

Table S1: Results for Case 1 in Scenario 1: (a) Period 1, (b) Period 2, (c) Period 3, (d) Period 4, (e) Period 5 and (f) Period 6

	Fuel	Gross Energy (TWh/y)	CO ₂ Intensity (Mt/TWh)	Net Energy (TWh/y)	CO ₂ Load (Mt/y)	Total Cost (mil USD/y)
Plant_1	SOLAR	20.02	0.15	20.02	3	
Plant_2	SOLAR	0	0.15	0	0	
Plant_3	NG	15.33	0.5	15.33	7.67	
Plant_4	NG	0	0.5	0	0	
Plant_5	NG	0	0.5	0	0	
Plant_6	OIL	0	0.8	0	0	
Plant_7	COAL	6.67	1	6.67	6.67	
Plant_8	COAL	17.97	1	17.97	17.97	
Plant_9	SOLAR	0	0.15	0	0	
Plant_10	SOLAR	0	0.15	0	0	
SOLAR	SOLAR		0.1	0	0	
HYDRO	HYDRO		0.15	0	0	
BIOMASS	BIOMASS		0.3	0	0	
BIOGAS	BIOGAS		0.25	0	0	
TOTAL					35.31	3000

(a)

	Fuel	Gross Energy (TWh/y)	CO ₂ Intensity (Mt/TWh)	Net Energy (TWh/y)	CO ₂ Load (Mt/y)	Total Cost (mil USD/y)
Plant_1	SOLAR	26.7	0.15	26.7	4	
Plant_2	SOLAR	0	0.15	0	0	
Plant_3	NG	19.69	0.5	19.69	9.85	
Plant_4	NG	0	0.5	0	0	
Plant_5	NG	0	0.5	0	0	
Plant_6	OIL	0	0.8	0	0	
Plant_7	COAL	10.51	1	10.51	10.51	
Plant_8	COAL	18.1	1	18.1	18.1	
Plant_9	SOLAR	0	0.15	0	0	
Plant_10	SOLAR	0	0.15	0	0	
SOLAR	SOLAR		0.09	0	0	
HYDRO	HYDRO		0.14	0	0	
BIOMASS	BIOMASS		0.28	0	0	
BIOGAS	BIOGAS		0.23	0	0	
TOTAL					42.46	3500

(b)

	Fuel	Gross Energy (TWh/y)	CO ₂ Intensity (Mt/TWh)	SOLID_2 (TWh/y)	GAS_2 (TWh/y)	Net Energy (TWh/y)	CO ₂ Load (Mt/y)	Total Cost (mil USD/y)
Plant_1	SOLAR	26.7	0.15	0	0	26.7	4	
Plant_2	SOLAR	0	0.15	0	0	0	0	
Plant_3	NG	19.69	0.5	0	14	19.69	5.79	
Plant_4	NG	0	0.5	0	0	0	0	
Plant_5	NG	0	0.5	0	0	0	0	
Plant_6	OIL	0	0.8	0	0	0	0	
Plant_7	COAL	10.51	1	0	0	10.51	10.51	
Plant_8	COAL	18.1	1	18.1	0	18.1	6.52	
Plant_9	SOLAR	15	0.15	0	0	15	2.25	
Plant_10	SOLAR	0	0.15	0	0	0	0	
SOLAR	SOLAR		0.08			0	0	
HYDRO	HYDRO		0.13			0	0	
BIOMASS	BIOMASS		0.26			0	0	
BIOGAS	BIOGAS		0.21			0	0	
TOTAL							29.06	4000

(c)

	Fuel	Gross Energy (TWh/y)	CO ₂ Intensity (Mt/TWh)	CCS_2 Ret (TWh/y)	SOLID_2 (TWh/y)	GAS_2 (TWh/y)	Net Energy (TWh/y)	CO ₂ Load (Mt/y)	Total Cost (mil USD/y)
Plant_1	SOLAR	26.7	0.15	0	0	0	26.7	4	
Plant_2	SOLAR	0	0.15	0	0	0	0	0	
Plant_3	NG	19.75	0.5	5.75	0	14	18.49	3.58	
Plant_4	NG	0	0.5	0	0	0	0	0	
Plant_5	NG	9.94	0.5	9.94	0	0	7.75	1.59	
Plant_6	OIL	0	0.8	0	0	0	0	0	
Plant_7	COAL	10.51	1	0	0	0	10.51	10.51	
Plant_8	COAL	18.1	1	0	18.1	0	18.1	6.15	
Plant_9	SOLAR	20	0.15	0	0	0	20	3	
Plant_10	SOLAR	0	0.15	0	0	0	0	0	
SOLAR	SOLAR		0.07				3.45	0.24	
HYDRO	HYDRO		0.12				0	0	
BIOMASS	BIOMASS		0.24				0	0	
BIOGAS	BIOGAS		0.19				0	0	
MSW	MSW		0.27				0	0	
TOTAL								29.08	4487.19

(d)

Fuel	Gross Energy (TWh/y)	CO ₂ Intensity (Mt/TWh)	CCS_2 Ret (TWh/y)	SOLID_2 (TWh/y)	GAS_2 (TWh/y)	Net Energy (TWh/y)	CO ₂ Load (Mt/y)	Total Cost (mil USD/y)
SOLAR	26.7	0.15	0	0	0	26.7	4	
SOLAR	0	0.15	0	0	0	0	0	
NG	20.5	0.5	6.5	0	14	19.13	3.39	
NG	0	0.5	0	0	0	0	0	
NG	9.94	0.5	9.94	0	0	7.85	1.54	
OIL	0	0.8	0	0	0	0	0	
COAL	0	1	0	0	0	0	0	
COAL	18.1	1	0	18.1	0	18.1	5.79	
SOLAR	20	0.15	0	0	0	20	3	
SOLAR	24.76	0.15	0	0	0	24.76	3.71	
SOLAR		0.06				3.45	0.21	
HYDRO		0.11				0	0	
BIOMASS		0.22				0	0	
BIOGAS		0.17				0	0	
MSW		0.26				0	0	
							21.65	4051.18

(e)

	Fuel	Gross Energy (TWh/y)	CO ₂ Intensity (Mt/TWh)	CCS_2 Ret (TWh/y)	SOLID_2 (TWh/y)	GAS_2 (TWh/y)	Net Energy (TWh/y)	CO ₂ Load (Mt/y)	Total Cost (mil USD/y)
Plant_1	SOLAR	26.7	0.15	0	0	0	26.7	4	
Plant_2	SOLAR	0	0.15	0	0	0	0	0	
Plant_3	NG	20.5	0.5	6.5	0	14	19.2	3.08	
Plant_4	NG	7.9	0.5	0.82	0	7.08	7.74	1.19	
Plant_5	NG	16.8	0.5	9.94	0	6.86	14.81	2.52	
Plant_6	OIL	0	0.8	0	0	0	0	0	
Plant_7	COAL	0	1	0	0	0	0	0	
Plant_8	COAL	18.1	1	0	18.1	0	18.1	5.43	
Plant_9	SOLAR	20	0.15	0	0	0	20	3	
Plant_10	SOLAR	25	0.15	0	0	0	25	3.75	
SOLAR	SOLAR		0.05				3.45	0.17	
HYDRO	HYDRO		0.1				0	0	
BIOMASS	BIOMASS		0.2				0	0	
BIOGAS	BIOGAS		0.15				0	0	
MSW	MSW		0.25				0	0	
TOTAL								23.14	4098.1

(f)

Table S2: Results for Case 1 in Scenario 2: (a) Period 1, (b) Period 2, (c) Period 3, (d) Period 4, (e) Period 5 and (f) Period 6

	Fuel	Gross Energy (TWh/y)	CO ₂ Intensity (Mt/TWh)	Net Energy (TWh/y)	CO ₂ Load (Mt/y)	Total Cost (mil USD/y)
Plant_1	SOLAR	20.02	0.15	20.02	3	
Plant_2	SOLAR	0	0.15	0	0	
Plant_3	NG	15.33	0.5	15.33	7.67	
Plant_4	NG	0	0.5	0	0	
Plant_5	NG	0	0.5	0	0	
Plant_6	OIL	0	0.8	0	0	
Plant_7	COAL	6.68	1	6.68	6.68	
Plant_8	COAL	17.97	1	17.97	17.97	
Plant_9	SOLAR	0	0.15	0	0	
Plant_10	SOLAR	0	0.15	0	0	
SOLAR	SOLAR		0.1	0	0	
HYDRO	HYDRO		0.15	0	0	
BIOMASS	BIOMASS		0.3	0	0	
BIOGAS	BIOGAS		0.25	0	0	
TOTAL					35.31	3000

(a)

	Fuel	Gross Energy (TWh/y)	CO ₂ Intensity (Mt/TWh)	SOLID_2 (TWh/y)	GAS_2 (TWh/y)	Net Energy (TWh/y)	CO ₂ Load (Mt/y)	Total Cost (mil USD/y)
Plant_1	SOLAR	26.18	0.15	0	0	26.18	3.93	
Plant_2	SOLAR	0	0.15	0	0	0	0	
Plant_3	NG	20.5	0.5	0	0	20.5	10.25	
Plant_4	NG	0	0.5	0	0	0	0	
Plant_5	NG	0	0.5	0	0	0	0	
Plant_6	OIL	0	0.8	0	0	0	0	
Plant_7	COAL	10.22	1	0	0	10.22	10.22	
Plant_8	COAL	18.1	1	0	0	18.1	18.1	
Plant_9	SOLAR	0	0.15	0	0	0	0	
Plant_10	SOLAR	0	0.15	0	0	0	0	
SOLAR	SOLAR		0.09			0	0	
HYDRO	HYDRO		0.14			0	0	
BIOMASS	BIOMASS		0.28			0	0	
BIOGAS	BIOGAS		0.23			0	0	
MSW	MSW		0.29			0	0	
TOTAL							42.5	3500

(b)

	Fuel	Gross Energy (TWh/y)	CO ₂ Intensity (Mt/TWh)	CCS_2 Ret (TWh/y)	SOLID_1 (TWh/y)	SOLID_2 (TWh/y)	GAS_1 (TWh/y)	GAS_2 (TWh/y)	Net Energy (TWh/y)	CO ₂ Load (Mt/y)	Total Cost (mil USD/y)
Plant_1	SOLAR	26.18	0.15	0	0	0	0	0	26.18	3.93	
Plant_2	SOLAR	0	0.15	0	0	0	0	0	0	0	
Plant_3	NG	20.5	0.5	0	0	0	0	0	20.5	10.25	
Plant_4	NG	0	0.5	0	0	0	0	0	0	0	
Plant_5	NG	0	0.5	0	0	0	0	0	0	0	
Plant_6	OIL	0	0.8	0	0	0	0	0	0	0	
Plant_7	COAL	10.22	1	0	0	0	0	0	10.22	10.22	
Plant_8	COAL	18.1	1	0	18.1	0	0	0	18.1	3.26	
Plant_9	SOLAR	15	0.15	0	0	0	0	0	15	2.25	
Plant_10	SOLAR	0	0.15	0	0	0	0	0	0	0	
EP_NET_3	EP_NET_3		-0.42						0	0	
EC_NET_3	EC_NET_3		-0.22						0	0	
SOLAR	SOLAR		0.08						0	0	
HYDRO	HYDRO		0.13						0	0	
BIOMAS S	BIOMASS		0.26						0	0	
BIOGAS	BIOGAS		0.21						0	0	
MSW	MSW		0.28						0	0	
TOTAL										29.91	3979.32

(c)

	Fuel	Gross Energy (TWh/y)	CO ₂ Intensity (Mt/TWh)	CCS_1 Ret (TWh/y)	CCS_2 Ret (TWh/y)	SOLID_1 (TWh/y)	SOLID_2 (TWh/y)	GAS_1 (TWh/y)	GAS_2 (TWh/y)	Net Energy (TWh/y)	CO ₂ Load (Mt/y)	Total Cost (mil USD/y)
Plant_1	SOLAR	26.69	0.15	0	0	0	0	0	0	26.69	4	
Plant_2	SOLAR	0	0.15	0	0	0	0	0	0	0	0	
Plant_3	NG	20.5	0.5	0	20.5	0	0	0	0	15.99	3.28	
Plant_4	NG	0	0.5	0	0	0	0	0	0	0	0	
Plant_5	NG	9.49	0.5	0	9.49	0	0	0	0	7.4	1.52	
Plant_6	OIL	0	0.8	0	0	0	0	0	0	0	0	
Plant_7	COAL	10.22	1	0	0	0	0	0	0	10.22	10.22	
Plant_8	COAL	18.1	1	0	0	18.1	0	0	0	18.1	3.08	
Plant_9	SOLAR	20	0.15	0	0	0	0	0	0	20	3	
Plant_10	SOLAR	0	0.15	0	0	0	0	0	0	0	0	
EP_NET_2	EP_NET_2		-0.63							0	-4.16	
EP_NET_3	EP_NET_3		-0.43							0	0	
EC_NET_2	EC_NET_2		-0.43							0	0	
EC_NET_3	EC_NET_3		-0.23							0	0	
SOLAR	SOLAR		0.07							0	0	
HYDRO	HYDRO		0.12							0	0	
BIOMASS	BIOMASS		0.24							0	0	
BIOGAS	BIOGAS		0.19							0	0	
MSW	MSW		0.27							0	0	
TOTAL											20.95	4500

(d)

EC_NET _3	EC_NET _3		-0.25							0	0	
SOLAR	SOLAR		0.05							0	0	
HYDRO	HYDRO		0.1							0	0	
BIOMAS S	BIOMAS S		0.2							0	0	
BIOGAS	BIOGAS		0.15							0	0	
MSW	MSW		0.25							0	0	
TOTAL											1.2	5500

(f)

Table S3: Results for Case 2 in Scenario 2: (a) Period 1, (b) Period 2, (c) Period 3, (d) Period 4, (e) Period 5 and (f) Period 6

	Fuel	Gross Energy (TWh/y)	CO ₂ Intensity (Mt/TWh)	Net Energy (TWh/y)	CO ₂ Load (Mt/y)	Total Cost (mil USD/y)
Plant_1	SOLAR	26.7	0.15	26.7	4	
Plant_2	SOLAR	21.3	0.15	21.3	3.19	
Plant_3	NG	0	0.5	0	0	
Plant_4	NG	0	0.5	0	0	
Plant_5	NG	6.9	0.5	6.9	3.45	
Plant_6	OIL	0	0.8	0	0	
Plant_7	COAL	0	1	0	0	
Plant_8	COAL	5.1	1	5.1	5.1	
Plant_9	SOLAR	0	0.15	0	0	
Plant_10	SOLAR	0	0.15	0	0	
SOLAR	SOLAR		0.1	0	0	
HYDRO	HYDRO		0.15	0	0	
BIOMASS	BIOMASS		0.3	0	0	
BIOGAS	BIOGAS		0.25	0	0	
TOTAL					15.75	3673.7

(a)

	Fuel	Gross Energy (TWh/y)	CO ₂ Intensity (Mt/TWh)	SOLID_2 (TWh/y)	GAS_2 (TWh/y)	Net Energy (TWh/y)	CO ₂ Load (Mt/y)	Total Cost (mil USD/y)
Plant_1	SOLAR	26.7	0.15	0	0	26.7	4	
Plant_2	SOLAR	21.3	0.15	0	0	21.3	3.19	
Plant_3	NG	0	0.5	0	0	0	0	
Plant_4	NG	0	0.5	0	0	0	0	
Plant_5	NG	6.9	0.5	0	0	6.9	3.45	
Plant_6	OIL	0	0.8	0	0	0	0	
Plant_7	COAL	0	1	0	0	0	0	
Plant_8	COAL	5.1	1	0	0	5.1	5.1	
Plant_9	SOLAR	15	0.15	0	0	15	2.25	
Plant_10	SOLAR	0	0.15	0	0	0	0	
SOLAR	SOLAR		0.09			0	0	
HYDRO	HYDRO		0.14			0	0	
BIOMASS	BIOMASS		0.28			0	0	
BIOGAS	BIOGAS		0.23			0	0	
MSW	MSW		0.29			0	0	
TOTAL							18	4119.7

(b)

	Fuel	Gross Energy (TWh/y)	CO ₂ Intensity (Mt/TWh)	CCS_2 Ret (TWh/y)	SOLID_1 (TWh/y)	SOLID_2 (TWh/y)	GAS_1 (TWh/y)	GAS_2 (TWh/y)	Net Energy (TWh/y)	CO ₂ Load (Mt/y)	Total Cost (mil USD/y)
Plant_1	SOLAR	26.7	0.15	0	0	0	0	0	26.7	4	
Plant_2	SOLAR	21.3	0.15	0	0	0	0	0	21.3	3.19	
Plant_3	NG	0	0.5	0	0	0	0	0	0	0	
Plant_4	NG	0	0.5	0	0	0	0	0	0	0	
Plant_5	NG	6.9	0.5	0	0	0	3.94	0	6.9	1.99	
Plant_6	OIL	0	0.8	0	0	0	0	0	0	0	
Plant_7	COAL	0	1	0	0	0	0	0	0	0	
Plant_8	COAL	18.1	1	0	18.1	0	0	0	18.1	3.26	
Plant_9	SOLAR	17	0.15	0	0	0	0	0	17	2.55	
Plant_10	SOLAR	0	0.15	0	0	0	0	0	0	0	
EP_NET_3	EP_NET_3		-0.42						0	0	
EC_NET_3	EC_NET_3		-0.22						0	0	
SOLAR	SOLAR		0.08						0	0	
HYDRO	HYDRO		0.13						0	0	
BIOMAS S	BIOMASS		0.26						0	0	
BIOGAS	BIOGAS		0.21						0	0	
MSW	MSW		0.28						0	0	
TOTAL										15	4056.82

(c)

	Fuel	Gross Energy (TWh/y)	CO ₂ Intensity (Mt/TWh)	CCS_1 Ret (TWh/y)	CCS_2 Ret (TWh/y)	SOLID_1 (TWh/y)	SOLID_2 (TWh/y)	GAS_1 (TWh/y)	GAS_2 (TWh/y)	Net Energy (TWh/y)	CO ₂ Load (Mt/y)	Total Cost (mil USD/y)
Plant_1	SOLAR	26.7	0.15	0	0	0	0	0	0	26.7	4	
Plant_2	SOLAR	21.3	0.15	0	0	0	0	0	0	21.3	3.19	
Plant_3	NG	0	0.5	0	0	0	0	0	0	0	0	
Plant_4	NG	0	0.5	0	0	0	0	0	0	0	0	
Plant_5	NG	12.22	0.5	0	0	0	0	12.22	0	12.22	1.47	
Plant_6	OIL	0	0.8	0	0	0	0	0	0	0	0	
Plant_7	COAL	6.67	1	0	0	0	0	0	0	6.67	6.67	
Plant_8	COAL	18.1	1	0	0	18.1	0	0	0	18.1	3.08	
Plant_9	SOLAR	20	0.15	0	0	0	0	0	0	20	3	
Plant_10	SOLAR	0	0.15	0	0	0	0	0	0	0	0	
EP_NET_2	EP_NET_2		-0.63							9.83	-6.19	
EP_NET_3	EP_NET_3		-0.43							0	0	
EC_NET_2	EC_NET_2		-0.43							9.83	-4.23	
EC_NET_3	EC_NET_3		-0.23							0	0	
SOLAR	SOLAR		0.07							0	0	
HYDRO	HYDRO		0.12							0	0	
BIOMASS	BIOMASS		0.24							0	0	
BIOGAS	BIOGAS		0.19							0	0	
MSW	MSW		0.27							0	0	
TOTAL											11	5118

(d)

BIOGAS	BIOGAS		0.17							0	0	
MSW	MSW		0.26							0	0	
TOTAL											6	4618.86

(e)

	Fuel	Gross Energy (TWh/y)	CO ₂ Intensity (Mt/TWh)	CCS_1 Ret (TWh/y)	CCS_2 Ret (TWh/y)	SOLID_1 (TWh/y)	SOLID_2 (TWh/y)	GAS_1 (TWh/y)	GAS_2 (TWh/y)	Net Energy (TWh/y)	CO ₂ Load (Mt/y)	Total Cost (mil USD/y)
Plant_1	SOLAR	26.7	0.15	0	0	0	0	0	0	26.7	4	
Plant_2	SOLAR	21.3	0.15	0	0	0	0	0	0	21.3	3.19	
Plant_3	NG	0	0.5	0	0	0	0	0	0	0	0	
Plant_4	NG	11.68	0.5	0	11.68	0	0	0	0	9.34	1.75	
Plant_5	NG	12.22	0.5	0	0	0	0	12.22	0	12.22	1.22	
Plant_6	OIL	0	0.8	0	0	0	0	0	0	0	0	
Plant_7	COAL	0	1	0	0	0	0	0	0	0	0	
Plant_8	COAL	18.1	1	0	0	18.1	0	0	0	18.1	2.72	
Plant_9	SOLAR	20	0.15	0	0	0	0	0	0	20	3	
Plant_10	SOLAR	25	0.15	0	0	0	0	0	0	25	3.75	
EP_NET_1	EP_NET_1		-0.85							6.75	-5.74	
EP_NET_2	EP_NET_2		-0.65							10.83	-7.04	
EP_NET_3	EP_NET_3		-0.45							0	0	
EC_NET_1	EC_NET_1		-0.65							0	0	
EC_NET_2	EC_NET_2		-0.45							15.25	-6.86	

EC_NET _3	EC_NET _3		-0.25							0	0	
SOLAR	SOLAR		0.05							0	0	
HYDRO	HYDRO		0.1							0	0	
BIOMAS S	BIOMAS S		0.2							0	0	
BIOGAS	BIOGAS		0.15							0	0	
MSW	MSW		0.25							0	0	
TOTAL											0	5064.7

(f)