Ryan F. Stege
Director Locomotive Operations & Maintenance

July 30, 2020

REDUCING LOCOMOTIVE FUEL BURN

Powering the Low Carbon Economy

NORFOLK SOUTHERN

NS IN NEW JERSEY

PEOPLE

205 NS Employees

65 Railroad Retirement Recipients

SUPPORTING GLOBAL TRADE

Norfolk Southern serves the Port of New York and New Jersey, the largest on the East Coast, through its E-Rail intermodal terminal in Elizabeth, N.J.

ECONOMIC IMPACT

pays $12 MILLION

PAYROLL

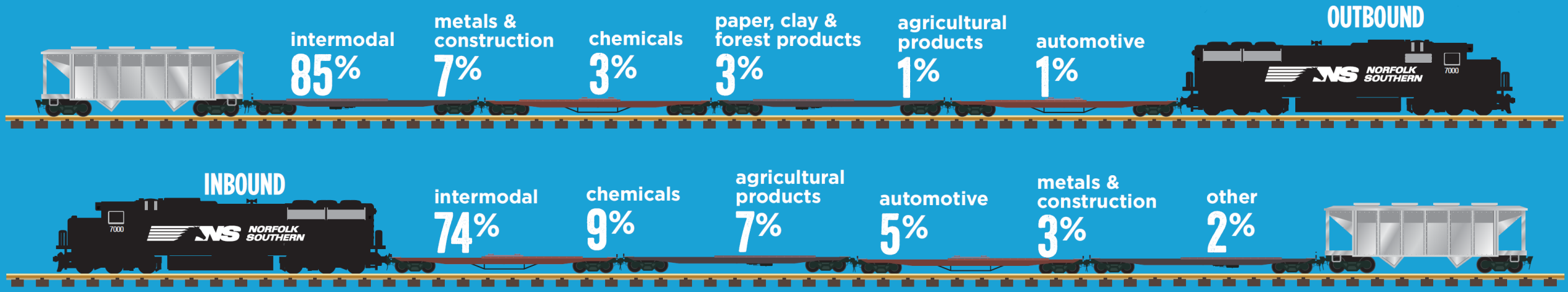
invests $8 MILLION

INFRASTRUCTURE & FACILITIES

spends $85 MILLION

PURCHASES, PAYMENTS, & TAXES

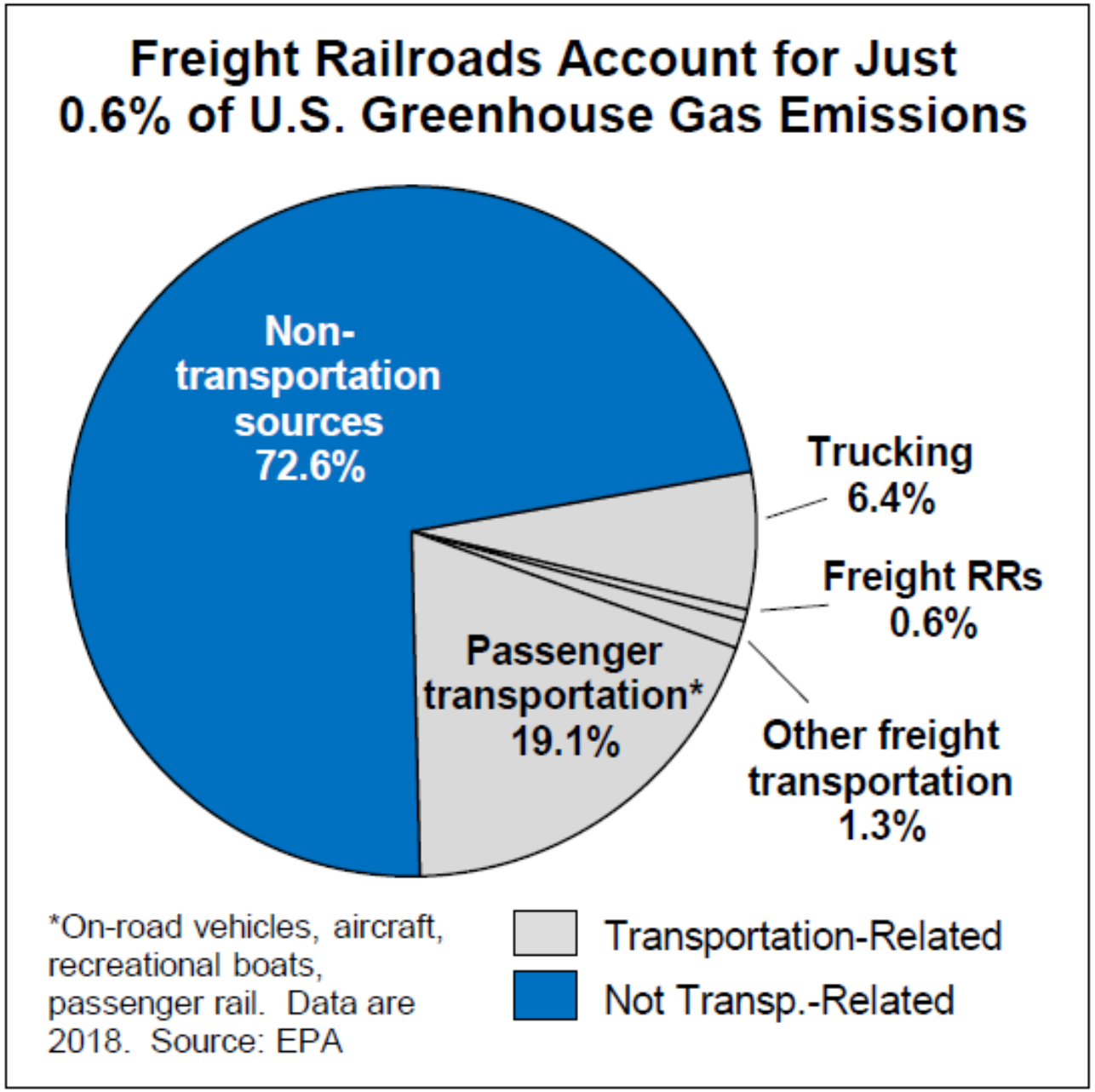
WHAT NS MOVES BY RAIL IN THE GARDEN STATE



2017 carloads.

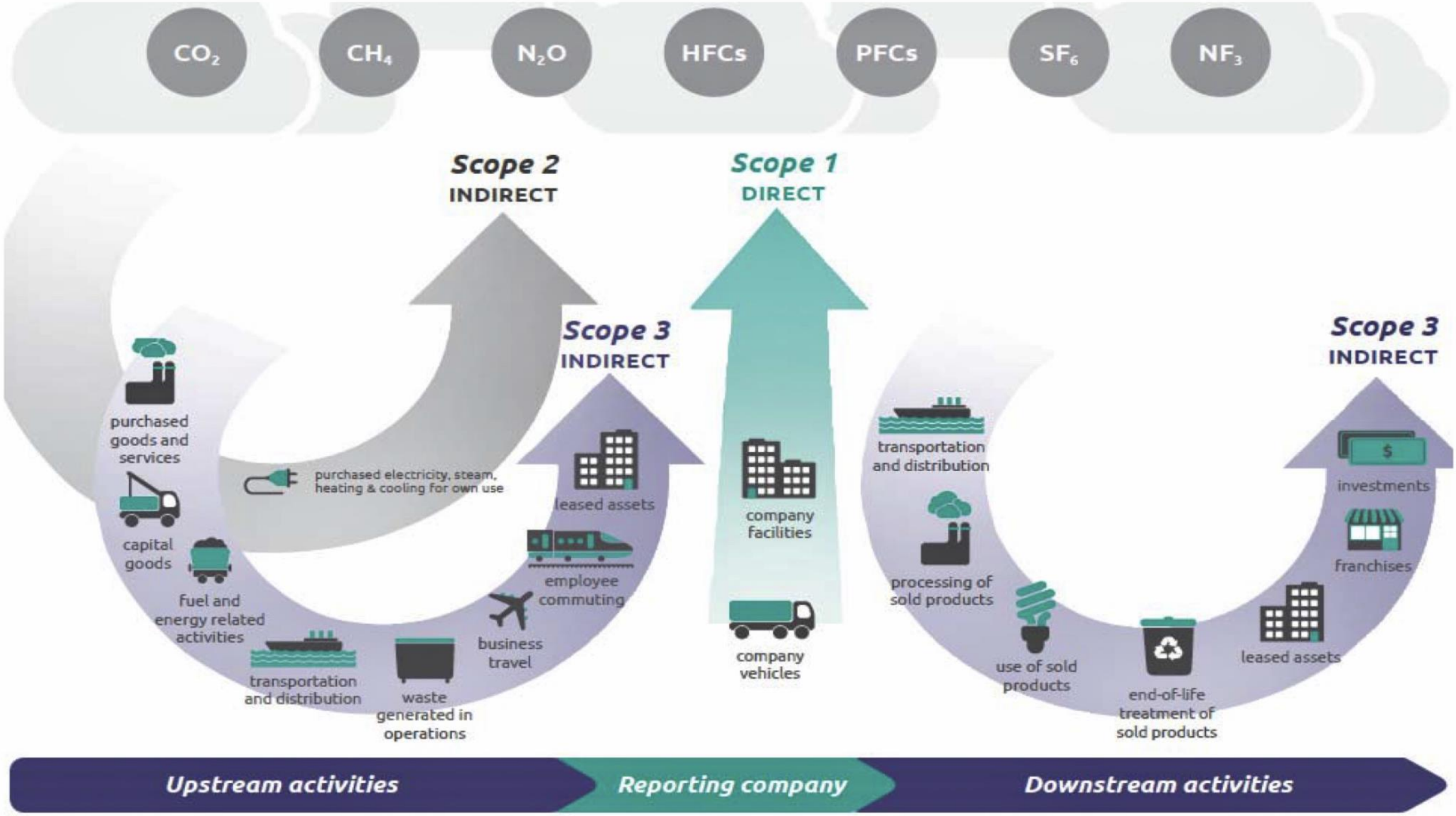
NS FUEL BACKGROUND

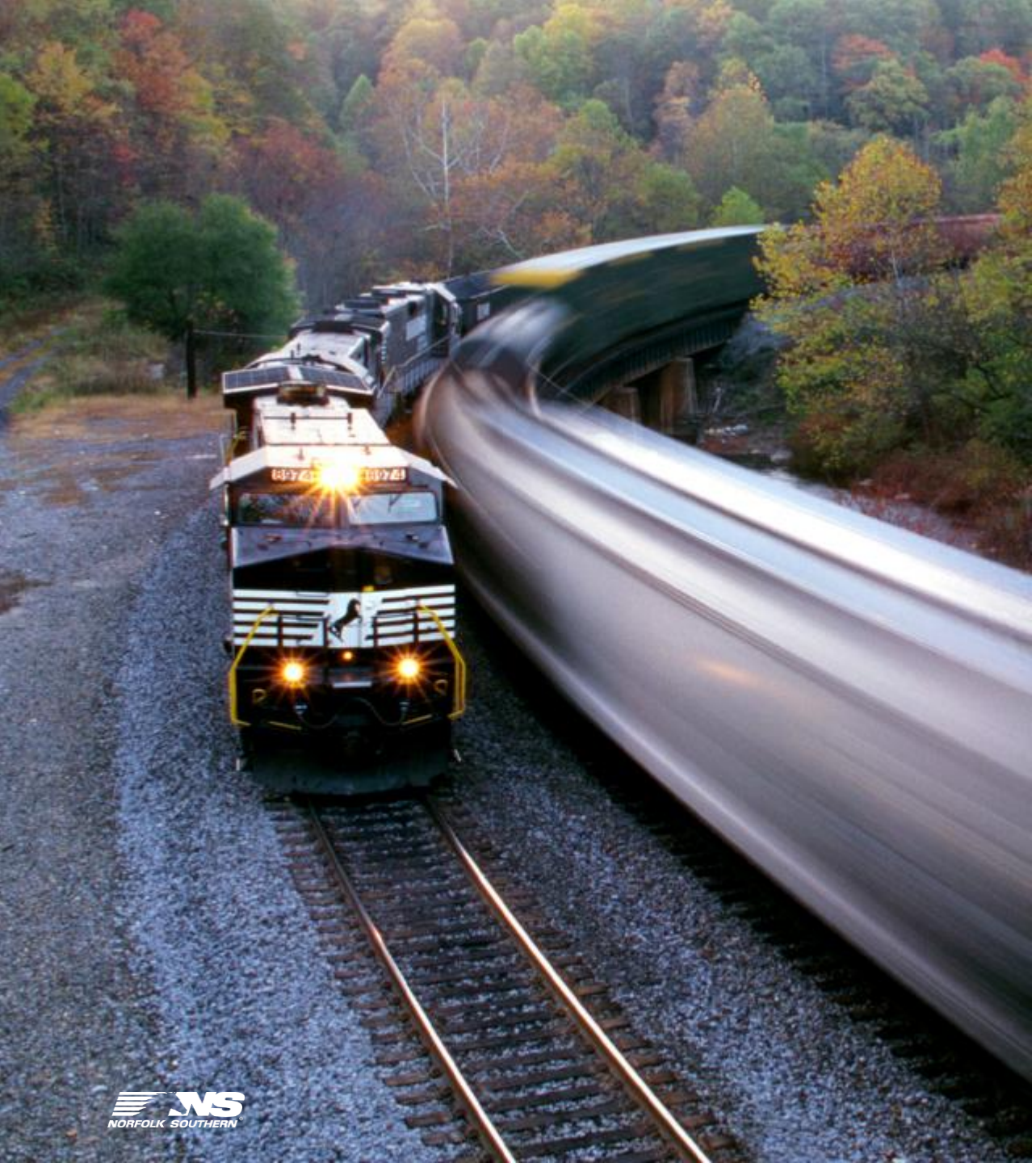
- Fuel is our 2nd largest expense!
- In 2019, NS used 450 million gallons of diesel
- Typical road locomotive
  - SD70ACE makes 4300HP, 11,360 cubic inch (186 L) diesel engine
  - Idling for an hour burns 4 gallons of diesel
- Typical road train
  - Can be over 2 miles long
  - Can weigh over 15,000 tons



GHG EMISSIONS

- Rail moves 40% of the freight ton miles in the U.S. each year but only produces 8% of all freight emissions.
- Moving freight by rail instead of truck can save up to 1,000 gallons of fuel per carload.


CO_2
CH_4
N_2O
HFCs
PFCs
SF_6
NF_3
Scope 2
INDIRECT
Scope 1
DIRECT
Scope 3
INDIRECT
Scope 3
INDIRECT
purchased goods and services
capital goods
fuel and energy related activities
transportation and distribution
waste generated in operations
business travel
employee commuting
leased assets
purchased electricity, steam, heating & cooling for own use
company facilities
company vehicles
transportation and distribution
processing of sold products
use of sold products
end-of-life treatment of sold products
leased assets
franchises
investments
$
Upstream activities
Reporting company
Downstream activities

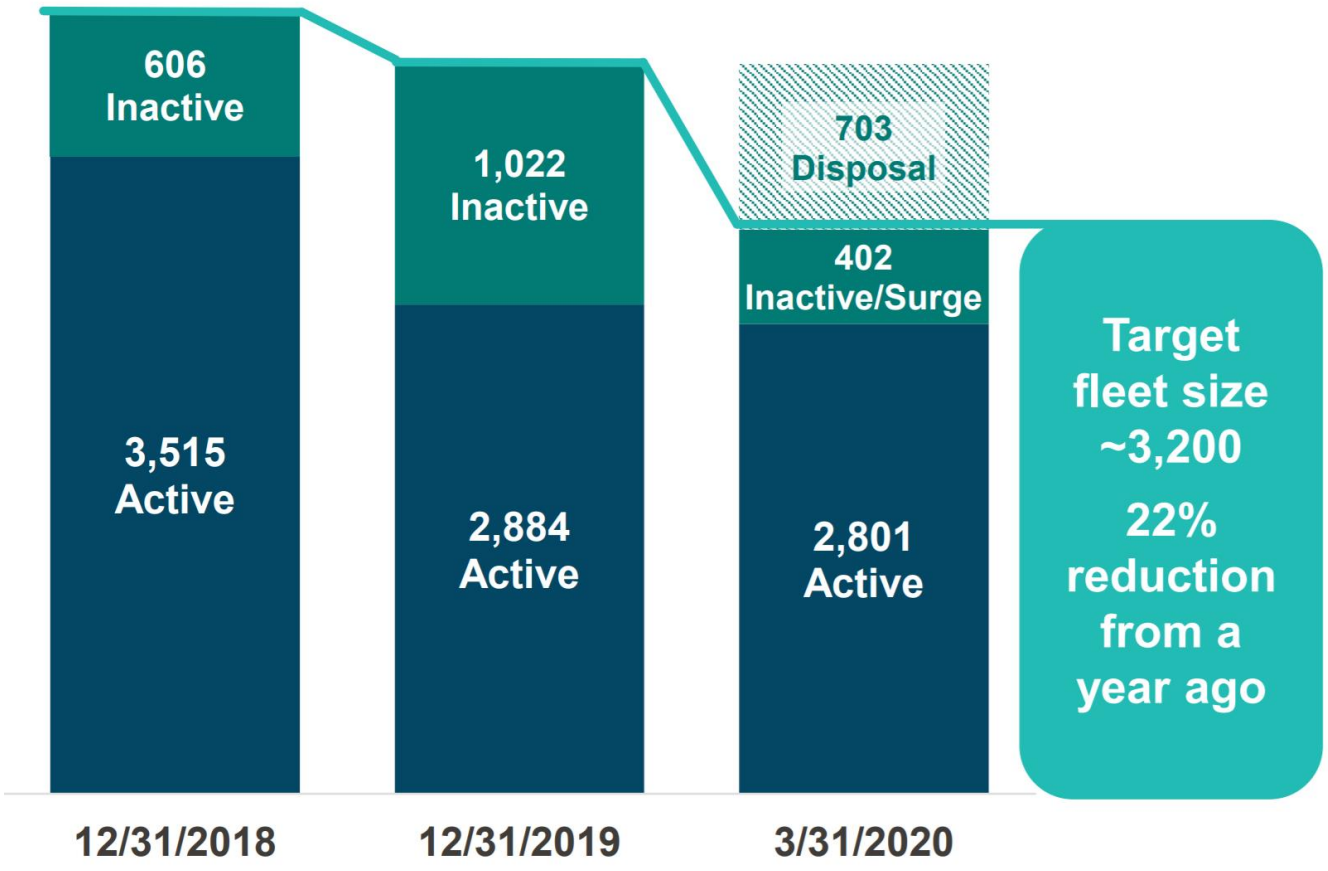


NORFOLK SOUTHERN'S PATH TO FUEL SAVINGS AND REDUCED EMISSIONS

- Reduce locomotive fleet size
- Maximize energy management technologies
- Use horsepower per ton (HPT) operations tools
- Increase the use of distributed power (DP) technology

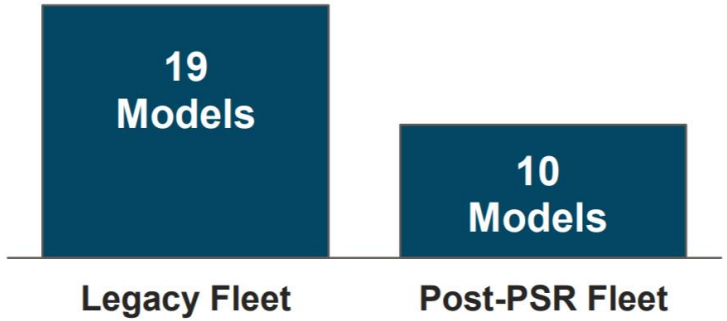
FLEET SIZE REDUCTION

Owned Locomotives



Model Rationalization

- Less inventory & mechanical resources
- Simplified power optimization

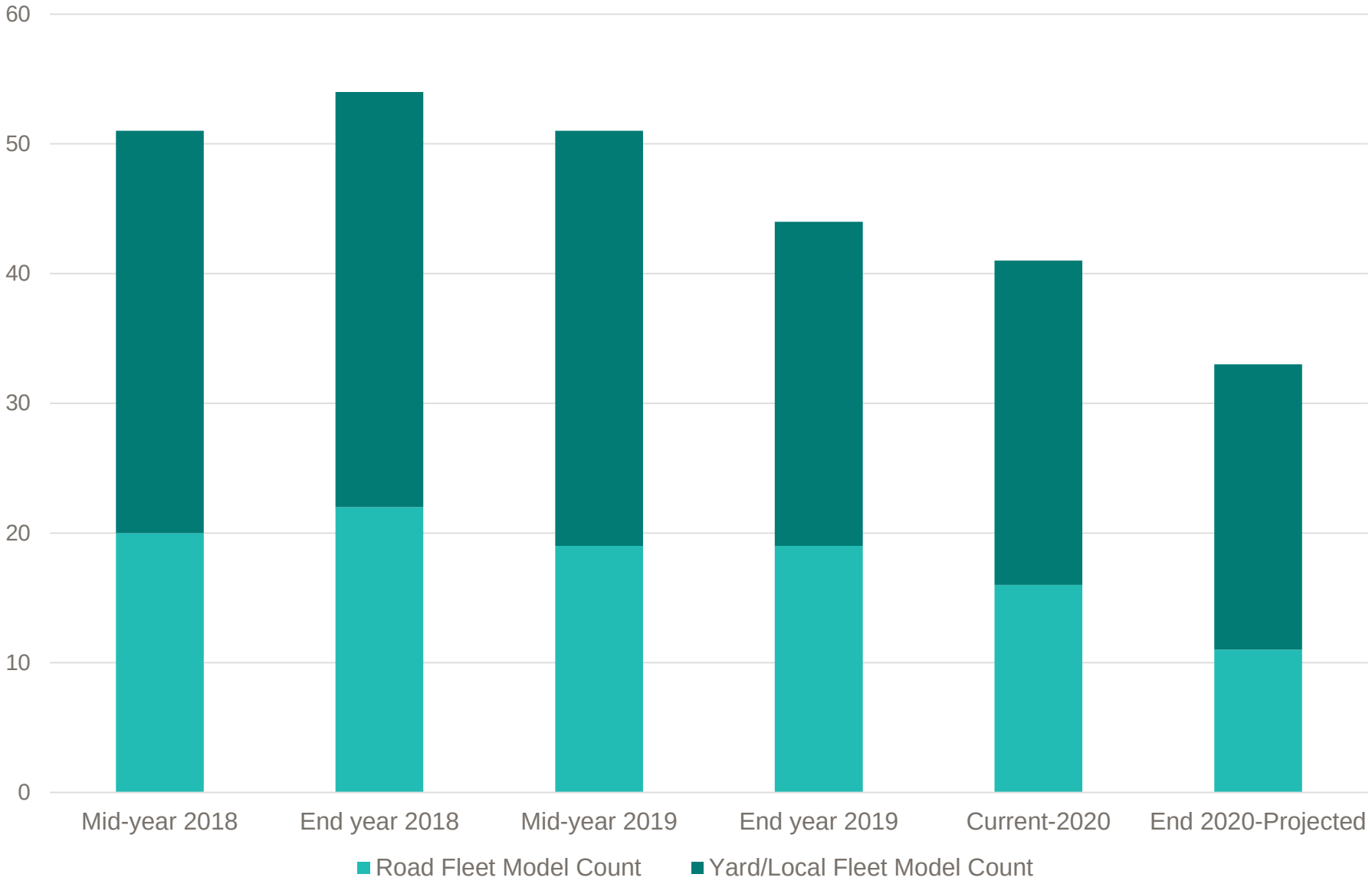


Other Benefits

- Less yard congestion
- Lower average age + higher AC mix =
  - Improved reliability
  - Improved fuel efficiency
  - Capacity dividend

NORFOLK SOUTHERN

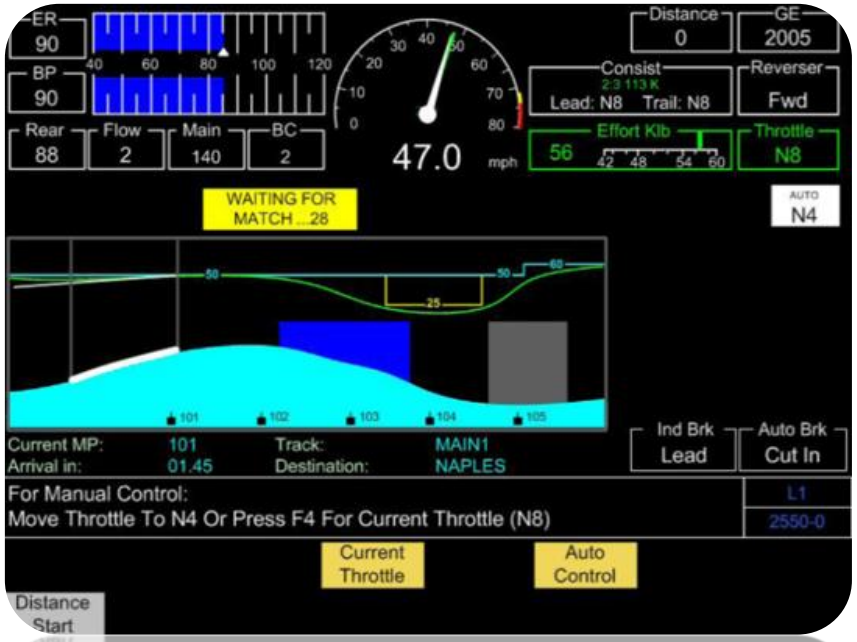
UNIQUE LOCOMOTIVE MODELS

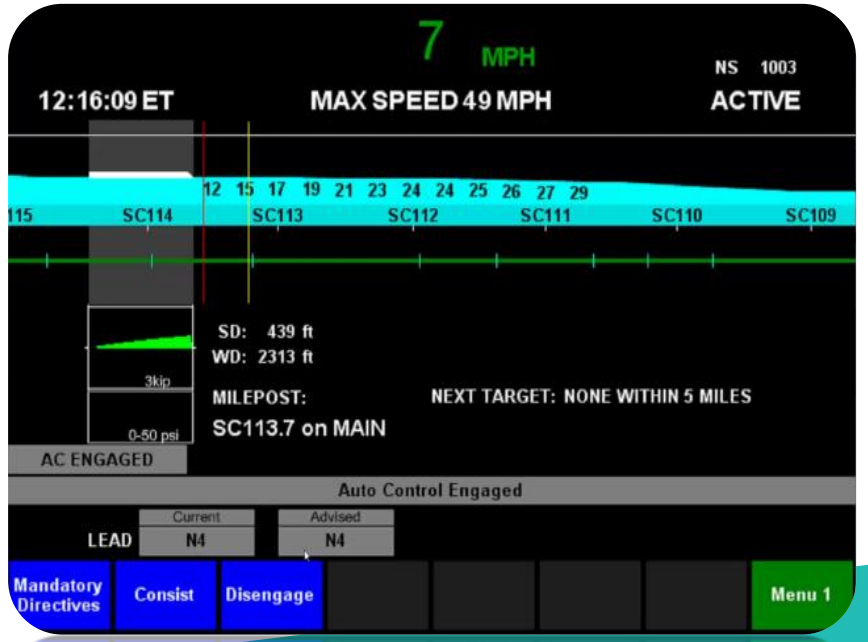


ENERGY MANAGEMENT SYSTEMS

NS implementing two types of energy management systems

- Systems are loaded with train consist information and route topography.
- Both provide an auto throttle control that minimizes fuel burn for a given route and train.





HPT

- HPT – horsepower per ton
- Fewer units, same tonnage = more efficient

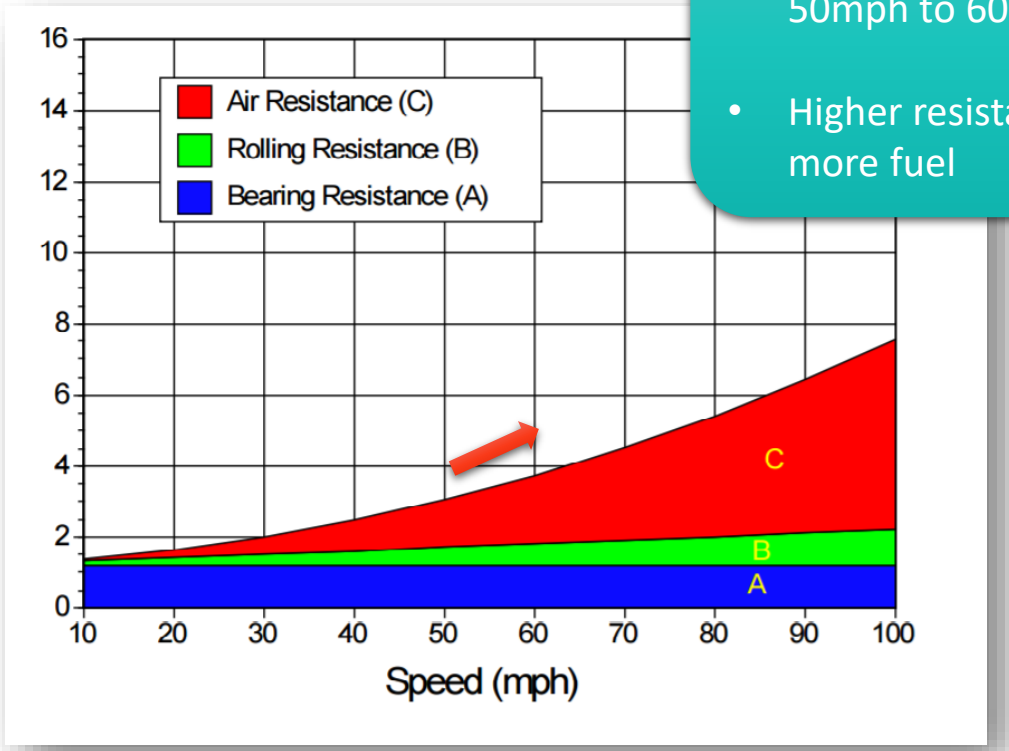
  One unit in a higher notch is more efficient than two in lower notches

- Large potential fuel and GHG savings benefit

$$HPT = \frac{Horsepower}{Tonnage}$$

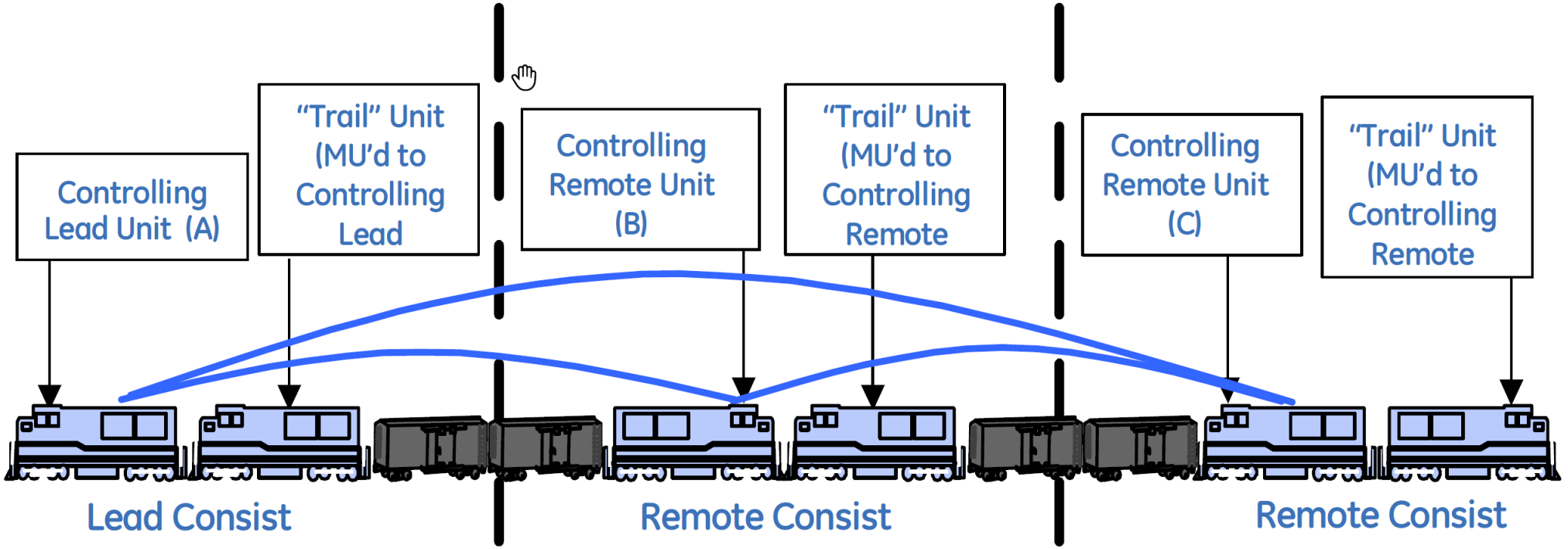
THROTTLE LIMITING

- Maximum throttle position allowed at (x) speed
- Very basic fuel saving approach
- Throttle 5 was chosen as Limit
- Several roads currently utilize throttle limiting
- Does not impact current HPT instructions since throttle limiting only enforced at higher speeds



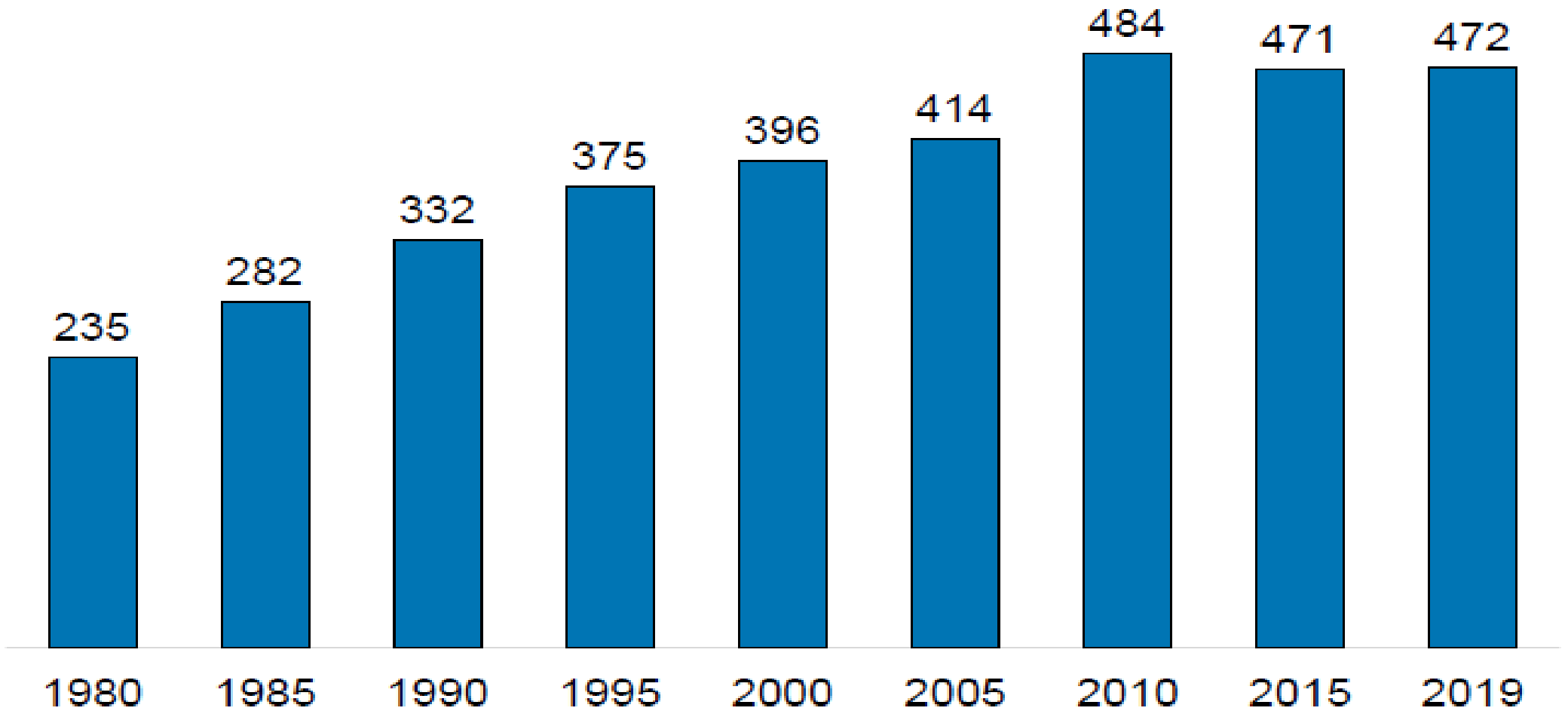
- Significant increase in wind resistance from 50mph to 60mph
- Higher resistance = more fuel

DISTRIBUTED POWER TECHNOLOGY



- Technology involves strategically distributing locomotives throughout the train
- One crew and energy management system controls all locomotives in the train from the head end
- Improves fuel efficiency and train handling
- Fewer locomotives necessary for longer and heavier trains, leading to less fuel consumed

Freight Rail Fuel Efficiency
(ton-miles per gallon)



Source: Association of American Railroads

Ryan F. Stege
ryan.stege@nscorp.com

NORFOLK SOUTHERN