

# AQTAC IPM Power Sector Modeling- Questions & Answers

## 1. IPM Model/Assumptions

### Model Capabilities

**Q: In the description of the IPM power model (slide 9), there is no mention of its accuracy ( e.g., +/- X%). Has it been retroactively applied to previous years with the results compared with actuals today? (Joe Duckett)**

Accuracy of the model is a challenging question because there are so many underlying assumptions – it comes down to how effective EIA is at projecting gas prices, the Independent System Operators (e.g. PJM) are at projecting load, and the accuracy of the other assumptions and inputs. If ICF plugs into IPM everything that actually occurred in a past year (unplanned nuclear outages, weather, etc.), would IPM give a reasonable prediction for that year? ICF does not do that type of testing across broad regions, but they often look at calibration of the model in small market areas when teams are working on specific assets. The New York State Energy Research and Development Authority (NYSERDA) completed a 2010 white paper entitled Relative Effects of Various Factors on RGGI Electricity Sector CO2 Emissions. Included in this analysis was a comparison of the modeled electricity requirements for 2005-2009 in their PM based RGGI modeling against actual electricity requirements for the period 2005- 2009. According to this analysis (see Table 5), the difference in predicted vs actual (weather normalized) electricity requirements was only 1.33% in 2005 increasing to 1.50% for the 2009 predictions.

**Q: Per Joe Duckett’s comments, what are the error bars / uncertainties associated with these projections (slide 32)? It is certainly conceivable that inclusion of those uncertainty estimates would confirm that there is no statistically significant decrease in CO2 emissions within PJM between the reference and policy cases. (John Shimshock)**

In reference to Slide #32, *Change in Fossil Generation in PA and Non-PA PJM, Policy Minus Reference Case*- we have included these slides to inform the conversation around the potential for both generation and emissions related leakage. The 12 TWh net difference in generation in 2022 is significant and does not result from model variability or uncertainty. The reductions of overall emissions in PJM is not a driver or justification for Pennsylvania’s participation in RGGI, though these net reductions across the RTO would provide regional benefits. See also the response to Joe Duckett’s question above.

**Q: What are the predictive capabilities of the model? Has anyone looked at how well it has predicted CO2 emissions in the states that joined RGGI initially? (Michelle Homan)**

A state-by-state analysis of predicted vs. actual has not been completed. Though modeling results are more tied to the input assumptions rather than the accuracy of the model. See also the responses to Joe Duckett and John Shimshock above.

**Q: Has a statistical analysis been conducted on the modeling results to evaluate the trend lines for CO2 emissions pre- and post-RGGI implementation? This goes back to the statement that “Significant emissions reductions realized over the decade.” Does that mean significant from a statistical perspective? (Michelle Homan)**

A: The comment was in reference to the value of the emissions reductions, not a reference to the statistical significance of the results. Modeling estimates that the participation of Pennsylvania in the RGGI program would result in a net emission reduction of 180 million tons of CO2 emissions in PA for the period between 2020 and 2030. This is essentially about 20% additional reductions from the emissions during the same period with the business as usual scenario. Furthermore, as co-benefits there will be net reduction of about 110,000 of NOx emission and 62,200 tons of SO2

emissions in PA during the same period. Therefore, the emission reductions estimated as a result of RGGI participation over 10 years is sizeable.

## Assumptions & Sensitivities

**Q: Has a sensitivity analysis been performed on the model inputs? What are the parameters contributing most to the model results? Which parameters have the most uncertainty built around the estimates? (Michelle Homan)**

A: There are many parameters and inputs that enter into the dynamic IPM model, all of which impact the resulting data. In partnership with ICF, the Department identified the Natural Gas commodity price as a primary factor impacting the modeling results. Therefore, the Department conducted a sensitivity analysis of the natural gas price for the Reference Case. The analysis resulted in slight differences in emissions, generation mix, etc., however, results followed the same trajectory differing only in terms of the timing of impacts. In consultation with ICF, the Department decided the most appropriate natural gas pricing assumption was a hybrid of the AEO 2020 High Resource and AEO Reference values.

**Q: Much of the economic analysis that DEP is relying on is tied to the ICF's IPM Model. The model has been described by EPA as "... a dynamic linear programming model that generates optimal decisions under the assumption of perfect foresight".**

**Further, IPM represents power markets through model regions that are geographical entities with distinct characteristics. Reportedly, the model regions are generally representing the U.S. power market being largely consistent with the North American Electric Reliability Council (NERC) assessment regions and with the organizational structures of the Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs).**

**Was the IPM modeling assumptions/considerations based on the existing transmission system in Pennsylvania including constraints within the transmission network of bulk transfer limitations on inter-regional power flows both internal and external to Pennsylvania? (Gary Merrit)**

A: ICF's IPM Model incorporates all known information regarding existing generation, transmission, and distribution capabilities in Pennsylvania and surrounding regions and then the model builds necessary distribution and transmission infrastructure to add transmission constraints or additional need based on new capacity additions. All major modeling assumptions can be found in the Assumptions tabs of the results.

**Q: The information in the model was tied to generation. What are the future projections for demand? Pre-and Post – Coronavirus? The market has been stagnant for quite some time. Will the demand be lower than the demand prior to Coronavirus? At today's level? Or do you see growth in demand? If so, what sectors and when? (Gary Merrit)**

A: The model uses the demand projections made by the PJM Interconnection and included in their load demand forecasts. However, there are certainly power sector impacts of COVID-19 which in terms of electricity generation impacts are represented by decreases in demand as some facilities are not running or only running certain shifts. PJM is monitoring this as are other information reporting agencies. According to PJM, an average weekday decrease thus far is about 7 percent. It is too early to predict the long-term impact on the energy demand. If necessary, DEP may update the demand projections in the model post-2020 to determine the impacts on the modeling results and adjust accordingly.

## 2. Emissions

### Emissions Projections

**Q: From the graph (slide 20), it appears that the trajectory of CO2 reductions from 2010 -2018 would take us to or below the "Policy" emission level in 2030 and definitely below the "Reference" level. Most of this reduction, as**

**pointed out in the meeting, is due to replacement of coal-based power with gas-based power. Please explain why your model doesn't expect this to continue, even without RGGI. (Joe Duckett)**

A: The Reference Case results project Pennsylvania's power sector emissions, showing that emissions do decrease out to 2030, at a slower pace and ultimately result in less cumulative emissions. There are many factors that influence the emissions from the power sector, which is why the dynamic IPM model is used. However, major trends in the sector support the Reference Case results. Primarily, the number of coal plants remaining in Pennsylvania is decreasing and they are operating less often, therefore limiting the amount of future emissions reductions to be achieved through fuel switching from coal to natural gas. This major trend has accounted for much of the emissions decrease from this sector from 2010-2018, but it is not expected to continue.

Additionally, as outlined in the related data files, Pennsylvania has added 1.5 GW of fossil generation in the last 18-months and there is another 3.1 GW of firm fossil capacity coming online between now and 2022.

**Q: The graph shows an increase in gas-related CO2 for 2018-2022 (slide 22) but then an almost constant level of gas-related CO2 emissions from 2022-2030, under both the Reference and Policy assumptions. The net drop in CO2 is essentially all from coal replacement/retirement. Is this correct? (Joe Duckett)**

A: Pennsylvania's natural- gas related emissions increase between 2018 and 2022 in the reference case as a result of the additional fossil generation coming online in Pennsylvania, all of which is natural gas generation whether internal combustion engine or combined cycle natural gas facilities. Starting in 2022, the CO2 emissions reductions can be attributed to a decrease in coal generation (orange portion of the bar)- and decreased emissions from some of the older, less efficient natural gas units. Though coal retirements are a significant contributor to the decrease in emissions over the 2022-2030-time horizon, there are incremental decreases in natural gas related emissions as well.

**Q: The PJM graph (slide 32) suggests that the Reference and Policy emission plots almost converge by 2030. If so, doesn't this call into question the rationale for RGGI? (Joe Duckett)**

A: This question was also raised and discussed during the presentation- and the short answer is no. Though the emissions plots almost converge by 2030, the path to arrive at those emissions are significantly different in the two cases. The policy case – with Pennsylvania participation in RGGI, results in emissions reductions over the decade of 180 million tons of CO2- which is 10 times more CO2 reductions than Pennsylvania would achieve with business-as-usual. We are going to display this slide differently in the upcoming presentation better highlight the differences in these cases in terms of emissions reductions.

**Q: As discussed during the call, the reductions from PA will be at least partially offset by increases in the other PJM states (slide 33). The PJM net annual reduction by 2030 is shown as approximately 4 million metric tons of CO2. This would amount to less than 0.1% (0.07% by my calculation) of total USA CO2 emissions. Isn't this a small reduction to justify adoption of the RGGI program? (Joe Duckett)**

A: While a portion of the emissions reductions in Pennsylvania would shift (or leak) to non-RGGI participating PJM states, this amount of leakage remains minimal. Despite the leakage, the participation of Pennsylvania in the RGGI program would result in a net emission reduction of 86.9 million tons of CO2 emissions in PJM for the period between 2020 and 2030. Furthermore, as co-benefits there will be net reduction of about 110,000 tons of NOx emission and 62,200 tons of SO2 emissions in PA during the same period. While PA's participation in RGGI does have a positive impact across the region, our major focus is on the positive benefits that accrue first to Pennsylvania as a result of the program- which are significant.

Furthermore, the RGGI states combined, including Pennsylvania and Virginia, will be the third largest economy in the world based on GDP. Pennsylvania's emissions reductions are significant locally, and regionally, as the entire RGGI regions reductions will have reach and impact beyond the northeast.

***Q: An analysis of the inventory of carbon emissions from smaller generators not currently envisioned as subject to this program, and an analysis that puts emission reductions foregone from such sources into perspective with respect to other components of the program. (Kevin Stewart)***

A: DEP staff conducted an analysis of power sector emissions and those that would be covered by the proposed regulation and determined that 97-98% of PA's power sector units would be RGGI affected sources. Thus, they would be covered under the proposed regulation and be subject to PA's declining allowance budget and be required to purchase allowances to offset emissions. A full list of generators and their anticipated status regarding RGGI compliance can be found in the Reference Case data file- 'Assumptions PA Units' tab.

## Climate Change

***Q: As a follow-up to the item above, climate experts note that the residence time for CO2 in the atmosphere is generally 5 to 50 years. Recognizing that global wind circulation time scales are on the order of hours to a few weeks, CO2 emitted in PA or any other specific locale will be well-mixed in the global atmosphere and will remain in the atmosphere for years. Consequently, why is the Department inexplicably focused on in-state / parochial changes in CO2 emissions, especially if the emissions are simply displaced outside of state borders, which are completely arbitrary from a climate change perspective?***

***This point is supported by the knowledge that long-term CO2 monitoring sites are located at a few select sites only as administered by the National Atmospheric and Oceanic Administration. These sites are located in Barrow, Alaska; Mauna Loa, Hawaii; American Samoa; and South Pole, Antarctica.***

***Additional monitoring sites are located in throughout the country in support of various carbon cycling investigative studies (link: <https://www.esrl.noaa.gov/gmd/ccgg/insitu/>). (John Shimshock)***

A: Participation in the Regional Greenhouse Gas Initiative, will reduce CO2 emissions over the next decade and is instrumental in meeting Pennsylvania's Greenhouse Gas reduction goals, which are designed to avoid the worst impacts of climate change.

***Q: Governor Wolf's Executive Order No. 2019-01 includes the following, which is also captured in the Department's "Pennsylvania Climate Action Plan:"***

***Climate Goal for the Commonwealth of Pennsylvania. The Commonwealth shall strive to achieve a 26 percent reduction of net greenhouse gas emissions statewide by 2025 from 2005 levels, and an 80 percent reduction of net greenhouse gas emissions by 2050 from 2005 levels. Based on the best available emissions inventory data, the Department notes that "electricity production, transportation and industrial make up approximately 84% of all PA GHG emissions." Because the percentage contributions from each of these 3 sectors are similar to one another, we believe that it would be inappropriate and discriminatory for the Department to expect CO2 reductions from a particular sector that is not in accordance with the reductions specified by the above-mentioned goals. Importantly, the climate goal specified in the Executive Order does not provide or authorize the Department to establish interim goals, i.e., goals between the years 2025 and 2050.***

***For the EGU sector, 2005 CO2 emissions = 132 MM short tons. For the EGU sector, the 2025 climate goal is 98 MM short tons, which has already been achieved (please refer to Slide 20 of the subject presentation), and the 2050 goal is***

**26 MM short tons. The use of a glide path approach for gauging progress on obtaining the CO2 emissions goal in 2050 (30 years from now) should be used to formulate CO2 emission reduction strategies. A glide path approach is used by EPA in their Regional Haze Rule Program which establishes a long-term (2064) visibility goal in Class I areas.**

**In its proposed rule, the Department established the 2030 CO2 budget = 58 MM short tons. This value is the 2039 budget if the glide path approach was used. Please explain why the Department has elected to (i) accelerate the budget reductions or (ii) require additional CO2 emission reductions from the EGU sector that are greater than the percentages specified in the climate goal. (John Shimshock)**

A: DEP's Greenhouse Gas Inventory Tool tracks emissions reductions over time. The year 2005 is used as a reference point for emissions reductions in order to maintain consistency with U.S. Climate Alliance goals, and goals set forth in the Paris Climate Agreement. As of 2016, Pennsylvania had achieved a nearly 19 percent reduction in GHG emissions, compared to 2005. (289.43 million metric tons of carbon dioxide equivalent (MMTCO2e) in 2005 vs 235.05 MMTCO2e in 2016).

Executive Order 2019-01, signed by Governor Wolf on January 8, 2019, sets economy wide GHG emissions reduction goals at 26 percent by 2025 from 2005 levels and 80 percent by 2050 from 2005 levels. A further reduction of 20.87 MMTCO2e from 2016 would be required to reach the 2025 goal of 214.17 MMTCO2e.

A predicted reduction of 13.6 million metric tons by 2025 via participation in RGGI provides significant assurance that along with prudent investments of RGGI revenue and other Greenhouse Gas abatement activities, PA will remain on track to reach the 2025 goal.

Additionally, the Department has established a 2022 CO2 allowance budget of 78 million tons of CO2 and matching the stringency of the existing RGGI program begins a decline in that allowance budget to 58 million short tons in 2030. Pennsylvania is not accelerating the emissions reductions, rather are prescribing to the same emissions reduction trajectory being implemented by the other RGGI participating states.

## Emissions Reductions

**Q: To what extent has ICF (and the Department for its own analysis) taken into account full life-cycle CO2e emissions associated with respective sources? For example, do natural gas combustion emission factors include the global-warming contributions of extraction activities and methane emissions from well operations, processing, transmission, storage, and the post-extraction period? If not, please include them and discuss. (Kevin Stewart)**

A: The CO2 Budget Trading Program is only applicable to covered electric generating units emitting CO2. The ICF analysis is limited to these covered electricity producing units- and therefore an analysis of full life-cycle CO2e emissions is outside of the scope of the program and has not been included in the related analyses.

**Q: PA CO2 emissions from power plants decreased significantly from 2005 to present (over 30%) because of the voluntary switch from coal to natural gas, without participation in RGGI. PADEP is anticipating another 25% reduction in CO2 through 2030 by participation in RGGI. However, on Slide 30 (PJM CO2 Emissions), the emission reductions from PJM are not that significant. Could CO2 reduction in PA be done without participation in RGGI? (Kimberly Coy)**

A: Emissions did decrease in Pennsylvania from 2005 to roughly 2018 - though with the addition of 1.5 GW of fossil generation in the last 18-months and another 3.1 GW of fossil capacity coming online between now and 2022- emissions has or will increase emissions between 2018 and 2022.

While a portion of the emissions reductions in Pennsylvania would shift (or leak) to non-RGGI participating PJM states, there is still modeled to be a net decrease in emissions for the PJM Interconnection states. Furthermore, while PA's

participation in RGGI does have a positive net impact across the region, our major focus is on the positive benefits that accrue first to Pennsylvania as a result of the program. As is indicated in the Reference Case, there would be some emissions reductions without RGGI participation; however, we accomplish 10 times those reductions with RGGI participation. Additionally, doing nothing at this point and relying solely on generation shifts due to current market forces, is inefficient in that current market does not properly price carbon emissions and would result in Pennsylvania missing the 2025 GHG reduction goals further risking adverse climate impacts.

***Q: An analysis of the economics and carbon emissions resulting from the waste-coal component of the Department's plan, and the true future magnitude of those emissions in the context of the true net reductions of the comprehensive proposal. I did not see that the ICF analysis did anything to break this contribution out from the remaining energy sources using coal. What is the Department's response with respect to managing carbon emissions from waste coal? (Kevin Stewart)***

A: Emissions from the waste coal generation sector are included under the general heading of coal in the modeling results- both for the reference and the policy cases. The 9.3-million-ton set-aside is part of and not in addition to the PA starting allowance budget of 78 million tons of CO<sub>2</sub> in 2022. As a result of this 9.3 million set-aside, waste coal-fired units may emit up to that sector-wide amount without requiring the purchase of any additional allowances. If the 9.3 million sector-wide allocation is exceeded in any compliance year, waste coal-fired units will be required to purchase the additional allowances needed to satisfy their compliance obligation. This set aside is not intended to increase or decrease CO<sub>2</sub> emissions from waste coal-fired units. The goal is simply to assist these units, which provide an environmental benefit of reducing waste coal piles, with their compliance obligation under the regulation. Waste coal piles are combustible and when left to burn they emit CO<sub>2</sub> emissions and other pollutants that harm local air quality, in addition to leaching toxins into ground water and nearby streams. It is important to note that the total amount of CO<sub>2</sub> emissions each waste coal-fired unit may emit will remain regulated by each facility's Title V permit.

***Q: In terms of USA national emissions (ref slide 33 comment)? Or global temperature – was this effect included in your model? Or even meeting PA's GHG reduction goals (ref slide 20 comment). (Joe Duckett)***

A: The goals as outlined in the PA Climate Action Plan is to reduce warming to 2 degrees. Contributions to emission reductions in PA and regionally are a portion of the solution. As the 4th leading carbon dioxide emitter in the country we have a responsibility to act to reduce emissions- and our reductions 180 million tons over 10 years are significant and an important part of meeting the commonwealth's greenhouse gas reduction goals as established by Governor Wolf last year- 26% by 2025 and 80% by 2050 (compared to 2005 levels). A further reduction of 20.87 MMTCO<sub>2</sub>e from 2016 would be required to reach the 2025 goal of 214.17 MMTCO<sub>2</sub>e

A predicted reduction of 13.6 million metric tons by 2025 via participation in RGGI provides significant assurance that along with prudent investments of RGGI revenue and other Greenhouse Gas abatement activities, PA will remain on track to reach the 2025 goal. Furthermore, combined with the other RGGI participating states - by 2022 based on GDP, RGGI would be the third largest economy in the world- significant when viewed from this collective impact.

### 3. Co-benefits

***Q: The first bullet says that RGGI will result in "significant" emission reductions (slide 37). How is "significant being defined? Has someone quantified the co-benefits resulting from RGGI? (Joe Duckett)***

A: The significant emissions reductions is referring to the reduction of 180 million short tons of CO<sub>2</sub> by 2030 that would occur as a result of PA's participation in the Regional Greenhouse Gas Initiative. While the regulation targets CO<sub>2</sub> emissions reductions from the power sector, there are additional co-benefits realized in terms of NO<sub>x</sub> and SO<sub>2</sub>

reductions as well. The modeling estimates that there will be net reduction of about 110,000 tons of NOx emissions and 62,200 tons of SO2 emissions in PA during 10-year period.

**Q: The Department contends that “Environmental Benefits Accrue in the near-term” (slide 37) via participation in RGGI but acknowledged that such benefits are attributable to expected reductions in criteria pollutants such as NOx and PM2.5, not CO2. Has the Department quantified the net emissions reduction (i.e., those occurring in the PJM region)?**

**If so, then please identify the locations of the emissions reductions and relate those values to changes in ambient air quality. Importantly, though, the Department need to be informed that as part of its recent review of the MATS Rule, U.S. EPA noted that accounting for environmental benefits solely attributable from reductions in criteria pollutants not targeted by a subject rule is “particularly inappropriate.” Please see the following citation which was included in a recent EPA ruling concerning the MATS Rule: “The EPA believes that relying almost exclusively on benefits accredited to reductions in pollutants not targeted by CAA section 112 (JPS – this citation is pertinent to hazardous air pollutants, HAPs) is particularly inappropriate given that those other pollutants are already comprehensively regulated under other CAA provisions, such as those applying to the NAAQS. As the EPA outlined in the 2019 Proposal, the determination that it is not appropriate to give equal weight to non-HAP co-benefits in making the appropriate and necessary determination is further supported by the fact that Congress established a rigorous system for setting standards of acceptable levels of criteria air pollutants and provided a comprehensive framework directing the implementation of those standards in order to address the health and environmental impacts associated with those pollutants. See, e.g., 42 U.S.C. 7409; 7410; 7501; 7502; 7505a; 7506; 7506a; 7507; 7509; 7509a; 7511; 7511a; 7511b; 7511c; 7511d; 7511e; 7511f; 7512; 7512a; 7513; 7513a; 7513b; 7514; and 7515.” (John Shimshock)**

A: The statement regarding environmental benefits accruing in the near term is referring solely to the drop in CO2 emissions that is expected beginning in the first year of Pennsylvania participation in RGGI and continuing. These CO2 emissions reductions are the sole focus of the regulation; however, there are other co-benefits of NOx and SO2 reductions that occur in tandem with these CO2 reductions.

Yes, slide #31 of DEP’s presentation addresses the net reductions in CO2 emissions across PJM- the underlying data for which is included in the policy case data file available online.

**Q: Overall, the modeling results do not seem to show a large CO2 reduction nor increase in percentage of renewables. While there are other benefits not addressed by the model (lower PM, NOx, SO2, etc. emissions) does the implementation of RGGI actually make an impact that has realized benefits? This is difficult to tell without further understanding of the modeling uncertainties. (Michelle Homan)**

A: The policy case – with Pennsylvania participation in RGGI, results in emissions reductions over the decade of 180 million tons of CO2- which is 10 times more CO2 reductions than Pennsylvania would achieve with business-as-usual.

In terms of renewables, the build out of distributed solar (rooftop, etc.) is occurring and increasing, though it is not represented in the model as the model is only reflecting utility or large-scale solar development that is happening in front of the meter. You are correct participation in RGGI alone is not driving increased development of grid scale renewable generation. However, the reinvestment of the RGGI auction proceeds does have the capability to increase future penetration of renewables in Pennsylvania. We plan to discuss this more at this week’s AQTAC meeting. Additionally, this is where there are opportunities for complementary policies, such as an increased Alternative Energy Portfolio Standard goals to complement Pennsylvania’s participation in RGGI and drive further renewable development.

## 4. Leakage

### Electricity Leakage

***Q: Shouldn't WV and OH be included on your pricing slide to indicate whether power importation from these states might occur in western PA (slide 36)? I know these states are not in PJM but has importation been considered in your model? (Joe Duckett)***

A: The pricing slides- and raw data regarding pricing is a comparison of the existing and future RGGI participating states which is why WV and OH are excluded from that specific chart. West Virginia and Ohio are PJM states, and the flow of electricity within RGGI, PJM and outside of PJM have been considered in the model. Additional information on specific exports and imports can be found in the data files in the 'Transmission' tab. This portion of the data specifically outlines the flows of electricity into and out of Pennsylvania categorized by PJM- RGGI, Non-PJM RGGI (e.g. OH and WV), and Non-PJM states.

In the reference case, 2020 PA imports from PJM Non-RGGI states are estimated at 12 TWh decreasing to 5 TWh annually by 2030. Comparatively imports to PA from PJM Non-RGGI states in the policy case are estimated to be roughly 1 TWh less each year- arriving at the same value of 5 TWh in 2030. Indicating that imports into Pennsylvania from the non-RGGI participating PJM states decreases as a result of PA participation in RGGI.

***Q: One issue that I don't believe was addressed was the issue of "leakage." If PA joins RGGI – it is predicted that leakage in other RGGI states will decrease. The presentation just dealt with PA but I'm curious if the model has been used to look at all RGGI states together and how PA's addition to RGGI might impact regional CO2 emissions/electricity generation mix, etc. (Michelle Homan)***

A: Historically, the RGGI program has experienced some leakage. Despite the leakage, the participation of Pennsylvania in RGGI would result in a net emission reduction of 86.9 million tons of CO2 emissions in PJM for the period between 2020 and 2030.

Regarding how PA's participation affects the emissions from all RGGI states together, the cumulative CO2 emissions for the period between 2020 and 2030 from 12 states (including PA) are predicted to reduce from 2,009 million tons to 1,843 million tons, thus realizing a 166-million-ton reduction. See slides #31 and #32 related to changes in power sector generation and CO2 emissions in Pennsylvania as compared to PJM.

***Q: Did the model address leakage relative to the Coal Fired Units in Western Pennsylvania shutting down and new or existing units in adjacent states replacing this power? The economic analysis anticipates that many of the coal fired plants will not be competitive with the RGGI cost adder to their power generation! One can see opportunity for the adjacent non RGGI states (specifically West Virginia and Ohio) that have the potential to install generation to replace the PA Generation as a lower price option using gas. Please explain if this was done or not. If so, what assumptions were used? (Gary Merrit)***

A: The IPM model does address leakage- and the related shift in emissions and generation from Pennsylvania to other PJM states can be viewed in the presentation on slides #31 and #32 respectively. Additionally, Pennsylvania's total generation is not eroded as a result of RGGI participation- and the price differential is not so great that plants are closing in PA only to reopen in surrounding states. There is some future fossil generation that instead of being built in Pennsylvania may be built in surrounding states as a result of those states not having a price on carbon. Pennsylvania's location in the heart of the Marcellus gives us a competitive advantage regarding natural gas prices, and in terms of location from where the electricity is generated to where it is ultimately consumed. Even with the price adder of the RGGI allowance price, natural gas generation in Pennsylvania continues to be extremely competitive.

**Q: Further, the power demands by the coal industry will continue to decrease as production decreases for the mining operations (especially underground operations), coal processing plants, and on associated support industry. Slow down in industrial, commercial, and institutional sectors will reduce demand. As demand is reduced, actual generation is reduced. With that, short and or long-term leakage from adjacent states is a possibility! This would impact Pennsylvania being net exporter of power in the future. (Gary Merrit)**

A: In terms of the IPM power sector modeling that DEP has conducted with ICF, we did not examine the impacts specifically on the coal industry- as this is outside of the scope of the IPM model. However, as result of these shifts (leakage) in fossil generation from PA to other PJM states, so to will shift the demand for coal.

Further the modeling indicates that in the future PA will easily continue to be a net energy exporter and continue to be a leader in electricity exports. Historically, Pennsylvania has exported 30% of electricity generation, and comparatively exports remain within 2 TWh of historic export levels.

## Emissions Leakage

**Q: Is PADEP planning an analysis on if/how emissions leakage will be avoided? If power generation shifts from PA to neighboring non-RGGI states like OH or WV, regional CO2 emissions will most likely increase, defeating the whole purpose of RGGI and potentially harming PA's economy. (Kimberly Coy)**

A: Yes, we are examining opportunities to address potential leakage- including further exploring this issue through participation in PJM's Carbon Pricing Senior Task Force. Modeling indicates that though there is some leakage, overall there are net emissions benefits across PJM. Modeling conducted by PJM as part of the Carbon Pricing Senior Task Force analysis further bolster the results that PA's participation in RGGI does result in a net emissions reduction across PJM.

**Q: An analysis, starting from what is already known (including, for example, information displayed by John Shimshock from EIA tracking), of the economics and modeling of market behavior around the leakage question, taking into account the kinds of power generation capacity (accessible for consumption by Pennsylvanians) from sources that are outside of meaningful boundaries—including those of the Commonwealth, the RGGI states, and PJM, as appropriate for the evaluation of leakage. The analysis should also be able to demonstrate that real total carbon reductions will be achieved, and that the sources of carbon emissions will not be significantly translocated beyond Pennsylvania's borders. (Kevin Stewart)**

A: The IPM model does address leakage- and that shift in emissions and generation from Pennsylvania to other PJM states can be viewed in the presentation on slides #31 and #32 respectively. Though there is a shift in generation and emissions from PA to other PJM states, this increase does not exceed PA's reductions and still results in net emission reductions in the PJM footprint. Further information about electricity flows within the states and regions can be found in the 'Transmission' tab of the posted spreadsheets.

## 5. Change in electricity generation mix

**Q: This suggests virtually no change ( up or down) in generation from renewables, gas or nuclear through 2030 (slide 24). I thought one of the drivers for RGGI was to increase adoption of renewable energy. I know this subject was address briefly during our April 23 call but the answer sounded like, absent further financial incentives, the RGGI allowance pricing alone will not be sufficient to promote more renewables. (Joe Duckett)**

A: In terms of renewables, the build out of distributed solar (e.g. rooftop) is occurring and increasing, though it is not represented in the model as the model is only reflecting the utility or large-scale solar development that is happening in front of the meter. You are correct that participation in RGGI alone will not drive increased development of grid scale renewable generation. However, the reinvestment of the RGGI auction proceeds does have the capability to increase

renewable generation. Additionally, this is where there are opportunities for complementary policies, such as an increased AEPS to complement Pennsylvania's participation in RGGI and drive further renewable development.

***Q: The constant role of nuclear power was a little puzzling. I couldn't find it in the slides but I thought one of the assumptions shown was that nuclear plants would have an 80 year life. Are you assuming that all current nuclear power plants will continue in operation through 2030 and/or that some new nuclear capacity will be built to replace aging nukes? (Joe Duckett)***

A: In the first tab 'Assumptions Overview' of the posted data spreadsheets, nuclear lifetime is assumed at 80 years or as planned by owners. In the policy case 'Capacity Additions' tab, the last portion of the Pennsylvania specific chart shows a retirement of 805 MW of nuclear capacity in the 2020 column- which represents the closure of Three Mile Island. The policy case shows no further reductions or additions to nuclear capacity between 2020 and 2030.

***Q: It appeared that the ICF analysis concluded that no real progress would be made with respect to true-renewables when comparing the policy case against the reference case. Specifically, for Pennsylvania, net generated energy from renewable sources in 2030 for both cases is virtually indistinguishable from 11500 GWh, and even in the policy case, remains at only at 5.5% of the state total. And with a rate of increase of less than 1% of renewables per year (with a rate of increase averaging at about 0.05% of total generation per year), the model shows the Commonwealth as failing to attain the carbon reductions necessary to do its share toward its global contribution. Therefore, two items:***

- ***How does the Department respond to the absence of progress in this respect?***
- ***Remaining to be seen would be an analysis of the economics and carbon reductions that could be achieved by a robust set-aside for true-renewable (not biomass) sources. (Kevin Stewart)***

A: In terms of renewables, the build out of distributed solar (e.g. rooftop) is occurring and increasing, though it is not represented in the model as the model is only reflecting the utility or large-scale solar development that is happening in front of the meter. You are correct that participation in RGGI alone will not drive increased development of grid scale renewable generation. However, the reinvestment of the RGGI auction proceeds does have the capability to increase renewable generation. Additionally, this is where there are opportunities for complementary policies, such as increased AEPS targets to complement Pennsylvania's participation in RGGI and drive further renewable development.

We are finalizing that analysis now- modifying the power sector inputs to reflect the benefits of PA reinvesting RGGI revenue in Energy Efficiency, Renewable Energy, and Greenhouse gas reductions etc.

There are significant benefits to be had from additional renewable energy buildout- there is less pressure on the overall emissions cap as renewable energy has a significant role in air pollution reduction. Also, DEP has added a Strategic Energy use set-aside to the regulation for qualifying renewable and EE projects.

***Q: An analysis of the economics over time and the carbon reductions gained through a process by which allowances will be retired rather than be permitted to support continuation of carbon-emitting generation—the concept being that timely retirement of allowances no longer truly needed would maintain the favorable climate for encouraging further development of true renewable generation within the Commonwealth. (I defer to Mr. Altenburg to handle this matter, if I have not quite captured the issue.) (Kevin Stewart)***

A: The updated Draft Annex now includes the addition of a Strategic Use set-aside, a use for which could be to retire allowances on behalf of qualifying renewable and other Greenhouse Gas reduction projects. Other states have also sold remaining set-aside allowances into the quarterly auction as recently as this past auction and done so in a strategic manner that does not erode the value of the allowances or disrupt the market.

***Q: Perhaps this was addressed in the presentation, but the percentage of electricity generation from renewables does not seem to change much as a result of participation in RGGI (slides 24 & 25). Isn't the program intended to increase the use of renewables? (Michelle Homan)***

A: DEP's Draft Proposed Rulemaking establishes a CO2 Budget Trading Program for Pennsylvania which creates a cap-and-invest program to reduce CO2 emissions from the power sector- certainly renewables are part of the movement toward reducing CO2 emissions from the power sector, as is the transition from coal to less carbon intensive natural gas.

In terms of renewables, the build out of distributed solar (e.g. rooftop) is occurring and increasing, though not represented in the model as the model is only reflecting the utility or large-scale solar development that is happening in front of the meter. You are correct that participation in RGGI alone is not driving increased development of grid scale renewable generation. However, the reinvestment of the RGGI auction proceeds does have the capability to increase renewable generation. Additionally, this is where there are opportunities for complementary policies, such as increased Alternative Energy Portfolio Standard targets to complement Pennsylvania's participation in RGGI and drive further grid-scale renewable development.

***Q: PADEP is forecasting a negligible increase in the quantity of renewables to aid in meeting the RGGI goals – it appears that the retirement of coal units is the main focus for CO2 reduction. Additionally, there are currently no feasible controls to mitigate CO2 emissions from combustion. The only available options to reduce CO2 are fuel switching, energy efficiency, renewables, reduced utilization. Does PADEP plan to conduct studies on the feasibility of using renewables to replace fossil fuel units in PA to see if this is a viable option? (Kimberly Coy)***

A: The build out of distributed solar (e.g. rooftop) is occurring and increasing, though not represented in the model as the model is only reflecting the utility or large-scale solar development that is happening in front of the meter. You are correct that participation in RGGI alone is not driving increased development of grid scale renewable generation. However, the reinvestment of the RGGI auction proceeds does have the capability to incentivize and increase renewable generation.

## 6. DEP Process/other programs

***Q: This model did not present a compelling case for adopting RGGI. I'm not involved in the power industry at all but the bottom line on RGGI seems to be that its primary objective is to further reduce coal-fired power production. If that is the purpose, why not just ban coal-fired power as Ontario has done. I got the impression during the presentation that PA is already committed to joining RGGI; is this the case or is it still an open question? (Joe Duckett)***

A: As mentioned in a few responses to previous questions; we believe the modeling to be very compelling- as it further bolsters and quantifies the benefits of PA's participation in the RGGI. The primary objective of Pennsylvania's CO2 budget trading program is to create a cap-and-invest program for CO2 emissions from the power sector. This prices carbon, which is an externality that is currently not priced into the market- and allows the market forces to decide the rest. There is no desire to eliminate coal-fired power in Pennsylvania.

Governor Wolf has directed the Department through Executive Order 2019-7, "Commonwealth Leadership in Addressing Climate Change Through Electric Sector Emissions Reductions" to develop a draft regulation to establish a CO2 Budget Trading Program for Pennsylvania. The Department is moving forward with that direction having identified proposed participation in the Regional Greenhouse Gas Initiative as meeting the direction given to the Department. Though Pennsylvania is working toward participation in the Regional Greenhouse Gas Initiative – decisions remain regarding the regulations, program implementation and revenue reinvestment options. It is collaboration with the Advisory

Committees and public comment that will assist DEP in making these decisions- and ultimately implement a program that benefits all Pennsylvanians.

**Q: Title V Emission Fees – Should PADEP adopt emission fees for CO2 and GHGs, will electricity generation be exempt since they will be paying significant amounts through RGGI? (Kimberly Coy)**

A: The Department determined not to include a Title V emission fee for GHGs including CO2 in its draft final-form rulemaking for Air Quality Fees. Any future rulemakings would involve an evaluation of the impact on the regulated industry.

**Q: What impact will lost coal markets and production have on DEP Staffing? Will there be funds to continue the 50% funding of the Coal Mining Regulatory Program as well as the AML Program? (Gary Merrit)**

A: Air Quality Program: The Clean Air Act requires the Air Quality Title V program to be completely self-sufficient, relying only on fees received from Title V sources to cover Title V program expenditures. In the future, as needed, the Department will assess the impact of declining emissions from coal-fired EGUs on the Title V Appropriation of the Clean Air Fund.

Mining Program: The coal mining Title V regulatory program has been undergoing contraction for the last decade, as a result of industry size and improved productivity from technological advancements. Related reductions in staff have come through attrition, and the expectation is that the trend will continue. Pennsylvania must demonstrate that it has the funds available to match the Title V grant at the 50% rate. The state match comes from various sources which helps mitigate the risk of failing to be able to provide the necessary matching funds.

Decreased coal production nationally will result in less AML fees paid into the national AML Trust fund which ultimately will result in smaller annual AML grants for Pennsylvania. However, Congress has authorized an AML Pilot Program funding (which is U.S. Treasury funding not coal industry fees) for PA for the last 5 years (\$25 million or \$30 million per year) and there is no indication that will be going away anytime soon. Also, the authorization to collect the AML fee is set to expire in September 2021. If the fee is not reauthorized, the unappropriated balance in the Trust Fund (currently approximately \$2.5 billion) will be distributed according to a formula outlined in SMCRA. PA should continue to receive AML grants for another 12-15 years in approximately the same amount that is received in FY2022. So, there should be no impact on BAMR staffing for foreseeable future regardless of the national coal production figures. Lastly, there is no 50% match requirement for the AML Program.

## 7. Economic Impacts

**Q: The Department's Pennsylvania Climate Action Plan includes the following:**

**Goals: To ensure the effectiveness of this Plan, overarching adaptation goals and emissions reduction targets are used to frame the strategies. This Plan identifies two adaptation-focused goals, which can be achieved by actions from citizen, businesses, and leaders in the commonwealth:**

- **Minimize disruptions to Pennsylvania's citizens, economy, and environment from climate related hazards.**
- **Increase Pennsylvania's ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from climate-related disruptions.**

***The Department acknowledged that implementing the proposed RGGI Rule will make essentially all non-CFB coal-fired generation uneconomical and will likely force such assets to deactivate and retire. As has been included in recent testimony to the PA Legislature, this outcome will result in great economic disruption to PA, especially in the western bituminous coal region, as outlined below:***

- ***The loss of 8,000 plus jobs***
- ***The loss of \$2.87 billion in total economic impact***
- ***The loss of \$539 million in employee compensation***
- ***The loss of \$34.2 million to state and local taxes base***
- ***Reference: IMPLAN (2015), ECONSULT SOLUTIONS (2019)***

***Recognizing that the change in net CO2 emissions between the reference and policy case is negligible, and that the increase in renewables generation in 2030 is the same both the reference and policy cases, please explain how the Department can justify the “disruptions to Pennsylvania’s citizens, economy, and environment” by implementing this rule? (John Shimshock)***

A: Pennsylvania participation in RGGI results in emissions reductions over the decade of 180 million tons of CO<sub>2</sub>- which is 10 times more CO<sub>2</sub> reductions than Pennsylvania would achieve with business-as-usual. Coal generation is expected to decrease significantly representing roughly 1% of Pennsylvania’s generation portfolio in 2030 irrespective of Pennsylvania’s RGGI participation.

While we cannot speak to the specific studies that you mention, these changes in the generation sector are coming, and the impacts to Pennsylvania coal generation will occur by 2030. We will have funding and options available through the auction proceeds to assist in communities and families through the energy transition.

What we can speak to is the more than ten-year history of the Regional Greenhouse Gas Initiative and the positive net economic benefits that have resulted from participation and reinvestment of auction revenue by participating states. From just 2015-2017, RGGI states saw \$1.4 billion in net positive economic activity due to the RGGI program, specifically tied to reinvestment of program revenue in the energy sector.

***Q: What impacts will the projected costs of generation to account for CO2 Allowances have on the Institutional, the Commercial, and the non-EGU Industrial Sectors? Will this impact their competitiveness based on being located in Pennsylvania? Or will the increase costs of power have an economic impact resulting in loss jobs? (Gary Merrit)***

A: Pennsylvania’s energy prices see a slight increase of 3% by 2030. This represents a \$1.10 increase per MWh, or 0.1 cents per kWh which is less than the typical price variation associated with weather. Furthermore, generation costs are only a portion- roughly half or less of an electricity bill. So theoretically a 3% increase may result in a 1.5% increase on a residential customer’s bill. Considering the average consumption of a PA residential electric customer is 700 kWh per month- this is a minimal increase- more impact for larger energy users, but on the order of roughly a dollar per month.

Even with participation in RGGI, Pennsylvania remains the state with the most competitive pricing among the RGGI states as indicated in Slide #34 of DEP’s modeling presentation.

Additionally, these energy price impacts do not reflect demand reductions and other benefits from RGGI revenue investments which will have price suppressing impacts amidst other positive economic benefits. For instance, Energy Efficiency (EE) projects assist in reducing peak demand- which benefits all customers, even those that are not direct recipients of EE benefits.

**Q: In different presentations by the Department, there has been a reference to the economic benefits to the member RGGI States. This has always been problematic suggesting these economic benefits would occur in Pennsylvania. I don't believe you can make that type of simple statement. Especially, since Pennsylvania's CO2 emissions basically doubles the number of Allowances within the RGGI states. Further, there are different regional transmission organizations as well as a major difference in the industrial base. The following represents concerns when comparing benefits to RGGI states thinking it will be the same in Pennsylvania:**

- **First, there are 3 different Regional Transmission Organizations involved:**
  - **New England ISO – Maine, New Hampshire, Massachusetts, Vermont, and Rhode Island**
  - **New York ISO – New York**
  - **PJM ISO – New Jersey, Delaware, Maryland, District of Columbus, and Virginia**
    - **Possibly Pennsylvania**
- **With the exceptions of New York, Maryland, and Virginia, none of the other states have a fossil fuel industry (Gas, Oil, and/or Coal).**
  - **Further, New York, Maryland, and Virginia are importers of energy as well as fossil fuels.**
  - **Their fossil fuel industries are relatively small when compared to Pennsylvania.**
- **Thus, there will be a significant impact on Pennsylvania's Fossil Fuel Industry, especially coal as identified by John Shimshock in his comments.**
  - **One important point not included in John's Comments is the impact on Pennsylvania's Abandoned Mine Lands Reclamation Program.**
    - **There is an Abandoned Mine Land Reclamation Fee paid by the Coal Industry for each ton of coal mined in Pennsylvania.**
    - **With reductions in coal fired generation, there will be less coal mined and less AML Fees paid.**
    - **50% of this money that comes from Pennsylvania Coal Production is returned via a Federal OSM AML Grant.**
    - **The remaining money is used by OSM to provide additional AML Grant Money to Pennsylvania and/or other states or vice-a-versa. As fewer dollars are delivered to the AML Fund, fewer dollars will be returned to Pennsylvania based on OSM criteria as set forth in SMCRA.**
    - **With fewer dollars to conduct AML reclamation, there are lost jobs and additional economic impacts to the Commonwealth**
    - **The reclamation of these sites results in environmental improvements especially to water and air) when the sites are reclaimed**
    - **Reclamation under the AML program lends itself.**

**Where these issues consider in the economic impact analysis relative to Pennsylvania? If so, please provide more detail. If not, provide basis why it was not? (Gary Merrit)**

A: We recognize that Pennsylvania is a different in many ways than the existing RGGI states and may mean that program benefits may accrue to PA in slightly different ways- but will not undermine the positive economic benefits of the program. As we have completed the Power Sector Modeling, we now shift to economic modeling to determine how the auction proceeds may be reinvested to maximize benefits to PA and will examine sector specific impacts.

## 8. Program Investments

***Q: Ms. Marks of the Public Utility Law Project, at the April 16<sup>th</sup> meeting, noted that the power price increases due to the Carbon Dioxide Budget Trading Program will impact consumers and that this impact will disproportionately affect lower income consumers. Other states have implemented programs as part of their state-specific programs to offset that economic impact.***

***I believe I recall that PADEP stated in the last presentation that the PA Air Pollution Control Act (Act) restricts how funds collected under the Act can be utilized and that the statute would not allow a similar consumer program in Pennsylvania. Since the last presentation, has the Department determined if the Carbon Dioxide Budget Trading Program will include a program to implement a consumer assistance provision? And, are there other programs typical in other state carbon dioxide budget programs that will not be implemented in Pennsylvania due to the statutory restrictions? (John Tissue)***

A: DEP is promulgating the Pennsylvania CO2 Budget Trading Program rulemaking (i.e. RGGI regulation) under the authority of the Pennsylvania Air Pollution Control Act (APCA). As such any revenue resulting from the sale of Pennsylvania CO2 allowances must be used solely for the reduction of air pollution in Pennsylvania. Some of the expenditures made in other states—such as direct electricity bill assistance for low-income households — would not be possible without additional legislative authority. However, expansion of or increased funding for low-income weatherization and energy efficiency programs is an option under current authority which would also be impactful. We continue to explore ways to ensure RGGI benefits accrue to all Pennsylvanians, especially those most vulnerable households.

***Q: For the funds generated by RGGI, how does the money flow, what will be done with the money, and who in PA makes the decisions on how the funds are spent? Could some of the money generated in the program be used to keep consumer rates lower? (Kimberly Coy)***

A: Pennsylvania receives revenue from the auctions equal to the value of those PA allowances sold at auction. This revenue will be deposited into a sub-account in the Clean Air Fund to be used to reduce air pollution in Pennsylvania and satisfy the purpose of the regulation. DEP is conducting economic modeling to determine the impacts of various reinvestment scenarios and will develop a draft plan for public comment outlining reinvestment options.

Some of the expenditures made in other states—such as electricity bill assistance for low-income households — would not be possible without additional legislative authority. However, expansion of or increased funding for low-income weatherization and energy efficiency programs is an option under current authority which would also be impactful in terms of ratepayer savings.

***Q: If the budget for CO2 emissions is tied to the 78,000,000 Ton RGGI Budget and for discussion purposes the price is \$5/Ton, the results are a potential cash infusion to the Clean Air Fund of between \$330 to \$390 million dollars a year (accounting for the Coal Refuse CO2 set aside)! How does the Department plan on utilizing this money? Will these expenditures need to be authorized in the budget before they can be utilized? (Gary Merrit)***

A: For planning purposes, we have conservatively estimated Pennsylvania's 2022 potential revenue associated with RGGI participation at around \$300 million. As Pennsylvania's allowance budget decreases each year, so will the generated revenue. Pennsylvania would receive revenue from the auctions equal to the value of those PA allowances sold at auction. This revenue will be deposited into a sub-account in the Clean Air Fund to be used to reduce air pollution in Pennsylvania and satisfy the purpose of the regulation. DEP is conducting economic modeling to determine the impacts of various reinvestment scenarios and will develop a draft plan for public comment outlining reinvestment options. The APCA and the Department's regulations in Chapter 143 provide limitations on disbursements from the Clean Air Fund.