

Optimizing Clean Power Everywhere

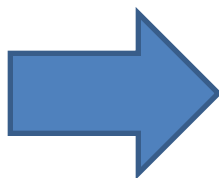
Remote Microgrid Business Models

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The Future of Power

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



But what is holding us back?

Business Case Challenges

- Where are the policies?
- What technologies?
- Who are the stakeholder? How do they think?
- Where are the applications?
- How are the systems designed?
- Why microgrids?

Too Many Choices

Solar

Fuel Cells

Wind

Hydro

Micro-turbines

Geothermal



Micro-grids

Biomass

Demand
Response

New Storage Techs.

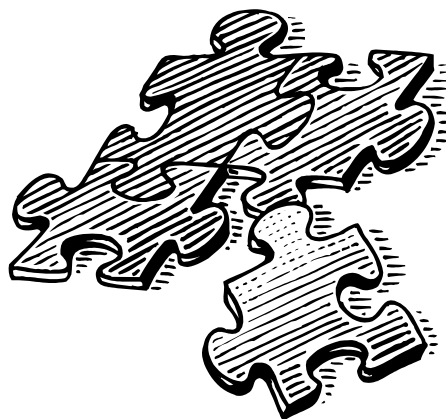
Electric
Vehicles

Load Management

Smart grids

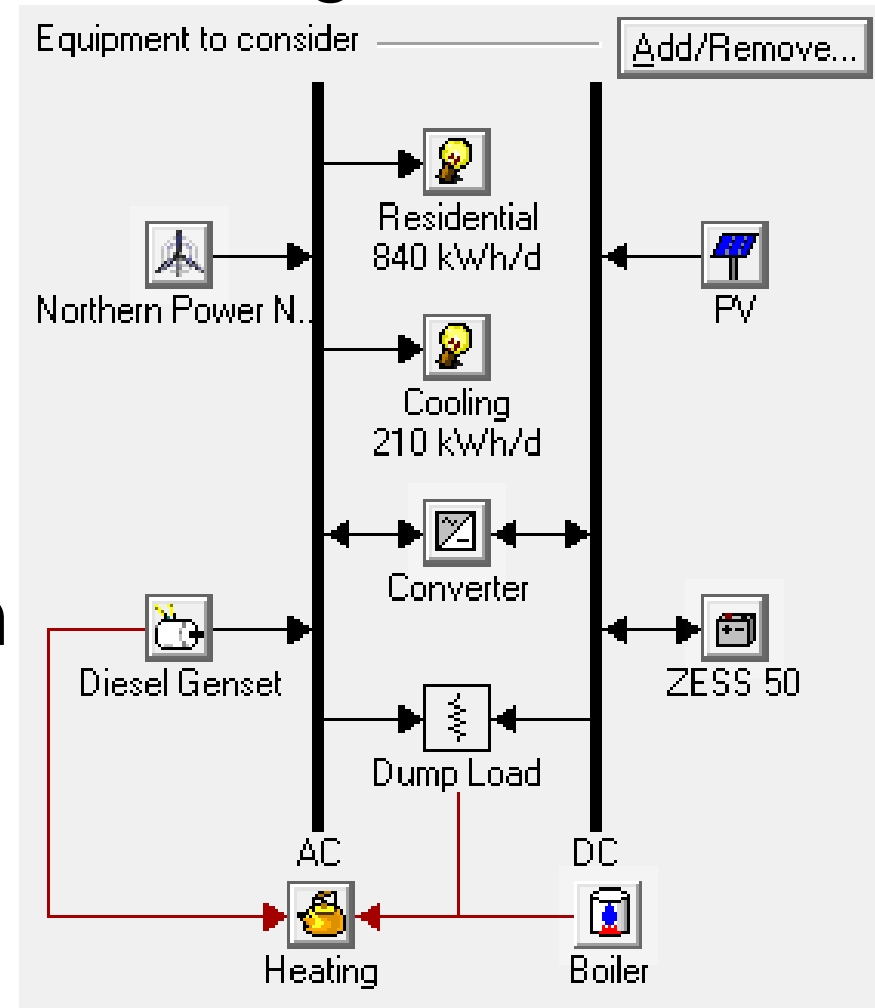
What is best?

- Unfortunately, it depends on:
 - The application
 - Loads
 - Resources
 - Equipment prices
 - Equipment performance
- **A confused mind says “No!”**



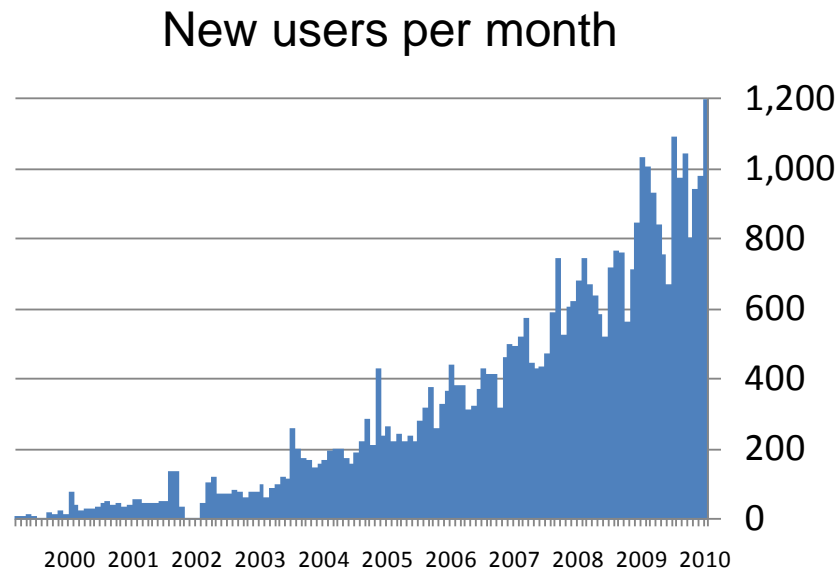
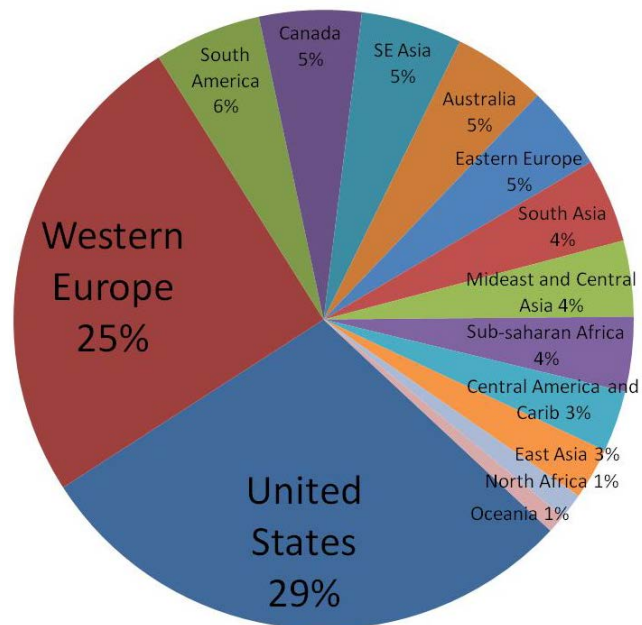
HOMER

- Global standard for hybrid micro-grids
 - Conventional resources
 - Renewable resources
 - Storage
 - Load Management
- Chronological Simulation
- Optimization
- Decision Analysis

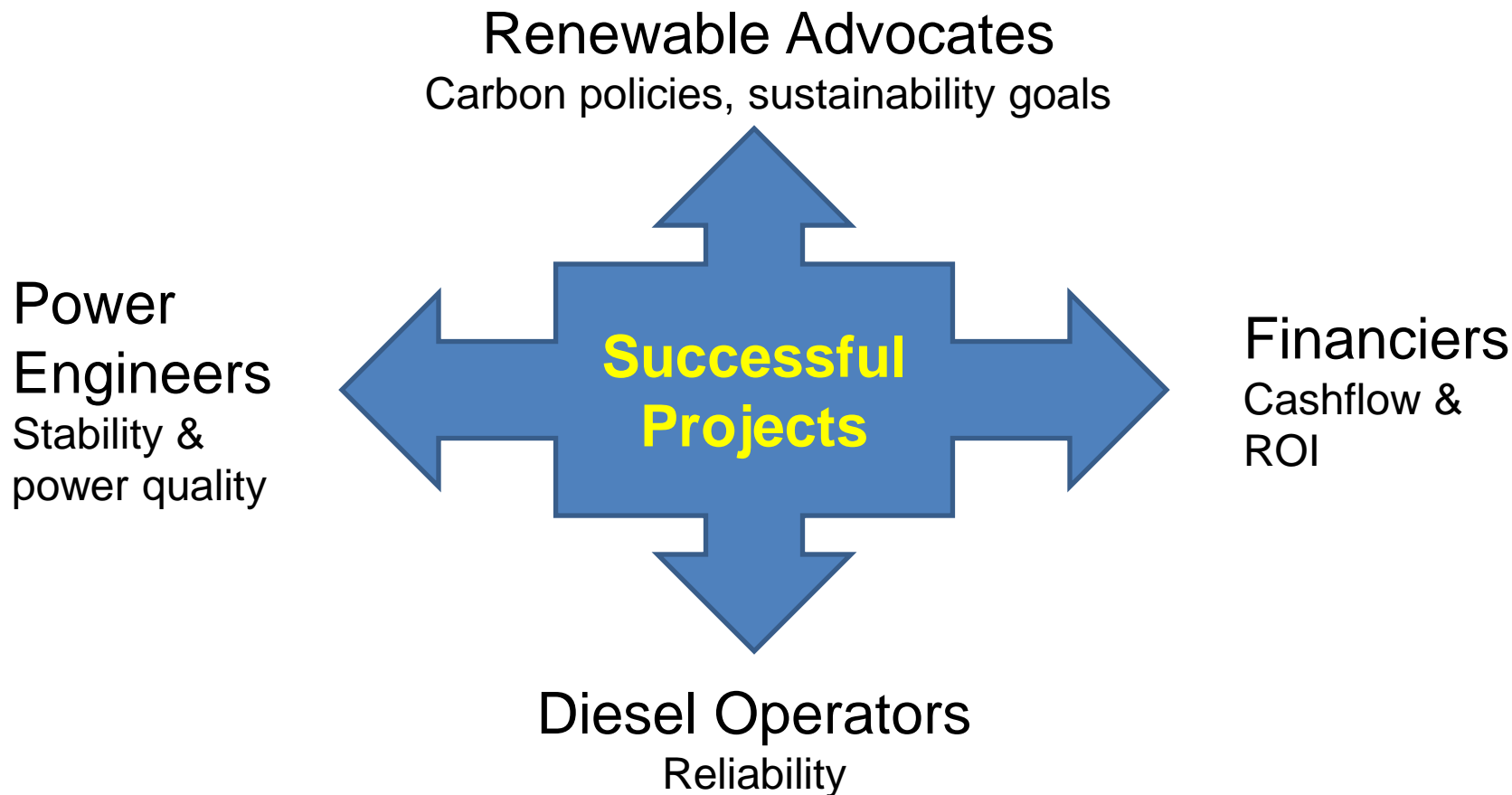


HOMER

- NREL: 1992-2009
- Original developers now at HOMER Energy
- 98,000+ users in 193 countries



Models Create a Common Language



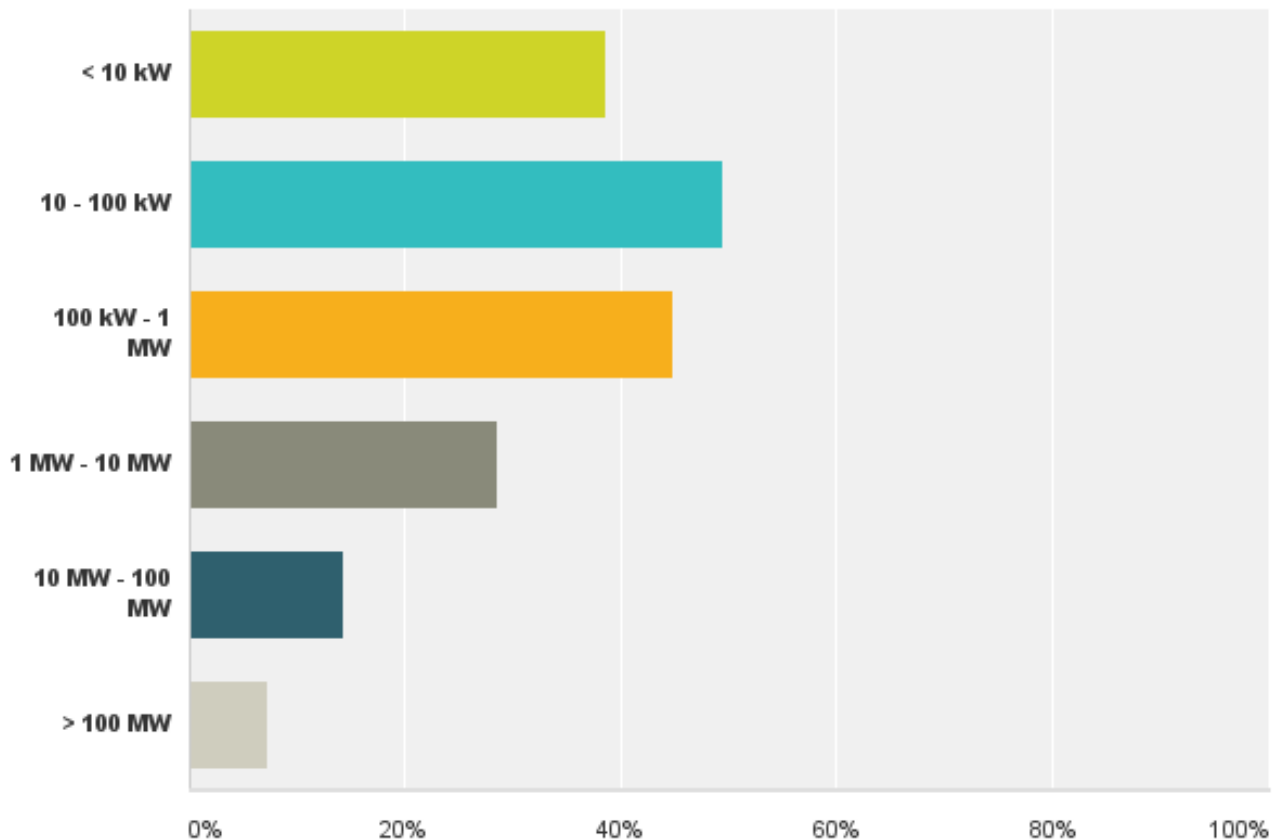
Equipment suppliers:

Navigate entire ecosystem to find customers, design alternatives and submit proposals.

Survey Results

Q3 I am interested in power systems that serve peak loads that are

Answered: 554 Skipped: 0



Types of Microgrids

	Existing generation	Major challenge
Village Power for Energy Access	Nothing	Local management entity
Dumb, dirty, diesel microgrids	A single, part-time diesel	User & operator education
Island microgrids	A real utility plant burning liquid fuels	Integration
Grid-connected microgrids	A back-up system	Economics

Levels of renewable regimes

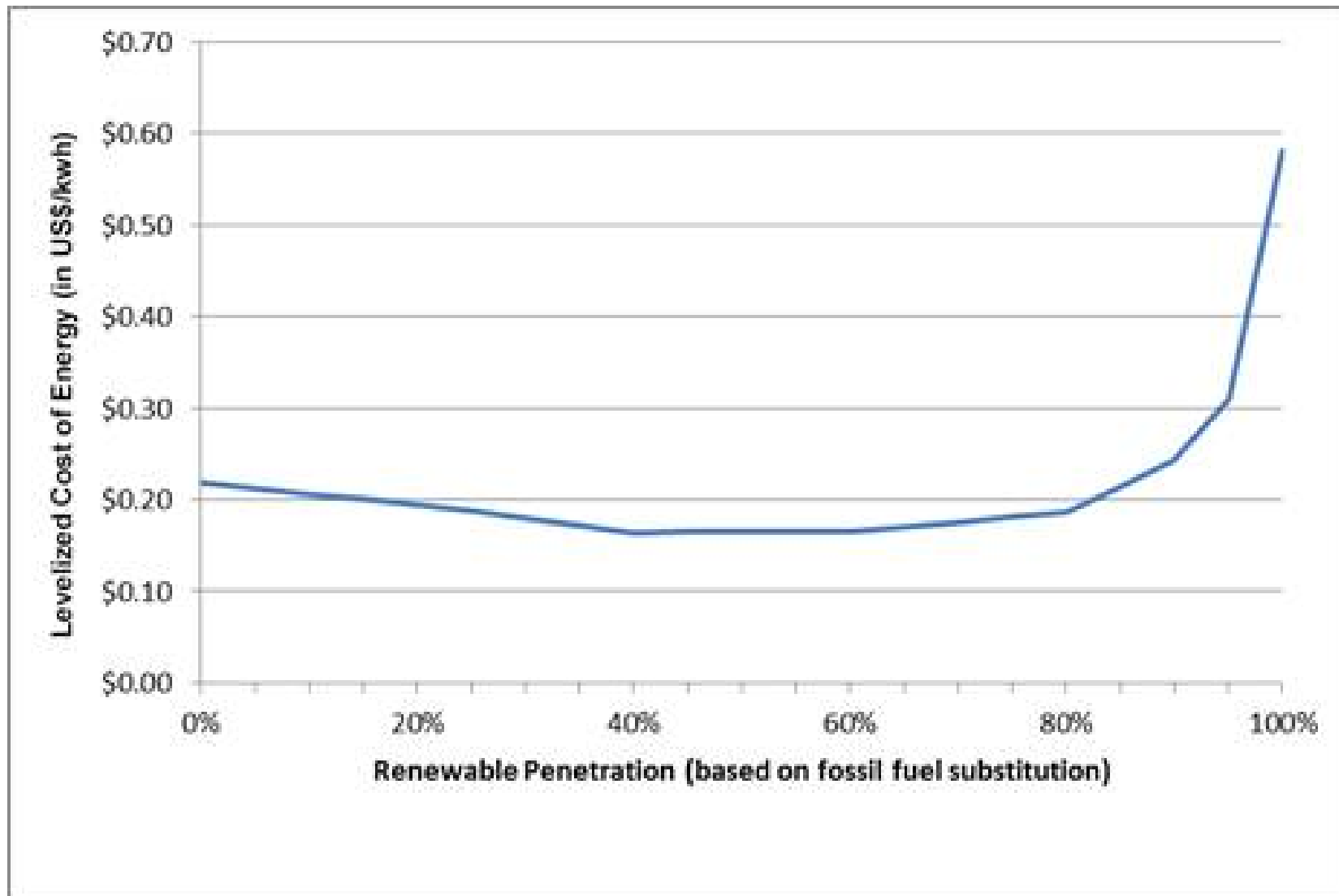
Low	No Special Controls
Medium	Control excess renewables
High	Re-dispatch diesels
Very high	Operate diesel off

- More renewables requires:
 - More intelligent controls
 - Storage, electric or thermal
 - Load management
- Five different penetration metrics

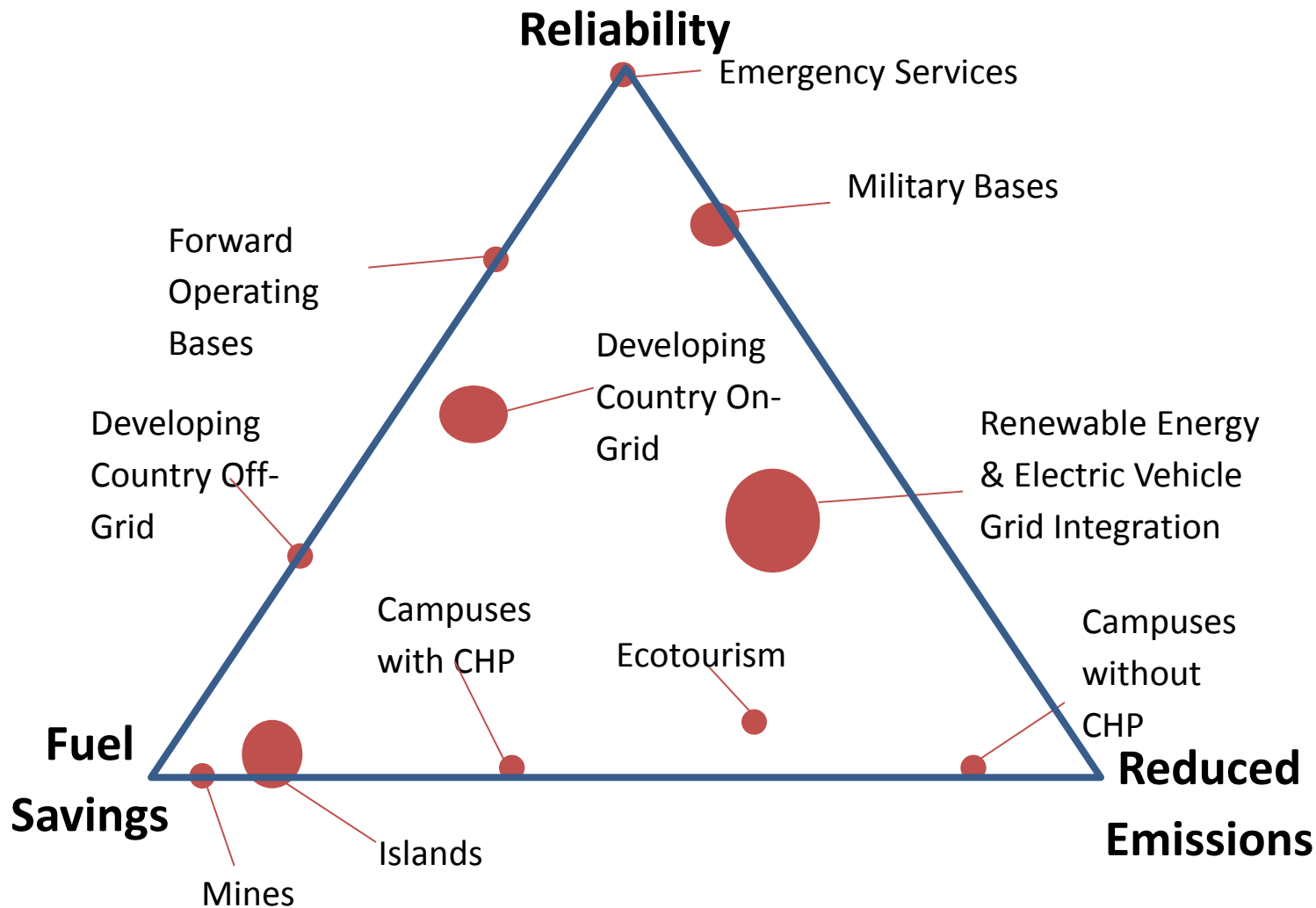


St. Paul, Alaska

100% Renewable. Really?



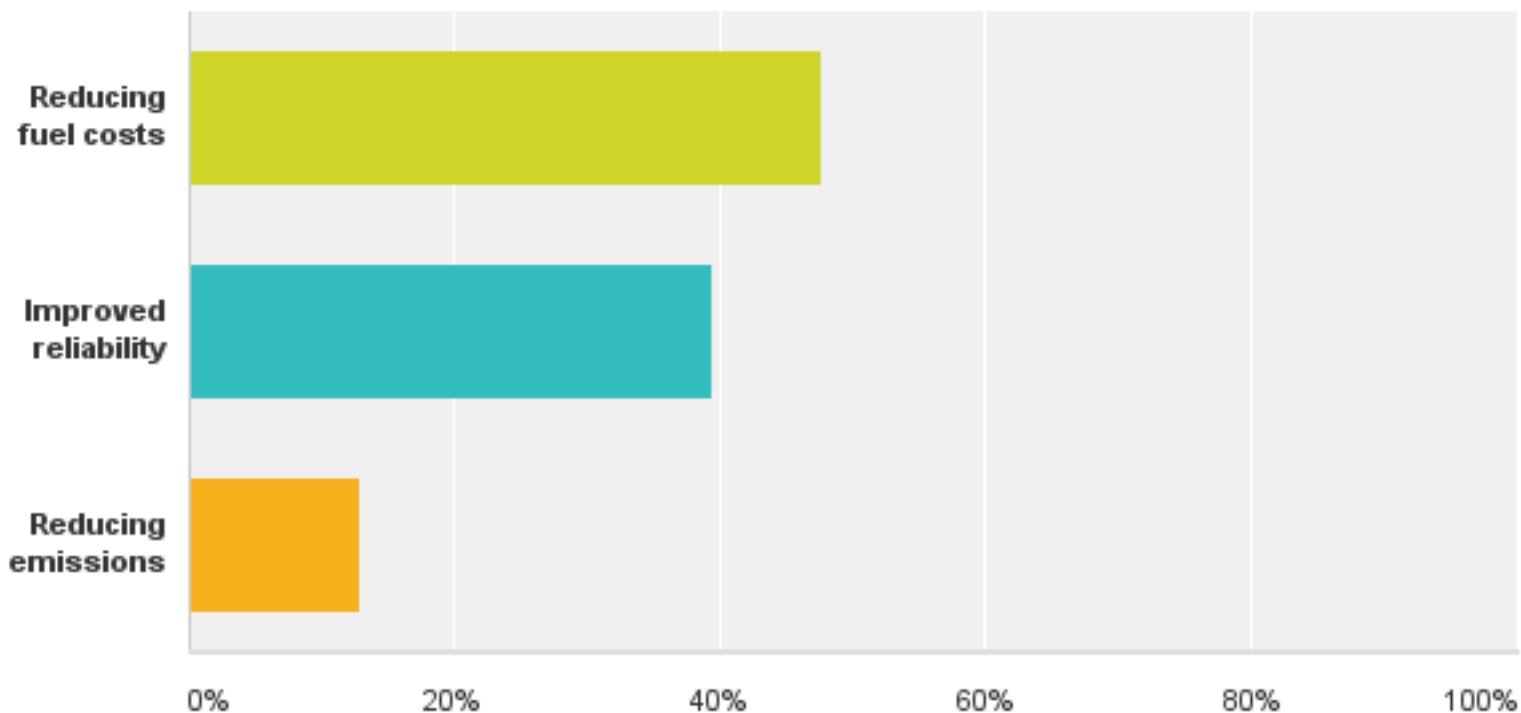
Microgrid Value Proposition



Survey Results

Q5 I believe the strongest rationale for microgrids is

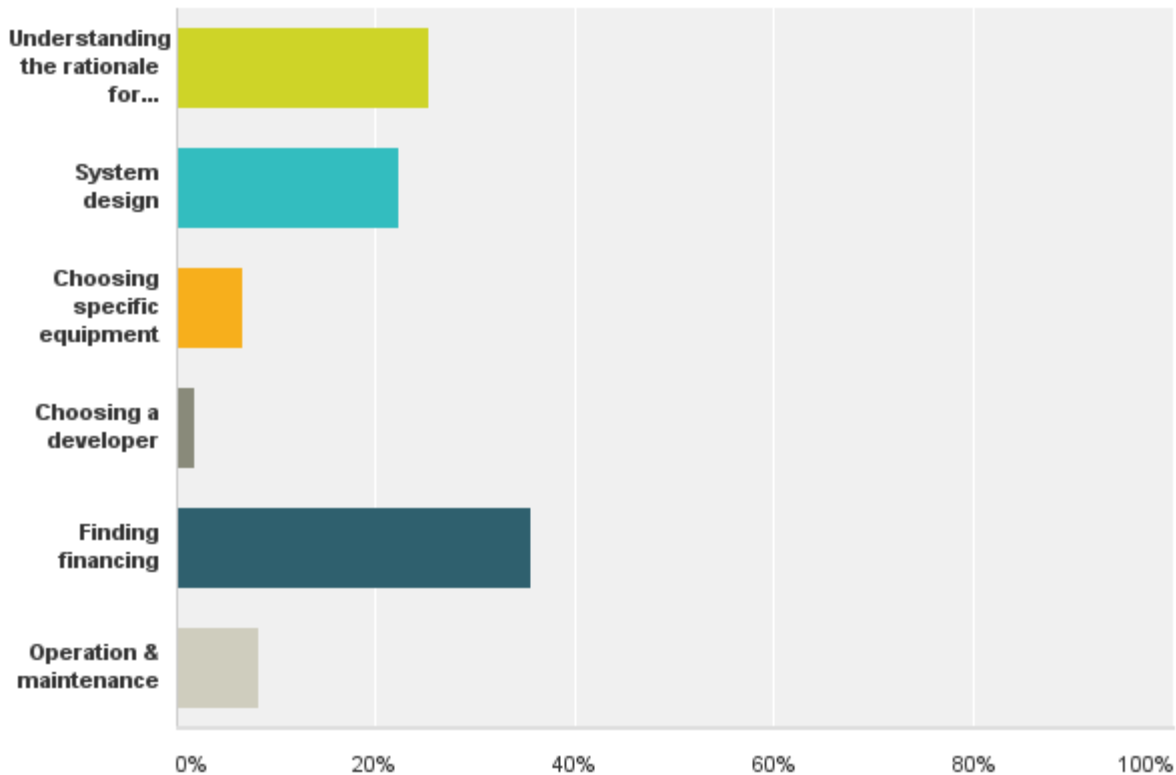
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Survey Results

Q6 What do you/your organization see as the most significant barriers to adoption of microgrids?

Answered: 554 Skipped: 0



Remote vs. Grid-connected

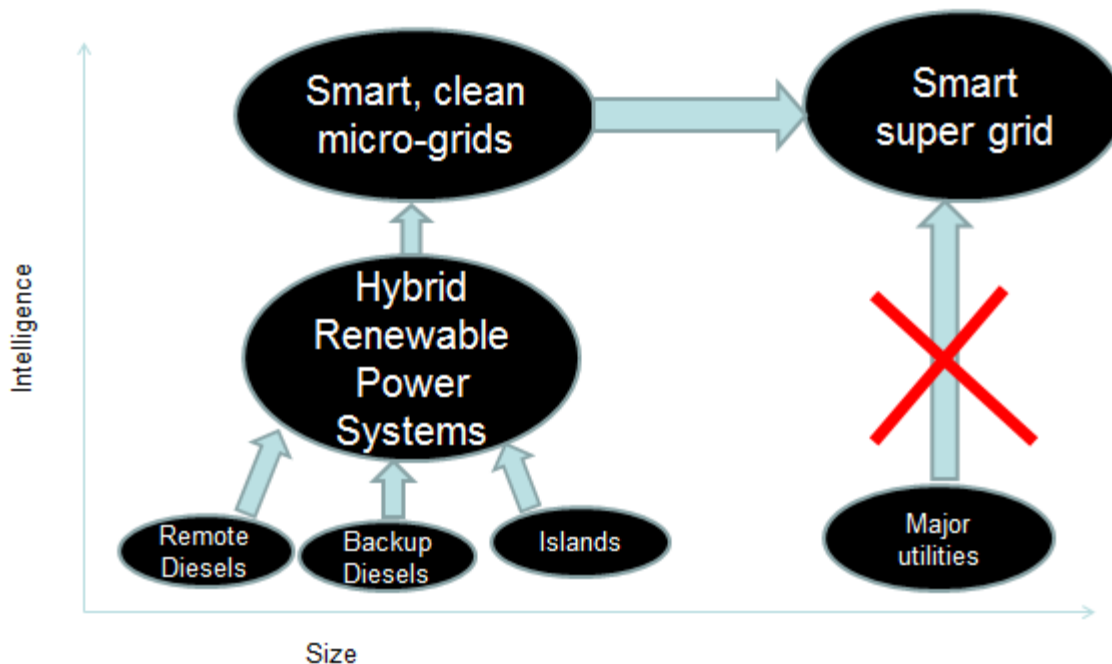
Differences

- Frequency of islanded operation
- Incumbent technology
- Value proposition
 - Economics vs. reliability
- Renewable penetration level
- Switchgear

Similarities

- Ability to stand on its own
- Hybrid systems
- Integration requirements:
 - Renewables
 - Storage
 - Power electronics
 - Controls
 - Load management

Clean Power Evolution

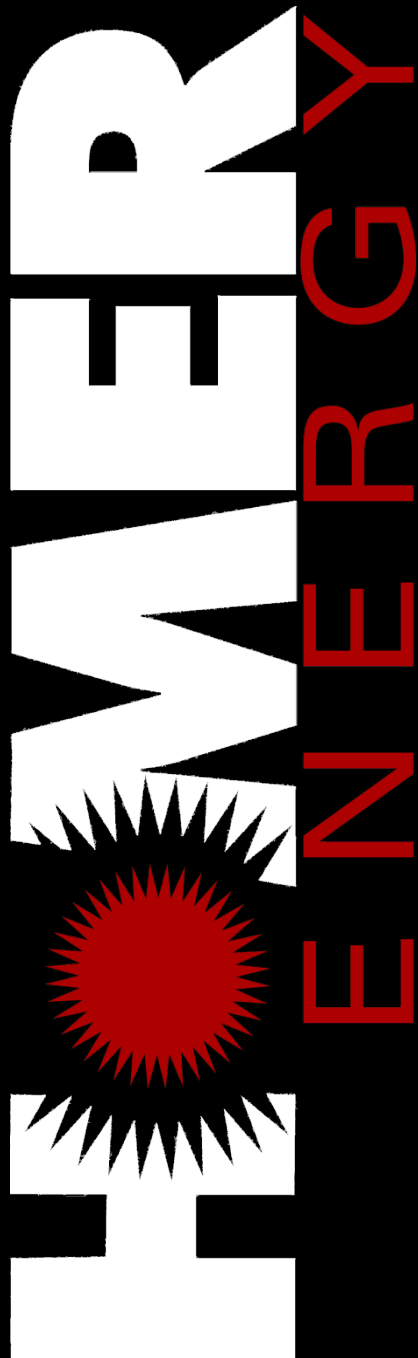


- Large utilities
 - Security obstacles
 - Regulatory obstacles
- Smaller systems
 - Liquid fuels from oil
 - High renewable penetrations

Micro-grids with distributed controls for reliability and efficiency

Lessons from the Remote Market

- What to do when the wind blows too strongly
 - Secondary loads
- What to do when it stops too abruptly
 - Load management as “spinning” reserve
- What to do with storage
 - Use it sparingly until costs come down
- How to develop “medium-sized” systems
 - Use standardized approaches
 - Simpler models
- Stop thinking about base and peak loads
 - Flexibility is the buzzword



Thank you.

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