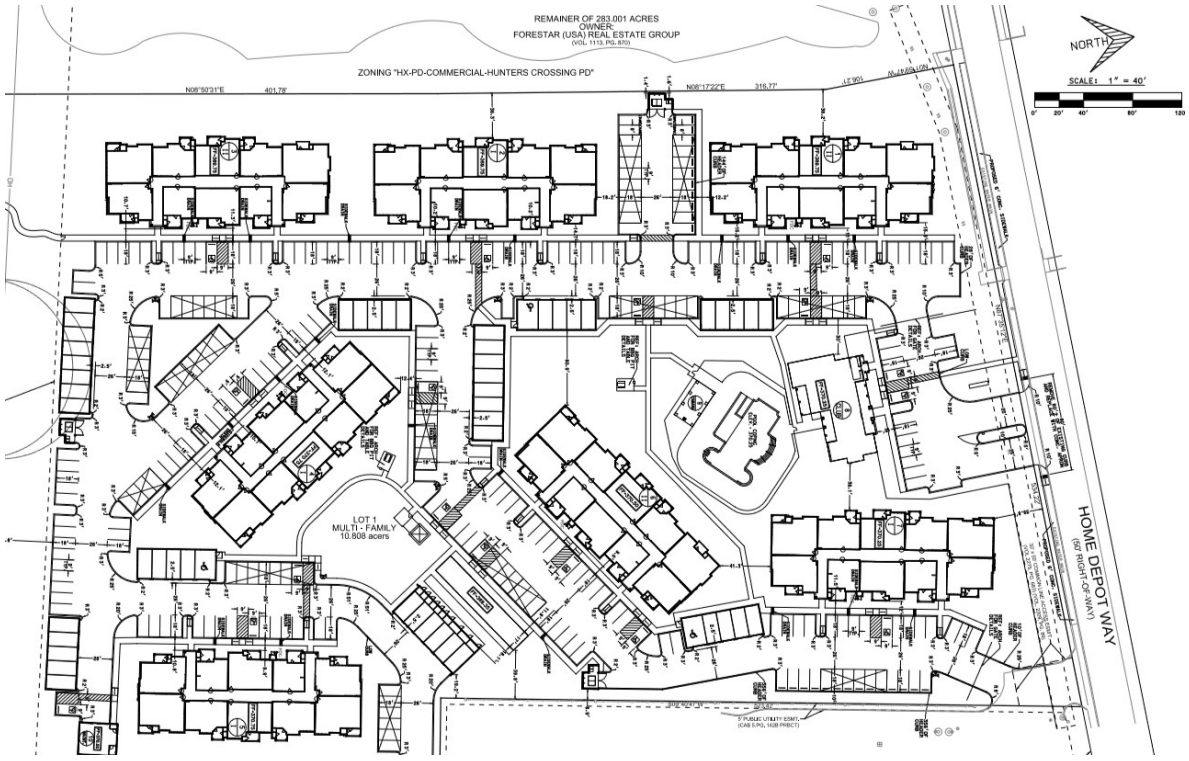
Case Study:
Multifamily with Complex Envelope

Condense

Building decisions in full context, less time.

This case study shows the relative accuracy of the easy Condense energy modeling platform compared to traditional Energy Plus modeling. This particular case study looks at a multifamily apartment complex that includes a clubhouse with light commercial spaces. The apartment buildings have complex exterior walls that jog in and out. The Condense energy results varied from traditional modeling results by only 0.1% to 0.6% (depending on location), yet Condense was much quicker and easier to use, with far less opportunity for human error in entering inputs.

This project was part of a series of similar projects we modeled for HUD MIP reduction documentation. All were approved by the HUD reviewer.



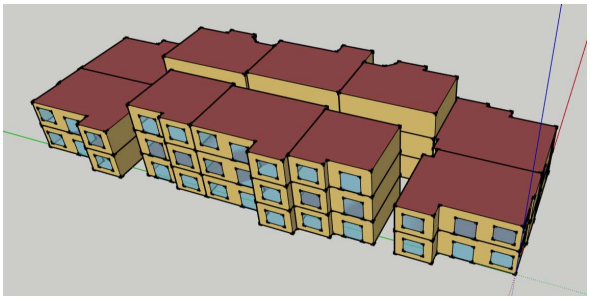
The project was a typical low rise multifamily development near Austin, Texas, with 3-story multi-unit buildings in a variety of orientations and unit combinations, and a central amenity center that includes offices, fitness room, and lounge space.

Energy Basics	Lighting w/sf	0.51
	Wall reflectance > 60%	no
	Ceiling reflectance > 80%	no
	Lighting controls	none
	HVAC type	accool-elecheat
	Cooling Performance	14 SEER
	Cooling COPnf	3.82
	Heating HSPF (for heat pump)	0.95
	Heating Eff (furnace, boiler, electric resistanc	0.95
	HVAC Fan Efficiency	0.70
	Exhaust Fan Efficiency	0.70
	Exhaust Fan Flow Rate (CFM)	110.00
	Tower Pump Head (Pa)	150000
	Chiller or Boiler Pump Head (Pa)	150000
	Zone Distribution Loop Pump Head (Pa)	150000
Ventilation	CFM per occupant	30.00
	CFM total	90.00
	CFM/sf	0.08
Infiltration	Infiltration Calc Method	AirChanges/Hour
	Infiltration ACH	5ACH50
	Infiltration per Exterior Area (CFM/sf)	0.40
	Duct Leakage (DSE)	0.95
Exterior walls	Wall Frame Type	wood_at16o.c.
	Wall Insulation Batt or Fill	R-13 batt or fill
	Wall Insulation Continuous	
	Wall Inside Layer	gyp board
	Wall Assembly R	11.24
Roof	Roof Attic or Purlin Insulation	attic-R-38
	Roof Continuous Insulation	
	Roof Assembly R	37.04
	Roof Solar Abs	0.30

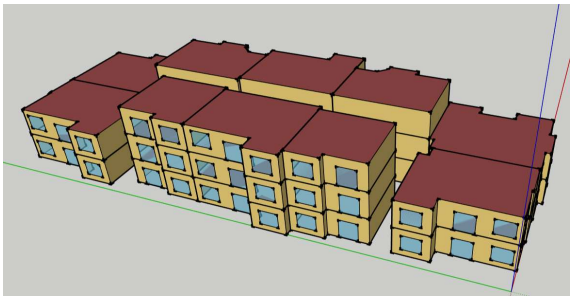
Unconditioned floors	Floor Frame Type	concrete
	Floor Insulation	R-11 batt
	Floor Assembly R	14.06
Solid doors	Door R - Value	2.60
Windows	U-Factor Fixed (North)	0.33
	U-Factor Fixed (SEW)	0.33
	U-Factor Operable (North)	0.33
	U-Factor Operable (SEW)	0.33
	U-Factor Glazed Doors (North)	0.33
	U-Factor Fixed (SEW)	0.33
	SHGC Fixed (North)	0.23
	SHGC Fixed (SEW)	0.23
	SHGC Operable (North)	0.23
	SHGC Operable (SEW)	0.23
	SHGC Glazed Doors (North)	0.23
	SHGC Glazed Doors (SEW)	0.23
Appliances	refrigerator watts	61.00
	Dishwasher watts	370.00
	Stove Type	electric
	Stove watts	4500.00
	Clotheswasher watts	400.00
	Dryer watts	2950.00
Electrical Loads	Plug Load (w/sf)	0.50
	Special Electric Equipment	
	Special Electric Equipment Schedule	Standard
Water heater	WH type	#REF!
	WH efficiency	#REF!
	max flow rate	2.00
Water use	toilets type	regular
	toilets gallons per flush	1.28
	urinals gallons per flush	1.60
	lavs type	regular
	lavs gallons per minute	1.00
	kitchen faucets gallons per minute	1.80
	showers gallons per minute	2.00
Thermostat	Heating setpoint °F	70.00
	Heating Setpoint Schedule	Standard
	Cooling setpoint °F	75.00
	Cooling Setpoint Schedule	Standard

HVAC systems were typical air conditioners with electric heat, and energy specs such as insulation and lighting were typical. The original project had some variation in specs between multifamily unit types, but for this case study we normalized them across the project as listed above. The amenity center was similar but with lighting at 0.85 w/sf.

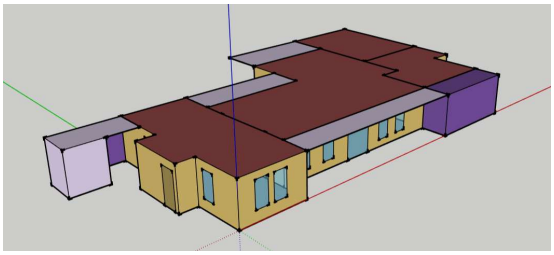
Traditional Models



Building Type I



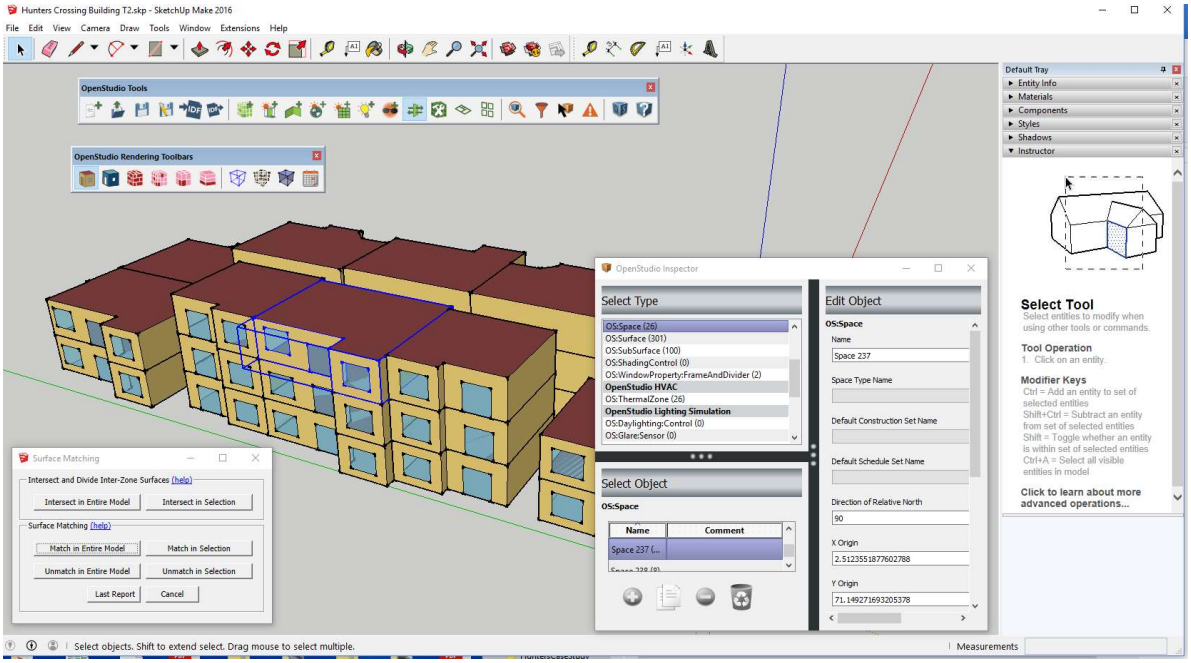
Building Type II



Amenity Center with shading

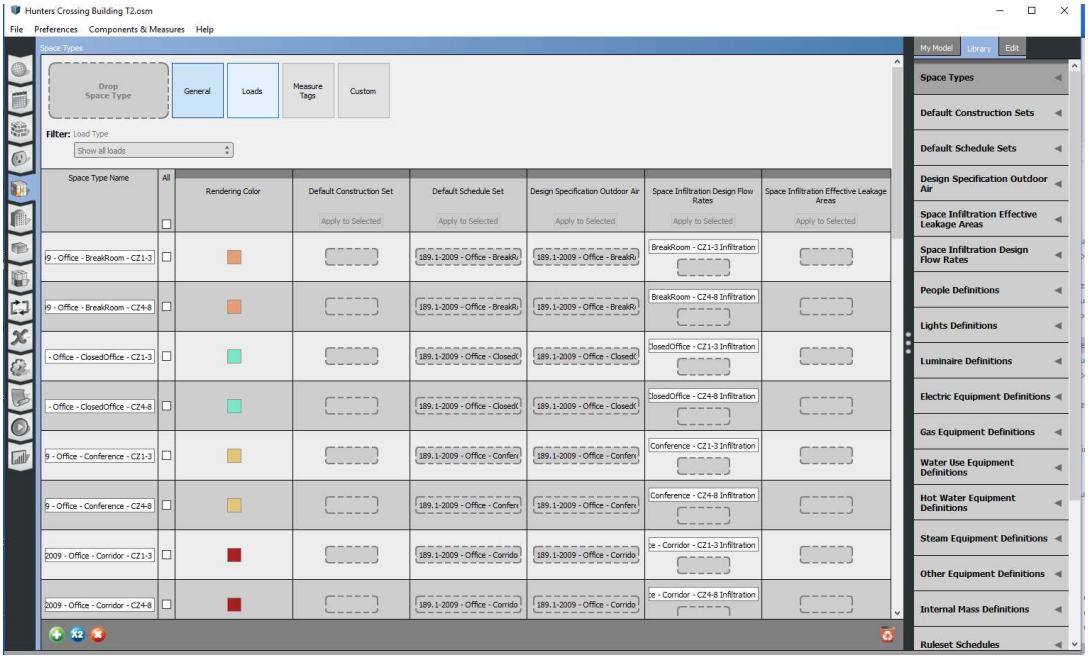
The traditional models started with full building 3D CAD models, with each zone drawn and placed, including detailed wall layout with jogs and detailed window placement. The clubhouse model includes several shading elements (covered porches).

Traditional Models



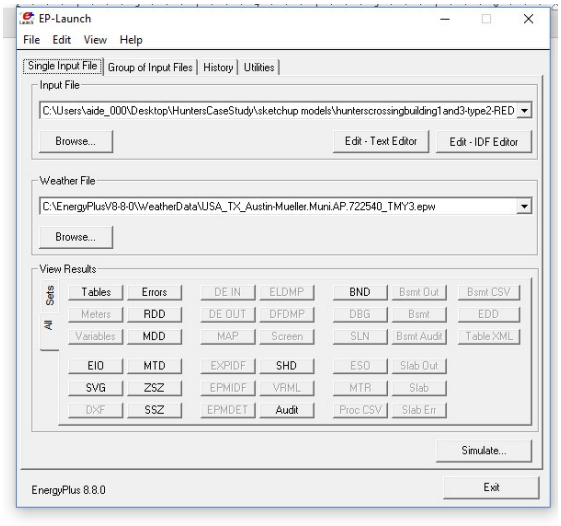
These models were created in Sketchup 2016, then, using an Open Studio plugin compatible with that Sketchup version, they were translated into Energy Plus Open Studio models with thermal zones and matching of adjacent surfaces to model heat transfer between zones. Many things can go wrong during this 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.

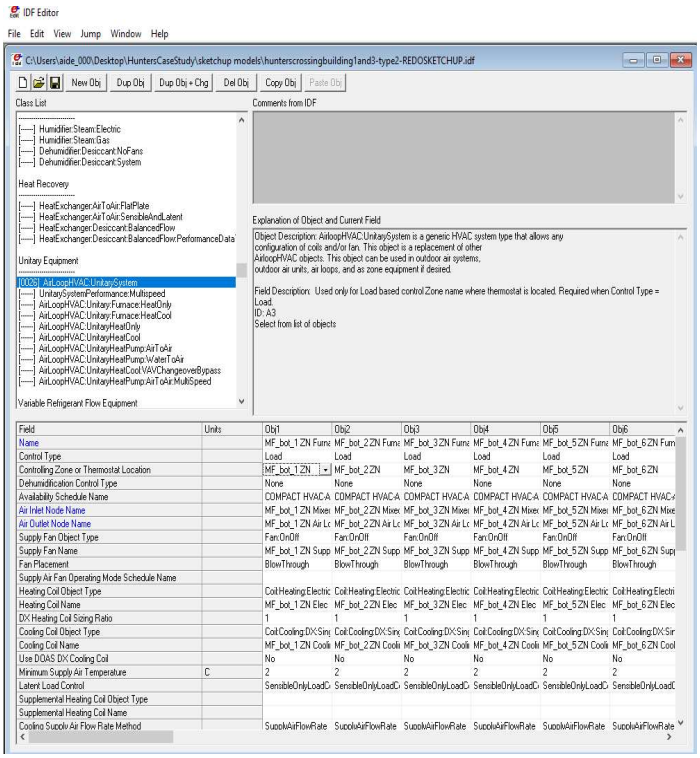
Traditional Models



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.

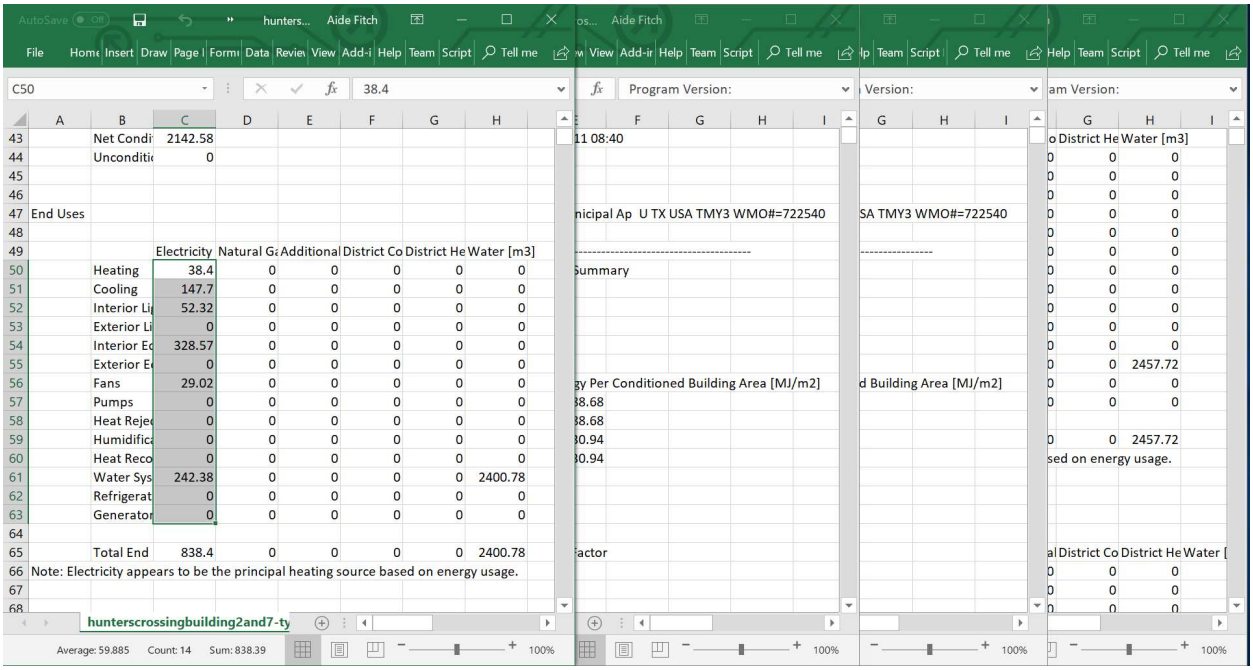
Traditional Models





Since there were two common multifamily building types with minor variations such as orientation, we exported the common idf files from Open Studio and used the Energy Plus idf editor to make the minor adjustments to each model. Then we ran each building in Energy Plus with its correct weather file.

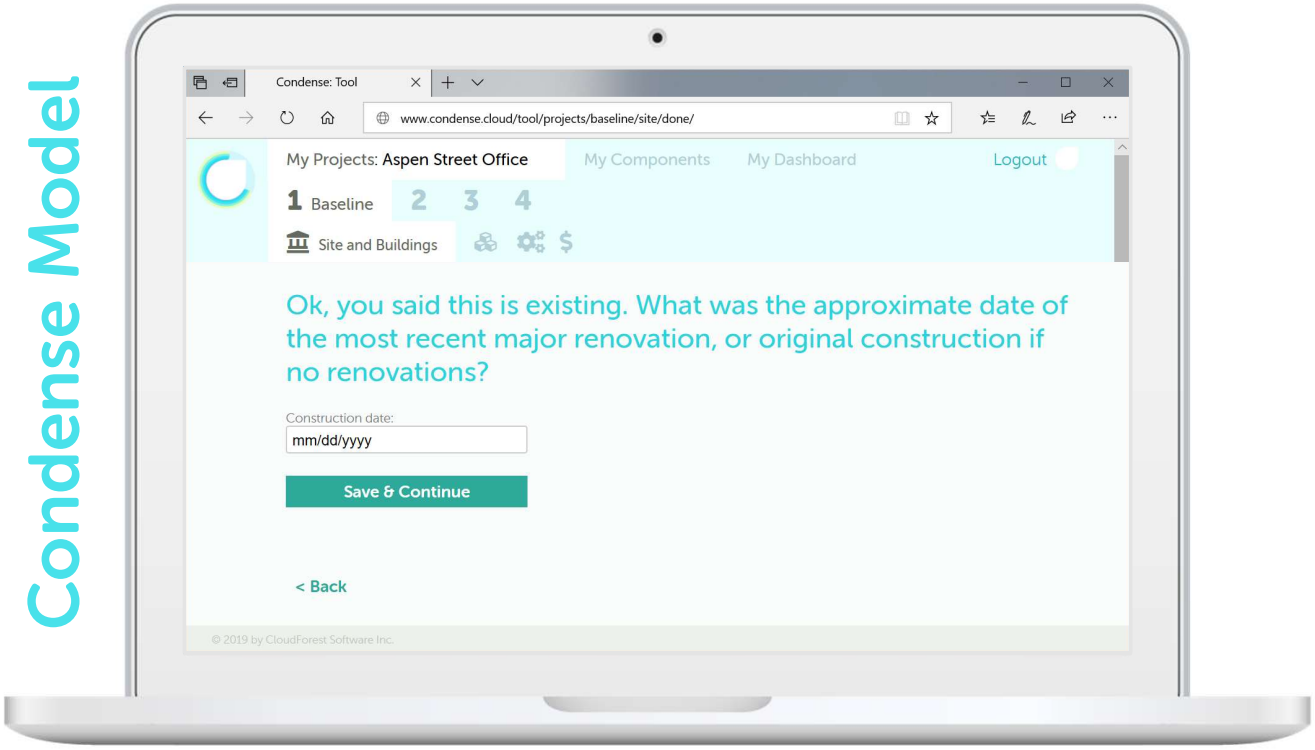
Traditional Models



	A	B	C	D	E	F	G	H
43		Net Condi	2142.58					
44		Unconditi	0					
45								
46								
47	End Uses							
48								
49			Electricity	Natural G	Additional	District Co	District He	Water [m3]
50		Heating	38.4	0	0	0	0	0
51		Cooling	147.7	0	0	0	0	0
52		Interior Li	52.32	0	0	0	0	0
53		Exterior Li	0	0	0	0	0	0
54		Interior Ec	328.57	0	0	0	0	0
55		Exterior Ec	0	0	0	0	0	0
56		Fans	29.02	0	0	0	0	0
57		Pumps	0	0	0	0	0	0
58		Heat Reje	0	0	0	0	0	0
59		Humidifica	0	0	0	0	0	0
60		Heat Reco	0	0	0	0	0	0
61		Water Sys	242.38	0	0	0	0	2400.78
62		Refrigerat	0	0	0	0	0	0
63		Generator	0	0	0	0	0	0
64								
65		Total End	838.4	0	0	0	0	2400.78
66	Note: Electricity appears to be the principal heating source based on energy usage.							
67								
68								

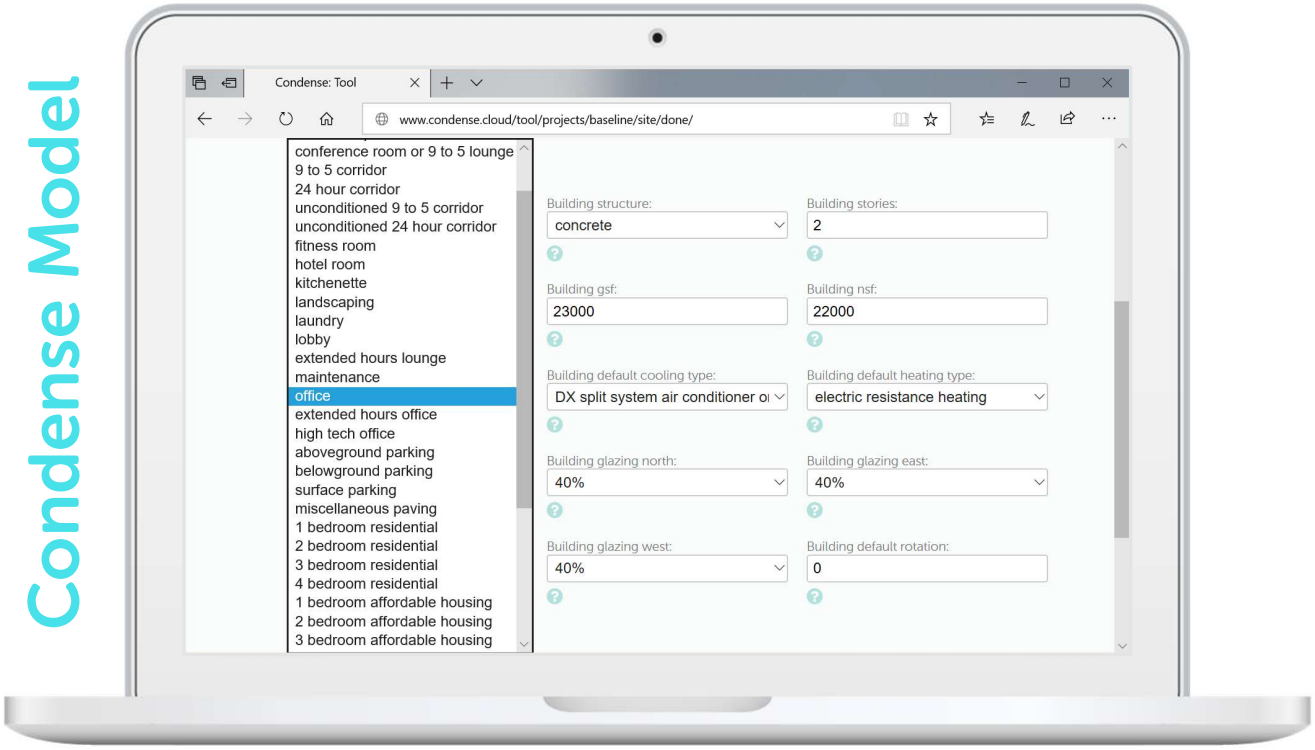
We collected and compiled results from each output csv file.

Condense Model

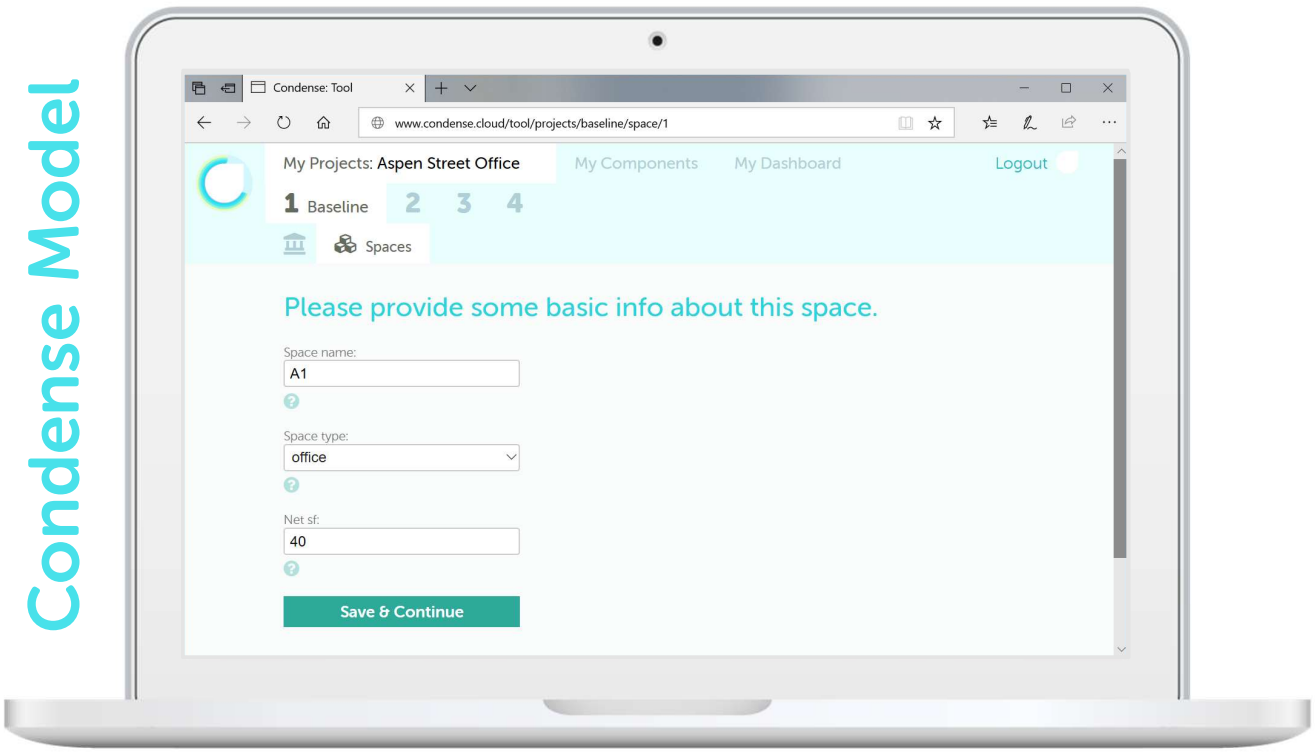


The Condense work flow was much simpler. The newest version of Condense is a modern website-based platform that guides you through with zero training required.

Condense Model

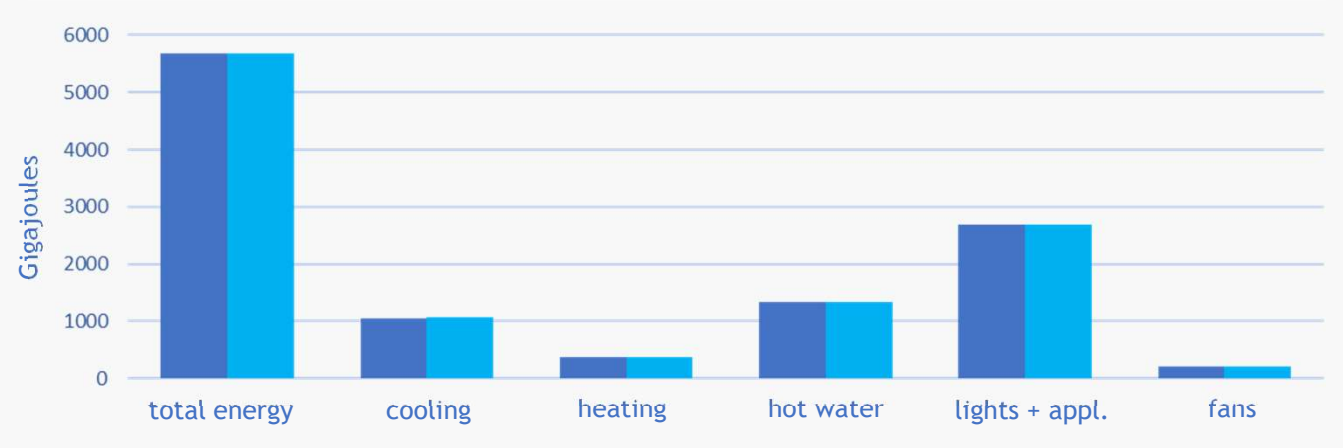


You can model new or existing buildings. You can model at the building level...



... 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: Austin, TX



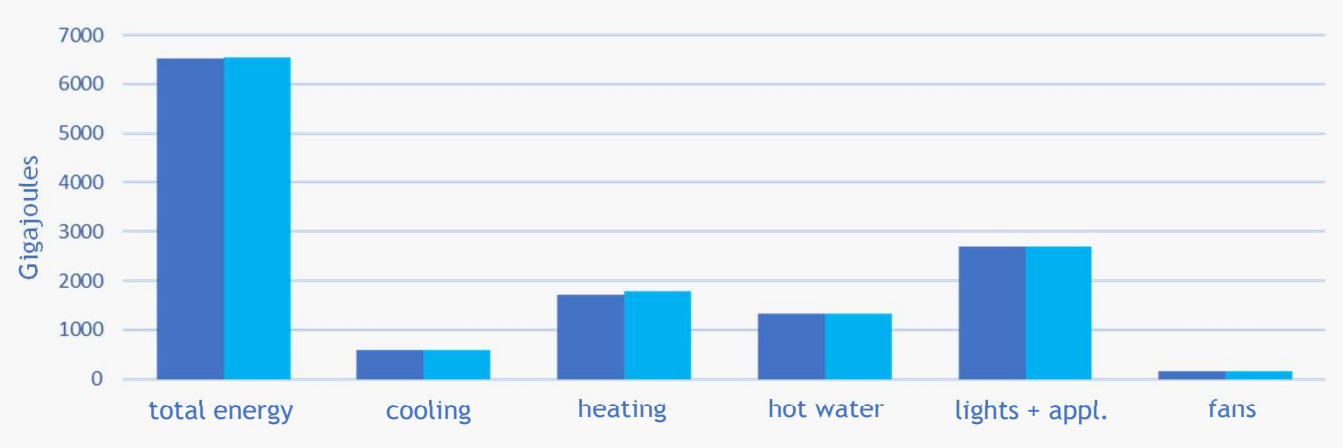
- full traditional Energy Plus model from 3d CAD
- Condense

We compiled all results from the traditional vs. Condense run. Above you can see results for the model located in Austin, TX, with appropriate weather files. The total margin of error was only 0.1%, with a margin of 0.5% for heating and 0.5% for cooling. These are negligible margins of error that show that the Condense model is equivalent to a traditional Energy Plus model in its ability to predict both overall building performance, and relative savings from energy efficiency strategies.

full traditional model from 3d CAD (results are in GJ)						
	total energy	cooling	heating	hot water	ts + appliances	fans
Building 1	797	149	54	192	373	30
Building 2	795	148	54	190	373	30
Building 3	797	149	54	192	373	30
Building 4	795	147	54	190	373	29
Building 5	789	143	54	190	373	28
Building 6	789	142	53	192	373	28
Building 7	795	148	54	190	373	30
Amenity	126	33	4	0	83	5
total project	5682	1057	382	1337	2695	208
Condense (results are in GJ)						
	total energy	cooling	heating	hot water	ts + appliances	fans
Building 1	796	149	54	192	372	29
Building 2	794	148	54	190	372	29
Building 3	796	149	54	192	372	29
Building 4	788	143	54	190	372	28
Building 5	794	148	54	190	372	29
Building 6	789	142	54	192	372	28
Building 7	794	148	54	190	372	29
Amenity	128	37	2	0	83	6
total project	5678	1063	380	1337	2688	209
margin	**0.1%**	**-0.5%**	**0.5%**	**0.0%**	**0.3%**	**-0.5%**

Above are tabulated building-by-building results from the Austin location. Detailed models and results are available on request.

Results Comparison: Richmond, VA



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

To test a range of climate zones, we also ran the same models in Richmond, VA, with appropriate weather files. The total margin of error was only 0.6%, with a margin of 3% for heating and 0.1% for cooling. The main discrepancy was in the heating, where Condense slightly overestimated heating. However, this is still in a range that allows accurate prediction of savings from energy efficiency strategies.

full traditional model from 3d CAD (results are in GJ)						
	total energy	cooling	heating	hot water	ts + appliances	fans
Building 1	915	84	244	192	373	22
Building 2	914	84	245	190	373	22
Building 3	915	84	244	192	373	22
Building 4	913	84	245	190	373	22
Building 5	908	80	243	190	373	21
Building 6	906	81	239	192	373	21
Building 7	914	84	245	190	373	22
Amenity	132	22	23	0	83	5
total project	6517	602	1727	1337	2695	155
Condense (results are in GJ)						
	total energy	cooling	heating	hot water	ts + appliances	fans
Building 1	921	84	251	192	372	22
Building 2	920	84	252	190	372	22
Building 3	921	84	251	192	372	22
Building 4	913	80	250	190	372	21
Building 5	920	83	252	190	372	22
Building 6	914	80	252	192	372	21
Building 7	920	84	252	190	372	22
Amenity	128	23	18	0	83	4
total project	6557	602	1778	1337	2688	154
margin	**-0.6%**	**0.1%**	**-3.0%**	**0.0%**	**0.3%**	**0.7%**

Above are tabulated building-by-building results from the Richmond, VA location. Detailed models and results are available on request.