FOTC 2014 Fertilizer Outlook & Technology Conference

MAKING THE RIGHT MOVES

OUR CHALLENGES. OUR IMAGE. OUR FUTURE

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The Market Outlook for Diesel Exhaust Fluid

The Fertilizer Institute
Nourish, Replenish, Grow

Fertilizer Industry Round Table

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The market outlook for Diesel Exhaust Fluid

Fabricio Cardoso
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2014 Fertilizer Outlook & Technology Conference

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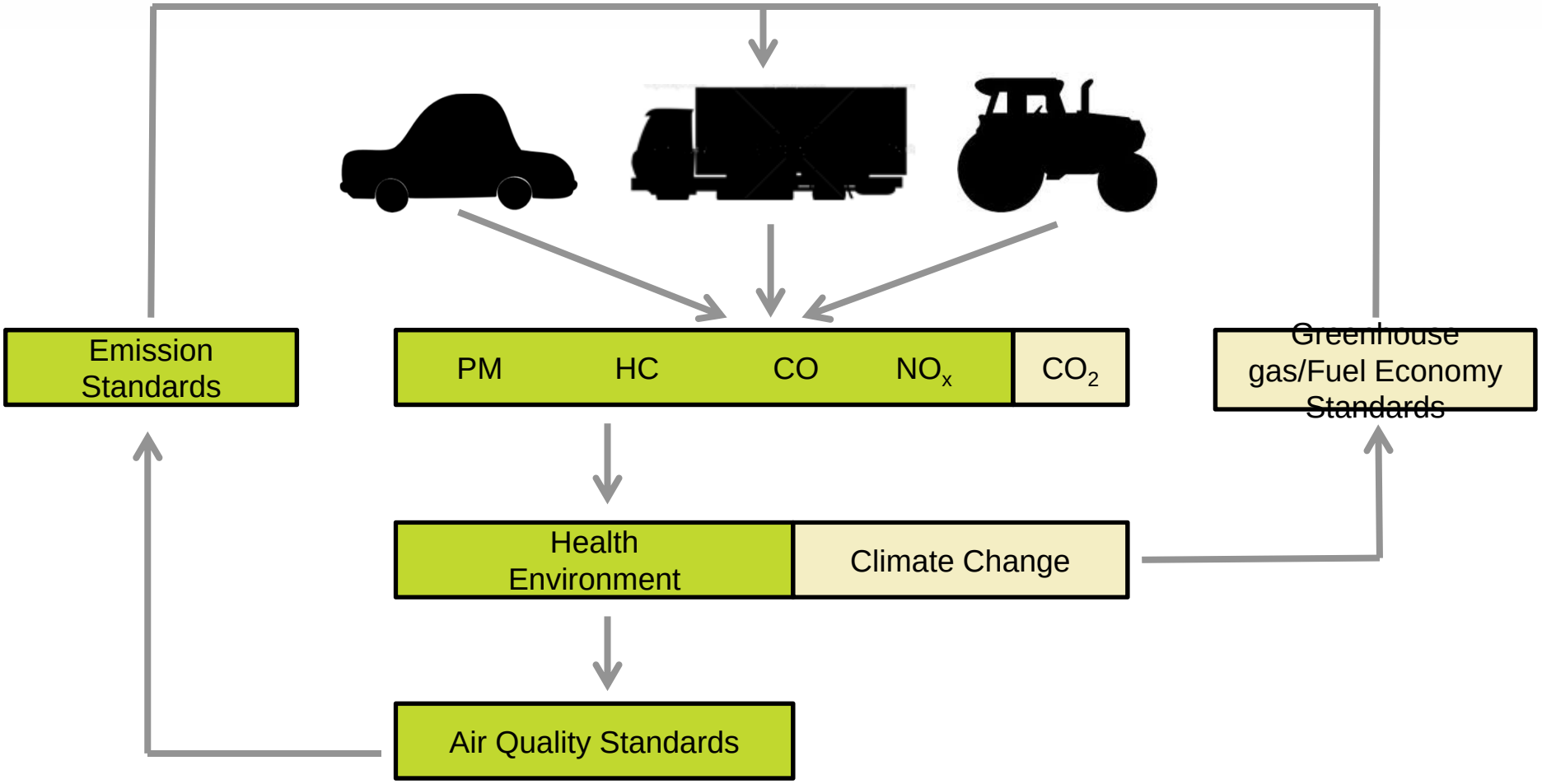
FROM AIR QUALITY STANDARDS TO DEF

Source:

The relationship between air quality, emission standards and DEF



PM – particulate matter, HC – hydrocarbons, CO – carbon monoxide, NO_x – nitrogen oxide, CO_2 – carbon dioxide

Source: Integer

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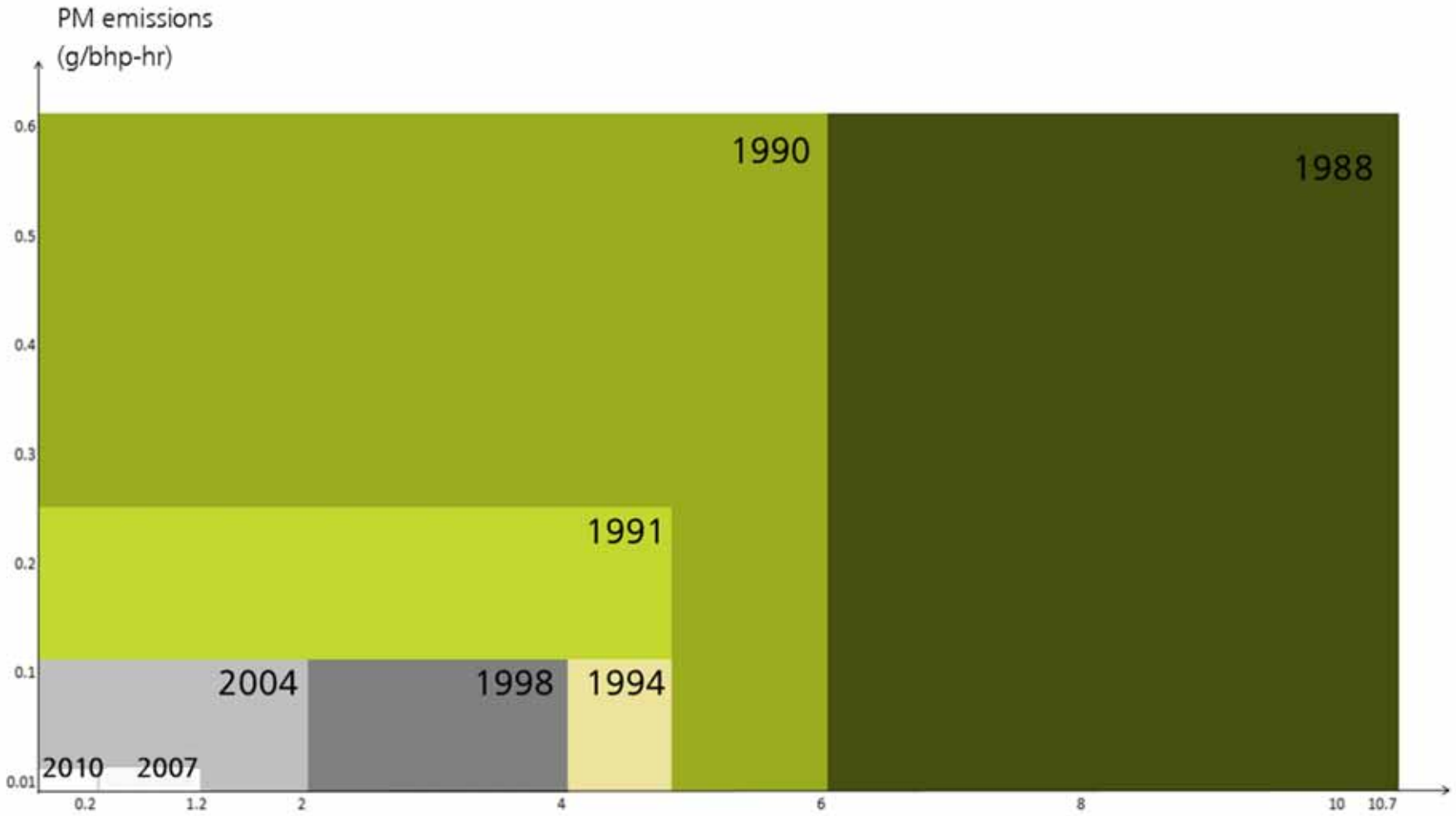
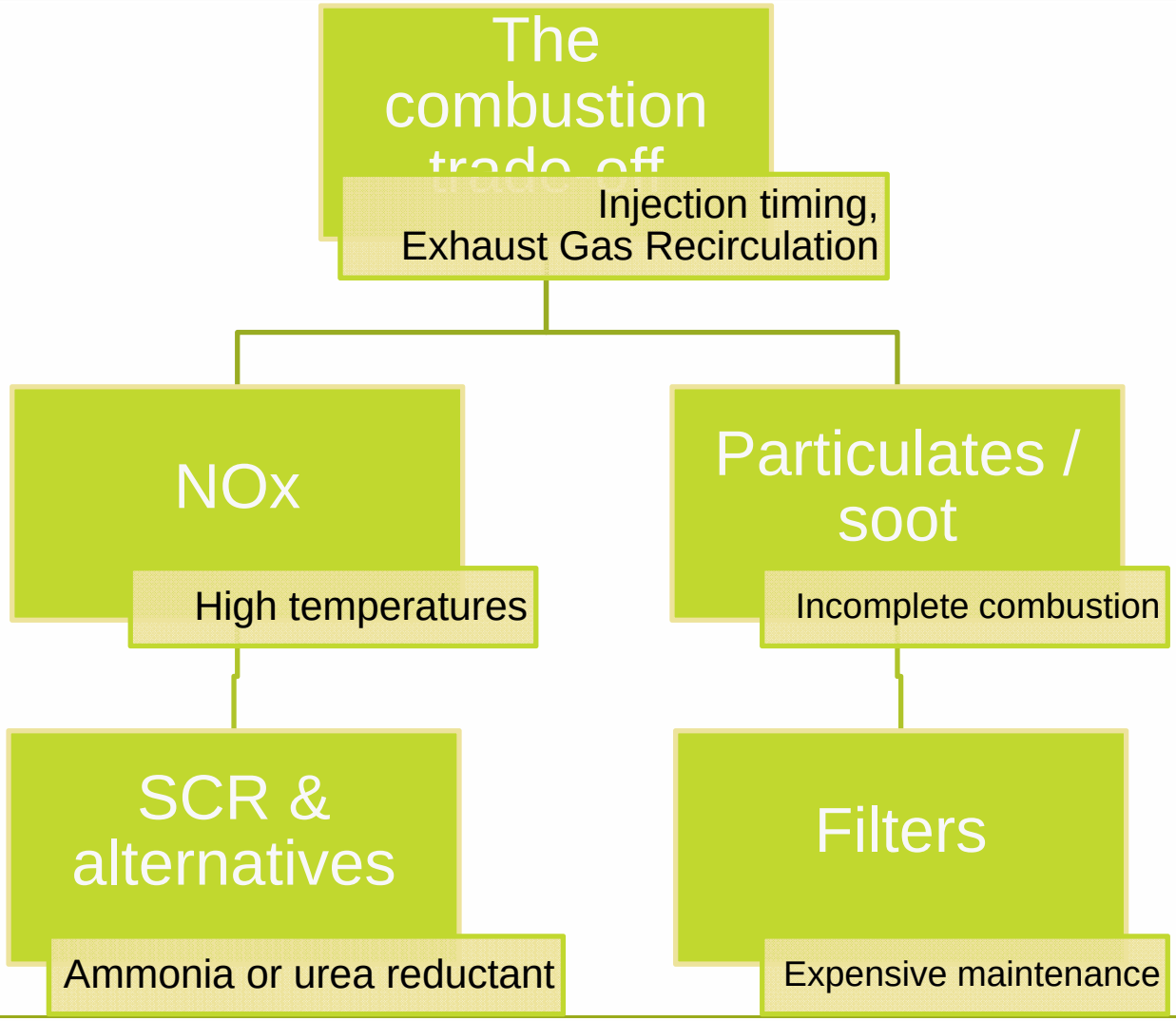
NOx and PM levels have been dramatically reduced since the first standards



Source: Integer, EPA, NHTSA

Demand driver: why ammonia/urea?



Several aftertreatment technologies are available to reduce NOx levels

Aftertreatment technologies to reduce NO_x levels

Exhaust Gas Recirculation EGR

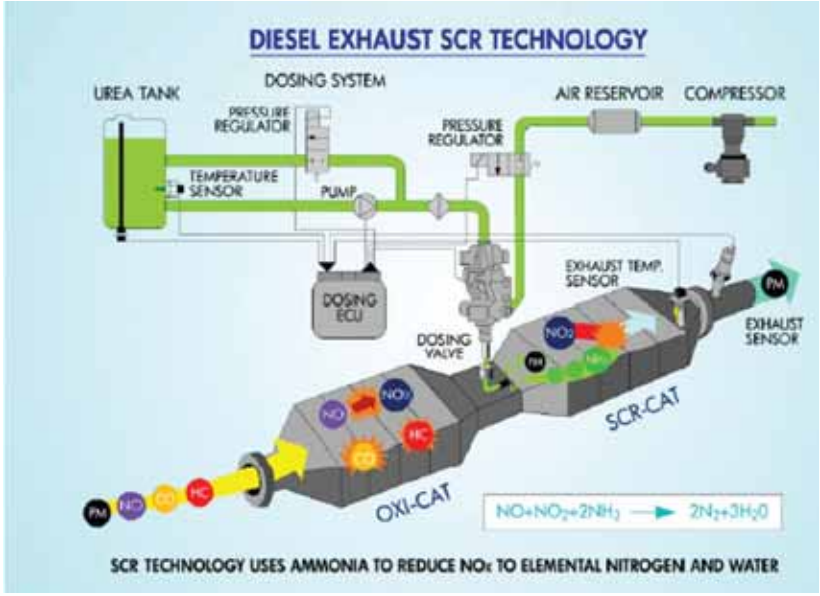
Lean NOx Trap LNT

Selective Catalytic Reduction SCR

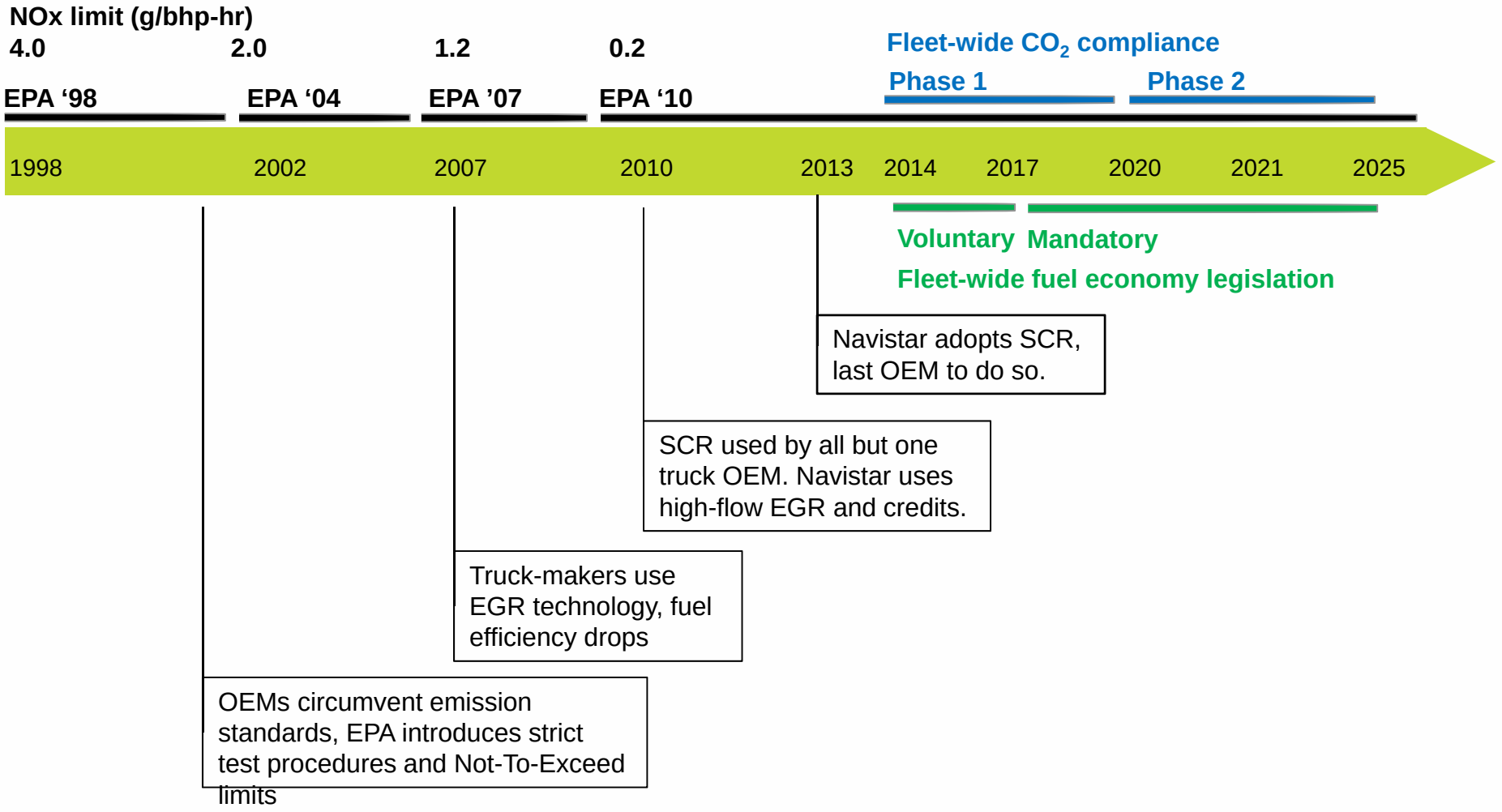
Selective Catalytic Reduction (SCR)

AUS 32 (urea solution, 32.5 wt%)
DEF

NO, NO_2 (NO_X) from combustion → **Ceramic catalyst** (Vanadium, Iron, Copper) → N_2, H_2O



The EPA has regulated heavy-duty diesel engine emissions since its inception in 1970, but GHG and fuel economy requirements have just been introduced



Source: Integer, EPA, NHTSA

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If SCR requires ammonia, why urea?

- Ammonia is technically more suitable for use in every application
- However: storing, transporting, dispensing and using ammonia has challenges due to its pungent smell and safety-related issues
- **Urea is therefore used as an ammonia carrier.** It must first be converted back to ammonia before it can be used to destroy NOx
- Other options were considered, including aqueous ammonia and ammonium formate and more recently solidly methods for storing ammonia. None have yet reached commercial acceptance.
  - Absorbed on a salt matrix: Amminex
  - As ammonium bicarbonte: Tenneco

Urea fluid standardised globally

- 32.5% urea solution – allows freezing of vehicle tank
- Names: AdBlue / Diesel Exhaust Fluid (DEF) / ARLA-32

- ISO 22241 standard defines the quality requirements
  - biuret and formaldehyde limits mean that fertilizer urea cannot be used
  - water must be de-ionised
- This standard was originally defined by truck industry in discussion with catalyst suppliers and urea producers, then adopted by non-road equipment and car manufacturers.

- 40% urea solution for marine applications because tank freezing is not an issue

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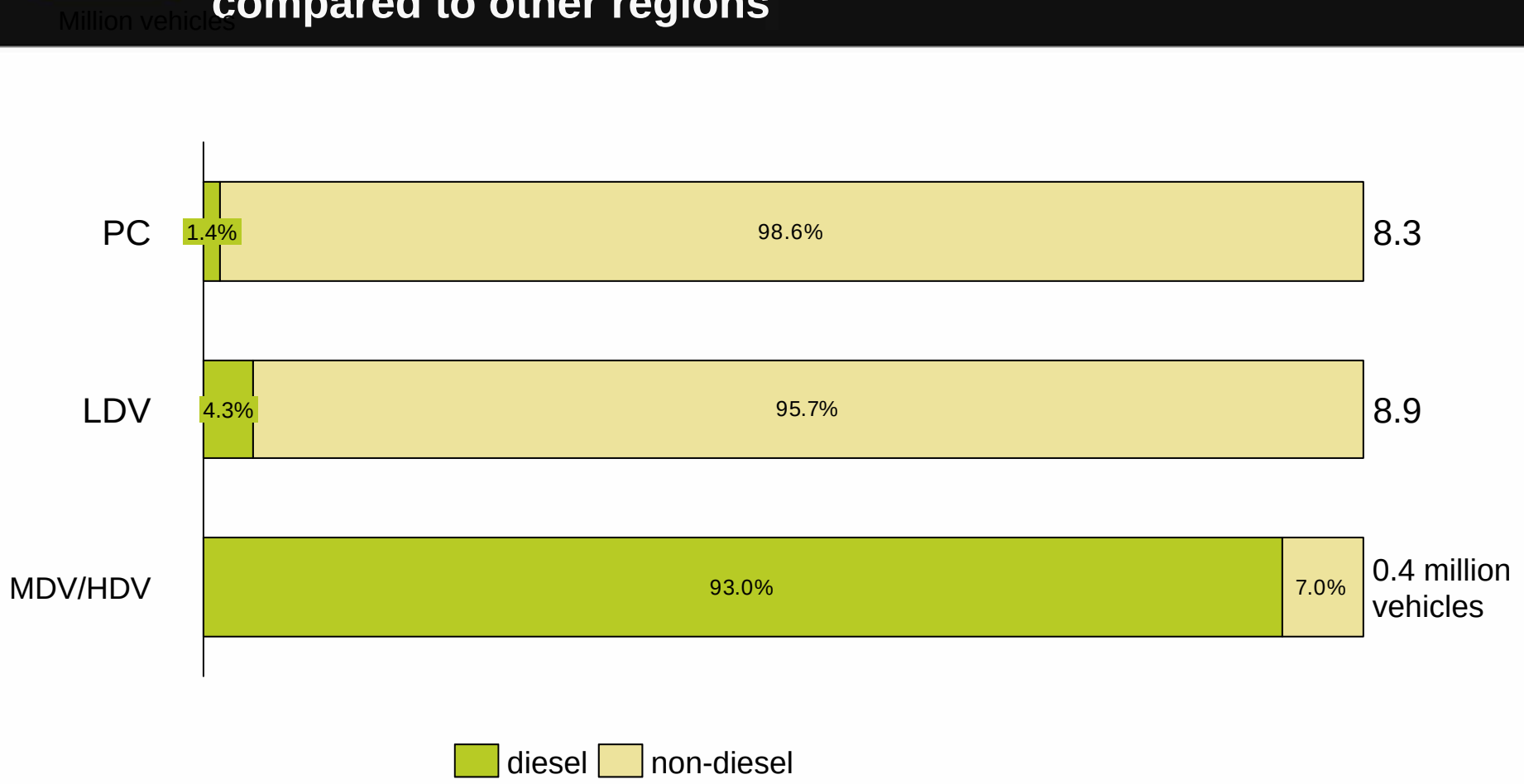
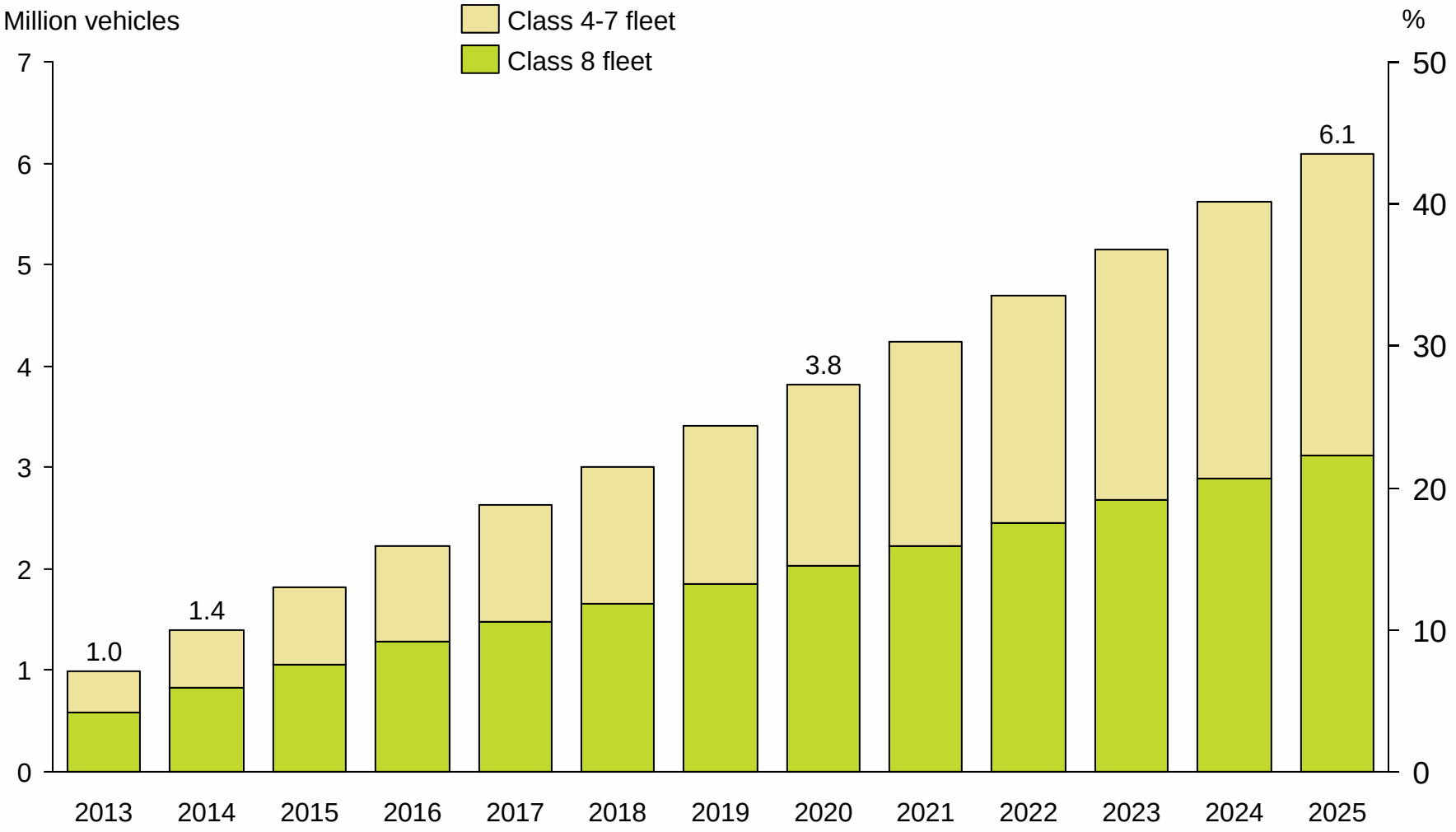
VEHICLE, SCR AND DEF FORECAST

While the majority of commercial vehicles in North America are equipped with a diesel engine, the share of diesel passenger cars and light-duty vehicles is still small compared to other regions



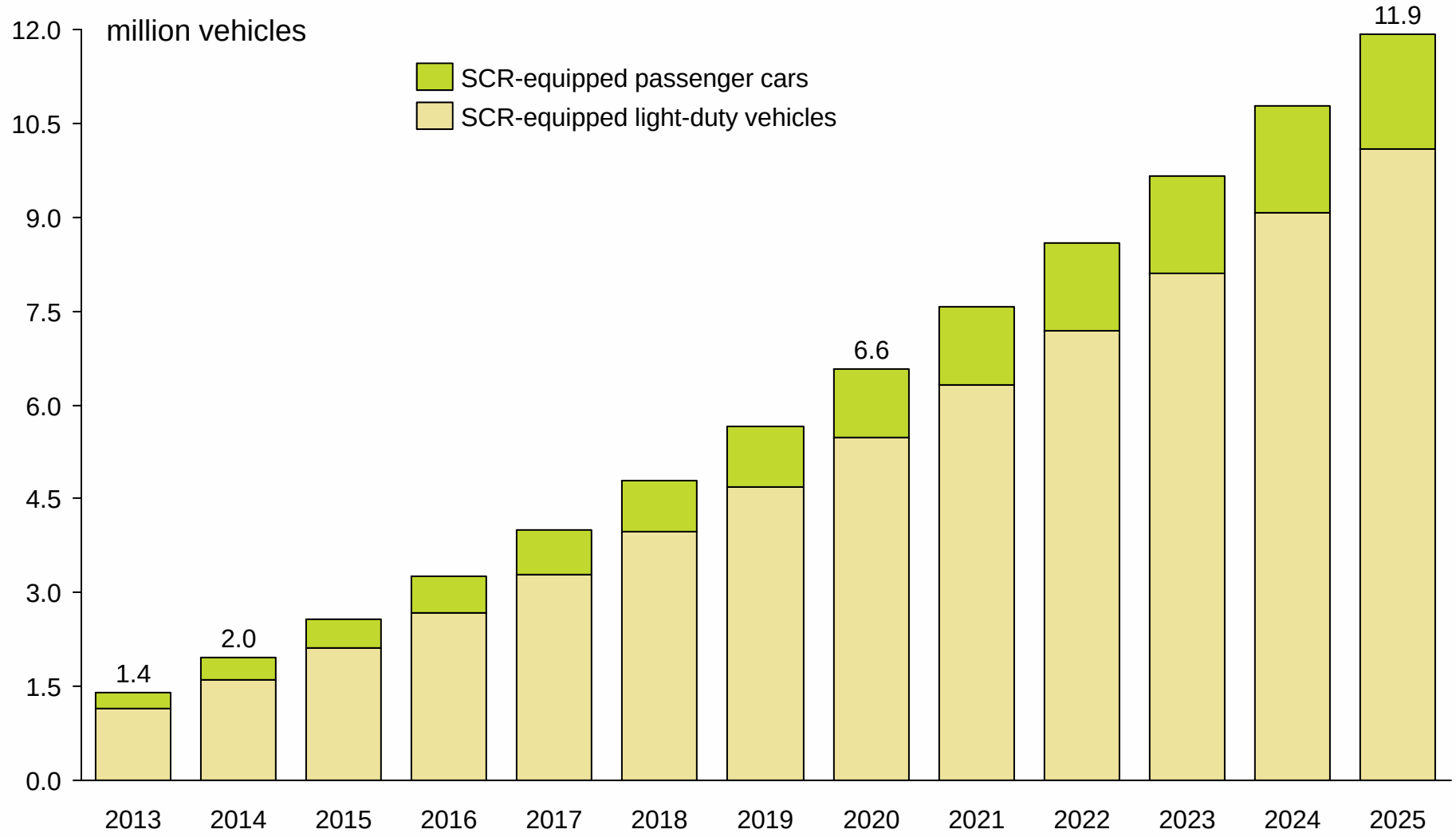
Source: Integer, WardsAuto, ACT

The commercial vehicle SCR fleet is expected to be six times bigger in 2025 compared to 2013



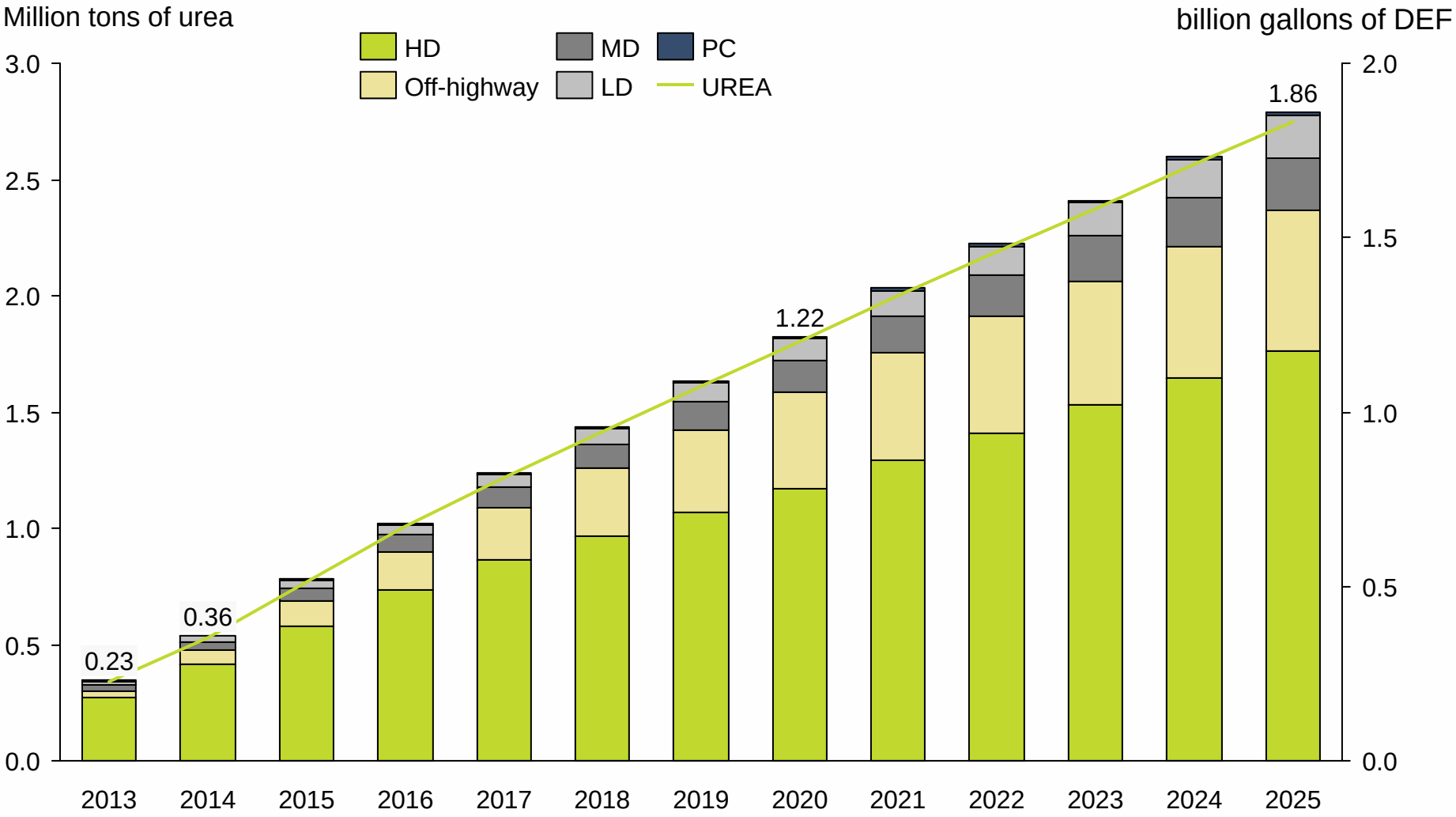
Source: Integer

More than 11 million passenger cars and light-duty vehicles are forecast to be on the road in North America by 2025



Source: Integer

Our base-case scenario shows DEF consumption is expected to reach 1 billion gallons in North America by 2019



Source: Integer Research

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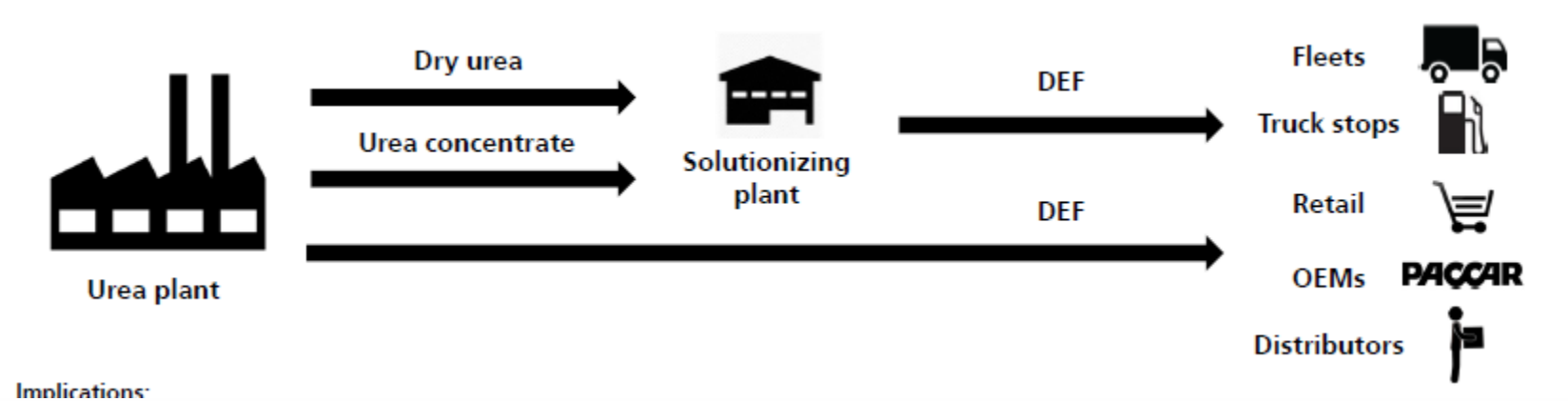
DEF MARKET, CURRENT AND OUTLOOK

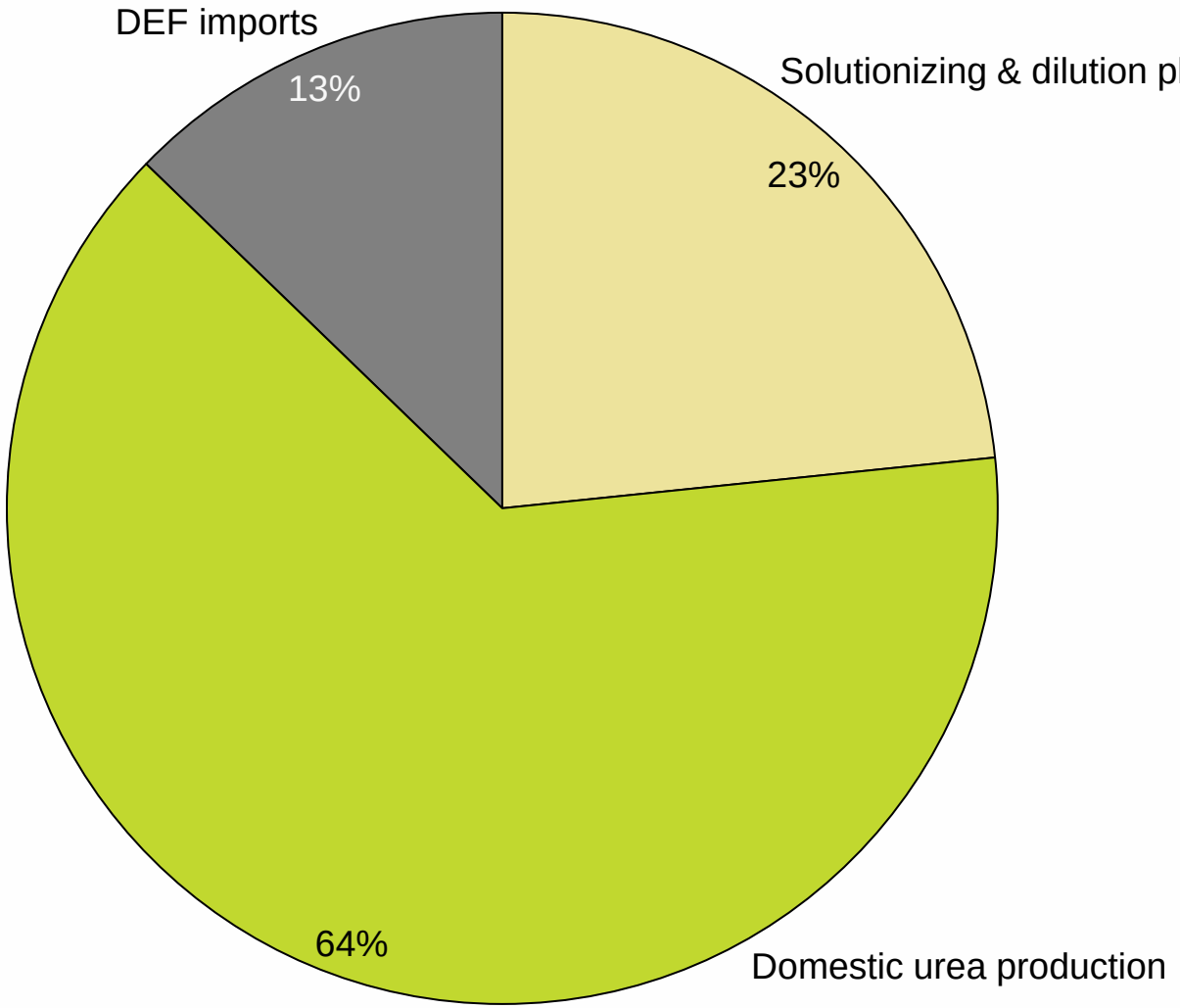
DEF logistics: It's all about the water

- 67.5% of AdBlue/DEF is water
- Supply chain options account for transport optimisation:

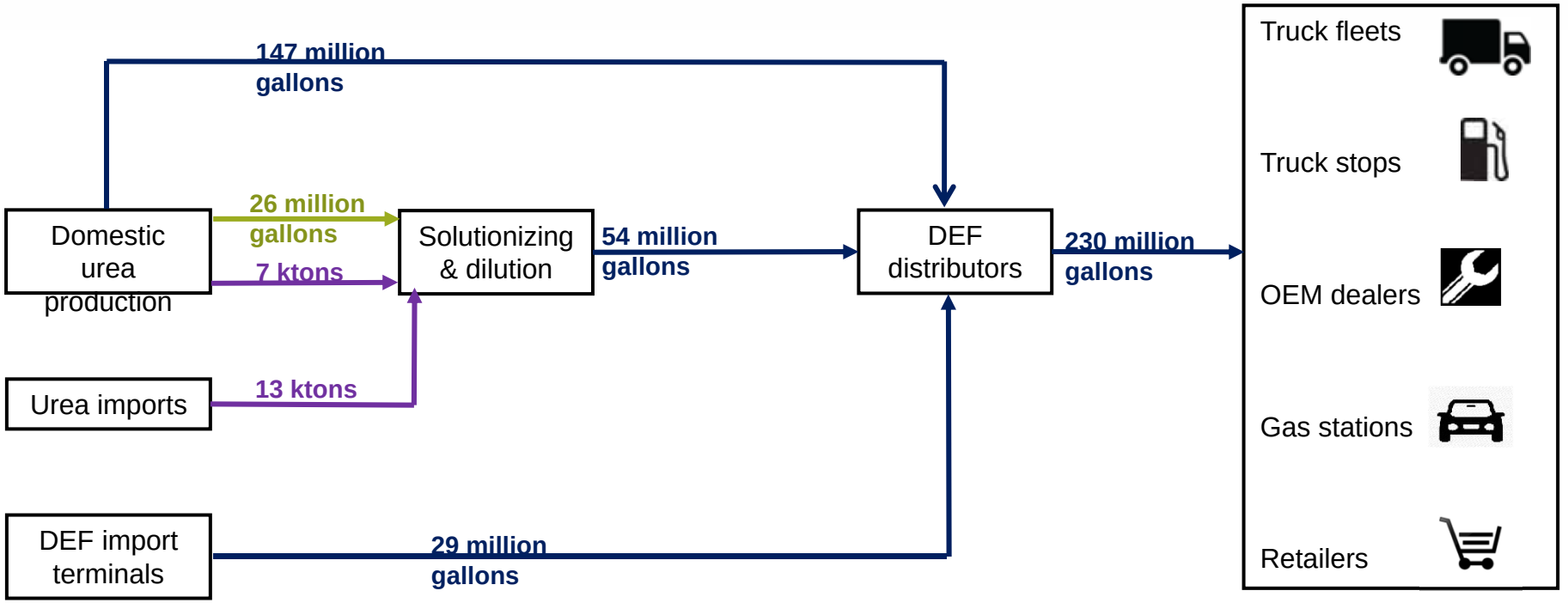


- End-user prices reflect supply chain requirements

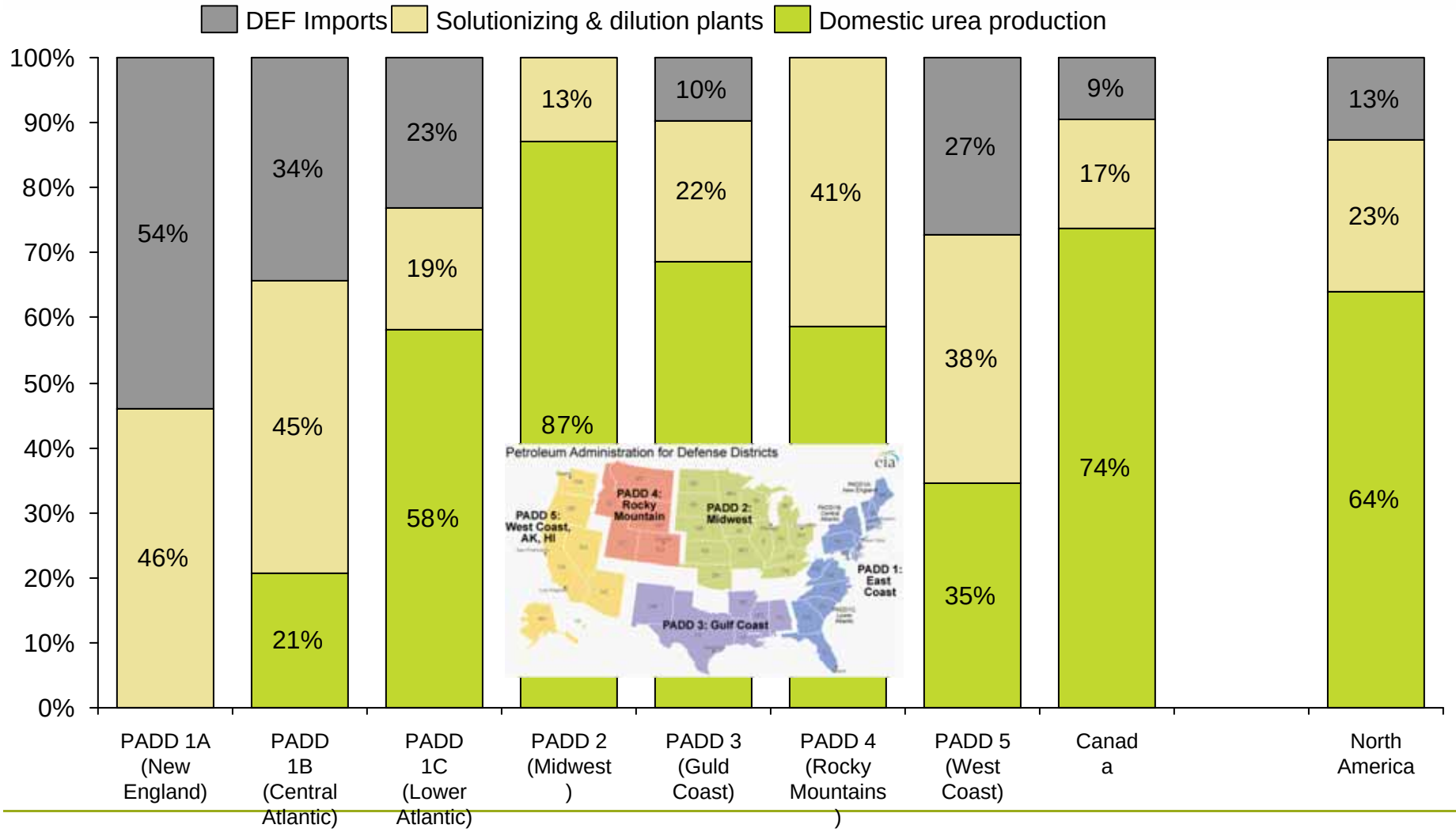
About 65% of total DEF consumption in 2013 originated from domestic urea production



DEF production from urea plants in North America totalled 147 million gallons in 2013



Midwest, Gulf Coast and Canada have the highest shares of DEF coming from domestic urea plants



What to expect for 2020?

- Urea plants coming online – domestic DEF production will remain strong
- More efficient logistics – urea plants producing more concentrate solution and distributing to solutionizing & dilution plants across the country and closer to the main consumption markets
- Prilled urea imports – likely to maintain an important growth, specially in California, where the gap between supply and demand will increase

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Thank you!
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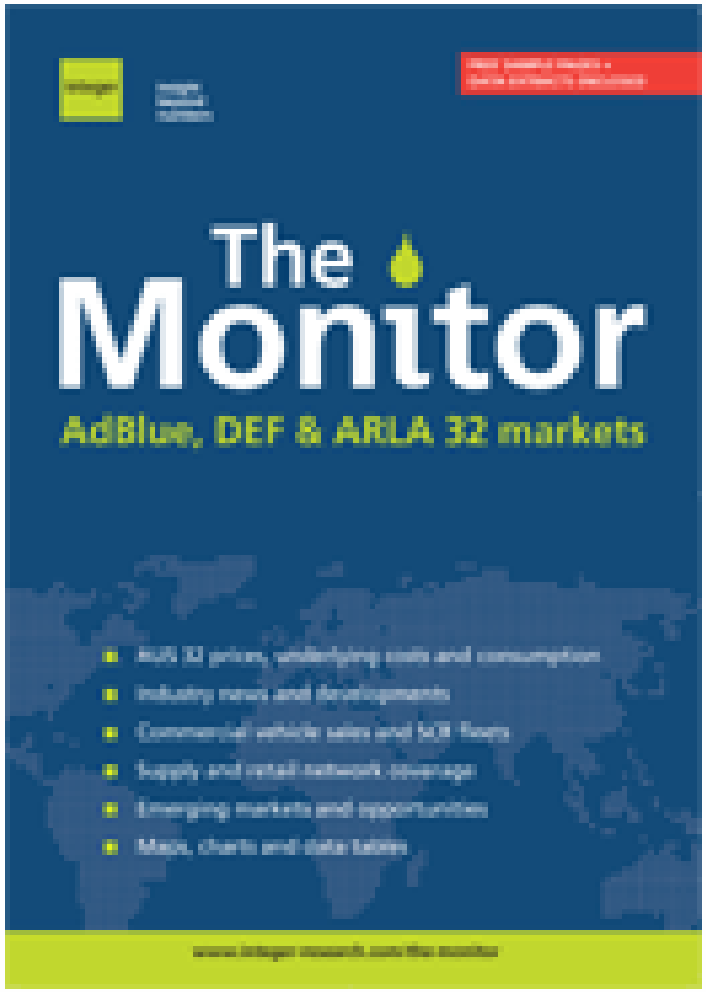

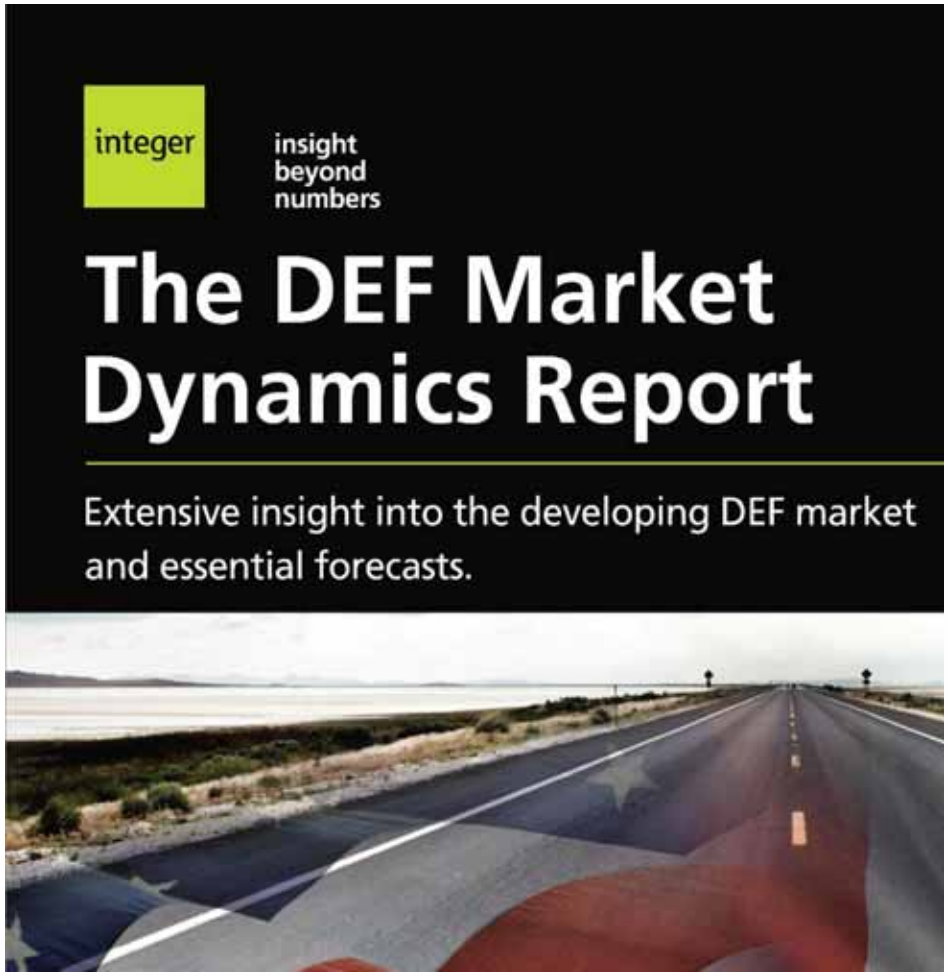

Our nitrogen publications