The New York Maglev Network – A New Transport System for the 21st Century

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In the coming decades, as oil becomes scarcer and much more expensive, America will have to shift from its present oil-fueled transport systems – road, rail, and air – to transport systems that are electrically powered and do not consume oil. Maglev, because of its very high energy efficiency, and its ability to transport passengers, highway trucks, personal autos, and freight at speeds of 300 mph with costs much less than present transport systems, will play a key role in the shift to electric transport. The New York Maglev Network described in this white paper will interconnect virtually all of the metropolitan areas in New York, New Jersey, Massachusetts, Ohio, Pennsylvania, Delaware, Maryland, Washington DC, Indiana, Illinois, Virginia, Michigan, and the Canadian cities of Montreal and Toronto into a 300 mph Network. 70 million people, almost 1/4 th of the U.S. population will live less than 15 miles from a Maglev station on the Network, from which they can reach any other location in the Network, in a very short time at very low cost. The average savings in transport cost for persons served by the Network will be on the order of $1000 per person per year. The New York Maglev Network would use the new and advanced 2nd generation Maglev-2000 System, which has the unique capability to transport high revenue highway trucks, personal autos, and freight plus the ability for levitated travel at very low cost along existing RR tracks in urban and suburban areas. The NY Maglev Network can be privately financed and will not require government subsides for construction and operations after it has been certified for commercial use. Once it starts to form, it can quickly add other neighboring states, e.g., Connecticut, Rhode Island, New Hampshire, Vermont, Maine, West Virginia, Minnesota, Wisconsin, North Carolina, etc. and grow into a National Maglev Network for all America.

New York's present transport systems – road, rail, and air have served the state well during the 20th Century. However, as we move into the 21st Century, the present transport systems are running into serious problems that will only worsen with time. New York needs to think about the future, and how it will meet the transport challenges that lie ahead.

With very minor exceptions, all of New York's present transport systems depend completely on oil. World oil production has plateaued and soon will begin to decline. Even worse, as China, India and other countries rapidly industrialize, they will compete for ever scarcer, ever more expensive oil. Today, Americans consume on average 25 barrels of oil per person per year, compared to only 4 barrels average per person per year for the rest of the World. Oil imports are a major contributor to our national trade deficit. At 100 dollars a barrel, it costs the U.S. 700 Billion dollars per year to buy oil from abroad. At 200 dollars a barrel, a price that the World will soon reach, America will have to spend 1.4 Trillion dollars annually on oil imports. We can't afford it.

What are America's transport options in the years ahead? Biofuels can only supply a minor fraction of transport fuel needs, and deprive a hungry world of needed food. Hydrogen fuel is a delusion – it would take 1000 new nuclear reactors, each of 1000 megawatts electrical output, to make the hydrogen fuel equivalent to the 180 Billion gallons of transport fuel that America currently consumes per year. Moreover, the tremendous safety and security problems of hydrogen fueled cars will prevent them from being implemented on a large scale. Think of a terrorist carjacking a hydrogen-fueled auto, and planting it somewhere to explode with the equivalent of 500 pounds of TNT. Synfuels from coal and oil shale are a possibility, but their greatly increased carbon dioxide emissions would only make worse the very serious problems of global warming and ocean acidification.

America's increasing dependence on foreign suppliers of vital materials like oil, and vital manufactured goods like computer chips and other equipment for our military is hurting our national security. Maintaining independence in the critical area of transport is a vital part of ensuring that America can meet any challenge to its national security. The U.S. cannot continue to depend on other countries for the fuel and equipment we need for transport. Without efficient, affordable, and massive transport capability, America's strength would be greatly diminished.

In the decades ahead, New York and America's transport systems will have to be primarily powered by electricity, not combustion fuels. What are the options for electric transport? There are only 3:

- Electric cars and trucks
- Electric trains, low and high speed
- Maglev

Which of these options best meets the future transport needs of New York and America?

Electric cars and trucks are feasible, but only for short travel distances, e.g. 50 to 100 miles at most, before recharging is needed. Imagine a trip of 300 miles where one stops several times to recharge, with each recharge taking several hours. Plug-in hybrids would help, but then one would have to buy very expensive gasoline.

Most of America's railroads operate with diesel powered trains. Only a few commuter railroads are electrically powered. Converting the many thousands of miles of existing rail track would be difficult and very expensive.

Presently, there is a big push to buy high speed steel-wheeled rail trains from abroad to operate in a few isolated corridors in the U.S. This would be a major mistake:

- High speed rail is very expensive and must be funded and subsidized by the government. Its costs are too great and its revenues too small to be privately financed.
- Its fare costs are very high, even when subsidized, greater than the cost for flying or driving.
- High speed rail trains can only carry passengers, not fast delivery freight presently carried by highway trucks. The U.S. annual transport outlays for intercity highway trucks are much greater (over 300 Billion dollars) than for air passengers (60 Billion dollars) and rail passengers (3 Billion dollars).

Today's total outlay for U.S. transport systems including private autos, is over 1,600 Billion dollars annually. Intercity rail passengers at 3 Billion are miniscule. Even if high speed intercity passenger rail increased 10 fold it still would be a minor part of America's transport future.

Maglev, however, will play a major role in New York and America's transport future. The Maglev-2000 electrically powered system:

- Is much more energy efficient than existing trains, planes, and automobiles.
- Transports passengers, highway trucks, freight containers, and personal autos at 300 mph at lower cost than by driving.
- Travels between cities on high speed elevated monorail guideways erected alongside existing Interstate Highways.
- Travels in densely populated urban and suburban areas above existing RR tracks fitted with thin panels on the cross-ties to levitate and propel the Maglev vehicles.
- Is non-polluting, emits no greenhouse gases, very quiet (no rail noise) and very comfortable (no vibration).

Below, we describe how the proposed New York Extended Maglev Network would serve 70 million Americans, transporting passengers along with their personal autos, if they desired to do so, plus transporting long distance highway freight trucks and freight containers, reduce highway congestion and the cost of transport for food and goods. The transport savings per person served would be $1000 per year.

New York is a prime location to begin the National Maglev Network that will serve all Americans. It connects major metropolitan areas with fast, low cost, environmentally benign transport. Moreover, it fulfills NY Senator Moynihan's vision of Maglev as the future transport system for America.

The New York Maglev Netwrok would begin with the construction of the Maglev Demonstration and Certification Facility at Calverton, Long Island. A TIGER grant proposal for the facility has been submitted to the U.S. DOT. Phases 1 and 2 of the program would test and certify Maglev vehicles for levitated commercial application on existing railroad tracks (e.g., the LIRR and other RR systems) that would be adapted for Maglev operation. With additional funding, the Calverton Facility would also test high speed Maglev vehicles on an elevated monorail guideway.

In Phase 3 of the program, high speed certification tests would be carried out on a 25 mile long elevated monorail guideway erected alongside the NY Thruway South of Stewart Airport. Following certification, the guideway would then become part of a New York City to Stewart Airport Maglev route. Using it, Stewart Airport would become the 4th major international airport in the NY Region, relieving congestion at the JFK, LaGuardia, and Newark Airports. Many millions of air passengers per year could travel between New York City and Stewart, with a trip time of just 30 minutes, at a cost of only $10 per trip.

With funding, Maglev could be certified for commercial use on RR tracks in only 4 years, and for high speed use on elevated monorail guideways in as little as 5 years.

Figure 1 shows a map of the NY State Maglev Network. It would be constructed by extending the proposed Maglev route between Manhattan and Stewart Airport North to Albany, then would go West along the Thruway to Buffalo/Niagara Falls and the New York/Pennsylvania Border. The NY State Maglev System would also extend northwards along I-87 to the Canadian Border, a few miles south of Montreal.

Figure 1 NY State Maglev Network

Table 1 gives the various metropolitan and micropolitan areas, as well as small cities, that would be directly served by the NY State Maglev Network, together with the population in each area. "Directly Served" is defined as living within 15 miles of a Maglev Station (depending on the metropolitan size, there may be several Maglev stations in the area.)

Besides the elevated monorail Maglev guideways erected along I-90 and I-87, an elevated monorail guideway will go along I-495 on Long Island. Also, railroad tracks will be adapted for Maglev service on Long Island and other regions in the State. Adapting existing RR tracks for Maglev is very cheap, e.g. 4 million dollars per 2-way mile.

The total mileage of the Maglev Network in New York State is 870 miles, which directly serves 16.9 million people. The New York State population is 19.4 million, so the NY Maglev Network directly serves 87% of NY inhabitants, an extremely high fraction.

Extending the NY Maglev Network North a few miles to Montreal, connects its 2.5 million inhabitants to the NY Network. With an additional 150 miles, 6.9 million inhabitants in Northern New Jersey can be connected. To the East, 135 miles of Maglev route along the Massachusetts Turnpike to Boston will add another 5.65 million people. 100 additional miles of Maglev route to Toronto will add 4.65 million persons.

Extending the NY Maglev Network to the West, connects Cleveland, Toledo, Detroit, South Bend, Gary, and then Chicago, adding 18.04 million people, for an additional 470 miles.

Finally, extending the NY Maglev Network South along I-95 connects Trenton, NJ, Philadelphia, PA, Wilmington, Delaware, Washington, DC and Richmond, Virginia to the Network, adding 16.1 million persons for an additional 343 miles of Maglev routes.

Table 2 summarizes the route extensions to the NY Maglev Network and the increase in the directly served population. Figure 2 shows the map of the NY Maglev Network with the extensions.

Figure 2 NY State Maglev Network with Extensions

Table 3 summarizes the routes, mileages, and population served for the NY Maglev Network and its extensions. 70 million persons would be directly served, almost 1/4th of the total U.S population of 300 million people. Total Maglev route mileage is slightly over 2100 miles.

At 25 million dollars per 2-way mile of elevated guideway, the construction cost for the 2100 miles is approximately 53 Billion dollars, not including land acquisition and station costs. Most guideways will be on the rights-of-way alongside Interstate Highways, Senator Moynihan's vision, eliminating right-of-way costs. In the few locations with tight curves or structures that interfere with the route, the guideway can depart for a short distance from the Interstate right of way. However, the cost of land acquisitions for such departures should be small.

The cost of stations is not included because more detailed study of the traffic flow and topography of the various Metropolitan and Micropolitan areas in the Network needs to be carried out. However, these will be modest. At an average station spacing of 30 miles (70 stations along the 2100 miles of route) and 10 million dollars per station, total station cost would be only 700 million dollars, small compared to the guideway cost.

While 53 Billion dollars construction cost is a lot of money, compared to what people now spend for transport in the U.S., it is extremely modest. Assuming that the construction cost was paid by the U.S. government, it amounts to an annual cost of only $25 per person served, when amortized over a period of 30 years. In practice, Maglev guideways need very little maintenance, and should last for much more than 30 years. There are no heavy-wheel-loads from trucks and cars – just distributed, very low-level loading. Just to bring America's existing highway and bridge construction up to snuff, experts project that the U.S. will have to spend at least 3000 Billion dollars – 60 times greater than the cost of the extended NY Maglev Network

The annualized construction cost is calculated as 53 Billion $/30 years x 70 million persons, equaling $25 per person per year. $25 per person per year. That's only 1/2 tank of gasoline annually and less than 1/1000 th of the annual per capita disposable income in the states served by the Network! For the States connected to the Maglev Network, annual per capital disposable income in 2007 dollars ranges from $52, 450 (District of Columbia), $42,070 (New Jersey), $41, 446 (Massachusetts), $39, 621 (New York), $39,153 (Maryland), $35,490 (Virginia), $35, 196 (Illinois), $33,948 (Pennsylvania), $31,294 (Michigan), $30, 616 (Ohio), to $29, 913 (Indiana) [Ref. 2009 U.S. Statistical Abstracts].

Table 4 shows what Americans pay annually for transport using today's systems, i.e., personal autos, air travel, taxi, buses, railroads, intercity and local trucks, etc. The data, taken from the U.S. Statistical Abstracts handbook, are for 2001 (later data are not available) so that 2009 costs will be significantly higher. 2009 gasoline prices are considerably greater than in 2001, for example.

There are many surprises in the data. First is the annual average transport expenditure per person. 5,500 dollars? Personal autos account for about half of the $5,500. Driving an auto costs about 40 cents a mile when one includes depreciation, fuel, insurance, maintenance, etc. As World oil production peaks and then declines, and as rapidly industrializing countries like China become strong competitors for scarce oil supplies, the cost of driving will climb substantially.

A second surprise is the importance of trucking cost; the cost for intercity trucks was over 300 Billion dollars per year in 2001 and has grown considerably since then. This is 5 times greater than the annual cost of air passenger travel. Adding in the cost of local trucking, one finds that almost 30% of the average American's annual transport bill is consumed by truck transport. Highway trucks are an absolute necessity

for modern society. They deliver the large amounts of food and goods that urban areas need to survive, much more quickly and conveniently than railroads, which haul bulk materials like coal, grain, etc.

The third surprise is how small intercity rail passenger travel is – only $10 worth out of the $5500 annual transport expenditure per person. Amtrak travel is not attractive. High Speed Rail (HSR) will probably be more attractive if it is built in America. However, even in Europe and Japan, the average annual mileage on their modern HSR lines is only about 400 miles per person – a small fraction of the approximately 10,000 miles per year traveled by the average American.

Clearly, the $25 per person per year cost for constructing the extended NY Maglev Network is minuscule compared to the $5500 per person per year spent on transport by the average American, and would not be an obstacle in building the Maglev System. In fact, the system most probably will be privately financed, so there won't be any government funding required at all.

The next question is, "How much will the average person directly served by the NY Maglev Network with its extensions save per year by using Maglev Transport?" Table 5 addresses this issue.

The principal areas where Maglev can offer substantial savings are:

- Intercity trucking
- Intercity auto
- Intercity air passengers and freight

There will be additional significant savings by converting commuter rail to Maglev service, by laying down very low cost panels on the existing railroad and subway tracks. Service will be much faster and cheaper and much more convenient. However, we do not include these savings here.

Table 5 shows projections of the transport savings that would result from building the extended NY Maglev Network. The projected savings, together with the assumptions on which the savings are based, are given for each mode. Total savings are $1021 per person per year, approximately $1/5^{th}$ of the $5500 now spent per person per year. Most of the savings came from intercity trucks, followed by private autos, followed by local transit, air passengers, and air freight.

Private auto savings are limited to about 10% of existing expenditures on autos by the fact that most passenger autos are used for round trips under 300 miles (only 1/3 of auto passenger miles are for round trips greater than 100 miles and only 1/3 rd of that are for round trips greater than 300 miles). For those longer driving trips, travelers could either go as passengers on high speed Maglev vehicles, or as passengers with their personal autos accompanying them on Maglev vehicles outfitted to carry automobiles.

The Maglev projections are based on design and cost studies carried out for construction and operating expenses, plus estimates of the market share for each transport mode that would be captured by Maglev based on its lower costs.

The ratio of annual transport savings per person per year to the construction cost of the Maglev system per person per year is very large, i.e., $1021/$25 or more than 40/1. This very attractive ratio plus the many environmental and national security benefits of Maglev, make an extremely strong case for building the NY Maglev Network.

It would be a serious economic mistake for the U.S. government to invest in imported steel-wheel high speed rail systems and not invest in the demonstration of the 2^{nd} generation Maglev system. The simplicity of the wheel less Maglev system, low maintenance costs and its potential for launching a strong export

manufacturing industry to support future high income jobs make a compelling case for New York State to take the lead in introducing this new transport system, the first since the airplane, to the inevitable (because of the environmental and oil scarcity) U.S. and World transport market. Investing solely in high-cost, taxpayer subsidized high-speed rail transport systems can only make a minor contribution to America's future transport needs.

James Powell and Gordon Danby are the inventors of superconducting Maglev. They received the Benjamin Franklin Medal in Engineering in 2000 for their invention "using superconducting magnets and subsequent work in the field." They are Directors of the MAGLEV 2000 Corporation. James Jordan is President of the Interstate Maglev Project, which was formed to advocate Senator Moynihan's vision for National Maglev Network for passengers and freight along the rights-of-way of the Interstate Highway System using the 2nd generation superconducting Maglev transport system invented by Powell and Danby. Ernie Fazio is the Chairman of the Long Island Metro Business Action, Dr. Fletcher "Bud" Griffis is the founder and Director of the Maglev Research Center at Polytechnic Institute at New York University.

Table 1
The New York Maglev Network –Routes and Metropolitan/Micropolitan/Cities Served by I-87 and I-90

Segment #	Maglev Route	Route Mileage	Metro/Micropolitan Areas & Cities	Population Served (millions)
1.	I-87, NY Thruway Major Dugan Expressway to Albany	142 miles	NY Metropolitan	
			Bronx County	1.37
			King County	2.53
			NY County	1.62
			Queens County	2.27
			Richmond County	0.48
			Rockland County	0.30
			Westchester County	0.95
			Subtotal	**9.52**
			Newburgh-Beacon Stewart Airport	0.10
			Kingston	0.18
			Albany-Schenectady Troy	0.85
			Total	**10.65**
2.	I-90, NY Thruway Albany to Buffalo to Pennsylvania Border	354 miles	Amsterdam	0.05
			Utica Rome	0.30
			Syracuse	0.64
			Auburn	0.08
			Seneca Falls	0.03
			Rochester	1.03
			Batavia	0.06
			Buffalo-Niagara Falls	1.13
			Subtotal	**3.32**
3.	I-87, Albany to Canadian Border	200 miles	Plattsburgh	0.08
			Glens Falls	0.13
4.	I-90 NY Thruway Albany to Massachusetts Border	24 miles		
	Total	**720 miles**		**14.15**
The New York Maglev Network – Nassau and Suffolk Counties Served by I-495 and LIRR Adapted for Maglev				
5.	Elevated Monorail along I-495 from NYC to Riverhead plus travel on LIRR Tracks	150 miles including LIRR Tracks	Nassau-Suffolk	2.76
Total NY Population (2007)				**19.4**
Total NY Population Directly Served by NY Maglev Network				**16.9**
% Directly Served by NY Maglev Network (Living within 15 miles of a Maglev Station				**87%**
Total Route Length		**870 miles**		

Table 2
Extension of the Maglev Network to Regions and States Beyond New York State – Additional Mileage and Population Served

Segment #	Maglev Route Extension	Route Mileage	Metro/Micropolitan Areas & Cities	Population Served (millions)
1.	Northern New Jersey & Pennsylvania	150 miles	**Part of NY-NJ-PA Metropolitan Area**	
			Edison, NJ	2.76
			Newark Union, NJ	2.13
			Bergen County, NJ	0.40
			Hudson County, NJ	0.60
			Passaic County, NJ	0.50
			Total	**6.89**
2.	Montreal, Canada	40 miles	Longuevil	0.37
			Montreal	1.47
			Laval	0.34
			Total	**2.52**
3.	Toronto, Canada	100 miles	St. Catherines	0.13
			Hamilton	0.49
			Burlington	0.15
			Oakville	0.14
			Mississauga	0.61
			Toronto	2.48
			Brampton	0.32
			Markham	0.21
			Cambridge	0.11
			Total	**4.64**
4.	NY/Mass Border Along Massachusetts Turnpike to Boston	135 miles	Massachusetts SMSA s & Cities	
			Pittsfield	0.13
			Springfield	0.68
			Worchester	0.78
			Boston-Quincy	1.86
			Cambridge/Framingham	1.47
			Peabody	0.73
			Total	**5.65**
5.	NY/PA Border to Erie (PA), Cleveland & Toledo (OH), Detroit (MI), South Bend & Gary (IN), Chicago (IL) Maglev follows I-90 North 60 mile extension to Detroit on I-75	I-90 410 miles I-75 60 miles Total 470 Miles	Erie, PA	0.28
			Cleveland, OH	2.10
			Akron, OH	0.70
			Toledo, OH	0.65
			Detroit, MI	4.47
			South Bend, IN	0.32
			Gary, IN	0.70
			Chicago-Naperville-Joliet, IL	7.45
			Lake & Kenosha Counties, IL-WI	0.87
			Total	**18.04**

Table 2 (Continued)

Extension of the Maglev Network to Regions and States Beyond New York State
Additional Mileage and Populations Served

Segment #	Maglev Route Extension	Route Mileage	Metro/Micropolitan Areas & Cities	Population (millions)
6.	Route I-95 from NY City to Richmond, VA	231 Miles to Washington, DC plus 106 miles from Washington,DC to Richmond, VA = 343 miles	New Brunswick (NJ)	0.36
			Princeton (NJ)	6.14
			Trenton (NJ)	0.36
			Camden (NJ)	1.25
			Philadelphia (PA)	3.89
			Wilmington (DE)	0.69
			Baltimore-Towson (MD)	2.67
			Alexandria, VA, DC, MD, NV	5.31
			Richmond, VA	1.21
			Total	**16.1**
Total Additional Mileage for Maglev Extension Routes Beyond New York State				**1238 miles**
Total Additional Population Served by Maglev Extension Routes Beyond New York State				**53.8 million**

Table 3
Summary of Maglev Route Mileage and Population Served by NY Maglev Network and Its Extensions

	Routes	Route Mileage	Population Directly Served & live within miles of a Maglev station (millions)
1.	**NY State via NY Thruway**	**870**	**16.90**
2.	**Northern NJ**	**150**	**6.89**
3.	**Montreal, Canada**	**40**	**2.52**
4.	**Toronto, Canada**	**100**	**4.64**
5.	**Boston, MA**	**135**	**5.65**
6.	**Erie, PA, Cleveland & Toledo, OH, Detroit, MI, South Bend & Gary, IN, Chicago, IL**	**470**	**18.04**
7.	**Trenton & Camden NJ Philadelphia, PA Wilmington, DE Baltimore, MD Washington, DC Fredericksburg & Richmond**	**343**	**16.10**
	Total	**2108 miles**	**70.7 million**
Construction Cost @ 25 million $ per 2-way mile			**52.7 Billion $**
Construction Cost Per Person Served $24.80 per person served per year. (Per year amortized over 30 years.)			**$24.80**

Table 4
Annual U.S. Transport Outlays by Mode in 2001
Basis: 2006 U.S. Statistical Abstracts, Table 1046 and 1047

Mode of Transport	Total Annual Outlays (Billions$)	Annual (1) Outlay per Person ($/Capita)	Outlay per Passenger Mode (Cents/Pass Mile)	Outlay per Ton Mile (Cents/Ton Mile)
Personal Auto	802	$2870	44	----
Private Air	26	$80	160	----
Local Bus, Taxi and Rail	148	$490	----	----
Intercity Air	65	$217	13	----
Intercity Rail	3	$10	20	----
Intercity Bus	2	$7	5	----
Intercity Freight Truck	309	$1030	----	29
Local Freight Truck	158	$530	----	----
Intercity Freight Rail	37	$120	----	2.4
Intercity Freight Air	26	$87	----	173
Intercity Water	28	$93	----	5.6
Total	1664 Billion Dollars	$5500 per person per year		
Annual Cost Per Person For Construction of NY Maglev Network with Extensions		$25 per person per year		

Table 5
Savings in Transport Costs Enabled by New York Maglev Network

Basis:

- **$5500 per year per person n U.S. in 2001 AD (U.S. Statistical Abstracts)**
- **NY Maglev Network Directly Serves 70 million people. Construction cost of Network is $25 per person per year (Amortized over 30 years)**
- **DOT Data**

Existing Transport Mode	Projections for Maglev Share and Cost Performance	Savings in Transport Cost Enabled by Maglev ($/person per year)
1. Private Auto	-1.3 Trillion Passenger Miles for Round Trips =100 miles (1/3 of total U.S. Passenger Miles U.S. DOT Statistics) -1/3 of 1.3 Million Passenger Miles are = 300 miles (U.S. Statistical Abstracts) -Maglev Captures 80% of Market over 300 miles with savings of 80% in cost/passenger mile (Maglev Projections)	$204
2. Intercity Trucks	-Maglev captures 80% of Intercity Truck Ton Miles (Maglev Projections) -Cost Reductions of 2/3 per Ton Mile (Maglev Projections)	$552
3. Intercity Air Passengers	-Maglev captures 80% of Intercity Air Passenger Market (Maglev Projections) -Cost Reduction of 1/2 passenger mile (Maglev Projections)	$87
4. Intercity Air Freight	-Maglev Captures 100% of Intercity Air Freight Market (Maglev Projections) -Cost Reduction of 90% (Maglev Projections)	$78
5. Commuter Rail and Subway Transit	-Maglev Captures 20% of Local Transport Expenditures (Maglev Projections)	$100
Ratio: Maglev savings per year/Maglev construction cost per year = $1021/$25 = 41		
Annual U.S Savings = 306 Billion per year.		