Incorporating the Costs of Climate Change in Duke Energy Indiana's 2018 Integrated Resource Plan

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1. Introduction and Recommendations

On July 1, 2019, Duke Energy Indiana (DEI or the Company) submitted its 2018 Integrated Resource Plan (IRP). The Company considered five scenarios, with various combinations of technological and policy inputs, and nine resource portfolios that mapped out resource additions and retirements throughout the study period. In this report, we examine how DEI's 2018 IRP fails to adequately incorporate the impacts of climate change into its resource planning based on current best practices. We recommend that DEI include the following elements in any of its future resource planning, including for its 2021 IRP.

Reasonable reference case carbon price

- DEI should make sure that reference case IRP assumptions incorporate a reasonable estimate of the carbon price associated with expected future regulations.

Symmetrical sensitivity cases

- DEI should include sensitivity scenarios that vary carbon prices in a symmetrical manner. The 2018 IRP includes a scenario without any carbon price (including a "Reference Case without Carbon Legislation") but not optimized cases with correspondingly higher carbon prices. While the "High Technology" scenario does include a slightly higher carbon price, it also includes changes to other assumptions (including lower fossil fuel prices) that counteract the effect of the carbon price.

Social cost of carbon scenario scenario

- DEI should include a scenario that incorporates a reasonable estimate of the social cost of carbon, which is likely to exceed the expected regulatory cost of carbon, at least within the IRP planning period.

Rapid emissions reductions scenario

- DEI should include at least one scenario and corresponding optimized portfolio with reference case technology costs that results in rapid reductions in carbon emissions, in line with Intergovernmental Panel on Climate Change (IPCC) recommendations.

Electrification of transportation and building sectors

- As part of a deep decarbonization scenario, DEI should include increases in load due to electrification in the transportation and buildings sectors that will be necessary for achieving economy-wide deep decarbonization.

2. THE IMPORTANCE OF MITIGATING CLIMATE CHANGE

Climate change is an existential threat to society and the planet's ecosystems, and it is already harming communities, damaging infrastructure, and causing extinctions. According to the IPCC's 2018 Special Report, "Without increased and urgent mitigation ambition in the coming years, leading to a sharp decline in greenhouse gas emissions by 2030, global warming will surpass 1.5°Celsius in the following decades, leading to irreversible loss of the most fragile ecosystems, and crisis after crisis for the most vulnerable people and societies."[1] After considering the costs associated with global warming and sea level rise, the IPCC estimates the global economic damages of climate change to be $54 trillion if we manage to limit the Earth's warming to 1.5°Celsius and $69 trillion if we reach 2°Celsius.[2]

The costs of continuing to emit greenhouse gas emissions to power our economy as we do today are too high for business as usual to be a viable path forward. Instead, we must take actions to dramatically reduce greenhouse gas emissions associated with energy consumption. First, we must minimize energy waste by increasing energy efficiency across the residential, commercial, industrial, and transportation sectors. Reducing energy consumption is one of the most cost-effective ways to reduce emissions. Simultaneously, energy consumption will need to shift away from polluting fossil fuels and toward clean energy sources. The IPCC has highlighted solar, wind, and energy storage as important tools during this energy transition due to the dramatic improvements in their political, economic, social, and technical feasibility.[3] For example, the cost of installing solar has decreased by over 70 percent since 2010 and is currently at an all-time low.[4] The levelized cost of wind energy in the United States has fallen by 45 percent since 2008.[5] Zero carbon technologies are readily available and affordable today.

Decarbonizing the electric power sector is essential not only because of the importance of reducing electric power sector emissions, but also because the most viable path for reducing emissions from most other sectors is electrification. Electric vehicles (EVs) are already beginning to increase in market share, particularly in Europe and China. Bloomberg New Energy Finance forecasts that EVs will make up 31

[1] IPCC, 2018: Global Warming of 1.5°C.An IPCC Special Report on the impacts of global warming of 1.5°Celsius above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.

[2] IPCC, 2018

[3] IPCC, 2018

[4] Wood Mackenzie/SEIA U.S. Solar Market Insight, Q3 2019. Available at: https://www.seia.org/research-resources/solar-market-insight-report-2019-q3.

[5] Hand, M.M., ed. 2018. IEA Wind TCP Task 26–Wind Technology, Cost, and Performance Trends in Denmark, Germany, Ireland, Norway, Sweden, the European Union, and the United States: 2008–2016. NREL/TP-6A20-71844. National Renewable Energy Laboratory, Golden, CO (US). https://www.nrel.gov/docs/fy19osti/71844.pdf.

percent of new vehicle sales in the United States by 2030.[6] Similarly, in the buildings sector, electric technologies are increasingly competitive with appliances using fossil fuels such as natural gas, oil, or propane. Heat pumps can affordably and efficiently provide space and water heating, even in cold climates, and governments are increasingly seeking to accelerate heat pump adoption. For example, Maine has set a target of installing 100,000 new heat pumps in homes between 2020 and 2025,[7] which will result in the installation of heat pumps in nearly 20 percent of Maine's 554,000 households.[8]

In September 2019, Duke Energy publicly recognized the importance of reducing emissions from the power sector and committed to achieving net zero carbon emissions by 2050. The Company set an interim target of reducing carbon emissions by at least 50 percent by 2030.[9] These goals are necessary steps for mitigating the worst impacts of climate change. Duke must now take appropriate steps to make sure that each of its regulated utilities will meet these targets.

To decarbonize by 2050, the electric power sector must make substantial shifts toward clean generation sources in the next few years. Investments in generation have traditionally been long-lived, but if new fossil fuel-powered generation is built today it will need to be retired relatively soon to achieve necessary emissions reductions. Utilities should be very cautious when investing in fossil fuel power plants that can only be utilized for a short amount of time. The required accelerated depreciation imposes larger costs on customers that could render the investments imprudent. Transitioning to a clean power grid will be easier if utilities prepare in advance. Another critical consideration is that the carbon emissions from these power plants during their years of operation contribute to cumulative emissions and climate change even if emissions targets are met in later years. The IPCC findings on climate change mentioned above make clear that clean energy shifts need to happen immediately, meaning that utilities need to adapt their resource planning now. Climate damages continue to grow every year utilities delay.

To best serve its customers during this power sector transition, DEI must conduct a resource planning process that adequately addresses climate change. The Company should include at least one scenario that recognizes the full social cost of its emissions and achieves deep decarbonization. To do this, DEI can either include a higher carbon price representing the social cost of carbon or enforce a cap on carbon emissions in line with the DEI service territory's equitable contribution to limiting warming to 2 degrees Celsius.

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[6] Bloomberg New Energy Finance. 2019. *Electric Vehicle Outlook 2019.* Available at: https://about.bnef.com/electric-vehicle-outlook/.

[7] Maine L.D. 1766, § 6 (129th Legis. 2019). Available at: http://legislature.maine.gov/legis/bills/bills_129th/billtexts/SP059701.asp.

[8] U.S. Census Bureau, American Community Survey (ACS), 5-Year Estimates

[9] Duke Energy. September 17, 2019. "Duke Energy aims to achieve net-zero carbon emissions by 2050." *News Center.* Available at: https://news.duke-energy.com/releases/duke-energy-aims-to-achieve-net-zero-carbon-emissions-by-2050.

3. CARBON EMISSIONS IMPOSE A COST

The most widely used measure of climate damages is the social cost of carbon (SCC), which measures the cost of the damage associated with greenhouse gas emissions. The SCC measures the incremental damage caused by emitting an extra ton of CO_2 in a certain year. In practice, this value is determined by examining the change in the net present value of all climate damages that results from the marginal emissions increase.

Calculating the SCC presents a significant challenge. As described in a 2019 Synapse report about the climate impacts of a proposed natural gas plant in Florida, "some climate damages, such as extinction of endangered species, or loss of unique, irreplaceable environments, are difficult or impossible to monetize. And even if damages can be monetized, it remains necessary to project the pace at which damages increase with temperatures or other climate indicators."[10] As a result, studies have come to different conclusions about the magnitude of the social cost of carbon. The same report describes various studies of the SCC and the values they determine.

Excerpt from Synapse's *The Proposed Plant at Big Bend* report: The U.S. Interagency Working Group on the Social Cost of Greenhouse Gases

The federal government's Interagency Working Group on the Social Cost of Greenhouse Gases developed and refined estimates of the SCC from 2010 to 2016 for use in cost-benefit analyses of federal programs and regulations. The group presented four estimates: three use the estimated average value of climate sensitivity (a measure of how fast the world is warming in response to rising concentrations of greenhouse gases), combined with discount rates of 5, 3, and 2.5 percent; a fourth variant uses a much higher estimate of climate sensitivity, and a 3 percent discount rate. In practice, most users have cited the version with a 3 percent discount rate and average climate sensitivity, sometimes called the "central estimate."

In the final, August 2016 iteration, the federal SCC estimates for emissions in 2020 ranged from $15 to $149, rising to $31–$257 in 2050. The "central estimate" rose from $51 for 2020 to $83 for 2050 emissions (all SCC values in this section have been converted to 2018 dollars per metric ton of CO_2.)

The Interagency Working Group relied on an average of results from three simple models of climate economics, all of which minimized or ignored some of the most serious climate risks. In particular, these models ignored or minimized the risks of tipping points and abrupt, irreversible losses, one of the most damaging features of future climate projections. This and other criticisms of the methodology are spelled out in an extensive evaluation and critique of the federal SCC by the National Academy of Sciences.[11]

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[10] Ackerman, F., B. Biewald. 2019. *The Proposed Plant at Big Bend*. Synapse Energy Economics for the Sierra Club.

[11] National Academy of Sciences, Engineering, and Medicine (2017). *Valuing Climate Damages: Updating Estimates of the Social Cost of Carbon Dioxide* (Washington, DC: The National Academies Press), https://www.nap.edu/catalog/24651/valuing-climate-damages-updating-estimation-of-the-social-cost-of.

Excerpt from Synapse's *The Proposed Plant at Big Bend* report: Alternative Studies on the Social Cost of Carbon

Concerns about limitations of the Interagency Working Group methodology have led to research by many economists on risks and uncertainties, producing alternative SCC values that are often higher than the Working Group estimates. A review of the effect of climate risks on the SCC found that, in order to reflect well-known major risks, the SCC needs to be at least $131.[12] A major study by the well-known British climate economists Simon Dietz and Nicholas Stern found a range of optimal carbon prices (i.e., SCC values), depending on key climate uncertainties, ranging from $45 to $160 for emissions in 2025, and from $111 to $394 for emissions in 2055.[13]

While the report notes that most of these estimates are large values, there is substantial variation between sources. The report points to The Interagency Working Group numbers[14] as a useful starting point because of the extent to which they have been cited. It is important to note though that these are almost certainly underestimates of climate damages. Thus, they should be interpreted as a lower bound on the potential costs of carbon pollution rather than an accurate estimate. This is one reason why it may be helpful to instead utilize an emissions cap in deep decarbonization scenarios, as this will identify the optimal resource plan in line with established emissions reduction targets from the IPCC.

[12] J.C.J.M. van den Bergh and W.J.W. Botzen (2014), "A lower bound to the social cost of CO_2 emissions," *Nature Climate Change* 4, pp. 253-258.

[13] Simon Dietz and Nicholas Stern (2015), "Endogenous growth, convexity of damage and climate risk: how Nordhaus' framework supports deep cuts in carbon emissions," *Economic Journal* 125, pp. 574-620, Table 4.

[14] Interagency Working Group (August 2016), "Technical Support Document – Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866." Available at: https://www.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf.

4. INCORPORATING THE COST OF CARBON POLLUTION INTO RESOURCE PLANNING

The social cost of carbon should be incorporated into long-term power sector investments. These investments often cause more climate damage than short-term financial benefit. As such, failing to incorporate the social cost of carbon leads optimization models to make incorrect choices. In addition, ignoring these costs puts excessive risks on ratepayers, who are too often held responsible for the costs of poor utility investment decisions. Future governments are likely to pursue climate action to reduce greenhouse gas emissions through public policies that can change much faster than a utility's generation fleet typically turns over. Policies could take the form of regulation or market-oriented programs that price carbon, but either way investments in fossil fuel-powered assets could quickly become uneconomic or not "used and useful" in providing service to customers. Decisions to invest in such assets could be found to be imprudent. Accordingly, zero carbon alternatives capable of both near-term and sustained deployment in lieu of new fossil fuel generation must be characterized, evaluated, and planned starting now.

Some utilities and jurisdictions have already taken the lead and use carbon prices in planning. For instance, Colorado passed a law in 2019 directing its Public Utilities Commission to have utilities incorporate the social cost of carbon when evaluating electric generation resources.[15]

DEI should include at least one deep decarbonization scenario in its IRP to accommodate the high cost of climate damages and the potential for government mandates to reduce carbon emissions. The risk of extreme damage and costs related to climate change is too severe to exclude an evaluation of what it would take to meet necessary emissions reduction targets. If modeled cases including higher carbon prices fail to achieve emissions reductions in line with IPCC and other recommendations, an emissions cap should be imposed and used to develop an optimized portfolio. This scenario must be modeled appropriately. Arbitrary constraints and excessively conservative treatment of renewable energy technologies render the planning process useless for evaluating the potential to achieve deep decarbonization. Unknowns related to transitioning to an electric grid powered mostly by renewables and storage should be noted and studied prior to the completion of the IRP. Renewable and storage powered systems will operate differently than today's legacy infrastructure, and there will be times when utilities will need to perform such studies to understand the effects of this shift. However, this is not a reason to leave deep decarbonization out of integrated resource planning. Utilities should not exclude scenarios simply for being unfamiliar.

Modeling tools must be capable of simulating important characteristics of zero emissions technologies so that the planning process is not biased toward traditional generation. Portfolios of intermittent renewable energy can reliably support the electric grid and may achieve similar or greater levels of

[15] Colorado SB19-236. Available at: https://leg.colorado.gov/bills/sb19-236.

reliability in different ways. In recognition of the fact that hybrid renewable and storage generation resources become increasingly competitive as the cost of battery storage declines, DEI should analyze the potential for storage technologies to be combined with variable renewable resources to provide dispatchable power. DEI should also incorporate the reliability benefits of a diverse set of intermittent resources. Utilizing solar and wind generation from a wide geographic area can decrease the volatility of total renewable generation and provide a steadier and more predictable generation profile. In addition, the Company should look to take advantage of the services that demand resources can provide. Existing and new flexible loads (such as water heating and electric vehicles) can provide the grid-balancing services historically provided mostly by fossil fuel power plants.

The U.S. Mid-Century Strategy for Deep Decarbonization offers a framework for how utilities can think about emissions reduction trajectories in deep decarbonization scenarios.[16] The study can help determine an appropriate cap for power sector carbon emissions, given the expected trajectories of other sectors. The study can be useful for understanding how much electrification DEI should incorporate in a deep decarbonization scenario as heat pumps and electric vehicles become increasingly viable technologies for displacing fossil fuel consumption. Certain industrial end uses should be electrified as well. DEI should ideally conduct a service-territory-specific efficiency and electrification analysis. For example, the pace of building electrification and the resulting changes in electric consumption will depend on the building stock, existing heating fuels, and climate in the utility's territory. However, in the absence of other studies, DEI should at least estimate electrification load requirements by scaling the national results from the U.S. Mid-Century Strategy to its load. The report's benchmarks for emissions reductions and load growth can help guide DEI's future resource planning.

[16] United States Mid-Century Strategy for Deep Decarbonization. November 2016. Available at: https://unfccc.int/files/focus/long-term_strategies/application/pdf/mid_century_strategy_report-final_red.pdf.

5. Climate and Carbon in Duke Energy Indiana's 2018 IRP

Duke Energy Indiana's 2018 IRP identifies a set of scenarios that result in some reduction in greenhouse gas emissions, but the IRP fails to adequately account for the costs imposed by climate change and contains flaws that skew the modeling results. The IRP's preferred portfolio is called the "Moderate Transition Portfolio." Under the Company's Reference Case scenario conditions, the portfolio results in a reduction in greenhouse gas emissions of just over 60 percent between 2005 and 2037. In other scenarios (which vary resource costs, fuel costs, and carbon policies) the preferred portfolio leads to emissions reductions between approximately 45 and 70 percent by 2037.[17]

However, the emissions reductions achieved by the preferred portfolio are not enough to prevent the worst impacts of climate change. DEI's current system is one of the dirtiest in the country: almost all the Company's power is currently generated by burning coal, even though coal generation accounts for just one quarter of electricity generation nationally. This means that DEI will need to make particularly deep reductions in emissions. For example, powering most of the grid using natural gas is not a viable path toward deep decarbonization, as natural gas plants still emit substantial amounts of CO_2. DEI's preferred portfolio achieves most of its emissions reductions by replacing coal generation with natural gas. This will achieve some reductions in the short term but does not put the Company on a path to meeting its own net zero emissions goal for 2050. Natural gas power plants built in the later 2020s and 2030s will need to be retired soon after commencing operation if the Company is to meet its goal of eliminating greenhouse gas emissions by 2050.

In addition, the preferred portfolio relies heavily on market purchases, which in the Company's modeling also contribute to the reduction in emissions. DEI should not count so heavily on being able to import relatively clean power from its neighbors. Overreliance on market purchases was a problem that emerged in DEI's modeling for many of its scenarios, including a stakeholder-requested decarbonization scenario that the Company was ultimately unable to realistically model. One contributing factor to this issue was that the Company's market price forecast did not include a deep decarbonization case, which led to a mismatch in assumptions between DEI's service territory and the rest of the market. The modeling treatment of carbon prices and emissions caps should be addressed early in the IRP timeline, ideally prior to the substantive planning process, so that all carbon-related inputs are aligned.

DEI's preferred portfolio appears to perform favorably compared to other portfolios, but this is due to DEI's skewed selection of scenarios. The DEI reference case correctly incorporates a carbon price, though it is unclear that the small price included (which begins at just $5/ton of CO_2 in 2025) is a reasonable estimate of future carbon regulation. The more severe problem is that the sensitivity analysis DEI performs regarding carbon prices is asymmetrical. DEI incorporates a "Reference Case without Carbon Legislation" scenario that has no carbon price and this case inflates the financial

[17] Duke Energy Indiana. July 1, 2019. *The Duke Energy Indiana 2018 Integrated Resource Plan.* Available at: https://www.in.gov/iurc/files/Duke%20Energy%20Indiana%20Public%202018%20IRP%20Volume%201.pdf.

performance of higher carbon portfolios. However, there is no scenario that adds a higher carbon price to the reference case scenario. While the "High Technology" scenario includes a slightly higher carbon price, this scenario also confusingly includes lower fossil fuel prices that counteract the effect of the incremental increase in the carbon price. At no point over the IRP's study period in any of the scenarios does DEI consider a carbon price equal to or greater than \$50/ton of CO_2.[18]

Importantly for a utility announcing a lofty climate goal of net zero emissions, there is no scenario that attempts to capture the full costs of climate change by including either an estimate of the social cost of carbon or a sustainability-based emissions cap. Such a scenario is essential to demonstrate the massive risks associated with maintaining (or transitioning too slowly away from) a carbon-intensive generation fleet. A deep decarbonization scenario is also important for creating an optimized low carbon portfolio. We note the IRP does examine two portfolios that achieve larger emissions reductions by increasing the amount of renewable energy that DEI would acquire. These cases provide some insight regarding how such a portfolio would work. However, they are not optimized and therefore may be costlier than necessary. DEI should include an optimized portfolio that achieves necessary emissions reductions.

[18] Duke Energy Indiana. July 1, 2019. *The Duke Energy Indiana 2018 Integrated Resource Plan.* Available at: https://www.in.gov/iurc/files/Duke%20Energy%20Indiana%20Public%202018%20IRP%20Volume%201.pdf.

6. CONCLUSION

Duke Energy as a utility holding company has much challenging work to do to achieve its recently announced goal of zero carbon emissions by 2050. DEI as an operating utility subsidiary of Duke Energy has an especially challenging task before it to achieve its corporate parent's goal. First and foremost, this challenge involves achieving the required emissions reductions by 2050 – a challenge which can only be met by starting now with aggressive near-term actions and sustaining that policy and pace of actions over the next 30 years. This challenge also requires major changes in Duke's and DEI's resource planning process and framework. The Companies must deploy on a timely basis the decision-making tools and methodologies required to characterize, evaluate, select, and execute the resource choices necessary to achieve zero carbon emissions by 2050.