SF Peak Oil Preparedness Task Force
ENERGY SECTION - DRAFT 2
1/30/09

INTRODUCTION

At its core the issue of Peak Oil is about energy, and in that sense, this entire report is about energy, so it raises the question, why have a distinct energy section and what should be in it? The Resolution Establishing the Peak Oil Preparedness Task Force specifically directed the Task Force to assess "current modes of electricity generation and transmission, and the feasibility of distributed generation alternatives."[1] This section embodies a response to that directive. Further, limitations in petroleum fuels will likely have impacts across the entire energy sector; therefore, the Task Force has endeavored to take a holistic approach to the problem of Peak Oil.

Electricity generation, transmission, distribution, and end use is an enormous issue. This section does not attempt to address every aspect of the energy sector. Rather, it will focus on the impacts that peak oil and peak natural gas will have on the City and County of San Francisco (City), and the practical, constructive measures the City may choose to implement in response.

Early in its deliberations, the Task Force recognized that in order to adequately address issues such as electricity generation, the other two primary fossil fuels involved in electricity generation, natural gas and coal, would need to be included in the analysis. Natural gas is also used widely in space and water heating in San Francisco. Therefore, this section does assess the degree to which the City depends on natural gas for those purposes, for electricity generation, and for other energy-related purposes, and the risks associated with that dependency. Since a small amount of coal is used for electricity generation, coal is included in the analysis as well.

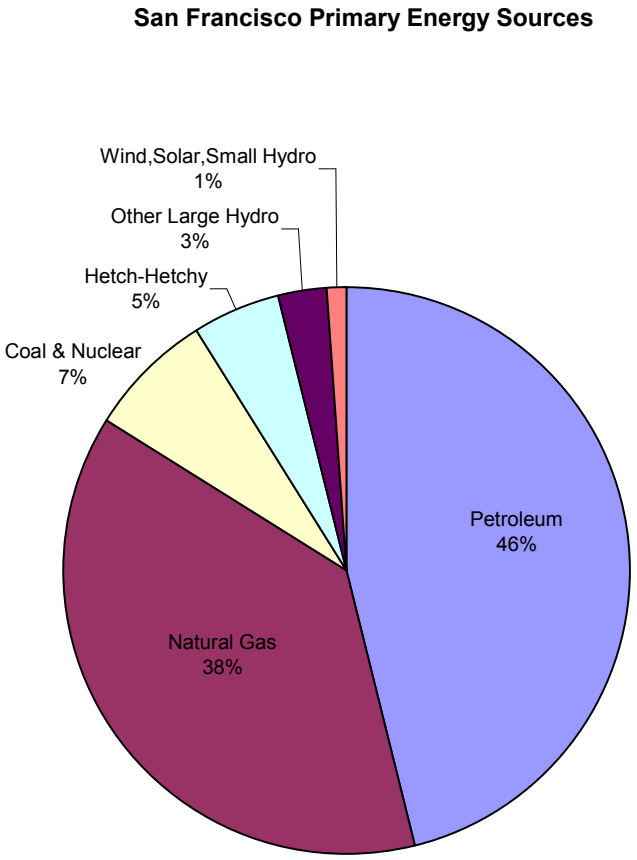
In recent years, San Francisco and many other cities have adopted programs aimed at reducing greenhouse gas emissions. Responses to concerns about the peaking of fossil fuel supplies must not counteract these programs. Fortuitously there is a confluence of interest in this matter in that the primary response that most effectively addresses both problems is the same: reduce and eventually eliminate fossil fuel use. However, this seemingly common sense response is not necessarily the case. There do exist strong proponents of a coal-based approach to mitigating declines in petroleum and natural gas supply. The Task Force does not view an increase in coal use as an appropriate response to decreases in other fossil fuels.

[1] San Francisco Peak Oil Preparedness Founding Resolution:
http://www.sfgov.org/site/uploadedfiles/bdsupvrs/resolutions07/r0268-07.pdf

I. Assessment of Current Reality

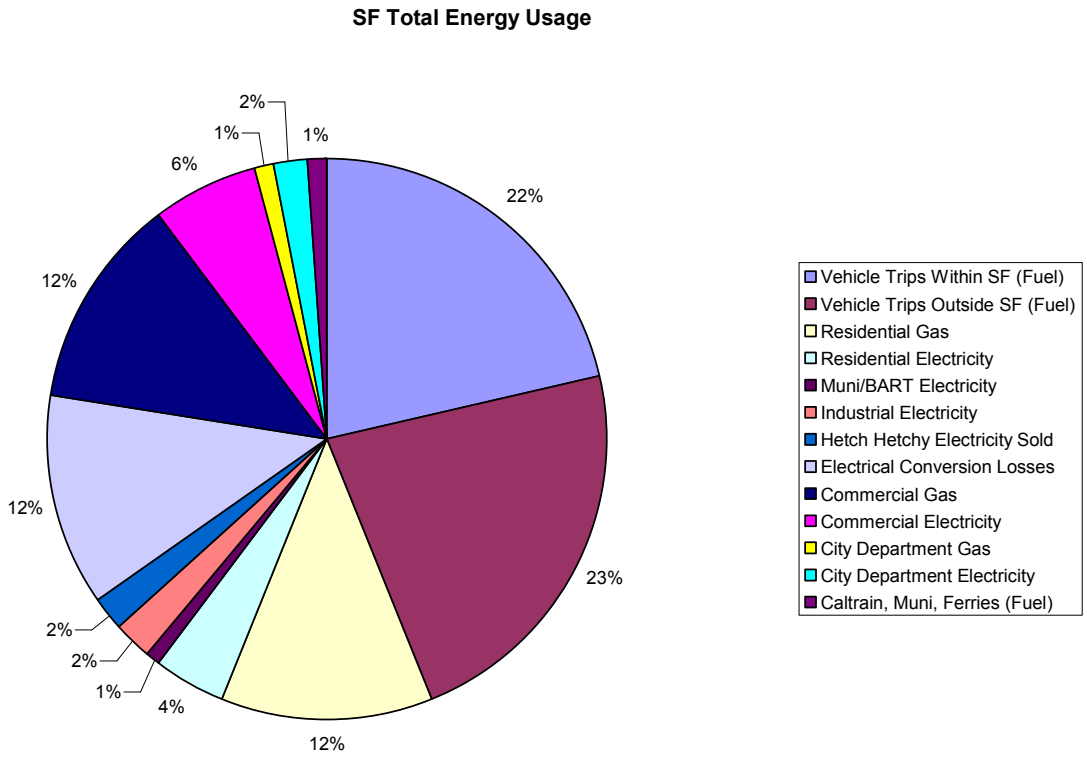
The picture painted of current energy use in the City of San Francisco is painted in broad swaths with fossil energy. Something on the order of 86% of the total primary energy sources for all purposes are fossil - petroleum, natural gas, and a small amount of coal.

The following chart indicates the major primary energy sources for San Francisco for all purposes, including transportation.[2]



[2] Multiple Sources: Hetch-Hetchy, Hetch-Hetchy Brochure; Natural gas-fired electricity, Electric Resource Investment Strategy (ERIS) Figure 4.3; Diesel fueled electricity, ERIS, Figure 4.3; Co-generation of electricity, SF Climate Action Plan update, 2005 Data; PG&E electricity, Total PG&E is calculated from net of uses vs. other sources of electricity: Natural gas, large hydro, coal, small hydro-powered, wind, nuclear, geothermal, all from PG&E 2007 Power Mix; Solar, SF Solar Map; Natural gas calculated based on output figures; Petroleum-based fuel calculated based on 2005 VMT data from SF Climate Action Plan

This following chart indicates the end usage of all energy sources in San Francisco.[3]



Three Principal Energy Sinks (As reflected in the usage chart above)

1. Vehicle Fuel ~45%

Over 95% of the petroleum fuels used in San Francisco are used in transportation as vehicle fuel. The Task Force Report includes a section dedicated to the issue of transportation. Please refer to that section for information regarding that sector. Some modes of transportation depend on grid electricity. Some scenarios for future mobility include substantial increases in the availability and use of plug-in hybrid electric vehicles (PHEVs) and pure Electric Vehicles (EVs), as well as electrification of currently non-electrified transit lines. In these scenarios, significant increases in

[3] Multiple sources: Electricity for residential, commercial, industrial, City Depts, Muni & BART was from the SF Climate Action Plan 2005 update; Solar, SF Solar Map; Hetch-Hetchy power sold calculated from Hetch-Hetchy total generated, less power used by City Depts and Muni; Electricity conversion losses estimated in inputs; Residential, commercial, and City Depts natural gas, SF Climate Action Plan 2005 update; Gasoline & Diesel trips within SF based on vehicle miles traveled data in Climate Action Plan 2005 update; Trips partly in SF, Caltrain, and ferries, Climate Action Plan 2005 update

the load on the electrical utility are projected. The City must anticipate this potential increase in its forecasts.

2. Electrical Generation & Use[4] ~30%
Total electricity consumption for the City in 2007 (the latest year available) was 1555.2 million kilowatt-hours (kWh). Residential accounted for 1,451 million kWh and non-residential use accounted for 104.2 million kWh.[5] The electricity produced for and used by the City falls within three categories: that provided by PG&E to residential and commercial ratepayers (~78%); that provided by the SFPUC mostly for powering municipal buildings and services (12-16%); and that which is provided to large commercial customers via "direct access" a holdover from the deregulation experiment of the late 1990s and early 2000s (6-10%).[6] Total usage in the City peaks at about 900 megawatts (MW, equal to one million watts) in a given year and over the course of a year uses about 5,000 gigawatt-hours of electricity.[7] A gigawatt is one billion watts, or one thousand kilowatts.[8] The mission at hand is not to figure out how to provide 900MW of capacity with non-fossil sources, but how to first reduce the demand significantly so that the job of powering the City is a less daunting one.

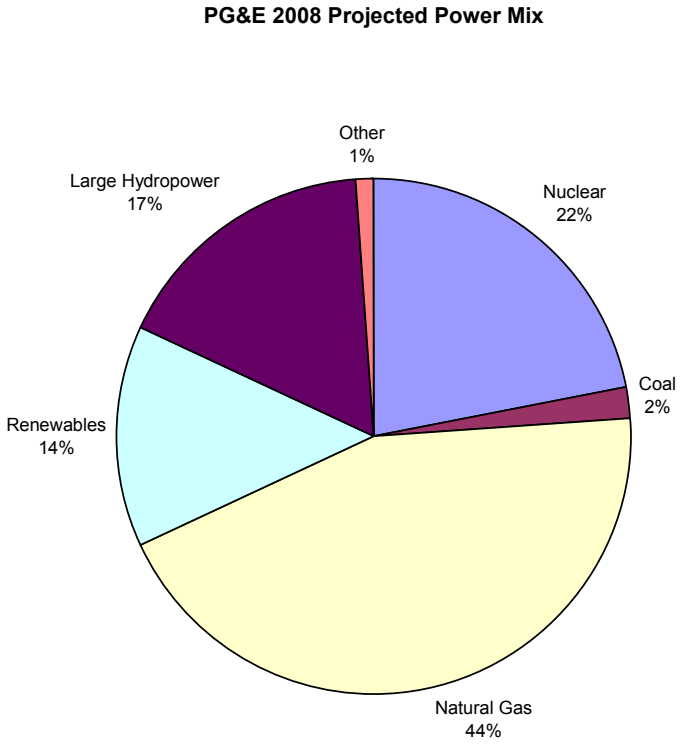
Petroleum is not a component of the electricity generation power mix for San Francisco. Although oil is not currently used directly for power generation in the City power mix, it must be acknowledged that oil is necessary in the *platform* that allows non-petroleum energy systems to function. For example, petroleum fuels are used in vehicles that deliver supplies and help maintain infrastructure, and many components of systems and infrastructure currently require petroleum inputs. In follow-up studies, the City should assess the degree to which its non-petroleum energy sources depend on a petroleum platform.

Pacific Gas & Electric (PG&E)
PG&E is a private corporation that provides natural gas and electric service to approximately 15 million people in a 70,000 square mile service area in northern and central California that includes San Francisco, but excluding power for municipal buildings, Muni, streetlights, and other City services.[9]

Action that may be required to rapidly adapt to Peak Oil impacts may include measures, such as a robust program to increase and expand distributed generation, that would probably not be in the best interest of shareholders and salary recipients in the PG&E for-profit model. As long as the major portion of power-provision to the City remains in the hands of a private corporation, the ability of the City to take meaningful action will be significantly limited.

[4] Note that this analysis does not take into account fuel-to-electricity transformation loss. Statewide, these losses amount to about 53%: See CA Energy balances Database and 2000 Energy Flow Chart: http://www.lbl.gov/Science-Articles/Archive/sabl/2005/November/Cal-Energy-Balance_Murtishaw.pdf
[5] CEC Website Database: http://ecdms.energy.ca.gov/elecbycounty.asp
[6] Phone Conversation with SFPUC Staff Camron Samii and Jim Hendry 1/14/09
[7] SF Electricity Resource Plan, page 27
[8] A kilowatt is 1,000 watts. A kilowatt-hour is equal to a 100 watt light bulb burning for 10 hours equals one kilowatt-hour (kWh).
[9] PG&E Website: http://www.pge.com/about/company/profile/

PG&E Power Mix - 2008[10] (Refers solely to electricity generation)
The 14% renewable energy component is comprised of wind (2%), solar (<1%), geothermal (4%), biomass (4%), and small hydroelectric (4%).



San Francisco Public Utilities Commission (SFPUC)
The SFPUC provides electric power derived almost exclusively via the O'Shaughnessy Dam at Hetch Hetchy to meet the municipal requirements of the City, including power to operate Muni streetcars and electric buses, street and traffic lights, municipal buildings and other City facilities, including the airport. This totals about 140MW and comprises between 12 and 16% of total electrical power use in the City.[11]

Total power generated at Hetch Hetchy averages about 1.6 billion kWh per year with a peak capacity of ~410MW. Under the provisions of the Raker Act[12], San Francisco can draw whatever it needs for its own use before allocating any to the Turlock and Modesto Irrigation Districts or any others after that. It may be plausible for the City to increase its capacity from this resource to accommodate increased transit electrification and/or EV battery charging.

[10] February 2008 PG&E bill insert:
http://www.pge.com/mybusiness/myaccount/explanationofbill/billinserts/previous/2008/feb.shtml
[11] Phone conversation with SFPUC staff Camron Samii and Jim Hendry 1/14/09
[12] The Raker Act is the 1913 federal legislation that authorized damming the Tuolumne River in Yosemite National Park

3. Direct Use of Natural Gas ~25%

Total residential use for 2007 was 152.228651 Therms.[13] Total non-residential use for 2007 was 104.237183 Therms. A breakdown of how gas is used for space heating, water heating, residential vs. non-residential was not easy to find at any City, SFPUC, or PG&E website. It would be very helpful if this information were made readily available to the public, including use trends over time so that progress or lack thereof can be easily seen.

Residential

- Space Heating [?]
- Water Heating [?]

Commercial

- Industrial Process Use [?]
- Co-generation [?]
- Space Heating [?]
- Water Heating [?]

Conservation, Energy Efficiency, and Renewable Energy: Existing Programs and Plans

In the early 2000s the City produced an Electricity Resources Plan (ERP) and commissioned the Rocky Mountain Institute to carry out an Energy Resources Investment Strategy (ERIS). Many of the objectives in the ERP have been met and many other factors have emerged since the early 2000s. Also true is that many of the goals, such as those for renewably-generated power, have not been achieved. These two plans remain the plans under which the City operates with respect to electrical resources. The City should direct SFE and SFPUC to work together to produce a new updated integrated long term energy/electricity resource plan that takes the downside of the peak into consideration.

The City has a wide variety of conservation, energy efficiency, and renewable energy programs and plans underway. Most of them can be reviewed at the City's and the SFPUC's websites. Rather than listing them all here, many of them will be referenced as part of the mitigation strategies proposed herein due to the fact that their significance to Peak Oil & Gas comes in the context of a meaningful response, which is to rapidly increase conservation, energy efficiency, and renewable energy in the City.

[13] CEC Website Database: http://ecdms.energy.ca.gov/gasbycounty.asp; A therm is 100,000 British Thermal Units, the equivalent of burning about 100 cubic feet of gas, and equivalent to about 29kWh of electrical power: http://en.wikipedia.org/wiki/Therm

II. Vulnerabilities.

The principal vulnerability is that so much, nearly all, of the sources of energy that San Franciscans use to power their lives are fossil fuel sources - petroleum, natural gas, and coal. None of these sources are derived from within the City's boundary. In fact, San Francisco has limited capacity to generate any kind of power within its political boundary due to the fact that it is "built out" and very little developable land remains within the City. This leaves rooftops, parking areas, and few areas of open space as possibilities for energy generation within the City.

A second major vulnerability is a populace that is woefully unaware of the predicament that the City and society at large will face as the global extraction peak is passed and we are forced to learn to live in a contracting energy environment.

Petroleum

This is covered very briefly here because it is addressed more thoroughly in other areas of the Report.

- Price

Oil prices are currently very volatile and difficult to predict. In August 2008 oil was at about $150/bbl and at the time of this writing it is at about $50/bbl and slowly rising. Price of oil at a given time is not necessarily an indicator of the proximity of the peak, although this kind of volatility has been predicted as a part of the experience of living through the peak. Daily oil price is a micro-metric; Peak Oil is a macro problem. It is a mistake to think that the peak is not a problem based on current relatively low oil prices. An analogy would be arguing that climate change is not a problem because we are having some cold weather.

> *"Last summer's $4-a-gallon gas was no anomaly, it was a brief glimpse of our future. We must address the inevitability of peak oil by developing vehicles powered by alternatives."*
> *Irv Miller, vice president, Toyota USA*
> *News Release of 1/10/09*

- Supply

Supply estimates in terms of time-of-peak range from now, to most estimating the very near future, to a very few optimists estimating some time around 2030. Total planetary endowment is conventionally estimated at 2 trillion bbls prior to commercial extraction, with about 1 trillion bbls remaining. The more difficult-to-extract trillion.

- End Use/s

Over 95% of petroleum fuel is used for transportation purposes. The remainder is used in industrial applications. Some petroleum diesel is used for emergency back-up generators in hospitals and other facilities that can't afford a blackout. If sustainably-produced biodiesel is not available, these generators will be vulnerable.

Natural Gas

- Price

It is likely that the price of natural gas will be the limiting factor before actual economically significant shortages of supply become a reality. The eventual high prices due to competition

and other factors will render natural gas effectively unavailable. Prices are notoriously difficult to predict with accuracy. Therefore, the Task Force recommends that the City adopt a general policy of erring on the side of high price estimates when conducting forecasts in this regard. For the periods when high estimated prices do not materialize, the City and consumers will benefit by unexpectedly lower prices. If prices are at or above anticipated estimates, the City will be better prepared than if lower estimates had been used.

- Supply

Natural gas production peaked in the U.S. in 1973.[14] However, in recent years, production has increased nearly to the level of this historic peak due to an increase in the number of wells drilled and improvements in natural gas drilling technology. Even so, California and San Francisco increasingly rely on natural gas imported via pipeline. Supplies from overseas can be liquefied and shipped then returned to the gaseous state for end use, but this system is extremely dangerous, controversial, and requires extensive infrastructure investment for supply that cannot be guaranteed. Additionally, conversion losses for liquefied natural gas (LNG) to electricity are about 40%.

- End Uses

All users of natural gas will be vulnerable to price hikes. As mentioned in the Assessment section, City-specific data is not easy to obtain. Having this information readily available to the public would be a step in the right direction.

- Electric Utility

The electrical utility will remain very vulnerable to price increases as long as it remains so dependent on natural gas. Gas, like oil, is ultimately a finite resource. It would be prudent to begin the process of transitioning away from these resources now.

Coal

Although coal is the largest single source of fuel for the generation of electricity worldwide, the City uses very little for this purpose, or for any other purpose. Therefore, the Task Force does not anticipate that coal prices or supply will be a significant factor in energy decision-making for the City in the foreseeable future. This does not imply that the City will be immune to economic impacts in the broader U.S. and international context due to future coal price/supply fluctuations. The risk also exists that energy decision-making that is not in the hands of the City government may result in an increase in coal use.

- Price

Thermal coal (the coal used in power generation) is priced in short tons (a short ton = 2000 lbs.). In the year 2000 coal stood below $25/short ton. As of January 2008, the median price per short ton of thermal coal is $100. The near-term price is expected to decline due to the current global economic downturn.[15]

- Supply

Global coal supply estimates range from “enough coal to last us over 190 years” (World Coal Institute), to “a global production peak in about 15 years” (Energy Watch Group). Although coal exists in far greater quantity than oil or gas, extraction and combustion impacts may inhibit fully exploiting this resource. The Task Force urges the City to resist public policies that would facilitate increased coal use as a primary electricity generation source in nearby

[14] High Noon for Natural Gas, Julian Darley 2004
[15] Reuters 11/27/08 Fayen Wong

states and nationally. Similarly, and for identical reasons, coal-to-liquid fuel technology should not be considered as an option to mitigate declining petroleum supply.

- End Use

Coal is used in San Francisco exclusively for electrical power generation and comprises about 2% of PG&E's power mix.

Geographic Characteristics

San Francisco is perched at the end of a long narrow peninsula. This presents challenges for the City in terms of transmission of electricity in that most transmission, and the least-cost method, is land-based. However, the Trans-Bay Cable from Pittsburg will bring power to the City on transmission line beneath the Bay. The source of power transmitted via the cable remains an issue of concern. The fact that the City is surrounded by water may be advantageous in some respects - offshore wind, ocean wave, and marine current potential.

III. Impact Mitigation Strategies

First, an explanation of what, hopefully, is being mitigated. It is not the problem itself. There is no way for the City of San Francisco to influence the timing of the peaking of oil & gas. What the City is able to influence is the ways and the degree to which the peaking impacts the City. So these are *impact* mitigation strategies.

The first step necessary to respond meaningfully to this issue is for the City to establish a permanent body of dedicated staff that will take up the baton beyond the Task Force to produce further reports and other materials and to begin to educate City staff and the public on the issue. In lieu of a new division or department or commission, some means of promulgating peak oil preparedness measures throughout the City government and the populace at large must be defined.

A principal mitigation strategy is public education. If the public is made adequately aware of the gravity of the situation, many of the things that need to be done – choosing public transit instead of a gasoline-powered car for example – will happen as a result of individual choice that is in turn the result of an effective public education campaign.

> *"Viable mitigation options exist on both the supply and demand sides, but to have substantial impact, they must be initiated more than a decade in advance of peaking."* - *The Hirsch Report: Peaking of World Oil Production: Impacts, Mitigation, & Risk Management - Commissioned by U.S. DoE*

Mitigation strategies in response to the problem of Peak Oil will likely be subject to a similar factor that mitigation strategies for global climate change are subject to, namely, that they are both problems that are global in nature. This does not mean that the City's efforts are unimportant, but ultimately it will require concerted effort at the international level in order to respond effectively. For this reason the Task Force recommends that the City take steps to "wag the dog," in the sense that the City should take actions that compel responses and action at the state, federal, and international levels.

It is not important that the City to try to predict what petroleum fuel and natural gas prices might be in the future, nor is it likely to be accurate no matter how sophisticated the models used. The important thing is to anticipate more than one scenario, and at least one scenario included should be the one where prices are high enough to render petroleum fuels and natural gas effectively unavailable.

In order for the City to meaningfully respond in the context of what it can do for itself, the City will require an ongoing commitment to the issue with City staff dedicated to carrying out, for example, infrastructure investment analysis that takes into account a constricting fossil fuel universe. It would also be in the City's interest in this regard, to operate an "Energy Transition Resource Center" that would provide information and services to residents and businesses to assist them in "de-carbonizing" their energy consumption.

As noted earlier in this section, in 2002 the City produced an Electricity Resource plan (ERP). This plan is now becoming out-of-date, particularly in light of looming fossil fuel supply

limitations. The City should produce a new Plan, similar to the 2002 ERP, retaining consideration of the drivers of that effort (environmental justice, public health, and energy deregulation) but updated to take into account fossil fuel scarcity considerations, and explicitly incorporating the goal of ending dependency on fossil fuels. The Plan should also include a requirement that, once the report is published, follow-up public meetings in the months and years ahead should be held to address the status of implementation of the plan.

Demand Side Management

Demand reduction may turn out to be the single most important response in addressing peak oil & gas. All of the alternative and renewable energy possibilities will likely only fill a fraction of current energy demand given current technology. Therefore, reducing demand is imperative. Corresponds to recommendation B.

Conservation and Energy Efficiency

Conservation comes first. Perhaps a bit out of fashion, conservation is still the best way to adapt to limited resources of any kind. Strictly speaking, conservation and energy efficiency are two different things, but they are closely related. Energy efficiency is a form of conservation. Energy efficiency means using a low wattage compact fluorescent light bulb that puts out as much light as a higher watt incandescent bulb. Conservation means turning off the light. Most of what this report will recommend falls under the category of energy efficiency technology implementation. However, the Task Force feels that the City should not discount the value of promoting conservation as a public education imperative. New or expanded energy efficiency measures have the potential to give the City the greatest "bang for the buck" in terms of mitigating demand. The CCA plan mandates 107 "negawatts" or MW *not used* as a result of energy efficiency and conservation. This is not necessarily the maximum that can be achieved.

Currently PG& E administers energy efficiency program finds from the CPUC in a partnership with SFE. PG&E has an inherent conflict of interest in this matter. The situation should be reversed. SFE should petition the CPUC to allow it to take control of these funds. This is in the process of being renewed. The public goods discharge funds

Smart Grid

The "smart grid" concept is basically creating an energy Internet - replacing the conventional system of monolithic, centralized power generation with little ability for the generator to communicate with the consumer within the system. The smart grid is a decentralized system where a web of interactive electronic communication exists between large generation centers, distribution nodes, smaller distributed generation, and end users. Think of it as an Internet of energy. Advantages of the smart grid are that it increases efficiency, reduces peak demand, and allows for small, distributed renewable energy generators.[16] On December 9th, 2008, the San Francisco Board of Supervisors passed Resolution 081562, establishing City policy supporting Smart Grid technology and protocols for City electric systems urging the Public Utilities

[16] US Dept. of Energy, The Smart Grid: An Introduction
http://www.oe.energy.gov/DocumentsandMedia/DOE_SG_Book_Single_Pages.pdf

Commission to prepare a study to identify the most effective and economic means to implement smart grid technology.[17] Corresponds to recommendation E.

Green Workforce
Another critical component of implementing demand side mitigation measures is having the trained workforce available to do the actual work of retrofitting buildings and installing cleaner more energy efficient systems. Powerful momentum is building on a national level to inaugurate a "green economy" that will be comprised of thousands newly trained in "green collar jobs" to retrofit existing homes and businesses with things as simple as weather-stripping and water heater jacketing to installing the latest energy efficient technologies. The City can take a lead in this arena by establishing a green jobs workforce development program to train and place people in this vocation. The City should establish a green jobs workforce development program to train and place people in the skills required to install new, or upgrade, repair, reconstruct, replace, or expand existing energy efficiency and renewable energy infrastructure. Corresponds to recommendation F.

Supply Side Management
What is needed is an estimate of how much energy can be generated in the city by each non-fossil method of electrical generation. Combining maximum demand reduction with the theoretical maximum of non-fossil alternatives, plus the Community Choice Aggregation plan to put solar and wind along the Hetch-Hetchy corridor, plus CCA's energy use reduction plan, to get a picture of what the prospects are for powering the City. Whether that will be contained in this report, or offered as a recommendation of work that the City should undertake has not yet been determined.

As with demand management, a trained workforce will be needed to do the work of installing new cleaner, renewable energy infrastructure on the supply side.

Community Choice Aggregation (CCA)
CCA is a program enabled under state law that allows the City to become an electricity purchaser for residents and businesses currently served by Pacific Gas & Electric (PG&E). Ratepayers are able to opt-out and remain full customers of PG&E if they prefer, and PG&E may continue to provide electricity transmission, distribution, meter reading and billing services under the CCA program. The main advantage of CCA relative to Peak Oil & Gas is that the City has the ability to choose non-fossil primary energy sources, and is not at the mercy of PG&E, which is a private corporation, for decision-making in this regard. Local control of pricing is another advantage of CCA. The CCA implementation plan calls for 360MW of non-fossil energy generation and conservation. This is comprised of 31MW of PV power, 72MW of non-solar distributed generation, such as stationary fuel cells, 150MW of wind power, and 107MW of efficiency and conservation measures.[18] Corresponds to recommendation A.
[More?]

[17] Resolution 081562: http://muni.sfgov.org/site/bdsupvrs_page.asp?id=94692
[18] San Francisco CCA Program Description and Revenue Bond Action Plan, Page 5

Feed-in Tariffs

A feed-in tariff is a mechanism that allows small renewable generators to sell their power to utilities at predefined terms and conditions. In early 2008 the California Public Utilities Commission (CPUC) made new feed-in tariffs available for the purchase of up to 480 MW of renewable generating capacity from small facilities.[19] Pursuant to this, effective February 2008, PG&E will purchase power from our customers who install eligible renewable generation up to 1.5 MW in size[20] Since PG&E is already doing this under AB1969 and CPUC supervision, the City should see if there is anything it might be able to do in this arena. Corresponds to recommendation G.

Renewable Energy Plan

Currently, no comprehensive plan exists that would result in the City ceasing its dependence on fossil fuels for non-transportation energy use. The City - SFE, SFPUC - should produce a plan that would do so, combining robust energy demand reduction with aggressively increased cleaner renewable energy infrastructure investments. Such a plan should have near 100% clean renewable energy as its objective. This can be characterized as an updated Electricity Resource Plan or not. It can also be carried out in the context of CCA or not. It doesn't matter, but it needs to be done. Corresponds to recommendation C.

Renewable Energy Infrastructure Implementation

The key to risk mitigation in this arena is diversification. There is no single energy source currently known that can replace petroleum or natural gas. It is also unlikely that any combination of known non-fossil, non-nuclear alternatives will be able to meet current or projected demand. However, some combination of all non-fossil alternatives combined with robust programs of conservation, energy efficiency, and localization, may be the best way to approach mitigation. An aggressive program, whether in the context of CCA or not, will be an inevitable key to transitioning out of the fossil fuel era. Corresponds to recommendation D.

The following are renewable energy sources and technologies that are presented in this section as part of a peak oil response strategy due to the fact that all of these sources and technologies have barely been tapped and are in their early stages of development. The general strategy is to rapidly expand these non-fossil based potentialities.

Solar

- Solar Photovoltaic (PV)

Solar PV refers to technologies that convert solar photons directly into electrical current. The most common types are silicon crystal-based panels, but many other types of products are coming on line, such as "thin-film" solar cells made from materials other than silicon. This is a rapidly growing technology both in the economic sense and as it pertains to the technology itself. State and local incentives exist to assist home owners and businesses to install PV systems. One concern raised in the Task Force proceedings is that the manufacture of solar panels themselves is a very energy intensive endeavor that currently requires fossil fuel inputs. This is true of virtually every "alternative" energy technology. Since the technology and

[19] CPUC Press Release 2/14/08: http://docs.cpuc.ca.gov/PUBLISHED/NEWS_RELEASE/78824.htm
[20] PG&E Feed-in Tariff FAQ:
http://www.pge.com/includes/docs/pdfs/b2b/wholesaleelectricsuppliersolicitation/Feedin_Tariffs_FAQs.pdf

economics of PV are evolving rapidly, it is difficult to estimate the maximum amount of power that might eventually be achieved through this technology. Currently there are about 924 solar PV installations in the City totaling about 6.5MW as of November 2008.[21] The mandate under CCA is 31MW, so there is a lot of potential for expansion in this arena.

- Solar Thermal

Solar thermal refers to technologies that take direct advantage of the heat energy from the sun. A very common and tested solar thermal technology is solar water heating. In 2007 AB 1437 passed which authorizes the CPUC to create a $250 million program with the goal to install 200,000 solar water heating systems throughout the state. The program is expected to be in place by 2010.[22] There will be a lot of new activity in this arena in the City by 2010 and forward. In addition, a new pre-market analysis coming on-line about solar hot water.[jp] The City should promote solar thermal to offset natural gas used to heat water.

- Distributed Solar

Distributed generation (DG) refers to electrical generation systems that are typically smaller than conventional power plants and are "distributed" over a given geographical area. Small-scale solar, such as residential roof-top, is a good example of this. DG theoretically offers several advantages over the conventional monolithic power generation paradigm in that it reduces risk of black outs, offers opportunities to increase efficiency, allows for more renewable energy systems, and minimizes risk of catastrophic accident or effective terrorist attack. It is mentioned here as "distributed" to distinguish it from large concentrated solar power facilities.

- Concentrated Solar Power (CSP)

Several types of CSP systems have been proven. As the name implies, these facilities focus or concentrate solar energy to produce electricity by means of the extreme temperatures reached. The facility is typically located in a remote area and the power is transmitted to the grid or load centers.

Marine-Based Power Generation

- Ocean Wave Energy Conversion

Ocean wave power generation is possible in places where enough strong, constant wind results in waves that have enough kinetic energy – a high vertical trough-to-peak differential – to allow specially designed buoys to take advantage of the differential and produce electricity. The nearest locations where this is the case, in close enough proximity to San Francisco, are off the coasts of Mendocino and Humboldt counties. Currently, PG&E is investigating the possibility of securing electricity from projects for which permits are pending. The current maximum generation estimate from the Mendocino project is 40MW. Another pending project in Humboldt County may produce up to 100MW. The total amount of electrical generation possible via this type of system is estimated by the California Energy Commission to be about 8GW, so there is a lot of potential.

- Tidal Power

Between 2001 and 2008 the CITY investigated the possibility of harnessing the power of the tidal current flowing through the Golden Gate into and out of the San Francisco Bay.

[21] Phone conversation with SF Dept. of Environment staff, Johanna Partin 1/5/09
[22] CPUC Solar Hot Water Program: http://www.cpuc.ca.gov/PUC/energy/Solar/080220_SD_SolarPilot.htm

Currently the investigation is on indefinite hold.[23] In 2006 the Electric Power Research Institute (EPRI), conducted a study that initially stated that about 35 MW of electricity could be generated from the Golden Gate tidal current. However, SFPUC conducted its own feasibility study and determined that only about 10MW of extractable power exists.[24] Currently URS Corporation is carrying out another study. It remains to be seen whether this will be an option for powering the City. And even under the most ideal scenario, only about one fifth of the City's current demand can be fulfilled via this potential power source.

- Marine Current [more]

Wind Power

- Urban (land-based) Wind Power

A California Energy Commission study in 2004 that looked at wind energy resource in SF found not much large scale potential due to the lack of available undeveloped land. However, there may be some potential for smaller scale wind power installations on rooftops. The SF Urban Wind Power Task Force is investigating this prospect and a report is expected in March 2009. One of the things the City might be able to do in this arena is to provide information on wind generation to residents and businesses. SFE is currently investigating where some demonstration projects might be installed. SFPUC is looking into potential for wind along Hetch Hetchy corridor. Much of the state's best wind resource is already "locked up."[25]

- Offshore Wind

The City is currently investigating the potential for offshore wind power. SFE is working with Stanford students, but the process has just started. Offshore wind is about four times more expensive than land-based wind.[26] An April 2008 Stanford University study found that somewhere between 63 to 86% of California's electricity needs can be met with offshore wind energy alone.[27]

Geothermal

Geothermal energy is energy that is obtained from the heat within the Earth. It can be used "as is" as a heating source, or can be used to produce steam to run a geothermoelectric turbine to generate electricity. The geothermal we are talking about here is not to be confused with geothermal heat pumps that take advantage of the very near-surface (<10ft.) temperature stability that allows one to take advantage of a slight differential in temperature in order to heat or cool a space.

- Conventional

Conventional geothermal energy is limited to areas where the resource (heat) is near the surface and readily accessible. San Francisco has a large conventional geothermal resource located only 75 miles away, the Geysers, mostly owned by Calpine Corporation.

- Enhanced

[23] Phone conversation with SF Dept. of Environment staff, Cal Broomhead 12/8/08
[24] SF Bay Guardian 6/27/07
[25] Phone conversation with SF Dept. of Env. staff Johanna Partin 1/05/09
[26] ibid.
[27] Assessing California's Offshore Wind Potential, Dvorak, et al, April 2008: http://www.image.ucar.edu/public/TOY/2008/focus4/Presentations/TALKDvorak.pdf

Enhanced geothermal, also known a hot dry rock geothermal, refers to a relatively new prospect where very deep bore holes are drilled, water is injected, and hot water or steam emerges from a secondary bore hole.

Biomass
Biomass is exactly what it sounds like, large quantities of biological matter. Biological matter contains potential energy. The City

Unproven Sources / Technologies
This section will touch on the various unproven technologies that are either newly emerging or have been around for a while but are, as yet, unproven on a large scale.

The following three items are not energy sources per se, but have been proposed as means of generating electricity within the City.

Combustion Turbines
Combustion turbines (CTs) are stationary engines that run on natural gas or liquid fuels for the purpose of producing electricity. CTs have been proposed as a means of increasing in-City electrical generation. [More]

Cogeneration
Cogeneration refers to the practice of capturing waste heat from existing industrial or commercial boilers or turbines that produce electricity on-site. The heat can be used for other industrial purposes or for space heating. The City carried out a limited study of the potential for cogeneration and found that there is a potential for more than106MW capacity from places like hotels, residential high rises, and hospitals.[28]

Stationary Hydrogen Fuel Cell Stacks
Fuel cells are a long-proven and gradually improving technology but remain expensive. As the technology improves and manufacturing costs are reduced, stationary fuel cells may become a significant option for onsite generation. In the context of Peak Oil & Gas concerns, they only make sense when the hydrogen fuel that powers them is produced via clean renewable non-fossil energy sources such as wind. Significant improvements in hydrogen storage and transportation technologies will also be required to make general use of fuel cells feasible.

What *Not* To Do
The Task Force is unanimous in opposition to nuclear fission power as a mitigation strategy for addressing peak oil & gas. Once these plants are decommissioned, new sources must emerge to take their place.

The Task Force urges the City to resist public policies that would facilitate increased coal use as a primary electricity generation source in nearby states and nationally. Similarly, and for identical reasons, coal-to-liquid fuel technology should not be considered as an option to mitigate declining petroleum supply.

[28] SF Dept. of Env. 2007 Cogeneration Study:
http://www.sfenvironment.org/downloads/library/ciscocogenerationreportpdf.pdf

IV. RECOMMENDATIONS

For more detail on these recommendations see the corresponding text in III. Impact Mitigation Strategies of this section.

A. Implement Community Choice Aggregation

B. Contract an independent city-wide energy waste audit

C. Produce a new Electricity Resource Plan

> *"Securing energy supplies and speeding up the transition to a low carbon energy system both call for radical action by governments - at the national and local levels…"*
> - *International Energy Agency, World Energy Outlook 2008*

D. Pursue renewable energy portfolio diversification

E. Develop smart grid technology

F. Advance a green jobs workforce development program

G. Explore the pros & cons of feed-in tariffs

H. Take control of energy efficiency funding for programs and public education

I. Seek ways to maximize the City's influence on primary energy resource decision-making

The following people provided valuable insight and/or expertise and/or materials in the preparation of this section of the Report:

- June Brashares, Green Energy Programs Director, Global Exchange www.globalexchange.org
- Eric Brooks, Sustainability Committee Chair, San Francisco Green Party www.sfgreenparty.org
- Cal Broomhead, SF Dept. of the Environment www.sfenvironment.org
- Rory Cox, Pacific Environment www.pacificenvironment.org
- Alice Friedemann
- John Geesman, Former Commissioner, California Energy Commission www.energy.ca.gov
- David Room, Director, Energy Preparedness www.energypreparedness.net
- Jeanne Marie Rosenmeier, SF Peak Oil Preparedness Task Force Chair
- Marlene Vogelsang, Resource Specialist, Pacific Energy Center http://www.pge.com/pec/