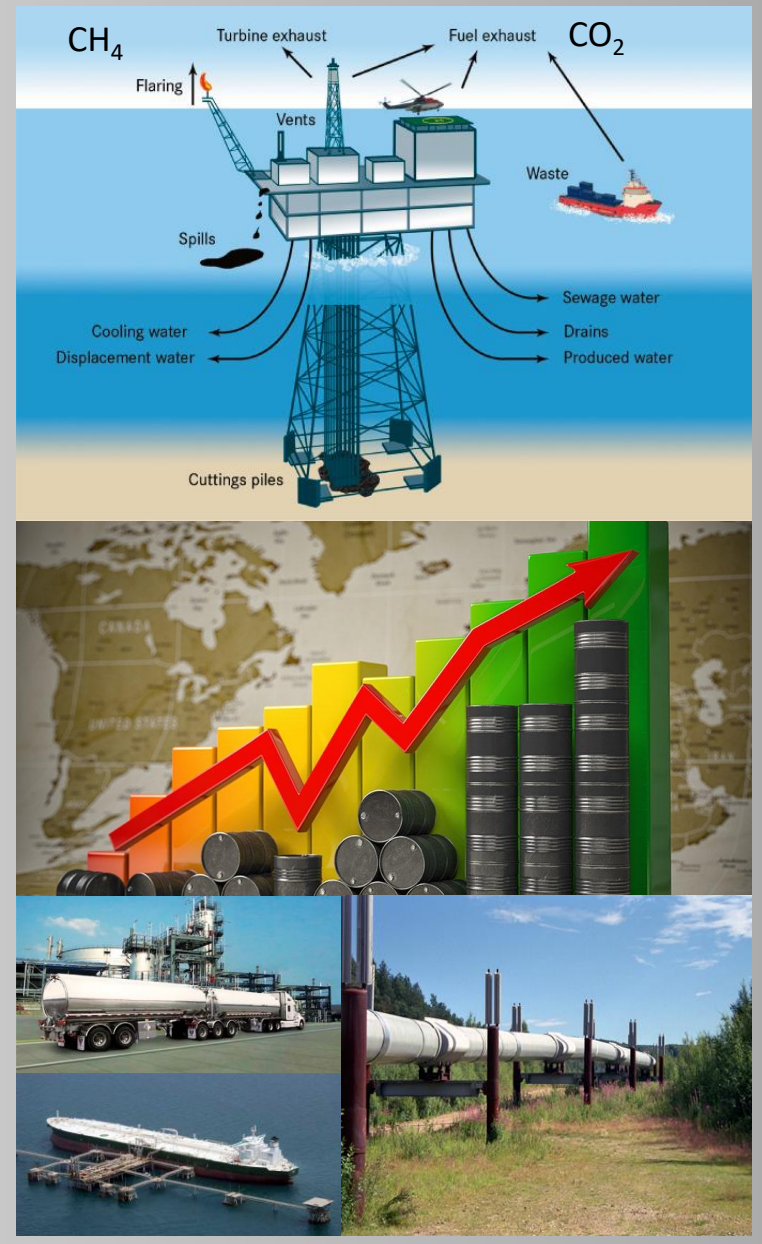
OnLocation
A KEYLOGIC COMPANY

NRDC23-NEMS Analysis of a Moratorium on New Offshore Leasing in the Gulf of Mexico



Prepared for NRDC

August 15, 2023

Project Goal

- OnLocation created the NRDC23-NEMS[1] model with updated assumptions in the transportation sector to assess the impact of stopping new offshore oil and gas leasing after May 2021 in the Gulf of Mexico (GOM), while continuing onshore and offshore leases prior to May 2021, on:
  - Crude oil and natural gas production from U.S. and GOM, imports and exports
  - Domestic price of oil and gas final energy products
  - Carbon dioxide and methane emissions, including expressed as CO_2 equivalents, from oil and gas production, distribution, and consumption

- Analysis time frame is until 2050.

[1] *NRDC23-NEMS was developed by OnLocation for use in this analysis and is based on the Annual Energy Outlook (AEO) 2023 version of NEMS.*

NRDC23-NEMS Scenarios

OnLocation used the NRDC23-NEMS model and ran the following scenarios to evaluate the effects of the leasing moratorium on oil and gas production in the U.S. and GOM along with sensitivities related to new transportation policies and regulations:

1. Reference Case (Ref)

Represents technological and demographic trends as well as policies (such as the partial representation of IRA provisions) and regulations used in the Annual Energy Outlook 2023 (AEO2023) Reference Case, while including the international feedback to crude oil and natural gas imports, exports, and prices.

2. No New Offshore Leasing Scenario (NNL)

Builds off the 'Reference Case' and includes issuance of no new offshore leases in the GOM after May 2021, while allowing existing and announced onshore and offshore projects to continue for leases before May 2021. The oil and gas production from leases issued as a result of sales 257 and 259, as well as lease sale 261 (scheduled for fall 2023), is excluded.

3. Transportation Policy Scenario (POL)

Builds off the 'Reference Case' and includes the Advanced Clean Trucks (ACT) rule for medium- and heavy-duty vehicles, proposed EPA greenhouse gas (GHG) standards for light- medium- and heavy-duty vehicles for model years 2027 and later, and additional Inflation Reduction Act (IRA) tax credit provisions for the transportation sector that are not yet reflected in the AEO2023 Reference Case.

4. No New Offshore Leasing and Transportation Policy Scenario (NNL_POL)

Builds off the 'No New Offshore Leasing Scenario' and includes the transportation-related policies and regulations as described in the 'Transportation Policy Scenario'.

Transportation Policy Assumptions

Updated transportation policies for NRDC23 POL and NNL_POL scenarios include:

1. Advanced Clean Trucks (ACT) rule

The ACT rule for Medium-Heavy Duty Vehicles has been adopted in MA, NJ, OR, and WA in addition to CA and NY. Table A-1 shows zero emission vehicle (ZEV) targets for class 2-8 trucks obtained from California Air Resource Board (CARB)[1].

Table A-1. ZEV Sales Percentage Schedule

Model Year	Class 2b-3 Group	Class 4-8 Group	Class 7-8 Tractors Group
2024	5%	9%	5%
2025	7%	11%	7%
2026	10%	13%	10%
2027	15%	20%	15%
2028	20%	30%	20%
2029	25%	40%	25%
2030	30%	50%	30%
2031	35%	55%	35%
2032	40%	60%	40%
2033	45%	65%	40%
2034	50%	70%	40%
2035 and beyond	55%	75%	40%

[1] https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2019/act2019/fro2.pdf

2. Proposed EPA GHG standards for light medium and heavy-duty vehicles

In April 2023, EPA announced a proposal for more stringent standards to reduce greenhouse gas emissions from light-, medium-[2], and heavy-duty[3] vehicles for model years 2027 through 2032 and later. Table below represents the GHG standards for various vehicle size classes in NRDC23-NEMS.

3. Additional IRA tax credit provisions for the transportation sector

Described in the next slide.

Vehicle type	EPA Proposed GHG Standard (gr CO2/mile)					
	2027	2028	2029	2030	2031	2032 and later
Cars	134	116	99	91	82	73
Light Trucks	163	142	120	110	100	89
Class 2b-3	438	427	389	352	312	275
Class 4-6	732	678	621	573	519	405
Class 7-8	1125	1100	1063	1000	875	825

[2] https://www.epa.gov/regulations-emissions-vehicles-and-engines/proposed-rule-multi-pollutant-emissions-standards-model#rule-summary

[3] https://www.epa.gov/regulations-emissions-vehicles-and-engines/proposed-rule-greenhouse-gas-emissions-standards-heavy

Transportation Related IRA Tax Credits

- **Clean Vehicle Credit (SEC. 13401, Part 4)**
  - 30D Passenger clean vehicle tax credit: Critical mineral and battery components requirements are based on the International Council on Clean Transportation (ICCT) Moderate Case[1], assuming multiplicative MSRP and AGI eligibility.
    - AEO23 tax credits are lower because EIA targeted tax expenditures are based on a study by Congressional Budget Office (CBO)[2] to account for uncertainty around battery component sourcing, critical mineral supply chain, and consumer income.
  - 45X Advanced battery manufacturing production tax credit is based on ICCT Moderate Case, shown in the table.
- **Commercial Clean Vehicle Credit (SEC. 13403, Part 4)**
  - 45W Tax credit for electric freight trucks is the lesser of the incremental cost of the electric truck relative to a diesel truck and $7,500 for class 2b-3, or $40,000 for class 4-8.
  - 45X Advanced battery manufacturing production tax credit is based on ICCT Moderate Case, shown in the table.

Year	AEO23 Ref Case and NRDC23 Ref and NNL Cases ($)	30D tax credits in NRDC23 POL and NNL_POL Cases ($)	45X tax credits in NRDC23 POL and NNL_POL Cases ($/kWh)
2023	117	4437	11.3
2024	360	4284	22.5
2025	484	4121	22.5
2026	655	4164	22.5
2027	676	4205	22.5
2028	697	4245	22.5
2029	719	4283	22.5
2030	743	4321	16.9
2031	767	4396	11.3
2032	793	4472	5.63
2033	710	4005	0
2034	623	3515	0
2035	532	2998	0
2036	435	2454	0
2037	334	1881	0
2038	227	1282	0
2039	116	655	0
2040-2050	0	0	0

Caveat: The IRA tax credits will expire in 2033, but AEO2023 gradually reduces tax credits from 2033 to $0 by 2040. The same approach was applied to 30D tax credits in NRDC23 Policy Cases and $4472 tax credit in 2032 from ICCT Moderate Case linearly decreases to $0 in 2040.

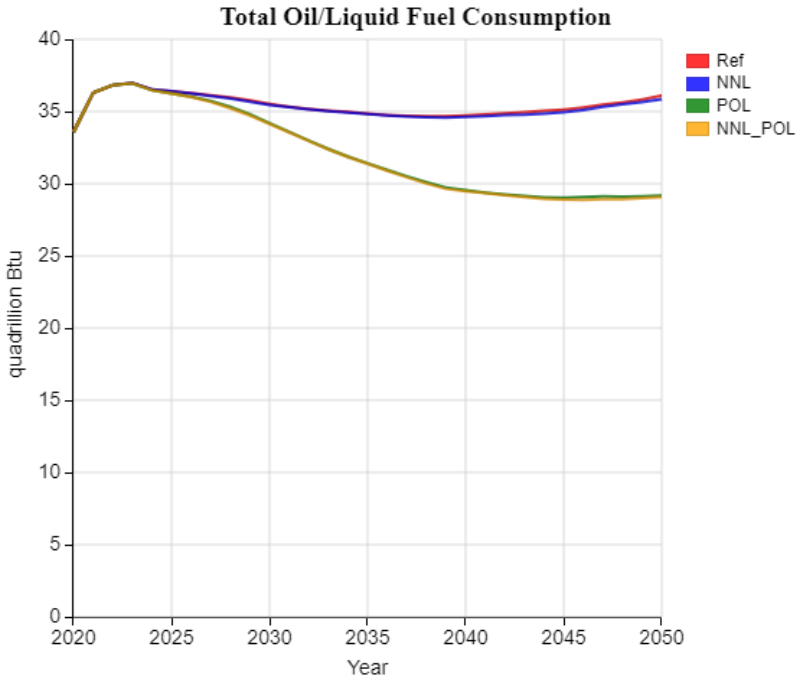
[1] ICCT Energy Innovation: https://energyinnovation.org/wp-content/uploads/2023/01/Analyzing-the-Impact-of-the-Inflation-Reduction-Act-on-EV-Uptake-in-the-U.S..pdf

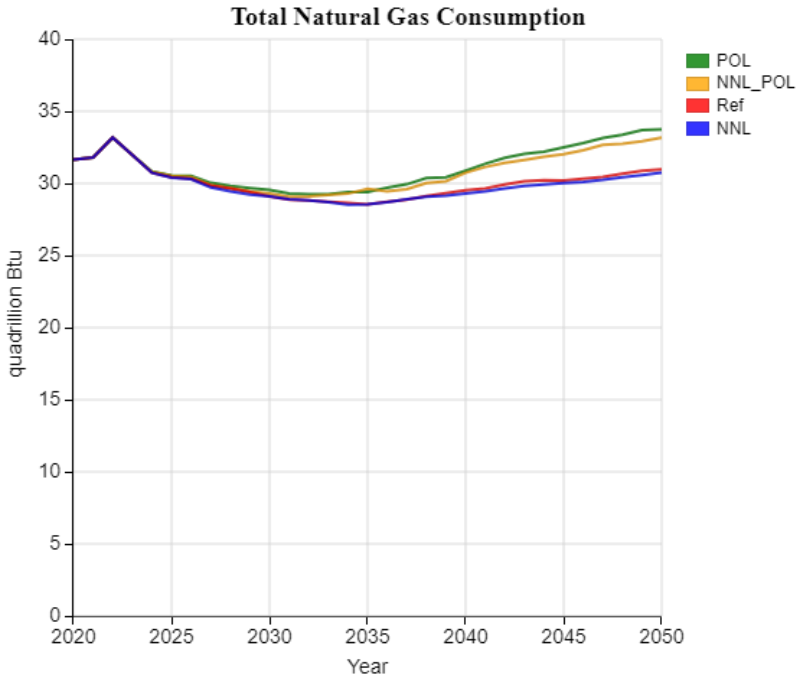
[2] Congressional Budget Office, Estimated Budgetary Effects of H.R. 5376, the Inflation Reduction Act of 2022. https://www.cbo.gov/system/files/2022-08/hr5376_IR_Act_8-3-22.pdf

Transportation Policy Assumptions in NRDC 2023 vs. AEO 2023

Transportation Policy	AEO 2023 Reference Case and NRDC 2023 Ref and NNL Scenarios	NRDC 2023 POL and NNL-POL Scenarios
ACT Rule for Medium and Heavy-Duty Vehicles	None	Included for CA, NY, MA, NJ, OR, and WA based on ZEV sales shares from CARB
EPA Proposed GHG Standard for Light- Medium- and Heavy-Duty Vehicles for Model Year 2027 and Later	None	Proposed GHG standards are included for light duty vehicles and class 2-8 freight trucks for model years 2027 and later
IRA Tax Credits for Light Duty Vehicles: Clean Vehicle Credit (30D and 45X)	30D: $116 to $800 average weighted credit	30D and 45X based on the ICCT Moderate Case 30D: $4100 to $4500 average weighted credit
IRA Tax Credits for Medium- and Heavy-Duty Vehicles: Commercial Clean Vehicle Credits (45W and 45X)	None	45W and 45X based on section 13403, part 4

Domestic Oil and Natural Gas Demand

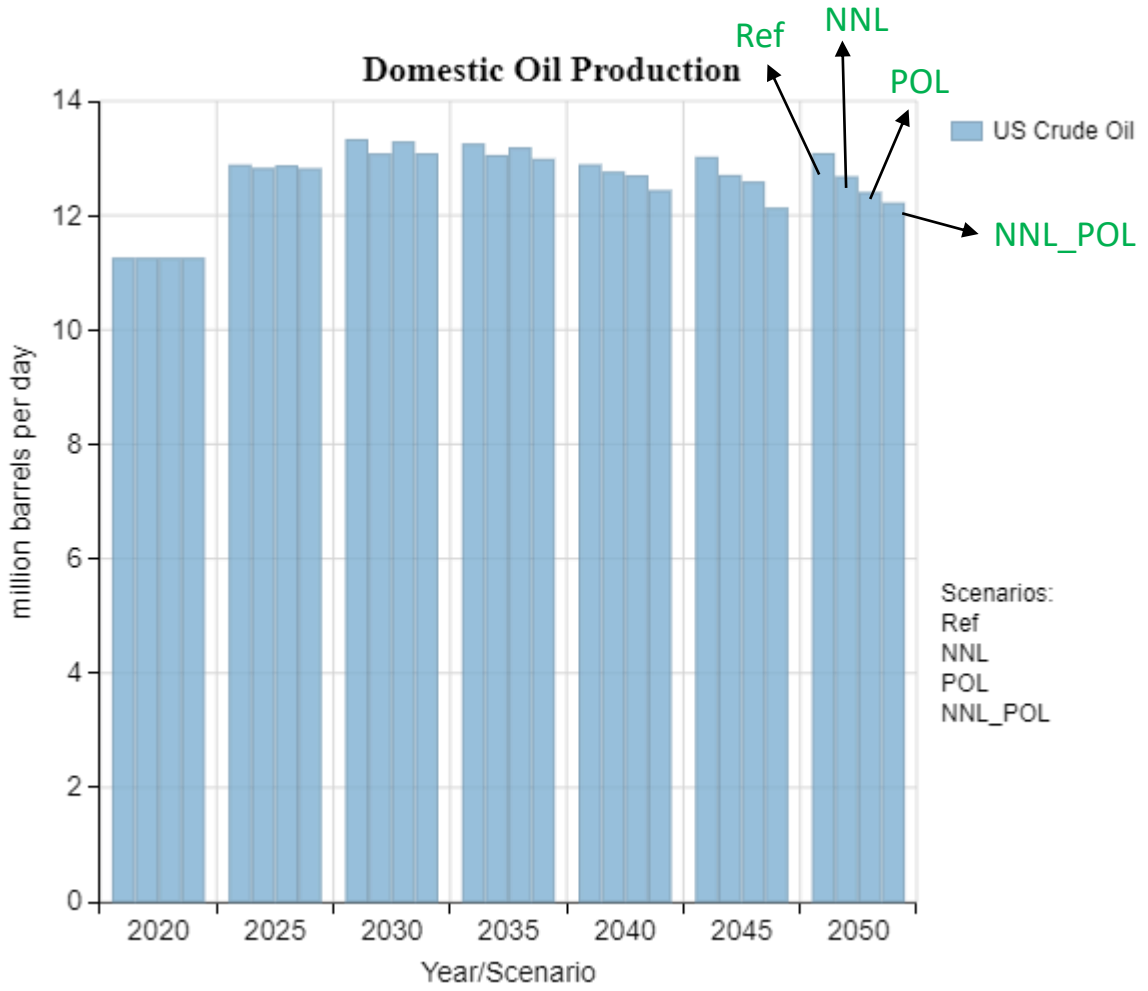




- Crude oil and natural gas demands in NNL are slightly lower than the projected demands in the Ref Case (~0.7% by 2050).
- As a result of IRA tax credits for electric vehicles (EVs), ACT rule, and proposed EPA GHG standards for light-, medium-, and heavy-duty vehicles in the transportation sector in the POL and NNL_POL scenarios, total U.S. petroleum consumption is 10% and 19% lower in 2035 and 2050, respectively, relative to Ref and NNL cases.
- While the increase in EV sales in POL and NNL_POL scenarios relative to Ref and NNL cases displaces vehicle demand for motor gasoline and diesel, it leads to an increase in electricity demand and more generation using natural gas. As a result, total natural gas consumption is up to 9% higher in the POL scenario and 7% higher in the NNL_POL scenario by 2050.

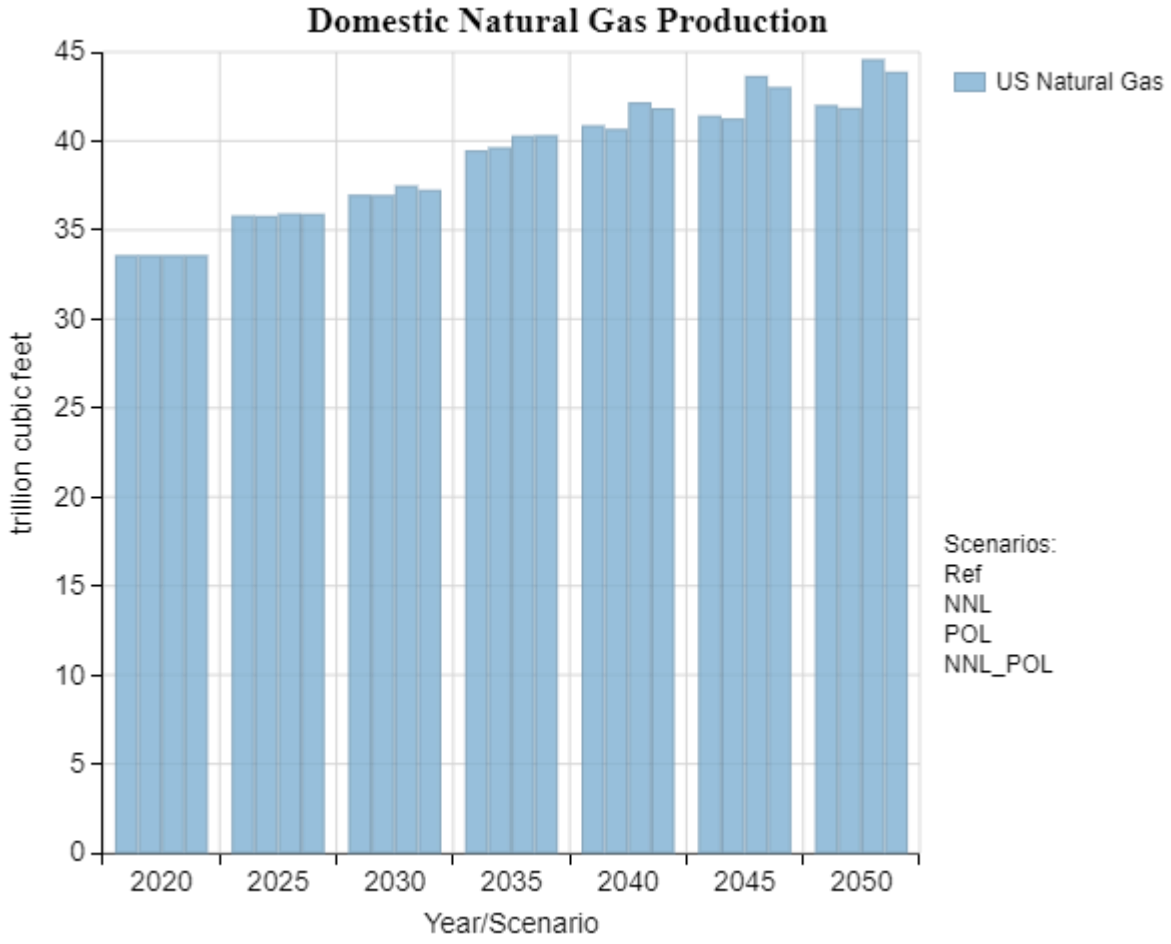
Crude Oil Domestic Production

- Annual domestic production of crude oil starts to decrease from 2025 in NNL and NNL_POL scenarios relative to the Ref Case. The annual oil production in NNL_POL scenario is the same as NNL scenario until 2030 and lower than that of NNL scenario from 2035 to 2050.
- Oil production in the POL scenario remains slightly lower than the Ref Case until 2035, but then starts to decline faster and becomes lower than that of in NNL scenario from 2040 through 2050 due to lower crude oil prices.
  - In 2035, total U.S. crude oil production is 1.5%, 0.5%, and 2% lower in NNL, POL, NNL_POL scenarios relative to the Ref Case, respectively.
  - In 2050, total U.S. crude oil production is 3%, 5%, and 6.5% lower in NNL, POL, NNL_POL scenarios relative to the Ref Case, respectively.



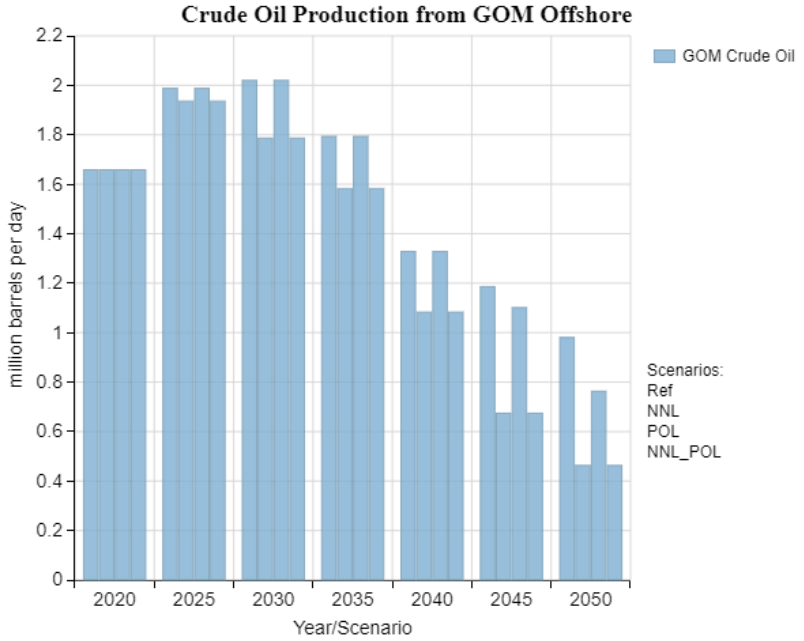
Natural Gas Domestic Production

- Annual natural gas production in NNL scenario remains close to the Ref Case through 2038 and is 0.5%/yr lower than that of in the Ref Case from 2039 to 2050.
- In POL and NNL_POL scenarios, IRA tax credits for EVs, ACT rule, and proposed EPA GHG standards for light-, medium-, and heavy-duty vehicles in the transportation sector, result in increasing EV market penetration and electricity generation from natural gas starting 2024. Annual natural gas production begins to increase from 2025 and is 2% higher in POL and NNL_POL scenarios relative to the Ref Case by 2035 and up to 6% by 2050.
- From 2036 through 2050, natural gas production is 1% to 1.5% lower in NNL_POL than POL scenario due to slightly lower electricity generation from natural gas power plants (up to 5%), which are replaced by nuclear and renewable plants.

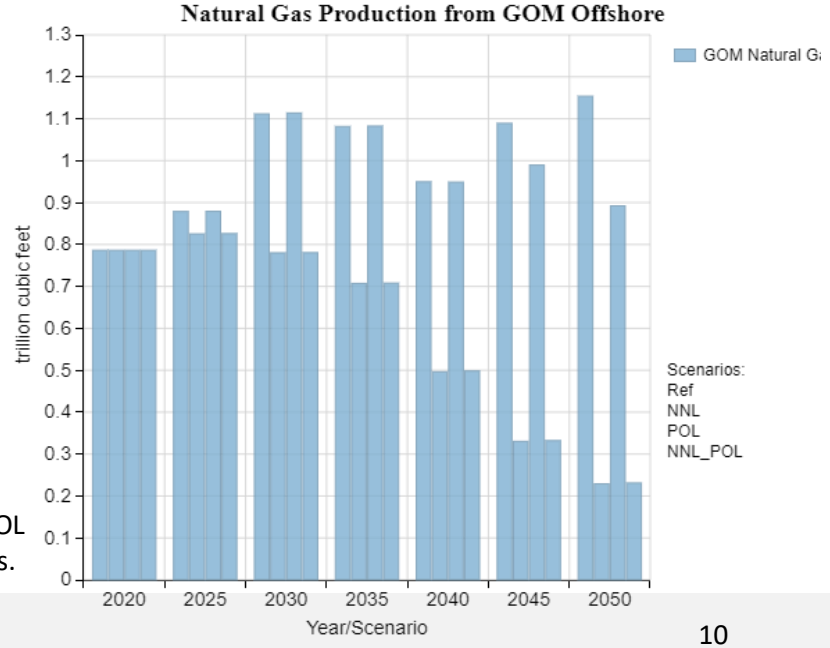


Crude Oil and Natural Gas Domestic Production from Gulf of Mexico

- Annual crude oil production from GOM in Ref and POL scenarios are the same from 2020 to 2040; production in the POL scenario is 7% and 20% lower than the Ref Case in 2045 and 2050, respectively in response to lower oil prices resulting from lower demands in the transportation sector.
- Annual crude oil production from GOM in NNL and NNL_POL scenarios is the same from 2020 through 2050 and starts to decrease from 2025 compared to the Ref Case.
- Crude oil production from GOM in NNL and NNL_POL scenarios is 12% and 53% lower than the Ref Case in 2035 and 2050, respectively, which is caused by the leasing moratorium itself and not due to reductions in oil demands.



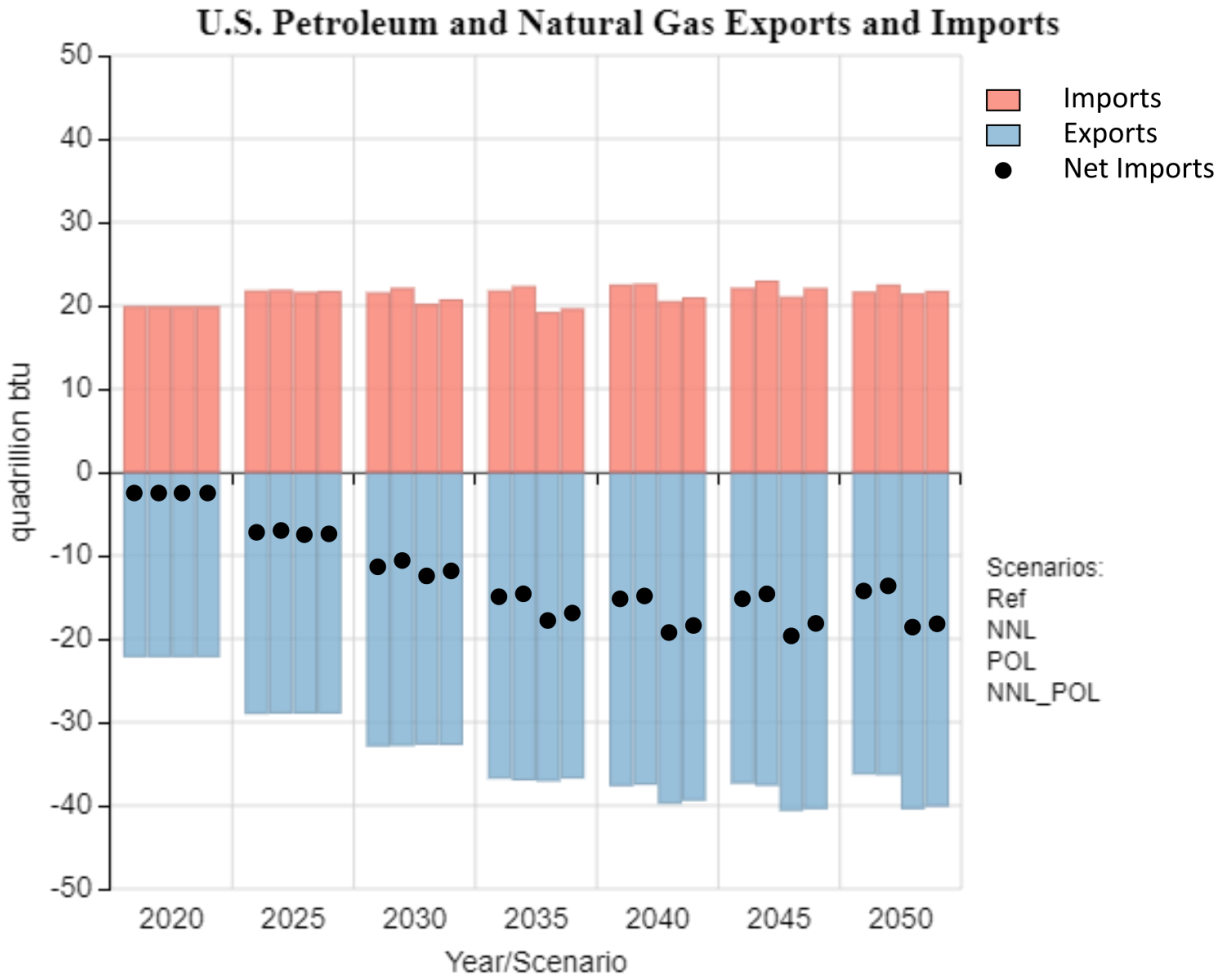
- Annual natural gas production from GOM in Ref and POL scenarios are the same from 2020 to 2040; production in the POL scenario is 9% and 23% lower than the Ref Case in 2045 and 2050, respectively.
- Annual natural gas production from GOM in NNL and NNL_POL scenarios is the same from 2020 to 2050 and steadily declines from 2025 through 2050.
- Natural gas production from GOM in NNL and NNL_POL scenarios is 35% and 80% lower than the Ref Case in 2035 and 2050, respectively.



*It should be noted that Lease Sales 257 and 259 have proceeded. Actual crude oil and natural gas production in GOM from NNL and NNL_POL scenarios, which would include production resulting from these lease sales, would be higher than production values estimated in this analysis.

Petroleum and Natural Gas Imports and Exports

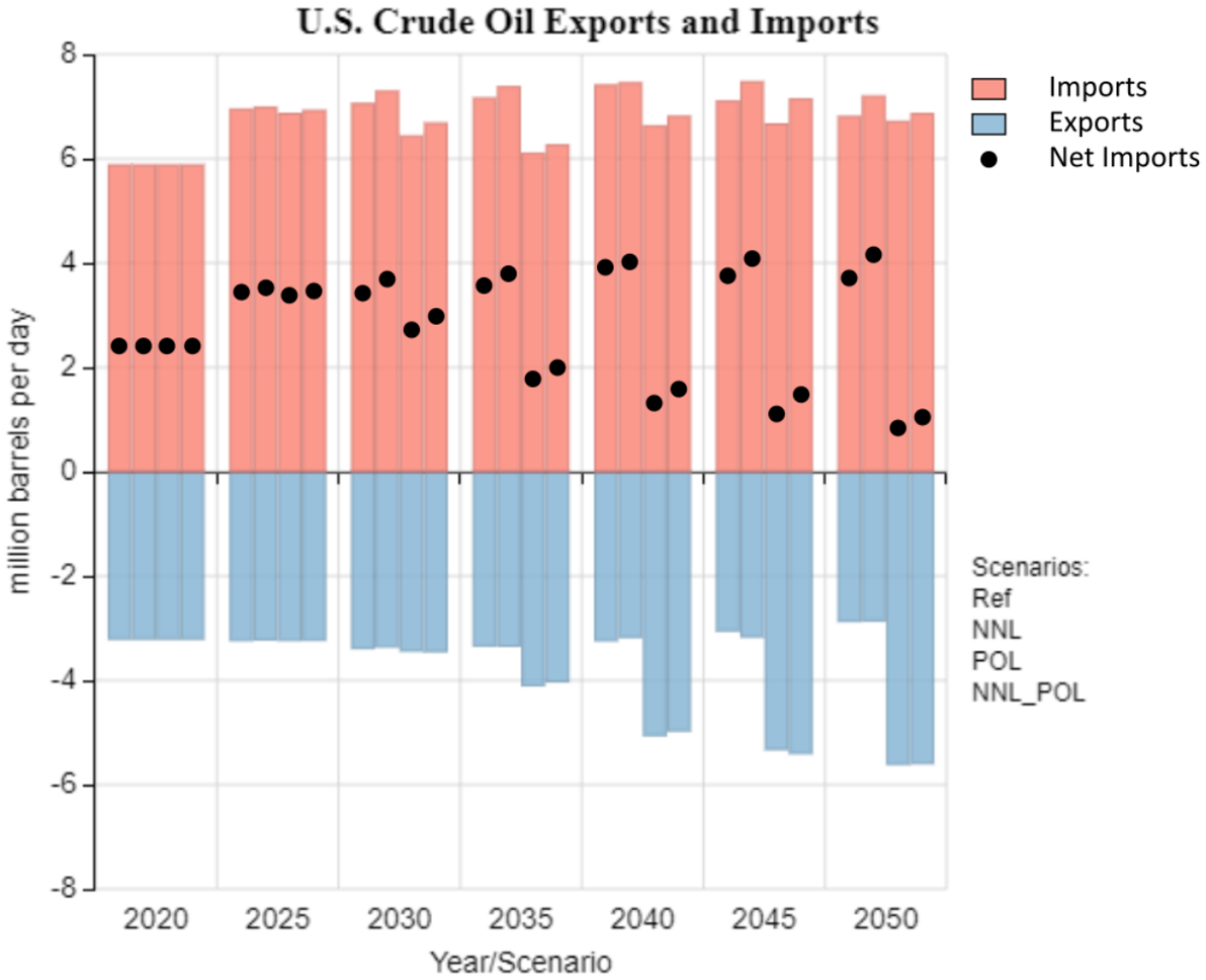
- Petroleum and natural gas imports in the NNL scenario are higher than the Ref Case from 2025 to 2050 (up to 4.5% by 2050) due to lower domestic production. In POL and NNL_POL scenarios, as a result of lower oil demands, combined oil and gas imports are between 1% to 12% lower than the Ref Case from 2025 to 2050.
- Petroleum and natural gas exports are almost the same across all scenarios from 2020 to 2030. From 2035 to 2050, while combined oil and gas exports in Ref and NNL cases remain roughly the same, significant reductions in domestic oil demands due to high EV deployment in POL and NNL_POL scenarios result in 12% and 11% increase in total oil and gas exports relative to the Ref Case by 2050, respectively.



Crude Oil Exports and Imports

- Crude oil imports in NNL scenario are higher than the Ref Case from 2025 to 2050 (up to 6% by 2050) due to lower domestic production. In POL and NNL_POL scenarios, as a result of lower oil demands, oil imports are up to 15% and 13% lower than the Ref Case, respectively.

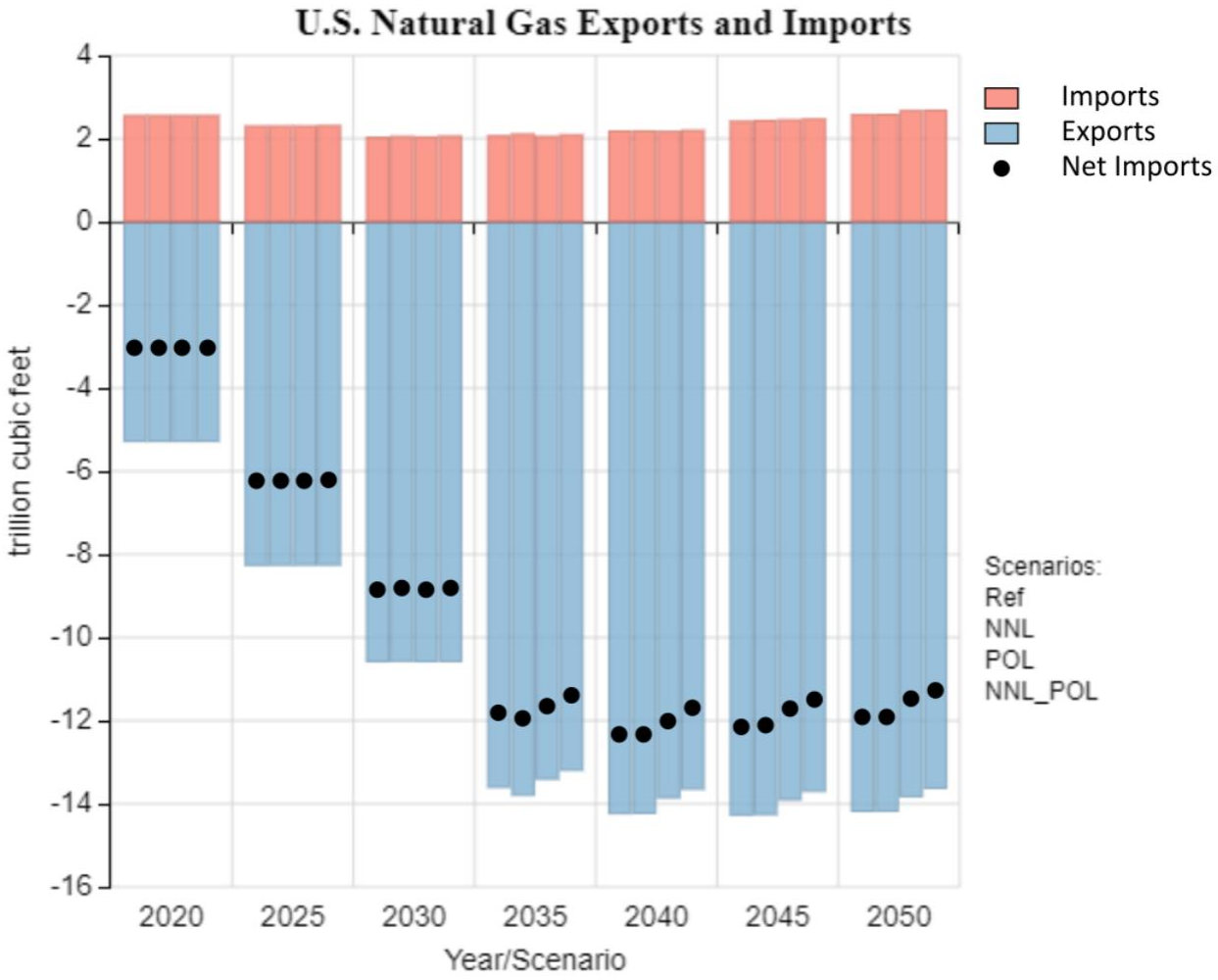
- Crude oil exports are almost the same across all scenarios from 2020 to 2030. From 2035 to 2050, while oil exports in Ref and NNL cases remain roughly the same, significant reductions in U.S. oil demands due to high EV deployment in POL and NNL_POL scenarios result in 20% to 95% increase in oil exports relative to the Ref Case.



Natural Gas Exports and Imports

- Natural gas imports are the same across all scenarios from 2020 to 2030 and between NNL and Ref cases from 2035 to 2050. In POL and NNL_POL scenarios, higher natural gas demands increase gas imports up to 4% by 2050 compared to the Ref Case.

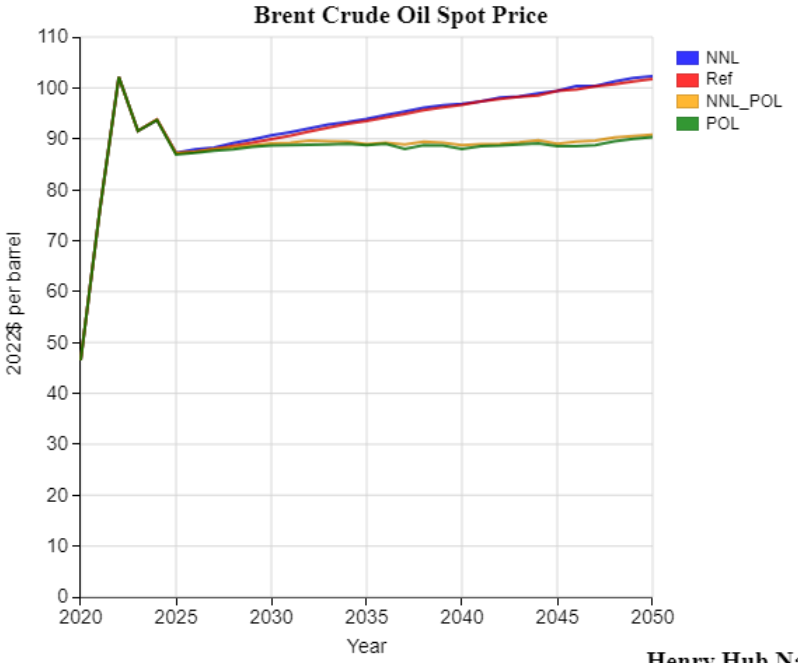
- Natural gas exports are also the same across all scenarios through 2030. From 2035 to 2050, while gas exports in Ref and NNL cases remain almost the same, higher natural gas demands for electricity generation to meet high EV penetration result in 1.5% to 2.5% lower gas exports in the POL and 3% to 4% in the NNL_POL scenario relative to the Ref Case.



Crude Oil and Natural Gas Prices

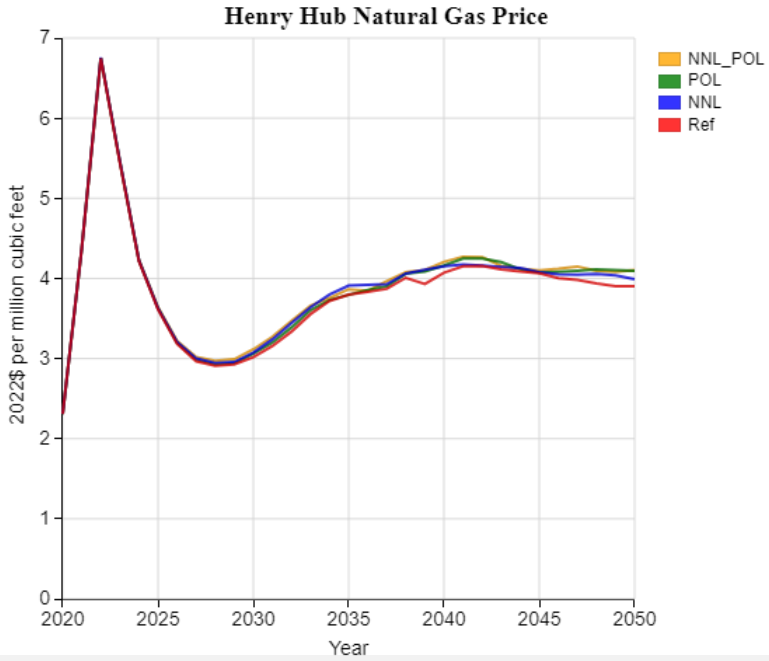
Brent crude oil prices:

- Ref and NNL cases: Decreases from $102/b in 2022 to $87/b in 2025 following historical and projected production and demand trends then steadily increases to $94/b by 2035 and $102/b by 2050.
- POL and NNL_POL scenarios: crude price decreases by $4.5/b by 2035 and $11/b by 2050 relative to the Ref Case due to lower oil demands in the transportation sector and estimated global market impacts.

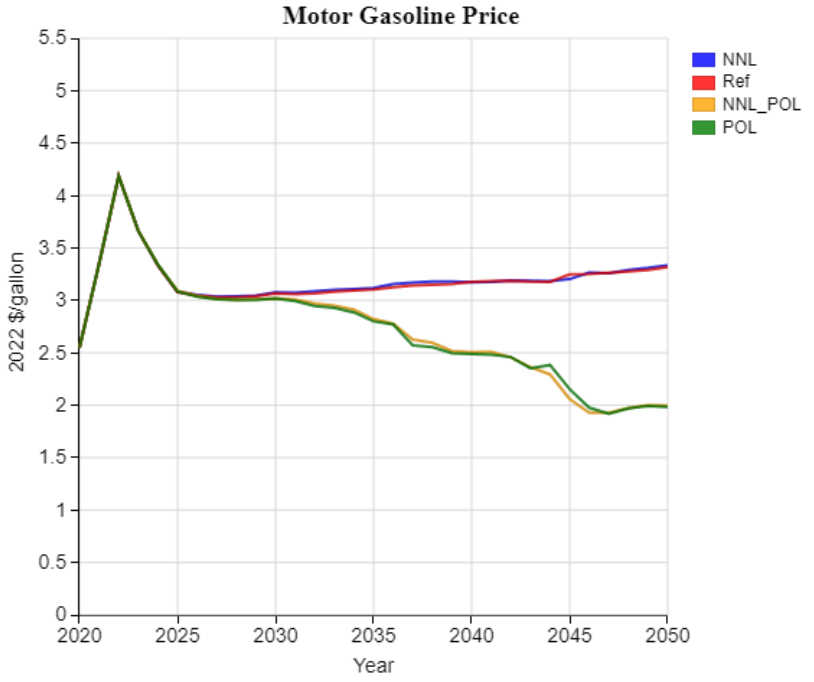


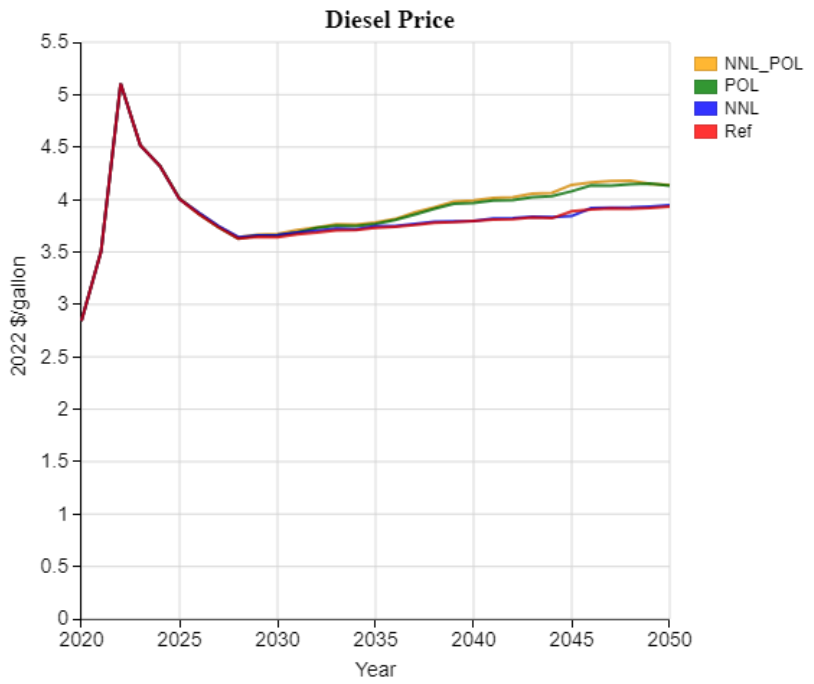
Henry Hub natural gas prices:

- Ref Case: Price decreases from $6.7/Mcf in 2022 to $3.6/Mcf in 2025 then rises to $4.1/Mcf in 2041 and gradually decreases to $3.9/Mcf in 2050.
- NNL, POL, and NNL_POL scenarios: Prices increase slightly by $0.2/Mcf from 2030 to 2050 relative to reference, but the differences between scenarios are small compared to the overall price of natural gas.



Gasoline and Diesel Prices

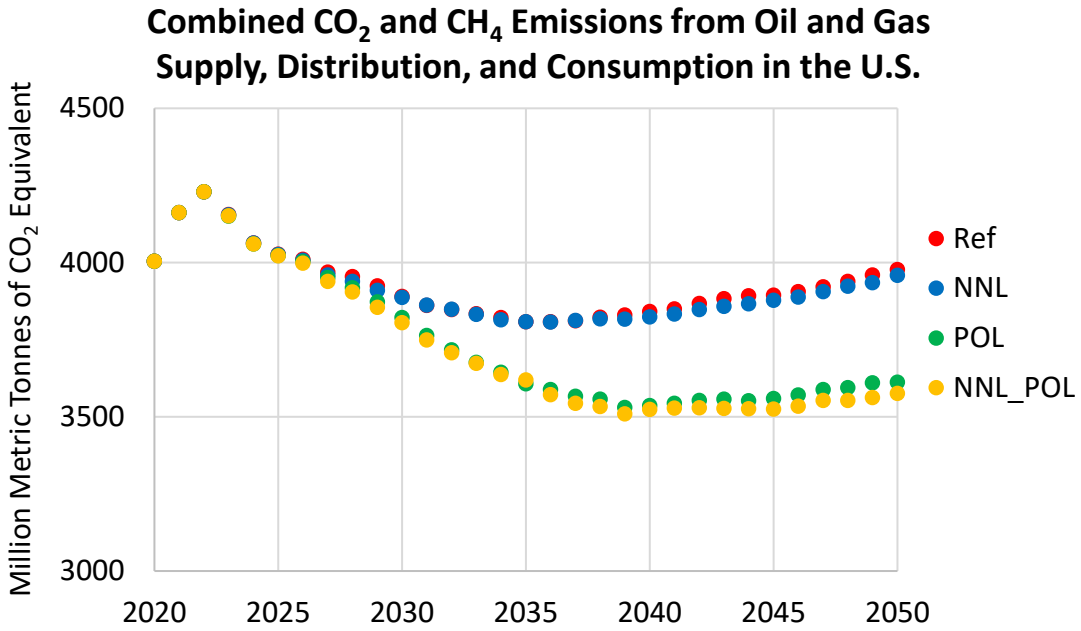




- Gasoline prices decrease to $3.1/gallon in 2025 and gradually increase to $3.3/gallon in 2050 in Ref and NNL scenarios.
- In POL and NNL_POL scenarios, gasoline prices follow the same quantity and trend as Ref Case until 2028. From 2029 through 2050, gasoline prices are 5 to 135 cents/gallon lower than those prices in Ref Case due to higher EV adoption and significantly lower gasoline consumption in the transportation sector.
- Diesel price starts at $5.1/gallon in 2022 and decreases to $3.6/gallon in 2028 then steadily increases up to $3.9/gallon by 2050 in Ref and NNL scenarios. Diesel prices in POL and NNL_POL scenarios are the same as those in Ref and NNL scenarios until 2030 and increase by 25 cents/gallon over the next 20 years.
- Higher diesel prices likely result from the significant shift in refined products away from gasoline and proportionally to more distillates, even though distillate demands are also lower in the POL scenarios. This effect may be overstated in NRDC23-NEMS, as greater flexibility in product mix and exports/imports of refined products may exist than is portrayed in the model.

Emissions from Oil and Gas Supply Chain and Consumption

- Combined CO_2 and CH_4 emissions occurring in the U.S. from oil and gas production and consumption peak in 2022 at 4230 million metric tonnes of CO_2 equivalent[1] (MMT CO_2 eq.). From here, the Ref and NNL scenarios decrease to a low of 3810 MMT CO_2 eq. around 2035 before increasing to 3980 and 3960 MMT CO_2 eq., respectively.
- Combined CO_2 and CH_4 emissions in the POL and NNL_POL scenarios decrease more quickly to respective lows of 3530 and 3510 MMT CO_2 eq. in 2039 before raising slightly to 3610 and 3580 MMT CO_2 eq. in 2050.
- The annual decrease in emissions in NNL relative to Ref Case is 0.1 to 0.7% and NNL_POL relative to POL scenario is 0.1 to 1.3%, driven by small decreases in both oil and gas consumption.
- The larger 9 to 10% decrease in emissions in POL relative to Ref Case and NNL_POL relative to NNL scenario are caused by significant decreases in oil consumption, mitigated by some increases to gas consumption.
- From 2020 through 2050, the cumulative CO_2 and CH_4 emissions from oil and gas production and consumption in the U.S. are 290, 5640, and 6150 MMT CO_2 eq. lower than the Ref Case in NNL, POL, and NNL_POL scenarios, respectively.



* The Y-axis scale does not start from 0.

** CH_4 emissions are multiplied by a global warming potential of 28 to convert to CO_2 equivalents[1]

*** The following sources of CO_2 and CH_4 emissions are assumed to occur outside of the U.S. and are excluded from this analysis:

- Emissions from the exploration and production of imported oil and gas
- Emissions from the processing of imported gas
- Emissions from the combustion of exported oil and gas (emissions from imported oil and gas are included)
- Emissions from oil refining of exported oil (emissions from imported oil are included)
- Emissions from the distribution and post-meter leakage of exported gas (emissions from imported gas are included)

[1] Table 1-2 from: https://www.epa.gov/system/files/documents/2023-04/US-GHG-Inventory-2023-Main-Text.pdf