



Abating Climate Change by (Re)Designing Buildings Quickly & Cheaply

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Autodesk Sustainability Initiative

Autodesk®

- San Rafael-based Autodesk was founded in 1982 and is a world leader in design innovation technology.
- 2D and 3D technologies that let customers design, simulate, and analyze the real-world performance of their ideas early in the design process.
- Global company: > 8,000 employees, offices and R&D centers in more than 60 locations worldwide.

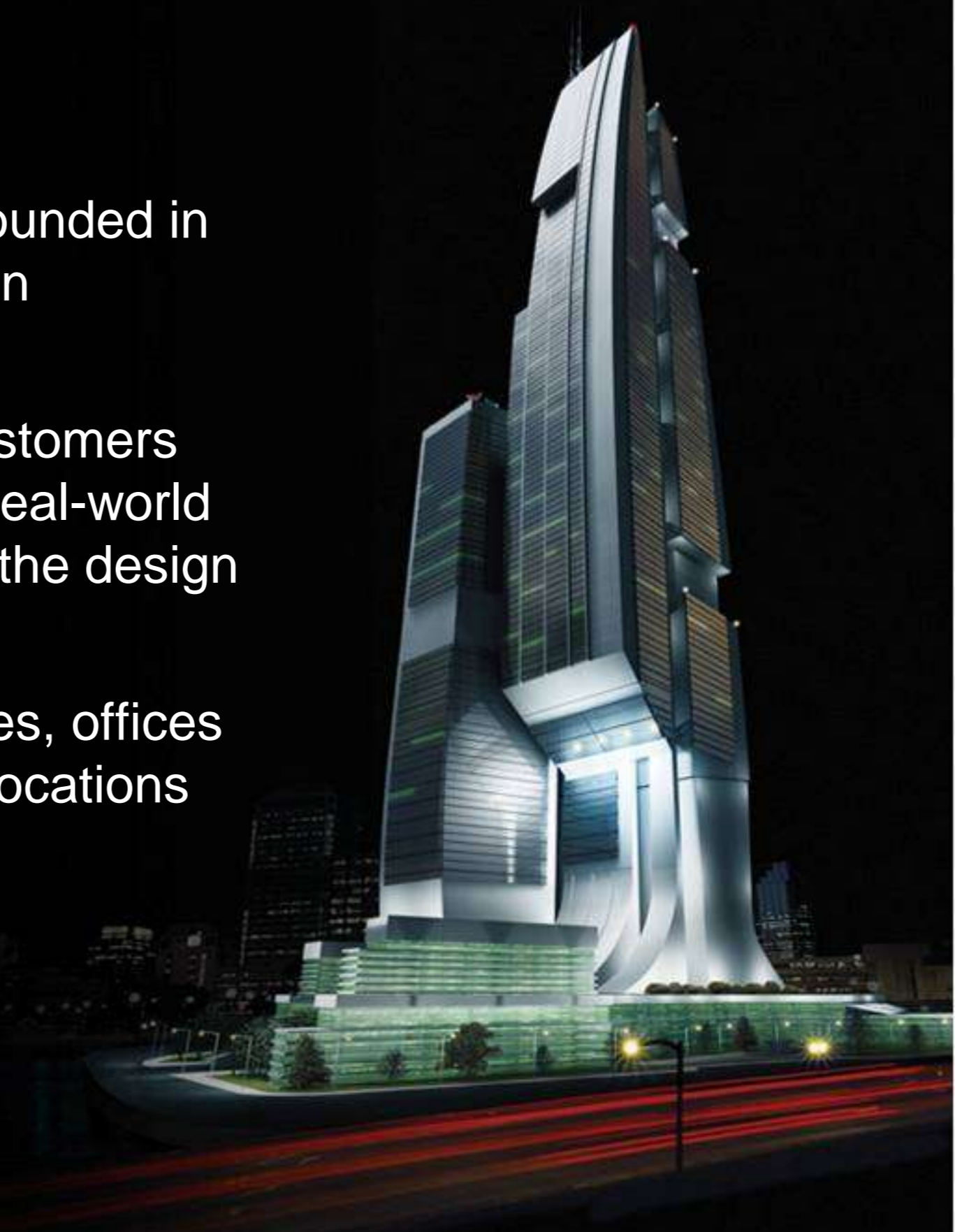




Image Courtesy of Uniform Communications LDT



Visualization

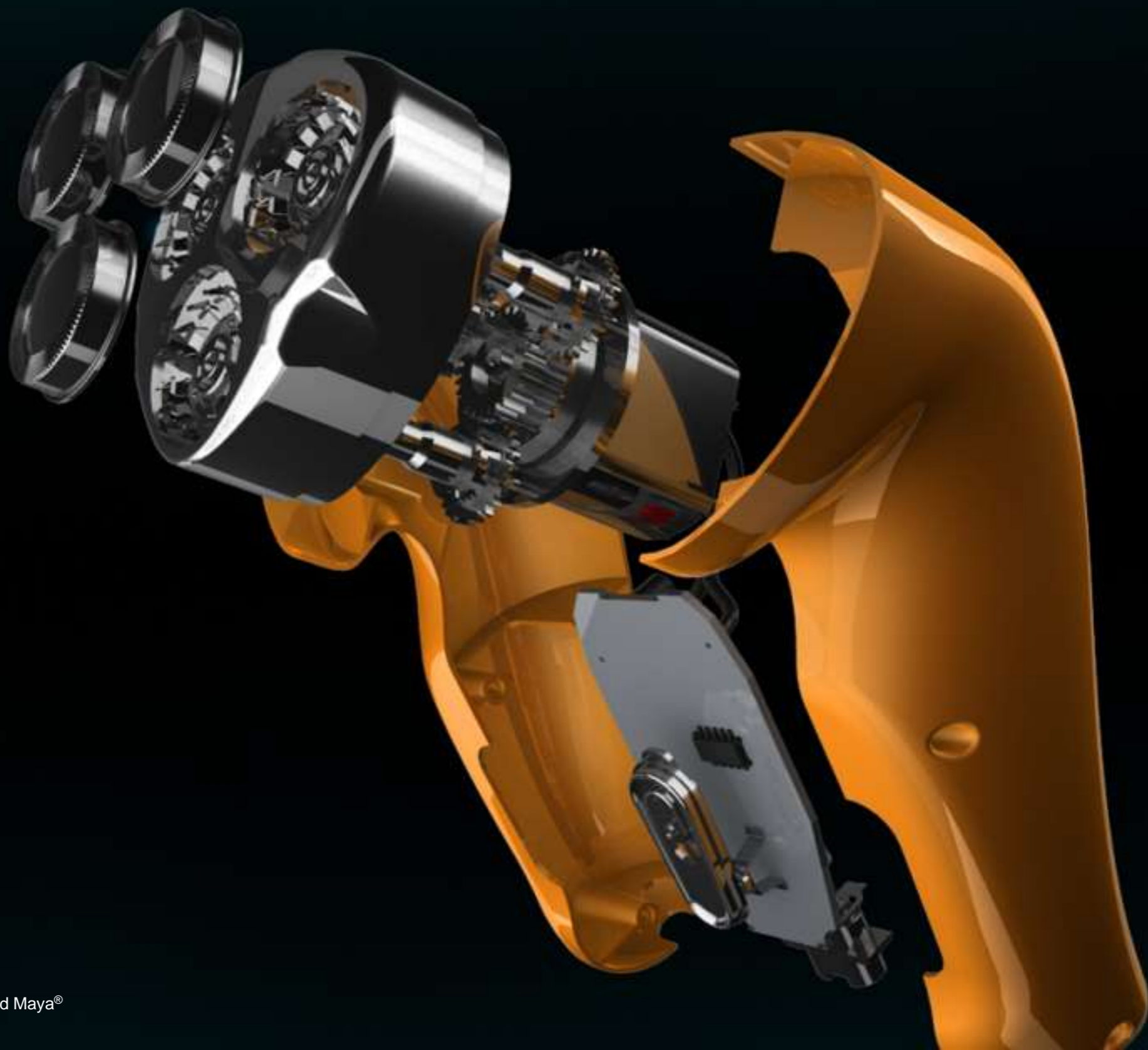


Image Courtesy of Mathieu Lesage and Martti Lemieux



Image Courtesy of Jacques Defontaine

Simulation



Analysis

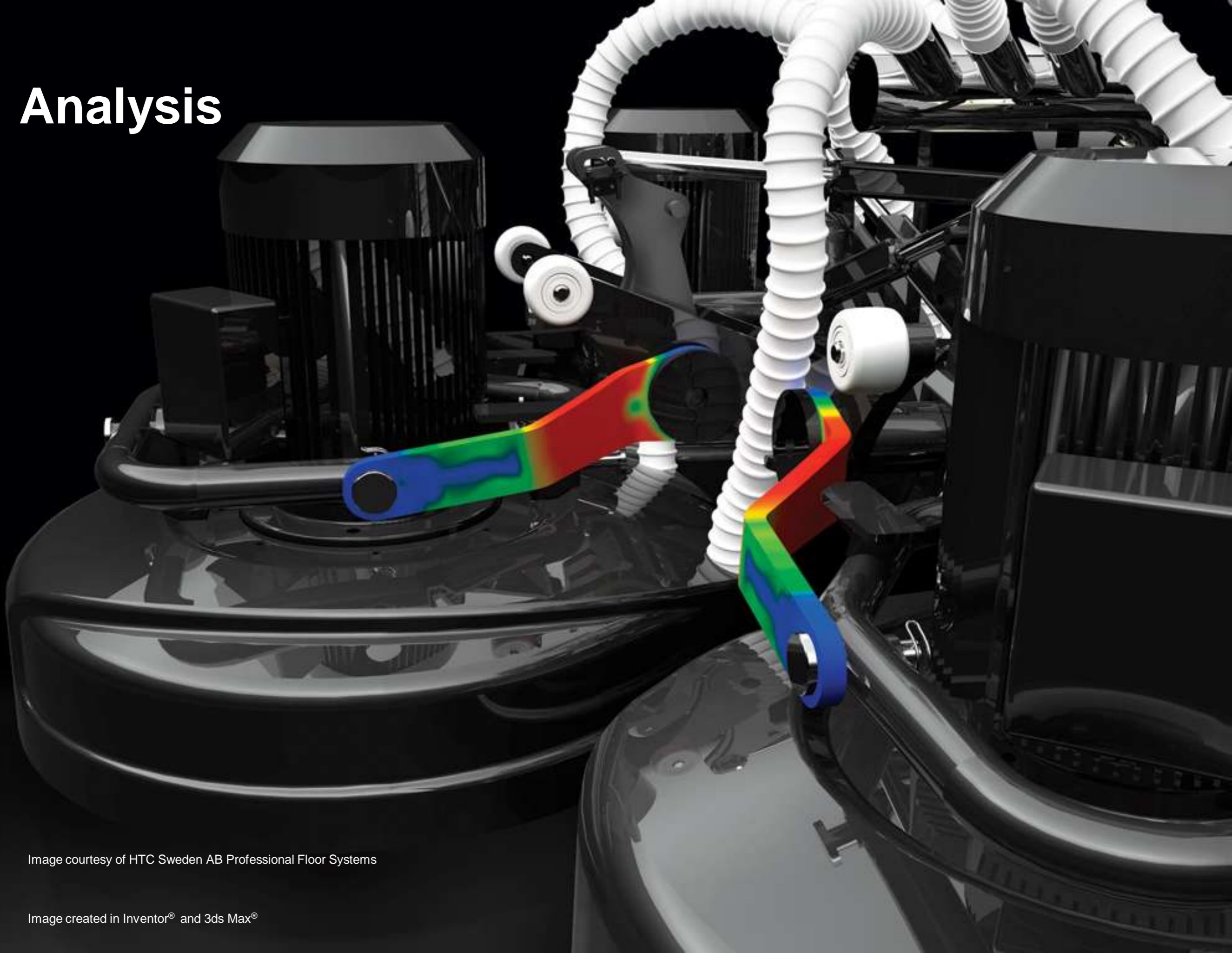


Image courtesy of HTC Sweden AB Professional Floor Systems

Image created in Inventor® and 3ds Max®

Autodesk's Commitment to Sustainability

Our Company

Our Partners

80+ Products

9 Million Users

Billions of People

Our mission is to simplify & democratize sustainable design by providing customers with the information and tools they need to make the best decisions possible.

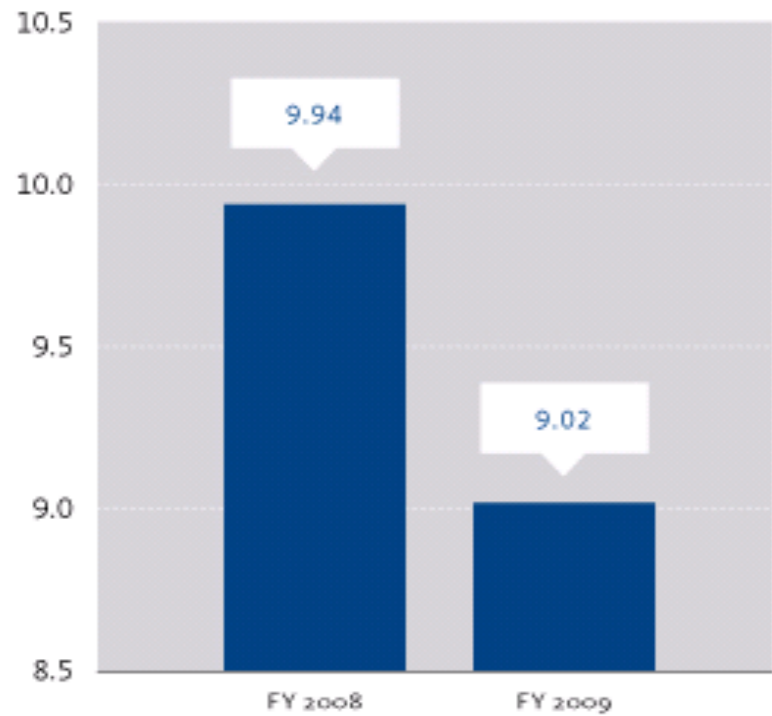
Take-Away #1: Climate Change Abatement Has Benefited Our Company



Climate Change Abatement Has Benefited Our Company

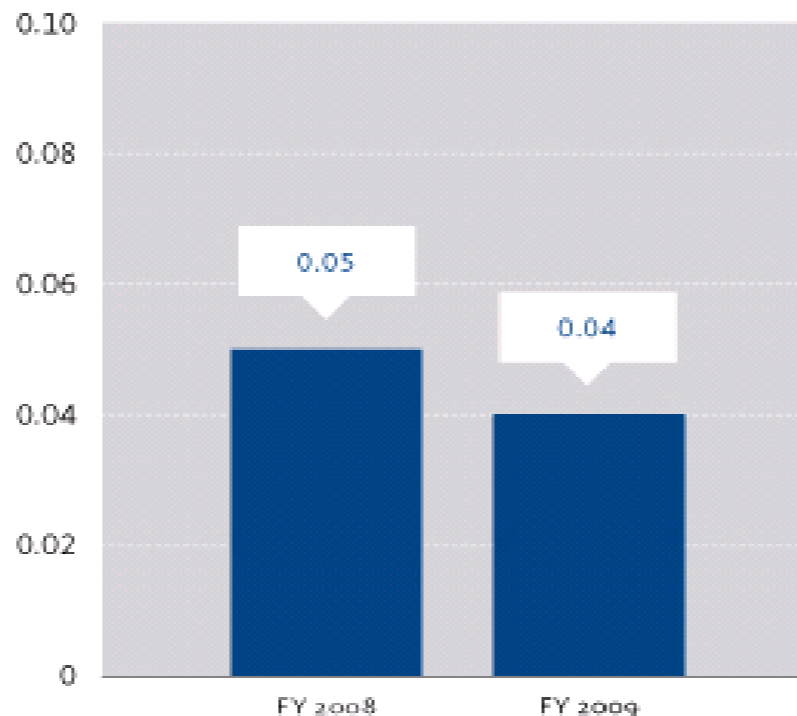
Autodesk CO₂ Normalized by Headcount

Metric Tons CO₂ per employee, including contingent workers



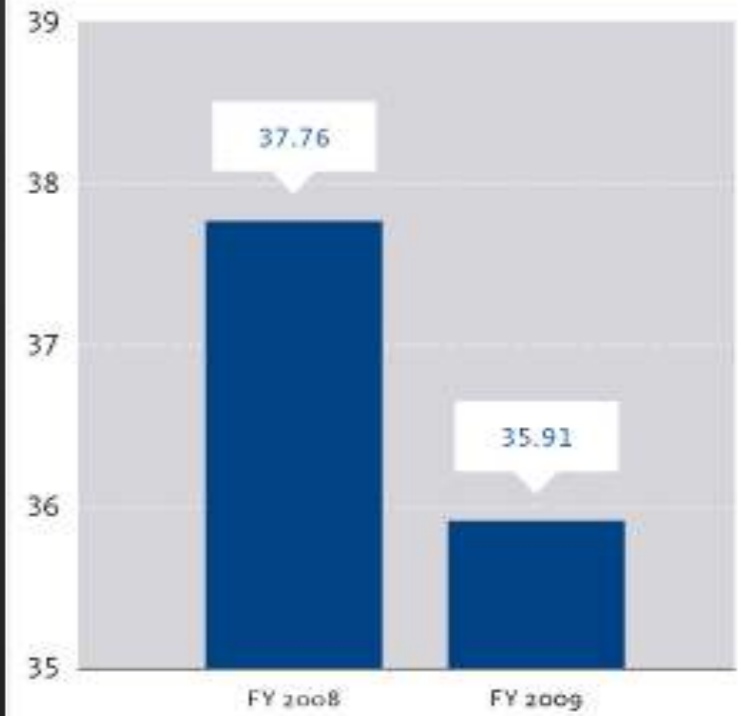
Autodesk CO₂ Normalized by Facility Square Feet

Metric Tons CO₂ per square feet



Autodesk CO₂ Normalized by Net Revenue

Grams CO₂ per USD Net Revenue



Corporate Finance Approach to Climate-stabilizing Targets (“C-FACT”)

A Science-Driven, Business-Friendly, Transparent methodology for GHG Target-Setting

Adopt a normalized goal but use a more nuanced approach that recognizes companies are GHG emitters but simultaneously create economic value.

ADSK and other leading companies should aim to:

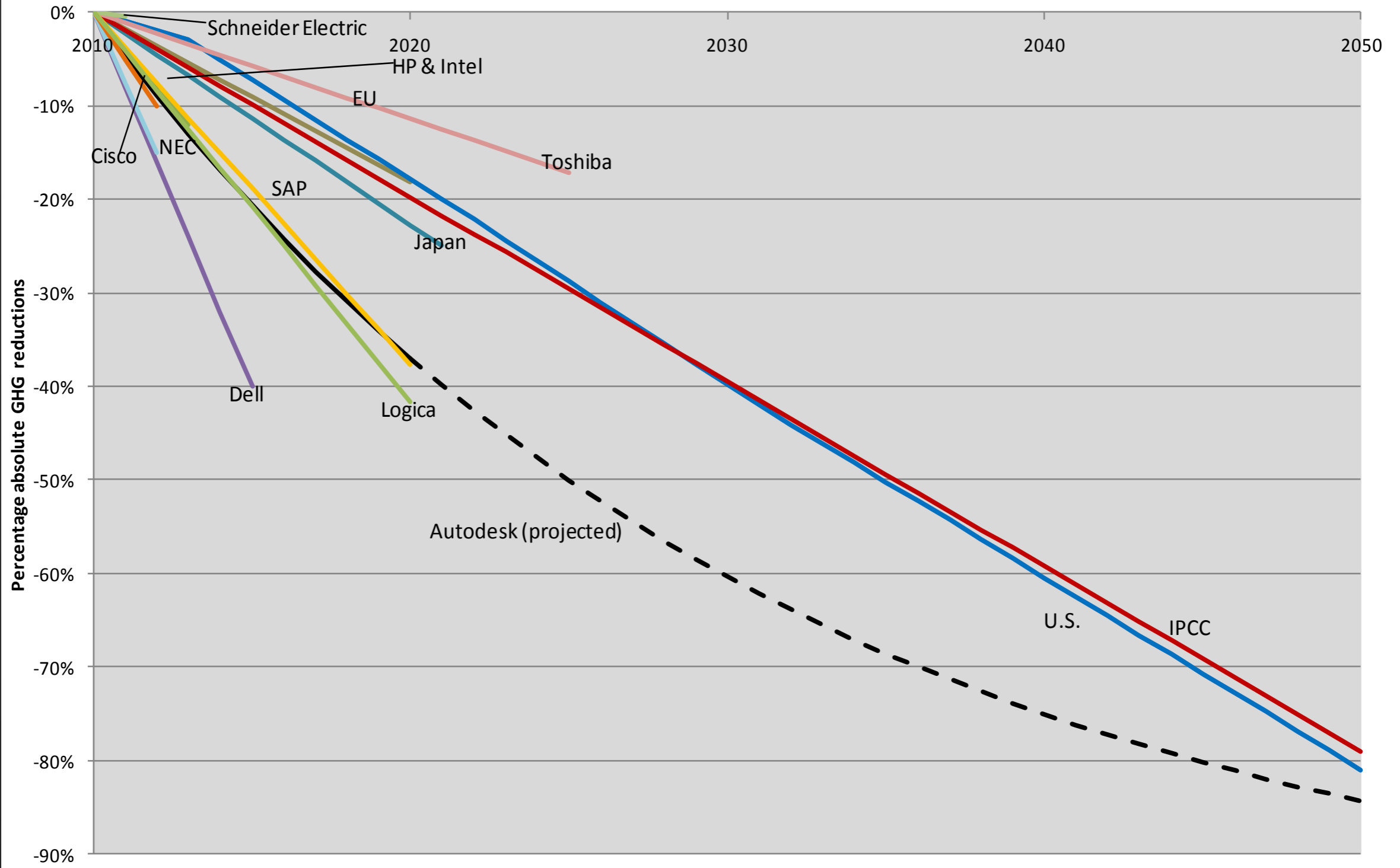
- a. Reduce their GHGs in line with scientific and policy climate stabilization targets (85% reduction by 2050 from current levels)*
- b. But do so proportional to their relative value-add to the economy (as measured by contribution to global GDP) -- not more, not less.*

Our Principles

- **Fairness:** Acknowledges that corporate commitments should be proportional to their contribution to GDP and not to the corporations' existing size and footprint.
- **Verifiability:** Uses available financial and carbon disclosure information, enabling 100 percent verifiability of methodology and progress.
- **Flexibility:** Adapts to inaccurate financial forecasts, economic uncertainty, organic and inorganic changes in business, and inevitable deviations of real performance versus intended target.

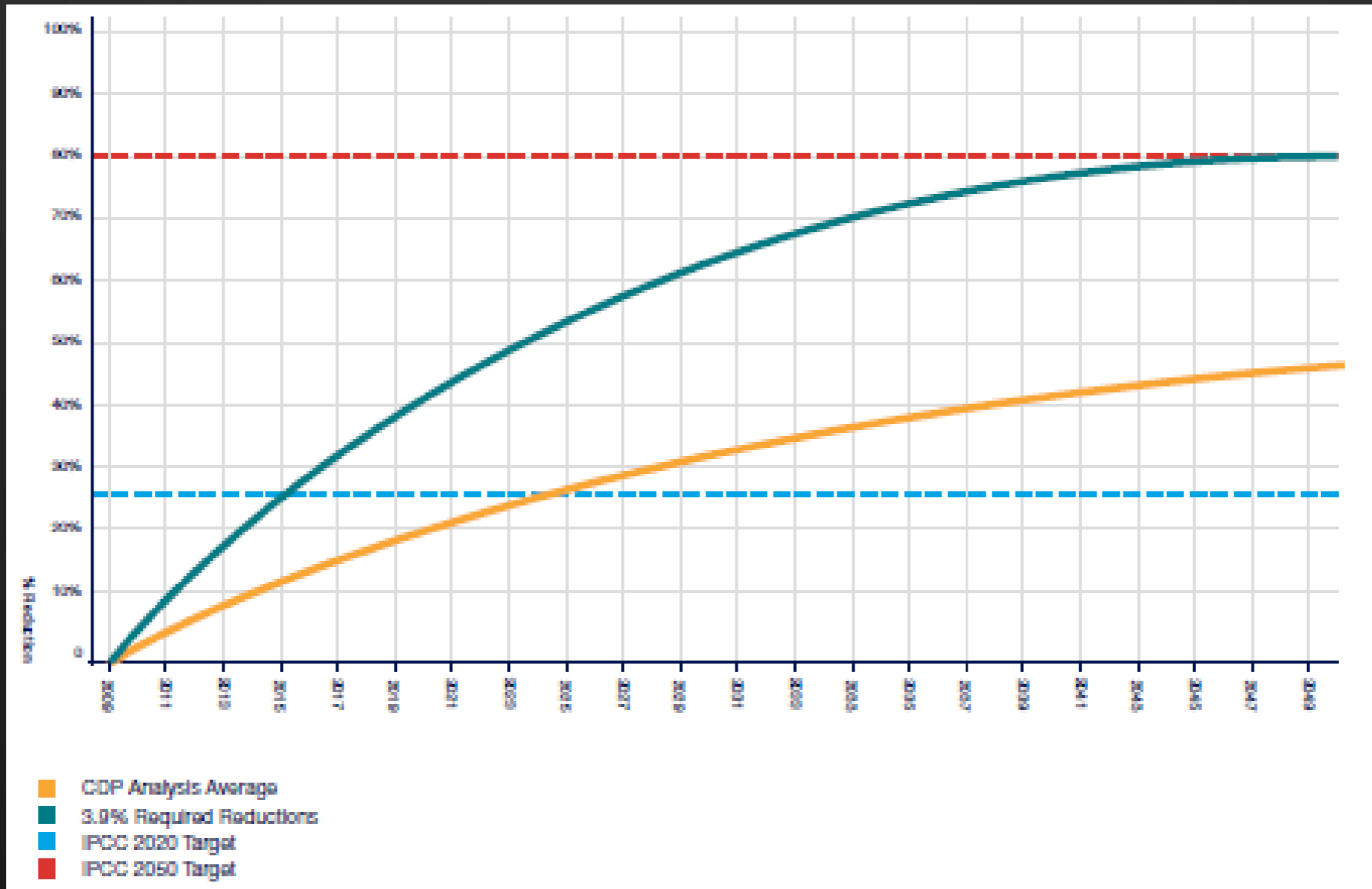


Comparing Current Corporate Targets with Science and Policy Trajectories



Addressing the Gap in Corporate GHG Target-Setting

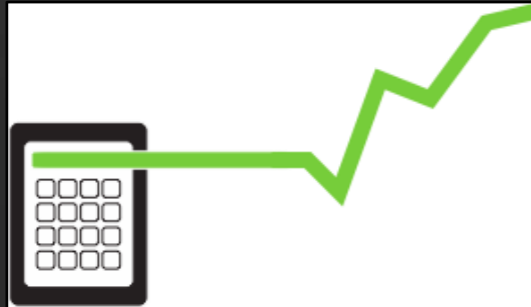
Global100 targets equate to a global 1.9% reduction per annum, when 3.9% is needed to reach climate stabilization by 2050.



*So even when including companies currently lacking targets, at this rate, we'll still achieve the necessary reductions **39 years too late.***

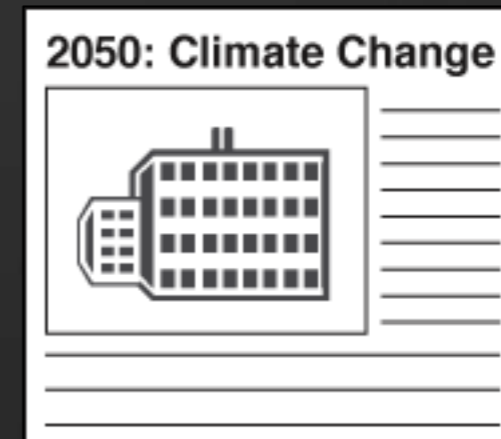
Source: CDP (2009) "The Carbon Chasm"

The Four Steps of C-FACT



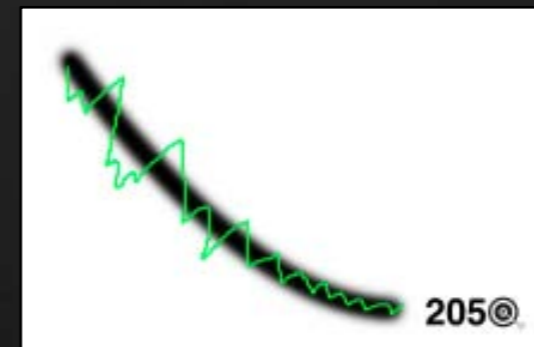
1. Calculate

2. Commit & Publish

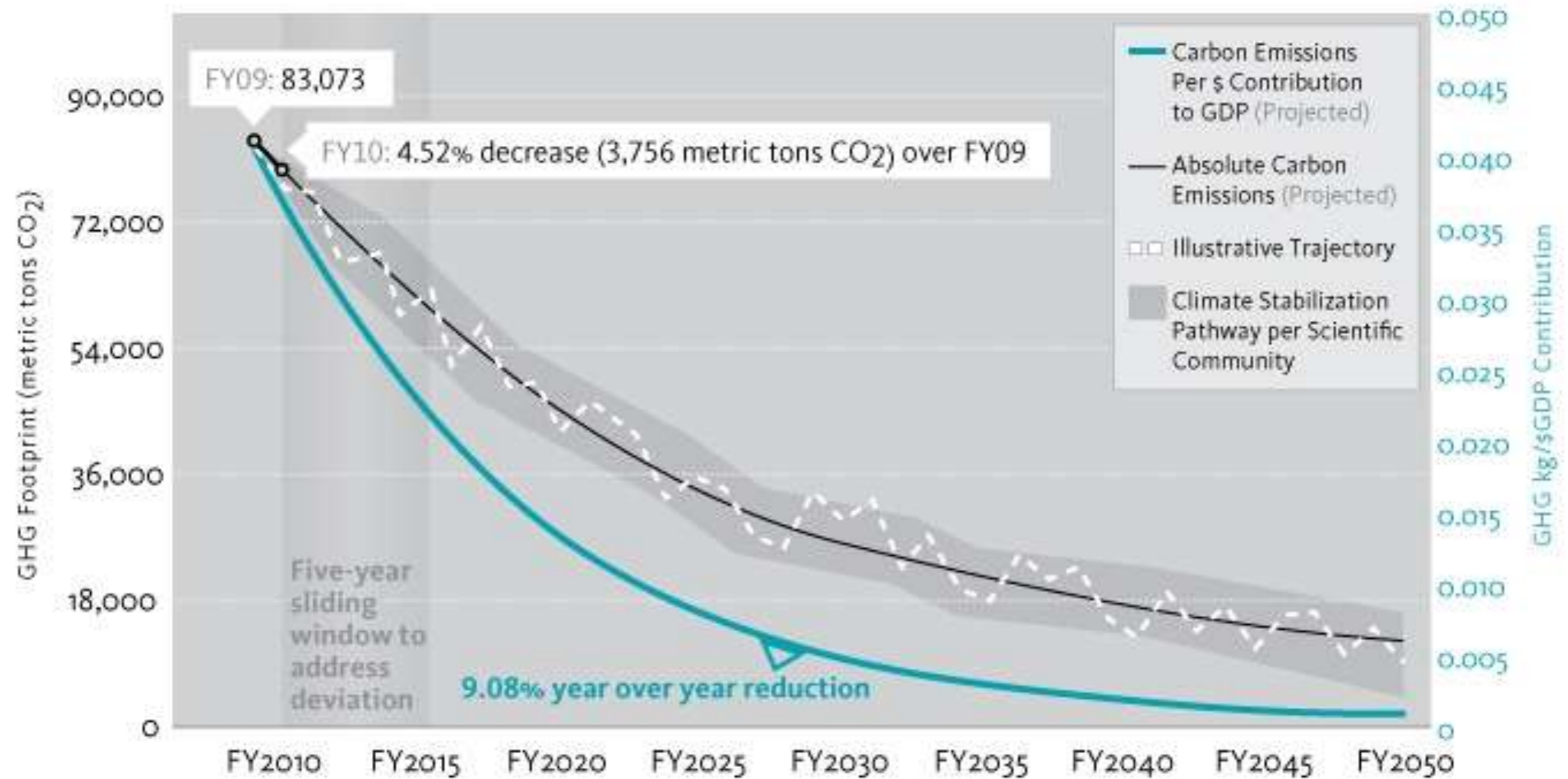


3. Annualize

4. Adjust

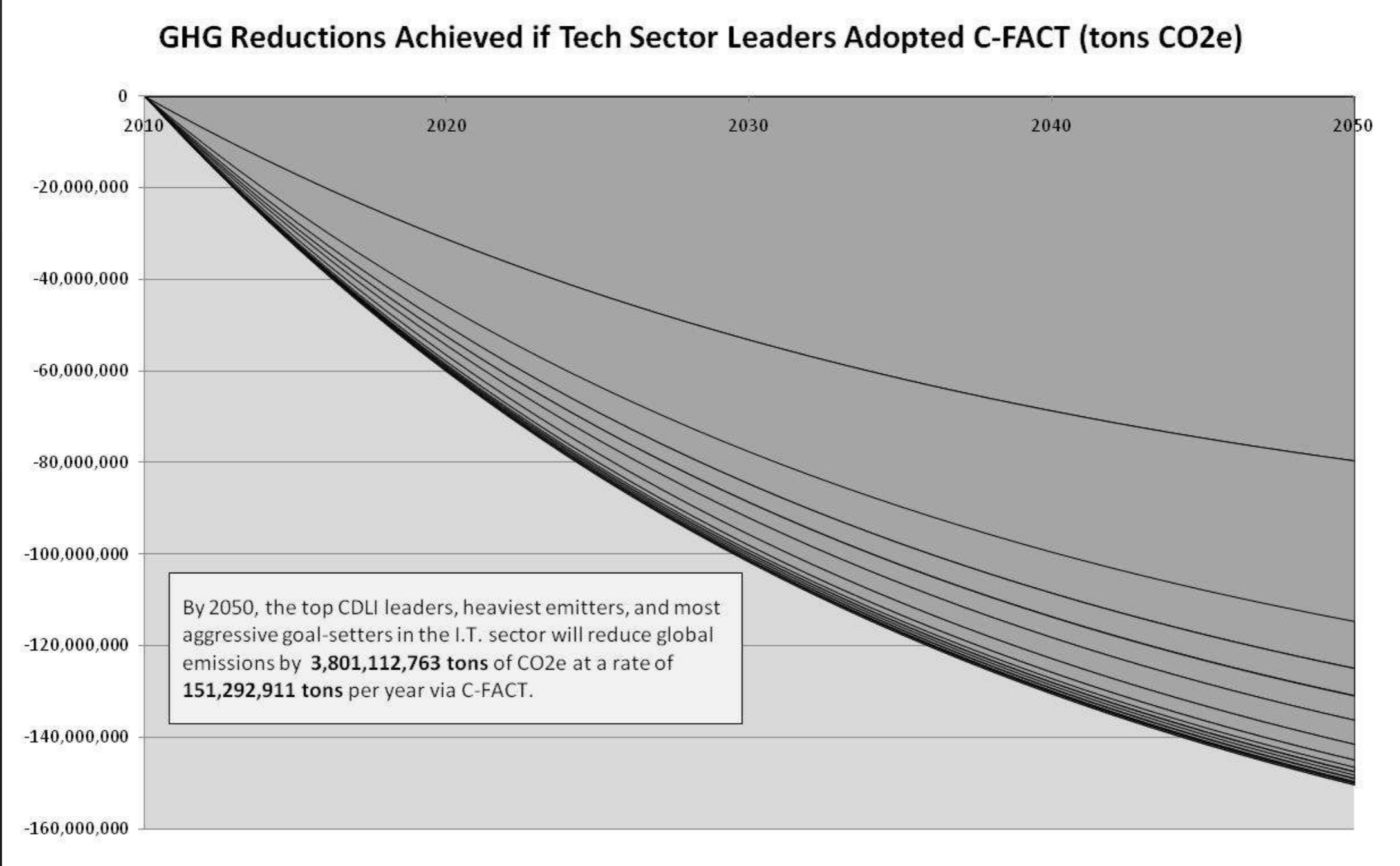


Autodesk's Approach to Corporate Greenhouse Gas (GHG) Target Setting



Autodesk has committed to reducing its carbon emissions per dollar contribution to GDP by 9.08% year over year, every year through 2020. For FY10, we will reduce our absolute emissions by 4.52% (or 3,756 metric tons) compared to our FY09 baseline. The dotted line shows that in some years we may overshoot or undershoot, but we commit to addressing that deviation within a 5-year period. The gray band illustrates a worldwide pathway toward climate stabilization as recommended by the Intergovernmental Panel on Climate Change. (See the white paper for more detail.)

An Open Source Model and a Call to Action



Take-Away #2: Building Energy Analysis addresses the Biggest Source of Emissions with the Most Attractive Payback



Buildings are Leaking Money and Carbon

	Energy Saved (Trillions of BTUs)	Present Value of Energy Savings through 2020 (US\$)	Annual Energy Savings post-2020 (US\$)
Residential Building Structure			
Existing non-low-income homes	1300	\$167,000,000,000	\$14,000,000,000
Existing low-income homes	610	\$80,000,000,000	\$7,000,000,000
New homes	320	\$41,000,000,000	\$4,000,000,000
Inside Residential Buildings			
Electrical devices & appliances	590	\$65,000,000,000	\$11,000,000,000
Lighting and major appliances	340	\$42,000,000,000	\$6,000,000,000
Commercial Building Structure			
Existing private buildings	810	\$104,000,000,000	\$11,000,000,000
New private buildings	270	\$35,000,000,000	\$4,000,000,000
Government buildings	360	\$49,000,000,000	\$5,000,000,000
Inside Commercial Buildings			
Office equipment and other devices	570	\$57,000,000,000	\$11,000,000,000
	5170	\$640,000,000,000	\$73,000,000,000

Source: Author's adaptation of data from McKinsey & Co 2009 report "Unlocking Energy Efficiency in the US Economy"



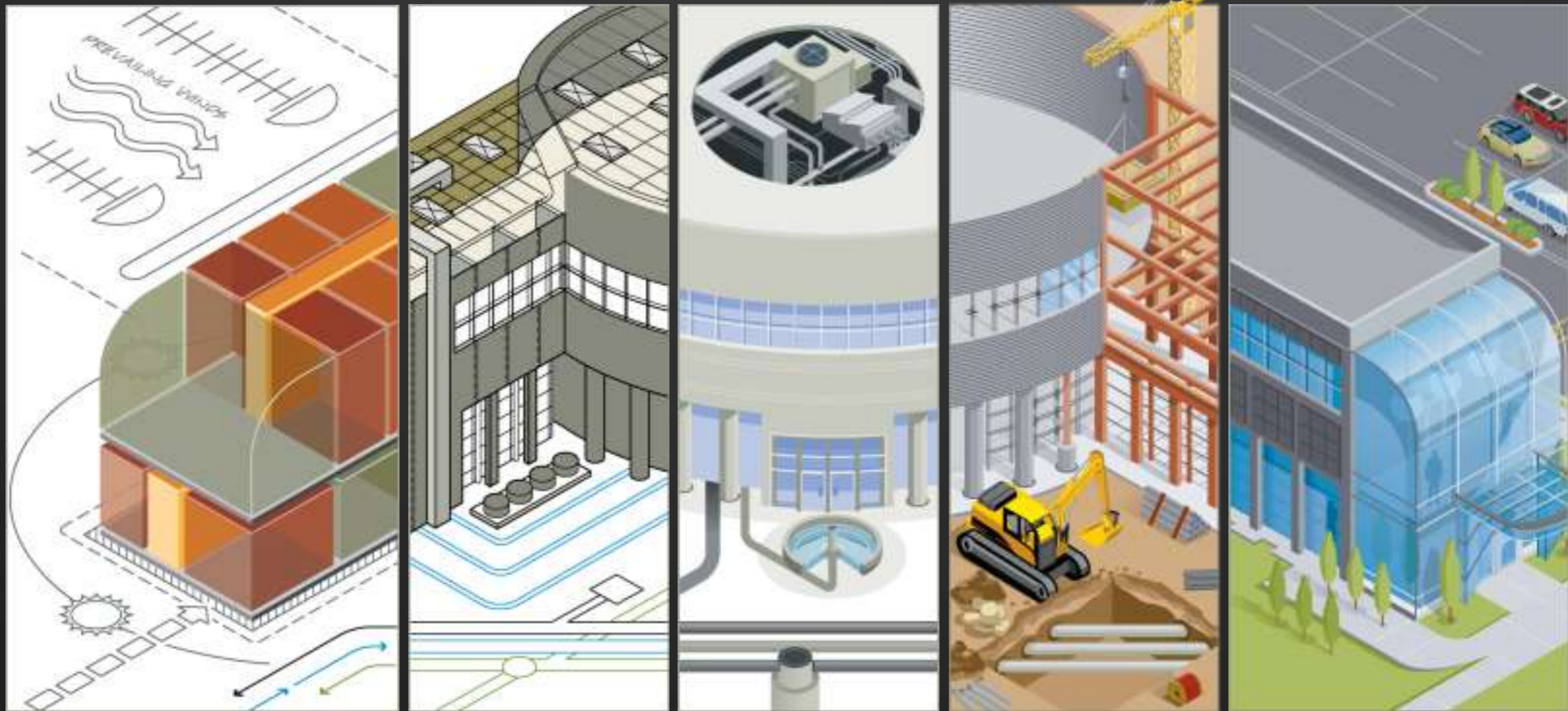
- **85% GHG** reduction by 2050 (IPCC)
- Buildings → **40%** - linchpin to achieving that goal (WBCSD 09)
- Whole Building Analysis typically **saves 20% more** energy than CA Title 24 (RLW Analytics 2003)



- A **\$400B** market in US alone (by 2030, Pike Research)
- **150 billion sf** up for renovation (by 2040, AIA)
- Only **50% of commercial buildings** have undergone energy renovation, (only 30% HVAC, lighting or window upgrades, 10% insulation upgrade) (EIA CBECS 2003)

Before: Linear

PROJECT PHASES



CONCEPTUALIZATION

DESIGN

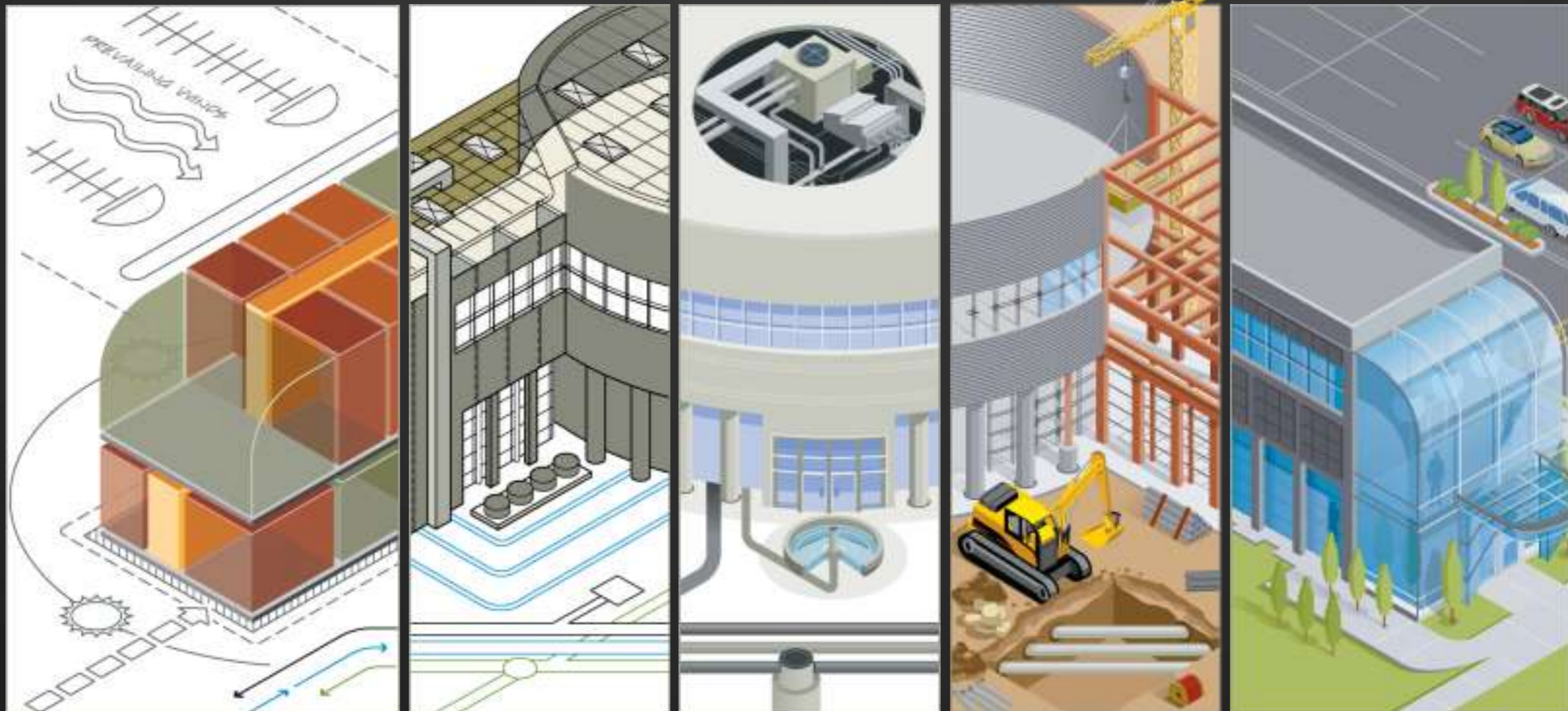
IMPLEMENTATION
DOCS

CONSTRUCTION

OWN/OPERATE

Now: Integrated Project Delivery with BIM

PROJECT PHASES



CONCEPTUALIZATION

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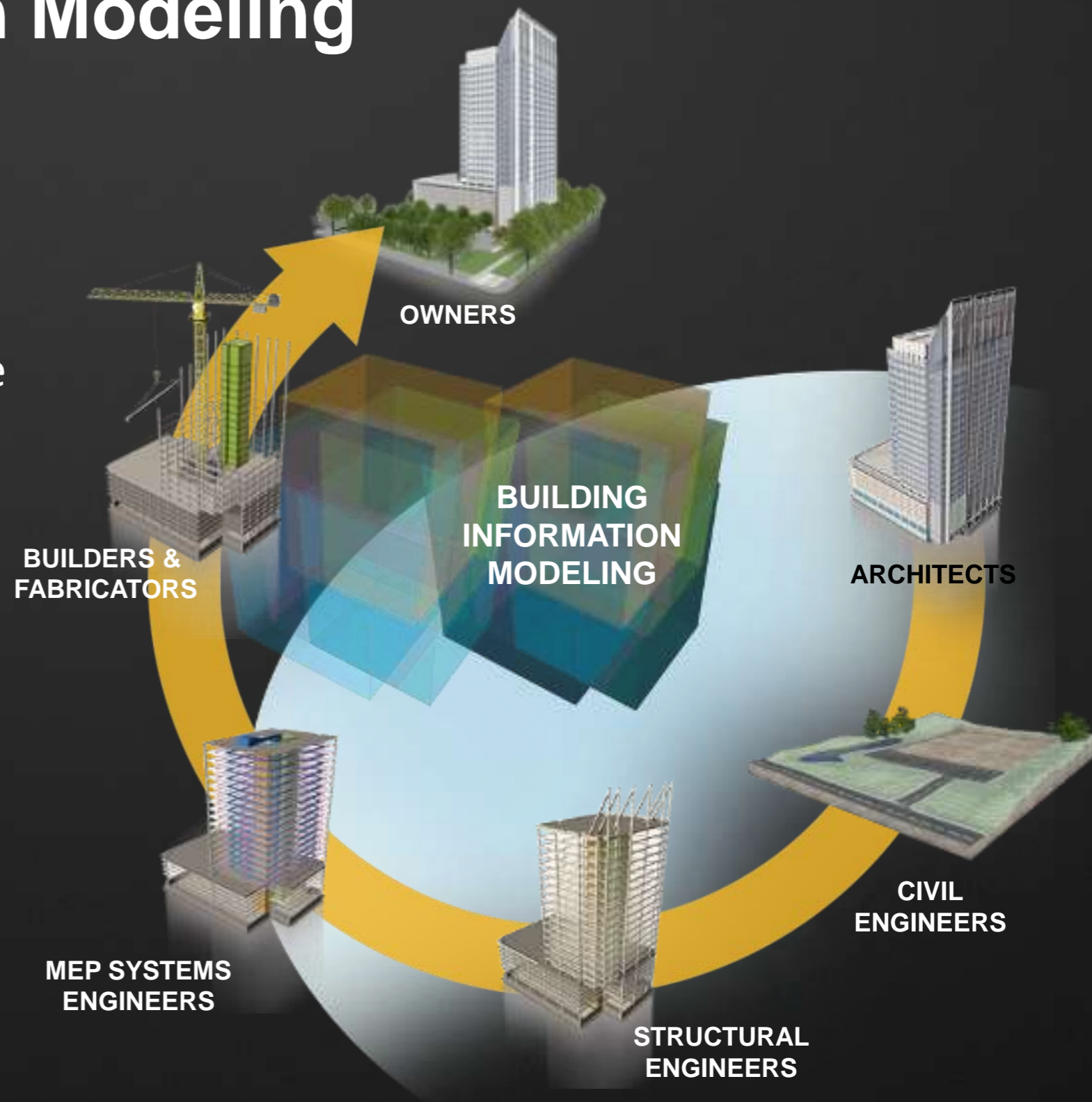
CONSTRUCTION

OWN/OPERATE

- Building Information Modeling
- Integrated Project Delivery
- Rapid Energy Modeling

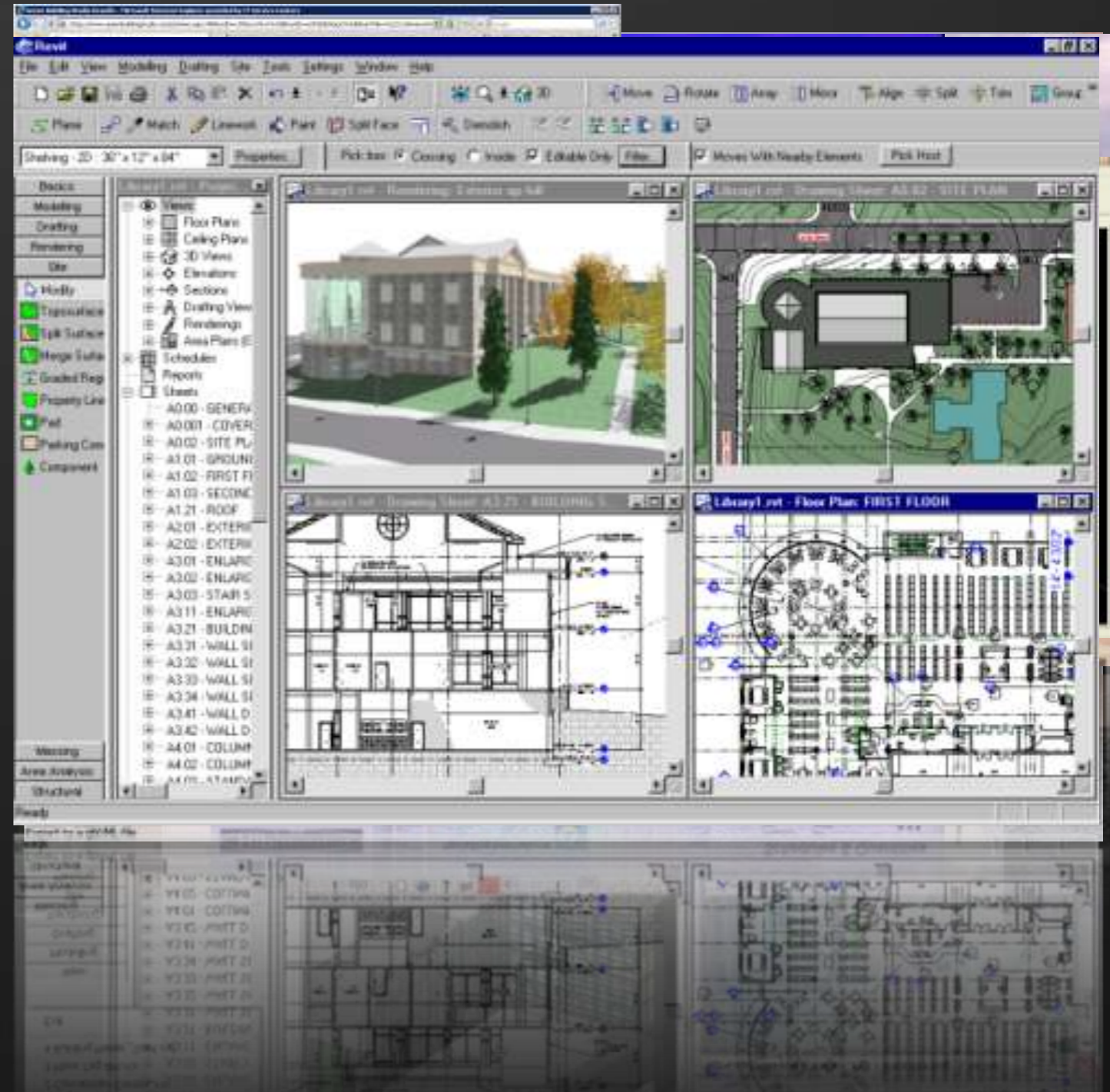
Building Information Modeling

- Building information modeling (BIM) is an integrated workflow that enables architects, engineers, and builders to explore a project digitally before it is built.
- Coordinated, consistent information is used throughout the process to:
 - Design innovative projects
 - Accurately visualize physical appearance
 - Simulate real-world performance



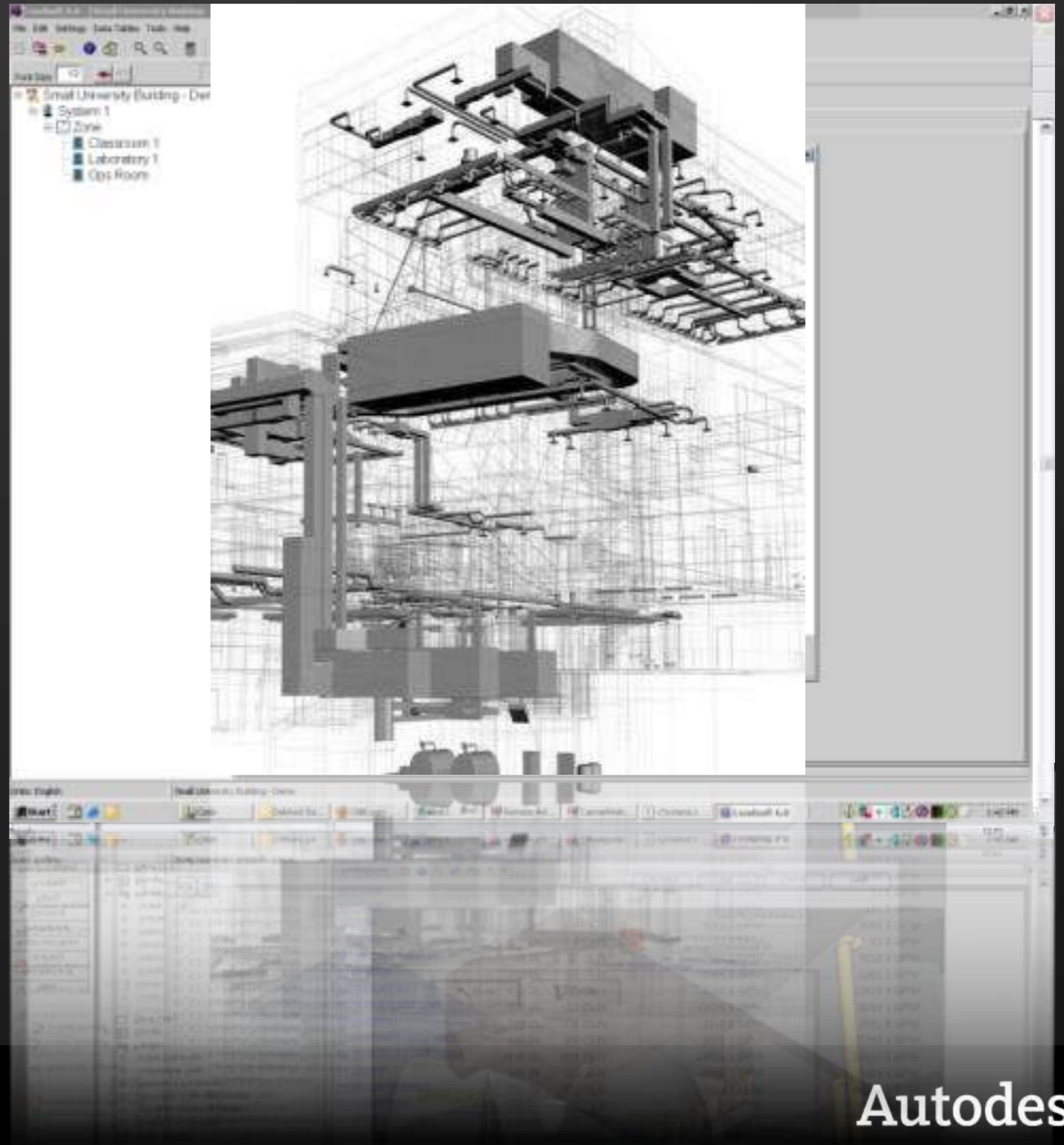
BIM Enabled Sustainable Design Architecture

- Explore multiple design options within a single building model
- Simulate energy, water and carbon use
- Optimize environmental design factors



BIM Enabled Sustainable Design Mechanical, Electrical & Plumbing Systems

- Visualize the analytical model
- Better predict building performance
- Simplify load calculations and manipulate pipe and HVAC duct sizing for optimum sustainability



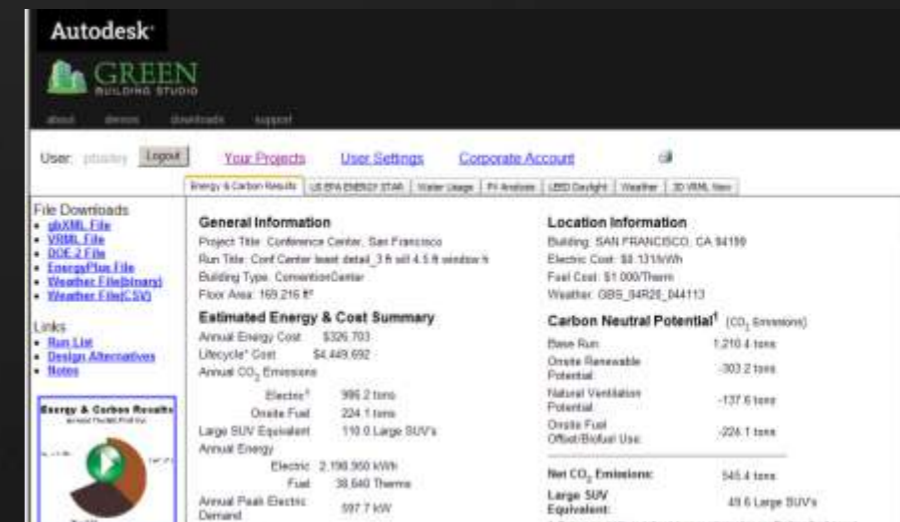
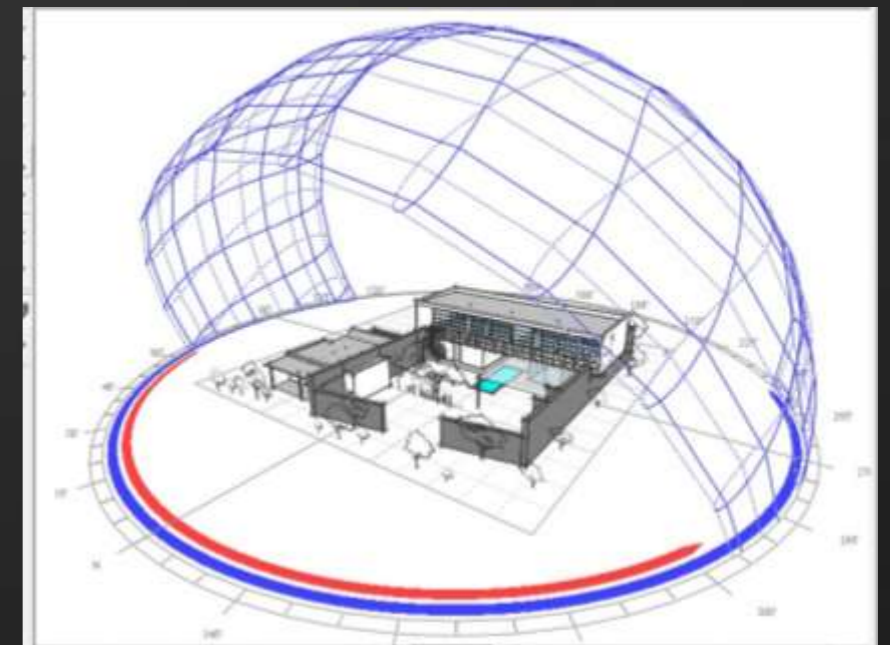
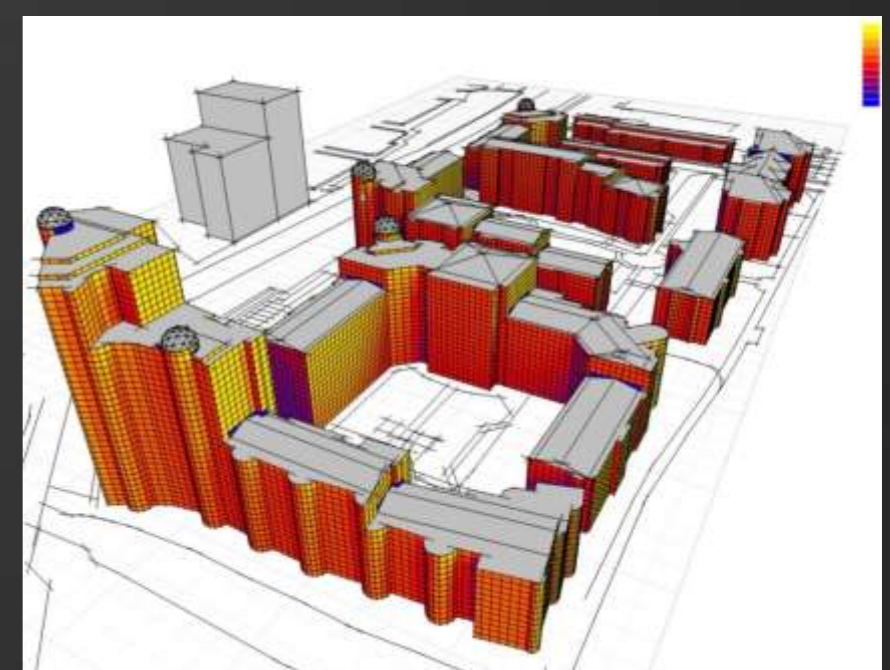
Autodesk Ecotect Analysis

Ecotect Analysis

- Conceptual early analysis solution
- Standalone site and building analysis tool
- Whole or partial building analysis
- Schematic environmental analysis (indoor and outdoor)
- Powerful visual representations

Green Building Studio web service

- Analysis of the whole building
- Uses the design model (gbXML)
- Early and rapid analysis tool
- Reports –primarily related to resource consumption
- Set and assess goals



Building Information Modeling Flagship Project



- 20+ different exhibits regularly on display that showcase the innovative work of Autodesk customers, the gallery illustrates the role technology plays in great design and engineering.
- The Autodesk Gallery at One Market is Platinum certified in the U.S. Green Building Council's LEED for Commercial Interiors (LEED-CI) rating system. The Autodesk Gallery was only the second project in the state of California to earn a Platinum rating for LEED-CI.
- Design firms Anderson Anderson Architecture and HOK plus general contracting firm DPR Construction worked with Autodesk to renovate the space using an [integrated project delivery \(IPD\)](#)



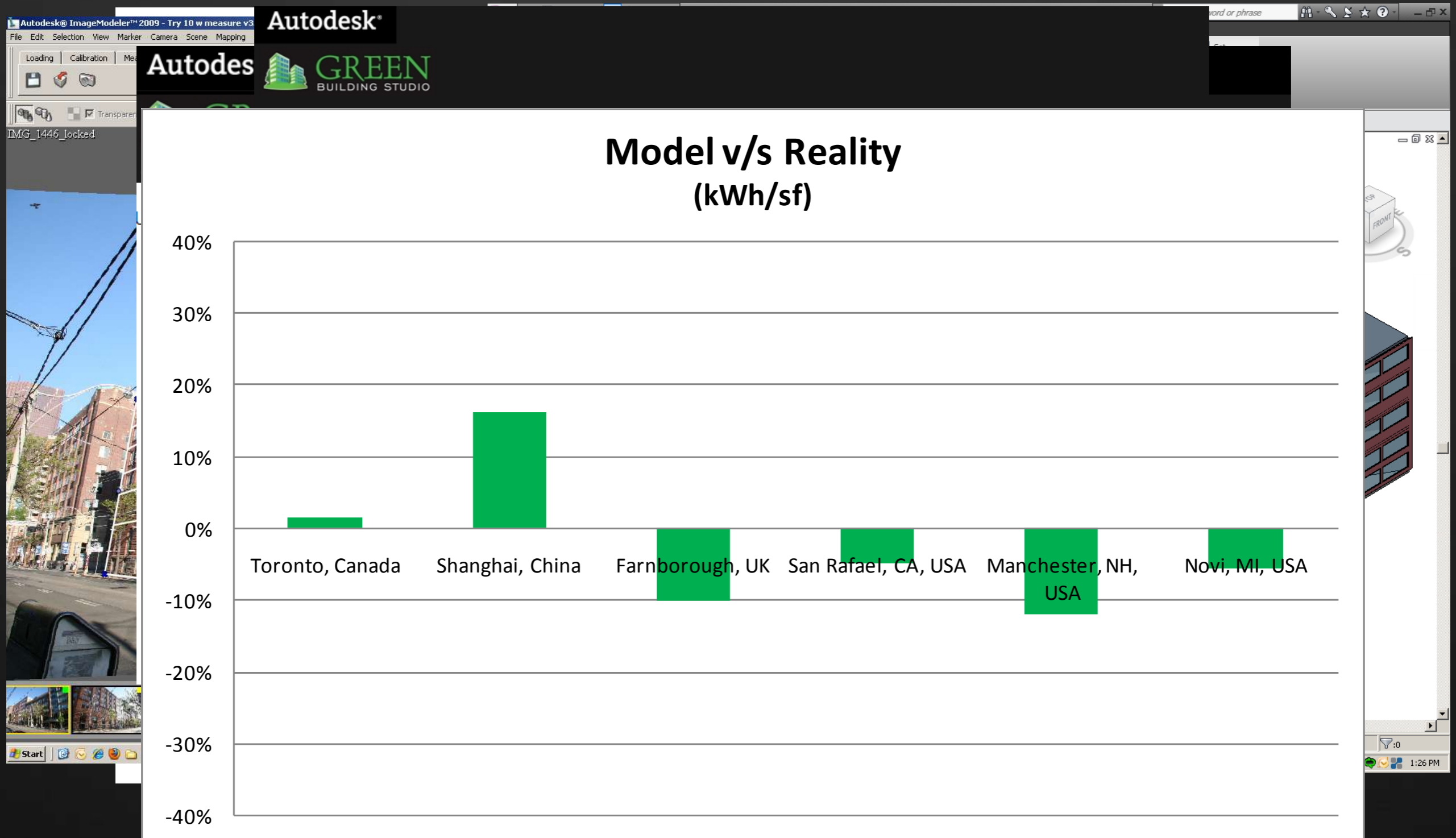
Integrated Project Delivery Flagship Project



- 61,000-square-foot complex built according to Platinum CI LEED Certification for the interior and Gold LEED Certification for the building's core and shell
- The project team employed Autodesk's own integrated project delivery (IPD) methodology to speed LEED certification
- Autodesk, the projects' designers and contractors signed a three-party agreement with financial incentives for achieving budget, schedule and sustainability goals
- IPD enabled shorter, overlapping timeframes.
- On time and LEED Platinum despite aggressive timeline.
- Saved so much \$\$ that numerous upgrades became attainable



Rapid Energy Modeling Flagship Project



Take-Away #3: Smart Policy Mechanisms can Accelerate both #1 and #2



Policy Measures Help Overcome the Following Obstacles

- a. **Empirical:** difficulties and consequential costs in measuring and verifying the financial and carbon benefits of avoided energy use
- b. **Sociological:** split incentives for efficiency investments between builders, owners, and tenants
- c. **Financial:** significant upfront cost to receive longer term payback



“Reveal”



“Realign”



“Reward”

Specific Recommended Policy Measures

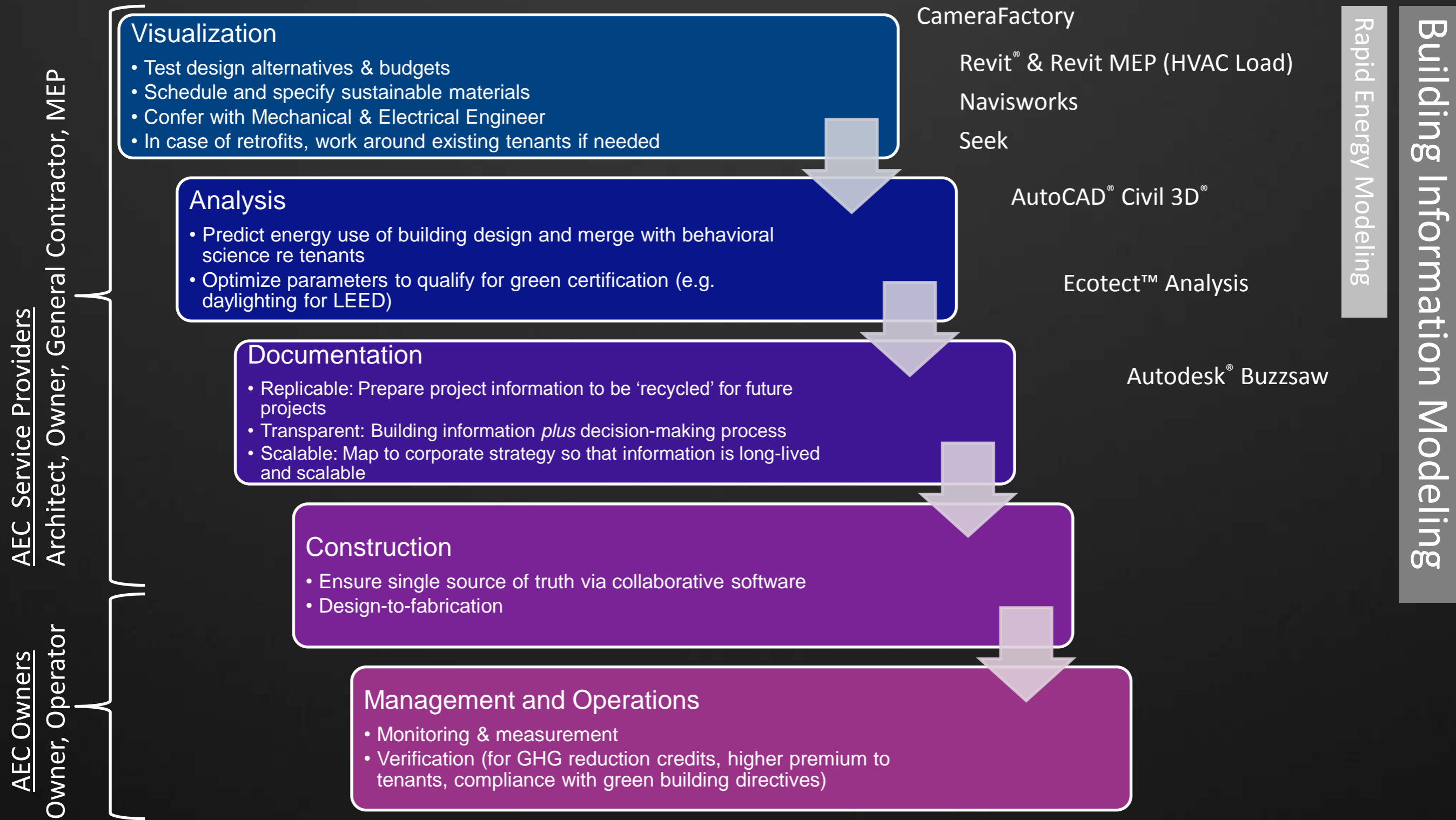
1. *Adopt and enforce binding zero net energy targets for all new and existing buildings.*
2. *Implement a mandatory energy performance certification and labeling program*
3. *Finance and deliver 'whole buildings' efficiency retrofits to existing buildings*
4. *Drive innovation through voluntary programs and public funding for research and development (R&D).*

For More Info & Tools:
www.autodesk.com/green



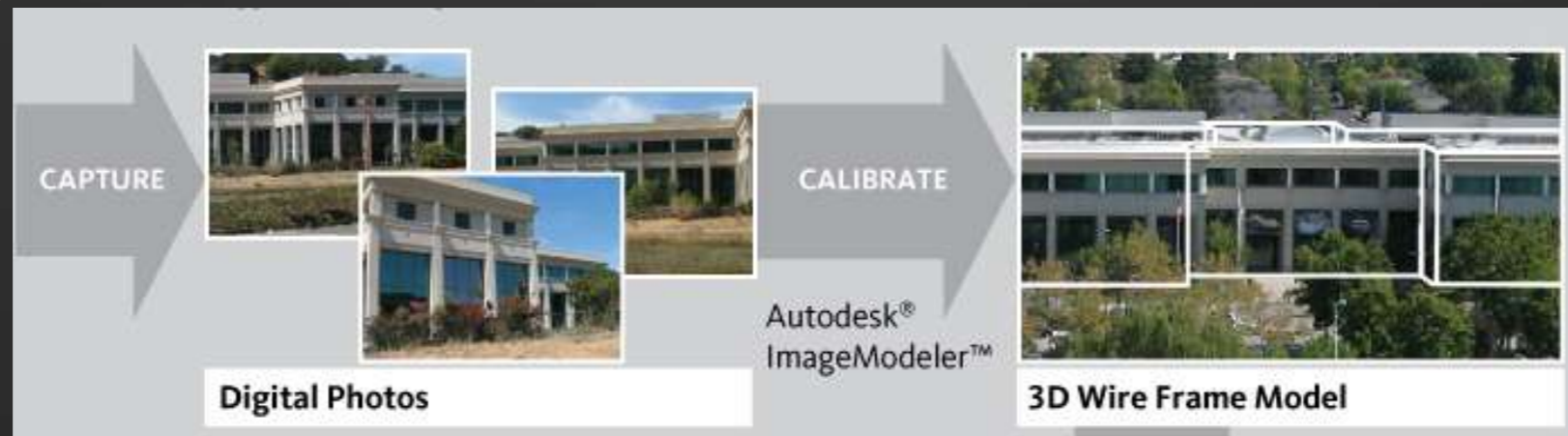
Wind Turbine design based on QuietRevolution.

Envisioning the Future Green Building Workflow



The Autodesk Workflow for rapid energy modeling

Step 1: 2D images to 3D wireframe



With Autodesk® ImageModeler™:

- Take photos of building exteriors
- Calibrate 2D photos into a 3D space
- Set the scale and user coordinate system
- Model and measure

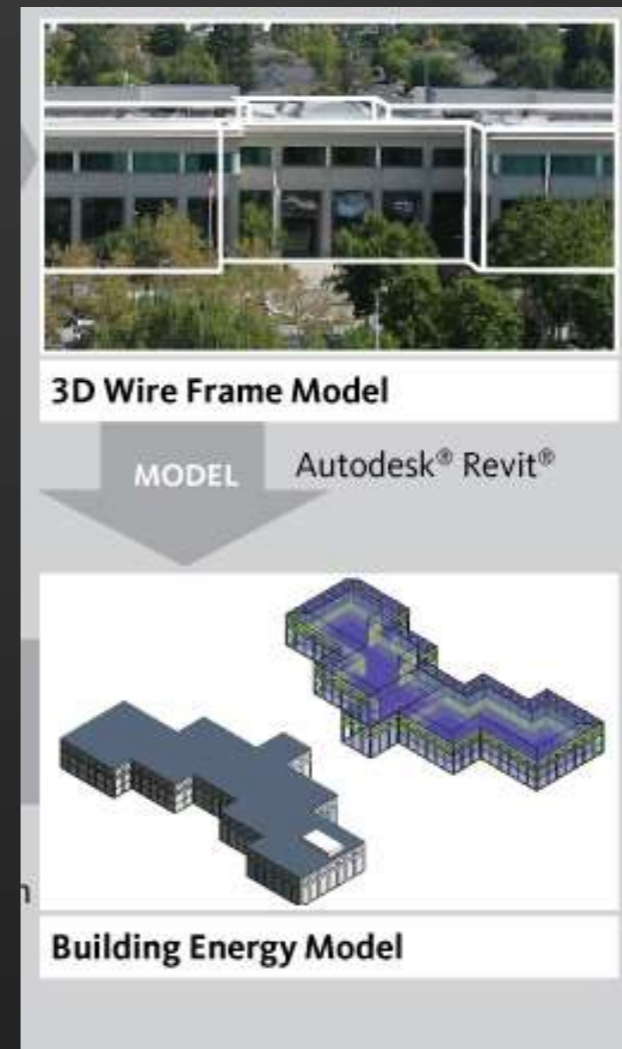
Key findings: Calibration is very crucial. A little planning before taking pictures will go a long way.

The Autodesk Workflow for rapid energy modeling

Step 2: 3D wireframe to building energy model

With Autodesk® Revit® by adding few basic design elements:

- Walls
- Floors
- Windows
- Roof and
- Rooms



Key finding: Not necessary or desirable to construct a very detailed model to get accurate results

Key Takeaway #1

Low barrier to modeling and analysis (in terms of technology, cost, time)



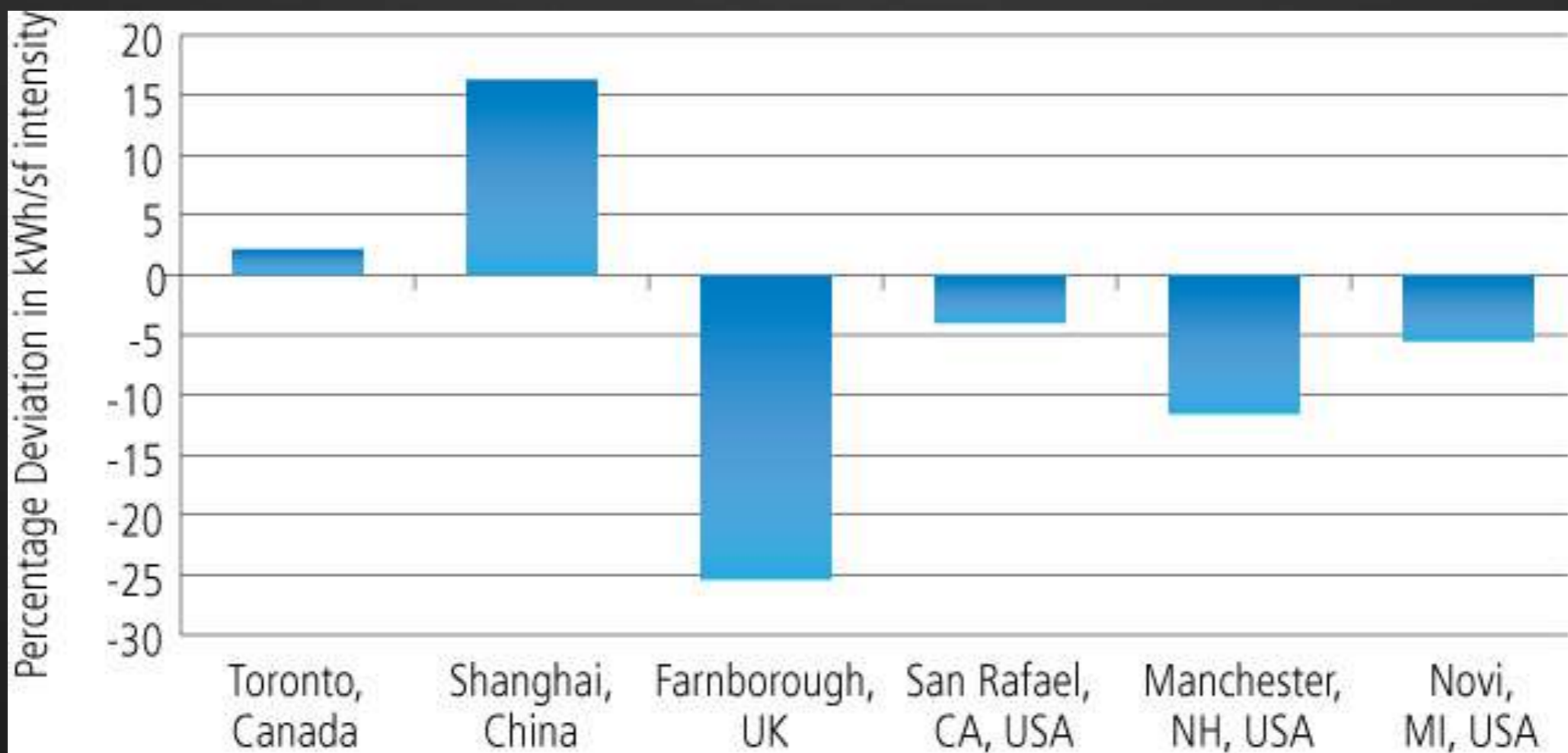
- Avoids on-site visits, giving economies of scale
- Gentler learning curve
- Needs minimal information on building operations and design
- Assumes little familiarity /experience with design tools, drawings and modeling



Autodesk and ICF project managers, with no previous Autodesk software experience and starting from just digital photos, can now model a facility and validate and analyze results in a matter of days

Key Takeaway #2

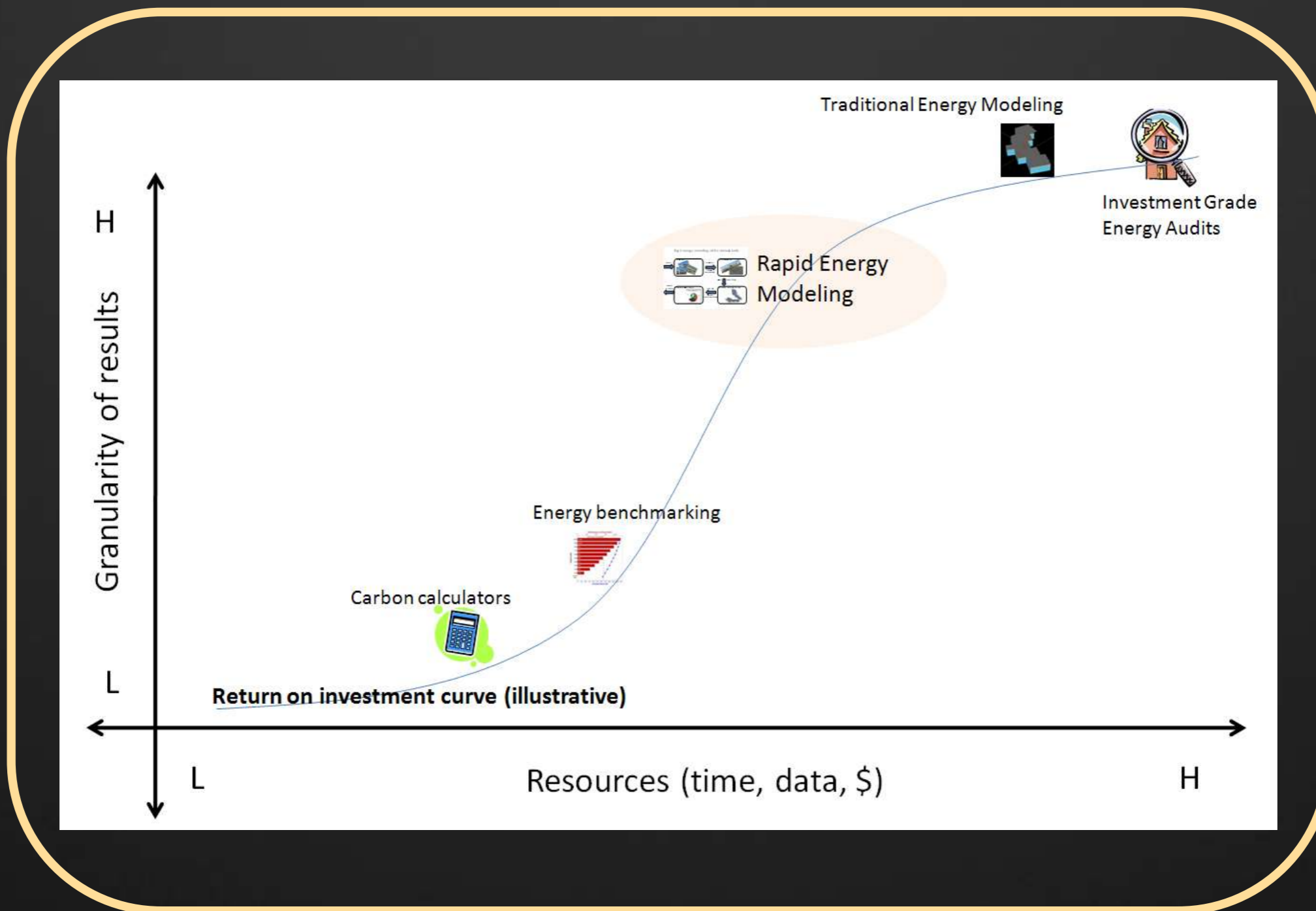
A shortcut to estimating actual energy use



Three facilities within 6%, one 12% off. Conversations with managers of facilities with higher deviations (a) helps fine tune model and (b) lends insights into operational inefficiencies

Key Takeaway #3

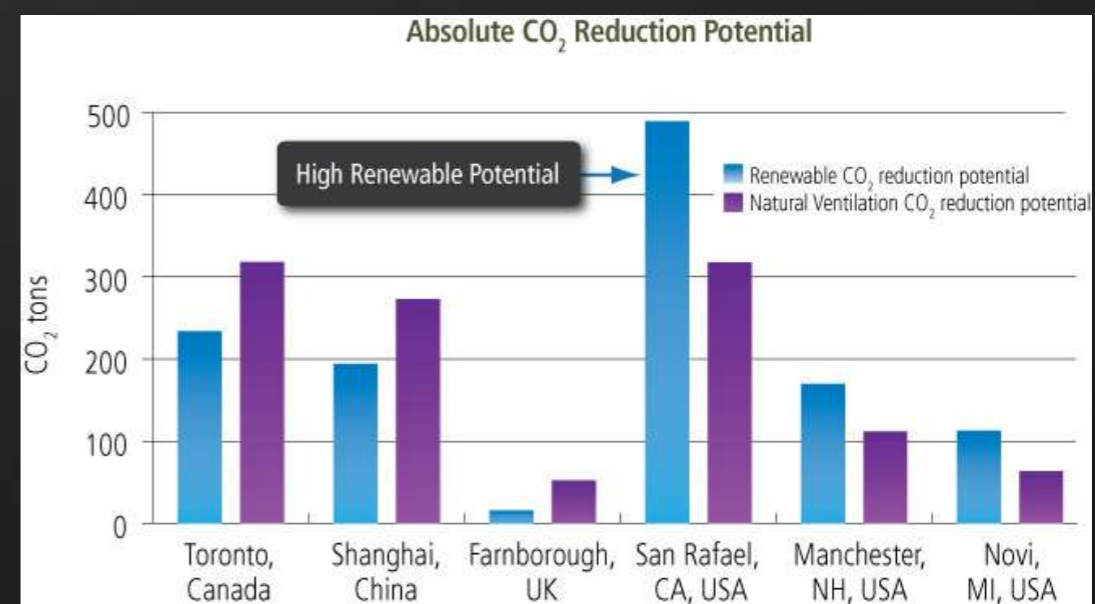
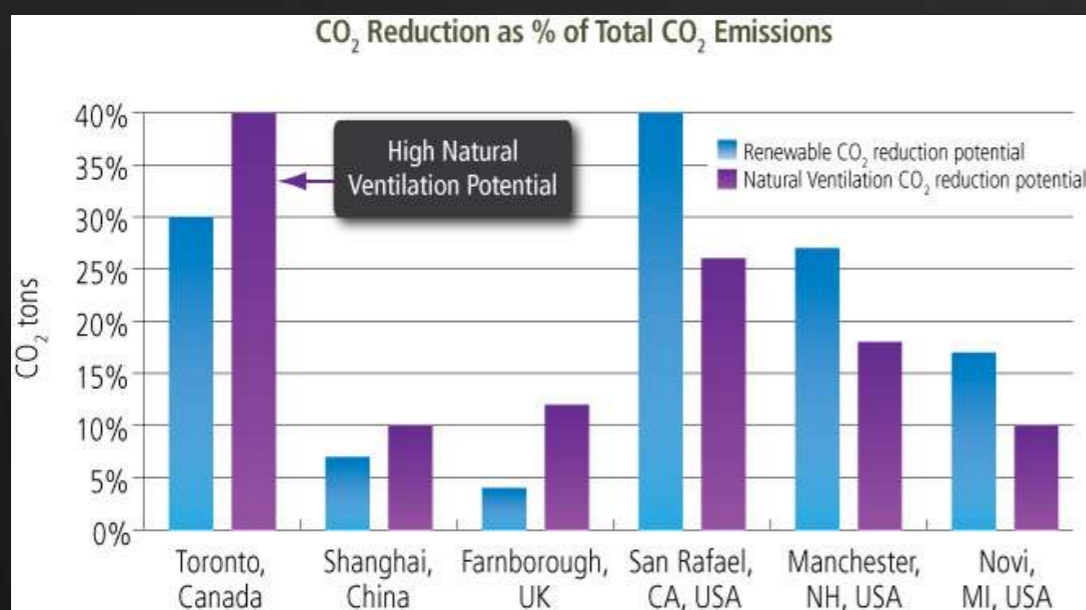
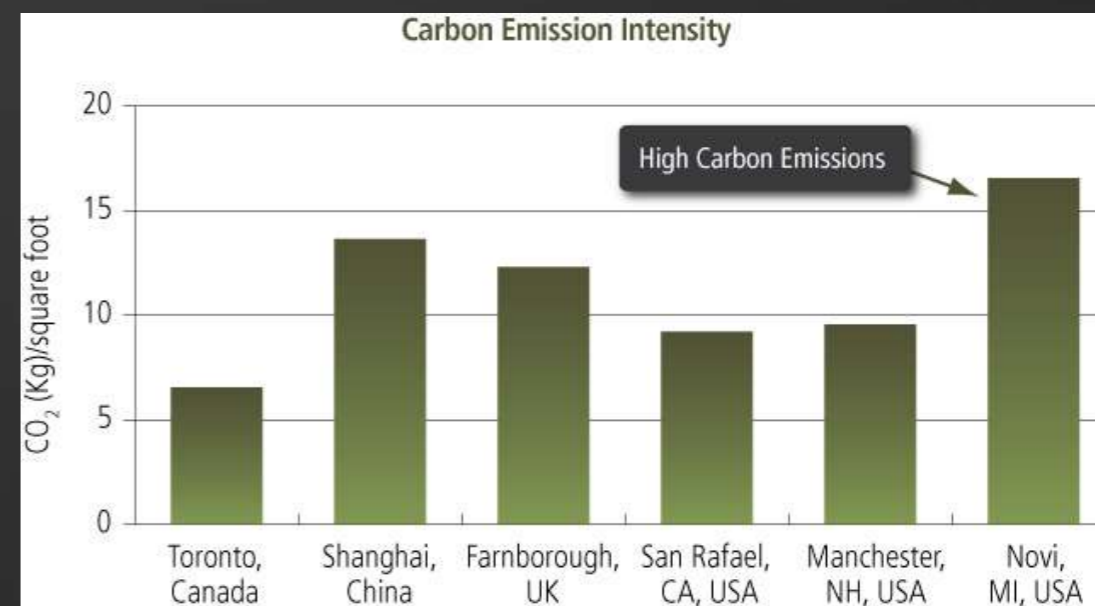
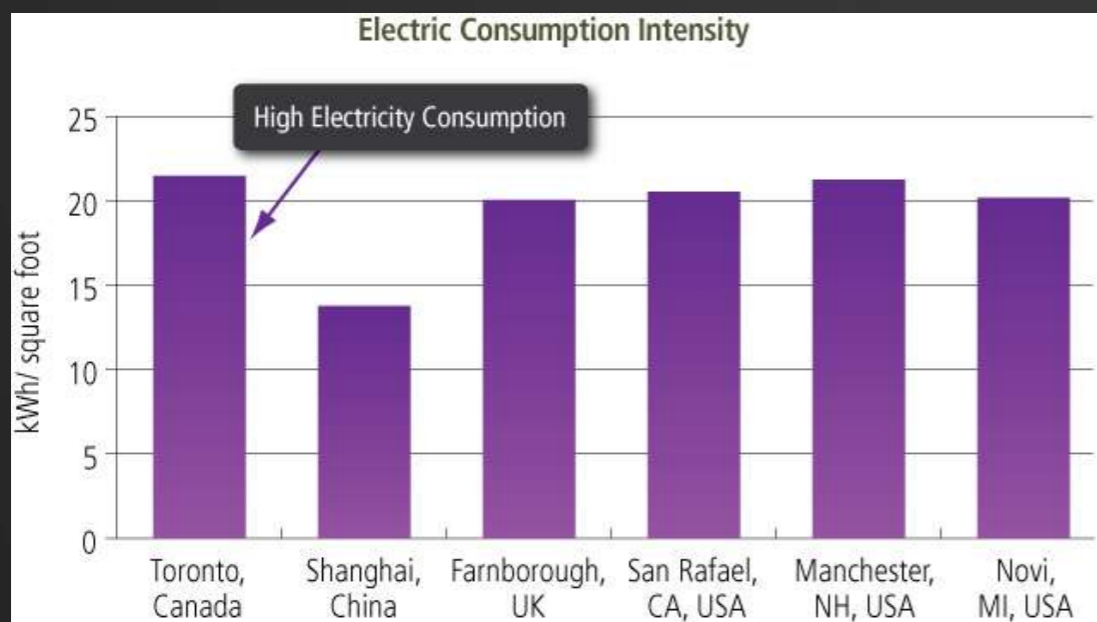
Stepping stone between quick benchmarking and investment grade audits



Traditional energy modeling and auditing techniques give higher granularity of results but offer diminishing returns on resource investment, in terms of broad conclusions that can be drawn

Key Takeaway #4

A screen for high carbon reduction potential buildings



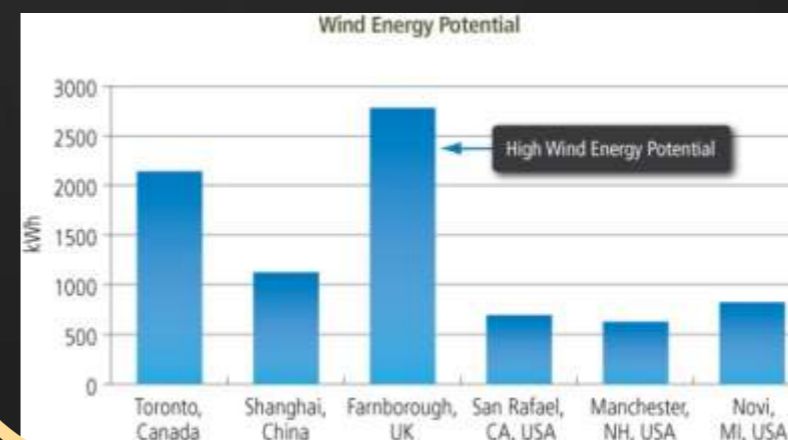
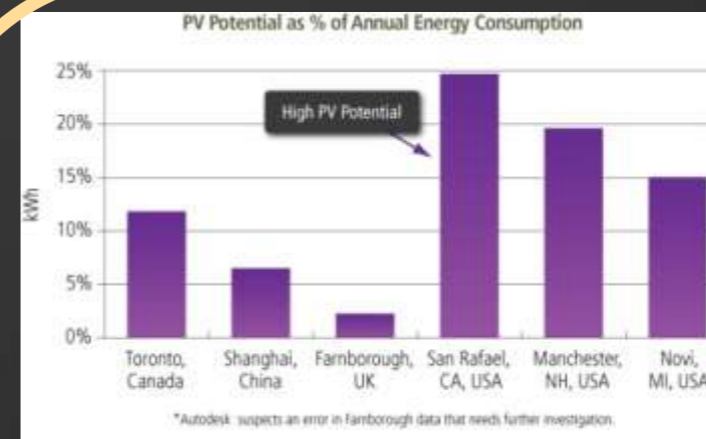
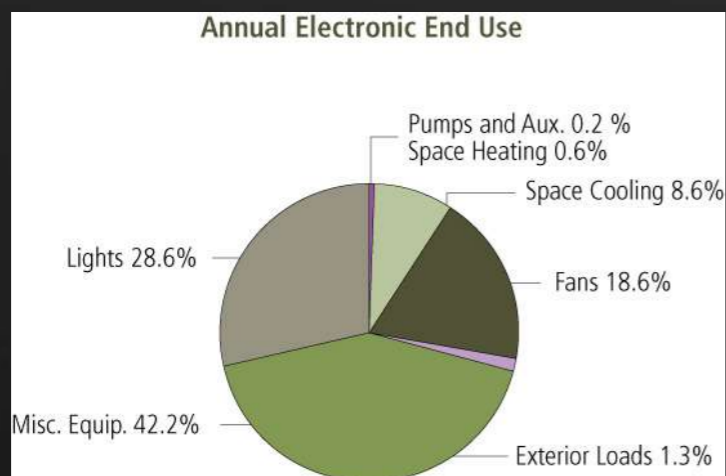
Carbon intensity analyses prioritizes high (carbon reduction) potential buildings without significant investment of time and resources in research or on-site evaluations.

Key Takeaway #5

Communicate financial and environmental return on investment

ESTIMATED ELECTRICITY SPEND REDUCTION POTENTIAL

Facility Name	Annual Electricity Spend (Local Currency)	Annual Electricity Spend (\$US)	Building SF	\$/SF	10% Reduction in Annual Spend
Toronto, Canada	198,559	\$198,559	102,760	1.93	\$19,856
Shanghai, China	2,712,082	\$383,527	125,593	3.05	\$38,353
Farnborough, UK	67,416	\$107,866	33,620	3.21	\$10,787
San Rafael, CA, USA	295,863	\$295,863	130,987	2.26	\$29,586
Manchester, NH, USA	151,080	\$151,080	56,013	2.70	\$15,108
Novi, MI, USA	84,217	\$84,217	37,944	2.22	\$8,422
Total		\$1,221,111	486,917		\$ Savings Potential → \$122,111



Analysis of solar, natural ventilation, wind energy potential and energy spend helps hone in on energy efficiency alternatives with the highest ROI potential

Benefits to Multiple Constituencies

BUILDING OWNERS



- Modeling Comparison to Actual Data
- Designing Alternatives to Model Retrofits
- Targeting and Focusing Building Audits

BUILDING TENANTS



- Estimating Energy Use without Access to Utility Bills
- Designing Alternatives to Model Retrofits
- Targeting and Focusing Building Audits

BUILDING DESIGN TEAM



- Delivering Quick, Energy Model in under a Week
- Designing Alternatives to Model Retrofits
- Comparing Expected vs Actual Energy Use
- Facilitating Targeted Communication with Building Managers