Rhode Island Code Compliance Enhancement Initiative Savings and Attribution Logic Evaluation

12/11/2013

Submitted to:

Narragansett Electric and Gas Company
(National Grid)

Submitted by:

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Executive Summary

This report provides a review of the residential and commercial savings and attribution logic model created by National Grid for the Narragansett Electric and Gas Company (National Grid) Code Compliance Enhancement Initiative (CCEI). The main aim of CCEI is to improve the building energy code compliance rate of new and retrofit residential and commercial buildings in the State of Rhode Island, thereby achieving more electric and gas savings. CCEI is the short-term focus of National Grid's larger Codes & Standards Initiative, which encompasses four distinct components: 1) Code Compliance through CCEI; 2) Stretch Code Initiative; 3) Base Code Advocacy; and 4) Appliance Standards Advocacy. This scope of this evaluation focused only on CCEI, and involved 1) reviewing the Savings Model, and 2) reviewing the Attribution Methodology.

National Grid provided the National Grid spreadsheet "*7.25.13 National Grid CCEI Savings Methodology.xlsx*" (the "original model") to the Tetra Tech Team (NMR, Tetra Tech, and Left Fork Energy (the Team)) in July of 2013. The original model calculates projected gross savings based on inputs from a residential baseline study and a commercial baseline study, along with assumptions from other sources.

The Team has prepared a revised spreadsheet containing recommended changes to the CCEI model, *NMR_CCEI Savings and Attribution Logic Review- 11-7-2013.xlsx* (the "recommended model") as a supporting document to this report. The Team has also prepared a clean version with the recommended changes. Some of the changes have been implemented, while others require additional data that were not available during the review study period.

This Executive Summary provides an overview of the following:

- Residential Savings Model Review
- Commercial Savings Model Review
- Attribution Logic Review

Residential Savings Model Review

The Team developed the following questions for the residential review:

- Is the current code compliance rate of 56%, calculated using the Pacific Northwest National Laboratory (PNNL) code compliance checklist, the appropriate value for the CCEI savings model?
- Are the modeled savings for New Construction projects using the appropriate methodology and weights?
- Are the modeled savings for Retrofit projects using the appropriate methodology and weights?
- What defines a retrofit project and to what compliance requirements are these projects subject?

Summary Residential Findings and Recommendations

The Team identified these findings and recommendations during the residential savings model review.

- Finding 1: The current baseline code compliance estimate of 56% for new construction and retrofit activity is the most appropriate value to use for the CCEI model, though it could be updated (see Finding 2 and Recommendation 2).
    - Recommendation 1: Continue to use the PNNL value as the baseline compliance estimate for residential new construction and retrofit activity until a study is conducted to update that value. If this approach is adopted by National Grid, the Team recommends that the compliance path utilized by sampled homes (in any compliance study) be confirmed so that the PNNL checklist can be populated according to PNNL standards[1] Additionally, the Team recommends that in future studies REScheck™ documentation be obtained for any home complying with the energy code using this software.[2]
- Finding 2: The current baseline code compliance estimate of 56% is incomplete based on Recommendation 1. When the compliance value of 56% was calculated, the compliance path was verified for 30 of the 40 homes included in the calculations; 10 homes were assumed to comply via the prescriptive compliance path. In addition, eight homes complied via the UA trade-off approach and the evaluation Team did not obtain REScheck documentation for these sites.
    - Recommendation 2: The Team sees two possible solutions to this issue: 1) conduct a new code compliance baseline study following the protocols outlined in Recommendation 1 or 2) update the current baseline estimate by determining the compliance path for the 10 homes for which the prescriptive path was assumed and obtain REScheck documentation for each of the homes that complied via the UA trade-off approach.
- Finding 3: The per-home gross savings estimates from new construction code compliance enhancement are currently weighted based on the primary heating fuel and mechanical system distributions found in the RNC program.
    - Recommendation 3: Update the per-home gross savings estimate from new construction code compliance enhancement to reflect the primary heating fuel and mechanical system distributions found outside of the RNC program.
- Finding 4: Projected growth rates for new construction activity are low based on permit data that was provided to the evaluation Team.
    - Recommendation 4: Update growth rates for new construction activity based on the current permit data.

[1] This information should be publicly available through local building departments.
[2] When assessing compliance with the checklist, any efficiency levels indicated on a REScheck™ compliance form should be verified onsite.

- Finding 5: Market penetration for RNC program is static and does not reflect current penetration rates.
    - Recommendation 5: Update the CCEI model to reflect the current market penetration of the RNC program and to incorporate evolving market penetration rates.
- Finding 6: Retrofit savings are currently based on new construction modeling results.
    - Recommendation 6: Use savings from the Renovation/Rehabilitation Program as a proxy for the technical potential savings from increasing code compliance with retrofit projects. The Team views this as an interim recommendation, and proposes that retrofit savings be modeled similarly to the way new construction savings are currently calculated. One way to approach this would be to use prototypes to reflect the types of retrofit projects occurring in the state and compare these prototypes to the energy code that is being assessed. For example, projects that have gone through the Renovation/Rehabilitation Program can be used to develop a range of prototypes that reflect the different characteristics of renovation projects in the state. Initial prototype models would reflect the baseline conditions of these projects (the conditions before any renovation work took place). The energy consumption of these baseline models could then be compared to the same models (in terms of size, shape, etc.) with code compliant efficiency levels for all applicable measures within the renovation area. The difference in energy consumption between the two models (the baseline prototype model and the code-built model) would reflect the total technical potential savings from 100% compliance with the energy code. The Team understands this is not how savings are calculated for the renovation/rehabilitation program, but believes a prototype approach will ensure consistency between the new construction and retrofit pieces of the CCEI model and will result in more accurate savings estimates than the interim retrofit savings presented in this report.
- Finding 7: The market penetration of the Renovation/Rehabilitation Program is not incorporated in the CCEI model.
    - Recommendation 7: Incorporate the current market penetration of the Renovation/Rehabilitation Program into the CCEI model and allow for an evolving penetration over time. After incorporating this penetration rate the calculations that assess retrofit projects eligible for CCEI savings should be adjusted.
- Finding 8: The original model calculates the gross number of retrofit projects by using a 350% multiplier that references the activity of new construction in the state.
    - Recommendation 8: Investigate ways to update the gross number of retrofit projects in the state. While the Team feels the 350% multiplier is an appropriate estimate at this point in time, National Grid should consider ways to develop an

empirically based estimate of the number of energy-related retrofit projects in the state.[3]

Commercial Savings Model

The Team considered the following questions in conducting their review of the commercial savings model:

- How should actual baseline Energy Use Intensities (EUI) by building type be determined for new construction? For retrofits?
- How should actual post-construction EUIs by building type be determined for retrofits?
- Can the assumption of 3.5 ft^2 of retrofit activity for each $1ft^2$ of new construction activity be refined? What are the best sources for tracking retrofit activity?
- Since it is unlikely that the retrofit EUI savings potential is equal to new construction as proposed in the National Grid model, what method might provide a better estimate of retrofit EUI potential?
- Do EUI estimates based on energy modeling for Massachusetts commercial buildings apply to Rhode Island?

Summary Commercial Findings and Recommendations

The Team identified these findings and recommendations from the commercial savings model review.

- Finding 1: The Team agrees that CCEI has the potential to improve compliance rates from 70% to 90%. However, the original model overstates the gross technical savings potential that is associated with this improved compliance. At issue is the identification of the portion of the gross technical potential (GTP) that can be influenced by CCEI but that is independent of normally occurring compliance rates.
    - Recommendation 1a: New construction gross technical potential initially should be estimated as the difference between the baseline IECC 2009 partially compliant EUI and 2012 IECC fully compliant EUI. Additional recommendations include a method to improve the initial gross technical potential estimate by modeling the baseline EUI estimate.
    - Recommendation 1b: Retrofit gross technical potential initially should be estimated as the difference between the baseline, estimated as two times the 2012 IECC fully compliant EUI, and an average of 2006 and 2012 IECC fully compliant EUIs. Additional recommendations include methods to improve the initial gross technical potential estimate by modeling the estimates of both baseline and post-retrofit EUIs.

[3] CSG is currently tracking permits in Rhode Island and as a result may be able to come up with more concrete estimate of energy-related retrofit activity.

- Finding 2: The new construction baseline EUI in the original CCEI model is estimated; Rhode Island-specific values are needed for more accurate projections. New construction baseline EUI values in the original CCEI model are estimated using the DNV KEMA baseline compliance study and code compliance evaluation guidelines established by Pacific Northwest National Laboratory (PNNL) for compliance with the American Recovery and Reinvestment Act (ARRA).[4] The PNNL guidelines provide for a direct measurement of compliance, but the extrapolation to EUI values makes a number of assumptions regarding the influence of compliance scores on building energy use. True building energy performance likely differs from what is deduced from the PNNL approach. For example, below-grade insulation levels will have different impacts on multi-story and single-story building energy use, but the same PNNL weight applies to both. Also, there is no justification for assuming that a zero percent compliant building has two times the EUI of a fully compliant building, which is implied by the linear relationship assumed between compliance and EUI.
    - Recommendation 2: National Grid should model the energy use and EUI of the buildings that were included in the DNV KEMA baseline compliance study to establish the baseline EUI by building type. In addition to addressing a major source of uncertainty in the model, this will result in a uniform approach for both the residential and commercial sectors targeted by the CCEI. In the original CCEI model, residential new construction baseline energy use is based on modeled reference homes (User Defined Reference Home [UDRH]).
- Finding 3: Retrofit baseline EUIs in the original model are assumed to be equal to new construction baseline EUI; actual values are likely to be different. Given that retrofits occur in buildings that have a wide range of ages, were governed by varying codes and building practices at the time of construction, and are subject to different maintenance levels and degrees of depreciation, the baseline EUI is likely to be different from that of new construction.
    - Recommendation 3: National Grid should obtain a sample of buildings subject to the 2009 IECC at the time of retrofit, and that were retrofitted prior to 2013. National Grid should model actual baseline performance and EUI for the sampled buildings. Like the new construction baseline recommendation, this will reduce a major source of uncertainty in the model.
- Finding 4: The CCEI is unlikely to realize savings before 2014. The original model assumes that the program will influence the market and achieve savings in 2013. The 2012 IECC does not go into effect until October of 2013, and there is a lag time of months, if not years, between permitting and construction completion for new construction and retrofit commercial projects. It is therefore unlikely that any savings from enhanced code compliance will be realized until 2014.

[4] Pacific Northwest National Laboratory. "Measuring State Energy Code Compliance." March 2010.

  - Recommendation 4: National Grid should forecast savings to start in 2014 and true up for any realized savings during an ex-post impact evaluation. No savings should be forecast for 2013.

- Finding 5: The original CCEI model relies on out-of-state data and study results; Rhode Island-specific inputs are needed for a more accurate model of savings potential. A number of inputs currently used in the original CCEI model are based on Massachusetts studies and data. These include EUIs for code-compliant buildings for 2006, 2009, and 2012 IECC; distribution (percent) of new construction activity by building type; and weather inputs to the EUI models.
  - Recommendation 5: All modeled building performance and building distribution characteristics should be based on Rhode Island-specific new construction and retrofit market data and Rhode Island weather.
- Finding 6: The true retrofit annual activity, the number of completed retrofit ft^2/year, is estimated in the current model and contributes to uncertainty about the true CCEI savings potential. National Grid assumes that there are 3.5 ft^2 of retrofit activity subject to IECC for each 1 ft^2 of new construction activity.
  - Recommendation 6: The CCEI model should use actual retrofit (additions, renovations) ft^2 information drawn from the Dodge Players Database for both forecasted and ex-post evaluation savings.
- Finding 7: Retrofit code compliance rates and post-retrofit EUIs are estimated in the original CCEI model and contribute uncertainty to potential savings estimates. The original CCEI model assumes that retrofit code compliance rates and post-retrofit EUIs are the same as in new construction, though this is not likely to be true in practice. Actual retrofit compliance rates are unknown, as they were not included in the DNV KEMA code compliance baseline study, and fewer measures subject to code are likely to be included in retrofit activities and impacts.
  - Recommendation 7: National Grid should model the post-retrofit EUI using the same sample of buildings drawn for the baseline retrofit EUI model. The Team also recommends that code compliance rates be estimated for the sample using the PNNL guidelines.
- Finding 8: The original CCEI model appears to over-count new construction activity by including all stages from start to completion, as recorded in the Dodge data. The original CCEI model counts the total ft^2 of new construction and retrofit activity in the Dodge data regardless of construction stage: Start, Construction, Notice of Completion, Sub-Contract Award. Including buildings that are still in development, in construction, or otherwise incomplete in the savings calculations overstates the savings.
  - Recommendation 8: When estimating savings for new construction and retrofit activity, National Grid should include ft^2 only for buildings that have been completed.

- Finding 9: New construction and retrofit activity is likely to change year to year, but is currently modeled as a static value. In the CCEI model, National Grid assumes a static 2,500,000 ft^2 of new construction activity per year.
    - Recommendation 9: The CCEI model should incorporate an annual new construction activity growth rate as a more realistic representation of the market.

Attribution Logic

The Team reviewed the CCEI attribution logic, which assigned a 40% attribution to National Grid, and developed an empirically based attribution rate, as requested by the Rhode Island Public Utility Commission (PUC). The Team created an integrated attribution model, assessing naturally occurring market adoption (NOMAD), CCEI, other entities involved in code compliance, and non-compliance in one step.

Code Cycles

The Team believes that compliance estimates should be understood to change over time because code compliance is likely to increase over the code cycle.

Residential Code Cycles

The Rhode Island 2011 residential baseline study conducted at the beginning of the 2009 code cycle found a 56% compliance rate; since Rhode Island is commencing the 2012 IECC code cycle on October 1, 2013, a 56% compliance estimate is appropriate for the beginning of the 2012 code cycle, assuming no new program activities.

Commercial Code Cycles

The 2012 Rhode Island commercial baseline study found a 70% compliance rate at the *end* of the 2006 IECC. We estimate a compliance rate of 52% for the beginning of 2012 IECC code cycle, assuming no new program activities. We estimated 52% by taking into account NOMAD and ongoing programs and using a similar change in business-as-usual compliance over the code cycle as with the residential model.

Compliance Rate

Following from the original model, the Team has estimated a final compliance rate of 90%, including both program and non-program residences and commercial buildings. The compliance study should be done at the end of 2017 for homes at the end of 2018 for commercial buildings to allow for adequate time for builders to adjust to the 2012 code, thus sampling buildings that should have higher levels of compliance. The samples should consist of homes and commercial buildings permitted before October, 2016, when the next code goes into effect. The original model and the recommended CCEI model assume that Residential New Construction (RNC) and Renovation/Rehabilitation Program homes are 100% energy code compliant. The 2011 Rhode Island Residential baseline study does not include program homes, and neither do the original and recommended CCEI residential savings models. Accordingly, the target compliance rate for non-program homes can be lower than 90% since the weighted average of non-program and program homes will need to be at least 90%. While the original model included RNC programs as an attribution factor, we recommend removing them from the attribution model since program homes are not part of the savings estimates. Based on the 90% weighted compliance for program and non-program homes, we calculate a target non-program home code compliance rate of 86%

by 2017. The Team has estimated an 86% target compliance rate for non-program homes, which is a weighted average of non-program home new construction and retrofit target compliance, averaged with 100% program home compliance, to reach 90% compliance overall.[5]

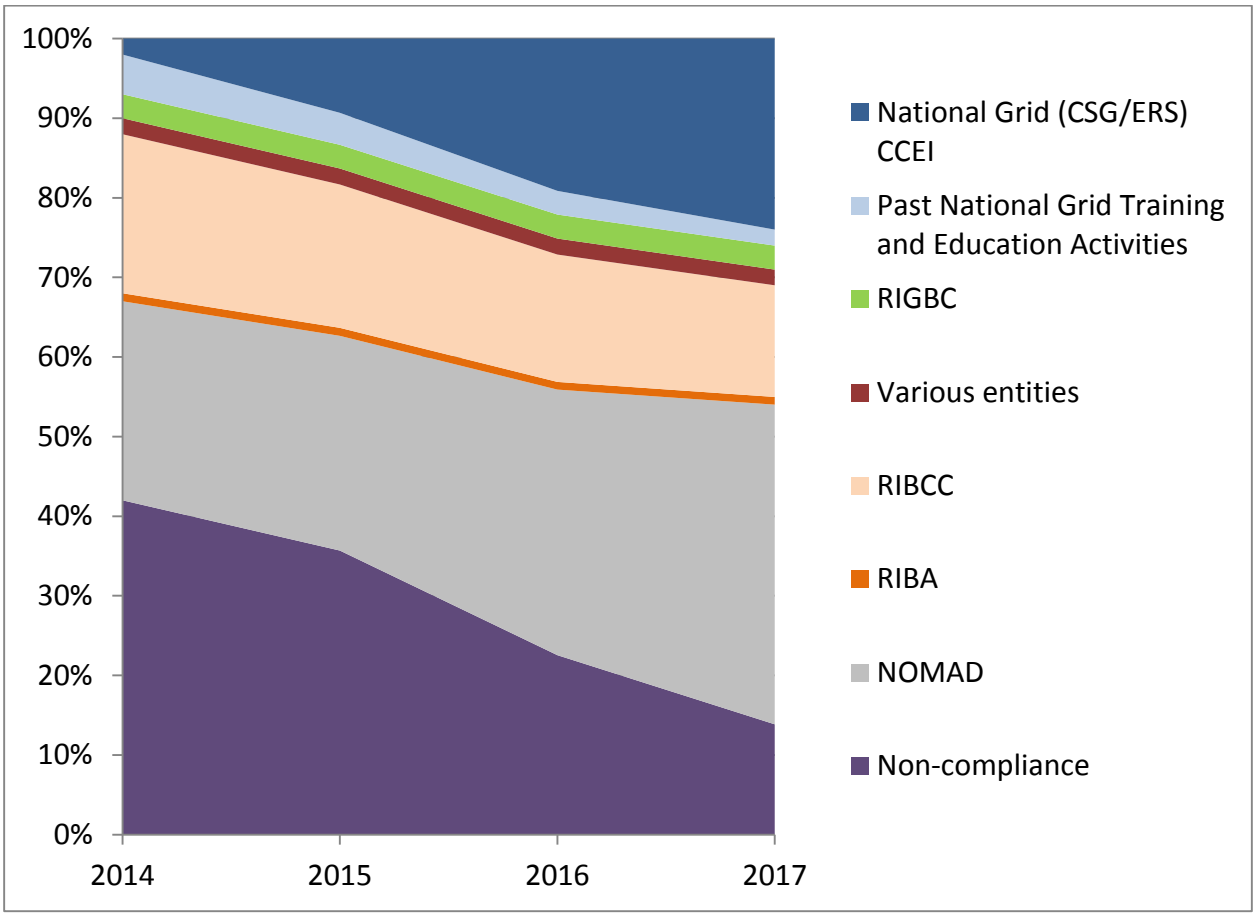
Since the DNV KEMA study did not remove commercial program buildings from the 2012 Rhode Island baseline study, and since we do not know the penetration rates for commercial new construction and retrofit programs, we cannot develop a savings model that removes these buildings from the analysis. Accordingly, for commercial code compliance we set a target of 90%, which includes non-program and program buildings. Given the longer building time required for commercial buildings, the Team projects compliance achieved by 2018, rather than by 2017.[6]

Recommended Attribution Model Estimates

The recommended residential attribution model for non-program homes, not including new construction (NC) and retrofit (RF) influence, is shown in Figure ES-1. Non-compliance decreases over time to 14% in 2017,[7] as NOMAD increases to 40% and CCEI increases to 24%.[8]

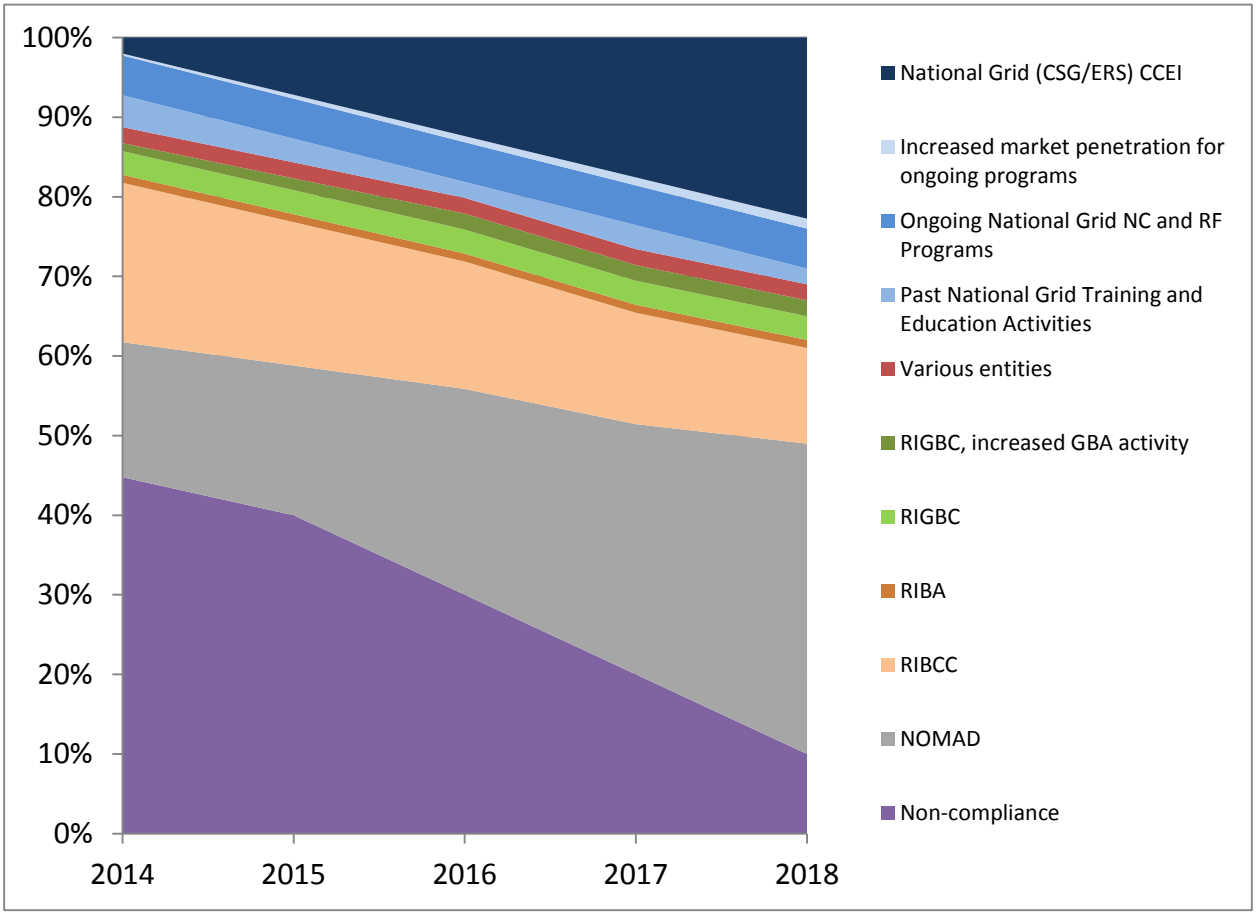
[5] See the "Res. Attr. No program. infl." tab in the accompanying spreadsheet for details.
[6] NMR understands that Rhode Island is on a three-year code cycle and assumes that the RIBCC would likely mandate the 2015 IECC starting October 1, 2016.
[7] As a reminder, the target non-compliance rate for non-program homes can be higher than 10% (100%-90%) because the weighted average non-compliance of non-program and program homes should equal 10%, with program homes assumed to be 100% compliant.
[8] The residential attribution model including the influence of NC and RF Programs is shown in the *NMR CCEI Savings and Attribution Logic Review- 10-11-2013.xlsx*

Figure ES-1: Residential Attribution (without the Influence of NC and RF Programs)



The recommended commercial attribution model for non-program and program buildings is shown in Figure ES-2. Non-compliance decreases over time to 10% in 2018, as NOMAD increases to 39% and CCEI increases to 23%.

Figure ES-2: Commercial Attribution (with the Influence of NC and RF Programs)



Recommended Attribution Savings Estimates

This section describes the Team's development of savings estimates with attribution to CCEI.

Residential Percent of Maximum Potential Improvement

The Team used residential CCEI attribution and the baseline compliance rate of 56% to determine the percent of maximum potential improvement in savings due to CCEI. The formula is CCEI Attribution/ (1-56%) (Table ES-1).

Table ES-1: Residential Percent of Maximum Potential Improvement

Year	CCEI Attribution	Percent of Max. Potential Improvement
2014	2%	5%
2015	9%	21%
2016	19%	43%
2017	24%	55%

Residential New Construction

The Team applied the residential percent of maximum potential improvement to the GTP estimates in Table 3-7 to estimate net savings attributable to CCEI for residential new construction (Table ES-2).

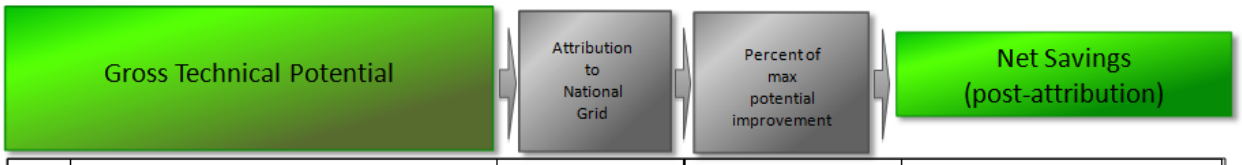
Table ES-2: Residential New Construction Net Savings Post-attribution[9]

Year	Heating (Therms)	Heating (kWh)	Lighting (kWh)
2014	2,988	3,504	49,008
2015	14,663	17,194	240,858
2016	30,855	36,181	506,846
2017	39,610	46,447	650,650
4-year Cumulative Savings	88,116	103,326	1,447,441

Development of Net Program Savings Post-attribution: Example Residential New Construction

The following chart summarizes how the Team used GTP, CCEI attribution, and the percent of maximum potential improvement to determine net savings post-attribution, using residential new construction as an example.[10] (Figure ES-3).

Figure ES-3: Development of Net Program Savings Post-attribution: RNC Example



	Gross Technical Potential				Percent of overall compliance rate attributable to National Grid (CSG/ERS) CCEI	Percent of max potential improvement	Net Savings (post-attribution)		
	Heating (Therms)	*Heating (kWh)*	*Cooling (kWh)*	*Lighting (kWh)*			*Heating (Therms)*	*Heating (kWh)*	*Lighting (kWh)*
2014	65,743	77,091	(16,417)	1,079,928	2%	=2%/(1-56%)=5%	2,988	3,504	49,088
2015	69,125	81,056	(17,261)	1,135,471	9%	=9%/(1-56%)=21%	14,663	17,194	240,858
2016	71,039	83,301	(17,739)	1,166,924	19%	=19%/(1-56%)=43%	30,855	36,181	506,846
2017	72,618	85,153	(18,133)	1,192,858	24%	=24%/(1-56%)=55%	39,610	46,447	650,650
						Cumulative Savings	**88,116**	**103,326**	**1,447,441**

Residential Retrofit

[9] There are different column headings between residential new construction and retrofit because new construction indicated no domestic hot water savings and negative cooling savings, which would not receive an attribution score.

[10] For Heating (Therms), for example, we multiplied the GTP of 65,743.2 by the 4.545% maximum potential improvement to arrive at 2,988 Heating (Therms) net savings (post-attribution).

The Team applied the residential percent of maximum potential improvement to the GTP estimates in Table 3-8 to estimate net savings attributable to CCEI for residential retrofits (Table ES-3).

Table ES-3: Residential Retrofit Net Savings Post-attribution

Year	Heating (Therms)	DHW (Therms)	Heating (kWh)	DHW (kWh)	Cooling (kWh)	Lighting (kWh)
2014	6,881	383	2,810	2,129	6,088	26,011
2015	33,001	1,856	13,613	10,313	29,495	126,023
2016	69,719	3,922	23,759	21,787	62,311	266,239
2017	89,793	5,051	37,040	28,060	80,252	342,897
4-year Cumulative Savings	199,324	11,212	82,221	62,289	178,146	761,170

Commercial Percent of Maximum Potential Improvement

Similar to the residential estimate, the Team used commercial CCEI attribution and the estimated baseline compliance rate[11] to determine the percent of maximum potential improvement in savings due to CCEI. The formula is CCEI Attribution/ (1-52%) (Table ES-4).

Table ES-4: Commercial Percent of Maximum Potential Improvement

Year	CCEI Attribution	Percent of Max. Potential Improvement
2014	2%	4%
2015	7%	15%
2016	12%	26%
2017	18%	37%
2018	23%	47%

Commercial New Construction

The Team applied the commercial percent of maximum potential improvement to the GTP estimates in Table 4-3 to estimate net savings attributable to CCEI for commercial new construction (Table ES-5).

[11] As discussed above, the Team estimated the start-of-code-cycle commercial compliance rate to be 52%, assuming no new activities.

Table ES-5: Commercial New Construction Net Savings Post-attribution

Year	Compliance Savings (MMBTUs)	Electric Component (MWh)	Gas Component (Therms)
2014	2,352	407	9,643
2015	8,579	1,483	35,173
2016	14,992	2,592	61,467
2017	21,596	3,734	88,542
2018	28,394	4,910	116,416
5-year Cumulative Savings	75,912	13,126	311,240

Commercial Retrofit

The Team then applied the commercial percent of maximum potential improvement to the GTP estimates in Table 4-4 to estimate net savings attributable to CCEI for commercial retrofits (Table ES-6).

Table ES-6: Commercial Retrofit Net Savings Post-attribution

Year	Compliance Savings (MMBTUs)	Electric Component (MWh)	Gas Component (Therms)
2014	16,129	2,789	66,129
2015	58,833	10,173	241,216
2016	102,815	17,778	421,541
2017	148,103	25,609	607,221
2018	194,726	33,670	798,377
5-year Cumulative Savings	520,606	90,019	2,134,484

Summary Attribution Logic Findings and Recommendations

This section presents the key findings and recommendations that the Team identified during the attribution logic model review.

- Finding 1: The original model assumes that 90% code compliance will be achieved by 2017, at the end of the 2012 code cycle. Ninety percent code compliance is a weighted average that includes program homes and buildings. The Team does not include program homes in the recommended residential savings and attribution models because National Grid and the Team understand these homes to be 100% code compliant. The Team has estimated an 86% target compliance rate for non-program homes, which is a weighted average of non-program new construction and retrofit target compliance to reach 90% compliance when averaged with 100% program home compliance. The commercial baseline study and original savings model included program buildings so the Team has included program buildings in the recommended commercial and attribution models, retaining the 90% target compliance rate.

  - Recommendation 1a: Calculate compliance at the end of the code cycle, after National Grid CCEI activities have taken place, to determine whether homes meet the 90% compliance requirement. The sample should consist of homes and buildings permitted under the 2012 IECC from April through September of 2016, assuming a six-month period allows a large enough sample. The study should be done at the end of 2017 for homes at the end of 2018 for commercial buildings to allow for adequate time for builders to adjust to the 2012 code, thus sampling buildings that should have higher levels of compliance. The code compliance calculation should include program homes and non-program homes and buildings, which both count toward the 90% compliance target.
  - Recommendation 1b: Conduct a net savings evaluation of CCEI, interviewing Rhode Island builders to measure the influence of CCEI on building practices, as well as the influence of other factors that could have caused the change, including "natural" evolution of technology and practices (NOMAD), past and future code requirements, PA programs, programs offered by other entities such as the state and federal governments, energy prices, the economy, climate change, etc. Conduct a Delphi survey among a panel of experts to develop a final net savings estimate and attribution to CCEI. Panelists would be presented with the initial estimates of CCEI influence from the builder surveys. In addition, panelists would receive information on findings from baseline studies conducted in the last several years. Finally, panelists would receive information about associated program requirements over the years, changes in code for those parameters, and program efforts that have targeted changes in those areas.

- Finding 2: The original model uses the compliance baseline findings (56% for residential; 70% for commercial) as starting compliance rates for the 2012 IECC code cycle. However, 56% residential compliance is from the beginning of the 2009 IECC code cycle and the 70% commercial compliance is from the end of the 2006 IECC cycle.
  - Recommendation 2: The Team recommends using 56% compliance for the beginning of the 2012 IECC code cycle for the residential model and 52% for the commercial model.
- Finding 3: The original residential model calculates Estimated Annual Savings assuming 90% compliance and a potential improvement of 77%. The residential model adjusts for the Percent of Annual Net Savings Achieved to determine Gross Savings (pre-attribution) and applies the CCEI attribution factor of 40%. The original commercial model applies the 20% (90%-70%) non-compliance rate to the 2012 IECC EUI to determine the Delta EUI. The model multiplies Delta EUI by the square footage of commercial new construction and applies the Percent of Annual Net Savings Achieved and the CCEI 40% attribution factor.
  - Recommendation 3: The Team recommends first calculating gross technical potential (GTP) savings at 100% compliance with 2012 IECC and then

calculating NOMAD, all attribution factors, and non-compliance in one step. Related to this, the Team recommends a revised percent of maximum potential improvement, which is the CCEI attribution percent divided by one minus the starting compliance rate (for the residential model in 2014: 2%/(1-56%)=5%; for the commercial model: 2%/(1-52%)=4%). The Team then recommends multiplying the percent of maximum potential improvement by the GTP to determine net savings due to CCEI. The maximum potential improvement calculation converts the yearly CCEI attribution into an estimate of energy savings over the baseline code compliance rate.

- Finding 4: The commercial compliance baseline study included commercial NC and RF buildings in the 70% compliance estimate. The energy savings for NC and RF commercial buildings are not known, so it is not possible to remove program building savings from the savings model, which National Grid would need to do when assuming 100% compliance and no influence from CCEI on their compliance rate. Commercial program buildings, and even program homes, may not be 100% compliant.
    - Recommendation 4a. Estimate the market penetration of commercial program buildings so that a) National Grid can remove or adjust them in the saving model, or b) National Grid can better estimate program attribution if keeping them in the savings model.
    - Recommendation 4b. Future baseline studies should provide energy savings estimates for program and non-program buildings (and homes) so that National Grid can calculate the energy savings from each type of building and include or remove them in savings models as appropriate.
    - Recommendation 4c: Consider conducting research to estimate the percent of commercial program buildings that are 100% code compliant or are significantly more compliant than non-program buildings. If program buildings are 100% compliant and if National Grid estimates compliance to be due to the NC and RF programs rather than to CCEI, then National Grid should remove them from the savings model. If program buildings are not 100% compliant, but are significantly more compliant than non-program buildings and CCEI influences their compliance, then National Grid should create adjustment factors to reflect their higher compliance rates in the savings and attribution models. If National Grid estimates that program buildings are not significantly more compliant than non-program buildings then it can keep them in the savings and attribution models, as CCEI would be a likely influence on their compliance rate.
    - Recommendation 4d: National Grid indicated that, as part of program activities, their engineering teams educate developers on the code and that going forward National Grid can track this program activity in order to link the programs to increased code compliance. The Team recommends that National Grid in fact do so, both tracking these activities as well as assessing their influence on the market

by number of projects, number and percent of projects with owner education, topic of education, and relationship to code compliance.

- Recommendation 4e: While the Team believes that assuming 100% compliance for program homes is reasonable, National Grid could also consider additional research to confirm this assumption.

- Finding 5: The RIGBC is helping to build awareness and understanding about the Green Building Act (GBA), which requires higher building standards for some public buildings.
  - Recommendation 5a: Consider estimating the influence of the GBA on IECC 2012 code compliance. GBA buildings are likely to have higher compliance rates, which would impact the savings and attribution models. Estimate the percent of buildings that are subject to the GBA and their compliance rate.
  - Recommendation 5b: Since the GBA is a requirement for some public buildings, consider estimating savings for these buildings built to GBA standards rather than to IECC 2012 standards. Adjust the attribution model to include compliance with the GBA and attribute influence to entities as appropriate. For example, consider increasing attribution to RIGBC, which is helping to increase awareness and understanding about the GBA, but also consider increasing attribution to CCEI or other factors that might influence GBA compliance.

1 Introduction

This report provides a review of the residential and commercial savings and attribution logic model created by National Grid for the Narragansett Electric and Gas Company (National Grid) Code Compliance Enhancement Initiative (CCEI)[12]. The main aim of CCEI is to improve the building energy code compliance rate of new and retrofit residential and commercial buildings in the State of Rhode Island, thereby achieving more electric and gas savings. CCEI is the short-term focus of National Grid's larger Codes & Standards Initiative, which encompasses four distinct components: 1) Code Compliance through CCEI; 2) Stretch Code Initiative; 3) Base Code Advocacy; and 4) Appliance Standards Advocacy. This scope of this evaluation focused only on CCEI, and involved 1) reviewing the Savings Model, and 2) reviewing the Attribution Methodology.

National Grid provided the National Grid spreadsheet "*7.25.13 National Grid CCEI Savings Methodology.xlsx*" (the "original model") to the Tetra Tech Team (NMR, Tetra Tech, and Left Fork Energy (the Team)) in July of 2013. The original model calculates projected gross savings based on inputs from a residential baseline study and a commercial baseline study, along with assumptions from other sources.

The Team has prepared a revised spreadsheet containing recommended changes to the CCEI model, *NMR_CCEI Savings and Attribution Logic Review- 11-7-2013.xlsx* (the "recommended model") as a supporting document to this report. The Team has also prepared a clean version with the recommended changes. Some of the changes have been implemented, while others require additional data that were not available during the review study period.

This report is organized with the following sections:

- Code Compliance Enhancement Initiative Background
- Savings Model Review Approach
- Residential Savings Model Review
- Commercial Savings Model Review
- Attribution Logic Review

[12] See Appendix C for a list of acronyms used in this report.

2 Savings Model Review Approach

The objective of the review of the CCEI Savings Model is to ensure that the projected savings estimates are as accurate as possible, making use of the best available information and adhering to best practices. For the Savings Model Review task the Team reviewed all assumptions, inputs, and algorithms as implemented in the original model. The Team worked closely with the National Grid Strategy Group during the review to ensure that all aspects of the savings model were investigated and analyzed.

The Team's hypothesis is that it is unlikely that any new construction or retrofits will be completed in 2013 under the 2012 IECC, which Rhode Island mandates as of October 1, 2013. Accordingly, residential and commercial savings in the recommended model begin in 2014, rather than 2013 (Year 1) in the original model.

3 Residential Savings Model Review

The Team developed the following questions for the residential review:

- Is the current code compliance rate of 56%, calculated using the Pacific Northwest National Laboratory (PNNL) code compliance checklist, the appropriate value for the CCEI savings model?
- Are the modeled savings for New Construction projects using the appropriate methodology and weights?
- Are the modeled savings for Retrofit projects using the appropriate methodology and weights?
- What defines a retrofit project and to what compliance requirements are these projects subject?

The following sections will address these questions and recommendations based on the Team's review of the residential savings model and methodology.

3.1 Baseline Code Compliance Rate

As part of the 2011 Residential Baseline Study of Single-family Residential New Construction[13] the Team assessed code compliance with the 2009 International Energy Conservation Code (IECC) for single-family homes in Rhode Island using the following compliance paths:

- The PNNL code compliance checklist
- The prescriptive compliance path
- A theoretical compliance path using Home Energy Rating System (HERS) indices
- The Annual Energy Cost Compliance path, using REM/Rate™
- The Overall Building UA Compliance path, using REM/Rate™

Of these five compliance paths, only the PNNL checklist approach allows for partial compliance. The checklist was designed to assess compliance using a weighted point system for a variety of measures. Each measure within the checklist is assigned one, two, or three points, based on the item's relative importance. An overall compliance estimate is calculated based on the percentage of points a home receives relative to the total number of available points. For example, if a home received 50 points out of a possible 100 points the compliance rate for that home would be 50%.

The other four compliance paths that the Team assessed as part of the baseline study do not allow partial compliance. Instead, compliance with these paths is assessed on a "yes/no" basis. That is, the homes either fully comply with the code or they do not. For example, using the prescriptive approach a home would be considered non-compliant (0% compliant) if it met 11 out of 12 applicable requirements.

[13] http://www.rieermc.ri.gov/documents/evaluationstudies/2012/Final-RI-RNC-2011-Baseline-Report-sent-10-8-12.pdf

When assessing which of these compliance paths was most appropriate for the CCEI model, the Team first considered what type of influence the program was likely to have on building practices throughout the state. Given that many homes are non-compliant with many measures and that CCEI trainings are unlikely to cover all aspects of the energy code, the Team believes that CCEI training efforts are more likely to influence increases in partial compliance (e.g., moving homes from 50% to 75% compliant) than they are to influence overall compliance (e.g., moving homes to 100% compliance with the energy code). For these reasons, the Team determined that the PNNL baseline code compliance rate of 56%, as reported in the baseline study, is the most appropriate compliance rate for the CCEI model. Utilizing this compliance rate in the future will allow National Grid to assess the initiative's influence on partial compliance, which will allow National Grid to claim savings from their training efforts even if they are not pushing homes into 100% compliance.

Given that there have not been any studies of residential code compliance for retrofit projects, the Team feels that utilizing the new construction baseline compliance rate as a proxy for retrofit projects is appropriate at this point in time (this is the current assumption in the model).

3.2 New Construction

This section discusses new construction per-home savings, the new construction growth rate, and Residential New Construction (RNC) program home market penetration.

3.2.1 Per-home Savings

In the existing model, the per-home savings values for new construction units are based on weighted values from modeled homes with primary fuel and heating and cooling system distributions found only in RNC program homes. These distributions are likely different than the distribution of single-family homes located outside of the RNC program. To achieve a better savings estimate, the Team compared the primary heating fuel distribution for homes built since 2000[14] to the primary heating fuel distributions that savings are currently based on (distributions from RNC program homes) (Table 3-1). The Team also compared the primary heating and cooling system distributions for the residential baseline study[15] to those currently utilized in the model (again based on RNC program homes) (Table 3-2). After assessing these comparisons, the Team recommends the values in Table 3-1 and Table 3-2 be utilized in the CCEI model to the extent possible. Note, the system distributions from the baseline study only reflect single-family homes but the Team feels they are a more accurate representation of all homes outside of the RNC program than the current system distribution weights.

[14] This is based on 3-year American Community Survey census estimates.

[15] http://www.rieermc.ri.gov/documents/evaluationstudies/2012/Final-RI-RNC-2011-Baseline-Report-sent-10-8-12.pdf

Table 3-1: Comparison of Primary Heating Fuel Weights

Primary Heating Fuel	Original Model	Recommended Model
Natural Gas	92.9%	57.2%
Propane	3.4%	4.7%
Electricity	3.4%	5.4%
Fuel Oil	0.3%	32.8%

Table 3-2: Comparison of Primary Heating and Cooling System

Primary HVAC System Type	Original Model	RI RNC Baseline Study
Boiler w/Radiant Heat w/no Central Air Conditioning (CAC)	48.8%	30%
Forced Air (Ducted) w/ CAC	43.3%	45%
Air Source Heat Pump (Ducted)	7.9%	7.9%
Hydro-Air Boiler w/CAC	--	15%
Boiler w/Radiant Heat w/CAC	--	3%
Other*	--	8%

*Includes one combination boiler, one ground source heat pump, and one electric resistance system.

3.2.2 New Construction Growth Rate

The original model projects an annual growth rate for new construction units of 1.5% for each program year (Table 3-3). The Team believes this underestimates the number of new units that will be constructed in the near term. Building permit data for new single- and multifamily units provided by Conservation Services Group (CSG), the implementation contractor for the RNC program, indicates a growth rate of 36.5% from June 2012 to June 2013.[16] As a result, the Team recommends using this as the value for new construction growth in 2013 of the CCEI model. For subsequent years, we suggest using a growth rate of 5%, the average growth rate of single- and multifamily units for 2009-2013. This value should be updated as new data or projections are available. A summary comparison of the current growth rates and the Team's recommended changes can be found in Table 3-3.

Table 3-3: Comparison of New Construction Growth Rates

Year	Original Model	Recommended Model
2013	1.5%	36.5%
2014		5.0%
2015		5.0%
2016		5.0%
2017	NA	5.0%

[16] CSG, e-mail message August 15th, 2013.

3.2.3 RNC Program Home Market Penetration

In the original model, the market penetration for the RNC program homes is estimated at 25% for all program years (Table 3-4). Units with savings attributed to the RNC program cannot also have savings claimed under CCEI and must be deducted from the total. Given that efforts to increase the reach of the RNC program will continue, the Team believes the market penetration value should increase throughout the years assessed in the model. Additionally, the Team found that 25% is a low penetration rate for 2013, based on CSG permit and project data that was provided to the Team for projects through October 2013. The Team recommends beginning with an estimated market penetration value of 30% for 2014 completed units, increasing to 33% in 2017.[17] These values should be updated annually based on new data from the RNC program. A summary comparison of the current market penetration rates and the Team's suggested changes can be found in Table 3-4.

Table 3-4: Comparison of New Construction Market Penetration Rates

Year	Original Model	Recommended Model
2013	25%	42%
2014		30%
2015		30%
2016		31%
2017	NA	33%

3.3 Retrofits

This section discusses retrofit per-home savings, the ratio of retrofits to new construction, and the market penetration of the Renovation/Rehabilitation Program.

3.3.1 Per-home Savings

Savings for new construction homes are based on a modeled comparison of the RNC user defined reference home (UDRH) and the 2012 IECC prescriptive requirements. To de-rate this for retrofit homes, the original model uses a comparison of the UDRH to 2009 IECC standards. Under this approach the retrofit savings are based on a full-sized new construction prototype model. The Team believes that a different method would be more appropriate and better account for the differences between new construction homes and retrofit projects. Retrofit projects vary widely in size and scope, from remodeling of single rooms to multifamily buildings, which makes it more difficult to define per-unit savings than with new construction homes.

[17] The Team assumes a one year lag from permitting to completion for new construction. Based on CSG permit data, the Team estimated that 783 permits were issued for residential new construction projects in 2012 and that 328 projects were completed through the RNC Program in 2013. The Team estimated that 318 residential new construction projects will be completed in 2014. The Team assumes that the decline in program penetration from 42% in 2013 to 30% 2014 is due to a recovering economy with more non-program builders re-entering the market during this period; then we assume a slight growth in penetration. See the Permits Tab in the accompanying spreadsheet for details.

Complicating matters further, the range of possible energy improvements to the existing housing stock is wider, and the savings potentially greater, than can be captured in a comparison of new homes built to different code standards. The Team received data on projects that have passed through National Grid's Renovation/Rehabilitation Program and used the modeled savings from these projects as the basis for new values for per home savings for retrofit homes in the CCEI. Using the full savings claimed under this program would not be appropriate, since the implementers actively seek to expand the scope of projects to include additional energy improvements, which the Team does not expect will be the case under the average retrofit project outside of the Renovation/Rehabilitation Program. For this reason, as an interim solution, the Team suggests de-rating the per-home savings values to an estimated 25% of the values calculated for the Renovation/Rehabilitation Program homes. Note, this value is only an estimate and is meant to reflect the fact that the Team does not feel CCEI efforts will result in savings comparable to the renovation/rehabilitation program. [18] Table 3-5 presents a summary comparison of the current total technical potential savings per home, the average per home savings from the renovation/rehabilitation program, and the Team's recommended savings.

Table 3-5: Comparison of Technical Potential Savings per Home

Model Approach	Heating (Therms)	DHW (Therms)	Heating (kWh)	DHW (kWh)	Cooling (kWh)	Lighting (kWh)
Original Model	9.00	--	221.00	--	-16.00	794.00
Avg. per Home Savings from Reno Program	160	9	66	50	143	611
Suggested Changes (25% of Avg. per Home Reno Savings)	40.00	2.25	16.50	12.50	35.75	153.00

3.3.2 Ratio of Retrofit to New Construction

Based on our discussions with National Grid, we believe that the ratio of 3.5 retrofit projects for each new construction project is the best estimate currently available. This value should be reviewed as new or better permit data become available.

3.3.3 Market Penetration of Renovation/Rehabilitation Program

Just as homes constructed under the RNC program must be deducted from the new construction homes eligible for CCEI savings, the Team believes the pool of retrofit projects should be reduced by the number of homes passing through the Renovation/Rehabilitation Program to avoid double-counting the savings. In the existing model, the number of retrofit units is calculated from the number of new construction homes after deducting RNC program homes, in effect incorporating the market penetration of the RNC Program into both the new construction and retrofit calculations. The Team recommends separating the RNC Program market

[18] The Team knows these need to be de-rated, but the 25% is an estimate. We do not know how much to de-rate them, which is why we propose a prototype approach.

penetration from the retrofit estimates and using the market penetration of the Renovation/Rehabilitation program instead. Based on the data provided for projects completed under the Renovation/Rehabilitation Program[19] and the ratio of 350% more retrofit units than new construction, the Team estimates a market penetration of 4% for the Renovation/Rehabilitation Program in 2013 (Table 3-6).[20] Since the Renovation/Rehabilitation Program is new, it is likely to grow at a faster rate than the RNC Program. The Team recommends an increase in the market penetration value of 5% per year over four years, to 10% in 2017. These values should be updated as actual penetrations are calculated over time. Table 3-6 presents a comparison of the current market penetration rates and the Team's suggested changes.

Table 3-6: Comparison of Market Penetration Rates for Renovation/Rehabilitation Program

Year	Original Model	Recommended Model
2013	No estimate	4%
2014		5%
2015		6%
2016		7%
2017		10%

3.4 Impact on Potential Savings from CCEI

Table 3-7 presents a comparison of the gross technical potential (GTP) savings for the residential new construction market using the original model and the Team's recommended model. Savings for the residential new construction market represent the savings that can be achieved in non-program homes by moving from 56% baseline compliance with 2009 IECC to 100% compliance with 2012 IECC.[21] Similarly, Table 3-8 presents a comparison of the GTP savings for the residential retrofit market. Savings for the residential retrofit market, within the recommended model, were assessed by de-rating the per-home savings found in National Grid's Renovation/Rehabilitation program (see Retrofits, Per-home Savings for more detail). As shown, after implementing the Team's recommended revisions, National Grid could expect an increase in GTP savings (between 52% and 59%) for new construction projects. It should be noted that the savings reflecting the Team's revisions *do not* account for the Team's recommendation to re-weight the modeled per home savings estimates by a new primary heating fuel distribution.[22] On the retrofit side, National Grid could expect significant increases in GTP savings from gas related measures (over a 600% increase), but could expect a decrease in electric savings (on average between a 63% to 65% decrease across the four year period).

[19] CSG, e-mail message, August 15th, 2013.
[20] See tab "Res Permits" in the accompanying spreadsheet.
[21] We discuss the 90% target compliance rate and attribution to CCEI in the attribution section.
[22] See tab "NC Revised Weights" in the accompanying spreadsheet for starting information for revising the weights.

Table 3-7: Comparison of Gross Technical Potential Savings for New Construction

Estimated Annual Savings	Heating (Therms)	DHW (Therms)	Cooling (Therms)	Heating (kWh)	DHW (kWh)	Cooling (kWh)	Lighting (kWh)
Gross New Construction Savings: Original Model							
Gross Potential Savings-2013	53,846	--	--	63,578	--	(13,624)	888,038
Gross Potential Savings-2014	54,654	--	--	64,531	--	(13,828)	901,358
Gross Potential Savings-2015	55,474	--	--	65,499	--	(14,036)	914,879
Gross Potential Savings-2016	56,306	--	--	66,482	--	(14,246)	928,602
Gross New Construction Savings: Recommended Model*							
Gross Potential Savings-2014**	65,743	--	--	77,091	--	(16,417)	1,079,928
Gross Potential Savings-2015	69,125	--	--	81,056	--	(17,261)	1,135,471
Gross Potential Savings-2016	71,039	--	--	83,301	--	(17,739)	1,166,924
Gross Potential Savings-2017	72,618	--	--	85,153	--	(18,133)	1,192,858
Change in Savings							
Change-2013	(53,846)	--	--	-63,578	--	13,624	(888,038)
Change-2014	11,089	--	--	12,560	--	(2,589)	178,570
Change-2015	13,651	--	--	15,557	--	(3,225)	220,592
Change-2016	14,733	--	--	16,819	--	(3,493)	238,322
Change-2017	72,618			85,153		(18,133)	1,192,858

*Does not account for the Team's recommendation of re-weighting the per home modeled savings results.
** The Team estimates that savings will begin in 2014.

Table 3-8: Comparison of Gross Technical Potential Savings for Retrofits

Estimated Annual Savings	Heating (Therms)	DHW (Therms)	Cooling (Therms)	Heating (kWh)	DHW (kWh)	Cooling (kWh)	Lighting (kWh)
Gross Retrofit Savings: Original Model							
Gross Potential Savings-2013	20,436	--	--	501,808	--	(36,330)	1,802,718
Gross Potential Savings-2014	20,742	--	--	509,335	--	(36,875)	1,829,759
Gross Potential Savings-2015	21,053	--	--	516,975	--	(37,428)	1,857,205
Gross Potential Savings-2016	21,369	--	--	524,730	--	(37,989)	1,885,064
Gross Retrofit Savings: Recommended Model							
Gross Potential Savings-2014*	149,848	8,429	--	61,812	46,828	133,927	572,233
Gross Potential Savings-2015	155,577	8,751	--	64,176	48,618	139,047	594,111
Gross Potential Savings-2016	160,516	9,029	--	66,213	50,161	143,461	612,970
Gross Potential Savings-2017	164,620	9,260	--	67,906	51,444	147,129	628,644
Change in Savings							
Change-2013	(20,436)	--	--	(501,808)	--	36,330	(1,802,718)
Change-2014	129,106	8,429	--	(447,523)	46,828	170,802	(1,257,526)
Change-2015	134,524	8,751	--	(452,799)	48,618	176,475	(1,263,094)
Change-2016	139,147	9,029	--	(458,517)	50,161	181,450	(1,272,094)
Change-2017	164,620	9,260	--	67,906	51,444	147,129	628,644

* The Team estimates that savings will begin in 2014.

Table 3-9 presents a comparison of the combined GTP savings from new construction and retrofit activities using National Grid's original model assumptions and the Team's suggested revisions. A few things to note:

- This table *does not* account for the re-weighted new construction savings that the Team previously recommended.
- This table *does* include the retrofit savings presented in Table 3-8, but the Team views these savings as interim estimates until more accurate savings values can be developed.
- This table *does not* account for the Team's suggested changes to the attribution logic or time-frame for achieving 90% compliance.

The savings presented in Table 3-9 are strictly GTP savings estimates. That said, if National Grid were to adopt the Team's recommended changes to the CCEI model they could expect to see increases in gas savings and decreases in electric savings relative to the estimates presented in the initial CCEI model.

Table 3-9: Comparison of Gross Technical Potential Savings for all CCEI Activities (New Construction and Retrofit)

Estimated Annual Savings	Heating (Therms)	DHW (Therms)	Cooling (Therms)	Heating (kWh)	DHW (kWh)	Cooling (kWh)	Lighting (kWh)
Gross Technical Potential Savings: Original Model							
Gross Potential Savings-2013	74,282	--	--	565,386	--	(49,954)	2,690,756
Gross Potential Savings-2014	75,396	--	--	573,866	--	(50,703)	2,731,117
Gross Potential Savings-2015	76,527	--	--	582,474	--	(51,464)	2,772,084
Gross Potential Savings-2016	77,675	--	--	591,212	--	(52,236)	2,813,665
Gross Technical Potential Savings: Recommended Model							
Gross Potential Savings-2014	215,591	8,429	--	138,903	46,828	117,510	1,652,161
Gross Potential Savings-2015	224,702	8,751	--	145,232	48,618	121,786	1,729,582
Gross Potential Savings-2016	231,555	9,029	--	149,514	50,161	125,722	1,779,894
Gross Potential Savings-2017	237,238	9,260	--	153,059	51,444	128,996	1,821,502
Change in Savings							
Change-2013/2014*	141,309	8,429	--	(426,483)	46,828	167,464	(1,038,595)
Change-2013/2015	149,306	8,751	--	(428,634)	48,618	172,489	(1,001,535)
Change-2015/2016	155,028	9,029	--	(432,960)	50,161	177,186	(992,190)
Change-2016/2017	159,563	9,260	--	(438,153)	51,444	181,232	(992,163)

* Comparison between 2013 original model and 2014 recommended model savings.

3.5 Residential Findings and Recommendations[23]

This section presents the key findings and recommendations that the Team identified during the residential savings model review.

- Finding 1: The current baseline code compliance estimate of 56% for new construction and retrofit activity is the most appropriate value to use for the CCEI model, though it could be updated (see Finding 2 and Recommendation 2).
    - Recommendation 1: Continue to use the PNNL value as the baseline compliance estimate for residential new construction and retrofit activity until a study is conducted to update that value. If this approach is adopted by National Grid, the Team recommends that the compliance path utilized by sampled homes (in any compliance study) be confirmed so that the PNNL checklist can be populated

[23] See Table A-17 for a calendar of recommended activities for CCEI.

according to PNNL standards[24] Additionally, the Team recommends that in future studies REScheck™ documentation be obtained for any home complying with the energy code using this software.[25]

- Finding 2: The current baseline code compliance estimate of 56% is incomplete based on Recommendation 1. When the compliance value of 56% was calculated the compliance path was verified for 30 of the 40 homes included in the calculations; 10 homes were assumed to comply via the prescriptive compliance path. In addition, eight homes complied via the UA trade-off approach and the evaluation Team did not obtain REScheck documentation for these sites.
    - Recommendation 2: The Team sees two possible solutions to this issue: 1) conduct a new code compliance baseline study following the protocols outlined in Recommendation 1 or 2) update the current baseline estimate by determining the compliance path for the 10 homes for which the prescriptive path was assumed and obtain REScheck documentation for each of the homes that complied via the UA trade-off approach.
- Finding 3: The per-home gross savings estimates from new construction code compliance enhancement are currently weighted based on the primary heating fuel and mechanical system distributions found in the RNC program.
    - Recommendation 3: Update the per-home gross savings estimate from new construction code compliance enhancement to reflect the primary heating fuel and mechanical system distributions found outside of the RNC program.
- Finding 4: Projected growth rates for new construction activity are low based on permit data that was provided to the evaluation Team.
    - Recommendation 4: Update growth rates for new construction activity based on the current permit data.
- Finding 5: Market penetration for RNC program is static and does not reflect current penetration rates.
    - Recommendation 5: Update the CCEI model to reflect the current market penetration of the RNC program and to incorporate evolving market penetration rates.
- Finding 6: Retrofit savings are currently based on new construction modeling results.
    - Recommendation 6: Use savings from the Renovation/Rehabilitation Program as a proxy for the technical potential savings from increasing code compliance with retrofit projects. The Team views this as an interim recommendation, and proposes that retrofit savings be modeled similarly to the way new construction savings are currently calculated. One way to approach this would be to use prototypes to reflect the types of retrofit projects occurring in the state and

[24] This information should be publicly available through local building departments.
[25] When assessing compliance with the checklist, any efficiency levels indicated on a REScheck™ compliance form should be verified onsite.

compare these prototypes to the energy code that is being assessed. For example, projects that have gone through the Renovation/Rehabilitation Program can be used to develop a range of prototypes that reflect the different characteristics of renovation projects in the state. Initial prototype models would reflect the baseline conditions of these projects (the conditions before any renovation work took place). The energy consumption of these baseline models could then be compared to the same models (in terms of size, shape, etc.) with code compliant efficiency levels for all applicable measures within the renovation area. The difference in energy consumption between the two models (the baseline prototype model and the code-built model) would reflect the total technical potential savings from 100% compliance with the energy code. The Team understands this is not how savings are calculated for the renovation/rehabilitation program, but believes a prototype approach will ensure consistency between the new construction and retrofit pieces of the CCEI model and will result in more accurate savings estimates than the interim retrofit savings presented in this report.

- Finding 7: The market penetration of the Renovation/Rehabilitation Program is not incorporated in the CCEI model.
    - Recommendation 7: Incorporate the current market penetration of the Renovation/Rehabilitation Program into the CCEI model and allow for an evolving penetration over time. After incorporating this penetration rate the calculations that assess retrofit projects eligible for CCEI savings should be adjusted.
- Finding 8: The original model calculates the gross number of retrofit projects by using a 350% multiplier that references the activity of new construction in the state.
    - Recommendation 8: Investigate ways to update the gross number of retrofit projects in the state. While the Team feels the 350% multiplier is an appropriate estimate at this point in time, National Grid should consider ways to develop an empirically based estimate of the number of energy-related retrofit projects in the state.[26]

[26] CSG is currently tracking permits in Rhode Island and as a result may be able to come up with more concrete estimate of energy-related retrofit activity.

4 Commercial Savings Model Review

The Team considered the following questions in conducting their review of the commercial savings model:

- How should actual baseline Energy Use Intensities (EUI) by building type be determined for new construction? For retrofits?
- How should actual post-construction EUIs by building type be determined for retrofits?
- Can the assumption of 3.5 ft^2 of retrofit activity for each 1ft^2 of new construction activity be refined? What are the best sources for tracking retrofit activity?
- Since it is unlikely that the retrofit EUI savings potential is equal to new construction as proposed in the National Grid model, what method might provide a better estimate of retrofit EUI potential?
- Do EUI estimates based on energy modeling for Massachusetts commercial buildings apply to Rhode Island?

4.1 New Construction Baseline EUI and Gross Technical Potential

The initial new construction baseline EUI is the EUI observed in the market place prior to new 2012 IECC code adoption and CCEI interventions. The CCEI period begins on October 1, 2013, with the Rhode Island adoption of the 2012 International Energy Conservation Code (IECC). The baseline EUI decreases with time as Rhode Island adopts new versions of the IECC, and as naturally occurring market adoption increases. Gross technical potential for the 2012 IECC code cycle is calculated using the initial baseline; changes in baseline EUI over time are addressed in the attribution review.

The original model assumes that the maximum savings that can be achieved by improving code compliance is the difference between the EUIs for new construction building stock that is 70% compliant with the 2012 IECC and a 100% compliant building stock, based on the DNV KEMA commercial new construction compliance baseline study; the commercial savings model review investigated the technical potential starting with the baseline.[27]

The DNV KEMA code compliance study concluded that the new construction code compliance rate was 70% for RI commercial buildings and interpreted that to mean that "average commercial buildings perform approximately 30% worse than the code requires, and, by extension, use 30% more energy than fully compliant buildings."[28] Applying this interpretation, the Team estimates the commercial new construction baseline EUI as 130% of a fully compliant building for the baseline period. The Team has recommended that National Grid's original model incorporate

[27] DNV KEMA, Energy & Resource Solutions and APPRISE. "Draft Final Report Rhode Island Energy Code Compliance Baseline Study." July 23, 2012. http://www.rieermc.ri.gov/documents/evaluationstudies/2012/RI%20Code%20Compliance20Baseline%20Study%20%20Final%20Report%20-%20July%2023%202012.pdf

[28] DNV KEMA. Ibid. p 1-4.

this approach by calculating the new construction EUI baseline as 130% of a fully compliant 2009 IECC EUI. However, the Team considers this baseline estimate, which relies on a linear correlation between compliance rates and building energy use, to be a placeholder until better data can be developed by modeling the energy performance for the sample of 33 buildings included in the DNV KEMA compliance study. The recommendation to model new construction baseline EUIs by building types is a key outcome of this review, as described in the Commercial Findings and Recommendations.

The new construction baseline EUI values in the original model are estimated using the DNV KEMA baseline compliance study and code compliance evaluation guidelines established by Pacific Northwest National Laboratory (PNNL) for compliance with the American Recovery and Reinvestment Act (ARRA). The PNNL guidelines provide for a direct measurement of compliance, but the extrapolation to EUI values makes a number of assumptions regarding the influence of compliance scores on building energy use. Indeed, a PNNL researcher stated that "… it [fractional code compliance] is not a direct EUI fraction."[29] True building energy performance likely differs from what is deduced from the PNNL approach. For example, below grade insulation levels will have different impacts on multi-story and single-story building energy use, but the same PNNL weight applies to both. Also, a linear relationship between compliance and energy use relative to a code compliant building leads to the conclusion that a 0% compliant building has two times the EUI of a fully compliant building. A building with 0% code compliance is undefined at best, and any correlation with energy use does not make mathematical sense.

Despite these shortcomings, the DNV KEMA baseline compliance study suggested that estimates of new construction EUIs be extrapolated from compliance rates, the approach adopted in the National Grid original model, because better information has not been available. The Team has also applied this approach to estimating the new construction baseline EUI of 70% compliant buildings, but with the understanding that improved estimates of baseline EUIs through computer modeling are needed.

In addition to the baseline EUI, the commercial review considered the savings potential for improved code compliance. Given a maximum compliance rate of 100% (assuming that building beyond code is rare and atypical) the gross technical potential is the savings in EUI that would be realized by boosting compliance from the baseline to full compliance with the new code. The recommended model implements this approach as the difference between the EUIs for a 70% compliant building under the 2009 IECC and a building that is 100% compliant with 2012 IECC. As noted earlier, the weak link in this calculation is the baseline, the 70% code compliant new construction EUI, which needs to be modeled. The 2012 IECC 100% compliant EUI is already based on computer simulations performed for National Grid, though the models need to be updated for Rhode Island weather.

[29] Personal email, Olga Livingston, September 27, 2013.

Table 4-1 depicts the estimated new construction gross technical potential calculations from the recommended model.

Table 4-1: Recommended New Construction Gross Technical Potential

A	B	C	D	E	F
RI Dodge data			**Revised Savings Delta EUI Calculation**		
New Construction RI (Avg ksf 2008-2010)	% of Total	Building Type	Baseline (70% 2009 IECC EUI)	2012 IECC EUI (100% compliance)	Technical Potential Savings EUI (2009@70% - 2012 @100%)
373	17%	Apartment	69.9	50.2	19.7
562	26%	Office	78.7	55.6	23.1
504	23%	Retail	80.2	53.6	26.6
371	17%	Education	64.7	42.5	22.2
112	5%	Storage	38.5	26.4	12.1
260	12%	Other	62.0	42.0	20.0
2,182	100%	Weighted Avg.	71.1	48.9	22.2

Column Notes
A New construction activity (ft^2/year) from Dodge data for RI, 2008-2010, by building type
B Percent of activity for building type compared to total activity, used to calculate weighted average
C Building type
D Baseline EUI by building type and weighted average for new construction that is 70% compliant with 2009 IECC
E EUI by building type and weighted average for new construction that is 100% compliant with 2012 IECC
F Technical potential EUI, D-E; 100% compliance with 2012 IECC before considering attribution

4.2 Retrofit Baseline EUI

In the original model retrofit baseline EUIs are assumed to be equal to the new construction EUIs, but this assumption is unlikely to hold true in practice. Retrofits occur in buildings with a wide range of ages that were subject to varying codes and building practices at time of construction. Furthermore, these older buildings were likely maintained to varying levels and standards resulting in varying changes in energy performance since commissioning. Finally, the DNV KEMA code compliance baseline study did not examine retrofitted buildings, and there is no direct measurement of their compliance rate and therefore their extrapolated baseline EUIs. For these reasons the Team considers retrofit baseline EUIs, as unknown at this point. As a placeholder the recommended model uses retrofit baseline EUIs that are 200% of a 2012 IECC compliant building. The 200% value captures the expectation that existing commercial buildings use more energy than those complying with the 2012 IECC, and it acknowledges that we do not know the mix of codes and standards to which they were built. The value is in close agreement with the most recent Commercial Buildings Energy Consumption Survey (CBECS) EUI estimate of 99.8 kBTU/ft^2/year for New England, which is approximately twice the 48.9 EUI assumed in the recommended model for a commercial new construction building that is 100% compliant with the 2012 IECC.

As with new construction, the Team concluded that there is a need for estimates of retrofit EUIs by building types that are derived from the examination of existing building stock. And like new construction, the Team concluded that these could be derived from computer simulations of energy performance for a sample of Rhode Island commercial buildings. In the retrofit case the sample frame should be buildings that were retrofitted prior to 2013.

4.3 Retrofit Post-Construction EUI and Technical Potential

The Team concluded that not only are retrofit baseline EUIs unknown, but that retrofit post-construction EUIs are also undetermined. Energy use for code compliant retrofitted buildings will be different than for new construction because 1) the IECC makes special provisions for retrofits and 2) while all code requirements apply comprehensively to new construction the requirements for retrofits are more selective. For example with regards to the first point, the 2012 IECC does not trigger a roof insulation requirement if the roof cavity is not opened, and compliant retrofitted buildings may therefore have lower roof insulation levels than new construction buildings. Regarding the second point, the 2012 IECC applies only to the portion of a retrofitted building that undergoes renovation or alteration. Thus, the renovation of a leased office space may not affect existing HVAC equipment located outside of the renovated space, even though it does not meet code minimums. In addition, it is likely that different building types will be characterized by changes in different energy using equipment; e.g. office building renovations may be weighted towards lighting equipment while warehouse retrofits may involve both lighting and packaged HVAC units.

Currently there are no reliable estimates of retrofit post-construction EUIs for Rhode Island. The original model assumed that they would be the same as for new construction. The recommended model post-retrofit EUIs are assumed to be an average of EUIs that are 100% compliant with 2006 and 2012 IECC. Like the retrofit baseline EUI assumption this is a placeholder to demonstrate the recommended model until better estimates can be developed. Also like the retrofit baseline EUI case, the Team concluded that these better estimates could be derived from computer simulations of a sample of Rhode Island retrofitted buildings using the same sample as for the retrofit baseline simulations.

The gross technical potential is the weighted average difference between the retrofit building baseline and post-construction EUIs, where the EUIs are estimated in the recommended model, but should be determined through modeling by building type and then averaged. Table 4-2 summarizes the baseline, post-construction, and gross technical potential calculations as implemented in the recommended model.

Table 4-2: Recommended Retrofit Gross Technical Potential

A	B	C	D	E	F	G
RI Retrofit Activity (assumed 350% of New Construction)			**Revised RF Savings Delta EUI Calculation**			Technical Potential Savings EUI (Baseline - 2012 RF @100%)
Retrofit RI (Avg ksf 2008-2011)	% of Total	Building Type	Baseline EUI (unknown - estimated as 2.0 * 2012 IECC EUI)	2012 IECC EUI (100% NC compliance)	2012 IECC EUI (100% RF compliance - unknown, estimated as average of 2006 and 2012 codes @ 100%)	Delta EUI (0% to 100% compliance)
1,304	17%	Apartment	100.4	50.2	52.7	47.7
1,968	26%	Office	111.2	55.6	58.3	52.9
1,765	23%	Retail	107.2	53.6	63.7	43.5
1,299	17%	Education	85.0	42.5	49.1	36.0
391	5%	Storage	52.8	26.4	28.0	24.8
910	12%	Other	84.0	42.0	47.4	36.7
7,637	100%	Weighted Avg.	97.8	48.9	54.2	43.6

Column Notes

A Retrofit activity (ft^2/year), 350% (assumed) of Dodge NC data for RI, 2008-2010, by building type.

B Percent of activity for building type compared to total activity, used to calculate weighted average

C Building type

D Baseline EUI by building type and weighted average. Unknown. Assumed 2 x 2012 IECC 100% compliant building. Retrofit building stock is older, depreciated compared to new construction; EUI will be greater than NC.

E NC EUI by building type and weighted average for retrofit that is 100% compliant with 2012 IECC

F RF EUI, assumed to be average of 2009, 2012 IECC EUIs. RF EUI will be different from NC due to different end-use activity.

G Technical potential EUI, D-F; 100% compliance with average 2009 & 2012 IECC before considering attribution

4.4 Measuring Retrofit Activity

The original model assumes that 3.5 ft^2/year of retrofit activity occur for each 1.0 ft^2/year of new construction. The source of 3.5 factor appears to be professional judgment solicited from actors in the commercial new construction and retrofit markets in Massachusetts. Since the technical potential savings are a product of retrofit EUI potential and retrofit activity, errors in retrofit activity values result in a proportional error in the calculated potential savings.

The recommended model, "RF_Calculations Com-NMR" worksheet, also uses the 3.5 ft^2/year factor to calculate gross technical potential savings. However, the expectation is that actual retrofit activity data are available from the Dodge database, and that these should be used in the model, as summarized in the Commercial Findings and Recommendations.

4.5 Using Massachusetts Data to Estimate Rhode Island Potential

The original model uses building type distribution data and EUI modeling results that were developed for Massachusetts. The recommended model substitutes Rhode Island new construction building type distribution data that was included in the information provided by National Grid for the review. There is a need however for Rhode Island data for retrofit construction activity, modeled new construction baseline EUIs determined for Rhode Island building types (the DNV KEMA sample), and modeled retrofit baseline and post-retrofit EUIs determined for a sample of Rhode Island buildings, as summarized in Commercial Findings and Recommendations.

4.6 Comparison of Original and Recommended Estimates of Gross Technical Potential

Table 4-3 and Table 4-4 present a comparison of the original and recommended estimates of gross technical potential savings, before accounting for attribution. For new construction savings the difference reflects a recommended estimation method for the difference in EUI between the baseline 70% compliance with 2009 IECC code and the ideal 100% compliance with 2012 IECC code. An assumed annual increase in square feet of new construction is also reflected in the recommended commercial new construction savings model. For retrofit savings the difference reflects a recommended estimate of the baseline EUI that is intended to represent existing building conditions before retrofit that are of various ages and are thus built to various earlier codes. The EUI of older buildings would be expected to be higher than the EUI of the baseline 70% compliant buildings observed for new construction. The EUI for the ideal condition of 100% compliance with 2012 IECC code for retrofit buildings is estimated to be lower than the EUI of a new construction building 100% compliant with 2012 IECC code because all building systems are not affected by retrofit activities. An assumed annual increase in square feet of new construction is also reflected in the recommended commercial retrofit savings model.

Note that the recommendations for developing improved estimates for a number of input variables (new construction baseline EUI, retrofit baseline and post-retrofit EUIs, retrofit construction activity, commercial construction growth rates) will significantly affect the modeled gross technical potential savings.

Table 4-3: Comparison of Commercial Gross New Construction Savings Potential

Forecasted annual savings from increasing compliance:	2013	2014	2015	2016	2017	2018	6-year cumulative savings
GTP New Construction Savings: Original Model							
Commercial new construction (MMBTUs)	116,888	116,888	116,888	116,888	116,888*	116,888*	701,328
Gross New Construction Savings: Recommended Model							
Commercial new construction (MMBTUs)	--	56,445	57,291	58,151	59,023	59,908	290,818
Change in Savings							
Commercial new construction (MMBTUs)	(116,888)	(60,443)	(59,597)	(58,737)	(57,865)	(57,980)	(410,510)

* Assumes same gross technical potential is available in years 5 and 6 of original model

Table 4-4: Comparison of Commercial Gross Retrofit Savings Potential

Forecasted annual savings from increasing compliance for:	2013	2014	2015	2016	2017	2018	6-year cumulative savings
GTP Retrofit Savings: Original Model							
Commercial new construction (MMBTUs)	409,108	409,108	409,108	409,108	409,108*	409,108*	2,454,647
Gross Retrofit Savings: Recommended Model							
Commercial new construction (MMBTUs)	--	387,097	392,903	398,797	404,779	410,851	1,994,427
Change in Savings							
Commercial new construction (MMBTUs)	(409,108)	(22,011)	(16,204)	(10,311)	(4,329)	1,743	(460,220)

* Assumes same gross technical potential is available in years 5 and 6 of original model

4.7 Commercial Findings and Recommendations[30]

- Finding 1: The Team agrees that CCEI has the potential to improve compliance rates from 70% to 90%. However, the original model overstates the gross technical savings potential that is associated with this improved compliance. At issue is the identification of the portion of the gross technical potential that can be influenced by CCEI but that is independent of normally occurring compliance rates.
    - Recommendation 1a: New construction gross technical potential initially should be estimated as the difference between the baseline IECC 2009 partially compliant EUI and 2012 IECC fully compliant EUI. Additional recommendations include a method to improve the initial gross technical potential estimate by modeling the baseline EUI estimate.
    - Recommendation 1b: Retrofit gross technical potential initially should be estimated as the difference between the baseline, estimated as two times the 2012 IECC fully compliant EUI, and an average of 2006 and 2012 IECC fully compliant EUIs. Additional recommendations include methods to improve the initial gross technical potential estimate by modeling the estimates of both baseline and post-retrofit EUIs.
- Finding 2: The new construction baseline EUI in the original CCEI model is estimated; Rhode Island-specific values are needed for more accurate projections. New construction baseline EUI values in the original CCEI model are estimated using the DNV KEMA baseline compliance study and code compliance evaluation guidelines established by Pacific Northwest National Laboratory (PNNL) for compliance with the American Recovery and Reinvestment Act (ARRA).[31] The PNNL guidelines provide for a direct measurement of compliance, but the extrapolation to EUI values makes a number of assumptions regarding the influence of compliance scores on building energy use. True building energy performance likely differs from what is deduced from the PNNL approach. For example, below-grade insulation levels will have different impacts on multi-story and single-story building energy use, but the same PNNL weight applies to both. Also, there is no justification for assuming that a zero percent compliant building has two times the EUI of a fully compliant building, which is implied by the linear relationship assumed between compliance and EUI.
    - Recommendation 2: National Grid should model the energy use and EUI of the buildings that were included in the DNV KEMA baseline compliance study to establish the baseline EUI by building type. In addition to addressing a major source of uncertainty in the model, this will result in a uniform approach for both the residential and commercial sectors targeted by the CCEI.

[30] See Table A-17 for a calendar of recommended activities for CCEI.
[31] Pacific Northwest National Laboratory. "Measuring State Energy Code Compliance." March 2010.

- Finding 3: Retrofit baseline EUIs in the original model are assumed to be equal to new construction baseline EUI; actual values are likely to be different. Given that retrofits occur in buildings that have a wide range of ages, were governed by varying codes and building practices at the time of construction, and are subject to different maintenance levels and degrees of depreciation, the baseline EUI is likely to be different from that of new construction.
    - Recommendation 3: National Grid should obtain a sample of buildings subject to the 2009 IECC at the time of retrofit, and that were retrofitted prior to 2013. National Grid should model actual baseline performance and EUI for the sampled buildings. Like the new construction baseline recommendation, this will reduce a major source of uncertainty in the model.
- Finding 4: The CCEI is unlikely to realize savings before 2014. The original model assumes that the program will influence the market and achieve savings in 2013. The 2012 IECC does not go into effect until October of 2013, and there is a lag time of months, if not years, between permitting and construction completion for new construction and retrofit commercial projects. It is therefore unlikely that any savings from enhanced code compliance will be realized until 2014.
    - Recommendation 4: National Grid should forecast savings to start in 2014 and true up for any realized savings during an ex-post impact evaluation. No savings should be forecast for 2013.
- Finding 5: The original CCEI model relies on out-of-state data and study results; Rhode Island-specific inputs are needed for a more accurate model of savings potential. A number of inputs currently used in the original CCEI model are based on Massachusetts studies and data. These include EUIs for code-compliant buildings for 2006, 2009, and 2012 IECC; distribution (percent) of new construction activity by building type; and weather inputs to the EUI models.
    - Recommendation 5: All modeled building performance and building distribution characteristics should be based on Rhode Island-specific new construction and retrofit market data and Rhode Island weather.
- Finding 6: The true retrofit annual activity, the number of completed retrofit ft^2/year, is estimated in the current model and contributes to uncertainty about the true CCEI savings potential. National Grid assumes that there are 3.5 ft^2 of retrofit activity subject to IECC for each 1 ft^2 of new construction activity.
    - Recommendation 6: The CCEI model should use actual retrofit (additions, renovations) ft^2 information drawn from the Dodge Players Database for both forecasted and ex-post evaluation savings.
- Finding 7: Retrofit code compliance rates and post-retrofit EUIs are estimated in the original CCEI model and contribute uncertainty to potential savings estimates. The original CCEI model assumes that retrofit code compliance rates and post-retrofit EUIs are the same as in new construction, though this is not likely to be true in practice. Actual

retrofit compliance rates are unknown, as they were not included in the DNV KEMA code compliance baseline study, and fewer measures subject to code are likely to be included in retrofit activities and impacts.

  - Recommendation 7: National Grid should model the post-retrofit EUI using the same sample of buildings drawn for the baseline retrofit EUI model. The Team also recommends that code compliance rates be estimated for the sample using the PNNL guidelines.

- Finding 8: The original CCEI model appears to over-count new construction activity by including all stages from start to completion, as recorded in the Dodge data. The original CCEI model counts the total ft^2 of new construction and retrofit activity in the Dodge data regardless of construction stage: Start, Construction, Notice of Completion, Sub-Contract Award. Including buildings that are still in development, in construction, or otherwise incomplete in the savings calculations overstates the savings.
  - Recommendation 8: When estimating savings for new construction and retrofit activity, National Grid should include ft^2 only for buildings that have been completed.
- Finding 9: New construction and retrofit activity is likely to change year to year, but is currently modeled as a static value. In the CCEI model, National Grid assumes a static 2,500,000 ft^2 of new construction activity per year.
  - Recommendation 9: The CCEI model should incorporate an annual new construction activity growth rate as a more realistic representation of the market.

5 Attribution Logic Review

This section describes the attribution review plan from the evaluation work plan, the Team's hypotheses on how code cycles affect attribution, and our attribution methodology.

5.1 Attribution Review Plan

The goal of conducted the attribution logic review is to develop an empirically-based attribution rate, as requested by the Rhode Island Public Utility Commission (PUC). The steps outlined in the work plan are:

- Develop an integrated attribution model.
- Assess the influence of other entities involved in code compliance enhancement.

5.1.1 Code Cycles

The Team believes that compliance estimates should be understood to change over time because code compliance is likely to increase over the code cycle.

5.1.1.1 Residential Code Cycle

NMR conducted the Rhode Island 2011 residential baseline study at the beginning of the 2009 code cycle and calculated a 56% compliance rate. Since Rhode Island is commencing the 2012 IECC code cycle on October 1, 2013, a 56% compliance estimate is appropriate for the beginning of the 2012 code cycle, assuming no new program activities.

The original model and the recommended CCEI model assume that Residential New Construction (RNC) and Renovation/Rehabilitation Program homes are 100% energy code compliant. The Team did not include program homes in the 2011 Rhode Island Residential baseline study. and the original and recommended CCEI residential savings model do not include them either. Accordingly, the target compliance rate for non-program homes can be lower than 90% since the weighted average of non-program homes and program homes will need to be at least 90%. The Team has provided the resulting estimates for compliance with 2012 IECC for non-program homes, assuming that builders complete no homes or buildings under the 2012 IECC in 2013. While the original model included RNC programs as an attribution factor, we recommend removing them from the attribution model since program homes are not part of the savings estimates. Based on the 90% weighted compliance for program and non-program homes, we calculate a target non-program home code compliance rate of 86% by 2017. The 86% target compliance rate for non-program homes is a weighted average of non-program home new construction target compliance, retrofit target compliance, and100% program home compliance, to reach 90% compliance overall.[32]

[32] See the "Res. Attr. No program. infl."tab in the accompanying spreadsheet for details.

5.1.1.2 Commercial Code Cycle

DNV KEMA conducted the 2012 Rhode Island commercial baseline study on a sample of buildings from 2008-2011 Dodge data.[33] The DNV KEMA report indicates that most of the buildings in the sample had permits under the 2006 IECC. Rhode Island mandated the 2009 IECC as of July 2010, but RIBCC only permitted three buildings in the sample under that code. Thus, the reported 70% compliance is an end-of-code-cycle estimate and should be adjusted with an estimate for the beginning of code cycle compliance with 2012 IECC. We estimate a compliance rate of 52% for the beginning of 2012 IECC code cycle, assuming no new program activities. We estimated 52% by taking into account naturally occurring market adoption (NOMAD) and ongoing programs and using a similar change in business-as-usual compliance over the code cycle as the residential model. The final compliance rate should be at least 90%, including program and non-program residences and commercial buildings.

Since the DNV KEMA did not remove commercial buildings from the 2012 Rhode Island baseline study, and since we do not know the penetration rates for commercial new construction and retrofit programs we cannot develop a savings model that removes these buildings from the analysis. Accordingly, for commercial code compliance we set a target of 90%, which includes non-program and program buildings. Given the longer building time required from commercial buildings the Team projects compliance achieved by 2018, rather than by 2017.[34]

5.1.1.3 Estimated 2012 IECC Code Compliance

In Table 5-1, the Team has provided the resulting estimates for residential and commercial code compliance with 2012 IECC.

Table 5-1: Estimated 2012 IECC Code Compliance

Year	Residential Code Compliance (without NC and RF Program Influence)	Commercial Code Compliance
2014	58%	55%
2015	66%	60%
2016	82%	70%
2017	86%	80%
2018	--	90%

5.2 Methodology

The Team reviewed the raw data from interviews that DNV KEMA conducted with Rhode Island code officials.[35] The Team conducted in-depth interviews with the Rhode Island Building

[33] DNV KEMA, Energy & Resource Solutions and APPRISE. "Draft Final Report Rhode Island Energy Code Compliance Baseline Study." July 23, 2012. http://www.rieermc.ri.gov/documents/evaluationstudies/2012/RI%20Code%20Compliance20Baseline%20Study%20%20Final%20Report%20-%20July%2023%202012.pdf

[34] NMR understands that Rhode Island is on a three year code cycle and assumes that the RIBCC would likely mandate the 2015 IECC starting October 1, 2016.

[35] Cadmus Group, August 2012, Rhode Island Residential Building Codes: Views of Builders and Code Officials. See also the 2012 DNV KEMA commercial baseline study discussed above.

Code Commission (RIBCC), Northeast Energy Efficiency Partnerships (NEEP), Rhode Island Builders Association (RIBA), and Conservation Services Group (CSG), the program implementer for National Grid. The Team worked closely with National Grid to gather information on a wide range of activities. The Team also conducted web searches to gather background information and additional information on the possible influence of diverse entities.

The Team compared the size and scope of the efforts from other entities to the efforts planned by National Grid for 2014 and developed estimates of the percentages of gross savings attributable to the National Grid CCEI program, naturally occurring market adoption (NOMAD), and other code compliance efforts, along with non-compliance. The original model shows NOMAD as a separate step from attribution, but we recommend developing estimates of NOMAD, attribution to CCEI, attribution to other code compliance efforts, and non-compliance in a single step, because all involve unknowns or counterfactuals and must be estimated rather than directly measured.

The Team estimated attribution percentages for CCEI residential and commercial savings and applied these to the recommended gross technical potential savings (GTP) to develop net savings (post-attribution). The recommended model is detailed in the accompanying spreadsheet.

5.3 Original Attribution Model Deemed Attribution

The Arizona (AZ) negotiated value is 33%, based on an estimate of Program Administrator (PA) activities influencing code compliance.[36,37] Based on the Arizona estimate, National Grid and the Rhode Island Public Utility Commission (PUC) negotiated a deemed attribution rate of 40% for National Grid for 2013, estimating that National Grid has a somewhat larger influence on code compliance in Rhode Island than the PA in Arizona.

5.4 Original Residential Attribution Model

The original residential attribution model starts with the 56% baseline code compliance rate, the code compliance rate jump (90%-56%=34%), and maximum potential improvement (34%/(1-56%)=77%). Maximum potential improvement provides the link between code compliance improvement and potential energy savings per home (Table 5-2).

Table 5-2: Residential Inputs

Residential Inputs	Percentages
Baseline code compliance rate	56%
Maximum code compliance rate	90%
Code compliance rate jump	34%
Percent of max potential improvement	77%

[36] http://neep.org/Assets/uploads/files/emv/emv-products/NEEP_IMT_IEE_Codes%20Attribution%20FINAL%20Report%2002_16_2013.pdf

[37] See also http://www.aceee.org/files/proceedings/2012/data/papers/0193-000174.pdf

The original model multiplies the 2012 Delta (per home) (83 Therms for Heating) by the percent of maximum potential improvement (77%) and the number of non-program homes in year 1 to determine Estimated Annual Savings (Table 5-3).

Table 5-3: Residential Estimated New Construction Annual Savings: Original Model

Estimated Annual Savings	Heating (Therms)	Heating (kWh)	Cooling (kWh)	Lighting (kWh)
Potential energy savings from reaching max compliance in new construction (2012 IECC) – 2013	41,608	49,128	(10,527)	686,211
Potential energy savings from reaching max compliance in new construction (2012 IECC) - 2014	42,233	49,865	(10,685)	696,504
Potential energy savings from reaching max compliance in new construction (2012 IECC) - 2015	42,866	50,613	(10,846)	706,952
Potential energy savings from reaching max compliance in new construction (2012 IECC) - 2016	43,509	51,372	(11,008)	717,556

The original model multiplies the estimated annual savings by the percent of annual net savings achieved, which is the percent of savings that National Grid aims to claim for CCEI each year, starting in 2013 (Table 5-4). This results in gross savings (pre-attribution) shown in Table 5-5.

Table 5-4: Percent of Annual New Construction Net Savings Achieved: Original Model

Percent of Annual Net Savings Achieved	Percent
2013	11%
2014	22%
2015	66%
2016	100%

Table 5-5: New Construction Gross Savings (pre-attribution): Original Model[38]

Gross Savings (pre-attribution)	Heating (Therms)	Heating (kWh)	Lighting (kWh)
2013	4,577	5,404	75,483
2014	9,291	10,970	153,231
2015	28,292	33,405	466,588
2016	43,509	51,372	717,556
4-year Cumulative savings	85,669	101,151	1,412,858

[38] Revised original numbers: Percent of annual net savings achieved corrected to 11% from 11.111% for 2013 and 22% from 22.222% for 2014.

The original model then applies the deemed 40% (1-0.6) attribution factor to determine net savings (post-attribution) (Table 5-6). For both residential and commercial attribution, the original model combines several entities into one attribution factor of 60%.[39]

Table 5-6: New Construction Net Savings (post-attribution): Original Model

Gross Savings (pre-attribution)	Heating (Therms)	Heating (kWh)	Lighting (kWh)
2013	1,831	2,162	30,193
2014	3,716	4,388	61,292
2015	11,317	13,362	186,635
2016	17,404	20,549	287,022
4-year Cumulative savings	34,268	40,460	565,143

5.5 Original Commercial Attribution Model

The original commercial attribution model starts with Rhode Island attribution of 100%, noting "100% savings max attributable to the PAs (similar to the AZ [Arizona] model)." The Team understands the Rhode Island attribution of 100% in the commercial sections of the NC and RF Inputs tabs in the National Grid savings methodology spreadsheet to be a rescaling of the 20% of estimated code compliance improvement (90% goal minus 70% baseline compliance). Given that this percentage will be 100% regardless of code compliance levels, it does not need to be in the model and the Team recommends removing it. In addition, the original residential model does not apply such a percentage and we recommend using similar models when possible.

The original and recommended models target 90% compliance. The commercial baseline study compliance rate is 70%. The commercial model applies the 20% non-compliance rate (90%-70%=20%) to the 2012 IECC EUI to determine the Delta EUI. The Delta EUI (9.4) is multiplied by the average thousand square feet (2,500 ksf for commercial new construction) and the percent of annual delta max savings used above (11%, 22%, 66%, 100%; for years 1-4) to calculate compliance energy savings (pre-attribution) (Table 5-7).

Table 5-7: Commercial Compliance Energy Savings (pre-attribution): Original Model

Compliance Energy Savings (pre-attribution)	2013	2014	2015	2016	4-year cumulative savings	
Code compliance savings w/ 90% compliance	2,572	5,143	15,429	23,378	46,521	MMBTU
Electric component - 59%	445	889	2,668	4,042	8,044	MWh
Gas component - 41%	10,543	21,087	63,260	95,848	190,738	Therms

[39] The original model states "60% to other efforts; NEEP, Rhode Island Code Commissioner, PA New Construction program."

The commercial model then applies the National Grid attribution factor of 40% to determine commercial compliance energy savings (post-attribution) (Table 5-8).

Table 5-8: Commercial Compliance Energy Savings (post-attribution): Original Model

Compliance Energy Savings (pre-attribution)	2013	2014	2015	2016	4-year cumulative savings	
Code compliance savings w/ 90% compliance	1,029	2,057	6,172	9,351	18,609	MMBTUs
Electric component - 59%	178	356	1,067	1,617	3,218	MWh
Gas component - 41%	4,217	8,435	25,304	38,339	76,295	Therms

5.6 Recommended Attribution Model

As indicated above, the Team recommends estimating NOMAD, attribution to CCEI, attribution to other code compliance efforts, and non-compliance in a single step, because all four involve counterfactuals (so named because they are counter to fact) and must be estimated rather than directly measured. The Team model identifies the key entities individually in order to assess their separate effects on compliance.

5.6.1 Naturally Occurring Market Adoption

The Team recommends including naturally occurring market adoption (NOMAD) in the attribution model. NOMAD is the influence of technological and market changes, and includes the influence from past program activities.

5.6.2 Rhode Island Building Code Commission

The Rhode Island Building Code Commission (RIBCC) is a leading actor in code compliance enhancement efforts. In addition to their core work developing the code and educating code officials and inspectors on code compliance, the RIBCC is actively working with National Grid and other entities on code compliance enhancement initiatives.

As in past years, in 2013, the RIBCC had the International Code Council (ICC) conduct mandatory training courses for building officials and inspectors. These courses were on the building code in general, but included energy code training. In the fall of 2013, RIBCC will lead six training sessions on the building code and will lead six to twelve large events on the building code. The building commissioner expected 39 building officials and about 20 building inspectors to attend each event, along with others recruited by National Grid's implementation contractor Conservation Services Group (CSG).[40] Based on past events, NEEP estimated that each commercial session would have about 180 attendees and each residential session would have about 150 attendees. Since November, 2010, RIBCC has been working with National Grid and

[40] Energy & Resource Solutions (ERS) is serving as a subcontractor to CSG on the commercial program.

NEEP on planning code compliance enhancement initiatives.[41] The three organizations have decided upon leading smaller events in 2014, which some code officials will attend. These smaller events will include onsite visits to buildings to view quality and poor installations. NEEP estimated that the smaller training sessions might have about 40 people.

5.6.3 National Grid Commercial[42] and Residential Programs[43,44]

While, the original model cites "PA New Construction" programs in the 60% of other attribution factors, the Team recommends removing RNC and RRF programs from the residential attribution model because National Grid and the Team assumes that these homes are 100% compliant. The 2011 baseline study did not include program homes thus no energy savings estimates are available for them; accordingly, the original and recommended savings models remove program homes from the savings calculations.

The commercial compliance study did not remove program buildings; accordingly, the 70% compliance rate and energy savings estimates include program buildings. Market penetration for program buildings is not available; but we have estimated overall new construction and retrofit penetration to be 5%, based on program participation estimates provided by National Grid. Even while estimating program market penetration, the Team does not have the necessary information to estimate energy savings for these program buildings so it is not possible to remove them from the savings model; thus we include NC and RF programs as a commercial attribution factor.

When asked about the influence of programs on code compliance, National Grid indicated that, as part of program activities, engineering teams educate developers on the code. When teams find that a project is not meeting code requirements the engineering team helps the developers meet code. National Grid indicated that going forward they can track this program activity in order to link the program to code compliance, and the Team recommends that National Grid do so.

National Grid indicated that program buildings in the comprehensive building program are likely 100% code compliant; however program buildings in the prescriptive program are not necessarily 100% compliant. Accordingly, the Team recommends that only buildings in the comprehensive commercial program should be assessed as program buildings, which are 100% compliant. [45]

If National Grid determines that program homes and buildings are not meeting 100% code compliance then it should include them in savings estimates, with an adjustment for their

[41] See slides 20-24 for background on Rhode Island collaboration efforts:
http://www1.eere.energy.gov/wip/solutioncenter/pdfs/municipalpartnershipscodesenhancement.pdf
[42] http://www.nationalgridus.com/narragansett/business/energyeff/energyeff.asp
[43] https://www1.nationalgridus.com/BuildRI-RI-RES
[44] https://www1.nationalgridus.com/files/AddedPDF/POA/2012%20RI%20Application.pdf
[45] For similar recommendations on comparability in code compliance studies see "Lessons Learned from Building Energy Code Compliance and Enforcement Evaluation Studies." Harry Misuriello et al. 2010 ACEEE Summer Study on Energy Efficiency in Buildings. Page 8-249.

estimated code compliance rate as program homes might have a higher compliance rate (e.g. 65%, rather than the 56% found in the baseline study). If National Grid includes these homes and buildings in the savings models then it should include these in the attribution logic as well. The Team presents an alternate residential attribution model that includes the independent influences of residential NC and RF [46] programs. The alternate recommended model lists them independently because of differences in program market penetration. For both the residential and commercial models, if National Grid includes attribution to NC and RF programs, then National Grid should also independently identify the programs because of differences in square footage for NC and RF in the market. National Grid currently estimates retrofit square footage for all construction to be 350% of that of new construction. National Grid could use this estimate for program homes and buildings, but would ideally calculate or estimate the ratio of retrofit to new construction square footage for program homes and buildings.

In the alternate residential recommended model, the team has estimated attribution to these programs without a Net-to-Gross (NTG) adjustment, based on the *Rhode Island Technical Reference Manual for Estimating Savings from Energy Efficiency Measures: 2013 Program Year*,[47] which indicates a 1.00 Net-to-Gross (NTG) ratio for program activities.

5.6.4 Past National Grid Training and Education Initiatives

National Grid has conducted a number of training and education initiatives over several years that have helped to improve code compliance.[48] The Team considers these to be past program influences, which have ongoing influence, and which will be now be gradually supplanted by CCEI. The Team believes that National Grid should be able to claim savings from these activities.

5.6.5 Northeast Energy Efficiency Partnerships

The Team recommends including NEEP activities under National Grid since National Grid is paying NEEP a fee for their work in Rhode Island. NEEP facilitated code discussions with Commissioner Leyden, is working with RIBCC and National Grid on training initiatives, and is a member of the CCEI advisory group. NEEP's efforts are notable for their research and outreach on code compliance,[49] especially for their work on schools and the CHPS program.[50]

[46] Other than CCEI, the only new element is the Residential Renovation/Rehabilitation program, which is a pilot program that began in 2012, and is offered as part of the New Construction program. The Team understands that National Grid plans for the renovation program to be a full part of the program in the 2014 plan, barring any budget constraints.

[47] See Appendix B, *Rhode Island Technical Reference Manual for Estimating Savings from Energy Efficiency Measures: 2013 Program Year*. National Grid.

[48] See Section B.1.3 in the Appendix for details.

[49] See https://www.neep.org/public-policy/energy-efficient-buildings/building-energy-codes/model-progressive-building-energy-codes-policy

[50] http://www.neep.org/public-policy/energy-efficient-buildings/high-performance-schools/northeast-chps

5.6.6 Rhode Island Builders Association

The Rhode Island Builders Association (RIBA) has worked with CSG, advertising and hosting recent CSG focus groups to understand builder needs for code compliance enhancement. The Executive Director said that RIBA is actively working with CSG, but indicated no specific plans for the fall of 2013 or for 2014.

5.6.7 Rhode Island Green Building Council

RIGBC will conduct at least two Fall 2013 trainings, which suggests that they might have similar events in 2014.[51] RIGBC is running a LEED V4 overview September 18th, 2013 and a High Performance Framed Wall Assemblies presentation on October, 2nd, 2013.[52] While RIGBC influences the market, it is likely to have little influence on bringing buildings to code, as most builders attending RIGBC events already likely build at, or close to, code. However, RIGBC work on increasing awareness and understanding of the Green Buildings Act (GBA) will probably positively influence code compliance more generally.[53] The GBA requires that some public buildings be built to higher than code requirements. Similar to NC and RF program homes and buildings, National Grid may want to assume 100% compliance and remove GBA-required buildings from the savings model and reduce RIGBC attribution accordingly.

Alternately, National Grid could consider GBA requirements to be code requirements that should be included in savings models (to GBA energy-saving standards) and to which the RIGBC, CCEI and other entities would receive attribution.

5.6.8 Various Entities

As part of this evaluation, the Team asked interviewees from RIBCC, RIBA, NEEP, and CSG about other entities involved in code compliance efforts. These interviewees indicated no other entities leading enhancement efforts, but said some organizations are helping to build awareness. The interviewees cited:

- The Rhode Island American Institute of Architects (RI AIA)
- RIGBC (specified above), and
- Apeiron (a Rhode Island non-profit focused on sustainable development).[54]

National Grid also provided a list from CSG of organizations potentially having an influence on code compliance in Rhode Island.[55] Based on interviews, it appears that these organizations promote code compliance training sessions, but do not have independent enhancement efforts.

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[51] Activities listed here:
http://usgbcri.org/content/index.php?option=com_content&view=section&layout=blog&id=9&Itemid=56

[52] https://events.r20.constantcontact.com/register/eventReg?llr=octzzydab&oeidk=a07e82t7jqmf0becd91&oseq=a021jkhkmw2sjb

[53] http://sos.ri.gov/documents/archives/regdocs/released/pdf/DOA/6248.pdf

[54] One interviewee said Apeiron would help to make people aware of the training events; however a review of their website suggests that they are not a very active organization as their last, limited events were in 2012 and 2010. http://www.apeiron.org/new/aboutus/programs.php

The Department of Energy (DOE) website provides information on code compliance enhancement activities by the RIBCC, National Grid, and NEEP, along with other organizations such as the Rhode Island Office of Energy Resources (OER).[56]

The NEEP website notes that The Energy Efficiency and Resource Management Council (EERMC) provides oversight for and input to the state's efficiency programs.[57] The EERMC website indicates that they are working with Rhode Island Code Commissioner, Jack Leyden, and Department of Administration Policy Director Allison Rogers on building code and other green building initiatives.[58] The EERMC meets monthly but only discusses code compliance when it is suggested by National Grid. This information suggests that they are not very active and thus should receive little attribution. [59]

5.6.9 National Grid's Code Compliance Enhancement Initiative

The Code Compliance Enhancement Initiative (CCEI) is part of National Grid's Codes and Standards (C&S) Initiative (see Section B.1.1 in the appendix), identified in the Energy Efficiency Program Plan for 2013, which National Grid submitted to the Rhode Island Public Utility Commission (PUC). CCEI aims to increase the ability and desire of architects, engineers, contractors, and construction managers to comply with energy codes and improve the ability of local building departments to enforce the code.[60] CCEI includes trainings, technical assistance energy code circuit riders, who act as consultants on energy codes, support for third-party inspections, and documentation tools planned for 2014.[61]

5.6.10 Non-Compliance

Non-compliance is calculated as one minus compliance resulting from any source, including NOMAD and all compliance efforts.

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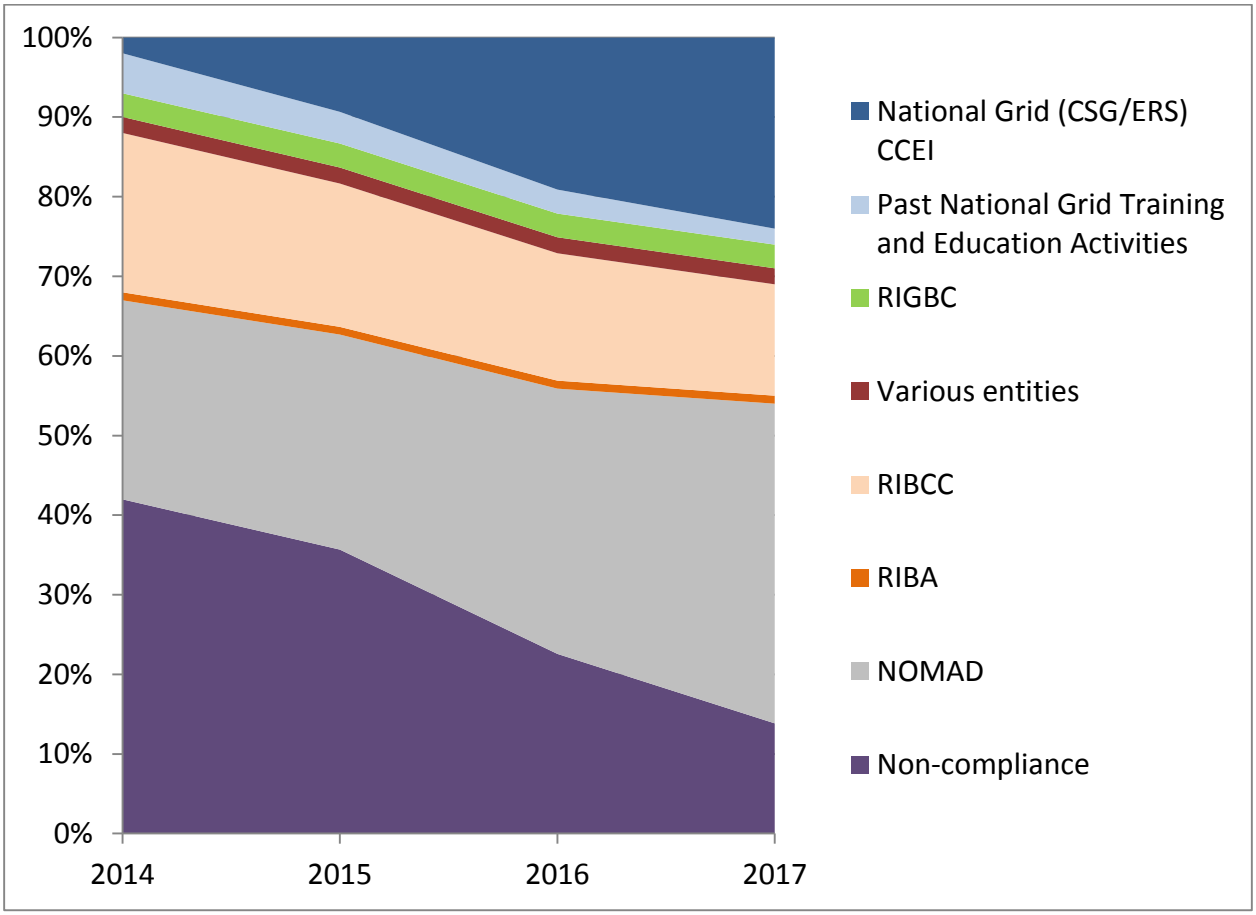
[55] See the Appendix, Section B.1.3.
[56] http://www1.eere.energy.gov/wip/solutioncenter/pdfs/municipalpartnershipscodesenhancement.pdf
[57] http://www.neep.org/public-policy/policy-outreach-analysis/state-activities/rhode-island
[58] http://www.rieermc.ri.gov/
[59] http://www.rieermc.ri.gov/documents/minutes/2013/1_January%2010,%202013.pdf
[60] Page 21. http://www.ripuc.org/eventsactions/docket/4366-NGrid-2013EEPP(11-2-12).pdf
[61] In the Appendix, Section B.1.3 provides details on a number of trainings and webinars that National Grid has conducted over the past few years.

5.7 Recommended Attribution Model Estimates

The recommended residential attribution model for non-program homes, not including NC and RF influence is shown in Figure 5-1. Non-compliance decreases over time to 14% in 2017,[62] as NOMAD increases to 40% and CCEI increases to 24% (Table 5-9).[63] The estimate of 2% attribution for CCEI vs. 20% for RIBCC in 2014 stems from the fact that the RIBCC's activities have occurred for years and are likely to have an immediate effect on compliance, whereas CCEI's activities are just ramping up; we expect the relative importance of CCEI's activities to increase over time, to 24% (vs. 14% for RIBCC) by 2017.

Figure 5-1: Residential Attribution (without the Influence of NC and RF Programs)



[62] As a reminder, the target non-compliance rate for non-program homes can be higher than 10% (100%-90%) because the weighted average non-compliance of non-program and program homes should equal 10%, with program homes assumed to be 100% compliant.

[63] The residential attribution model including the influence of NC and RF Programs is shown in the accompanying spreadsheet.

Table 5-9: Residential Attribution (without the Influence of NC and RF Programs)

RI Entities for Residential Attribution	2014	2015	2016	2017
NOMAD	25%	27%	33%	40%
RIBCC	20.0%	18.0%	16.0%	14.0%
Past National Grid Training and Education Activities	5.0%	4.0%	3.0%	2.0%
RIBA	1.0%	1.0%	1.0%	1.0%
RIGBC	3.0%	3.0%	3.0%	3.0%
Various entities	2.0%	2.0%	2.0%	2.0%
National Grid (CSG/ERS) CCEI	*2%*	*9%*	*19%*	*24%*
Non-compliance	42%	36%	23%	14%
Total	**100%**	**100%**	**100%**	**100%**

The recommended commercial attribution model for non-program and program buildings is shown in Figure 5-2. Non-compliance decreases over time to 10% in 2018, as NOMAD increases to 39% and CCEI increases to 23% (Table 5-10).

Figure 5-2: Commercial Attribution (with the Influence of NC and RF Programs)

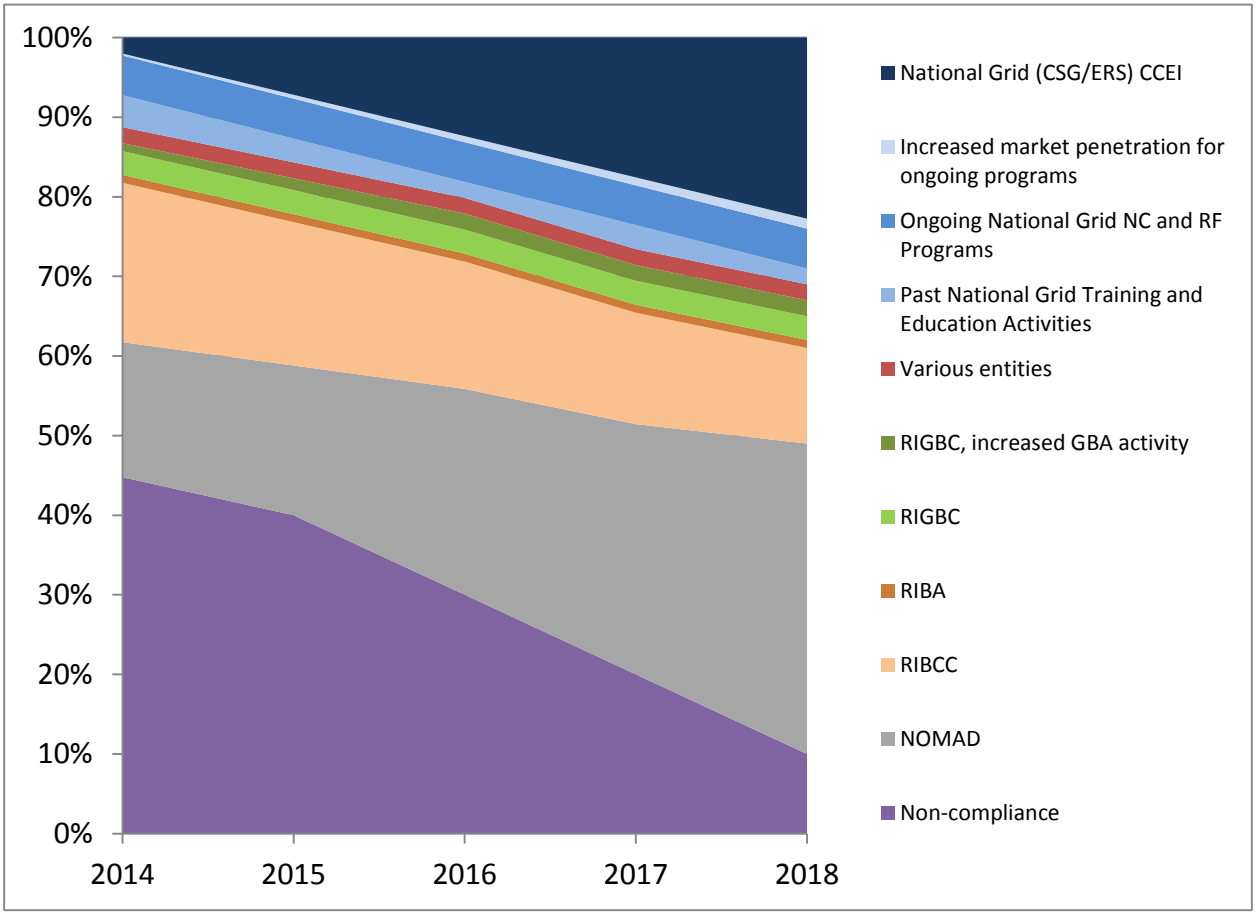


Table 5-10: Commercial Attribution (with the Influence of NC and RF Programs)

RI Entities for Commercial Attribution	2014	2015	2016	2017	2018
NOMAD	17%	19%	26%	31%	39%
Ongoing National Grid NC and RF Programs	5%	5%	5%	5%	5%
Increased market penetration for ongoing programs	--	1%	1%	1%	1%
RIBCC	20%	18%	16%	14%	12%
Past National Grid Training and Education Activities	4%	3%	2%	3%	2%
RIBA	1%	1%	1%	1%	1%
RIGBC	3%	3%	3%	3%	3%
RIGBC, increased GBA activity	1%	2%	2%	2%	2%
Various entities	2%	2%	2%	2%	2%
National Grid (CSG/ERS) CCEI	*2%*	*7%*	*12%*	*18%*	*23%*
Non-compliance	45%	40%	30%	20%	10%
Total	**100.0%**	**100.0%**	**100%**	**100.0%**	**100%**

5.8 Recommended Attribution Savings Estimates

This section describes the recommended model's development of savings estimates with attribution to CCEI.

5.8.1 Residential Percent of Maximum Potential Improvement

The Team used residential CCEI attribution and the baseline compliance rate of 56% to determine the percent of maximum potential improvement in savings due to CCEI. The formula is CCEI Attribution/ (1-56%) (Table 5-11).

Table 5-11: Residential Percent of Maximum Potential Improvement

Year	CCEI Attribution	Percent of Max. Potential Improvement
2014	2%	5%
2015	9%	21%
2016	19%	43%
2017	24%	55%

5.8.1.1 Residential New Construction

The Team applied the residential percent of maximum potential improvement to the GTP estimates in Table 3-7 to estimate net savings attributable to CCEI for residential new construction (Table 5-12).

Table 5-12: Residential New Construction Net Savings Post-attribution

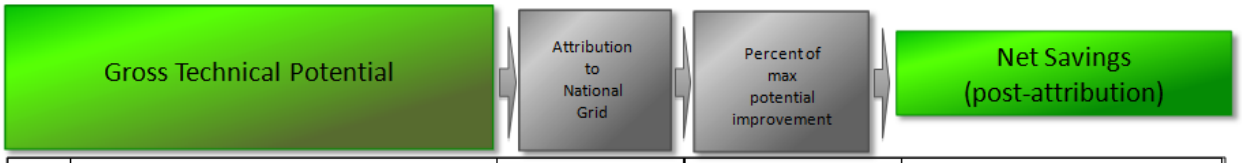
Year	Heating (Therms)	Heating (kWh)	Lighting (kWh)
2014	2,988	3,504	49,008
2015	14,663	17,194	240,858
2016	30,855	36,181	506,846
2017	39,610	46,447	650,650
4-year Cumulative Savings	88,116	103,326	1,447,441

5.8.1.2 Development of Net Program Savings Post-attribution: Example Residential New Construction

The following chart summarizes how the Team used the savings model, CCEI attribution, and the percent of maximum potential improvement to determine net savings post-attribution, using residential new construction as an example[64] (Figure 5-3).

[64] For Heating (Therms), for example, we multiplied the GTP of 65,743.2 by the 4.545% maximum potential improvement to arrive at 2,988 Heating (Therms) net savings (post-attribution).

Figure 5-3: Development of Net Program Savings Post-attribution: RNC Example



	Gross Technical Potential				Percent of overall compliance rate attributable to National Grid (CSG/ERS) CCEI	Percent of max potential improvement	Net Savings (post-attribution)		
	Heating (Therms)	*Heating (kWh)*	*Cooling (kWh)*	*Lighting (kWh)*			*Heating (Therms)*	*Heating (kWh)*	*Lighting (kWh)*
2014	65,743	77,091	(16,417)	1,079,928	2%	=2%/(1-56%)=5%	2,988	3,504	49,088
2015	69,125	81,056	(17,261)	1,135,471	9%	=9%/(1-56%)=21%	14,663	17,194	240,858
2016	71,039	83,301	(17,739)	1,166,924	19%	=19%/(1-56%)=43%	30,855	36,181	506,846
2017	72,618	85,153	(18,133)	1,192,858	24%	=24%/(1-56%)=55%	39,610	46,447	650,650
						Cumulative Savings	**88,116**	**103,326**	**1,447,441**

5.8.1.3 Residential Retrofit

The Team applied the residential percent of maximum potential improvement to the GTP estimates in Table 3-8 to estimate net savings attributable to CCEI for residential retrofits (Table 5-13).

Table 5-13: Residential Retrofit Net Savings Post-attribution

Year	Heating (Therms)	DHW (Therms)	Heating (kWh)	DHW (kWh)	Cooling (kWh)	Lighting (kWh)
2014	6,881	383	2,810	2,129	6,088	26,011
2015	33,001	1,856	13,613	10,313	29,495	126,023
2016	69,719	3,922	23,759	21,787	62,311	266,239
2017	89,793	5,051	37,040	28,060	80,252	342,897
4-year Cumulative Savings	199,324	11,212	82,221	62,289	178,146	761,170

5.8.2 Commercial Percent of Maximum Potential Improvement

Similar to the residential estimate, the Team used commercial CCEI attribution and the estimated baseline compliance rate[65] to determine the percent of maximum potential improvement in savings due to CCEI. The formula is CCEI Attribution/ (1-52%) (Table 5-14).

[65] As discussed above, the Team estimated the start-of-code-cycle commercial compliance rate to be 52%.

Table 5-14: Commercial Percent of Maximum Potential Improvement

Year	CCEI Attribution	Percent of Max. Potential Improvement
2014	2%	4%
2015	7%	15%
2016	12%	26%
2017	18%	37%
2018	23%	47%

5.8.2.1 Commercial New Construction

The Team applied the commercial percent of maximum potential improvement to the GTP estimates in Table 4-3 to estimate net savings attributable to CCEI for commercial new construction (Table 5-15).

Table 5-15: Commercial New Construction Net Savings Post-attribution

Year	Compliance Savings (MMBTUs)	Electric Component (MWh)	Gas Component (Therms)
2014	2,352	407	9,643
2015	8,579	1,483	35,173
2016	14,992	2,592	61,467
2017	21,596	3,734	88,542
2018	28,394	4,910	116,416
5-year Cumulative Savings	75,912	13,126	311,240

5.8.2.2 Commercial Retrofit

The Team then applied the commercial percent of maximum potential improvement to the GTP estimates in Table 4-4 to estimate net savings attributable to CCEI for commercial retrofits (Table 5-16).

Table 5-16: Commercial Retrofit Net Savings Post-attribution

Year	Compliance Savings (MMBTUs)	Electric Component (MWh)	Gas Component (Therms)
2014	16,129	2,789	66,129
2015	58,833	10,173	241,216
2016	102,815	17,778	421,541
2017	148,103	25,609	607,221
2018	194,726	33,670	798,377
5-year Cumulative Savings	520,606	90,019	2,134,484

5.9 Attribution Logic Recommendations

This section presents the key findings and recommendations that the Team identified during the attribution logic model review.

- Finding 1: The original model assumes that 90% code compliance will be achieved by 2017, at the end of the 2012 code cycle. Ninety percent code compliance is a weighted average that includes program homes and buildings. The Team does not include program homes in the recommended residential savings and attribution models because National Grid and the Team understand these homes to be 100% code compliant. The Team has estimated an 86% target compliance rate for non-program homes, which is a weighted average of non-program home new construction and retrofit target compliance reaching 90% compliance when averaged with 100% program home compliance. The commercial baseline study and original savings model included program buildings so the Team has included program buildings in the recommended commercial and attribution models, retaining the 90% target compliance rate.
    - Recommendation 1a: Calculate compliance at the end of the code cycle, after National Grid CCEI activities have taken place, to determine whether homes meet the 90% compliance requirement. The sample should consist of homes and buildings permitted under the 2012 IECC from April through September of 2016, assuming a six-month period allows a large enough sample. The study should be done at the end of 2017 for homes at the end of 2018 for commercial buildings to allow for adequate time for builders to adjust to the 2012 code, thus sampling buildings that should have higher levels of compliance. The code compliance calculation should include program homes and non-program homes and buildings, which both count toward the 90% compliance target.
    - Recommendation 1b: Conduct a net savings evaluation of CCEI, interviewing Rhode Island builders to measure the influence of CCEI on building practices, as well as the influence of other factors that could have caused the change, including "natural" evolution of technology and practices (NOMAD), past and future code requirements, PA programs, programs offered by other entities such as the state and federal governments, energy prices, the economy, climate change, etc.

Conduct a Delphi survey among a panel of experts to develop a final net savings estimate and attribution to CCEI. Panelists would be presented with the initial estimates of CCEI influence from the builder surveys. In addition, panelists would receive information on findings from baseline studies conducted in the last several years. Finally, panelists would receive information about associated program requirements over the years, changes in code for those parameters, and program efforts that have targeted changes in those areas.

- Finding 2: The original model uses the compliance baseline findings (56% for residential; 70% for commercial) as starting compliance rates for the 2012 IECC code cycle. However, 56% residential compliance is from the beginning of the 2009 IECC code cycle and the 70% commercial compliance is from the end of the 2006 IECC cycle.
    - Recommendation 2: The Team recommends using 56% compliance for the beginning of the 2012 IECC code cycle for the residential model and 52% for the commercial model.
- Finding 3: The original residential model calculates Estimated Annual Savings, assuming 90% compliance and a potential improvement of 77%. The residential model adjusts for the Percent of Annual Net Savings Achieved to determine Gross Savings (pre-attribution) and applies the CCEI attribution factor of 40%. The original commercial model applies the 20% (90%-70%) non-compliance rate to the 2012 IECC EUI to determine the Delta EUI. The model multiplies Delta EUI by the square footage of commercial new construction and applies the Percent of Annual Net Savings Achieved and the CCEI 40% attribution factor.
    - Recommendation 3: The Team recommends first calculating gross technical potential (GTP) savings at 100% compliance with 2012 IECC and then calculating NOMAD, all attribution factors, and non-compliance in one step. The Team recommends a revised percent of maximum potential improvement, which is the CCEI attribution percent divided by one minus the starting compliance rate (for the residential model in 2014: 2%/(1-56%)=5%; for the commercial model: 2%/(1-52%)=4%). The Team then recommends multiplying the percent of maximum potential improvement by the GTP to determine net savings due to CCEI. The maximum potential improvement calculation converts the yearly CCEI attribution into an estimate of energy savings increased from the baseline code compliance rate that is attributable to CCEI.
- Finding 4: The commercial compliance baseline study included commercial NC and RF buildings in the 70% compliance estimate. The energy savings for NC and RF commercial buildings are not known so it is not possible to remove program building savings from the savings model, which National Grid would need to do when assuming 100% compliance and no influence from CCEI on their compliance rate. Commercial program buildings, and even program homes, may not be 100% compliant.

  - Recommendation 4a. Estimate the market penetration of commercial program buildings so that a) National Grid can remove or adjust them in the saving model, or b) National Grid can better estimate program attribution if keeping them in the savings model.
  - Recommendation 4b. Future baseline studies should provide energy savings estimates for program and non-program buildings (and homes) so that National Grid can calculate the energy savings from each type of building and include or remove them in savings models as appropriate.
  - Recommendation 4c: Consider conducting research to estimate the percent of commercial program buildings that are 100% code compliant or are significantly more compliant than non-program buildings. If program buildings are 100% compliant and if National Grid estimates compliance to be due to the NC and RF programs rather than to CCEI, then National Grid should remove them from the savings model. If program buildings are not 100% compliant, but are significantly more compliant than non-program buildings and CCEI influences their compliance, then National Grid should create adjustment factors to reflect their higher compliance rates in the savings and attribution models. If National Grid estimates that program buildings are not significantly more compliant than non-program buildings then it can keep them in the savings and attribution models as CCEI would be a likely influence on their compliance rate.
  - Recommendation 4d: National Grid indicated that, as part of program activities, their engineering teams educate developers on the code and that going forward National Grid can track this program activity in order to link the programs to increased code compliance. The Team recommends that National Grid in fact do so, both tracking these activities as well as assessing their influence on the market by number of projects; number and percent of projects with owner education; topic of education and relationship to code compliance.
  - Recommendation 4e: While the Team believes that assuming 100% compliance for program homes is reasonable, National Grid could also consider additional research to confirm this assumption.
- Finding 5: The RIGBC is helping to build awareness and understanding about the GBA, which requires higher building standards for some public buildings.
  - Recommendation 5a: Consider estimating the influence of the GBA on IECC 2012 code compliance. GBA buildings are likely to have higher compliance rates, which would impact the savings and attribution models. Estimate the percent of buildings that are subject to the GBA and their compliance rate.
  - Recommendation 5b: Since the GBA is a requirement for some public buildings; consider estimating savings for these buildings built to GBA standards, rather than to IECC 2012 standards. Adjust the attribution model to include compliance with the GBA and attribute influence to entities as appropriate. For example,

consider increasing attribution to RIGBC, which is helping to increase awareness and understanding about the GBA; but also consider increasing attribution to CCEI or other factors that might influence GBA compliance.

Appendix A Calendar of Recommended Activities for CCEI

Table A-17: Calendar of Recommended Activities for CCEI

Item	Update Timeline	Description of Task
Residential		
Baseline Compliance Rate	At the beginning of the 2012 IECC code cycle.	Develop a new baseline compliance estimate by conducting site visits at units permitted at the beginning of the 2012 IECC code cycle.
New Construction Modeled Savings	ASAP	Re-weight ICF modeled savings results
Retrofit Savings Estimates	ASAP	Run models similar to the models ICF ran for new construction savings estimates
Growth Rates	Annually	Update the growth rates of the new construction and retrofit markets based on current data
Market Penetration	Annually	Update the market penetration rates of the new construction and retrofit markets based on current data
Commercial		
Gross Technical Potential Savings	ASAP	Revise method for calculating gross technical potential savings for commercial new construction and retrofit building.
New Construction Baseline EUI	ASAP	Model the energy use and EUI of the buildings that were included in the DNV KEMA baseline study to establish the baseline EUI by building type.
Retrofit Baseline and Post-Retrofit EUIs	ASAP	Obtain a sample of buildings subject to 2009 IECC and retrofitted prior to 2013, and model actual baseline performance and EUI and post-retrofit performance and EUI.
Rhode Island Specific Model Inputs	Annually	Develop RI specific model building performance and market characteristic model inputs where MA based data is currently used.
Commercial Building Annual Activity	Annually	Include only buildings that have been completed in estimates of ft^2 of building activity, and use actual retrofit (additions, renovations) ft^2 information for retrofit activity.
Attribution		
Compliance over Code Cycles	ASAP	Estimate code compliance over the code cycle.
Savings and Attribution Estimates	ASAP	First calculate GTP savings at 100% compliance with 2012 IECC and then calculating NOMAD, all attribution, factors, and non-compliance in one step.

Commercial Program Buildings	ASAP	Remove from the savings and attribution model
Green Buildings Act	ASAP	Consider estimating the influence of the GBA on IECC 2012 code compliance and adjusting the savings and attribution models accordingly.
All		
Savings forecast	ASAP	Forecast savings to start in 2014.
Compliance at the end of a Code Cycle	End of 2012 IECC code cycle after CCEI efforts have been fully implemented	Determine the actual compliance at the end of a code cycle. The code compliance calculation should include program homes and non-program homes and buildings.

Appendix B Attribution Logic Elements

This appendix provides background information on code compliance enhancement efforts. The Team has reviewed documents for a sense of the size and scope of National Grid's and other entities current initiatives and planned initiatives for 2014, with the goal of developing comparable categories and types of numbers in terms of frequency of training, number of various types of people trained (code officials, builders, HVAC contractors, etc.), topics covered in the trainings, and materials provided to whom.

B.1 National Grid Initiatives

National Grid initiatives are described below.

B.1.1 The Codes and Standards (C&S) Initiative[66]

The National Grid Codes and Standards (C&S) Initiative includes CCEI,[67] which is described as follows:

1. Code compliance support: The Compliance Enhancement Initiative will be designed to increase the ability and desire of both the design community (architects and engineers) and the construction community (contractors and construction managers) to comply with the locally mandated building energy code and improve the ability of the local building departments to enforce the code.

This initiative includes the following activities, which are further specified in Table B-18, which are KPIs for CSG:

B.1.1.1 Code Compliance Support Activities

1. Trainings: The Company will identify third-party vendors[68] to deliver combinations of classroom style trainings, location-based training[69] that is geographically dispersed around the state, and accessible Web-based trainings. In addition, focus group training sessions will be conducted that are targeted towards the building envelope, HVAC, and electrical sections of the code, and also on the use of compliance software (possibly even energy modeling software). Training and outreach efforts will be developed and delivered separately for residential and commercial markets. The Company will also sponsor on-site demonstration type trainings, as these are an excellent bridge between the code requirements, classroom lessons and on-the-job-site realities.

[66] Source: http://www.ripuc.org/eventsactions/docket/4366-NGrid-2013EEPP(11-2-12).pdf.
[67] National Grid's Code Compliance Enhancement Initiative RFP:
http://www.energy.ri.gov/documents/rfp/NGRID%20Code%20Compliance%20RFP,%202.12.2013.pdf
[68] CSG/ERS. ERS subcontracts to CSG on the commercial side.
[69] RIBCC leads the classroom trainings as they are mandatory for code officials, but the location-based training seems to be a NEEP-inspired, but CSG led effort. However, when probed on this point, both RIBCC and NEEP said that the initiatives would all be organized and run by the three groups.

2. Technical Assistance Energy Code Circuit Riders: The Company proposes Energy Code Circuit Riders (Circuit Riders) as the providers of technical assistance for all Rhode Islanders. The roles of Circuit Riders are: to act as consultants on energy codes and energy efficient building design and practice; to interpret and explain code administrative requirements; and to be a go-between between participating market actors and Rhode Island's code officials. The goal of Circuit Riders would be to clarify any confusion or misunderstanding that building design and construction professionals may have about energy codes, and to ultimately support their efforts to better understand and execute code compliant building designs. The Company proposes support for at least five Circuit Riders (either individuals or firms) who will serve all the five counties in Rhode Island. They will serve as an extension of the building department staff and provide technical assistance to project teams as need arises within building departments.

3. Support for third-party inspections: In 2012, and in collaboration with NEEP, the Company assisted the Rhode Island Code Commission in incorporating legislative provision for optional/voluntary third-party inspections of the building energy code, both for residential and commercial buildings. If the State establishes this provision in 2013, the Company will support the development and implementation of technical and administrative training for any professional who wishes to become a third party inspector. Note that these trainings are distinctly separate from the trainings described above. Other states have succeeded in training and utilizing Home Energy Rating System (HERS) raters for the residential sector for both residential energy code compliance assistance and the verification of incentive-based program measures. This initiative will investigate the opportunities available to provide support for similar activities in Rhode Island.

4. Documentation Tools:[70] Much of the confusion regarding code compliance occurs in the lack of standardization of acceptable levels of documentation at the time of building permitting. A more consistent expectation of documentation and formatting requirements will allow designers and builders to more effectively communicate with plan reviewers and inspectors on how specific projects can comply with codes. The Company will develop and support consistent documentation tools such as builder manuals, software tools, checklists, and code check protocols for adoption by jurisdictions as a means of compliance enhancement.

[70] The CSG plan indicates no activity for this.

Table B-18: CSG KPIs for 2014

	Number of Activities 2013				Number of Activities 2014	
Tasks	Original Submission		Updated Proposal			
	Residential	Commercial	Residential	Commercial	Residential	Commercial
Outreach						
Attend code officials meetings	--	--	3	3	6	6
Bulletins	--	--	1	1	4	4
Focus groups	--	--	4	3	--	--
Website	--	--	1	1	1	1
Recruit partners	--	--	4	4	--	--
Trainings						
Trainings report	--	--	1	1	12	12
Classroom Trainings	6	6	4	4	12	12
Webinars	6	6	--	--	20	16
Focus group trainings	6	6	--	--	2	2
On-site trainings	3	3	1	1	4	4
Circuit Rider Technical Assistance						
Phone calls	--	--	15	15	50	50
Visits	2	3	8	8	20	20
FAQ	--	--	1	1	4	4
3rd Party Inspection Support	5	4	N/A	N/A		
Recruit partners	--	--	10	10	30	30
Documentation Tools	N/A	N/A	N/A	N/A		
Total	**28**	**28**	**53**	**52**	**165**	**161**

B.1.2 National Grid Residential and Commercial Program Activities

There are many commercial building types (e.g. office, retail) and each market section may interpret the code differently so it is hard to know the influence of the program on the market. Schools had had a higher participation rate, as indicated in the compliance study.[71] Architects and engineers have more influence in commercial work and may be more aware of code. Thus, there is a better awareness, but the commercial code is more complex. Safety is more important than energy issues in commercial building.

[71] School aim for higher performing buildings with NE CHPs: http://www.chps.net/dev/Drupal/node/35.

National Grid estimated 200 participants[72] in 2012 in the C&I New Construction program, but could not estimate the total number of buildings. At least 70% of the program buildings follow the prescriptive path, which has less influence on bringing buildings to code. National Grid received about 550 retrofit program applications in 2012. About 50% of participating buildings follow the prescriptive path and 50% follow performance paths. National Grid also offers a New Construction lighting program. National Grid indicated that their engineering teams educate developers on the code. When teams find they are not meeting code requirements they help them get up to code. National Grid indicated that going forward they can track that and cross-connect the programs and code initiatives. National Grid indicated that on residential side, there are not so many building types and architects and engineers do not have as much influence on the residential side since the buildings don't require a stamp.

According to National Grid, the RNC program includes the Renovation/Rehabilitation offering:

> *National Grid piloted it last year and had quite a bit of success. In 2013 [National Grid] is claiming savings from it but still proceed[s] on a case by case basis so as to properly manage the budget. It's been a great enhancement to the program because we've been able to bring on new builders while also providing savings for the program that are lost due to the sluggish improvement of the new construction housing market in RI.*

According to CSG, so far 126 homes have completed the program in 2013. Twenty-three homes participated in the pilot in 2012.

B.1.3 Past National Grid Initiatives

National Grid has been doing code trainings in residential side for many years (typically tied to the New Construction program). Since 2011, National Grid has included commercial buildings code training as well. National Grid indicated doing one residential and one commercial in 2011 with about 150 attendees in both sessions. In 2012, National Grid organized one residential code training and one commercial training, each with about 100 attendees. As indicated in the CSG KPIs for National Grid, for 2013, CSG plans four residential and four commercial trainings and one residential and one commercial onsite training. National Grid also conducts Building Operate Certification (BOC) [73] trainings, typically doing two sessions per year with approximately 20 attendees or more. National Grid has also been reaching out trade allies in many ways and has been doing dedicated seminars and webinars in last two years on Laboratory Ventilation, CHP, Exterior Lighting and Data Centers. The webinars for 2013 are:

- Steam Systems – August 28th
- High Efficiency Commercial Water Heating – September 12th
- Lighting Control Systems for New Construction & Retrofit – September 26th

[72] These participants (200) consist of "time of replacement" equipment applications. Thus, they are not truly "new construction."
[73] http://www.theboc.info/

National Grid has been working with CSG, who provided a list of organizations involved in code compliance enhancement.

CSG List of Entities Involved in Code Compliance Enhancement

- American Institute of Architects (AIA), RI
- American Society of Heating & Refrigeration & Air Conditioning Engineers (ASHRAE)
- Arnold Lumber
- National Lumber
- Lumber Yards - Many
- Builder Supply houses like Kamco/ Grainger/ Insulmart/ Harvey
- HVAC supply houses like – WEBB/ Plumbers Supply/ RI Refrigeration/ Johnstones Supply
- Chain Stores – Home Depots – Lowes – Ace Hardware
- Electrical Supply houses like – Granite City, Major Electric etc.
- Builders
- Developers
- Insulation Contractors
- Real Estate Agents
- HVAC installers
- Plumbers
- Electricians
- End Purchaser
- Associations:
- RIBA
- American Heart and Lung
- Many More
- Community Action Partnership (CAP) agencies
- Housing Authorities
- Low Income groups that provide housing, like AIDS Care/ Veterans Homes etc
- Manufacturers:
- HVAC products
- Lighting Products
- Insulation
- Caulking and weatherizing products
- Windows
- Engineers (ASHRAE Group RI Chapter)
- NESEA Group RI Chapter
- USGBC – RI Chapter
- ACCA – RI Chapter
- Appraisers
- The Housing Network
- Marketing groups
- Construction Management groups
- Construction Consultants
- Mortgage Companies

NEEP is working with RIBCC and National Grid on training initiatives. However, no specific enhancement activities are listed on the NEEP website. The NEEP website indicates that The Energy Efficiency and Resource Management Council (EERMC) provides oversight for and input in the state's efficiency programs."[74] However, based on the limited influence that EERMC is likely having, the Team has included EERMC in a group with other entities.

B.1.3.1 National Grid Website Information

The National Grid website indicates that "Regular meetings with the Codes & Standards Implementation Group and Evaluation Group continue to occur, pushing the program forward and solidifying the savings methodology." [75]

The website lists the following events:[76]

- The Company promoted energy efficiency at the RI League of Cities and Towns 13th Annual Convention on January 30
- Residential program vendors gathered for a kickoff meeting on February 26 in Warwick
- The Company held several Commercial New Construction focus groups in January and February
- The Company held the 2013 RI Vendor Open House for C&I trade allies on February 28
- The Company held a Multifamily Focus Group on March 12
- The Company will participate in the World Trade Day at Bryant University on May 22
- BOC Level I Training course at URI will begin on May 15

National Grid programs[77] include Building Operator Certification, Advanced Buildings, and Whole Building training and education.

B.2 Rhode Island Building Code Compliance Office Initiatives

The RIBCC holds mandatory building code compliance courses for building officials and inspectors. The ICC conducted the courses on the building code in general, but they covered energy efficiency issues, and thus deserve some attribution for the energy code attribution model. The ICC taught these courses in 2013:

- Friday, April 19, 2013 Energy Code Seminar
- Friday, May 3, 2013 Mechanical Code Seminar
- Friday, May 17, 2013 Energy Code Seminar for Commercial
- Friday, June 28, 2013 International Green Construction Code with Rhode Island Amendments

The RIBCC has planned 6 events for the fall of 2013. The RIBCC has planned 6-12 building code events for 2014, some of which will address energy issues. The RIBCC requires all 39 building officials, plus about 20 building inspectors (depending on the town or city and the specialty covered) (in total about 59 people) to attend. In addition, CSG will recruit people on behalf of National Grid. The RIBCC will not require all building officials and inspectors to

[74] http://www.neep.org/public-policy/policy-outreach-analysis/state-activities/rhode-island
[75] https://www1.nationalgridus.com/StateLandingRI-RI-RES
[76] http://www.nationalgridus.com/non_html/eer/ri/2013%20First%20Quarter%20Highlights%20w%20tracking%20FINAL.pdf
[77] http://www.nationalgridus.com/narragansett/business/energyeff/3_training.asp

attend the smaller events and onsite events that the RIBCC, National Grid, and NEEP have planned.

B.2.1 Insights from Code Official Interviews

In 2011, DNV KEMA conducted in-depth interviews with 31 Rhode Island building officials. Building official interviews focused on code officials' knowledge of commercial energy code, staffing and training practices, processes for determining energy code compliance and barriers to enforcing energy codes.[78] The DNV KEMA report highlights the challenges that code officials face regarding code compliance:

> *It is assumed that code officials actually site verify the myriad of energy code provisions. The interviews with code officials that were conducted for this project make it clear that it is not possible for code officials to do so. Code officials have many other code responsibilities, and cannot allocate unlimited time to site and/or plan review. Our interviews with code officials suggest that many times they rely on the design professional statements of energy code compliance. This is not inappropriate, as code compliance, including energy provisions, is a responsibility of professional, registered architects and engineers, as well as licensed construction practitioners. The code official interviews indicated several opportunities to enhance code compliance. For example, code compliance would be enhanced if code officials relied more on construction practitioners and not just design professionals, as they do sometimes.*
>
> *It is also assumed that code officials would record non-compliance with individual provisions and that recorded information could be utilized to determine code compliance rates. As it is the code officials responsibility to enforce compliance it is counterintuitive that they would record non-compliance.*
>
> *It tends to undervalue, or ignore, the importance of proper installation and proper commissioning. Both are code compliance issues, and both can have a much greater impact than the actual efficiency level of an installed piece of equipment.*
>
> *The tiered system may or may not be accurate for any particular climate zone or building type. It generates an overall compliance value that is useful for ARRA program compliance. However, it is much more useful for program administrators to look at individual provisions and provision categories when assessing efficiency improvement opportunities.*
>
> *It tends to undervalue, or ignore, the importance of proper installation and proper commissioning. Both are code compliance issues, and both can have a much greater*

[78] See Section 4.1.1 "DOE/PNNL Compliance Methodology" "DRAFT Final Report Rhode Island Energy Code Compliance Baseline Study" July 23, 2012.

impact than the actual efficiency level of an installed piece of equipment. (Page 4-2 to 4-3).

CSG is planning to address these and other issues found in the baseline studies in their smaller training sessions.

B.3 Rhode Island Builders Association Initiatives

In an interview with the Team, the head of RIBA[79] indicated that RIBA advertised and hosted a focused group led by CSG and that they are actively working with CSG. However, they have no specific energy code compliance enhancement plans for 2014.[80] They also indicated that they promote the code book in their publications.[81] The Team conducted internet searches, but uncovered no information on RIBA 2013 or 2014 code compliance activities.

B.4 The Rhode Island Green Building Council (RIGBC)

RIGBC is hosting a LEED V4 training in September, 2013, a September Green Eggs Networking Breakfast, and is organizing a seminar on Exterior Insulation and Finish Systems (EIFS).[82]

The RIGBC Executive Director indicated that the RIGBC is educating builders in Rhode Island about the Green Building Act (GBA). The GBA has the following requirements:

> *The Rhode Island Green Buildings Act identifies the IGCC as an equivalent standard in compliance with requirements that all public agency major facility projects be designed and constructed as green buildings. The Rules and Regulations to implement the Act take effect in October 2010. The IGCC applies to new and existing, traditional and high-performance commercial buildings. It includes ANSI/ASHRAE/USGBC/IES Standard 189.1 as an alternative compliance requirement…. Any new, substantially expanded, or renovated building owned by the state, and state agencies, departments, offices, boards, commissions, or institutions of higher learning must meet LEED design, construction, operation and maintenance standards. Specifically, buildings must be designed to qualify for LEED Silver certification. The design, construction, operation, and maintenance of these buildings must also evaluate feasible energy efficiency measures on the basis of total life-cycle costs (Green Building Standards for State Facilities, 2005).*[83]

[79] https://ribuilders.org/
[80] The publicly available calendar is here: https://ribuilders.org/events/#bf_calendarList_600.
[81] Publications are listed along with other programs here: https://ribuilders.org/members/education-programs/. See also https://ribuilders.org/news/SBC-2_Residential_Code_REV_4-8-13.pdf
[82] http://www.usgbcri.org/
[83] http://www.energycodes.gov/adoption/states/rhode-island

Appendix C Acronyms

American Recovery and Reinvestment Act (ARRA)

Building Operate Certification (BOC)

Central Air Conditioning (CAC)

Community Action Partnership (CAP)

Conservation Services Group (CSG)

Code Compliance Enhancement Initiative (CCEI)

Commercial Buildings Energy Consumption Survey (CBECS)

Conservation Services Group (CSG)

Department of Energy (DOE) Building Energy Codes Program (BECP)

Energy Efficiency and Resource Management Council (EERMC)

Energy Use Intensities (EUI)

Energy & Resource Solutions (ERS)

Home Energy Rating System (HERS)

International Code Council (ICC)

Key Performance Indicator (KPI)

Green Building Act (GBA)

Gross Technical Potential (GTP)

New Construction (NC)

Naturally Occurring Market Adoption (NOMAD)

Northeast Energy Efficiency Partnerships (NEEP)

Pacific Northwest National Laboratory (PNNL)

Program Administrator (PA)

Residential New Construction (RNC)

Retrofit (RF)

Rhode Island American Institute of Architects (RI AIA)

Rhode Island Building Code Commission (RIBCC)

Rhode Island Builder's Association (RIBA)

Rhode Island Green Building Council (RIGBC)

Rhode Island Office of Energy Resources (OER)

Rhode Island Public Utility Commission (PUC)

User Defined Reference Home (UDRH)