Integrated Urban Modeling to Reduce GHGs in California

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California Climate Laws

- Assembly Bill 32 (2006) requires GHGs to be reduced to 1990 levels by 2020. About 30% reduction from trend. Tough.
  - Main policy will be cap-and-trade for industry
  - Maybe a carbon tax, too
  - Renewable portfolio requirements for electric utilities
  - MPG standards for light-duty vehicles

- Governor's Executive Order requires 80% below trend by 2050. **Tough !**
  - Agrees with IPCC4 and Stern Commissions reports
  - Basically, redoing your whole economy

- Senate Bill 375 (2008) requires all urban counties to reduce VKT with land use and transport policies

Modeling Required by These Laws

- Need consistent methods for projecting energy use and GHGs, in all counties
  - Need integrated urban models (land use/transport/economy)

- Land Use/Transport/Economic models studied a lot by the EC
  - ISGLUTI, SPARTACUS, PROPOLIS, STEPS...
  - Some are traditional location choice models
  - Some add inter-industry trade (input-output tables)

- HEATCO (2006) EC report recommended I-O models for capturing the wider impacts of sustainable development plans
  - "Spatial Computable General Equilibrium" models capture effects in land markets

Urban Modeling Background in California

- Tested several types of urban models, 1995-2000
  - Showed that using a land use model changes travel results substantially (Rodier and Johnston, TRB 2000)
  - Compared three urban models on same data (Hunt et al., TRR 2002)

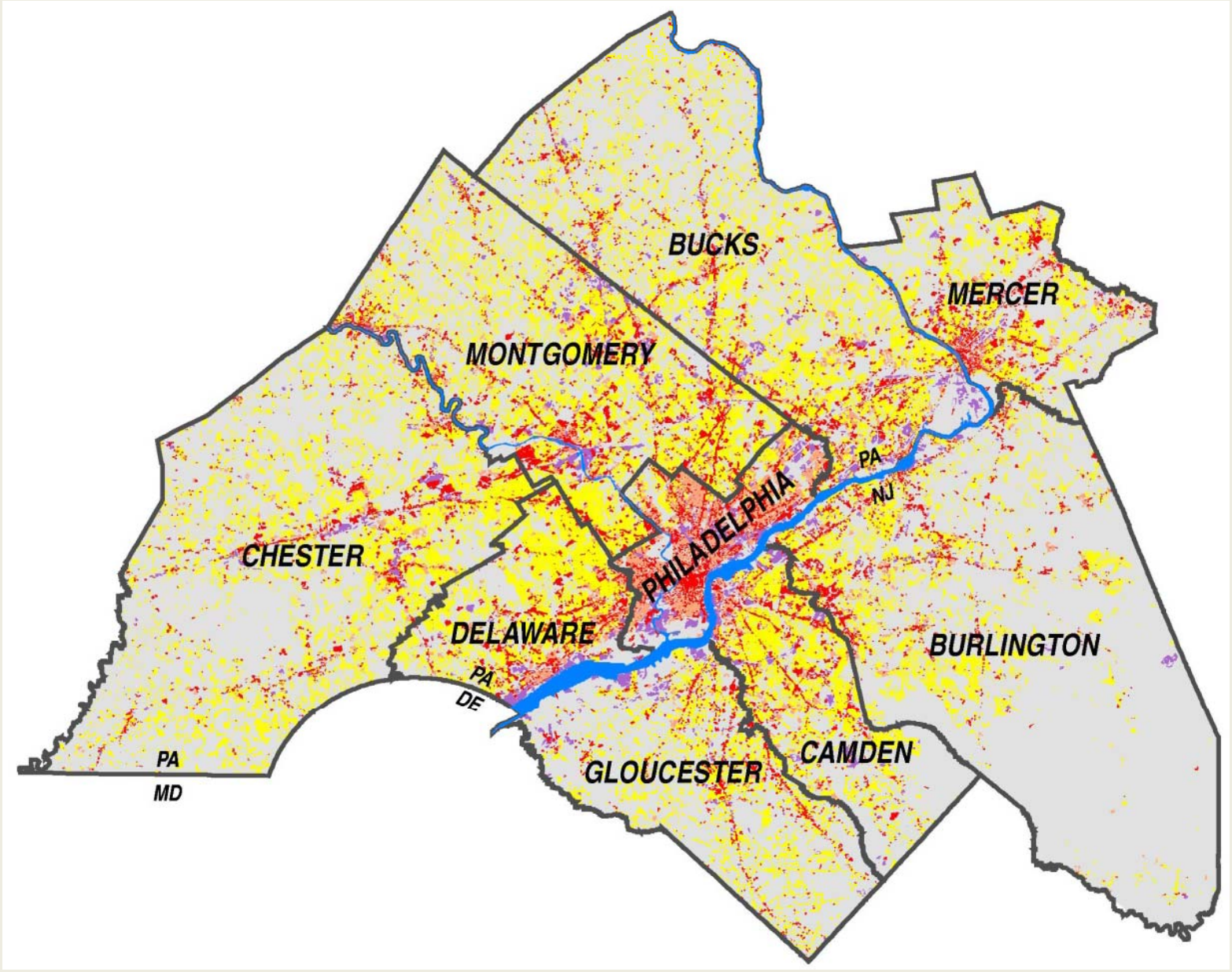
- In our workshops, MPO staff said modeling priorities were:
  - Land use/Smart growth, Pricing parking and roads, Transit, Social equity, Induced land development, How land use affects travel, Air quality, Habitat protection...

- Found that the 4 large regional transportation agencies had economists and database staff. Could use complex models.
  - Other counties had only GIS staff. Some had travel modelers.

Uplan Overview

- Wrote a simple model that runs in GIS
  - Used by 25 counties in California, now
  - Rule-based proximity model. Pseudo-economic.
    - Distance from freeway interchanges, highways, cities
    - Users set land use types and percentages
    - Obeys local land use plans
    - Can run on county, sub-county areas, or groups of counties
  - Open-code and free. ArcGIS9.
  - We support all counties. State DOT $.

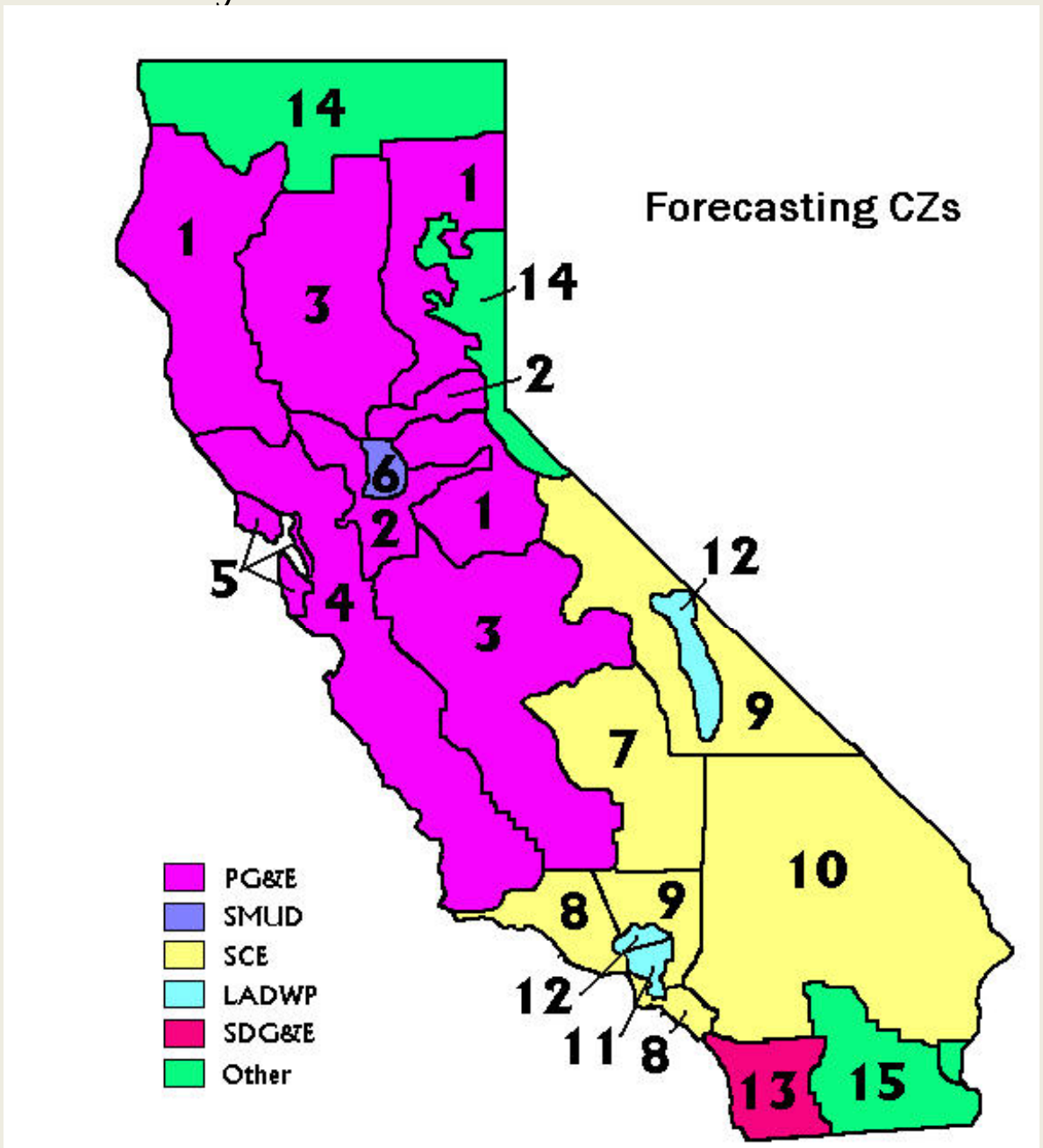
UPlan: A GIS, Integrated, Land Use Planning Model



UPlan GHG Calculator for Buildings

- Converts hectares of each land use into floorspace
  - Industry, Commercial, various Residential densities
- Calculates end use energy by climate zone and utility area
- Calculates primary energy and then GHGs. GREET model.
- Cities and counties can reduce GHGs by increasing densities and by reducing rural sprawl
- Also, can specify a stronger building code

Climate and Utility Zones



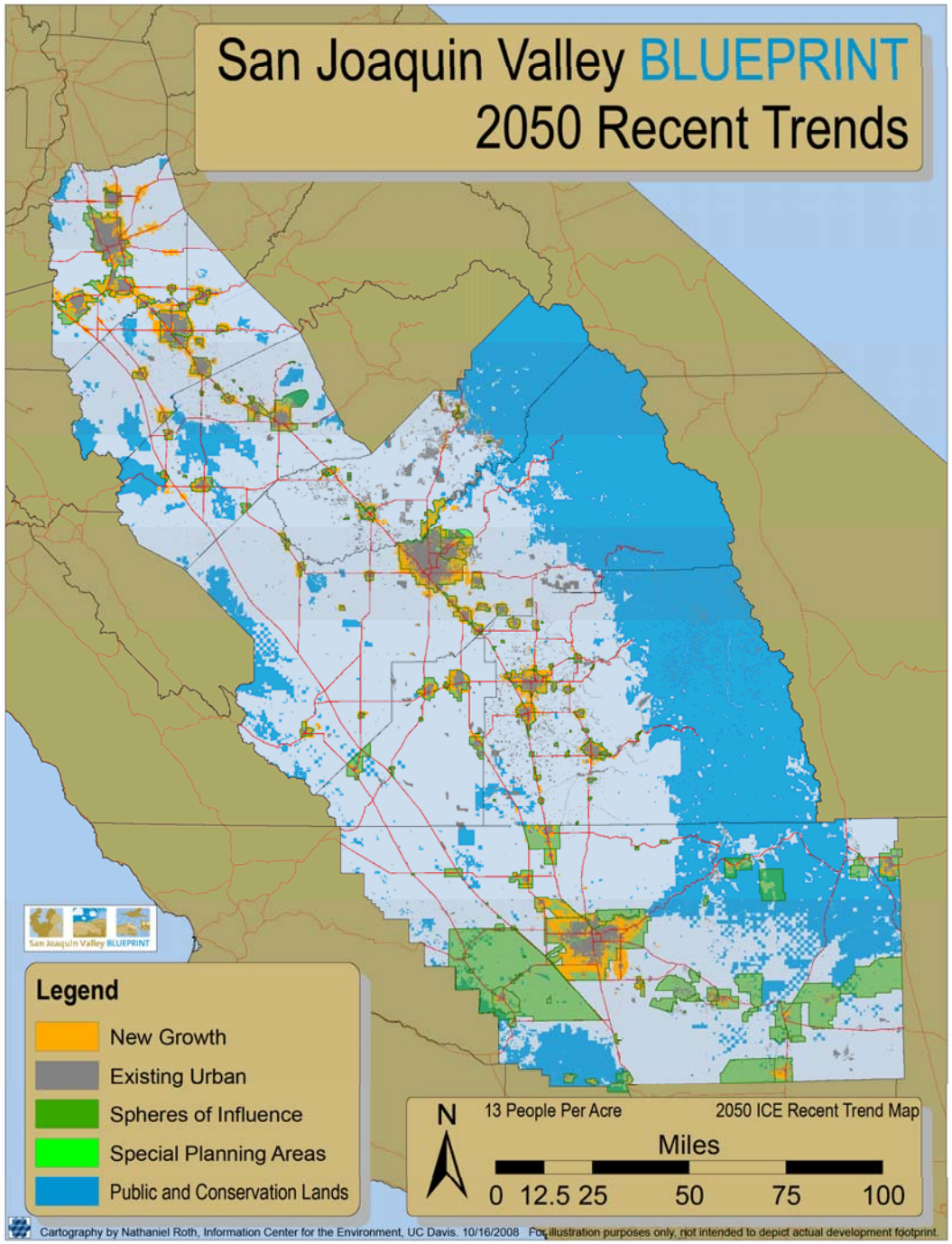
Recent Study of 8 Counties with UPlan

- San Joaquin Valley. Rapid growth. Important agricultural region.

- Mapped 7 scenarios (sprawl, compact growth, protect prime agricultural lands, great cities, etc.)
  - Impacts on habitats, ag. lands, service costs, loss of ag. revenues, and energy and GHGs in buildings

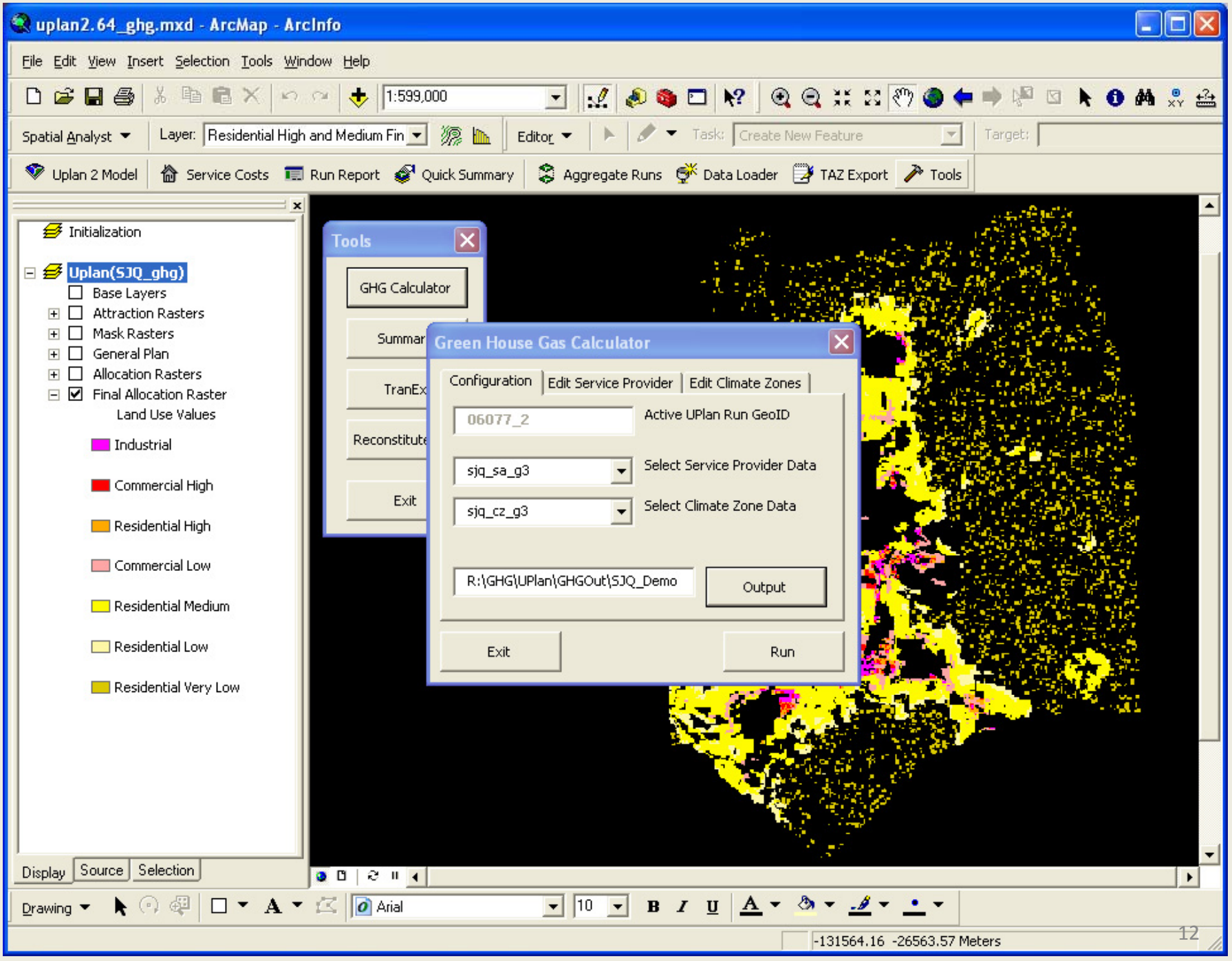
- They adopted the most-compact growth scenario

- Now each county will run UPlan with their travel model
  - Detailed scenarios


San Joaquin Valley BLUEPRINT
2050 Recent Trends
Legend
New Growth
Existing Urban
Spheres of Influence
Special Planning Areas
Public and Conservation Lands
N
13 People Per Acre
2050 ICE Recent Trend Map
Miles
0 12.5 25 50 75 100
Cartography by Nathaniel Roth, Information Center for the Environment, UC Davis. 10/16/2008
For illustration purposes only, not intended to depict actual development footprint.

UPlan Run with Travel Model

- Take households and employees into TAZs for travel model
- On-road GHG emissions from the California emissions model
- Our past modeling exercises with MEPLAN show that the most-effective policies for reducing VKT are:
  - Worktrip parking charges
  - Urban growth boundaries
  - No highway expansions
  - Strong transit improvements
  - Fuel tax (VMT tax, carbon tax)
- Similar to findings in various EC studies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Base Layers
Attraction Rasters
Mask Rasters
General Plan
Allocation Rasters
Final Allocation Raster
Land Use Values
Industrial
Commercial High
Residential High
Commercial Low
Residential Medium
Residential Low
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Complex, Economic Urban Models

- We looked at various urban economic models and chose PECAS
  - Successor to MEPLAN. Has full I/O table inside.
  - All goods and services, labor, wages, households, floorspace
  - Open code and "free"
  - Can get macroeconomic measures, such as State Product or Total Exports ("economic development")
  - Can get economic welfare measures, such as Producer Surplus for households and for employees (bidding for all economic exchanges)

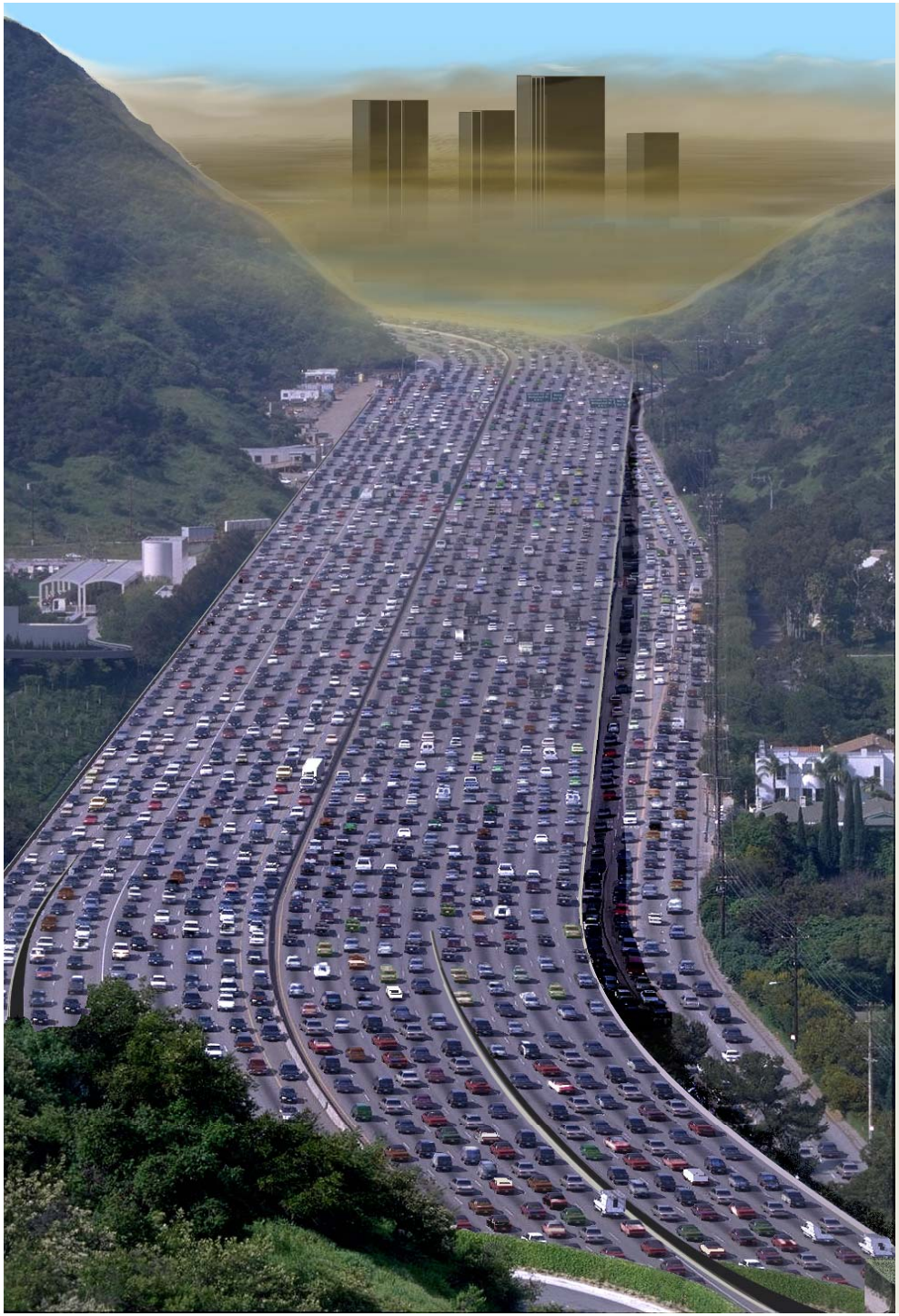
- AB 32 (2006) requires economic analysis and equity analysis
  - Can get surplus for HHs by income class and zone, county, or State
  - Surplus for employees by sector and zone, county, or State

California Statewide PECAS

- We have about 50 economic sectors and 500 zones
  - 2nd Stage model allocates floorspace into 50m grid cells
  - Can do detailed analysis of impacts on natural resources

- Run with the State Travel Model
  - 5,000 zones
  - Several modes, including urban rail, commuter rail, HSR, and airline
  - Can get GHG emissions

- All four large MPOs are now developing PECAS models.
  - So, we can compare results from the 5 PECAS models.
  - Easier for the State agency approving the regional Climate Plans



California Action

New freeway bond

High-speed rail

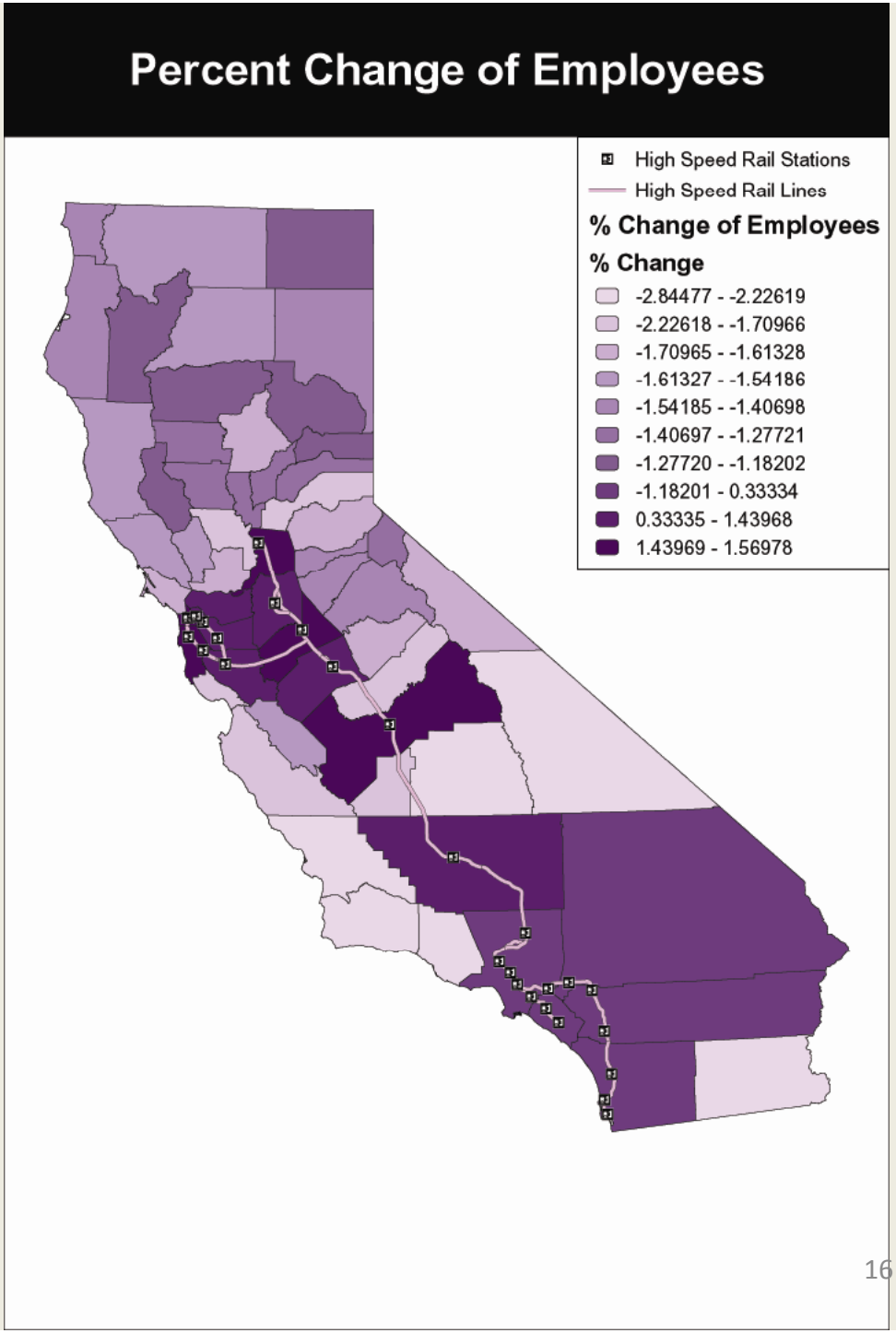
AQ and greenhouse gases

Huge population growth

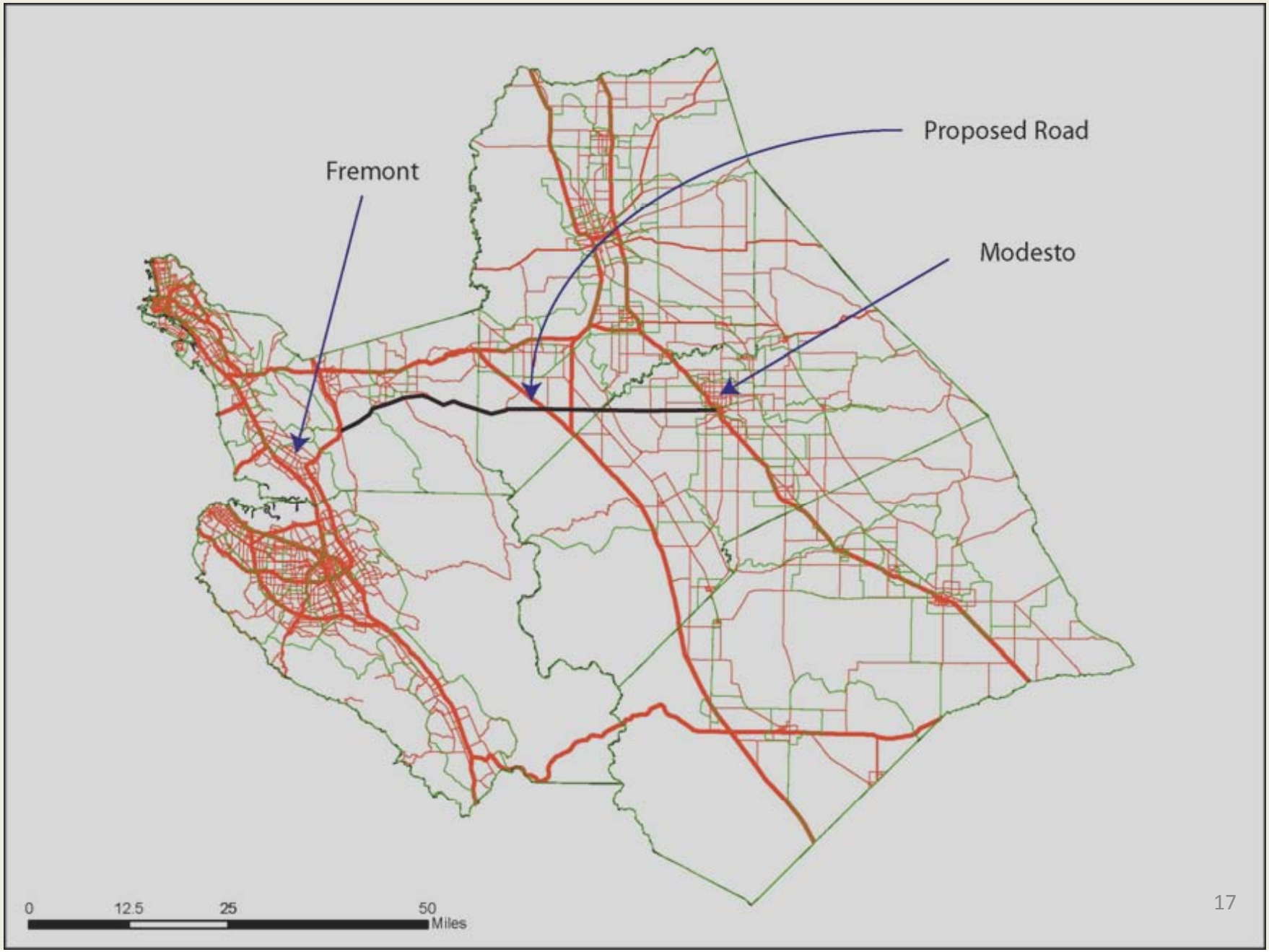
Severe freight congestion

Example Policy Map

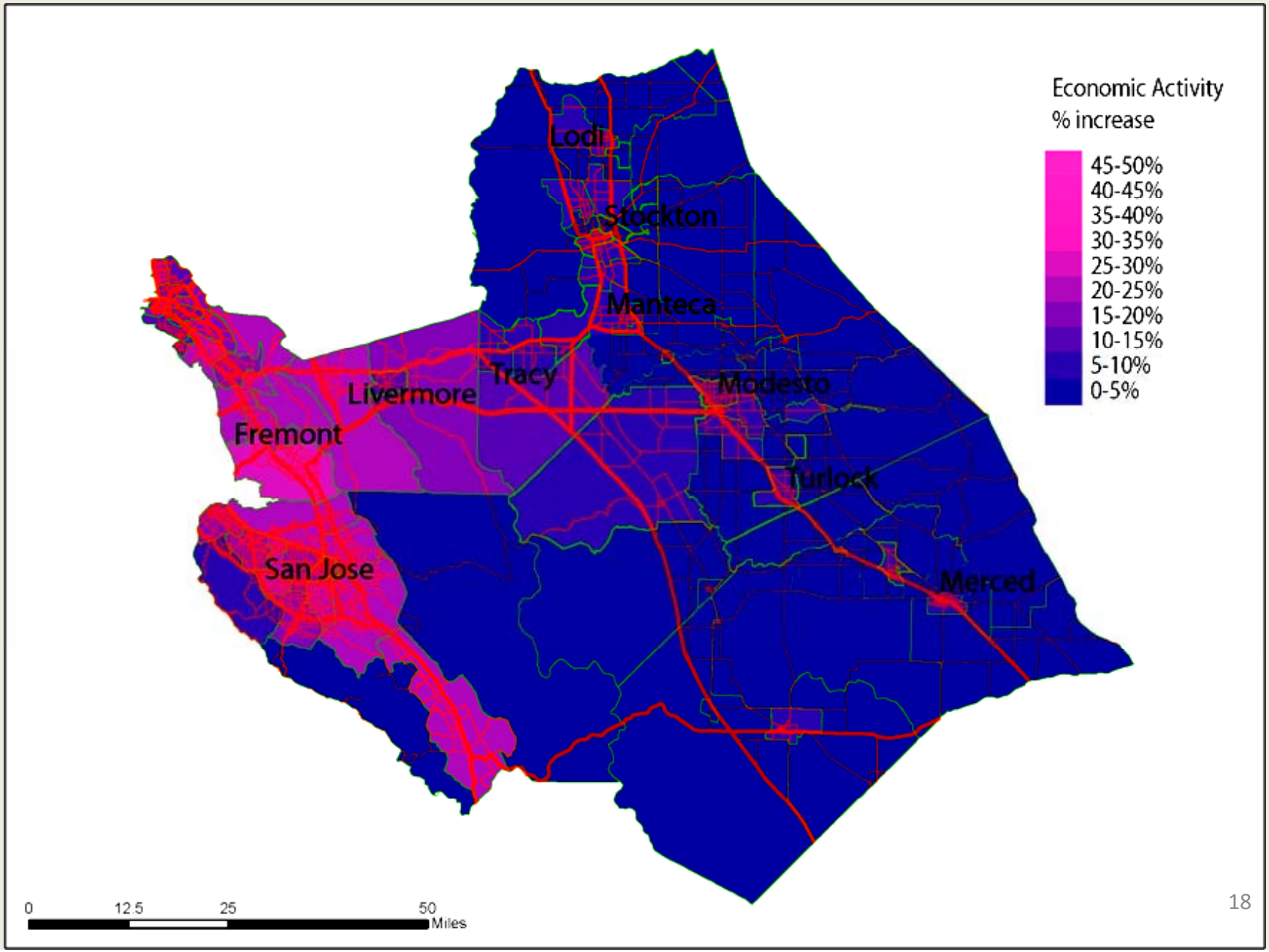
Percent Change
in Employees
(Yr. 2000), Due
to Hi Speed Rail.
County Data.



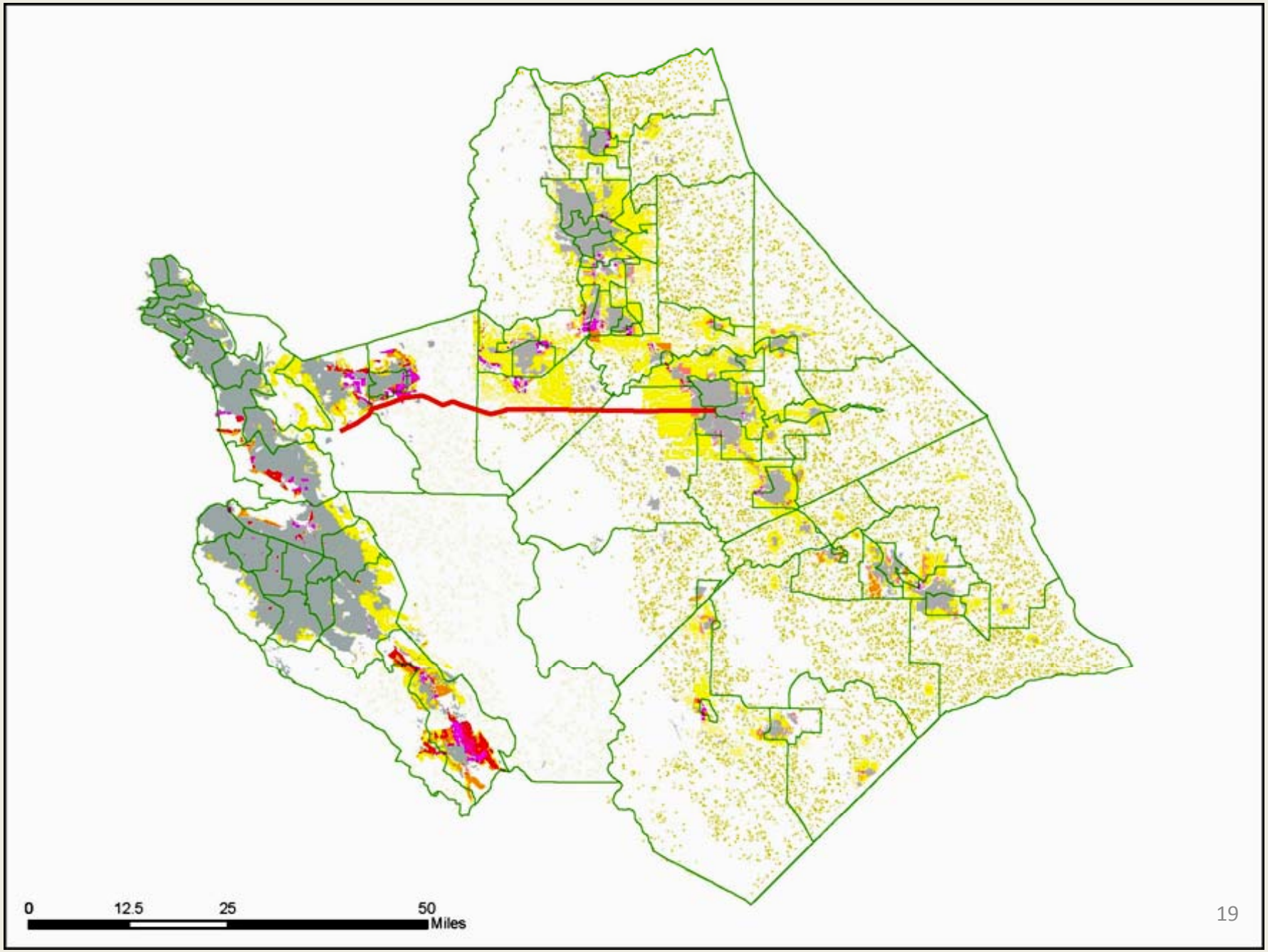
Hypothetical Proposed Road



With Road 2050 : Economic Activity per Zone % Increase



With Road 2050: Land Use



Summary

- We are developing a PECAS model for the State and the 4 large regional transport agencies are also doing PECAS models ($15-20M)

- The smaller counties are doing UPlan GIS-based models, with no economic evaluation capability ($1M)

- We will also apply PECAS to regions, such as the San Joaquin Valley and then let the counties run UPlan on the PECAS zonal outputs
  - So, we get economic evaluations, but also local participation

- California is a demonstration for the other states in the U.S.

Policy Recommendations Re. Modeling

- Need rules for GHG inventorying
  - IPCC rules followed in U.S.
- Need rules for economic evaluation of transportation projects
  - EC has proposed guidebook (HEATCO, 2006)
  - U.K. has a BCA manual.
  - USDOT has guidebooks. AASHTO has guidebook.
  - California DOT has guidebook.
- Need rules for travel modeling
  - None in U.S.
- Need rules for urban modeling
  - New field, many models

Recent Advances in California

- AB 32 passed in 2006 and got enviro groups worried about poor transportation modeling in many MPOs
  - They got the leader of one Legislative house to request modeling guidelines from the State agency that funds most major transportation projects
  - Started as recommendations and were quite weak
  - I pushed for a strong set of best practice suggestions, along with the Sacramento regional agency and the enviro's

- The California Transportation Commission adopted Modeling Guidelines for Climate Planning, May 29, 2008
  - For use in doing Regional Transportation Plans
  - I drafted the guidelines, based on earlier work for an NAS committee

The California Modeling Guidelines

- California DOT has said they are "strongly recommended" and most MPOs are following them now. Expensive.

- Covers urban models, as well as transportation models
  - All models must be peer-reviewed and sensitivity tested

- Recommends different models for 5 groups of counties, by complexity of problems (population growth, AQ, amount of transit...)
  - The four large MPOs should have activity-based travel models and commodity flows for goods movement
  - Also, economic urban models with floorspace rents
  - Go to microsimulation in the future

California Influences on Federal Bills

- Great opposition to GHG legislation, at the Federal level
  - Very useful to have several state climate programs in operation

- California offers a useful program example
  - Modest medium-term GHG goal for 2020 (-30%). Not too scary.
  - Strong long-term goal for 2050 (-80%). Very scary, but far away.
  - Cap & trade for industry, maybe carbon tax [1/3rd of GHG pie]
  - MPG standards for cars/light trucks. Congress passed a weaker law. Obama is going to strengthen. [1/3rd of pie]
  - SB 375 law for on-road GHGs. Directly addresses local land use.
  - Strong building code since 1979. State energy regulators have set a long-term goal of zero net fossil energy use in buildings [1/3rd of pie]
  - Renewable portfolio rule for electric utilities (20% now, going to 30%)
  - EC nations more economically efficient with high fuel taxes and vehicle purchase fees. We need to catch up.