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City & Campus Rapid Energy Modeling and Data-Driven Forge Dashboard

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Learning Objectives

- Understand the need for rapid energy modeling (REM) based on energy simulation of BIM models and how to scale energy analyses to meet goals and mandates
- Understand how REM can streamline energy assessments through a case study at a facility campus in the Northeast
- Learn about different workflows depending on data availability and reporting requirements
- Understand scenario analyses and how to interpret and apply energy analysis results
- Learn how to use the Forge Viewer to create dashboards

Description

Federal, state, local, and city governments continue to set ambitious targets to reduce energy consumption and greenhouse gas emissions of existing buildings through building retrofits and conservation measures. To meet these targets, building owners are challenged with scaling energy analyses across large building portfolios to identify and prioritize the correct buildings and retrofit measures across that portfolio. Prior rapid energy modeling (REM) methods were only applicable to single buildings, but this session will introduce new capabilities that allow evaluation of entire building portfolios with minimal data inputs required. The new method allows simultaneous energy analysis of multiple buildings, evaluation of retrofit measures for energy savings, and exploration of scenarios to achieve energy goals at a city-scale. Results are presented dynamically with a digital model and custom dashboards. The session is intended for owners and managers including: the Department of Defense (DoD); federal, state, and local government; airports; higher education; architectural firms; and planning entities.

Speaker(s)

Matthew Goss – Practice Leader: M/E/P + Energy, CDM Smith Inc.

Matt leverages his mechanical and energy systems engineering expertise to address CDM Smith's clients' challenges in both the facilities and energy realms. He is one of CDM Smith's foremost experts at executing and supporting energy projects, from audits and efficiency studies to energy-efficient design and construction support engagements.

Mathews Mathai – Principal Business Consultant, Autodesk, Inc.

Mathews provides business and domain expertise to Autodesk customers in the areas of infrastructure planning, civil engineering, and transportation software solutions and services. Mathews also provides expertise and customer success activities around building performance and energy analysis as well as business transformations leveraging building Information Modeling (BIM).

Why do we need REM?

With the issuance of various federal, state, city, and local regulations and guidance documents, facilities and energy managers may find it difficult to comprehensively evaluate their current operations to identify and plan for future action and investment.

While proper planning is important for success, planning efforts must be grounded in reliable data and usable information to make savings opportunities actionable. These efforts are critical to develop capital improvement plans, facility master plans, and energy planning for any installation or campus.

Field work for energy audits is often very labor intensive. In addition, the most valuable information is not frequently visible or accessible. Equipment identification and capacity is often incomplete or difficult to ascertain. Other data, like occupancy and setpoints, is dynamic and only observed periodically. This means that site inspectors need to approximate the equipment capacities, age, usage, and setpoints.

REM streamlines energy assessments

CDM Smith performed REM on more than 19 buildings at a 1900-acre installation using proprietary Autodesk computer technology. The buildings, built between 1918 and 2018, comprised over 387,000 square feet and were used for various purposes including maintenance, housing, and water/wastewater treatment administration. Using customer-supplied energy data, CDM Smith developed facility models and wrote custom applications to perform interactive energy analyses on the buildings modeled and analyzed with various Autodesk tools, including Infracore, Revit, and Insight 360.

Four improvement scenarios were created for each of the 19 buildings after the building energy baselines were completed. The team considered actual energy usage and consumption data to propose upgrades, consisting of:

- Upgrades to increase lighting efficiency (0.3 W/sf)
- Upgrades to the HVAC system (high-efficiency heat pump)

Data for all 19 buildings and four scenarios was exported from Insight 360 and compiled into a propriety spreadsheet with the addition of cost metrics \$/sf (construction cost). Proprietary spreadsheets were developed to evaluate the energy conservation measures (ECMs) of the existing buildings, as well as the proposed upgrades.

Understanding the workflow

As the energy planner steps through the workflow, they can easily gather and access energy-related data to compare energy conservation measures and identify peak building performance i.e., optimization.

The following applications are used within the workflow:

1. **GIS-based Infracore** serves as a platform and foundation to visualize and collect appropriate geographically-referenced data (weather). This platform enables energy

planners to perform location-specific (GIS-based) analyses. As a result, site-specific climate and weather data will be applied to any analyses conducted and options analyzed. Infracore also serves as the central data repository. Information regarding existing utility consumption, building data (type, age, use, size, etc.) can be stored within the Infracore platform. The platform allows specific building geometry to be used. Whether it's publicly available, constructed in real time, imported from Revit, or provided through a third-party, a graphical representation of buildings will be stored and presented in the Infracore platform.

2. Once information is created and/or developed and stored within the Infracore platform, it is communicated to **Autodesk's Insight 360** and **Green Building Studio** platforms. Within the Insight 360 platform, users can evaluate and visualize energy conservation measure impacts in real time. The platform allows users to evaluate measure interactivity (e.g., reduction in lighting energy's effects on heating/cooling).
3. Simulated energy consumption can now be imported back into the **Infracore** platform and evaluated in several manners, including theming facilities by energy utilization index (EUI) to provide a graphical (color) representation of existing building performance.
4. Once analyses or "insights" are developed within **Insight 360**, these results can be exported into a series of proprietary analysis tools to incorporate implementation costs and conduct a series of financial evaluations.
5. Based on the evaluations completed, graphical representations are often created to present different options for consideration.

Moving from steps 1 through 3 is intuitive and follows a logical progression of gather, analyze, compare, and report, thus expediting the energy decision-making process. Armed with reliable comparative energy and cost data, the user will find the tool useful in the following ways:

- Produces results faster than a traditional American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) audit
- Provides a visual representation and data theming
- Compares ECMs to aid in decision-making
- Allows for customization of ECMs in dashboard environment
- Analyzes a rate of return output for financial analysis
- Compares facility performance to standard Department of Energy (DOE) EUIs
- Compares facility performance to each other
- Helps the planner quickly identify the poorest performing facilities

The benefit is that using facility values to determine usage and normalized usage has no assumptions. The usages are based on measured quantities and the normalized usage is based on measurable and verifiable quantities. This removes the inherent error of the assumptions. These comparisons are all relative to the campus and published indexes.

Using the Forge Viewer to create dashboards

The amount of information collected in BIM 360 software can be overwhelming. Identifying connections between data that can lead to project insight is not always easy. However, because of the flexibility of the Forge API and its seamless communication with BIM 360, it's now possible to connect information systems that highlight important data and enable better-informed decisions.

The Forge platform <https://forge.autodesk.com/> has existed for several years, and at its heart is the Forge Viewer. The Viewer is a client-side JavaScript library based on [three.js](#) and its behavior can be enhanced to provide more robust functionality.

The Forge Viewer is an important component of the Forge workflow. After a model has been translated to the Forge Serial Vector Format (SVF) (see Mode Derivative API), it can be visualized and explored in a web browser, while keeping the information related to the model (like component hierarchy, materials, properties, and other metadata). Before the Forge Viewer technology became available, there were other, less convenient options for viewing. Many were desktop-based and required anyone viewing the model to have software pre-installed. Even in the browser world, this was difficult without plugins until WebGL and HTML 5 came along, making it possible to render 3D directly in the browser. Today, most browsers and devices support WebGL and HTML 5, making viewing as simple as navigating to a website.

The Forge Viewer technology can also be found in in Revit, 3ds Max, etc. as Shared Views.

Where BIM 360 comes into play

BIM 360 is the source of all information that will be used in the dashboard. As the common data environment of a construction project, and because of its flexibility and connectivity among systems, it can provide information on different levels and for each project stakeholder to easily understand it.

Types of dashboards

Dashboards can serve different purposes depending on the actions or decisions that will be taken with the information they provide. There are three main types of dashboards that can be used efficiently in the project. Their difference comes in the level of detail and the timeframe of the data they display.

- Operational dashboards

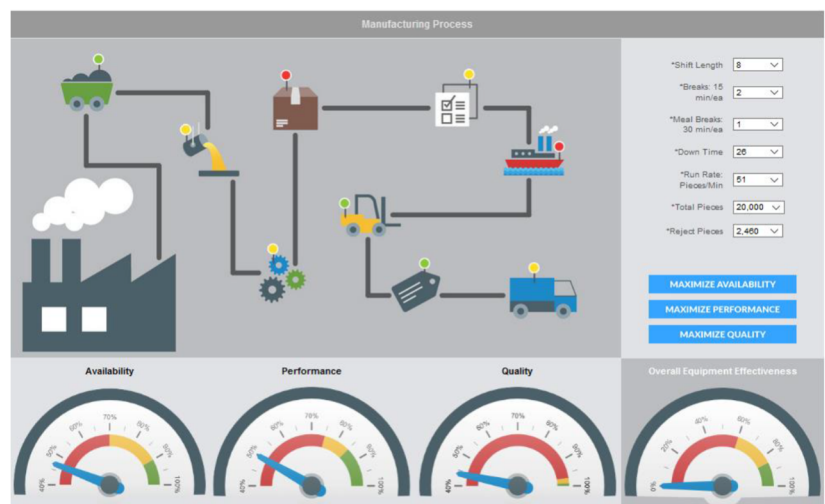
This dashboard provides information on the daily status of the activities of a project. It goes into reporting the real time performance metrics of all the tasks at hand in a simple unified solution. It provides immediate information about the project current results and indicators.



Operational dashboards need to focus on the current status of the project and have a specific scope to give the user the required information at a glance and without further interaction. This dashboard is especially great for informing the project team on the status of current activities so they can implement any required actions as soon as possible.

- Analytical dashboards**
 Opposite of operational dashboards, which focus on the moment, analytical dashboards consider past performance to identify trends and get a clear view of the factors that have contributed to the project's current status. This dashboard uses iterations and more interaction with the users to supply the required information as they are analyzing and reviewing the performance of the project.

Due to its use for identifying trends and cross-referencing information, analytical dashboards require a higher level of understanding of the information. The decisions based on this data are made by correlating it to both past and present references.



- Strategic dashboard

Some data requires an extra layer of analysis before it can be insightful regarding the status of a project in its past and future performance. In order to properly get this data, it is important to set KPIs of the different aspects of the project. This will help the users easily find value within the data and set up context when reading the information.

Strategic dashboards use predefined KPIs and measures them on both daily information and retrospective records. This kind of dashboard can be really insightful since it indicates risk factors and improvement opportunities easily. However, they also require the most amount of preliminary work, it is only by having clear workflows and setting up parameters for your KPI that an analytical dashboard can be created.



Combining Forge modules to link visual reference with project data

Just as BIM 360 is the source of information of the whole project, Forge is the key to accessing that information in an efficient way that allows data to be easily analyzed and presented to the final user. At its core, Forge functions as the toolset that works as the means of connectivity for the project.

We will also look into how each module can come into play when creating the dashboard and what it has to offer.

Forge modules

Forge is divided into different modules depending on the type of information to be used and the work that needs to be done to it. To properly understand how each of these tools are used within the dashboard, we will discuss the six main modules that form Forge. We will cover its potential use to connect information in a way that provides the final user with the knowledge to make better assessments of the project.

Forge unlocks the power of design and engineering data so you can connect teams, workflows, and build new services to address today's connected customer. It enables companies to leverage design and engineering data to develop custom software applications and connected workflows for manufacturing, media/entertainment, architecture, engineering, and construction.

View 3D models directly in your browser

- The Viewer allows you to embed, interact with, and retrieve meta data from design files in over 50 formats right in your browser, without having to install extra software.

Centrally manage data

- The Data Management API allows you to access your data across A360, Fusion, and the Object Storage Service.

Convert your design files to formats that unlock their potential

- Use the Model Derivative API to prepare files for the Viewer, extract geometries, retrieve metadata, and more, from over 50 different industry-standard formats.

Viewer

The viewer service allows us to visualize the 2D and 3D design documents produced by the design team and interact with them. Using the viewer, it is possible to not only get a clear idea of what the project scope consists of, but to manipulate the model visualization to create more a detailed analysis using sections.

The viewer is a great way to get a visual reference for project elements. By using the proper standards in both the model and other project data, it is also possible to connect elements and generate a 3D view that accompanies information such as costs or tasks.

Data management

The Data Management service will allow our dashboard to access and read all the BIM 360 information of the project. This module connects the app to a specific BIM 360 project and allows it to retrieve any version of any document located in any folder. The ability to access the project's documents and read them at ease is a key feature of this dashboard.

Model derivative

The model derivative tool allows you to transform 2D and 3D design information to svl. This will allow the documents to be visualized using the viewer and for their properties to be properly mapped and available for analysis.