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Monitoring Building Energy Systems Using NASA's Near Real-Time Solar and Meteorological Data and RETScreen® Plus Software for Decision Support

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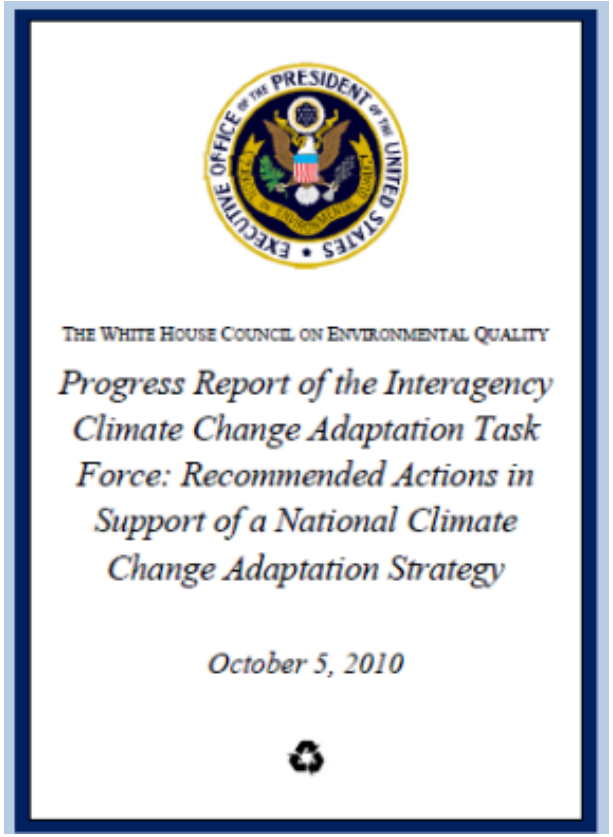
Climate change and energy monitoring in the building sector

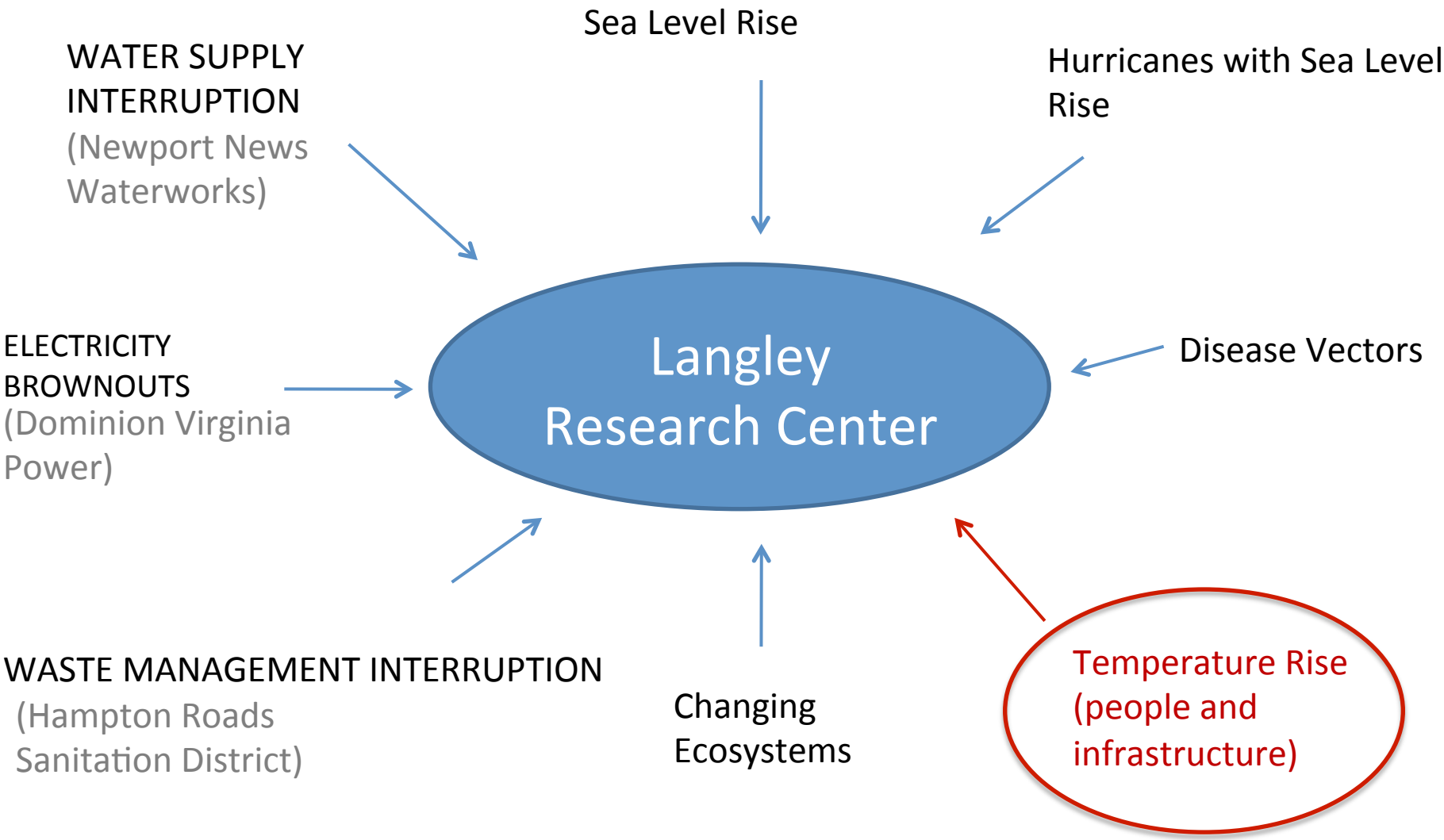
- Increasing energy use and carbon emissions are impacts of climate change.
- Building sector is responsible for ~40% of total energy consumed globally.
- Energy and carbon reduction can be achieved through renewable energy technologies (RETs), and increasing the efficiency of current energy systems.
- **This talk presents a comprehensive analysis program that manages building energy usage and performance of energy improvement technologies.**

NASA Climate Adaptation Science Investigator (CASI)

- In response to a Presidential order, NASA initiated a Climate Adaptation Science Investigator (CASI) Team involving all NASA centers.
- **Mission**: advance and apply NASA's scientific expertise and products to develop climate adaptation strategies.
- CASI team at NASA LaRC assessing building infrastructure for:
  - adaptation to potential climate and weather changes to prevent negative impact to center operations.
  - mitigation of climate change impacts through programs to reduce the carbon footprint.



NASA Langley climate change impacts



RETScreen® International

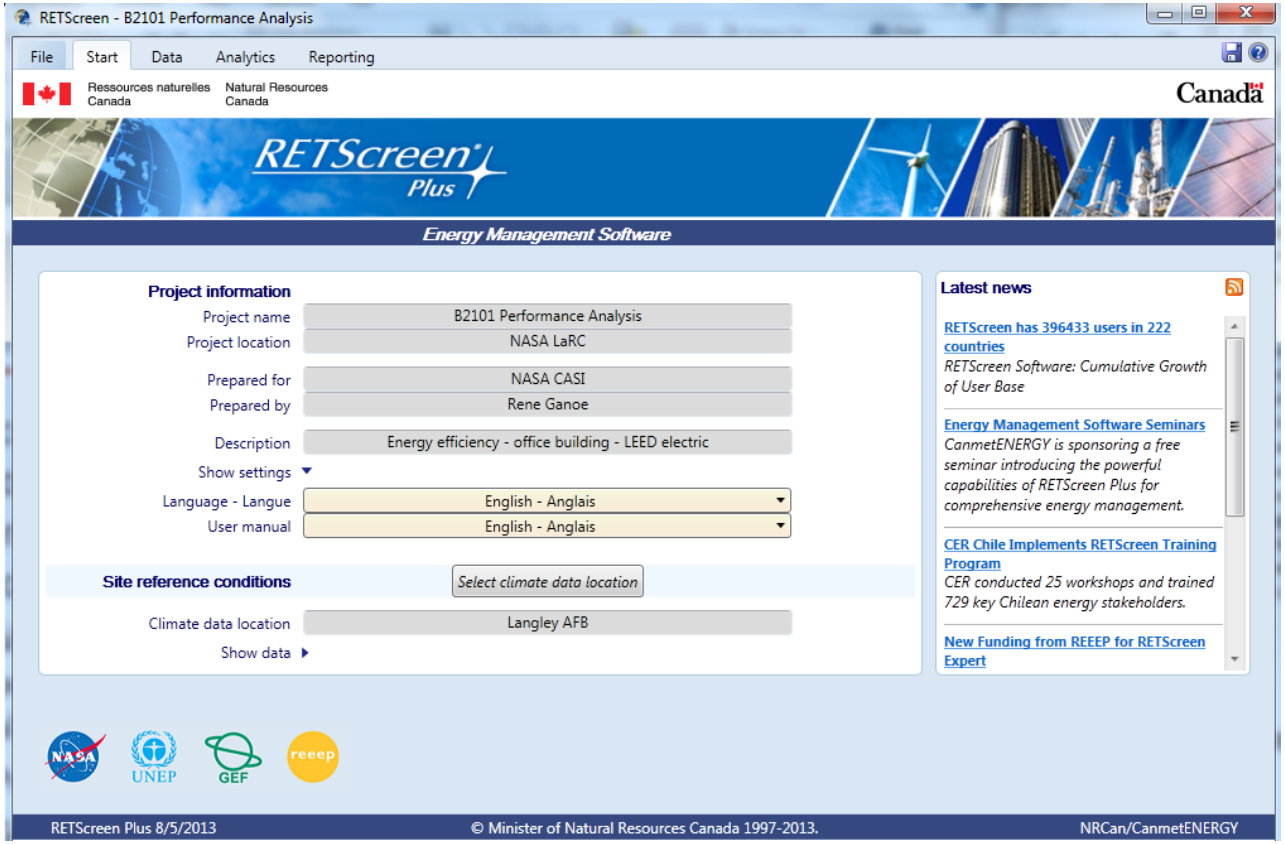
(www.retscreen.net)

- RETScreen ® International is a project of Natural Resources Canada's CanmetEnergy Diversification Research Laboratory (CEDRL) to empower cleaner energy decisions.
- Developed a comprehensive software tool that monitors energy performance and analyzes energy efficiency improvements to provide decision support.
  - Has over 395,000 users and available in 35+ languages.
  - Responsible for ~$8 billion in user energy savings and ~20 million ton/yr reduction in greenhouse gas emissions.

RETScreen Plus Software

RETScreen Plus, the Windows-based Performance Analysis module employs the monitoring, targeting, and reporting of current building performance with integration of meteorological and solar insolation data.

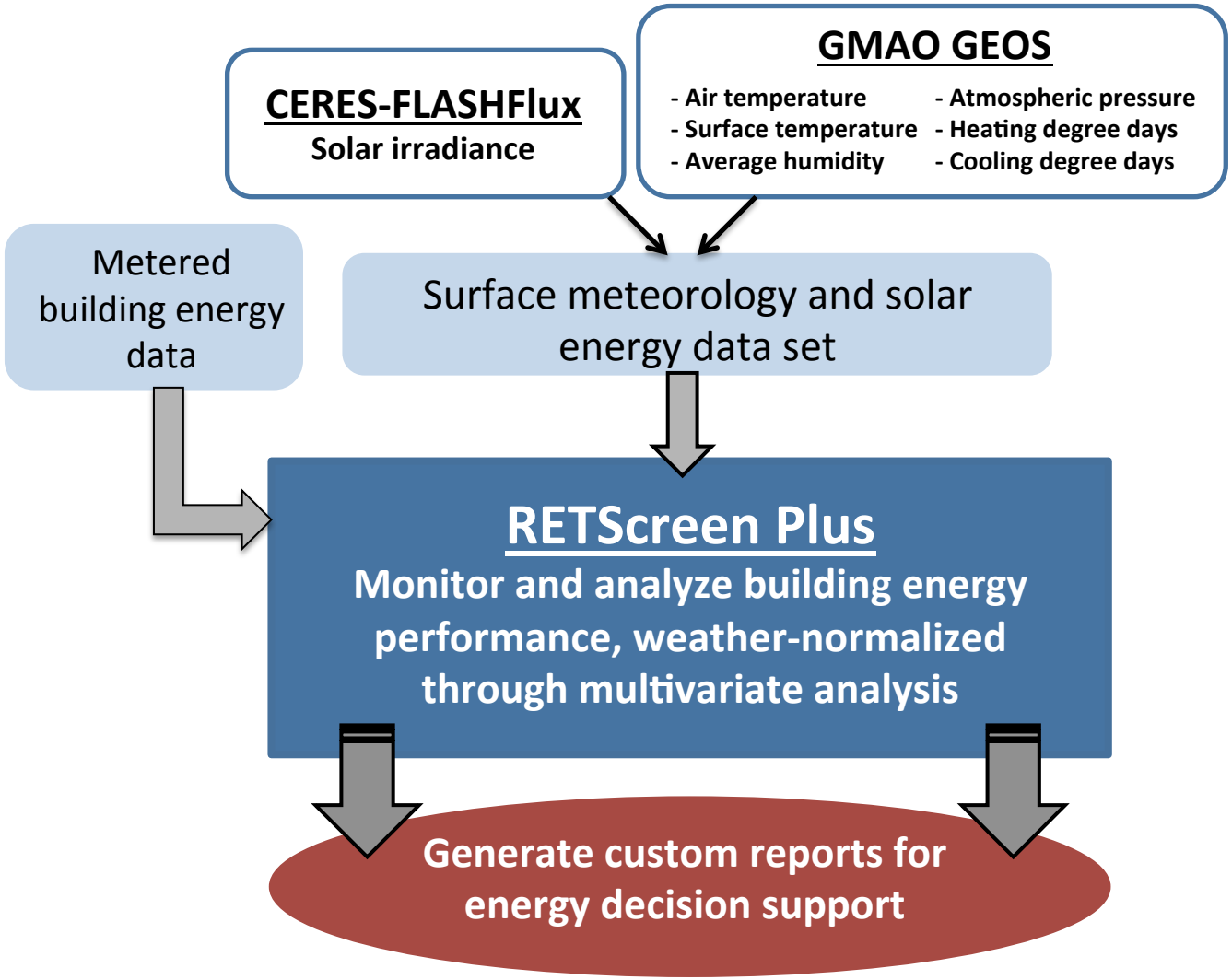
- Maps energy usage over time to demonstrate performance changes due to building improvements or alterations.
- Provides quantitative measure of building efficiency.
- Gauges financial feasibility prior to implementation of energy efficiency measures or renewable technology systems.



RETScreen Plus integration with NASA Solar and Meteorological Data

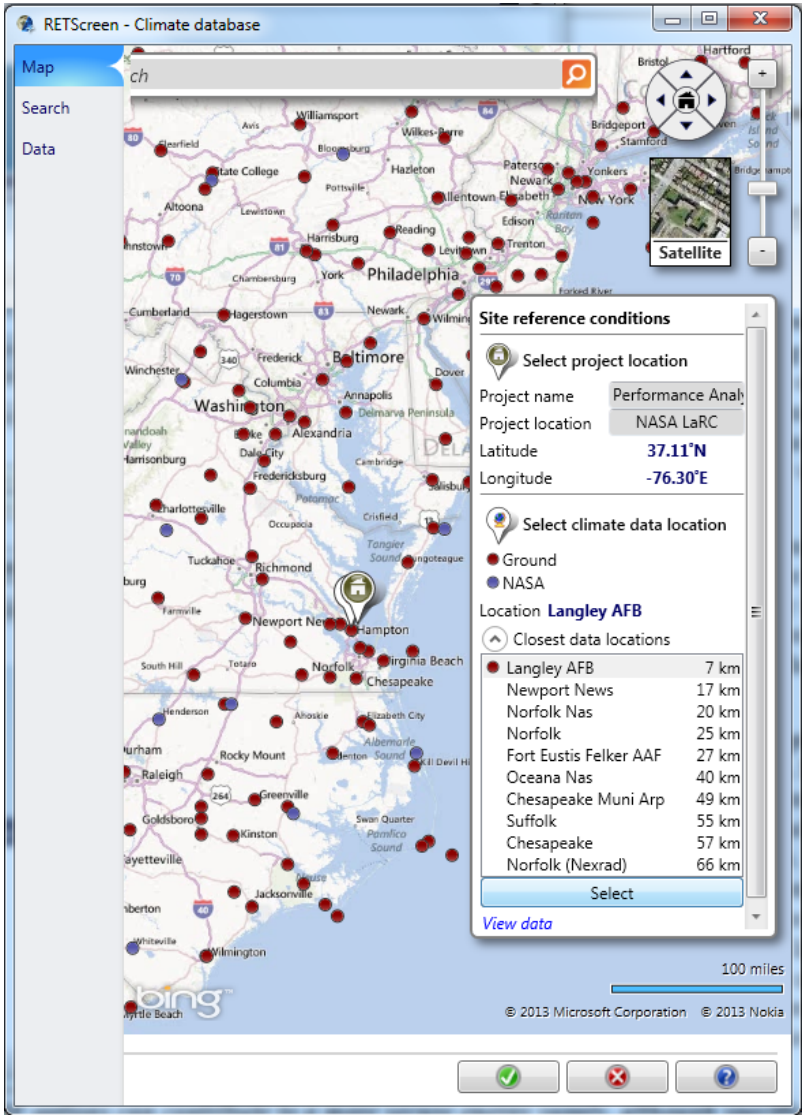
NASA near real-time data provided by the Surface meteorology and solar energy data set.

- Meteorological data from the NASA GMAO (Global Modeling and Assimilation Office) GEOS (Goddard Earth Observing System).
- Solar observations from NASA CERES (Clouds and Earth's Radiance Energy System) and FLASHFlux (Fast Longwave and SHortwave radiative Fluxes).



NASA near real-time solar and meteorological data sets

The availability of NASA data sets to RETScreen Plus users has increased spatial resolution of meteorological data to an Earth surface 1° x 1° global grid.



RETScreen Climate database for site location selection

NASA near real-time data validation

- Satellite and model derived parameters validated by surface observations from the National Climatic Data Center.
- Near real-time data sets enable users to maintain ongoing energy monitoring of their facilities within a week of real-time.

NASA Near-Real Time Data Accuracies

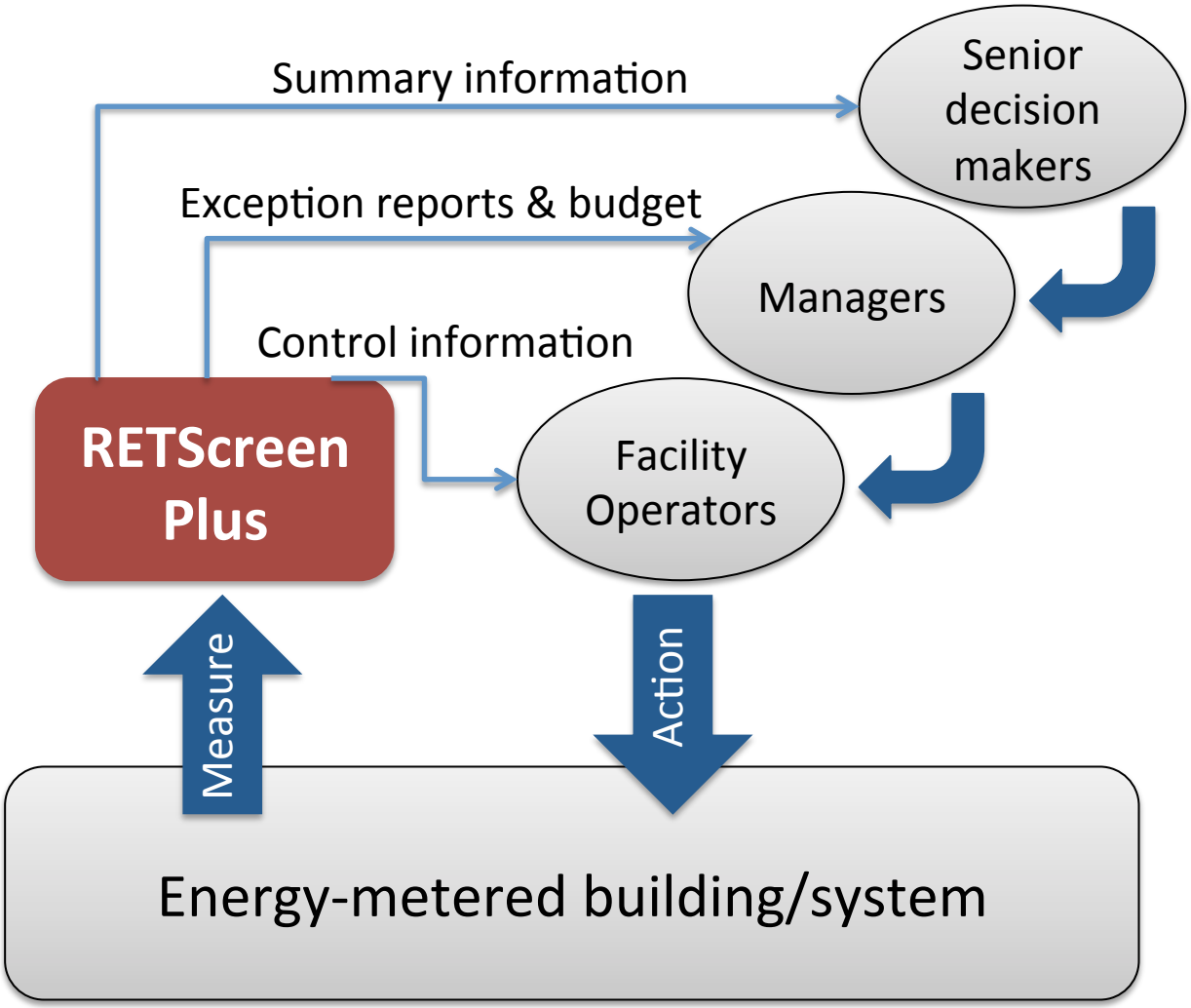
Parameter	Slope	Intercept	R^2	RMSE	Bias
Tmax (°C)	0.97	-1.01	0.94	3.5	-1.5
Tmin (°C)	0.98	0.43	0.92	3.4	0.3
Tavg (°C)	0.99	-0.37	0.96	2.6	-0.5
RH (%)	0.74	19.05	0.61	11.5	1.3
Heating Degree Days (degree days)	0.95	25.66	0.89	97.59	12.62
Cooling Degree Days (degree days)	0.97	-2.75	0.96	40.44	-7.47
Atmospheric Pressure (hPa)	1.10	-96.84	0.92	17.7	1.3
Solar Irradiance (W m^{-2})	0.94	2.76	0.90	31.8	-8.5

Linear least squares regression analysis of SSE values versus NCDC daily averaged values for year 2013.

RETScreen Plus Reporting Pathway

Reporting has a number of functions:

- Create motivations for energy saving actions.
- Report regularly on performance.
- Monitor overall energy costs.
- Measure cost savings or energy production revenue.



www.retscreen.net

NASA Langley Case Studies

Demonstration of managing building energy usage and efficiency for select buildings using NASA data sets

Badge and Pass Office

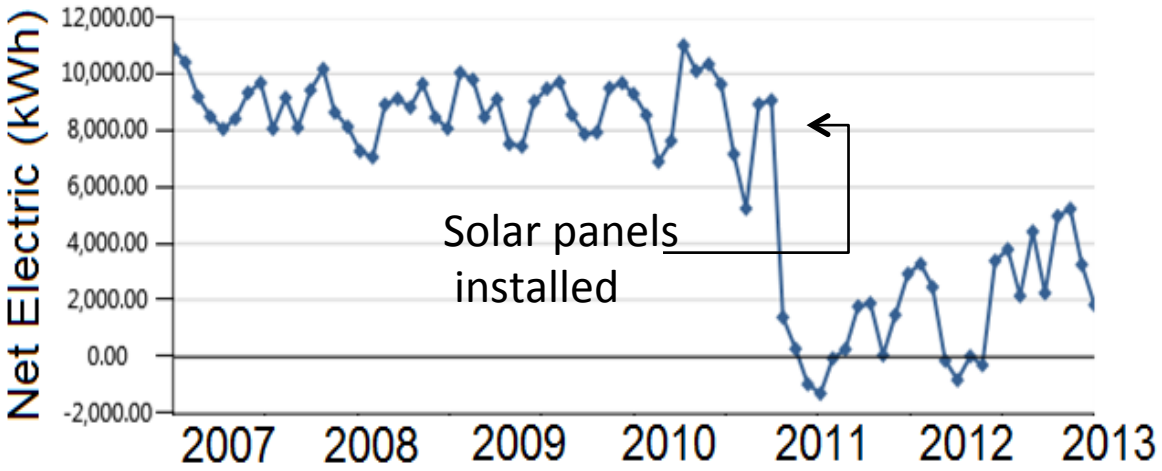
Year built: 2005
Square footage: 3,473

Power Source: Electric power with solar panels installed in 2010. Two solar panel arrays consist of 168 photovoltaic modules. Each year, this 39.5 kW system will produce 50,000 kWh.

Photo credit: David Bowman, Genex

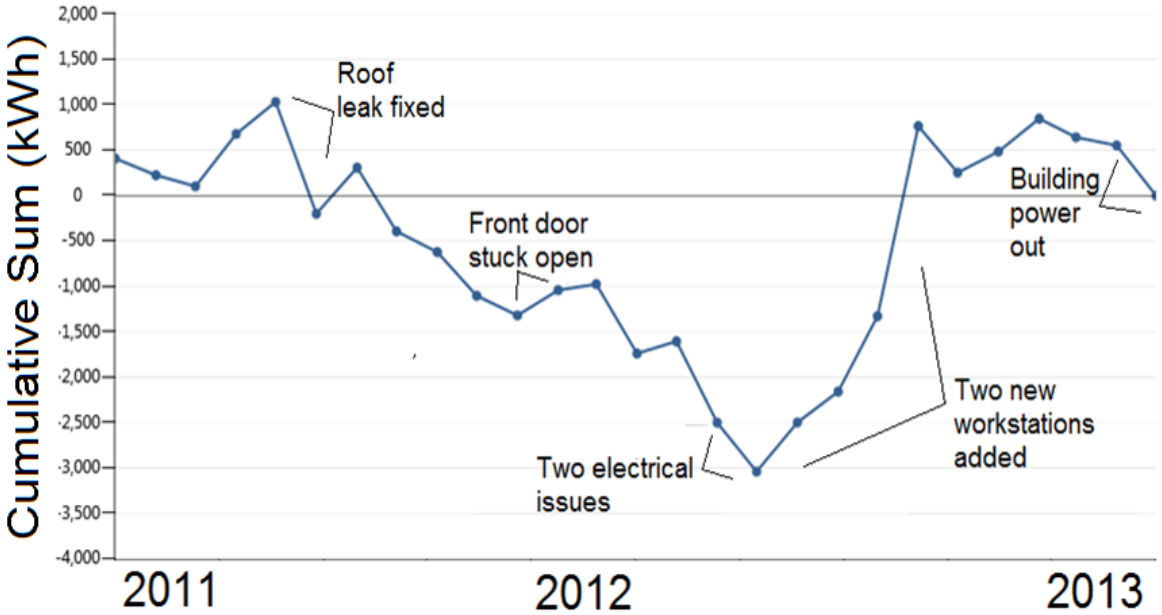
Photo credit: Sean Smith, NASA

Badge and Pass Office



PV system accrued a net savings of 169 MWh since commissioning.

Weather normalized energy usage allow other changes in building energy to be correlated with work orders, occupancy fluctuations, etc.



NASA LaRC Headquarters

Year built: 2011

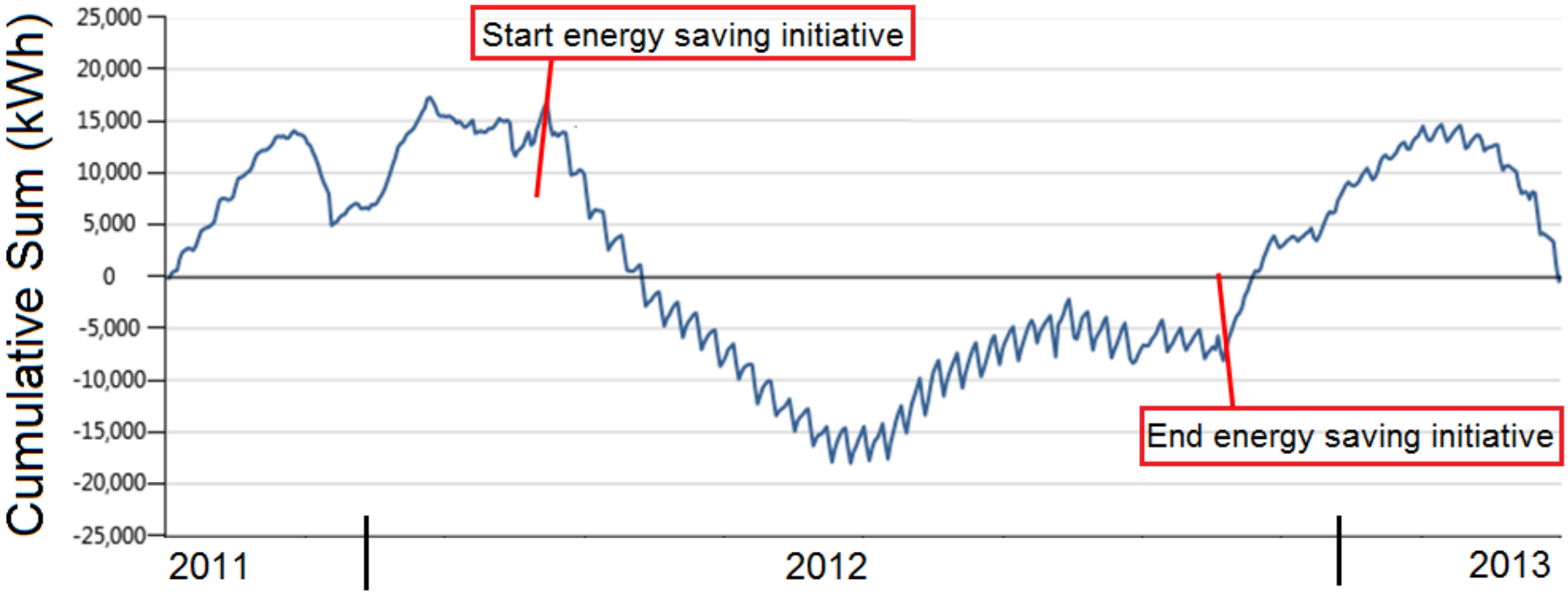
Square footage: 79,000

Power source: electric power Leadership in Energy and Environment Design (LEED) green building.

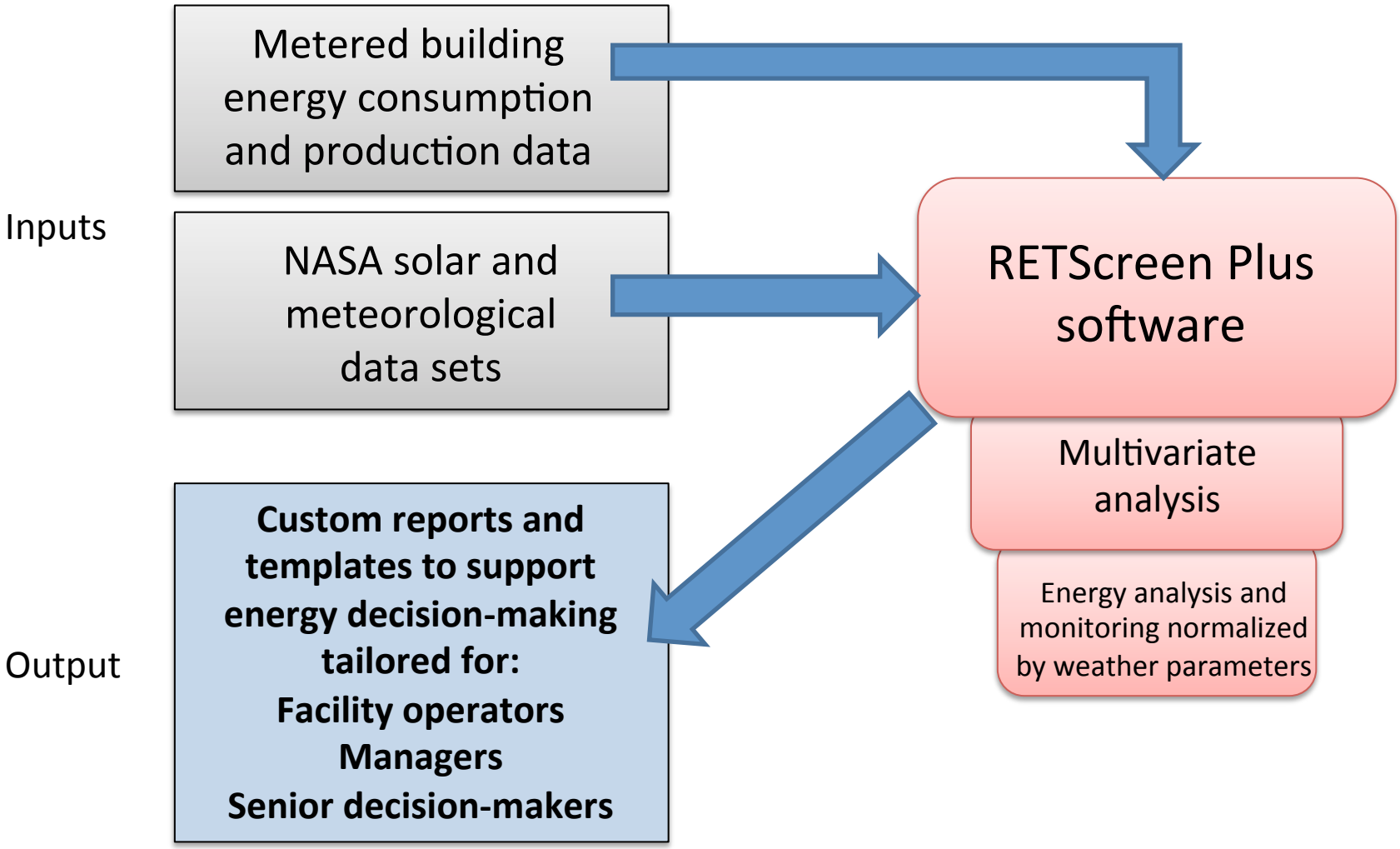
Photo credit: David Bowman, Genex

NASA LaRC Headquarters

- Energy usage was reduced ~2000-3000 kWh/day for every weekend occurring between the red markers (3/24/2012 - 11/30/2012)
- This decreased energy usage is quantifiable using RETScreen Plus.



Summary


Inputs
Metered building energy consumption and production data
NASA solar and meteorological data sets
RETScreen Plus software
Multivariate analysis
Energy analysis and monitoring normalized by weather parameters
Output
Custom reports and templates to support energy decision-making tailored for:
Facility operators
Managers
Senior decision-makers

Conclusions

- RETScreen Plus software has shown to be a valuable instrument in managing ongoing energy usage in commercial buildings as described by the case studies in this report.
- Provides means of identifying the validity of new energy efficiency projects.
- The availability of NASA Surface meteorology and Solar Energy data to RETScreen users has increased spatial resolution of meteorological data to a 1°x1° global grid system within days of real-time.

Supplemental Slides

RETScreen 4

RETScreen Suite comprised of two modules:

- RETScreen Plus, as discussed. (Pre-feasibility analysis)
- RETScreen 4 (Feasibility analysis)
  - an Excel-based clean energy project analysis software tool
  - allows users to develop project models and generate a five-step analysis including energy usage, cost, emissions, financial benefits, and risk.
  - Usually the next step after using RETScreen 4 for pre-feasibility.