NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Business Case for CNG in Municipal Fleets

Clean Cities Webinar

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Agenda

- Why municipal fleets?
- Assessing investment profitability
- VICE model
- Base-case scenario
- Pressing questions for fleet owners

Why municipal fleets?

- Transit buses, refuse trucks, and school buses
- Circular routes lead to CNG station!
- Municipal governments value some CNG attributes that many businesses don't
  - Long-term cost-effectiveness (instead of just short-term)
  - Consistent operating costs
  - Increased energy and climate security
  - Reduced local air and noise pollution
- Future report to cover delivery trucks and taxi cabs

Credit: Leslie Eudy, NREL PIX12293


Courtesy of Kevin Chandler, Battelle PIX09569

Courtesy of John Kubesh, Southwest Research Institute PIX04151

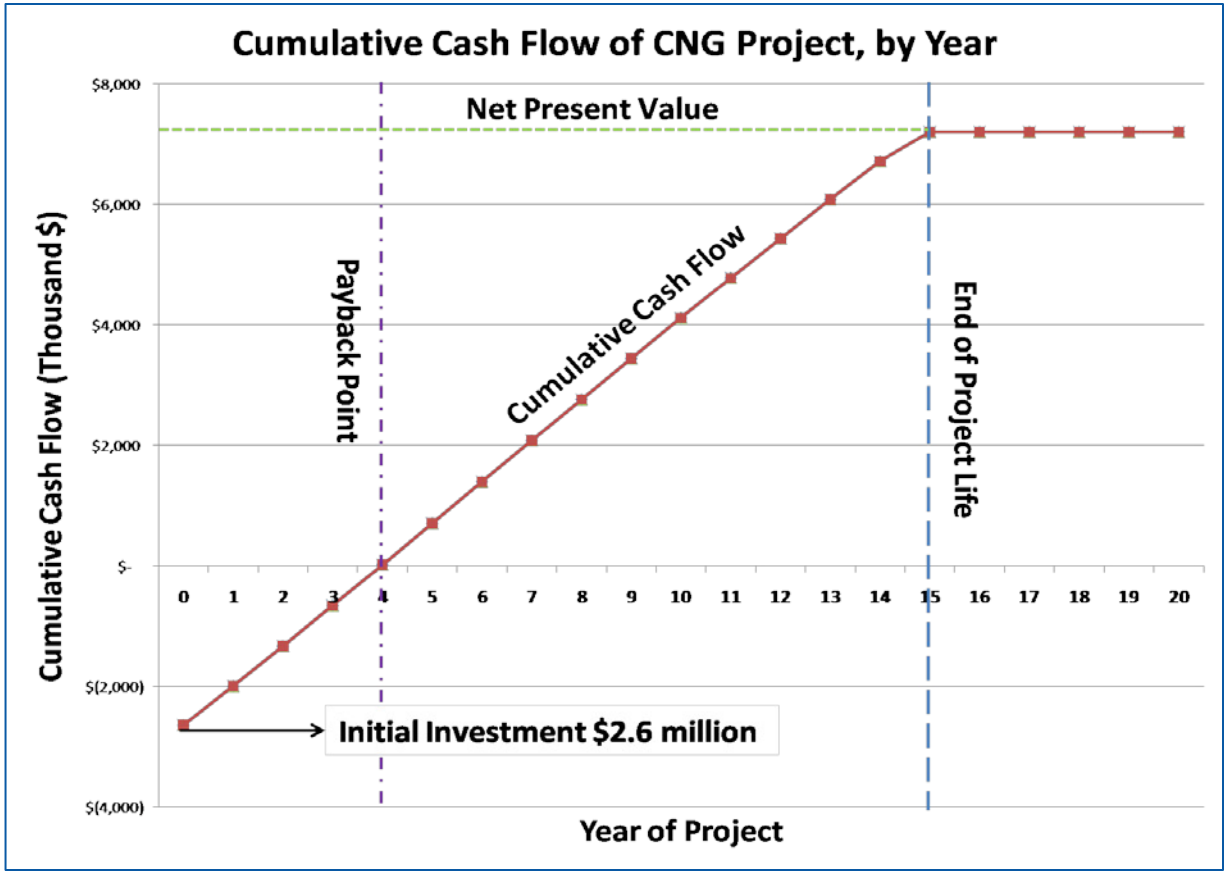
Assessing project profitability

- Look at discounted cash-flow of initial investment and future payback/savings
- Discount expenses and savings incurred in the future because money is worth more now than later (because you can invest it now)
- Discount rate is set at what you could make from alternative investments at similar risk

Discount Rate	6%										
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Annual Cash Flow	-$1,000,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000
Discount Factor	1.00	0.94	0.89	0.84	0.79	0.75	0.70	0.67	0.63	0.59	0.56
Discounted Cash Flow	-$1,000,000	$ 188,679	$ 177,999	$ 167,924	$ 158,419	$ 149,452	$ 140,992	$ 133,011	$ 125,482	$ 118,380	$ 111,679
Cumulative Cash Flow	-$1,000,000	-$811,321	- $633,321	-$465,398	-$306,979	-$157,527	-$16,535	$116,476	$241,959	$360,338	$472,017
NPV	$ 472,017	note: npv would be $1,000,000 if not discounted									

Assessing project profitability 2

- Most common metrics are payback period, net present value, or percent return on investment (ROI)
- ROI= discount rate when NPV=0



Vehicle and Infrastructure Cash-Flow Evaluation (VICE) Model

- Contrasts the cash flow for CNG infrastructure, vehicles, and fuel with that of a diesel fleet
- Determines discounted payback period, NPV, and ROI
- Assesses finances for transit, refuse, school fleets, and mixes thereof
- Discount rate for municipal governments is assumed to be 6% because that is what municipal bonds cost them
- Excel-based and I can send you a copy

VICE input/output screen shot

Cell Name	Value	Unit
Fleet_Inputs	1	1: Transit Buses
No_Vehicles	100	Vehicles
Tax_Incentive	80%	% of Inc_C
Realized_Incentive	$ 32,000	$
Inc_Cost	$ 18,502	$
CNG_Maint_Costs	$ 0.52	$/mile
CNG_Price	$ 1.18	$/DGE
CNG_Inflation	1.6%	% per yea
Excise_Tax_Credit	$ 0.55	$/DGE
Monthly_CNG_Use	97,288	DGE/month
Diesel_Maint	$ 0.52	$/mile
Diesel_Price	$ 2.56	$/gallon
Diesel_Inflation	5.6%	%/year
Diesel_tax_exempt	$ 0.38	$ per gallo
Monthly_diesel_used	89,924	gallons
ROR	6%	%
GGE_DGE_Conv	0.904	DGEs per
CNG_Station_Salv	20%	% of origin
Garage_Cost	$ -	
Hossler_Cost	$ 4,167	

80%		
$ 0.52		
$ 1.18		
1.6%		
$ 0.55		
$ 0.52		
$2.56		
5.6%		
$ 0.38		
6%		
0.904		
20%		
Y=(No_Vehicles*3750)+40000		
$ 4,167		

Scenario	Fleet Type	NPV	Payback Period
1	1: Transit Buses	$ 16,309,283	3.6
2	2: School Buses	$ 743,227	11.5
3	3: Trash Trucks	$ 11,033,736	2.6
4	4: 1/2 Transit, 1/2 School	$ 5,458,700	5.6
5	5: 1/2 Transit, 1/2 Trash	$ 14,356,471	2.9
6	6: 1/2 School, 1/2 Trash	$ 4,034,214	5.4
7	7: 1/3 Each	$ 6,769,920	4.4

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Scenario	Fleet Type	Avg. VMT	FE CNG (mpDGE)	FE Diesel	Efficiency Loss	Incremental Cost	Realized Fed Veh Incentive	Average Vehicle Life	Monthly CNG Use (DGE)	Station Cost	Monthly Maintenance Costs	Monthly Electricity Costs	Hosslers or Attendants Needed
1	Transit Buses	35,286	3.02	3.27	7.6%	$ 50,502	$ 32,000	15	97,288	$ 2,981,385	$ 17,114	$ 15,814	0
2	School Buses	12,000	6.13	7.00	12.5%	$ 31,376	$ 25,101	15	16,327	$ 1,328,252	$ 9,007	$ 2,323	0
3	Trash Trucks	25,000	2.51	2.80	10.5%	$ 30,295	$ 24,236	12	83,134	$ 2,282,750	$ 15,909	$ 11,395	0
4	1/2 Transit, 1/2 School	23,643	4.57	5.14	10.0%	$ 40,939	$ 28,550	15	43,078	$ 1,802,527	$ 12,012	$ 6,040	0
5	1/2 Transit, 1/2 Trash	30,143	2.76	3.04	9.0%	$ 40,399	$ 28,118	14	90,872	$ 2,375,523	$ 16,579	$ 14,861	0
6	1/2 School, 1/2 Trash	18,500	4.32	4.90	11.5%	$ 30,836	$ 24,668	14	35,724	$ 1,714,367	$ 11,218	$ 5,029	0
7	1/3 Each	24,095	3.88	4.36	10.2%	$ 37,391	$ 27,112	14	51,691	$ 1,905,796	$ 12,911	$ 7,213	0

Base Case- Fleet Parameters

- Base case is an average or common value
- Allows a benchmark from where we can test the effect of changing one parameter.

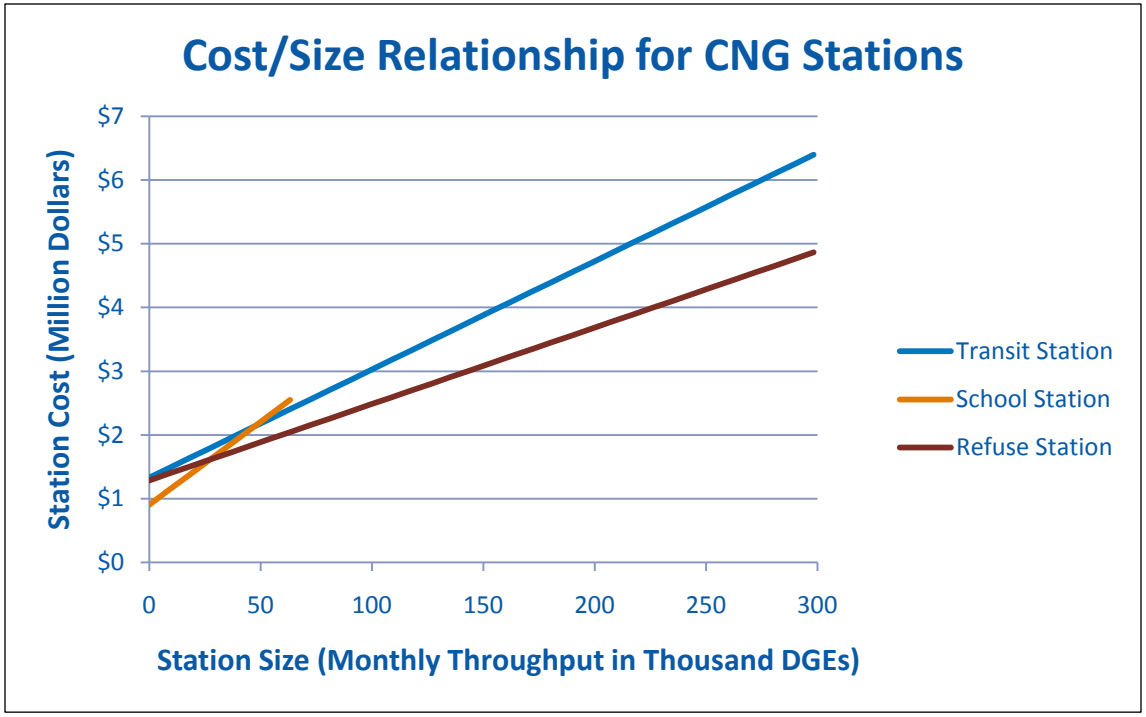
Seven modeled fleets and their parameters

Scen-ario	Fleet Type	Avg. VMT	FE Diesel (mpg)	FE CNG (mpDGE)	Incremental Cost	Vehicle Life
1	Transit Buses	35,286	3.27	3.02	$50,502	15
2	School Buses	12,000	7.00	6.13	$31,376	15
3	Refuse Trucks	25,000	2.80	2.51	$30,295	12
4	1/2 Transit, 1/2 School	23,643	5.14	4.57	$40,939	15
5	1/2 Transit, 1/2 Refuse	30,143	3.04	2.76	$40,399	14
6	1/2 School, 1/2 Refuse	18,500	4.90	4.32	$30,836	14
7	1/3 Each	24,095	4.36	3.88	$37,391	14

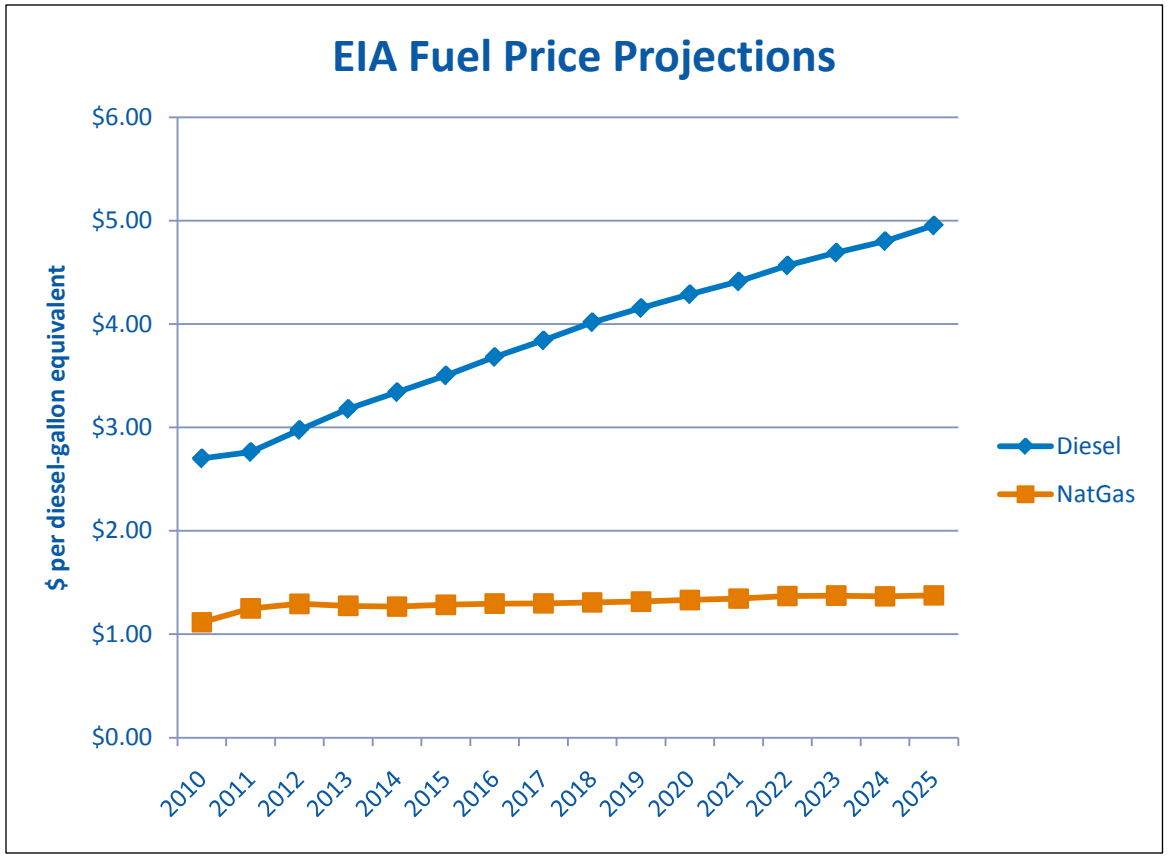
- Numerous data sources
  - Most published, a few from interviews
  - Tried to get multiple sources and take average
  - Mixed fleets are simply averaged

Base Case- Station Parameters

- Equations developed from Rob Adams' (Marathon Technical Services) cost calculator
- Replicates buffered fast-fill station
  - Applicable to time-fill scenarios because compression (not storage) is the bulk of the cost
- Fleets determine refueling window and expected throughput

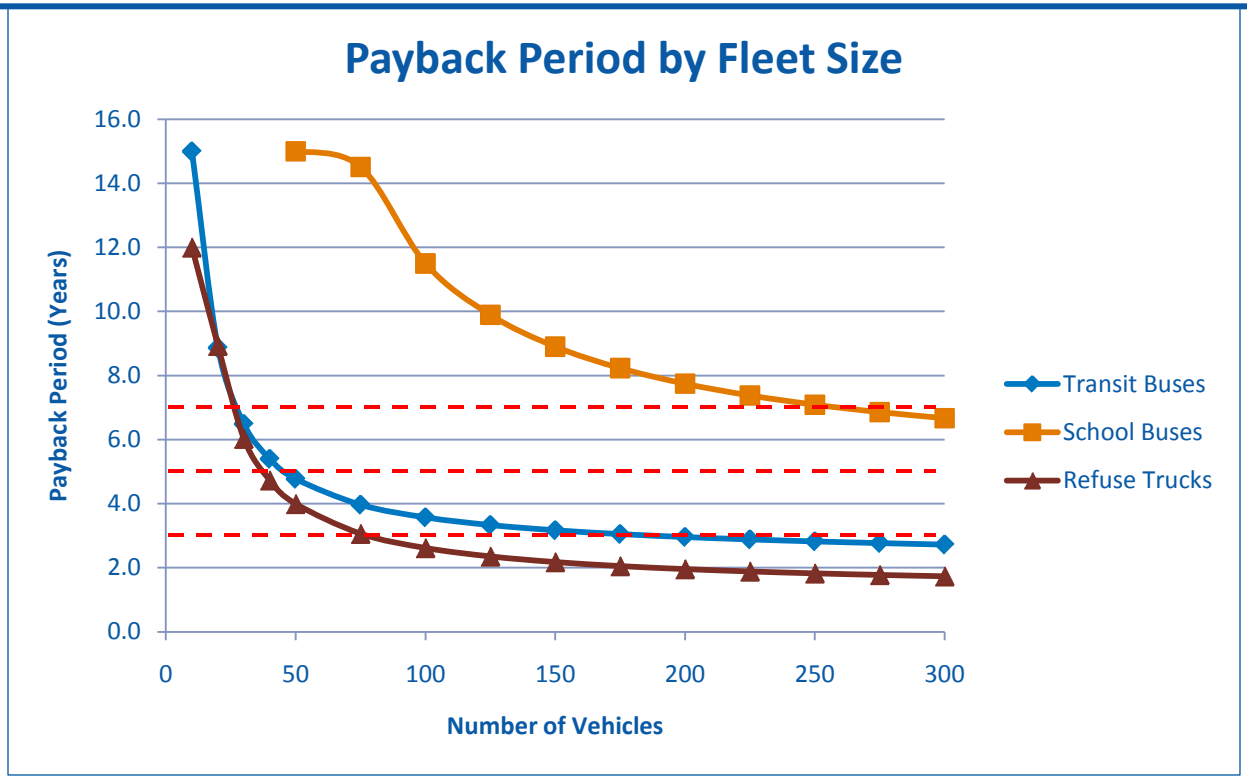


Base Case- Fuel Costs



- Savings from fuel costs are what pays back the investment in a station and vehicles
- Per-DGE saving increase further into the future

Profitability of Base Case



Minimum Number of Vehicles to Have a Positive NPV or 6% ROR

Type of Vehicle	# of Vehicles
Transit Buses	11
School Buses	68
Refuse Trucks	14
1/2 Transit, 1/2 School	26
1/2 Transit, 1/2 Refuse	12
1/2 School, 1/2 Refuse	32
1/3 Each	22

Using VICE to answer FAQ's

With the base case established, we can see what effect specific changes have on project profitability.

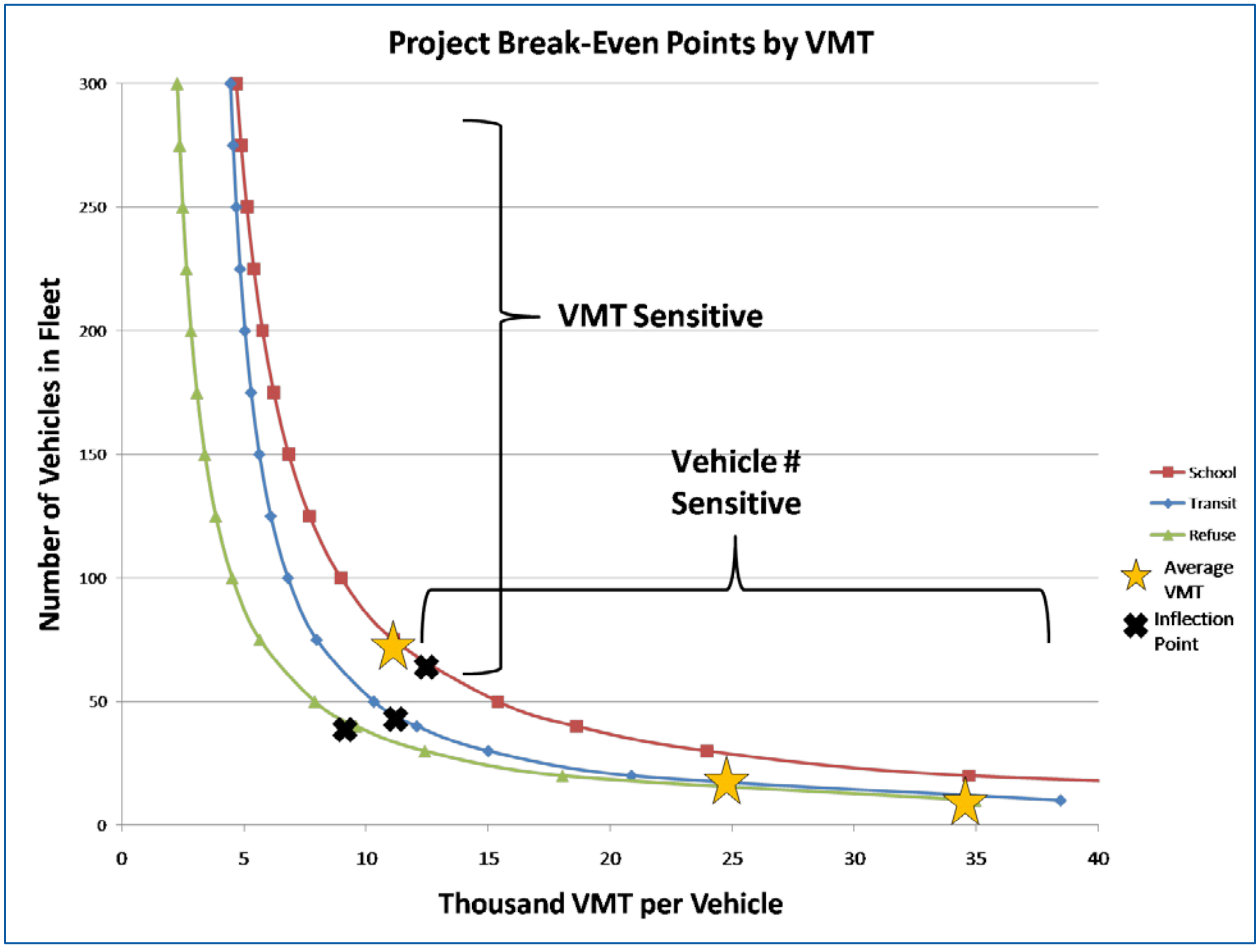
Most important question is wrapped up into all answers:

- How many vehicles do I need to make the project profitable?

Three question categories:

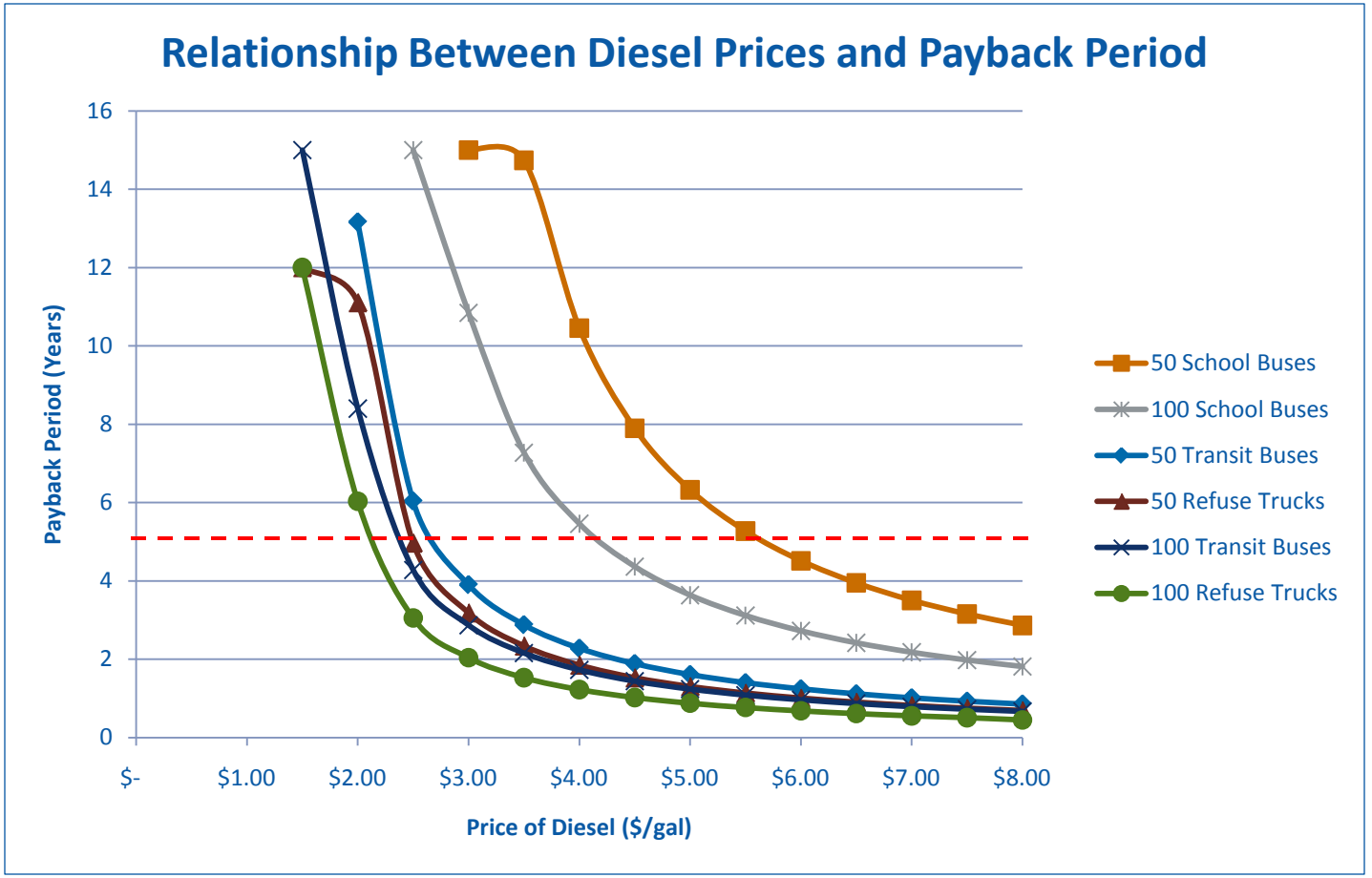
- Variations in fuel expenditures
- Changes in Upfront Costs
- Changes in Operating Costs

How many miles per year do I need to drive my vehicles to break even?

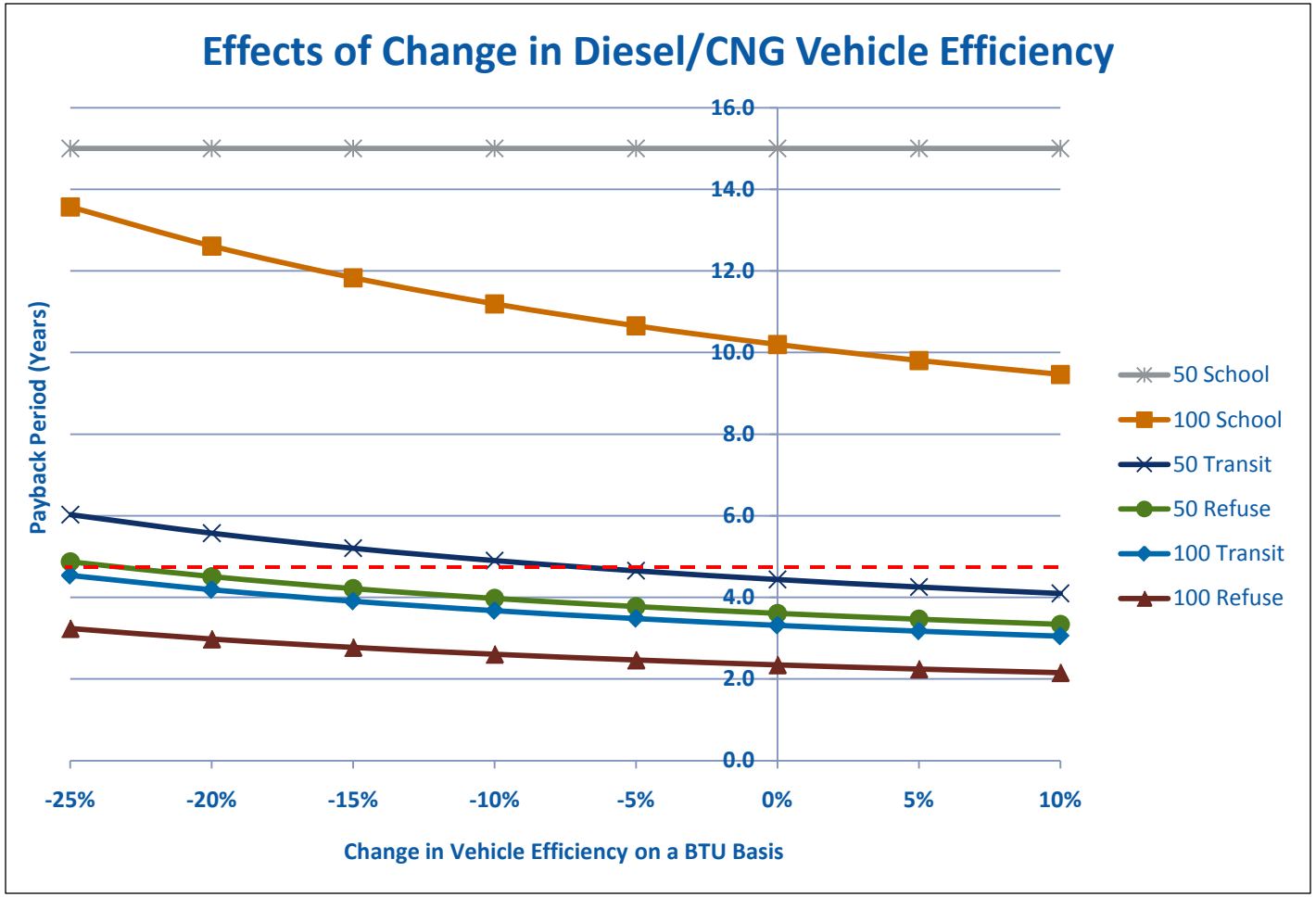


What if diesel prices change?

Great question, given the volatility of diesel prices



What happens as my vehicle efficiency changes?



Not much, except for in school buses

What if I don't get the tax incentives?

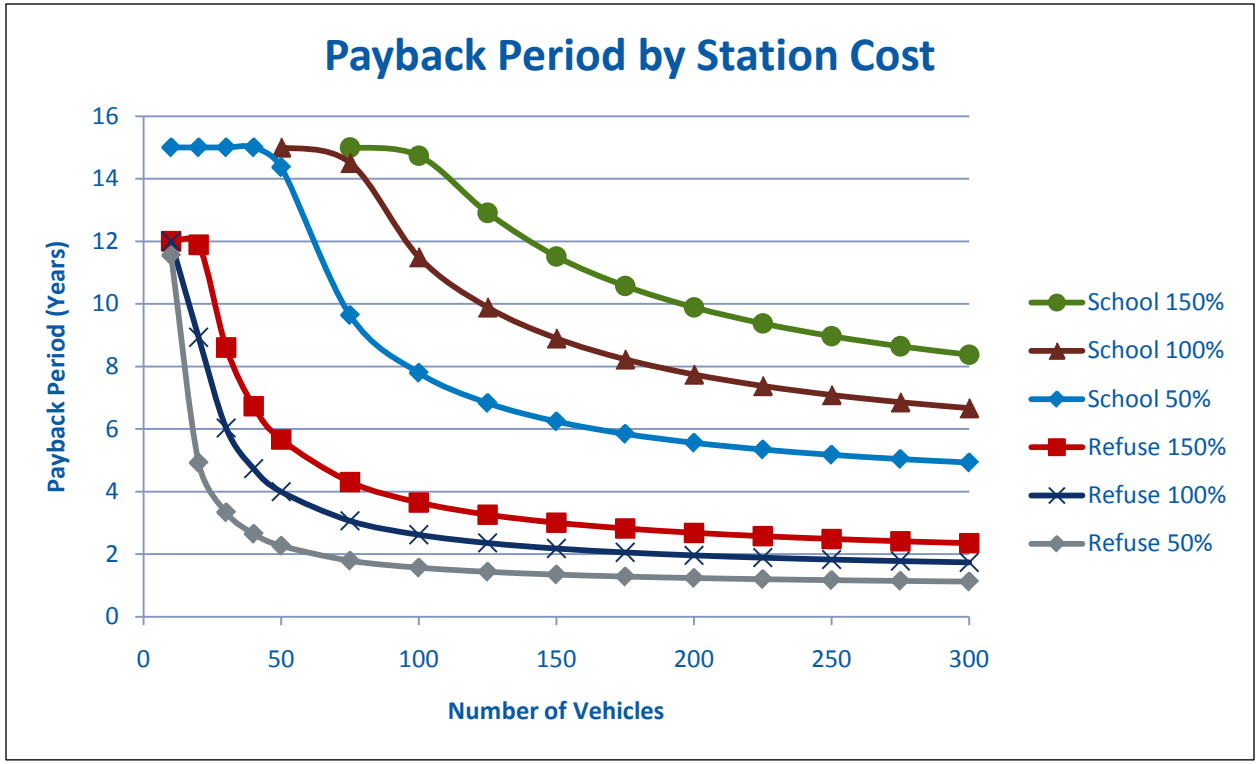
- Some of the tax incentives are under debate in Congress
- Tax incentives need to be passed along to municipal governments—an uncertain proposition

Payback Period (Years) with Various Tax Credits Missing

Fleet (100 Vehicles)	All Credits	No Fuel Credit	No Vehicle Credit	No Station Credit	No Credits
Transit Buses	3.6	5.9	5.5	3.6	9.1
School Buses	11.5	≥15.0	≥15.0	11.8	≥15.0
Refuse Trucks	2.6	4.6	4.8	2.7	7.8

- Station tax credit ($50K) doesn't matter much
- Fuel ($0.55/gal diesel) and vehicle (≤$32K/vehicle) credits make a big difference
  - Fuel credit matters most for transit buses
  - Vehicle credit matters most for refuse trucks
- There are synergies between the three credits

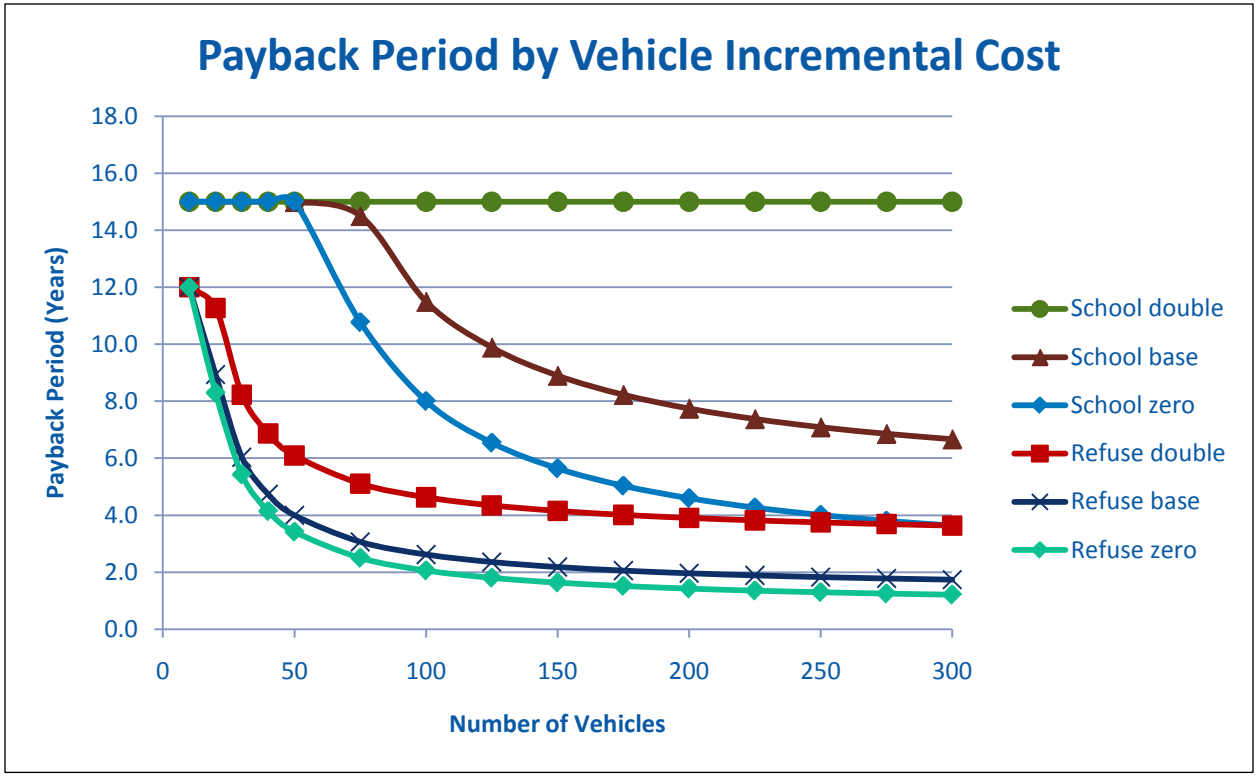
What happens if the price of my station changes?



Big difference for refuse/transit fleets less than 75 vehicles

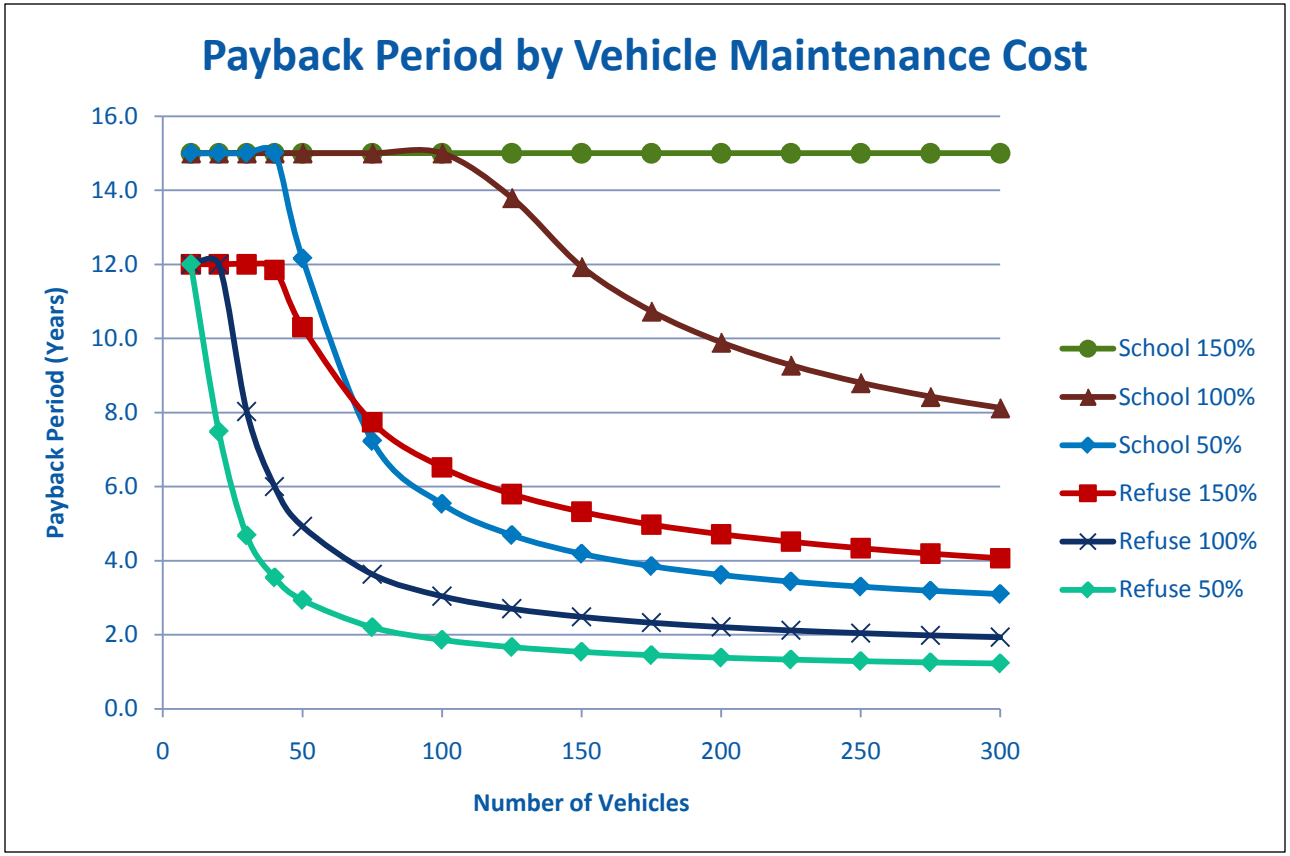
Can bring school fleets to a reasonable payback period

What happens as my vehicle incremental cost changes?



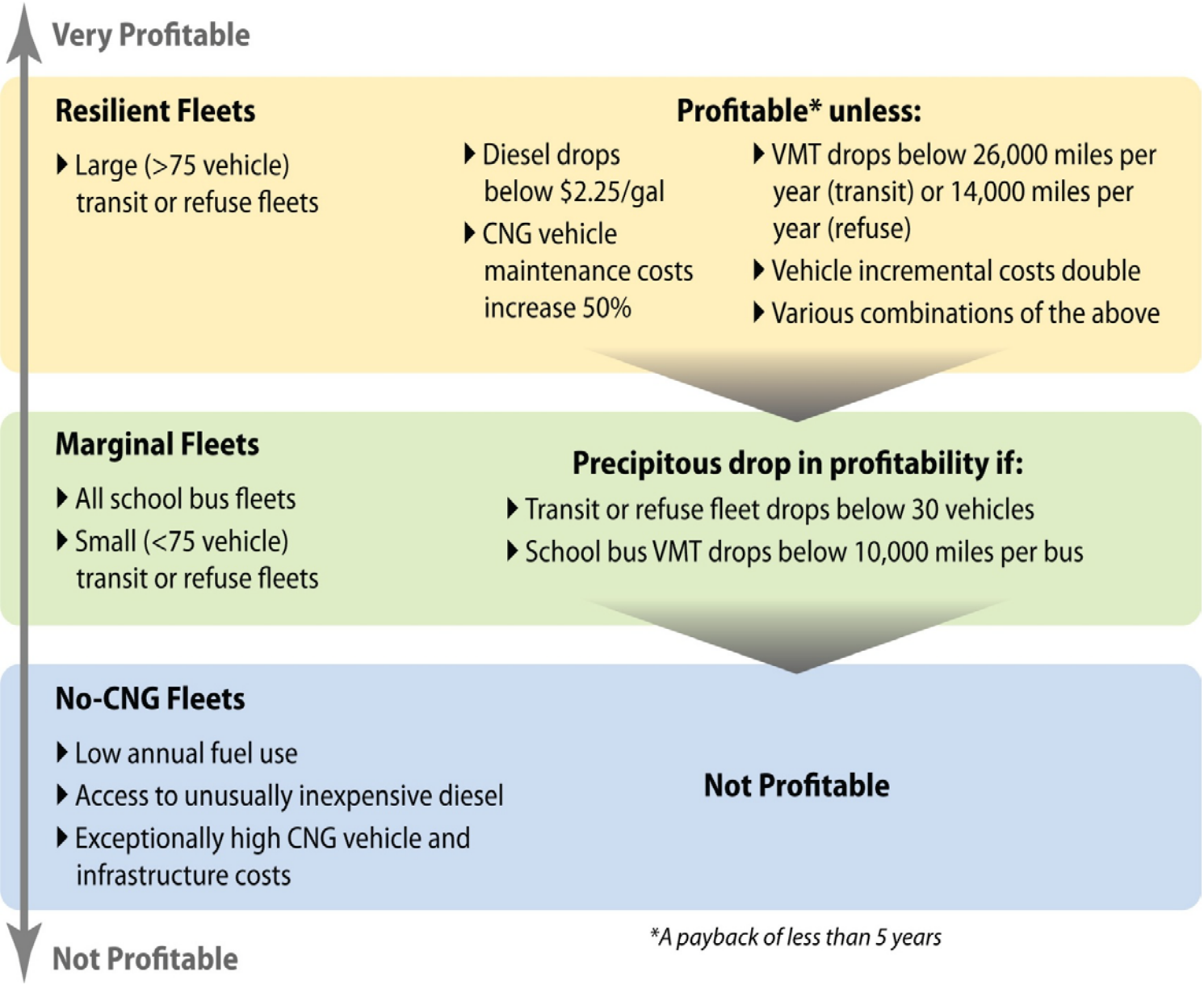
- Grants effectively reduce the incremental cost
- Asymmetrical changes because subsidy covers most of difference between zero and base case

What happens if my vehicle maintenance costs change?



- Both CNG and diesel maintenance costs start at $0.50 per mile
- Asymmetrical—reducing CNG maintenance costs is more important if it is more expensive than diesel to begin with
- Can make school bus fleet profitable

Conclusion


Very Profitable
Resilient Fleets
Large (>75 vehicle) transit or refuse fleets
Profitable* unless:
Diesel drops below $2.25/gal
CNG vehicle maintenance costs increase 50%
VMT drops below 26,000 miles per year (transit) or 14,000 miles per year (refuse)
Vehicle incremental costs double
Various combinations of the above
Marginal Fleets
All school bus fleets
Small (<75 vehicle) transit or refuse fleets
Precipitous drop in profitability if:
Transit or refuse fleet drops below 30 vehicles
School bus VMT drops below 10,000 miles per bus
No-CNG Fleets
Low annual fuel use
Access to unusually inexpensive diesel
Exceptionally high CNG vehicle and infrastructure costs
Not Profitable
Not Profitable
*A payback of less than 5 years

Questions

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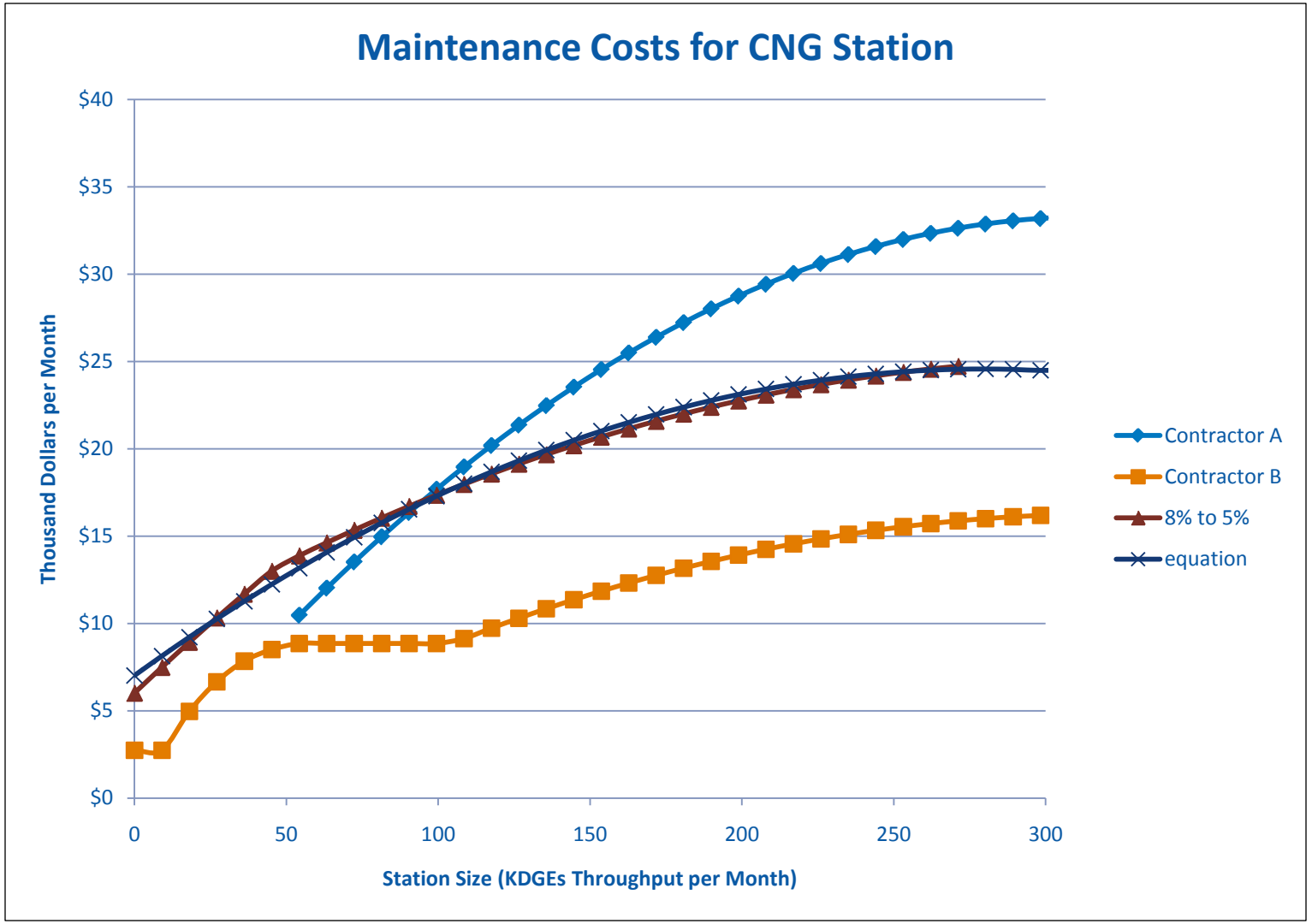
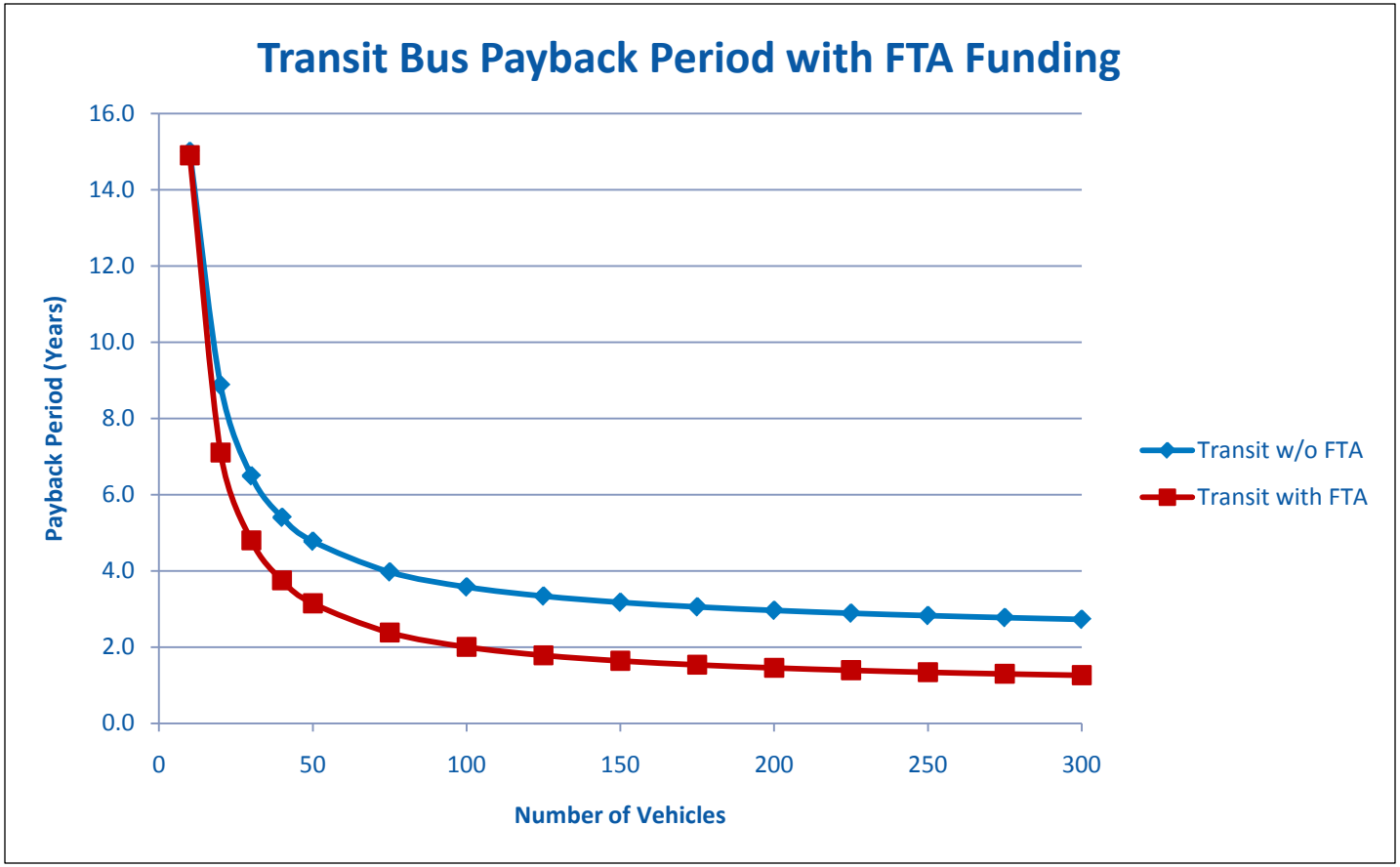
Business Case for CNG in Municipal Fleets report at:
www.afdc.energy.gov/afdc/pdfs/47919.pdf

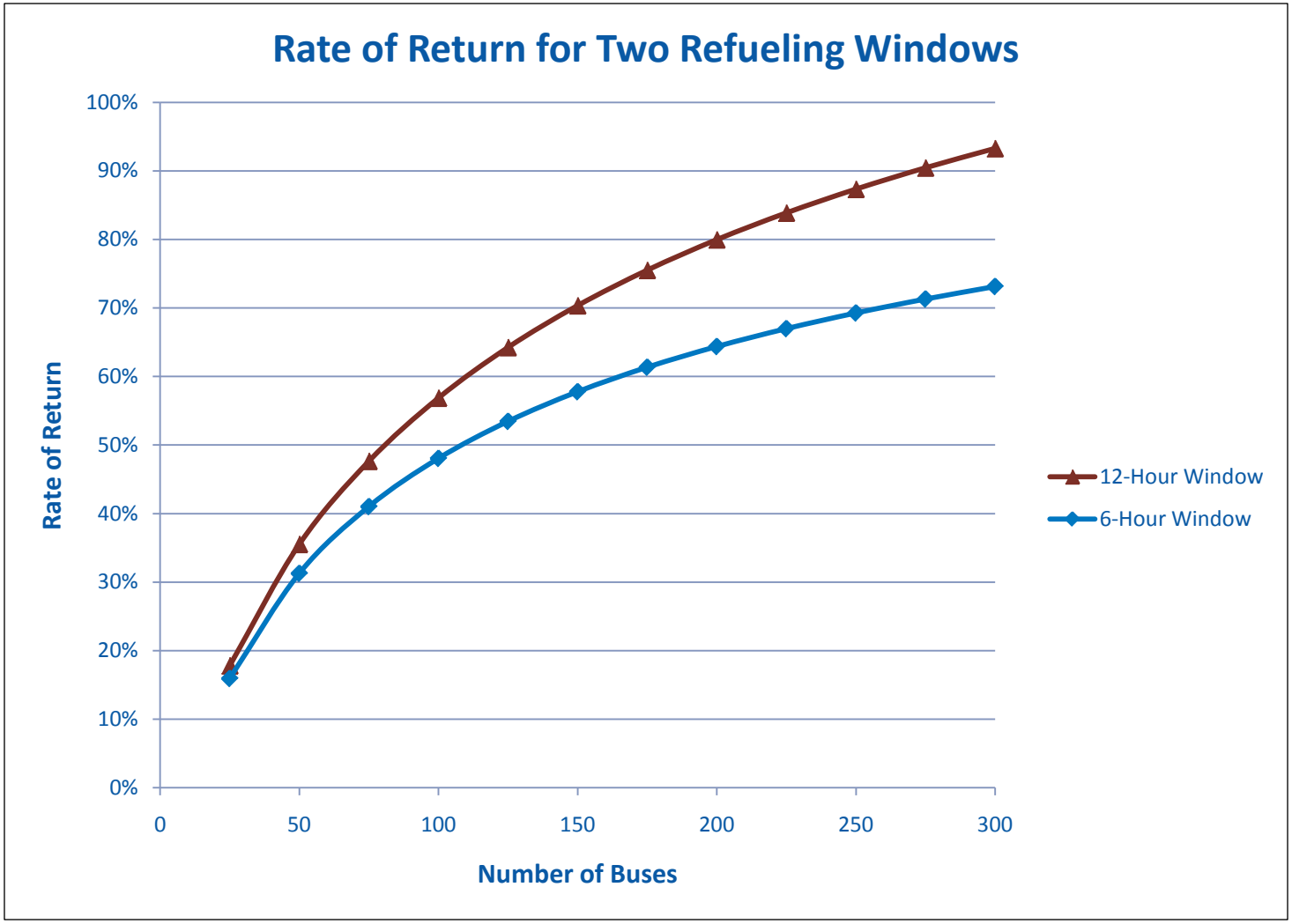
Supplemental Slides

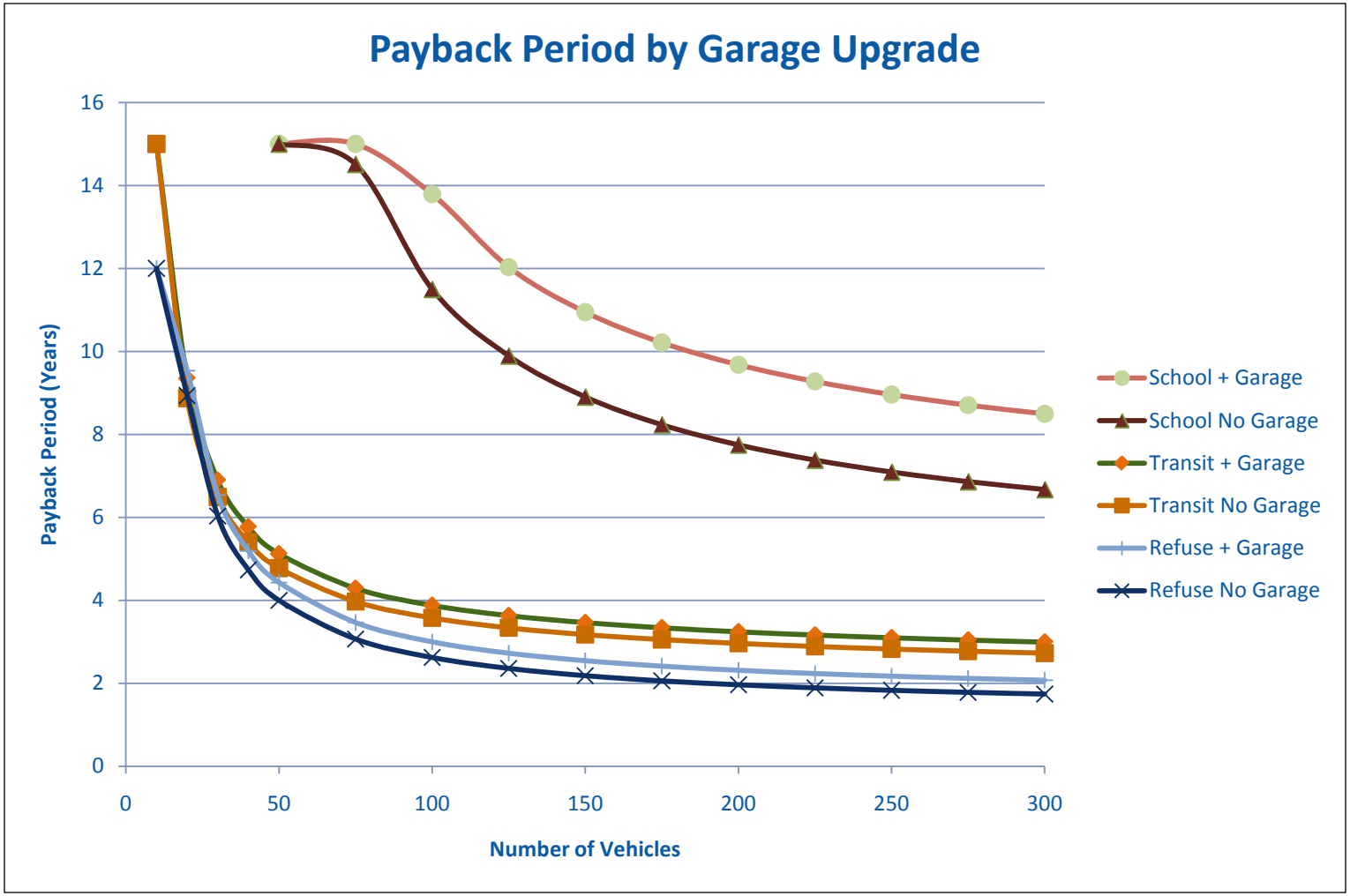

Maintenance Costs for CNG Station
$40
$35
$30
$25
$20
$15
$10
$5
$0
Thousand Dollars per Month
0
50
100
150
200
250
300
Station Size (KDGEs Throughput per Month)
Contractor A
Contractor B
8% to 5%
equation

What if I receive an FTA grant?



- FTA can pay for 80% of a diesel bus or 83% of a CNG bus


Rate of Return for Two Refueling Windows
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Rate of Return
0
50
100
150
200
250
300
Number of Buses
12-Hour Window
6-Hour Window


Payback Period by Garage Upgrade
Payback Period (Years)
16
14
12
10
8
6
4
2
0
0
50
100
150
200
250
300
Number of Vehicles
School + Garage
School No Garage
Transit + Garage
Transit No Garage
Refuse + Garage
Refuse No Garage