CENTER FOR CLIMATE AND ENERGY SOLUTIONS

PLENARY SESSION MATERIALS

New Approaches to Financing the Publicly Available Electric Vehicle Charging Network

This document provides background information on the business case challenge for EV charging and workshop materials for the plenary session. Additional workshop materials include:

- Workshop agenda
- Summary of charging infrastructure gaps for the breakout group sessions
- Solutions Toolbox for consideration during the breakout group sessions

The purpose of this workshop is to assess the effectiveness of various business concepts for financing publicly available charging infrastructure in the state of Washington. The workshop will begin with an opening plenary session based on a simple business model for publicly available charging that Washington state has already explored. Following the plenary session, each workshop participant will be assigned to one of three breakout groups. Each group will explore three types of EV charging infrastructure gaps, and discuss alternative ways to finance charging stations. The charging gaps will be drawn from cases in the Task 1 report from this study, *Assessing the EV Charging Network in Washington State*.

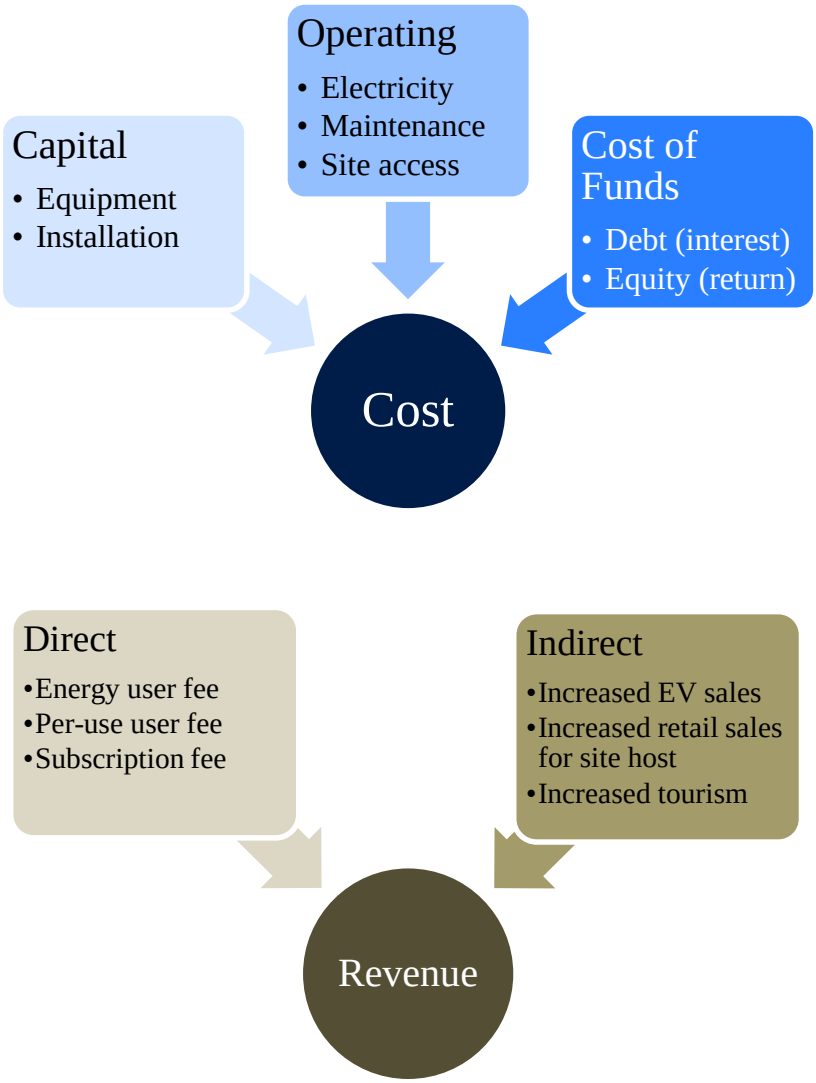
Background

While state and federal governments have played a central role in funding EV charging infrastructure to date, charging gaps still remain and greater private investment will be needed to ensure adequate access to publicly available charging stations. Steady private investment in charging infrastructure is essential to advance EV adoption. However, it is currently challenging to construct a profitable business case for EV charging investments for several reasons.

In order for the private sector to consider investing in EV charging, project developers will need to expect that the investment will generate direct and indirect revenue that is greater than its total cost, including the cost of funds. This could be achieved by some combination of increased revenue, decreased capital cost, decreased operating cost, or decreased cost of funds.

A summary of the key cost and revenue components of EV charging business models is presented in the two figures below.

Cost and Revenue Components of EV Charging Business Models



The figures above show private, market-based costs and returns. While most if not all of the costs must be paid by the project developer, some of the revenues (particularly the indirect revenues) are received by other stakeholders.

Plenary Session

The workshop will begin with an opening plenary session based on a simple business model for publicly available charging that Washington state has already explored. This plenary will provide workshop participants with an introduction to the key concepts and issues surrounding EV charging infrastructure and the challenge of formulating sustainable business models that ensure adequate charging access. The plenary will include the presentation of a financial model of DC fast charging based on assumptions and data previously analyzed by the state. The model will illustrate that a simple per-use payment approach for EV charging is financially unsustainable given current levels of demand and current technology. This model will also serve as a "base case" that participants can use to compare with alternative business models explored in the breakout sessions.

The formula below illustrates the basic barrier to profitable operation of an EV charging network. For the private market to invest in a charging station or network of stations, the direct and indirect revenue must be greater than the costs of the station(s). This net difference between revenues and costs per dollar of total capital must provide a greater rate of return than alternative investments.

$$Direct\ \&\ Indirect\ Revenue\ [R] > \ Capital\ Costs\ [C] + Operating\ Costs[O] + Cost\ of\ Funds\ [F]$$

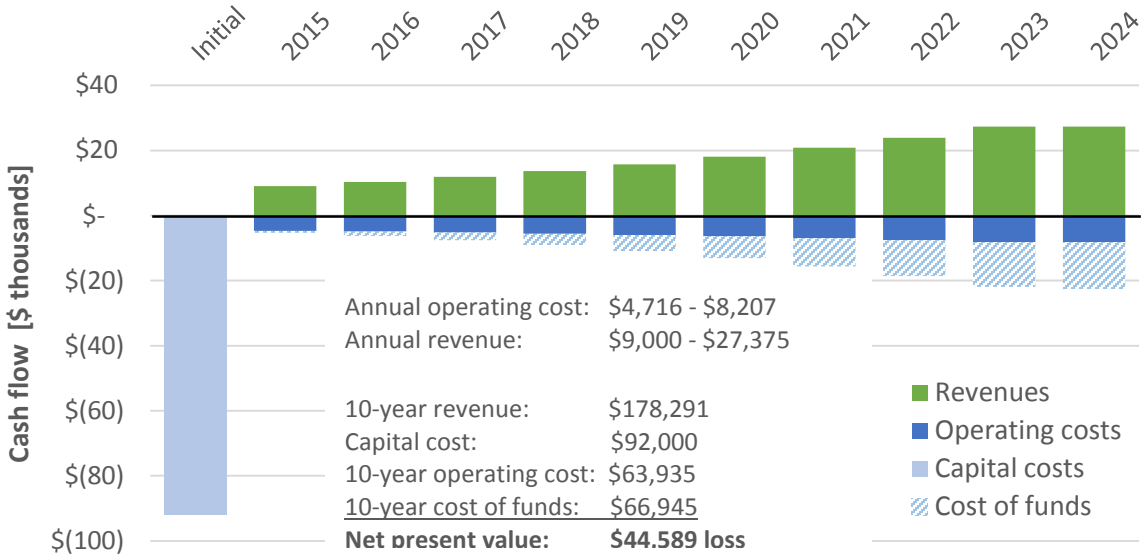
Where:

- *Capital Costs* are the cost of equipment and installation.
- *Operating Costs* are the ongoing costs to maintain and run the station.
- *Cost of Funds* are the cost of paying interest on debt and investor returns on equity.
- *Direct Revenue* are funds attributable to direct use of a charging station (e.g., per-use fee).
- *Indirect Revenue* are funds that are realized through sales of other products but could be attributed to the charging station. These are not always captured by the project developer.

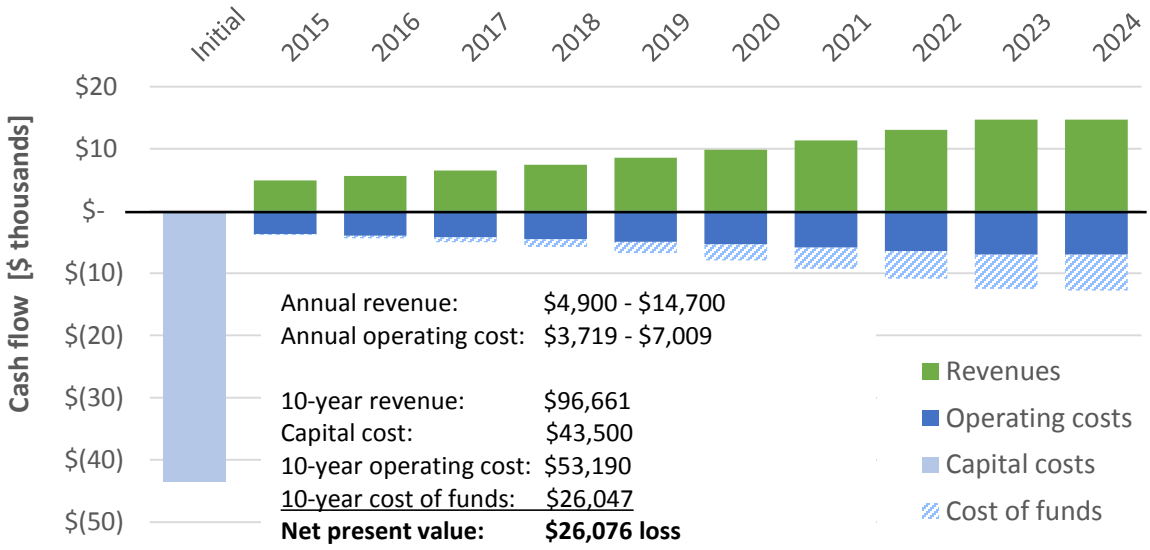
To demonstrate and quantify the challenge of establishing a compelling business case for offering EV charging, C2ES constructed two simple financial models: one for a single DC fast charging station and one for a charging site with five Level 2 charging stations. Each financial model calculates the net value of a charging station project to the project developer (the "net present value" or NPV), as well as the time required for the project to generate net positive value to the project developer (the "discounted payback period," which we will refer to simply as the "payback period" throughout this workshop).

Base case financial models were constructed to quantify the financial performance of a simple "pay-per-unit-of-energy" model for both DC fast charging station and Level 2 charging station sites. The assumptions behind these models are presented in Appendix A. Notably, the calculations are made for a 10-year period because this is widely considered to be a conservative estimate of the useful life of EV charging equipment, according to conversations with equipment manufacturers. The cost of funds is represented as the weighted average of interest on debt and return on investor equity (assumed as 15% for the base case) and is applied as the 'discount factor' of future cash flows. The cash flows for each base case are depicted in the two charts below.

DC Fast Charging Station Cash Flow is Net Negative over Project Lifetime



Level 2 Charging Site Cash Flow is Net Negative over Project Lifetime



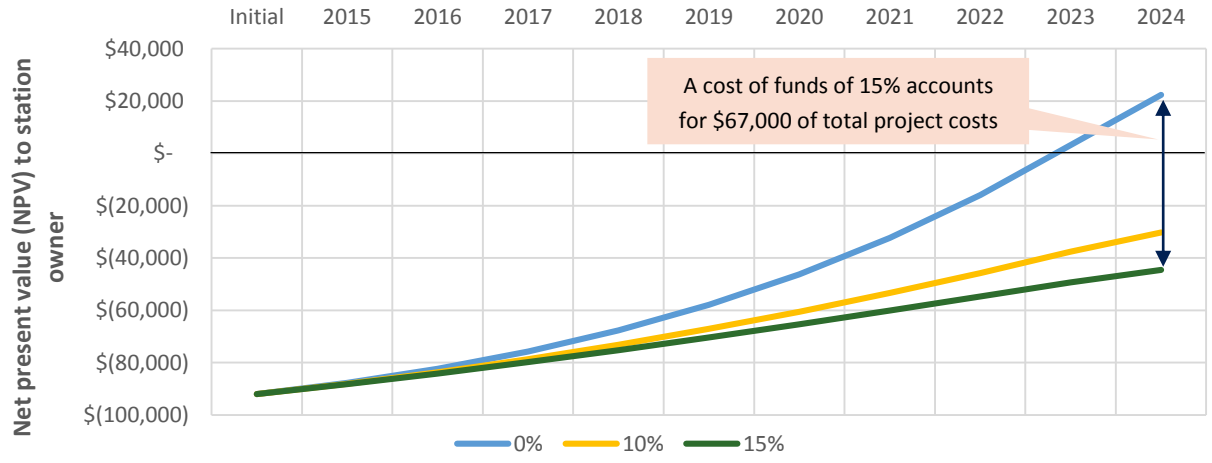
These two charts illustrate the challenge of paying back large initial capital cost investments in charging stations. Although the capital costs of the Level 2 charging site are smaller than for a DC fast charging station, net revenues also still are relatively small. Although in both cases annual revenues exceed operating costs, revenues are small compared to initial capital costs. Instead of presenting discounted future cash flows, the time value of money is represented through the "cost of funds" term. By assumption, all capital costs occur at the beginning of year 2015, and all revenue and operating cost cash flows are received at the end of each year.

The results indicate that offering charging services that relies only on revenue from the sale of electricity is not currently financially sustainable for private sector entities for either DC fast charging or Level 2 charging under the assumptions of this analysis. For DC fast charging, investment in a single station results in a net loss of $44,589 for a private project developer over ten years. For Level 2 charging, investment in a charging site with five Level 2 charging stations results in a net loss of $26,076 for a private project developer over the same period.

In addition to capital cost, operating cost, and revenue cash flows, the cost of funds has a significant impact on the financial performance of charging station investments. The charts below demonstrate the sensitivity of project financial performance to the cost of funds. The base case model results described above assume a cost of funds of 15 percent. That is, the weighted average of interest paid on debt and payments made to equity investors (weighted by the relative contribution of debt and equity used to finance the project) is assumed to be 15 percent. The cost of funds is largely driven by the risk perceived by lenders and investors, who demand a higher interest rate or return on investment to compensate for this risk. If the risk perceived by lenders and investors can be reduced, then the cost of funds to private charging service providers may be reduced.

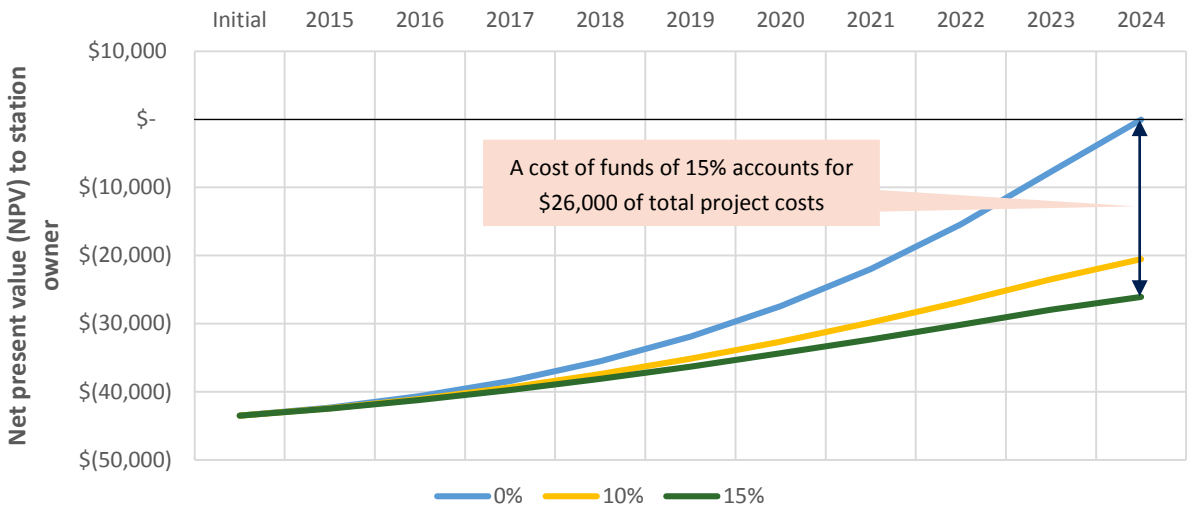
The charts below demonstrate that, if the cost of funds is zero, either a DC fast charging or a Level 2 charging project may generate net value within ten years, using the assumptions given. However, the cost of capital is not zero for any private firm and since the capacity of government to invest public dollars into charging stations is limited, expanded private sector investment is likely needed to ensure adequate access to charging infrastructure.

Cost of Funds Significantly Impacts Net Present Value of DC Fast Charging Station Projects



This figure shows the sensitivity of DC fast charging project financial performance to variations in the cost of funds. The figure depicts the net value generated by a DC fast charging station project for the project developer over time under three rates for the cost of funds. *The project begins to generate net positive value for the project developer if and when it crosses above the $0 line.* For the base case assumption of a 15 percent cost of funds, the project does not generate net value. If the cost of funds is zero, however, the project generates net value within ten years using the assumptions given.

Cost of Funds Significantly Impacts Net Present Value of Level 2 Charging Site Projects



This figure shows the sensitivity of Level 2 charging site project financial performance on the cost of funds. The figure depicts the net value generated by a DC fast charging station project for the station project developer over time under three rates for the cost of funds. *The project begins to generate net positive value for the project developer if and when it crosses above the $0 line.* For the base case assumption of a 15 percent cost of funds, the project does not generate net value. If the cost of funds is zero, however, the project comes very close to generating net value within ten years.

Generally, in order for private sector developers to invest in a project, they need to expect the project to be profitable and to achieve net profitability in a short period—many private investors are only interested in projects that can achieve payback within 3 to 5 years. The two tables below show by how much (1) charging station capital costs would have to be subsidized or (2) annual revenues would have to be increased in order to achieve a payback period of 5 years.

Capital Cost Subsidies Needed for Projects to Achieve Payback within 5 Years (Revenues Held Constant)

PROJECT TYPE	TOTAL CAPITAL COSTS	CAPITAL COST SUBSIDY NEEDED
DC Fast Charging Station	$92,000	$70,381 (76% of capital costs subsidized)
Level 2 Charging Site	$43,500	$36,300 (83% of capital costs subsidized)

Additional Annual Revenue Needed for Projects to Achieve Payback within 5 Years (Capital Cost Unsubsidized)

PROJECT TYPE	ANNUAL REVENUE	ADDITIONAL ANNUAL REVENUE NEEDED
DC Fast Charging Station	$9,000 - $27,375	$22,100 (between 1.8 and 3.4 times greater revenue needed)
Level 2 Charging Site	$4,900 - $14,700	$11,400 (between 1.7 and 3.3 times greater revenue needed)

Appendix A: Financial Model Assumptions

Base Case Assumptions: DC Fast Charging Station Project

PARAMETER	ASSUMPTION	SOURCE
Capital Costs		
Charging station equipment	$35,000 per unit	Plug-In America and ABB Ltd.
Equipment installation (labor and electric-panel upgrade)	$26,000 per location	Washington State Department of Transportation (WSDOT)
Host-site identification, analysis, and screening	$5,000 per location	WSDOT
Negotiation, legal review, and execution of lease	$6,000 per location	WSDOT
Utility interconnection	$20,000 per location	WSDOT
Operations and Use		
Number of charging sessions in first year	1,200 sessions per year (3.3 sessions per day, in use 4% of a 24-hour day)	C2ES assumption
Annual compounded growth rate in number of charging sessions	15%	C2ES assumptions
Maximum number of charging sessions	3,650 sessions per year (10 sessions per day, in use 13% of a 24-hour day)	C2ES assumption
Average charging energy per session	15 kWh per session	C2ES assumption
Electricity retail price in first year	$0.07 per kWh	U.S. Energy Information Administration
Annual compounded growth rate in electricity price	0%	C2ES assumption
Maximum power draw	50 kW	C2ES assumption
Demand charge	$1.26 per kW	Based on Seattle City Light rates

Annual station maintenance cost as percent of capital cost	3%	C2ES assumption
Host site lease or access cost	$1,200 per year	C2ES assumption
General & Administrative costs as percent of revenues	5%	C2ES assumption
Cost of funds (weighted average of interest on debt and return on equity), applied as the 'discount factor' of future cash flows	15%	C2ES assumption
Period of analysis	10 years	ABB Ltd.
Per-energy user fee	$0.50 / kWh	Based on energy-equivalent price of gasoline (and CarCharging Group prices)

Base Case Assumptions: Level 2 Charging Site Project

PARAMETER	ASSUMPTION	SOURCE
Capital Costs		
Number of recharging stations per site	5 stations	C2ES assumption
Charging station equipment	$2,500 per unit	WSDOT
Equipment installation (labor and electric-panel upgrade)	$4,000 per unit	Rocky Mountain Institute
Host-site identification, analysis, and screening	$5,000 per location	WSDOT
Negotiation, legal review, and execution of lease	$6,000 per location	WSDOT
Utility interconnection	$0 per location	C2ES assumption
Operations and Use		
Number of charging sessions per station in first year	400 sessions per year (1.1 sessions per day, in use 7% of a 24-hour day)	C2ES assumption

Annual compounded growth rate in number of charging sessions	15%	C2ES assumption
Maximum number of charging sessions	1,200 sessions per year (3.3 sessions per day, in use 21% of a 24-hour day)	C2ES assumption
Average charging energy per session	10 kWh per session	C2ES assumption
Electricity retail price in first year	$0.07 per kWh	U.S. Energy Information Administration
Annual compounded growth rate in electricity price	0%	C2ES assumption
Maximum power draw per station	6.6 kW	C2ES assumption
Demand charge	$1.26 per kW	Based on Seattle City Lights rates
Annual maintenance cost as percent of capital cost	3%	C2ES assumption
Host site lease or access cost	$1,200 per year	C2ES assumption
General & Administrative costs as percent of revenues	5%	C2ES assumption
Cost of funds (weighted average of interest on debt and return on equity), applied as the 'discount factor' of future cash flows	15%	C2ES assumption
Period of analysis	10 years	ABB Ltd.
Per-energy user fee	$0.25 / kWh	C2ES assumption

Appendix B: Example Model Pro Forma

DC Fast Charging Station Project Base Case

	INITIAL	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
CAPITAL COSTS											
Charging station equipment	$35,000										
Construction and equipment installation	$26,000										
Electric utility upgrades and grid interconnection	$20,000										
Lease and property transaction costs	$6,000										
Host site identification and screening	$5,000										
TOTAL CAPITAL COST	**$92,000**										
OPERATING COSTS											
Energy cost (based on kWh)		$1,260	$1,449	$1,666	$1,916	$2,204	$2,534	$2,914	$3,352	$3,833	$3,833
Power cost (based on kW)		$756	$756	$756	$756	$756	$756	$756	$756	$756	$756
Maintenance cost		$1,050	$1,050	$1,050	$1,050	$1,050	$1,050	$1,050	$1,050	$1,050	$1,050
Host site lease or access cost		$1,200	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200
General & Administrative cost		$450	$518	$595	$684	$787	$905	$1,041	$1,197	$1,369	$1,369
TOTAL OPERATING COST		**$4,716**	**$4,973**	**$5,267**	**$5,607**	**$5,997**	**$6,445**	**$6,961**	**$7,555**	**$8,207**	**$8,207**
REVENUES											
Per-energy user fee revenue		$9,000	$10,350	$11,903	$13,688	$15,741	$18,102	$20,818	$23,940	$27,375	$27,375
TOTAL REVENUE		**$9,000**	**$10,350**	**$11,903**	**$13,688**	**$15,741**	**$18,102**	**$20,818**	**$23,940**	**$27,375**	**$27,375**
FREE CASH FLOW	**$(92,000)**	**$4,284**	**$5,378**	**$6,635**	**$8,081**	**$9,744**	**$11,657**	**$13,856**	**$16,386**	**$19,168**	**$19,168**

Level 2 Charging Site Project Base Case

	INITIAL	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
CAPITAL COSTS											
Charging station equipment	$12,500										
Construction and equipment installation	$20,000										
Electric utility upgrades and grid interconnection	$0										
Lease and property transaction costs	$6,000										
Host site identification and screening	$5,000										
TOTAL CAPITAL COST	**$43,500**										
OPERATING COSTS											
Energy cost (based on kWh)		$1,400	$1,610	$1,852	$2,129	$2,449	$2,816	$3,238	$3,724	$4,200	$4,200
Power cost (based on kW)		$499	$499	$499	$499	$499	$499	$499	$499	$499	$499
Maintenance cost		$375	$375	$375	$375	$375	$375	$375	$375	$375	$375
Host site lease or access cost		$1,200	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200	$1,200
General & Administrative cost		$245	$282	$324	$373	$429	$493	$567	$652	$735	$735
TOTAL OPERATING COST		**$3,719**	**$3,966**	**$4,249**	**$4,576**	**$4,951**	**$5,383**	**$5,879**	**$6,450**	**$7,009**	**$7,009**
REVENUES											
Per-energy user fee revenue		$4,900	$5,635	$6,480	$7,452	$8,570	$9,856	$ 11,334	$ 13,034	$ 14,700	$ 14,700
TOTAL REVENUE		**$4,900**	**$5,635**	**$6,480**	**$7,452**	**$8,570**	**$9,856**	**$ 11,334**	**$ 13,034**	**$ 14,700**	**$ 14,700**
FREE CASH FLOW	**$(43,500)**	**$1,181**	**$1,669**	**$2,231**	**$2,876**	**$3,619**	**$4,473**	**$5,455**	**$6,584**	**$7,691**	**$7,691**