Energy Conservation Through Applying an Energy Management System (EnMS) ISO 50001

By

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Scientific Environment

This thesis uses the System Dynamics methodology to Energy Conservation Through Applying an Energy Management System (EnMS) ISO 50001formulation and evaluation.

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بسم الله الرحمن الرحيم

"Bism Allah Alruhmin Alrahim"

At first, I want to start by showing my gratefulness to the GOD who gave me the power to make this thesis. Secondly, I want to show my sincere gratitude to my thesis supervisor, Professor Erling Moxnes for his dedication for me to learn System Dynamics from the first day at the University of Bergen and guidance for this thesis and also Professor Birgit Kopainsky for her support. Thirdly, I want to say thanks to my Father and my son and daughter for their support. At last, I am dedicating this thesis work for the soul of my mother Salima Al Riz which she passes away this year.

Abstract:

Energy considers is an important factor for Sustainable development in the modern world and it has been much research to save the energy due to the Non - renewable natural sources, This issue inspired a lot of specialists to talked about how to make the best use and practice for saving this energy, And how to stop the depleted of natural resources and reduce the planet pollution and greenhouse phenomenon.

Energy management has become pivotal for the industrial sector as a structured approach to lowering the cost of production and in reducing the Co2 emissions.

This Thesis a study of how the reduce Co2 emissions and electricity consumption by applying management methodology and adopting energy management systems (EnMS) ISO 50001 in industrial sectors as a way to reduce energy consumption and emissions and effect of that on electricity Prices and fuel substitution in electricity generation.

ISO 50001 is international system management standards, focusing on Energy management. ISO 50001 is launched by (International Organization for Standardization) to fulfilled the needs to concentrate on saving energy and reduced consumption by best practice work in Companies and enterprises for both industrial and services sectors.

Keywords: Electricity consumption, ISO 50001, Energy management system, Co2 Emissions, Power Plants, Electricity Price, Production capacity.

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Chapter 1: Introduction

1.1 Introduction :

Electricity power considers one of the most important energy types due to the multi ways for produces and easy to transfer at a reasonable cost.

the increase for electric power demand will increase the demand and use of nature recourse such as oil, gas, coal and that has a big impact on the greenhouse in the atmosphere in addition for that the side effect on the global warming problem.

Here is the main problem the emission is increased by the increments of electricity demand.

“World electricity production is now a day dominated by the use of coal (41.5%). Projections indicate that the most likely scenario is to maintain this share in the future, mainly due to the increase in population and economic growth in the developing countries. China already uses more coal than the USA, EU, and Japan together, whereas India is right behind China in the construction of coal combustion power plants carbon dioxide emissions that contribute to global warming and climate change have gained wider interest.

“The increase in global-warming gases derived from the use of coal in the emerging economies is likely to exceed the overall greenhouse gases emissions in all the industrialized countries over the next 25 years”:

Optimization of global and local pollution control in electricity production from coal-burning (Jorge,2014.P1)

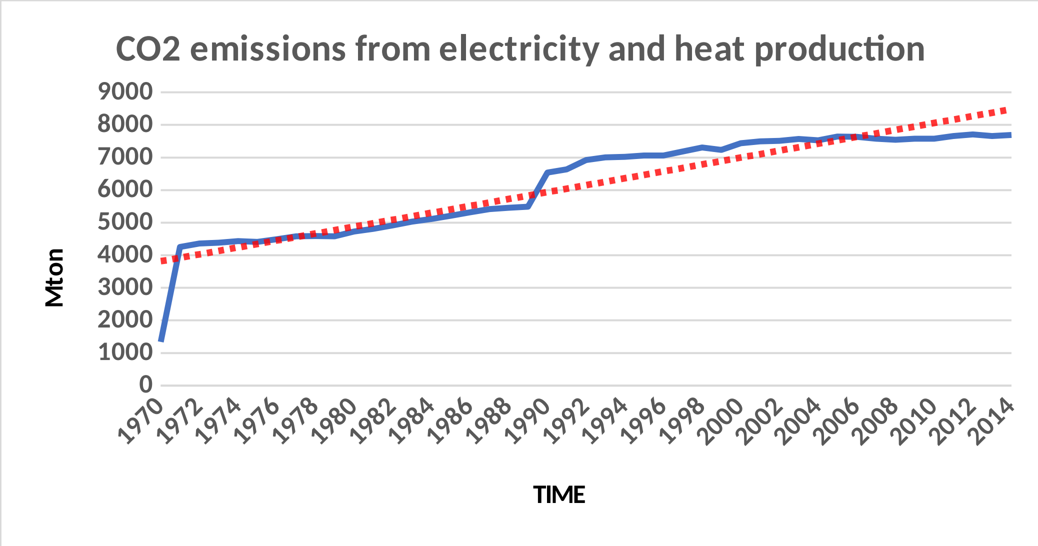


Figure 1: Co2 emissions over the world from electricity and heat production.

Resource: The World Bank Data

The Co2 emissions as flow from barning coal are accumulated in the atmosphere stock and that bad impact on the environment and of course, the dynamic of natural renewable resources process become a more complicated problem by the increment of electricity demand due to the increment of population and that means more coal burn and more pollution and less of renewable recourses.

There is no argument that the increase of population is contributing and cause the increased of energy-intensive and especially for electric, that relationships

Were test by (John P. Holdren,1991) in his book Population and the Energy Problem

Johan Was explain The equation which can clear that causality relationships as "A society's total energy use E, is the product of its population P, and its energy use per capita e" (John P. Holdren,1991.P 243)

$$[E = P \times e]$$

He believed that there is also another factor like “The environmental impact I, associated with a society’s energy use is the product of total energy use times a technology-dependent factor i, that measures the impact per unit of energy supplied” (John P. Holdren,1991.P 243)

$$[I = E \times i,](2) \text{ or}$$

$$[I = P \times e]$$

To find the contribution to the growth of multiplicative product for long of the time period we have to use the logarithms of a ration of the initial values or to covert the percentages to annul averages

“[Population share of growth = annual averages population growth rate]”

annual average energy growth rate

(John P. Holdren,1991.P 244)

It is obvious that there are cause and effect relationships between the population growth and electric consumption and also there is a causality relationship between the increase of the electric consumption and the growth of industrial and economic activity and that we can define it as the growth of a domestic product (GDP).

This increment in electricity demand because of the industrial and economic growth will lead to the increment in the electricity prices

(Athanasios A.Rentizelas,2012,P 625) in their book Investment planning in electricity production under CO2 price uncertainty discussed these issues by estimate the prices will reduce if the emission of CO2 is decreased

Table1: CO2 price scenarios.

year	Scenario1: zero CO2 price (€/ton CO2)	Scenario 2: low CO2 price (€/ton CO2)	Scenario 3: medium CO2 price (€/ton CO2)	Scenario 4: high CO2 price (€/ton CO2)
2010	0	15.00	15.00	15.00
2015	0	15.17	16.97	19.14
2020	0	15.17	19.20	24.43
2025	0	15.29	21.72	31.18
2030	0	15.45	24.58	39.80
2035	0	15.59	27.81	50.80
2040	0	15.79	31.46	64.83
2045	0	15.90	35.60	82.74
2050	0	16.10	40.28	105.60

Source: Investment planning in electricity production under CO_2 price uncertainty (Athanasios A.Rentizelas,2012,P 625)

It is will be obvious that the market price will be affected by the rise in electricity consumption and that will influence the prices products and services because the cost of electric power included in the total cost of products and services cost and that makes The problem more complicated.

(Erling Moxnes,1990) made a study paper about the interfuel substitution in electricity production he was argued the cost of produce electricity by analyzing the use of a different way of fuel and power plants.

Moxnes mention that lifetimes of power plants are 30 years and there is a cost in converting a plant from a type of fuel to another.

He also showed that the producer of electricity will choose the fuel according to the total cost which consists of the capital cost, the operation cost of the plants, the burner efficiency, and also the positive or negative premium reflect related to many factors such as flexibility, availability, employment opportunity.

Moxnes illustrate that by using the multinomial logit model to choose the fuel shares (PSi)used to generate electricity by using the equation (Moxnes,1990.P 46):

$$[PS_i = \frac{e^{-\alpha Ci}}{\Sigma_i e^{-\alpha Ci}}]$$

(As $e^{-\alpha Ci}$) is the cost of the fuel used and ($\Sigma_i e^{-\alpha Ci}$) is the sum of all fuel used in the power plants.

The objective of this study is to assess the dynamics using different fule and the effect of electricity consumption on CO_2 emissions.

The study raises issues such as:

1. How does the fuel mix develop over time as a function of cost assumptions?
2. Is applying Menergy management ISO 50001 as a policy will affect CO_2 emissions.

1.2. Hypothesis:

The increment of electricity demand in the last decades causes significant increment for electricity generation by different types of fuel and this made the accumulation of Co2 in atmospheric layers.

Recent research shows that Co2 is one of the important causes of Greenhouse gases phenomenon and increment of earth temperature.

1.3 Analysing the problem :

The world electricity demand growing due to the rapid growth of economies for individual and industrial activities, this creates the need for more electricity plants to meet electricity demand. Most of the electricity plants using coal and natural gas as the cheapest recourses to produce electricity, the burn of coal and natural gas during the electricity process generates fumes and gases, Co2 is one of the gases which create during the burn operation and this gas accumulates in the atmosphere and causes the most serious environmental problem of our time.

There is also a growing scientific consensus that not only the electricity plants cause this problem but human activity also is a substantial cause of greenhouse gas accumulation in the atmosphere.

1.4 suggestion policies and implementation:

It is obvious from analyzing the hypothesis and analyzing the problem that electricity consumption plays significant rolls is this issues, and of course, the electricity plants and the fuel mix and the cycle of the fuel cost and cycle of electricity price due using the renewable recourses for energy, all these variables make a big challenge for decision-maker to find the best policy from alternative such as :

In this thesis study, we consider applying an energy management system ISO 50001 to reduce electricity consumption in the industrial and service sector.

Chapter 2: Background Theory

2.1 Background:

Produce electrical energy and the way of using become of the serious issues for last decades, the negative impact on the environment and global warming due Emissions and continuous depleted for natural resources in electricity plants made this problem more critical, in addition to the serious effect, the cycle pricing in the electricity market supply and the reflection of that of the electricity demand cause influence on the economic growth and on the smooth flow of products and services into the end-user.

Energy Management System (EnMS) become one of the policies to reduce energy consumption, many of the research has taken place to show up the benefits and challenges of adopting energy management system (EnMS) ISO 50001.

Some of this research figured out that the cost savings are the common factor to motivate the decision-maker in the industrial sector to invest in energy efficiency, in addition to that some factors like Environmental sustainability, clean energy goal, and government regulation play significant roles in adopting this policy.

In this study, I will highlight the effect of applying (EnMS) energy management system of reducing emission from the fuel mix used by electricity plants and reflect that on the electricity price.

2.2 Methodology:

This thesis research was conducted followed by system dynamics methodology based on data collected from reliable resources concern on energy and electricity data, it was difficult to collect data based on interview methods because of the crisis of Corona Epidemic.

Stella Architect version 2.0 used to stimulate the model and demonstrate system behavior

Chapter 3: Explanatory Model

3.1 overview of the model:

An overview of the model shows the behavior of the model, electricity consumption plays a significant role in the dynamic and share the causality and the effect with electricity generation and price.

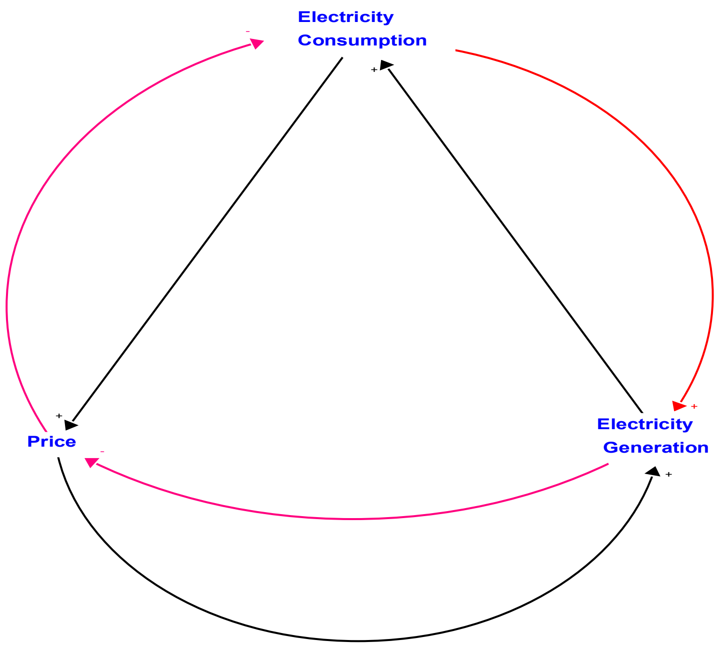


Figure 2: Simplified view of the model.

3.2 The model:

This model is built by using the system dynamics theories with Stella Architect software. By using this explanatory model, it explains how is the rise in electricity consumption causes the rise of emission.

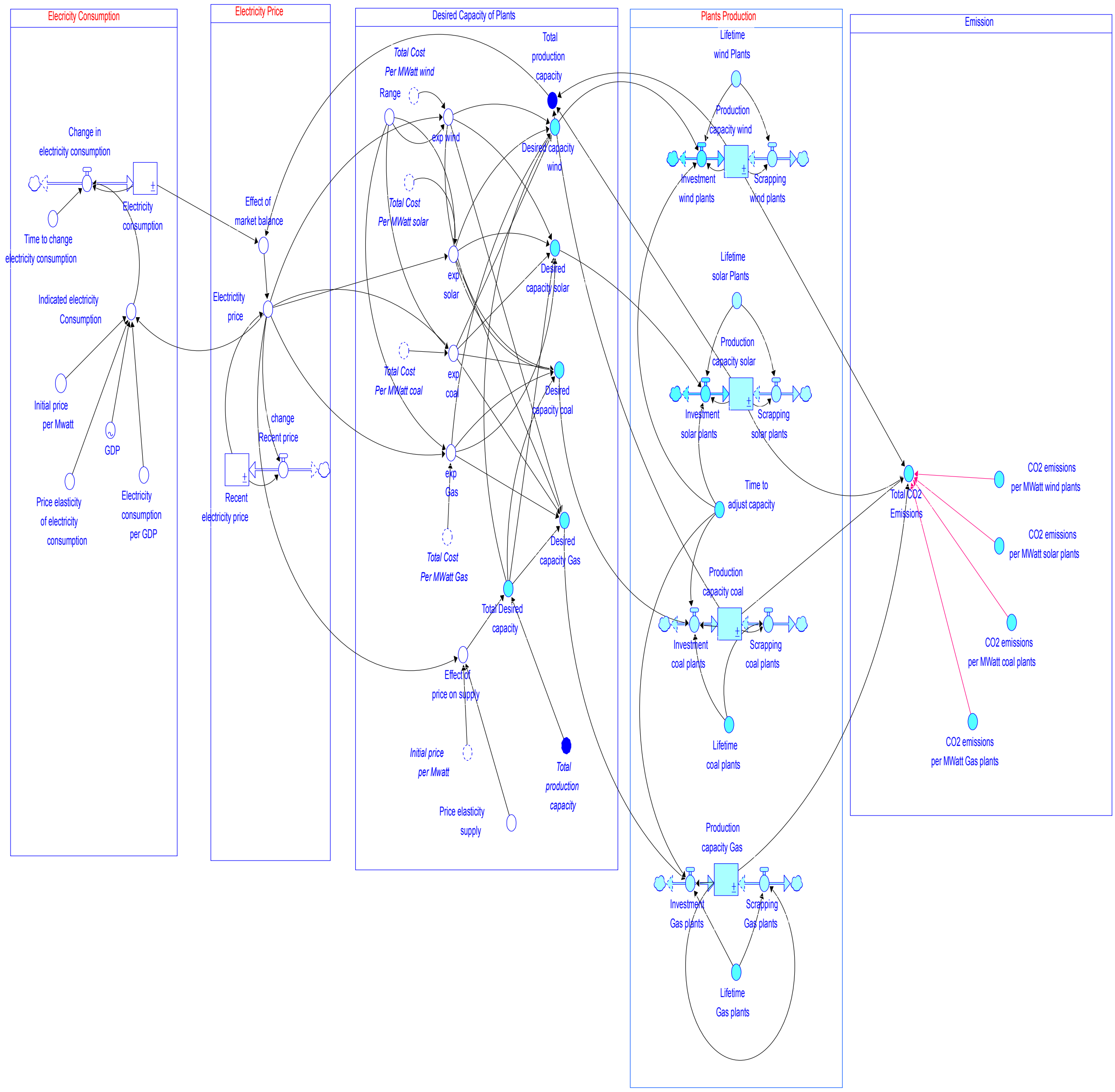


Figure 3: Stock and Flow Diagram of the total Explanatory Model.

The system in the model is consist of five sectors to illustrate how the behavior of the system based on the boundary and effective variables

The sectors are electricity consumption, electricity price, desired capacity of plants, production of plants, and emission.

3.2.1 Electricity Consumption :

Electricity consumption affected by four variables which cause the change in the inflow of electricity consumption the price of electricity is playing a very important role in electricity demand and that will be analyzing in the electricity price sector we assumed that the average electricity price per megawatt is 2000 $ and the time to change consumption is 30 years and this is the lifetime of the power plants

The equation of this flow is:

(Electricity consumption*Indicated Electricity Consumption)/Time to change consumption

The indicated of electricity Consumption contains all the variables which make the effect and cause an increase or decrease in the consumption stock.

Electricity_consumption(t) =

Electricity_consumption(t - dt) + (Change_in_elelectricity_consumption) * dt

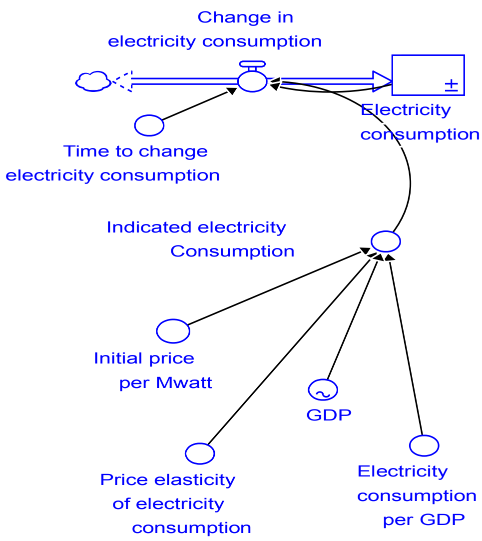


Figure 4: Stock and Flow Diagram of Electricity consumption.

Price elasticity is a factor to affect with the initial price the amount of consumption by the equation :

(Electricity price/Initial Price)^Price elasticity of electricity consumption

The third factor is growth domestic product (GDP) which of course have a significant effect on electricity consumption, the increment of demand on products and services will push the demand for energy to use in the production process and manufacturing operation.

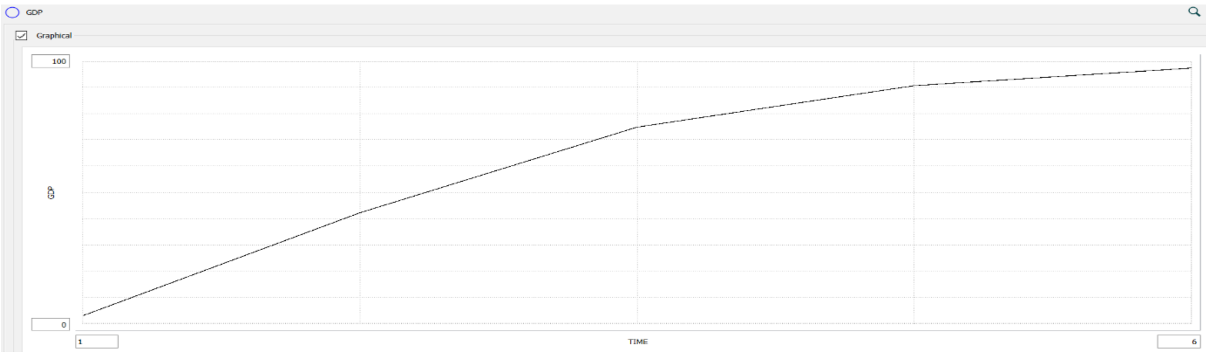


Figure 5: A Graphical function for GDP.

The fourth factor is the electricity consumption per GDP this factor gives the rate of electricity consumption per the demand for GDP growth.

3.2.2 Electricity Price :

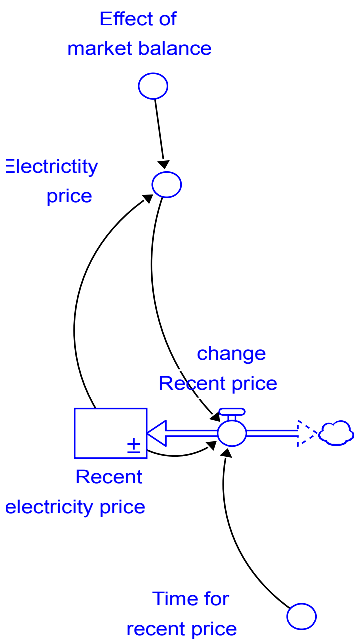


Figure 6: Stock and Flow Diagram of the Electricity price.

This sector shows that the price is effect by the inflow and stock of recent prices which represented by the equation :

Recent electricity price(t) =

Recent electricity price(t - dt) + (change Recent price) * dt

The effect of market balance represents the demand and supply for the electricity market int the model the supply is the total production capacity and the demand is the electricity consumption so the equation become for the market balance:

Electricity consumption/ Total Production Capacity

The electricity price is multiple of two variables

Recent electricity price *Effect of market balance

The recent equation demonstrates how the price is effective by the consumption and production of power plant

3.2.3 Desired Capacity of Power Plants :

The desired capacity for electricity supply is coming in the model from four types of electric power generators using different types of fuel to produce electricity Coal, Natural Gas, Solar, and wind.

3.2.3.1 Power plants using coal fule:

This kind of power plants generator is the most common due to the chipset cost of operating and service the generator and availability of the raw material using in produce process the desired capacity for one type of fuel like coal is related to the total desired capacity and the total cost of Coal divided on the sum of the total cost for all kinds of fule using in other power plants the equation of that relationship is :

Desired Capacity for Coal fule = (Total Desired capacity * Exp Coal)/(Exp Coal+Exp Solar+Exp Wind+Exp GAS)

Exp of Coal is represented by the equation of multinomial logit

Exp(Electricity price – the total Cost of using Coal to produce 1 unit of electrical power)/ Range

The Total cost of Coal is consist of three parts

- Cost of using Coal as raw material to produce 1 unit of power energy which is in our model Megawatt (Mwatt).
- Leasing cost of using capital to buy Coal as fuel.

- Other operation costs for using Coal fule such as maintenance, wages, basic operation cost.

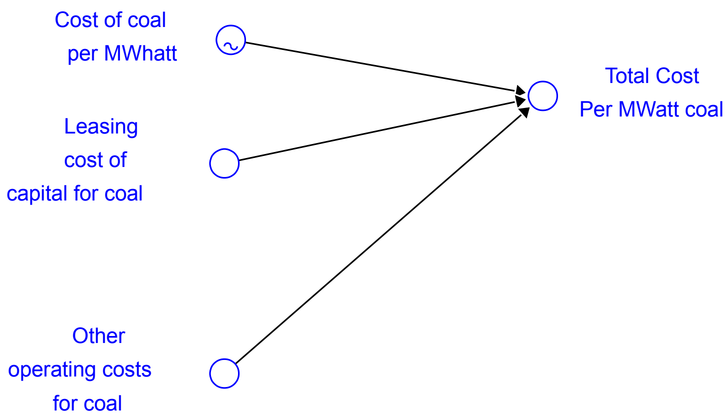


Figure 7: Total Cost for Coal Fuel.

The Rang in the previous equation is a parameter that reflects how cost and price changing between different electricity producers.

Total_Cost_Per_MWatt_coal=Cost_of_coal_per_MWatt +Leasing_cost_of_capital_for_coal+ Other_operating_costs_for_coal

3.2.3.2 Power plants using natural gas fuel :

Also, the gas plant's power generator is common to use due to the availability of the raw material and low cost of transfer and operation.

The statistics show that power plants operate by gas fuel is the second major electricity generator after the coal fuel.

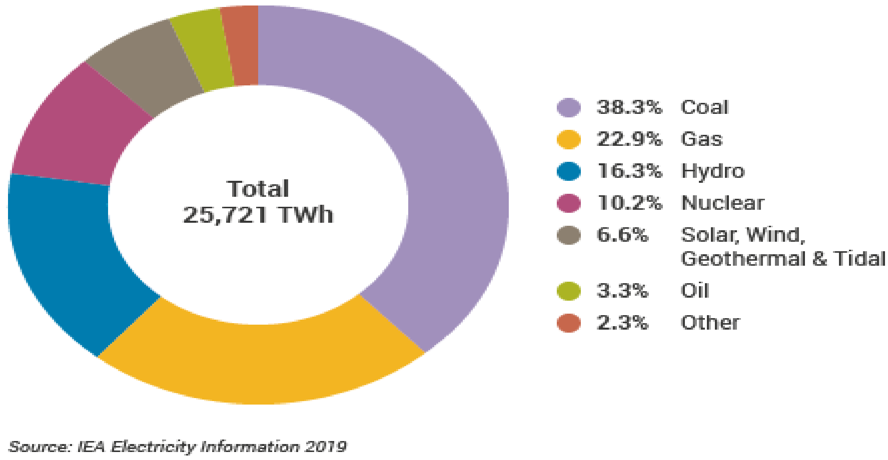


Figure 8: Percentage of power plants produce electricity by type.

3.2.3.3 Power plants using wind power:

This kind of power plants consider as clean renewable energy resources but the cost of operation and maintenance and some research show a negative impact of wind turbines on the human and environment.

Environmental impact of wind energy "It has been found that this source of energy will reduce environmental pollution and water consumption. However, it has noise pollution, visual interference, and negative impacts on wildlife"(*R. Saidur*, *N.A. Rahim*, *2011. P1)*

3.2.3.4 Power plants using solar energy :

This plant generator is considered a green energy resource the difficulty to find a good place to plant the solar mirror to give good efficiency and the high cost of service are the disadvantage of these power plants.

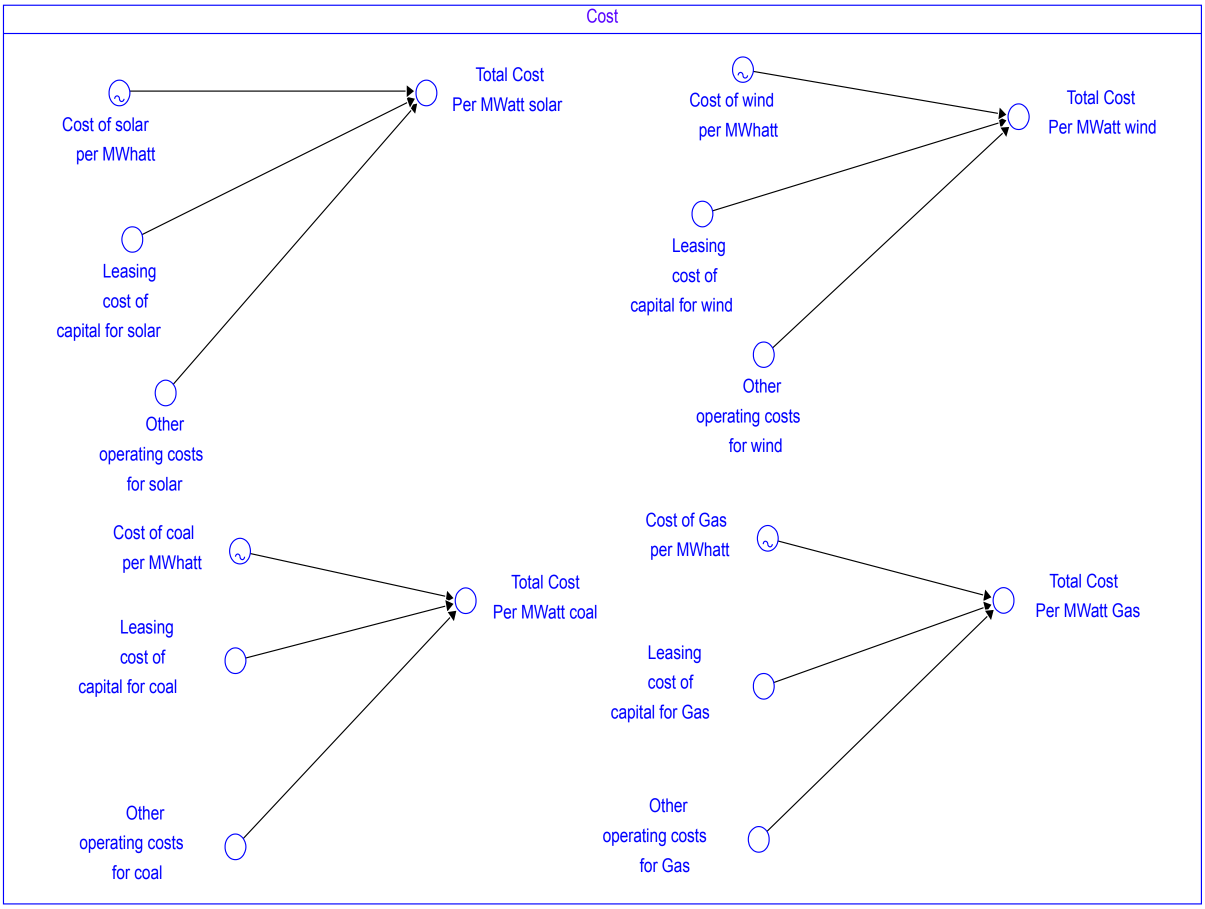


Figure 9: Total Cost for the power plants in the model.

The price elasticity supply and the initial price will affect the total desired capacity and this will show the effect of the prices on the supply.

The model excludes nuclear power plants from the study due to simplifying the model and that kind of power generation needs high technology and the radiation emission is not covered in this thesis.

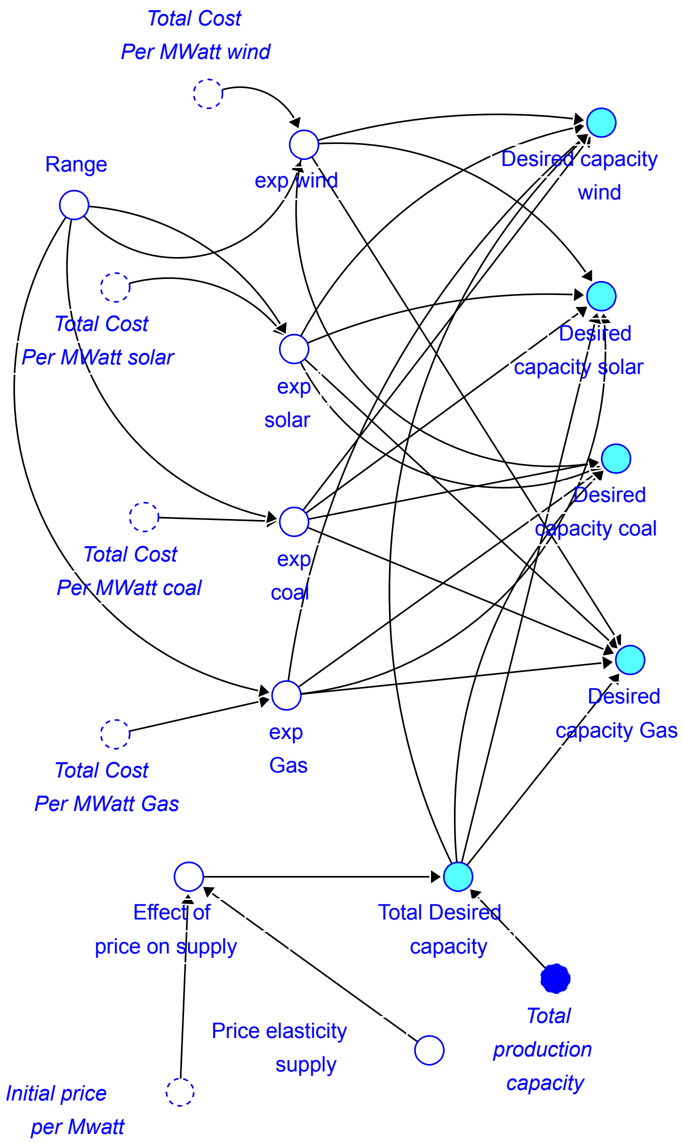


Figure 10: varieties of The Desired capacity of different plant fuel.

3.2.4 Plants Production:

Any power plants have a lifetime for investment and Scrapping in the model we adopted the time 30 years which mention in the paper of Erling Moxnes at 1990 about the interfuel substitution in electricity production due it is a realistic and objective study he made, also the time to adjust capacity is 20 years consider a reasonable time for capacity adjustment.

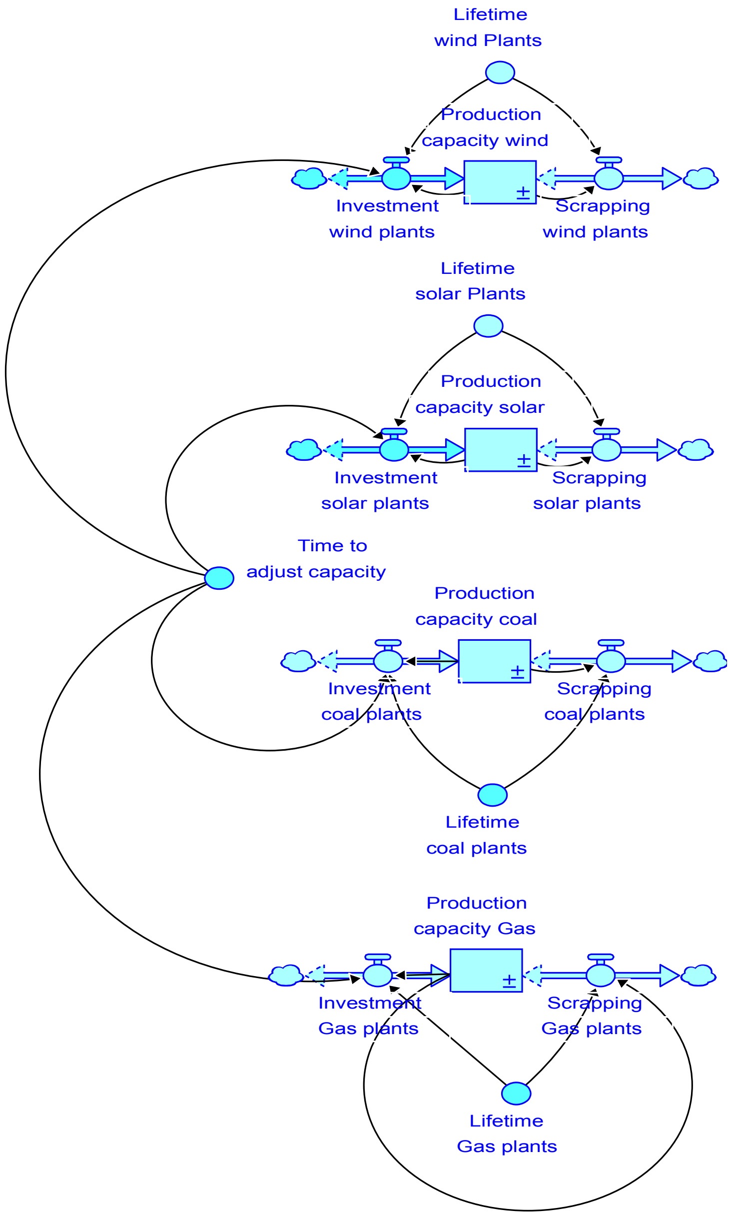


Figure 11: Stock and Flow Diagram of the Plants production.

3.2.5 Emission from Power Plants :

The emissions released from the power plants is different by the type of fuel used and the plants model, the coal and natural gas plants are the most power plants that emit CO2, and other gases during the burn process to produce electricity.

Solar energy and wind power are considered fewer pollution recourses to generate electrical power.

The emissions from generating electricity are increased over the world

We adopted the value of IEA organization, for the emissions rise from using coal and natural gas in power plants, and we assumed that solar and wind power have emission equal to 1 for simplifying the model.

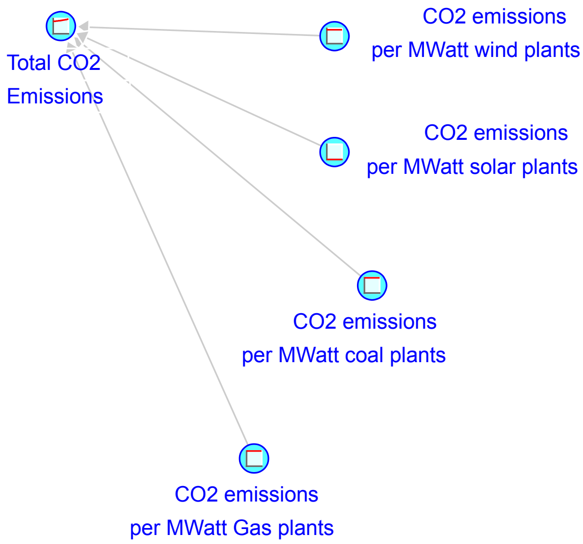


Figure 12: Emissions sector in the model.

3.3 Parmeter values:

The parameter values of Co2 emissions and initial production capacity is based on the statistics of IEA, and we estimate the cost of the different plants based on the fuel used and technology and operation applied.

IEA has trustable research and studies consider energy issues, we adopted Monex Paper 1990 for Power plants lifetime, adjustment capacity time.

Parameters Names	Values	Units
Range	10	dimensionless
Lifetime Solar Plants	30	Year
Lifetime coal Plants	30	Year
Lifetime wind plants	30	Year
LifeTime Gas Plants	30	Year
Time to Adjust capacity	20	Year
Time for recent price	0,8	Year
Time to change Consumption	30	Year
Time for Recent Price	1	Year
Initial Production capacity Coal	36420	MWatt
Initial Production capacity Gas	18500	MWatt
Initial Production capacity Wind	12000	MWatt
Initial Production capacity Solar	10000	MWatt
Price elasticity supply	-0.1	dimensionless
Price elasticity of Electricity consumption	-0.5	dimensionless
Adjust time to Apply ISO 50001	0.6	Year

Table 2: Different parameters used in the model

3.4 Model Boundaries:

There are boundaries for the model to keep the simplify and reduce the uncertain condition for variables.

- The Total cost for different fuel used in power plants is estimated due to the different types and technology used to produce electricity and different vintages power plants.
- The prices of electricity are changing in the market energy so we take the average price for a megawatt use industrial sector(Non-household).
- The model excludes the electricity consumption of the household.
- The model excluded nuclear power plants.
- Price elasticity supply should be changeable over time, but for simplification of this model, it was taken as fixed.
- Price elasticity of electricity consumption should be changeable over time, but in this model, it was taken as fixed.
- The Time to run the model is 6 years.
- The range should change according to the degree of competition between producer and changing of price and cost over time.
- The model excludes the other factors which affect indicated electricity consumption more than GDP and electricity Price for model simplifying.

3.5 Causal Loop Diagram of the Model:

Causal loop diagram gives a quick overview of the inside of the whole model. These system dynamics tools are used to simplify an easy understanding of system behavior.

By analyzing the causal loop relationship diagram, it will give insight into the feedback mechanism of the whole system.

There are two types of feedback loops working inside the model, the balancing feedback loop and the reinforcing feedback loop. With polarities of different variables, it also shows the impact of different variables.

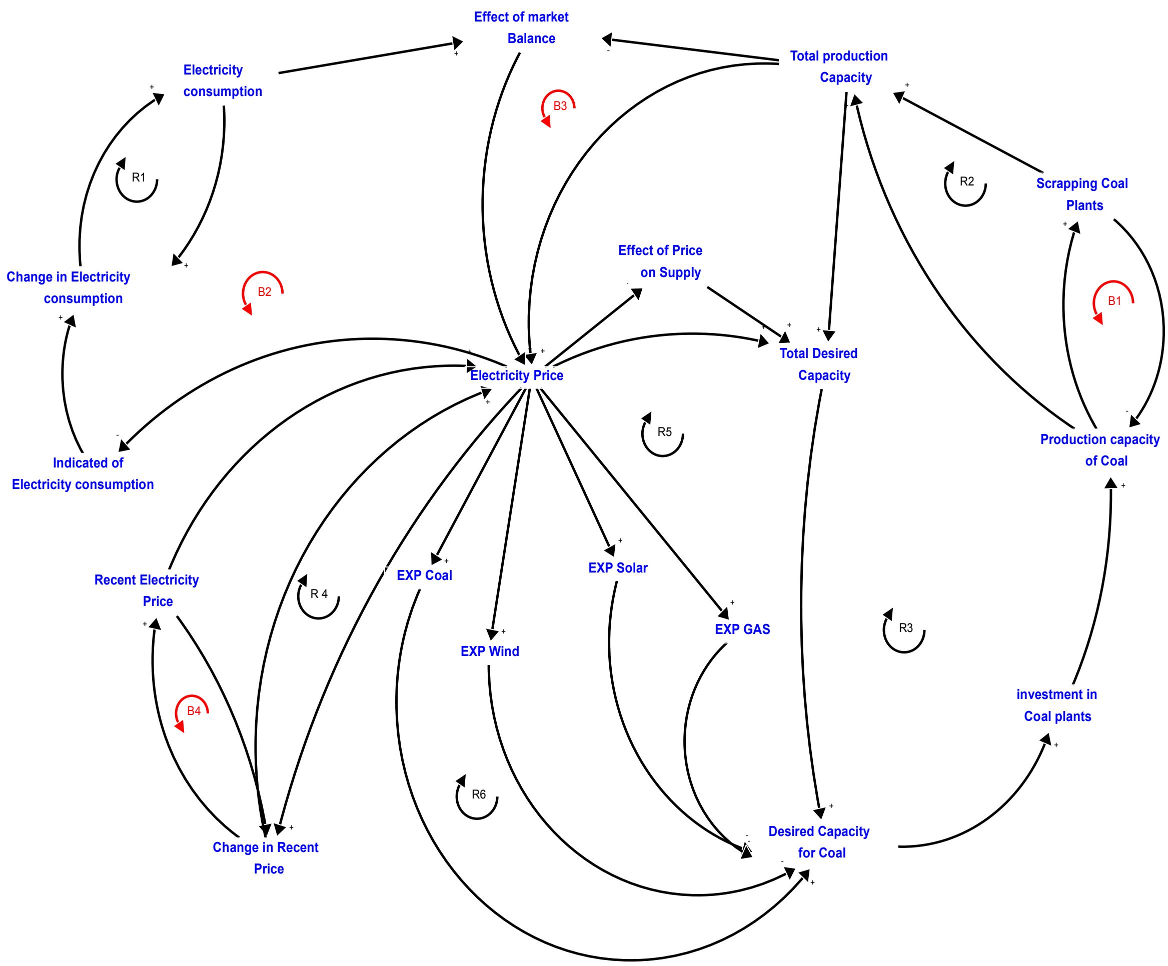


Figure 13 : Causal Loop Diagram (CLD).

There are(6) reinforcing loops and (4)Feedback balance loops in the model

The loop R1 is the strongest dominates reinforcing loops and B1 is the Balancing Feedback loops which dominate the Balancing Feedback loop.

Table {2} illustrates the loops in the model.

The loop type	The loop governs stocks, flows, variables
Reinforcing (R1)	Electricity Consumption ↔ change in Electricity Consumption
Reinforcing (R2)	Electricity Price → Desired Capacity Coal → Investment Coal Plants → Production Capacity Coal → Total Production Capacity ↩
Reinforcing (R3)	Production Capacity Coal → Total Production Capacity → Total Desired Capacity → Desired Capacity → Investment Coal Plants ↩
Reinforcing (R4)	Electricity Price ↔ Change in Recent Price
Reinforcing (R5)	Production Capacity Coal → Total Production Capacity → Electricity Price → Total Desired Capacity → Desired Capacity → Investment Coal Plants ↩
Reinforcing (R6)	Production Capacity Coal → Total Production Capacity → Electricity Price → EXP WIND → Desired Capacity for Coal → Investment Coal Plants ↩
Balancing Feedback	Production Capacity Coal ↔ Scrapping

(B1)	Coal Plants
Balancing Feedback (B2)	Electricity Consumption → Effect of Market Balance → Electricity Price → → Indicated Electricity Consumption → Change in Electricity consumption ⮌
Balancing Feedback (B3)	Production Capacity Coal → Total Production Capacity → Effect of Market Balance → Electricity Price → EXP Coal → Desired Capacity for Coal → Investment Coal Plants ⮌
Balancing Feedback (B4)	Recent Electricity Price ⟷ Change In Recent Price

Table 3: Loops dominate in the model

Chapter 4: Behavior testing & verifications for validations of the model

In this chapter, we make a behavior testing this step is needed to verify if the model is reflecting the reality of the existing systems. For model validation, the assessment deals with sufficient accuracy between the computation results and hypothetical data from the system (Martis 2006).

It is so important as the first step is to make a Verification test and that includes the structure verification, Variables Parameter Test, and Unite consistency test.

4.1 Structure verifications test:

The model we have is relatively accurate to real systems for reflecting on prices to demand and supply in the energy market. the data were based on assumptions so relatively accurate data used here. These assumed data produced based on different trustable resources. the detailed view of different parameters and equations with causal loop diagram in the previous chapter gives the properly structured view of the model. The structure of the model was produced according to the study propose and aiming.

4.2 Variables parameter tests :

Variables parameter tests were conducted in the previous chapter. Provided variables values were changed according to the model specifications over time.

The parameter is shown by different values a different logical model behavior.

For example, the change in GDP value will make changes in Electricity consumption through the effect on the indicted of electricity consumption parameter. So the model parameter behaves according to the real system.

4.3 Unit consistency test:

The unit consistency test was conducted during the modeling process and verify through Stella Architect software. It can be checked through the attached model with this thesis.

The behavior test conducted were:

- model in Equilibrium mode.
- model behavior Without policy.
- Test the model With recommended Policy.

4.4 Test The model In Equilibrium Mode :

The equilibrium test will show that all the model parameters are working in conditions and the Parmenter are represent the model in equilibrium condition, also equilibrium testing a model shows its sensitivity to changes in different parameters. the equilibrium can be achieved by conducting several simulations and changing the value of parameters of the effective loops.

The parameters which set the model in equilibrium mode are:

- Initial production Coal = 1
- Initial production Gas = 1
- Initial production wind = 1
- Initial production solar = 1
- Total Cost Coal = 3
- Total Cost Wind = 3
- Total Cost Solar = 3
- Total Cost Gas = 3
- Time to Change electricity consumption = 2e14
- Time for recent price = 1e18
- GDP = 1

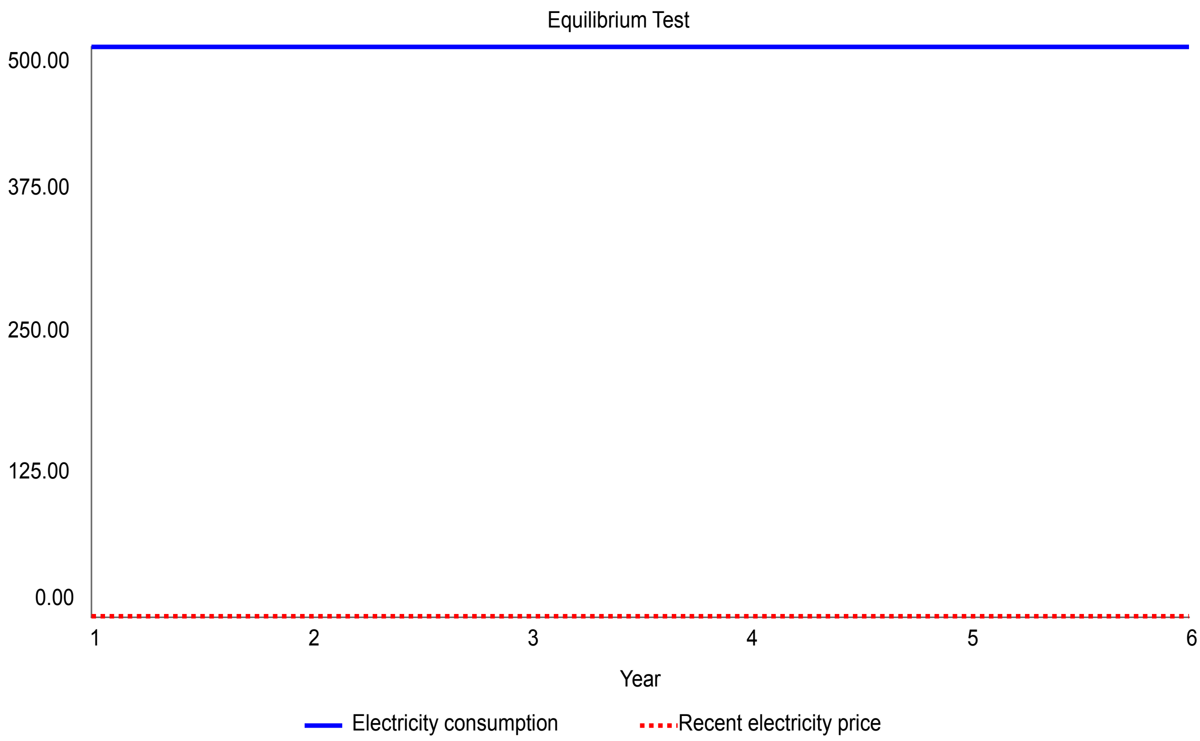


Figure 14: Electricity consumption, Recent Electricity Price In Equilibrium.

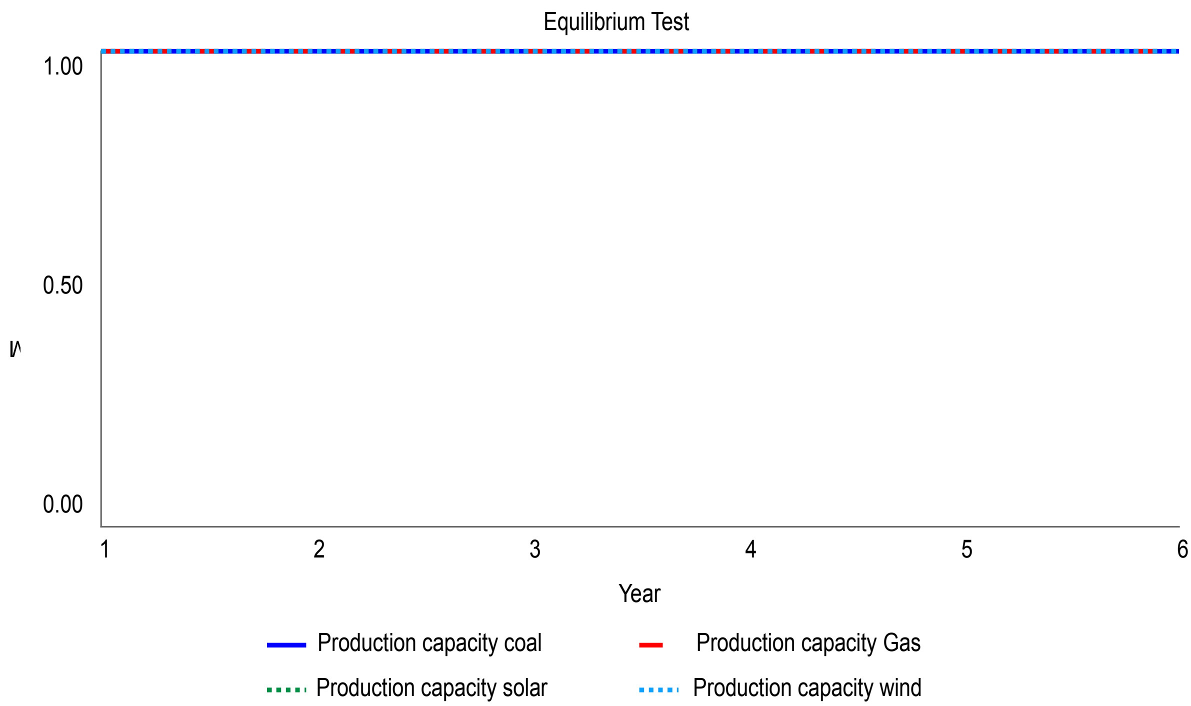


Figure 15: Production Capacity forAll Fuel use in Power Plants.

During the equilibrium test the all stocks stay constant.

4.5 Model behavior Without Policy :

In this step of the study, we check the model if representing and reflecting the reality of the existing System, in other words, does the model capture in the behavior the main Problem for this study.

Highlighting the behavior of the system and see the changing occurred du to adjust the value of the related variable will give a good understanding of why the problem happens and who we can recommend adequate Policy to reduce the impact of this problem.

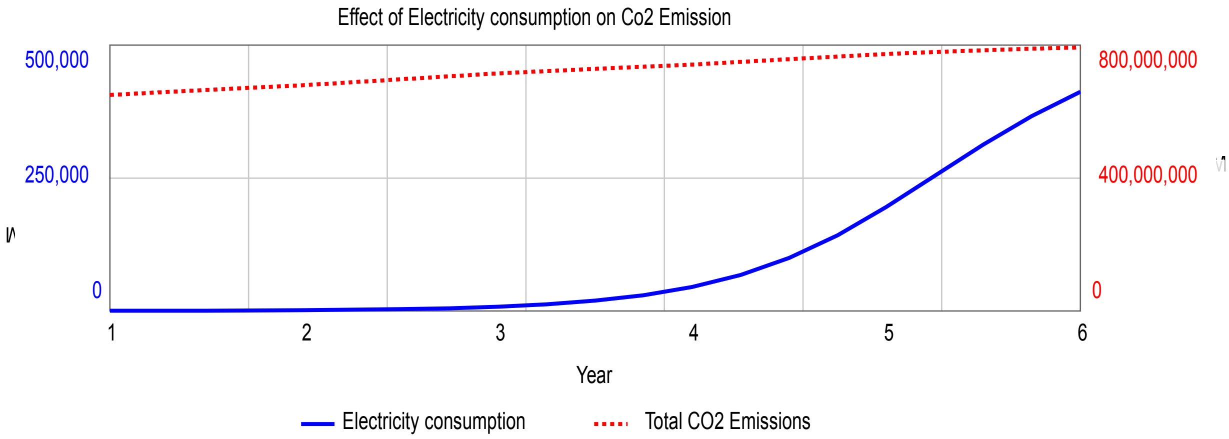


Figure 16: Electricity Consumption Vs Co2 Emission

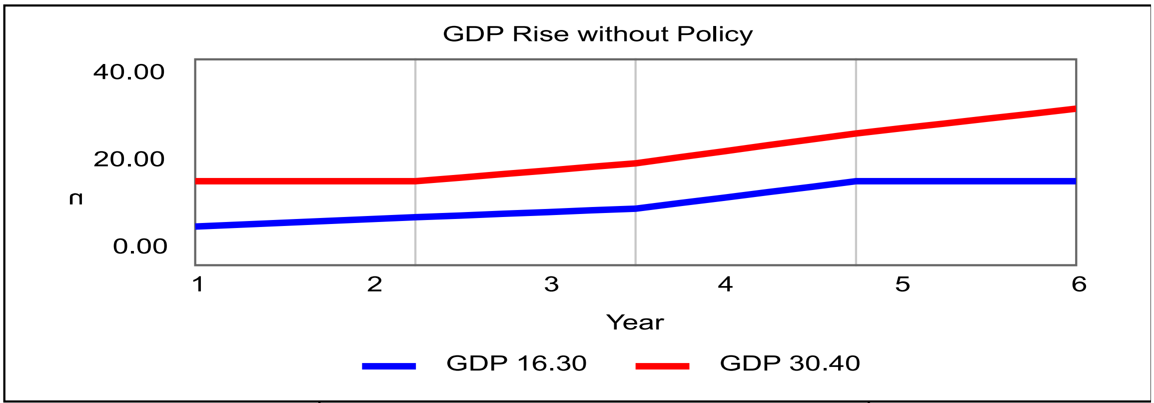
It is obvious from figure }16{ that the increment in Electricity consumption is led to effect the Co2 emission and that causality happens in the real world system as we showed in the explanatory graph for the problem definition.

without policy		
	Electricity consumption	Total CO2 Emissions
1	500.00	650,327,860.00
2	1,913.39	680,317,834.61
3	11,049.28	716,745,747.32
4	45,948.85	742,483,580.45
5	171,215.35	773,359,041.92
Final	448,503.34	794,535,965.74

Table 3: the values f increment to emissions due to electricity consumption

Table }3{ shows that the rate of emissions is increasing as the rate of electricity consumption increased.

To go deeper into the casualty of this increment we have to highlight variables which involved in this casualty relationship.



	16.30: GDP	GDP 30.40: GDP
1	7.50	16.30
2	8.94	16.30
3	10.32	18.40
4	13.12	22.12
5	16.30	26.56
Final	16.30	30.40

Figure 17 & Table 4: Increment of GDP

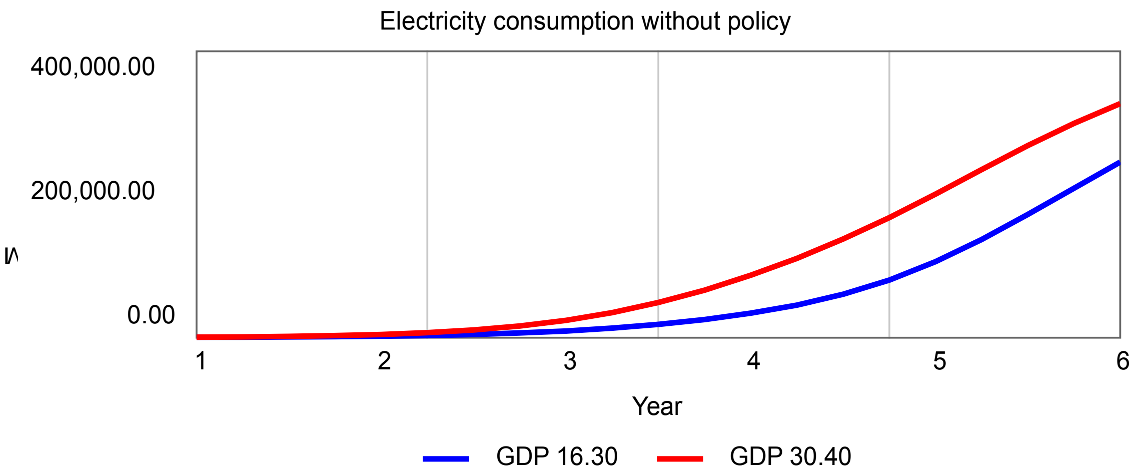
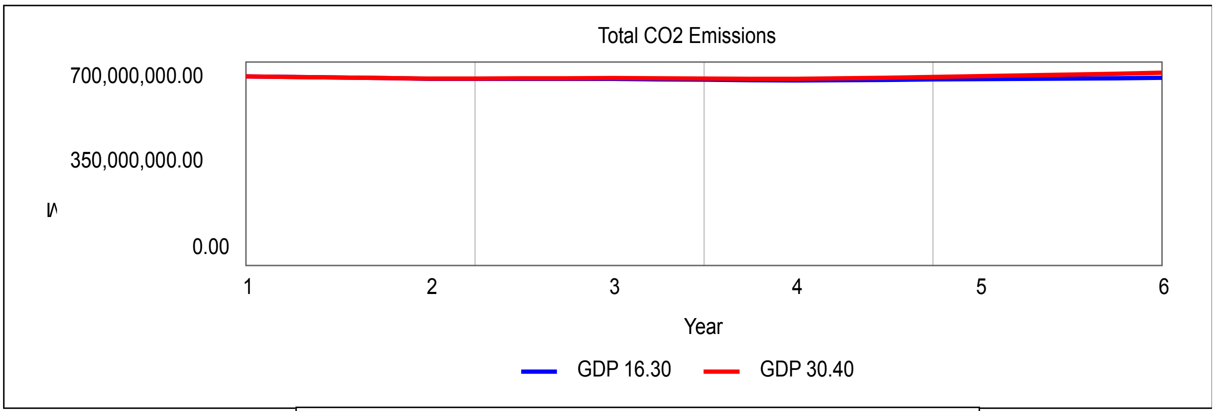


Figure 18: Electricity Consumption due to GDP rise



	GDP 16.30: Total CO2 Emissions	GDP 30.40: Total CO2 Emissions
1	650,327,860.00	650,327,860.00
2	642,112,077.06	642,876,679.78
3	641,771,926.59	644,416,418.93
4	636,430,107.04	641,826,195.06
5	641,253,918.80	651,307,474.38
Final	645,484,520.64	663,074,007.94

Figure 19 &Table 5: Emission rise due to GDP

The increase in demand for goods and service will make growth in GDP, and of course, this will make an increase in electricity demand and consumption and that make that increment of emission. Figures{18},{19}, and Table{5} illustrates this in the existing model.

The rise in demand for electricity consumption will raise the demand for electricity supply and production to meet that increment, and that will increase the production capacity for power plants and more use of fuel to produce electrical energy and that release more emission.

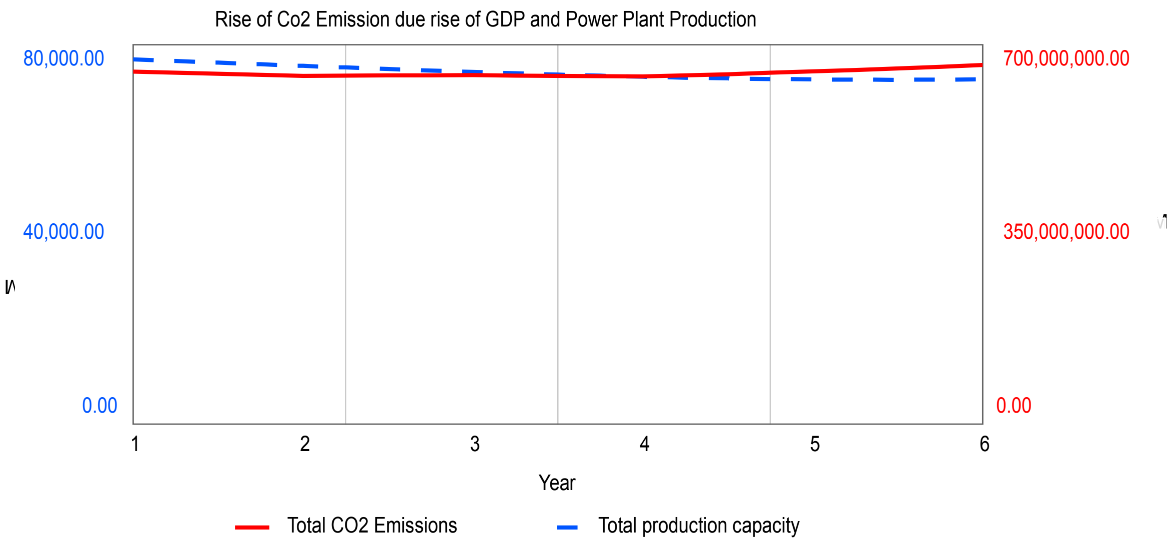
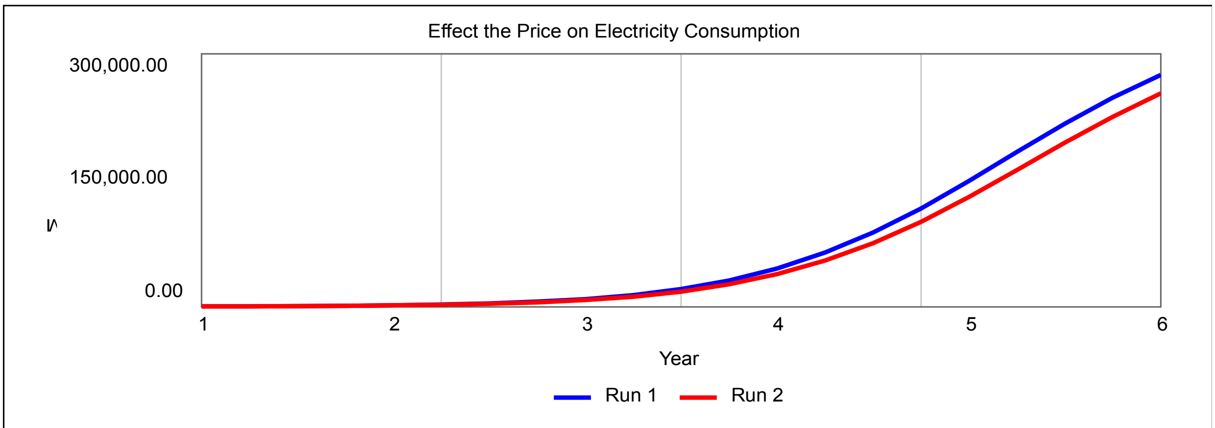


Figure 20: Emission rising due to rising of plant production when GDP rises.

The price of electricity is playing significant roles in changing the rate of electricity consumption, the model can show this Inverse relationship between the price and electricity consumption figure{19},{20} shows that causality relationship.



	Run 1: Initial price per MWatt	Run 2: Initial price per MWatt
1	1,360.00	2,310.00
2	1,850.00	2,560.00
3	1,850.00	2,560.00
4	1,850.00	2,560.00
5	1,850.00	2,560.00
Final	1,850.00	2,560.00

Figure 21 & Table 5: Changing in Consumption according to Electricity Price.

The total cost of fuel used in the power plant affects electricity consumption and Co2 emission, the model shows that when the total cost of Coal fuel increases from 34 USD to 180 USD the producer of electricity chang the investment in power plants operate by another type of fuel.

Figure{22} and table{6} show that the production capacity for power plants in using solar energy increase from 8 Mwatt to 11 Mawatt when the total cost of Coal is increasing to 180 USD.

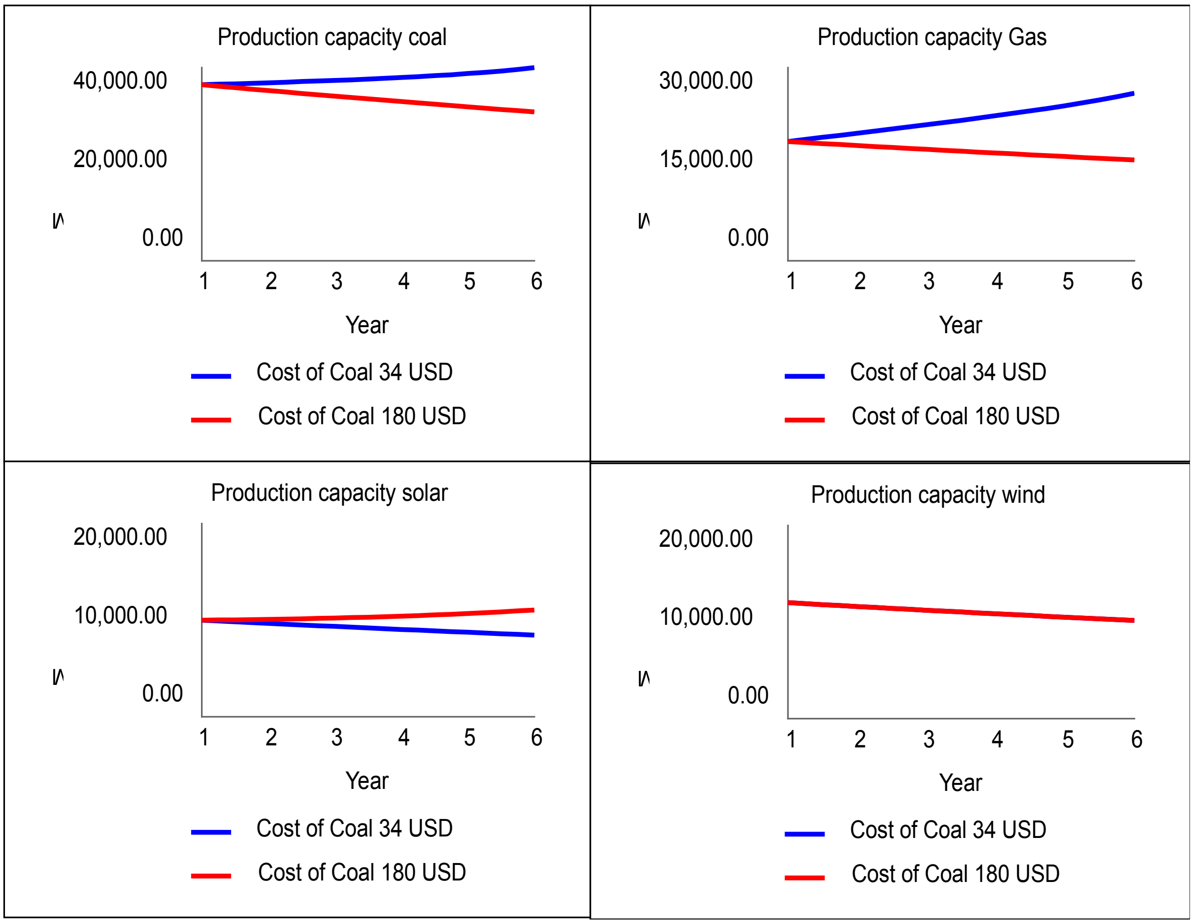


Figure 22: Changes in Fuel sharing when the cost of Coal fuel increases.

	Cost of Coal 34 USD: Production capacity coal	Cost of Coal 180 USD: Production capacity coal	Cost of Coal 34 USD: Production capacity Gas	Cost of Coal 180 USD: Production capacity Gas
1	36,420.00	36,420.00	18,500.00	18,500.00
2	36,849.04	35,221.09	19,808.37	17,891.00
3	37,328.16	34,061.65	21,123.69	17,302.05
4	37,924.23	32,940.37	22,514.92	16,732.48
5	38,733.46	31,856.01	24,080.29	16,181.66
Final	39,948.03	30,807.34	26,013.90	15,648.98

	Cost of Coal 34 USD: Production capacity solar	Cost of Coal 180 USD: Production capacity solar	Cost of Coal 34 USD: Production capacity wind	Cost of Coal 180 USD: Production capacity wind
1	10,000.00	10,000.00	12,000.00	12,000.00
2	9,670.81	10,082.56	11,604.97	11,604.97
3	9,352.46	10,222.38	11,222.95	11,222.95
4	9,044.58	10,419.98	10,853.50	10,853.50
5	8,746.85	10,692.68	10,496.21	10,496.21
Final	8,458.91	11,053.71	10,150.69	10,150.69

Table 6:Changing in Production for Fuels when the cost of Coal fuel increases.

The total production of coal fuel decrease from (39) Mwatt (30)Mwatt, and this, of course, will affect the emissions and electricity consumption

Due to using clean energy resources Wind Power.

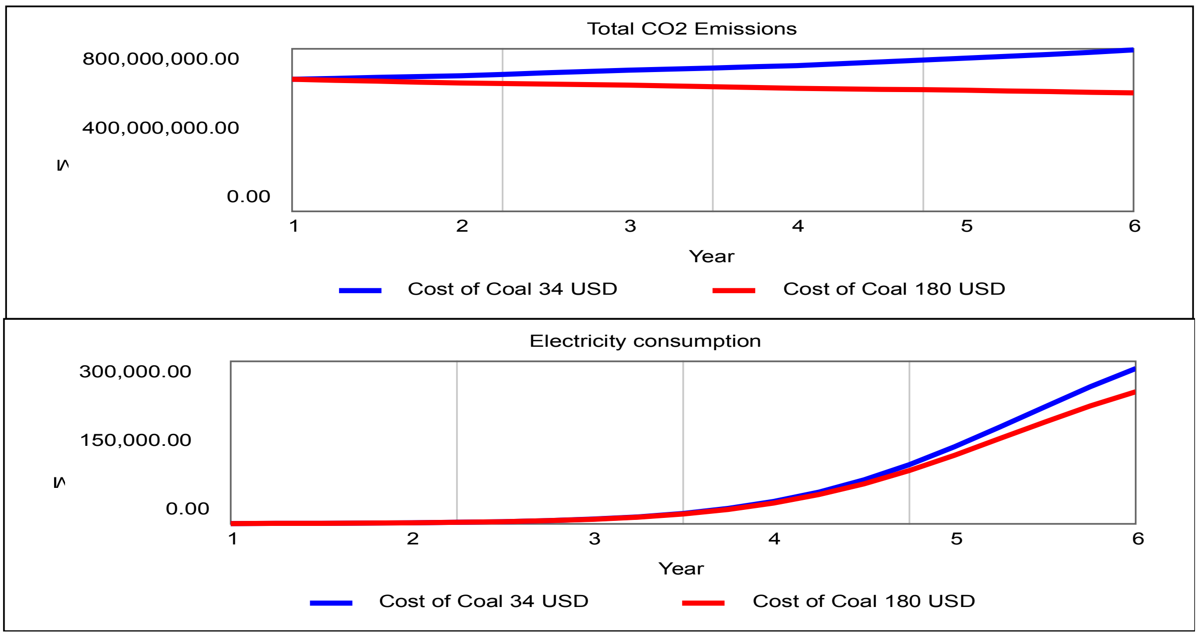


Figure 22: Changes in consumption and Emission without policy.

4.6 Model behavior with Policy :

Analyzing and test the behavior of the model after implementing the policy is an important part of any study, we aim to reduce the main Problem by targeting the factors which consider the root cause of this issue.

Appling energy management system (EnMS) ISO 50001 as a policy to reduce electricity consumption, and reduce Co2 emission is one of the methods adopted by decision-makers to achieve the management quality system in the energy used in industrial and service sector.

By adopting the ISO policy the decision-maker in top management sets a goal to reduce electricity consumption in all the processes and activities of the enterprise and company.

The model represents this as goal-seeking and gap to cover.

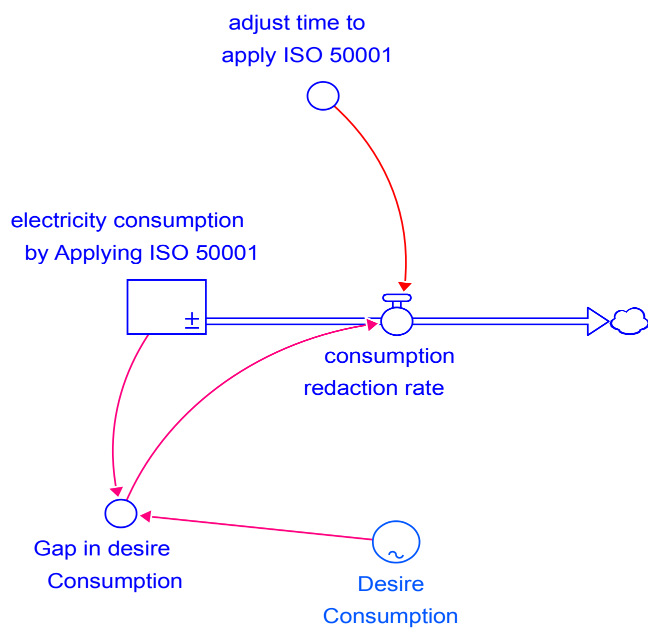


Figure 23: The policy structure

Electricity consumption is affective by GDP and the Initial Price so By connecting Policy structure into Indicated electricity consumption

The behavior of the model change due to target the Balancing Feedback loop (B2), the model shows that change by adjusting the value of desired consumption. Figure {24} shows the effect of Policy on electricity consumption and Co2 Emission by reducing the desired consumption from 0.33 to 0.23

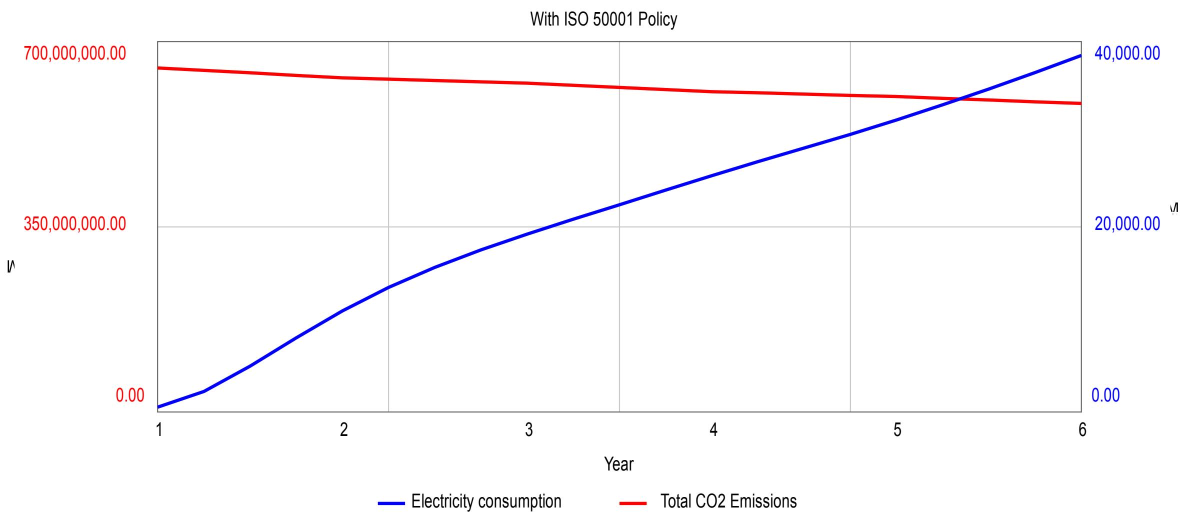


Figure 24: Electricity Consumption and CO2 Emission with applying policy.

The policy mange to reduce electricity consumption and reduce the emission of CO2 compering with Figure{16} without policy.

Consumption and Emission with Policy

	DC 0.33: Electricity Consumption	DC 0.23: Electricity Consumption	DC 0.33: Total CO2 Emissions	DC 0.23: Total CO2 Emissions
1	500.00	500.00	650,327,860.00	650,327,860.00
2	2,013.89	1,972.91	654,888,096.45	654,874,784.44
3	3,058.80	2,831.50	665,844,943.04	665,703,599.18
4	4,466.98	3,797.19	665,891,287.11	665,437,705.66
5	7,476.31	5,708.81	671,011,441.57	669,998,231.46
Final	14,540.49	9,996.75	670,652,216.46	668,775,627.08

Table 7: effect of applying Policy on consumption and emission.

To run the model several runs and to check the sensitivity of important parameters in the system we make model sensitivity analysis.

The model shows by set the electricity consumption by applying ISO 50001 as a sensitive parameter for 10 runs that the emission is decreased and electricity consumption figure{25} illustrates the behavior of the model in a sensitive condition test and shows the decrease of Co2 Emissions.

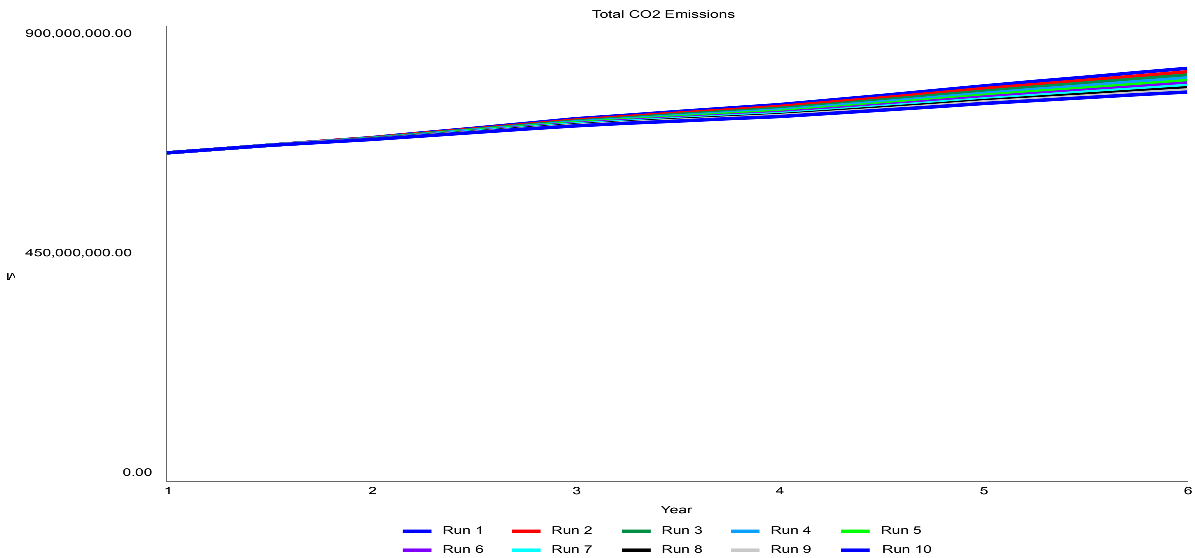


Figure 25: Analysis Sensitivity Parameter Electricity consumption applying ISO

Also, Electricity prices and the desired capacity for power plants decrease as the demand for electricity in the energy market because of the reduction of electricity consumption when applying the policy of ISO 50001.

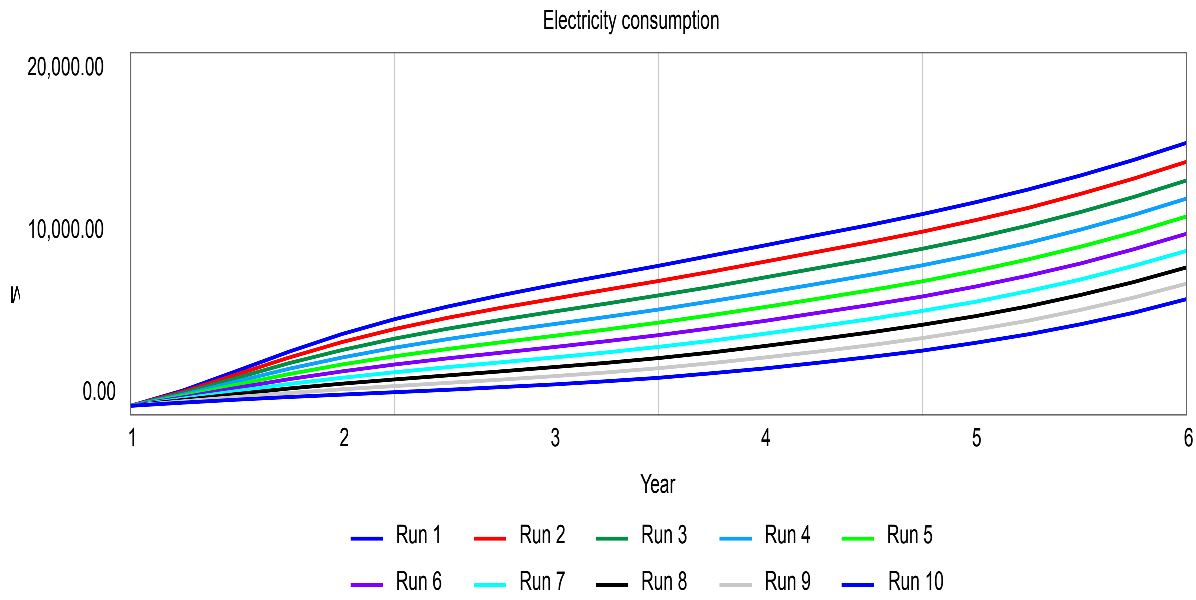


Figure 26: Analysis Sensitivity Parameter Electricity consumption applying ISO

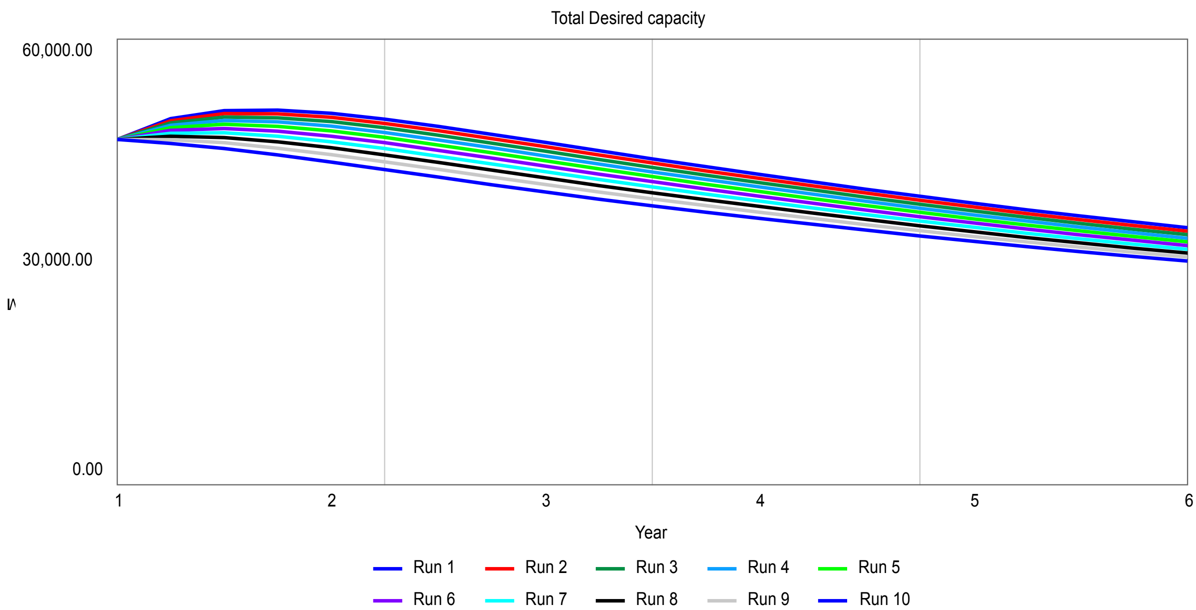


Figure 27: Analysis of Sensitivity Parameter Electricity consumption applying ISO.

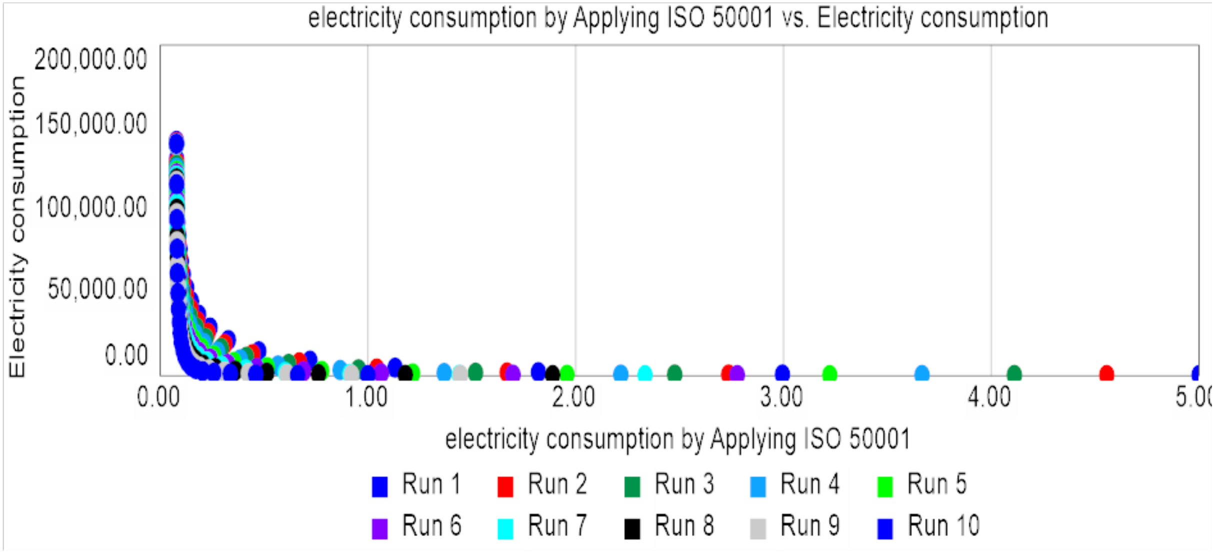


Figure 28:Electricity consumption by applying ISO 50001.

Figure {28} explains the behavior of the curve of consumption by a decrease in the target value of electricity consumption as a goal in the Iso 50001 policy.

Chapter 5: implementation of ISO 50001 Policy Cost and Benefit.

In this chapter, the study will verify the cost and benefits of applying ISO 50001 as a policy to reduce the impact of the definite problem in our thesis. Applying the energy management system and adopting this policy as a method to reduce electricity consumption in the industrial sector has a cost, The cost to convert the working system of the organization into a new working system and to meet the criteria of the Energy Management System, consider one of the biggest challenges for decision-maker.

The requirement to apply Energy management stander starts with the leadership commitment clause (5,1) in stander requirement.

The leadership here is the decision-maker which should adopt an energy management system as a working system to operate all the activities and processes of the organization.

The implementation of an energy management system go through stages,

Starting with adopting an energy management system by the decision-maker and change the procedures and work instructions of the organization and training the staff and employees on the energy concept. Sometimes the organization need to change the Infrastructure of the company to meet that energy stander criterial or hire qualification company to do working system documentation and training, in additional for that the organization have to ask from a credibility certificate Company from ISO organization such as British stander Institute (BSI) or

Norwegian Stander (DNV) to estimate the fulfill of the energy stander requirement by the organization and reward this company with ISO 50001 certificate, all these steps have cost to apply energy management system.

Saving the electricity cost in short time terms is one of the important factors to motivate decision-makers to find the best solutions to reduce electricity consumption at a low cost.

In some industries, the energy cost makes up 30% of production costs like cement industrial.

Results and prospects of applying an ISO 50001 based reporting system on a cement plant), said: “We were able to achieve an electrical energy cost reduction of 25%” (Wiehan A. Pelser,2017.P1) the study applied on cement industrial sector and shows that the profitability from reducing the production expensive will come from reducing the bill of the electricity power.

The governmental legislation to reduce the impact of emissions on the environment add more taxes on the power plants working on Coal and Gas Fuel and support organization to apply energy management system by subsidies to reduce the cost of applying the new energy system.

The study in this paper sees that “Using this methodology, a scenario with 50% of projected global industrial and service sector energy consumption under ISO 50001 management by 2030 would generate cumulative primary energy savings of approximately 105 EJ, cost savings of nearly US $700 billion”(Aimee McKanea,2017.P1).

The study paper shows A list of a country that adopting an energy management system as a methodology to reduce the emission and climate change phenomenon in table }8{.

National policies in support of industrial energy management and energy efficiency.

	IN	TP	REG	TSA	FEII	EnMS	SA	FEEM	TREM	RP
Austria	✓		✓			✓	✓			
Brazil			✓			✓				
Canada	✓	✓		✓	✓	✓	✓	✓	✓	✓
China	✓		✓	✓	✓	✓	✓	✓	✓	✓
Colombia	✓					✓	✓		✓	✓
Denmark	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Egypt	✓							✓	pend	
France	✓	✓	✓		✓	✓				✓
Germany	✓	✓	✓		✓	✓		✓		✓
India	✓		✓	✓	✓	✓			✓	✓
Ireland	✓	✓	✓	✓(VA, no negotiated targets)	✓	✓	✓		✓	✓
Japan	✓	✓	✓		✓	✓	✓	✓	✓	✓
Korea	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Macedonia	✓				✓				✓	
Mexico	✓					✓			✓	
Netherlands	✓	✓	✓	✓	✓	✓✓	✓	✓	✓	✓
South Africa	✓	✓	pend	✓	✓	✓			✓	
Sweden	✓	✓	✓	✓	✓	✓	✓		✓	✓
Thailani	✓	✓	✓		✓	✓	✓		pend	✓
TTurkey	✓			✓		✓		✓		
United Kingdom	✓	✓	✓		✓	✓	✓			✓
United States	✓			✓	✓	✓	✓		✓	✓

Source: Updated by authors from Global Energy Assessment: Toward a Sustainable Future 2012.
IN-Informational Programs; TP-Tax policies (incentives and/or penalties); REG-Regulations for energy efficiency/energy management; TSA-Target-setting Agreements w/ industry; FEII-Focus on Energy-Intensive Industries; EnMS-Energy Management Standard; SA-Subsidized Energy Assessments or Audits; FEEM-Financial assistance for Energy Efficiency/ EnMS Implementation; TREM-Training for Energy Managers; RP-Recognition Program.

Source: (Aimee McKanea,2017.P280)

Table 7: ***List of National policies in support of industrial energy management and energy efficiency***

Chapter 6: Conclusion

Reducing the CO_2 emissions to decrease the impact of greenhouse and climate-changing is consider a big challenge to the governments over the world. rising emission problem comes from different recourse, and electricity power plants which operate by coal and natural gas counts as one of these resources which create this Phenomenon.

Encouraging the producer of electricity to use clean energy to produce electricity in power plants like solar energy and wind power, was not the best solution even it helps. (Hans -Werner Sinn,2012) discussed in his Book

The Green Paradox, about the term that refers to an undesirable effect of environmental measures by using the friendly environment recourse, but that makes the problem worst “If we threaten resource owners with ever more environmentally-friendly policy that will destroy their future business, they preempt the threat and extract their resources even faster. Instead of slowing down climate change, we accelerate it. That is the green paradox” (Hans -Werner Sinn,2012, Introduction page).

Other policies based on reducing Electricity Consumption by minimize emissions rise from power plants and one of these policies is to apply an energy management system ISO 50001 this stander achieved a good result in decrease the emissions of CO_2 and raise the profitability of the organization by reducing the electricity consumption during the industrial and working process. The Policy of (EnMS) can adjust the electricity prices by control the demand for electricity in the energy market and also set a target to reduce electricity consumption in their energy reduction policy and work instructions and procedures for organization activities.

In (2018) Survey For Iso shows that total valid certificates for companies reward ISO 50001 becomes (18059) certificate over the world for (8545) business sector, in different business sector *sources (ISO.org*,*2018)* this show an optimistic view of the future of the energy management system as a good solution for both energy-producing and emission problems

"ISO 50001 has the potential to impact 60% of the world's energy use, including not only an industry but also the commercial and institutional sectors. Based on demonstrated savings that have been achieved by organizations that have implemented energy management plans and a continual improvement framework, energy intensity improvements of greater than 2.5% per year are achievable and can be sustained for the next decade. The International Energy Agency has stated that"(Aimee McKane,2009,P12).

Appendix

Model documentation

Study Energy Conservation Through Applying an (EnMS) ISO 50001

Formulation and comments

Electricity_consumption(t) =
Electricity_consumption(t - dt) + (Change_in_elelectricity_consumption) * dt
INIT Electricity_consumption = 500
UNITS: Mwatt

This stock influences on Reforicing loop (R1) and Blanancing feedback loop (B2) which affect the Market balance and electricity price variables and that will make the change in electricity consumption.

INFLOWS:

Change_in_elelcricity_consumption =
(Electricity_consumption*Indicated_electricity_Consumption)/Time_to_change_el_consumption
UNITS: Mwatt/Year

This inflow participates in the Reforicing loop (R1) and the Balancing feedback loop (B2).

Electricity_consumption_by_Applying_ISO(t) = electricity_consumption_by_Applying_ISO(t - dt) + (-consumption_redaction_rate) * dt

INIT electricity_consumption_by_Applying_ISO = 5
UNITS: Mwatt

This stock represents the policy of applying ISO 50001 to reduce electricity consumption through indicated Electricity Consumption.

Applying_Policy = IF switch =1 THEN electricity_consumption_by_Applying_ISO_50001 ELSE 1

UNITS: Mwatt

This equation is working to activate the Policy of applying ISO 50001 in the mode by getting Value(1)or reactivate it by getting value (0)

switch = 1

UNITS: dmnl

This variable is working as switch on -Off for the Policy(1/ 0).

OUTFLOWS:

Consumption_redaction_rate = -Gap_in_consumption/adjust_time_to_apply {UNIFLOW}
UNITS: Mwatt/Year

The outflow is affected by the stock of applying ISO5001 and the Gap in consumption.

Production_capacity_coal(t) = Production_capacity_coal(t - dt) + (Investment_coal_plants - Scrapping_coal_plants) * dt

INIT Production_capacity_coal = Initial_production_capacity_coal
UNITS: Mwatt

This stock affects the loops (R3),(R5),(R6), and loops(B1),(B3)

INFLOWS:

Investment_coal_plants = MAX(0, (Desired_capacity_coal-Production_capacity_coal)/Time_to_adjust_capacity+Production_capacity_coal/Lifetime_coal_plants)
UNITS: Mwatt/Year

This inflow for the investment in Coal plants and that determined by maximum between Desired capacity and production capacity in adjustment time of capacity and the life of coal plants (30) years

OUTFLOWS:
Scrapping_coal_plants = Production_capacity_coal/Lifetime_coal_plants
UNITS: Mwatt/Year

This outflow affects the loop (B1)

Production_capacity_Gas(t) = Production_capacity_Gas(t - dt) + (Investment_Gas_plants - Scrapping_Gas_plants) * dt
INIT Production_capacity_Gas = Initial_production_capacity_Gas
UNITS: Mwatt

This stock affects the model when the total cost is the minimum

INFLOWS:
Investment_Gas_plants = MAX(0, (Desired_capacity_Gas-Production_capacity_Gas)/Time_to_adjust_capacity+Production_capacity_Gas/Lifetime_Gas_plants)
UNITS: Mwatt/Year

OUTFLOWS:
Scrapping_Gas_plants = Production_capacity_Gas/Lifetime_Gas_plants
UNITS: Mwatt/Year

Same

Production_capacity_solar(t) = Production_capacity_solar(t - dt) + (Investment_solar_plants - Scrapping_solar_plants) * dt
INIT Production_capacity_solar = Initial_production_capacity_solar
UNITS: Mwatt

INFLOWS:

Investment_solar_plants = MAX(0, (Desired_capacity_solar-Production_capacity_solar)/Time_to_adjust_capacity+Production_capacity_solar/Lifetime_solar_Plants)
UNITS: Mwatt/Year

OUTFLOWS:
Scrapping_solar_plants = Production_capacity_solar/Lifetime_solar_Plants
UNITS: Mwatt/Year

Production_capacity_wind(t) = Production_capacity_wind(t - dt) + (Investment_wind_plants - Scrapping_wind_plants) * dt
INIT Production_capacity_wind = Initial_production_capacity_wind
UNITS: MWatt

INFLOWS:
Investment_wind_plants = MAX(0, (Desired_capacity_wind-Production_capacity_wind)/Time_to_adjust_capacity+Production_capacity_wind/Lifetime_wind_Plants)
UNITS: MWatt/Year

OUTFLOWS:
Scrapping_wind_plants = Production_capacity_wind/Lifetime_wind_Plants
UNITS: MWatt/Year

Recent_electricity_price(t) = Recent_electricity_price(t - dt) + (changeRecent price) * dt
INIT Recent_electricity_price = Initial_price_per_MWatt
UNITS: USD

INFLOWS:
Change recent price = (Electrictity_price-Recent_electricity_price)/Time_for_recent_price
UNITS: US Dollars Per Year

adjust_time_to_apply_ISO _50001 = 0.6
UNITS: year

Applying polcy need at less 6 monthes

adjustment_indicated = 1
UNITS: 1/usd/MWatt/MWatt

CO2_emissions_per_MWatt_coal_plants = (14683),(14725),(14998),(15100),(15361),(15502)
UNITS: Mton/MWatt

The number CO2 emissions for using Coal are six years from (2012-2017)

Recourse: IEA
https://www.iea.org/subscribe-to-data-services/co2-emissions-statistics

CO2_emissions_per_MWatt_Gas_plants = (6246),(6321),(6410),(6456),(6604),(6743)
UNITS: Mton/MWatt

The number CO2 emissions for using Gas are six years from (2012-2017)

Recourse: IEA

https://www.iea.org/subscribe-to-data-services/co2-emissions-statistics

CO2_emissions_per_MWatt_solar_plants = 1
UNITS: Mton/MWatt

CO2_emissions_per_MWatt_wind_plants = 1
UNITS: Mton/MWatt

Cost_of_coal_per_MWatt = GRAPH(TIME)
Points: (0.00, 28.91), (1.00, 30.22), (2.00, 31.745), (3.00, 33.27), (4.00, 33.8533333333), (5.00, 34.4366666667), (6.00, 35.02), (7.00, 36.33), (8.00, 36.98), (9.00, 37.63), (10.00, 38.72), (11.00, 39.81), (12.00, 40.685), (13.00, 41.56), (14.00, 43.30), (15.00, 45.05), (16.00, 45.05), (17.00, 45.92), (18.00, 46.79), (19.00, 47.23), (20.00, 48.97)
UNITS: USD

Cost_of_Gas_per_MWatt = GRAPH(TIME)
Points: (0.00, 17.57), (1.00, 18.88), (2.00, 18.88), (3.00, 20.63), (4.00, 21.50), (5.00, 23.24), (6.00, 24.11), (7.00, 24.11), (8.00, 25.86), (9.00, 27.60), (10.00, 28.91), (11.00, 29.35), (12.00, 31.09), (13.00, 32.84), (14.00, 33.71), (15.00, 33.71), (16.00, 34.58), (17.00, 35.45), (18.00, 36.33), (19.00, 38.07), (20.00, 38.07)
UNITS: USD

Cost_of_solar_per_MWatt = GRAPH(TIME)
Points: (0.00, 49.8), (1.00, 51.5), (2.00, 52.0), (3.00, 55.1), (4.00, 57.3), (5.00, 60.8), (6.00, 62.1), (7.00, 62.1), (8.00, 62.75), (9.00, 63.4), (10.00, 63.4), (11.00, 63.65), (12.00, 64.3), (13.00, 64.8), (14.00, 64.8), (15.00, 64.8), (16.00, 64.8), (17.00, 64.8), (18.00, 64.8), (19.00, 64.8), (20.00, 63.9)
UNITS: USD

Cost_of_wind_per_MWatt = GRAPH(TIME)
Points: (0.00, 18.5), (1.00, 24.7), (2.00, 33.5), (3.00, 39.2), (4.00, 43.6), (5.00, 45.4), (6.00, 46.3), (7.00, 47.1), (8.00, 48.0), (9.00, 49.8), (10.00, 51.5), (11.00, 53.3), (12.00, 53.3), (13.00, 55.1), (14.00, 55.1), (15.00, 55.1), (16.00, 55.5), (17.00, 55.5), (18.00, 56.8), (19.00, 56.8), (20.00, 56.4)
UNITS: USD

Desire_consumption = GRAPH(TIME)
Points: (1.000, 1.330), (1.100, 1.207), (1.200, 1.110), (1.300, 0.960), (1.400, 0.899), (1.500, 0.784), (1.600, 0.670), (1.700, 0.573), (1.800, 0.485), (1.900, 0.432), (2.000, 0.185)
UNITS: MWatt

Desired_capacity_coal = Total_Desired_capacity*exp_coal/(exp_coal+exp_solar+exp_wind+exp_Gas)
UNITS: MWatt

Desired_capacity_Gas = Total_Desired_capacity*exp_coal/(exp_coal+exp_solar+exp_wind+exp_Gas)
UNITS: MWatt

Desired_capacity_solar = Total_Desired_capacity*exp_solar/(exp_solar+exp_coal+exp_wind+exp_Gas)
UNITS: MWatt

Desired_capacity_wind = Total_Desired_capacity*exp_wind/(exp_coal+exp_solar+exp_wind+exp_Gas)
UNITS: MWatt

Effect_of_market_balance = Electricity_consumption/Total_production_capacity
UNITS: dmnl

Effect_of_price_on_supply = (Electrictity_price/Initial_price_per_MWatt)^Price_elasticity_supply
UNITS: dmnl

Elelcricity_consumption_per_GDP = 0.5
UNITS: MWatt

Electrictity_price = Recent_electricity_price*Effect_of_market_balance
UNITS: USD

exp_coal = EXP((Electrictity_price-Total_Cost_Per_MWatt_coal)/Range)
UNITS: USD

exp_Gas = EXP((Electrictity_price-Total_Cost_Per_MWatt_Gas)/Range)
UNITS: USD

exp_solar = EXP((Electrictity_price-Total_Cost_Per_MWatt_solar)/Range)
UNITS: USD

exp_wind = EXP((Electrictity_price-Total_Cost_Per_MWatt_wind)/Range)
UNITS: USD

Gap_in_consumption = Desire_consumption-electricity_consumption_by_Applying_ISO
UNITS: MWatt

GDP = GRAPH(TIME)
Points: (1.000, 16.7), (2.000, 22.5), (3.000, 34.8), (4.000, 46.3), (5.000, 51.5)
UNITS: USD

Indicated_electricity_Consumption =
electricity_consumption_by_Applying_ISO*GDP*El_consumption_per_GDP*(Electrictity_price/
Initial_price_per_MWatt)^Price_elasticity_of_el_consumption*adjustment_units
UNITS: dmnl

Initial_price_per_MWatt = 2000
UNITS: USD

Initial_production_capacity_coal = 36420
UNITS: MWatt
DOCUMENT: Resource:

https://www.iea.org/reports/coal-information-2019

Initial_production_capacity_Gas = 18500
UNITS: MWatt
DOCUMENT: Resource:

https://www.iea.org/subscribe-to-data-services/natural-gas-statistics

Electricity production from Neutral gas
Initial_production_capacity_solar = 10000
UNITS: MWatt
DOCUMENT: Resource:

https://www.iea.org/reports/renewables-information-2019

Initial_production_capacity_wind = 12000
UNITS: MWatt
DOCUMENT: Resource:

https://www.iea.org/reports/renewables-information-2019

Leasing_cost_of_capital_for_coal = 8
UNITS: USD

Leasing_cost_of_capital_for_Gas = 14
UNITS: USD

Leasing_cost_of_capital_for_solar = 20
UNITS: USD

Leasing_cost_of_capital_for_wind = 25
UNITS: USD

Lifetime_coal_plants = 30
UNITS: year

Lifetime_Gas_plants = 30
UNITS: year

Lifetime_solar_Plants = 30
UNITS: year

Lifetime_wind_Plants = 30
UNITS: year

Other_operating_costs_for_coal = 7
UNITS: USD

Other_operating_costs_for_Gas = 11
UNITS: USD

Other_operating_costs_for_solar = 13
UNITS: USD

Other_operating_costs_for_wind = 25
UNITS: USD

Price_elasticity_of_el_consumption = -0.5
UNITS: dmnl

Price_elasticity_supply = 0.1
UNITS: dmnl

Range = 10
UNITS: dmnl

Time_for_recent_price = 1
UNITS: year

Time_to_adjust_capacity = 20
UNITS: year

Time_to_change_el_consumption = 30
UNITS: year

Total_CO2_emissions =
Production_capacity_solar*CO2_emissions_per_MWatt_solar_plants+Production_capacity_coal*CO2_emissions_per_MWatt_coal_plants+Production_capacity_wind*CO2_emissions_per_MWatt_wind_plants+Production_capacity_Gas*CO2_emissions_per_MWatt_Gas_plants
UNITS: Mton

Total_Cost_Per_MWatt_coal =
Cost_of_coal_per_MWatt+Leasing_cost_of_capital_for_coal+Other_operating_costs_for_coal
UNITS: USD

Total_Cost_Per_MWatt_Gas =
Cost_of_Gas_per_MWatt+Leasing_cost_of_capital_for_Gas+Other_operating_costs_for_Gas
UNITS: USD

Total_Cost_Per_MWatt_solar =
Cost_of_solar_per_MWatt+Leasing_cost_of_capital_for_solar+Other_operating_costs_for_solar
UNITS: USD

Total_Cost_Per_MWatt_wind =
Cost_of_wind_per_MWatt+Leasing_cost_of_capital_for_wind+Other_operating_costs_for_wind
UNITS: USD

Total_Desired_capacity = Effect_of_price_on_supply*Total_production_capacity
UNITS: MWatt

Total_production_capacity =
Production_capacity_solar+Production_capacity_coal+Production_capacity_wind
UNITS: MWatt

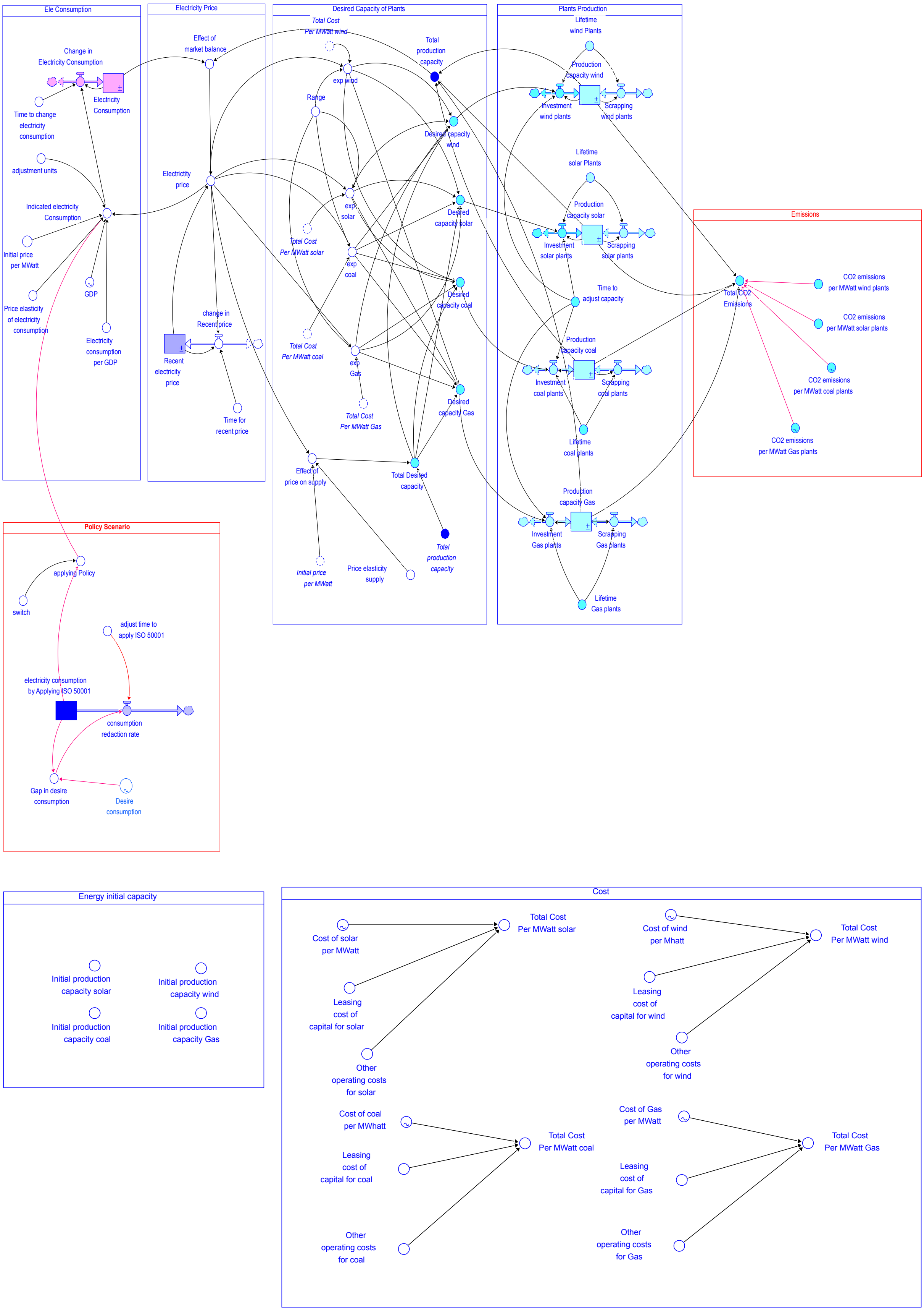
{ The model has 76 (76) variables (array expansion in parens).

In the root model and 0 additional modules with 5 sectors.

Stocks: 7 (7) **Flows**: 11 (11) **Converters**: 58 (58)

Constants: 28 (28) **Equations**: 41 (41)}

Model with PolicyStock and Flow Diagram



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