AUTODESK **UNIVERSITY** 2015

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How Much is Zero?
Agile Solar Power Design with Insight360

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Learning Objectives

- Learn how to visualize, optimize and integrate solar power systems during the design workflow
- Learn how to identify the best locations, sizes and orientations for solar PV systems to meet energy targets
- Learn how to use detailed design tools like Solar Analysis for Revit and Solar Analysis for Dynamo to define the specific solar PV system geometry and specifications.
- Gain confidence in the underlying Energy and Solar Analysis engines and use them to make better decisions faster.

Description

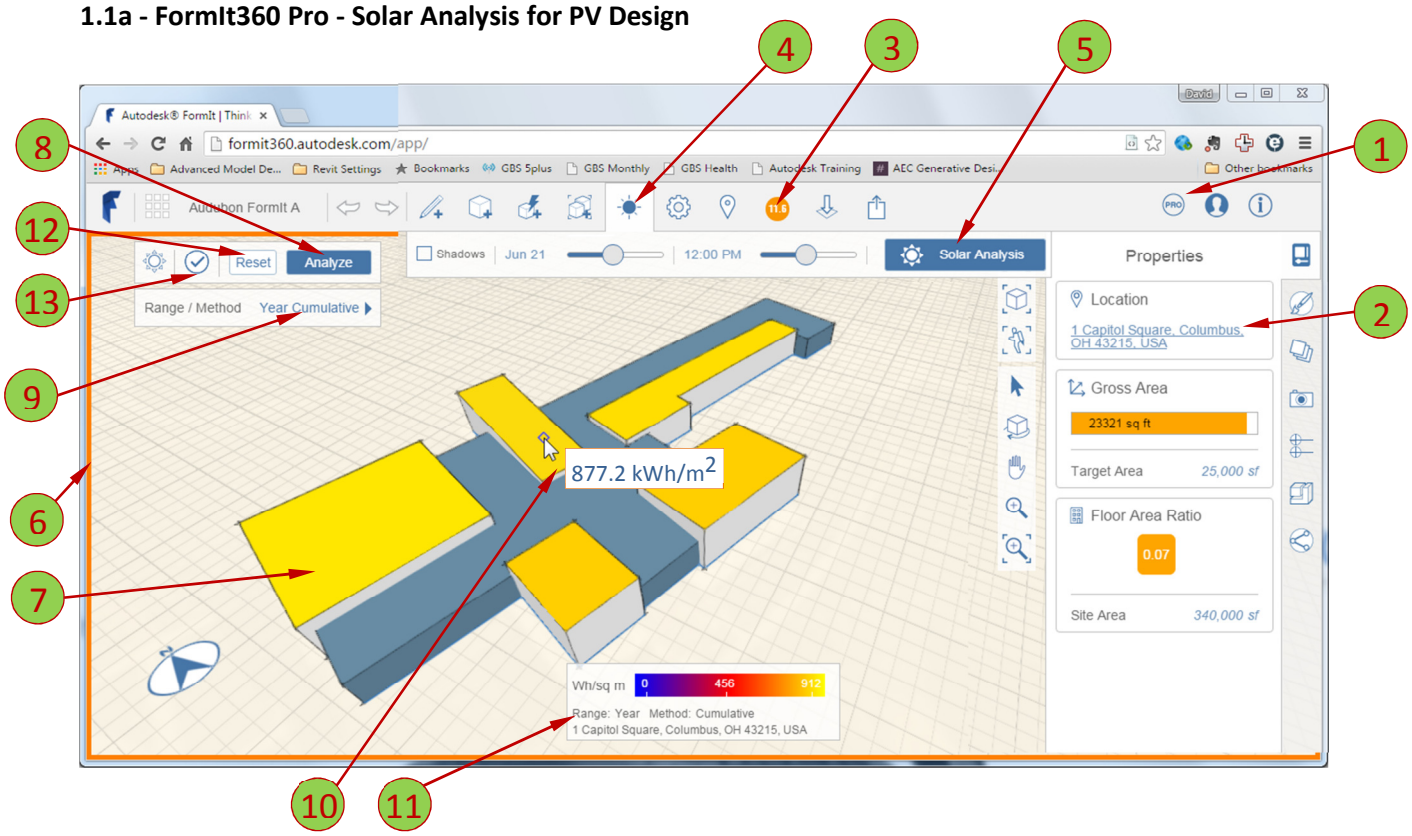
Whether building for net zero or reducing building utility bills through net-metering with on-site energy production, distributed solar has become a common component of the modern design process. To consider photovoltaic, solar hot water, or passive solar from rooftop or remote panels, or to build optimal integrated installations into a building design, designers need to understand solar-energy-generation potential as an integrated part of the design process. This class will show how to use built-in tools in Revit software and FormIt software to understand the potential of solar power from the very beginning of conceptual design, and to generate and analyze a complete solar design from concept phase all the way to detailed panel layouts and specifications and their effects on overall building-energy performance. We will also show advanced processes using Dynamo solar analysis graphs to parameterize, automate, and optimize your solar power installation at all design phases.

Your AU Experts

*After many previous lives, **David Scheer**, a registered Architect began working at Autodesk as a subject matter expert and developer. David currently serves as a Sr. Product Manager with the building performance analysis and generative design group working on special projects for lighting, solar and city-scale performance modeling. David has a background in architectural design and energy consulting, as well as land planning, GIS research, building construction and flying commercial float planes in California and Alaska. David works San Francisco where he is currently completing construction on his zero energy home with the help of the Insight360 tools used in this class.*

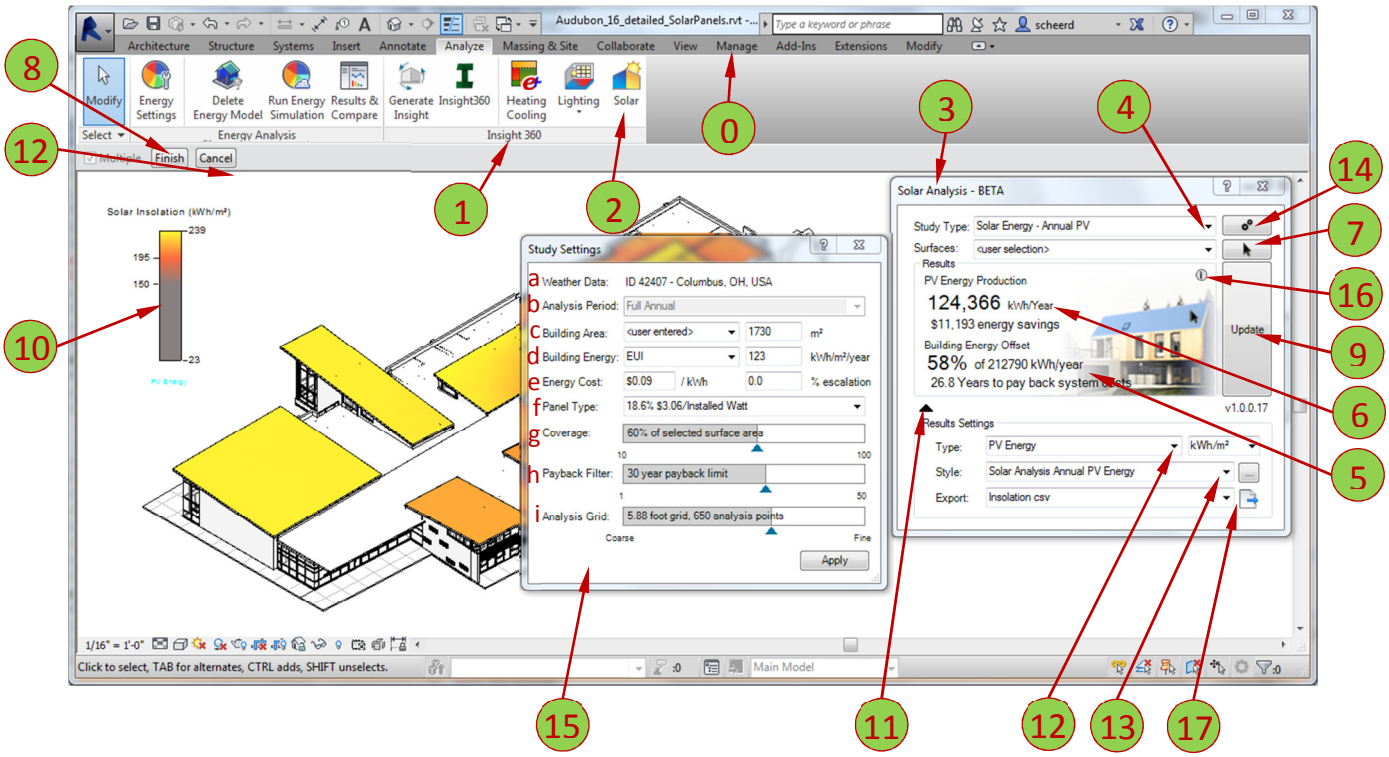
***Dr. J.K. Schlecht** has been teaching at the College of Engineering, Bangalore and has been in academics for the last 2 decade. He recently developed an interest in teaching AutoCAD related tools to the Undergraduate Students of Mechanical Engineering and is now an Associate Professor in the Department of Mechanical Engineering.*

1.1a - FormIt360 Pro - Solar Analysis for PV Design



1. Sign in to A360 with a FormIt Pro trial or subscription for access to Solar Analysis and Insight360.
2. Set Location and select weather station to provide solar geometry and hourly intensity data for Solar Analysis and Energy Analysis from Green Building Studio Climate Server weather files.
3. Generate or review Insights with Insight360 to understand solar energy needs and basic PV system design factors.
4. Enter Solar Analysis tool through the Sun and Shadows tool.
5. Enter Solar Analysis mode.
6. Bold, colored border shows that model is in Solar Analysis mode.
7. Select surfaces to generate insolation results.
8. Click Analyze to calculate insolation on selected surfaces for annual cumulative and monthly peak analysis sets using the location weather data.
9. Select 'Year Cumulative' results to see the total annual solar energy/insolation on the selected surfaces for Solar Power analysis.
10. Hover over a surface point to see the cumulative annual insolation for the point.
11. Range is automatically set to the full range of the selected surfaces. This range is fixed for all analyses during the current Solar Analysis session so other surface selections can be compared.
12. Click Reset to make a new surface selection.
13. Click the checkbox to exit Solar Analysis mode and return to modeling mode.

1.1b – Revit 2016 with Insight360 plugin - Solar Analysis for PV Design



0. Set the Location and Weather Station in the Manage toolbar, Location tool, Internet Mapping Service option. You must be signed in to A360 and connected to the web to access GBS Climate Server weather stations. If not connected or signed in, weather station list will not be visible in the Mapping dialog. If working with a FormIt RVT file, the location of the FormIt model will be used. If no Location is set, the default location and weather data for Boston, MA, USA will be used.
1. Download and install Insight360 plugin for Revit 2016 (recommend Release 2) from insight360.autodesk.com. Generate or review Insights with Insight360 to understand solar energy needs and basic PV design factors.
2. Open Solar Analysis for Revit from the Insight360 toolbar.
3. The Solar Analysis tool is designed to stay open during design work in any 3d ortho view. Results are coordinated with the open view. Helper tools allow easy navigation of in-canvas visual results. Default settings are appropriate for initial analysis and are coordinated with Insight360 defaults.
4. For Solar Energy PV design work, choose the Solar Energy – Annual PV Study Type. Sun Settings are automatically set for a full annual range for annual cumulative insolation and PV energy results.
5. The Results section shows data relevant to the result Type and the stage of the study settings. The lower section of the Results section shows either selected surface area and study period, or PV panel area or Building Energy % Offset and PV system payback period. Tooltips explain the data in more detail.
6. The upper section of the Results section shows either summary insolation data for the selected surfaces, or PV Energy Production and the value of the energy for the selected surfaces and PV system settings.
7. Select surfaces for analysis or PV system with either a preset surface selection set or manual selection model.
8. After selecting surfaces for analysis, click Finish to complete the selection.

9. After making any change that requires update of results, Results data will show 'Update' message. Click the Update button to run a new analysis. Some settings changes do not require Update.

10. The Legend shows a preset scale and Analysis Display Style for colored surface data display. Due to Revit AVF restrictions, the range will always be min to max of the data in the analysis, but the colors are fixed in the Style.

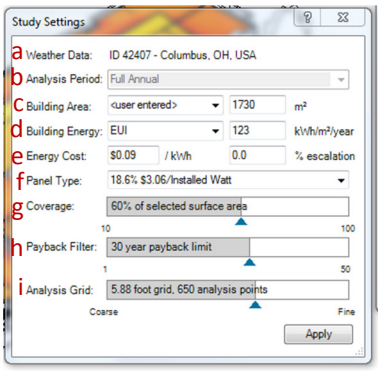
11. To view surface and advanced results helper tools, click the arrow to expand the dialog. The in-canvas results style tools are also available in the Analysis Display Style Properties for the view.

12. Select from 3 result Types for PV and the display units: Cumulative Insolation, PV Energy, or Payback Period. Cumulative Insolation is the total solar energy falling on surfaces for the Sun Settings study period, fixed to full annual for PV Study Type. PV Energy shows the amount of electricity produced by PV system on the selected surfaces for the PV system settings (see #14). Payback Period is the number of years it would take to produce an amount of electricity with a value equivalent to the PV system installation costs.

13. Analysis Display Styles are automatically defined appropriate to the result Type selected. You can also select a different style or customize the style here.

14. Open the Study Settings dialog to customize the advanced Study settings and the PV system settings. By default, these are set to appropriate initial assumptions for full annual study period, standard 16.0% PV panel type, full 100% surface coverage and maximum payback filter, and moderate analysis point grid density.

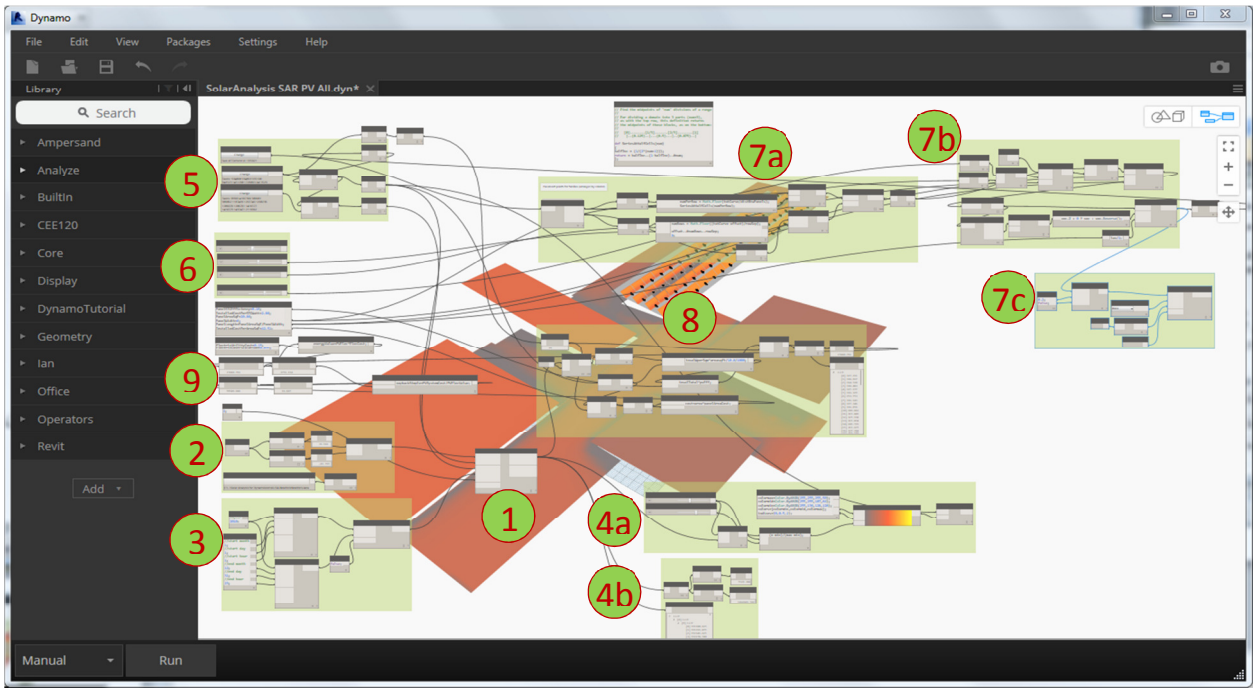
15. The Study Settings for PV Study Type includes:
    a. Project Location and Weather Station ID.
    b. Analysis Period, same as Sun Settings. Fixed to Full Annual for PV.
    c. Building Area, used to calculate annual Building Energy if EUI is selected in Building Energy. Used for Building Energy Offset results.
    d. Building Energy, entered as a total or as EUI available from Insight360.
    e. Electricity Cost, utility cost for electricity, available from Insight360 project in GBS. Escalation is the % annual increase of electricity costs.
    f. PV Panel Type. 3 panel efficiencies are currently available and are the same used in Insight360. Typical installation cost is included for each.
    g. Surface Coverage is the % of the selected surface area assumed to be covered by PV panels.
    h. Payback Filter determines the minimum annual insolation required for an analysis point to be included in the Results. Low-performing areas of surfaces will be filtered out by value of energy produced at that point.
    i. Analysis grid defines the density of analysis points on the selected surfaces.



16. Info button will expose a tooltip showing a summary of the Study Settings without opening the Settings dialog.

17. Raw Insolation data for all analysis points can be exported to CSV for advanced analysis work.

1.1c – Solar Analysis with Dynamo 0.9.0 in Revit and Dynamo Studio - Solar Analysis for PV Design



1. Solar Analysis node is available as a standard node in Dynamo 0.9.0 from dynamobim.com. Revit is not required for using this node, which can operate on Dynamo native surfaces and definition data. This example uses Dynamo with Revit.
   [note: A bug in 0.9.0 and 0.9.1 provides correct results only for TMY weather stations (noted as year '2010' or 'TMY')]
2. Weather data defines the hourly solar values of diffuse horizontal and direct normal radiation needed for the Solar Analysis node to calculate the insolation incident on included surfaces for the selected time Study range. Weather data is chosen from the GBS Climate Server station closest to the Revit project- or manually-defined latitude and longitude. Note that this may not be the station used in the Revit model if the weather station closest to the project location is not selected in the Internet Mapping Service.
3. Time Study defines the time range of weather data and corresponding sum positions used to calculate cumulative, peak or average hourly insolation results from the Solar Analysis node. Time Study can be defined in a number of ways, two of which are included in this example
4. Results from the Solar Analysis node can be visualized in Dynamo using the Display.BySurfaceColors node. This node requires a color range and results normalized to values from 0-1. In this example the range of colors are defined in two ways:
   a. By fixed maximum and minimum. The example values correspond to the range of the Cumulative Insolation Analysis Display Style in Revit SAR.
   b. By results maximum and minimum. This method is useful for peak and average results or initial studies.
5. Analysis and Shading surfaces are defined by surface selection nodes. For this example there are 3 sets of surface selections: automatic PV panel array parent object (not used in analysis results), analysis surfaces (in this example, the PV panel array surfaces are used, but any surfaces can be selected just like SAR in Revit), shading surfaces (in this example, all analysis surfaces plus any additional surfaces are used for shading).
6. PV panel array parameters are defined here for the automated array functionality of this graph. This is not required for Solar Analysis and shows how advanced functionality of Dynamo can enhance the normal manual Solar Analysis workflows for PV system design. Panel types and array spacing and tilt are defined here.

7. The automated panel array function will distribute PV panels over a selected parent surface per the array definitions and surface orientation. This example has 3 parts:
   a. Distribute reference points on the parent surface per the rules for spacing of panels in the array sliders.
   b. Create reference surfaces and panel locations and tilt at the reference points.
   c. Create a Revit object to place in the Revit model for analysis in SAR and visualization and documentation.
8. PV Results calculations for the system settings are defined in this area. These are the same calculations used in SAR in Revit.
9. Final results are shown here in Watch windows, so results can be viewed as input parameters are changed. These are similar results as those used in SAR in Revit.