# Market Driven Automotive Recycling in North America

2004 International Car Recycling Workshop
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**Dr. Claudia Duranceau**
Vehicle Recycling Partnership
U.S. Council for Automotive Research

# Collaboration is Key

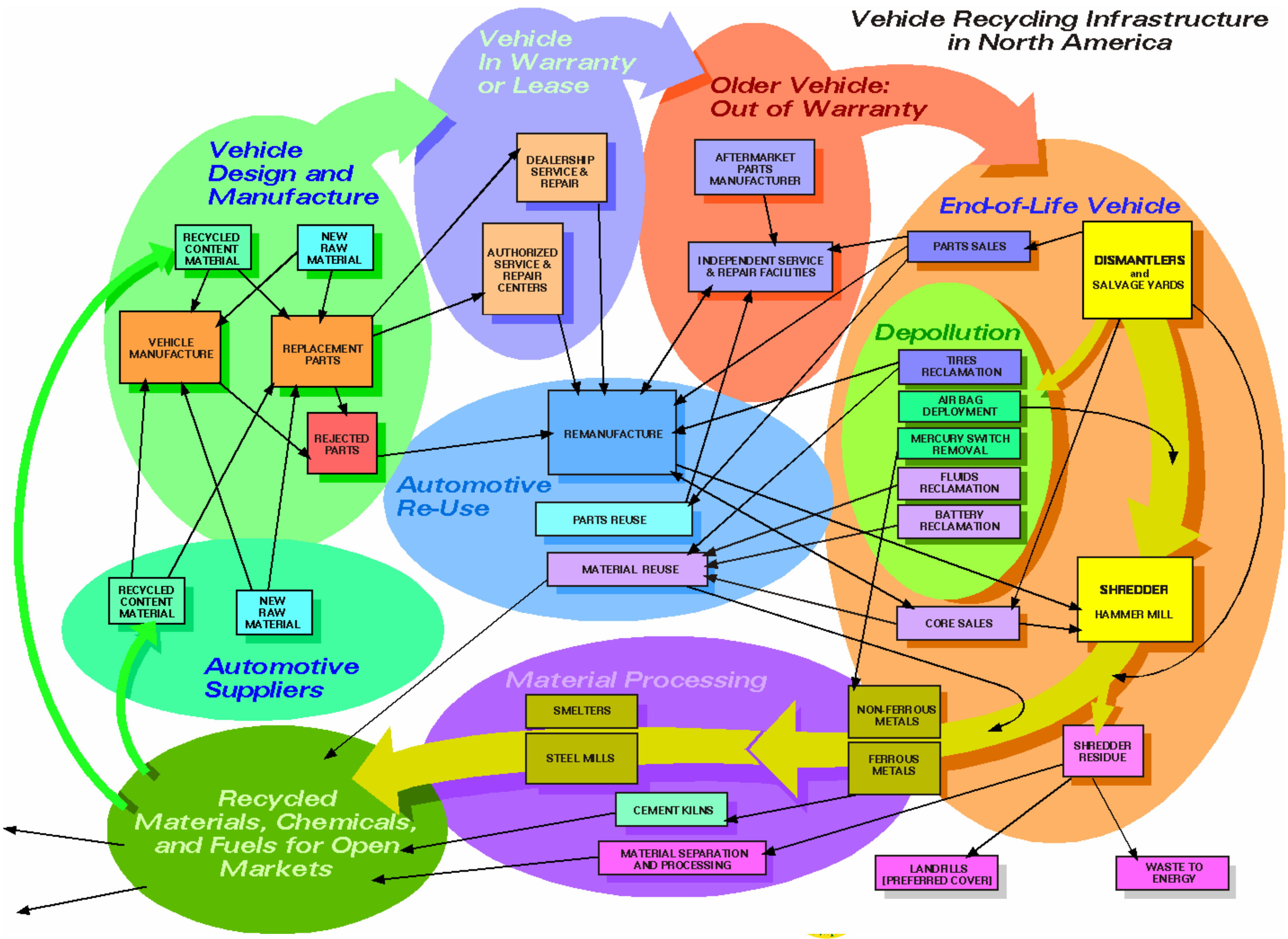
- Precompetitive, legal partnership for research to enhance an already successful, market-driven vehicle recycling infrastructure
- Leveraged Resources
  - -American Plastics Council
  - -Argonne National Laboratories
  - -U.S. Department of Energy
  - -Vehicle Recycling Partnership

# Vehicle Recycling Partnership

- VRP formed (1991); charter member of USCAR's umbrella organization (1992)
- Formal collaboration agreements organized with:
  - -Aluminum Association
  - -American Plastics Council
  - -Automobile Recyclers Association
  - -Institute for Scrap Recycling Industries

# VRP Accomplishments

- Published recycling preferred practices
- Established efficient fluid removal process
- Licensed Vehicle Recycling Development Center facility - dismantled ≈ 1000 vehicles over 6 years of operation
- Researched separation technologies for commingled material streams
- Established USCAR Substances of Concern task forces - conducted supplier-based seminars
- Supported life cycle tools for quantifying resource use over the manufacturing, operation and end-of-useful-life phases.


Vehicle Recycling Infrastructure
in North America
Vehicle Design and Manufacture
RECYCLED CONTENT MATERIAL
NEW RAW MATERIAL
VEHICLE MANUFACTURE
REPLACEMENT PARTS
REJECTED PARTS
Vehicle In Warranty or Lease
DEALERSHIP SERVICE & REPAIR
AUTHORIZED SERVICE & REPAIR CENTERS
Older Vehicle: Out of Warranty
AFTERMARKET PARTS MANUFACTURER
INDEPENDENT SERVICE & REPAIR FACILITIES
End-of-Life Vehicle
PARTS SALES
DISMANTLERS and SALVAGE YARDS
Depollution
TIRES RECLAMATION
AIR BAG DEPLOYMENT
MERCURY SWITCH REMOVAL
FLUIDS RECLAMATION
BATTERY RECLAMATION
CORE SALES
SHREDDER
HAMMER MILL
SHREDDER RESIDUE
LANDFILLS [PREFERRED COVER]
WASTE TO ENERGY
Automotive Re-Use
REMANUFACTURE
PARTS REUSE
MATERIAL REUSE
RECYCLED CONTENT MATERIAL
NEW RAW MATERIAL
Automotive Suppliers
Material Processing
SMELTERS
STEEL MILLS
NON-FERROUS METALS
FERROUS METALS
CEMENT KILNS
MATERIAL SEPARATION AND PROCESSING
Recycled Materials, Chemicals, and Fuels for Open Markets

# Vehicle Recycling Infrastructure in North America: Color Key

### ITEMS CURRENTLY CONSIDERED 'REMANUFACTURABLE' BY THE FEDERAL TRADE COMISSION

- Air Conditioning Compressors and Clutches
- Alternators
- Automatic Transmissions
- Brake Boosters
- Carburetors
- Clutches
- Crankshafts
- Cylinder Heads
- Disk Brake Calipers and Pads
- Distributors
- Drum Brake Shoes
- Engines
- Fuel Pumps
- Integral Power Steering Pumps
- Master Cylinders
- Oil Pumps
- Power Steering Pumps
- Rack and Pinion Assemblies
- Standard Transmissions
- Starters
- Torque Converters
- Water Pumps
- Window Lift Motors

### CRADA VRP/ANL/APC

- Shredder Residue
- Recycling Hybrid Vehicles
- Recycling Fuel-Cell Vehicles
- Substances of Concern
- Lifecycle Approach to Recycled/Recovered Material Streams

### DEPOLLUTION ACTIVITIES

- Fluids Reclamation
- Battery Reclamation
- Mercury Switch Removal
- Tires Reclamation
- Oil Filter Removal
- Air Bag Deployment
- CFC/HFC Reclamation
- Seat Belt Pretensioner Deployment

### 'RECYCLABLE' ITEMS, PER FEDERAL TRADE COMISSION GUIDELINES

- All Metals
- Engine Oil
- Refrigerant
- Coolant
- Windshield Washer Fluid
- Catalytic Converters
- Lead Acid Batteries

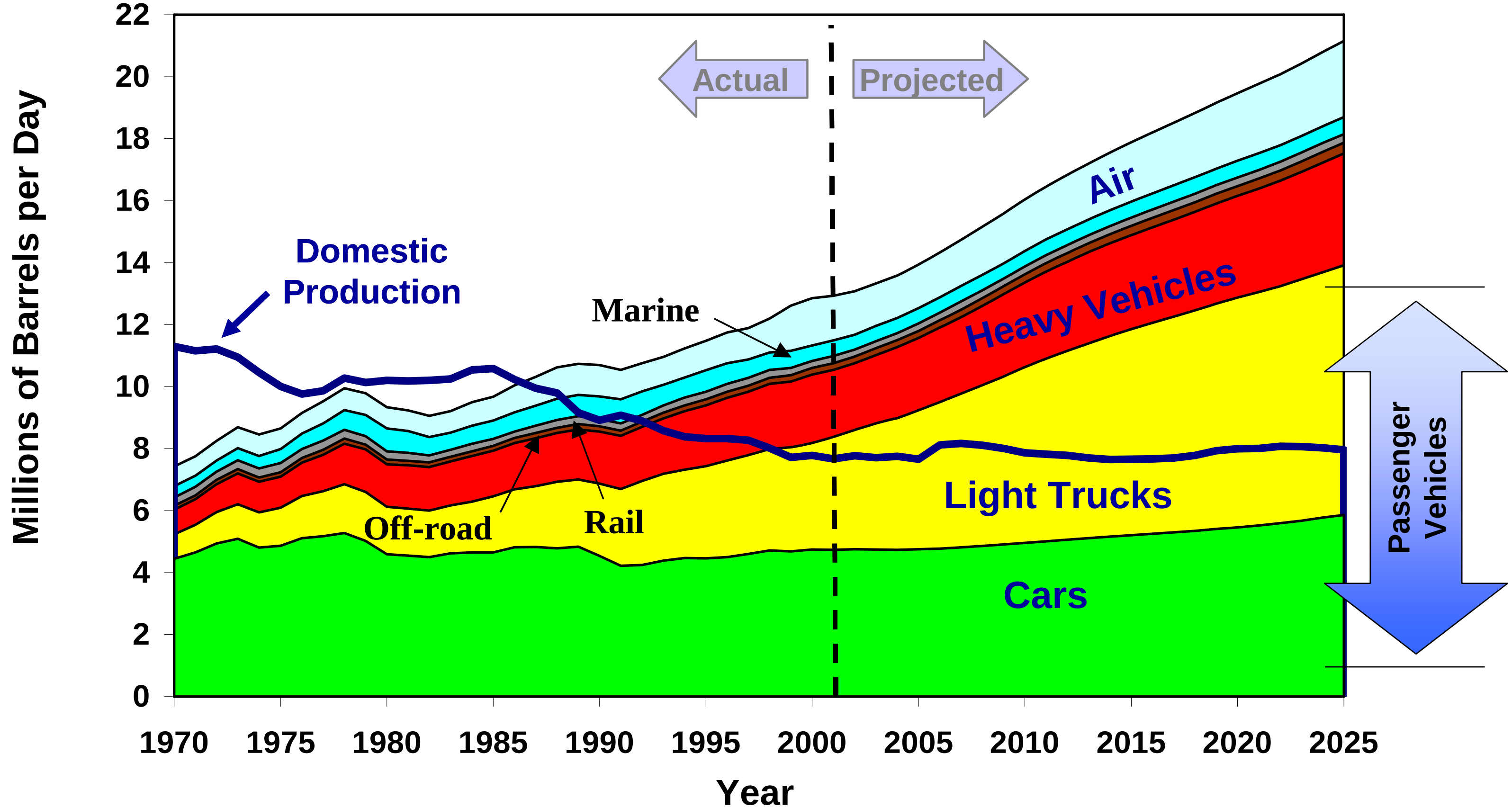
American Plastics Council

# Dr. Joseph Carpenter

U.S. Department of Energy

# U.S. Energy Dependence is Driven By Transportation

## U.S. Oil Use for Transportation




Source: Transportation Energy Data Book: Edition 22, September 2002, and EIA Annual Energy Outlook 2003, January 2003

- Transportation accounts for 2/3 of the 20 million barrels of oil our nation uses each day.
- The U.S. imports 59% of its oil, expected to grow to 68% by 2025 under the status quo.
- Nearly all of our cars and trucks currently run on either gasoline or diesel fuel.

# Material Use in Some PNGV Concept Vehicles

| Table 3. Material Use in PNGV Vehicles (lbs.) | | | |
|---|---|---|---|
| **Material** | **1994 Base Vehicle** | **P2000** | **ESX2** |
| Plastics | 223 | 270 | 485 |
| Aluminum | 206 | 733 | 450 |
| Magnesium | 6 | 86 | 122 |
| Titanium | 0 | 11 | 40 |
| Ferrous | 2168 | 490 | 528 |
| Rubber | 138.5 | 123 | 148 |
| Glass | 96.5 | 36 | 70 |
| Lexan | 0 | 30 | 20 |
| Glass fiber | 19 | 0 | 60 |
| Carbon Fiber | 0 | 8 | 24 |
| Lithium | 0 | 30 | 30 |
| Other | 391 | 193 | 273 |
| Total Weight | 3248 | 2010 | 2250 |

*Source*: Ducker 1998

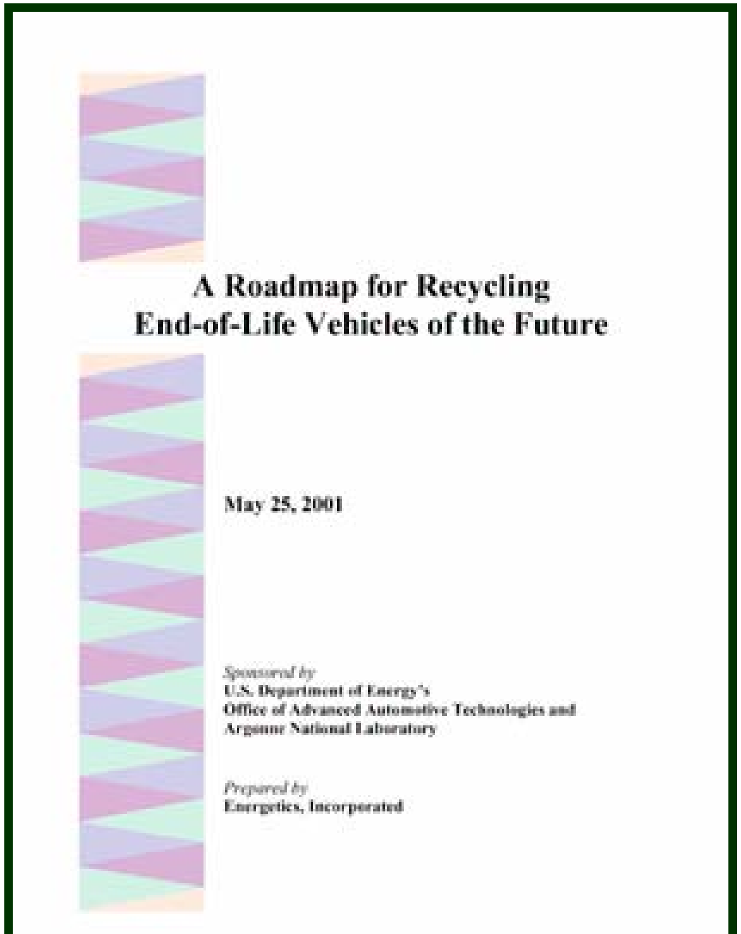
# Objectives of the DOE Automotive Recycle R&D Plan

- To maximize the cost-effective recycling of current and advanced automotive materials
- To ensure that materials are not de-selected for the lack of recyclability
- To obtain stakeholder input concerning program development

# “Recycle Roadmap”

- Objective of the “Roadmap”: to provide overall direction to the DOE recycle program
- Workshop held in Sep 2000; workshop facilitated by Energetics
- Roadmap completed in May 2001 (http://pe.es.anl.gov)

# The Roadmap for Recycling ELV's of the Future Prepared in May 2001



A Roadmap for Recycling
End-of-Life Vehicles of the Future

May 25, 2001

*Sponsored by*
U.S. Department of Energy's
Office of Advanced Automotive Technologies and
Argonne National Laboratory

*Prepared by*
Energetics, Incorporated

Key Barriers

– Information
– Technology
– Markets

**Dr. Michael Fisher**

American Plastics Council

# Roadmap 2001

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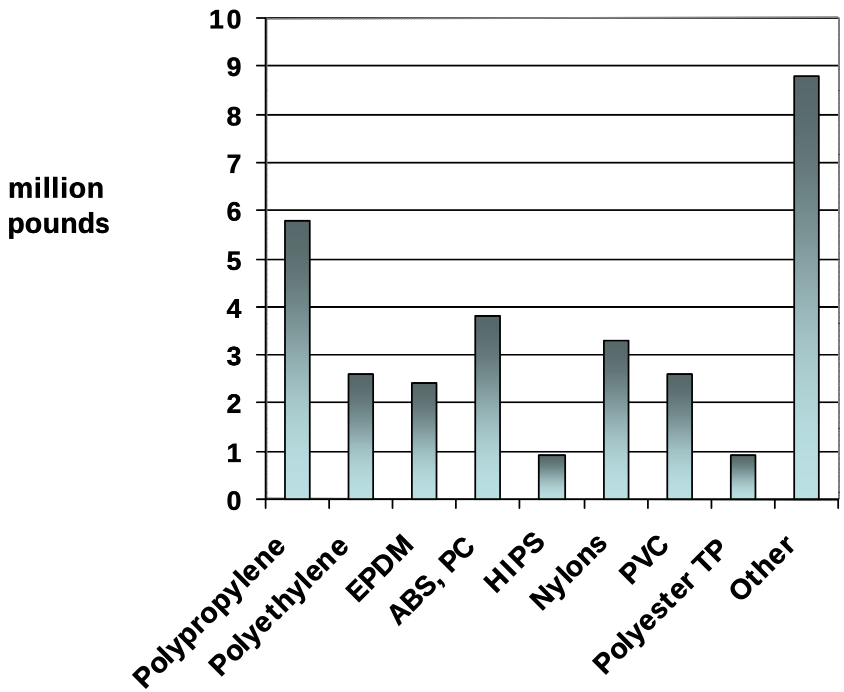
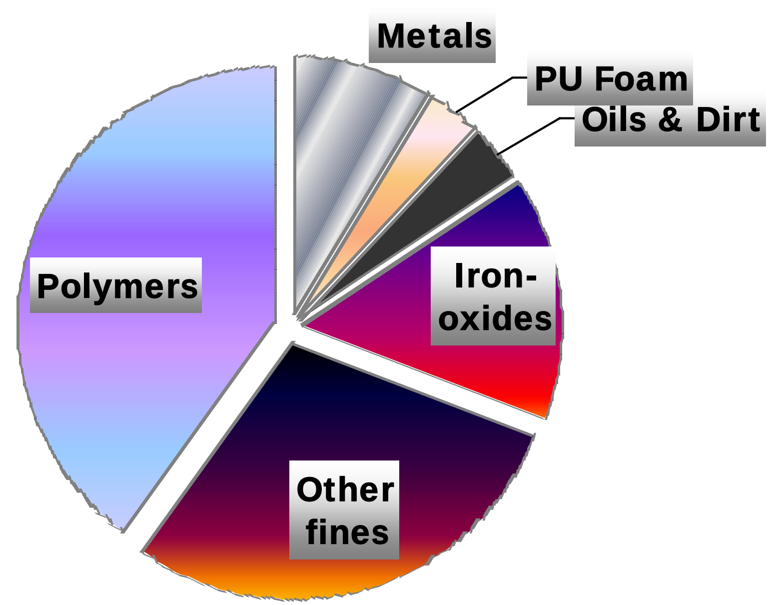
# CRADA 2003

# Roadmap Recommendations

- The recyclability of ELVs is presently limited and several technical and economic barriers need to be overcome to increase recovery and recycling
  - Lack of commercially proven technical capabilities to cost-effectively separate, identify and sort materials
  - Lack of profitable post-use markets
- Development of technology to recycle today's materials will provide the basis for recycling of future materials
- Focus should be on post-shred technology demonstration
- Industry-wide collaboration is needed
- Worldwide technology needs to be tracked and information disseminated to users

# Resources Recoverable from Shredder Residue




**Basis: 75,000,000 pounds of ASR**

# Five-year R&D Program Plan Developed

**Approach:** Research, development, and validation of market acceptable ELV options compatible with the North American infrastructure

**Strategy:** Cooperative Research and Development Agreement (CRADA) involving government and industry

**Goal:** Maximize Sustainable Recovery and Recycling of Current and Future Automotive Materials

American Plastics Council

# Five-Year R&D Program Plan Developed

## Elements of the Plan

- Life-cycle approach supported by LCA
- Sustainable transportation objectives
- Baseline technology assessment
- Material, fuel, and energy recovery technology development and demonstration
- Advocacy and communications support
- Synergy with EU, Japan, others

## Funding

- ~ $3 Million per year, 50% govt./50%industry

## Research Agreement

- Argonne National Laboratory/U.S. Department of Energy
- USCAR Vehicle Recycling Partnership (VRP)
- American Plastics Council (APC)

# Conclusions I

- A joint U.S. government-industry CRADA was established in 2003 to lead the development of improved recovery and recycling methods for future ELVs
- The vision leading to this effort is one of sustainability and reduced environmental impact over the lifecycle of the automobile

# Conclusions II

- The changing automotive material mix over the past fifteen years and evolutionary technology trends relative to automobile architecture for improved safety and environmental performance increase the recycling technical challenge
- Ultimately, any new technology developed in response to these changes must have minimal risk--
  - Proven cost-effective at full-scale
  - Proven markets for products
  - Regulatory barriers removed/transactions costs minimized

# Conclusions III

Research, development, and validation under the CRADA will embrace the following elements:

- Focus on innovation, not reinvention--communicate, collaborate, build
- Seek sustainability as the overarching goal
- Establish a sound business case
- Advance solutions that are both regionally and globally relevant

# Summary

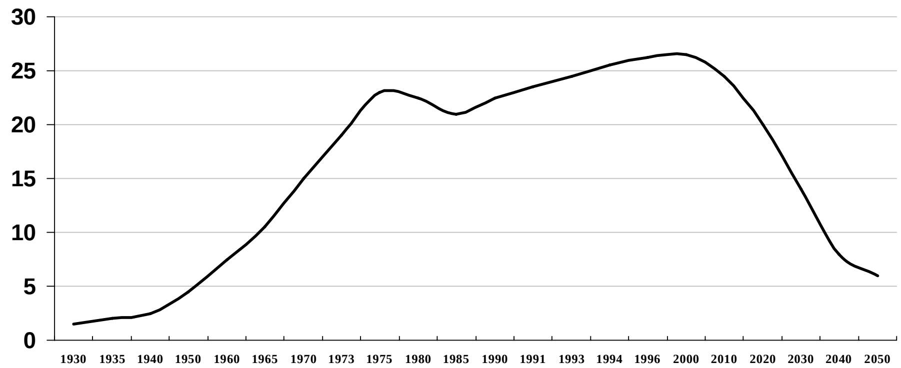
- The North American Vehicle Recycling Infrastructure is a successful market driven approach to vehicle recycling
- Collaboration is key to continued success
- The CRADA is a powerful mechanism to leverage the vast technical resources of the US government and industry

# Thank You

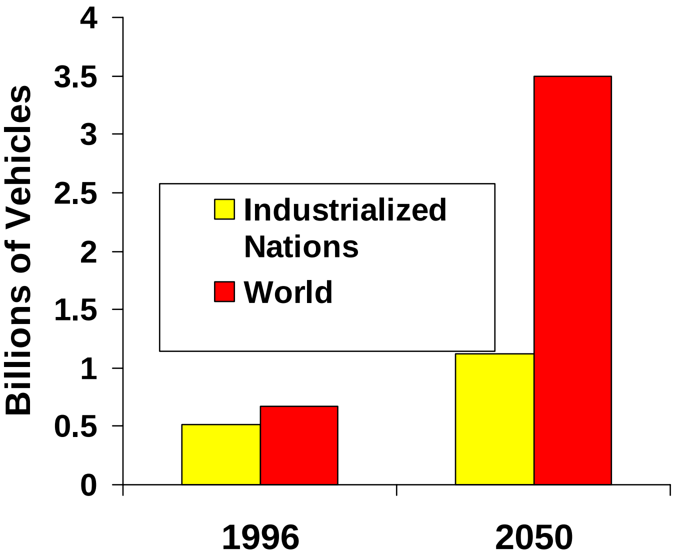
# Back Up Slides

# Can We Sustain Increasing Consumption?

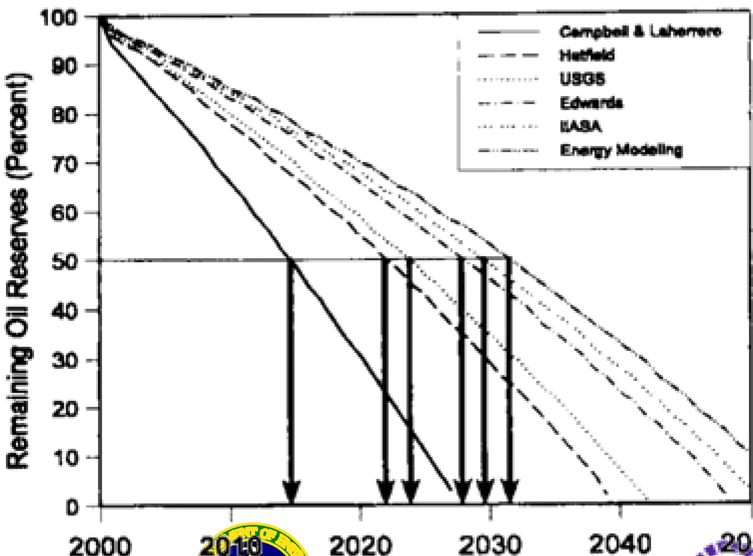
**Annual World Oil Production (Billions of Barrels)**




**Projected Growth in Light-Duty Vehicle Registrations**




**Estimates of Remaining Oil Reserves**



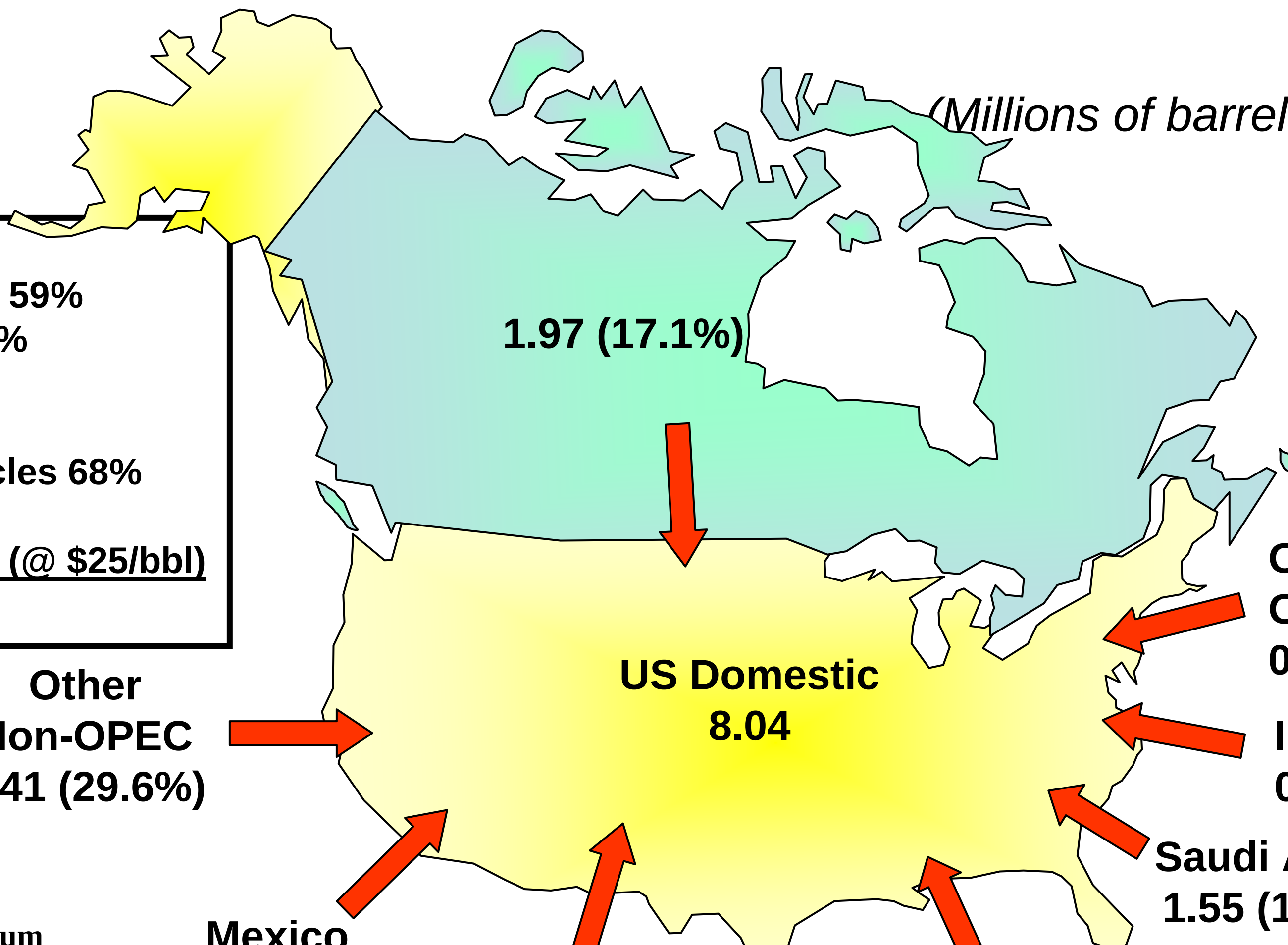
# Our Oil Situation

*(Millions of barrels per day)*

**Source of Oil**
Gross Imports 59%
Domestic 41.1%

**Consumption**
Highway Vehicles 68%

**Cost of Imports (@ $25/bbl)**
$105.2 Billion




Source: EIA Petroleum Supply Annual 2002, Vol. 1

# Weight Savings and Costs for Automotive Lightweighting Materials

| *Lightweight Material* | *Material Replaced* | *Mass Reduction (%)* | *Relative Cost (per part)** |
|---|---|---|---|
| High Strength Steel | Mild Steel | 10 | 1 |
| Aluminum (Al) | Steel, Cast Iron | 40 - 60 | 1.3 - 2 |
| Magnesium | Steel or Cast Iron | 60 - 75 | 1.5 - 2.5 |
| Magnesium | Aluminum | 25 - 35 | 1 - 1.5 |
| Glass FRP Composites | Steel | 25 - 35 | 1 - 1.5 |
| Graphite FRP Composites | Steel | 50 - 60 | 2 - 10+ |
| Al matrix Composites | Steel or Cast Iron | 50 - 65 | 1.5 - 3+ |
| Titanium | Alloy Steel | 40 - 55 | 1.5 - 10+ |
| Stainless Steel | Carbon Steel | 20 - 45 | 1.2 - 1.7 |

**** Includes both materials and manufacturing.***

***Ref:*** *William F. Powers, Advanced Materials and Processes, May 2000, pages 38 – 41.*