Solutions Submitted by the Public

Community Climate Action Plan

With accompanying analyses of public solutions
prepared by
Jerrell Ross Richer, Ph.D., Consulting Economist

For the
Climate Protection Campaign
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Solutions Submitted by the Public

Sonoma County Community Climate Action Plan

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Introduction

The public was invited to submit solutions for reducing GHG emissions in Sonoma County. A "Recommended Action Worksheet" was provided to the public for use in describing information about their solutions. The person completing the form provided an explanation of the technical, political and financial feasibility of the action as well as a projection of the reduction in GHG emissions that would result. Solutions from the public were considered along with those developed by our technical consultants.

A total of ten submissions from the public were received. After a preliminary screening, six promising submissions were selected to be analyzed by consulting economist and Sonoma State University professor Jerrell Ross Richer Ph.D.[1]

Dr. Richer prepared a report for each of the six solutions that included the following sections:

- Executive Summary
- Summary of the Recommended Action
- Contact Information
- S.W.O.T. Analysis
- Financial Analysis
- Environmental Economic Analysis
- Conclusion
- References

Information about terms and concepts used by Dr. Richer in his analyses follows.

S.W.O.T. ANALYSIS

A "Strengths-Weaknesses-Opportunities-Threats" (SWOT) analysis offers a useful means of assessing the viability of a project, or Recommended Action, from a variety of perspectives. The exercise typically begins with a clear statement of the objective of the Action, followed by a detailed description of the its intrinsic attributes (strengths and weaknesses) as well as any external factors that must be accounted for when evaluating its viability (opportunities and threats). The elements of a SWOT analysis are, in order of consideration:

- Objective of the Recommended Action
- Strengths – Attributes of the action that are helpful to achieving the objective
- Weaknesses – Attributes of the action that are harmful to achieving the objective
- Opportunities – External conditions that are helpful to achieving the objective
- Threats – External conditions that are harmful to achieving the objective

Dr. Richer estimates a variety of standardized measures of the financial performance of this project, beginning with the simplest to understand. Some of the measures make

[1] Jerrell Ross Richer, Ph.D., Consulting Economist, jerrellrr@goshen.edu Please note that Dr. Richer moved out of state in the summer of 2007.

use of a concept called the "time value of money." The basic notion here is that money can be invested today to earn a predictable rate of return. For this reason, money earned in the future is less valuable on a dollar-for-dollar basis than money earned today, as future earnings cannot be reinvested as quickly as present earnings. In general, the more distant into the future that revenue is earned from an investment, the less valuable it is in today's terms. Analysts typically "discount" a future amount into today's terms ("present value") using the techniques described below.

Simple Return on Investment
Dr. Richer defines the "Simple Return on Investment" as the undiscounted savings (SA) for the typical year divided by the initial start-up costs (IN), or

Simple ROI = (SA) / (IN)

In a typical application, investors compare the simple ROI to the cost of capital (or the interest rate for alternative investments). Investments are considered worthwhile if the simple ROI exceeds the cost of capital.

Lifetime Annualized Return on Investment
To calculate the "Lifetime Annualized Return on Investment" requires summing the present value of the annual savings (SA, for every year, t, discounted to the present using a discount rate, r). This sum is then divided by the initial start-up costs, IN, to generate a percentage return and divided again by the number of years the project is expected to last, T, to generate an annualized return for the lifetime of the project.

$$\text{Lifetime Annualized ROI} = [\ \textstyle\sum(SA_t)/(1+r)^t\ ] / [\ (IN)(T)\ ] \text{ for } t = 1,\ldots, T$$

The lifetime annualized ROI can be used much like the simple ROI, comparing it to the cost of capital to assess the attractiveness of an investment.

Simple Payback Period
The "simple payback period" equals the number of years necessary to pay back the initial investment, ignoring the time value of money. Analysts sometimes use this measure as a quick way to compare investments. Investments with lower payback periods are considered more attractive.

Discounted Payback Period
The "discounted payback period" takes into account the time value of money by discounting future savings before calculating the payoff period. Payback periods tend to be longer when the future savings are discounted. In general, the lower the discounted payback period the more attractive the investment.

Net Present Value
The "Net Present Value" (NPV) in this context equals the sum of the savings, SA, in each year, t, discounted to the present using discount rate, r, minus the initial start-up

cost, IN. (More generally, NPV equals the sum of discounted net benefits in all years, including the initial year, 0.)

$$NPV = [\sum(SA_t)/(1+r)^t] - [IN] \text{ for } t = 1,\ldots,T$$

Analysts typically recommend investing in projects where the NPV is positive, rejecting those where the NPV is zero or negative.

Internal Rate of Return

The internal rate of return (IRR) is defined as the discount rate that generates a zero net present value for the investment. The IRR is sometimes referred to as the "break-even rate of return." Analysts often recommend an investment if the IRR exceeds the cost of capital.

Note that the IRR suffers from several well known problems, including:

Problem 1: If net revenues are negative in the future (e.g. additional investment is required at a later date), IRR can be misleading since it treats the negative net revenues as if they need to be borrowed and financed. In this case, multiple IRRs can result, leaving the analyst unsure of the true IRR. The use of NPV rather than IRR is recommended in this case.

Problem 2: The IRR ignores the magnitude of the investment (absolute dollar amounts). This means that the IRR is not adequate for the purpose of comparing investments. For instance, an investment with a high IRR may involve small dollar amounts while a rival investment with a lower IRR may actually generate a greater financial surplus since it involves larger dollar amounts. For this reason, many analysts prefer using NPV to IRR.

Problem 3: The IRR assumes that net benefits are reinvested at the same rate of return. This is can be unrealistic and misleading since revenues generated by an investment are often placed in other investments that earn a significantly different return. Many analysts recommend the use of an alternative statistic, modified IRR, to correct for this problem.

Modified Internal Rate of Return

As explained above, one problem with the measure known as Internal Rate of Return is that it assumes that net revenues in a future year are reinvested at the same rate of return as the original investment, which is often incorrect. The Modified Rate of Return (MIRR) offers a useful alternative since it allows the analyst to specify a particular reinvestment rate. Typically, the discount rate used for the NPV calculation (7% as recommended by the OMB) or a more specific measure of the cost of capital for a particular industry is used as the reinvestment rate when calculating MIRR.

External costs

"External costs" are the costs of production or consumption that are not paid by producers or consumers. These so-called "third party" costs are incurred by others. A prime example is the health costs incurred by victims of air pollution. Neither the producer nor the consumer of gasoline pay for the medical treatment necessary to mitigate the impacts of high concentrations of ground-level ozone and particulate matter.

Motor Cruise Control™ Submission
Enviro World Technologies Inc.

A brochure was submitted. As a substitute for relaying the information in the brochure, the following information was retrieved from the web.[2]

The Motor Cruise Control™ is a unique, feature-rich approach to control the energy consumed by 3-phase electric motors. Driven by an advanced microprocessor, the **MCC**™ system uses a patented, proprietary algorithm to deliver only the necessary power to a 3-phase electric induction motor. This, combined with its ability to improve power factor, allows the **MCC**™ to reduce energy consumed by the motor, especially when operated at less than its rated load. Energy losses in an induction motor can be reduced through a reduction of the stator voltage. Unlike any other product, our patented algorithm allows the **MCC**™ to control the current, effectively minimizing the reactive power component, i.e. VAR, measured at the motor (see figures 1-3). Sampling the voltage and current waveforms simultaneously at 96kHz, the algorithm achieves an unmatched level of control and performance, preventing motor stall or burnout by supplying enough power & torque to match any change in load conditions. In an inductive motor, wasted energy generates excess heat. In addition to reducing this heat energy, the **MCC**™ reduces arcing on the rotor, which also contributes to cooler operation. A ten degree drop in operating temperature will double the life of a motor and increase bearing life. Analysis of our system installations over the past ten years demonstrate typical motor core temperature reductions in excess of 15-20 degrees while the motor is under load.

[2] http://www.modernenergysales.com/

Motor Cruise Control™ Analysis

EXECUTIVE SUMMARY

The Motor Cruise Control is a new technology capable of reducing energy use in existing electric motors by 8 to 20%. Currently in the testing stage, Enviro World Technologies plans to manufacture the device in Rohnert Park and distribute it to water districts and other users of industrial-size electric motors in the future.

Strengths of the project include:

- Innovative technology
- Add-on capability
- Local production
- Local application

Weaknesses of the project are:

- New technology
- Expected life
- Initial cost

Opportunities arise from this external factor:

- Electric price appreciation

Threats exist due to this external factor:

- Alternate technologies

From a *financial* perspective, this project offers an acceptable return on investment (simple ROI of 26.14%). However, the modified internal rate of return (MIRR) is only 8.49% if the device lasts only as long as its five-year warranty. The MIRR is higher, 13.37%, if the device reaches its expected life of fifteen years. In either case, the net present value (NPV) is positive.

From an *environmental economics* perspective, the project generates external benefits in the form of reduced air pollution and other harmful effects of electricity generation. These externalities, though difficult to quantify, increase the already positive NPV of adopting the technology from the perspective of society as a whole.

SUMMARY OF THE RECOMMENDED ACTION

Modern Energy Sales recommends that industrial users of electric motors install an efficiency-enhancing device on each of their motors to reduce electricity use by 8-20%. The new technology acts as a “cruise control,” reducing power use and extending the life of the motor.

CONTACT INFORMATION

Mark Avery
Modern Energy Sales
Representative for Enviro World Technologies
345 Lily St.
Fairfield, CA 94533
707.208.2629
markavery77@sbcglobal.net

S.W.O.T. ANALYSIS

A. Objective of the Recommended Action

Reduce greenhouse gas emissions in Sonoma County by increasing the efficiency of industrial-scale electric motors through adoption of a new "cruise control" technology.

B. Strengths – Attributes of the Action Helpful to Achieving the Objective

- Innovative Technology The technology was first proposed by NASA and is now under development and testing by Enviro World Technologies, Incorporated. Here is how it works: Electric motors naturally generate harmonics. The Motor Cruise Control (MCC) device uses these harmonics in a feedback loop to adjust the motor's amperage. Power needs fluctuate for a typical motor and the technology allows the electricity delivered to the motor to match its actual needs in real time, thereby saving energy (Avery 2007). In technical terms, the technology uses a "patented, proprietary algorithm to deliver only the necessary power to a 3-phase electric induction motor… By firing the current at the zero crossing point on the sine wave, the MCC effectively eliminates the negative VA component from the waveform… Also eliminated is the arcing on the rotor, allowing the motor to operate cooler" (Enviro World Technologies 2007).

- Add-on Capability According to the description in the *Worksheet*, the device can be installed on an existing electric motor to increase its operating efficiency and extend its life. This provides a modest amount of energy savings (8 to 20%) without requiring a new configuration or redesign of the production process.

- Local Production The devices will be manufactured by Masterwork Electronics in Rohnert Park (www.masterworkelectronics.com).

- Local Application The *Worksheet* author indicates that a likely use for the technology would be to improve the efficiency of the motors that pump water throughout the county (e.g. Sonoma County Water Agency). Local agencies could be provided with a demonstration unit for testing purposes as well as

attractive lease terms to eliminate the need to finance the initial investment (Avery 2007).

C. Weaknesses – Attributes of the Action Harmful to Achieving the Objective

- New Technology This appears to be a fairly novel and relatively untested technology. A search of the internet yields no results for either the name of the manufacturer (Enviro World Technologies) or the sales agent (Modern Energy Sales). The author of the Worksheet states that Enviro World Technologies has operated with a low profile in order to prevent the theft of their technology by competitors. Nonetheless, electric motor operators may be reluctant to adopt a technology supplied by an unknown company until it can be proven and legitimized.

- Expected Life The device comes with a five-year warranty. It is likely that the device will last considerably longer (e.g. fifteen-years), but the actual lifetime is uncertain given the novelty of the technology (Avery 2007).

- Initial Cost The cost of acquiring and installing the device (e.g. $45,000 for a 150 horse power motor) is significant. Whether this cost is justified by the energy savings depends on the expected life of the device as well as energy prices. Assuming a 10% savings and $0.12 per kWh (savings of $11,763 per year), the simple return on investment is fairly attractive (26.14%). However, if the device only lasts for 5 years the modified internal rate of return is relatively low (8.49%). A fifteen year life yields a higher MIRR (13.37%). See below for a complete financial analysis.

D. Opportunities – External Conditions Helpful to Achieving the Objective

- Electricity Price Appreciation The device becomes more attractive if electricity prices increase. The price assumption underlying the current analysis is $0.12 per kWh. As prices rise in the future the energy savings could generate a substantially greater return on investment.

E. Threats – External Conditions Harmful to Achieving the Objective

- Alternate Technologies This device provides a modest energy savings and requires a significant investment. As research and development continues in this area, comparable technologies with greater savings and/or lower initial investments may emerge. As new technologies are brought to market this device may become obsolete.

FINANCIAL ANALYSIS

The financial analysis presented here employs specific assumptions to estimate a set of financial metrics. The assumptions that underlie the financial analysis as presented by the author of the Recommended Action *Worksheet* and supporting spreadsheet are as follows:

- The device operates with a 150-horse-power motor (other sizes are available, as described in the spreadsheet).
- The motor operates continuously (24 hours per day for 365 days each year).
- The device can be purchased and installed for $45,000.
- There are no maintenance costs (a solid state design with no moving parts).
- The device reduces a motor's energy use by 10%.
- The price of electricity is $0.12 per kWh.
- The device lasts for 5 years (and perhaps 15 years, as described below).
- Savings are static (no appreciation, depreciation or other changes occur over time).
- The time value of money is reflected in a discount rate of 7% per year. This is the standard rate recommended by the U.S. Office of Management and Budget (OMB, 1992). .

The simple ROI for this project is 26.14%, which is likely to exceed the cost of capital.

The lifetime annualized ROI for this project is 18.64%, which would likely exceed the cost of capital. This assumes the device lasts for 5 years.

The simple payback for this project is 3.83 years.

The discounted payback for this investment is 4.61 years.

The net present value for this investment is $3,230. This assumes the device lasts only 5 years. For a 15-year life, the NPV is significantly greater, $62,135.

The IRR in the final year of this project is 9.64%, which is significantly lower than the ROI since the device is assumed to last only 5 years. For a 15-year lifetime, the IRR is 25.25%

Assuming a 5-year lifetime, the MIRR is 8.49%. For a 15-year lifetime, the MIRR is 13.37%. The MIRR exceeds the assumed cost of capital (7%) in both cases.

Cost per Ton of Reduced CO2 Emissions

Finally, the author of the *Worksheet* estimates the project will result in a reduction of 920 pounds of CO2 for each 1,000 kWh of energy savings. For the 150-horse-power motor in continuous operation, this amounts to a 225 ton reduction over a 5-year period, or a 676 ton reduction over a 15-year period.

Calculating the cost per ton of CO2 reduction does not make sense in this context since the NPV of the device is positive. That is, the energy savings exceed the initial investment (even accounting for the time value of money), so the technology generates positive net benefits rather than costs.

ENVIRONMENTAL ECONOMIC ANALYSIS

The preceding financial analysis shows that the technology could be attractive to an investor seeking to generate an above-market return on investment, depending on the true cost of capital (assumed to be 7% in this analysis) as well the perception of risk for this new technology. This is only part of the picture, however, since it ignores the societal benefits that could be generated by adoption of the Motor Cruise Control technology. The field of "environmental economics" analyzes investments such as this from the perspective of society as a whole, considering all the possible costs and benefits to those affected directly or indirectly by the project.

A. Reductions in External Costs

The technology examined here offers a mechanism to reduce electricity consumption and, thereby, reduce the external costs associated with power generation. A complete accounting of the societal benefits would include the following:

- Greenhouse Gases Carbon dioxide emissions would be reduced as energy is conserved. The reduction amounts to 45 tons per year.

- Air Pollution In addition to carbon dioxide, electricity generation emits common air pollutants classified and monitored by the Environmental Protection Agency as "criteria pollutants" (Environmental Protection Agency, 2007). The device reduces energy consumption by 98,024 kWh per year.

Estimating the savings in external costs associated with a reduction in electricity use is difficult in practice. One would need a specific dollar value per kilowatt hour for a particular power mix that incorporates a wide variety of external costs, including health, ecosystem and related effects. The current PG&E power mix relies heavily on natural gas as well as nuclear and large hydroelectric sources to supply electricity to Sonoma County (Pacific Gas and Electric 2007).

Given the uncertainty of the true impacts of fossil fuel combustion and the economic damages that result, I do not have the information required to provide a credible estimate of the range of external costs that are avoided when electric motors consume less energy. Suffice it to say that inclusion of these externalities would create an even larger NPV in the preceding financial analysis and would bolster the justification for this and other investments that promote energy conservation.

CONCLUSION

The Cruise Control Motor technology described in the *Recommended Action Worksheet* and supporting spreadsheet offers a promising and relatively simple means of generating a modest but consistent reduction in greenhouse gas emissions in Sonoma County. It would also improve air quality by reducing the need to produce power with conventional sources (e.g. natural gas).

While a promising and compelling technology, the device is undergoing testing and is as yet unproven. Assuming it provides the savings shown in the spreadsheet and lasts significantly longer than the specified warranty period, the technology could offer a safe and reasonable return on investment to water districts and other users of electric motors.

REFERENCES

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Environmental Protection Agency, 2007, *Six Common Air Pollutants*, accessed on May 23, 2007 at http://www.epa.gov/air/urbanair/.

Enviro World Technologies, Inc., *Motor Cruise Control* brochure, 2007.

Office of Management and Budget, 1992, *Circular No. A-94*, October 29, 1992.

Pacific Gas and Electric, 2007, *Power Content Label*, accessed on May 22, 2007 at http://www.pge.com/customer_service/bill_inserts/#powercontentlabel.

Electric Vehicle Conversion Program Submission

Your Contact Info:	Name: Chris Jones, home PV system owner, EV driver and North Bay chapter president of the Electric Auto Association (NBEAA), http://www.nbeaa.org/ Phone: 577-2391 Email: chris_b_jones@prodigy.net Mailing address: c/o Agilent Technologies, 1400 Fountaingrove Parkway, Santa Rosa, CA 95403
Action Description:	Make it easier for Sonoma County residents to switch to Electric Vehicles (EVs) with charging offset by Photovoltaics (PVs) by: 1. Install and maintain PV-powered charging stations in all downtown areas and other strategic locations. 2. Provide local incentives that are easy to find and access for PV installations, EV purchase or conversion, advanced technology batteries, faster chargers, and long range car rental to EV drivers. 3. Switch to EVs with charging offset by PVs for as many local government vehicles as possible, utilizing advanced batteries and chargers in them.
Who is Responsible?:	X City/County Government X Business X Residents X Organization
Status:	☐ New idea X Being developed ☐ Already existing
Explain Status:	Very few EVs are available today, but there is a local chapter of the EAA and the SRJC has started an EV conversion program. And if plug-in hybrids become mass produced over the next few years like GM's Volt prototype, they will be able to run mostly on electricity and would be able to take advantage of all of the above.
Political Feasibility:	☐ Easy X Some effort ☐ Challenging ☐ Not applicable
Explain Political Feasibility	Most EVs currently are short range and can be quite expensive, which are two major drawbacks to switching over to them, but for those of us who have already made the switch, the benefits far outweigh the drawbacks for us, and range limitations can be adapted to, so it might take some persuasion and faith but many of us believe it can and just might happen.
Technical Feasibility:	☐Easy X Some Effort ☐ Challenging ☐ Not applicable
Explain Technical Feasibility:	Long range, quick charge EVs are currently very expensive or under development, but most trips do not require such performance, and the benefits of driving from PVs is very compelling. So a two pronged approach to encourage development while removing barriers for lower performance EVs is suggested.

Estimated Annual CO_2 reduction:	Years 1 – 2:	Years 3 – 5:	Years 6 – 10:	Years 11+:
	An EV charged by PV reduces almost all of the CO2 for that driver when driving, so assuming 40% of our CO2 comes from transportation and there are 200,000 vehicles regularly driven in Sonoma County, if 100 of these vehicles were switched over in years 1-2 there would be a 0.02% reduction.	If by year 5, 1000 vehicles had been switched over, there would be a 0.2% reduction.	If by year 10, 10,000 vehicles had been switched over, there would be a 2% reduction.	Assuming that 63% of the local fleet or 125,000 EVs could eventually be afforded and could offer enough range to be usable or be a plug in hybrid running on electricity most of the time, we could achieve the entire 25% CO2 reduction goal by EVs alone.

Financial Analysis:	Costs (Describe)	Dollar Estimate	Who pays?	How is it paid for?
	One Time: (initial start-up) Recurring: (annual maintenance)	-$10M to install 9 large PV-powered charging stations in all Sonoma County city downtown areas - $5M to spend $50K more each on 100 government vehicles to be EVs with PV offset, advanced batteries and chargers - $625M to provide $5K incentive total for 125,000 EVs ~$100K per year to maintain chargers	- each city and the county pays to install and maintain their chargers and provide incentives	- reduce cost with free student labor in exchange for learning materials, such as SRJC EV conversion program - local philanthropic gifts - federal funds and grants - reprioritization of local government budget allocation - local sin tax on CO2 emitters such as gasoline purchase - local general tax increase

Benefits (Describe)	Dollar Estimate	Who receives these benefits?
- We meet our CO2 reduction goal - we stimulate the local economy - we lower and stabilize ongoing fuel costs for government, businesses and individuals	$642M over 20 years or $32.1M per year average	our children

Duration of the Proposed Action
(How many years will it last?):

Indefinitely, or until EVs are inexpensive and filling the auto malls, and charging for them is offset by PV and charging stations are ubiquitous.

Note 1: Vacaville has PV powered charging stations and local EV incentives and may provide a role model for this sort of program.

Note 2: These incentive levels of course could be modulated, but I think it needs to be several $K on most vehicles to be effective.

Note 3: I would be happy to discuss this issue with you further, give a presentation to any interested parties on how EVs can and should be a key element in meeting our CO2 reduction goal, and do more analysis on the costs and details of implementation.

Electric Vehicle Conversion Program Analysis

EXECUTIVE SUMMARY

The conversion of gasoline-powered vehicles into electric vehicles offers a way for residents of Sonoma County to reduce their reliance on fossil fuel as well as their emissions of greenhouse gases. Generating the electricity with photovoltaic panels installed at charging stations located in the downtown areas of each Sonoma County municipality would provide carbon-free transportation to vehicle operators.

Strengths of the program include:

- Same vehicle, new fuel
- Carbon-neutral transportation
- Novelty

Weaknesses of the program are:

- Infant technology
- High conversion costs
- Performance limitations
- Charging station network

Opportunities arise from these external factors:

- SRJC's conversion program
- Plug-in hybrids
- Battery innovations
- Fuel-price appreciation

Threats exist due to several external factors:

- Alternative technologies

From a *financial* perspective, this program generates negative returns and a negative net present value since the gasoline savings do not compensate for the high cost of conversion under the set of assumptions employed here. Alternative assumptions would yield different results.

From an *environmental economics* perspective, the project generates a positive net present value if the external costs of gasoline use are valued at $3.23 or more per gallon.

SUMMARY OF THE RECOMMENDED ACTION

The North Bay Chapter of the Electric Auto Association recommends a public program to encourage auto drivers to convert their internal-combustion-engine vehicles into battery-powered electric vehicles (EV). The program involves financial incentives to encourage conversions and local public production of carbon-neutral photovoltaic electricity distributed in the downtown of each municipality in Sonoma County.

CONTACT INFORMATION

The contact listed on the Recommended Action Worksheet is:

Chris Jones
President, North Bay Chapter of the Electric Auto Association (NBEAA)
c/o Agilent Technologies
1400 Fountaingrove Parkway
Santa Rosa, CA 95403
707.577.2391
chris_b_jones@prodigy.net
www.nbeaa.org

S.W.O.T. ANALYSIS

A. Objective of the Recommended Action

Reduce greenhouse gas emissions in Sonoma County by converting automobiles into battery-powered vehicles charged with photovoltaic electricity.

B. Strengths – Attributes of the Action Helpful to Achieving the Objective

- Same Vehicle, New Fuel The technology exists to convert existing gasoline-powered vehicles into battery-powered vehicles. The North Bay Electric Automobile Association shows photographs and descriptions of members'

vehicles on their website (www.nbeaa.org). It is interesting to note that many of the vehicles converted to battery power are quite conventional in appearance.

- Carbon-Neutral Transportation The electricity for the charging stations can be supplied with local photovoltaic systems, a proven and increasingly-popular technology. The stations would be located in downtown areas of each municipality in Sonoma County so that employees, shoppers and others can charge their batteries while spending time downtown.

- Novelty Converting a vehicle from fossil fuel to electricity is a fairly novel and intriguing concept, certainly a conversation piece in many circles.

C. Weaknesses – Attributes of the Action Harmful to Achieving the Objective

- Infant Technology The technology necessary to convert gasoline-powered vehicles into battery electric vehicles is relatively new. Vehicle owners may be reluctant to trade a known quantity – their vehicle's current performance and reliability – for a new technology that is still in its infancy. Many vehicle owners would hesitate to attempt the conversion without guarantees on the quality of parts, installation, and performance.

- High Conversion Cost According to the author of the *Worksheet*, the cost of converting a gasoline-powered vehicle into a battery electric vehicle is approximately $30,000 (Jones 2007). This cost factor is likely to discourage most vehicle owners from making the switch. As the author states, it would be helpful if a local government agency offered a financial incentive (e.g. $5,000 per vehicle) to encourage conversions. The cost of providing this subsidy to the funding agency could be substantial if enough owners take advantage of it.

- Performance Limitations One of the limiting factors for wide-spread diffusion of this technology has been the limited range and speed that are characteristic of battery electric vehicles. The state-of-the-art battery technology, lithium ion, limits vehicle operators to no more than 50 miles between charges, and substantially less for some vehicles. As an example, the *Worksheet* author's converted '66 Ford Mustang has a range limit of 30 miles (www.nbeaa.org). While his vehicle is capable of speeds up to 70 mph, it does not have the power at high speeds characteristic of a gasoline-powered vehicle (Jones 2007). These limitations are compounded by the amount of time required to charge the batteries, typically overnight.

- Charging Station Network Offering vehicle owners opportunities to charge their batteries while parked downtown using photovoltaic power in all nine of the municipalities in Sonoma County requires a substantial initial investment (estimated at $10 million in the *Worksheet*). On the other hand, a network of charging stations seems necessary to promote adoption of the technology. This

is an example of a "network externality", where use of a technology is feasible only if a sufficient number of other users exist so that the necessary infrastructure can be developed to support its use.

D. Opportunities – External Conditions Helpful to Achieving the Objective

- SRJC's Conversion Program Santa Rosa Junior College has developed an electric vehicle conversion program. Presumably this program will increase the capacity to convert internal-combustion-engine vehicles using local labor, capital and expertise. As demand for conversion services grows, so does the ability to train new providers.

- Plug-In Hybrids In addition to serving converted battery electric vehicles, the publicly-provided charging stations would be available to owners of the "plug-in hybrid" vehicles which under development by several major auto manufacturers. Plug-in hybrids offer the advantage of being gas-powered, which provides unlimited range in an efficient manner, while also having the capacity to be charged, enabling their operators to avoid the use of gasoline for travel around town. This is a promising technology that may become popular in the next few years.

- Battery Innovations The limited range associated with battery electric vehicles is a function of current battery technology. It is likely that new technological developments will enable operators to drive much longer distances between charges in the foreseeable future. As a result, the cost of batteries (lithium ion batteries currently cost approximately $17,000) is likely to fall due to innovation and economies of scale in production.

- Fuel Price Appreciation Owners will be more willing to convert their vehicles in the future if gasoline prices continue to rise. The current upward trend in fossil fuel prices appears highly likely due to supply constraints and increases in demand.

E. Threats – External Conditions Harmful to Achieving the Objective

- Alternative Technologies The conversion to battery power derived from photovoltaic systems may seem attractive to many vehicle owners given rising gasoline prices and a lack of other options. As new technologies are developed to move people and goods from place to place, however, the idea of converting a vehicle to battery power may appear second-best. For example, a new transit system such as SMART may offer commuters a car-free means of getting to work each day. Alternatively, hydrogen-powered vehicles may become the standard for carbon-free transportation in the future if issues surrounding its production and distribution can be solved. Or, in the shorter run, biofuels such as

ethanol and biodiesel may become more prevalent as suppliers find affordable ways of converting plant material or waste into combustible fuel. This could be a very attractive alternative given the much lower cost of conversion necessary to burn biofuels.

FINANCIAL ANALYSIS

The financial analysis presented here employs specific assumptions to estimate a set of financial metrics. The assumptions that underlie the financial analysis as presented by the author of the Recommended Action *Worksheet* are as follows:

- The initial start-up cost equals $10,000,000 (installation of the PV charging stations).
- The annual maintenance cost for the charging stations equals $100,000.
- The cost of converting a vehicle equals $30,000.
- The benefit of converting a vehicle is a reduction in gasoline purchases. The price of gasoline is $3.50.
- The gasoline savings associated with each conversion equals the amount of gasoline consumed by the average gasoline-powered vehicle in the county.
- There are 200,000 vehicles operated in the county at any given time over the life of the program.
- The number of vehicles converted equals 100 at the end of year two, 1,000 at the end of year five, 10,000 at the end of year 10 and 125,000 at the end of year twenty.
- The program has a lifespan of 20 years.
- Maintenance costs and gasoline savings are static (no appreciation, depreciation or other changes occur over time).
- The time value of money is reflected in a discount rate of 7% per year. This is the standard rate recommended by the U.S. Office of Management and Budget (OMB, 1992).
- The electricity used to charge the vehicles is carbon neutral.

The simple ROI for this program is negative in every year, which therefore never exceeds the cost of capital.

The lifetime annualized ROI for this program is negative, which does not exceed the cost of capital.

The simple payback for this program is longer than the life of the program (assumed to be 20 years). The costs of investment are not recouped during the program life.

The discounted payback exceeds the life of the program (which is 20 years). That is, the discounted stream of net benefits does not compensate for the initial start-up costs and high conversion costs and therefore the program does not pay itself off considering the time value of money.

The net present value for this project is $-683,017,544, which implies that the future net income generated by the project is not sufficient given the time value of money to compensate for the initial investment. In other words, an investor would fare better earning a 7% per year elsewhere rather than funding this program.

The IRR in the final year of this project is irrelevant, given the nature of the cost stream (see Problem 1 below).

The MIRR for this project is irrelevant given the nature of the cost stream.

Cost per Ton of Reduced CO2 Emissions

Finally, it is straightforward to calculate the cost of reducing emissions of carbon dioxide on a per-ton basis. The author of the *Workshee*t estimates the project will result in a reduction of 6,091,829 tons of carbon dioxide over the life of the program. Dividing the NPV of the project by this figure yields an estimate of the cost per ton of carbon dioxide reduced over the entire life of the project.

The cost of reducing CO2 emissions for this project equals $112.12 per ton.

ENVIRONMENTAL ECONOMIC ANALYSIS

It is clear from the preceding financial analysis that the program would be unattractive to an investor seeking to generate an above-market return on investment. This is important, since it explains why it is extremely unlikely that the private sector would invest in this type of vehicle conversion program. This is only part of the picture, however, since it ignores the societal benefits that could be generated by implementation of a maglev system. The field of "environmental economics" analyzes large scale investments such as this from the perspective of society as a whole, considering all the possible costs and benefits to those affected directly or indirectly by the project.

A. Reductions in External Costs

"External costs" are the costs of production or consumption that are not paid by producers or consumers. These so-called "third party" costs are incurred by others. A prime example is the health costs incurred by victims of air pollution. Neither the producer nor the consumer of gasoline pay for the medical treatment necessary to mitigate the impacts of high concentrations of ground-level ozone and particulate matter.

The maglev system examined here offers a mechanism to reduce gasoline consumption and, thereby, reduce the external costs associated with automobile use. A complete accounting of the societal benefits of the maglev system would include the following:

- Greenhouse Gases Carbon dioxide emissions would be reduced as drivers shift from gasoline-powered vehicles to carbon-neutral electric vehicles. As described above, the generates a reduction of 6,091,829 tons of CO2 over the twenty-year life of the program.

  Keep in mind that another key assumption underlying these cost-per-ton figures is that the electricity used to charge the vehicle batteries is carbon neutral. This is possible given available technology and considerable investment in photovoltaic power, but will not hold true if the energy is provided by the local utility using current generation technologies. The power mix for PG&E is reported to be only 13% renewable at the time of this writing (Pacific Gas and Electric 2007).

- Air Pollution In addition to carbon dioxide, gasoline-powered automobiles emit common air pollutants classified and monitored by the Environmental Protection Agency as "criteria pollutants" (Environmental Protection Agency, 2007b). Each conversion would result in a reduction in gasoline consumption that benefits the entire community by reducing emissions of carbon monoxide, particulates, nitrous oxides and other pollutants.

B. The Monetary Value of Reductions in External Costs

While most economists agree that gasoline consumption imposes external costs on third parties, there is no consensus on the monetary value of these costs. A recent study published in the journal *Nature* suggests a range from $0.29 to $1.80 per gallon, taking into account estimates of reduced health, lost productivity, hospitalization and death and the cleanup of polluted sites (Jacobson, Colella and Golden 2005).

Published estimates of the external costs of gasoline consumption vary widely, however, depending on methodology and types of costs included in the analysis. In 2002 the National Research Council offered an estimate of only $0.26 per gallon. A more recent summary of several other published studies provides a higher estimate, $2.67 per gallon, including health costs as well as taxpayer-funded road improvements and a fairly conservative estimate of the economic costs of petroleum-related climate change (Cobb 2006).

Whereas these and other reports represent only a partial accounting of the external costs of gasoline consumption, one noteworthy study attempted to estimate the full external cost of gasoline consumption (International Center for Technology Assessment 1998). This includes tax subsidies to the oil industry (ranging from $0.035 to $0.06 per gallon), government expenditure subsidies ($0.32 to $0.95), protection

costs ($0.65 to $1.05), environmental, health and social costs ($2.00 to $8.13) and other economic costs ($1.59 to $3.95). Total external costs, according to this study, range from $4.60 to $14.14 per gallon.

C. Net Present Value Including External Cost Reductions

Ideally, the external costs that are avoided by operation of the maglev system would be factored into the estimate of net present value to determine whether the project is worthwhile from the perspective of society. That is, do the program's lifetime discounted net benefits exceed zero, including initial start-up costs, net operating revenues and reductions in external costs? This is complicated by the uncertainty regarding external costs described above. If, for example, the external costs of gasoline consumption are only $0.26 per gallon (the National Research Council figure), then NPV is negative. On the other hand, NPV is positive if external costs are $14.14 (the upper bound of the International Center for Technology Assessment estimate).

As it turns out, the NPV for this project would be positive if the external costs generated by gasoline equal or exceed $3.23 per gallon. This is a relatively high figure in relation to the other estimates described above, but is certainly plausible given the wide variety of negative impacts associated with gasoline use and the increasingly-apparent effects of auto emissions on the earth's climate.

CONCLUSION

The electric vehicle conversion program described in the *Recommended Action Worksheet* offers a promising approach to reduce greenhouse gas emissions in Sonoma County. It would also improve local air quality and decrease dependence on foreign oil.

The concept has inherent strengths and could prove beneficial given the outcome of a number of external factors. The program also has weaknesses related to cost and technology. It may not be advantageous if more attractive alternative transportation technologies are developed in the future.

Like many programs to promote alternative transportation, the program would not generate financial returns acceptable to private sector investors. Public sector investment is necessary to install and maintain the charging stations and to provide financial incentives to encourage owners to convert their vehicles.

Is the project a good use of public funding? Considering the initial start-up costs as well as the annual benefits and costs to residents of Sonoma County, the program appears worthwhile from a societal standpoint if the external costs associated with gasoline consumption are believed to equal or exceed $3.23 per gallon. This estimate is based

on a number of simplifying assumptions and could change significantly under different scenarios.

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Green Conservation Loan Program Submission

From:
Dennis R. Hunter
P.O. Box 9069, Santa Rosa, CA 95405
(707) 525-9187, (707) 525-9013 (fax)

Date: Mary 2, 2007

Sonoma County Green Conservation Loan Program
The purpose of this loan program is to make funds available to property owners to improve the energy and resource efficiency of their properties and to promote utilizations of alternative energy sources. By participating, lenders can expand their markets while helping to improve their communities and the environment.

The buildup of greenhouse gasses in the atmosphere and its potential to trigger destructive global climate change is the subject of much current media coverage. Since the principle cause of this buildup is the burning of fossil fuels, efforts to reduce fossil fuel consumption should be encouraged. In general, there are two ways to do this – 1) reduce total energy demand, and 2) convert to renewable energy sources that do not generate greenhouse gasses. These solutions work whether your concern is building or vehicles or manufacturing or any other energy consuming activities. Solutions that incorporate both tend to produce the most benefit – the greatest reduction in "carbon footprint."

This term, brought to everyday discourse by the global warming debate, defines the amount of greenhouse gas added to the atmosphere as a result of any activity. For buildings – homes for example, - the carbon footprint can be calculated from the sum of all of the fossil fuel energy consumed by all of the activities of all of the occupants of the home. Anything that the property owner does to reduce the fossil fuel energy demand of the building will reduce the carbon footprint for that building.

This is where the Sonoma County Green Loan Program can help. By providing financing that will allow property owners to install energy saving and renewable energy producing improvements, lenders can have a direct impact in this crucial environmental initiative.

The Program
The basic program is simple – and profitable.

Eligibility: Property owners. No non-owner loans available through this program.

Loan Amount: Limited by credit worthiness and/or the security offered – subject to good underwriting practices.

Security: The loans should be secured by real property, personal property or unsecured according to the credit-worthiness of the borrower and underwriting guidelines of the lender.

Terms: Minimum five (5) year term – up to 30 years. Sort-term loans can be interest-only or amortize over the term of the loan – according to policies of the lender.

Processing: Standardized program should offer quick turn-around time from application through funding. Minimum fees and costs for appraisals, documentation preparation and closing costs.

Use of Funds: Loan proceeds must be used for verifiable installation, replacement and retrofit of components of the property that increase energy efficiency of reduce resource consumption, and for installation of renewable energy systems (i.e., solar and wind generation) and for acquisition of Renewable Energy Credits.)

Qualifying components include one of more of the following:

a) Installation of on-site photo-voltaic (solar) electricity generating systems.
b) Installation of on-site wind turbines for electricity generation.
c) Purchase of credits for renewable resource energy (wind, hydro-electric, solar, fuel cell) from designated authorized suppliers.
d) Installation of insulation increasing the existing “R” value of the building.
e) Installation of reflective or other energy-conserving roofing products.
f) Installation of double-pane, low-e or better windows.
g) Installation of energy-star-rated appliances where none currently exist including refrigerators, washers/dryers, ranges and ovens, microwave ovens, etc.
h) Installation of energy-efficient furnaces, HVAC systems and/or hot water systems (including on-demand and re-circulating systems).
i) Installation of ducting insulation and 100% no-leak gap seals for HVAC systems.
j) Installation of attic fans and other systems designed to actively improve the heating and cooling efficiency of the building.
k) Installation of water saving devices including, but not limited to, low-volume or waterless toilets and urinals, low-flow shower heads and faucets, water conscious irrigation timers and distribution systems (drip), etc.
l) Installation of energy-efficient lighting.

Mechanics: Energy savings created through this program will translate directly into monetary savings for the borrowers, thereby increasing their cash flow and their ability to service the debt. In most cases, there will be a net savings for the borrower after making the loan payments. In addition, there are a number of federal and state programs that provide tax credits and rebates for installation of qualified energy-saving features. We will make resources available to participating lenders to help evaluate the economics of individual projects.

We intend that this program should be widely and easily accessible for qualified prospective customers. To accomplish this, the process should be as quick and easy for

the customer as possible. A simple flyer explaining the program and including a short-form application could be mailed to customers and also made available in the customer areas of branch offices as a point-of-sale piece. A window sticker should be provided to borrowers for display on the property that would advertise their participation in the program and promote the lender. We believe there is considerable opportunity for community public relations and good will for lenders through participation in the program and we will push for CRA credits for this type of loan.

Resources: We have consulted with a number of individuals and organizations that are available to provide technical and scientific data. Information that will help to evaluate projects and advise participants of potential tax credits and rebates is readily available. We expect to standardize and format the important elements of this information for easy distribution to customers by participant lenders.

The Sonoma County Green Conservation Loan Program offers a solid business opportunity for participant lenders – one that addresses community needs, helps the local environment and promotes global responsibility. We believe there is a great opportunity for participants to improve and promote their community image through this program. In short, it is a win for all concerned.

Green Conservation Loan Program Analysis

EXECUTIVE SUMMARY

The Green Conservation Loan Program promotes investments by property owners in energy conservation as well as renewable energy production. The program would encourage local lenders to finance these investments by participating in the program. Program benefits for the lenders include potential new markets and positive recognition in the community. Benefits for property owners include up-to-date information on rebates and tax incentives, assistance evaluating the various investments and a simplified loan application process.

Strengths of the program include:

- Transactions costs
- Information
- Marketing
- Public relations

Weaknesses of the program are:

- Interest rates
- Administration

Opportunities arise from this external factor:

- Energy price appreciation

Threats exist due to several external factors:

- Borrower reluctance
- Lender reluctance

No data were provided for a financial or environmental economic analysis of the concept.

SUMMARY OF THE RECOMMENDED ACTION

The Green Conservation Loan Program is intended to promote investments in renewable energy production as well as energy conservation. The program would encourage lenders to offer financing in this area by helping to find borrowers who were previously unaware of the financial benefits of these investments and need assistance sorting out the incentives that are offered by various government agencies. Both lenders and borrowers benefit from the good will generated by investments which help the community reach its goal of reducing carbon dioxide emissions.

CONTACT INFORMATION

The contact listed on the Recommended Action Worksheet is:

Dennis Hunter
P.O. Box 9069
Santa Rosa, CA 95405
707.525.9187
Fax 707.525.9013

S.W.O.T. ANALYSIS

A. Objective of the Recommended Action

Reduce greenhouse gas emissions in Sonoma County by promoting private financing for households and businesses to invest in renewable energy production and technologies that reduce energy use.

B. Strengths – Attributes of the Action Helpful to Achieving the Objective

- Transactions Costs The author of the *Worksheet* describes a lending program that is streamlined and simple. It features a standardized process with a short application form, quick turnaround and minimal processing fees.

- Information The program provides potential borrowers updated information on government incentives that can be leveraged to improve their return on investment. These include various federal, state, local and utility-provided rebates and tax credits. It helps borrowers assess the financial benefits and costs of potential investments.

- Marketing The program distributes flyers to potential borrowers explaining the program. It also offers window stickers for display at properties where investments have been financed to advertise the owners' participation and promote the lenders.

- Public Relations Participation in the program can generate goodwill for both lender and borrower since it advances the community's desire to reduce greenhouse gas emissions.

C. Weaknesses – Attributes of the Action Harmful to Achieving the Objective

- Interest Rates The *Worksheet* does not specify how high the interest rates might be for the program. Presumably these are determined by market conditions and vary across lenders. If rates seem unattractive, however, borrowers are unlikely to invest in technologies that are perceived to have a long

payback period. In principal, lenders could offer reduced interest rates since the risk associated with this type of investment is lower than comparable investments. Energy conservation and renewable energy production provide savings to the building owner each month in the form of lower utility bills. This frees up cash that can be used to repay the loan, reducing the risk of default. If lenders cannot be convinced, however, that the rates they charge for these types of investments should reflect the lowered risk then the program may not generate much interest among potential borrowers.

- Administration It is not clear from the *Worksheet* description how the Conservation Loan Program would be administered and funded, including staffing, outreach and program budgets. The organization could take many forms (nonprofit, for profit, government) and the structure needs to be developed before the work can proceed.

D. Opportunities – External Conditions Helpful to Achieving the Objective

- Energy Price Appreciation As energy prices continue to rise, investments in conservation and renewable energy generation will appear increasingly attractive.

E. Threats – External Conditions Harmful to Achieving the Objective

- Borrower Reluctance Property owners often fail to invest in energy conservation despite the potential payoffs. This behavior is fairly notorious, seemingly irrational and difficult to explain (Hawken, Lovins and Lovins 1999). The W*orksheet* author assumes that this problem can be solved with savvy marketing, centralized information and reduction of transactions costs. It remains uncertain, however, whether these steps will be sufficient to motivate property owners to make the desired investments.

- Lender Reluctance Similarly, lenders may not be willing to extend credit at favorable terms to property owners if, for example, they perceive the technologies to be financed as risky or unproven.

CONCLUSION

The Green Conservation Loan Program sounds sensible and promising. It promotes private financing for investments that either save energy or produce clean energy by increasing awareness of these opportunities in the community, providing useful information about tax incentives and rebates, expediting and streamlining the application process and providing recognition to borrowers and lenders alike.

One might ask: Why is this not already happening? One answer may be the cost of capital. Lenders may be unwilling to provide financing at favorable rates if they do not believe the technologies can generate substantial savings or perceive them as risky and unproven. Borrowers may be unwilling to borrow, even at low rates, if they perceive a long payback period or simply favor other types of investments over energy conservation and renewable energy production.

The program may be able to overcome these and other barriers by promoting the concept in the wider community and developing a brand that is recognizable and fashionable. This will, of course, require start-up funding and an organizational structure, neither of which are described in the *Worksheet*.

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Housing Equity and Transportation Efficiency Submission

The Housing Equity and Transportation Efficiency Fund (HETE Fund) is a financing asset designed to induce homeowners to live near where they work. The effect of the HETE Fund will be a steadily accelerating change to housing patterns in the cities of Sonoma County. The Fund works by “tilting the financial playing field” in favor of vehicular trip length reductions. A target of HETE is greenhouse gas reduction via cutback of vehicle miles traveled, and substitution of walking or bicycling for driving. The substitutions are created by making a home purchase easier to finance if it is located near where the buyer works. The closer the home to the workplace, the stronger the financial incentive created by the HETE Fund.

There are two main components of HETE: 1) Walking Districts, and 2) location-specific Housing Equity Funds.

WALKING DISTRICT

A Walking District is a financial tool which induces workers to buy housing within walking distance of their places of work. It is also a financing mechanism for employers to reduce their cost of operation by locating in either downtown, or a mixed use area. Employers who participate in Walking Districts can offer employees higher compensation without higher cost to the employer. By the same token, employees who join Walking Districts achieve higher disposable income on the same salary.

Here is how it works:
A Walking District can be created in any geographically limited area where both employment and housing are in fairly close proximity. A boundary is set up to define the District. For discussion purposes, we'll use Downtown Santa Rosa as the example, say College to Sonoma, 101 to E. The area inside the boundary would usually be about one square mile.

Employers inside the District place funds in the District Equity Pool. For every $12,000 an employer puts into the Pool, he is relieved of one otherwise required parking space at his place of business. (Note that the cost for an employer to produce a parking space is approximately $15,000.) Workers who are employed inside the District may draw cash from the Pool to use in a down payment on the purchase of a condominium inside the District. When an employee draws from the Pool, he gives up the right to park a car at his place of work. This is perfectly natural, since the employee now lives within walking distance of work. Of course, the employee still has a car, but it is parked at his condo.

Analysis:
Now let's examine the impact of such a Walking District (as distinct from a Parking District) on the various parties involved.

Employer: 1) There is an immediate savings to the employer of $3,000/participating employee, which is the difference between the cost of an employee parking space and the contribution to the Equity Pool. 2) The employer gains the benefit of having employees who have not had to face long commutes, so they are presumably more productive during the work day. 3) The employer has also effectively increased his participating employees' disposable income without increasing their salary. This results from the employees' auto expenses dropping significantly as compared to employees not living and working inside Walking Districts. For an average worker in Santa Rosa, this would amount to about $300 - $400/month in eliminated automobile costs.

Employee: 1) The employee is provided with a significant portion of the down payment on a home. 2) There is an immediate increase in net disposable income to the employee in a Walking District as a function of eliminated transportation costs. 3) The combination of down payment plus increased income brings home ownership within reach of many workers who would otherwise not be able to buy a home. 4) There is an immediate and ongoing capture of free time for the employee, resulting from elimination of commute time.

Developer: For developers, the existence of a Walking District means that the risk of building attached, for-sale housing in the downtowns of the County's cities is significantly reduced by the financial incentives which employers are providing to employees to buy the condos.

Civic: 1) For the Cities and County, every participant in a Walking District is removed from the daily peak transportation demand. Traffic congestion is thereby reduced with no reduction in population or economic activity. 2) Since the ideal Walking Districts will be in the downtowns of the County's cities, the increase of disposable income can be expected to show up in higher sales in downtown businesses, resulting in higher sales tax revenues to cities having Walking Districts.

For all concerned, the key benefit of Walking Districts is that they are powerful economic incentives to induce a housing and business location pattern in which a significant percentage of workers live within walking distance of work. This can be expected to occur steadily, increasing over time, acting as a strong counter to sprawl patterns.

For all concerned, the other key benefit is that Walking Districts induce production of attached housing in preference to detached housing, thereby shifting the city's housing stock in the direction of the more affordable, attached product type.

When combined with the Housing Equity program outlined below, the results for all concerned will be a steady shift in homeowner locations, toward a compact city-centered, transportation-efficient pattern, accompanied by significant greenhouse gas reduction resulting from cutbacks of work-related vehicle trips. The financial incentives created by Walking Districts operate every time a home purchase takes place. Since re-sales of existing homes occur at 10 times the frequency of new home purchases, HETE offers transportation efficiency gains which are not dependent on the design and location of new development.

Economist's definition:
A Walking District is a mechanism for recognizing the increased land value which is created when a worker uses only 50% of the parking land to perform the same quantity of work as a worker who uses parking land at both his residence and his place of work. A Walking District further provides the means for distributing that land value to the parties which create it.

HOUSING EQUITY FUND

Using the Southwest Quadrant and the Santa Rosa Corporate Center as an example: For folks who work in the Santa Rosa Corporate Center, employers in the Center will invest in the Corporate Center Housing Equity Fund. Assets of the Fund will be used to secure Letters of Credit issued to local lenders who furnish 100% financing for Center workers who buy a condominium in the quadrant. The lenders will use conventional underwriting standards for 90% financing, but can rely on the security enhancement provided by the Fund to validate those standards.

Other investors in the Fund will participate through the Sonoma County Transportation Authority, based on the premise that creation of a financial incentive for employees to live in the same Southwest Quadrant where they work draws vehicle trips off of Highways 101 and 12, as well as Stony Point Road and Hearn Avenue. By reducing vehicular miles traveled and by targeting trip reductions for key pieces of backbone infrastructure, the HETE Fund lengthens the life of existing roadways and potentially obviates the need for building presently assumed expansion of carrying capacity. Since those capacity expansions are extremely expensive, financial benefits to the members of the Transportation Authority can be quite large.

Here is how the Fund works:

Assuming a 1,000 square foot condo selling at $300,000, the program works like this:

1) An employee working in the Corporate Center selects a condo in the quadrant.

2) The employee goes to a bank for a loan to buy the unit. The lender normally requires 10% down payment. Under the program, however, the lender provides 100% financing, because the lender receives a $30,000 Letter of Credit, secured by the fund, in lieu of the down payment.

3) The employee makes payments on the full $300,000 mortgage.

4) Once the condo value hits $350,000, then the Letter of Credit is released by the bank. This replenishes the capacity of the Fund, so the employer can offer the same program to other or additional employees.

5) If the employee sells within the first 5 years (the vesting period), then the Fund gets the benefit of any price appreciation. Once the vesting date has passed, then all price appreciation from the date of original sale goes to the employee.

6) If the condo falls in price, and the employee sells, then the Fund covers the loss, up to the $30,000 Letter of Credit face amount.

Analysis:
With a 5% default rate on the mortgages, the actual loss rate on the condos would be $1500/unit. (One of 20 units defaults and the Fund pays out $30,000.) If, instead, the price of housing appreciates during the vesting period, there is no loss rate for the Fund.

For the employer of a worker who rents: if the price of housing were to appreciate 2%/year during the vesting period, the salary increase that would be required from the employer to allow the employee to just "stay even," would be $1500/year.

Thus, for the relatively low risk of a one time loss of $1500, the employer insures himself against an annual cost of $1500. And, with the vesting period, the employer insures that his investment in the employee's training is not lost, as both employer and employee have an added financial incentive for stability. In this respect, it works much like a stock option. Further, if cash in the Fund is properly invested, the employer can expect to have all losses covered by income earned.

The employee, by taking a job with a participating employer, acquires a home very near his place of work, and is insured of access to housing for as long as he likes, since the employee is the owner under a 30 mortgage, and is thereby insulated against rising rents and future housing cost increases.

The Fund is most effective to all concerned when the Letters of Credit are available for use only on owner-occupied condos, and only for condos within specifically defined geographic Districts related to the employer's place of business. This not only increases the employee's net income (by reducing his commute costs), it also reduces the City's capital requirements, fiscal burden and traffic congestion by inducing a higher percentage of employees to live very close (if not walking distance) to their work, so they don't show up on the highways or key arterials at all.

Once the natural economic power of the program takes hold it will continue to influence homebuyer location selections over time, throughout the City and County. One can expect the HETE Fund to induce a steady shift of the population toward shorter and shorter commutes. It is analogous to a game of musical chairs in which the participants get a financial benefit for sitting (living) next to their workplace, and the winners are the ones who no longer need a chair (parking place) at all because they can walk to work. Most importantly, the game steadily removes chairs (either shortens or eliminates vehicular trips), which in this case equates to removing greenhouse gases.

Housing Equity and Transportation Efficiency Analysis

EXECUTIVE SUMMARY

The Housing Equity and Transportation Efficiency (HETE) Fund offers employees financial incentives to purchase an attached home close to their place of employment. Two distinct but comparable Funds are suggested: a Walking District Equity Pool and a Housing Equity Fund. Both are funded by employers on a voluntary basis.

Strengths of the programs include:

- Employee benefits
- Employer benefits
- Developer benefits
- Community benefits
- Private funding

Weaknesses of the programs are:

- Employer incentives
- Cost of walking
- Comparative prices
- Coordination
- Risk of default

Opportunities arise from this external factor:

- Development patterns

Threats exist due to several external factors:

- Perverse incentives
- Quality of life

No data were provided for a financial or environmental economic analysis of the concept.

SUMMARY OF THE RECOMMENDED ACTION

The Housing Equity and Transportation Efficiency (HETE) Fund is a financing tool designed to encourage homeowners to live near their places of employment. There are two components to the Recommended Action: Walking Districts and Housing Equity Funds.

A *Walking District* can be created in any geographic area where housing and employment exist in close proximity. A boundary is defined around the Walking District with an area of approximately one square mile. Employers place funds into a District Equity Pool. Employees can withdraw funds from the pool to provide a down payment for a condominium inside the walking district and agree to forfeit their right to park at their place of employment. In exchange for every $12,000 contributed to the Pool, employers are exempted from the requirement to provide parking places for a participating employee.

A *Housing Equity Fund* pools employer contributions to assist employees who purchase condominiums in a particular geographic area, or quadrant. The Fund offers employees a letter of credit worth 10% of the purchase price of a condominium near their place of employment. This enables employees who would only be able to finance 90% of the purchase with the ability to finance 100% (i.e. no down payment required). Employees pay off the entire 100% in monthly payments as they would a typical mortgage. Once the employee gains enough equity in the home (through price appreciation as well as principal payments), the letter of credit is released by the lender, thus replenishing the Fund. The fund assumes the risk of default for the 10% letter of credit. In the meantime, monies in the fund are invested in capital markets to cover the costs of default as well as administrative expenses.

CONTACT INFORMATION

The contact listed on the Recommended Action Worksheet is:

Alan Strachan
3929 New Zealand Ave.
Santa Rosa, CA 95407
707.332.4456
Fax 707.578.4087
strach@pacbell.net

S.W.O.T ANALYSIS

A. Objective of the Recommended Actions

Reduce greenhouse gas emissions in Sonoma County by promoting homeownership near places of employment.

B. Strengths – Attributes of the Action Helpful to Achieving the Objective

1. Walking District:

- Employee Benefits The program offers assistance in purchasing a home near ones place of employment. Qualifying employees receive a grant that is used as a down payment on a condominium located within walking distance of work. In addition to making homeownership more affordable, employees enjoy a reduction in commuting costs, estimated at $300-400 per month in the *Worksheet*. The employees' disposal income, net of commuting costs, is therefore higher (assuming the cost of the housing unit in the Walking District is comparable to condominiums outside the District).

- Employer Benefits This program saves employers the cost of developing parking places, which the author of the *Worksheet* estimates at $15,000 per place. Assuming this figure is correct, the employer enjoys a $3,000 net benefit ($15,000 in saved parking development less the $12,000 contribution to the Fund). In addition, employees who walk to work may be more productive than those who drive, given the benefits of exercise and the frustration caused by commuting in traffic.

- Developer Benefits Developers of attached housing units in the Walking District benefit from the down payment subsidy offered to employees since demand for their product is increased.

- Community Benefits Members of the community benefit from reduced traffic congestion and increased economic activity in downtown areas.

- Private Funding The program is funded voluntarily by employers and no public monies are required.

2. Housing Equity Fund:

- Employee Benefits Employees can receive a line of credit from the fund equal to 10% of the purchase price of a condominium in the same quadrant as their place of employment. This enables employees who lack a down payment to be able to

purchase a home. As in the case of the walking district, employees also benefit from reduced commuting costs.

- Employer Benefits Employers benefit from the fact that their employees are homeowners and therefore enjoy a fixed monthly cost of housing (rather than annual increases in rent). In theory, this reduces the wage increases that employers need to offer to retain their employees (more on this below). Employers also benefit to the extent that employees who walk to work are more productive than those who drive.

- Developer Benefits As with the Walking District, developers of attached housing in the quadrant benefit from an increase in demand for their product.

- Community Benefits As with the Walking District, members of the community benefit from reduced congestion on the roads and highways that lead into the quadrant.

- Private Funding This program also does not require public funding.

C. Weaknesses – Attributes of the Action Harmful to Achieving the Objective

1. Walking District:

- Employer Incentives The author of the *Worksheet* states that employers receive an immediate savings since they are not required to provide parking for each employee who participates in the program. This seems applicable at the time an employer is developing a new facility and calculating the number of parking spaces that will be required to accommodate employees. It does not, however, seem applicable to places of employment that are already developed. How can an employer collect $15,000 after the parking place has already been provided? Is there a market for parking places where the employer can offer to sell the space to another employer or retail business? If there is no way to retrieve the cost of providing an employee a parking space then few employers would be expected to contribute to the Fund.

- Cost of Walking Reducing the distance between home and work to less than one mile certainly makes walking more attractive, but it does not make it costless. People often drive rather than walk short distances because they perceive that walking takes more time and energy. A one-mile walk may take 15-20 minutes each way. To the extent that time can be used for other valuable purposes and/or walking is not considered a pleasant activity to the commuter (e.g. in the winter during a rain storm), walking to work will continue to be costly. If this is the case, the Walking District program can reduce but not eliminate commuting costs.

- Comparative Prices The *Worksheet* implicitly assumes that condominiums in the Walking District are comparable in price to those outside. If this assumption holds, then many employees are likely to participate in the program since it offers both assistance with a down payment as well as lower commuting costs. It is well known, however, that housing tends to be more expensive per square foot in central business districts (O'Sullivan 2007). That is, rational buyers incorporate their expectation of commuting costs into the prices they are willing to pay for housing. To the extent that this is the case, condominiums in the Walking District may be more expensive than those outside, which reduces the likelihood that employees will participate in the program.

- Coordination While some employers may agree to contribute to the Fund (those who can benefit financially from reducing the parking they provide, for example), others may not. To achieve the desired results, the program must coordinate the desires of employers with those of employees. The employer cannot, it would seem, contribute to the fund unless it has an employee who is willing to participate in the program. It is unknown whether the employers' demand for parking exemptions will equal the employees' supply of parking forfeitures. The dollar amounts – contribution costs to the employer and/or down payment grants to the employee – may need to be adjusted periodically to bring about a balance between demand and supply.

2. Housing Equity Fund:

- Employer Incentives The typical employer seems to have little incentive to contribute to the Fund. First, there is a public good (free rider) problem. Contributions made by one employer would benefit other employers by making housing more affordable to all employees. Given that all employees (and employers) benefit from the contributions made to the fund by a particular employer, employers will tend to provide little, if anything, to the fund. To fix this problem would require a matching between employers and employees that could prove unwieldy. Second, it seems unlikely that employers can actually reduce or eliminate the wage increases they would otherwise provide their employees to compensate for changes in rent (as a component of a cost-of-living-type adjustment). While an employer might attempt to make the case that the worker does not need the increased wage given their fixed monthly mortgage payment, workers are free to find employment where they wish and would likely seek other employment if they were not offered the same annual increases that other employers provide. (On a technical note, the $1,500 per year estimate of the salary increase necessary for an employee who rents housing to "stay even" implies an annual housing cost of $75,000. This seems very high, since it corresponds to $6,250 per month for rent. I know of very few houses in the county that are this pricey.)

- Risk of Default While the program seems to make housing more affordable to participants by allowing them to qualify for a loan equal to 100% of the purchase price, it does not reduce the monthly cost of the mortgage. Arguably, lenders typically require down payments for a good reason, both as a signal that the borrower is financially-disciplined as well as the fact that a down payment lowers the monthly payment which thereby reduces the risk of default. In a sense, the program may put those who are not qualified to purchase a given house into the house anyway, requiring them to make the relatively high monthly payments or risk losing the home. These generous terms may not benefit potential homebuyers if houses do not appreciate as hoped or the buyers suffer a loss of income. This phenomenon seems to be one of the factors at play in the recent housing bubble. The only feature of the program that helps to mitigate this risk of default is the fact that commuting costs may be cheaper for program participants. This should be factored into the equation before encouraging employees to go out on a financial limb to purchase a home near their place of employment.

- Cost of Walking As in the case of the Walking District, reducing the distance between home and work lowers but does not eliminate commuting costs.

- Comparative Prices Like the Walking District, the implicit assumption is that condominiums in the quadrant are comparable in price to those outside. If, on the other hand, they tend to be more expensive the program may not attract as many participants.

D. Opportunities – External Conditions Helpful to Achieving the Objective

1. Walking District:

   - Development Patterns Municipalities in the county are promoting in-fill, mixed-use and transit-oriented development in downtown areas. The HETE Fund would benefit from this trend since these development patterns tend to increase housing opportunities and enhances the vitality of downtown areas.

2. Housing Equity Fund:

   - Development Patterns To the extent that local managers of the quadrants promote in-fill, mixed-use and transit-oriented development, program participants would benefit from increased housing opportunities and enhanced vitality in these areas.

E. Threats – External Conditions Harmful to Achieving the Objective

1. Walking District:

- Perverse Incentives As the program is described in the *Worksheet,* it would seem that employees have an incentive to buy and sell condos frequently in order to take advantage of the down payment subsidy. This could be prevented by limiting the program to first-time homebuyers, for example, or to those who have not received down payment assistance for at least X years.

- Quality of Life Traditionally, employees have chosen to live at some distance from work due to the relative amenities associated with suburban neighborhoods as compared to central business districts. Factors that drive people away from their places of employment include crime, congestion, noise, schools, shopping and others. This trend seems to be changing as many downtown areas are being redeveloped in ways that make them appear more attractive to residential development, at least to those in certain demographic groups. The success of the program will depend, however, on the perceived quality of life in the Walking District.

2. Housing Equity Fund:

- Quality of Life As with the Walking District, employees must perceive that the amenities associated with life inside the quadrant are favorable enough to make them want to purchase housing there.

CONCLUSION

The Housing Equity and Transportation Efficiency (HETE) Fund offers an innovative approach to encourage county residents to purchase housing much closer to places of employment. It relies on employer contributions to one of two Funds, rather than public monies, to offer employees financial incentives to relocate.

The program could conceivably be beneficial to both employers and employees, as well as result in reduced traffic congestion and emissions of carbon dioxide that could benefit everyone in the county. It is uncertain, however, whether the incentives to employers are great enough to encourage their contributions into the Funds. It is also unknown whether employees would actually participate in one or both programs given quality of life concerns and housing costs differentials.

The proposal would benefit from addressing these concerns as well as more research into comparable programs that have been attempted in other parts of the world. There may be adaptations to the design presented in the *Worksheet* that would make one or both of the programs suitable and effective in the context of Sonoma County.

REFERENCE

O'Sullivan, Arthur, 2007, *Urban Economics*, Sixth Edition, Boston: McGraw-Hill Irwin.

Cap and Share for Sonoma County's Transportation Submission

Your Contact Info: Name: Mike Sandler Phone: 707-529-4620 Email: msandler@pair.com Mailing address: 4731 La Villa Marina, Unit B Marina del Rey, CA 90292

Action Description: Cap and Share fossil fuel for transportation in Sonoma County.

Total fuel imports for transportation would be capped, and certificates ("shares") representing the fuel would be issued to Sonoma County residents on a per capita basis. Citizens would cash the certificate at a bank or brokerage. The bank or brokerage would sell the certificate to companies which would be required to return them to the County in order to import fuel into the county. More information is below.

Who is Responsible?: X City/County Government X Business X Residents X Organization

Status: X New idea ☐ Being developed ☐ Already existing

Explain Status: I am researching cap and share for its applicability at the State level regarding AB32.

Political Feasibility: ☐ Easy ☐ Some effort X Challenging ☐ Not applicable

Explain Political Feasibility: More feasible than a tax, but challenging to communicate.

Technical Feasibility: ☐Easy ☐ Some Effort X Challenging ☐ Not applicable

Explain Technical Feasibility: You would need a database of residents, and voter approval of plan.

Estimated Annual CO_2 reduction:

Years 1 – 2:	Years 3 – 5:	Years 6 – 10:	Years 11+:
Depends on the cap.			The cap could be set at whatever level is required.

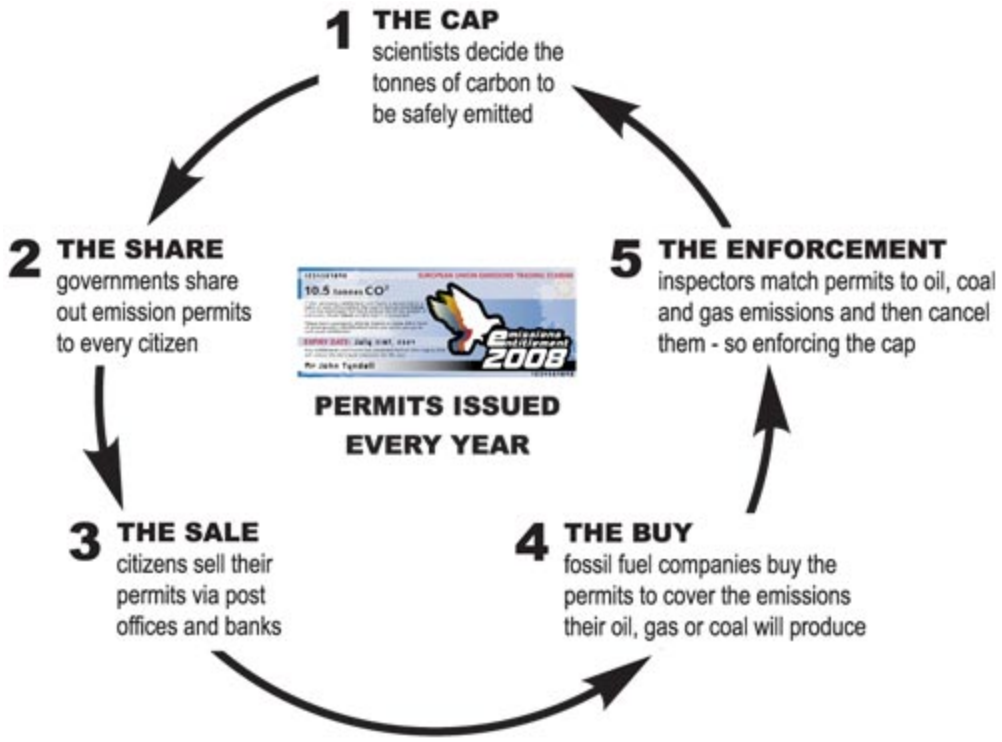
Other Benefits Of This Action (Describe): This is a Bold Action. It aligns economic incentives with GHG reduction. It also has a per capita equity component, so this is a local version of the global long term solution.

Financial Analysis:

Costs (Describe)	Dollar Estimate	Who pays?	How is it paid for?
One Time: (initial start-up)	$		
Recurring: (annual maintenance)	$		
Benefits (Describe)	**Dollar Estimate**	**Who receives these benefits?**	
	$		

Duration of the Proposed Action (How many years will it last?): Until Sonoma's transportation sector reaches the reduction goals.

Cap & Share: A cap on emissions within the jurisdiction is imposed, and the emissions under the cap are distributed as certificates, or 'shares,' to the residents in the jurisdiction. The picture below shows how shares circulate through the economy. People are given certificates. They exchange them for money at banks. Companies buy the certificates from the banks. To companies, the certificates are permits to purchase or distribute fossil fuel. Presumably, companies pass the price along to people. People will come out ahead if they use less of the resource, or they come out behind if they use more. The example below was written by Richard Douthwaite, an economist in Ireland. The same ideas could apply in Sonoma County.



Example: Cap and Share for Transportation in Ireland (by Richard Douthwaite)

Cap and Share (C&S) is being considered by the Department of Transport in Ireland and it will be one of the options discussed in a Green Paper on Sustainable Transport to be published in late 2007. The problem is that CO2 emissions from road transport in Ireland were 2.5 times greater in 2005 than they were in 1990, and are continuing to increase. If this increase had not taken place, Ireland would have no problem in meeting its commitment to its EU partners under the Kyoto Protocol to limit its emissions growth to a 13% rise above 1990 levels. As things are, the increase will be about twice that amount.

One reason for the huge increase in transport emissions is that the cost in terms of people's earnings of driving a car for a kilometer has fallen to about half the level it was in the 1970s and 80s. Increasing the tax on motor fuels by enough to start a downward emissions trend would be political suicide, but C&S could do the same job in a

politically-acceptable way. It would work like this. The tonnage of CO2 emissions from the petrol and diesel fuel used in Ireland in the initial year would be calculated and divided by the number of people on the electoral register. Each person would then be sent a certificate conveying his or her share of the emissions tonnage, which they would sell to a bank or post office. The tonnage purchased would be consolidated and sold on to companies importing or refining motor fuels in Ireland. Customs and Excise would verify that each firm had bought enough emissions rights when it collected the duty on the fuel. Very little extra work would be involved.

Each year, as the emissions from road transport were reduced by distributing a smaller and smaller emissions tonnage, the price of each person's allocation would rise. This would compensate them, at least in part, for higher bus fares and fuel costs. Anyone who was, directly or indirectly, using less motor fuel that the Irish average would come out better off. And, although the cost of living index would rise because of the additional cost of fuel and transport services, there should be no effect on wage claims as negotiators would know that everyone had already been compensated for the increase.

Naturally, Feasta is doing all it can to encourage the system's introduction. We are suggesting that gas and heating oils should be brought into the system too. This would put around 58% of the country's emissions under C&S control and mean that, if people preferred to cut emissions by insulating their houses or turning the thermostat down rather than by buying a smaller car or by driving less, they would get an equivalent encouragement to do so.

Cap and Share for Sonoma County's Transportation Analysis

EXECUTIVE SUMMARY

A Cap and Share program for Sonoma County could generate substantial reductions in carbon dioxide emissions within the time frame required to meet the countywide target. The policy is ambitious, comprehensive and novel. It is also challenging to explain and potentially expensive to administer, depending on the mechanism chosen to distribute emission certificates.

Strengths of the program include:

- Cap and trade model
- Sustainable scale
- Fair distribution
- Efficient allocation
- Absolute limit
- Control at the source
- Bold action

Weaknesses of the program are:

- Novel concept
- Distribution of certificates
- Redemption of certificates

Opportunities arise from this external factor:

- Fuel price appreciation

Threats exist due to several external factors:

- Cross-border purchases
- Opposition by distributors
- Overlapping policies

No data were provided for a financial or environmental economic analysis of the concept.

SUMMARY OF THE RECOMMENDED ACTION

The Cap and Share program would place a limit on fossil fuel imports into Sonoma County using a program modeled on the "cap and trade" concept. Total fossil fuel (e.g. gasoline, diesel) imports would be capped at a level to achieve the target reduction in carbon dioxide emissions countywide. The cap could be phased in over a number of years to ease its impact. Fuel distributors would be required to purchase certificates to bring gasoline and other carbon-emitting transportation fuels into the county. Each certificate allows its owner to import a quantity of fossil fuel that, when consumed, will result in one ton of carbon dioxide emissions.

Certificates would be initially distributed on an equal per-capita basis to all county residents. Residents would sell the certificates to banks or brokerages who would in turn resell them to fuel distributors. Certificate prices would be determined by market conditions. Residents could expect higher gas prices but would generate income from the sale of the certificates, providing a financial incentive to reduce fossil fuel consumption and a small annual income to offset higher fuel prices or, better, fund alternative modes of transportation.

CONTACT INFORMATION

The contact listed on the Recommended Action Worksheet is:

Mike Sandler
4731 La Villa Marina, Unit B
Marina Del Rey, CA 90292
707.529.4620
msandler@pair.com

S.W.O.T. ANALYSIS

A. Objective of the Recommended Action

Reduce greenhouse gas emissions in Sonoma County by implementing a policy to limit the importation of fossil fuel into the county in a fair and efficient manner.

B. Strengths – Attributes of the Action Helpful to Achieving the Objective

- Cap and Trade Model The program is similar in some respects to the successful sulfur dioxide cap and trade policy developed in the early 1990s and administered by the U.S. EPA. This program has generated significant reductions in sulfur dioxide emissions from coal-fired power plants for more than a decade. By 2010 emissions will be reduced to one-half of 1980 levels. The

policy has been cost-effective (i.e. it minimizes the cost of reducing emissions) since it promotes flexibility and innovation among the electric-power producers (Environmental Protection Agency 2006).

- Sustainable Scale In the emerging field of *ecological economics*, three criteria are used to assess public policies such as this: sustainable scale, just distribution and efficient allocation (Daly and Farley 2004). In this context, "sustainable scale" refers to reducing CO2 emissions to a level that can be sustained by ecosystems. While a 25% reduction in emissions compared to 1990 levels in Sonoma County will not be sufficient to avert the negative impacts of climate change worldwide, it does offer a promising and significant step in the right direction.

- Fair Distribution The cap and share program would be fair, or equitable, since it provides each resident of Sonoma County an equal share of the certificates: one person, one share. Each resident would have the freedom and flexibility to redeem the certificates as they see fit by selling it at a price determined by market conditions to a bank or broker of their choice.

- Efficient Allocation The program promotes efficiency since it fosters flexibility and rewards innovation. Fossil fuel distributors can simply purchase certificates from banks or brokers and import fuel as in the past (albeit not as much, in the aggregate, as previously done since countywide emissions are capped). Alternatively, fuel distributors can import low-carbon or zero-carbon fuels (e.g. ethanol, biodiesel, hydrogen) and thereby reduce the number of required certificates. Since the cost of purchasing certificates tends to be passed along to consumers, fossil fuels become more expensive relative to low- or zero-carbon alternatives. This market-based incentive encourages innovation and development of low- and zero-carbon transportation technologies.

- Absolute Limit One significant advantage of cap-and-trade systems over command-and-control regulations or fuel taxes is that a maximum limit is placed on total emissions in the jurisdiction (i.e. county in this case). Total emissions cannot, therefore, increase in the future assuming the cap is constant (or, more likely, decreasing each year) and the program is enforced. Economic growth or an increase in the number of sources cannot result in an increase in total emissions. In contrast, regulations or fuel taxes tend to allow increasing emissions over time as the economy grows and/or the number of sources increases unless the regulations are periodically strengthened or the taxes are periodically increased, neither of which tends to be politically-viable.

- Control at the Source The carbon content of gasoline and related fossil fuels is well-known and the carbon dioxide emissions generated by burning these fuels in an internal combustion engine are predictable. The EPA calculates that consumption of one gallon of gasoline results in 19.4 pounds of carbon dioxide emissions. The figure is slightly higher, 22.2 pounds of CO2 per gallon, for diesel

fuel (Environmental Protection Agency 2007). It is therefore straightforward to calculate the total number of certificates that can be issued each year to reduce CO2 emissions to the target level. Requiring fuel distributors to purchase the certificates before bringing the fuel into the county is more practical than attempting to control emissions for each fuel consumer. The burdens placed on the administrative agency are minimized by this arrangement since there are relatively few fuel distributors to monitor. Monitoring involves annual inventories of fossil fuel imports and assessment of fines for noncompliance. Possible administering agencies include the county's Economic Development Board, the Environmental Health Division of the Department of Health Services or the Waste Management Agency (Sandler 2007).

- Bold Action As the author of the *Worksheet* states, this is a bold action. It is the one policy with sufficient impact to single-handedly reduce county-wide carbon dioxide emissions to the target level in the transportation sector. Given the importance of transportation as a source of emissions it may be difficult to achieve the reductions that are desired without an ambitious policy such as this. It is difficult, for example, to imagine a reconfiguration of the bus system that would have a similar result.

C. Weaknesses – Attributes of the Action Harmful to Achieving the Objective

- Novel Concept Cap and share is, of course, a rather new idea. The related concept, cap and trade, has been applied in limited contexts (e.g. sulfur dioxide as described above, as well as carbon dioxide in Europe more recently). Cap and share is distinct from cap and trade in one important way: certificates are allocated to each resident of the county who must then do something (sell the certificates to a bank or broker) to benefit from the program. The policy is fairly complex and, as the author of the *Worksheet* points out, will be "challenging to communicate".

- Distribution of Certificates Distributing the certificates on an equal per-capita basis promotes fairness but may prove to be extremely challenging and expensive from an administrative perspective. This requires a list of county residents which could be developed by merging existing data bases (e.g. voter registration, Department of Motor Vehicle registration, property tax assessments, etc.) or by establishing a registration process that utilizes multiple media (e.g. web, phone, mail) to collect the necessary information from each resident on an opt-in basis.

- Redemption of Certificates Once the certificates are distributed, residents must act to redeem them or else forfeit the financial benefit that helps to offset the cost of higher fuel prices as well as provide funding to promote the use of alternative transportation. Once the certificates have been sold, residents may use the funds to purchase bus passes or bicycles, for example. However, many

residents may fail to sell the certificates to a bank or brokerage for any number of reasons, including loss, theft, inconvenience or ignorance of the process. An effective marketing campaign will be required to explain the concept to a diverse and multi-lingual population. Further, some residents may fail to benefit as much from the sale of permits as others due to limited opportunities to exchange the certificates and possible exploitation. For example, check cashing centers may purchase the certificates at lower prices than mainstream banks, taking advantage of the limited opportunities, awareness and financial acumen of the populations they serve. This problem might be solved by relying on a single county agency to auction the certificates to the fuel distributors and then distribute the *income* from the auction (rather than the certificates) on an equal per capita basis directly to county residents. This is the approach proposed by Peter Barnes (2001) and other advocates of the U.S. Sky Trust model.

D. Opportunities – External Conditions Helpful to Achieving the Objective

- Fuel Price Appreciation As gasoline and diesel prices continue to rise, rational consumers will increasingly seek alternative modes of transportation. The switch to low- or zero-carbon alternatives seems inevitable, and Sonoma County residents will have a head start if a cap and share program is adopted, since fossil-fuel prices will be even higher in the county than elsewhere and residents will receive compensation from the sale of the certificates to help finance alternative modes.

E. Threats – External Conditions Harmful to Achieving the Objective

- Cross-Border Purchases Residents of Sonoma County may choose to purchase fossil fuel, when possible, outside the county to avoid paying higher prices. This would reduce the impact of the policy on emissions in the county since fuel is being brought in from outside the jurisdiction and thereby increasing the total amount consumed.

- Opposition by Distributors Fossil fuel distributors are likely to oppose the policy and some might even decide to reduce or eliminate deliveries into the county. Whether this occurs depends in part on the ability of fuel distributors to pass along the cost of certificate purchases to their customers. Typically, the burden of an additional cost of this type is shared by both producers (distributors) and consumers, with relative impacts a function of supply and demand elasticities.

- Overlapping Policies Policies to reduce carbon dioxide emissions are under development in California in response to the 2006 passage of A.B. 32 and are presently under consideration in the U.S. Congress. The impact and outcomes of a cap and share program in Sonoma County will depend in large part on the

design and implementation of policies in the larger political and regulatory context.

CONCLUSION

The cap and share program analyzed here offers an ambitious and promising approach to reduce carbon dioxide emissions in Sonoma County. This single policy has the potential to bring about the dramatic reductions necessary to meet the target – a reduction of 25% below 1990 level by 2015 – in the transportation sector.

By focusing on transportation, the largest and fastest-growing source of carbon dioxide emissions in the county, cap and share changes incentives by driving up fossil fuel prices while simultaneously offering each resident of the county the financial means to switch to an alternative mode of transportation. Rational drivers will choose to drive less as gasoline and diesel prices increase. They will also enjoy a modest increase in income to help fund the transition to biofuels, mass transit or non-motorized transportation.

Cap and share promises to be difficult to explain, however, as well as to administer. It would require an effective marketing campaign to communicate the benefits and costs to each resident of the county. It engages the financial sector as the arbiter of trades between those who receive the certificates (residents) and those who need them (fuel distributors), but still requires significant local government involvement to distribute the certificates and monitor the distributors' fossil fuel imports.

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Environmental Protection Agency, 2007, *Emission Facts: Average Carbon Dioxide Emissions Resulting from Gasoline and Diesel Fuel*, accessed on May 22, 2007 at http://www.epa.gov/otaq/climate/420f05001.htm.

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Magnetic Levitation (Maglev) Commuter Transit System Submission

Your Contact Info:	Name:	Phone:	Email:	Mailing address:
	Maglev Transit Group William Alich	(650) 564-9397	balich@timension.com	3400 Kauai Ct, #204 Reno, NV 89509

Action Description:

Medium-Speed Maglev for Marin-Sonoma Corridor Feasibility Effort

Who is Responsible?: ☐ City/County Government _ Business ☐ Residents X Organization

Status: _ New idea ☐ Being developed X Already existing

Explain Status:

This is a proposal to evaluate deployment of maglev technology in the Marin-Sonoma corridor

Political Feasibility: ☐ Easy X Some effort ☐ Challenging ☐ Not applicable

Explain Political Feasibility

The primary challenge is to educate voters and policy-makers about the wisdom of deployment

Technical Feasibility: ☐Easy X Some Effort ☐ Challenging ☐ Not applicable

Explain Technical Feasibility:

The evaluation is straightforward, but requires a realistic ridership model, and study of the right-of-way options

Estimated Annual CO_2 reduction:	Years 1 – 2:	Years 3 – 5:	Years 6 – 10:	Years 11+:
	655,357,500 pounds/year	same	same	same

Other Benefits Of This Action (Describe):

Sharply reduced travel time to San Francisco, reduced local congestion, improved air quality

Financial Analysis:

Costs (Describe)	Dollar Estimate	Who pays?	How is it paid for?
One Time: (initial start-up)	$800 M – 1.2 B Estimate depends on right-of-way	Local, state, federal governments, users	Combination tax/grants, perhaps public-private partnership
Recurring: (annual maintenance)	$15 M initial estimate	Users	Recovered from operating revenue; operating revenue could reach $30M
Benefits (Describe)	**Dollar Estimate**	**Who receives these benefits?**	
Clean air, lowered travel costs, reduced greenhouse gases, **rapid travel times**	$225,000,000 per year initial rough estimate for travel cost reduction	Marin and Sonoma County Residents, City of San Francisco	

Duration of the Proposed Action
(How many years will it last?): 75 year system lifetime

Magnetic Levitation (Maglev) Commuter Transit System Analysis

EXECUTIVE SUMMARY

The Maglev Transit Group has proposed the development of an innovative magnetic levitation (maglev) transit system to reduce greenhouse gas emissions in Sonoma County, California. This cutting-edge technology permits passengers to enjoy a quiet and comfortable ride while traveling at speeds up to 125 miles per hour. Transit stations are proposed in five locations, from Santa Rosa to the Larkspur Ferry Terminal.

Strengths of the project include:

- Novelty
- High-speed travel
- Ferry connection
- Location of guideway
- Power source
- Longevity

Weaknesses of the project are:

- High start-up costs
- Low net operating revenues
- New technology
- Few access points
- Location of transit stations

Opportunities arise from these external factors:

- Sponsorship
- Fuel price appreciation
- Smart growth
- Electricity transmission

Threats exist due to several external factors:

- Sourcing of electricity
- Larkspur ferry capacity
- SMART
- Ridership

From a *financial* perspective, this project offers a low return on investment and a negative net present value. Like many mass transit systems, the project's net operating revenues are low relative to initial start-up costs. Annual projected revenues exceed operating costs, however, which makes the system financially self-sustaining once it begins operation (ignoring sunk costs). From an *environmental economics* perspective, the project generates a positive societal net present value if the human health, environmental and other external costs associated with gasoline consumption are valued at $5.48 or more per gallon.

SUMMARY OF THE RECOMMENDED ACTION

The Maglev Transit Group recommends development of a medium-speed magnetic-levitation commuter transit system along the U.S. Highway 101 corridor linking Sonoma and Marin Counties with the San Francisco Ferry Terminal in Larkspur.

CONTACT INFORMATION

The contact listed on the Recommended Action Worksheet is:

William Alich
Maglev Transit Group
3400 Kauai Ct. #204
Reno, NV 89509
(650) 564-9394

An alternate contact is J.R. (Dick) Wilson, who can be reached at the same phone number.

S.W.O.T. ANALYSIS

A. Objective of the Recommended Action

Reduce greenhouse gas emissions in Sonoma County by offering commuters an alternative mode of travel to the ferry that links Marin County with the city of San Francisco.

B. Strengths – Attributes of the Action Helpful to Achieving the Objective

- Novelty Magnetic levitation is a promising technology for comfortably and quietly moving people at very high speeds along an elevated rail. A 2004 report examining a proposed maglev system along the Interstate 70 corridor in Colorado describes the technology as follows:

  > Magnetic levitation is a cutting-edge technology employing the use of magnetic fields to create a gap between the vehicle and guideway. The magnetic levitation force transmitted across the gap creates a smooth, comfortable, quiet ride for passengers and allows for a frictionless environment for mechanical parts, minimizing failure rates (Colorado Department of Transportation, 2004, page 1).

  To date, no maglev system exists in the U.S., though systems have been successfully tested and deployed in Japan and China (*ibid*, page 2).

- High-speed Travel A maglev train can travel at speeds up to 125 miles per hour with an acceleration/deceleration time of only 36 seconds, resulting in an extraordinarily fast trip between Santa Rosa and the Larkspur Ferry Terminal. Travel time equals 21.4 minutes, plus dwell times as passengers board and disembark at each of the five stations en route, for a total travel time of approximately 33 minutes from Santa Rosa to Larkspur. By comparison, driving the 40-mile route takes at least 40 minutes during off-peak hours and considerably longer during peak commute times. The train serves only five stations (Santa Rosa, Rohnert Park, Petaluma, Novato and Larkspur) in order to shorten the time required to make the trip.

- Ferry Connection Rail trips would be coordinated with the Larkspur-San Francisco Ferry to facilitate travel to the San Francisco Ferry Building with further connections to public transit from the Ferry Building (Wilson 2007).

- Location of Guideway The track, or "guideway," could be constructed above the Highway 101 median to avoid interference with the railroad right of way and other land uses. It would require minimal land (e.g. stations and nearby parking) and would involve minimal ecosystem disturbance. Its above-ground installation puts it out of reach of wildlife, people and automobiles, resulting in fewer accidents compared to conventional rail.

- Power Source The train is powered by electricity, which can be produced from renewable sources. There are no operational emissions.

- Longevity The train has a long predicted lifespan given the low-friction design. The system proposed here is expected to last for 75 years.

C. Weaknesses – Attributes of the Action Harmful to Achieving the Objective

- High Start-up Costs This project requires a large initial investment (estimated between $800 million and $1.2 billion). Financing this investment requires a combination of bonds, tax revenue, grants, partnerships and/or other sources of funding.

- Low Net Operating Revenues Projected net revenues are $15 million per year (equal to $30 million in operating revenue minus $15 million in operating costs). Net operating revenue appears small relative to the initial investment. The investment yields a 1.5% simple return on investment resulting in 67-year simple payback period (see the complete financial analysis in the next section).

- New Technology Maglev is a relatively new and underutilized technology that has never been deployed in the United States. At this time, operable systems exist only in three nations: Germany, Japan and China. As with any new technology, there are inherent risks and potential unforeseeable consequences.

- Few Access Points The train will not have stations in San Rafael, Cotati, Windsor, Healdsburg, Cloverdale or other urban areas on the Highway 101 corridor, which speeds up the trip but makes it more costly and time-consuming for residents of these areas to drive to the train station. This may reduce the popularity of the train vis-à-vis the proposed Sonoma-Marin Area Rail Transit (SMART) project, which is designed with more stations.

- Location of Transit Stations Locating transit stations on the median of Highway 101 may be problematic due to traffic noise, lack of space and lack of parking. Commuters may dislike waiting for the maglev train in a noisy, crowded environment. Transit-oriented development may not prosper near the freeway as well as it would near a dedicated railway or other location (Woodhall 2007).

D. Opportunities – External Conditions Helpful to Achieving the Objective

- Sponsorship This high-technology project could attract investment from public, private and non-profit sector entities wishing to be associated with a high-profile, noteworthy attempt to reduce greenhouse gas emissions caused by vehicle commuting.

- Fuel Price Appreciation Gasoline prices are likely to continue trending upward, which should increase future ridership.

- Smart Growth Sonoma County represents an ideal location for increased transit-oriented development. Compared to other counties in the San Francisco Bay Area, Sonoma County has the potential to promote considerable mixed-use development near transit hubs (Wilson 2007).

- Electricity Transmission There is a possibility of installing a gas-insulated electricity transmission line inside the guideway during construction in order to transmit electricity for other uses. This offers a relatively secure and low-cost alternative to the construction of conventional transmission lines suspended from towers and prone to problems related to maintenance, damage and aesthetics (Wilson 2007).

E. Threats – External Conditions Harmful to Achieving the Objective

- Sourcing of Electricity The source of electricity may not be renewable. The power mix for the local utility, PG&E, is reported to be only 13% renewable (Pacific Gas and Electric 2007). Therefore, using PG&E electricity to power the train could result in increased generation from non-renewable sources (e.g. natural gas) and, consequently, an increase in greenhouse gas emissions. In

this sense, the technology is only as green as the source of electricity upon which it depends.

- Larkspur Ferry Capacity The ferries that currently comprise the Larkspur-San Francisco segment of the Golden Gate Transit Ferry system are already fairly crowded during the rush hour. While many of these commuters would presumably use the maglev system rather than drive to the ferry terminal, others would not since there is no station near their home (e.g. residents of San Rafael). The proposal assumes that 15,000 commuters will transfer from the maglev system to the ferry at Larkspur during the morning rush hour (5 to 9 am), which will require adding more ferries to the current schedule. While parking space is limited at the Larkspur terminal, there is excess capacity to handle additional boats (i.e. slips) and the ferry operator, Golden Gate Transit, is amenable to increasing its scheduled service by adding to its existing fleet (Wilson 2007).

- SMART The maglev train may compete with the proposed Sonoma-Marin Area Rail Transit (SMART) train for riders, resources and public support. The SMART proposal has been defeated by voters in recent elections but may be approved in a future election if support grows. The projects are not necessarily mutually-exclusive, since the lines can be located in different locations. SMART would utilize the existing rail right-of-way through Marin and Sonoma Counties while the maglev guideway could be installed in the median of Highway 101 or another location. In addition, the two projects could, conceivably, share a terminus in Larkspur if planned accordingly. In some respects, the maglev system may seem more attractive than the SMART concept given the high speeds, comfortable ride, quiet operation and advanced technology. To the extent that the two projects are considered rivals it may be difficult to gain support for the maglev project from those who favor SMART. On the other hand, supporters of mass transit may decide that the maglev proposal offers a superior technology and therefore focus their efforts on gaining public support for this relatively fast, quiet and novel system.

- Ridership It is uncertain whether there is sufficient demand for maglev transit travel between the four proposed stations (Santa Rosa, Rohnert Park, Petaluma and Novato) and the Ferry Terminal in Larkspur. The proposal assumes that the system will run at full capacity, carrying 15,000 passengers during rush hour each way. The actual demand will demand on a variety of factors largely outside the control of the system managers, including fuel prices, highway congestion, alternate transit options, economic conditions and changes in demographics and employment in the region, to name a few.

FINANCIAL ANALYSIS

The financial analysis presented here employs specific assumptions to estimate a set of financial metrics. The assumptions that underlie the financial analysis as presented by the author of the Recommended Action *Worksheet* are as follows:

- The initial start-up cost equals $1,000 million (or the midpoint of the range provided in the *Worksheet*: $800 million to $1,200 million).
- The annual maintenance cost equals $15 million.
- The annual operating revenue equals $30 million.
- The system has a lifespan of 75 years.
- Maintenance costs and operating revenues are static (no appreciation, depreciation or other changes occur over time).
- The time value of money is reflected in a discount rate of 7% per year. This is the standard rate recommended by the U.S. Office of Management and Budget (OMB, 1992).
- The electricity used to power the system is carbon neutral.

The simple ROI for this project is 1.5%, which would not exceed the cost of capital.

The lifetime annualized ROI for this project is 0.28%, which would not exceed the cost of capital.

The simple payback for this project is 67 years. Most analysts would consider this an unattractive project given the lengthy wait necessary to recoup the original investment.

The discounted payback for this investment exceeds the life of the project (which is 75 years). That is, the discounted stream of net operating revenues does not compensate for the initial start-up costs and therefore the investment does not pay itself off considering the time value of money.

The net present value for this project is $-787,054,610, which implies that the future net income generated by the project is not sufficient given the time value of money to compensate for the initial investment. In other words, an investor would fare better earning a 7% per year elsewhere rather than putting money into this project.

The IRR in the final year of this project is 0.32%, which would not exceed the cost of capital.

The MIRR for this project is 4.82%, which does not exceed the 7% rate assumed here to represent the cost of capital.

Cost per Ton of Reduced CO2 Emissions
Finally, it is straightforward to calculate the cost of reducing emissions of carbon dioxide on a per-ton basis. The author of the *Worksheet* estimates the project will result in a reduction of 655,357,500 pounds of carbon dioxide emissions each year. Over the 75-year life of the project, 49,151,812,500 pounds of emissions are reduced. Dividing the NPV of the project by this figure and converting into tons yields an estimate of the cost per ton of carbon dioxide reduced over the entire life of the project.

Based on the Worksheet author's assumptions, the cost of reducing CO2 emissions for this project equals $32.03 per ton. Alternate assumptions would yield a different figure (see below).

ENVIRONMENTAL ECONOMIC ANALYSIS

It is clear from the preceding financial analysis that the project would be unattractive to an investor seeking to generate an above-market return on investment. This is important, since it explains why it is extremely unlikely that the private sector would invest in this type of mass transit operation. This is only part of the picture, however, since it ignores the societal benefits that could be generated by implementation of a maglev system. The field of "environmental economics" analyzes large scale investments such as this from the perspective of society as a whole, considering all the possible costs and benefits to those affected directly or indirectly by the project.

A. Reductions in External Costs

"External costs" are the costs of production or consumption that are not paid by producers or consumers. These so-called "third party" costs are incurred by others. A prime example is the health costs incurred by victims of air pollution. Neither the producer nor the consumer of gasoline pay for the medical treatment necessary to mitigate the impacts of high concentrations of ground-level ozone and particulate matter.

The maglev system examined here offers a mechanism to reduce gasoline consumption and, thereby, reduce the external costs associated with automobile use. A complete accounting of the societal benefits of the maglev system would include the following:

- Greenhouse Gases Carbon dioxide emissions would be reduced as commuters shift from automobiles to the maglev system. As described above, the author of the Worksheet estimates a reduction of 655,357,500 pounds per year. I have done a separate calculation to verify this figure and have come up with a different estimate of greenhouse gas emissions avoided. My assumptions are:

    - 15,000 passengers use the maglev system each day.

- Each maglev commuter would have driven alone, in a vehicle that averages 20 miles per gallon, an average of 30 miles each way (60 miles roundtrip) from home to work if the maglev system were unavailable.
- Each maglev commuter drives an average of 3 miles each way (6 miles round trip) from home to the nearest maglev station. It is assumed that some commuters will walk to the station, others will take public buses and others will drive a considerable distance. On average, maglev commuters will drive 3 miles each way.
- Each maglev commuter travels to work 250 days each year (5 days per week for 50 weeks each year).
- Each gallon of gas consumed generates 19.4 pounds of carbon dioxide emissions (Environmental Protection Agency 2007).

Based on these assumptions, the reduction in greenhouse gas emissions is 196,425,000 pounds per year, or 14,731,875,000 over the 75-year life of the project. The cost per ton of emissions reduction over the life of the project is $106.85 in this case. My figure is considerably higher than the estimate based on the assumptions provided by the author of the *Worksheet* ($32.03 per ton).

Keep in mind that another key assumption underlying these cost-per-ton figures is that the electricity used to power the maglev system is carbon neutral. This is possible if the electricity can be generated from development of new, renewable sources (e.g. geothermal, wind, biomass, etc.) but will not hold true if the energy is provided by the local utility using current generation technologies (only 13% renewable at the time of this writing).

- Air Pollution In addition to carbon dioxide, automobiles emit common air pollutants classified and monitored by the Environmental Protection Agency as "criteria pollutants" (Environmental Protection Agency, 2007b). According to the Power Point presentation submitted with the Worksheet, the maglev train could reduce gasoline consumption by 27,375,000 gallons annually. Assuming present emission standards for cars, this reduces annual emissions of carbon monoxide by 3,030,522 pounds, nitrous oxide by 356,532 pounds and hydrocarbons by 222,833 pounds. The reductions are smaller, though still noteworthy, if one employs the assumptions I developed above, since gasoline consumption falls by a more modest 10,125,000 gallons under my scenario. In either case, however, development of the maglev train could be expected to yield improvements in local and regional air quality.

- Traffic Congestion It is conceivable that implementation of a maglev system would reduce traffic congestion on Highway 101, causing a significant reduction in travel times for automobile drivers.

B. The Monetary Value of Reductions in External Costs

While most economists agree that gasoline consumption imposes external costs on third parties, there is no consensus on the monetary value of these costs. The powerpoint presentation included with the *Worksheet* suggests a cost ranging from $0.29 to $1.80 per gallon that takes into account the following external costs: "reduced health, lost productivity, hospitalization and death, as well as the cleanup of polluted sites" (Jacobson 2005). This estimated range for these costs is based on a study published in the journal *Science* (Jacobson, Colella and Golden 2005).

Published estimates of the external costs of gasoline consumption vary widely, depending on methodology and types of costs included in the analysis. One study, for example, offers a lower estimate, $0.26 per gallon (National Research Council, 2002)). A recent summary of several other published studies provides a higher estimate, $2.67 per gallon, including health costs as well as taxpayer-funded road improvements and a fairly conservative estimate of the economic costs of petroleum-related climate change.

Whereas these and other reports represent only a partial accounting of the external costs of gasoline consumption, one noteworthy study attempted to estimate the full external cost of gasoline consumption (International Center for Technology Assessment, 1998). This includes tax subsidies to the oil industry (ranging from $0.035 to $0.06 per gallon), government expenditure subsidies ($0.32 to $0.95), protection costs ($0.65 to $1.05), environmental, health and social costs ($2.00 to $8.13) and other economic costs ($1.59 to $3.95). Total external costs, according to this study, range from $4.60 to $14.14 per gallon.

C. Net Present Value Including External Cost Reductions

Ideally, the external costs that are avoided by operation of the maglev system would be factored into the estimate of net present value to determine whether the project is worthwhile from the perspective of society. That is, do the program's lifetime discounted net benefits exceed zero, including initial start-up costs, net operating revenues and reductions in external costs? This is complicated by the uncertainty regarding external costs described above. If, for example, the external costs of gasoline consumption are only $0.26 per gallon (the National Research Council figure), then NPV is negative. On the other hand, NPV is positive if external costs are $14.14 (the upper bound of the International Center for Technology Assessment estimate).

As it turns out, the NPV for this project would be positive if the external costs generated by gasoline equal or exceed $5.48 per gallon. This is a relatively high figure in relation to the other estimates described above, but is certainly plausible given the wide variety of negative impacts associated with gasoline use and the increasingly-apparent effects of auto emissions on the earth's climate.

CONCLUSION

The Maglev train system described in the *Recommended Action Worksheet* and supporting Power Point presentation offers an ambitious, intriguing and high-profile technology to reduce greenhouse gas emissions in Sonoma County. It would also improve local air quality and decrease traffic congestion on Highway 101. The list of strengths and opportunities is large, as is the list of potential weaknesses and external threats.

Like most mass transit systems, the maglev train does not produce sufficient operating revenue to generate returns acceptable to private sector investors due to the high initial start-up costs. Public sector investment is necessarily to finance all or part of the initial start-up costs, but the project becomes self-sustaining once it becomes operational (annual operating revenues exceed operating costs).

Is the project a good use of public funding? Considering the initial start-up costs as well as the annual revenue and cost streams, the project appears worthwhile from a societal standpoint if the external costs associated with gasoline consumption are believed to equal or exceed $5.48 per gallon. This estimate is based on a number of simplifying assumptions and could change significantly under different scenarios.

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