Objective:

Develop and implement an automated power source switching system utilizing Programmable Logic Controllers (PLCs) to efficiently manage the transition between the national power supply, Generator 1, and Generator 2, ensuring a stable power supply.

Interface:

The interface consists of:

Physical inputs

No	Symbol	Function	Lock	Parameters	Location of (L/C)	Comment
I1		Discrete inputs	---	No parameters	(37/1)	NP_Supply
I2		Discrete inputs	---	No parameters	(1/3) (2/3) (7/1) (14/3) (15/2) (20/3) (23/3) (26/1)	G1_Available
I3		Discrete inputs	---	No parameters	(1/4) (9/1) (16/2) (23/4) (32/1)	G2_Available
I7		Discrete inputs	---	No parameters	(2/1) (5/1) (8/1) (11/1)	Circuit_Breaker

Module keys

No	Symbol	Function	Location of (L/C)	Comment
Z1		Zx keys	(13/1)	Initiate

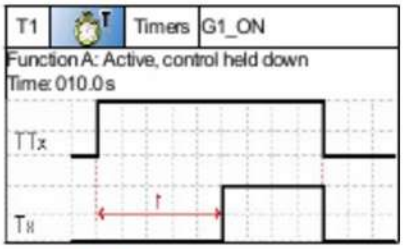
Physical outputs

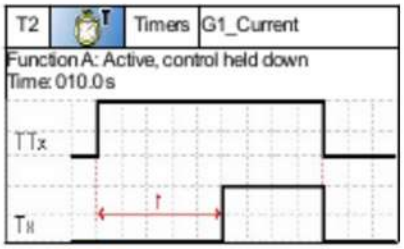
No	Symbol	Function	Latching	Location of (L/C)	Comment
Q1		Discrete outputs	No	(34/6)	Electricity
Q2		Discrete outputs	No	(10/3) (22/3) (29/6)	G1_ON
Q3		Discrete outputs	No	(27/6)	G2_ON
Q9		Discrete outputs	No	(6/2) (18/3) (31/6)	G1_Min_DONE
QA		Discrete outputs	No	(10/1) (19/3) (22/4) (33/6)	G2_Min_DONE

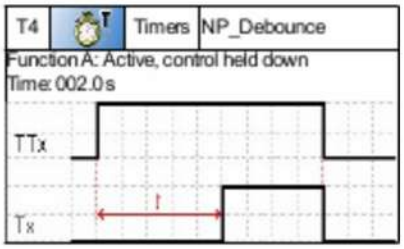
Configurable functions

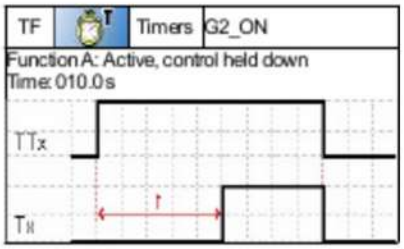
No	Symbol	Function	Lock	Latching	Parameters	Location of (L/C)	Comment
M1		Auxiliary relays	---	No	No parameters	(1/6) (13/6) (17/1) (20/1) (23/1)	FSM_1
M2		Auxiliary relays	---	No	No parameters	(4/6) (14/1) (17/6) (21/1) (24/1) (34/1)	FSM_2
M3		Auxiliary relays	---	No	No parameters	(6/6) (15/1) (18/1) (20/6) (25/1) (26/2) (30/1)	FSM_3
M4		Auxiliary relays	---	No	No parameters	(9/6) (16/1) (19/1) (22/1) (23/6) (27/2) (32/2)	FSM_4
T1		Timers	No	No	See details below	(26/6) (29/1) (30/2) (35/1)	G1_ON
T2		Timers	No	No	See details below	(30/6) (31/1)	G1_Current
T4		Timers	No	No	See details below	(1/1) (3/1) (4/1) (6/1) (14/2) (17/2) (18/2) (19/2) (20/2) (22/2) (23/2) (37/6)	NP_Debounce
TF		Timers	No	No	See details below	(28/1) (32/6) (36/1)	G2_ON
TG		Timers	No	No	See details below	(28/6) (33/1)	G2_Current

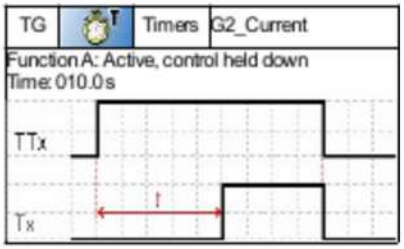
Timer



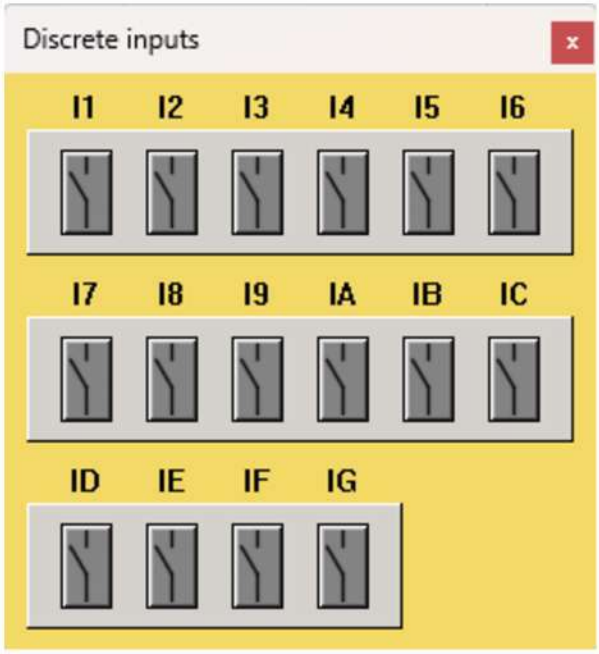


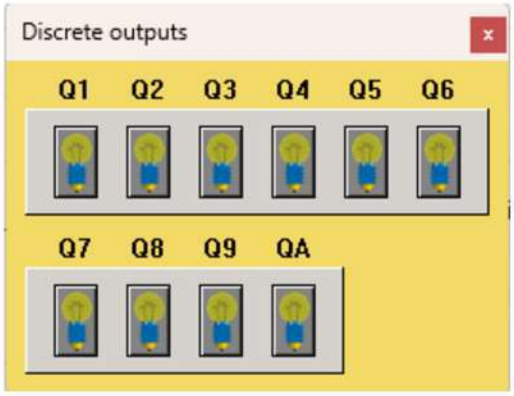


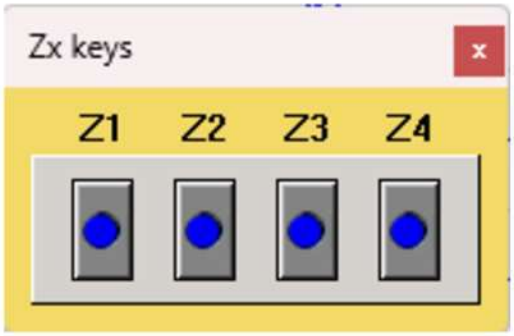


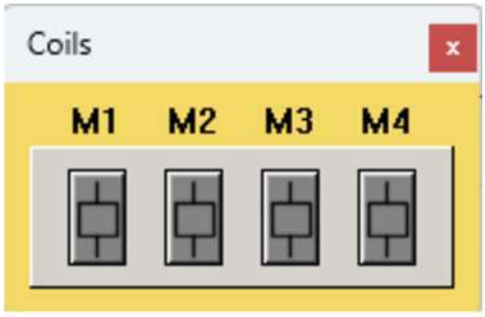


In the simulation, every input is depicted as a switch, and each output is symbolized by a light bulb. The push button is characterized as Zx Keys. Similarly, counter values and coil states are illustrated below.









Here, each Coil represents a state in the finite state machine; M1 represents state 1 and so on...

Function blocks

No	Function	Label	Type	Preset	Current	Lock	Comment
001	Timer	T1	A: Active,	T1 = 010.0 S	T1 = 000.0 S	No	G1_ON
002	Timer	T2	A: Active,	T2 = 010.0 S	T2 = 000.0 S	No	G1_Current
003	Timer	T4	A: Active,	T4 = 002.0 S	T4 = 000.0 S	No	NP_Debounce
004	Timer	TF	A: Active,	TF = 010.0 S	TF = 000.0 S	No	G2_ON
005	Timer	TG	A: Active,	TG = 010.0 S	TG = 000.0 S	No	G2_Current

Key Map:

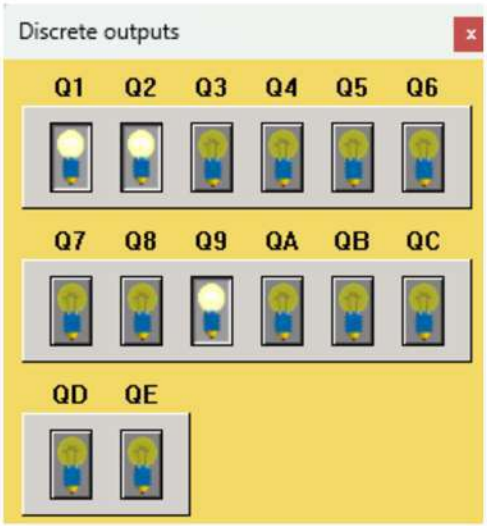
The lamps (outputs) are controlled by the following switches:

Controlled Switches:

- National Power Supply: I1
- Generator 1 Available: I2
- Generator 2 Available: I3

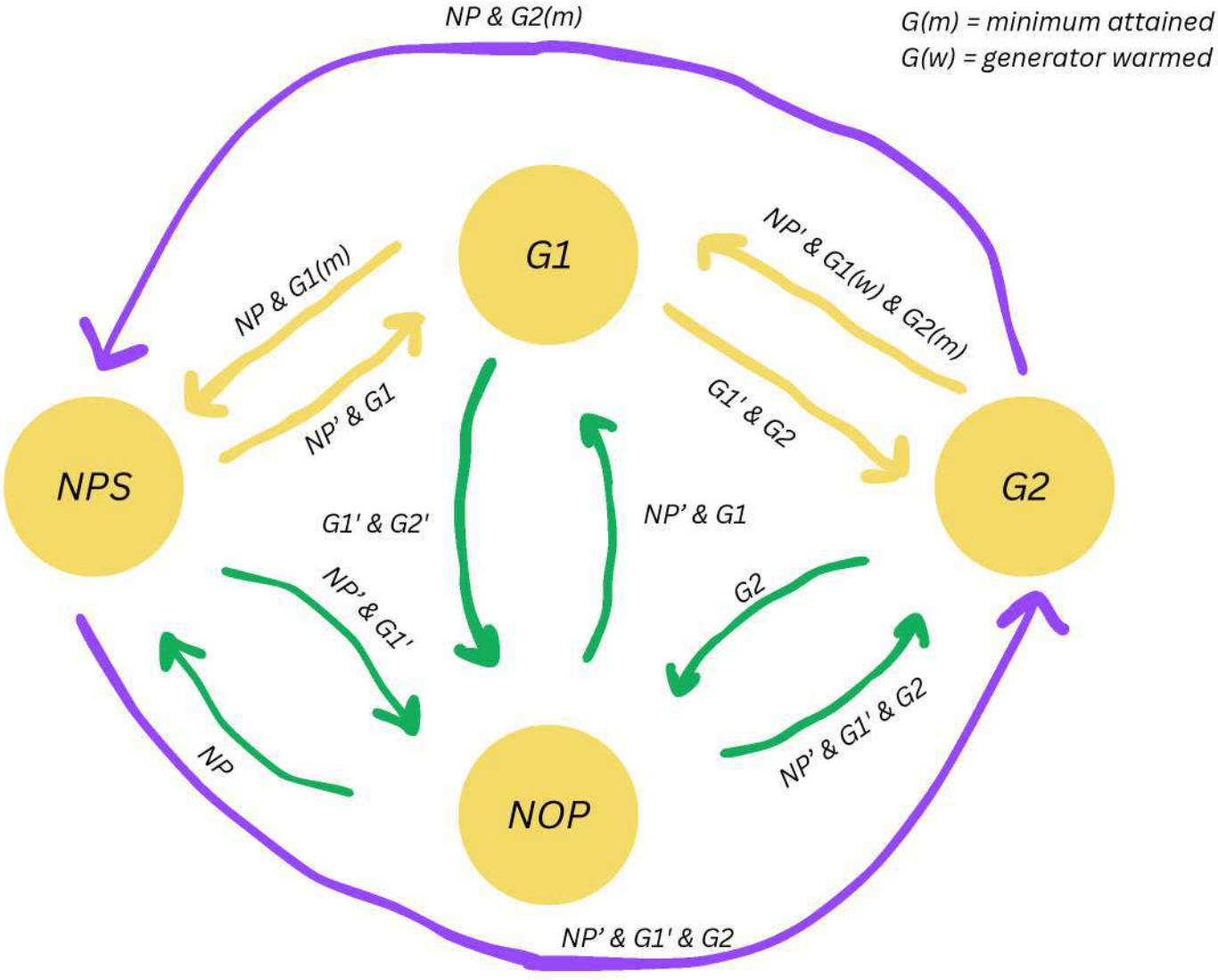
Controlled Lamps:

- Electricity: Q1
- Generator 1: Q2
- Generator 2: Q3
- Indicator for Generator 1 supply: Q9
- Indicator for Generator 2 supply: QA



Generator States:

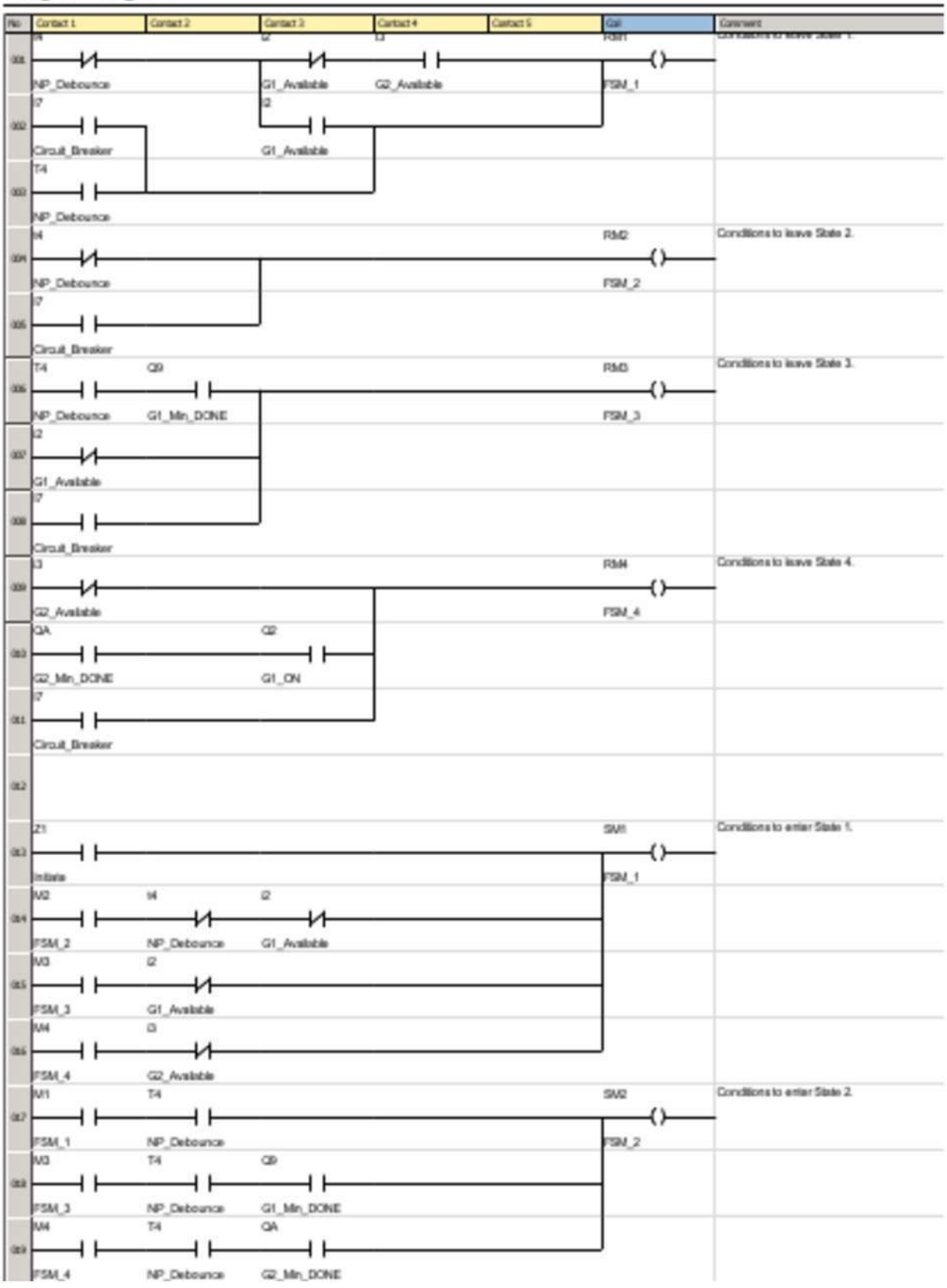
- **State 1: NOP: No Power**
- **State 2: NPS: National Power**
- **State 3: G1: Generator 1 Supply**
- **State 4: G2: Generator 2 Supply**



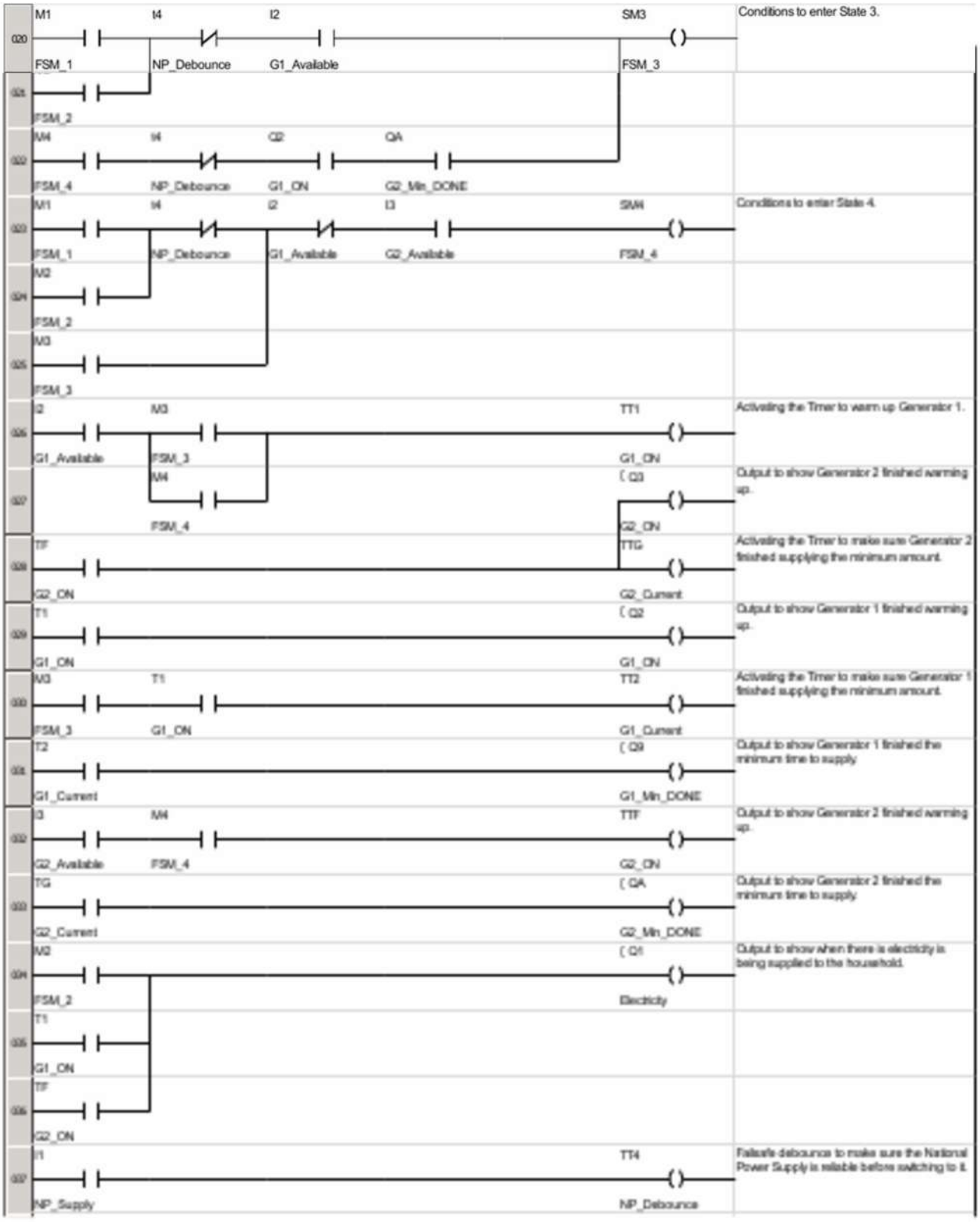
The System:

Below is the system design that fulfills the objective and focuses on all the scenarios listed.

Program diagram



Continuation:



Estimated Price Breakdown:

- Programmable Logic Controller (PLC): $250 - $350
- Sensors and Switches: $75 - $125
- Relay Modules: $50 - $75
- User Interface (HMI) or Display: $75 - $125
- Wiring and Connectors: $25 - $50
- Labor Costs (if applicable): $150 - $250

- Estimated Total Cost: $650 - $1,000

Additional Suggestions:

- **Remote Monitoring:** Implement a remote monitoring system that allows users to check the status of power sources and generators via a mobile app or web interface, providing real-time updates and alerts.

- **Load Management:** Incorporate load management features to prioritize essential circuits during power outages, ensuring that critical systems remain operational while non-essential loads are temporarily disconnected.

- **User Alerts:** Develop an alert system that notifies users via SMS or email about power source changes, generator status, or maintenance requirements, keeping them informed and proactive.

Conclusion:

The system is designed to be simple and efficient, with a straightforward sequence of states that minimizes complexity and reduces the risk of errors, making it easier to implement and maintain.