Using LEAP to Develop Low Emission Development Strategies

Charles Heaps, Ph. D.

LEAP Developer and

Director, SEI U.S. Center

SEI STOCKHOLM ENVIRONMENT INSTITUTE

Stockholm Environment Institute

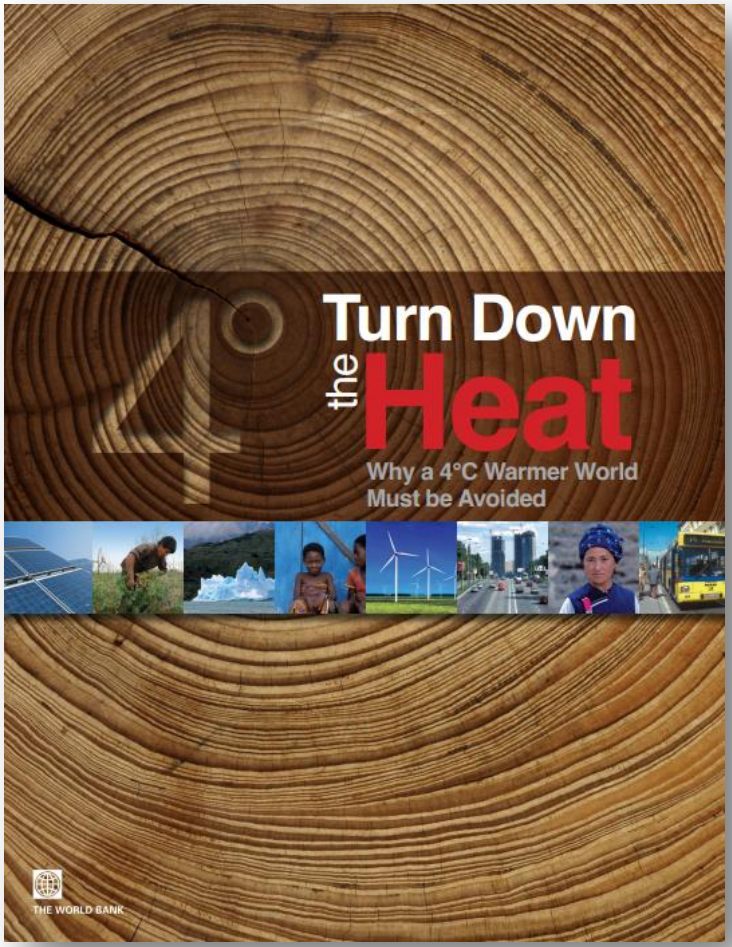
- An independent international research organization conducting applied scientific research on the issue of sustainable development.
- HQ in Stockholm. Centers in the UK, US, Estonia, Thailand and Tanzania.
- 160 staff (28 in the U.S.).
- Interdisciplinary work: drawing upon engineering, economics, ecology, ethics, operations research, international relations, software design, etc.
- Main research areas: climate mitigation and adaptation, climate economics, energy policy, water resources planning & ecological sanitation, atmospheric pollution, livelihoods & vulnerability, sustainable futures.
- Funders include: Swedish, US and European governments, multilateral agencies (World Bank, UNDP, UNEP, UNFCCC, etc.), foundations, national & local governments.
- SEI's US Center is not-for-profit 501c3 research institute affiliated with Tufts University.
- www.sei-international.org and www.sei-us.org

Talk Outline

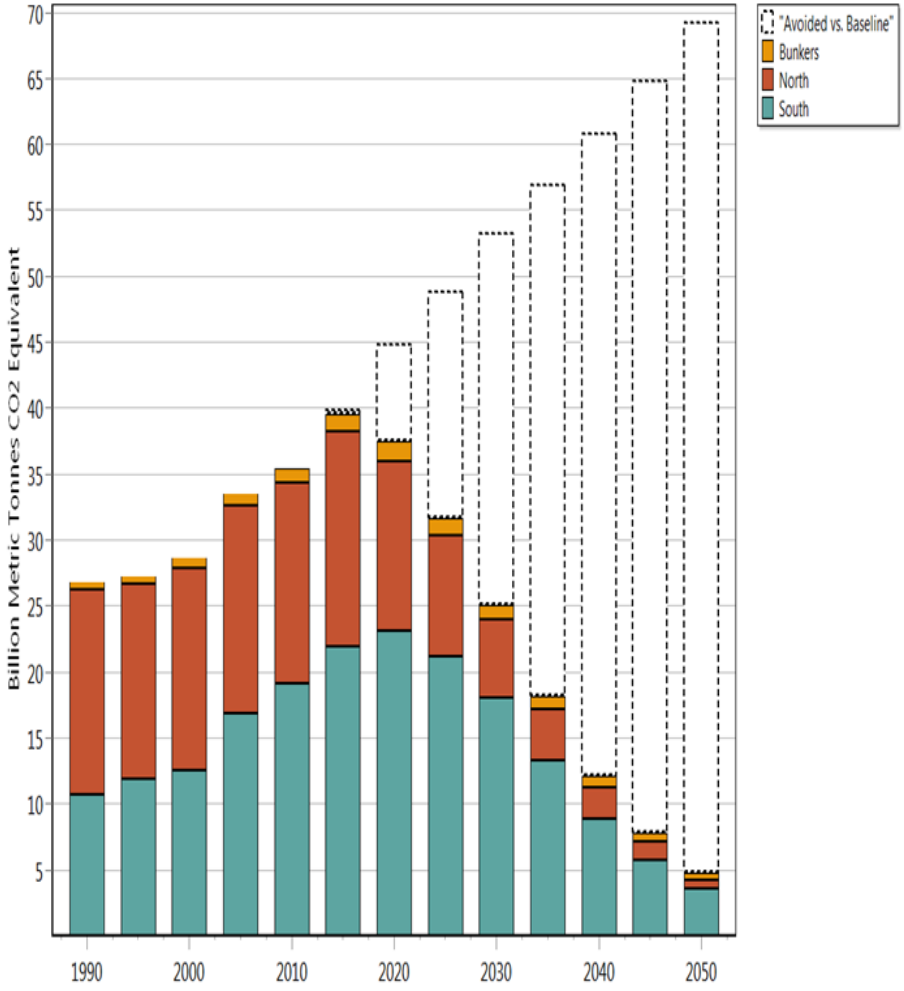
- Context: The Global Climate Challenge
- Part 1: Low Emission Development Strategies
- Part 2: Models and Methods for GHG Mitigation Assessment
- Part 3: An Introduction to LEAP: The Long range Energy Alternative Planning System

Where are We Headed?
Excerpts from a Recent World Bank Report
Turn Down the Heat (November 2012)

- Present emission trends put the world plausibly on a path toward 4°C warming within century.
- Even with current mitigation commitments and pledges fully implemented, there is roughly a 20% likelihood of exceeding 4°C by 2100.
- If commitments not met, a warming of 4°C could occur as early as the 2060s.
- Further warming to levels over 6°C, with several meters of sea-level rise, would likely occur over the following centuries.
- A 4°C world would be one of unprecedented heat waves, severe drought, and major floods in many regions, with serious impacts on human systems, ecosystems, and associated services.
- No certainty that adaptation to a 4°C world is possible.



Global CO_2 Scenarios: From SEI Scenario: "**Energy for a Shared Development Agenda**"



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Full report available here:
www.sei-international.org/rio20

Cumulative CO_2 Emissions

Cumulative CO2 Emissions: 2000-2050	Gt CO2
Baseline (97% chance exceeding 2°C)	2,436
50% Chance of 2°C	1,440
SDA (60% Chance of 2°C)	1,300
67% Chance of 2°C	1,169

Already Emitted (2000-2012): ~406 GT CO_2

Key Strategies & Measures

Energy Efficiency:
Very high levels of insulation of buildings, lighting, heating, cooling, industrial processes, road vehicles, shipping and airplanes.

Electrification and Renewables
Helps achieve efficiency goals and eliminate CO_2 in end-use sectors. Requires that electricity production has close to zero emissions of CO_2 (renewables and some nuclear and CCS).

Switching to Low Carbon Fuels
Switching from coal and oil to sustainably grown biomass and limited use of natural gas w/CCS. May also require expansion of nuclear.

Sufficiency
Loosen tight link between economic growth and consumption of goods and services.

Part 1: Low Emission Development Strategies

What is a LEDS?

- A **L**ow **E**mission **D**evelopment **S**trategy
- Describes actions, policies, programs and implementation plans that:
  - meet national development objectives, and
  - achieve long-term GHG emissions reductions an/or GHG sink enhancements relative to a business-as-usual development pathway.

Credits: Slides drawn from the OpenEnergyInfo web site (NREL) and slides developed by UNDP.

LEDS: Some Background

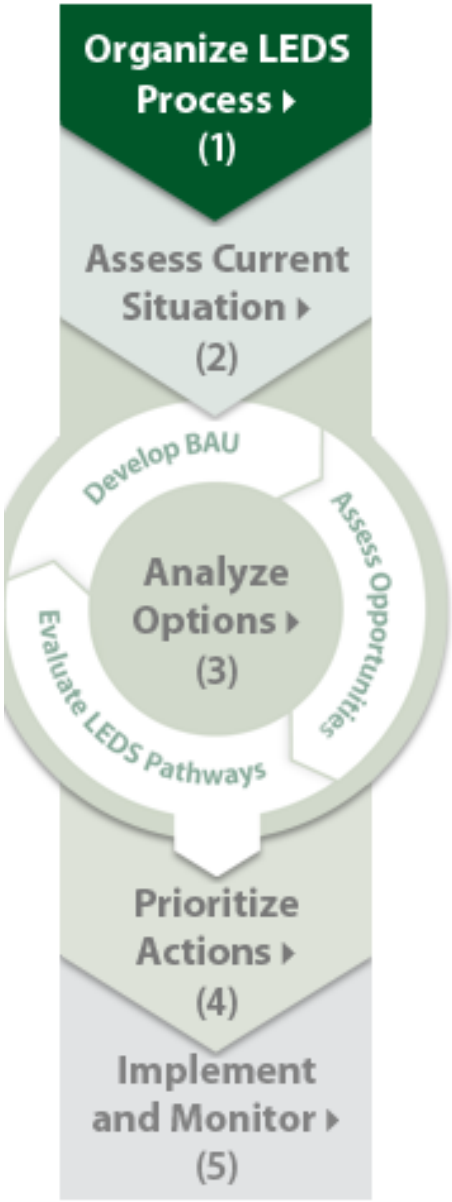
- LEDS first emerged under the UNFCCC in 2008
- Specifically mentioned in negotiating texts at COP15 in Copenhagen (2009)
- Cancun Agreements (2010) encourage LEDS in context of sustainable development, reaffirmed in Durban (2011)
- Green Climate Fund governing instrument "will promote paradigm shift to low emission, climate resilient pathways"
- Will also fund LEDS preparation/strengthening

Benefits of a LEDS

- Contribute to sustainable development and poverty reduction goals.
- Promote local economic development, industrial energy efficiency, and energy security.
- Provide incentives for home-grown technology innovation, deployment and transfer.
- Attract foreign direct investment into key sectors.
- Access to the Green Climate Fund.

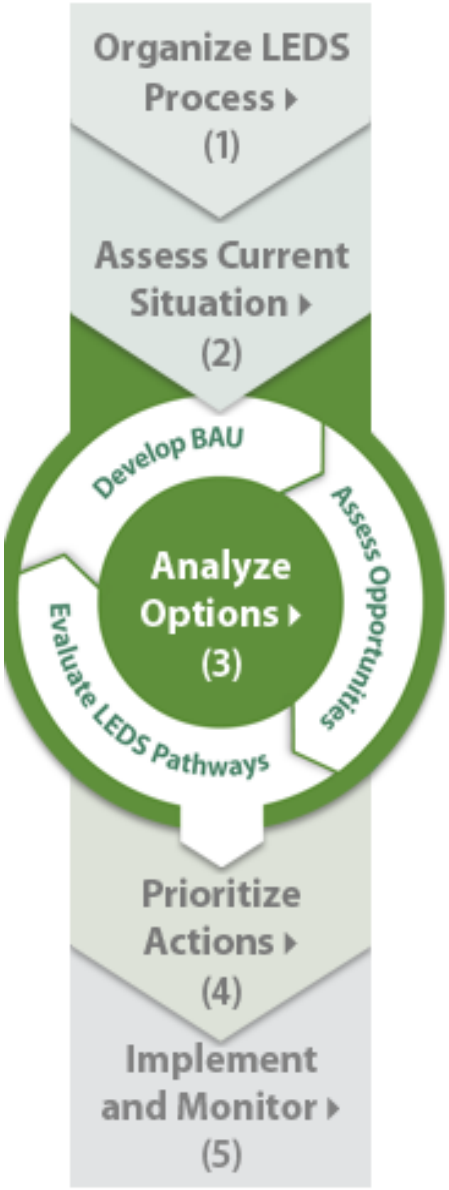
Key Stages in a LEDS

1. Organizing the LEDS Process
2. Assessing the Current Situation
3. Analyzing Options
4. Prioritizing Actions
5. Implementation and Monitoring



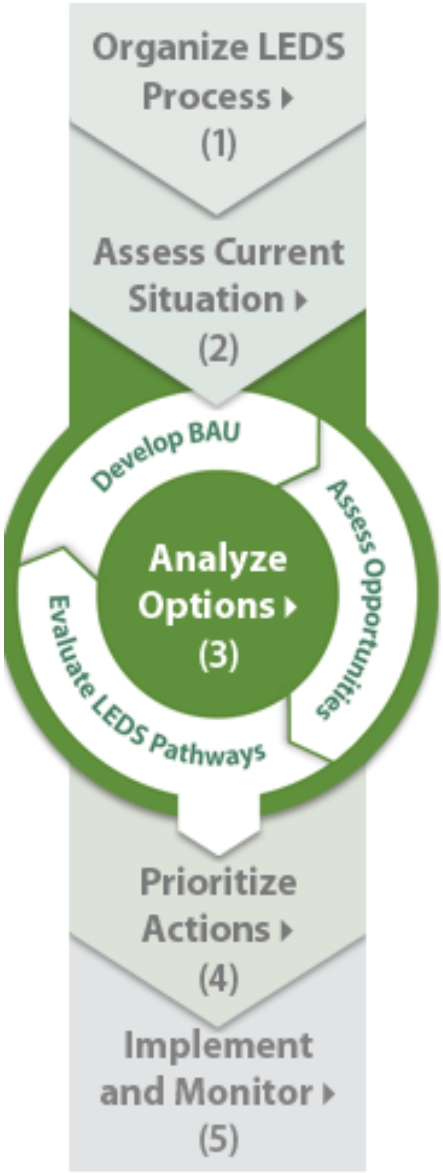
3. Analyze Options

1. Develop "No Climate Action" baseline scenario to 2050: consistent with development goals.
   - Documented & shared with stakeholders for review and feedback.
2. Assess Opportunities for Climate Action.
3. Develop Low GHG Scenarios
4. Identify Policy and Financing Options for Implementing LEDS



3.1 Baseline Scenario

- A plausible and consistent description of the future in the absence of new GHG mitigation policies
- The counterfactual against which potential LEDS actions can be evaluated.
- Not simply an extrapolation of past trends, requires data and assumptions regarding:
  - Macroeconomic and demographic projections
  - Structural shifts in the economy
  - Planned investments and existing policies in individual sectors
  - Likely evolution of technologies and practices
- Can be useful to have multiple baselines:
  - With and without existing policies
  - With efficiencies and other parameters “frozen”

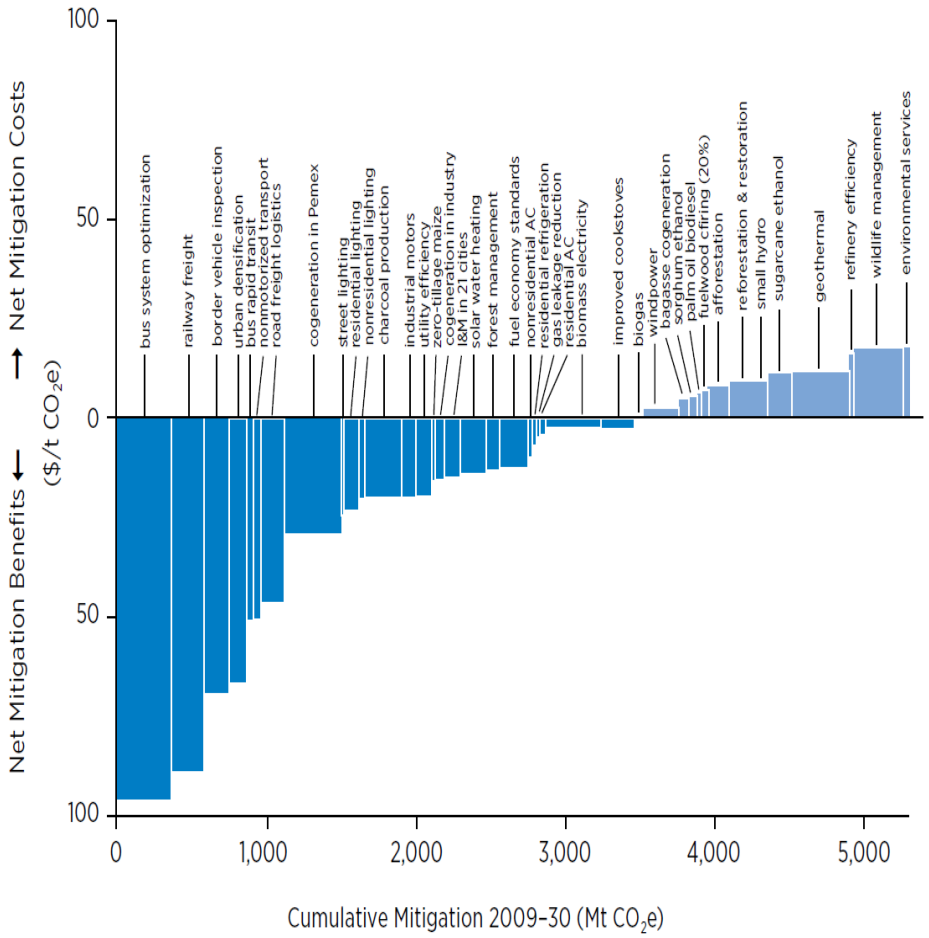


3.2 Assess Opportunities

1. Assess potential and costs of options in key sectors (buildings, industry, transport, electricity generation, forestry, solid waste, etc.)
2. Screen to identify and prioritize affordable options that also match development goals.
3. Tools such as Marginal Abatement Cost Curves (MACCs) and Multi Criteria Attribute (MCA) Analysis can be used to consider energy security, environmental protection, employment, job creation, income generation, rural development, urban air quality, etc.
4. Screening may also be based on:
   - Review of policies for overcoming barriers to LEDS.
   - Review of international best policy practices & lessons learned

Marginal Abatement Cost Curves

- A technique for screening and ranking GHG mitigation options
- Plots cumulative GHG reduction from successive mitigation options (e.g. tonnes of CO2 avoided) against cost per unit of GHG reduction (e.g. $/tonne)
- Area under curve yields total cost of avoided emissions
- Care should be taken to consider interdependencies among options e.g. through use of integrated models



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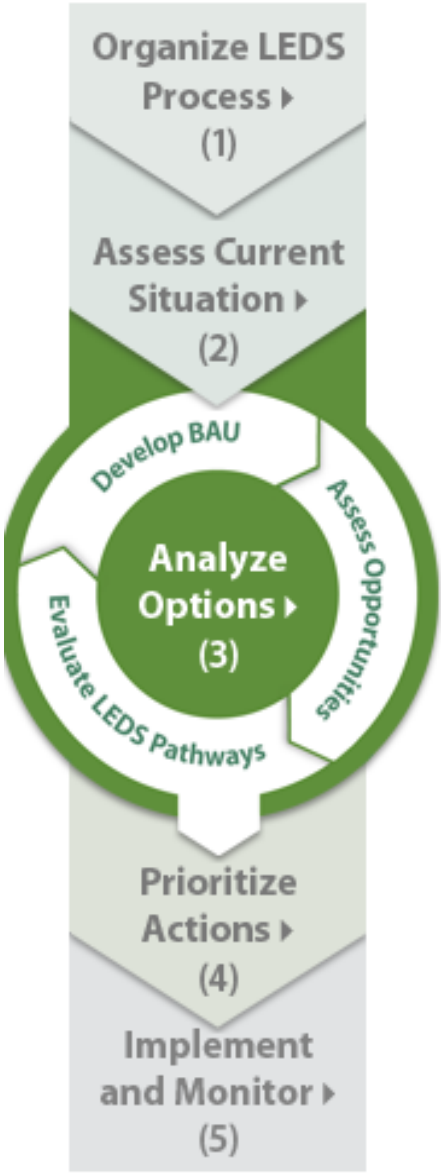
Source: Mexico Low Carbon Country Case Study, World Bank ESMAP

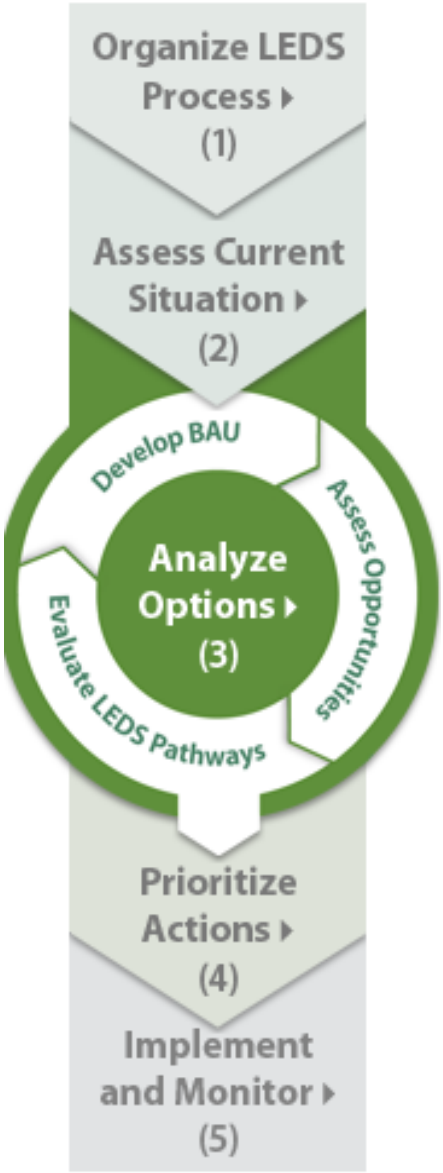
3.3 Low GHG Scenarios

- Create and evaluate alternative visions for accelerating use of technologies and practices to achieve LEDS goals.
- May be integrated economy-wide analyses or focused on particular sectors.
- Typically most countries will want to examine both energy sector and land-use change/forestry sectors.
- LEDS Pathways to 2050 may be created using top-down (macroeconomic) or bottom-up models (like LEAP).
- Finalized LEDS Pathways should form the outline of a LEDS implementation plan.
- Should be evaluated in terms of their costs, mitigation and development potential (e.g. through MCA analysis).
- Should also be reviewed by stakeholders and require buy-in from high level steering committee.



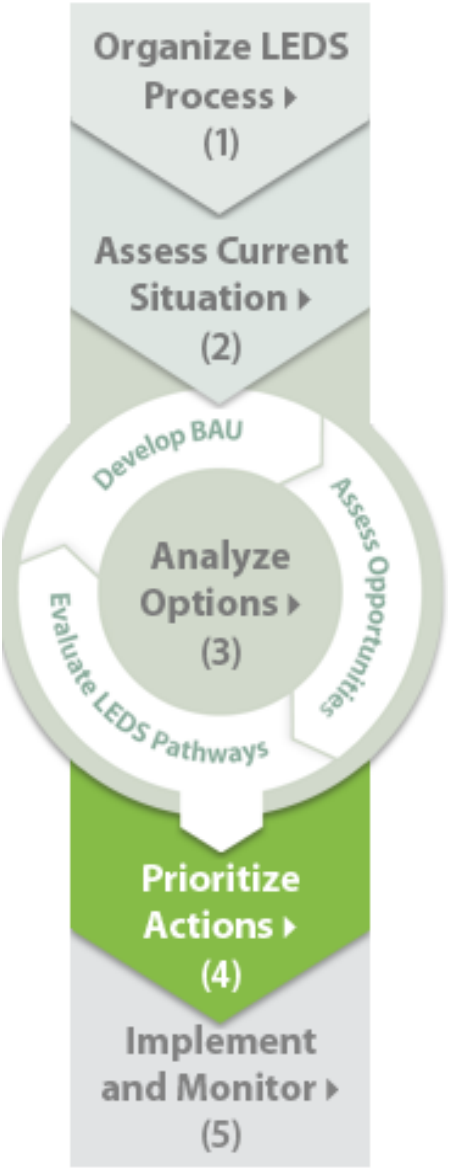
3.4 Identify Policy and Financing Options

- Determine policy & financing needs for options in low GHG scenario (e.g. with investment & financial flow analyses)
- Identify available domestic resources
- Determine need for external financial support
- Identify sources of financial support
- Link to existing processes & programmes



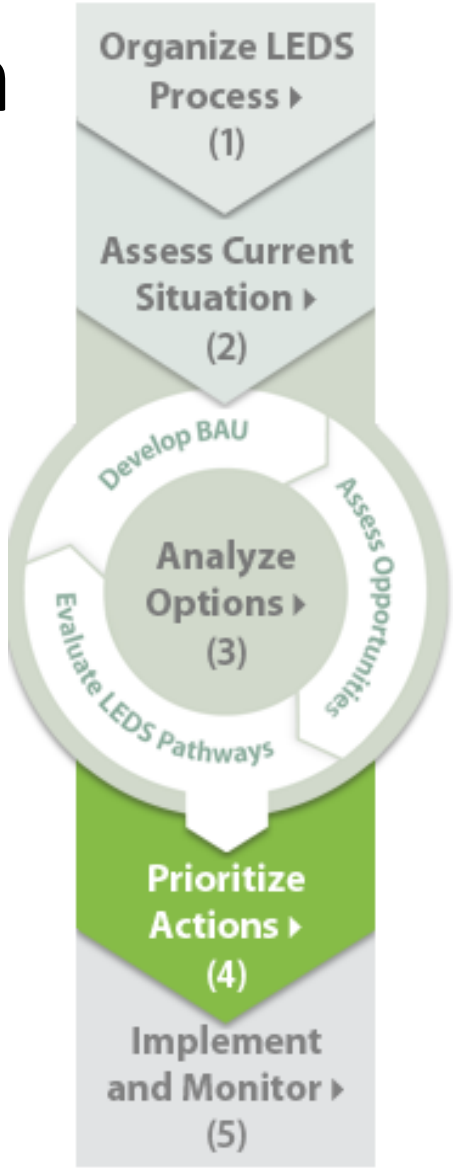
4. Prioritize Actions

1. Prepare for Implementation
2. Develop and launch comprehensive implementation plan



4.1. Prepare for Implementation

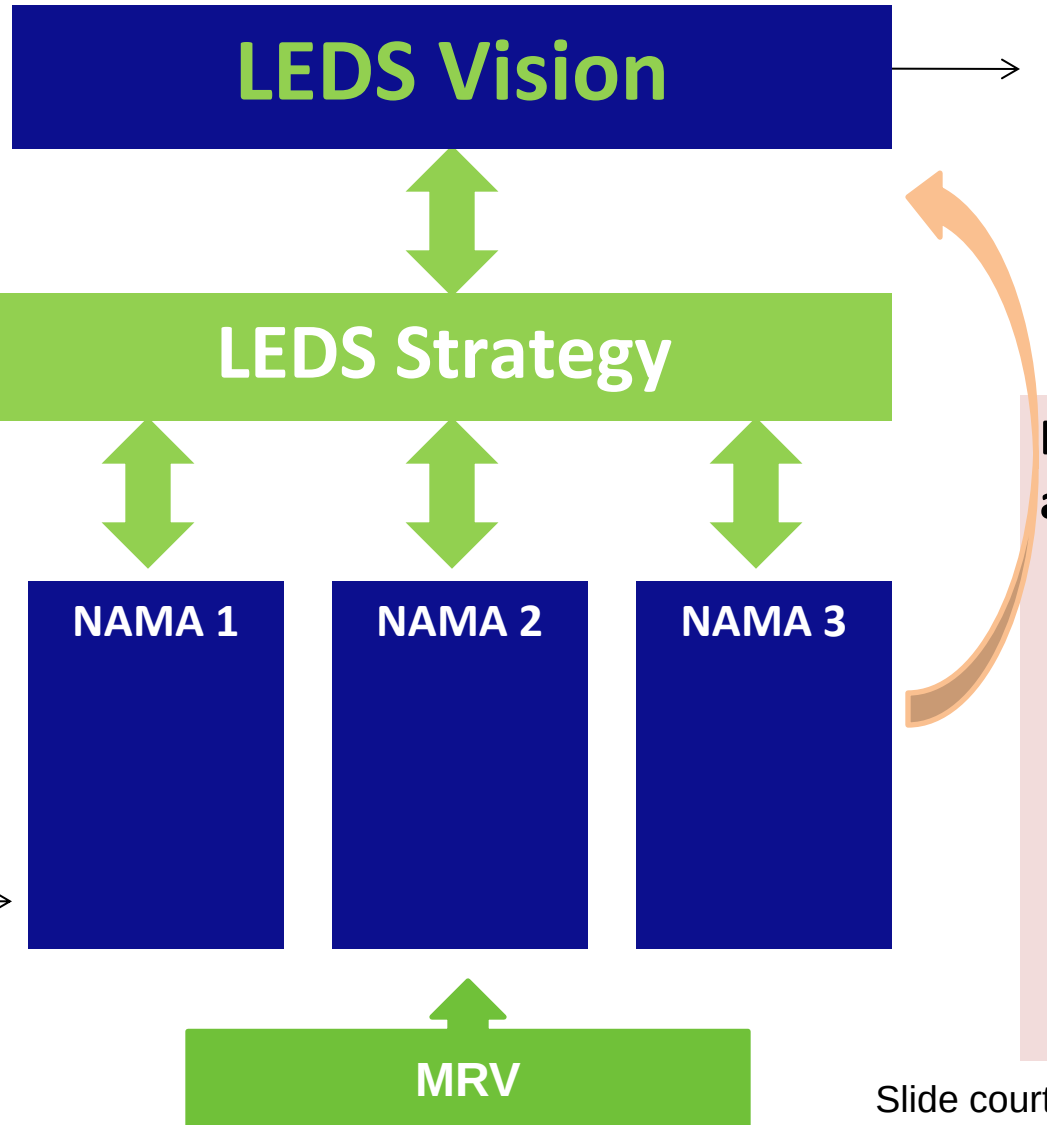
- Review and refine actions through stakeholder consultations.
- Finalize goals & recommendations.
- Seek highest level endorsement of goals and commitment to implement actions.
- Identify responsible agencies.
- Develop detailed implementation plans.
- Ensure targets are specific & measureable.
- Submit requests for external support if needed (e.g. Green Climate Fund).



Relationship between LEDS & NAMAs (Nationally Appropriate Mitigation Actions)

Top down approach:

1. Set policy objective & targets
2. Identify NAMAs in various sectors (macro-economic modelling)



Voluntary targets

Bottom up approach:

1. Identify NAMAs
2. Analyse aggregate options
3. Lay foundation for LEDS

International support: $, CD, technologies

Slide courtesy of: UNDP LECB

Key LEDS-related activities at SEI

- Developing, supporting and distributing LEAP: a key tool for developing national level baseline and mitigation scenario analyses.
- LEAP has been widely adopted by countries creating LEDS and undertaking national climate change mitigation assessments. It is used by thousands of organizations in 190 countries.
- SEI has also been closely involved in initiatives to build capacity for LEDS.
- Many other climate-related activities at SEI. Providing authors to the upcoming IPCC 5th Assessment Report, research on climate adaptation, climate finance, and climate mechanisms, etc.

SEI's Support for LEDS

United Nations Framework Convention on Climate Change

SEI developed the UNFCCC's training materials on GHG mitigation: the basis for 3 regional UNFCCC workshops in Asia, Latin America & the Caribbean and Africa led by SEI.

National Communications Support Programme

SEI has provided technical support to NCSP and run numerous NCSP regional training workshops over the last 10 years, teaching countries how to apply LEAP for National Mitigation Assessments.

LOW EMISSION CAPACITY BUILDING PROGRAMME

SEI recently developed national "starter" baseline scenarios for the LECB for 22 countries, which will help kick start LEDS analyses.

LEAD
LOW EMISSIONS ASIAN DEVELOPMENT PROGRAM

SEI will be supporting US AID as it helps Asian nations develop LEDS in 2013 and thereafter.

USAID

Supported by US-AID, Mexico is developing an LEDS. SEI, with support from Universidad Autónoma de México, is helping the Mexican National Institute of Ecology and Climate Change (INECC) to update and strengthen its baseline and mitigation scenarios: key elements of the LEDS.

Part 2: Models and Methods for GHG Mitigation Assessment

Using Models for LEDS: Important Considerations

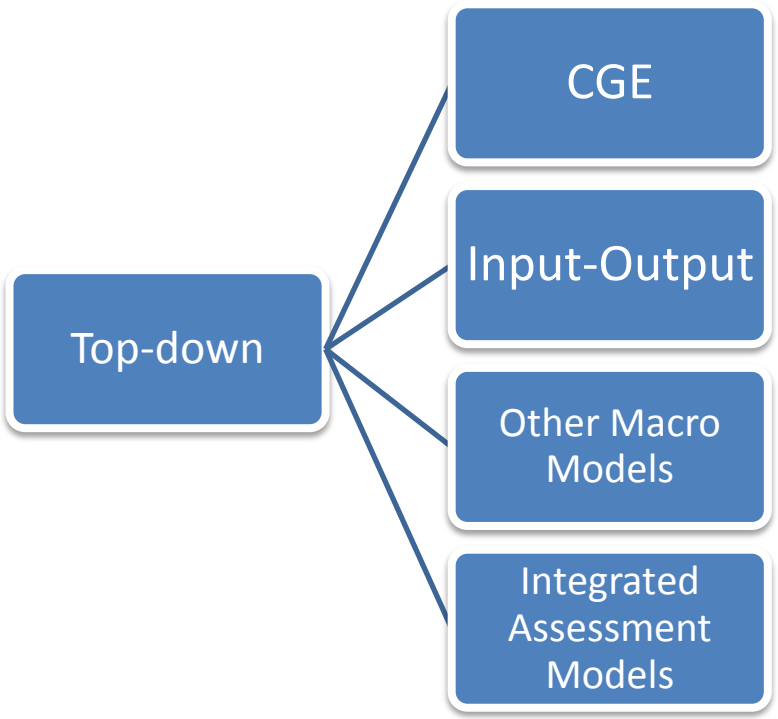
- Modeling sophistication is less important than the rigor, consistency and data quality underpinning the analysis itself.
- Consider who will undertake the analysis. Outside consultants provide ready source of expertise, but may do little to build capabilities in-country.
- Even relatively simple models require many months and a good level of expertise.
- Don't expect modeling to be done only by analysts: policy analysis requires strong guidance from local experts and buy-in from high level decision makers.
- Ideally setup up a permanent team responsible for LEDS modeling to ensure continuity of expertise.
- Strong, coordinated and diverse team needed: economists, engineers, energy & industrial engineers, agriculture & LULUCF experts, etc.
- Close coordination needed with other national groups: e.g. those working on GHG inventories and those doing national energy planning.

Types of Models

- Both **Top-Down** and **Bottom-up** models can yield useful complementary insights on mitigation.
  - Top-down models are most useful for studying broad macroeconomic and fiscal policies for mitigation such as carbon or other environmental taxes.
  - Bottom-up models are most useful for studying options that have specific sectoral and technological implications.
- Different models will likely be required for studying energy sector-related emissions vs. land-use change and forestry-related GHG emissions.

Types of Top-Down Models

- **CGE** (Computational General Equilibrium) models use economic data to estimate how an economy will respond to changes in policies, technologies and prices. Assumes economies approach or reach equilibrium status.
- **Input/Output models** focus on interdependencies among different sectors of an economy. Often assume static economic structures.
- **Integrated Assessment Models**: Tend to be based on physical/technological descriptions of systems and their interconnections (energy, water, land, agriculture, forestry, food, etc.). Examples include IMAGE (PBL) and PoleStar (SEI).



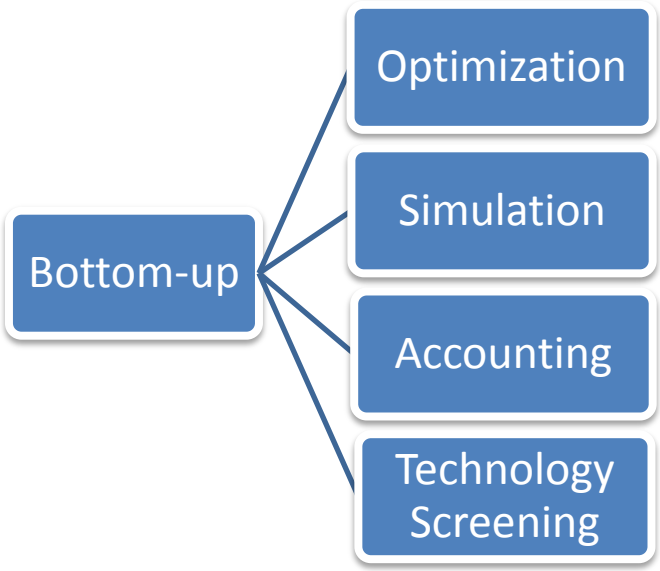
Types of Bottom-Up Energy Sector Models

Optimization: Use mathematical programming to identify configurations of energy systems that minimize the total cost of providing services.
EG: MARKAL/TIMES, LEAP, MESSAGE

Simulation: Simulate behavior of consumers and producers under various signals (e.g. price, income levels) and constraints (e.g. limits on rate of stock replacement).
EG: ENPEP-BALANCE

Accounting Frameworks: Account for physical stocks and flows in systems based primarily on engineering relationships and explicit assumptions about the future (e.g. technology improvements, market penetration rates).
EG: LEAP, EFFECT, MAED

Technology Screening: Focus on how a particular technology (or set of technologies) will perform under certain constraints and can track associated costs and emissions.
EG: RETScreen, HOMER. ClimateDesk



Notable Bottom-up Models Used in the Energy Sector

Integrated Tools

- Climate Desk
- EFFECT
- ENPEP-BALANCE
- MARKAL/TIMES
- IAEA Modeling Tools
- LEAP

Sector-specific Tools

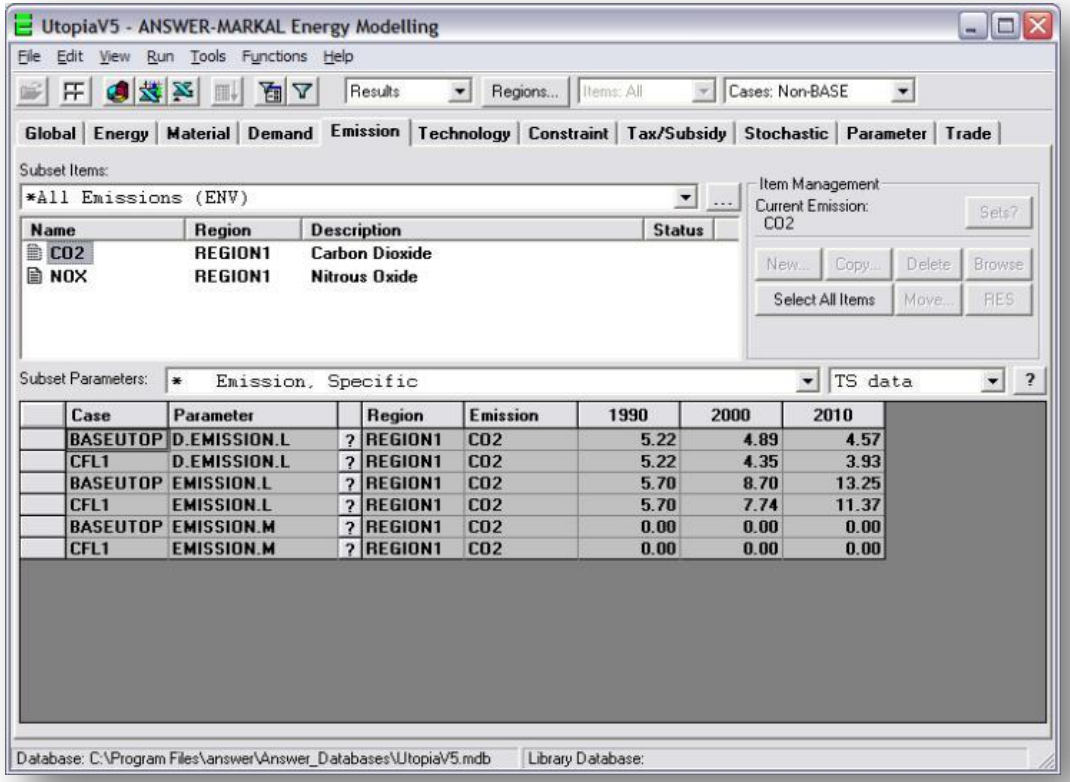
- HOMER
- RETScreen

EFFECT: Energy Forecasting Framework and Emissions Consensus Tool

- **Description** : An Excel-based model used to forecast greenhouse gas (GHG) emissions from a range of development scenarios.
- **Developer**: World Bank, ESMAP
- **Licensing**: Free
- **Contact**: John A Rogers - jarogers@worldbank.org
- **Website**: www.esmap.org/esmap/EFFECT

MARKAL/TIMES

- **Description** : An optimization-based energy modeling system that also calculates GHGs and local air pollutants. TIMES (The Integrated MARKAL-EFOM System) is gradually expected to replace MARKAL.
- **Developer**: International Energy Agency, Energy Technology Systems Analysis Programme (IEA/ETSAP)
- **Licensing**: $3,000-$15,000
- **Contact**: etsap.org
- **Website**: www.iea-etsap.org

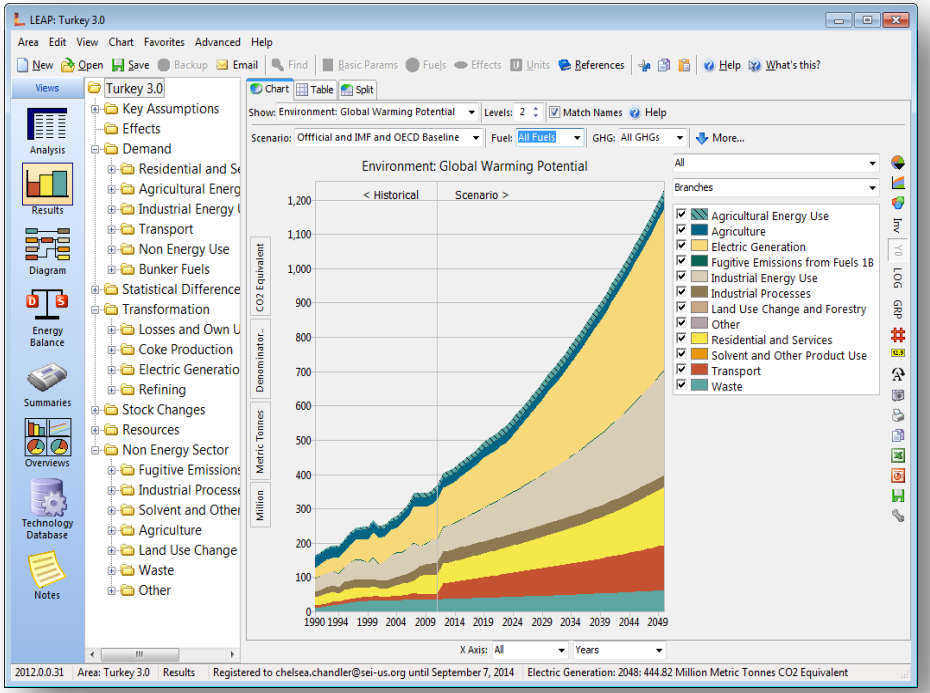


IAEA's Modeling Tools

- A Loosely coupled set of models:
  - MAED (for energy demand)
  - MESSAGE for supply optimization.
  - SIMPACTS: Simplified approach for estimating impacts of electricity generation
  - FINPLAN: Model for financial analysis of electric sector expansion plans
- **Developer**: International Atomic Energy Agency
- **Licensing**: Free to IAEA partner governments.
- **Contact**: Mr. Ahmed Irej Jalal - A.Jalal@iaea.org
- **Website**: http://www.iaea.org/OurWork/ST/NE/Pess/capacitybuilding.html

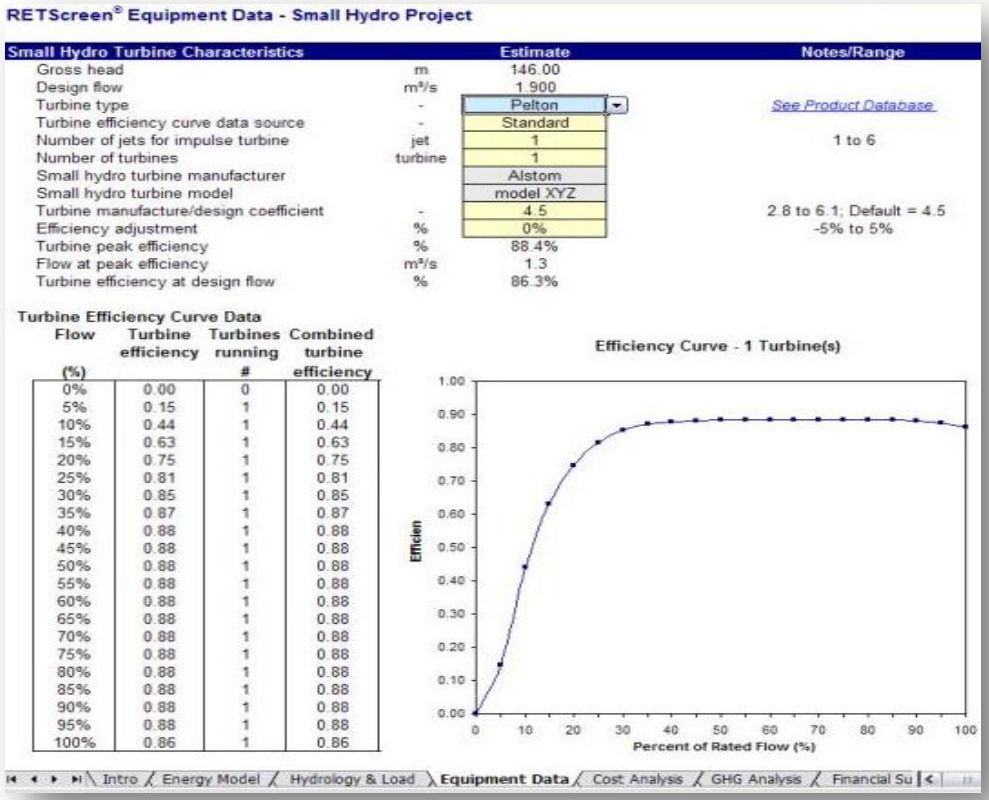
LEAP: Long range Energy Alternatives Planning System

- **Description:** Accounting and optimization model covering energy demand and energy supply and to examine both GHGs and local air pollutants. Also covers non-energy sector sources and sinks.
- **Developer:** Stockholm Environment Institute
- **Licensing:** Free for government, academic and NGOs in developing countries and for students.
- **Contact:** Charles Heaps leap@sei-us.org
- www.energycommunity.org



RETScreen

- Excel-based tool to evaluate the energy production, life-cycle costs and GHG emissions from renewable energy and energy efficient technologies. Used primarily for project screening/feasibility: complementary to integrated modeling tools.
- **Developer**: Natural Resources Canada
- **License**: Free
- retscreen@nrcan.gc.ca
- www.retscreen.net



Part 3:
LEAP: The Long range Energy Alternative Planning System