NYSERDA Residential Retrofit Impact Evaluation Report (PY2012—2016)

Final Report

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Appendix A: Detailed Results

This appendix delves more deeply into the program tracking data and billing analysis. Specifically, it provides the following information for the three programs:

- Regression coefficients from the billing analysis models for each program and fuel
- Measure-specific estimates of program savings as derived from the program tracking databases
- Measure-specific estimates of achieved savings derived from the billing analysis, presented for informational purposes only due to small sample sizes and the challenges inherent in isolating the savings for individual measures when multiple measures where installed at the same time.

A.1 EmPower Regression Coefficients

The Impact Evaluation Contractor used regression analysis to estimate the program savings. They ran a single model by program and fuel type with yearly controls to produce annual savings estimates rather than running a separate model for each analysis year. The two approaches yield similar results with samples of this size, but one using model streamlines the analysis. See Section 3.3 for additional model information.

The regression coefficient estimates for the whole-home EmPower electric model,[1] as well as the standard error about that point estimate, are presented in **Table 1**. The table presents the estimates by year of installation in the second column and an aggregated program estimate in the third column. The parameter estimates are all negative in sign indicating program savings and are significant at 90/10. The degree day variable estimates are positive and significant indicating that average consumption increases during hotter or colder days. The adjusted R^2 is 0.80 for the electric models meaning the models explain 80% of the variability in the daily electric consumption. The results yield estimates of daily savings, which the Impact Evaluation Contractor then aggregates to annual savings estimates.

[1] This analysis employs two main models: the whole-home model and the measure-specific model. In the whole-home model, the variable of interest captures the impact of the program for the entire home. The measure-specific model captures the impact for the different measure categories installed through the program. Refer to Section **Error! Reference source not found.** for more information.

Table 1: EmPower Electric Fixed Effect Results by Year [a, b, c]
(Dependent variable is kWh per day)

Variables	Estimates by Year (kWh per day)	Estimates – Aggregated (kWh per day)
All Installations		-1.4991*
		(0.1489)
2012 Installations	-1.6927*	
	(0.1539)	
2013 Installations	-1.6011*	
	(0.3615)	
2014 Installations	-1.5366*	
	(0.1522)	
2015 Installations	-0.9895*	
	(0.1869)	
2016 Installations	-1.3534*	
	(0.2191)	
Average Daily HDDs	0.2249*	0.2238*
	(0.0169)	(0.0172)
Average Daily CDDs	0.6691*	0.6680*
	(0.0946)	(0.0948)
Constant	16.3820*	16.5115*
	(0.8014)	(0.8028)
N Observations	444,834	444,834
Adj. R-square	0.8027	0.8027

[a] Robust standard errors in parentheses
[b] * p < 0.10
[c] Model includes 13 ancillary homes. When compared to model results with homes excluded from the analysis, the 13 homes have little impact on overall results.

The regression coefficient estimates for the whole-home EmPower natural gas model are presented in **Table 2**.[2] The table presents the estimates by year of installation and an aggregated program estimate for 2012 to 2016. The parameter estimates are all negative in sign indicating program savings and are significant at 90/10. A positive and significant heating degree day estimate shows that average consumption increases on cooler days. The model explains 79% of

[2] This analysis employs two main models: the whole-home model and the measure-specific model. In the whole-home model, the variable of interest captures the impact of the program for the entire home. The measure-specific model captures the impact for the different measure categories installed through the program. Refer to Section **Error! Reference source not found.** for more information.

the variability in the daily natural gas consumption, indicated by the adjusted R^2. The results yield estimates of daily savings, which the Impact Evaluation Contractor then aggregates to annual savings estimates.

Table 2: EmPower Natural Gas Fixed Effect Results by Year [a, b, c]
(Dependent variable is MMBtu per day)

Variables	Estimates by Year (MMBtu per day)	Estimates – Aggregated (MMBtu per day)
All Installations		-0.0337*
		(0.0013)
2012 Installations	-0.0350*	
	(0.0028)	
2013 Installations	-0.0387*	
	(0.0021)	
2014 Installations	-0.0312*	
	(0.0018)	
2015 Installations	-0.0293*	
	(0.0023)	
2016 Installations	-0.0389*	
	(0.0035)	
Average Daily HDDs	0.0110*	0.0110*
	(0.0001)	(0.0001)
Constant	0.1889*	0.1901*
	(0.0123)	(0.0124)
N Observations	235,472	235,472
Adj. R-square	0.7873	0.7873

[a] Robust standard errors in parentheses
[b] * $p < 0.10$
[c] Model includes 55 ancillary homes. When compared to model results with homes excluded from the analysis, the 55 homes have little impact on overall results.

A.2 EmPower Electric Measure Results

The program tracking data identified EmPower reported savings and, sometimes, increased usage for each fuel type and measure type. **Table 3** lists project completion year and measure category and percent of total savings and total increased use by measure category. The table excludes RGGI funded measures, which are addressed separately in Appendix C. This assessment reports measure savings funded by EEPS2 Electric and Gas. CFLs and LEDs (42% of reported savings) have the highest savings followed by refrigerator replacement savings (27% of reported savings).

Building envelope was expected to increase electric usage by an estimated 0.2 MWh (Error! Reference source not found.the negative sign indicates increased usage).

Table 3: EmPower Electric Program Reported Annual Savings and Increased Use (MWh) for EEPS2 Funded Measures [a, b]

Measure Category	2012	2013	2014	2015	2016	Total	Percent of Total Savings
CFL/LED	2,553	4,079	3,913	4,266	2,174	16,985	42%
Refrigerator	2,801	3,989	2,627	929	498	10,845	27%
Envelope	448	865	853	835	342	3,343	8%
Hot water	503	731	715	650	303	2,902	7%
Freezer	613	816	443	181	71	2,124	5%
Clothes Dryer	372	369	345	302	107	1,495	4%
Heating	72	243	305	417	301	1,337	3%
Hardwired Lighting	318	391	284	233	90	1,317	3%
Other	68	208	97	34	12	418	1%
Savings Total	**7,748**	**11,691**	**9,582**	**7,847**	**3,898**	**40,765**	**100%**
Envelope – Increased use	0	0	0	0	-0.2	-0.2	100%
Increased Use Total	**0**	**0**	**0**	**0**	**-0.2**	**-0.2**	**100%**

[a] Program savings does not include savings from sources other than EEPS2. Refer to Appendix C for savings from RGGI funded measures.
[b] Savings may not sum to total due to errors in rounding.

Table 4 below provides evaluated and program-reported savings and associated RRs for major measure categories across the full 2012 to 2016 time period. The RRs are presented for informational purposes only but may be useful for identifying underachieving measures. Freezers have the highest aggregated RR at 0.80 while lighting measures had the lowest RR at 0.43.

Table 4: For Informational Purposes Only - EmPower Electric Model Measure-Specific Program Annual Savings

Measure Category	Number of Homes in Analysis	Evaluated Savings per Home (kWh) (A)	Program Reported Savings per Home (kWh) (B)	RR (A/B)	Significant at 90/10
Lighting	11,240	178	416	0.43	Yes
Refrigerators	3,325	440	763	0.58	Yes
Envelope	145	3,304	5,773	0.57	Yes
Hot Water	1,533	439	716	0.61	Yes
Freezer	900	524	657	0.80	Yes
Clothes dryer	372	1,416	1,922	0.74	Yes
Primary Heating	64	3,731	7,144	0.52	Yes

Table 5 to **Table 11** present evaluated measure-specific savings. The variability in the yearly measure-level regression results and statistical significance within a measure category could be attributed to simultaneous installation of multiple measures, and to small samples associated with installation of less common measures (or both), making it difficult to tease apart the effect of specific measures. Therefore, the RRs are for informational purposes only and are not recommended for use in future program planning but may be useful for identifying underachieving measures.

Table 5: For Informational Purposes Only - EmPower Electric Model Measure-Specific Program Annual Savings – Lighting

Year	Number of Homes in Analysis	Evaluated Savings per Home (kWh)	Program Reported Savings per Home (kWh)	RR	Significant at 90/10
2012	1,798	126	385	0.33	Yes
2013	2,492	296	451	0.66	Yes
2014	3,251	240	412	0.58	Yes
2015	1,785	48	401	0.12	No
2016	1,914	147	421	0.35	Yes
Aggregated[a]	11,240	178	416	0.43	Yes

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

Table 6: For Informational Purposes Only - EmPower Electric Model Measure-Specific Program Annual Savings – Refrigerators

Year	Number of Homes in Analysis	Evaluated Savings per Home (kWh)	Program Reported Savings per Home (kWh)	RR	Significant at 90/10
2012	841	620	751	0.83	Yes
2013	1,087	257	764	0.34	No
2014	931	351	813	0.43	Yes
2015	219	594	717	0.83	Yes
2016	247	736	645	1.14	Yes
Aggregated[a]	3,325	440	763	0.58	Yes

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

Table 7: For Informational Purposes Only - EmPower Electric Model Measure-Specific Program Annual Savings – Envelope

Year	Number of Homes in Analysis	Evaluated Savings per Home (kWh)	Program Reported Savings per Home (kWh)	RR	Significant at 90/10
2012	11	51	7,814	0.01	No
2013	26	8,778	7,569	1.16	No
2014	44	1,353	6,495	0.21	Yes
2015	28	2,115	3,726	0.57	Yes
2016	36	3,181	4,562	0.70	Yes
Aggregated[a]	145	3,304	5,773	0.57	Yes

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

Table 8: For Informational Purposes Only - EmPower Electric Model Measure-Specific Program Annual Savings – Hot Water

Year	Number of Homes in Analysis	Evaluated Savings per Home (kWh)	Program Reported Savings per Home (kWh)	RR	Significant at 90/10
2012	285	316	575	0.55	Yes
2013	392	-112	562	-0.20	No
2014	549	448	677	0.66	Yes
2015	177	998	1,219	0.82	Yes
2016	130	1,572	966	1.63	Yes
Aggregated[a]	1,533	439	716	0.61	Yes

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

Table 9: For Informational Purposes Only - EmPower Electric Model Measure-Specific Program Annual Savings – Freezer

Year	Number of Homes in Analysis	Evaluated Savings per Home (kWh)	Program Reported Savings per Home (kWh)	RR	Significant at 90/10
2012	243	605	674	0.90	Yes
2013	309	513	668	0.77	Yes
2014	233	449	674	0.67	Yes
2015	50	106	615	0.17	Yes
2016	65	966	512	1.89	No
Aggregated[a]	900	524	657	0.80	Yes

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

Table 10: For Informational Purposes Only - EmPower Electric Model Measure-Specific Program Annual Savings – Clothes dryer

Year	Number of Homes in Analysis	Evaluated Savings per Home (kWh)	Program Reported Savings per Home (kWh)	RR	Significant at 90/10
2012	95	1,287	1,912	0.67	Yes
2013	96	1,225	1,935	0.63	Yes
2014	95	1,728	1,848	0.94	Yes
2015	63	1,457	1,945	0.75	Yes
2016	23	1,018	2,160	0.47	Yes
Aggregated[a]	372	1,416	1,922	0.74	Yes

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

Table 11: For Informational Purposes Only - EmPower Electric Model Measure-Specific Program Annual Savings – Primary Heating

Year	Number of Homes in Analysis	Evaluated Savings per Home (kWh)	Program Reported Savings per Home (kWh)	RR	Significant at 90/10
2012	7	4,786	8,550	0.56	Yes
2013	13	2,749	4,940	0.56	Yes
2014	18	4,976	9,875	0.50	Yes
2015	15	4,453	6,887	0.65	Yes
2016	11	2,571	4,737	0.54	Yes
Aggregated[a]	64	3,731	7,144	0.52	Yes

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

A.3 EmPower Natural Gas Measure Results

Table 12 lists the EmPower program-reported natural gas savings by project completion year and measure category and percent of total savings and total increased use by measure category. Building envelop measures which include air sealing, insulation, and programmable thermostats consist of almost all the savings (90% of reported savings) followed by heating replacement (6% of reported savings). Note that some measures, such as fuel switched domestic hot water and heating repairs, were expected to increase usage totaling 937 MMBtu Error! Reference source not found.the negative sign indicates increased usage).

Table 12: EmPower Natural Gas Program Reported Annual Savings and Increased Use (MMBtu) for EEPS2 Funded Measures [a, b, c]

Measure Category	2012	2013	2014	2015	2016	Total	Percent of Total Savings
Envelope	55,058	120,180	148,171	175,000	78,779	577,188	90%
Heating replacement	1,048	8,137	13,215	12,000	1,345	35,744	6%
Heating repair	1,215	3,287	2,322	4,814	1,384	13,023	2%
Hot Water	916	4,254	3,816	2,358	920	12,265	2%
Other	124	623	236	132	37	1,153	<1%
Savings Total	**58,361**	**136,482**	**167,760**	**194,304**	**82,466**	**639,373**	**100%**
Hot water – Increased use	0	0	-294	-318	-50	-662	71%
Heating Repair – Increased use	0	-5	-2	-82	-11	-100	11%
Envelope – Increased use	0	0	0	-44	-32	-76	8%
Heating Replacement – Increased use	0	0	-2	-2	-7	-11	1%
Other – Increased use	0	0	-48	-41	0	-88	9%
Increased Use Total	**0**	**-5**	**-346**	**-487**	**-100**	**-937**	**100%**

[a] Program savings does not include savings from sources other than EEPS2. Refer to Appendix C for savings from RGGI funded measures

[b] Program savings for homes that use natural gas for space and domestic hot water heating. Savings from homes that use other fuels for primary heating such as fuel oil, propane, or kerosene are excluded.

[c] Savings may not sum to total due to errors in rounding.

Table 13 provides evaluated and program-reported savings and associated RRs for major measure categories across the full 2012 to 2016 time period. The measure with the highest aggregated RR at 0.63 is heating replacement while clothes dryers had the lowest statistically significant RR at 0.28. Measure categories heating repair and hot water were not statistically significant.

Table 13: For Informational Purposes Only - EmPower Natural Gas Model Measure-Specific Program Annual Savings

Measure Category	Number of Homes in Analysis	Evaluated Total Savings per Home (MMBtu) (A)	Program Reported Savings per Home (MMBtu) (B)	RR (A/B)	Significant at 90/10
Envelope	5,120	13	29	0.44	Yes
Clothes dryer	256	-5	-17	0.28	Yes
Heating replacement	575	11	18	0.63	Yes
Heating repair	498	-1	5	-0.18	No
Hot water	1,540	1.07	-0.38	-0.40	No

Table 14 to **Table 18** present evaluated measure-specific savings. The variability in the yearly measure-level regression results and statistical significance within a measure category could be attributed to simultaneous installation of multiple measures, and to small samples associated with installation of less common measures (or both), making it difficult to tease apart the effect of specific measures. Therefore, the RRs are for informational purposes only and are not recommended for use in future program planning but may be useful for identifying underachieving measures.

Table 14: For Informational Purposes Only - EmPower Natural Gas Model Measure-Specific Program Annual Savings – Envelope

Year	Number of Homes in Analysis	Evaluated Total Savings per Home (MMBtu)	Program Reported Savings per Home (MMBtu)	RR	Significant at 90/10
2012	385	13	35	0.39	Yes
2013	839	15	32	0.46	Yes
2014	1,412	11	26	0.44	Yes
2015	1,742	11	29	0.37	Yes
2016	742	15	27	0.55	Yes
Aggregated[a]	5,120	13	29	0.44	Yes

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

Table 15: For Informational Purposes Only - EmPower Natural Gas Model Measure-Specific Program Annual Savings – Clothes Dryer [a]

Year	Number of Homes in Analysis	Evaluated Total Savings per Home (MMBtu)	Program Reported Savings per Home (MMBtu)	RR	Significant at 90/10
2012	48	-1	-11	0.05	No
2013	62	-2	-36	0.05	No
2014	62	-9	-11	0.84	Yes
2015	68	-7	-11	0.63	Yes
2016	16	-8	-13	0.63	Yes
Aggregated[b]	256	-5	-17	0.28	Yes

[a] The program switched out working electric dryers for natural gas dryers, hence the negative savings.

[b] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

Table 16: For Informational Purposes Only - EmPower Natural Gas Model Measure-Specific Program Annual Savings – Heating Replacement

Year	Number of Homes in Analysis	Evaluated Total Savings per Home (MMBtu)	Program Reported Savings per Home (MMBtu)	RR	Significant at 90/10
2012	20	17	23	0.72	Yes
2013	76	16	26	0.61	Yes
2014	215	13	18	0.76	Yes
2015	232	7	15	0.48	Yes
2016	32	8	10	0.79	Yes
Aggregated[a]	575	11	18	0.63	Yes

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

Table 17: For Informational Purposes Only - EmPower Natural Gas Model Measure-Specific Program Annual Savings – Heating Repair

Year	Number of Homes in Analysis	Evaluated Total Savings per Home (MMBtu)	Program Reported Savings per Home (MMBtu)	RR	Significant at 90/10
2012	33	-3	5	-0.62	No
2013	104	-1	5	-0.20	No
2014	78	1	6	0.19	No
2015	203	0	5	-0.07	No
2016	80	-4	3	-1.17	No
Aggregated[a]	498	-1	5	-0.18	No

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

Table 18: For Informational Purposes Only - EmPower Natural Gas Model Measure-Specific Program Annual Savings – Hot Water

Year	Number of Homes in Analysis	Evaluated Total Savings per Home (MMBtu)	Program Reported Savings per Home (MMBtu)	RR	Significant at 90/10
2012	130	1.07	-0.38	-2.83	No
2013	335	-0.07	0.33	-0.22	No
2014	504	-0.82	-0.54	1.51	No
2015	418	1.47	-0.69	-2.15	No
2016	153	0.62	-0.35	-1.76	No
Aggregated[b]	1,540	1.07	-0.38	-0.40	No

[a] The program tracking data does not differentiate MMBtu by fuel here, so it is likely much of the variability for this measure reflects increased usage of natural gas but decreased usage of fuel oil or other unregulated fuels.

[b] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

A.4 LIURP Regression Coefficients

The Impact Evaluation Contractor used regression analysis to estimate the program savings. They ran a single model with yearly controls to produce annual savings estimates rather than running a separate model for each analysis year. The two approaches yield similar results with samples of this size, but one using model streamlines the analysis. See Section 3.3 for additional model information.

Table 19 presents the whole-home regression coefficient estimates by year of installation and an aggregated program estimate for 2012 to 2016.[3] The parameter estimates are all negative in sign indicating program savings and are significant at 90/10. Positive and significant degree day variable estimates show that average consumption increases during hotter or colder days. The model explains 80% of the variability in the daily natural gas consumption, indicated by the adjusted R^2. The results yield estimates of daily savings, which the Impact Evaluation Contractor then aggregates to annual savings estimates.

[3] This analysis employs two main models: the whole-home model and the measure-specific model. In the whole-home model, the variable of interest captures the impact of the program for the entire home. The measure-specific model captures the impact for the different measure categories installed through the program. Refer to Section **Error! Reference source not found.** for more information.

Table 19: LIURP Natural Gas Fixed Effect Results by Year [a, b]
(Dependent variable is MMBtu per day)

Variables	Estimates by Year (MMBtu per day)	Estimates – Aggregated (MMBtu per day)
All Installations		-0.0591*
		(0.0022)
2012 Installations	-0.0588*	
	(0.0034)	
2013 Installations	-0.0611*	
	(0.0038)	
2014 Installations	-0.0592*	
	(0.0035)	
2015 Installations	-0.0547*	
	(0.0052)	
2016 Installations	-0.0426*	
	(0.0118)	
Average Daily HDDs	0.0143*	0.0143*
	(0.0002)	(0.0002)
Constant	0.1864*	0.1848*
	(0.0089)	(0.0088)
N Observations	94,754	94,754
Adj. R-square	0.7997	0.7997

[a] Robust standard errors in parentheses
[b] * $p < 0.10$

A.5 LIURP Natural Gas Measure Results

Table 20 lists the LIURP program-reported natural gas savings by project completion year and measure category and percent of total savings by measure category. Building envelop measures make up the majority of savings (95% of reported savings) followed by heating replacement (4% of reported savings). The table excludes EEPS2-funded projects completed in 2016 due to the small sample sizes.

Table 20: LIURP Natural Gas Program Reported Annual Savings (MMBtu) for NFGDC Funded Measures [a, b, c]

Measure Category	2012	2013	2014	2015	Total	Percent of Total Savings
Envelope	33,075	32,790	48,455	34,470	148,790	95%
Heating Replacement	405	503	2,603	2,060	5,571	4%
Heating Repair	180	346	186	331	1,043	1%
Hot Water	75	227	219	149	670	<1%
Other	66	0	154	0	220	<1%
Total	33,801	33,866	51,617	37,010	156,294	100%

[a] Program savings does not include savings from sources other than NFGDC (e.g. EEPS2, RGGI), which are captured by other analyses presented in this report.
[b] Program savings for homes that use natural gas for space and domestic hot water heating.
[c] Savings may not sum to total due to errors in rounding.

Table 21 reports evaluated and program-reported savings and associated RRs for major measure categories across the full 2012 to 2015 time period. The RRs are presented for informational purposes only but may be useful for identifying underachieving measures. The measure with the highest aggregated RR at 2.09 is hot water, while heating replacement had the lowest RR at 0.37. Heating repair was not statistically significant.

Table 21: For Informational Purposes Only - LIURP Natural Gas Model Measure-Specific Program Annual Savings

Measure Category	Number of Homes in Analysis	Evaluated Total Annual Savings per Home (MMBtu) (A)	Program Reported Annual Savings per Home (MMBtu) (B)	RR (A / B)	Significant at 90/10
Hot water	293	3	1	2.09	Yes
Envelope	1,996	21	41	0.52	Yes
Heating replacement	162	8	22	0.37	Yes
Heating repair	110	1	6	0.19	No

Table 22 to **Table 25** to present evaluated measure-specific savings, again excluding the handful of EEPS2-funded projects completed in 2016. The variability in the yearly measure-level regression results and statistical significance within a measure category could be attributed to simultaneous installation of multiple measures, and to small samples associated with installation of less common measures (or both), making it difficult to tease apart the effect of specific measures. Therefore, the RRs are for informational purposes only and are not recommended for use in future program planning but may be useful for identifying underachieving measures.

Table 22: For Informational Purposes Only - LIURP Natural Gas Model Measure-Specific Program Annual Savings – Envelope

Year	Number of Homes in Analysis	Evaluated Total Savings per Home (MMBtu)	Program Reported Savings per Home (MMBtu)	RR	Significant at 90/10
2012	351	21	50	0.42	Yes
2013	393	21	42	0.49	Yes
2014	754	21	38	0.56	Yes
2015	498	20	37	0.54	Yes
Aggregated[a]	1,996	21	41	0.52	Yes

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

Table 23: For Informational Purposes Only - LIURP Natural Gas Model Measure-Specific Program Annual Savings – Heating Replacement

Year	Number of Homes in Analysis	Evaluated Total Savings per Home (MMBtu)	Program Reported Savings per Home (MMBtu)	RR	Significant at 90/10
2012	9	18	27	0.67	Yes
2013	14	24	20	1.18	Yes
2014	82	8	21	0.37	Yes
2015	57	3	23	0.14	No
Aggregated[a]	162	8	22	0.37	Yes

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

Table 24: For Informational Purposes Only - LIURP Natural Gas Model Measure-Specific Program Annual Savings – Heating Repair

Year	Number of Homes in Analysis	Evaluated Total Savings per Home (MMBtu)	Program Reported Savings per Home (MMBtu)	RR	Significant at 90/10
2012	15	-3	7	-0.51	No
2013	34	3	7	0.42	No
2014	25	3	4	0.74	No
2015	36	-1	5	-0.19	No
Aggregated[a]	110	1	6	0.19	No

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

Table 25: For Informational Purposes Only - LIURP Natural Gas Model Measure-Specific Program Annual Savings – Hot Water

Year	Number of Homes in Analysis	Evaluated Total Savings per Home (MMBtu)	Program Reported Savings per Home (MMBtu)	RR	Significant at 90/10
2012	45	2	1	2.27	No
2013	52	7	3	2.10	Yes
2014	127	2	1	2.47	No
2015	69	2	1	1.58	No
Aggregated[a]	293	3	1	2.09	Yes

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

A.6 HPwES Regression Coefficients

The Impact Evaluation Contractor used regression analysis to estimate the program savings. They ran a single model by program and fuel type with yearly controls to produce annual savings estimates rather than running a separate model for each analysis year. The two approaches yield similar results with samples of this size, but one using model streamlines the analysis. See Section 3.3 for additional model information.

The regression coefficient estimates and associated standard errors for the HPwES whole-home model are presented in **Table 26**. The table presents the estimates by year of installation in the second column and an aggregated program estimate in the third column. Because AHPwES is a secondary stratification within the HPwES program, the model includes controls for HPwES and AHPwES to account for the separate program impacts. The parameter estimates of interest for

HPwES are negative in sign and are significant at 90/10 indicating program savings are statistically different from zero. However, while the impact estimate for the aggregate AHPwES (column 3) is statistically significant, it is only significant for 2012 and 2014 analysis years (column 2). While AHPwES generated significant savings over the span of study period, the model was not able to detect significant savings for 2013, 2015, and 2016. The average HPwES and AHPwES participants saved 2.14 kWh and 1.09 kWh per day, respectively. The degree day variable estimates are positive and significant indicating hotter or colder days are associated with higher electricity consumption. The 0.64 adjusted R^2 for the electric models means the models explain 64% of the variability in the daily electric consumption. The results yield estimates of daily savings, which the Impact Evaluation Contractor then aggregates to annual savings estimates.

The regression coefficient estimates for the HPwES whole-home model are shown in Table 27.[4] The program impact estimates are negative in sign and are significant at 90/10 indicating program savings for HPwES and AHPwES (a secondary stratification within the HPwES program). A positive estimate for the heating degree days variable indicates higher natural gas consumption during cooler days. The models explain 79% of the variability in the daily electric consumption, indicated by the 0.79 adjusted R^2.

[4] This analysis employs two main models: the whole-home model and the measure-specific model. In the whole-home model, the variable of interest captures the impact of the program for the entire home. The measure-specific model captures the impact for the different measure categories installed through the program. Refer to Section **Error! Reference source not found.** for more information.

Table 26: HPwES Electric Fixed Effect Results by Year [a, b]
(Dependent variable is kWh per day)

Variables	Estimates by Year (kWh per day)	Estimates – Aggregated (kWh per day)
HPwES Installations		-2.1350*
		(0.3067)
AHPwES Installations		-1.0948*
		(0.3225)
HPwES - 2012 Installations	-1.4633*	
	(0.4829)	
HPwES - 2013 Installations	-1.6856*	
	(0.5120)	
HPwES - 2014 Installations	-1.1258*	
	(0.5195)	
HPwES - 2015 Installations	-3.9716*	
	(0.8198)	
HPwES - 2016 Installations	-2.7479*	
	(1.0253)	
AHPwES - 2012 Installations	-1.7176*	
	(0.4879)	
AHPwES - 2013 Installations	-0.6653	
	(0.6062)	
AHPwES - 2014 Installations	-1.5881*	
	(0.5834)	
AHPwES - 2015 Installations	-0.9570	
	(0.6461)	
AHPwES - 2016 Installations	-1.7254	
	(1.2162)	
Average Daily HDDs	0.1966*	0.2007*
	(0.0308)	(0.0309)
Average Daily CDDs	0.9004*	0.9047*
	(0.1499)	(0.1501)
Constant	21.7654*	21.4188*
	(1.5386)	(1.5518)
N Observations	54,278	54,278
Adjusted R-square	0.6388	0.6385

[a] Robust standard errors in parentheses
[b] * $p < 0.10$

Table 27: HPwES Natural Gas Fixed Effect Results by Year [a, b]
(Dependent variable is MMBtu per day)

Variables	Estimates by Year (MMBtu per day)	Estimates – Aggregated (MMBtu per day)
HPwES Installations		-0.0362*
		(0.0013)
AHPwES Installations		-0.0407*
		(0.0018)
HPwES - 2012 Installations	-0.0415*	
	(0.0021)	
HPwES - 2013 Installations	-0.0353*	
	(0.0027)	
HPwES - 2014 Installations	-0.0347*	
	(0.0023)	
HPwES - 2015 Installations	-0.0299*	
	(0.0028)	
HPwES - 2016 Installations	-0.0310*	
	(0.0042)	
AHPwES - 2012 Installations	-0.0420*	
	(0.0037)	
AHPwES - 2013 Installations	-0.0552*	
	(0.0036)	
AHPwES - 2014 Installations	-0.0406*	
	(0.0033)	
AHPwES - 2015 Installations	-0.0279*	
	(0.0034)	
AHPwES - 2016 Installations	-0.0323*	
	(0.0053)	
Average Daily HDDs	0.0099*	0.0098*
	(0.0002)	(0.00012)
Constant	0.1984*	0.2019*
	(0.0096)	(0.0097)
N Observations	202,112	202,112
Adjusted R-square	0.7866	0.7865

[a] Robust standard errors in parentheses
[b] * $p < 0.10$

A.7 HPwES Electric Measure Results

Table 28 lists the HPwES program-reported electric savings by project completion year and measure category and percent of total savings by measure category. Building envelope (36% of reported savings), appliances and lighting (31% of reported savings), primary heating and cooling (18% of reported savings) make up the majority of the savings. Certain measures (e.g., primary heating and cooling measures installed in new load situations) were expected to increase electric usage by an estimated 1 MWh. HPwES provides RGGI funding for measures associated with unregulated fuels that do not qualify for EEPS2 Electric or Gas funding. Appendix C provides additional details on program savings and measures funded by RGGI.

Table 28: HPwES Electric Program Reported Annual Savings and Increased Use (MWh) for EEPS2 Funded Measures [a, b, c]

Measure Category	2012	2013	2014	2015	2016	Total	Percent of total savings
Envelope	154	157	205	298	98	911	36%
Appliances & Lighting	277	162	155	142	65	801	31%
Primary Heating and Cooling	211	106	41	71	41	471	18%
Hot Water	26	39	29	16	20	130	5%
No Category Assigned[d]	5	17	77	111	23	234	9%
Savings Total	**672**	**482**	**507**	**638**	**247**	**2,547**	**100%**
Primary Heating and Cooling – Increased use	-0.3	-0.7	0	0	0	-1	75%
Appliances & Lighting – Increased use	>-0.1	-0.1	0	0	0	-0.1	8%
Envelope – Increased use	0	>-0.1	>-0.1	0	0	>-0.1	3%
No Category Assigned – Increased use[d]	0	-0.2	0	0	0	-0.2	14%
Increased Use Total	**0**	**-1**	**0**	**0**	**0**	**-1**	**100%**

[a] Program savings does not include savings from sources other than EEPS2. Refer to Appendix C for savings from RGGI funded measures.
[b] Program savings does not include savings from AHPwES projects.
[c] Savings may not sum to total due to errors in rounding.
[d] Projects measures without an assigned measure category in the program tracking data.

Table 29 lists the AHPwES program-reported electric savings by project completion year and measure category and percent of total savings by measure category. Primary heating and cooling (39% of reported savings), appliances and lighting (28% of reported savings), and building envelope (16% of reported savings) make up the majority of the savings.

Table 29: AHPwES Electric Program Reported Annual Savings (MWh) for EEPS2 Funded Measures [a, b]

Measure Category	2012	2013	2014	2015	2016	Total	Percent of total savings
Primary Heating and Cooling	112	64	341	44	334	895	39%
Appliances & Lighting	138	86	134	257	16	631	28%
Envelope	20	31	176	136	13	376	16%
Hot Water	27	21	52	58	8	166	7%
Other	0	0	15	0	0	15	1%
No Category Assigned[c]	0	15	67	105	23	209	9%
Savings Total	**296**	**217**	**785**	**600**	**395**	**2,292**	**100%**

[a] Program savings does not include savings from sources other than EEPS2. Refer to Appendix C for savings from RGGI funded measures.
[b] Savings may not sum to total due to errors in rounding.
[c] Projects measures without an assigned measure category in the program tracking data.

Table 30 provides evaluated and program-reported savings and associated RRs for major measure categories across the full 2012 to 2016 time period. The analysis combined HPwES and AHPwES to maximize sample sizes and the information on which the estimates are based. Only the hot water and building envelope measure-categories showed statistically significant savings, with RRs at 1.09 and 0.64, respectively. Space heating and cooling and appliances, lighting, and other measure categories were not statistically significant. Appliances and lighting measures are often installed as part of a larger project and their impacts may be absorbed by larger measures such as building envelope.

Table 30: For Informational Purposes Only - HPwES Electric Model Measure-Specific Program Annual Savings (includes AHPwES)

Measure Category	Number of Homes in Analysis	Evaluated Total Savings per Home (kWh) (A)	Program Reported Savings per Home (kWh) (B)	RR (A / B)	Significant at 90/10
Envelope	762	669	1047	0.64	Yes
Hot water	239	668	614	1.09	Yes
Space heating	475	-273	817	-0.33	No
Cooling	138	-217	391	-0.55	No
Appliances, lighting, and other	909	-39	551	-0.07	No

Table 31 to **Table 35** present evaluated measure-specific savings. The variability in the yearly measure-level regression results and statistical significance within a measure category could be attributed to simultaneous installation of multiple measures, and to small samples associated with installation of less common measures (or both), making it difficult to tease apart the effect of specific measures. Therefore, the RRs are for informational purposes only and are not recommended for use in future program planning but may be useful for identifying underachieving measures.

Table 31: For Informational Purposes Only - HPwES Electric Model Measure-Specific Program Annual Savings (includes AHPwES) – Space Heating

Year	Number of Homes in Analysis	Evaluated Total Savings per Home (kWh)	Program Reported Savings per Home (kWh)	RR	Significant at 90/10
2012	124	2	660	<0.01	No
2013	58	-53	882	-0.06	No
2014	97	1,348	984	1.37	Yes
2015	142	725	813	0.89	No
2016	54	-265	813	-0.33	Yes
Aggregated[a]	475	-273	817	-0.33	No

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

Table 32: For Informational Purposes Only - HPwES Electric Model Measure-Specific Program Annual Savings (includes AHPwES) – Envelope

Year	Number of Homes in Analysis	Evaluated Total Savings per Home (kWh)	Program Reported Savings per Home (kWh)	RR	Significant at 90/10
2012	139	244	523	0.47	Yes
2013	106	258	915	0.28	Yes
2014	173	166	861	0.19	No
2015	239	350	1,592	0.22	Yes
2016	105	73	936	0.08	No
Aggregated[a]	762	669	1,047	0.64	Yes

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

Table 33: For Informational Purposes Only - HPwES Electric Model Measure-Specific Program Annual Savings (includes AHPwES) – Appliances, Lighting, and Other

Year	Number of Homes in Analysis	Evaluated Total Savings per Home (kWh)	Program Reported Savings per Home (kWh)	RR	Significant at 90/10
2012	215	1	655	<0.01	No
2013	160	105	476	0.22	No
2014	208	365	479	0.76	Yes
2015	235	499	503	0.99	Yes
2016	91	711	732	0.97	Yes
Aggregated[a]	909	-39	551	-0.07	No

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

Table 34: For Informational Purposes Only - HPwES Electric Model Measure-Specific Program Annual Savings (includes AHPwES) – Hot Water

Year	Number of Homes in Analysis	Evaluated Total Savings per Home (kWh)	Program Reported Savings per Home (kWh)	RR	Significant at 90/10
2012	40	937	257	3.65	Yes
2013	34	1,010	836	1.21	Yes
2014	61	699	814	0.86	Yes
2015	69	560	516	1.09	Yes
2016	35	1,388	651	2.13	Yes
Aggregated[a]	239	668	614	1.09	Yes

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

Table 35: For Informational Purposes Only - HPwES Electric Model Measure-Specific Program Annual Savings (includes AHPwES) – Cooling

Year	Number of Homes in Analysis	Evaluated Total Savings per Home (kWh)	Program Reported Savings per Home (kWh)	RR	Significant at 90/10
2012	22	346	100	3.47	No
2013	12	58	54	1.07	No
2014	21	-476	164	-2.91	No
2015	67	495	586	0.84	No
2016	16	770	529	1.46	No
Aggregated[a]	138	-217	391	-0.55	No

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

A.8 HPwES Natural Gas Measure Results

Table 36 lists the HPwES program-reported natural gas savings by project completion year and measure category and percent of total savings by measure category. Building envelop measures which include air sealing, insulation, and programmable thermostats (66% of reported savings) followed by primary heating and cooling (29% of reported savings) make up the majority of the savings. NYSERDA expected increased usage for such fuel switching measures as primary heating and domestic hot water totaling 146,123 MMBtu (Error! Reference source not found.the negative sign indicates increased usage). Likewise, some lighting and appliance measures were expected to lead to increased usage due to the waste heat penalty – the reduction of the waste heat from more efficient lighting and appliances means the heat will be substituted by the heating system.

Table 36: HPwES Natural Gas Program Reported Annual Savings and Increased Use (MMBtu) for EEPS2 Funded Measures [a, b, c, d]

Measure Category	2012	2013	2014	2015	2016	Total	Percent of total savings
Envelope	34,559	29,750	34,694	43,381	15,293	157,678	66%
Primary Heating and Cooling	20,024	12,935	12,859	17,696	7,089	70,603	29%
Hot Water	1,247	2,006	1,864	3,068	863	9,048	4%
Appliances & Lighting	2	0	0	0	0	2	<1%
No Category Assigned[e]	0	136	275	1,221	1,195	2,827	1%
Savings Total	**55,832**	**44,826**	**49,692**	**65,367**	**24,440**	**240,158**	**100%**
Primary Heating and Cooling – Increased Use	-627	-26,274	-41,905	-55,821	-10,171	-134,797	92%
Hot Water – Increased Use	-19	-1,610	-3,156	-3,992	-765	-9,543	7%
Envelope – Increased Use	-10	-1	0	-2	0	-13	<1%
Appliances & Lighting – Increased Use	0	-1	0	0	0	-1	<1%
No Category Assigned – Increased Use[e]	0	-129	-1	-557	-1,082	-1,770	1%
Increased Use Total	**-657**	**-28,014**	**-45,062**	**-60,372**	**-12,017**	**-146,123**	**100%**

[a] Program savings does not include savings from sources other than EEPS2. Refer to Appendix C for savings from RGGI funded measures
[b] Program savings does not include savings from AHPwES projects.
[c] Program savings for homes that use natural gas for space and domestic hot water heating. Savings from homes that use other fuels for primary heating such as fuel oil, propane, or kerosene are excluded.
[d] Savings may not sum to total due to errors in rounding.
[e] Projects measures without an assigned measure category in the program tracking data.

Table 37 lists the AHPwES program-reported natural gas savings by project completion year and measure category and percent of total savings by measure category. Building envelop measures which include air sealing, insulation, and programmable thermostats (51% of reported savings) followed by primary heating (43% of reported savings) make up the majority of the savings. NYSERDA expected increased usage for such fuel switching measures as primary heating and

domestic hot water totaling 71,103 MMBtu (Error! Reference source not found.the negative sign indicates increased usage). Like the HPwES program, some lighting and appliance measures were expected to lead to increased usage due to the waste heat penalty.

Table 37: AHPwES Natural Gas Program Reported Annual Savings and Increased Use (MMBtu) for EEPS2 Funded Measures [a, b, c]

Measure Category	2012	2013	2014	2015	2016	Total	Percent of total savings
Envelope	15,744	15,328	25,026	39,899	12,586	108,583	51%
Primary Heating	15,599	14,299	19,250	28,357	13,516	91,022	43%
Hot Water	708	1,399	1,280	5,085	3,352	11,823	6%
Appliances & Lighting	12	0	0	0	0	12	<1%
Other	0	0	0	9	0	9	<1%
No Category Assigned[d]	0	43	313	814	1,362	2,532	1%
Savings Total	**32,063**	**31,070**	**45,869**	**74,164**	**30,815**	**213,981**	**100%**
Primary Heating – Increased use	-390	-13,255	-23,248	-23,385	-5,311	-65,589	92%
Hot Water – Increased use	-54	-987	-1,665	-1,734	-392	-4,832	7%
Appliances & Lighting – Increased use	0	0	-4	0	0	-4	<1%
Envelope – Increased use	0	0	0	-1	0	-1	<1%
No Category Assigned – Increased use[d]	0	-8	-149	-205	-315	-676	1%
Increased Use Total	**-445**	**-14,250**	**-25,065**	**-25,325**	**-6,017**	**-71,103**	**100%**

[a] Program savings does not include savings from sources other than EEPS2. Refer to Appendix C for savings from RGGI funded measures
[b] Program savings for homes that use natural gas for space and domestic hot water heating. Savings from homes that use other fuels for primary heating such as fuel oil, propane, or kerosene are excluded.
[c] Savings may not sum to total due to errors in rounding.
[d] Projects measures without an assigned measure category in the program tracking data.

Table 38 provides evaluated and program-reported savings and associated RRs for major measure categories across the full 2012 to 2016 time period. The analysis combined HPwES and

AHPwES to maximize sample sizes and the information on which the estimates are based. The RRs are presented for informational purposes only but may be useful for identifying underachieving measures. The measure with the highest aggregated RR at 0.63 is hot water, with space heating yielding the lowest RR at 0.28.

Table 38: For Informational Purposes Only - HPwES Natural Gas Model Measure-Specific Program Annual Savings (includes AHPwES)

Measure Category	Number of Homes in Analysis	Evaluated Total Savings per Home (MMBtu)	Program Reported Savings per Home (MMBtu)	RR	Significant at 90/10
Hot water	746	3	5	0.63	Yes
Envelope	4,614	12	28	0.43	Yes
Space heating	1,980	5	17	0.28	Yes

Table 39 to **Table 41** present evaluated measure-specific savings. The variability in the yearly measure-level regression results and statistical significance within a measure category could be attributed to simultaneous installation of multiple measures, and to small samples associated with installation of less common measures (or both), making it difficult to tease apart the effect of specific measures. Therefore, the RRs are for informational purposes only and are not recommended for use in future program planning but may be useful for identifying underachieving measures.

Table 39: For Informational Purposes Only - HPwES Natural Gas Model Measure-Specific Program Annual Savings (includes AHPwES) – Envelope

Year	Number of Homes in Analysis	Evaluated Total Savings per Home (kWh)	Program Reported Savings per Home (kWh)	RR	Significant at 90/10
2012	823	13	29	0.45	Yes
2013	839	14	25	0.56	Yes
2014	1,072	13	28	0.48	Yes
2015	1,325	9	28	0.31	Yes
2016	555	9	28	0.33	Yes
Aggregated[a]	4,614	12	28	0.43	Yes

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

Table 40: For Informational Purposes Only - HPwES Natural Gas Model Measure-Specific Program Annual Savings (includes AHPwES) – Space Heating

Year	Number of Homes in Analysis	Evaluated Total Savings per Home (kWh)	Program Reported Savings per Home (kWh)	RR	Significant at 90/10
2012	382	3	19	0.17	Yes
2013	342	4	13	0.29	Yes
2014	451	3	17	0.19	Yes
2015	544	5	18	0.30	Yes
2016	261	7	20	0.35	Yes
Aggregated[a]	1,980	5	17	0.28	Yes

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

Table 41: For Informational Purposes Only - HPwES Natural Gas Model Measure-Specific Program Annual Savings (includes AHPwES) – Hot Water

Year	Number of Homes in Analysis	Evaluated Total Savings per Home (kWh)	Program Reported Savings per Home (kWh)	RR	Significant at 90/10
2012	113	5	3	1.58	Yes
2013	109	8	5	1.53	Yes
2014	152	-3	5	-0.71	No
2015	264	5	5	0.94	Yes
2016	108	0.7	5	0.16	No
Aggregated[a]	746	3	5	0.63	Yes

[a] Row reflects results from a separate regression modeling the aggregate impact of the program and savings may not equal the sum of the individual year savings.

Appendix B: Weather Analysis

This study examined the impact that the choice of weather data has on predicted energy savings. The engineering models used by Home Performance Contractors to estimate project savings use what is known as the Typical Meteorological Three (TMY3) dataset.[5] This dataset was designed to reflect what the weather generally is for a location, which aligns with the purpose of the engineering models to reflect the general energy savings projects will achieve. The TMY3 dataset, the most current TMY available, reflects the temperatures from 1991 to 2005 (updates to TMY3 have addressed factors that only tangentially affect heating and cooling variables). In contrast, the aim of impact evaluation studies is to describe actual usage; therefore, billing analysis conducted as part of impact studies almost always use the actual weather data recorded for the time period observed in the billing records. If the analysis has billing data for a customer from June 17, 2015 to June 16, 2017, the evaluator uses the weather data from the same period. Separate to this study, however, NYSERDA had been exploring the possibility that the TMY3 data was too old to reflect the more recent typical weather in the state. NYSERDA provided the Impact Evaluation Contractor with a weather dataset designed to replace TMY3; this dataset covered the period of January 2011 to December 2017. The Impact Evaluation Contractor then reran the models applied in this study using TMY3 data, NYSERDA's alternative weather dataset, and the actual weather for the time period under consideration. **Table 42** presents a summary of these results for EmPower, HPwES, and AHPwES.

The results indicate that RRs are generally higher using TMY3 than the replacement or than actual weather. This provides evidence to support the argument that differences in weather data serve affect evaluated savings estimates and RRs. For electric RRs, TMY3 data show a larger impact on the RRs for HPwES and AHPwES than for EmPower, as EmPower primarily funded lighting and appliance measures while HPwES and AHPwES also had substantial heating and cooling related electricity measures. On the natural gas side, TMY3 data produced slightly higher RR for all three programs.

Table 42: Summary of Programs' RRs by Weather Data Source

	Electric			Natural Gas		
Program	**Actual**	**TMY3 Replacement**	**TMY3**	**Actual**	**TMY3 Replacement**	**TMY3**
EmPower	0.58	0.57	0.58	0.44	0.44	0.46
HPwES	0.71	0.74	0.77	0.42	0.42	0.44
AHPwES	0.61	0.63	0.65	0.43	0.42	0.44

[5] For more information on TMY3, refer to https://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/

Appendix C: RGGI Funded Measures

Table 43 lists the EmPower program-reported electric savings for projects funded by RGGI. Hot water measures (42% of reported savings) have the highest savings followed by building envelope savings (32% of reported savings). Some RGGI-funded measures resulted in *increased* use, totaling 65 MWh (not shown).

Table 43: EmPower Electric Program Annual Reported Savings (MWh) for RGGI Funded Measures [a]

Measure Category	2012	2013	2014	2015	2016	Total	Percent of Total Savings
Hot water	<1	-	2	30	14	46	42%
Envelope	-	-	2	20	13	35	32%
Heating replacement	-	-	<1	2	8	10	10%
Dryer	-	-	-	5	1	6	6%
Heating repair	-	-	-	-	<1	<1	<1%
Other	-	-	5	4	2	11	10%
Total	<1	-	9	61	38	108	100%

Table 44 reports the EmPower program-reported natural gas savings for projects funded by RGGI. The majority of the savings came from building envelope (69%) and heating replacement (28%) measures. Some RGGI-funded measures resulted in increased use, totaling 19 MMBtu (not shown).

Table 44: EmPower Natural Gas Program Annual Reported Savings (MMBtu) for RGGI Funded Measures [a]

Measure Category	2012	2013	2014	2015	2016	Total	Percent of Total Savings
Envelope	184	317	207	2,046	2,782	5,535	69%
Heating replacement	-	-	17	118	2,137	2,273	28%
Heating repair	-	-	-	18	112	130	2%
Hot water	24	8	3	12	5	51	1%
Other	-	-	-	-	3	3	<1%
Total	207	325	227	2,195	5,038	7,992	100%

Table 45 presents the HPwES (including AHPwES) program-reported electric savings for projects supplemented by RGGI. Building envelope and hot water measures generated the almost all the savings

(48% and 42% of reported savings). A subset of RGGI-funded measures resulted in increased use of 168 MWh (not shown).

Table 45: Home Performance Electric Program Annual Reported Savings (MWh) for RGGI Funded Measures [a]

Measure Category	2012	2013	2014	2015	2016	Total	Percent of Total Savings
Envelope	91	187	247	275	132	932	48%
Hot water	91	199	163	257	109	819	42%
Primary heating	33	41	33	35	21	163	8%
Appliances and lighting	6	<1	0	<1	<1	7	<1%
Other	7	3	5	3	4	22	1%
Total	228	430	448	570	266	1,943	100%

Table 44 lists the EmPower program-reported natural gas savings for projects funded by RGGI. Building envelope measures generated the majority of the savings (88%). Certain RGGI-funded measures resulted in increased use of 36,722 MMBtu primarily from fuel switching away from unregulated fuels to natural gas for primary heating, shown in **Table 47**.

Table 46: Home Performance Natural Gas Program Annual Reported Savings (MMBtu) for RGGI Funded Measures [a]

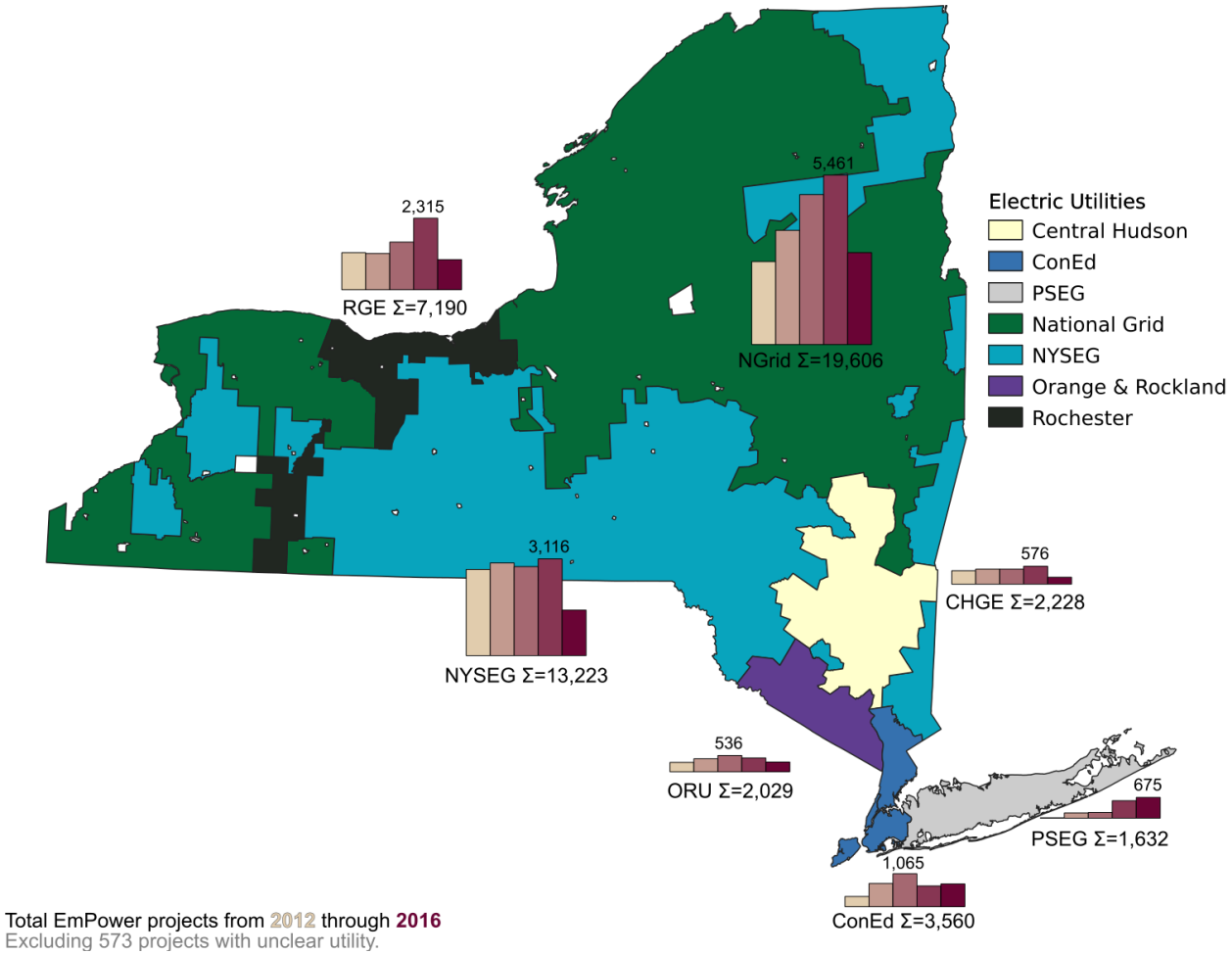
Measure Category	2012	2013	2014	2015	2016	Total	Percent of Total Savings
Envelope	866	565	773	1,109	11,988	15,301	83%
Primary heating	518	49	91	67	1,606	2,331	13%
Hot water	90	59	14	29	375	567	3%
Other	1	0	0	51	98	150	1%
Total	1,475	673	878	1,256	14,067	18,349	100%

Table 47: Home Performance Natural Gas Program Annual Reported Increased Use (MMBtu) for RGGI Funded Measures [a]

Measure Category	2012	2013	2014	2015	2016	Total	Percent of Total Savings
Primary heating	-22,085	-3,666	-382	-151	-6,371	-32,655	89%
Hot water	-1,407	-243	-27	-67	-688	-2,432	7%
Lighting	-1	0	0	0	0	-1	0%
Envelope	0	<-1	0	0	0	<-1	0%
Other	-94	0	0	0	-1,540	1,634	4%
Total	-23,587	-3,909	-409	-218	-8,599	-36,722	100%

Appendix D: Program Maps by Territory

Figure 1: EmPower Projects by Utility Territory and Year – Electric



Total EmPower projects from 2012 through 2016
Excluding 573 projects with unclear utility.

Figure 2: EmPower Projects by Utility Territory and Year - Gas

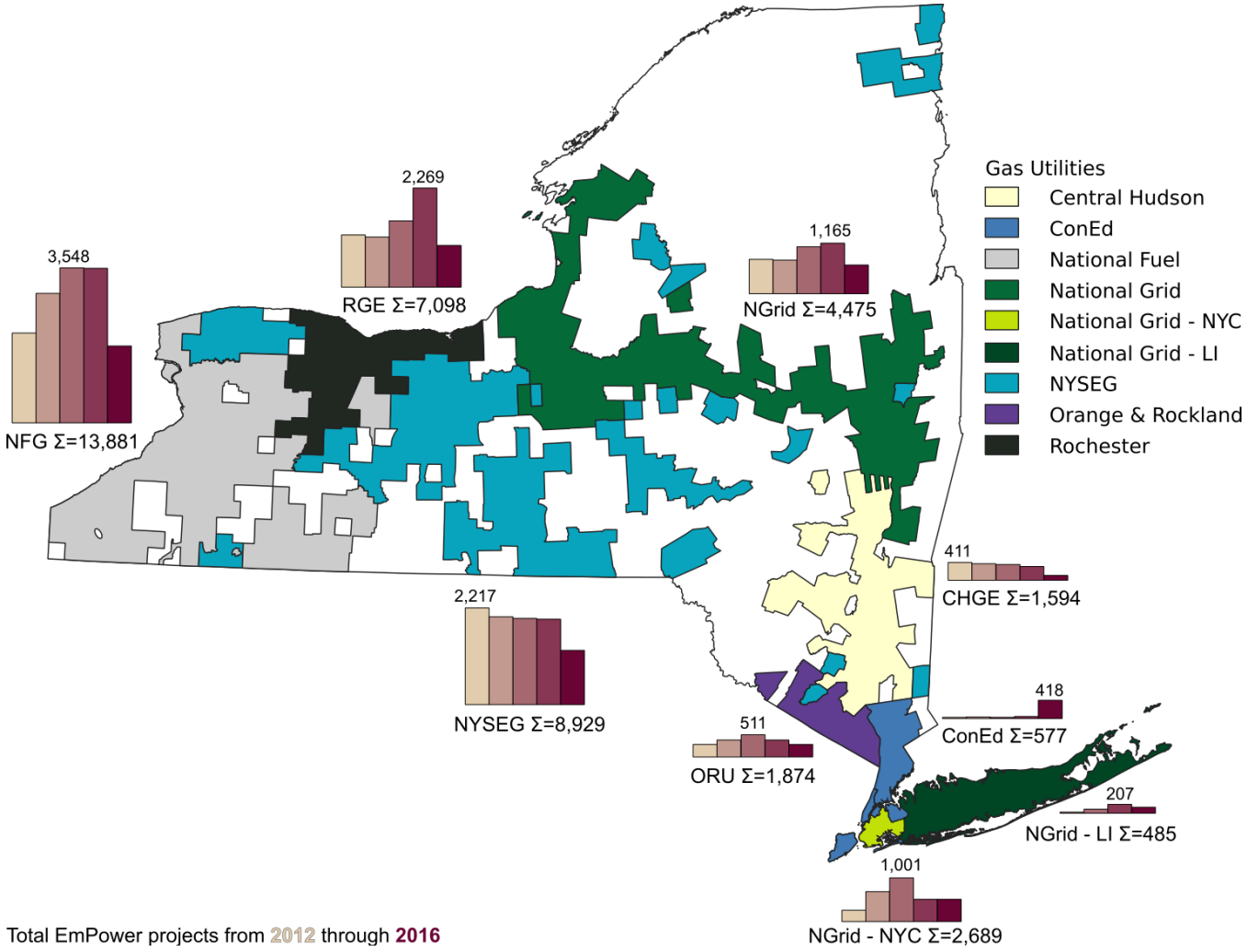
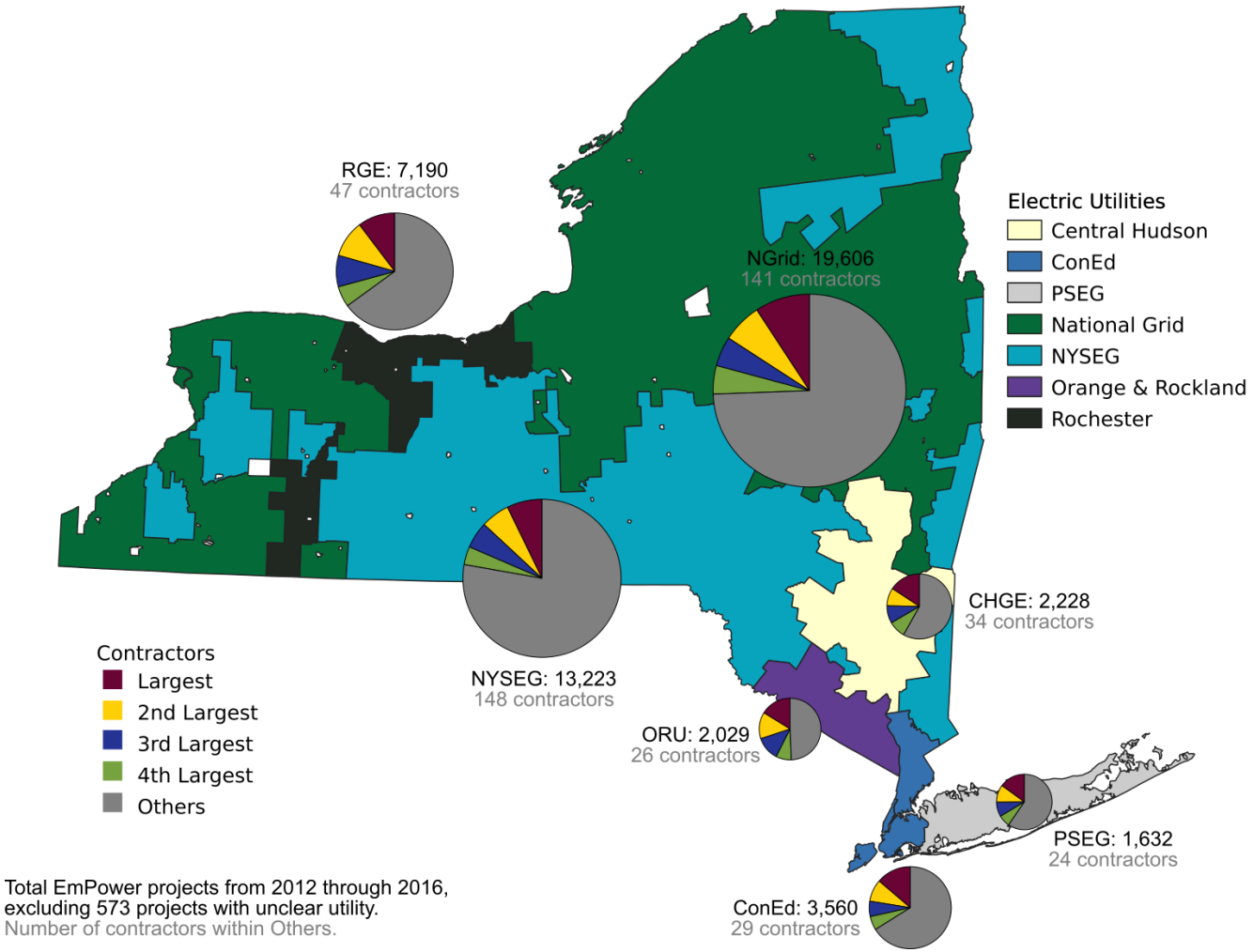


Figure 3: EmPower Projects by Utility Territory and Contractor - Electric



Total EmPower projects from 2012 through 2016, excluding 573 projects with unclear utility.
Number of contractors within Others.

Figure 4: EmPower Projects by Utility Territory and Contractor – Gas

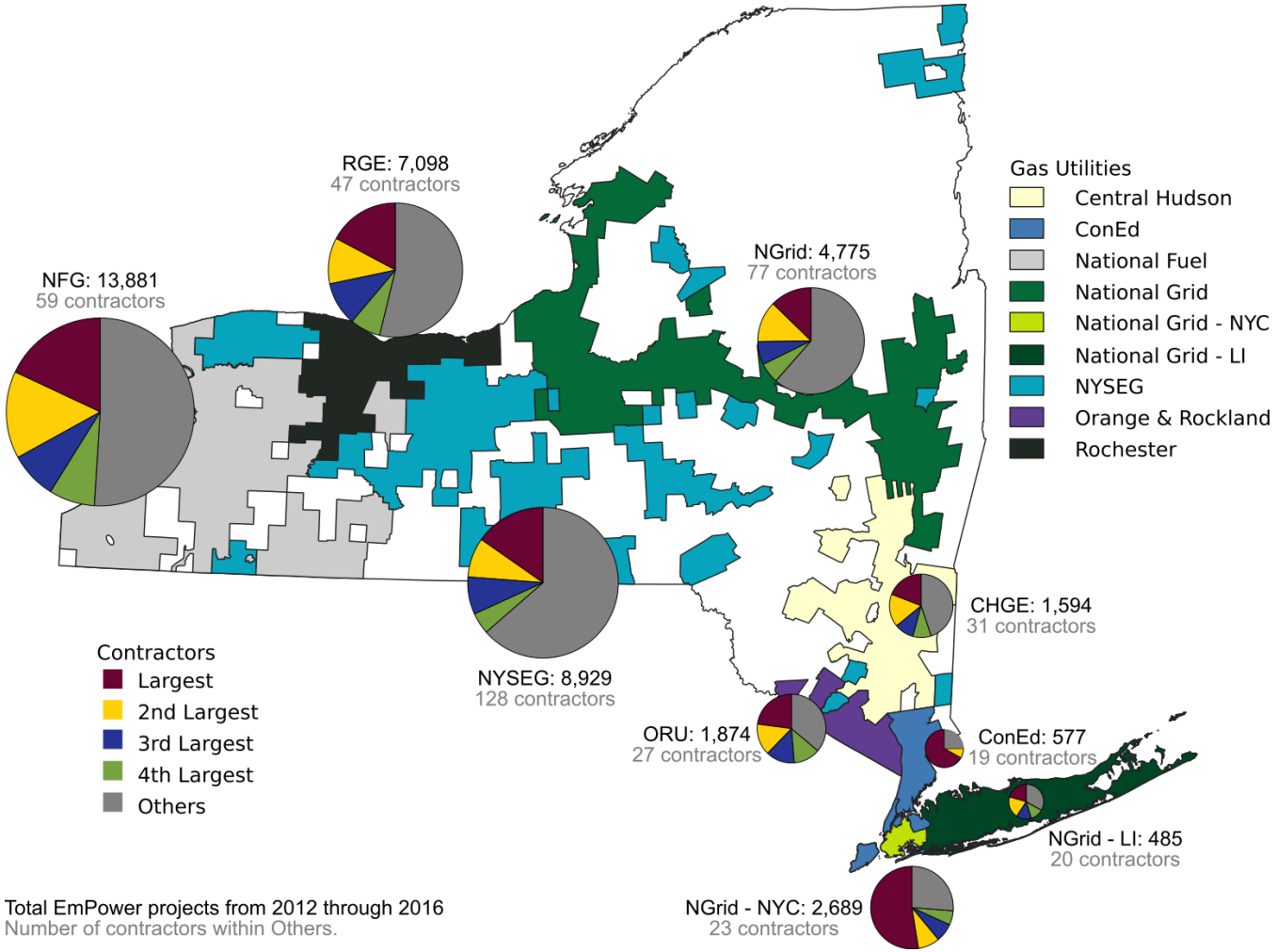


Figure 5: HPwES Projects by Utility Territory and Year – Electric

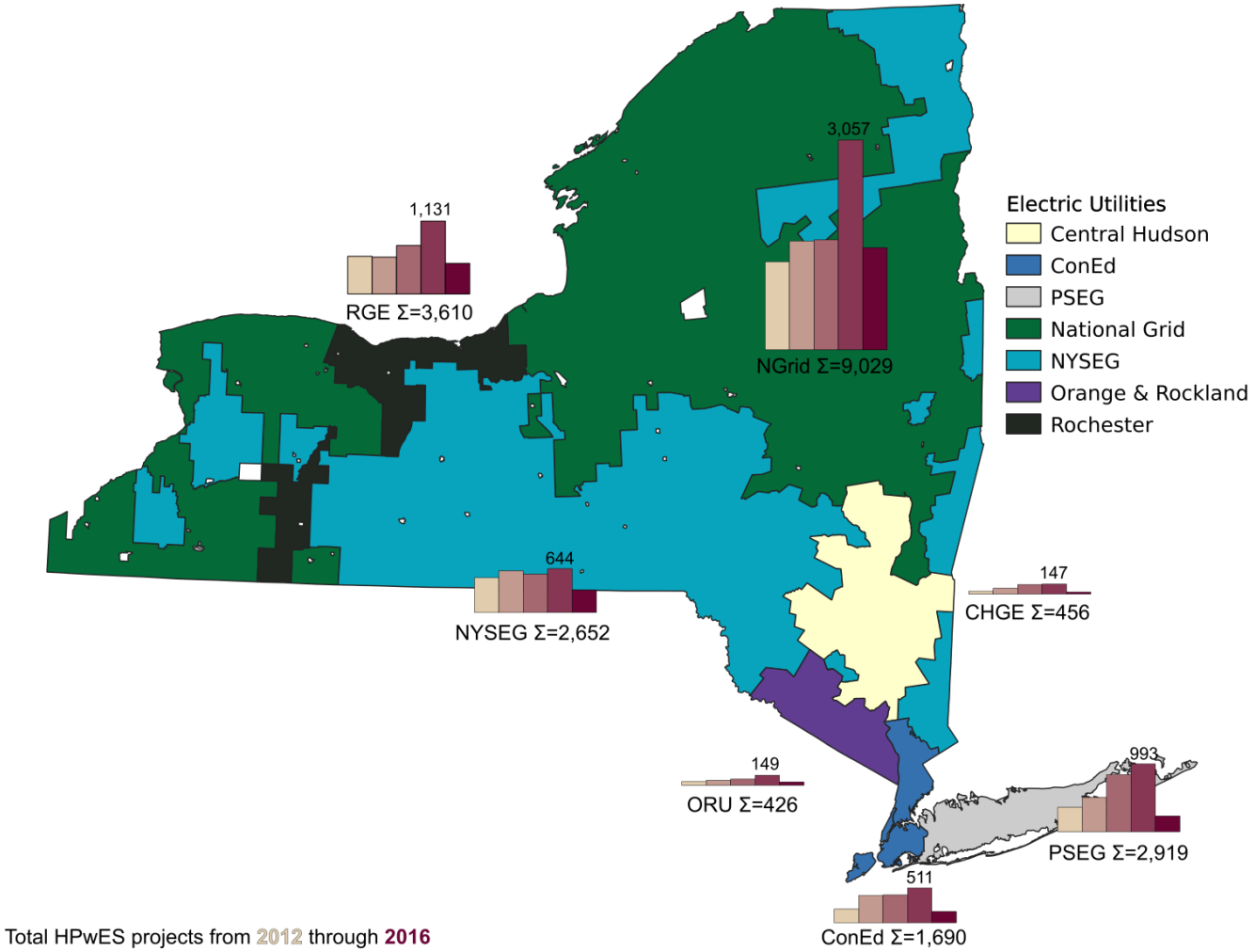
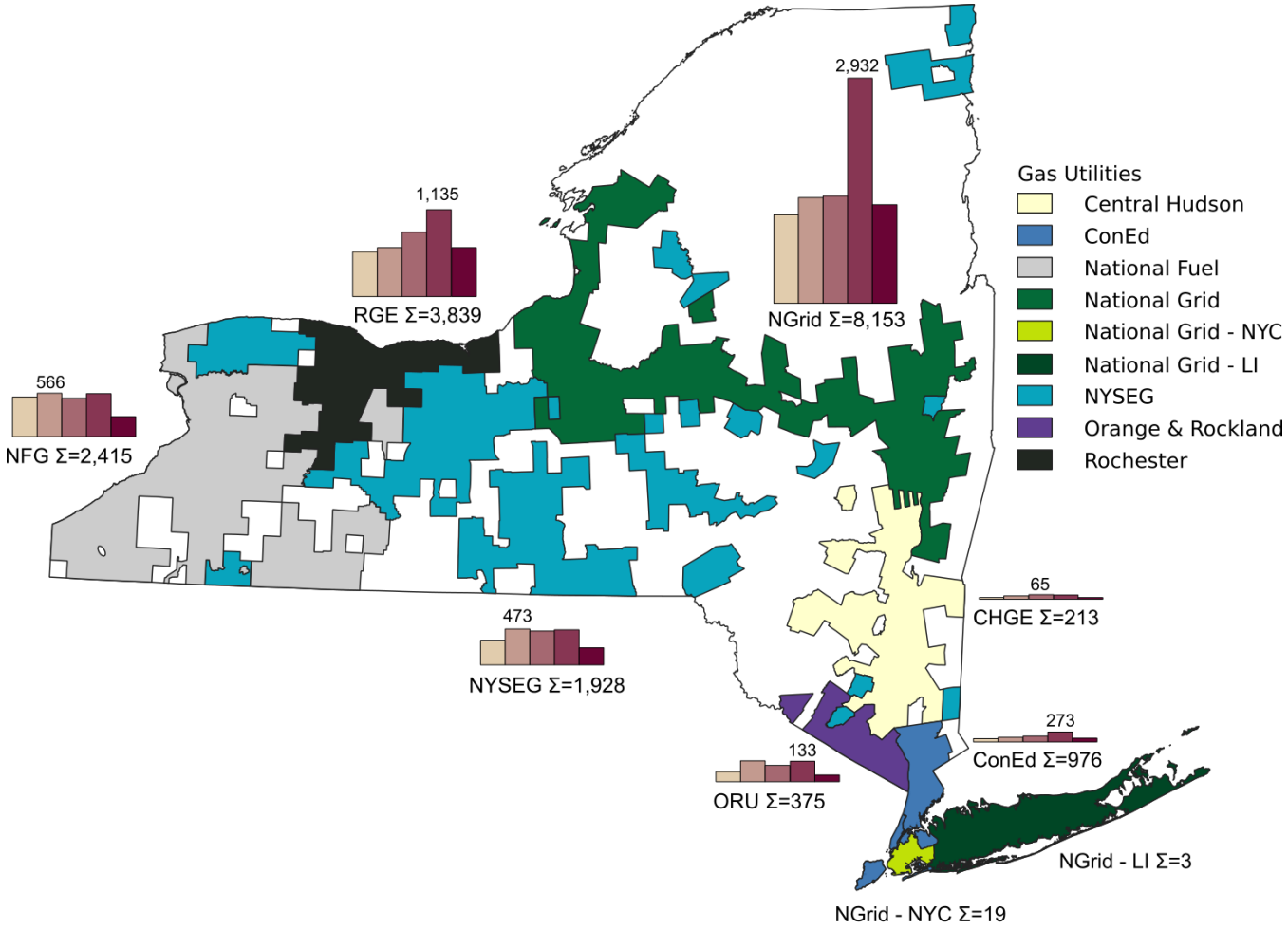


Figure 6: HPwES Projects by Utility Territory and Year – Gas



Total HPwES projects from 2012 through 2016

Figure 7: HPwES Projects by Utility Territory and Contractor – Electric

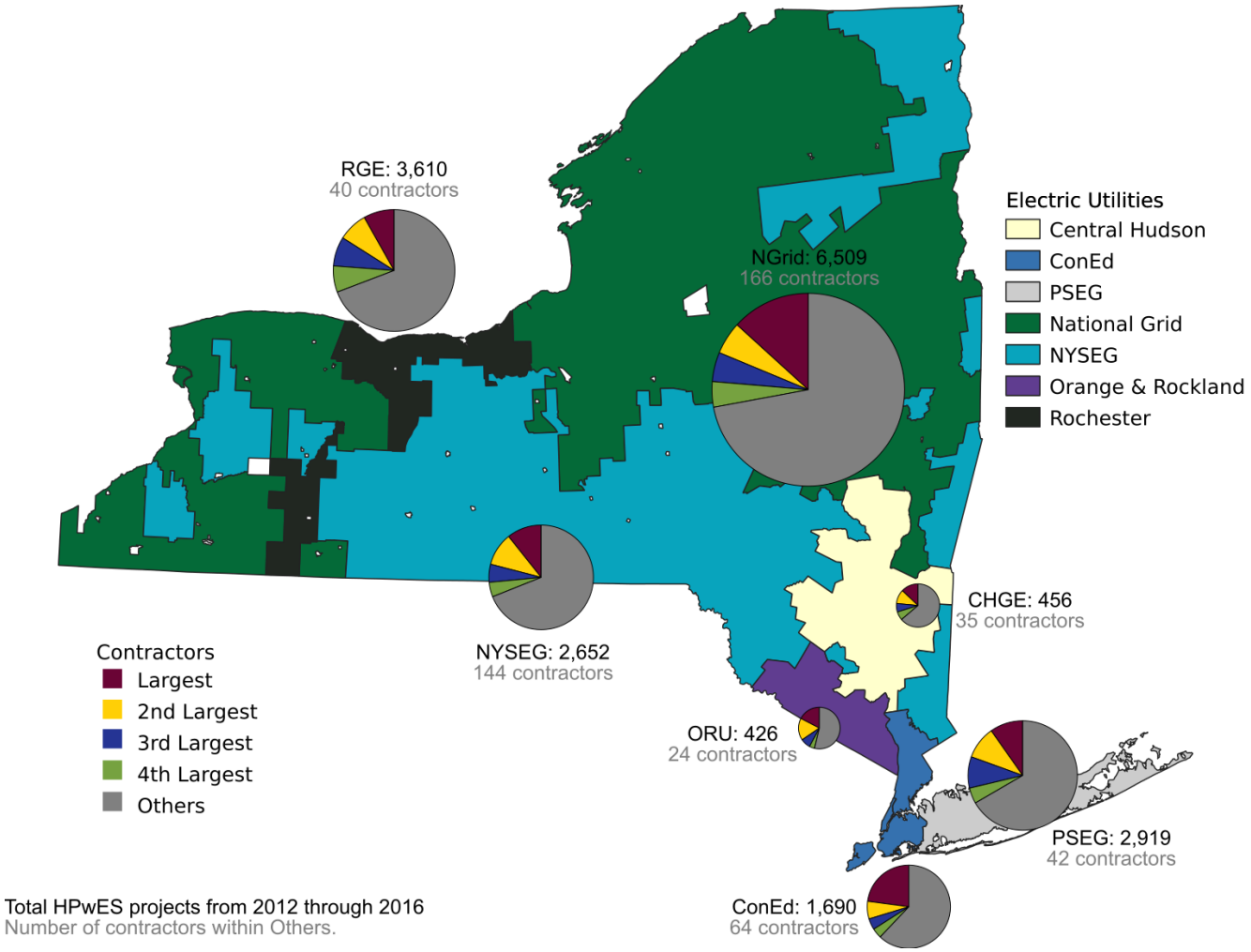
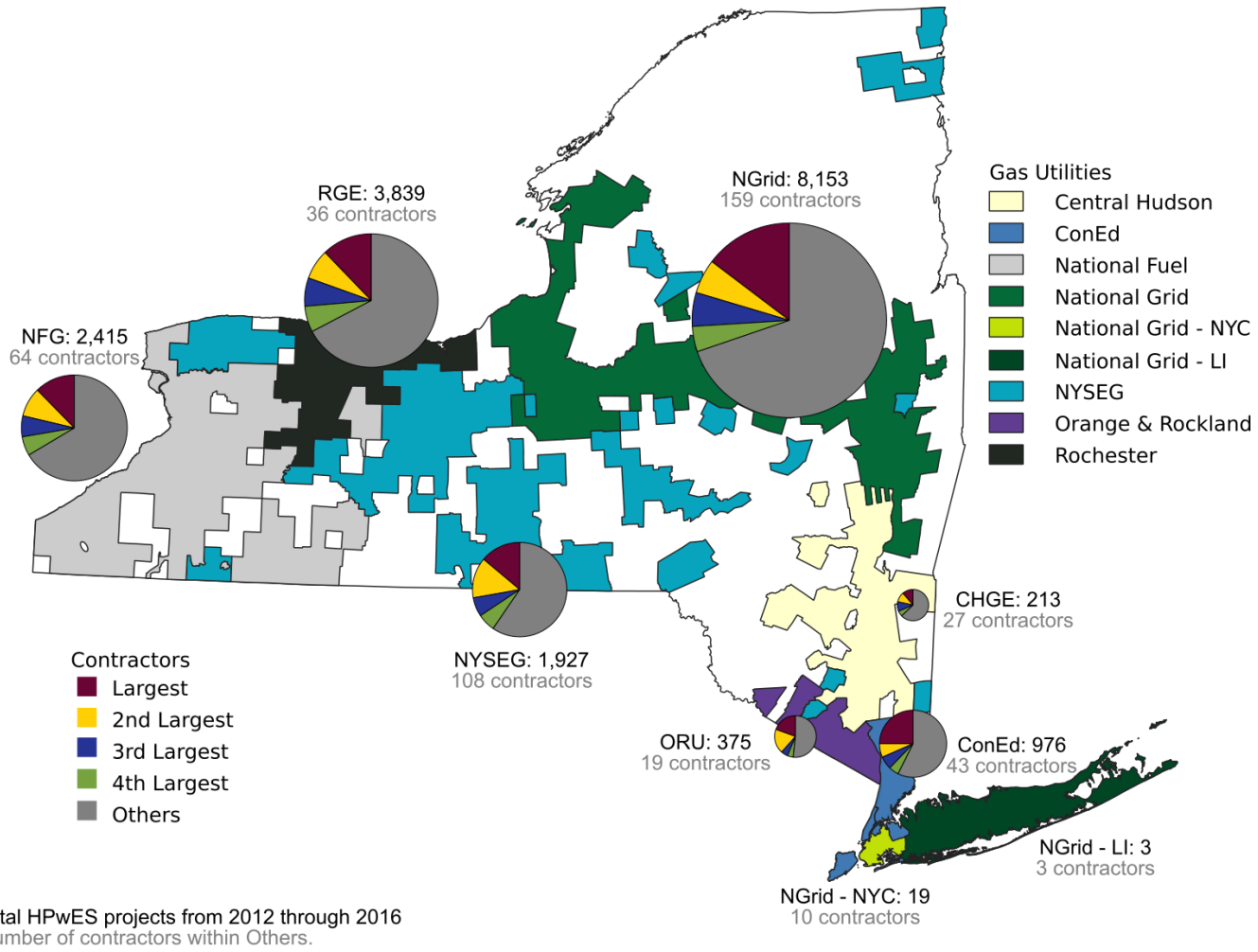


Figure 8: HPwES Projects by Utility Territory and Contractor – Gas



Total HPwES projects from 2012 through 2016
Number of contractors within Others.