Fleet Innovation: Driver Feedback, Electric, and Hydrogen

March 23,2010

12000 Government Center Parkway,

Fairfax, VA 22035

This workshop made possible through support from the U.S. Department of Energy and partners.

Materials for the Clean Transportation Education Project were developed by the NC Solar Center/NC State University and partners with funding from the U.S. Dept of Energy Clean Cities program. The U.S. Government does not assume any legal liability, responsibility for the accuracy, completeness, or usefulness of any information provided, nor endorse any particular product through this support.

Clean Transportation Education Project

- CTEP is a 2 year initiative that will deliver 36 workshops across the U.S. in 4 subject areas:
  - Biodiesel
  - Ethanol
  - Natural Gas and Propane
  - Fuel Economy/ Idle Reduction (including electric & hybrid vehicles)
- CTEP success relies on partnerships among Clean Cities coalitions, industry and educational organizations
- Lead by NC Solar Center/NC State University and Wake Tech Community College with funding provided by the U.S. Department of Energy
- Workshop schedule and more information at www.altfueled.org

Driving for Economy: Goals Of This Presentation

1. What is eco driving? Why practice it?
2. Learn ways to implement eco driving.
3. Evaluate your current driving habits.
4. Get on the road and test out some eco driving methods by using a Scan Gauge.
5. Create a personal eco driving action plan.

Material for this workshop adapted from University of Vermont Transportation Research Center Eco-Driving Workshop

What We Will Cover

- Illustrating that small changes in driver behavior can make measurable differences in MPG.
- Vehicle maintenance, road conditions and driving style affect MPG.
- Better MPG saves fuel, reduces pollution, and saves money.
- Monitoring MPG performance is key to discovering what works for you.
- Steps to “GREEN” your fleet

Benefits To Applying This Lesson

Practice “driving for economy” and you will benefit because…

- You will be more attentive, more aware of traffic conditions and of your vehicle’s performance.
- Driving attentively = SAFE driving.
- These tips apply for your own vehicle, your company vehicle, or any vehicle.
- You can save fuel and save money.

Things That Effect MPG

In addition to learning about fuel economy tracking this presentation will focus on three criteria that can affect fuel economy:

- **Practices:** Different drivers of identical vehicles can get different MPG results.
- **Procedures**: Identical vehicles deliver different economy depending on how they are used and cared for.
- **Equipment:** A big truck uses more fuel than a small car.

What is Eco Driving?

- Definition: A set of simple driving habits that result in using less fuel, generating fewer emissions, and increasing safety.
- Eco driving is economical and better for the environment/ecosystem.
- The typical eco driver can increase fuel efficiency 15-33%.

Slide compliments of University of Vermont Transportation Research Center

Why Practice Eco-driving?

- Cut down on greenhouse gas emissions and air pollution
- Reduce fuel consumption
- Increase safety
- Save money by saving fuel

CO_2 and Climate Change

- Greenhouse Effect: increased levels of CO_2 in the atmosphere trap solar radiation
- The earth warms…

Top 5 Warmest Years

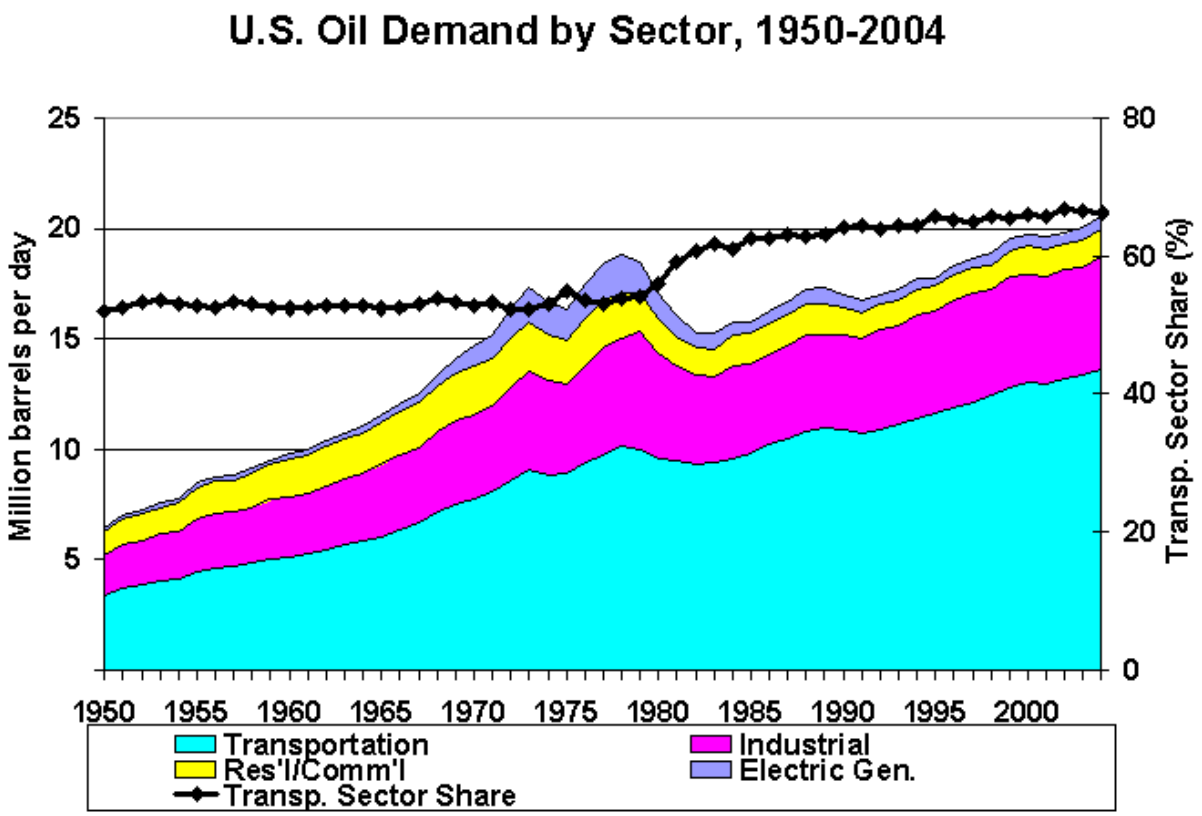
Worldwide Since 1890

1) 2010 tied with 2005
2) 2009
3) 2007
4) 1998
5) 2002

- 2000-2009 was the warmest decade on record

http://www.giss.nasa.gov/research/news/20100121/

Reducing Petroleum Consumption



- Transportation accounts for 2/3 of U.S. oil use.
- Gasoline accounts for 2/3 of oil used in transportation.
- Reducing consumption through fuel economy enhances U.S. energy security.

Source Energy Information Agency
http://www.eia.doe.gov/pub/oil_gas/petroleum/analysis_publications/oil_market_basics/demand_text.htm#U.S.%20Consumption%20by%20sector

Safety

- A eco-driver is a safer driver
- In 2008 there were 824 traffic fatalities in Virginia.
- Nearly 1 out of 3, or 246, of these deaths were speed related.

Image: www.mandellaw.com/auto_accident.shtml

www.census.gov/compendia/statab/cats/transportation/motor_vehicle_accidents_and_fatalities.html

Driving Practices

Eco-Driving Practices

1. Chose the best vehicle for the job and combine trips if possible.
2. Avoid “Jackrabbit” starts and stops.
3. Watch your speed.
4. Maintain a steady speed.
5. Use the highest gear possible & coast.
6. Avoid idling.
7. Use air conditioning appropriately.

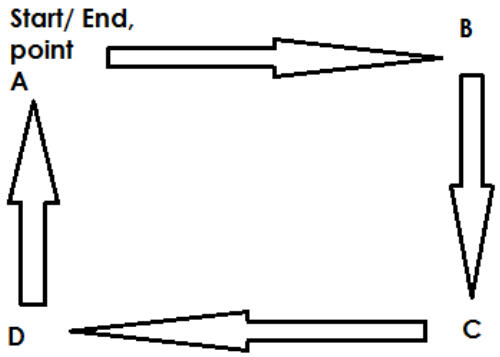
What's Within Your Control?

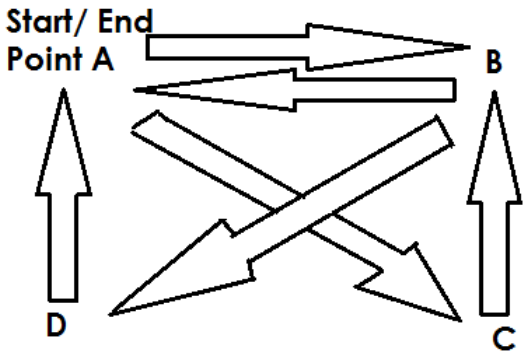
- Can you choose which vehicle to take on a trip? If you can, don't take more than you need.

Combine Trips

If your errands allow the flexibility of choosing their order, take the most efficient route.

Carpool when practical.





Slide courtesy of University of Vermont Transportation Research Center

Avoid “Jackrabbit” Starts

- Ease into starts and stops.
- High RPMs vs. lower RPMs find your vehicle’s efficiency ‘sweet spot’.
- Keep RPMs under 2,500.
- Avoid tailgating.
- Keep safety in mind.

Watch Your Speed

- Safety: Leave time and distance to react to the unexpected.
- Improve mileage by 7-23%.
- Every 5 mph you drive over 60 mph reduces your fuel economy by 10%.

Estimates for the effect of speed on MPG are based on a study by West, B.H., R.N. McGill, J.W. Hodgson, S.S. Sluder, and D.E. Smith, *Development and Verification of Light-Duty Modal Emissions and Fuel Consumption Values for Traffic Models*, Oak Ridge National Laboratory, Oak Ridge, Tennessee, March 1999.

http://www.fueleconomy.gov/feg/driveHabits.shtml

Need Another Reason?

Image from www.dailykos.com/blog/doubleseven/ Dec 13, 2010

Maintain A Steady Speed

- Look ahead to anticipate traffic.

- Traffic lights are timed in some places.

- Increase MPG, decrease emissions, & increase traffic flow and safety.

Driving Practices

- Shift into the highest gear/overdrive, as soon as possible (without lugging). Automatics will self-select the optimum gear.
- Coast when going downhill, and allow yourself to slow down a bit when going uphill. (Don't try to speed up).
- Using cruise control can be 7% more fuel efficient under the right circumstances (open stretches of road, not urban or mountainous areas).

http://money.cnn.com/2005/09/01/Autos/tipsandadvice/gas_saving_test/index.htm

Idling = 0 mpg

- Idling is dangerous.
- Idling is wasteful.
- Idling is illegal under many circumstances.
- Idling is usually unnecessary.

Common Sense Idling Policy

- The rule of thumb is if you're going to be idling more than 10 -30 seconds, better to turn off your car.
- It doesn't take more gas to shut down and restart your car than it does to leave it idling for a few minutes.
- Every 2 minutes of idling is equivalent to driving approximately 1 mile.
- Most cars can be "warm" within 30 seconds, but the misconception is that it takes five or more minutes.

www.carsdirect.com/car-maintenance/benefits-of-idling-reduction

www.consumerenergycenter.org/myths/idling.html

Virginia Idling Rule

- 10 minutes for diesel vehicles (3 minutes for all other vehicles) in commercial or residential urban areas.
- Fine: Not more than $25,000 *Virginia Administrative Code, Title 9, 5-40-5670(B).*

photo from: yourgreenfriend.com

Air- Conditioning Uses Fuel

- Running electrical accessories (e.g., air conditioner) decreases fuel economy. Operating the air conditioner on "Max" can reduce MPG by roughly 5-25% compared to not using it.
- Open windows cause aerodynamic drag.
- Solution: 40mph rule: If it is not unbearably hot and your travel speed is under 40, open the windows. At higher speed, use the A/C.

www.fueleconomy.gov/feg/factors.shtml

Conditions That Reduce MPG

Condition		Average	Maximum
Low Temp	20^{o} vs. 77^{o}	- 5.3%	- 13%
Head Winds	20 mph	- 2.3%	- 6%
Mountains	7 % grade	- 1.9%	- 25%
Gravel, Slush, Snow	Reduced traction	- 4.3%	- 50%
Heavy Traffic	20 mph vs. 27 mph	- 10.6%	- 15%
High Speed	70 mph vs. 55 mph		- 25%

Ideal Driving Conditions

- In a world with nothing but blue skies, green lights, and little traffic you can achieve optimum mpg with some practice.
- Adverse weather and traffic congestion cannot always be avoided but, don't volunteer for it.
- Control what you can for best MPG.

Vehicle Procedures

Maintenance Procedures

1. Remove excessive weight from vehicle.
2. Keep tires properly inflated.
3. Change your oil as recommended.
4. Replace air filters regularly.
5. Observe your check engine light.
6. Tighten your gas cap.
7. Perform preventive maintenance as recommended.

Remove Excess Weight

- An extra 100 pounds in your vehicle could reduce your MPG by up to 2 percent.
- Reduction is based on the percentage of extra weight relative to the vehicle's weight and affects smaller vehicles more than larger ones.

- Evaluate the necessity, don’t take extra equipment.
- Things outside the outline of your vehicle cause air drag.

http://www.greenercars.org/GreenDrivingTips.pdf http://www.fueleconomy.gov/feg/driveHabits.shtml

Tire Pressures Are Important

- Low tire pressure is the leading cause of tire failure, causes 660 fatalities, 33,000 injuries per year (according to NHTSA)
- 1.2 billion gallons of fuel wasted annually (www.gao.gov/new.items/d07246r.pdf)
- 25% or more of cars have underinflated tires (NHTSA survey, August 2001)
- Under-inflated tires can lower gas mileage by 0.3 percent for every 1 psi drop in pressure of all four tires.
  fueleconomy.gov/feg/maintain.shtml

Use A Tire Pressure Gauge

- Check tire pressure at least monthly.
- Change in weather: seasonal drop in temp. makes air contract, lowers pressure.
- Pay attention to tire pressure warning light. If it lights, find out why.

Change Your Oil

- Motor oil deteriorates, it becomes contaminated, it becomes oxidized, and can't do its job.
- Review manufacturer's recommended schedule, adjust accordingly. Review "severe service" definition. Does it apply to your usage?
- Review manufacturer's recommended oil & oil filter change intervals and keep to the schedule.
- Use the recommended motor oil for your vehicle.

Replace Air Filters Regularly

- Modern fuel injected vehicles may adjust enough to keep a clogged air filter from affecting the vehicle's perceived performance but, restricted air flow will reduce fuel economy.
- Dirty air filter increases likelihood of mass air flow sensor failure.
- In a 2009 U.S. DOE study, MPG with a new air filter improved 14% over that with a severely clogged filter. Under a more typical state of clog, the improvement with a new filter ranged from 2 to 6%.
- Check filters about every 15K miles, or annually, change when necessary.

www.fueleconomy.gov/feg/pdfs/Air_Filter_Effects_02_26_2009.pdf

Observe Your Check Engine Light

- On-board diagnostic: OBD in 1987 (CA only) and OBDII (all states) systems since 1996 monitor engine emissions.
- A technician can easily check OBD system; don't ignore the warning light
- A technician should repair OBD faults: OBD is cross-functional; checks emissions and monitors proper engine operation.

Tighten The Fuel Cap

- Tighten your gas cap fully- loose cap can trigger an OBD fault code.
- Avoids fuel evaporation which wastes fuel and releases harmful emissions.
- Check your owners' manual- fuel caps can be different from model to model- don't assume you know how to close it.

Preventive Maintenance

- Cars need preventive maintenance (PM) to run most efficiently- check your manual for recommended intervals.
- On average, perform every 15,000 miles or yearly.
- Tires may need rotating, balancing. Your wheels may also need re-alignment.

To Review

1. Combine trips
2. Avoid “Jackrabbit” starts and stops
3. Watch your speed
4. Maintain a steady speed
5. Use the highest gear possible & coast
6. Avoid idling, it is a waste of fuel
7. Use air conditioning appropriately

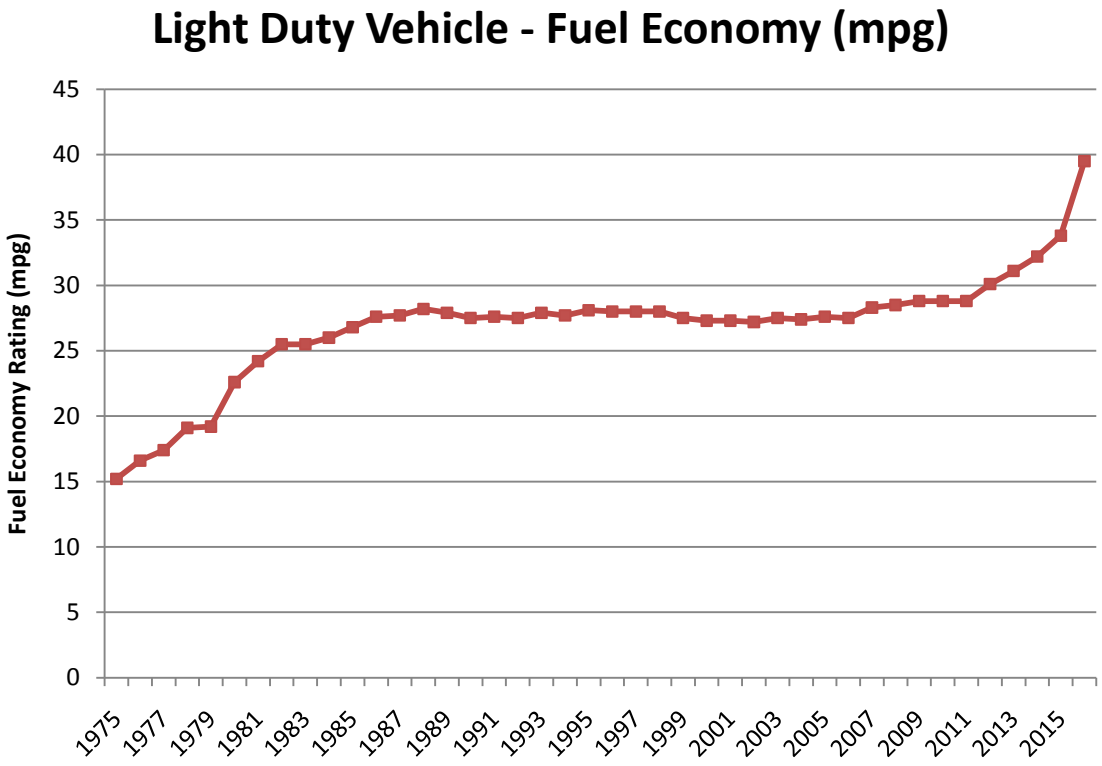
1. Remove excessive weight from vehicle
2. Keep tires properly inflated
3. Change your oil
4. Replace air filters regularly
5. Observe your check engine light
6. Tighten your gas cap
7. Preventive maintenance

Equipment: Vehicle Uses, Choices & Fuel Tracking

Vehicle Uses: What Are You Doing?

- TAXI accumulates miles rapidly. It is often loaded (passengers & luggage), if driven carefully may return decent fuel economy and last a long time.
- POLICE CRUISER also accumulates many hours use rapidly. It has a heavy electrical load, idles for long periods, and often needs to accelerate rapidly. Good fuel economy is a challenge, idle reduction technology may help.
- A fleet or civilian SEDAN will deliver fuel economy, reliability, and durability based on how it is used and maintained.

Fuel Economy Is Expected To Rise



- In the U.S. fuel economy has remained stagnant for over 2 decades.
- In 2009, U.S. EPA and U.S. DOT proposed a joint regulation for greenhouse gas (GHG) emissions and fuel economy for light duty vehicles standards.
- Auto makers expect to meet goals through technologies that are emerging in the market place today such as turbo charging, cylinder deactivation & regenerative braking.

Graph compliments of NC Division of Air Quality, from U.S. EPA and U.S. Dept of Transportation projections

Hybrids Have Differences

- Hybrid- electric cars offer excellent economy if driven properly.
- If you drive a hybrid don't assume you have no room for MPG improvement
- To get best results, understand how they work.

- Hybrids make it easy to monitor your driving style.
- Learn to go to EV mode (if your hybrid has it).
- Braking gently recaptures electric energy. Smoothness is crucial.

Low Rolling Resistance Tires

Tips:

- Rolling resistance accounts for about 20% of a vehicle's parasitic friction
- SAE estimates every 10% reduction in rolling resistance improves FE by 1-2%, but results vary widely
- Using LRT's can impact fuel economy by 3-7%
- Remember! New tires have a higher rolling resistance than used tires!

Yokohama db Super-E tire is made from 80% non petroleum compounds including Orange Oil and natural Rubber to reduce Carbon content

When Purchasing Vehicles

Right size vehicles to optimize fuel economy & reduce emissions.

- It is important to remember that real emissions are based on the mass of emission products (such as CO_2 produced) and that this is a function of engine size (displacement).
- When choosing a vehicle/power train, right size your vehicle to its intended application! Only buy the power you need.

Use Web Resources To Compare

- Websites such as U.S. DOE's Fuel Economy or U.S. EPA Green Vehicle Guide allow you to do side by side comparison of fuel economy and emissions going back as far as 1984
- They also provide annual ranking of the most efficient vehicles by class.

2011 DOE Fuel Economy rankings:

- **Most Efficient Compact Cars**
- **Honda Civic Hybrid** 4 cyl, 1.3 L, Automatic(CVT), HEV, Regular40/ 43
- **Honda Insight** 4 cyl, 1.3 L, Automatic(AV), HEV, Regular 40/ 43
- **Honda Insight** 4 cyl, 1.3 L, Automatic(AV-S7), HEV, Regular 40/ 43
- **Volkswagen Golf** 4 cyl, 2.0 L, Manual(6), Diesel30/ 42
- **Volkswagen Jetta** 4 cyl, 2.0 L, Manual(6), Diesel30/ 42
- **Most Efficient Midsize Cars**
- **Toyota Prius Hybrid**4 cyl, 1.8 L, Automatic(CVT), HEV, Regular51/ 48
- **Nissan Versa** 4 cyl, 1.6 L, Manual(5), Regular26/ 34

www.fueleconomy.gov

Green Choice vehicle

from US EPA Green Vehicle Guide

2011 Malibu 2LT 4 cylinder

- Combined MPG= 26
- Gals/100 miles = 4
- Fuel cost/yr = $1,529 15K/yr
- Smog/yr = 3.64 lbs
- GHG/yr = 5.68 tons
- MSRP= $22,895

2011 Malibu 2LT 6 cylinder

- Combined MPG= 20
- Gals/100 miles = 4.55
- Fuel cost/yr = $1,988 15K/yr
- Smog/yr = 5.29 lbs
- GHG/yr = 7.38 tons
- MSRP= $24,690

6 cyl costs $1,795 more, uses more fuel, cost more to operate, emits more criteria pollutants and greenhouse gas emissions.

Green Fleet Assessment Steps

- Identify the vehicles in your current fleet.
- Analyze the purpose of those vehicles.
- Chart the use of the vehicles (i.e. look at miles driven),
- Record fuel usage,
- Determine what environmental goals are you trying to achieve
  - for example: save money, reduce petroleum consumption, reduce criteria pollutants,
- Review vehicle replacement and purchasing policy
  - predicting how many vehicles will be replaced or added on.

Green Fleet Policies

What: Policy will indentify the goals your organization hopes to accomplish, and lays out the mechanisms and metrics required to meet the desired goals.

How do we adopt a "green fleet" policy?

- **Option 1: (From the top)** Pass a City/County wide *ordinance*, or enact an executive order, that codifies the "green fleet" process and delegates specific responsibilities within local government to take action.
- **Option 2: (From the bottom)** Establish internal departmental or agency fleet policies, which are clear and carry sufficient weight with departmental or agency heads.
- **Option 3: (Hybrid of 1 & 2)** Pass a *resolution* that serves as enabling legislation for establishing a "green fleet" policy, and then work out the details of the policy at the departmental or agency level.

Sample Ordinance template at:
www.cleanaircounts.org/content/Green%20Fleet%20Policy%20Ordinance.pdf

Establish group and plan

Successful transportation assessments involve the:

Fleet manager

Maintenance manager

Vehicle Technicians

Purchasing director

Facility planner

Administrative leader

Vehicle users

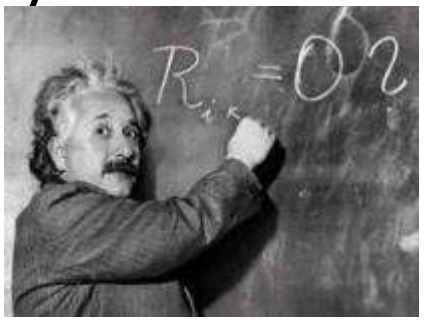
- **Review** current fleet & maintenance procedures
- **Develop** option list to reduce fuel use and fleet-based emissions
- **Research** specific products and services
- **Explore** existing incentives and grants

Strategies

- Procurement specifications to encourage more efficient vehicles and full life cycle costing,
- Rightsizing of vehicles,
- Elimination of older vehicles or those that are used infrequently,
- Implementation of driver training and idle-reduction program,
- Developing a green fleet policy, setting clear goals and schedule to assess progress.
- Utilization of software programs and other tools to track fuel use and increase fleet efficiency,

Track Your Fuel Use

- High tech- there's an app for that! Use a smart phone app: try MPG, Gas Cubby, Fuelly or use a spreadsheet.
- Low tech- write notes: miles now – miles last = miles traveled, miles/ gallons = MPG.
- Vehicle tech: many cars & trucks have on-board display for mpg. Read the manual, learn to use it.
- Use an aid: Scan Gauge™ or another device used for a week or so will uncover pattern to your fuel use.

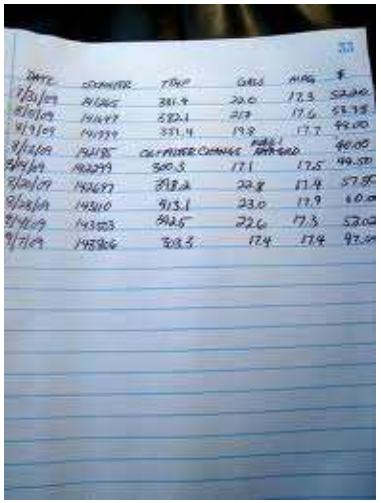


MPG-OMG, that's like, MATH!

Measure However You Like…

… but measure (or you are just guessing).

- Low tech or high tech- don't worry you have the tools



- Paper notes work

- Smart apps work too!

Evaluate Your Behavior

- You can invest in a ScanGauge or similar tool,
- keep good records on paper or a simple spread sheet.
- Measure your baseline economy/ hold yourself accountable for change.

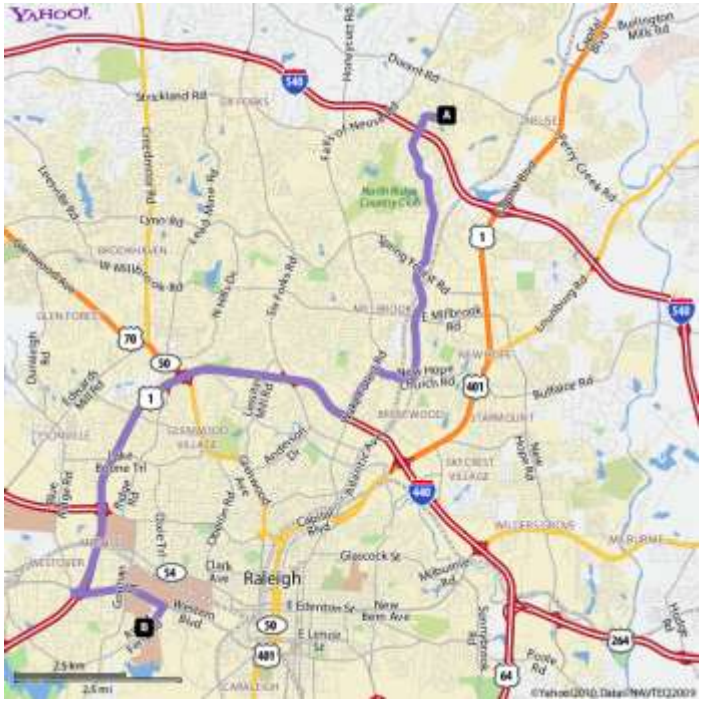
Real Example: 2009 Subaru Forester

2.5Liter , 4 cyl, auto, AWD

EPA est.: City 20 Highway 26 Combined 22

In service, 9/3/08 records through 2/10/11	Miles driven	Avg MPG indicated by in-dash display	Avg MPG calculated, miles/gallons = mpg
Driver A	15,585	24.2	23.2
Driver B	8,680	23.2	22.3
Overall	24,265	23.9	22.9

Real Example: Choose A Route



FAST- 28 min., 15.95 miles

Slow & steady-29 min, 12.34 miles

- A steady pace is more economical than FAST, then slow
- Is 3.6 extra miles at highway speed worth 1 minute?

Scan Gauge II Used: Eco-Driving Tactics Applied

- Driver A's typical commute: about 13 miles each way, 814 miles observed, about 62 trips

	Trips in std. (eco) mode	Trips in Sport mode	Trips blind of scan, 6 trips
highest	29.8	27.5	31.5
Scan indicated average	27.0	25.4	27.0
lowest	23.4	22.3	23.3

Note: Auto. Transmission settings: standard "D" yields best economy, "Sport" mode holds rpm's longer for more responsive driving. Both modes were used and observed for comparison.

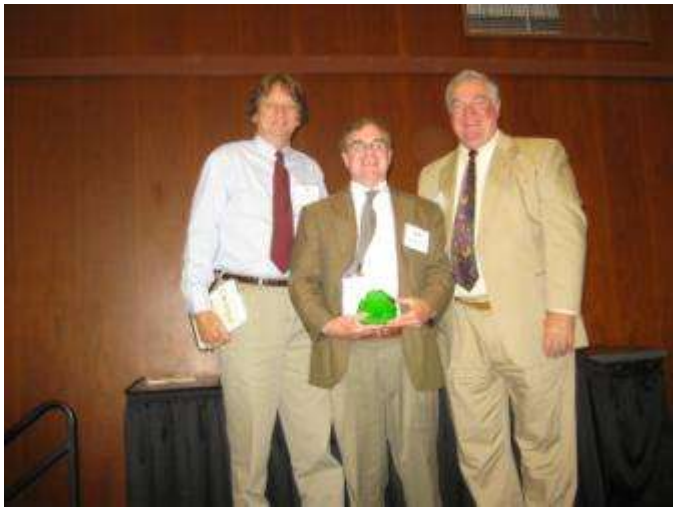
Observed Improvement

	Indicated by mfg's dash mounted instrument	Calculated: miles/ gallons dispensed (Pen & Paper calculation)	At maximum : overall average indicated/ max observed
Baseline driver A	24.2	23.2	23.9
Scan observed	27.0	27.0	31.5
improvement	11.6%	16.4%	31.8%

- Simple changes and observation yield better than 11% improvement for Driver A.
- Based on calculation error (difference between on-board display and result calculated at fill-up) this may be as much as 16% improvement.
- If maximum result could be repeated a potential gain of nearly 32% could be achieved.

Recognize Success

- Consider on site fuel economy driver training
- Take pledges, follow progress
- Establish a mechanism that recognizes fuel economy efforts.
- Recognition should include everyone on the team from ownership through fleet managers to technicians and operators.



Resources For Economical Choices

- Auto Alliance

www.ecodrivingusa.com/#

- U.S. DOE Fuel Economy Guide

www.fueleconomy.gov

- U.S. EPA Smartway

www.epa.gov/smartway/

- U.S. EPA Green Vehicle Guide

  www.epa.gov/greenvehicles/Index.do

When Driving Be SAFE Out There…

Driving is a complex activity that demands your attention.