WUFI Passive Simulation

Tiered Retrofit Strategies for a 1901 New York Row House

4. Baseline Model

The baseline model builds the existing performance condition of a typical New York City row-house prior to any retrofit intervention. The model is based on a representative early twentieth-century rowhouse in Brooklyn, constructed in 1901, as shown in Figure 6, reflecting common construction methods and material conditions found throughout New York City's historic residential housing stock.

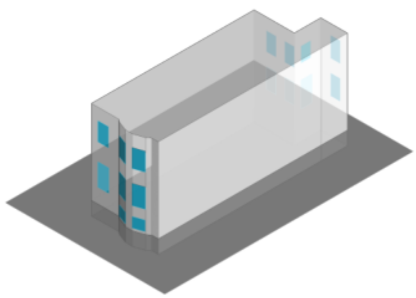
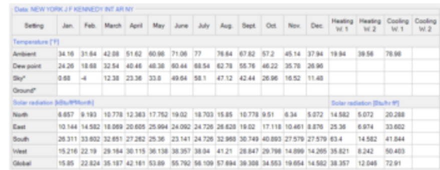


Figure 6. Baseline Row-House Geometry and Spatial Organization

The interior-lot baseline model is Located in Brooklyn, New York, the environmental simulations and climate evaluations utilize the John F. Kennedy International Airport (JFK) weather data set, corresponding to Climate Zone 4A.

Figure 7. Location of Baseline Row-House



Data: NEW YORK J F KENNEDY INT AR NY

Setting	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Heating W. 1	Heating W. 2	Cooling W. 1	Cooling W. 2
Temperature [°F]																
Ambient	34.16	31.64	42.08	51.62	60.98	71.06	77	76.64	67.82	57.2	45.14	37.94	19.94	39.56	78.98	
Dew point	24.26	18.68	32.54	40.46	48.38	60.44	68.54	62.78	55.76	46.22	35.78	26.96				
Sky*	0.68	-4	12.38	23.36	33.8	49.64	58.1	47.12	42.44	26.96	16.52	11.48				
Ground*																
Solar radiation [kBtu/ft²Month]													Solar radiation [Btu/hr ft²]			
North	6.657	9.193	10.778	12.363	17.752	19.02	18.703	15.85	10.778	9.51	6.34	5.072	14.582	5.072	20.288	
East	10.144	14.582	18.069	20.605	25.994	24.092	24.726	26.628	19.02	17.118	10.461	8.876	25.36	6.974	33.602	
South	26.311	33.602	32.651	27.262	25.36	23.141	24.726	32.968	30.749	40.893	27.579	27.579	63.4	14.582	41.844	
West	15.216	22.19	29.164	30.115	36.138	38.357	38.04	41.21	28.847	29.798	14.899	14.265	35.821	8.242	50.403	
Global	15.85	22.824	35.187	42.161	53.89	55.792	56.109	57.694	39.308	34.553	19.654	14.582	38.357	12.046	72.91	

Figure 8. JFK Int.Airport Weather Data Set

The selection of the Brooklyn context is important, as the climatic conditions of New York City, characterized by cold winters, humid summers, and significant seasonal fluctuations, directly influence the thermal and moisture behavior of the row houses, constructed using traditional Masonry Construction Methods.

The baseline building reflects common construction methods found throughout New York City rowhouse development during this period. The structure consists primarily of multi-wythe masonry bearing walls, wood-framed floor assemblies, limestone foundation walls, and wood roof framing systems, as illustrated in the wall section studies and assembly details, shown in Appendix F.

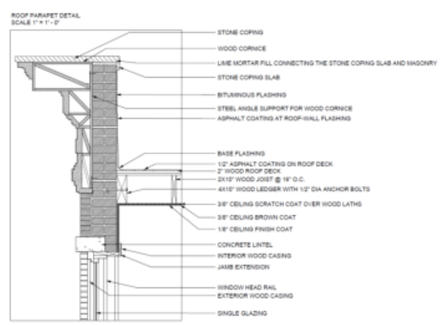


Figure 9. Sample of Baseline Model Material Construction Wall Section

1. Research Context

This simulation study investigates how retrofit intensity changes the environmental performance of a representative early twentieth-century New York City row house. The broader research frames retrofit as a tiered decision problem rather than a single all-or-nothing intervention.

The study compares three levels of intervention: component retrofit, code-compliant retrofit, and Passive House / EnerPHit-level deep retrofit. The intent is to evaluate the trade-offs among energy performance, constructability, material complexity, spatial impact, and practical feasibility.

Case Study

The baseline model represents a 1901 Brooklyn row house in Climate Zone 4A. The research describes the existing condition as multi-wythe masonry construction with limited or no insulation, single-glazed windows, traditional construction assemblies, and relatively uncontrolled infiltration. JFK weather data is used for the environmental simulation.

Why WUFI Passive?

WUFI Passive is used to study whole-building energy performance together with the thermal and hygrothermal behavior of enclosure assemblies. Key inputs identified in the research include wall U-values, window U-values, thermal-bridge coefficients (ψ-values), insulation thickness, airtightness assumptions, and ventilation-system performance.

Important: the uploaded research document is still a work in progress. Appendix H currently contains one documented WUFI result set rather than completed results for all three tiers. This report therefore presents the available simulation as a **preliminary component-retrofit case** and does not invent missing Tier 2 or Tier 3 results.

2. Experimental Framework

The research controls building geometry, occupancy assumptions, and climate conditions so that changes in performance can be attributed to the retrofit strategy. Across the tiers, the principal variables are envelope thermal resistance, window performance, airtightness, and mechanical systems.

	Tier 1	Tier 2	Tier 3
Approach	Component retrofit	Code-compliant retrofit	Passive House / EnerPHit
Envelope	Partial insulation + air sealing	Moderate continuous insulation	High-performance continuous insulation
Wall target	R-5 to R-10	R-15 to R-25	R-30+
Windows	Double glazing U ~0.4–0.5	Low-E double glazing U ~0.25–0.3	Triple glazing U ≤ 0.14
Airtightness	Minimal improvement	Moderate improvement	<0.6 ACH
HVAC	Existing / partial upgrade	Efficient heat pump systems	Integrated HVAC + ERV/HRV
Complexity	Low	Moderate	High

Available WUFI Experiment: Blown-In Cellulose Wall Retrofit

Appendix H documents a component-level exterior-wall insulation experiment. The modeled assembly is listed as 4 in. face brick, 10 in. middle brick, 0.5 in. lime plaster on wood lath, 3.5 in. blown-in cellulose, a vapor retarder, and 3/8 in. interior gypsum plaster.

The WUFI assembly table reports a total thermal resistance of approximately **R-19.564 hr·ft²·°F/Btu**. Within that assembly, the 3.5 in. cellulose layer contributes approximately **R-14.14**.

APPENDIX H - WUFI RESULTS

H1. GENERAL

This appendix documents the material selections and assembly systems proposed across the three retrofit tiers developed within this study. The material schedules are organized according to varying levels of environmental intervention, ranging from incremental component upgrades to comprehensive high-performance retrofit assemblies aligned with Passive House and EnerPHit methodologies.

The purpose of this appendix is to illustrate how material selection evolves in response to increasing performance demands, airtightness requirements, vapor control strategies, and thermal continuity objectives. Each retrofit tier reflects a different balance between environmental performance, constructability, preservation concerns, spatial impact, and economic feasibility. Rather than proposing a singular universal solution, the study establishes a comparative framework that evaluates how varying assembly strategies interact with the existing conditions of historic New York City rowhouses.

The material assemblies documented within this appendix are derived through a combination of IECC and New York City Energy Code requirements, Passive House / EnerPHit standards, manufacturer technical documentation, and precedent studies involving historic masonry retrofit systems.

G2. By Component

G2.1 Exterior Wall Insulation - Blown-In Cellulose

Retrofit: Wall 4" Face Brick, 10" Middle Brick, 0.5" Plaster on Wood Lath, 3.5" Blown-in Cellulose, 3/8" Interior Finish

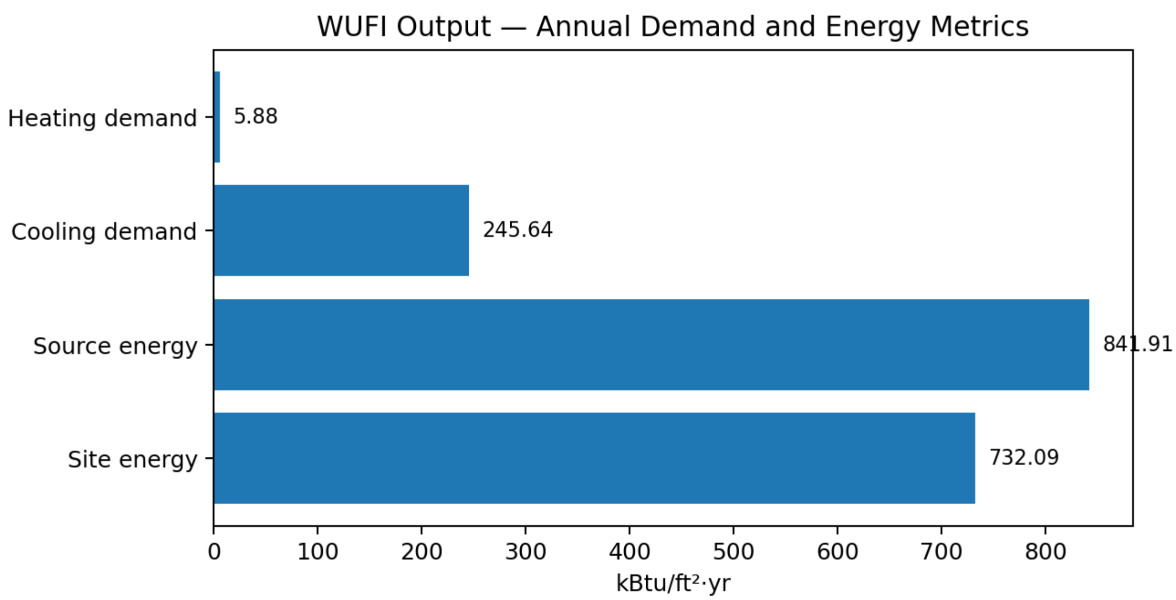
Thermal resistance [hr ft² °F/Btu]: 19.564 / 19.564 (EN ISO 6946 / homogenous layers)

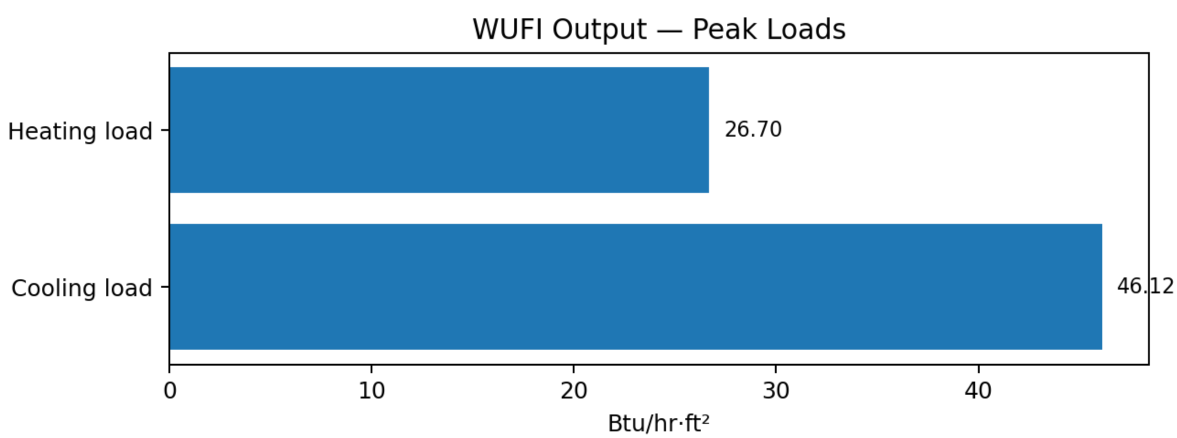
Nr.	Material / Layer (from outside to inside)	Color	λ [Btu/hr ft °F]	Thickness [in]	R [hr ft² °F/Btu]
1	Brick (old)		0.2311	4	1.442
2	Brick (old)		0.2311	10	3.606
3	Lime Plaster (stucco, A-value: 3.0 l		0.4045	0.5	0.103
4	Cellulose Insulation		0.0206	3.5	14.14
5	vapor retarder (0.1perm)		1.3289	3.9E-2	0.002
6	Interior Plaster (Gypsum Plaster)		0.1156	0.375	0.27

3. Preliminary WUFI Results

The available WUFI output reports the following whole-building metrics for the documented component-retrofit simulation. These values are reproduced directly from Appendix H.

WUFI metric	Reported value	Unit
Heating demand	5.88	kBtu/ft²·yr
Cooling demand	245.64	kBtu/ft²·yr
Heating load	26.70	Btu/hr·ft²
Cooling load	46.12	Btu/hr·ft²
Source energy	841.91	kBtu/ft²·yr
Site energy	732.09	kBtu/ft²·yr





The annual energy metrics and peak-load metrics are charted separately because they use different units. The WUFI screenshot in the source document displays red status indicators beside the reported metrics; this report preserves the numerical output without reinterpreting those status checks.

4. Interpretation and Next Simulation Steps

The strongest value of this research is not a single WUFI number; it is the comparative framework. A component retrofit establishes the lower-intervention case, while the code-compliant and Passive House / EnerPHit scenarios are intended to test progressively more integrated envelope, airtightness, glazing, ventilation, and mechanical strategies.

What the current model demonstrates

The current Appendix H case shows how a historically masonry-based wall can be translated into a defined WUFI assembly and evaluated quantitatively. It also creates a repeatable baseline for later experiments in which insulation level, window performance, airtightness, thermal bridges, and ventilation can be changed while geometry and climate remain controlled.

Recommended comparison set for the next iteration

To complete the study as originally structured, the same output metrics should be recorded for the baseline, Tier 1, Tier 2, and Tier 3 models. The final comparison can then calculate percentage change in heating demand, cooling demand, source energy, site energy, and peak loads. Those values would support a true tier-by-tier bar chart and allow the website case study to state measured reductions rather than projected performance.

Website-ready research takeaway

Question: How far can incremental retrofit measures improve a historic New York row house, and when does a whole-building strategy become necessary?

Method: A 1901 Brooklyn row house is modeled in WUFI Passive using a controlled Climate Zone 4A baseline. Retrofit strategies are organized into component, code-compliant, and Passive House / EnerPHit tiers and evaluated through changes to envelope assemblies, glazing, airtightness, thermal bridges, and mechanical systems.

Current stage: The preliminary WUFI model documents a blown-in-cellulose wall retrofit and establishes the workflow for a broader comparative simulation study.

Source

Adapted from Jenny (Xinyu) Ye, "Evaluating Tiered Retrofit Strategies in a 1901 New York Row House: A Simulation-Based Approach," May 5, 2026. This condensed report uses the research language, framework, assembly data, and preliminary WUFI output contained in the uploaded working paper.