PennState College of Engineering

GE Transportation

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Freight, Fuel, & Emissions

Introduction to Engineering Design
EDGSN 100 Section 002

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Presented to: Prof. Berezniak
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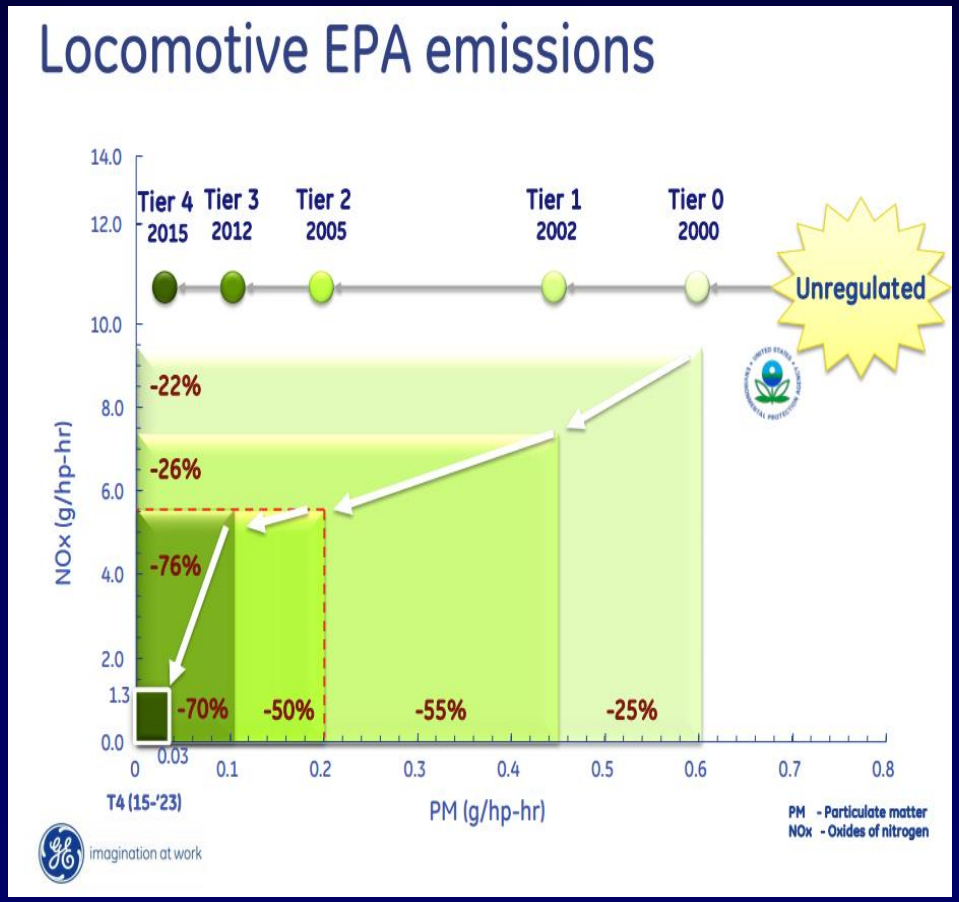
Introduction

Objective: Find a cost effective, emission friendly, and realistic solution to transporting freight

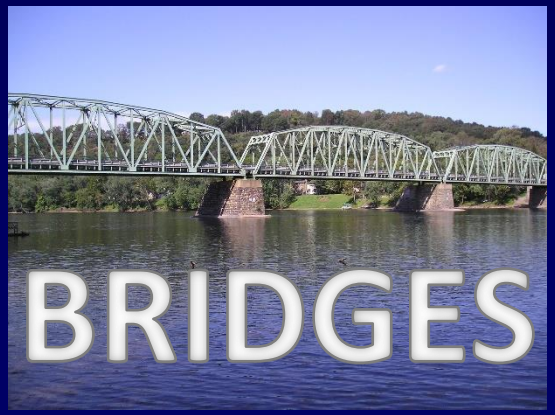


Transportation Infrastructure Condition and Capacity

Pennsylvania's infrastructure is one of the worst in the nation, with bridges, inland waterways, and roads all classified as Ds.

Pa has the third highest number bridges in the country and the highest number of structurally deficient bridges, about 23%.
Reconstruction has began!!

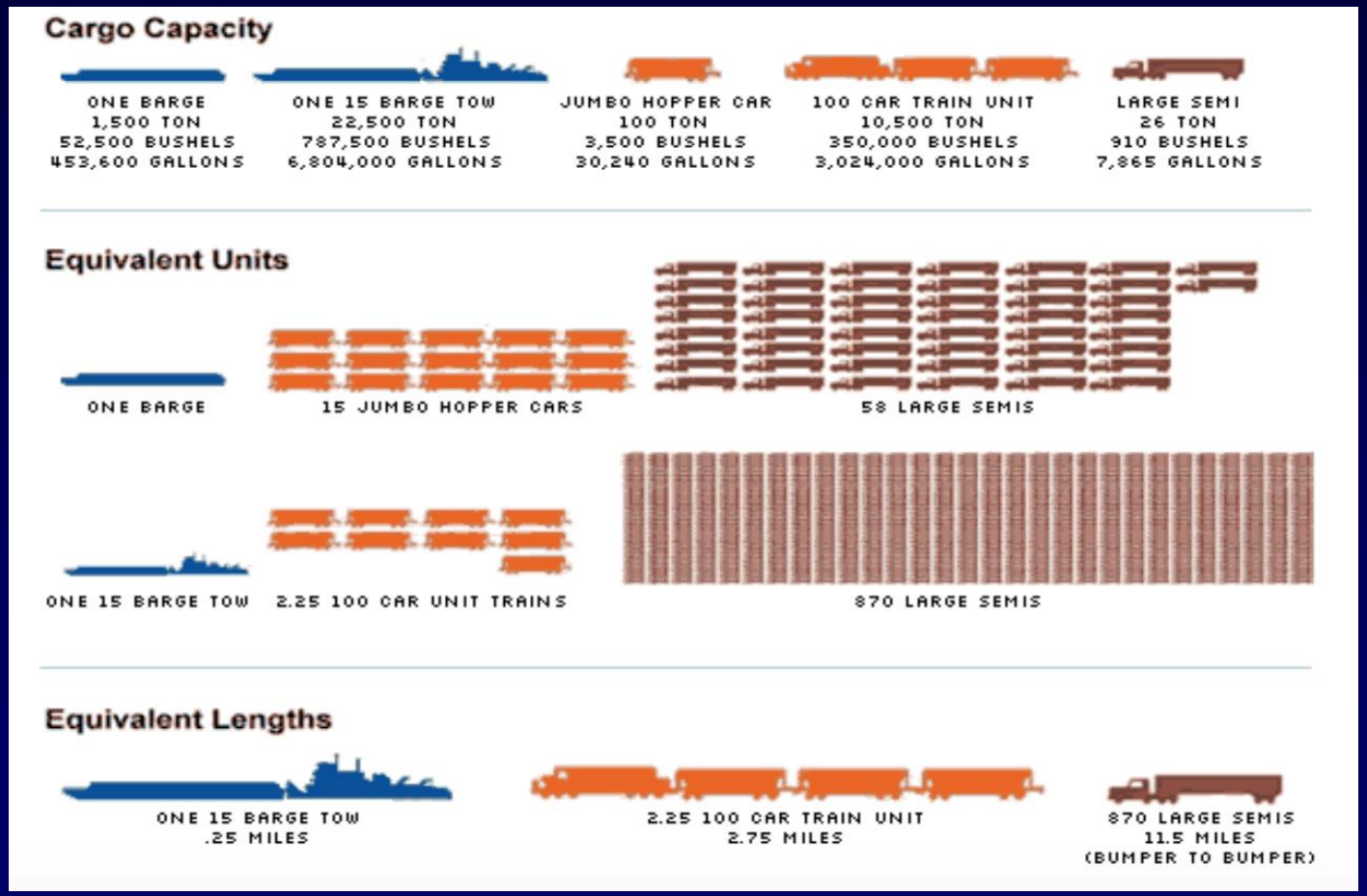
PA has a total of 41,000 miles of state highways and 79,000 local roads, 44% oh which are rated fair to poor



PA inland waterway system given an overall grade of D+, only 18% of the bridges were "satisfactory" rating. Pittsburgh was the busiest port in the nation in 2012!!

Standard Capacity for Alternate Transportation Modes

- The typical cargo ship capacity ranges from 1,500 tons for a single barge and 2,250 tons for a 15 barge tow. An average transport truck may hold up to 26 tons, and the capacity of trains ranges from 100 tons for a single car to 10,500 tons for an 100 car unit.



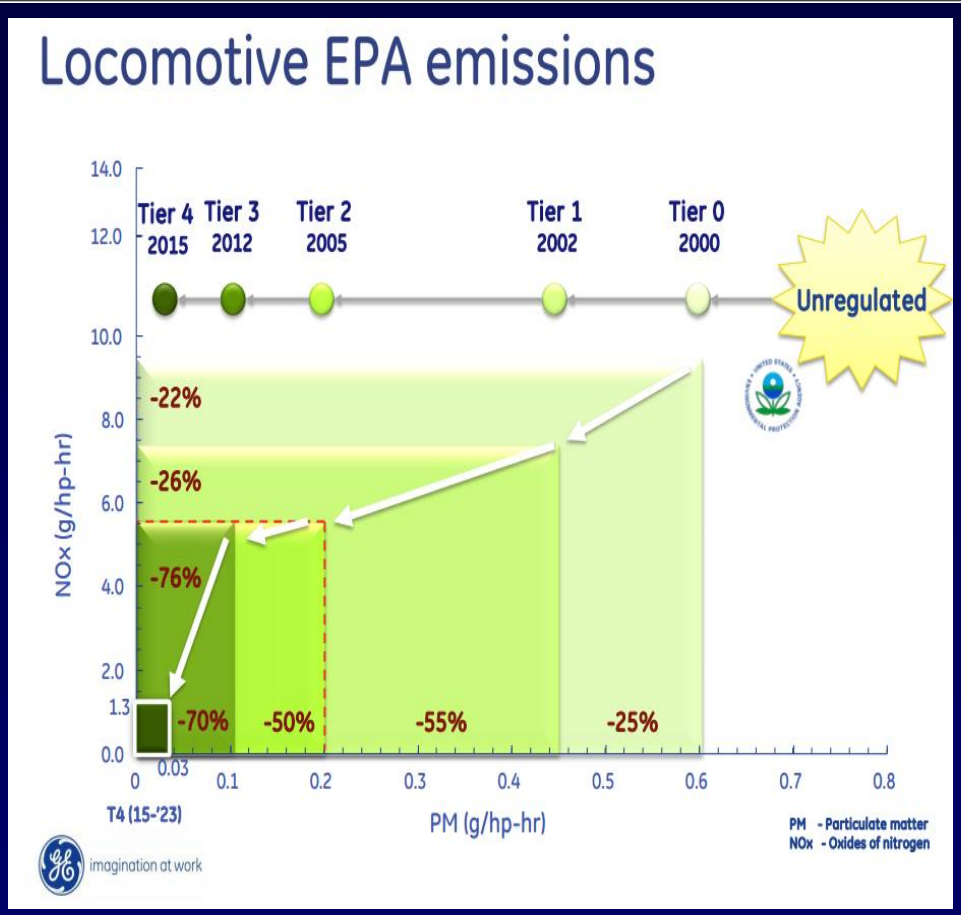
Transportation Costs and Concept of Operations (ConOps)

Barges and Railroads have had decreases in cost or are already low cost, making them more cost efficient than trucks!

Method	Cost per Mile	Evaluations
Truck	$1.68	Costs are increasing yearly, as well as road congestion and negative emission effects
Barge	$0.97	Least costly, but do produce environmental issues due to emissions
Railroad	$0.04	Cost per mile is drastically decreasing (43% less in last 30 years)

EPA Diesel Emission Standards

Year of original manufacture	Tier of standards	Standards (g/bhp-hr)			
		NO_x	PM	HC	CO
1973-1992[a]	Tier 0[b]	8.0	0.22	1.00	5.0
1993[a]-2004	Tier 1[b]	7.4	0.22	0.55	2.2
2005-2011	Tier 2[b]	5.5	[e]0.10	0.30	1.5
2012-2014	Tier 3[c]	5.5	0.10	0.30	1.5
2015 or later	Tier 4[d]	1.3	0.03	0.14	1.5



Diesel Engine Exhaust Emissions (DEEE)

Emissions chemistry

NO_x

Air → NO_x

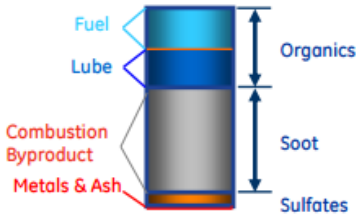
$N_2 + O_2 \xrightarrow{Heat} (NO, NO_2)$

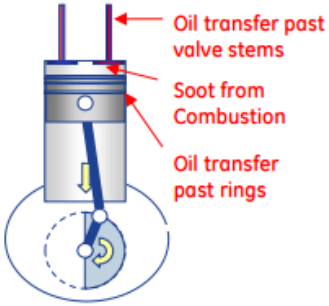
High temp → high NO_x
Higher temp → much higher NO_x

- NO_x ($NO + NO_2$) is formed when air (oxygen and nitrogen) is heated
- NO_x formation is exponential with temperature
  - Higher T → much higher No_x
  - More time at T→ much higher No_x

PM

Origin | What it is





- PM - not a single substance - anything collected on test filter
- Delicate balance of compression, oil control & wear management

CO_2

Fuel + Oxygen → CO_2 + Water + etc.

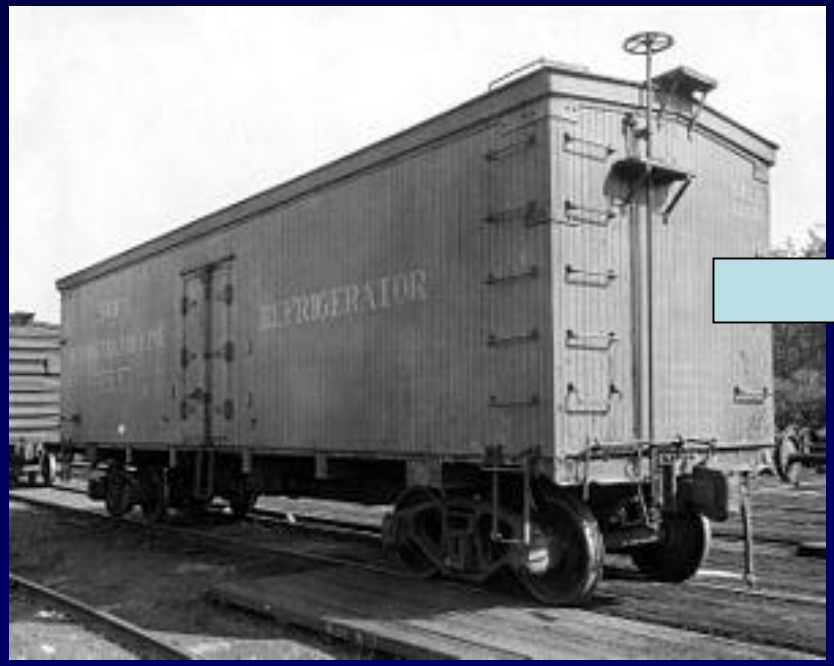
$C_XH_Y + O_2 \rightarrow CO_2 + H_2O + ...$

$C_{in} = C_{out}$, fuel consumption and CO2 production are directly related

- CO_2 is formed in direct proportional to fuel consumed
  - Reduce fuel consumption → reduce CO_2
  - Increase fuel consumption → increase CO_2

Locomotive Fleet Upgrade

- Upgrade from Tier 2 to TIER 4!!!!!!
- Get 2 barges for MAXIMUM CAPACITY!!!
- Sell the Tier 2 locomotives



Summary

We chose an environmental friendly solution that will hold for a long time

- Sell Tier 2
- Buy Tier 4
- Get 2 barges (Capacity)
- Get money ($$$)

Closing

Thanks for an awesome class Prof. B!!!!!!!!!!!

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