

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



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Technologies
HEAT**

A road sign on a moon surface. The sign is white with a blue border and the word "EDAR" written in blue. A red arrow points from the sign towards the bottom left of the frame. The background shows a dark, cratered moon surface with a large, bright full moon in the sky.

EDAR



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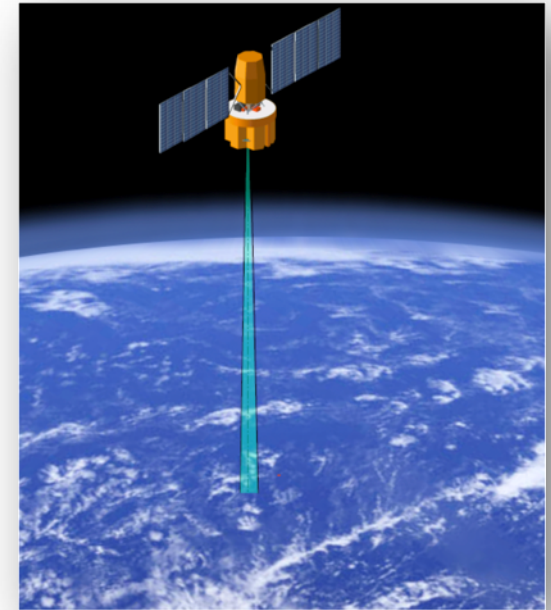
H.E.A.T.

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





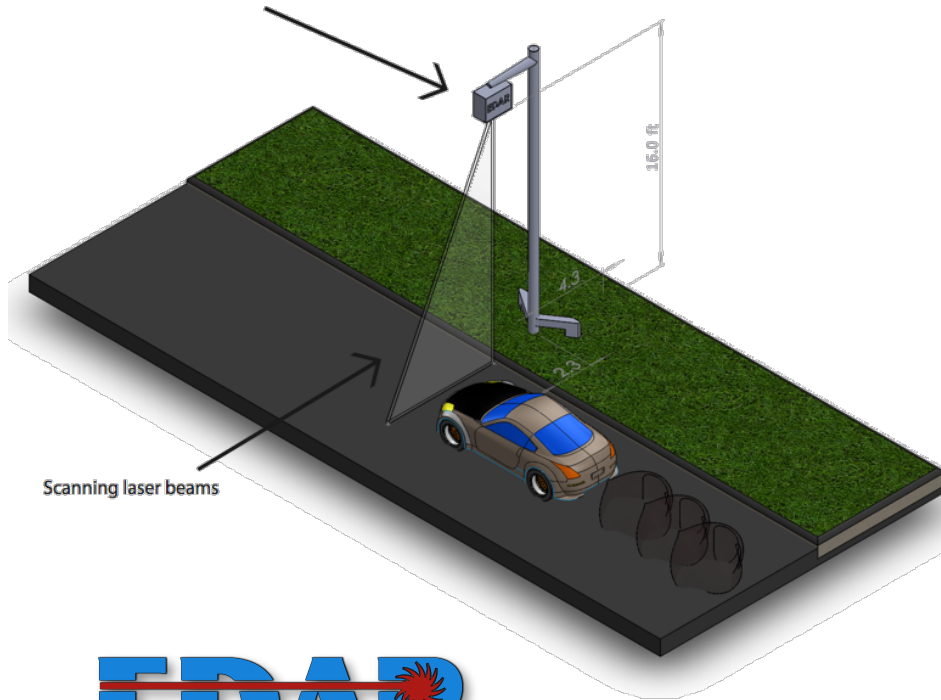
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What is EDAR?

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

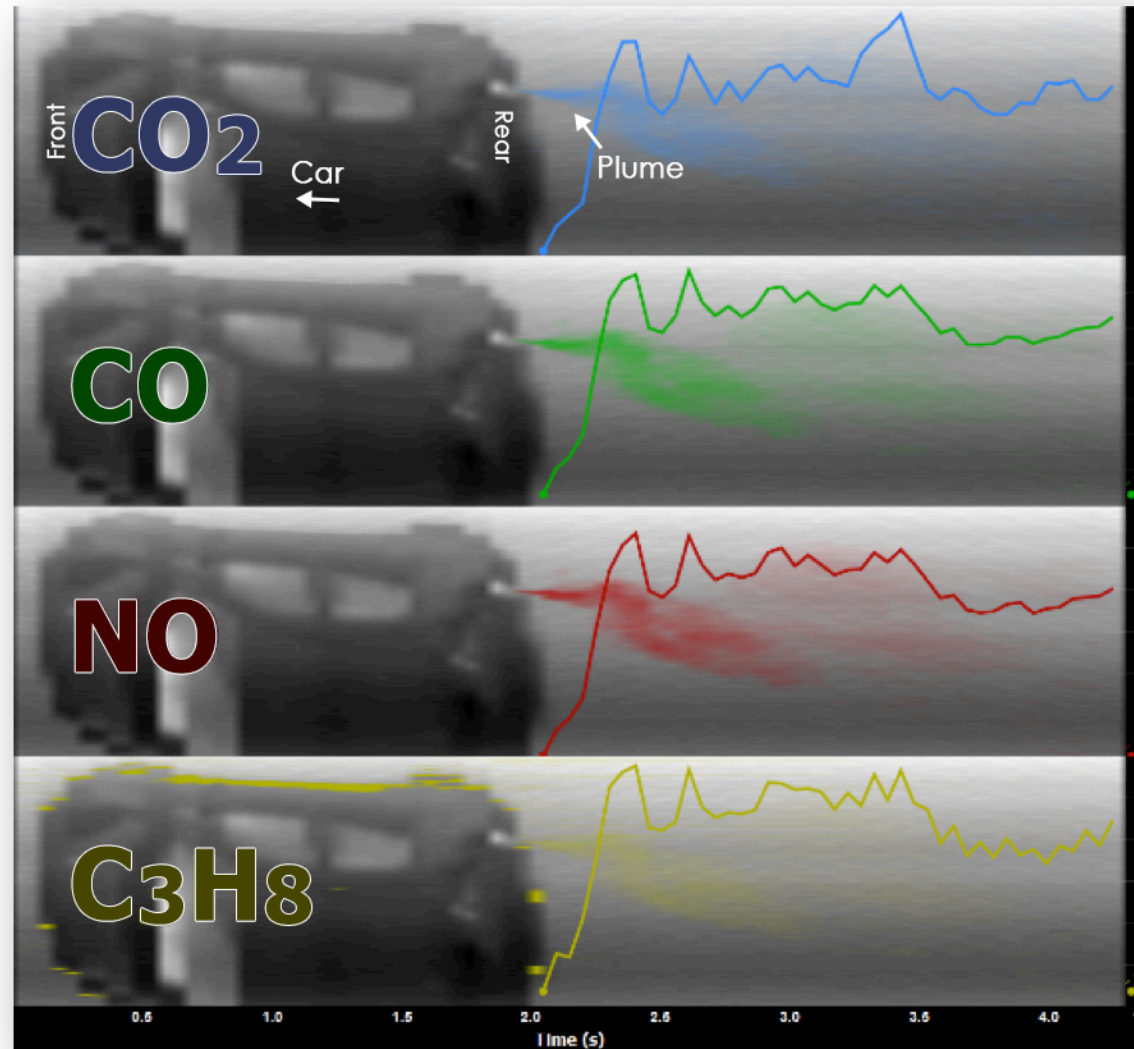


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Pollution of Vehicles is No Longer Invisible

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



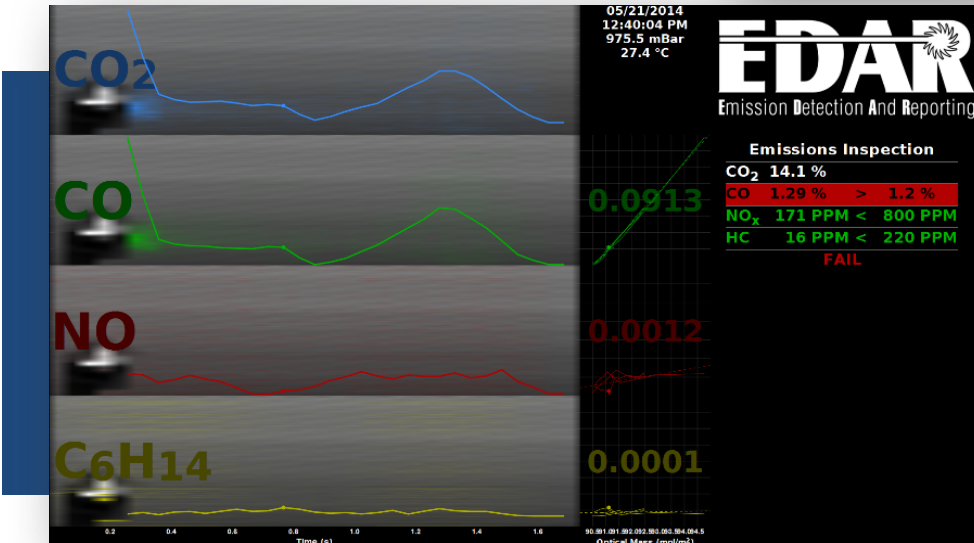
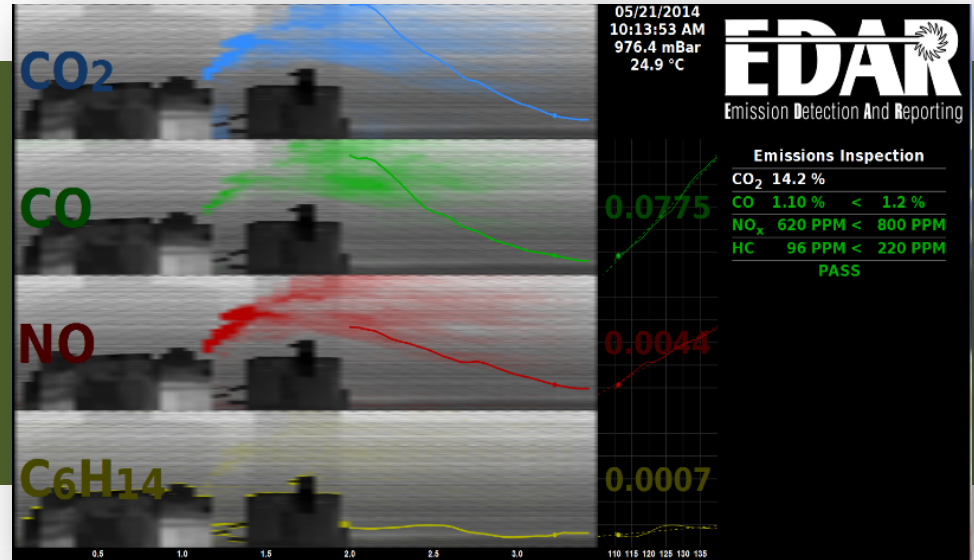


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Trucks and Motorcycles

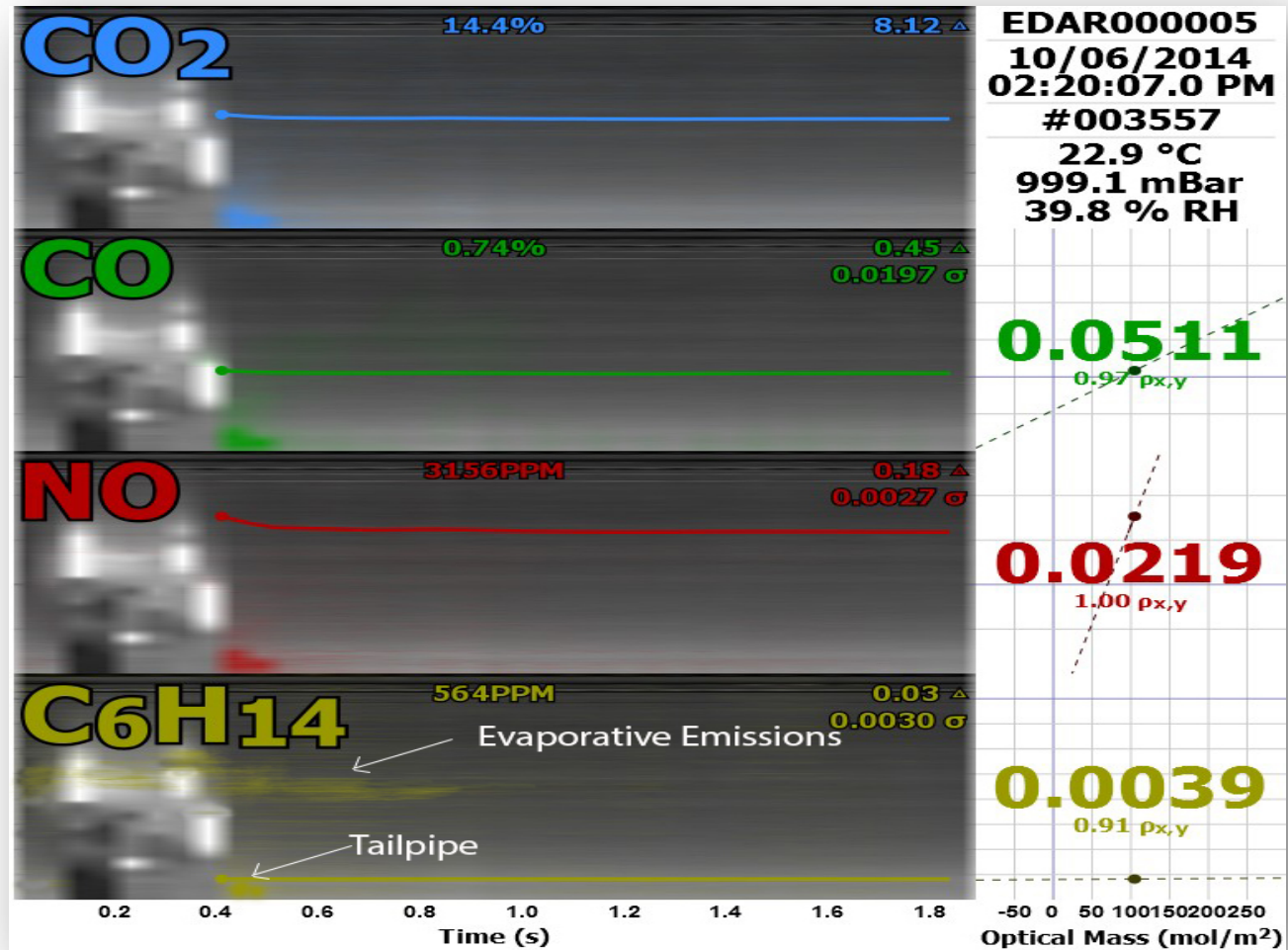
Image of a Truck Pulling a Trailer



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.





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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

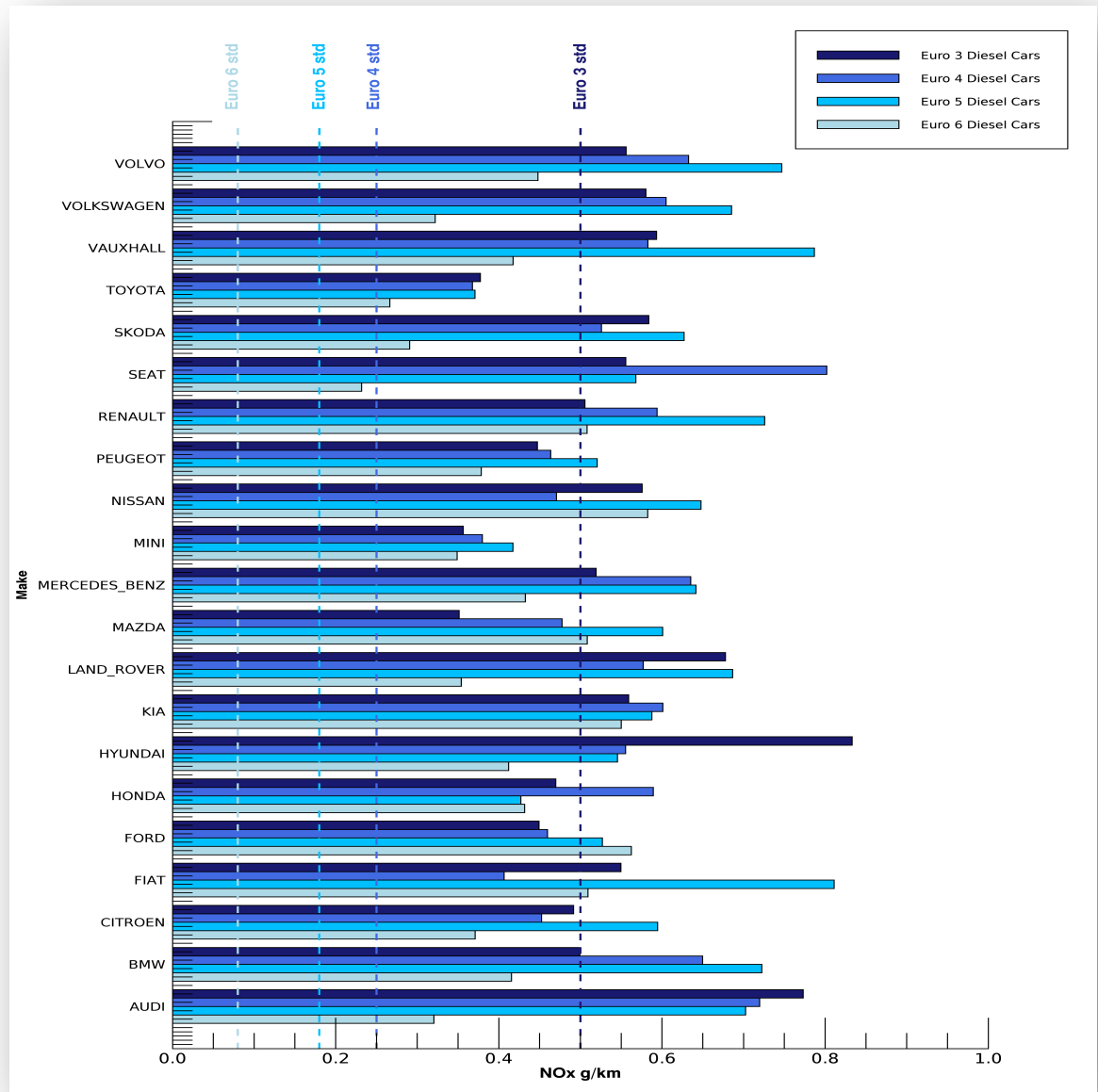


- Remote Sensing Pilot to Access the Fleet in Edinburgh, Broxburn and North Lanarkshire
- EDAR detected over 140,000 valid vehicle measurements in 26 days

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