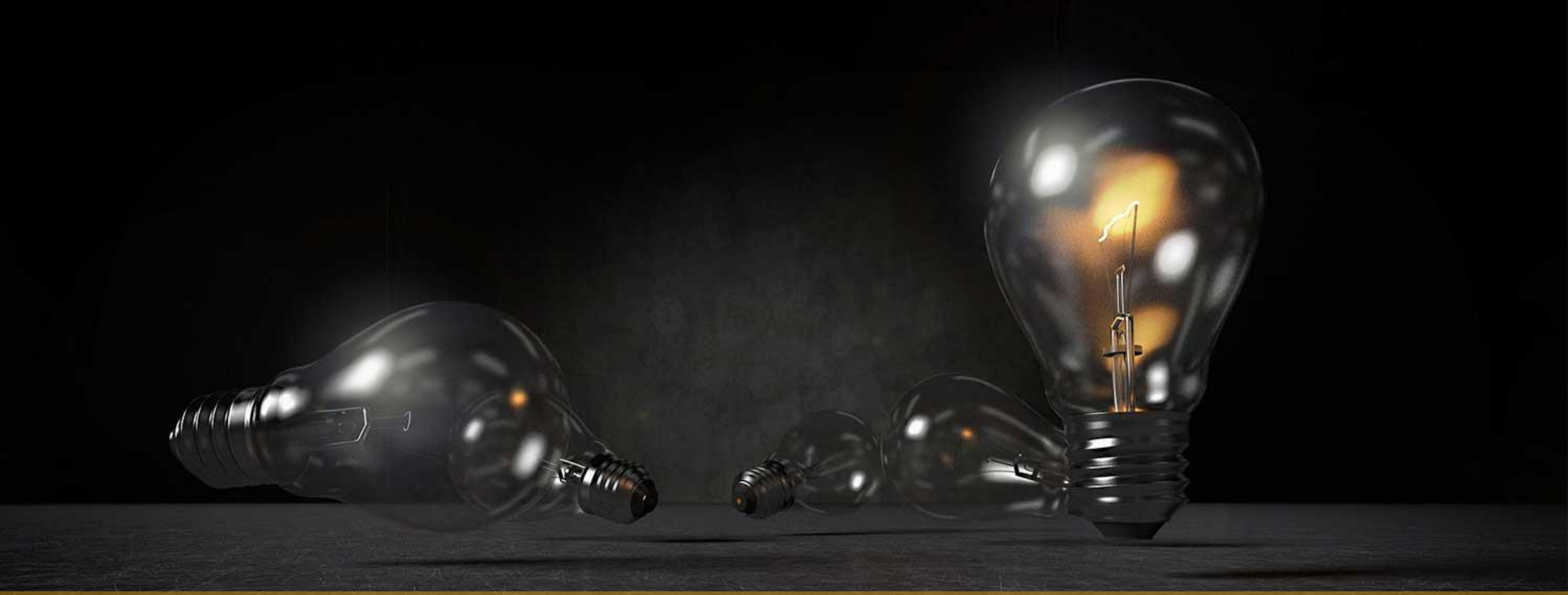
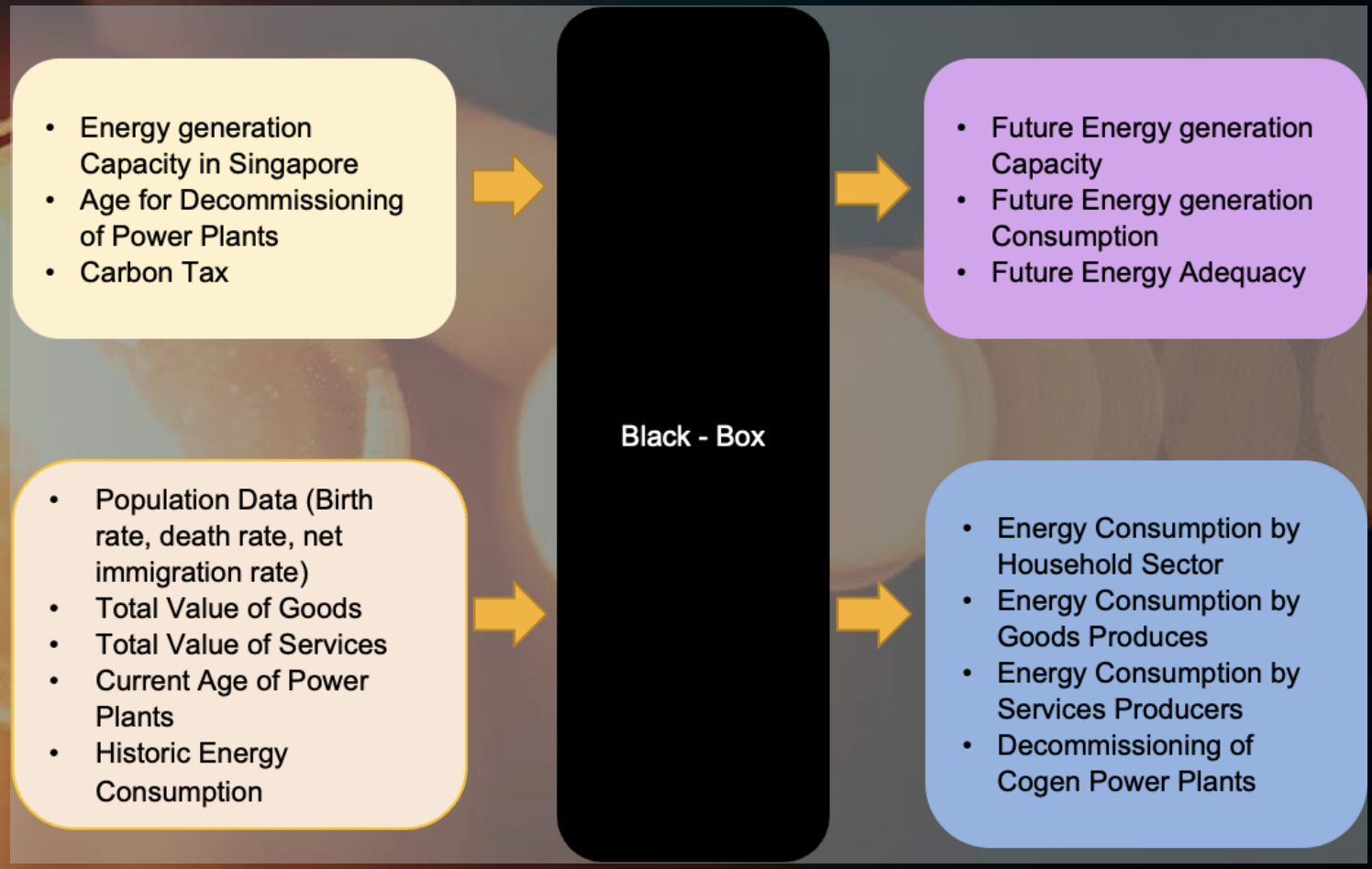


Singapore Power Adequacy Forecast

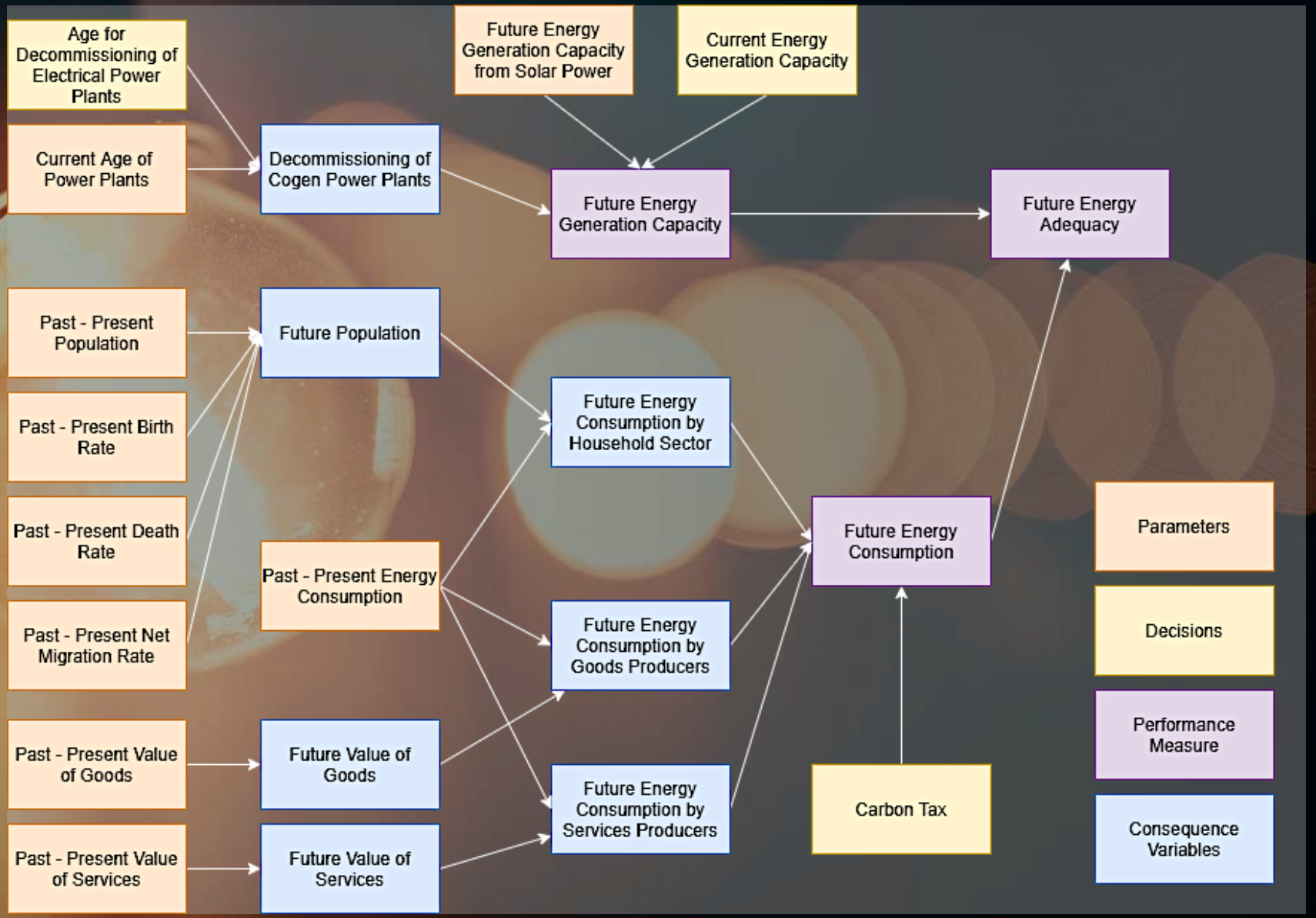
Objective

- Conduct detailed analysis on the energy consumption pattern in Singapore based on the historical energy consumption data
- Understand how the consumption pattern has changed over time
- Predict the consumption pattern till 2050 considering various parameters such as GDP, population, carbon tax, tariffs, power plants capacity

Black Box Diagram



Influence Diagram

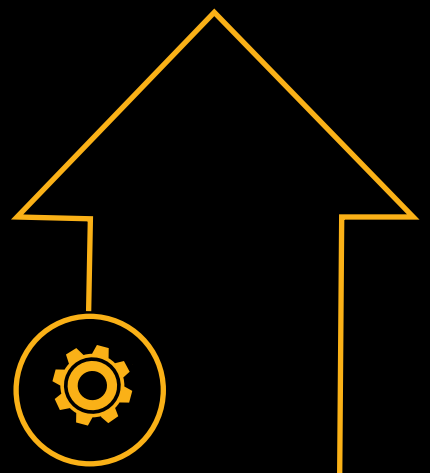


Base Model: Consumption Forecast

Households

Population Growth

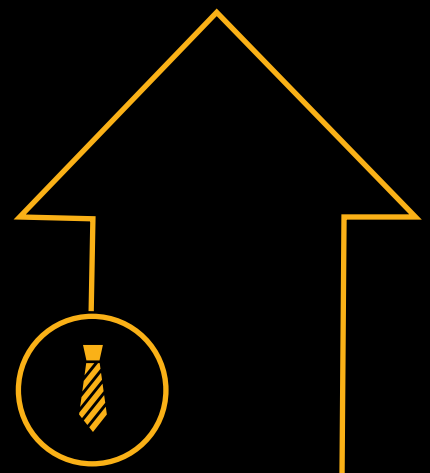
- Birth Rate
- Death Rate
- Net Migration Rate



Goods Producers

Total Value of Goods

- Manufacturing
- Construction
- Others (Utilities, Agriculture)



Service Providers

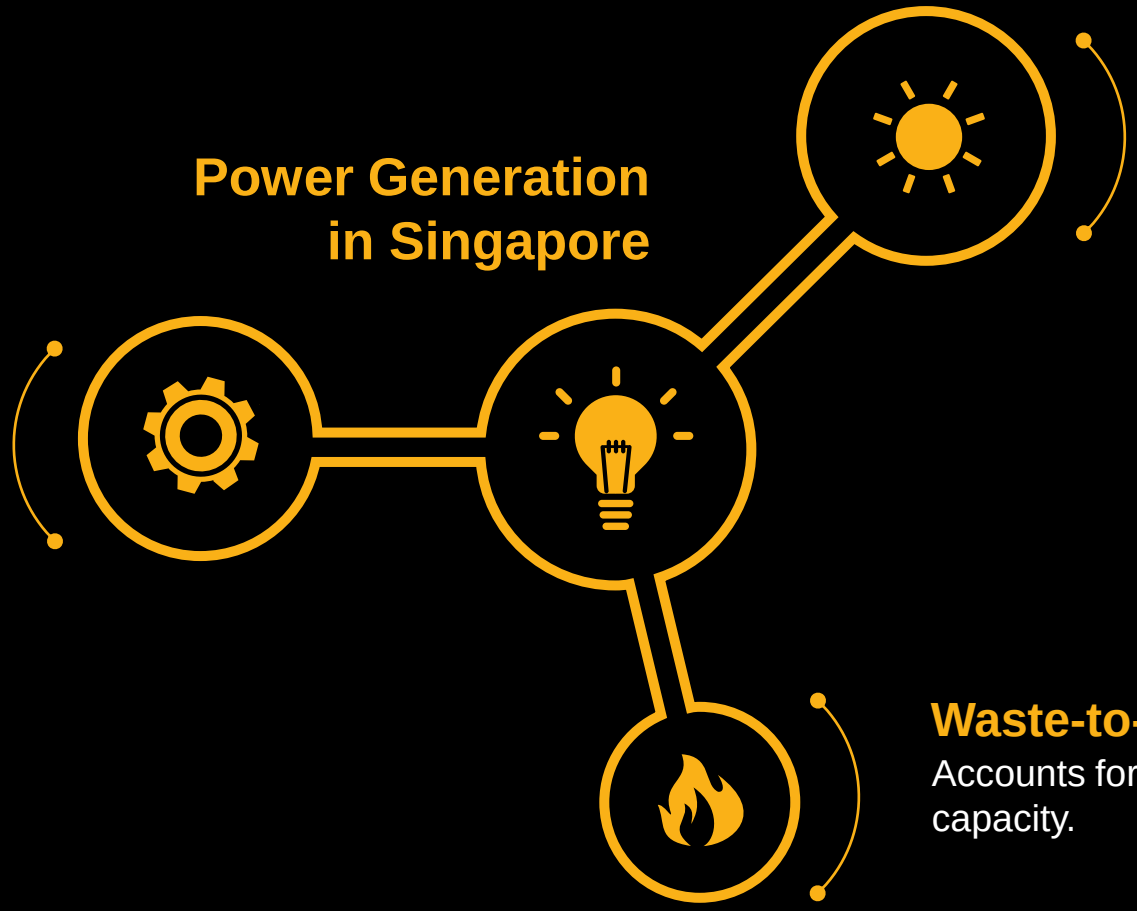
Total Value of Services

- Trade, Transport, Logistics
- Infocomm, Finance, Professional
- Accomodation, Food, Admin.

Forecasted using linear

Forecasted using exponential

Base Model: Available Capacity



Co-Gen Power Plants

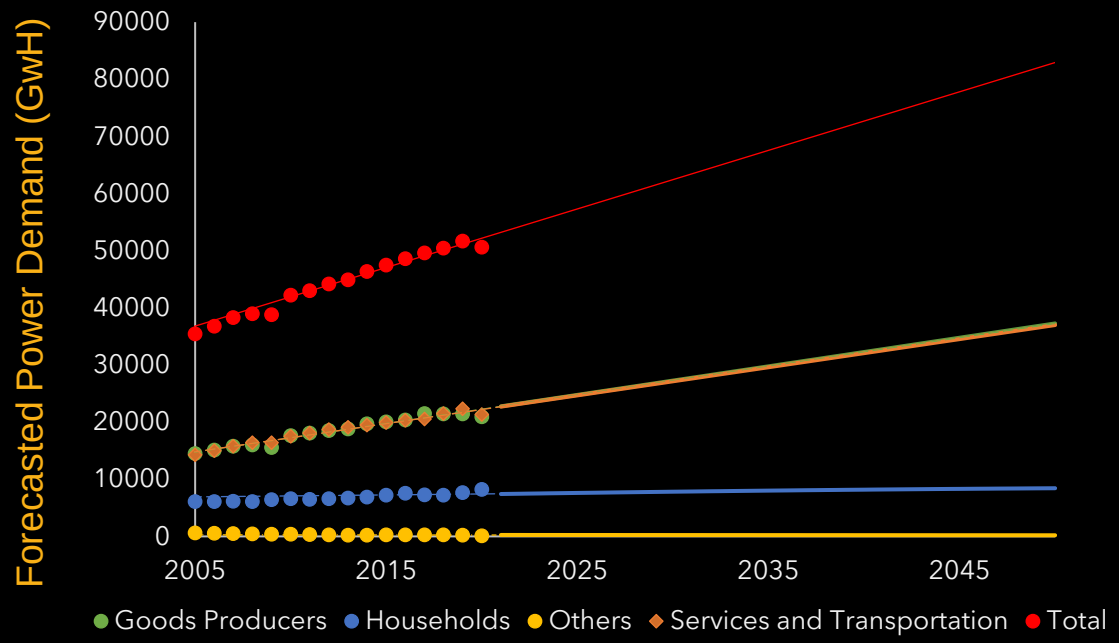
Majority of power is produced by co-gen power plants, with the main source of fuel as natural gas.

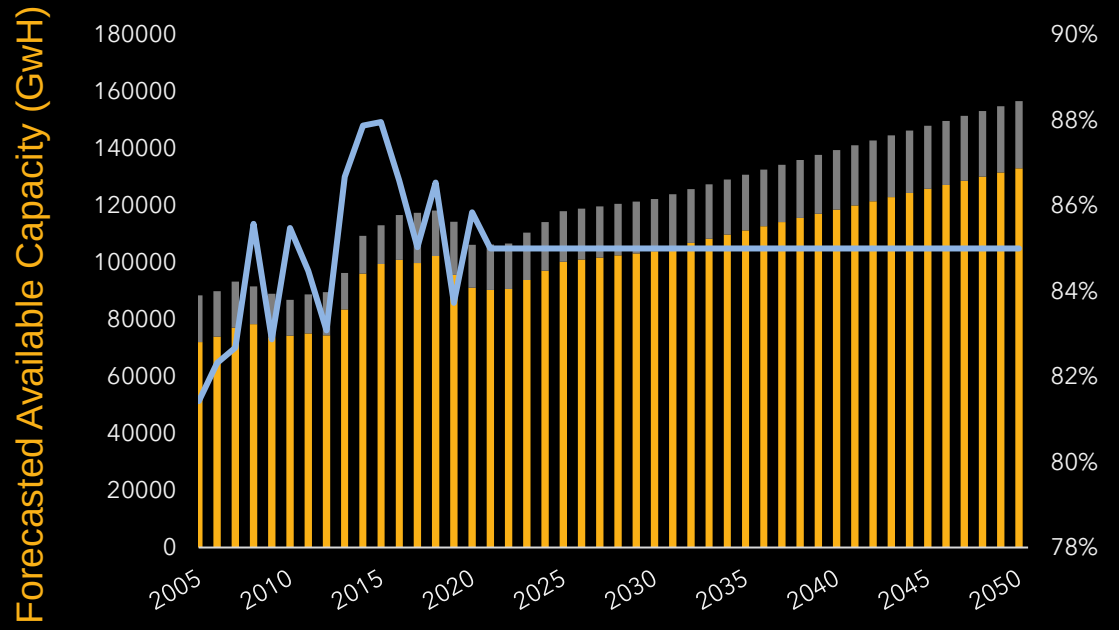
Solar PV

- Singapore Green Plan target: 1.5 GWp by 2025 and 2.0 GWp by 2030
- Potential future plans: 4.0GWp of imports from Solar farms in 2035

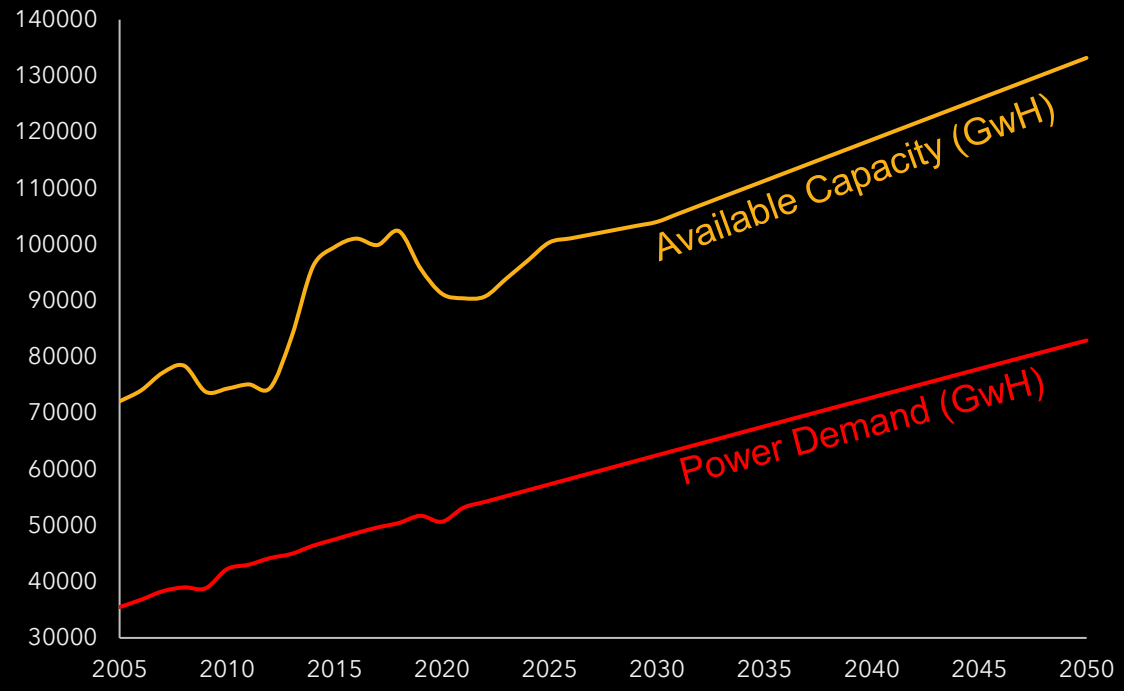
Waste-to-energy Incineration

Accounts for about 2% of generation capacity.


Forecasted Power Demand (GwH)
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
2005
2015
2025
2035
2045
Goods Producers
Households
Others
Services and Transportation
Total

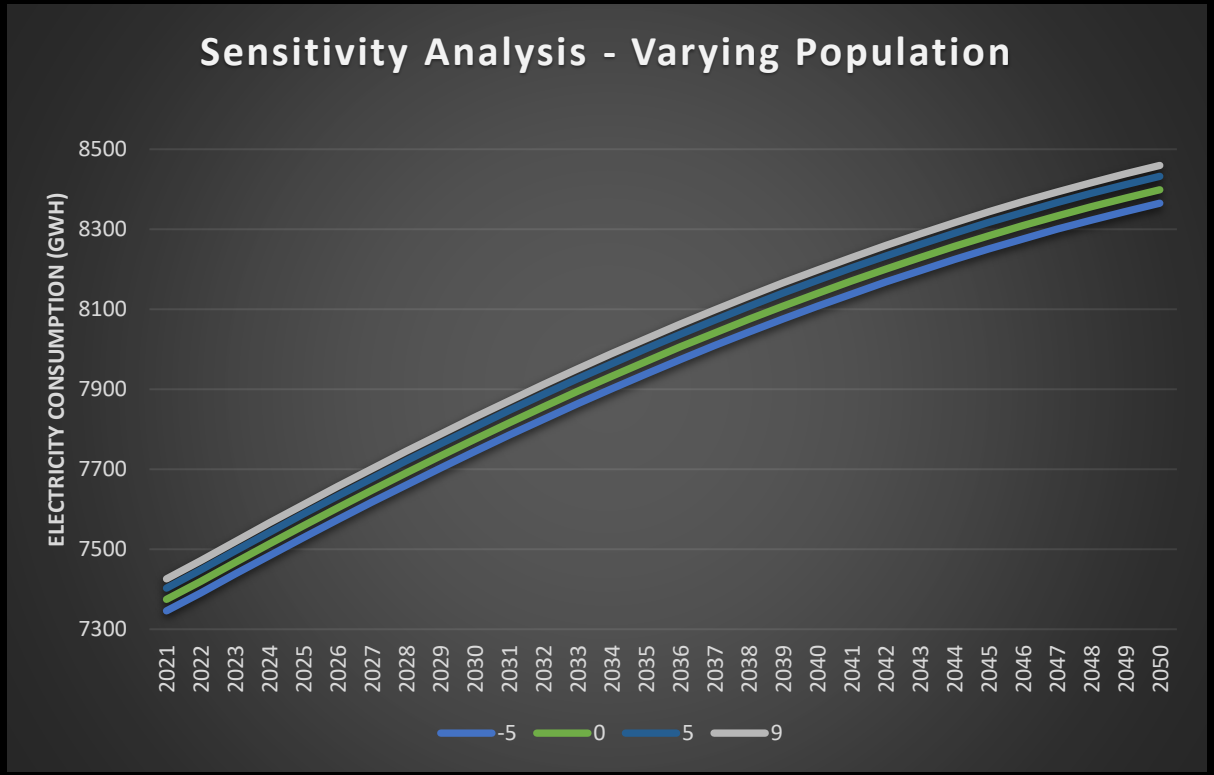

Forecasted Available Capacity (GwH)
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
90%
88%
86%
84%
82%
80%
78%
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050

Base Model


140000
130000
120000
110000
100000
90000
80000
70000
60000
50000
40000
30000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Available Capacity (GwH)
Power Demand (GwH)

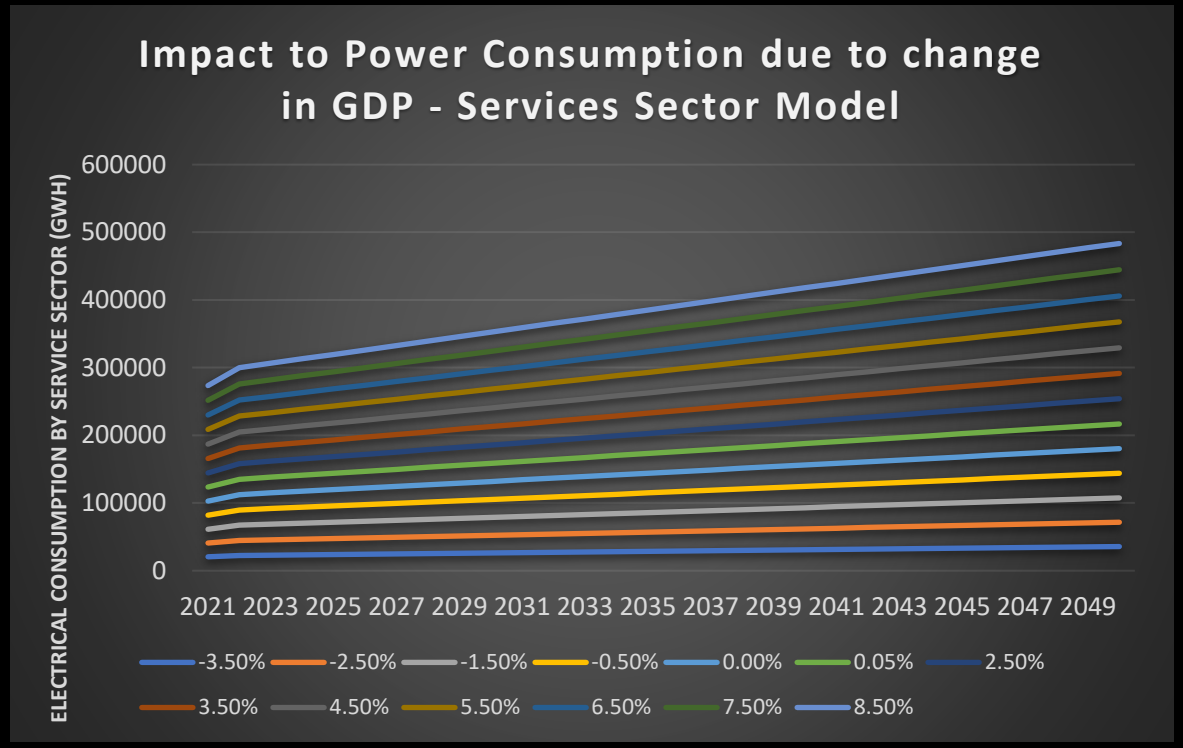
Sensitivity Analysis

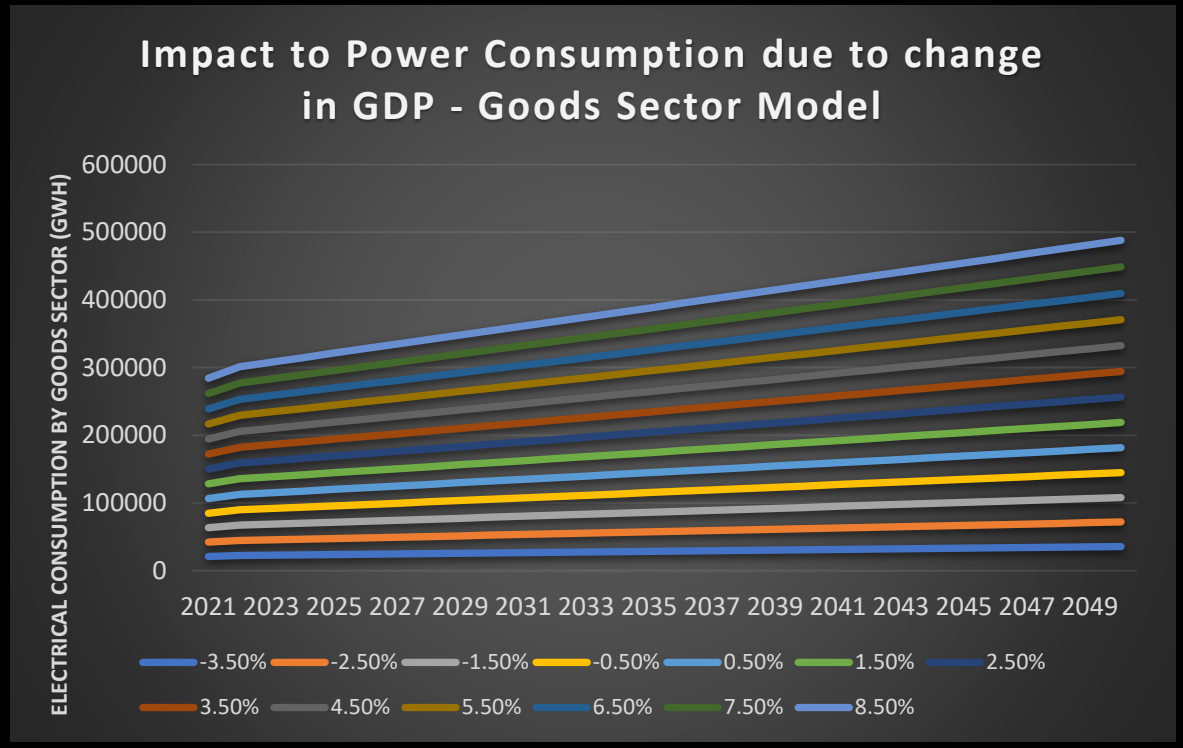
Incorrect Population Prediction



Electricity consumption varies with changes in Population

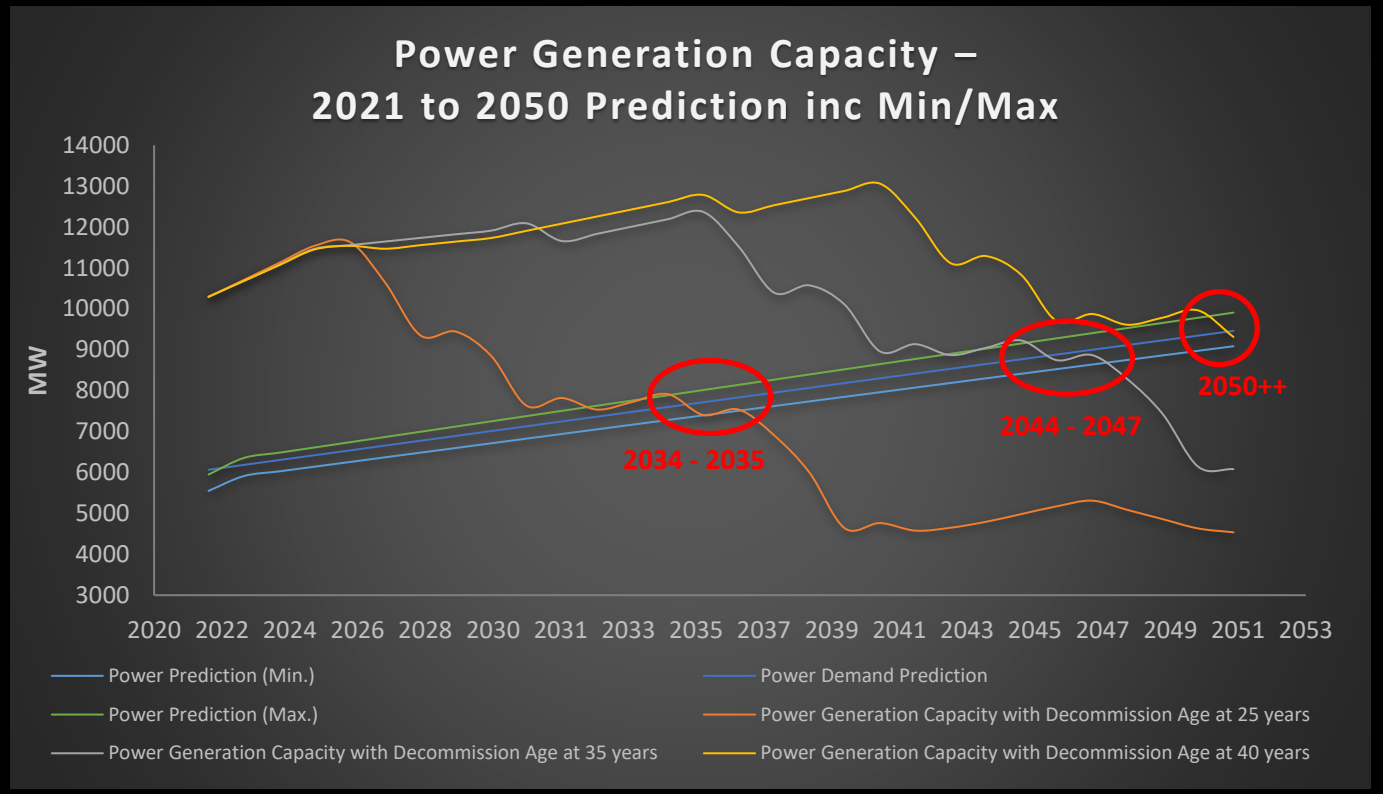
Incorrect Estimation of Goods & Services





> Changes to GDP, be it Services or Good industry sector, impacts the rate of power consumption

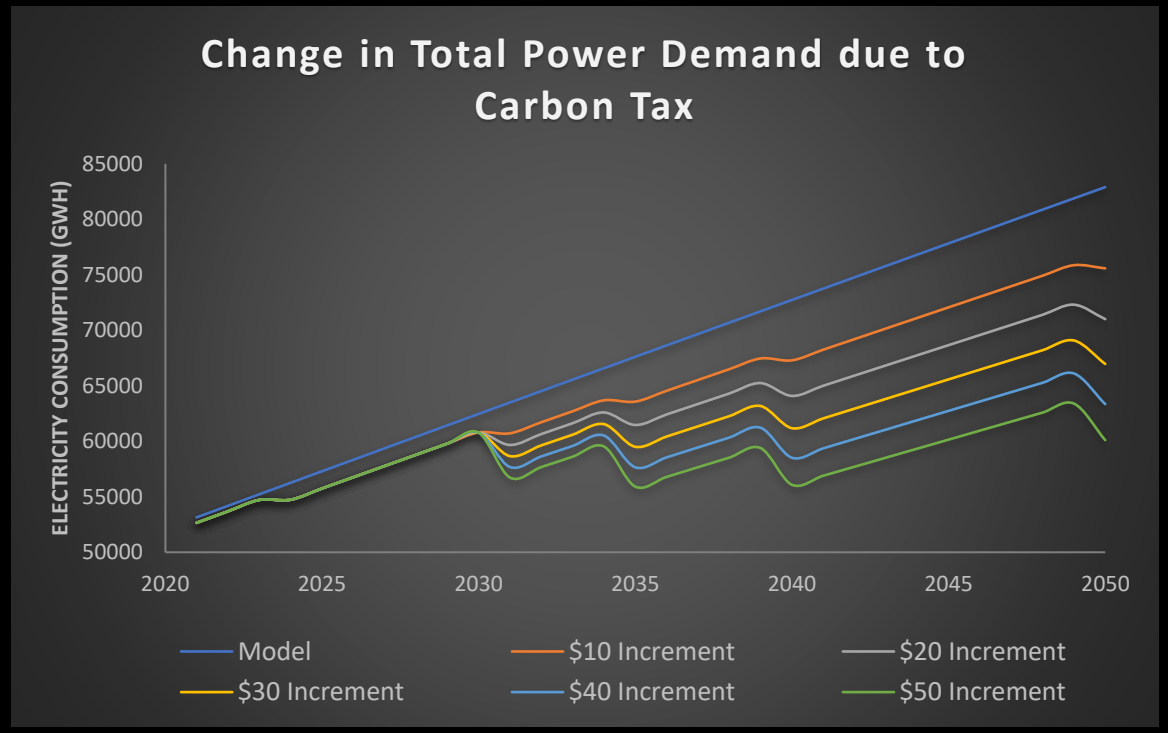
Decommissioning of Power Plants

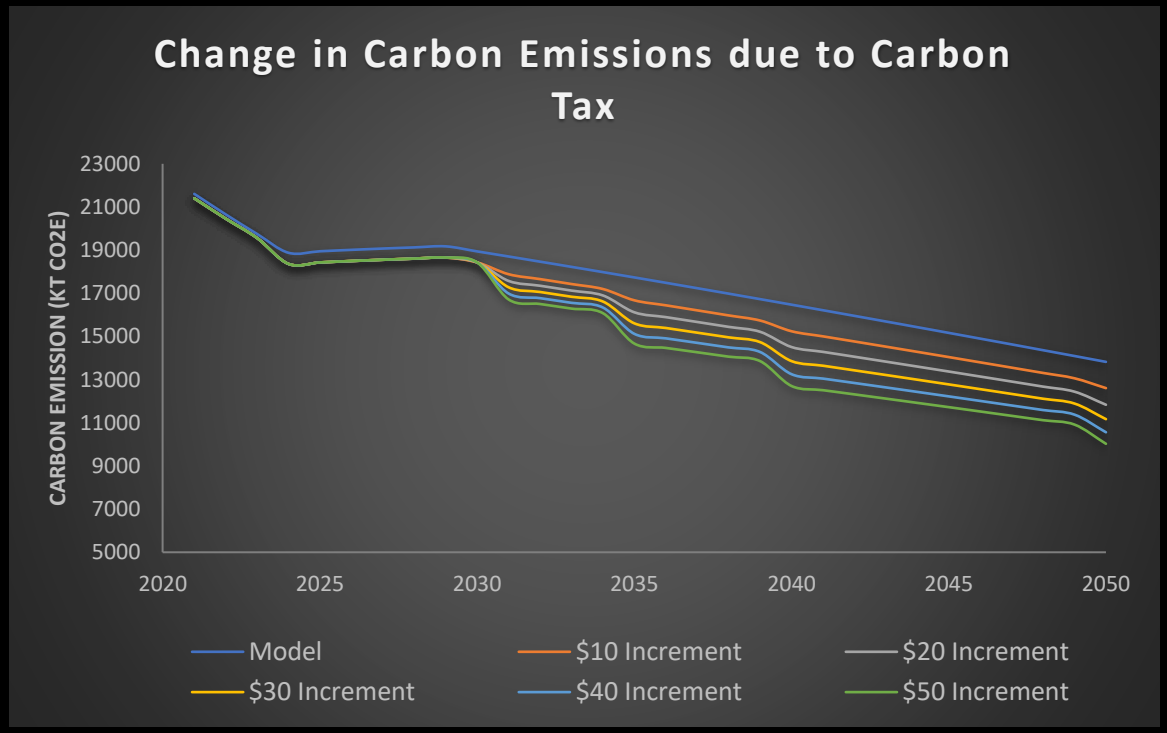


> Potential energy supply crunch between year 2034 and 2050

Trade-off Analysis

Impact of Carbon Tax





> Effective carbon taxing can lead to lower power consumption

G	H	I	J	K	L	M	N	O	P	Q

Demand: Annual Power Consumption (GwH)				
ds cers	Services and Transportation	Households	Others	Total
.04	14275.62	6092.46	612.14	35489.26
.38	15031.11	6109.13	546.19	36801.81
.97	15820.74	6163.74	501.47	38304.91
.88	16404.46	6094.03	457.59	38986.96
.26	16407.87	6430.80	413.94	38822.87
.58	17568.40	6635.97	384.81	42251.75
.51	18100.42	6482.70	346.51	43007.14
.53	18694.68	6629.53	303.97	44200.71
.82	19087.70	6754.91	263.38	44948.82
.20	19487.66	6924.39	237.70	46402.95
.00	19925.87	7220.93	279.14	47513.94
.44	20338.69	7589.44	280.07	48626.64
.32	20555.03	7295.82	276.48	49643.65
.73	21506.03	7221.43	270.70	50448.90
.45	22335.90	7688.01	251.67	51720.03
.20	21324.90	8244.50	129.87	50656.47
.90	22707.78	7419.72	256.49	53158.89
.08	23201.16	7466.79	253.97	54196.99
.27	23694.54	7513.14	251.44	55234.39
.45	24187.92	7558.76	248.92	56271.05
.64	24681.30	7603.62	246.39	57306.95
.82	25174.69	7647.71	243.86	58342.08
.01	25668.07	7690.99	241.34	59376.40
.19	26161.45	7733.45	238.81	60409.90
.38	26654.83	7775.06	236.28	61442.55
.56	27148.21	7815.81	233.76	62474.34
.75	27641.59	7855.66	231.23	63505.24
.94	28134.97	7894.61	228.70	64535.22
	28628.36	7932.63	226.18	65564.28
.31	29121.74	7969.69	223.65	66592.39
	29615.12	8005.79	221.13	67619.53
		.90	218.60	68645.67
	.88	8075.00	216.07	69670.81
		8108.07	213.55	70694.92
			211.02	71717.99
			208.49	72740.00
		8200.94	205.97	73760.92

Supply: Annual Power Available Capacity					
Years	Available Capacity (GwH)	Outage Capacity (GwH)	Total Capacity (GwH)	Availability (%)	Normalised Total Capacity (GwH)
2005	73656	16802	90458	81%	8
2006	75649	16248	91897	82%	899
2007	78844	16515	95359	83%	93364
2008	80108	13503	93611	86%	91653
2009	75387	15578	90966	83%	89063
2010	75953	12904	88857	85%	86999
2011	76721	14095	90816	84%	88916
2012	76079	15495	91573	83%	
2013	85380	13123	98503	87%	
2014	98190	13546	111736	88%	
2015	101674	13916	115589	88%	
2016	103223	15976	119199	87%	
2017	102049	17970	120019	85%	
2018	104566	16258	123	87%	
2019	97784	19007	11	84%	
2020	93194	15363	10855	86%	
2021	92365	16300	108665		
2022	92704	16360	109064		
2023	95975	16937	112912		
2024	99247	17514	116761	85%	
2025	102527	18093	120620	85%	
2026	103271	18224	121496		
2027	104016	18356	122372		
2028	104761	18487	123248		
2029	105507	18619	124126	8	
2030	106252	18750	125002		
2031	107741	19013	126754	85	
2032	109230	19276	128506	85	
2033	110	19539	130263	85%	
2034	112215	19802	132015		
2035	113702	20065	133767		
2036	115191	28		85	
2037	116684	20	137	85%	
2038	118174	20854	139028		
2039	119663	2			
2040	121152	2			
2041	122643	2			
2042	124135				
	5624				
	13				

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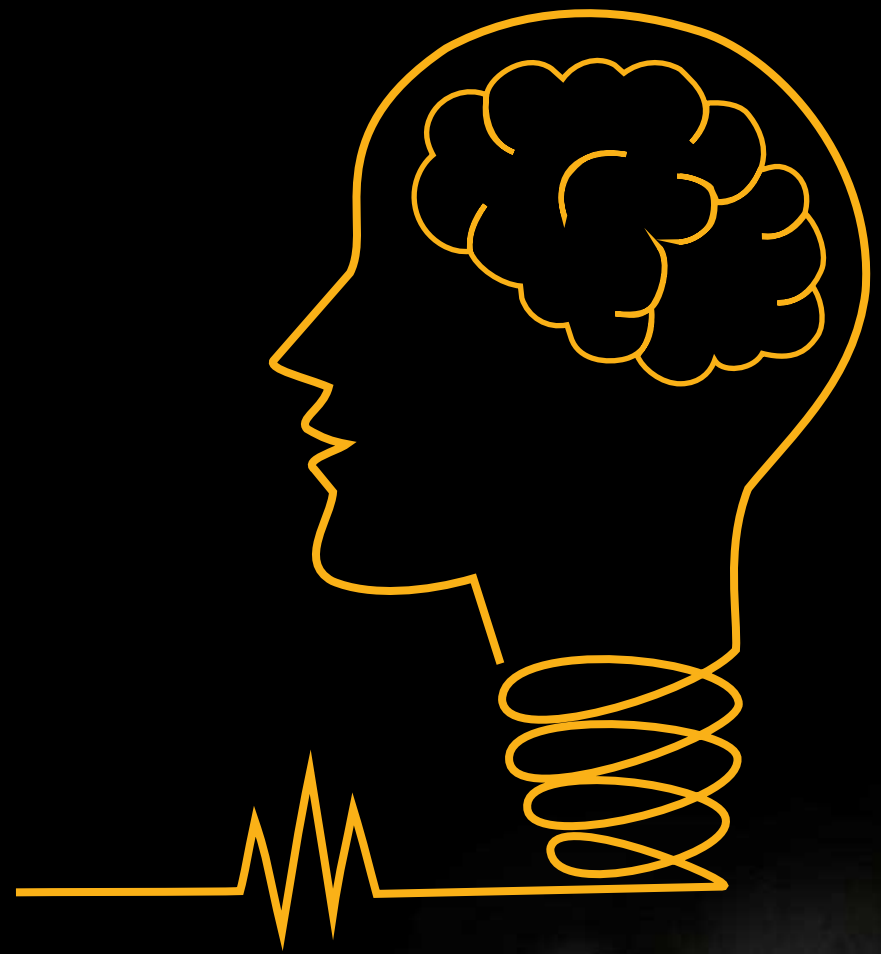
Model Demo

Improvements to be made

- To explore other possible variables that may affect energy consumption
- Improvement to COVID19 assumptions
- To further improve on data regarding alternative power sources



Conclusion

- ☑ Change in GDP or population growth rate affects the electricity consumption
- ☑ Potential energy crunch from year 2034 to 2050 due to aging power plants
- ☑ Effective carbon taxing can lead to lower power consumption

Question & Answer


Thank You