How to Implement Renewable Energy

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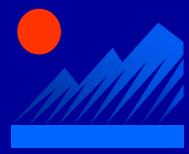


Sources of Renewable Energy

Two Different RE Worlds

- **Grid-connected World** (focus on low ¢/kWh)
  - Competition between renewables & conventional options
  - Competition and complementarity among renewable options
- **Off-grid, Rural Electrification World** (focus on provision of basic energy services)
  - Small-Scale Individual DC Systems for Specific Loads
    - 12-48V PV and/or Wind Battery Charging Systems
  - Hybrid AC Power Systems for Village Mini-grids
    - Wind, PV, Biomass, μ-Hydro, Battery, Gen-sets
    - Mini-grids, Micro-Enterprise Zones, Motor Loads

Basic Steps

Technology

- Resource Assessment
- Load Assessment
- Technical Options Analysis

Policies

- Delivery Pathways (government, private sector)
- Incentives (subsidies)

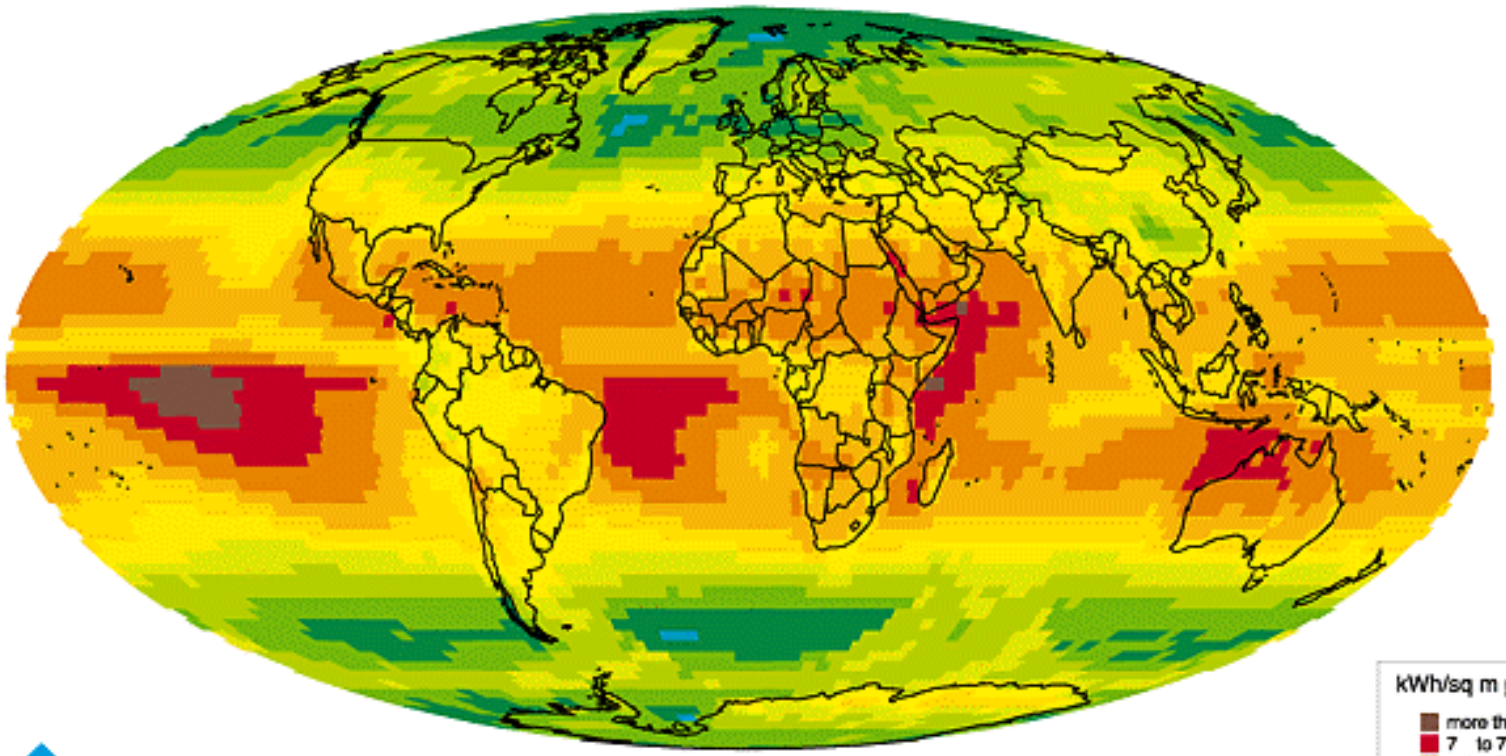
Programs & Projects

- Definition and Implementation

Resource Assessment

Solar
Wind
Biomass
Hydro
Geothermal

Resource Assessment



Preliminary satellite-derived estimates based on the method of Dr. Rachel Pinker, University of Maryland

Data source: World Climate Research Program data available from the NASA Langley DAAC
NREL contact: Dave Renne (303) 275-4648
Date: December 14, 1994

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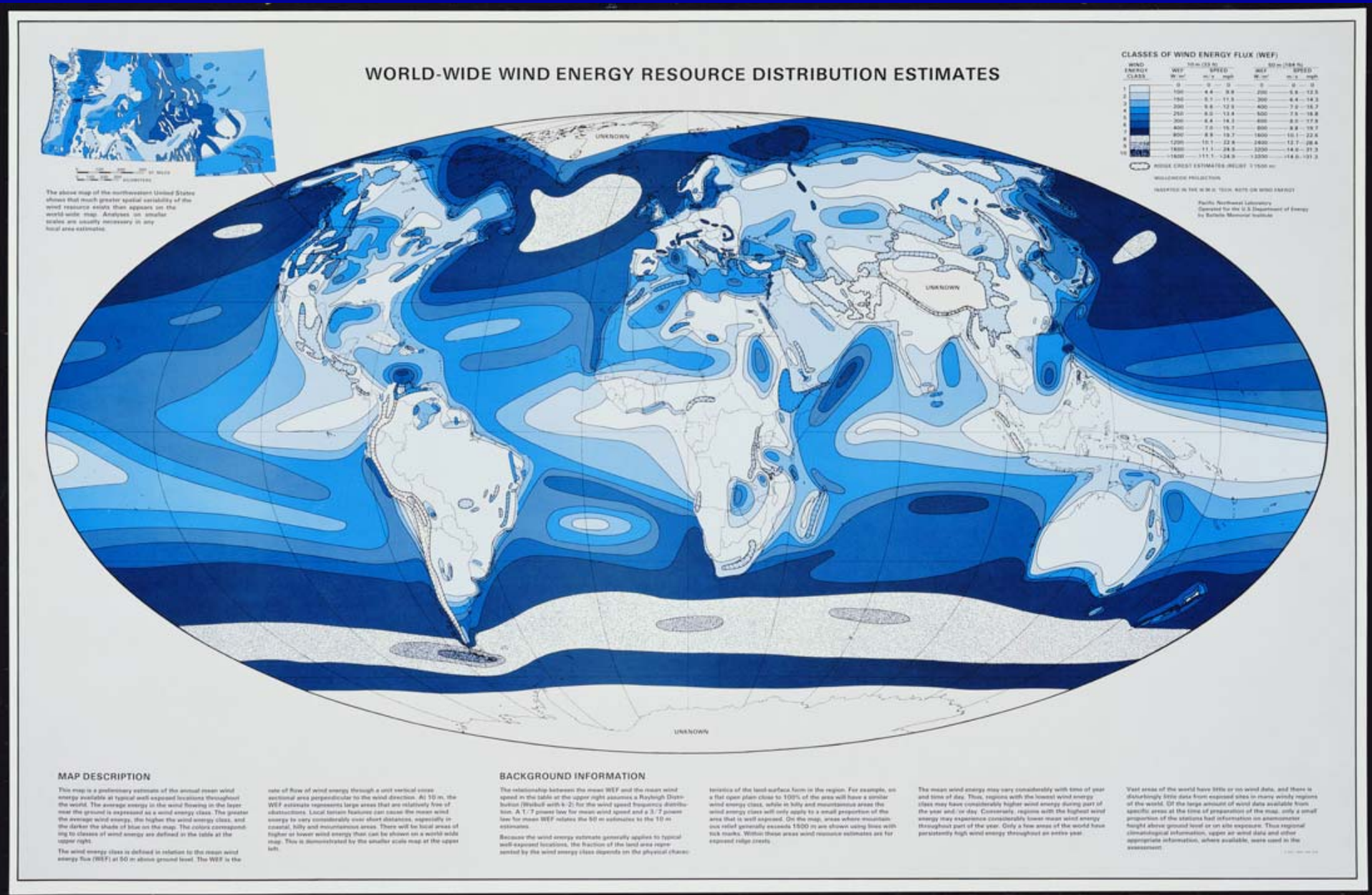
Wind Energy Resource Assessment (10 years ago)



Other RE Resources

- Biomass, Hydro, and Geothermal are highly site-specific
- Need to assess local inventory and quantify specific opportunities

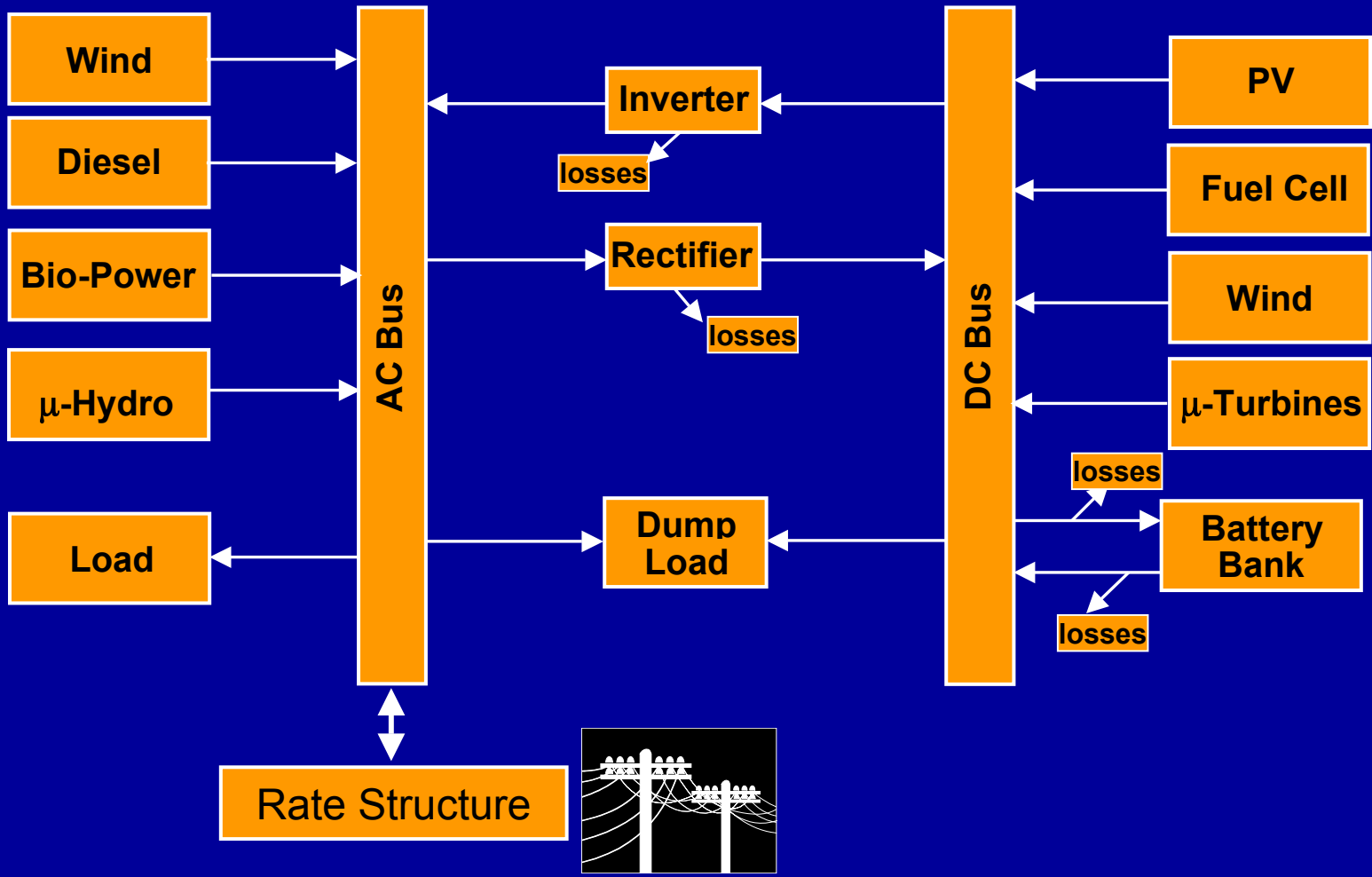
Load Assessment

- **Grid:**
  - Inter-connection requirements and power distribution limitations
  - Purchase power rates and requirements
  - Need for systems perspective at a national level, independent of local political interests
- **Off-grid:**
  - Specifics of insolated dc-powered loads.
  - Specifics of individual village mini-grid ac power loads.

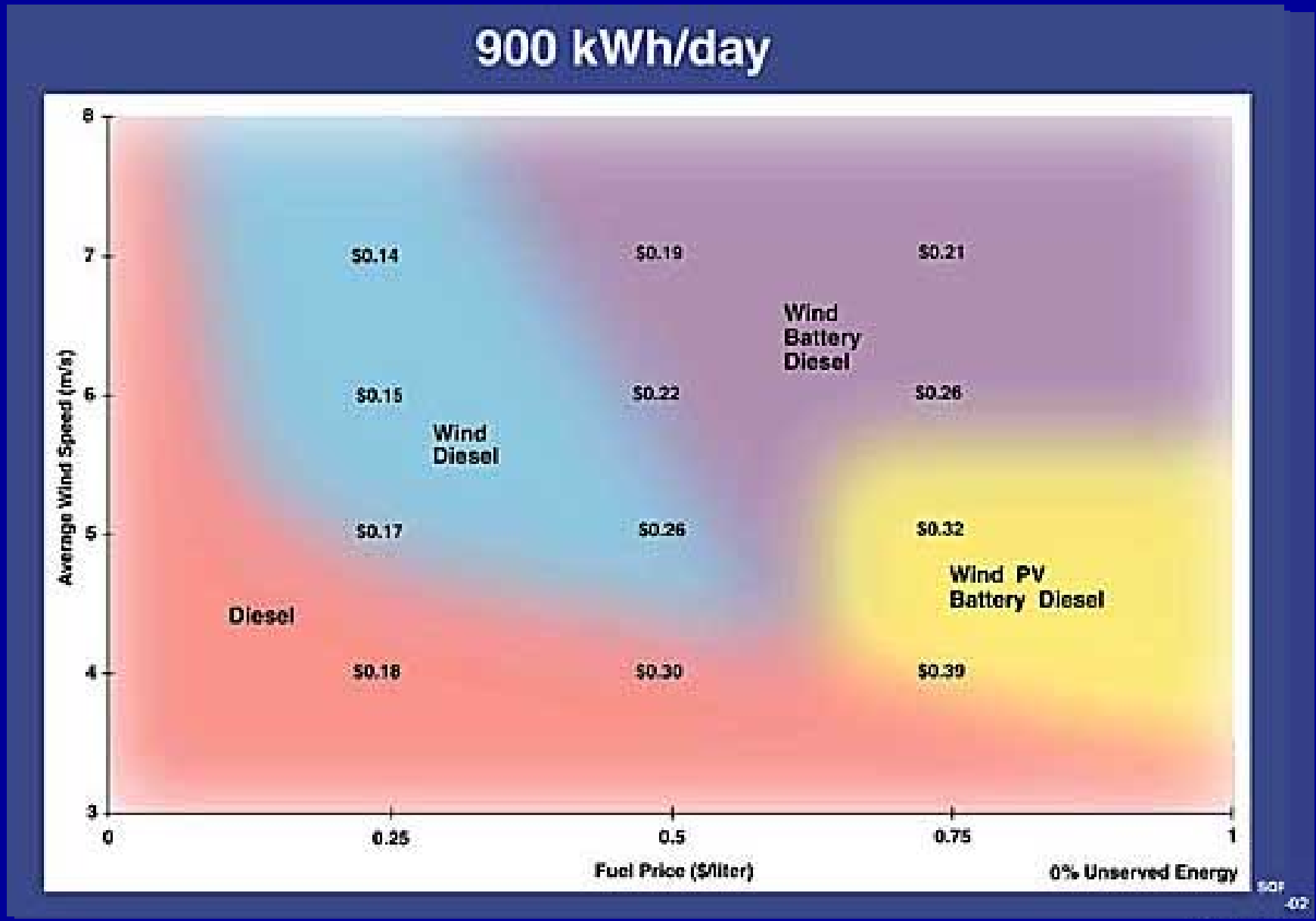
Technical Options Analysis

- **Grid:**
  - Strategic planning time-horizon
  - Competition among other investment options
  - Synergistic operation with existing and future national system
- **Off-grid:**
  - New computer-based approaches to system optimization

Village Power Hybrids
Simulation Models for Options Analysis



Diesel Retrofits: Options Analysis



National Incentive Programs

Large-Scale Grid Connected Power

RE implementation usually requires some combination of:

- Government Will and/or Private Sector Encouragement
- Direct incentives/subsidies (tax credits, buy-down program)
- IPP Incentives (purchase power rate, long term contracts)
- Green Pricing (consumer contributions)
- Renewable Portfolio Standard (requires utility privitazation and regulation)

Focus on Delivery Pathways is the Key to Success for Rural Electrification

- **Retailers, Individual Entrepreneurs** (manufacturer-linked?)
- **"McSolar"** (Franchise Model)
- **Traditional Rural Electric Cooperatives** (member owned)
- **Local or Municipal Power Association**
- **Rural Energy Service Companies** (very small to very large)
- **National Utility – Diesel Group, Rural Electrification Group**
- **Non-Government and Private Voluntary Organizations**
- **Independent Power Production**

Focus on the "How"
Delivery of energy services on a sustainable (business-like) basis.

Sustainable RE Programs and Projects

- Establish National Priorities
- Assess Resource and Technology Options
- Develop Separate, Independent Programs for On-grid and Off-grid Energy Needs
- Focus on Life-Cycle Economics
- Focus on Long-term Maintenance and Service
- Focus on Cost-Recovery, and Business Financial Viability