The Inequity of Early Credit Incentives in EPA's Proposed Heavy-Duty Emissions Rules

Why EPA Credits for Early Adoption Will Delay Investment in Cleaner Diesel Technologies

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EPA has proposed a number of different credit flexibilities and incentives, including windfall credits that would apply to vehicles already being driven to market by state regulations that go into effect ahead of EPA's rules and exceed the stringency of the proposed federal program. The harm that could be caused by EPA's failure to consider the impact of such credit programs, including transitional credits, were detailed in comments submitted to the docket on behalf of the Moving Forward Network (MFN 2022, Section III.D.). However, in responding to comments in the docket, EPA may choose alternative credit program designs it did not propose but did consider as alternatives to accelerate the transition to cleaner-burning diesel engines. This whitepaper is meant to directly respond to some of those possible alternative credit strategies.

The design of EPA's credit program can have a substantial impact of the effectiveness of heavy-duty engine regulations driving emissions controls technology to market. As discussed in this report, awarding early credits could delay by at least five years and as much as a decade, depending upon the stringency of EPA's final rule, the adoption of more advanced technology than is already required by state standards in 2024. Such a program would be inconsistent with the Agency's requirements under the Clean Air Act and poses a significant risk to the communities currently harmed by freight pollution.

Methodology

Given the wide range of considerations being taken by the agency in its unusual proposal spanning a range of alternatives, it is helpful first to bound the problem. Below is detailed some of the different limitations considered in this analysis.

REGULATORY SCENARIOS

The impact of credit incentives is dependent upon the final requirements on manufacturers seeking to take advantage of such programs. However, because EPA has not yet finalized those requirements, it is difficult to say for certain precisely what the impacts could be.

To encompass possible outcomes, we can refer back to the proposal. EPA co-proposed two regulations, Option 1 and Option 2. Additionally, California has already passed the Heavy-duty Omnibus ("Omnibus"),[1] which is more stringent than either proposed option. Because EPA noted that it is considering "Options 1 and 2 standards and useful life periods, and the range of options in between them" (87 FR 17436), we consider a fourth possible regulatory scenario

Table 1. Regulatory Scenarios Considered in This Analysis

Class	Federal Omnibus				Option 1			
	2027-2030		2031+		2027-2030		2031+	
	Standard (mg NO_X /bhp-hr)	FUL (000 miles)	Standard (mg NO_X /bhp-hr)	FUL (000 miles)	Standard (mg NO_X /bhp-hr)	FUL (000 miles)	Standard (mg NO_X /bhp-hr)	FUL (000 miles)
HDO	20	155	20	200	35	155	20	200
HHDD	35	600	40	800	35	600	40	800
LHDD	20	190	20	270	35	190	20	270
MHDD	20	270	20	350	35	270	20	350

Class	Option 1+2				Option 2			
	2027-2030		2031+		2027-2030		2031+	
	Standard (mg NO_X /bhp-hr)	FUL (000 miles)	Standard (mg NO_X /bhp-hr)	FUL (000 miles)	Standard (mg NO_X /bhp-hr)	FUL (000 miles)	Standard (mg NO_X /bhp-hr)	FUL (000 miles)
HDO	35	150	35	150	50	150	50	150
HHDD	50	650	50	650	50	650	50	650
LHDD	35	250	35	250	50	250	50	250
MHDD	35	325	35	325	50	325	50	325

The regulatory scenarios considered in this analysis reflect the endpoints of EPA's proposal (Option 1 and Option 2), a scenario that falls within the range of the proposed scenarios (Option 1+2), and an adaptation of California's Heavy-duty Omnibus regulation (Federal Omnibus).

Notes: FUL = Full Useful Life; HDO = Heavy-duty Otto Cycle; HHDD, LHDD, MHDD = Heavy-, Light-, and Medium-Duty Diesel, respectively

that mixes the family emission limits of Option 1 for light- and medium-duty diesel and heavy-duty Otto-cycle engines with the useful life and heavy-duty diesel requirements of Option 2, thus falling between the co-proposed options in stringency. The range of regulatory options considered is shown in Table 1 and is meant to be illustrative of the range of potential outcomes, not prescriptive. As noted in comments on the proposed rule, after years of research and public engagement, the Omnibus continues to prove itself viable, and the consideration of regulatory scenarios weaker than that rule is not meant to suggest that EPA should not finalize a rule at least as strong as what is already being implemented in states in the same timeframe.

FLEET DETAILS

To assess the relative number of vehicles in each engine class, we have utilized heavy-duty vehicle registration data from the Atlas EV Hub as well as WardsAuto data on both new truck and bus sales by gross vehicle weight rating (GVWR) and diesel engine sales by manufacturer,

Table 2. Assumed Heavy-duty Engine Sales, by Engine Class

Engine Class	Annual Sales	Marketshare
Heavy-duty Otto-cycle (HDO)	95,043	14.6%
Heavy Heavy-duty Diesel (HHDD)	361,088	55.3%
Light Heavy-duty Diesel (LHDD)	21,499	3.3%
Medium Heavy-duty Diesel (MHDD)	174,894	26.8%

Around half a million heavy-duty vehicles are sold annually, with more than half of those powered by the largest engines on the market, heavy heavy-duty diesel engines. Total volumes may fluctuate year to year, but this analysis fixes both the total volume and relative shares of each engine class over time for simplicity.

with limited data on engine size. Because of the differences in full useful life (FUL), the relative ratio of sales to each class is more important than absolute sales, particularly if early credits were granted fungibility between vehicle classes. Total sales volumes are assumed fixed over time for simplicity, since year-to-year variations in sales will be determined by complicated economic factors that exceed the scope of this research and would be challenging for manufacturers to consider in the long-run in anticipation of compliance strategy, as indicated by errors of over ± 25 percent in industry forecasts when looking just five years out (Vieth 2007, pp. 29-30). Assumed static values are shown in Table 2.

ELECTRIC TRUCKS

While total vehicle sales are considered fixed over time, the increasing availability of electric offerings in various size classes means that a decreasing share of those vehicles will be powered by fossil fuels.

Previous comments to the docket illustrate clearly how significant adoption of electric trucks could undermine a standard on nitrogen oxide (NO_X) emissions that did not adequately consider broad scale adoption of such trucks (MFN 2022, Section III.D.c—e). An appropriate technology-forcing NO_X standard should consider electric trucks as a viable NO_X-reduction technology, driving zero-tailpipe emission vehicles through either explicit sales requirements or a standard reflecting such capability. Barring the inclusion of EVs in setting a standard, however, it would be appropriate to exclude them altogether. The agency moving forward with a supplemental greenhouse gas emissions regulation to explicitly consider the impacts of recent legislation on EV adoption on a different timeline than the NO_X rule suggests that the agency is not considering EV adoption in this rule (Shepardson 2022).

For this analysis, we are thus assuming that NO_X standards are applicable *only* to on-road heavy-duty vehicles with engines. Should any credit be given to electric trucks in scenarios identified in this analysis, it would only serve to further lessen the requirements of the fossil fuel-powered trucks.

For consideration of future electric truck production (which would thus be eliminated from any fleet averaging under an engine-only rule), we have assumed in the central analysis only a modest baseline of EV adoption reflecting state regulatory requirements from adopting the Advanced Clean Truck rule, with a small amount of uptake outside those states, resulting in an 11 percent share of the new truck market by 2030. Because credits are used to weaken requirements on the remaining diesel fleet, this is a conservative assumption—to the extent EV truck shares outpace this assumption, that would further lessen the requirements on the remaining fossil fuel-powered trucks (see sensitivity case for further detail).

Analysis of Early Credit Impacts

State leadership on heavy-duty vehicle regulations means that there will be trucks sold ahead of 2027 that exceed current federal standards, thus potentially earning credit toward the federal program. Given the increasing number of states pursuing adoption of these standards, including not just the Advanced Clean Truck program that drives electrification but the Omnibus program as well, manufacturers are likely already well positioned for selling large volumes of trucks that exceed the current federal standards in advance of whatever regulation EPA promulgates for 2027 and beyond.

THE RISKY IMPACTS OF CREDITS ON TECHNOLOGY ADOPTION

While state programs will drive early adoption of some technologies, EPA is considering different credit programs that could incentivize manufacturers to sell such engines more broadly. To avoid both a windfall to manufacturers and conserve benefits of the program, design of any such incentives is critical. Otherwise, EPA could not only risk maximizing the total tons of life-saving emissions reductions but delay the deployment of technologies identified by the agency.

Previous analysis showed clearly the harm of neglecting to exclude credits generated under state programs (MFN 2022, Section III.D.). While this general principle remains important, this analysis is focused specifically on the generation of credits from vehicles sold in the 2024-2026 timeframe, when federal NO_X regulations remain unchanged.

Because state regulations are already pushing the technology frontier forward for emissions controls, advanced credits are unlikely to result in anything more than an increase in volume, rather than an improvement in technology. On the other hand, the use of such credits is likely to effect a weaker stringency of the program, depressing deployment of advanced technologies.

Given the inequitable and unjust impact of truck pollution on communities of color, it is difficult to see how a rule delaying the deployment of the most advanced diesel control technologies while failing to accelerate zero-emissions technologies is consistent with EPA's requirements under Executive Orders 12898, 14008, and 13563. It is further difficult to see how such a rule design would be consistent with the "technology-forcing" requirements of the Clean Air Act (42 U.S.C. § 7521(a)(3)).

EPA is already well aware of just such impacts on technology deployment from credit usage based on the roll-out of the current federal heavy-duty NO_X program. In its final rule, EPA set standards for diesel engines based on a 3-year phase-in of engines that could achieve a 0.2 g/bhp-hr NO_X standard, whereby 50 percent of the fleet would in theory be required to meet this objective (66 FR 5036). In practice, however, manufacturers deployed virtually no such engines in this timeframe, choosing instead to take advantage of the ABT provisions to delay such technology adoption from 2007 to 2010, when a 100 percent requirement (along with reduced FELs) went into effect (NASEM 2020, pp. 71-72). It is quite likely a similar result could be precipitated should EPA move forward with incentives that do not actually move the market forward.

CREDIT PROGRAMS IN THE PROPOSED RULE

EPA proposed two main incentives for exceeding the federal requirements in the 2024-2026 timeframe, a transitional credit program and early adoption incentives. As EPA makes clear in its proposal, the existing federal credit program is fundamentally flawed, and credits generated under the program are therefore not applicable to the 2027+ standards (87 FR 17553). As a result, any credit bank a manufacturer may wish to use to offset pollution generated by its engines in excess of the 2027+ standards must be generated through the 2027+ averaging, banking, and trading program, or one of the two aforementioned early credit programs.[2]

The transitional credit program generates credits for engines that exceed the current federal requirements and meet the new testing criteria of the proposed 2027+ program, including the requirements of the low-load cycle (LLC) (87 FR 17553). Such credits would be given a five-year lifetime and limited to the class in which they were generated, consistent with the proposed averaging, banking, and trading (ABT) program, though EPA requested commented on applying a different credit lifetime (87 FR 17554).

The early adoption incentives are generated by engines which meet a standard ahead of schedule (for example, meeting the 2027 standard in 2024) (87 FR 17554). In this case, not only is EPA proposing to credit vehicles in advance, but they are awarding such credits a multiplier, whereby the credit generated is not commensurate with the credit produced in the real world by the vehicle. Any such credits thus automatically result in emission losses through the program. In theory, this disbenefit is meant to be offset by pulling forward technology, but the use of a multiplier in the light-duty vehicle program instead directly undermined the efficacy of the program (Cooke 2021, Gillingham 2021), and there is no reason not to suppose a multiplier to do the same for the heavy-duty vehicle program.

In addition to the conditions of the programs as proposed, EPA identified a few other credit-related issues for comment that are worth mentioning. EPA referenced the possibility of a multiplier of 1.25 being used for engines certified to the Omnibus 2024-2026 standards, a combination of the early adoption and transitional credit programs (87 FR 17556). Additionally, EPA requested comment on whether to limit the use of credits to the engine class in which they were generated (87 FR 17558).

Given the different functional role each of these incentives can play in reducing the stringency of the regulation, delaying technology adoption, and/or generally undermining the program's effectiveness, below each facet is considered separately to illustrate each decision's unique harms.

EARLY ACTION CREDITS WITH DIFFERENT CREDIT LIFETIMES

To consider the impact of early action credits, we focus below on the deployment of a technology that we know will exist in the 2024-2026 timeframe: diesel engines that meet the

Table 3. 2024-2026 Marketshare of 50 mg NO_X/bhp-hr-certified Engines Required to Sell Option 2-Certified Engines in Lieu of Achieving More Stringent Standards

	Federal Omnibus			Option 1			Option 1 + 2		
Class	**5 yrs**	**8 yrs**	**10 yrs**	**5 yrs**	**8 yrs**	**10 yrs**	**5 yrs**	**8 yrs**	**10 yrs**
HDO	45.8%	76.6%	96.3%	28.2%	59.0%	78.7%	21.0%	32.5%	39.9%
HHDD	21.4%	32.5%	39.7%	21.4%	32.5%	39.7%	0.0%	0.0%	0.0%
LHDD	54.7%	92.4%	**	34.0%	71.7%	95.1%	33.4%	50.8%	61.7%
MHDD	47.6%	79.8%	**	29.4%	61.5%	82.1%	27.1%	42.0%	51.6%

For nearly all engine classes, it is possible to manufacture a sufficient number of engines certified to a 50 mg NO_X/bhp-hr standard in the 2024-2026 timeframe to offset the difference in stringency between Option 2 and other proposed standards, for as much as ten years.

Notes: Asterisks indicate that 100 percent share would be insufficient to offset the full adoption of Option 2 under a given stringency, over a number of years. In the case of HHDD engines, Option 1 + 2 is equivalent to the Option 2 stringency, so no early credits would be necessary.

Omnibus standard for 2024-2026. Such engines achieve a 50 mg NO_X/bhp-hr standard at current FUL, as well as the off-cycle, LLC, etc. requirements proposed by EPA, meaning they would be eligible for transitional credits, as proposed.

To consider the impacts of these credits, we focus specifically on the use of such credits to delay the adoption of technology meeting more stringent standards. Effectively, this can be considered equivalent to trucks achieving no better than the requirements of Option 2, even if on paper the rule may appear more stringent than this alternative.[3]

CREDIT USE TO REDUCE STRONGER RULES TO OPTION 2

To illustrate this, we identify in Table 3 the nationwide marketshare needed in 2024-2026 for each engine class to offset the shortfall for 2027 and later for a given number of years for selling engines that meet, on average, a 50 mg NO_X/bhp-hr target at FUL.

As proposed, transitional credits would expire after 5 years, so the fact that manufacturers selling just 1 year of 50 mg NO_X/bhp-hr-certified engines in the HHDD engine class (or 1/3 of 2024-2026 sales) could, under even the most stringent standard proposed by the agency, sell no better than a 50 mg NO_X/bhp-hr engine at FUL for 8 or 10 years may appear moot, since in theory those credits would expire before being used in years 6, 7, etc. However, as noted earlier, EPA requested comment on different credit lifetime and thus may be considering extending the lifetime of such transitional credits.

The low marketshare required to offset requirements for HHDD engines is particularly alarming given that manufacturers are already obligated for about 10 percent of their sales volume to meet the Omnibus requirements via sales in states which have already adopted the Omnibus standards for 2024-2026. Additionally, a number of states continue to move forward with the adoption of the Omnibus standard, so even if those states may not have the Omnibus program requirements for the entirety of the 2024-2026, these additional state requirements will further incentivize the deployment of Omnibus engines beyond the 10 percent level currently already required. This incentive exists *in absence of any EPA incentive*, so anything EPA does to reward such deployment is a windfall to manufacturers and thus proportionally negates benefits of the federal program for 2027 and beyond.

Early crediting of 50 mg NO_X/bhp-hr engines, technology already required by existing standards, could delay sale of the cleanest engines from MY2027 to MY 203X or even later if credit lifetimes are extended

CREDIT USE TO EXTEND SALES OF TODAY'S DIESEL ENGINES

In addition to offsetting the difference between Option 2 and the proposed standards, credits could be further used to offset any benefits even Option 2 poses beyond the current regulations. EPA proposed a family emission limit (FEL) of 150 mg NO_X/bhp-hr based on the capability of today's vehicles. Any credits for early adoption could be used to continue the sale of those engines, prolonging the lifetime of diesel engine controls far below the requirements of EPA's technology-forcing mandate under the Clean Air Act.

Table 4. Early Adoption Required to Perpetuate Today's Diesel Control Technologies

	Federal Omnibus			Option 1		
Class	**5 yrs**	**8 yrs**	**10 yrs**	**5 yrs**	**8 yrs**	**10 yrs**
HDO	78.5%	93.4%	99.1%	71.6%	88.5%	94.9%
HHDD	69.2%	81.6%	86.2%	69.2%	81.6%	86.2%
LHDD	84.0%	98.1%	**	76.6%	93.1%	99.0%
MHDD	79.7%	94.5%	**	72.7%	89.5%	95.9%
	Option 1 + 2			**Option 2**		
Class	**5 yrs**	**8 yrs**	**10 yrs**	**5 yrs**	**8 yrs**	**10 yrs**
HDO	67.1%	78.7%	83.6%	58.3%	68.5%	72.7%
HHDD	61.3%	71.3%	75.4%	61.3%	71.3%	75.4%
LHDD	79.4%	88.8%	92.5%	69.0%	77.2%	80.4%
MHDD	74.0%	84.8%	89.1%	64.4%	73.7%	77.5%

In addition to delaying technology adoption beyond controls needed to achieve a 50 mg NO_X/bhp-hr FUL standard, early credits could extend the nationwide sale of today's diesel emissions controls.

Notes: Asterisks indicate that there is no scenario which could perpetuate 150 mg NO_X/bhp-hr engines over the given timeframe.

Table 4 shows the share of 2024-2026 sales required to achieve the Omnibus standard such that industry could perpetuate such a slate of vehicles over a 5-, 8-, or 10-year period. For example, if 81.6 percent of HHDD engines sold in 2024-2026 achieve the Omnibus standard, not only would there be sufficient credits available such that the proposed Option 1 requirements could be met through 2034 through the sale of no engines certified to no better than 50 mg NO_X/bhp-hr FUL, but there would exist enough excess credits such that 18.4 percent of those sales could be certified to the 150 mg NO_X/bhp-hr maximum FEL. In such a situation, EPA would propose trading a 60 percent reduction in NO_X emissions over 3 years' worth of vehicle sales in exchange for manufacturers being allowed to *nearly double* NO_X *emissions* for 8 consecutive years of trucks.

While some of the required shares sound high, it is worth further explaining what this trade-off would mean in terms of technology requirements for manufacturers. To the extent that these transitional credits may pull forward NO_X benefits, they are not pulling forward any additional technology requirements—California's Omnibus already requires the deployment of diesel emissions controls that would achieve a 50 mg NO_X/bhp-hr FUL standard. Additionally, the market proposed in Table 4 would not achieve a technology level more advanced than that in any regulatory scenario over a given time period. Rather than accelerating the deployment of diesel emissions control technologies, these credits could serve to delay *by up to a decade*

Table 5. Early Adoption Required to Perpetuate Today's Technologies, with Credit Multiplier

	Federal Omnibus			**Option 1**		
Class	**5 yrs**	**8 yrs**	**10 yrs**	**5 yrs**	**8 yrs**	**10 yrs**
HDO	71.5%	87.3%	93.6%	65.1%	82.6%	89.6%
HHDD	63.1%	76.3%	81.6%	63.1%	76.3%	81.6%
LHDD	77.1%	92.5%	98.2%	70.4%	87.7%	94.2%
MHDD	72.7%	88.4%	94.6%	66.3%	83.8%	90.7%
	Option 1 + 2			**Option 2**		
Class	**5 yrs**	**8 yrs**	**10 yrs**	**5 yrs**	**8 yrs**	**10 yrs**
HDO	60.8%	73.0%	78.3%	52.8%	63.4%	68.0%
HHDD	55.9%	66.5%	71.0%	55.9%	66.5%	71.0%
LHDD	73.7%	84.0%	88.2%	64.1%	73.1%	76.7%
MHDD	68.0%	79.5%	84.4%	59.1%	69.2%	73.4%

Increased shares of today's diesel control technologies would be viable if transitional credits for Omnibus-certified engines were further given a 1.25 multiplier, consistent with EPA's request for comment.

the adoption of technologies more advanced than what research by CARB and the Southwest Research Institute identified as widely deployable in the 2024-2026 time period while allowing over the same period the continued deployment of today's control technologies.

THE IMPACT OF MULTIPLIERS

In its proposal, EPA referenced giving Omnibus-certified engines a 1.25 multiplier (87 FR 17556). The impact of this is problematic—not only does it pose the same moral quandary as in the above analysis, but now it doesn't even attempt to conserve the benefits of the program, further eroding the efficacy of a credit that already acted to delay technology adoption. Generally, this multiplier serves simply as a scalar in the case of Table 3, reducing the necessary shares by 20 percent. For example, rather than needing Omnibus sales of 32.5 percent of HHDD to reduce the stringency of Option 1 to Option 2 for the 2027-2034 time period (Table 3), a manufacturer would need just 26.0 percent of its 2024-2026 HHDD sales to continue to sell 50 mg NO_X/bhp-hr engines for the following eight years. Additionally, in this case it is now possible for even the LHDD and MHDD to offset the difference between Option 2 and a federal adoption of the Omnibus standard for a decade, thanks to the multiplier.

The interaction of the multiplier with the continued sale of 150 mg NO_X/bhp-hr engines in perpetuity is more complicated, however, since the share of trucks generating the credits also impacts the share of debits being covered, when the multiplier is no longer in effect. Because the 150 mg/bhp-hr engines require large credit offsets, the impact on marketshare is less than the 20 percent difference noted above. However, it is still quite significant, as can be seen when comparing Table 5 to Table 4.

HOW FUNGIBLE CREDITS INCREASE INEQUITY

Thus far this analysis has limited credits earned by a given vehicle to be utilized solely to offset future requirements in the same vehicle class. However, during the phase-in period of the current federal regulation, EPA allowed for credits to be traded between vehicle classes (66 FR 5110). EPA further requested comment on this in its current proposal (87 FR 17558), so it is worth examining how such a decision would impact the stringency of the proposed programs.

Because of the differences in stringency and useful life, allowing credits to be fungible between classes reduces the total number of engines required to offset future debits (Table 6). Importantly, however, such fungibility can also be used to delay improvements in other vehicle classes, which creates a substantial inequity if a manufacturer can more easily deploy reductions technology in a particular class for any reason. As shown in Table 6, it is possible to allow the 2024-2026 sale of Omnibus-certified HHDD engines to entirely offset the difference between Option 2 and other rules for HDO, LHDD, and MHDD engines in years following. However, the reverse is not true—under neither the Federal Omnibus nor Option 1 is it possible for non-HHDD engines alone to offset the additional stringency between Option 2 and stronger rules for all engines. However, fungibility would reduce the total number of engines needed within the HDO, LHDD, and MHDD classes to offset the additional stringency of the Option 1 + Option 2 regulatory scenario (there are no additional requirements on HHDD engines beyond 50 mg NO_X/bhp-hr in this scenario).

As an example, if half of all 2024-2026 HHDD engines sold meet the Omnibus standard, enough credits would be generated such that even if EPA finalized its most stringent proposal (Option 1), no engine sold in any class from 2027-2034 would need to achieve better than a 50

Table 6. Early Adoption Required to Sell Option 2-Certified Engines with Fungible Credits

	Each Vehicle Class			Just HHDD			Just HDO,LHDD,MHDD		
Rule	**5 yrs**	**8 yrs**	**10 yrs**	**5 yrs**	**8 yrs**	**10 yrs**	**5 yrs**	**8 yrs**	**10 yrs**
Federal Omnibus	27.2%	42.9%	53.1%	35.0%	55.2%	68.2%	**	**	**
Option 1	23.2%	38.9%	49.1%	29.8%	50.0%	63.0%	**	**	**
Option 1 + Option 2	5.8%	8.9%	11.0%	7.4%	11.5%	14.1%	26.0%	40.3%	49.4%

Differences in stringency and useful life allow for manufacturers to either minimize the total number of engines required to ensure no engines need improve beyond a 50 mg NO_X/bhp-hr standard for a given number of years or to eliminate the need for any early adoption of technologies in a given vehicle class.

Notes: Asterisks indicate that 100 percent share would be insufficient to offset the full adoption of Option 2 under a given stringency, over a number of years.

mg NO_X/bhp-hr standard at FUL. This would create extreme equity issues, as the use cases for HHDD engines vary significantly from non-HHDD engines and would allow manufacturers to completely ignore technology investments in the smaller-class engines.

SENSITIVITY CASE: TECHNOLOGY REQUIREMENT AND USEFUL LIFE

Thus far, the analysis has not distinguished significantly between the technology requirements to achieve a 50 mg NO_X/bhp-hr standard under the Omnibus standard in 2024-2026 and Option 2 in 2027+. However, it could be argued that the increase in FUL from 435,000 to 650,000 miles for HHDD engines may require additional technology options beyond those identified in the Omnibus. Or, put another way, an engine certified to 50 mg NO_X/bhp-hr for a FUL of 435,000 miles may be certified to a higher FEL at an FUL of 650,000 miles.

Because this analysis is especially concerned with the way in which early credits would delay the adoption of diesel emissions control technologies, it is worth considering this even more conservative approach to HHDD assumptions to illustrate an even worse scenario for public health. To represent the shortfall of 2024-Omnibus-certified engines at useful life beyond 435,000 miles, this analysis assumes a linear extrapolation (i.e., the emissions of the engine at 800,000 miles is twice the emissions at 400,000 miles). This is obviously a simplification but is roughly consistent with the data on accelerated aging supporting the Omnibus rule.

Table 7 shows that even under this much more conservative technology deployment scenario, manufacturers can continue to delay the types of technologies readily identified in EPA's proposal for years, even under the most stringent rule proposed by the agency. For example, less than 60 percent marketshare for HHDDs in 2024-2026 certified to the Omnibus standard could delay the addition of better control technology under Option 1, even under its much longer FULs, where the assumption is that such an engine would have emissions of 92 mg NO_X/bhp-hr at 800,000 miles. Similarly, less than half of 2024-2026 engines across all classes would need to be certified to Omnibus standards to ensure that no engines performed any better for 8 years, if the agency were to finalize Option 2 with credit fungibility and an 8-year credit lifetime for early credits.

SENSITIVITY CASE: HIGHER ELECTRIC TRUCK MARKETSHARE

This analysis assumed a relatively low rate of adoption of electric trucks over time, consistent with only the bare minimum required by state regulations and a meager adoption outside of those states. However, as noted by EPA, much greater adoption is likely, which has caused the agency to re-evaluate its greenhouse gas emission targets for 2027 and beyond (Shepardson 2022). Much higher rates of electrification would allow credits to be used over a longer period of time if the final NO_X rule considers only vehicles with an engine, so it is worth considering what impact the assumption on electric truck deployment has on the findings in this analysis.

As a surrogate for a much higher penetration of electric trucks than the baseline scenario, the sensitivity analysis assumes electric truck sales consistent with a national adoption of the Advanced Clean Trucks program, which corresponds to a 40 percent marketshare by 2030. To put this into perspective, this is a greater share than the memorandum of understanding agreed to by the United States, but less than the global penetrations committed to by truck manufacturers (MOU on ZE M/HDVs 2021, Hirsch 2022, Ohnsman 2022).

There are two competing effects that result in different outcomes depending on the amount of time for which the credits can be utilized. Because fewer vehicles are assumed to have engines in the 2024-2026 period under this high-penetration scenario, the magnitude of the starting bank of early credits generated is reduced. This means that a greater share of conventional vehicles sold in that time period may need to meet targets more stringent than current federal

Table 8. Early Adoption Required to Sell Option 2-Certified Engines with More EV Adoption

	Federal Omnibus			Option 1			Option 1 + 2		
Class	**5 yrs**	**8 yrs**	**10 yrs**	**5 yrs**	**8 yrs**	**10 yrs**	**5 yrs**	**8 yrs**	**10 yrs**
HDO	50.0%	71.7%	82.1%	29.6%	51.3%	61.7%	23.2%	31.3%	35.2%
HHDD	26.7%	38.1%	45.5%	26.7%	38.1%	45.5%	0.0%	0.0%	0.0%
LHDD	62.1%	90.7%	**	37.2%	65.8%	79.0%	38.5%	51.7%	57.8%
MHDD	52.1%	75.1%	86.5%	30.9%	53.9%	65.2%	30.1%	40.7%	46.0%

If a greater share of electric trucks is sold in 2024 and beyond, credits earned from diesel vehicles in the early years would be applied to a reduced share of vehicles, allowing those offsets to be utilized over a greater number of years. While the initial bank would be smaller due to the reduction in diesel vehicle sales earning credits, requiring a greater share of 2024-2026 diesel vehicles be sold to offset five years of Option 2 certification, a reduced share of the remaining diesel vehicles would be necessary to offset eight or ten years of Option 2 certification, compared to other proposed standards.

Notes: Asterisks indicate that 100 percent share would be insufficient to offset the full adoption of Option 2 under a given stringency, over a number of years.

standards in order to generate sufficient credits to offset the early years of the 2027+ program. However, because the number of conventional trucks is significantly reduced in this same timeframe, any credits generated will be able to offset more years' worth of dirtier trucks.

In comparing Tables 3 and 8, it is possible to examine how these competing effects play out for different rules. For most vehicle categories, a greater share of 2024-2026 vehicle sales is required to offset 5 years' worth of vehicles because of the reduced bank size, but in the longer term that number is reduced as the reduced bank size is overwhelmed by the greater reduction in total remaining conventional trucks and is thus significantly reduced. In the case of MHDD engines under a federal standard consistent with the Omnibus, for example, what once was an impossibility (offsetting 10 years of Option 2-certified engines) becomes possible because of the extent to which earned credits are utilized over a reduced number of remaining engines.

Because the modeled electric truck share in this scenario remains lower for Class 8 trucks than other classes (just over 30 percent in 2030, compared to about 50 percent for other classes), a slightly different behavior is observed, where the share of early adoption needed remains slightly higher for 2024-2026 across all lengths of time. This indicates that the precise balance of stringency, credit length, and share needed is not monotonic. However, in this case, the variance is quite small (a few percent), meaning that the differences are quite asymmetric: while increasing electric truck share can increase only slightly the early requirements needed to offset later shortfalls, in the long run this can be parlayed into greater reductions in marketshare needed in the long run in a market accelerating towards electrification.

Summary

Our analysis shows clearly that EPA's early credit program could be used to dramatically reduce the deployment of technology on which EPA has predicated its rules, particularly when combined with additional flexibilities EPA has considered in its proposal, including extended credit lifetimes and credit fungibility across classes. This holds true for regulations even more stringent than those considered by the Agency.

While the above analysis highlighted the threshold level of early deployment needed to offset shortfalls related to manufacturers choosing to deploy emissions controls less effective than EPA's regulations require, the harm of any such credit program is not limited to such a threshold—even one truck granted credits for deploying technology already required by state programs will weaken the stringency of any regulations, and it will do so without accelerating the technology frontier. The use of such a credit program is inconsistent with the "technology forcing" requirements of the Clean Air Act under which EPA is setting its regulations.

To illustrate this misalignment, Table 9 depicts a host of scenarios, showing the number of dirty trucks in the 2027+ period offset by the sale of that same truck in 2024-2026. It is difficult to imagine how EPA could justify the value of selling a truck in 2026 that meets state regulatory requirements when such credits would offset the sale of up to 7 trucks just a year later, despite falling well short of regulatory targets. This is particularly galling when such credits could be used to ensure that the technology on which EPA bases its final rule could be delayed for up to a decade as the result of such credits.

Table 9. Number of Future Dirty Diesel Trucks (50 mg NO_X/bhp-hr) Allowed per Early Sale (MY2024-2026) of the Same Technology

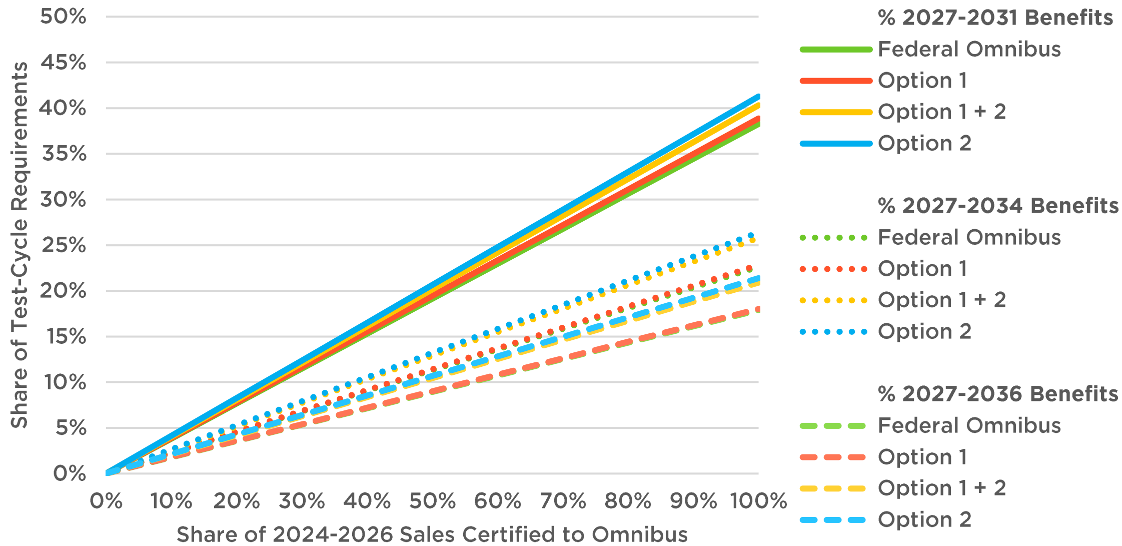
	Option 2-certified Trucks Under Federal Omnibus			2024-Omnibus-certified Trucks Under Option 1 + Option 2		
Class	**5 yrs**	**8 yrs**	**10 yrs**	**5 yrs**	**8 yrs**	**10 yrs**
HDO	3.4	3.1	3.0	7.3	7.3	7.3
HHDD	7.4	7.7	7.8	4.1	4.1	4.1
LHDD	2.7	2.4	2.3	4.4	4.4	4.4
MHDD	3.2	3.0	2.9	5.7	5.7	5.7
w/Fungible Credits	5.8	5.7	5.7	4.3	4.3	4.3
Fungibility + Multiplier	7.2	7.1	7.1	5.4	5.4	5.4

Early credits dissuade manufacturers from deploying more stringent technologies in a timely manner by rewarding the deployment of less efficient technologies already required under state regulation. For example, the sale of a single Class 8 diesel (HHDD) truck in 2024-2026 that can be certified to Option 2 levels (50 mg NO_X/bhp-hr at 650,000 miles FUL) would allow for the sale of over 7 Option-2-certified trucks in 2027 and beyond under a regulatory scenario meant to require meeting a 20 mg NO_X/bhp-hr target at 800,000 FUL in 2031 and beyond, one which actually is more stringent than any option considered by EPA. Industrywide, this incentive is made even worse if combined with credit fungibility and a 1.25 multiplier. Under an even weaker regulatory scenario that falls between the two considered by EPA, less ambitious emissions controls would be deployed. The sale of a single Class 8 diesel (HHDD) truck achieving the required average standard of the Omnibus program (50 mg NO_X/bhp-hr at 435,000 miles FUL) would enable the continued deployment of more than 4 such vehicles after 2027.

Manufacturers are already required to bring 50 mg NO_X/bhp-hr trucks to market in 2024. An early credit program that rewards such deployment does nothing to further the technology frontier and, in fact, simply delays the best available diesel emissions controls while failing to incentivize what should be EPA's ultimate objective: the complete elimination of tailpipe emissions from heavy-duty trucks, something which can be done today via electrification.

In addition to delaying the deployment of lifesaving emissions controls consistent with the technology-forcing requirements of the Clean Air Act, early credits threaten the very effectiveness of the program. Because state regulations are already pushing manufacturers to deploy these technologies, the additional sales would not be additive to the potential available performance of the new vehicle fleet in this timeframe. Any credits granted to manufacturers for such sales would, however, erode the overall effectiveness of emissions controls technologies in the 2027 model year and beyond. Figure 1 depicts the share of benefits for that would be eroded for a given national share of vehicles certified to the Omnibus in 2024-2026.[4] For reference, states making up around 10 percent of the heavy-duty truck market have already adopted the Omnibus standard.

Figure 1. Early Credits as a Share of Emissions Reductions for Model Years 2027 and beyond



If EPA awards early credits to technology already required by state regulations, it threatens to undermine the benefits anticipated for vehicles sold in model years 2027 and beyond. The 2024-2026 state Omnibus standards require technology that can be rapidly deployed—if half of 2024-2026 diesel engines sold are certified to the same level as required by states in that timeframe, over 20 percent of the first five years' worth of benefits of the federal standards would be eliminated. If this were paired with a 1.25 multiplier, that would jump to one quarter *of the benefits of model years 2027-2031. Even when viewed over a full decade, the damage that would be done to the intended benefits of the federal program through the deployment of technology already being required would be devastating.*

In rewarding technologies state leadership is already ensuring will be brought to market, EPA could significantly undermine the effectiveness of its own standards. As much as half of the first five years' worth of benefits of the EPA program are at risk if manufacturers move to deploy these technologies nationwide and EPA not just credits them but gives them the credit multiplier identified in its proposal. This would further delay the technologies identified to maximize emissions reductions from conventionally powered vehicles, eroding the efficacy of the standard and delaying the availability of the cleanest fossil-fuel powered trucks.

EPA is already likely to finalize a rule that does nothing to require the electric trucks capable of eliminating local tailpipe pollution entirely—it cannot also allow for early credit loopholes which will slow progress cleaning up the remaining segment of the new truck fleet that continues to be powered by fossil fuels.

The dirtiest trucks on the road are frequently found in the communities hit hardest, such as port and warehouse areas, where aging trucks used for drayage find a last lease on life (Greenberg 2022). If one truck sale just a year early could delay the deployment of many more trucks in the future, a credit policy promoting such activity will likely substantially delay the advancement of the most advanced emissions control technologies so desperately needed to fight the harms of the freight sector. EPA should not in good conscience move forward with such a strategy.

ENDNOTES

1. There are a couple differences for simplicity between the "Federal Omnibus" as described in this analysis and the rule passed by California: 1) all scenarios have assumed the maximum family emission limit (FEL) to be 150 mg NO_X/bhp-hr, consistent with the proposed Options 1 and 2, rather than including the FEL of 50 mg NO_X/bhp-hr; and 2) no intermediate lifetime standard was included.

2. In the proposal, a third option is available, which is credits generated through the sale of electric trucks. As noted earlier in the report, however, this analysis assumes that such credits will be eliminated in the final rule.

3. Because of the longer FUL of Option 2 over which the 50 mg NO_X/bhp-hr standard must be maintained, it could be argued that in the case of HHDD engines in particular there may be a substantial difference in the technology requirements of the Omnibus in 2024-2026 and Option 2 in 2027 and beyond. This difference is explored in a sensitivity case.

4. The benefits are determined as the total tons of NO_X emissions over the FUL as required on the HD FTP, compared to today's federal standards. While this does not fully capture all the nuance around real-world performance and improvements related to changes to the program from introducing new real-world requirements and additional test procedures, this does capture the lion's share of total reductions in tons of NO_X emissions.

REFERENCES

Cooke, D. 2021. "We need more electric vehicles, but extending regulatory incentives for EVs is a bad idea," *The Equation (UCS)*, July 13, 2021. Online at https://blog.ucsusa.org/dave-cooke/we-need-more-electric-vehicles-but-extending-regulatory-incentives-for-evs-is-a-bad-idea/.

Gillingham, K.T. 2021. Designing Fuel-Economy Standards in Light of Electric Vehicles. Working paper 29067 of the National Bureau of Economic Research. DOI: 10.3386/w29067.

Greenberg, M. 2022. Letter to Thomas Armitage, EPA, November 3, 2022. Re: Control of Pollution from New Motor Vehicles: Heavy-Duty Engine Standards Docket No. EPA-HQ-OAR-2019-0055. Comments to the EPA Science Advisory Board.

Hirsch, J. 2022. "Volvo Trucks president explains electric truck strategy," *Trucks.com*, May 16, 2022. https://www.trucks.com/2022/05/16/volvo-trucks-president-explains-electric-truck-strategy/.

Moving Forward Network (MFN). 2022. Comment Re : Control of Air Pollution from New Motor Vehicles : Heavy-Duty Engine Standards, submitted to Docket No. EPA-HQ-OAR-2019-0055, May 16, 2022. https://www.regulations.gov/comment/EPA-HQ-OAR-2019-0055-1277.

Memorandum of Understanding (MOU) on Zero-Emission (ZE) Medium- and Heavy-duty Vehicles (MHDVs). 2021. Finalized and opened for signatures on October 5, 2021. Online at https://globaldrivetozero.org/mou-nations/.

National Academies of Sciences, Engineering, and Medicine (NASEM). 2020. Reducing Fuel Consumption and Greenhouse Gas Emissions of Medium- and Heavy-Duty Vehicles, Phase Two: Final Report. Washington, DC: The National Academies Press. https://doi.org/10.17226/25542.

Ohnsman, A. 2022. "Big rigs going electric as Navistar, Cummins, Daimler rev up next-generation trucks," *Forbes*, May 13, 2022. https://www.forbes.com/sites/alanohnsman/2022/05/13/big-rigs-going-electric-as-navistar-cummins-daimler-rev-up-next-generation-trucks/.

Shepardson, D. 2022. "U.S. EPA to set tougher heavy duty emissions rules in 2023," *Reuters*, November 3, 2022. https://www.reuters.com/business/environment/us-epa-set-tougher-heavy-duty-emissions-rules-2023-2022-11-03/.

Vieth, K. 2007. "Commercial Vehicle Demand Review: 2007-2008." Presentation. Automotive Outlook Symposium, June 1, 2007. https://www.chicagofed.org/-/media/others/events/2007/automotive-outlook-symposium/presentation-truck-outlook-pdf.pdf.