Will High Density Improve Cost and Energy Efficiency of Transit?

One often hears that if we could just achieve higher density, transit would become competitive with the automobile and we would save money and energy. To check that supposition, we reviewed the cost and energy usage of the nations ten largest transit systems, by annual passenger-miles.

A survey (below) of the **ten largest bus systems** (by annual passenger-miles) shows that they carry passengers at a cost of 3,876 BTU and $0.85 per passenger-mile ($1.01 if your include annual capital expense.)

Compared to PORTLAND'S Tri-met's 3,619 BTU and $0.93 per passenger-mile ($0.94 with annual capital expense) the **larger agencies use more energy**, **save a little on operating cost** but **cost more if you include annual capital expense**.

Compared to the average automobile's 3512 BTU and $0.25, both consume more energy and cost more than driving a car. (Car's cost of $0.25 includes expenses and right of way)

A similar survey (below) of the **ten largest light rail systems** that carry the most annual passenger-miles shows that they carry passengers at a cost of 3.371 BTU and $1.38 per passenger-mile (including capital exp.) This is **equal to a car that gets 23-28 mpg (depending on passengers per car) at over 5 times the cost.**

Conclusion

1. Increasing density WILL NOT improve energy efficiency compared to readily available cars.
2. Increasing density WILL NOT lower costs anywhere near the cost of a car.

Since transit appears incapable of achieving the claimed goals of lower cost and/or lower energy consumption, one must ask:

What is the highest & best use of transit money?

1. Get more people to use transit which uses more energy and costs more than driving?
2. Spend a lot of money on a transit system in hopes of encouraging high density development which likely will only slightly improve the transit system's efficiency and WILL cause the agency to lose more money by attracting more riders?

OR

*** Serve the truly needy in the best way possible?**

Top Ten Bus Agencies (by annual passenger-miles)

City	Total system Passenger-miles	Average trip length (PM/Tri)	People/ Vehicle (PM/VRM)	Vehicle Capacity	Operating cost/ trip	Operating $/Mile	Fare/trip	Total Cost/ Passenger-mile	Operating Cost/ passenger-mile	BTU/ Passenger-mile	Auto MPG to Match Bus BTU/pm	
											1.3/car	1.57/car
New York, NY	1,812,108,125	2.1	17.9	81.7	2.43	20.65	0.90	1.26	1.15	3222	29.6	24.5
Los Angeles, CA	1,491,338,894	3.7	17.5	53.8	2.15	10.04	0.61	0.68	0.58	3649	26.1	21.6
Newark, NJ	920,864,038	6.1	13.5	69.2	4.20	9.34	1.79	0.82	0.69	3446	27.7	22.9
Chicago, IL	762,277,885	2.5	11.2	77.6	2.82	12.76	0.85	1.38	1.14	4590	20.8	17.2
Philadelphia,	476,535,831	2.8	11.9	81.3	2.77	11.81	0.89	1.05	0.99	4634	20.6	17.0
Seattle, WA	463,901,941	5.4	14.8	63.3	3.99	10.99	0.75	0.88	0.74	3041	31.4	26.0
Miami, FL	427,626,902	5.1	12.0	78.3	3.83	8.96	0.85	0.98	0.75	4186	22.8	18.9
Washington, DC	410,761,850	3.1	10.7	60.1	3.66	12.51	0.80	1.33	1.17	5189	18.4	15.2
Houston, TX	397,539,383	5.7	13.0	67.7	3.27	7.41	0.56	0.89	0.57	3575	26.7	22.1
Minneapolis, MN	303,491,661	4.5	13.2	66.3	3.20	9.42	0.99	0.88	0.72	3223	29.6	24.5
Averages	**746,644,651**	**4.10**	**13.55**	**69.9**	**3.23**	**11.39**	**0.90**	**1.01**	**0.85**	**3876**	**24.6**	**20.4**
Portland, OR	223265805	3.5	9.9	57.1	3.27	9.22	0.71	0.94	0.93	3619	26.4	21.8
Vancouver, WA	25849236	4.7	6.7	51.5	4.31	6.17	0.97	1.34	0.92	4701	20.3	16.8

Reprinted fron: http://www.portlandfacts.com/top10bus.html

Top Ten Light Rail Agencies (by annual passenger-miles)

City	Total system Passenger-miles 000s	Average trip length (PM/Trip)	People/ Vehicle (PM/VRM)	Vehicle Capacity	Operating cost/ trip	Operating$/Mile	Fare /trip	Total Cost/ Passenger-mile	Operating Cost/ passenger-mile	BTU/ Passenger-mile	Auto MPG to Match Rail BTU/pm	
											1.3/Car	1.57/Car
Los Angeles	291,158	7.0	33.5	144.0	3.49	16.63	0.50	$1.38	$0.50	3158	30.2	25.0
San Diego	207,727	5.9	26.2	185.2	1.59	7.05	0.78	$0.42	$0.27	2065	46.2	38.2
Portland, OR	186,541	5.2	28.4	165.4	2.04	11.22	0.81	$1.11	$0.39	2387	40	33.1
Boston, MA	176,196	2.5	30.7	243.2	1.72	20.99	0.93	$1.24	$0.68	3023	31.5	26.1
Dallas, TX	138,867	7.8	26.6	186.0	4.46	15.28	0.52	$3.06	$0.57	4433	21.5	17.8
St. Louis, MO	137,439	6.3	22.2	178.0	2.36	8.30	0.78	$0.90	$0.37	2684	35.5	29.4
Denver, CO	119,750	6.4	13.7	184.0	2.17	4.64	0.96	$1.39	$0.34	3829	24.9	20.6
San Francisco,	106,543	2.6	21.0	200.5	2.96	24.36	0.60	$1.98	$1.16	4843	19.7	16.3
Salt Lake City,	82,248	5.1	29.2	124.0	1.61	9.29	0.45	$1.34	$0.32	2614	36.5	30.2
Sacramento	78,760	5.4	19.1	232.4	3.27	11.49	0.85	$0.97	$0.60	4677	20.4	16.9
Averages	**152,522**	**5.42**	**25.06**	**184.3**	**$2.57**	**$12.93**	**$0.72**	**$1.38**	**$0.52**	**3371**	**28.3**	**23.4**

Transit Agencies/cities that have both light rail & bus

City	Pass Miles 000s	Capital cost 000s	Operating cost 000s	BTUs 000,000s	BTU / PM	Operate Cost/PM	Total Cost/PM	Car MPG 1.3/car	Car MPG 1.57/car
Los Angeles, CA	2,053,867	437,559	1,149,895	7,532,620	3,668	$0.56	$0.77	26	22
Boston, MA	1,682,454	540,110	905,873	5,438,650	3,233	$0.54	$0.86	30	25
Philadelphia, PA	1,419,602	347,640	870,256	5,983,607	4,215	$0.61	$0.86	23	19
Houston, TX	425,857	255,544	241,705	1,503,317	3,530	$0.57	$1.17	27	23
Portland, OR	409,806	135,515	281,357	1,253,093	3,058	$0.69	$1.02	31	26
San Francisco, CA	403,455	144,599	446,402	1,567,172	3,884	$1.11	$1.46	25	20
Denver, CO	381,837	154,404	228,485	1,321,326	3,460	$0.60	$1.00	28	23
Dallas, TX	380,179	363,403	291,722	2,083,734	5,481	$0.77	$1.72	18	15
Minneapolis, MN	356,185	63,303	239,130	1,149,862	3,228	$0.67	$0.85	30	25
Baltimore, MD	354,920	69,222	302,684	1,684,591	4,746	$0.85	$1.05	20	17
Pittsburgh, PA	323,060	129,321	301,458	1,541,653	4,772	$0.93	$1.33	20	17
Salt Lake City, UT	309,767	119,180	133,646	917,634,	2,962	$0.43	$0.82	32	27
San Diego, CA	305,929	53,079	130,478	1,070,623	3,500	$0.43	$0.60	27	23
St. Louis, MO	260,260	76,980	163,712	1,033,788	3,972	$0.63	$0.92	24	20
San Jose, CA	182,817	55,554	254,945	941,481,	5,150	$1.39	$1.70	19	15
Sacramento, CA	133,310	40,692	129,691	742,413	5,569	$0.97	$1.28	17	14
Averages					**4,027**	**$0.73**	**$1.09**	**24.9 MPG**	**20.6 MPG**

The average USA light rail city's transit system uses MORE energy than the average USA car. In fact of the 16 cities with light rail, only 6 beat the average USA car for energy efficiency per passenger transported each mile. The remaining 10 (in red) use more energy.

All cost much more than a car, ranging from almost double the cost of a car at $0.43/passenger mile, to over five times that of a car at $1.39, seven times the cost of a car, if you include capital cost.

Reprinted fron: http://www.portlandfacts.com/top10bus.html

NOTES:

- Average USA car (not SUV) gets **3512 BTU/passenger-mile** (Table 2.13, TRANSPORTATION ENERGY DATA BOOK: EDITION 27–2008). Of the top ten agencies, only 3 beat the average car and then by small margins.
- Average passengers per vehicles range from 10.7 to 17.9.
- The cost per passenger-mile ranges from $0.68 to $1.26 (see below for method.). None come close to the cost of a car, about $0.25 per passenger-mile.
- Cost per passenger mile is listed for operation costs only and operation+capital cost.
- Auto BTU per passenger-mile uses both the national average of 1.57 people per car and a lower number (1.3) to allow for lower passenger loads in the urban areas. Opinions differ on the appropriate urban number.
- BTU & Costs are system averages and the highly productive lines will better these numbers.

All Data is from this bus file and this light rail file which was excerpted from **http://ti.org/NTD07sum.xls** which combines data from the many separate files of the National Transit Database at http://204.68.195.57/ntdprogram/data.htm (select *RY 2007 Database (Self-extracting xls)*

We used

Data sources used by data table:

- Passenger-miles from Table 19
- BTU calculated from fuel consumption in Table 17
- Vehicle revenue miles from Table 19
- Capital Cost from Table 11
- Operating Cost from Table 12

Calculated data:

- BTU/Passenger-mile calculated from total system BTU / total system passenger-miles
- Cost per passenger-mile calculated by: (Capital cost + Operating cost) / passenger-miles
- Auto equivalent MPG calculated based on 123,976 Btu/gallon and 1.3 or 1.57 people per car as labeled. Calculatied by: BTU/Mile divided by Miles/gal then divide by people per car.
- Passengers/vehicle calculated from total system passenger-miles / total system vehicle revenue miles.

For more data see: Table 2.13, TRANSPORTATION ENERGY DATA BOOK: EDITION 27–2008

Notes, Data sources, and calculations data same as motor bus

- Light rail energy and costs are not directly comparable with bus numbers because, typically, buses service low usage routes which drives up their cost and energy consumption.
- Light rail lines are usually built only where there are relatively large numbers of users.
- For a valid comparison, the LRT data should be compared to data for the best bus line(s) in a given area.

NTD Table Contents

(For the data, go to **http://204.68.195.57/ntdprogram/data.htm** (select *RY 2007 Database (Self-extracting xls)*
Data is in 27 files, this one file combines the important data: **http://ti.org/NTD07sum.xls**)

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