Understand the model. Explore baseline 1. Open the model and read the code. Create monitor with total demand of all users for previous day. The idea of power generation is to generate the same amount users are demanding. Create adjustment procedure, so power plant will produce the mean amount of demanded power for previous 5 days (each tick max-power should be equal to mean-day-demand / 24). Create plot: total demand per day of all users with days as x-axis steps

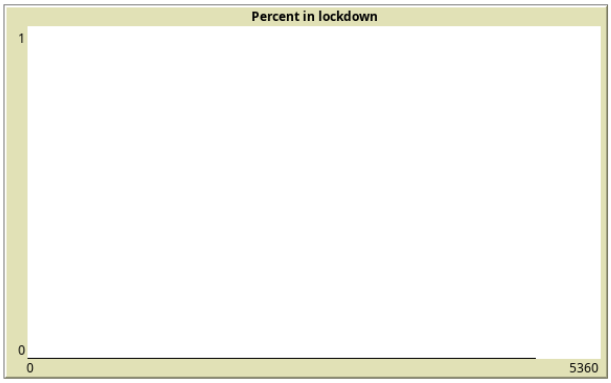
```
adjust-demand

set cur-day-demand cur-day-demand + sum [demand] of users
set hour remainder ticks 24




if hour = 0 [
  set days days + 1
  set prev-day-demand cur-day-demand
  set cur-day-demand 0

  set last-five-demand fput (prev-day-demand) last-five-demand
  ifelse length last-five-demand = 5 [
    set cur-mean mean last-five-demand
    set last-five-demand remove-item 0 last-five-demand
  ] [
    set cur-mean mean last-five-demand
  ]

]


to adjust-demand
  ask power-stations [
    set max-power cur-mean / 24
      ]

end
```

Here I calculated the overall mean demand for the last 5 days and set max-power for each stations according to demand/24 (hourly)

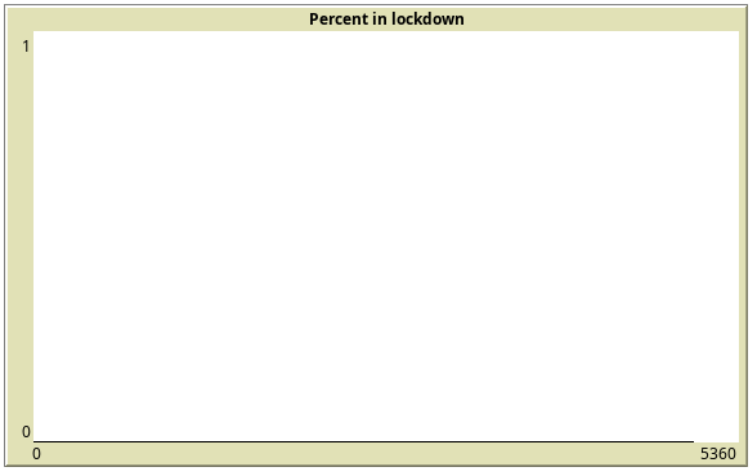
2. Consider network with 1 plant, 5 distribution stations and 100 users. For three implemented network types explore how productivity (number of satisfied users) will change with grow of demands. Set stations to maximum levels (generation-capacity should change with user demands grow). Find threshold when more then 10% users will face power shutdown.

1. Network: minimal

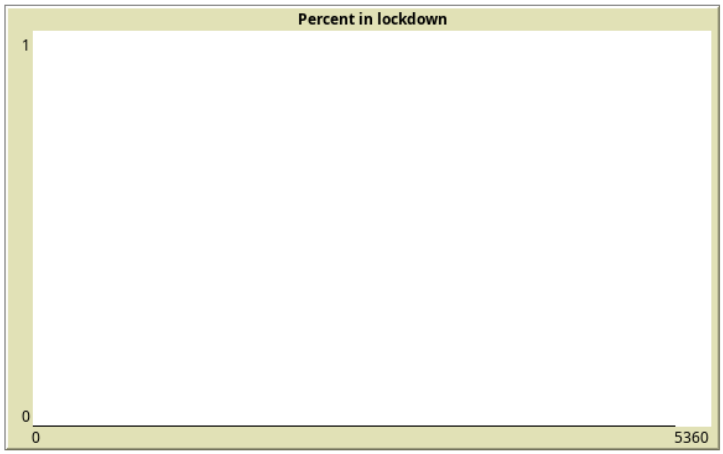
1)Max-demand-users = 0



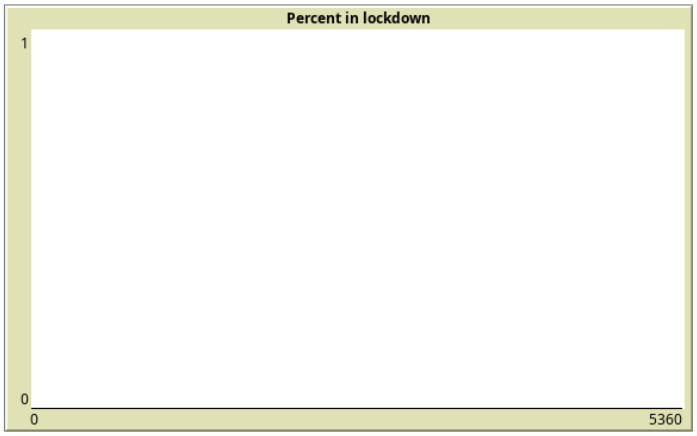
2)Max-demand-users = 0.1



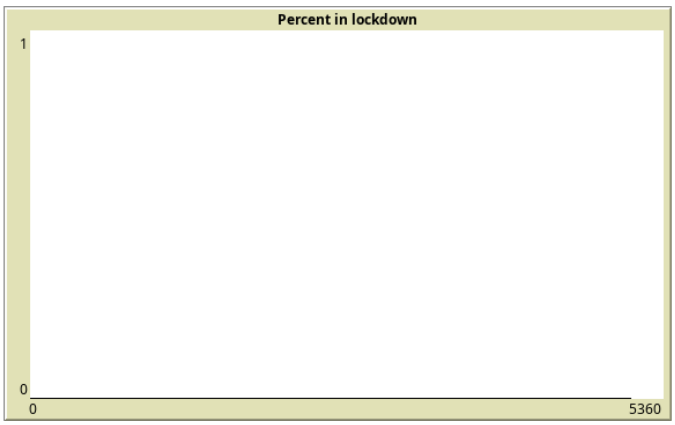
3)Max-demand-users = 0.2



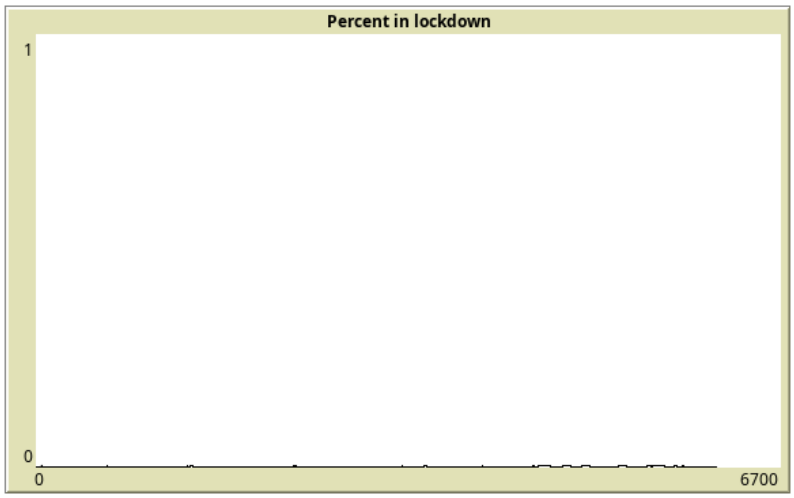
4)Max-demand-users = 0.3



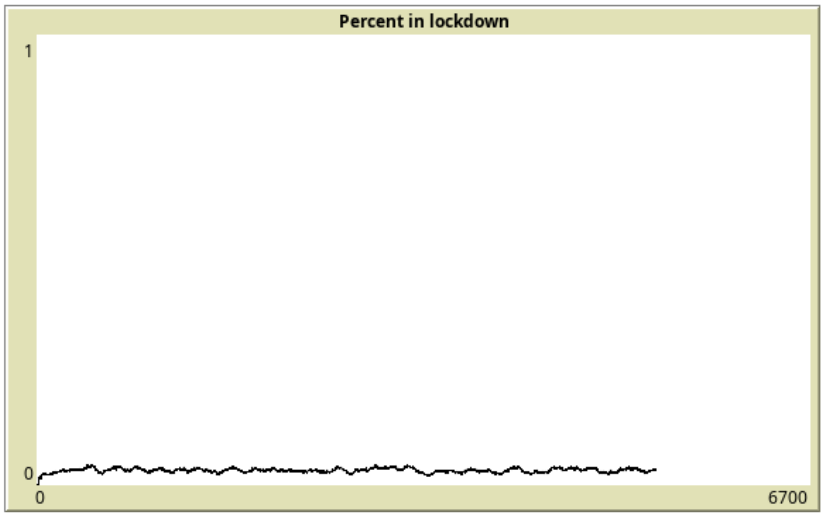
5)Max-demand-users = 0.4



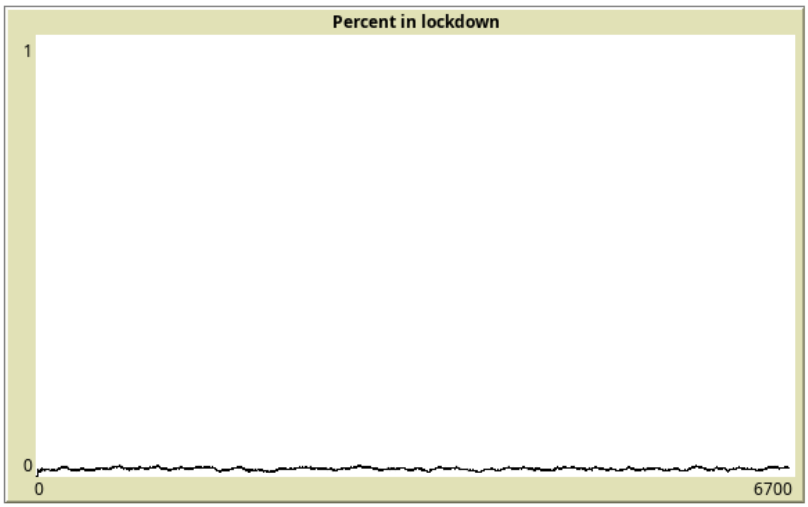
6)Max-demand-users = 0.46



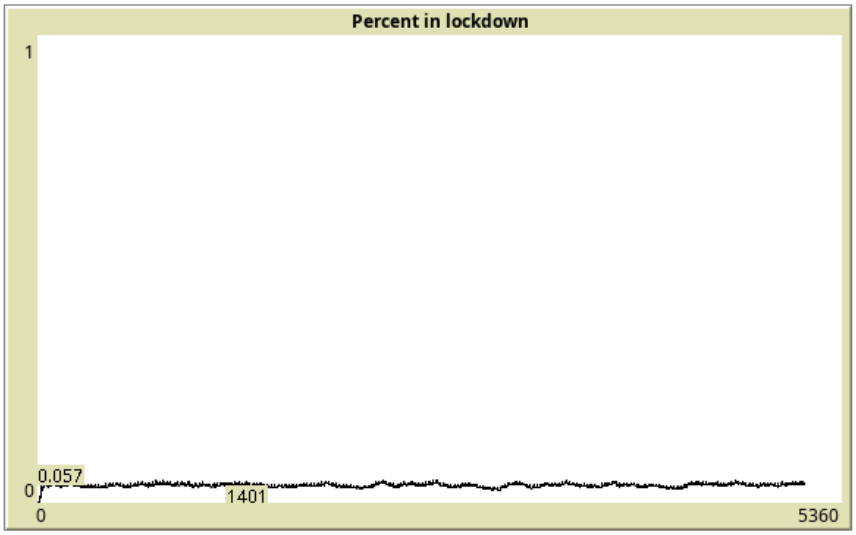
7)Max-demand-users = 0.47



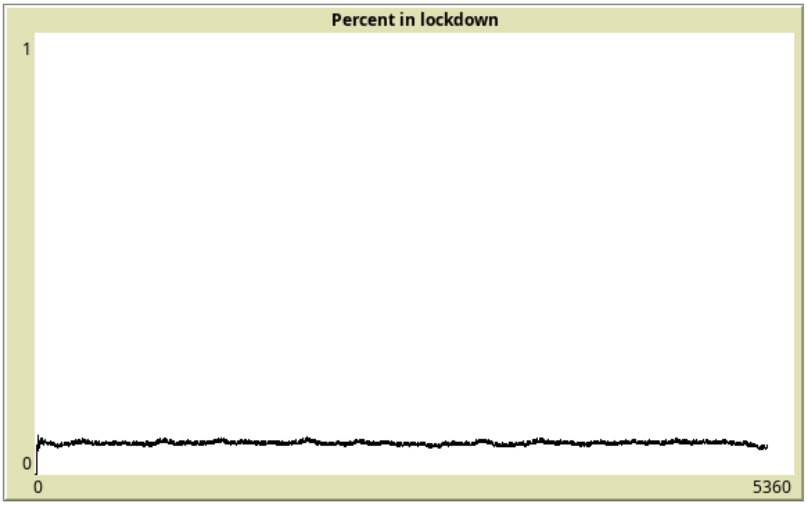
8)Max-demand-users = 0.5



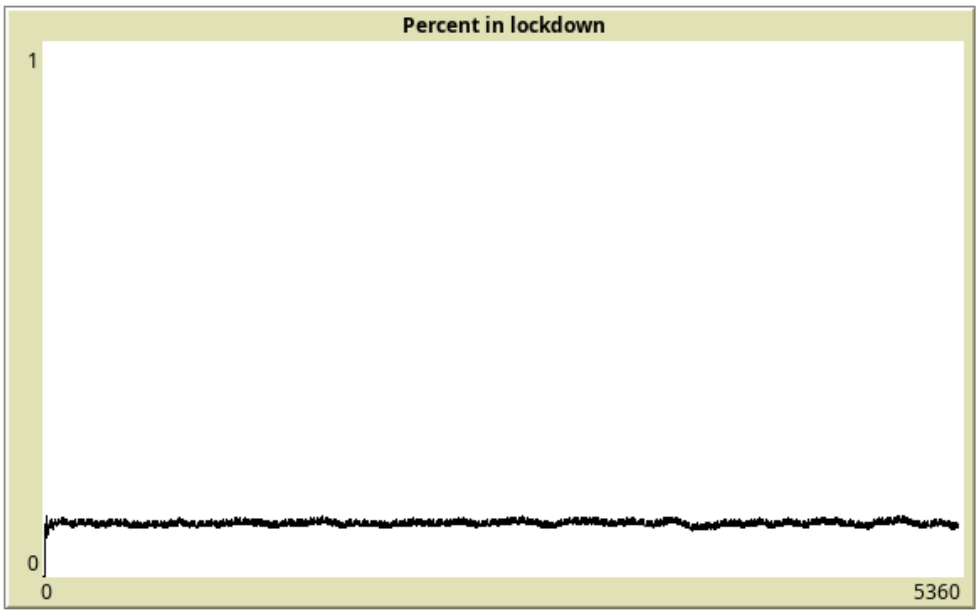
8)Max-demand-users = 0.6 : 0.04-0.045



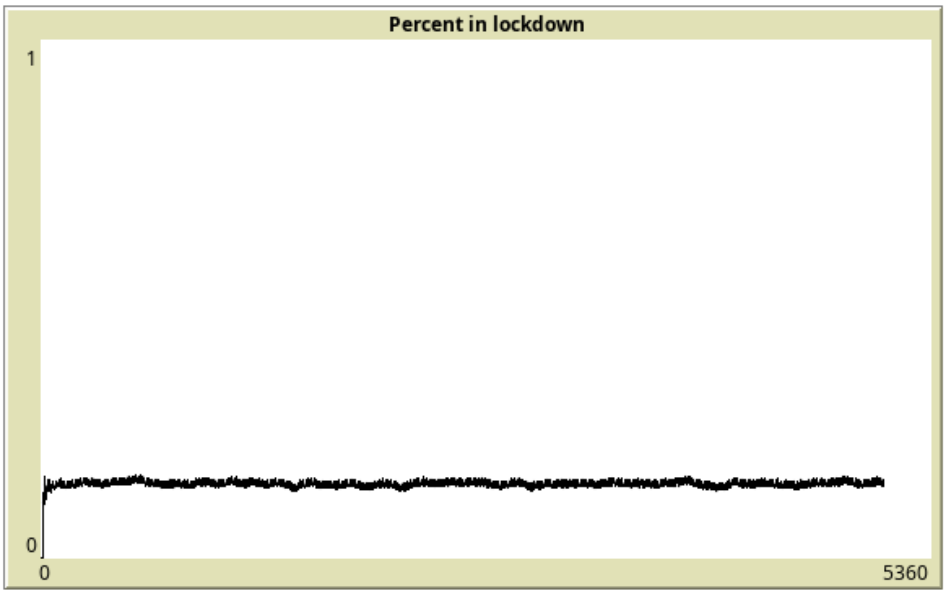
9)Max-demand-users = 0.7: 0.075-0.08



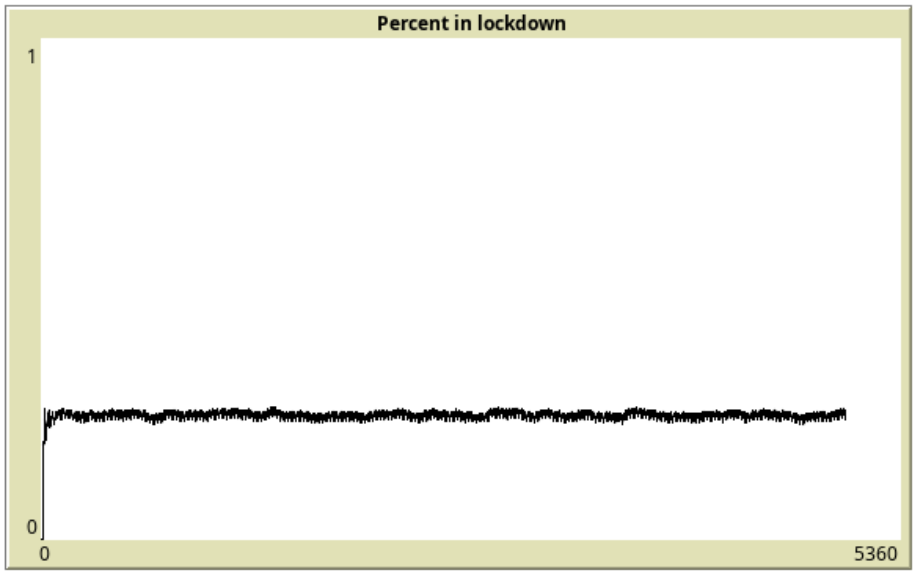
10)Max-demand-users = 0.8: 0.1-0.11



11)Max-demand-users = 0.9: 0.145-0.15



12)Max-demand-users = 1: 0.245-0.25

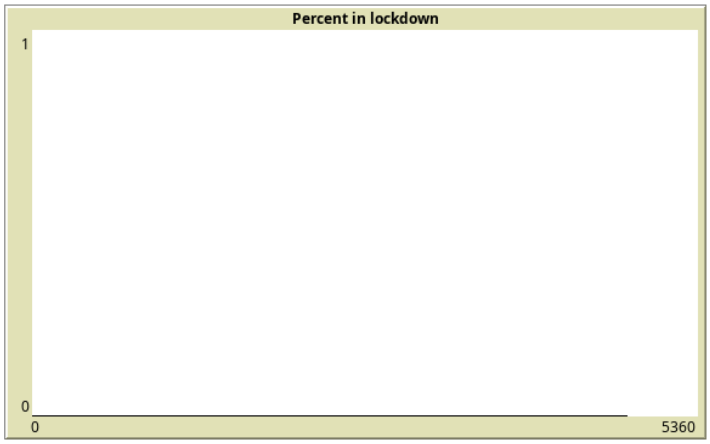


Some unsatisfied users appear after max-demands increased to 0.46.
From 0.0 to 0.45 all users are satisfied.
On 0.46 there are some tiny jumps, but the sharp increase of unsatisfied users become on point 0.47, where constantly some small amount of users are unsatisfied (about 3 to 4 percent)

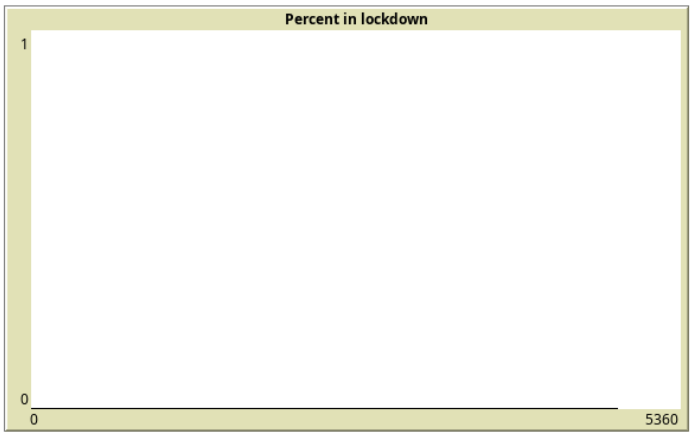
Before 0.46 statistics of shutted houses is very good. Percent of no-power houses
At max-demand at 0.8 the percent of people in lockdown is 10-11% so the threshold for max-demand i 0.8.

2. Network: random

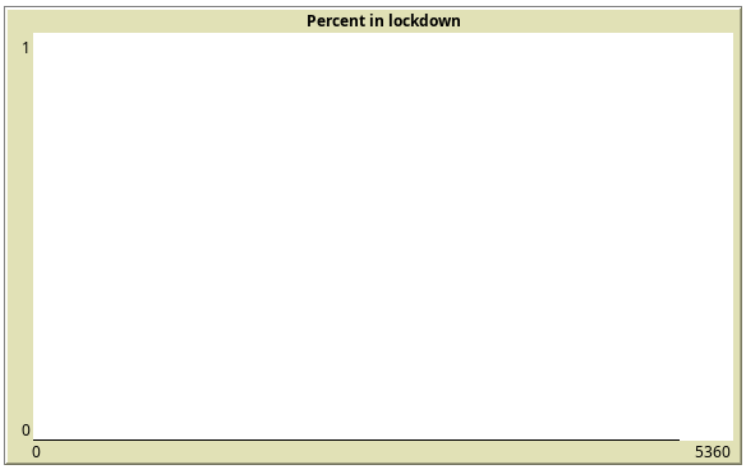
1)Max-demand-users=0



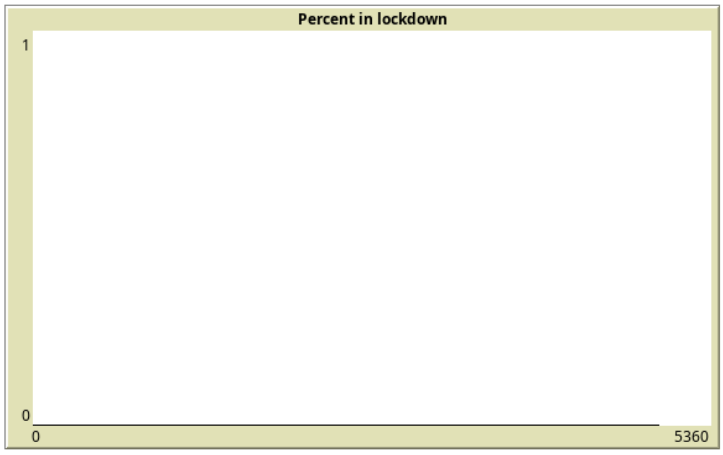
2)Max-demand-users=0.1



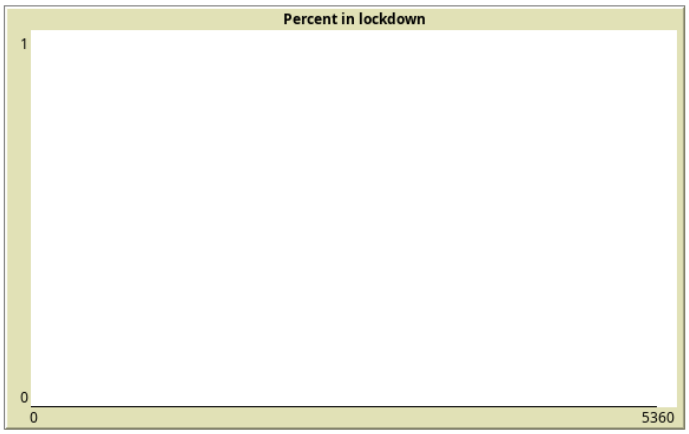
3)Max-demand-users=0.2



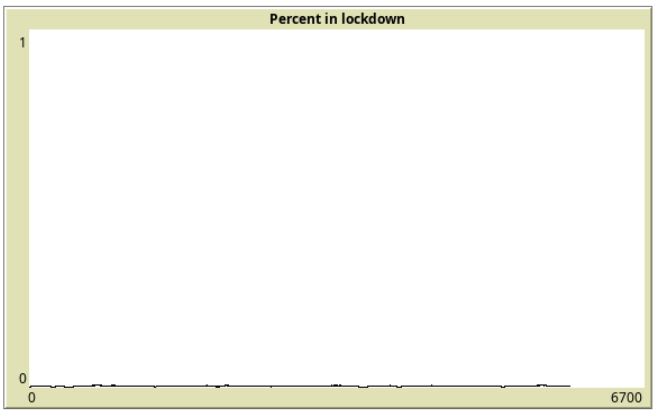
4)Max-demand-users=0.3



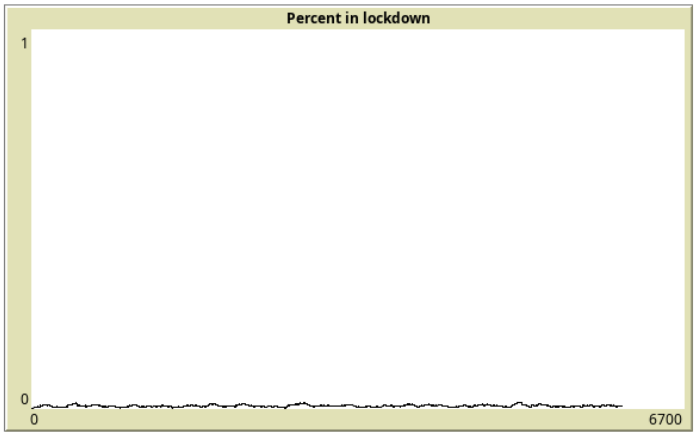
5)Max-demand-users=0.4



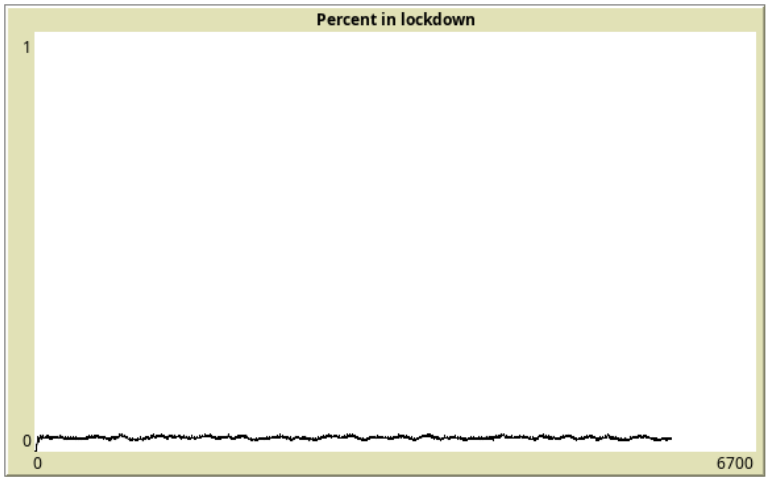
6)Max-demand-users=0.51



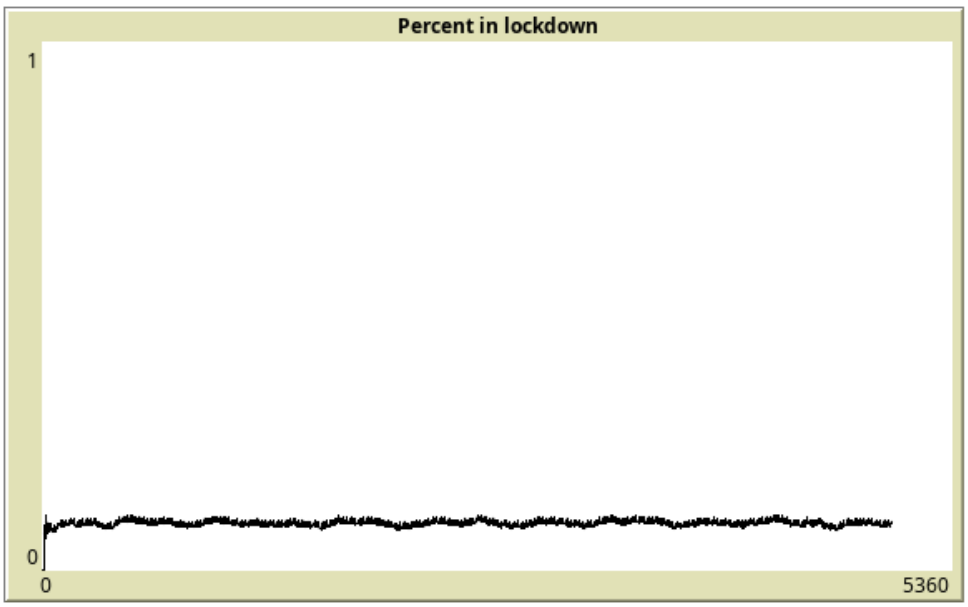
7)Max-demand-users=0.6



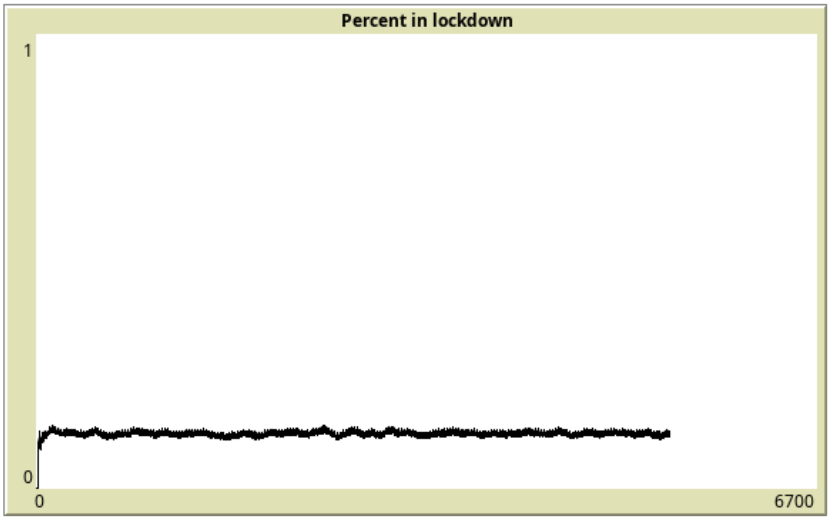
8)Max-demand-users=0.71



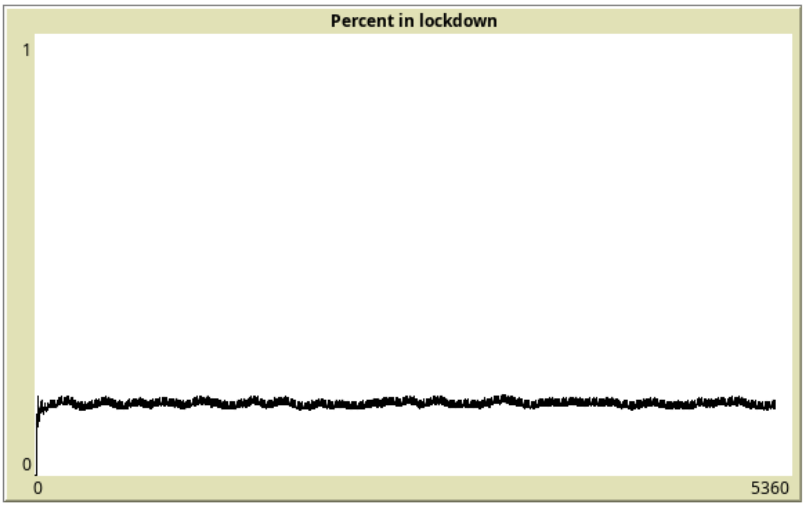
9)Max-demand-users=0.81



10)Max-demand-users=0.89



11)Max-demand-users=1

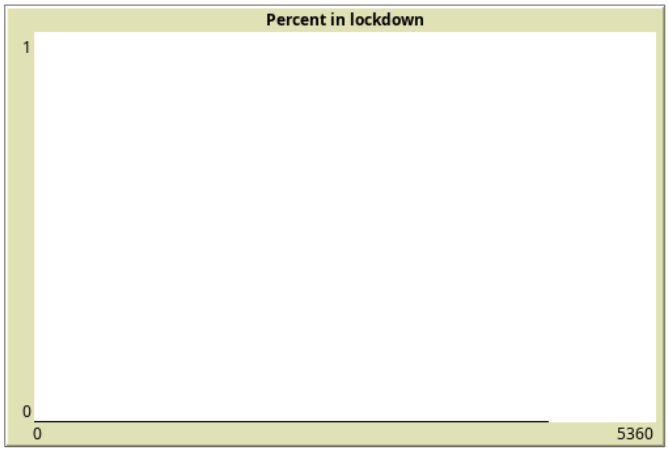


6)0.01-0.012
7)0.02
8)0.04
9)0.09-0.1
10)0.12-0.13
11) 0.17-0.18

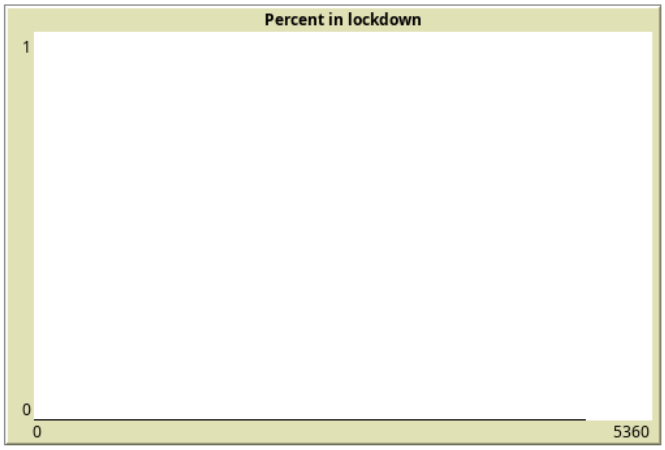
On the random network we can see that up to 0.5 there is practically no blackouts,
After the half there is some very small increases up to 1 percent.
The sharper increase in no-powered houses starts between 0.6 and 0.7 (up to 4 %)
Then the number of no-powered houses increases pretty sharply with the value of max-demand:
10% on 0.8, 12-13% on 0.9 0,17-0.18%.

3. Complete

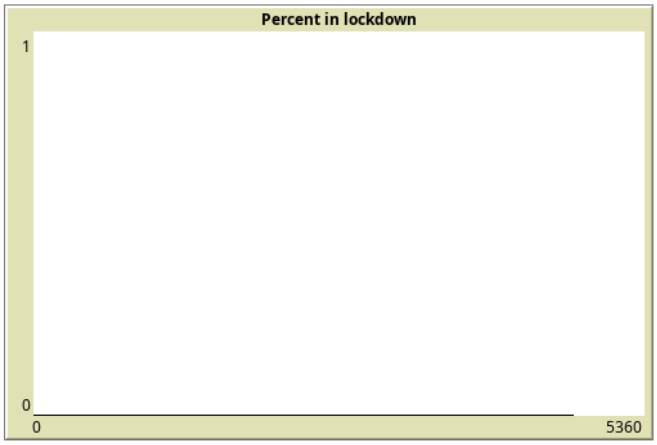
1)Max-demand-users=0.



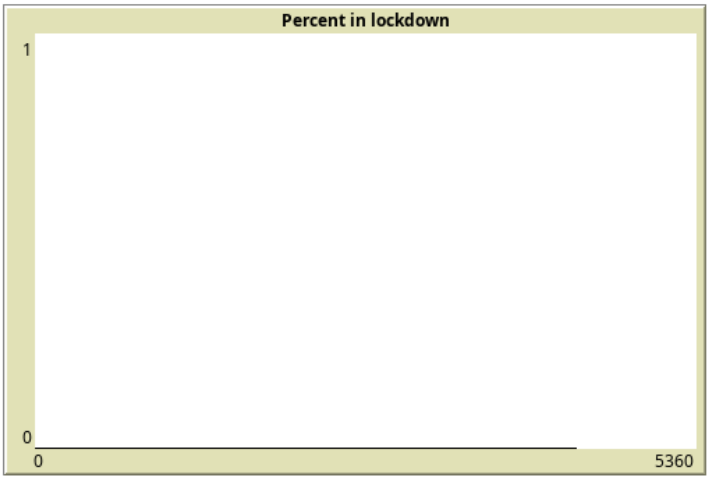
2)Max-demand-users=0.1



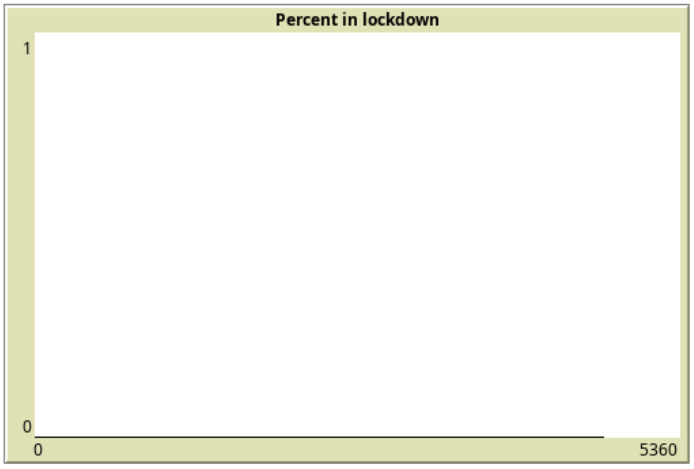
3)Max-demand-users=0.2



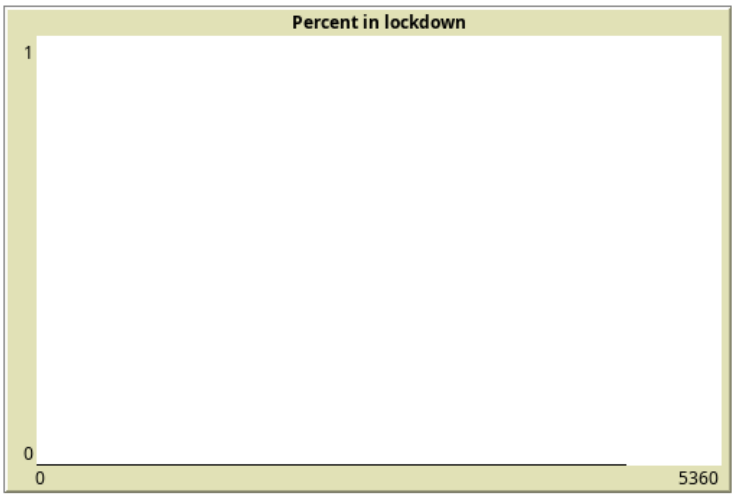
4)Max-demand-users=0.3



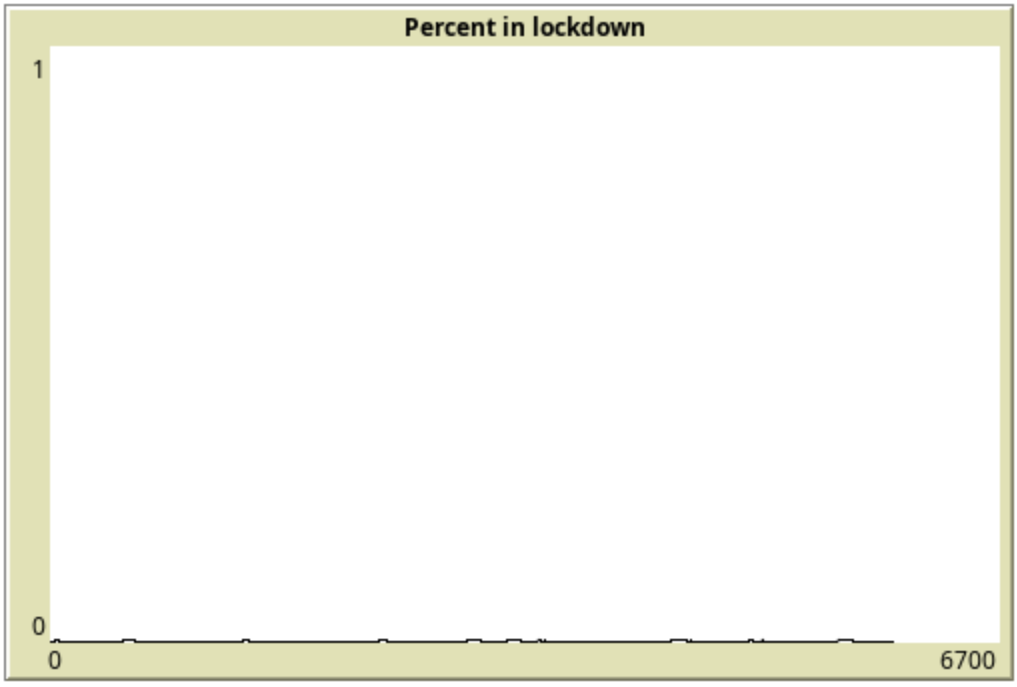
5)Max-demand-users=0.4



6)Max-demand-users=0.5

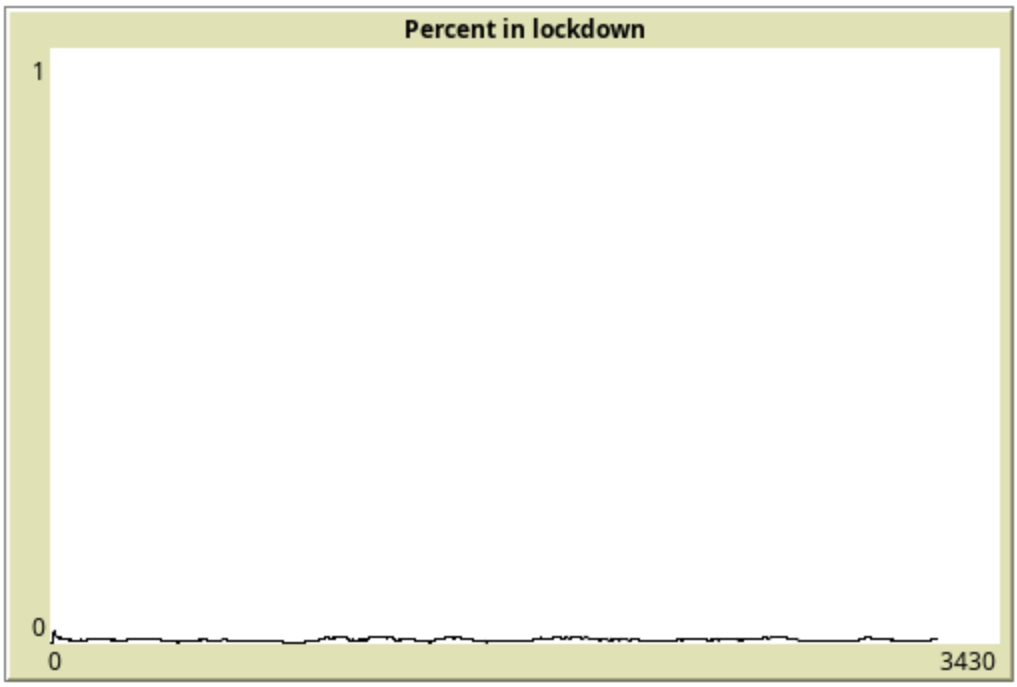


6)Max-demand-users=0.57



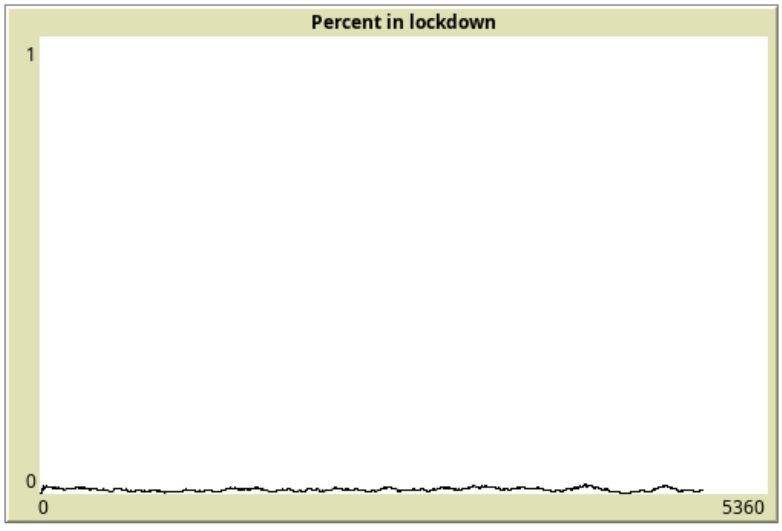
0.003

6)Max-demand-users=0.59

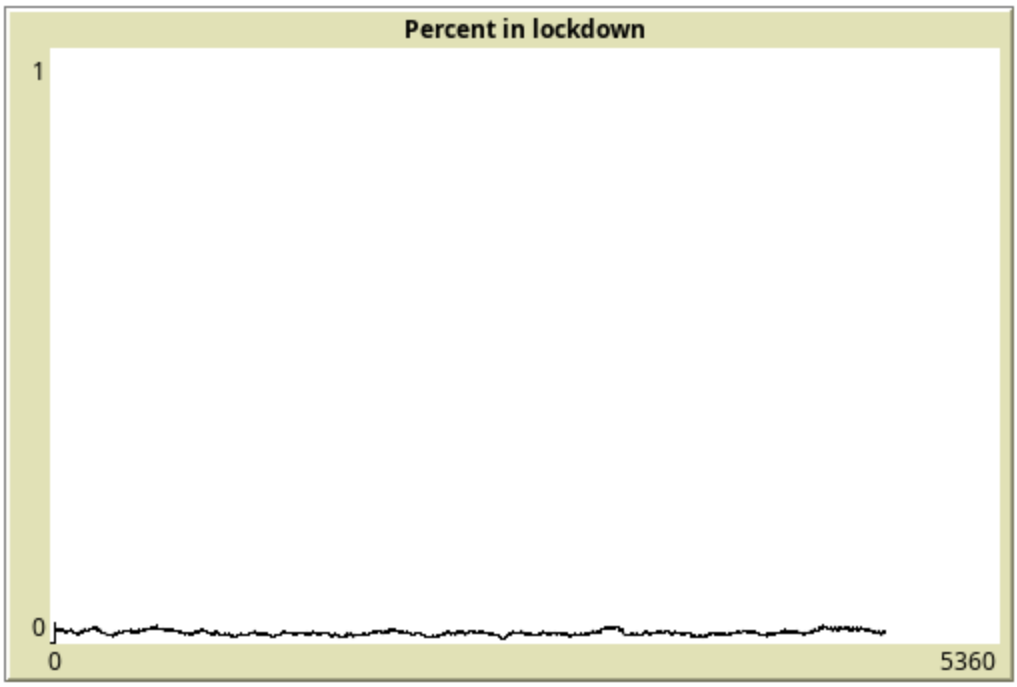


0.01

7)Max-demand-users=0.6

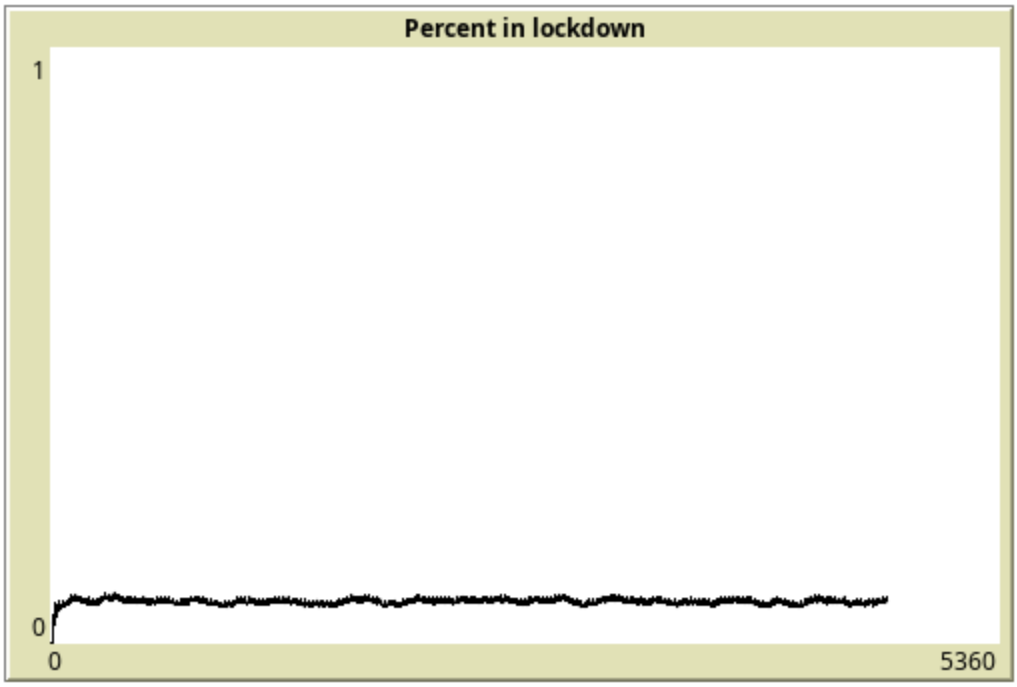


8)Max-demand-users=0.7



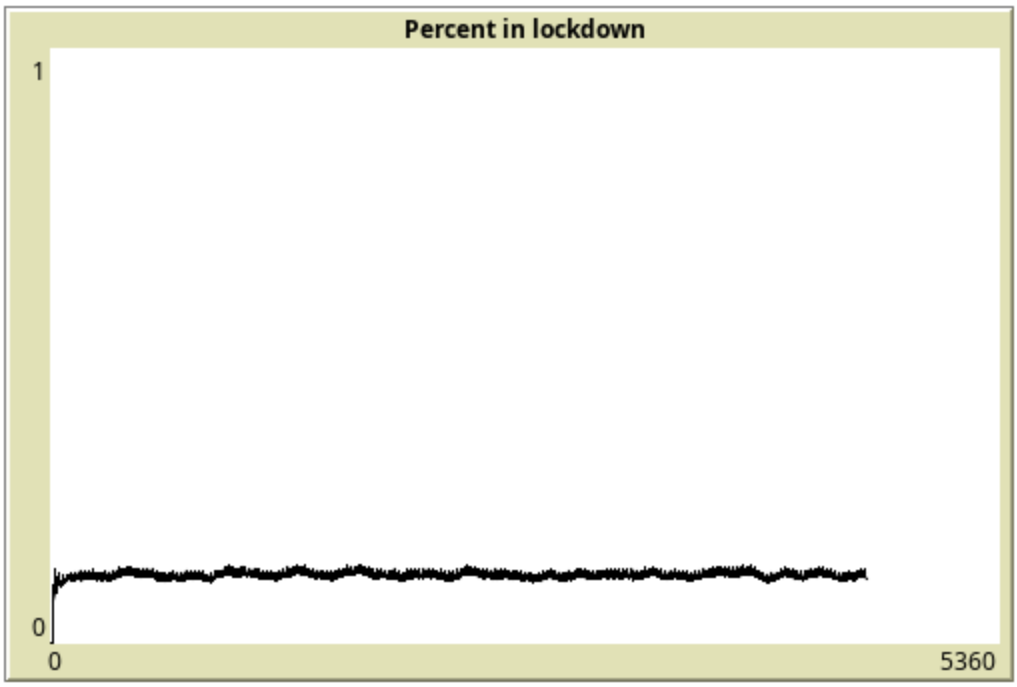
0.02-0.03

9)Max-demand-users=0.8



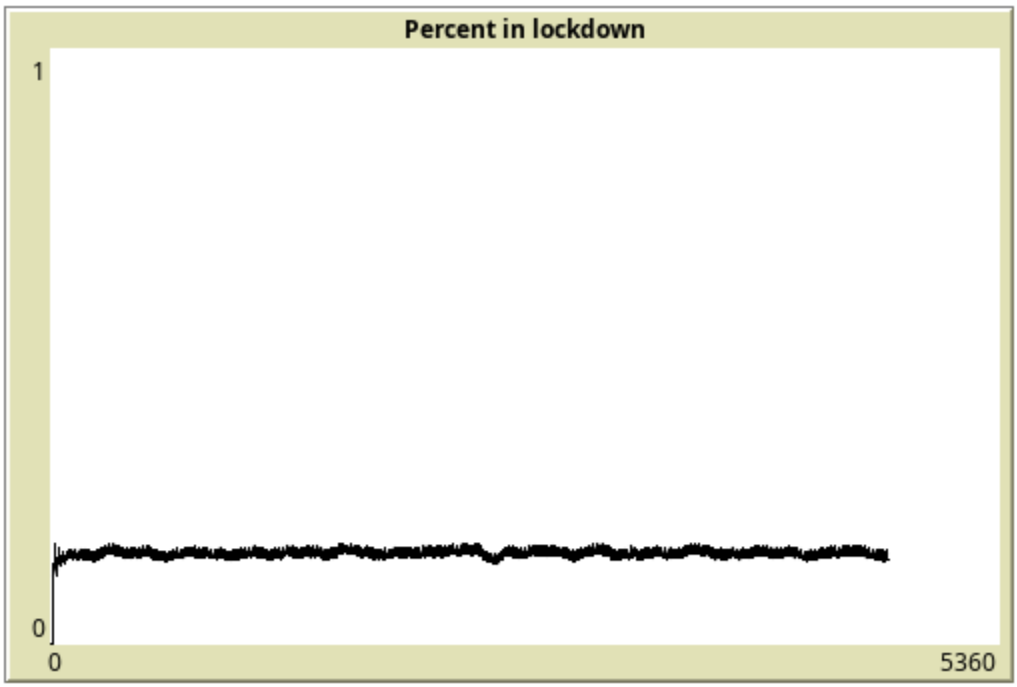
0.7-0.8

10)Max-demand-users=0.9



0.12-0.13

10)Max-demand-users=1



0.15-0.17

All houses have power until 0.56, at 0.57 there are small increases of np-powered houses
Number of blackout houses is slightly increasing up to 0.8, and really sharply after it.

In the minimal network the increase of no-powered houses starts way sooner, about on 0.65,
When in the random on 0.8 and on complete about on 0.8 as well.

With the most demand:

1. Complete 15-17%
2. Random 17-18%
3. Minimal 24-25%

As expected the worst results (the most non-powered houses) are in minimal network and the example of biggest demand shows it

Generate own network Note! You need to create own network, based on general principle, using following rules: 1. Each distribution station linked to power plant. Power plant cant be linked to users 2. Distribution stations cant be linked together 3. Users can be linked together (this will be difference of your network from baseline). If one user get power through other - you need to change algorithm or distribution. Think about logic of power distribution and propose solution (this is one of tasks of this lab). 4. Each user must be linked at least to one source of power

In this part users can be linked to each others, so using this we can improve the performance of our system.

```
ask users [
  let c self
  set outer-id id
  ask users [
    set users-to-link []
    set inner-id id
   ; output-print outer-id
   ; output-print inner-id
   ; print "------"
    if inner-id != outer-id [
      if random-float 1 > 0.6 [
        create-link-with c

    ]
    ]


  ]


]
```

So, I created links between each pair of users with chance of 40% (VARIANT 2)

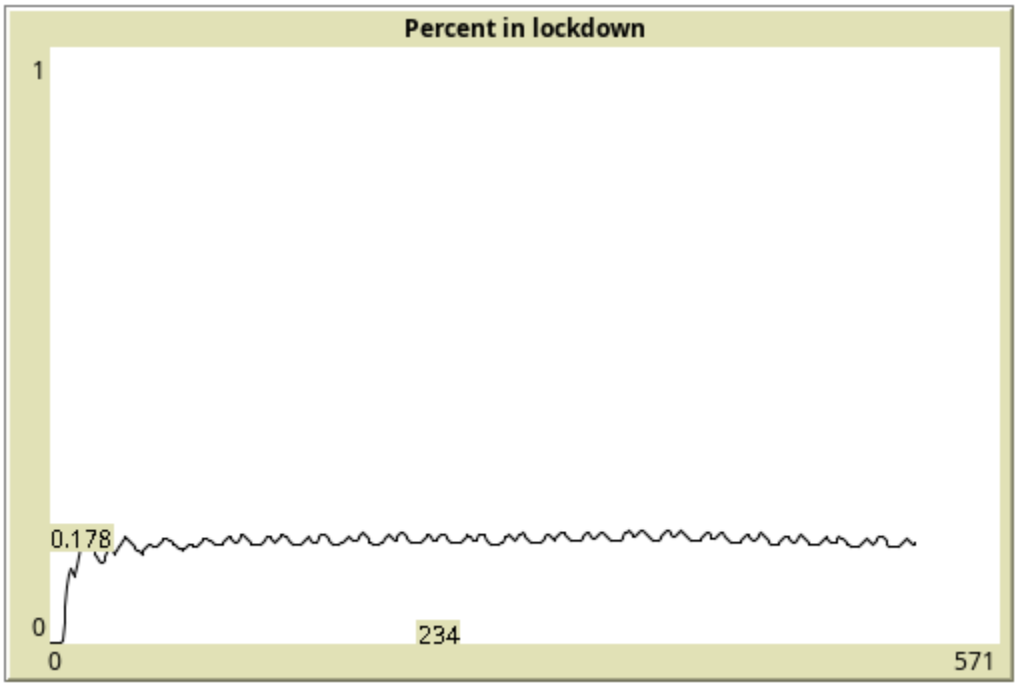
```
ifelse m > demand and demand > 0[
  set check 1
  let d demand
  set color yellow
  ask one-of my-stations with [level = m] [
    set level level - d
  ]

][


  set isDone 0
  ask link-neighbors [


    if breed = users and color = yellow and isDone = 0[
      let m1 0
      set m1 max [level] of my-stations
      if m1 > cur-demand [
        set check 1
        set isDone 1
        ask one-of my-stations with [level = m1] [
          set level level - cur-demand
        ]
      ]


    ]

]
  if check = 1 [
  set color yellow]
]
if check = 0 [
  set color blue
]
```

Here I changed the distribution of electricity. So I modified the code in the following way:

In the ifelse part with power condition check, I added else part. So, if there is no power station that can directly provide power for the user, I check the users, that are connected to current users. If any of connected users is already with power, and his power station has enough power resource to cover the demand of current user, it provides power to that user.

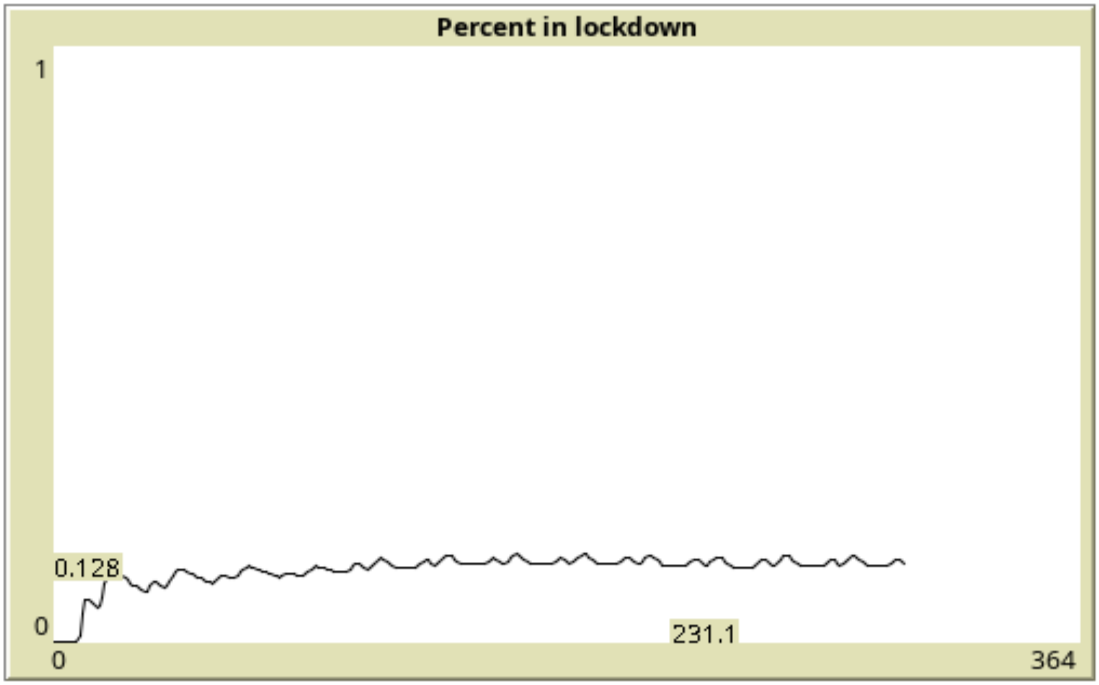
Result:

1) Without changed distribution



17-19% percent of users are with no power.

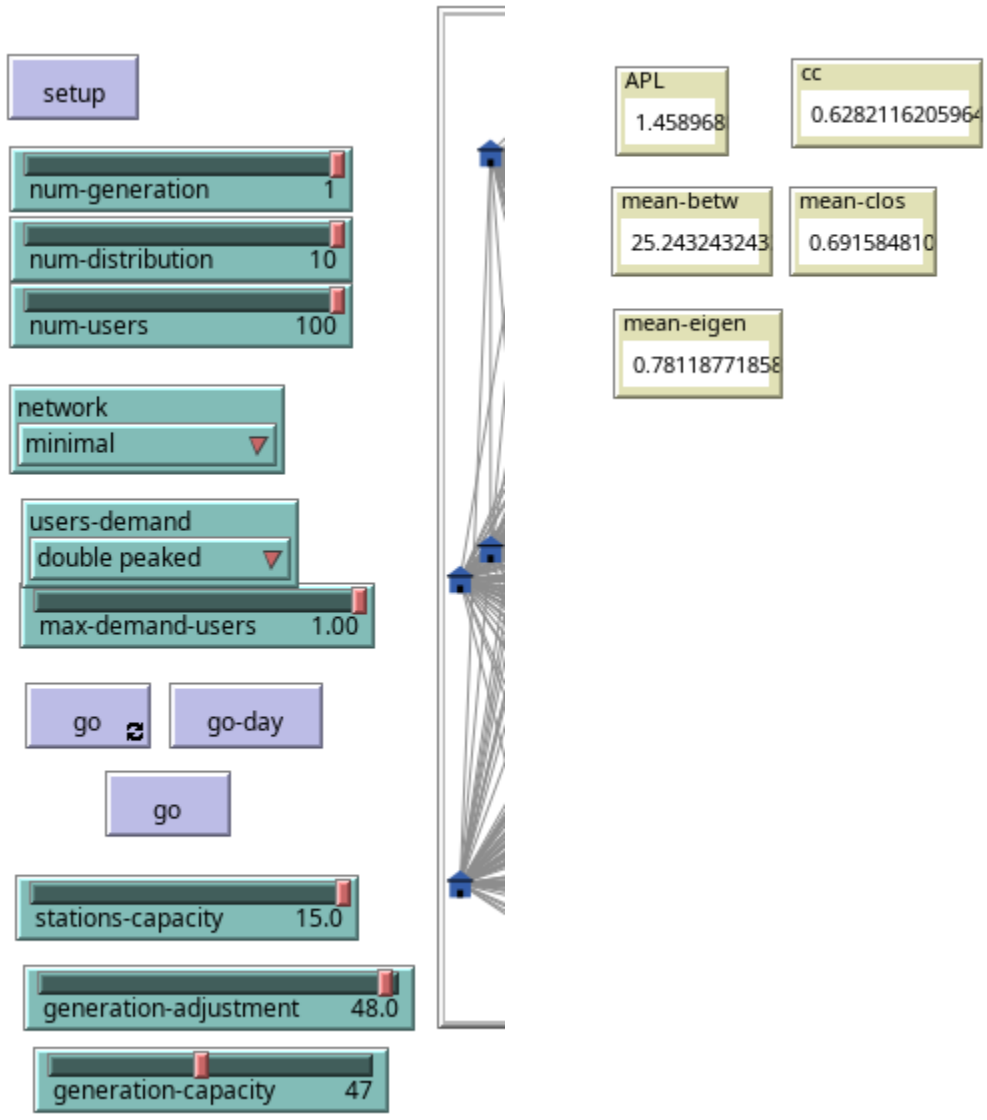
2) With power distribution



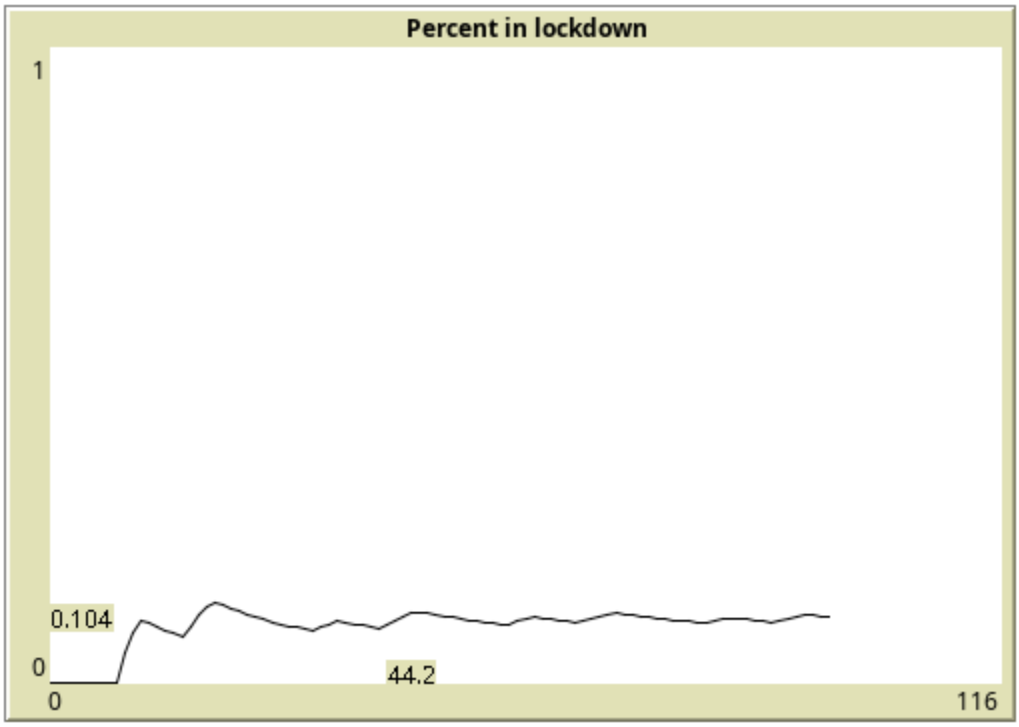
12-13% percent of users are without power

APL, CC, mean betweenness of nodes, mean Closeness, EigenCentrality.

Results of different metrics with following configuration:

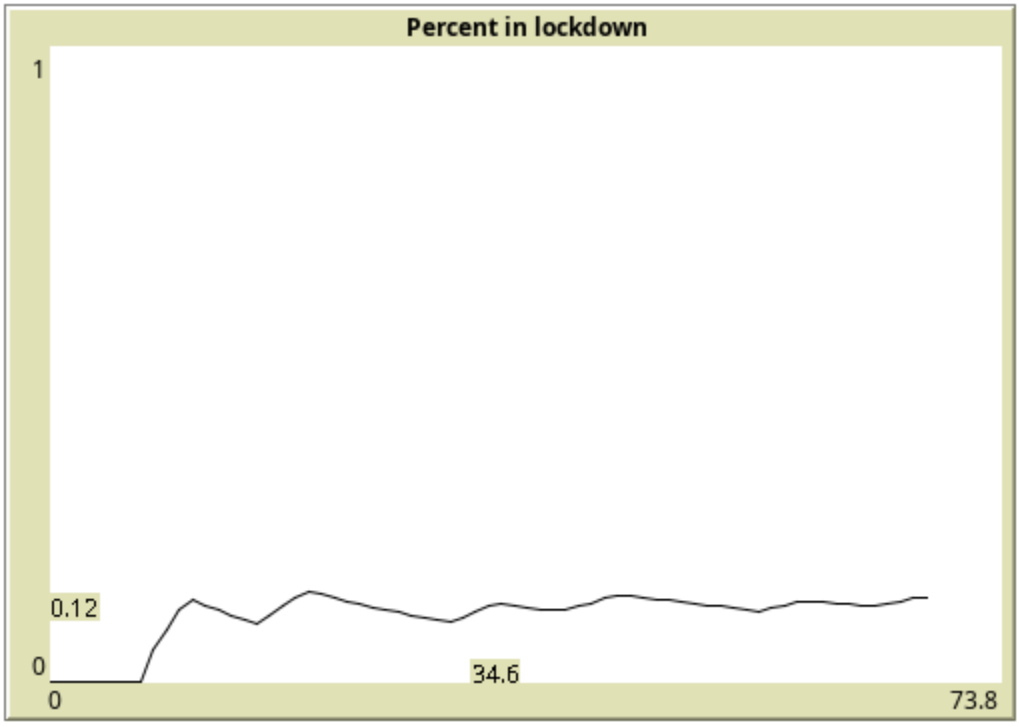


Destroying distribution stations:
Threshold: max-demand-users = 0.85
1)5 stations



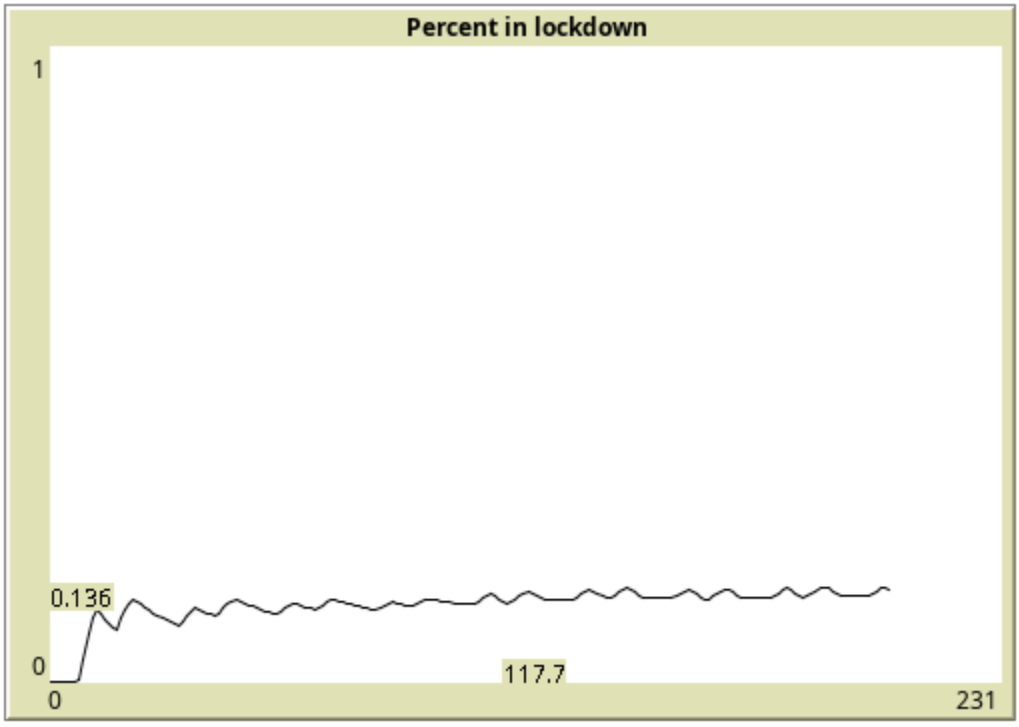
10.4%

2) 4 stations



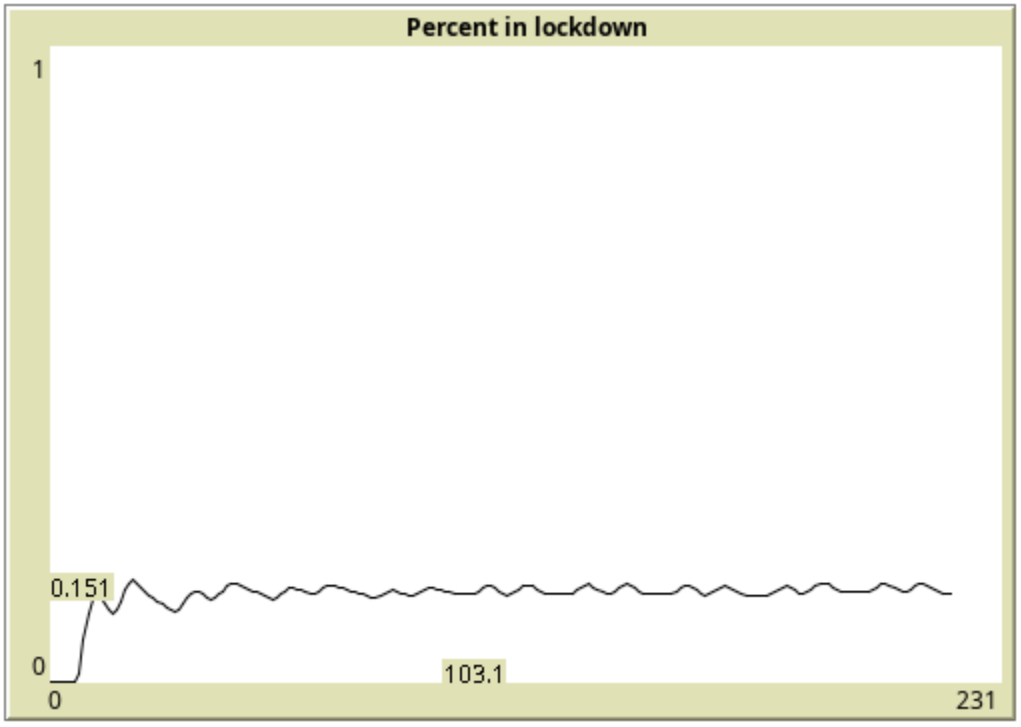
12%

3)3 stations



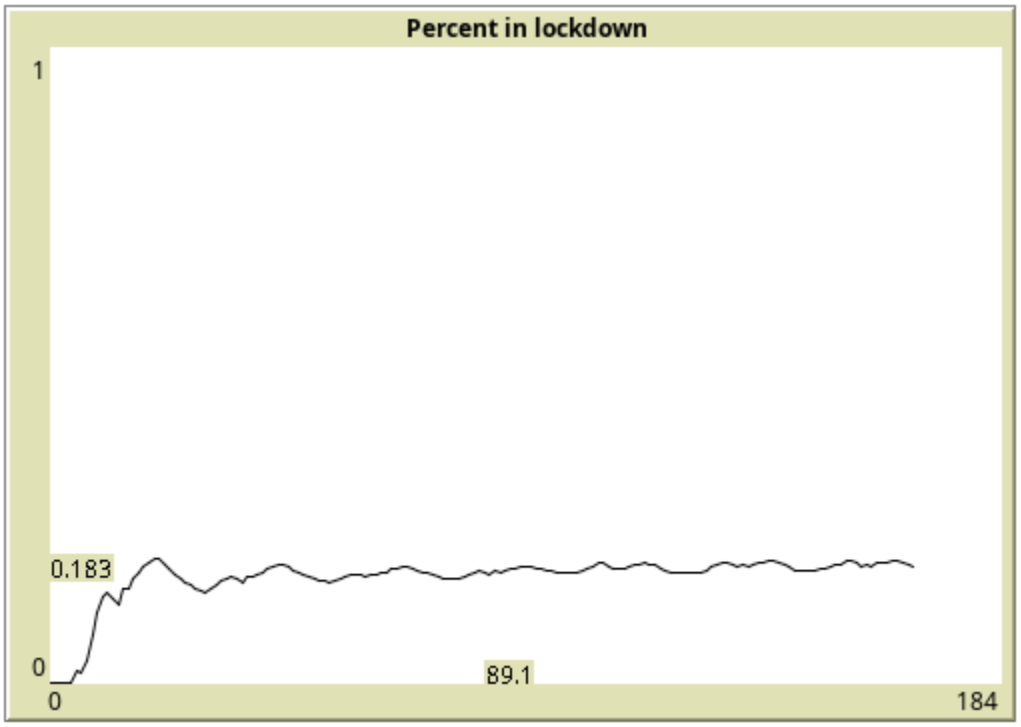
13.5%

4) 2 stations



15%

5) 1 station

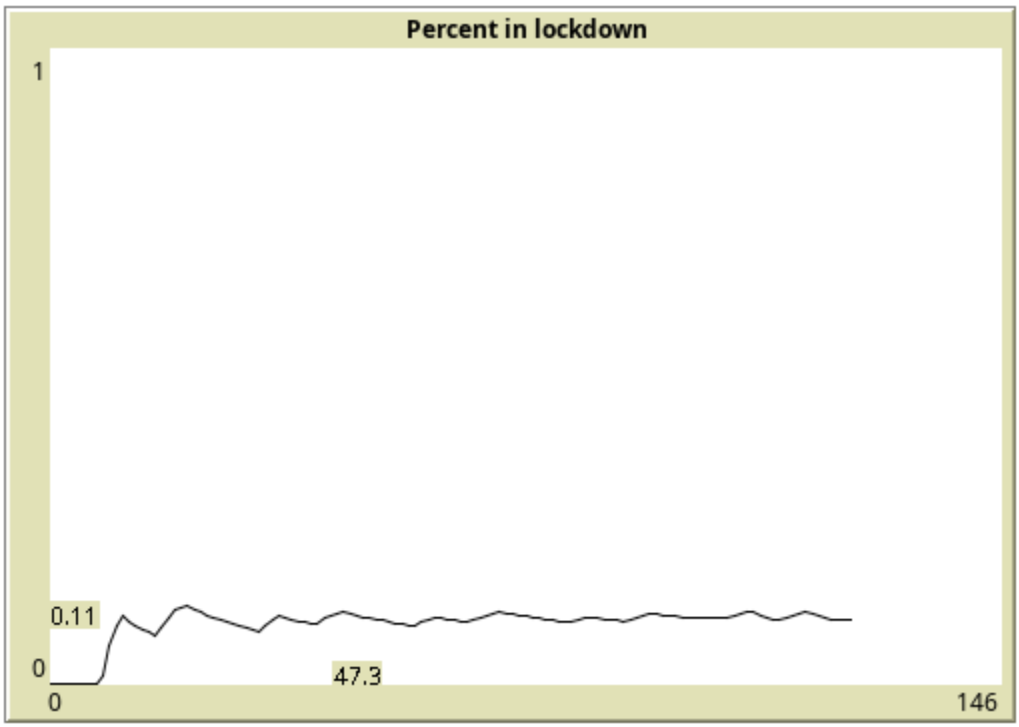


18%

We can see that with less distribution stations the less houses are power as expected, but the situation is not that bad as we reduced number of stations in 5 tims and the number of non-powered houses barely increased twice.

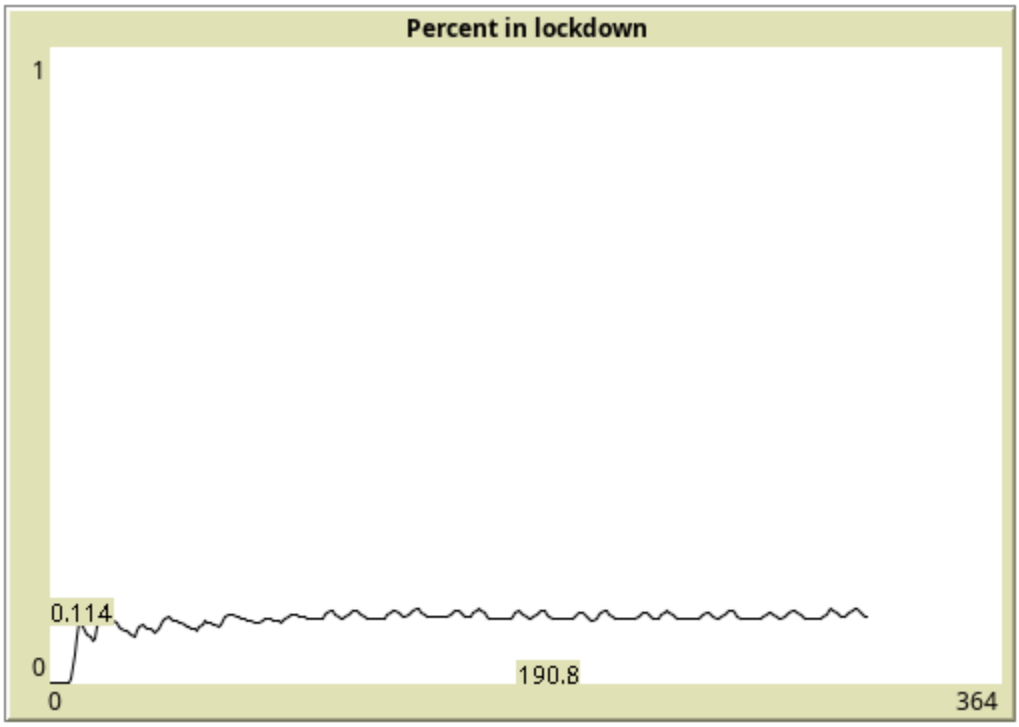
Destroying links (still 5 distributions stations)

1) 5% of links:



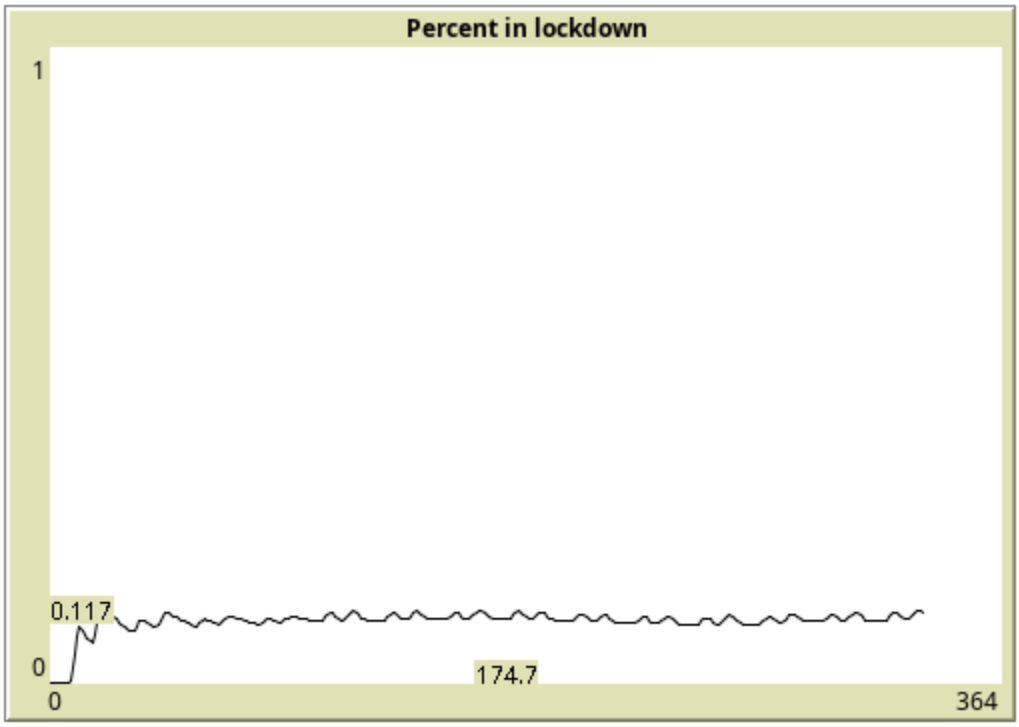
11%

2) 10% of links



11.5%

3) 15% of links



17%

For 5 distributions stations having such a small changes in reducing percent of links doesn't really affect result much.