

Microgrids Simplified

Deriving Insights from the HOMER Software About Mini-grid Options for Energy Access

June 9, 2016

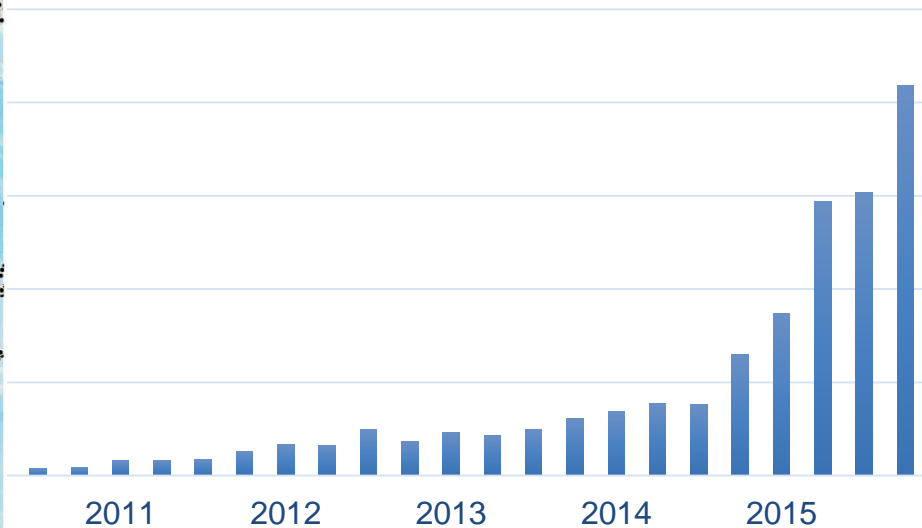
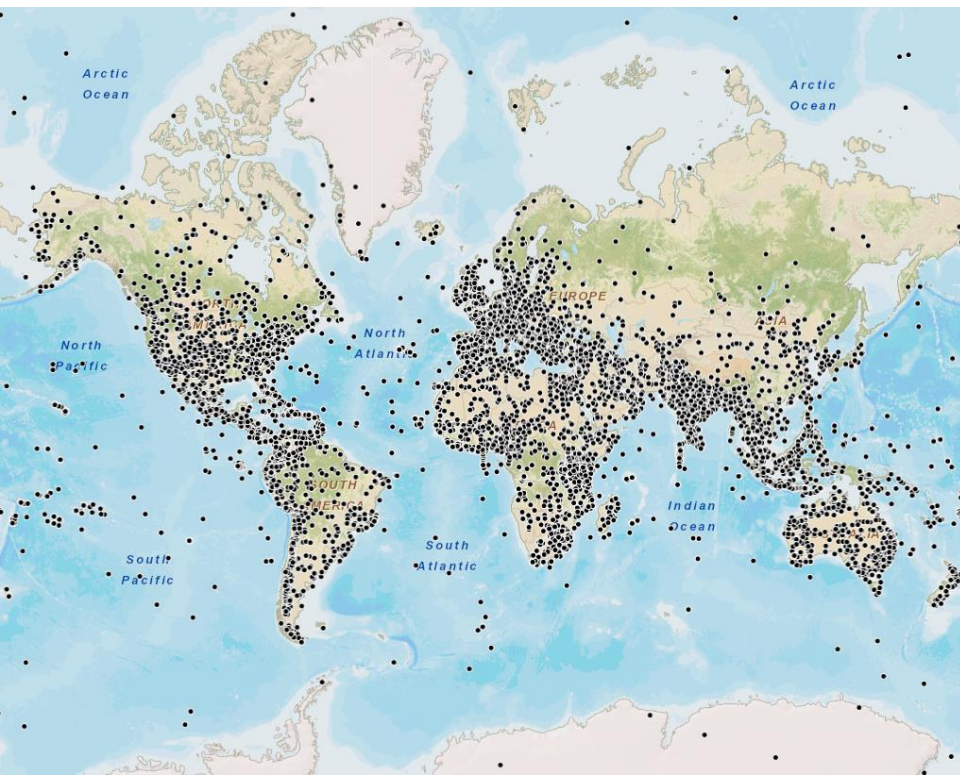
Asia Clean Energy Forum
Manila, Philippines

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Who is HOMER?

- NREL: 1992-2008
- Original developers now at HOMER Energy
- 160,000 users in 193 countries



Too Many Choices

Solar

Fuel Cells

Wind



Hydro

Micro-turbines

Geothermal

Micro-grids

Biomass

Demand Response

New Storage Techs.

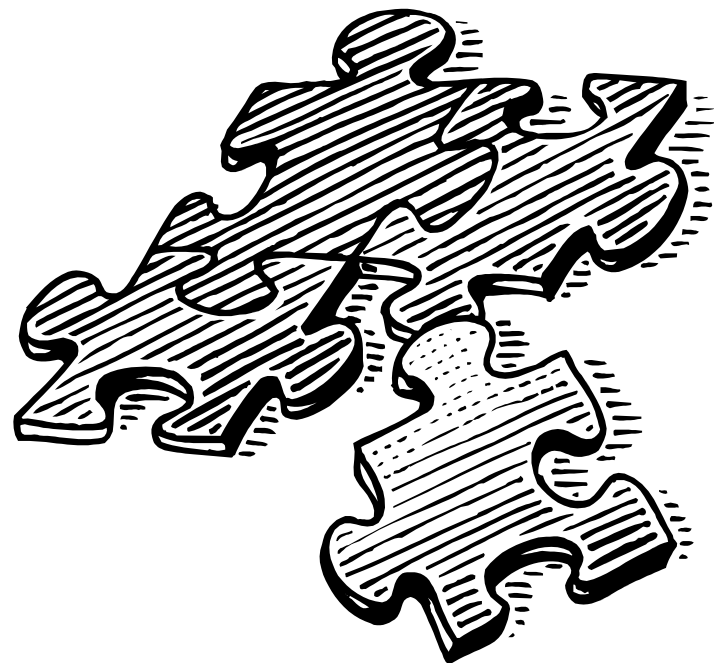
Load Management

Electric Vehicles

Smart grids

What is best?

- It depends on:
 - Resources
 - Loads
 - Equipment prices
 - Equipment performance

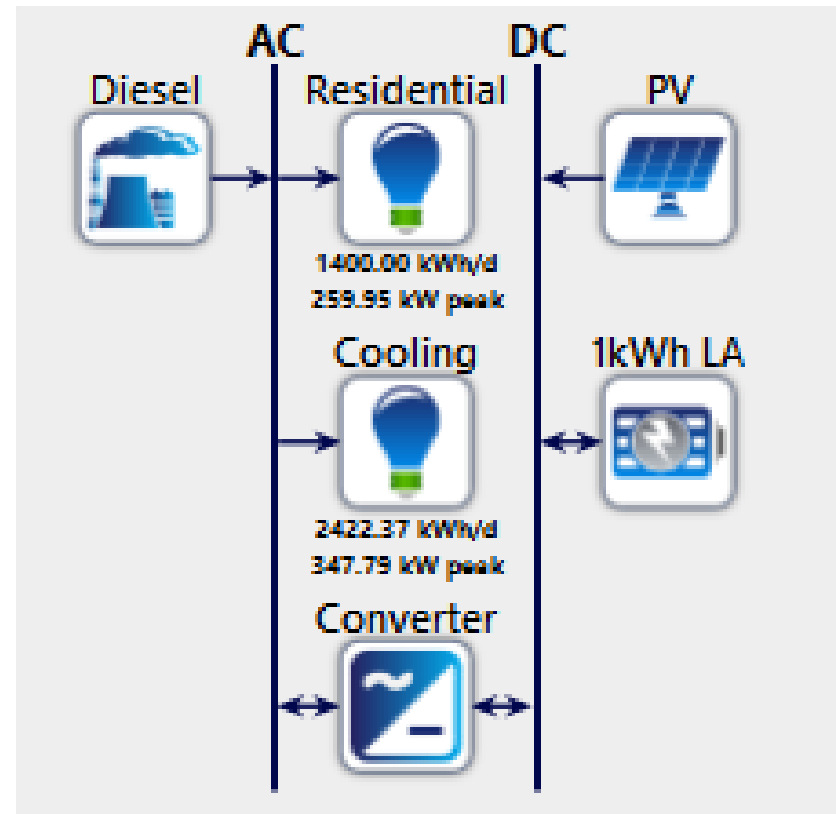


- **A confused mind says “No!”**
 - **HOMER fits the pieces together**
-

HOMER

- Industry standard for hybrid micro-grids

- Conventional resources
- Renewable resources
- Storage
- Load Management



HOMER Analysis Layers

Design the most cost effective system by analyzing thousands of systems in minutes

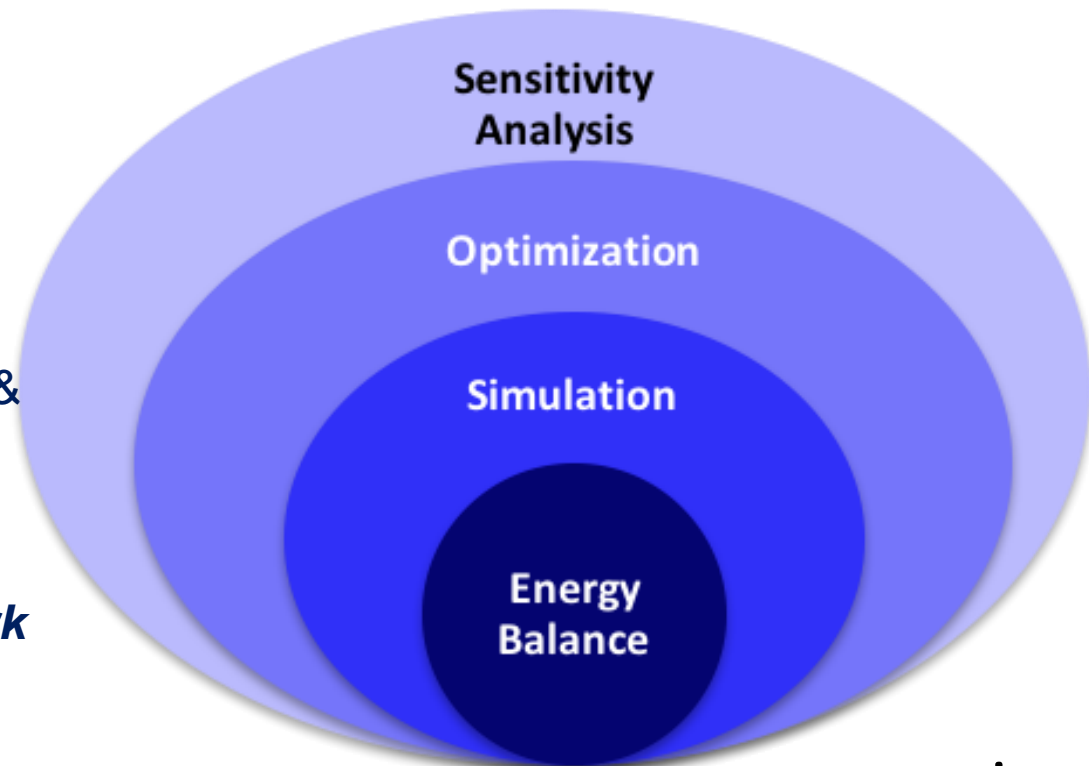
Sensitivity Analysis -

Evaluates uncertain inputs: prices, weather, loads,

Optimization - LCOE, reliability, max. renewables, & resiliency

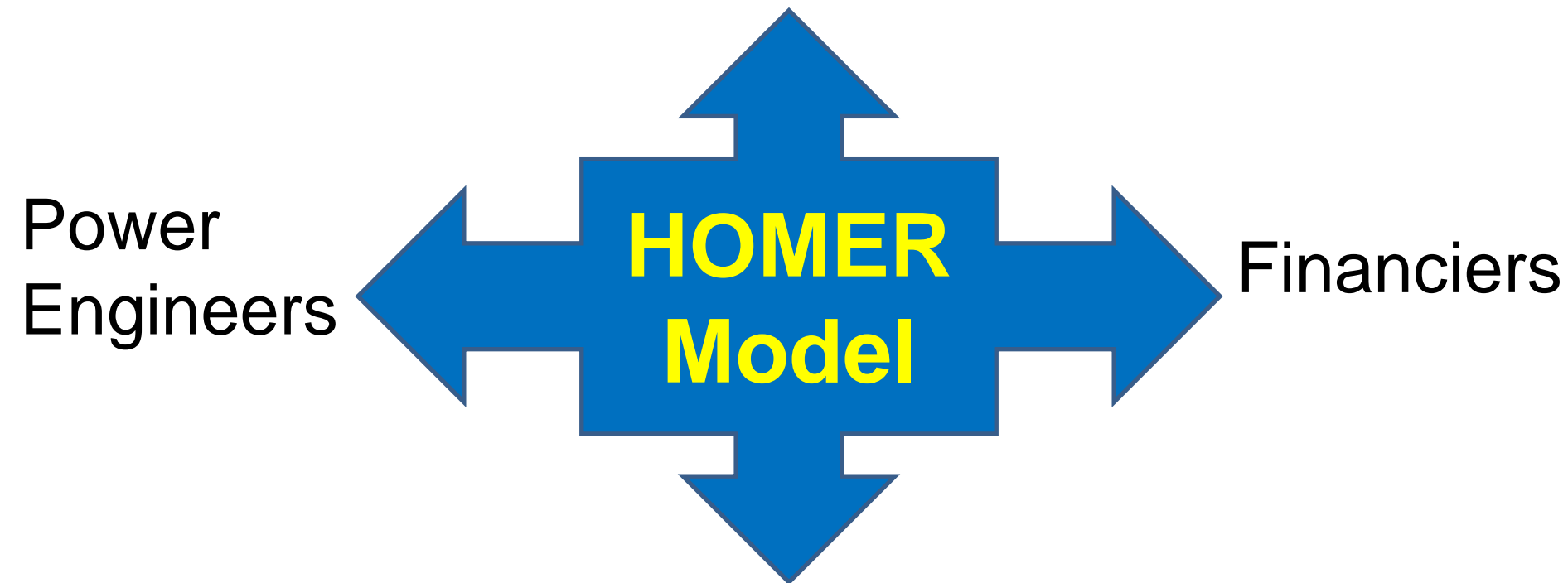
Simulation - Time varying loads & resources require chronological analysis for entire year

Engineering and economics work side by side to arrive at an ANSWER!



HOMER as a Communication Tool

Renewable Advocates

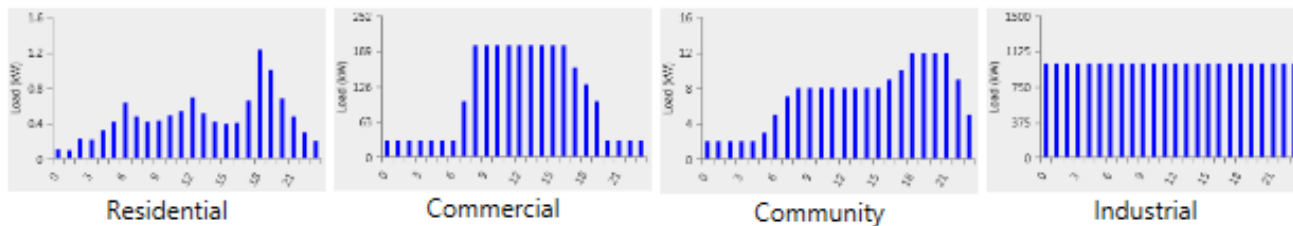


Diesel Mechanics

HOMER bridges different worlds

New in HOMER Pro

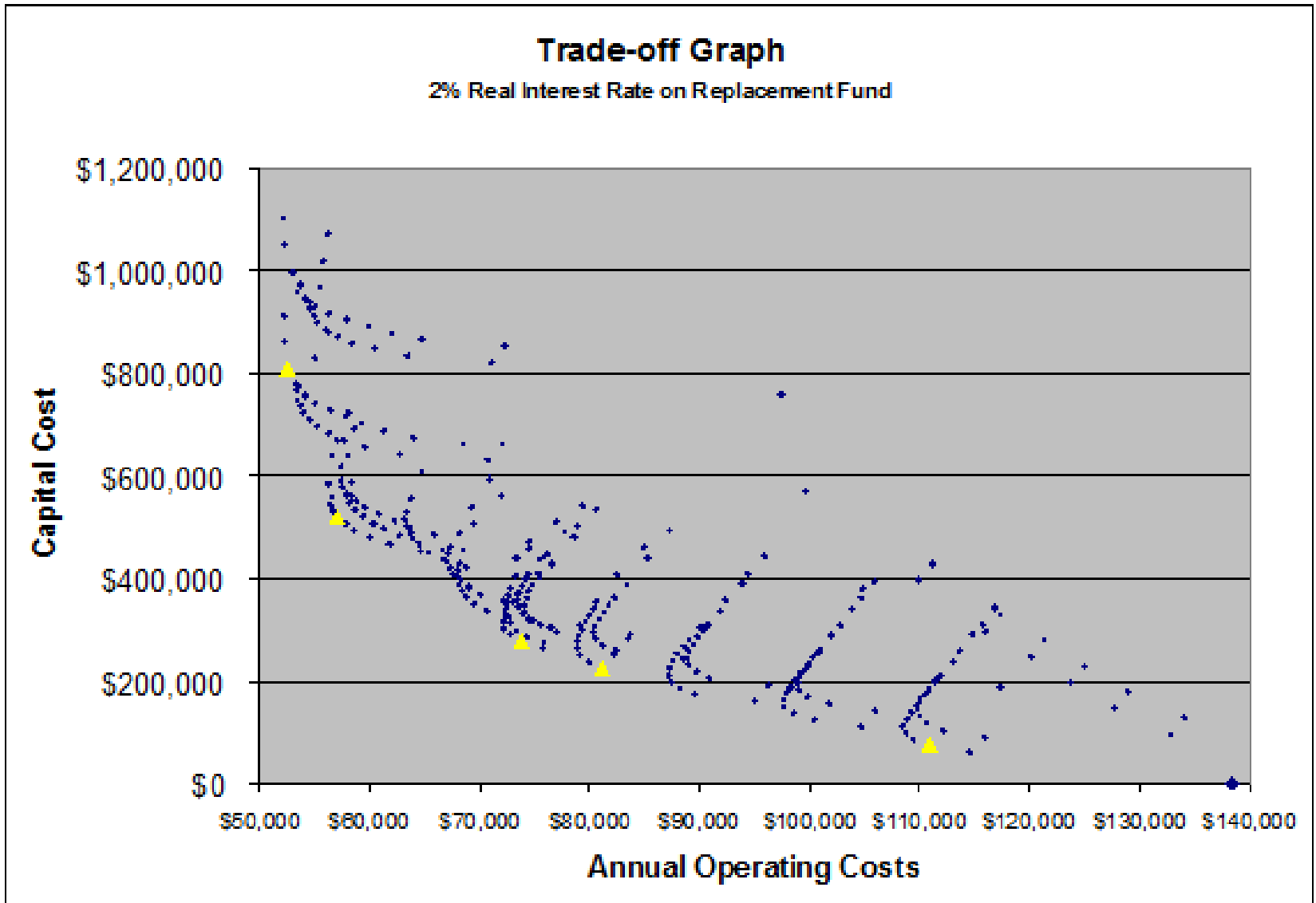
- Optimizer
- Getting Started Wizard
- Unreliable Grid
- Advanced Battery
- Multi-year
- API's
- Load Profiles



Sustainable Tariffs

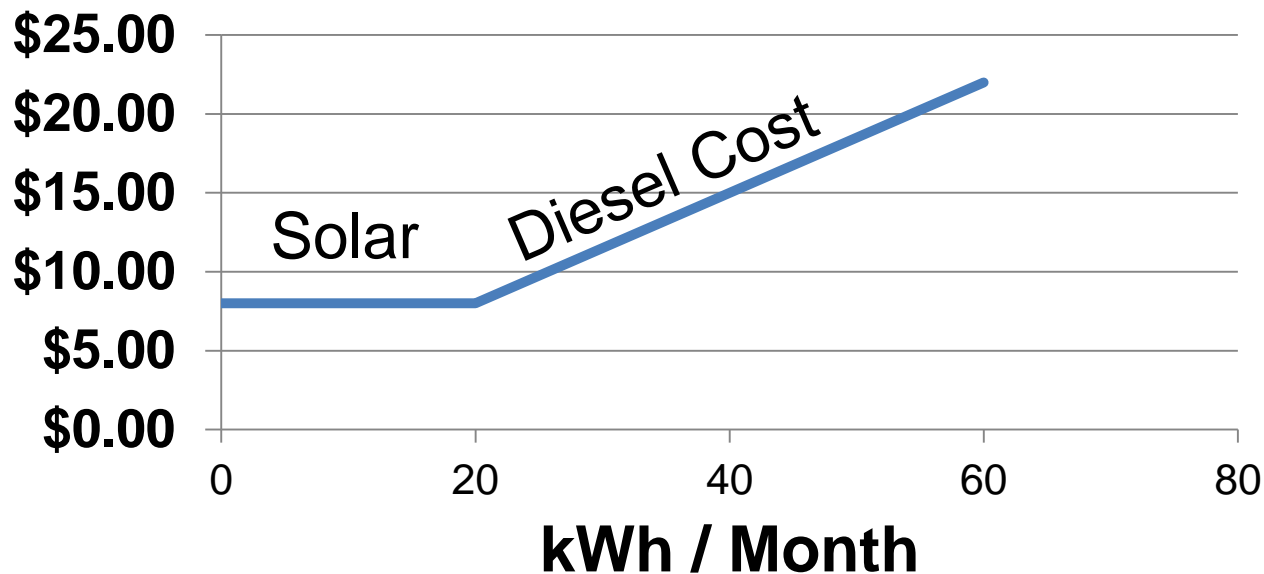
- Affordable
 - Consumers
 - Producers
 - Government
- Equitable
 - Subsidy goes to poor
- Efficient
 - Incentive to use efficient appliances
- Capital subsidies to reduce operating cost

Capital / Operating Cost Tradeoff



Two-part Tariff

Monthly Cost



- Wealthy households don't get more of the subsidy
- Limited fiscal burden
- Maintain incentive for energy efficiency
- Full cost recovery for increased load
 - Pays for system expansion

Other Tariff Concepts

- Productive uses based on solar
- Evening household use based on diesel
- Night-time use based on battery wear
- Waterpumping based on excess energy

Renewable Penetration: Definition

- 8 definitions
 - Based on capacity or energy
 - Instantaneous versus average
 - Allocation of excess energy
- Factor of 10 difference

Taxonomy of System Designs

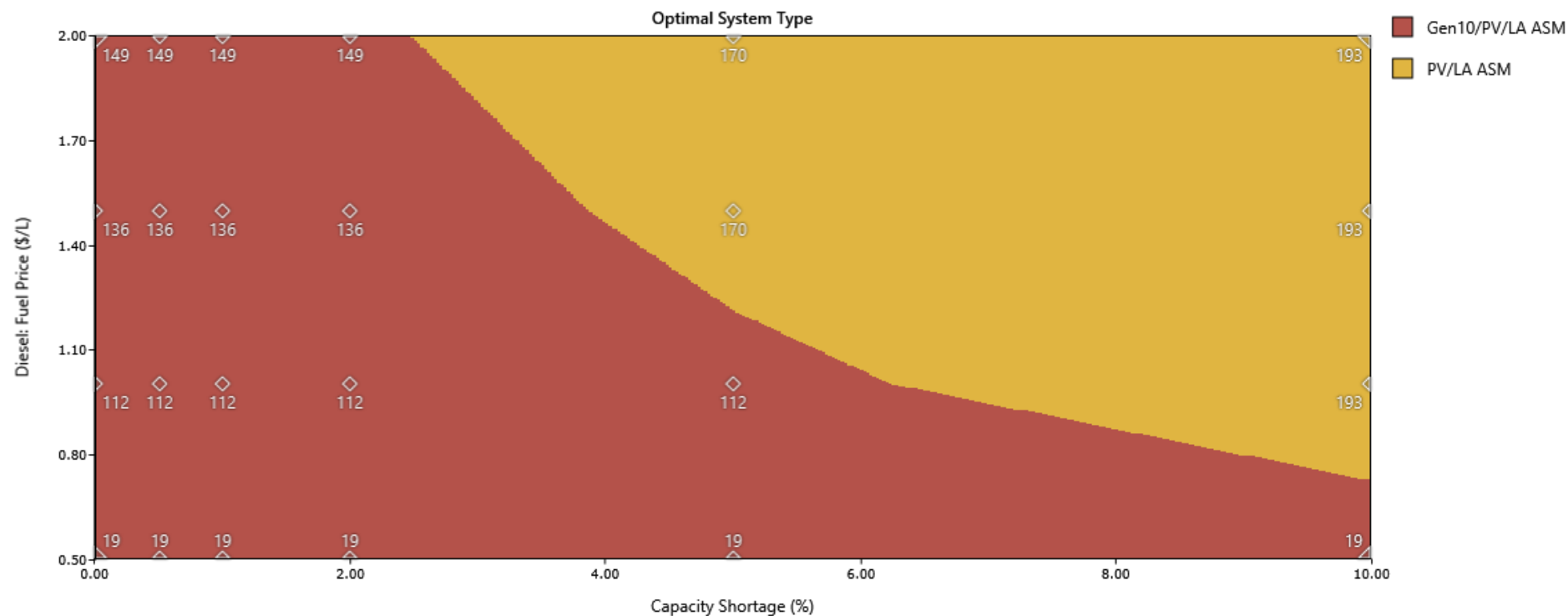
- Low penetration
 - RE variability comparable to load variability
- Medium penetration
 - Curtail renewables to protect diesels
- High penetration (large systems)
 - Re-dispatch diesels for O&M & greater fuel savings
- Very high penetration
 - Run diesel-off except during low resource periods
 - Requires grid-forming inverter

100% renewables without diesel backup

- Advantages:
 - No fuel supply issues
 - Vastly reduced maintenance
- Disadvantages:
 - Unmet load
 - Battery management

- Applicable for very small systems

Capacity Shortage without backup



HOMER Energy's Services

HOMER[®] Software: Global standard for microgrid design

Education, Training, & Capacity Building

Consulting: Model reviews and strategic planning

Market Access: Connecting suppliers with projects



Conclusions

- **No “one-size-fits-all” solution**
- Make load growth pay for itself
- Base tariffs on incremental cost
- Small systems based on batteries
- Large systems based more on diesel
- **30 day free trial**