

Investing in Clean Air

Aligning Incentives to Achieve Results





Overview

- Looking beyond the emission inventory
- Balancing private and public needs
- Why choose incentives?
- Where to apply incentives
- Optimizing effects of incentives: Pollutant prioritization and valuation
- Example of a quantitative incentive analysis tool based on the ESI program



Beyond the Emission Inventory

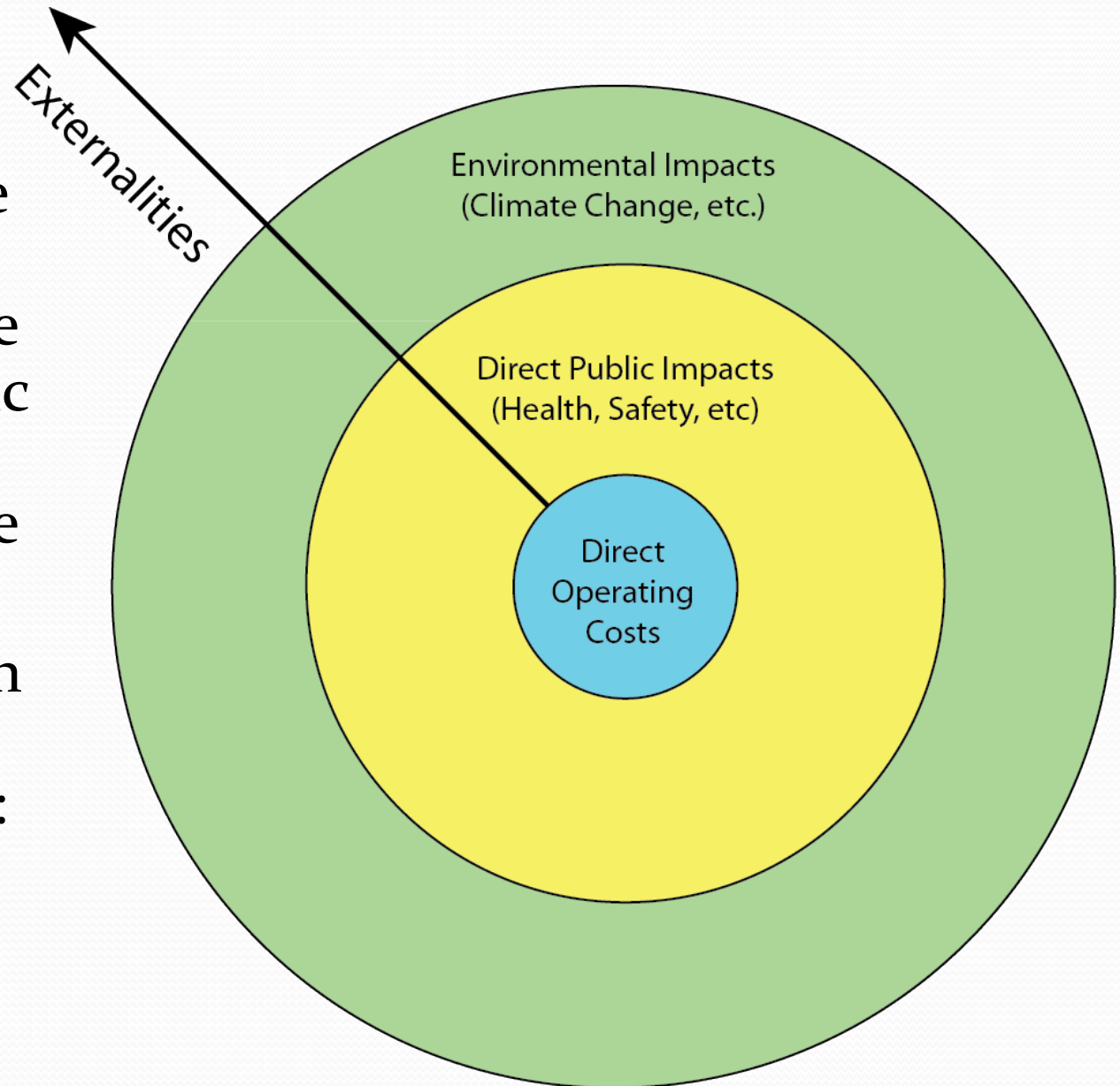
- Planning to mitigate emissions builds on the partnerships created among ports, regulators, and industry during the inventory process
- Many demonstrated options are available for what to do and how to do it, but the discussion quickly comes down to *what will this cost* and *who pays?*

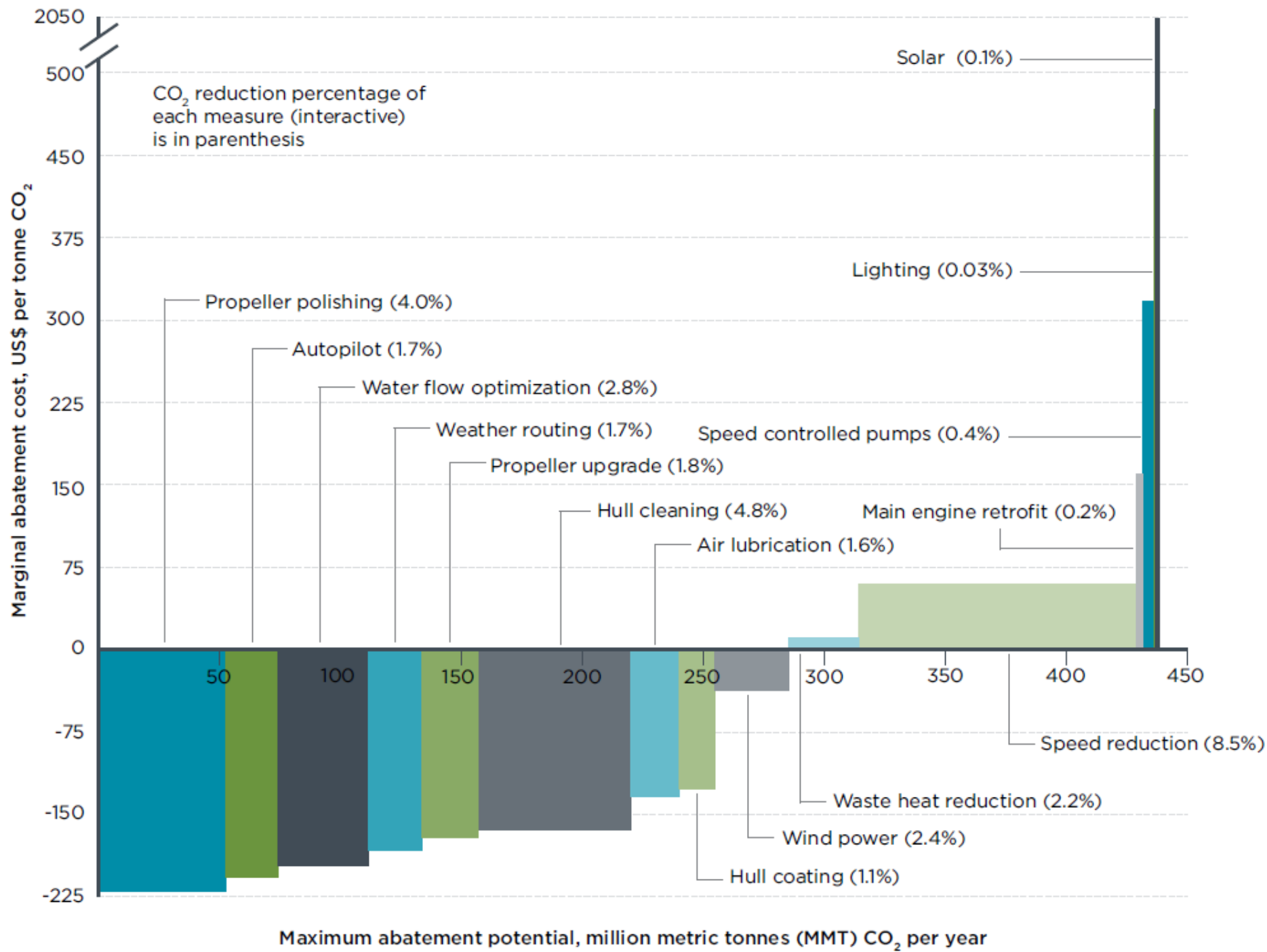


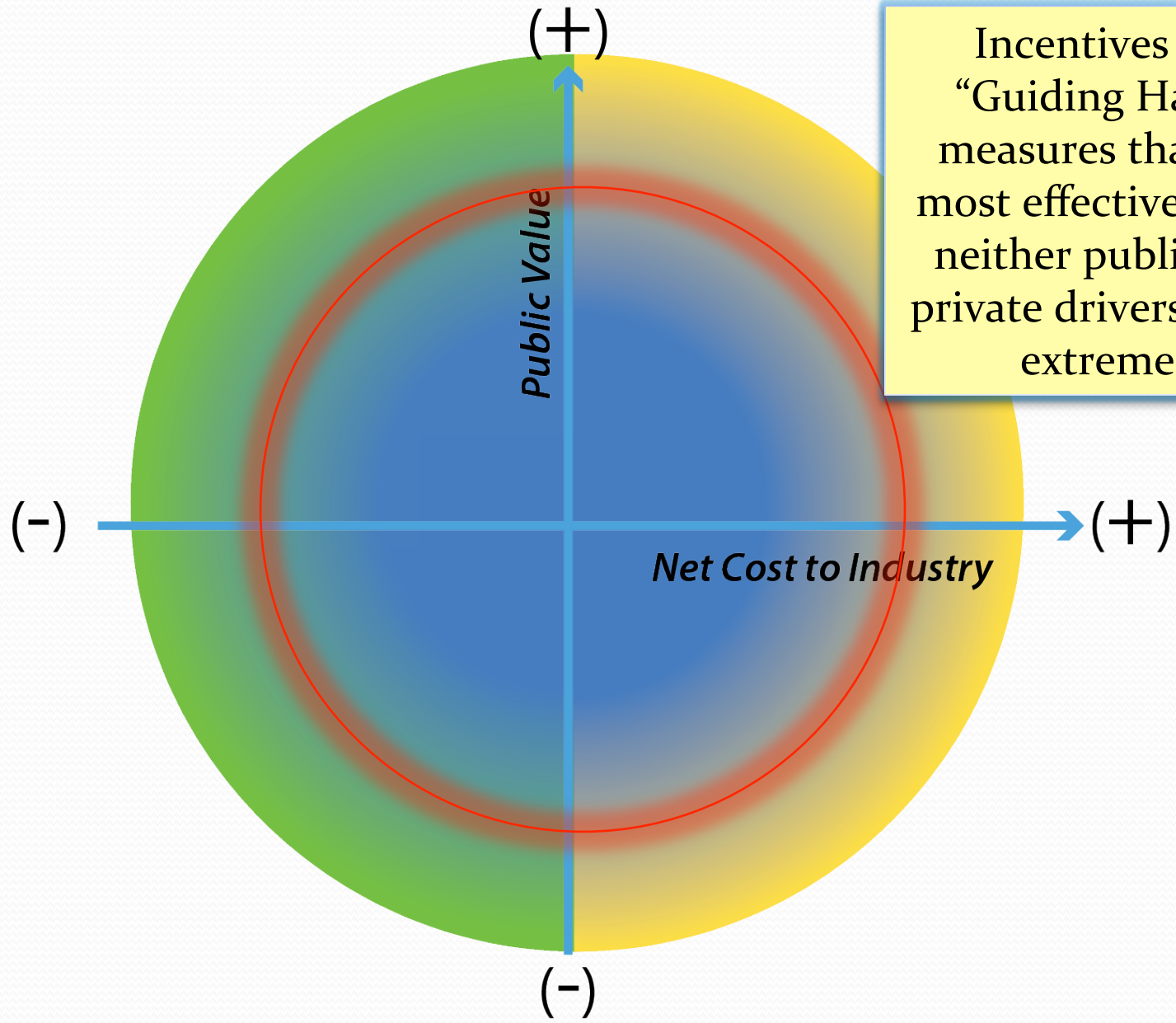
What is Fair?

- Polar opposite concepts of fairness could apply:
 - “Polluter” should pay
 - Public who benefits should pay

- Industry cannot be expected to appropriately value externalities; public cannot appropriately value industry costs
- Fairness is found in between, so most effective approach: *everybody pays*
- *(But how much?)*







Incentives are “Guiding Hand” measures that are most effective when neither public nor private drivers are at extremes

Why Incentives?

(And why ports?)

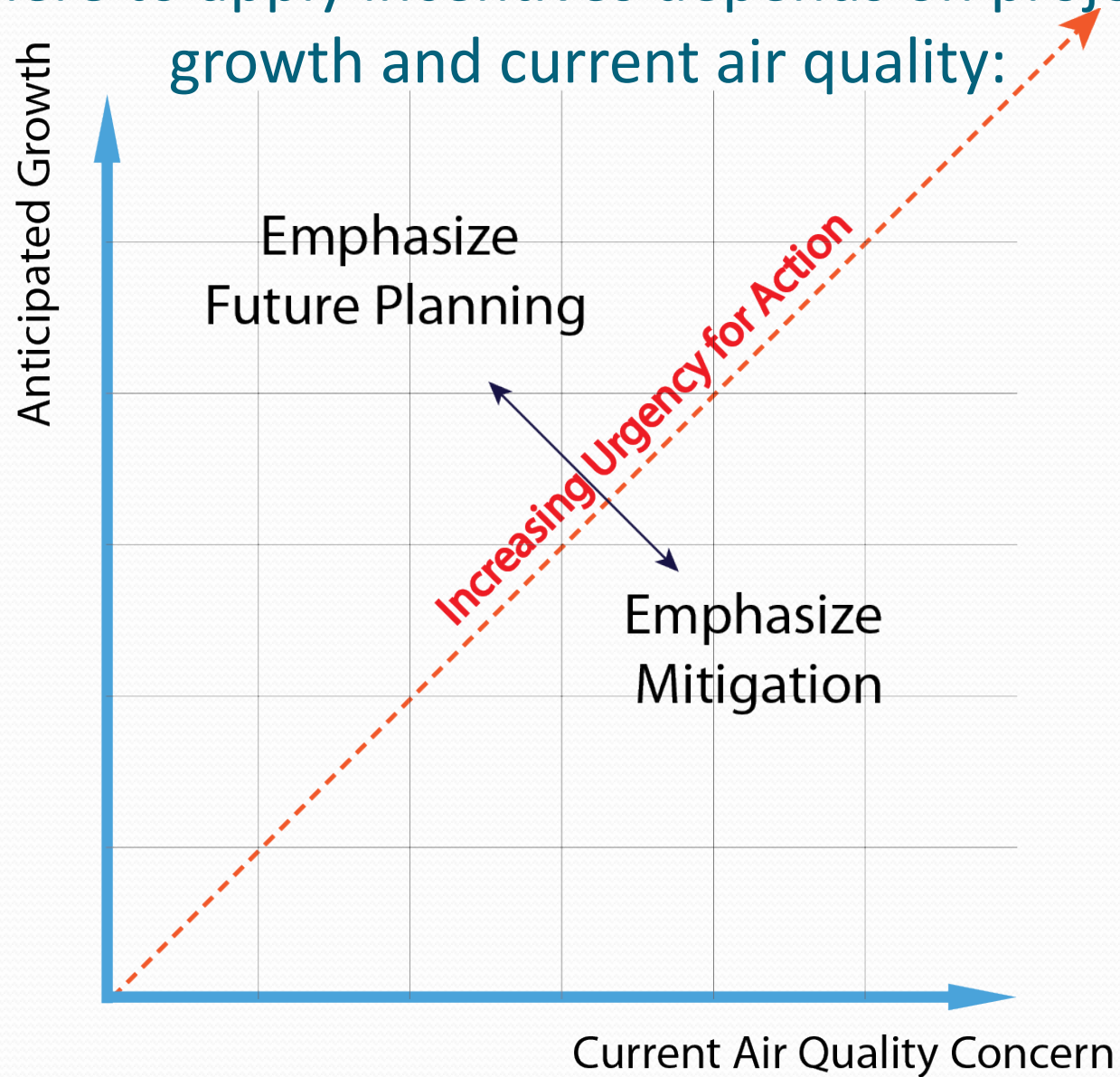
- *Externalities* are usually accounted by an arms-length relationship between government and industry that relies on some combination of industry proactiveness and regulation
- **Incentives function to:**
 - Enhance the ability of industry to be proactive and
 - Serve as a public signal for how much needs to be done and how best to do it
- **Ports** can serve a **critical link** in formulating and deploying incentives because they occupy a **unique position** in the industry/public relationship – **the middle!**



Where to apply incentives:

- How much to invest in what we want things to look like in the future vs. mitigating the current situation
- ***Future investment:***
 - based on anticipated growth; Need to account for long term economic growth and the effects of impending (or lacking) national and international regulation
- ***Mitigate current situation:***
 - If current air quality is already exceeding regulatory or health limits, near-term action is necessary
- How to balance these two?

Where to apply incentives depends on projected growth and current air quality:



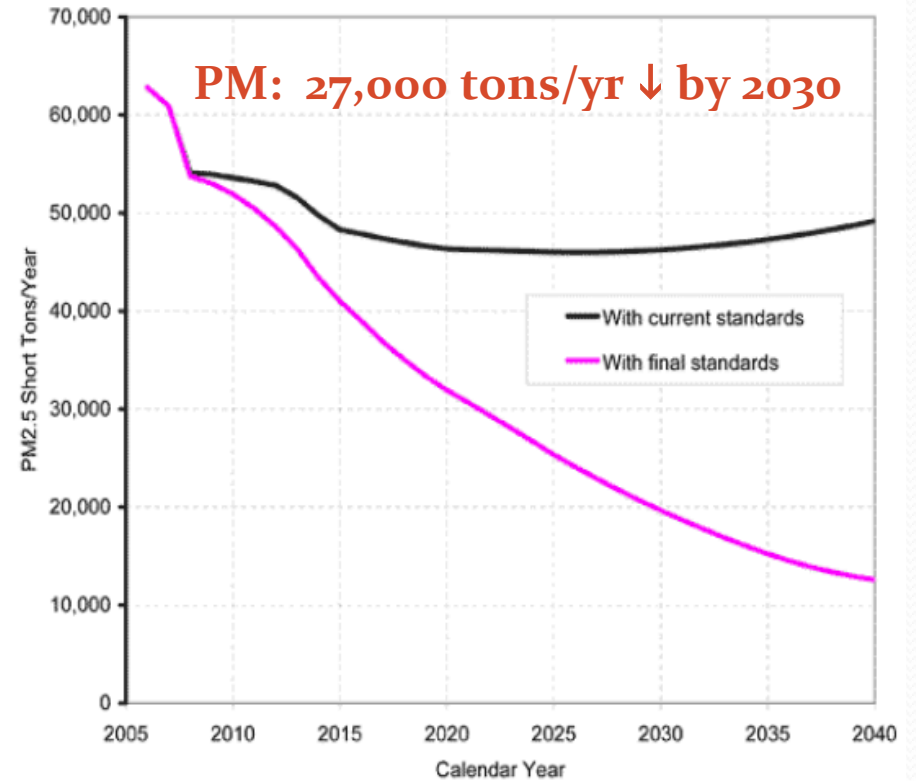
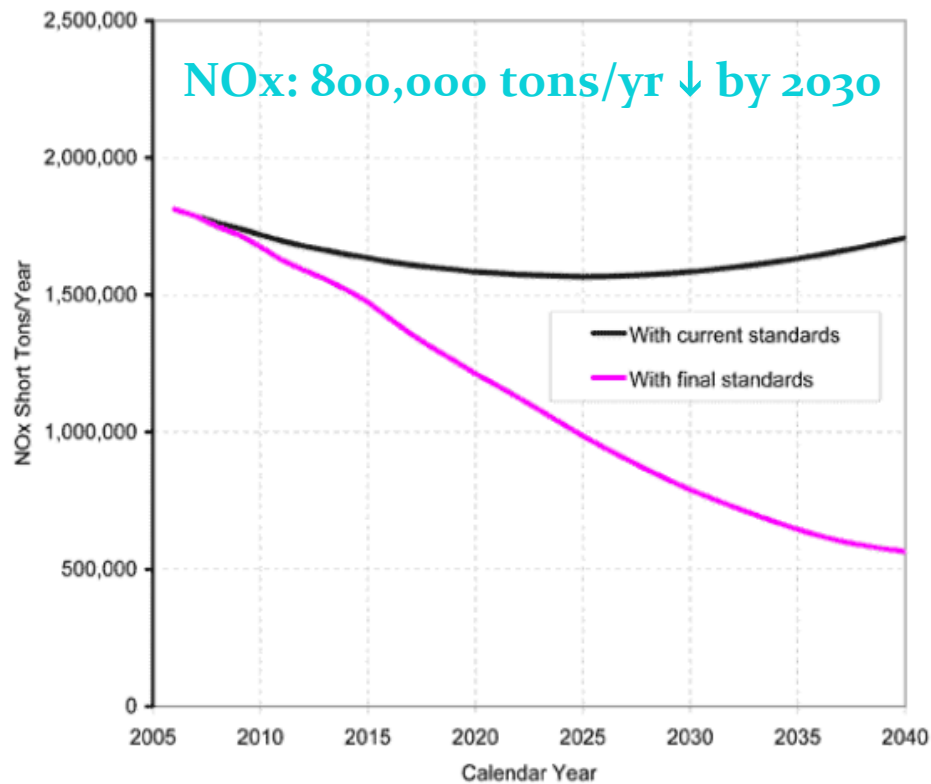
Example: IMO approach to greenhouse gasses started with long-term efficiency

EEDI is great, but ships can only get so big and travel so slow – new focus is on “market-based measures” that will have *near-term* benefits




(Image by Pawel Kuczynski)

Example, Long Term Initiative: US Marine Engine Standards- Gradual Reductions, Major Benefits



- Benefits: ~\$10Billion/year by 2030
- Benefits outweigh costs by between 9:1 and 15:1



Costs and Benefits will vary substantially by pollutant *type* and *location*

- **Many Pollutants Types:**
 - Particulate Matter: PM₁₀, PM_{2.5}, Diesel PM (DPM)
 - SO_x
 - NO_x
 - VOC's, ROG's, NMOG's, etc.
 - Greenhouse Gasses
 - CO₂
 - CH₄
 - Black Carbon (!)

● **Example: Regional values per ton of reducing various PM2.5 precursors**

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Air Qual Atmos Health (2009) 2:169–176

| | | | | | | | | | | | | |
|-------------|--------------------|----------------------|----------------------|-----------------|-----------|-------------|---------|-----------------|-------------------|-----------|-------------|-------------------|
| National | \$720,000 | \$550,000 | \$460,000 | \$40,000 | \$82,000 | \$59,000 | \$2,400 | \$38,000 | \$95,000 | \$15,000 | \$9,700 | \$10,000 |
| Atlanta | \$670,000 | \$590,000 | \$620,000 | \$48,000 | \$15,000 | \$42,000 | \$1,200 | -\$4,100 | \$56,000 | \$7,900 | -\$4,500 | -\$4,100 |
| Chicago | \$510,000 | \$580,000 | \$600,000 | \$29,000 | \$18,000 | \$15,000 | \$3,100 | \$36,000 | \$100,000 | \$1,100 | \$2,000 | -\$8,700 |
| Dallas | \$1,100,000 | \$790,000 | \$1,100,000 | \$140,000 | | \$29,000 | \$600 | \$16,000 | \$36,000 | \$34,000 | \$920 | \$370 |
| Denver | \$280,000 | \$450,000 | \$220,000 | \$75,000 | \$6,400 | \$19,000 | \$1,400 | \$10,000 | \$58,000 | \$3,200 | \$3,800 | \$2,700 |
| NY/Phi | \$570,000 | \$710,000 | \$780,000 | \$14,000 | \$74,000 | \$50,000 | \$4,300 | \$53,000 | \$140,000 | \$1,500 | -\$2,600 | -\$8,200 |
| Phoenix | \$2,500,000 | \$1,700,000 | \$980,000 | \$73,000 | | \$550,000 | \$2,000 | \$15,000 | \$43,000 | \$11,000 | -\$2,100 | -\$680 |
| Salt Lake | \$140,000 | \$150,000 | \$65,000 | \$15,000 | | \$9,100 | \$2,600 | \$29,000 | \$43,000 | | \$4,200 | \$1,500 |
| San Joaquin | \$910,000 | \$560,000 | \$720,000 | \$140,000 | \$350,000 | \$46,000 | \$5,700 | \$36,000 | \$140,000 | \$28,000 | \$28,000 | \$43,000 |
| Seattle | \$500,000 | \$570,000 | \$720,000 | \$54,000 | \$6,300 | \$52,000 | \$560 | \$18,000 | \$49,000 | \$120,000 | -\$2,300 | -\$8,100 |
| | Area source carbon | Mobile source carbon | EGU & Non-EGU carbon | Area source SOX | EGU SOX | Non-EGU SOX | VOC | Area source NH3 | Mobile source NH3 | EGU NOX | Non-EGU NOX | Mobile source NOX |

Monetized \$/ton in 2015 of reductions in PM2.5 precursor emissions by area of the country (2006\$, 3% discount rate)

(Chart from Fann et al (2008); mortality estimates from Laden et al. (2006): Reduction in fine particulate air pollution and mortality. Am J Respir Crit Care Med 173:667–672.)



Where to start?

Example: Starcrest model of costs and benefits associated with the ESI

- IAPH's Environmental Ship Index (ESI), a universal incentive program designed to be applicable to all ports
- Starcrest is developing a model (funded by ICCT, POLA, POLB) that calculates benefits in **tons** and **dollars** associated with various levels of incentive investment
- Goal is to more easily identify and align incentive program goals and investment budget

Model Overview

Enter OGV Geographical Domain Parameters

Enter Ship Main Engine Parameters

Enter Ship Auxiliary Engine Parameters

Enter Ship Fuel Type & Sulfur Parameters

Enter Incentive Parameters

Model Overview

Model Calculates User
Scenario Inputs & Outputs
Results

Output:
ESI Score

Output:
Emissions
Reduced

Output:
\$/ton

Model Overview



Incentive Programs Analysis Tool - Scenarios Summaries

DRAFT

v. 16 Feb 12

| Vessel Type | ESI Scenario Summary \$750 per Call | | | | | | Tier Scenario Summary | | | | | VSR Scenario Summary 1-Day Dockage | | | |
|----------------------------|---|---|---|---|--------------------------------------|---|--|--|---|---|---|---|---|--|---|
| | | | | 1-Day Dockage | | | Variable Fixed | | 1-Day Dockage | | | | | | |
| | 2012 ESI Prog NOx Reductions (tons) | 2012 ESI Prog DPM Reductions (tons) | 2012 ESI Fixed Incentive (\$) | 2012 Fixed Avg Cost \$/tons Reduced per Call | 2012 Dockage Incentive (\$) | 2012 Dockage Avg Cost \$/tons Reduced per Call | 2012 Tier Prog NOx Reductions (tons) | 2012 Scenario Fixed Incentive (\$) | 2012 Fixed Avg Cost Eff \$/tons Reduced per Call | 2012 Dockage Based Incentive (\$) | 2012 Dockage Avg Cost Eff \$/tons Reduced per Call | 2012 Scenario Net NOx Reduction (tons) | 2012 Scenario Net DPM Reduction (tons) | 2012 Scenario Dockage Incentive (\$) | 2012 Dockage Incentive \$/ton Reduced per Call |
| Auto Carrier | 17.7 | 0.8 | \$75,000 | \$2,244 | \$26,807 | \$802 | 38.6 | \$87,500 | \$2,269 | \$29,041 | \$753 | 15.2 | 0.37 | \$35,743 | \$1,586 |
| Bulk | 8.6 | 0.4 | \$42,000 | \$2,692 | \$20,706 | \$1,327 | 19.0 | \$49,000 | \$2,579 | \$22,432 | \$1,180 | 4.9 | 0.05 | \$27,608 | \$4,617 |
| Bulk - Heavy Load | 0.5 | 0.0 | \$2,250 | \$2,547 | \$749 | \$848 | 1.3 | \$3,500 | \$2,765 | \$1,082 | \$855 | 0.3 | 0.00 | \$999 | \$3,278 |
| Bulk Wood Chips | 0.2 | 0.0 | \$1,500 | \$4,165 | \$877 | \$2,435 | 0.5 | \$2,000 | \$4,181 | \$1,169 | \$2,444 | 0.2 | 0.00 | \$1,169 | \$4,986 |
| Container1000 | 7.3 | 0.3 | \$43,500 | \$3,473 | \$21,446 | \$1,712 | 15.2 | \$51,000 | \$3,352 | \$23,418 | \$1,539 | 9.1 | 0.20 | \$28,594 | \$2,193 |
| Container2000 | 50.3 | 2.3 | \$156,750 | \$1,641 | \$123,895 | \$1,297 | 102.4 | \$183,500 | \$1,792 | \$134,566 | \$1,314 | 46.7 | 1.06 | \$165,194 | \$2,436 |
| Container3000 | 7.9 | 0.4 | \$18,750 | \$1,231 | \$16,965 | \$1,114 | 16.1 | \$22,500 | \$1,397 | \$18,775 | \$1,166 | 6.7 | 0.07 | \$22,620 | \$2,768 |
| Container4000 | 129.5 | 6.3 | \$250,500 | \$984 | \$324,247 | \$1,274 | 272.4 | \$292,500 | \$1,074 | \$351,753 | \$1,291 | 101.3 | 2.28 | \$432,330 | \$2,943 |
| Container5000 | 131.1 | 7.8 | \$248,250 | \$868 | \$287,176 | \$1,004 | 296.4 | \$290,500 | \$980 | \$312,047 | \$1,053 | 101.0 | 2.22 | \$382,901 | \$2,632 |
| Container6000 | 88.2 | 5.9 | \$158,250 | \$767 | \$204,839 | \$993 | 208.9 | \$185,500 | \$888 | \$222,960 | \$1,067 | 78.7 | 1.81 | \$273,118 | \$2,377 |
| Container7000 | 55.5 | 3.7 | \$87,000 | \$671 | \$152,476 | \$1,175 | 132.1 | \$101,500 | \$768 | \$165,183 | \$1,250 | 50.8 | 1.22 | \$203,302 | \$2,701 |
| Container8000 | 88.6 | 6.1 | \$153,000 | \$726 | \$268,148 | \$1,273 | 214.4 | \$178,500 | \$833 | \$290,493 | \$1,355 | 67.0 | 1.58 | \$357,530 | \$3,627 |
| Container9000 | 7.9 | 0.5 | \$11,250 | \$611 | \$19,717 | \$1,071 | 17.1 | \$14,000 | \$821 | \$22,784 | \$1,336 | 2.2 | 0.02 | \$26,289 | \$9,876 |
| Cruise | 118.3 | 5.3 | \$117,000 | \$521 | \$79,509 | \$354 | 277.3 | \$136,500 | \$492 | \$86,134 | \$311 | 38.7 | 0.87 | \$106,011 | \$1,893 |
| General Cargo | 25.4 | 0.9 | \$61,500 | \$1,426 | \$30,320 | \$703 | 48.4 | \$72,000 | \$1,487 | \$33,031 | \$682 | 11.7 | 0.32 | \$40,426 | \$2,222 |
| MISC | 0.2 | 0.0 | \$1,500 | \$4,230 | \$100 | \$283 | 0.4 | \$2,000 | \$5,282 | \$134 | \$353 | 0.4 | 0.00 | \$134 | \$277 |
| Reefer | 12.2 | 0.3 | \$27,000 | \$1,449 | \$7,139 | \$383 | 20.3 | \$31,500 | \$1,555 | \$7,734 | \$382 | 2.9 | 0.02 | \$10,708 | \$3,283 |
| RoRo | 0.2 | 0.0 | \$750 | \$2,929 | \$153 | \$596 | 0.5 | \$1,500 | \$2,979 | \$254 | \$505 | 0.1 | 0.00 | \$203 | \$2,062 |
| Tanker - Aframax | 1.3 | 0.1 | \$3,000 | \$1,264 | \$2,714 | \$1,143 | 3.7 | \$3,500 | \$957 | \$2,941 | \$804 | 0.8 | 0.01 | \$3,619 | \$3,846 |
| Tanker - Chemical | 29.4 | 1.2 | \$72,000 | \$1,360 | \$29,462 | \$557 | 62.2 | \$84,000 | \$1,351 | \$31,918 | \$514 | 8.8 | 0.30 | \$39,283 | \$2,661 |
| Tanker - Handyboat | 15.3 | 0.5 | \$47,250 | \$1,837 | \$23,294 | \$906 | 27.6 | \$56,000 | \$2,026 | \$25,636 | \$927 | 6.2 | 0.07 | \$31,059 | \$4,143 |
| Tanker - Panamax | 19.7 | 0.8 | \$45,750 | \$1,266 | \$36,161 | \$1,000 | 48.5 | \$54,000 | \$1,113 | \$39,520 | \$815 | 6.8 | 0.07 | \$48,214 | \$5,838 |
| Tanker - VLCC | 0.9 | 0.0 | \$750 | \$528 | \$868 | \$611 | 2.6 | \$1,500 | \$567 | \$1,446 | \$547 | 0.2 | 0.00 | \$1,157 | \$5,384 |
| Programmatic Totals | 816.3 | 43.4 | \$1,624,500 | \$964 | \$1,677,766 | \$996 | 1,825.8 | \$1,904,000 | \$1,043 | \$1,824,449 | \$999 | 560.7 | 12.64 | \$2,238,211 | \$2,758 |

Notes: Forecast - 2007 high growth and does not include IMO Tier 2 & 3 standards

VSR + ESI \$3,791 /ton Reduced per Call Fixed
VSR + ESI \$3,844 /ton Reduced per Call Dockage

Module Specific Notes:

\$/ton Reduced includes NOx & DPM combined

Dockage Rate Reduction: 15%

Fixed Incentive per Call: Tier 2 \$500 Tier 3 \$1,500

Dockage Rate Reduction: Tier 2 15% Tier 3 25%

Dockage Rate Reduction (20nm): 15%

Dockage Rate Reduction (40nm): 25%

\$/ton Reduced includes NOx & DPM combined



Model Aspirations

- We expect that a generic version of this model will be available for ports and regulators to analyze cost and benefits of incentive scenarios.
- ICCT may also use the model to evaluate regional applications of ESI and incentive programs to promote progressive incentive-based maritime air quality policies.
- Starcrest hopes to expand the model to cover additional pollutants, incentives schemes, and other policy considerations.



Success or failure is a matter of perspective

Make sure external perception is correct!

Establish appropriate metrics that measure and demonstrate progress and allow iterative planning for improvement
– or somebody else will define success for you!

Thank You!
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