

The Future is Now for “Real World” Remote Sensing!

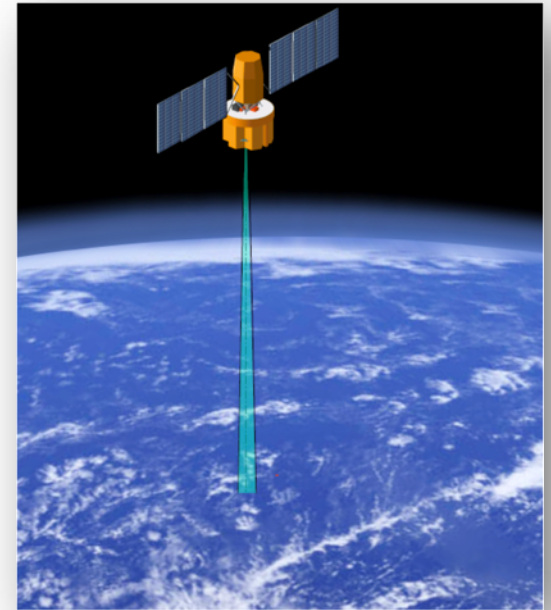


**Hager Environmental & Atmospheric
Technologies
HEAT**



Genesis of HEAT's Technology: EDAR

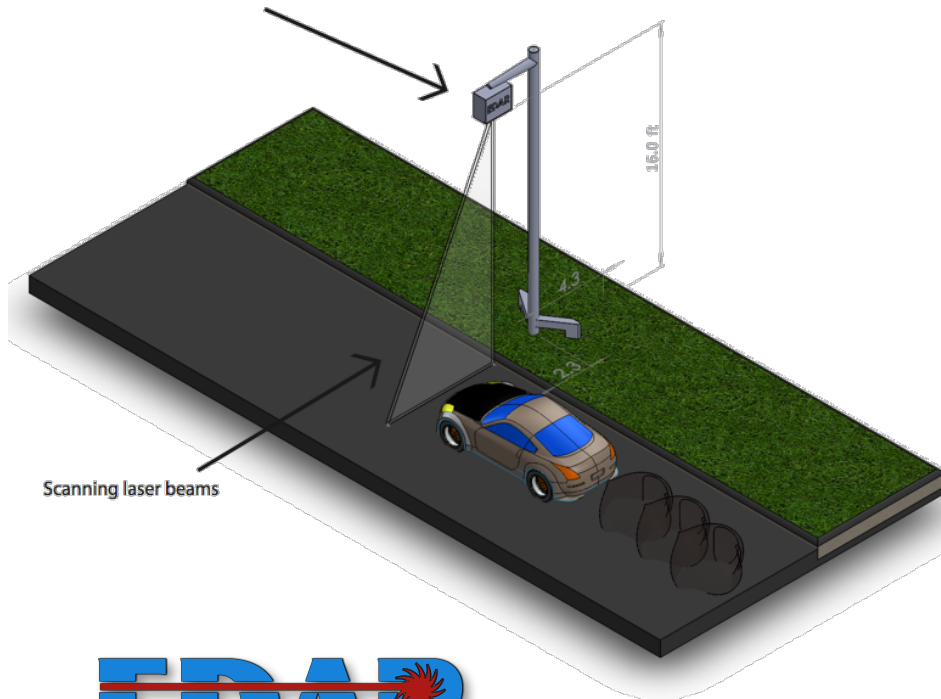
- HEAT's Remote Sensing Technology named EDAR is based on NASA's ASCENDS Satellite's platform
 - Dr. Stewart Hager, EDAR's inventor, worked with NASA Langley in the development of the ASCENDS Satellite
- Most recently, NASA recognized EDAR as one of their SPINOFF Technologies in their journal published in January 2017
- EDAR began in 2009 and was commercialized then introduced to the North American Market in 2014



What is EDAR?

EDAR system includes:

- License plate Recognition Camera
- Speed & Acceleration Detector
- Laser Remote Sensing of Vehicle Exhaust



EDAR
Emission Detection And Reporting



Remote sensing: detects
real world emissions



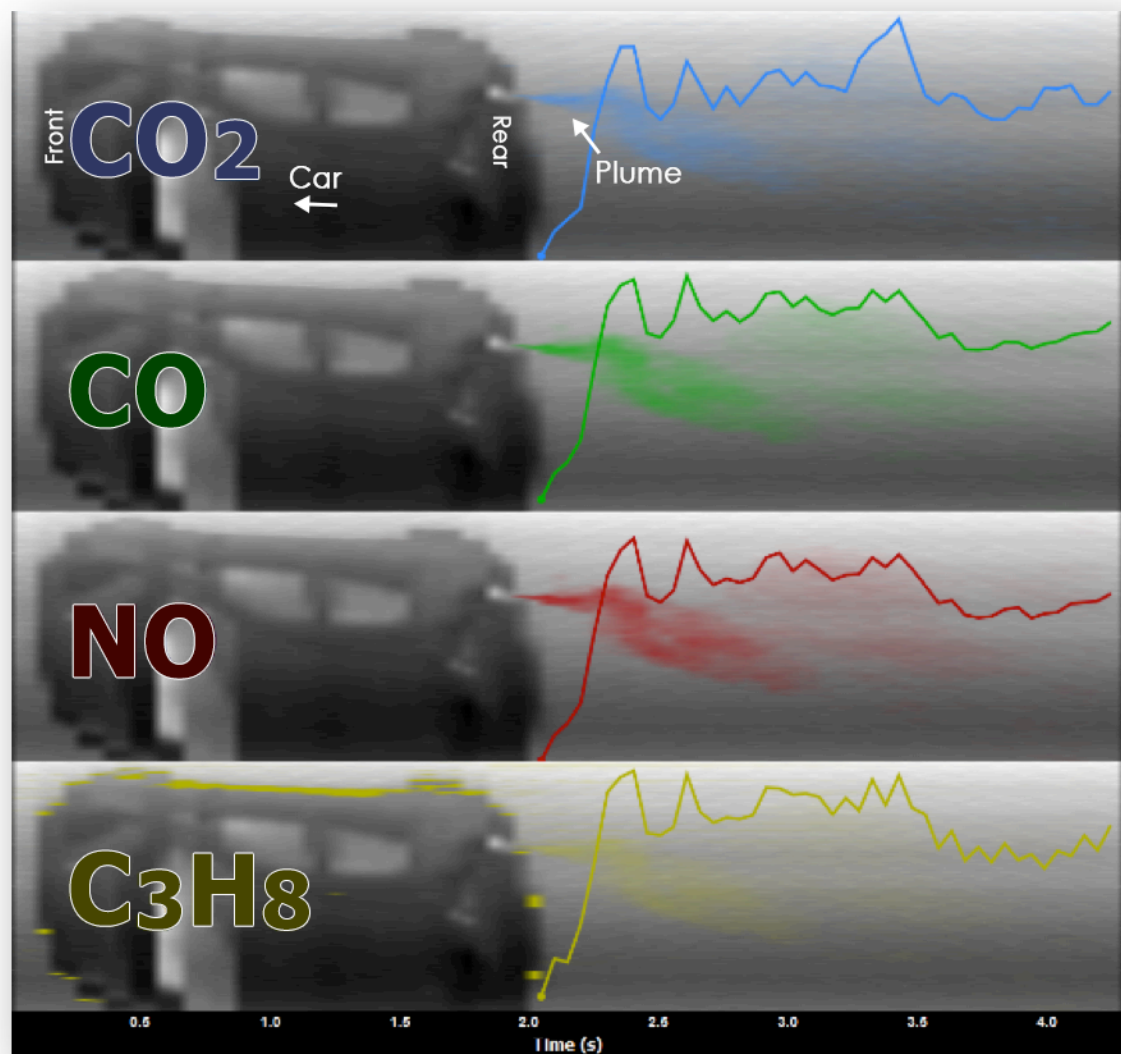
Measures & quantifies
CO₂, CO, NO, NO₂, HC
and **PM_{2.5}**



Remote sensing monitors
24 hours a day, 7 days a
week, 365 days a year
unmanned

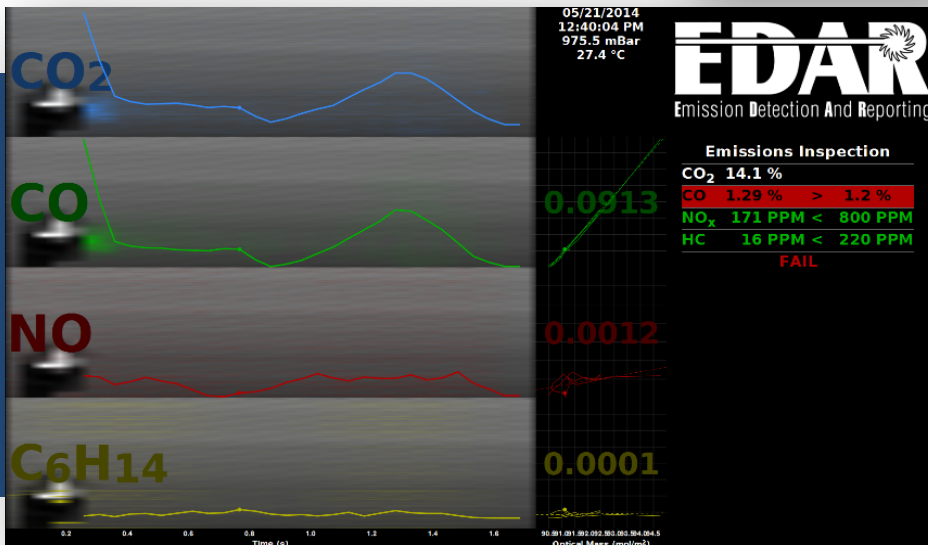
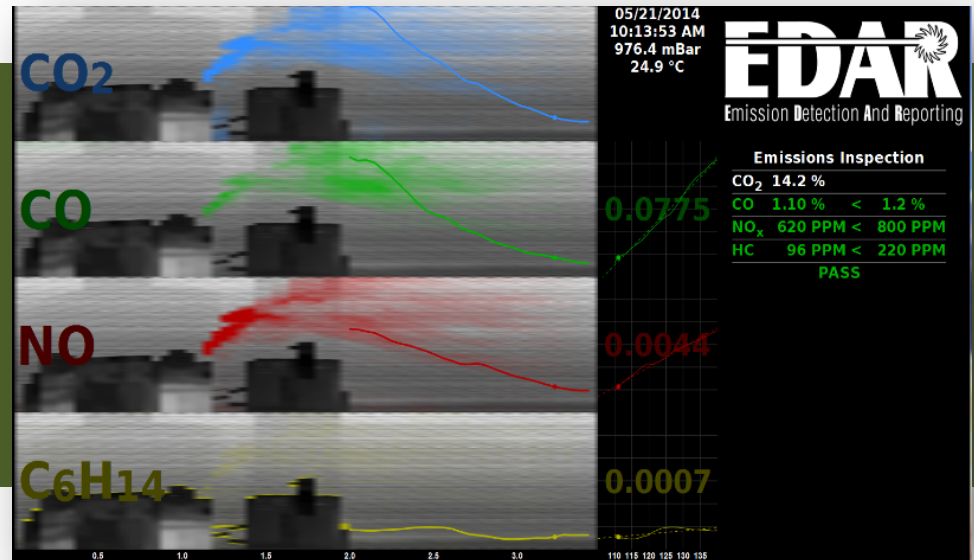
Pollution of Vehicles is No Longer Invisible

Remote Sensing Technologies can Detect all Vehicles on Road and Image the Plume in Real Time as Vehicles Drive Under Normal Driving Conditions



Trucks and Motorcycles

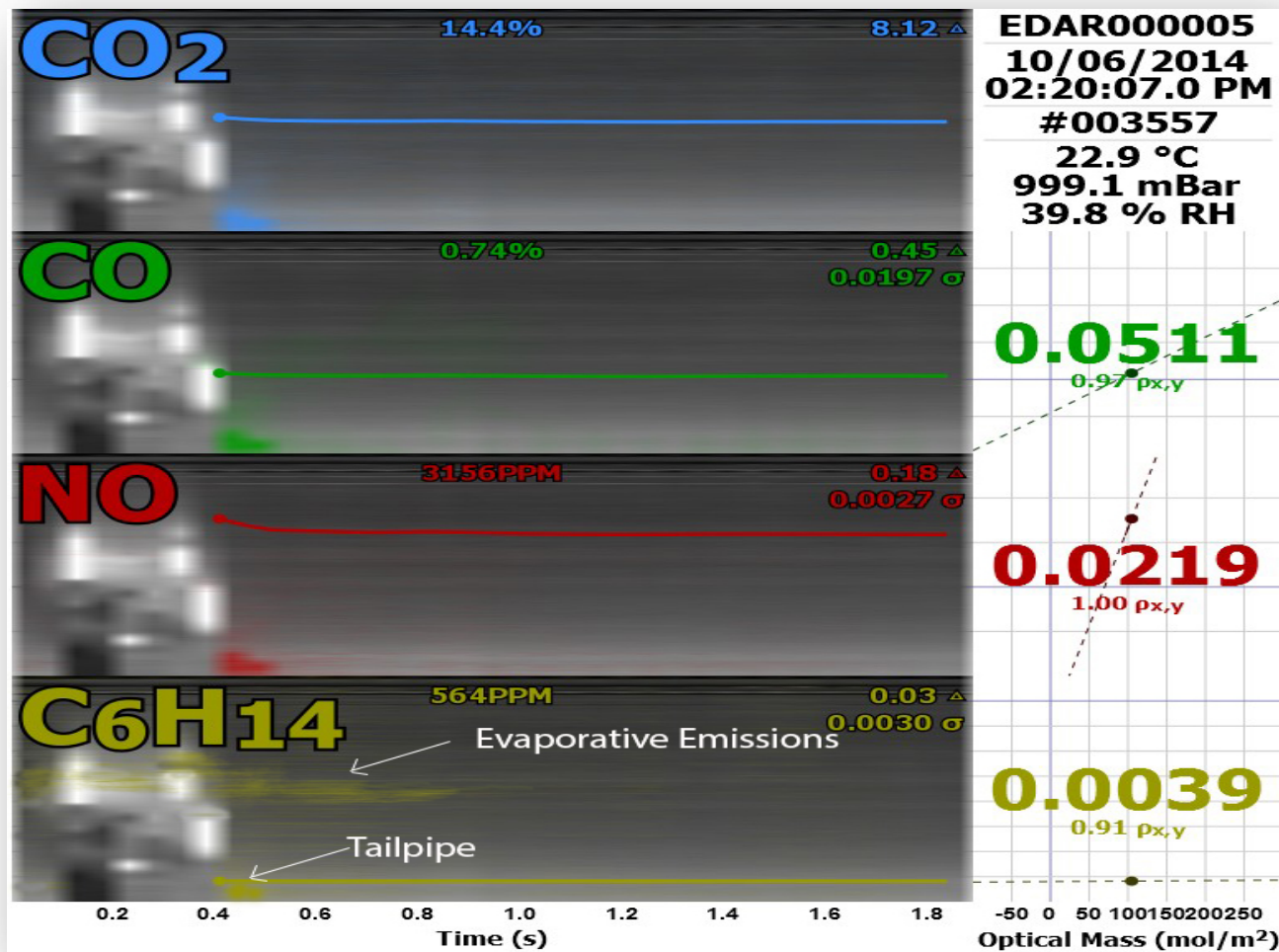
Image of a Truck
Pulling a Trailer



Two Dimensional
Image of a Motorcycle

Remote Sensing Can Also Detect Leaks such as Evaporative Emissions in Real Time

Evaporative emissions coming out of a moving vehicle captured by EDAR shown by the 2D image of the plume.



Remote Sensing Capabilities

Continuous Monitoring with Remote Sensing Allows for:

➤ Identification of:

- anomalies in the fleet
- vehicles that have disconnected their diesel particulate filters (DPF) or let their Ad Blue run out
- broken emissions systems on classes of vehicles in real time

➤ Detection of:

- Defeat Devices
- leaks from other sources on the vehicle such as a faulty gas cap or a leak in the emission system

➤ Enforcing positive behavioral change on road



Recent Remote Sensing Studies Show Unique Trends



- Recent Studies using Remote Sensing Showed Pattern failures for High NO_x Emitters Seen Repeatedly in Various Vehicle Makes
 - In these cases, it was concluded that similar vehicle makes shared the same engine and emissions control platforms.

Remote Sensing Pilot: EDAR in Scotland

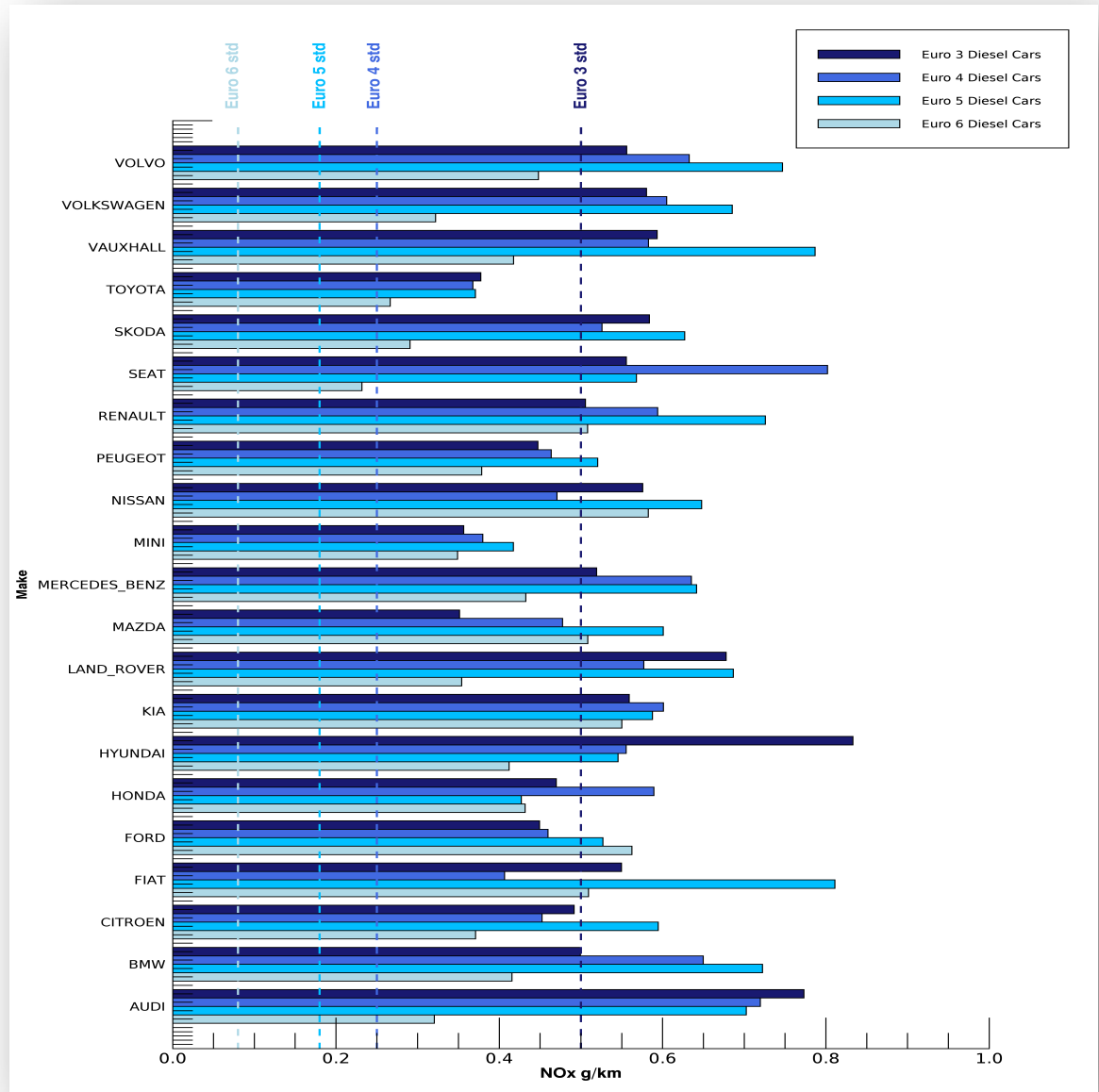


- Remote Sensing Pilot to Access the Fleet in Edinburgh, Broxburn and North Lanarkshire
- EDAR detected over 140,000 valid vehicle measurements in 26 days

NOx Emissions by Make and Euro Class as Seen in Scotland by RSD

Interesting Findings:

- **Car Manufacturers** that had at least 600 types of diesel vehicles on road as seen in this pilot
- **All Euro 6 vehicles** in this pilot **failed** the **EU Euro 6 Standards** and in most cases **did not even meet the Euro 4 Standards**



Today's Options of Technologies for On-Road Real World Driving Emissions

Portable Emissions Monitoring System (PEMS)

- Tests only 1 car at a time
- Needs experienced and well trained operator
- Expensive on a per test basis
- Vehicle can Detect when it is being monitored



Remote Sensing

- Tests millions of vehicles
- Unmanned
- Inexpensive on a per test basis
- Vehicle can not detect it is being monitored



Remote Sensing Can be Utilized to Allow for Valid Clean Air Zones and Positive Behavioural Change



Continuous Monitoring: Enforces positive behavioral change on road



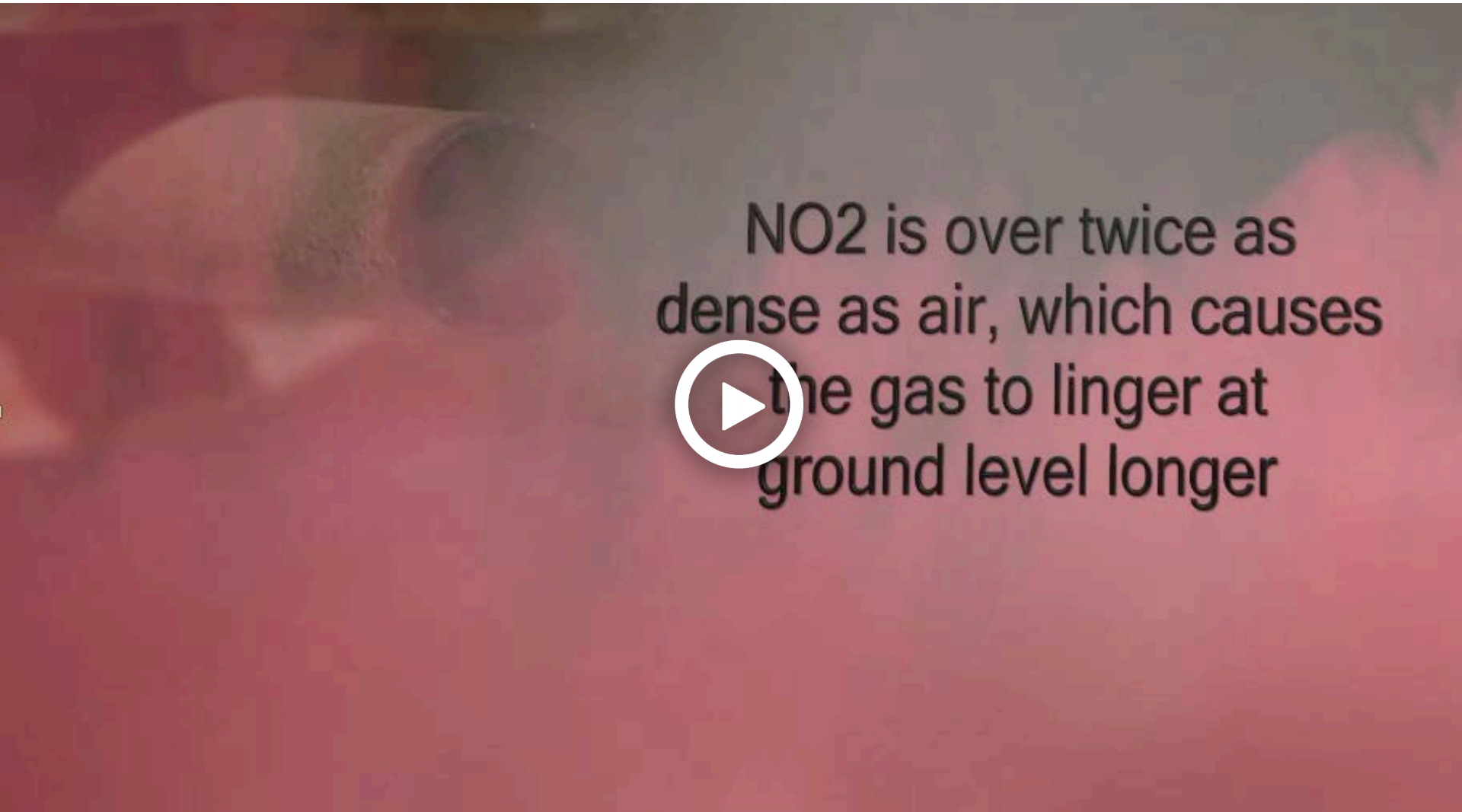
Remote Sensing Allows for:

- Vehicle Classification
- Anomalies in the Fleet
- Governments to make Policy Decisions Based on Real World Data



Create a smart **high-tech zones** that will **improve air quality** worldwide

One Last Point to Ponder: Now Vehicle Pollution is Visible



NO₂ is over twice as
dense as air, which causes
the gas to linger at
ground level longer