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Innovation for Our Energy Future

HOMER
The Micropower Optimization Model

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What is HOMER?

- A tool for comparing and evaluating micropower technology options for a wide range of applications
  - Village power systems
  - Stand-alone applications
  - Grid-connected systems
  - Conventional technologies
  - New technologies

HOMER
The Micropower Optimization Model

Why did we Develop HOMER?

- Many new choices for rural energy
  - Past: diesel, micro-hydro, & grid extension
  - Solar, wind, biomass, hybrids
- Many variations of hybrids
- Different quality of services
- A confused mind says “No!”

What does HOMER do?

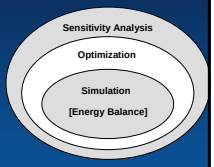
- HOMER finds the type of system that can best serve different loads.
- What if conditions are different?
  - Resources
  - Loads
  - Equipment prices
  - Equipment performance

The Hourly Energy Balance

- Invisible: internal HOMER process
- Compare the energy supply and demand in a single hour
- Decide how to operate dispatchable sources (generators, battery, grid)

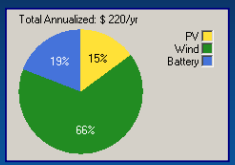
Simulation - Optimization - Sensitivity Analysis

- Simulation
  - Estimate the cost and determine the feasibility of a system design over the 8760 hours in a year
- Optimization
  - Simulate each system configuration and display list of systems sorted by net present cost (NPC)
- Sensitivity Analysis
  - Perform an optimization for each sensitivity variable



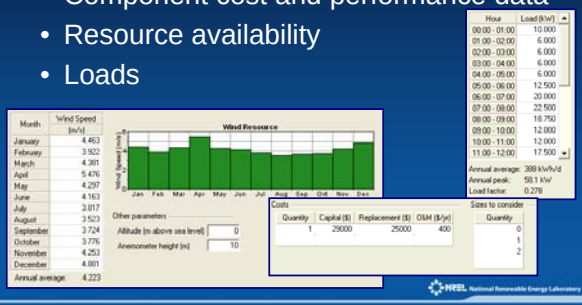
Life-cycle Cost

- The cost of a system over its useful life
  - Initial costs associated with equipment purchases and installation
  - Costs of owning, operating, and maintaining the system
  - Costs of replacing components
- Net Present Cost: life-cycle cost expressed as a lump sum in "today's dollars"



Inputs

- Component cost and performance data
- Resource availability
- Loads

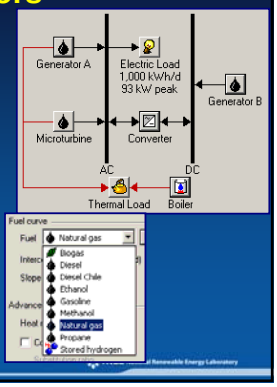


Technologies HOMER Can Model

- Single technology systems and mutiple-technology (hybrid) systems
- Compare multiple combinations of different technologies

Generators

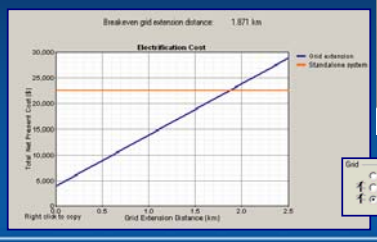
- Fossil fuels
- Biofuels
- Cofired
- Cogeneration
- Up to three generators



Grid Extension

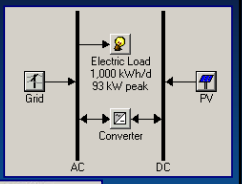
- Compare to stand-alone system
- Breakeven grid extension distance

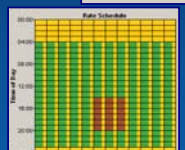
Figure 1: Grid system in a rural area ©Steve Fisher/ITDG



Grid-connected Systems

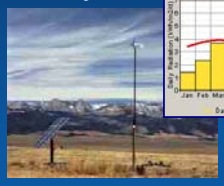
- Rate schedule
- Net metering
- Demand charges

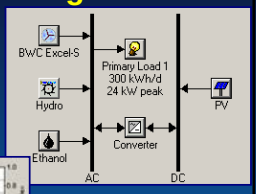




Renewable Technologies

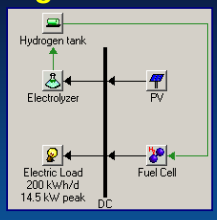
- Solar PV
- Wind
- Biomass and biofuels
- Hydro





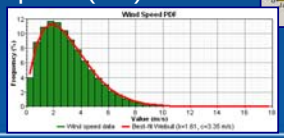
Emerging Technologies

- Fuel cells
- Microturbines
- Small modular biomass



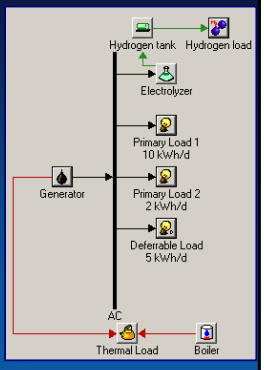
Resources

- Wind speed (m/s)
- Solar radiation (kWh/m^2/day)
- Biomass (tonnes/day)
- Stream flow (L/s)
- Fuel price ($/L)



Loads

- Electrical
  - One or two load profiles
  - Deferrable
- Thermal
- Hydrogen

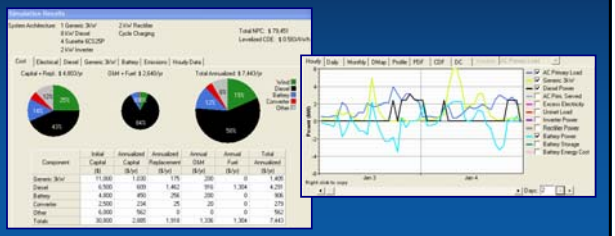


Questions HOMER can Answer

– How should I design a particular system?
  • Wind, PV, both, or something else?
  • Diesel or larger battery bank?
– How to meet growing demand?
– What if the fuel price changes?
– How should I operate my system?
– And many others…

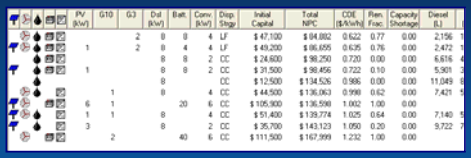
Simulation Results

• Cost and performance of a particular system configuration



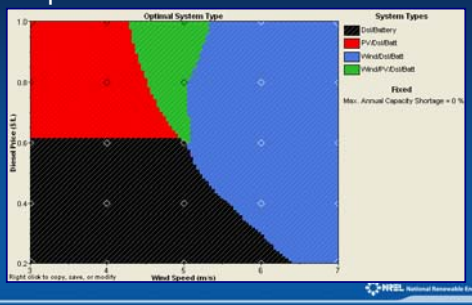
Optimization Results

• Ranked list of system configurations



Sensitivity Results

• Graphs and tables



HOMER is Flexible

- Rough estimated inputs for general analysis
  - Annual averages for resources and loads
  - Cost per kW or unit for equipment
- Detailed inputs for system design
  - Measured hourly data
  - Detailed cost curves
  - Create your own wind turbine, battery, fuels

What you need to get started

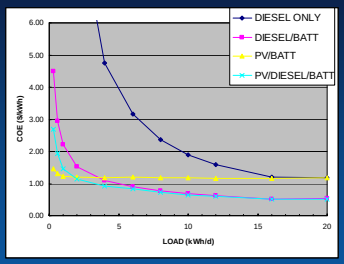
- Getting Started Guide
- Resource data
- Component installation and maintenance costs
- Basic component performance characteristics

Default values minimize need for detailed input data

HOMER is only a model!

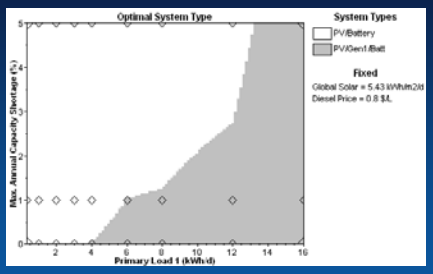
- Models help you consider important factors, and evaluate and compare options.
- Generating insights and understanding

Economies of Scale



Load size affects technology choice

Diesel Backup



Reliability and resource quality also affects design

Who Uses HOMER?

- System designer: evaluate options
- Project manager: evaluate costs
- Program manager: explore factors
  - resources, fuel price, load, emissions…
- Educator: teach and learn
- Tech. developer: evaluate performance

HOMER Around the World

- About 8,000 total downloads
- 177 countries
- Over 1,200 active users

Top five countries:

Canada, Australia, Spain, Germany, U.K

India, Brazil, Thailand, Philippines, Mexico

Country Category	Users
United States	1622
Other OECD	1858
Developing	1399

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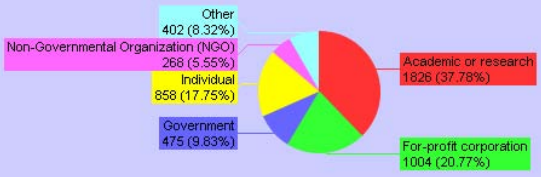
Organizations

Organization types of HOMER users



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User Testimonials

- "HOMER is an indispensable tool when we talk of electrification with renewables" -- **Cecilio U. Sumaoy**, Cagayan Electric Power & Light Co., Philippines
- "I have found that [HOMER] is being accepted within certain circles of industry and could potentially become a widely adopted industry standard for presenting economic and technology evaluations" -- **Brook Porter**, Intelligent Energy, Ltd., USA

Downloading HOMER

- http://www.nrel.gov/homer
- Complete registration survey
  - HOMER development team uses survey to make improvements to software
- Renew after 180 days by completing renewal form
- Send email to renew if Web access is difficult