

Software Modelling Tools & Toolkits for Renewable Energy Businesses

Daniel Kerr, UCL Energy Institute

Second STEPs Network Meeting, Richard's Bay, South Africa, 28.10.14

STEPs – Sustainable Thermal Energy Service Partnerships

Software Modelling for Renewable Energy Businesses

- A wide variety of free and paid options exist for modelling all aspects of a renewable energy business in software.
- Applications range from resource modelling to select viable sites for projects, through system design and tuning for the design objectives, to financial and economic modelling to support business development.

STEPS – Sustainable Thermal Energy Service Partnerships

Models

- HOMER Software Package
- CREST Cost of Energy Model
- JEDI Jobs and Economic Development Impact Models
- Long-Range Energy Alternatives and Planning Systems (LEAP)
- RETScreen

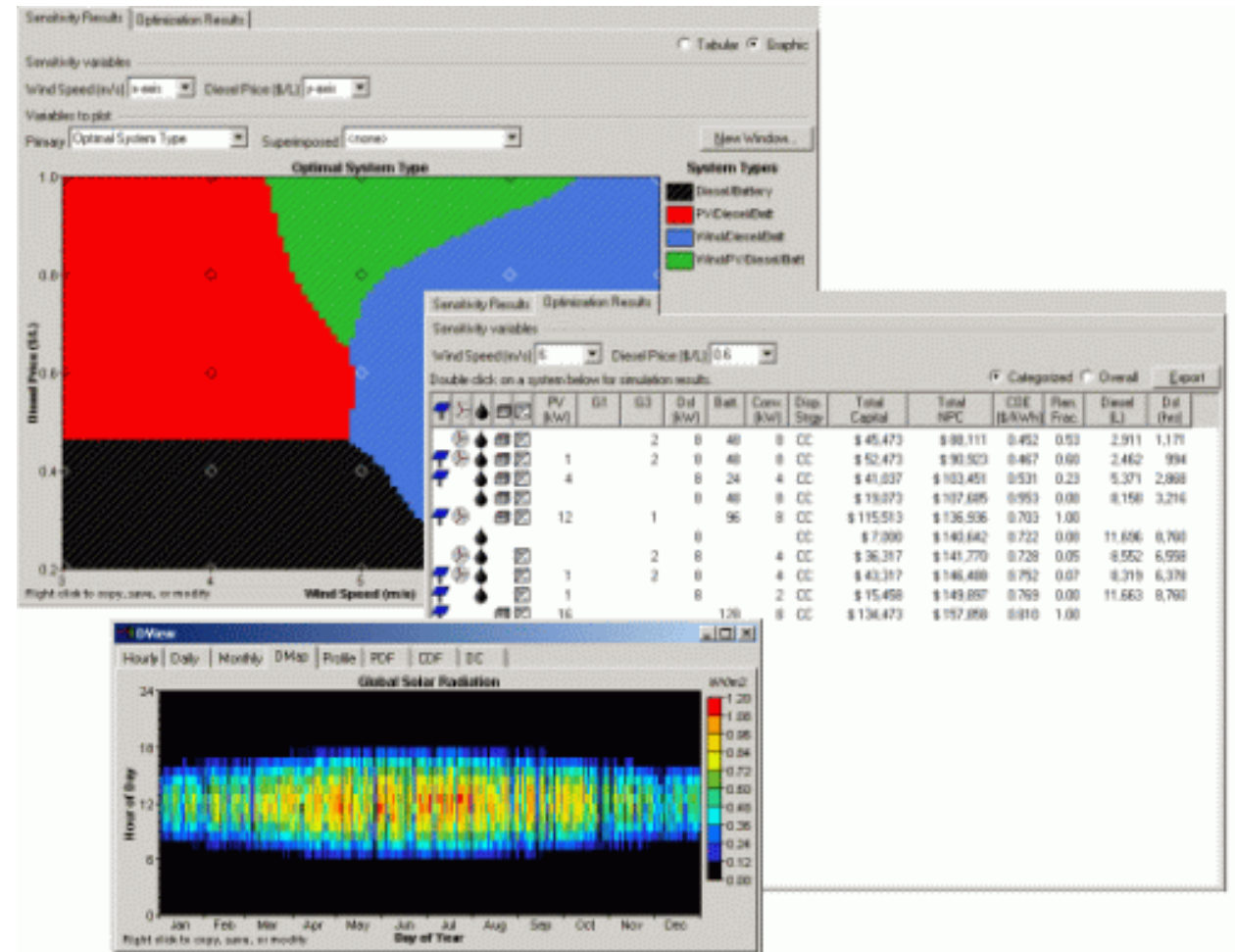
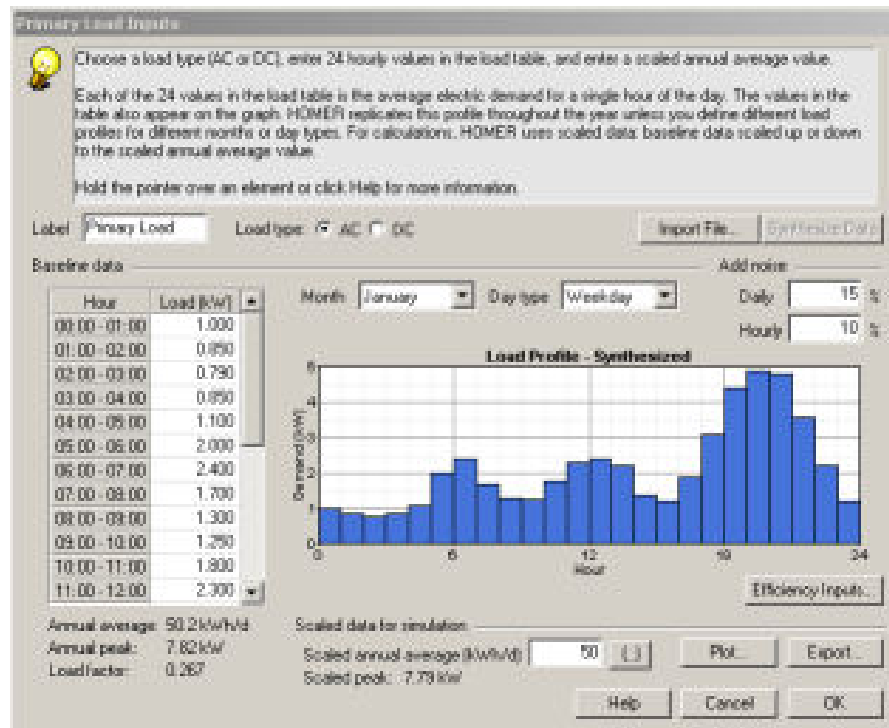
STEPS – Sustainable Thermal Energy Service Partnerships

HOMER Software Package

- HOMER has been at the forefront of renewable energy software modelling since its inception. The package is based on designing renewable energy hybrid micro-grids, with facilities for assessing both the technical and economic feasibility of power projects across a wide range of applications. The software supports over 15 fuel source and storage options, and has facility to account for seasonal resource changes, fuel price changes and many other factors for project assessment.
- URL - <http://homerenergy.com/software.html>

STEPS – Sustainable Thermal Energy Service Partnerships

HOMER Demonstration



STEPS – Sustainable Thermal Energy Service Partnerships

CREST Cost of Energy Model

- The CREST software tool is an economic cash flow model, designed to allow policy-makers, renewable energy entrepreneurs and regulators to assess project economics, design appropriate cost-based incentives (for example, feed-in tariffs), and assess the relative impacts of different economic drivers on renewable energy projects. The software focuses primarily on electricity generation projects, from solar, wind and geothermal energy sources, and is designed with the US market in mind. The model consists of a spreadsheet, optimised for MS Excel, and is such very simple to use.
- URL - <https://financere.nrel.gov/finance/content/crest-cost-energy-models>

STEPS – Sustainable Thermal Energy Service Partnerships

CREST Demonstration

Excel window: nrel_crest_solar_version1-3_0 - Excel

FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW DEVELOPER

Clipboard: Paste, Copy, Format Painter

Font: Arial, 12, Bold, Italic, Underline, Text Color, Background Color, Wrap Text, Merge & Center

Alignment: Left, Center, Right, Indent, Decrease Indent, Increase Indent

Number: Percentage, Decimal, Fraction, Scientific, Text, Error, Custom

Styles: Conditional Formatting, Format as Table, Cell Styles

Cells: Insert, Delete, Format

Editing: AutoSum, Fill, Clear, Sort & Filter, Find & Select

Formulas: P42, fx, \$

Columns: AE, C, E, F, G, H, I, J, K, L, M, N, O, P, Q

Rows: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22

Performance, Cost, Operating, Tax & Financing Inputs

Check	Notes	Check																												
Selected Technology	Photovoltaic	?																												
Project Size and Performance																														
<table border="1"><thead><tr><th>Units</th><th>Input Value</th></tr></thead><tbody><tr><td>Generator Nameplate Capacity</td><td>kW dc</td><td>2,000</td><td>?</td></tr><tr><td>Net Capacity Factor: Select "State Average" or "Custom" →</td><td>State Average</td><td>?</td></tr><tr><td>Net C.F.: If "State Average" method, then select state →</td><td>CO</td><td>?</td></tr><tr><td>Net Capacity Factor, Yr 1</td><td></td><td>17.7%</td><td>?</td></tr><tr><td>Production, Yr 1</td><td>kWh</td><td>3,101,354</td><td>?</td></tr><tr><td>Annual Production Degradation</td><td>%</td><td>0.5%</td><td>?</td></tr><tr><td>Project Useful Life</td><td>years</td><td>25</td><td>?</td></tr></tbody></table>			Units	Input Value	Generator Nameplate Capacity	kW dc	2,000	?	Net Capacity Factor: Select "State Average" or "Custom" →	State Average	?	Net C.F.: If "State Average" method, then select state →	CO	?	Net Capacity Factor, Yr 1		17.7%	?	Production, Yr 1	kWh	3,101,354	?	Annual Production Degradation	%	0.5%	?	Project Useful Life	years	25	?
Units	Input Value																													
Generator Nameplate Capacity	kW dc	2,000	?																											
Net Capacity Factor: Select "State Average" or "Custom" →	State Average	?																												
Net C.F.: If "State Average" method, then select state →	CO	?																												
Net Capacity Factor, Yr 1		17.7%	?																											
Production, Yr 1	kWh	3,101,354	?																											
Annual Production Degradation	%	0.5%	?																											
Project Useful Life	years	25	?																											
Capital Costs																														
<table border="1"><thead><tr><th>Units</th><th>Input Value</th></tr></thead><tbody><tr><td>Select Cost Level of Detail</td><td>Intermediate</td><td>?</td></tr><tr><td>Generation Equipment</td><td>\$</td><td>\$3,500,000</td><td>?</td></tr><tr><td>Balance of Plant</td><td>\$</td><td>\$2,000,000</td><td>?</td></tr><tr><td>Interconnection</td><td>\$</td><td>\$500,000</td><td>?</td></tr></tbody></table>			Units	Input Value	Select Cost Level of Detail	Intermediate	?	Generation Equipment	\$	\$3,500,000	?	Balance of Plant	\$	\$2,000,000	?	Interconnection	\$	\$500,000	?											
Units	Input Value																													
Select Cost Level of Detail	Intermediate	?																												
Generation Equipment	\$	\$3,500,000	?																											
Balance of Plant	\$	\$2,000,000	?																											
Interconnection	\$	\$500,000	?																											
Cost-Based Tariff Rate Structure																														
<table border="1"><thead><tr><th>Units</th><th>Input Value</th></tr></thead><tbody><tr><td>Payment Duration for Cost-Based Tariff</td><td>years</td><td></td></tr><tr><td>% of Year-One Tariff Rate Escalated</td><td>%</td><td></td></tr><tr><td>Cost-Based Tariff Escalation Rate</td><td>%</td><td></td></tr></tbody></table>			Units	Input Value	Payment Duration for Cost-Based Tariff	years		% of Year-One Tariff Rate Escalated	%		Cost-Based Tariff Escalation Rate	%																		
Units	Input Value																													
Payment Duration for Cost-Based Tariff	years																													
% of Year-One Tariff Rate Escalated	%																													
Cost-Based Tariff Escalation Rate	%																													
Forecasted Market Value of Production; applies after Incentive Expiration																														
<table border="1"><thead><tr><th>Units</th><th>Input Value</th></tr></thead><tbody><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr></tbody></table>			Units	Input Value																										
Units	Input Value																													
Federal Incentives																														
<table border="1"><thead><tr><th>Units</th><th>Input Value</th></tr></thead><tbody><tr><td>Select Form of Federal Incentive</td><td>Cost-Based</td><td></td></tr><tr><td>Investment Tax Credit (ITC) or Cash Grant?</td><td>Cash Grant</td><td></td></tr><tr><td>ITC or Cash Grant Amount</td><td>%</td><td></td></tr><tr><td>ITC or Cash Grant</td><td>\$</td><td>\$1</td></tr></tbody></table>			Units	Input Value	Select Form of Federal Incentive	Cost-Based		Investment Tax Credit (ITC) or Cash Grant?	Cash Grant		ITC or Cash Grant Amount	%		ITC or Cash Grant	\$	\$1														
Units	Input Value																													
Select Form of Federal Incentive	Cost-Based																													
Investment Tax Credit (ITC) or Cash Grant?	Cash Grant																													
ITC or Cash Grant Amount	%																													
ITC or Cash Grant	\$	\$1																												

Navigation: Introduction, Inputs, Summary Results, Annual Cash Flows & Returns, Cash Flow, Complex Inputs

STEPs – Sustainable Thermal Energy Service Partnerships

JEDI Jobs and Economic Development Impact Models

- The JEDI models are designed to assess the economic impacts of renewable electricity generation projects from a local to regional level. Technologies covered include wind power, biofuels, coal, concentrating solar power, geothermal, marine and hydrokinetic power, natural gas, and photovoltaic power plants. The model files are free to download, and designed to be user-friendly, being presented as Excel spreadsheets optimised on a technology-by-technology basis. The software primarily focuses on the US market.
- URL - <http://www.nrel.gov/analysis/jedi/>

STEPS – Sustainable Thermal Energy Service Partnerships

JEDI Demonstration

Offshore Wind Farm Project Data

INSTRUCTIONS: Begin by entering Project Location (from pull-down list) and other Descriptive Data. After inserting required data press enter (or cursor to the next cell) to continue. Once Descriptive Data is complete, choose "Y" or "N" on Line 30 to continue. Choose "Y" to accept Project Cost and Local Share defaults or "N" to review/modify values. To utilize new values in analysis you must choose an "N" in "Utilize Model Default Values (below)?" - Line 30. Additional information is available by pointing to the red triangles located in cell corners and in the FAQ tab. Only those cells with a white background can be changed (accept new values).

Project Descriptive Data

Project Location (i.e., nearest state)	MASSACHUSETTS
Year Construction Starts	2018
Construction Period (months)	
Total Project Size - Nameplate Capacity (MW)	50
Turbine Size (KW)	3,000
Number of Turbines (included in Total Project Size)	17
Project Capital Cost (\$/KW)	\$6,080
Owner Average Annual Operations and Maintenance Cost (\$/kW)	\$133
Foundation Type	Jacket
Average Water Depth (meters)	25
Distance to Port (nautical miles)	100
Distance to Grid Interconnection (nautical miles)	50
Marine Cable Type	DC
Number of Substations	2
Money Value (Dollar Year)	2011

Utilize Project Cost Data default values in analysis? Choose "Y" to accept default values below or "N" to over-ride default values and utilize new user defined values as entered below. See FAQ for related topics.

Press 'Go To Summary Impacts' Button

Go To Summary Impacts

If desired, default values (in cells below - based on Project Descriptive Data entered above) may be restored by pressing the 'Restore Default Values' button. Note: it is not necessary to restore defaults to incorporate default Project Cost Data in system analysis - simply choose "Y" in cell B30 above.

Restore Default Values

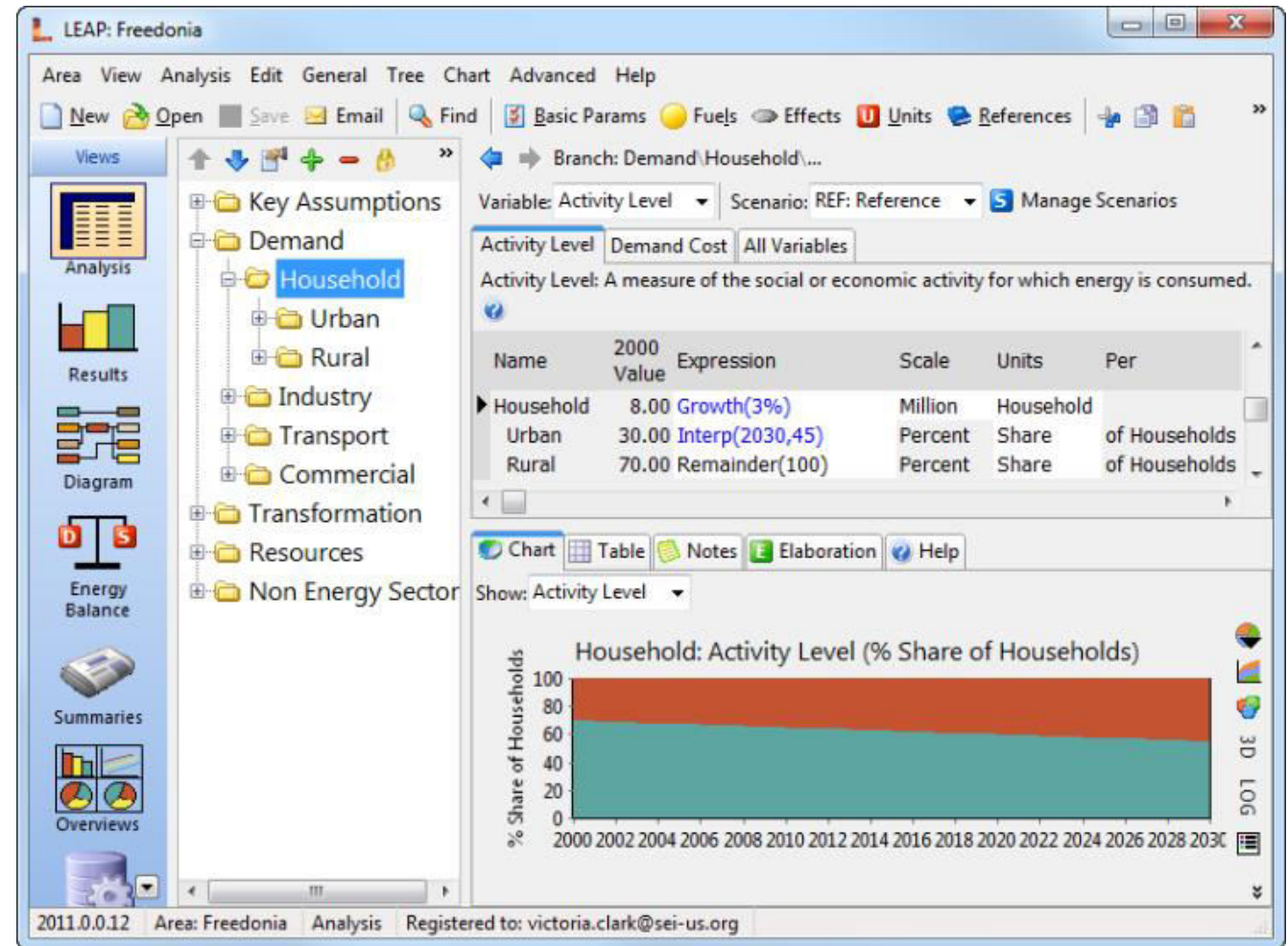
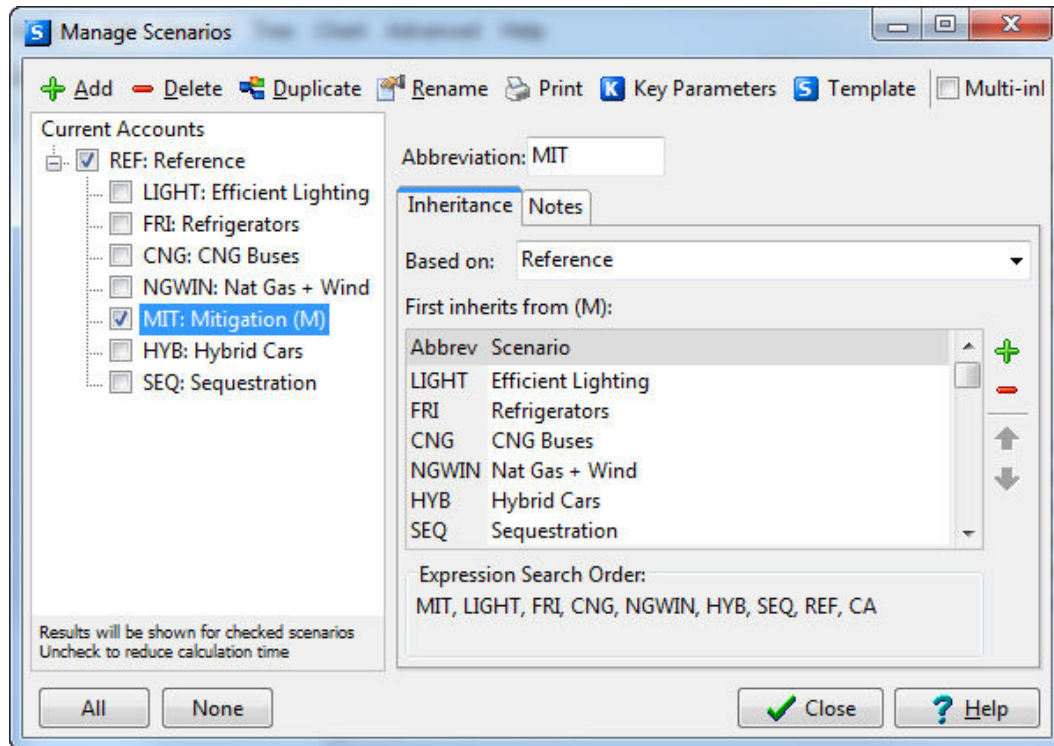
STEPS – Sustainable Thermal Energy Service Partnerships

Long-Range Energy Alternatives Planning System (LEAP)

- The LEAP software is a widely-used package for energy policy analysis and climate change mitigation assessment. The LEAP model integrates both demand and supply-side concerns, and has the ability to integrate data from other more specialised models into its overall outputs. A number of built-in calculations are supported by spreadsheet-style computing ability, enabling users to specify time-variable data and create sophisticated multi-variable models. The latest version also supports optimisation modelling for least-cost expansion and dispatch of electricity systems. The unique feature of LEAP is the very low initial data requirements, due to the software relying on simpler accounting principles, and the iterative nature of the simulations, allowing users to enter data only when necessary and available.
- URL - <http://www.energycommunity.org/default.asp?action=47>

STEPS – Sustainable Thermal Energy Service Partnerships

LEAP Demonstration




STEPS – Sustainable Thermal Energy Service Partnerships

RETScreen

- RETScreen is designed as a decision support tool, provided free of charge, intended for use by governmental, industry and business users to evaluate the viability of renewable energy projects. The software can forecast total energy production and savings, costs of implementation, and emissions reduction for a large range of renewable energy and energy efficient technologies. Of particular interest is the included financial analysis and sustainability/risk analysis components of the software, allowing users to directly assess the financial sensitivity and viability of potential renewable energy projects. Also included is a comprehensive suite of training materials, from e-textbooks to webinars and case studies, to enable users to get the most out of the software from the beginning.
- URL - <http://www.retscreen.net/ang/home.php>

STEPS – Sustainable Thermal Energy Service Partnerships

RETScreen Demonstration

 Natural Resources Canada / Ressources naturelles Canada



RETScreen® International
www.retscreen.net


Clean Energy Project Analysis Software

Project Information [See project database](#)

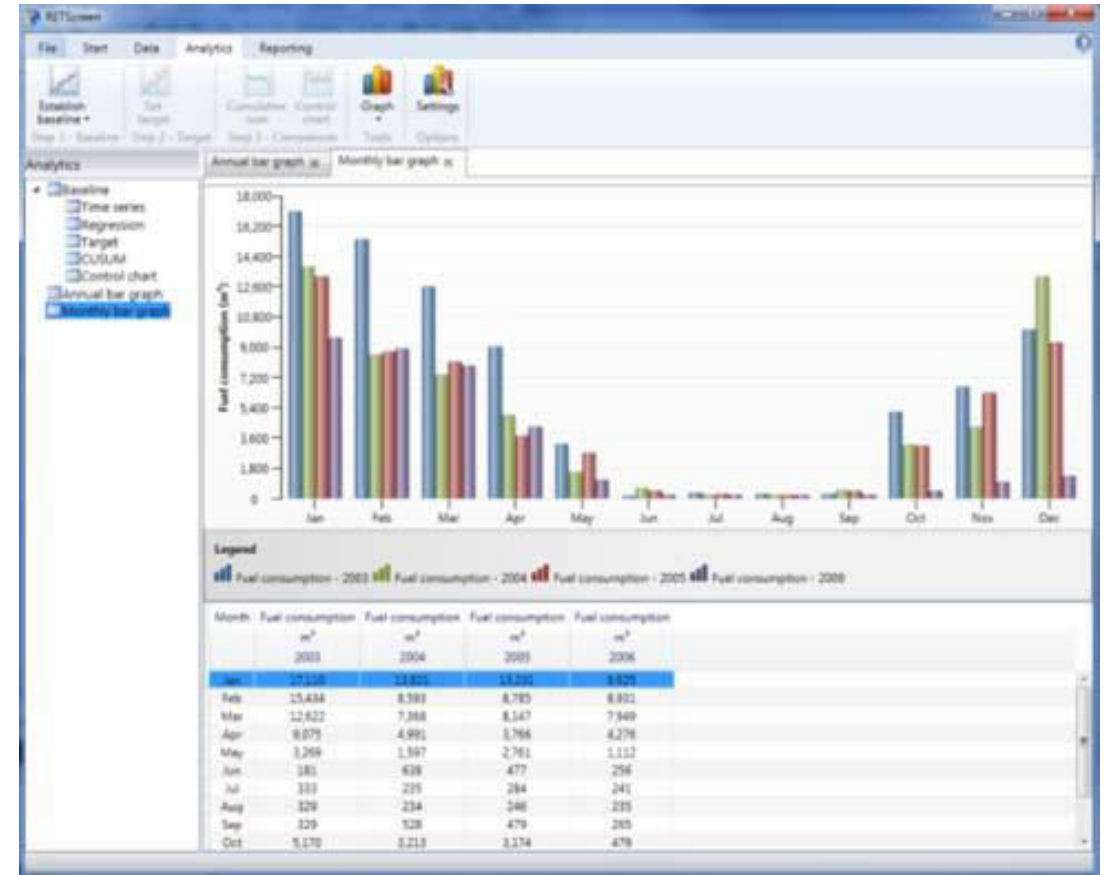
Project name:
Project location:
Prepared for:
Prepared by:
Project type:
Facility type:
Analysis type:
Heating value reference:
☐ Show settings

Site reference conditions [Select climate data location](#)

Climate data location:
☐ Show data

    [Complete Energy Model sheet](#)

RETScreen 4 2007-12-03 © Minister of Natural Resources Canada 1997-2007. NRCan/CRTC - Vancouver



STEPs – Sustainable Thermal Energy Service Partnerships

Toolkits for Renewable Energy Businesses

- A number of free “toolkits” are available online relating to planning and implementation for renewable energy projects and business.
- Toolkits can range from policy case studies and discussion papers to online libraries and small software tools, often covering a specific area within the renewables sector in great detail.

STEPS – Sustainable Thermal Energy Service Partnerships

Toolkits

- REN21 Mini-grid Policy Toolkit
- World Bank REToolKit – Renewable Energy Terms of Reference
- Institute for Sustainable Renewable Energy Toolkit
- USAid Grid-Connected Renewable Energy Generation Training and Field Support Toolkit
- REEEP – RE Case Studies in Southern Africa
- The Role of Feed-in Tariff Policy in Renewable Energy Development in Developing Countries – A Toolkit for Parliamentarians

STEPS – Sustainable Thermal Energy Service Partnerships

REN21 Mini-grid Policy Toolkit

- The REN21 Mini-grid Policy Toolkit is intended for use by policy-makers in the design of mini-grid schemes and support mechanisms. It contains information on mini-grid operator models, the economics of mini-grids, and necessary policy and regulation that must be considered for successful implementation, focusing on the African market. Of particular interest is a comprehensive pros-cons discussion of various mini-grid operator models, covering utility, hybrid public/private, unregulated and regulated private, and community-based models for mini-grid operators.
- URL - <http://www.ren21.net/REN21Activities/MinigridPolicyToolkit.aspx>



▼

STEPS – Sustainable Thermal Energy Service Partnerships

World Bank REToolKit – Renewable Energy Terms of Reference

- The World Bank REToolKit is an operationally-oriented set of tools intended for use by World Bank staff, but freely available online, to improve the design and implementation of renewable energy projects, and incorporate best practice into new projects. The RE Terms of Reference library contains 54 separate Terms of Reference documents related to various World Bank assignments. These cover topics including business development, financing mechanism design, financial analyses, regulation and monitoring/evaluation of RE projects.
- URL - <http://goo.gl/PVPUUI>



THE WORLD BANK

STEPS – Sustainable Thermal Energy Service Partnerships

Institute for Sustainability Renewable Energy Toolkit

- This toolkit focuses on UK SMEs in the renewable energy and sustainable building sectors, but offers a range of useful information that can be applied globally. This includes an in-depth summary and discussion of financing and business models for SMEs in the sector, covering loan and equity finance, ESCO models, grant financing and community cooperatives. The toolkit also offers planning advice on the barriers and challenges to RE SME deployment, including a technology-demarcated summary of financial, industrial, political and social considerations when planning new businesses in the sector.
- URL - <http://renewablestoolkit.instituteforsustainability.org.uk/>



Institute for Sustainability

STEPS – Sustainable Thermal Energy Service Partnerships

USAid Grid-Connected Renewable Energy Generation Training and Field Support Toolkit

- This toolkit is presented as six sets of detailed slides on USAID experience in developing large, grid-connected renewable energy projects. An overview provides economic factors, barriers and policy strategies to large on-grid RE projects, and five technology-specific modules (covering biomass, geothermal, hydroelectric, solar electric and wind power) cover issues and solutions for each technology, as well as best practice summaries. The toolkit also includes two case studies on large PV and wind project, and is freely available online in PDF format or in-browser.
- URL - <http://www.energytoolbox.org/gcre/>



STEPS – Sustainable Thermal Energy Service Partnerships

REEEP – RE Case Studies Southern Africa

- This toolkit is a collection of case studies on renewable energy and carbon projects in Southern Africa, covering the use of ESCOs in low-income housing sector energy interventions and financing mechanisms for the sector, as well as carbon financing, the role of the CDM, and industrial RE financing for large consumers. Project documents are available in PDF, as well as a brief summary of key features of the projects in-browser.
- URL - <http://toolkits.reeep.org/index.php?work=detail&asset=toolkit&id=1>



STEPS – Sustainable Thermal Energy Service Partnerships

The Role of Feed-in Tariff Policy in Renewable Energy Development in Developing Countries – A Toolkit for Parliamentarians

- This AFREPREN/FWD-produced toolkit is presented in PDF format, and covers the basics of establishing a feed-in tariff policy and its benefits, as well as a case study of implementation in Kenya. Model feed-in tariff policies are also presented from Mauritius, South Africa and Sri Lanka, and the report concludes with specific lessons for policy-makers in designing FiT policies, including long-term commitment and specialisation of policies.
- URL - <http://www.e-parl.net/eparliament/pdf/090911FITDevCountries.pdf>

