FACTORS CONSIDERED WHEN ESTIMATING THE REVENUE EFFECTS OF THE ENERGY PROVISIONS OF PUBLIC LAW 117-169 AND SUBSEQUENT DEVELOPMENTS

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INTRODUCTION

The staff of the Joint Committee on Taxation ("Joint Committee staff") published revenue estimates of the revenue provisions of Public Law 117-169, the "Inflation Reduction Act" ("IRA"), on August 9, 2022.[1] This report describes how the Joint Committee staff constructed revenue estimates for the IRA reconciliation legislation, discusses subsequent economic and legal developments that affect the IRA provisions and how these will factor into revenue estimates of legislation in 2023, and provides some commentary on a few specific estimates from other organizations including why making comparisons between Joint Committee staff revenue estimates and estimates from other organizations must be done with caution.

This report elaborates on several main points. First, revenue estimates are not tax expenditures and the two should not be directly compared without accounting for the differences. Generally, tax expenditure estimates of the IRA provisions are significantly larger than revenue estimates because they lack several features specific to revenue estimates. Most estimates performed by other organizations are tax expenditures, and thus directly comparing the values of these estimates with the revenue estimates of the same provisions produced by Joint Committee staff may not yield any meaningful conclusion. Second, because the Joint Committee staff were bound to using the 2021 revenue baseline when producing revenue estimates of the IRA in August 2022 under reconciliation instructions, the revenue estimates prepared by Joint Committee staff for JCX-18-22[2] are based on outdated data and economic forecasts from 2020 and early 2021. Significant new information is now available which Joint Committee staff could not factor into the revenue estimates in JCX-18-22, but which is factored into revenue estimates produced using the 2023 revenue baseline. Third, the final implementation of regulations by Treasury (and other entities) can significantly affect the revenue estimates of many provisions. The details of the regulations were not known at the time Joint Committee staff produced JCX-18-22, and in some cases remain uncertain. Future revenue estimates may be subject to further change depending on the regulations ultimately adopted.

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[1] Joint Committee on Taxation, *Estimated Budget Effects Of The Revenue Provisions Of Title I – Committee On Finance, Of An Amendment In The Nature Of A Substitute To H.R. 5376, "An Act To Provide For Reconciliation Pursuant To Title II Of S. Con. Res. 14," As Passed By The Senate On August 7, 2022, And Scheduled For Consideration By The House Of Representatives On August 12, 2022* (JCX-18-22), August 9, 2022.

[2] *Ibid.*

I. REVENUE BASELINE, REVENUE ESTIMATES, AND ESTIMATES FOR RECONCILIATION LEGISLATION

In general

A revenue estimate compares (1) predicted Federal revenues under a proposal with (2) the revenue baseline, which is predicted Federal revenues under present law. The revenue estimate is the difference between these two values.

In constructing the annual revenue baseline, the Joint Committee staff relies on the Congressional Budget Office ("CBO") forecast of macroeconomic circumstances and the CBO forecast of Federal receipts under present law.[3] In general, the Joint Committee staff then expands on the CBO forecast with information on historic tax receipts for existing provisions, relevant forecasts from other sources, and applicable academic research. In constructing the baseline for revenues pertaining to energy provisions in particular, tax return data on existing energy provisions, forecasts from other sources such as the Energy Information Administration's ("EIA") Annual Economic Outlook ("AEO") for projections on the markets for fuels, alternative energy, and vehicles, and academic research on energy markets are used.

The revenue baseline serves as the benchmark for measuring the effects of proposed tax law changes. The baseline assumes that present law remains unchanged during the 10-year budget period. Thus, the revenue baseline is a projection of the Federal revenues that will be collected over the next 10 years in the absence of statutory changes, in other words, predicted Federal revenues under present law.[4]

To construct a prediction of Federal revenues under a proposal, for instance the IRA, the Joint Committee staff begins with the revenue baseline for that 10-year budget period and expand upon it to account for the proposal's changes to statutory tax rates, the base on which tax is calculated, and any behavioral change in taxable activity or tax claiming that is induced by the proposal. To do so, the Joint Committee staff relies on the previously mentioned data as well as academic or industry research on past behavioral changes in response to modifications of specific parameters of the Internal Revenue Code (the "Code"), including in some cases internal research performed by Joint Committee staff.

To further illustrate the difference between predicted Federal revenues under a proposal, the revenue baseline, and a revenue estimate, consider the credit for the purchase of electric vehicles. Under prior law, before passage of the IRA, a credit of up to $7,500 was allowed for certain electric vehicles. The 2021 revenue baseline accounted for the reduced revenue resulting

[3] Generally, the Joint Committee staff produce an annual revenue baseline that is used throughout the year. However, following enactment of major legislation that is expected to produce major changes to the revenue baseline, or subsequent to significant changes to macroeconomic conditions, the Joint Committee staff may construct an updated baseline that accounts for these changes to use thereafter when constructing revenue estimates. In that case, there would be multiple revenue baselines in a given year.

[4] Note that some tax provisions change over time according to present law. For example, provisions may expire after a certain date, and to the extent such changes have effects within the 10-year budget period these are incorporated into the revenue baseline.

from the existence of this tax credit in its prediction of revenues during the 2021-2031 budget period. That is, the 2021 revenue baseline accounted for vehicles eligible for a credit under prior law (revenue loss). The IRA modified this credit, removing a per manufacturer cumulative sales limitation of 200,000, among other changes. The estimate of predicted Federal revenues under the IRA accounts for these modifications, meaning this estimate would account for vehicles newly eligible for a credit (revenue loss), vehicles eligible for a credit under prior law that are still eligible (revenue loss), and vehicles eligible for a credit under prior law but no longer eligible (revenue gain) during the 2021-2031 budget period. However, because a revenue estimate is the difference between the predicted Federal revenues under the proposal and the revenue baseline, a revenue estimate nets out vehicles eligible under the proposal and under baseline law. Thus, the revenue estimate only contains the cost of vehicles newly eligible for a credit under the proposal (revenue loss) and vehicles eligible for a credit under baseline law but no longer eligible (revenue gain) during the 2021-2031 budget period; it would not account for the entire cost of the electric vehicle credit under the IRA.

A final important feature of revenue estimates is that many revenue estimates incorporate an offset to capture interactions between various parts of the Code. The essential logic of these offsets is that one type of tax on an activity may reduce the income subject to another tax. For example, increasing an excise tax rate reduces the profitability of the taxable activity and results in a decrease in income subject to Federal income and payroll taxes. This reduction in Federal income and payroll taxes thus offsets some of the revenue raised through the increased excise tax.[5] The reverse logic holds for many tax credits – they incentivize activity by raising its profitability, which in turn leads to higher tax liability for some organizations or individuals.

Reconciliation legislation

Congress passed the IRA under 2021 reconciliation instructions. Consequently, the revenue effects of the IRA were estimated by Joint Committee staff relative to the 2021 revenue baseline. This revenue baseline starts with the forecasts prepared by the CBO in 2021. Generally, these CBO forecasts are updated annually, and unforeseen changes in economic conditions can result in the forecasts differing substantially from those made in prior years. For example, relative to the 2022 forecast, CBO projects changes in growth and inflation for the 2023 forecast. Changes in projections were due to data showing more persistent inflation and supply-side disruptions than previously forecast.[6] Similarly, relative to the 2021 forecast, CBO projected higher inflation, more investment, higher real GDP, and a faster reduction of the unemployment rate following the pandemic for the 2022 forecast. These changes between the 2021 CBO forecast to the 2022 CBO forecast all move in the direction of greater predicted

[5] For an in-depth description of tax offsets see Joint Committee on Taxation, *The Income and Payroll Tax Offset to Changes in Excise Tax Revenues* (JCX-59-11), December 23, 2011 and Joint Committee on Taxation, *The Income and Payroll Tax Offset to Changes in Payroll Tax Revenues* (JCX-89-16), November 18, 2016. For a description of the standard 2021 excise tax offset calculations (averaging 23.3 percent over ten years) see Joint Committee on Taxation, *Updated Income and Payroll Tax Offsets to Changes in Excise Tax Revenues 2021-2031* (JCX-11-21), February 23, 2021. For the current values (average 25.7 percent over ten years) see Joint Committee on Taxation, *Income and Payroll Tax Offsets to Changes in Excise Tax Revenues 2023-2033* (JCX-2-23), February 22, 2023.

[6] See Congressional Budget Office, *The Budget and Economic Outlook: 2023 to 2033*, February 2023.

revenue reductions for energy tax credits. This is because higher real income and lower employment would increase demand for products such as qualifying electric vehicles, biofuels and alternative fuels, energy efficient residential property such as heat pumps, and electricity generated from wind and solar, while greater overall investment includes investments in energy infrastructure. Consequently, had the 2022 CBO forecast been incorporated for the revenue estimate of the IRA, the predicted revenue losses would have been commensurately higher. Other projections that the Joint Committee staff incorporates with these CBO forecasts to create the annual revenue baseline can also vary as new information is incorporated.

Which CBO forecast underlies any given revenue baseline or revenue estimate may have a significant effect on the predicted Federal revenues. For the revenue baseline in a particular year or a specific proposal, even if expectations for the induced activity of a particular taxable activity remain the same, substantial changes in economic conditions may dramatically increase or decrease revenues in a particular revenue baseline, or for a revenue estimate of a specific proposal.

In the case of provisions for which an identical or similar provision existed previously, generally the revenue baseline relies on the CBO forecast of associated revenues during the relevant 10-year budget period. However, these forecasts themselves rely on the state of the macroeconomy. Faster expected economic growth under one forecast will increase the expected revenues under a specific tax, or decrease revenues due to a specific tax credit, specifically because more of the taxable activity takes place during stronger economic growth and not because of any change in induced activity resulting from a tax or tax credit. Similarly, because Joint Committee staff estimates are provided in nominal dollars, higher than expected inflation may produce a larger nominal-dollar revenue baseline or revenue estimate, holding the level of a taxable activity constant. In cases where no prior-law analogue of the provisions exists, or where the CBO forecast provides insufficient detail alone to accurately model a provision, the Joint Committee staff incorporates projections from other sources. But like the CBO forecast, these other projections are fixed to the year in question for which the projections are produced, and also may affect expected revenues under a baseline or revenue estimate when updated to a more recent projection. Additional detail on how the 2021 Joint Committee staff baseline was constructed for estimating certain provisions of the IRA is provided below.

II. 2021 BASELINE COMPONENTS RELEVANT FOR ESTIMATES OF THE IRA

IRA credits

Investment and production credits related to electricity

For the production and investment tax credits, the Joint Committee staff constructed baseline projections of major renewable resources such and wind and solar. To construct the 2021 baseline, the Joint Committee staff relied upon investment data for renewables contained in IRS statistics of income ("SOI") data files that are reported on the actual IRS forms the taxpayer files to claim the investment and production tax credits. This data gives the actual basis of investment in the various renewables eligible for the tax credits. To generate the investment forecast for wind and other renewables that the Joint Committee staff used to produce revenue estimates of proposals under the 2021 revenue baseline, such as extensions to the section 45 production credit, the Joint Committee staff also relied upon historical data on the number of gigawatts of capacity added in years in which credits were available. The baseline projections for investment and production also draw upon but do not directly rely on EIA forecasts contained in the "reference case" of the AEO, as the reference case reflects present law provisions of the Code.[7] Additionally, the Joint Committee staff asked the EIA to provide their projections from their national energy modeling system ("NEMS") assuming that the section 45 and section 48 energy credits are made permanent. Together, this information is used to project how many GW of renewable capacity, by technology, are likely to be stimulated by extensions or modification to these provisions.

Credit for carbon oxide sequestration

The modification to the section 45Q carbon oxide sequestration credit was estimated to be $3.2 billion using the 2021 revenue baseline. The Joint Committee staff estimate is largely based upon historical taxpayer information on the number of taxpayers who have claimed the credit, the magnitude of the credit per taxpayer, and an estimate of the production of oil and gas from enhanced oil recovery ("EOR") as the vast majority of CO2 that is captured is used for EOR purposes.[8] The revenue estimate of this provision assumed that the increase in the supply of CO2 via carbon capture would be utilized in EOR projects as this has been the predominant use of captured CO2 in the past.

Credits related to electric vehicles

The Joint Committee staff's baseline forecast of electric vehicle sales uses as a starting point the most recent annual sales figures in the public domain by nameplate. The 2021 baseline relied upon the most recent annual sales data, which at the time were annual sales ending in

[7] For example, the "reference case" contains estimates based on tax provisions in effect at the time, which would reflect the sunset of any such provision.

[8] Jones, Angela C and Ashley J. Lawson, "*Carbon Capture and Sequestration in the United States*," Congressional Research Service report R44902, October 18, 2021.

2020. Growth rates from EIA's 2021 forecasts of electric vehicle sales were then used to construct baseline forecasts of vehicle sales for fiscal years 2021 through 2031, the 10-year budget window for reconciliation. The IRA provides new incentives for the purchase of electric vehicles. The incentives will induce sales outcomes different from these baseline forecasts. To estimate the new sales outcomes, the Joint Committee staff used information drawn from the SOI data, such as the distribution of the electric vehicle credit by adjusted gross income ("AGI") to estimate the universe of potential electric vehicle buyers, and estimates of demand elasticities from the empirical economic literature on electric vehicle demand to estimate the magnitude of increased electric vehicle sales by eligible buyers due to the new incentives.

Additionally, changes made by the IRA to the clean vehicle credit under section 30D include a portion of the credit being dependent on whether a certain percentage of critical minerals in the battery of the vehicle are sourced from the United States or a country with which the United States has a free trade agreement. In preparing the revenue estimate, the Joint Committee staff considered the ability of companies to source critical minerals (including lithium, nickel, cobalt, manganese, and graphite) domestically or from countries with which the United States has a free trade agreement. The Joint Committee staff's primary source for this information was the 2022 edition of the U.S. Geological Survey's annual Mineral Commodities Summaries. That document suggests that nearly all the minerals listed above are readily available either from domestic sources or from U.S. Free trade partners such as Canada, Mexico, and Australia. The Joint Committee staff also relied on publicly available data, including from industry announcements, on domestic electric vehicle battery plants coming online, and professionals at the Department of Energy and various nongovernmental organizations.

Extension of existing fuels incentives

Several provisions in the IRA pertaining to fuels were extensions of already existing provisions, including the incentives for second-generation biofuels, alternative fuels and alternative fuel mixtures, and biodiesel and renewable diesel. The 2021 baseline for these items, which was created in the spring of 2021, incorporated tax credit claims and trust fund transfer data from 2020 and the most recent forecasts available at that time from other agencies such as the EIA 2020 AEO, the Alternative Fuels Data Center quarterly price updates, the National Renewable Energy Laboratory ("NREL"), and nongovernmental organizations on the current and expected future states of fuels markets as of the end of 2020. As these tax credits existed prior to the enactment of the IRA and have been previously extended, the revenue estimate of extending these incentives utilized historic data on tax collections to predict induced activity.

Production credit for clean fuel

A new fuels provision, the section 45Z clean fuel production credit, effectively subsumes these aforementioned prior-law fuels incentives into a new single "technology neutral" tax credit after the prior-law provisions expire. Unlike previous fuels incentives the clean fuel production credit depends not only on the volumes of qualifying fuel, but also on the estimated lifecycle greenhouse gas emissions of the fuel. As a new tax credit, the 2021 baseline had no reduction in Federal revenues due to the clean fuel production credit. The Joint Committee staff revenue estimate for the clean fuel production credit relied on all the data used for the prior-law fuels baselines, but in order to incorporate the increased complexity of this provision the Joint

Committee staff relied on the CBO macroeconomic forecast of inflation and excise tax revenues for certain fuels, as well as additional information from the EPA, NREL, and academic and industry sources on the estimated lifecycle emissions of various types of fuels produced using different feedstocks and production pathways, the availability of feedstocks, facilities currently producing certain fuels, and planned future facilities and their intended production capacities.

Production credit for clean hydrogen

Section 45V creates a new clean hydrogen production credit. As a new credit, the 2021 baseline had no reduction in Federal revenues due to clean hydrogen, similar to the clean fuel production credit. Producing the revenue estimate for the section 45V clean hydrogen production credit was subject to higher uncertainty than other fuels provisions due to the lack of an identical or similar prior law incentive. Like the clean fuel production credit this provision depends on both the amount of qualifying hydrogen produced and the lifecycle emissions of that hydrogen. The revenue estimate incorporated the CBO macroeconomic forecast of inflation as well as information from the EIA, NREL, the Argonne National Laboratory, the International Energy Agency ("IEA"), and academic and industry sources in estimating the volumes of qualifying hydrogen that will be produced, the number and capacity of existing and potential hydrogen production facilities, and where possible the expected production methods to be used by these facilities. These and additional academic and industry sources were also used to identify the possible production pathways of hydrogen which might qualify, the necessary feedstocks, and estimates of lifecycle greenhouse gas emissions of various production pathways.

Advanced manufacturing production credit

The IRA created section 45X, the advanced manufacturing production credit. This credit applies to wind and solar components, critical minerals, and battery cells and modules built in the United States. This is a new Code provision, rather than a modification of an existing one. To estimate the potential revenue effects of this provision the Joint Committee staff researched information from public announcements and other sources available in 2021 of planned United States battery cell manufacturing facilities, their capacity, and their construction schedules. Because the market for batteries is largely driven by the market for electric vehicles, the Joint Committee staff also relied on its baseline forecast of electric vehicle sales in addition to industry statistics on the share of electric vehicles sold in the United States that contained a battery that was produced in the United States. For investment in eligible wind and solar components, the Joint Committee staff relied on its wind and solar baseline investment forecast in addition to informal estimates from the Department of Energy as to the capital cost per kilowatt-hour that is attributable to the various wind and solar components eligible for the credit. Finally, for the critical mineral portion of section 45X, data was collected from the U.S. Geological Survey on the U.S. production of critical minerals that would qualify for the credit. The Joint Committee staff also drew on conversations with various nongovernmental organizations to estimate the share of U.S. production of minerals that would be of the appropriate quality.

III. ECONOMIC AND LEGAL DEVELOPMENTS SUBSEQUENT TO INITIAL IRA ESTIMATES

In general

As discussed above, changes in general economic and sector specific conditions can alter the annual revenue baseline that the Joint Committee staff constructs to create revenue estimates. Joint Committee staff estimates include predicted changes in taxpayer behavior due to a proposed change in law in constructing predicted Federal revenues (for example, how a tax credit may increase investment in the production of wind energy). However, certain factors that may affect future revenues are assumed to stay constant, such as Federal regulations and foreign and State laws. Changes in these factors may have a significant effect on future revenues. The following describes how certain economic changes and regulatory decisions that occurred since the construction of the 2021 revenue baseline and the Joint Committee staff's revenue estimates of the IRA may affect Federal receipts by creating a different economic environment and different economic incentives than those considered by the Joint Committee staff when first estimating the take-up of certain credits modified, extended, or created by the IRA.

IRA credits

Investment and production credits related to electricity

The combined revenue estimate of the modifications to the section 45 credit for electricity produced from certain renewable resources and the enactment of the new section 45Y clean electricity production tax credit was $62.3 billion using the 2021 baseline ($51.1 billion for section 45 and $11.2 billion for section 45Y). Projecting the 2023 baseline investment activity related to these provisions suggests substantially larger and faster take-up of these credits than the Joint Committee staff estimated in JCX-18-22. As discussed above, the Joint Committee staff starts from tax return data on claims for electricity production and historical data on the number of gigawatts of capacity added in years in which credits were available as well as the EIA forecast of investment in renewable electricity generating technologies in developing the relevant baseline. For example, the EIA's AEO 2021 forecast, which the Joint Committee staff drew upon in estimating the IRA, shows that cumulative investment in wind capacity equals 200 gigawatts ("GW") by 2031 and reflected an annual growth rate in wind capacity between 2021 and 2031 of four percent per year.[9] The Joint Committee staff revenue estimate for the section 45 extension and modification, in addition to the clean electricity production credit under section 45Y, is consistent with an additional 12 to 15 GW of new grid-connected wind capacity being added each year, which has been the historical norm during periods when the section 45 credit has been available. However, the EIA's 2023 AEO, which incorporates the relevant portions of the IRA, forecasts that investment in grid-connected wind capacity will increase significantly over the EIA's 2021 AEO forecast. Some reasons for the 2023 AEO's larger forecast are discussed below in the section on developing estimates for 2023 legislation.

[9] As noted above, the EIA reference case wind forecast only reflected the prior law sunset date for the section 45 credit.

Credits related to electric vehicles

Several regulatory decisions by Treasury will affect estimates of the clean vehicle credits. The critical mineral and battery component requirements of the 30D credit have gone into effect for vehicles placed in service on or after April 18, 2023, rather than for vehicles placed in service after December 31, 2022.[10] The commercial clean vehicle credit under 45W is based on the incremental cost of a qualified commercial clean vehicle which is the excess of the price of such vehicle over the price of a comparable gas- or diesel-powered vehicle. Treasury determined that generally, the incremental cost of clean vehicles with a gross vehicle weight rating of less than 14,000 pounds is greater than $7,500 for purposes of the commercial clean vehicle credit under 45W.[11] This means that such clean vehicles, leased to consumers, may qualify for a $7,500 credit. The AGI and MSRP limitations, domestic assembly, critical mineral, and battery component requirements of section 30D do not apply to the credit under 45W. Generally, the Joint Committee staff estimates of the clean vehicle credits modified and implemented by the IRA anticipated a narrower interpretation by Treasury. Consequently, the Joint Committee staff 2023 baseline estimates for these credits are larger than originally anticipated.

Additionally, the Environmental Protection Agency ("EPA") has announced new proposed Federal vehicle emissions standards to take effect for model year 2027 vehicles and beyond.[12] If these standards go into effect, there could be a significant change in the take-up of electric vehicles that would not have been accounted for in the 2021 baseline projections of electric vehicle sales. Additionally, foreign governments providing similar production incentives for producing in those foreign countries may lessen the take-up of Federal energy incentives in the United States while State governments providing additional State production incentives may have an additive effect on Federal energy incentives. If such changes in policy take effect, future baselines would be different than the baselines used to produce the revenue estimates of the IRA.

Production credit for clean hydrogen

Economic developments since the development of the 2021 revenue estimate for clean hydrogen have increased the Joint Committee staff's expectations for potential clean hydrogen production credit claims. One source important in producing the 2021 baseline was the IEA's dataset of known clean hydrogen projects. In May of 2021, it contained only 16 such projects, mostly experimental or research facilities. The Joint Committee staff based its revenue estimates of the clean hydrogen production credit on the possible eligible production from these known facilities plus the potential for increased eligible capacity coming on line in the 2022-2031 budget period. As of this report, the IEA's dataset now contains 114 clean hydrogen projects, including more higher-capacity facilities. This indicates a substantial increase in investment in clean hydrogen production in less than two years, an increase that the information available in 2021 would not have justified predicting. As a result, the 2023 revenue baseline estimates a

[10] See IRS Fact Sheet FS-2023-08.

[11] See IRS Notice 2023-9.

[12] EPA-HQ-OAR-2022-0829 and EPA-HQ-OAR-2022-0985.

commensurately higher cost of the clean hydrogen credit as compared to the 2021 Joint Committee staff revenue estimate in JCX-18-22.[13]

In developing its estimates of the revenue effects of the clean hydrogen production credit, the Joint Committee staff assumed that Treasury would adopt a relatively stringent regime for assessing the lifecycle carbon emissions of hydrogen production, including regulations for matching electricity usage. One source of uncertainty when estimating the revenue effects of the clean hydrogen production credit is the manner in which Treasury ultimately regulates qualifying hydrogen. The amount of credit a kilogram of clean hydrogen qualifies for, or whether it qualifies for the credit at all, depends on the lifecycle greenhouse gas emissions rate of its production process. One of the most important factors in determining a production process's emissions rate is the carbon emissions of electricity used in production, particularly for hydrogen produced through electrolysis. The carbon emissions of electricity from the grid varies across hours of the day and across seasons and can significantly affect the emissions of a production for a facility drawing power from the grid. Thus, assessing the emissions rate for a particular production process and even a specific facility will depend on what time of day or year the hydrogen is produced, the location of the facility and the electricity generation mix of the local grid, and type of new generation added by the grid to meet new electricity demand created by hydrogen production. Matching a facility's electricity use annually can produce significantly lower lifecycle emissions estimates than matching electricity use on an hourly basis and may even subsidize hydrogen production with emissions rates higher than for hydrogen produced using fossil fuels.[14] The stringency of the regime for assessing the lifecycle carbon emissions of hydrogen production ultimately adopted by Treasury will have a significant effect on the cost of the provision.

[13] Note that in both baselines, these totals include projects in all stages of completion, including those in the "concept" stage with no estimated date to be placed in service.

[14] Ricks, Wilson, Qingyu Xu, and Jesse D. Jenkins, "Minimizing emissions from grid-based hydrogen production in the United States," *Environmental Research Letters*, January 6, 2023.

IV. DEVELOPMENT OF ESTIMATES FOR LEGISLATION DURING 2023

In general

An important factor to consider when comparing revenue estimates of IRA provisions produced under the 2021 revenue baseline versus the 2023 revenue baseline is the two-year shift in the budget window. Revenue estimates of Federal receipts under the 2021 revenue baseline include the years from 2021-2031, while the estimates of Federal receipts under the 2023 baseline include the years from 2023-2033. To the extent that the provisions of the IRA induce new investments, and these investments grow or ramp up over time, the modest amount of qualifying activity that the Joint Committee staff estimated to occur in the first fiscal year of the 2022-2031 budget period, 2022, may be more than offset by the increased amount of estimated qualifying activity that will reduce Federal receipts in fiscal years 2032 and 2033 of the 2023-2033 budget period. For many IRA provisions the Joint Committee staff expects the annual cost to increase over time, and that the years with the greatest reduction in Federal receipts will be the mid-2030s.

For example, under the clean hydrogen credit, facilities, including modified existing facilities, can claim the credit for 10 years beginning on the date the facility is placed in service. In addition, a facility may qualify for the credit so long as its construction begins prior to January 1, 2033. The Joint Committee staff expects the number of facilities beginning construction each year to increase until January 1, 2033. Facilities beginning construction just before this date will enter service several years later, just as the first facilities constructed under this credit are in the final years of their credit eligibility. As a result, shifting from a budget window going from 2021-2031 to a window running from 2023-2033 increases the revenue estimate substantially, even if there were no change to 2023-2031 in the 2023 revenue baseline, as Joint Committee staff expect there will be significantly more claims for the credit in 2032 and 2033, and that technology improvements mean that qualifying hydrogen will be cleaner under the criteria of the provision, and thus qualify for higher credit rates. For example, the Joint Committee staff currently estimates that the reduction in Federal fiscal year receipts in 2032 and 2033 will each be larger than the reduction in receipts from 2023-2028. The clean hydrogen credit is more expensive under the 2023 baseline due to large increases in the number of clean hydrogen facilities that were not anticipated using the sparse data available in 2021. Using the 2023 revenue baseline, total credits for clean hydrogen are estimated to be 2.5 times larger than under the 2021 baseline, with nearly three quarters of this increase due to the addition of the years 2032 and 2033.

Other credits behave similarly, and thus the effect on Federal receipts from these provisions generally will be larger when a proposed change in law is measured relative to the 2023 baseline than were that provision measured relative to the 2021 baseline, even if the estimates are the same in the years appearing in both baselines. The other fuels credits are estimated to have a higher cost under the 2023 baseline as well, although the difference is much smaller than for clean hydrogen. The increased cost for incentives for biodiesel, renewable diesel, and alternative fuels is largely a result of significantly higher actual claims for these credits in tax data for the years 2021 and 2022 than has been observed historically, as well as increased forecasts for domestic production capacity from other sources such as the EIA. While smaller in magnitude, the increased cost for sustainable aviation fuels is primarily due to a large

number of purchase agreements between airlines and sustainable aviation fuel producers since the creation of the 2021 revenue estimate, although it should be noted that many of these agreements are for future purchases from facilities that are not yet in service.

As discussed above, the CBO forecast and other external projections that account for changes in economic conditions can substantially affect predicted Federal revenues under a provision. For example, the new fuels provisions introduced by the IRA generally adjust the tax credit in each year for inflation. Relative to the 2021 CBO macroeconomic forecast, the 2022 and 2023 CBO macroeconomic forecasts both expect higher inflation for a longer duration. Because revenues are reported in nominal dollars and the CBO forecast expected higher inflation in 2023 than in 2021, the reduction in revenues due to the clean fuel production credit and clean hydrogen provisions are larger under the 2023 revenue baseline than for the 2021 revenue estimate, and would have been larger even with induced activity held constant.

Moreover, much of the difference in inflation expectations occurred between the 2021 and 2022 CBO macroeconomic forecasts. For the inflation measure used to adjust the clean fuel production credit and clean hydrogen credit, the 2022 forecast expected the price level to rise 6.3 percent more than the 2021 forecast by the end of the 2021-2031 budget period. The 2023 forecast expected price levels to rise 9.6 percent more than the 2021 forecast over the same budget window. That is to say, had the revenue estimates of IRA provisions produced in August of 2022 using the 2021 revenue baseline instead have been estimated using the expected inflation from the 2022 revenue baseline, then nearly two-thirds of the difference between the 2021 and 2023 revenue estimates caused by differences in inflation expectations would have been reflected in the estimate using the 2022 baseline, and the estimated reduction in Federal revenues due to the clean fuel production credit and clean hydrogen credit would have been commensurately larger. Analogous logic applies to other differences between the 2021 and 2023 forecasts such as a faster economic recovery, lower unemployment, and more investment, although the individual contributions of these items are not necessarily easily decomposed from the total difference in estimated baseline activity.

Similar effects of improved economic conditions between the 2021, 2022, and 2023 forecasts apply to other provisions. For instance, for the revenue estimates of sections 25C and 25D, tax credits for energy efficient home improvements and energy efficient property, the move from the 2021 baseline to the 2022 baseline included an approximately 65-percent increase in the sales growth rate for several eligible product categories. That growth rate was further adjusted in the 2023 baseline, but it was a smaller change, around 33 percent. Similar to the difference in inflation forecasts to the clean fuel production credit and clean hydrogen credit above, had the 2021 revenue estimates been updated to the 2022 baseline forecast the IRA revenue estimate would have been commensurately larger, and the difference between the IRA revenue estimate and 2023 revenue estimates would have been smaller.

This change in the forecast sales growth of eligible products carries through into the revenue estimate of the provisions – with particularly large effects later in the window. One reason for these large shifts in the baseline forecasts is that the sensitivity to price changes, the underlying price elasticities, are growing. This is a consequence of many eligible products starting to hit the price range where they are competitive with the products they substitute for. As products become competitive, they become much more sensitive to price, and forecasting this

sensitivity, the resulting elasticities, is difficult. The 2021 forecast did not adequately account for this, in part because the market for these products is rapidly changing as the products eligible for the tax credits are becoming more competitive on price, and some of these changes are reflected in the 2022 economic forecast but not the 2021 forecast. It is evident that for many products targeted by the IRA the competitive price threshold is above the subsidized price and a higher growth rate should be expected.

As an example, heat pumps have made large technological strides over the last decade, with improved cold weather performance and lower prices. Nevertheless, the upfront cost is still typically higher than competing systems. Whether the unsubsidized price of an air source heat pump is competitive today depends in part on whether consumers view them as competing just with an AC system (they are more expensive) or as replacing both an AC and furnace (the heat pump is cheaper), as well as the extent to which consumers consider the ongoing energy costs associated with each system. Furthermore, some consumers may have only an AC system or a heating system, are unwilling to invest in both, but may consider adding a heat pump for its dual role. Consequently, the competitive threshold for heat pumps is difficult to estimate and may vary from person to person and State to State. However, it has become clear over the last two years that because of their dual ability, subsidized heat pumps are now becoming competitive in many places in the country. This is one example of how a developing industry's product can be challenging to forecast as it crosses from price ranges where it is largely uncompetitive, into ranges where it is.

IRA credits

Investment and production credits related to electricity

Relating to analyzing proposals that modify the section 45 and section 45Y production tax credits, the 2023 AEO forecast shows cumulative wind capacity to equal 298 GW by 2031. This significant increase in wind capacity is due to a few causes aside from the increase in credit rates. First, increases in the generosity of the wind credit and the retirement of a sizable amount of fossil fuel fired generating capacity that is expected to be replaced mainly by solar and wind. Second, per conversations with NEMS modeling staff at EIA, the US electrical generating system has increased its ability to eventually absorb a greater amount of annual investment in wind capacity ("potential investment"). Thus, the 2023 EIA wind forecast has annual additions to wind capacity increasing from the 12-15 GW per year historical norm with full credit availability, to 30 GW by 2028 and gradually decreasing thereafter as the wind market becomes saturated. This increase in potential wind investment is a factor which the Joint Committee staff did not incorporate into its revenue estimate. The Joint Committee staff does not consider this a behavioral response by taxpayers but more of a change in the structural makeup of the U.S. wind industry. Finally, in addition to a significant increase in annual investment in wind reflected in the 2023 baseline, the Joint Committee staff, per conversations with EIA staff, has been informed that the domestic content bonus of an additional 10 percent in the credit rate will likely be met by most U.S. wind installations. This domestic content bonus is an item which was not reflected in the revenue estimates of the two provisions and thus, the Joint Committee staff estimate of the effective credit rate for grid-connected wind facilities was underestimated which, also led to an underestimation of how much new wind capacity may be stimulated by the credit.

The effects on Federal receipts of section 48 and section 48E investment tax credits are also significantly larger using the 2023 baseline versus the 2021 baseline. This is mainly due to a large increase in solar investment resulting from provisions in the IRA resulting in levelized costs for solar becoming competitive with fossil fuel fired capacity. For example, the 2021 baseline estimate of total grid-connected solar capacity installed in 2023 equaled 82.1 GW increasing to 183 GW by 2031. The 2023 AEO forecast of total grid connected solar capacity installed in 2023 is 103 GW increasing to 362 GW by 2031. The Joint Committee staff's estimate of baseline solar capacity used in estimating the section 48 and 48E provisions against the 2021 baseline resulted in significantly lower investment in solar capacity as the baseline relied on historical SOI data for the basis of the potential growth in investment for various technologies eligible for the section 48 credit.

Credits related to electric vehicles

The Federal receipts effects of the clean vehicle credits modified and created by the IRA are significantly larger using the 2023 baseline compared to the 2021 baseline. Annual sales and growth rate estimates of electric vehicles have changed significantly in the 2023 baseline compared to the 2021 baseline. For example, annual sales of passenger and light duty truck electric vehicles were projected to be 642,000 by 2031 in the 2021 baseline. The 2023 baseline estimates that annual sales will total 2.3 million electric and plug-in hybrid electric vehicles by 2031. The growth rate of sales projected in the 2023 baseline exceeds the sum of 2021 baseline projected sales plus the increase in sales estimated as part of the Joint Committee staff's estimate of these provisions for the IRA. Thus, even after accounting for projected behavioral change due to the credits, the growth rates the Joint Committee staff assumes in the 2023 baseline estimate are significantly higher than what was assumed for the 2021 baseline. This increase in the growth rate of the electric vehicle sales compared to what the Joint Committee staff had assumed for the 2021 baseline reflects a greater growth rate per existing electric vehicle model in addition to many new models of electric vehicles that have been introduced in 2023 that were not reflected in the 2021 baseline forecasts. The IRS has also recently released a list of the electric vehicles that will qualify for the credit in 2023, which was information not available in 2022. As mentioned above, Treasury also implemented rules that allowed more electric vehicles to qualify for clean vehicle credits in 2023 than anticipated.

Advanced manufacturing production credit

The advanced manufacturing production credit under section 45X is the item in the IRA that potentially represents the largest increase in the estimated baseline cost relying on 2023 baseline information relative to the cost using the 2021 baseline. There are several reasons including a significant increase in battery manufacturing capacity in United States that is likely to be placed-in-service between now and 2033. Estimates from Argonne National Laboratory, which were not available at the time the 2021 baseline was constructed, indicate a total battery manufacturing capacity of close to 1,000 GW hours by 2033. This is several multiples of what the Joint Committee staff reflected in the 2021 baseline estimate upon which estimates of increased capacity investment induced by the advanced manufacturing production credit were based. For the updated estimate of U.S. battery manufacturing capacity, the Joint Committee staff has relied on the Argonne National Lab estimate as a starting point in estimating baseline battery cell and module production that would qualify for the credit.

V. DISCUSSION OF RECENT COMMENTARY ON ESTIMATES PREPARED BY JOINT COMMITTEE STAFF

In general

A misunderstanding of what a Joint Committee staff revenue estimate reports, the difference between predicted Federal revenues under a proposal and predicted Federal revenues under baseline, creates confusion among some outside analysts that reference Joint Committee staff revenue estimates for comparison to their estimates. Many of these outside estimates appear to be tax expenditure estimates. That is, they are estimates of the total cost of a tax provision, rather than revenue estimates, which are estimates of revenue loss attributable only to the *change* in a tax provision, in other words the marginal cost.[15] In addition, these outside estimates generally do not mention the use of any offset, as described above, which reduces the cost of tax credit provisions substantially.

While the IRA modified, extended, and created energy related credits, two of the largest, by dollar amount, business credits claimed under prior law were the energy investment credit under section 48 and the renewable electricity production credit under section 45.[16] That is, prior law versions of credits for energy investment and electricity production are accounted for under the revenue baseline, as well as prior law versions of credits for electric vehicles, renewable fuels, *etc*.[17] For example, the revenue estimate of the energy investment credit reported on JCX-18-22[18] was not the projected cost of the energy investment credit under the IRA, rather it was the projected cost of the energy investment credit under the IRA less the projected cost of the energy investment credit under the revenue baseline.

Additionally, as discussed above, many Joint Committee staff revenue estimates incorporate offsets to capture interactions between various parts of the Code. For example, the IRA offers a tax credit for home energy audits, capped at $150. Even (wrongly) assuming all claimants use the maximum credit amount, the cost to the U.S. government of this credit will be less than $150 times the number of claimants because the auditors will pay taxes on their income and/or profits. Comparing estimates of IRA tax credits performed by other organizations that do not account for offsets with estimates produced by the Joint Committee staff may result in estimates that are mechanically approximately 20-25 percent larger than those provided by Joint

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[15] For a more detailed description of the difference between the Joint Committee staff's tax expenditure and revenue estimates see Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2022-2026* (JCX-22-22), December 22, 2022.

[16] Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2022-2026* (JCX-22-22), December 22, 2022.

[17] For a description of prior law energy tax credits and changes made by the IRA to energy tax credits, see Joint Committee on Taxation, *Description of Energy Tax Changes Made by Public Law 117-169* (JCX-5-23), April 17, 2023.

[18] Joint Committee on Taxation, *Estimated Budget Effects of the Revenue Provisions of Title I – Committee on Finance, Of An Amendment In The Nature Of A Substitute To H.R. 5376, "An Act To Provide For Reconciliation Pursuant to Title II of S. Con. Res. 14," As Passed by the Senate On August 7, 2022, And Scheduled For Consideration By The House Of Representatives On August 12, 2022* (JCX-18-22), August 9, 2022.

Committee staff. The paragraphs below provide more detail on comparisons to Joint Committee staff estimates of specific IRA provisions made by outside analysts.

Comparison with other estimates

Investment and production credits related to electricity

Estimates by Christine McDaniel with George Mason University ("GMU") place the cost of wind production tax credits alone at $68 billion.[19] Although this is similar in magnitude to the Joint Committee staff's revenue estimate of modifications to such production tax credits using the 2021 baseline, the two estimates are not directly comparable. The Joint Committee staff estimate is the difference between baseline cost and the cost of the proposal, a revenue estimate, whereas the GMU estimate is the total cost of the provisions alone, not relative to any baseline. Additionally, in making this cost comparison, the author only compared to the estimate of the clean electricity production credit under section 45Y, omitting the estimate of the extension of the section 45 production credit.

Credit for carbon oxide sequestration

The Brookings Institution estimated the cost of the section 45Q provision (credit for carbon oxide sequestration) to be $100 billion through 2031.[20] This estimate represents the total cost of the provision rather than a revenue estimate. This estimate was generated by the Electric Power Research Institute ("EPRI") model which only focuses on the electric power sector. The Joint Committee staff finds the magnitude of this estimate to be difficult to rationalize based on estimates of oil and gas production via enhance oil recovery technologies given that the vast majority of carbon capture and storage is used for enhanced oil recovery purposes.[21] For example, the 2023 AEO forecast of the production of oil via enhanced oil recovery shows this increasing to 0.42 million barrels per day by 2031. The 2021 baseline estimated 0.38 million barrels per day by 2031. This appears to suggest EPRI assumes the vast majority of CO2 captured via sequestration from the electric power sector will be used for industrial purposes. This would imply that this CO2 would be competing with CO2 that is captured and distributed from naturally occurring sources. Without significant research into the operations of CO2 markets for industrial purposes, it is difficult to determine if it would be profitable to engage in CO2 capture from industrial sources as the taxpayer would have to incur the costs of not only the capture equipment but also a distribution system. The Joint Committee staff's review of the literature on carbon capture and storage, suggests there is a fairly wide distribution of costs relating to carbon capture depending on the specific industry. It also is not clear what the market effects of significantly increasing the market supply of CO2 for commercial use may be and whether the necessary investments are profitable even accounting for the section 45Q credit.

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[19] https://www.forbes.com/sites/christinemcdaniel/2023/03/08/the-costs-of-wind-production-tax-credits-provided-in-the-ira/, last accessed April 20, 2023.

[20] Bistline, John, Neil Mehrotra, and Catherine Wolfram. "Economic Implications of the Climate Provisions of the Inflation Reduction Act," *Brookings Papers on Economic Activity*, March 31, 2023.

[21] CRS report R44902 indicates a total of 12 facilities in the United States are engaged in carbon capture and storage of which 11 use the CO2 as an injectant in EOR projects.

Thus, without considerable insight into the assumptions and model parameters contained in the EPRI estimate, it is difficult to rationalize the $100 billion estimate for this provision.

Credits related to electric vehicles

The Brookings Institution report estimates the total cost of clean vehicle credits to be $390 billion by 2031.[22] The Joint Committee staff finds this estimate of the clean vehicle provisions to be difficult to reconcile based on vehicle market data and plausible assumptions regarding the growth of electric vehicle market share between now and 2033. For example, U.S. passenger vehicle and light duty trucks (which include SUVs) sales are projected to be 15 million vehicles in 2031 according to the AEO vehicle forecast. As of the end of 2022, electric vehicles account for approximately a six-percent market share. The 2023 AEO forecasts this market share to increase to approximately 16 percent by 2031. Using this growth rate, it seems unlikely that costs could reach $390 billion. The estimate reported by the Brookings Institution also does not account for the MSRP or AGI limitations in the clean vehicle credit. Finally, there are "second order" effects which are not taken into consideration by the Brookings report such as an offsetting impact on gasoline and diesel excise tax receipts of increased electric vehicle sales diminishing future Federal receipts from the motor fuel excise taxes.

Credit for sustainable aviation fuel

For some provisions, misunderstandings regarding how the Joint Committee staff modeled the interactions between provisions has led external organizations to interpret Joint Committee staff estimates incorrectly. For instance, the Brookings Institution report states that with respect to sustainable aviation fuel "The IRA also adds a tax credit for sustainable aviation fuels of $1.75/gallon with the labor bonus, although CBO [sic] estimates, consistent with those of outside modelers, reflect relatively low take-up of this credit."[23] However, the section 40B provision providing for a credit (up to $1.75 per gallon) for qualified sustainable aviation fuel mixtures interacts with the provision providing a $1 tax credit per gallon for the production of biodiesel and renewable diesel. Both provisions apply to fuel sold or used after December 31, 2022, and before January 1, 2025.

The feedstocks used to produce sustainable aviation fuel can also be used to produce renewable diesel at lower cost. Moreover, the supply of these feedstocks is likely to remain constrained in the near future, such that the larger incentive for producing sustainable aviation fuel will result in the diversion of feedstock that would otherwise have ultimately been used for the production of renewable diesel. As a result, the Joint Committee staff estimates for the incentives for sustainable aviation fuel and for biodiesel and renewable diesel are sensitive to stacking order, and the cost in terms of reduced revenue for each gallon of sustainable aviation

[22] Bistline, John, Neil Mehrotra, and Catherine Wolfram. "Economic Implications of the Climate Provisions of the Inflation Reduction Act," *Brookings Papers on Economic Activity*, March 31, 2023.

[23] *Ibid.* While CBO published estimates of the IRA, the estimates of the tax provisions were produced by Joint Committee staff.

fuel is offset by the reduction in revenue that would have happened had the feedstock not been diverted from renewable diesel.

Because the Joint Committee staff revenue estimate for sustainable aviation fuel relies on the difference between the credit for sustainable aviation fuel, which itself is between $1.25 and $1.75 and depends on the lifecycle carbon emissions of sustainable aviation fuel, and the credit the feedstock would have gotten had it been used for renewable diesel, it is impossible to infer from only the published revenue estimate how many gallons of sustainable aviation fuel are implied to have claimed the tax credit. While the published revenue estimate of the reduction of Federal fiscal year receipts of $49 million for sustainable aviation fuel does reflect relatively moderate take-up compared to the volume of claims for biodiesel or renewable diesel, total gallons claimed would be approximately 4.5 times higher than implied by simply dividing this amount by $1.75.

Production credit for clean fuel

Some organizations such as Goldman Sachs have reported substantially higher estimates of the section 45Z clean fuel production credit.[24] The Joint Committee staff revenue estimate of the cost of this provision on the 2021 revenue baseline, including the extensions of existing credits for alternative fuels, biodiesel and renewable diesel, and second-generation biofuel through December 31, 2024, is $8.6 billion. Goldman Sachs estimates these provisions will cost $43 billion. However, due to the structure of the credit, the clean fuel production credit is, for the most part, less generous than the existing alternative fuel and biofuel incentives. Under prior law, the section 40A credits for biodiesel and renewable diesel, which comprised the vast majority of all fuels credits, were $1 per gallon of qualifying fuel. The clean fuel production credit base credit is also $1, but it is multiplied by the emissions factor for the fuel in question, which equals 50 minus the fuels emissions rate (in kilograms of carbon dioxide equivalents per million British thermal units, "kg of CO2e per mmBTU)", divided by 50. Qualifying fuel must have an emissions rate less than 50 kg CO2e per mmBTU. Thus, most fuels that are rated by the EPA to have a net positive emissions rate shall receive a credit less than $1, and possibly much less.

Thus, relative to most fuel claiming this credit under the extended prior law, the clean fuel production credit is a less generous incentive. However, the estimate from Goldman Sachs is larger than the estimate of an extension of the prior law fuels incentives on the 2021 revenue baseline through 2027 (the termination date for the clean fuel production credit). Estimates of extending prior law fuels provisions are still subject to the standard uncertainty that affects all estimates due to, for instance, unforeseen changes in macroeconomic circumstances, natural disasters, or international relations. However, extensions of existing provisions are based on historical credit claims data, and thus have higher certainty than do estimates for new provisions. The Joint Committee staff estimates that extension of the incentives for alternative fuels, biodiesel and renewable diesel, and second-generation biofuels through 2027 would reduce

[24] Goldman Sachs. "Carbonomics: The third American energy Revolution." March 22, 2023.

Federal fiscal year receipts by $17.1 billion. The Joint Committee staff does not believe an estimate two and a half times larger for a generally less generous credit to be likely.

There are a few cases in which the clean fuel production credit may be more generous than prior law. First, prior law alternative fuels incentives were only 50 cents per gallon. However, many of these fuels are also petroleum based and will be eligible for little or no credit under section 45Z. Second, fuels that receive a negative lifecycle emissions rating from the EPA can receive a credit larger than $1 per gallon. However, current production of such fuels is limited or not suited to widespread use as a transportation fuel without further processing.[25] Finally, the clean fuel production credit incentive for sustainable aviation fuel is larger than existing incentives, between $1.25 and $1.75. However, much less sustainable aviation fuel is produced than biodiesel or renewable diesel, and it will take several years to design, permit, and construct the necessary facilities, giving them little time to claim the clean fuel production credit before the provision sunsets after 2027.

Production credit for clean hydrogen

The clean hydrogen production credit is available for hydrogen produced at a qualifying facility that is (1) produced after December 31, 2023, (2) during the 10-year period beginning on the date the qualifying facility was originally placed in service, and (3) the construction of such facility begins before January 1, 2033. For the purposes of the credit, existing facilities originally placed in service prior to January 1, 2023, and that did not produce qualified clean hydrogen, but that are modified to produce qualified clean hydrogen, are deemed to have originally been placed in service on the date the property required for the modification is placed in service. Because this credit is new and construction of qualifying facilities can take many years, the Joint Committee staff do not expect initial claims for the credit to be large. However, there are several issues when comparing the estimate for this credit to external estimates.

While it is possible the final revenue cost of the provision will be significantly higher than that which the Joint Committee staff estimated under the 2021 revenue baseline, the scale of some external estimates for the clean hydrogen credit appear unjustifiably large. For instance, the Brookings Institution report estimates in their "higher fiscal costs" scenario that the total cost of clean hydrogen credits could reach $100 billion through 2031, as compared to the Joint Committee staff's estimate on the 2021 baseline of $13.2 billion. These estimates are difficult to compare without more details on Brooking's model. For example, whether they assume all hydrogen is produced through electrolysis, which is relatively electricity intensive, or through other means, and whether they include the credits for renewable electricity used for electrolysis in this figure.

Assuming the $100 billion represents credit amounts going directly to production of clean hydrogen and that all clean hydrogen will receive the full $3 credit per kg, this implies average annual green hydrogen production of 3.7 million metric tons ("MMT") over the years the credit is effective under the 2021 revenue estimate (calendar years 2023-2031). The United States presently produces approximately 10 MMT of hydrogen of all types annually, over 95 percent of

[25] Renewable natural gas can achieve significant negative emissions factors, but few vehicles can utilize it as a fuel and building the infrastructure to use it in existing vehicles or reformulate it would take several years.

which is produced through steam-methane reforming of natural gas alone. Because green hydrogen comprises only a small fraction of current hydrogen production and production facilities take many years to plan, permit, and build, displacing more than one third of current annual production on average implies an optimistic view that a large share, and perhaps majority, of all domestic hydrogen production will be green hydrogen within only nine years.

However, it is unlikely that all hydrogen will receive the full $3 credit, as carbon may be emitted at several points along the production path, particularly for methods that are not electrolysis. If the $100 billion figure assumed that not all green hydrogen will be eligible for the full $3 credit, then the implied amounts of green hydrogen produced will be larger still.

All revenue estimates contain uncertainty and could be either overestimates or underestimates. Whether any particular provision is an underestimate will not be known for several years. However, there are some indicators that the 2021 baseline used to estimate claims for the clean hydrogen production credit may have underestimated the level of claims (although this will depend to a large degree on Treasury's final regulations, particularly for matching electricity usage). Common sources of information pertaining to energy used by the Joint Committee staff in preparing annual baselines, such as EIA's AEO, presently do not forecast total hydrogen production, much less any measure of clean hydrogen production, specifically.