Retrofit Technology Verification

A Texas Perspective

RUDY SMALING

HOUSTON ADVANCED RESEARCH CENTER

HARC

Texas Emissions Reduction Plan

- *The **Texas Emissions Reduction Plan (TERP)*** is a comprehensive set of incentive programs aimed at improving air quality in Texas
- The ***New Technology Research and Development (NTRD)*** program is part of TERP and is aimed at stimulating the development and verification of NO_x reduction technology and products
- The ***Emissions Reduction Incentive Grants (ERIG)*** program is part of TERP and provides grants to eligible projects in nonattainment areas and affected counties. The grants offset the incremental costs associated with reducing NO_x emissions from diesel engines

Texas Emissions Reduction Programs

- **Texas Legislature**
  - Established *Texas Emissions Reduction plan* in 2001
  - NO_x capped at $15,000/ton
  - Funded through registration fees, current level ~$180M/year
- **Texas Commission on Environmental Quality**
  - Administers TERP (ERIG and RGP)
  - Sub-contracts the New Technology Research & Development program
  - Average NO_x retrofit cost effectiveness approximately $5500/ton
- **Texas Environmental Research Consortium**
  - Non-profit established in 2002 (http://www.tercairquality.org)
  - Board of Directors consists primarily of high level public officials
  - Sub contracts all work to the Houston Advanced Research Center
- **Houston Advanced Research Center**
  - A non-profit research management organization
  - HARC Administers NTRD program with oversight from TCEQ

NTRD Legislative Requirements

- Support the development of new technologies that reduce emissions, specifically NO_x
- Support those new technologies which will be commercially available in five years
- Balance between projects for new and existing engines
- Support technologies that are cost effective
  - Texas Legislature capped NO_x value at $15,000 per ton*
- Minimum reduction in NO_x of 25% required
- Ineligible if already required by law or rule.

*Current TERP cost effectiveness ~$5,000-$6,000 per ton NO_x

NTRD Technology Development Strategy

- Focus on major NOx emissions sources
  - On-road, Construction, Marine, Locomotives, Commercial/industrial
- Expedite emissions technology verification & implementation
  - Verification of new retrofit technologies or extend verification to other applications
- Develop new, low-emissions engine technologies
- Develop engine upgrade kits and retrofits
  - Particularly cost-effective when installed at scheduled engine overhaul
- Develop exhaust treatment retrofit technology
  - Critical to match technology and application operational characteristics
- Study and pursue alternative fuels and fuel additive improvements
- Seek opportunities to develop hybrid powertrain projects
  - Energy and emissions win-win solutions

Technology Funding Decisions

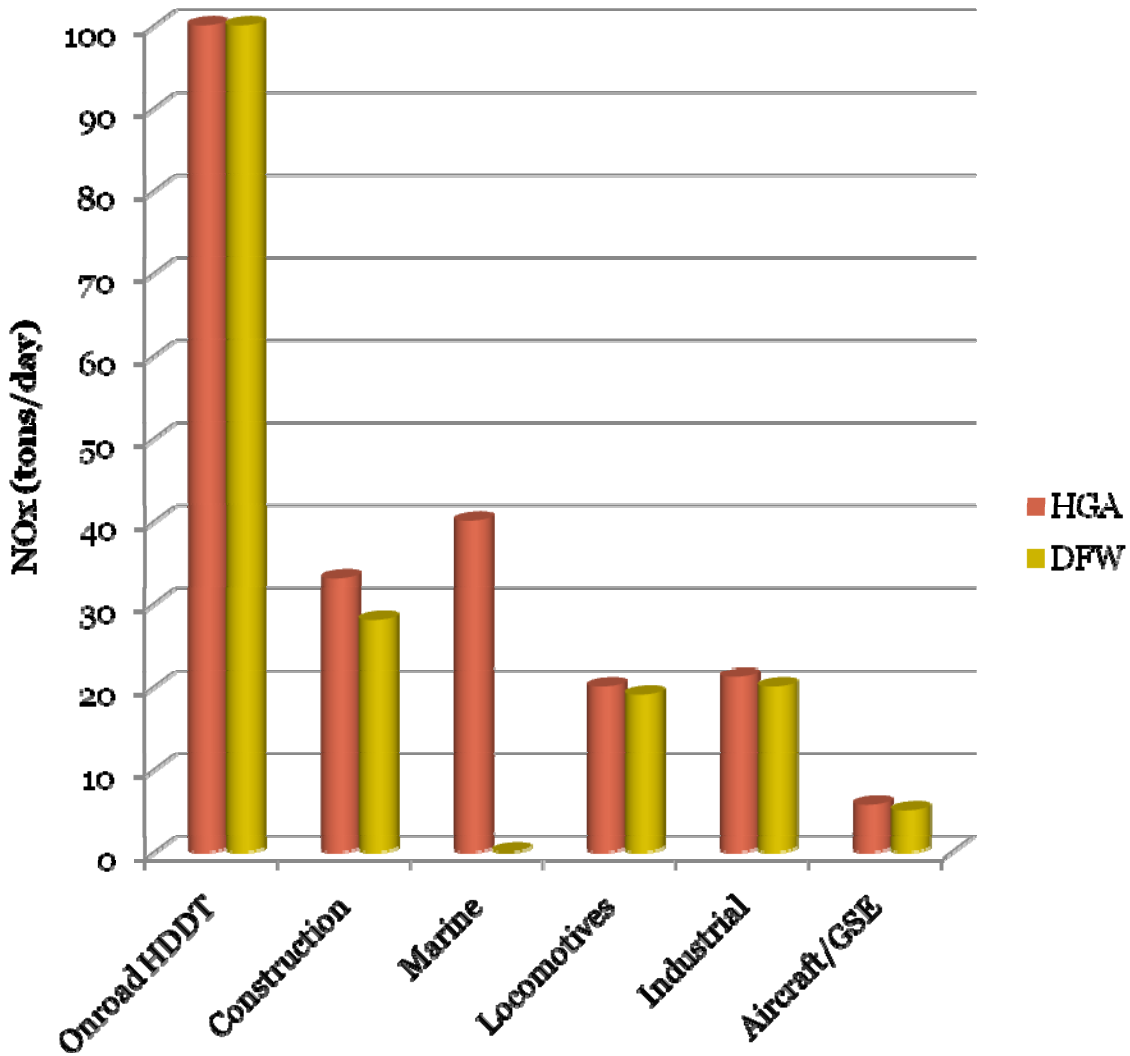
- Complicated interplay of science, technology, economics, and policy at both the national and regional level with many stakeholders
- A project portfolio strategy with both targeted and broad funding rounds to balance across a range of applications and technologies
- A pragmatic approach focusing more product development and business sensibility than truly advanced technologies

2007 Texas NO_x Emissions Inventory

On-road HDDT by far the largest NO_x source category

Overall category emissions not necessarily the best indicator for NTRD project selection

More detailed evaluation required of the distribution of the various regulated emissions levels within the categories



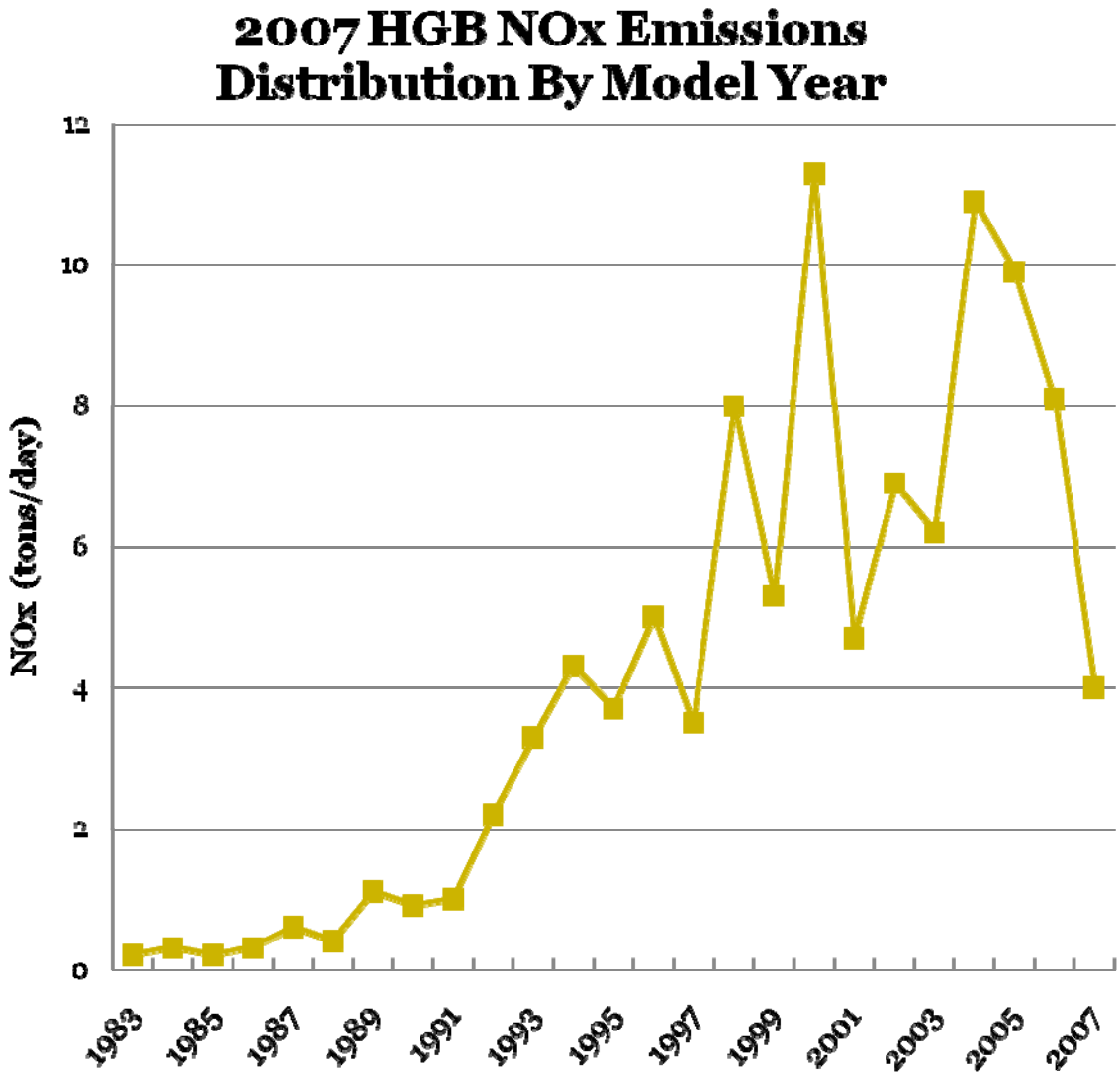
On-Road HDDT Emissions

TERP has been very successful replacing pre-1990 engines at ~$5,000 per ton NO_x

Greater than 90% of NO_x emissions from trucks less than 15 years old

Engine replacement of post-1990 engines half as cost effective as for pre-1990 engines

Largest source category for diesel NO_x emissions



Source: TERC H42

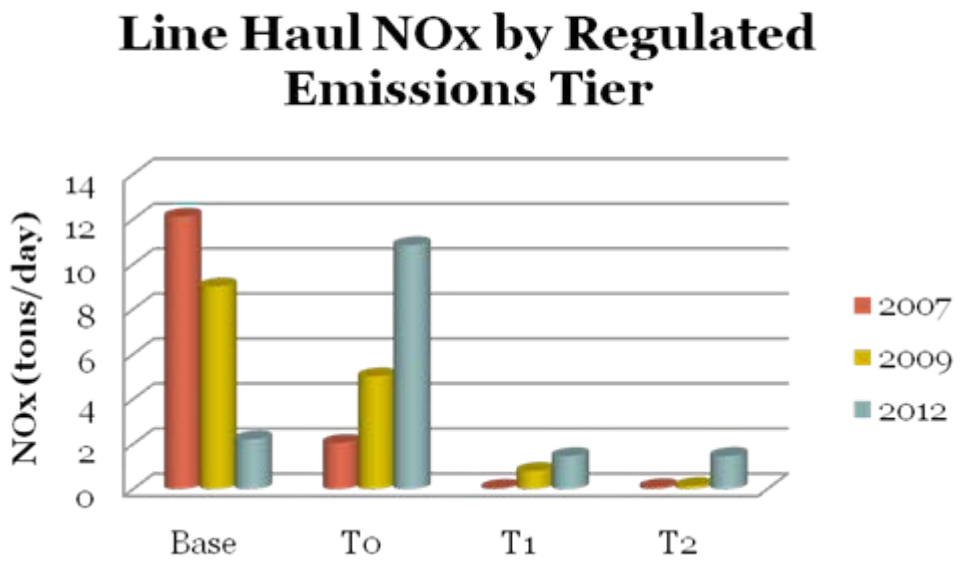
HGB Locomotive Emissions

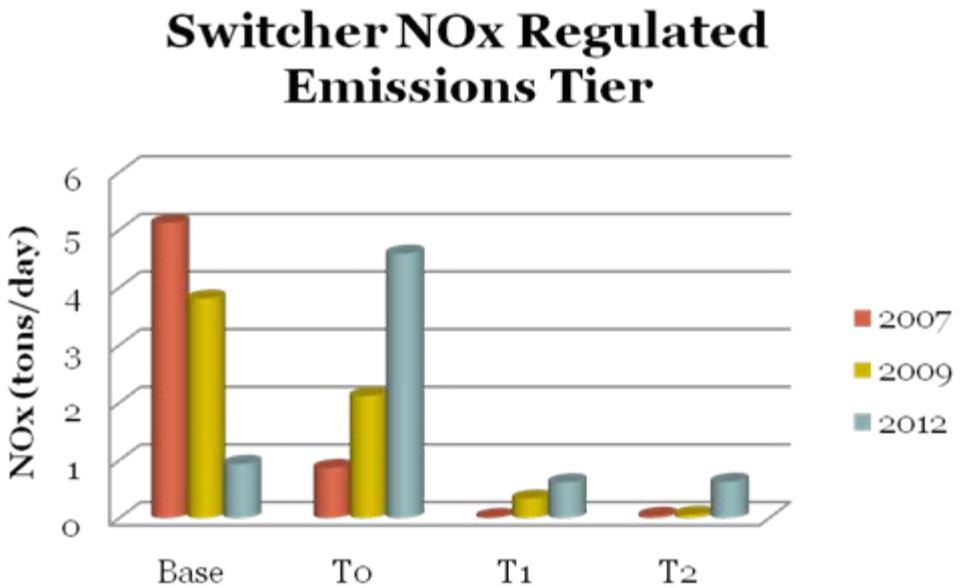
TERP has been very successful replacing uncontrolled or Tier 0 engines at ~$2,500 per ton NO_x

More than $120M spent through August 2006

Significant potential left for additional cost effective NO_x reductions

Numbers may not reflect recent switcher locomotive retrofits





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Source: TERC H72

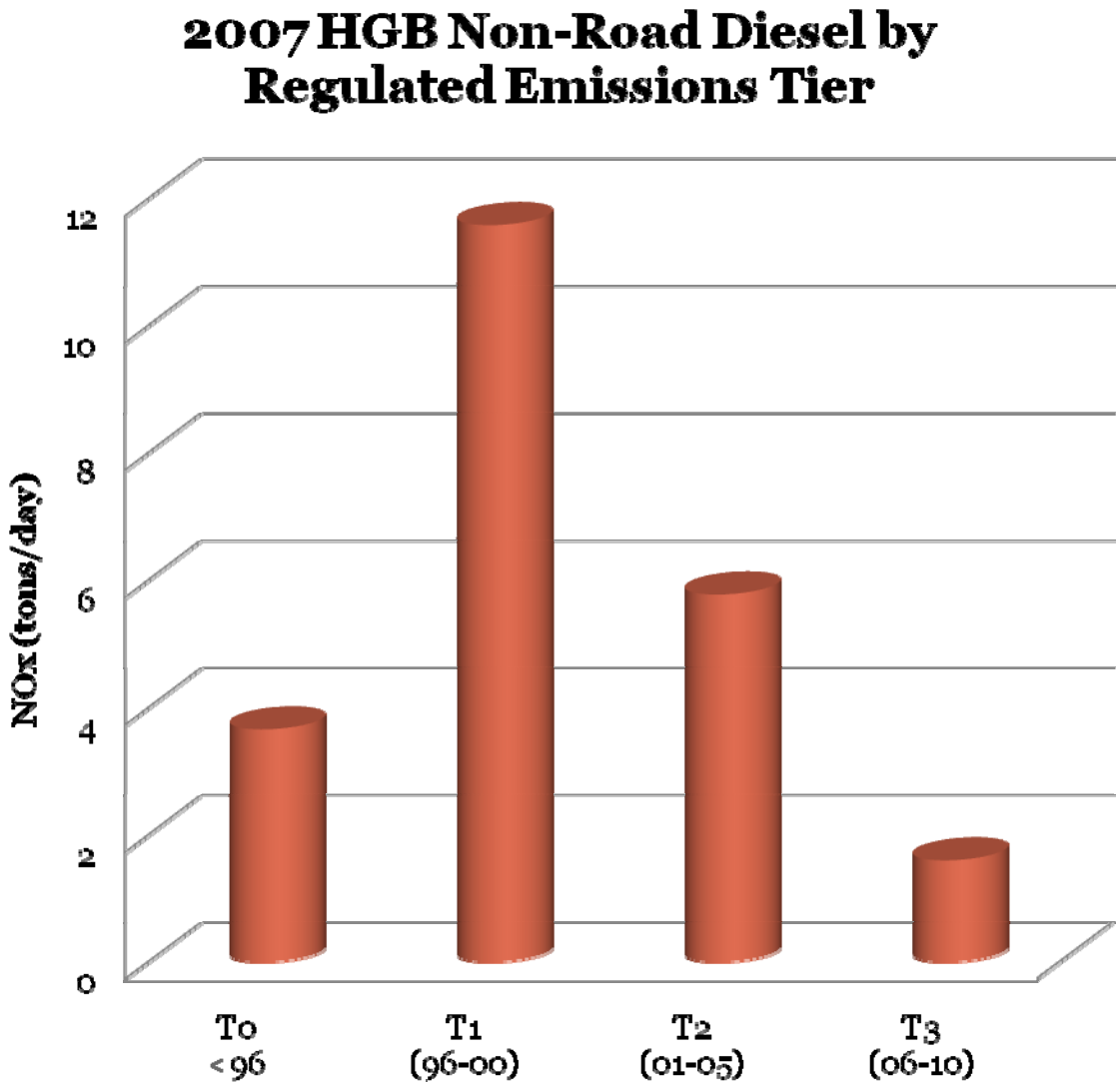
Non-road Construction Equipment Emissions

Possibly the most challenging category for reducing NO_x emissions

A wide variety of equipment with many different engines types and sizes

A wide variety of duty cycles

TERP cost effectiveness currently around $10,000 per ton NO_x



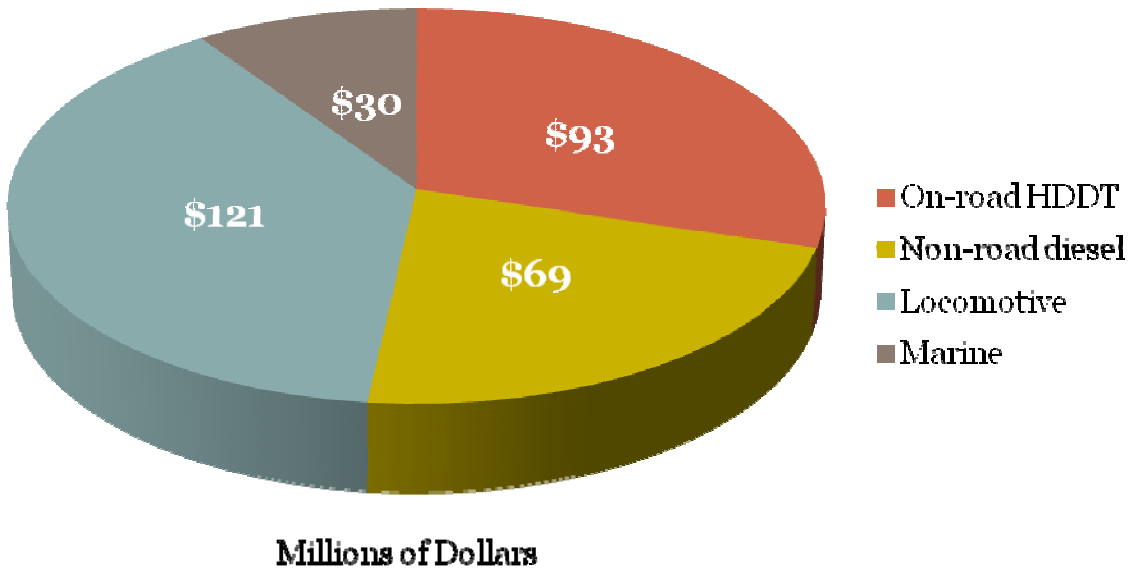
HARC

Source: TERC H42

TERP Spending through August 2006

Nearly all TERP funds spent on engine replacements

Largest portion of funds spent in the locomotive sector



Project Number	RFGA	Project Title	Applicant	Grant Amount
N-01	1	Strategic Technology Assessment	ERG	$199,977
N-02	2	Drayage Drive Cycle Development	UT-Austin	$212,892
N-03	3	SCR for on- and off-road application	NETT Technologies	$750,000
N-04	3	UREA SCR retrofit for select Texas HDDE	Volvo/Mack	$750,000
N-05	3	Off-road SCRT retrofit system	Johnson Matthey	$749,400
N-06	3	On-road SCRT retrofit system	Johnson Matthey	$749,400
N-07	3	SCR for non road applications	CCA	$230,750
N-09	3	DOC + SCR system	ECS	$560,220
N-11	3	Verification of compact SCR in Locomotives	EFEE	$116,635
N-12	3	Mechanical variable injection timing	Motive Engineering	$576,179
N-13	3	DPF system with some NOx reduction	Rypos, Inc.	$750,000
N-14	3	HC SCR retrofitting of select Texas HDDE	Volvo/Mack	$750,000
N-15	6	Reformate assisted LNT	Electricore	$750,000
N-16	6	Exhaust Burner for SCR	Woodward	$544,914
N-17	6	Low temperature SCR	Cummins	$750,000
N-18	6	Idle reduction technology	Nextronics	$408,260
N-19	6	Ceramic catalyst Nox reduction system	Analytical Engineering	$600,000
N-20	6	Hydraulic Launch Assist refuse hauler	Eaton	$692,867
N-21	7	50% NOx Reduction Kit for Marine Engines	Advanced Global Engineering	$226,427
N-22	7	Urea-SCR System for Marine application	MJ Bradley	$248,815
N-23	7	XTRM Cat™ Aftertreatment for Marine	ESW America	$250,000
N-24	8a	EMD645E Overhaul Kit	Electro Motive Diesel	$409,443
N-25	8a	EMD710 Overhaul Kit Phase I	Electro Motive Diesel	$749,750
N-26	8a	EMD645EB/FB Overhaul Kit	Electro Motive Diesel	$456,200
N-27	8a	25-40% NOx reduction Kit	International Truck & Engine	$357,720
N-28	9	Biodiesel blend TxLED testing	National biodiesel Board	$122,775
N-29	9	Biodiesel blend TxLED testing	Viscon	$250,000
N-30	10	Biodiesel NOx effect R&D	Texas A&M	$600,000

How to Apply

- Funding opportunities are available on a regular basis
- Go to http://www.tercairquality.org/NTRD/Funding/RFGAs/ to see the latest Request For Grant Applications
- Download and complete all required documents and submit by the listed deadline