Case Study:
Large Commercial with Central HVAC

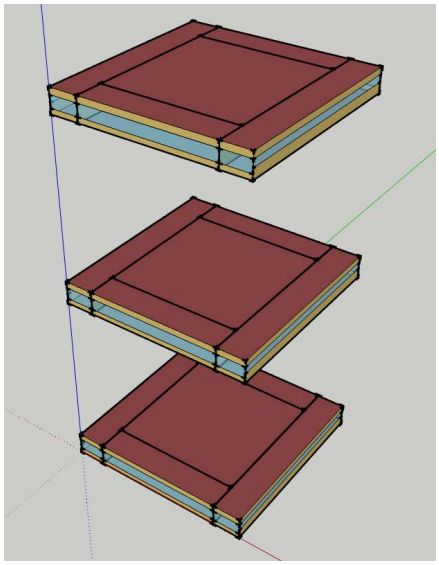
Condense

Building decisions in full context, less time.

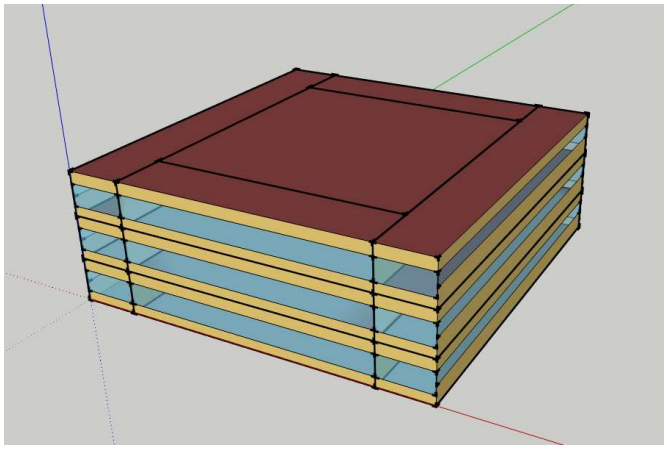
This case study demonstrates the relative accuracy of the simplified Condense energy modeling platform compared to traditional Energy Plus modeling. We compared the results of modeling a high rise commercial office building with central water cooled chillers. The Condense energy results varied from traditional modeling results by only 0.6%-1.5% yet Condense was much quicker and easier to use, with far less opportunity for human error in entering inputs.

The process for creating a traditional energy model included multiple steps in a variety of software, including 3D CAD drawing. Meanwhile, the process for creating a simplified Condense energy model was completed in one file, with no drawing required, using smart defaults to eliminate thousands of inputs required by Energy Plus. Simple numerical and performance inputs were entered into a web-connected interface and were quickly replicated across the project as space instances. By clicking one button, the Energy Plus models were run on remote server and populated to our reports, including total energy and disaggregated data. A full Energy Plus model was immediately available for download.

Traditional Models



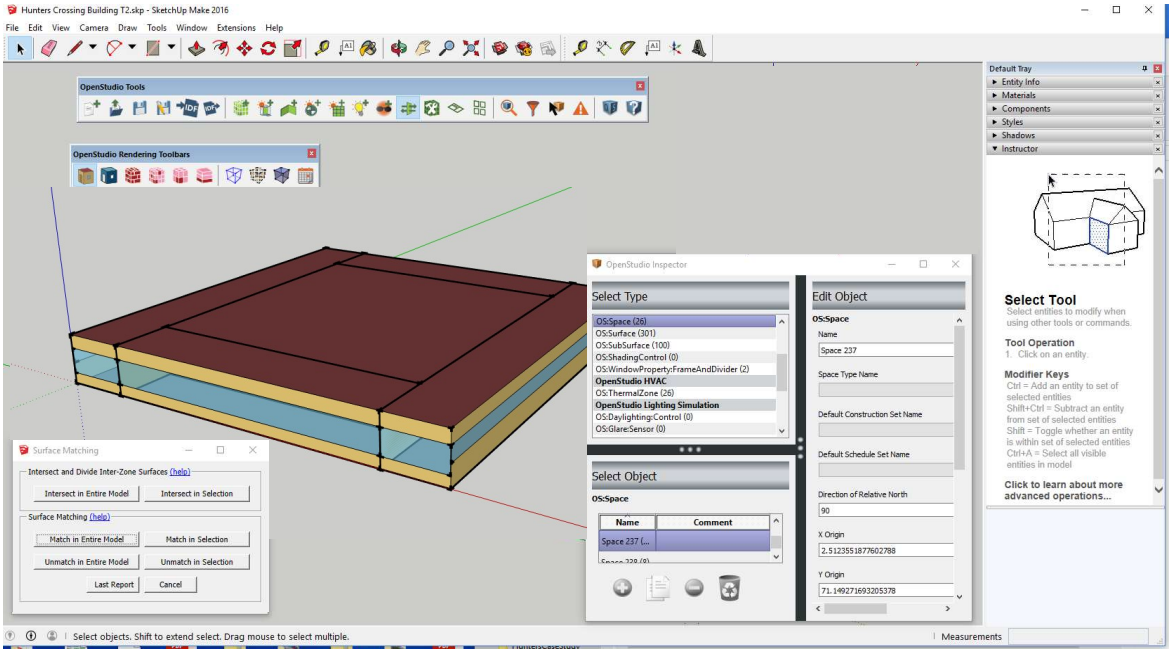
High Rise Model



3-Story Model

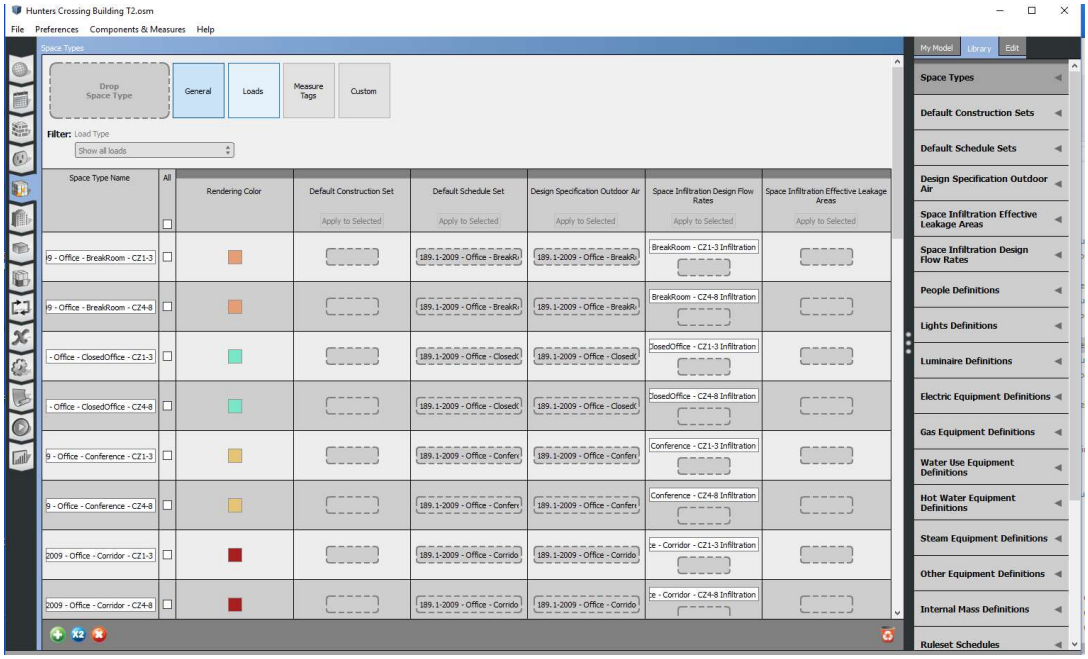
Because Condense models are discretely broken out by zone, we wanted to demonstrate how the Condense energy modeling tool is used on a centralized HVAC system. As our case study we used the Energy Plus example file for a standard commercial office building with central water cooled chillers. The high rise model followed the recommended Energy Plus protocol of using a representative mid floor with a multiplier. Because in our initial tests there was less discrepancy in the middle floors, we then created a more compact 3-story model to more rigorously test against Condense. The traditional models started with full building 3D CAD models, with each zone drawn and placed, and realistic window placement.

Traditional Models



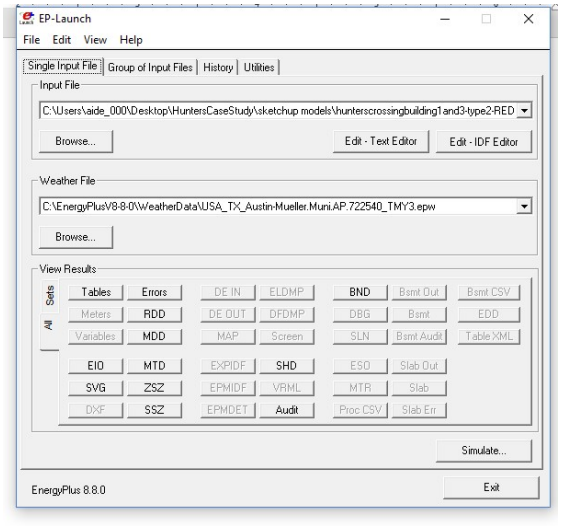
These models were created in Sketchup 2016, then, using an Open Studio plugin compatible with that Sketchup version, they were translated into Energy Plus Open Studio models with thermal zones and matching of adjacent surfaces to model heat transfer between zones. Many things can go wrong during this step, and must be troubleshooted: a stable version of Sketchup that is compatible with the Open Studio plugin must be maintained, 3d model surfaces must be complete and not overlapping, windows must drawn and placed flat on exterior walls then cut out of the walls, adjacent surfaces must be matched to translate into the idf file, zones must be identified by clicking in the 3d model. (Alternatives to Energy Plus exist, such as Equest, however Equest is even less facile at modeling complex building and space shapes, less accurate or robust than Energy Plus, and less able to model newer and green technologies. Other direct 3D-CAD platforms exist, but of course these require a 3D model, which, as discussed above, is problematic.)

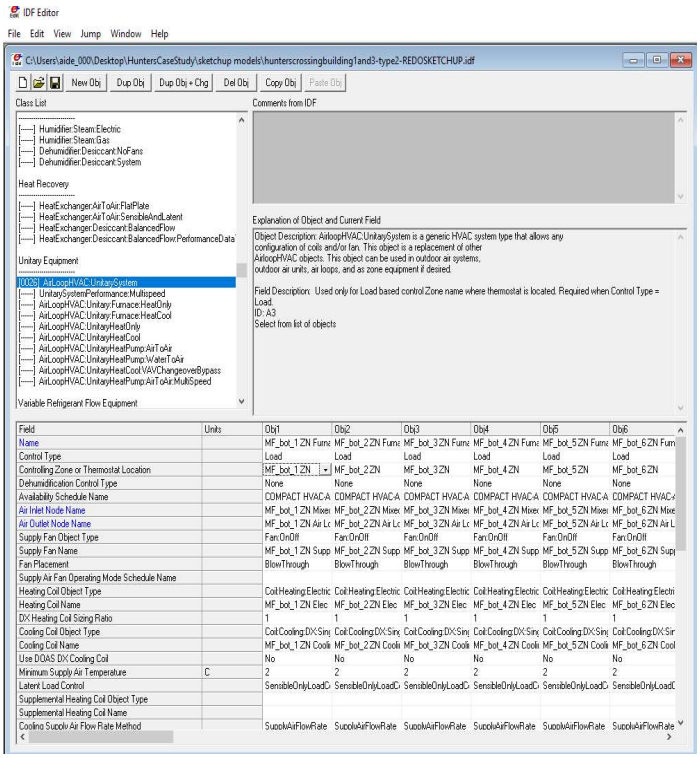
Traditional Models



The Open Studio files were then opened in Open Studio, and HVAC systems, lighting, insulation and other Energy Plus components were wired up. These components must all be selected from libraries and applied to each zone. HVAC systems must be designed with proper branching and integration of subcomponents.

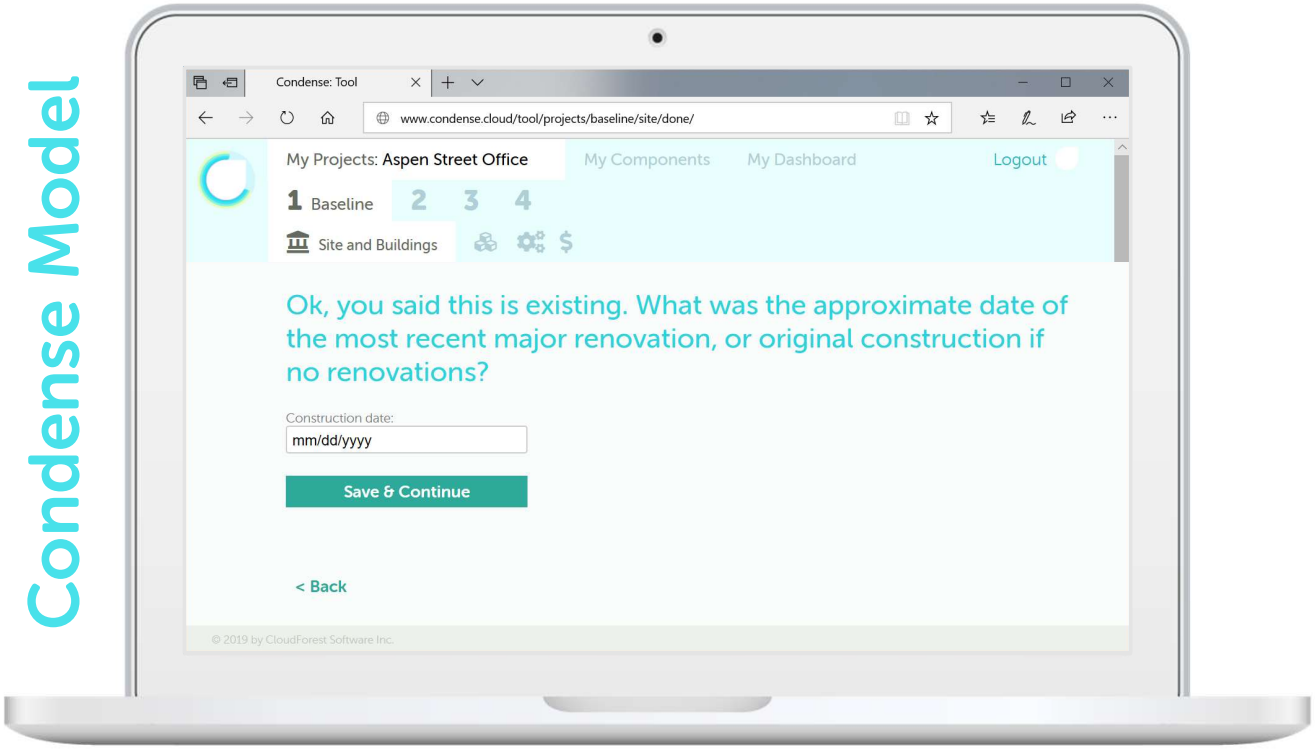
Traditional Models





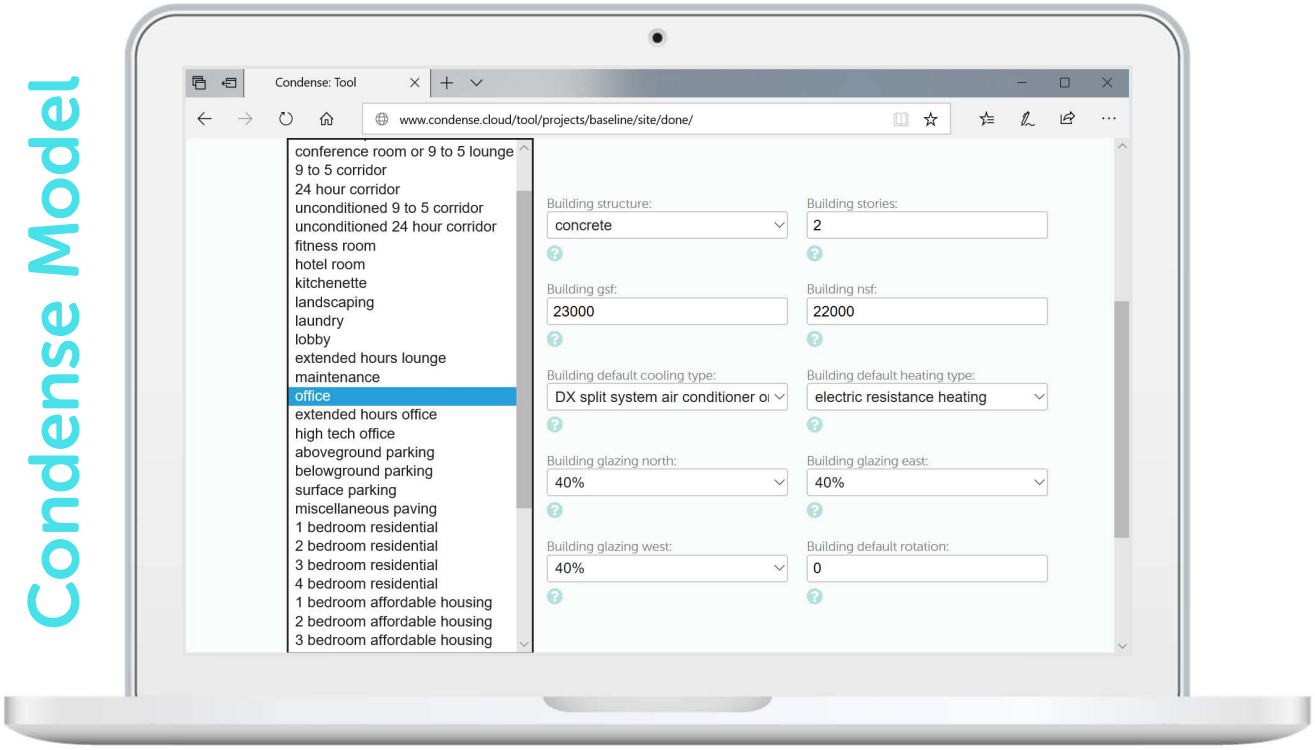
We exported the idf files from Open Studio and used the Energy Plus idf editor to more easily review inputs and make sure they were aligned with our Condense model inputs. Then we ran the model in Energy Plus with its correct weather file.

Condense Model

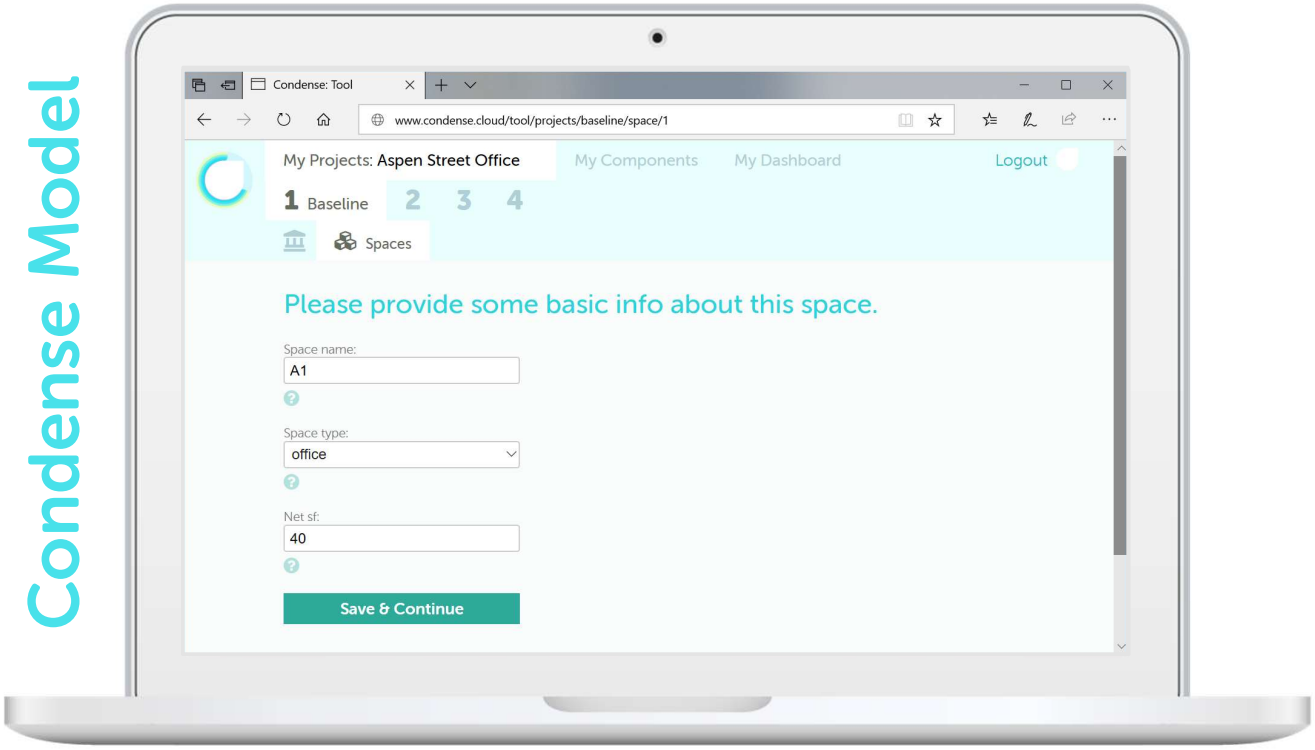


The Condense work flow was much simpler. The newest version of Condense is a modern website-based platform that guides you through with zero training required.

Condense Model

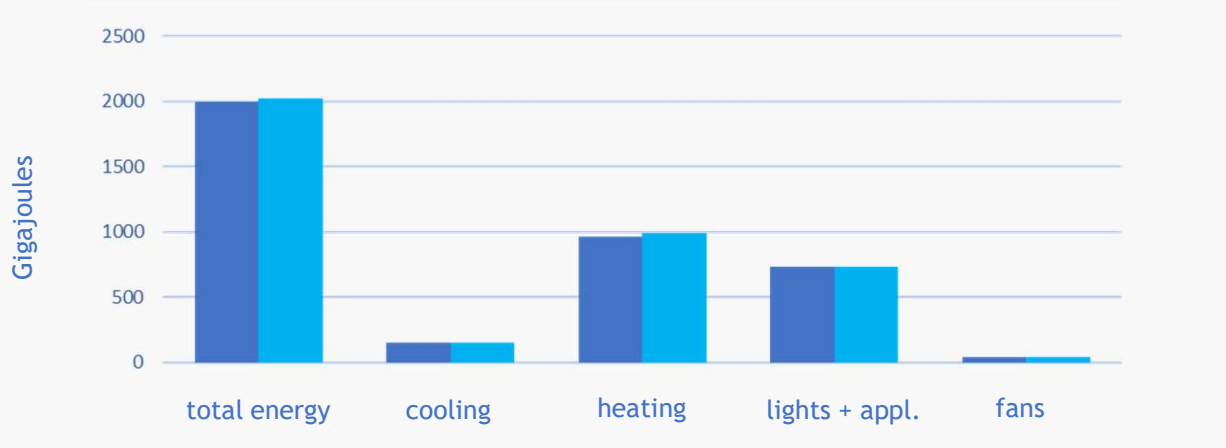


You can model new or existing buildings. You can model at the building level...



... or walk through space by space. There is zero drawing required, no jockeying between CAD programs, and just a few critical geometric inputs (square footage, estimated length of exposed walls only (non-exposed walls are ignored), and estimated window area). So, on geometry, Condense is MUCH faster and more foolproof than the traditional approach. When it comes to specifications (lighting, insulation, HVAC systems), Condense translates your project basics (location, year of construction, etc.) to predict what specifications are most likely in your building. So you start with a completely specified predictive model. You can then check the specs, such as your HVAC system type and equipment efficiency rating, but Condense guides you through in a way that is simple and understandable even to non-experts.. Your simple inputs are translated by powerful algorithms into the 3D and expert engineering inputs required by Energy Plus. You will get automatically produced Energy Plus models, with results automatically summarized, long-term financial outlook, and more.

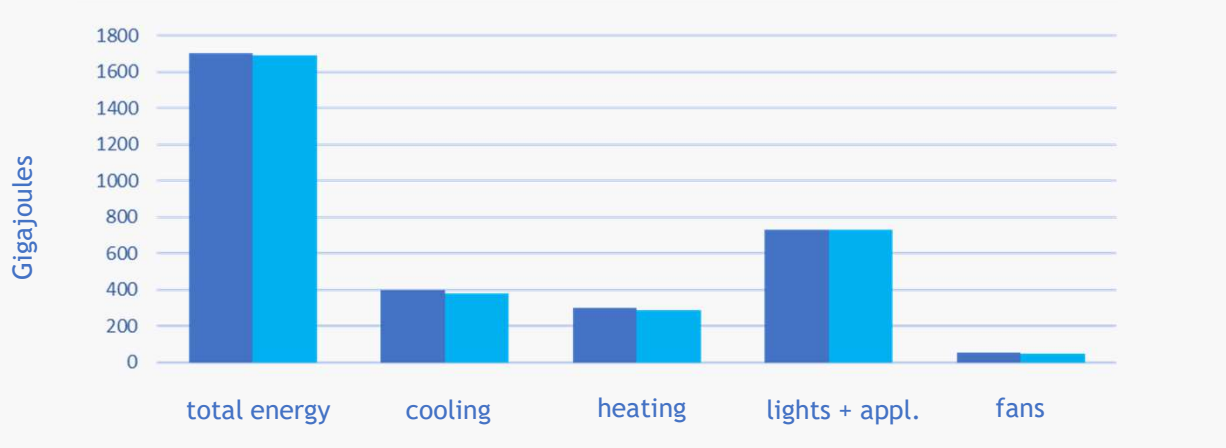
Results Comparison: Denver



- full traditional Energy Plus model from 3d CAD
- Condense

We compiled all results from the traditional vs. Condense energy models. We ran the energy models in both Austin, Texas as well as Denver, Colorado, in order to test a range of climates. The total margin of error was only 1.5% in Denver.

Results Comparison: Austin



- full traditional Energy Plus model from 3d CAD
- Condense

The total margin of error was only 0.6% in Austin.

Date/Time	Traditional Bottom 3	Condense Bottom 3	Difference
01/01 01:00:00	12,514,654	12,270,301	244,353
01/01 02:00:00	15,021,329	14,812,910	208,419
01/01 03:00:00	15,290,585	15,186,752	103,833
01/01 04:00:00	15,433,653	15,391,200	42,454
01/01 05:00:00	15,368,140	15,384,148	(16,008)
01/01 06:00:00	14,956,851	15,036,434	(79,583)
01/01 07:00:00	21,071,938	20,760,338	311,601
01/01 08:00:00	18,392,719	18,532,230	(139,511)
01/01 09:00:00	14,362,836	14,647,194	(284,358)
01/01 10:00:00	6,908,895	7,473,607	(564,711)
01/01 11:00:00	1,662,412	2,192,039	(529,627)
01/01 12:00:00	-	-	-
01/01 13:00:00	-	-	-
01/01 14:00:00	-	-	-
01/01 15:00:00	-	-	-
01/01 16:00:00	427,235	337,926	89,309
01/01 17:00:00	4,586,941	4,190,216	396,725
01/01 18:00:00	7,348,718	6,865,834	482,884
01/01 19:00:00	9,406,738	8,971,217	435,520

Overall numbers only tell part of the story. We also zoomed in on individual results for each of the 8760 hours of the year. Here you can see a sample of data for heating energy in J, for one zone ("Bottom 3"), over each hour of the whole year.

Heating

Hourly Results Analyzed (Difference of Condense vs. Traditional Model)

	Austin				Denver			
	Sum of hourly differences	Hours 2M J under traditional	Hours 2M J over traditional	Total hours of 2M discrepancy	Sum of hourly differences	Hours 2M J under traditional	Hours 2M J over traditional	Total hours of 2M discrepancy
Bottom Core	13%	86	0	86	7%	178	1	179
Bottom 4	1%	1	0	1	0%	0	0	0
Bottom 3	1%	0	0	0	0%	0	0	0
Bottom 2	0%	0	1	1	-1%	0	1	1
Bottom 1	-10%	0	1	1	-8%	0	1	1
Mid Core	19%	285	73	358	-9%	444	916	1360
Mid 4	9%	157	31	188	-2%	171	516	687
Mid 3	13%	106	0	106	4%	115	56	171
Mid 2	6%	120	46	166	-3%	113	570	683
Mid 1	0%	11	2	13	-5%	1	48	49
Top Core	9%	382	236	618	-14%	492	1548	2040
Top 4	5%	171	68	239	-4%	186	874	1060
Top 3	9%	97	1	98	1%	76	143	219

We used two metrics to verify how accurate our model was with the traditional model, hour by hour. 1) We looked, zone by zone, at the sum of differences for each hour divided by total traditional result (to make a %). 2) We also used a divergence of over 2,000,000 J in one hour as a flag, and counted the number of times this occurred in each zone. With both metrics, the greatest discrepancies occurred in the core zones. But generally the hours trend similarly on the traditional and Condense models, and discrepancies are in an acceptable range for modeling relative effects of energy savings measures. A summary for heating is shown above.

Cooling

Hourly Results Analyzed (Difference of Condense vs. Traditional Model)

	Austin				Denver			
	Sum of hourly differences	Hours 2M J under traditional	Hours 2M J over traditional	Total hours of 2M discrepancy	Sum of hourly differences	Hours 2M J under traditional	Hours 2M J over traditional	Total hours of 2M discrepancy
Bottom Core	1%	349	349	698	1%	235	106	341
Bottom 4	0%	31	264	295	2%	31	45	76
Bottom 3	-1%	36	126	162	0%	28	41	69
Bottom 2	0%	1	280	281	0%	2	68	70
Bottom 1	0%	0	0	0	2%	0	16	16
Mid 3	2%	597	105	702	13%	1045	21	1066
Top Core	4%	1771	846	2617	15%	1910	375	2285
Top 4	5%	1005	457	1462	14%	1235	209	1444
Top 3	4%	658	142	800	14%	1111	12	1123

This is the summary of Cooling hour-by-hour, zone-by-zone, per the methodology described in the previous page. (To see full detailed results and hourly trending, as well as the energy model files, please contact us.)