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Cap & Share of Transportation Fuel in California

Abstract

Fuel rationing brings to mind the 1970's oil embargoes, and is seen as something to be avoided if at all possible. However, three situations may cause the return of mandatory limits on fuel consumption: 1) climate change, 2) geopolitics, and 3) peak oil. Fuel rationing may be imposed by external forces due to a supply disruption (i.e. Hurricane Katrina, Middle East politics, or a terrorist act), or by internal forces as a "last resort" (i.e. to meet self-imposed greenhouse gas reduction goals, or similar to water rationing during a drought). This paper discusses the possibility of future fuel rationing, and describes a method of capping fuel use in California by distributing a tradable "Share" of the fuel under the cap to residents on an equal per capita basis. The Share could take the form of a value on a debit card that would be recognized by card readers at gas stations. Most local governments may prefer to reduce fuel consumption through voluntary conservation and efficiency measures, but resource constraints, geopolitics, and natural disaster may force 21st century planners to consider enforcing limits on transportation fuel through a program such as Cap & Share.

Outline

I. Introduction

If given the choice, governments would avoid fuel rationing as a method of reducing consumption. They prefer voluntary programs, incentives, or technology-specific regulations. They are often hesitant to impose mandatory supply restrictions until they are absolutely necessary. The exception in the U.S. was during times of war, such as World War II. Supply restrictions in other countries have been implemented in other circumstances, such as drought, famine, or governmental instability. The U.S. has typically been able to avoid such rationing, with the notable exception of the oil embargoes in the 1970's. However, three situations in the 21st century may cause the return of strict limits on fuel consumption: 1) climate change, 2) geopolitics, and 3) peak oil.

This paper discusses the concept of fuel rationing, three situations where rationing may become necessary, estimates of U.S. and global fuel supply and demand, and a method of "capping" (limiting) fuel use in California, in which a tradable "Share" of the fuel under the cap is distributed to residents on an equal per capita basis. The Share could take the form of a value on a debit card that would be recognized by card readers at gas stations. The final part of this paper discusses the variations in California counties of a policy to reduce gasoline and diesel fuel demand to 15 percent below recent demand levels by 2020.

Climate change

Fuel rationing may be imposed as a way to address climate change, or as a result of supply disruptions due to extreme weather events associated with climate change. Climate change is is caused by the accumulation of greenhouse gases (GHG), primarily carbon dioxide (CO2), in the atmosphere, as a result of the burning of fossil fuels, deforestation, and other human activities. Climate scientists believe that industrialized nations must cut emissions by 80 percent from today's levels to stabilize the amount of carbon dioxide in the atmosphere and prevent the most severe impacts of climate change. Predicted impacts from unabated climate change include sea level rise, drought, agricultural losses, mass migration, species extinction, and global economic turmoil.

Transportation accounts for 28 percent of U.S. GHGs, and is the second largest source of emissions, just behind electricity generation (34 percent).[1] The EPA's GHG Emissions Inventory for the U.S. showed that in the 1990s GHGs from mobile sources increased 18 percent. In California, which has less coal in its electricity mix, the transportation sector is the largest source of emissions. Transportation was responsible for 38 percent of California's GHG emissions in 2004, while electric power emissions accounted for 25 percent.[2] The transportation sector is responsible for an even larger share of emissions in some localities including Northern California, where coal only represents 3 percent of the electricity in the mix

[1] US EPA. " Inventory of US Greenhouse Gas Emissions and Sinks 1990-2006" USEPA #430-R-08-005 April 2008. http://www.epa.gov/climatechange/emissions/downloads/08_Trends.pdf
[2] http://www.arb.ca.gov/cc/inventory/data/graph/graph.htm

of the major utility, PG&E. Transportation accounted for 58 percent of Marin County's total greenhouse gas emissions in 2000, 42 percent of Sonoma County's 2000 total emissions, and 48.6 percent of 2006 emissions in the nine county Bay Area.[3]

California has taken action on climate change through its landmark law, AB32, requiring the state to reduce GHG emissions back to 1990 levels by 2020. It has also passed Clean Car Regulations requiring auto manufacturers to implement technological improvements that achieve maximum economically-feasible GHG reductions, and a low-carbon fuel standard that will incorporate oxygenates and biofuels that reduce the fuel intensity of gasoline sold in the State. Another law, SB375, encourages the State's metropolitan planning organizations to implement smart growth strategies that have the potential to reduce VMT.

Unfortunately, despite these commendable efforts, the State may still not be able to achieve emission reductions from the transportation sector due to population growth and the automobile dependence in many parts of the state. California's population is predicted to increase by 24 million people by 2050, an increase of 40 percent.[4] Los Angeles County is projected to grow from 9.6 million to 13 million by 2050, an increase of 27 percent. The California Energy Commission has predicted that population growth and VMT growth could overwhelm the efficiency measures taken to reduce greenhouse gas emissions from the transportation sector.[5]

Fuel rationing could be implemented as a preemptive action to address climate change, although governments may prefer to wait to see if they have success reducing emissions with other measures first. The effects of climate change could also result in mandatory fuel rationing. In 2005, Hurricanes Katrina and Rita knocked out oil refineries along the Gulf Coast and resulted in oil supply disruptions. Those disastrous Hurricanes, along with the concurrent release of the movie An Inconvenient Truth, served to raise public awareness and the political acceptability of taking action on climate change. Future extreme weather events may play a role in communicating the urgency of mitigating climate change, and place fuel rationing on the political agenda.

Geopolitics

The most recent major fuel rationing experiences in the U.S. came about during the 1973 and 1979 oil embargoes. The 1973 oil embargo occurred when Arab members of the Organization of Petroleum Exporting Countries (OPEC) cut exports to the U.S. due to American support of Israel in the Yom Kippur War. When Iran took U.S. embassy employees hostage in 1979,

[3] Erickson, Dave and Ann Hancock. "Climate Protection in Sonoma County," and "Climate Protection in the San Francisco Bay Area" July 2006 and September 2007. www.climateprotectioncampaign.org
[4] California Department of Finance. Press Release, July 7, 2007. http://www.dof.ca.gov/html/DEMOGRAP/ReportsPapers/Projections/P1/documents/P1_Press_Release_7-07.pdf
[5] Bartholomy, Panama, Gerry Bemis, Gina Barkalow, Nancy McKeever, Suzanne Phinney, Julia Silvas, and Joanne Vinton. "The Role of Land Use in Meeting California's Energy and Climate Change Goals." California Energy Commission. CEC-600-2007-008-SR. August 2007.

President Carter prohibited the importation of Iranian oil, which at the time had supplied about 5 percent of the U.S. oil supply. It is easy to envision 21st century scenarios of supply disruption as a result of Middle East politics or a terrorist act. Iran, Iraq, Nigeria, and Venezuela hold one-third of proven oil reserves and are considered at high risk for political disruption. Some members of OPEC have been outspoken against U.S. foreign policy in the Middle East. In January 2009 during Israel's incursion into Gaza, an Iranian Revolutionary Guard commander urged Islamic nations to use the crude oil supply as an economic "weapon" to exert pressure on Western backers of Israel.[6] At the time, Iranian President Mahmoud Ahmadinejad declined to go on record supporting this concept, and key Persian Gulf producers such as Saudi Arabia did not comment.

Oil price increases can also redistribute wealth to oil producing countries, and can contribute to military aggression. During the 2008 oil price spike, the influx of petrodollars was cited as a reason for Russia's invasion of neighboring Georgia. A similar situation may have played a role in Saddam Hussein's decision to invade Kuwait in 1990. Multinational oil companies have been targets of violence in Nigeria, and in November 2008 an oil tanker with a capacity of 2 million barrels, equivalent to one-quarter of Saudi Arabia's daily output, was hijacked and held for ransom by pirates in the Persian Gulf near Somalia. In a post 9/11 world, with the continuing U.S. military presence in Middle East, geopolitics could easily become a reason for a supply disturbance in the U.S.

Peak oil

Peak oil production occurs when about half of recoverable oil reserves have been produced, marking the point of decline of future production. In 1956, a geologist at Shell oil named M. King Hubbert predicted that U.S. oil production would peak between 1965 and 1970. When data proved him right, analysts called the bell-shaped peak oil curve "Hubbert's peak." Recent events, including the increase in oil consumption in China and India, and the oil price spikes following Hurricane Katrina and again in 2008, have brought peak oil to broader public attention.

The lack of transparent of accounting of oil reserves poses a problem in estimating the timing of world peak oil. OPEC's estimates of reserves are not verified by independent auditors. Venezuela, Iraq, and Russia do not release their current oil reserves, leading some analysts to describe the publicly available figures as "paper barrels" (oil that exists only on paper). A debate over peak oil is ongoing between self-described peak oil "pessimists" (often geologists) and "optimists" (often economists). Estimates of the timing of world peak oil vary. The U.S. Geological Survey (USGS) estimates conventional oil production will peak between 2010 and 2030. The OECD World Energy Outlook (1998) projected a peak of 80 mbd between 2010 and 2020.[7]

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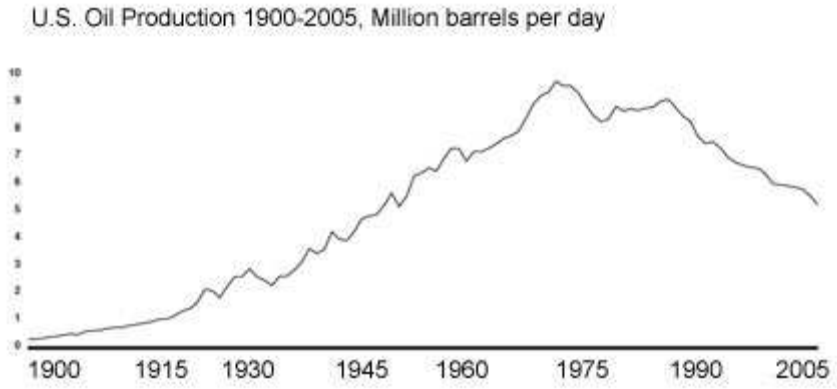
[6] Reuters. "Iran says oil embargo over Gaza is good idea," January 15, 2009. http://uk.reuters.com/article/oilRpt/idUKDAH55043020090115

[7] OECD World Energy Outlook, 1998. http://www.iea.org/textbase/nppdf/free/1990/weo1998.pdf

Table 1:



Source: GAO (See cit. 12)

II. Future Fuel Supply Restrictions

The major oil companies accept the concept of future fuel supply limitations, and have initiated marketing campaigns to assure their customers that they are trying as hard as they can. BP was probably the first to do so, changing its name from "British Petroleum" to "Beyond Petroleum" in 2000. In 2005 Chevron initiated the "Will you join us?" campaign which strangely seems to be asking its customers to use less gasoline.[8] It asks, "In a world where we need all the energy we can find, how do we do more with less?" Citing the Worldwatch Institute, Chevron's website states, "Oil production is in decline in 33 of the 48 largest oil producing countries, yet energy demand is increasing around the globe as economies grow and nations develop." Jeroen van der Veer, the chief executive of Royal Dutch Shell, was reported to have sent an email to Shell employees in early 2008 stating, "We are experiencing a step-change in the growth rate of energy demand due to population growth and economic development, and Shell estimates that after 2015 supplies of easy-to-access oil and gas will no longer keep up with demand."[9]

Back in 1980, the Department Energy released a Standby Gasoline Rationing Plan, required by the Energy Policy and Conservation Act, which would be implemented in case of an oil supply shock.[10] More recently in 2005 Congress formed a Peak Oil Caucus, co-chaired by Congressmen Roscoe Bartlett (R-MD) and Tom Udall (D-NM).[11] In response to a request from the Caucus, the US Government Accountability Office issued a report on peak oil.[12]

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[8] http://www.willyoujoinus.com/

[9] Reported on the website The Oil Drum. http://www.theoildrum.com/node/3548#more and in a radio interview on Marketplace, "Oil demand could soon outstrip supply," American Public Media, January 25, 2008.

[10] U.S. Department of Energy, Standby Gasoline Rationing Plan, 1980. http://ntl.bts.gov/lib/12000/12200/12291/12291.pdf

[11] Website of Congressman Roscoe Bartlett. http://www.bartlett.house.gov/Issues/Issue/?IssueID=2057

[12] "CRUDE OIL - Uncertainty about Future Oil Supply Makes It Important to Develop a Strategy for Addressing a Peak and Decline in Oil Production," February 2007. (GAO-07-283) http://www.gao.gov/products/GAO-07-283

At the state level, California is researching the State's dependence on imported petroleum. Following Assembly Bill 1007, the CEC developed the State Alternative Fuels Plan, which encourages the use of alternative non-petroleum fuels. Assembly Bill 2076, passed in 2000, directed the California Energy Commission (CEC) and the California Air Resources Board (CARB) to develop a statewide strategy to reduce the rate of growth in the demand for petroleum fuels. The resulting 2003 report by the CEC and CARB considers increasing transportation energy efficiency and using non-petroleum fuels and advanced transportation technologies including alternative fueled vehicles and hybrid electric vehicles.[13] Most salient for this paper, the report also recommended that **California adopts a policy to reduce gasoline and diesel fuel demand to 15 percent below 2003 demand levels by 2020** and maintain that level for the foreseeable future. The agencies describe measures to meet this goal through technological and behavioral improvements ranging from properly inflating tires, increasing vehicle fuel efficiency, fuel substitution, oxygenates, fuel cell vehicles.

III. Estimates of Oil Supply and Demand

Production

As shown in Table 1 above, U.S. oil production peaked around 1970 at close to 10 million barrels per day (mbd) and has been generally declining ever since, to about 5 million barrels per day in 2005.

According to a presentation by Matthew Simmons that cites the Department of Energy's Energy Information Administration (EIA), world oil production peaked in May 2005 at 74.3 million barrels per day.[14] The Oil Drum newsletter shows another possible peak on 2008 when production excluding natural gas plant liquids was about 73.8 mbd. Other statistics that include natural gas plant liquids and unconventional sources such as oil sands show peak production at around 81.7 mbd, far below some future projected demand levels of 118 mbd.

Consumption

U.S. consumption reached a modern low of 15.2 mbd in 1983. The EIA states in a 2006 report that world consumption of petroleum had reached 84 million barrels per day in 2005. US consumption was 20.6 million barrels per day in 2005, and EIA projects it will reach 27.6 million barrels per day in 2030. The United States imported about 66 percent of its oil and petroleum products in 2005, with the transportation sector accounting for approximately 65 percent of U.S. oil consumption.[15]

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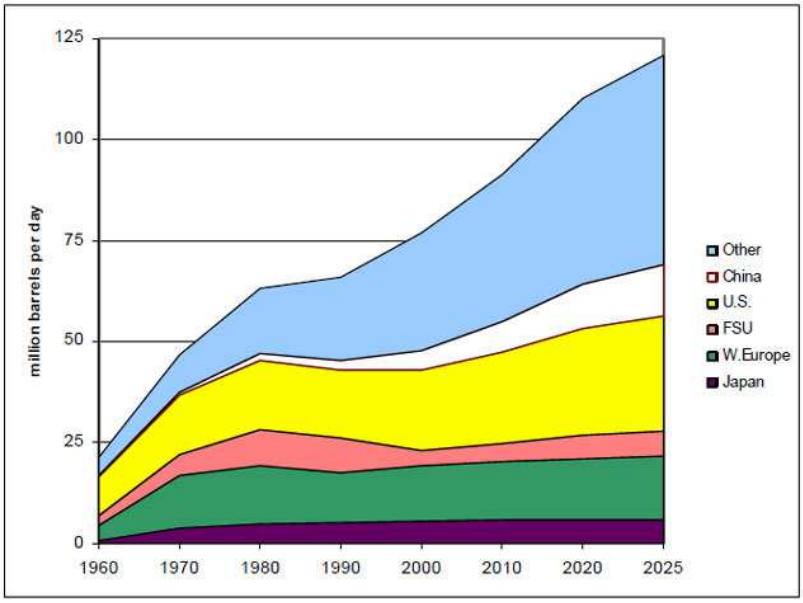
[13] California Energy Commission. "Reducing California's Petroleum Dependence." Joint Agency Report. August 2003. http://www.energy.ca.gov/reports/2003-08-14_600-03-005.PDF

[14] Simmons, Matthew. "The Peak Oil Debate as the EIA Turns 30" http://www.eia.doe.gov/conf_pdfs/Monday/Simmons.pdf

[15] Greene, David L., Janet L. Hopson, and Jai Li, "Running Out Of and Into Oil: Analyzing Global Oil Depletion and Transition Through 2050," Oak Ridge National Laboratory, Department of Energy (2003);

The EIA also projects that world oil consumption will continue to grow to 118 million barrels per day in 2030. Part of this projected growth is due to China's oil demand growing from 4 mbd in 2000 to 8-10 mbd in 2015 and then to 12-16 mbd in 2030.[16] If world production has already peaked at 80 mbd, this implies a significant supply shortfall.

Table 2



World Petroleum Consumption, 1960-2025

Source: Hirsch, Figure A-4 (cit. 15)

The International Energy Agency (IEA) estimates infrastructure investment in exploration and production expand supply capacity would need to total about $2.25 trillion from 2004 through 2030 to meet projected demand.

IV. Pricing as a Rationing Strategy

One potential solution to encourage conservation of resources is to raise the price of the resource, which can reduce demand to the optimal level. Pricing policies have the potential to address the environmental externalities of overuse. The EIA estimates that the decline in oil consumption of 6.1% in 2008 compared to 2007 was due to high oil prices. However, oil prices

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Ahlbrandt, Thomas S., Ronald R. Charpentier, T.R. Klett, James W. Schmoker, Christopher J. Schenk, and Gregory F. Ulmishek, "Global Resource Estimates from Total Petroleum Systems," The American Association of Petroleum Geologists: Tulsa, Oklahoma, 2005; and
Hirsch, Robert L., Roger Bezdek, and Robert Wendling, "Peaking of World Oil Production: Impacts, Mitigation, and Risk Management," Science Applications International Corporation and Management Information Services Inc. (February 2005). http://www.netl.doe.gov/publications/others/pdf/Oil_Peaking_NETL.pdf

[16] Simmons, Matthew. "China's Insatiable Energy Needs." Presentation posted at Simmons and Company website. http://www.simmonsco-intl.com/files/Chinas%20Insatiable%20Energy%20Needs.pdf

in 2009 have fallen because of the economic slowdown, potentially removing the incentive to buy more fuel efficient vehicles or save fuel through behavioral changes. Severin Borenstein of the UC Energy Institute has proposed the idea of a price floor on fuel in California to provide a continued price signal that encourages conservation and investments in fuel alternatives. His paper estimates a state price floor of $82/barrel would result in a gasoline retail price of approximately $3.00 per gallon. [17]

Pricing is a potential solution. However, rationing may still be required if supply disruptions occur or quantity restrictions become necessary. The next section discusses the Cap & Share concept as a potential approach to fuel rationing.

V. Cap & Share

The Cap & Share concept has been promoted since 2006 by FEASTA-The Foundation for the Economics of Sustainability, a non-profit organization based in Ireland and the UK.[18] Cap & Share was originally developed as a method to distribute shares of an economy-wide cap on greenhouse gas emissions (GHG) to citizens on an equal per capita basis. The point of regulation is upstream, and fossil fuel producers and importers are required to purchase the shares from people. As people sell their shares to the upstream companies, the companies raise fuel prices, but return the "scarcity rent" of the permits back to households. As the overall cap declines, the shares gain in value. Households that use more fuel than average will end up spending the value back to fuel companies, while households that use less fuel may come out ahead at the end of the year.[19] The Share might take the form of a value on a debit card that would be recognized by card readers at gas stations. When customers fill up, they would swipe a card that would deduct gallons from their Share. Gas stations would electronically report the number of gallons sold to the agency administering the Shares.

The Cap & Share program is actually quite similar to the U.S. Department of Energy's Standby Gasoline Rationing Plan mentioned above (see cit. 10). In that Plan from 1980, end users may "exchange Government ration checks for ration coupons at designated coupon issuance points, endorse them for deposit in a ration rights account, endorse them for transfer or sale to any individual or firm, or exchange them for gasoline to a willing supplier." Firms and individuals may open ration rights accounts at banks. "Ration rights accounts will operate in much the same manner as monetary checking accounts, i.e., account holders will be able to deposit ration coupons and ration checks in their accounts and can write ration checks against their accounts." The Plan also mentions the possibility of electronic transfers of rations.

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[17] Borenstein, Severin. "The Implications of a Gasoline Price Floor for the California Budget and Greenhouse Gas Emissions," Study of Energy Markets (CSEM) Working Paper Series, University of California Energy Institute, December 2008.

[18] FEASTA's website is http://www.feasta.org. The Cap & Share website is www.capandshare.org. The author maintains a website describing a similar concept called Carbon Share at www.carbonshare.org.

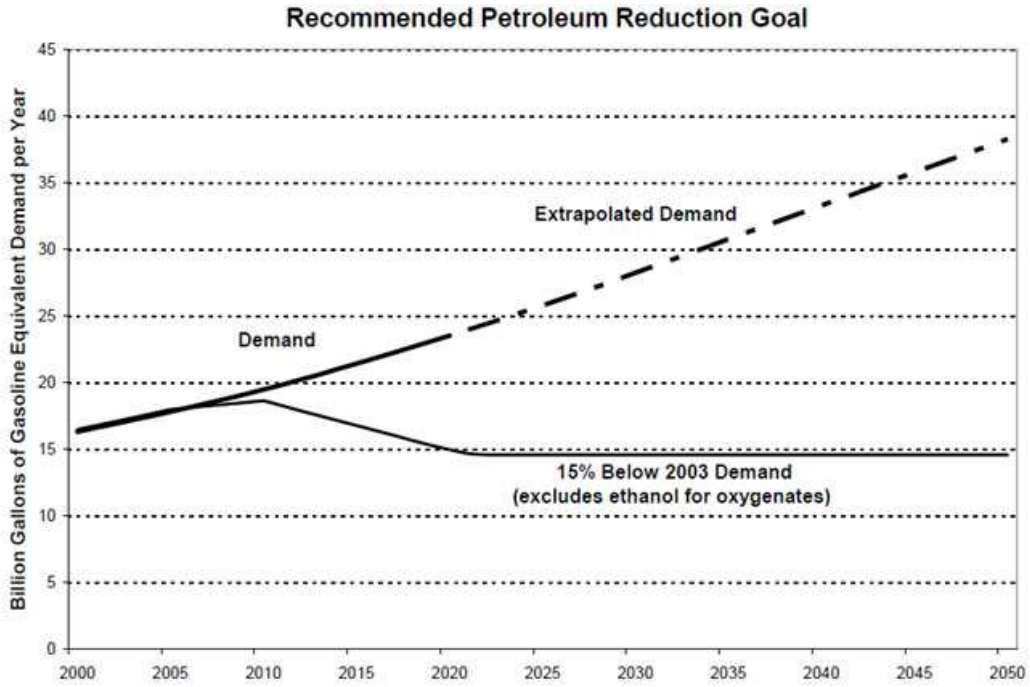
[19] Johnson, Mark, Michael Harfoot, Courtney Musser, Tricia Wiley. "Cap and Share: Phase 1; policy options for reducing greenhouse gas emissions," AEA Energy & Environment, Report to Comhar Sustainable Development Council, Ireland, May 2008.

Cap & Share for Fuel in California Counties

California's population has been increasing by 1.2% per year, and is expected to reach 60 million people by 2050. At the same time, the CEC and CARB have recommended that California adopt a policy to reduce gasoline and diesel fuel demand to 15 percent below existing demand levels by 2020. Could Cap & Share help the State meet this goal, and if so, how would each county be affected?

As shown in Table 3 and in Appendix A, California's gasoline and diesel consumption totaled 18.098 billion gallons in 2006. If this total were divided by 35.99 million people, each person would be allocated 503 gallons.[20] At the statewide average of 1.82 drivers per household, each household's Share would be 915 gallons.

Table 3



Source: California Energy Commission (See cit. 13)

By 2020, it is possible that 45.5 million Californians will have 31.5 million registered vehicles. CalTrans projects total fuel consumption in 2020 to be 24.337 billion gallons of gasoline and diesel fuel, with a projected population of 44.135 million people. That baseline forecast attributes 1004 gallons per household. The CEC reduction goal of 15% below current (2006) levels would provide only 778 gallons per household. Therefore, by 2020, the average household would exceed the reduction goal by 226 gallons. That reduction amount could be

[20] These calculations do not separate residential and commercial/industrial fuel use. Shares allocated to businesses could be calculated according to fleet size rather than by household.

achieved by issuing tradable certificates up to the 778 gallons. Households that exceeded their amount would purchase Shares from others that were able to use less.

Appendix A shows the average household's projected baseline in 2020. Three rural counties, Madera, Yuba, and Sutter, had baselines already below the 15% reduction goal. This is probably due to their projected population growth exceeding their gasoline usage. Alpine, Inyo, Tuolumne, and Sierra counties' baselines exceeded the 15% goal by over 900 gallons per household. This could be due to low populations and potentially high commercial and industrial petroleum usage as a percentage of total use. Appendix B shows maps of current and projected fuel use of different counties.

VI. Policy Implications and Conclusion

Gas tax revenues have already been falling due to more fuel efficient cars. Under fuel rationing, they would fall even further, jeopardizing transportation funding, and representing a loss of government revenue. One potential supplementary revenue source could be a mileage fee. Such a fee might be needed anyway if fuel substitution and plug-in hybrids become popular.

The per-capita allocation of the Share would benefit households that drove less than average, including low-income households without a car. Some higher-income households with multiple vehicles might be expected to exceed their Share, and purchase extra gallons from others, providing a reward to those who conserved. Still, one concern is that low-income households could be unfairly burdened if the program made fuel above the basic Share more expensive, since the price increase would represent a larger percentage of their income.

Rural households may also be negatively impacted. Rural households often drive greater distances and often drive less fuel efficient trucks. By contrast, urban drivers may have a greater opportunity to switch to public transit, bicycle, or other options once their Share was consumed.

Is fuel rationing a reasonable policy response to peak oil? Some experts believe peak oil will simply hasten a transition from conventional oil to unconventional sources such as oil sands and coal-to-liquid. However, those fuel substitutes often entail greater GHGs. Others believe peak oil can be addressed through technology or fuel substitution such as ethanol, compressed natural gas, plug-in hybrid electric vehicles, hydrogen vehicles, and more. The transition time in those cases may take decades. Fuel rationing is still an important policy option in the event of a sudden supply disruption.

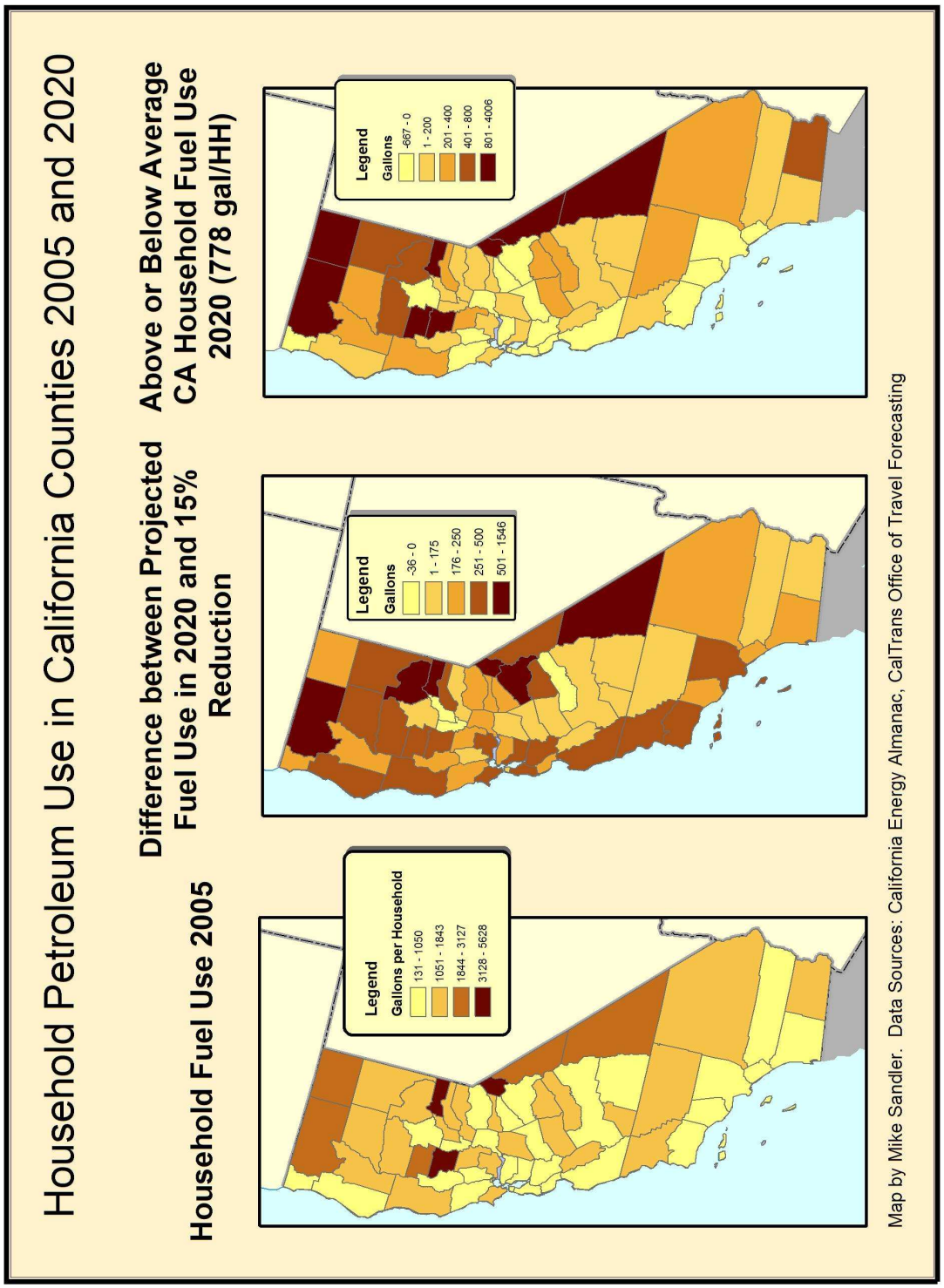
Fuel rationing may be imposed by external forces (i.e. Hurricane Katrina, Middle East politics, or a terrorist act), or by internal forces (i.e. to meet self-imposed greenhouse gas reduction goals, similar to water rationing during a drought). Most local governments may prefer to reduce fuel consumption through voluntary conservation and efficiency measures, but resource constraints due to climate change, geopolitics, peak oil or natural disaster may force 21st century planners to consider enforcing limits on transportation fuel through a program such as Cap & Share.

Appendix A: 2006 Gasoline and Diesel Consumption in California counties, in millions of gallons

County	Total Gasoline and Diesel 2006	Population 2005	Gallons per person	Gallons per household (1.82)	CalTrans Fuel Use projection 2020	CA population projection 2020	Projected Gallons per person 2020	Projected Gallons per household 2020	2020 Gallons Per Household (15% decrease from 2006)
Alameda	761	1446608	526	957	1023	1663481	615	1119	814
Alpine	3	1126	3092	5628	5	1453	3166	5762	4784
Amador	23	37827	618	1124	31	47593	660	1201	955
Butte	95	215208	442	804	128	281442	454	826	683
Calaveras	23	45752	492	895	30	56318	536	976	761
Colusa	43	20675	2070	3768	58	29588	1950	3549	3202
Contra Costa	438	1005106	436	793	589	1237544	476	866	674
Del Norte	14	28549	488	888	19	36077	518	943	755
El Dorado	90	173659	520	947	121	221140	549	999	805
Fresno	472	873364	540	983	635	1201792	528	961	835
Glenn	34	27572	1235	2247	46	37959	1207	2196	1910
Humboldt	73	129104	569	1036	99	142167	695	1265	880
Imperial	118	153857	767	1396	159	239149	664	1209	1186
Inyo	30	17743	1718	3127	41	20495	2000	3641	2658
Kern	547	750665	729	1327	738	1086113	679	1236	1128
Kings	86	143854	599	1091	116	205707	564	1027	927
Lake	33	64217	511	930	44	77912	566	1030	791
Lassen	32	34083	937	1705	43	42394	1012	1842	1449
Los Angeles	4252	9891484	430	782	5716	11214237	510	928	665
Madera	100	140521	709	1291	124	212874	583	1062	1097
Marin	148	245272	604	1099	199	260305	764	1391	934
Mariposa	13	17732	743	1353	18	21743	814	1482	1150
Mendocino	64	87160	733	1334	86	102017	842	1532	1134
Merced	167	238777	701	1275	225	348690	646	1176	1084
Modoc	12	9294	1309	2383	16	13134	1241	2259	2025
Mono	18	12806	1384	2518	24	18080	1316	2396	2141
Monterey	205	408777	501	912	276	476642	578	1052	776
Napa	60	130519	463	842	81	165786	489	890	716
Nevada	68	96675	705	1284	92	114451	801	1458	1091
Orange	1372	2982262	460	838	1844	3520265	524	954	712
Placer	195	315206	618	1125	262	428535	612	1113	957
Plumas	19	20990	907	1650	26	22934	1112	2024	1403
Riverside	1112	1927211	577	1050	1496	2904848	515	938	893
Sacramento	642	1361962	472	858	863	1622306	532	969	729
San Benito	32	55098	587	1069	44	83792	519	945	909
San Bernardino	1269	1953229	650	1182	1708	2581371	662	1204	1005
San Diego	1482	2941658	504	917	1992	3550714	561	1021	780
San Francisco	172	751461	229	418	232	844466	274	499	355
San Joaquin	406	657665	618	1124	547	965094	567	1031	955
San Luis Obispo	163	258200	631	1148	219	293540	746	1357	975
San Mateo	338	698072	485	882	454	761455	597	1086	750
Santa Barbara	197	402740	489	891	265	459498	576	1049	757
Santa Clara	792	1698642	466	849	1065	1992805	534	972	722
Santa Cruz	104	250360	414	754	139	287480	485	882	641
Shasta	119	177696	667	1214	160	224386	711	1295	1032
Sierra	7	3347	1985	3613	9	3508	2537	4617	3071
Siskiyou	62	44459	1384	2519	83	51283	1617	2942	2141
Solano	247	408243	605	1100	332	503248	659	1200	935
Sonoma	205	463631	442	805	276	546151	505	919	684
Stanislaus	242	501084	484	880	326	699144	466	849	748
Sutter	48	87965	543	988	64	141159	455	828	840
Tehama	60	59702	1012	1843	81	79484	1024	1864	1566
Trinity	10	13661	740	1347	14	18236	746	1357	1145
Tulare	222	406491	546	994	299	599117	499	909	845
Tuolumne	4	56295	72	131	46	64161	712	1296	111
Ventura	356	790868	451	820	479	956392	501	912	697
Yolo	125	187044	671	1221	169	245052	689	1254	1038
Yuba	40	67084	591	1076	53	109216	488	888	915
Total	**18098**	35990312	503	915	24337	44135923	551	1004	778

Source: 2007 California Motor Vehicle Stock, Travel, and Fuel Forecast, May 2008. California Department of Transportation, Division of Transportation System Information, Office of Travel Forecasting and Analysis Statewide Modeling Branch, available at the California Energy Almanac, accessed March 16, 2009 http://energyalmanac.ca.gov/gasoline/gasoline_by_county.html

Appendix B


Household Petroleum Use in California Counties 2005 and 2020
Household Fuel Use 2005
Legend
Gallons per Household
131 - 1050
1051 - 1843
1844 - 3127
3128 - 5628
Difference between Projected Fuel Use in 2020 and 15% Reduction
Legend
Gallons
-36 - 0
1 - 175
176 - 250
251 - 500
501 - 1546
Above or Below Average CA Household Fuel Use 2020 (778 gal/HH)
Legend
Gallons
-667 - 0
1 - 200
201 - 400
401 - 800
801 - 4006
Map by Mike Sandler. Data Sources: California Energy Almanac, CalTrans Office of Travel Forecasting

Appendix C

Top World Oil Producing and Consuming Countries - 2002

Producers			**Consumers**		
Rank Country	**MM bpd**	**Percent**	**Rank Country**	**MM bpd**	**Percent**
1 United States	9.0	11.7	1 United States	19.8	25.3
2 Saudi Arabia	8.7	11.3	2 Japan	5.3	6.8
3 Russia	7.7	10.0	3 China	5.2	6.6
4 Mexico	3.6	4.7	4 Germany	2.7	3.5
5 Iran	3.5	4.6	5 Russia	2.6	3.3
6 China	3.5	4.6	6 India	2.2	2.8
7 Norway	3.3	4.3	7 Korea, South	2.2	2.8
8 Canada	2.9	3.8	8 Brazil	2.2	2.8
9 Venezuela	2.9	3.8	9 Canada	2.1	2.7
10 United Kingdom	2.6	3.3	10 France	2.0	2.5
11 United Arab Emirates	2.4	3.1	11 Mexico	2.0	2.5
12 Nigeria	2.1	2.8	12 Italy	1.8	2.4
13 Iraq	2.0	2.7	13 United Kingdom	1.7	2.2
14 Kuwait	2.0	2.6	14 Saudi Arabia	1.5	1.9
15 Brazil	1.8	2.3	15 Spain	1.5	1.9
16 Algeria	1.6	2.0	16 Iran	1.3	1.7
17 Libya	1.4	1.8	17 Indonesia	1.1	1.4
18 Indonesia	1.4	1.8	18 Taiwan	0.9	1.2
19 Kazakhstan	0.9	1.2	19 Netherlands	0.9	1.1
20 Oman	0.9	1.2	20 Australia	0.9	1.1

Source: Hirsch (cit. 15)