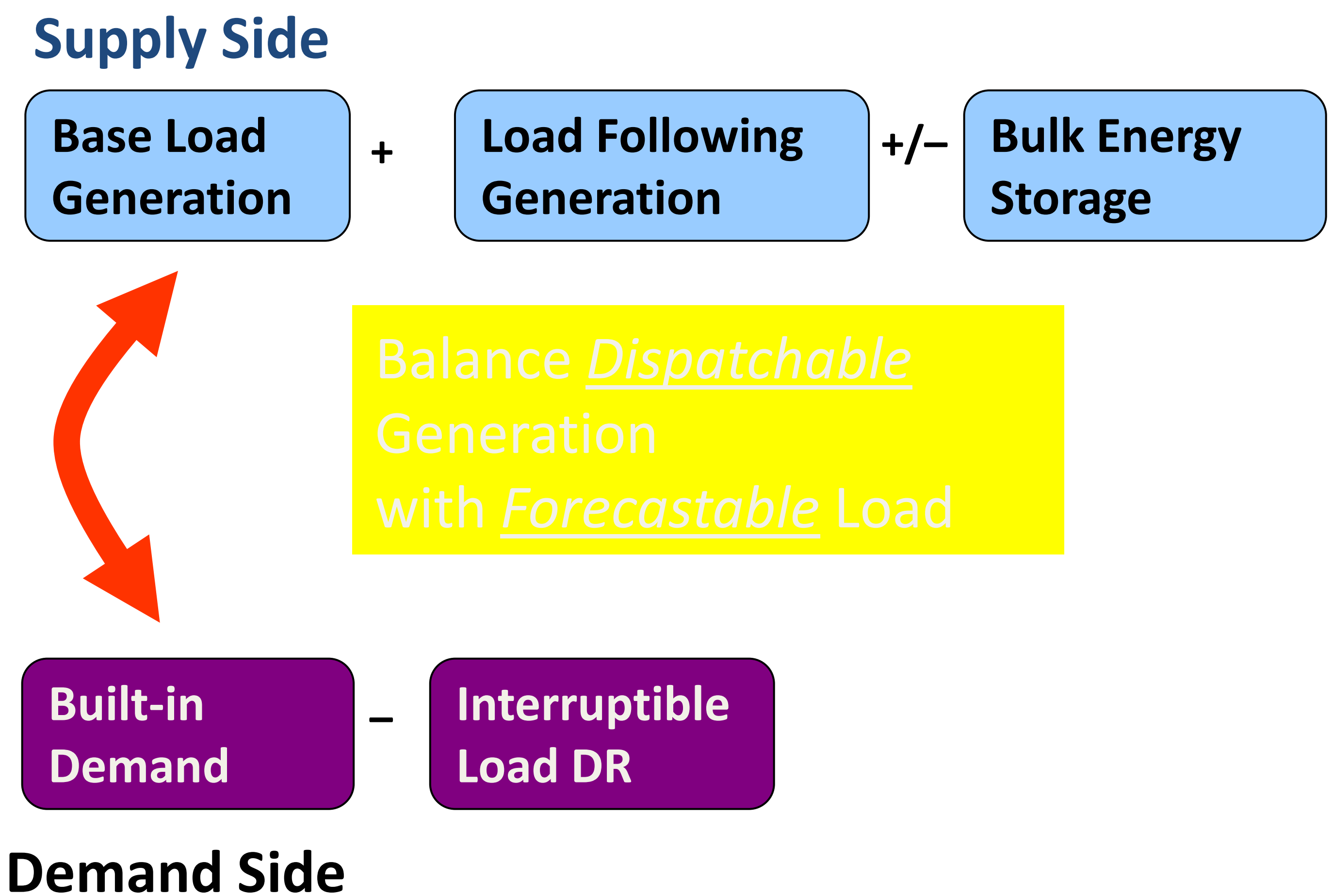
Transformation at Distribution Systems Level

Larisa Dobriansky, Global Energy Network, 703 920 1377

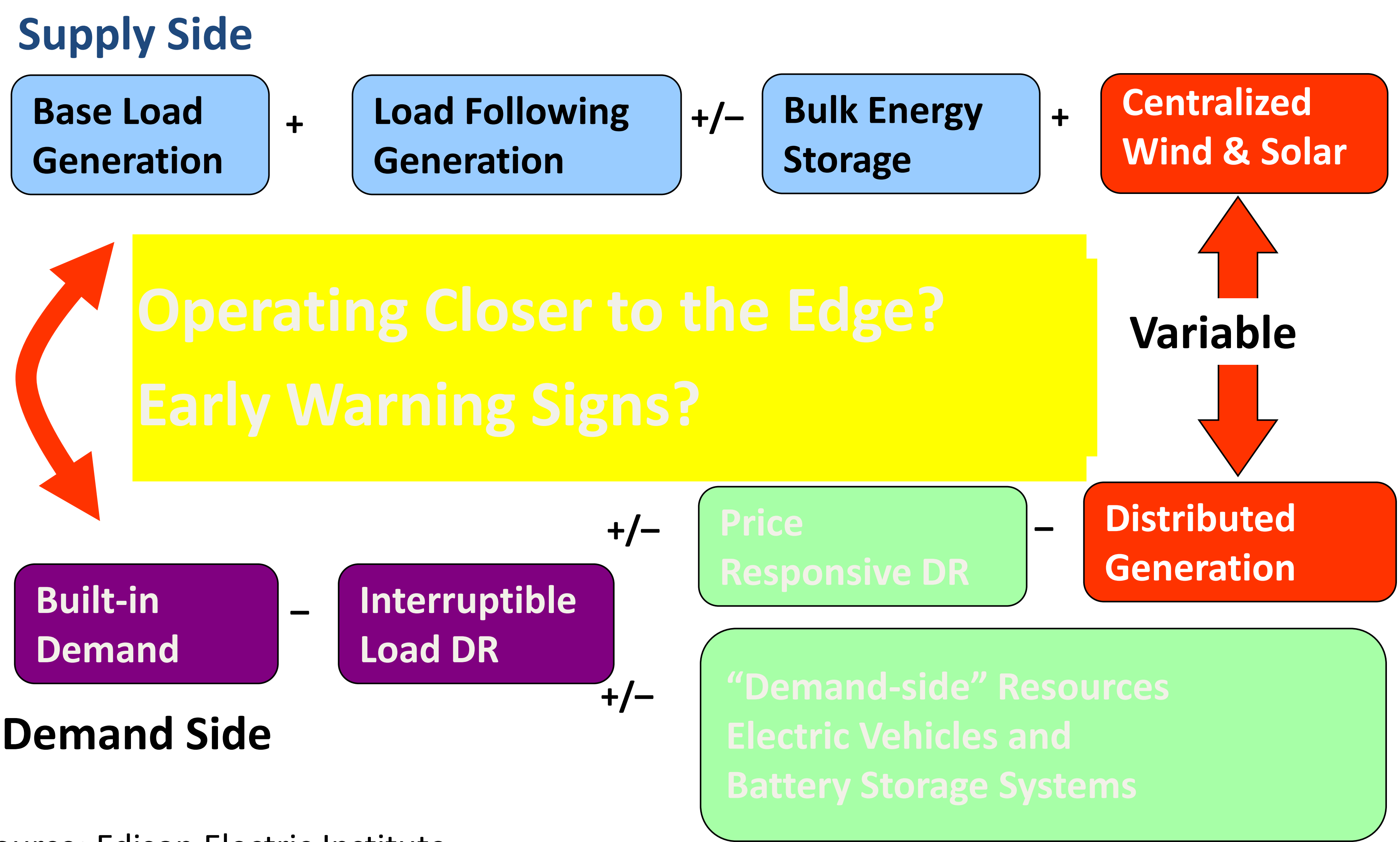
ACORE Electric Power Workshop 2011

Central Station Paradigm



Source: Edison Electric Institute

Integrated DER Paradigm



Source: Edison Electric Institute

Smart Grid Enabling Technology

- Significant potential at Distribution Systems Level for creating the conditions for new “electric resources”
- Potential to expand and modernize electrification from source to sink, deployment of two-way communications, allowing consumers to benefit from dynamic pricing and DE;
- Increase market value and support more widespread use of DER combining power engineering, sensing and monitoring technology, information and communications technology with legacy elements of T&D.

NETL: Smart Grid Characteristics

Smart Grid is transactive and will:

- Enable active participation by consumers
- Accommodate all electric resources, including demand-side resources
- Enable new products, services and markets
- Provide power quality for the digital economy
- Optimize asset utilization and operate efficiently
- Anticipate and respond to system disturbances
- Operate resiliently against attack and natural disaster

Rethinking Our Power Delivery System

Current Paradigm

- T&D
- Stability from inherent rotational inertia; Passive
- Resource Specific
- Some assistance via ancillary services
- Dispatchable generation
- Interconnection of Units
- Unlinked Power Markets

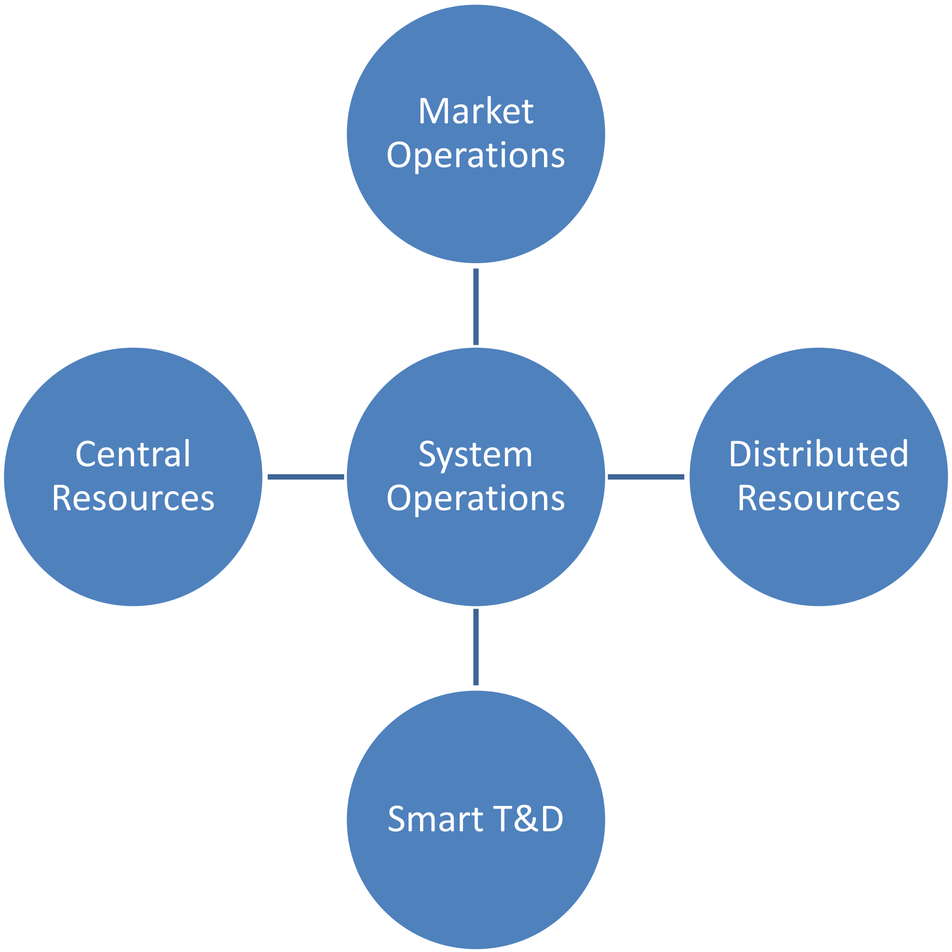
Future Paradigm

- Power Value Chain
- More instability; reduced rotational inertia; Active Control
- Portfolio Management
- VER/DER contribution to E, capacity, regulation
- Stochastic generation
- Interconnection of Networks; Integration
- Link Wholesale and Retail

Creating VPPs

- EPRI Smart Grid Demonstration Initiative: Create VPPs (Virtual Power Plants) leveraging "Smart Grid" Technologies
- Fusion of Power and Information can enable VER/DER portfolio management and balancing of supply and demand
- "Firming Up" VER/DER for integration into the grid and market: Intelligence, Visibility, Interoperability and Forecasting
- Sensors, Communication and Information, Computation and Control
- Architectural Design to Support DER; Open Source; Systems
- Modeling, Simulation and Analytical Tools, Data Management and Processing, Best Energy Management Practices (IntelliGrid Methododology/User Cases)

Parity of DER and Bulk Power Supplies



Microgrids: Local Energy Networks

- Objectives: optimization of energy availability across a larger variety of energy sources; infrastructure for more optimum management of overall energy requirements; control and management of reliability at local level.
- Capable of operating autonomously and in support of grid
- Value Maximizing; Nesting into System
- Scales: Building, Campus, Community
- UCSD example; features; Master Controller for Portfolio Management
- Sharing of capabilities with Utility over wider areas, including EV infrastructure, controllable load, uncontrollable onsite ES
- Smart Grid "Eco-Systems:" Energy as a means for evaluating interaction between energy using sectors (power, water, waste, transport, buildings)
- Transitioning; Staging (Energy Security and protection of critical infrastructure and essential municipal services)

Policies Needed for New Distributed Energy Model

- New resources: utility, third-party or user-owned, user to grid, user to user energy transactions; real-time customer energy management;
- True costing of electricity delivery systems; valuation of benefits/impacts of DE applications;
- New intelligent energy management; DER to meet individual facility requirements and offer larger grid support, flexibility for generation, storage and loads to operate autonomously;
- Utility business and service delivery model changing; new customer-oriented choices and solutions emerging; Customer-driven, service-oriented;
- Policy changes needed to effect new structures, parameters, players in efficient, intelligent, sustainable market and to capture efficiencies and systems benefits of modernized grid.

Role of Distributed Energy in Greening and Modernizing Our Power System

Presented by:
Larisa Dobriansky, National Energy Center for Sustainable Communities

Role of Distributed Energy

- The value proposition of distributed energy resource planning and development is changing due to market, technology and policy drivers;
- These forces are driving investment into a widening range of DE applications and shaping a new role for clean DE in transforming our electricity grid;
- Significant potential lies at the distribution systems level for improving reliability, security, sustainability, efficiency and affordability of energy use, including increasing load management capability, asset utilization, better balancing of supply and demand, and integrating and optimizing clean, efficient and intelligent technologies into our power system.

NECSC

Role of Distributed Energy

-
- Pioneering work underway in smart grid-enabled community-scale energy efficiency and renewable energy projects:

  - Austin Energy Pecan Street Project
  - RESCO UCSD Community Based Master Controller Optimizer

- Modernizing and expanding electrification enabled by smart grid technologies;
- Fusing traditional elements with transformative ones;
- Integrated with grid and also autonomous, controlling both power flows and digital information;
- New customer solutions for meeting onsite energy needs, not just complementary to utility baseload;

NECSC

Adaptation or Transformation

- RESCO RD&D Model: Break down the Silos
  - Test-bed demonstrations integrating DG devices, E storage and communications and control systems;
  - Virtual Power Plant demonstrations using master-controller and scheduling optimizer software technology to integrate onsite RE, ES, and communications and control systems to capture interconnectivity and interdependencies of distributed system assets;
- Land Use Planning and Strategic Growth Management: Design Energy and Resource-Efficient Communities; Use Energy as Means to assess how different sectors interact and how to improve energy performance and environmental quality within a smart grid eco-system.

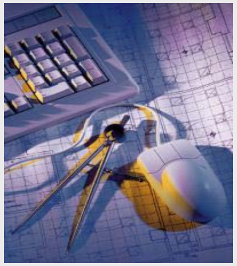
New Tools for Sustainable Community Energy System Design & Development

Presented by: Larisa Dobriansky, Executive Director
Global Energy Network (GEN)

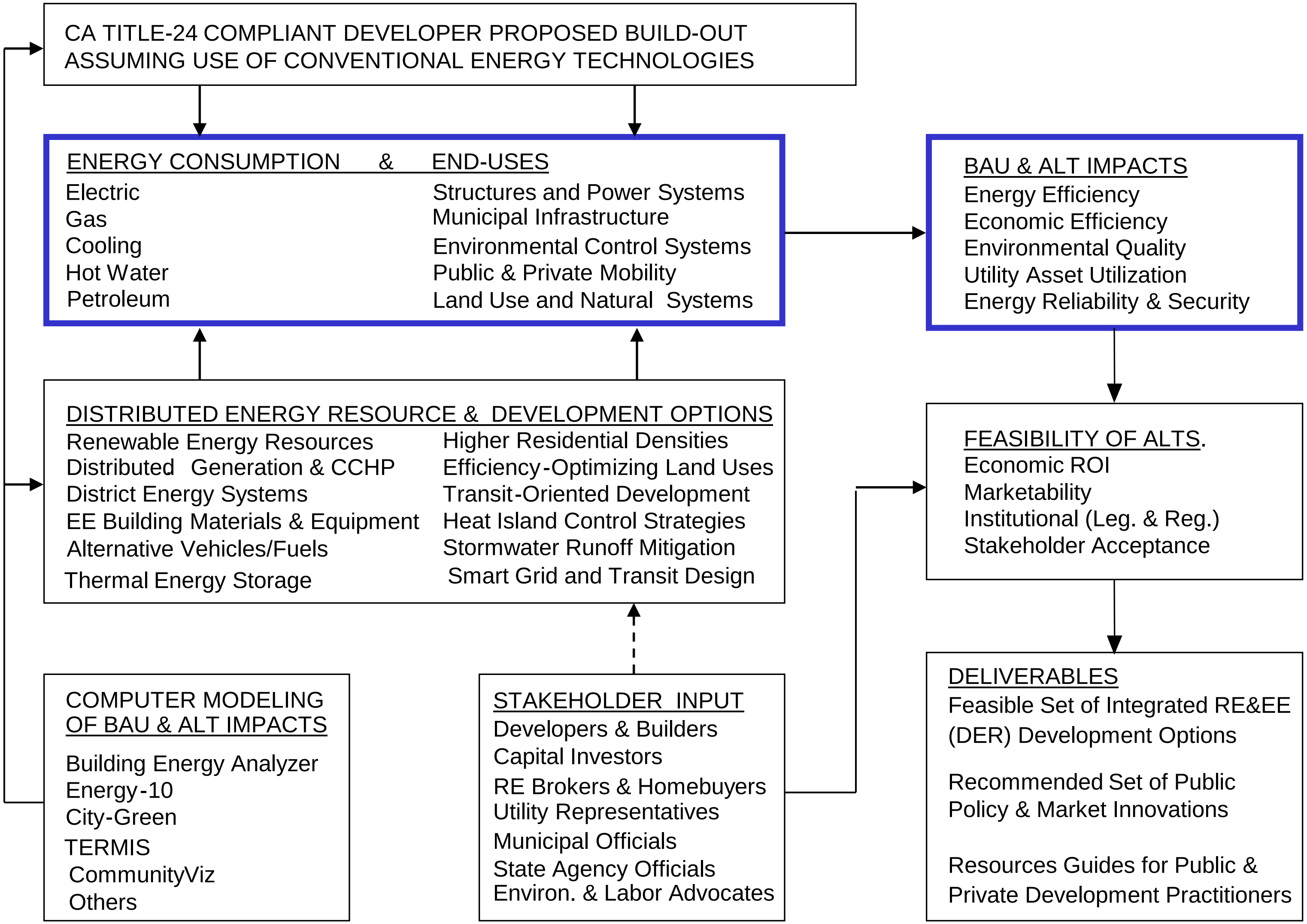
- NECSC/GEN
- Projects
- Methods
- Modeling Tools
- Value of Methods and Tools

Projects

- ❑ Greyfield – Urban Infill Mixed-Use & TOD
- ❑ Greenfield – New Planned Communities
- ❑ Brownfield Redevelopment
- ❑ Alternative Fuels & Transit
  - ❑ Advance use of energy-efficient & renewable energy technologies (distributed energy resources) in community development projects & optimize their performance through complimentary land use & urban design features
  - ❑ Quantify the energy efficiency & emission reduction gains that can be achieved through the combination of these technologies & design features in representative community development projects
  - ❑ Assess the impact of this alternative development approach on the electric & natural gas utility infrastructure & on potable water & sanitary water processing systems
  - ❑ Resolve, market, economic & policy / regulatory barriers preventing the finance, real estate & development industries from pursuing energy-efficient development



Methods


CA TITLE-24 COMPLIANT DEVELOPER PROPOSED BUILD-OUT
ASSUMING USE OF CONVENTIONAL ENERGY TECHNOLOGIES
ENERGY CONSUMPTION & END-USES
Electric
Gas
Cooling
Hot Water
Petroleum
Structures and Power Systems
Municipal Infrastructure
Environmental Control Systems
Public & Private Mobility
Land Use and Natural Systems
BAU & ALT IMPACTS
Energy Efficiency
Economic Efficiency
Environmental Quality
Utility Asset Utilization
Energy Reliability & Security
DISTRIBUTED ENERGY RESOURCE & DEVELOPMENT OPTIONS
Renewable Energy Resources
Distributed Generation & CCHP
District Energy Systems
EE Building Materials & Equipment
Alternative Vehicles/Fuels
Thermal Energy Storage
Higher Residential Densities
Efficiency-Optimizing Land Uses
Transit-Oriented Development
Heat Island Control Strategies
Stormwater Runoff Mitigation
Smart Grid and Transit Design
FEASIBILITY OF ALTS.
Economic ROI
Marketability
Institutional (Leg. & Reg.)
Stakeholder Acceptance
COMPUTER MODELING
OF BAU & ALT IMPACTS
Building Energy Analyzer
Energy-10
City-Green
TERMIS
CommunityViz
Others
STAKEHOLDER INPUT
Developers & Builders
Capital Investors
RE Brokers & Homebuyers
Utility Representatives
Municipal Officials
State Agency Officials
Environ. & Labor Advocates
DELIVERABLES
Feasible Set of Integrated RE&EE
(DER) Development Options
Recommended Set of Public
Policy & Market Innovations
Resources Guides for Public &
Private Development Practitioners

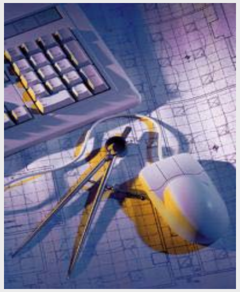
Modeling Tools: Building Scale

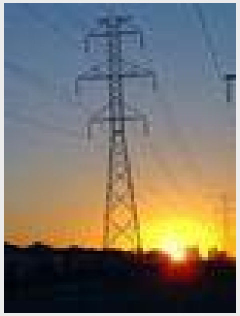
Evaluation of economics, emissions related environmental and energy efficiency impacts of the following types of technologies:

- Energy efficiency of the building envelope
    - Glazing alternatives
    - Roofing alternatives
    - Improved envelope insulation
    - High efficiency HVAC system components
    - Energy Efficiency Lighting
    - Energy Star appliances
- Demand control strategies through application of thermal storage to mitigate daily electric peak demand
- Renewable sources of power (solar photovoltaics; solar thermal)
- Distributed generation (including CHP)/distributed energy technology with heat recovery for heating, domestic hot water, absorption cooling and desiccant dehumidification in selected commercial and institutional buildings

Modeling Tools

- Building Energy, Economic & Emissions Modeling
  - ***Building Energy Analyzer & Energy10*** (GTI & SBIC)
    - Building Types
      - Residential - single-family & multifamily
      - Commercial – retail, office, mixed-use
      - Industrial & institutional
    - Modeling Parameters
      - Building Envelope
        - foundation, framing, roofing, insulation, glazing, doors
      - Operating equipment, appliance & plug loads
      - Heating, ventilation, air conditioning, lighting, control systems, distributed generation with CHP, solar PV & thermal & thermal storage
- District Energy Systems Analysis
  - ***TERMIS*** (7-Technologies)





NECSC

Modeling Tools: Community Scale

Evaluation of economics, emissions related environmental and energy efficiency impacts:

- Aggregated and Integrated Systems Impacts of Implementing Customized EE Packages in Individual Buildings
- Electric Grid Impacts: Load Duration Curve (deferred distribution costs), Grid Stability (distributed energy)
- Natural Gas Distribution (CHP) impacts
- District Cooling, Heating and Power
- Integrated Energy System Development in Communities

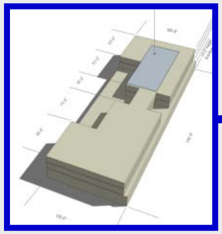
NECSC

Modeling Tools

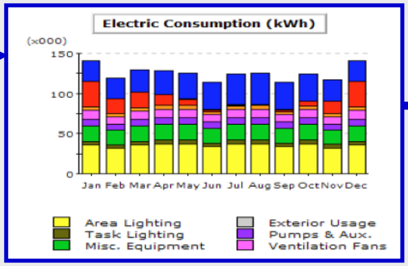
- Land Use & Infrastructure
  - **CommunityViz** (Orton Fnd./PlaceMatters)
    - Mixed uses, TOD & alternative densities
    - Landscape/green space elements
    - Potable water & waste water infrastructure
- Stormwater Runoff, Carbon Sequestration & Tailpipe Emissions Reduction
  - ***CITYgreen*** (American Forests)
    TR-55 / Urban Hydrology for Small Watersheds & UFORE (USDA)
- Transportation
  - **CommunityViz** (Orton Fnd./PlaceMatters)
    - Household trips/day & trip length
    - Alternative ridership modes & fuels
    - 4D Land use & travel behavior analysis
- Urban Heat Island Effect Mitigation
  - ***Mitigation Impact Screening Tool*** (USEPA)

Modeling Tools

Create Building Prototypes



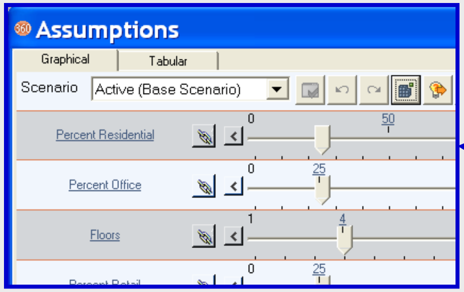
Analyze Annual & 8760 Energy Performance for Different EE&RE (DER) Applications



Build Land Use Scenarios

Measure aggregate impacts

Experiment interactively & see changes



Choose preferred plan (Buildings AND Land Use)

Value of Methods and Tools

- ***Broadening Understanding of Energy Demand, Use and Impacts*: Generating more comprehensive information.**
- ***Charting Zero Net Energy Pathways:* Contributing to the information and knowledge base to chart cost-effective ZNE pathways.**
- ***Fostering New Urban Energy Management:* Incorporating energy planning into local land-use development and urban design.**
- ***Developing Community-Based Energy Solutions:* Redefining infrastructure and land development, roles of market players and strategic growth management.**
- ***Stimulating New Research, Business and Financing Models and Policy Design:* Generating new models and targeted policy measures to shift market demand, create new industries and accelerate clean technology deployment.**
- ***Unleashing Significant Community-Scale Energy and Resource Efficiencies:* Enabling Community Energy and Resource Systems development.**

NECSC

Value of Methods and Tools

Model-based community energy system design has the potential to inform and evolve:

- A New Research Model for Urban Energy Systems
- New Performance-Based Metrics/Indicators
- New Business and Value Chain Models
- New Financing Schemes
- Performance-Based, Risk-Targeted Policy Measures, Incentives, Contracting; and Market-Based Delivery Mechanisms

NECSC

Value of Methods and Tools

Generating Community Energy Systems Outcomes:

Expanding use of local renewable and recycling energy resources;
Developing grid reinforcing local and regional energy smart networks;
Optimizing energy efficiency, renewable energy, demand response;
Securing critical infrastructure with strategically sited DER;
Enhancing supply and demand network control with grid enabling storage and IT technologies;
Advancing integrated resource management.

Significant Potential Results:

Efficiencies in distribution and use of energy throughout end-uses;
Increased utilization of grid, reducing supply investment needs;
Carbon emissions reductions;
Reduction in embedded energy costs of materials;
Secure power to critical facilities and local energy network or cells;
Increased distributed energy resource applications;
Integrated DSM
Multi-Media environmental permitting and integrated resources management.

New Tools for Sustainable Community Energy System Design & Development

For More Information Contact:

- Larisa Dobriansky,
  Executive Director, GEN
  703-920-1377 phone
  larisa.dobriansky@gmail.com

Visit Us At:

www.necsc.us

www.globalenergynetwork.org