ESG Report

CREDIT SUISSE

Treeprint

US Inflation Reduction Act – A tipping point in climate action

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Executive summary

The knowns and the known unknowns

The IRA is the most comprehensive, ambitious climate legislation passed in the US, preserving most of the key provisions in Biden's original Build Back Better Plan (BBB). The bill is well designed and should be politically durable: it's economically attractive and technology-agnostic in the production of clean electricity and clean fuels (inclusive of carbon capture and nuclear); it incentivizes deployment of clean energy supply and transformation of energy demand; it focuses on scaling mature technologies in this decade and advancing climate tech innovations for the 2030s and beyond; it reduces cost of green financing and puts just transition considerations front and center. The profound effects of the IRA could take years to unfold.

From an execution standpoint, there are still many known unknowns. Internal Revenue Service (IRS) guidance is critical to providing clarity around wage and apprentice requirement, credit stackability, definition of domestic content (i.e., assembled or fully built) and qualification of specific components, among others. Permitting uncertainty remains the single biggest execution risk in our view in reaching the full potential of the IRA, particularly around transmission, CO_2 Class VI permits, and future green infrastructure build-outs. Many domestic manufacturing credits could also be challenged by other countries and WTO.

Some may also question whether the IRA may be reversed if Republicans take control of the White House and/or Congress. It's not impossible (to an extent) but doesn't seem sensible, in our view. Not only because the effects of the IRA will be starting to be felt in two-years time but also that Republican-leaning states are likely to see the most investment, job, and economic benefits from the IRA. The bill is also supportive of the US' long-term energy security, geopolitics, and trade interests.

Macro implications

Roughly two-thirds of the baseline IRA spending is allocated to provisions where the potential federal incentive is uncapped, meaning the ultimate outlay is either based on units of production or upfront capital spent. As such, we believe the Congressional Budget Office is significantly underestimating costs of certain provisions as the attractiveness of credits could propel much higher activity levels, particularly in green manufacturing, carbon capture and clean hydrogen.

Using our own forecasts, we see federal climate spending at over US$800 billion, doubling the baseline of >US$400 billion. Combined with the multiplier effect on private investments and green financing programs, total spending could reach nearly US$1.7 trillion over the next ten years. The question of how all of this spending would be funded is another matter entirely and is beyond the scope of this note.

The IRA magnifies the strategic advantages the US already holds (natural resources, infrastructure, geologic storage, technical expertise and technology talent) and enables the industry to become a dominant energy supplier in the low carbon economy. The stacked benefits of the clean electricity and manufacturing tax credits would make US solar and wind the cheapest in the world, reaching <US$5/MWh by 2029. The cost of green hydrogen on the Gulf Coast could also be among the lowest in the world, owing to clean hydrogen credits and cheap clean electricity. This cost competitiveness positions the US to potentially export solar components as well as hydrogen and derivative products. In addition, with incentives in place for both upfront capex and future production, we believe the scale and speed of carbon and hydrogen hub developments could surprise to the upside, enabling the US to leapfrog other nations in climate actions.

However, not all aspirations are achievable. The US is not currently competitive globally in the production of lithium-ion batteries and critical minerals. Even with the manufacturing incentives in place, the US$7,500 EV credit may not be sufficient to incentivize automakers to completely overhaul their supply chain (assembly, battery components, and critical mineral sourcing), particularly given other restrictive requirements (i.e., price and income caps).

Sector implications

Power: The new credits provide long-term certainty, flexibility on the choice of credits (production- or investment-based) and are technology-agnostic. Combined with the manufacturing tax credits, the US should benefit from the lowest levelized cost of clean electricity in the world. This should accelerate renewable energy adoption and unlock additional market opportunities particularly for the production of green hydrogen. While there are uncertainties around permitting and transmission and that the benefit is unlikely to materialize until 2024 or later, we believe stocks in general are not reflecting the long-term growth potential unlocked by the IRA.

Energy transition solutions: We believe natural gas-based hydrogen with carbon capture (aka blue hydrogen) is now cost competitive with existing production without carbon capture though renewable-based hydrogen (aka green) may be the cheapest option today with the new US$3/kg tax credit. On carbon capture, the increase in the 45Q tax credit more than doubles the total point source carbon capture addressable emission to nearly 350 million tons per year, of which an additional 75–100 million tons per year could be captured and sequestered by 2030 vs. current projects in development. We expect hub developments to accelerate with 22 hydrogen hub proposals currently in play for DOE's US$8 billion hydrogen hub grant (funding announcement to be decided in Fall 2023). Multiple large-scale carbon capture coalitions are also being formed.

Transport: The US$7,500 credit appears highly restrictive from a price/income/assembly/domestic content perspective, though lack of credit has not negatively affected EV penetration in the past. We believe US Autos OEMs will benefit more than the EMEA Autos OEMs, mainly from removal of volume cap and from the subsidies to build out manufacturing capacity in the US. It should also support the global EV ambitions of Japanese OEMs.

On the other hand, there are no restrictions on the US$40,000 credit for commercial trucks; we estimate total cost of ownership for BEV (battery electric vehicles) may now be cheaper than diesel trucks, albeit not yet for fuel cell trucks, helping trucking companies, particularly those with shorter/local routes, to accelerate electrification. However, range concerns, limited number of models offered, and electric infrastructure availability remain key hurdles. EV charging also gets credit of up to US$100k per location but is limited to low-income and rural areas, which benefits highway/remote DC fast chargers. We believe IRA should also be positive for biofuel/sustainable aviation fuel companies given extension/increase of credits and for renewable natural gas given credits are now available for both transport and electricity use cases.

Solar/wind manufacturing: We estimate subsidized cost of solar modules may be 20–40% of the unsubsidized costs while wind turbine costs may be reduced by >50% with the IRA manufacturing credits. The attractiveness of subsidies is such that not only could the US replace demand almost entirely with domestically sourced products (we assume 90% of domestic manufacturing by 2030), it could also become a net exporter (though it could be challenged via tariffs from other countries and WTO retaliation). We expect to see strong competition from existing and new crystalline silicon suppliers given strong incentives. Polysilicon remains key to self-reliant supply chain, since 90% of global polysilicon manufacturing is currently in China.

From a global perspective, the IRA is a positive for APAC solar manufacturing in the near term as two-thirds of US modules are imported, but the long-term implication is more negative. APAC companies may also be incentivized to build manufacturing capacity in the US.

US steel producers should also benefit from less outsourcing and accelerated growth in wind and solar installations.

Battery manufacturing: Battery factories are burgeoning with BloombergNEF (BNEF) estimating US battery capacity to grow to over 600 GWh/year by 2030, 6x the capacity in 2022. Announcements have continued following the signing of the IRA. Auto OEMs and battery makers are well positioned to benefit from IRA credits for plants in development as well as future expansions. However, material sourcing away from China will be a challenge. It's yet to be seen whether auto OEMs are willing to completely overhaul their supply chain as a single breach (i.e., using graphite processed in China) could disqualify the vehicle from claiming the US$7,500 credit.

The anti-China provisions in the EV credit would also put a premium on domestically produced critical minerals and battery components. Critical mineral producers in the US and Free Trade Agreement (FTA) countries are likely to be beneficiaries.

Buildings: While our total spending is not baking in higher demand for building-related tax credits (most uncapped), there's upside given attractive incentives for heat pumps, solar, and home energy efficiency upgrades. There's also indirect benefit from lower cost of renewable energy by accelerating building electrification. We believe the incentives are more impactful for retrofits than for new home construction. This should benefit HVAC companies, insulation installers, the installation of heat pumps, solar panels and EV charging stations. Leaders of low-emission cement should also benefit given incentive to purchase low-carbon materials for federal projects.

Oil and gas: We believe the IRA will have little direct impact on US oil and gas production (i.e., more lease sales and higher royalty rates on federal lands are unlikely to materially affect capex programs). Introduction of a methane fee addresses an issue the industry is already actively engaged in and one where US Environmental Protection Agency's (EPA) rulemaking is ongoing. Meanwhile, tax credits for hydrogen, CCUS (carbon capture, utilization, and storage), and biofuels should all be a net positive for the oil and gas industry as they target energy transition areas where companies are already investing in and where they have a competitive advantage. This ensures the energy sector a role in the transition, which is supportive of transition initiatives of oil majors.

Land and water: There's US$20 billion allocated toward agriculture, most of which is tied to advancement of sustainable farming and conservation practices. We also expect the IRA to benefit the broader water industry, with US$4 billion toward mitigation of the impact of droughts in Reclamation sites, and >US$2 billion toward wildfire relief.

David Bleustein
Global Head of Securities Research

Portfolio Manager's guide to the IRA

Below we provide key highlights of the bill based on our observations – what we know, the known unknowns and what's missing. The chapter Macro Implications of this report includes on a sector-by-sector basis a detailed rundown of the climate and energy-related provisions and sector implications.

The knowns

- **Climate spending will likely be significantly higher than the headline estimate.** Roughly two-thirds of the baseline spending is allocated to provisions where the potential federal credit/incentive is uncapped. Our assessment of potential demand for clean electricity production tax credits (PTC) and investment tax credits (ITC), carbon capture, clean hydrogen, and renewable/battery manufacturing credits shows federal spending could reach >3x the cost estimates assigned for these key provisions. The advanced manufacturing provision alone could cost US$250 billion given the credits across solar, wind, and battery supply chains.
- **Broad-based incentive program with a technology-agnostic approach.** After 2024, any electricity-generating facility with zero GHG emissions can qualify for either a 30% ITC or a US$26/MWh PTC, which would theoretically include geothermal, biogas, and power plants with 100% carbon capture. Similarly, hydrogen credits are based on emission intensity metrics rather than specific technology, and the increase in carbon capture credit from US$35-50/ton to US$60-85/ton would also make sequestration of many point-source CO_2 streams economical. Energy storage, biofuels, sustainable aviation fuels, renewable natural gas, and nuclear all have incentives.
- **Funding the transition from both the demand and the supply side.** Of the climate and energy-related provisions, we estimate that nearly 20% of the total spending will be used to spur demand transformation – such as incentives for home energy efficiency, heat pumps, electric vehicle credits, and green financing (such as green bank), which could be particularly effective to accelerate private capital into sub-scale investment areas or to overcome upfront cost hurdles. Similarly, IRA provides incentives for both demand pull and supply push to spur development of a green manufacturing industry in the US.
- **Benefit of certain tax credits can last well into 2040s.** The vast majority of the tax credits are available for ~10 years (ending in either 2031 or 2032), and are based on construction date, meaning a project constructed in early 2030s would receive tax credits into the 2040s. IRS has historically allowed a two- to four-year construction duration for such projects, implying projects starting in 2034–35 could also receive the full tax credits. Clean electricity credits could last even longer as they are available until the latter of when US electricity generation related emissions reach 25% of the 2022 level or 2032. NextEra Energy, the US' largest renewable developer, noted in September that the 75% reduction may not be reached until the 2040s, meaning clean energy credit may last potentially for two decades. Meanwhile, the clean fuels production credit (applicable to biofuels, sustainable aviation fuels, etc.) is only available until 2027. The majority of green financing funds (e.g., DOE loan programs) are authorized until 2026, meaning the bulk of the impact on capital deployment would be seen within the first five years.
- **Domestic content a key feature for ITC, PTC, EV and manufacturing credits.** Clean electricity ITC and PTC credits have a 10% bonus (percentage points in the case of ITC) if all **steel, iron** and >40% **manufactured products** are made in the US. The latter is defined as products where certain percentage of the total costs of the components are mined, produced, or manufactured in the US. Half of the US$7,500 clean vehicle credit is tied to **battery components** made in North America while the other half is tied to **critical minerals** from US and FTA countries, though clean commercial vehicle credits are not subject to the same restriction. In addition, the government will directly subsidize part of the cost to make components for solar, wind, storage projects, and critical minerals.
- **Bonus for energy communities and for environmental justice.** Clean electricity projects in "energy communities" and "low-income communities" can each receive a 10% bonus (albeit just solar and wind for the latter group in 2023 and 2024 only). An estimated US$47 billion of spending is related to environmental justice. Forty percent of the US$10 billion advanced energy manufacturing credit funding is allocated to "energy communities" while a new US$250 billion DOE loan guarantee authority is made available to "retool, repower, repurchase, or replace energy infrastructure that has ceased operations."
- **Excluding battery components from China and Russia starting 2024.** The clean vehicle credit specifically disqualifies vehicles that are imported or built with battery materials sourced from "foreign countries of concern" starting in 2024 and vehicles that use critical minerals from those countries starting in 2025.

This effectively disadvantages China and Russia as trading partners. The clean electricity credit bonus is also contingent on US content only, which disadvantages Canada and Mexico, among other trading partners.

- **Introduces direct pay and credit "transferability."** Direct pay feature is available only to non-profits/tax-exempt entities and publicly owned utilities for all credits.

Taxable entities can claim the credit for production of clean hydrogen, CCUS (45Q), and advanced manufacturing production, but only for the first five consecutive years. However, all credits can now be sold for cash (likely at some discount) to any entity with income tax liability, reducing the reliance on tax equity financing.

The known unknowns

- **Waiting on specific IRS guidelines.** We attended multiple industry trade shows and conferences covering solar, energy storage, hydrogen, carbon capture, etc., in mid-late September, and almost all public and private companies told us they await clarity from the Treasury/IRS on interpretations of the various provisions in the IRA. Many specific criteria for tax credits need to be set by the IRS, including the new wage and apprentice requirement, stackability, what qualifies as domestic content (i.e., assembled or fully built). Some of these guidelines will also help companies firm up their manufacturing plans. The industry expects resolution in the next three to six months, i.e., in 4Q22/1Q23.
- **Credit "stackability" could have outsized impact on value chain economics.** Clean hydrogen production credit (45V) cannot be used in conjunction with CCUS credit (45Q) but can be used with renewable or nuclear credits, giving less preferential treatment to blue hydrogen. Similarly, a gallon of sustainable aviation fuel (SAF) could potentially benefit from four layers of credits across the supply chain: advanced manufacturing credit for production of solar/wind components, ITC/PTC for the generation of clean electricity, 45Q for direct air capture with utilization, and up-to-US$1.75/gallon of clean fuels production credit for using CO_2 as a feedstock for SAF. The actual multiplying effect of these credits should unfold over time as government agencies, lawyers and corporates translate the massive IRA bill into implementation plans, though we believe it's likely going to be more profound than what we currently anticipate.
- **Permitting reform.** Arguably the biggest risk to the full extent of the IRA is the ability to site, permit, and connect renewable/clean energy projects and related transmission infrastructure at sufficient pace and scale. To gain the support from Senator Joe Manchin for the IRA, the Senate Majority Leader (Chuck Schumer) struck a deal with Manchin to vote on comprehensive permitting reform legislation before the end of September as part of a stopgap government funding bill. However, after much pushback from certain Democratic and Republican Senators (and House Democrats) that seemed to indicate Manchin did not have the 60 required votes in the Senate to proceed, Manchin and Schumer agreed to have the permit reform language removed from the bill to avoid a government shutdown. According to reporting from The Hill, lawmakers may try to add permit reform to a different piece of legislation later this year, but this recent impasse highlights the challenge ahead.
- **US political environment.** Some may also question whether the IRA may be reversed if Republicans take control of the White House and/or Congress. That doesn't seem sensible, in our view. We believe IRA does not marginalize the US energy industry; instead, it's beneficial to the energy transition interest areas the industry is already engaged in such as carbon capture and biofuels. Republican-leaning states currently lead in the production of renewable electrification generation as they have the most abundant natural resources. Post IRA, they stand to benefit the most from future renewable/battery capacity expansion, and the development of new low-carbon industrial hubs. This creates jobs, new tax revenue sources, and ultimately, support for climate investments from the voting base more broadly.
- **Wage and apprenticeship requirement:** The IRA requires all projects >1 MW to comply with prevailing wage and apprenticeship requirements to receive full tax credits. Projects that don't qualify receive only a fifth of the tax credits. However, in the absence of precedence, the renewable and clean energy industry awaits the Treasury to issue clear guidance and compliance requirements for contractors.

- **Spirit of the law on alternatives – Thin film solar wafer/poly incentives:** The Clean Manufacturing Tax Credit provides ~1c/W of incentive for solar polysilicon and ~6–7c/W for solar wafer. However, the bill doesn't explicitly specify if other alternative technologies, such as First Solar's thin film technology, qualify for the polysilicon and wafer manufacturing tax credits. First Solar's thin film technology is based on Cadmium-Telluride, instead of polysilicon, which is directly deposited on a large glass instead of cutting into wafers. While the spirit of the law implies First Solar (FSLR) should also receive the same benefits, credit recognition will require a confirmation from the IRS.
- **Inverter/electronics assembly requires analysis:** The IRA gives ~6.5c/W for residential inverters (benefits SEDG) and ~11c/ for microinverters to be manufactured in the US (benefits ENPH). Our company checks suggest that even labor-intensive string inverter/electronics assembly can be economically moved to the US, paving the way for even automated assembly lines used for microinverters. However, companies are in the early stages of studying potential costs for US manufacturing to ascertain incremental benefits to manufacturers.
- **Battery economics require cost/benefit analysis:** The Advanced Manufacturing Tax Credit potentially provides significant funds for developing a localized supply chain for battery and critical materials, though it is still unknown if it will be enough to attract additional investment to the world's third largest EV market, on top of the ~400 GWh planned battery capacity additions in the next few years. A thorough cost analysis must be completed to determine if costs of compliance will yield an acceptable return or improve competitiveness.
- **Access to critical minerals in the US:** There is still more clarity to come as guidance must be provided on the battery components and critical materials elements of the bill, which may also lead to a delayed strategy shift from some players (including those who have final assembly in the US but will need to adjust their supply chains). The legislation allows the US to procure critical minerals from partner countries (i.e., those with free trade agreements), but it is unclear if IRS can expand the list.
- **Country/WTO retaliation:** We expect countries to challenge US tax credits directly or via the WTO. Moreover, we expect challenges from auto manufacturers that do not qualify for EV tax credits given they assemble in other countries or use non-Union labor. We expect retaliation against cheap solar modules and wind turbines made in the US from other countries aiming to build their own manufacturing base (e.g., Europe).
- **EV tax credits:** The final assembly restrictions on the US$7,500 tax credit will make many EVs that currently qualify for the credit lose their eligibility. It is yet to be seen if lost sales of EVs that are no longer eligible for the tax credit will lead to an incremental sale at a company where the tax credit still exists, or if a lower-priced ICE (internal combustion engine) vehicle is purchased instead.

What's missing

- **No investment tax credit for new transmission lines.** This is likely due to the view that impediment to building new transmission lines is less about economics than inability to get permits. As we discussed, the separate deal between Senators Manchin and Schumer on permit reform has collapsed. However, the Federal Energy Regulatory Commission (FERC) reform to address the backlog related to connecting new renewable energy projects to US transmission grids remains ongoing.
- **Direct pay:** One of the most requested features in BBB and from environmental lobbies was a direct pay mechanism which would make it easier for companies to monetize different tax credits. However, the IRA only includes direct pay for clean hydrogen, 45Q (CCUS/DAC), clean energy manufacturing, and non-tax paying entities.
- **Comparatively light on agriculture/forestry:** While the IRA provides comprehensive incentives for energy-transition-related industries, agriculture spending was just US$20 billion (5% of the headline spending) when agriculture accounts for 11% of the US' GHG emissions. Specific efforts such as protecting biodiversity or reducing the use of chemical pesticides is also lacking, unlike spending being allocated in the EU (€100 billion under Nature Restoration law).

Macro Implications

The passing of the Inflation Reduction Act (IRA) will likely be seen as the tipping point in the US' response to climate in the decades to come. After much uncertainty around passage of a reconciliation bill, the large majority of the climate and energy provisions originally proposed in the Build Back Better Plan survived unscathed. As such, the bill marks the most ambitious legislative action the US has ever taken on climate. It contains sweeping tax credits/incentives and grants/loan programs across multiple industries – most notably clean energy, transportation, and manufacturing – and will foster innovations in climate tech and related R&D. We believe the bill will have far-reaching effects on the energy systems transition, financing, supply chains, global trade, and policies, and the profound nature of which may take years to unfold.

In this chapter, we delve into macro implications of the IRA bill, putting into context:

- The magnitude of potential spending on climate and energy in the next decade
- Why we believe IRA is transformative for green developments from a financing, social and policy perspective
- Implications on US manufacturing, supply chains and global competitiveness

Spending in context: significant impact on total climate investments

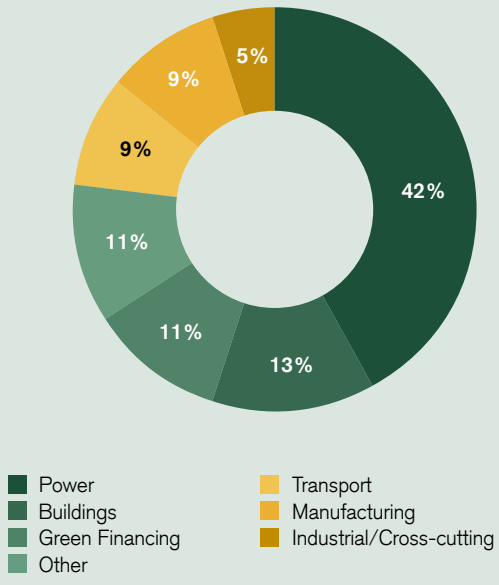
The baseline

We identified over 60 provisions on climate and energy initiatives in the IRA, which add up to **over US$400 billion in spending over the next 10 years** based on cost score published by the Congressional Budget Office (CBO)[1]. Based on those estimates, most (~42%) of the investment is earmarked for the power sector which encompasses funds for clean electricity generation, energy storage, and transmission. This is followed by buildings, accounting for ~13% of the spending, aimed mostly at residential and commercial energy efficiency upgrades along with incentives for green building developments. Green financing is the third largest category at 11%, which we discuss in more detail below. The remaining allocation is broken into transport and manufacturing at ~9% each, industrial/cross-cutting (e.g., CCS and hydrogen) at 5% and other sectors (e.g., land, water, agriculture etc.) at 11% in total. See Figure 1.

The IRA in conjunction with last year's Infrastructure Investment and Jobs Act and more recently passed CHIPS Act implies the US federal government is set to triple its average annual spending on climate and clean energy this decade relative to the 2010s. See Figure 2.

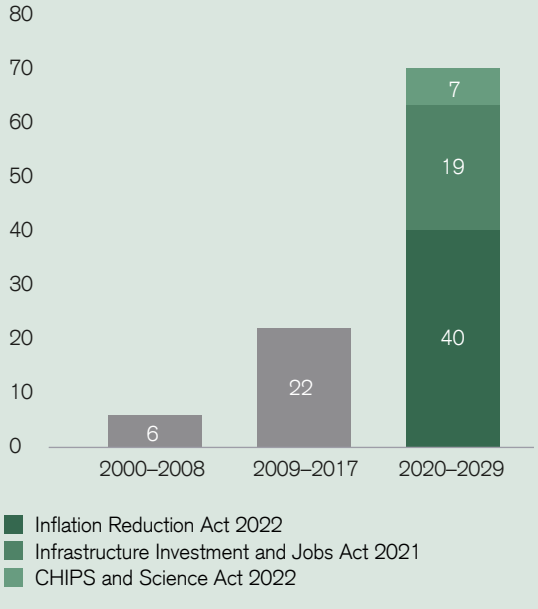
This has implications not only for the US reducing its own GHG emissions (estimates are ~40% by 2030 relative to 2020 levels), but also for the country setting itself up to be a major global manufacturer of green-related products/materials. The multiplier effect of this spending could mean actual climate spending from both public and private entities could be significantly higher.

Figure 1: Breakdown of >US$400 bn climate and energy-related provisions (CBO estimates)



Source: CBO, Credit Suisse

Figure 2: US federal government's average annual climate spending in US$ bn



Source: RMI, Credit Suisse estimates

1 Congressional Budget Office estimate as of August 3, 2022, prior to finalization of IRA bill.

The upside

We believe the actual spending could be significantly higher for three reasons:

1. **Roughly two-thirds of the baseline spending is allocated to provisions where the potential federal credit/incentive is uncapped.** This applies to tax credits that are either based on production units - such as MWh of clean electricity generated, kilogram of hydrogen produced, per ton of carbon captured and sequestered - or investment based – such as 30% of upfront investment for certain qualifying clean electricity project. **Our assessment of potential demand for clean electricity PTC/ITC, carbon capture, clean hydrogen and renewable/battery manufacturing credits shows federal spending could reach 3x the cost estimates assigned for these key provisions.** See Figure 3.

- **The largest spending delta we see is the 45Q credit**, or incentive for carbon capture and storage. CBO only assigned US$3.2 billion in total for that provision with only ~US$340 million estimated for 2030, or ~4 million tons per annum (MTPA) of CO_2 captured and sequestered at the new US$85/ton credit level. In comparison, we see potential for an additional 100 MTPA of point source capture to be added by 2030 (~70 MTPA incremental to Global CCS Institute's latest project tally). Combined with growth in direct air capture (we estimate 3 MTPA by 2030), this brings our estimate of the provision cost to US$52 billion. Our estimate may even be conservation as BNEF is forecasting the 45Q credit could total over US$100 billion between 2023 and the early 2030s.

Figure 3: Upside to federal tax credit spending based on Credit Suisse demand forecasts for select provisions

Energy tax credits, US$ bn	CBO Estimate 2022–2031	CS Estimate 2022–2031	CSe vs. CBO est	CS demand assumptions
Wind		67		130 GW of new wind capacity 2022–2031 including 30 GW related to H2 and DAC
Solar		112		368 GW of solar wind capacity 2022–2031 including 56 GW related to H2 and DAC
Total PTC (no bonus adder)	**62**	**179**	**2.9x**	
Residential solar		54		Doubling of resi-solar capacity buildout from 5 GW to 10 GW per year by 2030
Battery energy storage solution		7		Incremental ITC for ~40% higher BESS demand
Total ITC (no bonus adder)	**65**	**62**	**1.0x**	
45Q	3	52	16.3x	Additional 100 MTPA point-source capture by 2030 with 10% utilized and 3 MTPA direct air capture by 2030 with 50% utilized (e.g. air-to-fuel)
Clean hydrogen PTC	13	33	2.5x	6.5 MTPA of clean hydrogen production by 2030 of which 50% is green hydrogen
Total CCUS + H2 (direct pay)	**16**	**85**	**5.2x**	
Manufacturing tax credits, US$ bn				
Solar – US		58		Assumes US mfg supplies ~90% of US solar demand by 2030 (no export demand)
Wind – US		41		Assumes US mfg supplies ~90% of US wind demand by 2030 (no export demand)
Battery cell + pack		152		15% haircut to BNEF's US battery capacity build out, reach >500 GWh/yr by 2030
Total clean mfg (direct pay)	**31**	**250**	**8.2x**	
Total tax credits, US$ bn	**174**	**576**	**3.3x**	
potential bonus adders (@10%)		24		

Source: CBO, Credit Suisse

- **We also see significantly higher spending for the manufacturing tax credit.** CBO allocated US$31 billion for solar, wind, battery component manufacturing combined. Meanwhile, we see potential for US$250 billion in total tax credits, or 8x the baseline. There are significant subsidies for solar and wind manufacturing; in fact, we believe IRA subsidies would make US solar modules the cheapest in the world, even lower than China made modules from 2025 to 2030. This would not only incentivize close to 100% domestic sourcing of solar/wind projects going forward but also position the US as a potential exporter (notwithstanding WTO challenges, and any political risk of IRA repeal). Meanwhile, for batteries, future demand is already materializing with over 600 GWh of US battery manufacturing capacity either fully commissioned, under construction or announced to be online by 2030, according to BNEF. Our battery capacity forecast takes a 15% haircut off of BNEF's forecasts.

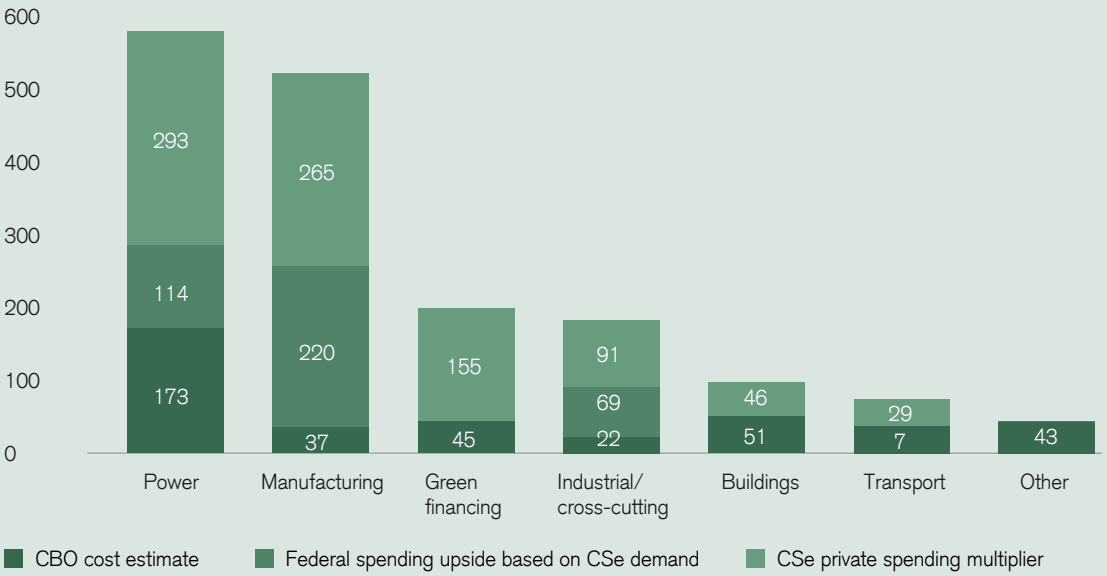
2. **The leverage effect of public spending on private sector investments.** The leverage effect – i.e., how much private investments are being triggered by public spending – has been explored in many academic studies especially related to climate. The multiplier generally ranges from **1.1x to 1.6x**[2], meaning for every dollar of public spending, at least 1.1 dollar is being spent by the private sector. As such, we can conservatively say that every "uncapped" public spending on tax credits/ incentives discussed above will be matched by the same level of private spending. In addition, there are investment credits where public spend is specifically set at 30% to up-to-60% of project total (i.e., ITC and advanced energy project) and for certain grants where federal share of the project cost is capped (i.e., 25% for USDA assistance for rural electric cooperatives).

3. **Subsidized lending from DOE loan program and Greenhouse Gas Reduction Fund (aka green banks) to supercharge green financing.** Beyond tax credits and subsidies, what may be underappreciated is the catalyzing effect of the 1) US$27 billion Greenhouse Gas Reduction Fund, which may be the precursor to the first ever national green bank; and 2) ~US$13.5 billion appropriations for the Department of Energy's loan programs. Green banks are already operating at a state/ city level today which are used to channel private funding into sub-scale investment areas. According to Coalition for Green Capital, the 21 state and local green banks have invested US$1.9 billion from 2011 to 2020, driving total investment of US$7 billion or a **3.7x multiplier**. Applying that to US$27 billion of new financing in IRA implies more than 14x the spending level in this decade than in the prior one. The multiplier effect for DOE loan program is even greater. The IRA appropriates ~US$13.5 billion to cover "credit subsidy cost" for loan guarantees issued under DOE's loan programs which have a total authorized lending capacity of ~US$390 billion – or **over a 25x multiplier**. Now, an implied sub-5% loan loss ratio may be low for loans that often finance early-stage climate and decarbonization-related projects, but even 10% would imply a robust 10x effect. We discuss both of these provisions in more detail in the green financing section below.

Taking all of the above into account, we estimate total federal spending at double the headline figure to over US$800 billion and total public and private spending mobilized by the IRA could reach nearly US$1.7 trillion. Of that overall spending, the power sector remains the largest category at ~US$580 billion, or 34%, but manufacturing jumps to second place at ~US$520 billion, or 31%. Green financing sits third at ~US$200 billion, or 12%, and most other sectors could see overall spending much higher than what's allocated in the IRA. The multiplier effect is less clear on spending areas such as water, conservation, agriculture where funding is mostly in the form of public grants where the "crowd-in" effect of private investments are not easily quantifiable. The logical question at this point would be how all of this federal spending gets funded and whether the impact of this bill would indeed meet the objective of "inflation reduction." But that's beyond the scope of this report.

2 "What is the relationship between public and private investment in science, research and innovation?" Economic Insight, 2015. Report commissioned by the Department for Business, Innovation and Skills
"Assessing "Leverage" in the Climate Investment Funds."
Michele de Nevers, 2017. CGD Policy Paper. Washington, DC: Center for Global Development.

Figure 4: Potential public and private climate spending – Credit Suisse estimate in US$ bn



Source: CBO, Credit Suisse Industrial/cross cutting includes hydrogen, carbon capture, and advanced industrial deployment grant

We believe the IRA catalyzes a positive feedback loop on US green developments that could have a profound impact across industries for the next decade and beyond. In our view, IRA is well-designed legislation that's differentiated from leading climate policies around the world. Perhaps in part due to the nature of US politics, the fundamental difference is that US climate legislations are founded on an incentive-based approach (i.e., through various tax credits) instead of a penalty-avoidance approach (i.e., carbon prices in Europe). IRA offers "locked-in" government subsidy at a fixed level for a fixed period of 5–10-plus years (varies by provision), giving developers and investors sufficient "certainty" to greenlight projects. This should channel private capital into projects that are "in-the-money" today; the increase in investments should drive economics of scale, which should in turn unlock more decarbonization opportunities. And it's not just about deployment of mature technologies. The IRA is also funding innovation and R&D (i.e., DOE's loan program) which should fuel the next generation of climate solutions. This positions the US to lead on climate in the 2030s and beyond.

Green financing: expands access and lowers cost of capital

Fundamentally changes the status quo

The IRA will not only significantly increase the amount of climate-related spending, but it also expands access to and lowers the cost of green financing. This is accomplished through **higher certainty and longer duration of credits** and a new feature referred to as "transferability" which will **significantly broaden the pool of eligible investors** in clean energy tax credits. Meanwhile, a massive **upsizing to low-cost subsidized lending for both large- and small-scale projects** that reduce GHG emissions should accelerate investments from the private sector at lower required rates of return than the status quo.

Higher certainty and longer duration of credits

All the debate and uncertainty over the last couple years on whether a clean energy-focused bill would actually be passed into law presumably kept some developers and investors on the sidelines until they had more clarity regarding future legislation.

Most of the tax credits are now available from 2023–2032, which not only provides long-standing certainty and predictability, but also covers the most pivotal decade to advance climate actions. Additionally, many of the supply side credits (e.g., clean electricity, hydrogen, CCUS, etc.) are based on when the project commences construction… so projects that commence construction before the end of 2032 can still receive credits beyond this expiration. In particular, the clean electricity tax credits will be in place until at least annual US power sector emissions are reduced by 75% relative to 2022 levels. Relative to before the IRA, this enhances visibility on project revenue and returns, thus should lower cost of capital for clean energy projects.

Larger pool of eligible investors

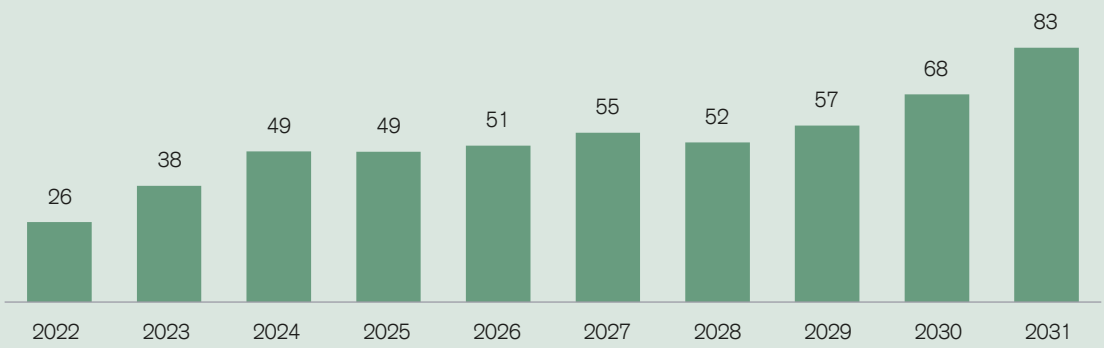
A key new feature of the IRA is that clean energy developers are able to sell their tax credits for cash to any business with income tax liability.

Under "direct pay", the government will send a check to the taxpayer (i.e., developer) for 100% of the credit, regardless of tax liability. In the IRA, the availability of direct pay feature was restricted to only non-profits/tax- exempt entities and publicly owned utilities as well as to taxable entities (for the first five consecutive years only) that claim the credit for **clean hydrogen, CCUS** (45Q), and **advanced manufacturing production** supposedly due to the nascency and risk associated with these technologies/projects.

The IRA also introduces a new feature referred to as **"transferability,"** which refers to the ability to sell the credits for cash to any business (i.e., does not have to be equity investor in the project) with income tax liability. This significantly expands the pool of eligible investors, which in turn should reduce the discount developers are currently receiving for credits and thus improving their returns. That said, developers will not likely receive 100% of the credit as they would under direct pay (businesses need incentive to participate), but nonetheless a better deal than under a typical tax equity model. It also removes the implied cap on availability that has historically existed as there is more than enough federal tax liability available to utilize the credits.

Our checks with the solar industry also suggest that transferability could reduce the cost of tax equity. However, transferability will still require detailed due diligence as projects could be still subject to IRS clawback (i.e., if projects fail to perform within the first five years). Such diligence structures might increase the cost of tax credit transferability. Moreover, many developers will also require tax equity investors to help absorb depreciation and other tax benefits, especially since most renewable projects are capital heavy and will likely elect accelerated depreciation.

Figure 5: US ITC and PTC require ~US$500 bn of tax equity to monetize ITC/PTC and depreciation benefits



Source: Credit Suisse estimates, Assumptions – PTC (75% upfront, pre-flip to TE 15% cash and 99% tax benefit, post-flip 5% of both), ITC (pre-flip to TE 25% cash and 99% of tax benefits, post-flip 5% for both)

DOE's Loan Program Office subsidizes lending for large-scale projects

The IRA significantly expands the size and scope of the DOE's Loan Programs Office (LPO), which has had the availability to deploy ~US$40 billion in debt financing (direct loans or loans guarantees) toward large-scale energy infrastructure and advanced automotive manufacturing projects in the US. While the program was not utilized under the Trump administration, Biden's DOE has brought it back to life with the first two deals since 2014. These included a ~US$504 million loan guarantee to the Advanced Clean Energy Storage hydrogen project in Utah and ~US$102 million loan to expand the Syrah Vidalia Facility (produces a critical material used in lithium-ion batteries). Thus, the program is a critical tool for the government to directly sponsor and kick start early-stage climate technologies for which traditional lenders either are not willing or too costly to take on the risk, or do not have the debt capacity to support projects of such scale. For loans issued by the Federal Financing Bank and backed by 100% DOE loan guarantee, the interest rate is the applicable US Treasury Rate for the loan's tenor plus a spread based on credit rating (e.g., 37.5bps for AA and above). See full fee schedule here.

Each DOE loan and loan guarantee includes a "credit subsidy cost," which is basically a premium that must be paid to compensate the government for the risk that it might not be repaid. This cost is based on the project's risk profile and, while not publicly disclosed, can be upward of ~30% of the loan, according to a Congressional report. If there are sufficient appropriations available, the DOE will pay this cost; otherwise, it must be paid by the borrower.

The IRA not only expands the DOE's lending authority (direct loans and guarantees) from ~US$40 billion to ~US$390 billion (CS estimate), but it also increases the amount of its appropriations to cover credit subsidy costs from ~US$4.4 billion (nearly all in one program) to ~US$15.9 billion. Combined with the other incentives in the IRA, these expansions should support greater utilization of the LPO, which in turn can also accelerate investments from the private sector.

Figure 6: Summary table of DOE programs (pre- and post-IRA)

	Amount of direct loans or loan guarantees available (in US$)		Appropriations for subsidy costs (in US$)		
Loan program	**Pre-IRA**	**Post-IRA**	**Pre-IRA**	**Post-IRA**	**Eligibility criteria**
Title 1703 "Innovative Clean Energy" (Advanced Fossil Energy, Advanced Nuclear Energy, and Renewable Energy and Energy Efficiency)	21.9 billion	61.9 billion	160 million	3.6 billion	Projects must (1) avoid, reduce, or sequester air pollutants or anthropogenic greenhouse gas emissions; and (2) employ new or significantly improved technologies
Advanced Technology Vehicles Manufacturing (ATVM)	15.1 billion	~55.1 billion (DOE estimate)	4.2 billion	7.2 billion	Projects must (1) manufacture eligible vehicles or components that are used in eligible vehicles that achieve defined fuel economy targets (1) or (2) build new facilities; reequip, modernize, or expand existing facilities where eligible vehicles or components are manufactured
Title 1706 Energy Infrastructure Reinvestment (generation or transmission of electric energy, or production, processing, and delivery of fossil fuels)	N/A	250 billion	N/A	5 billion	Energy infrastructure can be either currently operating or ceased operations, but the projects that utilize fossil fuels must avoid/ reduce/utilize/ sequester air pollutants and anthropogenic GHG emissions
Tribal Energy	2 billion	20 billion	8.5 million	83.5 million	Projects must be for energy development by a federally recognized Indian tribe or Alaska Native Corporation
Totals	**~40 billion**	**~390 billion**	**~4.4 billion**	**~15.9 billion**	

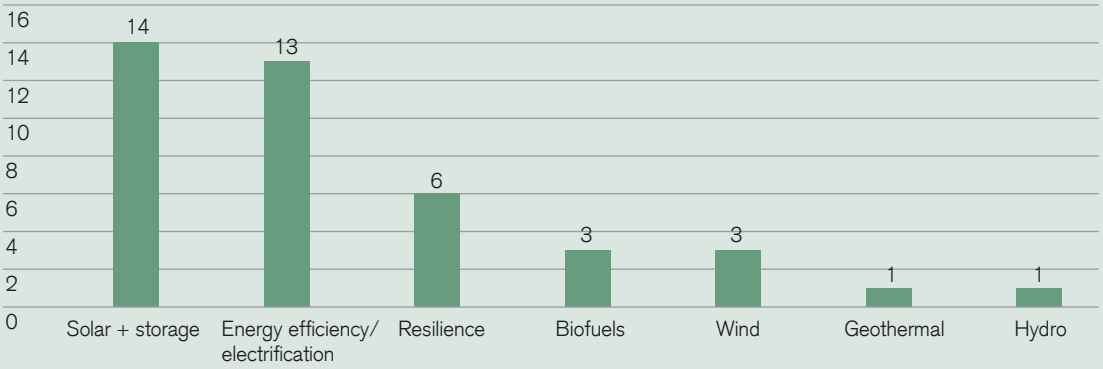
(1) Advanced technology vehicles are defined as light-duty vehicles that meet or exceed a 25% improvement in fuel efficiency beyond a 2005 model year base-line of comparable vehicles; and/or ultra-efficient vehicles which achieve a fuel efficiency of 75 miles per gallon or equivalent using alternative fuels.
Source: US Department of Energy, Credit Suisse

Green bank helps to fund small-scale projects

While the DOE funding will target large-scale infrastructure and clean energy projects, the US$27 billion Greenhouse Gas Reduction Fund (GGRF) is earmarked for relatively small-scale investments into low- and zero-emission products, technologies, and services for households, small businesses, and communities. This includes emission-reduction projects such as rooftop solar, clean transportation, efficiency retrofits and electric heat-pump installations, which typically are not offered as loans/financing from traditional private sector commercial banks due to small scale, high credit risks, often long payoff periods, and uncertainty of investing in lower income communities. Instead, non-profit "green banks" have been popping up across the US over the last decade (23 across 17 states) to fill this void. Green banks use public capital (e.g., direct lending, loan loss reserves, loan guarantees, etc.) to mobilize more private investment (~3–5x) into local projects that reduce GHG emissions. With the risk profile greatly reduced having green banks onboard, the interest rates on these loans are relatively quite low (e.g., as low as <5% at Connecticut's Green Bank).

The GGRF will be set up and run by the Environmental Protection Agency (EPA), which is tasked with "rapidly" allocating US$20 billion of the funds to "eligible participants" (i.e., non-profit green banks). Of this amount, US$8 billion must be dedicated to projects benefiting low-income and disadvantaged communities. Given the IRA does not specify a minimum or maximum number of grant recipients, it's possible the EPA could allocate the US$20 billion to fund the nation's first national green bank. The remaining US$7 billion is designated for states, municipalities, Tribal governments, or "eligible participants" in low-income and disadvantaged communities (i.e., capital for new state green banks or existing ones). We note the Coalition for Green Capital has already identified a "project backlog" of >US$21 billion that requires state and local green bank capital. The same study found that most green banks would prioritize solar + storage and energy efficiency/electrification projects with national green bank financing.

Figure 7: State/local green banks were asked what markets they would invest in with national green bank financing[1]



1 Does not include electric vehicles; disadvantaged communities' investment is cross-cutting.
Source: Coalition for Green Capital

Some believe that a single national green bank has the potential to catalyze even more private investment than the ~3.7x multiplier achieved at the regional level over the last decade. For example, an independent study by Vivid Economics shows that a US$100 billion public investment in a "Clean Energy and Sustainability Accelerator" (aka national green bank) would drive ~US$750 billion in private investment over 10 years, a >7x multiplier.

It could also operate at a scale that lowers the cost of capital even further by, for example, centralizing back-office functions and thus reducing non-core expenses for state/local green banks. Moreover, if successful, the funding can be recycled into future projects and thus avoid additional appropriations from Congress. But regardless of whether the funds are disbursed to a national green bank, the green bank model is poised to see a massive increase in scale relative to the US$7 billion total investment since 2011.

US is well positioned to be the premier energy supplier for the world

Availability of clean electricity (generation plus energy storage) and clean molecules (zero carbon hydrogen, ammonia, sustainable aviation fuels, etc.) are the foundation of a low carbon economy. Building blocks on the former are abundant renewable natural resources (areas that are windy and/or sunny, geothermal, etc.) and a sustainable supply chain, particularly on battery components and minerals; building blocks on the latter are clean hydrogen and derivative products, transport infrastructure, and geological storage (for both hydrogen and CO_2). Biomass, waste feedstocks serve both clean electricity and fuel but tend to be more localized solutions and have agriculture/food security implications. In a supportive and stable regulatory environment (admittedly a big "if"), countries that have competitive advantage on several of these fundamental building blocks are best positioned to be strategic winners in a transitioning economy.

As the largest fossil fuels producer in the world, US already holds several key competitive advantages to become a leader in the low carbon economy.

- **Infrastructure.** The US is home to the world's largest onshore CO_2 pipeline network of >5,000 miles (~85% of all global CO_2 pipelines) as well as the largest hydrogen pipelines of >1,600 miles[3] (~57% of all global hydrogen pipelines). The US also holds nearly 320,000 miles[4] of natural gas transmission and gathering pipelines plus over 2 million miles of distribution lines. While not all natural gas pipelines can be repurposed, some could be converted to either CO_2 or hydrogen pipeline at a fraction of newbuild costs. An established oil and gas import/export infrastructure complements this pipeline network.
- **Geologic storage.** The US has by far the most abundant geological CO_2 storage potential in the world and also has the most discovered (aka de-risked) storage. The US holds over 8 trillion tons of potential CO_2 storage, which could theoretically store nearly 2,000 times its annual CO_2 emissions in 2020. In comparison, China has just over 500 billion tons of storage, which is less than 50 times its annual emissions run rate. The Texas Gulf Coast is also home to three of the four operational salt caverns[5] in the world for hydrogen storage, which is the most mature and lowest cost storage option for the world's lightest gas.
- **Skilled workforce and climate innovation hub.** The human capital of the fossil fuel and petrochemical industry provides both experience and technical expertise that can be leveraged in the low carbon transition. The Silicon Valley is also fueling a new source of talent, innovation, and energy for the burgeoning climate tech space. It's unsurprising at present to find many climate start-ups having founders with tech background (not the least due to data analytics, automation, and AI, which are all critical parts of the solution); similarly, Big Tech is also leading the conversation and venture investments, such as Microsoft and Stripe's authoritative roles in the carbon removal space and Google's 24/7 carbon free energy initiative. Notably, despite the US lagging in energy transition investments historically, it holds 3x as many climate unicorns as Europe.

With these existing moats as a foundation, **the IRA brings the critical economic signals that can unlock investments across many sectors and across the nation.** In particular, the level of incentives could be viewed as a breakthrough for investments in hydrogen and carbon capture and sequestration. Development in those two fields could unlock other advancements in clean fuels export (such as green ammonia and sustainable aviation fuels), carbon removal solution (e.g., direct air capture), and carbon utilization innovation (e.g., low carbon concrete, synthetic fuels) among other emerging opportunities.

3 Hydrogen pipeline data from Hydrogen Tools Portal developed by Pacific Northwest National Laboratory
4 According to Department of Transportation annual statistics, Gas distribution system has an additional 2.3 million miles of pipelines.
5 "Houston as the epicenter of a global clean hydrogen hub" Greater Houston Partnership etc.

Figure 8: US competitive advantage vs. Europe and APAC on climate

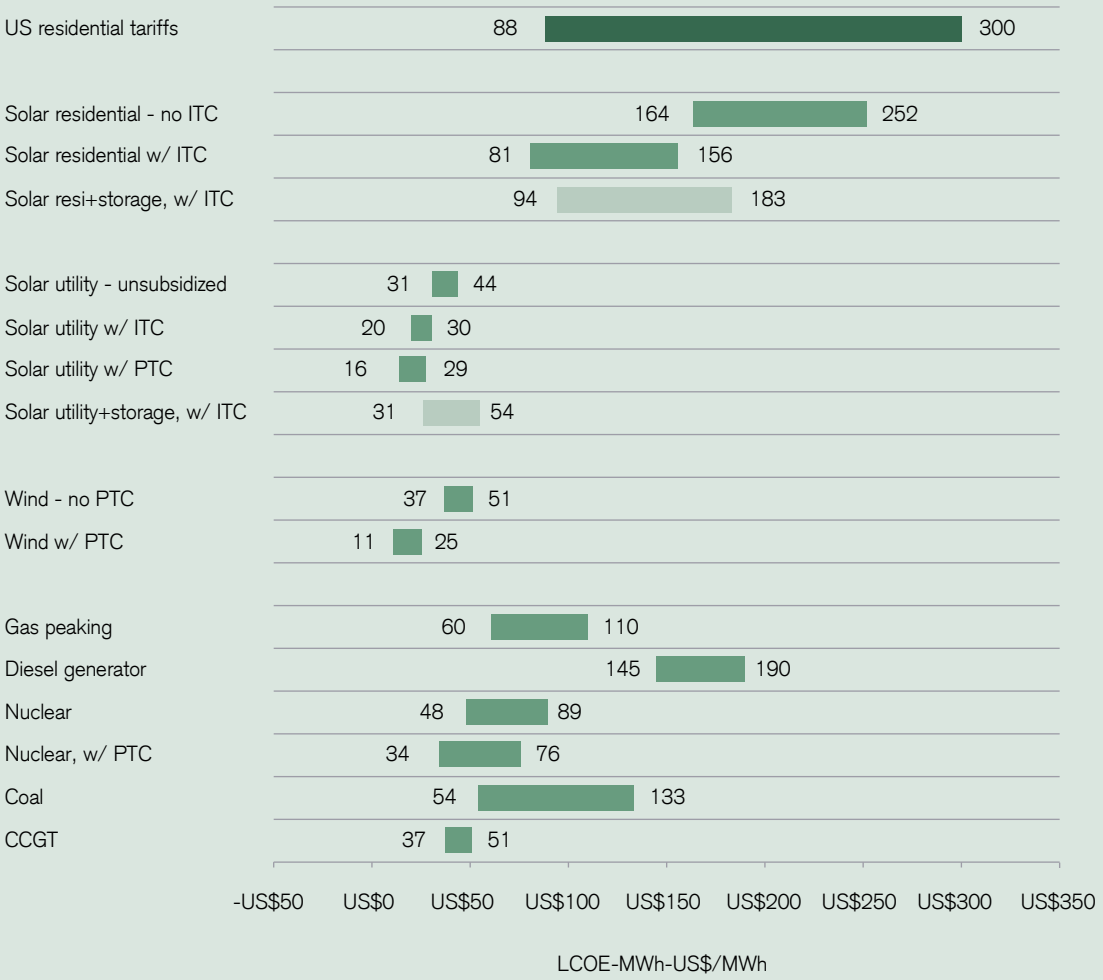
	USA	Europe	China	Australia
Hydrogen economy				
Current production of hydrogen (million tonnes)	~10	~10	~25	NA
Cost of fossil-based hydrogen with CCS – 2030 (US$/kg)	~0.70	1.60	1.80	1.70
Cost of eletrolysis-based hydrogen – 2030 (US$/kg)	<0.0	2.30	2.10	1.70
Carbon capture and storage				
Technical geologic storage potential (billion tonnes CO_2)	8,062	555	518	502
Discovered geologic storage (billion tonnes CO_2)	258	73	11	31
Existing CO_2 pipeline (kilometers)	>8,000	~1,300	~116	~50
Carbon capture capacity growth 2030 vs. 2020 (million tonnes CO_2 per year)	46	36	2.6	1.9
Direct air capture capacity growth 2030 vs. 2020 (million tonnes CO_2 per year)	5.5–6.0	1.0–2.0	NA	NA
Climate-related financing				
Post-COVID green stimulus (US$ billion)	>660 (IRA + IIJA + CHIPS)	~1,500	~195	~22
Energy transition investment cumulative 2020–1H22 (US$ billion)	238.3	498.0	609.4	19.5
Climate Tech venture funding cumulative 2020–1H22 (US$ billion)	4.5	16.7	16.3	NA
Number of Climate Tech unicorns	28	9	7	1

Source: Green Hydrogen Coalition, McKinsey, IPCC, Global CCS Institute, company and regulatory documents, BNEF, Holon IQ, Credit Suisse estimates

Renewable energy

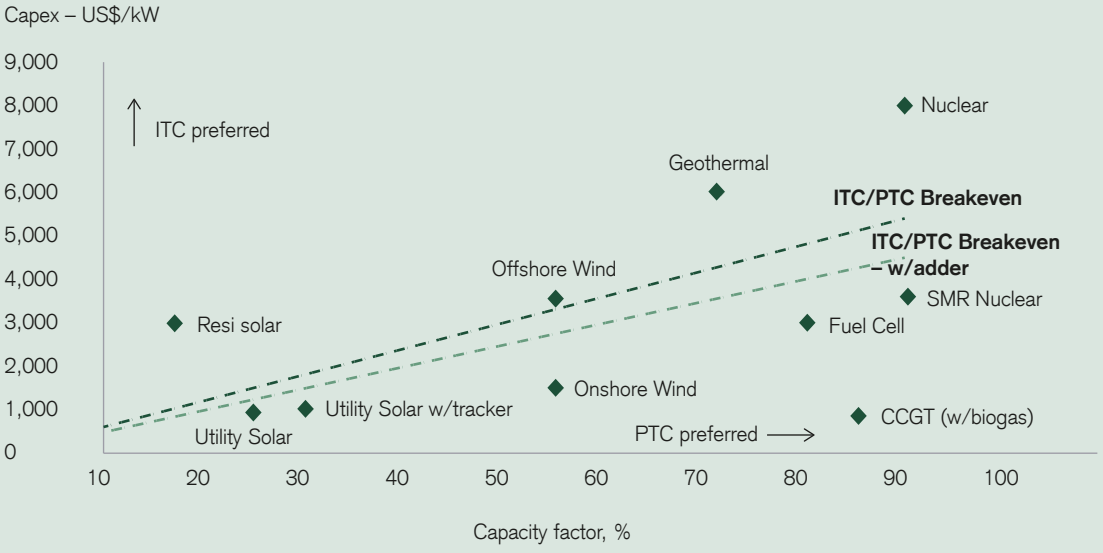
- **Renewables remain the cheapest energy source due to PTC:** We estimate that solar and wind remain the cheapest source of energy in the US with average PPAs (power purchase agreements) likely ~US$15–20/MWh starting next year and likely declining every year. Utility solar and wind remain the cheapest source of electricity (35%/61% cheaper with incentives than without), even when compared to forward gas prices at US$4.5–5.5/MMBtu.
- **PTC would be preferred by most, ITC by higher capex or lower utilization:** Historically solar, geothermal, fuel cells, and other technologies were limited to claiming tax credits under the ITC with an upfront 30% incentive. While PTC was limited to mainly wind. However, IRA changes it in two regards. First for the short term the law makes solar also eligible for PTC starting next year, and secondly the tax credits become technology agnostic after 2024. The technology agnostic aspect would make it beneficial for developers to choose between the two. We estimate that most utility scale technologies would prefer PTC, including utility solar, onshore wind, Fuel cells, SMR Nuclear, CCGT with negative carbon fuels, etc. For example, a PTC for utility solar increases NPV of a project by ~25% vs claiming ITC, or inversely helps reduce PPA for solar projects by >10% vs historical levels. On the other hand, ITC is economical for residential solar, geothermal, and traditional nuclear given higher upfront capex or lower utilization. In our analysis offshore wind is at the edge of the PTC vs ITC decision making.

Figure 9: Cheap getting cheaper – solar and wind LCOE (levelized cost of electricity) will perform well in 2023



Source: Credit Suisse estimates. The range of bars represents high and low end of capex, opex, and utilization factor assumptions.

Figure 10: Upfront ITC subsidy is good for either higher capex or lower capacity utilization technologies. PTC is economical for most technologies



Source: Credit Suisse estimates

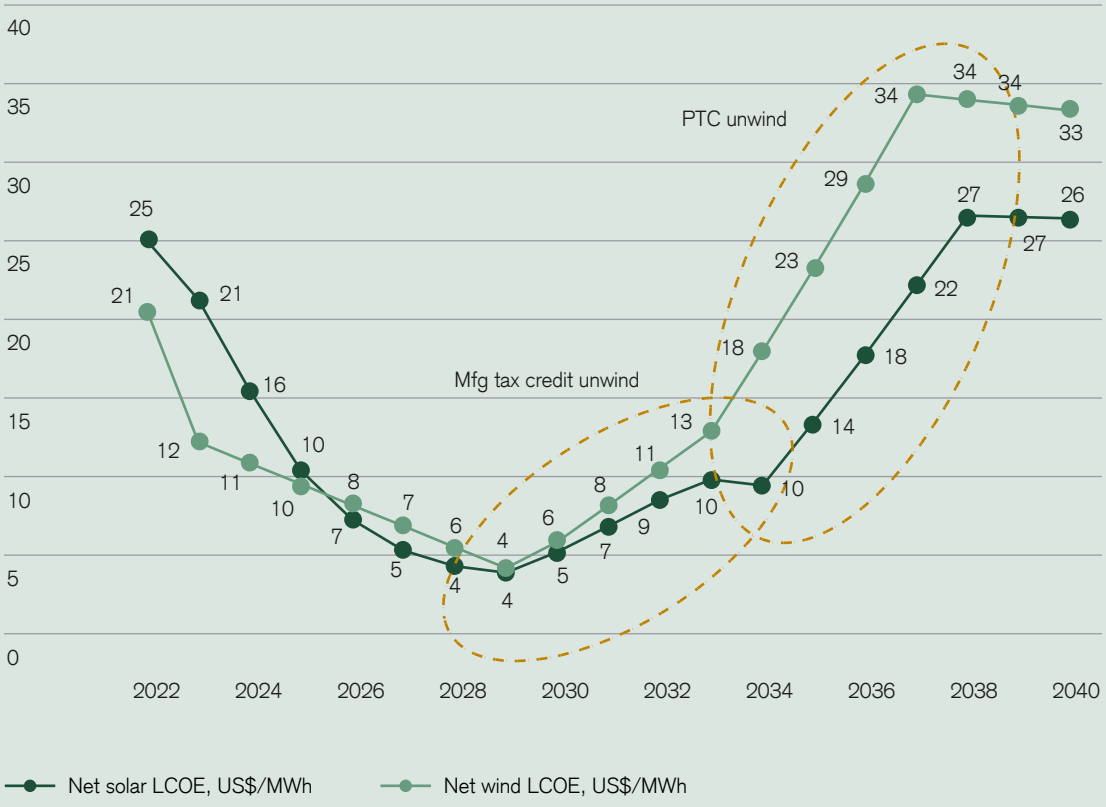
- **Manufacturing tax credits make US solar and wind the cheapest globally in 2025-2030 – reaching - <US$5/MWh in 2029:** The double benefit of energy production tax credits and solar module/wind turbine equipment manufacturing tax credits make US solar and wind the cheapest globally. We estimate US solar LCOE reduces from ~US$25/MWh in 2022 to lows of ~US$5/MWh by 2029, though recovering back to ~US$26/MWh as tax credits step down after 2030. Similarly for wind we estimate wind LCOE reduces from ~US$20/MWh in 2022 to <US$5/MWh in 2029 and recovering to ~US$33/MWh by 2040.

  - US made solar modules should benefit from the clean manufacturing tax credit which will help reduce US made module manufacturing costs from ~US$0.30/W in 2024 to ~US$0.10/W in 2029, though recovering back to ~US$0.22/W after 2032.

    Note this is a very conservative forecast and assumes nominal 1%/yr improvement in US module manufacturing cost and depends upon significant manufacturing capacity addition in the US. We estimate US cell/module manufacturing lines are operational in 2024, wafer in 2025, and polysilicon in 2026. Scale in the US could even push manufacturing costs below that of China and other regions.

  - Wind industry benefits from clean manufacturing tax credit which will reduce wind capex from ~US$1500/kWh in 2022 to ~US$1000/kWh in 2029, recovering back to ~US$1300/kW by 2033. Incentives are ~US$200/kW for blades, ~US$500/kW for nacelle, US$300/kW, most of which we believe will be passed down to end customers by the latter half of this decade.

Figure 11: US Solar and Wind LCOE – US$5/MWh projects close to reality in 2029–30. Note assumes majority of incentives are passed down to end customers.



Source: Credit Suisse estimates

Hydrogen

The IRA provides a per-kilogram credit for qualified clean hydrogen for a ten-year period. Credit is available as long as construction begins by 2032, meaning hydrogen benefit could last well into 2040s. Assuming wage and apprenticeship requirement is met, electrolysis-based hydrogen (aka green hydrogen) can receive a full tax credit of US$3.0/kg. For fossil-fuel based hydrogen with carbon capture (aka blue hydrogen), those could receive at least US$0.6/kg depending on capture efficiency.

45Q incentives make blue hydrogen competitive with grey hydrogen immediately. We expect blue H2 projects to gain traction in the short term, especially those using biogas from landfill or MSW. We expect most blue hydrogen is in the 2.5–4kg CO2e/kgH2 bracket, qualifying for 20% of the US$3 credit. Credit could also be higher depending on the carbon capture rate if the producer chooses to use the 45Q credit (based on tons of emissions capture) instead of the hydrogen credit. Assuming US$0.60/kg, this would give a blue LCOH (levelized cost of hydrogen) of US$2.63/kg – cost competitive with grey priced at US$2.43/kg (assuming a gas price of US$8.50/MMBtu).

However, **green hydrogen is now the cheapest option** due to low power prices (benefitting from the ITC/PTC tax credits) and a US$3/kg PTC credit for for electrolysis-based hydrogen. Our model estimates a current cost of green hydrogen in the US of US$2.82/kg - using Alkaline electrolyzer, US$2.39/kg – using PEM electrolyzer, assuming a power price of US$23/MWh. With the US$3/kg credit, this implies a LCOH of negative US$0.61/kg and negative US$0.18/kg (for ALK and PEM, respectively). It is worth noting this is the price excluding returns to hydrogen producers. This of course is significantly below grey, even if the gas price falls to US$4.50/MMBtu (Dec 2025 forward price) then the grey LCOH would still be above green at US$1.78/kg.

Notably, we believe prices could be even lower due to lower cost solar and wind PPAs which are in turn subsidized by PTC and manufacturing tax credits. We believe green hydrogen could achieve **delivered costs of <US$0.5/kg in 2025–30.**

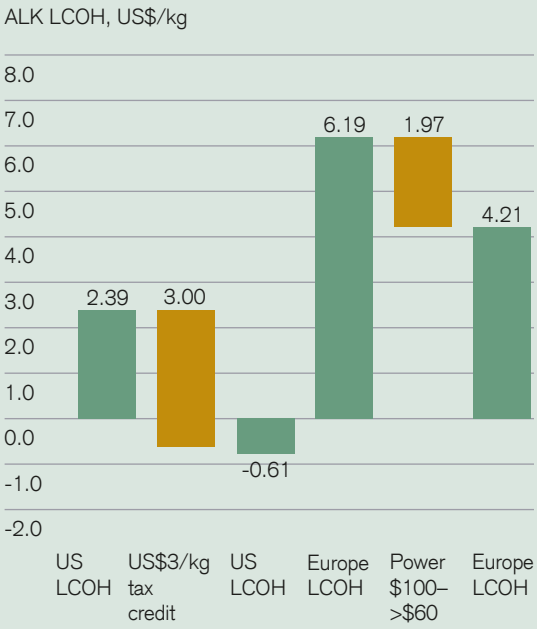
Figure 12: US comparative LCOH using IRA tax credits (onsite generation)

Source: Company data, Credit Suisse estimates

The IRA tax credits will make the US one of the cheapest places in the world to produce green hydrogen with a green LCOH below US$0/kg with the full US$3 tax credit. This compares to US$4.21–US$4.73/kg (Alkaline vs PEM) achievable in Europe with a US$60/MWh power price. Given the current energy crisis in Europe is unlikely to reverse in the near term, we expect this relative price differential to remain for some time in the absence of similar subsidies for green hydrogen in Europe.

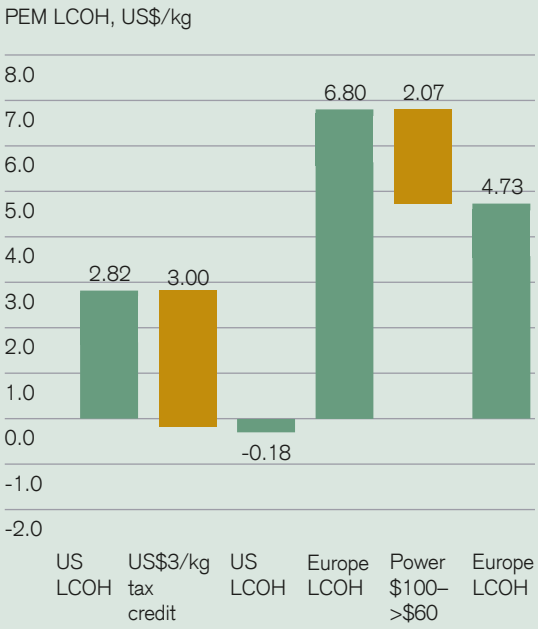
This pricing dynamic can pull hydrogen producers to the US and create an influx of investment into the domestic green hydrogen industry from around the world. There is now an incentive for companies globally to base production in the US and take advantage of the generous tax credits. However, we do expect other countries aiming to be leaders in the green hydrogen market to step up state support to avoid losing out.

Figure 13: US vs Europe Green LCOH (ALK)



Source: Credit Suisse estimates

Figure 14: US vs Europe Green LCOH (PEM)



Source: Credit Suisse estimates

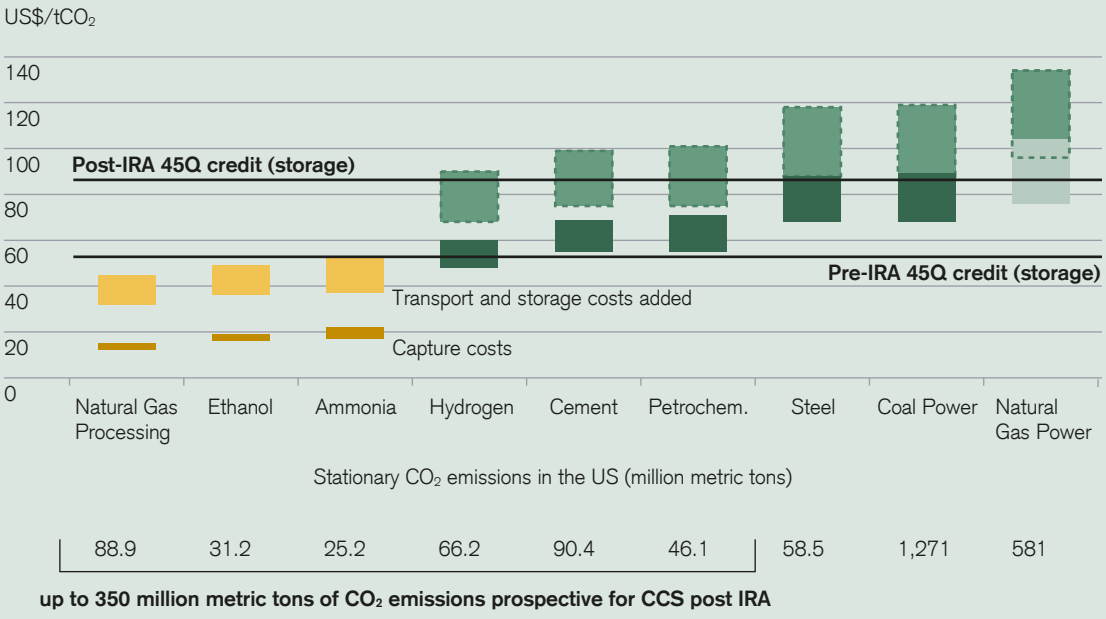
The project economics alone could secure US a strategic leadership position in the emerging clean hydrogen and derivative products market, just as it did in the global LNG market. Execution and speed of capital deployment also matter as many projects have already been proposed, and more coalitions and public/private partnerships are being announced.

This is before taking into account other non-cost strategic considerations such as energy security, geopolitical alliances, and supply diversification, etc.

Carbon capture

The upgraded 45Q tax incentives could substantially accelerate carbon capture investments in the US due to 1) higher price of incentive; and 2) lower volume threshold under which a facility can be eligible for the credit. For point-source carbon capture projects (such as on industrial or power plants), the IRA increases the credit from US$35/ton to US$60/ton for captured carbon that is utilized (e.g., in enhanced oil recovery projects) and US$50/ton to US$85/ton for captured carbon that is stored underground in geologic formations. We note that **the higher credit level would make carbon capture and storage a viable decarbonization solution for a large number of industries with close to 350 million tons of annual CO_2 emissions in the US.**

Figure 15: Old and new 45Q tax credit level vs. breakeven capture costs for various CO_2 sources



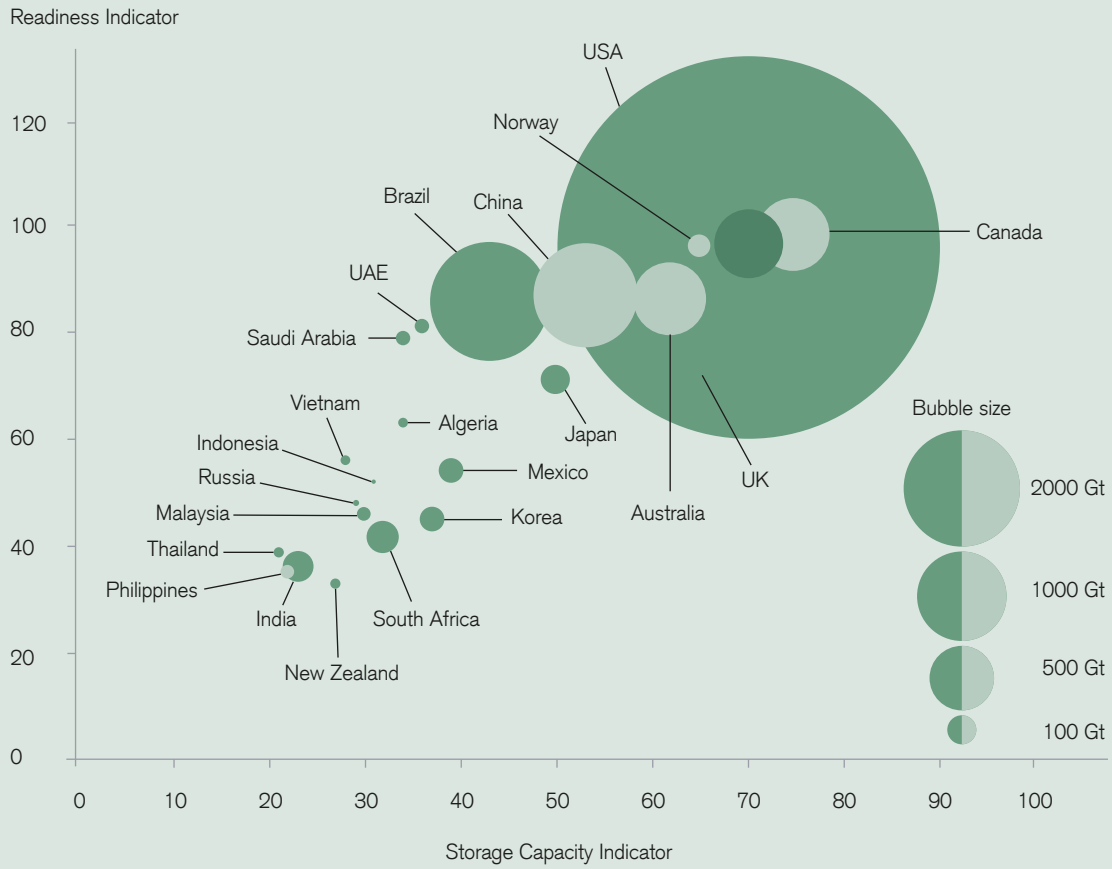
Source: Great Plains Institute, BloombergNEF, Credit Suisse

In addition, 45Q more than triples incentive for direct air capture facilities. Credits were the same as point-source capture prior to IRA, but the bill increases them to US$130/ton if utilized and US$180/ton if stored. The amount of capture to be eligible also decreases from 100,000 tons to just 1,000 of CO_2 per year. While DAC projects are still costing north of US$400/ton today, leading developers are setting long-term cost of capture goals for DAC at ~US$100–125/ton. Coupled with other revenue channels such as the California Low Carbon Fuel Standard, carbon removal credits in the voluntary carbon market as well as a rapidly growing sustainable aviation fuel space for CO_2 utilization, we believe the DAC industry in the US is particularly well positioned to scale quickly in the coming years.

The Global CCS Institute had developed a country readiness index based on its assessment of supportive policy, legal and regulatory framework and storage resources. These factors are plotted against a nation's potential storage indicator. Based on that analysis, the **US is among the countries most ready for commercial carbon capture deployment and is by far the most advantaged given its storage potential.** See Figure 16.

According to the IEA, the majority of stationary emission sources in the US are located close to potential geological storage sites: 85% of emissions come from plants located within 100 km of a site and 80% within 50 km. To put these distances into context, the average distance over which CO_2 is currently transported by pipeline between existing CCUS facilities is around 180 km and the maximum around 375 km (from the Lost Cabin Gas Plant).

Figure 16: Country readiness to deploy CCUS vs. theoretical storage capacity



Source: One Earth – "Carbon capture and storage at the end of a lost decade" (November 2021).

Going big on carbon and hydrogen hubs

The comprehensive climate incentives included in the IRA will likely catalyze development of carbon and hydrogen hubs in the US that could potentially leapfrog those in progress in Europe. While the concept of a hydrogen hub or a carbon capture hub is already gaining momentum in the US, a large-scale low-carbon industrial hub will likely include three key attributes: zero carbon electricity, clean hydrogen production, and carbon capture, storage, and utilization. To be competitive, hubs should be situated nearby low-cost clean electricity resources, advantageous geologic storage (such as deep saline formation for CO_2 storage and salt cavern for hydrogen storage), and expandable infrastructure (such as pipelines, docks, distribution systems).

From a transition perspective, development of low-carbon industrial hubs will be the most effective pathway to achieve large scale and rapid decarbonization, particularly for hard-to-abate sectors. Industrial clusters of companies/facilities (aka a hub) are poised to take the most advantage of government incentives as the group can also share the investment costs associated with the necessary transport infrastructure, thereby supporting economies of scale and further reducing unit costs/risks.

Companies that are early champions and/or anchors in such hub development would also likely get first-mover advantage in reducing their climate risk exposure and capturing new market opportunities.

There are already 22 hydrogen hub proposals under development[6] plus several carbon capture coalitions being formed in the US. This was in response to the passage last year of the Infrastructure Investment and Jobs Act (aka Bipartisan Infrastructure Deal) which allocates an unprecedented >US$9 billion and >US$12 billion of investment toward CCUS and hydrogen projects, respectively. These investments will essentially work in conjunction with various incentives in the IRA – such as the US$5.8 billion Advanced Industrial Facilities Deployment Program, the credit for production of clean hydrogen, and the 45Q credit for CCUS – to accelerate adoption of CCUS and production of clean hydrogen in the US. See Figure 17.

Given the attractiveness of economics as we discussed above, we believe projects could move forward rather quickly on the back of the IRA incentives.

Figure 17: Funding for hydrogen and carbon capture from bipartisan infrastructure and IRA bills

	Infrastructure Investment and Jobs Act	Inflation Reduction Act
Hydrogen		
Allocated Spending	**US$8bn** for 6–10 regional clean hydrogen hubs ▪ At least one hub from fossil-fuel based hydrogen, one from renewable energy, and one hub from nuclear energy; ▪ Each hub in different region of the US with at least 2 in regions with abundant natural gas resources; ▪ Fund min of US$0.4–0.5bn and max of US$1–1.25bn per hub for total spend of US$6–7bn initially; min of 50% non-federal cost share **US$1bn** for electrolysis "green hydrogen" RD&D program	Hydrogen production tax credit (CBO cost estimate **US$13bn**) ▪ US$3/kg (inflation adjusted) if lifecycle GHG emissions rate of <0.45 $kgCO_2e/kgH2$; ▪ 33% of full value (US$1/kg) between >=0.45 and <1.5; ▪ 25% of full value (US$0.75/kg) between >=1.5 and <2.5, ▪ 20% of full value (US$0.60/kg) between >=2.5 and <4.0; ▪ Available for 10 years of operations ▪ May be used in conjunction with renewable or nuclear PTC, but not in conjunction with CCUS credit
Carbon Capture		
Allocated Spending	**US$3.5bn** Direct air capture hubs (aim 4 regional hubs) **US$3.5bn** Carbon capture pilot and demonstration Program **US$2.5bn** CO_2 storage commercialization program **US$2.1bn** Carbon capture transportation infrastructure program **US$0.3bn** Carbon utilization and procurement grant program **US$0.12bn** Direct air capture prize **US$0.1bn** Carbon capture tech program **US$0.05bn** Funding for Class VI Well Permits at EPA and States	45Q CCUS tax credit (CBO cost estimate **US$3.2bn**) ▪ Point source capture: US$60/ton if utilized; US$85/ton if stored ▪ Direct air capture: US$130/ton if utilized; US$180/ton if stored ▪ Available for 12 years of operations

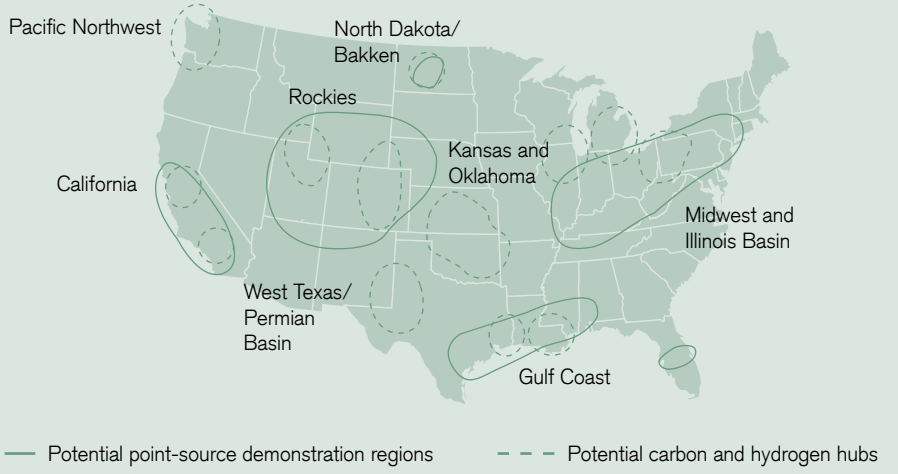
Source: Government documents, Congressional Budget Office (CBO), Credit Suisse

6 The Center for Strategic and International Studies (CSIS) recently identified 22 hydrogen hub proposals under development that are planning to apply for the government funding under the IIJA.

Gulf Coast and Midwest regions likely to dominate initial carbon capture developments. The Great Plains Institute identified[7] eight regions where highly concentrated industrial and power generating facilities coincide with opportunities for permanent geologic carbon storage. Perhaps not surprisingly, the Midwest and Illinois Basin and Gulf Coast (mostly Houston and southern Louisiana) have the most concentration of industrial and power facilities and thus aggregate emissions from these facilities. Moreover, the majority of CCS projects in planning are located along the Gulf Coast.

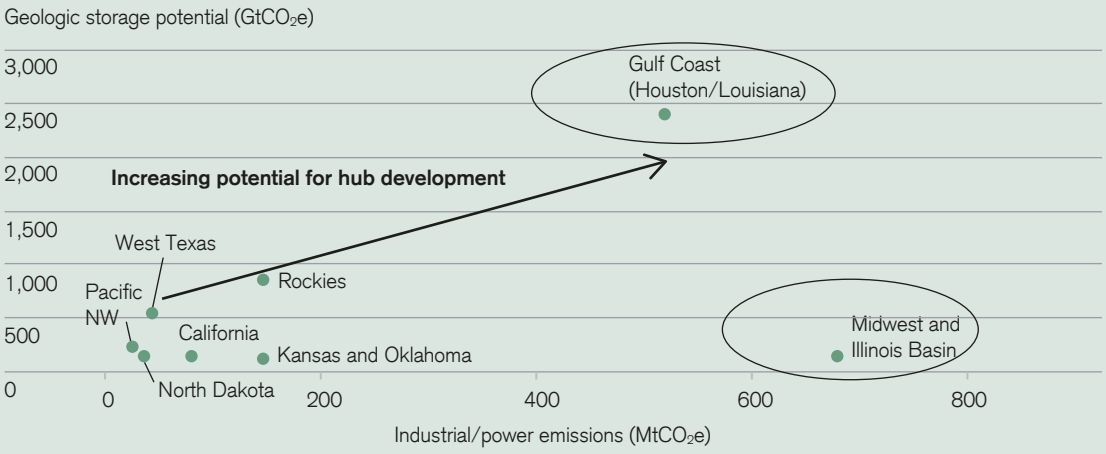
There are also two major pipeline projects in discussion in the Midwest by developers Summit Carbon Solutions and Navigator in partnership with landowners, local, and industry partners. While more specific details on the requisite criteria for eligible projects to receive government funding should emerge with the application opening process in 4Q22, the Department of Energy will likely favor those that have the potential to form a regional hub, in our view. In fact, respondents to the DOE's Request for Information (RFI) proposal identified potential host site regions for the point-source carbon capture demonstrations that were almost spot on with potential carbon and hydrogen hub sites identified by the GPI.

Figure 18: Potential point-source demonstration regions in response to DOE's RFI vs. hub sites identified by GPI



Source: US Department of Energy, Great Plains Institute

Figure 19: Emissions from industrial/power facilities relative to geologic storage potential in eight select regions in the US



Source: Great Plains Institute, National Carbon Sequestration Database and Geographic Information System

7 "An Atlas of Carbon and Hydrogen for United Stated Decarbonization" Feb 2022, Great Plains Institute

Boost to domestic clean manufacturing

The IRA aims to spur the domestic clean manufacturing industry by subsidizing US supply of various clean energy components and by incentivizing demand of domestic products. See Figure 20.

- On the production side, the advanced manufacturing provision may become the single most expensive ticket item in the bill given credits provided for components across the solar, wind, and battery supply chains, including critical minerals. In addition to this uncapped tax credit, there are also loans and grants such as the advanced technology vehicle manufacturing program under the DOE's LPO as well as the US$10 billion energy project investment credit which is applicable for a wider use of clean energy equipment manufacturing.
- On the demand front, clean electricity production- and investment-based credits have a 10% bonus (percentage points in the case of ITC) if all steel, iron and >40% manufactured products are made in the US. The latter is defined as products where a certain percentage of the total costs of the components are mined, produced, or manufactured in the US. This is a positive for US steel producers and synergistic to the manufacturing credits noted above.

  On the transport side, half of the US$7,500 clean vehicle credit is tied to battery components made in North America while the other half is tied to critical minerals from the US and FTA countries. In our view, this credit may be one of the most restrictive provisions in the bill given many layers of requirements in addition to material sourcing.

Figure 20: IRA provisions that are dedicated to or encourage domestic green manufacturing

Sector/area	Tax credit/incentive amount	IRA provisions
Power		
Clean electricity production tax credit (PTC) and investment tax credit (ITC)	10% bonus adder if project meets domestic content requirement	▪ Steel and iron that are not part of a manufactured product to be 100% produced in the US ▪ Increasing percentages of the total cost of manufactured products shall be produced in the US – Offshore wind: 20% for construction before 2025, 27.5% in 2025, 35% in 2026, 45% in 2027, and 55% in 2028+ – All others: 40% for construction before 2025, 45% in 2025, 50% in 2026 and 55% in 2027+
Transport		
Clean vehicle credit (new passenger vehicles only)	US$7,500	▪ Final assembly must take place in North America ▪ US$3,750 if increasing percentage of the value of the battery's critical minerals are either extracted and processed in the US or Free Trade Agreement country, or recycled in North America – 40% for a vehicle placed in service before 2024, 50% in 2024, 60% in 2026, 70% in 2026 and 80% in 2027+ ▪ US$3,750 if increasing percentage of the value of the battery's components are manufactured or assembled in North America – 50% for a vehicle placed in service before 2024, 60% in 2024-25, 70% in 2026, 80% in 2027, 90% in 2028, 100% in 2029+ ▪ **Expires** for vehicles with battery's components manufactured or assembled by a foreign entity of concern (e.g., China, Russia, North Korea, Iran, etc.) starting in 2024 ▪ **Expires** for vehicles with battery's critical minerals extracted, processed, or recycled by a foreign entity of concern starting in 2025
Advanced technology vehicle manufacturing	US$3 billion (to cover credit subsidy cost)	DOE loan program – reequipping, expanding, or establishing a manufacturing facility in the US to produce advanced technology vehicles that emit low or zero exhaust GHG emissions
Domestic manufacturing conversion grants	US$2 billion	Domestic production of efficient hybrid, plug-in hybrids, electric vehicles, and hydrogen fuel cell vehicles and components
General		
Advanced manufacturing production tax credit	Credit varies by product	Eligible components include US-manufactured PV cells, PV wafers, solar grade polysilicon, solar modules, wind energy components, torque tubes, structural fasteners, electrode active materials, battery cells, battery modules, and critical minerals
Advanced energy project investment credit	US$10 billion in total 30% of investment	Facilities that manufacture equipment/components used for renewables, grid modernization, CCUS, low carbon fuels, energy conservation, EVs/fuel cell vehicles

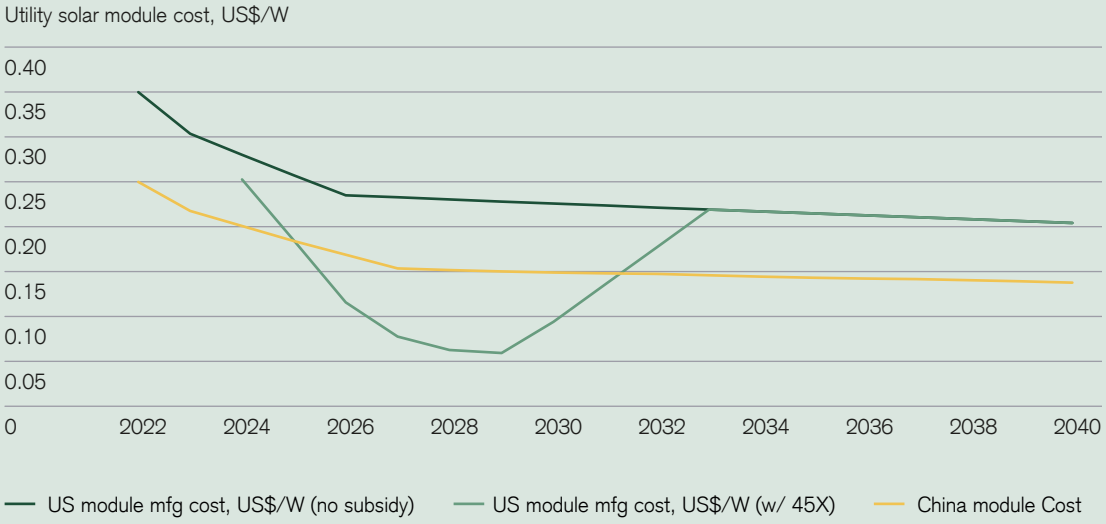
Source: Congress, Credit Suisse.

Implications for US manufacturing

We believe 90% of the domestic demand for solar and wind installations could come from domestic manufacturing supply chain by 2030. This no doubt seems high given we start from scratch in many industries (such as solar), but this estimate may actually be conservative given the attractiveness of the credits. We estimate the subsidized cost of a solar module may be 20–40% of the unsubsidized costs while wind turbine cost may be reduced by >50% with the IRA manufacturing credits. The question is more about how likely the US may be exporting solar components down the road, which is not baked into our climate spending estimates.

US solar modules will be the cheapest globally. The solar manufacturing tax credits make US made modules among the cheapest globally, and even cheaper than China made modules from 2025 to 2030. We estimate solar module cost will reduce to as low as ~US$0.05–0.10/W in the US in 2025–2030 vs unsubsidized module manufacturing cost in the US >US$0.25-0.30/W. The favorable cost structure will be aided by multiple tax credits, including Solar grade polysilicon: US$3/kg (~1c/W), Photovoltaic wafer: US$12/sqm (~6–7c/W), solar cell 4c/W (thin film or crystalline silicon), and Solar module 7c/W. We estimate total subsidies of ~17–19c/W at its peak.

Figure 21: US Solar module <50% cheaper than China modules with tax credits



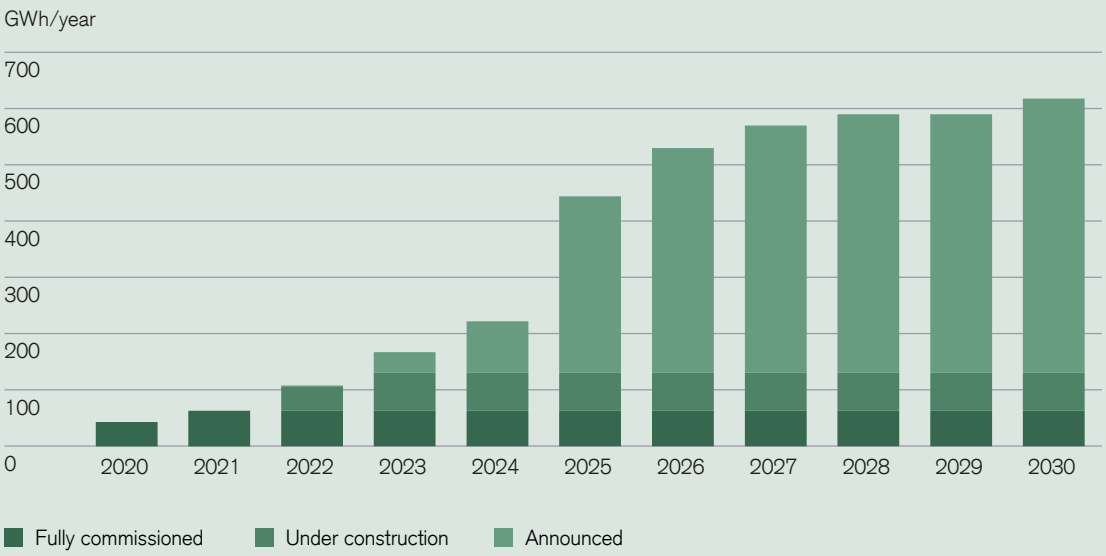
Source: Credit Suisse

For light-duty transport, there are two provisions that matter the most for autos. Manufacturing tax credits for the supply of US made batteries (US$35/kWh for battery cells and US$10/kWh for battery packs) and US$7,500 credit for the purchase of an electric vehicle (EV). The manufacturing credits are not subject to any domestic content requirements, but the EV tax credit is, in addition to other price/income/assembly restrictions. There is also a 30% investment tax credit for facilities that refine or process critical minerals and other grants/loan guarantees available (in both the IRA and Infrastructure Investment and Jobs Act) to support US auto manufacturing supply chains.

As such, these incentives should benefit battery plants that have already been announced/planned in the US and encourage additional buildout and/or expansion of current ambitions.

These incentives should benefit battery plants that have already been announced/planned in the US and encourage additional buildout and/or expansion of current ambitions. According to BNEF, cell manufacturing capacity in the US could grow from just over 100 GWh/year in 2022 to over 600 GWh/year by 2030. More project announcements have been made more recently after the signing of the IRA.

Figure 22: Cell manufacturing capacity buildout in the US



Source: BloombergNEF

Meanwhile, the EV tax credit is highly restrictive, particularly the anti-China provisions. To qualify for half of the US$7,500 credit, an increasing percentage of EV battery components need to be manufactured or assembled in North America. For the other half, an increasing percentage of critical minerals (such as lithium, nickel, cobalt, and aluminum for the cathode active materials and graphite for the anode) in the batteries need to be sourced from North America or a country with an FTA. Moreover, if any battery materials and critical minerals are sourced from "foreign entity of concern", aka China, starting in 2024 and 2025, respectively, then it disqualifies the vehicle from receiving any of the US$7,500 credit.

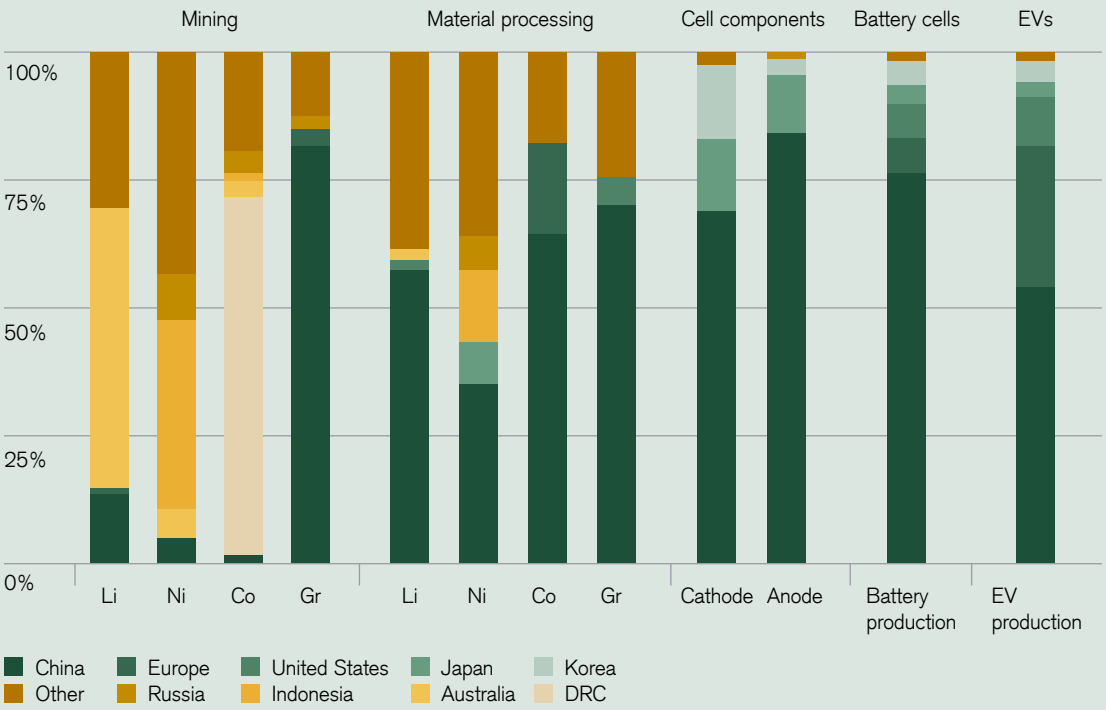
Figure 23: Eligibility for the full US$7,500 incentive contingent on two new requirements

Requirements for the US$7,500 tax credit	2023E	2024E	2025E	2026E	2027E	2028E	2029E	2030E
% of critical minerals extracted, processed, or recycled in North America or in countries that have free trade agreements with the US	40%	50%	60%	80%	80%	80%	80%	80%
% of components manufactured or assembled in North America	50%	60%	70%	80%	90%	100%	100%	100%

* highlighted cells means "foreign entity of concern" requirement in effect
Source: IRA, Credit Suisse estimates

- According to the Alliance for Automotive Innovation (AAI), ~70% of the 72 models that were previously eligible for EV credit will lose their qualification due to the requirement to have final assembly in North America;
- Many EVs will not meet the new price limit as the average new EV price in the US is ~US$67K according to Kelley Blue Book, vs. a limit of US$55k for sedans and US$80k for SUVs/trucks;
- China commands significant market share of critical minerals, battery metals, and rare earth oxides. Rectifying the USA's reliance on outsourced mining and battery assembly will prove challenging as China accounts for 56% of global market battery production, 74% cathode materials (~99% for LFP – lithium, iron, phosphate), and 90% for anode materials. The graphite requirement alone removes eligibility for the vast majority of the cars. This is the same for rare earth minerals as there's currently only one significant producer outside of China.

Figure 24: Geographical distribution of the global EV battery supply chain: China dominates cell and material components



Source: IEA, Credit Suisse

To what extent the EV manufacturing supply chain could change varies by automaker. Every OEM would need to determine whether the US$7,500 credit is sufficient to incentivize an overhaul of their supply chain and/or manufacturing footprint. It's likely that some OEMs will do an analysis and find that the economies of scale and manufacturing efficiency achieved at plants in other regions exceed the benefits of establishing new facilities in the US, even with all possible incentives.

If there is worry that some models will not remain eligible for the purchase tax credit owing to the restrictiveness of the requirements (particularly material sourcing), the reluctance may be even higher. We believe US Autos OEMs will benefit more than the EMEA Autos OEMs, mainly from removal of volume cap and dominant manufacturing footprint in North America. That being said, we have already had reports of foreign OEMs considering changing plans to meet eligibility.

Just transition: building bipartisan support on climate

The IRA contains many provisions that aim to mitigate the negative social consequences of the transition to a low-carbon economy. For the most vulnerable energy-dependent, low-income and rural communities, the bill provides tax credits to spur buildout of clean energy supply and low-cost grants/loans to facilitate transition on the demand side.

Together with the wage and apprenticeship requirement, these provisions ensure steps are taken toward a just transition and that these communities can benefit from the economic growth and the substantial job creation.

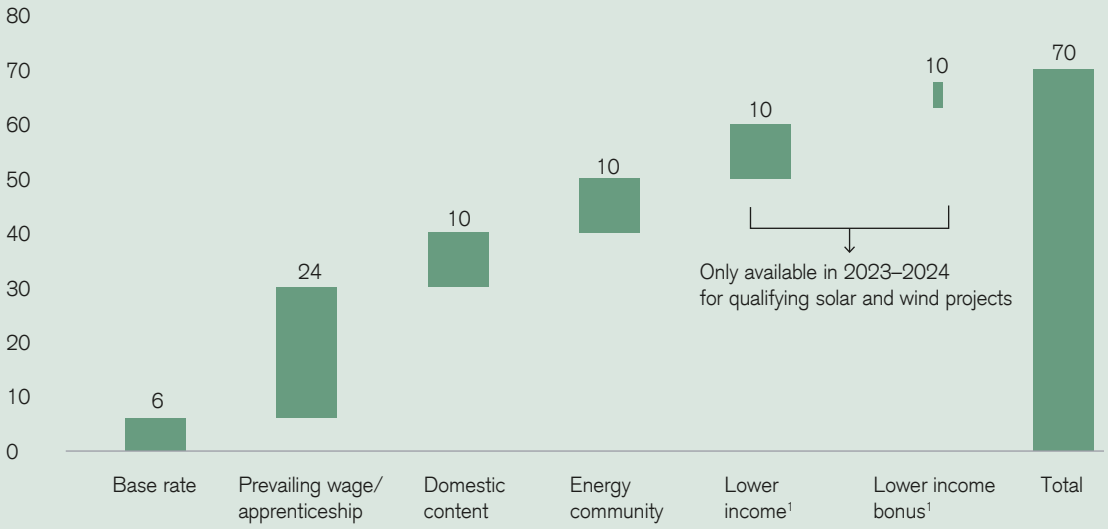
Tax credits

Developers can collect as much as 70% of the upfront investment cost for solar and wind projects located in energy communities that also meet certain low-income criteria in 2023–2024. See Figure 25. Beginning in 2025, any zero-emission electricity generation project can get 50% of the cost back if it meets wage and apprenticeship, domestic content, and energy community criteria.

Energy community can be defined in three ways:

- brownfield sites
- an area with significant employment/tax revenue related to coal, oil, or natural gas and which has an unemployment rate at or above the national average
- a census tract in which a coal mine has closed after December 31,1999 or a coal-fired electric generating unit has been retired since December 31, 2009

Figure 25: Cumulative renewable investment tax credit as % of upfront cost



1 For solar and wind projects with less than 5 MW capacity, the bill allows an additional 10% investment tax credit if located in a low-income community or on Indian land, or an additional 20% credit if located in low-income residential building or a qualified low-income economic benefit project. These are limited up to 1.8 GW/year, available in 2023–2024, and any unused portions are available to roll over into the following year.

Source: Congress, Credit Suisse

Another notable credit is the **advanced energy project investment credit**, of which US$4 billion of the US$10 billion is earmarked for energy communities. The credit pays for up to 30% of the investment cost of manufacturing facilities in clean energy sectors, such as energy storage systems, critical minerals processing, and grid modernization equipment.

- As mentioned earlier, **DOE's loan program in Energy Infrastructure Reinvestment** could have an outsized impact on energy communities. The program allows DOE to issue **up to US$250 billion in loan guarantees** to "retool, repower, repurpose or replace" energy infrastructure that is either currently operating or has ceased operations. The projects that utilize fossil fuels must avoid/reduce/utilize/sequester air pollutants and anthropogenic GHG emissions. In addition, projects that remediate environmental damage associated with energy infrastructure would also qualify under the program. This provides lower cost of financing not only for projects that upgrade existing fossil fuel infrastructure (such as adding carbon capture equipment) but also those that repurpose old infrastructure (such as converting gas pipeline to CO_2 pipelines).

In addition to energy communities, **an estimated US$47 billion is earmarked for provisions related to environmental justice**[8]. The purpose of this spending is to directly benefit communities based on various criteria (e.g., income, energy burden, or other demographics) that are affected by the earliest impacts of climate change and less equipped to adapt. Most notably, **US$15 billion of the US$27 billion Greenhouse Gas Reduction Fund** is allocated toward low-income and disadvantaged communities; US$7 billion of which is designated for zero-emission technologies like rooftop solar, while the remainder is in a general fund making broader GHG reduction investments.

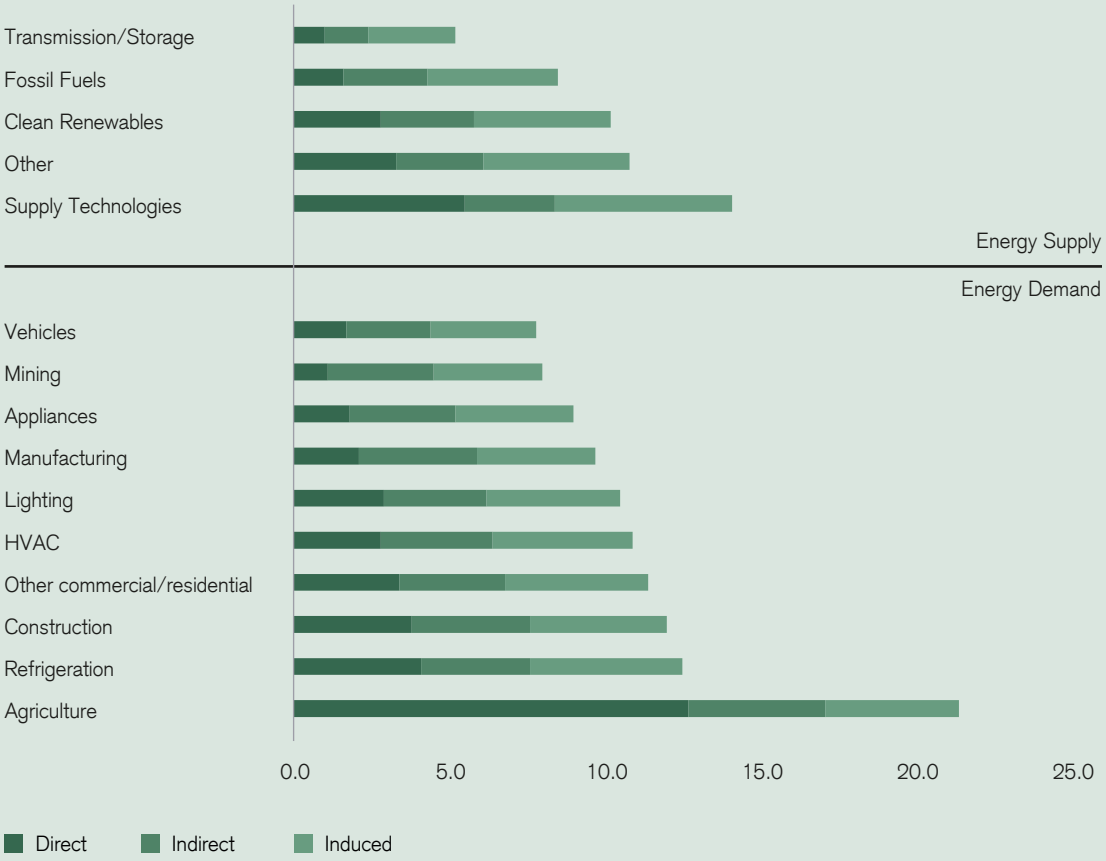
In addition, US$3 billion is allocated to environmental and justice block, designed to address pollution, mitigate health risks, and improve resiliency and another US$3 billion for the neighborhood access and equity grant, which centers around accessibility, construction projects, and affordable transportation. While some of these are yet to be formally defined, low-income is defined as any area where (1) the poverty rate is at least 20% or (2) the median income for the tract is <80% of the statewide median family income.

IRA is estimated to create over 9 million jobs by 2030, or close to ~1 million a year annually. For perspective, this represents more than 5% of the civilian labor force today and would be multiples of the ~1.7 million workers[9] in the fossil fuel industry currently. It is estimated that for every US$1 million spent for energy supply and demand this investment would generate between 9.7 and 11.3 jobs, respectively, at current domestic content levels. Upside exists for an additional 9% in the event we reach 100%.

We also note that prevailing wages and apprenticeship requirements are attached to many provisions offering a 5x multiplier incentive to baseline tax credits (e.g., clean hydrogen, ITC, 45Q). The former requires designated wage rates are paid during the construction of the project and, in some cases, for alteration/repair for a defined period after the project is placed in service. IRS guidance is needed on how prevailing wage is determined, and what that means for a project's labor cost relative to the current rate. The apprenticeship requirements dictate that a minimum percentage of labor hours need to be performed by qualified personnel stepping up from 10% prior to 2023, to 12.5% within that year, and up to 15% on any project thereafter.

8 Breaking Down the Environmental Justice Provisions in the 2022 Inflation Reduction Act - Environmental & Energy Law Program – Harvard Law School
9 How renewable energy jobs can uplift fossil fuel communities and remake climate politics (brookings.edu)

Figure 26: Net Zero scenario Job Multiplier (Direct, Indirect, and Induced) per US$1M spent (2050)



Source: Zero Carbon Action Plan Credit Suisse estimates

Building durable political support on climate

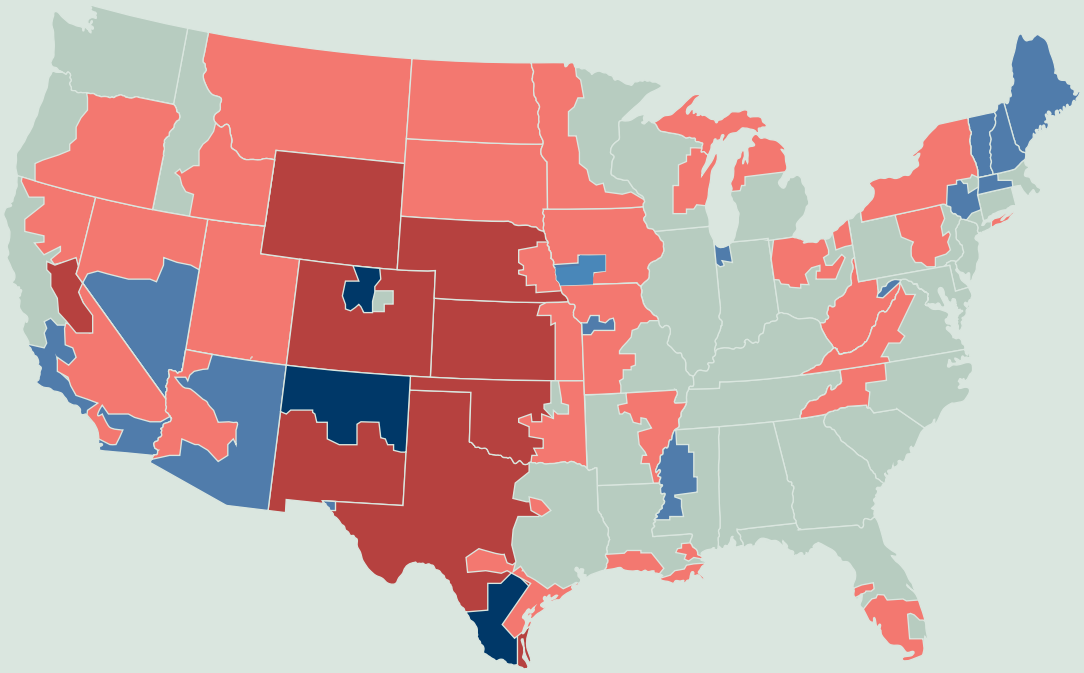
We believe the economic interests created by the IRA could make these climate legislations more politically durable. While the future of US politics is far from certain, IRA will jump start new investments, create jobs in construction and green manufacturing, and increase income and tax revenues tied to climate-related interests across the country. State and city legislations could follow suit with the support of federal funding (i.e., California recently approved a record US$54 billion in climate spending). The positive feedback loops help to build bipartisan support for climate actions set in motion under the IRA as well as more ambitious actions in the years to come.

In the US, there's a significant overlap between where fossil fuel jobs are today and where the best renewable energy resources are located. Researchers from University of Texas at Austin found[10] that **a quarter of the counties in the US with high potential for both wind and solar are also fossil fuel hubs.**

In addition, many Republican-leaning states are competitive in solar or wind (bright red in Figure 27) or are competitive in both solar and wind (dark red), including dominant energy-producing states such as Texas, Oklahoma, and North Dakota.

Investments would naturally flow into regions with the best economics; the technology-agnostic nature of the bill also ensures there's a role for the oil and gas industry in the transition. Adding to these benefits, there are bonuses for projects located in "energy communities" and for those meeting wage and apprenticeship program requirements (all but a given considering the benefit to receive 5x the base credit rate). All of this sets the foundation for a green transition while protecting the US' existing competitiveness on energy and its national security interests.

Figure 27: Party representation and renewable energy potential by congressional district



Party holding house seat, potential renewable competitiveness

Republican, competitive in solar and wind | Democratic, competitive in solar and wind | All other districts

Source: Brookings analysis

10 "How renewable energy jobs can uplift fossil fuel communities and remake climate politics" – Brookings

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Figure 28: Report contributors across Credit Suisse global teams

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