



Redefining possible.

USING BUILDING ENERGY MODELING TO INFORM THE NEXT DESIGN

Our Experience Creating the COMPASS
Energy Benchmarking Tool

Building Energy Simulation Forum (BESF)

December 19, 2018

Speakers



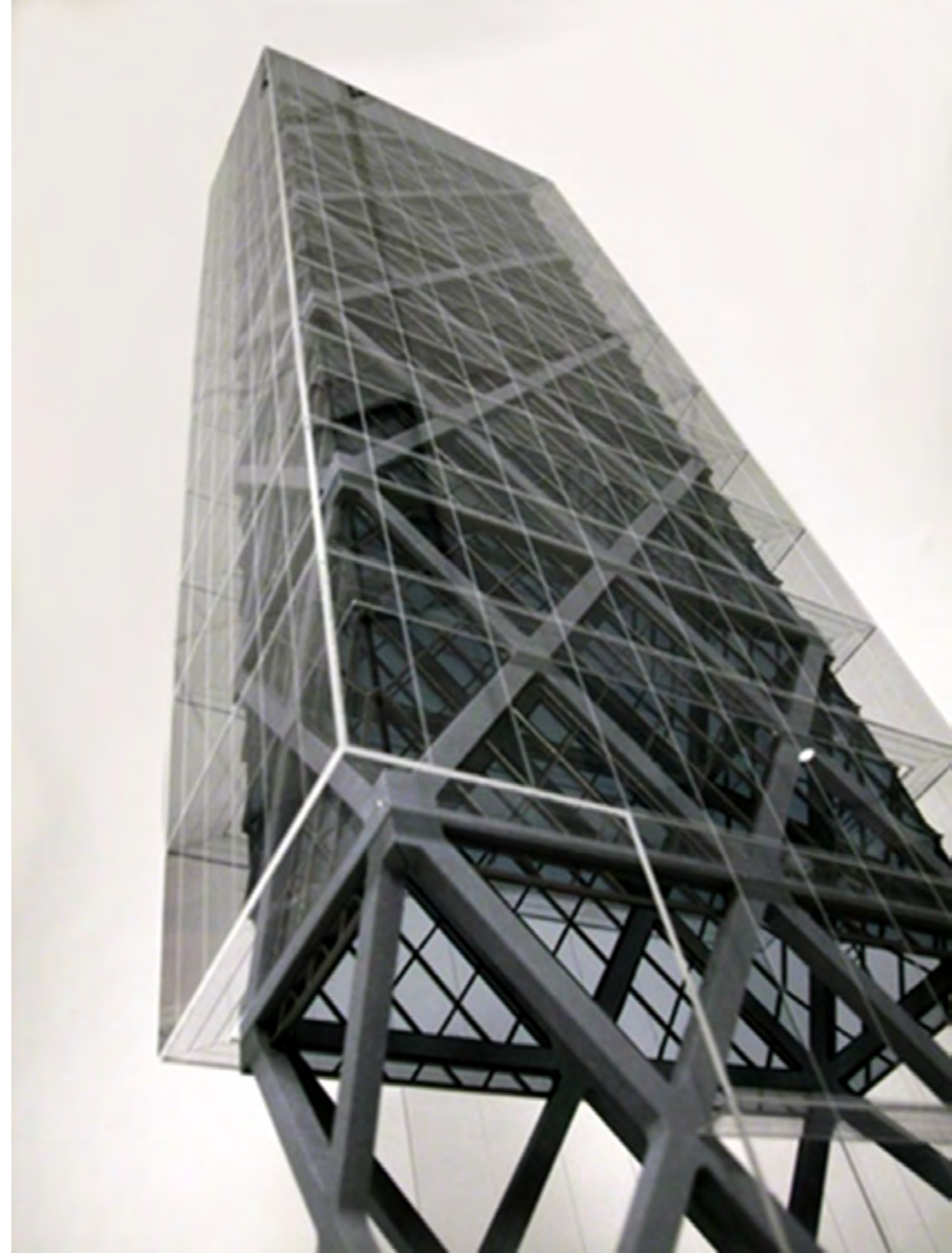
Joel Good, M.A.Sc., P.Eng
Associate – Building Performance
RWDI



Matthew Hyder, MS, LEED GA, WELL AP
Technical Project Coordinator
RWDI

Agenda

1. Introduction
2. Existing Benchmarking Tools
3. COMPASS Origins
4. COMPASS Description
5. COMPASS Demo
6. Takeaways & Next Steps

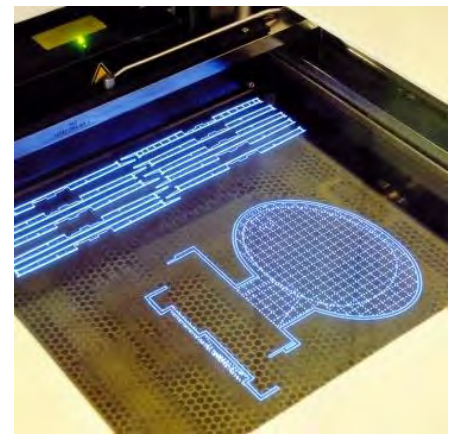
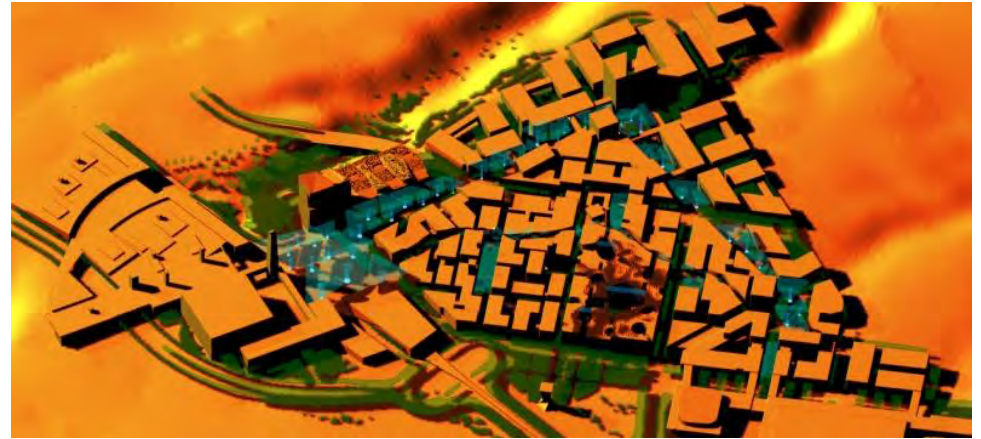
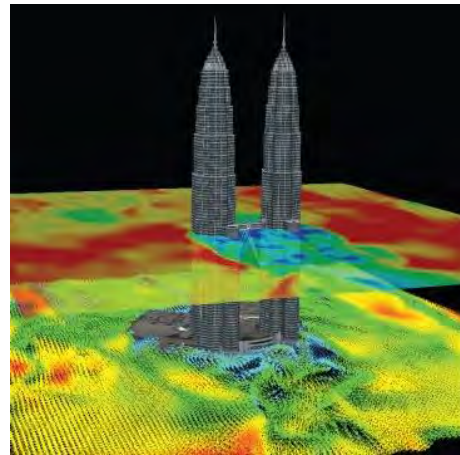


How do you make
energy decisions at the
onset of projects?

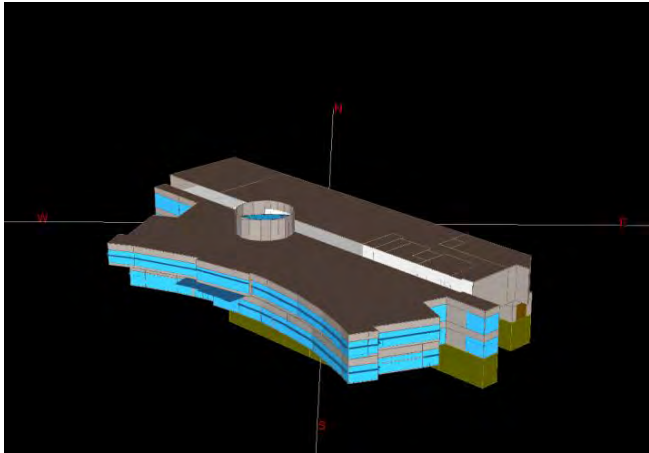
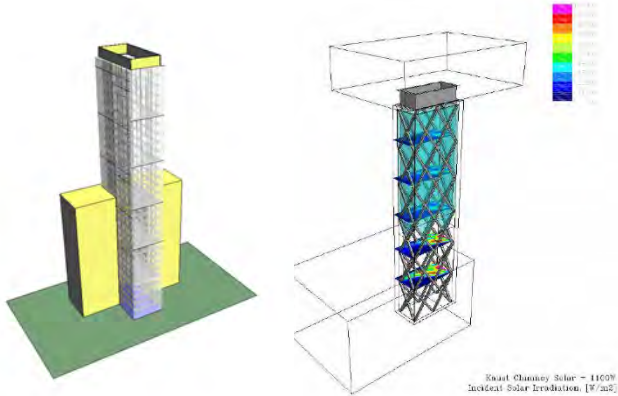
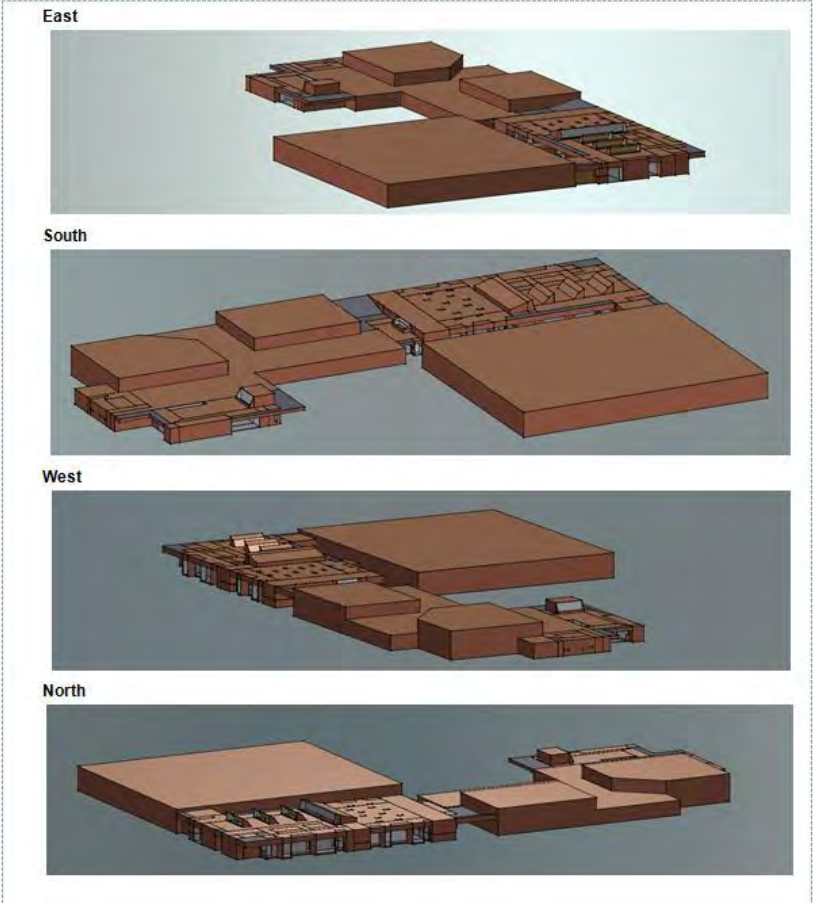
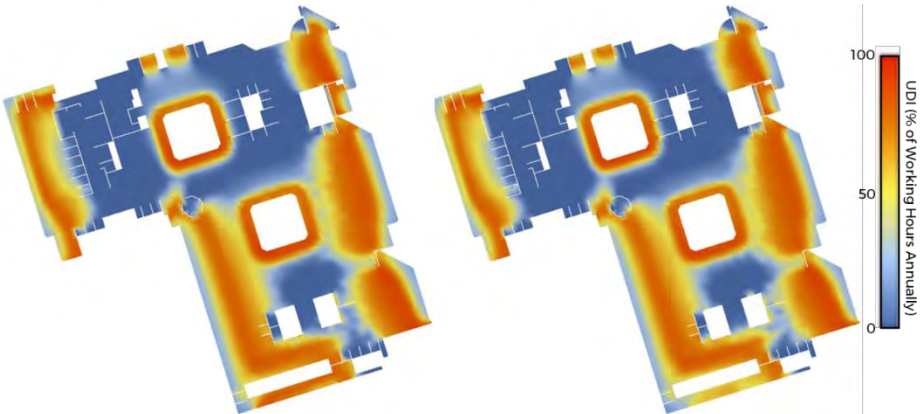
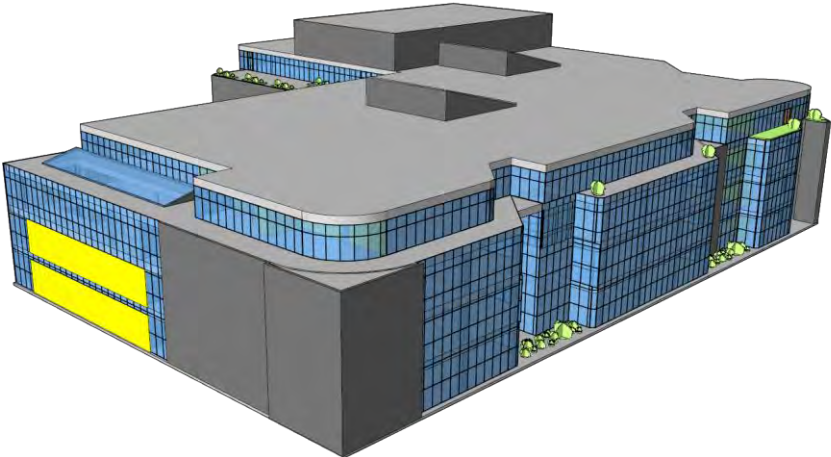
What benchmarking
data do you use?

Introduction

RWDI



RWDI



Energy Modeling



- LEED (ASHRAE 90.1)
- Oregon Energy Code
- Seattle Energy Code
- Title 24
- IECC
- ETO Incentives
- ECM runs

Hundreds of models, tons of data points

Wouldn't it be Nice

- ✓ Harness energy modeling experience
- ✓ Document & learn from our successes and failures
- ✓ Simplify reporting
- ✓ Learn from & share with the design community
- ✓ Apply current design knowledge, maintain security



Existing Benchmarking Tools

Existing Tools

Commercial Buildings Energy Consumption Survey (CBECS)

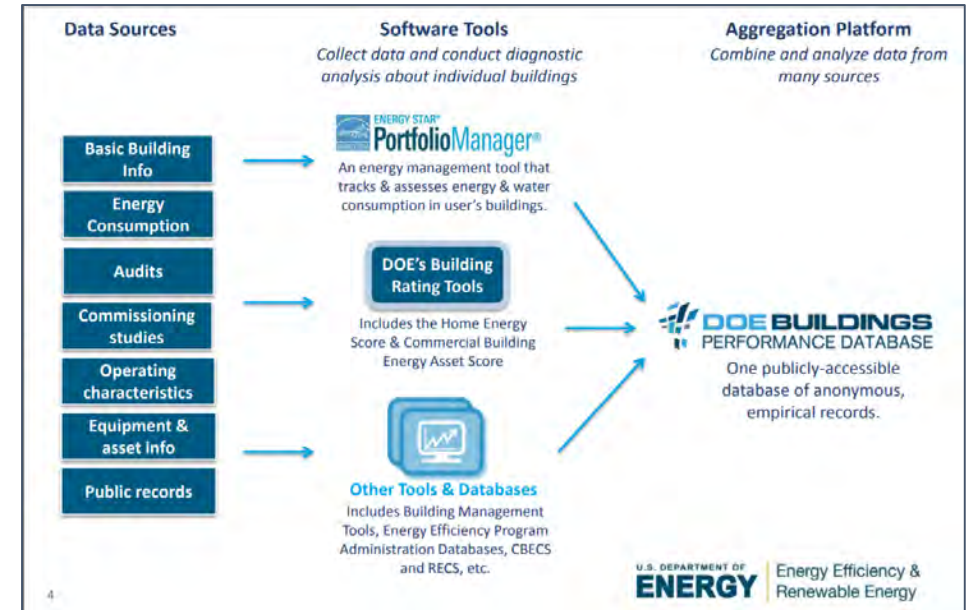
- Statistically representative sample of building stock
- Latest 2012 (2018 coming)
- Benchmarking existing buildings
- Analyze trends, impact of policy



Existing Tools

Building Performance Database (BPD)

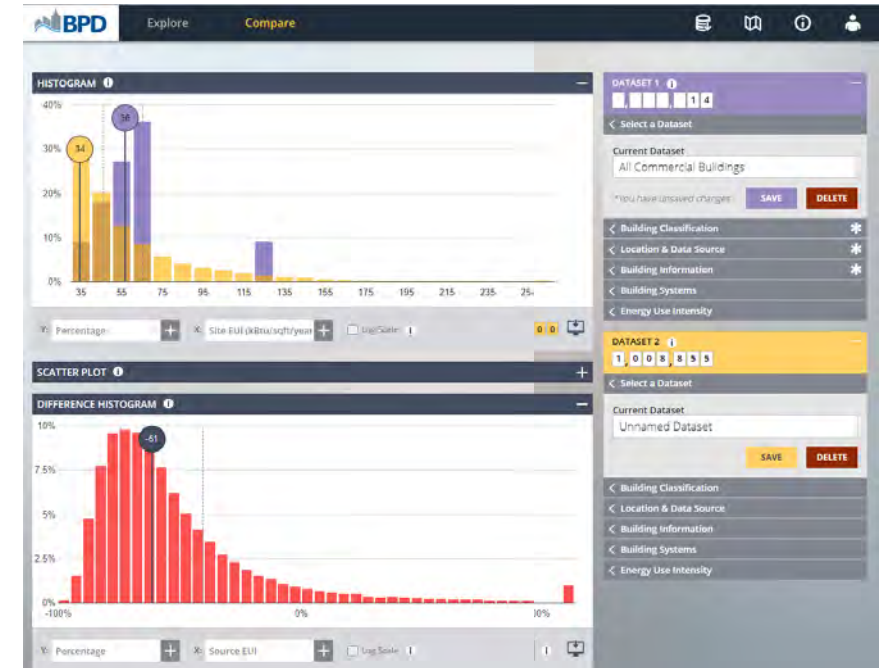
- DOE / LBNL – June 2013
- Largest publicly available source of building energy performance data
- ~1 million existing commercial and residential buildings



Existing Tools

Building Performance Database (BPD)

- Location, use + physical & operational characteristics
- Determine large trends, inform energy based decisions across markets and regions, establishing benchmarks, etc...
- Lacks data points for design learning



Existing Tools

AIA 2030 Design Data Exchange DDx



- 2030 challenge reporting system
- Firm wide portfolio
- Ease of tracking and submission for AIA 2030, progress reports
- Better design thinking, but minimal inputs for design

Existing Tools



BEST
Directory

Building Energy Software Tools

Formerly hosted by US Dept. of Energy

[Home](#) [FAQ](#) [Software Listing](#) [About](#) [Contact](#)

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Search

Capabilities

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

Building Type

- Subsystem Level
- Commercial

Software Listing

Total Listed Programs: 18



Benchmark My Building

Is your building energy efficient? This building energy performance tool by Lucid, ENERGY STAR & the DOE will tell you in seconds. Try it today!

Building Energy Benchmarking

Commercial, Residential

Last Software Update: 01 June 2017 | Last Entry Update: 18 July 2018

Ratings ☆☆☆☆☆ | Reviews 0 | [Add to compare](#)



AET (Architect's / Engineer's Energy Tool.)

AET is a Windows 10 App for quick energy use evaluations of commercial or residential buildings, and can be used by homeowners as well as students, architects and engineers. Included is a built-in weather database for over 2000 cities worldwide.

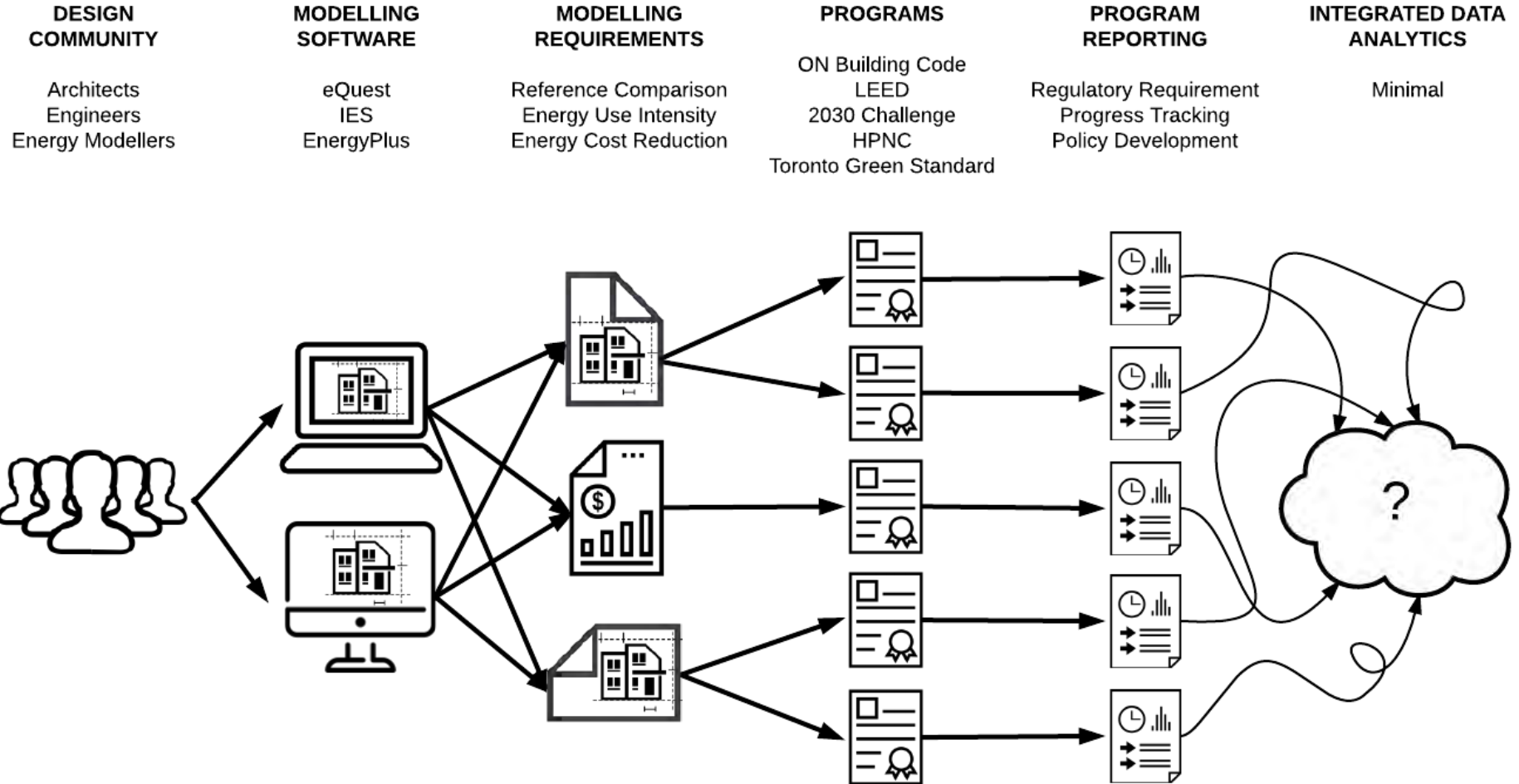
Whole Building Energy Simulation | Weather Data and Climate Analysis | Building Energy Benchmarking

Commercial, Residential

Last Software Update: 05 August 2018 | Last Entry Update: 07 August 2018

Ratings ☆☆☆☆☆ | Reviews 0 | [Add to compare](#)

State of Play

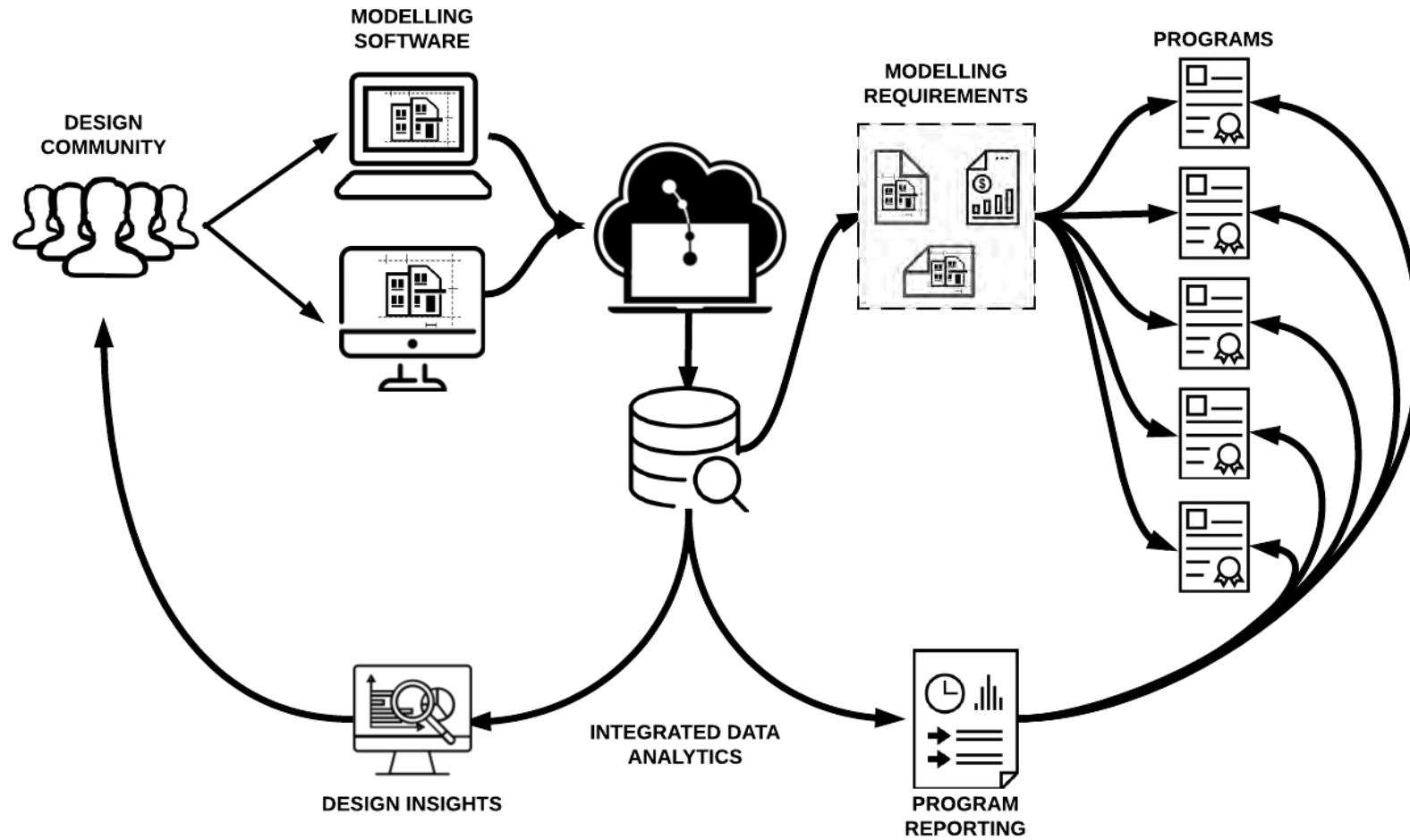




COMPASS

Origins

COMPASS



The Value Proposition



Creating tools to enable conversations

- Experts & non-experts alike
- A common language
- Multiple lenses

Foster an environment of continuous learning

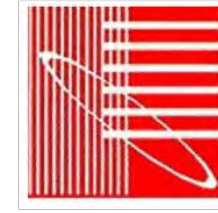
- Redefining success
- Data collection

We are a community of designers

- How do we package our knowledge to create better buildings?
- Leverage data to advocate for change
- Can we share and learn from each other?



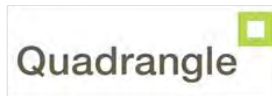
***Development
Funding***



IBPSA Canada

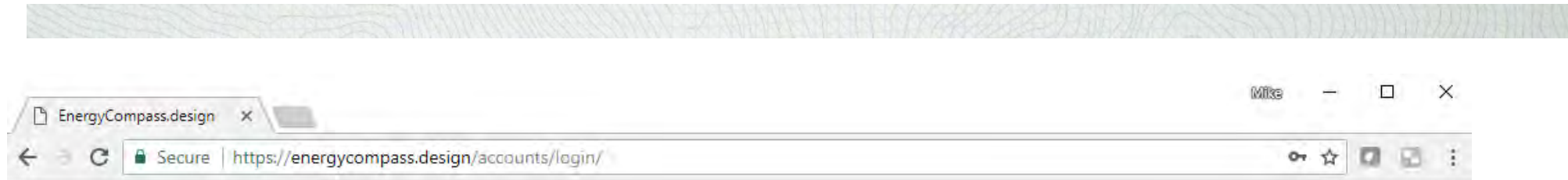


Governance



***Letters of
Support &
Beta Tester***

COMPASS



ENERGYCOMPASS!design

Email address

Password

Sign in

[Sign Up](#)

[Forgot Password](#)

[About](#)

COMPASS

Description



COMPASS Inputs

v1 built in Tableau

Python based code – compatibility

Drag and drop uploading

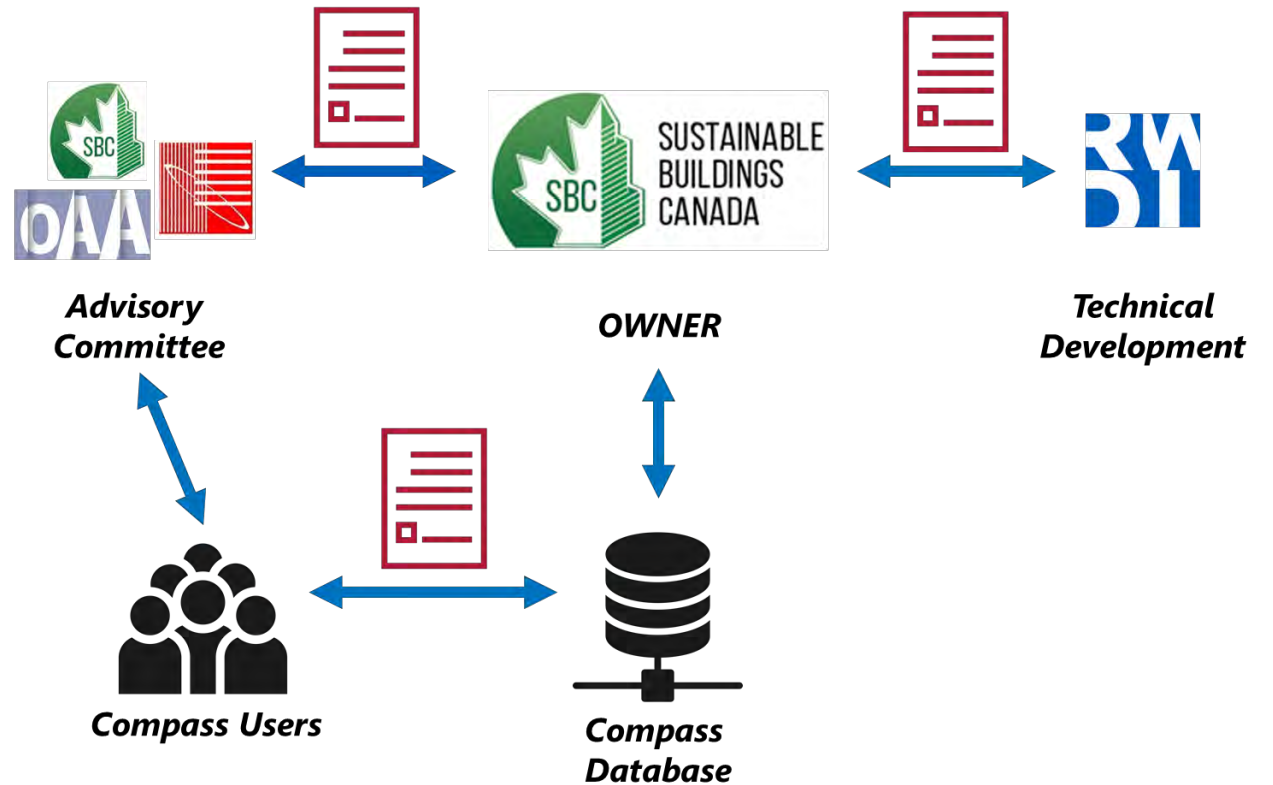
Visualization tools

Third party data storage - privacy



COMPASS Privacy

Governance Approach



COMPASS Inputs



Drag and drop energy
model files:

- eQuest
- IES VE
- Energy Plus

As designed

Baseline

Alternate (ECM) runs

Privacy settings

COMPASS Outputs

Extracts 400 variables

Energy breakdown – end-use breakdown,
fuel-type breakdown... filter

Bubble chart – how does your project
compare against the database... sort by
like characteristics

Parallel Coordinates – tool displays
building characteristics, use to compare
how they impact total energy performance

Version Details [\(edit\)](#)

| | |
|---|----------|
| Version Name | As-Built |
| Included in Public Database ? | Yes |

Shared Results [?](#)

| | | |
|----------------------------|---|--------------------|
| Area ? | 5,000m ² - 1,000m ² | |
| Interior Lighting | 14 | kWh/m ² |
| Task Lighting | 0 | kWh/m ² |
| Plug Loads | 25 | kWh/m ² |
| Space Heating | 14 | kWh/m ² |
| Space Cooling | 9 | kWh/m ² |
| Heat Rejection | 0 | kWh/m ² |
| Pumping | 0 | kWh/m ² |
| Ventilation Fans | 6 | kWh/m ² |
| Refrigeration Display | 0 | kWh/m ² |
| Heat Pump Supplementary | 3 | kWh/m ² |
| Domestic Hot Water | 34 | kWh/m ² |
| External Usage | 1 | kWh/m ² |
| Total | 107 | kWh/m ² |
| Improvement over reference | 21 | % |

COMPASS Outputs

Building Properties

| | | |
|--------|--------|----------------|
| Area | 5,976 | m ² |
| Volume | 16,394 | m ³ |

Energy Uses

| | Electricity (kWh) | Natural Gas (kWh) |
|-------------------------|-------------------|-------------------|
| Interior Lighting | 84,668 | 0 |
| Task Lighting | 0 | 0 |
| Plug Loads | 150,668 | 0 |
| Space Heating | 52,958 | 28,897 |
| Space Cooling | 56,006 | 0 |
| Heat Rejection | 0 | 0 |
| Pumping | 938 | 0 |
| Ventilation Fans | 36,751 | 0 |
| Refrigeration Display | 0 | 0 |
| Heat Pump Supplementary | 19,841 | 0 |
| Domestic Hot Water | 0 | 203,626 |
| External Usage | 7,884 | 0 |
| Total | 409,684 | 232,523 |

Enclosure Details

| | Roof Area (m ²) | Skylight Area (m ²) | WWR |
|------|-----------------------------|---------------------------------|-----|
| Roof | 1,686 | 0 | 0% |

| | Wall Area (m ²) | Window Area (m ²) | WWR |
|--------------|-----------------------------|-------------------------------|------------|
| North | 608 | 157 | 26% |
| North East | 61 | 38 | 62% |
| East | 560 | 181 | 32% |
| South | 615 | 299 | 49% |
| South West | 95 | 61 | 64% |
| West | 485 | 155 | 32% |
| Total | 2,425 | 891 | 37% |

| | U-value (S.I) W/m ² -K | R-value (S.I) m ² -K/W |
|------------------------------|-----------------------------------|-----------------------------------|
| Walls Above Grade | 0.318 | 3.145 |
| Walls Below Grade | 0.102 | 9.784 |
| Windows | 1.953 | 0.512 |
| Roof | 0.165 | 6.073 |
| Enclosure Above Grade | 0.608 | 1.646 |

Gains

| | | |
|-----------|-----|--------|
| People | 363 | People |
| Lighting | 37 | kW |
| Equipment | 65 | kW |

Mechanical Systems

| | | |
|---------------------------|------|-------------------|
| Heating Load exc. OA | -330 | kW |
| Heating Load inc. OA | 15 | kW |
| Cooling Load exc. OA | 252 | kW |
| Cooling Load inc. OA | 262 | kW |
| Plant Heating Capacity | -296 | kW |
| System Heating Capacity | 311 | kW |
| Plant Heating Efficiency | 0 | % |
| System Heating Efficiency | | % |
| Plant Cooling Capacity | 204 | kW |
| System Cooling Capacity | 58 | kW |
| Plant Cooling Efficiency | 0 | % |
| System Cooling Efficiency | | % |
| Supply Air Rate | 16 | m ³ /s |
| Outside Air Rate | 1 | m ³ /s |
| Fan Load | 9 | kW |

COMPASS Outputs



Energy Breakdown

View where buildings expend their energy.



Bubble Chart

Compare various impacts of projects within the database.



Parallel Coordinates

Explore how various building characteristics impact energy usage and GHG intensities.

COMPASS Outputs

Controls

Size By:
 Color By:
 Highlight:

Filters

Projects:
 Model Type:
 Use Types:
 Floor Area:

Project Selection

Project:

View Controls

View:
 Sort:

Filters

Projects:
 Model Type:
 Use Types:
 Floor Area:

Project Selection

Project:
 Isolate selected? Isolate

LEED for Homes 1 FO : As-Built (Ref.) (5,976 m²)

| | |
|--------------------------|--|
| EUI: | 135.5 kWh/m ² |
| GHGI: | 12.0 kg CO ₂ e/m ² |
| Cost Intensity: | 0.0 \$/m ² |
| Occupant Density: | 0.06 People/m ² |
| Lighting Power Density: | 11.7 W/m ² |
| Equipment Power Density: | 11.6 W/m ² |

Average of displayed projects (57 Models)

| | |
|--------------------------|--|
| EUI: | 263.6 kWh/m ² |
| GHGI: | 38.3 kg CO ₂ e/m ² |
| Cost Intensity: | NaN \$/m ² |
| Occupant Density: | 0.10 People/m ² |
| Lighting Power Density: | 10.6 W/m ² |
| Equipment Power Density: | 6.2 W/m ² |

Select a project to view details.

| | |
|---------------------|--------------------|
| Electricity: | kWh/m ² |
| Natural Gas: | kWh/m ² |
| Process: | kWh/m ² |
| Pumping: | kWh/m ² |
| Fans: | kWh/m ² |
| Domestic Hot Water: | kWh/m ² |
| Exterior Lighting: | kWh/m ² |
| Interior Lighting: | kWh/m ² |
| Space Cooling: | kWh/m ² |
| Space Heating: | kWh/m ² |
| EUI: | kWh/m ² |


Average of displayed projects (105 Models)

| | |
|---------------------|--------------------------|
| Electricity: | 126.6 kWh/m ² |
| Natural Gas: | 136.0 kWh/m ² |
| Process: | 29.5 kWh/m ² |
| Pumping: | 5.6 kWh/m ² |
| Fans: | 28.2 kWh/m ² |
| Domestic Hot Water: | 28.6 kWh/m ² |
| Exterior Lighting: | 0.6 kWh/m ² |
| Interior Lighting: | 31.2 kWh/m ² |
| Space Cooling: | 15.7 kWh/m ² |
| Space Heating: | 123.1 kWh/m ² |
| EUI: | 262.6 kWh/m ² |


COMPASS Outputs

Submission reports


Program Forms




Ontario Building Code




Toronto Green Standard




Savings By Design



LEED 2009



Architecture 2030



HPNC

LEED Canada for New Construction and Major Renovations 2009
EA Prerequisite 2: MINIMUM ENERGY PERFORMANCE & EA Credit 1: OPTIMIZE ENERGY PERFORMANCE

Whole Building Energy Simulation

OPTION 1 (PATH 2): ASHRAE 90.1-2007, Energy Standard for Buildings Except Low-Rise Residential Buildings

OPTION 2 (PATH 2): ASHRAE Advanced Energy Design Guide for Small Office Buildings 2004

OPTION 2 (PATH 3): ASHRAE Advanced Energy Design Guide for Small Retail Buildings 2004

OPTION 2 (PATH 4): ASHRAE Advanced Energy Design Guide for Small Workplaces and Self-Storage Buildings 2004

OPTION 3: Advanced Building Core Performance Path

Special Circumstances or Alternative Compliance Path

OPTION 1: Whole Building Energy Simulation

| Energy Type | Prepared Building Energy [MJ] | Reference Building Energy [MJ] | Intensity [MJ/m ²] | Energy Savings [%] |
|-----------------------|-------------------------------|--------------------------------|--------------------------------|--------------------|
| Lighting | 304,096 | 304,096 | 104,032 | 0% |
| Space Heating | 194,024 | 201,521 | 201,521 | 0% |
| Space Cooling | 2,374 | 2,374 | 132,094 | 0% |
| Pumps | 432,384 | 432,384 | 732,093 | 0% |
| Fans | 542,404 | 542,404 | 942,404 | 0% |
| Service Water Heating | 0 | 0 | 0 | 0% |
| Plug Loads | 0 | 0 | 0 | 0% |
| Other: | 0 | 0 | 0 | 0% |
| Other: | 0 | 0 | 0 | 0% |
| Other: | 0 | 0 | 0 | 0% |
| Subtotal | 1,474,363 | 1,474,363 | 151 | 0% |

| Category | Prepared Building Cost | Reference Building Cost | Energy Savings | Percent Savings |
|-----------------|------------------------|-------------------------|----------------|-----------------|
| Electricity | 2,311,544 | 2,311,544 | 0 | 0% |
| Natural Gas | 2,021,593 | 2,021,593 | 0 | 0% |
| Oil/Other Fuels | 0 | 0 | 0 | 0% |
| Total | 2,021,593 | 2,021,593 | 0 | 0% |

Subtotal Energy Costs: 2,021,593
 Reasonable Energy Costs: 2,021,593
 Max Total: 2,021,593

Percent Savings = 100 * (EOB - DEC) / (EOB + DEC) = 0% (REC) = 0% (REC)



COMPASS Demo

Your Next Steps

1. Call to action
2. We need Portland, Oregon and PNW projects
3. Help inform local design!

ENERGYCOMPASS!*design*

Email address

Password

Sign in

Our Next Steps

1. Pushing past beta...
2. Expand regional capabilities
3. Units
4. Improving search capabilities
5. User help & feedback

The background features a solid dark blue field on the right side, which transitions into a white area on the left. The boundary between the blue and white is defined by large, smooth, organic, and somewhat irregular shapes. The word "QUESTIONS" is centered in the blue area.

QUESTIONS



Redefining possible.

THANK YOU



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