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Comprehensive Transportation Fuel Reduction Policies

A Comparison of Heavy Truck Fuel Efficiency and Rigid Pavement Policies

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PCA Market Intelligence

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Fuel Reduction Policies Should Be Comprehensive

Key Findings

- ***Tough new Corporate Average Fuel Economy (CAFE) standards for the nation's fleet of heavy-duty trucks have been initiated as part of a campaign to reduce fuel consumption via presidential executive order***. The fuel-economy standards are aimed at reducing truck fuel use by as much as 20 percent.

- ***CAFE policy's impact will be limited at first.*** Very little of the stock of heavy trucks accrued to new truck sales is impacted in the early years (roughly 4% annually); therefore, the corresponding policy impacts on fuel consumption will initially be small. By 2035 64% of the stock is expected to be impacted. This gradual penetration reduces the immediate impact of the White House's heavy truck CAFE policy.

- ***Heavy truck CAFE standards will save billions of gallons of fuel.*** PCA estimates that White House's heavy truck CAFE policy will cumulatively save about 42 billion gallons of fuel by 2035. Most of the savings are not immediate. One half of the savings materialize during 2030-2035.

- ***Pavement choice also affects fuel efficiency.*** There is a wealth of research that indicates fuel consumption is ***partially*** determined by the roads themselves and that road conditions and type of pavement can improve fuel efficiency by a range of 3% to 5% for heavy trucks and passenger cars, according to the nation's premier scientists at the Massachusetts Institute of Technology (MIT).

- ***Pavement's impact on fuel reduction is significant.*** PCA calculated the total fuel savings for ***all vehicles*** associated with the pavements policy. PCA estimates that a fuel reduction policy focused on paving 15% of all roads scheduled for repaving with a rigid surface will cumulatively save roughly 7 billion gallons of fuel by 2035 – roughly 16% of the White House's heavy truck CAFE policy.

- ***A comprehensive fuel efficiency policy, therefore, should not only focus on the vehicle efficiency, but include its partner – the roads themselves.***

- ***Pavement strategies could also reduce paving costs.*** Stiffer pavements could reduce initial and long-term paving costs, reduce maintenance expenditures and provide state DOTs with long term spending relief. According to PCA estimates, paving cost parity between asphalt and concrete urban roadways correlates to $70 per barrel. This analysis suggests that concrete roadways not only offer the potential for fuel savings, but also a potential reduction in state's paving costs.

Overview

New fuel standards for the nation's fleet of heavy-duty trucks have been mandated as part of a campaign to tackle climate change via presidential executive order. According to the White House, heavy-duty trucks account for just four percent of highway vehicles, but are responsible for 20 percent of fuel consumption from the transportation sector. Current fuel-economy standards are aimed at reducing truck fuel use by as much as 20 percent.

The new regulations are expected to be drafted by the EPA in 2014 and in-place roughly one year later in an effort to cut greenhouse gases. Such actions combine with previous rules that require more efficient performance by passenger cars and light trucks. The president stated that ***"improving gas mileage for these trucks is going to drive down our oil imports further, that reduces carbon pollution and cuts down on business' fuel costs, which could pay off for consumers. So it's not just a win-win, it's a win-win-win"***.

Fuel consumption, however, is only ***partially*** determined by the fuel efficiency of the vehicles that run on the roads. It is also ***partially*** determined by the roads themselves, according to the nation's premier scientists at the Massachusetts Institute of Technology (MIT). A comprehensive fuel efficiency policy, therefore, should not only focus on the vehicle efficiency, but include its partner – the roads themselves. According to MIT's research, stiffer pavements could save 740 million gallons of fuel annually[1].

While the details of the White House initiative are unknown at this time, this report provides estimates comparing the long-term fuel savings from White House's proposed policies of raising heavy truck fuel efficiency standards by an assumed 20% against a policy that targets rigid pavements for roadways scheduled for repaving and where a rigid system makes cost sense. As a conservative approach, PCA assumes a 2018 onset of the heavy truck CAFE program.

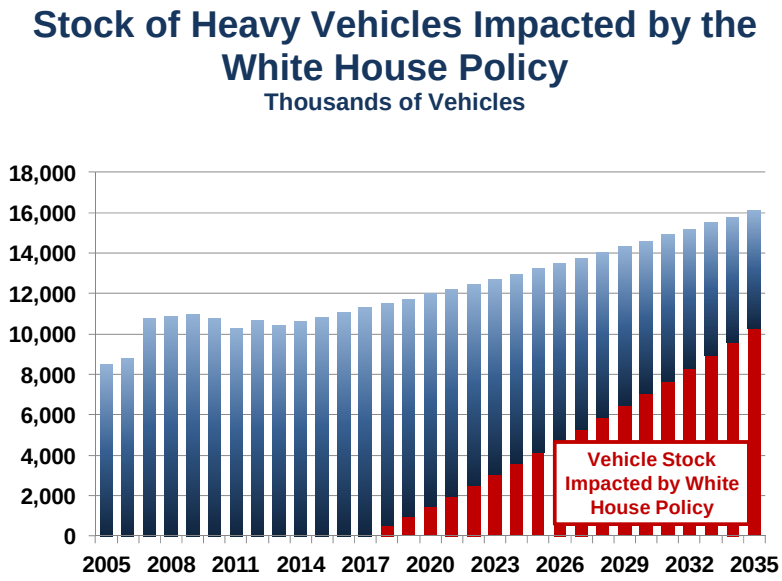
The intent of the report is to help policymakers understand the importance pavement selection can play in the context of a comprehensive fuel efficiency policy. With success, policymakers may recognize a dual mandate to their fuel reduction objectives – one centered on vehicle efficiency and a second centered on pavement selection.

Point 1: Heavy truck CAFE policies will take time to have a meaningful impact on fuel reduction.

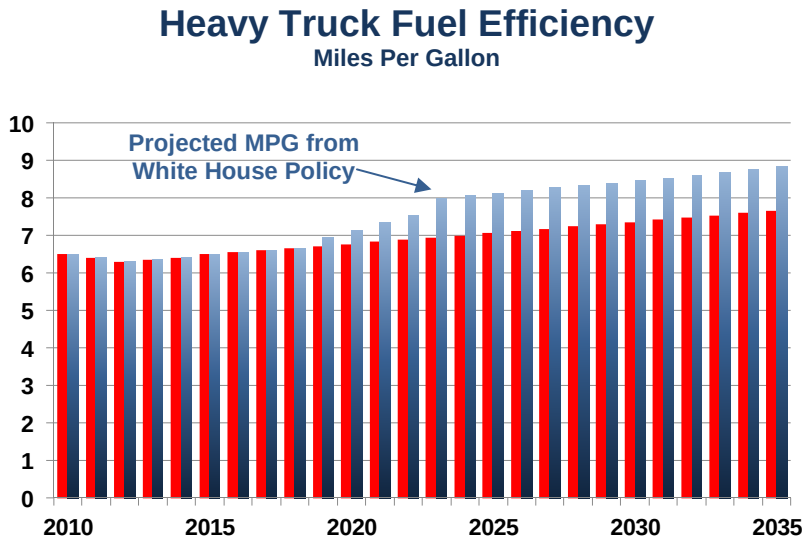
Currently, there are an estimated 250 million vehicles on the road. Of this, roughly 10 million are categorized as heavy trucks – or 4% of the total fleet of vehicles on the road. These vehicles account for slightly more than 9% of the total vehicle miles traveled and nearly 25% of total motor fuel consumed. Due to this prominence, the White House targeted heavy trucks' fuel usage by way of corporate average fuel efficiency standards (CAFE).

CAFE standards target the production of ***new*** vehicles only. There are roughly 10 million heavy trucks on the road. Taking into consideration scrap rates and fleet expansion, this translates into **new** heavy truck sales of roughly 400-450 thousand vehicles annually. Based on this simple and rough estimate, 4% of the stock of heavy trucks will be impacted annually – at most. Because very little of the stock of heavy trucks accrued to new truck sales is impacted in the early years, the policy impacts on fuel consumption will be small. A 20% mandatory increase in CAFE standards would impact 4% of the fleet each year. At this rate, it would take more than 30 years for the fleet to completely turn-over. Assuming a 2018 onset for the policy, this suggests full impact of the policy would not be achieved until 2050.

[1] LCA Research Brief: Potential Roadway Network Savings and PVI, Concrete Sustainability Hub@MIT, July 1, 2012.



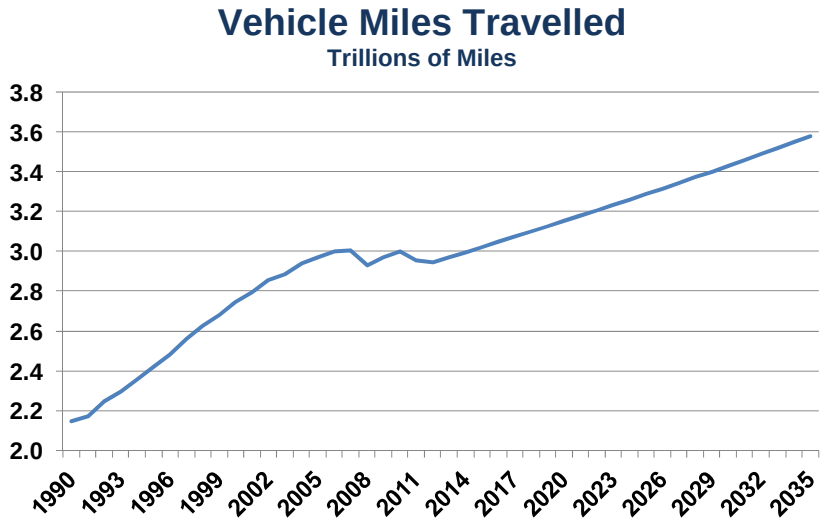
PCA assumes that the White House will enact new CAFE standards for heavy trucks in 2018. This date is based on a review of previous administration announcements regarding CAFE adjustments and resulting policy compliance mandates. PCA assumes a 20% mandatory fuel efficiency increase in new heavy vehicles is phased in over five years.



Point 2: Vehicle miles travelled is expected to grow.

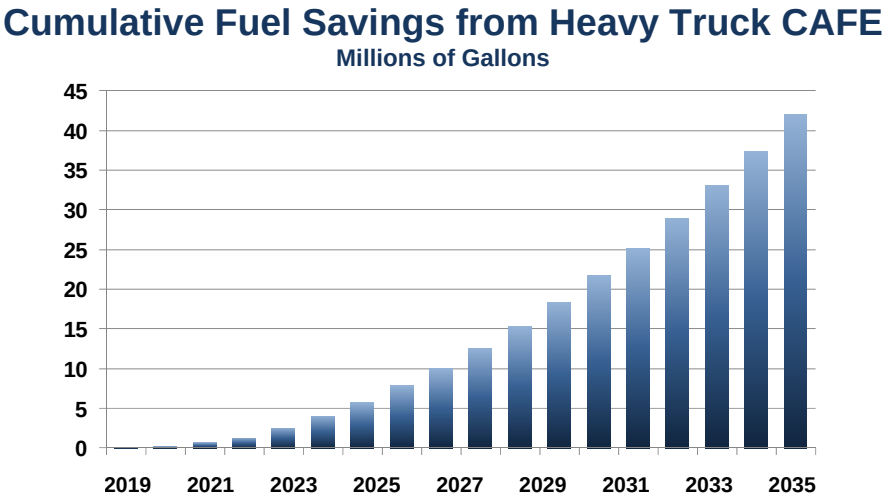
The effectiveness of the heavy truck CAFE policy is partially determined by the amount of miles travelled by heavy trucks. The miles travelled by all vehicles on rigid pavements determine the effectiveness of a fuel reduction strategy inclusive of pavements.

The vehicle miles travelled are highly correlated to the number of vehicles on the road and economic activity. Adjusting for the recovery and assuming 2.5% long-term real GDP annual growth rate, PCA estimates that VMT will grow close to 0.9% annually through 2035. Total vehicle miles travelled is expected to reach 3.6 trillion miles by 2035, compared to 3.0 trillion miles currently. Of this, heavy truck VMT is expected to grow 2.0% annually. This implies that heavy truck VMT will eventually reach 423 billion miles by the end of the forecast horizon, compared to 280 billion miles currently, which comprises 9.3% of total VMT.



Point 3: Fuel savings from heavy truck CAFE.

Combining the stock turnover with estimated average vehicle miles travelled and assumptions regarding improvements in heavy truck fuel efficiency yields an estimate of fuel consumption associated with heavy trucks. Two scenarios are estimated. The baseline scenario assumes that the average MPG per heavy truck improves at a rate that is consistent since the year 2000. A second scenario uses MPG assumptions enforced by the White House's policy.



The difference in fuel consumption between the baseline and White House's scenarios yields the impact of the heavy truck CAFE policy. The gradual penetration reduces the immediate impact of the new heavy truck CAFE policy. Based on this methodology, PCA estimates that the proposed heavy truck CAFE policy could save roughly 42 billion gallons of fuel by 2035. By 2035, 64% of the stock is expected to be impacted. One half of the savings will materialize during 2030-2035.

Point 4: Research on pavement's role on fuel efficiency.

The issue of pavements' impact on fuel efficiency has been long debated by the asphalt and concrete industries. The debate can be reduced to which pavement offers least rolling resistance and roughness – enabling higher fuel efficiency. The asphalt industry emphasizes its supposed advantages of smoothness and the concrete industry emphasizes its low deflection and longer term smoothness. The debate is further complicated by the time horizon and methodology of the analysis. Despite the assumptions and methodology, both groups agree that pavement can contribute to fuel efficiency gains. Consider the following:

- Researchers at the MIT recently found that how the road is constructed could have a significant impact on the fuel economy of cars and trucks. Research models predict the use of stiffer pavements, for example, could reduce fuel use by as much as five percent.

- Florida International University tested MIT's research models in real-world conditions with similar results. They concluded that vehicles riding on rigid pavements consume 3.2 percent less fuel than riding on flexible pavements for passenger vehicles and 4.5 percent less fuel for loaded tractor-trailers.

- Another study by the National Research Council (NRC)[2] Canada concluded similar findings. When comparing concrete to asphalt roads fuel consumption savings ranged from 0.8 to as much as 4.1 percent in favor of concrete. The highest savings occurred for fully loaded trailer trucks.

- The Asphalt Pavement Alliance (APA) claims that even small improvements in pavement smoothness could reduce annual vehicle fuel consumption by up to 10 percent on those roads. They cite a field study conducted by the Federal Highway Administration at the WesTrack pavement test track in Nevada which indicated that trucks running on slightly smoother pavement could reduce fuel consumption by 4.5 percent.

The key point is that there is a wealth of research that indicates that fuel consumption is ***partially*** determined by the roads themselves and that road conditions and type of pavement can improve fuel efficiency by a range of 3% to 5% for heavy trucks and passenger cars.

The President is quite correct, "improving gas mileage will drive down oil imports, reduce carbon pollution and cut down on business' fuel costs, which could pay off for consumers. So it's not just a win-win, it's a win-win-win". **Policymakers targeting fuel consumption must understand that they have a dual mandate to their fuel reduction objectives – one centered on vehicle efficiency and a second centered on pavement selection.**

Point 5: Pavement's impact on fuel savings.

While there is a wealth of research regarding pavement systems impact on fuel consumption, the foregoing MPG improvement estimates contained in this assessment are based on MIT's research. MIT's estimates regarding fuel savings is based on science and has been validated in the real world by Florida

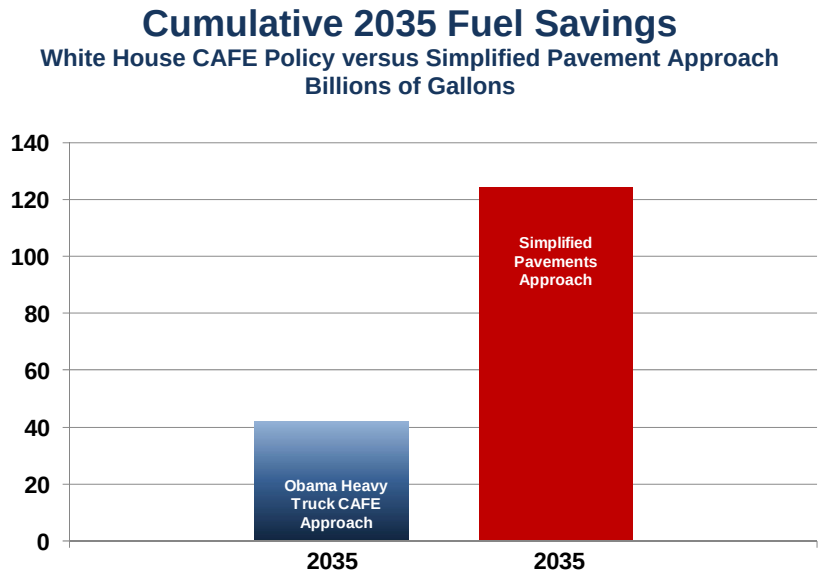
[2] Effects of Pavement Structure on Vehicle Fuel Consumption-Phase III, National Research Council of Canada, January 27, 2006.

International University. According to this research, riding on rigid pavements consumes 3% less fuel than riding on flexible pavements (asphalt) for light vehicles and 4.5% less fuel for loaded tractor-trailers. Roughly 94% of all roads are asphalt (flexible). The MIT research suggests that fuel economy gains can be achieved by converting flexible payments to more rigid pavements (concrete). Fuel economy gains can be achieved by the conversion of some existing roadways to concrete.

In contrast to the White House's CAFE policy targeting only heavy trucks, pavement selection policies have a much broader impact. These policies do not discriminate by type of vehicle – all vehicles on the road, (passenger cars, light trucks and heavy trucks) show an improvement in fuel economy. While the fuel savings is relatively small on a per mile basis, (3% for light vehicles and 4.5% for heavy vehicles) there are many more vehicle miles travelled that are impacted by a pavement selections policy compared to a heavy truck CAFE policy.

Point 6: A simple estimate of pavement's fuel savings.

The simple calculation to estimate the potential fuel savings associated with a pavement selection strategy is to apply the MIT estimates fuel savings for light vehicles and heavy trucks to the total vehicles miles travelled and fuel efficiencies of each. That translates into 6 billion gallons of fuel for 2014 – or a 3.4% reduction in fuel consumption in that year. This is roughly 20 times the estimated fuel savings arising from the first year of a heavy truck CAFE strategy. Pavements have a role in a fuel consumption reduction strategy.



This is a powerful statistic, but it is also misleading because not all roads are subject to repaving. In an ideal world, transportation agencies would repave all roads that deteriorate beyond a predetermined point. Budget constraints force DOT's to prioritize paving initiatives, and only repair a small portion of their road stock in a given year. This impacts annual paving activity and hence fuel savings that can be attributed to a pavements policy.

Point 7: A pavements fuel reduction strategy must take into consideration likely paving activity.

PCA estimates of the pavement policy impact on fuel reduction are based on "normal" road repaving schedules. Repaving schedules are likely to vary depending upon the roads' usage. PCA applied different re-pavement schedules to different road types. Repaving activity assumptions among different road types were based on the overall average of 6% of stock. Higher traffic roads probably need to be serviced more frequently. Local roads, that are used less, do not receive the same level of attention and repaving is more likely allowed to be postponed in lieu of higher paving priorities. PCA, as a result, assumes nearly 4% of local and collector roads need to get repaved annually. In contrast, higher use roadways, such as interstate roadways, need repaving more often. PCA assumes 8% of these roads are repaved annually. Following similar logic, other principle arterial and minor arterial are assumed to be repaved at a rate of roughly 7% and 6%, respectively.

These assessments are based on a rather small sample of state paving activity. PCA, as a result, performed two cross-checks on these results. Both cross-checks generally validate the conclusions reached using the Oman sample. For the total stock of roads, using the Oman data, PCA's analysis implies repaving occurs every 23 years – 18 years for primary roads and 26 years for secondary roads.

Point 8: Practically, concrete does not play in the entire paving market.

For many heavily travelled roadways, concrete enjoys an initial bid and life cycle cost advantage. In some cases, however, it is not economical for states and localities to pave with concrete due to comparative cost estimates. While some successes have occurred, concrete typically does not compete well in the three inch or less overlay market due to cost, convenience, and/or other technical factors. Generally speaking these roads are characterized by ***very*** light traffic and are excluded from our analysis. PCA estimates that the "three inches or less" overlay market captures roughly one third of the primary and interstate overlay market. Local road usage of less than three inch asphalt overlays is considerably more prevalent than among primary roads and interstates. PCA assumes two thirds of local roads are comprised of three inches or less overlays. Based on these assumptions, the pavement market that concrete actually competes on a cost basis is much smaller than the entire paving market – reducing the potential fuel reduction effectiveness.

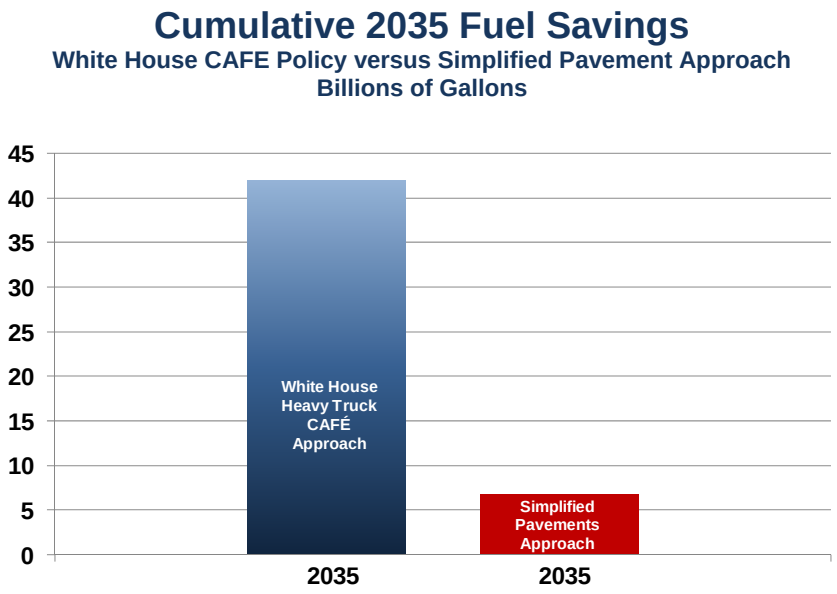
Point 9: Realistic impact of a pavement's fuel reduction policy.

PCA's pavement fuel reduction scenario assumes that 15% of the stock of roads that are scheduled for repaving are applied to a pavement fuel reduction strategy. This assumption translates into roughly 40,000 lanes miles of roadway annually. Given this stock of roads, the corresponding vehicle miles travelled are calculated. These miles are translated into fuel consumption. Fuel consumption is estimated by combining the vehicle miles travelled with MPGs that employ MITs' estimate of 3% fuel savings for light vehicles (passenger cars and light trucks) and 4.5% fuel savings for heavy trucks. PCA calculates the total fuel savings for ***all vehicles*** associated with the pavements policy. Based on this methodology, PCA estimates that a fuel reduction policy focused on pavement will save roughly 7 billion gallons of fuel by 2035.

Point 10: Comparisons of the two policies impact on fuel reduction.

The rough estimates contained in this report clearly suggest that fuel consumption is only ***partially*** determined by the fuel efficiency of the vehicles on the roads; it is also ***partially*** determined by the roads themselves. PCA estimates that the White House's heavy truck CAFE policy will save roughly 41 billion

gallons of fuel by 2035. PCA estimates that a fuel reduction policy that includes a focus on pavement will save an additional 7 billion gallons of fuel by 2035 – roughly 16% of the proposed heavy truck CAFE policy. **Both policies save fuel.**



More rigorous assessments may prove that pavements play a somewhat greater or lesser role in a fuel reduction strategy. The point is that fuel consumption is ***partially*** determined by the roads themselves and should be part of a comprehensive policy to ***"improve gas mileage, drive down oil imports, reduce long term carbon pollution and cut down on business' fuel costs, which could pay off for consumers".***

Point 11: A pavement fuel reduction strategy must take into consideration costs.

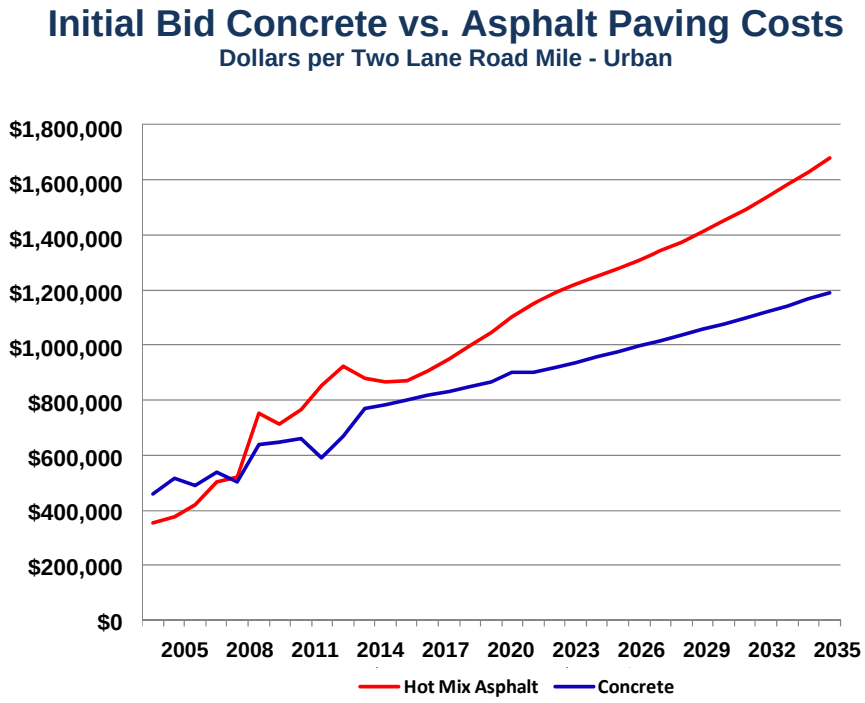
Such a fuel reduction strategy makes sense as long as the costs to implement them are favorable. Until recently, initial bid costs favored asphalt paved roads. Using DOT software to calculate initial bid costs for a one mile "urban standard" two lane roadway, PCA calculated asphalt enjoyed a $104,000 cost advantage over a concrete paved road in 2003 – roughly a 22.7% advantage[3]. Initial bid costs now favor concrete paved roads. Between 2000 and 2009 asphalt prices increased 95%. Concrete prices increased 45% during the same period. Based on DOT software, near parity in initial bid paving costs between asphalt and concrete was reached in fiscal 2008 (August 2007). In FY 2009, concrete paved roads enjoyed a $64,000 cost advantage over asphalt paved roads. This reversal in initial bid paving costs was due largely to the increase in oil prices since 2003. Since 2009, asphalt pavement prices have increased 18%. Concrete prices have not kept pace. The Energy Information Agency (EIA) expects world oil prices to rise from $96 per barrel currently and reach $132 per barrel by 2025 and $190 per barrel by 2035[4].

[3] Estimates based of Wisconsin Department of Transportation's WISPAV software. A standard road as designed in WisPAVE for this analysis consists of traffic average daily traffic of 7512 vehicles with 15% of all traffic being heavy truck. Soil specifications consist of a design grade index (DGI) of 12, Frost Index of F-3, Soil Support Value of 4.2, and a Modulus of Subgrade Reaction (k) of 150. The pavements were then designed according to these parameters with an asphalt pavement depth of 6.5 inches and 15.5 inches of crushed aggregate, and an 8 inch concrete road with 6 inches of aggregate.

[4] Energy Information Agency's "Annual Energy Outlook 2014", April 2014.

According to PCA estimates, paving cost parity between asphalt and concrete urban roadways correlates to $70 per barrel. **This analysis suggests that concrete roadways not only offer the potential for fuel savings, but also a potential reduction in state's paving costs.**

Based on EIA oil price projections, PCA expects oil based products will increase in price more rapidly than concrete during the next 10 years, perhaps longer. Asphalt pavement prices are highly correlated to the price of oil. Crude oil is the principal feedstock for asphalt. Therefore, oil price movements are reflected in asphalt costs. While other factors contribute to asphalt pricing, such as the use of cokers at oil refineries, roughly 60% of long-term asphalt price increases are accounted for by oil price changes.



Correlation analysis between annual percent changes in oil prices and the six month lagged annual percent change in asphalt prices suggest asphalt prices rose 7% for every 10% increase in oil prices during the past 10 years. Based on this analysis and EIA's oil price projections, asphalt pavement prices could be expected to rise roughly 26% by 2025 and 68% by 2035.