

Ultra-low Sulfur Diesel Fuel/Heating Oil Market Study

Prepared for the
National Oilheat Research Alliance

9/15/2014

Outline

- **Key observations and conclusions**
- **Heating oil demand**
- **Refining and refinery production**
- **PADD 1 distillate imports**
- **Distillate exports**
- **Distillate market balance**
- **Ultra-low sulfur diesel and heating oil values**
- **Impact on consumers**
- **Options**

9/15/2014

KEY OBSERVATIONS AND CONCLUSIONS

9/15/2014

Key Observations

- **Market trends will not result in a shift to ULSD for the heating oil market within the study period to 2020.**
- **Refiners add capacity only in response to market/regulatory requirements. Announced distillate upgrading projects closely match the amount of off-highway diesel that will need to be upgraded to ULSD by 2012.**
- **The US refining industry today does not have the capacity to convert all heating demand to ULSD.**
- **Refiners will be able to meet low sulfur heating oil specifications with enough lead time for the necessary investments. Past experience suggests at least 5 years will be needed for the industry to make the necessary investments.**

Key Observations

- **ULSD supply in the US is currently in excess of domestic demand resulting in about 200,000 bpd being exported. A short-term shift to ULSD in some markets would have the effect of moving exported ULSD back into the US domestic market. However,**
 - *Domestic ULSD prices would rise relative to the world market and,*
 - *Domestic heating oil prices would fall relative to the world market in order to export displaced heating oil supplies.*
- **Export markets for US quality heating oil are becoming more limited, smaller in size and more remote due to low sulfur regulations around the world.**
 - *As a result, the cost to export heating oil is likely to be higher than the cost to export ULSD due to the added transportation cost.*

Key Observations

- ULSD prices are expected to average for the study period 1 to 3 cpg over heating oil in the PADD 1 winter season wholesale market.
 - *The very high ULSD prices relative to heating oil in the 2006 – 2008 period were an anomaly, unsustainable and are not expected to repeat.*
- If a rule to move to ULSD in heating markets is adopted, price spikes could occur if the timing and implementation of the rule change is not done properly
- For consumers, the higher cost of ULSD relative to heating oil will be more than offset by lower maintenance costs and higher fuel efficiency.

ULSD for Heating Oil – Potential Regulatory Options

- **Option 1: Change the heating oil sulfur specification to ULSD for the entire market at once with enough lead time for refiners to add capacity.**
 - *This option would insure supply at a specified time. However, past experience indicates that not all refiners would receive a return on capital invested.*
- **Option 2: Phase in ULSD for heating oil by state on a fixed schedule.**
 - *Some states could shift right away as current ULSD exports could be moved to heating oil markets.*
 - *Timing for the remaining states would need to be sufficient to allow refining to add capacity.*

HEATING OIL DEMAND

9/15/2014

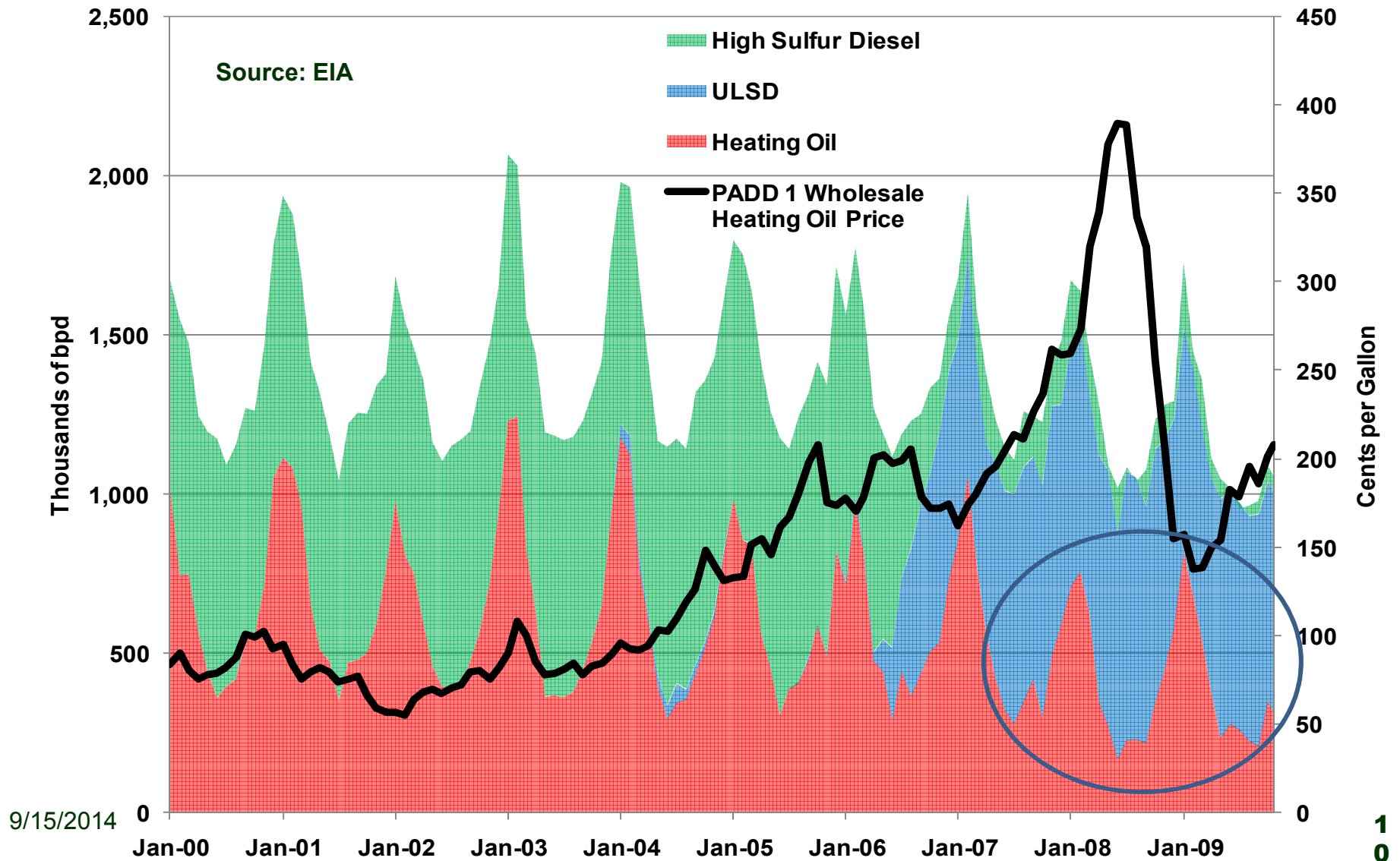
© 2010  Kevin J. Lindemer LLC

Confidential: Not for distribution without written consent from Kevin J. Lindemer LLC

Heating Oil Demand

- This analysis assumes that a shift to ULSD for the heating oil market will slow the structural decline in heating oil demand.
 - *With a shift, demand is expected to fall over 20% from 2009 to 2020 which is similar to the decline experienced in the previous decade.*
 - *Without a shift to ULSD, the decline could be greater.*
- Heating oil is becoming a very small volume product compared to total distillate demand and total oil demand.
 - *In 2000, heating oil was 35% of total distillate demand in PADD 1, 2, and 3.*
 - *By 2009, heating oil declined steadily to 14% of distillate demand and is expected to be less than 10% by 2020.*
- Heating oil is still an important product for PADD 1 refiners.
 - *Heating oil demand is about one third of total distillate demand in PADD 1 in 2009 and is expected to be as much as 25% in 2020.*

PADD 1 Middle Distillate Demand

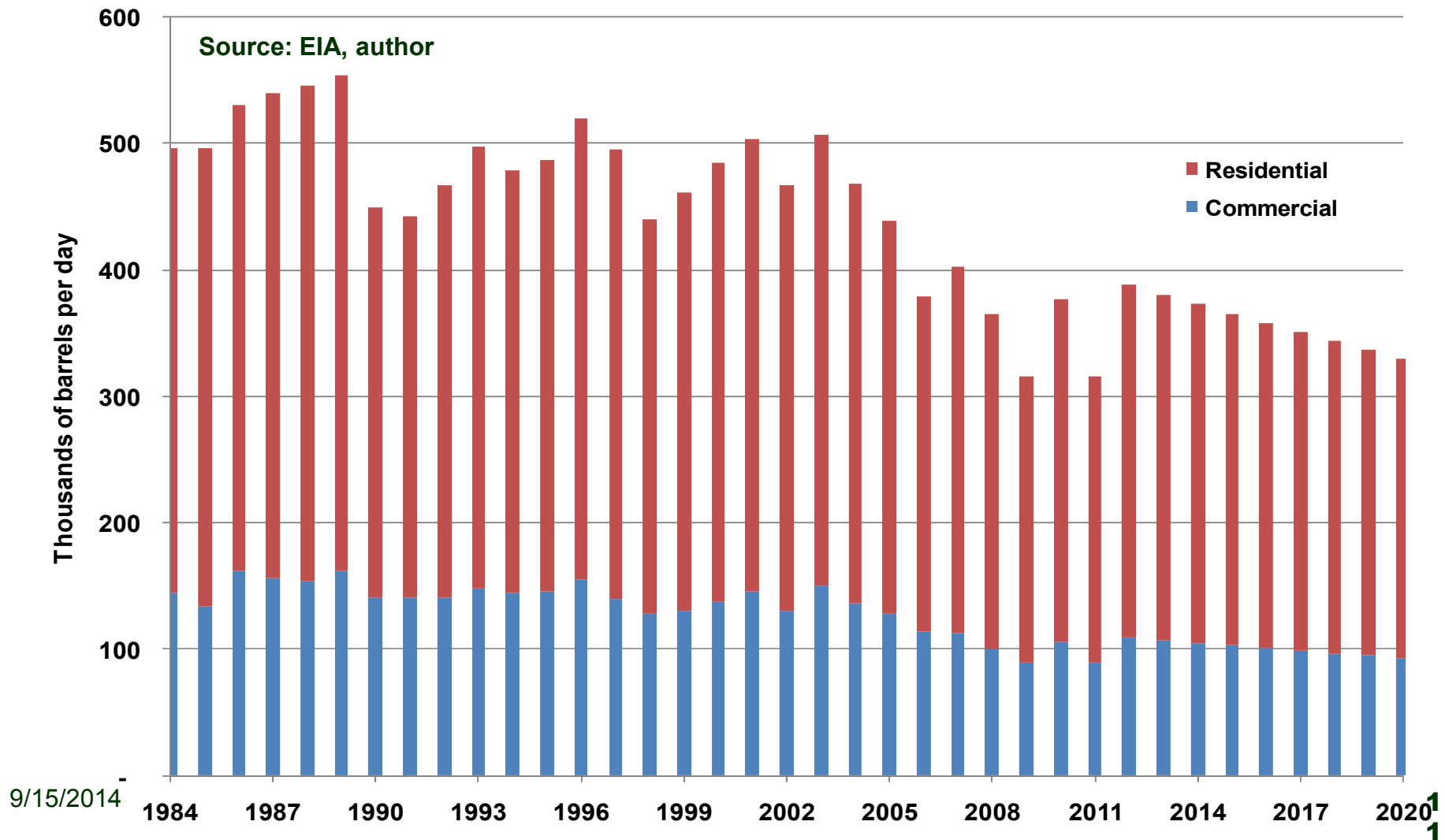


9/15/2014

© 2010 Kevin J. Lindemer LLC

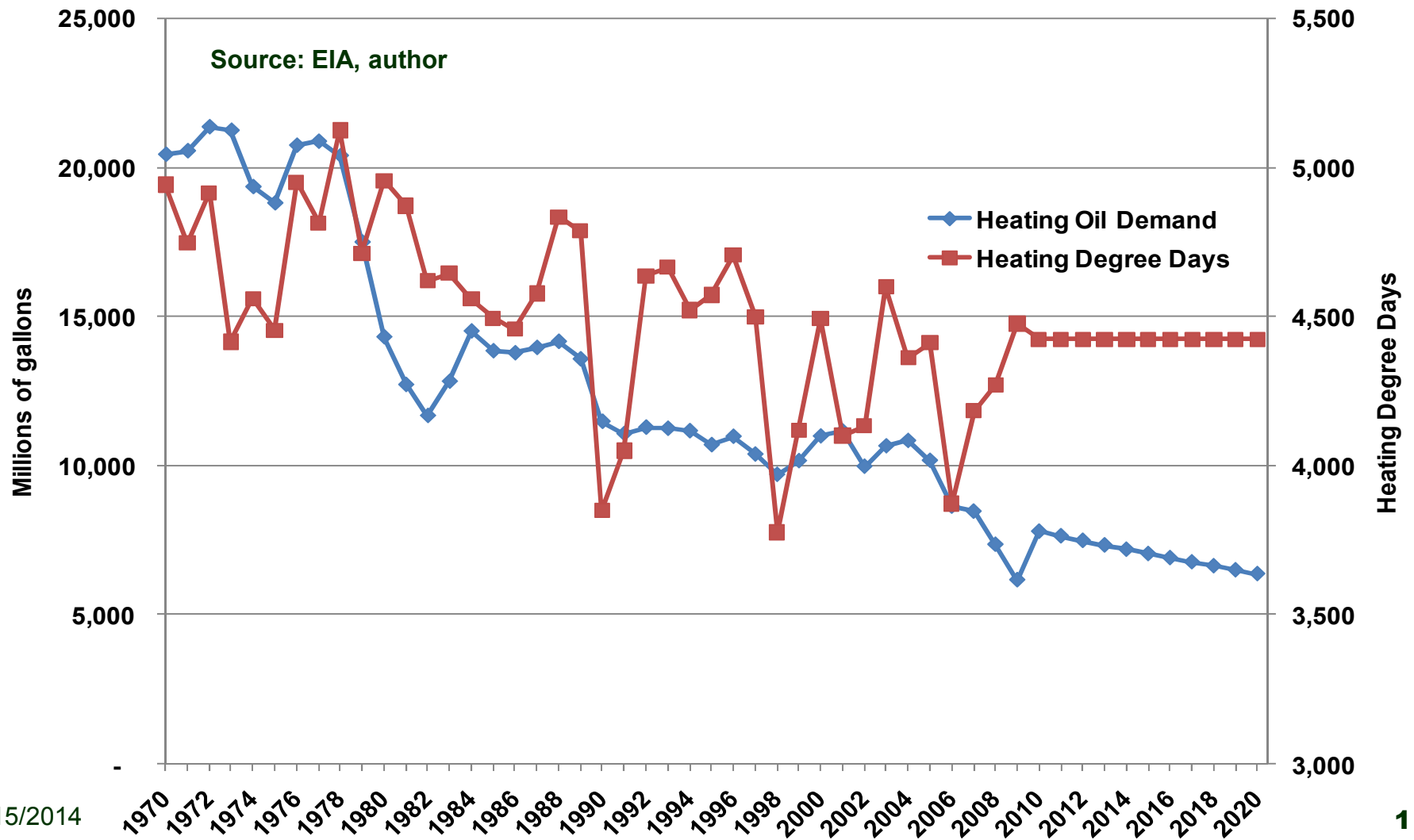
Confidential: Not for distribution without written consent from Kevin J. Lindemer LLC

PADD 1 Residential/Commercial Heating Oil Demand with ULSD for Heating Oil



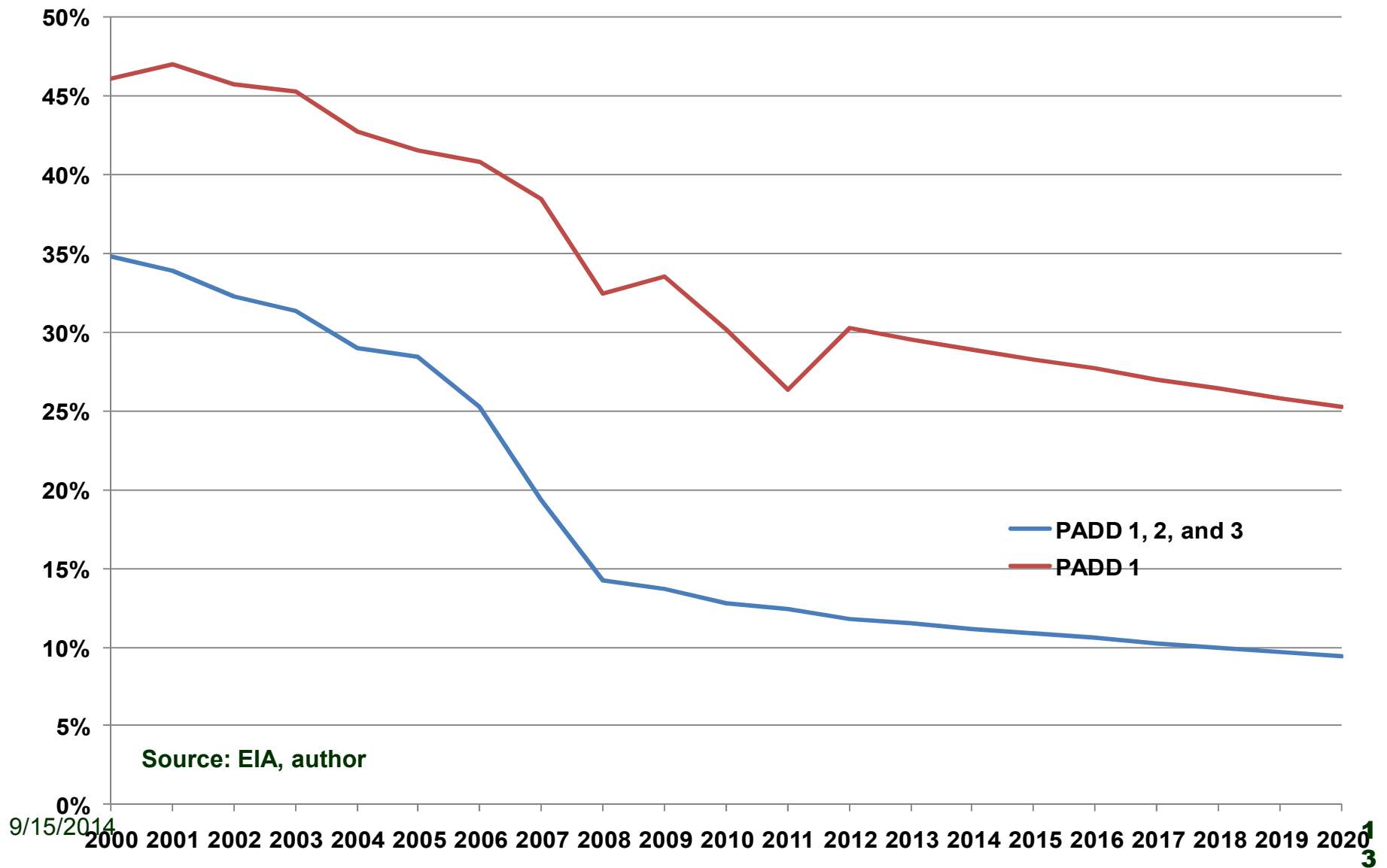
9/15/2014

PADD 1 Residential/Commercial Heating Oil Demand and Degree Days



9/15/2014

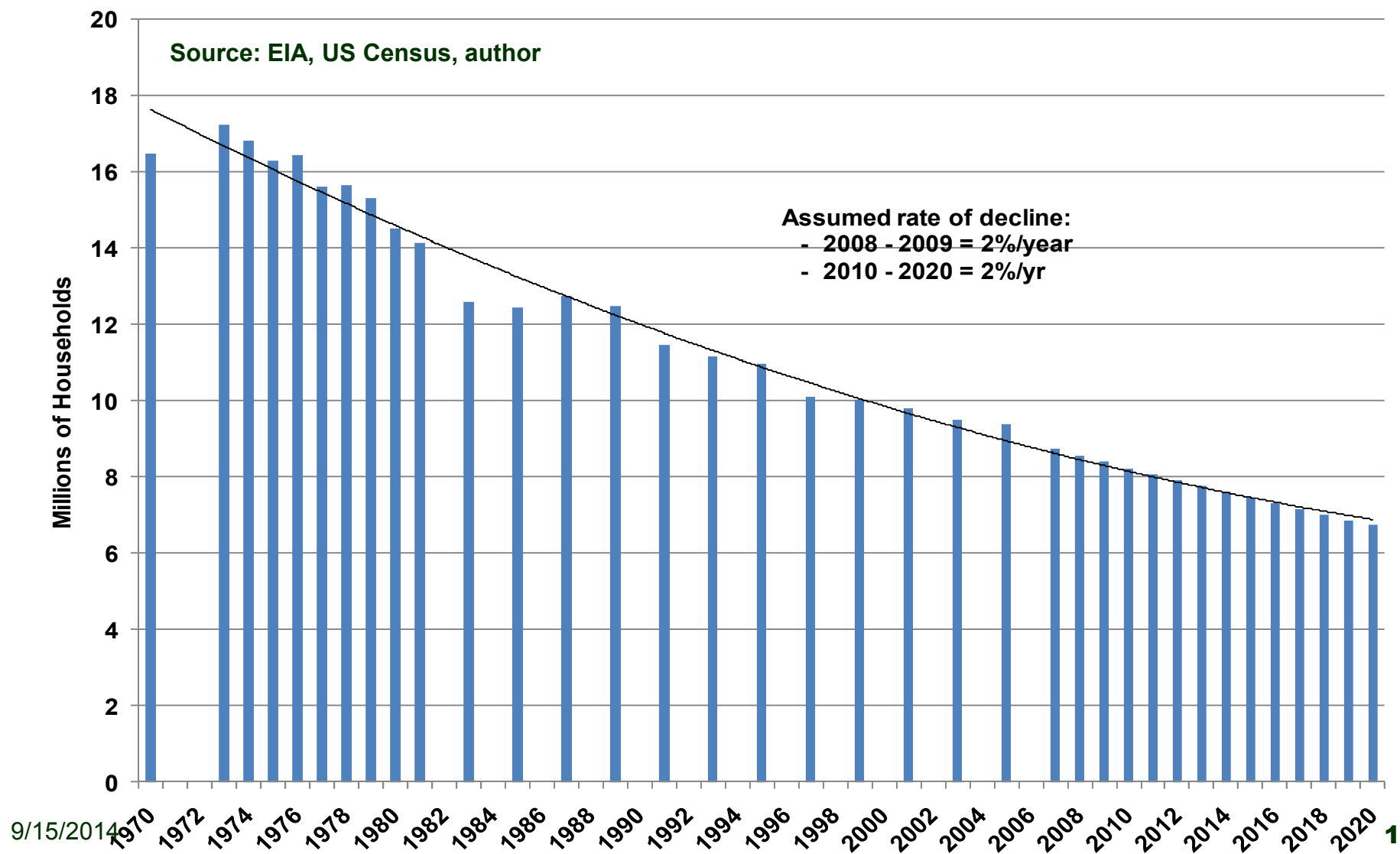
Heating Oil Share of Total Distillate Demand



Heating Oil Demand Fundamentals and Key Assumptions

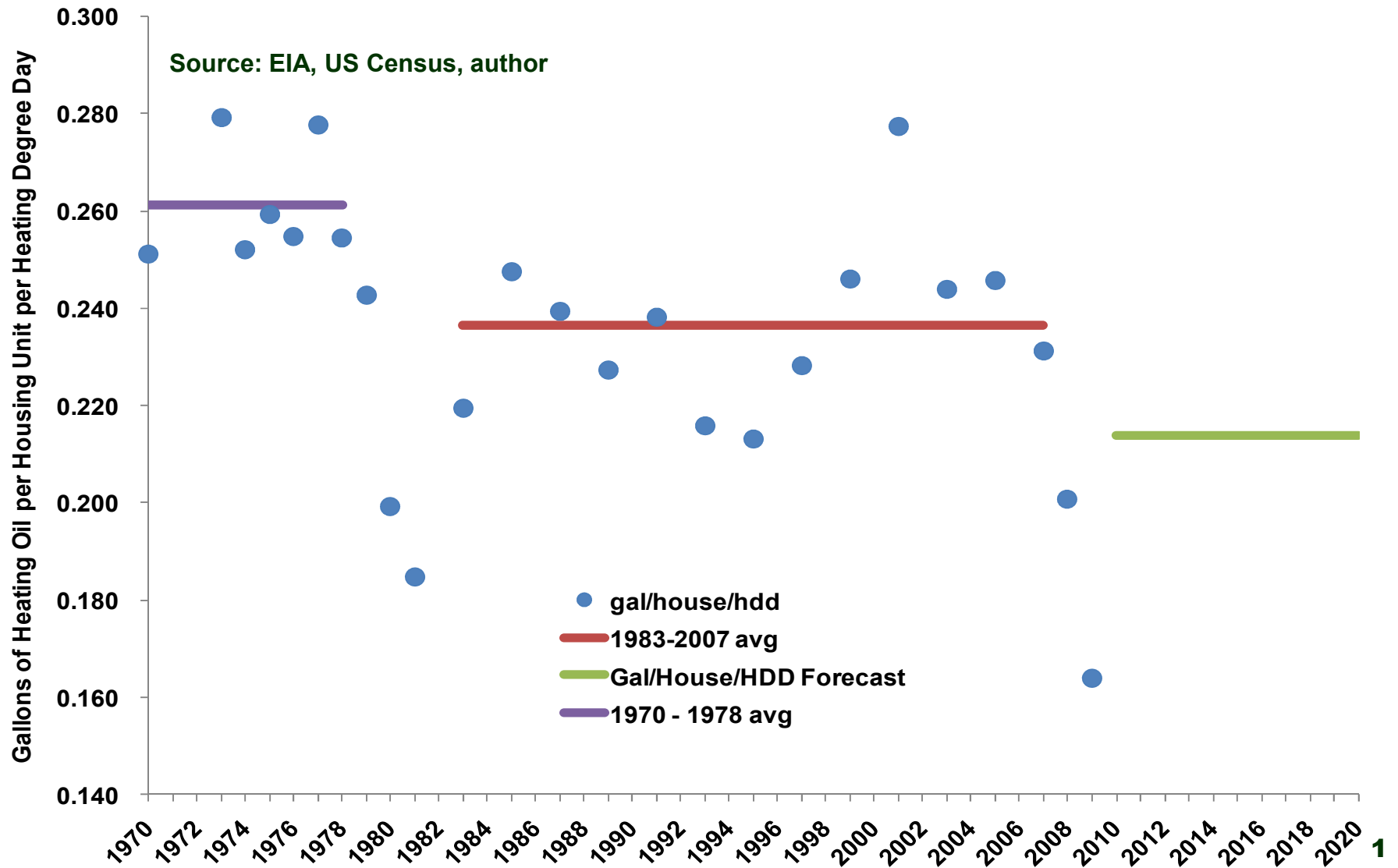
- The analysis assumes a conversion rate from heating oil to natural gas through 2020 consistent with long-term historic trend rate.
- Heating oil demand/house/HDD has declined sharply due to high prices over the past few years. A similar pattern occurred in the early 1980s after the oil shock of the late 1970s.
 - *When prices declined again in the mid-1980s, demand did not recover back to the pre-price shock levels due to efficiency gains and fuel switching.*
 - *This analysis assumes a similar permanent loss in demand/customer as a result of the recent high oil prices.*

US Households with Heating Oil Heat



9/15/2014

PADD 1 ResComm Heating Oil Consumption



REFINING AND REFINERY PRODUCTION

9/15/2014

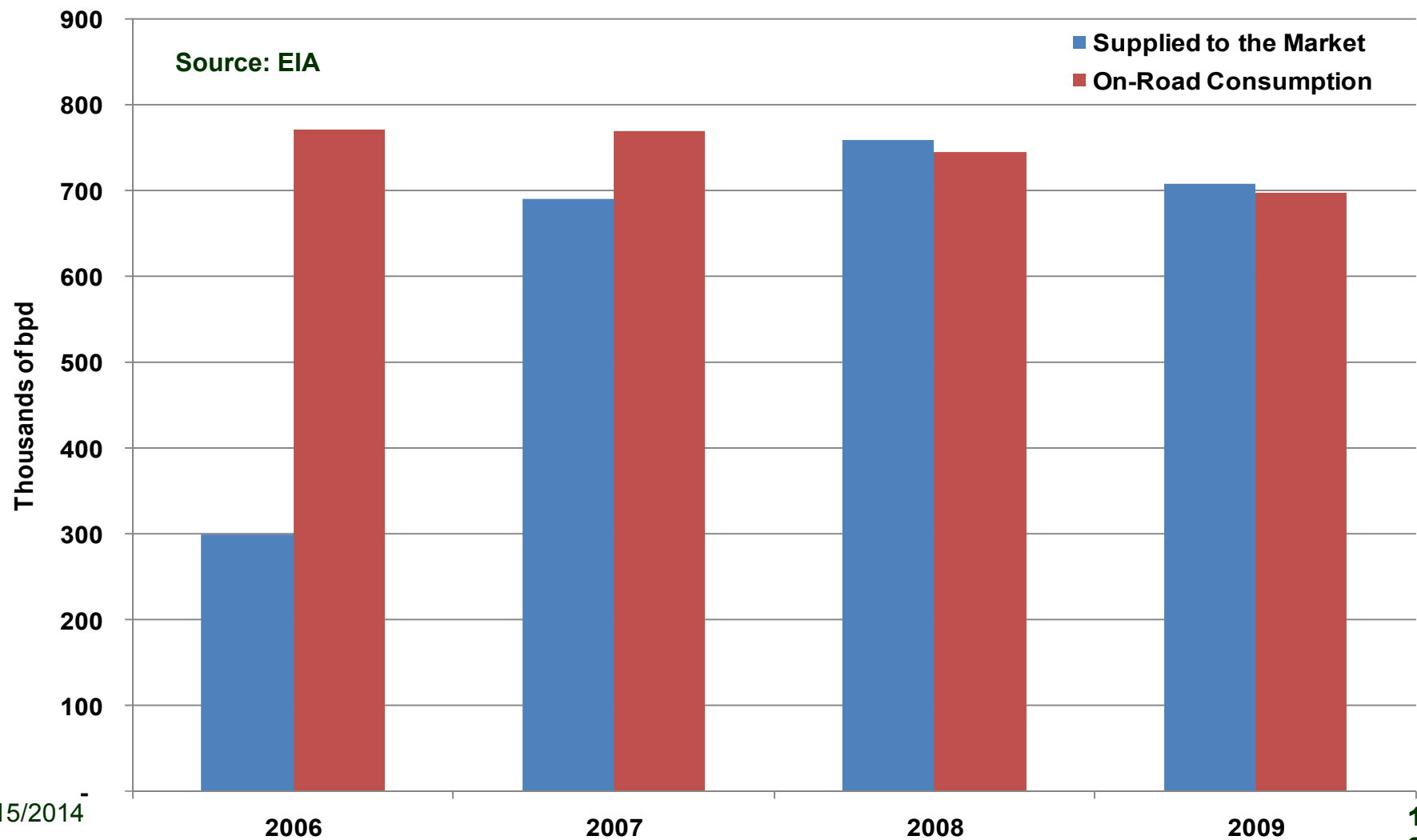
© 2010  Kevin J. Lindemer LLC

Confidential: Not for distribution without written consent from Kevin J. Lindemer LLC

Product Supplied Closely Matches Demand by Sulfur Specifications

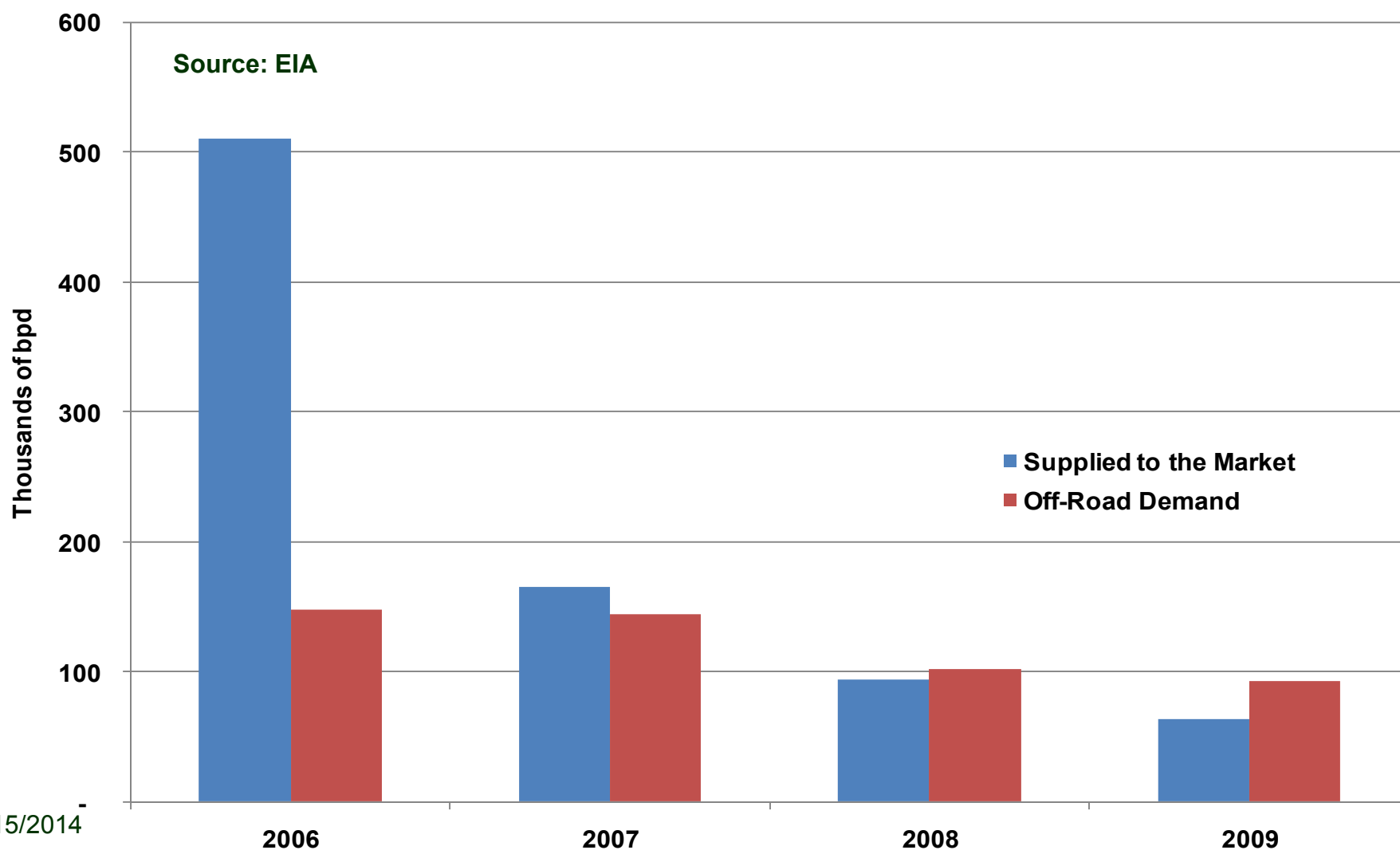
- Refinery production of distillates by sulfur grade closely matches the demand in the sectors that can use each grade.
- Refiners minimize economic losses from producing products that are not matched with market requirements. As a result, there isn't a significant amount of lower sulfur distillates being used in higher sulfur applications. In some regions of the country, logistics constraints dictate elimination of certain grades and force the use of products of higher quality in market segments that do not require them.
 - *The large coastal markets of PADD 1 have higher logistics flexibility than inland markets. Marine terminals and significant terminal capacity allow suppliers to more accurately match market needs with specific quality products.*
- Announced additions to ULSD capacity to 2013 closely matches off-road diesel fuel demand.
- Some ULSD projects have been indefinitely postponed due to the market environment.
 - *Demand for ULSD has fallen, and the market does not need the capacity at this time.*

PADD 1 ULSD Demand: Supply is Balanced with Consumption



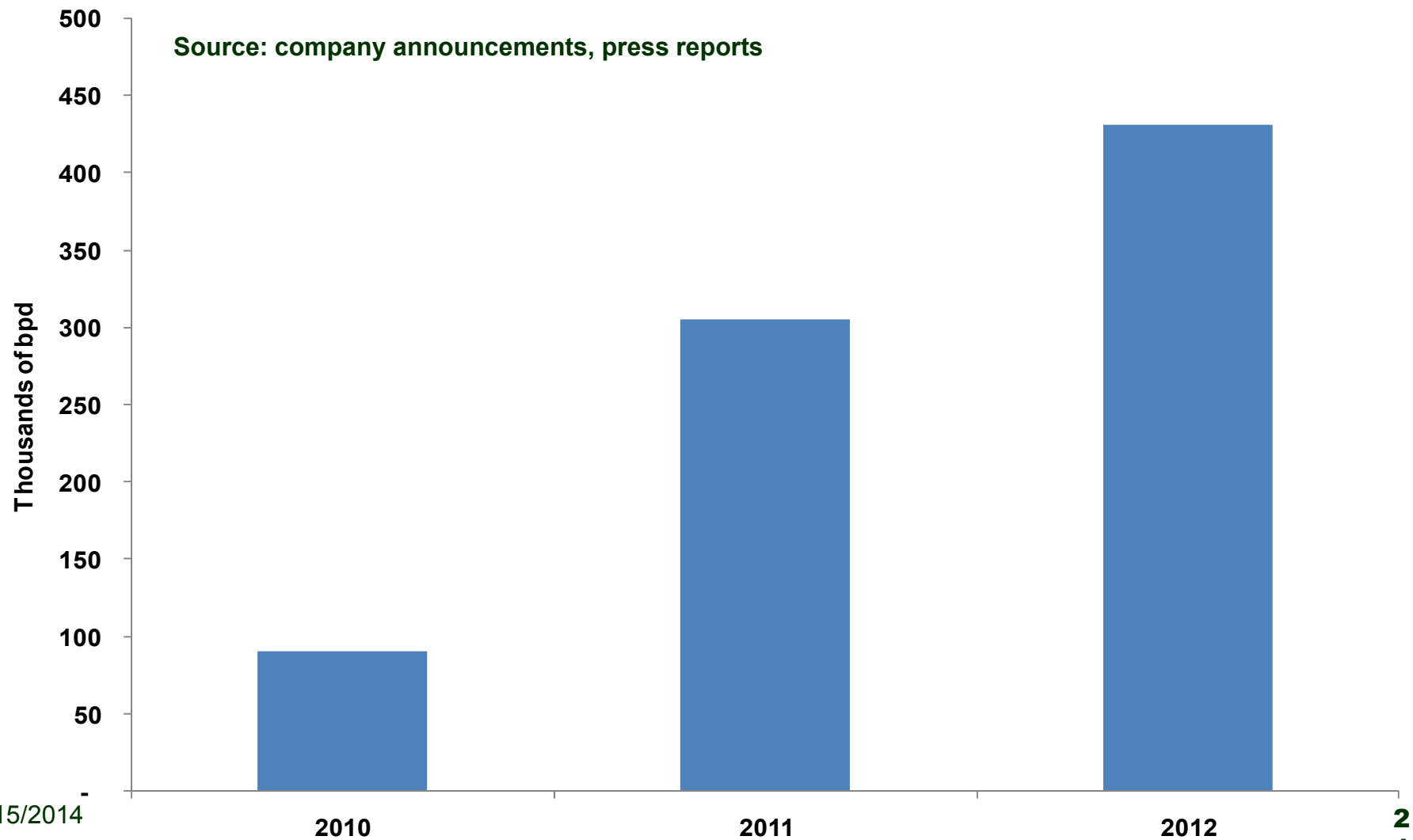
9/15/2014

PADD 1 High Sulfur Diesel: Supply is Balanced with Demand



9/15/2014

PADD 3 Expected New ULSD Capacity 2010 - 2013



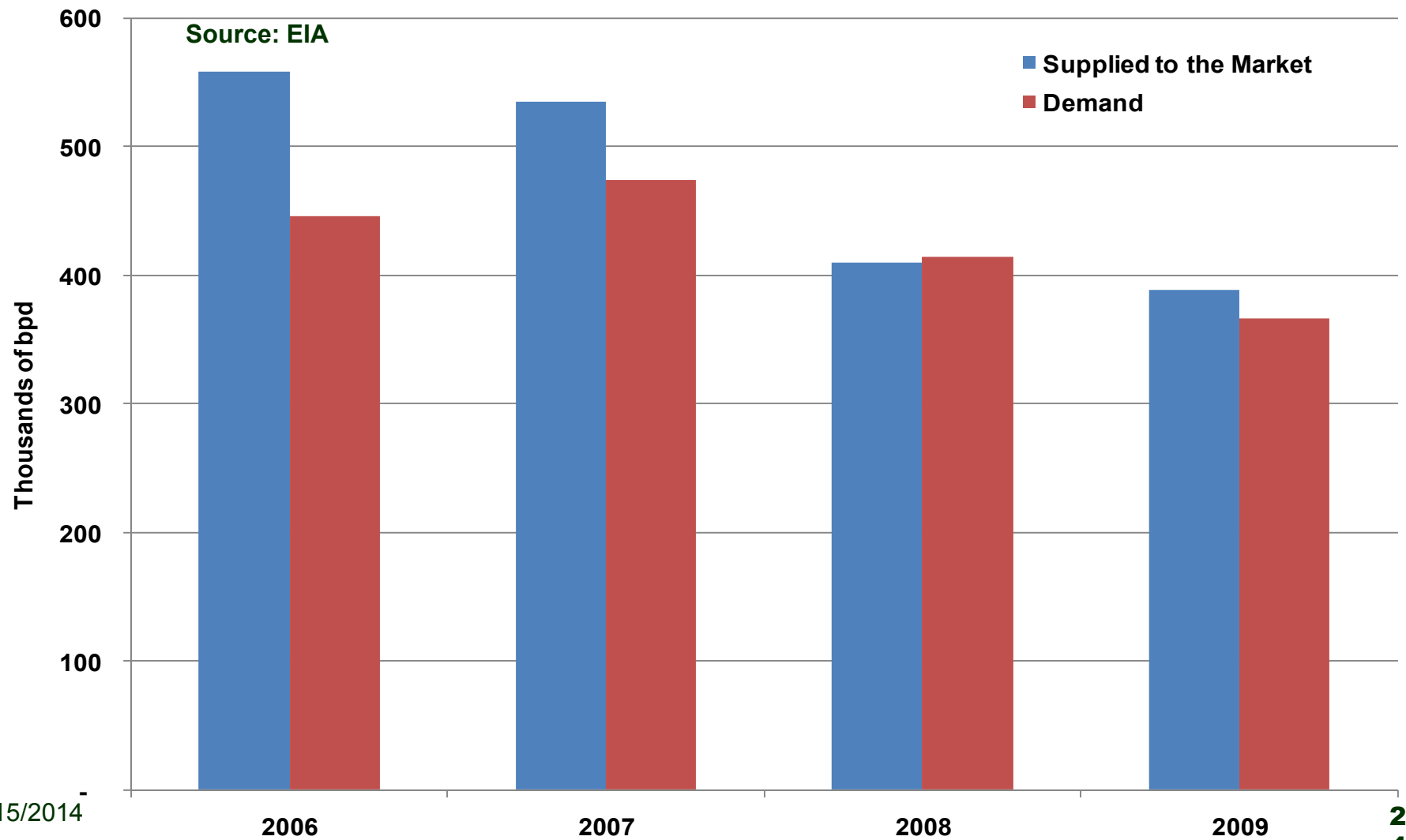
Refinery Heating Oil Production

- Refiners produce products as the market requires.
- As heating oil demand declines, the marginal or high cost supplies decline first.
- A shift to ULSD for heating oil will cause the marginal suppliers of heating oil to either shift production, export or shut down first.
- Production shifts and refinery closures have already occurred - driven by a variety of market forces. Heating oil exports are also declining due to smaller markets resulting from more stringent sulfur regulations internationally.
- Refineries in US close regularly due to competitive and market forces. A switch to ULSD in the heating oil markets may affect that decision, but is likely to be one of many factors that would result in a decision to close a refinery.

Heating Oil Production and Demand

- Heating oil volumes supplied closely matches the demand from the residential/commercial sectors.
- Refiners in PADD 1 will need to invest in 150 – 200 thousand bpd of additional desulphurization capacity to meet lower heating oil sulfur requirements. This is slightly less than the capacity that has already been required to meet the ULSD specifications.
 - *In PADD 1, heating oil is 38 percent of distillate production and 14 percent of total refinery output.*
- PADD 3 refiners will also need to invest in distillate upgrading if the heating oil specification is changed to ULSD. However, heating oil is only 11 percent of the total distillate production in the region and just over three percent of total refinery output.
 - *Nearly all of the heating oil produced in PADD 3 is sent to PADD 1.*

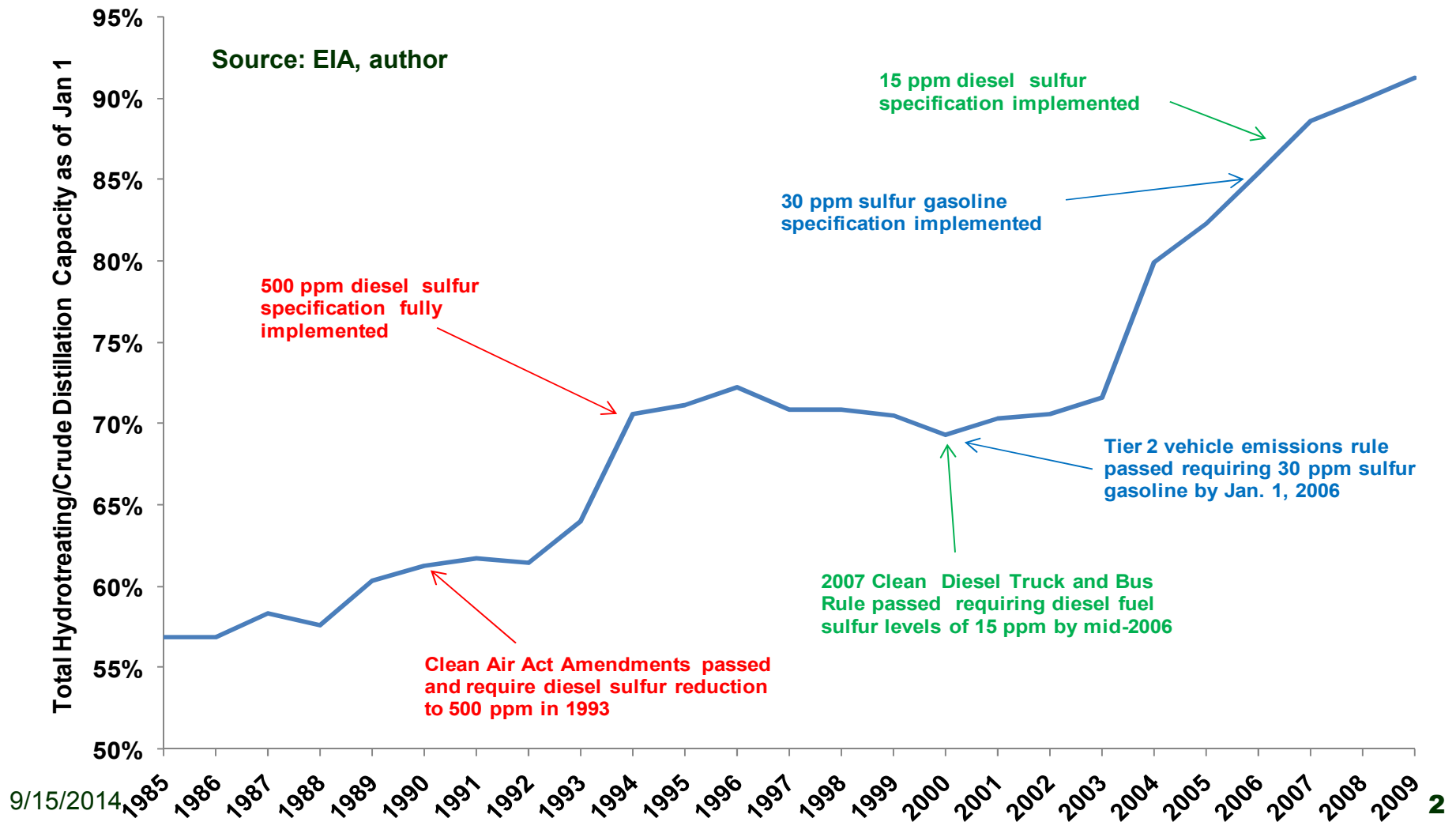
PADD 1 Heating Oil: Supply is Balanced with Demand



Refining

- Refiners will need market and/or regulatory signals before making investments to upgrade heating oil to ULSD.
- Past changes in refined products specifications were largely driven by environmental requirements. In all cases, the refining industry has met the regulations.

US Refining Hydrotreating Capacity is Driven by Regulatory Changes



9/15/2014

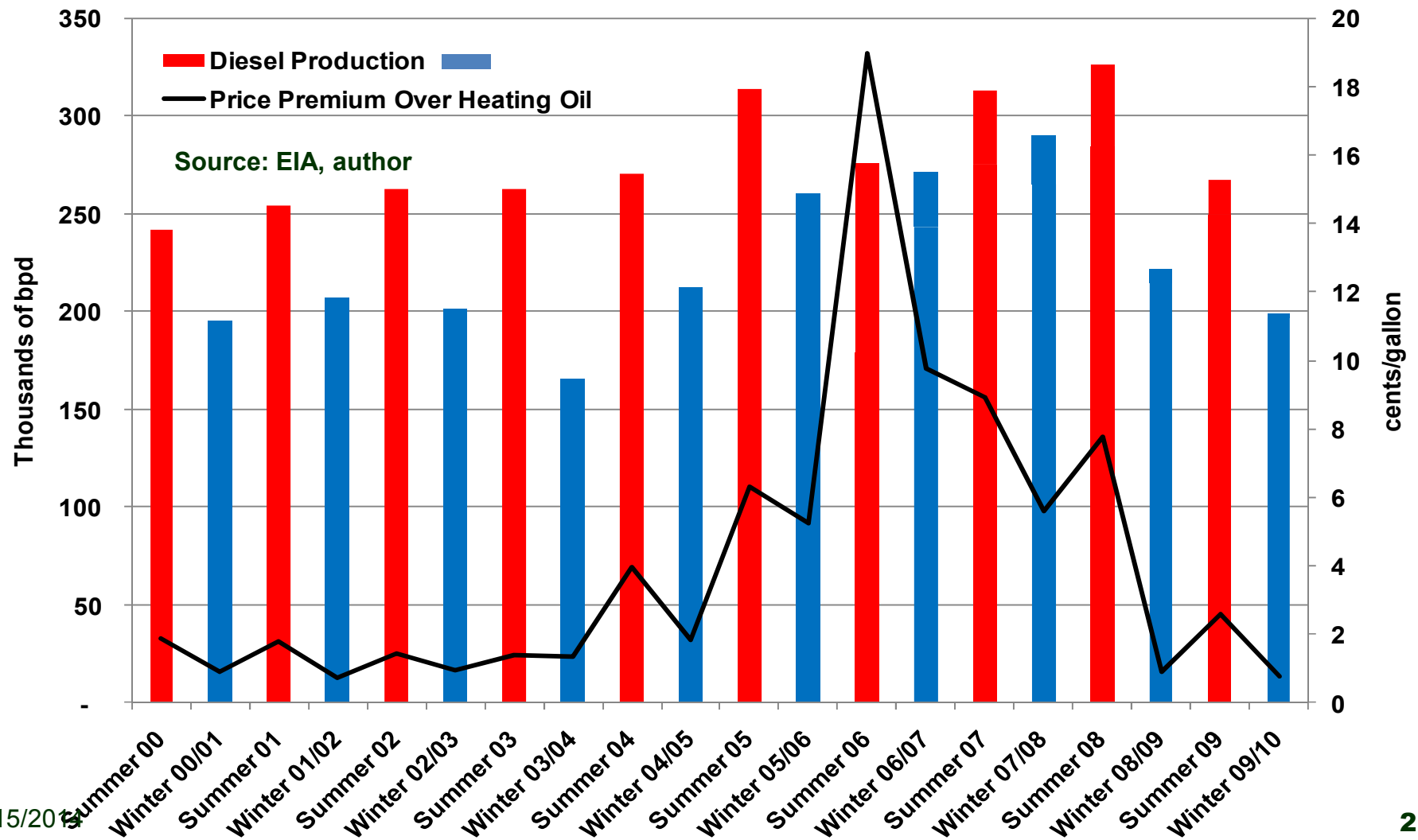
PADD 1 Distillate Production Seasonality

- There is little additional ULSD production capability within existing PADD 1 refineries.
 - *Prior to the winter of 2005/2006 there was a seasonal trade-off between diesel fuel and heating oil production.*
 - Average seasonal change was about 50,000 bpd.
 - *The seasonality in production virtually disappeared from summer 2005 through winter 2006/2007*
 - *From mid-2005 to mid-2008, the ULSD price premium far exceeded the cost of adding new capacity due to a convergence of several factors that are unlikely to re-converge.*
 - *Grade shifts in the US and several other countries at relatively the same time.*
 - *Hurricanes reduced the capacity to produce in the USGC.*
 - *Very strong global economic growth drove strong global diesel fuel demand resulting in world refiners running at or near maximum capacity.*

PADD 1 Distillate Production Seasonality (cont'd)

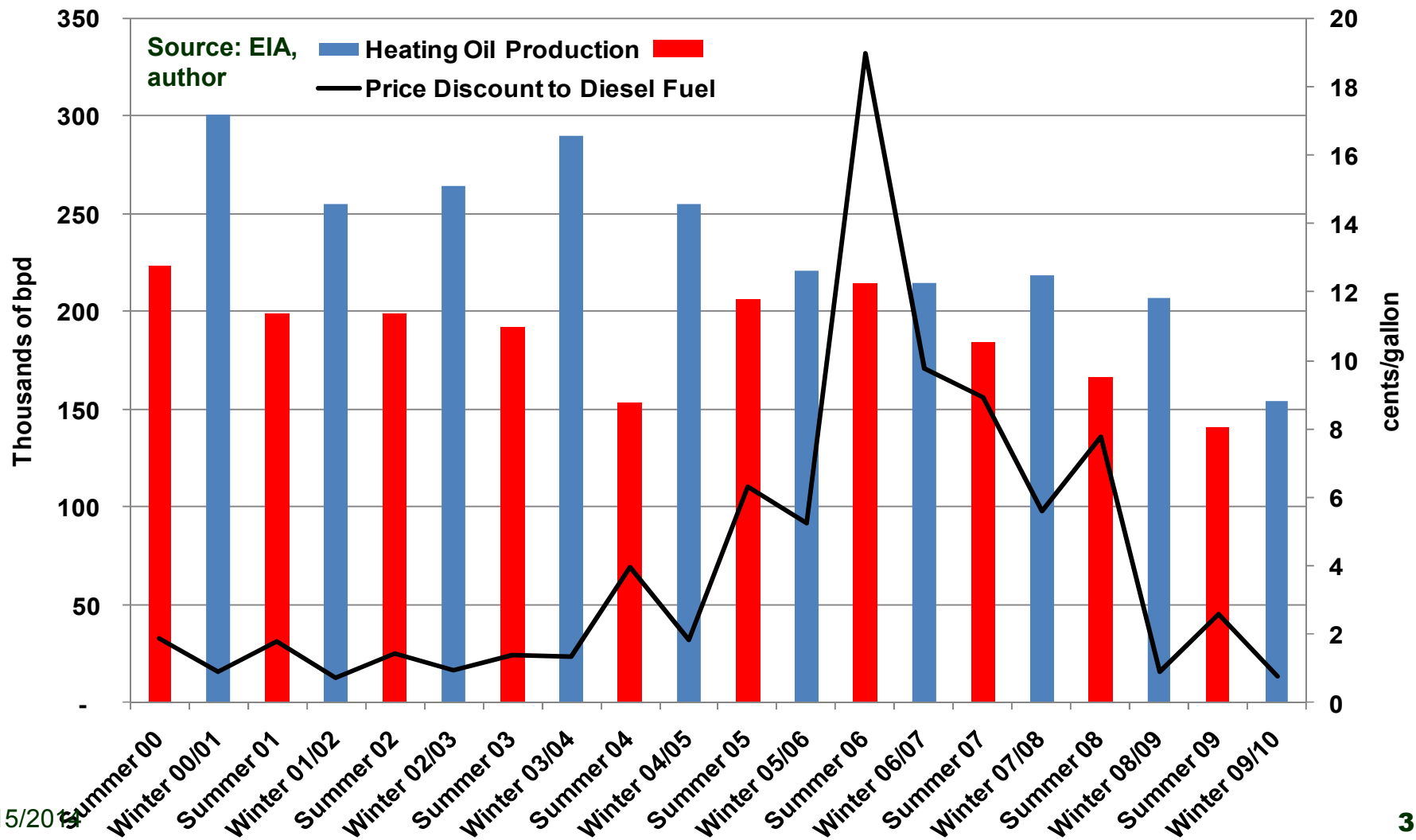
- Seasonality reappeared in the summer of 2007 when the refining industry had added sufficient capacity to produce ULSD. This continued through the summer of 2009.
 - *Seasonal variation returned to about 50,000 bpd.*
- In 2009, two refineries in PADD 1 closed. These plants' distillate production was mostly heating oil. Their closure has again removed seasonal production from PADD 1.

PADD 1 Seasonal Diesel Fuel Production and Premium to Heating Oil



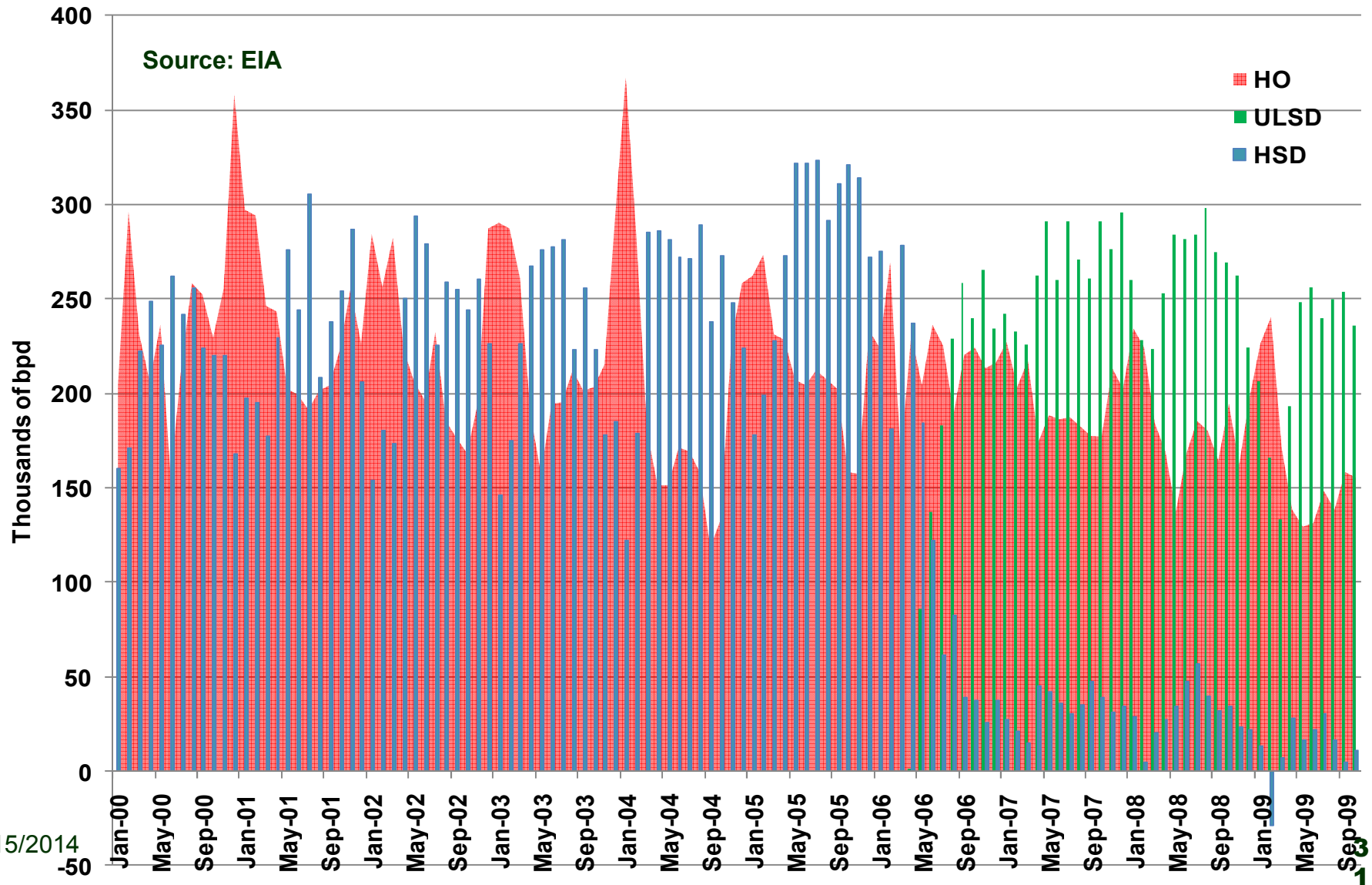
9/15/2015

PADD 1 Seasonal Heating Oil Production and Price Discount to Diesel Fuel



9/15/2010

PADD 1 Middle Distillate Refinery Production



PADD 1 DISTILLATE IMPORTS

9/15/2014

© 2010  Kevin J. Lindemer LLC

Confidential: Not for distribution without written consent from Kevin J. Lindemer LLC

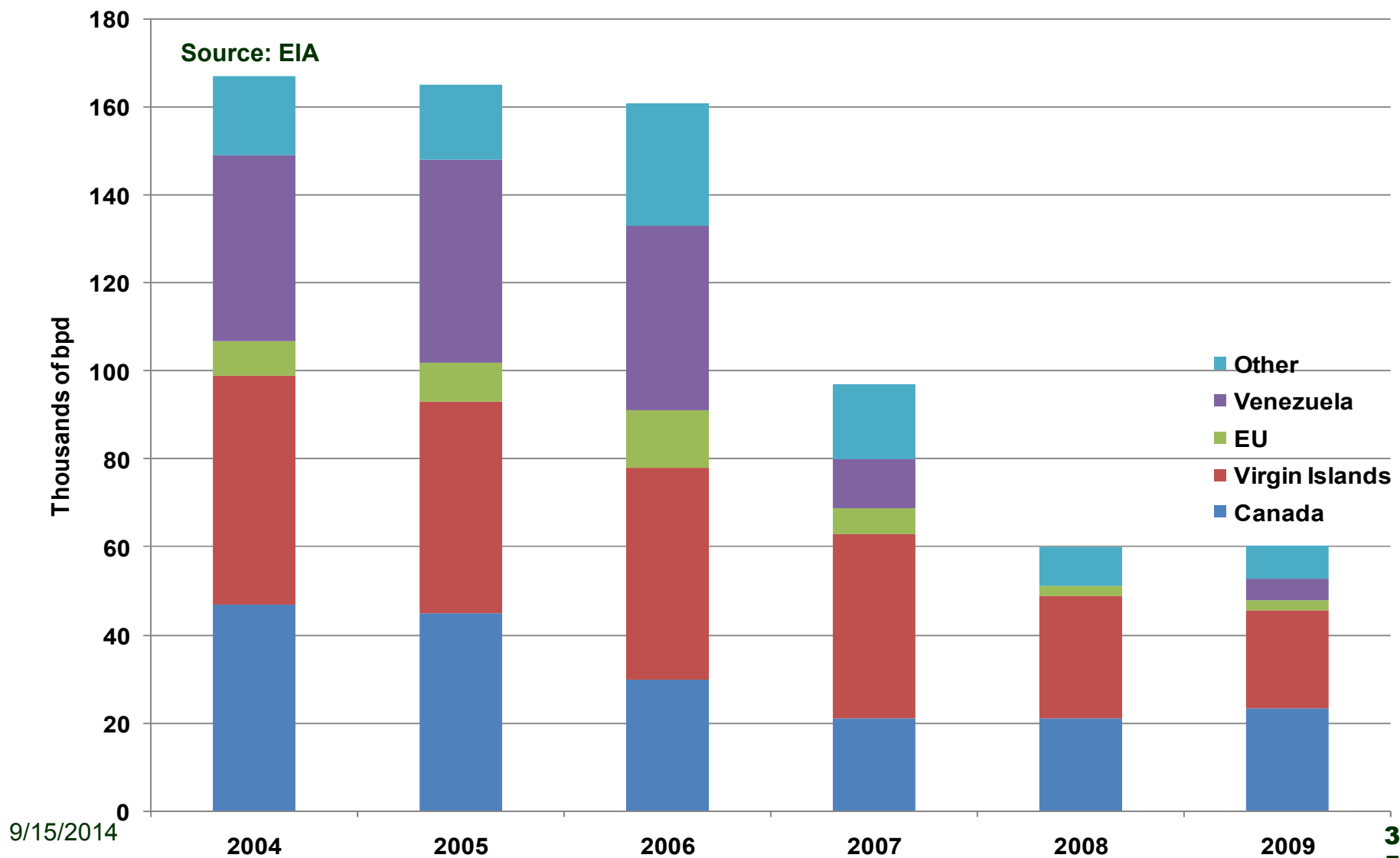
PADD 1 Distillate Imports

- Heating oil imports in the PADD 1 market have declined sharply from declining demand and rising domestic supply.
 - *PADD 1 imports are now sourced largely from eastern Canada and the US Virgin Islands.*
 - *Imports take up the seasonal variation in demand.*
- The market was balanced from a sharp drop in heating oil demand from 2000 to 2009 – in part, by a decrease in imports.

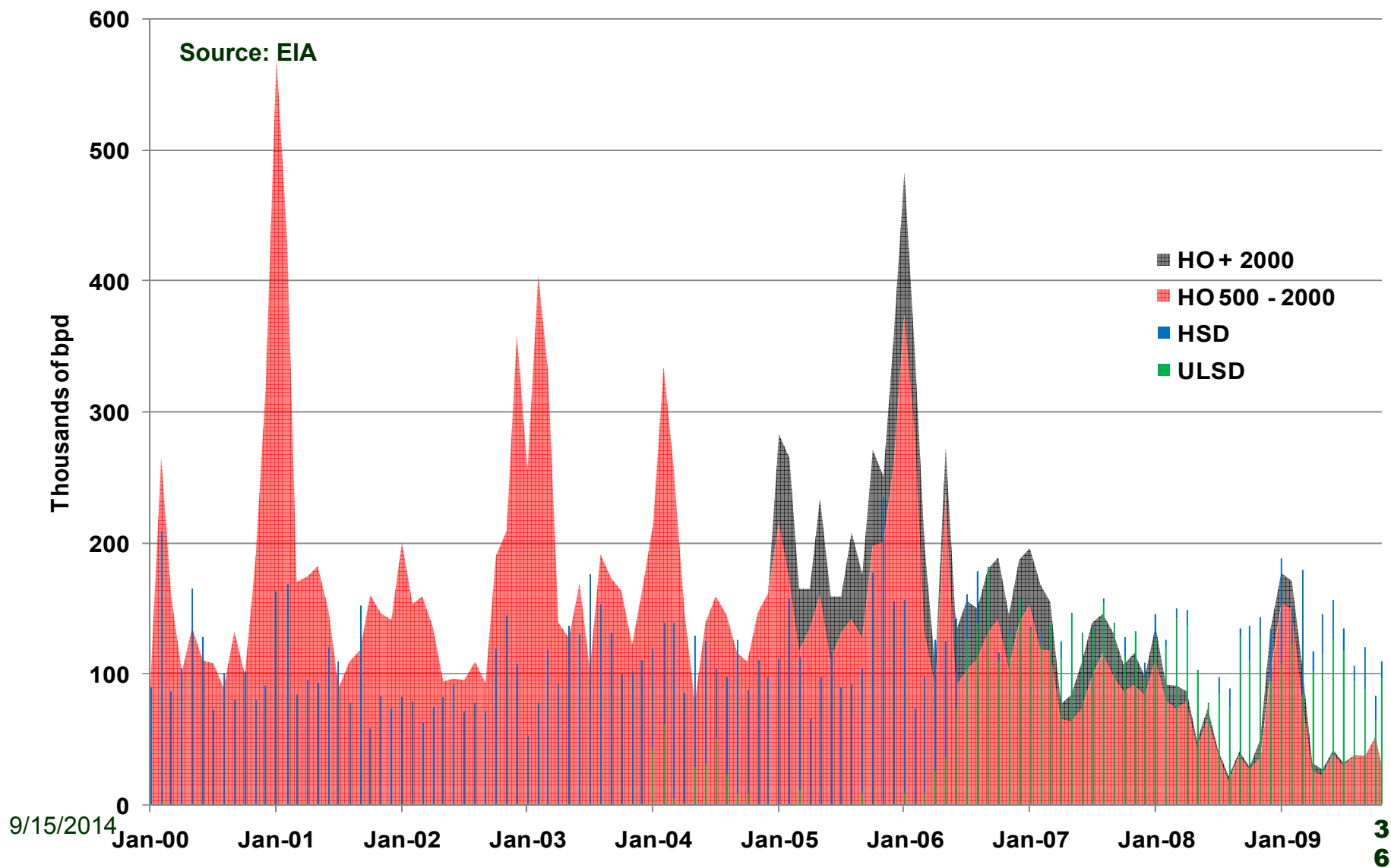
PADD 1 Distillate Imports

- **ULSD imports have declined slightly from 2007.**
 - *ULSD imports are almost exclusively from Canada and USVI.*
- **PADD 3 is the largest source of distillate supply for PADD 1.**
 - *Nearly double PADD 1 refinery production.*
 - *Supplies have fallen in the last two years due to the loss of heating oil demand and economic recession.*

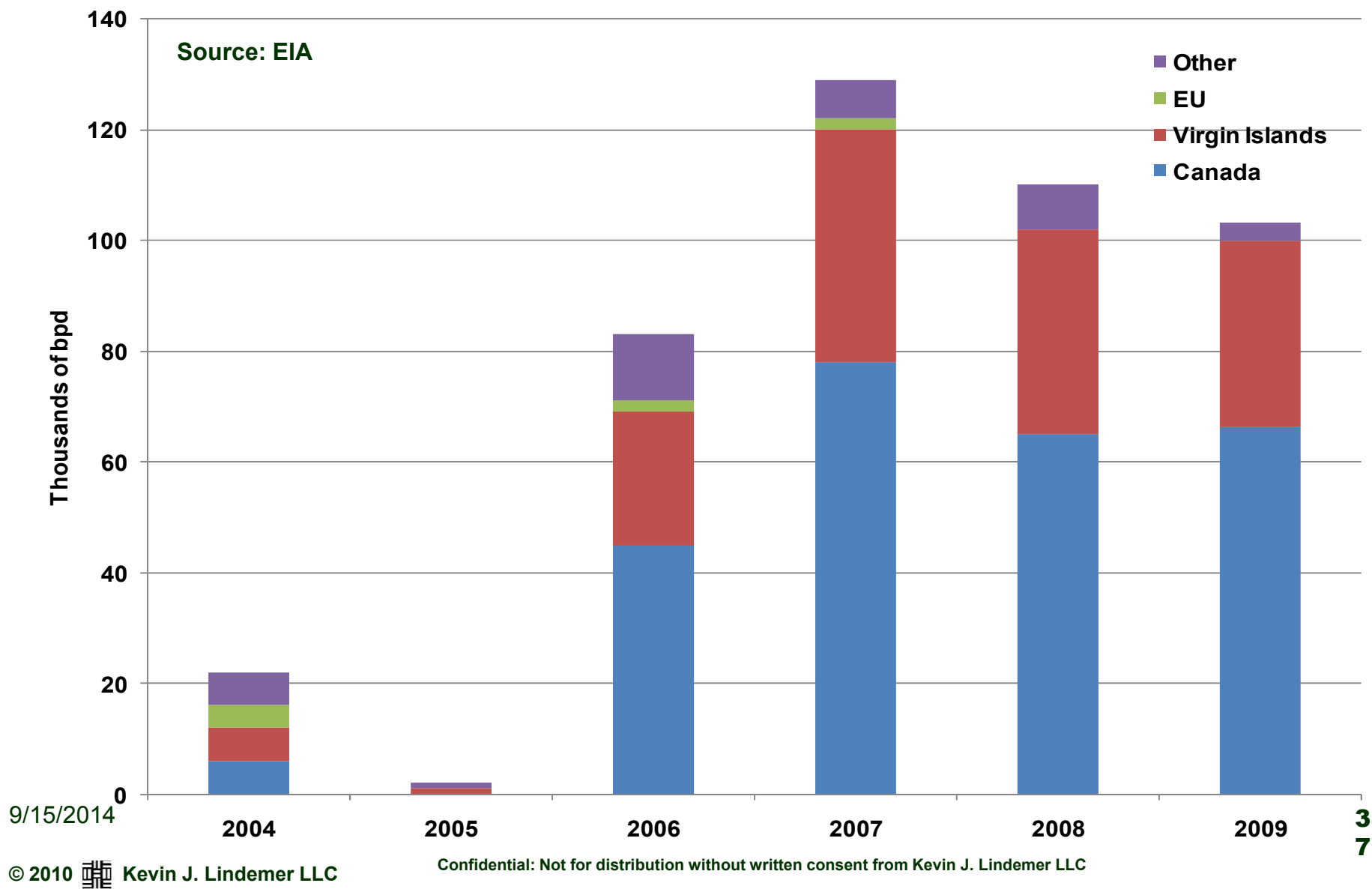
PADD 1 Heating Oil Imports (>500 ppm sulfur)



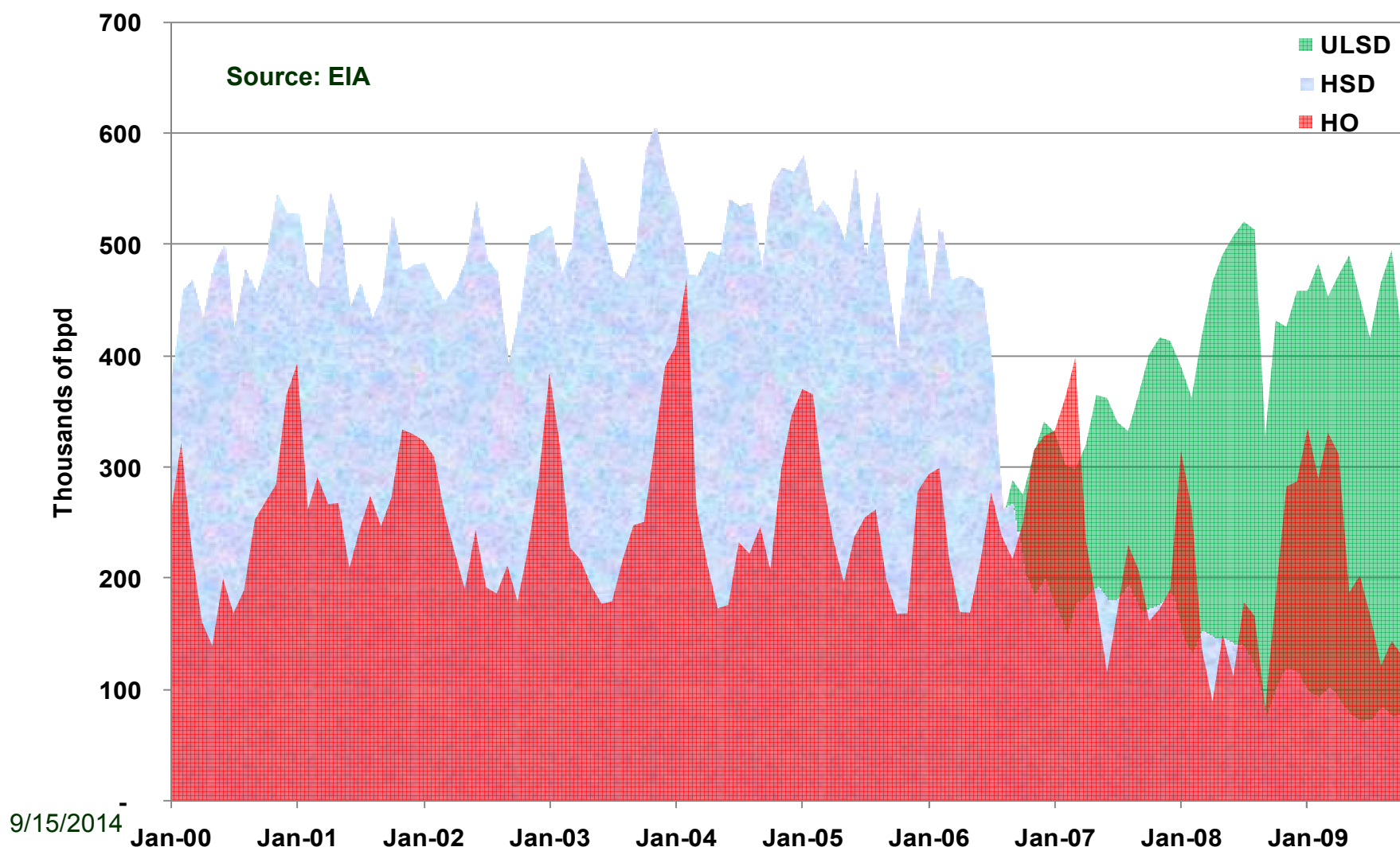
PADD 1 Middle Distillate Imports



PADD 1 ULSD Imports



PADD 3 to PADD 1 Shipments of Middle Distillates



DISTILLATE EXPORTS

9/15/2014

© 2010  Kevin J. Lindemer LLC

Confidential: Not for distribution without written consent from Kevin J. Lindemer LLC

Distillate Exports

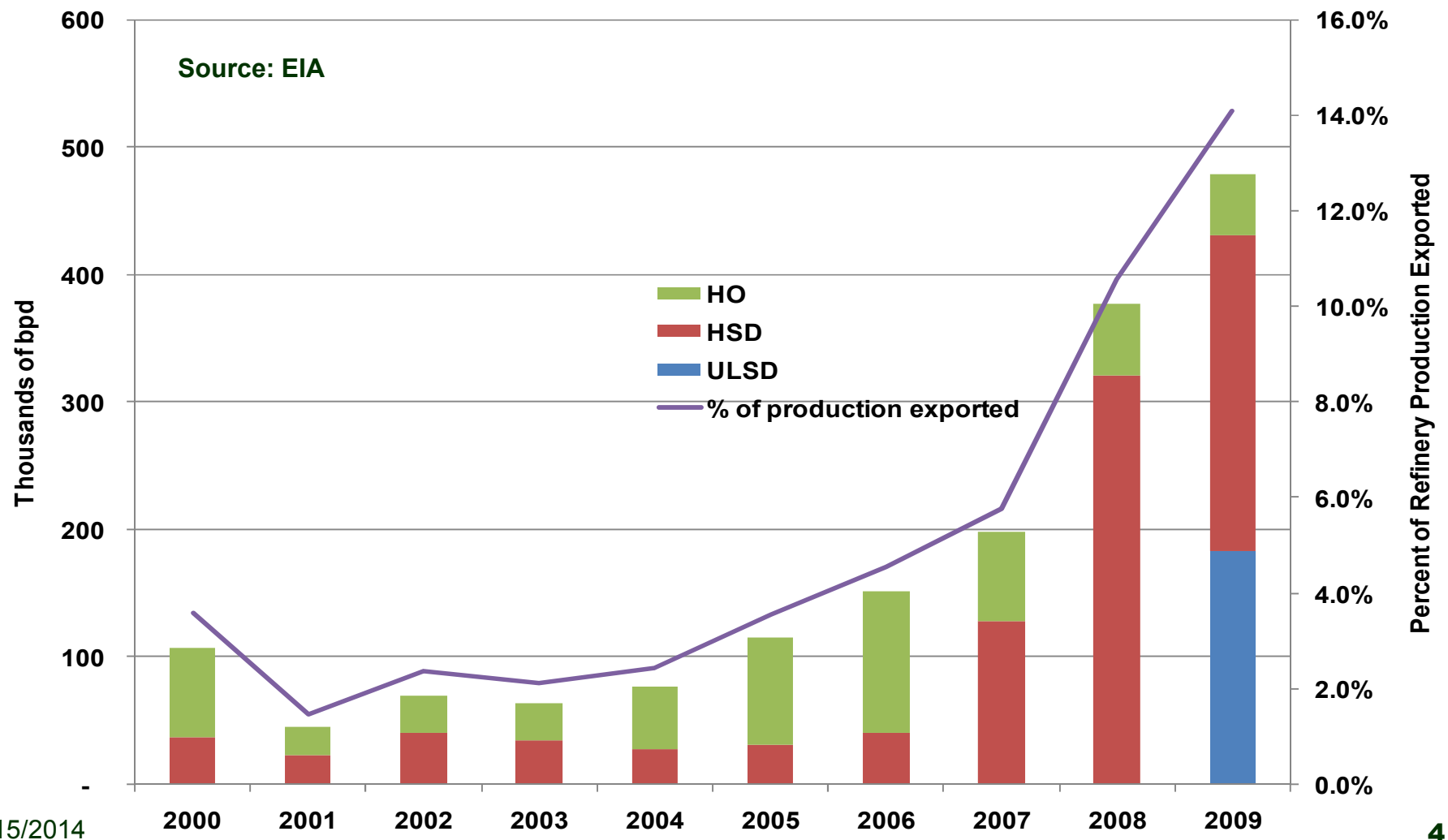
- The combination of rising production of ULSD and the decline in diesel fuel demand resulting from the recession has caused both high and low sulfur diesel fuel exports to rise substantially.
 - *ULSD exports have been mostly to Colombia and the EU - both are adding ULSD capacity over the next two to three years.*
- High sulfur diesel exports decline sharply due to additions in domestic ultra-low capacity in the Gulf Coast.
- Distillate exports are expected to gradually decline over the next several years due to rising domestic demand for diesel fuel.

9/15/2014

Distillate Exports

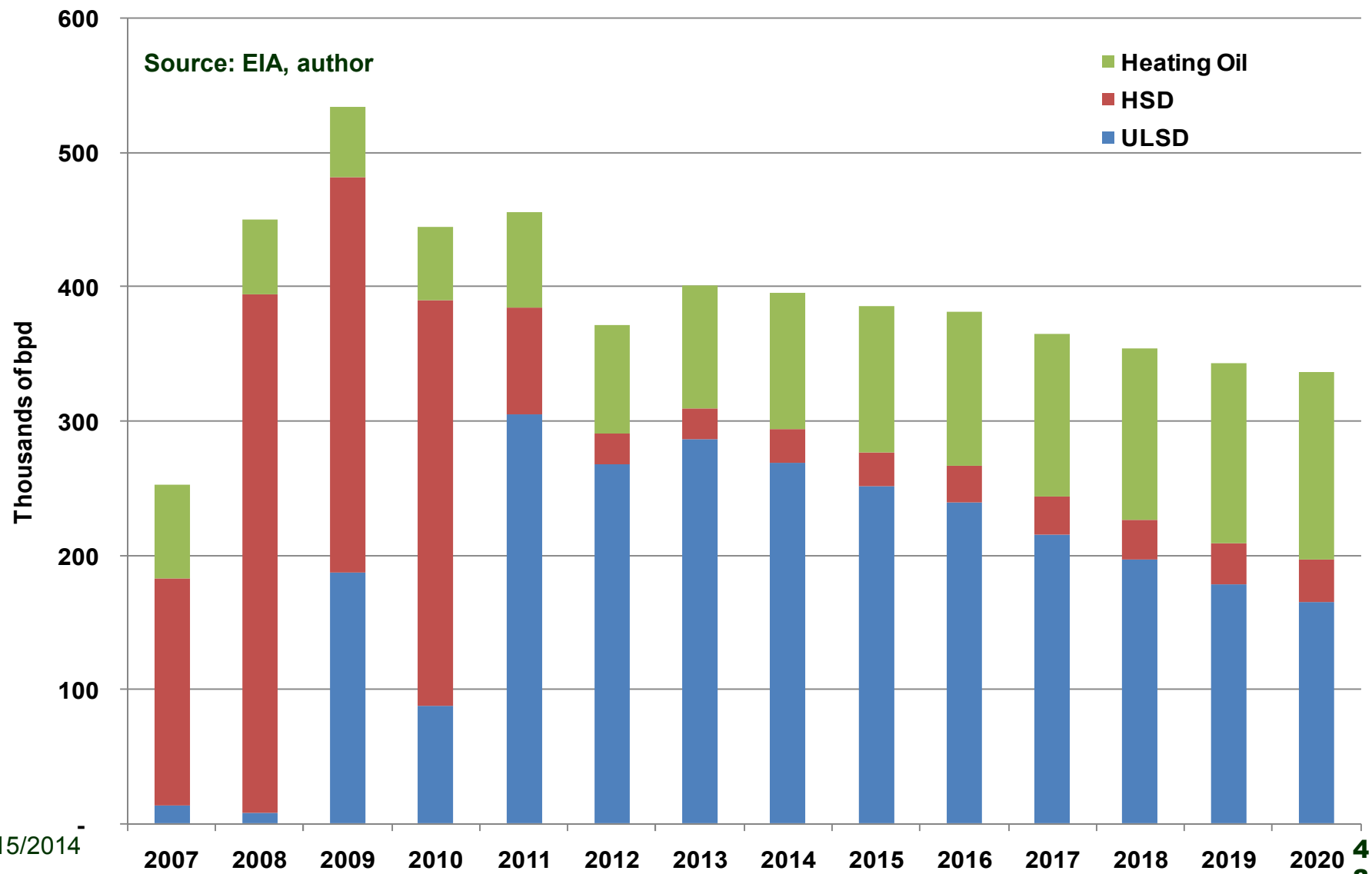
- **Heating oil exports are expected to rise over the next few years due to falling domestic demand.**
 - *Heating oil values to refiners could fall as exports rise due to:*
 - International markets are moving to lower sulfur specifications for distillate.
 - Markets for US exports of current quality heating oil are small and getting smaller.
 - These markets will have higher transportation costs than the current export markets, resulting in lower netback prices for US refiners.
 - *Some of the larger potential export markets for higher sulfur distillates are also supplied by local refiners that can easily make sufficient volumes of high sulfur distillates for the local markets.*

PADDs 1, 2, and 3: Distillate Exports on the Rise



9/15/2014

Projected Distillate Exports: PADDs 1, 2, and 3



DISTILLATE MARKET BALANCE

9/15/2014

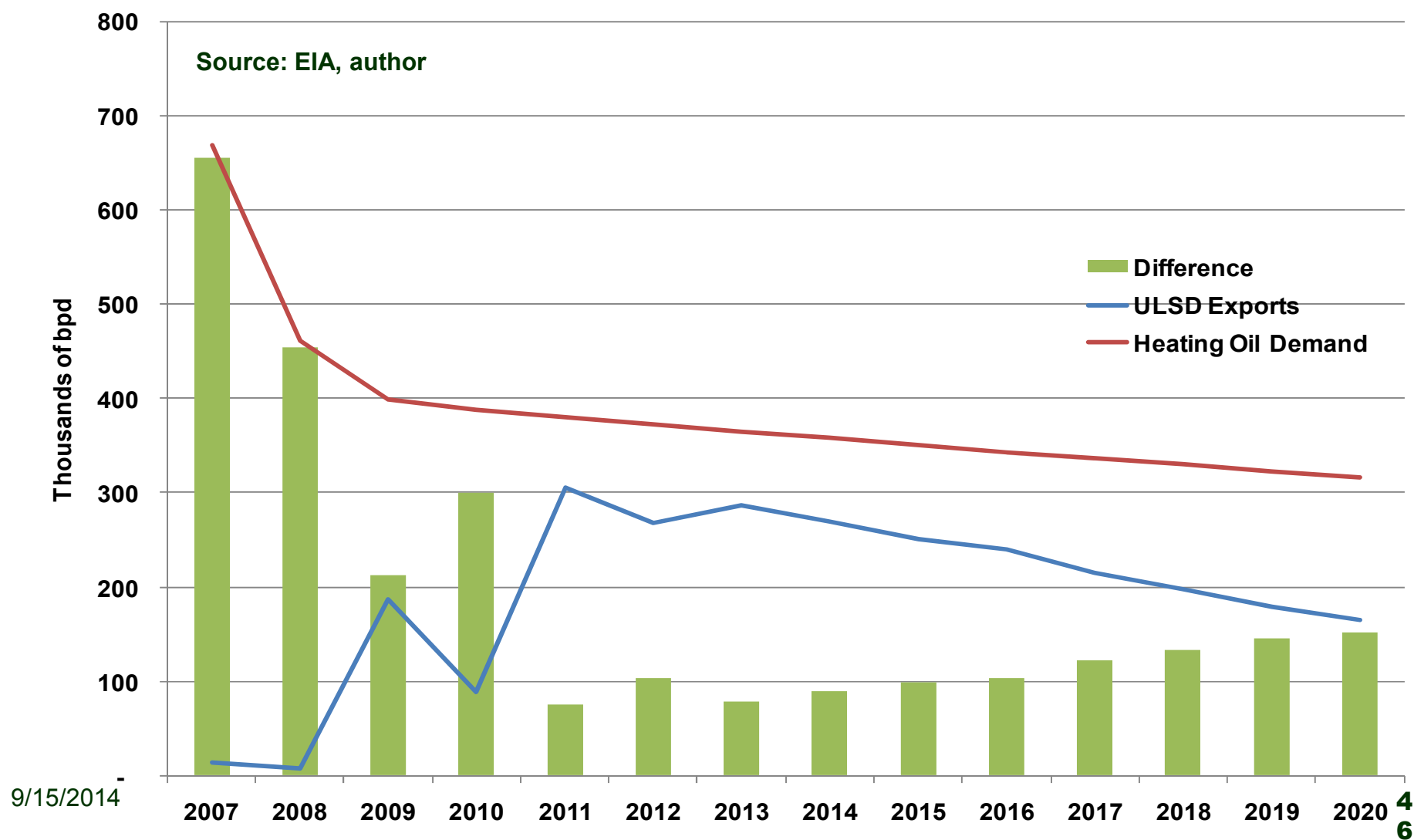
© 2010  Kevin J. Lindemer LLC

Confidential: Not for distribution without written consent from Kevin J. Lindemer LLC

ULSD Heating Oil Balance

- **ULSD exports are lower than the total demand for heating oil in the residential/commercial sectors.**
- **If all exported ULSD is shifted to the US heating oil market, it would be equivalent to about one third of the current heating oil market.**
- **Such a shift would result in much lower refinery margins for heating oil in the East Coast.**
 - *Refiners in PADD 1 are not prepared for the shift.*
 - *Exports and/or additional refinery closures would likely occur.*

Heating Oil Demand minus ULSD 'Surplus' -- PADDs 1, 2, and 3



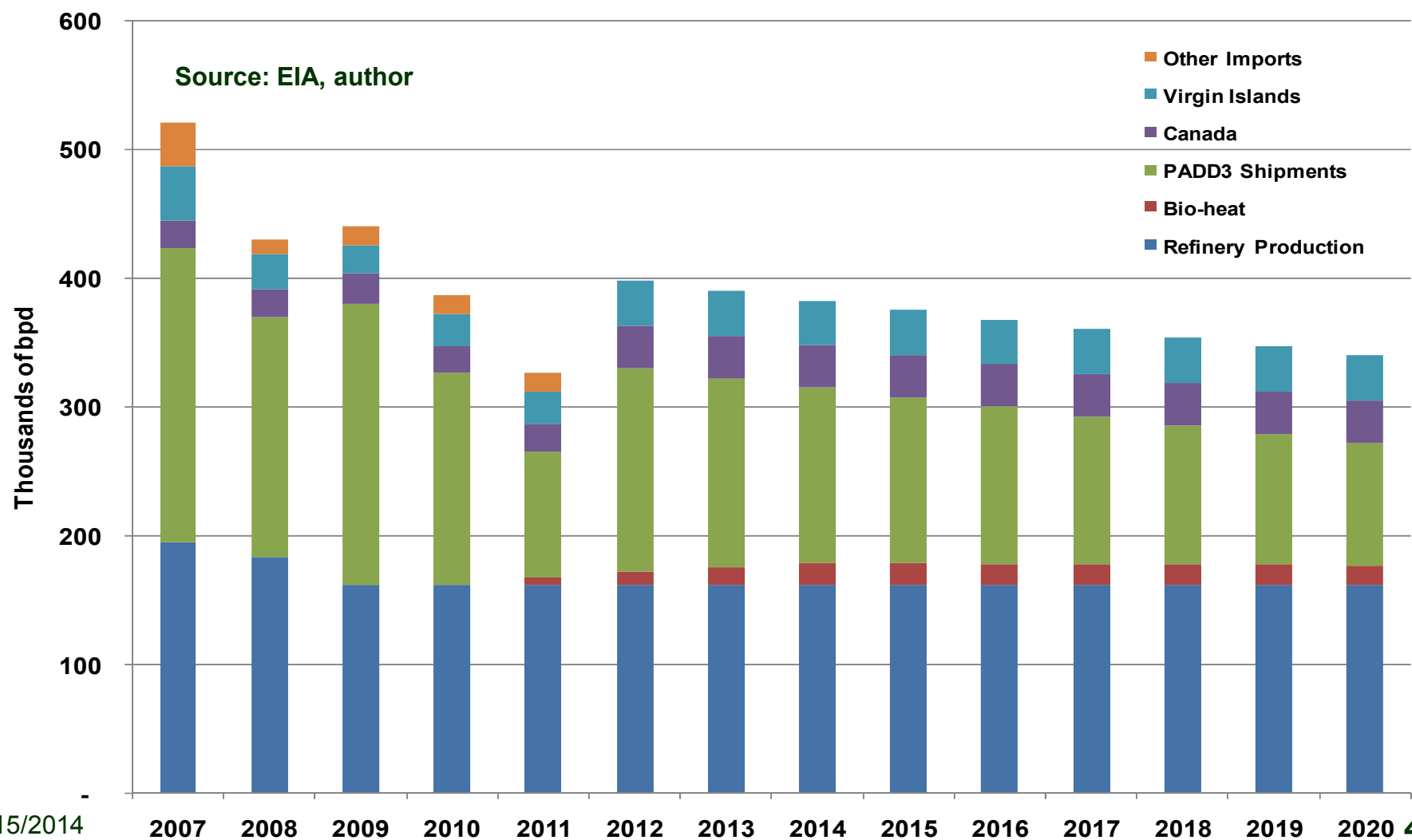
PADD 1 Heating Oil Supply Assuming No Specification Changes

- PADD 1 refineries can maintain heating oil and diesel production at current levels.
- High sulfur diesel imports from Canada and USVI are shifted to heating oil.
 - *Displaces all other imports – Canada and USVI remain the only 'off-shore' sources.*
 - *Represents a 'down-grade' in the value of HSD.*
- Shipments from PADD 3 decline with demand.
 - *These are assumed to be the incremental supply.*
- PADD 1 refiners will become the major source of heating oil spec supply to the market.
- Bio-heat is expected to be 5% by volume by 2014.

9/15/2014

PADD 1 Heating Oil Sources of Supply

(assuming no further specification changes)



9/15/2014

Future ULSD Supply Drivers

- **By 2012, all off-road diesel fuel markets are required to use ULSD.**
 - *Domestic refiners are investing to meet these regulations. Expected increases in ULSD production capability closely matches the demand for off-road diesel fuel.*
- **ULSD demand is expected to rise, however, refinery level gasoline demand is expected to be weak for the next several years.**
 - *Rising ethanol volumes from government mandates.*
 - *Rising vehicle efficiency from CAFÉ standards.*
- **The changing gasoline/diesel demand mix will result in refiners being under sustained pressure to reduce gasoline production and increase distillate production in order to maintain refinery throughput.**

Future ULSD Supply Drivers (cont'd)

- **Changes in refinery operations from gasoline to distillate production will require additional hydrocracking capacity.**
 - *Hydrocracking will produce low sulfur distillates.*
- ***Without refinery closures, future supplies of ULSD are likely to continue to increase as refiners invest to shift production from gasoline to ULSD.***

ULTRA LOW SULFUR DIESEL AND HEATING OIL VALUES

9/15/2014

© 2010  Kevin J. Lindemer LLC

Confidential: Not for distribution without written consent from Kevin J. Lindemer LLC

Diesel Fuel Premium to Heating Oil Prices

- PADD 1 ULSD prices are expected to average 1 to 3 cents per gallon above heating oil prices through 2020 at the wholesale market level based on a volume weighted average winter price basis.
 - *Volatility around this level should be expected and could be driven by short-term market dislocations and events including the transition from one specification of product to another.*
- Prior to ULSD, EPA low sulfur (LSD) (500 ppm) diesel fuel for highway use was in effect from 1994 to 2006.
 - *Through 2003, the price differential between LSD and heating oil averaged between 0.5 and 1.0 cpg in the wholesale market and 1.0 and 2.0 cpg in the spot market (volume weighted winter demand).*
 - *In 2005 , the LSD premium over heating oil rose to over 5 cpg in the spot market and to 3.5 cpg in the wholesale market in the US due to very strong US and global demand.*

Diesel Fuel Premium to Heating Oil Prices (cont'd)

- The very high premium of ULSD over heating oil from 2006 to mid-2008 was an anomaly in the market created by the convergence of non-recurring factors.
 - A shift to very low sulfur diesel fuel in several major global markets in a relatively short period of time.
 - Strong global diesel fuel demand generated by strong economic growth.
 - High global refinery utilization rates.
 - Shortage of light low sulfur crude oils.
 - Long capacity outages in the USGC from hurricane damage.
- *Since the end of 2008, the USLD heating oil price differentials at the wholesale level in PADD 1 have moved back to the historic range of the LSD heating oil price differential as the factors contributing to very wide differentials have dissipated. A slightly higher level of price difference between ULSD and heating oil is expected to be typical for the next several years.*

Diesel Fuel Premium to Heating Oil Prices (cont'd)

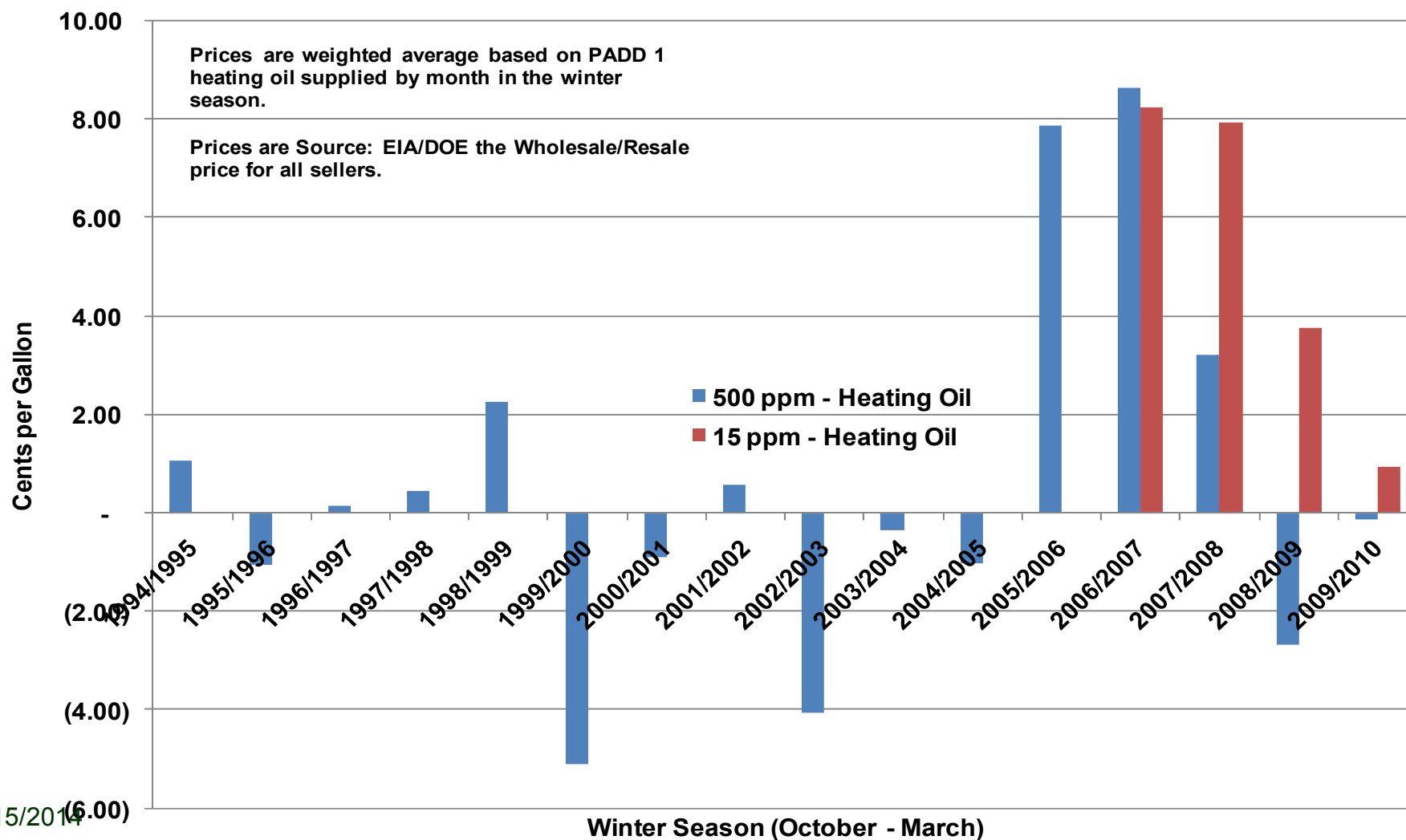
- Refinery costs to upgrade existing heating oil to ULSD could be higher than cost associated with the ULSD specification change.
 - *Heating oil contains higher amounts of sulfur and aromatic compounds than the distillate streams being upgraded to ULSD.*
- The cost of upgrading heating oil to ULSD is unlikely to be fully reflected in the price of ULSD relative to crude oil.
 - *Refiners can export heating oil rather than upgrade it to ULSD.*
 - *Some heating oil components that are high cost to upgrade could be diverted to other uses within refinery operations.*
 - This would leave components that are lower cost to upgrade for ULSD.
- **Some reduction in supply and distribution costs are likely due to a reduction in the number of grades of fuel.**

Diesel Fuel Premium to Heating Oil Prices (cont'd)

- The net effects on high sulfur distillate (heating oil quality distillate) and ULSD prices relative to crude oil are likely to be:
 - *Directionally higher ULSD prices as exports are diverted to the domestic market and directionally lower prices for heating oil as heating oil or components are diverted to exports or other lower value uses within the refinery.*
- The price of heating oil once a shift to ULSD occurs will set by the much larger global and US transportation diesel fuel market.
- The anticipated cost increase from a shift to ULSD will be relatively small in terms of the absolute price of heating oil and diesel fuel compared to the magnitude of volatility in crude oil prices.
 - *Since the introduction of ULSD, the cost of crude oil has averaged 75% of the retail price of ULSD.*
 - *The average annual change in crude oil prices over the past 15 years has been 25 cpg/year, nearly all of which has been passed through to the consumer.*

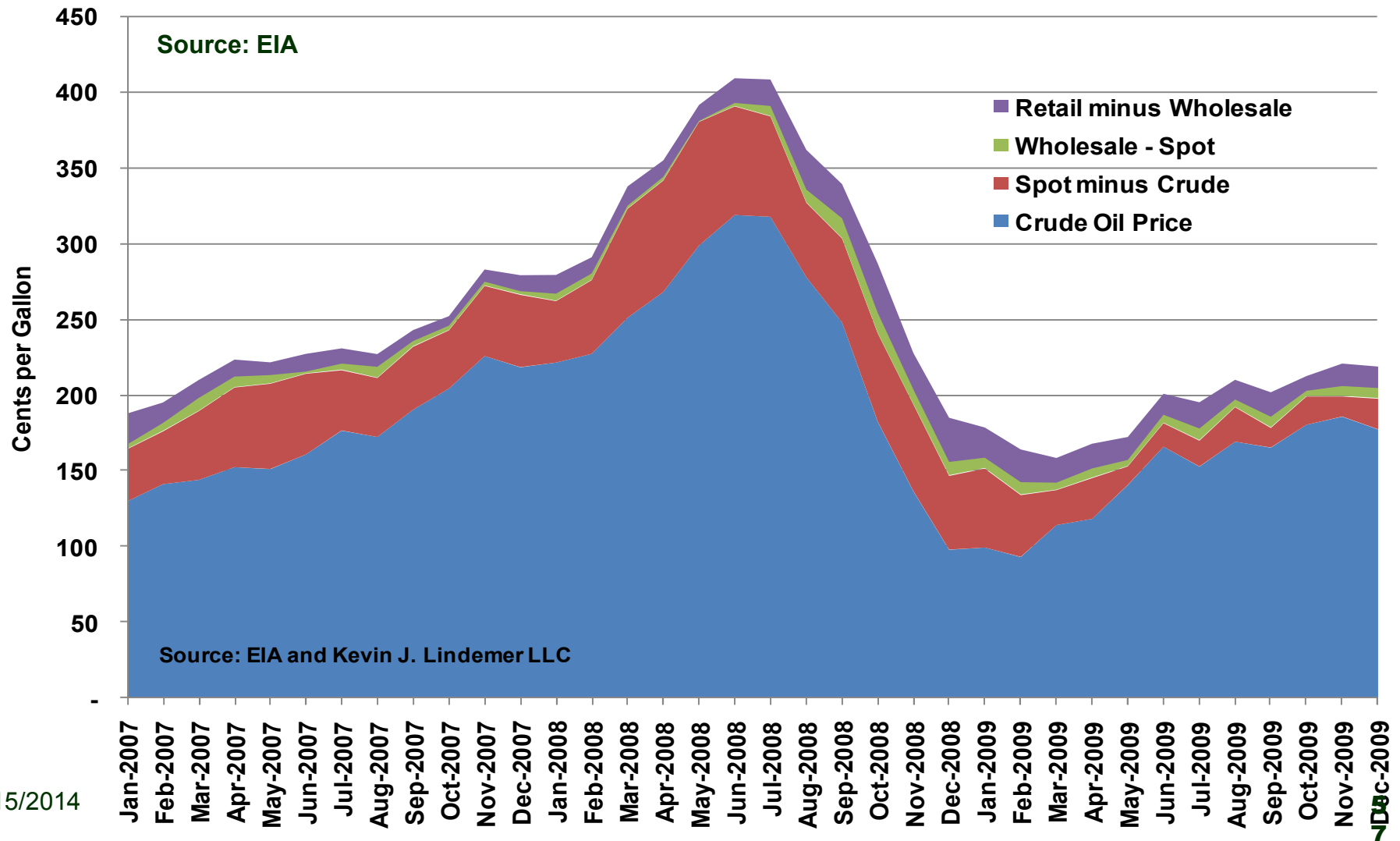
9/15/2014

PADD 1 Wholesale Diesel Fuel minus Heating Oil Price Winter Months (Oct - Mar)



9/15/2014

PADD 1 ULSD Estimated Price Components (excluding taxes)



9/15/2014

IMPACT ON CONSUMERS

9/15/2014

© 2010  Kevin J. Lindemer LLC

Confidential: Not for distribution without written consent from Kevin J. Lindemer LLC

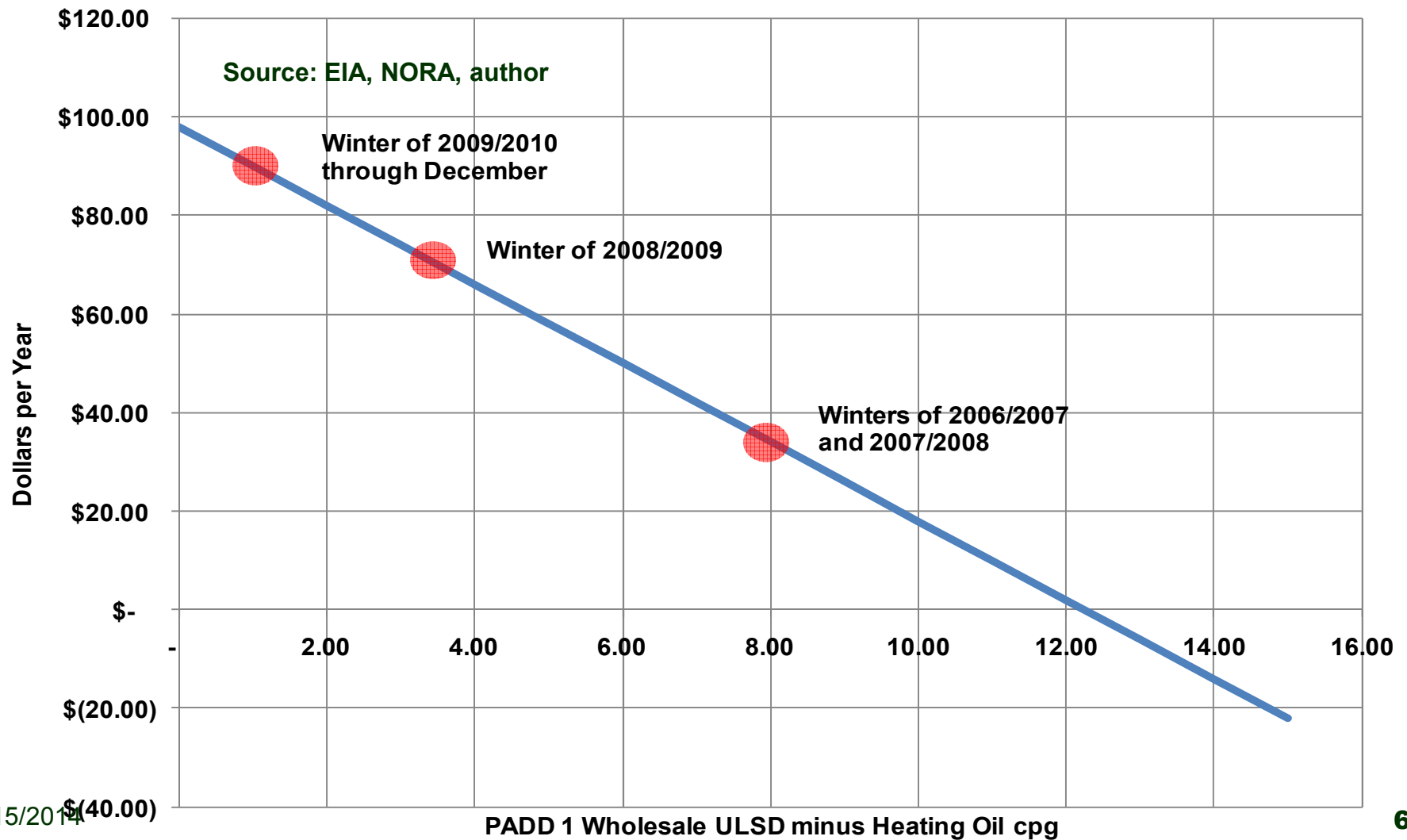
Impact on the Consumer

- The impact on the price of ULSD by requiring ULSD in heating oil markets is likely to be minimal for consumers of ULSD.
 - *Higher costs for additional ULSD for the heating oil market will originate in the refining industry. The highly competitive nature of the markets efficiently transfer changes in the spot prices to wholesale and retail markets.*
 - *Based on EIA price data, the volume weighted average PADD 1 wholesale ULSD prices minus heating oil in the winter seasons since the introduction of ULSD has averaged 5.2 cpg, but has steadily declined from a high of 8.25 cpg in the winter of 2006/2007 to only 1.0 cpg in the past winter season.*
- A shift to ULSD for heating oil will result in cost savings for the consumer from lower heating system maintenance costs and a small efficiency improvement.
 - *NORA estimates the heating plant service cost savings for a typical homeowner would be on the order of \$50 per year and fuel efficiency improves about 2 percent.*


Impact on the Consumer

- Assuming a home with 800 gallons per year demand and an average ULSD price of \$3.00/gallon delivered, the annual savings over heating oil would be on the order of 12.25 cpg:
 - *\$50 in maintenance or 6.25 cpg.*
 - *\$48 from lower fuel use due to a 2% efficiency improvement or 6.0 cpg.*
- If wholesale ULSD prices average 3 cpg higher than heating oil, the home in this example would pay an additional \$24/year for fuel.
- ULSD prices could average as much as 12.25 cpg higher than heating oil, and the consumer would be economically indifferent to the fuel quality.
 - *ULSD prices at the wholesale level in PADD 1 averaged 8 cpg during the winters of 2006/2007 and 2007/2008, 3.75 cpg in the winter of 2008/2009 and about 1.0 cpg in the winter of 2009/2010*

Annual Savings per Household Compared to PADD 1 Wholesale ULSD minus Heating Oil



9/15/2014



OPTIONS TO MOVE FROM HIGH SULFUR TO ULSD IN HEATING OIL MARKETS

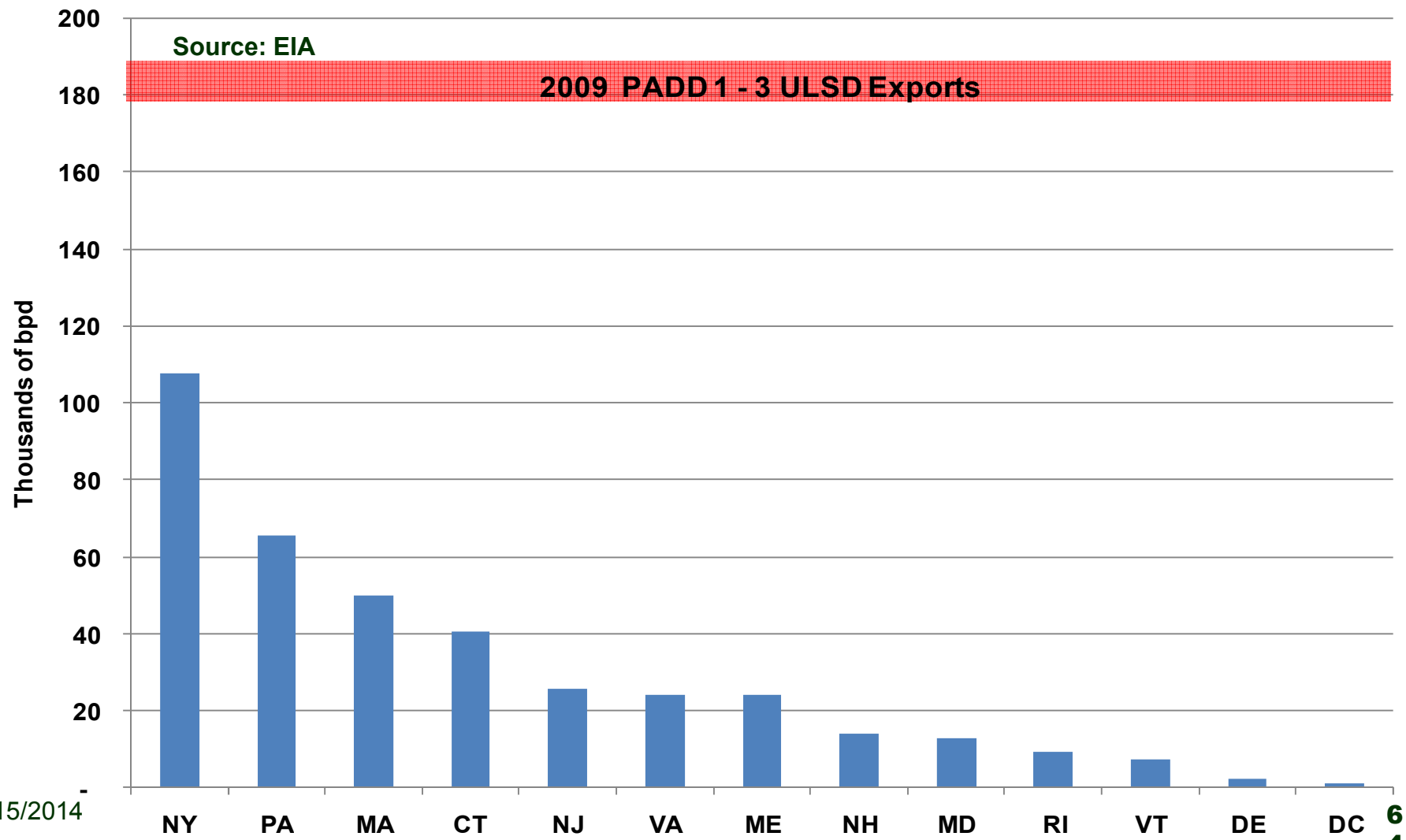
9/15/2014

Options

- **Policy Options**

- ***Option 1: Change the heating oil sulfur specification to ULSD for the entire market at once with enough lead time for refiners to add capacity.***
 - This option would insure supply at a specified time. However, past experience indicates that not all refiners would receive a return on capital invested.
- ***Option 2: Phase in ULSD for heating oil by state on a fixed schedule.***
 - Some states could shift right away as current ULSD exports could be moved to heating oil markets.
 - Timing for the remaining states would need to be sufficient to allow refining to add capacity.

Estimated 2008 State Level Heating Oil Demand Compared to ULSD Exports



END

9/15/2014

© 2010  Kevin J. Lindemer LLC

Confidential: Not for distribution without written consent from Kevin J. Lindemer LLC