



*Optimizing Clean Power Everywhere*

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# **Economic Optimization of Hybrid Renewable Microgrids with HOMER<sup>®</sup>**

**Dr. Peter Lilienthal**  
**peter@homerenergy.com**

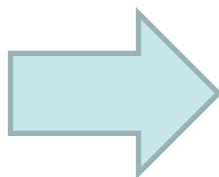
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1790 30th St, Suite 100, Boulder, Colorado 80301, USA [http://  
www.homerenergy.com](http://www.homerenergy.com) • +1-720-565-4046

# The Future of Power

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Clean, distributed power with hybrid renewables and smart micro-grids



But how do we get there?

# Too Many Choices

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Solar

Fuel Cells

Wind

Hydro

Micro-turbines

Geothermal

Micro-grids

Biomass

Demand  
Response

New Storage Techs.

Electric  
Vehicles

Load Management

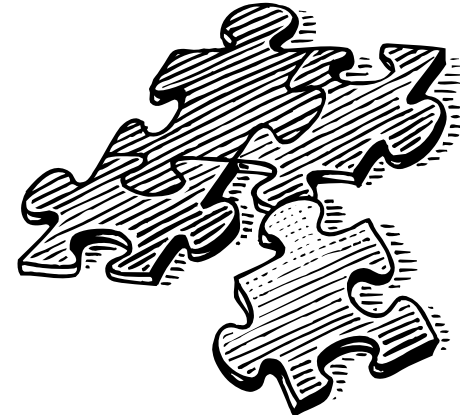


Smart grids

# What is best?

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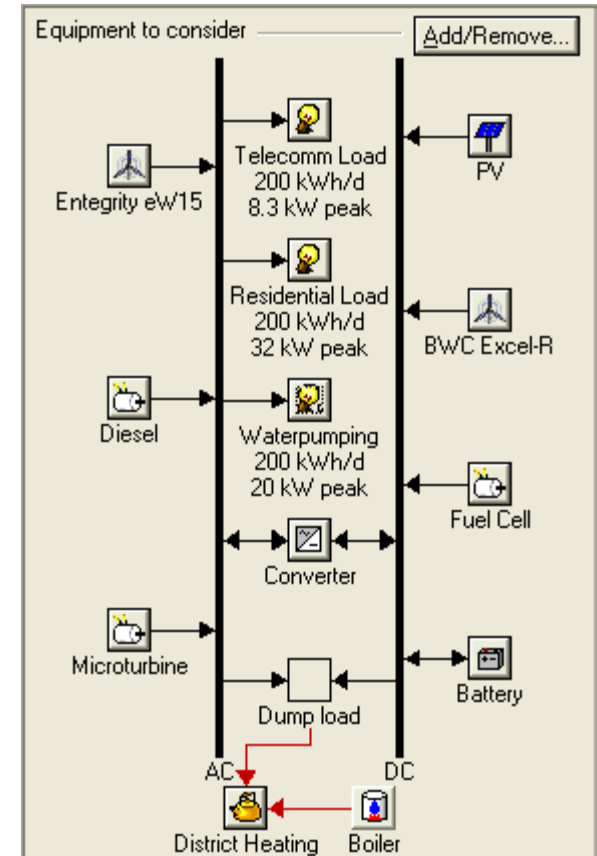
- A confused mind says “No!”
  - Resources
  - Loads
  - Equipment prices
  - Equipment performance



- **HOMER fits the pieces together**

# Fundamental HOMER Answer

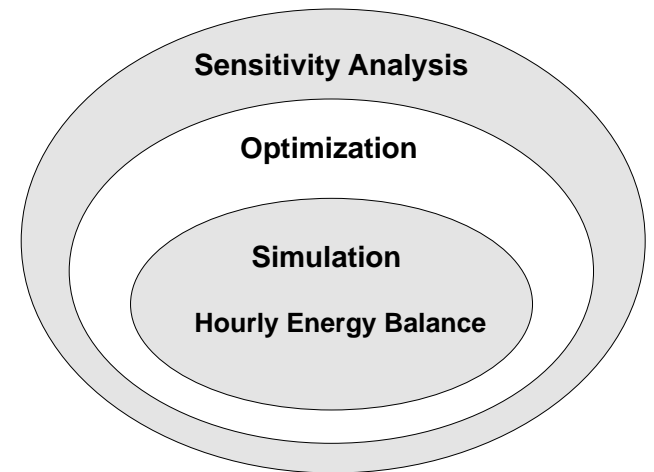
- **It depends.**
  - Resources
  - Loads
  - Equipment prices
  - Equipment performance
- Many different applications



# HOMER Analysis Layers

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- **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.....?



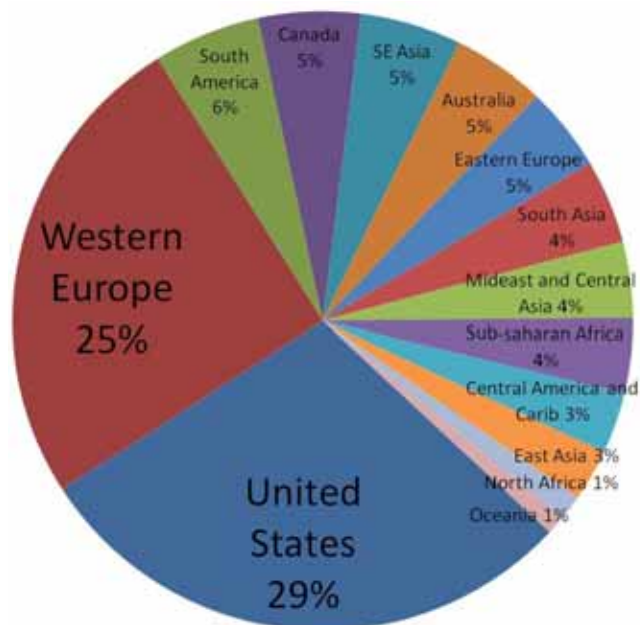
# Flexible Data Requirements

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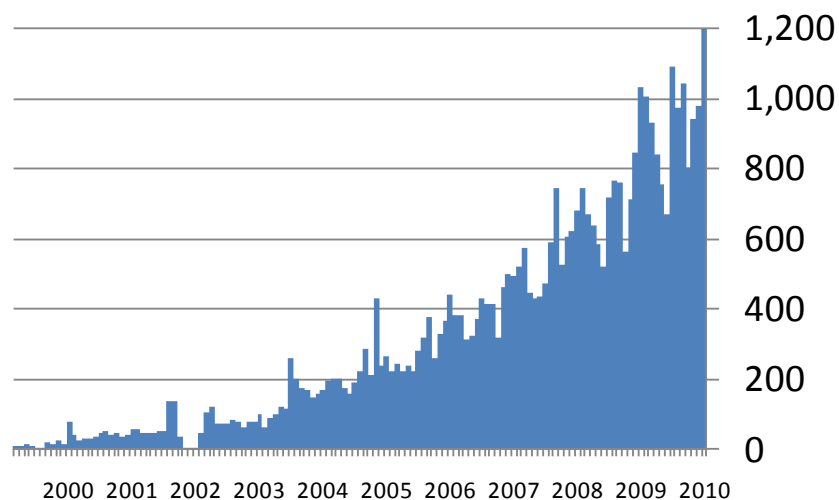
- Rough estimated inputs for general analysis
  - Annual averages for resources and loads
  - Cost per kW or unit for equipment
- Detailed inputs for system design
  - Measured hourly data
  - Detailed cost curves
  - Create your own wind turbine, battery, fuels

# HOMER

- NREL: 1992-2009
- HOMER Energy: 2009 →
- 94,000 users in 193 countries
- Market Access Opportunities



New users per month





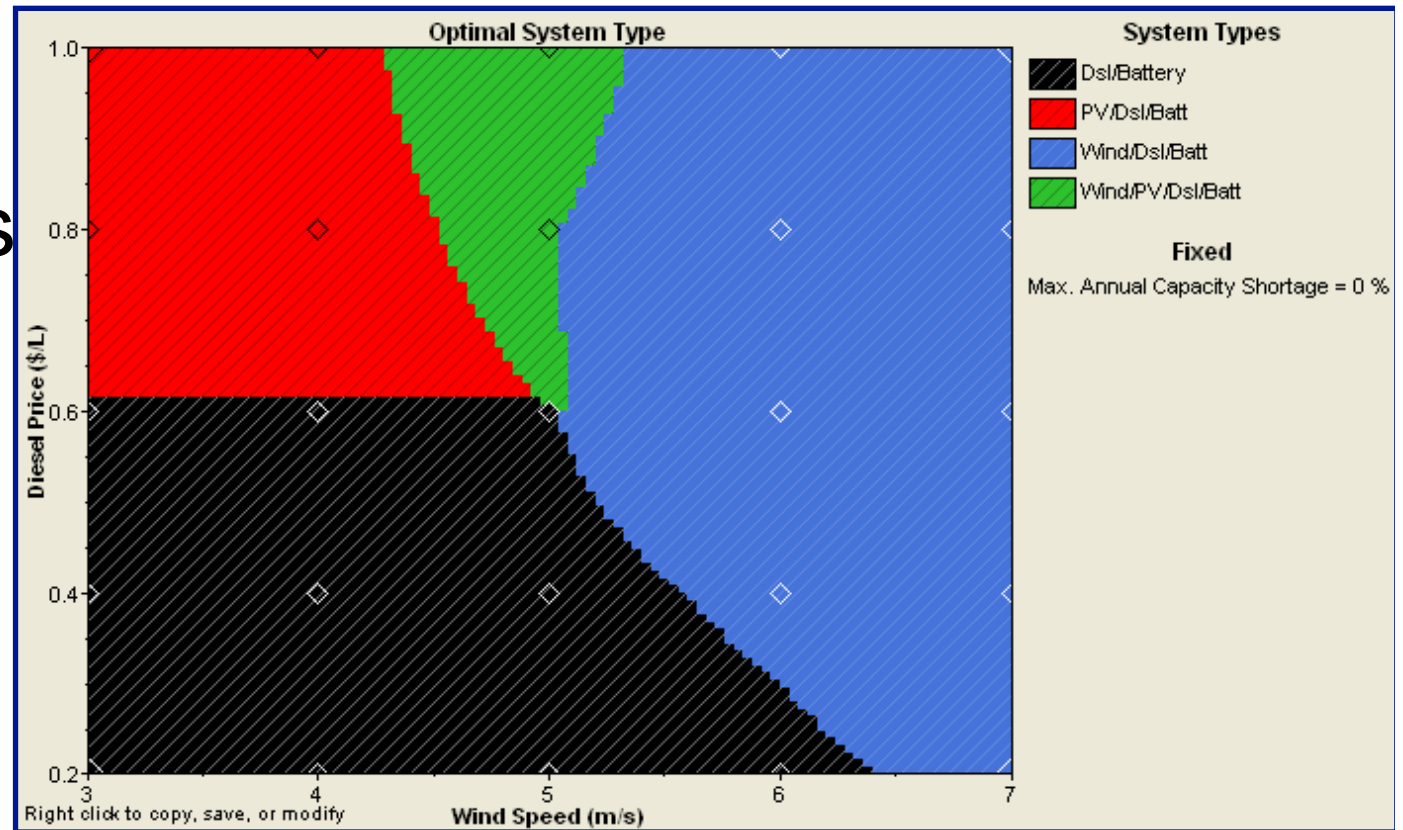
# Market Access Opportunities

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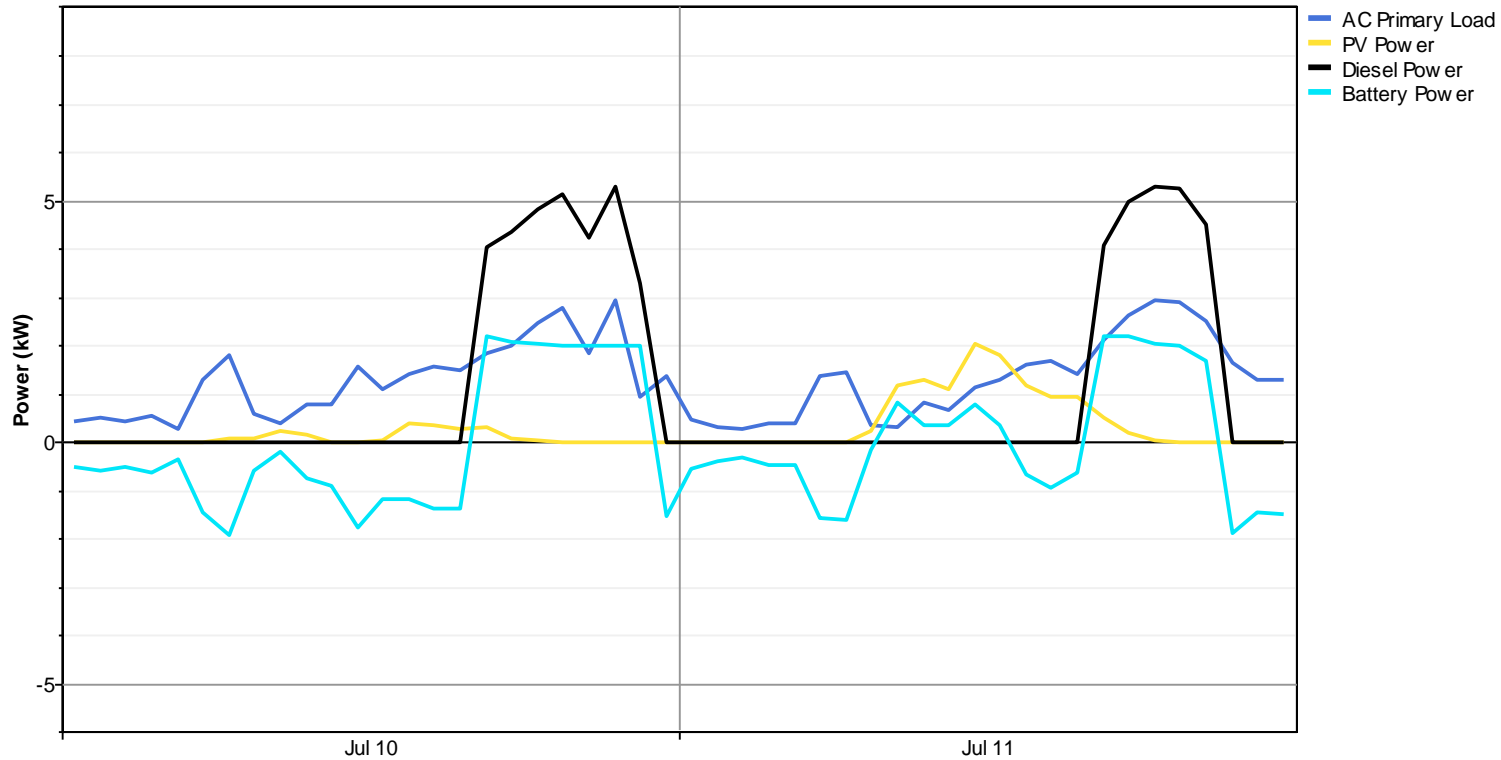
- Component Library
- Microgrid Deployment Workshop
  - Cancun November 8-9
  - In conjunction with ISES' Solar World Congress
- Newsletter
- White paper publication
- Webinars
- Market Intelligence Reports

# Optimal System Design

- What kind of system is best under which conditions?



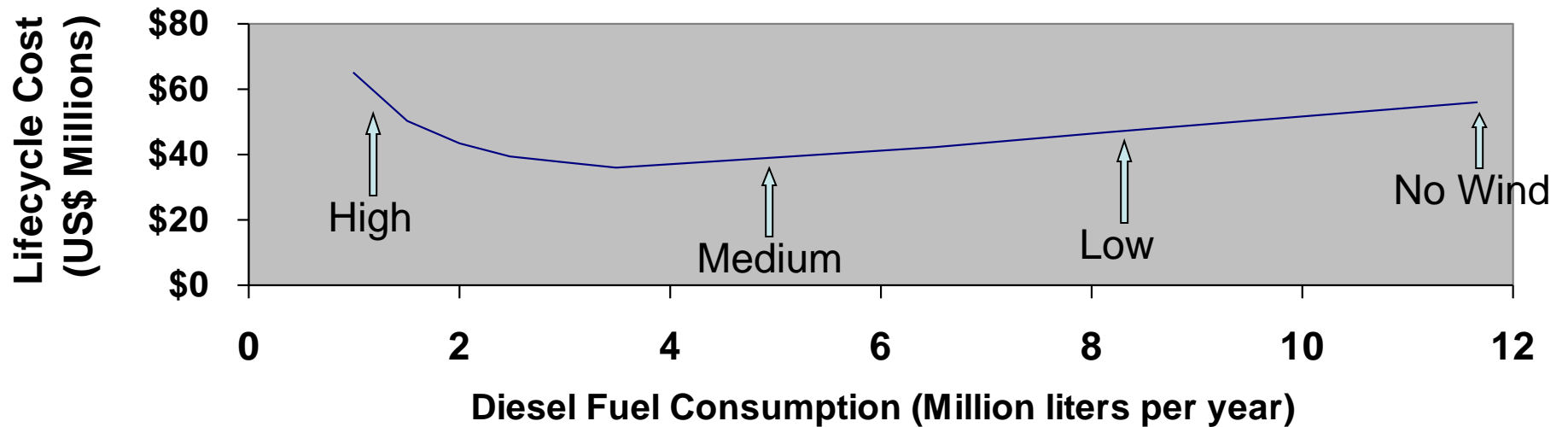
# Operational Analysis



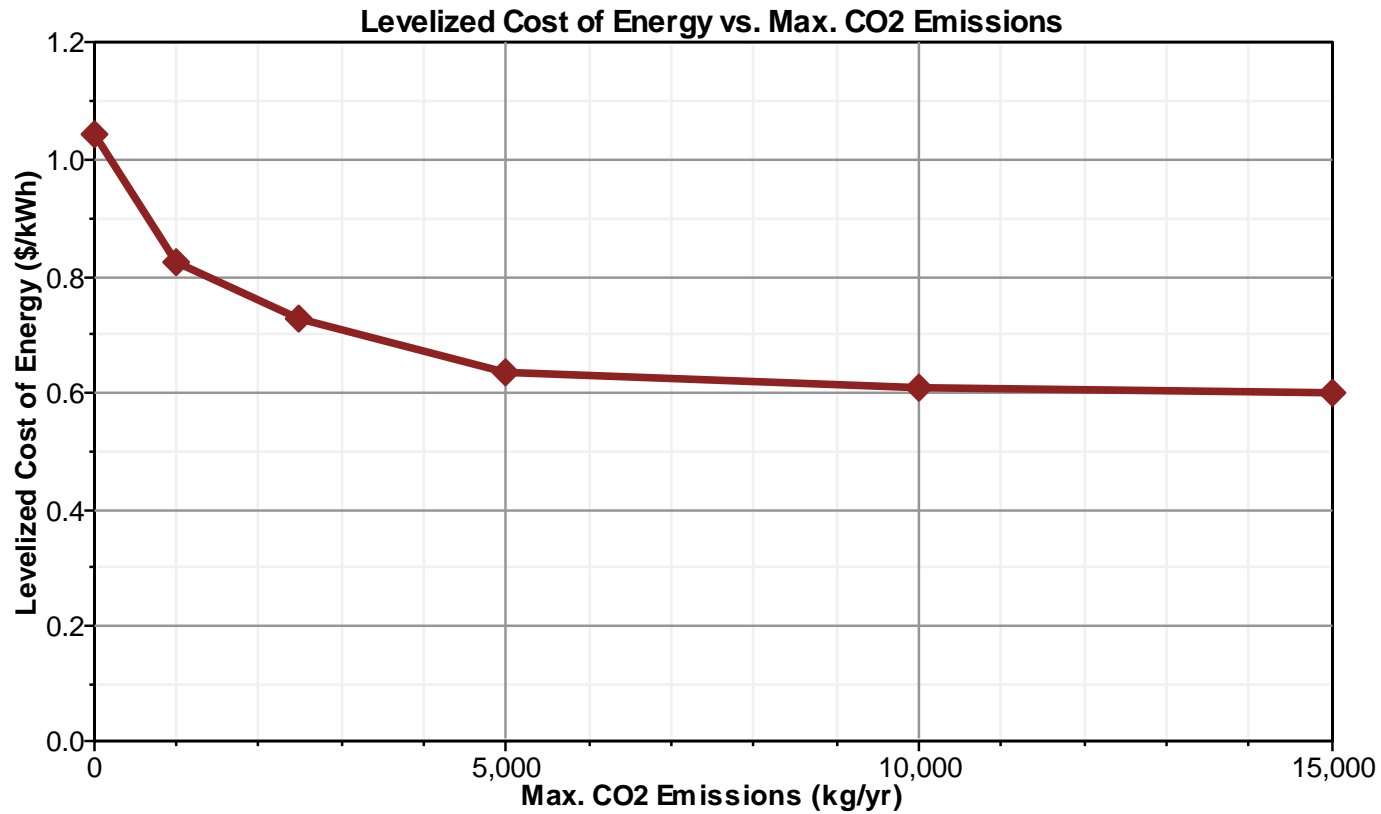
- When is backup power needed?

# Penetration Analysis from HOMER

**Molokai** (8.3 meter per second wind resource)



# Policy Analysis



- Cost of emission constraints

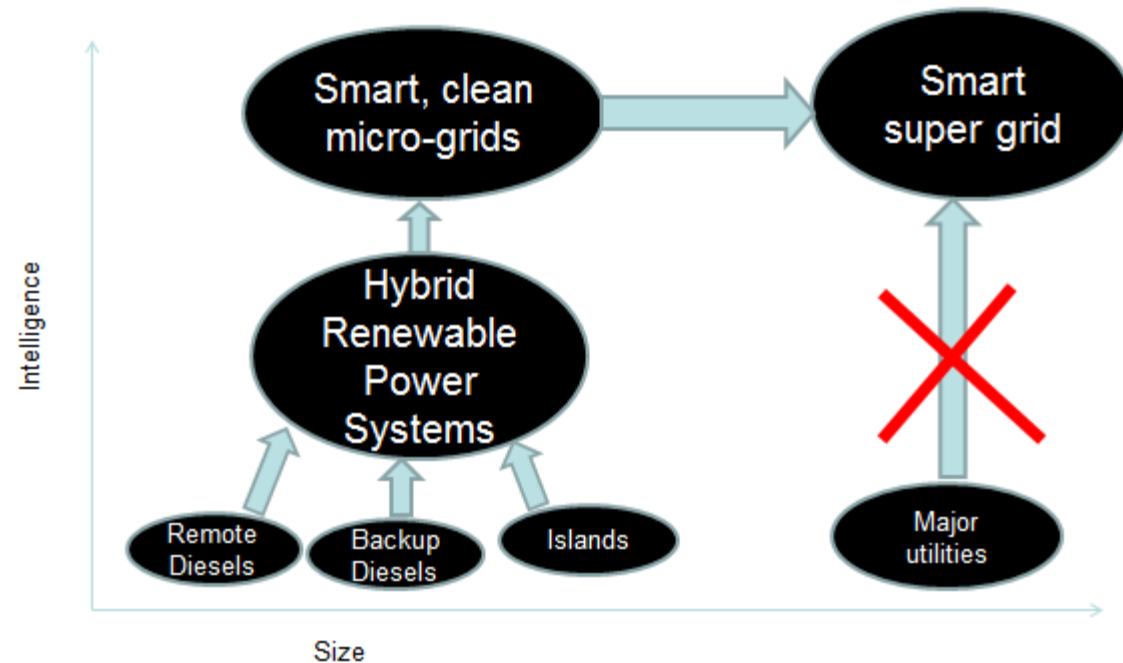
# HOMER as the Global Standard

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***“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

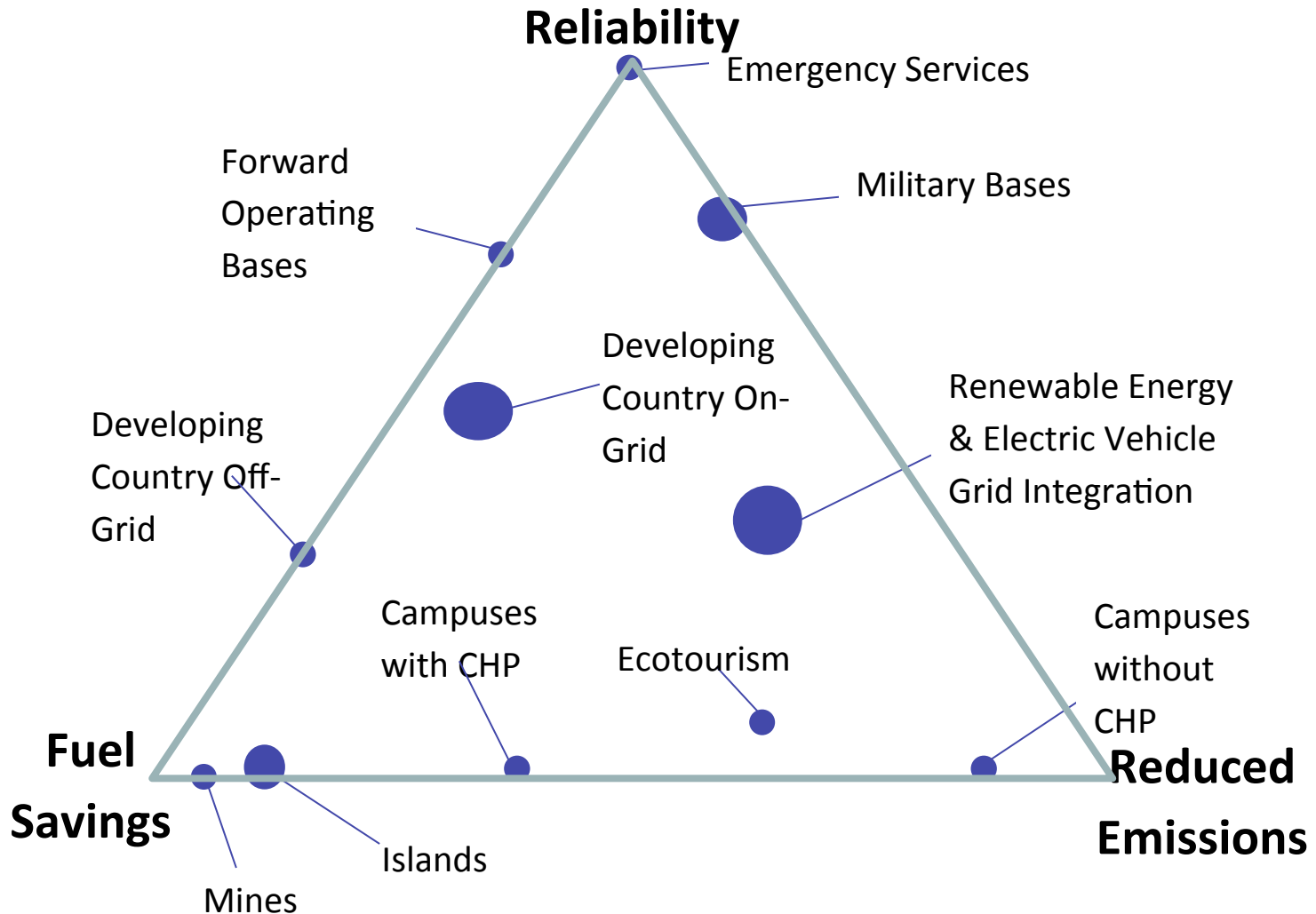
# Clean Power Evolution



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

**Micro-grids** with distributed controls for reliability and efficiency

# Microgrid Value Proposition





# Levels of renewable regimes

|                    | <b>Auxiliary equipment</b>            | <b>Impact on rest of plant</b>                  |
|--------------------|---------------------------------------|-------------------------------------------------|
| <b>Low</b>         | None                                  | none                                            |
| <b>Medium</b>      | Controls to maintain power quality    | RE curtailments possible                        |
| <b>High</b>        | Minutes of storage or load management | Re-dispatch diesels, but at least one always on |
| <b>"Very High"</b> | Grid-forming inverter                 | Ability to run diesel-off                       |
| <b>100%</b>        | Massive amounts of storage            | "Invisible" diesels                             |

# Different Definitions of Penetration

- Instantaneous Penetration
  - High winds in the middle of the night
  - Most useful measure for integration analysis
- Other measures
  - Fuel savings
  - Carbon reductions

| <b>TABLE 1<br/>PENETRATION BY<br/>VARIOUS METRICS</b> |             |              |
|-------------------------------------------------------|-------------|--------------|
|                                                       | <b>WIND</b> | <b>SOLAR</b> |
| Peak Instantaneous Penetration                        | 25%         | ~15%         |
| Penetration Based on Peak Load                        | 10%         | 10%          |
| Penetration Based on System Capacity                  | 6.67%       | 6.67%        |
| Penetration Based on energy                           | 5%          | 3%           |

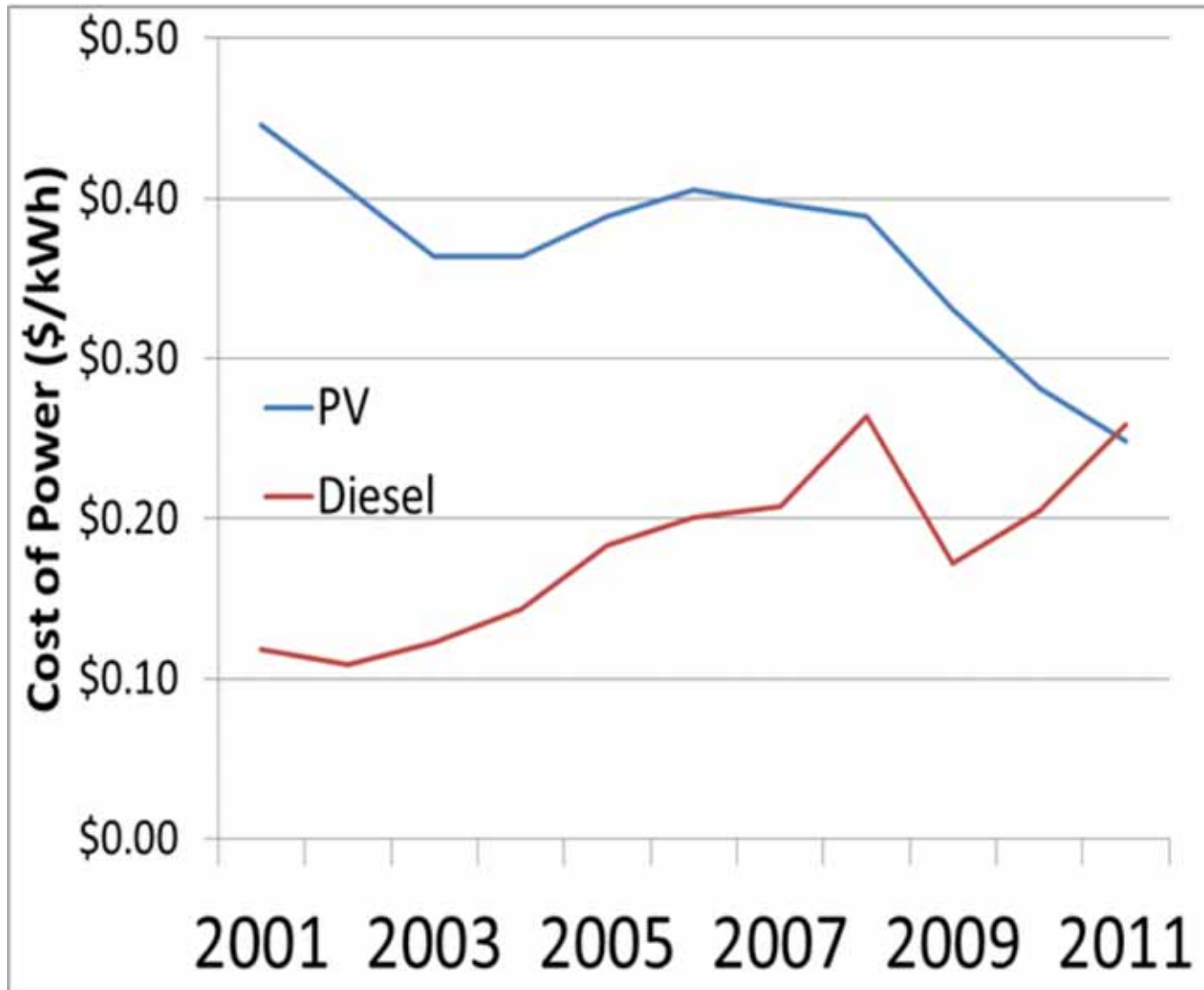
From: High Penetrations of Renewable Energy for Island Grids in Lillienthal, **Power Engineering**, November, 2007

# Valuing Storage

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- 3 broad categories
  - Reliability
    - Backup or reserves
  - Power quality
    - Frequency control, voltage control, VAR support
  - Reduces cost
    - Arbitrage, eliminate curtailments, prevent inefficient operation of other plants
- Most valuable close to load

# Diesel grid parity



# Hybrid Design Tradeoff

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Small Systems  
High Penetration

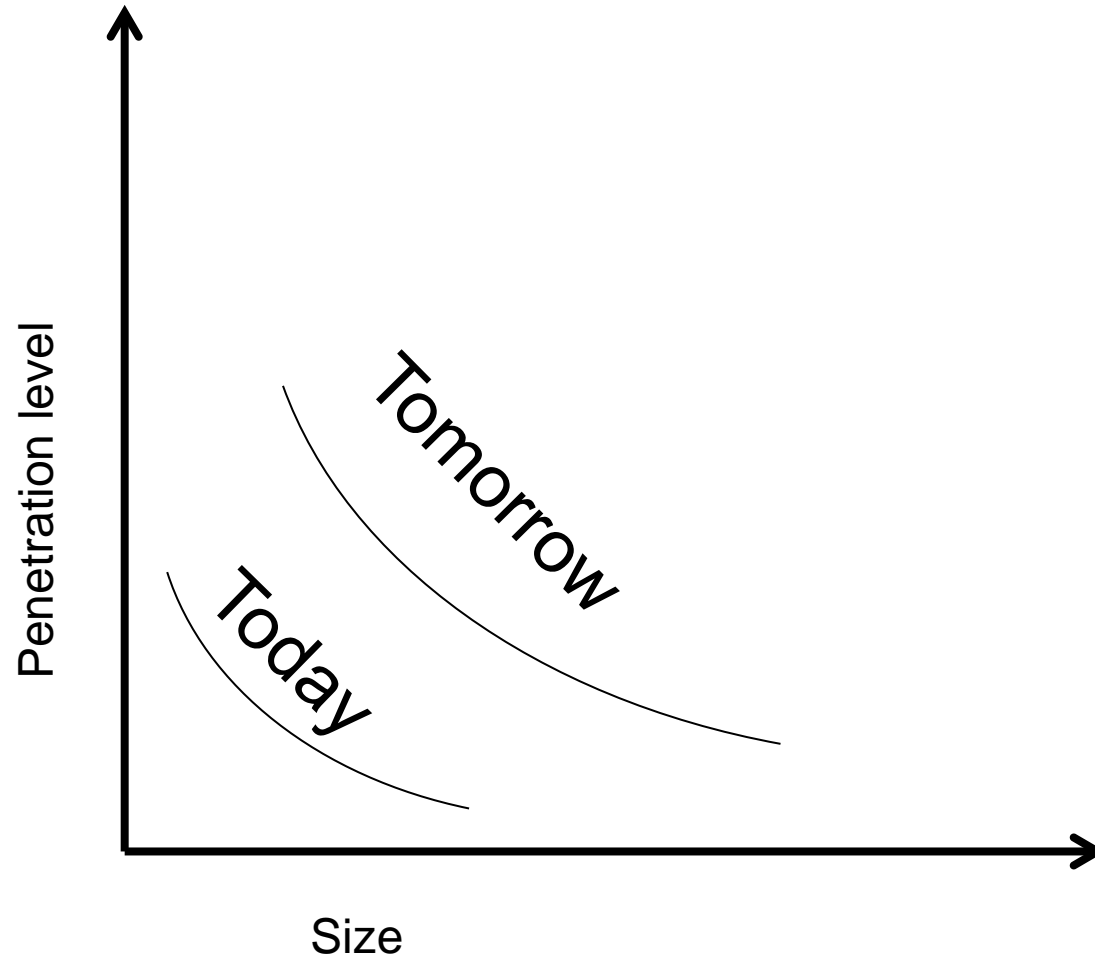
Large Systems  
Low – Med. Penetration



Solar Home  
Systems

Multi-megawatt  
scale systems

# Hybrids are the future



# Contact info

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- HOMER 2 available on our website.
- HOMER Explorer still in Beta, to be formally released later this year.
- HOMER Pro Beta to follow
- Expanded component library
- Web-based marketing apps
- For more information:
  - Website: [www.homerenergy.com](http://www.homerenergy.com)
  - Users' group: [homerusersgroup.ning.com](http://homerusersgroup.ning.com)