Training Workshop: RETScreen for Assessing Renewable Energy Projects

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Sponsored by
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Source of presentation materials – www.retscreen.net
RETScreen® Introduction
Developers and Partners

- Developed and maintained by the Government of Canada through Natural Resources Canada’s CanmetENERGY research centre in Varennes, Quebec
- The core RETScreen team includes 9 full-time staff, plus
- Network of Experts - There are 307 experts from across the globe have been directly involved in the development and support of RETScreen International
  - This approach provides RETScreen International with access to a broad array of expert skills that are needed for specialised tasks
  - Dr. Clarke is a Member of the Network of Experts
Developers and Partners

- Principal partners include:
  - National Aeronautics and Space Administration (NASA)
  - the Renewable Energy and Energy Efficiency Partnership (REEEP),
  - the United Nations Environment Programme (UNEP)
  - the Global Environment Facility (GEF)
  - World Bank’s Prototype Carbon Fund (PCF)
  - The Energy + Environment Foundation
  - Leonardo ENERGY Initiative
Market and Users

- Available in 35 languages covering more than 2/3 of the world’s population
- Used by more than 215,000 people in 222 countries and territories
- Part of the curriculum in more than 210 universities and colleges worldwide, including:
  - China University of Mining & Technology
  - Hong Kong University of Science and Technology
  - Renmin University
  - Tsinghua University
  - Christian University of Indonesia
  - University of the West Indies - Cave Hill, Barbados
Market and Users

• Used by various stakeholders in a project for:
  – Feasibility studies
  – Project lender due-diligence;
  – Market studies
  – Policy analysis
  – Information dissemination
  – Training
  – Sales of products and/or services;
  – Project development & management
  – Product development/R&D.
Growth in Number of Users

RETScreen Software: Cumulative Growth of User Base

- World
- Canada

216,065 users worldwide from 222 countries
Growing at 1,000 users every week

Top Twenty Countries
1. Canada 48,729
2. USA 30,507
3. France 24,257
4. Italy 12,708
5. UK 9,252
6. Spain 7,143
7. Portugal 5,117
8. Greece 4,074
9. Germany 3,505
10. Australia 3,483
11. India 3,127
12. Belgium 3,055
13. Romania 2,670
14. Brazil 2,576
15. Poland 2,442
16. China 2,295
17. Ireland 2,130
18. Mexico 1,933
19. Chile 1,656
20. South Korea 1,570

As of September 30, 2009
Why Use RETScreen

• RETScreen significantly reduces the costs (both financial and time) associated with identifying and assessing potential energy projects

• These costs arise at the pre-feasibility, feasibility, development, and engineering stages

• Dilemma for the Analyst/Developer:
  – Keep the project development costs low in case funding cannot be secured
  – or in case the project proves to be uneconomic when compared with other energy options
Why Use RETScreen

- Spend additional money and time on engineering to more clearly delineate potential project costs and to more precisely estimate the amount of energy produced or energy saved

  • Dilemma may be tackled by using a typical 4 step process that begins with the Pre-Feasibility and Feasibility Study

  • RETScreen provides a platform for both Pre-feasibility and Feasibility Studies
Typical Energy Project Implementation Process

1. Pre-feasibility Analysis
   - NO GO?
   - GO?

2. Feasibility Analysis
   - NO GO?
   - GO?

3. Engineering & Development
   - NO GO?
   - GO?

4. Construction & Commissioning

Time & Money → Go/No-Go Decision →
RETScreen and Pre-Feasibility Studies - 1

- Pre-feasibility Analysis: A quick and inexpensive initial examination of the project
- Determines whether the proposed project has a good chance of satisfying the proponent’s criteria e.g. financial profitability or cost-effectiveness
- Used as an aid to determine if project merits a more serious investment of the time and resources required by a feasibility analysis
- May use RETScreen
RETScreen and Pre-Feasibility Studies - 2

• Pre-feasibility studies characterised by:
  – the use of readily available site and resource data
  – coarse cost estimates
  – simple calculations and judgments often involving rules of thumb.

• e.g. For large hydro projects, site visit is required

• For small projects involving lower capital costs, such as for a residential solar water heating project, no site visit necessary
RETScreen and Feasibility Studies - 1

• Feasibility Analysis: A more in-depth analysis of the project’s prospects
• Designed to provide information about the physical characteristics, financial viability, and environmental, social, or other impacts of the project
• Used as an aid to decide whether or not to proceed with the project
• May use RETScreen
Feasibility Studies are characterized by:

- the collection of refined site, resource, cost and equipment data
- It typically involves site visits, resource monitoring
- energy audits, more detailed computer simulation
- the solicitation of price information from equipment suppliers
If project proceeds, engineering and development will be the next step.

Engineering includes the design and planning of the physical aspects of the project. May use HOMER.

Development involves the planning, arrangement, and negotiation of financial, regulatory, contractual and other nonphysical aspects of the project.

- May be aided by RETScreen Legal ToolKit.
Engineering Development - 2

• Some development activities, such as training, customer relations, and community consultations may extend through construction and operation.

• Project may still be halted prior to construction if:
  – Financing cannot be arranged
  – Environmental approvals cannot be obtained
  – The pre-feasibility and feasibility studies “missed” important cost items, or
  – For other reasons
Construction and Commissioning - 1

• Finally, the project is built and put into service
• Construction activities can be started before completion of engineering and development, and the two conducted in parallel
Accuracy of Cost Estimates vs. Actual Costs - 1

• Each step above represents increasing expenditure, and reduced uncertainty in costs estimates – Depicted in next diagram
Accuracy of Cost Estimates vs. Actual Costs - 2
RETScreen and Legal Issues

• RETScreen Legal Toolkit helps to reduce the transaction costs of developing legal structures and documents for clean energy projects
• Training manual
• Legal Templates
• Sample legal documents
• All for free from www.retscreen.net
• Dr. Clarke assisted in the development of Legal Tool Kit
Technologies - Wind

- Wind energy systems
  - central grids or isolated grids
  - remote power supply
  - water pumping
  - charge batteries
Technologies - Hydro

• Small hydro systems for electricity
  – provide power to a central grid, an isolated grid or an off-grid load
  – either run-of-river systems, or water storage reservoirs

• Large hydro projects of up to several GW that usually involve storage of vast volumes of water behind a dam
Technologies - PV

- Photovoltaic (PV) systems
  - Small off-grid applications, providing power to rural homes in developing countries, off-grid cottages
  - Motor homes in industrialised countries, and remote telecommunications,
  - Monitoring and control systems worldwide
  - Water pumping
  - PV hybrid system
  - Central grid
Technologies - Biomass

• Biomass heating systems to heat buildings
  – wood chips
  – Agricultural and residues
  – municipal waste

• For industrial processes
Technologies – Solar Thermal

- Solar air heating systems
  - building heating and ventilation
  - industrial processes such as drying
- Solar water heating systems
- Solar Thermal Power plants
- Passive solar heating for space heating
Technologies – Heat Pumps

• Ground-source heat pumps space heating and cooling, and domestic hot water
Technologies – Combined Heat and Power, CHP

• Combined heat and power and cogeneration

• Waste heat used for
  – space heating and cooling
  – water heating
  – industrial process heat

• Also Combined Heating, Cooling and Power
Technologies – Bio

- Biofuels (ethanol and bio-diesel) from
  - corn and sugar cane to generate ethanol
- Ethanol gasoline blend for transportation
- Ethanol from cellulose
- RETScreen can be used to determine the specifications of special user-defined fuels
Technologies - Bio

- Plant and animal oils, such as soybean oil and used cooking grease can be used as fuel in diesel engines i.e. bio-diesel
- Biodiesel is a chemical conversion of plant and animal oils + alcohols into an ester
- Biomass oil can also be mixed with fossil fuels
Technologies – Ocean

- Ocean-thermal power – Ocean thermal Energy Conversion (OTEC)
- Tidal power
- Wave power
- Ocean current power
Technologies – Energy Efficiency, EE

- EE recently added to RETScreen V 4.0
5 Step Process

Five Step Standard Analysis

START
Settings & Site Conditions
- Enter data in shaded cells from top to bottom of each worksheet

1. Energy Model
- Sub-Workshet

2. Cost Analysis
- Click on blue hyperlinks or floating icon to access integrated features

3. Emission Analysis
- Optional

4. Financial Analysis
- Optional

5. Sensitivity & Risk Analysis

Ready to make a decision

Integrated Features
- Climate Data
- Product Data
- Online Manual
- Tools
  - Distance Learning Course
  - Training Material
  - Engineering Textbook
  - Case Studies
  - Marketplace & Maps

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RETScreen® International

ESMAP
The Energy Sector Management Assistance Program

RETScreen® International
Empowering Cleaner Energy Decisions

WORLD BANK
International Bank for Reconstruction and Development
Start

- The *Start* worksheet is used to enter general information about the project, as well as site reference conditions regarding climate.
- Also used to select standard settings needed to perform the analysis.
Start cont’d
Step # 1 – Energy Model

• STEP 1 - Energy Model (and sub-worksheet(s))
• Describe the location of the energy project, the type of system used in the base case, the technology for the proposed case, the loads (where applicable), and the renewable energy resource (for RETs).
• In turn, the RETScreen Software calculates the annual energy production or energy savings.
• Often a resource worksheet (such as the “Solar Resource” or the “Hydrology and Load” worksheet) or an “Equipment Data” worksheet—or both—accompanies the Energy Model worksheet as sub-worksheet(s).
Step # 2 – Cost Analysis

- **STEP 2 - Cost Analysis**
- The user enters the initial, annual, and periodic costs for the proposed case system as well as credits for any base case costs that are avoided in the proposed case (alternatively, the user can enter the incremental costs directly).
- The user has the choice between performing a pre-feasibility or a feasibility study.
- For a “Pre-feasibility analysis,” less detailed and less accurate information is typically required.
- For a “Feasibility analysis,” more detailed and more accurate information is usually required.
Step # 3 – GHG Analysis

• STEP 3– Greenhouse Gas (GHG) Analysis (optional)
• Determines the annual reduction in the emission of greenhouse gases stemming from using the proposed technology in place of the base case technology.
• The user has the choice between performing a simplified, standard or custom analysis,
• Can also indicate if the project should be evaluated as a potential Clean Development Mechanism (CDM) project
• RETScreen automatically assesses whether or not the project can be considered as small scale
Step # 4 – Financial Summary

• STEP 4 - Financial Summary
• The user specifies financial parameters related to the avoided cost of energy, production credits, GHG emission reduction credits, incentives, inflation, discount rate, debt, and taxes.
• RETScreen calculates a variety of financial indicators (e.g. net preset value, etc.) to evaluate the viability of the project.
• A cumulative cash flow graph is also included in the financial summary worksheet
Steps # 5 - Sensitivity and Risk Analysis

- STEP 5 - Sensitivity & Risk Analysis (optional)
- How uncertainty in the estimates of various key parameters may affect the financial viability of the project.
- Performs either a sensitivity analysis or a risk analysis, or both
Spreadsheets in RETScreen

1. Start
2. Energy Model
3. Load and Network Design
4. Cost Analysis
5. Emissions Analysis
6. Financial Analysis
7. Risk and Sensitivity Analysis
8. Tools
The RETScreen Software uses both meteorological and product performance data as input.

Data used to determine the amount of energy that can be delivered (or saved) by a project, or to help calculate other important parameters, such as heating loads.

Data regarding costs and other financial parameters is used to determine various financial aspects of the project.

Data gathering for an individual project can be very time consuming and expensive.

RETScreen Software integrates a series of databases to help overcome this barrier, but user can adjust data.
International Databases - Weather

• Worldwide Ground-based Meteorological Data has been incorporated directly into the RETScreen.
• This integrated RETScreen International Online Weather Database includes ground-based observation averages for over 4,700 sites around the world, compiled from over 200 different sources for the 1961-1990 period.
• NASA’s Satellite-derived Meteorological Data for any location on earth is provided for use with RETScreen via the NASA Surface Meteorology and Solar Energy (SSE) Data Set.
World Wide Location of Weather Stations
International Databases - Weather

- A direct link to the NASA Website is provided from within the RETScreen Software
- User may simply copy the relevant data from the Website and paste it into the relevant worksheets of RETScreen
International Databases – Map of NASA SSE data for July
### Weather Database

<table>
<thead>
<tr>
<th>Region</th>
<th>Monthly Solar Radiation [kWh/m²/d]</th>
<th>Monthly Avg Temperature [°C]</th>
<th>Monthly Avg Rel Humidity [%]</th>
<th>Monthly Avg Wind Speed [m/s]</th>
</tr>
</thead>
<tbody>
<tr>
<td>N. &amp; Central America</td>
<td>Jan: 1.72, Feb: 2.80, Mar: 4.05, Apr: 4.64, May: 5.73, Jun: 6.11, Jul: 6.14, Aug: 5.18, Sep: 3.85, Oct: 2.52, Nov: 1.49, Dec: 1.34</td>
<td>-10.2, -8.9, -2.3, 5.6, 12.7, 17.9, 20.6, 19.0, 14.2, 8.0, 1.4, -7.0</td>
<td>72.5, 72.0, 69.0, 66.0, 64.0, 67.0, 69.0, 73.5, 75.0, 74.0, 77.0, 77.0</td>
<td>5.0, 5.0, 5.0, 4.7, 4.4, 4.2, 3.6, 3.6, 3.9, 4.4, 4.7, 4.7</td>
</tr>
</tbody>
</table>

Latitude: 45.52, Longitude: -73.42

Visit NASA Satellite Data Site

Help | Paste Data | Close

Date modified: 2004/11/01
International Weather Database
- Wind
• In the RETScreen Small Hydro Project Model, hydrological data are specified by a flow-duration curve.
• For reservoir storage projects, data must be manually entered by the user and should represent the regulated flow that results from operating a reservoir.
• For run-of-river projects, the required flow duration curve data can be entered either manually or by using the specific run-off method and data contained in the RETScreen Online Weather Database.
• Also see the international Small Hydro Atlas at http://small-hydro.com/index.cfm?fuseaction=welcome.home
RETScreen Screen Shot for Hydro
International Small Hydro Atlas - Philippines
International Small Hydro Atlas - China
International Databases – Product Data

• 6000 product data sets incorporated directly into the RETScreen
• Information needed to describe the performance of the proposed clean energy system in the first step of the RETScreen analysis (i.e. in the Energy Model and accompanying worksheets)
• Product data may also pasted into the relevant cells directly in the clean energy technology
• Includes for web links to manufacturers and suppliers for more information (e.g. a quotation)
RETScreen Screen Shot of Product Database (PV)

- User-Defined PV Module Type: Any
- Region: South America
- Supplier: Matrix Solar Technologies
- Model: PW1000-100W-24V
- Nominal PV Module Efficiency (%): 11.1%
- PV Module Rating (W): 100
- Number of PV Modules: 10
- Nominal PV Array Power (kW): 1.00

Supplier Information:
- Voltage [@ Peak Power] (Volts): 34.4
- Current [@ Peak Power] (Amps): 2.9
- Voltage [Open Circuit] (Volts): 43.2
- Current [Short Circuit] (Amps): 3
- Frame Area (m²): 0.88
- Mounting Dimensions Thickness (mm): 24.5
- Width (mm): 673
- Length (mm): 1,335
- Weight (kg): 11
- Certification.

Date modified: 2005/01/31
International Databases – Product Data

- Complementary to the product database is a companion Internet-based e-Marketplace.

- e-Market provides contact information for clean energy related equipment suppliers, service providers and other sources of information located around the globe.
  - Sharing of information among product and service suppliers, consumers, and users of RETScreen.
  - Consists of a searchable database of suppliers.
  - Consists of on-line forums where users can post questions and comments.
Online Manual

- Extensive Online User Manual
- For every cell displaying an output or requiring user input, there is an associated page in the online manual that explains what the cell means
- Users can step through the spreadsheet, seeking guidance from the online manual for every input cell they encounter
- The manual also provides background on both the clean energy technologies and the RETScreen methodology
Note that the azimuth must be entered with respect to true south and not magnetic north. Compares point to magnetic north (the complement of magnetic south) and azimuth directions based on this measure must be adjusted for the magnetic declination (for more information, refer to "Magnetic declination"). If the azimuth direction is being determined from site drawings, it should be determined what reference the site north is using. Site north does not always correspond to true north, as it is sometimes adjusted for convenience in the site and building drawings.

**Azimuth of a Photovoltaic Array**

Example: Collector faces 45° SW in Northern Hemisphere.

Select the following topic for more information:

- Magnetic declination
Training Materials – Engineering Text

- The electronic textbook *Clean Energy Project Analysis: RETScreen Engineering & Cases* is written for professionals and university students who are interested in learning how to better analyse the technical and financial viability of possible clean energy projects.

- It covers each of the technologies in the RETScreen including a background of these technologies and a detailed description of the algorithms found in some of the RETScreen software clean energy technology models.
Training Materials – Case Studies

• Case studies are provided to complement the training material and to facilitate the use of RETScreen
• Available free of charge from retscreen.net
• Case studies typically include assignments, worked-out solutions and information about how the projects fared in the real world
Thank You

- Next will be a hands-on demonstration of the RETScreen software
- Participants can follow using their computers
- Free download from [www.retscreen.net](http://www.retscreen.net)
- For more information contact Dr. Roland R. Clarke at [clarkeenergy@aol.com](mailto:clarkeenergy@aol.com)