OVERALL COMMENTS
1. We should establish a nice flow and explanations for the plots, and a storyline for these plots. But, I understand that this initial report was just for us to look at the results.
2. There should be a table that summarizes the results of multiple plots if it makes sense. [S]
3. There should be a table that summarizes the input file values [I]
OVERALL PLOT COMMENTS
1. Add grid lines and zoom into relevant parts of each plot. (We need to make all the plots more readable.) [Z] Perhaps also add a description saying that all plots are similar till timestep x then only plot from that time step onwards and for relevant y-axis values to eliminate white space.
2. Make legends not overlap with plots [L]
3. Captions need to be more informative [C]

DDCA Project Final Report

September 1, 2019

Contents

1 Objective

The objective of this report is to showcase results from the Demand-Driven Cycamore Archetypes project (NEUP-FY16-10512).

2 Eg01-Eg23

Figure 1 shows the flow of Eg01-Eg23.

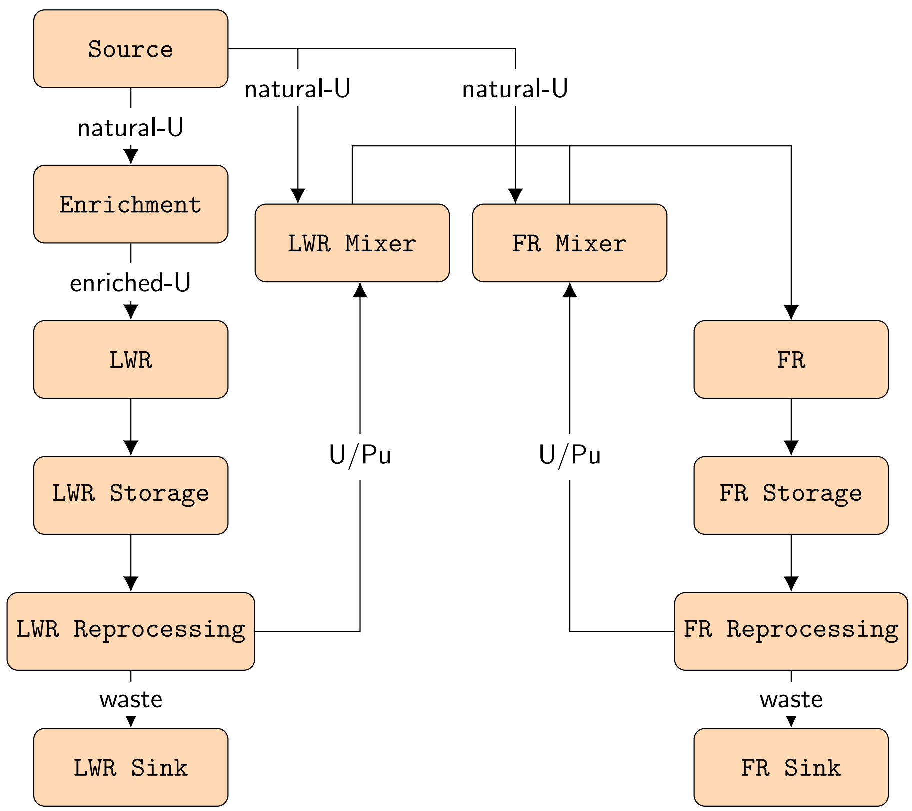
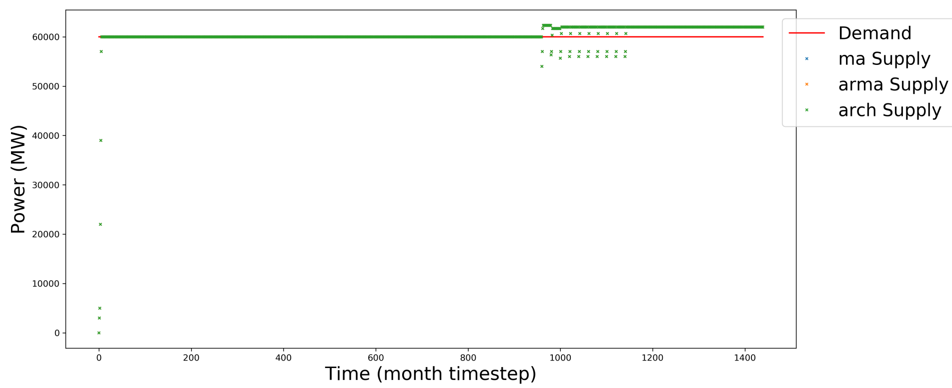


Figure 1: EG01-EG23.

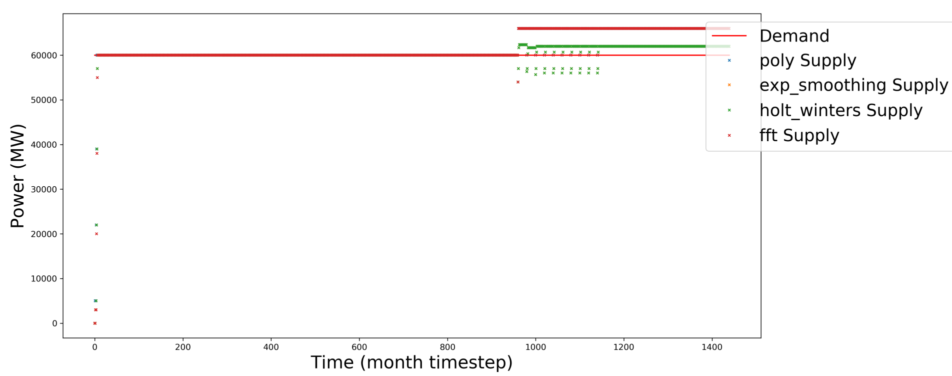
2.1 Power

This section presents plots of power for all the prediction methods. The power demand is 60000 MW throughout the whole simulation. The input files use the installed capacity feature. Buffer is set to zero, back steps is set to two, and steps takes the default value of one. Figures 2, 3, and 4 display the power supply and demand. Table 1 records the number of steps whit under supply, the cumulative under supply, and the cumulative oversupply. [I]



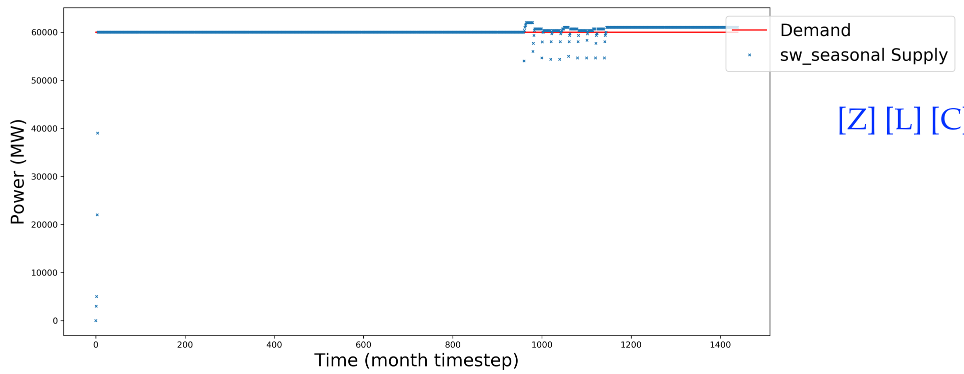
[Z] [L] [C]

Figure 2: NO algorithms.



[Z] [L] [C]

Figure 3: DO algorithms.



[Z] [L] [C]

Figure 4: SO algorithms.

Table 1: Undersupply and oversupply of Power for the different prediction algorithms used to calculate EG01-EG23.

Algorithm	Undersupplied Timesteps	Cumulative Undersupply [GW.mo]	Cumulative Oversupply [GW.mo]
MA	26	306.0	907.8
ARMA	26	306.0	907.8
ARCH	26	306.0	907.8
POLY	6	235.0	2820.5
EXP_SMOOTHING	27	366.0	907.8
HOLT-WINTERS	27	366.0	907.8
FFT	8	307.0	2820.5
SW_SEASONAL	36	308.0	398.1

Comment that Poly and FFT perform the best

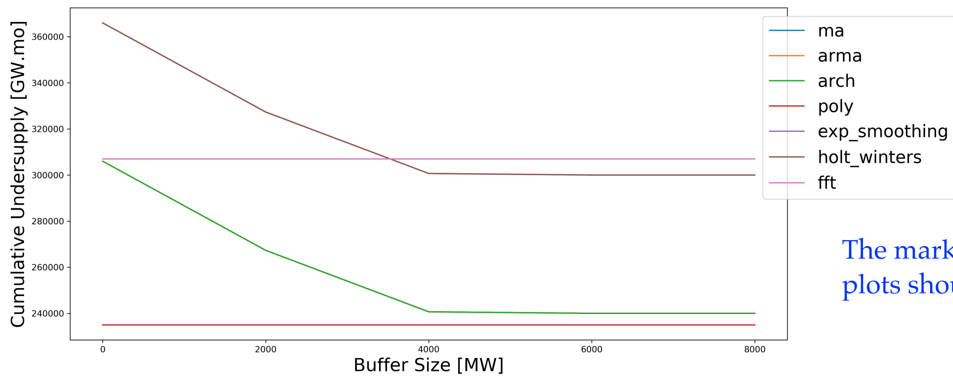
2.2 Buffer

This section presents a sensitivity analysis for different values of the power supply buffer. Figure 5 shows a comparison of the cumulative under supply for different buffer sizes.

Figures 6 to 12 display a comparison for some of the methods of the power supply for different buffer sizes.

The input files use the installed capacity feature. Buffer takes the values 0, 2000, 4000, 6000, and 8000. Back steps is set to two, and steps takes the default value of one.

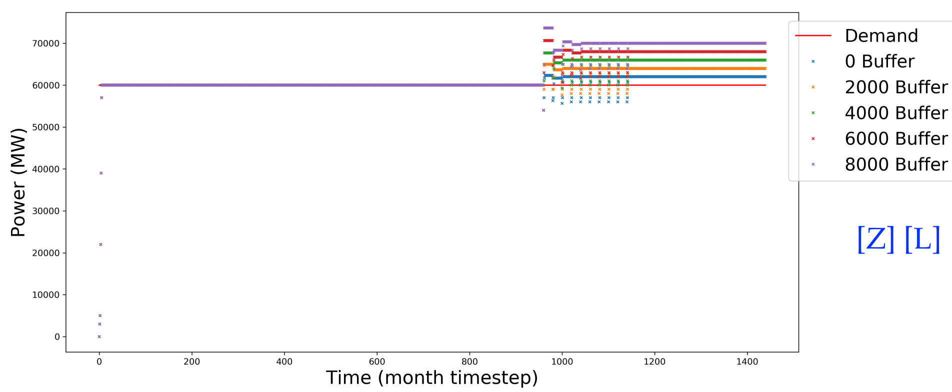
I thought we decided that we need a table that summarizes the results from figure 6-12



[L] [C]

The marker for these kinds of plots should be * or *-, not -

Figure 5: Sensitivity analysis for different buffer sizes for ~~some~~ prediction algorithms.



[Z] [L]

Figure 6: Power supply for different buffer sizes using ma.

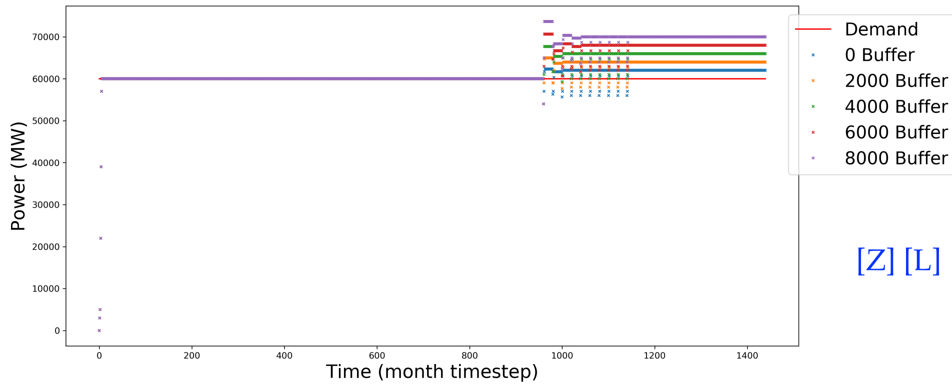


Figure 7: Power supply for different buffer sizes using arma.

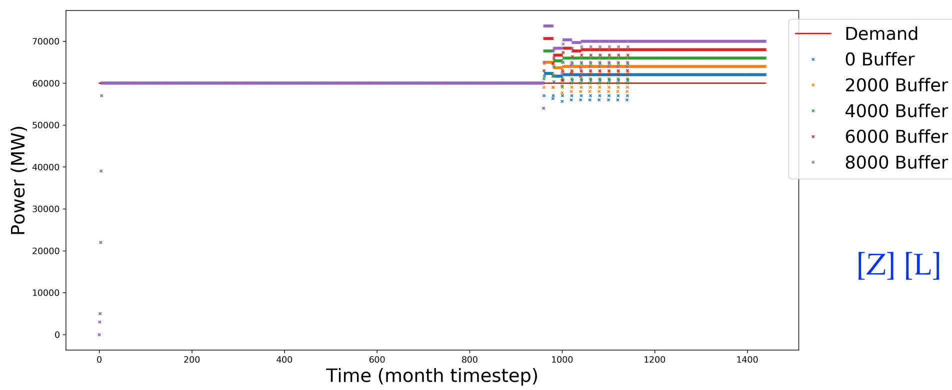


Figure 8: Power supply for different buffer sizes using arch.

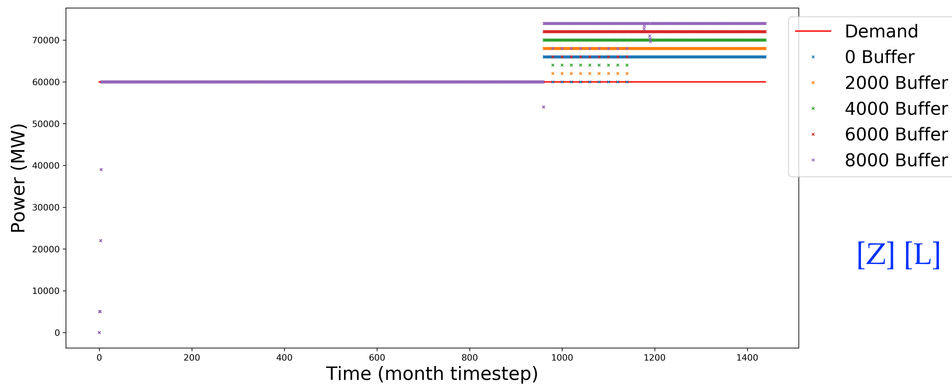


Figure 9: Power supply for different buffer sizes using poly.

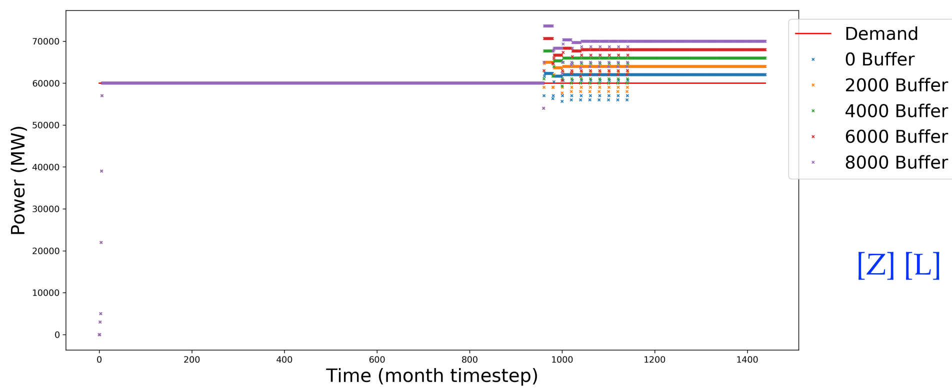
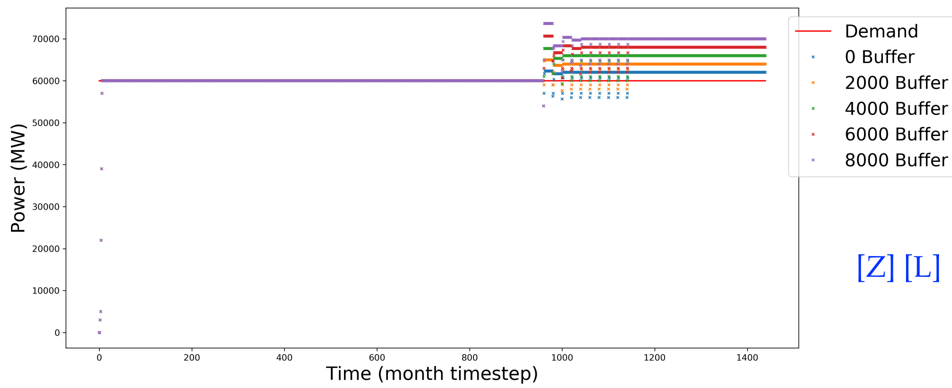
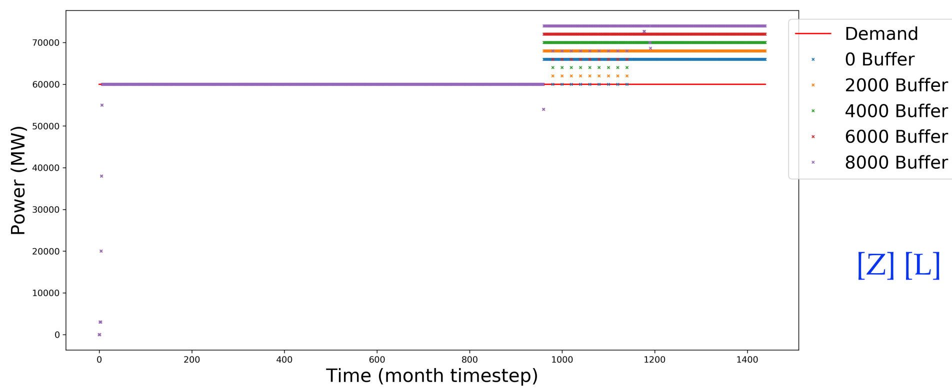


Figure 10: Power supply for different buffer sizes using exp_smoothing.



[Z] [L]

Figure 11: Power supply for different buffer sizes using holt_winters.



[Z] [L]

Figure 12: Power supply for different buffer sizes using fft.

2.3 ~~Steps forward~~ Forward Steps

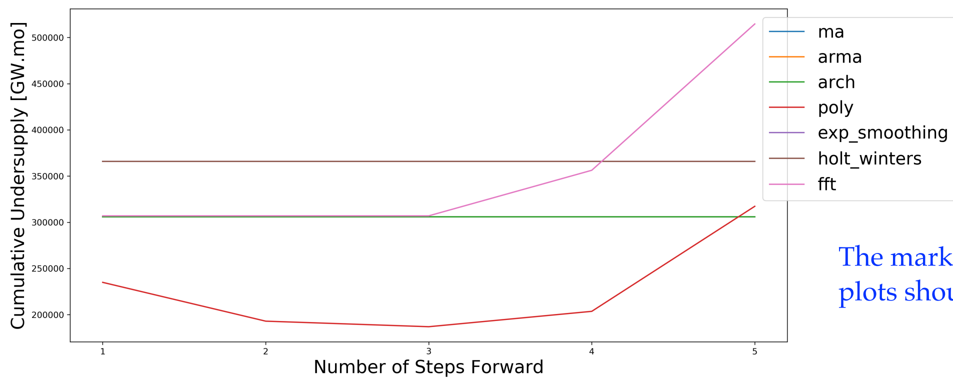
This section presents a sensitivity analysis for different values of steps. Figure 13 shows a comparison of the cumulative under supply for different values of steps forward.

Figures 14 to 20 display a comparison for some of the methods of the power supply for different steps.

The input files use the installed capacity feature. Buffer is set to zero, back steps is set to two, and steps takes the values 1, 2, 3, 4, and 5. [I]

~~Seeing~~ From figure 13 we note that the more steps used, the worse the simulation performs. Figure 21 helps to understand such behavior. 'Mixerout' is the commodity that represents the fuel that FR use. This figure shows that the LWRs produce enough fuel to almost start all the FRs. However, this expense of fuel is too big to keep the ones already deployed running until they produce their own fuel, so their power supply oscillates. The steps capability should be used cautiously to avoid this from happening.

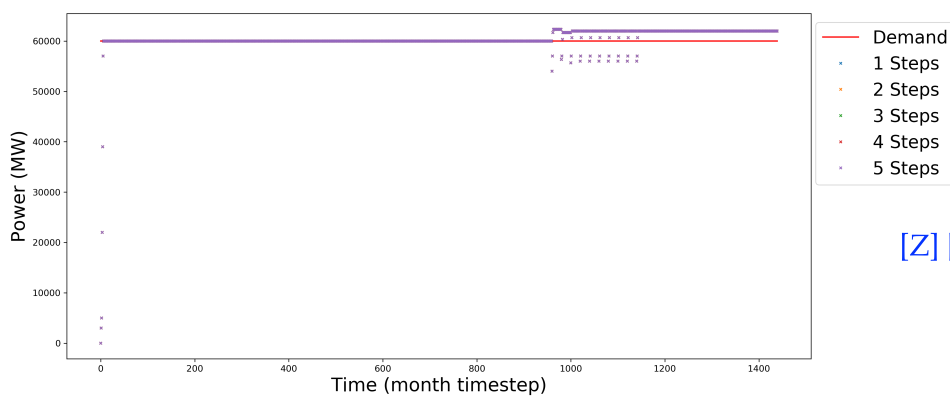
What do you mean by used cautiously?



[L] [C]

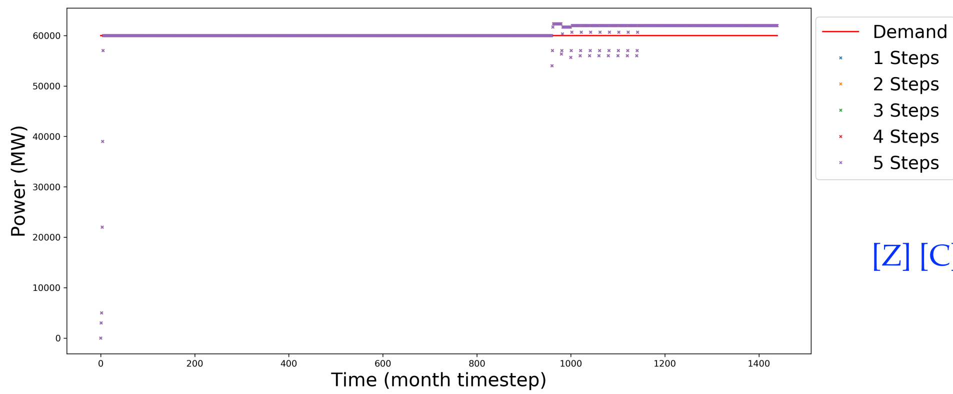
The marker for these kinds of plots should be * or *-, not -

Figure 13: Sensitivity analysis for ~~different number of steps forward~~ varying number of forward for ~~some~~ different prediction algorithms.



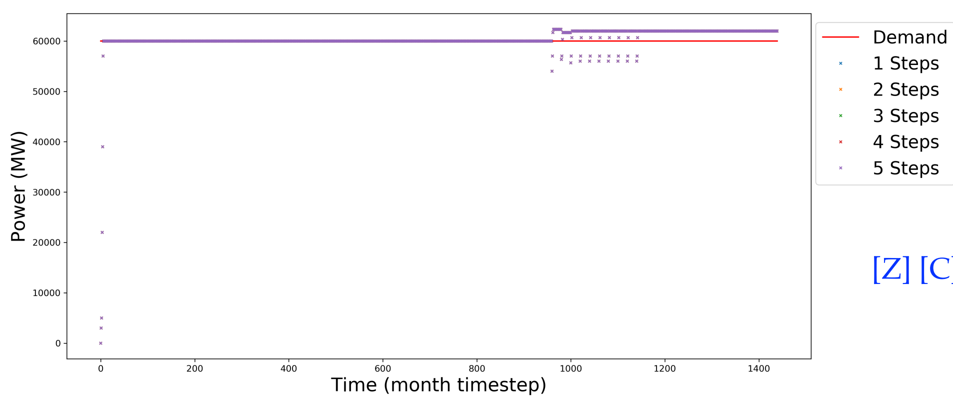
[Z] [C]

Figure 14: Power supply for different values of steps forward using ma.



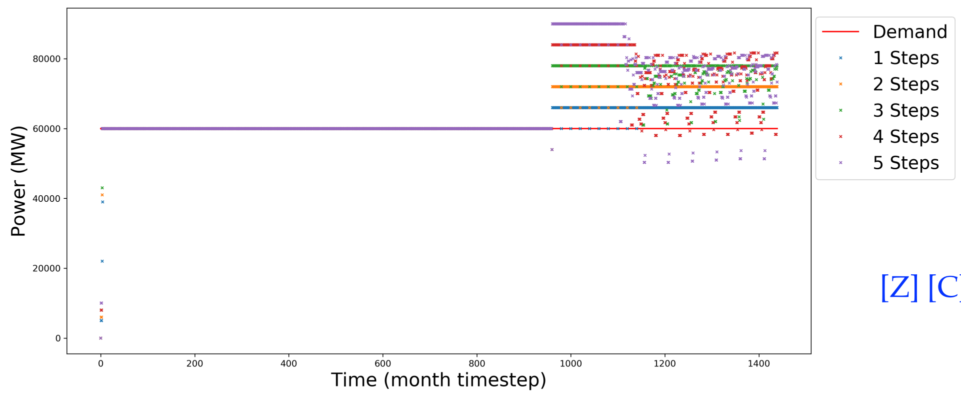
[Z] [C]

Figure 15: Power supply for different values of steps forward using arma.



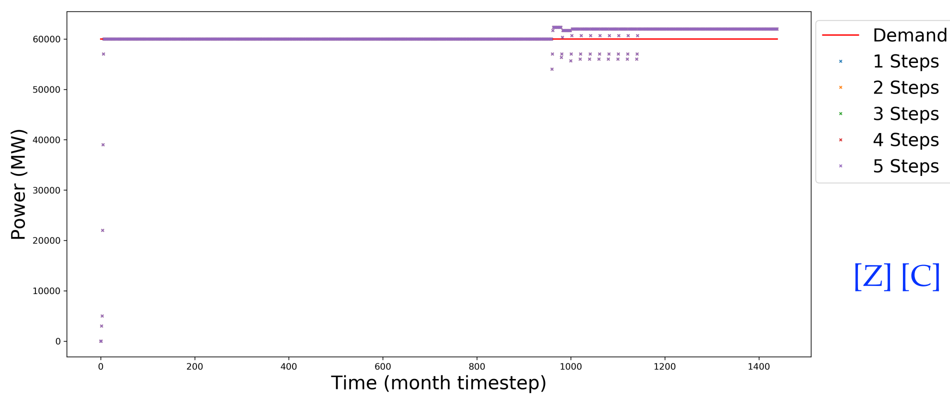
[Z] [C]

Figure 16: Power supply for different values of steps forward using arch.



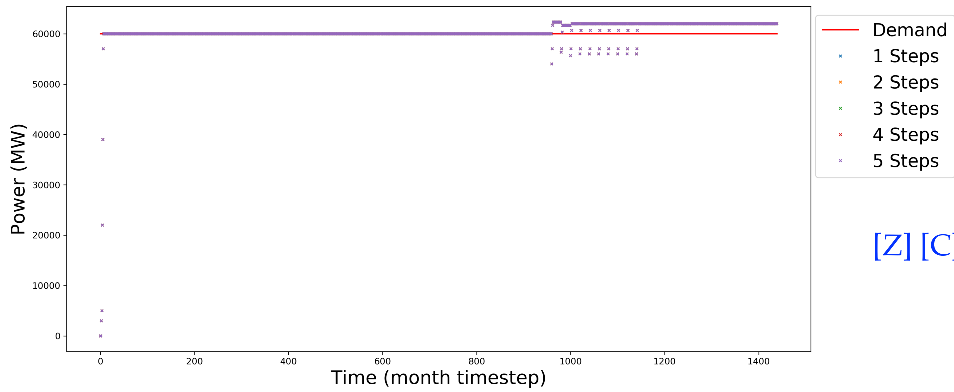
[Z] [C]

Figure 17: Power supply for different values of steps forward using poly.



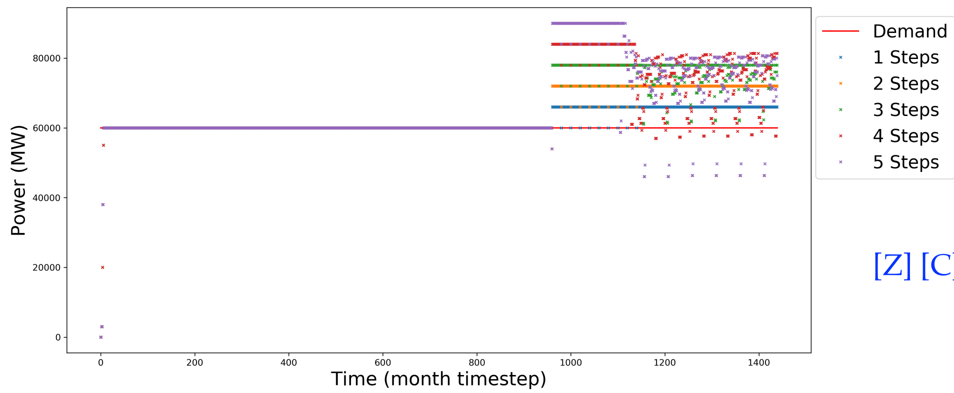
[Z] [C]

Figure 18: Power supply for different values of steps forward using exp_smoothing.



[Z] [C]

Figure 19: Power supply for different values of steps forward using holt_winters.



[Z] [C]

Figure 20: Power supply for different values of steps forward using fft.

This plot title doesn't really make sense.

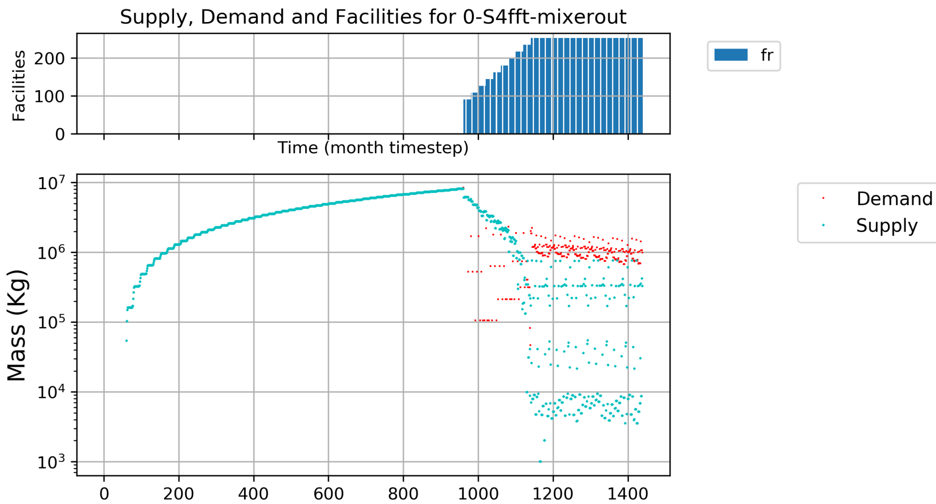


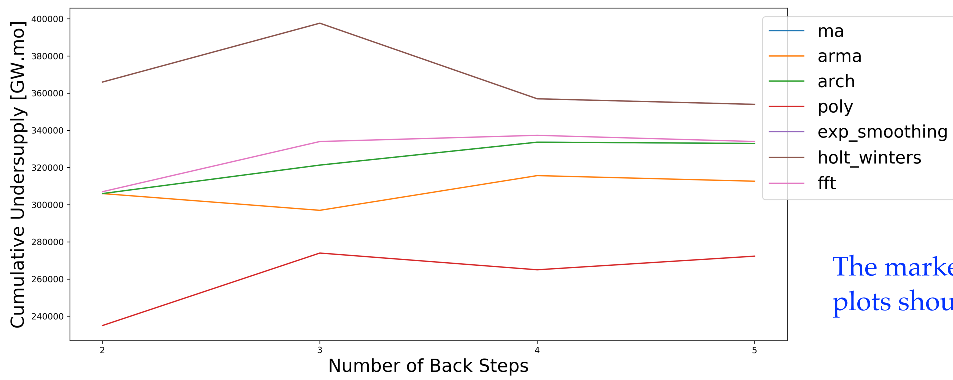
Figure 21: Power supply for 4 steps forward using fft.

2.4 Back steps

This section presents a sensitivity analysis for different values of back steps. Figure 22 shows a comparison of the cumulative under supply for different values of back steps.

Figures 23 to 29 display a comparison for some of the methods of the power supply for different values of back steps.

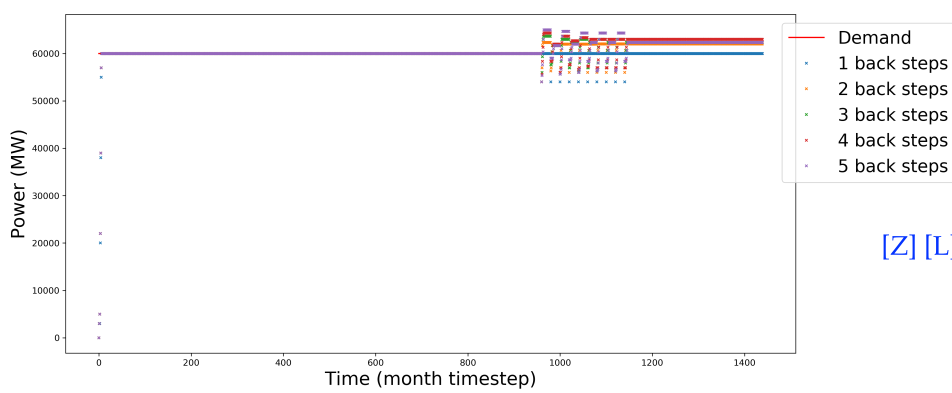
The input files use the installed capacity feature. The buffer is set to zero, steps is set to two, and back steps takes the values 1, 2, 3, 4, and 5.



[L] [C]

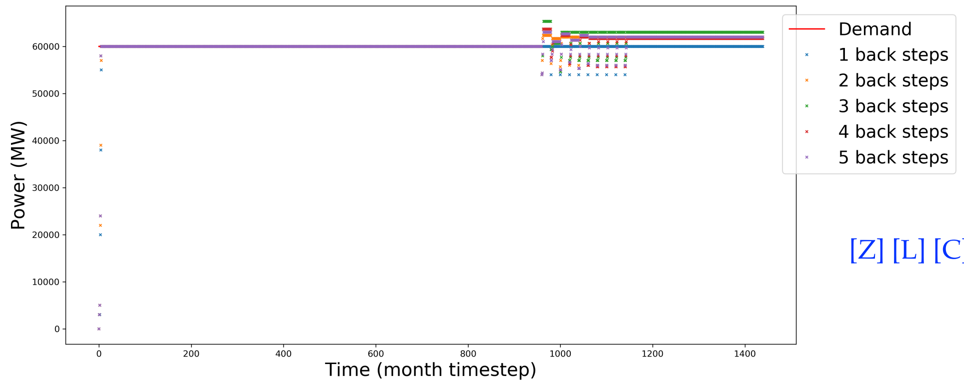
The marker for these kinds of plots should be * or *-, not -

Figure 22: Sensitivity analysis for ~~different number of~~ varying back steps for ~~some~~ different prediction algorithms.



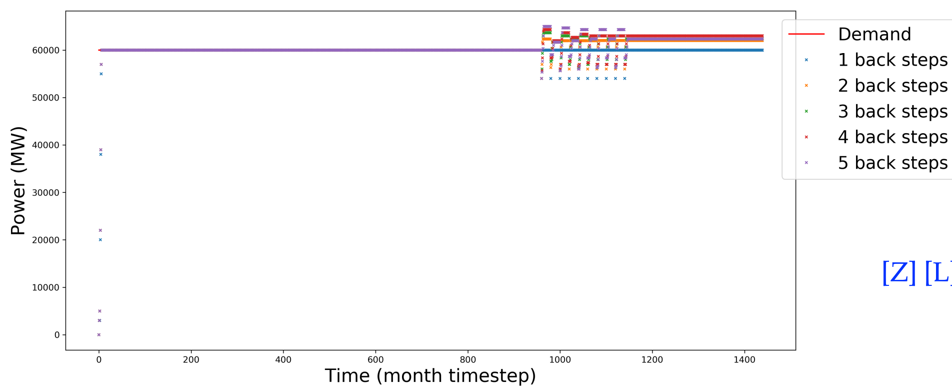
[Z] [L] [C]

Figure 23: Power supply for different values of back steps using ma.



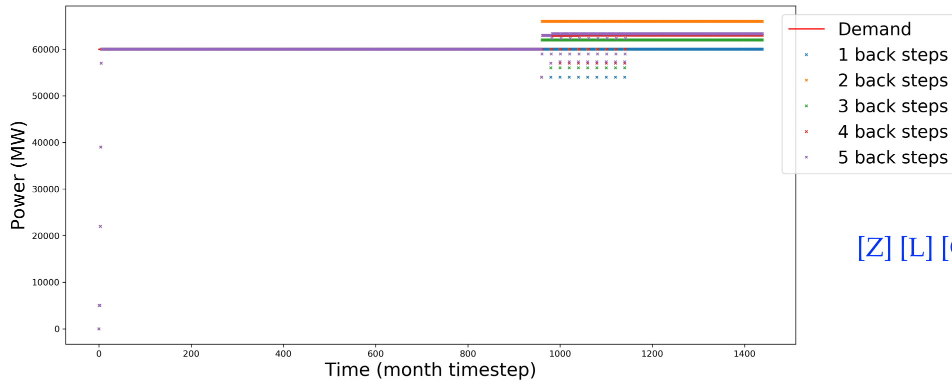
[Z] [L] [C]

Figure 24: Power supply for different values of back steps using arma.



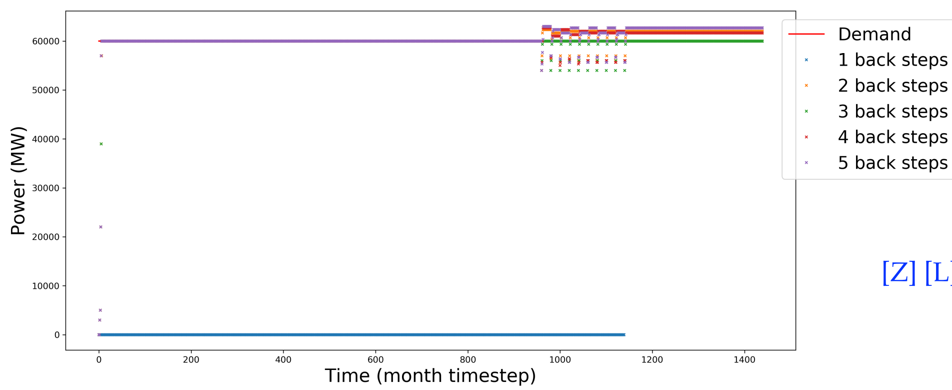
[Z] [L] [C]

Figure 25: Power supply for different values of back steps using arch.



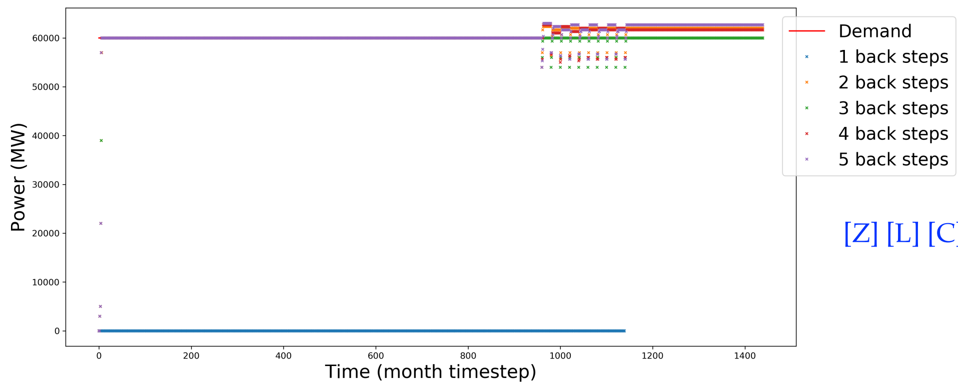
[Z] [L] [C]

Figure 26: Power supply for different values of back steps using poly.



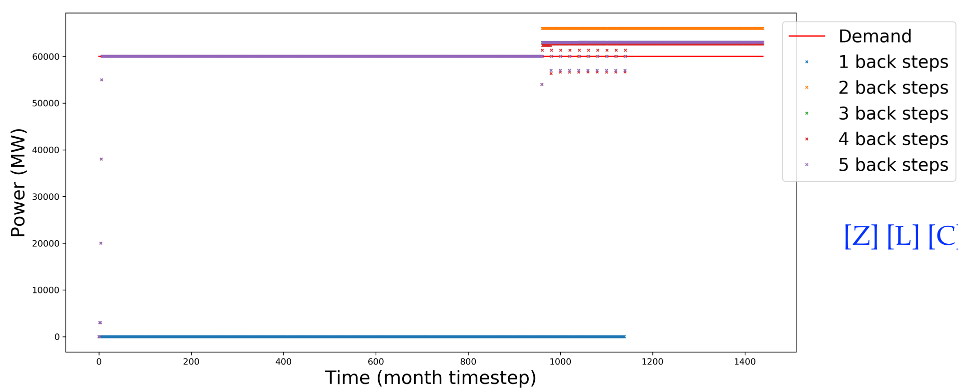
[Z] [L] [C]

Figure 27: Power supply for different values of back steps using exp_smoothing.



[Z] [L] [C]

Figure 28: Power supply for different values of back steps using holt_winters.



[Z] [L] [C]

Figure 29: Power supply for different values of back steps using fft.

Motivation for this section needs to be said: Since the prediction algorithm poly performed the best, it is used to produce the best performance model… etc.

Why is there a linearly increasing scenario, and no constant power scenario?

2.5 Different commodities

Table 2 shows the name of the variables used in the simulations and what they represent in the cycle. Table 3 presents the number of steps of under supply, cumulative under supply, and cumulative oversupply for some of the commodities.

commodity fuel simulation time ?

Table 3 needs some further explanation. The simulation differentiates between front-end and back-end commodities. In this simulation, front-end commodities are power, sourceout, and enrichmentout. All the rest of

We also need description in the form of a table to what input parameters are associated with this simulation scenario.

the commodities are back-end.

I think this section needs to be written more clearly.

For the first ones, under supply means that a facility requires that commodity and the supply is not enough. Over supply, means the opposite. A facility requires that commodity but there is too much of it. In other words, the facilities that provide such commodity are over sized. D3ploy can avoid this situation by deploying more facilities with smaller sizes.

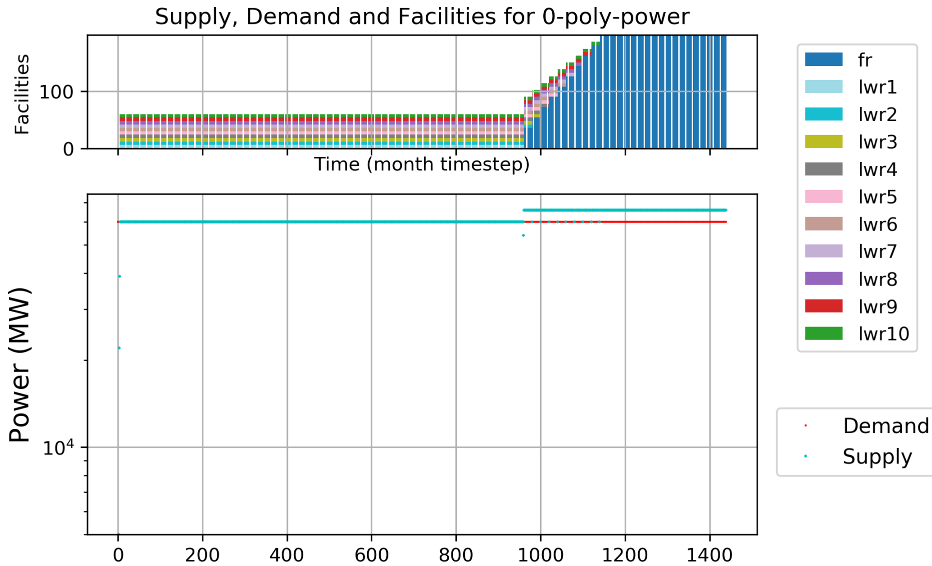
For the back-end commodities, the notion of under supply and over supply are different. This facilities are meant to have an accumulation of material, so they have to over sized. For example, a sink has to be large enough so we do not have to deploy new continuously. It could still happen that the sink gets full and there is a need to build a new one. This is measure by the under supply. When there is too much material that needs to be disposed and the current sinks cannot take that quantity, there is a time step with under supply. Consequently, d3ploy will deploy a new facility on the next time step.

doesn't the prediction algorithms make this not happen?

Table 2: Commodity names used in the simulation of EG01-EG23.

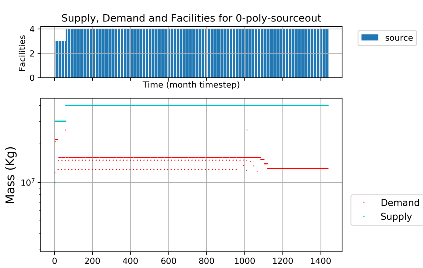
Commodity name	Figure	Represents
power	30	Power
sourceout	31a	Natural-U
enrichmentout	31b	Enriched-U
mixerout	32	FR fuel
lwrout	33a	Spent fuel of LWRs
frout	33b	Spent fuel of FRs
lwrstorageout	34a	Cooled down spent fuel of LWRs
frstorageout	34b	Cooled down spent fuel of FRs
lwrpu	35a	Pu from spent fuel of LWRs
frpu	35b	Pu from spent fuel of FRs
lwrreprocessingwaste	36a	Waste from the reprocessing of spent fuel of LWRs
frreprocessingwaste	36b	Waste from the reprocessing of spent fuel of FRs

This plot title doesn't really make sense.

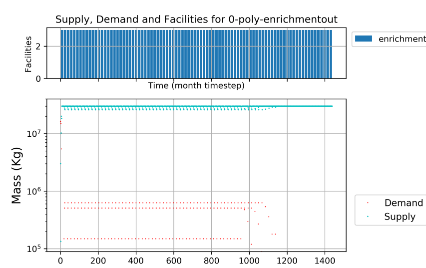


The y-axis is kind of weird?

Figure 30: Supply and demand of the commodity power.



(a) Commodity sourceout.



(b) Commodity enrichmentout.

Figure 31: Supply and demand of different commodities for the prediction method poly.

Caption should include which EG scenario [C]

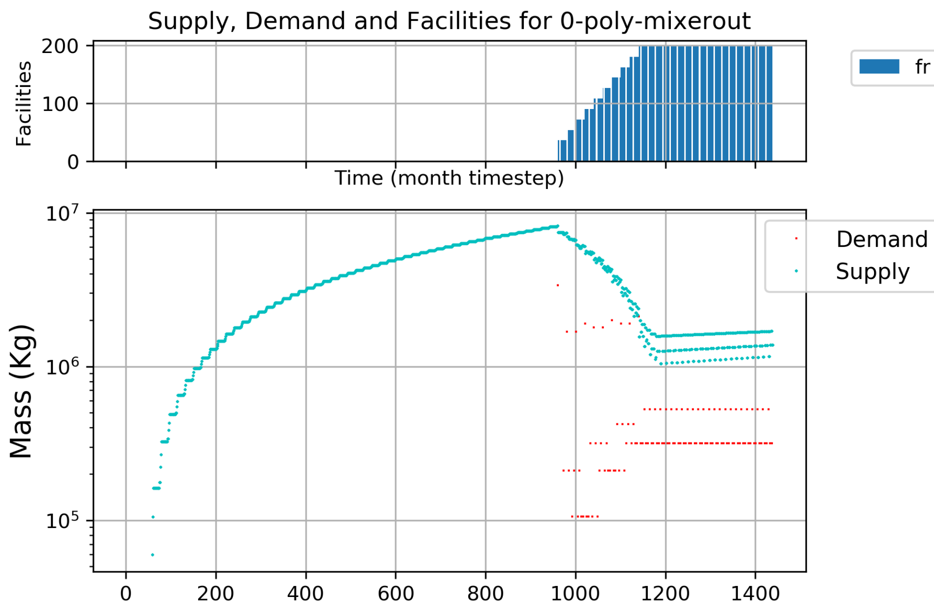
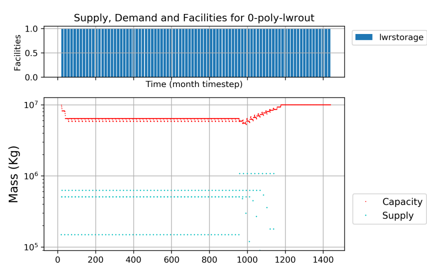
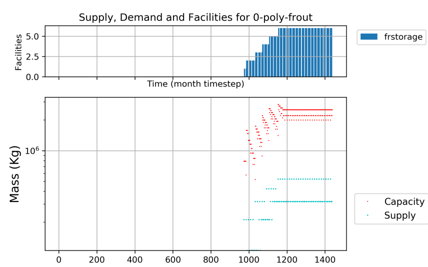


Figure 32: Supply and demand of the commodity mixerout.

[L] [C]



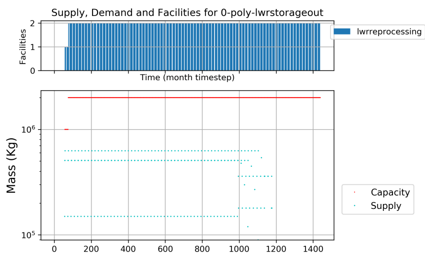
(a) Commodity lwrout.



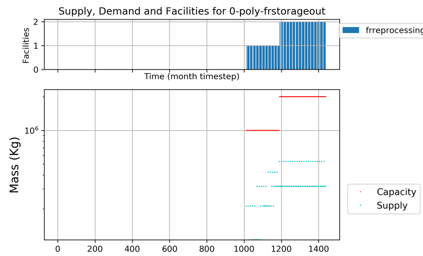
(b) Commodity frout.

Figure 33: Supply and demand of different commodities for the prediction method poly.

Caption should include which EG scenario



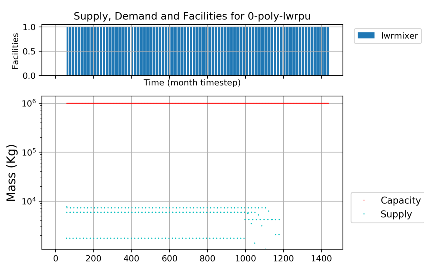
(a) Commodity lwrstorageout.



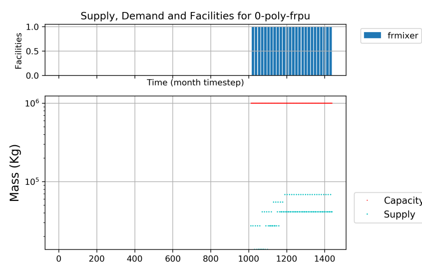
(b) Commodity frstorageout.

[L] [C]

Figure 34: Supply and demand of different commodities for the prediction method poly.



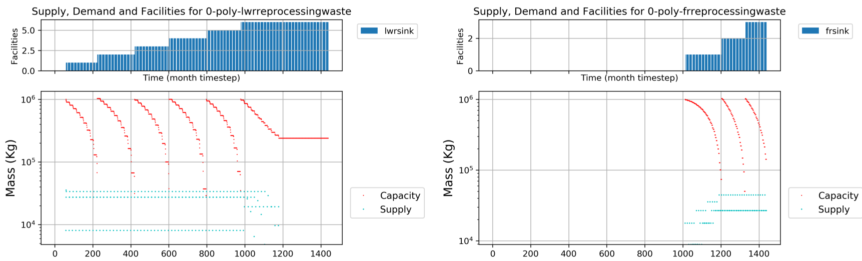
(a) Commodity lwrpu.



(b) Commodity frpu.

[L] [C]

Figure 35: Supply and demand of different commodities for the prediction method poly.



(a) Commodity lwrreprocessing-waste. (b) Commodity frreprocessingwaste.

sub and overall [C]

Figure 36: Supply and demand of different commodities for the prediction method poly.

Table 3: Undersupply and oversupply of different commodities using poly to calculate EG01-EG23.

Commodity	Undersupplied Timesteps	Cumulative Undersupply [10^3Kg]	Cumulative Oversupply [10^6Kg]
sourceout	2	4713.	35648
enrichmentout	4	48.5$x10^3$	42259
lwrout	1	149	-
frout	1	211	-
lwrstorageout	1	149	-
frstorageout	1	211	-
lwrpu	1	1.7	-
frpu	1	27.4	-

ooo, nice results! Could you add explanations to why undersupplied time steps are not zero?

3 Eg01-Eg24

Figure 37 shows the flow of Eg01-Eg24.

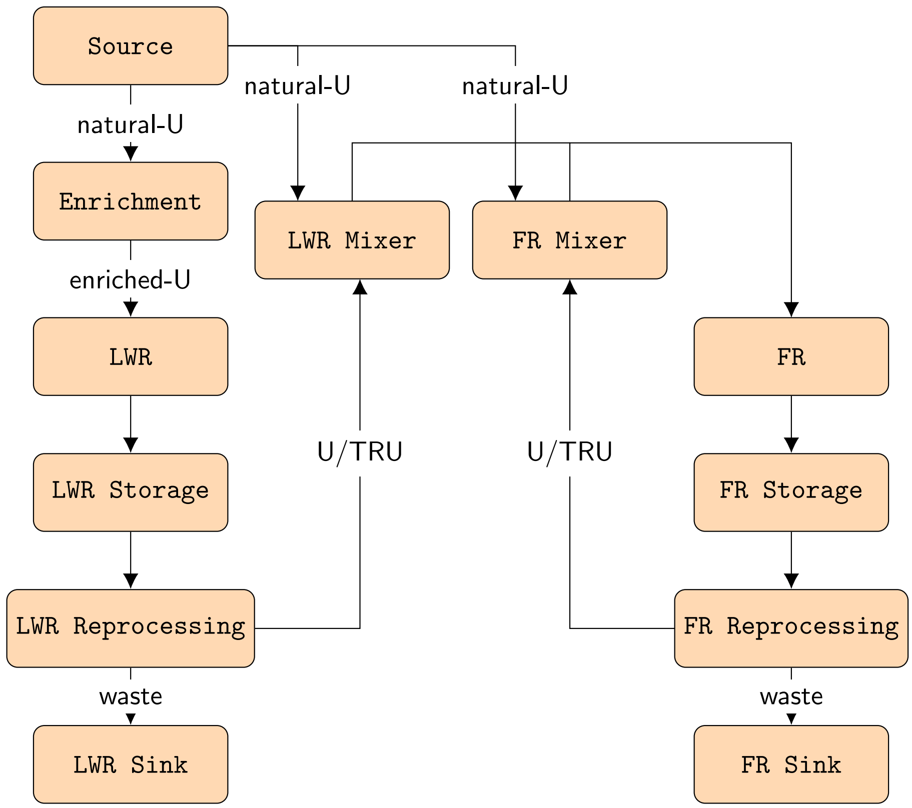
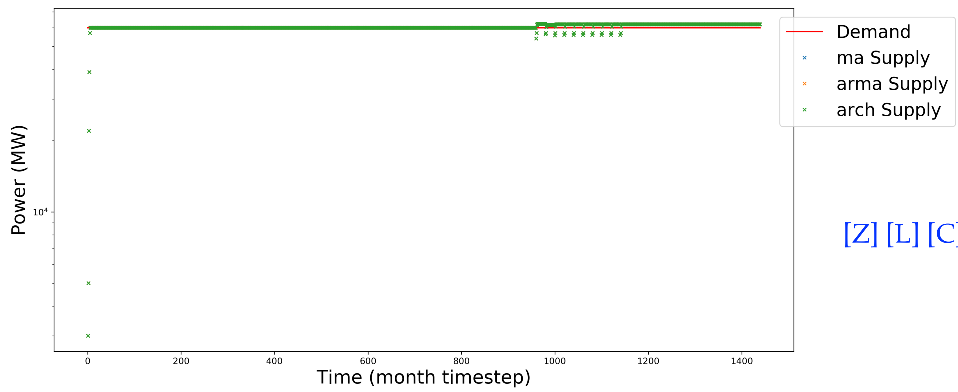


Figure 37: EG01-EG24.

3.1 Flat Power Demand

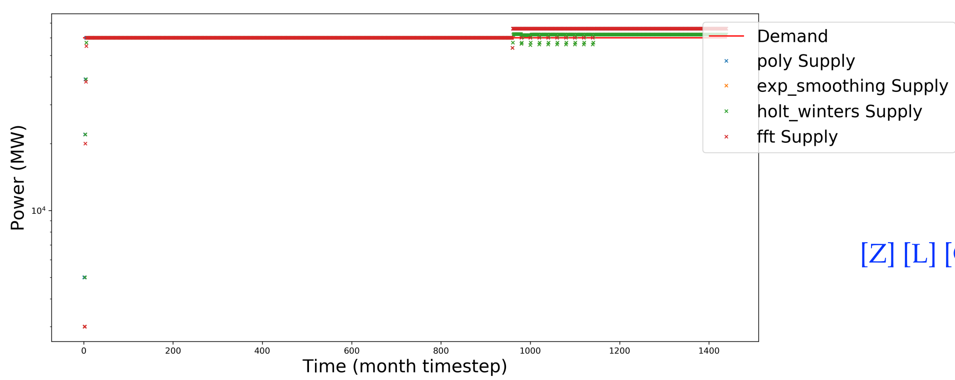
Why did you do a flat and linearly increasing power demand?

This section presents plots of power for all the prediction methods. The power demand is 60000 MW throughout the whole simulation. The input files use the installed capacity feature. Buffer is set to zero, back steps is set to two, and steps takes the default value of one. Figures 38, 39, and 40 display the power supply and demand. Table 4 records the number of steps whit under supply, the cumulative under supply, and the cumulative oversupply.



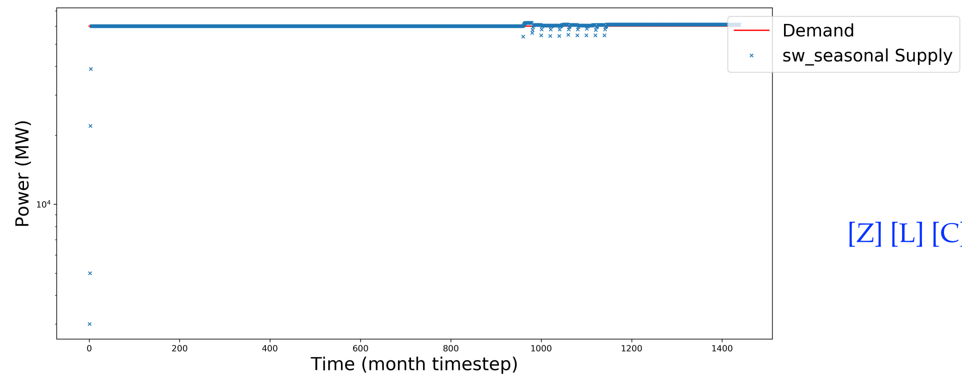
[Z] [L] [C]

Figure 38: NO algorithms.



[Z] [L] [C]

Figure 39: DO algorithms.



[Z] [L] [C]

Figure 40: SO algorithms.

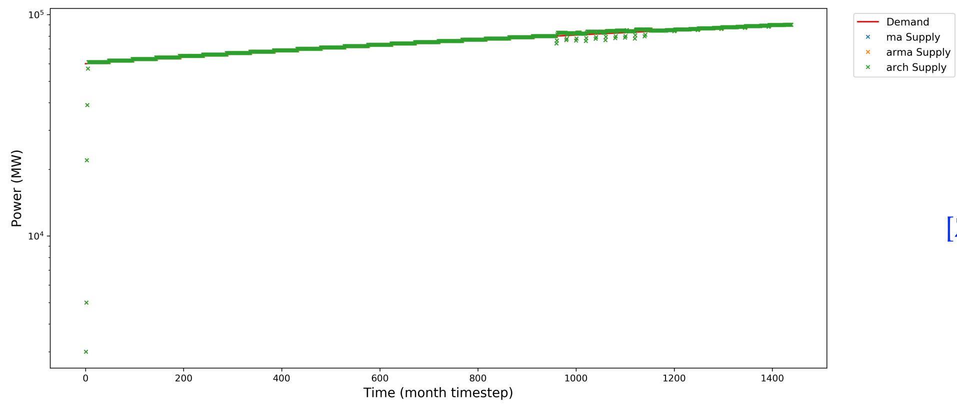
Table 4: Undersupply and oversupply of Power for the different algorithms used to calculate EG01-EG24.

Should include that it is for flat power demand

Algorithm	Undersupplied Timesteps	Cumulative Undersupply [GW.mo]	Cumulative Oversupply [GW.mo]
MA	26	306.0	907.8
ARMA	26	306.0	907.8
ARCH	26	306.0	907.8
POLY	6	235.0	2820.5
EXP_SMOOTHING	27	366.0	907.8
HOLT-WINTERS	27	366.0	907.8
FFT	8	307.0	2820.5
SW_SEASONAL	36	308.0	398.1

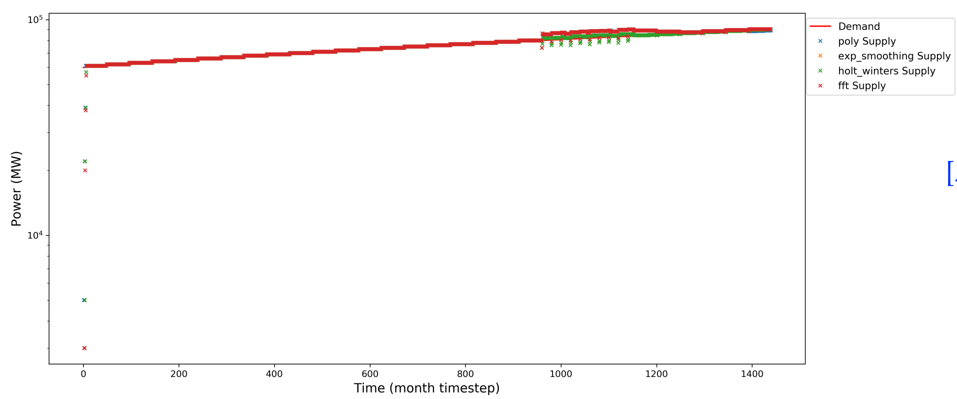
3.2 Linearly increasing Power Demand

This section presents plots of power for all the prediction methods. The power demand increases linearly with the expression $60000MW + 250 * tMW/year$. The input files use the installed capacity feature. Buffer is set to zero, back steps is set to two, and steps takes the default value of one. Figures 41, 42, and 43 display the power supply and demand. Table 5 records the number of steps whit under supply, the cumulative under supply, and the cumulative oversupply.



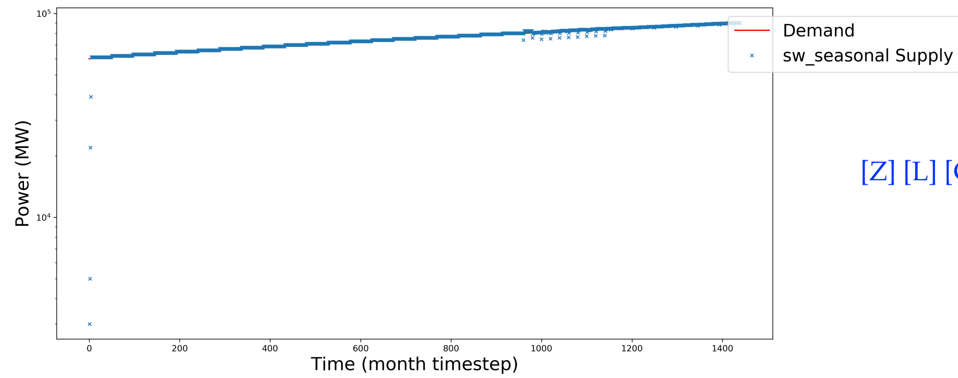
[Z] [C]

Figure 41: NO algorithms.



[Z] [C]

Figure 42: DO algorithms.



[Z] [L] [C]

Figure 43: SO algorithms.

Table 5: Undersupply and oversupply of Power for the different algorithms used to calculate EG01-EG24.

Should include that it is for linearly increasing demand

Algorithm	Undersupplied Timesteps	Cumulative Undersupply [GW.mo]	Cumulative Oversupply [GW.mo]
MA	36	313.7	840.9
ARMA	36	313.7	840.9
ARCH	36	316.8	859.0
POLY	65	282.4	1974.7
EXP_SMOOTHING	37	373.4	828.7
HOLT-WINTERS	37	373.4	828.7
FFT	20	315.1	2019.1
SW_SEASONAL	107	318.8	579.09

This seems like bad results?

4 Eg01-Eg29

Figure 44 shows the flow of Eg01-Eg29.

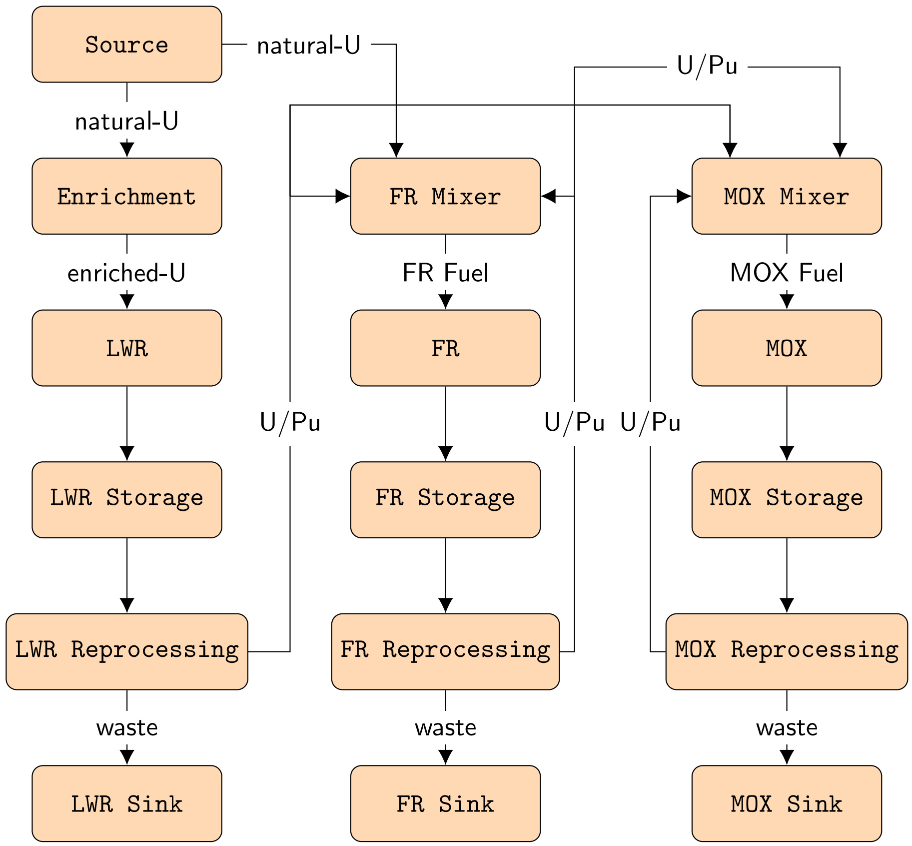
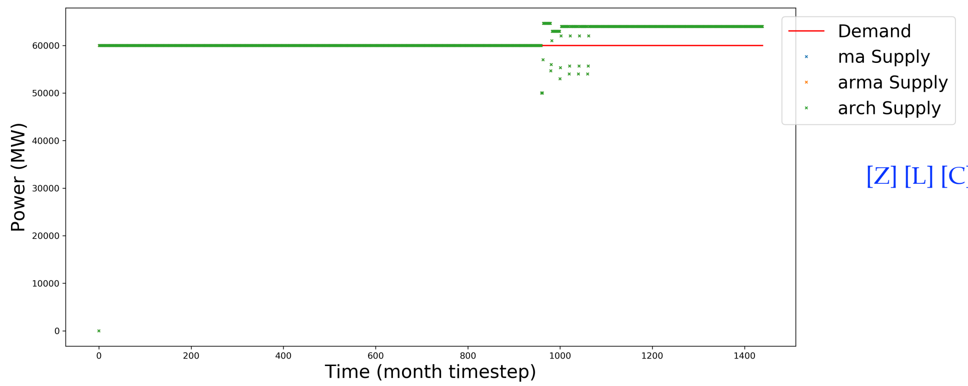


Figure 44: EG01-EG29.

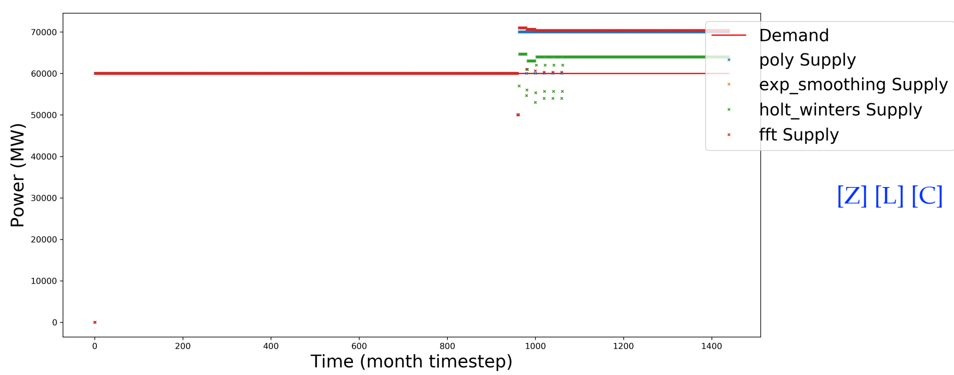
4.1 Power

This section presents plots of power for all the prediction methods. The power demand is 60000 MW throughout the whole simulation. The input files use the installed capacity feature. Buffer is set to zero, back steps is set to two, and steps takes the default value of one. Figures 45, 46, and 47 display the power supply and demand. Table 6 records the number of steps with under supply, the cumulative under supply, and the cumulative oversupply. [I]



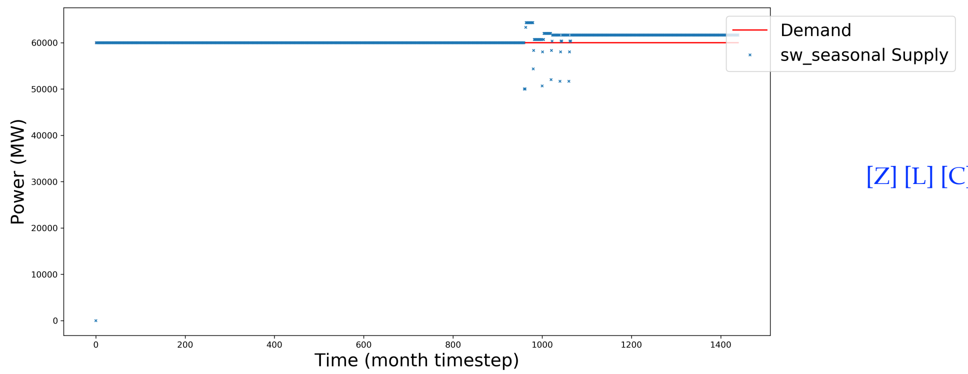
[Z] [L] [C]

Figure 45: NO algorithms.



[Z] [L] [C]

Figure 46: DO algorithms.



[Z] [L] [C]

Figure 47: SO algorithms.

Table 6: Undersupply and oversupply of Power for the different algorithms used to calculate EG01-EG29.

Algorithm	Undersupplied Timesteps	Cumulative Undersupply [GW.mo]	Cumulative Oversupply [GW.mo]
MA	15	145.0	1847.0
ARMA	15	145.0	1847.0
ARCH	15	145.0	1846.9
POLY	4	90.0	4720.3
EXP_SMOOTHING	16	205.0	1847.0
HOLT-WINTERS	16	205.0	1847.0
FFT	5	150.0	4898.0
SW_SEASONAL	14	139.0	798.9

4.2 Buffer

This section presents a sensitivity analysis for different values of the buffer. Figure 48 shows a comparison of the cumulative under supply for different buffer sizes.

Figures 49 to 55 display a comparison for some of the methods of the power supply for different buffer sizes. [I]

The input files use the installed capacity feature. Buffer takes the values 0, 2000, 4000, 6000, and 8000. Back steps is set to two, and steps takes the default value of one.

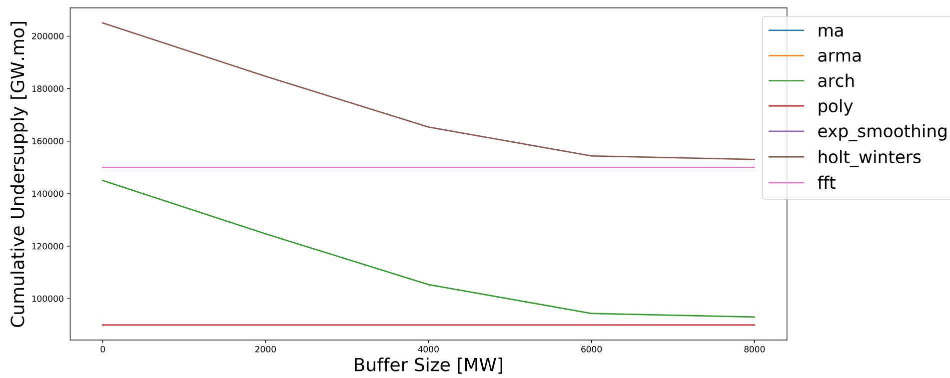


Figure 48: Sensitivity analysis for different buffer sizes for some prediction algorithms.

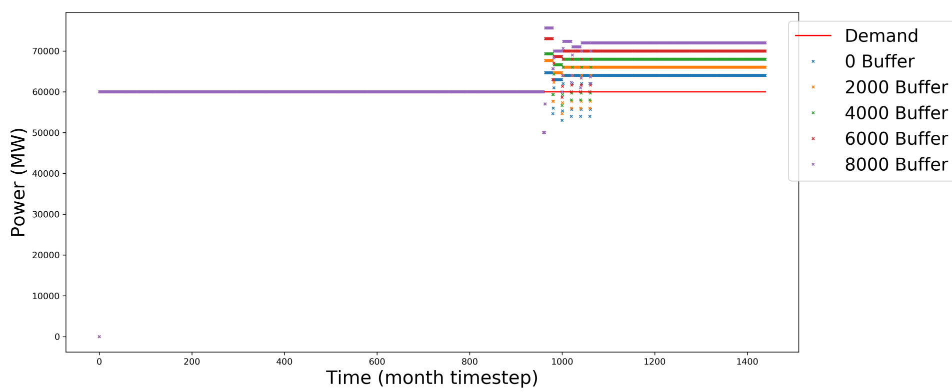


Figure 49: Power supply for different buffer sizes using ma.

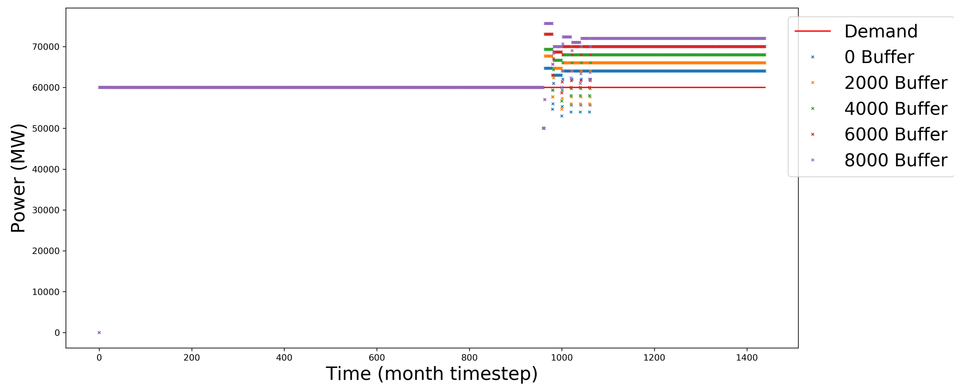


Figure 50: Power supply for different buffer sizes using arma.

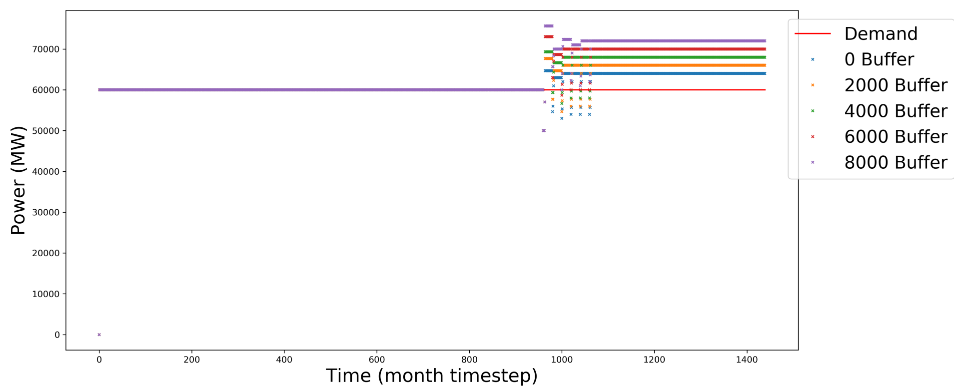


Figure 51: Power supply for different buffer sizes using arch.

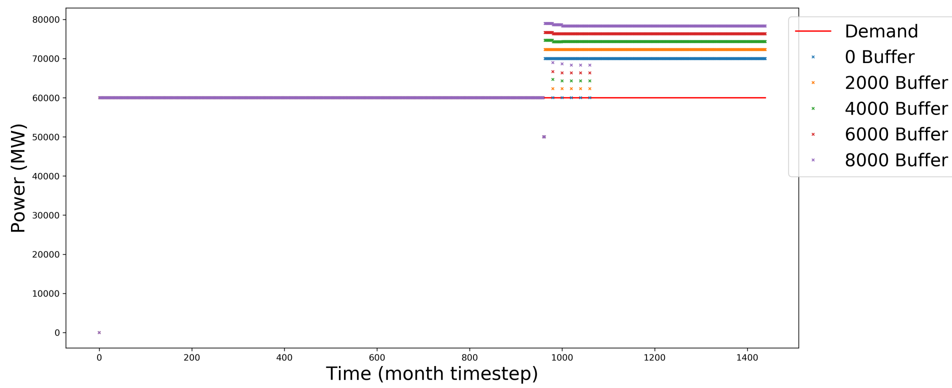


Figure 52: Power supply for different buffer sizes using poly.

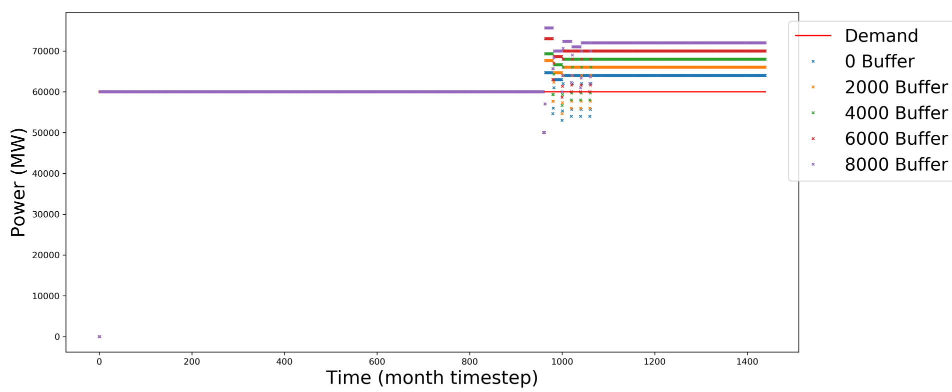


Figure 53: Power supply for different buffer sizes using exp_smoothing.

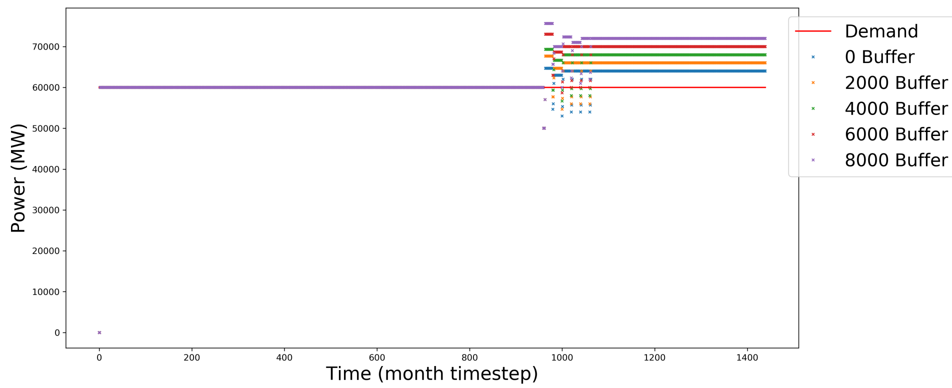


Figure 54: Power supply for different buffer sizes using holt_winters.

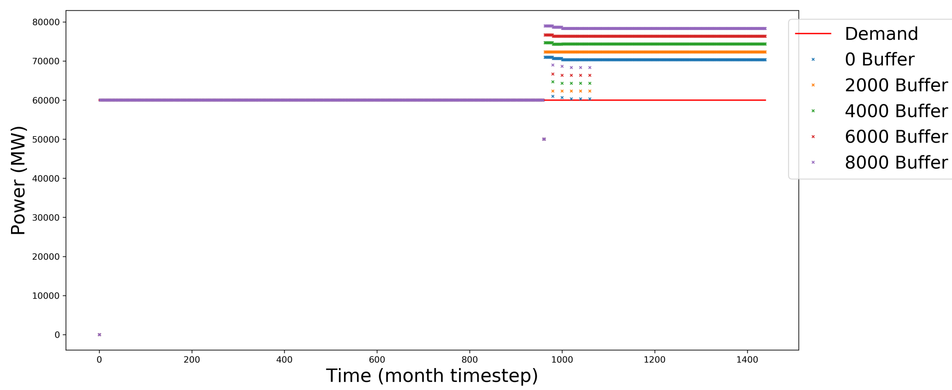


Figure 55: Power supply for different buffer sizes using fft.

4.3 Steps forward

This section presents a sensitivity analysis for different values of steps. Figure 56 shows a comparison of the cumulative under supply for different values of steps forward.

Figures 57 to 63 display a comparison for some of the methods of the power supply for different steps.

The input files use the installed capacity feature. Buffer is set to zero, back steps is set to two, and steps takes the values 1, 2, 3, 4, and 5.

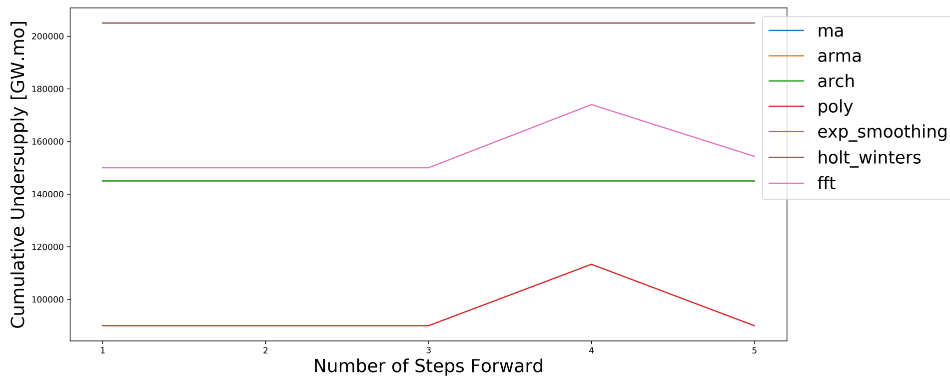


Figure 56: Sensitivity analysis for different number of steps forward for some prediction algorithms.

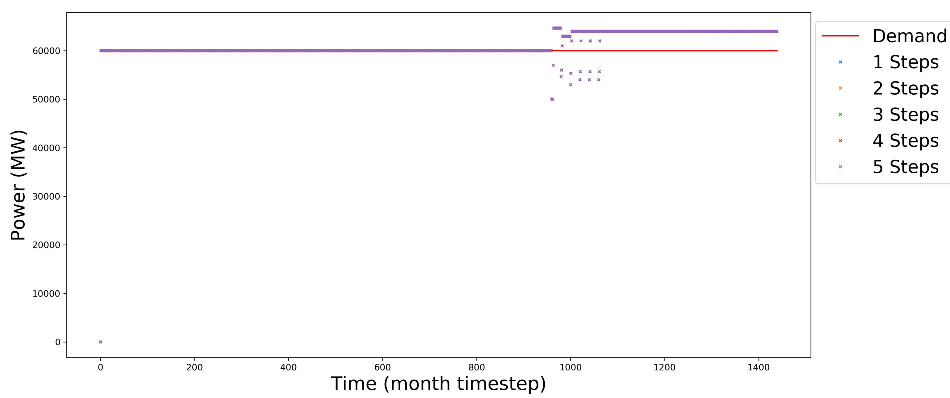


Figure 57: Power supply for different values of steps forward using ma.

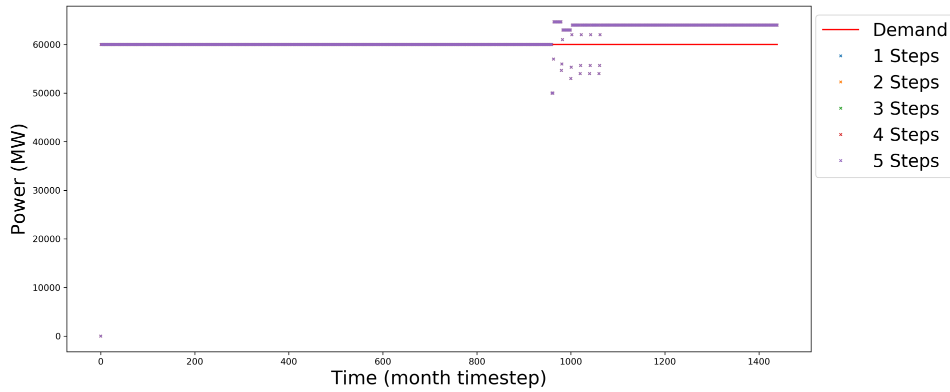


Figure 58: Power supply for different values of steps forward using arma.

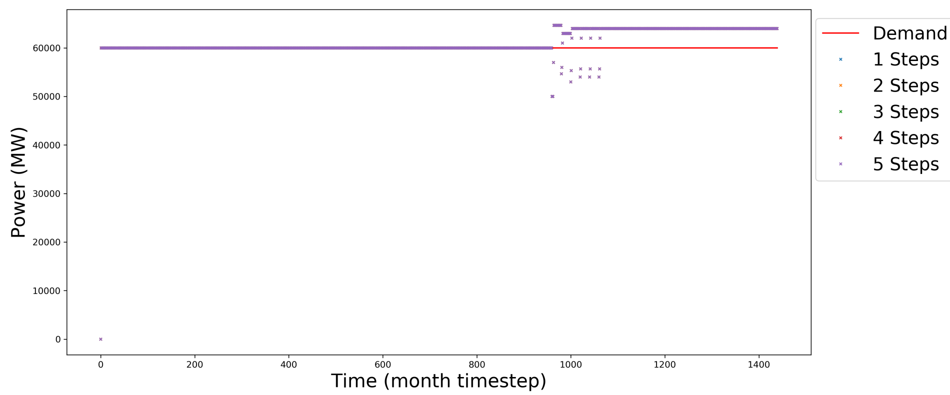


Figure 59: Power supply for different values of steps forward using arch.

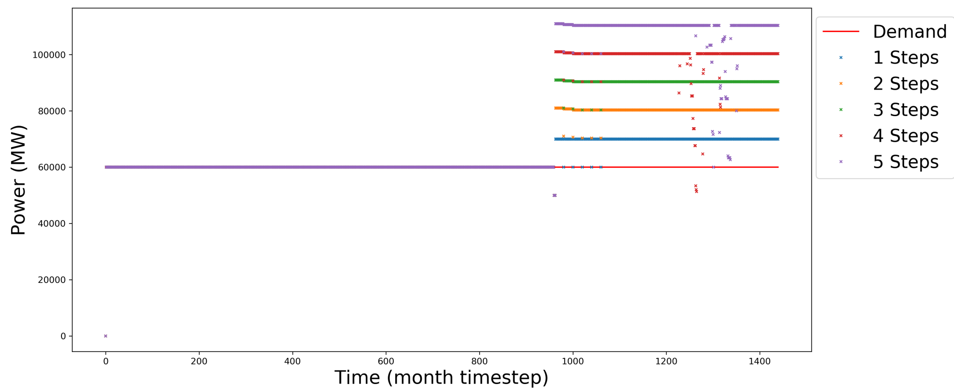


Figure 60: Power supply for different values of steps forward using poly.

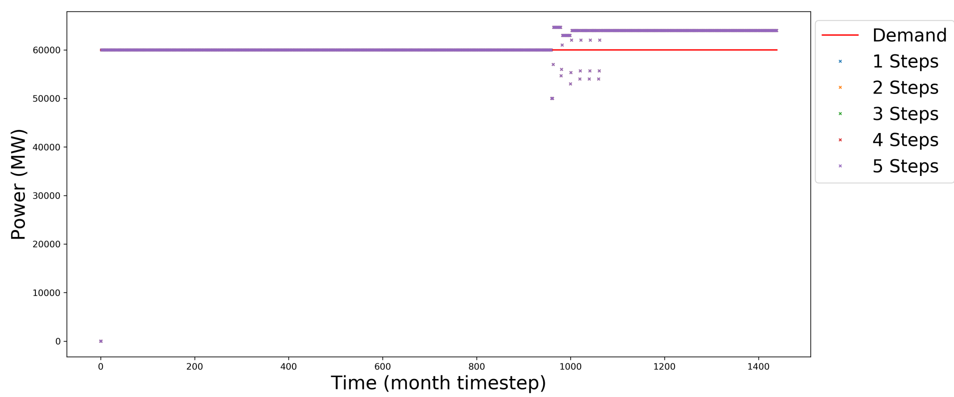


Figure 61: Power supply for different values of steps forward using exp_smoothing.

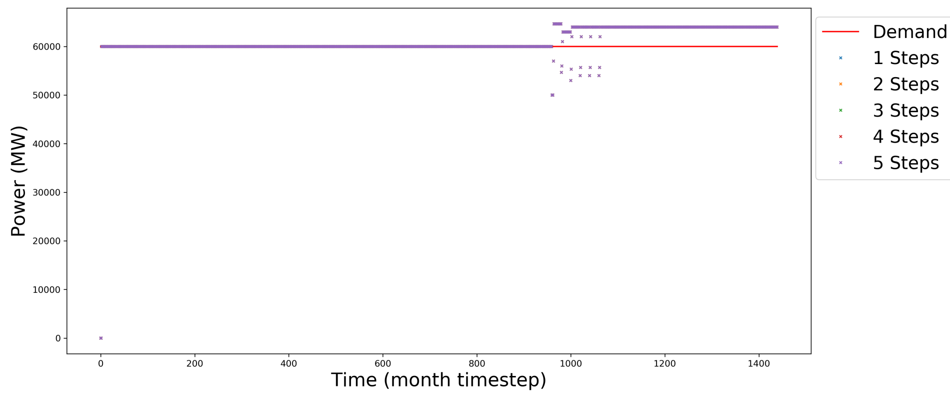


Figure 62: Power supply for different values of steps forward using holt_winters.

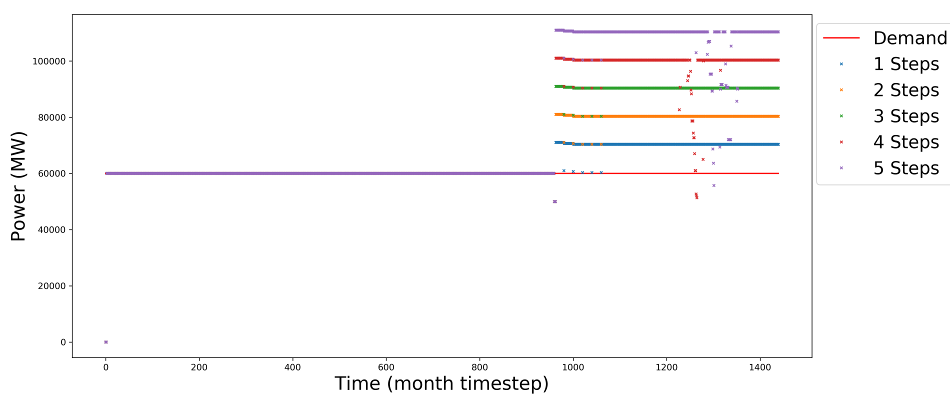


Figure 63: Power supply for different values of steps forward using fft.

4.4 Different commodities

Table 7 shows the name of the variables used in the simulations and what they represent in the cycle. Table 8 presents the number of steps of under supply, cumulative under supply, and cumulative oversupply for some of the commodities.

In this simulation, front-end commodities are power, sourceout, enrichmentout, frmixerout, and moxmixerout. All the rest of the commodities are back-end.

Table 7: Commodity names used in the simulation of EG01-EG29.

Commodity name	Figures	Represents
power	64	Power
sourceout	65a	Natural-U
enrichmentout	65b	Enriched-U
frmixerout	66a	FR fuel
moxmixerout	66b	MOX fuel
lwrout	67	Spent fuel of LWRs
frout	68a	Spent fuel of FRs
frout	68b	Spent fuel of MOX LWRs
lwrstorageout	69	Cooled down spent fuel of LWRs
frstorageout	70a	Cooled down spent fuel of FRs
moxstorageout	70b	Cooled down spent fuel of MOX LWRs
lwrpu	71	Pu from spent fuel of LWRs
frpu	72a	Pu from spent fuel of FRs
moxpu	72b	Pu from spent fuel of MOX LWRs
lwrreprocessingwaste	73	Waste from the reprocessing of spent fuel of LWRs
frreprocessingwaste	74a	Waste from the reprocessing of spent fuel of FRs
moxreprocessingwaste	74b	Waste from the reprocessing of spent fuel of MOX LWRs

Same question: Why Linearly Increasing, instead of constant power demand??

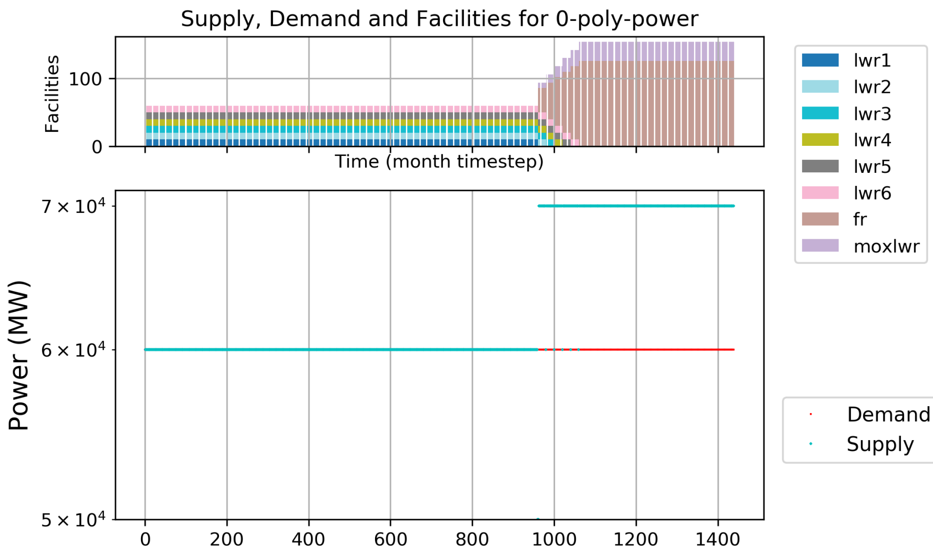
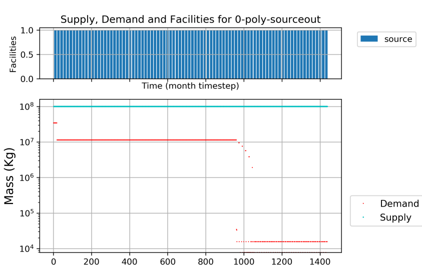
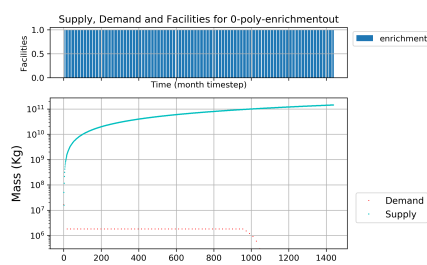


Figure 64: Supply and demand of the commodity power.

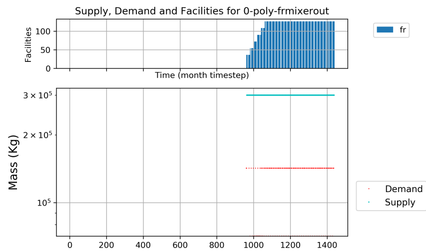


(a) Commodity sourceout.

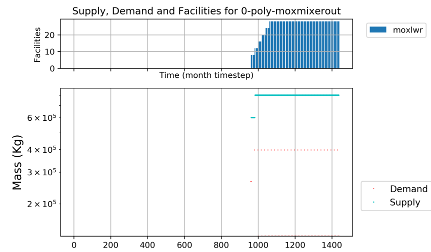


(b) Commodity enrichmentout.

Figure 65: Supply and demand of different commodities for the prediction method poly.



(a) Commodity frmixerout.



(b) Commodity moxmixerout.

Figure 66: Supply and demand of different commodities for the prediction method poly.

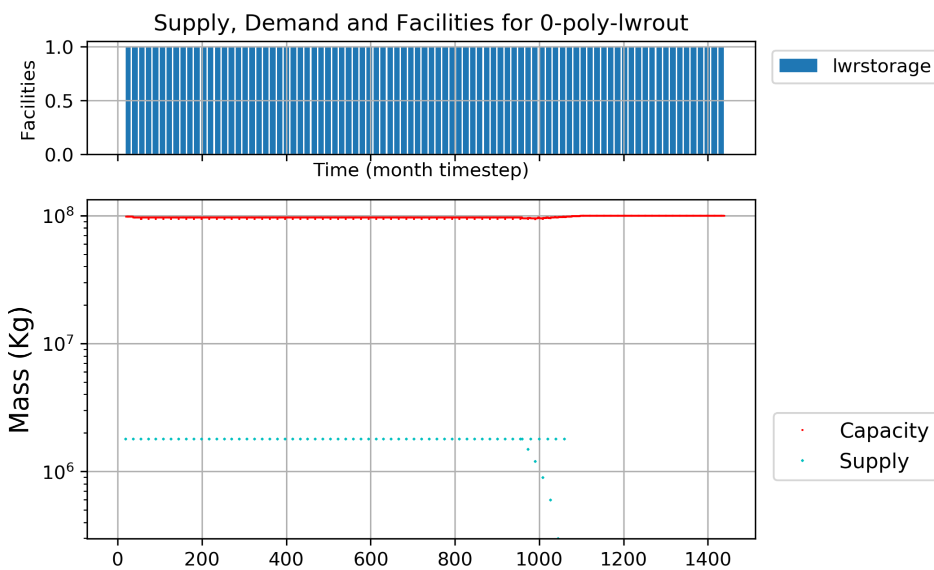
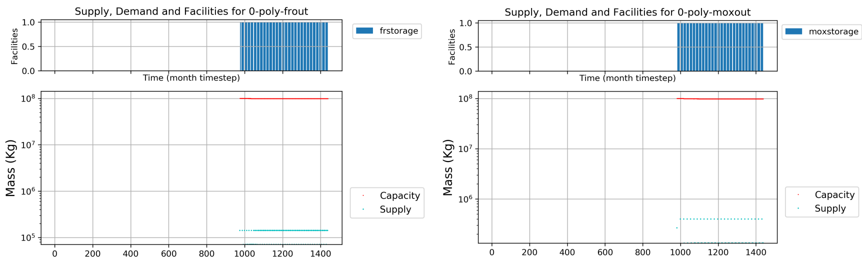


Figure 67: Supply and demand of the commodity lwrout.



(a) Commodity frout.

(b) Commodity moxout.

Figure 68: Supply and demand of different commodities for the prediction method poly.

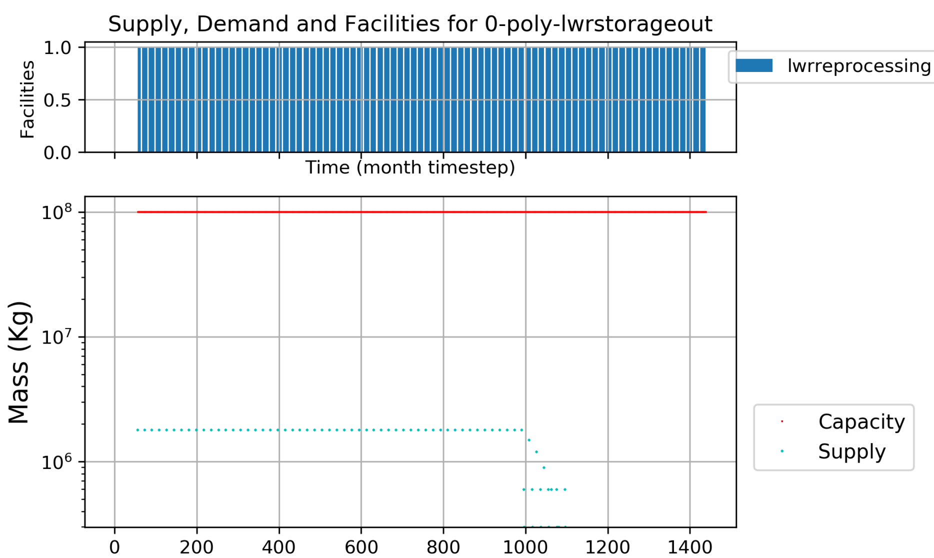
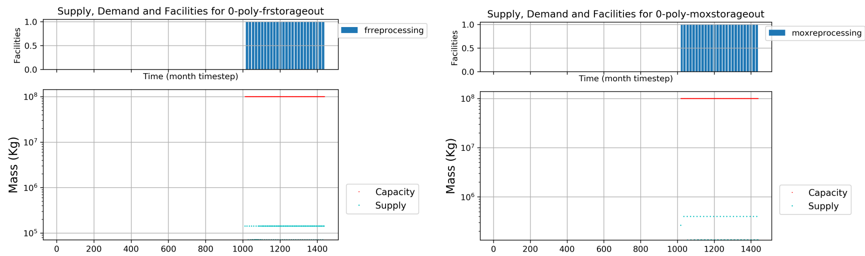


Figure 69: Supply and demand of the commodity lwrstorageout.



(a) Commodity frstorageout. (b) Commodity moxstorageout.

Figure 70: Supply and demand of different commodities for the prediction method poly.

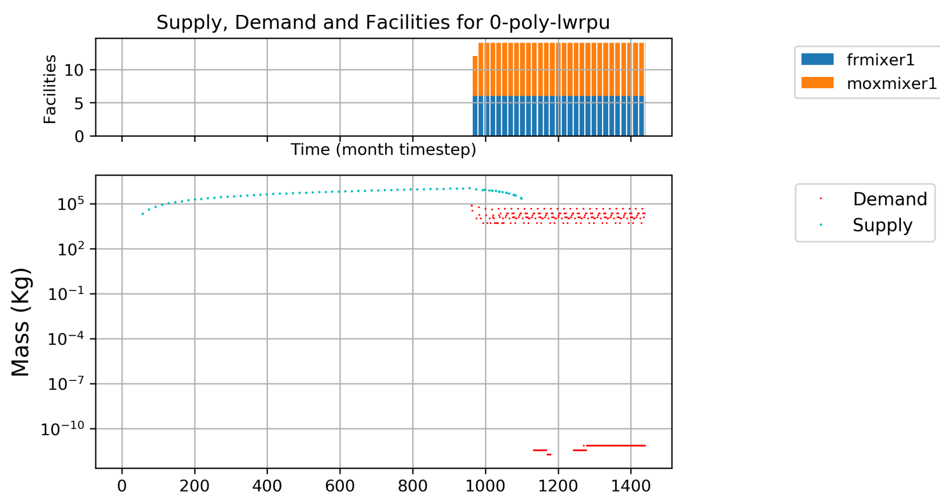
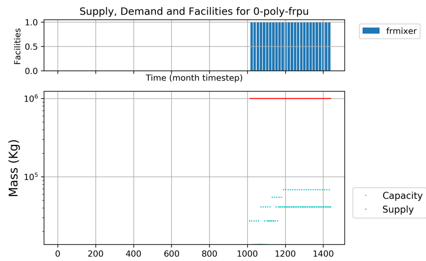
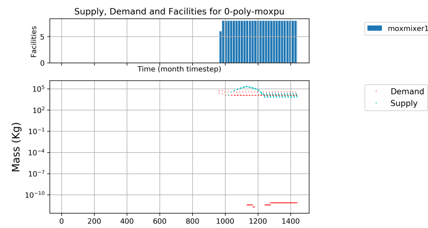


Figure 71: Supply and demand of the commodity lwrpu.



(a) Commodity frpu.



(b) Commodity moxpu.

Figure 72: Supply and demand of different commodities for the prediction method poly.

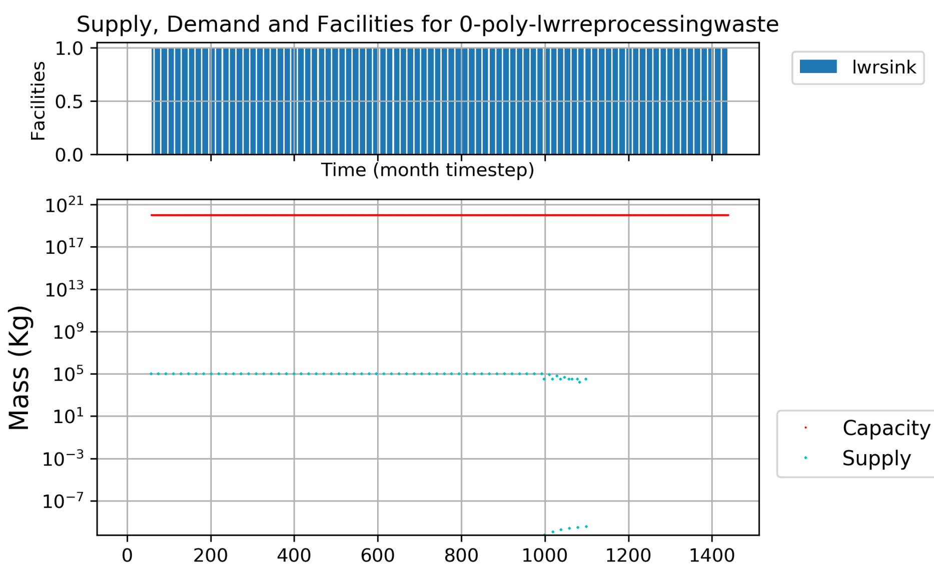
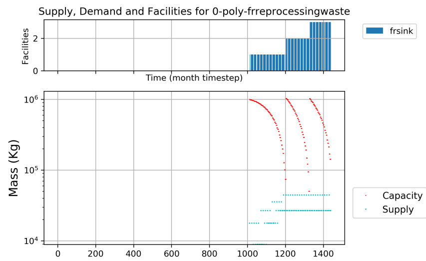
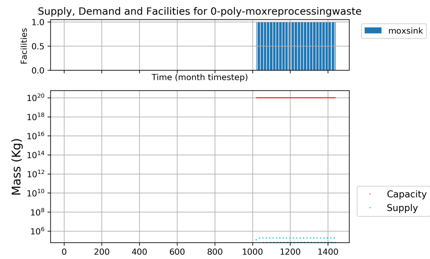


Figure 73: Supply and demand of the commodity lwrreprocessingwaste.



(a) Commodity frreprocessingwaste.



(b) Commodity moxreprocessingwaste.

Figure 74: Supply and demand of different commodities for the prediction method poly.

Table 8: Undersupply and oversupply of different commodities using poly to calculate EG01-EG29.

Commodity	Undersupplied Timesteps	Cumulative Undersupply [10^3Kg]	Cumulative Oversupply [10^6Kg]
sourceout	1	34394.0	132319869.5
enrichmentout	1	16126.1	102751545581.6
lwrout	1	1791.8	-
frout	1	142.2	-
moxout	1	265.0	-
frmixerout	2	284.4	124827.3
moxmixerout	2	530.1	354541.5
lwrstorageout	1	1791.8	-
frstorageout	1	142.2	-
moxstorageout	1	265.0	-

5 Eg01-Eg30

Figure 75 shows the flow of Eg01-Eg30.

Why constant and linearly increasing?

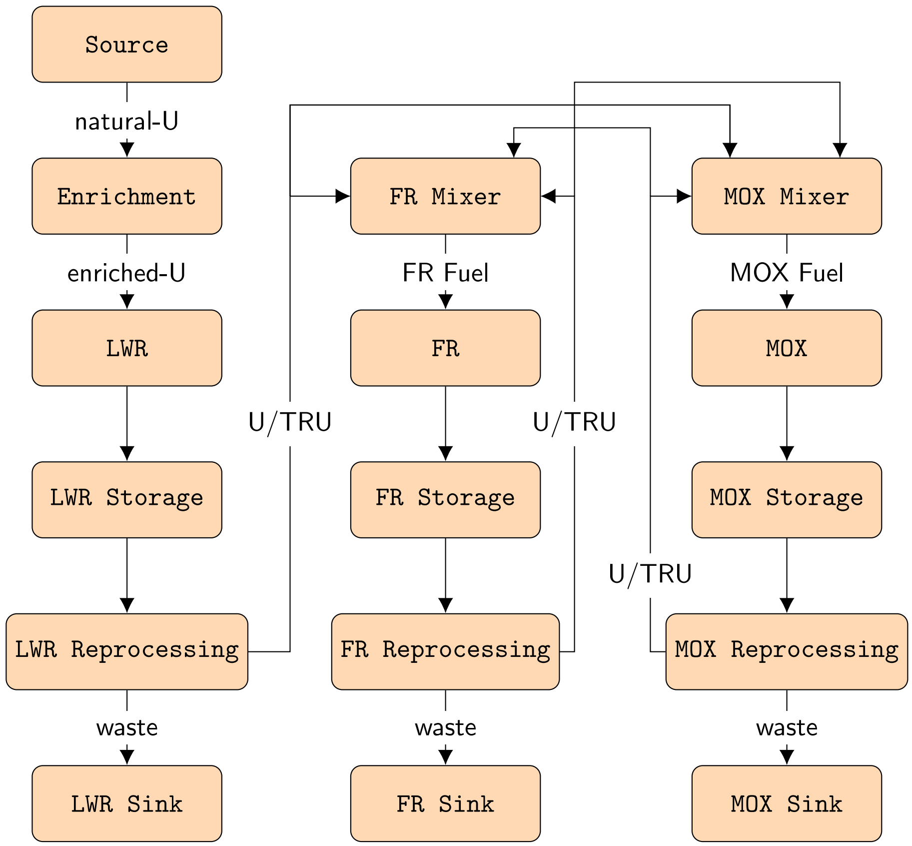


Figure 75: EG01-EG30.

5.1 Flat Power Demand

This section presents plots of power for all the prediction methods. The power demand is 60000 MW throughout the whole simulation. The input files use the installed capacity feature. Buffer is set to zero, back steps is set to two, and steps takes the default value of one. Figures 76, 77, and 78 display the power supply and demand. Table 9 records the number of steps whit under supply, the cumulative under supply, and the cumulative oversupply.

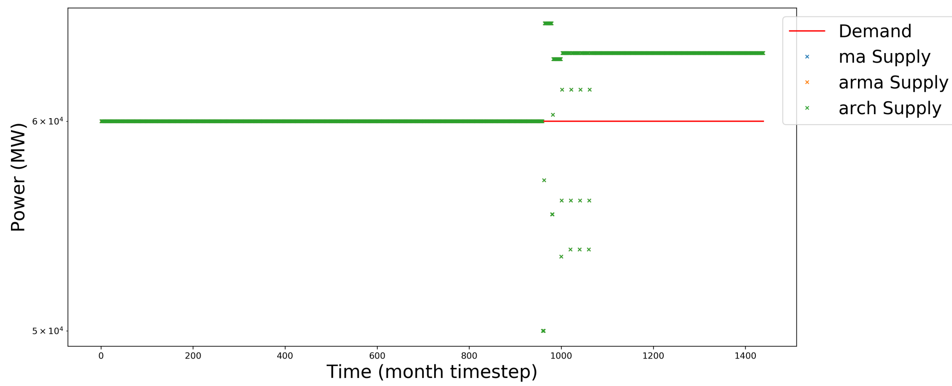


Figure 76: NO algorithms.

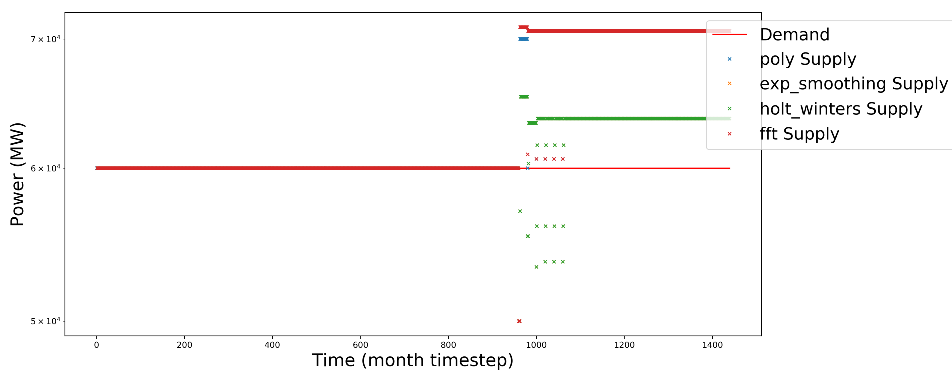


Figure 77: DO algorithms.

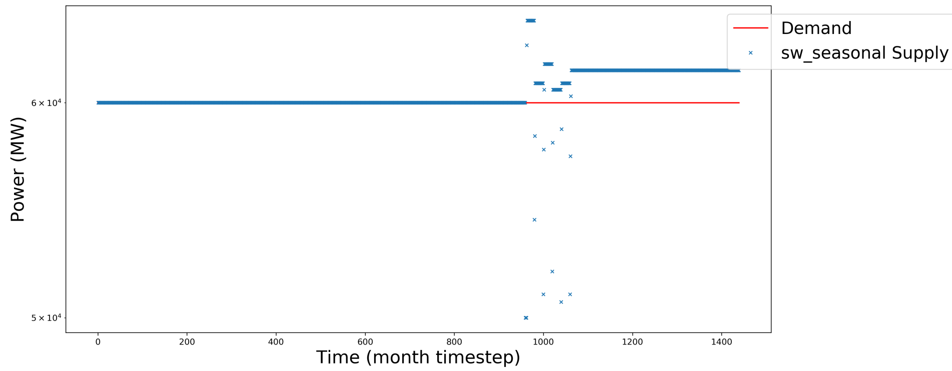


Figure 78: SO algorithms.

Table 9: Undersupply and oversupply of Power for the different algorithms used to calculate EG01-EG24.

Algorithm	Undersupplied Timesteps	Cumulative Undersupply [GW.mo]	Cumulative Oversupply [GW.mo]
MA	15	144.0	1718.7
ARMA	15	144.0	1718.7
ARCH	15	144.0	1718.7
POLY	4	90.0	5026.5
EXP_SMOOTHING	16	204.0	1718.7
HOLT-WINTERS	16	204.0	1718.7
FFT	5	150.0	5044.5
SW_SEASONAL	14	141.0	784.0

5.2 Linearly increasing Power Demand

This section presents plots of power for all the prediction methods. The power demand increases linearly with the expression $60000MW + 250 * tMW/year$. The input files use the installed capacity feature. Buffer is set to zero, back steps is set to two, and steps takes the default value of one. Figures 79, 80, and 81 display the power supply and demand. Table 10 records the number of steps whit under supply, the cumulative under supply, and the cumulative oversupply.

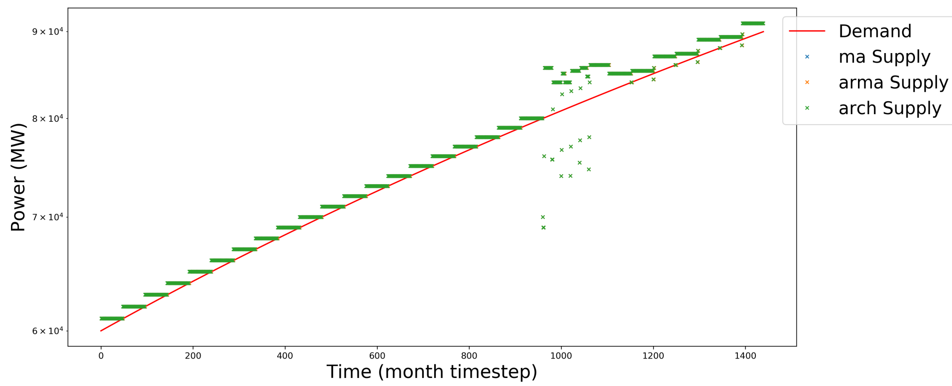


Figure 79: NO algorithms.

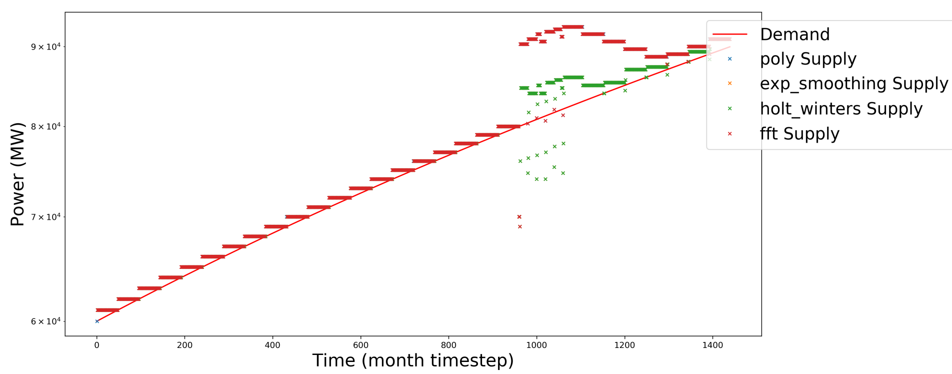


Figure 80: DO algorithms.

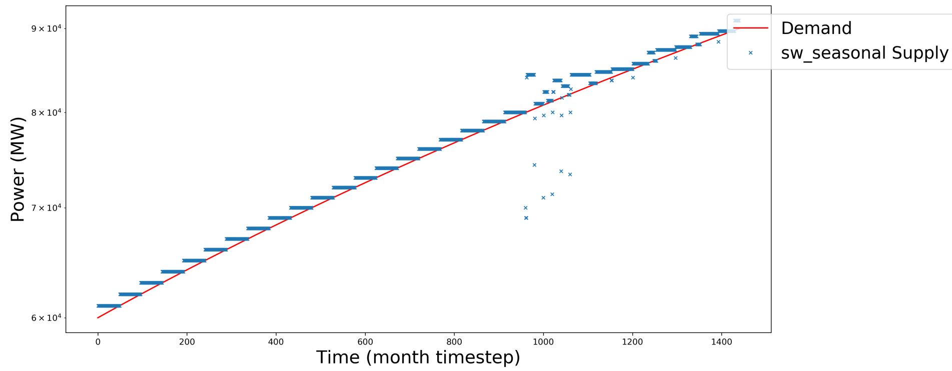


Figure 81: SO algorithms.

Table 10: Undersupply and oversupply of Power for the different algorithms used to calculate EG01-EG24.

Algorithm	Undersupplied Timesteps	Cumulative Undersupply [GW.mo]	Cumulative Oversupply [GW.mo]
MA	24	152.3	1334.1
ARMA	24	152.3	1334.1
ARCH	21	152.1	1355.9
POLY	9	92.5	3073.1
EXP_SMOOTHING	25	211.6	1317.8
HOLT-WINTERS	25	211.6	1317.8
FFT	9	152.5	3079.4
SW_SEASONAL	51	147.3	873.4