Potential for Solar PV on MA Highway Sound Barriers

College of Natural Sciences
Center for Agriculture, Food, and the Environment

Eamon Breen and Dwayne Breger

UMassAmherst
Clean Energy Extension

United States Department of Agriculture
National Institute of Food and Agriculture

Introduction

In Massachusetts, solar energy can provide a more sustainable method of energy generation in the urban areas of the future. Noise barriers offer the opportunity to be used in conjunction with solar arrays, referred to as PVNBs (photovoltaic noise barriers). The goals of this project were as follows: create a GIS layer and database detailing each sound barrier in the state and their characteristics (location, surface area, length, height, building material, etc.) ; identify the potential for these sites to be used as PVNBs, through the National Renewable Energy Laboratory's PVWatts tool, finding energy generation potential for each site and as a whole.

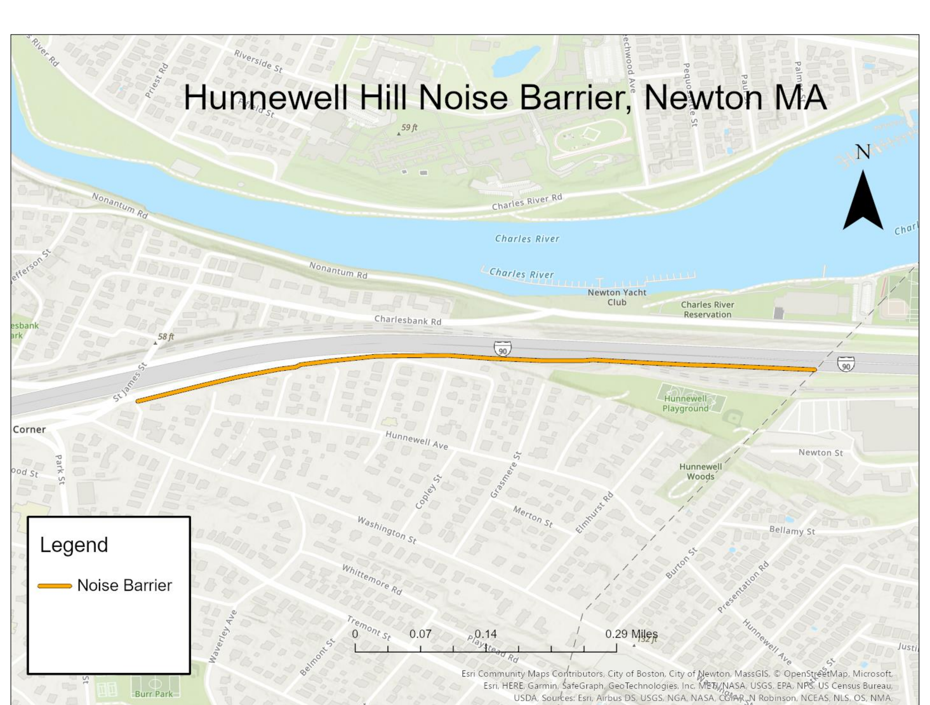
Figure 1: 3D rendering of proposed PVNB along Route 128 in Lexington.

Figure 2: PVNB along the A50 motorway in the Netherlands.

Methods

This project employed the use of GIS software ArcGIS Pro for the creation of a database modelled after MassDOT's 2018 sound barrier inventory. Using ArcGIS, geographic representations of each noise barrier along with data sourced from NREL's PVWatts solar energy calculator was created.

Figure 3: Map of a typical noise barrier, created using ArcGIS Pro.



Results

PVNBs could add 42 MW and 37,000 MWh of electricity to MA's grid

30 Degree PVNB	90 Degree PVNB
Aggregate Energy Production (MWh): 23,531.6	Aggregate Energy Production (MWh): 36,790.2
Aggregate DC System Size (MW): 19.5	Aggregate DC System Size (MW): 42.4
Mean Energy Production (MWh): 322.3	Mean Energy Production (MWh): 503.9
Mean DC System Size (MW): 0.3	Mean DC System Size (MW): 0.6

Figure 4: Aggregate and mean potential energy production and DC system size for PVNBs across MA.

19 large sound barriers possess equivalent energy potential to the other 54 sites

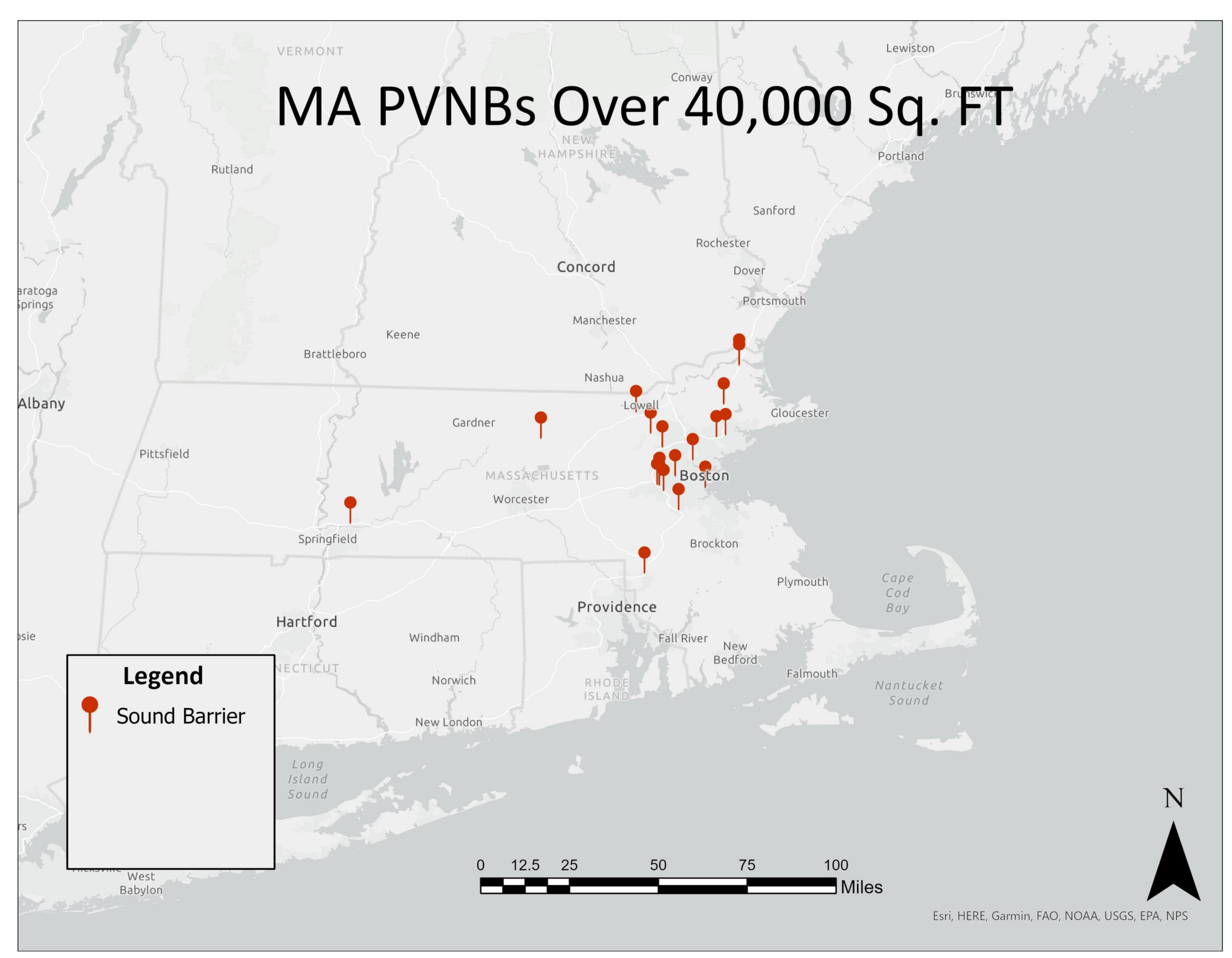


Figure 5: Locations of 19 sound barriers that possess roughly half of the potential energy generation for PVNBs across MA (at both 30- and 90-degree tilt angles).

Final database offers a resource to those considering PVNB development and potential.

O_ID	City	StateRef	Route	Average_Ht	Length_Feet	Area_Sq_Ft	r_constru	Primary_material	DDLat	DDLon	energy_30_kwh	energy_90_kwh	azimuth	zip	dc_size_30	dc_size_90	acity_fac	city_fact_90
2	Boxford	I 95 @ Ma	I 95	7	1,240	8,680	1975	Berm	42.65	-70.98	84269	140913	154.388	01921	70.68	164.92	13.6	9.8
3	Boxford	I 95 @ Upl	I 95	10	1,650	16,500	1975	Wood	42.65	-70.98	197410	222785	178.298	01921	188.1	313.5	12	8.1
4	Boxford	I 95 @ Rol	I 95	10	3,300	33,000	1975	Wood	42.68	-70.98	383170	428839	8.75592	01921	376.2	627	11.6	7.8
5	Newbury	I 95 @ Gol	I 95	7	850	5,950	1975	Precast Concrete	42.81	-70.91	50849	79915	181.201	01950	48.45	113.05	12	8.1
6	Newbury	I 95 @ Lau	I 95	7	1,148	8,036	1975	Precast Concrete	42.83	-70.92	68310	104396	15.0225	01950	65.44	152.68	11.9	7.8
7	Newbury	I 95 @ Sto	I 95	7	1,650	11,550	1975	Precast Concrete	42.81	-70.92	103389	163080	173.727	01950	94.05	219.45	12.5	8.5
8	Newbury	I 95 @ Clip	I 95	7	1,699	11,893	1975	Precast Concrete	42.82	-70.92	116557	191202	137.153	01950	96.843	225.97	13.7	9.7
9	Leominst	Rt 2 @ Ric	SR 2	7	249	1,743	1976	Wood	42.52	-71.72	18834	31595	100.149	01453	14.193	33.12	15.1	10.9
10	Leominst	Rt 2 @ Me	SR 2	7	400	2,800	1976	Wood	42.52	-71.71	30354	50868	89.553	01453	22.8	53.2	15.2	10.9
11	Leominst	I 190 @ Ra	I 190	7	2,601	18,207	1976	Wood	42.54	-71.74	185480	313797	133.612	01453	148.26	345.93	14.3	10.4
12	Lancaster	I 190 @ N	I 190	3	800	2,400	1979	Berm	42.49	-71.72	51506	36227	169.939	01523	45.6	45.6	12.9	9.1
13	Leominst	I 190 @ Bl	I 190	3	2,299	6,897	1979	Berm	42.51	-71.72	141982	97942	167.486	01453	131.04	131.04	12.4	8.5
14	Mansfield	I 495 @ Hi	I 495	10	2,699	26,990	1980	Berm, Combination	42	-71.2	404962	484713	283.183	02766	307.68	512.81	15	10.8
15	Norton	I 495 @ N	I 495	16	2,401	38,416	1980	Berm	41.99	-71.17	508825	654488	296.741	02766	410.57	729.9	14.1	10.2
16	Leominst	I 190 @ Jc	I 190	7	200	1,400	1980	Wood	42.51	-71.72	12859	21175	343.864	01453	11.4	26.6	12.9	9.1
17	Worceste	I 190 @ W	I 190	16	800	12,800	1980	Metal	42.3	-71.8	170280	218197	146.161	01606	136.8	243.2	14.2	10.2
18	Raynham	I 495 @ El	I 495	10	2,506	25,060	1981	Berm, Combination	41.96	-71.07	378582	450398	271.674	02767	285.68	476.14	15.1	10.8
19	West Boy	I 190 @ Pr	I 190	13	964	12,532	1981	Berm, Combination	42.34	-71.8	158988	212488	129.202	01583	128.21	238.11	14.2	10.2
20	Mansfield	Rt 140 @ (	SR 140	10	1,269	12,690	1983	Berm, Combination	42.01	-71.22	165220	194399	162.474	02048	144.66	241.11	13	9.2
21	Peabody	I 95 @ Cla	I 95	10	492	4,920	1987	Precast Concrete	42.54	-70.98	27596	59092	18.4349	01960	28.04	93.48	11.2	7.2
22	Peabody	Rt 128 @ .	Rt 128	10	787	7,870	1987	Precast Concrete	42.52	-70.97	60190	144173	256.8	01960	44.859	149.53	15.3	11
23	Natick	I 90 @ Har	I 90	14	2,070	28,980	1994	Wood	42.31	-71.36	368691	530493	66.5232	01760	275.31	550.62	15.3	11
24	Somervill	I 93 @ Bai	I 93	10	2,417	24,170	1995	Precast Concrete	42.4	-71.09	169875	405430	126.939	02145	137.76	459.23	14.1	10.1
25	Somervill	I 93 @ Car	I 93	11	1,197	13,167	1996	Precast Concrete	42.38	-71.08	77205	170665	188.213	02139	75.05	250.17	11.7	7.8
26	Quincy	I 93 @ Cal	I 93	12	1,000	12,000	2001	Precast Concrete	42.25	-71.03	145568	209821	111.589	02169	114	228	14.6	10.5
27	Wakefielc	I 95 @ Sal	I 95	25	5,500	136,103	2001	Precast Concrete	42.52	-71.05	1667531	2473265	98.6664	01056	1254	2585.96	15.2	10.9
28	Milton	I 93 @ Gra	I 93	15	2,300	34,500	2001	Precast Concrete	42.27	-71.05	461828	540474	154.504	02186	393.3	655.5	13.4	9.4
29	Milton	I 93 @ Squ	I 93	14	2,250	31,500	2002	Precast Concrete	42.26	-71.04	467667	515914	147.475	02186	384.75	598.5	13.9	9.8
30	Milton, Qu	I 93 @ Bry	I 93	12	1,200	14,400	2002	Precast Concrete	42.25	-71.04	155728	215974	155.002	02169	136.8	273.6	13	9
31	North Car	Rt 44 @ Bi	US 44	16	2,230	35,680	2002	Precast Concrete	41.94	-70.78	512767	627974	241.717	02330	394.04	677.92	14.9	10.6
32	Plymouth	Rt 3 @ Le	US 3	17	800	13,600	2002	Precast Concrete	41.97	-70.7	174377	234923	311.775	02363	136.8	258.4	14.6	10.4
33	Framingh	I 90 @ We	I 90	19	2,020	38,380	2003	Wood	42.3	-71.46	461180	702294	86.1447	01701	345.42	729.22	15.2	11
34	Newton	I 90 @ Bov	I 90	16	1,531	23,730	2003	Wood	42.35	-71.2	364183	440313	257.643	02458	270.53	450.87	15.4	11.1
35	Chelmsfo	Rt 3 @ Mc	US 3	15	1986	28,440	2004	Precast Concrete	42.6	-71.32	413223	499081	326.634	01824	324.22	540.36	14.5	10.5
36	Chelmsfo	Rt 3 @ C &	US 3	20	1200	24,000	2004	Precast Concrete	42.61	-71.33	221953	339142	10.8034	01824	205.2	456	12.3	8.5
37	Chelmsfo	Rt 3 @ Lee	US 3	20	1901	35,300	2004	Precast Concrete	42.63	-71.4	404847	639434	290.243	01863	307.97	670.7	15	10.9

Figure 6: Final database – cells in green provide added data on solar potentials to original MassDOT sound barrier inventory.

Future Research

Due to a lack of installed PVNBs to examine, further research overseas and in the US as PVNBs develop is required. Furthermore, as solar technology continues to progress, the efficacy of PVNBs and alterations to their design should be considered in order to facilitate more momentum in the solar energy sector. More research is needed to better understand the full economic implications of the proposed PVNBs discussed for MA, as economic impact was greater than the scope of this report. Finally, although safety for PVNBs has been examined in other reports, pilot programs like that in Lexington should be used to best understand the potential safety hazards regarding glare and driver distraction.

Acknowledgements

I would like to thank UMass Amherst's CAFE Summer Scholars Program for their support in this research. Without their funding and guidance throughout this period, none of this would have been possible. I would also like to thank Dr. Dwayne Breger from UMass Amherst's Clean Energy Extension, for his exhaustive help and instruction during the research, writing, and production of the report and poster.