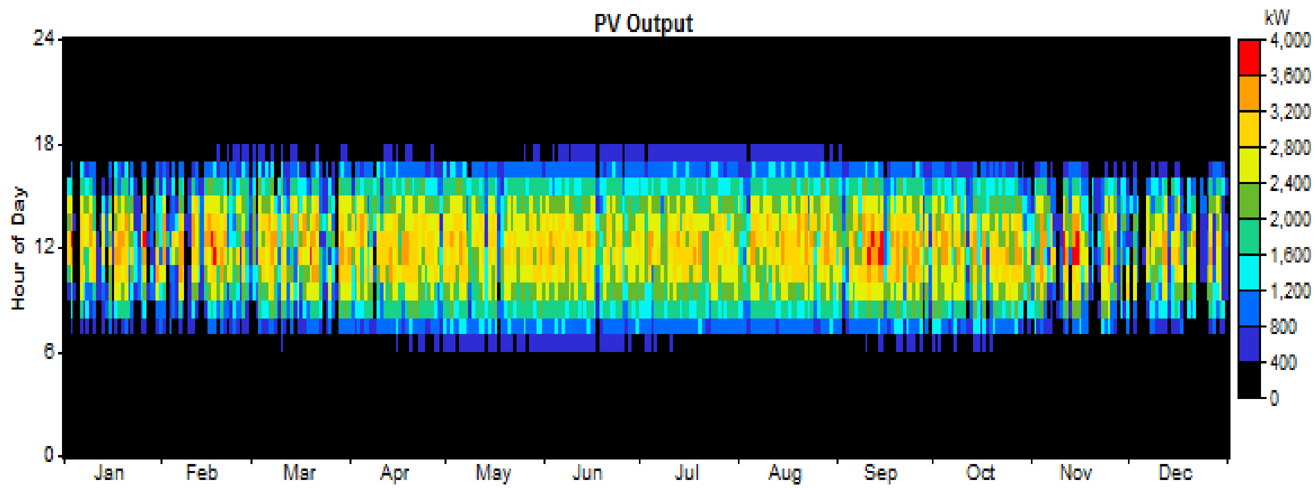
Legend: Record High Average High Average Low Record Low Precip
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
100ºF
80ºF
60ºF
40ºF
56 63 69 75 84 91 97 96 90 79 66 57
39 43 47 50 58 64 70 69 64 55 45 39

HOMER Results

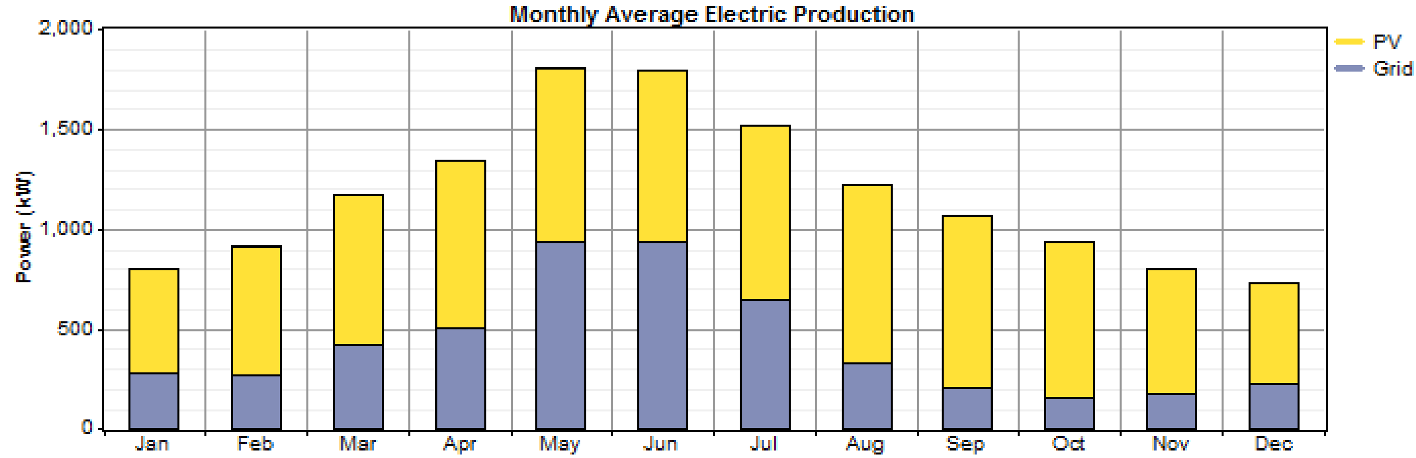
	PV (kW)	Conv. (kW)	Grid (kW)	Initial Capital	Operating Cost ($/yr)	Total NPC	COE ($/kWh)	Ren. Frac.
Grid, PV, Converter	1000	3800	2700	$ 1,842,105	583,882	$ 9,306,081	0.114	0.25
Grid			2700	$ 0	757,112	$ 9,678,436	0.118	0.00

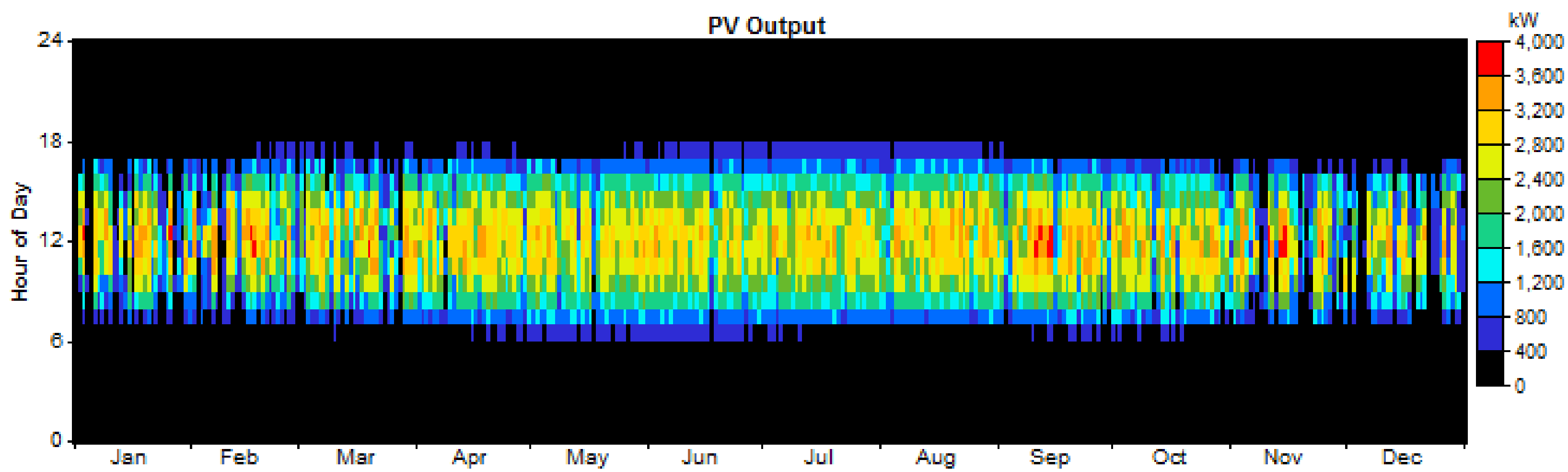






HOMER Results





Production	kWh/yr	%
PV Array	6,589,786	64
Grid Purchases	3,704,953	36
Total	10,294,738	100

Consumption	kWh/yr	%
AC Primary Load	6,403,182	66
Grid Sales	3,232,579	34
Total	9,635,761	100

Timeline & Milestones

Milestone	Costa	Donald	Expected Completion Date	Status
Written Proposal – First Draft	✓	✓	Oct. 15, 2013	Completed
Proposal Presentation	✓	✓	Oct. 29, 2013	Completed
Gather Customer/Utility Data	✓	✓	TBD	In Progress
Collect DG Technology Info	✓	✓	TBD	In Progress
Build Customer Models	✓	✓	TBD	In Progress
Collect DG Technology Info	✓	✓	TBD	In Progress
Prepare Public Presentation	✓	✓	Nov. 12, 2013	Completed
Written Proposal – Second Draft	✓	✓	TBD	In Progress

Verification Plan & Deliverables

1) Gather customer data with utility
    a. Interval Data/Month by month data also the current rate schedule for each utility, one residential, commercial and industrial customer.
2) Design the Customer Model for each technology.
3) Obtain information about each Distributed Generation Technology including:
    a. Operation characteristics;
    b. Overhaul frequency or life cycle period;
    c. Fuel consumption and recoverable exhaust heat (Spec Sheets);
    d. Equipment and installation costs;
    e. Maintenance costs.
4) Perform the nine different case studies in the model and HOMER.
5) Compare the results.

Deliverables:

- User-friendly model based in Microsoft Excel
- Flexibility to adapt to different input data

Costs and Resources

- No established budget
- Will require the following:
  - Customer/Utility Data from the websites of the three utilities: Pepco, CEMIG, and PG&E
  - Distributed Generation technology information
  - HOMER
  - Microsoft Excel
  - Consultations with Howard University professors

Conclusion

- To determine the best distributed generation solution for industrial, commercial, and residential customers, Green Alpha proposes to design a Microsoft Excel model.
- The model will use customer, utility, and DG technology information.
- By December, the model will be ready for demonstration and all the analysis will be completed.