UNIVERSITY OF NORTH CAROLINA CHARLOTTE

Tools for High-Performance Building Design

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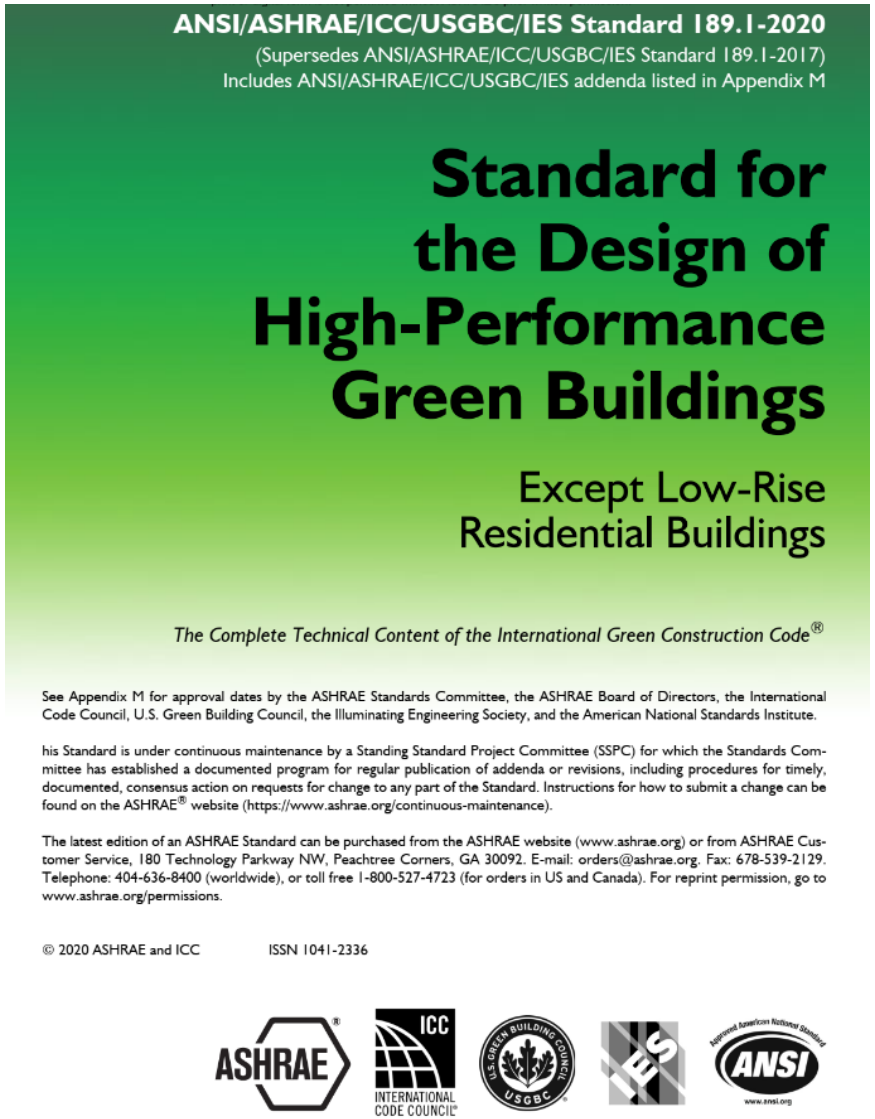
What is a High-Performance Building?

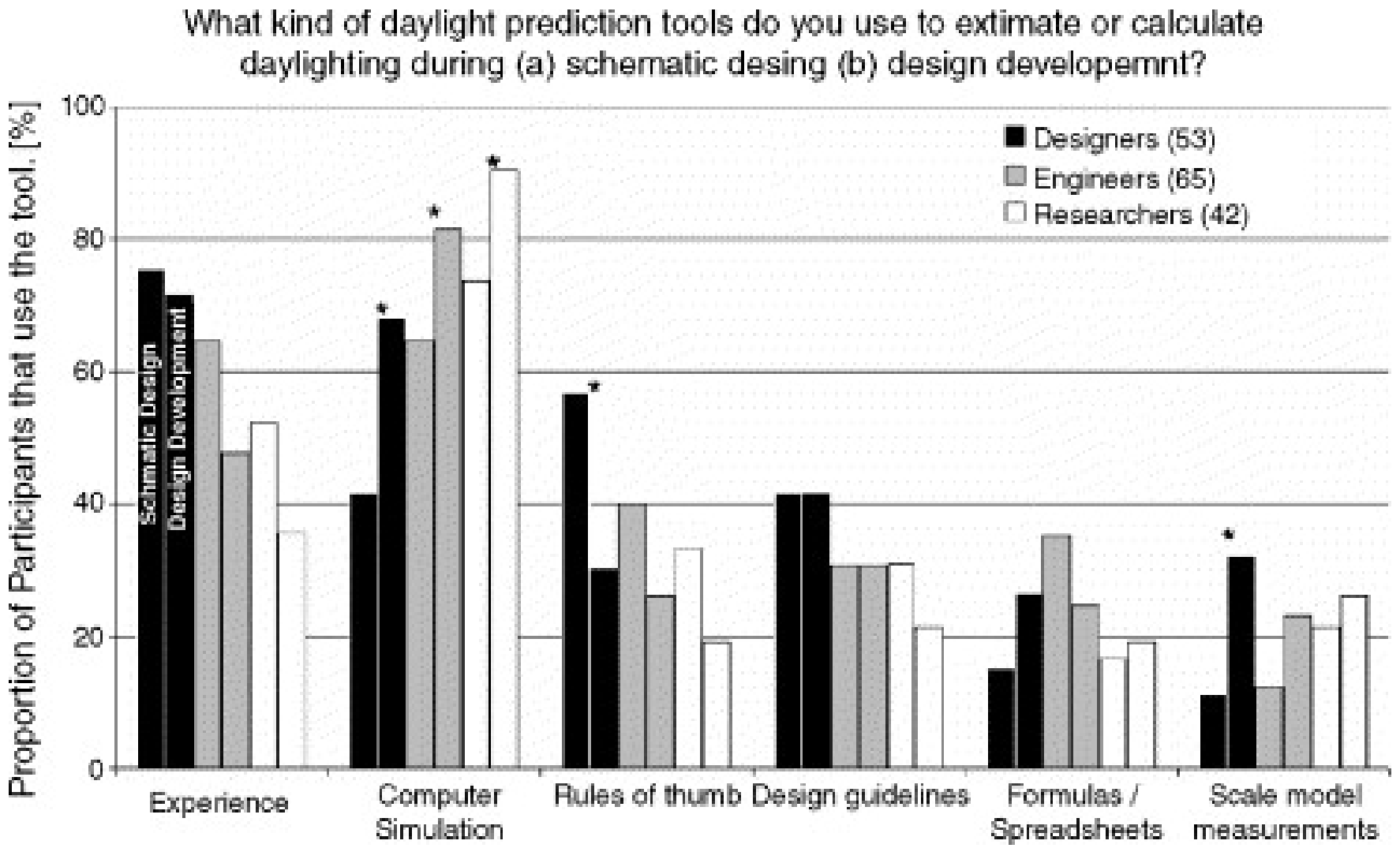


CONTENTS

ANSI/ASHRAE/ICC/USGBC/IES Standard 189.1-2020
Standard for the Design of High-Performance Green Buildings
Except Low-Rise Residential Buildings

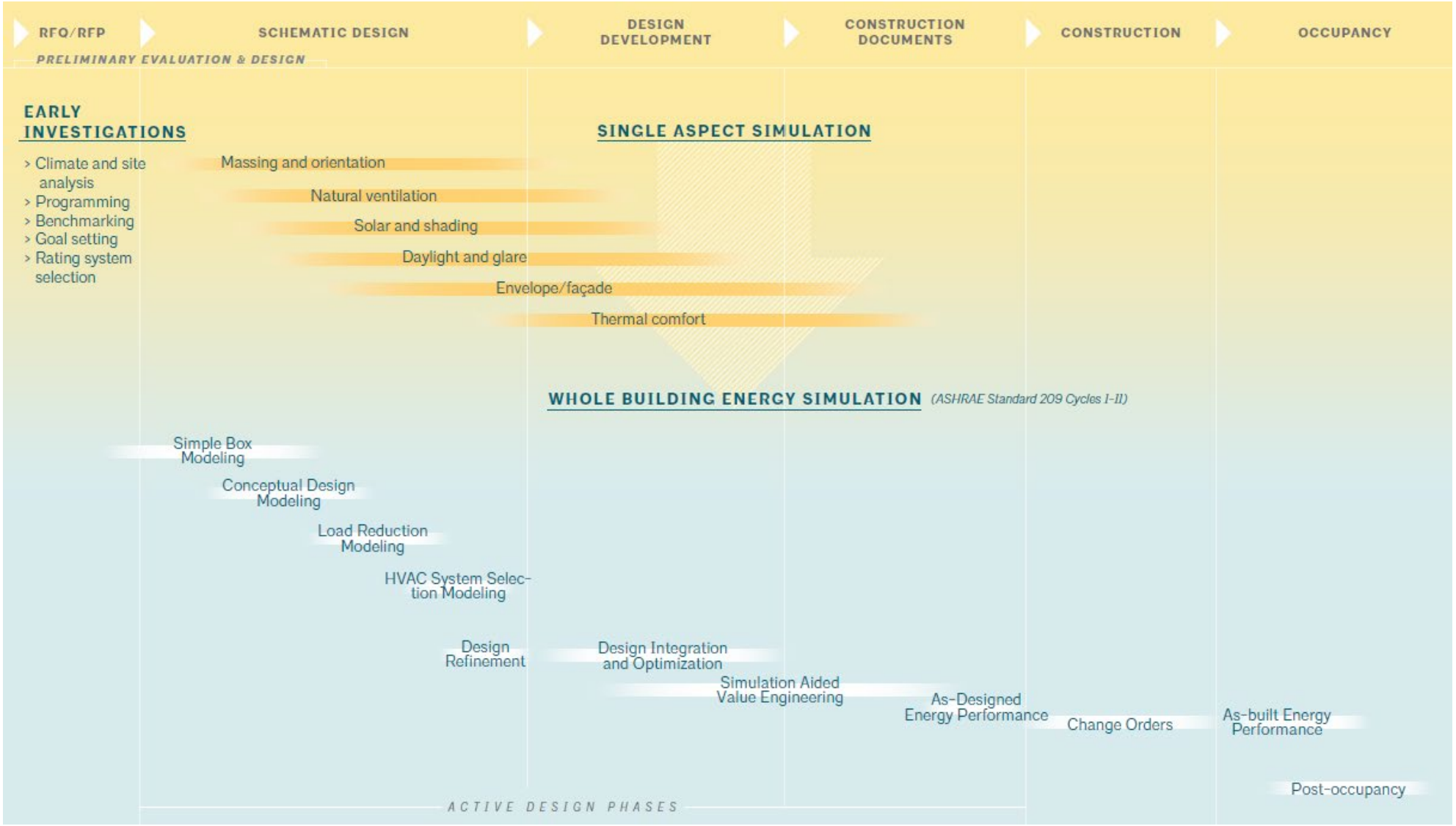
https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards

Tools for High-Performance Building Design



Source: Reinhart, C. and Fitz, A., 2006. Findings from a survey on the current use of daylight simulations in building design. Energy and buildings, 38(7), pp.824-835.

Architect's Role in Building Performance Simulation



Source: https://www.aia.org/resources/6157114-architects-guide-to-building-performance

Building Performance Simulation Software Directory

ibpsa.us/best-directory-list/

IBPSA USA

Find Software

Search ...

Capabilities

- [ ] Air Flow Simulation
- [ ] Building Automation
- [ ] Building Energy Auditing
- [ ] Building Energy Benchmarking
- [ ] Building Energy Monitoring
- [ ] Code Compliance
- [ ] Energy Conservation Measures
- [ ] HVAC System Selection and Sizing
- [ ] Life Cycle Analysis
- [ ] Lighting Simulation
- [ ] Load Calculations
- [ ] Other
- [ ] Parametrics and Optimization
- [ ] Ratings and Certificates
- [ ] Solar and Photovoltaic Analysis
- [ ] Support Services
- [ ] Training Services
- [ ] Utility Bill and Meter Data Analysis
- [ ] Weather
- [ ] Weather Data and Climate Analysis
- [ ] Whole Building Energy Simulation

Building Type

- [ ] Commercial
- [ ] District Scale
- [ ] Industrial
- [ ] Multi Family
- [ ] Portfolio Scale
- [ ] Residential
- [ ] Subsystem Level
- [ ] Urban Scale

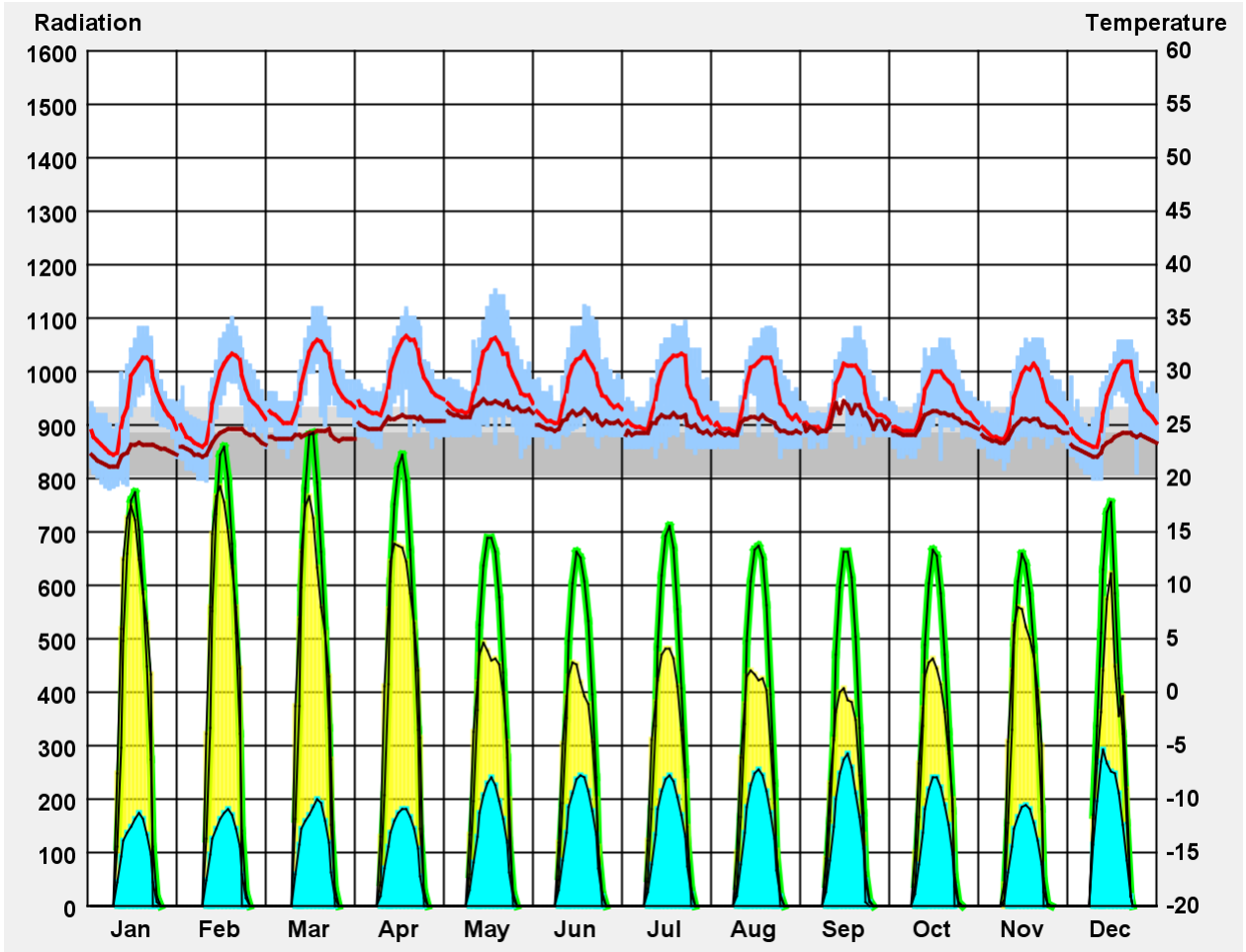
Tools Potentially Useful for the Workshop

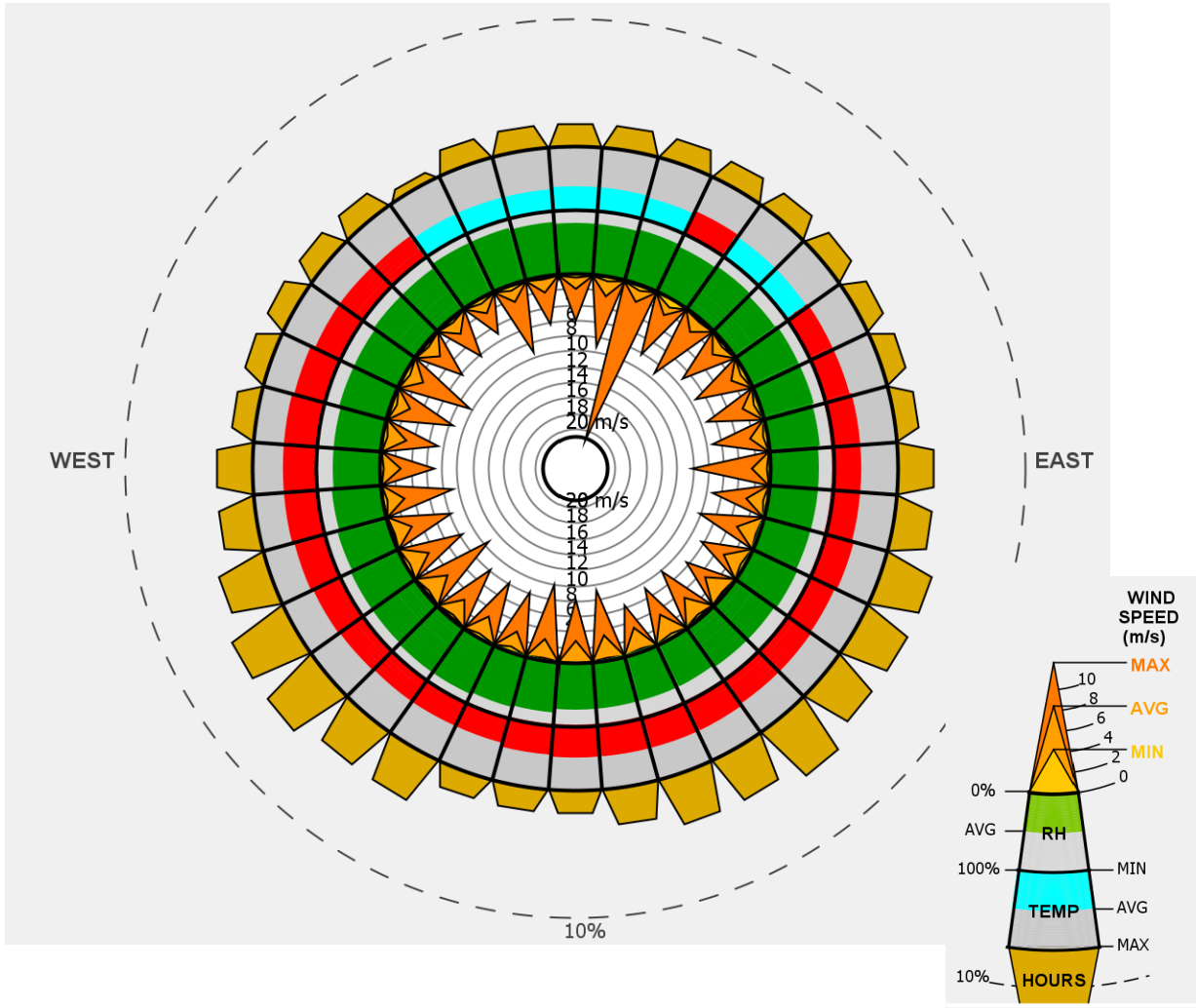
- Climate Analysis
  - Climate Consultant (https://www.sbse.org/resources/climate-consultant)
  - CBE Clima Tool (https://clima.cbe.berkeley.edu/)
- Energy, Solar Radiation, and Daylighting Analysis
  - Revit + Insight (https://www.autodesk.com/education/students)
- Thermal Comfort
  - CBE Thermal Comfort Tool (https://comfort.cbe.berkeley.edu/)
- Life-Cycle Assessment
  - BEES (https://ws680.nist.gov/bees2)
  - Athena Impact Estimator (http://www.athenasmi.org/our-software-data/overview/)

Climate Analysis Tools

- Climate data for building design
- Climate data files (https://climate.onebuilding.org/default.html)
- Climate Consultant Demo

Example Outputs of Climate Consultant





Energy Analysis with Revit and Insight

- Is based on Building Information Modeling
- Can be used in very early stage of design without detailed information
- Support design exploration and optimization
- Use Cloud computing
- Can generate and export the EnergyPlus model

References:

- https://www.youtube.com/watch?v=1nkK4yjqCfQ
- https://www.youtube.com/watch?v=7CrG6hw1Wdo

Key Steps of Energy Analysis with Revit and Insight

1. Create a Revit model using conceptual masses, building elements, or both
2. Set the project location
3. Review Revit energy settings
4. Generate the energy analytical model
5. Create and run energy models with different design options
6. Launch Insight for interactive project exploration, optimization & reporting

Email Notifications on Cloud Computing Progress

AUTODESK® INSIGHT

Hi Weimin Wang,

Your model has been received. You will receive an email when the analysis is complete and you can access your results.

Get Support

Thanks for using Insight!
Autodesk Insight Team

AUTODESK® INSIGHT

Hi Weimin Wang,

Your Analysis is complete. You can access the results on Insight.

Project details:
Model: Project4
Location: 78 Đường Lê Thánh Tôn, Ho Chi Minh City, Ho Chi Minh City

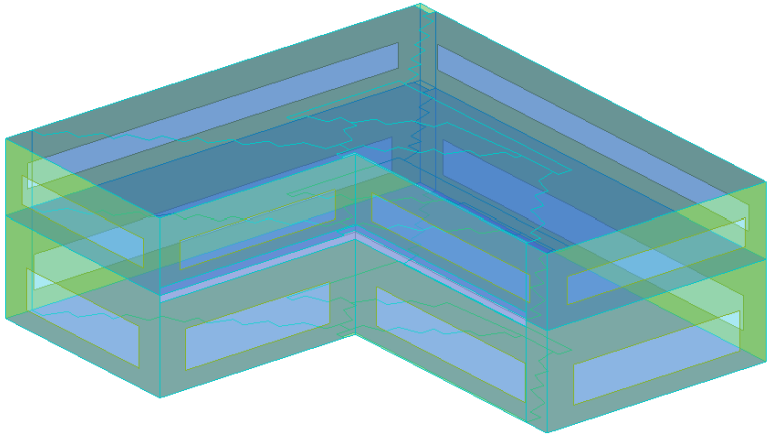
VIEW INSIGHT

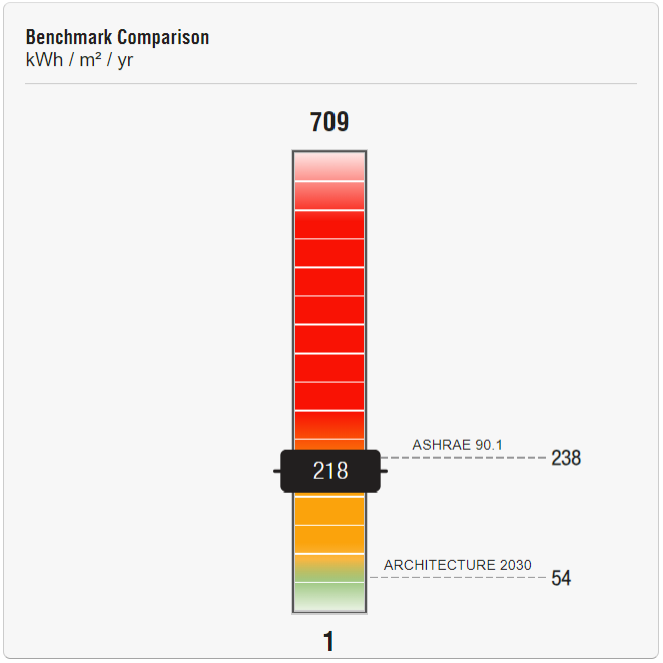
If the above link not working, please copy the following link and paste it into your browser:
https://insight.autodesk.com/OneEnergy/Model/446247

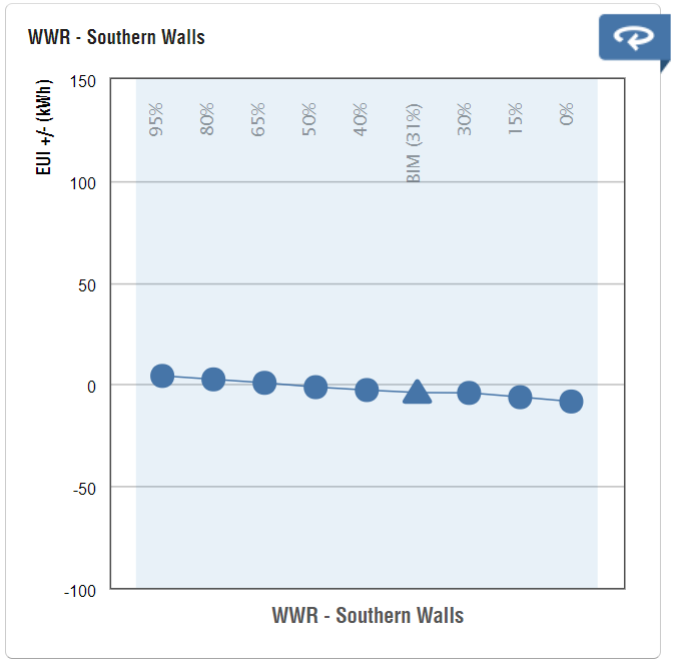
Get Support

Thanks for using Insight!
Autodesk Insight Team

Revit + Insight Demo

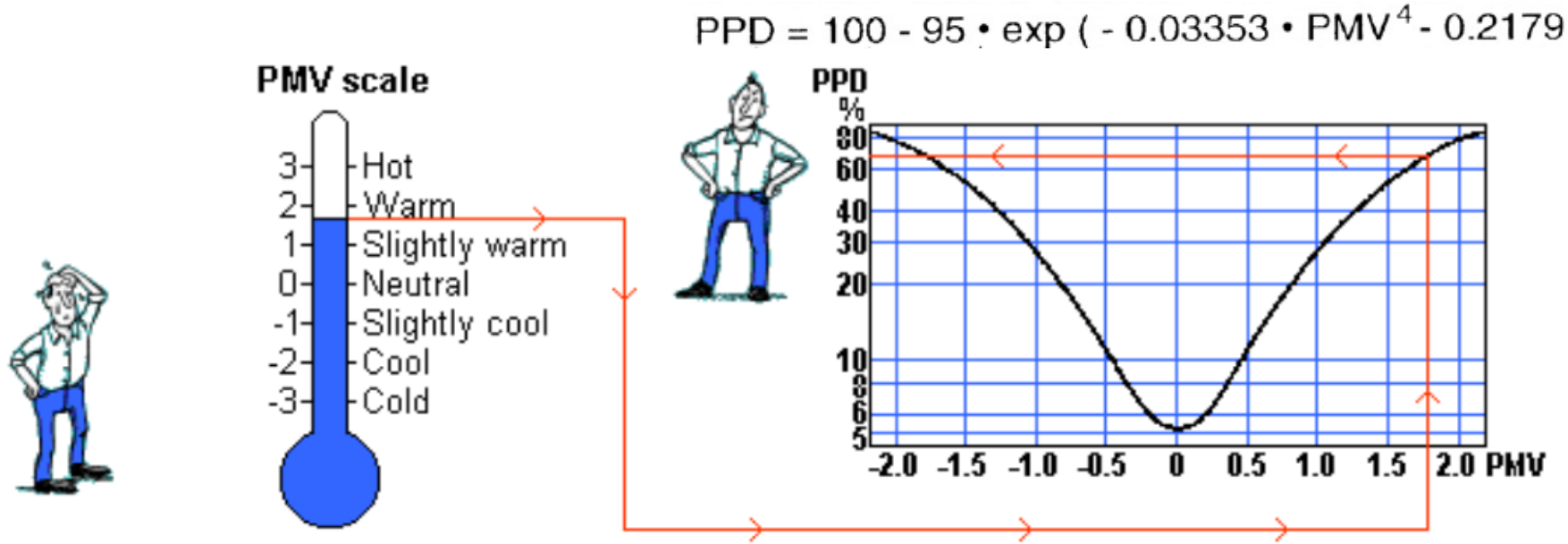






Thermal Comfort Tutorial

- Environmental factors: air temperature, mean radiant temperature, relative humidity, and air velocity
- Personal factors: clothing insulation, metabolic heat
- Metrics and models



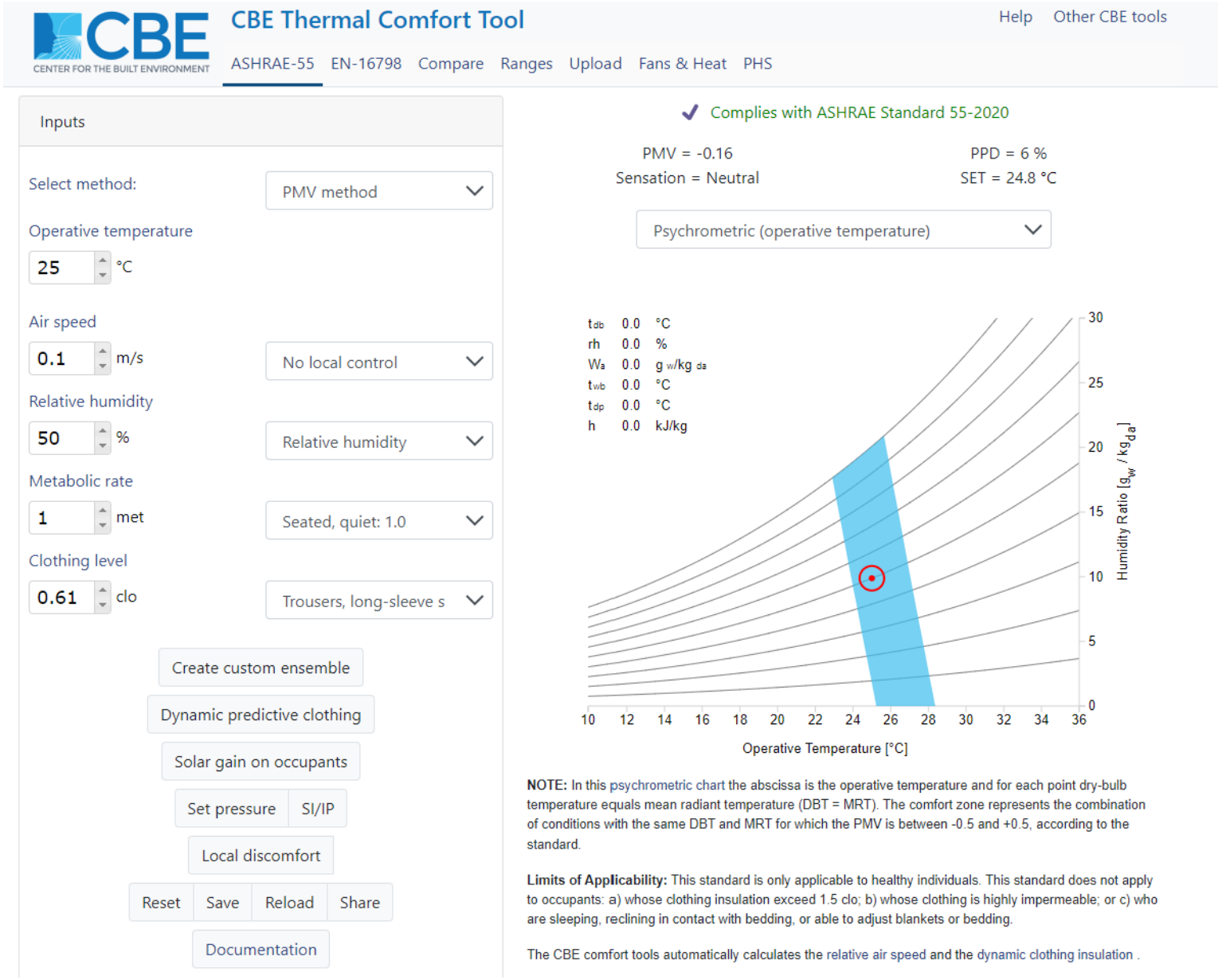
References:
https://www.ripcordengineering.com/files/tech_notes/Thermal%20Comfort_An%20Introduction.pdf
ASHRAE Standard 55: https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards

Different Applications

- Indoor built environment
  - Mechanically air-conditioned
  - Naturally air-conditioned
  - Heavily studied
  - ASHRAE Standard 55, ISO 7730, and EN-16798
- Outdoor environment
  - Urban planning, tourism attraction, weather information
  - Examples: street canyons, recreation parks, microclimate design
  - Fewer studies but draws increasing attention
- Semi-outdoor environment
  - Transitional spaces (e.g., passenger stations, stadiums, atriums)
  - Fewer studies but draws increasing attention

CBE Thermal Comfort Tool

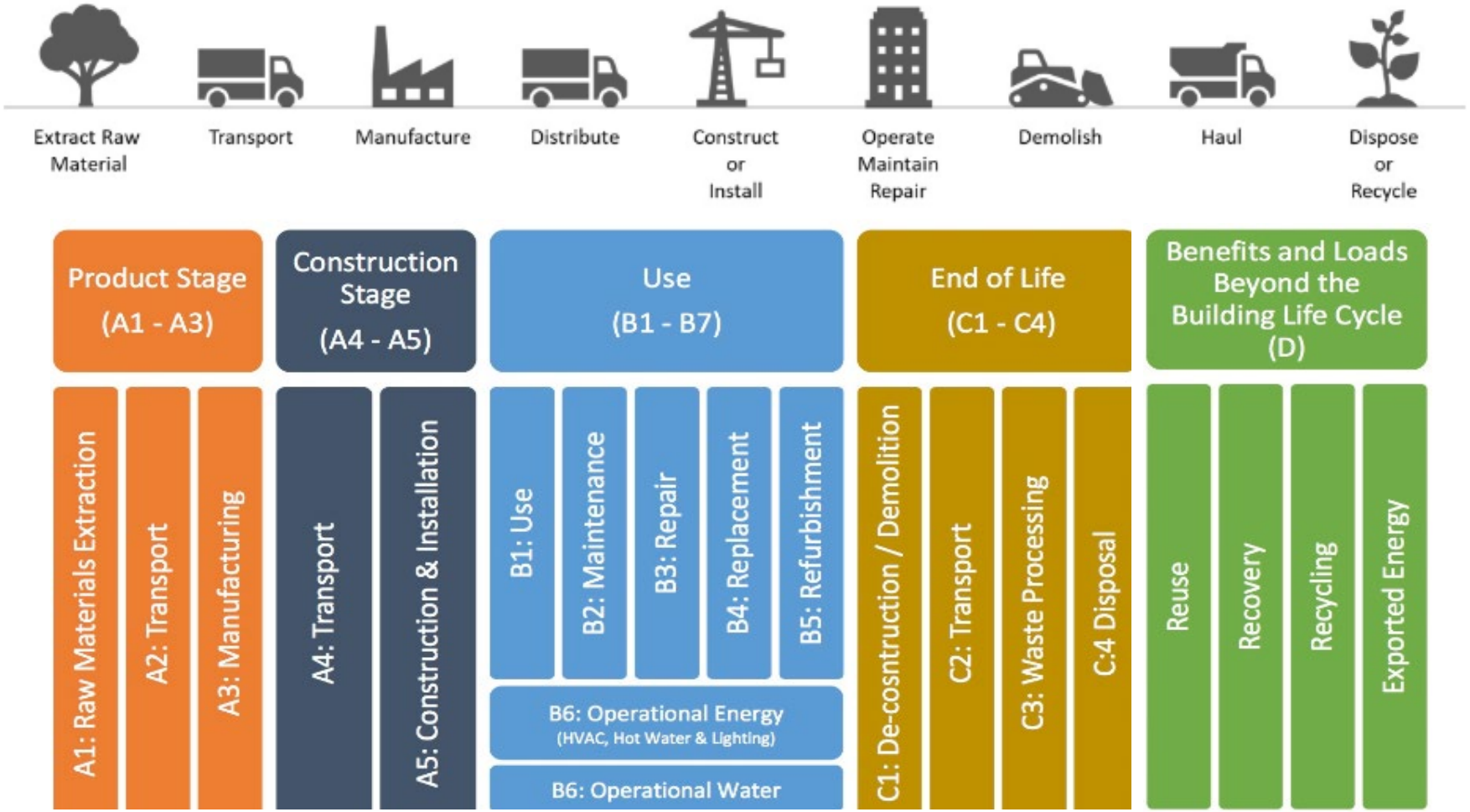
https://comfort.cbe.berkeley.edu



Building Life-Cycle Assessment (LCA)

- LCA basics
- Athena Impact Estimator demo

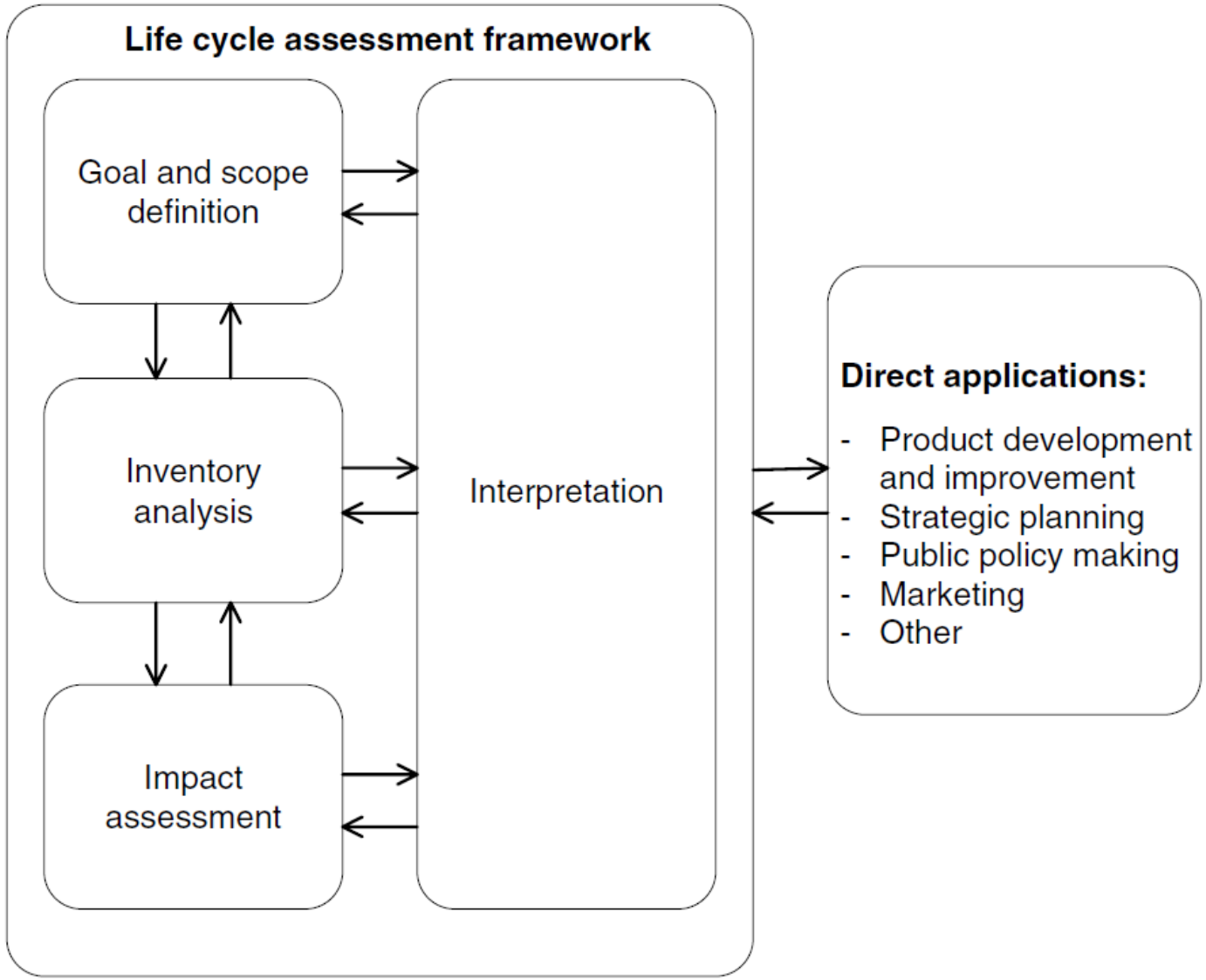
Building Life Cycle Stages



Sources:

- European Standard EN 15978:2011
- U.S. General Service Administration, https://sftool.gov/plan/399/life-cycle-perspective-life-cycle-thinking

LCA Components



Source: ISO 14040 (2006)

Impact Assessment

Evaluate the potential human health and environmental impacts of the inputs & output identified from the life-cycle inventory analysis.

- Select and define impact categories
- Classification
- Characterization
- Normalization (optional)
- Grouping (optional)
- Weighting (optional)

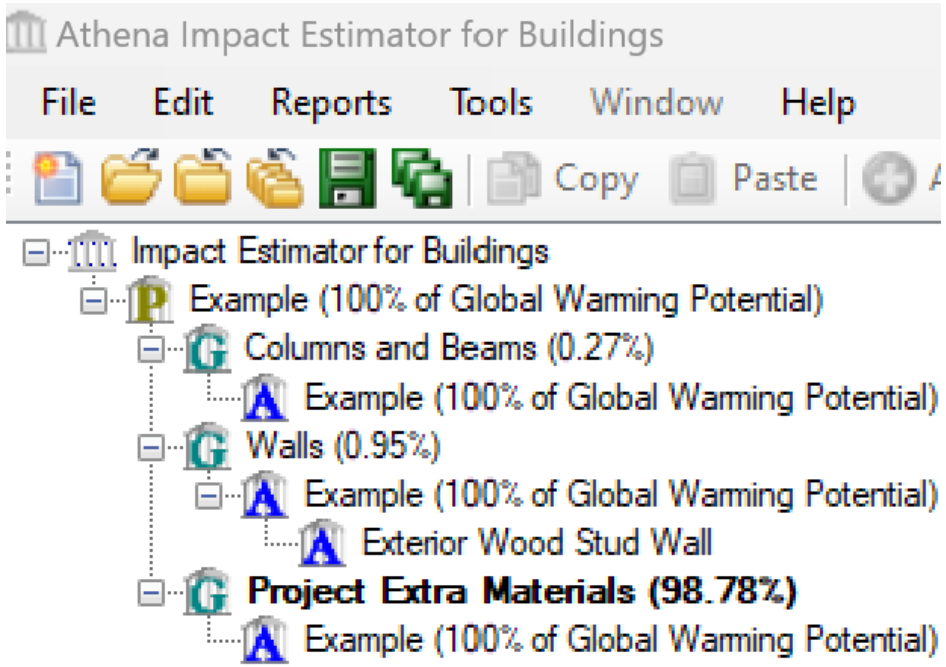
Impact Categories

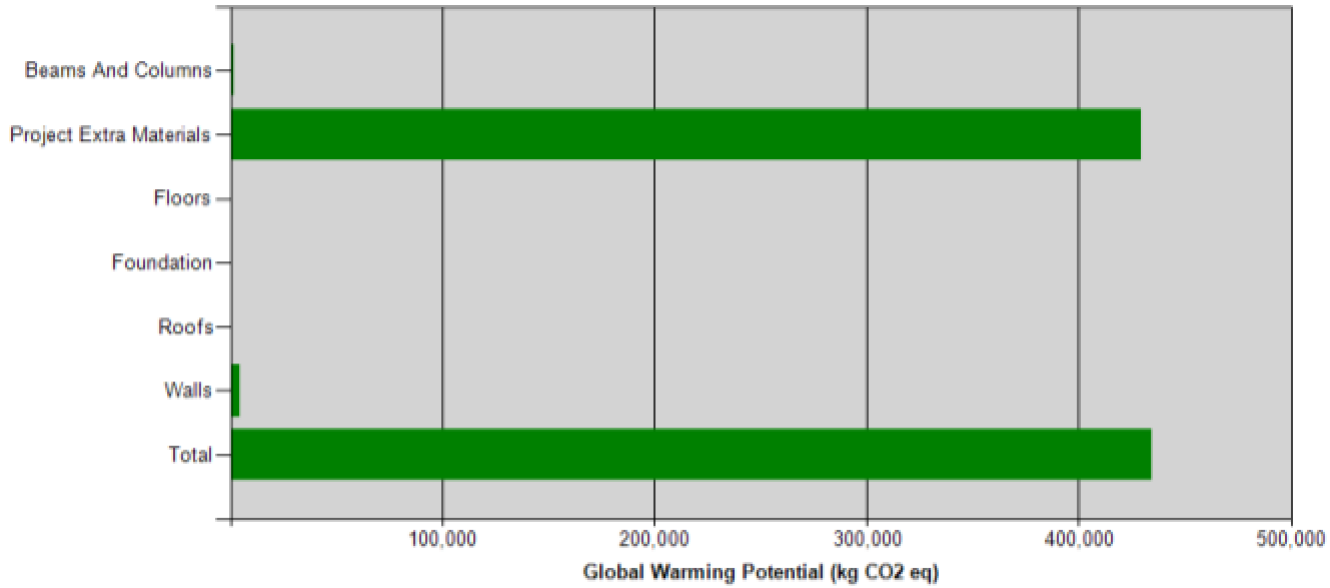
Commonly used impact categories include:

- Global Warming
- Ozone Depletion
- Acidification
- Eutrophication
- Smog Formation
- Human Health
- Ecotoxicity
- Fossil Fuel Use
- Land Use
- Water Use

Source: EPA TRACI 2.1: https://www.epa.gov/chemical-research/tool-reduction-and-assessment-chemicals-and-other-environmental-impacts-traci

Athena Impact Estimator Demo





		PRODUCT (A1 to A3)	CONSTRUCTION PROCESS (A4 & A5)	USE (B2, B4 & B6)			END OF LIFE (C1 to C4)	BEYOND BUILDING LIFE (D)	TOTAL EFFECTS	
LCA Measures	Unit	Total	Total	Replacement Total	Operational Energy Use Total	Total	Total	Total	A to C	A to D
Global Warming Potential	kg CO2 eq	**3.41E+05**	**7.80E+04**	1.54E+03	1.66E+06	**1.67E+06**	**1.46E+04**	**-6.29E+03**	**2.10E+06**	**2.09E+06**
Acidification Potential	kg SO2 eq	**1.19E+03**	**4.98E+02**	1.36E+01	1.12E+04	**1.12E+04**	**1.79E+02**	**-8.01E-01**	**1.31E+04**	**1.31E+04**
HH Particulate	kg PM2.5 eq	**4.78E+02**	**8.09E+01**	4.11E+00	1.99E+03	**2.00E+03**	**6.25E+00**	**-3.51E-01**	**2.56E+03**	**2.56E+03**
Eutrophication Potential	kg N eq	**4.72E+02**	**9.06E+01**	6.85E-01	5.30E+02	**5.30E+02**	**1.12E+01**	**-4.12E-02**	**1.10E+03**	**1.10E+03**
Ozone Depletion Potential	kg CFC-11 eq	**9.26E-03**	**1.34E-03**	4.45E-05	3.95E-02	**3.96E-02**	**5.81E-07**	**0.00E+00**	**5.02E-02**	**5.02E-02**
Smog Potential	kg O3 eq	**2.17E+04**	**1.38E+04**	1.69E+02	3.63E+04	**3.65E+04**	**5.85E+03**	**-8.10E+00**	**7.78E+04**	**7.78E+04**
Total Primary Energy	MJ	**2.92E+06**	**8.31E+05**	2.20E+04	2.88E+07	**2.88E+07**	**2.15E+05**	**-1.60E+03**	**3.27E+07**	**3.27E+07**
Non-Renewable Energy	MJ	**2.76E+06**	**8.10E+05**	1.74E+04	2.86E+07	**2.86E+07**	**2.15E+05**	**-1.60E+03**	**3.24E+07**	**3.24E+07**

Thank You!

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