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WHITEPAPER

The Advantages of BIM-Enabled Sustainable Design for Improving Commercial Building Performance

Introduction

Did you know that buildings are the largest contributors to greenhouse gas emissions annually? Currently, the building sector accounts for 30 to 40 percent of global energy use.[1] As our awareness of inefficient buildings increases, it is coupled with the emergence of building and energy mandates; therefore, it is little wonder that improving the performance of buildings is a cornerstone of sweeping energy usage reform, sustainability efforts, and economic stimulus packages. However, the task of developing a comprehensive and prioritized modernization plan to convert a substantial inventory of large, dated commercial buildings into sustainable, energy-efficient structures can be overwhelming. You need a pragmatic and cost-effective way to analyze building performance and rank projects and renovations—across a portfolio of dispersed buildings—based on economic and environmental goals.

So why are commercial buildings where we should be targeting improvements? Commercial buildings show the highest retrofit potential of all building types.[2] Global electricity use in commercial buildings has almost tripled since 1980 and is projected to rise another 50 percent by 2030. It will soon become the highest-growing end-use sector in industrialized countries.[3] As a result, commercial buildings are experiencing increasing pain due to rising energy costs. In the United States, for example, only 30 percent of commercial buildings have had HVAC, lighting or window upgrades, and only 10 percent have had insulation upgrades,[4] creating a surge of commercial buildings in need of retrofit improvements. Due to the vast inventory of existing buildings globally, there is an unprecedented opportunity for owners to play a leadership role in improving the performance of buildings. Deliberate and cost-effective renovations to commercial buildings can generate substantial environmental, financial, and societal benefits, from reducing energy consumption to creating new jobs. For example, deep retrofits to improve system performance can decrease utility bills by 40 to 60 percent,[5] and from a climate perspective, if Brazil, China, the European Union, India, Japan, and the United States invested $150 billion in retrofits, we could see a 40 percent decrease in greenhouse gas emissions with a 5-year payback.[6]

Contents

[1] United Nations Environment Programme (UNEP)
[2] Engineering News Record, 2009
[3] Source: Energy Information Administration, Annual Energy Outlook, 2007
[4] Commercial Building Energy Consumption Survey, Energy Information Agency
[5] RMI 2009—Interview with Amory Lovins, chief scientist, Rocky Mountain Institute, January 2010
[6] World Business Council on Sustainable Development (2009), *Transforming the Market: Energy Efficiency in Buildings, April*

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With approximately 76.9 billion square feet of existing building stock in the United States and approximately 44 billion square meters in China[7] as examples, the sheer number of buildings in need for improvements globally can make conducting comprehensive building performance analysis and implementing energy savings projects a daunting task. Dated or nonexistent building plans and incomplete energy consumption histories make it difficult to predict future performance throughout the life of a proposed renovation project.

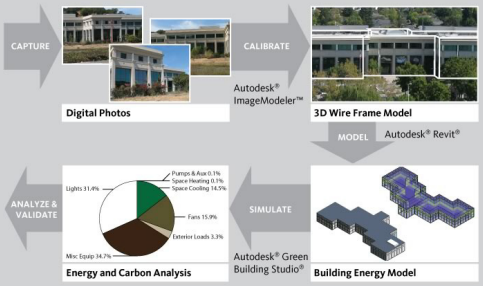
Fortunately, new technologies help make this once overwhelming prospect manageable—especially when compared to traditional 2D drafting tools. For example, building information modeling (BIM) is an integrated process for exploring a project's key physical and functional characteristics digitally—before it is built. The coordinated, consistent information used throughout the BIM process helps architects, engineers, contractors and owners to see, prior to construction, what their design will look like and more importantly, how it will perform. When applied to existing buildings, purpose-built BIM solutions can help you capture the building geometry and characteristics needed to conduct various aspects of energy performance analysis. For example, a basic model can be created through the BIM process that can then be used to support energy and investment-grade audits.

This paper will provide an overview of how purpose-built BIM solutions and integrated analysis tools can help you to assess building performance, prioritize investments, and evaluate proposals to reduce operational costs, conserve energy, reduce water consumption, and improve building air quality, helping to meet sustainability and energy-efficiency goals.

Using BIM in a rapid energy modeling workflow

Use purpose-built building information modeling solutions in a rapid energy modeling workflow to help evaluate different design scenarios and determine how to improve building performance to help realize cost and energy benefits throughout the life of your building.

Rapid Energy Modeling Workflow with Autodesk Software



The Call to Improve Building Performance

Commercial building owners are in a unique position to be leaders in sustainable design and improving building performance. Every day, commercial buildings use substantial amounts of energy, water, raw materials, and other natural resources, and generate waste and pollution. Due to the sizeable environmental footprint buildings have globally, they are the inevitable focus of a wide range of mandates. The goal of these directives is to increase building performance and thereby minimize energy consumption, reduce water and wastewater infrastructure demands, improve air quality, and create smaller overall carbon footprints. Unlike during the energy crisis of the 1970s, technology now exists to help improve building performance and help focus limited capital investments on the projects that will generate the highest environmental and economic return.

With the increase in building mandates, building owners globally are having to assess their existing building stock, improve existing building performance to meet higher standards, and they are essentially setting the bar high for other business leaders. There are a number of reasons to be driven to retrofit existing commercial buildings including the ability to promote your ambitious goals for sustainability and energy efficiency, to meet certification requirements and to influence your ecosystem of partners to also take measures to reduce their emissions. Examples of building mandates and movements that are emerging on a global level to improve performance include some of the following:

- The EU Energy Performance of Buildings Directive focuses on cutting energy use by 20 percent by 2020.
- The Energy Independence and Security Act of 2007 (EISA 2007) requires a steep reduction in fossil fuel energy usage, encourages the use of cost-effective solar hot water heaters, and extends the lifecycle cost period of capital improvement projects .
- Japan's prime minister has pledged that his government is committed to reducing greenhouse gas emissions by 25 percent from 1990 levels by 2020.

[7] McGraw Hill Construction SmartMarket Green Retrofit Report 2009

Renovate with BIM-Enabled Sustainable Design

The mandate is clear, improving building performance is crucial to achieving climate stabilization. In addition, energy-efficiency retrofits represent a massive latent market, projected to reach an estimated $400 billion by 2030 in the United States alone. To respond to these twin environmental and market demands at scale and speed, the building industry needs to respond quickly and cost-effectively.

To this end, you can leverage Autodesk® BIM solutions in a variety of ways to help make better informed decisions to meet sustainability and energy efficiency goals. One way to do this is to utilize BIM in a rapid energy modeling workflow. Rapid energy modeling is a streamlined process that involves moving rapidly—and with minimal data—from an image capture of building exteriors through simplified simulation to building energy analysis. Rapid energy modeling enables building energy assessments with a smaller budget and shorter time frame, and can thereby help increase the number of existing buildings that undergo assessment and energy upgrades. In only a few hours and with minimal data, by using rapid energy modeling with Autodesk BIM solutions at the core, can help you to:

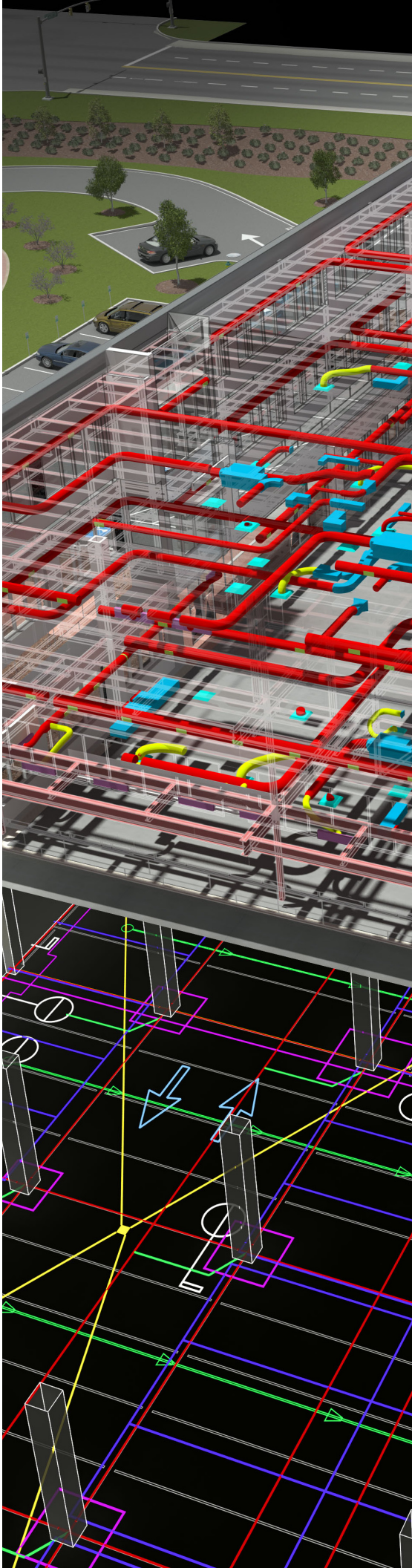
- Quickly estimate actual energy performance
- Screen for high potential buildings for achieving carbon reductions
- Assess and communicate return on investments for buildings

The rapid energy modeling workflow is based upon utilizing a core set of Autodesk solutions for more easily capturing existing conditions, creating a simple model, and then conducting whole building analysis. The Autodesk solutions that support this workflow include:

- Autodesk® ImageModeler 2009™ software to help build a 3D wireframe from digital pictures of building exteriors (ImageModeler is available to Autodesk Revit Architecture and Autodesk Revit MEP Subscription customers for the term of the subscription)
- Autodesk® Revit® Architecture software or Autodesk® Revit® MEP software, purpose built for BIM, to create a simple model
- Autodesk® Green Building Studio® web service to conduct whole building analysis

By using Revit Architecture or Revit MEP for BIM at the core of the rapid energy modeling workflow, BIM enables you to more quickly and easily create a basic model to help simulate the performance and cost of renovations and retrofits. The digital model includes data components that represent building elements and characteristics—such as materials, weight, thermal resistance, and other physical properties—that contribute to building performance. With BIM, you can analyze and assess the energy performance of individual buildings. Then evaluate, compare, and rank the environmental and financial impact of proposed renovations and retrofits. With a more comprehensive understanding of the relative performance of your property portfolio, you can recommend and prioritize an overall building modernization program, and focus detailed design efforts and construction on the projects with the greatest impact. BIM is a practical approach, whether evaluating a single office building or dozens of commercial buildings around the globe.

Using the rapid energy modeling workflow, you can quickly create a 3D wireframe based on digital photographs of the existing building. The 3D wireframe can then become the basis of a simple model within Revit Architecture or Revit MEP. Starting with a basic model, you can analyze, compare, or evaluate potential renovation and retrofit projects based on your own financial or environmental criteria. By using BIM you can more easily and accurately compare renovation and retrofit options within a building; for example, you can compare which of the following generates a better economic and energy-efficient return: installing higher R-value wall insulation, or modifying a heating system. BIM can also be used for project comparisons between buildings, such as determining which buildings in your portfolio would benefit the most from an HVAC upgrade. Leveraging basic building information, BIM helps you to make evidence-based decisions in a cost-effective manner.



Getting started with BIM is easier than you might think. Use BIM to help improve the energy efficiency and performance of your buildings by following these five basic steps:

1. Collect basic building information—including wall, floor, roof, and ceiling dimensions—on each building within the portfolio.
2. Create basic models for each building in the portfolio. You can generate a complete model—including floor plans, elevations, sections, and 3D views—from the most basic building dimensions in just a few hours.
3. Analyze building models for environmental and economic performance. Facilitate smarter, more sustainable performance by analyzing and simulating a wide range of options. For example, in the area of optimizing solar effects, use models and integrated analysis tools to evaluate sun position, solar radiation, shading, and daylight alternatives.
4. Compare and then prioritize projects or investment alternatives based on conservation objectives, such as water or fossil fuel usage, or financial goals. For example, evaluate the economic and environmental return on upgrades to mechanical, electrical, and plumbing (MEP) systems.
5. Select and act on top priority projects.

The Benefits of Using BIM to Improve Building Performance

Applying BIM to analyze existing commercial buildings also helps deliver a plethora of economic, environmental, and societal benefits—that go far beyond complying with mandates. Extending BIM to analysis can help you identify ways to reduce resource consumption, increase on-site renewable opportunities, build consensus, review investment-grade audits, increase investor confidence, improve employee morale, and meet requirements for sustainable design and energy efficiency.

Reduce resource consumption—Smart and sustainable building renovations and retrofits leverage modern, more efficient technology, systems, and controls designed to reduce the consumption of energy, water, and materials.

- **Energy:** Use BIM analysis tools to help analyze heating and cooling requirements, identify daylighting opportunities, and select major building equipment that may reduce energy use. Incorporate local weather and electric grid data to estimate building energy consumption and carbon emissions.
- **Water:** Renovate buildings to reduce water usage or to utilize more reclaimed water. Analyze potable and nonpotable supply options for occupants and building processes. Evaluate stormwater systems, and simulate the performance of collection systems, ponds, and culverts.
- **Materials:** Select recycled or renewable materials or finishes during building renovations. Consider incorporating recycle centers and other sustainable practices that cut down on waste.

Increase on-site renewable opportunities—Changes in temperature, precipitation, and weather patterns can affect rainwater, stormwater, and snowmelt amounts, and alter water supplies from year to year. A coordinated, consistent model created through the BIM process can help design systems that minimize water use, protect existing wetlands, and focus on net-zero water usage. With more sustainable designs, you can encourage the use of recycled water for irrigation of landscaping, minimize contaminants in wastewater, and investigate the feasibility of capturing, recycling, and reusing water onsite—minimizing the costs and impact on your water and wastewater systems.

Build consensus—Using BIM analysis and visualization tools can greatly increase the impact and clarity of presenting proposed modifications to stakeholders and decision makers in legal, procurement, and finance departments. Enable reviewers to perform virtual walk-throughs or to better see the modifications occurring over a timeline, so they can improve their understanding of the project and build consensus on how to address issues that arise. For example, a 3D model site plan may quickly help identify whether a building renovation would affect access roads in a way that makes the proposed renovation impractical. Provide evidence-based answers to financers to reduce financing costs and improve the project payback.

Review investment grade audits—An energy services company (ESCO) can perform an in-depth analysis of a building or properties, design an energy-efficient solution, and install the required elements. Energy savings performance contracts (ESPCs) improve the energy efficiency of commercial buildings and commit you to a defined payback period. However, it is still the responsibility of the building owner to perform due diligence on proposals to protect the constituent's best interests. Before signing an ESPC, use BIM to perform internal reviews of ESCO proposals to help evaluate key predictions and assumptions. For example, use a virtual walk-through of the proposed renovations—or submit the design into energy analysis tools—to increase your confidence in predicted performance levels and reduce the uncertainties associated with these long-term contracts.

Increase investor confidence—Making smart investments in building improvements increases potential investors confidence that funding will be used appropriately to support optimum performance of the building for a long and sustained life. BIM analysis tools can help you more quickly identify where limited dollars should be spent, helping to add integrity and legitimacy to the process. For example, presenting cost-effective sustainable design alternatives at investor and stakeholder meetings helps generate an understanding of the design and renovation process while promoting investor trust.

Improve employee productivity—BIM can help identify opportunities for increasing the use of natural lighting or flow of fresh air within the interior spaces of a building. Use BIM to visualize and simulate the impact of a lobby atrium or better ventilation on building performance—while also taking into account the positive and intangible benefits these improvements can have on employee morale. For example, job satisfaction is commonly linked to increased productivity, higher retention rates, and fewer sick days.

Meet demands for sustainability and energy efficiency—According to a recent study, building owners and tenants are recognizing financial rewards from green building retrofit investments,[8] which is helping to stimulate growth in this area and increasing requirements from owners for sustainability and energy efficiency. This demand, coupled with the increasing emergence of building mandates, is causing large multinational firms with expanding footprints to evaluate their existing building stock and focus on designing new buildings to a higher standard. As demands and mandates for green and efficient designs increase, some owners and tenants believe that energy audits will become mandated,[9] creating an opportunity for forward-thinking commercial building owners today to be well-positioned to facilitate cost-effective improvements

Conclusion

Whether you have one or multiple buildings in your portfolio, conducting building performance modeling and analysis can generate significant benefits. You need clear, consistent, and evidence-based building analysis that sufficiently details predicted performance. Requiring the use of BIM can help you to more accurately understand predicted performance and related issues over the multiyear lifecycle of the project.

The ability to create a basic model—and then use the model to help analyze the cost and benefit tradeoffs of proposed projects within a building and throughout the property portfolio—is key to building performance analysis. Innovative design products support BIM, making it a cost-effective way to evaluate, prioritize, and audit proposed building renovations.

For more details on BIM, visit **www.autodesk.com/BIM**.

For more details on rapid energy modeling, visit **www.autodesk.com/rem**.

[8] McGraw Hill Construction Smart Market Green Retrofit Report 2009
[9] McGraw Hill Construction Smart Market Green Retrofit Report 2009