FSTATE OF INDIANA
INDIANA UTILITY REGULATORY COMMISSION

VERIFIED PETITION OF INDIANAPOLIS POWER & LIGHT COMPANY ("IPL"), AN INDIANA CORPORATION, FOR (1) ISSUANCE OF A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR THE CONSTRUCTION OF A COMBINED CYCLE GAS TURBINE GENERATION FACILITY ("CCGT"); (2) ISSUANCE OF A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY TO CONVERT COAL FIRED GENERATING FACILITIES TO GAS; (3) APPROVAL OF THE CONSTRUCTION OF TRANSMISSION, PIPELINE AND OTHER FACILITIES; (4) APPROVAL OF ASSOCIATED RATE MAKING AND CAUSE NO. 44339 ACCOUNTING TREATMENT; (5) AUTHORITY TO TIMELY RECOVER 80% OF THE COSTS INCURRED DURING CONSTRUCTION AND OPERATION OF THE GAS REFUELING PROJECT THROUGH IPL'S ENVIRONMENTAL COMPLIANCE COST RECOVERY ADJUSTMENT; (6) AUTHORITY TO CREATE REGULATORY ASSETS TO RECORD (A) 20% OF THE REVENUE REQUIREMENT FOR COSTS, INCLUDING, CAPITAL, OPERATING, MAINTENANCE, DEPRECIATION TAX AND FINANCING COSTS ON THE REFUELING PROJECT WITH CARRYING COSTS AND (B) POST-IN-SERVICE ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION, BOTH DEBT AND EQUITY, AND DEFERRED DEPRECIATION ASSOCIATED WITH THE PROJECTS UNTIL SUCH COSTS ARE REFLECTED IN RETAIL ELECTRIC RATES; AND (7) ISSUANCE OF A NECESSITY CERTIFICATE TO TRANSPORT NATURAL GAS IN INDIANA	)	CAUSE NO. 44339

Direct Testimony of
Jeremy I. Fisher, PhD

Public Version

On Behalf of
Citizens Action Coalition of Indiana

August 22, 2013

Table of Contents

Table of Figures

Table of Tables

1. INTRODUCTION AND PURPOSE OF TESTIMONY

Q Please state your name, business address, and position.

A My name is Jeremy Fisher. I am a Principal Associate at Synapse Energy Economics, Inc. (Synapse), which is located at 485 Massachusetts Avenue, Suite 2, in Cambridge, Massachusetts.

Q Please describe Synapse Energy Economics.

A Synapse Energy Economics is a research and consulting firm specializing in energy and environmental issues, including electric generation, transmission and distribution system reliability, ratemaking and rate design, electric industry restructuring and market power, electricity market prices, stranded costs, efficiency, renewable energy, environmental quality, and nuclear power.

Q Please summarize your work experience and educational background.

A I have ten years of applied experience as a geological scientist, and six years of working within the energy planning sector, including work on integrated resource plans, long-term planning for utilities, states and municipalities, electrical system dispatch, emissions modeling, the economics of regulatory compliance, and evaluating social and environmental externalities. I have provided consulting services for various clients, including the U.S. Environmental Protection Agency (EPA), the National Association of Regulatory Utility Commissioners (NARUC), the California Energy Commission (CEC), the California Division of Ratepayer Advocates (CA DRA), the National Association of State Utility Consumer Advocates (NASUCA), National Rural Electric Cooperative Association (NRECA), the state of Utah Energy Office, the state of Alaska, the state of Arkansas, the Regulatory Assistance Project (RAP), the Western Grid Group, the Union of Concerned Scientists (UCS), Sierra Club, EarthJustice, Natural Resources Defense Council (NRDC), Environmental Defense Fund (EDF), Stockholm Environment Institute (SEI), Citizens Action Coalition, Civil Society Institute, and Clean Wisconsin.

I have provided testimony in electricity planning and general rate case dockets in Indiana, Wyoming, Utah, Kansas, Kentucky, Oregon, and Wisconsin.

Prior to joining Synapse, I held a post doctorate research position at the University of New Hampshire and Tulane University examining the impacts of Hurricane Katrina.

I hold a B.S. in Geology and a B.S. in Geography from the University of Maryland, and a Sc.M. and Ph.D. in Geological Sciences from Brown University.

My full curriculum vitae is attached as Exhibit JIF-1.

Q On whose behalf are you testifying in this case?

A I am testifying on behalf of Citizens Action Coalition of Indiana (CAC).

Q Have you testified in front of the Indiana Utility Regulatory Commission previously?

A Yes. I provided direct and surreply testimony in IURC Cause 44242, the petition of Indianapolis Power and Light (IPL, or the Company) for the issuance of a certificate of public convenience and necessity (CPCN) and rider recovery for various environmental controls at five coal units.

Q What is the purpose of your testimony?

A My testimony evaluates the reasonableness of IPL's application for a CPCN to replace Eagle Valley and various other retiring thermal generators with a 600 MW natural gas-fired combined cycle generation turbine unit (Eagle Valley CCGT). My testimony is focused on the justification provided by the Company to choose a single CCGT replacement unit in early 2017.[1] I evaluate the testimony and workpapers of Mr. Herman Schkabla and the 2011 Integrated Resource Plan attached to his testimony. In addition, I compare fundamental key assumptions used by the Company in this Cause versus as used in Cause 44242. My findings

[1] In the two phases of the analysis conducted by the Company supporting this Application for CPCN, the Company evaluated two different start dates for a replacement CPCN. In the first phase, the Company evaluated a January 2018 start date, while in the second phase the Company evaluated an April 2017 start date.

and recommendations are based both on my analysis and the analysis performed by my colleague, Mr. Tyler Comings.

Q How much is the Company proposing to invest in the CCGT as part of this application?

A The Company estimates that it will cost approximately $631 million, before AFUDC, to build the Eagle Valley CCGT.[2]

Q What is the stated purpose of the CCGT?

A The Company states "EPA rules…will directly or indirectly result in the shutdown or refueling of up to six (6) older coal units and five (5) associated oil/diesel-fired units. In addition, unit obsolescence and falling natural gas and market prices have contributed to the decision to retire these units. In total, these eleven (11) units comprise **607 MW** of capacity… [emphasis added]"[3] The Company further explains that "there is a need to replace this retiring capacity since NERC and MISO resource adequacy rules require IPL to secure capacity to meet its projected peak load plus a minimum planning reserve requirement of approximately 14%."[4]

The Company projects that the CCGT would be capable of delivering **683 MW**[5] replacement for the retiring capacity. However, the Company also anticipates repowering Harding Street Units 5 & 6 with natural gas, adding an additional **200-210 MW** of capacity.[6] With an additional 30 MW of capacity credit for photovoltaic capacity additions, the Company anticipates **913 MW** of new capacity online by April 2017, or 306 MW above and beyond their replacement capacity requirements.

[2] IPL Witness Crawford, p16 at 4.
[3] IPL Witness Crawford, p9, at 16-21
[4] IPL Witness Crawford, p10, at 11-13
[5] IPL Witness Crawford, p14 at 3.
[6] IPL Witness Crawford, p14 at 18

Q What are your findings regarding the Company's application?

A The Company's CPCN application for a CCGT to replace Eagle Valley is premature, relies on a faulty and insufficient planning construct, contains numerous internally inconsistent key planning assumptions, fails to provide a least cost solution for IPL's ratepayers, and is inconsistent in statement and fact with the nearly contemporaneous CPCN application filed in Cause 44242.

In particular, the analysis performed in this CPCN fails to seek an optimal solution for ratepayers. It excluded important considerations such as the acquisition of smaller blocks of replacement capacity, the examination of single-cycle generation turbines (SCGT) for the purpose of meeting capacity requirements, or a delay in the acquisition of replacement capacity. In addition, there are modeling errors, such as failure to include a carbon price for new resources in the "moderate environmental" scenario.

While interveners cannot correct all of the Company's errors, omissions, and inconsistencies at this point in time, the best option offered in the Company's limited modeling is to delay building replacement capacity. The acquisition of smaller blocks of capacity resources (i.e. peakers) would likely satisfy the Company's requirements at lower cost and lower risk.

Q What are your recommendations to the Commission regarding the Company's application for a CPCN for the replacement CCGT at issue in this case?

A Based on my findings and those of my colleague Mr. Comings, I recommend that the Commission deny granting a CPCN for the replacement CCGT, and require the Company to perform proper and correct electricity system planning prior to submitting a new CPCN. I do not have a recommendation regarding the Harding Street Station repowering project at this time.

Q Will the Company be able to meet their capacity obligations in absence of an immediate CPCN approval from this Commission?

A Yes. As I will discuss further later, one of the options explored by the Company is a delay in providing replacement capacity until 2020, instead of 2018 or 2017.[7] As Mr. Comings testifies, under the Company's most up-to-date projection of capacity prices – a price that already assumes an extremely tight capacity market – delaying the new CCGT is economically beneficial to consumers. The Company's current plan would result in a reserve margin above 24% in 2016 – or 300 MW above their peak load, and excess capacity through 2027.[8]

Q Please provide an overview of your testimony.

A My testimony focuses largely on the Company's initial justification to pursue a large CCGT as the appropriate replacement resource, and as such focuses on the 2011 IRP analysis, which provides the foundation of analysis used in this CPCN.

1. First, I review the two-phase modeling process used in the 2011 IRP that resulted in the Company's contention that a replacement CCGT is the preferred replacement resource;
2. Second, I review the two-phase modeling process used in this CPCN, and compare modeling assumptions used in the first and second phases;
3. Third, I compare the Company's modeled energy efficiency trajectory against IURC targets;
4. Fourth, I assess the Company's assumption of the contribution of demand-side management (DSM) to energy and peak requirements;
5. Fifth, I provide an overview of the Company's requirement, and show that the Company will require capacity resources, not energy;

[7] A 2018 replacement is considered in the first phase analysis of this CPCN, while an April 2017 replacement is considered in the second phase analysis of this CPCN.
[8] Comparison of "Non-Coincident Peak" from BCPCN (CPCN Phase 2) MIDAS output ("Transact C Monthly" endpoint 1) vs. capacity of "Total Resources" from BCPCN MIDAS output ("Monthly Thermal", endpoint 1). Estimate excess capacity to 2027 is 19 MW above 14% reserve margin.

6. Sixth, I compare statements and facts presented in this CPCN against contentions and assumptions from the Company's last CPCN, Cause 44242 and the 2011 IRP; and7. Finally, I provide a conclusion and recommendations to this Commission regarding the instant case.

2. OVERVIEW OF COMPANY MODELING

Q Please describe how the Company used modeling to decide that a 550-725 MW CCGT was the correct resource to replace retiring generating units.

A The Company appears to ultimately have decided on obtaining a large CCGT[9] following the 2011 IRP, published nearly two years ago. It does not appear that the Company has seriously revisited this basic assumption since the execution of the IRP. I argue that, in addition, the 2011 IRP did not actually select a CCGT as the optimal replacement unit, and the Company's forecast conditions have changed considerably from the 2011 IRP.

There are two fundamental model structures that are used in IRP resource selection and evaluation: optimization or capacity expansion models, and production cost models. These models are used in CPCN cases as well for similar purposes.

- Production cost models are typically built to simulate chronological dispatch with transmission constraints, and are designed to generate an accurate picture of how units will operate their production costs (i.e. fuel consumption, market purchases and sales, etc.). Typically, production cost models have a known and fixed portfolio of generators.
- Optimization or capacity expansion models are structured to determine the "optimal" new generation (or market) assets that should be acquired to meet demand or replace retiring capacity. Typically, capacity expansion models will be seeded with a handful to dozens of new resource options; the model selects the least cost portfolio of generating resources that meet

[9] IPL Witness Crawford, p16 at 3

system requirements. Newer optimization models are also able to optimize for existing capacity retirement when resources are non-economic.

Q What modeling was performed in the 2011 IRP?

A In the 2011 IRP, the Company performed two phases of modeling. Figure 1, below, shows a schematic demonstrating the stages of modeling in the 2011 IRP and in this CPCN.

In IRP Phase 1, the Company used the capacity expansion capabilities of MIDAS to evaluate new resource needs. Phase 1 allowed seven resource types (two coal types, gas CC and CTs, nuclear, wind and solar), as well as market capacity purchases, to fill resource requirements. Not surprisingly, since load growth was assumed to be quite slow and Harding Street 5 & 6 and Eagle Valley 6 were assumed to be in play through 2021, new generators were not chosen until, for the most part, 2022. Instead, the modeling identified market capacity purchases only through 2022.[10]

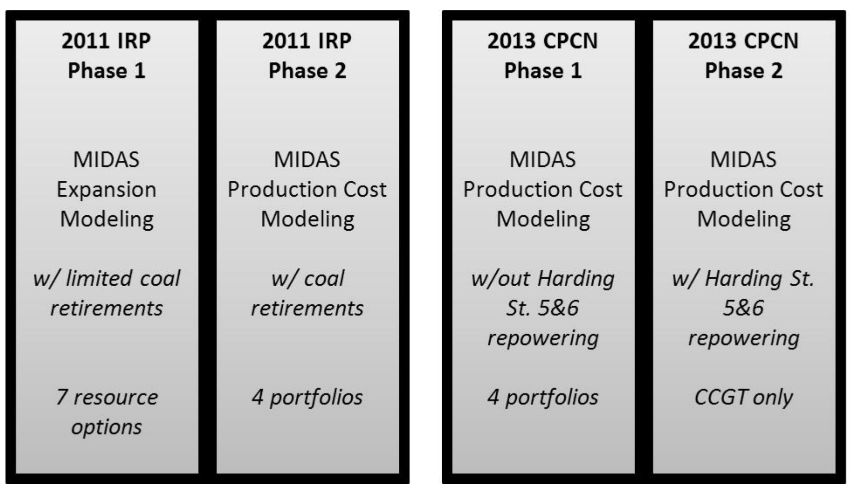


Figure 1. Schematic of IRP and CPCN modeling phases and limitations.[11]

[10] Exhibit HNS-2 (2011 IRP) p44-50

[11] While strictly speaking, six portfolios were tested in the 2011 IRP Phase 2 and Phase 1 of this CPCN, two sets of those portfolios are identical with just short temporal delays; thus while these portfolios can be compared against each other (the value of delay), the Company effectively tested only four unique scenario options.

In IRP Phase 2, the Company transformed the analysis: they assumed that all of Eagle Valley and Harding Street 5 & 6 would retire by the end of 2015, but rather than allowing the model to choose an optimal portfolio, the Company locked in six portfolios into a production cost model. These six options are the very same options discussed by Witness Schkabla.[12] These portfolios required that capacity resources (in this case 550 MW of CTs) be paired with 500 MW of wind, and effectively tested only four scenarios – a large CCGT, the peaker/wind combination, a mid-sized coal unit, or a fairly small nuclear unit. From this modeling, the Company chose the CCGT, built in 2018, as their preferred scenario, and effectively finished their IRP process there.

The Company filed the current Cause (44339) a year and a half after the submission of the 2011 IRP. In this Cause, the Company has performed two more stages of production cost modeling that I will refer to as CPCN Phase 1 and Phase 2.

Q What modeling was performed in this CPCN case?

A CPCN Phase 1 is nearly identical to the production cost modeling performed in Phase 2 of the 2011 IRP. The same six locked-in portfolios were evaluated, with some updates. As Mr. Schkabla explains, "the main purpose of the initial phase of the updated analysis was to review the finding of the 2011 IRP that a CCGT is the preferred resource alternative for IPL's customers." Not surprisingly, with few modifications to the Company's modeling assumptions, the outcome (i.e. the ordering and relative magnitude of the options in this modeling) is nearly identical to the 2011 IRP.

In CPCN Phase 2, the Company once again updated assumptions – including the repowering of Harding Street 5 & 6 rather than outright retirement – and tested the cost effectiveness of a self-build CCGT against several CCGT RFPs.

[12] Direct Testimony of Witness Schkabla, p10 lines 8-9.

Q What were the Company's findings for the justification component, or Phase 1, of this CPCN?

A The Company determined from their base case runs that the CCGT project in 2018 is the least cost solution. Table 1, below, shows the total PVRR of each replacement option tested in the base scenario, as well as the three sensitivities of high gas, low gas, and "moderate environmental" which includes a cost for CO_2 starting in 2021.

Table 1. Company present value of revenue requirement (PVRR) outcomes from CPCN Phase 1 modeling.[13]

	Base		High Gas		Low Gas		Mod Env.	
	PVRR	ΔPVRR to Opt 1.	**PVRR**	ΔPVRR to Opt 1.	**PVRR**	ΔPVRR to Opt 1.	**PVRR**	ΔPVRR to Opt 1.
CCGT (2018)	**$9,866**		**$10,227**		**$9,997**		**$12,680**	
CT/Wind (2018)	**$10,271**	$406	**$10,312**	$85	**$10,512**	$515	**$12,716**	$36
CCGT (2020)	**$9,888**	$23	**$10,249**	$22	**$10,020**	$23	**$12,703**	$23
CT/Wind (2020)	**$10,236**	$370	**$10,283**	$56	**$10,469**	$472	**$12,680**	$0
Coal (2020)	**$10,744**	$879	**$10,390**	$163	**$11,171**	$1,174	**$13,360**	$680
Nuclear (2020)	**$12,584**	$2,719	**$12,219**	$1,992	**$13,019**	$3,022	**$14,477**	$1,797

It is notable that in the Base case scenario, building a CCGT in 2018 is $23 million less expensive than building the same unit 2020. This same difference is reflected across the scenarios because the primary numerical difference between these scenarios is the presence or absence of a capacity price payment in 2018 & 2019. As my colleague Mr. Comings shows, updating that capacity price to the price used in the second phase of this CPCN removes and inverts the $23 million differential.

It is also significantly notable that the model finds the CT/Wind scenario, built in 2020, has exactly the same present value as building a CCGT in 2018 when a CO_2 price is considered. As I will show later, this value is likely in error, as the Company did not include a CO_2 price for new build resources; thus the CT/Wind scenario is likely far better than break-even in this scenario.

[13] IPL Public Workpapers--provided 8-14-13\Schkabla\IRP11_CPCN_Plan_Results_40_Years.xlsxtabs "Base", "High Gas", "Low Gas" and "INCO2", cells B71:B76

Q Why do you think that the Company's modeling was insufficient?

A For this case, the Company ran exactly one capacity expansion model, which was in Phase 1 of the 2011 IRP and was "performed early in the summer [of 2011], before new, but still preliminary MATS rules were released and evaluated."[14] This modeling effort contained an extremely limited set of resource options, but regardless, its primary finding – obtain market capacity preferentially – was still rejected out of hand.

Between the time that the 2011 IRP capacity expansion was completed and this CPCN was filed, gas price forecasts continued to fall, new federal environmental regulations were proposed and disclosed, and the Company determined that they could realistically repower Harding Street 5 & 6, amongst other changes. Nonetheless, the Company declined to search for an optimal model solution, instead falling back on the same pre-selected options from the IRP.

3. MODELING OPTIONS EXTRACTED FROM 2011 IRP ARE INSUFFICIENT FOR THIS CASE

Q Why do you think that the resource options explored in the 2011 IRP are insufficient for this CPCN?

A The 2011 IRP ran an optimization model to choose potential future resources, but then largely ignored the outcome of that optimization model effort when conducting the second phase evaluation in the IRP. The purpose of an optimization model is to provide reasonable alternatives without second-guessing outcomes. The first phase of the 2011 IRP found that market purchases of capacity and energy would provide a least cost solution for ratepayers through 2022.[15] This optimization model did not include the retirement of Harding Street 5 or 6, or Eagle Valley 6 until 2021.[16] Even after it was determined by the Company that those units would likely retire on an earlier timeframe; the Company did not again run an optimization model.

[14] Exhibit CFA-2 (2011 IRP), p42
[15] See Petitioners Exhibit HNS-2 (2011 IRP), p44-50
[16] See Petitioners Exhibit HNS-2 (2011 IRP), p42

The resources that were exported from the 2011 IRP into this CPCN included, exclusively:

- a 600 MW CCGT;
- a combination of three-and-a-half 160 MW CTs (550 MW) with a 500 MW block of 35% capacity factor wind (50 MW effective);
- a 600 MW coal unit; and
- a 600 MW nuclear unit.

The Company did not use an optimization model at all in this CPCN, nor did they provide justification for these particular sets of resources.

In particular, the pairing of the CT units with wind (and vice versa) disadvantages both of these resources in modeling. Wind provides an energy-rich resource with very low operating costs, but a relatively small amount of capacity credit. CTs provide a capacity resource with high operating costs. In a system that requires additional energy, but is not short on capacity, wind provides a low-cost, low-risk resource. However, in a system that is short on capacity but already produces significant energy (i.e. a baseload-rich system like that of IPL), CTs provide opportunities to meet capacity needs with low capital investments. Pairing CTs with wind provides minimal information to an optimization process.

Finally, not allowing the model to choose a combination of resource types, the Company cannot definitively show that they have provided a least cost solution for ratepayers. The Company might only require staged capacity resources over a number of years, instead of a simultaneous block of 600 MW. None of the options shown here provide a review of optimized portfolios.

Q Why do you think that an optimization model run with 2013 assumptions may have selected a different portfolio than the six sets offered in the 2011 IRP and by Mr. Schkabla?

A There are a few key changes that might suggest that an optimization model might select smaller peaking resources (if any) to replace Eagle Valley.

First, the repowering of Harding Street 5 & 6 alleviates 200 MW of shortfall that was not anticipated or modeled in the 2011 IRP. This reduced shortfall would allow smaller units to meet requirements without building excess capacity.

Second, as Mr. Comings discusses, the first phase of this CPCN excluded consideration of 100 MW of demand response, again alleviating a shortfall.

Third, as Mr. Comings also discusses, in the second phase of this CPCN, the Company has revised their market capacity price downward from the 2011 IRP by nearly 40%, a move that would allow capacity market purchases to participate in meeting the Company's resource requirements.

Finally, the Company appears to be projecting a completely new set of peak and energy requirements then considered in the 2011 IRP. As I will show later, the Company has reduced their estimated future energy requirements by about 9% in 2030, while increasing their peak requirements by almost 12% by 2030. Overall, the Company clearly now anticipates a peak demand requirement (i.e. capacity), not a significant energy shortfall.

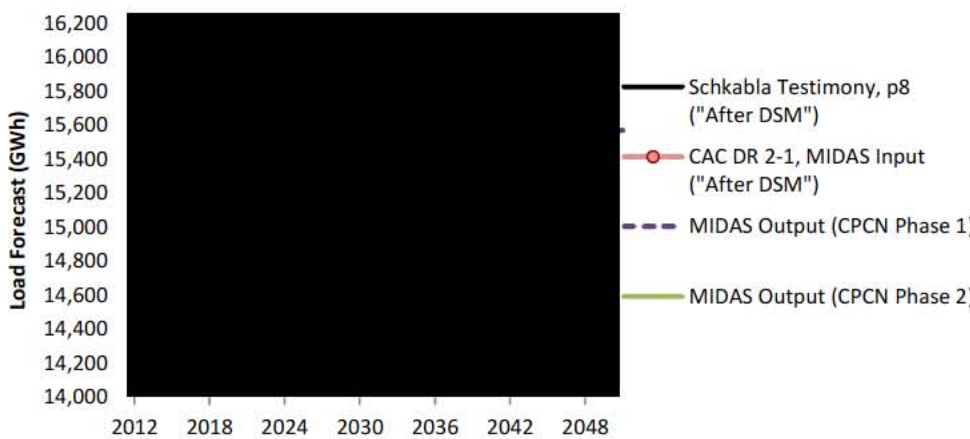
Taken together, the Company is projecting a very different set of requirements for their customers than anticipated in the 2011 IRP and, in addition, should now have significantly better resolution on the costs and characteristics of replacement capacity and energy resources. It is inappropriate for the Company to simply adopt the outcome of an outdated IRP, particularly when the Company clearly has the ability, resources, and background to run an optimization model and determine an optimal portfolio in their customers' interests.

4. LOAD ASSUMPTIONS ARE INTERNALLY INCONSISTENT WITHIN THIS CPCN

Q What is the Company's load forecast in this CPCN case?

A It is almost impossible to answer this question decisively. In the context of this CPCN alone, the Company presents three to four completely different sets of forecasts. It is not clear, by any means, which forecast is meant to be the forecast upon which they rely in this CPCN.

Below, I present four energy and peak forecasts drawn from four sources presented in testimony and discovery in this case. In the graphic of energy forecasts (Confidential Figure 2), the short black line represents the forecast provided in Mr. Schkabla's testimony (p8, line 11); the red circles represent a discovery response titled "Major Midas Input Files";[17] the dotted line represents load as perceived by MIDAS in the reference scenario in the first phase CPCN analysis;[18] and the green line represents load as perceived by MIDAS in the Company's self-build scenario in the second phase CPCN analysis.[19]



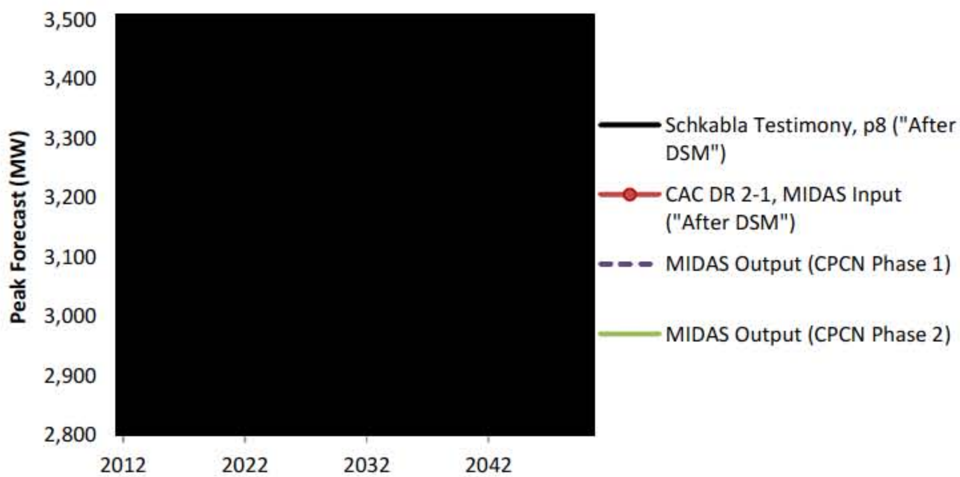
Confidential Figure 2. Load forecasts (energy in GWh) from testimony, input files, and CPCN analyses for Phase 1 and Phase 2.

It is clear that the Company's load forecast has been subject to numerous alterations, even within this CPCN process. The difference between the numbers offered in Mr. Schkabla's testimony and used in the CPCN Phase 2 modeling differ by over 8% in the year 2016 – a difference of over 1,300 GWh, the equivalent of a full quarter of IPL's residential customer base.[20] Either the

[17] CAC DR 2-1, Confidential Attachment 2 (Major Midas Input Files_Excel Format), tab "Peak and Energy Forecast"
[18] CAC DR 2-1, Confidential Attachment 5 (CPCN1), file CPCN1 Transact C Monthly Summary 20130709, endpoint 1, columns "Load Forecast" (energy) and "Non-coincident peak" (peak)
[19] CAC DR 2-1, Confidential Attachment 6 (BCPCN), file BCPCN Transact C Monthly Summary 20130709, endpoint 1, columns "Load Forecast" (energy) and "Non-coincident peak" (peak)
[20] IPL residential customer base in 2012 = 418,278 as reported to the US DOE Energy Information Administration in EIA-861, preliminary file (published August 14, 2013). Average customer use = 12.3 MWh per residential customer (5,144,104 MWh total).

Company has not transferred consistent assumptions between phases of this analysis, has inadvertently used incorrect data files in modeling, or has significant uncertainty about their future load requirements.

The graphic of Confidential Figure 3, below, contains peak demand requirements from the same four sources listed above. Again, assumptions are inconsistent between Mr. Schkabla's testimony, the stated model input data, and the MIDAS output files. It is particularly notable that the peak forecast remains inconsistent between the two phases of this CPCN.



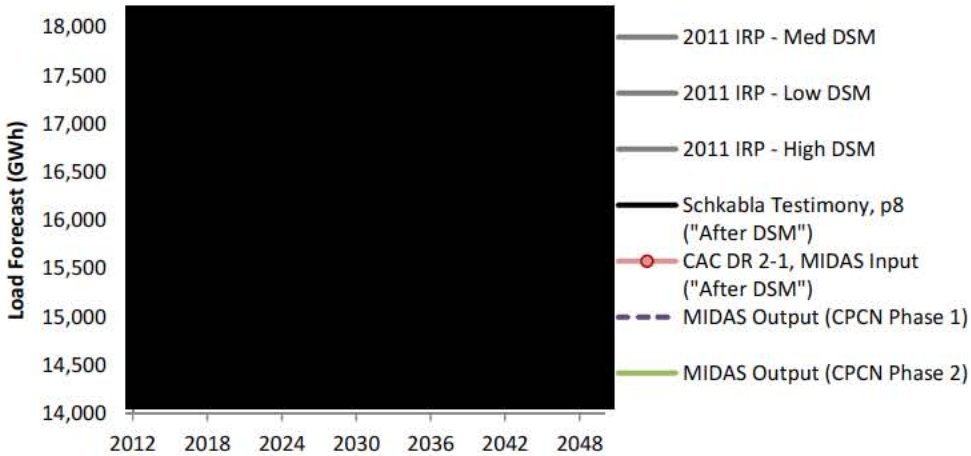
Confidential Figure 3. Peak demand forecasts (in MW) from testimony, input files, and CPCN analyses for Phase 1 and Phase 2.

Again, either the Company is using inconsistent assumptions, has used or provided incorrect modeling files, or has significant uncertainty about their own future demand requirements.

All of the forecasts shown here ostensibly account for demand-side measures and demand response.

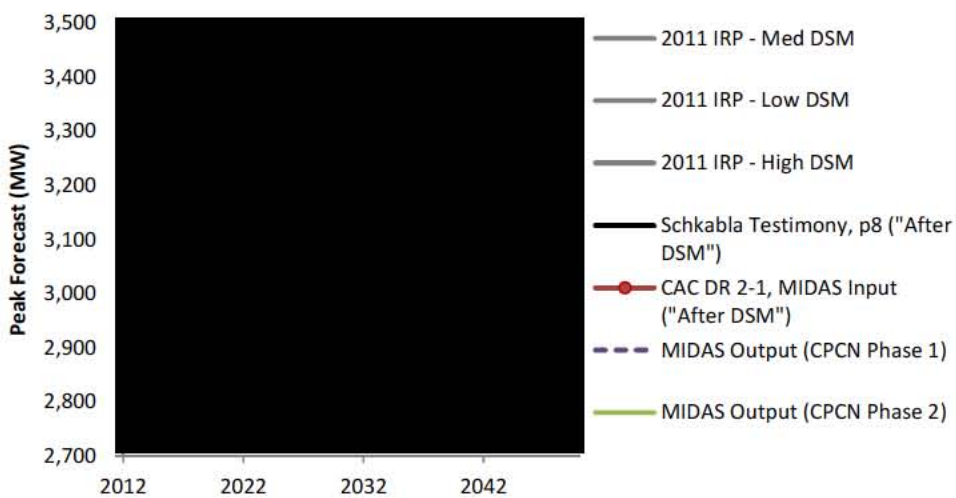
Q How has the Company's load forecast changed from the 2011 IRP?

A The Company's projections of energy requirements and peak demand have been shifted in opposite directions relative to the 2011 IRP. As shown in Confidential Figure 4, below, the Company's load forecast has flattened markedly relative to requirements anticipated in 2011. By 2030, the Phase 1 CPCN study load forecast is 8% (or [redacted]) lower than anticipated in the 2011 IRP (medium DSM case).



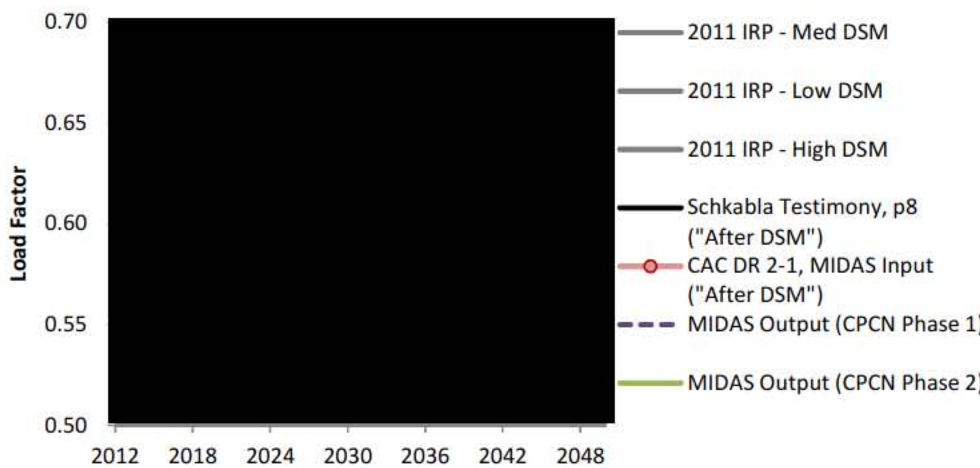
Confidential Figure 4. Load forecasts (energy in GWh) from testimony, input files, and CPCN analyses for Phase 1 and Phase 2, relative to 2011 IRP.

In contrast, the peak requirements now forecasted by the Company grow far faster than the 2011 IRP expectations (see Confidential Figure 5, below). Peak load is now expected to be nearly 12%, or [redacted] higher by 2030 (CPCN Phase 1) than forecasted in the 2011 IRP (medium DSM).



Confidential Figure 5. Peak demand forecasts (in MW) from testimony, input files, and CPCN analyses for Phase 1 and Phase 2, relative to 2011 IRP.

The practical implication of these dramatic changes is that the Company's load factor[21] projection has completely reversed direction – falling rather than rising (*see* Confidential Figure 6). Rather than anticipating that IPL load will gradually become flatter (mitigated by peak reductions, for example), the Company now projects that their load will become increasingly peaked over time.



Confidential Figure 6 Load factors from testimony, input files, and CPCN analyses for Phase 1 and Phase 2, relative to 2011 IRP.

Q What are the practical implications of these inconsistencies between the load forecasts in the 2011 IRP and the modeling performed for this filing?

A The implications are three-fold. First and foremost, the Company clearly based the portfolios chosen for evaluation in this CPCN based on portfolios created by the Company in the 2011 IRP. The 2011 IRP is clearly no longer applicable to the Company's requirements, and thus portfolios chosen by the Company in that process should not restrict IPL's choices today.

[21] Load factor is a common mechanism of portraying the "peakiness" of a load. It is calculated as the ratio of total demand divided by the product of peak demand and the total number of hours. A load with completely flat load shape would have a load factor of 1.0. Lower numbers indicate a peaky load shape, while higher numbers indicate a flatter load shape.

Secondly, the internal inconsistencies within this CPCN render it difficult, if not impossible, to understand what the Company's requirement actually is, much less whether a $631 million CCGT is the optimal resource to meet that requirement.

Thirdly, the drastic changes in the Company's forecast peak load and energy requirements since 2011 indicate that either the IRP process was faulty, the Company has completely changed forecast methodologies and expectations in the last year and a half, or that the Company has chosen a load forecast to justify a particular outcome rather than used an objective forecast to inform a resource choice. In summary, the Company's modeling and portfolios are insufficient and likely not optimal.

5. THE COMPANY'S ENERGY EFFICIENCY FORECASTS ARE INCONSISTENT AND BELOW COMMISSION ESTABLISHED TARGETS

Q Is energy efficiency able to alleviate requirements for capacity and energy?

A Yes. Energy efficiency provides an opportunity not only to avoid the use of high cost existing generation, but also the opportunity to avoid new capacity and generation requirements, as well as transmission and distribution infrastructure. As stated in the IURC Order on December 9, 2009 in Cause No. 42693 (the "Generic DSM Order"):

> While the Commission recognizes the need to approve additional generation capacity as necessary to meet the needs of customers and ensure Indiana's ongoing economic success, it also recognizes that an important component of long-term planning for Indiana's generation needs is the effective utilization of DSM programs by jurisdictional utilities that have a duty to serve their ratepayers in a cost effective manner. Saving energy is the most cost effective way of meeting future energy supply needs and has the corresponding benefit of reducing the need to build additional generation capacity.[22]

[22] Phase II Order in Cause 42693, (December 9, 2009). Page 30.

Q Would energy efficiency alleviate the Company's requirements for capacity as well as energy in this case?

A Yes. While there is not an expectation that the Company could establish sufficient new energy efficiency by 2017 to fully avoid 330 MW of capacity requirement, incremental steps towards meeting the IURC's efficiency targets (as stated in the Generic DSM Order) should alleviate much of the Company's requirement by 2018. It is not clear, however, if either (a) IPL has modeled the IURC's efficiency targets correctly, or (b) IPL has reasonably accounted for the peak reduction benefits of energy efficiency.

Q Does the Company provide clear evidence that the Company plans to achieve the Commissions' energy efficiency savings targets established under the Generic DSM Order?

A No. In fact, pieces of evidence presented by Mr. Allen and Mr. Schkabla are conflicting on this matter. As I will show below, Mr. Allen provides an energy reduction forecast consistent with the Commission's targets, but Mr. Schkabla's forecast suggests that the Company will meet only about half of the Commission's annual savings targets. Mr. Schkabla is responsible for the modeling that ultimately justifies the Company's application for CPCN.

Q Please explain Mr. Allen's energy savings forecasts for the Company's energy efficiency programs.

A Mr. Allen states in his direct testimony that "IPL reflects in its load forecast gross energy savings relating to the delivery of Core and Core Plus Program that are sufficient to meet the Generic DSM Order goals through year 2019."[23] Mr. Allen also provides numerical "energy" savings targets through 2020 in Exhibit LHA-4, which meet the Commission's annual "energy" savings targets.[24] For example, the annual incremental savings planned for year 2019 is 295,595 MWh, which is equal to 2% of the Company's annual sales forecast.[25]

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[23] Direct Testimony of IPL Witness Allen, p. 15, lines 8-9

[24] Indiana Utility Regulatory Commission, Cause No. 42693, Order December 9, 2009. Page 30 "the Commission finds that electric utilities subject to its jurisdiction shall meet an overall goal of 2% annual cost-effective DSM savings within ten years from the date of this Order."

[25] Presented in Petitioners Exhibit LHA-4.

Q How does Mr. Schkabla's energy savings forecasts for the Company's energy efficiency programs compare to Mr. Allen's energy savings forecast?

A Mr. Schkabla presents the Company's DSM related cumulative energy savings forecasts on page 8 of his testimony while he states that "[t]he projections are consistent with the Commission targets for energy efficiency DSM established in the Generic Phase II Order."[26] However, the incremental energy savings from year to year based on his forecast are significantly lower than the forecast presented by Mr. Allen (which is the Commission's annual savings target) as presented in Figure 1 below. For instance, the annual incremental savings in 2019 are about 150 GWh based on Mr. Schkabla's data and nearly 300 GWh based on Mr. Allen's data (see Figure 7, below).

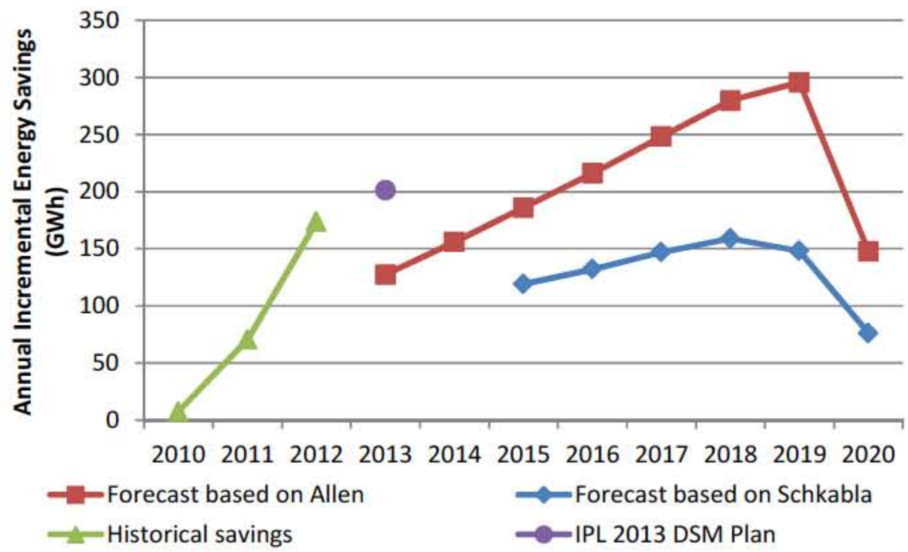


Figure 7.Annual incremental energy savings derived from IPL Witnesses Schkabla and Allen, compared against historic savings and 2013 DSM Plan[27]

In addition, as shown in this graph, neither trajectory conforms to either the Company's recent historic savings (in green) or 2013 DSM savings plan. Indeed, Schkabla's trajectory implies a dramatic reduction in savings in the next two years, rather than an improvement in efficiency penetration.

[26] Direct Testimony of IPL Witness Schkabla,, p. 7, lines 10-11)

[27] Direct Testimony of IPL Witness Allen, Exhibit LHA-4 and Direct Testimony of IPL Witness Schkabla, p. 7 – 8, also Exhibits LHA-5 and LHA-6

Q How do Mr. Allen and Mr. Schkabla's efficiency forecasts compare to the IURC's targets established in the Generic DSM Order?

A As shown in Figure 8, below, Mr. Schkabla's energy savings forecasts are significantly lower than Mr. Allen's energy savings forecasts and amount to only half of the Commission's goal of 2 percent annual incremental savings by 2019.

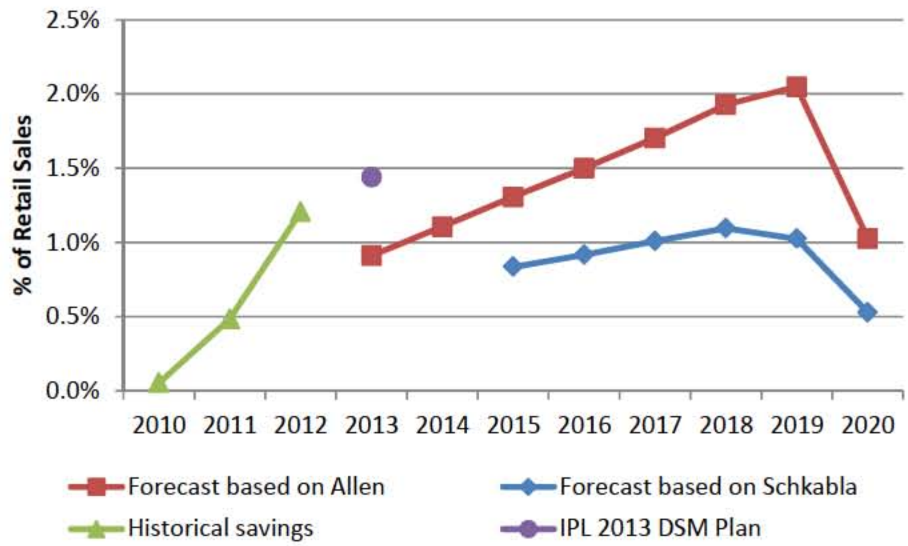


Figure 8. Comparison of Annual Incremental Energy Savings Forecast by Allen and Schkabla (% of Retail Sales Forecast)[28]

Q What are the implications of this inconsistency between Mr. Schkabla and Mr. Allen?

A It is by no means clear what level of energy efficiency or peak reductions are or were assumed in the justification to pursue a CCGT (CPCN Phase 1) or in the final analysis of the CCGT options. A failure to appropriately account for expected energy and peak savings could definitively change the outcome of the Company's justification.

[28] The retail sales forecast is based on the data table titled "IPL System Peak Load and Sales Forecast – After DSM", on page 8 of Mr. Schkabla's testimony.

Q Did CAC attempt to gain clarity from the Company on this question?

A Yes. In light of the uncertainty and confusion generated by inconsistent reporting of peak load and energy forecasts and peak reductions and energy efficiency by IPL's witnesses and within the various phases of modeling, CAC submitted a discovery request explicitly requesting that the Company provide peak load forecasts and energy demand forecasts for IPL from 2013-2051 both before and after demand-side management (DSM) programs (see Exhibit JIF-2).[29]

Q What was the Company's response to this discovery request?

A The Company provided a spreadsheet that provided peak requirements and energy demand before and after demand response programs (see Exhibit JIF-3).

Q Is DSM restricted to demand response only?

A No. Demand response is only one component of a comprehensive DSM program, which also includes energy efficiency programs and standards. Demand response programs are typically focused on peak reductions or shifting through interruptible load and/or backup generation. In the Generic DSM Order, this Commission clearly recognized that DSM applied to a broad variety of programs and standards targeting both peak and energy requirements.

Both IPL Witnesses Schkabla and Allen seemed to recognize the energy and peak reduction potentials associated with DSM, but the Company has not demonstrated an ability to organize its forecasts consistently and logically.

6. COMPANY UNDERESTIMATES DSM CONTRIBUTION TO PEAK REDUCTIONS

Q Given the Company's various estimates of forecast energy efficiency, do you believe that IPL has characterized peak reduction potential from DSM correctly?

A No. First, Mr. Allen's energy efficiency peak reduction estimates are not consistent with, and significantly lower, than the peak reduction estimates from

[29] CAC DR 4-4

the Company's 2011 IRP.[30] Second, Mr. Allen's estimates are not consistent with the findings from the most recent energy efficiency program evaluation, measurement and verification (EM&V) studies provided to CAC in DR 3-16 (see Exhibit JIF-4). Comparing these three cases, as shown in Figure 9, below, shows that Mr. Allen's estimate[31] in year 2020 is about 150 MW short relative to the 2011 IRP, and about 70 MW short relative to the evidence found in the EM&V studies.

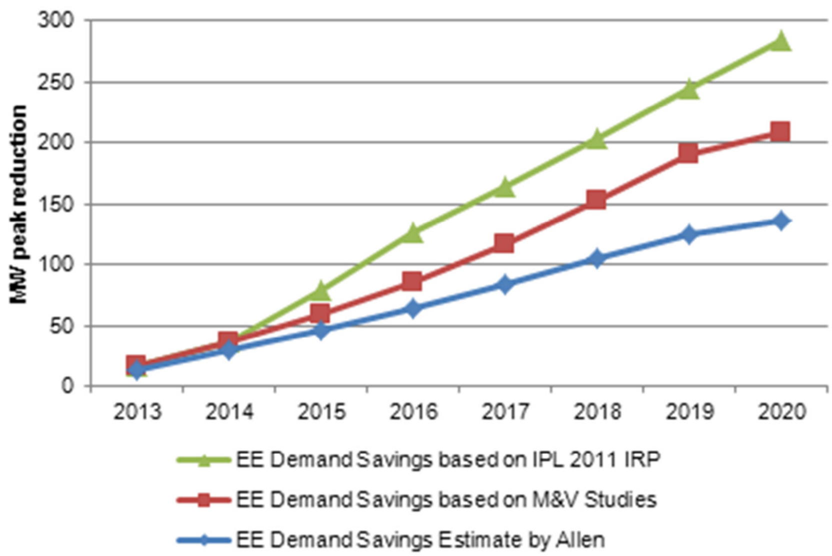


Figure 9. Comparison of cumulative demand savings estimates from energy efficiency (EE) by IPL 2011 IRP, EM&V Studies, and IPL Witness Allen

Q Please explain the peak reduction assumptions used in the 2011 IRP.

A The cumulative demand reduction estimate for the 2011 IRP was directly taken from Figure 4.2(b) of the 2011 IRP. This demand savings estimate is based on the assumption that the Company meets the Commission's energy savings target. The 2011 IRP states:

[30] IPL 2011 IRP, December 12, 2011, Figure 4.2(b), page 38

[31] Note Mr. Allen's Exhibit LHA-4 provides annual incremental savings. The savings presented in Figure 9 are cumulative savings estimated simply by adding each year's peak load reduction as years go by through 2020.

> While IPL was in the process of increasing the scale and scope of its DSM offerings in the 3 Year Plan filed in February 2009, the Phase II Generic Order (issued in December, 2009) required IPL to file an updated three year plan in October 2010 to achieve these higher targets. The next set of three year DSM plans for achievement of the IURC targets for the period from 2014 to 2016 will be filed in 2012. The order specified annual energy savings goals based on a percent of weather-normalized average electric sales for prior three years. These targets start at a 0.3% level in 2010 and ramp up to 2.0% in 2019. For IRP planning purposes, the DSM levels were considered mandatory, and integration of these load impacts on IPL's base case load forecast was treated as a resource planning requirement. (IPL 2011. p. 9)

Q Please explain how you derived peak reduction estimates based on the recent EM&V studies presented in Figure 9.

A The Company provided four EM&V studies for its Core and Core-Plus DSM programs in response to CAC discovery 3-16. I have used the Core and Core-Plus EM&V studies to derive a kW peak reduction per MWh energy reduction factor and applied it to Mr. Allen's energy savings forecasts from Exhibit LHA-4.

The cumulative peak reductions identified from Mr. Allen's testimony are calculated directly from Exhibit LHA-4.

Table 2, below, presents evaluated peak load savings (kW) and energy savings (MWh) in the three EM&V studies along with my estimate of a peak-reduction factor (kW/MWh) for each program, subtotal for the Core and Core-Plus programs, and the entire energy efficiency programs (excluding load response and renewable energy programs).[32] The peak-reduction factor for the entire program is 0.13 as presented at the bottom of the last column in this table. The total peak reduction presented in Figure 9 (above) is calculated by applying this 0.13

[32] The Indiana Statewide Core Program Evaluation Team 2012. 2012 Energizing Indiana Programs, May 3, 2012, Table 8: Statewide Ex-Ante and Verified Savings by Program by Utility – Energy; The Indiana Statewide Core Program Evaluation Team 2011a. 2011 IPL Residential Core Plus Programs EM&V Report - FINAL, December 12, 2012, Table 5: 2011 Residential Core Plus Programs Impacts: Comparison of Reported and Evaluated Gross and Net Savings; The Indiana Statewide Core Program Evaluation Team 2011b. Indianapolis Power and Light Commercial Core Plus Programs EM&V Report - for Programs with Year Ending December 2011, Table 4: 2011 Commercial Core Plus Program Impacts: Comparison of Goals vs. Evaluated Savings.

kW/MWh factor to the cumulative energy savings based on Mr. Allen's incremental energy savings estimate for each year as presented in Exhibit LHA-4.

Table 2. IPL Reported Energy and Peak Load Savings and calculated peak-reduction factors.

	Peak Load Savings (kW)	Energy Savings (MWh)	Peak-Reduction factor (kW/MWh)
Core Programs			
Home Energy Audit	681	6,010	0.11
Low-Income Weatherization	89	919	0.10
Energy Efficient Schools	625	5,739	0.11
Residential Lighting	1,914	16,091	0.12
Commercial and Industrial	5,186	27,312	0.19
Sub total	*8,495*	*56,072*	*0.15*
Core Plus Energy Efficiency Programs			
Multifamily Direct Install - IPL Only	327	11,619	0.03
Multifamily Direct Install – Joint	153	2,575	0.06
Residential Energy Assessment	271	2,279	0.12
Residential Walk Through Assessment and Direct Install	125	1,080	0.12
Residential Second Refrigerator Pick-up and Recycling	113	711	0.16
Residential ENERGY STAR New Homes	64	433	0.15
C&I Business Energy Incentive	2,208	18,696	0.12
Sub total	*3,261*	*37,393*	*0.09*
Grand total	**11,756**	**93,465**	**0.13**

Q What is the peak-reduction factor associated with Mr. Schkabla's testimony?

A Mr. Schkabla's testimony provides forecast demand and energy reductions (p8) that result in a peak-reduction factor that starts at 0.47 in 2014 and declines to 0.23 in 2020. This would suggest a very peak-oriented DSM reduction, which could alleviate some of the Company's capacity shortfall. However, based on the significant inconsistencies between Mr. Schkabla's load forecast as presented in testimony versus the actual values used in modeling (see Section 4, above), I am disinclined to take these values definitively.

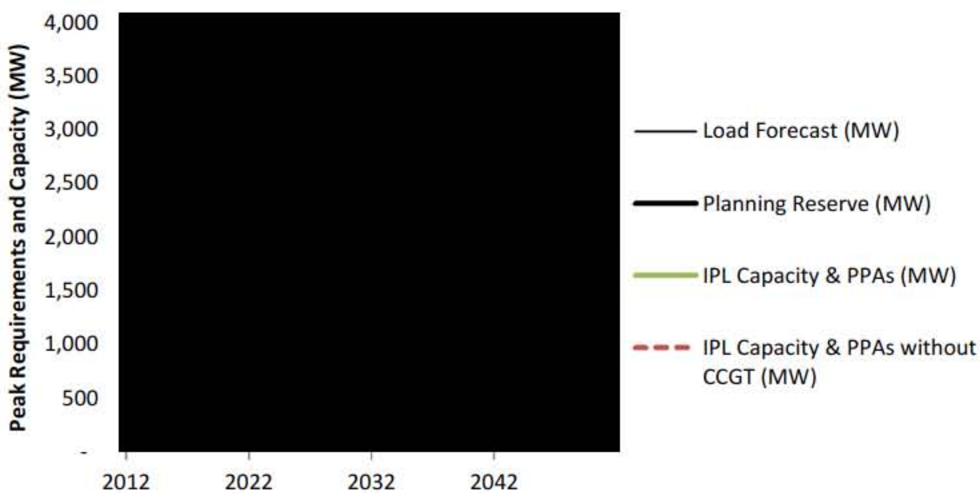
Q Do you know what peak reduction factors are actually used in the Company's forecast of DSM?

A No. CAC hoped to clear up this confusion with CAC DR 4-4, but the Company's confused response, as indicated earlier, only muddied the matter further.

7. COMPANY REQUIRES CAPACITY, NOT ENERGY RESOURCES

Q Please describe the Company's current requirement, as you understand it.

A The Company anticipates a loss of capacity currently served by non-economic coal generators (the "Small Six") and associated diesel generators. Following those retirements, the Company will be short on capacity by approximately 330 MW,[33] taking into account the re-firing of Harding St. 5 & 6, as well as demand response and solar capacity anticipated by the Company. Confidential Figure 10 shows the IPL system capacity balance with and without the new CCGT as modeled in Phase 2 of this CPCN (IPL CERES GE unit).

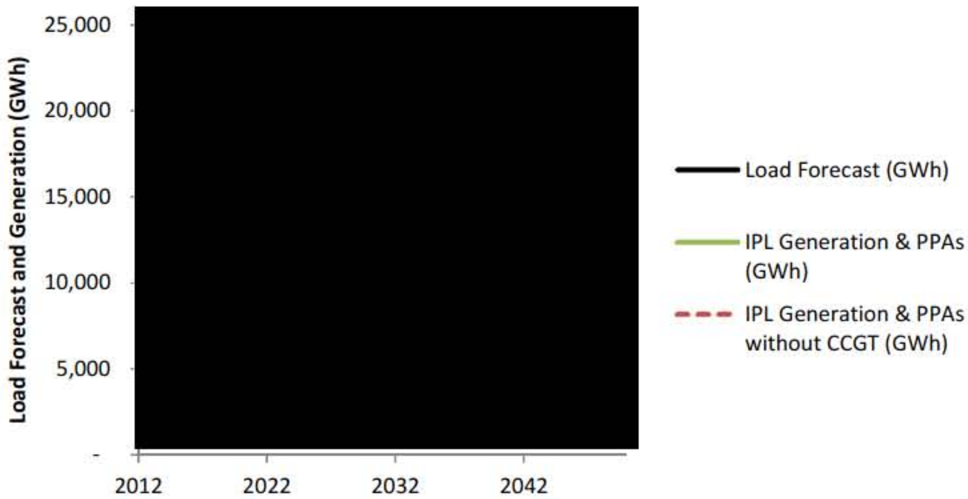


Confidential Figure 10. Capacity balance for IPL under CPCN Phase 2 assumptions.

Using the Company's most current assumptions (CPCN Phase 2), however, IPL will not experience a significant energy shortfall. Regardless of if the CCGT is built or not, IPL will have an energy shortfall of about [redacted] in 2016. This energy shortfall disappears when the CCGT comes online, but would otherwise be

[33] See IPL Response to CAC Set 2\CAC DR 2-1, Confidential Attachment 6 (BCPCN).zip file BCPCN Monthly Thermal 20130708, endpoint 1 column "Unit Capacity", rows "Total Resources", minus rows "IPL CERES GE" for generator capacity. See file BCPCN Transact C Monthly Summary 20130708, endpoint 1, "non-coincident peak" for requirement.

relieved by half in two years, and disappears in six years – largely on the basis of the Company's assumed improved performance of coal units.



Confidential Figure 11. Energy balance for IPL under CPCN Phase 2 assumptions.

Confidential Figure 11, above, shows that in the presence of the CCGT unit, IPL quickly goes from a net buyer to a massive net seller. In fact, by 2023, nearly 100% of the CCGT unit's output could be sold off system. As my colleague Mr. Comings points out, these off system sales (OSS) do not benefit IPL's ratepayers at all as the Company keeps 100% of net revenues from OSS.

Q What can you conclude from the Company's modeling and your observations?

A I conclude that, under the Company's stated assumptions, IPL only requires capacity resources, and then only requires about half of the capacity offered by the large CCGT unit (330 MW instead of 631 MW). I posit that if the Company were to reflect efficiency targets and peak reduction potentials from efficiency consistently with EM&V savings, IPL would require yet significantly less capacity. In addition, the CCGT is a massive overcompensation for the Company's net energy short position.

Q How do you think results would change if the Company re-ran an optimization, rather than production cost, model?

A Given the Company's most up-to-date assumptions, an optimization (or capacity expansion) model should favor incremental peak delivery resources, rather than CCGTs with 40-70% capacity factors.[34] As noted by IPL Witness Mr. Adkins in Cause 44242:

> In all my years of conducting IRP's and managing Request for Proposals for supply-side resources, the marginal capacity unit has always been a gas turbine and the marginal energy unit has always been a CCGT. The gas turbine is the marginal capacity unit due to its cost relative to a CCGT and Coal."[35]

This case appears to require a marginal capacity unit, not an energy unit.

Q Does IPL necessarily require those resources in 2017 or 2018?

A No. As Mr. Comings points out, the Company's own model in Phase 1 of the CPCN indicates that ratepayers are actually served better by delaying the acquisition of a new resource for two years rather than accelerating a new build.

8. OTHER CPCN MODELING ASSUMPTIONS ARE INTERNALLY INCONSISTENT, AND INCONSISTENT WITH CAUSE 44242

Q Do you have other concerns with the internal consistency of assumptions presented in this case?

A Yes. The Company's operating cost characteristics for the CCGT have fluctuated significantly from the 2011 IRP to the last CPCN filed by IPL a few months ago (Cause 44242) to the first phase of this CPCN and finally to Phase 2 of this CPCN.

Reviewing the model inputs for generic (or specific) CCGT replacement units, the Company seems to have updated costs from the 2011 IRP to the modeling performed in Cause 44242, but despite the fact that the instant CPCN (44339) was filed <u>after</u> modeling was complete for 44242, the Company still used 2011 IRP

[34] Direct Testimony of IPL Witness Crawford, p13 at 12-13
[35] Rebuttal Testimony of IPL Witness Adkins in 44242, p8

assumptions for the first phase of this CPCN and assumptions more in line with 44242 for the second phase of this CPCN.

Confidential Table 3, below, shows variable O&M (VOM) and fixed O&M (FOM) assumptions for the generic CCGTs modeled in the 2011 IRP, Cause 44242, and the two phases of this CPCN.

Confidential Table 3. Generic CCGT operational cost assumptions for recent IPL cases

	VOM ($/MWh)	FOM ($/kw-yr)	Capacity Factor in 2020	VOM + FOM / kW-yr
2011 IRP	[redacted]	[redacted]	[redacted]	[redacted]
Cause 44242	[redacted]	[redacted]	[redacted]	[redacted]
CPCN Phase 1	[redacted]	[redacted]	[redacted]	[redacted]
CPCN Phase 2*	[redacted]	[redacted]	[redacted]	[redacted]

* CPCN Phase 2 uses [redacted] as the representative unit

The higher VOM assumptions in the 2011 IRP and the first phase of this CPCN resulted in low capacity factors relative to the VOM assumed in Cause 44242 and the second phase of this CPCN.

The lower VOM is compensated for by far higher FOM costs in 44242 and the second phase of this CPCN – about double the 2011 IRP and Phase 1 assumptions.

Q Do these differences in operating costs matter?

A Yes, absolutely. The breakdown between which costs are assumed to be variable and fixed strongly determines how much the Company would expect to dispatch a unit – and is indicative of the amount of risk exposure the Company accepts by building resources of different types. Building a high FOM and low VOM generating unit (as is more typical of baseload coal and nuclear facilities) means that the Company depends on the unit operating at high levels to recover fixed costs.

More to the point, however, is that these are comparisons of completely different generators. There is no reasonable basis upon which to compare the outcome and economics of the units reviewed in the 2011 IRP and the first phase of this CPCN versus the units reviewed in Cause 44242 and the second phase of this CPCN. The justification of the Company to build a CCGT in the first place is completely unrelated to the actual CCGT that the Company now proposes to build.

Q What are the implications of using different operating cost assumptions between these recent cases?

There are three significant implications:

First, as shown in the fourth column of Confidential Table 3, the Company assumes that the all-in operational cost of the CCGT in Phase 1 of this CPCN is significantly lower than in the second phase. The justification for a CCGT banks on a significantly cheaper unit than the unit actually proposed by the Company.

Second, the lack of consistency between even the first and second phases of this CPCN suggest that the Company either has ineffective communication between modeling efforts, or has not updated their planning justification with their best and most reasonable source of information (i.e., RFP responses and engineering studies). The inability of the Company to use the most up-to-date information available to them in reviewing and providing justification of their course of action is simply imprudent.

Finally, the Company now presents a CCGT option that is significantly less expensive than the alternative replacement capacity for retiring coal units examined in Cause 44242. The Company had the information available in this CPCN prior to the closure of Cause 44242 – and even had this information prior to hearings in that case. The Company’s failure to present their most up-to-date CCGT costs in Cause 44242 denied the Commission and interveners the opportunity to evaluate reasonable alternative options available in that case.

Q Are there any other notable inconsistencies between cases?

A Yes. The two phases of this CPCN use different utility discount rates. The first phase uses a nominal discount rate of 7.54% evaluated from 2012 to 2051, [36] while the second phase uses a nominal discount rate of 6.47% evaluated from 2013 to 2052. [37] Regardless of the basis of these discount rates, the Company should, under most circumstances, use a consistent weighted average cost of capital (WACC) as their discount rate.

9. CARBON RISK IS UNADDRESSED, AND CARBON PRICE CASE IS MODELED INCORRECTLY

Q Do you have other concerns with the Company's justification for the CCGT?

A Yes. The Company has again, similarly to the CPCN presented in Cause 44242, almost completely ignored concerns about regulations or legislation that could impose costs on carbon dioxide emissions from fossil fuel fired generators.

Q Did you testify on this issue in Cause 44242?

A Yes. In that case, I noted that "with the exception of a single set of scenarios for each unit, the Company has disregarded the risk of a price on carbon in the next three decades."[38] During hearings on Cause 44242, no witness could explain why only a single scenario examined any form of carbon cost, or who was responsible for identifying the cost used in the "moderate environmental scenario."

Q How does this case compare in regards to the examination of potential carbon costs?

A Similarly to 44242, this case justifies the new CCGT on the basis of a commodity price scenario in which there is no price on carbon in the next four decades (the analysis extends to 2051). In the single sensitivity (of four) in which the Company

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[36] IPL Public Workpapers--provided 8-14-13\Schkabla\IRP11_CPCN_Plan_Results_40_Years.xlsx, tab "Base", cells B71:B76

[37] Corrected Workpapers--6-26-13\CONFIDENTIAL Schkabla WP 6 (CPCN CCGT Results LMP Pricing_4_24_13).xlsx, tab "Base_35 Years", cells B36:B42

[38] Surrebuttal Testimony of Jeremy Fisher in Cause 44242, p20

explores a price on carbon dioxide, that price is low and does not begin until the year 2021.

There is no carbon sensitivity at all in the second phase of this CPCN.

Q What is the outcome of the sensitivity that includes a price on carbon?

A Simply including a fairly low price on carbon equalizes the outcome of the Company's justification modeling in Phase 1 of this CPCN. The "moderate environmental" scenario shows the CT/Wind combination as the exact same present value as the CCGT option.

Q In the "moderate environmental" scenario, does the Company consistently apply the carbon price?

A No. Reviewing the Company's output files from Phase 1 modeling, it appears that the Company neglected to include the cost of carbon dioxide emissions in new resources – including the new 2018 CCGT.

Q Will a new CCGT emit carbon dioxide?

A Yes, and the Company models its emissions as well. However, they failed to model a cost for these emissions, leaving it as the sole fossil-fuel resource[39] that does not pay an emissions cost in the model.

Q Is the failure to model a price on emissions for the CCGT an error?

A Yes.

Q Does the failure to model a price on emissions for the CCGT make a difference in the outcome of this scenario?

A Yes. As I noted before, the Company's model indicates that building a CCGT in 2018 and a CT/Wind combination in 2020 are of approximately equal cost. However, IPL neglected to add a carbon cost for either the CCGT or the CT units in either scenario. The CCGT, however, has a much higher capacity factor and far

[39] In endpoint 1, the scenario that reviews the production cost of the CCGT starting in 2018. Other new resources in other endpoints (the new CCGT in 2020, the GTs in 2018/2020, and the coal unit in 2020) also do not pay a carbon cost in the Company's model.

higher emissions, and would thus incur more of a carbon cost than the CT/Wind combination. Had this cost been included, the Company would have likely found that in the "moderate environmental" scenario, the CT/Wind combination was financially preferred.

Q Has anything changed in regards to the risk of a cost on carbon emissions since your statements in Cause 44242?

A Yes. I submitted testimony in Cause 44242 in early April of 2013, and hearings were held later that month. On June 25, 2013, the President announced a series of initiatives to start regulating carbon emissions from new and existing fossil fuel fired electricity generators. In addition, in May of 2013, the Administration released a new series of estimates for the "social cost of carbon" (SCC), a monetized estimate of the damage caused to society by global climate change (see Exhibit JIF-5). Together, these two announcements signal a strong intent by the current Administration to seriously reduce carbon emissions from new and existing sources.

Q What was entailed in the President's June announcement?

A In conjunction with a public announcement, the White House released a memorandum with several directives in it. I have attached this memorandum as Exhibit JIF-6. Referring to the EPA, the memo stated (in part):

> Section 1. (b) Carbon Pollution Regulation for Modified, Reconstructed, and Existing Power Plants. To ensure continued progress in reducing harmful carbon pollution, I direct you to use your authority under sections 111(b) and 111(d) of the Clean Air Act to issue standards, regulations, or guidelines, as appropriate, that address carbon pollution from modified, reconstructed, and existing power plants and build on State efforts to move toward a cleaner power sector. In addition, I request that you:
>
> (i) issue proposed carbon pollution standards, regulations, or guidelines, as appropriate, for modified, reconstructed, and existing power plants by no later than June 1, 2014;
>
> (ii) issue final standards, regulations, or guidelines, as appropriate, for modified, reconstructed, and existing power plants by no later than June 1, 2015; and

> (iii) include in the guidelines addressing existing power plants a requirement that States submit to EPA the implementation plans required under section 111(d) of the Clean Air Act and its implementing regulations by no later than June 30, 2016.

Q Is it clear what would happen under a § 111(d) construct to regulate carbon dioxide emissions from existing power plants?

A Not yet. I am aware that the EPA is still considering a host of options, but I do not believe that there is any resolution yet on exactly what will be proposed by the EPA. On August 5, 2013, ICF International, a primary consultant for EPA responsible for modeling the impact of environmental regulations, released a whitepaper exploring options available to the EPA (Exhibit JIF-7). They note a number of non-flexible options, such as requiring specific heat-rate improvements or certain retirement deadlines, as well as flexible options, such as standards-based cap-and-trade mechanisms.

While it is unclear which mechanism will be proposed as of yet, it is increasingly certain that any proposal will effectively impose a cost on carbon emissions. In the current regulatory environment, it is inappropriate to still consider a zero cost as a reasonable baseline consideration.

Q What is the relationship of the SCC to the stringency of possible regulation?

A The SCC is an estimate of the damages caused to society at large from climate change, monetized, discounted, and divided by the emissions that lead to those damages. It is expressed in dollars per ton of CO_2. The purpose of an SCC is to provide a counterbalance to the potential costs of mitigating carbon pollution – i.e., replacing or controlling high emissions sources, increasing efficiency, and pivoting towards low emissions generation. In recent decades, the EPA has used social benefits to set a stringency threshold for regulations – i.e., if the cost of implementing a regulation outweighs its social benefit then the regulation has a low marginal value. In contrast, a policy can be justified on a cost/benefit basis if the social benefit outweighs the tangible costs.

Q Why does the EPA evaluate social costs or benefits?

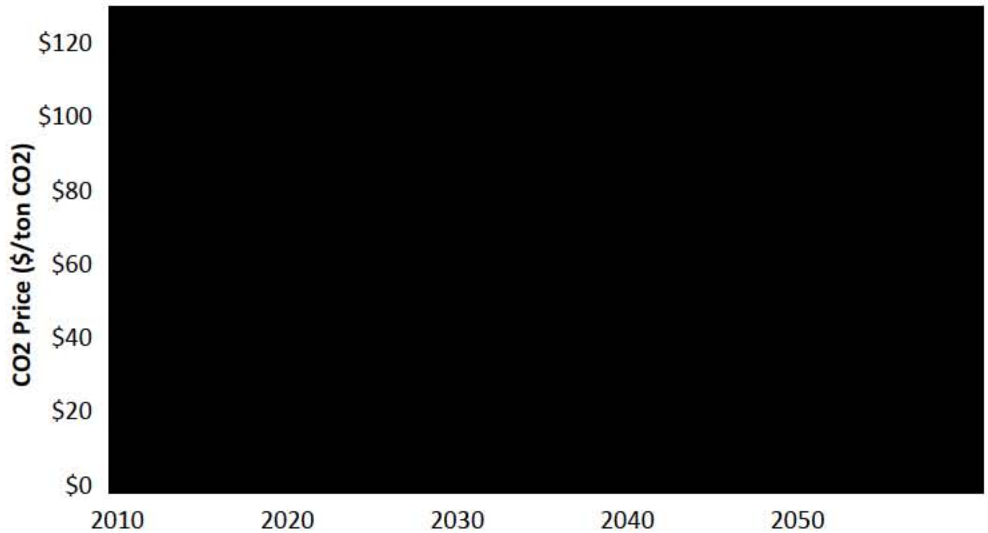
A Generally speaking, environmental regulations are designed to promote a public good – like health, improved visibility, social justice, or standard of living. From a cost/benefit perspective, the costs of an environmental regulation are fairly straightforward to monetize – they can usually be derived directly from engineering estimates and models. However, monetizing benefits such as the value of clean air or water is extremely difficult, calling into account societal preferences and requiring a monetization of invaluable resources such as comfort – or life.

The SCC is one tool that is likely to be used in the evaluation of the stringency of forthcoming regulations. The President signaled his intent to take this type of evaluation into account when referring to another controversial project, the Keystone Pipeline. From his climate action announcement, he stated that "the net effects of the pipeline's impact on our climate will be absolutely critical to determining whether this project is allowed to go forward."

Q How does the Company's "moderate environmental scenario" compare to the SCC?

A The Administration released three different estimates of the SCC, based on three different social discount rates – from 2.5% to 5%.[40] The 2.5% discount rate trajectory results in the highest SCC cost (i.e., we value damages in the future at a relatively high rate), while the financial equivalent rate (5%) has a far lower SCC cost (i.e., we significantly discount future damages). There is no consensus on the correct discount rate to use, as of yet. The Company's estimate for a cost of carbon, used <u>only</u> in the "moderate environmental" scenario, is significantly lower than two of the three estimates provided by the Administration, and approximates the lowest estimate from 2021 to 2036.

[40] The different discount rates are designed to take in social preferences to avoid damages and harm over longer periods than recognized by financial discount rates – using a high discount rate on a social harm indicates that society is less concerned about the livelihoods of our children than our own wellbeing, or is willing to discount the health of those two or three generations hence down to near zero values.



Confidential Figure 12. IPL carbon price in "Moderate Scenario) relative to 2013 social cost of carbon estimates at low, medium, and high discount rates.

I conclude that the Company has significantly underplayed the risk of CO_2 regulation – both by using a low CO_2 price trajectory and by only considering a price in one of four scenarios examined.

10. Conclusions and Recommendations

Q Please summarize your findings and recommendations.

A Briefly, I conclude that the Company has conducted an analysis justifying the CCGT that is:

- inconsistent with their own internal assumptions;
- does not reflect reasonable planning practice;
- underestimates the likely peak benefits of energy efficiency; and
- does not reflect likely environmental risks.

The Company has the technology, ability, and opportunity to repair these mistakes, but like the CPCN process in Cause 44242, will then produce untimely evidence when the Company has requested an expedited finding from this Commission.

Fortunately, the Company's own analysis indicates that ratepayers are best served by a delay in implementation. Thus, it is my recommendation that the Company revisit their analysis using an optimization model with updated assumptions, a wide variety of resource options, and a correct characterization of how off-system sales flow back to the Company, rather than ratepayers.

I recommend that the Commission deny CPCN at this time, or require the Company to provide further analysis subject to intervener scrutiny.

Q Are you recommending that the Company conduct a new IRP before submitting CPCN for replacement generation?

A Not necessarily, although completing an IRP would allow this Commission and stakeholders to ensure that decisions are data driven, and that assumptions are consistent. If IP&L planners perceive that there is a need for capacity or energy, it is incumbent on the Company to begin the process of examining that need and searching for lowest cost, low risk options to meet demand. The Company can, and should, regularly conduct that process internally without a public IRP process. But, if the materials submitted for this CPCN are indicative of the planning process that the Company uses internally, then I can only posit that either the Company plans only in piecemeal stages, or that the modeling here follows, rather than informs, Company decisions.

I do recommend that the Company establish a consistent set of assumptions that can be vetted by interveners and the Commission, improved and updated as required, and run an optimization model to determine the best resources to meet their anticipated requirements. The modeling presented for this CPCN contains inconsistent assumptions, is not logically incremental to previous modeling performed by the Company, and cannot reasonably be used to support the Company's decision over viable lesser cost opportunities.

VERIFICATION

I, Dr. Jeremy Fisher, affirm under penalties of perjury that the foregoing representations are true and correct to the best of my knowledge, information and belief.

______________________________ __August 22, 2013____________________

Jeremy Fisher, PhD Date

EXHIBIT JIF-1

Jeremy I. Fisher, PhD

Curriculum Vitae

Synapse Energy Economics	(617) 453-7045 (Direct)
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Cambridge, MA 02139	(617) 661-0599 (Fax)
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EMPLOYMENT

Principal Associate **2013 - Present**
Synapse Energy Economics, Cambridge, Massachusetts

Scientist **2007 - 2013**
Synapse Energy Economics, Cambridge, Massachusetts

Postdoctoral Research Scientist **2006 - 2007**
Tulane University, Department of Ecology and Evolutionary Biology
University of New Hampshire, Institute for the Study of Earth, Oceans, and Space

Visiting Fellow **2007 - 2008**
Brown University, Watson Institute for International Studies, Providence, Rhode Island

Research Assistant **2001 - 2006**
Brown University, Department of Geological Sciences, Providence, Rhode Island

EDUCATION

Ph.D. Geological Sciences	**2006**	Brown University, Providence, Rhode Island
M.Sc. Geological Sciences	**2003**	Brown University, Providence Rhode Island
B.S. Geology	**2001**	University of Maryland, College Park, Maryland
B.S. Geography	**2001**	University of Maryland, College Park, Maryland

TESTIMONY

Indiana Utility Regulatory Commission. *Verified Petition of Indianapolis Power and Light Company for Approval of Clean Energy Projects and Qualified Pollution Control Property and for Issuance of a Certificate of Public Convenience and Necessity for Construction and Use of Clean Coal Technology (etc…).* Direct Testimony of Jeremy Fisher, PhD. On Behalf of Citizens Action Coalition and Sierra Club. January 28, 2013. Cause 44242.

Wyoming Public Service Commission. *The Application of PacifiCorp for Approval of a Certificate of Public Convenience and Necessity to Construct Selective Catalytic Reduction Systems on the Jim Bridger Units 3 and 4*. Direct Testimony of Jeremy Fisher, PhD. On Behalf of Sierra Club. February 1, 2013. Docket 2000-418-EA-12.

Utah Public Service Commission. *The Voluntary Request of Rocky Mountain Power for Approval of Resource Decision to Construct Selective Catalytic Reduction Systems on Jim Bridger 3 & 4* Direct Testimony of Jeremy Fisher, PhD. On Behalf of Sierra Club. November 30, 2012. Docket No. 12-035-92

Wisconsin Public Service Commission. *Application of Wisconsin Public Service Corporation for Authority to Construct and Place in Operation a New Multi-Pollutant Control Technology System for Unit 3 of the Weston Generating Station, Marathon County, Wisconsin*. Direct Testimony of Jeremy Fisher, PhD. On Behalf of Clean Wisconsin. November 15, 2012. Docket 6690-CE-197.

Oregon Public Utility Commission. *In the Matter of PacifiCorp's Filing of Revised Tariff Schedules for Electric Service in Oregon.* Direct Testimony of Jeremy Fisher, PhD. On Behalf of Sierra Club. June 20, 2012. Docket UE 246

Kentucky Public Service Commission. *Application of Kentucky Power Company for Approval of its 2011 Environmental Compliance Plan, for Approval of its Amended Environmental Cost Recovery Surcharge Tariff, and for the Granting of a Certificate of Public Convenience And Necessity for the Construction and Acquisition of Related Facilities* Direct Testimony of Jeremy Fisher, PhD. On Behalf of Sierra Club. March 12, 2012. Docket 2011-00401

Kentucky Public Service Commission. *The Application of Kentucky Utilities / Louisville Gas and Electric Company for Certificates of Public Convenience and Necessity and Approval of its 2011 Compliance Plan for Recovery by Environmental Surcharge.* Direct Testimony of Jeremy Fisher, PhD. On Behalf of Sierra Club and Natural Resources Defense Council. September 16, 2011. Dockets 2011-00161 / 2011-00162

Kansas Corporation Commission. *In the Matter of the Petition of Kansas City Power & Light Company ("KCP&L") for Determination of the Ratemaking Principles and Treatment that will Apply to the Recovery in Rates of the Cost to be Incurred by KCP&L for Certain Electric Generating Facilities Under K.S.A. 66-1239.* Direct Testimony of Jeremy Fisher, PhD. On Behalf of Sierra Club. June 3, 2011. Docket 11-KCPE-581-PRE.

Utah Public Service Commission. *In the Matter of the Application of Rocky Mountain Power for Authority to Increase its Retail Electric Utility Service Rates in Utah and Approval of its Proposed Electric Service Schedules and Electric Service Regulations.* Direct Testimony of Jeremy Fisher, PhD. On Behalf of Sierra Club. May 26, 2011. Docket 10-035-124.

Wyoming Public Service Commission. *In the Matter of the Application of Rocky Mountain Power for Authority to Increase its Retail Electric Utility Rates in Wyoming Approximately $97.9 Million per Year or an Average Overall Increase of 17.3 Percent.* Direct Testimony of Jeremy Fisher, PhD. On Behalf of Powder River Basin Resource Council. April 11, 2011. Docket 20000-384-ER-10.

WHITE PAPERS

Fisher, J.I. 2013. Sierra Club's Preliminary Comments on PacifiCorp 2013 Integrated Resource Plan (Oregon Docket LC 57). Prepared for Sierra Club.

Fisher, J.I. P. Knight, E. Stanton, and B. Biewald. 2013. Avoided Emissions and Generation Tool (AVERT): User Manual. Version 1.0. Prepared for US EPA.

Fisher, J.I. T. Vitolo. 2012. Assessing the Use of the 2011 TVA Integrated Resource Plan in the Retrofit Decision for Gallatin Fossil Plant. Prepared for Sierra Club.

Fisher, J.I. K. Takahashi. 2012. TVA Coal in Crisis: Using Energy Efficiency to Replace TVA's Highly Non-Economic Coal Units. Prepared for Sierra Club.

Fisher, J.I., S. Jackson, B. Biewald. 2012. The Carbon Footprint of Electricity from Biomass: A Review of the Current State of Science and Policy. Whitepaper. Synapse Energy Economics.

Fisher, J.I. C. James, N. Hughes, D. White, R. Wilson, and B. Biewald. 2011. Emissions Reductions from Renewable Energy and Energy Efficiency in California Air Quality Management Districts. Prepared for the California Energy Comission. CEC-500-213-047.

Fisher, J.I., Ackerman, F. 2011. The Water-Energy Nexus in the Western States: Projections to 2100. Prepared for the Stockholm Environment Institute. Synapse Energy Economics.

Averyt, K., **J. Fisher**, A. Huber-Lee, A. Lewis, J. Macknick, N. Madden, J. Rogers, and S. Tellinghuisen. 2011. *Freshwater use by U.S. power plants: Electricity's thirst for a precious resource.* A report of the Energy and Water in a Warming World initiate. Cambridge, MA: Union of Concernered Scientists. November.

White, D., D. Hurley, **J.I. Fisher.** 2011. Economic Analysis of Schiller Station Coal Units. Prepared for Conservation Law Foundation. Synapse Energy Economics.

Fisher, J.I., R. Wilson, N. Hughes, M. Wittenstein, B.E. Biewald. 2011. Benefits of Beyond BAU: Human, Social, and Environmental Damages Avoided through the Retirement of the U.S. Coal Fleet. Prepared for Civil Society Institute. Synapse Energy Economics.

Fisher, J.I. and B. Biewald. 2011. Environmental Controls and the WECC Coal Fleet: Estimating the forward-going economic merit of coal-fired power plants in the West with new environmental controls.

Hausman, E.D, V Sabodash, N. Hughes, and **J.I. Fisher**. 2011. Economic Impact Analysis of New Mexico's Greenhouse Gas Emissions Rule. Prepared for New Energy Economy.

Fisher, J.I. and F. Ackerman. 2011. The Water-Energy Nexus in the Western States: Projections to 2100. Prepared for Stockholm Environment Institute.

Fisher, J. 2011. *A Green Future for Los Angeles Department of Water and Power: Phasing out Coal in LA by 2020.* Prepared for Sierra Club.

Fisher, J.I., J. Levy, Y. Nishioka, P. Kirshen, R. Wilson, M. Chang, J. Kallay, and C. James. 2010. Co-Benefits of Energy Efficiency and Renewable Energy in Utah: Air Quality, Health and Water Benefits. Prepared for State of Utah Energy Office. Synapse Energy Economics, Harvard School of Public Health, Tufts University.

Hausman, E.D., **Fisher, J.I.,** L.A. Mancinelli, B.E. Biewald. 2009. Productive and Unproductive Costs of CO_2 Cap-and-Trade: Impacts on Electricity Consumers and Producers. Prepared for the National Association of Regulatory Utility Commissioners, The National Association of State Utility Consumer Advocates (NASUCA), The National Rural Electric Cooperative Association (NRECA), The American Public Power Association (APPA). Synapse Energy Economics.

B. Biewald, **Fisher, J.I.** C James. L. Johnston, D. Schlissel. R. Wilson. 2009. Energy Future: A Green Energy Alternative for Michigan. Prepared forSierra Club. Synapse Energy Economics.

James, C. **J.I. Fisher**. K Takahashi. 2009. Alaska Climate Change Strategy's Mitigation Advisory Group Final Report: Greenhouse Gas Inventory and Forecast and Policy Recommendations Addressing Greenhouse Gas Reduction in Alaska. Energy Supply and Demand Sectors. Submitted to the Alaska Climate Change Sub-Cabinet.

James, C. **J.I. Fisher**. K. Takahashi, B. Warfield. 2009. No Need to Wait: Using Energy Efficiency and Offsets to Meet Early Electric Sector Greenhouse Gas Targets. Prepared for Environmental Defense Fund. Synapse Energy Economics

James, C., **J.I. Fisher**. **2008** Reducing Emissions in Connecticut on High Electric Demand Days (HEDD). Prepared for the CT Department of Environmental Protection and the US Environmental Protection Agency. Synapse Energy Economics.

Hausman, E.D., **J.I. Fisher**, B. Biewald. **2008** Analysis of Indirect Emissions Benefits of Wind, Landfill Gas, and Municipal Solid Waste Generation. Prepared for US. Environmental Protection Agency. Synapse Energy Economics.

Schlissel, D., **J.I. Fisher. 2008** A preliminary analysis of the relationship between CO_2 emission allowance prices and the price of natural gas. Prepared for the Energy Foundation. Synapse Energy Economics.

Fisher, J.I., B. Biewald. **2008** Costly Changes to the Energy Sector. *in* F. Ackerman and E.A. Stanton. *The Cost of Climate Change*. National Resources Defense Council.

Fisher, J.I., B. Biewald. **2007** Electricity Sector. *in* E.A. Stanton and F. Ackerman. *Florida and Climate Change: The Costs of Inaction*. Tufts University.

PEER-REVIEWED PUBLICATIONS

Ackerman, F., **J.I. Fisher. 2013**. Is there a water–energy nexus in electricity generation? Long-term scenarios for the western United States. *Energy Policy*. 59(2013) 235-241.

Averyt, K, J Macknick, J Rogers, N Madden, **J Fisher,** JR Meldrum, and R Newmark. *In press* (accepted Nov. 2012). Water use for electricity in the United States: An analysis of reported and calculated water use information for 2008. *Environmental Research Letters*.

J. T. Morisette, A. D. Richardson, A. K. Knapp, **J.I. Fisher** , E. Graham, J. Abatzoglou, B.E. Wilson, D. D. Breshears , G. M. Henebry, J. M. Hanes and L. Liang. **2009**. Tracking the rhythm of the seasons in the face of global change: Challenges and opportunities for phenological research in the 21st Century. *Frontiers in Ecology*. 7(5): 253–260

Fisher, J.I. G.C. Hurtt, J.Q. Chambers, Q. Thomas. **2008** Clustered disturbances lead to bias in large-scale estimates based on forest sample plots. *Ecology Letters*. 11:6:554-563.

Chambers, J.Q**., J.I. Fisher**, H. Zeng, E.L. Chapman, D.B. Baker, and G.C. Hurtt. **2007** Hurricane Katrina's Carbon Footprint on U.S. Gulf Coast Forests. *Science*. 318:1107

Fisher, J.I., A.D. Richardson, and J.F. Mustard. **2007** Phenology model from surface meteorology does not capture satellite-based greenup estimations. *Global Change Biology* 13:707-721

Fisher, J.I. & J.F. Mustard. **2007** Cross-scalar satellite phenology from ground, Landsat, and MODIS data. *Remote Sensing of Environment* 109:261–273

Fisher, J.I., J.F. Mustard, and M. Vadeboncoeur. **2006** Green leaf phenology at Landsat resolution: Scaling from the field to the satellite. *Remote Sensing of Environment*. 100:2:265-279

Fisher, J.I. & J.F. Mustard. **2004** High spatial resolution sea surface climatology from Landsat thermal infrared data. *Remote Sensing of Environment*. 90:293-307.

Fisher, J.I., J. F. Mustard, and P. Sanou. **2004** Policy imprints in Sudanian forests: Trajectories of vegetation change under land management practices in West Africa. *Submitted, International J.Remote Sensing*

Fisher, J.I. and S.J. Goetz. **2001** Considerations in the use of high spatial resolution imagery: an applications research assessment. *American Society for Photogrammetry and Remote Sensing (ASPRS) Conference Proceedings*, St. Louis, MO.

SELECTED ABSTRACTS

J.I. Fisher. Phenological indicators of forest composition in northern deciduous forests. *American Geophysical Union.* San Francisco, CA. December 2007.

J.I. Fisher, A.D. Richardson, and J.F. Mustard. Phenology model from weather station meteorology does not predict satellite-based onset. *American Geophysical Union.* San Francisco, CA. December 2006.

Chambers, J., **J.I. Fisher**, G Hurtt, T. Baker, P. Camargo, R. Campanella, *et al.*, Charting the Impacts of Disturbance on Biomass Accumulation in Old-Growth Amazon Forests. *American Geophysical Union.* San Francisco, CA. December 2006.

Fisher, J.I., A.D. Richardson, & J.F. Mustard. Phenology model from surface meteorology does not capture satellite-based greenup estimations. *American Geophysical Union. Eos Trans. 87(52).* San Francisco, CA. December 2006.

Fisher, J.I., J.F. Mustard, and M. Vadeboncoeur. Green leaf phenology at Landsat resolution: scaling from the plot to satellite. *American Geophysical Union. Eos Trans. 86(52).* San Francisco, CA. December 2005.

Fisher, J.I. and J.F. Mustard. Riparian forest loss and landscape-scale change in Sudanian West Africa. *Ecological Association of America*. Portland, Oregon. August 2004.

Fisher, J.I. and J.F. Mustard. High spatial resolution sea surface climatology from Landsat thermal infrared data. *American Society for Photogrammetry and Remote Sensing (ASPRS) New England Region Technical Meeting*. Kingston, Rhode Island. November, 2004.

Fisher, J.I., J.F. Mustard, and P. Sanou. Trajectories of vegetation change under controlled land-use in Sudanian West Africa. *American Geophysical Union*. *Eos Trans. 85(47).* San Francisco, CA. December 2004.

Fisher, J.I. and J.F. Mustard. Constructing a climatology of Narragansett Bay surface temperature with satellite thermal imagery. *The Rhode Island Natural History Survey Conference*. Cranston, RI. March, 2003.

Fisher, J.I. and J.F. Mustard. Constructing a high resolution sea surface climatology of Southern New England using satellite thermal imagery. *New England Estuarine Research Society.* Fairhaven, MA. May, 2003.

Fisher, J.I. and J.F. Mustard. High spatial resolution sea surface climatology from Landsat thermal infrared data. *Ecological Society of America Conference.* Savannah, GA. August, 2003.

Fisher, J.I. and S.J. Goetz. Considerations in the use of high spatial resolution imagery: an applications research assessment. *American Society for Photogrammetry and Remote Sensing (ASPRS) Conference Proceedings*, St. Louis, MO. March, 2001.

SEMINARS AND PRESENTATIONS

Fisher, J.I. Emissions Reductions from Renewable Energy and Energy Efficiency in California Air Districts *for* EPA State Climate and Energy Program. June 14, 2011.

Fisher, J.I. and B. Biewald. WECC Coal Plant Retirement Based On Forward-Going Economic Merit. Presentation *for* Western Grid Group. WECC, January 10, 2011.

Fisher, J.I. 2010. Protecting Electricity and Water Consumers in a Water-Constrained World. National Association of State Utility Consumer Advocates. November 16, 2010.

James, C., J.I. **Fisher,** D. White, and N. Hughes. 2010. Quantifying Criteria Emissions Reductions in CA from Efficiency and Renewables. CEC / PIER Air Quality Webinar Series. October 12, 2010.

Fisher, J.I. Climate Change, Water, and Risk in Electricity Planning. National Association of Regulatory Utility Commissioners (NARUC), Portland, OR. July 22, 2008.

Fisher, J.I. E. Hausman, and C. James. Emissions Behavior in the Northeast from the EPA Acid Rain Monitoring Dataset. Northeast States for Coordinated Air Use Management (NESCAUM), Boston, MA. January 30, 2008.

Fisher, J.I. J.F. Mustard, and M. Vadeboncoeur. Climate and phenological variability from satellite data. Ecology and Evolutionary Biology, Tulane University. March 24, 2006.

Fisher, J.I., J.F. Mustard, and M. Vadeboncoeur. Anthropogenic and climatic influences on green leaf phenology: new observations from Landsat data. Ecosystems Center at the Marine Biological Laboratory. Woods Hole, MA. Seminar, September 27, 2005.

Fisher, J.I. and J.F. Mustard. High resolution phenological modeling in Southern New England. Woods Hole Research Center. Woods Hole, MA. Seminar, March 16, 2005.

TEACHING

Teaching Assistant	**2005**	Global Environmental Remote Sensing, Brown University
Teaching Assistant	**2002 & 2004**	Estuarine Oceanography, Brown University

FELLOWSHIPS

2007 Visiting Fellow, Watson Institute for International Studies, Brown University
2003 Fellow, National Science Foundation East Asia Summer Institute (EASI)
2003 Fellow, Henry Luce Foundation at the Watson Institute for International Studies, Brown University

EXHIBIT JIF-2

Data Request Citizens Action Coalition DR 4-4

See Direct Testimony of Witness Schkabla, p23, Table "W/ HSS 5-6 Refueling in 2016 and EV CCGT in 2017" and CAC DR 2-1, Confidential Attachment 4 (CPCN1), workbook "CPCN Transact C Monthly Summary 20130709." Please provide the following:

a. Annual non-coincident peak load forecast (MW) before DSM for IPL from 2013-2051.
b. Annual non-coincident peak load forecast (MW) after DSM for IPL from 2013-2051.
c. Annual forecast reserve requirement (MW) for IPL from 2013-2051.
d. Annual energy demand forecast (MWh) before DSM for IPL from 2013-2051.
e. Annual energy demand forecast (MWh) after DSM for IPL from 2013-2051.
f. Please explain why the "Non Coincident Peak" (column X) is different in some years for endpoints 1 and 2.

Objection:

Response:

a.-f. See tab "DR 4.4 a.b.c.d.e.f." of attached spreadsheet CAC DR 4-4, Attachment 1.

The peak load and energy forecasts shown in the tables and used as input for the Midas modeling are net of energy efficiency DSM programs. For the CPCN1 workbook analysis, the peak load and energy data did not reflect 103MW of Demand Response DSM so the pre and post Demand Response forecasts are identical. The BCPCN workbook analysis did include the 103 MW of Demand Response DSM as shown in the table.

Although the omission of the Demand Response programs for the CPCN1 analysis will effectively increase the amount of capacity purchases and associated capacity expense for the six plans modeled, the additional capacity expense will be the same for each plan and will not change the relative PVRR results.

EXHIBIT JIF-3

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
a. Peak Load Forecast before Demand Response Program (MW)															
CPCN1	2928	2981	3031	3071	3084	3088	3098	3128	3157	3187	3208	3229	3251	3272	3294
BCPCN (Table, p.23)	2928	2981	3031	3071	3084	3088	3098	3128	3157	3187	3208	3229	3251	3272	3294
b. Peak Load Forecast after Demand Response Program (MW)															
CPCN1	2928	2981	3031	3071	3084	3088	3098	3128	3157	3187	3208	3229	3251	3272	3294
BCPCN (Table, p.23)	2825	2878	2928	2968	2981	2985	2995	3025	3054	3084	3105	3126	3148	3169	3191
Demand Response Program Difference	103	103	103	103	103	103	103	103	103	103	103	103	103	103	103
c. Forecast Reserve Requirement (MW)															
CPCN1 Load	2928	2981	3031	3071	3084	3088	3098	3128	3157	3187	3208	3229	3251	3272	3294
14% Reserve Requirements	410	417	424	430	432	432	434	438	442	446	449	452	455	458	461
BCPCN (Table, p.23) Load	2825	2878	2928	2968	2981	2985	2995	3025	3054	3084	3105	3126	3148	3169	3191
14% Reserve Requirements	396	403	410	416	417	418	419	424	428	432	435	438	441	444	447
d. Energy Demand Forecast before Demand Response Programs (MWh)															
CPCN1	14936865	15067350	15245304	15412358	15356739	15272864	15212317	15258807	15308913	15426703	15440896	15455102	15469320	15483552	15497797
BCPCN (Table, p.23)	14936865	15067350	15245304	15412358	15356739	15272864	15212317	15258807	15308913	15426703	15440896	15455102	15469320	15483552	15497797
e. Energy Demand Forecast After Demand Response Programs (MWh)															
CPCN1	14936865	15067350	15245304	15412358	15356739	15272864	15212317	15258807	15308913	15426703	15440896	15455102	15469320	15483552	15497797
BCPCN (Table, p.23)	14937174	15067659	15245613	15412667	15357048	15273173	15212626	15259116	15309222	15427012	15441205	15455411	15469629	15483861	15498106
	-309	-309	-309	-309	-309	-309	-309	-309	-309	-309	-309	-309	-309	-309	-309

f. Non-Coincident Peak is different in some years for endpoints 1 & 2 because the model takes the load forecast and modifies the hourly input energy requirements by any resources with an hourly load profile, like wind and solar. The differences begin in 2018.

Tab "Transpose Trans C Mthly CPCN1" is filtered to show the differences in the peak load forecast for endpoints 1 & 2. Endpoint one adds a CCGT in 2018 whereas endpoint 2 adds wind and a CT. The energy forecast is being modified by the wind energy added in 2018.

	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
a. Peak Load Forecast before Demand Response I															
CPCN1	3315	3337	3359	3381	3404	3404	3404	3404	3404	3404	3404	3404	3404	3404	3404
BCPCN (Table, p.23)	3315	3337	3359	3381	3404	3404	3404	3404	3404	3404	3404	3404	3404	3404	3404
b. Peak Load Forecast after Demand Response Pro															
CPCN1	3315	3337	3359	3381	3404	3404	3404	3404	3404	3404	3404	3404	3404	3404	3404
BCPCN (Table, p.23)	3212	3234	3256	3278	3301	3301	3301	3301	3301	3301	3301	3301	3301	3301	3301
Demand Response Program Difference	103	103	103	103	103	103	103	103	103	103	103	103	103	103	103
c. Forecast Reserve Requirement (MW)															
CPCN1 Load	3315	3337	3359	3381	3404	3404	3404	3404	3404	3404	3404	3404	3404	3404	3404
14% Reserve Requirements	464	467	470	473	477	477	477	477	477	477	477	477	477	477	477
BCPCN (Table, p.23) Load	3212	3234	3256	3278	3301	3301	3301	3301	3301	3301	3301	3301	3301	3301	3301
14% Reserve Requirements	450	453	456	459	462	462	462	462	462	462	462	462	462	462	462
d. Energy Demand Forecast before Demand Resp															
CPCN1	15512055	15526326	15540610	15554908	15569218	15569218	15569218	15569218	15569218	15569218	15569218	15569218	15569218	15569218	15569218
BCPCN (Table, p.23)	15512055	15526326	15540610	15554908	15569218	15569218	15569218	15569218	15569218	15569218	15569218	15569218	15569218	15569218	15569218
e. Energy Demand Forecast After Demand Respo															
CPCN1	15512055	15526326	15540610	15554908	15569218	15569218	15569218	15569218	15569218	15569218	15569218	15569218	15569218	15569218	15569218
BCPCN (Table, p.23)	15512364	15526635	15540919	15555217	15569527	15569527	15569527	15569527	15569527	15569527	15569527	15569527	15569527	15569527	15569527
	-309	-309	-309	-309	-309	-309	-309	-309	-309	-309	-309	-309	-309	-309	-309

f. Non-Coincident Peak is different in some years
requirements by any resources with an hourly loa
Tab "Transpose Trans C Mthly CPCN1" is filtered t
whereas endpoint 2 adds wind and a CT. The ene

	2043	2044	2045	2046	2047	2048	2049	2050	2051
a. Peak Load Forecast before Demand Response I									
CPCN1	3404	3404	3404	3404	3404	3404	3404	3404	3404
BCPCN (Table, p.23)	3404	3404	3404	3404	3404	3404	3404	3404	3404
b. Peak Load Forecast after Demand Response Pro									
CPCN1	3404	3404	3404	3404	3404	3404	3404	3404	3404
BCPCN (Table, p.23)	3301	3301	3301	3301	3301	3301	3301	3301	3301
Demand Response Program Difference	103	103	103	103	103	103	103	103	103
c. Forecast Reserve Requirement (MW)									
CPCN1 Load	3404	3404	3404	3404	3404	3404	3404	3404	3404
14% Reserve Requirements	477	477	477	477	477	477	477	477	477
BCPCN (Table, p.23) Load	3301	3301	3301	3301	3301	3301	3301	3301	3301
14% Reserve Requirements	462	462	462	462	462	462	462	462	462
d. Energy Demand Forecast before Demand Resp									
CPCN1	15569218	15569218	15569218	15569218	15569218	15569218	15569218	15569218	15569218
BCPCN (Table, p.23)	15569218	15569218	15569218	15569218	15569218	15569218	15569218	15569218	15569218
e. Energy Demand Forecast After Demand Respo									
CPCN1	15569218	15569218	15569218	15569218	15569218	15569218	15569218	15569218	15569218
BCPCN (Table, p.23)	15569527	15569527	15569527	15569527	15569527	15569527	15569527	15569527	15569527
	-309	-309	-309	-309	-309	-309	-309	-309	-309

f. Non-Coincident Peak is different in some years
requirements by any resources with an hourly loa
Tab "Transpose Trans C Mthly CPCN1" is filtered t
whereas endpoint 2 adds wind and a CT. The ene

EXHIBIT JIF-4

2012 Energizing Indiana Programs

EM&V Report

May 3, 2012

FINAL REPORT

Prepared for

The Indiana Demand Side Management Coordination Committee

Submitted by

The Indiana Statewide Core Program Evaluation Team:

TecMarket Works, Opinion Dynamics Corporation, The Cadmus Group, Integral Analytics, Building Metrics, and Energy Efficient Homes Midwest

With Maria Larson

TABLE OF CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

EXECUTIVE SUMMARY

This report presents the assessment of the ex-ante, audited, verified, ex-post gross, and net energy savings achieved by the Energizing Indiana statewide Core programs during the first year of operations (program year one or PY1). In addition, the report includes process evaluation findings designed to document the operations of the programs and to enhance or improve the programs' operations in future years. This report was completed by the TecMarket Works Indiana Statewide Core Program Evaluation Team consisting of representatives from TecMarket Works (the Evaluation Administrator), The Cadmus Group, Opinion Dynamics, Integral Analytics, and Building Metrics (the Evaluation Team).

Energizing Indiana consists of five Core energy efficiency programs serving low-income customers, residential customers, commercial and industrial customers, and schools. Specifically, these programs include: 1) The Residential Home Energy Audit (HEA) program; 2) Residential Low-Income Weatherization (LIW) program (also referred to the Income-Qualified Weatherization program[1]); 3) The Energy Efficient Schools (EES) Education and Building Assessment[2] programs; 4) The Residential Lighting program; and 5) The Commercial and Industrial (C&I) Prescriptive Rebates program.

The six utility companies taking part in the statewide Core program effort are Duke Energy, Vectren, Indianapolis Power & Light Company (IP&L), Indiana Michigan Power Company (I&M), Northern Indiana Public Service Company (NIPSCO), and the Indiana Municipal Power Agency (IMPA). The programs are administered by a third party, GoodCents (Program Administrator or Third-Party Administrator), who was hired through a competitive bid process in 2011.

The evaluation efforts included in this study are designed to meet among the highest reliability standards in the industry and conform to the definitions and requirements of the Indiana Evaluation Framework[3]. That Framework requires that the studies be reliable, such that they have a confidence level of 90% with a level of precision that is within plus or minus 10% over the standard three-year program cycle at the utility level and at the program level. This also means that because there are five programs sponsored by six utility companies, this evaluation provides 30 individual program impact assessments (5x6=30) reported across the six utility companies. The results of the utility-specific energy impacts assessments are then rolled up to report program-level energy impacts that achieve a 90% confidence level and ±10% precision interval for each program and the results in total. To be clear, while the savings reported in this PY1 evaluation are reliable at the program level, the highest level of utility-specific reliability will be reported at the end of the program cycle once all three years' worth of program sampling and evaluation analysis efforts have been completed and rolled up into the final program-cycle evaluation report (to be delivered in Spring of 2015). It should also be noted that all language and terminology in this report are written to be consistent with the DSM Impact Steps outlined in the Indiana Evaluation Framework and in the EM&V Methodology Overview section below (see page 35). Reviewers should reference these documents throughout the review of this report as needed.

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[1] The GoodCents Business Requirements Document (BRD) notes this program as the Low-Income Weatherization program, and the Energizing Indiana website lists it as the Income-Qualified Weatherization program. For this document we will refer to the program as the Low-Income Weatherization (LIW) program.

[2] The Building Assessment program was also referred to as the Energy Efficient Schools Audit program.

[3] The Indiana Evaluation Framework, TecMarket Works, September 25, 2012, as updated with measure-level effective useful lives in February 2012. (Note: The studies also comply with the California Energy Efficiency Evaluation Protocols, TecMarket Works, April 2006).

In total, the programs reported achieving 73% of the planned ex-ante gross goal for kWh in 2012, or 416,666,806 kWh and 88,587 kW. Of this, the Evaluation Team verified accomplishments of 294,986,472 kWh and 53,576.65 kW for an overall verified program realization rate of 71% for kWh and 60% for kW. The program's ex-post evaluated net savings were found to be 268,404,441 kWh and 69,053.50 kW. The net-to-gross (NTG) ratio for the kWh savings is .79, and for the kW savings is .75. Details on these totals are presented in table form below and are discussed in detail in each of the subsequent sections of this report.

Overall, at a high level, verified savings reported via this evaluation are significantly lower than the ex-ante gross savings reported by the Program Administrator. In several cases, the savings are also lower than the ex-ante gross savings being assumed for specific measures on a per-installation basis. While the ex-post net savings are usually lower than the ex-ante gross, the difference between the ex-ante projected gross and verified savings presented in this report is excessive. Several of the programs simply did not achieve the pre-established level-measure installation rates that were assumed when the programs were planned. The consistently seen discrepancies include:

- The types of homes served—far more gas heated and gas water heated homes were served than were assumed in planning[4].
- Low installation rate compared to planning assumptions—the number of measures installed via the programs, were installed in lower volumes than the levels assumed by the Program Administrator during the planning phase.
- Lower volumes of participants than planned—several of the programs did not achieve the participation rates assumed during the planning stage.

While we note the significant difference between ex-ante gross projected savings and the ex-ante verified savings, we also are cognizant that this first evaluation report represents the first year of the operations of a new set of programs offered statewide in Indiana. Hiring and training new staff, and designing and launching new start-up energy efficiency program structures are always challenging, and it can typically take several months before savings are achieved. The Energizing Indiana programs were established in a manner that expected the Program Administrator to meet very aggressive energy-savings objectives that required high levels of participation immediately upon launch. In the view of the Evaluation Team, this is significantly challenging and typically not seen in the first year of new programming. This challenge was noted to the DSMCC and the Commission by the Evaluation Administrator during the pre-program planning hearings held at the Commission prior to the finalization of the GoodCents contract for services.

We recognize that planning for and launching a set of five statewide programs would be a challenge for any Program Administrator. Simply put, in the opinion of the Evaluation Team, there was not enough ramp-up time, allowing for the levels of increasing participation needed to meet the first year's savings targets. Based on where the programs are after PY1, and on the outcomes of this evaluation, considerable thought should be given to the balance of the program years' savings targets and whether or not the ex-ante goals for the three-year cycle can be achieved. Success in future years will likely be dependent on a number of variables:

[4] The Program Administrator assumed that 50% of HEA and LIW homes would have electric water heating and that 23% of LIW homes would have electric heat and central air conditioning. However, based on program data, for LIW 33% of homes had electric water heaters and 13% of homes had electric heat and central air. For HEA, 30.7% of households had electric water heating.

- Can the Program Administrator continue to ramp-up participation to meet basic unit goals outlined in the contract?

- Can the Program Administrator change the mix of homes served to achieve the highest amount of electric savings possible, while limiting time and expense spent on gas measures that do not help meet the Core program goals?

- Will customer recognition and awareness of Energizing Indiana grow enough to increase demand in the market for these programs?

- Can the Program Administrator make changes to the program implementation approach that serves to maximize the number of measures installed in homes and businesses across the state?

- Can the utility-run Core and Core Plus programs evolve and collaborate in ways that contribute to the success of each?

If the Program Administrator focuses significant efforts on correcting the conditions that are leading to lower-than-expected ex-ante gross savings, and if they can improve the measure-installation rates for the measures covered by the program, there is a strong probability that two things can occur. The verified savings can be increased, and the Program Administrator can make major progress toward making up the PY1 gap and achieving the contracted ex-ante gross energy savings goals across the three-year cycle.

It is critical to note that the Evaluation Team does not believe that the current approach for projecting ex-ante gross savings should be continued. While each program is different, ex-ante gross savings should be counted at the measure level and only for measures that are installed and being used by participants in ways that produce the expected savings. Currently, programs like the Home Energy Audit (HEA) and Low-Income Weatherization (LIW) use a per-house ex-ante savings approach; that is, the assumption is that the same mix of measures is installed in each home. Because the Program Administrator did not install the number of measures assumed in the planning process in the types of homes they expected, the per-home ex-ante gross savings were higher than the audited and verified savings the Evaluation Team found for the program. Because progress toward utility goals is measured at the verified level, this gap as well as shortfalls in the achieved ex-ante savings will require the programs to make up savings in PY2 and PY3. It will be critically important for the Program Administrator to increase the rates of participation or the level of installations, or both, in order to have the programs perform at the required level needed to reach energy-savings goals.

While the program struggled with meeting the planning targets and ex-ante goals, there were many overall positive outcomes that the Evaluation Team highlights below and throughout this report. Notably, these positives indicate that PY2 and PY3 will be delivered upon a fairly solid base that was built in PY1. These positives outcomes include:

1. Generally, participants indicated high satisfaction with the program and their experience with individual programs.
2. Several programs experienced significant growth in participation rates in the last few months of PY1, which indicates through trending that volume may be increasing to the levels needed to meet program goals in future years, but only if this growth is continued and sustained.
3. A fully ramped-up Program Team is in place; the Program Administrator now has experienced staff in place who can focus on program delivery in the upcoming years.
4. The level and quality of marketing and outreach efforts were regarded as appropriate for most of the programs.

5. Coordination between the Third-Party Administrator and some of the utilities' Core Plus programs shows signs of working well (e.g., Core Plus programs). That is, for some utilities the Core and Core Plus programs are beginning to help customers know about the offers of these other programs, potentially increasing participation in both or either of the programs. If this leveraged marketing can be increased, thereby increasing total savings, the potential for reaching the overall Core and Core Plus combined goals is increased. This could provide an important basis for the balance of the three-year statewide cycle.

Detailed program-specific energy impact and process evaluation findings are provided in this report. The above findings are important enough to be placed up front in the Executive Summary, but it should be noted that they are more general in nature and apply to multiple programs. Readers are directed to the program-specific evaluation findings for summaries of program-specific evaluation results.

PROGRAM DESCRIPTIONS

Energizing Indiana is described as "*a united effort by the Indiana Office of Utility Consumer Counselor (OUCC), participating utilities, and consumer organizations to offer comprehensive energy efficiency programs that bring savings to communities across the state.*" The program consists of five Core offerings that are delivered by an independent third-party administrator, GoodCents. The year 2012 represented the first year (PY1) of a three-year program cycle for Energizing Indiana. The Energizing Indiana programs include offerings for homes, schools, businesses, and commercial facilities. Table 1 provides a program-by-program summary of the Energizing Indiana offerings.

Table 1: Program Descriptions

Program	Brief Program Description
Residential Home Energy Audit (HEA)	This program provides a free walk-through energy audit that analyzes participant energy use; assesses the heating, ventilation, and air conditioning (HVAC) systems in a home; recommends weatherization measures or upgrades; and facilitates the direct installation of low-cost energy-saving measures including low-flow showerheads, Compact Fluorescent Lamp (CFL) bulbs, sink aerators, pipe wrap, and water heater tank wrap.
Low-Income Weatherization (LIW)	This program provides a free walk-through audit that includes all HEA offerings, with the addition of full diagnostic testing (blower-door) for the home. Auditors recommend weatherization measures or upgrades that facilitate the direct installation of low-cost energy-saving measures including low-flow showerheads, CFL bulbs, sink aerators, pipe wrap, and water heater tank wraps. In addition, eligible homes may receive the installation of air sealing and attic insulation through the program.

Program	Brief Program Description
Energy Efficient Schools (EES) Education and Building Assessment	This program has two components. The first, the Education program, works with fifth- and sixth-grade students to help them learn about energy efficiency and how they can make an impact at their school and home. Participating schools receive classroom curriculum education and Energizing Indiana take-home efficiency kits. The second, the Building Assessment program, works with schools to assess their HVAC systems to determine if they are operating efficiently. The results of this assessment are used to guide schools to the appropriate upgrades and rebates that may be available through the Commercial and Industrial (C&I) program or other Core Plus programs.
Residential Lighting	This program works with retailers and manufacturers to offer bought-down pricing on CFLs, ENERGY STAR®-qualified fixtures, ceiling fans, and Light Emitting Diode lamps (LEDs) at the point of purchase.
Commercial and Industrial (C&I) Prescriptive Rebates	This program provides prescriptive rebates to commercial and industrial facilities based on the installation of energy efficiency equipment and system improvements. Upgrades can include Lighting, Variable Frequency Drives (VFDs), HVAC, and efficient ENERGY STAR commercial kitchen appliances. In addition, the program offered direct-mail CFLs kits starting in the fall of 2012.

BUDGET AND EXPENDITURES

Overall, the Program Administrator spent 57% of the PY1 implementation budget for all programs evaluated in this report in 2012. Spending was fairly consistent across utilities, although spending in the I&M territory, where there was more overall program activity for several of the programs, significantly outpaced spending in the other utility territories. Overall spending by program aligns with the savings achieved on behalf of the utilities by the Program Administrator, suggesting that savings and spending were pacing each other appropriately. Table 2 shows the budgets and reported expenditures by utility at the statewide level[5].

Table 3 shows the by-program spending, including spending for the branding effort not assessed as part of this evaluation.

[5] Budget data was provided to the Evaluation Team by GoodCents.

Table 2: Budget to Expenditures by Utility and Statewide[6]

Utility	Available Budget	Reported Expenditures	% of Budget Utilized
Duke	$28,513,436	$14,891,021	52%
I&M	$8,506,750	$6,328,630	74%
IPL	$14,685,488	$8,039,949	55%
IMPA	$5,127,801	$2,486,986	49%
NIPSCO	$11,519,895	$6,836,475	59%
Vectren	$6,047,324	$3,813,826	63%
Statewide	$74,400,693	$42,396,888	57%

Table 3: Budget and Expenditures

Program	2012 Budget	Reported Expenditures	% of Budget Utilized
Residential Home Energy Audit	$17,572,792.45	$10,149,143.28	58%
Low-Income Weatherization	$5,875,457.02	$5,875,818.78	100%
Energy Efficient Schools	$7,347,906.20	$7,302,787.83	99%
Residential Lighting	$6,290,026.70	$6,200,456.17	99%
C&I	$37,314,510.80	$12,868,681.48	34%
Branding	$689,544.00	$689,544.00	100%

The Commercial and Industrial (C&I) program came in furthest from the program spending target.

EX-ANTE SAVINGS SUMMARY

Ex-ante savings reflect the reported savings values provided by the Program Administrator. These are the savings reported by the Program Administrator in the program-tracking information aggregated, and reported in the GoodCents Portal.

Across all of the energy efficiency programs, the Program Administrator achieved 73% of its 2012 planned program energy savings goals, and 63% of its planned demand savings. Overall, the DSMCC portfolio fell short of the planning goal by 157,460,794 kWh and 52,127 kW. The Low-Income Weatherization (LIW) program and Energy Efficient Schools (EES) programs came in closest to the planned savings total at 100% and 98% of kWh, respectively. The Commercial and Industrial (C&I) and Home Energy Audit (HEA) programs fell farthest from meeting the planning goal, coming in at 63% and 62% of kWh goal, respectively. Table 4 provides a summary of the Program Administrator's ex-ante[7] savings compared to the planned savings for 2012. These savings do not present any adjustments (e.g.,

[6] Budget data was provided to the Evaluation Team by GoodCents.

[7] Reported or ex-ante sales are based on the GoodCents Portal reports represented by utility results from January 1, 2012, through December 31, 2012. https://indiana.goodcents.com/.

they do not reflect any evaluation activity) from the Evaluation Team, and simply show the savings as reported by the Program Administrator for the year 2012.

Table 4: 2012 Statewide Ex-Ante Savings by Program

Program	kWh			kW			Therms
	Goal	Ex-Ante	% of Goal	Goal	Ex-Ante	% of Goal	Ex-Ante
Home Energy Audit	52,357,368	32,293,623	62%	23,325	14,407.00	62%	NA
Low-Income Weatherization	9,877,800	9,877,800	100%	4,265	4,266.00	100%	345,657
Energy Efficient Schools	30,968,505	30,313,815	98%	NA	NA	NA	175,526
Residential Lighting	121,664,925	117,805,969	97%	19,444.20	18,827.45	97%	0
Commercial and Industrial	359,259,002	226,375,599	63%	93,680	51,087	55%	NA
Statewide Total	**574,127,600**	**416,666,806**	**73%**	**140,714**	**88,587**	**63%**	**521,183**

*Only two of the programs were identified by GoodCents as having therm goals, and only for two of the six utilities.

AUDITED SAVINGS SUMMARY

Audited savings reflect program savings after they have been reviewed by the Evaluation Team. The Team completed the audit of the Energizing Indiana savings by reviewing the programs' tracking databases; comparing results against the ex-ante energy savings numbers reported by the Program Administrator, including adjusting for incidence of measures; and ensuring that program ex-ante savings were applied correctly to a sampling of measures. Based on any findings, the Team made adjustments, as necessary, to correct for any errors or omissions as identified above, then recalculated program savings based on the adjusted audited number of measures. Table 5 provides a comparison of the total audited savings by program for the year 2012 against the ex-ante savings reported by the Program Administrator.

Table 5: 2012 Statewide Audited Savings by Program

Program	kWh Ex-Ante	kWh Audited	kW Ex-Ante	kW Audited	Therms Ex-Ante	Therms Audited
Home Energy Audit	32,293,623	23,607,570	14,407.00	11,581.42	231,379	664,650
Low-Income Weatherization	9,877,800	5,261,427	4,265.50	3,275.41	345,657	676,697
Energy Efficient Schools	30,313,815	30,313,815	NA	NA	175,526	175,502
Residential Lighting	117,805,969	117,701,601	18,827.45	18,793.53	0	0
Commercial and Industrial	226,375,599	217,830,865	51,086.68	47,856.18	NA	NA
Statewide Total	**416,666,806**	**394,715,278**	**88,586.63**	**81,506.54**	**752,562**	**1,516,849**

The audited savings for Residential Lighting program, Commercial and Industrial (C&I) program, and Energy Efficient Schools (EES) program are quite close to the ex-ante savings, coming in at 99%, 96% and 100%. In contrast, the audited savings for the Home Energy Audit (HEA) and Low-Income Weatherization (LIW) programs are significantly lower than reported. This is not because of errors in the count of total homes served, but because the makeup of measures actually installed in the homes and the type of homes served (electric versus gas heat) were significantly different than assumed in the planning stage. Thus, while the Program Administrator assumed that 50% of all homes served by the HEA program would receive water heater wraps, less than 1% of homes were actually treated with this measure. Additional details on the audited savings for each program can be found in subsequent sections of this report. In addition, the Evaluation Team has provided utility-specific Technical Volumes that have been delivered in tandem with this report. These volumes present the detailed by-utility analyses that were completed to develop the statewide savings numbers presented throughout this report.

VERIFIED SAVINGS SUMMARY

Verified savings are computed after confirming that measures have been installed and were found to be operating, by applying a statewide installation and persistence rate to the audited savings calculated above. Verification typically employs the detailed analysis of a stratified random sample of installations. Typical methods for collecting necessary data include telephone surveys and/or site visits. In this step, adjustments are made to the audited (above) savings to address issues such as measures rebated but never installed; measures not meeting program qualifications; measures installed but later removed; or measures improperly installed.

This step does not alter the per-measure ex-ante deemed saving values being claimed by the Program Administrator. For 2012, the Core programs had a goal of delivering 574,397 MWh and 140,714 kW in verified energy savings. Table 6 and Table 7 compares the ex-ante savings to the verified savings by program in total. Table 8 provides the utility breakouts.

Note that details on the verified savings shown below are provided in each of the program sections in this report.

Table 6: 2012 Statewide Ex-Ante and Verified Savings by Program – Energy

Program	kWh Ex-Ante	Verified kWh	kWh Realization Rate	kW Ex-Ante	Verified kW	kW Realization Rate
Home Energy Audit	32,293,623	17,190,585	53%	14,407.00	7,866.62	55%
Low-Income Weatherization	9,877,800	4,118,006	42%	4,265.50	2,570.39	60%
Energy Efficient Schools	30,313,815	28,718,896	95%	NA	NA	NA
Residential Lighting	117,805,969	92,944,602	79%	18,827.45	14,858.04	79%
Commercial and Industrial	226,375,599	152,014,384	67%	51,086.68	28,282	55%
Statewide Total	**416,666,806**	**294,986,472**	**71%**	**88,586.63**	**53,576.64**	**60%**

Table 7: 2012 Statewide Ex-Ante and Verified Savings by Program – Therms

Program	Therms Ex-Ante	Verified Therms	Therms Realization Rate
Home Energy Audit	231,379	573,383	287%[8]
Low-Income Weatherization	345,657	659,946	191%
Energy Efficient Schools	175,526	160,125	91%
Residential Lighting	0	0	0%
Commercial and Industrial	NA	NA	NA
Statewide Total	**752,562**	**1,393,454**	**185%**

[8] The Program Administrator only tracked therms savings information for two participating utilities.

Table 8: Statewide Ex-Ante and Verified Savings by Program by Utility – Energy

Program	2012 kWh Ex-Ante	2012 Verified kWh	kWh Realization Rate	2012 kW Ex-Ante	2012 Verified kW	kW Realization Rate
DUKE						
Home Energy Audit	6,368,469	3,499,648	0.55	2,841.00	1,532.99	0.54
Low-Income Weatherization	3,125,688	1,388,300	0.44	1,350.00	773.54	0.57
Energy Efficient Schools	16,450,650	15,585,122	0.95	N/A	NA	NA
Residential Lighting	43,553,056	34,338,302	0.79	6,960.53	5,511.83	0.79
Commercial and Industrial	92,696,419	64,678,069	0.70	19,088.00	10,718.00	0.56
TOTAL DUKE	162,194,282	119,489,441	0.74	30,239.53	18,536.36	0.61
I&M						
Home Energy Audit	4,238,031	2,343,867	0.55	1,883.86	1,062.80	0.56
Low-Income Weatherization	1,723,888	708,364	0.41	744.30	462.91	0.62
Energy Efficient Schools	2,058,312	1,950,017	0.95	NA	NA	NA
Residential Lighting	20,956,767	16,641,948	0.79	3,349.26	2,660.83	0.79
Commercial and Industrial	38,487,311	25,527,031	0.66	8,795.00	4,921.00	0.56
TOTAL I&M	67,464,309	47,171,227	0.70	14,772.42	9,107.54	0.62
IPL						
Home Energy Audit	10,934,024	5,690,564	0.34	4,875.82	2,567.00	0.53
Low-Income Weatherization	1,051,024	446,148	0.42	454.00	262.47	0.58
Energy Efficient Schools	4,127,466	3,910,305	0.95	NA	NA	NA
Residential Lighting	20,790,327	16,391,731	0.79	3,322.66	2,608.78	0.79
Commercial and Industrial	29,951,735	20,785,007	0.69	6,539.00	3,664.00	0.56
TOTAL IPL	66,854,576	47,223,755	0.71	15,191.48	9,102.25	0.60
IMPA						
Home Energy Audit	1,752,072	932,516	0.53	777.93	420.97	0.54
Low-Income Weatherization	391,200	180,372	0.46	169.00	103.87	0.61
Energy Efficient Schools	1,084,200	1,027,156	0.95	NA	NA	NA
Residential Lighting	5,715,155	4,492,942	0.79	913.38	714.50	0.78
Commercial and Industrial	19,503,585	13,931,261	0.71	4,928.00	2,850.00	0.58
TOTAL IMPA	28,446,212	20,564,247	0.72	6,788.31	4,089.34	0.60
NIPSCO						
Home Energy Audit	5,198,223	2,611,307	0.50	2,352.71	1,304.85	0.55
Low-Income Weatherization	2,268,960	831,650	0.37	980.00	619.54	0.63

Program	2012 kWh Ex-Ante	2012 Verified kWh	kWh Realization Rate	2012 kW Ex-Ante	2012 Verified kW	kW Realization Rate
Energy Efficient Schools	4,808,844	4,555,833	0.95	NA	NA	NA
Residential Lighting	17,586,488	13,787,432	0.78	2,810.63	2,198.16	0.78
Commercial and Industrial	30,162,786	17,035,343	0.56	8,301.00	4,337.00	0.52
TOTAL NIPSCO	60,025,301	38,821,565	0.65	14,444.34	8,459.55	0.59
VECTREN						
Home Energy Audit	3,802,803	2,112,683	0.56	1,675.84	977.40	0.58
Low-Income Weatherization	1,317,040	563,171	0.43	569.00	348.06	0.61
Energy Efficient Schools	1,784,343	1,690,462	0.95	NA	NA	NA
Residential Lighting	9,204,176	7,292,246	0.79	1,470.99	1,163.94	0.79
Commercial and Industrial	15,573,763	10,057,674	0.65	3,436.00	1,792.00	0.52
TOTAL VECTREN	31,682,125	21,716,236	0.69	7,151.83	4,281.40	0.60

Table 9: Statewide Ex-Ante and Verified Savings by Program by Utility – Therms

Program	2012 Therms Ex-Ante*	2012 Verified Therms	Therms Realization Rate
DUKE			
Home Energy Audit	NA	102,624	NA
Low-Income Weatherization	NA	112,355	NA
Energy Efficient Schools	NA	NA	NA
Residential Lighting	NA	NA	NA
Commercial and Industrial	NA	NA	NA
TOTAL DUKE	NA	214,979	NA
I&M			
Home Energy Audit	NA	83,064	NA
Low-Income Weatherization	NA	116,865	NA
Energy Efficient Schools	NA	NA	NA
Residential Lighting	NA	NA	NA
Commercial and Industrial	NA	NA	NA
TOTAL I&M	NA	199,929	NA
IPL			
Home Energy Audit	NA	187,765	NA
Low Income Weatherization	NA	74,829	NA
Energy Efficient Schools	NA	NA	NA
Residential Lighting	NA	NA	NA
Commercial and Industrial	NA	NA	NA
TOTAL IPL	NA	262,594	NA
IMPA			
Home Energy Audit	NA	29,412	NA
Low-Income Weatherization	NA	17,961	NA
Energy Efficient Schools	NA	NA	NA
Residential Lighting	NA	NA	NA
Commercial and Industrial	NA	NA	NA
TOTAL IMPA	NA	47,373	NA
NIPSCO			
Home Energy Audit	132,600	104,655	79%
Low-Income Weatherization	218,970	255,032	116%
Energy Efficient Schools	127,828	116,790	91%
Residential Lighting	0	NA	0
Commercial and Industrial	NA	NA	NA
TOTAL NIPSCO	479,398	476,477	99%

Program	2012 Therms Ex-Ante*	2012 Verified Therms	Therms Realization Rate
VECTREN			
Home Energy Audit	98,779	65,862	67%
Low-Income Weatherization	126,687	82,904	65%
Energy Efficient Schools	65,401	43,335	66%
Residential Lighting	0	NA	0
Commercial and Industrial	NA	NA	NA
TOTAL VECTREN	290,867	192,101	66%

*Ex-ante therm savings provided by GoodCents, programs without therm goals do not have a realization rate (NA).

EX-POST AND NET SAVINGS SUMMARY

Ex-post gross evaluated savings for the Energizing Indiana programs for PY1 are determined through engineering analysis, building-simulation modeling, billing analysis, metering analysis, or other accepted impact-evaluation methods. Adjustments made at this point reflect engineering adjustments made to the ex-ante per-measure savings that were claimed by the program and outlined in the Business Requirement Document[9], and do not include net adjustments. Adjustments to the verified savings may include changes to the baseline assumption, adjustments for weather, adjustments for occupancy levels, adjustments for decreased or increased production levels, and other adjustments following from the impact analysis approach. The engineering analysis for each measure type included in each program is discussed in the program-specific sections below.

Net savings reflect the ex-post savings with the net-to-gross (NTG) ratio applied to ex-post evaluated gross savings estimates to account for a variety of circumstances, including savings-weighted free rider and spillover effects. Net savings are provided and achieve a 90% confidence and +/-10% precision interval for each program[10].

Table 10 and Table 11 provide the program-level ex-post gross and net savings and the utility-level ex-post gross and net savings.

[9] From "Demand-Side Management Coordination Committee Independent Third Party Administrator Statement of Work." January 28, 2013.

[10] PY1 confidence and precision levels are 90/10 at the statewide level. Utility level 90/10 will be achieved at the end of PY3.

Table 10: 2012 Statewide Ex-Post and Net Savings by Program[11]

Program	kWh			kW			Therms		
	Ex-Post	NTG Ratio	Net	Ex-Post	NTG Ratio	Net	Ex-Post	NTG Ratio	Net
Home Energy Audit	17,939,625	0.89	15,960,939	2,030.00	0.89	1,804.00	1,718,321	1.00	1,720,108
Low-Income Weatherization	6,995,190	1.00	6,995,190	807.01	1.00	807.01	578,463	1.00	578,463
Energy Efficient Schools	40,566,432	1.02	41,414,941	4,600.00	1.09	5,010.99	977,932	1.21	1,147,481
Residential Lighting	91,411,428	0.57	52,104,514	10,867.56	0.57	6,194.51	(1,747,283)	0.57	(995,951)
Commercial and Industrial	182,642,707	0.83	151,928,857	74,342	0.74	55,237	0	NA	0
Statewide Total	**339,555,382**	**0.79**	**268,404,441**	**92,646.57**	**0.75**	**69,053.51**	**1,527,433**	**1.60**	**2,450,101**

Table 11: 2012 Statewide Ex-Post and Net Savings by Program by Utility

Program	kWh			kW			Therms		
	Ex-Post	NTG	Net	Ex-Post	NTG	Net	Ex-Post	NTG	Net
DUKE									
Home Energy Audit	3,664,688	0.89	3,271,487	404.95	0.89	361.06	333,256	1.00	334,184
Low-Income Weatherization	2,211,178	1.00	2,211,178	204.07	1.00	204.07	128,136	1.00	128,136
Energy Efficient Schools	23,470,892	1.03	24,081,247	2,563.30	1.09	2,792.58	435,551	1.19	518,838
Residential Lighting	33,886,113	0.57	19,315,084	4,028.37	0.57	2,296.17	(647,720)	0.57	(369,200)
Commercial and Industrial	58,073,046	0.88	51,269,915	47,154	0.68	31,961	0	NA	0
TOTAL DUKE	121,305,917	0.83	100,148,911	54,355	0.69	37,615	249,223		611,958

[11] Note that the NTG ratios provided above represent the total for the program and all its components (e.g. the C&I prescriptive effort has a NTG of .58 and while the bulb drop received a NTG of well over one, when all ex-post and all Net savings are combined the program level blended NTG is .86). NTG for individual components are reported within each program section.

Program	kWh			kW			Therms		
	Ex-Post	NTG	Net	Ex-Post	NTG	Net	Ex-Post	NTG	Net
								2.46	
I&M									
Home Energy Audit	2,456,323	0.89	2,180,481	275.39	0.89	243.87	239,344	1.00	238,605
Low-Income Weatherization	1,315,530	1.00	1,315,530	110.10	1.00	110.10	107,876	1.00	107,876
Energy Efficient Schools	2,770,869	1.02	2,822,012	306.54	1.09	334.38	79,306	1.16	91,804
Residential Lighting	16,337,807	0.57	9,312,550	1,942.27	0.57	1,107.09	(312,288)	0.57	(178,004)
Commercial and Industrial	30,972,533	0.81	25,093,655	6,630.00	0.86	5,730.00	0	NA	0
TOTAL I&M	53,853,062	0.76	40,724,228	9,264	0.81	7,525	114,238	2.28	260,281
IPL									
Home Energy Audit	6,010,373	0.89	5,355,687	681.45	0.89	606.41	562,989	1.00	565,499
Low-Income Weatherization	919,212	1.00	919,212	89.34	1.00	89.34	75,548	1.00	75,548
Energy Efficient Schools	5,738,881	1.02	5,851,412	625.05	1.09	680.16	156,807	1.16	181,568
Residential Lighting	16,091,318	0.57	9,172,051	1,913.50	0.57	1,090.70	(307,566)	0.57	(175,313)
Commercial and Industrial	27,312,033	0.79	21,706,520	5,186	0.88	4,559.00	0	NA	0
TOTAL IPL	56,071,817	0.77	43,004,882	8,495.34	0.83	7,025.61	487,778	1.33	647,302
IMPA									
Home Energy Audit	973,979	0.89	866,122	110.24	0.89	97.87	89,496	1.01	89,982
Low-Income Weatherization	330,926	1.00	330,926	30.01	1.00	30.01	19,175	1.00	19,175
Energy Efficient Schools	1,463,005	1.02	1,491,303	163.12	1.09	177.58	37,299	1.17	43,537

Program	kWh			kW			Therms		
	Ex-Post	NTG	Net	Ex-Post	NTG	Net	Ex-Post	NTG	Net
Residential Lighting	4,408,674	0.57	2,512,944	524.10	0.57	298.74	(84,272)	0.57	(48,035)
Commercial and Industrial	18,187,831	0.86	15,571,787	4,228.00	0.89	3,779.00	0	NA	0
TOTAL IMPA	25,364,415	0.82	20,773,082	5,055.47	0.87	4,383.20	61,698	1.70	104,659
NIPSCO									
Home Energy Audit	2,652,409	0.89	2,357,536	313.21	0.89	278.24	298,167	0.99	295,770
Low-Income Weatherization	1,273,453	1.00	1,273,453	174.79	1.00	174.79	163,783	1.00	163,783
Energy Efficient Schools	4,626,279	1.00	4,637,948	672.85	1.09	733.85	211,890	1.16	246,448
Residential Lighting	13,530,379	0.57	7,712,316	1,608.48	0.57	916.83	(258,630)	0.57	(147,419)
Commercial and Industrial	30,775,928	0.85	26,186,805	7,699	0.87	6,667	0	NA	0
TOTAL NIPSCO	52,858,448	0.80	42,168,058	10,468	0.84	8,771	415,210	1.35	558,582
VECTREN									
Home Energy Audit	2,181,854	0.88	1,929,626	244.97	0.88	216.67	195,069	1.01	196,068
Low-Income Weatherization	944,890	1.00	944,890	198.70	1.00	198.70	83,944	1.00	83,944
Energy Efficient Schools	2,496,506	1.01	2,531,019	268.87	1.09	292.45	57,078	1.14	65,285
Residential Lighting	7,157,136	0.57	4,079,568	850.84	0.57	484.98	(136,806)	0.57	(77,979)
Commercial and Industrial	17,321,336	0.70	12,100,174	3,445	0.74	2,541	0	NA	0
TOTAL VECTREN	30,101,722	0.72	21,585,277	5,008	0.75	3,734	199,285	1.34	267,318

SUMMARY OF IMPACT ADJUSTMENTS

Table 12: Summary of PY1 Planned, Ex-Ante, Audited, Verified, Ex-Post, and Net Statewide kWh Savings

Program	Planned kWh	Ex-Ante kWh	Audited kWh	Verified kWh	Realization Rate	Ex-Post kWh First Year	Ex Post kWh Lifetime	Net kWh First Year	Net kWh Lifetime
Home Energy Audit	52,357,368	32,293,623	23,607,570	17,190,585	53%	17,939,625	94,900,617	15,960,939	84,433,367
Low-Income Weatherization	9,877,800	9,877,800	5,261,427	4,118,006	42%	6,995,190	56,952,468	6,995,190	56,952,468
Energy Efficient Schools	30,968,505	30,313,815	30,313,815	28,718,896	95%	40,566,432	248,614,575	41,414,941	257,088,383
Residential Lighting	121,664,925	117,805,969	117,701,601	92,944,602	79%	91,411,138	457,055,690	52,104,514	260,522,570
Commercial and Industrial	359,259,002	226,375,599	217,830,865	152,014,384	67%	182,642,707	1,263,147,435	151,928,857	1,026,404,749
Statewide	**574,127,600**	**416,666,806**	**394,715,278**	**294,986,472**	**71%**	**339,555,092**	**2,120,670,785**	**268,404,441**	**1,685,401,538**

Table 13: Summary of Planned, Ex-Ante, Audited, Verified, Ex-Post, and Net Statewide kW Savings

Program	Planned kW	Ex-Ante kW	Audited kW	Verified kW	Realization Rate	Ex-Post kW First Year	Ex-Post kW Lifetime	Net kW First Year	Net kW Lifetime
Home Energy Audit	23,325.00	14,407.00	11,581.40	7,866.60	55%	2,030.20	2,030.20	1,804.13	1,804.13
Low-Income Weatherization	4,264.50	4,265.51	3,275.41	2,570.39	60%	807.01	807.01	807.01	807.01
Energy Efficient Schools	NA	NA	NA	NA	NA	4,600.00	4,600.00	5,010.99	5,010.99
Residential Lighting	19,444.17	18,827.45	18,793.53	14,858.04	79%	10,867.56	10,867.56	6,194.51	6,194.51
Commercial and Industrial	93,680.00	51,086.68	47,856.18	28,281.59	55%	74,342.00	74,342.00	55,237.00	55,237.00
Statewide	**140,713.67**	**88,586.64**	**81,506.52**	**53,576.62**	**60%**	**92,646.77**	**92,646.77**	**69,053.64**	**69,053.64**

Table 14: Summary of Planned, Ex-Ante, Audited, Verified, Ex-Post, and Net Statewide Therm Savings

Program	Planned Therms	Ex-Ante Therms	Audited Therms	Verified Therms	Realization Rate	Ex-Post Therms First Year	Ex-Post Therms Lifetime	Net Therms First Year	Net Therms Lifetime
Home Energy Audit	NA	231,379	664,650	573,383	248%	1,718,321	13,024,869	1,720,108	13,038,419
Low-Income Weatherization	NA	345,657	676,697	659,946	191%	578,463	6,570,840	578,463	6,570,840
Energy Efficient Schools	193,229	175,526	175,502	160,125	91%	977,932	6,390,928	1,147,481	7,373,152
Residential Lighting	NA	NA	NA	NA	NA	(1,747,283)	(8,736,414)	(995,951)	(4,979,755)
Commercial and Industrial	NA	NA	NA	NA	NA	0	0	0	0
Statewide	**193,229**	**752,562**	**1,516,849**	**1,393,454**	**185%**	**1,527,433**	**17,250,223**	**2,450,101**	**22,002,656**

CORE PROGRAMS HIGH-LEVEL INSIGHT AND FINDINGS

Below is a summary of the key findings for each of the five Core programs offered through Energizing Indiana. Additional detail on each program is provided in the program sections that follow.

Home Energy Assessment

The Home Energy Assessment (HEA) program offers a walk-through audit and direct installation of energy efficiency measures. In 2012, the program achieved 62% of its energy savings goals and 62% of its demand savings goals while using 58% of its budget. Key evaluation findings include:

- HEA participants[12] are satisfied with the program—especially with the professionalism of the auditors. On a scale of 0-10, overall satisfaction with the program was 8.8. Participants were most satisfied with the professionalism of the auditor, which scored a 9.6. The vast majority of participants (74%) could not list anything that could be done to improve the program.
- The incidence rates found in the program database are lower than the estimated incidence rates, or the frequency of installation per measure across homes, used in program planning. Fewer measures are being installed in each home than the program planned, and measures meant to capture electric savings are being installed in homes with natural gas water heating. This lowers the amount of total savings achieved in the home. In addition, the participant survey showed that measures left behind might be hurting overall installation rates because participants had not yet installed them on their own at the time of the survey[13]. Finally, participants reported that they did not remove measures once they were installed, which resulted in high near-term persistence rates.
- There were a number of issues with the program-tracking database. The program auditors are not consistently entering, or clearly identifying, the measures that are left behind in participants' homes and not installed. The program has some other data challenges. One challenge involves the lack of a data dictionary, which provides a definition for each field in a program database, its purpose, inputs, and data ranges, and is considered a best practice for energy efficiency program databases. Another challenge stems from inconsistent and ill-defined data-entry protocols for program staff/auditors, which lead to different tracking units (for example, BTUs versus tons) in the same fields. Likewise, auto-populate features included in the Optimizer Tool make it difficult to distinguish real from proxy data.
- The net-to-gross (NTG) ratio was calculated at the measure level. Tank wrap (100%), pipe wrap (93%), and aerators (93%) had the highest program attribution, while CFLs had the lowest (77%) which is similar to other utility programs nationally.

Low-Income Weatherization

The Low-Income Weatherization (LIW) program provides a walk-through audit and the direct installation of energy efficiency measures, including blower door-guided air sealing. Health and safety checks are also performed, and qualified homes may receive attic insulation. In 2012, the program achieved 100% of its kWh savings goal and 100% of its demand savings goal while using 100% of its budget. Key evaluation findings include:

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[12] Note that the participant survey only covered the first 10 months of the year. Significant increases in participation and the number of auditors may have changed overall program satisfaction. Please see the program-specific section for more details on this.

[13] The program will get eventual credit for CFLs left behind in PY1 but not installed at the time of the survey. 55% will be credited in PY2 and 44% in PY3, with 1% assumed to never be installed per the Indiana TRM.

- Survey data shows that 85% of participants are satisfied with the program overall[14], and a majority (55%) could not list anything that could be done to improve the program. The highest areas of satisfaction were the length of the audit and the professionalism of the auditor.

- Measure incidence rates, or the frequency of installation per measure across homes, in the program database are lower than planned by the Program Administrator, and measures meant to capture electric savings are being installed in homes with natural gas water heating. Auditors are also leaving several program measures behind with the participant to install later, rather than installing them at the time of the audit. This has resulted in much lower than anticipated installation rates. For example, CFLs have an installation rate of 78.6%[15], while in a neighboring state the installation rate was about 20% higher.

- Once program measures are installed, persistence rates are very high[16]. Persistence rates for program measures range from 97.2% for low-flow showerheads to 100% for pipe wraps. The program should ensure that auditors are installing as many program measures as possible in a participant's home. If measures are left behind, they should be tracked separately in the program database.

- There were several issues with the program-tracking database. The Program Administrator is not separately tracking measures that are left behind with the participant to install later. There are also several other issues related to the program data-tracking which make data analysis challenging, including inconsistent and poorly defined data-entry protocols for program staff/auditors to follow, different tracking units (e.g., BTUs versus tons) being used in the same fields, using the auto-populate function, and the lack of a data dictionary[17].

Energy Efficient Schools

The Energy Efficiency Schools (EES) program offers energy efficiency kits to students and energy assessments of school buildings at no cost. In 2012, the program achieved 98% of its energy savings goals and 91% of its energy savings goals while using 99% of its budget. Key evaluation findings include:

- Satisfaction is high among participating teachers and facility staff. Almost all surveyed teachers (91%) reported they would be highly likely to recommend the program to other teachers. Ninety-two percent (92%) of facility staff reported high satisfaction with the overall Building Assessment program.

- The Building Assessment program generates significant, untracked savings. Most savings generated in the first year of receiving the assessment are derived from behavioral changes such as setting air temperature controls and adjusting the building operating schedule. Sixty-nine percent (69%) of surveyed facility staff reported implementing at least one of the recommendations in the first year as a result of participating in the program.

- A lack of funding is the principal barrier to participating in the Building Assessment program. The most common suggestion for program improvement was to provide financing options to schools implementing recommended improvements.

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[14] Note that the participant survey only covered the first 10 months of the year. Significant increases in participation and the number of auditors may have changed overall program satisfaction. Please see the program-specific section for more details on this.

[15] This reflects measures installed by auditors and those later installed by participants.

[16] This represents near-term persistence and may not reflect long-term usage of installed measures.

[17] These inconsistencies could result in under-estimates or over-estimates of program savings, depending on the circumstances and the actual features of the home.

- Program implementers reported that some utilities' participation goals for the Education program are set higher than the number of fifth-grade students in a given territory; therefore goals need to be set at realistic expectations regarding the number of students.
- Teachers prefer to receive the kits earlier in the semester to allow time to teach the curriculum.

Residential Lighting

The Energizing Indiana Residential Lighting program works with retailers and manufacturers to offer bought-down pricing on CFLs, ENERGY STAR qualified fixtures, ceiling fans, and LEDs at the point of purchase. In 2012, the program achieved 97% of its ex-ante energy savings and demand goals while using 97% of its budget. This program achieved a realization rate of 79% between ex-ante and verified savings, and a net-to-gross (NTG) ratio of .57. Key evaluation findings include:

- Reported program savings tracked very closely to the audited savings found in the program database. While total unit counts aligned within .01%, there were some greater variances between individual measure-type counts and reported counts, but this had minimal effects on overall audited to ex-ante counts.
- Retailers report high satisfaction with the program overall, with 74% of retailers interviewed rating their satisfaction of the program with an average of 9 out of 10. Field representatives and program marketing generally received positive feedback, with retailers noting that in-store events were useful, increased sales, and provided immediate and more thorough information about the products to customers.
- The program appears to have considerable data-tracking issues. While issues do not pertain to the accuracy of total units tracked, there appear to be significant challenges around accuracy and tracking of unit types and SKUs, retailer-unique IDs, retailer price and incentive levels, and field definitions. In addition, there is indication of duplicative data-tracking efforts occurring, and challenges with the timeliness and consistency of retailer/manufacturer data uploads and allocation tracking.
- The free-ridership rate for this program is 43%; that is, of the bulbs sold 43% would have been sold in absence of the program, with .57 being the NTG ratio. This is in line with what we see in many other similar programs operating nationally and in the Midwest.

Commercial and Industrial Prescriptive Rebates

The Commercial and Industrial (C&I) Prescriptive Rebates program is designed to achieve long-term, cost-effective savings. This program relies on a prescriptive rebate structure that rewards participants with monetary incentives based on their installation of energy efficiency equipment upgrades. These upgrades include lighting, VFDs, HVAC, and ENERGY STAR kitchen equipment. The program also included a CFL-mailer program, referred to as the Bulb Drop. In 2012 the program achieved a realization rate of 67% for energy savings and 55% for demand savings, using 34% of the program budget. Key evaluation findings include:

- Ninety-two percent (92%) of Bulb Drop survey respondents reported being "somewhat" or "very" supportive of the program efforts. For both lighting and non-lighting customers, they ranked the program approximately a 9 out of 10, 10 indicating "very satisfied."
- The realization rate, when ex-ante is compared to the audited savings, was at 100% for energy and 98% for demand savings for participant-engaged rebated measures, without the Bulb Drop.

The reduced realization rate, down to 67% for energy and 55% for demand, was primarily due to the low installation rate achieved. Additional savings will be counted toward 2013 and 2014, when these bulbs begin to replace more of the existing stock.

- Large equipment, such as HVAC and VFDs, has the potential to achieve significant savings for the program. As the program matures and businesses have addition time to plan capital investments, these measures should be targeted through increased Trade Ally channels.
- The net-to-gross (NTG) figure (58%) achieved in the program is in line with what we see for first-year commercial programs. As the program has more time to influence the market and facilitate retrofit planning, this number could change.

Indianapolis Power and Light Commercial Core Plus Programs EM&V Report

For Programs with Year Ending December 2011

Prepared for

Indianapolis Power and Light

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CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

1. SUMMARY OF FINDINGS

Indianapolis Power and Light Company (IPL) is delivering Demand Side Management (DSM) programs to its customers. In Indiana these programs are classified as "Core" and "Core Plus" programs. Core programs are those programs that IPL sponsored in 2011 that are now (2012) being delivered by a statewide Third-Party Administrator ("TPA"). This evaluation report focuses on IPL's Core Plus efforts in 2011, but also includes 2010 savings for programs that were launched late that year.

The DSM Oversight Board and IPL contracted with the TecMarket Works team to conduct both impact and process evaluations for all of the Core Plus programs offered by IPL. As part of the TecMarket team, Opinion Dynamics led the residential evaluation effort, and The Cadmus Group led the commercial and industrial (C&I) evaluation effort. Note that this report contains findings for the C&I programs; findings for the Residential programs were previously submitted by Opinion Dynamics Corporation (ODC).

In 2011, IPL's C&I Core Plus portfolio consisted of three programs, which are described in Table 1.

Table 1: Commercial Core Plus Programs

Programs	Brief Program Description
C&I A/C Load Management	The objective of the program is to reduce peak load by curtailing air conditioning during peak usage periods during summer months, between June and September.
C&I Renewables Incentives	The program supports and promotes the generation of clean, renewable energy in commercial premises by reducing the net cost to the end user of such systems.
C&I Business Energy Incentive Program	The program offers incentives for commercial customers to upgrade to various energy-efficient measures including lighting, HVAC, and motors.

1.1 EM&V METHODOLOGY OVERVIEW

This evaluation's overall objective is to understand and help improve IPL's Core Plus programs, and to quantify each program's energy impacts. The evaluation team conducted both process and impact evaluations for three IPL C&I programs, as listed above. A description of the evaluation efforts follows.

Process Evaluation: The process evaluation seeks to help IPL improve program design to achieve additional savings, align its goals with customer needs, and increase participant satisfaction with the programs. Key efforts include a review of program materials, in-depth interviews with IPL staff and program implementer staff, participant surveys, and participant/non-participant contractor in-depth interviews. Our process evaluation sought to answer the following questions for each program:

- Is the program, as designed and implemented, on track to meet its goals?
- Can improvements be made in the program design and implementation processes, including marketing efforts and database tracking efforts?
- Could specific customer/contractor insights help improve the program and increase satisfaction levels?

Impact Evaluation: The impact evaluation seeks to accurately quantify demand and energy savings estimates. Through engineering site visits, participant surveys, and statistical and engineering analyses, the impact evaluation provides:

- Documentation of reported gross savings impacts;
- Evaluation of program's gross savings impacts; and
- Evaluation of program's net savings impacts.

Reported gross savings referenced throughout this report are taken from the 2011 IPL Scorecard for DSM Oversight Board provided by IPL.

Table 2 provides program-specific evaluation, measurement, and verification (EM&V) activities performed by the evaluation team to complete the goals stated above.

Table 2: EM&V Activities by Program

Program	Process Evaluation	Impact Evaluation
C&I A/C Load Management	• Interviewed program manager • Reviewed participant tracking database • Reviewed program materials	• Collected hourly load data for treatment group for 2011 • Collected hourly temperature and humidity data for the IPL service territory (Indianapolis station) for summer of 2011 • Developed average load shape for participant sample (i.e., referential load) • Assessed difference between referential load and actual usage during events to determine impacts
C&I Renewables Incentives	• Interviewed program manager • Conducted interviews with 5 participants and reviewed interview notes from residential contractor interviews • Reviewed participant data tracking database	• Conducted an engineering review • Reviewed tracking database
C&I Business Energy Incentive	• Interviewed program and implementation staff • Reviewed participant data tracking database • Reviewed materials to assess marketing and outreach efforts • Reviewed materials associated with training • Participant survey to be conducted upon receipt of customer list	• Conducted an engineering review of program and assumptions • Conducted site visits for 5 (large-savings) sites to measure and verify gross savings estimates

1.2 IMPACT SUMMARY

For 2011, IPL set a goal of delivering 6,704,384 kilowatt hours (kWh) and 1,518 kilowatts (kW) in gross energy savings and demand reductions, respectively, from the three commercial energy programs evaluated in this report. Overall, IPL's commercial portfolio met 95 percent of its energy savings goal and 151 percent of its demand goals. Table 3 lists participation goals for the programs and compares 2011 Commercial Core Plus Program goals with evaluated savings.

Table 3: 2011 Participation Goals by Program[1]

Program	2011 Goal	2011 Reported	% of Goals
C&I A/C Load Management	273 participants	109 participants	40%
C&I Renewables Incentives	6 installations	6 installations	100%
C&I Business Energy Incentive	76 participants	61 participants	80%

Table 4 shows a summary of impacts from the 2011 Commercial Core Plus Programs. The largest program, C&I Business Energy Incentives, performed well relative to goals, achieving 95% of its energy savings goal and 400% of its demand reduction goal. This program represents more than 99% of savings across the three programs. The Renewables program achieved 201% of its energy savings goal but only 25% of its goal for demand reduction. The Demand Response program fell significantly below both of its goals.

Table 4: 2011 Commercial Core Plus Program Impacts: Comparison of Goals vs. Evaluated Savings[2]

Program	Goal (kWh)	Reported Gross Energy Savings (kWh)	Evaluated Gross Energy Savings (kWh)	Evaluated Gross as % of Goal	Goal (kW)	Reported Gross Demand Savings (kW)	Evaluated Gross Demand Savings (kW)	Evaluated Gross as % of Goal
Energy Efficiency Programs								
C&I Business Energy Incentive	6,679,346	7,701,969	6,343,327	95%	552	2,408	2,208	400%
Renewables Programs								
C&I Renewables Incentives Program	14,100	14,100	28,303	201%	9	21	5.2	25%
Demand Response Programs								
C&I A/C Load Management Program	10,938	4,374	3,504	32%	957	404	74.2	8%
TOTAL	6,704,384	7,720,443	6,375,134	95%	1,518	2,833	2,287	151%

In this evaluation report, we also reviewed the underlying assumptions of these savings estimates in light of all available data collected through the program and evaluation effort. Based on this review, in each chapter we provide *evaluated gross energy savings* estimates that better reflect actual program conditions.

In 2011, IPL spent 74 percent of the total implementation budget for all programs evaluated in this report, as shown below.

Table 5: Commercial Core Plus Program Budgets

Program	2011 Budget	2011 Reported	Percent of

[1] Source: 2011 IPL Scorecard for DSM Oversight Board

[2] Source: 2011 IPL Scorecard for DSM Oversight Board

	Goals	Expenditures	Budget Goals
C&I A/C Load Management	$210,000	$96,478	46%
C&I Renewables Incentives	$36,000	$29,725	83%
C&I Business Energy Incentive	$685,000	$562,213	82%
TOTAL	**$931,000**	**$688,416**	**74%**

1.3 Commercial Core Plus Programs High-Level Insight and Findings

A/C Load Management Program

The objective of the C&I Air Conditioning Load Management (ACLM) Program is to reduce peak load by curtailing air conditioning during peak usage periods during summer months between June and September, and is used mostly as an emergency program. The ACLM program has had difficulty meeting its goals in the past year. In 2011, the program achieved 32 percent of its energy savings goal and 8 percent of its demand savings goals while using 46 percent of its budget. IPL has reduced the goals for Program Year 2012.

IPL called three load events in 2011, and called an additional two events for a sample population. There were 109 participants in the C&I ACLM program. The program has been marketed by utilizing IPL's account executives to communicate program offerings to their customers. However, recruitment has not been as successful as IPL had hoped because the program team has found it difficult to get traction in the larger retail and restaurant segments. Recruitment has been more successful with non-profit organizations, such as fire stations and libraries.

Due to the low program performance, the C&I ACLM team, in coordination with the Oversight Board, worked to move funds out of this program in order to invest in other opportunities with the IPL program portfolio. Should this program move forward again in the future or target a different sector, Cadmus recommends two key changes for a more robust impact evaluation: 1) establish a statistically representative control group with equivalent characteristics to serve as the treatment control; and 2) conduct an equivalency check between sampled participants and the participation population.

C&I Renewables Incentives program

The C&I Renewables Incentives program achieved a 28,303 kWh of energy savings during 2011 compared to an annual program goal set at 14,100 kWh – a 201 percent realization rate. The program, which seeks to promote the installation of solar photovoltaic (PV) and wind technology renewable energy systems, also realized 5.2 kW in peak demand savings from systems installed in 2011 (25 percent realization rate due to differences in calculation, detailed in Section 3). The program achieved these savings using 83 percent of its budget. Eight solar PV systems were installed during the evaluation period of June 2010 to December 2011.

IPL acknowledged that the program relies primarily on its trade allies to promote the Renewables Incentives program, and it has not invested heavily in marketing materials. However, if IPL intends to expand the program in the future, there are several improvements that could help the program run more smoothly and increase the number of customers. Increasing marketing efforts by utilizing existing channels and creating new marketing materials that can be leveraged by trade allies will raise awareness about the program. These new materials should focus on the incentive and financial return on investment since Cadmus' research showed money to be a primary motivating factor. Although the customers thought the application process ran smoothly, the contractors managing the application process saw room for improving the efficiency of the process. Inspection of the final project is a key step in the rebate application, and as the program grows, it will be important to define a clear process for contractors to notify IPL of project installation and schedule an inspection.

We note that the limited data collection of site specific conditions and parameters reduces IPL's ability to track and estimate energy generation and savings resulting from the installation of renewable energy systems. Cadmus recommends that the program implementers gather annual energy estimates or equivalent information to improve the accuracy of program savings claims.

C&I Business Energy Incentive

The C&I Business Energy Incentives Program is organized into three distinct program components: 1) Lighting prescriptive; 2) Non-lighting prescriptive; and, 3) Custom—each addressing a specific need for customers. The goal of the program is to reduce overall load while maintaining a high level of customer satisfaction. The program reported exceeding its goals for both gross energy savings and demand reduction, even though it fell short in its enrollment target; in 2011, the program achieved 95 percent of its energy savings goal and 400 percent of its demand savings goals while using 82 percent of its budget. The C&I Business Energy Incentive program accounts for 99.5% percent of all savings from IPL's commercial Core Plus programs.

During August and September 2012, Cadmus surveyed six custom program customers who participated in the Business Energy Incentive Program.[3] Due to the survey sample size, and the resulting insufficient basis for estimating a net-to-gross (NTG) ratio based on participant responses, the program assumption for NTG was not revised from the planning assumption of 1.0.

Cadmus recommends tracking program information centrally and in greater detail. By keeping information together in a more useable format, IPL and other stakeholders will be able to more easily observe trends in customer segments and measures, and make program adjustments. Cadmus also recommends that detailed operating schedules are required as part of the application process; this will help facilitate site-savings calculations. As the Business Energy Incentives program moves forward, it will be important to maintain regular communications between IPL and its evaluation stakeholders. Passing information from evaluators to utility clients to implementers and back with greater speed and simplicity means that lessons learned can be incorporated into the program sooner and shared with a wider audience.

1.4 REPORT STRUCTURE AND ORGANIZATION

Sections 2 through 4 provide a program-by-program review, including impact estimates and program insights and recommendations.

[3] While most of the evaluation research was conducted earlier in the year, the survey research was delayed because the team was unable to obtain an appropriate sample list. After several iterations, Cadmus received sufficient sample to complete six custom program customer surveys.

2011 IPL Residential Core Plus Programs EM&V Report - FINAL

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Prepared for

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TABLE OF CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

1. SUMMARY OF FINDINGS

Indianapolis Power and Light Company (IPL) is delivering Demand Side Management (DSM) programs to its customers. These programs are classified as "CORE" and "Core Plus" programs. CORE programs are those programs that IPL is currently implementing (in 2011) that will be later delivered by a statewide Third-Party Administrator ("TPA") in 2012-2013. Core Plus programs are programs that are in addition to IPL's CORE Programs. This evaluation report focuses on IPL's Core Plus efforts in 2011, but also includes 2010 savings for programs that were launched later that year.

The DSM Oversight Board and IPL contracted with the TecMarket Works team to conduct both impact and process evaluations for all of the Core Plus programs offered by IPL. As part of the TecMarket Works team, Opinion Dynamics led the residential evaluation effort, and The Cadmus Group led the commercial and industrial (C&I) evaluation effort. Note that this report contains findings for the Residential programs; C&I findings are provided as a separate report.

In 2011, IPL's Residential Core Plus portfolio consisted of nine programs. An additional program, the PerfectCents® Residential High Efficiency Heating and Cooling Rebate Program, was launched in early 2012. As such, this program is not included in the evaluation efforts. Table 1 lists the nine programs and their descriptions.

Table 1: Residential Core Plus Programs

Programs	Brief Program Description	Evaluation Status
Multi-Family Direct Install Program (IPL-only and Joint)	The main goal of the program is to direct install energy efficiency measures such as CFLs, low flow showerheads and kitchen and bathroom aerators at multi-family premises	Included in the report
Residential Walk Through Assessment and Direct Install	The program offers free energy efficiency measures to customers after completion of a walk through energy audit	Included in the report
Residential Energy Assessment	The program offers free energy efficiency measures to customers after completion of an online energy audit	Included in the report
Residential Second Refrigerator Pick-up and Recycling	The program collects and recycles functioning refrigerators and freezers to remove less efficient appliances from the power grid	Included in the report
Residential ENERGY STAR New Homes	The program is designed to increase the number of new homes built to the ENERGY STAR specification	Included in the report
Residential Air Conditioning Load Management	The objective of the program is to reduce peak load by curtailing air conditioning during peak usage periods during summer months, between May and September	Included in the report
Residential Renewables Incentives	The program supports and promotes the generation of clean, renewable energy in residential premises by reducing the net cost to the end user of such systems	Included in the report
Residential Conservation Program (Opower)	The goals of the program are to provide information to customers so that they can reduce their energy consumption through behavioral changes as well as increase customer engagement across program-targeted within the IPL service territory	Evaluation outside of the scope of this report. Rather it contains a description of the process for assigning customers to the treatment and control groups as performed by the evaluation team

Programs	Brief Program Description	Evaluation Status
PerfectCents® Residential High Efficiency Heating and Cooling Rebate Program (Added in 2012)	The objective of the program is to replace existing inefficient residential HVAC equipment for residential customers	Evaluation activities focused on robustness of proposed participant tracking database. Suggestions on database improvements included in this report.

1.1 EM&V METHODOLOGY OVERVIEW

The overall objective of this evaluation is to understand and help improve IPL's Core Plus Programs and to quantify each program's impact. The evaluation team conducted both a process and an impact evaluation for the IPL Core Plus residential programs. Below we provide a description of the evaluation efforts.

Process Evaluation: The objectives of the process evaluation are to help IPL improve program design to be able to achieve additional savings, better align its goals with customer needs, and increase participant satisfaction levels with the programs. The key efforts include a review of program materials, in-depth interviews with IPL staff and program implementer staff, participant surveys, and participant/non-participant contractor in-depth interviews. Our process evaluation sought to answer the following overall question:

- Is the program, as designed and implemented, on track to meet its goals?
- Are there improvements that can be made in the program design and implementation processes, including marketing efforts, and database tracking efforts?
- Are there specific customer/contractor insights that could help improve the program and increase satisfaction levels?

Impact Evaluation: The objectives of the impact evaluation are to accurately quantify energy savings values. The key efforts include participant surveys, and statistical and engineering-based analysis. The impact evaluation quantifies the following:

- Statement of reported gross savings impact
- Evaluation of program's gross savings impact
- Evaluation of program's net savings impact

The table below provides program specific evaluation measurement and verification (EM&V) activities performed by the evaluation team to help address the above noted research areas.

Table 2: EM&V Activities by Program

Program	Process Evaluation	Participant Surveys and In-Depth Interviews	Impact Evaluation
Multifamily Direct Install	• Interviewed Program Manager • Interviewed Implementer (WECC) • Reviewed materials to assess marketing and outreach efforts	• Conducted in-depth interviews with 10 managers/owners • Conducted site visits for 97 dwelling units within 10 buildings to measure and verify gross savings estimates	• Conducted an engineering review of program and assumptions
Walk Through Assessment and Direct Install	• Interviewed Program Manager • Interviewed Implementer (WECC) • Reviewed participant data tracking database • Performed document verification with a sample of 35 participants • Reviewed materials to assess marketing and outreach efforts	• Conducted telephone survey with 69 participants	• Reviewed deemed savings estimates outlined in the DSM Potential Study and Action Plan • Estimated evaluated savings based on algorithms that used IPL specific tracking information data and/or accepted standards based on various TRM and evaluated studies that were applicable to IPL customers • Estimated NTG (free ridership and spillover) based on self-report from participant survey
Residential Energy Assessment	• Interviewed Program Manager • Interviewed Implementer (WECC) • Reviewed participant data tracking database • Performed document verification with a sample of 35 participants • Reviewed materials to assess marketing and outreach efforts	• Conducted telephone survey with 70 participants	• Reviewed deemed savings estimates outlined in the DSM Potential Study and Action Plan • Estimated evaluated savings based on algorithms that used IPL specific tracking information data and/or accepted standards based on various TRM and evaluated studies that were applicable to IPL customers • Estimated NTG (free ridership and spillover) based on self-report from participant survey
Residential Second Refrigerator Pick-up and Recycling	• Interviewed Program Manager • Interviewed Implementer (JACO Environmental) • Reviewed participant data tracking database • Performed document verification with a sample of 60 participants (30 each for freezer and refrigerator participants) • Reviewed materials to assess marketing and outreach efforts • Conducted research on the used appliance market help understand the natural movement of used appliances	• Conducted interviews with market actors • Conducted telephone survey with 121 participants (71 refrigerator participants and 50 freezer participants)	• Reviewed deemed savings estimates outlined in the DSM Potential Study and Action Plan • Adjusted savings by self-reported appliance usage for the 12 months prior to recycling from the participant survey • Estimated evaluated savings based on algorithms that used IPL specific tracking information on characteristics of program appliances data and/or accepted standards based on various TRM and evaluated studies that were applicable to IPL customers • Estimated NTG (free ridership and spillover) based on self-report from participant survey

Program	Process Evaluation	Participant Surveys and In-Depth Interviews	Impact Evaluation
Residential ENERGY STAR New Homes	• Interviewed Program Manager • Interviewed Implementer (WECC) • Interviewed Implementer Subcontractor/Rater (TSI) • Reviewed participant data tracking database • Performed document verification with a stratified sample of homes that received incentives - 20 gas heat homes, 36 electric homes, and 26 heat pump incentives • Reviewed materials to assess marketing and outreach efforts • Reviewed materials associated with training	• Conducted a depth interviews with 3 participating builders, representing 50% of the builders, but 92% of measures paid • Conducted depth interviews with 4 non-participating builders to understand program reach, awareness, barriers to participation, customer motivations and related topics, current building practices from builders and market actors	• Reviewed deemed savings estimates provided by IPL for each home level and HVAC measures • Adjusted savings estimated based on engineering review of savings values, review of REM/Rate files, and calculations using REM/Rate software • Adjusted impact savings based on NTG estimates from self-report analysis from interview results
Residential Air Conditioning Load Management	• Interviewed Program Manager • Interviewed Implementer (GoodCents) • Interviewed Device Manufacturer (Cooper) • Reviewed participant data tracking database • Reviewed treatment group tracking information • Reviewed treatment group information to determine adequacy of sample size as representative of the participant population • Reviewed materials to assess marketing and outreach efforts • Reviewed materials associated with training	NA	• Collected hourly load data for treatment group for 2011 • Collected hourly temperature and humidity data for the IPL service territory (Indianapolis Airport station) for summer of 2011 • Develop average load shape for participant sample • Regression Analysis based on treatment group smart meter hourly consumption data as well as weather variables
Residential Renewables Incentives	• Interviewed Program Manager • Reviewed participant data tracking database • Reviewed application materials for all participating residential customers • Reviewed materials to assess marketing and outreach efforts	• Conducted a depth interviews with three out of 4 residential participants • Conducted depth interviews with 3 non-participating contractors to understand program reach, awareness, barriers to participation, customer motivations and related topics, current building practices from builders and market actors • Conducted depth interviews with 1 participating contractor	• Reviewed deemed savings estimates outlined in the DSM Potential Study and Action Plan • Reviewed program tracking database and incentive applications for accuracy and system design specifications • Estimated savings adjusted based on National Renewable Energy Laboratory System Advisor Model results for each rebated solar PV system

1.2 IMPACT SUMMARY

For 2011, IPL had a goal of delivering 18,012 MWh and 7,510 kW in gross savings from the residential energy programs evaluated. Overall, IPL's residential portfolio exceeded their energy savings goals by 4%, and exceeded program demand goals by 75% to 145%[1], across all energy efficiency, demand response and renewable programs offered to residential customers (see Table 4). Overall, IPL spent 81% of the total implementation budget for all programs evaluated in this report in 2011.[2] Table 3 lists unit goals associated with the Residential Core Plus program portfolio.

Table 3: 2011 Unit Goals by Program

Program	2011 Goal(1)	2011 Actual(2)	% of Goals
Multi-Family Direct Install - IPL Only	8,462 participants	4,447 participants	53%
Multi-Family Direct Install - Joint	7,822 participants	24,487 participants	313%
Residential Energy Assessment	4,455 participants	6,515 participants	146%
Residential Walk Through Assessment and Direct Install	2,500 participants	2,524 participants	101%
Residential Second Refrigerator Pick-up and Recycling	888 units	916 units	103%
Residential ENERGY STAR New Homes	72 measures	102 measures	142%
Residential Air Conditioning Load Management	5,000 customers*	3,599 customers*	72%
Residential Renewables Incentives	12 homes	2 homes	17%

(1) Source: IPL 2011 Scorecard
(2) Source: Program specific evaluated numbers
** These numbers include new customers in 2011 only, not the entire participant population of over 34,000 participants*

In this evaluation report, we reviewed the reported program savings estimates in light of all available data collected through the program and evaluation effort, as well as secondary information from similar programs around the country. Based on this review, in each chapter we provide *evaluated gross energy savings* estimates based on engineering review that better reflect actual program conditions. These *evaluated* numbers also provide insights on how future actual achieved savings may differ from those that might be estimated using the program deemed values per measure.

Table 4 provides a summary of budgets, program goals and evaluated gross savings for 2011. Table 5 provides a summary of reported gross savings from the 2011 IPL Scorecard against evaluated and net energy and demand savings.

[1] Range in demand savings is driven by capacity estimates associated with the AC Cycling program, which are variable depending on variables on the day an event is called which impact how much load can be obtained from the participant premises in the program (such as outside temperature – see AC Cycling chapter for a detailed explanation of demand savings calculations associated with this program).
[2] This total budget does not include the program budgets for the PerfectCents® Residential High Efficiency Heating and Cooling Rebate Program and the Conservation Program (OPOWER).

Table 4: 2011 Residential Core Plus Programs Impacts: Comparison of Budgets, Goals and Evaluated Gross Savings

	Budgets			Energy Savings			Demand Savings		
Program	2011 Budget Goals (1)	2011 Reported Expenditures (1)	% of Budget Goals	Program Goals (kWh) (1)	Evaluated Gross (kWh) (2)	Evaluated Gross kWh as % of Goals	Goal (kW) (1)	Evaluated Gross (kW) (2)	Evaluated Gross kW as % of Goals
Energy Efficiency									
Multifamily Direct Install - IPL Only	$379,500	$277,824	73%	9,934,388	11,619,222	117%	1,100	327	30%
Multifamily Direct Install - Joint	$354,500	$232,505	66%	1,994,610	2,574,859	129%	391	153	39%
Residential Energy Assessment	$267,000	$221,096	83%	1,340,955	1,079,771	81%	178	125	70%
Residential Walk Through Assessment and Direct Install	$1,081,023	$966,607	89%	3,698,724	2,278,561	62%	1,000	271	27%
Residential Second Refrigerator Pick-up and Recycling	$231,000	$161,191	70%	805,535	710,663	88%	178	113	64%
Residential ENERGY STAR New Homes	$41,414	$52,465	127%	156,816	433,267	276%	36	64	178%
SUBTOTAL	2,354,437	1,911,688	81%	17,931,028	18,696,342	104%	2,492	1,053	42%
Demand Response									
Residential Air Conditioning Load Management	$1,569,000	$1,317,441	84%	54,395	89,127	164%	5,000	12,079 – 17,325	335-481%
SUBTOTAL	1,569,000	1,317,441	84%	54,395	89,127	164%	5,000	12,079 - 17,325	335-481%
Renewables									
Residential Renewables Incentives	$72,000	$14,044	20%	27,417	17095	62%	18	3	17%
SUBTOTAL	72,000	14,044	20%	27,417	17,095	62%	18	3	17%
TOTAL	$3,995,437	$3,243,173	81%	18,012,840	18,802,564	104%	7,510	13,135 – 18,381	175% - 245%

(1) *Source: IPL 2011 Scorecard*

(2) *Source: Program specific evaluated numbers*

Table 5: 2011 Residential Core Plus Programs Impacts: Comparison of Reported and Evaluated Gross and Net Savings

Program	Energy Savings (kWh)				Demand Savings (kW)			
	Reported Gross(1)	Evaluated Gross(2)	Realization Rates	Evaluated Net(2)	Reported Gross(1)	Evaluated Gross(2)	Realization Rates	Evaluated Net(2)
Energy Efficiency Programs								
Multifamily Direct Install - IPL Only	9,267,556	11,619,222	1.25	11,619,222	1,122	327	0.29	327
Multifamily Direct Install - Joint	2,348,040	2,574,859	1.10	2,574,859	349	153	0.44	153
Residential Energy Assessment	3,844,052	2,278,561	0.59	2,048,664	1,010	271	0.27	244
Residential Walk Through Assessment and Direct Install	1,969,015	1,079,771	0.55	724,095	261	125	0.48	84
Residential Second Refrigerator Pick-up and Recycling	958,652	710,663	0.74	494,327	183	113	0.62	79
Residential ENERGY STAR New Homes	352,751	433,267	1.23	433,267	29	64	2.21	64
SUBTOTAL	**18,740,066**	**18,696,342**	**0.998**	**17,894,434**	**2,954**	**1,053**	**0.36**	**951**
Demand Response Programs								
Residential Air Conditioning Load Management	39,584	89,127	2.25	89,127	3,599	12,079 – 17,325	3.36 – 4.81	12,079 – 17,325
SUBTOTAL	**39,584**	**89,127**	**2.25**	**89,127**	**3,599**	**12,079-17,325**	**3.36 – 4.81**	**12,079-17,325**
Renewables Programs								
Residential Renewables Incentives	4,700	17,095	3.64	17,095	18	3	0.17	3
SUBTOTAL	**4,700**	**17,095**	**3.64**	**17,095**	**18**	**3**	**0.17**	**3**
TOTAL	**18,784,350**	**18,802,564**	**1.001**	**18,000,656**	**6,571**	**13,135 - 18,381**	**2.00 - 2.80**	**13,033 - 18,279**

(1) Source: IPL 2011 Scorecard

(2) *Source: Program specific evaluated numbers*

Among the residential energy efficiency programs, IPL achieved 104% of their program energy savings goals and 42% of its demand savings goals. With the exception of the ENERGY STAR New Homes program, which exceeded its energy and demand goals, and the Multi-Family Direct Install program, which exceeded its energy goals (but did not meet its demand goals), the other programs evaluated savings were overall lower than goals.

The ACLM program (IPL's demand response program) significantly exceeded its stated demand goals. However, as noted in the ACLM chapter to this report, the program goals were based on energy and savings attribution to the saving accrued by the number of program participants who enrolled in 2011 (or 3,599) rather than the currently active participating population of over 34,000. The observed load impact per participant premise (ranging from 0.35 kW/home to 0.51 kW/home depending on the ACLM event day) was on average lower than expected savings of 1 kW/home.

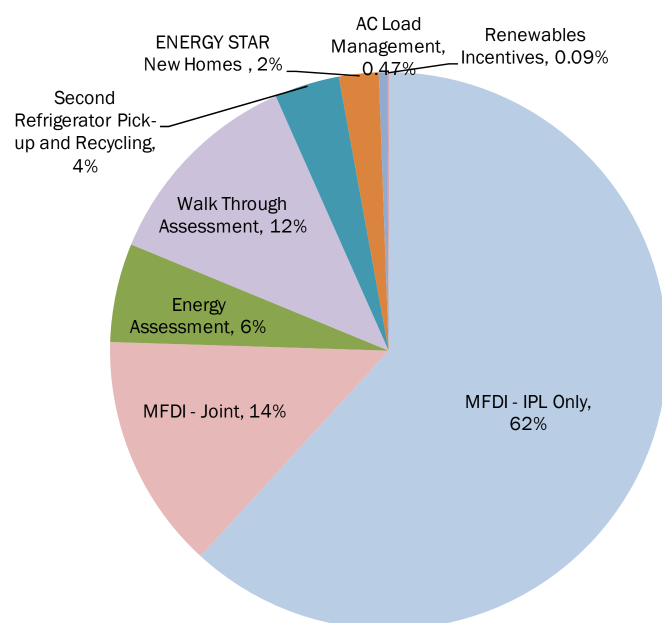
The program evaluated savings for the Residential Renewables Incentives program (IPL's renewable program) were also lower than expected goals due to the small number of participants in 2011.

1.3 Residential Core Plus Programs High-Level Insight and Findings

Figure 1 below shows each program's evaluated energy savings as a percentage of the total savings from all residential Core Plus programs. The main contributor to savings was the Multi-Family Direct Install program representing 76% of overall savings (62% IPL only; 14% Joint) and Walk-Through Assessment with Direct Install program representing 12% of overall savings of residential Core Plus programs. The Walk-Through Assessment with Direct Install program moved to the CORE portfolio in 2012.

The chapters for each of these programs are presented in this report in the order of their contribution to energy savings to the portfolio.

Figure 1: Residential Core Plus Program Portfolio (Evaluated Energy Savings)



Multi Family Direct Install

The Multi-Family Direct Install Program targets energy efficiency savings in large rental apartment buildings. For those buildings that participate, tenants receive free direct install measures. The program has two goals: one related to all electric homes in the IPL service territory (“IPL-only”) and a second related to combo electric and gas homes (“Joint”) run in partnership with Citizen’s Gas. This program accounted for 76% (62% IPL-only, 14% Join) of gross evaluated energy savings from IPL's residential Core Plus programs. In 2011, the IPL-only program achieved 53% of its enrollment target, while spending 73% of its budget. The Joint program achieved 313% of its enrollment target, while spending 66% of its budget.

The IPL-only program was implemented in 26 multifamily buildings, representing 4,447 units. As part of the evaluation, the team randomly selected sites and verified the installed measures approximately one year after the original installation date. The verified rate of installation of showerhead, kitchen, and bathroom sink aerators was 108%, 84%, and 95%, respectively. The verified installation rate of 13 watt CFLs was 84%, and 29% for 20 watt CFLs. Given these installation rates, the program’s demand and energy savings were lower than anticipated. To improve the accuracy and precision of the program’s reporting the TecMarket team recommends: 1) defining clear and consistent algorithms for calculating demand and energy savings, such as adoption of a TRM; and 2) tracking program participant information with greater granularity.

The Joint program conducted through an IPL partnership with Citizens Gas was implemented in 37 multifamily buildings, representing 24,487 tenant units. The evaluation team did not obtain data for this program until the draft report was completed; as such field verification activities were not conducted. Where possible, the TecMarket Works team applied field data from the IPL-only program to supplement the Joint program analysis. Parameters such as CFL retention and hot water flow rates derived from IPL-only program activities were applied to the Joint program data.

Overall, the IPL program manager and implementation contractor have been successful in managing the program, working with the multi-family customers, and marketing the benefits of the program through industry associations. Of the property managers interviewed, 90% were very satisfied with the program, and every property manager reported that they would recommend the program. However, IPL does not seem to be maximizing its opportunity to educate tenants and encourage further behavioral change. The evaluation team recommends developing a formal plan to capitalize on tenant education and outreach, including a script for implementers who visit apartments and a leave-behind packet.

Residential Walk-Through Assessment with Direct Install

The Residential Walk-Through Assessment with Direct Install program offers a walk through audit and direct installation of energy efficiency measures. This program was part of the Core Plus portfolio during the 2011 program cycle. In 2012, it has been moved to the CORE programs. This program accounted for 12% of evaluated gross energy savings from IPL's residential Core Plus programs. In 2011, the program achieved 59% of its energy savings goals and 27% of its demand savings goals while using 89% of its budget.

The main driver of lower performance against goals has to do with the adjustment to the per unit deemed savings estimates. Savings numbers were reduced across the board as compared with program deemed savings. In particular, estimates for water conservation measures were reduced when compared to program deemed estimates.

Customers are generally satisfied with the Walk-Thru Assessment with Direct Install program with participants rating their overall satisfaction with a mean of 7.7 on a 10-point scale. Although the satisfaction rate is high, some customers noted that they wanted expected higher bill savings and would like more useful information and tips on how to save energy.

Residential Energy Assessment

The Residential Energy Assessment program offers energy efficiency measures to customers who first create an online account through IPL's website and then complete an online energy audit. This program accounted for 6% of gross evaluated energy savings from IPL's residential Core Plus programs. In 2011, the program achieved 55% of its energy savings goal and 48% of its demand savings goals while using 83% of its budget. The program exceeded its participation goals by 46%. There were two primary drivers for the program not meeting its energy and demand goals. The first was a downward adjustment made to the tracked number of measures. This downward adjustment reflects installation rates gathered from surveys with participating customers. The other main driver was an adjustment made to each of the per measure energy and demand savings. In particular, evaluated energy and demand savings values for water conservation measures were significantly lower than the program's deemed savings.

For the future, savings estimates for the Energy Assessment program should be adjusted down to recognize installation rates as well as the assumptions behind the lower per-unit estimates for each measure. Further, the evaluation team could not reconcile the tracked data against the numbers reported in the 2011 Scorecard. In the future, we recommend that IPL track savings by measure and/or customer in the program database (rather than simply providing volumes, the deemed values and adjustment factors) so that tracked energy and demand savings can be reconciled with those reported in the scorecard.

Customers are generally satisfied with the Energy Assessment program, with participants rating their overall satisfaction as a mean of 8.1 on a 10-point scale. Although satisfaction is high, some customers noted that they wanted more useful information and tips on how to save energy. This program may also want to consider creating a feedback mechanism within the online assessment to allow the program staff to learn what information their customers find useful and to provide more personalized information to customers. Along the same lines, the program may want to consider offering a few types of kits more customized to customer types (e.g. ask questions in the survey to determine if customers get a lighting only or a lighting and hot water saving kit).

Finally, over half of the participants in this program say they took no further actions to reduce their home's energy use after participating in the program, which also speaks to the need to provide customers with more targeted tips and information. Their original participation suggests strong interests in energy efficiency, but their lack of action may indicate a need for more program contact to promote additional actions.

Second Refrigerator Pick-Up and Recycling

The Second Refrigerator Pick-Up and Recycling program accounts for 4% of gross evaluated savings from IPLs residential programs in 2011. The program met 88% of its energy savings goals and 64% of its demand goals. These values were driven to the difference in the profile of the actual recycled appliances when compared with those that may have informed the deemed savings estimates.

Overall, the program was successful exceeding its unit goals and achieving a high level of customer satisfaction, while only spending 70% of the budget. About 95% of customers reported high satisfaction with the program (mean of 9.5 on a 10-point scale). Generally, the program process is established and appears to be running smoothly. The program implementer, JACO Environmental, met or exceeded its own metrics for operational performance in terms of time to schedule an appointment, speed of response to customer contacts, speed of rebate processing and time to resolution of customer complaints.

Notably, however, the goals for this program are anticipated to increase significantly in future program years. Given the larger goals, marketing and recruiting new participants will be the key area of focus in 2012. Marketing messages emphasizing *free appliance pick-up* tend to resonate the most with customers. As such, the program should continue to emphasize this in the future. The rebate itself also helped to increase the number of participants in the program, and about 42% of customers indicated that they would be less likely to participate in the program in the absence of an incentive. Thus the use and marketing of the rebate should continue in order to help reach the new participation goal.

There may also be a need to even out the number of units over the course of the year. In 2011, most of the units were collected during the summer. As the participation increases, the program managers should consider the timing of the marketing efforts to ensure that the program does not exceed the capacity to collect units during the peak summer season. In addition, future efforts should seek to track gross savings more accurately by accounting for differences between refrigerators and freezers. Notably, past efforts tracked savings as a single value irrespective of the appliance type.

Residential ENERGY STAR® New Homes

The Residential ENERGY STAR® New Homes Program accounts for 2% of all savings from IPL's residential programs. In 2011, the program was successful, realizing 276% in its evaluated gross energy savings goals and 178% of its demand savings while exceeding their program funds by 27%.

Participating builders are generally satisfied with the ENERGY STAR® New Homes Program, in particular with the professionalism of the implementer, TSI, and the training provided to them. Two builders noted that in the absence of the program, they would not have built the homes to include energy efficiency measures given that they were not aware of these practices or measures. They became aware through training sessions with TSI and participation in the program.

However, we note that in general, builders' levels of awareness/understanding about energy efficiency building practices and about the program remain low. In various cases, builders do not understand the requirements associated with the different program measures, and believed that the program had exhausted its funding. The program leverages marketing channels (such as builders associations, trade allies, and monthly emails) and training materials, but they should consider adding channels (such as equipment manufacturers and LEED/Building Green seminars) and a cost-centric focus (emphasizing that the cost premium for some aspects of building energy efficient homes are not onerous) to the existing outreach efforts. Additionally, the program should consider targeting homebuyers, when they are actively thinking about building a new home (e.g. during parade of homes events, home shows, etc). Outreach should include an emphasis on both cost effectiveness and environmental benefits associated with living in an energy efficient home over time.

Over the two years of program implementation, there appears to be a growing focus on higher energy efficiency homes. HERS ratings for program homes were lower in 2011 than in 2010 (lower ratings are more desirable as they indicate a more energy efficient home); however, program-supported homes do not appear to be reaching the ENERGY STAR 3.0 requirements, which go beyond HERS ratings to require efficiency in water usage. While there were no rebates for ENERGY STAR 3.0 homes, this appears to be mostly due to the complex administrative requirements established by

ENERGY STAR to get this rating. Given the recent focus on more efficient homes, IPL may consider introducing a level with HERS rating lower than 70, but without the difficult ENERGY STAR 3.0 requirements. Alternatively, they should consider working closely with builders to help overcome the administrative and cost barriers associated with ENERGY STAR 3.0.

It is also important to note that the state of Indiana adopted a new energy code in April 2012, rendering building standards for residential premises to an equivalent code of ICEE 2009. This may require a review of the current HERS level that qualify for incentives under the program. We recommend that the program adopt the following: (1) reduce the HERS level even further to qualify for Gold Star and Silver Star, as well as increase the incentives for a more stringent Gold Star to encourage builders to keep building at more efficient levels. (2) Reduce (or eliminate completely) the incentive payments for Silver Star levels to remove the incentive to build to a lower standard in response to program changes. (3) Consider creating a Platinum tier for HERS scores under 60 or better.

Residential Air Conditioning Load Management

The objective of the Air Conditioning Load Management (ACLM) program is to reduce peak load by curtailing air conditioning during peak usage periods during the summer months, defined as May to September. While the primary goal of this program is demand reduction, the ACLM Program does account for 0.5% of the energy savings from IPL's residential Core Plus programs. However, savings are considerably higher, given that scorecard estimates are based on number of participants who enrolled in 2011, and overall participant population is almost 10 times larger (more than 34,000 with enrollment dates as early as 2003). Thus, IPL is significantly under-reporting savings associated with the program. ACLM programs accrue savings when load reduction events are called. IPL called for three such events in late July of 2011. While dependent on the time of day and outside temperature/humidity during the event, there was a drop in load during the event period for participant homes, of approximately 0.29 – 0.51 kW/home, with an overall demand capacity of 12,079 kW to 17,325 kW for the entire active participant population.

Notably, this program was established a decade ago, and as such, it is reaching saturation in recruitment levels. To meet annual enrollment targets, IPL is considering targeting multi-family units. The observed load shed is highly dependent on the type of premise and the usage strata of participant customers. By targeting multi-family homes, the expected load by additional home may be lower given multi-family often use of smaller HVAC units, and thus IPL should assess how cost effective it is to go after premises with marginal diminishing returns in load per home (in light of its goal to maintain recruitment levels).

We note that the impact values estimated in this report were based on a sample population of participant customers. The sample drew from residential customers who on average have modest loads. As such, the sample may not be a statistical representation of the currently enrolled population. Thus IPL should consider reestablishing the sample by creating a stratified treatment group based on sector (residential and commercial), strata (based on average consumption), and building type (single-family, multi-family) for a more precise a statistically representative load impact estimate.

Residential Renewables Incentives

The Residential Renewables Incentives program, which offers rebates on clean generation equipment and allows customers to bank excess energy as bill credits, accounts for 0.1% of gross evaluated savings from IPL's residential Core Plus programs. While participation is lower than anticipated (2 participants of 12 originally planned) due primarily to lack of customer awareness, both participants reported high satisfaction. Contractors are also looking forward to increased business through the program, and believe that the Program Manager has been an effective single point of contact.

There are two primary challenges with this program:

1. Program had low participation rates. Some of this is due to external market forces outside of IPL's control (such as generally low energy rates, and a poor economy). Program staff can more readily address other barriers such as low awareness levels and customer pull for renewables systems, and the high capital cost of installing a renewable system. Early adopters will make up the bulk of initial participation, although that may also mean that as the program ramps up, levels of free ridership may be high. Participants noted that they were likely going to install the system in the absence of the program. However, they also indicated they did so earlier because of the incentive payment. To encourage customers to adopt renewables, IPL should consider a tiered incentive system such as those in place in other states (e.g., California). In these systems, incentives per watt are initially high, but decrease over time as the installed base of renewable systems increase. This is effective in providing a time and/or capacity limit, which may prompt those who would otherwise wait to invest in the system. This can be a time based approach, for larger type programs. Given that the IPL program is in its early stages, a target capacity approach (once a certain number of premises, or kW connected is reached) may be more applicable, although not as easily understood by potential customers than a time-based approach.
2. The application process may be overly complex, since it requires several iterations with IPL in some instances to address technical information. One contractor also noted that some of the application materials and associated requirements appeared to be outdated and not in line with current technology and installation practices. IPL should consider reviewing and streamlining its application process.

Conservation (OPOWER)

The main goal of this program is to significantly increase customer engagement across various IPL energy efficiency programs by having customers receive regular information on their energy consumption through energy reports. This program was launched in 2011. Best practices for evaluation require that a full year of billing data be available for program participants. As such, evaluation activities were not performed for this program in this evaluation year. The evaluation team however selected a randomized and equivalent treatment and control groups which is a required step for future evaluations.

PerfectCents® Residential High Efficiency Heating and Cooling Rebate

The PerfectCents® Residential High Efficiency Heating and Cooling Rebate Program was launched in 2012, as such no evaluation activities were conducted. However, IPL requested a review of its program tracking database to ensure that the program collects appropriate information for future impact evaluations. Suggested additional variables to be tracked are included in the chapter for this program.

1.4 Report Structure and Organization

The remainder of this report is organized as follows:

- Sections 2 through 9 provide a program-by-program review including impact estimates and program insights and recommendations.

- Appendix A contains the assumptions and algorithms for calculations of evaluated energy and demand savings for CFLs, bathroom and kitchen aerators and low flow showerheads. These are applied in the evaluation of the Residential Energy Assessment and the Walk-Through Assessment and Direct Install programs

- Appendix B contains the temperature profiles for the ACLM program

- Appendix C contains the surveys and interview guides developed for each program, where applicable

2. Multi-Family Direct Install

2.1 Program Description

The Multi-Family Direct Install program targets energy efficiency in large rental apartment buildings. For buildings utilizing natural gas space heating, the program is coordinated with Citizens Gas to cover those measures. The program is separated into two categories based on how it is delivered: "IPL-only" for electric-only buildings and "Joint" for facilities that receive both electric and gas service.

For those buildings that participate in the program, tenants receive free direct install services by a utility-paid subcontractor. Measures installed through the program include:

- Up to five compact fluorescent lamps (CFLs)
- Low-flow showerhead
- Kitchen and bathroom aerators

The program is designed to educate tenants about their energy usage and the benefits of more-efficient options, encouraging a change in behavior that results in less consumption.

2.2 Program Budgets, Goals, and Scorecards

The table below outlines the 2011 goals and results of the Multi-Family Direct Install program.

Table 6: 2011 Multi-Family Direct Install Program Goals and Results

	Goal*	Tracked	% of Goals
IPL-only			
Budget	$379,500	$277,824	73%
Enrollment Targets	8,462	4,447	53%
kWh	9,934,388	11,619,222	117%
kW	1,100	327	30%
Joint			
Budget	$354,500	$232,505	66%
Enrollment Targets	7,822	24,487	313%
kWh	1,994,610	2,574,859	129%
kW	391	153	39%

*Source: *IPL 2011 Scorecard*

Overall, the scorecard shows that the IPL-only program achieved 53% of its enrollment target, while spending 73% of its program budget. The Joint program between IPL and Citizens Gas achieved 313% of its enrollment target, while spending 66% of its program budget.

2.3 EM&V METHODOLOGY

TecMarket Works evaluated program energy impacts based on an approved work plan dated February 6, 2012. The evaluation team assessed gross impacts primarily through measurement and verification (M&V) activities on site and an analysis of program tracking data. The team conducted on-site activities only for the IPL-only program, as program data were not made available for the Joint program until after draft report submission.

To determine representative samples for on-site evaluation, the evaluation team used a two-stage sampling approach. Under this design, buildings were randomly selected and then a sample of units within each selected building was visited. Therefore, the sampling error was a function of both the variance between installation rates within buildings and between buildings themselves. While we expected both of these to be relatively small (especially for showerheads and aerators), we expected the "within-building" variance to be particularly small, as apartments most likely received very similar treatment by the installation contractor. We, therefore, assumed a coefficient of variation (CV) of 0.10 within a given building, and we assumed a CV of measure installation between buildings (0.25) to account for the "between-building" variance. These assumptions led to a targeted sample of 10 buildings with an average of approximately 11 dwelling units to be visited within each building. In total, 97 dwellings units in 10 buildings were visited.

On-site M&V was conducted by TecMarket Works' subcontractor, Mad Dash, Inc. (Mad Dash). Mad Dash technicians recorded data about each eligible fixture[3] (e.g., total number of eligible fixtures installed in each unit, fixture discharge temperature, flow rate), as well as information about the dwelling and its occupants (e.g., total building unit count, available socket count). The analysis was based primarily on installation rates and statuses, but qualitative information recorded during the on-site visit also informed conclusions. Verification of installation was based on sampled dwelling units and buildings, and projected to the larger participant population.

The table below highlights EM&V activities associated with the Multi-Family Direct Install program.

Table 7: Multi-Family Program Evaluation Overall Tasks

Action	Details
Program Manager and Implementer Interviews	• Interviewed Program Manager • Interviewed Implementer (WECC)
Program Database Review	• Reviewed participant data tracking database (IPL-only database)
Participant Interviews	• Conducted interviews with building owners
Impact Analysis	• Performed on-site verification • Engineering analysis

[3] Shower, kitchen sink, bathroom sink, medium screw base socket lighting fixtures.

2.4 IMPACT ANALYSIS

2.4.1 PROGRAM TRACKING DATABASE REVIEW

The IPL-only program was implemented in 26 multi-family buildings near Indianapolis. These 26 buildings represent 4,591 dwelling units (an average of 177 units per building[4]). Two participating buildings were removed from the program analysis as their implementation dates were after the program year cutoff (August 31, 2011). Omitting these sites, the IPL-only program covered 24 buildings, representing 4,447 dwelling units. The table below summarizes the reported installation results.

Table 8: Measures Installed Across IPL-only Program

Measure	Quantity
Showerhead aerators	4,295
Kitchen aerators	4,438
Bathroom aerators	4,361
13 watt CFLs	8,650
20 watt CFLs	8,839

The Joint program with Citizens Gas was implemented in 37 multi-family buildings near Indianapolis, representing 24,487 dwelling units. The table below summarizes the reported installation results.

Table 9: Measures Installed Across Joint Program

Measure	Quantity
Showerhead aerators	22,909
Kitchen aerators	22,496
Bathroom aerators	13,071
CFLs	65,565

The tracking data for this program posed several challenges to the evaluation. Initially, limited program tracking materials obtained from IPL provided few details about quantities and locations of installed measures. Participating sites were listed in a tracking matrix, with a total of 26 buildings, representing 4,591 dwelling units. The tracking matrix identified the total number of dwelling units in the building and the total number of water-efficiency and lighting measures installed in the building; however, the matrix did not reveal the measures installed at each unit (only pre- and post-installation water flow measurements were identified for select individual units). For that reason, the evaluation team could not verify installation on a unit-by-unit basis but was only able to verify the percent of reported measures in an entire building. This granularity, however, was sufficient for a building-level analysis, as installed measure breakdowns were shown at the building level.

Reported baseline data contained limited detail. A subset of dwelling units (239 out of a potential 4,591 units, across these buildings) received pre- and post-install water-flow measurements. No information was catalogued regarding replaced lamp wattages, fixture locations, or projected operating hours for CFL measures.

[4] Based on information received from the implementation contractor (Wisconsin Energy Conservation Corporation, WECC).

Similar to the measure data, the tracking materials contained insufficient contact information for participants. Thirteen out of 26 buildings had a contact name listed, although five only had first names. As is common for this type of program, no contact information was provided in the tracking materials for dwelling unit occupants.

Subsequent to the draft report submission, the evaluation team obtained additional tracking materials. These tracking materials helped to clarify previous data submissions and delineate program participants. Initial tracking materials received only contained IPL-only [electric] program participants. Subsequent tracking materials included Joint [gas and electric] program data.

Additionally, this second data submission led to further examination of implementation dates, and the conclusion that two of the IPL-only buildings were implemented after the close of the program year. These sites were removed from the participant population and gross savings calculations. Furthermore, the program year (9/1/2010 through 8/31/2011) was found to be in conflict with the scorecard reporting period (1/1/2011 through 12/31/2011). Implementation dates for the Joint program were not available for this report.

Due to these findings, realization rates on gross evaluated savings are calculated based on tracked data, *rather than scorecard reported gross savings*.

2.4.2 ENGINEERING REVIEW

An engineering review of program savings values for installed measures was conducted; however, algorithm and calculation information made available was limited. The evaluation team reviewed low-flow showerhead and aerator calculations provided by IPL. These water measure calculations did not include any reference to claimed demand savings. No lighting calculations were provided for review; the evaluation team used data from recently performed lighting studies for comparable regions and sectors. The evaluation team was also directed to similar studies as the basis for claimed savings for the CFL measures, and we incorporated these studies into this revised analysis.

Energy savings values reported by IPL for water-efficient measures were calculated using the Federal Energy Management Program (FEMP) Energy Cost Calculator for faucet aerators and showerheads. Assumptions used in the tool are detailed in Table 10 below.

Table 10: Federal Energy Management Program Energy Cost Calculator Assumptions

Parameter	Showerhead	Faucet Aerator
Baseline GPM	2.5	2.2
Energy-efficient GPM (best available)	1.5	1.5
Days used per year	365	260
Use per day (minutes)	20	30

As part of the analysis, we reviewed assumptions used by the FEMP calculator for accuracy and compared them to recent studies and evaluations conducted by TecMarket Works. For the evaluated savings (discussed below), we used data collected from on-sites as parameters in this same FEMP calculator and compared them to another Cadmus-derived calculation algorithm.

For showerheads, the assumption of 2.5 gallons per minute (GPM) baseline is reasonable, as program tracking matrix data show an average baseline showerhead flow of 2.6 GPM. However, the assumption of 365 days per year of use does not seem reasonable, as occupants will likely travel or shower elsewhere on some occasions. This contention is supported by secondary data from the United States Environmental Protection Agency (EPA), suggesting an average 0.58 showers per day per person are taken in residential settings.[5] This data also suggest an average shower length of 8.36 minutes per person.

The evaluation team used the above parameter values, along with baseline and post-installation water flow rates measured on site, to calculate verified savings values. The FEMP calculator was used with revised flow data collected from on-sites, and contrasted with Cadmus-derived calculations using the above factors and flow rates. Due to approximate agreement between the two methods, and the FEMP calculator's status as a recognized industry resource, FEMP results utilizing on-site data were used as the final savings values.

Point-of-use temperature data was collected on-site as well, but only used as a holistic check on system operation and discharge set-point. Discharge temperatures at each hot water heater are time consuming to obtain and often inaccessible, therefore, these were not included as part of on-site activities. Point-of-use temperatures were a cost-effective check for reasonableness of a given building's discharge water temperature. In the savings calculations, secondary data sources were used for discharge set-point.

Low-flow aerators installed in kitchens and bathrooms also used the same calculation methodology to establish reported savings. According to the program matrix, baseline kitchen aerators averaged 2.5 GPM, and baseline bathroom aerators averaged 1.9 GPM in units where flow measurements were recorded. The evaluation team utilized the baseline and post-installation flow rates to calculate verified savings values. Post-installation flow rates were measured on-site as part of this evaluation. Secondary data sources and Cadmus-derived calculations were contrasted with the FEMP calculator output. FEMP results utilizing on-site data were used as the final savings values.

Reported savings values for lighting-efficiency measures were identified in the IPL DSM Scorecard. No savings calculations or algorithms were provided by IPL; therefore, per-measure, evaluated savings were based on a review of recent evaluation studies, the 2010 Ohio TRM, and other secondary sources. Per-measure lighting energy and demand savings values are based on data collected for other evaluations, and from other comparable secondary sources. The following tables summarize the reported and evaluated savings for each installed measure.

Table 11: Reported and Evaluated Per-Measure Savings (IPL-only)

Measure	Reported Gross Demand Savings per measure (kW/yr)	Evaluated Gross Demand Savings per measure (kW/yr)	Reported Energy Savings per measure (kWh/yr)	Evaluated Energy Savings per measure (kWh/yr)
Showerhead	Not Provided	0.043	949	1,423
Kitchen faucet aerator	Not Provided	0.012	155	573
Bathroom faucet aerator	Not Provided	0.012	265	617
13 watt CFL	Not Provided	0.0040	Not Provided	67
20 watt CFL	Not Provided	0.0044	Not Provided	74

[5] EPA's 2008 WaterSense document "Water-Efficient Single-Family New Home Specification Supporting Statement" references to Mayer P., DeOreo W. et al. 2000 and 2003.

Table 12: Reported and Evaluated Per-Measure Savings (Joint)

Measure	Reported Gross Demand Savings per measure (kW/yr)	Evaluated Gross Demand Savings per measure (kW/yr)	Reported Energy Savings per measure (kWh/yr)	Evaluated Energy Savings per measure (kWh/yr)
Showerhead*	N/A	N/A	N/A	N/A
Kitchen faucet aerator*	N/A	N/A	N/A	N/A
Bathroom faucet aerator*	N/A	N/A	N/A	N/A
13 watt CFL	Not Provided	0.0040	Not Provided	67
20 watt CFL	Not Provided	0.0044	Not Provided	74

*Notes: * only therm savings apply for these measures for joint customers.*

Fields omitted from program tracking data are shown as "Not Provided" in the table above. These same fields are addressed in the program scorecard. Due to conflicting values (as previously noted), the program tracking materials (and not the program scorecard) have been identified as the primary source for "Reported" values. Values in the charts above listed as "N/A" are not applicable since the energy savings resulting from these measures would be credited to the Citizens Gas side of the program.

On-Site Data Collection

As previously noted, M&V was conducted by Mad Dash. Out of the 26 buildings (4,591 dwelling units) that participated in the program, Mad Dash visited 97 dwelling units across 10 buildings. Sites were randomly selected. Information recorded included:

- Building: total unit count
- Building: total floor count
- Unit: estimated occupancy count
- Fixture discharge temperature
- Fixture discharge flow (GPM) – as labeled
- Fixture discharge flow (GPM) – as measured
- Installed CFL count
- Available socket count
- CFL wattage

The tables below compare the reported and evaluated quantity of measures installed per dwelling unit, as well as the reported and evaluated total quantity of measures installed.

Table 13: Reported and Evaluated Quantity of Measures Installed per Unit

Measure Description	Reported Quantity Installed per Dwelling Unit	Evaluated Quantity Installed per Dwelling Unit	Realization Rate / Persistence at ~1 year from install
Showerhead	0.94	1.03	108%
Kitchen faucet aerator	0.97	0.81	84%
Bathroom faucet aerator	0.95	0.90	95%

Measure Description	Reported Quantity Installed per Dwelling Unit	Evaluated Quantity Installed per Dwelling Unit	Realization Rate / Persistence at ~1 year from install
13 watt CFL	1.88	1.68	84%
20 watt CFL	1.93	0.23	29%

Approximately one year from the date of installation, the evaluated rate of installation of showerhead, kitchen, and bathroom sink aerators was 108%, 84%, and 95%, respectively. A persistence rate of 108% is possible here for showerhead measures because the program tracking data did not provide sufficient granularity. Measure installation at the unit (dwelling) level was not tracked, so the calculations were based on an average installed quantity per unit (0.94). On-site data collection revealed, on average, that more showerheads were installed than could be credited to the program. Exact installations at individual dwelling units were not tracked, so TecMarket Works cannot state explicitly whether the program resulted in spillover for this measure, or whether the sample populations varied enough to impact this rate.

The evaluated installation rate of 13 watt CFLs was 84% and the evaluated installation rate of 20 watt CFLs was 29%. A low number of 20 watt CFLs was observed during site verifications efforts, resulting in a low realization rate of 29%. The low realization rate may result from a number of factors, including occupants removing plug-in fixtures with CFLs installed by the program when they move from the apartment complex, a higher-than-average failure rate for 20 watt CFLs (as observed with other similar programs in the past), or occupants removing the CFLs due to issues with lighting levels and aesthetics preferences.

Post-installation flow rates for water measures (showerheads, kitchen aerators, and bath aerators) were also measured on site as part of the evaluation effort. These values were compared to the baseline measurements conducted by the implementation contractor. These values were used in the measure analysis, and are presented in the table below:

Table 14: Reported and Evaluated Quantity of Measures Installed

Measure Description	Baseline Flow Rate (gpm)	Post-Installation Flow Rate (GPM)
Showerhead	2.63	1.74
Kitchen faucet aerator	2.44	1.49
Bathroom faucet aerator	1.90	1.01

These measured values reflect a better-than-expected reduction in water flow from this program. The post-installation values are below that of the manufacturer's labeled flow rates. Based on field observation and dialogue with participants at sites, it is likely that these reduced flows (below that of the labeled flow rates) are attributable to Indianapolis' hard water. During the site verification activities, more than one building manager took the opportunity, while in their tenant's apartment, to clean the year-old, program-provided showerhead or aerator. Within the space of one year, the mineral deposits from hard water had accumulated in the devices to the point that flow was reduced below its rated capacity. These reduced flows, in turn, generated better-than-expected savings for these measures. While these observations give some explanation to the collected on-site data, a more focused study in the future is recommended.

2.4.3 Evaluated Gross Impacts

The evaluation team calculated gross impact savings values for the program based on the engineering review (above) and on monitoring and verification on-site data. The evaluated installation rates were used to assess program losses and measure retention as well as measure saturation. Total evaluated gross savings values are calculated as the product of per-measure savings and the evaluated number of measures installed. The realization rate for each measure is the ratio of total evaluated savings to total reported savings.[6]

Table 15 shows reported and evaluated IPL-only program demand reductions and the realization rate, by measure. Reported demand savings were not provided in program tracking materials ("Not Provided" below), but program-wide demand savings were claimed in the program scorecard (1,122 and 349, respectively, below).

Table 15: Reported and Evaluated Program Demand Savings (IPL-only)

Measure	Reported Demand Savings across program (kW/yr)	Evaluated Gross Demand Savings across program (kW/yr)	Program-Wide Demand Savings Realization Rate
Showerhead	Not Provided	195.46	N/A
Kitchen faucet aerator	Not Provided	41.63	N/A
Bathroom faucet aerator	Not Provided	49.93	N/A
13 watt CFL	Not Provided	28.39	N/A
20 watt CFL	Not Provided	11.16	N/A
Subtotal Gross (non-coincident)	**1,122**	**326.56**	**0.29**

Table 16 shows reported and evaluated Joint program demand reductions and the realization rate, by measure.

Table 16: Reported and Evaluated Program Demand Savings (Joint)

Measure	Reported Demand Savings across program (kW/yr)	Evaluated Gross Demand Savings across program (kW/yr)	Program-Wide Demand Savings Realization Rate
Showerhead	Not Provided	N/A	N/A
Kitchen faucet aerator	Not Provided	N/A	N/A
Bathroom faucet aerator	Not Provided	N/A	N/A
13 watt CFL	Not Provided	110.71	N/A
20 watt CFL	Not Provided	42.15	N/A
Subtotal Gross (non-coincident)	**349**	**152.86**	**0.44**

Table 17 and Table 18 show reported and evaluated energy savings and the realization rate, by measure for each program (IPL-only and Joint). For each measure, the evaluation team adjusted reported savings by the evaluated installation rate. The total realization rate is calculated as the sum of evaluated savings divided by the sum of database reported savings. Data provided for the multi-family direct installation was incomplete. To develop a realization rate for the program, engineers compared measure-level tracking data, as opposed to scorecard date, to evaluated findings.

[6] These percentages have been determined from the ratio of *ex post* savings to *ex ante* savings (i.e., Evaluated Gross savings / Reported Gross savings).

Table 17: Reported and Evaluated Program Energy Savings (IPL-only)

Measure	Reported Energy Savings across program (kWh/yr)	Evaluated Gross Energy Savings across program (kWh/yr)	Program-wide Energy Savings Realization Rate
Showerhead	3,958,279	6,409,979	1.67
Kitchen faucet aerator	666,204	2,065,396	
Bathroom faucet aerator	1,118,306	2,477,596	
13 watt CFL	566,425	478,242	
20 watt CFL	640,589	188,009	
Total	**6,949,802**	**11,619,222**	

Table 18: Reported and Evaluated Program Energy Savings (Joint)

Measure	Reported Energy Savings across program (kWh/yr)	Evaluated Gross Energy Savings across program (kWh/yr)	Program-wide Energy Savings Realization Rate
Showerhead	N/A	N/A	0.56
Kitchen faucet aerator	N/A	N/A	
Bathroom faucet aerator	N/A	N/A	
13 watt CFL	2,208,732	1,864,869	
20 watt CFL	2,419,088	709,989	
Total	**4,627,820**	**2,574,859**	

The program-wide energy savings realization rate was 1.67 for the IPL-only program and 0.56 for the Joint program. The major difference between these two values is attributed to the fact that the water measures experience better-than-expected savings (assumed from hard water deposits lowering flow rates), and these water measures are included in the IPL-only figures, and excluded from the Joint program figures (since the savings were on the natural gas side of the program). The electric measures from the Joint program (i.e., CFL installations) offered worse-than expected savings, similar to the IPL-only program. These measures suffered from poor retention when observed one year after installation, and this is likely attributable to the transient nature of the multi-family market, and the portable nature of the bulbs and their associated fixtures.

Given the limitations imposed by a small population, small sample, and limited number of qualitative interviews (not quantitative surveys), the evaluation team did not alter the baseline NTG ratio, currently assumed as 1.0. As such, the net evaluated savings are the same as the gross evaluated savings for the Multi-family Direct Install program.

2.5 PROGRAM IMPLEMENTATION

The same program manager has administered IPL's C&I Multi-Family Direct Install Program since its inception. That individual is responsible for troubleshooting issues with the program, budgeting, calculating energy savings, and more, and serves as the sole IPL staff member assigned to the program. A program manager at IPL's implementation contractor, WECC, also supports the program. The WECC program manager is responsible for management of subcontractors used to perform installations, ensuring that the program's goals are being met, and helping to maintain participation goals and program budgets.

The two managers communicate in several ways. WECC's program manager sends a weekly update to IPL's program manager, reviewing activities during the current week, and projects in the pipeline.

WECC's program manager mentioned that the two touch base every other week by phone as well, and text message and e-mail sporadically. Both IPL's and WECC's project managers felt communication levels they maintained were excellent, and that they stayed in close contact.

The implementation process begins when WECC's subcontracting installer, Thermoscan, identifies specific buildings to target from IPL's customer list of multi-family properties within the service area. Thermoscan begins outreach by sending out letters, cold-calling, and using contacts through the Indiana Apartment Association, or in other ways that put Thermoscan in touch with customers qualifying for the program.

Once Thermoscan has contacted a multi-family housing company manager, and the housing company decides to participate in the program, Thermoscan sets up an appointment with facility maintenance employees. The apartment company then sends out notifications, letting tenants know installers will be visiting their apartment units. Thermoscan and maintenance facility employees together approach each unit in the building, knocking on doors, and installing low-flow measures (faucet aerators and showerheads) and CFLs in each building unit.

If the resident is not at home at the time of the visit, the installer and facility employee leave notices saying they stopped by and describing measures they installed. Additionally, they leave another pamphlet in every building unit, describing other IPL programs, and listing the IPL website and phone numbers.

In addition to the work and information left behind, the program offers a one-year warranty on equipment installed, but rarely do complexes take them up their offers. Post-installation, Thermoscan workers collect the pre- and post-flow data, entering it into a WECC database, which is used to generate monthly reports for WECC and IPL. WECC's program manager also uses these data for quality control checks against unit owners' monthly invoices.

Marketing and Outreach

IPL markets its Multi-Family Direct Install program mostly through the local apartment association and trade shows, and through Thermoscan. IPL maintains a membership with a local apartment association, allowing IPL and WECC staff to participate in various events targeted at building owners. The program has also carried advertisements in Indiana Apartment Society's handbook and the apartment association's magazine, Insights. Thermoscan performs mailings and face-to-face marketing with potential customers. Both IPL and WECC's program managers consider word-of-mouth their best, most successful marketing technique. Program managers consider one of the program's benefits to be that customers do not have to take action; all they do is open their doors, and they receive free tools to help them make their bills more manageable. Given this, they feel the program sells itself.

2.6 PROGRAM INSIGHTS AND RECOMMENDATIONS

1. Demand and energy savings were unpredictable

Per-measure savings estimates were not specified for some measures installed through the program, and other input variables necessary to efficiently evaluate savings estimates for other direct-install measures were not documented. For CFL measures, missing information included real data or assumed values for runtime, baseline wattage, energy-efficient wattage, and anticipated lifetime of the unit. For domestic hot water measures, missing documentation included real data or assumed values for the number of occupants, average number of uses per occupant per day, average length of use, average inlet temperature (prior to heating, correlated to the average annual air temperature for the region), average outlet temperature (of hot water), and the fraction of electric domestic hot water present in multi-family residences throughout the service territory.

The lack of tracked, per-unit energy and demand savings, and the associated inputs, increased uncertainty in the accuracy of energy and demand savings realized by the program.

Recommendations:

- *Define clear and consistent algorithms for calculating demand and energy savings. Adoption of a TRM or other regimented approach for these measures would drive consistent, repeatable, and trusted savings calculations. Standardized assumptions specific to the utility and locale would increase precision and accuracy. Primary metered data could be referenced, from either IPL studies or comparable sources.*

- *Track program participant information with greater granularity. This could be achieved through a number of means. Request that participating building managers and/or dwelling occupants fill out basic building/dwelling information (e.g., year built, square footage, room listing, occupant count, and demographics). Mandate that contractors record information as they perform measure installations and survey program participants during or after implementation.*

2. Obstacles emerged at the program outset in the tracking of lighting savings

When the program started, there was a need to update WECC's database to include light bulbs as a measure. At that time WECC's information technology department was experiencing an internal backlog, thus causing a delay. WECC program managers expressed concerns that tracking removed and installed wattages of CFLs would likely pose the greatest change as data tracking efforts moved forward. Mixed responses on the added value of tracking wattages was discussed, but as incandescent light bulbs are being phased out, managers are uncertain of its value.

Recommendation: Lighting measure baseline details should be recorded. This could include space types (e.g., bathrooms); fixture types (vanity versus overheads); wattages replaced (60 watt versus 75 watt versus 100 watt versus other); and other pertinent details (e.g., dimming controls, fixtures located in unoccupied bedroom used as office, etc.).

3. IPL is doing an excellent job of recruiting participating buildings into the program; however, it appears to be missing an opportunity for further program outreach and education

Originally, the program was portrayed as one educating tenants about benefits of installed measures and behavioral changes, with lasting impacts on their energy and water consumption. During program manager interviews, conflicting opinions emerged regarding materials provided or information conveyed during visits, and never receiving copies of materials for handouts during visits.

Nevertheless, the program provides a strong opportunity to educate tenants about potential savings from measures. It also offers an avenue to promote other IPL programs and to encourage further behavioral changes to reduce energy usage.

Recommendation: Develop a formal plan to capitalize on tenant education and outreach, including a script for implementers visiting apartments and an in-home packet that can be left behind.

EXHIBIT JIF-5

Technical Support Document: -
Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis -
Under Executive Order 12866 -

Interagency Working Group on Social Cost of Carbon, United States Government

With participation by

Council of Economic Advisers
Council on Environmental Quality
Department of Agriculture
Department of Commerce
Department of Energy
Department of Transportation
Environmental Protection Agency
National Economic Council
Office of Management and Budget
Office of Science and Technology Policy
Department of the Treasury

May 2013

Executive Summary

Under Executive Order 12866, agencies are required, to the extent permitted by law, "to assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs." The purpose of the "social cost of carbon" (SCC) estimates presented here is to allow agencies to incorporate the social benefits of reducing carbon dioxide (CO_2) emissions into cost-benefit analyses of regulatory actions that impact cumulative global emissions. The SCC is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change.

The interagency process that developed the original U.S. government's SCC estimates is described in the 2010 interagency technical support document (TSD) (Interagency Working Group on Social Cost of Carbon 2010). Through that process the interagency group selected four SCC values for use in regulatory analyses. Three values are based on the average SCC from three integrated assessment models (IAMs), at discount rates of 2.5, 3, and 5 percent. The fourth value, which represents the 95th percentile SCC estimate across all three models at a 3 percent discount rate, is included to represent higher-than-expected impacts from temperature change further out in the tails of the SCC distribution.

While acknowledging the continued limitations of the approach taken by the interagency group in 2010, this document provides an update of the SCC estimates based on new versions of each IAM (DICE, PAGE, and FUND). It does not revisit other interagency modeling decisions (e.g., with regard to the discount rate, reference case socioeconomic and emission scenarios, or equilibrium climate sensitivity). Improvements in the way damages are modeled are confined to those that have been incorporated into the latest versions of the models by the developers themselves in the peer-reviewed literature.

The SCC estimates using the updated versions of the models are higher than those reported in the 2010 TSD. By way of comparison, the four 2020 SCC estimates reported in the 2010 TSD were $7, $26, $42 and $81 (2007$). The corresponding four updated SCC estimates for 2020 are $12, $43, $65, and $129 (2007$). The model updates that are relevant to the SCC estimates include: an explicit representation of sea level rise damages in the DICE and PAGE models; updated adaptation assumptions, revisions to ensure damages are constrained by GDP, updated regional scaling of damages, and a revised treatment of potentially abrupt shifts in climate damages in the PAGE model; an updated carbon cycle in the DICE model; and updated damage functions for sea level rise impacts, the agricultural sector, and reduced space heating requirements, as well as changes to the transient response of temperature to the buildup of GHG concentrations and the inclusion of indirect effects of methane emissions in the FUND model. The SCC estimates vary by year, and the following table summarizes the revised SCC estimates from 2010 through 2050.

Revised Social Cost of CO_2, 2010 – 2050 (in 2007 dollars per metric ton of CO_2)

Discount Rate Year	5.0% Avg	3.0% Avg	2.5% Avg	3.0% 95th
2010	11	33	52	90
2015	12	38	58	109
2020	12	43	65	129
2025	14	48	70	144
2030	16	52	76	159
2035	19	57	81	176
2040	21	62	87	192
2045	24	66	92	206
2050	27	71	98	221

I. Purpose

The purpose of this document is to update the schedule of social cost of carbon (SCC) estimates from the 2010 interagency technical support document (TSD) (Interagency Working Group on Social Cost of Carbon 2010).[1] E.O. 13563 commits the Administration to regulatory decision making "based on the best available science."[2] Additionally, the interagency group recommended in 2010 that the SCC estimates be revisited on a regular basis or as model updates that reflect the growing body of scientific and economic knowledge become available.[3] New versions of the three integrated assessment models used by the U.S. government to estimate the SCC (DICE, FUND, and PAGE), are now available and have been published in the peer reviewed literature. While acknowledging the continued limitations of the approach taken by the interagency group in 2010 (documented in the original 2010 TSD), this document provides an update of the SCC estimates based on the latest peer-reviewed version of the models, replacing model versions that were developed up to ten years ago in a rapidly evolving field. It does not revisit other assumptions with regard to the discount rate, reference case socioeconomic and emission scenarios, or equilibrium climate sensitivity. Improvements in the way damages are modeled are confined to those that have been incorporated into the latest versions of the models by the developers themselves in the peer-reviewed literature. The agencies participating in the interagency working group continue to investigate potential improvements to the way in which economic damages associated with changes in CO_2 emissions are quantified.

Section II summarizes the major updates relevant to SCC estimation that are contained in the new versions of the integrated assessment models released since the 2010 interagency report. Section III presents the updated schedule of SCC estimates for 2010 – 2050 based on these versions of the models. Section IV provides a discussion of other model limitations and research gaps.

II. Summary of Model Updates

This section briefly summarizes changes to the most recent versions of the three integrated assessment models (IAMs) used by the interagency group in 2010. We focus on describing those model updates that are relevant to estimating the social cost of carbon, as summarized in Table 1. For example, both the DICE and PAGE models now include an explicit representation of sea level rise damages. Other revisions to PAGE include: updated adaptation assumptions, revisions to ensure damages are constrained by GDP, updated regional scaling of damages, and a revised treatment of potentially abrupt shifts in climate damages. The DICE model's simple carbon cycle has been updated to be more consistent with a more complex climate model. The FUND model includes updated damage functions for sea level rise impacts, the agricultural sector, and reduced space heating requirements, as well as changes to the transient response of temperature to the buildup of GHG concentrations and the inclusion of indirect effects of

[1] In this document, we present all values of the SCC as the cost per metric ton of CO_2 emissions. Alternatively, one could report the SCC as the cost per metric ton of carbon emissions. The multiplier for translating between mass of CO_2 and the mass of carbon is 3.67 (the molecular weight of CO_2 divided by the molecular weight of carbon = 44/12 = 3.67).

[2] http://www.whitehouse.gov/sites/default/files/omb/inforeg/eo12866/eo13563_01182011.pdf

[3] See p. 1, 3, 4, 29, and 33 (Interagency Working Group on Social Cost of Carbon 2010).

methane emissions. Changes made to parts of the models that are superseded by the interagency working group's modeling assumptions – regarding equilibrium climate sensitivity, discounting, and socioeconomic variables – are not discussed here but can be found in the references provided in each section below.

Table 1: Summary of Key Model Revisions Relevant to the Interagency SCC

IAM	Version used in 2010 Interagency Analysis	New Version	Key changes relevant to interagency SCC
DICE	2007	2010	Updated calibration of the carbon cycle model and explicit representation of sea level rise (SLR) and associated damages.
FUND	3.5 (2009)	3.8 (2012)	Updated damage functions for space heating, SLR, agricultural impacts, changes to transient response of temperature to buildup of GHG concentrations, and inclusion of indirect climate effects of methane.
PAGE	2002	2009	Explicit representation of SLR damages, revisions to damage function to ensure damages do not exceed 100% of GDP, change in regional scaling of damages, revised treatment of potential abrupt damages, and updated adaptation assumptions.

A. DICE

DICE 2010 includes a number of changes over the previous 2007 version used in the 2010 interagency report. The model changes that are relevant for the SCC estimates developed by the interagency working group include: 1) updated parameter values for the carbon cycle model, 2) an explicit representation of sea level dynamics, and 3) a re-calibrated damage function that includes an explicit representation of economic damages from sea level rise. Changes were also made to other parts of the DICE model—including the equilibrium climate sensitivity parameter, the rate of change of total factor productivity, and the elasticity of the marginal utility of consumption—but these components of DICE are superseded by the interagency working group's assumptions and so will not be discussed here. More details on DICE2007 can be found in Nordhaus (2008) and on DICE2010 in Nordhaus (2010). The DICE2010 model and documentation is also available for download from the homepage of William Nordhaus.

Carbon Cycle Parameters

DICE uses a three-box model of carbon stocks and flows to represent the accumulation and transfer of carbon among the atmosphere, the shallow ocean and terrestrial biosphere, and the deep ocean. These parameters are "calibrated to match the carbon cycle in the Model for the Assessment of Greenhouse

Gas Induced Climate Change (MAGICC)" (Nordhaus 2008 p 44).[4] Carbon cycle transfer coefficient values in DICE2010 are based on re-calibration of the model to match the newer 2009 version of MAGICC (Nordhaus 2010 p 2). For example, in DICE2010, in each decade, 12 percent of the carbon in the atmosphere is transferred to the shallow ocean, 4.7 percent of the carbon in the shallow ocean is transferred to the atmosphere, 94.8 percent remains in the shallow ocean, and 0.5 percent is transferred to the deep ocean. For comparison, in DICE 2007, 18.9 percent of the carbon in the atmosphere is transferred to the shallow ocean each decade, 9.7 percent of the carbon in the shallow ocean is transferred to the atmosphere, 85.3 percent remains in the shallow ocean, and 5 percent is transferred to the deep ocean.

The implication of these changes for DICE2010 is in general a weakening of the ocean as a carbon sink and therefore a higher concentration of carbon in the atmosphere than in DICE2007, for a given path of emissions. All else equal, these changes will generally increase the level of warming and therefore the SCC estimates in DICE2010 relative to those from DICE2007.

Sea Level Dynamics

A new feature of DICE2010 is an explicit representation of the dynamics of the global average sea level anomaly to be used in the updated damage function (discussed below). This section contains a brief description of the sea level rise (SLR) module; a more detailed description can be found on the model developer's website.[5] The average global sea level anomaly is modeled as the sum of four terms that represent contributions from: 1) thermal expansion of the oceans, 2) melting of glaciers and small ice caps, 3) melting of the Greenland ice sheet, and 4) melting of the Antarctic ice sheet.

The parameters of the four components of the SLR module are calibrated to match consensus results from the IPCC's Fourth Assessment Report (AR4).[6] The rise in sea level from thermal expansion in each time period (decade) is 2 percent of the difference between the sea level in the previous period and the long run equilibrium sea level, which is 0.5 meters per degree Celsius (°C) above the average global temperature in 1900. The rise in sea level from the melting of glaciers and small ice caps occurs at a rate of 0.008 meters per decade per °C above the average global temperature in 1900.

The contribution to sea level rise from melting of the Greenland ice sheet is more complex. The equilibrium contribution to SLR is 0 meters for temperature anomalies less than 1 °C and increases linearly from 0 meters to a maximum of 7.3 meters for temperature anomalies between 1 °C and 3.5 °C. The contribution to SLR in each period is proportional to the difference between the previous period's sea level anomaly and the equilibrium sea level anomaly, where the constant of proportionality increases with the temperature anomaly in the current period.

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[4] MAGICC is a simple climate model initially developed by the U.S. National Center for Atmospheric Research that has been used heavily by the Intergovernmental Panel on Climate Change (IPCC) to emulate projections from more sophisticated state of the art earth system simulation models (Randall et al. 2007).
[5] Documentation on the new sea level rise module of DICE is available on William Nordhaus' website at: http://nordhaus.econ.yale.edu/documents/SLR_021910.pdf.
[6] For a review of post-IPCC AR4 research on sea level rise, see Nicholls et al. (2011) and NAS (2011).

The contribution to SLR from the melting of the Antarctic ice sheet is -0.001 meters per decade when the temperature anomaly is below 3 °C and increases linearly between 3 °C and 6 °C to a maximum rate of 0.025 meters per decade at a temperature anomaly of 6 °C.

Re-calibrated Damage Function

Economic damages from climate change in the DICE model are represented by a fractional loss of gross economic output in each period. A portion of the remaining economic output in each period (net of climate change damages) is consumed and the remainder is invested in the physical capital stock to support future economic production, so each period's climate damages will reduce consumption in that period and in all future periods due to the lost investment. The fraction of output in each period that is lost due to climate change impacts is represented as one minus a fraction, which is one divided by a quadratic function of the temperature anomaly, producing a sigmoid ("S"-shaped) function.[7] The loss function in DICE2010 has been expanded by adding a quadratic function of SLR to the quadratic function of temperature. In DICE2010 the temperature anomaly coefficients have been recalibrated to avoid double-counting damages from sea level rise that were implicitly included in these parameters in DICE2007.

The aggregate damages in DICE2010 are illustrated by Nordhaus (2010 p 3), who notes that "…damages in the uncontrolled (baseline) [i.e., reference] case … in 2095 are $12 trillion, or 2.8 percent of global output, for a global temperature increase of 3.4 ^{o}C above 1900 levels." This compares to a loss of 3.2 percent of global output at 3.4 ^{o}C in DICE2007. However, in DICE2010, annual damages are lower in most of the early periods of the modeling horizon but higher in later periods than would be calculated using the DICE2007 damage function. Specifically, the percent difference between damages in the base run of DICE2010 and those that would be calculated using the DICE2007 damage function starts at +7 percent in 2005, decreases to a low of -14 percent in 2065, then continuously increases to +20 percent by 2300 (the end of the interagency analysis time horizon), and to +160 percent by the end of the model time horizon in 2595. The large increases in the far future years of the time horizon are due to the permanence associated with damages from sea level rise, along with the assumption that the sea level is projected to continue to rise long after the global average temperature begins to decrease. The changes to the loss function generally decrease the interagency working group SCC estimates slightly given that relative increases in damages in later periods are discounted more heavily, all else equal.

B. FUND

FUND version 3.8 includes a number of changes over the previous version 3.5 (Narita et al. 2010) used in the 2010 interagency report. Documentation supporting FUND and the model's source code for all versions of the model is available from the model authors.[8] Notable changes, due to their impact on the

[7] The model and documentation, including formulas, are available on the author's webpage at http://www.econ.yale.edu/~nordhaus/homepage/RICEmodels.htm.

[8] http://www.fund-model.org/. This report uses version 3.8 of the FUND model, which represents a modest update to the most recent version of the model to appear in the literature (version 3.7) (Anthoff and Tol, 2013). For the purpose of computing the SCC, the relevant changes (between 3.7 to 3.8) are associated with improving

SCC estimates, are adjustments to the space heating, agriculture, and sea level rise damage functions in addition to changes to the temperature response function and the inclusion of indirect effects from methane emissions.[9] We discuss each of these in turn.

Space Heating

In FUND, the damages associated with the change in energy needs for space heating are based on the estimated impact due to one degree of warming. These baseline damages are scaled based on the forecasted temperature anomaly's deviation from the one degree benchmark and adjusted for changes in vulnerability due to economic and energy efficiency growth. In FUND 3.5, the function that scales the base year damages adjusted for vulnerability allows for the possibility that in some simulations the benefits associated with reduced heating needs may be an unbounded convex function of the temperature anomaly. In FUND 3.8, the form of the scaling has been modified to ensure that the function is everywhere concave and that there will exist an upper bound on the benefits a region may receive from reduced space heating needs. The new formulation approaches a value of two in the limit of large temperature anomalies, or in other words, assuming no decrease in vulnerability, the reduced expenditures on space heating at any level of warming will not exceed two times the reductions experienced at one degree of warming. Since the reduced need for space heating represents a benefit of climate change in the model, or a negative damage, this change will increase the estimated SCC. This update accounts for a significant portion of the difference in the expected SCC estimates reported by the two versions of the model when run probabilistically.

Sea Level Rise and Land Loss

The FUND model explicitly includes damages associated with the inundation of dry land due to sea level rise. The amount of land lost within a region is dependent upon the proportion of the coastline being protected by adequate sea walls and the amount of sea level rise. In FUND 3.5 the function defining the potential land lost in a given year due to sea level rise is linear in the rate of sea level rise for that year. This assumption implicitly assumes that all regions are well represented by a homogeneous coastline in length and a constant uniform slope moving inland. In FUND 3.8 the function defining the potential land lost has been changed to be a convex function of sea level rise, thereby assuming that the slope of the shore line increases moving inland. The effect of this change is to typically reduce the vulnerability of some regions to sea level rise based land loss, thereby lowering the expected SCC estimate. [10]

Agriculture

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consistency with IPCC AR4 by adjusting the atmospheric lifetimes of CH4 and N2O and incorporating the indirect forcing effects of CH4, along with making minor stability improvements in the sea wall construction algorithm.

[9] The other damage sectors (water resources, space cooling, land loss, migration, ecosystems, human health, and extreme weather) were not significantly updated.

[10] For stability purposes this report also uses an update to the model which assumes that regional coastal protection measures will be built to protect the most valuable land first, such that the marginal benefits of coastal protection is decreasing in the level of protection following Fankhauser (1995).

In FUND, the damages associated with the agricultural sector are measured as proportional to the sector's value. The fraction is bounded from above by one and is made up of three additive components that represent the effects from carbon fertilization, the rate of temperature change, and the level of the temperature anomaly. In both FUND 3.5 and FUND 3.8, the fraction of the sector's value lost due to the level of the temperature anomaly is modeled as a quadratic function with an intercept of zero. In FUND 3.5, the coefficients of this loss function are modeled as the ratio of two random normal variables. This specification had the potential for unintended extreme behavior as draws from the parameter in the denominator approached zero or went negative. In FUND 3.8, the coefficients are drawn directly from truncated normal distributions so that they remain in the range $[0,\infty)$ and $(-\infty,0]$, respectively, ensuring the correct sign and eliminating the potential for divide by zero errors. The means for the new distributions are set equal to the ratio of the means from the normal distributions used in the previous version. In general the impact of this change has been to decrease the range of the distribution while spreading out the distributions' mass over the remaining range relative to the previous version. The net effect of this change on the SCC estimates is difficult to predict.

Transient Temperature Response

The temperature response model translates changes in global levels of radiative forcing into the current expected temperature anomaly. In FUND, a given year's increase in the temperature anomaly is based on a mean reverting function where the mean equals the equilibrium temperature anomaly that would eventually be reached if that year's level of radiative forcing were sustained. The rate of mean reversion defines the rate at which the transient temperature approaches the equilibrium. In FUND 3.5, the rate of temperature response is defined as a decreasing linear function of equilibrium climate sensitivity to capture the fact that the progressive heat uptake of the deep ocean causes the rate to slow at higher values of the equilibrium climate sensitivity. In FUND 3.8, the rate of temperature response has been updated to a quadratic function of the equilibrium climate sensitivity. This change reduces the sensitivity of the rate of temperature response to the level of the equilibrium climate sensitivity, a relationship first noted by Hansen et al. (1985) based on the heat uptake of the deep ocean. Therefore in FUND 3.8, the temperature response will typically be faster than in the previous version. The overall effect of this change is likely to increase estimates of the SCC as higher temperatures are reached during the timeframe analyzed and as the same damages experienced in the previous version of the model are now experienced earlier and therefore discounted less.

Methane

The IPCC AR4 notes a series of indirect effects of methane emissions, and has developed methods for proxying such effects when computing the global warming potential of methane (Forster et al. 2007). FUND 3.8 now includes the same methods for incorporating the indirect effects of methane emissions. Specifically, the average atmospheric lifetime of methane has been set to 12 years to account for the feedback of methane emissions on its own lifetime. The radiative forcing associated with atmospheric methane has also been increased by 40% to account for its net impact on ozone production and stratospheric water vapor. All else equal, the effect of this increased radiative forcing will be to increase the estimated SCC values, due to greater projected temperature anomaly.

C. PAGE

PAGE09 (Hope 2013) includes a number of changes from PAGE2002, the version used in the 2010 SCC interagency report. The changes that most directly affect the SCC estimates include: explicitly modeling the impacts from sea level rise, revisions to the damage function to ensure damages are constrained by GDP, a change in the regional scaling of damages, a revised treatment for the probability of a discontinuity within the damage function, and revised assumptions on adaptation. The model also includes revisions to the carbon cycle feedback and the calculation of regional temperatures.[11] More details on PAGE09 can be found in Hope (2011a, 2011b, 2011c). A description of PAGE2002 can be found in Hope (2006).

Sea Level Rise

While PAGE2002 aggregates all damages into two categories – economic and non-economic impacts -, PAGE09 adds a third explicit category: damages from sea level rise. In the previous version of the model, damages from sea level rise were subsumed by the other damage categories. In PAGE09 sea level damages increase less than linearly with sea level under the assumption that land, people, and GDP are more concentrated in low-lying shoreline areas. Damages from the economic and non-economic sector were adjusted to account for the introduction of this new category.

Revised Damage Function to Account for Saturation

In PAGE09, small initial economic and non-economic benefits (negative damages) are modeled for small temperature increases, but all regions eventually experience economic damages from climate change, where damages are the sum of additively separable polynomial functions of temperature and sea level rise. Damages transition from this polynomial function to a logistic path once they exceed a certain proportion of remaining Gross Domestic Product (GDP) to ensure that damages do not exceed 100 percent of GDP. This differs from PAGE2002, which allowed Eastern Europe to potentially experience large benefits from temperature increases, and which also did not bound the possible damages that could be experienced.

Regional Scaling Factors

As in the previous version of PAGE, the PAGE09 model calculates the damages for the European Union (EU) and then, assumes that damages for other regions are proportional based on a given scaling factor. The scaling factor in PAGE09 is based on the length of a region's coastline relative to the EU (Hope 2011b). Because of the long coastline in the EU, other regions are, on average, less vulnerable than the EU for the same sea level and temperature increase, but all regions have a positive scaling factor. PAGE2002 based its scaling factors on four studies reported in the IPCC's third assessment report, and allowed for benefits from temperature increase in Eastern Europe, smaller impacts in developed countries, and higher damages in developing countries.

[11] Because several changes in the PAGE model are structural (e.g., the addition of sea level rise and treatment of discontinuity), it is not possible to assess the direct impact of each change on the SCC in isolation as done for the other two models above.

Probability of a Discontinuity

In PAGE2002, the damages associated with a "discontinuity" (nonlinear extreme event) were modeled as an expected value. Specifically, a stochastic probability of a discontinuity was multiplied by the damages associated with a discontinuity to obtain an expected value, and this was added to the economic and non-economic impacts. That is, additional damages from an extreme event, such as extreme melting of the Greenland ice sheet, were multiplied by the probability of the event occurring and added to the damage estimate. In PAGE09, the probability of discontinuity is treated as a discrete event for each year in the model. The damages for each model run are estimated either with or without a discontinuity occurring, rather than as an expected value. A large-scale discontinuity becomes possible when the temperature rises beyond some threshold value between 2 and 4°C. The probability that a discontinuity will occur beyond this threshold then increases by between 10 and 30 percent for every 1°C rise in temperature beyond the threshold. If a discontinuity occurs, the EU loses an additional 5 to 25 percent of its GDP (drawn from a triangular distribution with a mean of 15 percent) in addition to other damages, and other regions lose an amount determined by the regional scaling factor. The threshold value for a possible discontinuity is lower than in PAGE2002, while the rate at which the probability of a discontinuity increases with the temperature anomaly and the damages that result from a discontinuity are both higher than in PAGE2002. The model assumes that only one discontinuity can occur and that the impact is phased in over a period of time, but once it occurs, its effect is permanent.

Adaptation

As in PAGE2002, adaptation is available to help mitigate any climate change impacts that occur. In PAGE this adaptation is the same regardless of the temperature change or sea level rise and is therefore akin to what is more commonly considered a reduction in vulnerability. It is modeled by reducing the damages by some percentage. PAGE09 assumes a smaller decrease in vulnerability than the previous version of the model and assumes that it will take longer for this change in vulnerability to be realized. In the aggregated economic sector, at the time of full implementation, this adaptation will mitigate all damages up to a temperature increase of 1°C, and for temperature anomalies between 1°C and 2°C, it will reduce damages by 15-30 percent (depending on the region). However, it takes 20 years to fully implement this adaptation. In PAGE2002, adaptation was assumed to reduce economic sector damages up to 2°C by 50-90 percent after 20 years. Beyond 2°C, no adaptation is assumed to be available to mitigate the impacts of climate change. For the non-economic sector, in PAGE09 adaptation is available to reduce 15 percent of the damages due to a temperature increase between 0°C and 2°C and is assumed to take 40 years to fully implement, instead of 25 percent of the damages over 20 years assumed in PAGE2002. Similarly, adaptation is assumed to alleviate 25-50 percent of the damages from the first 0.20 to 0.25 meters of sea level rise but is assumed to be ineffective thereafter. Hope (2011c) estimates that the less optimistic assumptions regarding the ability to offset impacts of temperature and sea level rise via adaptation increase the SCC by approximately 30 percent.

Other Noteworthy Changes

Two other changes in the model are worth noting. There is a change in the way the model accounts for decreased CO_2 absorption on land and in the ocean as temperature rises. PAGE09 introduces a linear feedback from global mean temperature to the percentage gain in the excess concentration of CO_2, capped at a maximum level. In PAGE2002, an additional amount was added to the CO_2 emissions each period to account for a decrease in ocean absorption and a loss of soil carbon. Also updated is the method by which the average global and annual temperature anomaly is downscaled to determine annual average regional temperature anomalies to be used in the regional damage functions. In PAGE2002, the scaling was determined solely based on regional difference in emissions of sulfate aerosols. In PAGE09, this regional temperature anomaly is further adjusted using an additive factor that is based on the average absolute latitude of a region relative to the area weighted average absolute latitude of the Earth's landmass, to capture relatively greater changes in temperature forecast to be experienced at higher latitudes.

III. Revised SCC Estimates

The updated versions of the three integrated assessment models were run using the same methodology detailed in the 2010 TSD (Interagency Working Group on Social Cost of Carbon 2010). The approach along with the inputs for the socioeconomic emissions scenarios, equilibrium climate sensitivity distribution, and discount rate remains the same. This includes the five reference scenarios based on the EMF-22 modeling exercise, the Roe and Baker equilibrium climate sensitivity distribution calibrated to the IPCC AR4, and three constant discount rates of 2.5, 3, and 5 percent.

As was previously the case, the use of three models, three discount rates, and five scenarios produces 45 separate distributions for the global SCC. The approach laid out in the 2010 TSD applied equal weight to each model and socioeconomic scenario in order to reduce the dimensionality down to three separate distributions representative of the three discount rates. The interagency group selected four values from these distributions for use in regulatory analysis. Three values are based on the average SCC across models and socio-economic-emissions scenarios at the 2.5, 3, and 5 percent discount rates, respectively. The fourth value was chosen to represent the higher-than-expected economic impacts from climate change further out in the tails of the SCC distribution. For this purpose, the 95th percentile of the SCC estimates at a 3 percent discount rate was chosen. (A detailed set of percentiles by model and scenario combination and additional summary statistics for the 2020 values is available in the Appendix.) As noted in the 2010 TSD, "the 3 percent discount rate is the central value, and so the central value that emerges is the average SCC across models at the 3 percent discount rate" (Interagency Working Group on Social Cost of Carbon 2010, p. 25). However, for purposes of capturing the uncertainties involved in regulatory impact analysis, the interagency group emphasizes the importance and value of including all four SCC values.

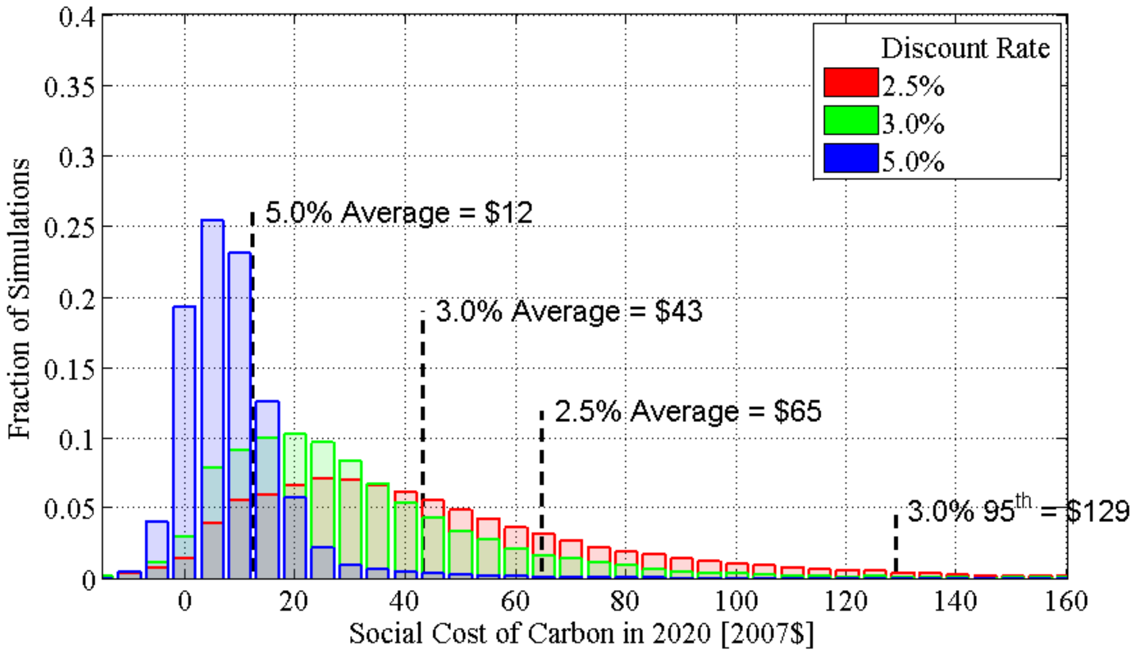
Table 2 shows the four selected SCC estimates in five year increments from 2010 to 2050. Values for 2010, 2020, 2030, 2040, and 2050 are calculated by first combining all outputs (10,000 estimates per model run) from all scenarios and models for a given discount rate. Values for the years in between are calculated using linear interpolation. The full set of revised annual SCC estimates between 2010 and 2050 is reported in the Appendix.

Table 2: Revised Social Cost of CO_2, 2010 – 2050 (in 2007 dollars per metric ton of CO_2)

Discount Rate Year	5.0% Avg	3.0% Avg	2.5% Avg	3.0% 95th
2010	11	33	52	90
2015	12	38	58	109
2020	12	43	65	129
2025	14	48	70	144
2030	16	52	76	159
2035	19	57	81	176
2040	21	62	87	192
2045	24	66	92	206
2050	27	71	98	221

The SCC estimates using the updated versions of the models are higher than those reported in the 2010 TSD due to the changes to the models outlined in the previous section. By way of comparison, the 2020 SCC estimates reported in the original TSD were \$7, \$26, \$42 and \$81 (2007\$) (Interagency Working Group on Social Cost of Carbon 2010). Figure 1 illustrates where the four SCC values for 2020 fall within the full distribution for each discount rate based on the combined set of runs for each model and scenario (150,000 estimates in total for each discount rate). In general, the distributions are skewed to the right and have long tails. The Figure also shows that the lower the discount rate, the longer the right tail of the distribution.

Figure 1: Distribution of SCC Estimates for 2020 (in 2007\$ per metric ton CO_2)



As was the case in the 2010 TSD, the SCC increases over time because future emissions are expected to produce larger incremental damages as physical and economic systems become more stressed in response to greater climatic change. The approach taken by the interagency group is to compute the cost of a marginal ton emitted in the future by running the models for a set of perturbation years out to 2050. Table 3 illustrates how the growth rate for these four SCC estimates varies over time.

Table 3: Average Annual Growth Rates of SCC Estimates between 2010 and 2050

Average Annual Growth Rate (%)	5.0% Avg	3.0% Avg	2.5% Avg	3.0% 95th
2010-2020	1.2%	3.2%	2.4%	4.3%
2020-2030	3.4%	2.1%	1.7%	2.4%
2030-2040	3.0%	1.8%	1.5%	2.0%
2040-2050	2.6%	1.6%	1.3%	1.5%

The future monetized value of emission reductions in each year (the SCC in year *t* multiplied by the change in emissions in year *t*) must be discounted to the present to determine its total net present value for use in regulatory analysis. As previously discussed in the 2010 TSD, damages from future emissions should be discounted at the same rate as that used to calculate the SCC estimates themselves to ensure internal consistency – i.e., future damages from climate change, whether they result from emissions today or emissions in a later year, should be discounted using the same rate.

Under current OMB guidance contained in Circular A-4, analysis of economically significant proposed and final regulations from the domestic perspective is required, while analysis from the international perspective is optional. However, the climate change problem is highly unusual in at least two respects. First, it involves a global externality: emissions of most greenhouse gases contribute to damages around the world even when they are emitted in the United States. Consequently, to address the global nature of the problem, the SCC must incorporate the full (global) damages caused by GHG emissions. Second, climate change presents a problem that the United States alone cannot solve. Even if the United States were to reduce its greenhouse gas emissions to zero, that step would be far from enough to avoid substantial climate change. Other countries would also need to take action to reduce emissions if significant changes in the global climate are to be avoided. Emphasizing the need for a global solution to a global problem, the United States has been actively involved in seeking international agreements to reduce emissions and in encouraging other nations, including emerging major economies, to take significant steps to reduce emissions. When these considerations are taken as a whole, the interagency group concluded that a global measure of the benefits from reducing U.S. emissions is preferable. For additional discussion, see the 2010 TSD.

IV. Other Model Limitations and Research Gaps

The 2010 interagency SCC TSD discusses a number of important limitations for which additional research is needed. In particular, the document highlights the need to improve the quantification of both non-catastrophic and catastrophic damages, the treatment of adaptation and technological change, and the way in which inter-regional and inter-sectoral linkages are modeled. While the new version of the models discussed above offer some improvements in these areas, further work remains warranted. The 2010 TSD also discusses the need to more carefully assess the implications of risk aversion for SCC estimation as well as the inability to perfectly substitute between climate and non-climate goods at higher temperature increases, both of which have implications for the discount rate used. EPA, DOE, and other agencies continue to engage in research on modeling and valuation of climate impacts that can potentially improve SCC estimation in the future.

References

Anthoff, D. and Tol, R.S.J. 2013. The uncertainty about the social cost of carbon: a decomposition analysis using FUND. *Climatic Change* 117: 515–530.

Fankhauser, S. 1995. Valuing climate change: The economics of the greenhouse. London, England: Earthscan.

Forster, P., V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D.W. Fahey, J. Haywood, J. Lean, D.C. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schulz and R. Van Dorland. 2007. Changes in Atmospheric Constituents and in Radiative Forcing. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Hope, Chris. 2006. "The Marginal Impact of CO_2 from PAGE2002: An Integrated Assessment Model Incorporating the IPCC's Five Reasons for Concern." *The Integrated Assessment Journal*. 6(1): 19–56.

Hope, Chris. 2011a "The PAGE09 Integrated Assessment Model: A Technical Description" Cambridge Judge Business School Working Paper No. 4/2011 (April). Accessed November 23, 2011: http://www.jbs.cam.ac.uk/research/working_papers/2011/wp1104.pdf.

Hope, Chris. 2011b "The Social Cost of CO_2 from the PAGE09 Model" Cambridge Judge Business School Working Paper No. 5/2011 (June). Accessed November 23, 2011: http://www.jbs.cam.ac.uk/research/working_papers/2011/wp1105.pdf.

Hope, Chris. 2011c "New Insights from the PAGE09 Model: The Social Cost of CO_2" Cambridge Judge Business School Working Paper No. 8/2011 (July). Accessed November 23, 2011: http://www.jbs.cam.ac.uk/research/working_papers/2011/wp1108.pdf.

Hope, C. 2013. Critical issues for the calculation of the social cost of CO_2: why the estimates from PAGE09 are higher than those from PAGE2002. *Climatic Change* 117: 531–543.

Interagency Working Group on Social Cost of Carbon. 2010. Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866. February. United States Government. http://www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf.

Meehl, G.A., T.F. Stocker, W.D. Collins, P. Friedlingstein, A.T. Gaye, J.M. Gregory, A. Kitoh, R. Knutti, J.M. Murphy, A. Noda, S.C.B. Raper, I.G. Watterson, A.J. Weaver and Z.-C. Zhao. 2007. Global Climate Projections. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Narita, D., R. S. J. Tol and D. Anthoff. 2010. Economic costs of extratropical storms under climate change: an application of FUND. *Journal of Environmental Planning and Management* 53(3): 371-384.

National Academy of Sciences. 2011. *Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia*. Washington, DC: National Academies Press, Inc.

Nicholls, R.J., N. Marinova, J.A. Lowe, S. Brown, P. Vellinga, D. de Gusmão, J. Hinkel and R.S.J. Tol. 2011. Sea-level rise and its possible impacts given a 'beyond 4°C world' in the twenty-first century. *Phil. Trans. R. Soc. A* 369(1934): 161-181.

Nordhaus, W. 2010. Economic aspects of global warming in a post-Copenhagen environment. *Proceedings of the National Academy of Sciences* 107(26): 11721-11726.

Nordhaus, W. 2008. A Question of Balance: Weighing the Options on Global Warming Policies. New Haven, CT: Yale University Press.

Randall, D.A., R.A. Wood, S. Bony, R. Colman, T. Fichefet, J. Fyfe, V. Kattsov, A. Pitman, J. Shukla, J. Srinivasan, R.J. Stouffer, A. Sumi and K.E. Taylor. 2007. Climate Models and Their Evaluation. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M.

Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Appendix

Table A1: Annual SCC Values: 2010-2050 (2007$/metric ton CO_2)

Discount Rate Year	5.0% Avg	3.0% Avg	2.5% Avg	3.0% 95th
2010	11	33	52	90
2011	11	34	54	94
2012	11	35	55	98
2013	11	36	56	102
2014	11	37	57	106
2015	12	38	58	109
2016	12	39	60	113
2017	12	40	61	117
2018	12	41	62	121
2019	12	42	63	125
2020	12	43	65	129
2021	13	44	66	132
2022	13	45	67	135
2023	13	46	68	138
2024	14	47	69	141
2025	14	48	70	144
2026	15	49	71	147
2027	15	49	72	150
2028	15	50	73	153
2029	16	51	74	156
2030	16	52	76	159
2031	17	53	77	163
2032	17	54	78	166
2033	18	55	79	169
2034	18	56	80	172
2035	19	57	81	176
2036	19	58	82	179
2037	20	59	84	182
2038	20	60	85	185
2039	21	61	86	188
2040	21	62	87	192
2041	22	63	88	195
2042	22	64	89	198
2043	23	65	90	200
2044	23	65	91	203
2045	24	66	92	206
2046	24	67	94	209
2047	25	68	95	212
2048	25	69	96	215
2049	26	70	97	218
2050	27	71	98	221

Table A2: 2020 Global SCC Estimates at 2.5 Percent Discount Rate (2007$/metric ton CO_2)

Percentile	1st	5th	10th	25th	50th	Avg	75th	90th	95th	99th
Scenario[12]					PAGE					
IMAGE	6	11	15	27	58	129	139	327	515	991
MERGE	4	6	9	16	34	78	82	196	317	649
MESSAGE	4	8	11	20	42	108	107	278	483	918
MiniCAM Base	5	9	12	22	47	107	113	266	431	872
5th Scenario	2	4	6	11	25	85	68	200	387	955
Scenario					DICE					
IMAGE	25	31	37	47	64	72	92	123	139	161
MERGE	14	18	20	26	36	40	50	65	74	85
MESSAGE	20	24	28	37	51	58	71	95	109	221
MiniCAM Base	20	25	29	38	53	61	76	102	117	135
5th Scenario	17	22	25	33	45	52	65	91	106	126
Scenario					FUND					
IMAGE	-17	-1	5	17	34	44	59	90	113	176
MERGE	-7	2	7	16	30	35	49	72	91	146
MESSAGE	-19	-4	2	12	27	32	46	70	87	135
MiniCAM Base	-9	1	8	18	35	45	59	87	108	172
5th Scenario	-30	-12	-5	6	19	24	35	57	72	108

Table A3: 2020 Global SCC Estimates at 3 Percent Discount Rate (2007$/metric ton CO_2)

Percentile	1st	5th	10th	25th	50th	Avg	75th	90th	95th	99th
Scenario					PAGE					
IMAGE	4	7	10	18	38	91	95	238	385	727
MERGE	2	4	6	11	23	56	58	142	232	481
MESSAGE	3	5	7	13	29	75	74	197	330	641
MiniCAM Base	3	5	8	14	30	73	75	184	300	623
5th Scenario	1	3	4	7	17	58	48	136	264	660
Scenario					DICE					
IMAGE	16	21	24	32	43	48	60	79	90	102
MERGE	10	13	15	19	25	28	35	44	50	58
MESSAGE	14	18	20	26	35	40	49	64	73	83
MiniCAM Base	13	17	20	26	35	39	49	65	73	85
5th Scenario	12	15	17	22	30	34	43	58	67	79
Scenario					FUND					
IMAGE	-14	-3	1	9	20	25	35	54	69	111
MERGE	-8	-1	3	9	18	22	31	47	60	97
MESSAGE	-16	-5	-1	6	16	18	28	43	55	88
MiniCAM Base	-9	-1	3	10	21	27	35	53	67	107
5th Scenario	-22	-10	-5	2	10	13	20	33	42	63

[12] See 2010 TSD for a description of these scenarios.

Table A4: 2020 Global SCC Estimates at 5 Percent Discount Rate (2007$/metric ton CO_2)

Percentile	1st	5th	10th	25th	50th	Avg	75th	90th	95th	99th
Scenario	PAGE									
IMAGE	1	2	2	5	10	28	27	71	123	244
MERGE	1	1	2	3	7	17	17	45	75	153
MESSAGE	1	1	2	4	9	24	22	60	106	216
MiniCAM Base	1	1	2	3	8	21	21	54	94	190
5th Scenario	0	1	1	2	5	18	14	41	78	208

Scenario	DICE									
IMAGE	6	8	9	11	14	15	18	22	25	27
MERGE	4	5	6	7	9	10	12	15	16	18
MESSAGE	6	7	8	10	12	13	16	20	22	25
MiniCAM Base	5	6	7	8	11	12	14	18	20	22
5th Scenario	5	6	6	8	10	11	14	17	19	21

Scenario	FUND									
IMAGE	-9	-5	-3	-1	2	3	6	11	15	25
MERGE	-6	-3	-2	0	3	4	7	12	16	27
MESSAGE	-10	-6	-4	-1	2	2	5	9	13	23
MiniCAM Base	-7	-3	-2	0	3	4	7	11	15	26
5th Scenario	-11	-7	-5	-2	0	0	3	6	8	14

Table A5: Additional Summary Statistics of 2020 Global SCC Estimates

Discount rate:	5.0%				3.0%				2.5%			
Statistic:	Mean	Variance	Skewness	Kurtosis	Mean	Variance	Skewness	Kurtosis	Mean	Variance	Skewness	Kurtosis
DICE	12	26	2	15	38	409	3	24	57	1097	3	30
PAGE	22	1616	5	32	71	14953	4	22	101	29312	4	23
FUND	3	560	-170	35222	21	22487	-85	18842	36	68055	-46	13105

EXHIBIT JIF-6

Exhibit JIF-6

The White House

Office of the Press Secretary

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For Immediate Release June 25, 2013

Presidential Memorandum -- Power Sector Carbon Pollution Standards

ENVIRONMENTAL PROTECTION AGENCY

SUBJECT: Power Sector Carbon Pollution Standards

With every passing day, the urgency of addressing climate change intensifies. I made clear in my State of the Union address that my Administration is committed to reducing carbon pollution that causes climate change, preparing our communities for the consequences of climate change, and speeding the transition to more sustainable sources of energy.

The Environmental Protection Agency (EPA) has already undertaken such action with regard to carbon pollution from the transportation sector, issuing Clean Air Act standards limiting the greenhouse gas emissions of new cars and light trucks through 2025 and heavy duty trucks through 2018. The EPA standards were promulgated in conjunction with the Department of Transportation, which, at the same time, established fuel efficiency standards for cars and trucks as part of a harmonized national program. Both agencies engaged constructively with auto manufacturers, labor unions, States, and other stakeholders, and the resulting standards have received broad support. These standards will reduce the Nation's carbon pollution and dependence on oil, and also lead to greater innovation, economic growth, and cost savings for American families.

The United States now has the opportunity to address carbon pollution from the power sector, which produces nearly 40 percent of such pollution. As a country, we can continue our progress in reducing power plant pollution, thereby improving public health and protecting the environment, while supplying the reliable, affordable power needed for economic growth and advancing cleaner energy technologies, such as efficient natural gas, nuclear power, renewables such as wind and solar energy, and clean coal technology.

Investments in these technologies will also strengthen our economy, as the clean and efficient production and use of electricity will ensure that it remains reliable and affordable for American businesses and families.

By the authority vested in me as President by the Constitution and the laws of the United States of America, and in order to reduce power plant carbon pollution, building on actions already underway in States and the power sector, I hereby direct the following:

Section 1. Flexible Carbon Pollution Standards for Power Plants. (a) Carbon Pollution Standards for Future Power Plants. On April 13, 2012, the EPA published a Notice of Proposed Rulemaking entitled "Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units," 77 Fed. Reg. 22392. In light of the information conveyed in more than two million comments on that proposal and ongoing developments in the industry, you have indicated EPA's intention to issue a new proposal. I therefore direct you to issue a new proposal by no later than September 20, 2013. I further direct you to issue a final rule in a timely fashion after considering all public comments, as appropriate.

(b) Carbon Pollution Regulation for Modified, Reconstructed, and Existing Power Plants. To ensure continued progress in reducing harmful carbon pollution, I direct you to use your authority under sections 111(b) and 111(d) of the Clean Air Act to issue standards, regulations, or guidelines, as appropriate, that address carbon pollution from modified, reconstructed, and existing power plants and build on State efforts to move toward a cleaner power sector. In addition, I request that you:

(i) issue proposed carbon pollution standards, regulations, or guidelines, as appropriate, for modified, reconstructed, and existing power plants by no later than June 1, 2014;

(ii) issue final standards, regulations, or guidelines, as appropriate, for modified, reconstructed, and existing power plants by no later than June 1, 2015; and

BLOG POSTS ON THIS ISSUE

August 21, 2013 6:36 PM EDT

White House Office Hours: College Affordability

During a live Q&A on Twitter Deputy Communications Director Katie Beirne-Fallon and Deputy Director of the Domestic Policy Council James Kvaal will answer your questions about President Obama's plan to keep the cost of college within reach for middle-class families.

August 21, 2013 4:00 PM EDT

The Affordable Care Act and Expanding Mental Health Coverage

Health care providers, mental health advocates, and individuals who have personally experienced mental illness came to the White House to talk about the intersection of two important Presidential priorities: the Affordable Care Act and mental health.

August 21, 2013 1:50 PM EDT

What the Affordable Care Act Means to Communities of Color

The Affordable Care Act is improving health and strengthening communities - especially communities of color that have long faced disparities in health and health care.

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Exhibit JIF-6

(iii) include in the guidelines addressing existing power plants a requirement that States submit to EPA the implementation plans required under section 111(d) of the Clean Air Act and its implementing regulations by no later than June 30, 2016.

(c) Development of Standards, Regulations, or Guidelines for Power Plants. In developing standards, regulations, or guidelines pursuant to subsection (b) of this section, and consistent with Executive Orders 12866 of September 30, 1993, as amended, and 13563 of January 18, 2011, you shall ensure, to the greatest extent possible, that you:

(i) launch this effort through direct engagement with States, as they will play a central role in establishing and implementing standards for existing power plants, and, at the same time, with leaders in the power sector, labor leaders, non-governmental organizations, other experts, tribal officials, other stakeholders, and members of the public, on issues informing the design of the program;

(ii) consistent with achieving regulatory objectives and taking into account other relevant environmental regulations and policies that affect the power sector, tailor regulations and guidelines to reduce costs;

(iii) develop approaches that allow the use of market-based instruments, performance standards, and other regulatory flexibilities;

(iv) ensure that the standards enable continued reliance on a range of energy sources and technologies;

(v) ensure that the standards are developed and implemented in a manner consistent with the continued provision of reliable and affordable electric power for consumers and businesses; and

(vi) work with the Department of Energy and other Federal and State agencies to promote the reliable and affordable provision of electric power through the continued development and deployment of cleaner technologies and by increasing energy efficiency, including through stronger appliance efficiency standards and other measures.

Sec. 2. General Provisions. (a) This memorandum shall be implemented consistent with applicable law, including international trade obligations, and subject to the availability of appropriations.

(b) Nothing in this memorandum shall be construed to impair or otherwise affect:

(i) the authority granted by law to a department, agency, or the head thereof; or

(ii) the functions of the Director of the Office of Management and Budget relating to budgetary, administrative, or legislative proposals.

(c) This memorandum is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by any party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person.

(d) You are hereby authorized and directed to publish this memorandum in the *Federal Register*.

BARACK OBAMA

Learn more:

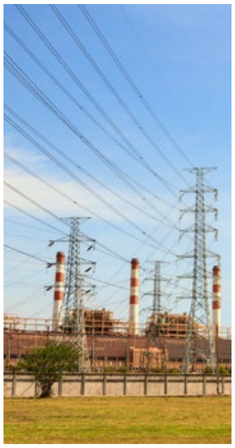
- View the Full PDF of the President's Climate Action Plan
- Watch President Obama's Climate Change Speech

EXHIBIT JIF-7

WHITE PAPER

President Obama's Climate Action Plan: What It Could Mean for the Power Sector

By Steve Fine and Chris MacCracken, ICF International



Summary

*For the first time, the U.S. Environmental Protection Agency (EPA) is moving forward with a clear timeline to regulate CO2 from existing power plants. The regulations are likely to be transformative for the energy industry, redefining prospective winners and losers, power prices, and capital allocation. But **how** the regulations will transform the industry is an open question that will be determined as each regulation is developed.*

In this paper, we discuss one of the most important factors affecting the transformation: the stringency and form of the regulations. Depending on the stringency and form (i.e., unit-specific emission standards or state- and regional-based emission standards), the level of reductions achieved and the implications for individual assets and the power sector as a whole could be dramatically different. Under relatively modest unit-specific emissions standards, the economics for non-emitting sources such as renewables and energy efficiency may only minimally be affected in the early phases of the regulation. Compliance costs for a subset of plants within each category (e.g., the top-performing coal plants from an emissions perspective) may be effectively negligible for a period of time (i.e., these plants require no or little further modifications initially and potentially limited modifications over time). In contrast, under more stringent standards that provide for a state- and regional-based standard that allows some form of trading or averaging, all coal plants possibly would incur more substantial compliance costs right from the start of the regulation. Here, potential also exists for the universe of facilities participating in a trading scheme to include non-emitters that could potentially realize emission credits and associated revenue.

The design of these programs and their implications on power prices, fuel switching, and retirements must be understood, as they will impact the economics of existing assets as well as investment decision making around new assets. New CO2 standards, even if they are not likely to take effect for several years, will become part of the equation of compliance and investment decisions today. They may result in incremental unit retirements beyond those already planned. Such retirements, along with expectations of power price impacts, will influence reliability considerations and decision making. They will shape investments in new capacity and affect the need for transmission upgrades or additions.

Overview of the Climate Action Plan and EPA Authority

President Obama's Climate Action Plan,[1] released on June 25, 2013, reignites the debate over regulating new and existing power plants under the Clean Air Act. In the plan, the President directed EPA to effectively reissue a proposal to regulate CO_2 emissions from new power plants through the establishment of New Source Performance Standards (NSPS). And for the first time, the President, under existing law, also directed EPA to issue "standards, regulations, or guidelines" to regulate CO_2 emissions from existing power plants. The timing, form, and stringency of the existing source rule have the potential to make it a transformative regulation for the U.S. power sector with wide-ranging impacts on power, fuel, and emissions markets. Depending on its structure, the regulation has the potential to redefine the winners and losers in the energy industry.

The rule for existing units would be established under the authority granted EPA by Section 111(d) of the Clean Air Act to "Establish a procedure…under which each State shall submit to the Administrator a

[1] FACT SHEET: President's Climate Action Plan. June 25, 2013. Retrieved July 26, 2013, from http://www.whitehouse.gov/the-press-office/2013/06/25/fact-sheet-president-obama-s-climate-action-plan.

plan which establishes standards of performance for any existing source for any air pollutant." In 2007, the Supreme Court ruled in *Massachusetts v. EPA*[2] that the agency not only had the authority to regulate greenhouse gases under Section 111 but also the responsibility to do so. In a subsequent settlement agreement with state and environmental petitioners, EPA consented to use its power under the Clean Air Act to establish emissions guidelines for greenhouse gas emissions from existing sources.

Under the Clean Air Act's guiding principle of "cooperative federalism," EPA will set the process for states to establish the standards but allow states themselves to determine how they will achieve them. It also may issue a "model rule" that would effectively allow states to opt in to a program preapproved by EPA. EPA will require that each state respond to its final rule with a State Implementation Plan (SIP) detailing how the state will comply. EPA may accept a SIP or return it to the state for revision. In cases where EPA and the state cannot agree on a final SIP, EPA may impose a Federal Implementation Plan on the state with a prescribed implementation approach. The President's proposed schedule for this rulemaking process appears in Figure 1.

Figure 1: Proposed Deadlines for New and Existing Source Rulemaking

Rulemaking	Stage	Proposed Deadline
New Sources	Reissue Proposal	September 20, 2013
	Final	"In a timely fashion after considering all public comments"
Existing Sources	Proposed Standards from EPA	June 1, 2014
	Final Standards from EPA	June 1, 2015
	State Implementation Plans submitted by states to EPA	June 30, 2016

The form EPA takes with the regulation will be an important determinant of its impact on power markets. However, what form the rule will take is not clear. EPA has used 111(d) to control conventional pollutant emissions from municipal waste incinerators, pulp and paper facilities, petroleum refiners and others, but not for power generation more broadly and not for CO_2. EPA also used Section 111(d) in its Clean Air Mercury Rule (CAMR), finalized in 2005, that would have established a national cap-and-trade program for mercury. The court vacated CAMR for other reasons before it could rule on the appropriateness of using Section 111(d) for a trading-based program. As a result, very limited precedent exists on what type of requirement EPA may develop to control CO_2 emissions from existing sources and to what extent any proposed approach would withstand legal challenge.

One option for EPA is setting unit-specific emission rate standards, similar to the approach used for waste combustors under Section 111(d). These standards, likely expressed on an output basis in tons per megawatt-hour, could be set for categories of technology types (e.g., sub- or super-critical steam boiler or combined cycle) and fuels (coal by rank, natural gas, or oil) based on the performance of the existing fleet. For example, EPA may specify a standard for coal-fired generators burning subbituminous coals based on the median emission rate for units in that category. An existing unit that did not already meet the standard would be required to undertake upgrades to improve its emission rate through improvements in its heat rate (efficiency). Or, the unit could potentially co-fire with less carbon-intensive

[2] Massachusetts, et al. v. Environmental Protection Agency, et al., 549 US 497 (2007). Retrieved July 26, 2013, from http://www.supremecourt.gov/opinions/06pdf/05-1120.pdf.

fuels or retire by a specific date. Although straightforward and requiring little interpretation, compliance costs at the program level for this type of requirement may be higher than alternatives achieving the same level of reductions.

NRDC's proposal would establish state-specific emission rate standards that are a function of each state's historical fossil generation levels and fuel-specific emission rate "benchmarks" defined by EPA.

Following the President's guidance on the use of flexibility mechanisms, EPA also may develop a rule allowing credit trading among affected units in a fashion similar to the model rule issued around the NO_X SIP Call.[3] The added flexibility in the program may allow for more stringent standards to be achieved at the same or less cost than less flexible alternatives. However, these flexibility measures also may incur additional legal challenges that could impact the schedule in Figure 1. To provide the greatest degree of flexibility to the states, EPA may offer both unit-specific and trading programs as options and possibly other options between those two, with the final choice made by the individual states (subject to EPA review).

NRDC Proposal for Existing Sources

The Natural Resource Defense Council (NRDC) recently released what is so far the only public proposal for establishing an existing source standard that would include such flexibility mechanisms. Its approach would create state-specific emission rate standards around which affected sources could trade compliance credits. NRDC's proposed standards would be a function of each state's historical fossil generation levels and fuel-specific emission rate "benchmarks" defined by EPA that would decline over time. Under this type of program:

To promote cost-effective emission reductions, the President's directive included language directing the EPA to "develop approaches that allow the use of market-based instruments, performance standards, and other regulatory flexibilities."

- Fossil sources emitting above the state standard would buy credits equal to the difference in their emission rates and the state standards;
- Fossil sources emitting below the standard would generate credits for sale to buyers in an amount equal to the difference between their rates and the standards; and
- Non-emitting sources, including energy efficiency and renewables to the extent they are allowed under the program, would generate credits for sale at the full state standard rate.

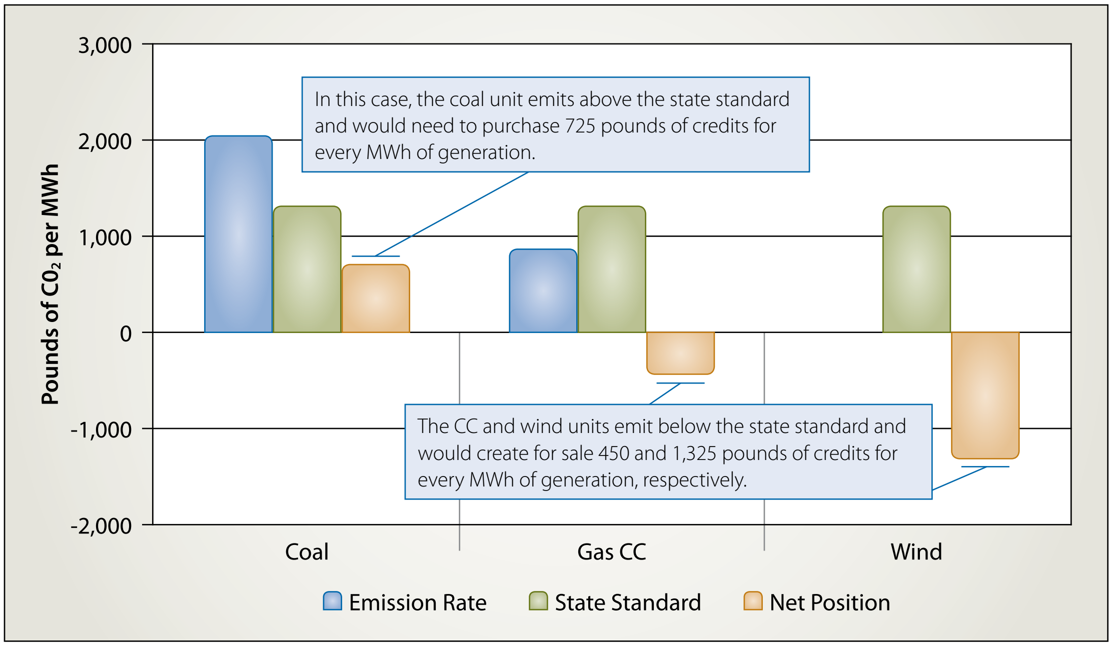
Figure 2 shows the net credit positions for representative generators of different types. The demand and supply for these credits would balance around a credit price, likely expressed in dollars per ton of CO_2. Greater demand for credits by higher-emitting units would lead to higher credit prices. Such prices would impose greater dispatch costs, leading the units to potentially reduce their levels of operation or potentially retire.

The credit prices would vary by state, consistent with each state's generation mix and its availability of lower-emitting options, including renewable resources, energy efficiency potential, and available generation capacity. States with an existing supply of under-used lower-emitting gas combined cycle (CC) units, for example, may realize lower credit prices than states dominated by coal with few generation

[3] EPA. NO_X Budget Trading Program/NOx SIP Call, 2003-2008. Retrieved July 26, 2013, from http://www.epa.gov/airmarkets/progsregs/nox/sip.html.

or efficiency alternatives. NRDC suggested that regional credit trading zones also may be a possibility to broaden the range of options for credit supply, potentially reducing compliance costs for these more constrained states.

Figure 2: Net CO2 Credit Positions for a Representative State Standard and Generating Units Under NRDC's Proposed Approach



Standard-Based Regulation vs. Traditional Cap-and-Trade Program

The mechanics of the standard-based approach, such as proposed by NRDC, would differ from those expected of a more traditional cap-and-trade program. Under a standard-based program, EPA would not place a limit on total CO_2 emissions. Instead, actual emissions would be based on the standard and the level of activity (generation) by affected sources. The programs also would differ in that credit allocations would not necessarily be a matter for discussion. Whereas allocations among sectors and generators were hotly debated in the development of the Waxman-Markey[4] and related cap-and-trade legislative proposals, a standard-based program builds an allocation into the program itself through the state standard. Under the standard-based program, generators that emit above the standard pay only on the difference between their emission rates and their states' standards, as discussed above, so they are implicitly "allocated" at the level of the state standard. Similarly, generators that emit below the standard would generate credits for sale, much as if they had been granted allocations in excess of their emissions under a cap-and-trade program.

The impact of the state-based standard also would differ from a cap-and-trade program. Under previous cap-and-trade proposals, generators would pay for credits based on their total emissions, regardless of their relative emission levels. Figure 3 shows how a CO_2 allowance price of $10 per ton would translate into dispatch costs for three representative unit types. Although allocations granted under such a program may offset some of the total cost of allowances to the generators, the price signal to the market, at least in

[4] H.R. 2454 (111th): American Clean Energy and Security Act of 2009. Retrieved July 26, 2013, from http://www.govtrack.us/congress/bills/111/hr2454/text.

competitive markets, would likely have been based on the equivalent CO_2 dispatch cost shown in the table. This cost would translate into higher power prices.

Figure 3: Dispatch Cost for Illustrative Generators Under Cap-and-Trade Program

Generator Type	Illustrative Emission Rate (lbs/MWh)	Illustrative State Standard (lbs/MWh)	Net Position Relative to Standard (lbs/MWh)	Illustrative CO_2 Price ($/Ton)	Equivalent CO_2 Dispatch Cost ($/MWh)
Coal	2,050	N/A	2,050 (short)	$10	$10.3 (cost)
Gas CC	875	N/A	875 (short)	$10	$4.4 (cost)
Non-emitting	0	N/A	N/A	$10	N/A

Figure 4 illustrates how the dispatch cost effects could differ under a standard-based trading program. The same $10 per ton CO_2 credit price would translate into a lower dispatch cost to coal units. The gas and non-emitting units would receive an incremental revenue stream under the program. In this case, the impact on power prices is less certain. Although the incremental cost to coal units would put upward pressure on coal prices, the revenues to gas and non-emitting generators resulting from the program may push power prices downward. Those generators would need less from the energy market to cover their costs and make their necessary returns. The trading system also would result in a transfer of funds from coal-fired generators to gas and renewable generators as credits are exchanged. To the extent that the program could generate credits for and incentivize energy efficiency projects—thus reducing demand for generation, power prices could face additional downward pressure. However, other offsetting and second-order impacts could occur, including pressure on natural gas prices and capacity prices.

Figure 4: Dispatch Cost for Illustrative Generators Under Standard-Based Trading Program

Generator Type	Illustrative Emission Rate (lbs/MWh)	Illustrative State Standard (lbs/MWh)	Net Position Relative to Standard (lbs/MWh)	Illustrative CO_2 Price ($/Ton)	Equivalent CO_2 Dispatch Cost ($/MWh)
Coal	2,050	1,325	725 (short)	$10	$3.6 (cost)
Gas CC	875	1,325	450 (long)	$10	$2.3 **(revenue)**
Non-emitting	0	1,325	1,325 (long)	$10	$6.6 **(revenue)**

Conclusions

Regardless of the form (or forms) that EPA's standards take, they will have impacts on the power sector. Many coal unit compliance decisions, including retirement, already have been made, and are continuing to be made, in the face of a 2015/2016 compliance deadline for EPA's Mercury and Air Toxics Standards. These decisions also are occurring in combination with expected final rules from EPA governing coal ash handling, effluent guidelines, and water intake structures. A new lower gas price regime, relatively low energy demand growth, and the Supreme Court's recent decision to review the Cross-States Air

Pollution Rule decision[5] only further complicate the uncertainty facing coal units and the sector as a whole. New CO_2 standards, even if they are not likely to take effect for several years, will become part of the equation of those compliance decisions today. They may result in incremental unit retirements beyond those already planned. Those retirements, along with expectations of power price impacts, will influence reliability considerations and decision making. They also will shape investments in new capacity and the need for transmission upgrades or additions.

EPA will conclude the rulemaking process for NSPS for new electric generating units in the coming months. Stakeholders will begin discussions in earnest over the potential look and feel of performance standards for existing units. Opportunities to shape the discussions and understand the implications of an EPA ruling under Section 111(d) are apparent. In particular, compliance costs will vary drastically based on the form of the standards. If a state plan resembles NRDC's proposal, a range of factors will determine the ultimate compliance costs and the resulting financial positions of the companies impacted. These factors include the rates set for fossil resources and the crediting mechanisms for renewable energy, energy efficiency, and potentially even new nuclear generation. State leaders and agencies also will serve an important role in this process, because the exact design of the performance standard could change depending on what flexibility EPA grants states in shaping implementation plans. Stakeholders must sift through these uncertainties and analyze the potential impacts on their assets in the near future.

ICF continues to be at the forefront of working with our clients to help them understand and evaluate the potential regulatory options and the impact on generation assets and on the power and fuel markets.

To discuss this further, please contact Steve Fine at Steve.Fine@icfi.com or +1.703.934.3302.

[5] EPA. Cross-State Air Pollution Rule (CSAPR). Retrieved July 26, 2013, from http://www.epa.gov/crossstaterule/.

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About ICF International

Since 1969, ICF International (NASDAQ:ICFI) has been serving government at all levels, major corporations, and multilateral institutions. With more than 60 offices and more than 4,500 employees worldwide, we bring deep domain expertise, problem-solving capabilities, and a results-driven approach to deliver strategic value across the lifecycle of client programs.

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An expert on environmental markets, Steve Fine has led numerous multistakeholder engagements, including the Edison Electric Institute, U.S. Climate Action Partnership, Regional Greenhouse Gas Initiative (RGGI), and Clean Energy Group. His work has concentrated on evaluating the economics of conventional and renewable energy resources within the context of developing environmental regulations.

Mr. Fine was an invited panelist to a U.S. Senate Roundtable discussion on the future of 3P and 4P legislation conducted by Senators Carper and Alexander. He has a B.A. from the University of California, Santa Cruz, and an M.A. in Economics from the Johns Hopkins School of Advanced International Studies.

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Chris MacCracken has more than 15 years of experience in energy and economic modeling and assessing the potential impacts of environmental policies on the energy sector. He has directed a number of studies examining the impacts of environmental regulation on emission, power and fuel markets, compliance planning, and electric generating unit valuations for electric utilities, independent power producers (IPPs), industry associations, and nonprofit policy organizations. He is lead author of the Emission Markets chapter in ICF International's quarterly Integrated Energy Outlook publication.

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