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DATA REPORT FOR THE
NORTHEAST RESIDENTIAL EXPERIMENT STATION,
NOVEMBER 1981

December 1981

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M.C. Russell
P. Raghuraman
P.C. Mahoney

Massachusetts Institute of Technology
Lincoln Laboratory
Lexington, Massachusetts 02173

Prepared for
THE U.S. DEPARTMENT OF ENERGY
UNDER CONTRACT NO. DE-AC02-76ET20279

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ABSTRACT

The Residential Experiment Stations of the Solar Photovoltaic Residential Project have been designed by MIT Lincoln Laboratory under Department of Energy sponsorship to develop residential photovoltaic systems and to gather and disseminate performance data for the photovoltaic community, cognizant institutions and, ultimately, the public. This report tabulates physical performance data for the month of November 1981 obtained from photovoltaic energy systems under test at the Northeast Residential Experiment Station in Concord, Massachusetts.

MIT Lincoln Laboratory, under the aegis of the U. S. Department of Energy, has established a Residential Experiment Station (NE RES) in Concord, Massachusetts, to monitor the performance of state-of-the-art residential solar photovoltaic (PV) energy systems. The attached package presents one month of physical data obtained at the RES for these systems. A one-page summary as well as a more detailed hour-by-hour tabulation for an average day of the month is included together with a monthly load duration curve for each of the loads being monitored. This report is distributed to the NE RES Consulting Committee, the other field centers in the PV program, the Jet Propulsion Laboratory Lead Center, the Department of Energy (DOE) and the technical community involved in the development of PV energy systems. The objective of this report is to disseminate authoritative and accurate information concerning the performance of residential PV systems and the typical loads which they serve. Such timely information is needed by the overall DOE PV Program to ensure a uniform and correct understanding of the performance of these developmental systems.

Presently at the NE RES, five prototype residential PV systems are under test. Each of these Prototype Systems consists of a roof-mounted PV array, sized to meet at least 50% of the annual electrical demand of an energy-conserving house, and an enclosed structure to house the remainder of the PV system equipment, test instrumentation and work space. Four of these PV systems were designed and built by industry participants in the Lincoln Laboratory project; the fifth prototype was designed in-house. The arrays provide dc energy which is converted to ac energy by power-conditioning equipment to service all the usual loads of the residence. A common feature of all the Prototype Systems is that excess solar-generated electric energy is fed back to the local utility grid, thereby eliminating the need for on-site storage. To quantitatively gauge the ability of the Prototype Systems to meet residential load demands, five homes in the vicinity of the RES, representative of the occupancy and loads found in the area, have been equipped with instrumentation which continually record the homes' electrical energy consumption. Telephone lines carry load information from these

monitored residences to the NE RES where the data are assimilated. One of the monitored houses is chosen to command the same programmable load profile for each Prototype System--thereby simulating a typical residential electrical load and permitting side-by-side comparison of the prototypes under essentially identical conditions.

In addition to the prototypes and monitored houses, one full-sized PV residence--the Carlisle House--is also being monitored. This home in Carlisle, Massachusetts, was provided with a PV system as part of the MIT Lincoln Laboratory Solar Photovoltaic Residential Project and will be monitored for up to five years.

Features of the Prototype Systems and monitored houses are listed in Tables 1 and 2, respectively.

Figure 1 illustrates the sequence by which the attached monthly data reports are generated from the data obtained from the Prototype Systems and monitored houses. The hour-by-hour tabulation of information for an average day of the month (see "Brief Monthly Report") and the monthly summary (see "Monthly Summary Report") are the end product of processing data measured every five seconds which are then averaged over six-minute intervals. The monthly load duration curve for each monitored house uses only 5-second data and illustrates the duration of time for which the load had a specific value. The quantities measured at the monitored houses presented here are intended for use both by electric utilities and PV system designers. This information will be particularly useful in the numerical simulation of PV system performance and in determining their ability to meet actual residential loads. The information concerning the prototypes and the Carlisle House is intended for use by PV system designers and electric utilities as well as by institutional observers and the institutions represented on the RES Consulting Committees. It is expected that this information will provide a basis for understanding the performance implications for the different prototype designs.

It is to be noted that the "Monthly Summary" tabulations are based on data obtained for "complete" days only, where a "complete" day is defined as

one where data exists for at least 23 hours. In contrast, the "Brief Monthly Report" is based on data obtained not only for complete days but also for days where data exist for less than 23 hours. It is worthy of remark that when different components and instrumentation in the PV system fail at different times, the hour-by-hour tabulations of the different physical quantities that are affected by it are obtained by averaging over different time periods. Cognizance has to be taken of this especially in using the "Brief Monthly Report" to evaluate component efficiencies or to do an energy balance (using the "hypothetical" energy flows to and from the utility).

Additional information on the retrieval, processing and dissemination of data collected by the residential data system has been reported in a recent DOE publication entitled, "Information Gathering, Data Reduction and Information Dissemination for Residential Experiment Station Operations," (Report No. DOE/ET/20279-141, June 1981) authored by P. Raghuraman and E. C. Kern of MIT Lincoln Laboratory. Copies of this publication are available upon request. Information concerning the reliability of the various residential systems, as well as assessments of their performance vis-a-vis the DOE price goals and milestones, will be presented in annual reports.

For additional information on the PV systems activity at MIT Lincoln Laboratory, please write to the address below:

Solar Photovoltaic Residential Project
MIT Lincoln Laboratory
Room D-437
P.O. Box 73
Lexington, MA 02173

FIG.1. FLOW CHART FOR DATA ACQUISITION & REPORTING OF RES & ISEE OPERATIONS

TABLE 1

FEATURES OF THE PHOTOVOLTAIC ENERGY SYSTEMS IN THE
NORTHEAST PROTOTYPES AND THE INITIAL SYSTEM EVALUATION EXPERIMENT
AT CARLISLE, MASSACHUSETTS

Photovoltaic System	Module Supplier	Array Area (m ²)	Rated Array Peak Power (kWp)	Mounting Method	Array Tilt (deg)	Inverter Supplier	Inverter Size (kVA)
General Electric	General Electric	76.8	6.7	Direct	33.7	Abacus	6
MIT LL	Solarex	84.9	6.8	Standoff	45.0	Windworks	8
Solarex	Solarex	68.4	5.0	Standoff	40.0	Abacus	6
TriSolarCorp	Applied Solar	47.2	4.8	Integral	45.0	Windworks	8
Westinghouse	ARCO Solar	69.2	5.1	Integral	45.0	Abacus	6
Carlisle House	Solarex	97.0	7.8	Standoff	45.0	Windworks	8

TABLE 2

MONITORED HOUSES FEATURES

	MH2	MH3	MH4	MH5	MH6
Occupants	5	5	4	5	4
Working Adults (Daytime Hours)	2	2	1	2	1
Heating System	Oil	Oil and Electric (2 rooms)	Oil	Oil	Oil
Domestic Hot Water System	Electric	Electric	Oil	Electric	Oil
Cooking	Electric	Electric	Electric	Electric	Electric
Clothes Drying	Electric	Electric	Electric	Electric	Electric
Air Conditioning	None	None	Window	None	Window

MONTHLY SUMMARY REPORT

November 1981

(based on complete days only*)

Site Location	NERES	CARLE
Latitude:	42.46°	42.53°
Longitude:	71.30°	71.36°
Elevation:	40.5 meters	

METEOROLOGICAL INFORMATION

	NERES	CARLE
Average maximum ambient air temp.(°C).....	9.8	9.0
Average minimum ambient air temp.(°C).....	0.6	0.6
Average ambient air temp.(°C).....	5.2	4.8
Average degree days(°C days/day).....	13.2	14.0
Total precipitation(cm).....	9.8	
Average wind speed(m/s).....	2.7	
Average total horizontal insolation(kWh/m ² /day).....	1.78	

MONITORED HOUSE (MH) INFORMATION

	MH2	MH3	MH4	MH5	MH6
Average total electric energy used(kWh/day).....	23.1	36.8	19.8	30.2	24.3
Average electric energy in use during sunhours(kWh/day).....	8.3	16.0	7.0	14.8	11.2
*Number of complete days of monitored house data.....	19	24	24	12	13

PROTOTYPE AND ISEE PHOTOVOLTAIC ARRAY INFORMATION

	MITLL	WEST	GE	TRISC	SOLRX	CARLE
Array tilt angle(°).....	45.	45.	33.7	45.	40.	45.
Average PV DC energy(kWh/day).....	20.5	---	---	14.4	10.9	22.2
Average PV DC energy/rated power(kWh/day/kWp).....	2.9	---	---	3.0	2.1	2.8
Array peak power(kW).....	8.5	---	---	5.7	6.0	7.6
Average array peak power(kW).....	4.6	---	---	3.3	3.0	5.6
Average total tilt insolation: during sunhours(kWh/m ² /day)...	3.22	2.99	3.11	3.21	2.96	3.14
Average total tilt insolation: PV system on(kWh/m ² /day).....	3.20	---	---	3.20	2.71	3.26
Peak insolation(kW/m ²).....	1.24	1.21	1.16	1.20	1.19	1.01
Average peak insolation(kW/m ²).....	0.71	0.68	0.69	0.72	0.70	0.70
PV array efficiency(%)†.....	7.2	---	---	10.0	5.3	6.5
Average maximum panel temp.(°C).....	31.7	32.9	39.4	32.4	30.6	36.3
Average minimum panel temp.(°C).....	-3.1	-3.7	-3.1	-0.6	-2.1	-1.5

PROTOTYPE AND ISEE POWER CONDITIONING UNIT (PCU) INFORMATION

	MITLL	WEST	GE	TRISC	SOLRX	CARLE
Average PCU AC energy output(kWh/day).....	17.5	---	---	12.3	9.0	20.4
Average PCU AC peak power output(kW).....	4.2	---	---	3.0	2.6	5.2
PCU peak power output(kW).....	7.4	---	---	5.2	5.1	7.2
PCU efficiency(%).....	85.4	---	---	85.5	82.3	91.7

PROTOTYPE AND ISEE AC ENERGY FLOW

	MITLL	WEST	GE	TRISC	SOLRX	CARLE
Average imposed load(kWh/day)**.....	30.3	---	---	30.4	29.0	54.3
Average energy supplied to utility feed(kWh/day).....	13.4	---	---	8.6	6.2	16.3
Average energy supplied by utility feed(kWh/day).....	26.4	---	---	26.6	27.0	52.1

*NUMBER OF COMPLETE DAYS OF PV SYSTEM OPERATION.....

25 0 0 24 21 12

NOTES: **Imposed load source changed from MH4 to MH3 on 11/4.

+MITLL had 1 of 8 strings off line until 11/24.

WEST inverter off since 7/20 pending repair.

MH6 back on line 11/12.

+CARLE had 1 of 9 strings taken off line on 11/23.

GE inverter off since 8/6 pending repair.

* Refer to text for discussion of data limitations.

BRIEF MONTHLY REPORT*

November 1981

(including partial days)

Monitored House Data

TOTAL ELECTRIC ENERGY USED (KWH) ENERGY FOR EACH HOUR ENDING AT LOCAL STANDARD TIME																									
HCUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
HH2	0.93	0.40	0.40	0.36	0.37	0.37	0.62	1.12	1.25	0.76	0.98	0.89	0.65	0.60	0.58	0.65	1.19	1.42	1.76	1.43	1.62	1.54	1.72	1.41	23.04
HH3	0.78	0.65	0.63	0.68	0.61	0.67	2.07	2.11	1.53	1.33	1.47	1.39	1.20	1.60	1.86	1.77	2.02	2.33	2.29	2.89	2.52	2.00	1.37	0.90	36.68
HH4	0.61	0.44	0.37	0.37	0.38	0.38	0.39	0.69	0.62	0.62	0.74	0.65	0.85	0.87	0.77	0.68	0.79	1.21	1.74	1.50	1.58	1.21	0.86	0.64	18.97
HH5	0.96	0.65	0.48	0.60	0.57	0.45	0.69	1.47	2.13	2.38	1.56	0.94	1.35	1.35	1.11	0.93	1.00	1.38	1.58	2.15	2.03	1.53	1.66	1.11	30.07
HH6	0.95	0.69	0.67	0.62	0.66	0.62	0.63	0.85	1.07	1.27	1.51	1.05	1.59	1.18	1.43	0.95	0.97	1.15	1.37	1.31	1.10	0.95	0.88	0.86	24.25
CARL	2.69	2.73	2.77	2.90	3.04	3.11	3.18	3.12	2.29	1.89	1.49	1.32	1.13	1.21	0.95	1.19	1.46	1.75	1.84	1.99	2.14	2.25	2.42	2.51	51.37

Prototype Systems Data

DC ARRAY OUTPUT (KWH) ENERGY FOR EACH HOUR ENDING AT LOCAL STANDARD TIME																									
HCUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
NITL	0.00	0.0	0.0	0.0	0.0	0.0	0.02	0.60	1.63	2.41	2.72	3.21	3.37	2.80	2.18	0.82	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.80
WEST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TFIS	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.47	1.16	1.65	1.85	2.18	2.27	1.88	1.41	0.43	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.34
SCLR	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.20	0.92	1.32	1.37	1.64	1.73	1.35	1.05	0.38	0.01	0.00	0.0	0.0	0.0	0.00	0.0	0.0	10.00
CARL	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.54	1.78	2.67	3.39	3.78	3.97	3.12	1.92	0.60	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.82

AC INVERTER - REAL ENERGY OUTPUT (KWH) ENERGY FOR EACH HOUR ENDING AT LOCAL STANDARD TIME																									
HCUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
NITL	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.00	0.51	1.40	2.08	2.35	2.80	2.97	2.47	1.92	0.71	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	16.90
WEST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TFIS	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.03	0.39	1.04	1.49	1.68	1.98	2.06	1.71	1.28	0.36	-0.03	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	11.33
SCLR	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.13	0.75	1.10	1.14	1.39	1.45	1.12	0.88	0.25	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	8.20
CARL	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.48	1.64	2.48	3.19	3.57	3.74	2.91	1.76	0.52	-0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	20.12

MAXIMUM INVERTER AC POWER (KW) MAX POWER FOR EACH HOUR ENDING AT LOCAL STANDARD TIME																									
HCUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
NITL	0.0	0.0	0.0	0.0	0.0	0.0	0.12	1.04	1.85	2.73	2.85	3.43	3.78	3.21	2.63	1.22	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WEST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TFIS	0.0	0.0	0.0	0.0	0.0	0.0	0.10	0.80	1.35	1.93	2.02	2.38	2.60	2.23	1.84	0.69	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SCLR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.53	1.01	1.50	1.49	1.82	2.09	1.69	1.37	0.56	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CARL	0.0	0.0	0.0	0.0	0.0	0.0	0.12	1.08	2.21	3.18	3.94	4.70	4.78	3.63	2.71	1.09	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

LOAD IMPOSED ON THE PROTOTYPE (KWH)
ENERGY FOR EACH HOUR ENDING AT LOCAL STANDARD TIME

HCUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
MILL	0.67	0.59	0.55	0.60	0.52	0.60	1.53	1.67	1.24	1.13	1.24	1.19	0.97	1.24	1.57	1.38	1.63	1.96	2.01	2.21	2.06	1.71	1.18	0.81	30.27
WEST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRIS	0.72	0.62	0.58	0.64	0.54	0.62	1.47	1.67	1.17	1.15	1.24	1.17	0.97	1.24	1.56	1.39	1.57	1.96	2.06	2.09	1.94	1.68	1.25	0.87	30.19
SCLR	0.56	0.57	0.52	0.58	0.44	0.57	1.65	1.62	1.18	0.90	1.13	1.11	0.89	1.14	1.56	1.17	1.33	1.81	1.96	2.35	1.98	1.74	1.23	0.78	28.79
CARL	2.69	2.73	2.77	2.90	3.04	3.11	3.18	3.12	2.29	1.89	1.49	1.32	1.13	1.21	0.95	1.19	1.46	1.75	1.84	1.99	2.14	2.25	2.42	2.51	51.37

ENERGY SUPPLIED TO UTILITY (KWH)
ENERGY FOR EACH HOUR ENDING AT LOCAL STANDARD TIME

HCUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
MILL	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.20	0.99	1.69	1.83	2.41	2.46	1.82	1.24	0.32	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.95
WEST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRIS	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.14	0.63	1.04	1.16	1.51	1.51	1.10	0.74	0.11	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.93
SCLR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.05	0.48	0.79	0.82	1.10	1.07	0.74	0.57	0.12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.74
CARL	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.17	1.13	2.00	2.76	3.08	3.21	2.45	1.39	0.33	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.52

ENERGY SUPPLIED BY UTILITY (KWH)
ENERGY FOR EACH HOUR ENDING AT LOCAL STANDARD TIME

HCUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
MILL	0.74	0.65	0.61	0.66	0.58	0.66	1.60	1.40	0.79	0.64	0.60	0.67	0.33	0.51	0.87	1.63	1.71	2.06	2.11	2.32	2.17	1.80	1.25	0.88	26.64
WEST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRIS	0.77	0.67	0.62	0.68	0.58	0.66	1.50	1.41	0.76	0.69	0.72	0.70	0.42	0.64	1.02	1.14	1.60	2.01	2.10	2.14	1.98	1.73	1.30	0.91	26.76
SCLR	0.59	0.60	0.55	0.61	0.47	0.60	1.68	1.56	0.94	0.62	0.84	0.86	0.55	0.79	1.28	1.06	1.36	1.83	1.98	2.38	2.01	1.77	1.26	0.81	27.01
CARL	2.79	2.82	2.86	3.00	3.14	3.20	3.26	2.89	1.85	1.48	1.12	0.91	0.67	0.83	0.65	1.06	1.53	1.83	1.93	2.08	2.23	2.34	2.51	2.61	49.59

SOLAR ARRAY PANEL TEMPERATURE (DEG. C)
AVG TEMP FOR EACH HOUR ENDING AT LOCAL STANDARD TIME

HCUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
MILL	0.8	0.5	0.2	-0.3	-0.6	-0.8	-0.8	3.6	12.1	18.5	22.0	25.4	27.0	25.6	22.9	15.7	7.4	4.6	3.4	2.8	2.3	1.7	1.4	1.0	
WEST	0.3	0.1	-0.2	-0.6	-0.9	-1.1	-1.0	4.1	13.3	19.6	23.2	26.6	28.4	26.7	23.5	14.2	6.8	4.0	2.8	2.2	1.6	1.1	0.8	0.5	
GE	1.4	1.1	0.8	0.3	0.0	-0.1	-0.1	4.3	14.0	22.3	26.0	31.1	33.0	31.1	27.2	18.2	9.0	5.6	4.2	3.5	2.9	2.2	1.9	1.6	
TRIS	3.2	2.9	2.6	2.2	1.9	1.7	1.7	5.6	13.1	19.1	22.8	25.5	26.9	25.9	23.5	17.9	10.6	7.7	6.3	5.6	4.9	4.2	3.9	3.5	
SCLR	1.7	1.4	1.1	0.7	0.4	0.2	0.3	4.1	11.2	16.5	20.1	23.4	24.8	23.7	21.0	14.5	7.4	4.9	3.9	3.3	2.8	2.2	2.0	1.6	
CARL	1.9	1.6	1.3	1.0	0.7	0.5	0.7	4.5	13.4	20.7	26.3	29.2	32.2	29.1	24.2	16.4	8.4	5.5	4.3	3.8	3.3	2.7	2.3	1.9	

TOTAL TILT INSOLATION (KWH/M**2)
ENERGY /M**2 FOR EACH HOUR ENDING AT LOCAL STANDARD TIME

HCUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
MILL	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.11	0.26	0.37	0.42	0.50	0.52	0.44	0.34	0.14	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.11
WEST	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.11	0.25	0.35	0.41	0.49	0.50	0.42	0.31	0.11	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.96
GE	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.11	0.24	0.35	0.38	0.47	0.48	0.40	0.31	0.13	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.90
TRIS	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.11	0.26	0.37	0.41	0.49	0.50	0.40	0.31	0.12	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.99
SCLR	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.09	0.21	0.31	0.37	0.45	0.47	0.40	0.32	0.13	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.76
CARL	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.11	0.26	0.37	0.43	0.48	0.53	0.43	0.32	0.14	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.12

Hypthetical Prototype — Monitored House Energy Exchange

MITLL - HYPOTHETICAL ENERGY TO UTILITY IF MITLL WERE INSTALLED AT EACH MH (KWH)
ENERGY FOR EACH HOUR ENDING AT LOCAL STANDARD TIME

HCUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
HH2	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.14	0.86	1.65	1.92	2.24	2.55	2.06	1.49	0.43	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.37
HH3	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.13	0.85	1.56	1.71	2.16	2.19	1.59	1.07	0.22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.48
HH4	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.24	1.03	1.74	1.98	2.53	2.48	1.91	1.51	0.42	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.84
HH5	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.17	0.59	1.08	1.67	2.26	1.71	1.45	1.02	0.27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.22
HH6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.14	0.66	1.09	0.97	1.62	1.65	1.53	0.98	0.26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.94

WEST - HYPOTHETICAL ENERGY TO UTILITY IF WEST WERE INSTALLED AT EACH MH (KWH)
ENERGY FOR EACH HOUR ENDING AT LOCAL STANDARD TIME

HCUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
HH2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HH3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HH4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HH5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HH6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

GE - HYPOTHETICAL ENERGY TO UTILITY IF GE WERE INSTALLED AT EACH MH (KWH)
ENERGY FOR EACH HOUR ENDING AT LOCAL STANDARD TIME

HCUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
HH2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HH3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HH4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HH5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HH6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TRISC - HYPOTHETICAL ENERGY TO UTILITY IF TRISC WERE INSTALLED AT EACH MH (KWH)
ENERGY FOR EACH HOUR ENDING AT LOCAL STANDARD TIME

HCUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
HH2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.08	0.58	1.10	1.29	1.51	1.69	1.32	0.87	0.14	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.59
HH3	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.08	0.55	1.00	1.13	1.43	1.37	0.96	0.62	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.22
HH4	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.15	0.70	1.15	1.33	1.71	1.59	1.19	0.90	0.15	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.86
HH5	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.11	0.36	0.66	1.07	1.46	1.04	0.88	0.53	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.19
HH6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.08	0.42	0.68	0.59	1.05	1.01	0.98	0.52	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.38

SOLRX - HYPOTHETICAL ENERGY TO UTILITY IF SOLRX WERE INSTALLED AT EACH MH (KWH)
ENERGY FOR EACH HOUR ENDING AT LOCAL STANDARD TIME

HCUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
HH2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.03	0.40	0.83	0.88	1.07	1.20	0.87	0.59	0.13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.99
HH3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.39	0.73	0.73	0.98	0.95	0.57	0.38	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.80
HH4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.04	0.50	0.84	0.91	1.20	1.07	0.76	0.60	0.12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.03
HH5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.23	0.56	0.68	1.04	0.68	0.61	0.37	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.26
HH6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.25	0.44	0.36	0.68	0.59	0.63	0.34	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.35

NITL -HYPOTHETICAL ENERGY FROM UTILITY IF NITL WERE INSTALLED AT EACH MH (KWH)
ENERGY FOR EACH HOUR ENDING AT LOCAL STANDARD TIME

HCJR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
NH2	0.95	0.42	0.42	0.39	0.39	0.39	0.62	0.77	0.77	0.36	0.52	0.37	0.21	0.14	0.16	0.38	1.20	1.45	1.79	1.45	1.65	1.56	1.74	1.43	19.53
NH3	0.80	0.67	0.66	0.70	0.63	0.69	2.08	1.72	0.97	0.73	0.74	0.76	0.42	0.72	1.02	1.29	2.03	2.35	2.31	2.91	2.55	2.02	1.39	0.92	31.10
NH4	0.64	0.46	0.39	0.39	0.40	0.40	0.39	0.42	0.26	0.20	0.28	0.28	0.30	0.32	0.36	0.40	0.80	1.24	1.77	1.50	1.63	1.24	0.89	0.67	15.63
NH5	0.98	0.57	0.50	0.62	0.60	0.47	0.69	1.14	1.33	1.31	0.79	0.33	0.38	0.71	0.51	0.68	1.02	1.41	1.60	2.17	2.05	1.56	1.68	1.13	24.32
NH6	0.88	0.71	0.70	0.65	0.68	0.64	0.64	0.63	0.67	0.64	0.69	0.50	0.68	0.59	0.76	0.62	0.99	1.17	1.39	1.34	1.12	0.98	0.91	0.89	19.44

WEST -HYPOTHETICAL ENERGY FROM UTILITY IF WEST WERE INSTALLED AT EACH MH (KWH)
ENERGY FOR EACH HOUR ENDING AT LOCAL STANDARD TIME

HCUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
NH2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NH3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NH4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NH5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NH6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

GE -HYPOTHETICAL ENERGY FROM UTILITY IF GE WERE INSTALLED AT EACH MH (KWH)
ENERGY FOR EACH HOUR ENDING AT LOCAL STANDARD TIME

HCUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
NH2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NH3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NH4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NH5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NH6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TRISC -HYPOTHETICAL ENERGY FROM UTILITY IF TRISC WERE INSTALLED AT EACH MH (KWH)
ENERGY FOR EACH HOUR ENDING AT LOCAL STANDARD TIME

HCUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
NH2	0.98	0.45	0.45	0.41	0.42	0.42	0.64	0.82	0.83	0.40	0.58	0.44	0.24	0.18	0.20	0.44	1.22	1.47	1.81	1.47	1.67	1.58	1.76	1.45	20.33
NH3	0.83	0.69	0.68	0.72	0.66	0.72	2.10	1.60	1.04	0.79	0.86	0.84	0.51	0.85	1.22	1.47	2.05	2.37	2.33	2.93	2.57	2.05	1.42	0.94	32.46
NH4	0.66	0.48	0.42	0.42	0.43	0.42	0.42	0.45	0.28	0.22	0.33	0.31	0.34	0.36	0.40	0.47	0.82	1.26	1.79	1.52	1.65	1.26	0.91	0.69	16.31
NH5	1.01	0.70	0.53	0.64	0.62	0.50	0.71	1.20	1.46	1.50	0.89	0.37	0.53	0.78	0.63	0.75	1.04	1.43	1.62	2.19	2.08	1.58	1.70	1.15	25.59
NH6	0.90	0.73	0.72	0.67	0.70	0.66	0.67	0.66	0.70	0.72	0.80	0.53	0.81	0.64	0.87	0.73	1.01	1.20	1.41	1.36	1.15	1.00	0.93	0.91	20.48

SOLRX -HYPOTHETICAL ENERGY FROM UTILITY IF SOLRX WERE INSTALLED AT EACH MH (KWH)
ENERGY FOR EACH HOUR ENDING AT LOCAL STANDARD TIME

HCJR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
NH2	0.94	0.40	0.41	0.36	0.37	0.37	0.52	1.00	0.90	0.54	0.78	0.63	0.37	0.31	0.27	0.50	1.25	1.41	1.75	1.45	1.64	1.55	1.72	1.33	20.79
NH3	0.73	0.67	0.62	0.70	0.62	0.69	2.05	2.01	1.24	0.98	1.07	1.09	0.62	0.98	1.43	1.60	2.06	2.35	2.35	2.86	2.64	2.04	1.36	0.93	33.69
NH4	0.63	0.45	0.37	0.38	0.38	0.38	0.39	0.60	0.37	0.34	0.52	0.45	0.50	0.53	0.51	0.57	0.78	1.14	1.71	1.51	1.61	1.23	0.88	0.66	16.90
NH5	0.84	0.61	0.49	0.58	0.57	0.45	0.71	1.44	1.74	1.72	1.17	0.54	0.78	1.07	0.73	0.86	1.05	1.38	1.59	2.17	1.99	1.56	1.62	1.12	26.78
NH6	0.87	0.70	0.69	0.65	0.66	0.64	0.65	0.77	0.85	0.94	0.98	0.70	1.07	0.83	1.03	0.81	1.00	1.13	1.30	1.33	1.11	0.97	0.89	0.88	21.46

Monitored House Load Duration Data