Optimizing Clean Power Everywhere

Engineering Design of Mini-Grids: Tools & Software

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Asia Clean Energy Forum

Deep Dive Workshop on Hybrid Mini-grids

June 15, 2015

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Modeling Challenge

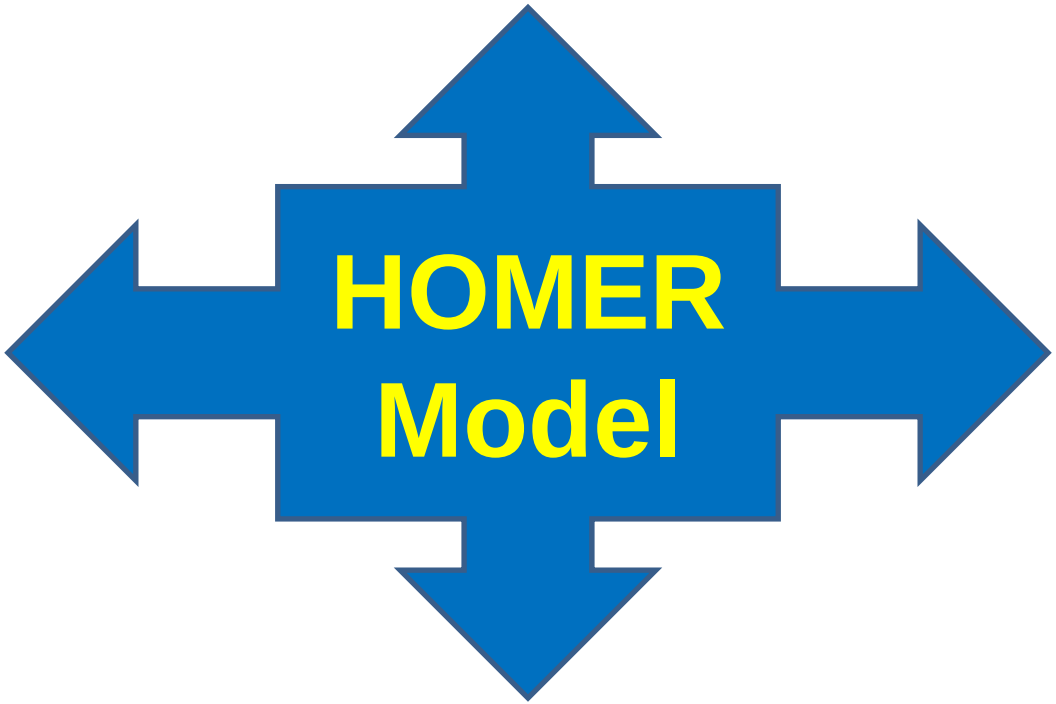
- Solar and wind are variable
  - Needs integration with dispatchable resources

- Smaller projects need simpler tools

Different Tools for Different Purposes

Renewable Advocates

Power Engineers



Financiers

Utility Operators

HOMER as a communication tool

Too Many Choices

Solar

Wind

Hydro

Geothermal

Biomass

New Storage Techs.

Electric Vehicles

Smart grids

Fuel Cells

Micro-turbines

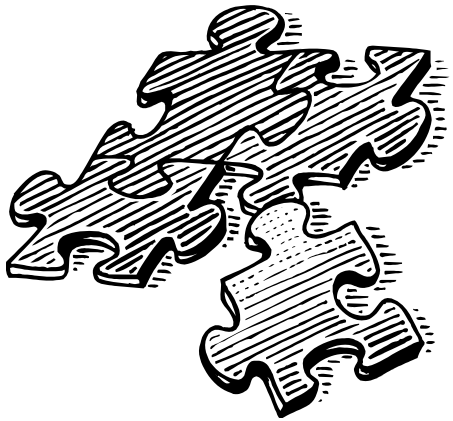
Micro-grids

Demand Response

Load Management

What is best?

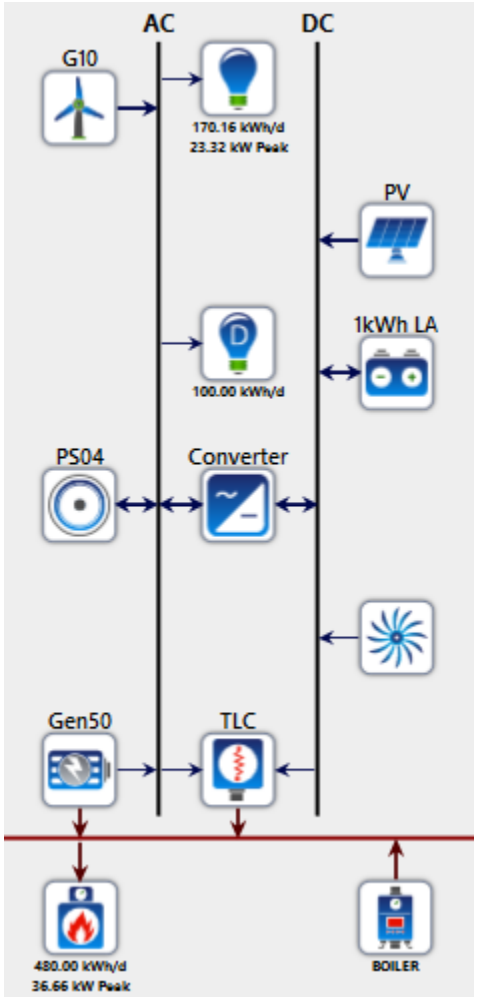
- Depends on the application
  - Resources
  - Loads
  - Equipment prices
  - Equipment performance



- A confused mind says “No!”
- **HOMER fits the pieces together**

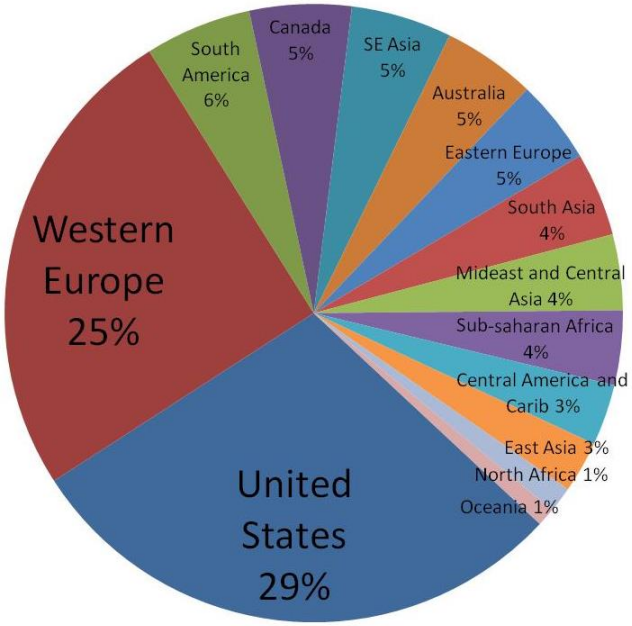
HOMER

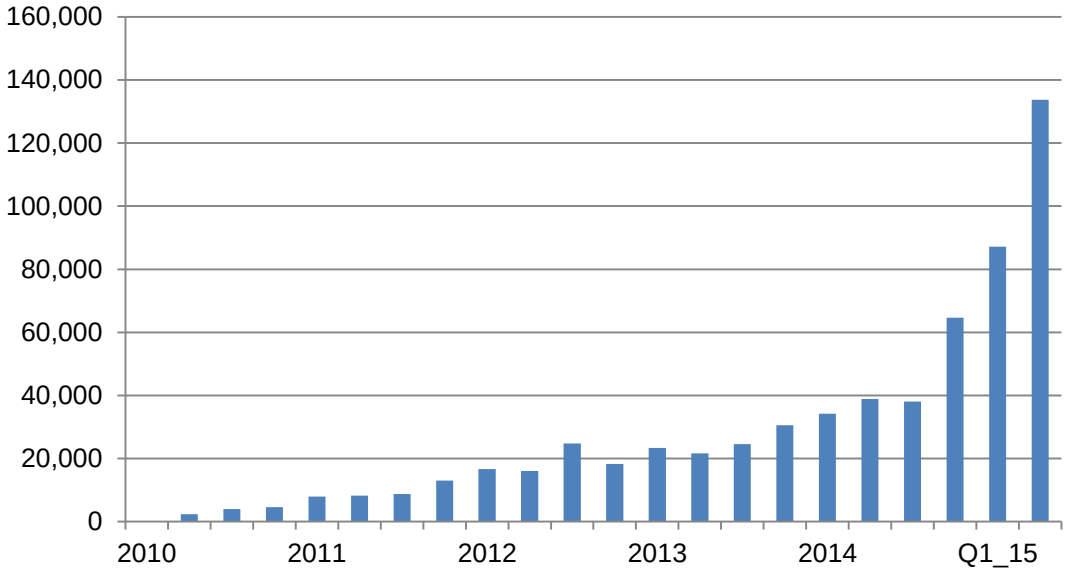
- Industry standard for hybrid micro-grids
  - Conventional resources
  - Renewable resources
  - Storage
  - Load Management
- Afternoon Deep Dive Workshop
- Full-day training on Saturday



HOMER

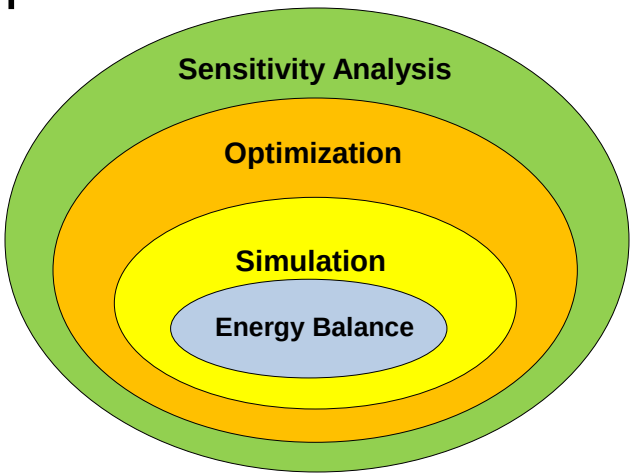
- NREL: 1992-2009
- Original developers now at HOMER Energy
- 125,000+ users in 193 countries





HOMER Analysis Layers

- Simulation
  - Accurate analysis of time varying loads and resources require an hour-by-hour analysis for entire year
- Optimization
  - Find the least cost solution
- Sensitivity Analysis
  - The data is never “good enough”.
  - What if….?



HOMER has a Global Reputation

"We spent a lot of money developing our own model, but threw it away because everyone kept asking for our HOMER results."

Bruce Levy, CEO, TDX Power

What's New with HOMER Pro

New components

- Thermal load controller
- Concentrating PV
- MPPT/Dedicated PV Inverter
- Hydrokinetic

Improved Components

- **Grid-connected battery**
- **Grid outages**
  - **Scheduled and random**
- Up to 20 generators
- Up to 10 PV arrays
- Wind turbine losses
- Maintenance schedules
- Minimum generator runtimes
- Fuel minimization

Library

- Store cost data in the library
- All components, loads, settings and resource in library
- Library management tool

New Results

- Choose parameters for summary tables
- Sort and filter on any output
- Direct results export to .CSV (spreadsheet format)

New Input capabilities

- **Built-in default load profiles**
- Obtain resource data by clicking on a map or typing address

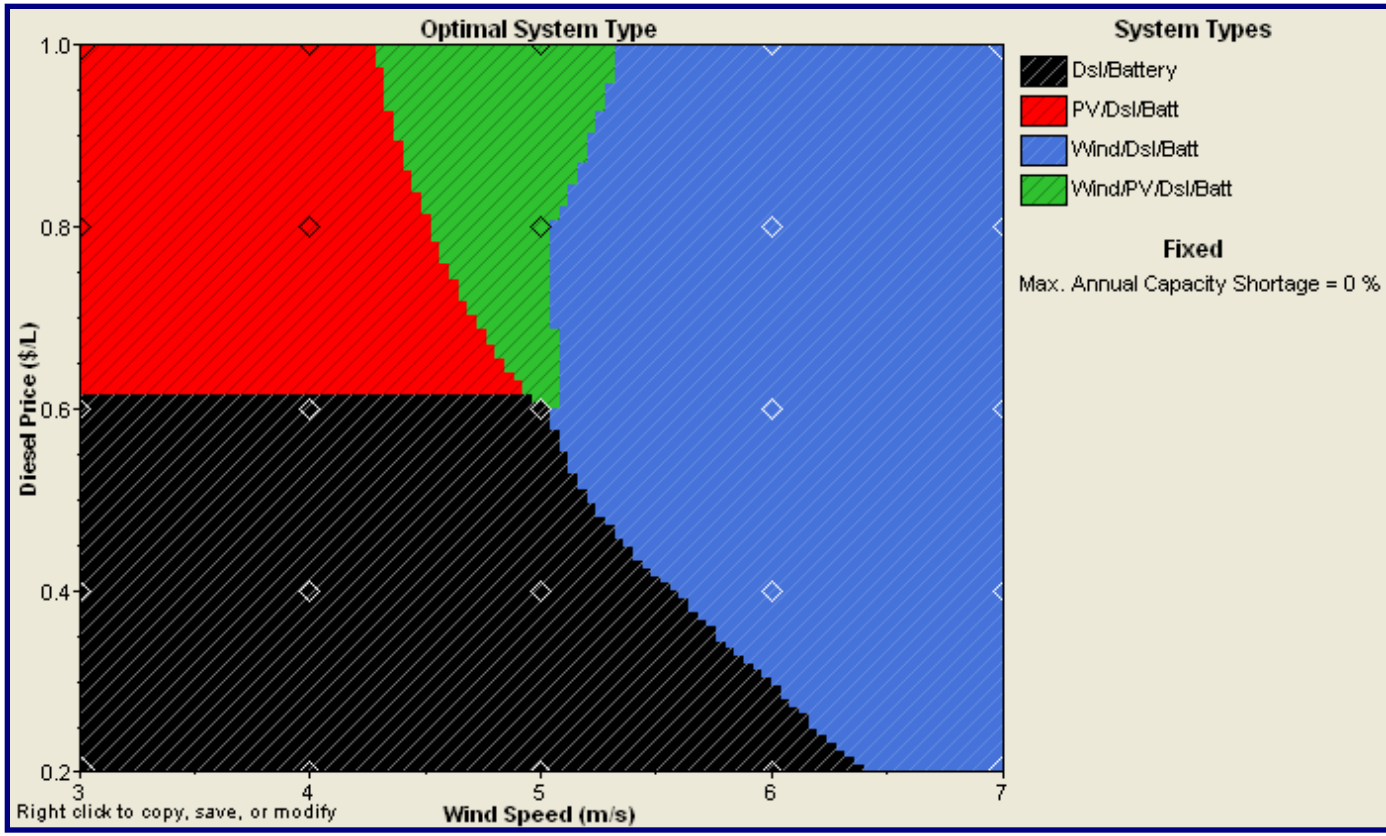
APIs

- Application Programming Interfaces
- Custom dispatch modules

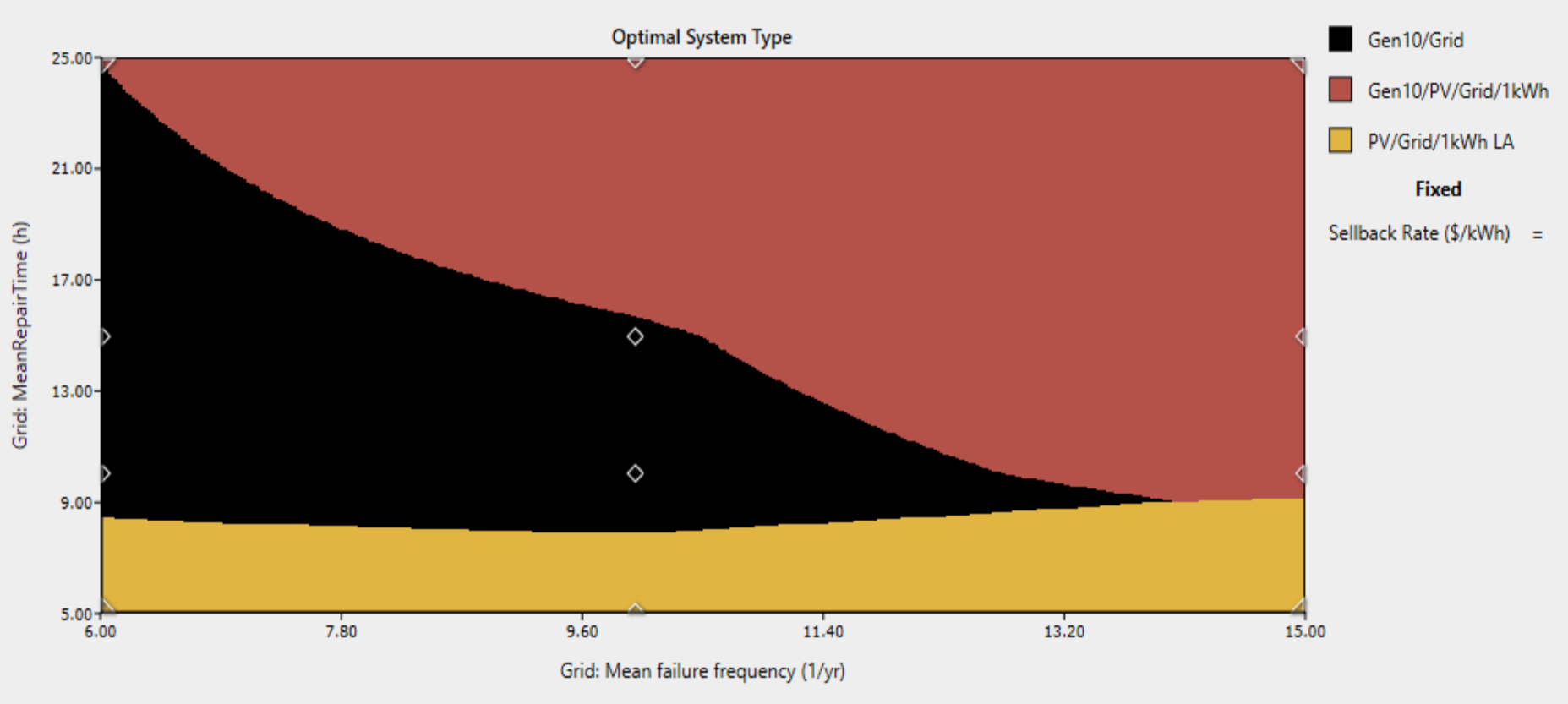
Parallel processing

Optimal System Design

- What kind of system is best under which conditions?

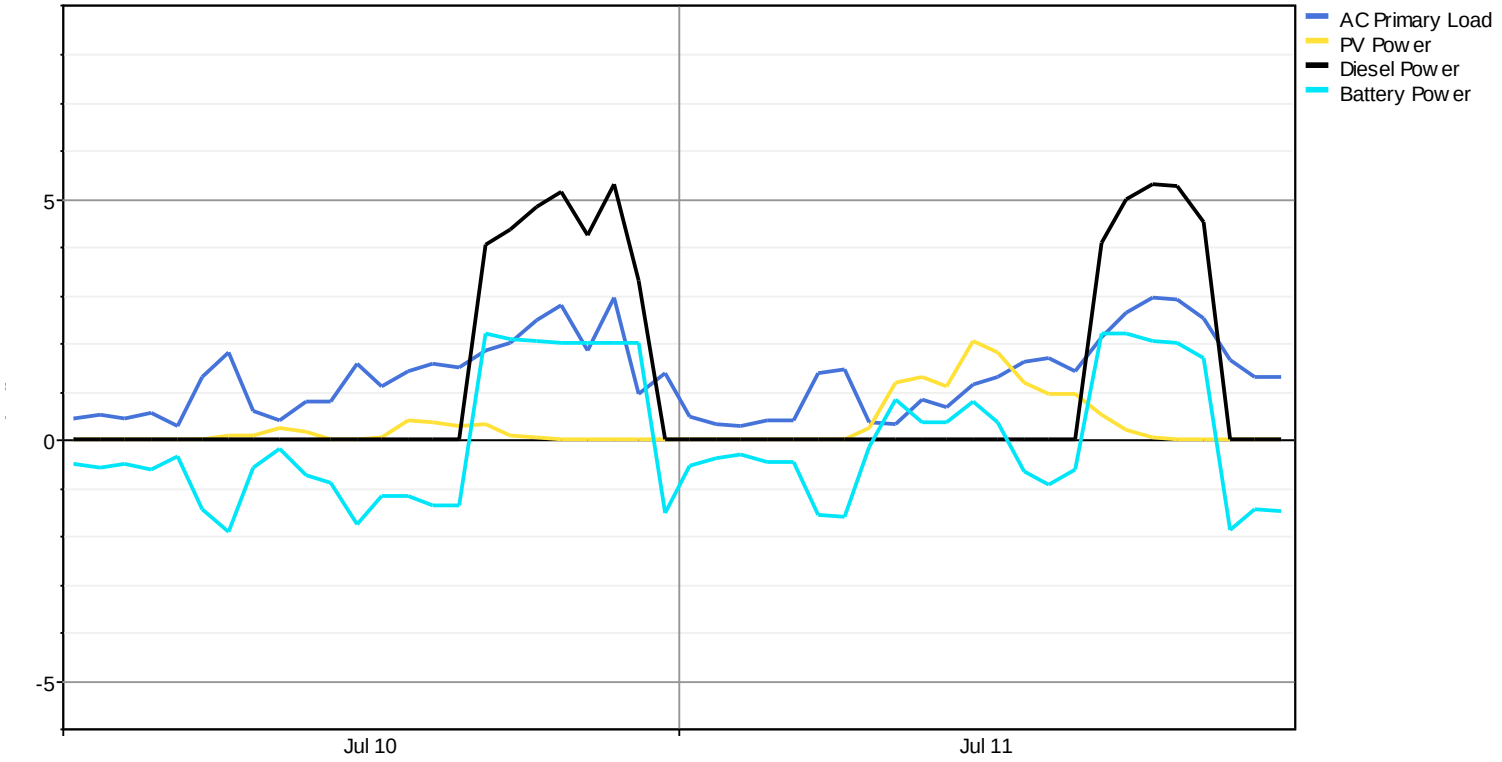


Random Outages



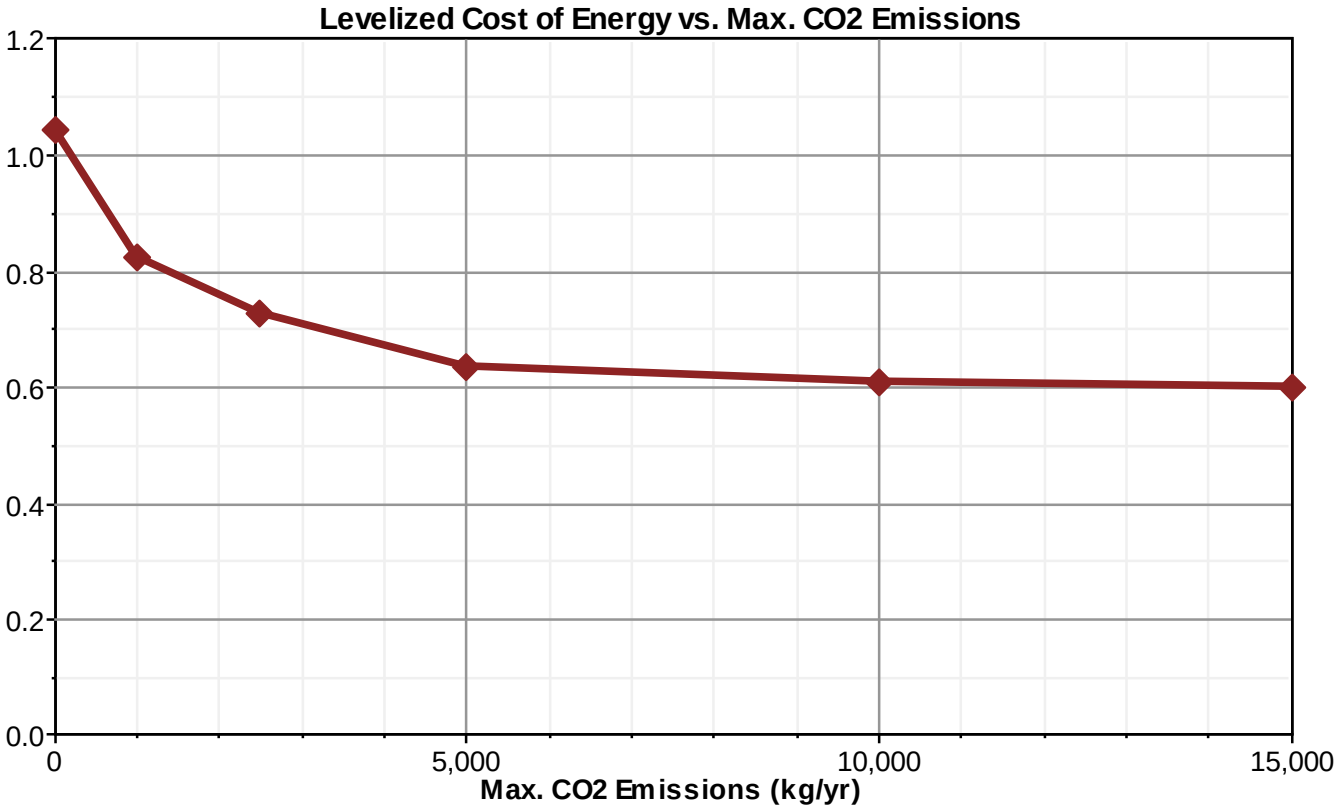
- Simple Diesel is best if outages are infrequent.
- Simple PV-Battery best if outages are short
- Hybrids are best in most cases

Operational Analysis



- When is backup power needed?

Policy Analysis



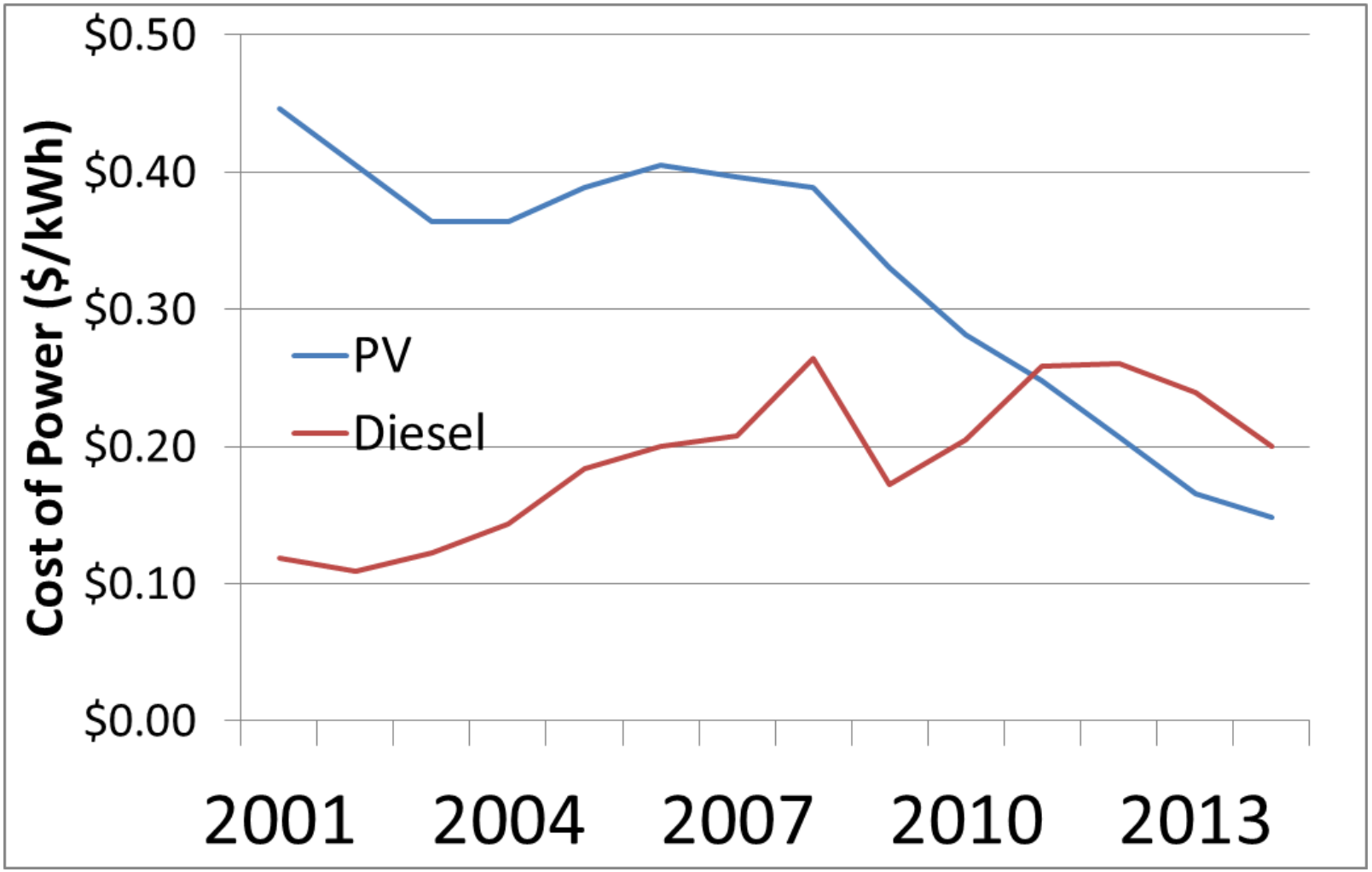
- Cost of emission constraints

Penetration Metrics

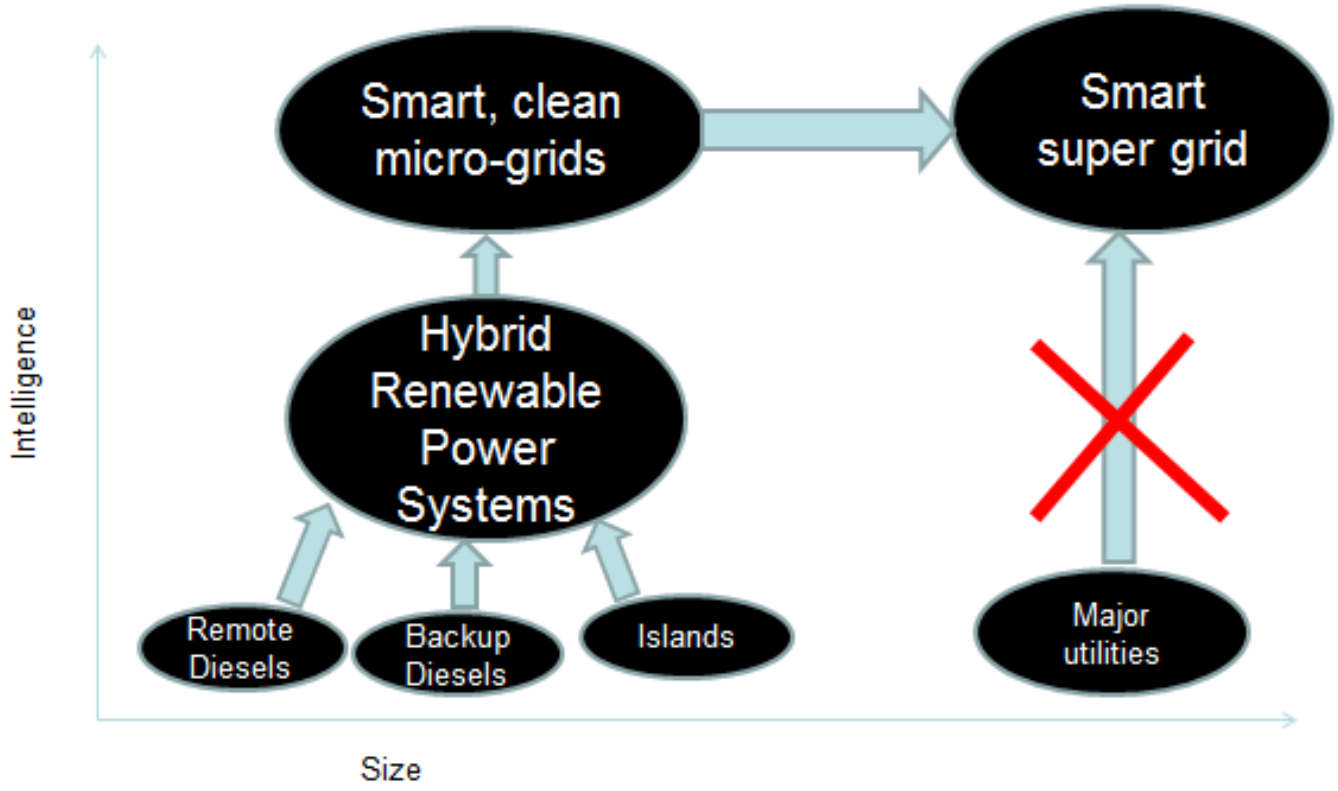
Maximum instantaneous	70.1%
Peak load	39.9%
Generation capacity	34.0%
Energy production	12.5%
Renewable fraction	11.6%
Fuel savings	8.7%

- Six very different metrics for the same system
  - 85 kW of PV with a 213 kW Peak load
  - 1% curtailed energy

Diesel grid parity



Clean Power Evolution



- Large utilities
  - Security obstacles
  - Regulatory obstacles
- Smaller systems
  - Liquid fuels from oil
  - High renewable penetrations