

Appendix D - Benefits and Costs of Applying PTC (Tables)

This appendix calculates the benefits and costs, discounted over a twenty year period, of applying PTC to the entire systems of the five largest railroads existing at the time this analysis was prepared. Since this analysis was prepared, one of the five railroads, Conrail, has been absorbed into two of the other railroads analyzed, NS and CSXT. The Conrail merger should not affect greatly these results, since most of its operations will continue. The five (now four) largest railroads account for a large part of nationwide freight operations, so it is illuminating to see what it would cost to implement PTC on them, and what benefits would flow from such an implementation. That is not to say that it would be realistic to implement PTC on all lines of those railroads. What follows is for illustrative purposes.

The following analysis relies on a few basic assumptions. One is that maintenance of a system would cost ten percent of its purchase cost every year after the initial year. In this analysis all benefits and costs are attributed to the midpoint of the year, so even year one figures are discounted by the square root of 1 plus the discount rate. The discount rate is assumed to be seven percent.

Appendix D - Benefits and Costs of Applying PTC (Tables)

Twenty Year Discounted Cost of PPA's (level 4, including maybes)

Discount factor 7.00%

Cost per PPA \$752,278

PPA's in 8 years (Level 4 y & m) 819

PPA's per year (Level 4 y & m) 102.375

PPA cost/year \$77,014,460

Year	Annual Benefit	Discount Factor	Annual	Cumulative
			Discounted Benefit	Discounted Benefit
1	\$77,014,460	0.97	\$74,452,689	\$74,452,689
2	\$77,014,460	0.90	\$69,581,952	\$144,034,641
3	\$77,014,460	0.84	\$65,029,862	\$209,064,503
4	\$77,014,460	0.79	\$60,775,572	\$269,840,075
5	\$77,014,460	0.74	\$56,799,600	\$326,639,675
6	\$77,014,460	0.69	\$53,083,738	\$379,723,413
7	\$77,014,460	0.64	\$49,610,970	\$429,334,383
8	\$77,014,460	0.60	\$46,365,393	\$475,699,776
9	\$77,014,460	0.56	\$43,332,143	\$519,031,919
10	\$77,014,460	0.53	\$40,497,330	\$559,529,249
11	\$77,014,460	0.49	\$37,847,972	\$597,377,220
12	\$77,014,460	0.46	\$35,371,936	\$632,749,157
13	\$77,014,460	0.43	\$33,057,884	\$665,807,041
14	\$77,014,460	0.40	\$30,895,219	\$696,702,260
15	\$77,014,460	0.37	\$28,874,036	\$725,576,296
16	\$77,014,460	0.35	\$26,985,081	\$752,561,377
17	\$77,014,460	0.33	\$25,219,702	\$777,781,079
18	\$77,014,460	0.31	\$23,569,815	\$801,350,893
19	\$77,014,460	0.29	\$22,027,864	\$823,378,757
20	\$77,014,460	0.27	\$20,586,789	\$843,965,546

Appendix D - Benefits and Costs of Applying PTC (Tables)

Twenty Year Discounted Cost of PPA's (level 4, excluding maybes)

Discount factor 7.00%

Cost per PPA \$717,537

PPA's in 8 years (Level 4 y) 565

PPA's per year (Level 4 y) 70.625

PPA cost/year \$50,676,051

Year	Annual Benefit	Discount Factor	Annual	Cumulative
			Discounted Benefit	Discounted Benefit
1	\$50,676,051	0.97	\$48,990,387	\$48,990,387
2	\$50,676,051	0.90	\$45,785,409	\$94,775,796
3	\$50,676,051	0.84	\$42,790,102	\$137,565,897
4	\$50,676,051	0.79	\$39,990,749	\$177,556,647
5	\$50,676,051	0.74	\$37,374,532	\$214,931,178
6	\$50,676,051	0.69	\$34,929,469	\$249,860,647
7	\$50,676,051	0.64	\$32,644,364	\$282,505,011
8	\$50,676,051	0.60	\$30,508,751	\$313,013,762
9	\$50,676,051	0.56	\$28,512,851	\$341,526,614
10	\$50,676,051	0.53	\$26,647,525	\$368,174,138
11	\$50,676,051	0.49	\$24,904,229	\$393,078,367
12	\$50,676,051	0.46	\$23,274,980	\$416,353,347
13	\$50,676,051	0.43	\$21,752,318	\$438,105,665
14	\$50,676,051	0.40	\$20,329,269	\$458,434,934
15	\$50,676,051	0.37	\$18,999,317	\$477,434,251
16	\$50,676,051	0.35	\$17,756,371	\$495,190,622
17	\$50,676,051	0.33	\$16,594,739	\$511,785,361
18	\$50,676,051	0.31	\$15,509,102	\$527,294,463
19	\$50,676,051	0.29	\$14,494,488	\$541,788,950
20	\$50,676,051	0.27	\$13,546,250	\$555,335,201

Appendix D - Benefits and Costs of Applying PTC (Tables)

Cost of PTC Level 4 System

Initial Cost \$3,965,899,120

Maintenance Cost (%) 10.00%

Maintenance Cost (\$) \$396,589,912

Discount rate 7.00%

Year	Annual Cost	Discount Factor	Annual Discounted Cost	Cumulative Discounted Cost
1	\$3,965,899,120	0.97	\$3,833,979,391	\$3,833,979,391
2	\$396,589,912	0.90	\$358,315,831	\$4,192,295,222
3	\$396,589,912	0.84	\$334,874,608	\$4,527,169,830
4	\$396,589,912	0.79	\$312,966,924	\$4,840,136,754
5	\$396,589,912	0.74	\$292,492,452	\$5,132,629,206
6	\$396,589,912	0.69	\$273,357,432	\$5,405,986,638
7	\$396,589,912	0.64	\$255,474,235	\$5,661,460,873
8	\$396,589,912	0.60	\$238,760,968	\$5,900,221,841
9	\$396,589,912	0.56	\$223,141,091	\$6,123,362,932
10	\$396,589,912	0.53	\$208,543,076	\$6,331,906,008
11	\$396,589,912	0.49	\$194,900,071	\$6,526,806,079
12	\$396,589,912	0.46	\$182,149,599	\$6,708,955,678
13	\$396,589,912	0.43	\$170,233,270	\$6,879,188,948
14	\$396,589,912	0.40	\$159,096,514	\$7,038,285,462
15	\$396,589,912	0.37	\$148,688,331	\$7,186,973,793
16	\$396,589,912	0.35	\$138,961,057	\$7,325,934,850
17	\$396,589,912	0.33	\$129,870,147	\$7,455,804,997
18	\$396,589,912	0.31	\$121,373,969	\$7,577,178,966
19	\$396,589,912	0.29	\$113,433,616	\$7,690,612,582
20	\$396,589,912	0.27	\$106,012,725	\$7,796,625,307

20- Year discounted:

	Benefit/Cost ratio
Cost	\$7,796,625,307
Benefit (y & m)	\$843,965,546 0.11

Appendix D - Benefits and Costs of Applying PTC (Tables)

Benefit (y only) \$555,335,201 0.07

Appendix D - Benefits and Costs of Applying PTC (Tables)

Twenty Year Discounted Cost of PPA's (level 3, including maybes)

Discount factor 7.00%

Cost per PPA \$725,203

PPA's in 8 years (Level 3 y & m) 543

PPA's per year (Level 3 y & m) 67.875

PPA cost/year \$49,223,154

Year	Annual Benefit	Discount Factor	Annual	Cumulative
			Discounted Benefit	Discounted Benefit
1	\$49,223,154	0.97	\$47,585,819	\$47,585,819
2	\$49,223,154	0.90	\$44,472,728	\$92,058,546
3	\$49,223,154	0.84	\$41,563,297	\$133,621,843
4	\$49,223,154	0.79	\$38,844,203	\$172,466,046
5	\$49,223,154	0.74	\$36,302,993	\$208,769,040
6	\$49,223,154	0.69	\$33,928,031	\$242,697,071
7	\$49,223,154	0.64	\$31,708,440	\$274,405,511
8	\$49,223,154	0.60	\$29,634,056	\$304,039,567
9	\$49,223,154	0.56	\$27,695,380	\$331,734,947
10	\$49,223,154	0.53	\$25,883,532	\$357,618,479
11	\$49,223,154	0.49	\$24,190,217	\$381,808,697
12	\$49,223,154	0.46	\$22,607,680	\$404,416,376
13	\$49,223,154	0.43	\$21,128,673	\$425,545,049
14	\$49,223,154	0.40	\$19,746,423	\$445,291,472
15	\$49,223,154	0.37	\$18,454,601	\$463,746,073
16	\$49,223,154	0.35	\$17,247,291	\$480,993,363
17	\$49,223,154	0.33	\$16,118,963	\$497,112,327
18	\$49,223,154	0.31	\$15,064,452	\$512,176,778
19	\$49,223,154	0.29	\$14,078,927	\$526,255,705
20	\$49,223,154	0.27	\$13,157,875	\$539,413,580

Appendix D - Benefits and Costs of Applying PTC (Tables)

Twenty Year Discounted Cost of PPA's (level 3, excluding maybes)

Discount factor 7.00%

Cost per PPA \$760,946

PPA's in 8 years (Level 3 y) 512

PPA's per year (Level 3 y) 64

PPA cost/year \$48,700,544

Year	Annual Benefit	Discount Factor	Annual	Cumulative
			Discounted Benefit	Discounted Benefit
1	\$48,700,544	0.97	\$47,080,593	\$47,080,593
2	\$48,700,544	0.90	\$44,000,554	\$91,081,147
3	\$48,700,544	0.84	\$41,122,013	\$132,203,160
4	\$48,700,544	0.79	\$38,431,788	\$170,634,948
5	\$48,700,544	0.74	\$35,917,559	\$206,552,507
6	\$48,700,544	0.69	\$33,567,812	\$240,120,319
7	\$48,700,544	0.64	\$31,371,787	\$271,492,106
8	\$48,700,544	0.60	\$29,319,427	\$300,811,533
9	\$48,700,544	0.56	\$27,401,334	\$328,212,867
10	\$48,700,544	0.53	\$25,608,723	\$353,821,590
11	\$48,700,544	0.49	\$23,933,386	\$377,754,976
12	\$48,700,544	0.46	\$22,367,651	\$400,122,627
13	\$48,700,544	0.43	\$20,904,346	\$421,026,973
14	\$48,700,544	0.40	\$19,536,772	\$440,563,745
15	\$48,700,544	0.37	\$18,258,666	\$458,822,411
16	\$48,700,544	0.35	\$17,064,174	\$475,886,585
17	\$48,700,544	0.33	\$15,947,826	\$491,834,410
18	\$48,700,544	0.31	\$14,904,510	\$506,738,920
19	\$48,700,544	0.29	\$13,929,449	\$520,668,369
20	\$48,700,544	0.27	\$13,018,176	\$533,686,545

Appendix D - Benefits and Costs of Applying PTC (Tables)

Cost of PTC Level 3 System

Initial Cost \$2,882,426,340

Maintenance Cost (%) 10.00%

Maintenance Cost (\$) \$288,242,634

Discount rate 7.00%

Year	Annual Cost	Discount Factor	Annual Discounted Cost	Cumulative Discounted Cost
1	\$2,882,426,340	0.97	\$2,786,546,720	\$2,786,546,720
2	\$288,242,634	0.90	\$260,424,927	\$3,046,971,647
3	\$288,242,634	0.84	\$243,387,782	\$3,290,359,429
4	\$288,242,634	0.79	\$227,465,217	\$3,517,824,646
5	\$288,242,634	0.74	\$212,584,315	\$3,730,408,961
6	\$288,242,634	0.69	\$198,676,930	\$3,929,085,891
7	\$288,242,634	0.64	\$185,679,374	\$4,114,765,265
8	\$288,242,634	0.60	\$173,532,125	\$4,288,297,390
9	\$288,242,634	0.56	\$162,179,556	\$4,450,476,946
10	\$288,242,634	0.53	\$151,569,679	\$4,602,046,625
11	\$288,242,634	0.49	\$141,653,905	\$4,743,700,530
12	\$288,242,634	0.46	\$132,386,827	\$4,876,087,358
13	\$288,242,634	0.43	\$123,726,007	\$4,999,813,365
14	\$288,242,634	0.40	\$115,631,782	\$5,115,445,147
15	\$288,242,634	0.37	\$108,067,086	\$5,223,512,233
16	\$288,242,634	0.35	\$100,997,277	\$5,324,509,509
17	\$288,242,634	0.33	\$94,389,978	\$5,418,899,488
18	\$288,242,634	0.31	\$88,214,933	\$5,507,114,421
19	\$288,242,634	0.29	\$82,443,863	\$5,589,558,283
20	\$288,242,634	0.27	\$77,050,339	\$5,666,608,622

20- Year discounted:

	Benefit/Cost ratio
Cost	\$5,666,608,622
Benefit (y & m)	\$539,413,580 0.10

Appendix D - Benefits and Costs of Applying PTC (Tables)

Benefit (y only) \$533,686,545 0.09

Appendix D - Benefits and Costs of Applying PTC (Tables)

Twenty Year Discounted Cost of PPA's (level 2, including maybes)

Discount factor 7.00%

Cost per PPA \$766,417

PPA's in 8 years (Level 2 y & m) 478

PPA's per year (Level 2 y & m) 59.75

PPA cost/year \$45,793,416

Year	Annual Benefit	Discount Factor	Annual	Cumulative
			Discounted Benefit	Discounted Benefit
1	\$45,793,416	0.97	\$44,270,166	\$44,270,166
2	\$45,793,416	0.90	\$41,373,987	\$85,644,153
3	\$45,793,416	0.84	\$38,667,277	\$124,311,430
4	\$45,793,416	0.79	\$36,137,642	\$160,449,073
5	\$45,793,416	0.74	\$33,773,498	\$194,222,570
6	\$45,793,416	0.69	\$31,564,016	\$225,786,587
7	\$45,793,416	0.64	\$29,499,081	\$255,285,668
8	\$45,793,416	0.60	\$27,569,234	\$282,854,902
9	\$45,793,416	0.56	\$25,765,640	\$308,620,542
10	\$45,793,416	0.53	\$24,080,037	\$332,700,579
11	\$45,793,416	0.49	\$22,504,708	\$355,205,286
12	\$45,793,416	0.46	\$21,032,437	\$376,237,723
13	\$45,793,416	0.43	\$19,656,483	\$395,894,207
14	\$45,793,416	0.40	\$18,370,545	\$414,264,751
15	\$45,793,416	0.37	\$17,168,734	\$431,433,485
16	\$45,793,416	0.35	\$16,045,545	\$447,479,031
17	\$45,793,416	0.33	\$14,995,837	\$462,474,867
18	\$45,793,416	0.31	\$14,014,801	\$476,489,668
19	\$45,793,416	0.29	\$13,097,945	\$489,587,613
20	\$45,793,416	0.27	\$12,241,070	\$501,828,683

Appendix D - Benefits and Costs of Applying PTC (Tables)

Twenty Year Discounted Cost of PPA's (level 2, excluding maybes)

Discount factor 7.00%

Cost per PPA \$794,427

PPA's in 8 years (Level 2 y) 456

PPA's per year (Level 2 y) 57

PPA cost/year \$45,282,339

Year	Annual Benefit	Discount Factor	Annual	Cumulative
			Discounted Benefit	Discounted Benefit
1	\$45,282,339	0.97	\$43,776,089	\$43,776,089
2	\$45,282,339	0.90	\$40,912,233	\$84,688,323
3	\$45,282,339	0.84	\$38,235,732	\$122,924,054
4	\$45,282,339	0.79	\$35,734,329	\$158,658,383
5	\$45,282,339	0.74	\$33,396,569	\$192,054,952
6	\$45,282,339	0.69	\$31,211,747	\$223,266,699
7	\$45,282,339	0.64	\$29,169,857	\$252,436,556
8	\$45,282,339	0.60	\$27,261,548	\$279,698,104
9	\$45,282,339	0.56	\$25,478,083	\$305,176,187
10	\$45,282,339	0.53	\$23,811,292	\$328,987,479
11	\$45,282,339	0.49	\$22,253,544	\$351,241,023
12	\$45,282,339	0.46	\$20,797,705	\$372,038,728
13	\$45,282,339	0.43	\$19,437,107	\$391,475,835
14	\$45,282,339	0.40	\$18,165,521	\$409,641,356
15	\$45,282,339	0.37	\$16,977,122	\$426,618,478
16	\$45,282,339	0.35	\$15,866,469	\$442,484,947
17	\$45,282,339	0.33	\$14,828,476	\$457,313,423
18	\$45,282,339	0.31	\$13,858,389	\$471,171,812
19	\$45,282,339	0.29	\$12,951,765	\$484,123,577
20	\$45,282,339	0.27	\$12,104,454	\$496,228,031

Appendix D - Benefits and Costs of Applying PTC (Tables)

Cost of PTC Level 2 System

Initial Cost \$1,481,514,840

Maintenance Cost (%) 10.00%

Maintenance Cost (\$) \$148,151,484

Discount rate 7.00%

Year	Annual Cost	Discount Factor	Annual Discounted Cost	Cumulative Discounted Cost
1	\$1,481,514,840	0.97	\$1,432,234,455	\$1,432,234,455
2	\$148,151,484	0.90	\$133,853,687	\$1,566,088,142
3	\$148,151,484	0.84	\$125,096,904	\$1,691,185,046
4	\$148,151,484	0.79	\$116,912,994	\$1,808,098,041
5	\$148,151,484	0.74	\$109,264,481	\$1,917,362,522
6	\$148,151,484	0.69	\$102,116,337	\$2,019,478,859
7	\$148,151,484	0.64	\$95,435,829	\$2,114,914,688
8	\$148,151,484	0.60	\$89,192,364	\$2,204,107,052
9	\$148,151,484	0.56	\$83,357,349	\$2,287,464,401
10	\$148,151,484	0.53	\$77,904,065	\$2,365,368,466
11	\$148,151,484	0.49	\$72,807,537	\$2,438,176,003
12	\$148,151,484	0.46	\$68,044,427	\$2,506,220,430
13	\$148,151,484	0.43	\$63,592,923	\$2,569,813,353
14	\$148,151,484	0.40	\$59,432,638	\$2,629,245,991
15	\$148,151,484	0.37	\$55,544,521	\$2,684,790,512
16	\$148,151,484	0.35	\$51,910,768	\$2,736,701,280
17	\$148,151,484	0.33	\$48,514,736	\$2,785,216,016
18	\$148,151,484	0.31	\$45,340,875	\$2,830,556,891
19	\$148,151,484	0.29	\$42,374,649	\$2,872,931,541
20	\$148,151,484	0.27	\$39,602,476	\$2,912,534,017

20- Year discounted:

Benefit/Cost ratio

Cost \$2,912,534,017

Benefit (y & m) \$501,828,683 0.17

Appendix D - Benefits and Costs of Applying PTC (Tables)

Benefit (y only) \$496,228,031 0.17

Appendix D - Benefits and Costs of Applying PTC (Tables)

Twenty Year Discounted Cost of PPA's (level 1, including maybes)

Discount factor 7.00%

Cost per PPA \$922,540

PPA's in 8 years (Level 1 y & m) 384

PPA's per year (Level 1 y & m) 48

PPA cost/year \$44,281,920

Year	Annual Benefit	Discount Factor	Annual	Cumulative
			Discounted Benefit	Discounted Benefit
1	\$44,281,920	0.97	\$42,808,948	\$42,808,948
2	\$44,281,920	0.90	\$40,008,362	\$82,817,310
3	\$44,281,920	0.84	\$37,390,993	\$120,208,303
4	\$44,281,920	0.79	\$34,944,853	\$155,153,157
5	\$44,281,920	0.74	\$32,658,741	\$187,811,898
6	\$44,281,920	0.69	\$30,522,188	\$218,334,086
7	\$44,281,920	0.64	\$28,525,410	\$246,859,496
8	\$44,281,920	0.60	\$26,659,261	\$273,518,757
9	\$44,281,920	0.56	\$24,915,197	\$298,433,954
10	\$44,281,920	0.53	\$23,285,231	\$321,719,186
11	\$44,281,920	0.49	\$21,761,898	\$343,481,084
12	\$44,281,920	0.46	\$20,338,223	\$363,819,307
13	\$44,281,920	0.43	\$19,007,685	\$382,826,991
14	\$44,281,920	0.40	\$17,764,191	\$400,591,183
15	\$44,281,920	0.37	\$16,602,048	\$417,193,231
16	\$44,281,920	0.35	\$15,515,933	\$432,709,164
17	\$44,281,920	0.33	\$14,500,872	\$447,210,035
18	\$44,281,920	0.31	\$13,552,217	\$460,762,252
19	\$44,281,920	0.29	\$12,665,623	\$473,427,875
20	\$44,281,920	0.27	\$11,837,031	\$485,264,906

Appendix D - Benefits and Costs of Applying PTC (Tables)

Twenty Year Discounted Cost of PPA's (level 1, excluding maybes)

Discount factor 7.00%

Cost per PPA \$1,106,275

PPA's in 8 years (Level 1 y) 307

PPA's per year (Level 1 y) 38.375

PPA cost/year \$42,453,303

Year	Annual Benefit	Discount Factor	Annual	Cumulative
			Discounted Benefit	Discounted Benefit
1	\$42,453,303	0.97	\$41,041,157	\$41,041,157
2	\$42,453,303	0.90	\$38,356,222	\$79,397,379
3	\$42,453,303	0.84	\$35,846,936	\$115,244,315
4	\$42,453,303	0.79	\$33,501,809	\$148,746,125
5	\$42,453,303	0.74	\$31,310,102	\$180,056,227
6	\$42,453,303	0.69	\$29,261,778	\$209,318,005
7	\$42,453,303	0.64	\$27,347,456	\$236,665,461
8	\$42,453,303	0.60	\$25,558,370	\$262,223,831
9	\$42,453,303	0.56	\$23,886,327	\$286,110,158
10	\$42,453,303	0.53	\$22,323,670	\$308,433,828
11	\$42,453,303	0.49	\$20,863,243	\$329,297,071
12	\$42,453,303	0.46	\$19,498,358	\$348,795,430
13	\$42,453,303	0.43	\$18,222,765	\$367,018,194
14	\$42,453,303	0.40	\$17,030,621	\$384,048,815
15	\$42,453,303	0.37	\$15,916,468	\$399,965,284
16	\$42,453,303	0.35	\$14,875,204	\$414,840,488
17	\$42,453,303	0.33	\$13,902,060	\$428,742,548
18	\$42,453,303	0.31	\$12,992,579	\$441,735,127
19	\$42,453,303	0.29	\$12,142,598	\$453,877,724
20	\$42,453,303	0.27	\$11,348,222	\$465,225,946

Appendix D - Benefits and Costs of Applying PTC (Tables)

Cost of PTC Level 1 System

Initial Cost \$591,453,840

Maintenance Cost (%) 10.00%

Maintenance Cost (\$) \$59,145,384

Discount rate 7.00%

Year	Annual Cost	Discount Factor	Annual Discounted Cost	Cumulative Discounted Cost
1	\$591,453,840	0.97	\$571,780,009	\$571,780,009
2	\$59,145,384	0.90	\$53,437,384	\$625,217,393
3	\$59,145,384	0.84	\$49,941,480	\$675,158,873
4	\$59,145,384	0.79	\$46,674,281	\$721,833,154
5	\$59,145,384	0.74	\$43,620,823	\$765,453,977
6	\$59,145,384	0.69	\$40,767,124	\$806,221,101
7	\$59,145,384	0.64	\$38,100,116	\$844,321,218
8	\$59,145,384	0.60	\$35,607,585	\$879,928,803
9	\$59,145,384	0.56	\$33,278,117	\$913,206,920
10	\$59,145,384	0.53	\$31,101,044	\$944,307,964
11	\$59,145,384	0.49	\$29,066,396	\$973,374,360
12	\$59,145,384	0.46	\$27,164,856	\$1,000,539,217
13	\$59,145,384	0.43	\$25,387,716	\$1,025,926,933
14	\$59,145,384	0.40	\$23,726,838	\$1,049,653,770
15	\$59,145,384	0.37	\$22,174,615	\$1,071,828,385
16	\$59,145,384	0.35	\$20,723,939	\$1,092,552,324
17	\$59,145,384	0.33	\$19,368,167	\$1,111,920,491
18	\$59,145,384	0.31	\$18,101,091	\$1,130,021,582
19	\$59,145,384	0.29	\$16,916,907	\$1,146,938,489
20	\$59,145,384	0.27	\$15,810,194	\$1,162,748,683

20- Year discounted:

	Benefit/Cost ratio
Cost \$1,162,748,683	
Benefit (y & m) \$485,264,906	0.42

Appendix D - Benefits and Costs of Applying PTC (Tables)

Benefit (y only) \$465,225,946 0.40