An Assessment of the Impact of the Introduction of Carbon Prices and Demand Side PV Penetration for Calendar Year 2007 using the 'ANEMMarket' model of the Australian National Electricity Market (NEM).

By

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Investigate possible roles that key supply side and demand side policy initiatives might play in pursuit of the policy goal of curbing growth in carbon emissions within the National Electricity Market (NEM):

- introduction of a carbon price signal – BAU ($0/tC02), $30/tC02, $50/tC02, $70/tC02.

- Increased penetration of solar PV take-up whose principal effect is to shave load during the day.

- For Calendar year 2007 – summer: 1 January to 21 May 2007 and 17 September to 31 December 2007

- Hydro generators (except pump storage) based on LRMC, not SRMC

Load Shaving: Summer

Hour Ending	BAU	PV Scenario A (2%)	PV Scenario B (5%)	PV Scenario C (10%)	PV Scenario D (15%)	PV Scenario E (20%)
01:00	1.000	1.000	1.000	1.000	1.000	1.000
02:00	1.000	1.000	1.000	1.000	1.000	1.000
03:00	1.000	1.000	1.000	1.000	1.000	1.000
04:00	1.000	1.000	1.000	1.000	1.000	1.000
05:00	1.000	1.000	1.000	1.000	1.000	1.000
06:00	1.000	1.000	1.000	1.000	1.000	1.000
07:00	1.000	1.000	0.995	0.990	0.980	0.980
08:00	1.000	0.995	0.990	0.970	0.960	0.940
09:00	1.000	0.990	0.980	0.950	0.930	0.900
10:00	1.000	0.985	0.965	0.930	0.890	0.850
11:00	1.000	0.980	0.950	0.900	0.850	0.800
12:00	1.000	0.980	0.950	0.900	0.850	0.800
13:00	1.000	0.980	0.950	0.900	0.850	0.800
14:00	1.000	0.980	0.950	0.900	0.850	0.800
15:00	1.000	0.980	0.950	0.900	0.850	0.800
16:00	1.000	0.985	0.965	0.930	0.890	0.850
17:00	1.000	0.990	0.980	0.950	0.930	0.900
18:00	1.000	0.995	0.990	0.970	0.960	0.940
19:00	1.000	1.000	0.995	0.990	0.980	0.980
20:00	1.000	1.000	1.000	1.000	1.000	1.000
21:00	1.000	1.000	1.000	1.000	1.000	1.000
22:00	1.000	1.000	1.000	1.000	1.000	1.000
23:00	1.000	1.000	1.000	1.000	1.000	1.000
24:00	1.000	1.000	1.000	1.000	1.000	1.000

Load Shaving: Winter

Hour Ending	BAU	PV Scenario A (2%)	PV Scenario B (5%)	PV Scenario C (10%)	PV Scenario D (15%)	PV Scenario E (20%)
01:00	1.000	1.000	1.000	1.000	1.000	1.000
02:00	1.000	1.000	1.000	1.000	1.000	1.000
03:00	1.000	1.000	1.000	1.000	1.000	1.000
04:00	1.000	1.000	1.000	1.000	1.000	1.000
05:00	1.000	1.000	1.000	1.000	1.000	1.000
06:00	1.000	1.000	1.000	1.000	1.000	1.000
07:00	1.000	1.000	1.000	1.000	1.000	1.000
08:00	1.000	1.000	1.000	0.990	0.980	0.980
09:00	1.000	0.995	0.995	0.970	0.960	0.940
10:00	1.000	0.990	0.980	0.950	0.930	0.900
11:00	1.000	0.985	0.965	0.930	0.890	0.850
12:00	1.000	0.980	0.950	0.900	0.850	0.800
13:00	1.000	0.980	0.950	0.900	0.850	0.800
14:00	1.000	0.985	0.965	0.930	0.890	0.850
15:00	1.000	0.990	0.980	0.950	0.930	0.900
16:00	1.000	0.995	0.995	0.970	0.960	0.940
17:00	1.000	1.000	1.000	0.990	0.980	0.980
18:00	1.000	1.000	1.000	1.000	1.000	1.000
19:00	1.000	1.000	1.000	1.000	1.000	1.000
20:00	1.000	1.000	1.000	1.000	1.000	1.000
21:00	1.000	1.000	1.000	1.000	1.000	1.000
22:00	1.000	1.000	1.000	1.000	1.000	1.000
23:00	1.000	1.000	1.000	1.000	1.000	1.000
24:00	1.000	1.000	1.000	1.000	1.000	1.000

Model Results Address 3 broad Policy Issues:

- Impact of carbon prices

- Impact of PV generated load shaving with and without carbon prices

- Implications for number of PV systems; scope of residential PV penetration to replicate load shaving patterns; possible need to supplement residential PV with commercial scale PV systems or embedded solar PV or thermal generation

Percentage change in Average price levels from BAU

Panel A: Carbon price of $0/tC02 – 'Business-As-Usual' (BAU)

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$0, BAU ($/MWh)	16.36	85.13	88.89	23.87	33.60	52.71
$0, PV_A	0.26	3.17	3.18	1.91	0.56	2.57
$0, PV_B	0.61	8.42	8.37	4.04	1.25	6.69
$0, PV_C	1.20	15.56	15.63	9.83	2.43	12.57
$0, PV_D	1.56	16.59	17.01	16.44	3.20	13.96
$0, PV_E	1.94	19.28	20.01	27.12	3.75	16.78

Panel B: Carbon Price of $30/tC02

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$30, BAU	(171.19)	(30.63)	(27.73)	(107.97)	(39.73)	(44.68)
$30, PV_A	0.13	2.27	2.26	0.62	0.17	1.60
$30, PV_B	0.27	6.13	6.09	1.25	0.46	4.27
$30, PV_C	0.52	11.16	11.19	2.50	1.19	7.86
$30, PV_D	0.74	11.88	12.02	3.70	1.73	8.57
$30, PV_E	0.95	13.82	14.05	5.48	2.31	10.14

Panel C: Carbon Price of $50/tC02

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$30, BAU	(283.30)	(47.60)	(43.63)	(181.03)	(63.24)	(71.70)
$30, PV_A	0.09	2.21	2.22	0.50	0.15	1.49
$30, PV_B	0.18	5.65	5.66	1.04	0.33	3.75
$30, PV_C	1.34	10.51	10.35	2.03	0.71	7.10
$30, PV_D	1.51	10.99	10.94	2.94	1.02	7.57
$30, PV_E	1.65	12.77	12.84	4.52	1.34	8.94

Panel D: Carbon Price of $70/tC02

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$30, BAU	(392.45)	(73.34)	(68.44)	(251.38)	(90.11)	(105.36)
$30, PV_A	0.07	1.87	1.88	0.40	0.13	1.24
$30, PV_B	0.14	4.74	4.75	0.87	0.28	3.09
$30, PV_C	1.02	8.11	7.99	1.72	0.60	5.41
$30, PV_D	1.13	9.30	9.29	2.74	0.88	6.34
$30, PV_E	1.23	10.75	10.87	5.70	1.20	7.62

Percentage change in Coal Plant Production

Panel A: Carbon price of $0/tC02 – 'Business-As-Usual' (BAU)

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$0, BAU (MW)	57,075,000	72,287,000	56,877,000	5,146,100	0	191,380,000
$0, PV_A	0.27	0.38	0.00	0.50	0.00	0.24
$0, PV_B	0.63	0.96	0.01	1.15	0.00	0.59
$0, PV_C	1.35	2.27	0.04	2.33	0.00	1.33
$0, PV_D	2.04	3.65	0.12	3.56	0.00	2.12
$0, PV_E	2.75	5.14	0.32	5.31	0.00	3.00

Panel B: Carbon Price of $30/tC02

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$30, BAU	(1.87)	(1.22)	9.77	25.71	00.0	2.57
$30, PV_A	0.24	0.20	0.31	0.61	0.00	0.25
$30, PV_B	0.57	0.49	0.68	1.52	0.00	0.59
$30, PV_C	1.21	1.26	1.34	3.21	0.00	1.31
$30, PV_D	1.81	2.21	1.97	4.33	0.00	2.06
$30, PV_E	2.45	3.31	2.62	5.31	0.00	2.89

Panel C: Carbon Price of $50/tC02

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$50, BAU	1.57	2.39	23.31	25.26	0.00	8.98
$50, PV_A	0.24	0.28	0.41	0.52	0.00	0.31
$50, PV_B	0.60	0.71	0.92	1.22	0.00	0.74
$50, PV_C	1.22	1.78	1.76	2.94	0.00	1.62
$50, PV_D	1.74	3.03	2.48	4.05	0.00	2.50
$50, PV_E	2.37	4.30	3.20	4.97	0.00	3.41

Panel D: Carbon Price of $70/tC02

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$70, BAU	3.03	2.06	31.61	29.60	0.00	11.87
$70, PV_A	0.19	0.25	0.42	0.48	0.00	0.28
$70, PV_B	0.45	0.59	1.13	1.00	0.00	0.68
$70, PV_C	0.98	1.41	2.44	1.85	0.00	1.52
$70, PV_D	1.51	2.45	3.33	2.46	0.00	2.34
$70, PV_E	2.09	3.69	4.21	3.09	0.00	3.27

Percentage change in Gas Plant Production

Panel A: Carbon price of $0/tC02 – 'Business-As-Usual' (BAU)

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$0, BAU (MW)	3,953,700	5,026,200	2,556,400	8,987,900	63,032	20,587,000
$0, PV_A	0.11	0.75	2.87	0.63	4.34	0.85
$0, PV_B	0.22	1.71	6.08	1.41	9.08	1.86
$0, PV_C	0.36	3.62	11.36	2.74	20.70	3.62
$0, PV_D	0.41	4.69	14.93	3.62	28.19	4.75
$0, PV_E	0.45	5.54	17.51	4.28	34.15	5.58

Panel B: Carbon Price of $30/tC02

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$30, BAU	(1.36)	(6.38)	12.87	(9.11)	50.93	(4.05)
$30, PV_A	0.15	0.71	2.10	0.61	4.10	0.71
$30, PV_B	0.27	1.91	4.40	1.66	7.41	1.76
$30, PV_C	0.47	4.08	8.48	3.64	20.60	3.69
$30, PV_D	0.65	5.46	10.88	4.96	29.56	4.93
$30, PV_E	0.82	6.70	12.48	6.13	38.52	5.99

Panel C: Carbon Price of $50/tC02

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$50, BAU	(68.80)	(34.68)	(12.97)	(25.06)	(90.03)	(34.51)
$50, PV_A	0.04	0.21	2.60	0.33	6.55	0.50
$50, PV_B	0.07	0.44	5.86	0.76	13.44	1.10
$50, PV_C	0.21	0.74	11.48	1.50	26.88	2.15
$50, PV_D	0.29	0.94	15.04	2.02	35.72	2.84
$50, PV_E	0.32	1.24	17.93	2.52	42.91	3.46

Panel D: Carbon Price of $70/tC02

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$70, BAU	(143.26)	(40.93)	(68.11)	(32.23)	(526.13)	(61.65)
$70, PV_A	0.19	0.17	2.00	0.51	4.26	0.58
$70, PV_B	0.42	0.33	4.57	1.06	10.43	1.28
$70, PV_C	0.86	0.61	9.60	2.05	21.35	2.60
$70, PV_D	1.25	0.73	13.40	2.90	29.45	3.63
$70, PV_E	1.66	0.81	16.44	3.61	36.01	4.49

Percentage change in Hydro Plant Production

Panel A: Carbon price of $0/tC02 – 'Business-As-Usual' (BAU)

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$0, BAU (MW)	774,640	440,790	865	0	6,810,200	8,026,500
$0, PV_A	0.00	5.03	2.35	0.00	0.80	0.95
$0, PV_B	0.00	10.09	3.34	0.00	1.80	2.08
$0, PV_C	0.00	14.96	6.43	0.00	3.51	3.80
$0, PV_D	0.00	16.10	6.99	0.00	4.68	4.86
$0, PV_E	0.00	16.41	7.05	0.00	5.52	5.59

Panel B: Carbon Price of $30/tC02

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$30, BAU	(0.14)	(24.41)	(0.38)	0.00	(55.50)	(48.45)
$30, PV_A	0.00	5.96	2.34	0.00	0.58	0.79
$30, PV_B	0.00	11.33	3.32	0.00	1.43	1.79
$30, PV_C	0.01	18.48	6.24	0.00	2.87	3.40
$30, PV_D	0.01	23.14	6.74	0.00	4.01	4.63
$30, PV_E	0.01	27.34	6.81	0.00	5.22	5.90

Panel C: Carbon Price of $50/tC02

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$50, BAU	(0.07)	(250.64)	11.51	0.00	(98.16)	(97.05)
$50, PV_A	0.01	2.35	2.66	0.00	0.01	0.24
$50, PV_B	0.01	5.61	3.77	0.00	0.02	0.56
$50, PV_C	0.05	12.52	7.27	0.00	0.04	1.26
$50, PV_D	0.06	18.50	7.89	0.00	0.06	1.86
$50, PV_E	0.09	27.13	7.96	0.00	0.13	2.77

Panel D: Carbon Price of $70/tC02

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$70, BAU	(32.55)	(422.97)	(1.62)	0.00	(100.16)	(111.35)
$70, PV_A	0.00	2.35	2.30	0.00	0.00	0.32
$70, PV_B	0.00	5.02	3.27	0.00	0.00	0.68
$70, PV_C	0.00	9.17	6.26	0.00	0.01	1.25
$70, PV_D	0.00	12.83	6.29	0.00	0.02	1.76
$70, PV_E	0.01	15.31	6.71	0.00	0.12	2.18

Percentage change in Total Production

Panel A: Carbon price of $0/tC02 – 'Business-As-Usual' (BAU)

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$0, BAU (MW)	61,803,000	77,754,000	59,434,000	14,140,000	6,873,300	220,000,000
$0, PV_A	0.25	0.43	0.13	0.58	0.83	0.32
$0, PV_B	0.59	1.07	0.27	1.32	1.86	0.76
$0, PV_C	1.27	2.42	0.53	2.60	3.67	1.64
$0, PV_D	1.91	3.79	0.75	3.60	4.90	2.46
$0, PV_E	2.57	5.23	1.06	4.66	5.79	3.34

Panel B: Carbon Price of $30/tC02

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$30, BAU	(1.82)	(1.68)	9.90	3.56	(54.53)	
$30, PV_A	0.23	0.27	0.39	0.61	0.59	0.32
$30, PV_B	0.54	0.66	0.83	1.63	1.45	0.77
$30, PV_C	1.15	1.57	1.63	3.53	2.92	1.65
$30, PV_D	1.71	2.57	2.34	4.79	4.09	2.48
$30, PV_E	2.31	3.70	3.03	5.91	5.32	3.36

Panel C: Carbon Price of $50/tC02

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$50, BAU	(2.95)	(1.44)	21.75	(6.73)	(98.09)	
$50, PV_A	0.22	0.32	0.55	0.38	0.06	0.33
$50, PV_B	0.54	0.78	1.23	0.88	0.14	0.77
$50, PV_C	1.10	1.90	2.36	1.87	0.28	1.66
$50, PV_D	1.57	3.15	3.26	2.55	0.38	2.50
$50, PV_E	2.13	4.48	4.11	3.15	0.51	3.37

Panel D: Carbon Price of $70/tC02

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$50, BAU	(6.78)	(3.13)	27.32	(9.72)	(104.07)	
$50, PV_A	0.19	0.30	0.58	0.51	0.12	0.33
$50, PV_B	0.44	0.69	1.47	1.05	0.30	0.77
$50, PV_C	0.95	1.56	3.15	2.01	0.61	1.66
$50, PV_D	1.45	2.59	4.33	2.80	0.85	2.49
$50, PV_E	2.00	3.77	5.43	3.50	1.13	3.37

Percentage change in Carbon Emissions

Panel A: Carbon price of $0/tC02 – 'Business-As-Usual' (BAU)

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$0, BAU (tC02)	48,733,000	64,273,000	69,714,000	10,062,000	32,127	192,810,000
$0, PV_A	0.27	0.41	0.06	0.58	4.48	0.26
$0, PV_B	0.63	1.02	0.14	1.31	9.32	0.62
$0, PV_C	1.36	2.36	0.27	2.59	20.69	1.37
$0, PV_D	2.04	3.75	0.40	3.72	27.90	2.11
$0, PV_E	2.74	5.24	0.63	4.98	33.71	2.93

Panel B: Carbon Price of $30/tC02

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$30, BAU	(1.65)	(0.05)	11.01	11.61	51.37	4.16
$30, PV_A	0.25	0.23	0.39	0.59	4.35	0.31
$30, PV_B	0.58	0.56	0.84	1.51	7.79	0.71
$30, PV_C	1.23	1.39	1.65	3.21	21.14	1.52
$30, PV_D	1.83	2.35	2.38	4.33	30.33	2.32
$30, PV_E	2.47	3.45	3.10	5.27	39.45	3.16

Panel C: Carbon Price of $50/tC02

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$50, BAU	(0.58)	2.16	23.87	5.61	(97.88)	9.48
$50, PV_A	0.24	0.29	0.49	0.43	6.81	0.35
$50, PV_B	0.59	0.72	1.09	0.99	13.94	0.81
$50, PV_C	1.20	1.77	2.08	2.16	27.59	1.74
$50, PV_D	1.71	2.97	2.88	2.92	36.38	2.60
$50, PV_E	2.31	4.20	3.64	3.56	43.54	3.48

Panel D: Carbon Price of $70/tC02

SCENARIO	QLD	NSW	VIC	SA	TAS	NEM
$50, BAU	(1.79)	2.09	30.61	4.99	(560.19)	11.48
$50, PV_A	0.19	0.26	0.48	0.53	4.36	0.32
$50, PV_B	0.46	0.60	1.23	1.09	10.69	0.78
$50, PV_C	0.99	1.41	2.62	2.05	21.91	1.69
$50, PV_D	1.52	2.41	3.58	2.80	30.12	2.54
$50, PV_E	2.10	3.60	4.48	3.47	36.65	3.45