National Renewable Energy Laboratory
Innovation for Our Energy Future

Achieving Sustainability in Cities

Singapore Energy Conference

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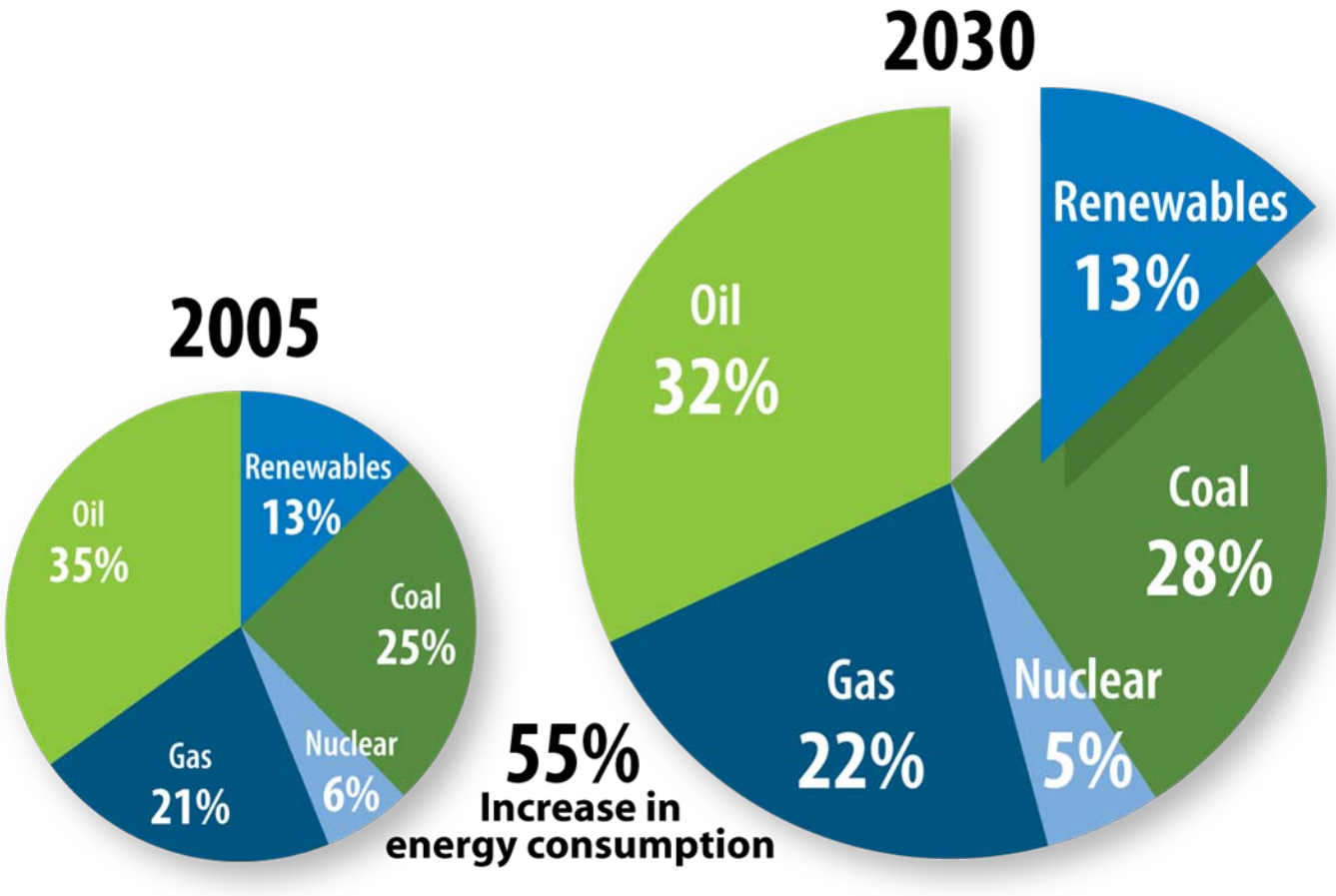
NREL is a national laboratory of the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy operated by the Alliance for Sustainable Energy, LLC

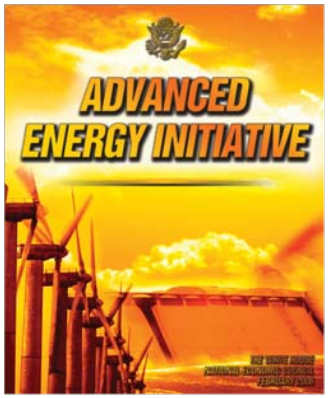
World Energy Supply and the Role of Renewable Energy



Source: IEA/OECD, World Energy Outlook 2007

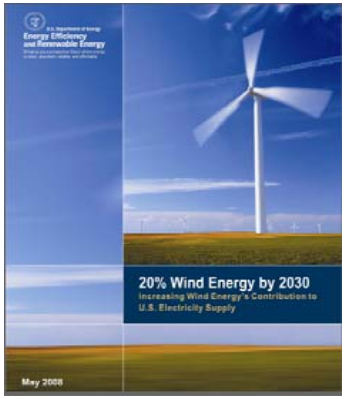
Table: Reference Scenario: World, p. 592

Setting the Bar Higher – Gigawatt-Scale Renewables



Solar Vision

10% U.S. electricity by 2025



Wind Vision

20% U.S. electricity by 2030

Energy Independence & Security Act 2007

36 billion gallons of renewable fuels by 2022

Requires investment in new infrastructure:

- Overall in U.S. = $2 trillion
- Worldwide = $22 trillion
  - Biofuels
  - Wind
  - Solar

} $2 trillion (est.)

Getting to "Speed and Scale" – Key Challenges

Implementing Renewable Gigawatts at Scale

NREL 140-1

BARRIERS

- Cost of renewable electricity
- Performance and reliability
- Infrastructure robustness and capacity
- Dispatchability of renewables

Displacement of Petroleum-Based Fuels

NREL 139-1

BARRIERS

- Cellulosic ethanol cost
- Life cycle sustainability of biofuels
- Fuels infrastructure, including Codes/Standards
- Demand and utilization, including intermediate blends

Reducing Energy Demand of Buildings, Vehicles, and Industry

NREL 196-1

BARRIERS

- Coordinated implementation of model building codes
- Market does not value efficiency
- Cost of energy efficient technologies
- Performance and reliability of new technologies

Vision for a Sustainable Community

The Vision – An Integrated Solution

A sustainable community

Why Focus on Communities?

Local economic development drives sustainable community implementation. Key considerations are:

- Sustainable community planning lends itself to an integrated approach
- Local decision making tends to be shorter term focused, so opportunities for long-term impact must be considered
  - Energy growth is increasing at a faster rate than energy savings
  - Carbon emission goals will require deeper emissions reduction over the long term

To Optimize Community Sustainability

Alignment of **strategic partnerships** and relationship building around shared set of values and defined goals

Do “technical homework” – **understand** the loads, the drivers, set measurable goals

- Buildings
- Vehicles
- Central plant

Public policy measures to **enable** sustainability

NEED A COMPREHENSIVE APPROACH

High Level Stakeholders Panel

Objective: Build a network of influential people in the community to help with issues that will become roadblock

- Public, private, utility partnership aligned around a shared set of values
- Recognition that traditional roles may changes
  - Electric car manufacturers may get into the home building business
  - Developers may get into the utility infrastructure business
  - The role of the utility may shift from producer of a commodity (electricity) to one of a distributor and managing the flow of electrons based on real time pricing

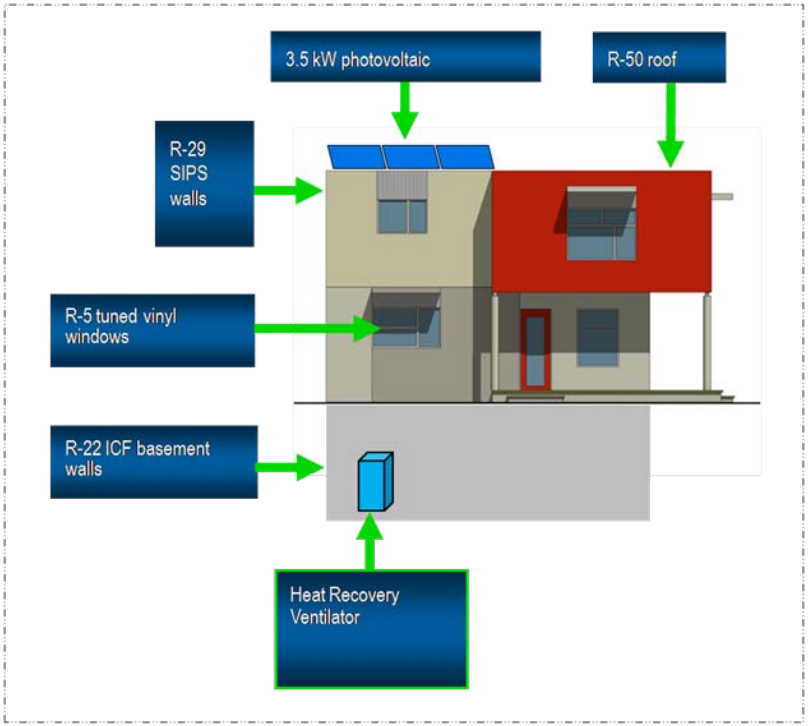
Understand the community energy loads for buildings, community infrastructure and vehicles

Objective: To fully define the energy picture in order to strategically develop solution

- Run series of parametrics using simulation tools to assess loads
- Use this to “bound” the range of loads
- Use the results to aid in sizing a central plant, define the level of efficiency needed in terms of buildings and transportation systems

Building Strategy

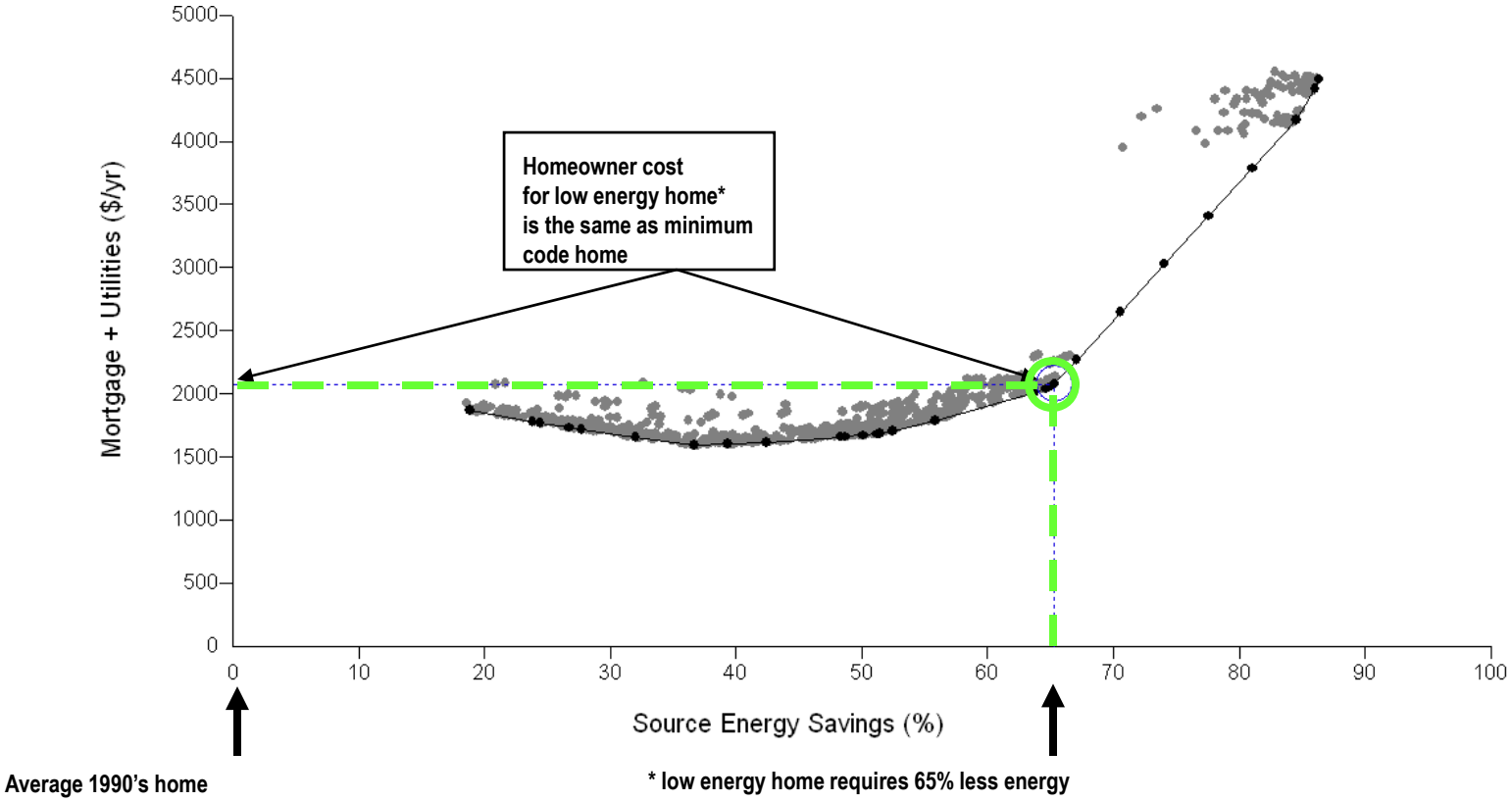
Objective: To understand and to communicate to builders the necessary degree of efficiency and renewable energy to be incorporated into new construction to reach the energy goals



- Run parametrics using simulation tools to assess loads under various scenarios
- Develop guidelines for building energy efficiency and distributed renewable energy systems
- Work with builders to assess options
- Monitor building energy performance to provide feedback

Net-Zero Energy Homes That Are Cash Flow Neutral

• NREL Analysis using BEOpt software for Boulder,CO climate



Example taken from the "GEOS" Neighborhood. Courtesy of Wonderland Hills Development, Boulder Colorado

Transportation Infrastructure

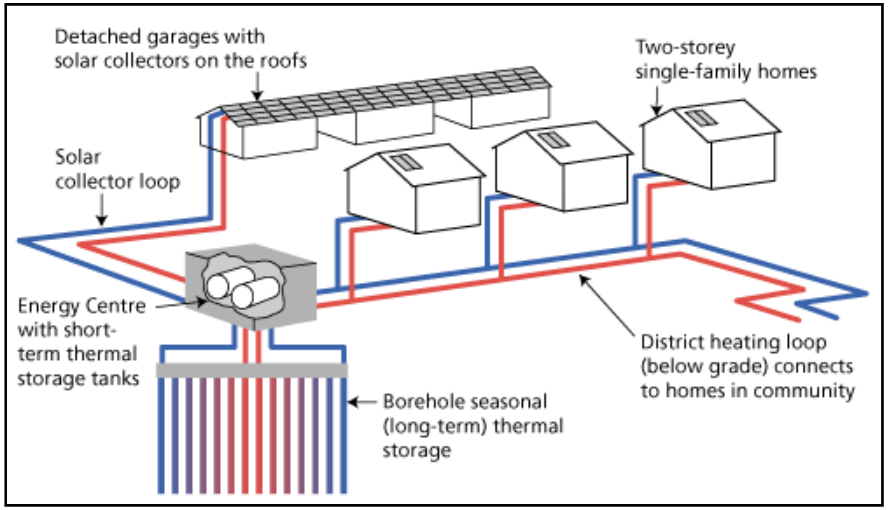
Objective: Develop a community wide approach to transportation planning

- Pedestrian
- Plan to include neighborhood electric vehicles a fleet of power assisted bikes
- Plan for PHEV ready
- Access to mass transportation

The Central Plant

Objective: Identify a strategy to design and build a central plant for a community powered by renewable energy

- Define options in terms of technology and costs
- Develop RFP
- Develop policy and financing approach
- Facilitate implementation



Energy Supply – Distributed or Central?

Integrated Design

Objective: Position communities for “smart grid” ; tie together a range of technological and behavioral issues that will “make or break” the zero energy aspect of the community

- Zero energy community design of power distribution\infrastructure will be breaking new ground (new roles for developer and utility)
- Issues such as storage, billing etc. are new
- Tie a community wide energy education with the school curriculum, and creating a strong neighborhood sense of place

Consumer Decisions Can Be Informed by Progressive Public Policy

Enabling Regulations

- Net Metering
- Interconnection Standards

Enabling Programs

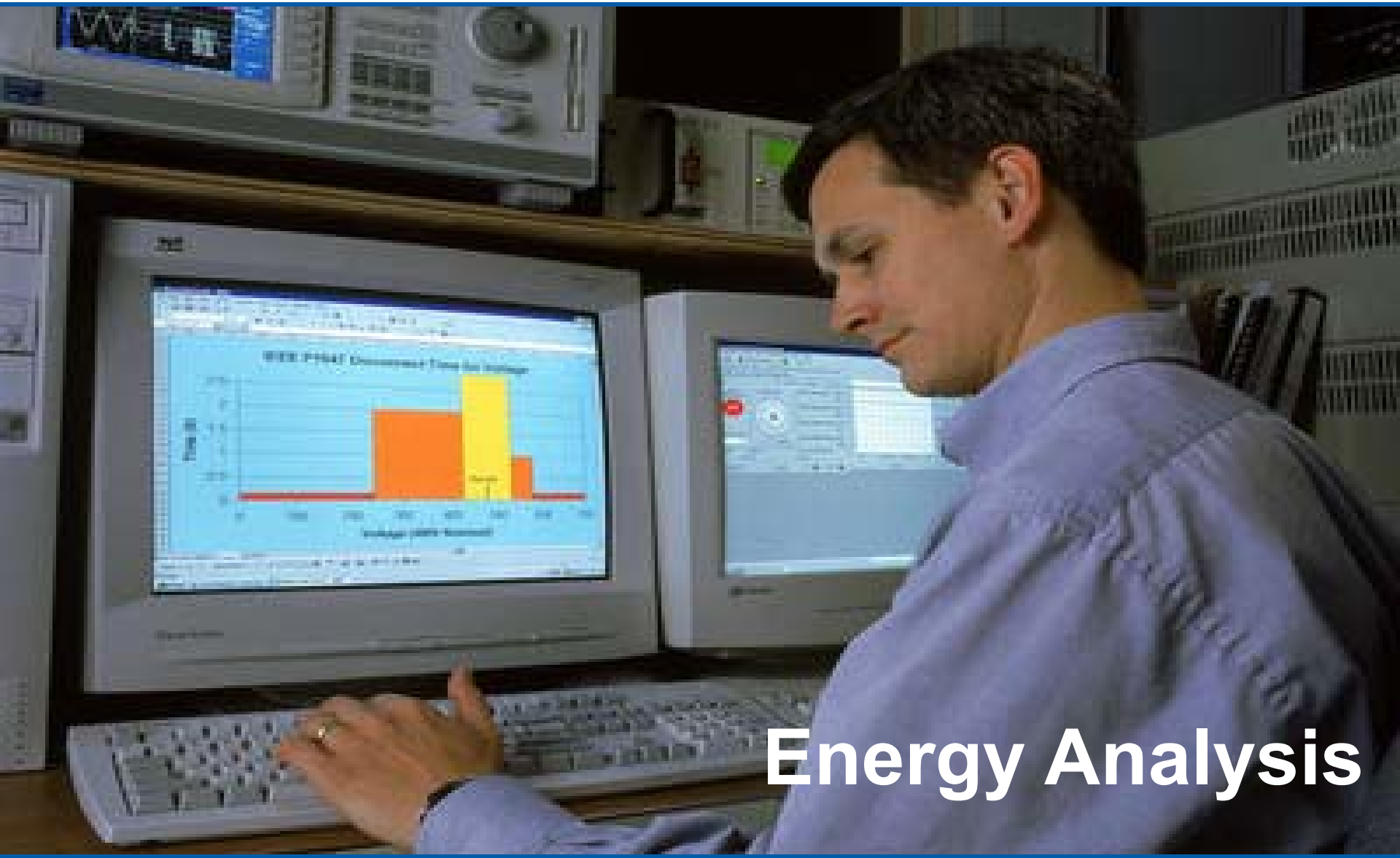
- Package information in a way people understand and know how to take next step!
- Make it easy for people to do the right thing

Policy Changes

- Building codes
- Renewables, efficiency, fuels portfolio standards

A Comprehensive Integrated Efficiency and Renewable Energy Strategy Requires:

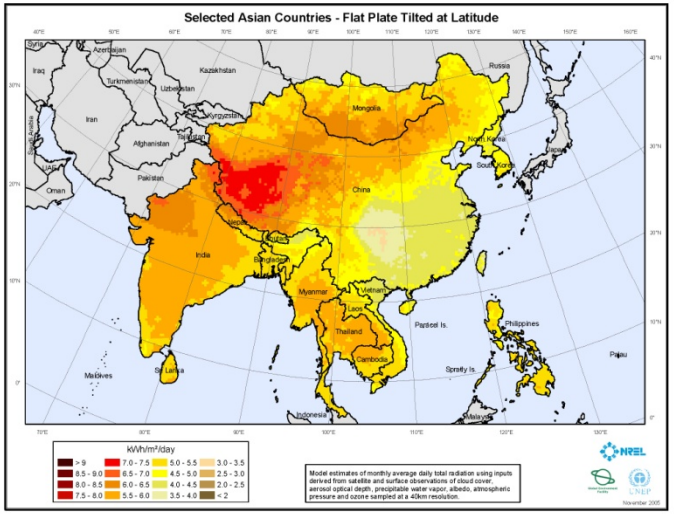
NREL: A Resource for Sustainable Communities

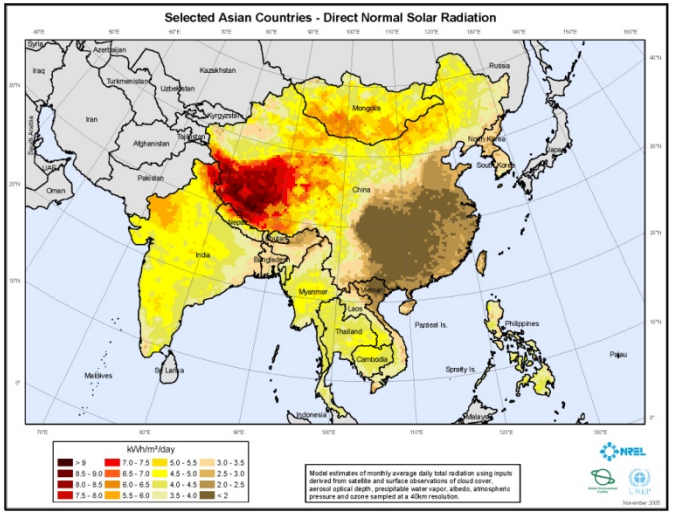


Resource, Technology, and Market Information

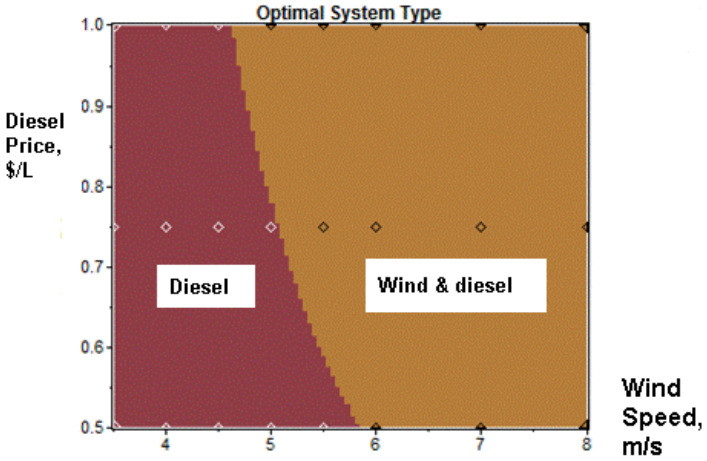
High-quality and timely data informs RE project decisions and policy development:

- Provide accurate resource assessment and mapping
- Collaborate on technology R&D
- Contribute timely and definitive analyses on technology, policy, and market issues that govern commercialization

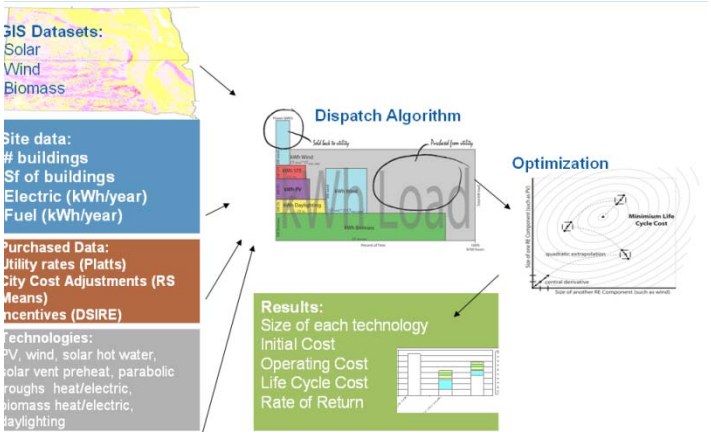




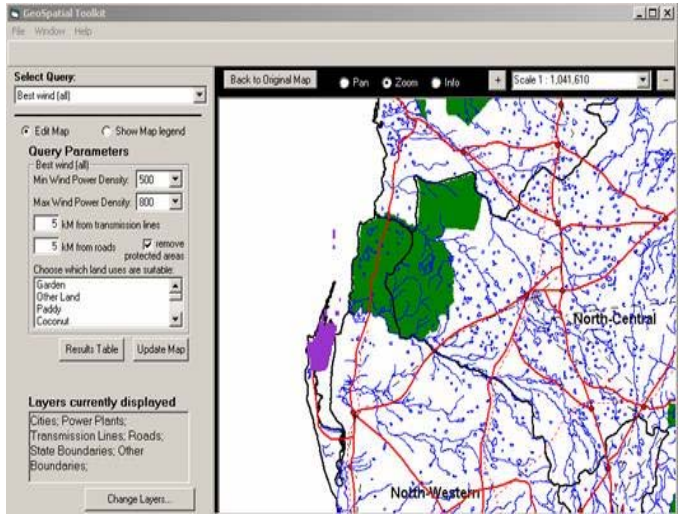
Examples of Analysis Tools and Models



HOMER®
NREL's Hybrid Optimization Model



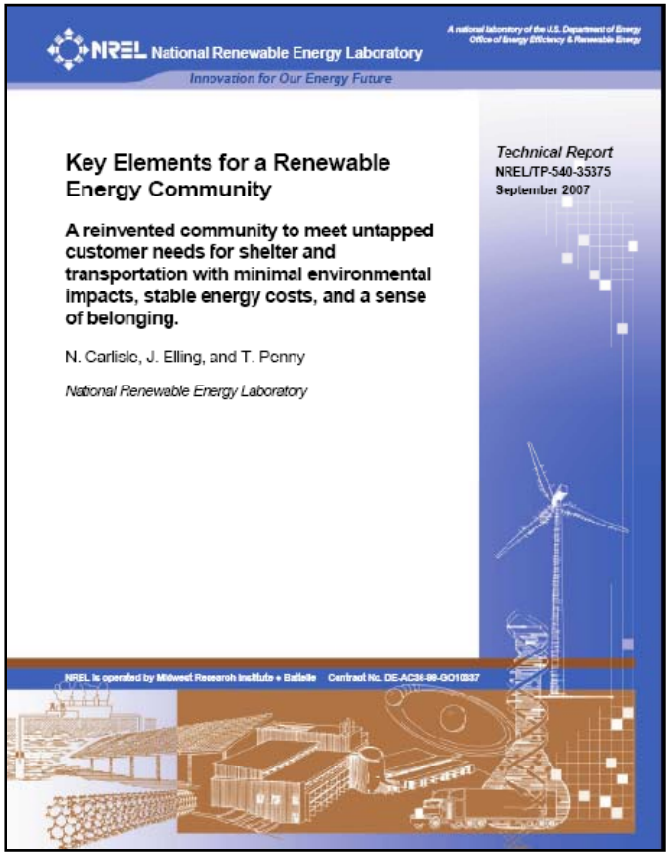
Renewable Energy Optimization (REO)



GeoSpatial Toolkit

NREL Work– Sustainable Communities

- Navy's San Nicholas Island\Miramar–DOD Pilot zero energy community
- Hawaii Initiative
- Support to Greensburg, KS, New Orleans, LA
- Work for others with large developers
- Informal relationship\contact with over 30 communities interested in piloting ideas
- Support to Solar America Cities
- Innovation in Wind and Solar Financing (NREL/TP 670-42919) Feb 2008
- Strategic Initiative to develop tools to support renewable communities
- Carbon Neutral Communities initiative (EERE Analysis Summit)



http://www.nrel.gov/applying_technologies/state_local.html

Making Transformational Change

Requires an integrated approach

Unleashing market-driven innovation

FILL technology pipeline

INFORM decision makers about choices

ENSURE appropriate market price signals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