Model Conservation Standards

COST-EFFECTIVENESS AND ECONOMIC FEASIBILITY OF THE MODEL CONSERVATION STANDARDS FOR NEW RESIDENTIAL BUILDINGS

This appendix provides an overview of the method and data used to evaluate the regional cost-effectiveness and consumer economic feasibility of the Council's Model Conservation Standards for New Residential Buildings. The first section describes the methodology, cost and savings assumptions used to establish the efficiency level that achieves all electricity savings that are cost-effective to the region's power system. The second section describes the methodology and assumptions used to determine whether the regionally cost-effective efficiency levels are economically feasible for new homebuyers in the region.

REGIONAL COST EFFECTIVENESS

Base Case Assumptions

Since the Council first promulgated its model conservation standards for new residential constructions in 1983 all of the states in the region have revised their energy codes. Consequently, many of the conservation measures included in the Council's original standards have now been incorporated into state regulations. In addition, some of the measures identified in prior Council Power Plan's as being regionally cost-effective when installed in new manufactured homes are now required by federal regulation.[1] This analysis assumes that the "base case" construction practices in the region comply with existing state codes and federal standards. However, since not all of the energy codes in the region are equally stringent this analysis uses the less restrictive measure permitted by code for each building component (e.g., walls, windows, doors, etc.). Table G-1 shows the levels of energy efficiency assumed for new site built and manufactured homes built to existing state codes and federal standards.

[1] The energy efficiency of new manufactured homes are regulated under the National Manufactured Housing Construction and Safety Standards Act of 1974. 42 USC §5401 et seq. (1983) which also pre-empts state regulation of their construction.

Table G-1: Base Case Efficiency Level Assumptions

Component	Site Built Homes	Manufactured Homes
Attic	R38 Standard Framing	R38 Intermediate Framing
Door	R5	R5
Floor	R25	R22
Infiltration	0.35 Air changes per hour	0.35 Air changes per hour
Joisted Vault	R30	R19
Slab-on-Grade (F-Value/linear foot of perimeter)	R10	Not Applicable
Trussed Vault	R38	R19
Wall	R19 Standard Framing	R19
Wall Below Grade (Interior)	R11	Not Applicable
Slab-below-Grade (F-Value/lin.ft. perimeter)	R10	Not Applicable
Window	Class 40 (U<0.40)	Class 50 (U<0.50)

Measure Cost Assumptions

The cost data for new site built homes used in the Council's analysis were obtained from a 1994 survey of new residential construction costs prepared for Bonneville.[2] These costs were converted to year 2000 dollars using the GDP Deflator from mid-1994 to mid-2000. Costs were obtained from builders, subcontractors and materials suppliers from across the region and include a 36 percent markup for overhead and profit. Table G-1 provides a summary of the incremental costs used in the staff analysis for site built homes.

Cost for new manufactured home energy efficiency improvements were obtained from regional manufacturers, insulation and window.[3] Table G-2 summarizes this same information for manufactured homes. These cost assume a manufacturer markup on material costs of 200 percent to cover labor and production cost and profit as well as and a retailer markup of 35 percent.

[2] Frankel, Mark, Baylon, D. and M. Lubliner 1995. Residential Energy Conservation Evaluation: Cost-Effectiveness of Energy Conservation Measures in New Residential Construction in Washington State. Washington State Energy Office, Olympia, WA. and the Bonneville Power Administration, Portland, OR.

[3] Davis, Robert, D. Baylon and L. Palmiter, 1995 (draft report). *Impact Evaluation of the Manufactured Housing Acquisition Program (MAP).* Bonneville Power Administration, Portland, OR.

Table G-2: Incremental Cost of New Site Built Residential Space Heating Conservation Measures

Conservation Measure	Incremental Installed Cost (2000$/sq.ft.)
Wall R19 Standard Framing	Base
Wall R19 Intermediate Framing	$(0.04)
Wall R21 Intermediate Framing	$0.15
Wall R21 Advanced Framing	$0.15
Wall R21 Standard Framing + R5 Foam	$0.84
Wall R30 Stressed Skin Panel	$1.15
Wall R38 Double Wall	$0.59
Attic R38 Standard Framing	Base
Attic R49 Advanced Framing	$0.69
Attic R60 Advanced Framing	$0.40
Vault R30 (Joisted)	Base
Vault R38 (Joisted w/High Density Insulation)	$0.61
Vault R50 Stressed Skin Panel	$2.11
Vault R30 (Scissor Truss)	Base
Vault R38 (Scissor Truss)	$0.61
Underfloor R25	Base
Underfloor R30	$0.24
Underfloor R38 (Truss joist)	$0.40
Window Class 40 (U<0.40)	Base
Window Class 35 (U<0.35)	$0.66
Window Class 30 (U<0.30)	$3.46
Window Class 25 (U<0.25)	$3.69
Exterior Door R5	Base
Slab-on-Grade R10 Perimeter, down 2 ft.	Base
Slab-on-Grade R10 Perimeter, down 4 ft.	$2.48
Slab-on-Grade R10 Perimeter & Full Under Slab	$4.98
Below-Grade Wall R11 Interior	Base
Below-Grade Wall R19 Interior	$0.30
Below-Grade Wall R21 Interior	$0.15

Table G-3: Incremental Cost of New Manufactured Home Residential Space Heating Conservation Measures

Conservation Measure	Incremental Installed Cost (2000$/sq.ft.)
Wall R11 Standard Framing	Base
Wall R19 Standard Framing	$0.54
Wall R21 Standard Framing	$0.15
Attic R19	Base
Attic R25	$0.11
Attic R30	$0.09
Attic R38	$0.13
Attic R49	$0.19
Vault R19	Base
Vault R25	$0.11
Vault R30	$0.09
Vault R38	$0.13
Underfloor R22	Base
Underfloor R33	$0.15
Underfloor R44	$0.15
Window Class 50 (U<0.50)	Base
Window Class 40 (U<0.40)	$1.91
Window Class 35 (U<0.35)	$1.00
Window Class 30 (U<0.30)	$1.00
Exterior Door R2.5	Base
Exterior Door R5	$4.54

Energy Use Assumptions

The Council used an engineering simulation model, SUNDAY©, which has been calibrated to end-use metered space heating for electrically heated homes built across the region.[4] Savings were computed for each measure based on the "economic" optimum order of application. This was done by first computing the change in heat loss rate (UA) that resulted from the application of each measure. The incremental cost of installing each measure was then divided by this "delta UA" to establish a measure's benefit-to-cost ratio (i.e., dollars/delta UA). The SUNDAY© simulation model was then used to estimate the space heating energy savings that would result from the applying all measures starting with those that had the largest benefit-to-cost ratios. Savings were estimated for three typical site built single-family homes and three typical manufactured homes. Table G-4 provides a summary of the component areas for each of these six homes.

[4] Palmiter, L., I. Brown and M. Kennedy 1988. *SUNDAY© Calibration*. Bonneville Power Administration, Portland, OR.

Table G-4: Prototypical Home Component Dimensions

	Site Built Homes			Manufactured Homes		
Component	1,344 sq.ft.	2,200 sq.ft.	2,283 sq.ft.	924 sq.ft.	1,568 sq.ft.	2,352 sq.ft.
Attic	960	802	719	400	908	1,092
Door	38	55	89	38	38	58
Floor	1,344	1,721	104	924	1,568	2,352
Volume	10,752	17,600	18,264	7,577	12,858	19,286
Joisted Vault			479			479
Slab-on-Grade (F-Value/lin.ft.perimeter)			140			140
Trussed Vault	405	684		524	660	1,558
Wall	1,231	2,122	1,817	1,048	1,026	1,059
Wall below Grade (Int.)			560			560
Slab-below-Grade (F-Value/lin.ft.perimeter)			140			140
Window	176	366	210	116	196	353
Envelop Area	4,154	5,750	4,258	3,050	4,396	7,791

Five locations, Seattle, Portland, Boise, Spokane and Missoula were selected to represent the range of climates found across the region. The savings produced by each measure across all five locations were then weighted together based on the share of new housing built in each location to form the three climate zones used by the Council. Table G-5 shows the weights used.

Table G-5: Location Weights Used to Establish Northwest Heating Zones

Location	**Portland**	**Seattle**	**Boise**	**Spokane**	**Missoula**
Heating Zone 1	25%	53%	22%	0%	0%
Heating Zone 2	0%	0%	15%	85%	0%
Heating Zone 3	0%	0%	0%	0%	100%

In order to determine whether a measure is regionally cost-effective the Council then compared to cost of installing each measure with the value of the energy savings it produced over its lifetime. The value of all conservation savings vary by time of day and season of the year based on the market prices for electricity across the West and the impact of the savings on the need to expand the region's transmission and distribution system.

Tables F-6 through F-8 show the results of the cost-effectiveness analysis for each heating climate zone for site built homes and Tables F-9 through F-11 show the results of the cost-effectiveness analysis for new manufactured homes. All measures with a benefit/cost (B/C) ratio of 1.0 or larger are considered regionally cost-effective.

Table G-6: Regional Cost-Effectiveness Results for Site Built Homes in Heating Zone 1

1344 sq.ft.				**2200 sq.ft.**				**2283 sq.ft**			
Measure	**Installed Cost**	**Savings (kWh/yr)**	**B/C Ratio**	**Measure**	**Installed Cost**	**Savings (kWh/yr)**	**B/C Ratio**	**Measure**	**Installed Cost**	**Savings (kWh/yr)**	**B/C Ratio**
Wall R21 ADV	$182	**565**	**2.77**	Wall R21 ADV	$313	**975**	**2.80**	Wall R21 ADV	$268	**894**	**3.05**
Window CL35	$117	**344**	**2.61**	Window CL35	$243	**710**	**2.61**	Window CL35	$133	**422**	**2.90**
Floor R30 STD	$318	**662**	**1.83**	Floor R30 STD	$407	**839**	**1.85**	Floor R30 STD	$25	**56**	**2.07**
Floor R38 STD w/12” Truss	$536	**382**	**0.62**	Floor R38 STD w/12” Truss	$686	**484**	**0.63**	BG Wall R19	$165	**294**	**1.62**
Attic R49 ADVrh	$666	**426**	**0.56**	Attic R49 ADVrh	$557	**352**	**0.57**	Slab R10-4 ft.	$347	**375**	**0.99**
Window CL30	$608	**335**	**0.48**	Window CL30	$1,265	**689**	**0.48**	Slab R10-Full	$697	**747**	**0.98**
Window CL25	$650	**332**	**0.44**	Window CL25	$1,351	**688**	**0.45**	Floor R38 STD w/12” Truss	$41	**32**	**0.71**
Vault R38 HD	$245	**111**	**0.39**	Vault R38 HD	$414	**187**	**0.40**	Attic R49 ADVrh	$832	**582**	**0.64**
Wall R21 STD+R5	$1,036	**381**	**0.32**	Wall R21 STD+R5	$1,786	**658**	**0.33**	Window CL30	$691	**418**	**0.55**
Wall 8” SS Panel	$1,418	**421**	**0.26**	Wall 8” SS Panel	$2,444	**725**	**0.26**	Window CL25	$738	**420**	**0.52**
Attic R60 ADVrh	$383	**107**	**0.24**	Attic R60 ADVrh	$320	**90**	**0.25**	Wall R21 STD+R5	$1,529	**635**	**0.38**
Wall R33 DBL	$727	**46**	**0.05**	Wall R33 DBL	$1,253	**79**	**0.06**	BG Wall R21	$83	**31**	**0.34**
Vault 10” SS Panel	$855	**15**	**0.01**	Vault 10” SS Panel	$1,444	**26**	**0.02**	Wall 8” SS Panel	$2,093	**711**	**0.31**

Table G-7: Regional Cost-Effectiveness Results for Site Built Homes in Heating Zone 2

1344 sq. ft				2200 sq. ft				2283 sq. ft			
Measure	**Installed Cost**	**Savings (kWh/yr)**	**B/C Ratio**	**Measure**	**Installed Cost**	**Savings (kWh/yr)**	**B/C Ratio**	**Measure**	**Installed Cost**	**Savings (kWh/yr)**	**B/C Ratio**
Wall R21 ADV	$182	**550**	**3.66**	Wall R21 ADV	$313	**948**	**3.66**	Wall R21 ADV	$268	**872**	**3.93**
Window CL35	$117	**335**	**3.46**	Window CL35	$243	**690**	**3.43**	Window CL35	$133	**411**	**3.74**
Floor R30 STD	$318	**644**	**2.45**	Floor R30 STD	$407	**816**	**2.42**	Floor R30 STD	$25	**54**	**2.68**
Floor R38 STD w/12” Truss	$536	**371**	**0.84**	Floor R38 STD w/12” Truss	$686	**471**	**0.83**	BG Wall R19	$165	**287**	**2.10**
Attic R49 ADVrh	$666	**414**	**0.75**	Attic R49 ADVrh	$557	**342**	**0.74**	Slab R10-4 ft.	$347	**366**	**1.27**
Window CL30	$608	**325**	**0.65**	Window CL30	$1,265	**669**	**0.64**	Slab R10-Full	$697	**729**	**1.26**
Window CL25	$650	**322**	**0.60**	Window CL25	$1,351	**668**	**0.60**	Floor R38 STD w/12” Truss	$41	**31**	**0.92**
Vault R38 HD	$245	**108**	**0.53**	Vault R38 HD	$414	**182**	**0.53**	Attic R49 ADVrh	$832	**569**	**0.83**
Wall R21 STD+R5	$1,036	**370**	**0.43**	Wall R21 STD+R5	$1,786	**639**	**0.43**	Window CL30	$691	**409**	**0.71**
Wall 8” SS Panel	$1,418	**409**	**0.35**	Wall 8” SS Panel	$2,444	**704**	**0.35**	Window CL25	$738	**410**	**0.67**
Attic R60 ADVrh	$383	**104**	**0.33**	Attic R60 ADVrh	$320	**87**	**0.33**	Wall R21 STD+R5	$1,529	**621**	**0.49**
Wall R33 DBL	$727	**44**	**0.07**	Wall R33 DBL	$1,253	**77**	**0.07**	BG Wall R21	$83	**30**	**0.44**
Vault 10” SS Panel	$855	**15**	**0.02**	Vault 10” SS Panel	$1,444	**25**	**0.02**	Wall 8” SS Panel	$2,093	**694**	**0.40**

Table G-8: Regional Cost-Effectiveness Results for Site Built Homes in Heating Zone 3

1344 sq. ft				2200 sq. ft				2283 sq. ft			
Measure	**Installed Cost**	**Savings (kWh/yr)**	**B/C Ratio**	**Measure**	**Installed Cost**	**Savings (kWh/yr)**	**B/C Ratio**	**Measure**	**Installed Cost**	**Savings (kWh/yr)**	**B/C Ratio**
Wall R21 ADV	$182	**655**	**4.35**	Wall R21 ADV	$237	**583**	**3.10**	Wall R21 ADV	$356	**910**	**3.23**
Window CL35	$117	**399**	**4.13**	Window CL35	$98	**223**	**2.86**	Window CL35	$118	**279**	**2.98**
Floor R30 STD	$318	**766**	**2.92**	Floor R30 STD	$71	**159**	**2.82**	Floor R30 STD	$168	**394**	**2.95**
Floor R38 STD w/12” Truss	$536	**443**	**1.00**	Floor R38 STD w/12” Truss	$78	**137**	**2.20**	BG Wall R19	$94	**171**	**2.28**
Attic R49 ADVrh	$666	**493**	**0.89**	Attic R49 ADVrh	$57	**100**	**2.20**	Slab R10-4 ft.	$135	**244**	**2.28**
Window CL30	$608	**386**	**0.77**	Window CL30	$374	**533**	**1.79**	Slab R10-Full	$674	**1,004**	**1.88**
Window CL25	$650	**384**	**0.71**	Window CL25	$196	**273**	**1.76**	Floor R38 STD w/12” Truss	$353	**517**	**1.85**
Vault R38 HD	$245	**129**	**0.63**	Vault R38 HD	$196	**265**	**1.70**	Attic R49 ADVrh	$353	**501**	**1.79**
Wall R21 STD+R5	$1,036	**444**	**0.52**	Wall R21 STD+R5	$152	**176**	**1.46**	Window CL30	$157	**190**	**1.52**
Wall 8” SS Panel	$1,418	**493**	**0.42**	Wall 8” SS Panel	$118	**129**	**1.38**	Window CL25	$142	**163**	**1.46**
Attic R60 ADVrh	$383	**126**	**0.40**	Attic R60 ADVrh	$86	**56**	**0.82**	Wall R21 STD+R5	$202	**138**	**0.86**
Wall R33 DBL	$727	**54**	**0.09**	Wall R33 DBL	$177	**102**	**0.73**	BG Wall R21	$212	**129**	**0.77**
Vault 10” SS Panel	$855	**18**	**0.02**	Vault 10” SS Panel	$237	**88**	**0.47**	Wall 8” SS Panel	$356	**139**	**0.49**

Table G-9: Regional Cost-Effectiveness Results for Manufactured Homes in Heating Zone 1

924 sq. ft				1568 sq. ft				2352 sq. ft			
Measure	**Installed Cost**	**Savings (kWh/yr)**	**B/C Ratio**	**Measure**	**Installed Cost**	**Savings (kWh/yr)**	**B/C Ratio**	**Measure**	**Installed Cost**	**Savings (kWh/yr)**	**B/C Ratio**
Floor R33	$140	**328**	**2.96**	Floor R33	$237	**583**	**3.10**	Floor R33	$356	**910**	**3.23**
Attic R25	$43	**94**	**2.75**	Attic R25	$98	**223**	**2.86**	Attic R25	$118	**279**	**2.98**
Vault R25	$57	**122**	**2.72**	Vault R25	$71	**159**	**2.82**	Vault R25	$168	**394**	**2.95**
Attic R30	$35	**57**	**2.08**	Attic R30	$78	**137**	**2.20**	Attic R30	$94	**171**	**2.28**
Vault R30	$45	**75**	**2.08**	Vault R30	$57	**100**	**2.20**	Vault R30	$135	**244**	**2.28**
Window CL40	$222	**304**	**1.73**	Window CL40	$374	**533**	**1.79**	Window CL40	$674	**1,004**	**1.88**
Window CL35	$116	**155**	**1.68**	Window CL35	$196	**273**	**1.76**	Window CL35	$353	**517**	**1.85**
Window CL30	$116	**152**	**1.65**	Window CL30	$196	**265**	**1.70**	Window CL30	$353	**501**	**1.79**
Wall R21 ADV	$156	**172**	**1.39**	Wall R21 ADV	$152	**176**	**1.46**	Wall R21 ADV	$157	**190**	**1.52**
Attic R38	$52	**54**	**1.31**	Attic R38	$118	**129**	**1.38**	Attic R38	$142	**163**	**1.46**
Vault R38	$68	**42**	**0.79**	Vault R38	$86	**56**	**0.82**	Vault R38	$202	**138**	**0.86**
Attic R49	$78	**43**	**0.70**	Attic R49	$177	**102**	**0.73**	Attic R49	$212	**129**	**0.77**
Floor R44	$140	**50**	**0.45**	Floor R44	$237	**88**	**0.47**	Floor R44	$356	**139**	**0.49**

Table G-10: Regional Cost-Effectiveness Results for Manufactured Homes in Heating Zone 2

924 sq. ft				1568 sq. ft				2352 sq. ft			
Measure	**Installed Cost**	**Savings (kWh/yr)**	**B/C Ratio**	**Measure**	**Installed Cost**	**Savings (kWh/yr)**	**B/C Ratio**	**Measure**	**Installed Cost**	**Savings (kWh/yr)**	**B/C Ratio**
Floor R33	$140	**441**	**3.98**	Floor R33	$237	**764**	**4.06**	Floor R33	$356	**1,175**	**4.16**
Attic R25	$43	**127**	**3.70**	Attic R25	$98	**293**	**3.76**	Attic R25	$118	**360**	**3.85**
Vault R25	$57	**165**	**3.68**	Vault R25	$71	**211**	**3.73**	Vault R25	$168	**512**	**3.84**
Attic R30	$35	**78**	**2.84**	Attic R30	$78	**181**	**2.91**	Attic R30	$94	**224**	**2.99**
Vault R30	$45	**102**	**2.84**	Vault R30	$57	**132**	**2.91**	Vault R30	$135	**319**	**2.98**
Window CL40	$222	**414**	**2.35**	Window CL40	$374	**711**	**2.39**	Window CL40	$674	**1,320**	**2.47**
Window CL35	$116	**212**	**2.30**	Window CL35	$196	**367**	**2.36**	Window CL35	$353	**683**	**2.44**
Window CL30	$116	**208**	**2.26**	Window CL30	$196	**356**	**2.29**	Window CL30	$353	**664**	**2.37**
Wall R21 ADV	$156	**234**	**1.90**	Wall R21 ADV	$152	**237**	**1.96**	Wall R21 ADV	$157	**253**	**2.03**
Attic R38	$52	**74**	**1.79**	Attic R38	$118	**174**	**1.86**	Attic R38	$142	**217**	**1.93**
Vault R38	$68	**58**	**1.07**	Vault R38	$86	**75**	**1.10**	Vault R38	$202	**185**	**1.15**
Attic R49	$78	**59**	**0.95**	Attic R49	$177	**137**	**0.98**	Attic R49	$212	**173**	**1.03**
Floor R44	$140	**68**	**0.61**	Floor R44	$237	**118**	**0.63**	Floor R44	$356	**186**	**0.66**

Table G-11: Regional Cost-Effectiveness Results for Manufactured Homes in Heating Zone 3

924 sq. ft				1568 sq. ft				2352 sq. ft			
Measure	**Installed Cost**	**Savings (kWh/yr)**	**B/C Ratio**	**Measure**	**Installed Cost**	**Savings (kWh/yr)**	**B/C Ratio**	**Measure**	**Installed Cost**	**Savings (kWh/yr)**	**B/C Ratio**
Floor R33	$140	**527**	**4.75**	Floor R33	$237	**914**	**4.86**	Floor R33	$356	**1,392**	**4.93**
Attic R25	$43	**152**	**4.42**	Attic R25	$98	**351**	**4.51**	Attic R25	$118	**428**	**4.57**
Vault R25	$57	**197**	**4.39**	Vault R25	$71	**254**	**4.48**	Vault R25	$168	**609**	**4.56**
Attic R30	$35	**93**	**3.39**	Attic R30	$78	**218**	**3.50**	Attic R30	$94	**265**	**3.54**
Vault R30	$45	**122**	**3.39**	Vault R30	$57	**159**	**3.50**	Vault R30	$135	**378**	**3.54**
Window CL40	$222	**495**	**2.82**	Window CL40	$374	**858**	**2.89**	Window CL40	$674	**1,566**	**2.93**
Window CL35	$116	**254**	**2.76**	Window CL35	$196	**441**	**2.84**	Window CL35	$353	**806**	**2.88**
Window CL30	$116	**249**	**2.70**	Window CL30	$196	**428**	**2.75**	Window CL30	$353	**783**	**2.80**
Wall R21 ADV	$156	**283**	**2.29**	Wall R21 ADV	$152	**284**	**2.35**	Wall R21 ADV	$157	**298**	**2.39**
Attic R38	$52	**89**	**2.16**	Attic R38	$118	**209**	**2.24**	Attic R38	$142	**256**	**2.28**
Vault R38	$68	**70**	**1.30**	Vault R38	$86	**90**	**1.33**	Vault R38	$202	**218**	**1.36**
Attic R49	$78	**71**	**1.15**	Attic R49	$177	**166**	**1.18**	Attic R49	$212	**204**	**1.21**
Floor R44	$140	**82**	**0.74**	Floor R44	$237	**143**	**0.76**	Floor R44	$356	**219**	**0.78**

The Council's Model Conservation Standards are "performance based" and not prescriptive standards. That is, many different combinations of energy efficiency measures can be used to meet the overall performance levels called for in the standards. In order to translate the regional cost-effectiveness results into "model standards" the Council calculates the total annual space heating use of a "reference building" that meets the Council's standards so that its efficiency can be compared to the same building built with some other combination of measures. Table G-12 shows the maximum annual space heating use permitted under the draft fifth Plan's model standards "reference" case requirements for site built and manufactured homes for each of the region's three heating climate zones. These "performance budgets" incorporate all of the conservation measures shown in Tables F-6 through F-11 that have a benefit-to-cost ratio of 1.0 or higher on a total resource cost basis.

Table G-12: Draft Fifth Plan Model Conservation Standards Annual Space Heating Budgets[5]

	Site Built Homes (kWh/sq.ft./yr)	Manufactured Homes (kWh/sq.ft/yr)
Heating Zone 1	3.3	2.6
Heating Zone 2	4.8	3.9
Heating Zone 3	5.8	4.8

The Council compared the annual space heating performance requirements in Table G-12 for site built homes with the requirements of state energy codes in the region. It also compared the annual space heating performance requirements in Table G-12 for manufactured homes with the requirements of regional Super Good Cents® manufactured home program specifications and current construction practices for non-Super Good Cents® manufactured homes. This comparison, shown in Table G-13, revealed that none of the region's energy codes or the Super Good Cents® program specifications for manufactured homes met the Model Conservation Standards goal of capturing all regionally cost-effective electricity savings. It therefore appears that further strengthening of these codes and program specifications is required. The following section addresses the question of whether these higher levels of efficiency would be economically feasible for consumers.

Table G-13: Estimated Annual Space Heating Use for New Site Built Homes Complying with State Energy Codes and Manufactured Homes Built to Current Practice and Super Good Cents®

	Site Built Space Heating Use (kWh/sq.ft./yr				Manufactured Home Space Heating Use (kWh/sq.ft./yr.	
	Idaho	Montana	Oregon	Washington	Current Practice	Super Good Cents®
Heating Zone 1	5.3	NA	3.5	3.6	4.3	3.0
Heating Zone 2	7.6	NA	5.3	4.7	6.2	4.6
Heating Zone 3	NA	6.8	NA	NA	7.7	5.8

[5] Annual space heating use for a typical 2100 sq.ft. site built home and 1730 sq.ft. manufactured home. Both homes are assumed to have a zonal electric resistance heating system.

Consumer Economic Feasibility

The Act requires that the Council's Model Conservation Standards be "economically feasible for consumers" taking into account any financial assistance made available through Bonneville and the region's utilities. In order to determine whether the performance standards set forth in Table G-12 met this test the Council developed a methodology that allowed it to compare the life cycle cost of home ownership, including energy costs, of typical homes with increasing levels of energy efficiency built into them. This section describes this methodology and results of this analysis.

The life cycle cost of home ownership is determined by many variables, such as the mortgage rate, down payment amount, the marginal state and federal income tax rates of the homebuyer, retail electric rates, etc. The value of some of these variables, such as property and state income tax rates are known, but differ across state or utility service areas or differ by income level. For example, homebuyers in Washington State pay no state income tax, while those in Oregon pay upwards of 9 percent of their income in state taxes. Since home mortgage interest payments are deductible, Oregon homebuyers have a lower "net" interest rate than do Washington buyers. The value of other variables, such as mortgage rates and the fraction of a home's price that the buyer pays as a down payment are a function of income, credit worthiness, market conditions and other factors. Consequently, it is an extreme oversimplification to attempt to represent the economic feasibility of higher levels of efficiency using the "average" of all of these variables as input assumptions.

In order to better reflect the range of conditions individual new homebuyers might face the Council developed a model that tested over a 1,000 different combinations of major variables that determine a specific consumer's life cycle cost of home ownership for each heating climate zone. Table G-14 lists these variables and the data sources used to derive the actual distribution of values used.

Table G-14: Data Sources and Variables Used in Life Cycle Cost Analysis

Variable	Data Source
Average New Home Price	Federal Housing Finance Board
Mortgage Interest Rates	Federal Housing Finance Board & Mortgage Bankers Association
Down payment	Federal Housing Finance Board
Private Mortgage Insurance Rates	Mortgage Bankers Association
Retail Electric Rates	Energy Information Administration
Retail Gas Rates	ID, MT, OR & WA Utility Regulatory Commissions
Retail Electric and Gas Price Escalation Rates	Council Forecast
Federal Income Tax Rates	Internal Revenue Service
State Income and Property Tax Rates	ID, MT, OR & WA State Departments of Revenue
Adjusted Gross Incomes	Internal Revenue Service
Home owners insurance	Online estimates from Realtor.com

A "Monte Carlo" simulation model add-on to Microsoft Excel called Crystal Ball® was used to select specific values for each of these variables from the distribution of each variable. Each combination of values was then to use to compute the present value of a 30-year (360 month) stream of mortgage principal and interest payments, insurance premiums, property taxes and energy cost for a new site built or manufactured home built to increasing levels of thermal

efficiency. Figures F-1 through F-10 show the distributions used for each of the major input assumptions to the life cycle cost analysis.

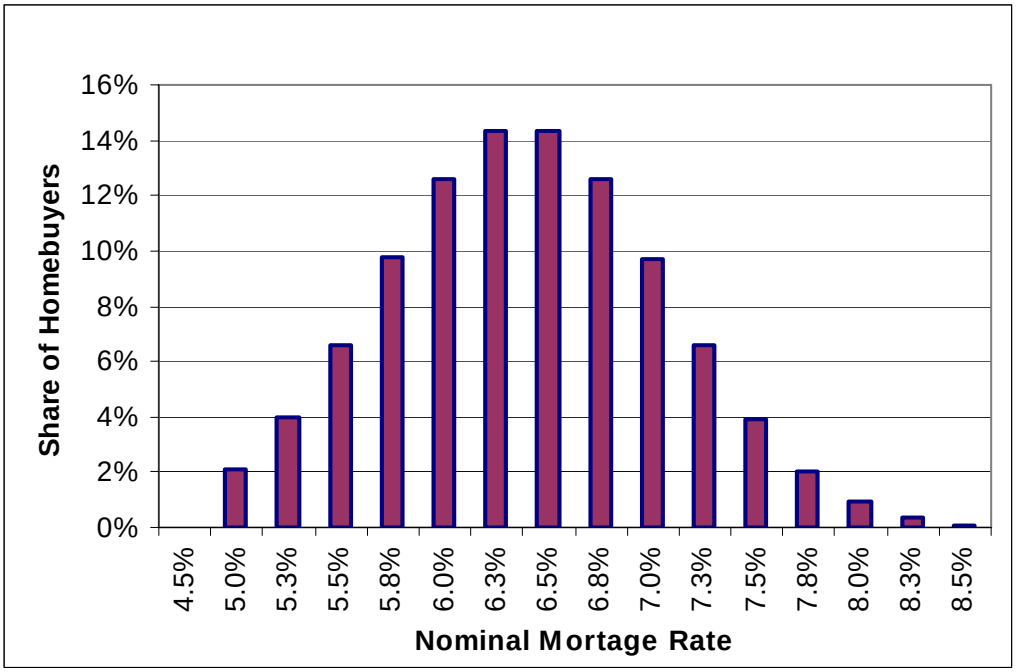

Figure G-1: Nominal Mortgage Rates - All Climate Zones for Single Family Homes

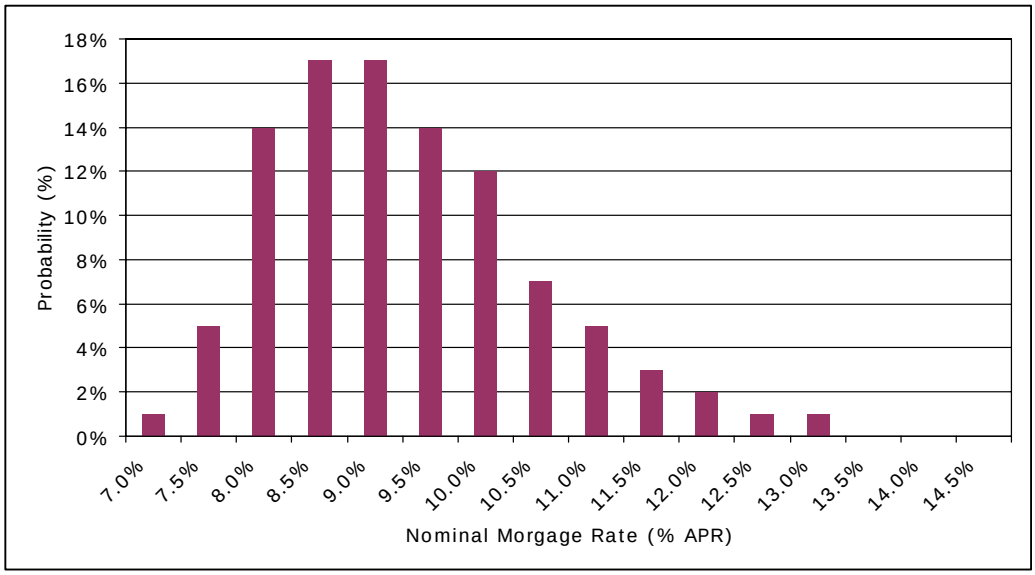

Figure G-2: Nominal Mortgage Rates - All Climate Zones for Manufactured Homes

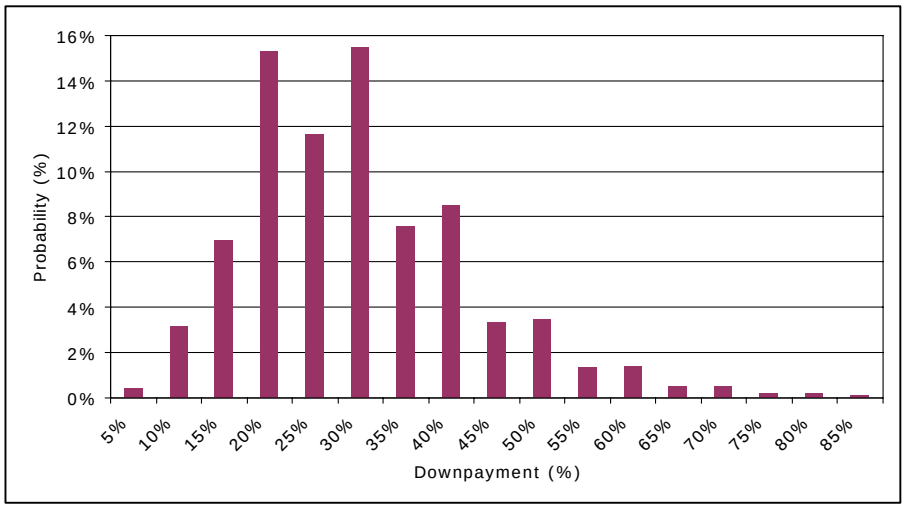

Figure G-3: Down payment Fraction for Single Family and Manufactured Homes- All Climate Zones

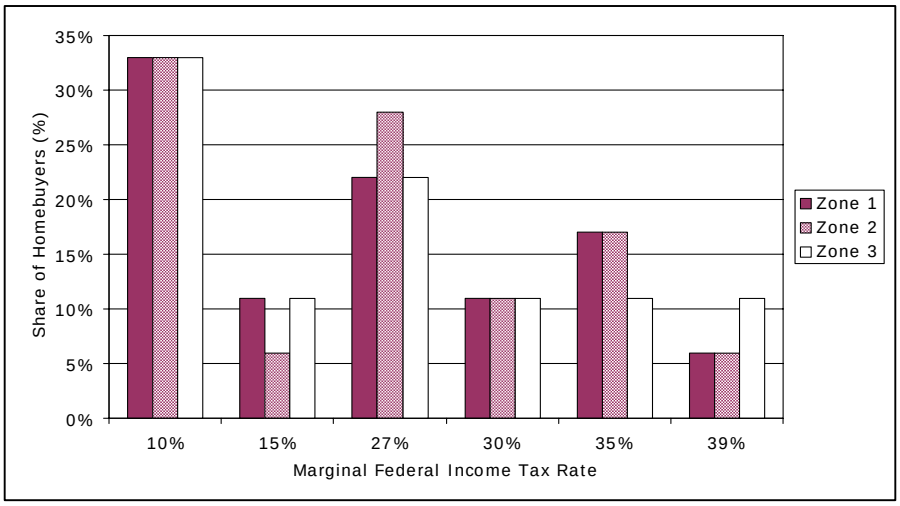

Figure G-4: Marginal Federal Income Tax Rates for Single Family and Manufactured Homes by Climate Zone

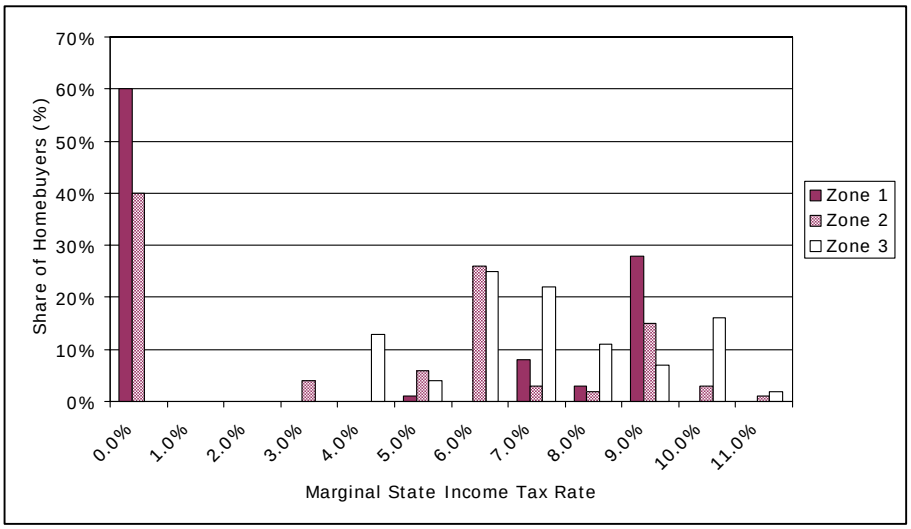

Figure G-5: Marginal State Income Tax Rates for Single Family and Manufactured Homes by Climate Zone

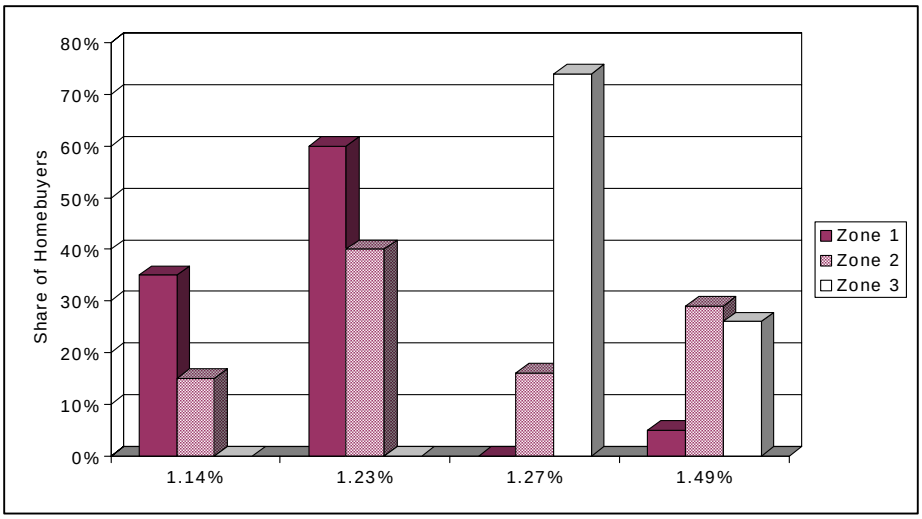

Figure G-6: Property Tax Rates by Climate Zone

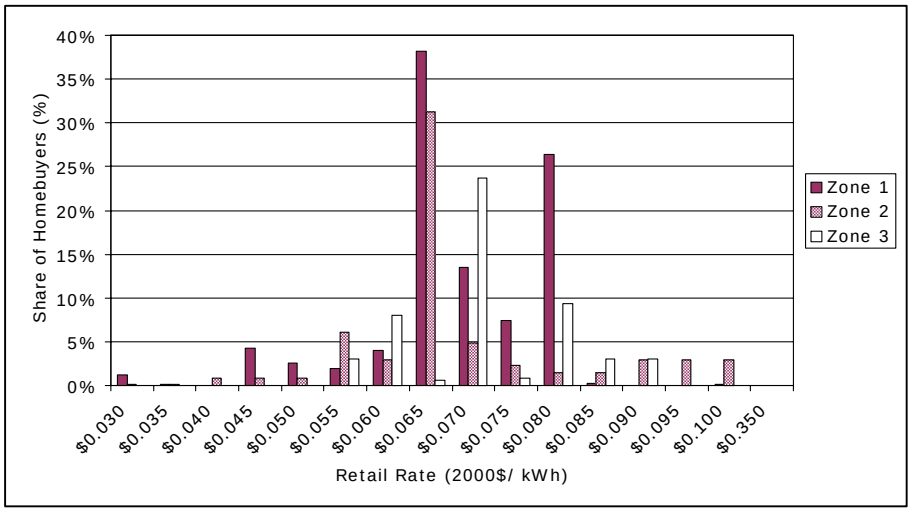

Figure G-7: Base Year Retail Electric Rates by Climate Zone

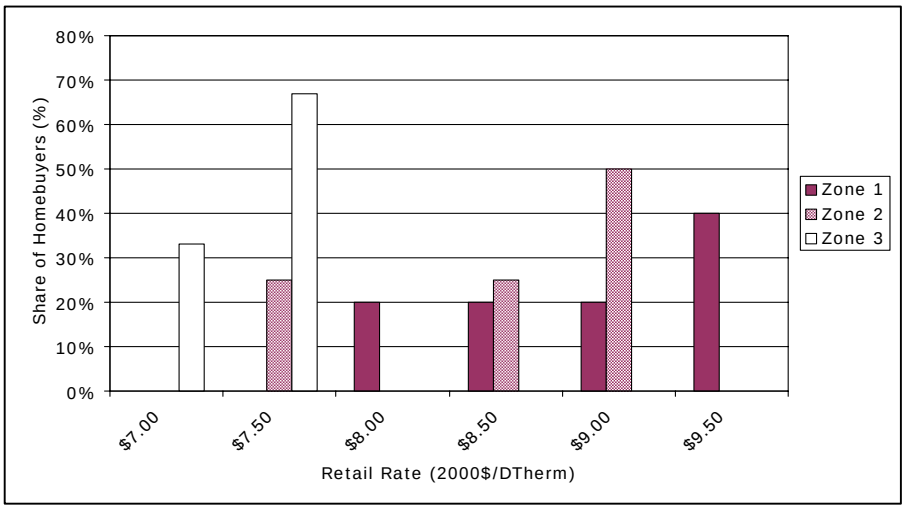

Figure G-8: Base Year Retail Natural Gas Rates by Climate Zone

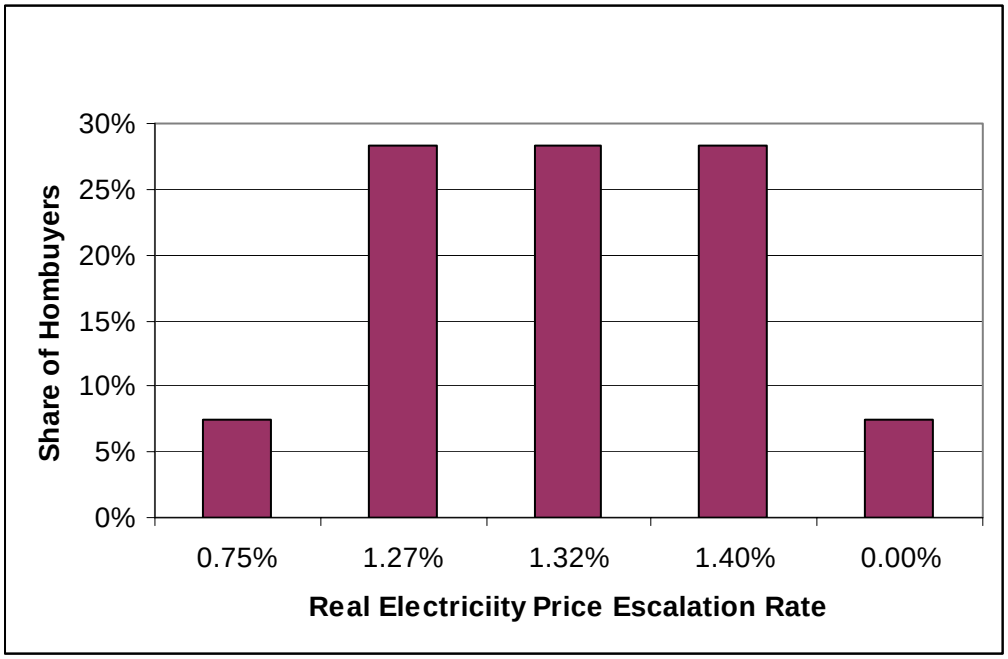

Figure G-9: Real Escalation Rates for Electricity Prices - All Climate Zones

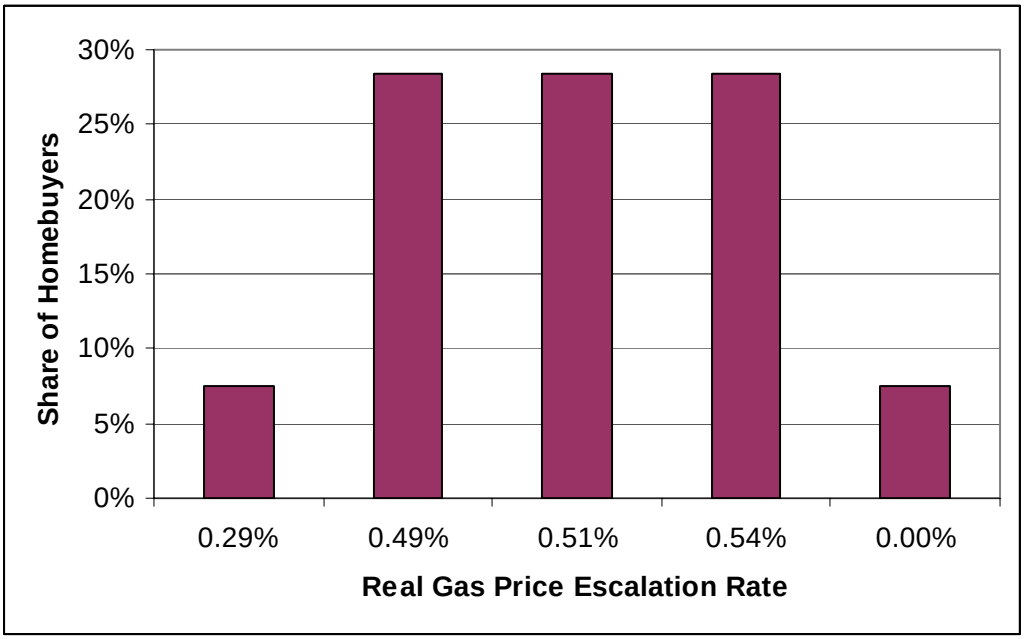

Figure G-10: Real Escalation Rates for Natural Gas Prices - All Climate Zones

The incremental costs of conservation measures described in the prior section on regional cost-effectiveness were used in these calculations. Annual space heating energy use was computed for four heating system types using the system efficiency assumptions shown in Table G-14. The system efficiency assumptions for electric and gas forced-air furnaces and heat pumps assume that the home has all or most of its ductwork outside the heated space.

Table G-15: Overall Heating System Efficiency Assumptions by System Type and Climate Zone[6]

Climate Zone	Zonal Electric	Electric Forced-Air Furnace	Air Source Heat Pump	Gas Forced-Air Furnace
Zone 1	100%	78%	155%	61%
Zone 2	100%	77%	124%	60%
Zone 3	100%	77%	114%	60%

The simulation model used the same 1,000 combinations of input assumptions for each level of energy efficiency tested. As a result, the Council could compare the distribution of 1,000 different net present value results for a home built to incrementally higher levels of efficiency, rather than just single cases. This allowed the Council to consider how "robust" a conclusion one might draw regarding the economic feasibility of each measure.

Figure G-11 illustrates a typical distribution of net present value results for one measure. In the upper left corner of the graph indicates the number ("2000 Trials") of different combinations of inputs tested in the analysis. The graph plots the net present value of a measures costs and savings over the term of the mortgage on the horizontal (x) axis. The "probability" of obtaining a given net present values is plotted on the vertical (y) axis. The percent of the cases tested that result in a particular net present value is shown on the left vertical axis and the number of cases

[6] Overall system efficiency includes the impact of duct system losses, combustion and cycling losses and for heat pumps losses due to defrost and the use of controls that energize back up electric resistance heating during "warm-up."

out of the total number tested is shown on the right vertical axis. The mean (average) and median net present values of all input combinations tested are shown as vertical lines near the center of the distribution.

Although the mean values can be considered the "expected" net present value it is also important to consider the entire distribution of results to determine the share of consumers who would be harmed or benefited. This is particularly important of the results are skewed by a specific combination of input assumptions (e.g., low initial electric rates combined with low real escalating rates and high mortgage rates). Figure G-12 displays the cumulative distribution of net present value across the range of possible combinations of inputs. The primary value of displaying the outcomes in this fashion is that it shows the both the fraction of consumers who may be benefited or harmed if required to invest in incremental improvements in efficiency and it also shows the magnitude of the benefit or harm. For example, Figure G-12 shows that approximately 90 percent of the combinations tested resulted in net present values. Moreover 75 percent of the combination of input assumptions produced net present values above $500 while less than 5 percent of the produced negative net present values, none of which were below $1,000.

Tables F-16 through F-18 show the average or "expected" net present value for each measure and heating system type by climate zone for site built homes. Tables F-19 through -21 show this information for manufactured homes.

The Council reviewed the net present value results for each measure. Measures were analyzed incrementally and in order of their cost-effectiveness. The package of measures that produced the highest average net present value (lowest life cycle cost) was considered by the Council to be "economically feasible" for consumers. The Council believes this is a conservation interpretation of the Act's requirements, since any package of measures that results in a higher net present value than current codes or standards leaves the consumer "better off" than they are today. However, the package of measures that produces the highest net present value leaves results in the "best" economic choice for the consumer.

Based on its review of these results shown in Tables F-15 through F-20 the Council concluded that the level of energy efficiency that is regionally cost-effective shown in Table G-12 are also economically feasible for consumers. Table G-21 compares the annual space heating performance of typical site-built home and manufactured homes built to three different levels of energy efficiency. One is built to current codes/practice, the second with all regionally cost effective measures (i.e., "the MCS") and the third with those measures that maximize the net present value of energy efficiency to the homeowner (i.e., "Economically Feasible").

It is important to note that Table G-21 shows that the level of energy efficiency that is economically feasible for consumers is equal to or higher than that which would be cost-effective for the regional power system. Since this is the first time the Council has observed this result, some explanation is in order. There are two primary reasons that consumers in the Northwest would find it more economical to invest in the energy efficiency of their new site built or manufactured home than the regional power system. The first is that as a result of recent increases in power rates retail rates for electricity are generally above wholesale market prices.

Second, new homebuyers can frequently finance their homes at lower interest rates than utilities can borrow money to fund conservation programs.

The complete distribution of net present value results for each measure by heating system type for site built homes are shown in Figures F-13 through F-58 for climate zone 1, Figures F-63 through F-108 for climate zone 2 and Figures F-113 through F-158 for climate zone 3. The "expected value" average net present value results for each measure and heating system type are shown in figures F-59 through F-62 for climate zone 1, Figures F-109 through F-112 for climate zone 2 and Figures F-159 through F-162 for climate zone 3. The complete net present value results for each measure for manufactured homes are shown in Figures F-163 through F-175 for climate zone 1, Figures F-177 through F-189 for climate zone 2 and Figures F-191 through F-203 for climate zone 3. The "expected value" average net present value results for each measure are shown in Figure G-176 for climate zone 1, Figure G-190 for climate zone 2 and Figure G-204 for climate zone 3. Tables F-19 through -20 average "expected value" net present value for each measure by climate zone for manufactured homes.

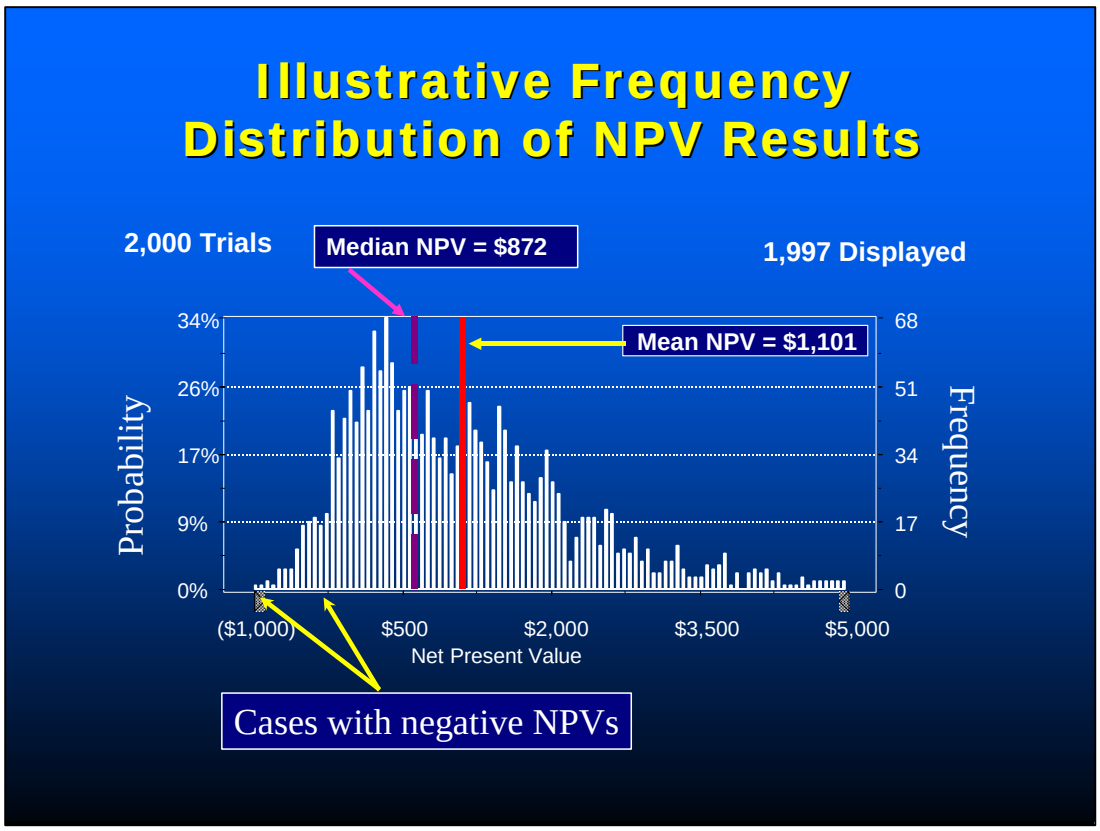

Figure G-11: Illustrative Distribution of Net Present Value Results

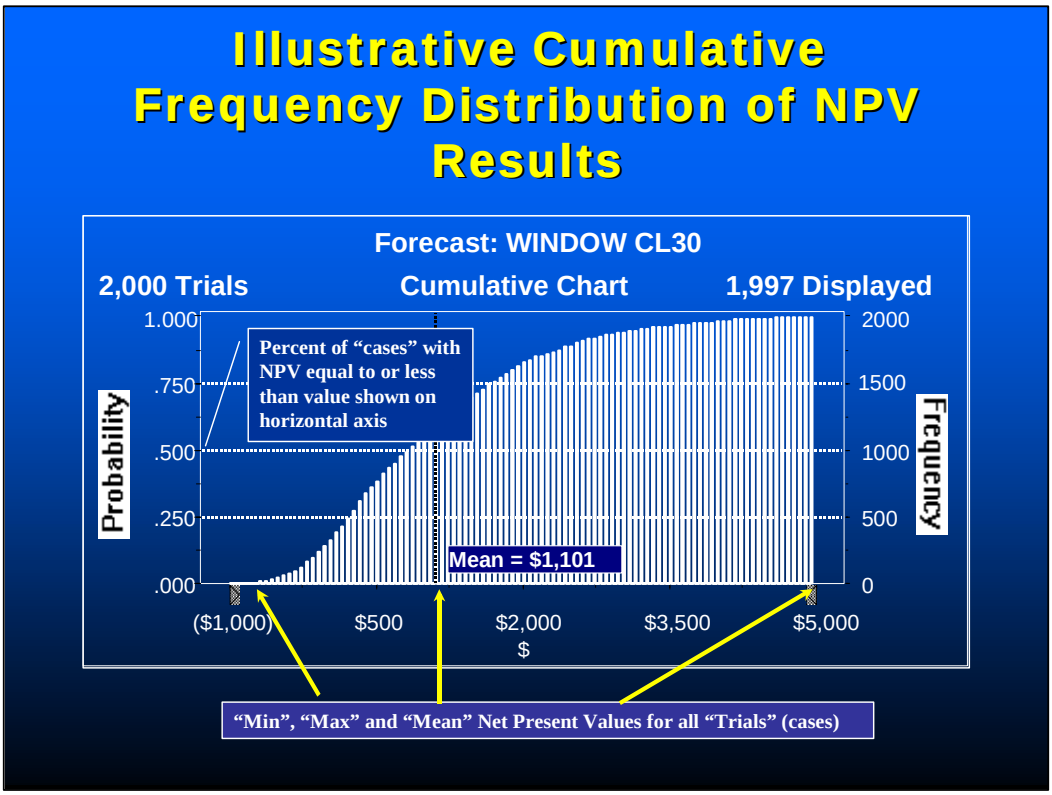

Figure G-12: Illustrative Cumulative Distribution of Net Present Value Results

Mean Net Present Value for Zone 1 (1000 Cases)

Measure	HP	Electric FAF	Gas FAF	Zonal
R21 Walls	$652	$1,581	$873	$1176
Class 35 Windows	$1113	$2,717	$1494	$2018
R30 Under Crawlspace Floors	$1546	$3,948	$2117	$2092
R38 Under Crawlspace Floor	$1374	$4,238	$2054	$2980
R49 Advanced Framed Attic	$1196	$4,395	$1955	$3001
Class 30 Windows	$683	$4,537	$1598	$2858
Class 25 Windows	$88	$4,598	$1158	$2634
R26 Walls	-$117	$4,571	$995	$2529
R30 Walls	-$1146	$4,168	$114	$1854
R60 Advanced Framed Attic	-$2725	$3,280	-$1302	$664

Maximum NPV = Lowest LCC

Table G-16: Climate Zone 1 Expected Value NPV by Measure and System Type

Mean Net Present Value for Zone 2
(1000 Cases)

Measure	HP	Electric FAF	GAS FAF	Zonal
R21 Walls	$942	$1,681	$832	$1237
Class 35 Windows	$1612	$2,890	$1422	$2122
R30 Under Crawlspace Floors	$2294	$4,208	$2010	$3057
R38 Under Crawlspace Floor	$2266	$4,547	$1927	$3176
R49 Advanced Framed Attic	$2192	$4,740	$1814	$3208
Class 30 Windows	$1882	$4,952	$1427	$3107
Class 25 Windows	$1490	$5,080	$957	$2992
R26 Walls	$1340	$5,072	$786	$2829
R30 Walls	$504	$4,734	-$123	$2191
R60 Advanced Framed Attic	-$862	$3,917	-$1570	$1044

Maximum NPV = Lowest LCC

Table G-17: Climate Zone 2 Expected Value NPV by Measure and System Type

Mean Net Present Value for Zone 3
(1000 Cases)

Measure	HP	Electric FAF	Gas FAF	Zonal
R21 Walls	$1342	$2,140	$872	$1569
Class 35 Windows	$2315	$3,699	$1500	$2708
R30 Under Crawlspace Floors	$3352	$5,430	$2127	$3942
R38 Under Crawlspace Floor	$3505	$5,986	$2042	$4209
R49 Advanced Framed Attic	$3560	$6,335	$1925	$4348
Class 30 Windows	$3491	$6,839	$1518	$4441
Class 25 Windows	$3326	$7,243	$1018	$4438
R26 Walls	$3234	$7,305	$835	$4389
R30 Walls	$2592	$7,195	-$137	$3891
R60 Advanced Framed Attic	$1391	$6,602	-$1680	$2870

Maximum NPV = Lowest LCC

Table G-18: Climate Zone 3 Minimum Expected Value NPV by Measure and System Type

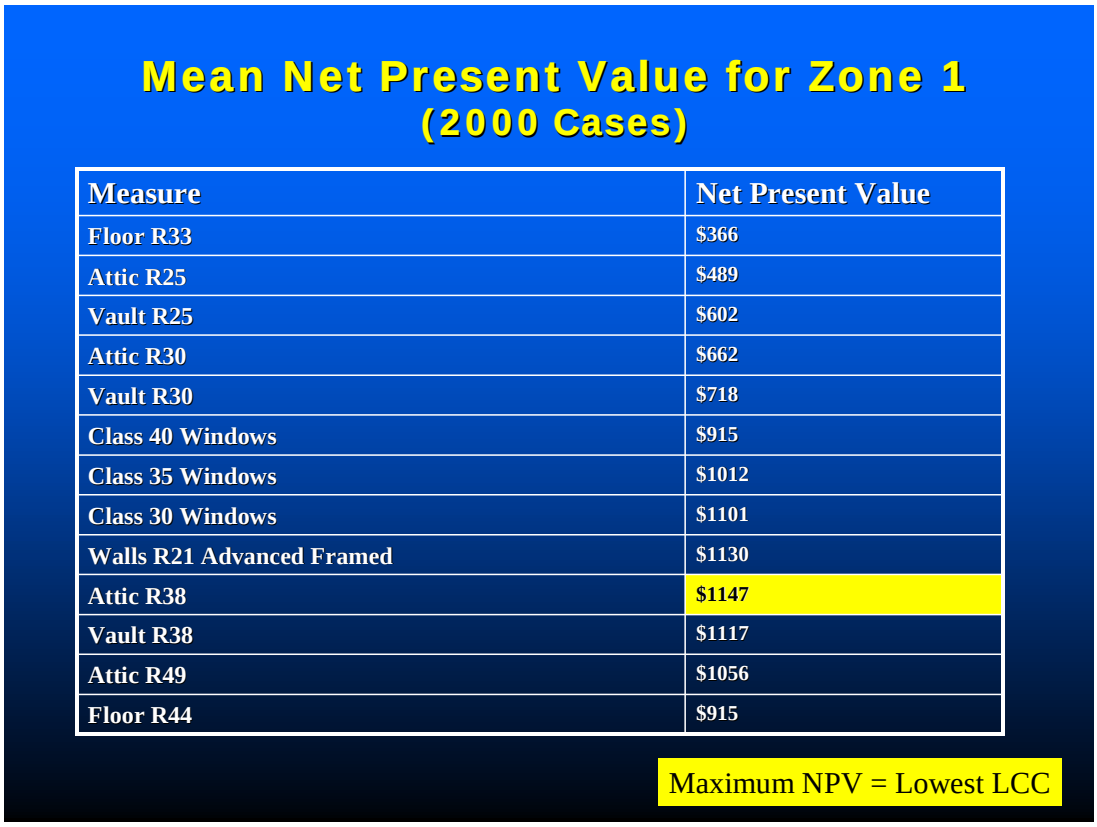

Table 19 - Climate Zone 1 Expected Value Mean Net Present Value Results for Manufactured Homes

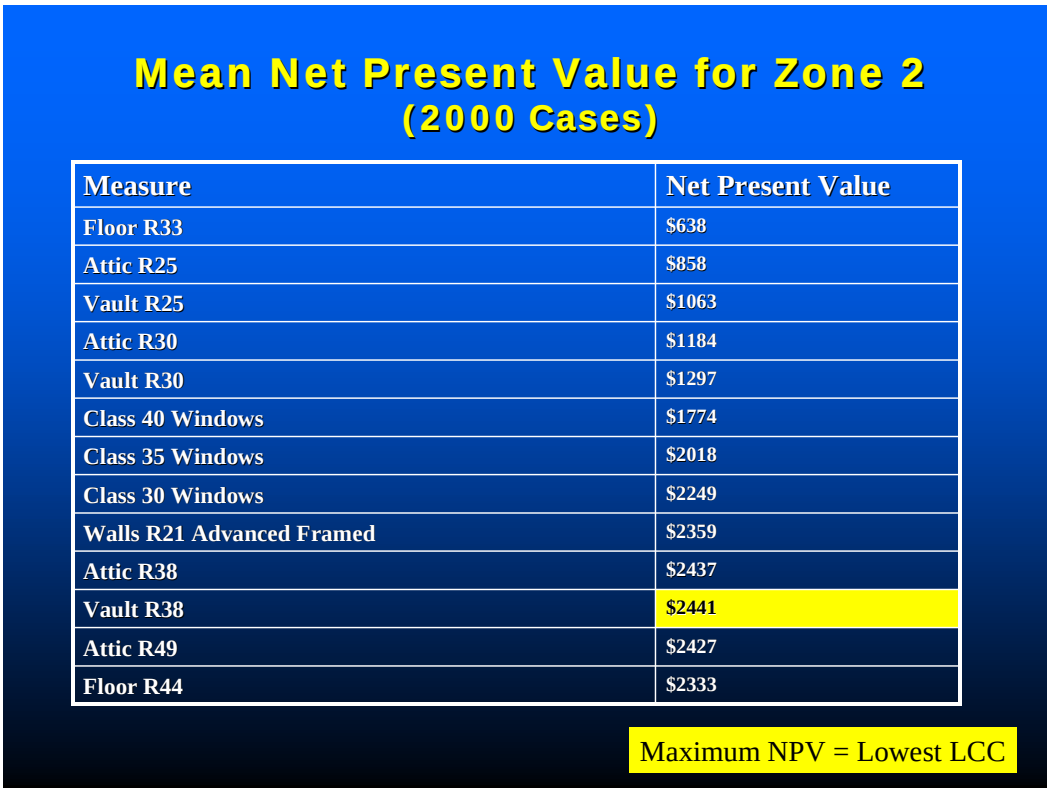

Table G-20: Climate Zone 2 Expected Value Mean Net Present Value Results for Manufactured Homes

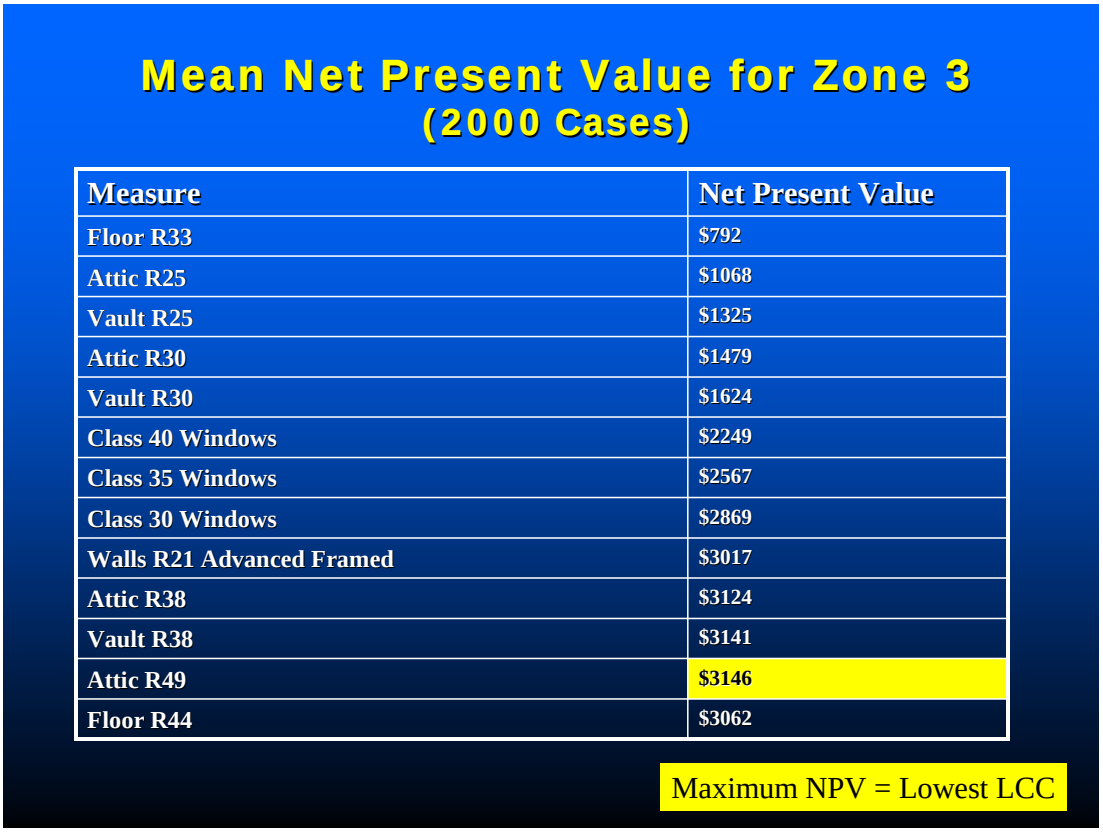

Table G-21: Climate Zone 3 Expected Value Mean Net Present Value Results for Manufactured Homes

Table G-22: Economic Feasibility of Regionally Cost-Effective Thermal Envelop Measures for New Electrically Heated Site Built and Manufactured Homes

	Site Built			Manufactured		
	Code Avg (kWh/sq.ft.yr)	MCS **(kWh/sq.ft.yr)**	Min LCC **(kWh/sq.ft.yr)**	Current Practice **(kWh/sq.ft.yr)**	MCS **(kWh/sq.ft.yr)**	Min LCC **(kWh/sq.ft.yr)**
Heating Zone 1	3.3	2.6	2.3	4.3	2.6	2.6
Heating Zone 2	5.3	4.3	3.9	6.2	3.9	3.9
Heating Zone 3	6.8	5.4	4.8	7.7	4.8	4.8

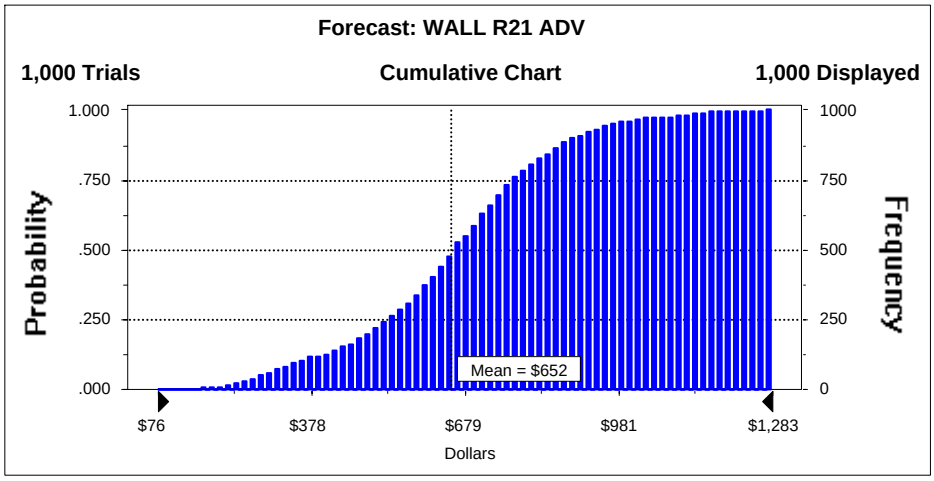

Figure G-13: Climate Zone 1 R21 Above Grade Wall NPV Results for Heat Pumps

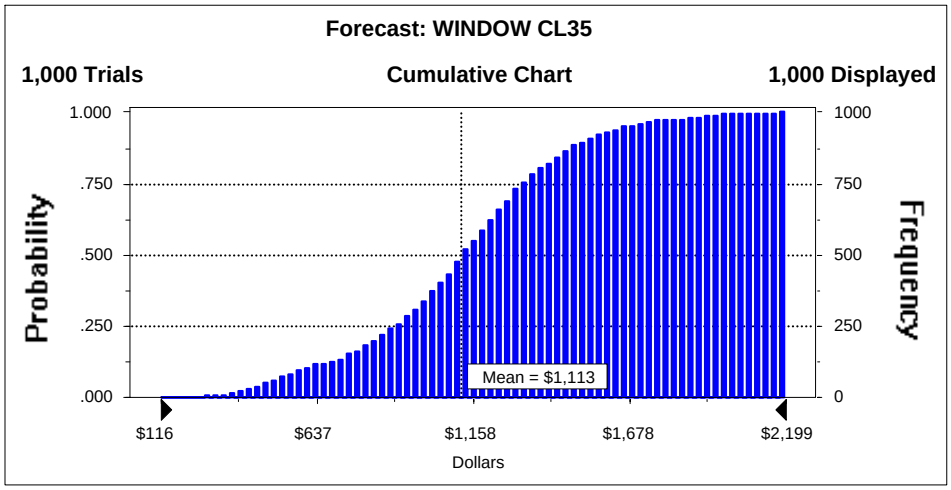

Figure G-14: Climate Zone 1 Class 35 Window NPV Results for Heat Pumps

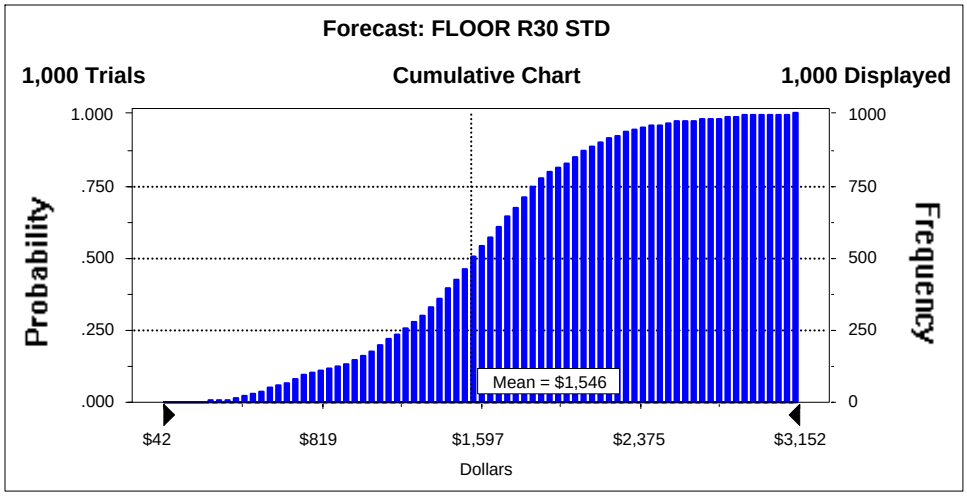

Figure G-15: Climate Zone 1 R30 Under floor NPV Results for Heat Pumps

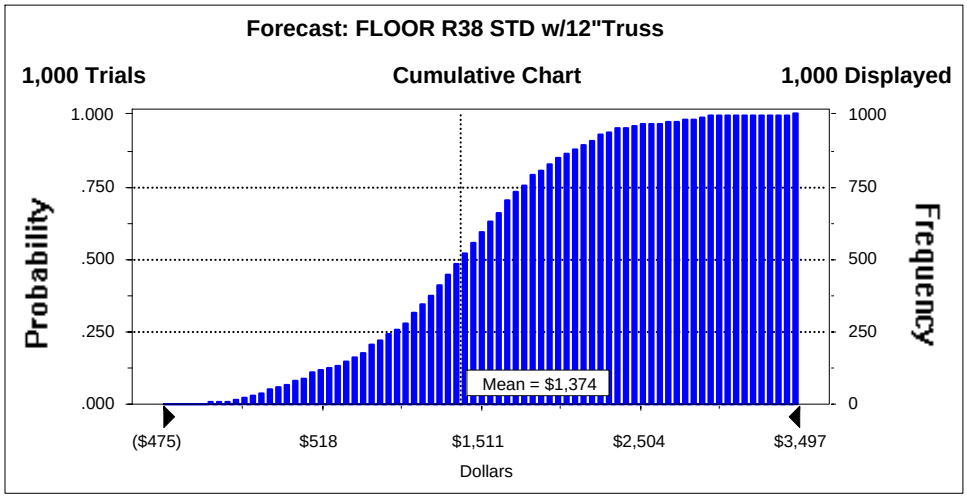

Figure G-16: Climate Zone 1 R38 Under floor NPV Results for Heat Pump

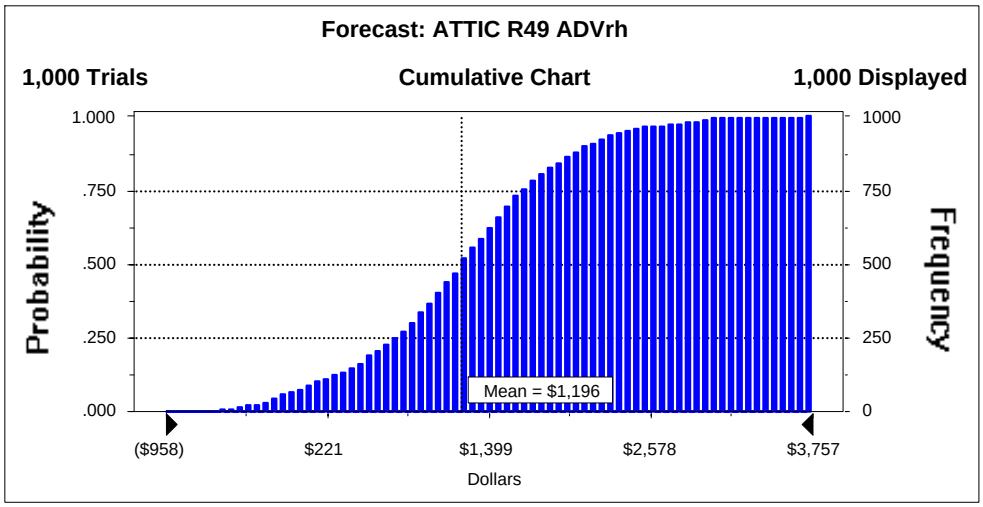

Figure G-17: Climate Zone 1 R49 Advance Framed Attic NPV Results for Heat Pumps

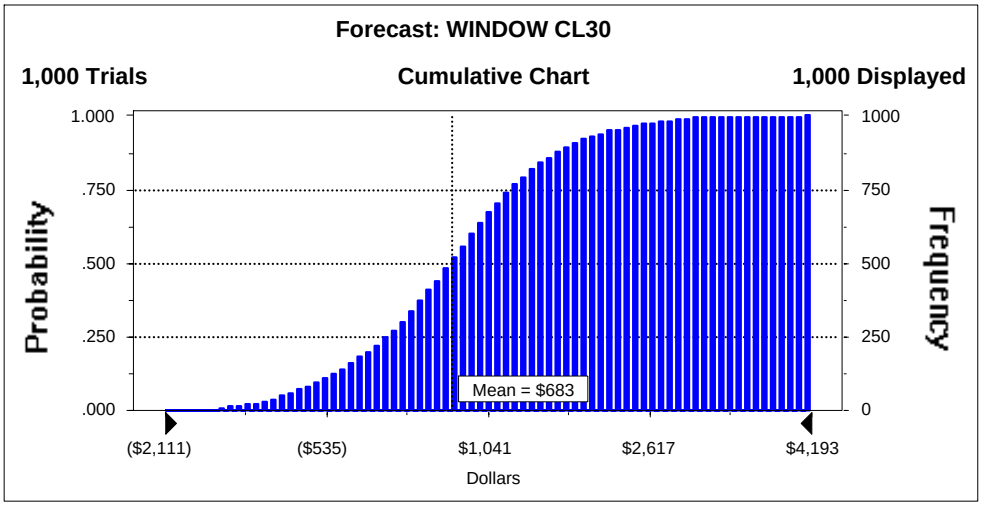

Figure G-18: Climate Zone 1 Class 30 Window NPV Results for Heat Pumps

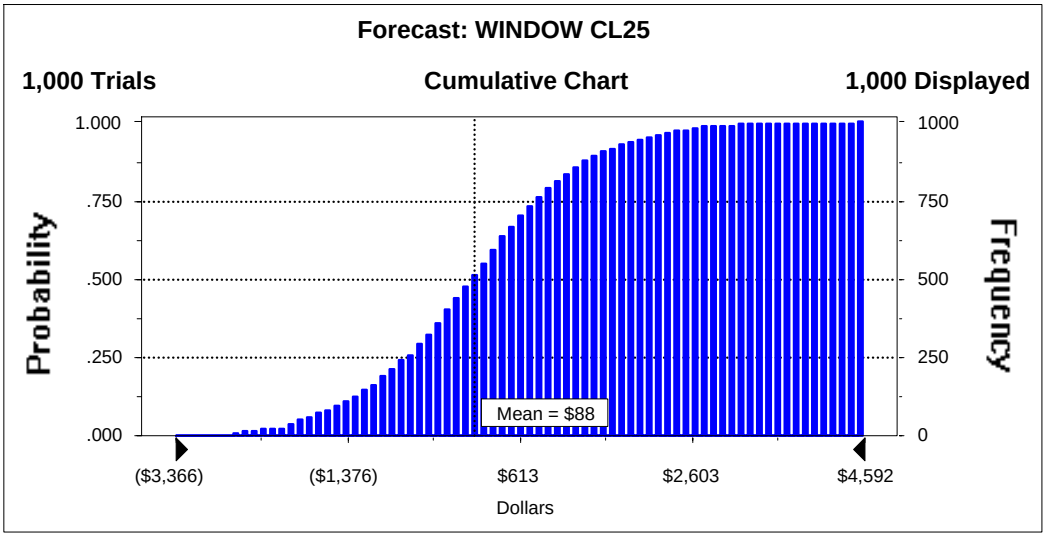

Figure G-19: Climate Zone 1 Class 25 Window NPV Results for Heat Pumps

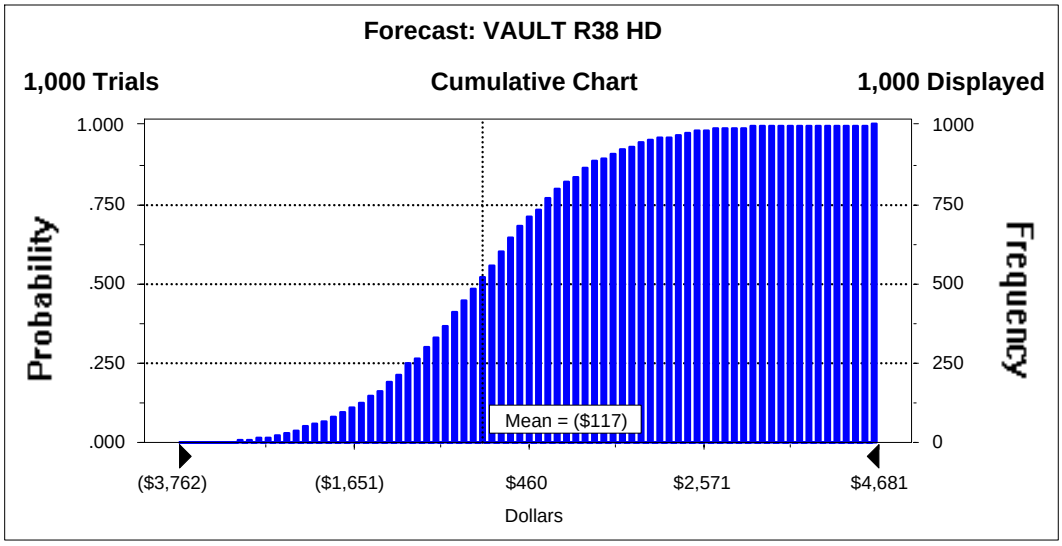

Figure G-20: Climate Zone 1 R38 Vaulted Ceiling NPV Results for Heat Pumps

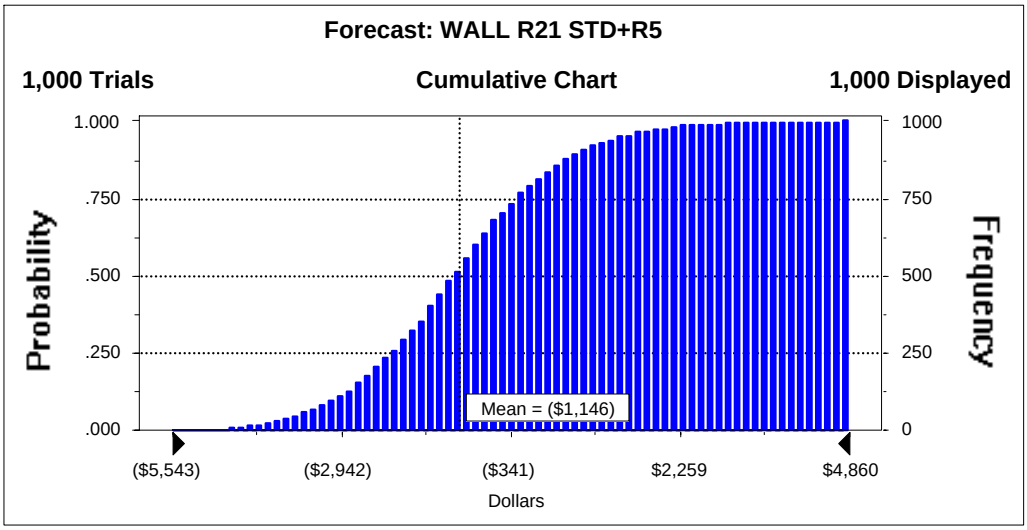

Figure G-21: Climate Zone 1 R26 Advanced Framed Wall NPV Results for Heat Pumps

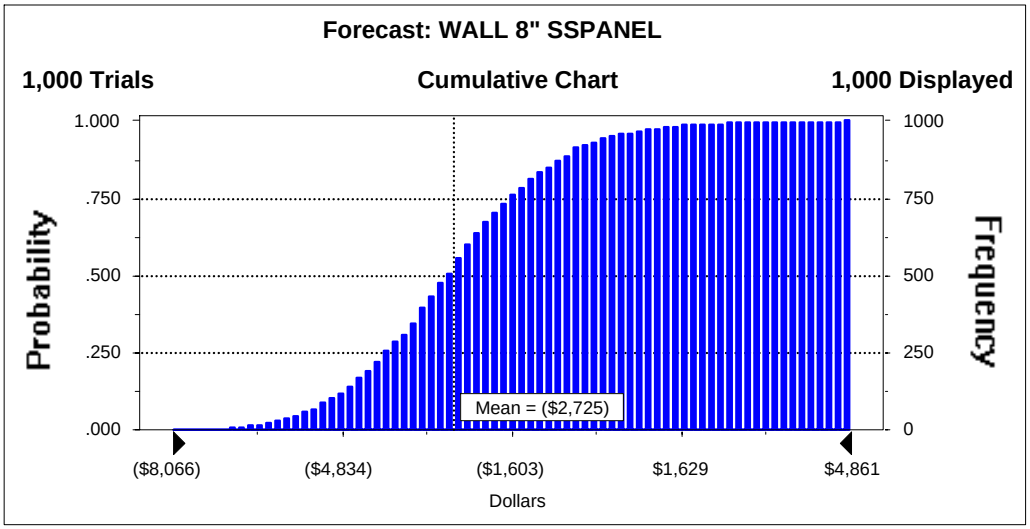

Figure G-22: Climate Zone 1 R33 Wall NPV Results for Heat Pumps

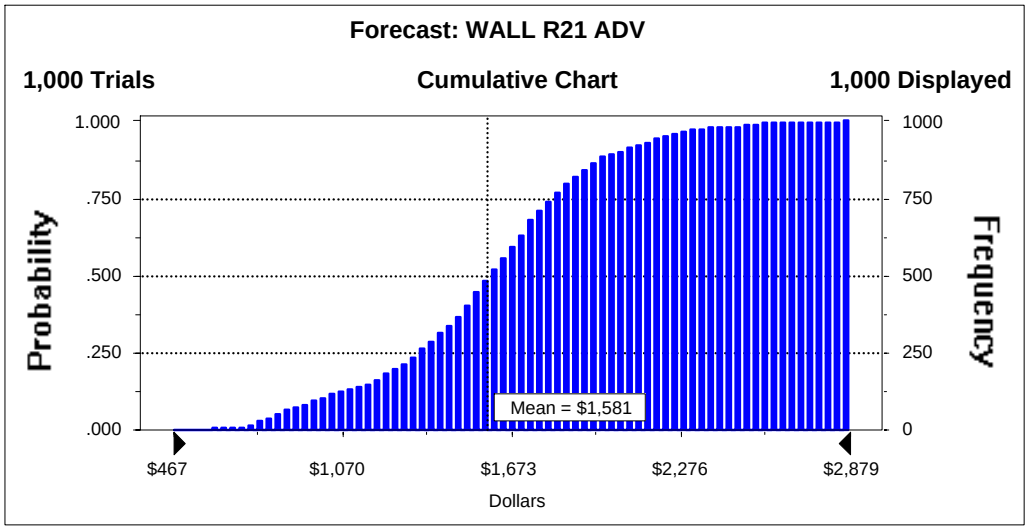

Figure G-23: Climate Zone 1 R21 Above Grade Wall NPV Results for Electric FAF

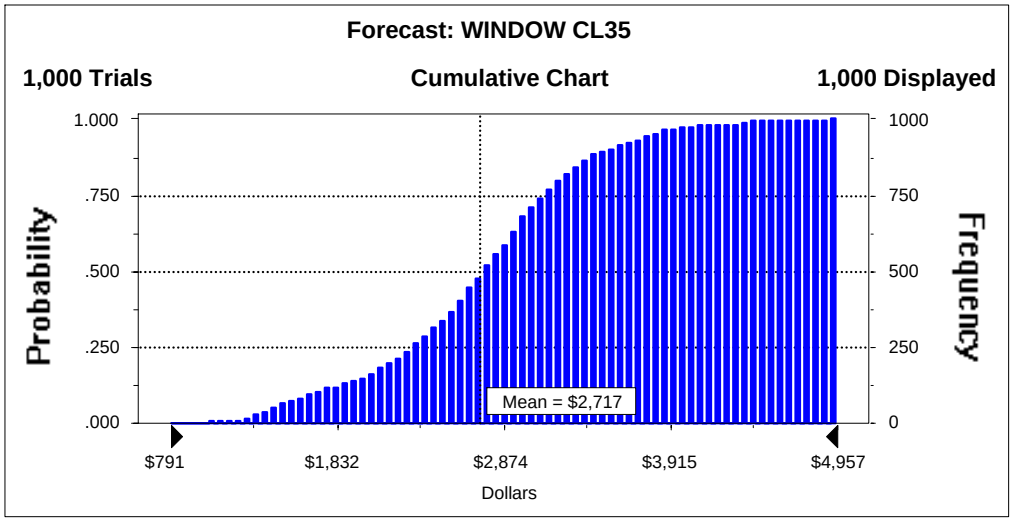

Figure G-24: Climate Zone 1 Class 35 Window NPV Results for Electric FAF

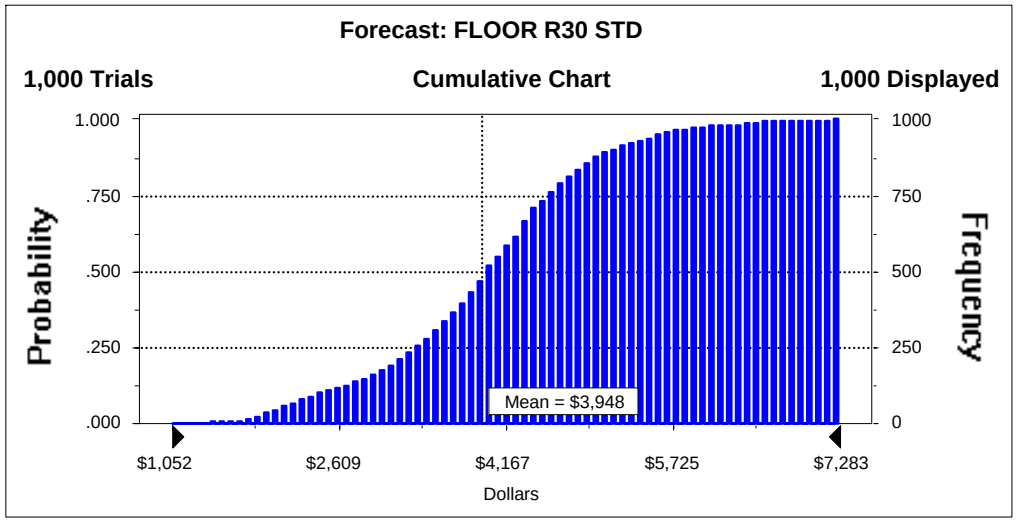

Figure G-25: Climate Zone 1 R30 Under floor NPV Results for Electric FAF

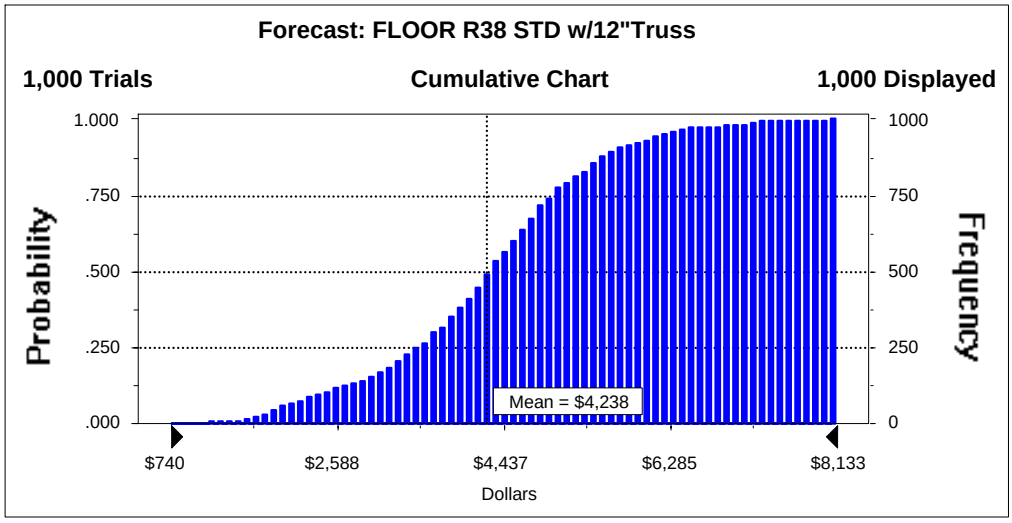

Figure G-26: Climate Zone 1 R38 Under floor NPV Results for Electric FAF

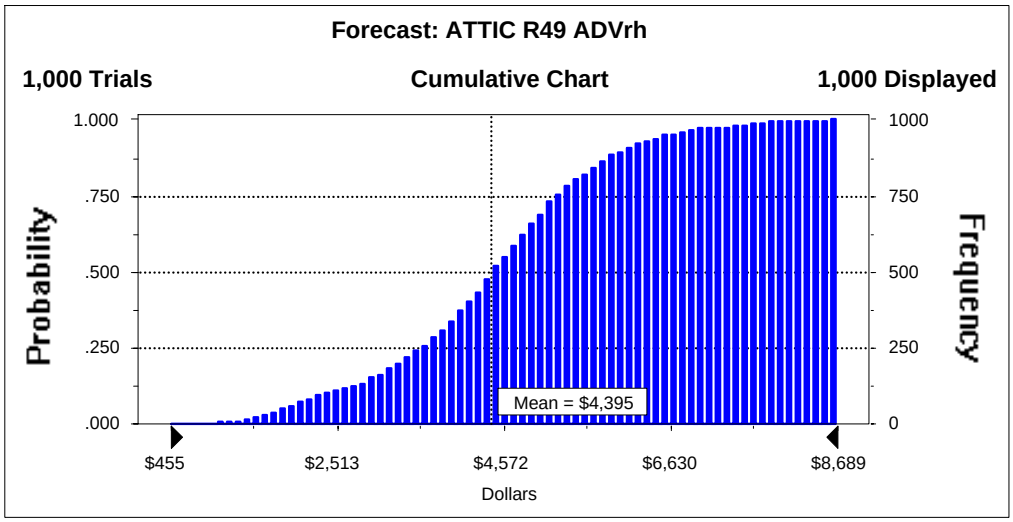

Figure G-27: Climate Zone 1 R49 Advanced Framed Attic NPV Results for Electric FAF

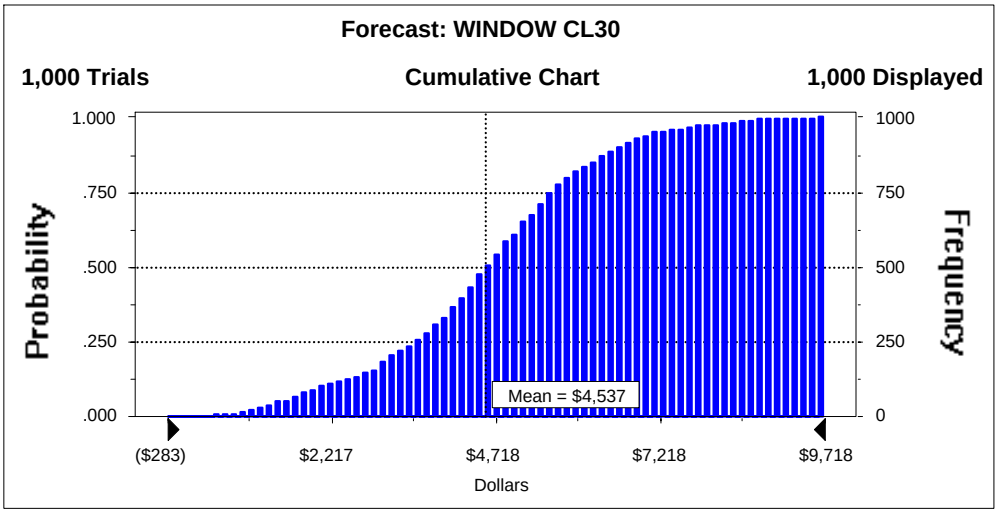

Figure G-28: Climate Zone 1 Class 30 Window NPV Results for Electric FAF

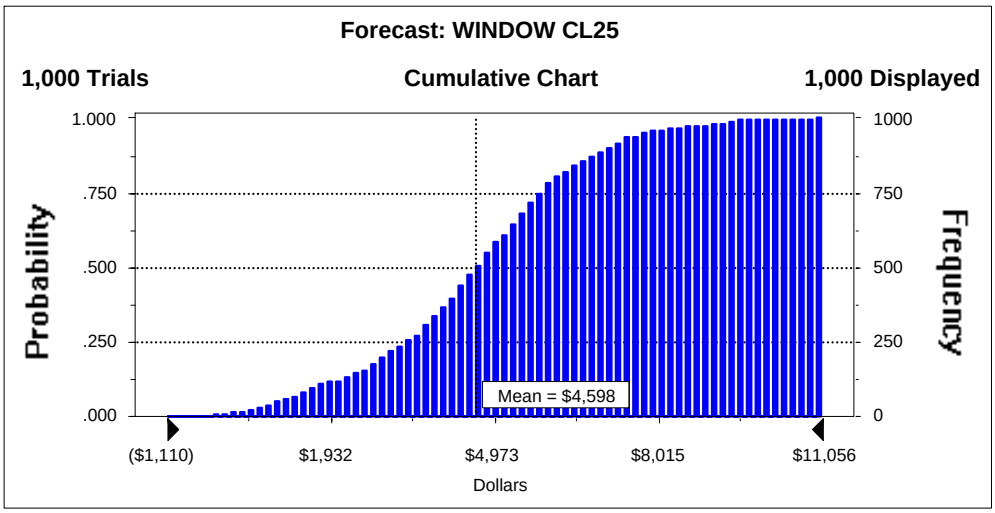

Figure G-29: Climate Zone 1 Class 25 Window NPV Results for Electric FAF

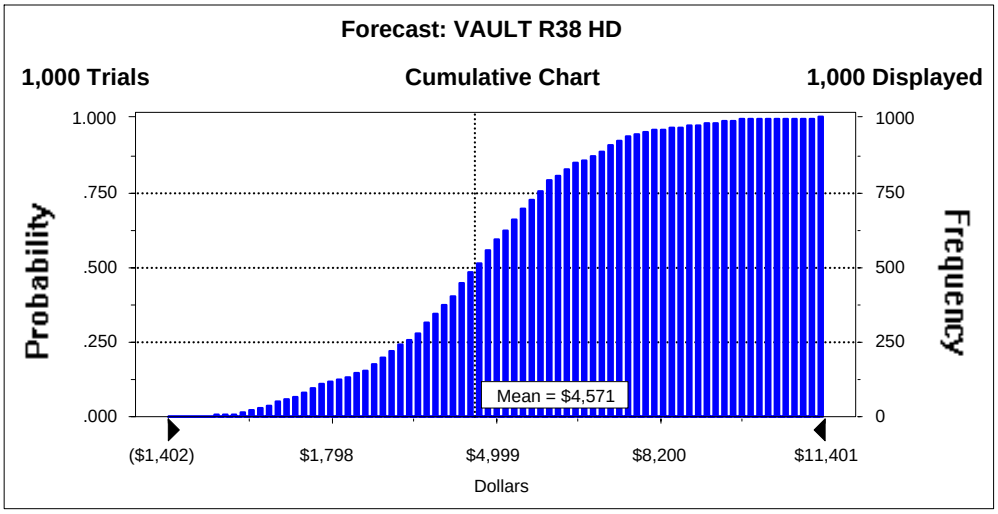

Figure G-30: Climate Zone 1 R38 Vaulted Ceiling NPV Results for Electric FAF

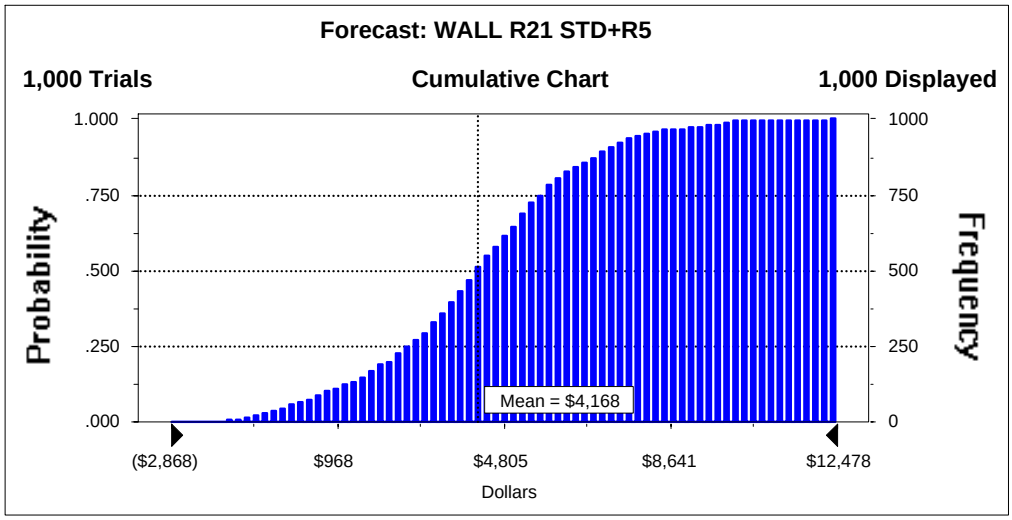

Figure G-31: Climate Zone 1 R26 Advanced Framed Wall NPV Results for Electric FAF

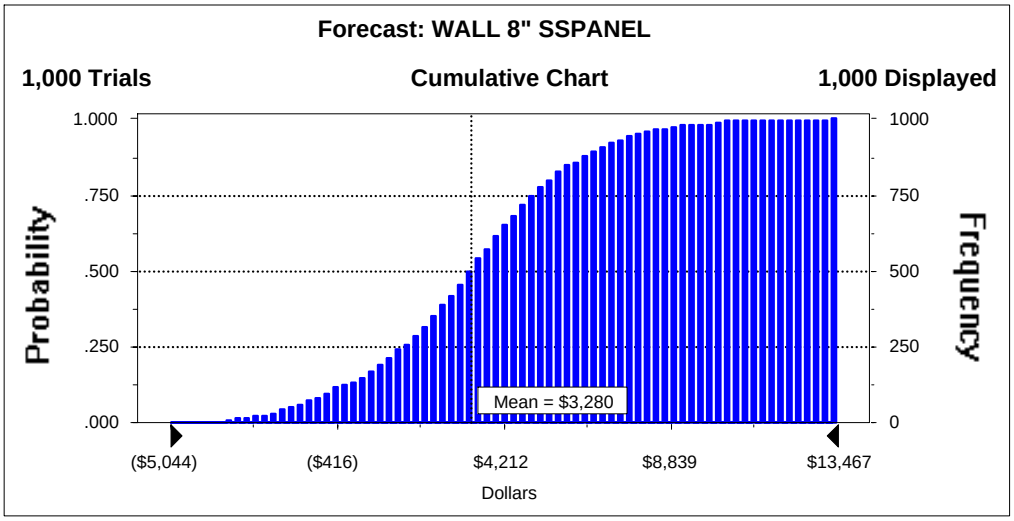

Figure G-32: Climate Zone 1 R33 Wall NPV Results for Electric FAF

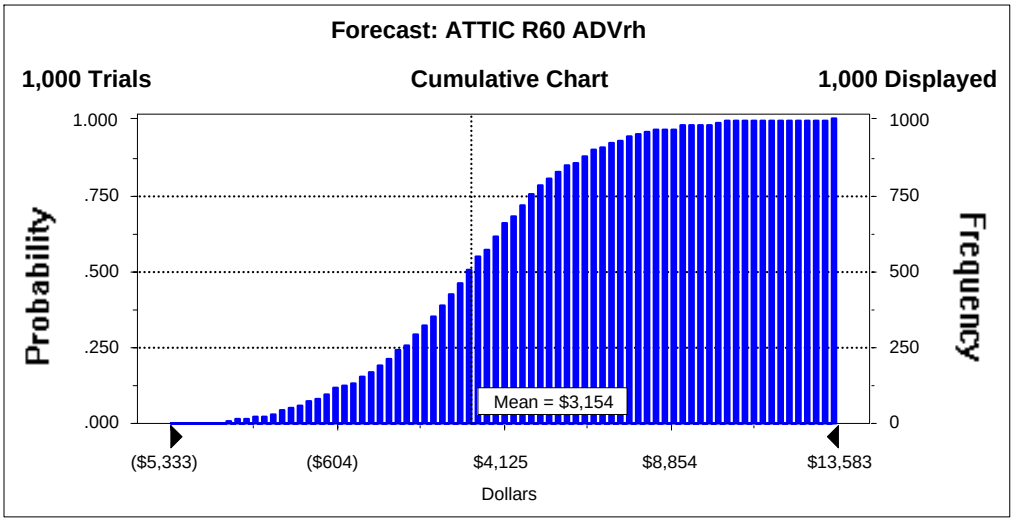

Figure G-33: Climate Zone 1 R60 Attic NPV Results for Electric FAF

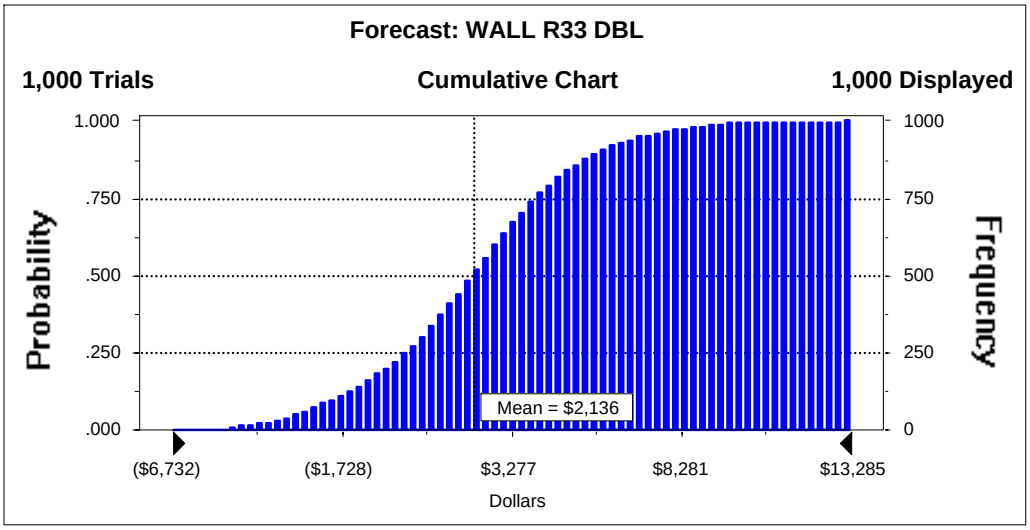

Figure G-34: Climate Zone 1 NPV Results for Electric FAF

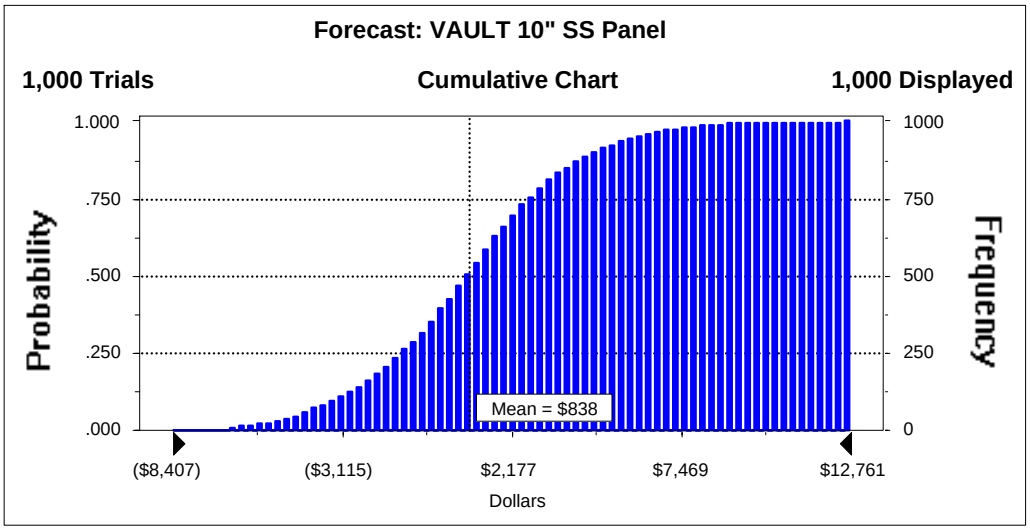

Figure G-35: Climate Zone 1 R38 Wall NPV Results for Electric FAF

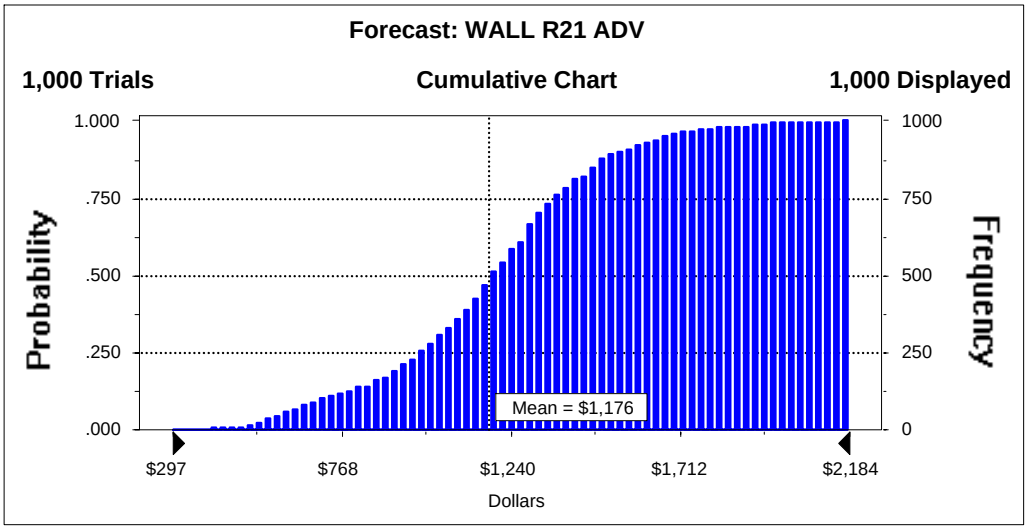

Figure G-36: Climate Zone 1 R21 Wall NPV for Electric Zonal

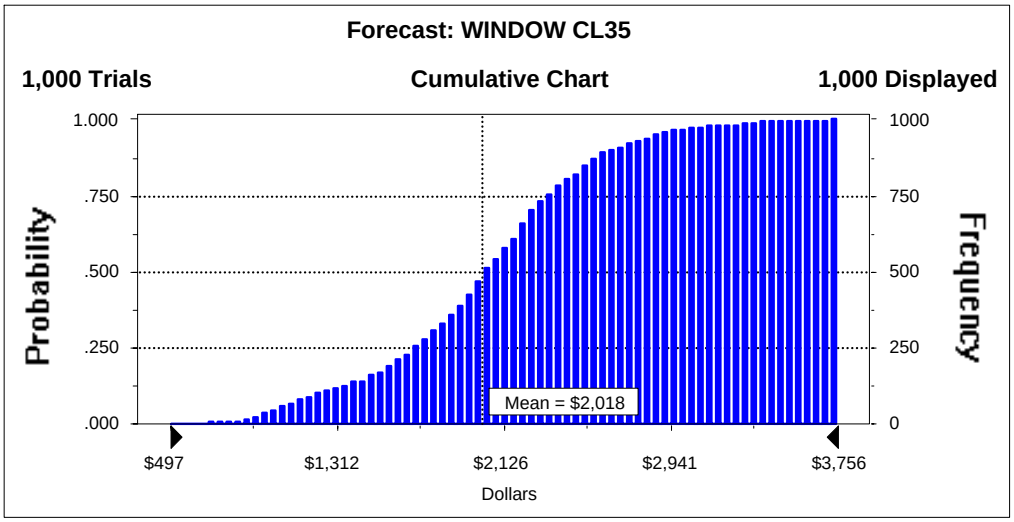

Figure G-37: Climate Zone 1 Class 35 Windows NPV Results for Electric Zonal

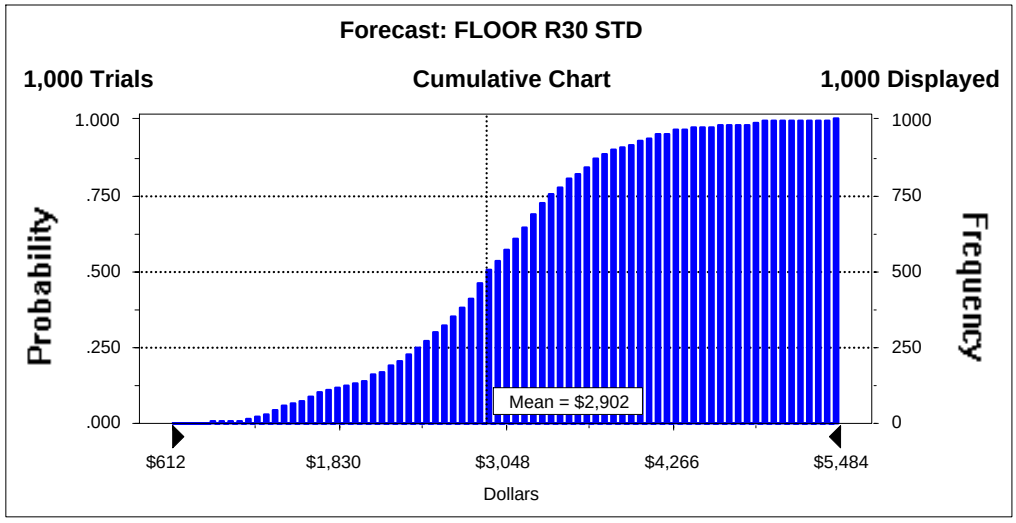

Figure G-38: Climate Zone 1 R30 Under floor NPV Results for Electric Zonal

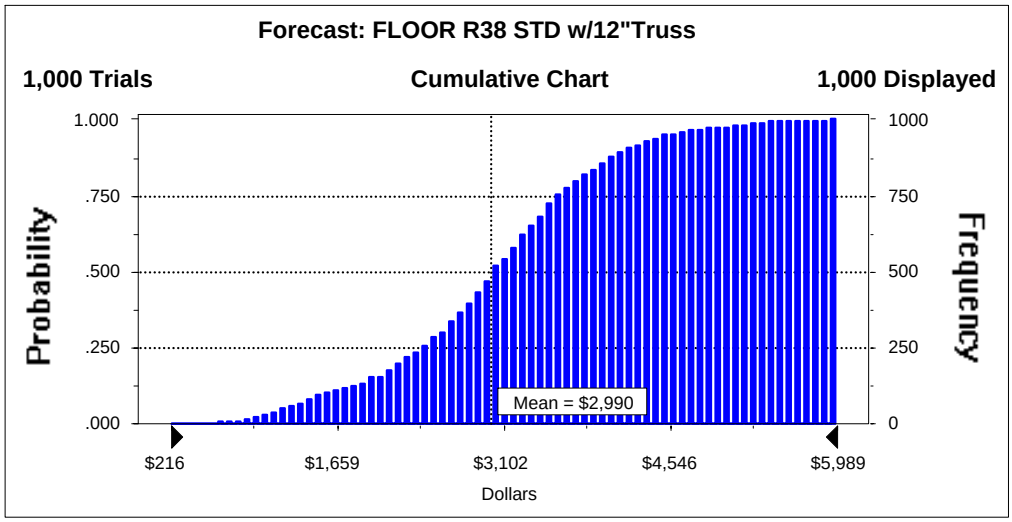

Figure G-39: Climate Zone 1 R38 Under floor NPV Results for Electric Zonal

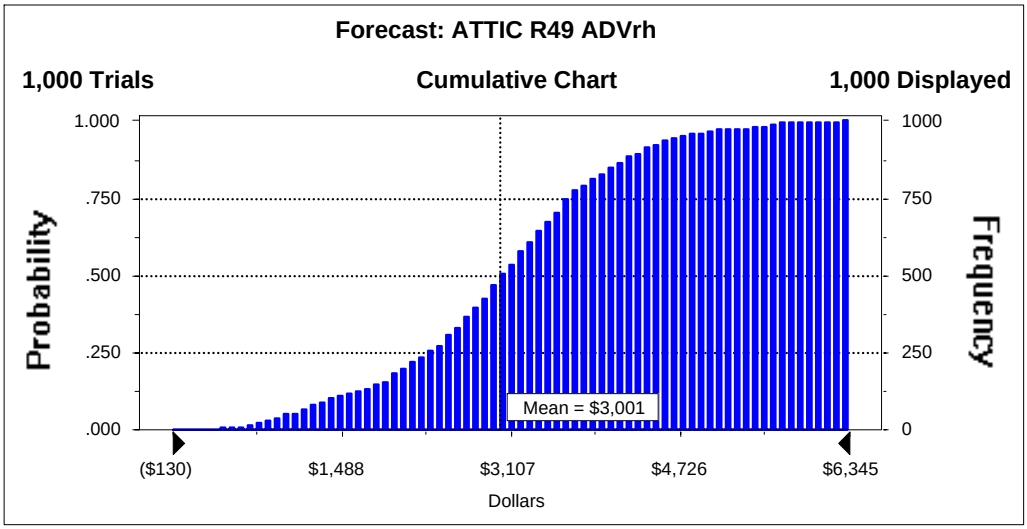

Figure G-40: Climate Zone 1 R49 Advanced Framed Attic NPV Results for Electric Zonal

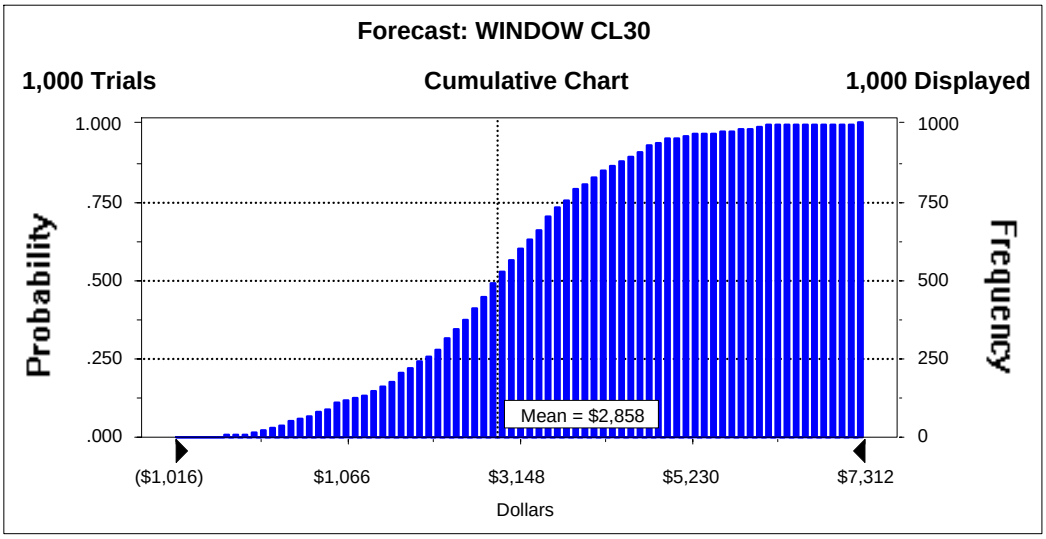

Figure G-41: Climate Zone 1 Class 30 Window NPV Results for Electric Zonal

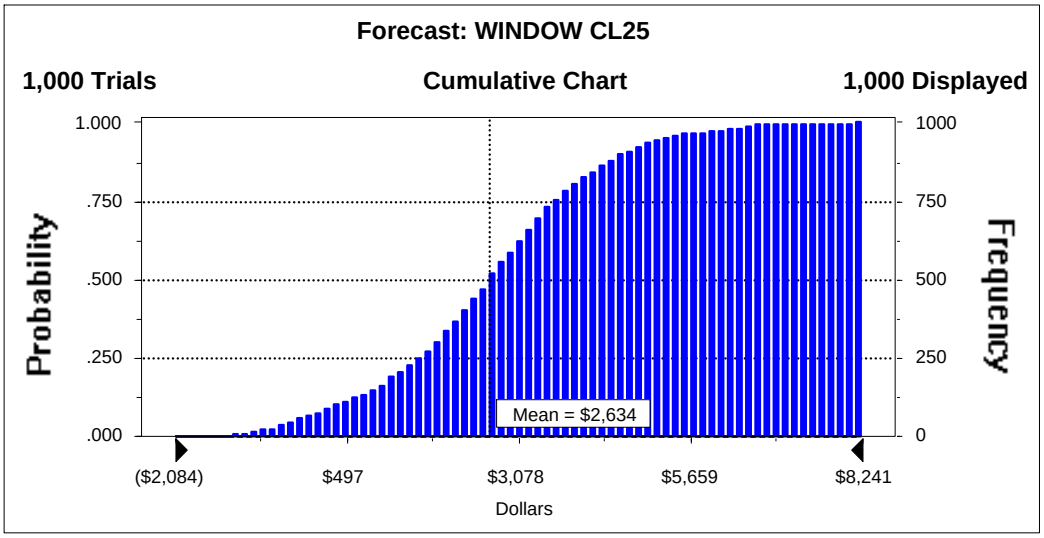

Figure G-42: Climate Zone 1 Class 25 Window NPV Results for Electric Zonal

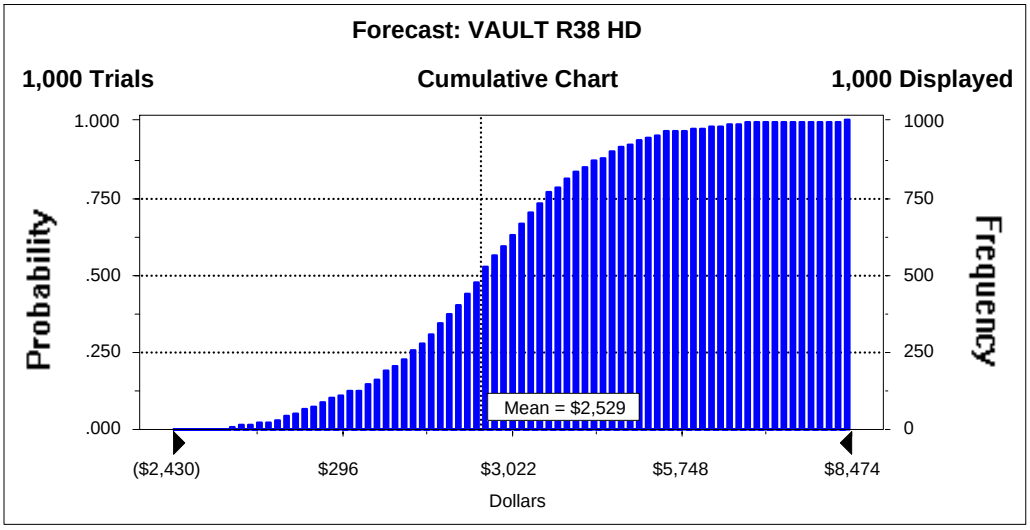

Figure G-43: Climate Zone 1 R38 Vaulted Ceiling NPV Results for Electric Zonal

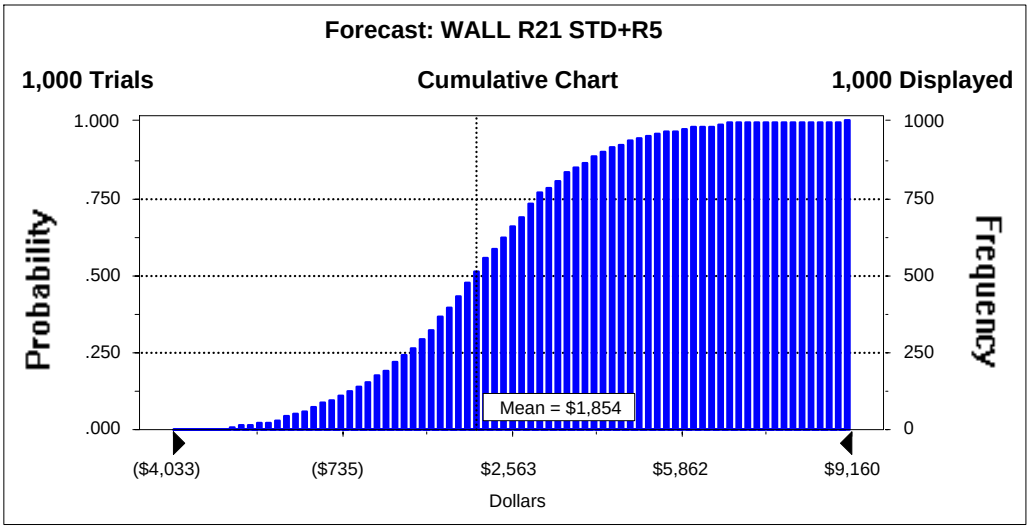

Figure G-44: Climate Zone 1 R26 Advanced Framed Wall NPV Results for Electric Zonal

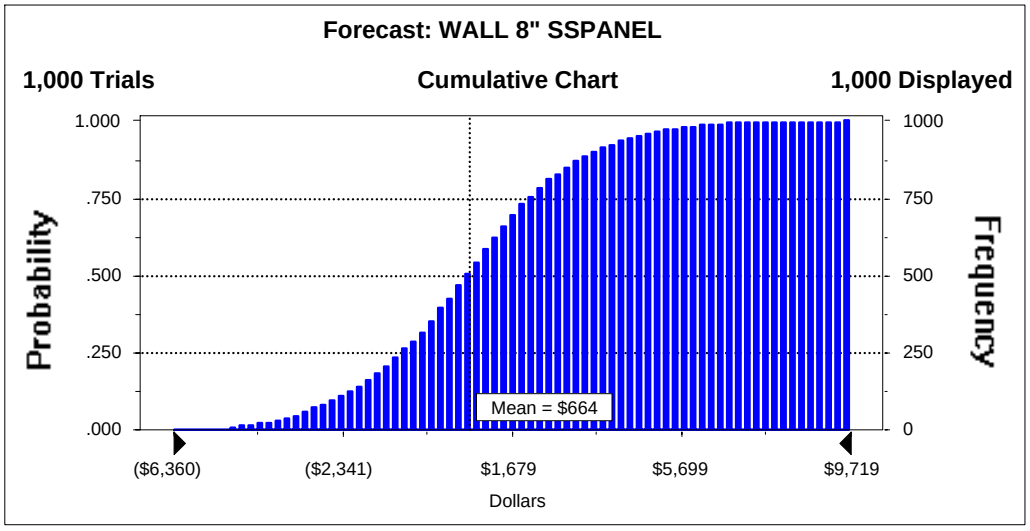

Figure G-45: Climate Zone 1 R33 Wall NPV Results for Electric Zonal

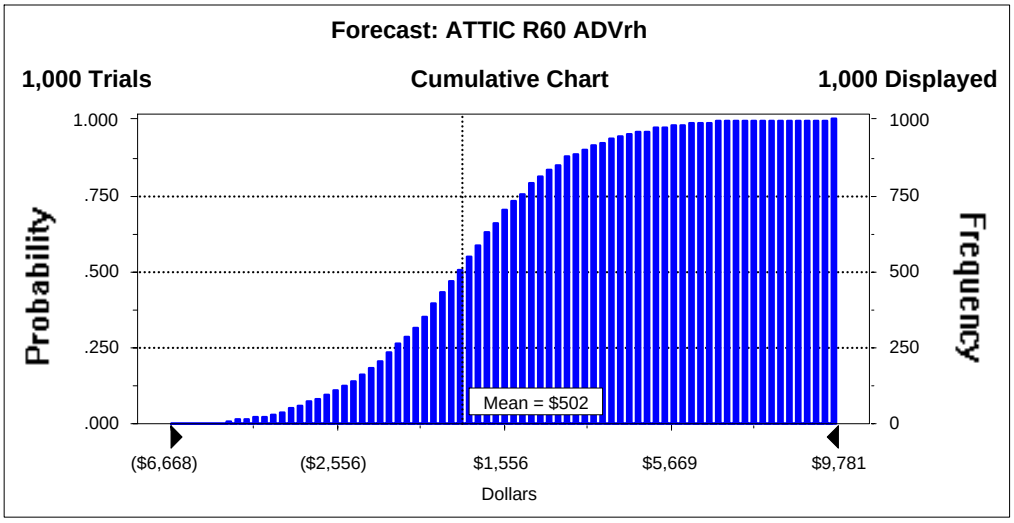

Figure G-46: Climate Zone 1 R60 Advanced Framed Attic NPV Results for Electric Zonal

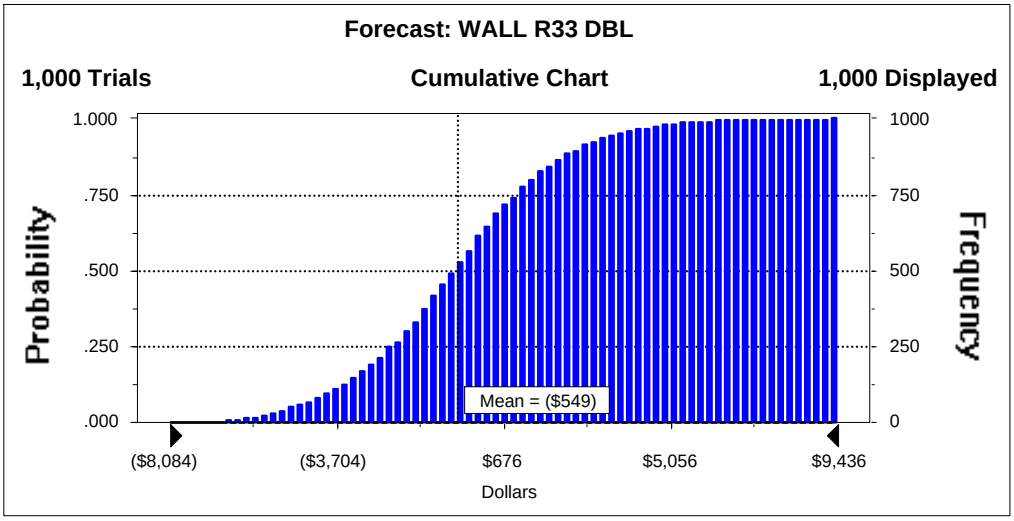

Figure G-47: Climate Zone 1 R38 Wall NPV Results for Electric Zonal

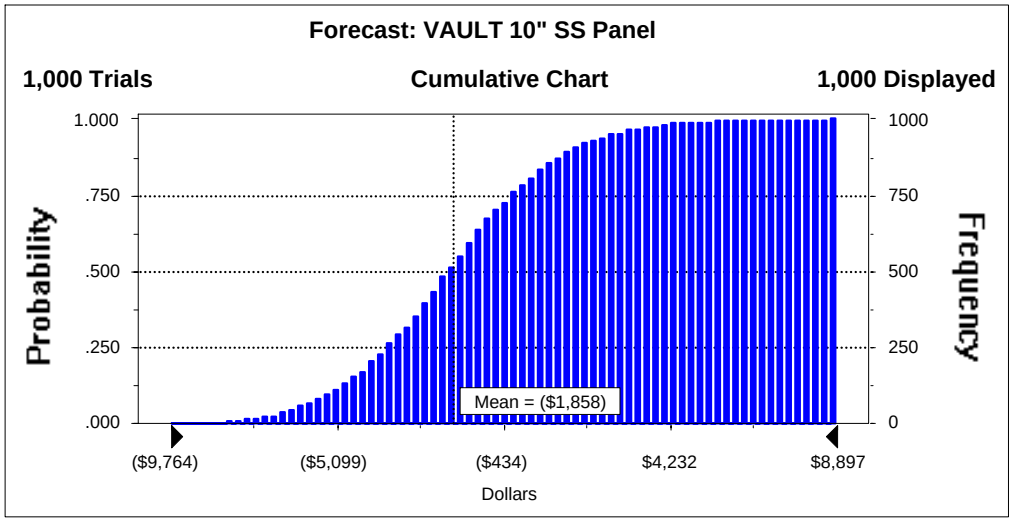

Figure G-48: Climate Zone 1 R49 Vault NPV Results for Electric Zonal

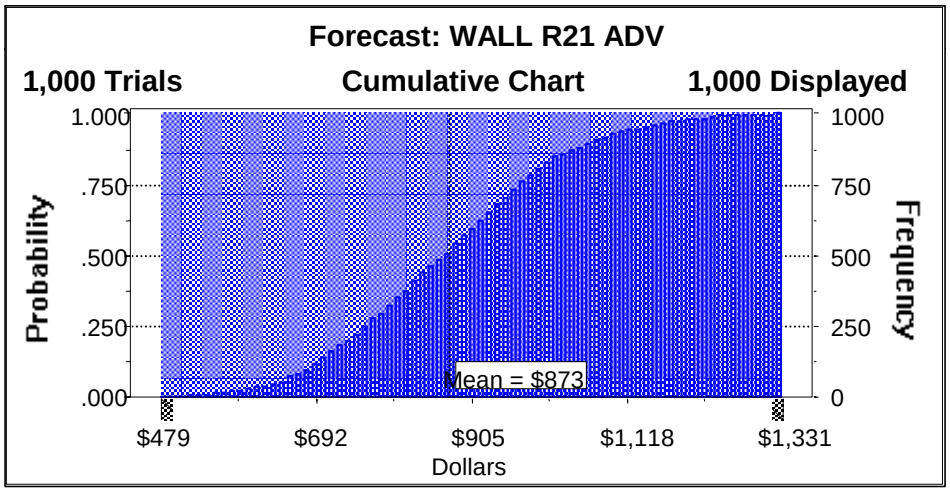

Figure G-49: Climate Zone 1 R21 Advanced Framed Wall NPV Results for Gas FAF

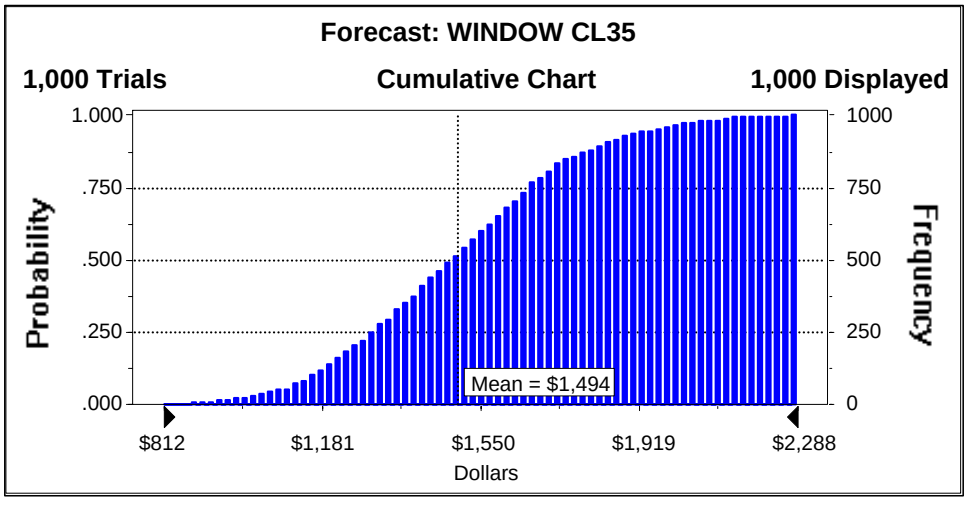

Figure G-50: Climate Zone 1 Class 35 Window NPV Results for Gas FAF

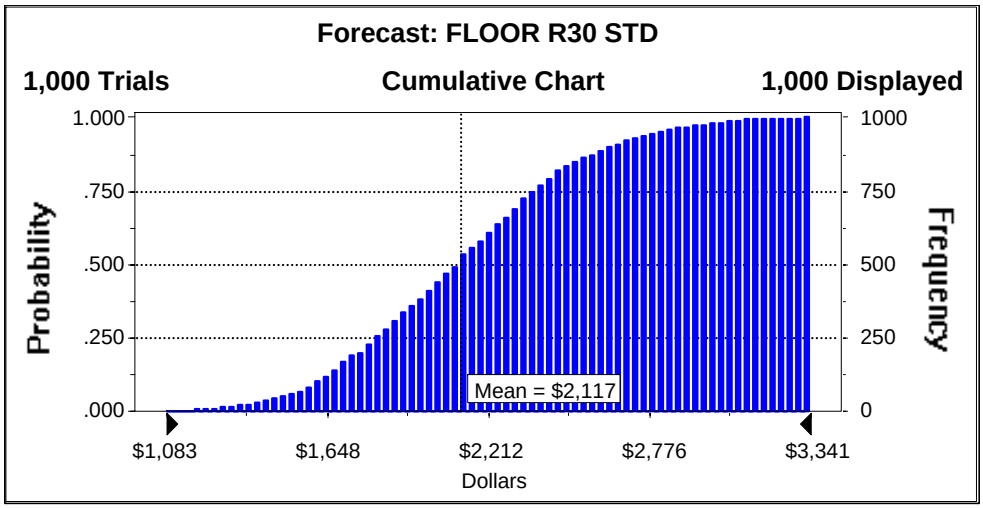

Figure G-51: Climate Zone 1 R30 Under floor NPV Results for Gas FAF

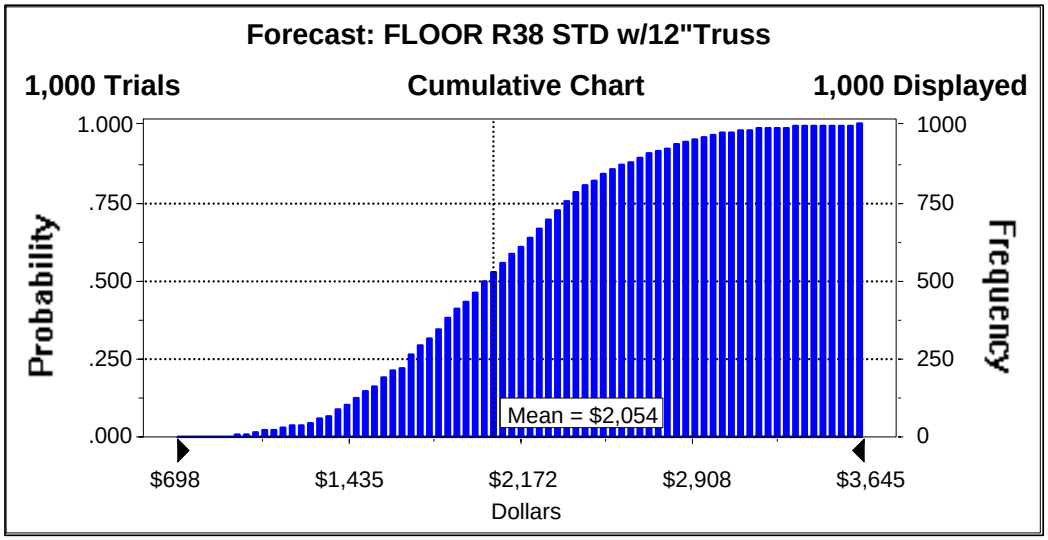

Figure G-52: Climate Zone 1 R38 Under floor NPV Results for Gas FAF

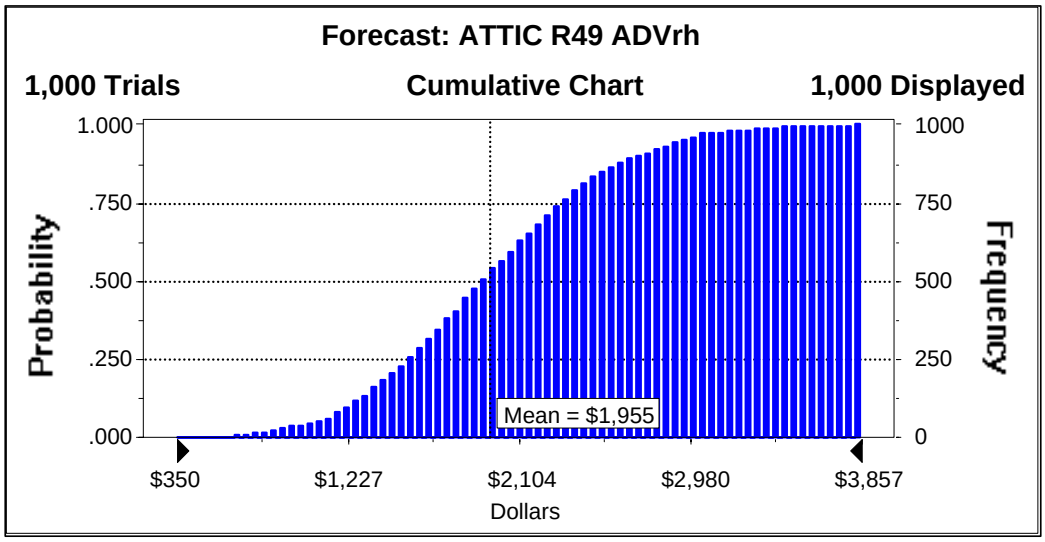

Figure G-53: Climate Zone 1 R49 Advanced Framed Attic NPV Results for Gas FAF

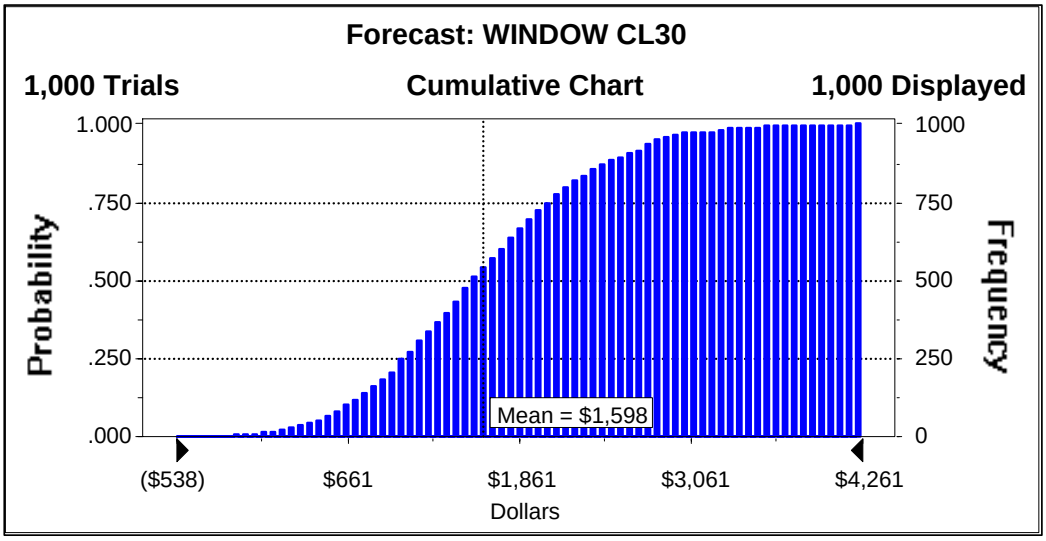

Figure G-54: Climate Zone 1 Class 30 Window NPV Results for Gas FAF

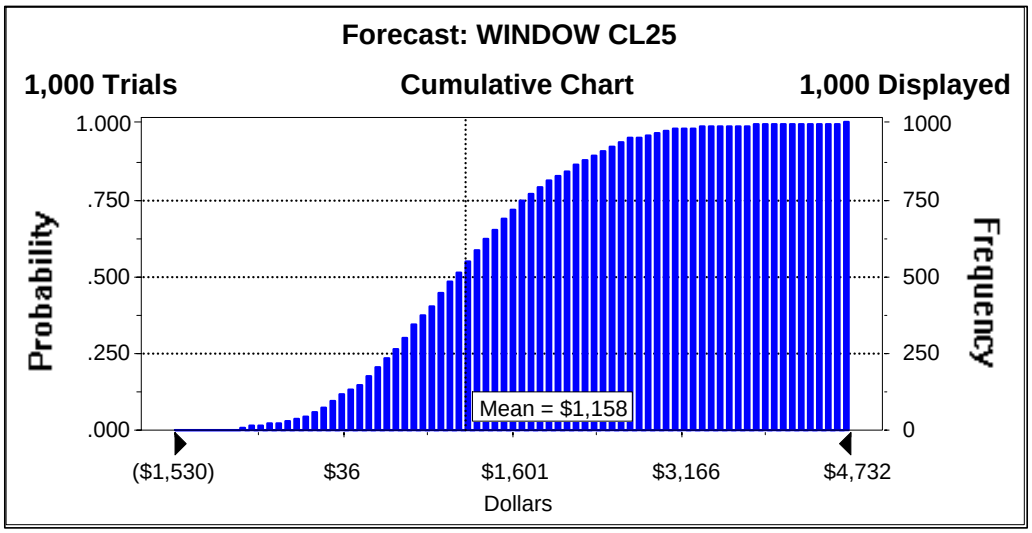

Figure G-55: Climate Zone 1 Class 25 Window NPV Results for Gas FAF

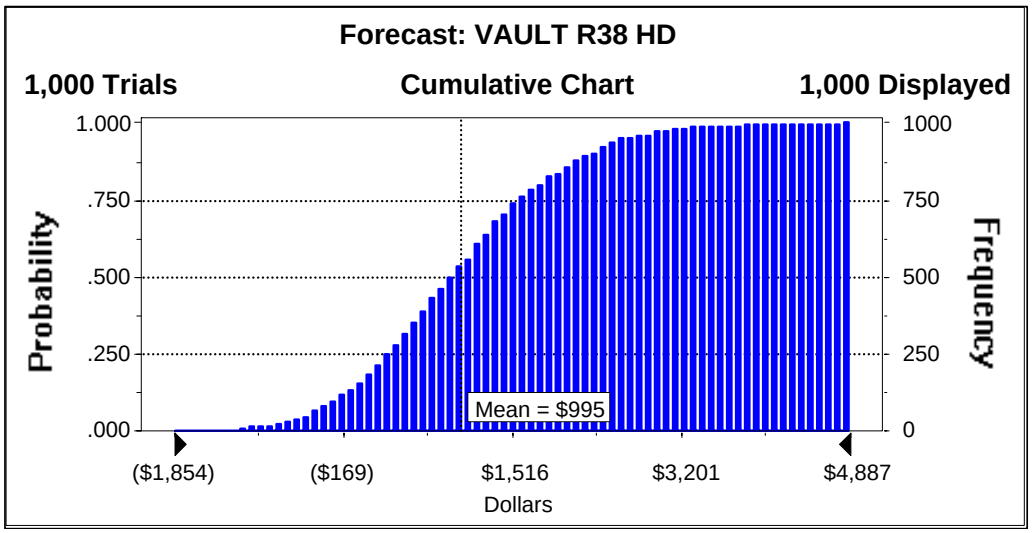

Figure G-56: Climate Zone 1 R38 Vault NPV Results for Gas FAF

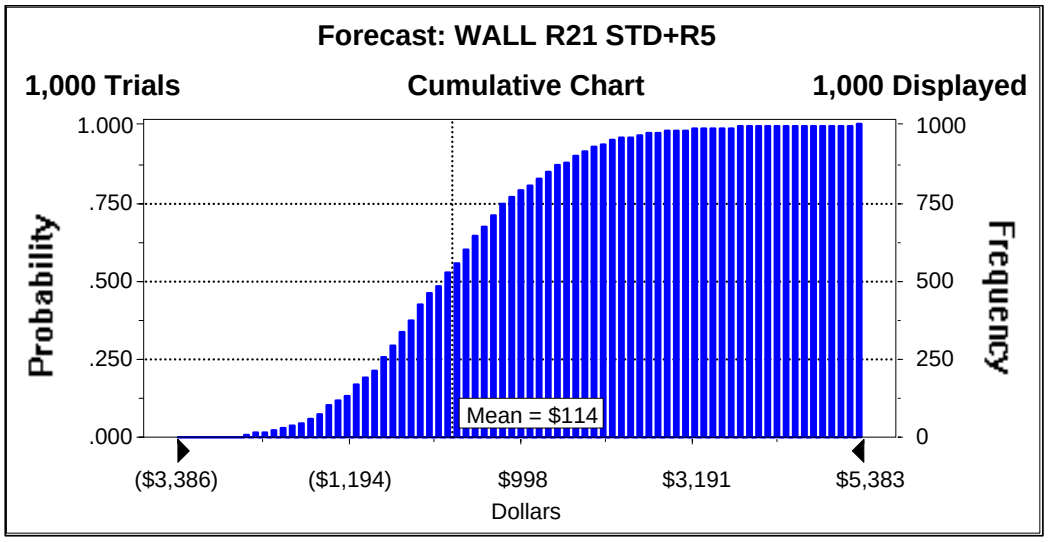

Figure G-57: Climate Zone 1 R26 Advanced Framed Wall NPV Results for Gas FAF

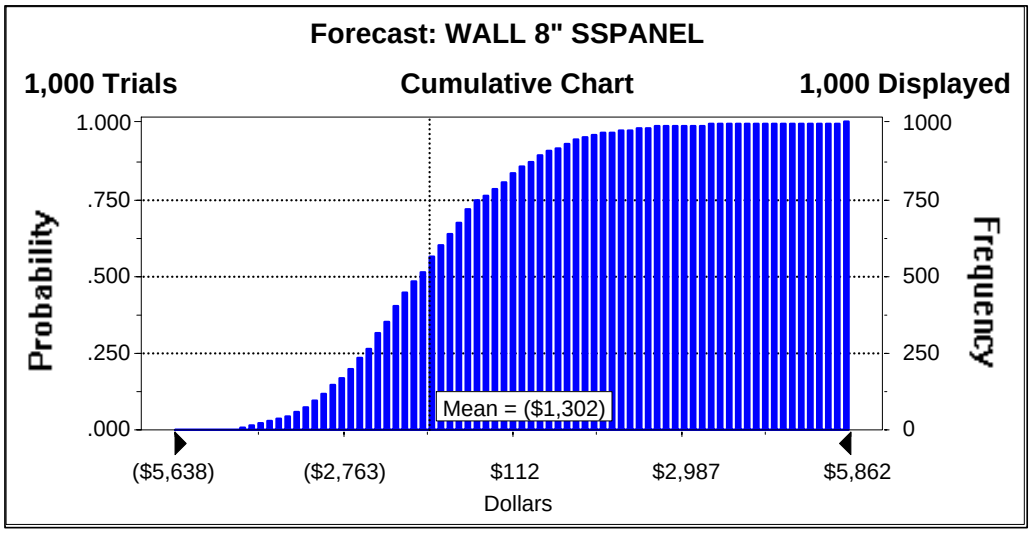

Figure G-58: Climate Zone 1 R33 Wall NPV Results for Gas FAF

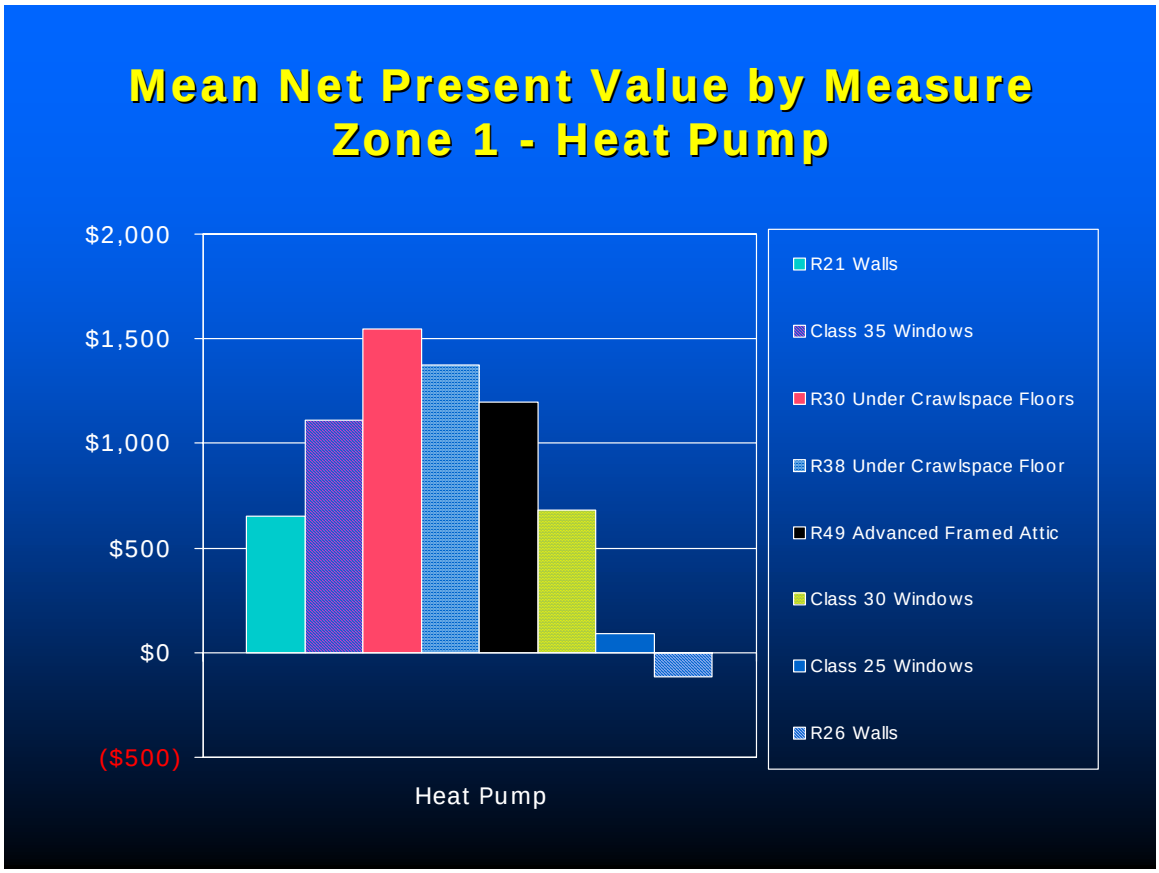

Figure G-59: Climate Zone 1 Mean NPV by Measure for Heat Pumps

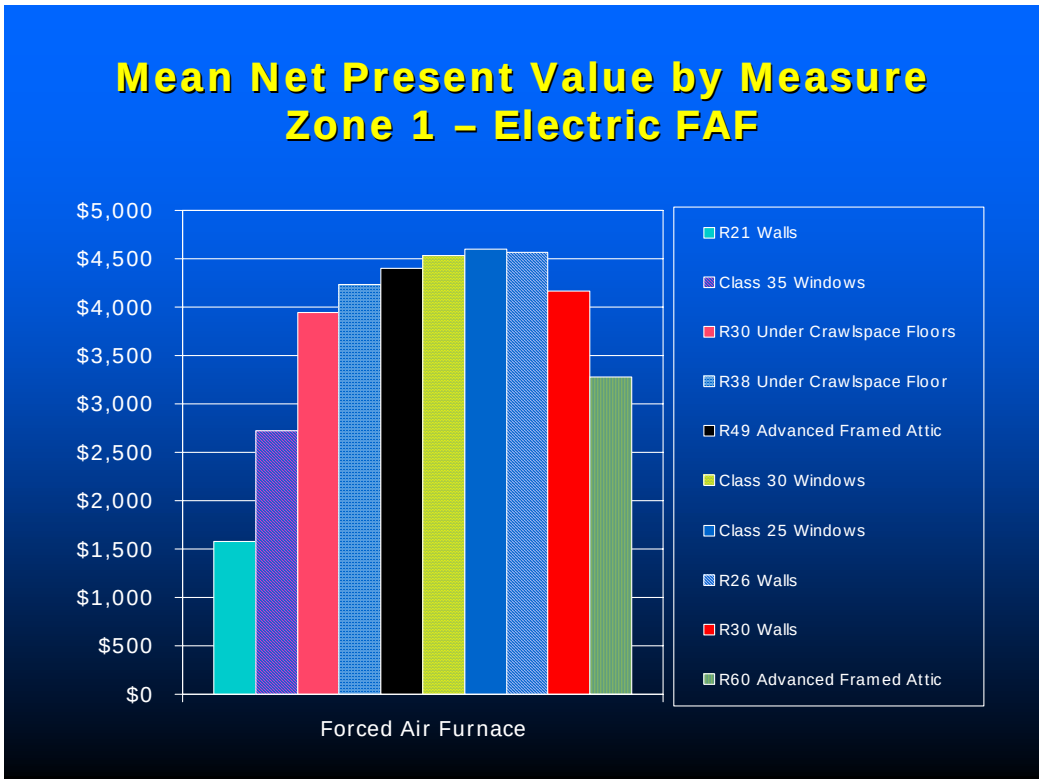

Figure G-60: Climate Zone 1 Mean NPV by Measure for Electric FAF

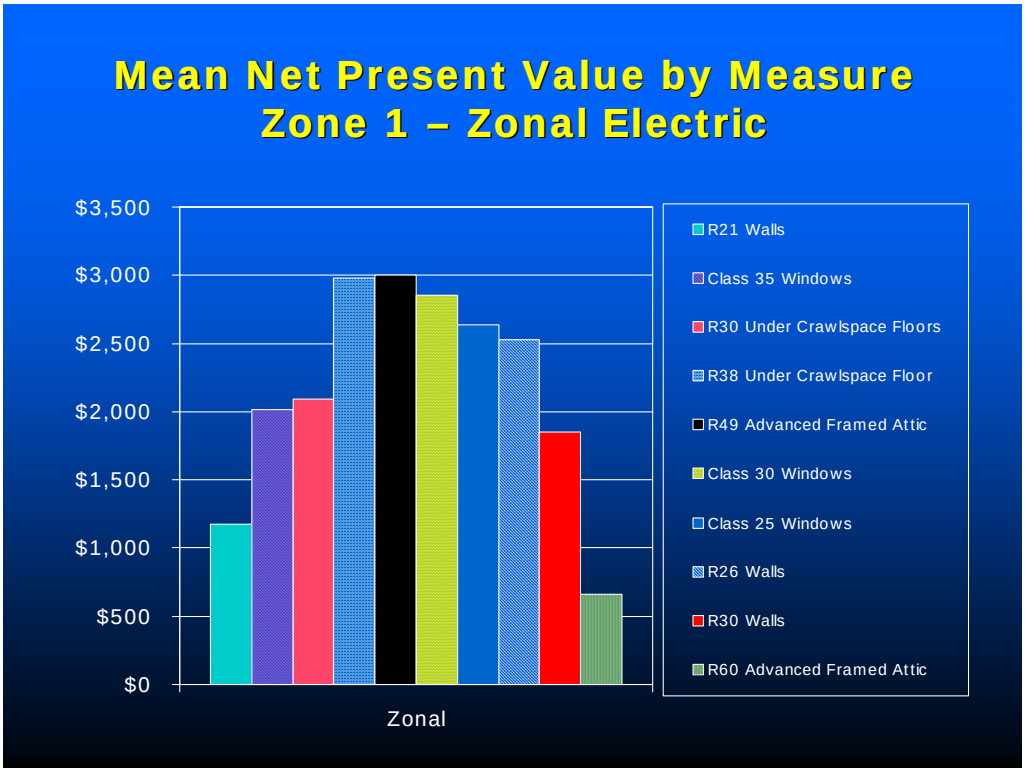

Figure G-61: Climate Zone 1 - Mean NPV by Measure for Electric Zonal

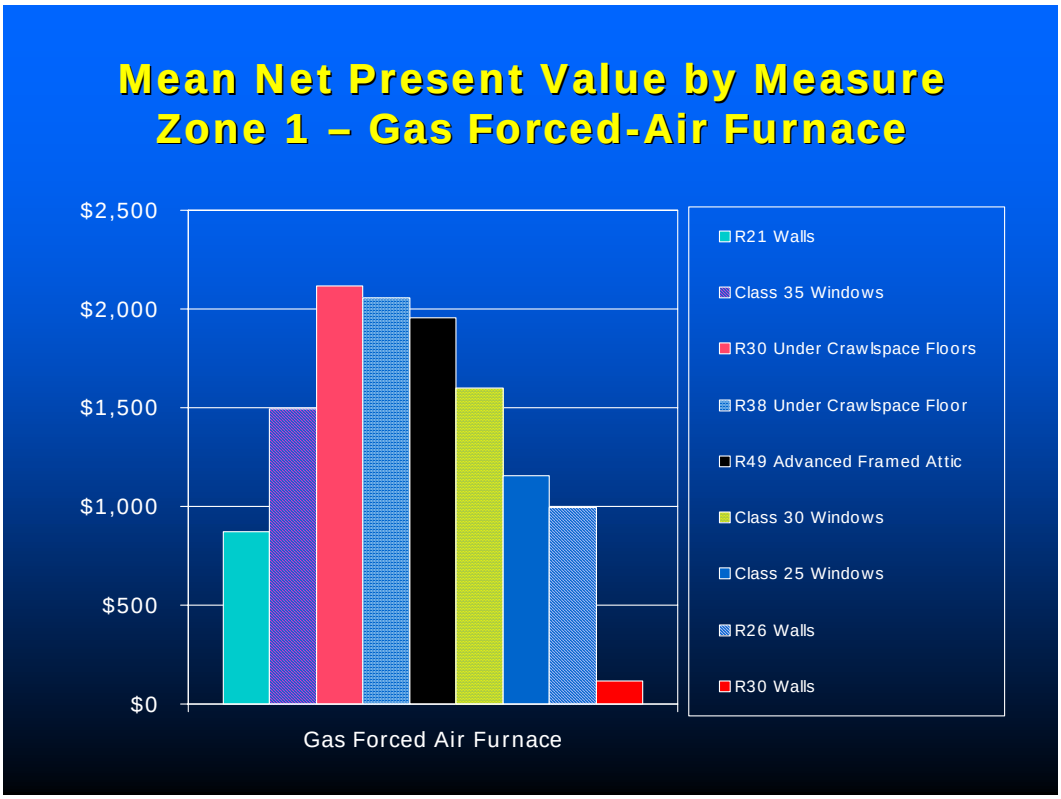

Figure G-62: Climate Zone 1 - Mean NPV by Measure for Gas FAF

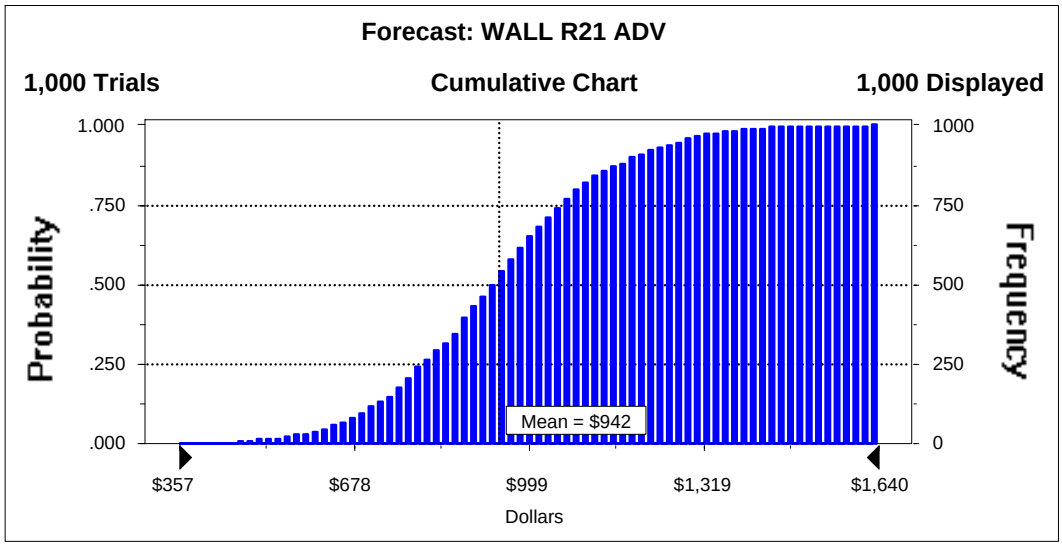

Figure G-63: Climate Zone 2 R21 Advanced Framed Wall NPV Results for Heat Pump

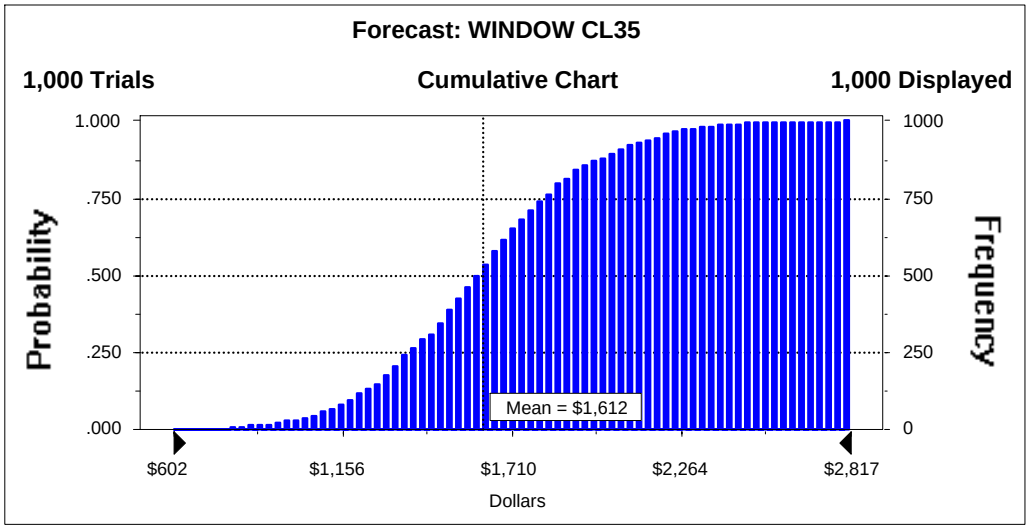

Figure G-64: Climate Zone 2 Class 35 Window NPV Results for Heat Pumps

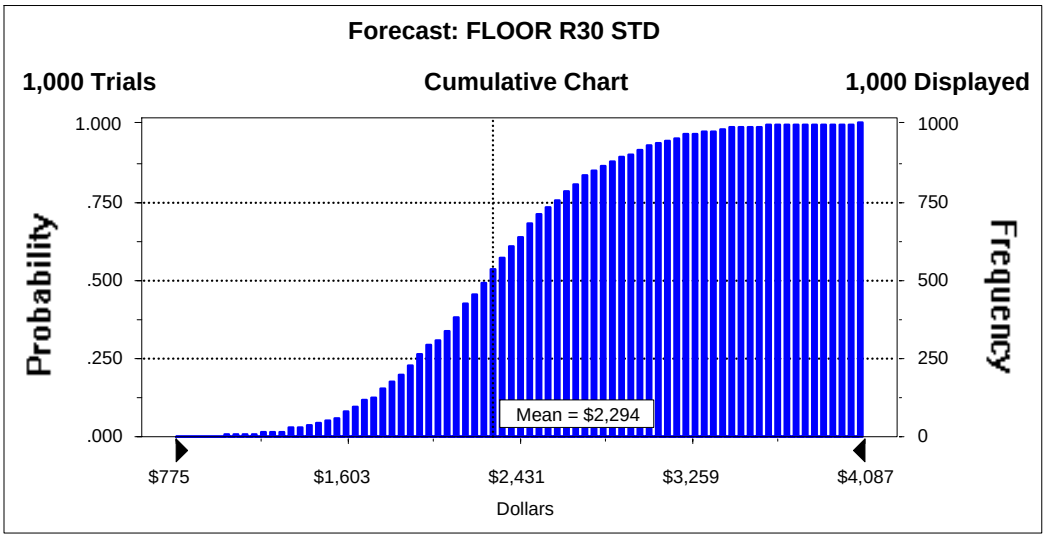

Figure G-65: Climate Zone 2 R30 Under floor NPV Results for Heat Pumps

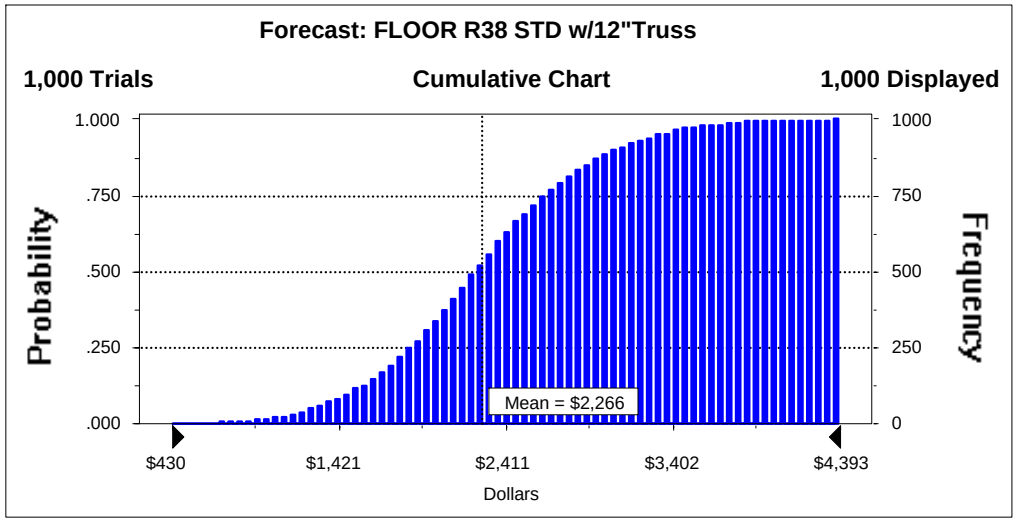

Figure G-66: Climate Zone 2 R38 Under floor NPC Results for Heat Pumps

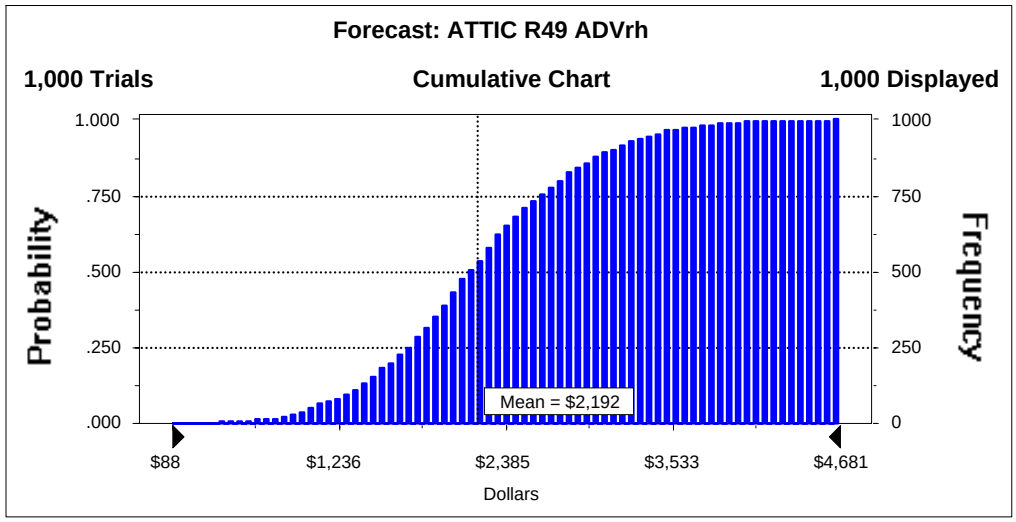

Figure G-67: Climate Zone 2 R49 Advanced Framed Attic NPV Results for Heat Pumps

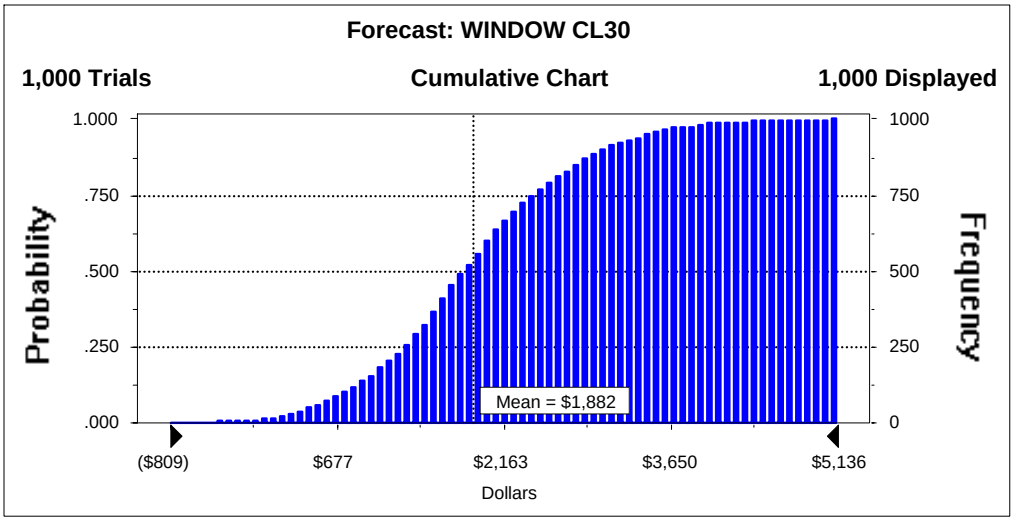

Figure G-68: Climate Zone 2 Class 30 Window NPV Results for Heat Pumps

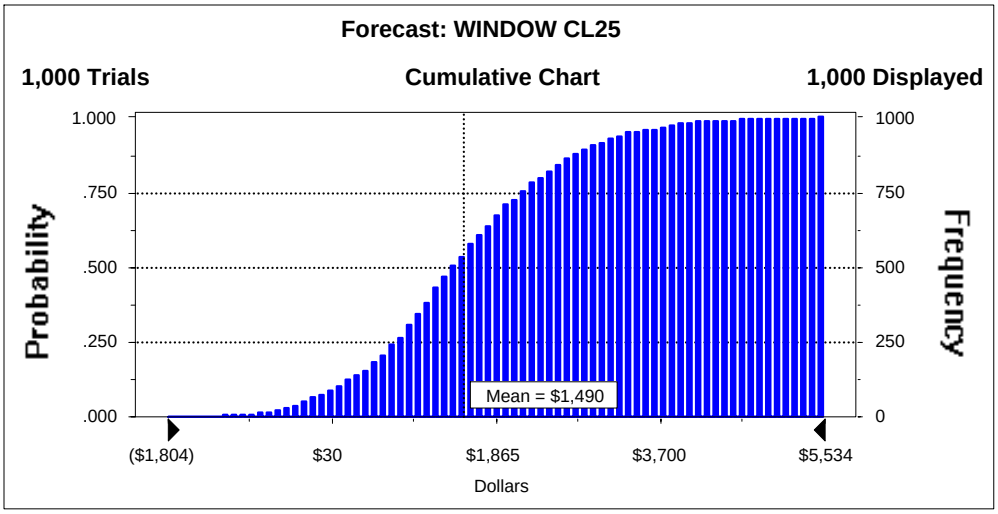

Figure G-69: Climate Zone 2 Class 25 Window NPV Results for Heat Pumps

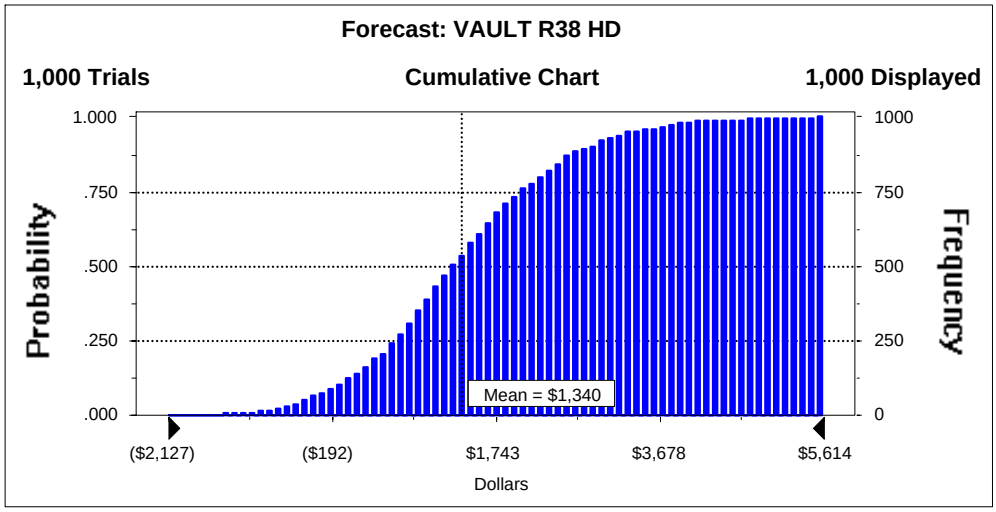

Figure G-70: Climate Zone 2 R38 Vault NPV Results for Heat Pumps

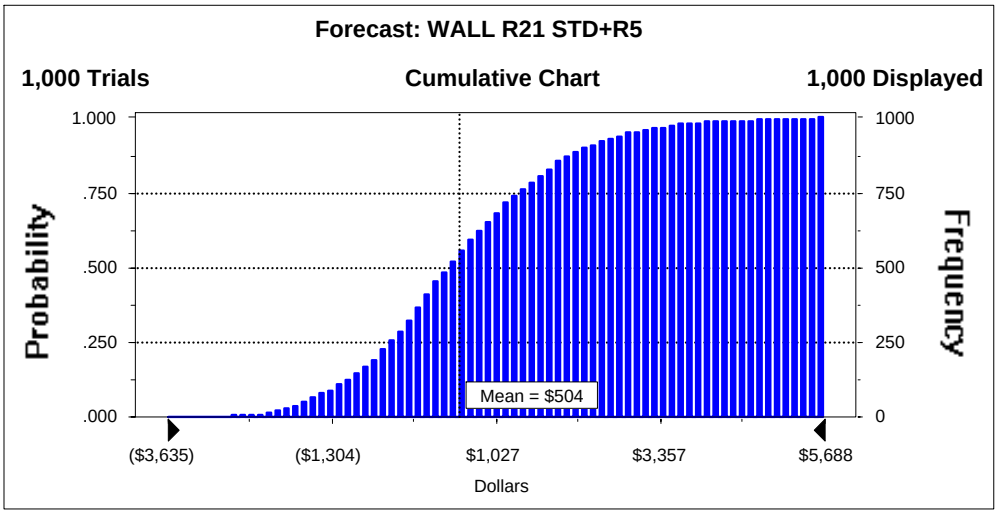

Figure G-71: Climate Zone 2 R26 Advanced Framed Walls NPV Results for Heat Pumps

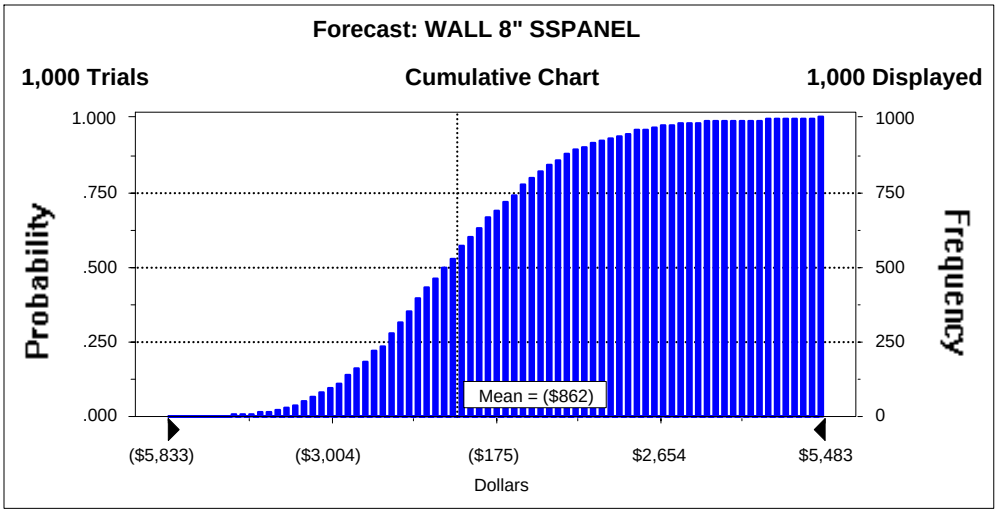

Figure G-72: Climate Zone 2 R33 Wall NPV Results for Heat Pumps

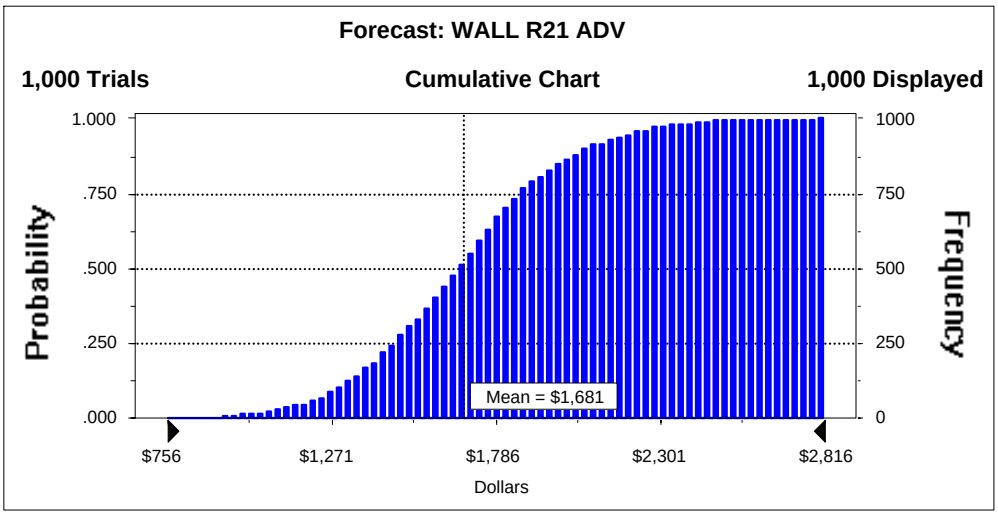

Figure G-73: Climate Zone 2 R21 Advanced Framed Walls NPV Results for Electric FAF

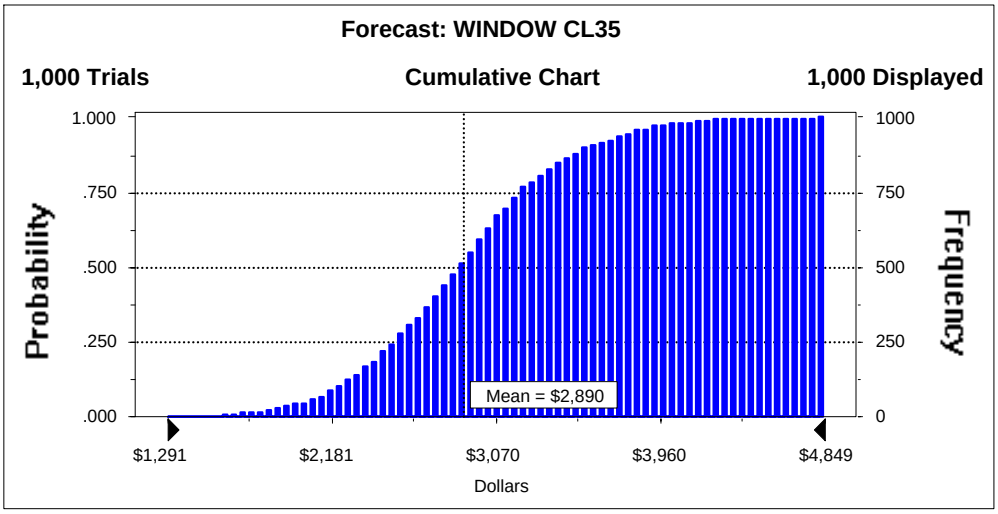

Figure G-74: Climate Zone 2 Class 35 Windows NPV Results for Electric FAF

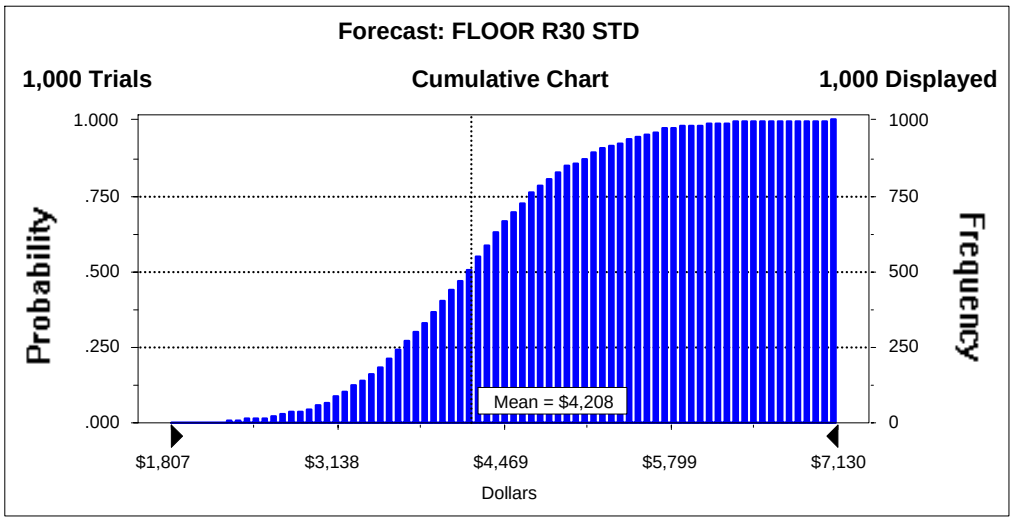

Figure G-75: Climate Zone 2 R30 Under floor NPV Results for Electric FAF

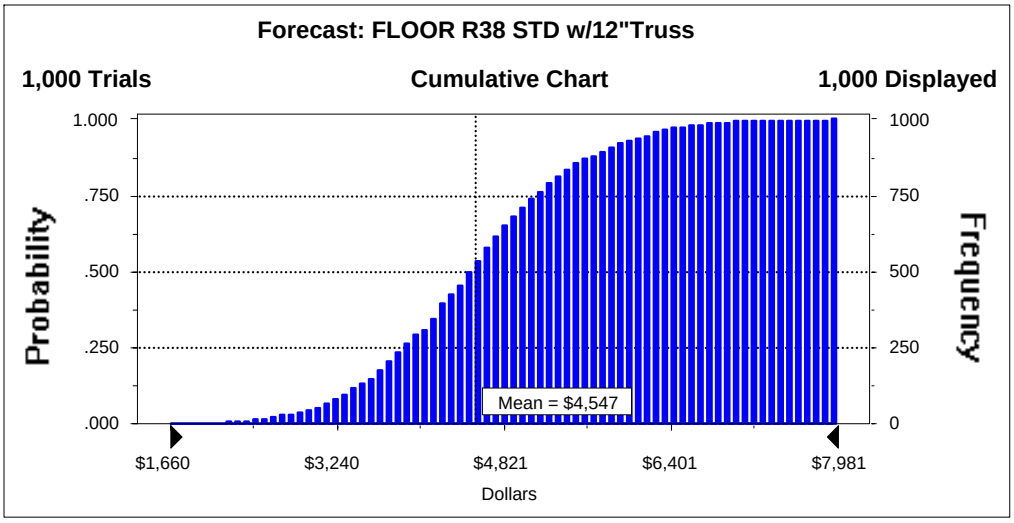

Figure G-76: Climate Zone 2 R38 Under floor NPV Results for Electric FAF

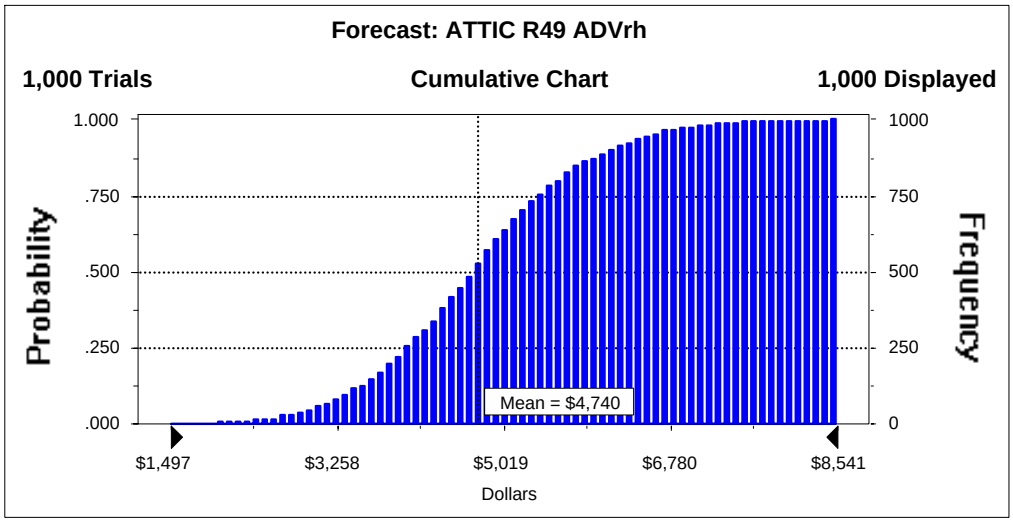

Figure G-77: Climate Zone 2 R49 Advanced Framed Attic NPV Results for Electric FAF

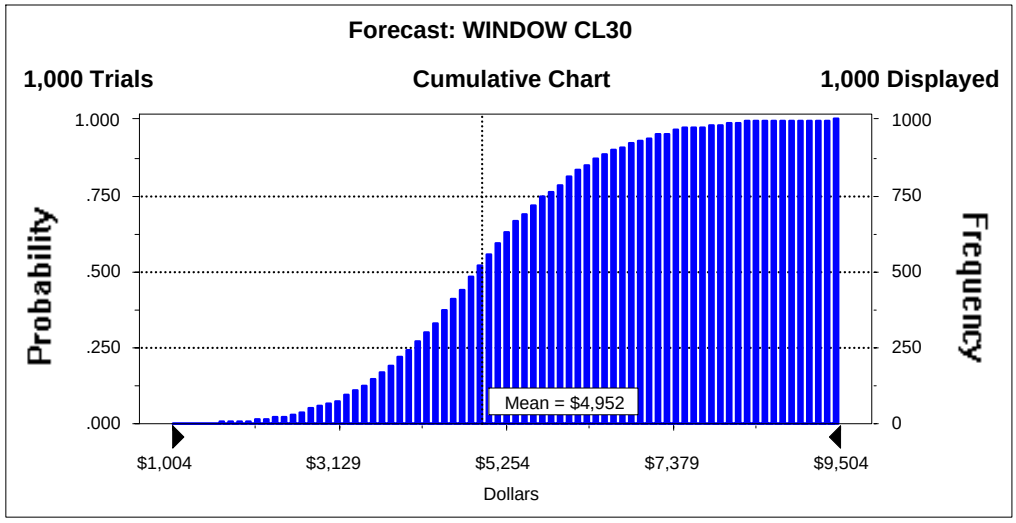

Figure G-78: Climate Zone 2 Class 30 Window NPV Results for Electric FAF

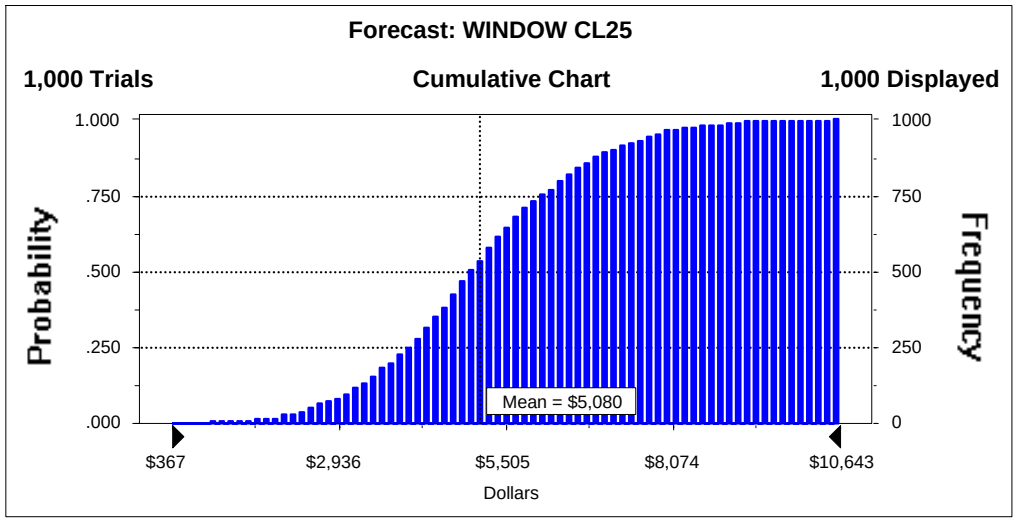

Figure G-79: Climate Zone 2 Class 25 Window NPV Results for Electric FAF

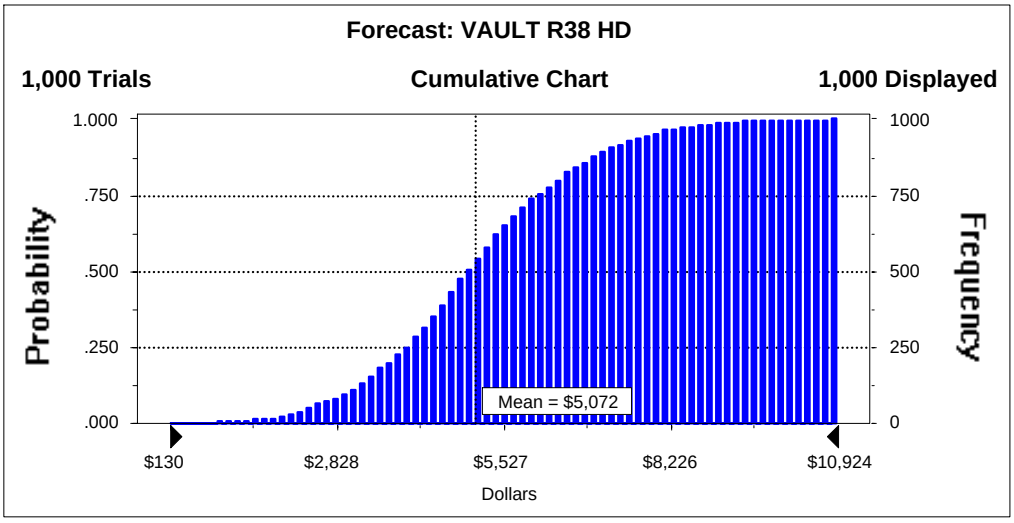

Figure G-80: Climate Zone 2 R38 Vault NPV Results for Electric FAF

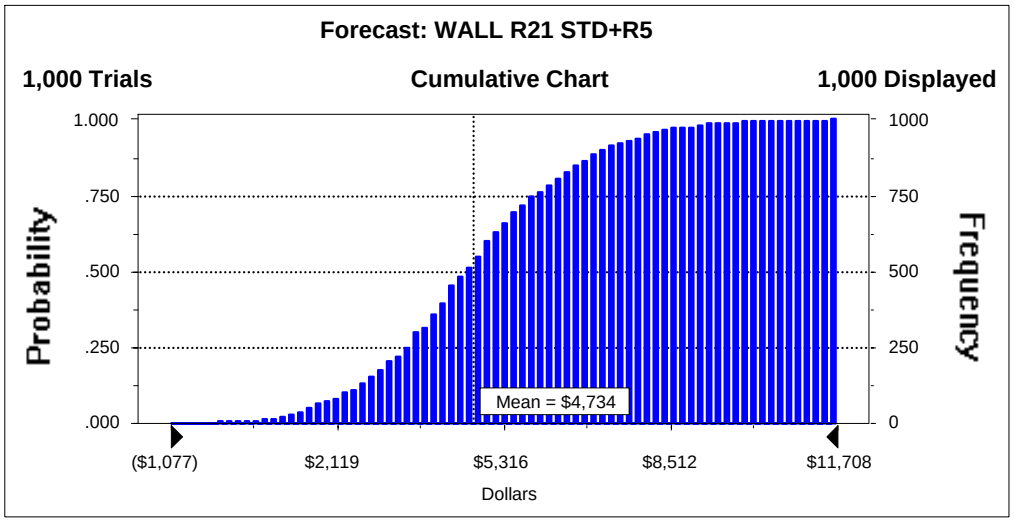

Figure G-81: Climate Zone 2 R26 Advanced Framed Wall NPV Results for Electric FAF

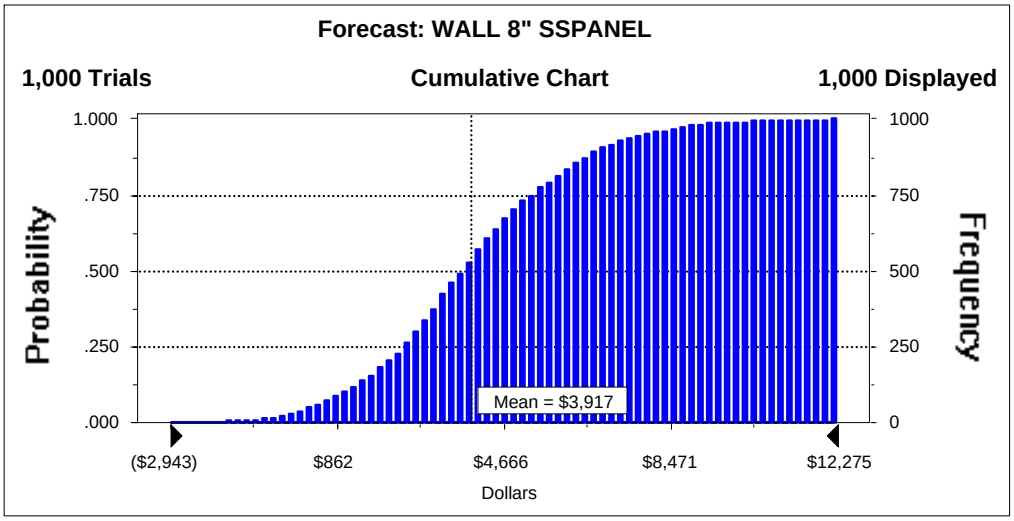

Figure G-82: Climate Zone 2 R33 Wall NPV Results for Electric FAF

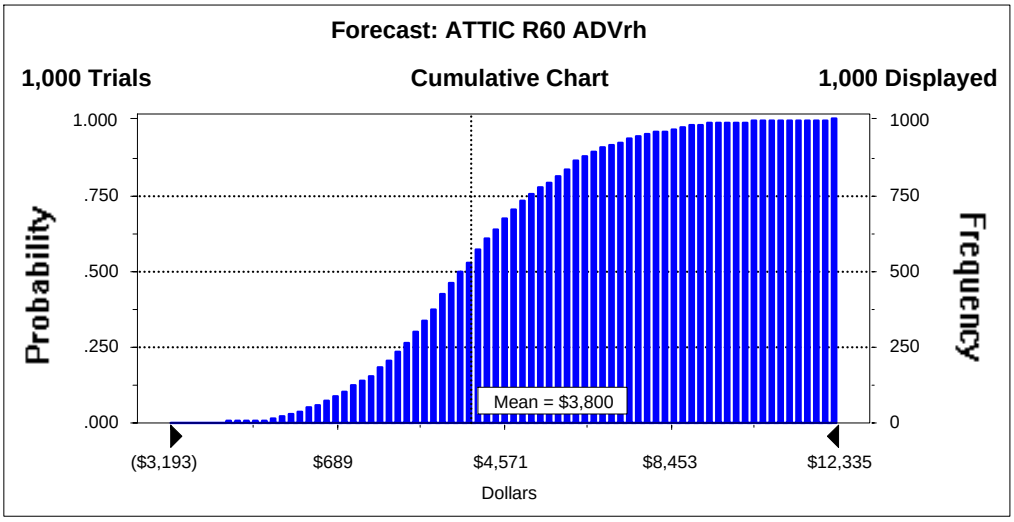

Figure G-83: Climate Zone 2 R60 Advanced Framed Attic NPV Results for Electric FAF

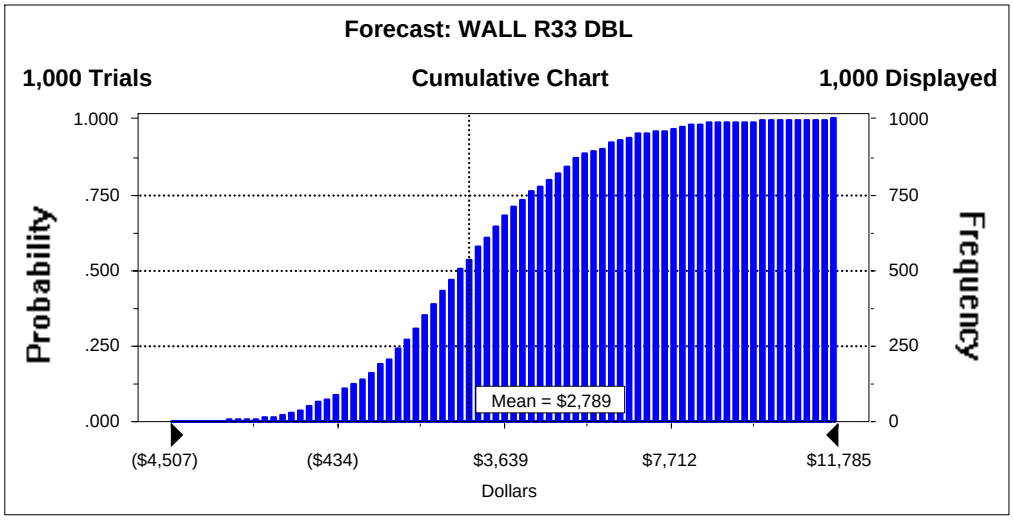

Figure G-84: Climate Zone 2 R38 Wall NPV Results for Electric FAF

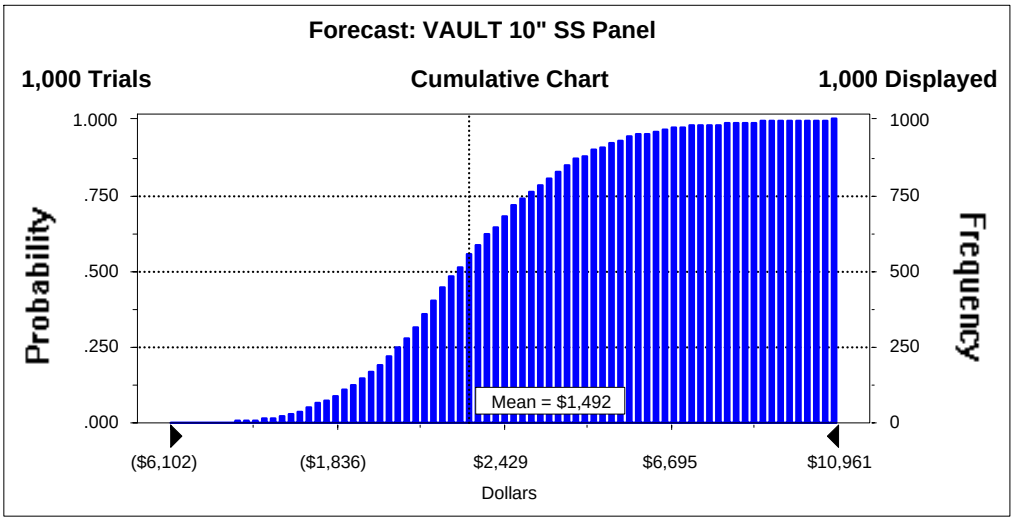

Figure G-85: Climate Zone 2 R49 Vault NPV Results for Electric FAF

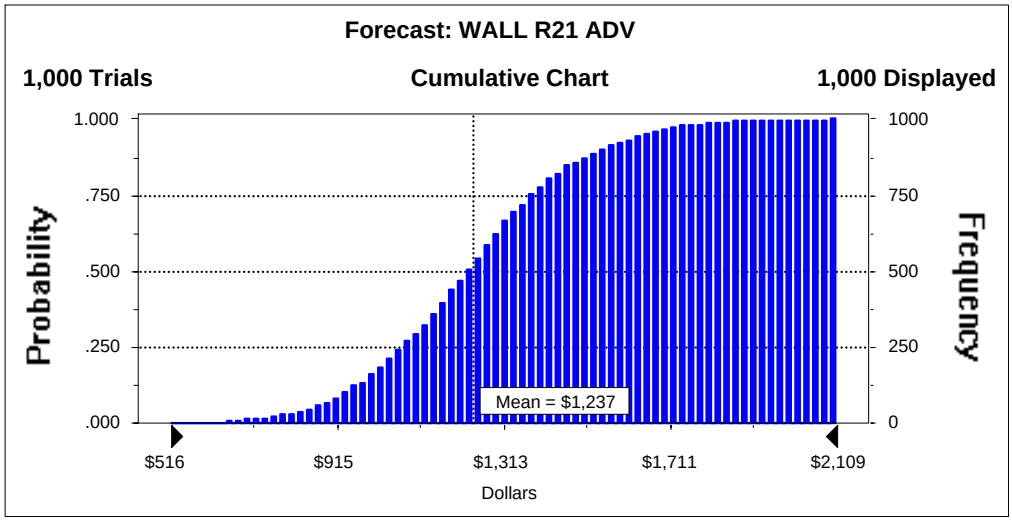

Figure G-86: Climate Zone 2 R21 Advanced Framed Walls NPV Results for Electric Zonal

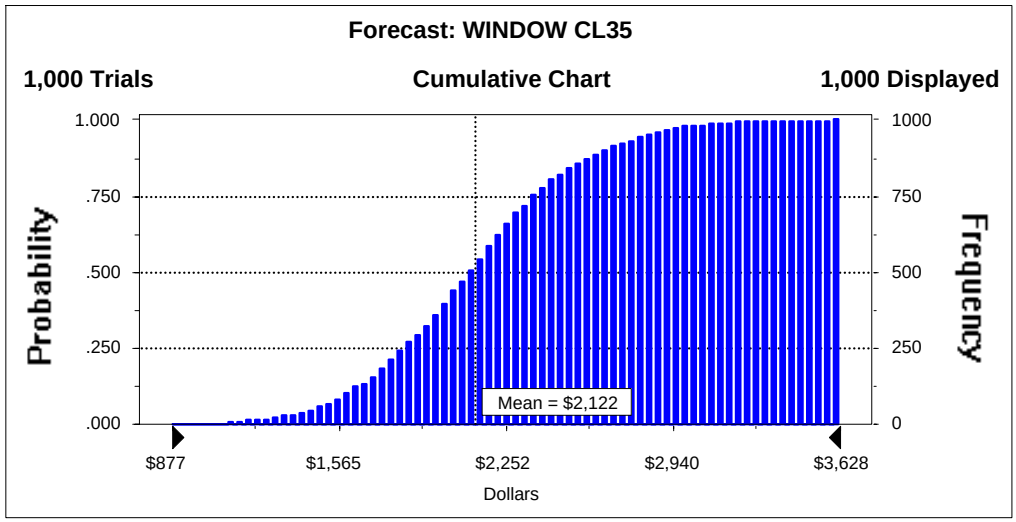

Figure G-87: Climate Zone 2 Class 35 Window NPV Results for Electric Zonal

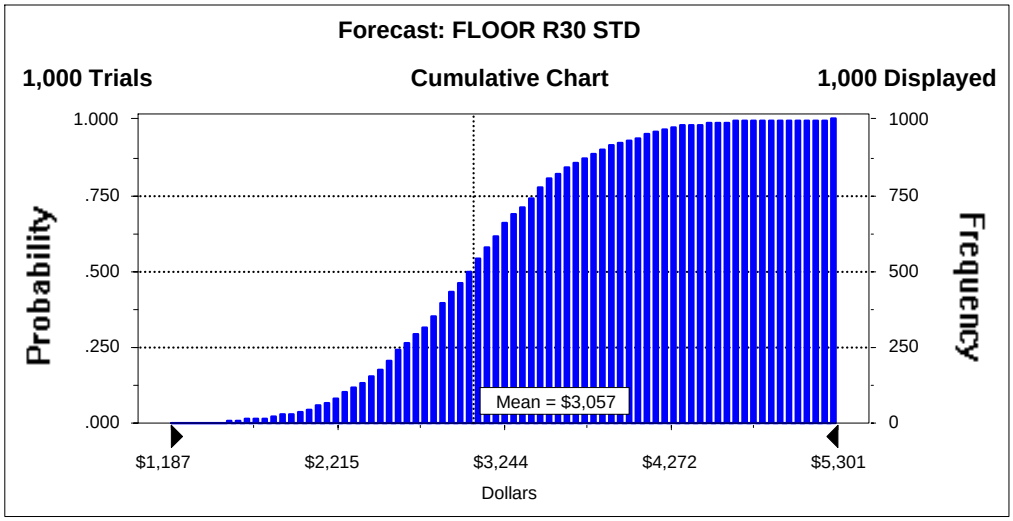

Figure G-88: Climate Zone 2 R30 Under floor NPV Results for Electric Zonal

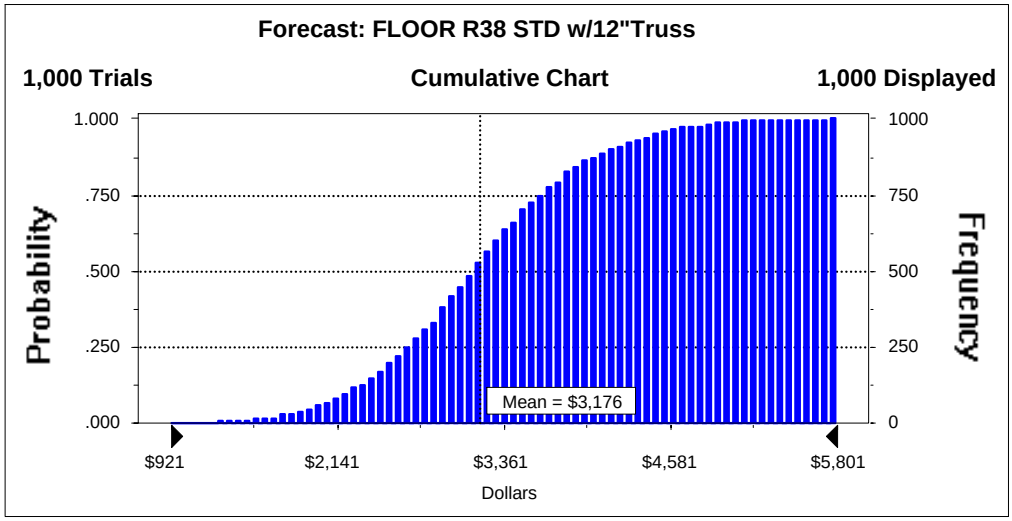

Figure G-89: Climate Zone 2 R38 Under floor NPV Results for Electric Zonal

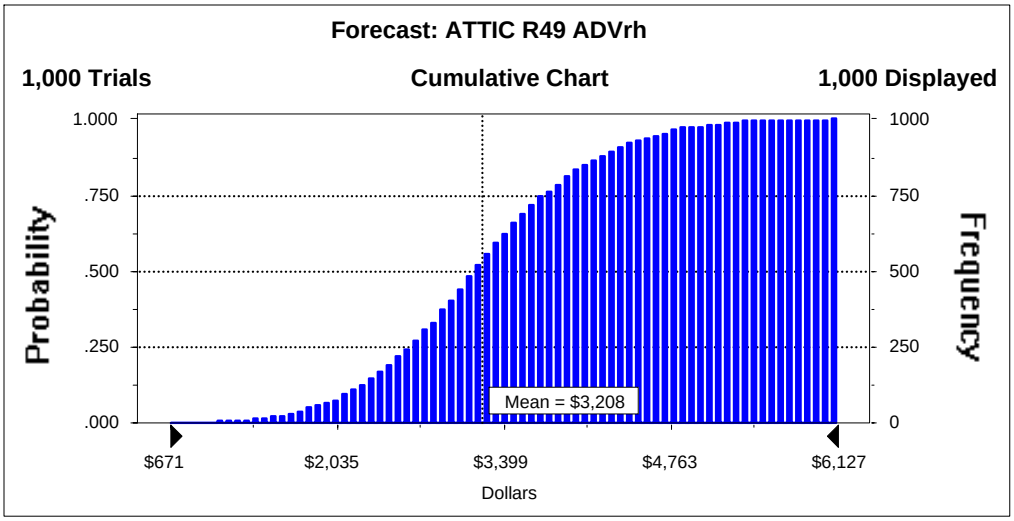

Figure G-90: Climate Zone 2 R49 Advanced Framed Attic NPV Results for Electric Zonal

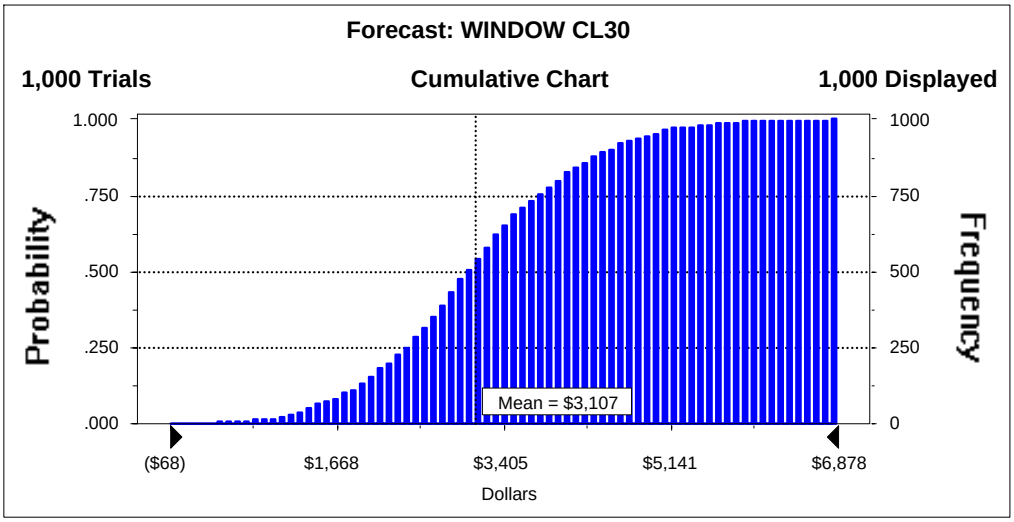

Figure G-91: Climate Zone 2 Class 30 Window NPV Results for Electric Zonal

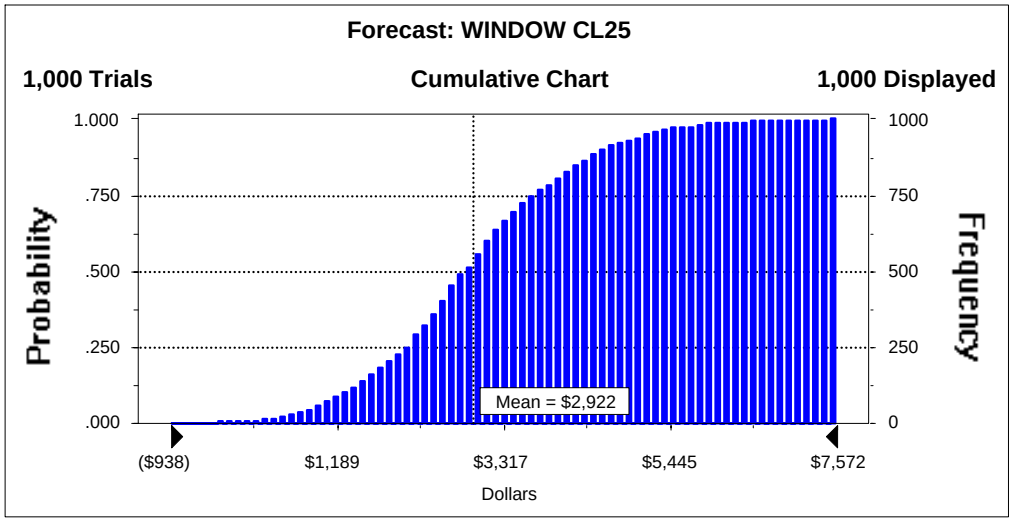

Figure G-92: Climate Zone 2 Class 25 Window NPV Results for Electric Zonal

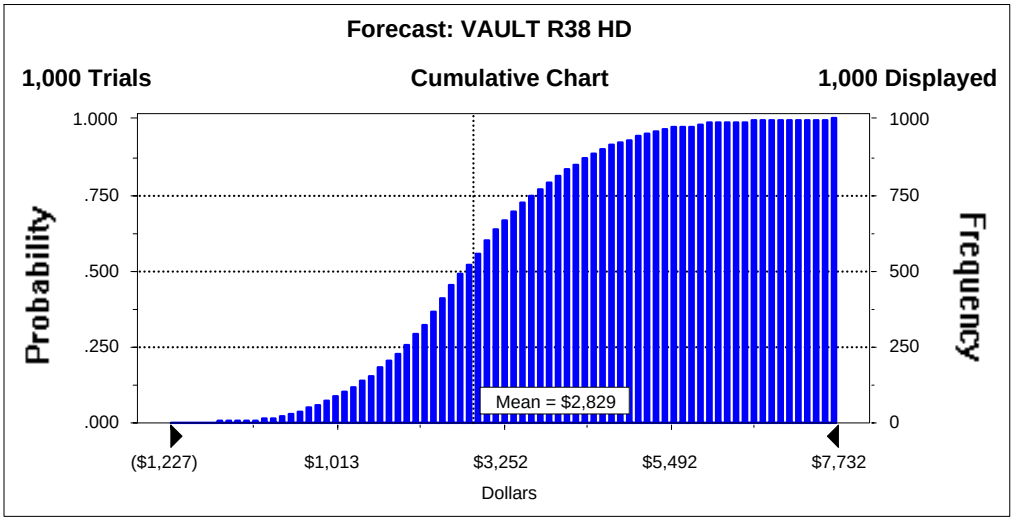

Figure G-93: Climate Zone 2 R38 Vault NPV Results for Electric Zonal

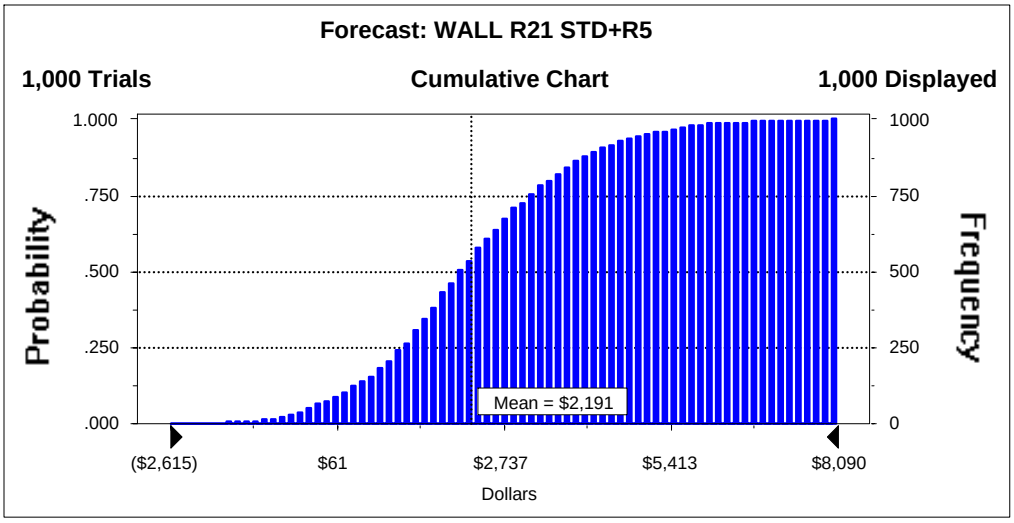

Figure G-94: Climate Zone 2 R26 Advanced Framed Wall NPV Results for Electric Zonal

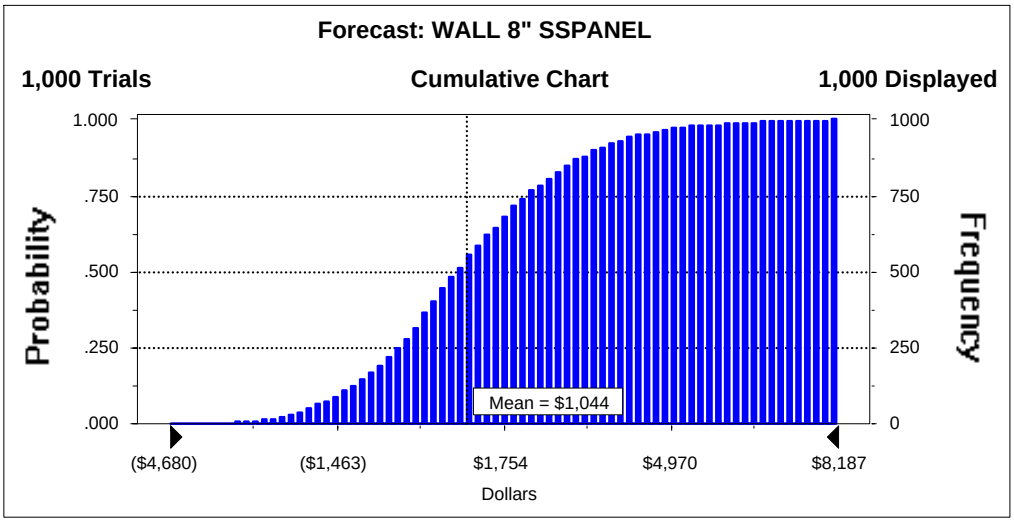

Figure G-95: Climate Zone 2 R33 Wall NPV Results for Electric Zonal

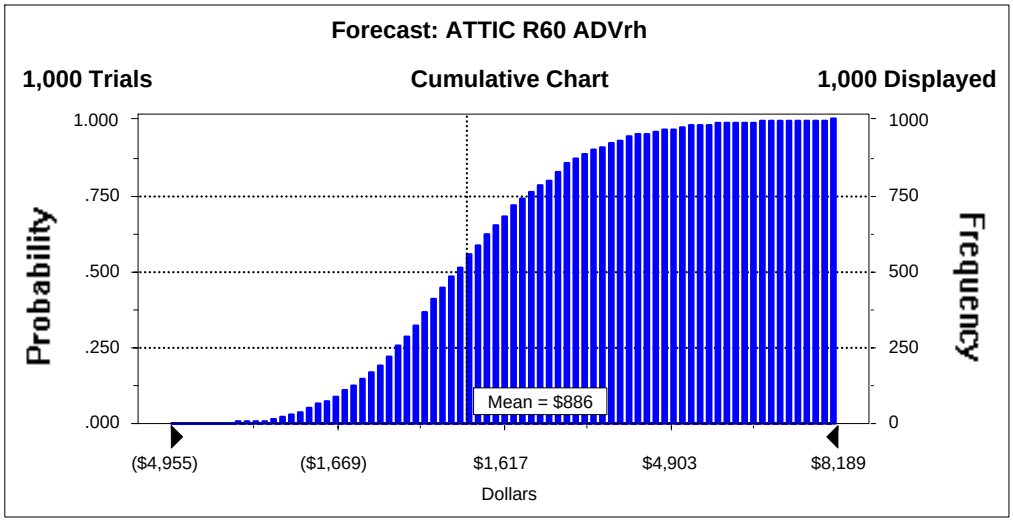

Figure G-96: Climate Zone 2 R60 Advanced Framed Attic NPV Results for Electric Zonal

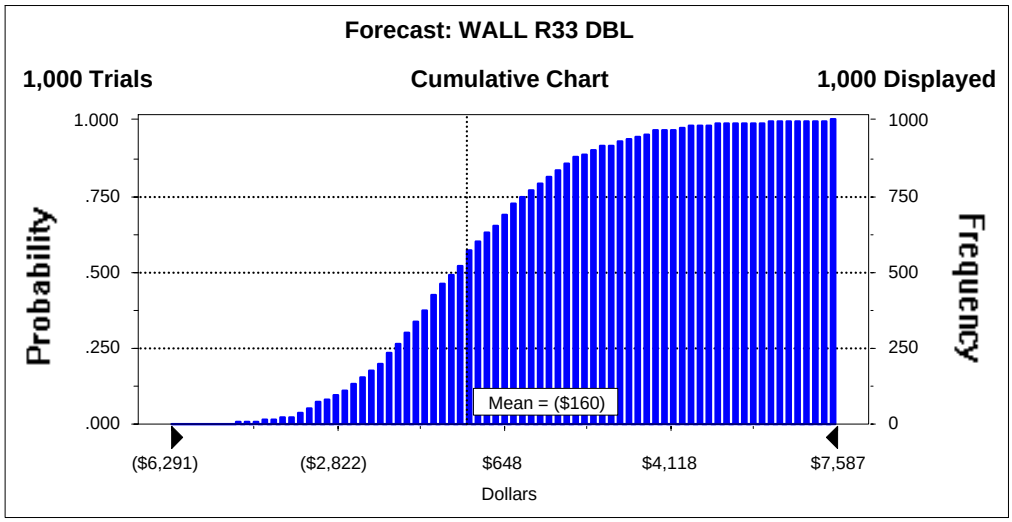

Figure G-97: Climate Zone 2 R33 Wall NPV Results for Electric Zonal

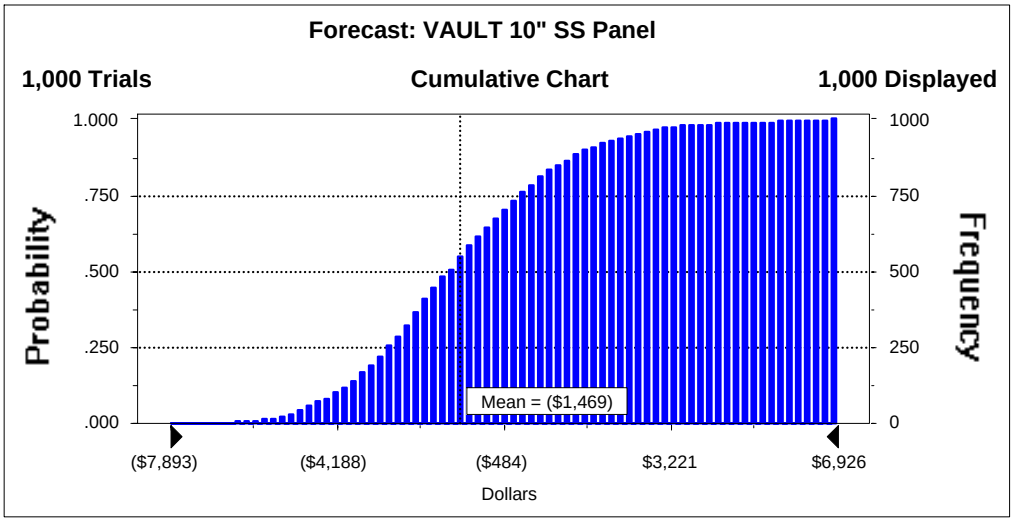

Figure G-98: Climate Zone 2 R49 Vault NPV Results for Electric Zonal

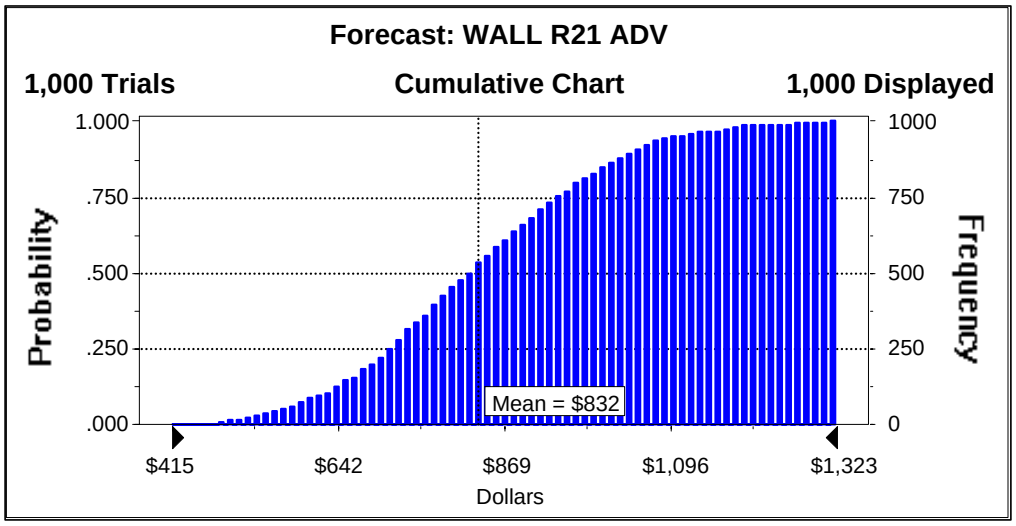

Figure G-99: Climate Zone 2 R21 Advanced Framed Wall NPV Results for Gas FAF

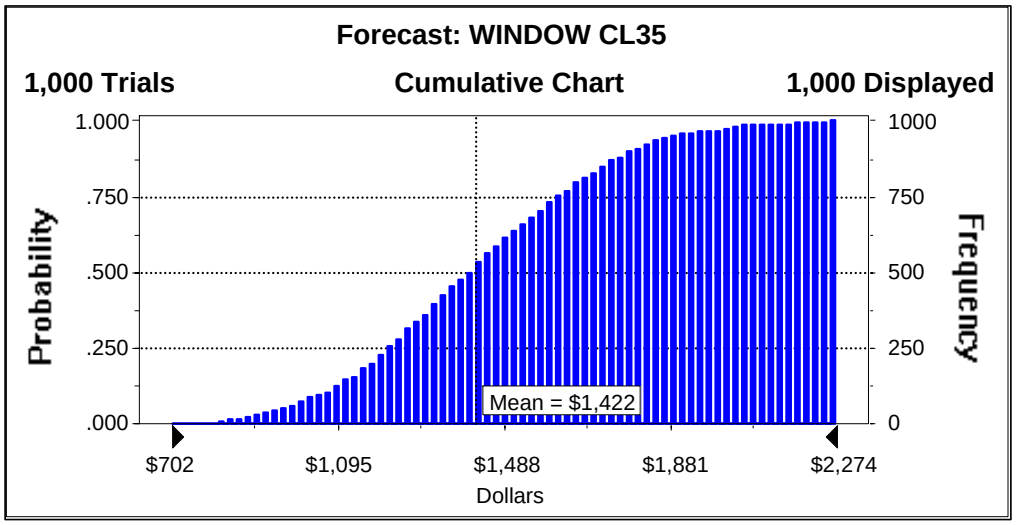

Figure G-100: Climate Zone 2 Class 35 Windows NPV Results for Gas FAF

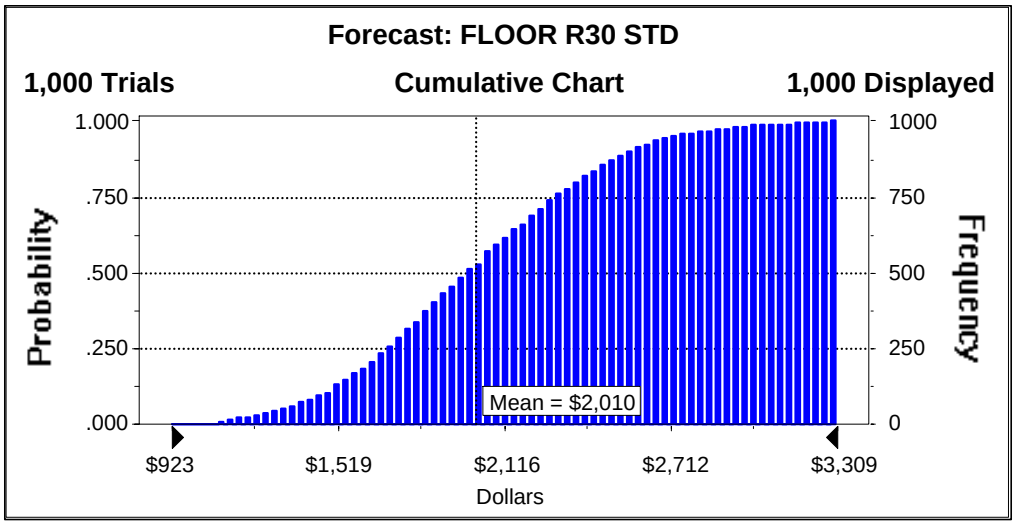

Figure G-101: Climate Zone 2 R30 Under floor NPV Results for Gas FAF

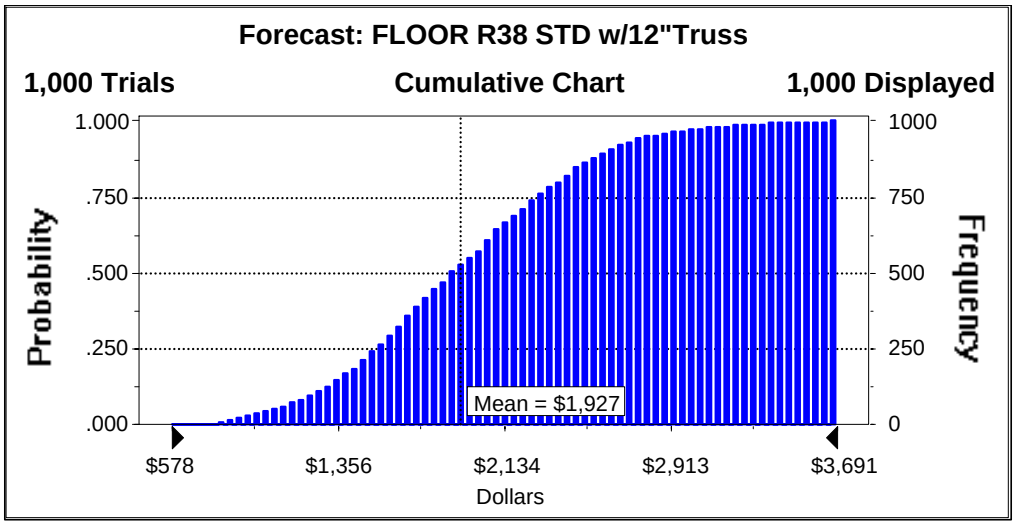

Figure G-102: Climate Zone 2 R38 Under floor NPV Results for Gas FAF

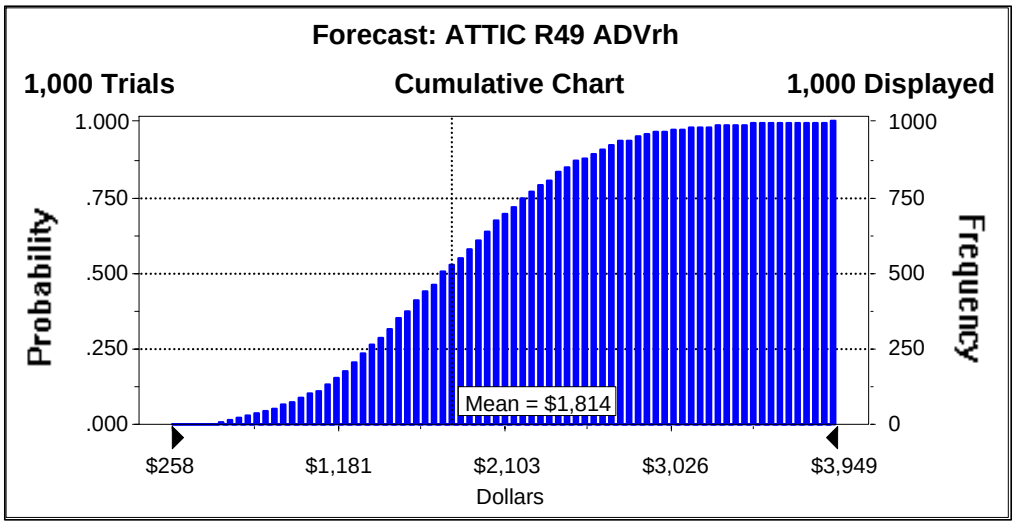

Figure G-103: Climate Zone 2 R49 Advanced Framed Attic NPV Results for Gas FAF

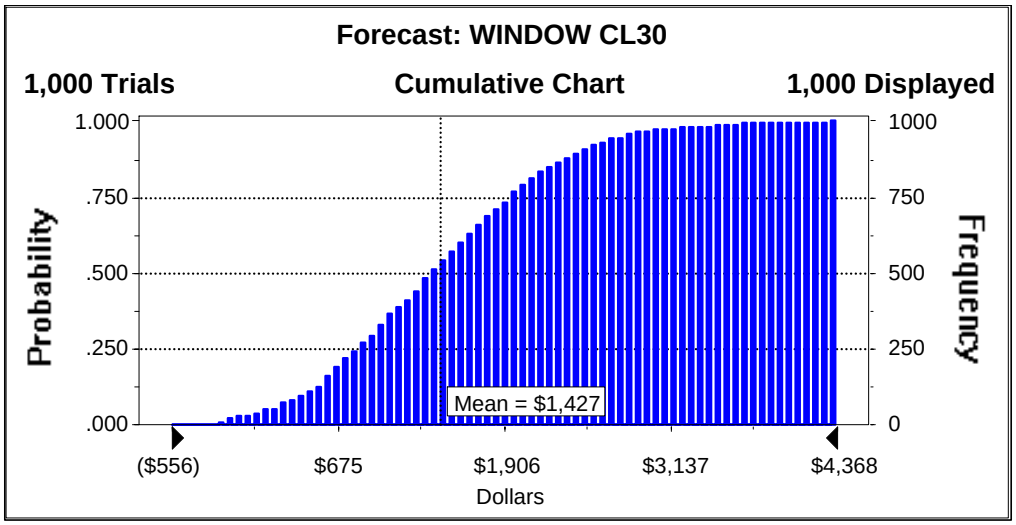

Figure G-104: Climate Zone 2 Class 30 Window NPV Results for Gas FAF

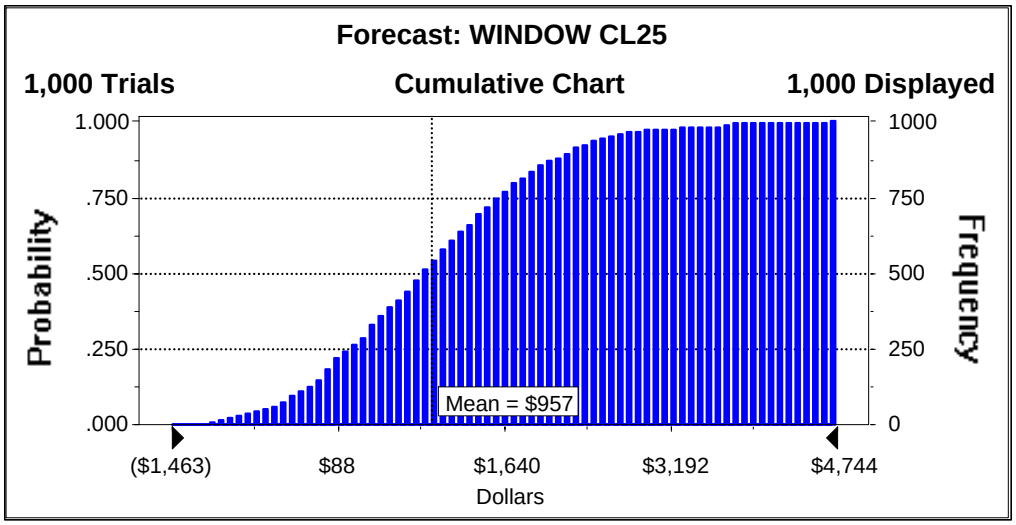

Figure G-105: Climate Zone 2 Class 25 Window NPV Results for Gas FAF

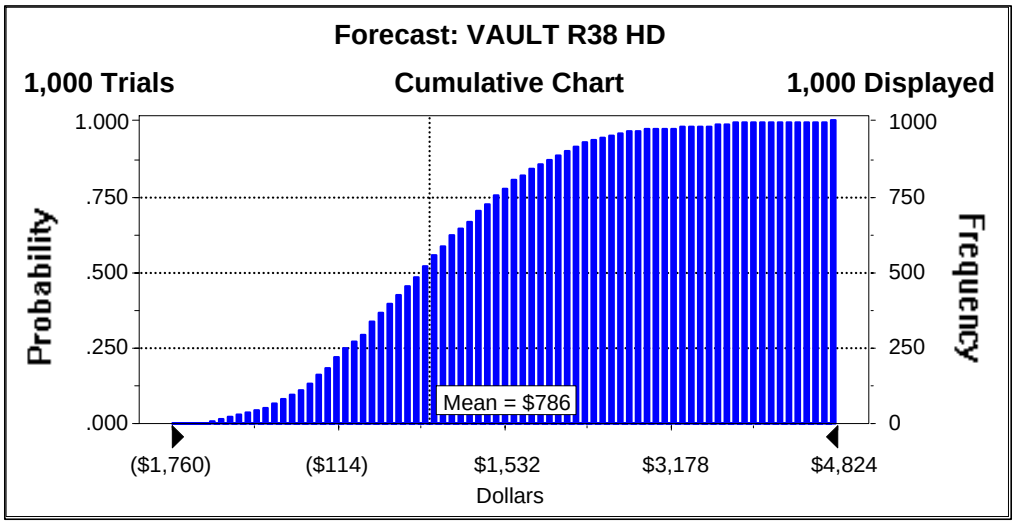

Figure G-106: Climate Zone 2 R38 Vault NPV Results for Gas FAF

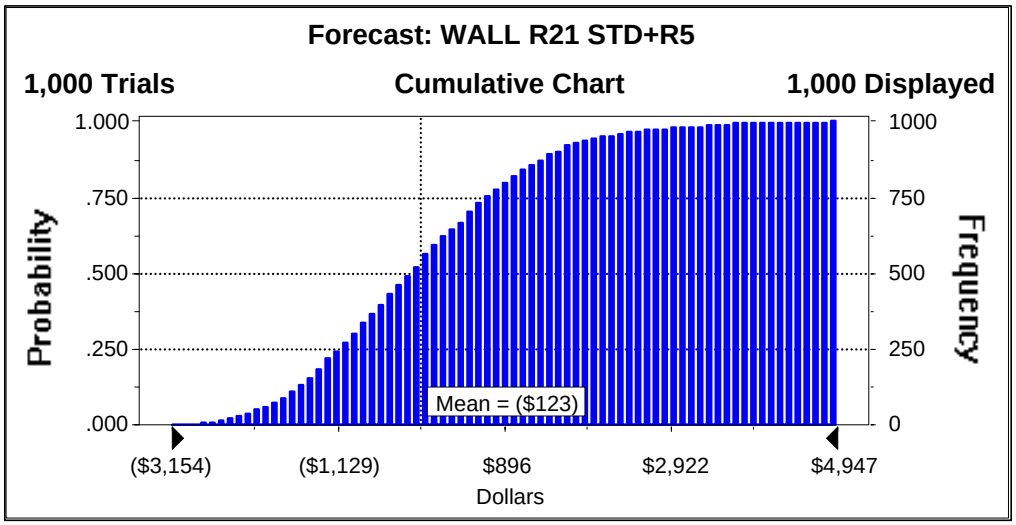

Figure G-107: Climate Zone 2 R26 Advanced Framed Wall NPV Results for Gas FAF

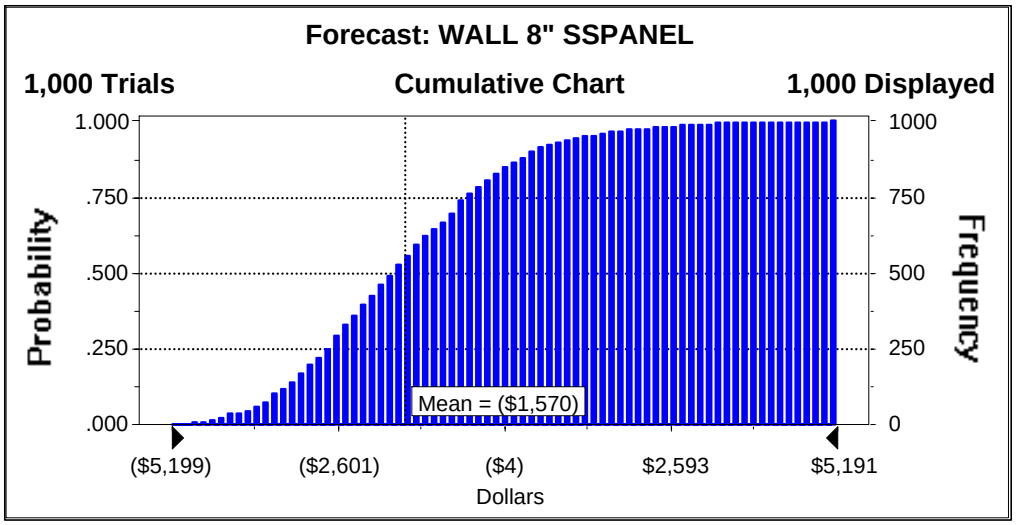

Figure G-108: Climate Zone 2 R33 Wall NPV Results for Gas FAF

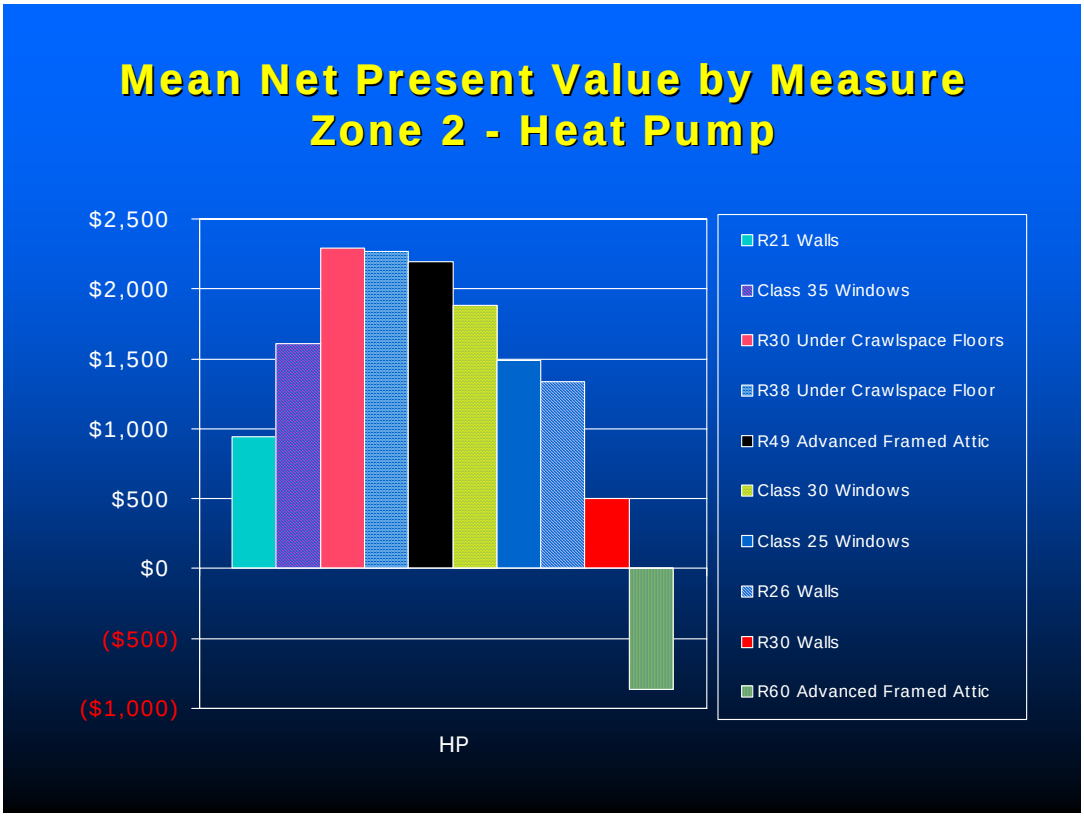

Figure G-109: Climate Zone 2 Summary of Mean NPV by Measure for Heat Pumps

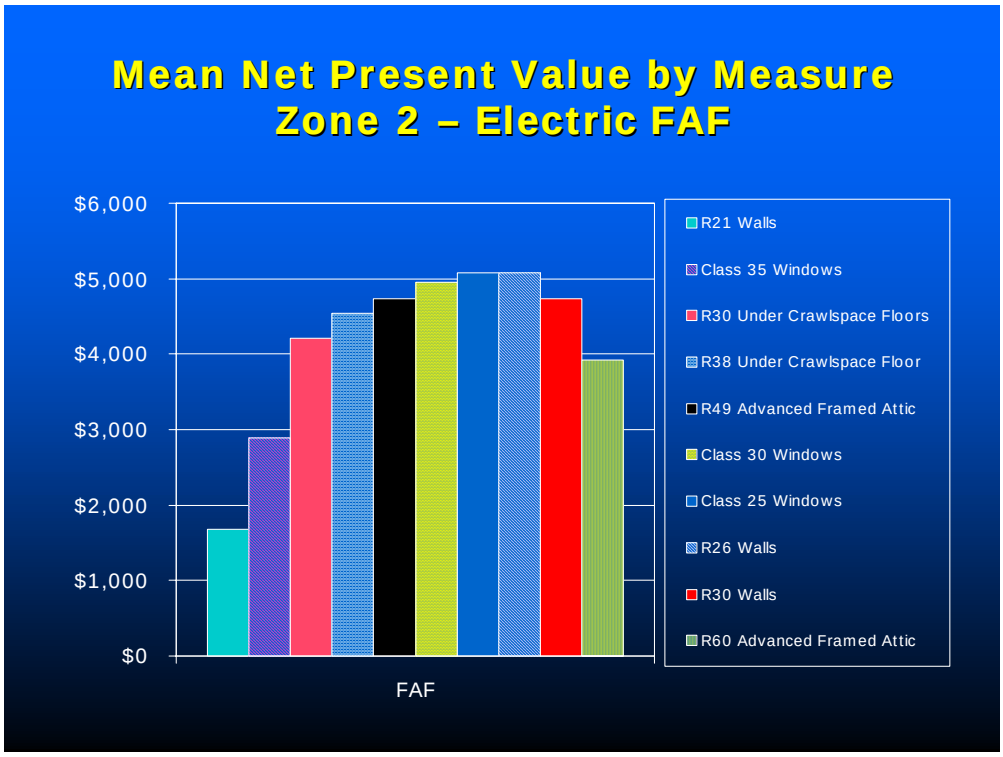

Figure G-110: Climate Zone 2 Mean NPV by Measure for Electric FAF

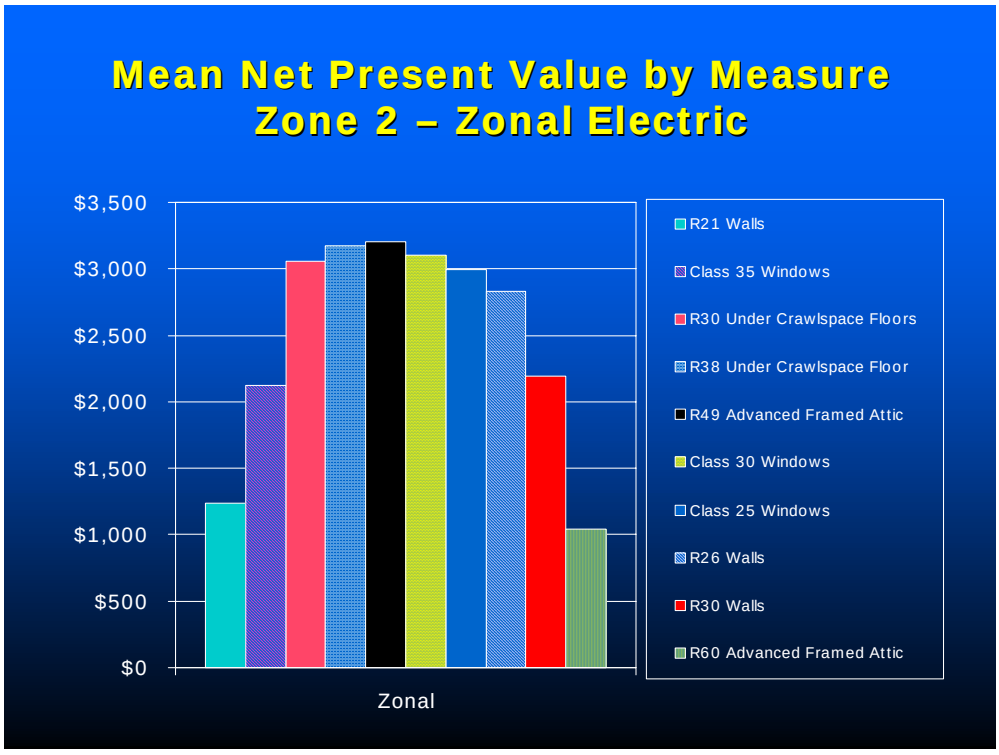

Figure G-111: Climate Zone 2 Mean NPV by Measure for Electric Zonal

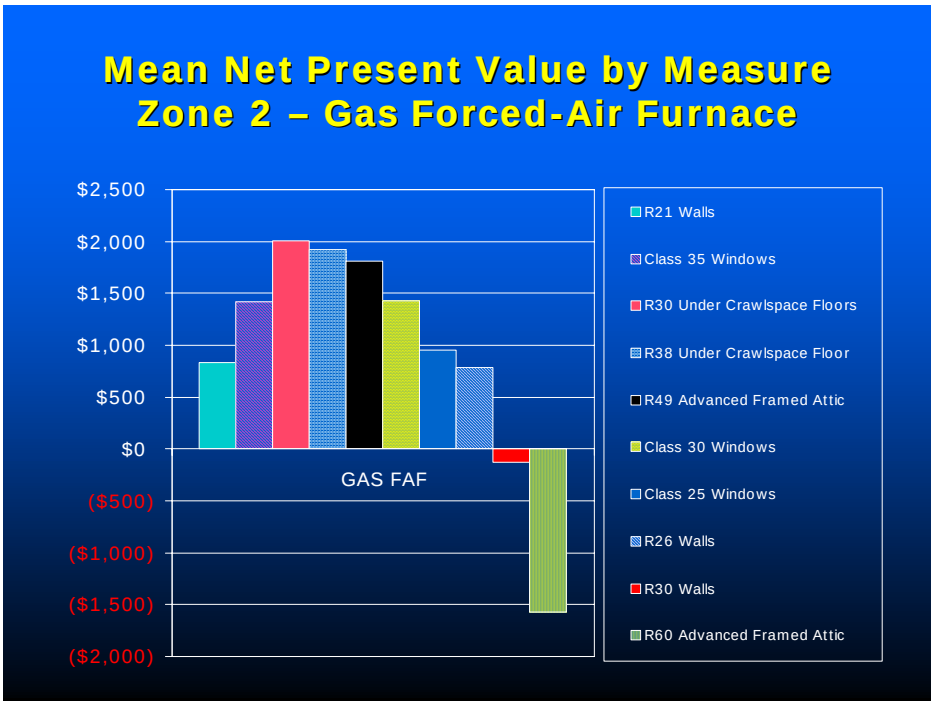

Figure G-112: Climate Zone 2 Mean NPV by Measure for Gas FAF

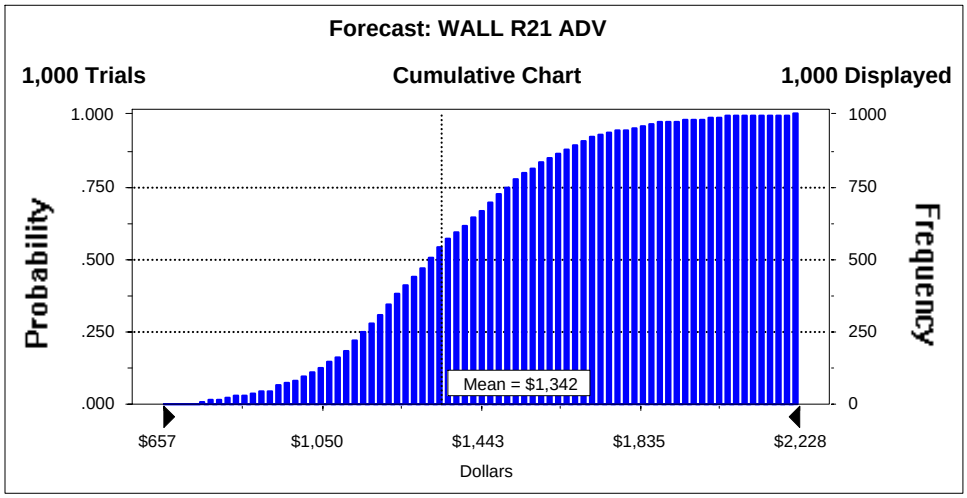

Figure G-113: Climate Zone 3 R21 Advanced Framed Wall NPV Results for Heat Pumps

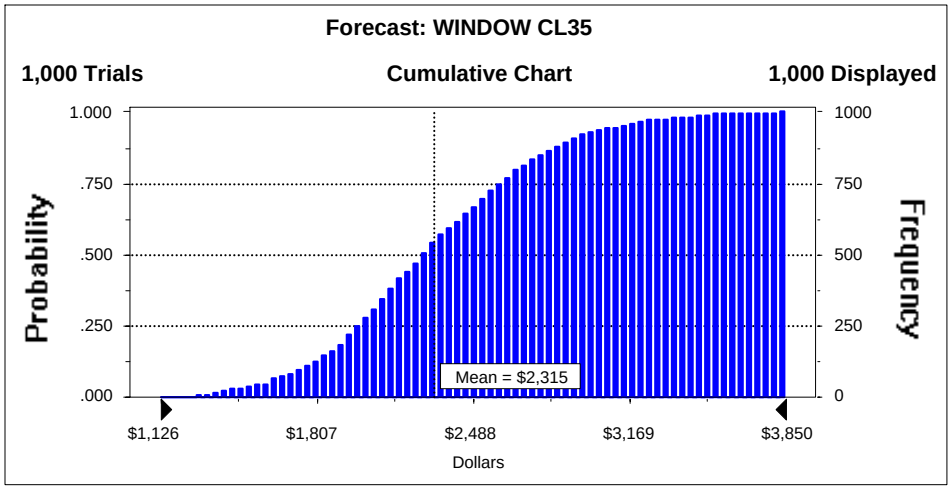

Figure G-114: Climate Zone 3 Class 35 Window NPV Results for Heat Pumps

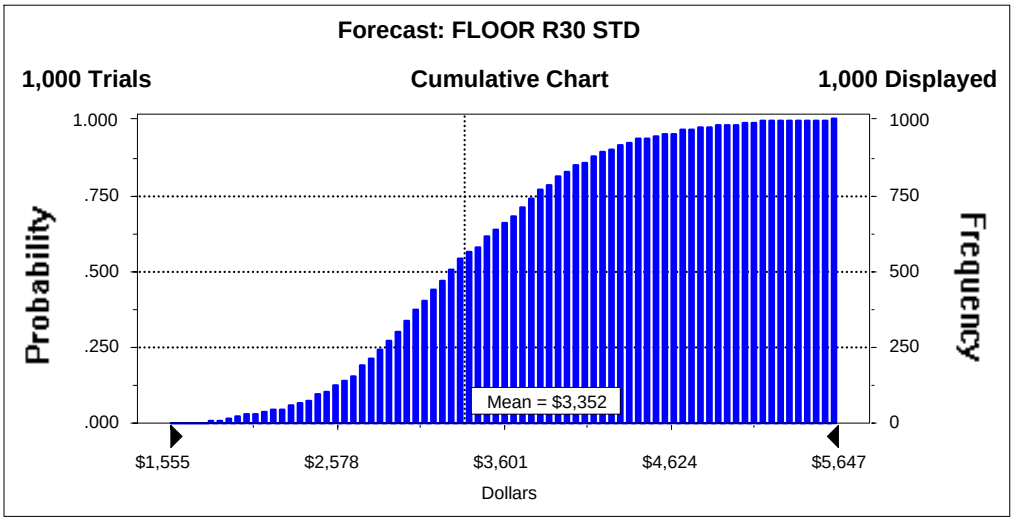

Figure G-115: Climate Zone 3 R30 Under floor NPV Results for Heat Pumps

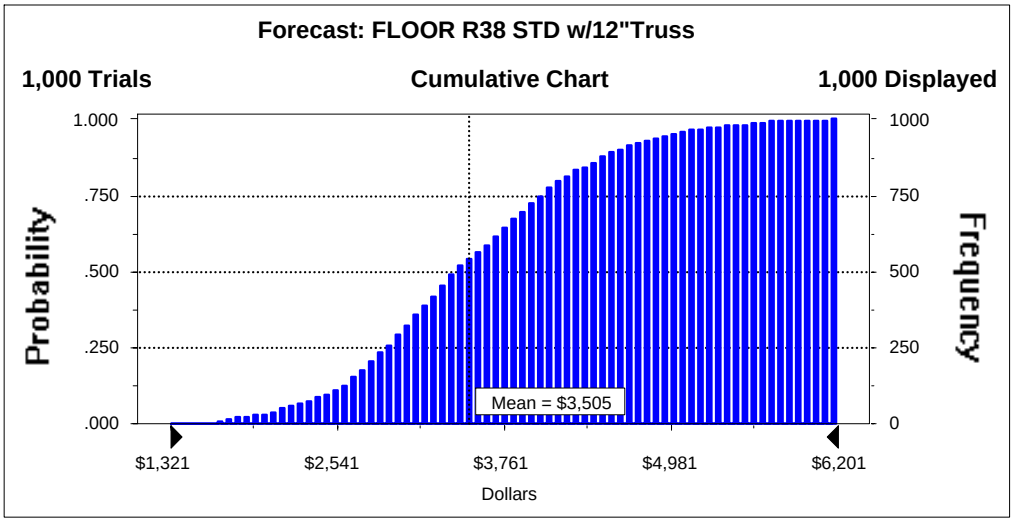

Figure G-116: Climate Zone 3 R38 Under floor NPV Results for Heat Pumps

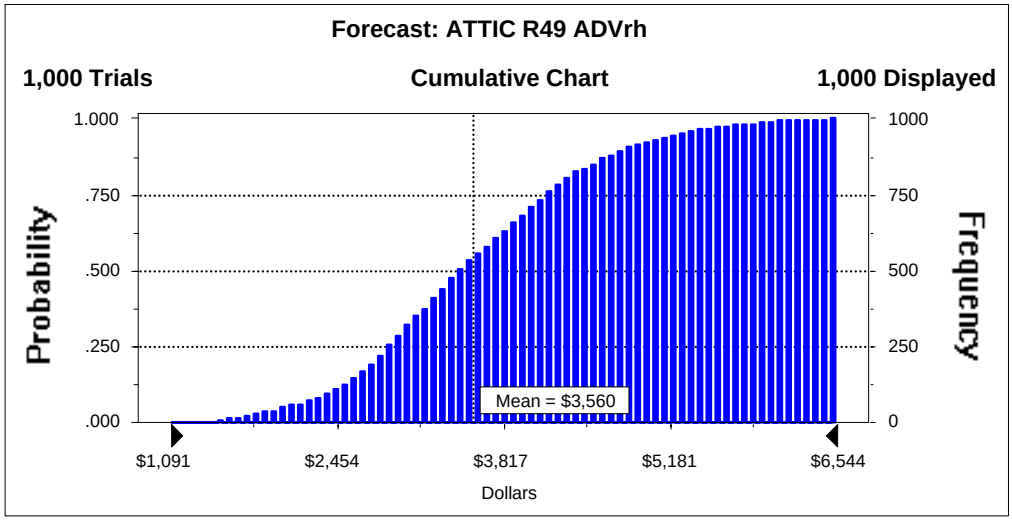

Figure G-117: Climate Zone 3 R49 Advanced Framed Attic NPV Results for Heat Pumps

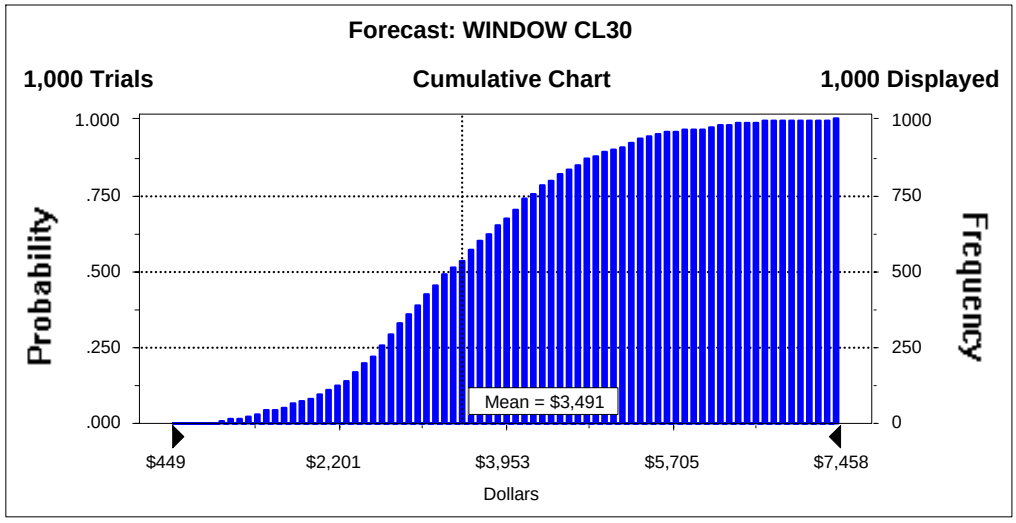

Figure G-118: Climate Zone 3 Class 30 Window NPV Results for Heat Pumps

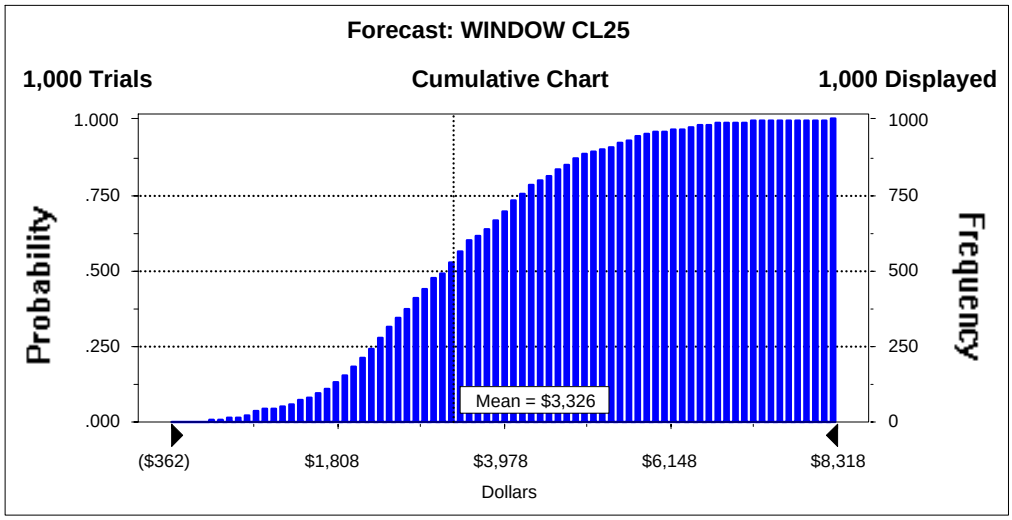

Figure G-119: Climate Zone 3 Class 25 Window NPV Results for Heat Pumps

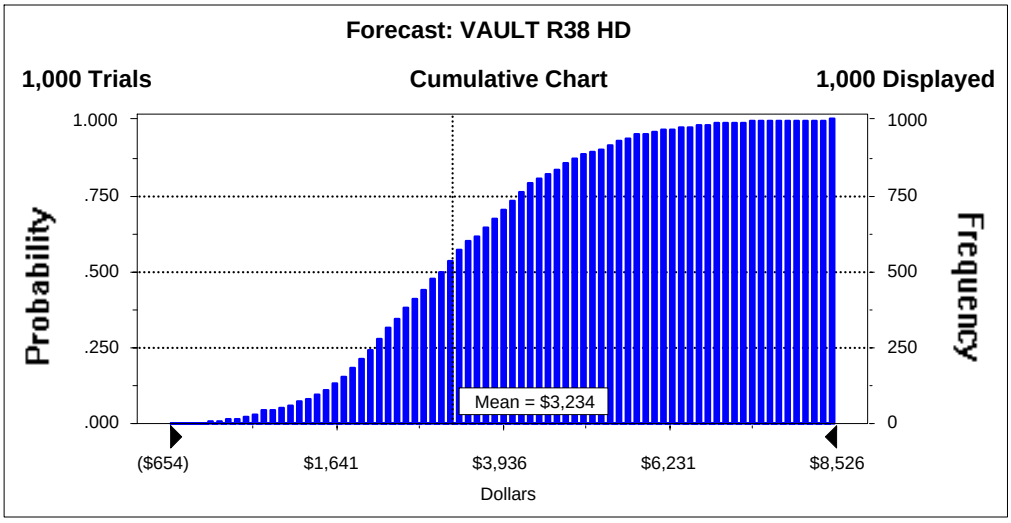

Figure G-120: Climate Zone 3 R38 Vault NPV Results for Heat Pumps

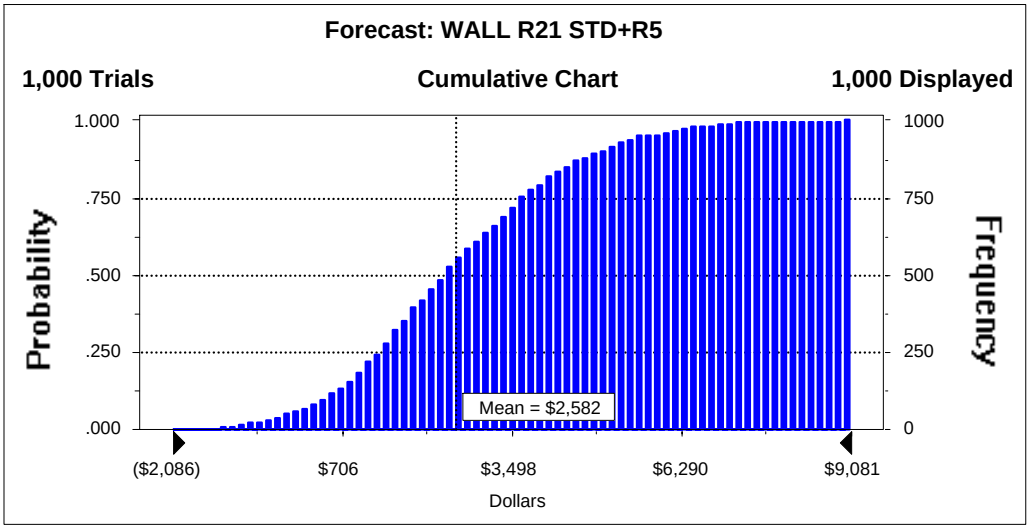

Figure G-121: Climate Zone 3 R26 Advanced Framed Wall NPV Results for Heat Pumps

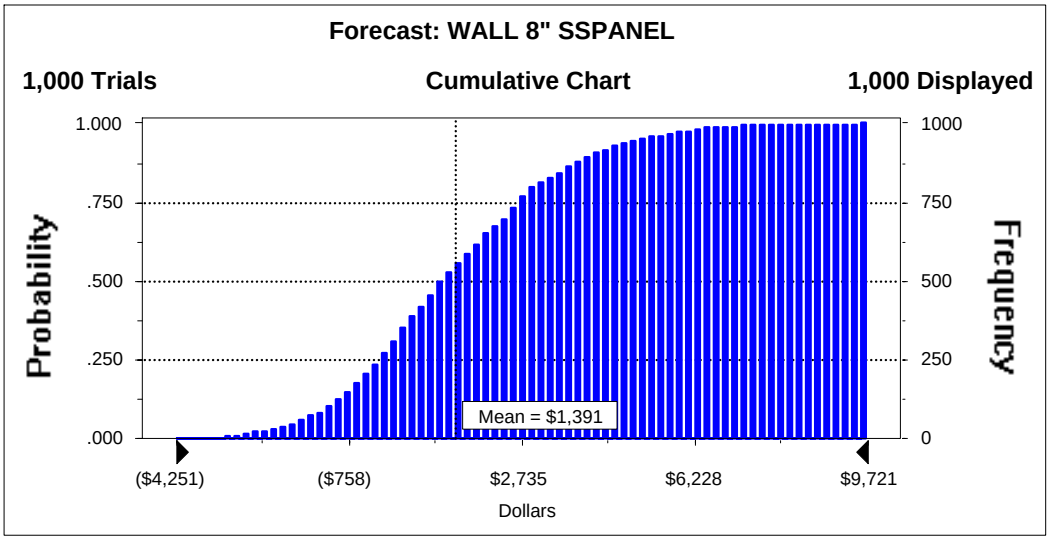

Figure G-122: Climate Zone 3 R33 Wall NPV Results for Heat Pumps

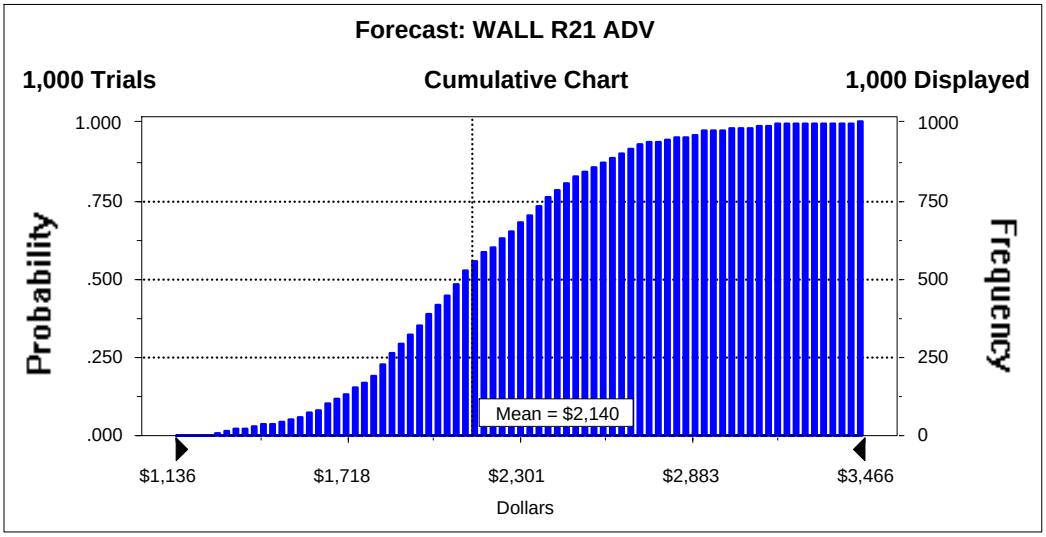

Figure G-123: Climate Zone 3 R21 Advanced Framed Wall NPV Results for Electric FAF

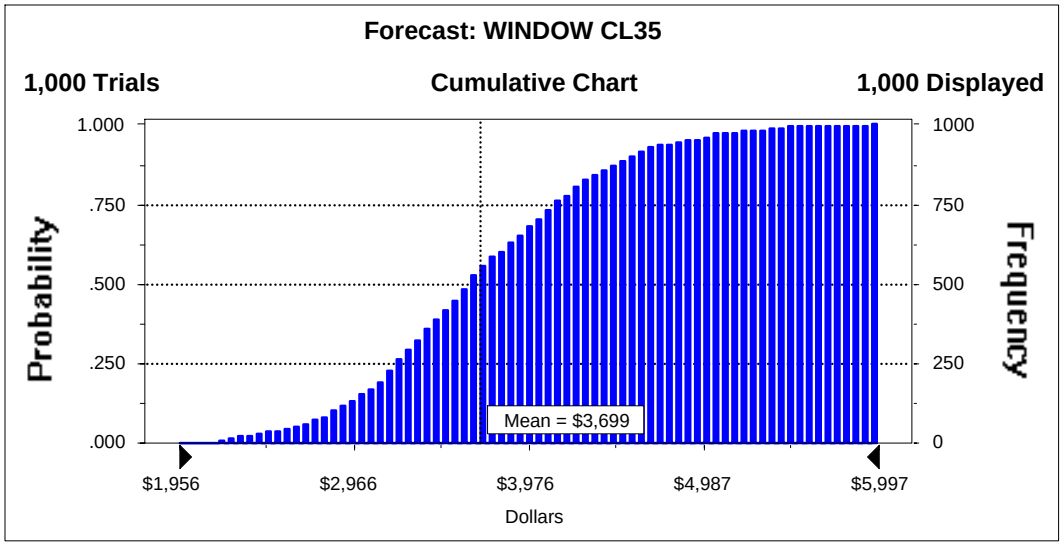

Figure G-124: Climate Zone 3 Class 35 Window NPV Results for Electric FAF

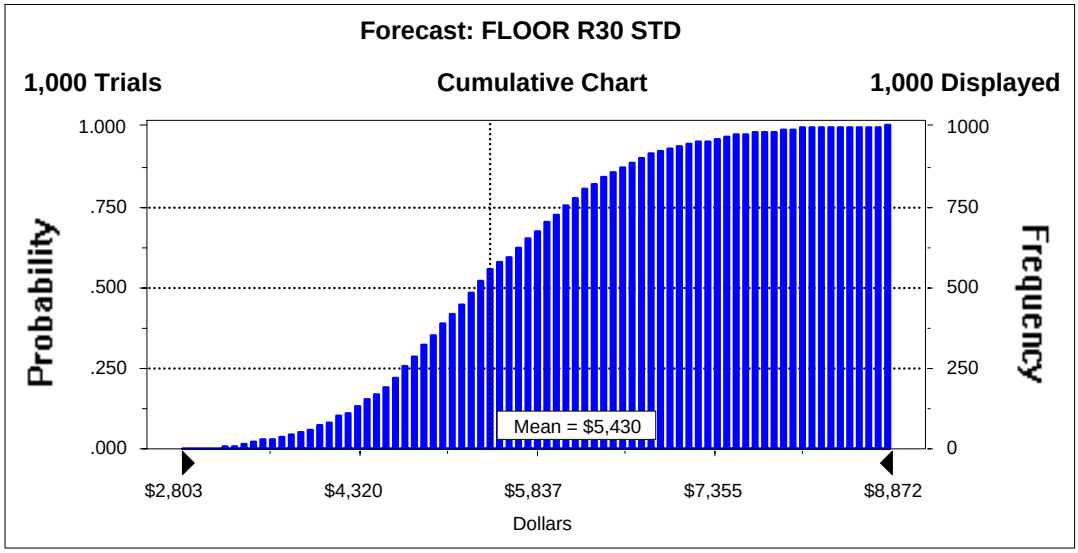

Figure G-125: Climate Zone 3 R30 Under floor NPV Results for Electric FAF

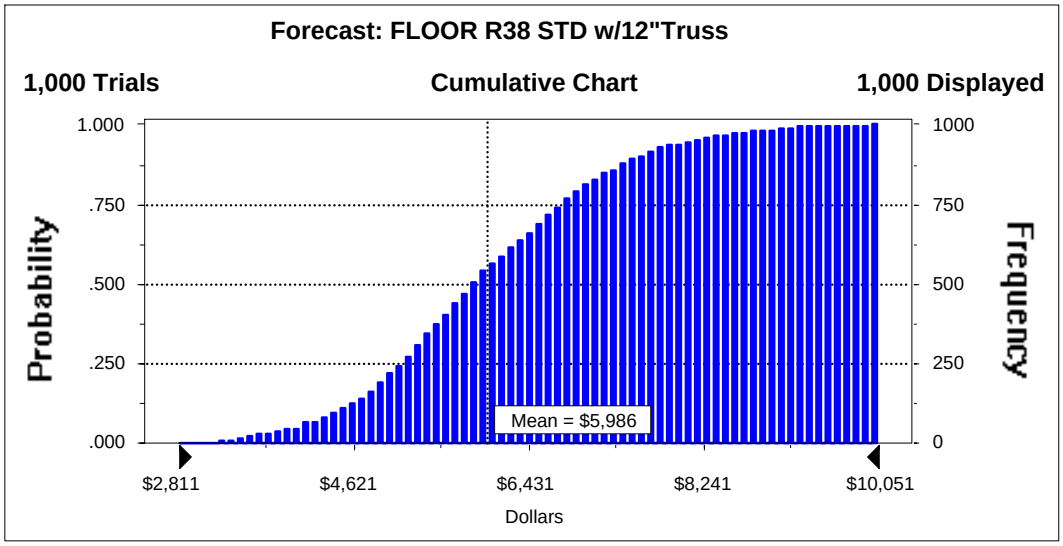

Figure G-126: Climate Zone 3 R38 Under floor NPV Results for Electric FAF

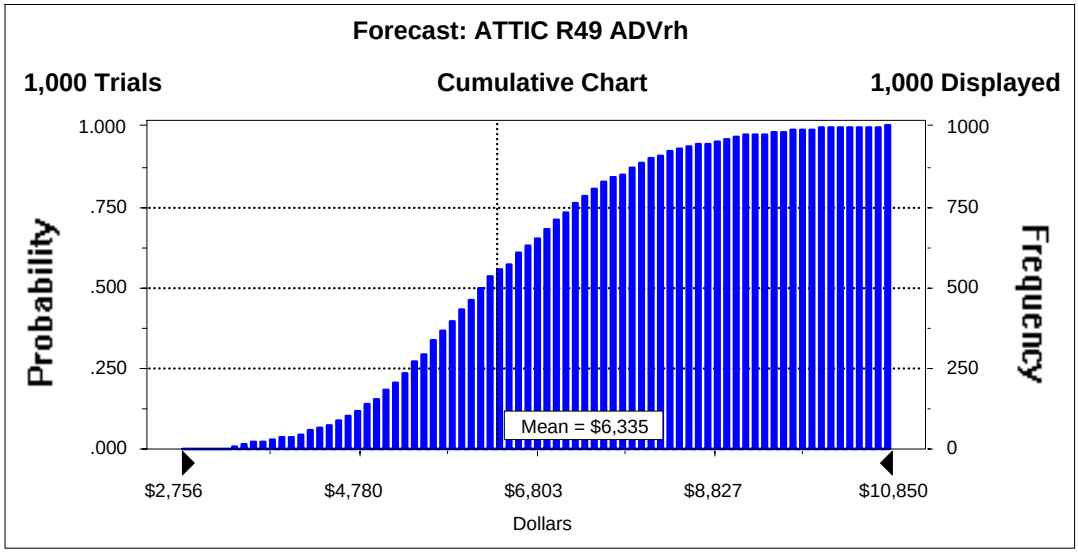

Figure G-127: Climate Zone 3 R49 Advanced Framed Attic NPV Results for Electric FAF

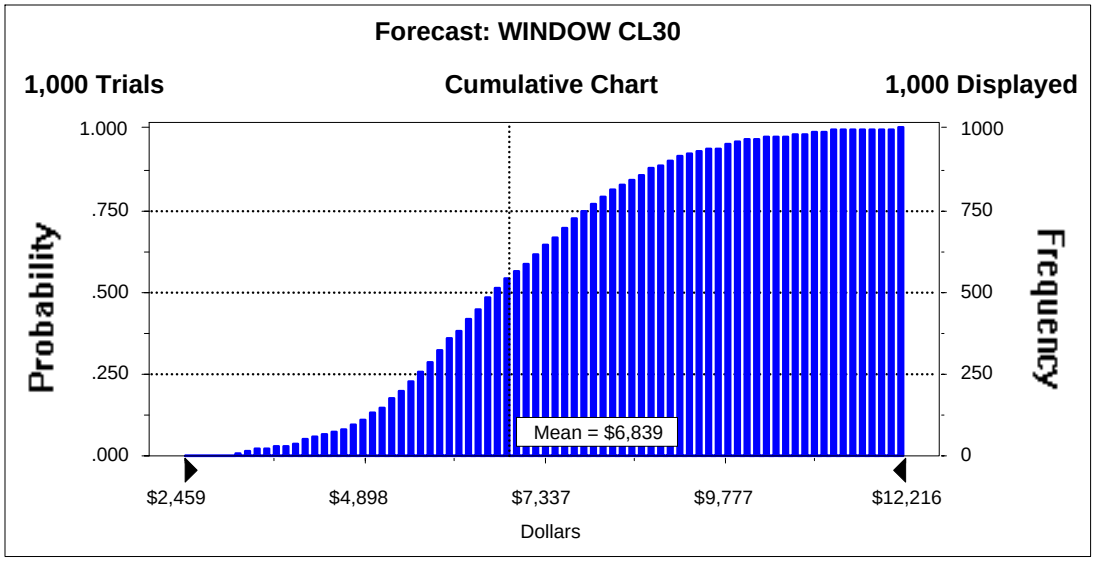

Figure G-128: Climate Zone 3 Class 30 Window NPV Results for Electric FAF

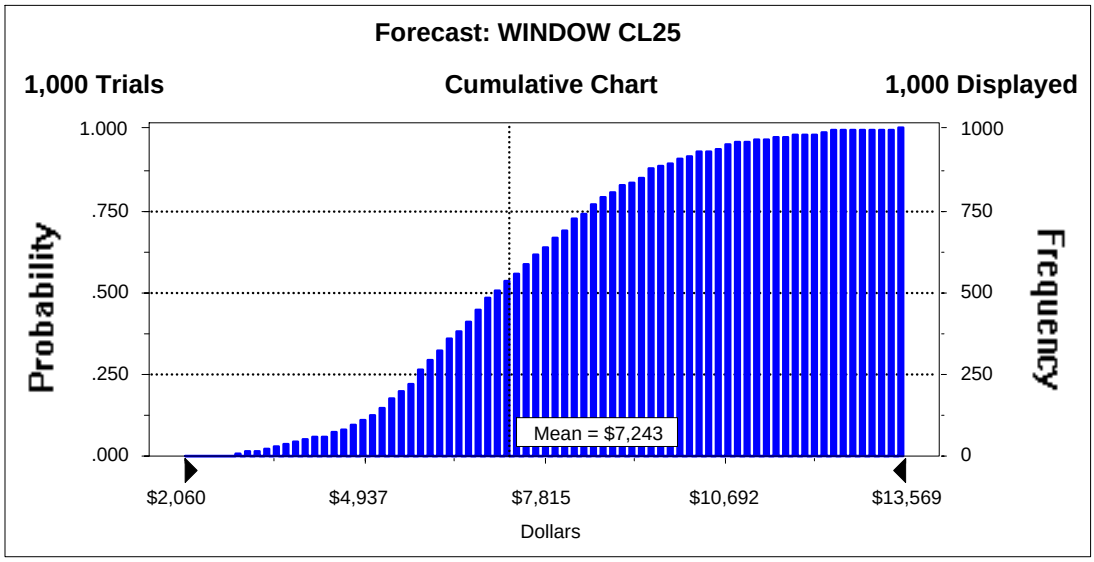

Figure G-129: Climate Zone 3 Class 25 Window NPV Results for Electric FAF

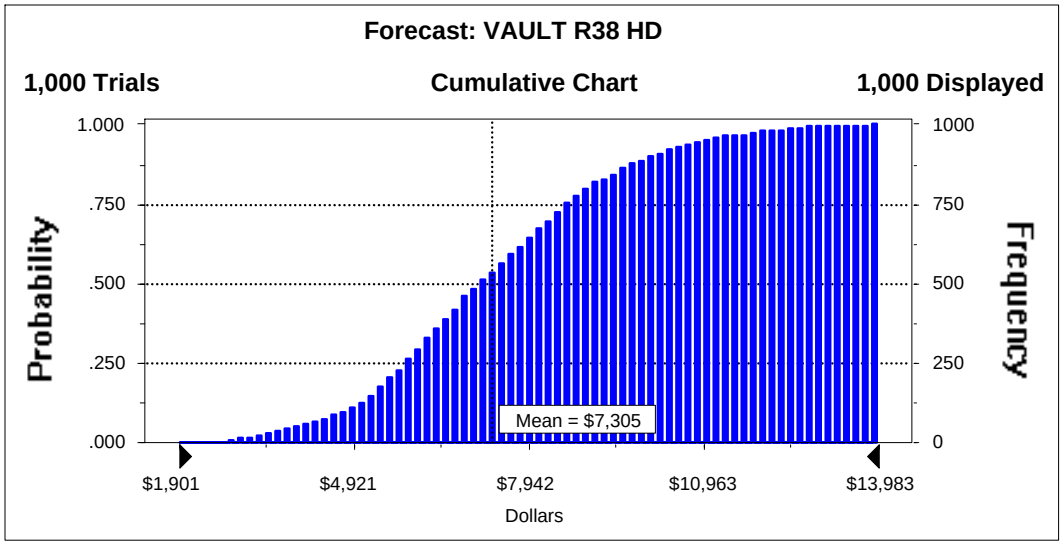

Figure G-130: Climate Zone 3 R38 Vault NPV Results for Electric FAF

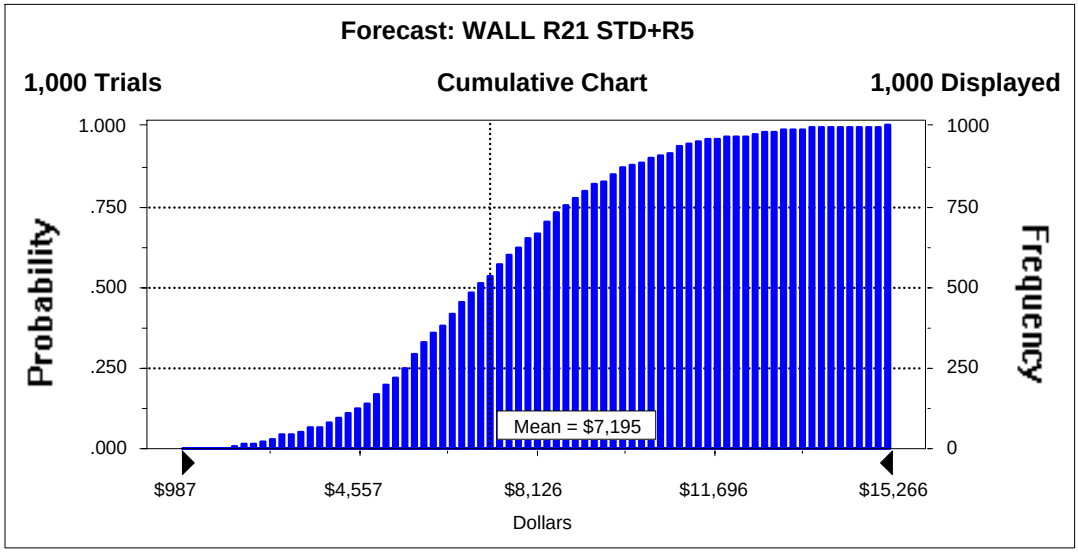

Figure G-131: Climate Zone 3 R26 Advanced Framed Wall NPV Results for Electric FAF

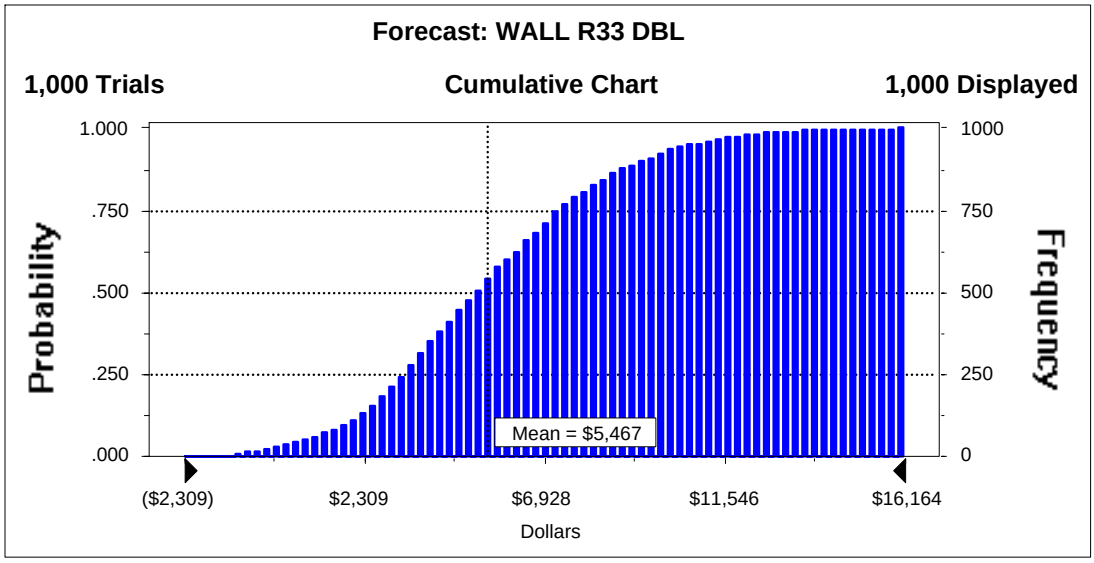

Figure G-132: Climate Zone 3 R33 Wall NPV Results for Electric FAF

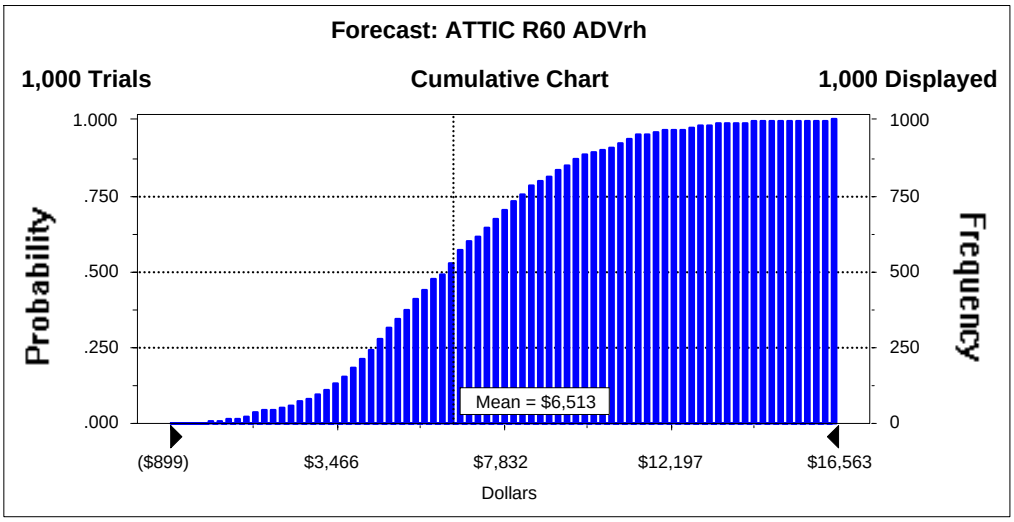

Figure G-133: Climate Zone 3 R60 Advanced Framed Attic NPV Results for Electric FAF

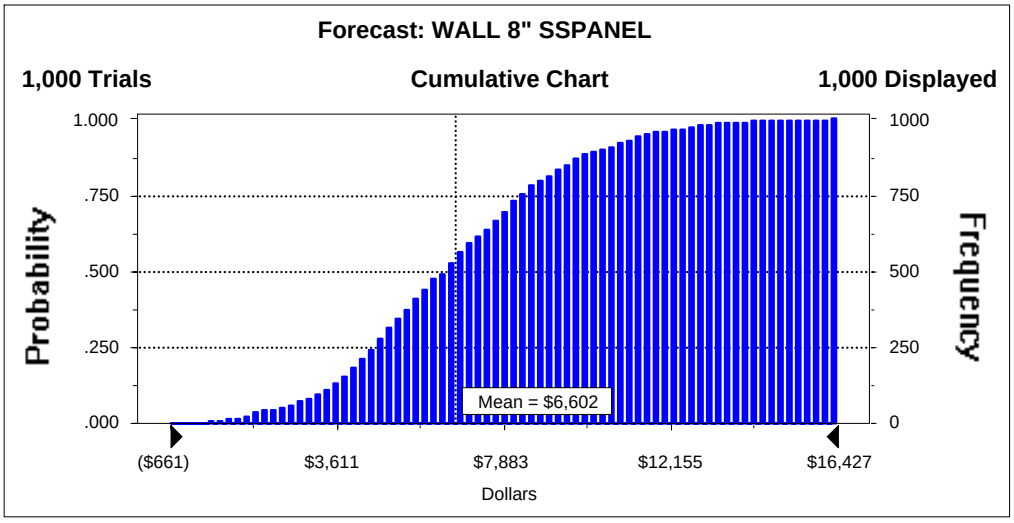

Figure G-134: Climate Zone 3 R38 Wall NPV Results for Electric FAF

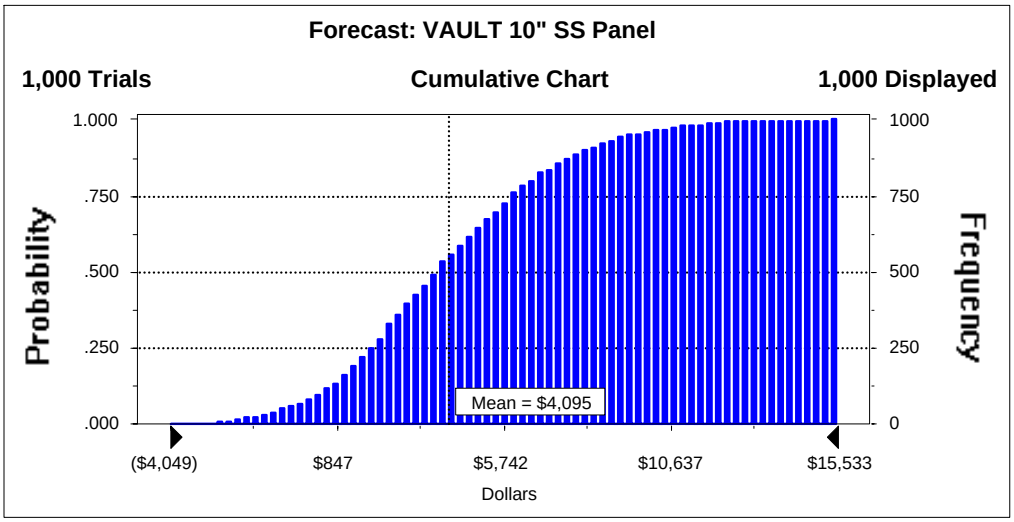

Figure G-135: Climate Zone 3 R49 Vault NPV Results for Electric FAF

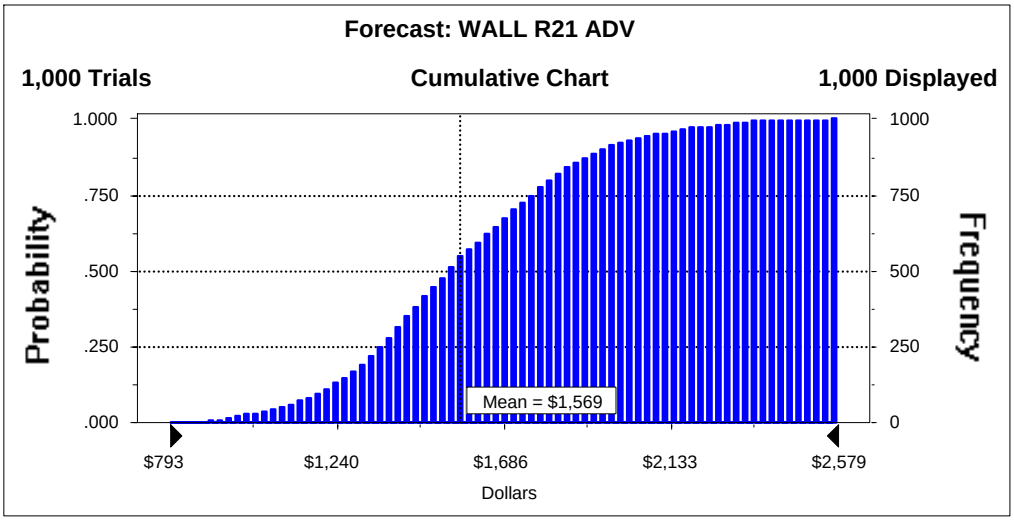

Figure G-136: Climate Zone 3 R21 Advanced Framed Wall NPV Results for Electric Zonal

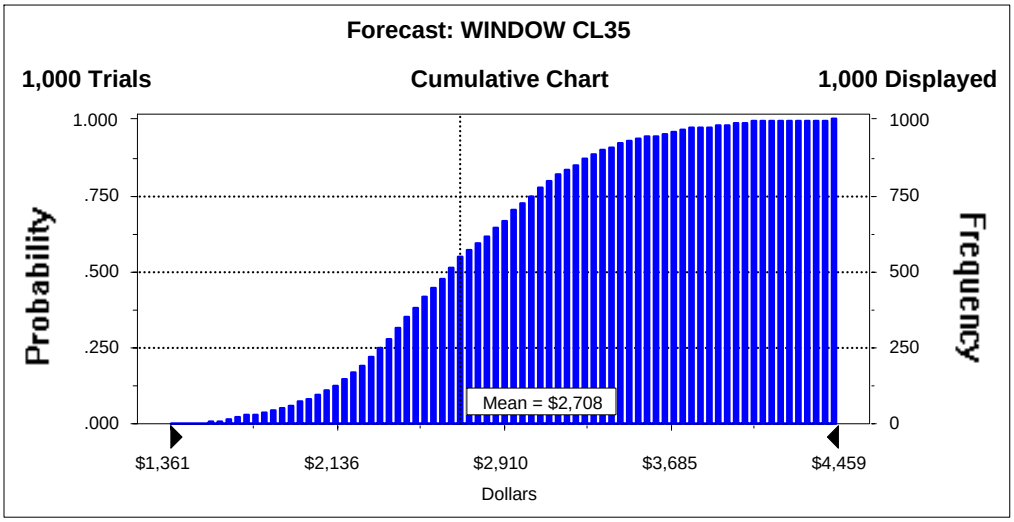

Figure G-137: Climate Zone 3 Class 35 Window NPV Results for Electric Zonal

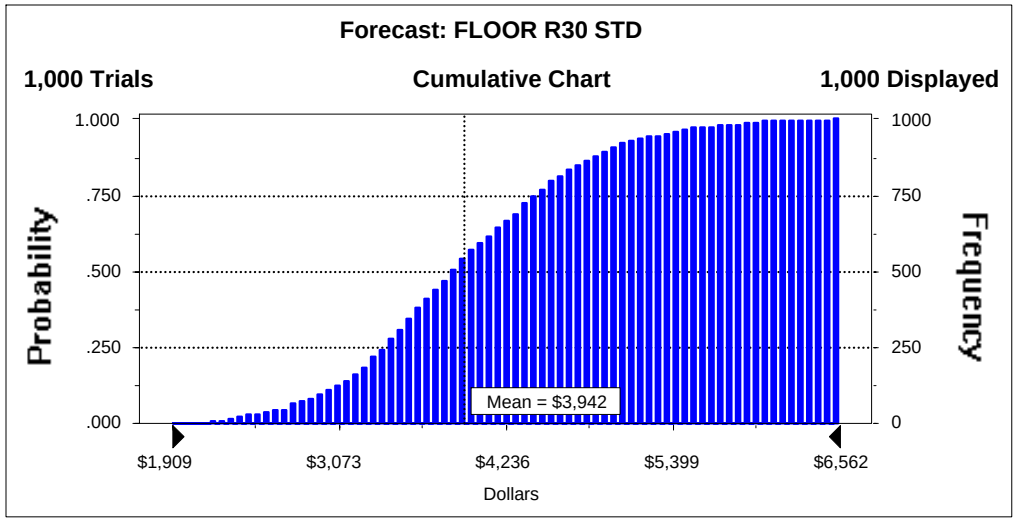

Figure G-138: Climate Zone 3 R30 Under floor NPV Results for Electric Zonal

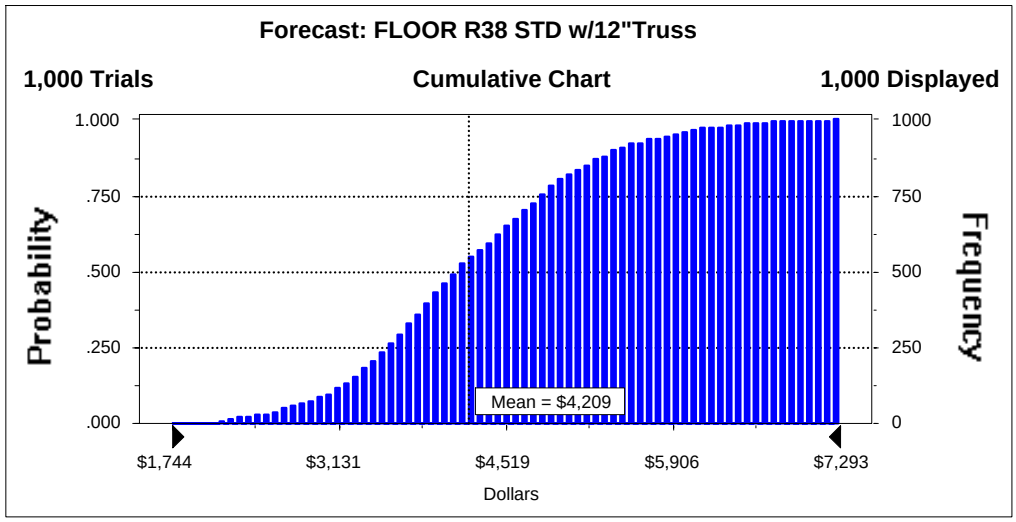

Figure G-139: Climate Zone 3 R38 Under floor NPV Results for Electric Zonal

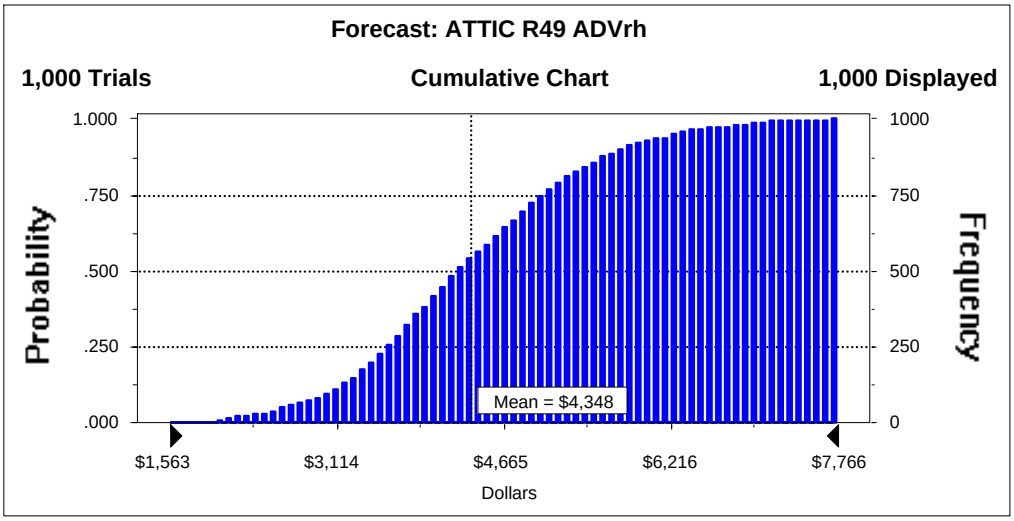

Figure G-140: Climate Zone 3 R49 Advanced Framed Attic NPV Results for Electric Zonal

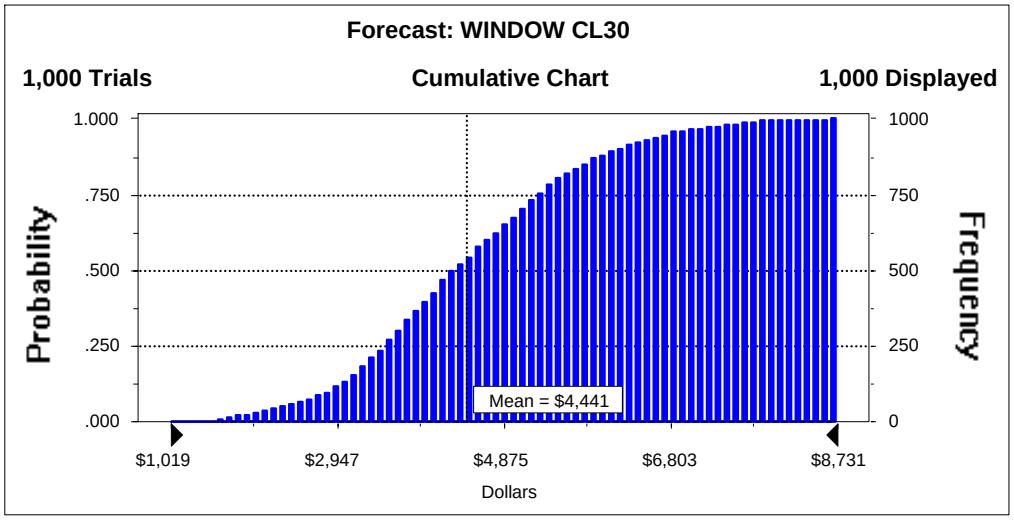

Figure G-141: Climate Zone 3 Class 30 Window NPV Results for Electric Zonal

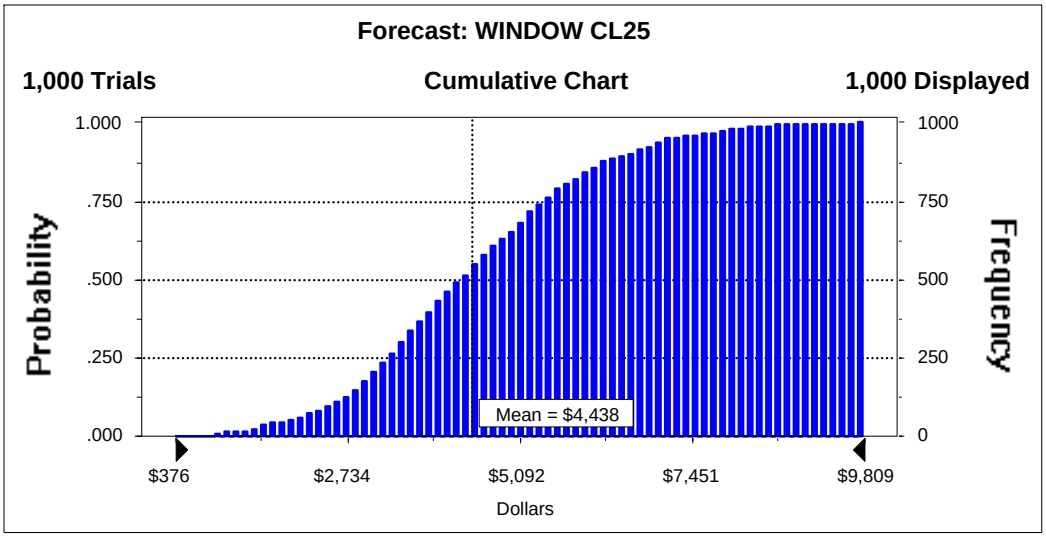

Figure G-142: Climate Zone 3 Class 25 Window NPV Results for Electric Zonal

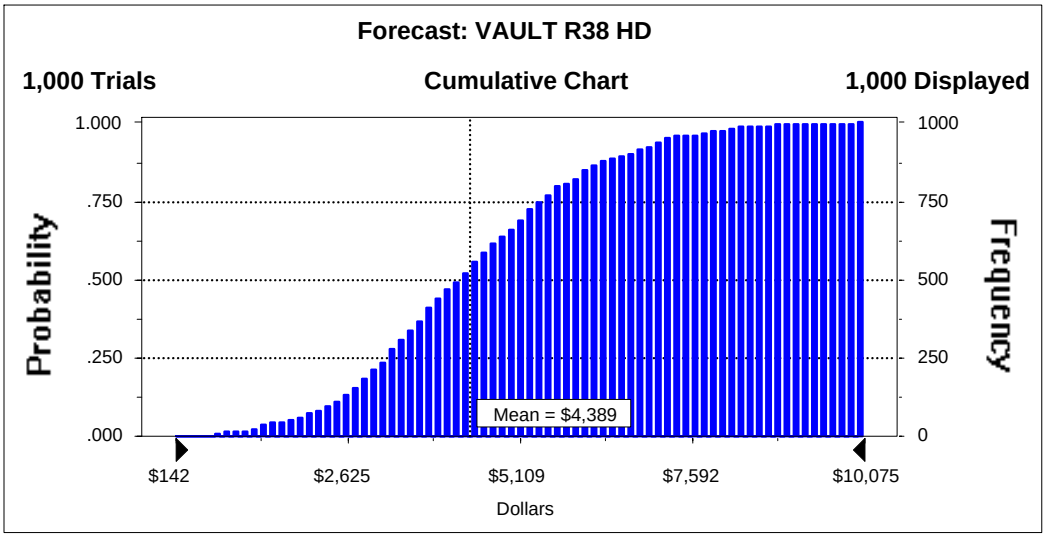

Figure G-143: Climate Zone 3 R38 Vault NPV Results for Electric Zonal

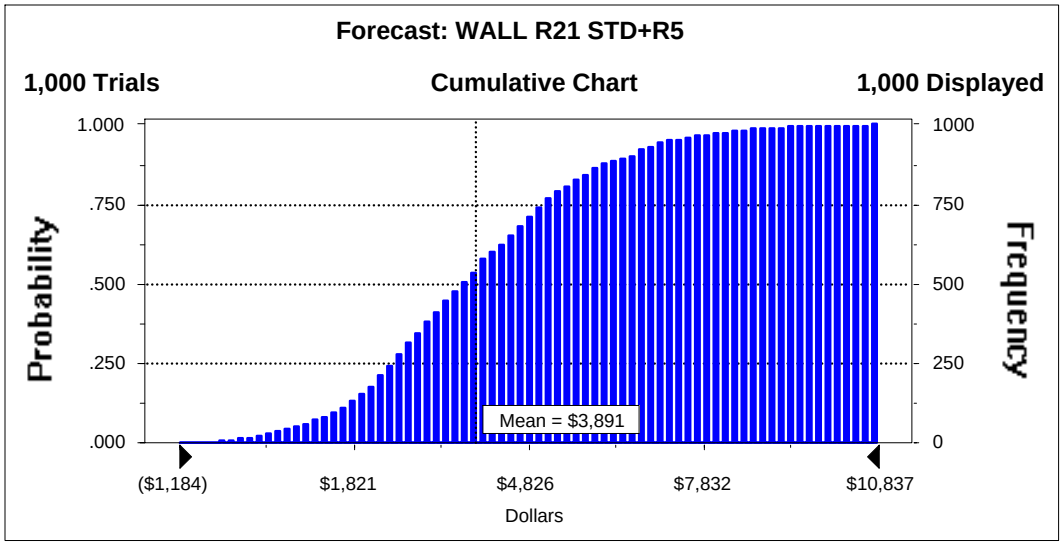

Figure G-144: Climate Zone 3 R26 Advanced Framed Wall NPV Results for Electric Zonal

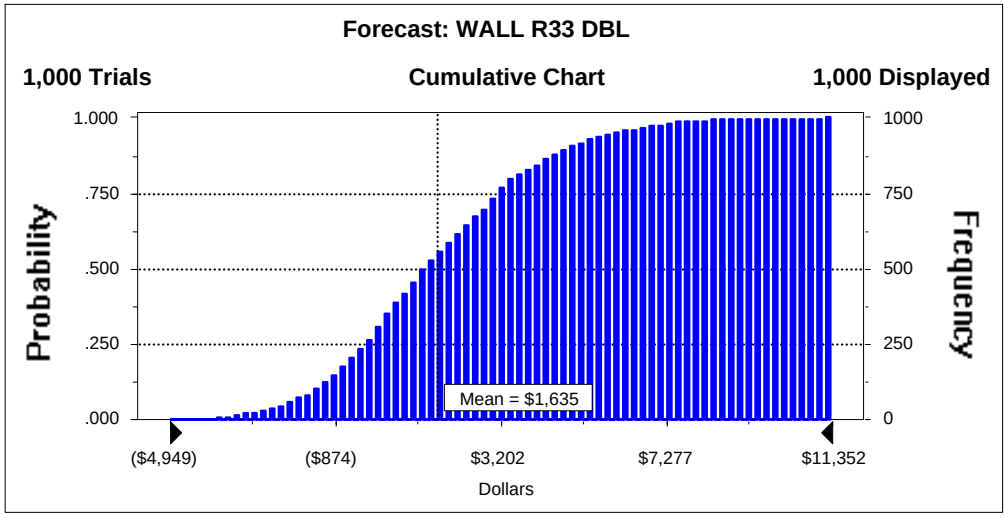

Figure G-145: Climate Zone 3 R33 Wall NPV Results for Electric Zonal

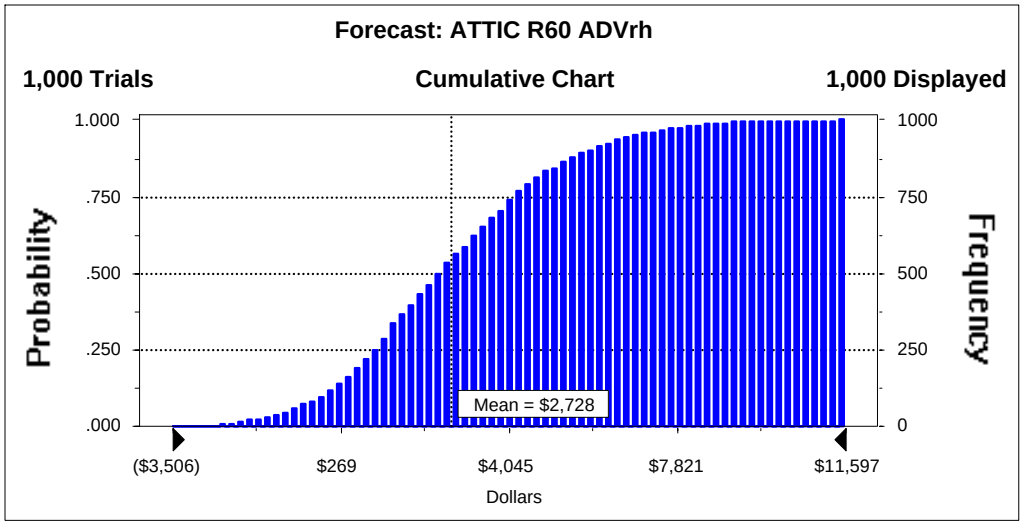

Figure G-146: Climate Zone 3 R60 Advanced Framed Attic NPV Results for Electric Zonal

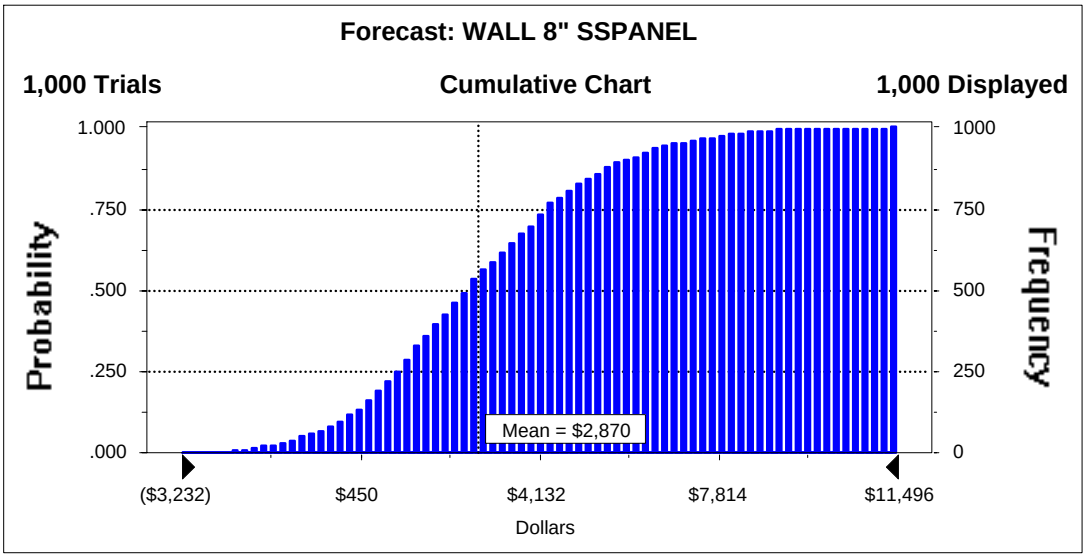

Figure G-147: Climate Zone 3 R38 Wall NPV Results for Electric Zonal

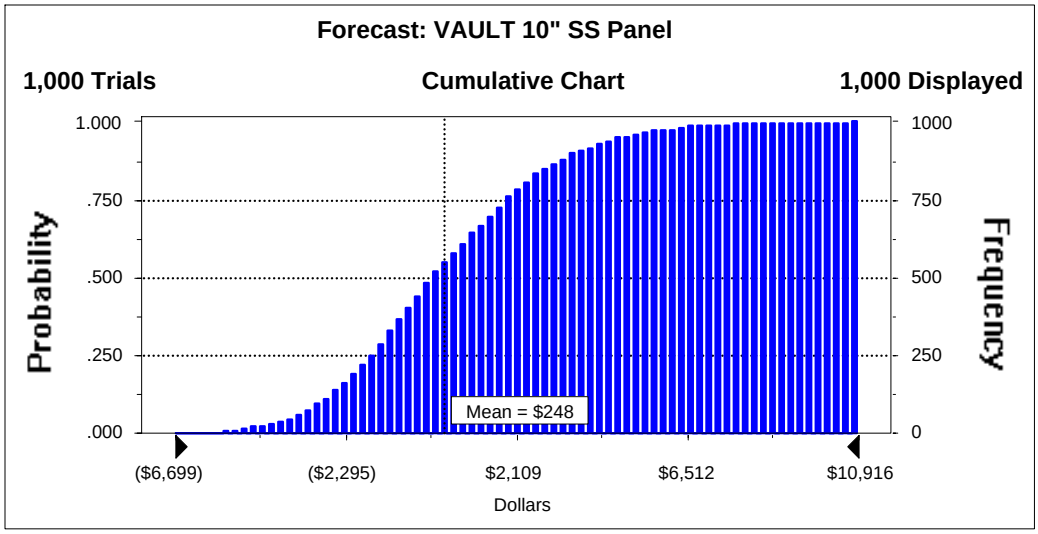

Figure G-148: Climate Zone 3 R49 Vault NPV Results for Electric Zonal

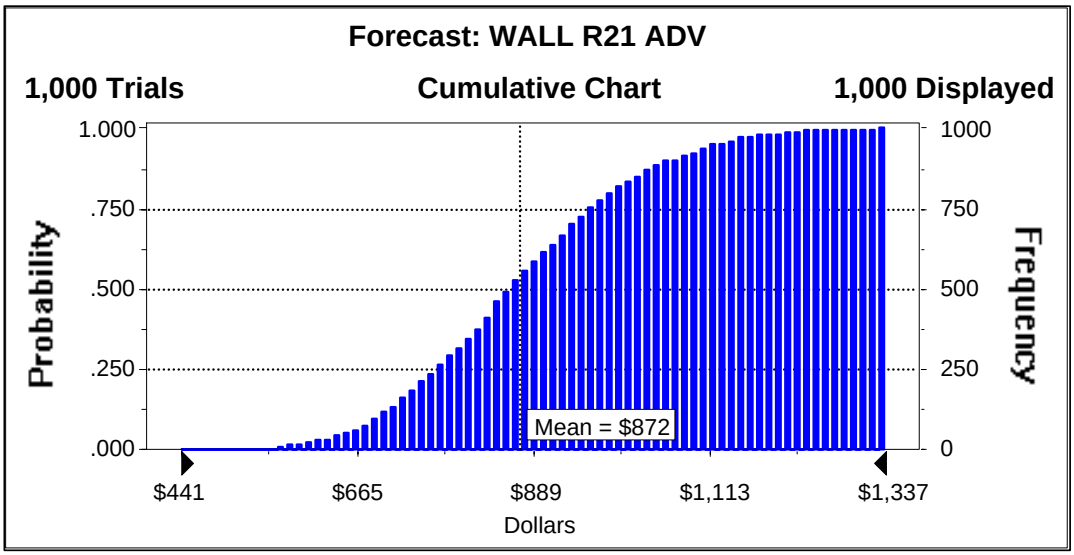

Figure G-149: Climate Zone 3 R21 Advanced Framed Wall NPV Results for Gas FAF

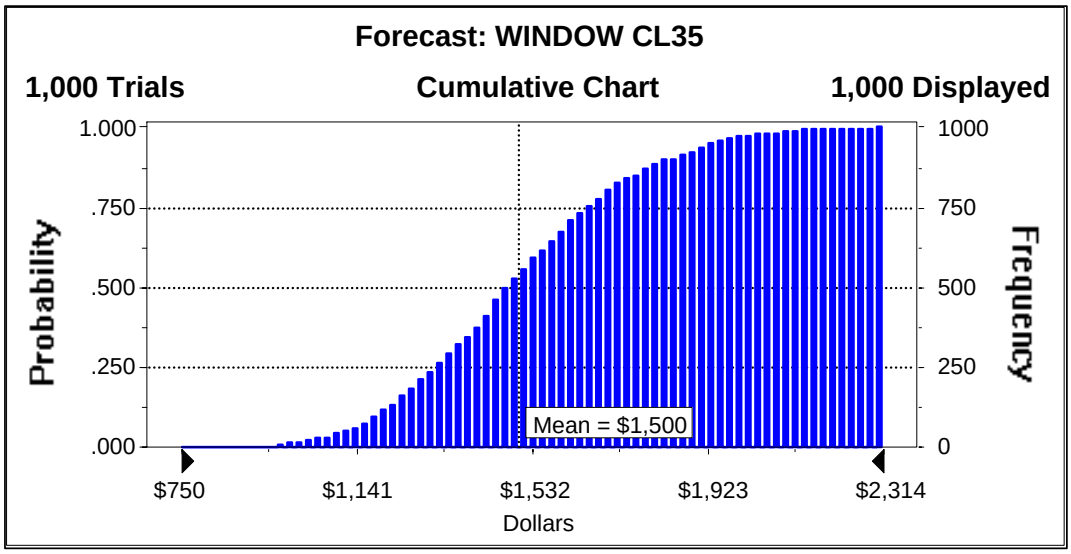

Figure G-150: Climate Zone 3 Class 35 Window NPV Results for Gas FAF

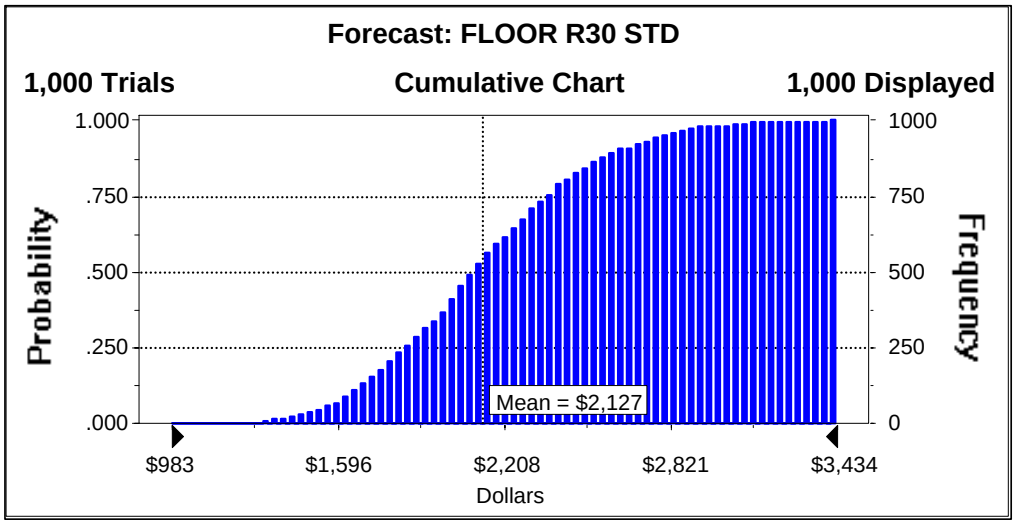

Figure G-151: Climate Zone 3 R30 Under floor NPV Results for Gas FAF

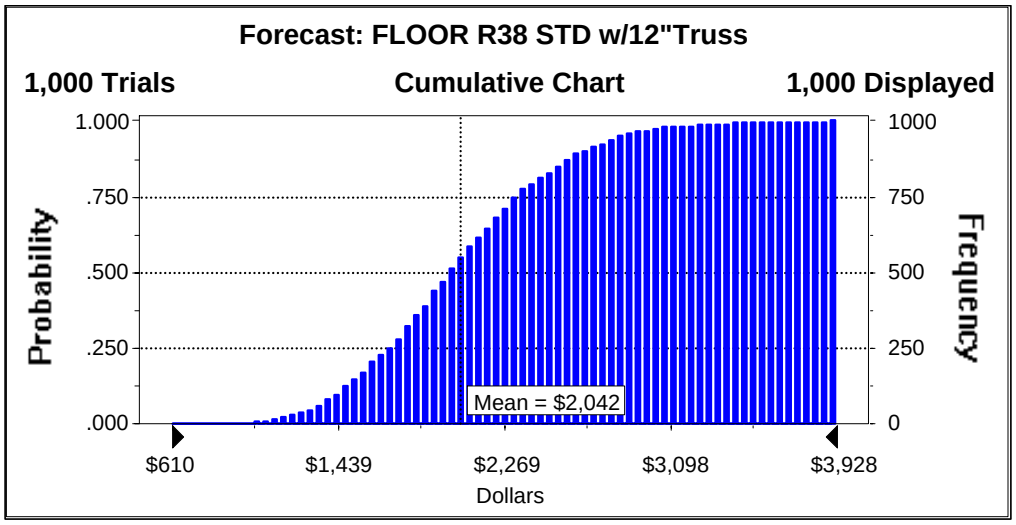

Figure G-152: Climate Zone 3 R38 Under floor NPV Results for Gas FAF

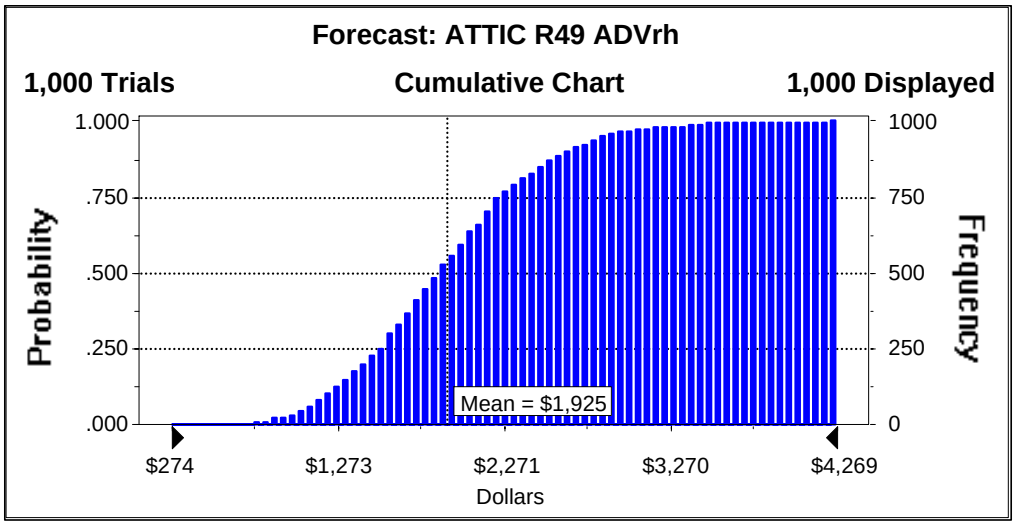

Figure G-153: Climate Zone 3 R49 Advanced Framed Attic NPV Results for Gas FAF

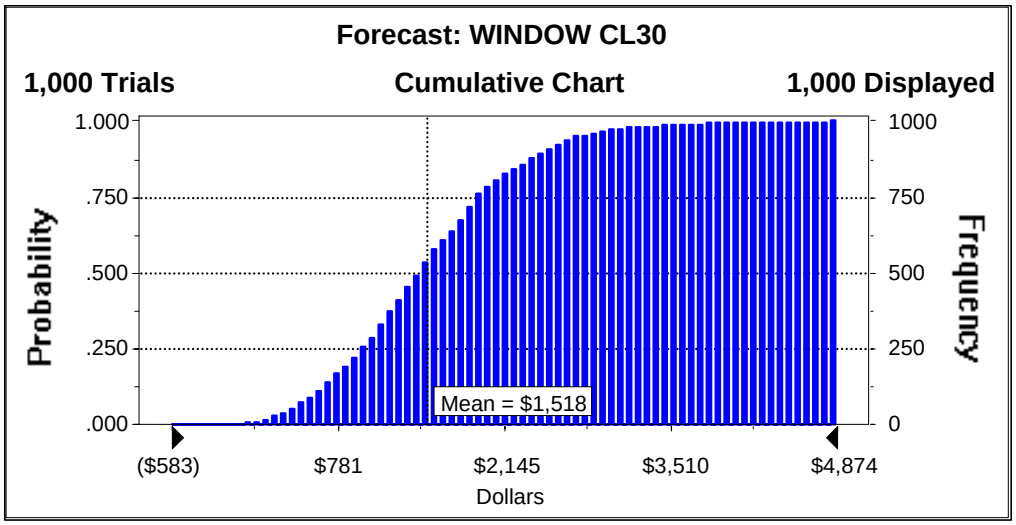

Figure G-154: Climate Zone 3 Class 30 Window NPV Results for Gas FAF

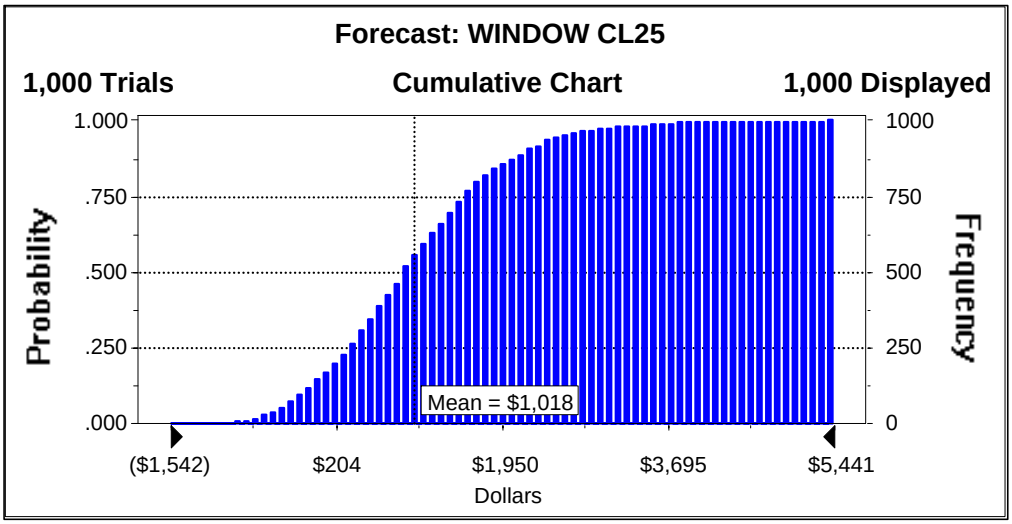

Figure G-155: Climate Zone 3 Class 25 Window NPV Results for Gas FAF

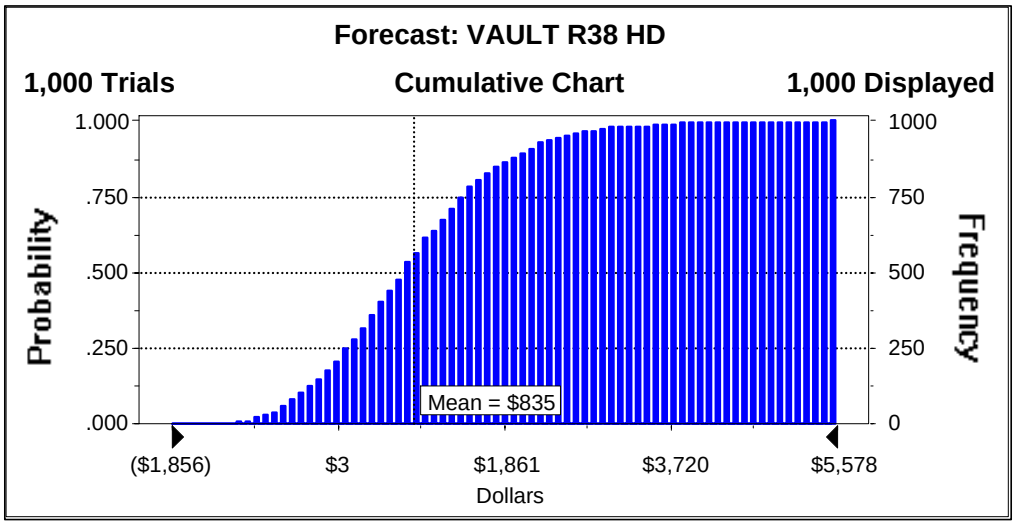

Figure G-156: Climate Zone 3 R38 Vault NPV Results for Gas FAF

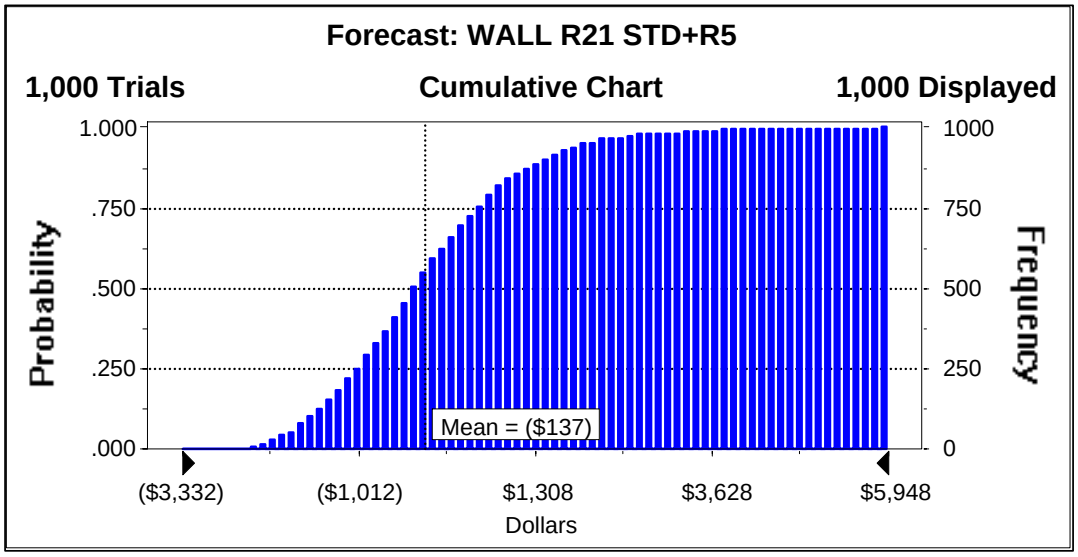

Figure G-157: Climate Zone 3 R26 Advanced Framed Wall NPV Results for Gas FAF

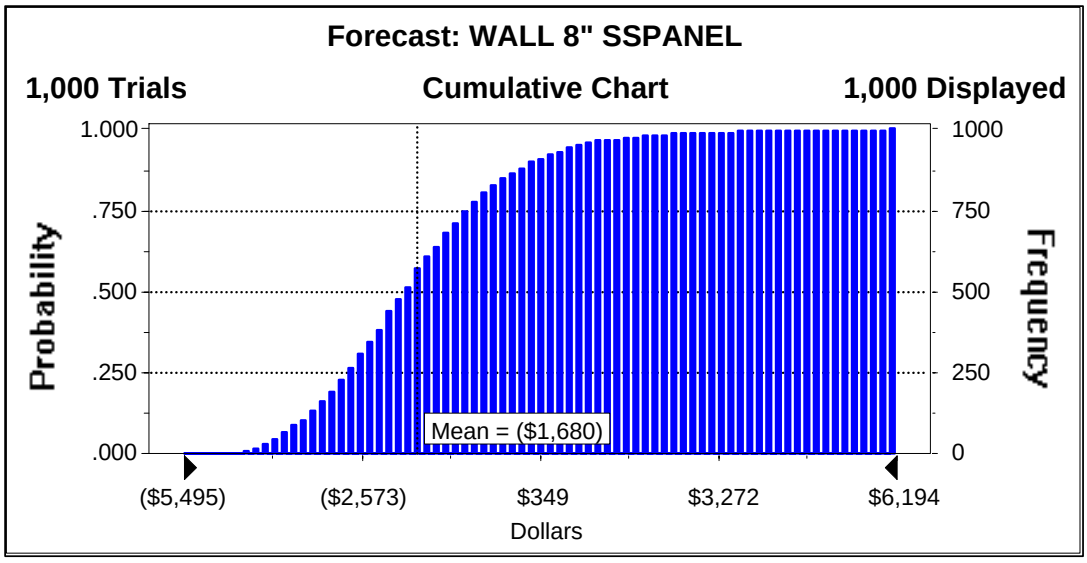

Figure G-158: Climate Zone 3 R33 Wall NPV Results for Gas FAF

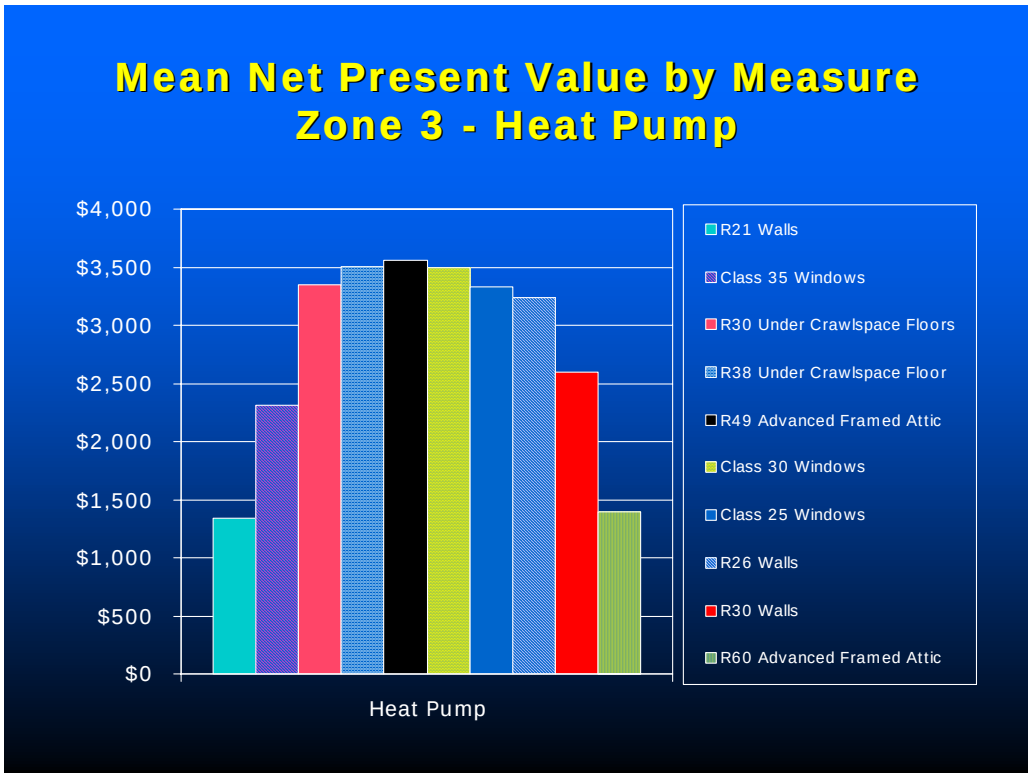

Figure G-159: Climate Zone 3 Mean Net Present Value by Measure for Heat Pumps

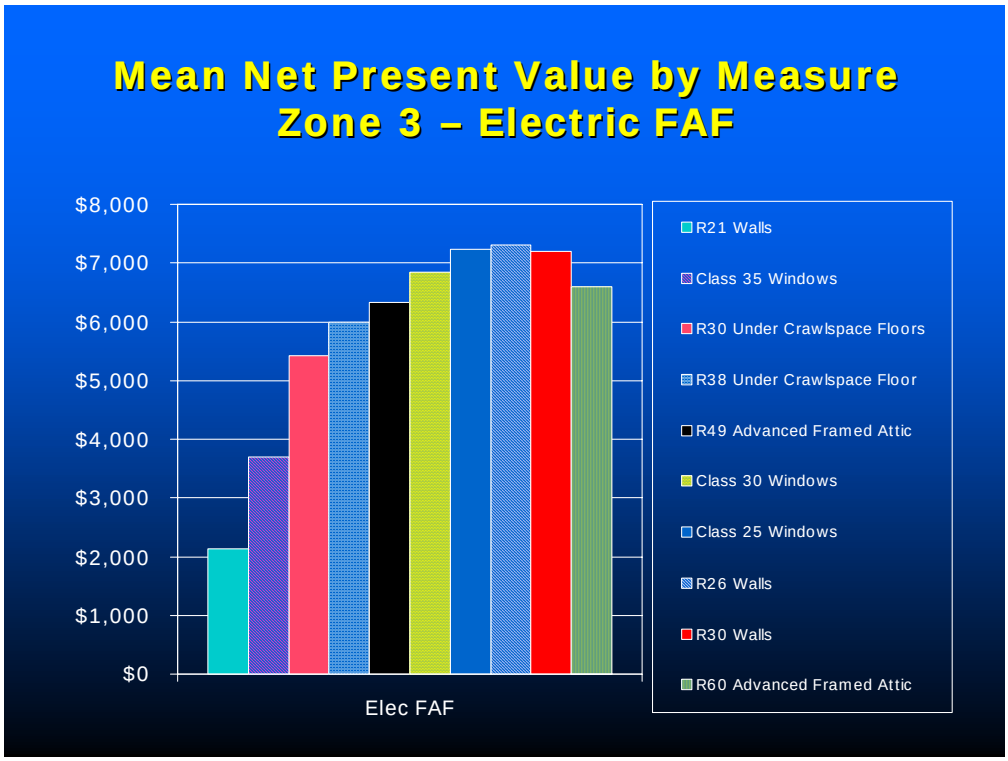

Figure G-160: Climate Zone 3 Mean Net Present Value by Measure for Electric FAF

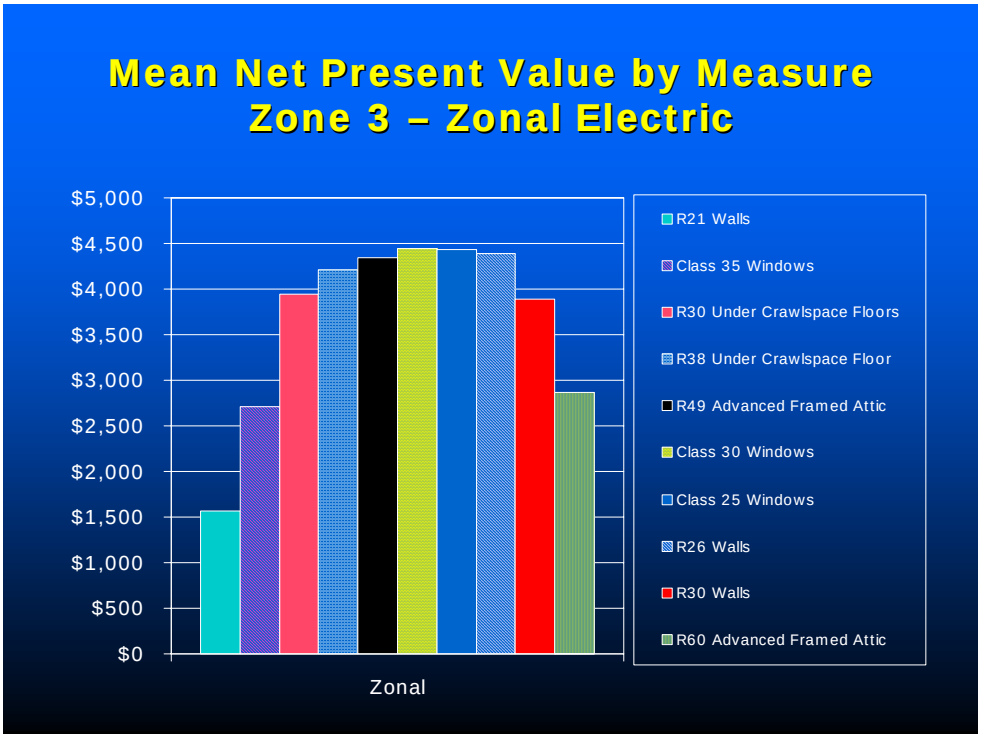

Figure G-161: Climate Zone 3 Mean Net Present Value by Measure for Electric Zonal

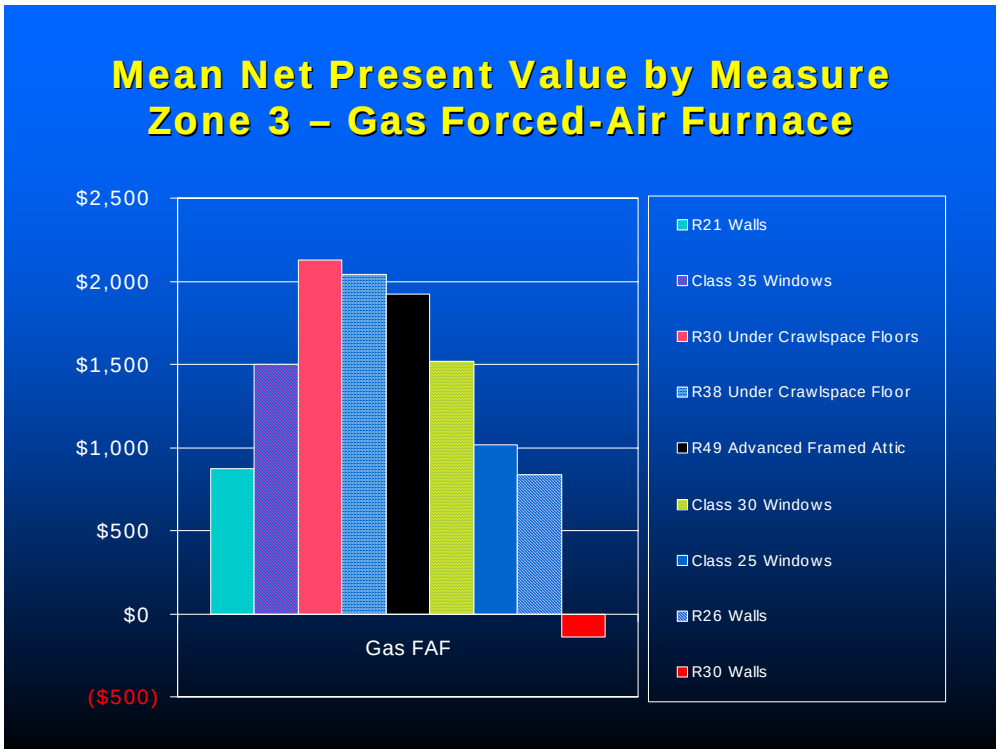

Figure G-162: Climate Zone 3 Mean Net Present Value by Measure for Gas FAF

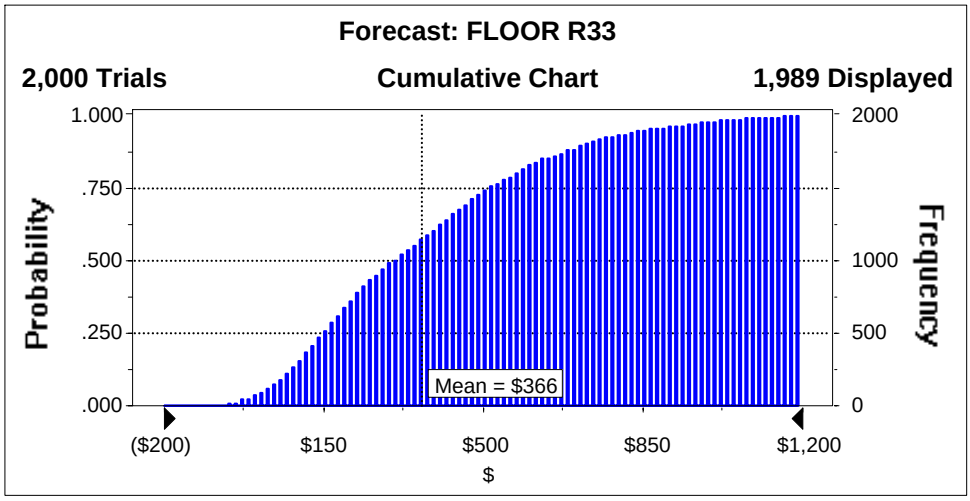

Figure G-163: Climate Zone 1 Net Present Value Results for Manufactured Homes for R33 Floors

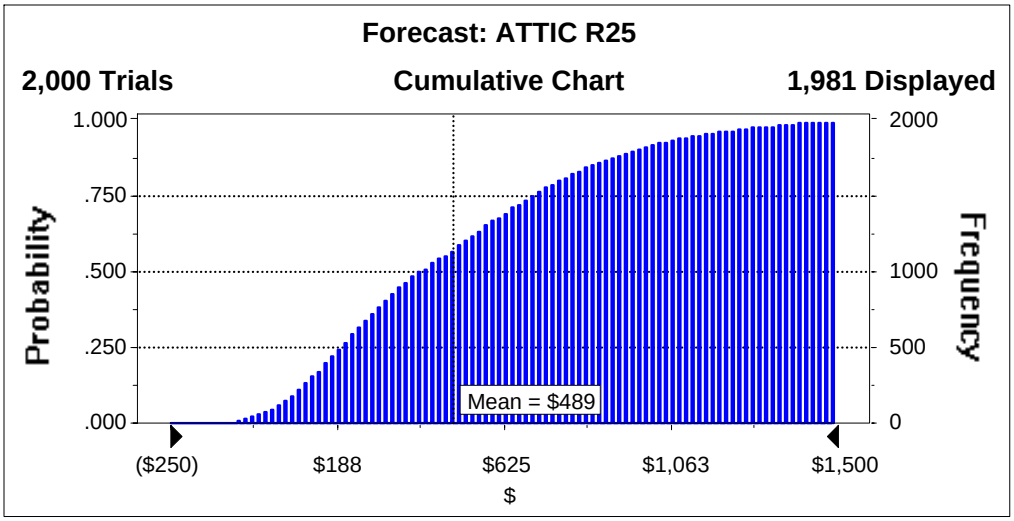

Figure G-164: Climate Zone 1 Net Present Value Results for Manufactured Homes for R25 Attic

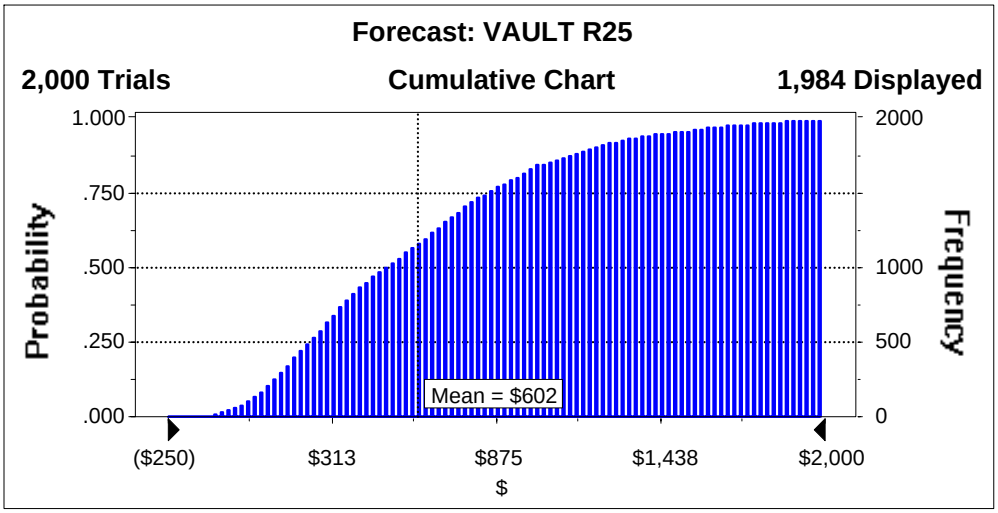

Figure G-165: Climate Zone 1 Net Present Value Results for Manufactured Homes for R25 Vault

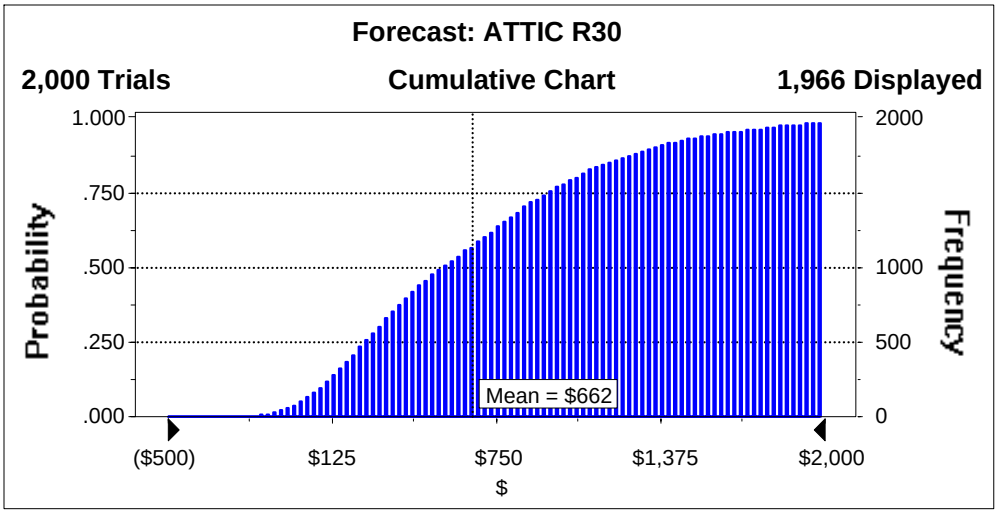

Figure G-166: Climate Zone 1 Net Present Value Results for Manufactured Homes for R30 Attic

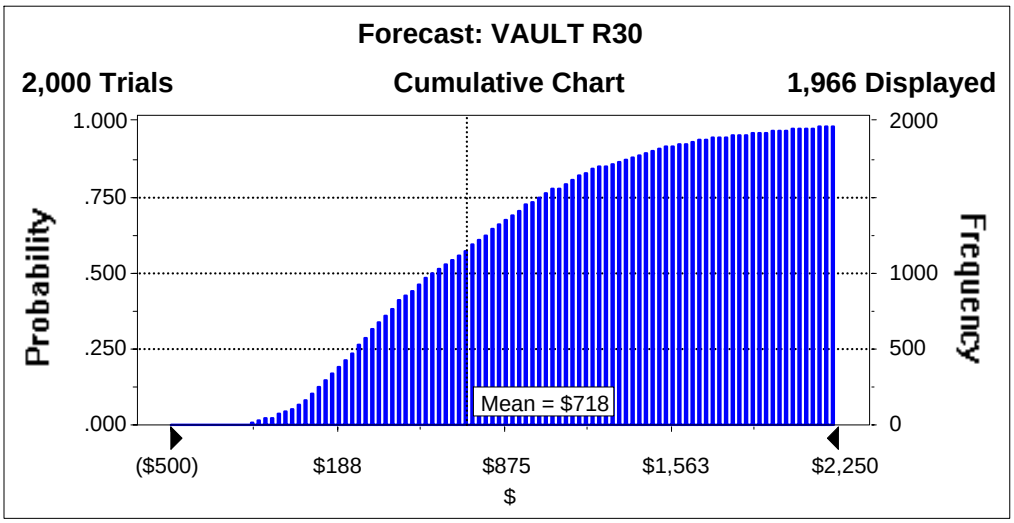

Figure G-167: Climate Zone 1 Net Present Value Results for Manufactured Homes for R30 Vaults

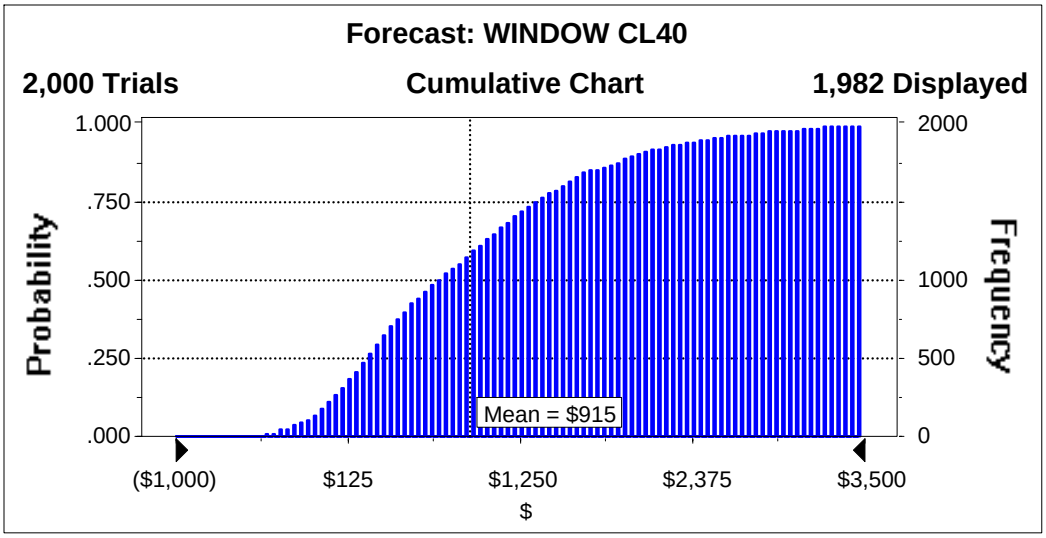

Figure G-168: Climate Zone 1 Net Present Value Results for Manufactured Homes for Class 40 Windows

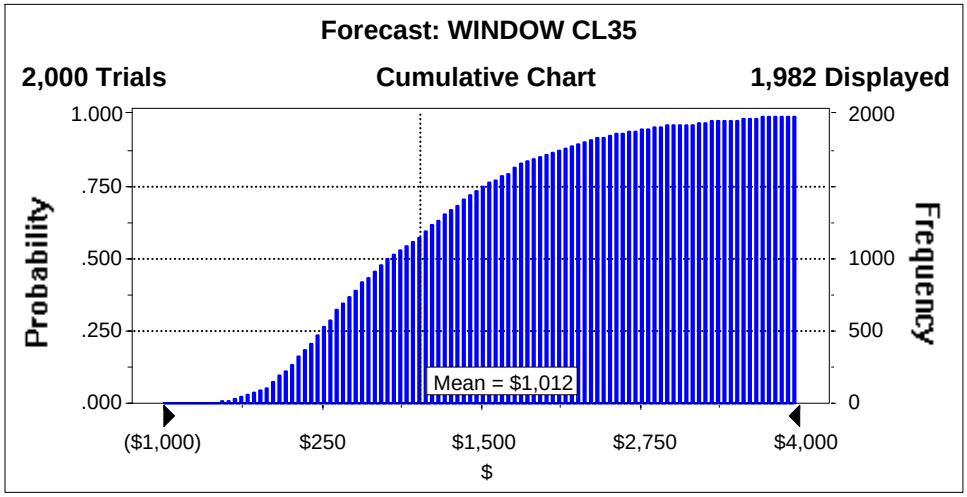

Figure G-169: Climate Zone 1 Net Present Value Results for Manufactured Homes for Class 35 Windows

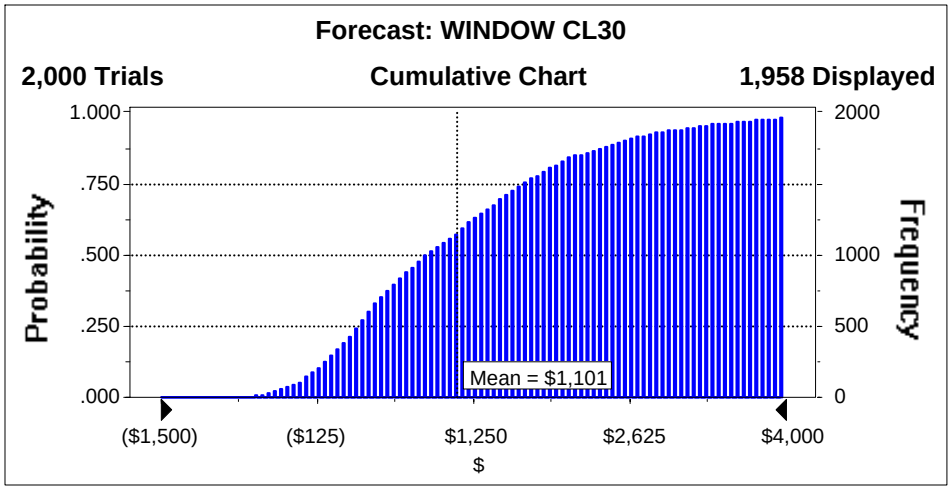

Figure G-170: Climate Zone 1 Net Present Value Results for Manufactured Homes for Class 30 Windows

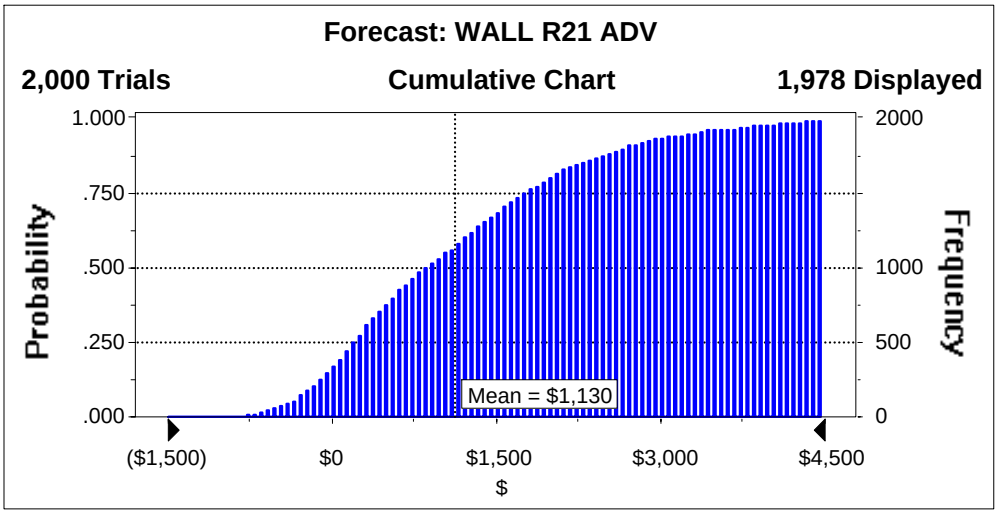

Figure G-171: Climate Zone 1 Net Present Value Results for Manufactured Homes for R21 Advanced Framed Walls

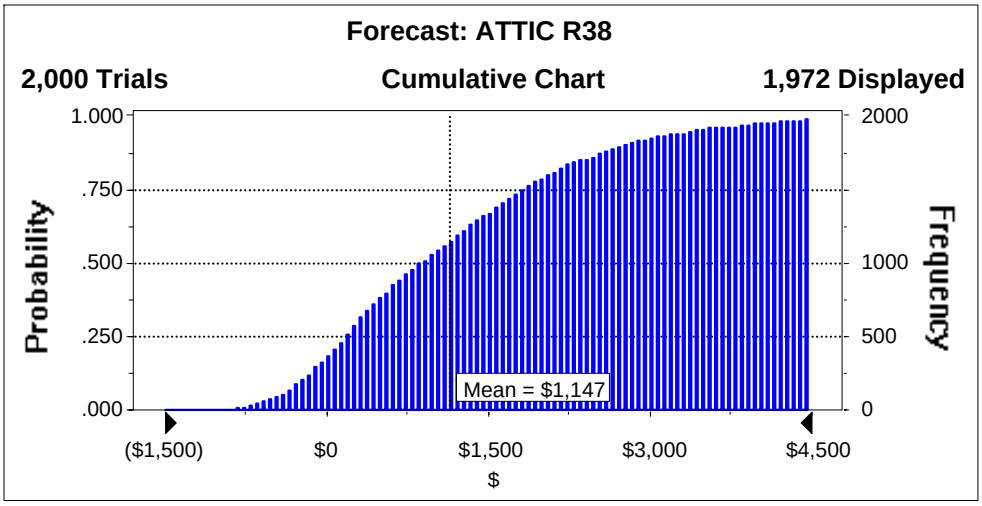

Figure G-172: Climate Zone 1 Net Preset Value Results for Manufactured Homes for R38 Attics

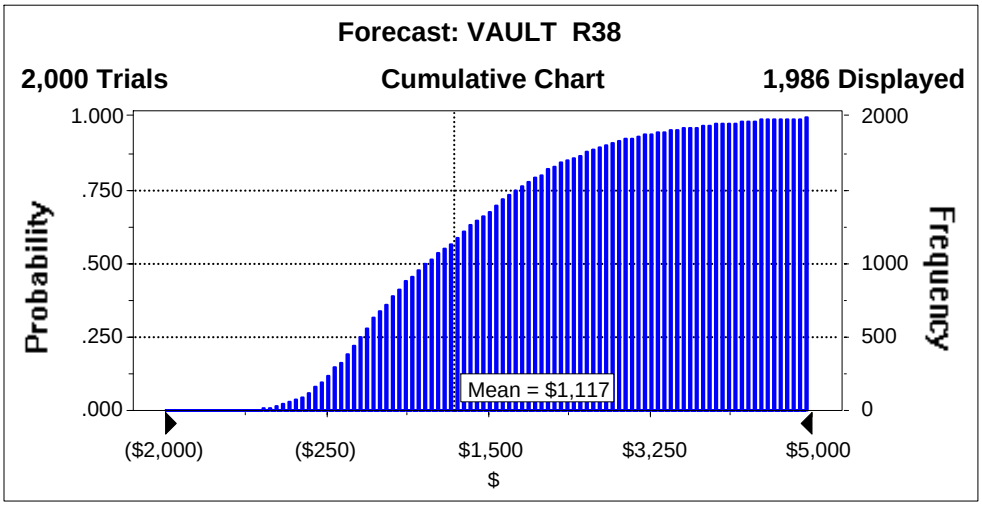

Figure G-173: Climate Zone 1 Net Present Value Results for Manufactured Homes for R38 Vaults

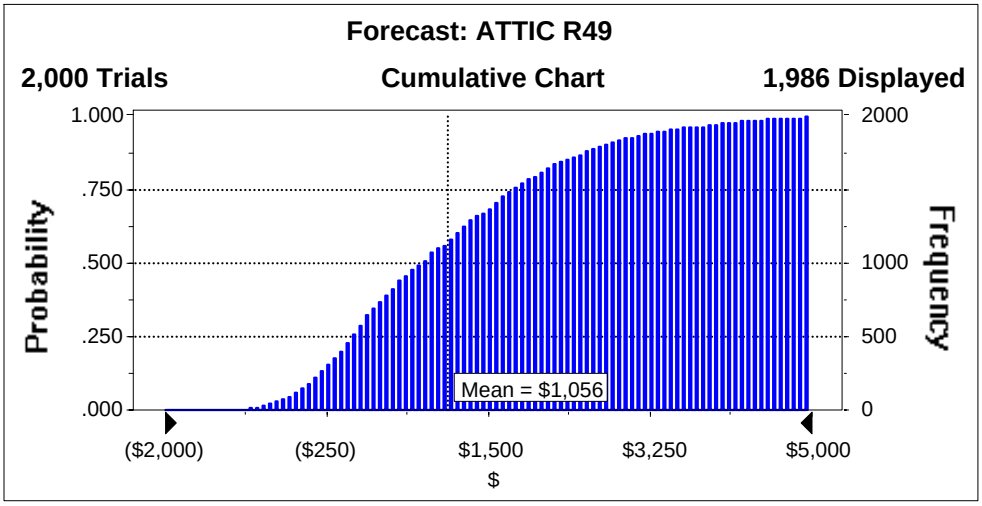

Figure G-174: Climate Zone 1 Net Present Value Results for Manufactured Homes for R49 Attics

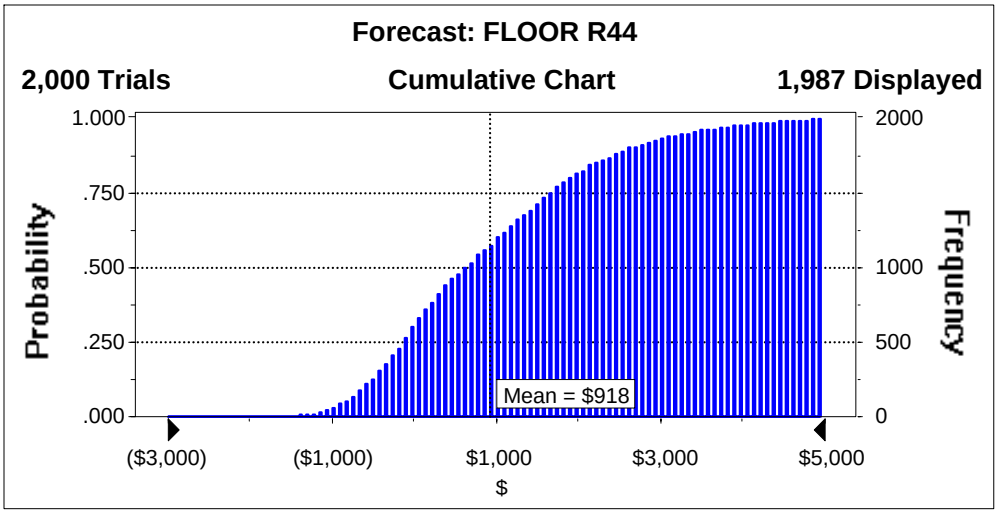

Figure G-175: Climate Zone 1 Net Present Value Results for Manufactured Homes for R44 Floors

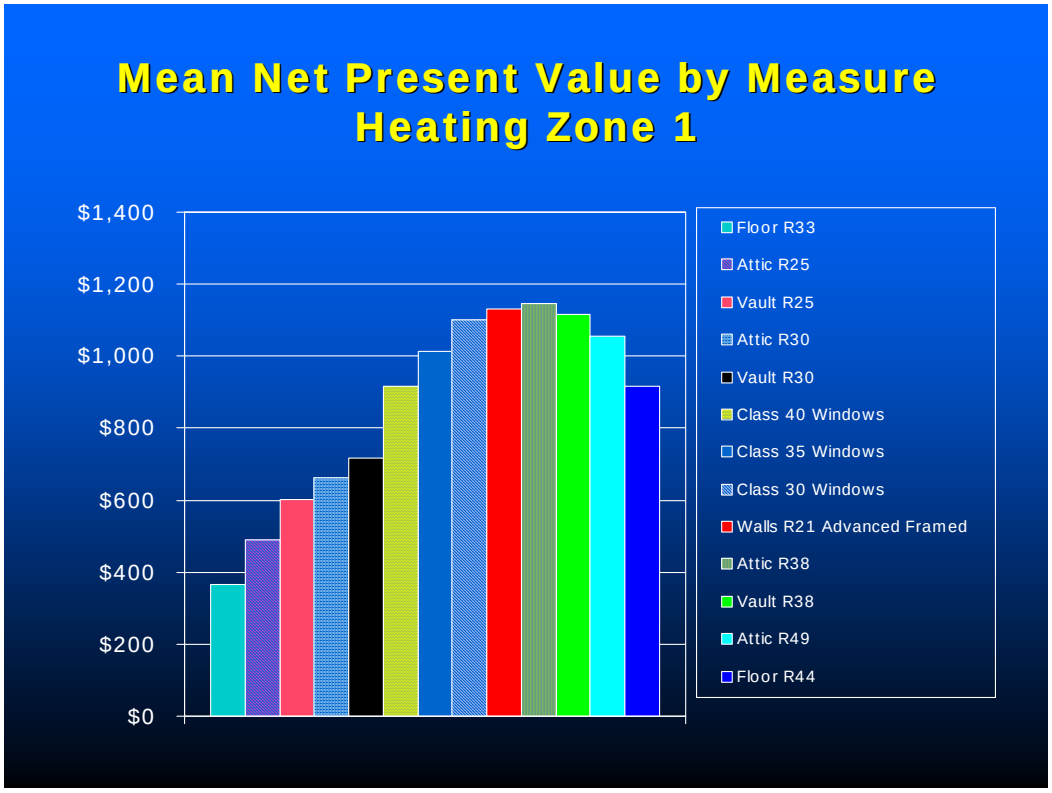

Figure G-176: Climate Zone 1 Expected Value Mean Net Present Value Results for Manufactured Homes

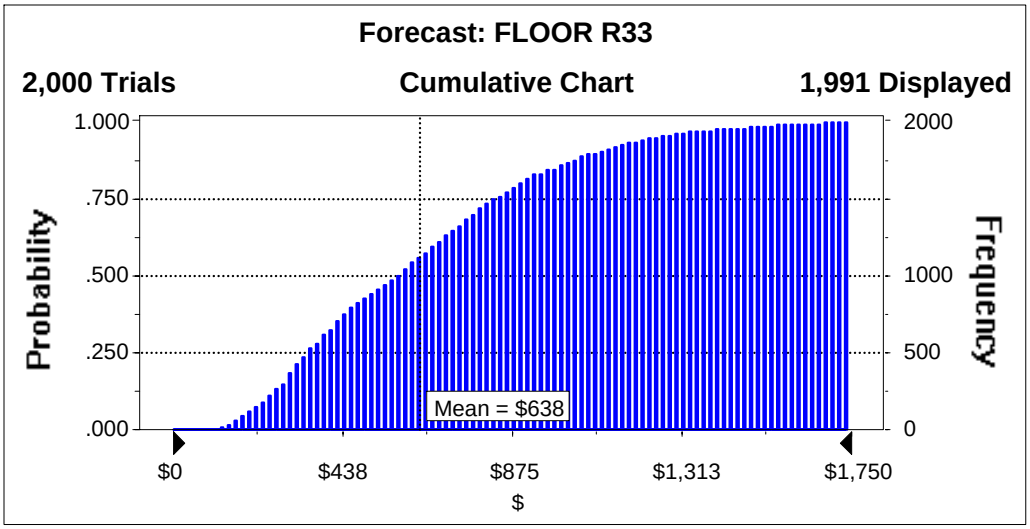

Figure G-177: Climate Zone 2 Net Present Value Results for Manufactured Homes for R33 Floors

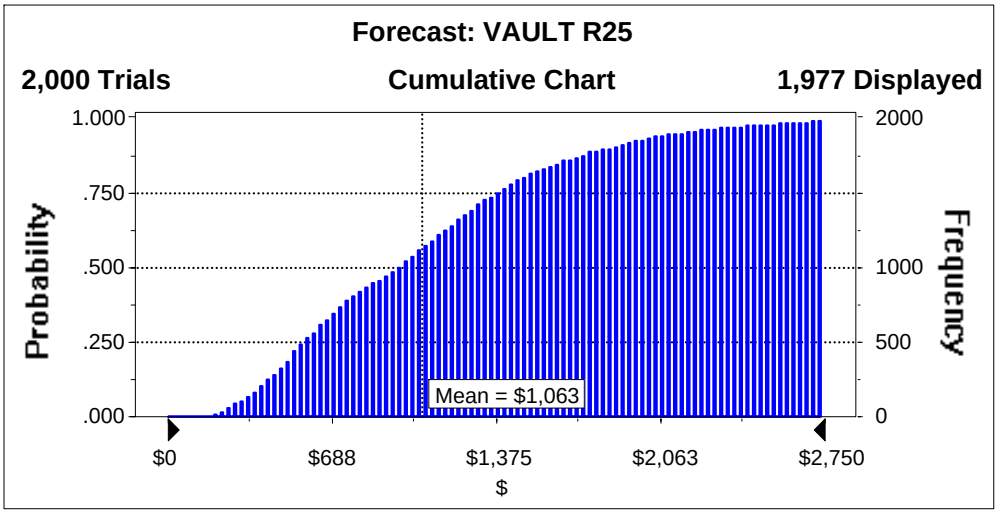

Figure G-178: Climate Zone 2 Net Present Value Results for Manufactured Homes for R25 Attics

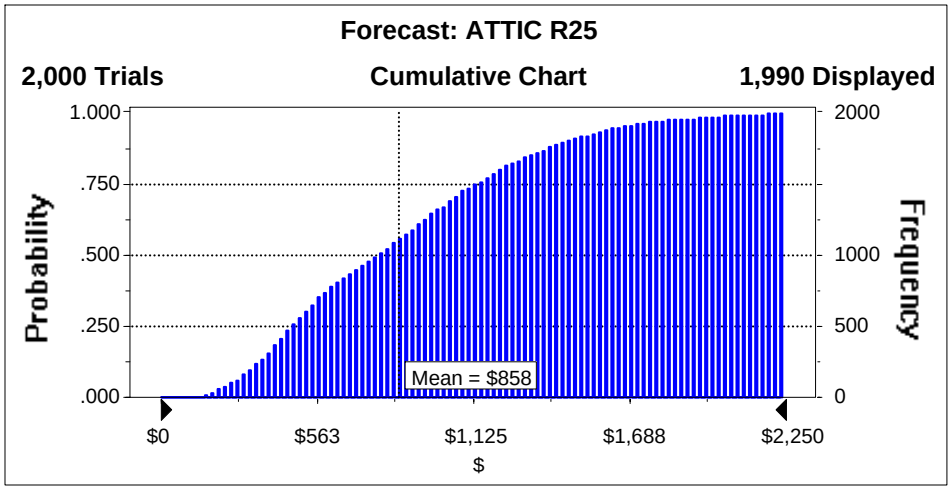

Figure G-179: Climate Zone 2 Net Present Value Results for Manufactured Homes for R25 Vaults

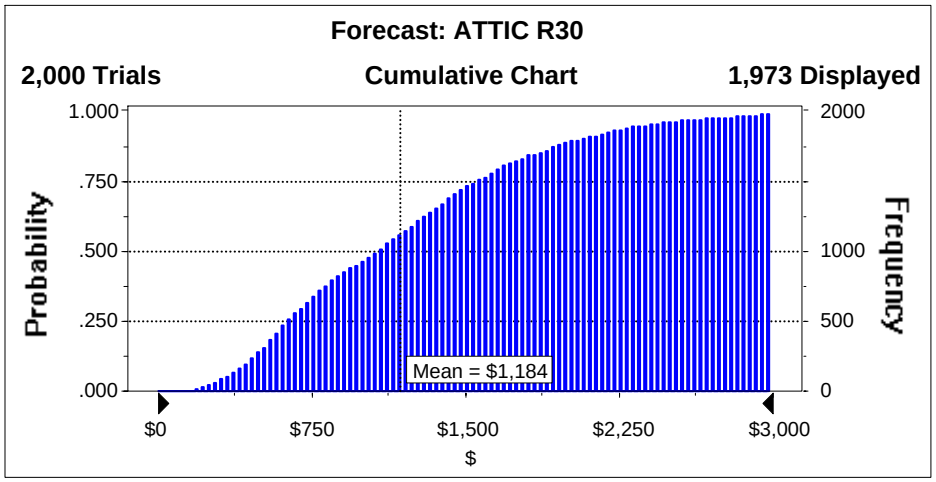

Figure G-180: Climate Zone 2 Net Present Value Results for Manufactured Homes for R30 Attics

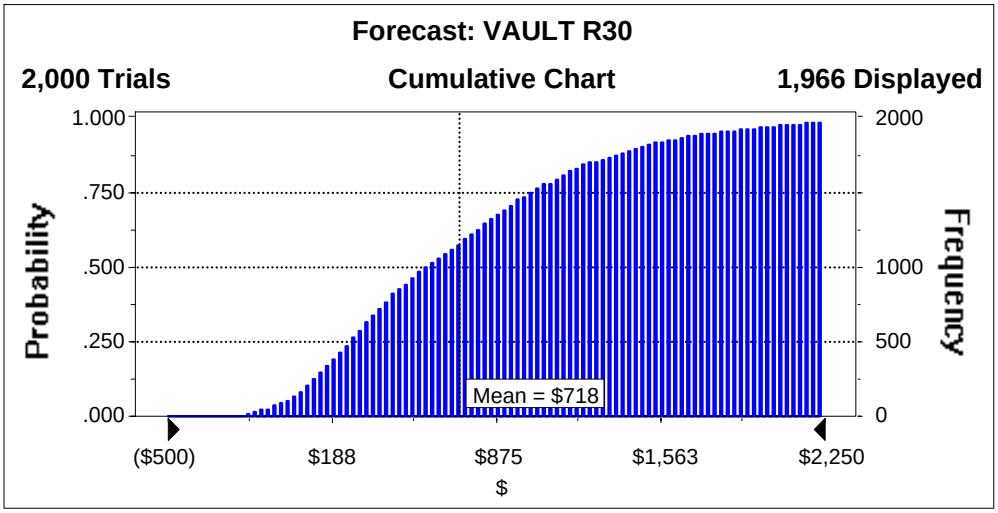

Figure G-181: Climate Zone 2 Net Present Value Results for Manufactured Homes for R30 Vaults

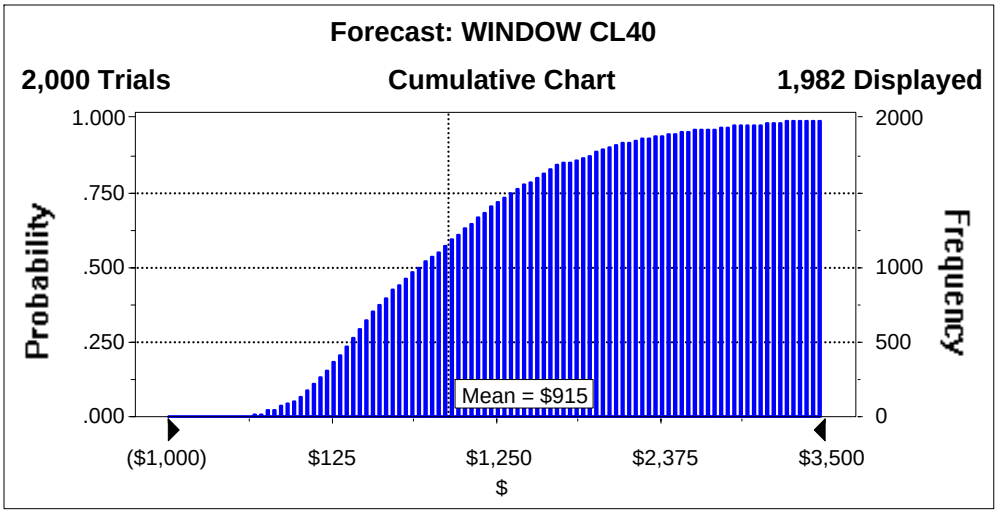

Figure G-182: Climate Zone 2 Net Present Value Results for Manufactured Homes for Class 40 Windows

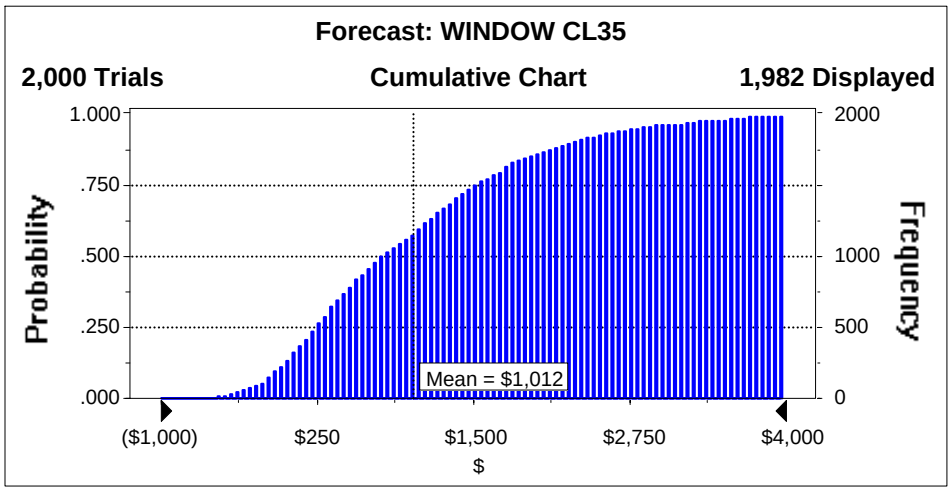

Figure G-183: Climate Zone 2 Net Present Value Results for Manufactured Homes for Class 35 Windows

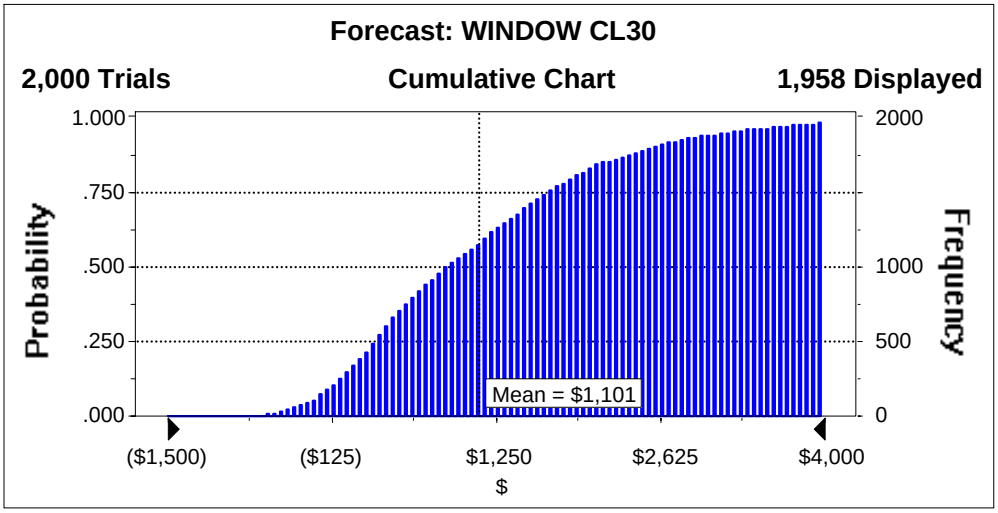

Figure G-184: Climate Zone 2 Net Present Value Results for Manufactured Homes for Class 30 Windows

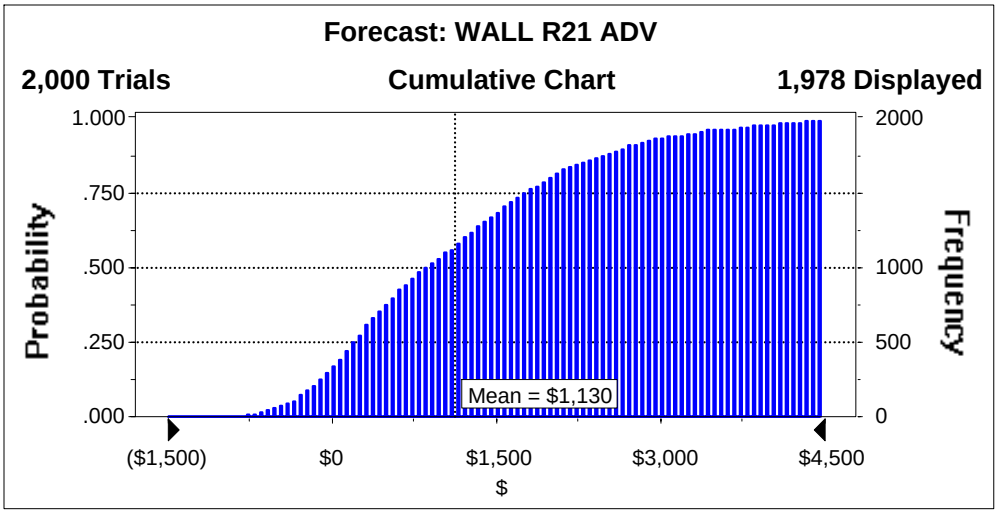

Figure G-185: Climate Zone 2 Net Present Value Results for Manufactured Homes for R21 Advanced Framed Walls

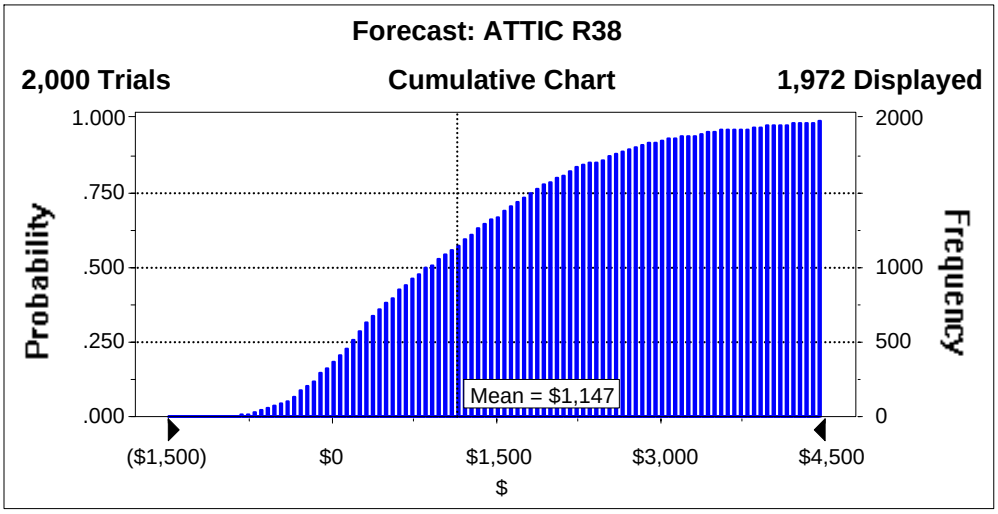

Figure G-186: Climate Zone 2 Net Present Value Results for Manufactured Homes for R38 Attics

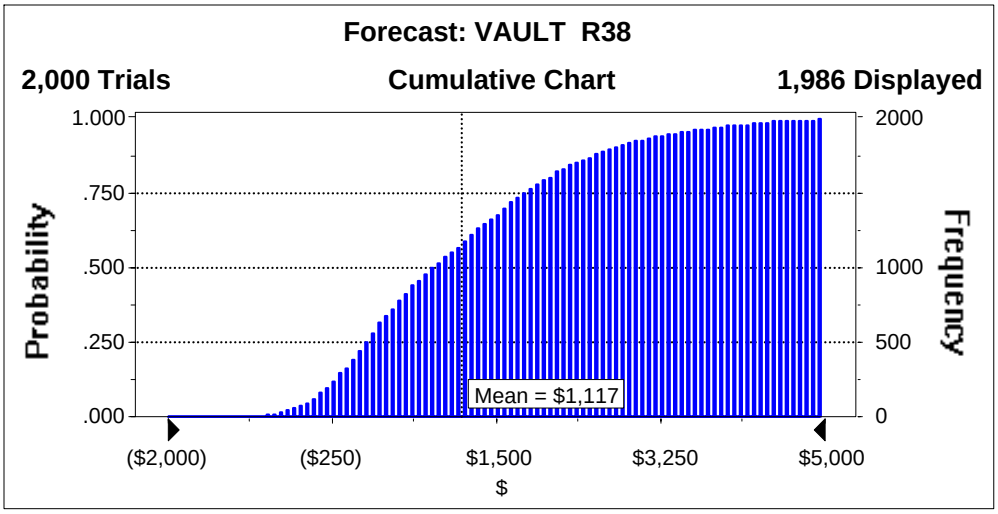

Figure G-187: Climate Zone 2 Net Present Value Results for Manufactured Homes for R38 Vaults

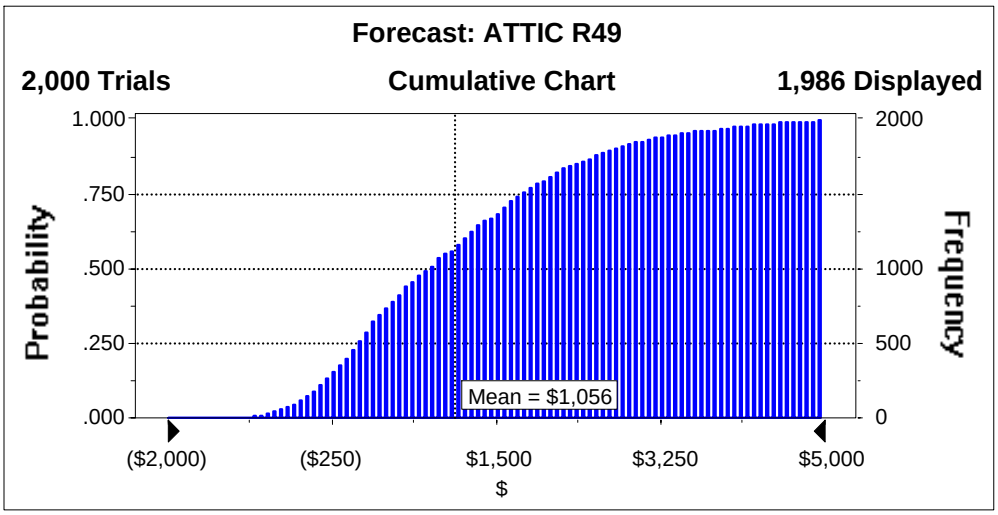

Figure G-188: Climate Zone 2 Net Present Value Results for Manufactured Homes for R49 Attics

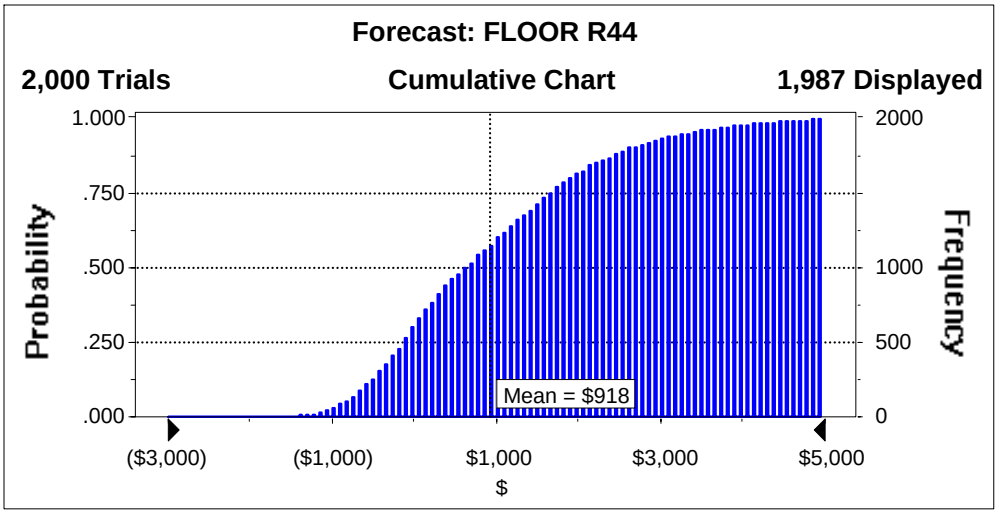

Figure G-189: Climate Zone 2 Net Present Value Results for Manufactured Homes for R44 Floors

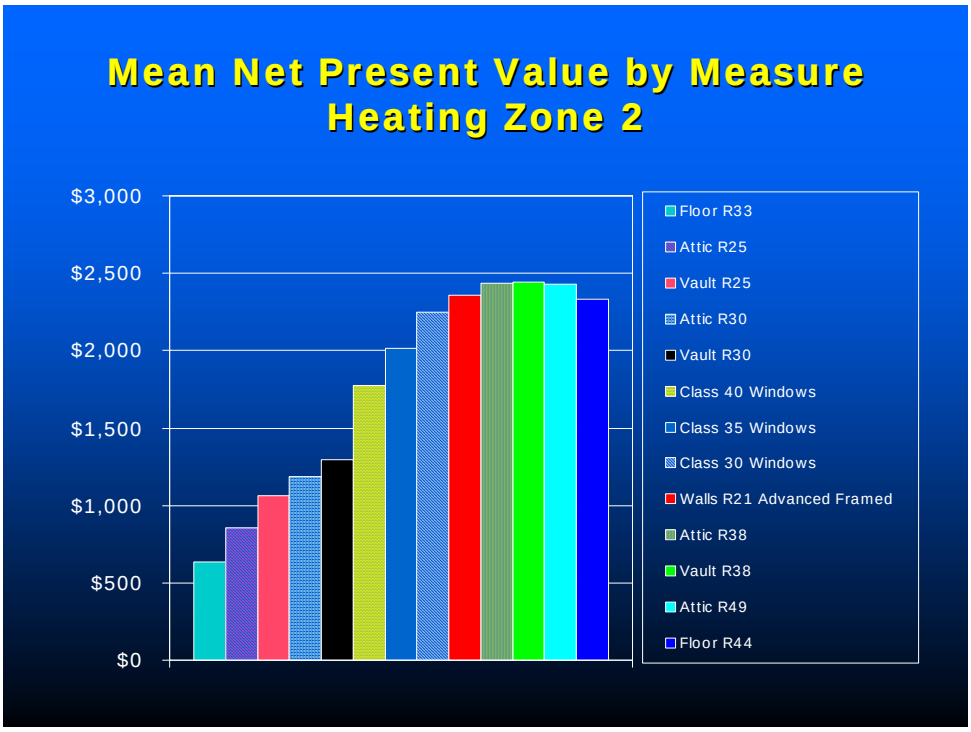

Figure G-190: Climate Zone 2 Expected Value Mean Net Present Value Results for Manufactured Homes

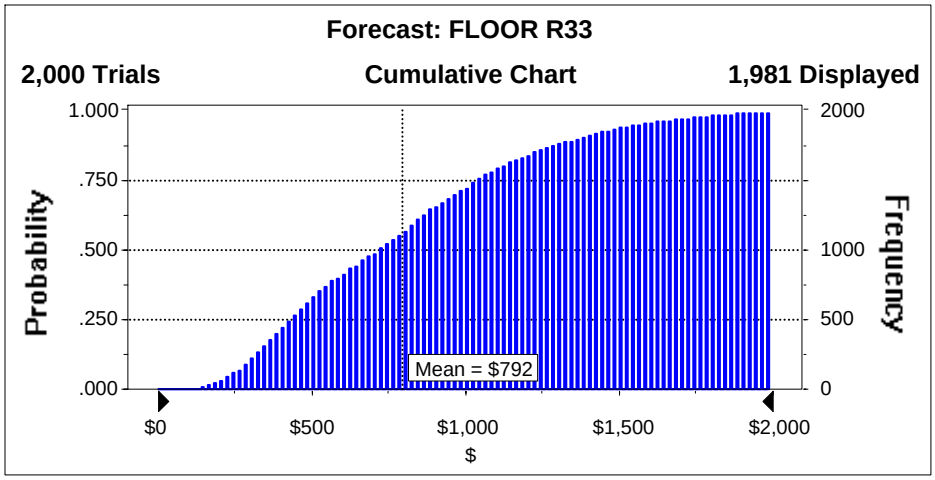

Figure G-191: Climate Zone 3 Net Present Value Results for Manufactured Homes for R33 Floors

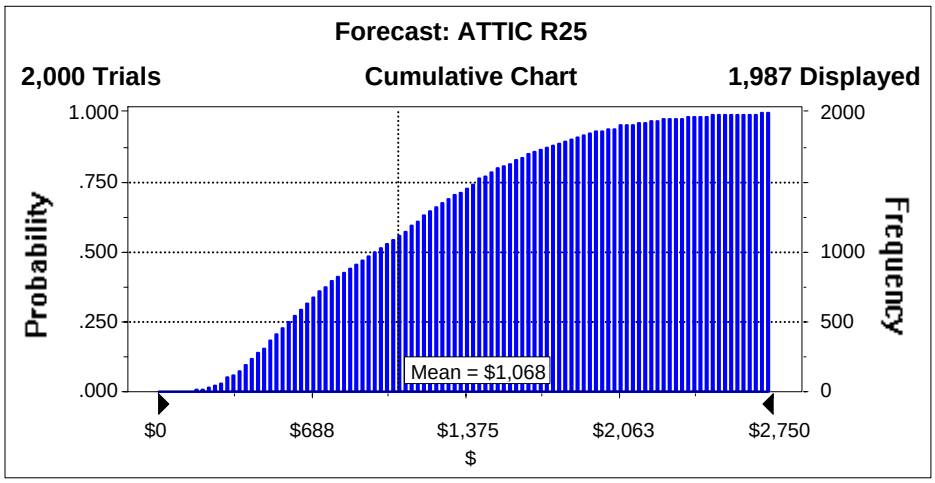

Figure G-192: Climate Zone 3 Net Present Value Results for Manufactured Homes for R25 Attics

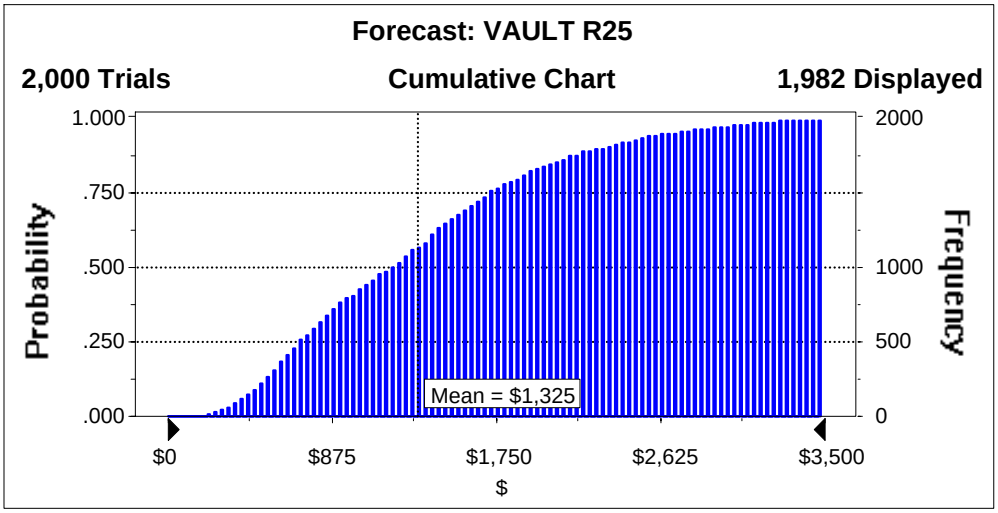

Figure G-193: Climate Zone 3 Net Present Value Results for Manufactured Homes for R25 Vaults

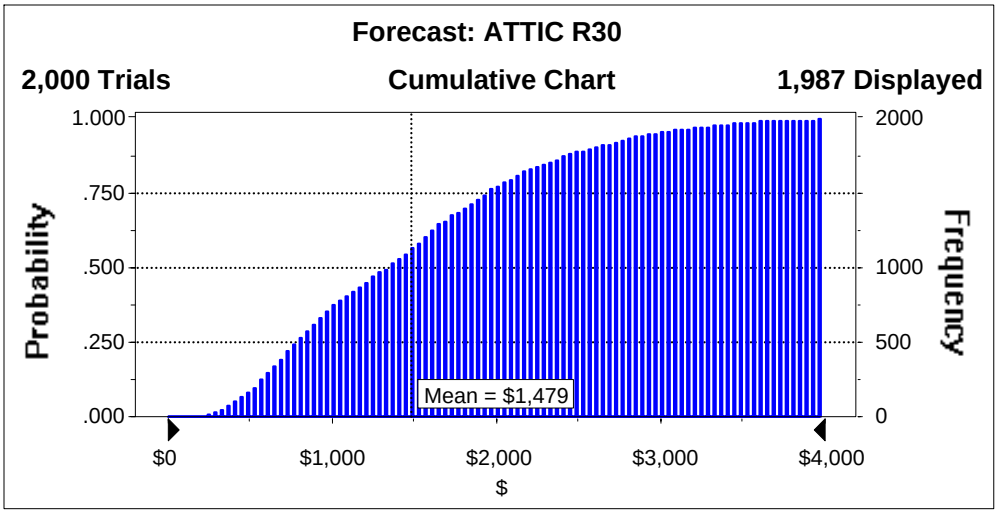

Figure G-194: Climate Zone 3 Net Present Value Results for Manufactured Homes for R30 Attics

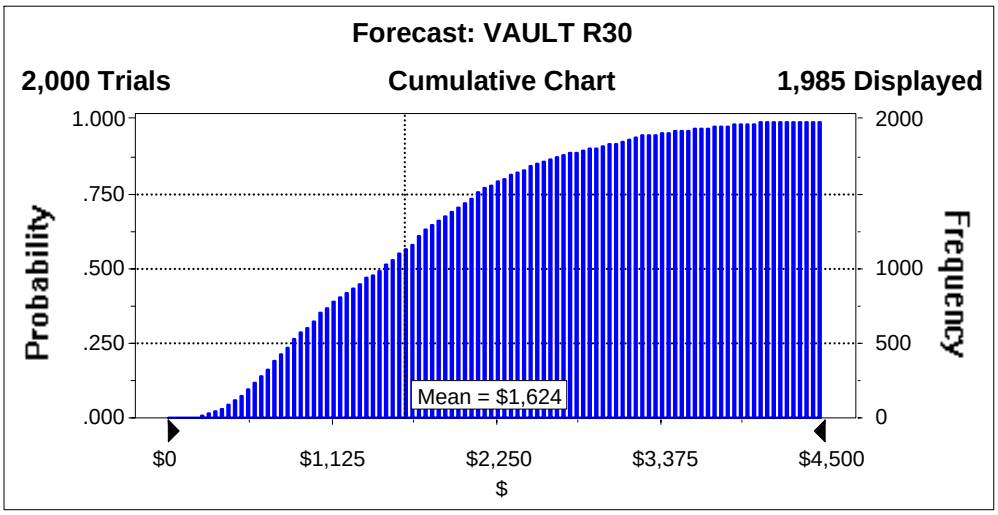

Figure G-195: Climate Zone 3 Net Present Value Results for Manufactured Homes for R30 Vaults

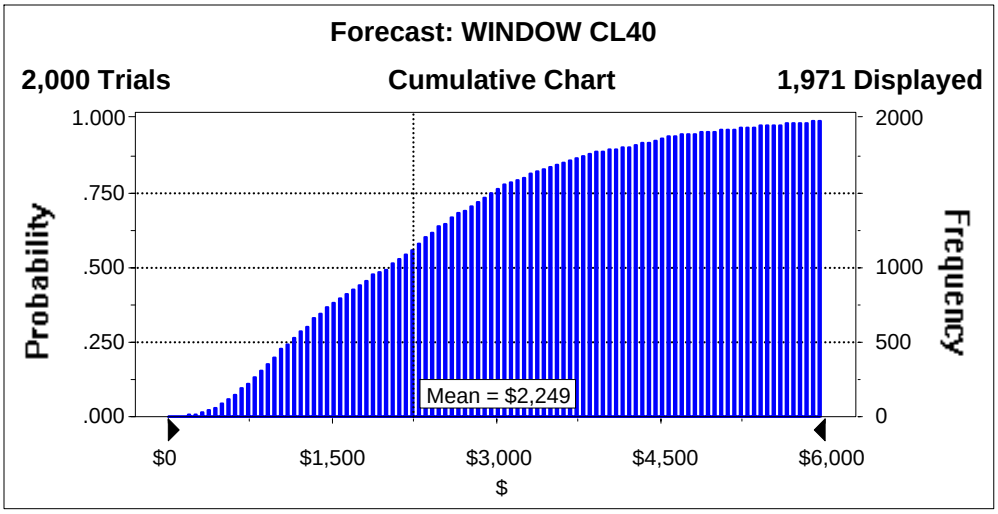

Figure G-196: Climate Zone 3 Net Present Value Results for Manufactured Homes for Class 40 Windows

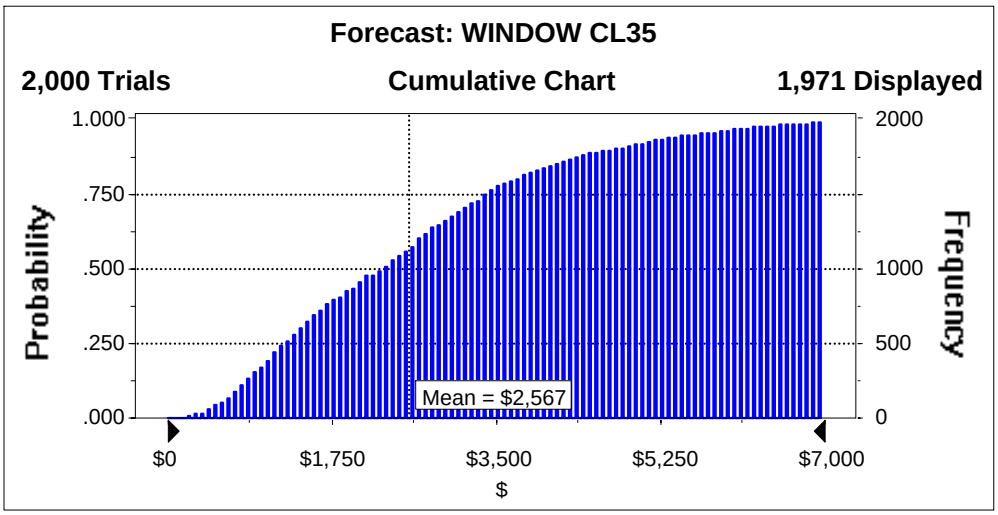

Figure G-197: Climate Zone 3 Net Present Value Results for Manufactured Homes for Class 35 Windows

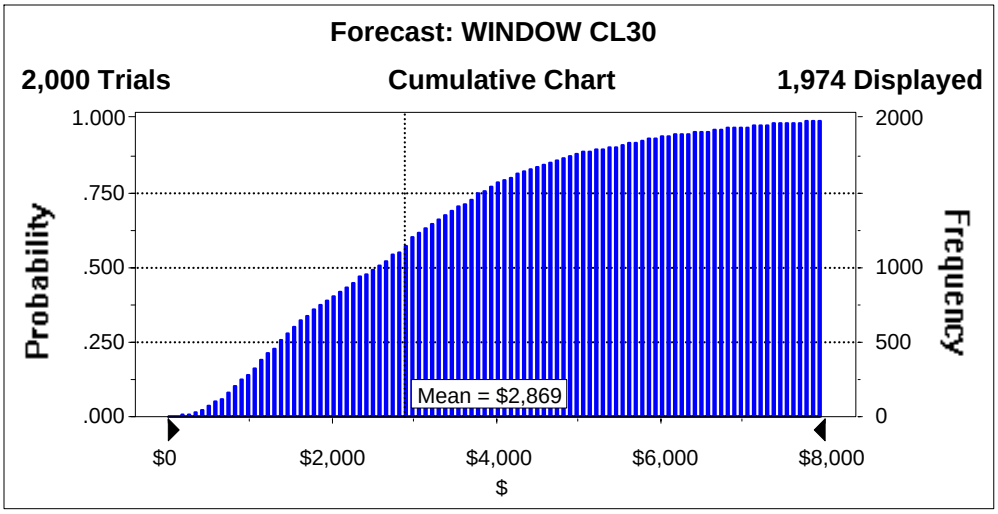

Figure G-198: Climate Zone 3 Net Present Value Results for Manufactured Homes for Class 30 Windows

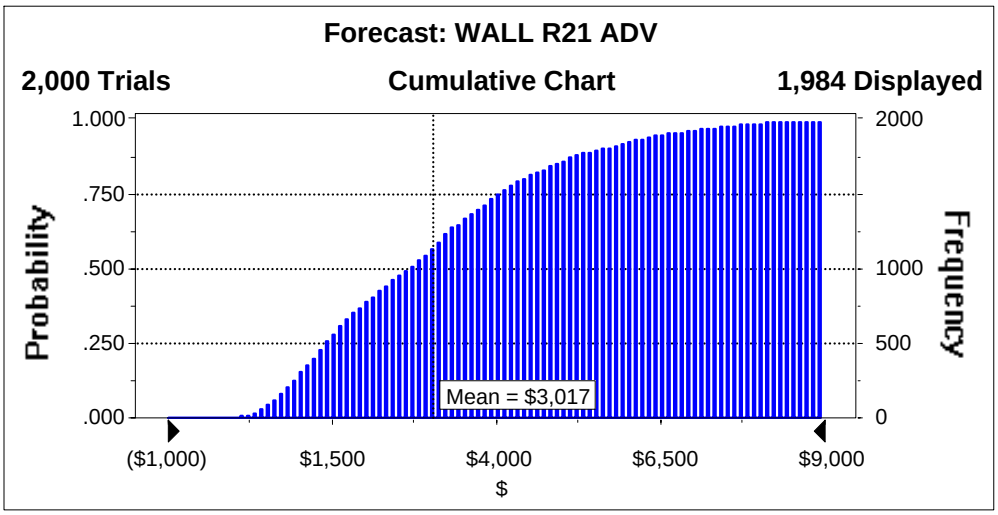

Figure G-199: Climate Zone 3 Net Present Value Results for Manufactured Homes for R21 Advanced Framed Walls

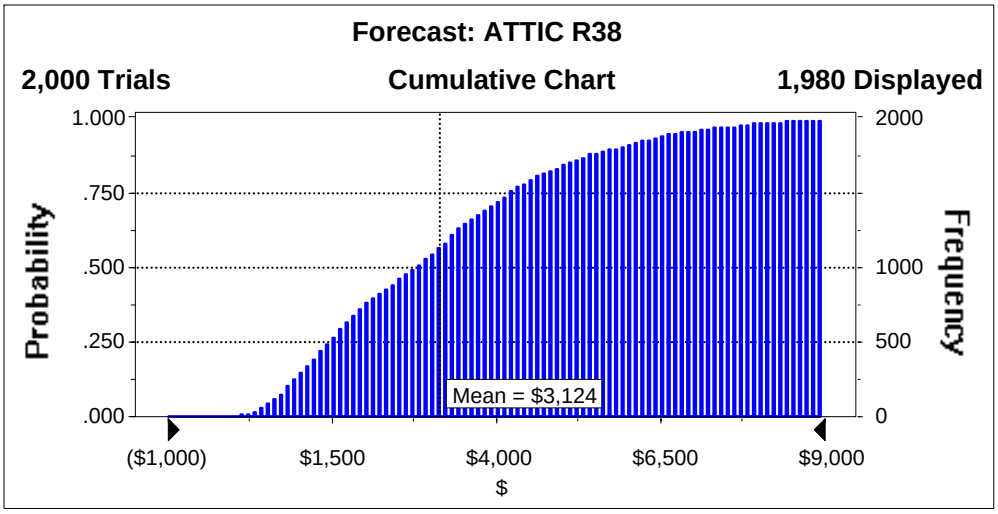

Figure G-200: Climate Zone 3 Net Present Value Results for Manufactured Homes for R38 Attics

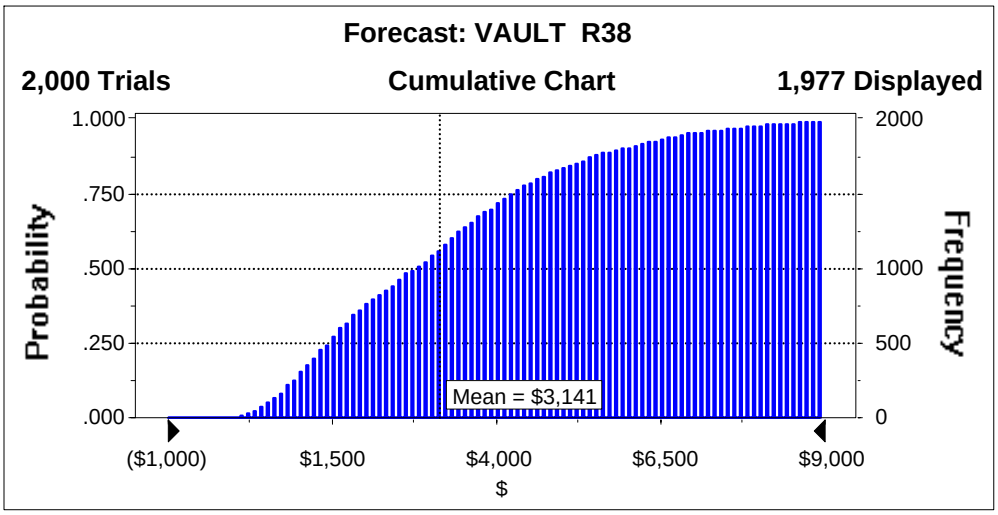

Figure G-201: Climate Zone 3 Net Present Value Results for Manufactured Homes for R38 Vaults

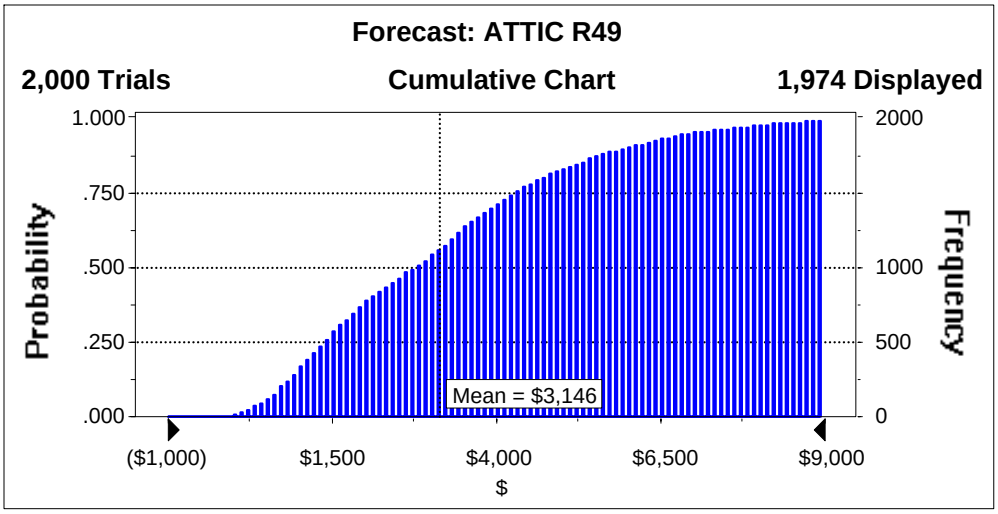

Figure G-202: Climate Zone 3 Net Present Value Results for Manufactured Homes for R49 Attics

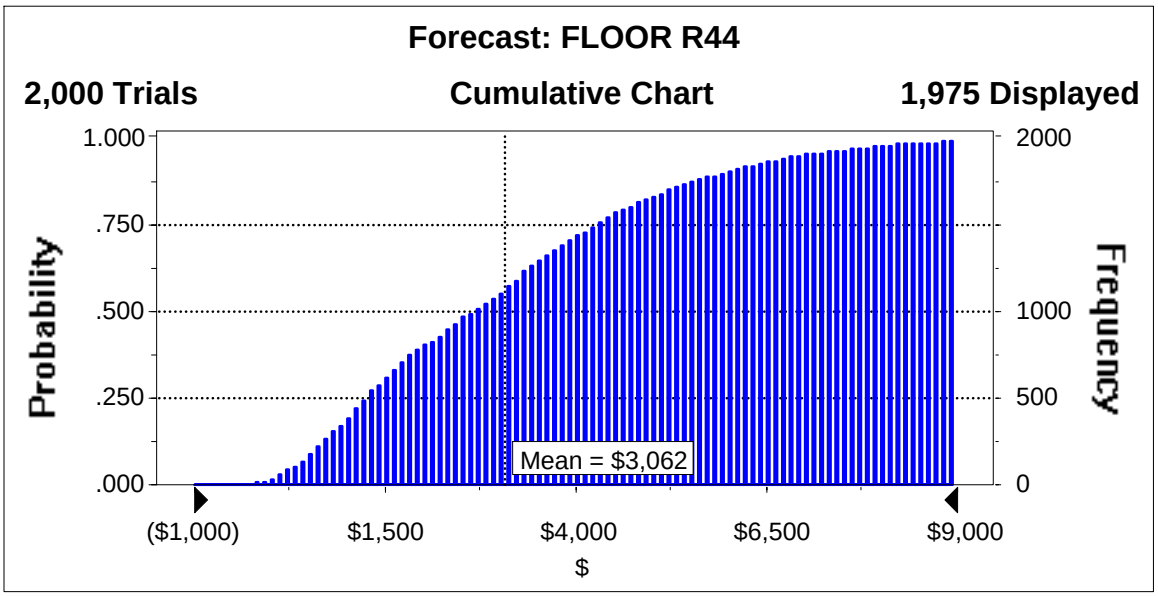

Figure G-203: Climate Zone 3 Net Present Value Results for Manufactured Homes for R44 Floors

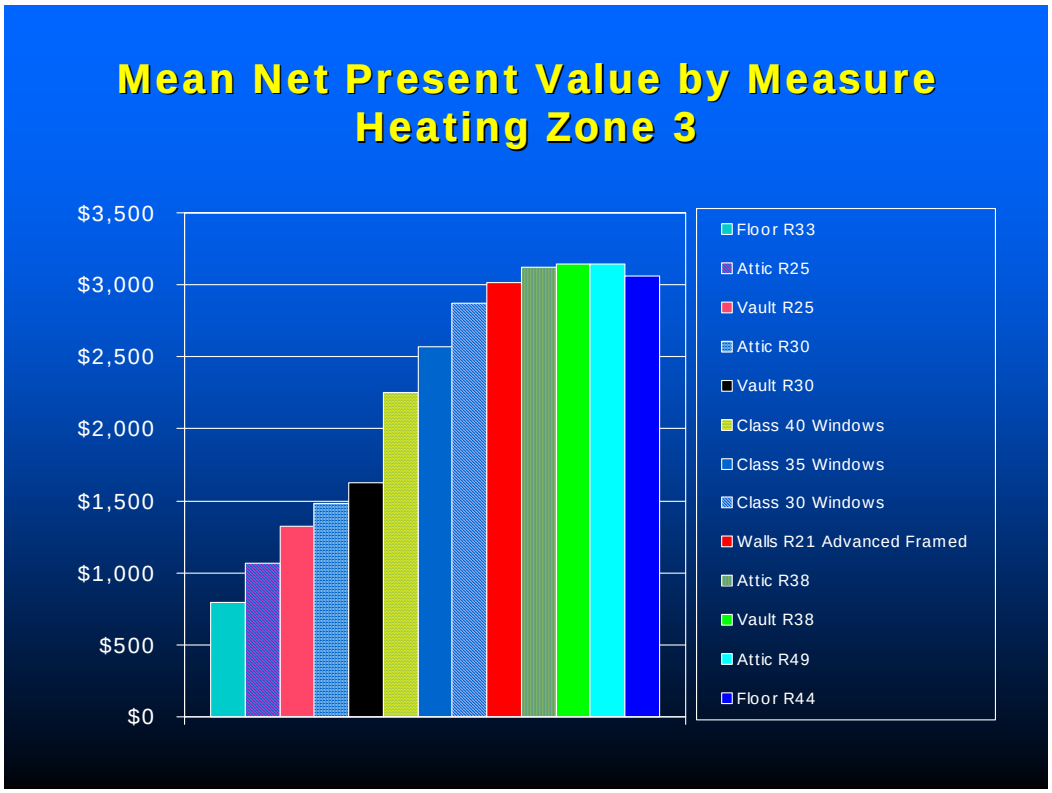

Figure G-204: Climate Zone 3 Expected Value Mean Net Present Value Results for Manufactured Homes

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