ABN·AMRO

Group Economics | 20 January 2021

Economic Climate Monitor

Loudina Erasmus, Climate Economist
Tel.: +31 6 2535 5796 / loudina.erasmus@nl.abnamro.com

Making America green again

- **President Biden's plan is to re-join the Paris agreement by executive order, and spend USD2 trillion on renewable investment over the coming four years**
- **We expect investment of this USD2 trillion to be targeted towards the highest emitting states, which together emit more than 50% of US CO2 emissions, with additional targeted investments for CO2 intensive electricity and transportation states, representing an additional 30% of US CO2 emissions**
- **If growth-supportive investment is targeted towards Republican states where CO2 intensity is high, and where the Republican voting margin is small, this plan could also boost Democrat prospects in the 2024 election. This would further raise the chances of success in achieving climate goals. With this in mind, Texas may attract a relatively high share of investments**
- **The biggest potential cost savings from climate-related damage would be in three of the four high emitting regions, where more than 50% of US natural disaster costs were incurred in the past 40 years**
- **The energy transition is already underway, with 50% of the total increase in renewables generation for September 2020 year to date from five Republican states, with Texas leading as the largest energy producer**

Biden's Climate Promise - to re-join the Paris Climate Agreement, reinstate emissions rules, and to invest USD 2 trillion to confront the "grave threat" of climate change – gave rise to two central questions.

1. **What does Biden's promise imply for global emissions and global temperature trajectory?**
2. **Where can the most cost effective and efficient CO2 emissions reduction within the US be made?**

Much of the response depends on how likely Biden's promise is to be realized. With the slim democratic majority in the senate gained on the 5th of January, Biden's ability to pass the required legislation and amendments to implement his plans increases substantially. The first question has been addressed in a prior publication, Global implications of Biden's climate Promise. This article addresses the second question focused on US states: where can the most cost effective and efficient CO2 emissions reduction within the US be made? What is feasible, and which obstacles remain.

US emissions and targets

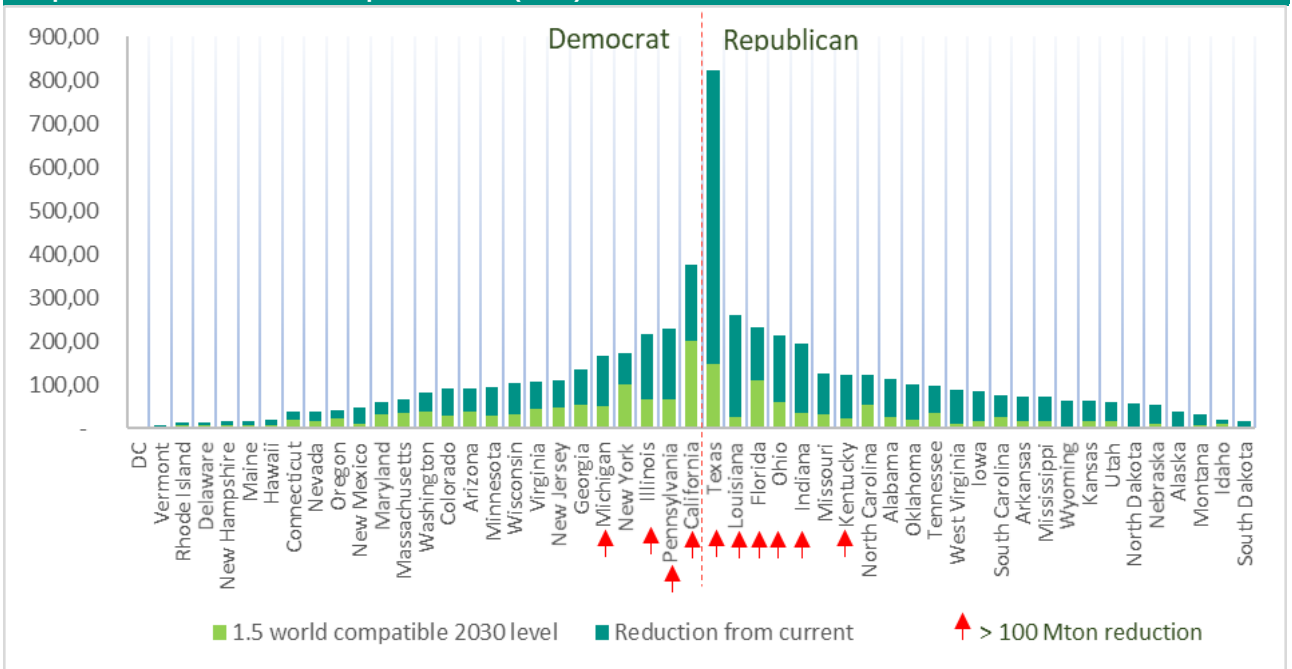
US emissions peaked around net 6,5 Gigaton CO2 equivalent in the early 2000s. In the Copenhagen Accord the US targeted a 17% reduction below 2005 levels. Following 2020 measures to slow the pace of the Covid-19 pandemic - reducing travel and altering demand for goods and services – a preliminary report from Rhodium Group, a private data analytics firm, estimates a 10.3% drop in US greenhouse gas (GHG) emissions and total reduction of 21% below 2005 levels. The US is expected to far exceed its 2020 target, with emissions below 1990 levels for the first time. Drivers in addition to the pandemic were mainly lower prices and emissions of gas displacing coal, Obama era tax breaks for renewable energy and standards for low emission vehicles.

Looking ahead and the challenge for Biden

To remain within the Paris agreement trajectory of 1.5°C by the end of this century, the US needs to reduce CO2 emissions by 70% in the next 10 years according to Carbon Action Tracker. The current NDC (nationally determined contribution) of 26-28% in 2025 compared to 2005 is not sufficient, and we expect stronger targets to be announced at COP26 in Glasgow later this year.

Considering fossil fuel emissions per state, Republican states Texas and Louisiana stand out as high emitters, with emissions tied mainly to industrial processes and fossil fuels. The coastal states California and Florida follow with emissions mainly from transportation, and electricity generation for Florida. The next six high emitters are driven by a combination of transport, energy and industrial activity.

Graph 1: Fossil fuel emissions per US state (2018)



Source: US environmental protection Agency; NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters; ABN AMRO group economics

Allocating reduced emissions per state by population isolates ten states where reductions in excess of 100 Megaton per annum would be needed, with Texas far in the lead at almost 700 megaton reduction required on annual basis – 1/5th of the total US reduction requirement.

These ten states are responsible for more than 50% of US emissions and are clustered in four regions.

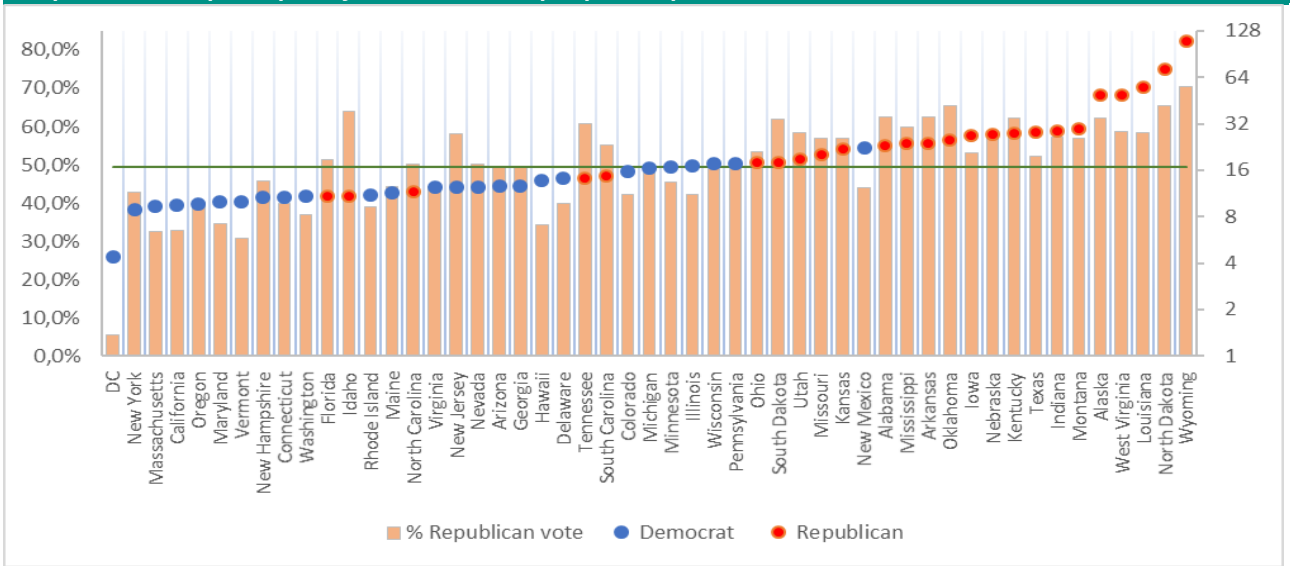
California, Texas, Louisiana and Florida also face the highest damage cost from natural disasters. Total US based losses from climate events amount to 1,8 trillion over the past 40 years. Most of these losses (91%) are the direct result of tropical cyclones, severe storms, drought or flooding. 2/3rds of losses were incurred during the last 15 years, with increases in losses driven by climate change as well as increase in exposure (and GDP/economic activity) in areas subject to climate-related events.

Source: US environmental protection Agency; Election results screenshot; ABN AMRO group economics

Political sentiment, carbon intensity and wealth

To critically consider how successful targeting high emission states would be we'll in turn look at voting behaviour in the November election compared to carbon per capita in all states. Plotting CO2 emissions per person to Republican and Democrat states shows is a clear trend from Democratic states emitting around 12 tons per person[1] increasing to deeply Republican states emitting more than 50 tons per person.

Graph 2: Carbon per capita by state - ton CO2 per person per annum



Source: Statista; US environmental protection Agency; ABN AMRO group economics [2]

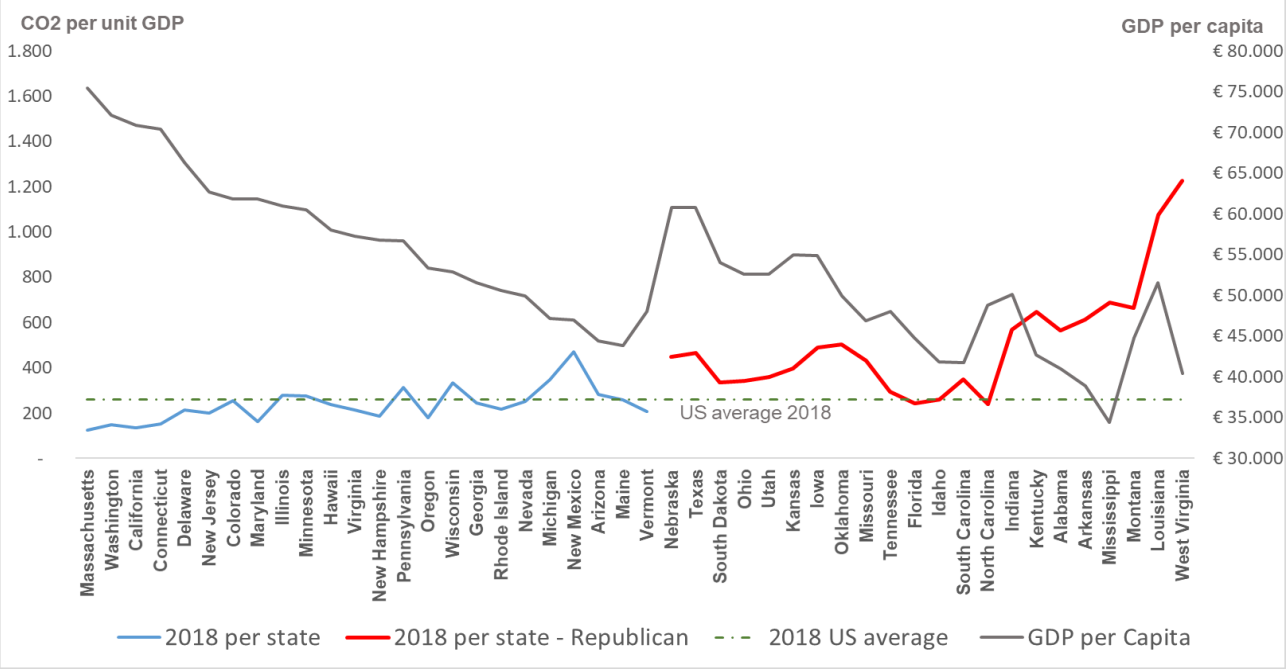
[1] as comparison, EU emissions are around 10 tons per capita

[2] The District Columbia has an extremely low carbon footprint at 4,4 tons per person. This is mainly due to the function as political capital and federal district (not actually a state, no senate seats), with all carbon intensive industry directly in the neighbouring states.

The swing states Pennsylvania, Wisconsin, Minnesota and Michigan are all around the average per capita emissions intersection, shown by the green line representing the average US per capita emissions of 16,8 per person on the right axis[3] (aligned to a 49% republican vote).

The per capita emission is likely driven by industry concentration in areas which are not the wealthiest places, rather than individual preferences. Comparing CO2 intensity of GDP to GDP per capita suggests that higher CO2 per unit GDP intensity is indeed associated with lower wealth.

Graph 3: Carbon intensity per state: CO2 per unit GDP vs GDP per capita



Source: Statista; US environmental protection Agency; ABN AMRO group economics

In grouping Democratic to the left and Republican states to the right of graph 3. The disparity in states is even more pronounced than the per capita footprint, with on average higher GDP per capita for Democratic states, decreasing as emissions intensity increases. Wealth likely resulted in lower emissions as activity moved from manufacturing to finance or technology, followed by further wealth increases as these industries scale faster.

Investing in poorer areas will very likely have beneficial impact on climate as well. Not coincidentally those less wealthy states are in general red states, and more exposed to disaster losses. For Louisiana – cumulative losses over the past 40 years is equal to 82% of annual GDP, roughly 2% per year. For Mississippi it is 68% of annual GDP.

Political sentiment is an important consideration for longer term success. A second term in office to bring initiatives to maturity would become less likely if investments rolled out in the next four years are not beneficial to voters. Green needs to be positively associated with an increase in wealth and well-being, and a decrease in risk and damages, even if the direct pay-off from investments take longer than 4 years. If targeted strategies were to reduce emissions dramatically, but result in decreasing standards of living for a critical mass of US voters, it will not be successful long term.

Considering the high absolute emissions, low majority vote, high per capita emissions and lower GDP per capita in Republican state, it could be politically wise if Biden invests more heavily in red states.

[3] on log scale demonstrating the exponential increases in emissions to relative increase in republican votes.

Where can the most cost effective and efficient CO2 emissions reduction within the US be made?

Reducing CO2 emissions by 70% in the next 10 years requires quite an extensive change in the drivers of the US economy. Where can the largest reductions be made and what is feasible? The question turns here to how you can best approach this problem: by focusing on states with the highest emissions, further improving in states where carbon intensity is already low, or a bit of both? 2018 emissions of the 10 highest emitting states (grouped to 4 regions and the 40 remaining states in a 5th bucket), split by sector and the proportional reduction needed toward 2030 are tabled below.

Table 1: Megaton CO2 emission by industry

		Transportation	Industrial	Electricity	Residential	Commercial	CO2 emissions 2018	Equitable share 2030	Reduction needed	%
1	Texas	245	349	201	13	15	**823**	148	675	82%
	Louisiana	49	171	34	2	2	**258**	24	234	91%
2	California	218	80	34	25	19	**376**	201	175	46%
3	Pennsylvania	63	57	73	22	12	**227**	65	162	71%
	Indiana	42	48	87	9	6	**192**	34	158	82%
	Ohio	63	42	75	19	12	**211**	60	152	72%
	Illinois	70	41	65	25	15	**215**	65	151	70%
	Michigan	52	22	58	21	11	**164**	51	113	69%
	Kentucky	34	18	65	3	3	**123**	23	101	82%
4	Florida	110	14	100	1	7	**233**	110	123	53%
	10 states above	948	841	791	141	103	**2.824**	780	2.044	
5	40 states rem.	1.000	417	931	204	152	**2.704**	894	1.810	67%
	US total	**1.948**	**1.258**	**1.722**	**345**	**255**	**5.528**	**1.674**	**3.854**	**70%**
		35%	23%	31%	6%	5%				

Source: US environmental protection Agency; NOAA National Centres for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters; Election results screenshot; ABN AMRO group economics

Economic sectors driving emissions per geographic territory gives some flavour of emission reductions needed, what the transition may look like and according investments.

Texas and Louisiana's emissions are mainly from industrial processes and fossil fuel - their combined population based reduction need is nearly 1 Gigaton.

To avoid becoming energy dependant on imports, the US will likely clean up the processing (rather than reducing) in Texas and Louisiana, while focusing on electricity and transport as part of the US wide roll-out. Overall, demand for oil and gas will reduce locally as transport transitions to electric, in turn further shrinking industrial activity. Older refineries with more intensive technology will likely close earlier. The South Coast location and high value infrastructure is vulnerable to tropical cyclones. Reducing economic reliance on the oil and gas industry, may also reduce cyclone damage directly since the infrastructure can be removed from a high (and increasing) risk area.

California has disproportionately high emissions from transportation as large coastal state as well as emissions from cement production, while GDP is largely driven by the tech sector. They're the lowest intensity electricity producer in the US, with a third of the emissions of Florida for the sector, while they have twice the population size. California also serves as one of the few examples of an implemented CO2 border tax – with a tariff on imported electricity.

Florida, also a large coastal state attributes most emission to transport and carbon intensive electricity generation while the South Coast location also exposes Florida to tropical cyclones.

From the six central states, steel and chemical production drives CO2 emissions, with associated high energy and transport requirements. Carbon Capture and Storage (CCS) is considered a potential solution with logistic advantages from the geographic concentration of this region.

Breaking the 10 high emission states down by political alignment: California, Illinois are safe blue states. Louisiana, Indiana, and Kentucky can be considered immovably red states. Which leaves Texas, Pennsylvania, Ohio and Michigan as the states with the most benefit politically for follow-up election. Some may argue that except for 2016, Pennsylvania and Michigan are historically blue. Which leaves Texas and Ohio as states to focus on. Expanding the unidimensional (economic) optimization to include the political dimension, would result in a strategy with high policy and investment focus on Texas.

For the 40 remaining states, electricity production and transport represent the bulk of emissions.

CO2 intensity of electricity generation

Electric power generation is specifically isolated in Joe Biden's plan with the goal to achieve 100% clean electricity by 2035. While this would be rolled out across all states – states like Texas, Florida, the central six and small coal dependant states have relatively higher emissions and we expect priority reduction and investment plans here.

The trend away from coal toward renewables is already in motion. For the year to date September 2020 there was a decrease of 3% in total electricity generation, attributed to a 24% reduction in coal and a 12% increase in renewables. Less ideal is a larger portion of generation shifted to natural gas, which also has relatively high CO2 intensity rather than renewables[4].

Table 2: Electric power generation by source YTD September

Fuel type	Q1-3 2019	Q1-3 2020	Abs	%
all fuels (utility-scale)	**3.152.671**	**3.046.634**	**-106.037**	**-3%**
natural gas	1.205.042	1.250.296	45.254	4%
nuclear	610.177	598.925	-11.252	-2%
coal	750.050	573.646	-176.404	-24%
other renewables	329.260	368.677	39.417	12%
conventional hydroelectric	227.872	228.058	186	0%
other	30.270	27.032	-3.238	-11%

As largest electricity producer, Texas is already the leading renewable energy producer, followed by California. The largest increases in renewable power generation, 50% of the total was in Texas, Iowa, Georgia, South Dakota and Florida. All republican states. There are a couple of drivers, including Renewable Portfolio Standards in some (state rules requiring utilities to have a certain amount of their portfolio be renewable), and federal incentives like the investment tax credit, and production tax credit, making it attractive for investors / generators to grow their share of wind and solar electricity.

[4] As a rough guide coal has a carbon intensity of about 1,000g CO2/kWh, oil is 800g CO2/kWh, natural gas is around 500g CO2/kWh, while nuclear, hydro, wind and solar are all less than 50 g CO2/kWh. The US average intensity was 412g/kWh in 2018.

Isolating high CO2 intensity electricity producers, Table 3 shows the CO2 reduction realized by reducing intensity to targets (highlighted in green) of

- 172g CO2/kWh (California level) for the largest 19 emitters. The total reduction would be 760 Mton – 1/5th of the total reduction needed over 10 years.
- 50g CO2/kWh (Renewables) further reductions for all states. The addition reductions contributes another 1/5th (331 + 422 Mton) of the total US reduction needed until 2030.

The 3 states with the highest CO2/kwh are Kentucky, West Virginia and Wyoming where coal is used for more than 70% of power generation – highlighted below in red.

Table 3: Electric power generation CO2/kwh intensity and reduction potential in Megaton

State	Transport	Electricity emissions	Electricty gWh	Coal	Gas	Nuclear and Hydro	Renewables	2018 CO2/kwh	Reduction to intensity 172	Reduction to intensity 50	Emissions on 50/kwh
United States	1.948	1.722	4.178.277	19%	41%	28%	12%	412			50
									760	331	
Texas	245	201	477.353	16%	54%	10%	21%	421	119	58	24
Louisiana	49	34	102.129	4%	69%	24%	2%	330	16	12	5
California	218	34	195.466	0%	44%	23%	33%	172	-	24	10
Florida	110	100	244.253	6%	76%	14%	4%	408	58	30	12
Pennsylvania	63	73	215.386	10%	53%	35%	3%	339	36	26	11
Illinois	70	65	188.003	17%	15%	58%	9%	346	33	23	9
Ohio	63	75	126.185	35%	45%	17%	3%	598	54	15	6
Indiana	42	87	113.459	52%	37%	3%	8%	767	67	14	6
Michigan	52	58	115.838	25%	35%	31%	8%	497	38	14	6
Kentucky	34	65	78.805	70%	23%	7%	1%	823	51	10	4
West Virginia	13	60	67.249	89%	5%	3%	3%	886	48	8	3
Wyoming	8	40	46.112	80%	4%	4%	12%	862	32	6	2
Wisconsin	31	39	65.936	39%	35%	21%	5%	592	28	8	3
Missouri	38	64	85.096	67%	12%	17%	5%	750	49	10	4
Arkansas	20	36	68.000	30%	32%	36%	2%	535	25	8	3
Arizona	34	46	111.925	12%	46%	36%	6%	412	27	14	6
Georgia	56	51	129.239	11%	50%	31%	8%	396	29	16	6
Alabama	33	53	145.058	15%	41%	41%	3%	364	28	18	7
North Carolina	50	47	134.250	17%	34%	39%	10%	353	24	16	7
Remaining 31 states	716	495	1.468.535	15%	34%	35%	15%	337		422	73

Source: US environmental protection Agency; U.S. Energy Information Administration; ***ABN AMRO Group Economics***

Policy and investments that both curb emissions and spur job growth will thus be particularly appealing. While transition to renewable energy would create jobs, and potentially increase GDP it would simultaneously reduce jobs in the traditional sectors (refineries, O&G exploration, coal mines etc). There may be a net gain in the number of jobs, but this comes at higher costs which can potentially be met with a CO2 tariff. This would also narrow the discrepancy in input cost. How progressive federal climate policy can be is still constrained however. There are also Democratic senators from coal states that will demand compromise and could jeopardise the senate majority. Democratic Senator Joe Machin III of West Virginia has mentioned using the 'fillibuster' where 60 senators can block legislation. Similar to previous years, he will block legislation to price CO2 (federal CO2 taxes or Emission Trading Schemes), while he is in favour of nuclear energy and CCS (carbon capture).

In parallel to the electricity transition, changing transport infrastructure can dramatical reduce transport related emissions in densely populated states with high transport emissions, for example New York and New Jersey. This would be a combination of electric and hybrid vehicle roll-out, and improved connectivity with public transport. As renewable electricity and electric vehicle infrastructure expands, the often quoted parody that electric vehicles are clean, but run on electricity produced with coal also dwindles. Considering the total transport emissions of nearly 2Gton per annum, a reduction of 40% already contributes another 1/5th of the required reduction.

While not mentioned as standalone sector in the per state data of Table 1, Biden also mentions interesting reforms for agriculture and forestry in his Climate 21 memo. These include Carbon Bank premiums for carbon capture in soil and forests (10-20% of total needed) as well as collaboration with Brazil and Norway to mobilise $20 trillion toward prevention of deforestation, by addressing import of beef and soya from Brazil.

Conclusion - Vouloir c'est pouvoir

As they say in French - where there is a will there is a way. Reducing US emissions by 70% in 10 years in the sprint to 2030 is possible.

- With a high level calculation, 2/5^{ths} of the reduction needed from the US to remain within a 1.5°C trajectory are feasible with existing electricity generation technology, to be rolled out across all states. It is a question of political will and investment, both of which look promising in a Biden administration.
- An additional 1/5th to be realised from process clean-up and closing the dirtiest plants in the short term, and longer term demand reduction from Texas and Louisiana.
- 1/5th of the reduction needed can be achieved in transport, where a 40% reduction would already meet the requirement.
- Up to 1/5th of total reductions needed to get to net-zero in 2050 can be achieved in agriculture and forestry.

The most effective investment and application of Biden's promise per state would be to strategically focus on Texas/Louisiana, California, Florida and the 6 central high emission states with targeted plans to address the phasing out of fossil fuels and the transitions within transportation, electricity generation and industry per state. These 10 states in aggregate emit more than 50% of US CO2 emissions. We expect Biden to direct a large proportion of the envisioned USD 2 trillion toward reaching 100% clean electricity by 2035 and net-zero emissions by 2050 here, in addition to country wide roll-out of transportation standards. Adding the political dimension, Texas stands out as highest emitter, with the largest reduction potential combined with a relatively small republican lead which can be influenced with a 2024 follow-up term in mind. Considering the high absolute emissions, low majority vote, high per capita emissions and lower GDP per capita in Republican state, it could be politically wise if Biden invests more heavily in red states.