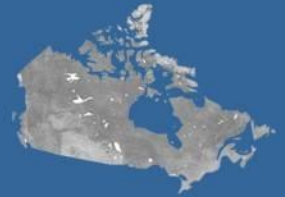


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RETScreen Tutorial

Renewables in Remote Microgrids Conference

Naveen Goswamy

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September 18, 2015



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Course outline

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- Introduction to PV
- Introduction to RETScreen 4
- Practical case study using Fort Simpson PV project
 - Getting started with RETScreen 4
 - How to estimate PV system losses by using NRCAN PV maps (www.pv.nrcan.gc.ca)
 - Using goal-seeking method for finding solutions
 - Sensitivity analysis, risk analysis
- Break 10 minutes
- Introduction to RETScreen Plus
- Practical case study using Fort Simpson PV Project
 - Getting started with RETScreen Plus
 - Importing data, using available data
 - Merging data sources
 - Performing PV analytics
 - Reporting
- Discussion, Q&A

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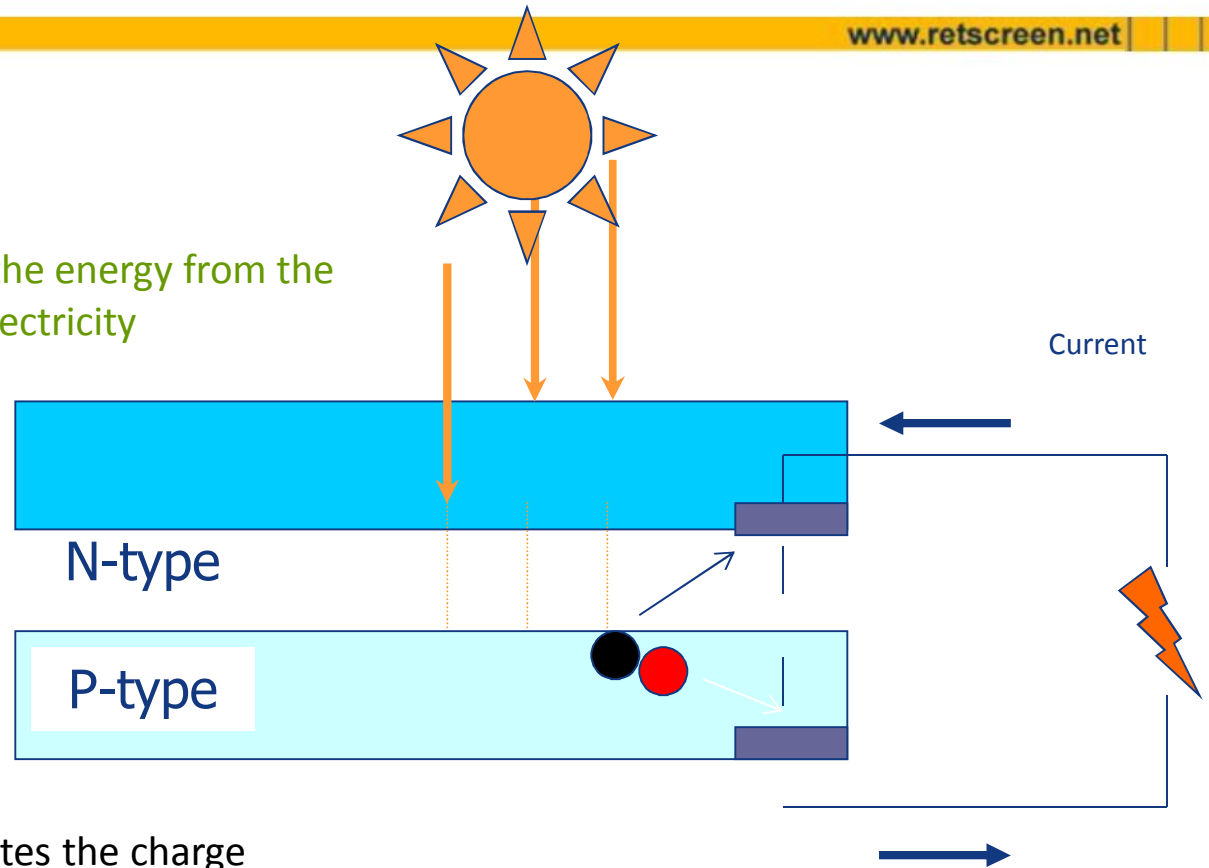
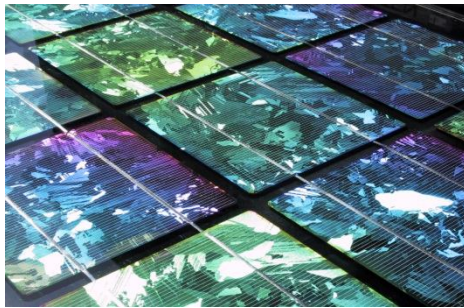
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Solar Photovoltaic (PV) Energy

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The solar cells absorb the energy from the photons to generate electricity



- The energy of the photons excites the charge carriers
- A voltage (EMF) is generated across the PN junction separating the negative and positive charges. The wires connecting the two layers conducts a current.

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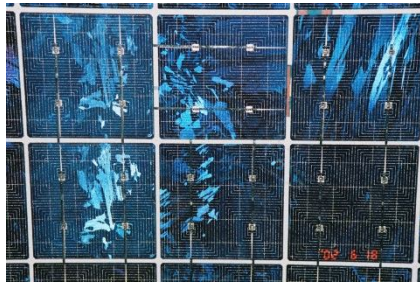
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Solar PV Cells, Modules, and Arrays

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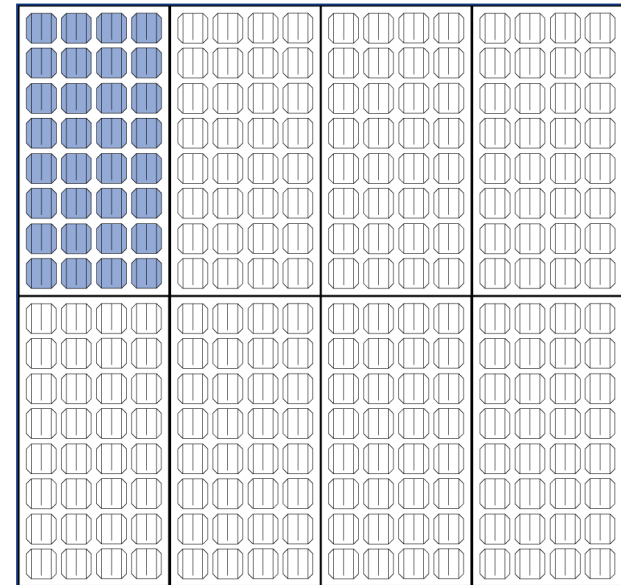


PV Cell



PV Module

PV Array



Solar photovoltaic (PV) modules come in a variety of sizes. Large power systems combine modules in parallel and series to increase the power output.



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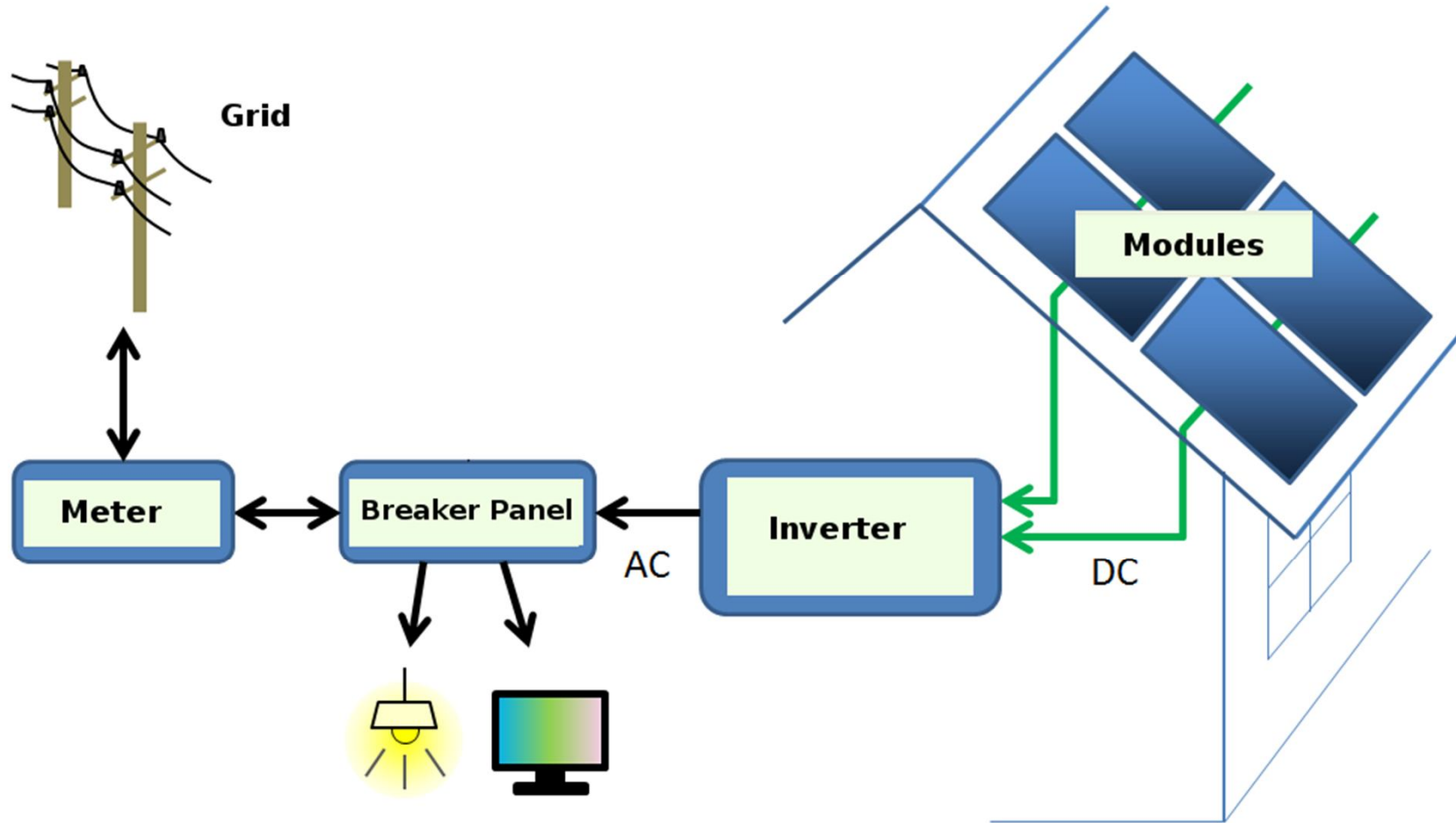


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Overview of a Grid-Connected PV System



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Overview of RETScreen Version 4

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- **Energy efficiency (EE)** models for residential, commercial & institutional buildings, & for industrial facilities & processes



- **Climate database** expanded to **4,700 ground-stations** & **NASA Satellite Dataset Integrated** within the software to cover populated areas across the entire surface of planet



- Renewable energy, cogeneration & EE models integrated into **one software file** & emerging technologies, such as wave & ocean current power added



- **Project database** providing users instant access to key data and information for hundreds of case studies & project templates
- **RETScreen file format (*.ret)** - small file size (<25 KB) that is easily shared over the Internet & which allows the user to create custom databases for RETScreen

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Project Analysis

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- **Energy resource at project site**
(e.g. solar radiation)
- **Equipment performance**
(e.g. capacity factor, efficiencies)
- **Initial project costs**
(e.g. solar modules, inverters)
- **Annual & periodic costs**
(e.g. monitoring, maintenance)



Image from <http://www.skyfireenergy.com/solar-commercial/grid-tied-electric-systems/104kw-diesel-offset-solar-photovoltaic-system-fort-simpson-northwest-territories/>

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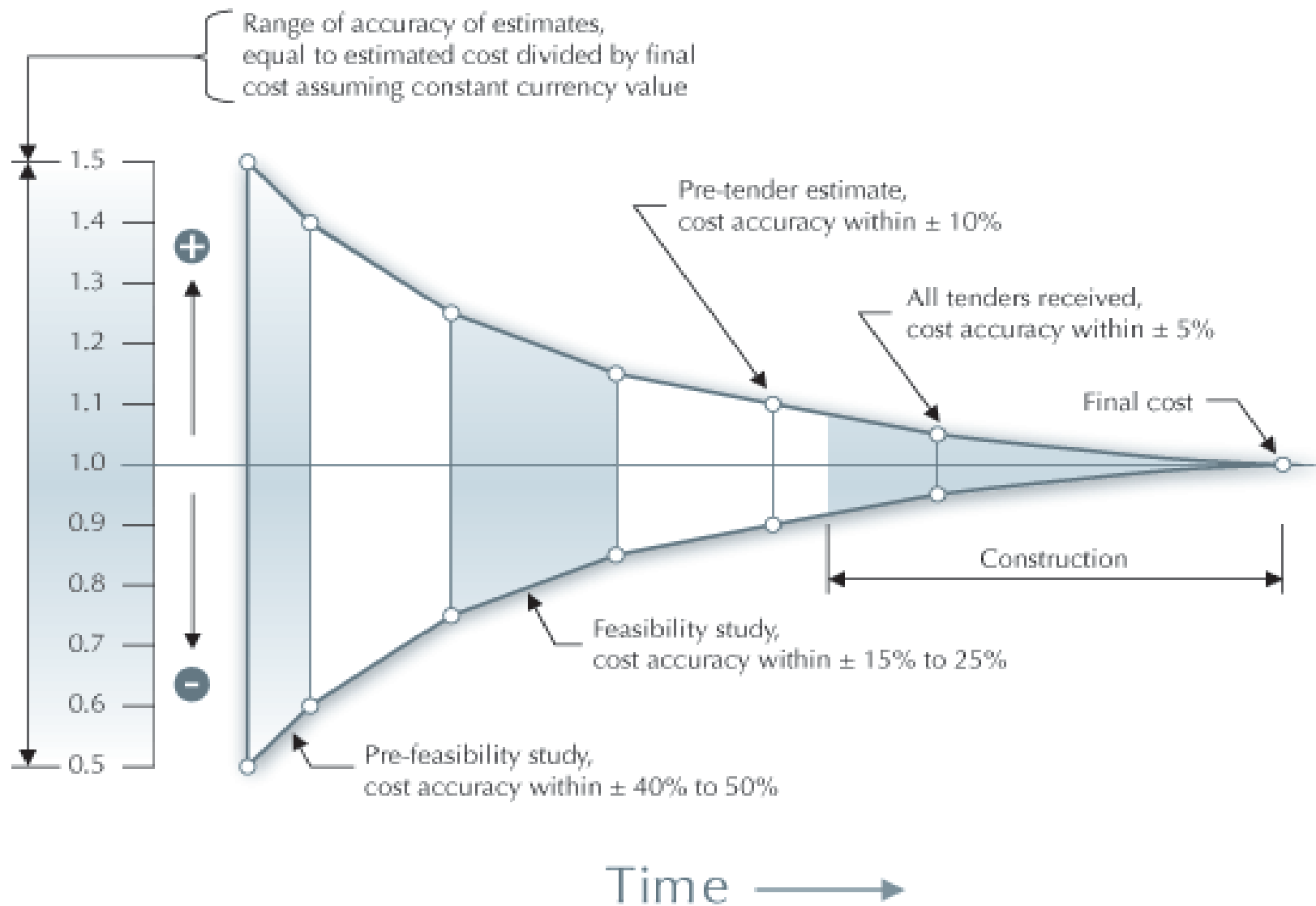
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Financial Analysis

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- **Base case system energy cost**
(e.g. retail price of diesel fuel)
- **Financing**
(e.g. debt ratio & length, interest rate)
- **Taxes on equipment & income (or savings)**
- **Environmental characteristics of energy displaced**
(e.g. oil, natural gas, grid electricity)
- **Environmental credits and/or subsidies**
(e.g. GHG credits, deployment incentives)
- **Decision-maker's definition of cost-effective**
(e.g. payback period, ROI, NPV, energy production costs)



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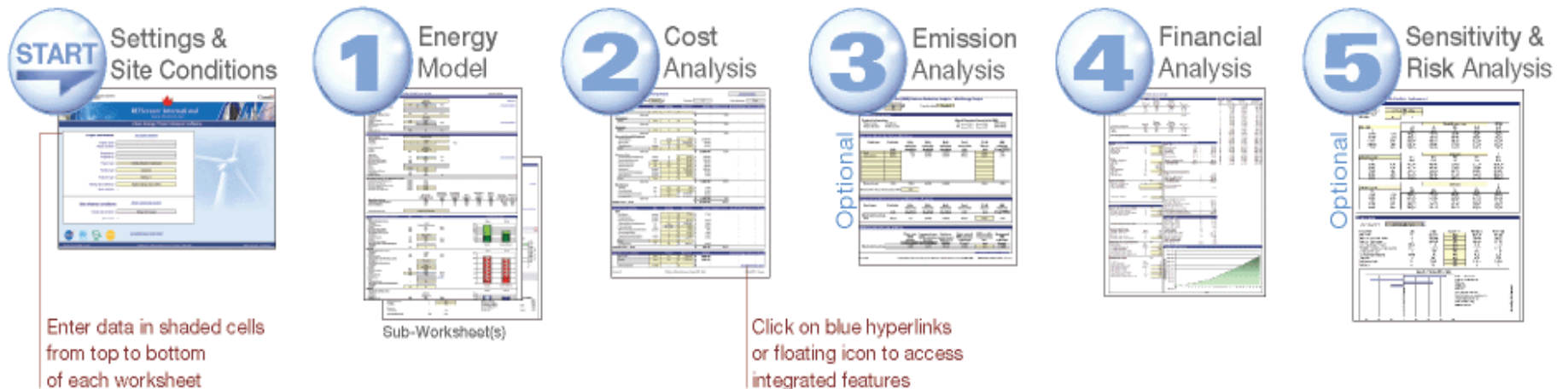


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Five Step Standard Analysis



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

Case Study: Fort Simpson, NWT

Assumptions		
Project duration in years	30	
Inflation	2%	
Interest rate on capital	4%	
Annual reduction in output	0.5%	
Project Details	Original Project	Expanded Project
Size in kW	60.6	104.2
Project Cost	\$740,000	\$1,070,000
Cost per watt installed	\$12.21	\$10.27
Electricity Production (kWh)	57,600	99,000
Annual Costs		
Finance payments including interest	\$42,800	\$61,900
O&M	\$2,000	\$3,000
Internet connection	\$1,000	\$1,000
Land lease	\$1,610	\$1,610
	\$47,400	\$67,500
Results		
Price per kWh required to break even	\$0.69	\$0.57

Let's develop a RETScreen 4 analysis for this project, using an Independent Power Producer framework

Table from GNWT document *Energy Facts: Solar Energy Resources* (2012, available at http://www.iti.gov.nt.ca/sites/default/files/2012_solar_energy_resources_v5.pdf)

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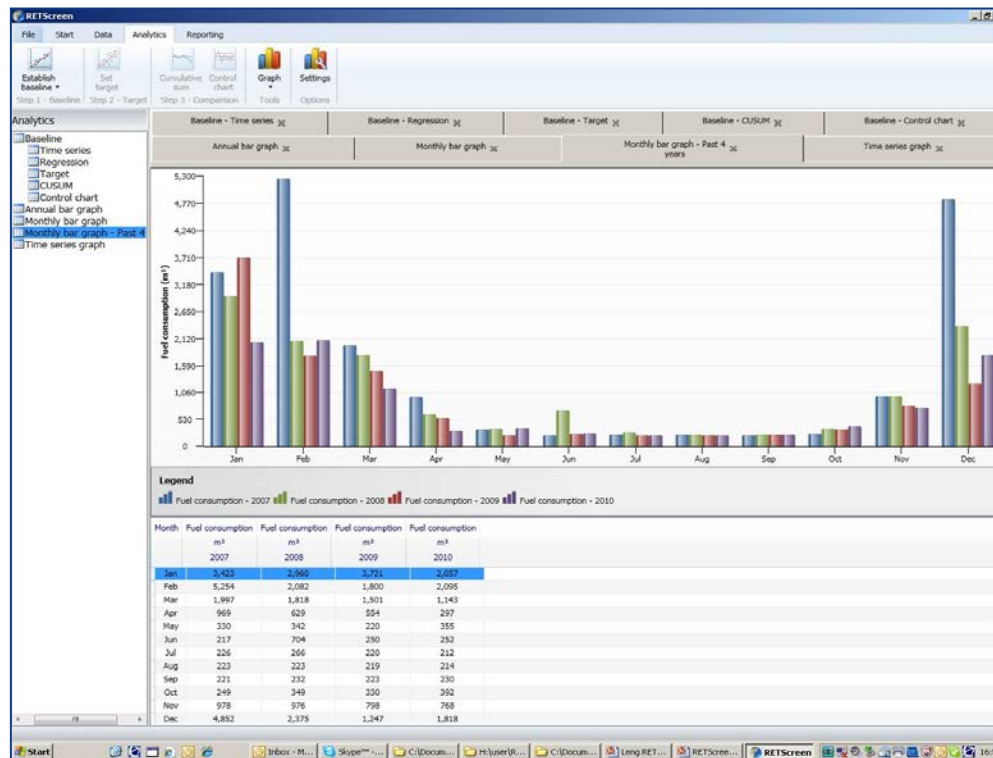
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Energy Performance Analysis with RETScreen Plus



Learning Objectives

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- Review basics of energy performance analysis
 - Illustrate methods and techniques for Monitoring, Targeting & Reporting (MT&R)
 - Highlight key concepts of Measurement & Verification (M&V)
- Introduce the energy management software tool within RETScreen – the Performance Analysis Module
 - Understand basic structure of the *RETScreen Plus* Performance Analysis Module
 - Be able to use the software to monitor, analyse, and report key energy performance data



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Monitoring, Targeting & Reporting (MT&R)

*MT&R provides a **systematic approach** to gaining and maintaining control over energy consumption (or production) through **measurement and analysis followed by well-directed actions***

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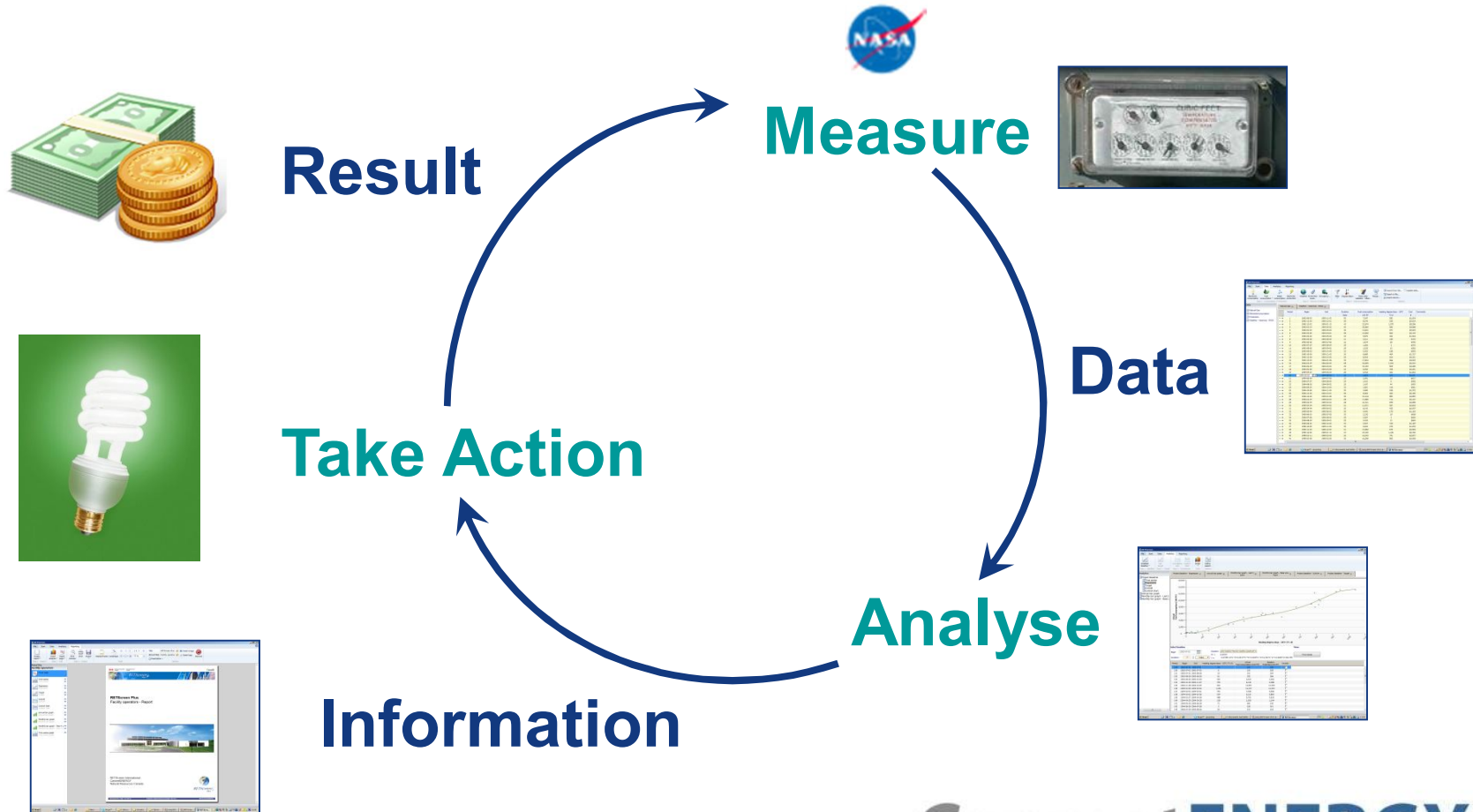


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MT&R Feedback Loop



Develop Relationship: Energy & Influencing Factors

- How does energy consumption or energy production vary with a factor of influence (i.e. driver, such as weather)?
- How does the relationship change with time?

Consumption or Production



Factors of influence



- Fuel consumption



- Electricity consumption



- Water consumption



- Electricity production



- Weather



- Occupancy



- Production level



- Solar radiation

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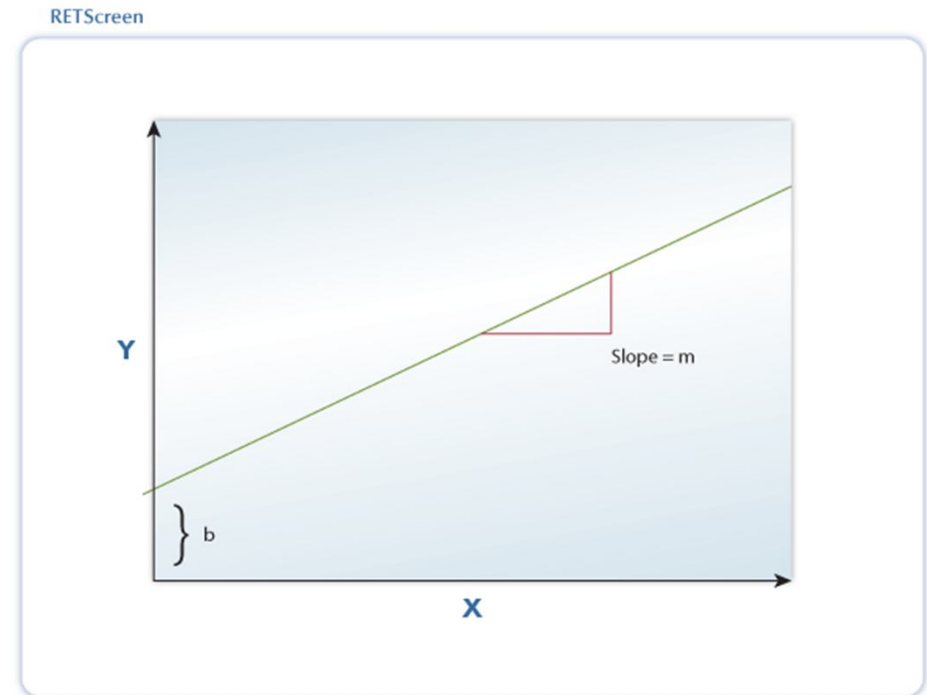
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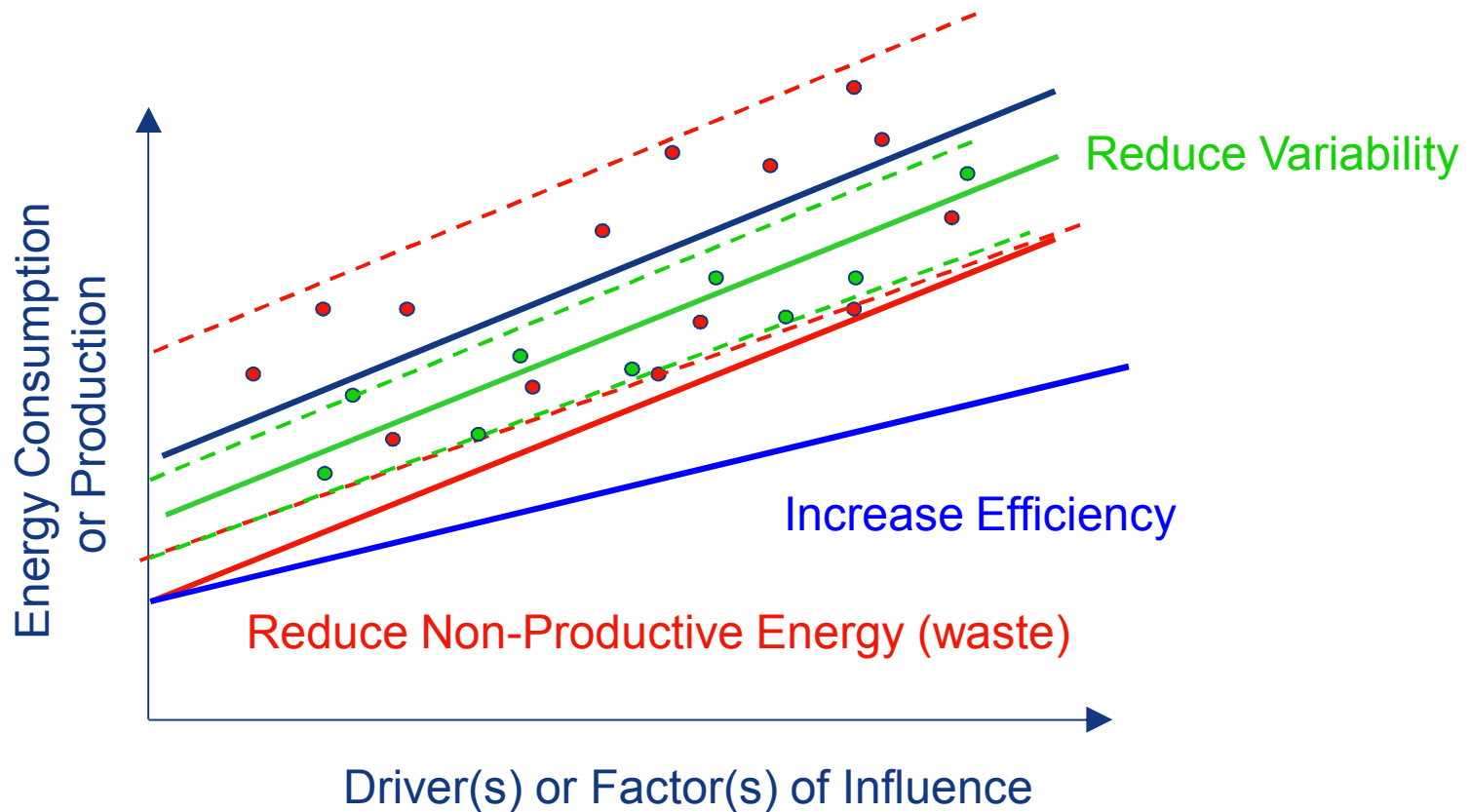


Models Predict Energy Consumption or Production

- Historical consumption or production
 - Static, not dynamic with drivers
- Statistical model $E = \text{Function of drivers}$
 - Mathematical relationship between energy consumption (or production) and the "driver" exists
 - It's often linear, of the form
$$y = mx + b$$
 - Simple linear regression
 - Multivariable non-linear regression



Establish Energy Reduction (or Production) Targets



Typical Tools Used for Energy Performance Analysis



- Data visualization (e.g. monthly graphs)



- Time series graphs



- Regression analysis



- Cumulative sum (CUSUM) charts



- Targeting

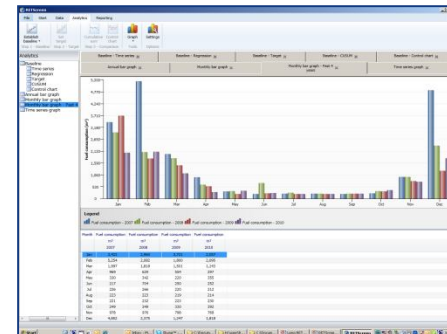


- Control charts

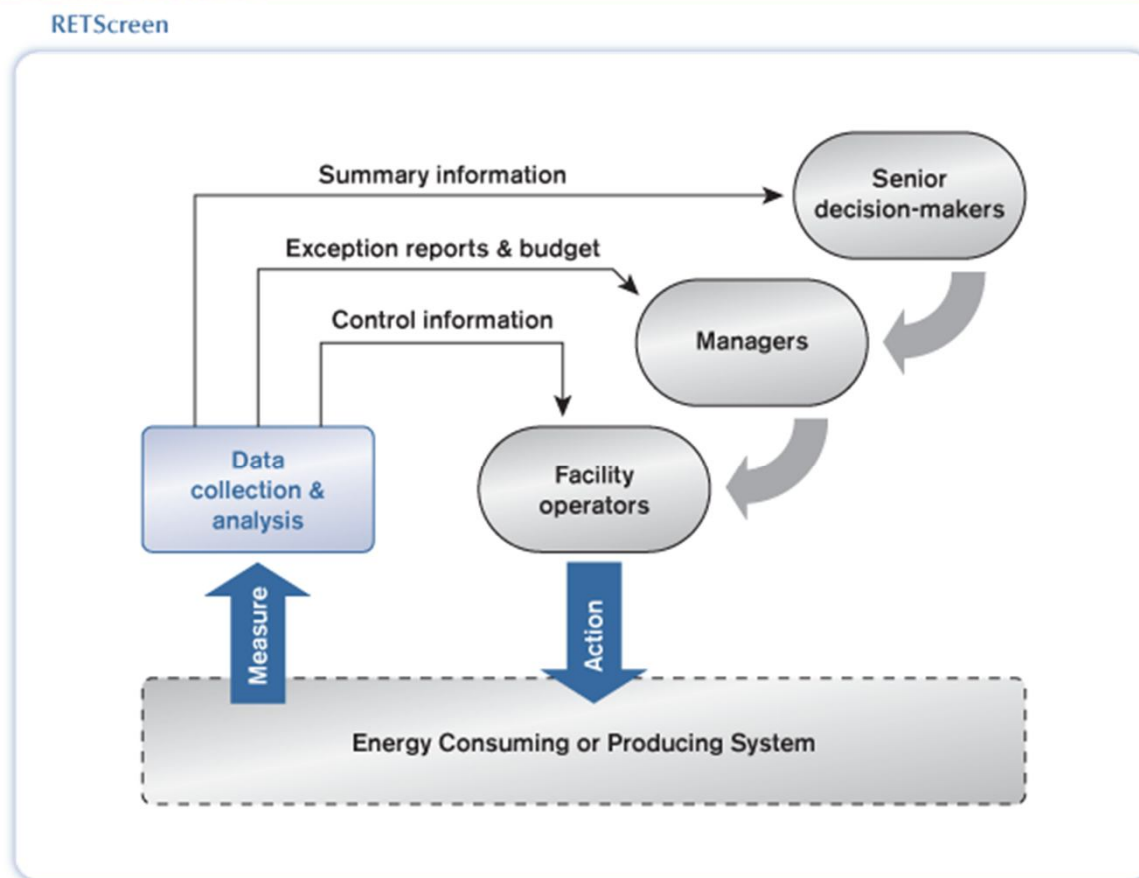


- Reports

"tools that help to identify, understand, quantify and display the relationship between energy and what drives it"



Reporting Pathways for a MT&R System

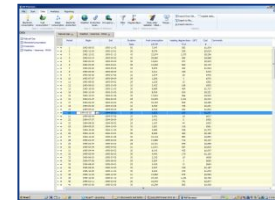


RETScreen Plus Performance Analysis Module

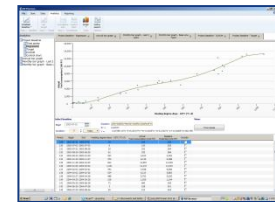
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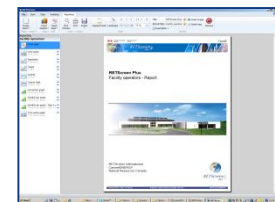
- Helps user monitor, analyse, and report key energy performance data to facility operators, managers and senior decision-makers
- Energy management software tool
 - Monitoring, Targeting & Reporting (MT&R)
 - Measurement & Verification (M&V)
 - Energy tracking
- Integrates near-real-time NASA satellite-derived weather data for entire surface of planet



Data



Analytics



Reporting

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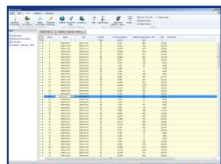
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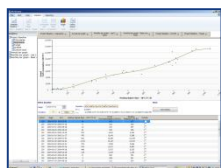
Performance Analysis Module - Structure



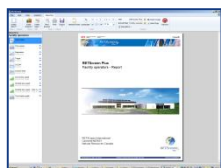
- Start
 - Project information
 - Site reference conditions



- Data
 - Step 1 – Consumption/production
 - Step 2 – Factors of influence
 - Step 3 – Data processing



- Analytics
 - Step 1 – Baseline
 - Step 2 – Target
 - Step 3 – Comparison



- Reporting
 - Step 1 – Report
 - Step 2 – Edit
 - Step 3 – Output



Clean Energy Project Analysis Software

Project information

[See project database](#)

Project name

Project location

Prepared for

Prepared by

Analysis type

Project type

Facility type

Heating value reference

Show settings ▼

Language - Langue

User manual

Currency

Units

Site reference conditions

[Select climate data location](#)

Climate data location

Show data ▶



File Start Data Analytics Reporting

Create report ▾ Insert analysis ▾ Insert page ▾ Print preview Print Export Header/Footer Landscape 1 / 1 77 %

Title RETScreen Plus [x] [i] Insert image [x] [i] Remove
@{SubTitle} Facility operator [x] [i] Insert logo
Description ▾

Step 1 - Report Step 2 - Edit Step 3 - Output Tools Options

- Reporting
Facility operators
- Cover page
 - Time series
 - Regression
 - Target
 - CUSUM
 - Control chart
 - Annual bar graph
 - Monthly bar graph
 - Monthly bar graph - Past 4 y
 - Time series graph

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RETScreen Plus Facility operators - Report



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RETScreen Plus - Beta - 2011-05-30 © Minister of Natural Resources Canada 1997-2011. NRCan/CanmetENERGY

Measurement & Verification (M&V)

- A process of quantifying energy consumption (or production) and water consumption before and after an Energy Conservation Measure is implemented to verify and report on the savings actually achieved
- International Performance Measurement and Verification Protocol (IPMVP)



<http://www.evo-world.org>

Project Example: Fort Simpson

Using the data files provided to you, let's analyse 2 years of performance from the Fort Simpson system, and create reports that can be sent to stakeholders.

Conclusions

- Implementing an energy monitoring, targeting and reporting (MT&R) system can be a powerful way to better manage energy project investments as well as identify additional project opportunities
- The *RETScreen Plus* Performance Analysis Module can be used worldwide to monitor, analyse, and report key energy performance data to facility operators, managers and senior decision-makers
 - A Data worksheet enables the user to create, import, calculate, filter, merge and store various datasets needed to prepare an analysis
 - An Analytics worksheet helps the user establish a baseline for the project, predict the energy consumption or production of a facility using regression analysis, set a target and then track the energy performance of an ongoing basis
 - The Reporting worksheet allows the user to create, edit and output various datasets and figures needed to properly present the analysis of the project
- The measurement and verification (M&V) of actual savings (or production) achieved by a clean energy project is an important final step in the energy decision chain

Questions?

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