ERC Project Assessment Documentation: Repowering Commercial Boats with Higher Tier Engines

NOx **11/26/2013**

Project Name	ERC Cost Effectiveness ($/Ton in $1,000s)	Total Emissions Inventory (tons/year)	Incentive Funding	Reductions Per Avg Project (lbs/yr)	District Avg Cost/ Project	Project Life (yrs)
Commercial Fishing Tier 0 to Tier 3 Repower	$157	23.30	80% or ~$194/hp	1,600.41	$62,764	15
Commercial Fishing Tier 1 to Tier 3 Repower	$413	13.38	80% or ~$194/hp	608.12	$62,764	15
Commercial Fishing Tier 2	$1,227	9.34	80% or ~$194/hp	204.64	$62,764	15
Charter Fishing Tier 1 to Tier 3 Repower	$194	9.62	80% or ~$194/hp	4,373.10	$211,771	15
Charter Fishing Tier 2 to Tier 3 Repower	$576	6.72	80% or ~$194/hp	1,471.58	$211,771	15
Other Commercial Tier 2 to Tier 3 Repower	$724	4.41	80% or ~$194/hp avg	966.61	$174,857	15

ROC

Commercial Fishing Tier 0 to Tier 3 Repower	$347,954	1.31	80% or ~$194/hp	0.72	$62,764	15
Commercial Fishing Tier 1 to Tier 3 Repower	No reduction	1.12	80% or ~$194/hp	0.00	$62,764	15
Commercial Fishing Tier 2	No reduction	1.12	80% or ~$194/hp	0.00	$62,764	15
Charter Fishing Tier 1 to Tier 3 Repower	No reduction	0.81	80% or ~$194/hp	0.00	$211,771	15
Charter Fishing Tier 2 to Tier 3 Repower	No reduction	0.81	80% or ~$194/hp	0.00	$211,771	15
Other Commercial Tier 2 to Tier 3 Repower	No reduction	0.53	80% or ~$194/hp avg	0.00	$174,857	15

PM

Commercial Fishing Tier 0 to Tier 3 Repower	$44,857	0.73	80% or ~$194/hp	5.60	$62,764	15
Commercial Fishing Tier 1 to Tier 3 Repower	$150,866	0.49	80% or ~$194/hp	1.66	$62,764	15
Commercial Fishing Tier 2	$776,813	0.23	80% or ~$194/hp	0.32	$62,764	15
Charter Fishing Tier 1 to Tier 3 Repower	$460,125	0.35	80% or ~$194/hp	1.84	$211,771	15
Charter Fishing Tier 2 to Tier 3 Repower	$2,369,200	0.17	80% or ~$194/hp	0.36	$211,771	15
Other Commercial Tier 2 to Tier 3 Repower	$2,175,317	0.11	80% or ~$194/hp avg	0.32	$174,857	15

Marine Vessel Repower Emission Reduction Estimates and Costs

Total Emissions

The first step in estimating emissions from commercial boats was to estimate the number of boats by type that operate out of the Santa Barbara harbor.

Commercial boat owners must submit detailed information to ARB (Harbor Craft Regulation) and to Fish and Game (commercial fishing boats). Unfortunately due to confidentiality issues we were unable to obtain this information.

We therefore contacted the Santa Barbara Harbor Master (Mr. Mick Kronman). He indicated that approximately 60 commercial fishing vessels operate out of the harbor. For charter fishing and whale watching he directed us to Mr. Chris Callahan of the Sea Landing. Mr. Callahan said there are 4 party type fishing boats (Truth, Conception, Vision, and Stardust) and two other commercial vessels (Condor Express - whale watching, and DannyC tug/supply vessel) that operate out of the harbor.

For the commercial/charter fishing vessels we assumed 1/3 would have Tier 0 engines, 1/3 would have Tier 1 engines, and 1/3 would have Tier 2 engines. The two other vessels are subject to the harbor craft regulation and required to have Tier 2 engines.

Emissions were calculate per pollutant by:

TE = B X HP X LF X HRs X EF /454
Where

B = no of boats by Tier (0, 1, or 2) or type (commercial fishing, charter fishing, other commercial)
HP = avg hp for that boat type
LF = average engine load for that boat type
HRs = hours per engine for that boat type
EF = emission factor in grams/bhp-hr for that engine size and tier.

These data are give below.

Boat Type	No.	Avg HP	Load	Hrs/Year	NOx Emissions g/bhp-hr	ROC Emissions g/bhp-hr	PM Emissions g/bhp-hr
Commercial Fishing Tier 0	20	323	0.27	1005	12.07	0.68	0.376
Commercial Fishing Tier 1	20	323	0.27	1005	6.93	0.58	0.255
Commercial Fishing Tier 2	20	323	0.27	1005	4.84	0.58	0.12
Charter Fishing Tier 1	2	1090	0.52	1112	6.93	0.58	0.255
Charter Fishing Tier 2	2	1090	0.52	1112	4.84	0.58	0.12
Other Commercial Tier 2	2	900	0.46	1000	4.84	0.58	0.12

References:

Load and emission rates from 2011 Carl Moyer Guidance, ARB, Appendix D, Tables D-19a and b.
Avg hp and hours per year from SBCAPCD Carl Moyer Program application files.
Note that the load for the other commercial was the avg of excursion (0.42) and tug (0.5)

Boat Type	NOx Emissions lbs/year	ROC Emissions lbs/year	PM Emissions lbs/year	NOx Emissions tons/year	ROC Emissions tons/year	PM Emissions tons/year
Commercial Fishing Tier 0	46,603	2,626	1,452	23.30	1.31	0.73
Commercial Fishing Tier 1	26,757	2,239	985	13.38	1.12	0.49
Commercial Fishing Tier 2	18,688	2,239	463	9.34	1.12	0.23
Charter Fishing Tier 1	19,242	1,610	708	9.62	0.81	0.35
Charter Fishing Tier 2	13,439	1,610	333	6.72	0.81	0.17
Other Commercial Tier 2	8,827	1,058	219	4.41	0.53	0.11
Total	133,555	11,383	4,160	66.78	5.69	2.08

Incentive Funding

It was difficult to estimate total project cost from SBCAPCD Moyer files because it appears the program covered only engine and not labor and other costs. ArrowTek worked with boat yards in the Los Angeles area and has access to full repower costs for charter fishing vessels.

Cost data from repowers completed for charter boats at Newport Beach.

Cost of engine, gear (transmission), misc parts, and labor per 350 hp engine:	$85,000
Boat Owner cost share (20%) - assume this is sufficient for participation.	$17,000
Net cost per engine repower	$68,000
Net cost per hp	**$194**

Incentive funding would therefore be

Boat Type	Avg HP	Funding/ Boat
Commercial Fishing Tier 0 to Tier 3	323	$62,754
Commercial Fishing Tier 1 to Tier 3	323	$62,754
Commercial Fishing Tier 2 to Tier 3	323	$62,754
Charter Fishing Tier 1 to Tier 3	1090	$211,771
Charter Fishing Tier 2 to Tier 3	1090	$211,771
Other Commercial Tier 2 to Tier 3	900	$174,857

Reductions Per Boat

Emission reductions per boat were calculated using the formula given under Total Emissions above, except the emission factor was replace with the: base factor minus new factor.

Boat Type	Base NOx Emissions g/bhp-hr	Base ROC Emissions g/bhp-hr	Base PM Emissions g/bhp-hr	Tier 3 NOx Emissions g/bhp-hr	Tier 3 ROC Emissions g/bhp-hr	Tier 3 PM Emissions g/bhp-hr	NOx Emissions lbs/boat/ year	ROC Emissions lbs/boat/ year	PM Emissions lbs/boat/ year
Commercial Fishing Tier 0 to Tier 3	12.07	0.68	0.376	3.78	0.58	0.068	1,600.4	0.7	5.6
Commercial Fishing Tier 1 to Tier 3	6.93	0.58	0.255	3.78	0.58	0.068	608.1	0.0	1.7
Commercial Fishing Tier 2 to Tier 3	4.84	0.58	0.12	3.78	0.58	0.068	204.6	0.0	0.3
Charter Fishing Tier 1 to Tier 3	6.93	0.58	0.255	3.78	0.58	0.068	4,373.1	0.0	1.8
Charter Fishing Tier 2 to Tier 3	4.84	0.58	0.12	3.78	0.58	0.068	1,471.6	0.0	0.4
Other Commercial Tier 2 to Tier 3	4.84	0.58	0.12	3.78	0.58	0.068	966.6	0.0	0.3

District Cost Per Project

District cost per project was given above under Incentive Funding

Project Life

The Carl Moyer program guidance allows a maximum of 16 year project life for marine vessel projects (2011 Carl Moyer Program Guidance Chapter 12, ARB). For this program we assumed 15 years. Note that fishing boats are exempt from the ARB 's harbor craft regulation, which requires other type of commercial craft meet Tier 2 engine standards.

ERC Cost Effectiveness ($/Ton in $1,000s)

ERC cost effectiveness is emission reductions/yr or 30 years divided by total SBCAPCD incentive required to generate those 30 years of annual reductions.

As indicated we assumed a project life of 15 years, which implies one half of each class of boats would be done during each incentive funding cycle. So the emission reductions over 30 years would be:

Boat Type	No. Boats	No Boats/15 yr cycle	NOx reductions per 15 yr cycle in tons/yr	ROC reductions per 15 yr cycle in tons/yr	PM reductions per 15 yr cycle in tons/yr
Commercial Fishing Tier 0 to Tier 3	20	10	8.00	0.00	0.03
Commercial Fishing Tier 1 to Tier 3	20	10	3.04	0.00	0.01
Commercial Fishing Tier 2 to Tier 3	20	10	1.02	0.00	0.00
Charter Fishing Tier 1 to Tier 3	2	1	2.19	0.00	0.00
Charter Fishing Tier 2 to Tier 3	2	1	0.74	0.00	0.00
Other Commercial Tier 2 to Tier 3	2	1	0.48	0.00	0.00

the total ERC costs and cost effectiveness would be:

Boat Type	No. Boats	No Boats/15 yr cycle	Total Cost in $1,000s	NOx ERC Cost/ton ($1,000s)	ROC ERC Cost/ton ($1,000s)	PM ERC Cost/ton ($1,000s)
Commercial Fishing Tier 0 to Tier 3	20	$62,754	$1,255	$157	$347,954	$44,857
Commercial Fishing Tier 1 to Tier 3	20	$62,754	$1,255	$413	No reduction	$150,866
Commercial Fishing Tier 2 to Tier 3	20	$62,754	$1,255	$1,227	No reduction	$776,813
Charter Fishing Tier 1 to Tier 3	2	$211,771	$424	$194	No reduction	$460,125
Charter Fishing Tier 2 to Tier 3	2	$211,771	$424	$576	No reduction	$2,369,200
Other Commercial Tier 2 to Tier 3	2	$174,857	$350	$724	No reduction	$2,175,317