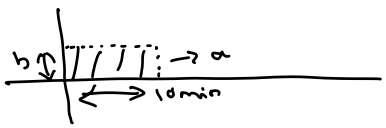
→ Friedge : 250 W → 2 KWh / Day

Wattage from → 2000wh / Days

Daily KWh → $\frac{2000}{24}$ wh / hour

a → $\frac{2000}{24} \times \frac{1}{6}$ wh / 10min



b x 10min = a

b(W) x $\frac{1}{6}$(h) = a (Wh) / $\frac{1}{6}$(h)

= 6a W

83.33 W

83.33 x $\frac{1}{6}$ x 144

→ Sizing : Florida

Average insolation = 5.67 h / day

Average yearly energy per house = 15000 KWh [EIA 2009]

⇒ 1250 KWh / Month

⇒ 42 KWh / Day

For Net zero solar size :

$P_{ac} = \frac{15000 \text{ KWh/yr}}{5.67 \text{ h/day} \times 365 \text{ days/yr}} = 7.248 \text{ KW}$

$P_{ac,STC} = \frac{7.248 \text{ W}}{0.75} = 9.664 \text{ KW} \approx 10 \text{ KW}$

[0.75 is efficiency for temperature effects]

s

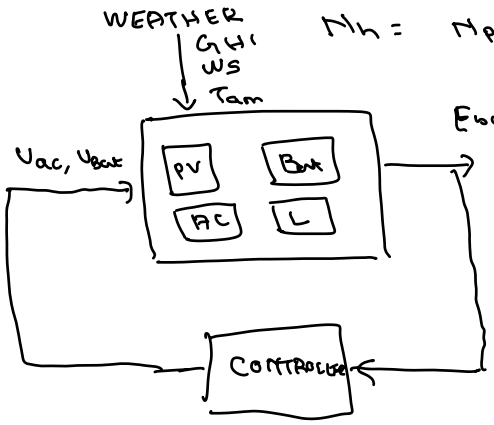
i)

PLANT MODEL :- N_h = 4 cases

$N_{pv,bat}$

N_{pv}

$N_h = N_{pv,bat} + N_{pv} + N$



N_{pvBat} PV, Bat, Th, EL

N_{Bat} Bat, Th, EL

N_{pv} PV, Th, EL

N_{none} Th, EL

PV_a PV_v PV_vw Ebat Ec Ed Th EL-d EL-o Vc Vd Vac Vpatv Tamb

1 2 3 4 5 6 7 8:11 12 13 18 19 20 21 22

8 - T_amb 10 - T_ambc

9 - T_mod 11 - T_lm

PLANT LEVEL :

$$\Sigma PV_a + \Sigma \min\{\Delta E_b, (E_{Bat} - E_{min})\} - \Sigma E_{L-D} - \Sigma V_{ac} E_{AC} = E_{MIS}$$

if $E_{MIS} > 0$, $E_{MIS} = 0$

Everything is served

Else if $E_{MIS} < 0$

E_{MIS} has to be shedded

if $|E_{MIS}| \leq \Sigma E_{L-D}$ {Proportional}

Then shedded through E_L-D

Even if $|E_{mis}| \leq \Sigma E_{L-D} + \Sigma_{vac} E_{AC}$

E_{L-D} AM

$\Sigma_{vac} E_{AC}$ some {Random}

Else if $|E_{mis}| > \Sigma E_{LD} + \Sigma_{vac} E_{AC}$

Nothing is served

Num turning ON AC's =

	v_{ac}	v_{pmu}	T_{ON}	T_{ON}
OFF-OFF	0	0		0
OFF-ON	0	1		1
ON-OFF	1	1		0
ON-OFF	-1	0		1

$$\Sigma E_{pv\_a} + \Sigma E_{Bat\_dis} = \Sigma E_{bat\_chan} + \Sigma E_{LA}$$

$$\Sigma E_{pv\_a} + \Sigma E_{Bat\_dis} > \Sigma E_{LD}$$

$$(\Sigma E_{pv\_a} - \Sigma E_{LA} + \Sigma E_{Bat\_dis}) = \Sigma E_{bat\_chan}$$

$$\Sigma E_{pv\_a} - \Sigma E_{LA} + \max(\Sigma E_{bat\_dis}) = \Sigma E_{bat\_chang}$$

$$\underbrace{\Sigma E_{pv\_a} - \Sigma E_{LA} + \Sigma \min[E_{max,dc} \Delta T, E_{bat} - E_{min}]}_{E_{c,AV}}$$

$$\Sigma E_{bat\_chang} = \underbrace{\Sigma \min(E_{max,c} \Delta T, \bar{E}_{max} - E_{bat})}_{E_{c,poss}}$$

If $|E_{c,AV}| > E_{c,poss}$

$$E_{changing\,i} = \min\left(\frac{E_{c,poss}}{N_{changing}}, \bar{E}_{max,c} - E_{bat}\right)$$

Else if $|E_{c,AV}| < E_{c,poss}$

$$E_{changing\,i} = \min\left(\frac{E_{c,AV}}{N_{changing}}, \bar{E}_{max,c} - E_{bat}\right)$$

else

$E_{charging,i} = 0$

end

$E_{dis} = \sum E_d = \sum E_{LA} + \sum E_c - \sum E_{pv}$

if $E_{dis} > 0$

$E_{disCharging,i} = \min\left[\frac{E_{dis}}{\eta_{discharging}}, E_{bat,i} - E_{min} \right]$

else

$E_{disCharging,i} = 0$

end

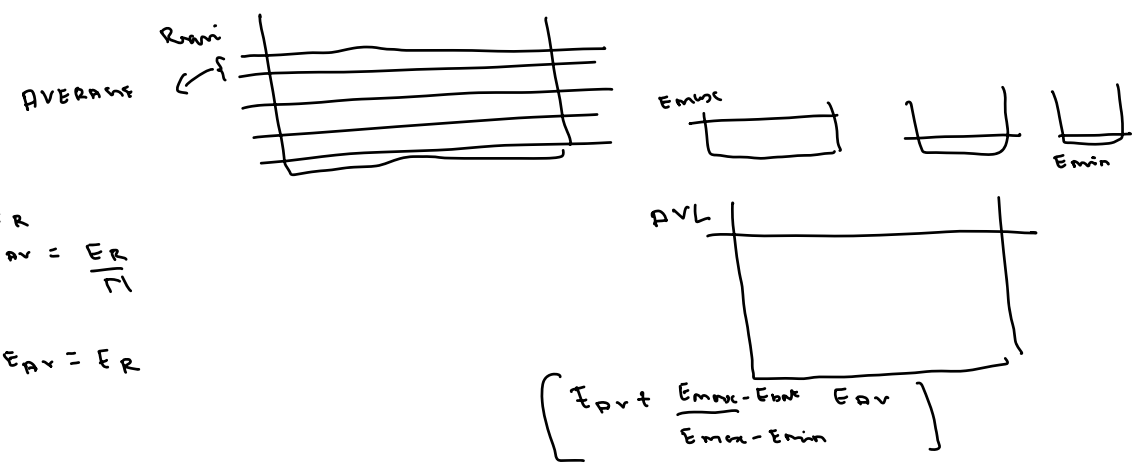
$\sum E_{pv,used} = \sum E_{LA} + E_c - E_d$

$\sum E_{pv,unused} = \sum E_{pv,av} - \sum E_{pv,used}$

$E_{pv,used,i} = \frac{\sum E_{pv,used}}{N_{pv}}$

$E_{pv,unused,i} = \frac{\sum E_{pv,unused}}{N_{pv}}$

$E_{bat,i} = E_{bat(i-1)} + \eta E_{charging(i)} - E_{dischanging(i)} / \eta$

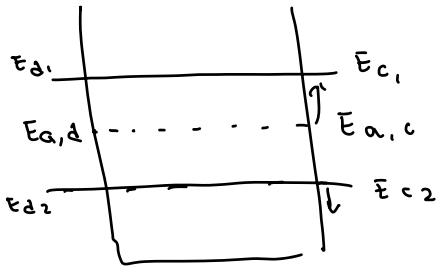


E_R

$E_{av} = \frac{E_R}{N}$

$N E_{av} = E_R$

$\left[E_{pv} + \frac{E_{max} - E_{bat}}{E_{max} - E_{min}} E_{av} \right]$



$$\Delta E_{c_1} = E_{c_1} - E_{a,c}$$

$$\Delta E_{c_2} = E_{a,c} - E_{c_2}$$

$$E_{c_1 a} = E_{a,c} + \Delta E_{c_1} \times \left[\frac{\bar{E}_{bat} - E_{B_1}}{\bar{E}_{bat} - \underline{E}_{bat}} \right]$$

$E_{B_1} = \underline{E}_{bat} \rightarrow 1$

$E_{B_1} = \bar{E}_{bat} \rightarrow 0$

$$E_{c_2 a} = E_{a,c} - \Delta E_{c_2} \times \left[1 - \frac{\bar{E}_{bat} - E_{B_1}}{\bar{E}_{bat} - \underline{E}_{bat}} \right]$$

E_{c_2}

$E_{B_1} = \underline{E}_{bat} \rightarrow 0$

$E_{B_1} = \bar{E}_{bat} \rightarrow 1$

$$\Delta E_{d_1} = E_{d_1} - E_{a,d}$$

$$\Delta E_{d_2} = E_{a,d} - E_{d_2}$$

$$E_{d_1 a} = E_{a,d} + \Delta E_{d_1} \left[1 - \frac{\bar{E}_{bat} - E_{B_1}}{\bar{E}_{bat} - \underline{E}_{bat}} \right]$$

$E_{B_1} = \underline{E}_{bat} \rightarrow 0$

$E_{B_1} = \bar{E}_{bat} \rightarrow 1$

$$E_{d_2 a} = E_{d_2} - \Delta E_{d_2} \left[\frac{\bar{E}_{bat} - E_{B_1}}{\bar{E}_{bat} - \underline{E}_{bat}} \right]$$

$E_{B_1} = \underline{E}_{bat} \rightarrow 1$

$E_{B_1} = \bar{E}_{bat} \rightarrow 0$

SMART COMMUNITY ENERGY FLOW :

SET OF DIFFERENT TYPES OF HOUSES, H (IS A SET OF SETS)

$H = \{\{N_{PV\_BAT}\}, \{N_{BAT}\}, \{N_{PV}\}, \{N_{NONE}\}\}$

SET OF HOUSES WITH PV + BAT : $N_{PV\_BAT} = \{N'_{PV\_BAT}, \dots, N^{N_1}_{PV\_BAT}\}$

$I_{H1} = \{1, \dots, N_1\}$

SET OF HOUSES WITH BAT : $N_{BAT} = \{N'_{BAT}, \dots, N^{N_2}_{BAT}\}$

$I_{H2} = \{1, \dots, N_2\}$

SET OF HOUSES WITH PV : $N_{PV} = \{N'_{PV}, \dots, N^{N_3}_{PV}\}$

$I_{H3} = \{1, \dots, N_3\}$

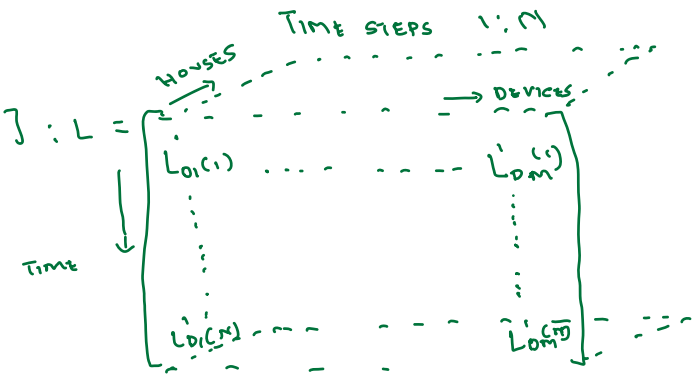
SET OF HOUSES WITH NONE : $N_{NONE} = \{N', \dots, N^{N_4}\}$

$I_{H4} = \{1, \dots, N_4\}$

WEATHER DATA [NSRDB, GAINESVILLE, 2017] : $W = \begin{bmatrix} GHI(1) & T_a(1) & WS(1) \\ \vdots & \vdots & \vdots \\ GHI(N) & T_a(N) & WS(N) \end{bmatrix}$

LOAD DATA [PECAN STREET, AUSTIN] : L =

(OTHER THAN AC)



$$E^{T}_{PV\_AV} = \sum_{i=1}^{n\_PV + n_{PV\_BAT}} E^{i}_{PV\_AV}$$

$$E^{T}_{BAT\_dis\_DP} = \sum_{i=1}^{n\_BAT + n_{PV\_BAT}} d^{i} \{ \min(\bar{E}_{DC}\, \Delta T , (E^{i}_{BAT} - \underline{E}_{BAT}) \,/\, \eta_{BAT,DIS} \}$$

$$E^{T}_{BAT\_c\_DP} = \sum_{i=1}^{n\_BAT + n_{PV\_BAT}} c^{i} \{ \min(E_{C}\, \bar{\Delta T} , (\bar{E}_{BAT} - E^{i}_{BAT}) * \eta_{BAT,C} \}$$

$$E_{D}^{T} = E_{d}^{AC} + E_{d}^{L} + E^{T}_{BAT\_C\_DP}$$

$$E_{AVAILABLE} = E^{T}_{PV,AV} + E^{T}_{BAT\_dis\_DP}$$

$$E_{MIS} = E_{AVAILABLE} - E_{D}^{T}$$

if ($E_{mis} >= 0$) ALL LOADS ARE SERVED

  if (AC_START_P_AV >= AC_START_P_REQ)
  else
  end

} AC STARTUP POWER CONSTRAINT

elseif ($E_{mis} < 0$) PART OF THE LOADS ARE SERVED

  if (abs(E_{mis}) <= $E^T_{AC\_A}$) E_{MIS} SHED THROUGH AC's

ENERGY CONSTRAINT AC if ($T_{on} - T_{sh} >= 0$) E_{MIS} SHED THROUGH TURNING ON AC's

    if (AC_START_P_AV >= AC_START_P_REQ)
    else
    end

} AC STARTUP POWER CONSTRAINT

ENERGY CONSTRAINT AC else E_{MIS} SHED THROUGH TURNING ON/TURNED ON AC's
  end

  elseif (abs(E_{mis}) <= E^T_d E_{MIS} SHED THROUGH AC's AND E^L_d

  else NOTHING CAN BE SERVED

  end

end

E_{AC_A} , E^L_A , $E^T_A = E_{AC\_A} + E^L_A$

$$E^{T}_{BAT\_C\_AV} = E^{T}_{PV\_AV} + E^{T}_{BAT\_DIS\_DP} - E^{T}_{A} \quad [\, E_{BAT} \uparrow \;\; E^{i}_{BAT\_C} \downarrow \,]$$

$$E^{i}_{BAT\_C} = \begin{cases} \min\left(E_{BAT\_C\_AVG} + \left\{ \Delta E^{i}_{BAT} * \left\{ \dfrac{\max\limits_{j \in J}\left(E^{j}_{BAT} \right) - E^{i}_{BAT}}{\max\limits_{j \in J}\left(E^{j}_{BAT} \right) - \min\limits_{j \in J}\left(E^{j}_{BAT} \right)} \right\} \right\}, \right. \\ \quad \left. \bar{P}_{BAT\_C}\, \Delta T,\; E^{i}_{BAT\_C\_REM},\; \left(\bar{E}_{BAT\_C} - E^{i}_{BAT} \right) / \eta_{BAT\_C} \right) \right); \quad \Delta E^{i}_{BAT\_C} > 0 \\ \min\left(E_{BAT\_C\_AVG} + \left\{ \Delta E^{i}_{BAT\_C} * \left\{ 1 - \left\{ \dfrac{\max\limits_{j \in J}\left(E^{j}_{BAT} \right) - E^{i}_{BAT}}{\max\limits_{j \in J}\left(E^{j}_{BAT} \right) - \min\limits_{j \in J}\left(E^{j}_{BAT} \right)} \right\} \right\} \right\}, \right. \\ \quad \left. \bar{P}_{BAT\_C}\, \Delta T,\; E^{i}_{BAT\_C\_REM},\; \left(\bar{E}_{BAT} - E^{i}_{BAT} \right) / \eta_{BAT\_C} \right) \right); \quad \Delta E^{i}_{BAT\_C} < 0 \end{cases}$$

WHERE,

$$E_{BAT\_C\_AVG} = \min\left\{ \frac{E^{T}_{BAT\_C\_AV}}{\sum\limits_{i \in \{N_{PV\_BAT},\, N_{BAT}\}} \prod_{i \in \{i\,:\,c^{i}=1\}}},\; \frac{E^{T}_{BAT\_C\_DP}}{\sum\limits_{i \in \{N_{PV\_BAT},\, N_{BAT}\}} \prod_{i \in \{i\,:\,c^{i}=1\}}} \right\}$$

$$\Delta E^{i}_{BAT\_C} = E^{i}_{BAT\_C\_DP} - E_{BAT\_C\_AVG}$$

$$J = \{ N_{PV\_BAT},\, N_{BAT} \} \uparrow \quad [\text{ASCENDING}]$$

$$E^{i}_{BAT\_C\_REM} = E^{T}_{BAT\_C\_AV} - \sum_{j \in J}^{i} E^{j}_{BAT,C}$$

$$E^{T}_{BAT\_DIS\_AV} = E^{T}_{PV\_AV} + E^{T}_{BAT\_C} - E^{T}_{A} \quad [\, E^{i}_{BAT} \uparrow \;\; E^{i}_{BAT\_DIS} \uparrow \,]$$

$$E^{i}_{BAT\_DIS} = \begin{cases} \min\left(E_{BAT\_DIS\_AVG} + \left\{ \Delta E^{i}_{BAT\_DIS} * \left\{ \dfrac{\max\limits_{j \in J}\left(E^{j}_{BAT} \right) - E^{i}_{BAT}}{\max\limits_{j \in J}\left(E^{j}_{BAT} \right) - \min\limits_{j \in J}\left(E^{j}_{BAT} \right)} \right\} \right\}, \right. \\ \quad \left. E^{i}_{BAT\_DIS\_REM},\; \left(E^{i}_{BAT} - \underline{E}_{BAT} \right) * \eta_{BAT\_DIS} \right) \right); \quad \Delta E^{i}_{BAT} < 0 \\ \min\left(E_{BAT\_DIS\_AVG} + \left\{ \Delta E^{i}_{BAT\_DIS} * \left\{ 1 - \left\{ \dfrac{\max\limits_{j \in J}\left(E^{j}_{BAT} \right) - E^{i}_{BAT}}{\max\limits_{j \in J}\left(E^{j}_{BAT} \right) - \min\limits_{j \in J}\left(E^{j}_{BAT} \right)} \right\} \right\} \right\}, \right. \\ \quad \left. E^{i}_{BAT\_DIS\_REM},\; \left(E^{i}_{BAT} - \underline{E}_{BAT} \right) * \eta_{BAT\_DIS} \right) \right); \quad \Delta E^{i}_{BAT\_DIS} > 0 \end{cases}$$

WHERE,

$$E_{BAT\_DIS\_AVG} = \min \left\{ \frac{E^{T}_{BAT\_DIS\_AV}}{\sum_{i \in \{N_{PV\_BAT}, N_{BAT}\}} \prod_{i \in \{i : d^{i} = 1\}}} , \frac{E^{T}_{BAT\_DIS\_DP}}{\sum_{i \in \{N_{PV\_BAT}, N_{BAT}\}} \prod_{i \in \{i : d^{i} = 1\}}} \right\}$$

$$\Delta E^{i}_{BAT\_DIS} = E^{i}_{BAT\_DIS\_DP} - E_{BAT\_DIS\_AVG}$$

$$J = \{ N_{PV\_BAT}, N_{BAT} \}\downarrow \quad [\text{DESCENDING}]$$

$$E^{i}_{BAT\_DIS\_REM} = E^{T}_{BAT\_DIS\_AV} - \sum_{j \in J}^{i} E^{j}_{BAT\_DIS}$$

$$E^{i+1}_{BAT} = E^{i}_{BAT} + E^{i}_{BAT\_C} * \eta_{BAT\_C} - E^{i}_{BAT\_DIS} / \eta_{BAT\_DIS}$$

$$E^{T}_{BAT\_C} = \sum_{i \in I = \{N\_PV\_BAT, N_{BAT}\}} E^{i}_{BAT\_C}$$

$$E^{T}_{BAT\_DIS} = \sum_{i \in I = \{N_{PV\_BAT}, N_{PV}\}} E^{i}_{BAT\_DIS}$$

$$E^{T}_{PV\_U} = \begin{cases} E^{T}_{A} + E^{T}_{BAT\_C} - E^{T}_{BAT\_DIS} & ; \quad \text{IF } E^{T}_{A} + E^{T}_{BAT\_C} - E^{T}_{BAT\_DIS} \geq 0 \\ 0 & ; \quad \text{O.W.} \end{cases}$$

$$E_{PV\_U\_AVG} = \frac{E^{T}_{PV\_U}}{\sum_{i} \prod_{i \in \Pi = \{N_{PV\_BAT}, N_{PV}\}}}$$

$$E^{i}_{PV\_U} = E_{PV\_U\_AVG}$$

$$E^{i}_{PV\_UM} = E^{i}_{PV\_AV} - E^{i}_{PV\_U}$$

MEETING: 03/15/2021

Doubts Regarding Bacnet controller:

→ If $E_{am} < E_d$ should there be a lower level control to handle it. ✓

→ If we have capability to turn some AC's ON should lower level control ensure that [choose Randomly]

→ And if we choose to turn some AC's ON should they be picked out randomly

→ simple AC

→ ?? Critical load, Non Critical load, AC load

vc vnc Critical loads power

c d

-

Eric Bethel House, ASME

Randomly select *

PECAN STREET DATA:

UNIT	COLUMN	Meaning	Priority Class
Air 1	1	AC compressor 1	
air 2	2	AC compressor 2	
air 3	3	AC compressor 3	
airwindow unit 1	4	window unit AC	
Aquarium 1	5	Aquarium Energy	7.1
Bathroom 1	6	Bathroom Energy	5.2
Bathroom 2	7	Bathroom Energy	5.3
Bedroom 1	8	Bedroom Energy	2.1
Bedroom 2	9	Bedroom Energy	2.2
Bedroom 3	10	Bedroom Energy	2.3
Bedroom 4	11	Bedroom Energy	2.4
Bedroom 5	12	Bedroom Energy	2.5
Battery 1	13	Battery Energy	
car 1	14	EV charger	
car 2	15	EV charger	
Circfurnace 1	16	Hydronic Heating/Cool Energy	
Clotheswasher 1	17	ON ELECTRIC	4.1
Clotheswasher_dryer 1	18	ON GAS	
Diningroom 1	19	DiningRoom Energy	5.4
Diningroom 2	20	DiningRoom Energy	5.4
Dishwasher 1	21	Dishwasher Energy	5.5
Disposal 1	22	Disposal sinkgarbage energy	4.4
Drye 1	23	Dryer Electric	4.2

Dryer 1	24	Dryer 1 gas	
freezer 1	25	freezer energy	1.2
furnace 1	26	furnace Air handler Energy	
furnace 2	27	furnace Air handler Energy	
garage 1	28	garage energy	6.1
garage 2	29	garage energy	6.2
grid	30	Energy to -> the grid	
heater 1	31	Electric Heater Energy	
heater 2	32	Electric Heater Energy	
heater 3	33	Electric Heater Energy	
housefan 1	34	Fan Energy	
icemaker 1	35	Ice maker Energy	8.1
jacuzzi 1	36	Jacuzzi Energy	8.4
Kitchen 1	37	Kitchen Energy Addn	1.4
Kitchen 2	38	Kitchen Energy Addn	1.4
Kitchenapp 1	39	Kitchen Appliance Energy	1.3
Kitchenapp 2	40	Kitchen Appliance Energy	1.3
lightsplugs 1	41	lights circuits Energy	
lightsplugs 2	42	lights circuits Energy	
lightsplugs 3	43	lights circuits Energy	
lightsplugs 4	44	lights circuits Energy	
lightsplugs 5	45	lights circuits Energy	
lightsplugs 6	46	lights circuits Energy	
LivingRoom 1	47	LivingRoom Energy	3.1
LivingRoom 2	48	LivingRoom Energy	3.2

Microwave 1	49	Microwave Energy	1.7
Office 1	50	Office Energy	3.3
Outside Lighting 1	51	Exterior Lights Energy	6.5
Outside Lighting 2	52	Exterior Lights Energy	6.6
Oven 1	53	Oven circuit Energy	1.7
Oven 2	54	Oven circuit Energy	1.7
Pool 1	55	Pool Pump + Pool light Energy	
Pool 2	56	Pool Pump + Pool light Energy	
Poolight 1	57	Pool light Energy	8.3
Poolpump 1	58	Pool Pump Energy	8.2
Pump 1	59	Any other Pump Energy	4.5
Range 1	60	Cooking Range Energy	1.5
Refrigerator 1	61	Refrigerator Energy	1.1
Refrigerator 2	62	Refrigerator Energy	1.1
Security 1	63	Security System Energy	5.1
Sewerpump 1	64	Sewer Pump Energy	4.3
Shed 1	65	Shed circuit Energy	6.4
Solar	66	Solar Energy Generated	
Solar 2	67	Solar Energy Generated	
Sprinkler 1	68	Sprinkler Energy	7.2
Sumppump 1	69	Water conveying Sump Energy	4.6
Utilityroom 1	70	Utility Room Energy	6.3
Vanthood 1	71	Vent hood circuit Energy	1.6
Waterheater 1	72	Water heater energy	8.5
Waterheater 2	73	Water heater Energy	8.6

[illegible]	74	[illegible] Pump Energy	4.7
Wirecooler1	75	Wirecooler Energy	7.3
leg1v	76	Voltage at Phase A	
leg2v	77	Voltage at Phase B	

CONTROLLABLE SOURCES (THERMAL MODES REQUIRED)

Ac 1	1	AC compressor 1	AC SOURCES CONTROLLABLE
air 2	2	AC compressor 2	
air 3	3	AC compressor 3	
airwindow unit 1	4	Window unit AC	
furnace 2	27	Furnace Airhandler Energy	
furnace 1	26	Furnace Airhandler Energy	HEATING SOURCES CONTROLLABLE
heater 1	31	Electric Heater Energy	
heater 2	32	Electric Heater Energy	
heater 3	33	Electric Heater Energy	
freezer 1	25	Freezer energy	REFRIGERATION SOURCES CONTROLLABLE
Refrigerator 1	61	Refrigerator Energy	
Refrigerator 2	62	Refrigerator Energy	
Waterheater 1	72	Water heater energy	HEATING SOURCE CONTROLLABLE
Waterheater 2	73	Water heater Energy	

REDUNDANT FIELDS :

lightsfmeg 1	41	Lights circuits Energy	LIGHTS CIRCUIT ENERGY
lightsfmeg 2	42	Lights circuits Energy	
lightsfmeg 3	43	Lights circuits Energy	
lightsfmeg 4	44	Lights circuits Energy	
lightsfmeg 5	45	Lights circuits Energy	
lightsfmeg 6	46	Lights circuits Energy	
Pool 1	55	Pool Pump + Pool light Energy	POOL LIGHT + POOL PUMP COMBINED ENERGY
Pool 2	56	Pool Pump + Pool light Energy	
leg1v	76	Voltage at Phase A	PHASE VOLTAGE INFORMATION
leg2v	77	Voltage at Phase B	

[MAY BE LATER CAN BE USED WITH PROPER ELECTRICAL MODEL OF HOUSE]

PRIORITY 1 : [FRIDGE + FREEZER + KITCHEN]

[SAFETY OF FOOD/MEDICINE + COOKING FOOD]

Refrigerator 1	61	Refrigerator Energy	1.1
Refrigerator 2	62	Refrigerator Energy	1.2
Freezer 1	25	Freezer energy	1.3
Kitchenaid 1	39	Kitchen Appliance Energy	1.4
Kitchen 1	37	Kitchen Energy Addn	1.5
Kitchenaid 2	40	Kitchen Appliance Energy	1.6
Kitchen 2	38	Kitchen Energy Addn	1.7
Range 1	60	Cooking Range Energy	1.8
Vent hood 1	71	Vent hood circuit Energy	1.9
Microwave 1	49	Microwave Energy	1.10
Oven 1	53	Oven circuit Energy	1.11
Oven 2	54	Oven circuit Energy	1.12

PRIORITY 2 : [BEDROOMS - LIGHTS/FANS/OUTLETS]

[FOR SLEEPING/CHARGING/THERMAL COMFORT/ILLUMINATION]

Bedroom 1	8	Bedroom Energy	2.1
Bedroom 2	9	Bedroom Energy	2.2
Bedroom 3	10	Bedroom Energy	2.3
Bedroom 4	11	Bedroom Energy	2.4
Bedroom 5	12	Bedroom Energy	2.5

PRIORITY 3 : [LIVINGROOM + OFFICE]

[PRODUCTIVITY / UNION / LIGHTS / FANS / CHARGING]

LivingRoom 1	47	Living Room Energy	3.1
Living Room 2	48	Living Room Energy	3.2
Office 1	50	Office Energy	3.3

PRIORITY 4 : [CLOTHES + GARBAGE + PUMPS]

[CLEAN CLOTHES / WASTE DISPOSAL / OTHER PUMPS]

Clothswasher 1	17	CM ELECTRIC	4.1
Dryer 1	23	Dryer Electric	4.2
Sewerpump 1	64	Sewer Pump Energy	4.3
Disposal 1	22	Disposal dirtygarbage energy	4.4
Pump 1	59	Any other Pump Energy	4.5
Sumppump 1	69	Water collecting Sump Energy	4.6
Wellpump 1	74	Well Pump Energy	4.7

PRIORITY 5 : [SECURITY / BATH / DINE / DISWASHER]

[EXTRA COMFORTS / SECURITY / BATHROOM+DINNING / DISHWAS]

Security 1	63	Security System Energy	5.1
Bathroom 1	6	Bathroom Energy	5.2
Bathroom 2	7	Bathroom Energy	5.3
Diningroom 1	19	DiningRoom Energy	5.4
Diningroom 2	20	DiningRoom Energy	5.4
Dishwasher 1	21	Dishwasher Energy	5.5

PRIORITY 6 : [REMAINING ROOMS + OUTSIDE LIGHTS]

[ALL ROOMS POWERED + OUTSIDE LIGHTS]

garage 1	28	garage energy	6.1
garage 2	29	garage energy	6.2
Utilityroom1	70	Utility Room Energy	6.3
shed 1	65	Shed circuit Energy	6.4
Outsidelightsspring1	51	Exterior lights Energy	6.5
Outsidelightsspring2	52	Exterior lights Energy	6.6

PRIORITY 7 : [FISH / GRASS / WINE]

[OTHER ORNAMENTAL AND LUXURY ITEMS POWERED]

Aquarium 1	5	Aquarium Energy	7.1
sprinkler1	68	sprinkler Energy	7.2
Winecooler1	75	Wine cooler Energy	7.3

PRIORITY 8 : [POOL / WATER HEATER / JACUZZI]

[MOST LUXURY ITEMS SERVED]

icemaker1	35	Ice maker Energy	8.1
Poolpump1	58	Pool Pump Energy	8.2
Poolight1	57	Pool light Energy	8.3
jacuzzi 1	36	Jacuzzi Energy	8.4
Waterheater1	72	Water heater energy	8.5
Waterheater2	73	Water heater Energy	8.6

NEXT STEPS :-

i) PRE PROCESS PECAN STREET DATA FILES

ii) CREATE A PRIORITY STACK FUNCTION BASED ON ABOVE LIST

iii) CREATE A PECAN STREET POST PROCESSING FUNCTION

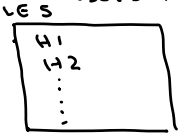
- 1 → COMMUNITY PROBLEM
- 2 → BIG HOUSE PROBLEM

iv) COMPLETE BASELINE SIMULATION

v) SEND RESULTS PPT TO PRABIR

iii) POST PROCESSING OF PECAN STREET HOUSE DATA

PRE PROCESSED HOUSE FILES



NEED TO SELECT N_HOUSE FILES OR 1 FILE

i) SAME FILE FOR ALL

ii) DIFFERENT FILE FOR ALL

CHECK PV → N_PV_BAT → N_PV

CHECK BAT → N_BAT → N_PV_BAT

↓

ONCE FILES ARE SELECTED

↓

i) FOR SINGLE HOUSE

ii) FOR COMMUNITY

KEEP REQUIRED FIELDS IN ORDER OF PRIORITY DISCUSSED ABOVE / WITH SIMULATION DATE-TIME MATCHING ROWS

↓

IF MORE THAN ONE FILE

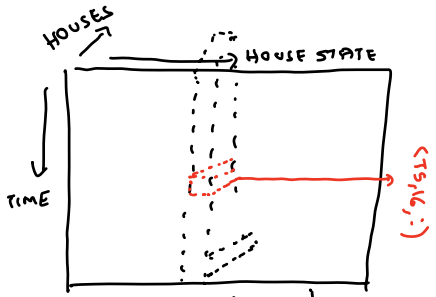
STACK IN 3D-ARRAY

N_PV_BAT_EV N_PV_BAT N_PV_EV N_BAT_EV

N_PV N_BAT N_EV N

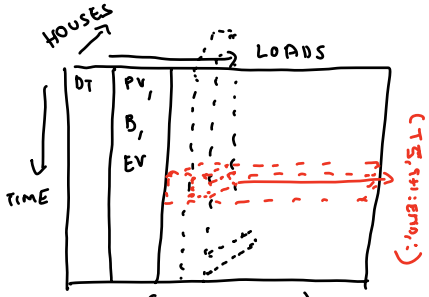
PRIORITY STACK CONTROLLER :

HOUSEDATAMATRIX (: , 16 , :)



(:,16,:) = E_d^1

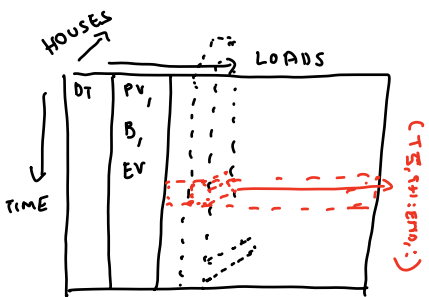
E_LOADDATA



C : , 9+1 : END , :)

DEVICE LOADS_DESIRED

E_LOADDATA_ACTUAL



C : , 9+1 : END , :)

DEVICE LOADS_ACTUAL

SQUISH

SQUISH

$E_d^T = [\ ]_{1\times 1}$

$E_{d\_v}^T = [\ \ ]_{1\times 9+1:END}$

E = 0

FOR ii = COLNUM_E_LOADDATA − (9+1) : −1 : 1

if (E ≤ E MIC_ABS)

E = E + E_d^T_v (ii)

else

E = E − E_d^T_v (ii+1)

lastDeviceCol = ii + (9+1) ; BREAK

end

end

4 5 6 7 8 9 10

E

$E_8^1 = E_8 - 8$

$E_{d\_ACTUAL}^T$ = sum ($E_{d\_v}^T$ (1 : lastdeviceCol − (9+1)))

Priority_Served_Section = 9+1 : lastDeviceCol

$E_{d\_Actual}^i = E_{d\_Actual}^T \dfrac{E_{d\_desired}^i}{E_d^1}$

$E_{device\_j\_act}^i = E_{d\_Actual}^i \dfrac{E_{d\_device\_j}^i}{E_{d\_v\ j}^T}$

1.) MEETING 04/12/2021 :-

→ ACC POSTER / VIDEO

- BASELINE

- ADDITION TO BASELINE [Battery Charging Removal]

2.) MEETING 04/26/2021 :-

Distance

O_1^i ∈ [-1, 0] $O \in \{1, 0\}$ [-1, 1]

O_2^i ∈ [0, 1] $T \in [-1, 1]$

Change $T \in [-1, 0]$

O_i^i ∈ [-1, 1]

T_1 [-1, 0] → T_1 [0, 1]

T_2 (0, 1]

O ∈ [0, 1]

C T_1 = 0.0 0.5

D T_2 0.3

G = $T_1 - T_2$

1 0.5

0.5 0

0.8 0.3

0.3 0

0.4 0.1

0.5 0.2

1 1

0

$\theta \quad \rightarrow \quad T_2 - T_1 \quad \rightarrow [-1, 1]$

$\theta \qquad \theta$

$T_1 > T_1 \qquad D$

$T_2 < T_2 \qquad C$

MEETING DR. BAROOAH : 04/27/2021

i) CCTA JOURNAL VERSION (PREPARE VERSION) (ADD MODELS)

- MORE LIT REVIEW
- CONTRIBUTIONS MADE CLEAR IN INTRODUCTION
- MORE SIMULATION TEST CASES
- NOT SPECIFIC TO HURRICANES !!
- EPSR

ii) SMART COMMUNITY - BASELINE

SLC1

IMPOVES WITH MORE PV+BAT

IF ALL PV+BAT ITS REALLY GOOD

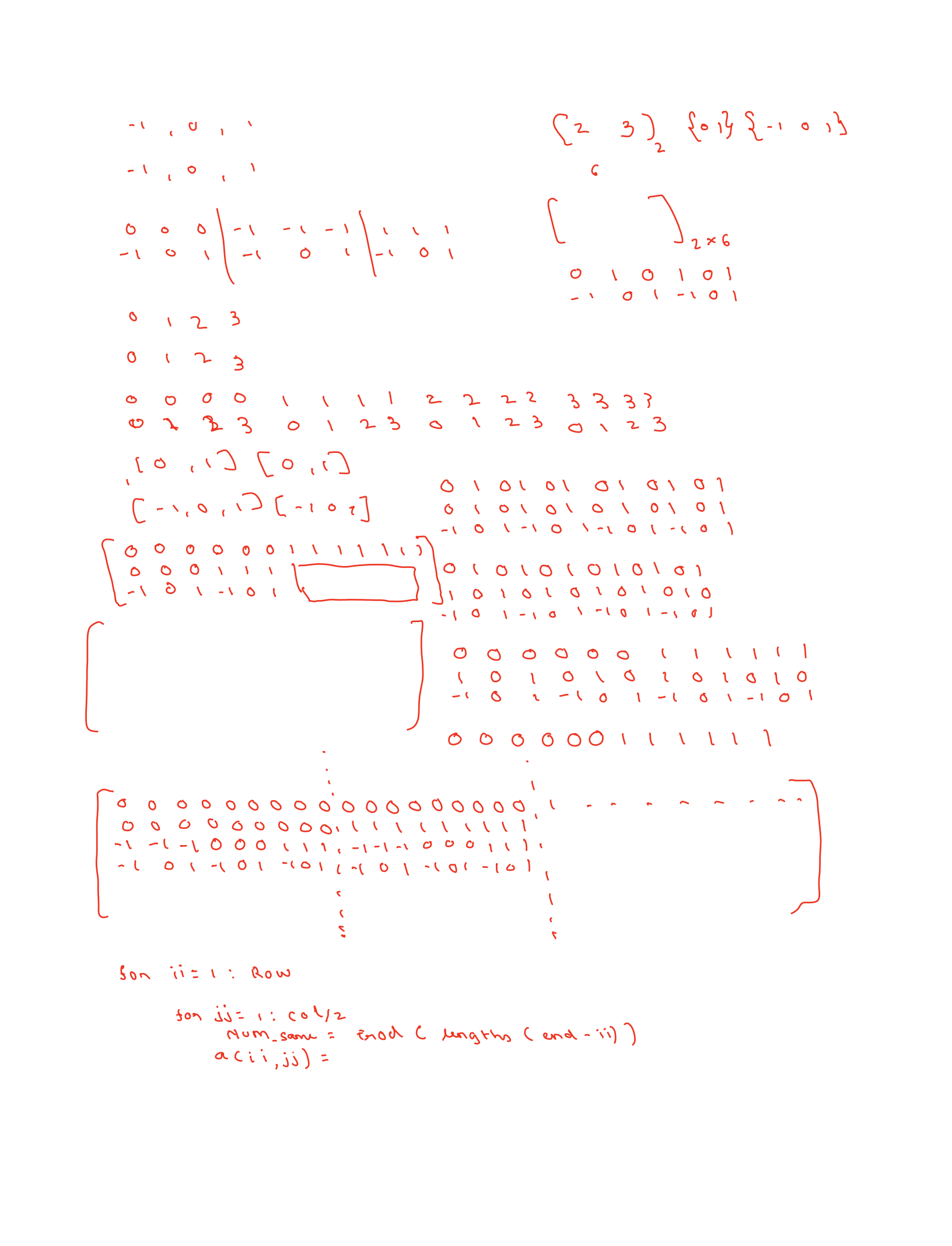
SLC2

VERY BAD

WHAT KIND OF PERFORMANCE METRICS ??

iii) INTERNSHIP : - CPT IN PROCESS

- LEAVE OF ABSENCE SIGNED


-1 , 0 , 1
-1 , 0 , 1
{0 1} {-1 0 1}
2 3
6
2×6
0 1 2 3
0 1 2 3
[0 , 1] [0 , 1]
[-1, 0 , 1] [-1 0 1]
for ii = 1 : Row
for jj = 1 : col/2
Num_same = fnod (lengths (end - ii))
a(ii, jj) =

$$
\text{STATE} = \Big[\; E_{BAT}(k),\ T_h(k),\ T_{am}(k),
$$

$$
E_{L1}(k),\ E_{L1,1h}(k),\ E_{L2,2h}(k),\ E_{L3,3h}(k)
$$

$$
E_{L2}(k),\ E_{L1,1h}(k),\ E_{L2,2h}(k),\ E_{L3,3h}(k)
$$

$$
E_{L3}(k),\ E_{L1,1h}(k),\ E_{L2,2h}(k),\ E_{L3,3h}(k)
$$

$$
E_{L4}(k),\ E_{L1,1h}(k),\ E_{L2,2h}(k),\ E_{L3,3h}(k)
$$

$$
E_{L5}(k),\ E_{L1,1h}(k),\ E_{L2,2h}(k),\ E_{L3,3h}(k)
$$

$$
E_{L6}(k),\ E_{L1,1h}(k),\ E_{L2,2h}(k),\ E_{L3,3h}(k)
$$

$$
E_{L7}(k),\ E_{L1,1h}(k),\ E_{L2,2h}(k),\ E_{L3,3h}(k)
$$

$$
E_{L8}(k),\ E_{L1,1h}(k),\ E_{L2,2h}(k),\ E_{L3,3h}(k)
$$

$$
E_{PV}(k),\ E_{PV,1}(k),\ E_{PV,2}(k),\ E_{PV,3}(k)
$$

$$
V_{oc}(k-1)\ \Big]
$$

Redesign of community and large house code:

Part I] sketch:

- OS -> FOR FILE PATHS
- SIMULATION PARAMETERS
- FOLDER PATHS
  - IMAGES
  - LOAD DATA
  - WEATHER DATA
- SIMULATION PERIOD
- WEATHER DATA EXTRACTION
- LOAD DATA EXTRACTION
- INITIAL CONDITIONS
  - HOUSE TEMPERATURE
  - BATTERY SOC
  - LOAD DATA DESIRED
- DISTURBANCEM CONDITIONS
  - WEATHER
  - LOAD DATA
- CONTROLLER
- PLANT
- PLOTTING.

25 - Startup Av
26 - Startup Req
27 - Startup used

N pvBat — PV, Bat, Th, EL
N Bat — Bat, Th, EL
N pv — PV, Th, EL
N none — Th, EL

PV_a	PV_u	PV_un	Ebat	Ec	Ed	Th	EL_D	EL_a	Uc	Ud	Uac	Uprev	Tag
1	2	3	4	5	6, 7	8:11	12	13	18	19	20	21	22

8 - T_amb
9 - T_mass
10 - T_attic
11 - T_in

EAC_d 14, EAC_a 15, ET_d 16, ET_a 17, Tagp 23, Ec_d 24

PLANT LEVEL :

1 PV Available
2 PV used
3 PV unused
4 Battery SOC
5 Battery Charging
6 Battery Discharging
7 Battery Discharging Dispatch Energy
8
9 House Temperature 4 variables
10
11
12 Energy Load Desired
13 Energy Load Actual
14 Energy AC Desired
15 Energy AC Actual
16 Total Energy Desired
17 Total Energy Actual
18 Battery Charging Command
19 Battery Discharging Command
20 AC on-off Command Current
21 AC on-off Command Previous
22 AC Actual ON-OFF Status Current
23 AC Actual ON-OFF Status Previous
24 Battery Charging Dispatch Energy
25 Startup Power Available
26 Startup Power Required
27 Start up Power used

States:

1) PV Available
2) PV used
3) PV unused
4) Battery SOC Energy
5) Battery Charging Energy
6) Battery Discharging Energy
7) House 1
8) House 2
9) House 3
10) House 4
11) Energy Consumed by AC
12) Energy Load Consumed Total
13) Energy Load Consumed Level 1
14) Energy Load Consumed Level 2
15) Energy Load Consumed Level 3
16) Energy Load Consumed Level 4
17) Energy Load Consumed Level 5
18) Energy Load Consumed Level 6
19) Energy Load Consumed Level 7
20) Energy Load Consumed Level 8
21) AC ON-OFF STATUS C
22) L1 ON-OFF STATUS C
23) L2 ON-OFF STATUS C
24) L3 ON-OFF STATUS C
25) L4 ON-OFF STATUS C
26) L5 ON-OFF STATUS C
27) L6 ON-OFF STATUS C
28) L7 ON-OFF STATUS C
29) L8 ON-OFF STATUS C

- -- 1-

30) AC ON-OFF STATUS P_n
31) L1 ON-OFF STATUS P_n
32) L2 ON-OFF STATUS P_n
33) L3 ON-OFF STATUS P_n
34) L4 ON-OFF STATUS P_n
35) L5 ON-OFF STATUS P_n
36) L6 ON-OFF STATUS P_n
37) L7 ON-OFF STATUS P_n
38) L8 ON-OFF STATUS P_n

39.) EV PRESENT - NOT PRESENT STATUS C
40.) EV PRESENT - NOT PRESENT STATUS P_n
41.) EV Battery SOC Energy
42.) EV Battery Charging Energy
43.) EV Battery Discharging Energy

Disturbances:

1) Ws
2) T_am
3) GHI
4) DNI
5) DATETIME MATRIX
6) Total Energy Desired
7) Energy Desired 1
8) Energy Desired 2
9) Energy Desired 3
10) Energy Desired 4
11) Energy Desired 5
12) Energy Desired 6
13) Energy Desired 7
14) Energy Desired 8
15) Energy Desired 9
16) EV PRESENT - NOT PRESENT FORECAST

Control:

1.) v_{Bat-c}

2.) v_{Bat-d}

3.) v_{ac}

4.) v_1

5.) v_2

6.) v_3

7.) v_4

8.) v_5

9.) v_6

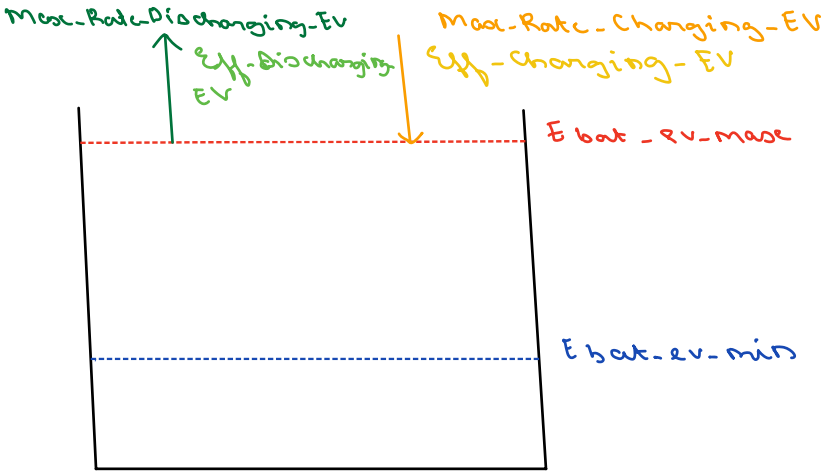
10.) v_7

11.) v_8

12.) $v_{Bat-EV-c}$

13.) $v_{Bat-EV-d}$

EV logic:


Max-Rate-Discharging-EV
Eff-Discharging EV
Max-Rate-Charging-EV
Eff-Charging-EV
E bat_ev_max
E bat_ev_min

- DONE WITH PLANT
  - COMMUNITY
  - SINGLE LARGE HOUSE
- DONE WITH CONTROLLERS
  - SMART LOCAL CONTROLLER
  - DUMB LOCAL CONTROLLER
- TO DO
  - FIGURE PLOTTER FUNCH
  - PERFORMANCE COMPUTER FUNCH
- CURRENTLY

  MAIN SCRIPTS
  - SINGLE HOUSE MPC
  - COMMUNITY MPC
  - SINGLE HOUSE RL
  - COMMUNITY RL

Basis Function :-

Large house :-

$x\text{-}k = [\, E\text{-}bat,\ Th,\ Tam,\ E_L, E_{L1}, E_{L2}, E_{L3},\ E_{PV}, E_{PV1}, E_{PV2}, E_{PV3},\ V_{ac}\,]$

Linear Basis $= [\, E\text{-}bat,\ Th,\ Tam,\ E_L, E_{L1}, E_{L2}, E_{L3},\ E_{PV}, E_{PV1}, E_{PV2}, E_{PV3},\ V_{ac}, V_L\,]$

Quadratic Basis =

$[\, E_{bat}^2,\ Th^2,\ Tam^2,$

$E_L^2, E_{L1}^2, E_{L2}^2, E_{L3}^2,$

$E_{PV}^2, E_{PV1}^2, E_{PV2}^2, E_{PV3}^2,$

$V_{ac}^2, V_L^2,$

$E_{bat} Th,\ E_{bat} Tam,$

$E_{bat} E_L, E_{bat} E_{L1}, E_{bat} E_{L2}, E_{bat} E_{L3}$

E_{bat}

QUADRATIC BASIS GENERATOR

x_K = [ ]

u_c_k = [ ]

Q_NOTPRESENT = { [ ] ..... [ ] }

Basis = [x_K , u_c_k]

for ii = 1 : length(Basis)

    Current_Q_Not_Present = Q_NotPresent(ii)

LEN1 = LEN_Q_Not Present = length(Current_Q_Not_Present)

    if (LEN1 == 0)

        for jj = 1 : leng(Basis)

            m(ii,jj) = Bassis(ii,1) * Basis(jj,1)

        end

    Elseif (LEN1 ≠ 0)

        for jj = 1 : leng(Basis)

            is part of set (jj, Current_Q_Not_Present)

            if (is Part)

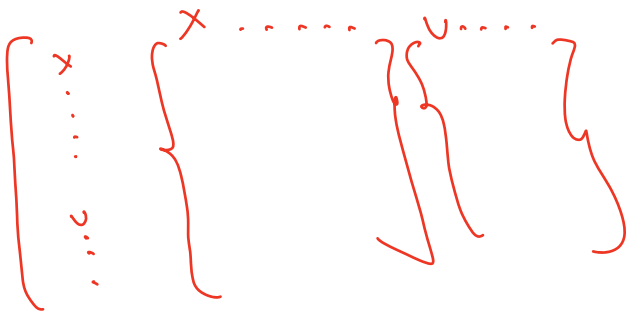
                m(ii,jj) = NAN

            Elseif (is not Part)

                m(ii,jj) = Bassis(ii,1) * Basis(jj,1)

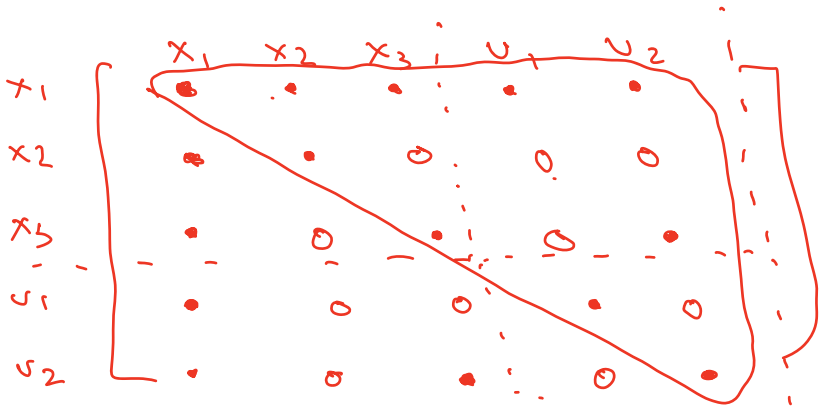
            end

        end



$(x_1+1)v_1$

$(x_1x_3+1)v_2$



$x_1v_1 \quad x_1v_2$

x_3v_2

$v_1 + v_2$

$$\begin{bmatrix} v_1 & v_2 \end{bmatrix} \begin{bmatrix} 1 & 1 \\ \cdot & \cdot \\ \cdot & \cdot \\ 1 & 1 \end{bmatrix} \begin{pmatrix} v_1 \\ v_2 \end{pmatrix}$$

$$\begin{bmatrix} v_1 & v_2 \end{bmatrix} \begin{pmatrix} v_1+v_2 \\ v_1+v_2 \end{pmatrix}$$

$[x_1^2 \; x_1x_2 \; x_1x_3 \; x_2^2 \; x_3^2]$

$[v_1x_1 \; v_2x_1 \; v_2x_3]$

$[v_1^2 \; v_2^2]$

$(x_1 \; x_2 \; x_3)$

$[v_1 \; v_2]$

$5C_2$

A B C D E

A B

A C

A D

A E

B C

B D

B E

C D

C E

D E

$v_1^2 + v_1v_2 + v_2v_1 + v_2^2$

$2v_1v_2$

$[x_1^2 \; x_1x_2 \; x_1x_3 \; x_2^2 \; x_3^2$

$x_1 \quad x_2 \quad x_3$

$v_1^2 \quad v_2^2$

$v_1x_1 \quad v_2x_1 \quad v_2x_3$

$v_1 \quad v_2]$

Total Basis $= \{ f(x^2) \quad f(x) \quad f(v^2) \quad f(v) \}$

Basis $a = \{ f(x^2)$

Basis a = $[f(x^2)\ \ f(v^2)\ \ f(x,v)]$

Basis b = $[f(x)\ \ f(v)]$

Basis total = $[f(x^2)\ f(x)\ \ f(v^2)\ f(x,v)\ f(v)]$

$[x_1^2\ \ x_1x_2\ \ x_1x_3\ \ x_2^2\ \ x_3^2$

$x_1\ \ x_2\ \ x_3$

$v_1^2\ \ v_2^2\ \ v_1v_2 \qquad a_1v_1^2 + a_2v_2^2 + a_3v_1v_2$

$v_1x_1\ \ v_2x_1\ \ v_2x_3 \qquad a_4v_1x_1 + a_5v$

$v_1\ \ v_2]$

$$[v_1\ v_2]\begin{bmatrix} a_1 & a_2 \\ a_3 & a_4 \end{bmatrix}\begin{bmatrix} v_1 \\ v_2 \end{bmatrix} + [b_1\ \ b_2]\begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

$$[v_1\ v_2]\begin{bmatrix} a_1 & a_{3/2} \\ a_{3/2} & a_2 \end{bmatrix}[v_1\ v_2]$$

$v_1\ \ v_2\ v_3$

$v_1 \quad 11 \quad 12 \quad 13$

$v_2 \quad\ \ 22 \quad 23$

$v_3 \quad\ \ \ \ 33$

$$[v_1\ v_2]\begin{bmatrix} a_1v_1 + \frac{a_3}{2}v_2 \\ \frac{a_3}{2}v_1 + a_2v_2 \end{bmatrix}$$

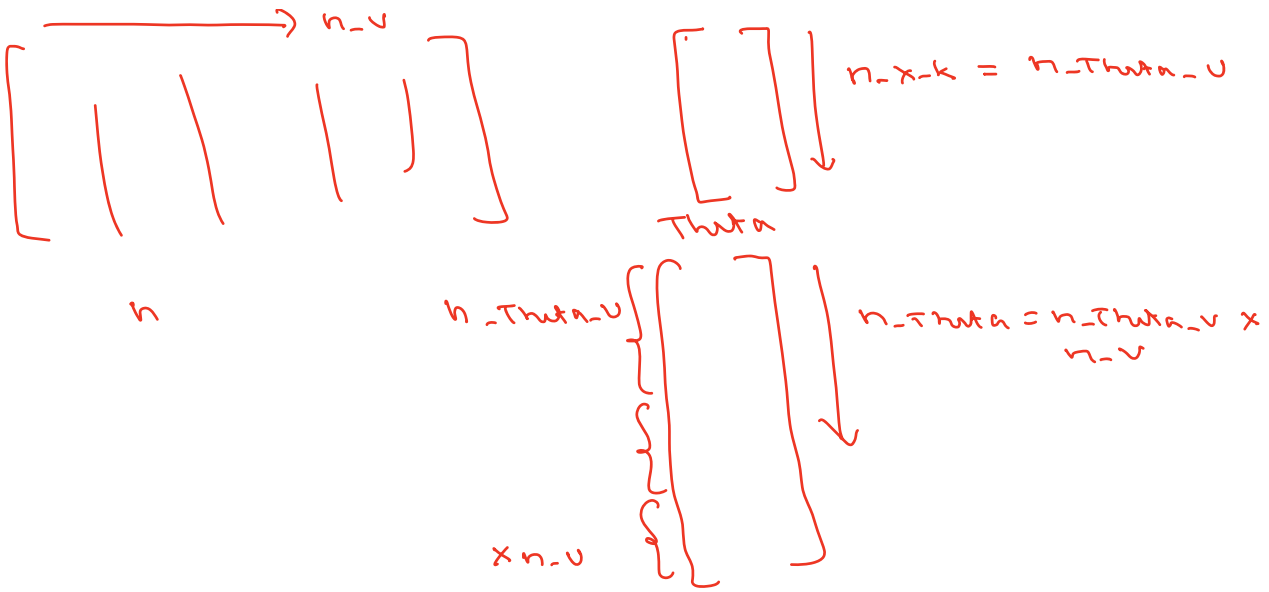
$$a_1v_1^2 + \frac{a_3}{2}v_1v_2 + \frac{a_3}{2}v_1v_2 + a_2v_2^2$$

$[12\ \ 13\ \ 23]$

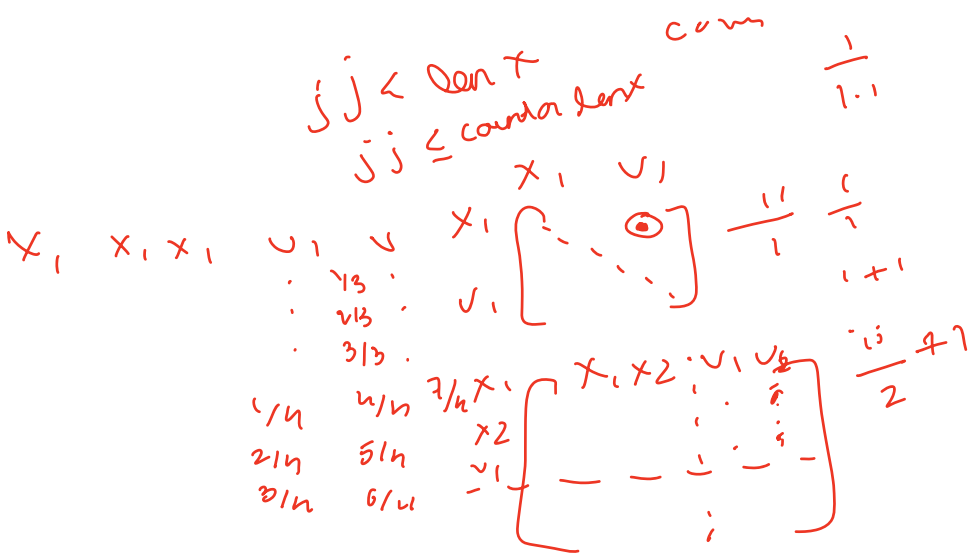
$[v_1\ \ v_2\ \ v_5]$

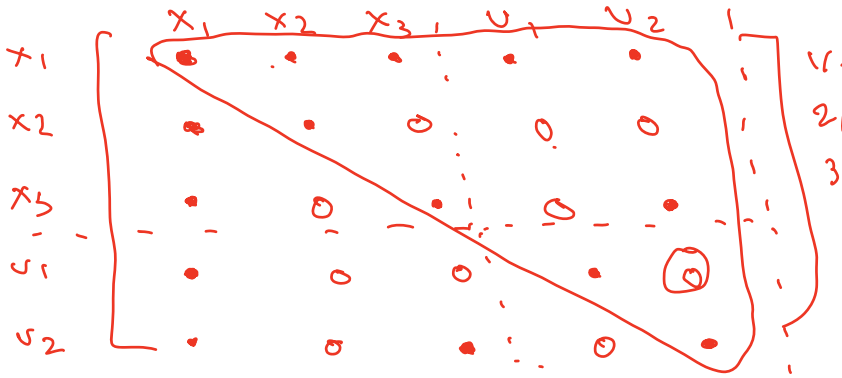
$[v_1v_2\ \ v_1v_3\ \ v_23]$

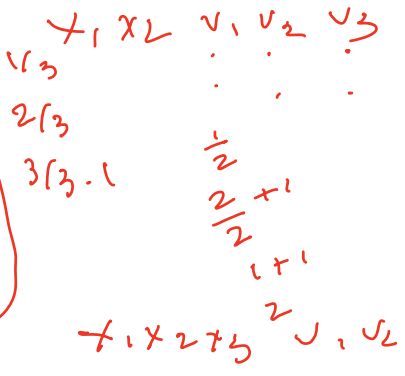
h_Thuta_v



V	x_{in}			
1	1			
0	0			
1	-	1	= 0	ON
1	-	0	= 1	TURN ON
0	-	1	= -1	TURN OFF
0	-	0	= 0	OFF







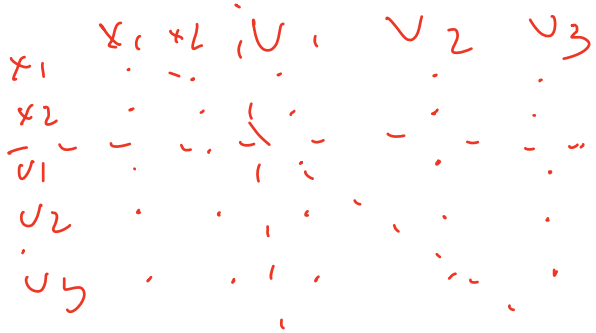
$vx_q\text{-}Log = [\ \ \ \ \ \ ]$ $\quad v_1\ v_2\ v_3$

$v_q\text{-}Log = [\ \ ]$

$v_q^2\text{-}log = [\ \ \ \ ]$

$v\text{-}log = [\ \ \ \ ]$

$[v_1 v_2\ v$

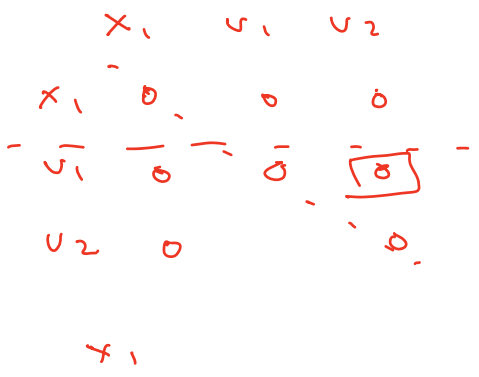


$vx_q = [\ \ \ \ \ \ ]$

$v_q = [\ \ ]$

$v_q^2 = [\ \ \ \ ]$

$v = [\ \ \ \ ]$



$v \quad [\ \ ]$

$[v_1 v_2]$

$[v_1v_2 \quad v_1v_3 \quad v_2v_3]$

$v(jj)\ v(jj+1)$

$v(jj)\ v(jj+2)$

$v(jj+1)\ v(jj+2)$

	v_1	v_2	v_3	v_4
v_1	0	0	0	0
v_2	0	0	0	0
v_3	0	0	0	0
v_4	0	0	0	0

$\rightarrow j$

$\downarrow i$

$[v_1v_2 \quad v_1v_3 \quad v_1v_4 \quad v_2v_3 \quad v_2v_4 \quad v_3v_4]$

jj		KK	KK+1
1	$v(jj)\ v(jj+1)$	1	2
2	$v(jj)\ v(jj+2)$	1	2
3	$v(jj)\ v(jj+3)$	1	2
4	$v(jj+1)\ v(jj+2)$	2	3
5	$v(jj+1)\ v(jj+3)$	2	3
6	$v(jj+3)\ v(jj+4)$	2	3

$v(KK)\ v(KK+1)$

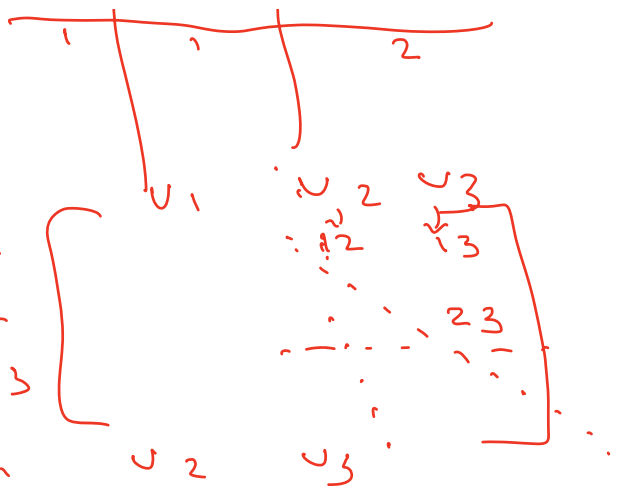
jj	KK	KK+1
1	1	2
2	1	3
3	1	4
4	2	3
5	2	4
6	3	4

$KK = \text{fix}\left(\frac{jj}{\text{no. of vertices}} + 0.1\right) + 1$

$= \frac{1}{3.01} + 1$

$= 0 + 1$

jj | KK | KK+1



	v_1	v_2	v_3
v_1	11	12	13
v_2	21	22	23
v_3	31	32	33

row =

KK

[_ _ _]

for jj = 2 : len v

for ii = 1 : jj - 1

jj = [2 , 3]

ii = [1 , 1 , 2]

ii = 1 : len v

jj = ii + 2 : len v - 1

1 2 1 3 2 3

len v = 1 ii = 1 jj = [ ]

len v = 2 ii = 1, 2 jj = 2 3

jj = 1 2 3

ii = 1, 2 jj =

jj = 2 : len v

ii = 1 : len v - 1

len v

jj_v = [2 3]

ii_v = [1 , 2]

jj = 2 : 2

jj = 2

ii = 1 : 1

jj	ii
1	
2	3
3	2 3

$$ii = 1 : len - 1$$

$$jj = 2 : len$$

$len = 1$ $\quad ii = 1 : 0 = [\,] \quad jj = 2 : 1 = [\,]$

$len = 0$ $\quad ii = 1 : -1 = [\,] \quad jj = 2 : 0 = [\,]$

$len = 2$ $\quad ii = 1 : 1 = [1] \quad jj = 2 : 2 = [2]$

$len = 3$ $\quad ii = 1 : 2 = [1, 2] \quad jj = 2 : 3 = [2, 3]$

1, 2

1, 3

2, 2

2, 3

$$\frac{1}{2} \begin{bmatrix} x_1 & x_2 \end{bmatrix} \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

$$\frac{1}{2} \begin{bmatrix} x_1 & x_2 \end{bmatrix} \begin{bmatrix} x_1 + x_2 \\ x_1 + x_2 \end{bmatrix}$$

$$\frac{1}{2} \left\{ x_1 (x_1 + x_2) + x_2 (x_1 + x_2) \right\}$$

$$\frac{1}{2} \left\{ x_1^2 + x_1 x_2 + x_2 x_1 + x_2^2 \right\}$$

$$\frac{1}{2} \left\{ x_1^2 + 2 x_1 x_2 + x_2^2 \right\}$$

$$\frac{1}{2} x_1^2 + \frac{1}{2} x_2^2 + x_1 x_2$$

MPC :-

1	E_{bat}	x	$\eta_{bat} + \eta_{PVBAT}$
2	T_h	x	η_{house}
3	T_{amb}	x	η_{house}
4	T_{max}	x	η_{house}
5	T_{in}	x	η_{house}
6	T	x	$\eta_{bat} + \eta_{PVBat}$
7	U_{ac}	x	η_{house}
8	E_L	x	η_{house}
9	g	x	$\eta_{pv} + \eta_{PVBat}$
10	E_{th}	x	η_{house}
11	E_{hL}	x	η_{house}
12	f_{on}	x	η_{house}
13	f_{off}	x	η_{house}
14	θ_{bat}	x	$\eta_{Bat} + \eta_{PVBat}$

HOUSE THERMAL DYNAMICS MODEL :

$$x = \begin{bmatrix} T_{wall} \\ T_{air} \\ T_{attic} \\ T_{in} \end{bmatrix} \qquad u = \begin{bmatrix} T_{am} \\ T_{sol,w} \\ T_{sol,r} \\ Q_{int} \\ V_{ac} Q_{ac} \\ Q_{venti} \\ Q_{infil} \\ Q\_solar \end{bmatrix}$$

$$A = \begin{bmatrix} A_1 & A_2 & 0 & 0 \\ A_3 & A_4 & A_5 & A_6 \\ 0 & A_7 & A_8 & 0 \\ 0 & A_9 & 0 & A_{10} \end{bmatrix} \qquad x = \begin{bmatrix} T_{wall} \\ T_{air} \\ T_{attic} \\ T_{in} \end{bmatrix} \qquad u = \begin{bmatrix} T_{am} \\ T_{sol,w} \\ T_{sol,r} \\ Q_{int} \\ -V_{ac} Q_{ac} \\ Q_{venti} \\ Q_{infil} \\ Q\_solar \end{bmatrix}$$

$$B = \begin{bmatrix} 0 & B_1 & 0 & 0 & 0 & 0 & 0 & 0 \\ B_2 & 0 & 0 & B_3 & B_4 & B_5 & B_6 & 0 \\ 0 & 0 & B_7 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & B_8 \end{bmatrix}$$

$$T_{wall}(k+1) = A_1 T_{wall}(k) + A_2 T_{air}(k) + B_1 T_{sol,w}$$

$$T_{air}(k+1) = A_3 T_{wall}(k) + A_4 T_{air}(k) + A_5 T_{attic}(k) + A_6 T_{in}(k) + B_2 T_{am} + B_3 Q_{int} - B_4 V_{ac} Q_{ac} + B_5 Q_{venti} + B_6 Q_{infil}$$

$$T_{attic}(k+1) = A_7 T_{air}(k) + A_8 T_{attic}(k) + B_7 T_{sol,r}$$

$$T_{in}(k+1) = A_9 T_{air}(k) + A_{10} T_{in}(k) + B_8 Q\_solar$$

$$x_{k+1} = A x_k + B u_k$$

$$T_{ave}(k+1) = A_4 T_{ave}(k) + A_3 T_{wall}(k) + A_5 T_{attic}(k) + A_6 T_{in}(k)$$
$$+ B_5 Q_{venti}(k) + B_6 Q_{infil}(k) + B_4 Q_{AC\,Vol}(k) + B_2 T_{am}(k) + B_3 Q_{int}$$

$$T_{wall}(k+1) = A_2 T_{ave}(k) + A_1 T_{wall}(k) + B_1 T_{solw}(k)$$

$$T_{attic}(k+1) = A_7 T_{ave}(k) + A_8 T_{attic}(k) + B_7 T_{solr}(k)$$

$$T_{in}(k+1) = A_9 T_{ave}(k) + A_{10} T_{in}(k) + B_8 Q_{solar}(k)$$

Subject To ;

$$Q_{venti}(k) = -Q_{venti\text{-}const} T_{ave}(k) + Q_{venti\text{-}const} T_{am}(k)$$

$$Q_{infil}(k) = Q_{infil\text{-}const} W_s(k) T_{am}(k) + Q_{infil\text{-}const} T_{am}(k) W_s(k)$$

Where;

$$Q_{venti}(k) = C_p \cdot V \cdot Den_{Air} * [T_{am}(k) - T_{ave}(k)]$$
$$= Q_{venti\text{-}const} T_{am}(k) - Q_{venti\text{-}const} T_{ave}(k)$$
$$= -Q_{venti\text{-}const} T_{ave}(k) + Q_{venti\text{-}const} T_{am}(k)$$

$$Q_{venti\text{-}const} = C_p \cdot V \cdot Den_{Air}$$

$$Q_{infil}(k) = C_p [T_{am}(k) - T_{ave}(k)] C_{oew} W_s(k)$$
$$= C_p C_{oew} T_{am}(k) W_s(k) - C_p C_{oew} W_s(k) T_{ave}(k)$$
$$= Q_{infil\text{-}const} T_{am}(k) W_s(k) - Q_{infil\text{-}const} W_s(k) T_{ave}(k)$$
$$= Q_{infil\text{-}const} W_s(k) T_{ave}(k) + Q_{infil\text{-}const} T_{am}(k) W_s(k)$$

$$Q_{infil\ const} = C_p \cdot C_{oew}$$

$$A = \begin{bmatrix} A_{11} & A_{12} & A_{13} & A_{14} \\ A_{21} & A_{22} & A_{23} & A_{24} \\ A_{31} & A_{32} & A_{33} & A_{34} \\ A_{41} & A_{42} & A_{43} & A_{44} \end{bmatrix} \quad x = \begin{bmatrix} T_{wall} \\ T_{air} \\ T_{attic} \\ T_{im} \end{bmatrix} \quad u = \begin{bmatrix} T_{am} \\ T_{sol,w} \\ T_{sol,r} \\ Q_{int} \\ -V_{ac} Q_{ac} \\ Q_{venti} \\ Q_{impl} \\ Q_{-sol,en} \end{bmatrix}$$

$$B = \begin{bmatrix} B_{11} & B_{12} & B_{13} & B_{14} & B_{15} & B_{16} & B_{17} & B_{18} \\ B_{21} & B_{22} & B_{23} & B_{24} & B_{25} & B_{26} & B_{27} & B_{28} \\ B_{31} & B_{32} & B_{33} & B_{34} & B_{35} & B_{36} & B_{37} & B_{38} \\ B_{41} & B_{42} & B_{43} & B_{44} & B_{45} & B_{46} & B_{47} & B_{48} \end{bmatrix}$$

OPTIMIZATION PROBLEM:

	VAR	#	TYPE	BOUNDS
1]	$X = [T_h$,	$N \times N\_house$	CONTINUOS	$\underline{T_h} \leq T_h \leq \bar{T}_{h+\alpha}$
2]	T_{wam},	$N \times N\_house$	CONTINUOS	$\alpha \leq T_{wam} \leq \alpha$
3]	T_{attic},	$N \times N\_house$	CONTINUOS	$\alpha \leq T_{attic} \leq \alpha$
4]	T_{im},	$N \times N\_house$	CONTINUOS	$\alpha \leq T_{im} \leq \alpha$
5]	Q_{ventil},	$N \times N\_house$	CONTINUOS	$\alpha \leq Q_{ventil} \leq \alpha$
6]	Q_{infil},	$N \times N\_house$	CONTINUOS	$\alpha \leq Q_{infil} \leq \alpha$
7]	v_{ac},	$N \times N\_house$	BINARY	$0 \leq v_{ac} \leq 1$
8]	f_{on},	$N \times N\_house$	BINARY	$0 \leq f_{on} \leq 1$
9]	f_{off}	$N \times N\_house$	BINARY	$0 \leq f_{off} \leq 1$
10]	g,	$N \times (N\_PV + \Gamma_{PV\,Bat})$	CONTINUOS	$0 \leq g \leq \bar{E}_{PV}$
11]	E_L	$N \times N\_house$	CONTINUOS	$0 \leq E_L \leq \bar{E}_L$
12]	$Zeta_h$,	$N \times N\_house$	CONTINUOS	$0 \leq Zeta_h \leq \alpha$
13]	$Zeta_l$	$N \times N\_house$	CONTINUOS	$0 \leq Zeta_l \leq \bar{E}_{CFL}$
14]	E_{bat},	$N \times (N\_Bat + \Gamma_{PV+Bat})$	CONTINUOS	$\underline{E_B} \leq E_{bat} \leq \bar{E}_B$
15]	$Gamma$,	$N \times (N\_Bat + \Gamma_{PV+Bat})$	CONTINUOS	$-1 \leq Gamma \leq 1$
16]	$ThetaBat$]	$N \times (N\_Bat + \Gamma_{PV+Bat})$	BINARY	$0 \leq ThetaBat \leq 1$

OBJECTIVE :

$$\sum_{k=j}^{j+N+1} \Bigg\{ \lambda_1 \sum_{\substack{i,m=1 \\ i \neq m}}^{N_h} \left[\xi_h^i(k) - \xi_h^j(k) \right]^2 +$$

$$\lambda_2 \sum_{\substack{i,m=1 \\ i \neq m}}^{N_h} \left[\xi_\lambda^i(k) - \xi_\lambda^j(k) \right]^2 +$$

$$\lambda_3 \sum_{\substack{i,m=1 \\ i \neq m}}^{N_h} \left[\frac{E_\lambda^i(k)}{\bar{E}_\lambda^i(k)} - \frac{E_\lambda^j(k)}{\bar{E}_\lambda^j(k)} \right]^2 +$$

$$\lambda_4 \sum_{\substack{i,m=1 \\ i \neq m}}^{N_h} \left[E_{bat}^i(k) - E_{bat}^j(k) \right]^2 +$$

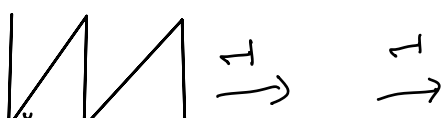
$$\lambda_5 (N-k) \sum_{i=1}^{N_h} \xi_h^i(k) +$$

$$\lambda_6 (N-k) \sum_{i=1}^{N_h} \xi_\lambda^i(k) -$$

$$\lambda_7 (N-k) \sum_{i=1}^{N_h} E_\lambda^i(k) -$$

$$\lambda_8 \sum_{i=1}^{N_h} E_{bat}^i(k) +$$

$$\lambda_9 \sum_{i=1}^{N_h} \theta_{Bat}^i(k) \Bigg\}$$



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Th	Twam	Tasic	Tim	Quanti	Qinfil	Vac	fon	fosf	g	E_λ	Ztah	Zetal	Ebat	Gamma	ThitaBat
										$-\lambda_3$ $(N-K)$	λ_1 $(N-K)$	λ_2 $(N-K)$	$-\lambda_4$		λ_5
										$-\lambda_7$ $(N-K)$	λ_5 $(N-K)$	λ_6 $(N-K)$	$-\lambda_8$		λ_9

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Th	Twam	Tasic	Tim	Quanti	Qinfil	Vac	fon	fosf	g	E_1	Ztah	Zetal	Ebat	Gamma	ThitaBat
										λ_3					
											λ_1				
												λ_2			
													λ_4		

VAR		
Th	1	N*Nh
Tman	2	N*Nh
Tattic	3	N*Nh
Tim	4	N*Nh
Qunti	5	N*Nh
Qinfil	6	N*Nh
Vac	7	N*Nh
fon	8	N*Nh
foff	9	N*Nh
g	10	$N*(N_{pv}+N_{PB})$
Ex	11	N*Nh
ξh	12	N*Nh
ξr	13	N*Nh
Ebat	14	$N*(N_B+N_{PB})$
Gamma	15	$N*(N_B+N_{PB})$
Qbat	16	$N*(N_B+N_{PB})$

$$[x_1 \quad x_2 \quad y_1 \quad y_2] \begin{bmatrix} 0 & & & \\ & 0 & & \\ & & 0 & \\ & & & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ y_1 \\ y_2 \end{bmatrix}$$

CONSTRAINTS : [USUAL FORM]

$$T_{ame}(K+1) = A_4 T_{ame}(K) + A_3 T_{wall}(K) + A_5 T_{attic}(K) + A_6 T_{im}(K) + B_5 Q_{warti}(K) + B_6 Q_{infil}(K) + B_4 Q_{AC} V_{ac}(K) + B_2 T_{am}(K) + B_3 Q_{in}$$

$$T_{wall}(K+1) = A_2 T_{ame}(K) + A_1 T_{wall}(K) + B_1 T_{solw}(K)$$

$$T_{attic}(K+1) = A_7 T_{ame}(K) + A_8 T_{attic}(K) + B_7 T_{solrn}(K)$$

$$T_{im}(K+1) = A_9 T_{ame}(K) + A_{10} T_{im}(K) + B_8 Q_{solar}(K)$$

$$Q_{warti}(K) = -Q_{warti\text{-}const} T_{ame}(K) + Q_{warti\text{-}const} T_{am}(K)$$

$$Q_{infil}(K) = -Q_{infil\text{-}const} W_S(K) T_{ame}(K) + Q_{infil\text{-}const} T_{am}(K) W_S(K)$$

$$E_{bat}(K+1) = E_{bat}(K) + Gamma(K) \bar{E}^c_{Bat}$$

$$\sum^{Nh} V_{ac}(K) E_{ac} + \sum^{NBat+NevBat} Gamma(K) \bar{E}^c_{Bat} + \sum^{Nh} E_i(K) = \sum^{Nh} g(K)$$

$$V_{ac}(K) - V_{ac}(K-1) = f_{on}(m) - f_{oss}(m)$$

$$\sum^{Nh} f_{on}(K) \bar{P}_{ac} \le \sum^{NBat+NevBat} Q_{Bat}(K) \bar{P}_{Bat} + \sum^{Nh} \frac{g(K)}{\Delta T_s}$$

$$T_h(K) - \varepsilon_h(K) \le \bar{T}_h + \alpha$$

$$-E_i(K) - \varepsilon_i(K) \le -\bar{E}_{ai}(K)$$

$$f_{on}(K) + f_{ost}(K) \le 1$$

$$Gamma(K) - Q_{Bat}(K) \le \varepsilon_{Epsilon}$$

CONSTRAINTS : [RHS/LHS FORM]

1. $T_{ama}(K+1) - A_4 T_{ama}(K) - A_3 T_{wall}(K) - A_5 T_{mic}(K) - A_6 T_{im}(K) - B_5 Q_{wall}(K) - B_6 Q_{infil}(K) - B_4 Q_{AC} U_{ac}(K) = B_2 T_{am}(K) + B_3 Q_{in}$

2. $T_{wall}(K+1) - A_2 T_{ama}(K) - A_1 T_{wall}(K) = B_1 T_{solw}(K)$

3. $T_{mic}(K+1) - A_7 T_{ama}(K) - A_8 T_{mic}(K) = B_7 T_{solm}(K)$

4. $T_{im}(K+1) - A_9 T_{ama}(K) - A_{10} T_{im}(K) = B_8 Q_{solam}(K)$

5. $Q_{wall}(K) + Q_{wall-const} T_{ama}(K) = Q_{wall-const} T_{am}(K)$

6. $Q_{infil}(K) + Q_{infil-const} W_s(K) T_{ama}(K) = Q_{infil-const} T_{am}(K) W_s(K)$

7. $E_{bat}(K+1) - E_{bat}(K) + Gamma(K) \bar{E}^c_{Bat} = 0$

8. $\sum^{Nh} U_{ac}(K) E_{ac} - \sum^{NBat+NPvBat} Gamma(K) \bar{E}^c_{Bat} + \sum^{Nh} E_i(K) - \sum^{Nh} g(K) = 0$

9. $U_{ac}(K) - U_{ac}(K-1) - f_{on}(K) + f_{oss}(K) = 0$

10. $\sum^{Nh} f_{on}(K) \bar{P}_{ac} - \sum^{NBat+NPvBat} Q_{Bat}(K) \bar{P}_{Bat} \leq \frac{E_{PV}(K)}{\Delta T_s} (N_{PV} + N_{PVBAT})$

11. $T_h(K) - \varepsilon_h(K) \leq \bar{T}_h + \alpha$

12. $-E_i(K) - \varepsilon_i(K) \leq -\bar{E}_{ai}(K)$

13. $f_{on}(K) + f_{ost}(K) \leq 1$

14. $Gamma(K) - Q_{Bat}(K) \leq Epsilon$

$$T_{ame}(K+1) - A_4 T_{ame}(K) - A_3 T_{wall}(K) - A_5 T_{envic}(K) - A_6 T_{im}(K)$$
$$- B_5 Q_{venti}(K) - B_6 Q_{infil}(K) - B_4 Q_{AC\,Vac}(K) = B_2 T_{am}(K) + B_3 Q_{int}$$

$$Q_{venti}(K) + Q_{venti\text{-}const}\, T_{ame}(K) = Q_{venti\text{-}const}\, T_{am}(K)$$

$$Q_{infil}(K) + Q_{infil\text{-}const}\, W_S(K)\, T_{am}(K) = Q_{infil\_const}\, T_{am}(K)\, W_S(K)$$

$$Q_{venti}(K) = -Q_{venti\text{-}const}\, T_{ame}(K) + Q_{venti\text{-}const}\, T_{am}(K)$$

$$Q_{infil}(K) = -Q_{infil\text{-}const}\, W_S(K)\, T_{am}(K) + Q_{infil\_const}\, T_{am}(K)\, W_S(K)$$

$$T_{ame}(K+1) - A_4 T_{ame}(K) - B_5 Q_{venti}(K) - B_6 Q_{infil}(K)$$
$$- A_3 T_{wall}(K) - A_5 T_{envic}(K) - A_6 T_{im}(K)$$
$$- B_4 Q_{AC\,Vac}(K) = B_2 T_{am}(K) + B_3 Q_{int}$$

$$T_{ame}(K+1)$$
$$- A_4 T_{ame}$$
$$- B_5 \left\{ -Q_{venti\text{-}const}\, T_{ame}(K) + Q_{venti\text{-}const}\, T_{am}(K) \right\}$$
$$- B_6 \left\{ -Q_{infil\text{-}const}\, W_S(K)\, T_{am}(K) + Q_{infil\_const}\, T_{am}(K)\, W_S(K) \right\}$$
$$- A_3 T_{wall}(K) - A_5 T_{envic}(K) - A_6 T_{im}(K)$$
$$- B_4 Q_{AC\,Vac}(K) = B_2 T_{am}(K) + B_3 Q_{int}$$

$$T_{cave}(k+1) - A_4 T_{cave} + B_5 Q_{venti-const} T_{cave}(k) + B_6 Q_{infil-const} W_S(k) T_{am}(k) - A_3 T_{wall}(k) - A_5 T_{attic}(k) - A_6 T_{im}(k) - B_4 Q_{AC} U_{ac}(k) = B_1 T_{am}(k) + B_3 Q_{int} + B_5 Q_{venti-const} T_{am}(k) + B_6 Q_{infil-const} T_{am}(k) W_S(k)$$

$$T_{cave}(k+1) + \left\{ -A_4 + B_5 Q_{venti-const} + B_6 Q_{infil-const} W_S(k) \right\} T_{cave}(k) - A_3 T_{wall}(k) - A_5 T_{attic}(k) - A_6 T_{im}(k) - B_4 Q_{AC} U_{ac}(k) = B_1 T_{am}(k) + B_3 Q_{int} + B_5 Q_{venti-const} T_{am}(k) + B_6 Q_{infil-const} T_{am}(k) W_S(k)$$

$$T_{cave}(k+1) + \left\{ -A_4 + B_5 Q_{venti-const} + B_6 Q_{infil-const} W_S(k) \right\} T_{cave}(k) - A_3 T_{wall}(k) - A_5 T_{attic}(k) - A_6 T_{im}(k) - B_4 Q_{AC} U_{ac}(k) = \left\{ B_1 + B_5 Q_{venti-const} + B_6 Q_{infil-const} W_S(k) \right\} T_{am}(k) + B_3 Q_{int}$$

WE HAVE;

VARIABLE = (12 * N * N_house) +

(1 * N * (N_PV + N_PV-BAT)) +

(3 * N * (N_BAT + N_PV-BAT))

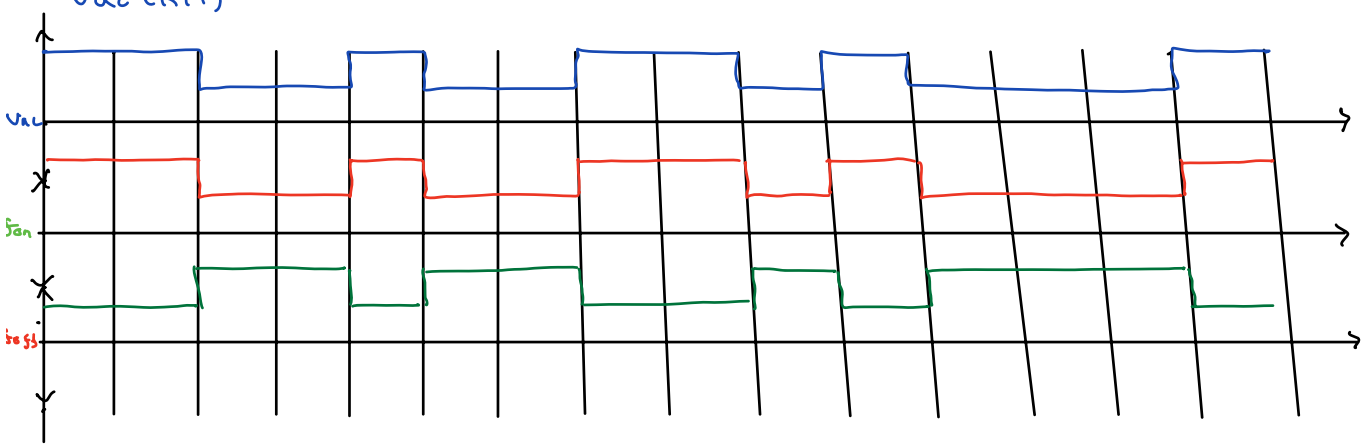
CONSTRAINTS = 14 * N

- EVERY OF ONE HOUSE # VAR = 16*N
  # CONST = 14*N

∴ # VAR < # CONS (FLEXIBILITY IS PRESENT)

$$V_{ac}(K) - \sum_{m=j}^{K} f_{on}(m) + \sum_{m=j}^{K} s_{oss}(m) = 0$$

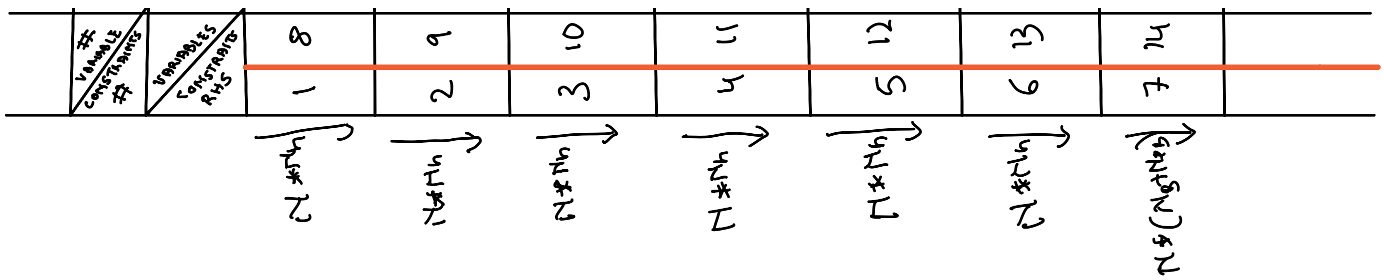
$V_{ac}(K+1)$ -

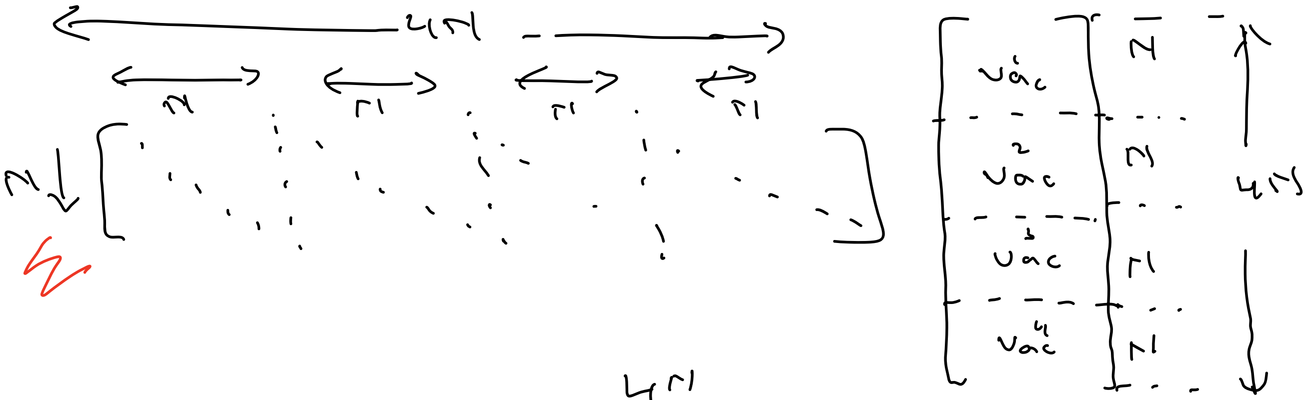


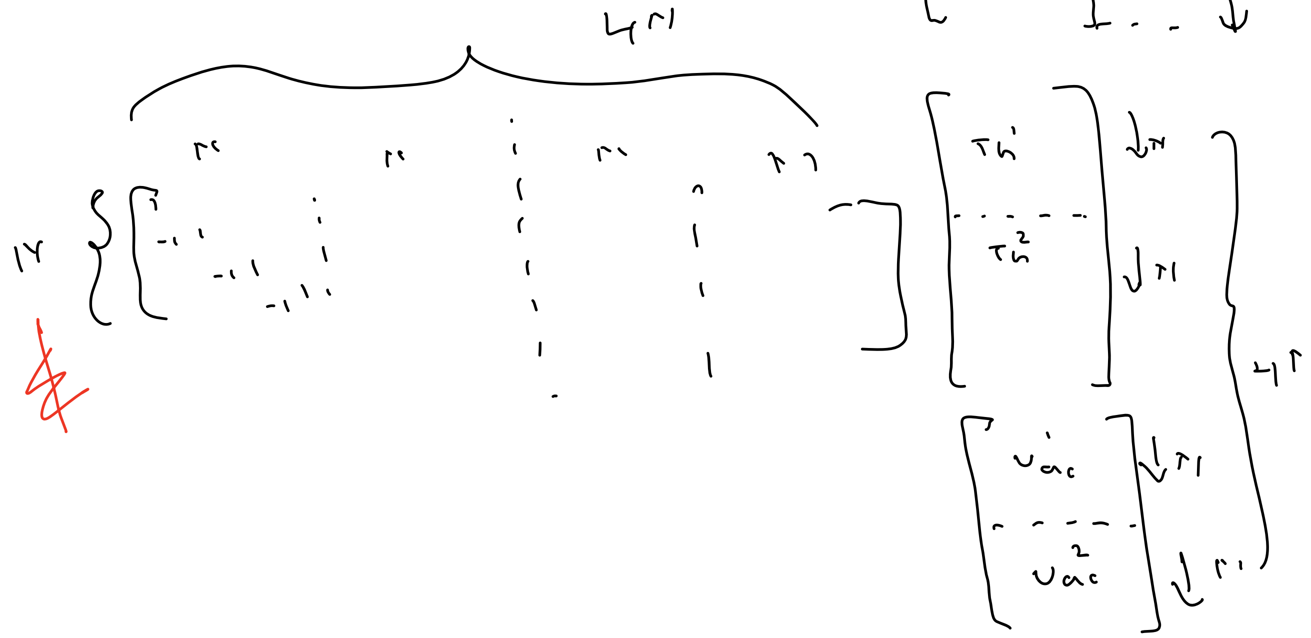
			1 →	N*1 →	1 →	N*1 →	N*1 →	N*1 →	N*(14+NPB) →
	1 - 7	B-14							
CONSTRAINTS #	DATA LHS	DATA LHS							
8	$\beta_1 T_{am}(K) + \beta_2 Q_{im}$	0	0	$\frac{E_{PV}(K)}{\Delta T_S}$	$-T_{in}$	$-\bar{E}_{on}(K)$	1	0	
9	$\beta_1 T_{sam}(K)$								
10	$\beta_2 T_{sim}(K)$								
11	$\beta_3 Q_{aon}(K)$								
12	$\alpha_{wall}(room\ T_{am}(K))$								
13	$Q_{insulation}(T_{am}(K) - T_{WS}(K))$								
14	0								
1									
2									
3									
4									
5									
6									
7									

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Th	Twall	Tabic	Tim	Quanti	Qinfil	Vac	fon	foff	g	E_λ	Zetah	Zetal	Ebat	Gamma	ThetaBat
						Eac			-1	1				$\bar{E}^{c}_{Bat}$	
						1	-1	1							
							$\bar{P}_{AC}$								$-\bar{P}_{Bat}$
1											-1				
										-1		-1			
							1	1							
														1	-1

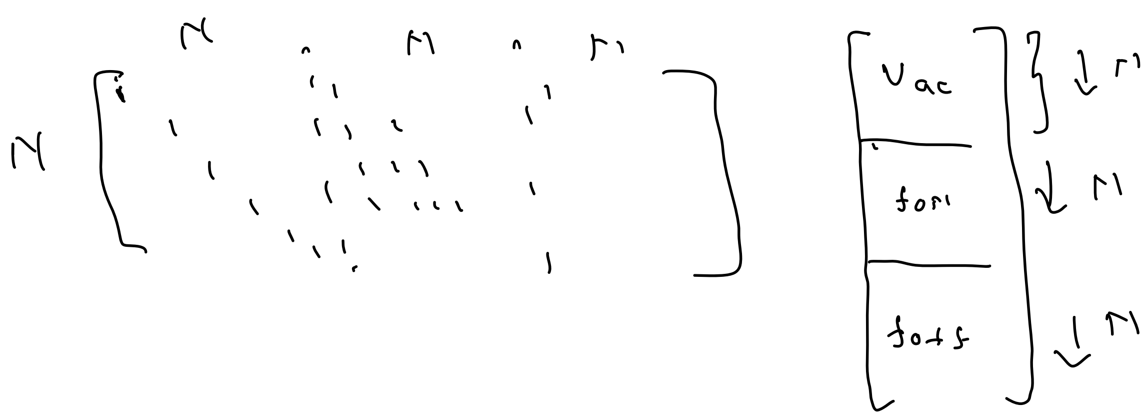
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Th	Twall	Tabic	Tim	Quanti	Qinfil	Vac	fon	fsoft	g	E_λ	Ztah	Zetal	Ebat	Gamma	ThitaBat
$(K+1)$ $-A_4(K)$	$-A_3$	$-A_5$	$-A_6$	$-B_5$	$-B_6$	$-B_4$ QAC									
$-A_2$	$(K+1)$ $-A_1(K)$														
$-A_7$		$(K+1)$ $-A_8(K)$													
$-A_9$			$(K+1)$ $-A_{10}(K)$												
Quanti const				1											
Qinfil const $W_5(K)$					1										
													$(K+1)-1(K)$	$\bar{E}_{bat}$	







$$U_{ac}(k) - \sum_{m=1}^{K} f_{on}(m) - \sum_{m=1}^{K} f_{off}(m) = 0$$



$$U(1) = \sum_{m=1}^{1} f_{on} + \sum_{m=1}^{1} f_{off}$$

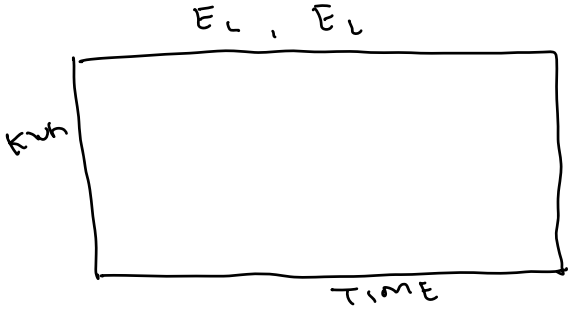
$$U(1) = f_{on}(1) + f(off)$$

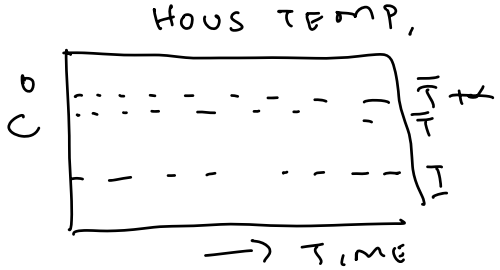
$$U(2) = \sum_{m=1}^{2} f_{on} + \sum_{m=1}^{2} f(off)$$

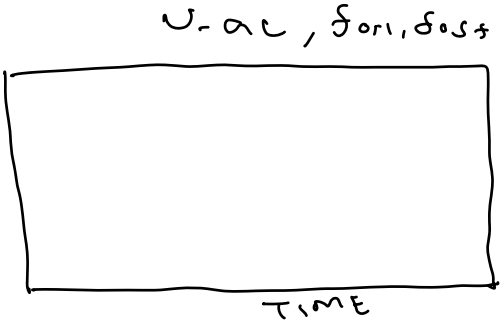
$$U(2) = f_o(1) + f_o(2) + f(1) + f(2)$$

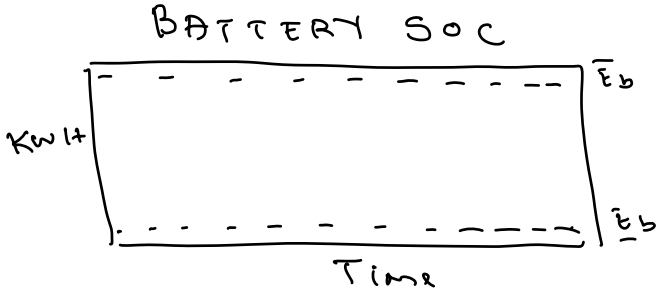
$$\vdots$$

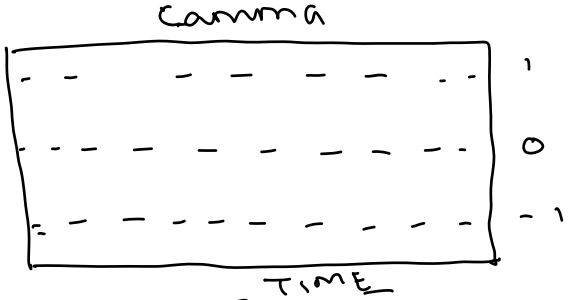
PLOTS FOR OPEN LOOP

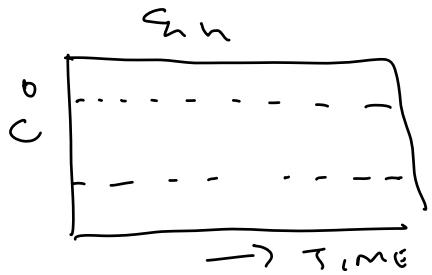


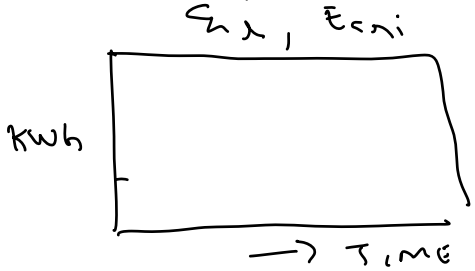












DEBUGGING:

1.] Hems_CommunityHouse_Parameter_Generation:

- Add Dimmation_Params to input → To get Dimmation Vector

2.] Hems_Plant: -1 E_LOADDATA_DC → ELOAD_DATA : Line 64

3.] Hems_Plant: Computing Num. of Dumingon ACs : TIME146

4.] Hems_Dumb_LocalController:

E_Load. TotalDesired = + TotalDesiredAC Energy

5.] Hems_Plant:

Common Debuggers for PV_Unused_Negative, Pv_unused_Negative1 } Depended on House Data_Matrix

6.] UPDATE CURRENT DISTURBANCE_PLANT:

- Make it not update at last iteration as we do not have weather data for last iteration + 1

Hems_Plant_FigurePlotter:

- House_Temperature = X_K Plant_History (:, 7, :)

  Line 77

- Truncating X_K_Plant_History to make it consistent for Plotting

  Line 72

Hems_Plant:

- Adding AC Dynamics to one Constraint.

Hems_Plant_Performance_computer :

- Truncating X-K. Plant-History to make it consistent for Plotting
- And House Numbers.

Hems_Smart_LocalController :

Zeros was used as variable → changed to function

LINE : 427

Hems-PriorityStackController_community

- Size is one (-, -, -) - should be scalars

Hems-Plant :

- using X-K-PressPlant instead of X-K-plant
  - for U-ac in House Thermal Model

- In our main scripts adding simulation-Params to function call of Hems_communityHouse_Parameter_generator.

Hems_Plant : → jj for Discharging Dispatch

Priority stack controller :-> Depth -> 1: Depth

for U-K-PS assignment

Items. WeatherData-Extraction_MPC

$$\sum_{k=1}^{2} \sum_{\substack{i,j=1 \\ j \neq i}}^{2} \left(\xi_1^i(k) - \xi_1^j(k) \right)^2$$

$$\sum_{k=1}^{2} \left[\xi_1^1(k) - \xi_1^2(k) \right]^2$$

$$\left[\xi_1^1(1) - \xi_1^2(1) \right]^2 + \left[\xi_1^1(2) - \xi_1^2(2) \right]^2$$

$$\left[\xi_1^1(1) \right]^2 + \left[\xi_1^2(1) \right]^2 - 2\, \xi_1^1(1)\, \xi_1^2(1) \quad +$$
$$\left[\xi_1^1(2) \right]^2 + \left[\xi_1^2(2) \right]^2 - 2\, \xi_1^1(2)\, \xi_1^2(2)$$

$$\left[\xi_1^1(1) \;\; \xi_1^1(2) \;\; \xi_1^2(1) \;\; \xi_1^2(2) \right] \begin{bmatrix} 1 & 0 & -1 & 0 \\ 0 & 1 & 0 & -1 \\ -1 & 0 & 1 & 0 \\ 0 & -1 & 0 & 1 \end{bmatrix} \begin{bmatrix} \xi_1^1(1) \\ \xi_1^1(2) \\ \xi_1^2(1) \\ \xi_1^2(2) \end{bmatrix}$$

$$\left[\xi_1^1(1) \;\; \xi_1^1(2) \;\; \xi_1^2(1) \;\; \xi_1^2(2) \right] \begin{bmatrix} \xi_1^1(1) - \xi_1^2(1) \\ \xi_1^1(2) - \xi_1^2(2) \\ \xi_1^2(1) - \xi_1^1(1) \\ \xi_1^2(2) - \xi_1^1(2) \end{bmatrix}$$

$$\Rightarrow \xi_1^1(1) \left\{ \xi_1^1(1) - \xi_1^2(1) \right\} + \xi_1^1(2) \left\{ \xi_1^1(2) - \xi_1^2(2) \right\} +$$
$$\xi_1^2(1) \left\{ \xi_1^2(1) - \xi_1^1(1) \right\} + \xi_1^2(2) \left\{ \xi_1^2(2) - \xi_1^1(2) \right\}$$

$$\Rightarrow \left[\xi_1^1(1) \right]^2 - \left[\xi_1^1(1)\, \xi_1^2(1) \right] + \left[\xi_1^1(2) \right]^2 - \left[\xi_1^1(2)\, \xi_1^2(2) \right]$$
$$\left[\xi_1^2(1) \right]^2 - \left[\xi_1^2(1)\, \xi_1^1(1) \right] + \left(\xi_1^2(2) \right)^2 - \left[\xi_1^2(2)\, \xi_1^1(2) \right]$$

$$\Rightarrow [\xi_i^1(1)]^2 + [\xi_i^2(1)]^2 - 2[\xi_i^1(1)\xi_i^2(1)] +$$

$$[\xi_i^1(2)]^2 + [\xi_i^2(2)]^2 - 2[\xi_i^1(2)\xi_i^2(2)]$$

$$= [\xi_i^1(1) - \xi_i^2(1)]^2 + [\xi_i^1(2) - \xi_i^2(2)]^2$$

CODE ORGANIZATION:

Single House → [SH]
- MPC
- RL
- Baseline

Community of Houses → [CH]
- Centralized [C]
  - MPC
  - RL
- Distributed at House [DH]
  - MPC
  - RL
- Baseline

Group of Communities → [GCH]
- Baseline
- Centralized [C]
  - MPC
  - RL
- Distributed at community [DC]
  - MPC
  - RL
- Distributed at House [DH]
  - MPC
  - RL

Pons; integrates R + L side of motor functions

Cerebelem

Nirad is cute