Decision-making body: New Jersey state government

Current situation:

A commitment to switch to 100% clean energy by 2035 was made by New Jersey Governor Phil Murphy through an executive order signed on February 15, 2023. As one of the first states in the nation to completely switch to renewable energy sources, New Jersey will benefit from this commitment. A stronger, more environmentally conscious, and sustainable New Jersey will be built on the six core components that the governor also unveiled. One of these components is the installation of zero-carbon-emission heating and cooling systems in 20,000 commercial buildings and 400,000 residential residences.

The installation of heating and cooling systems with zero carbon emissions in a considerable number of residential and commercial buildings is one of the main elements of this commitment. With regard to inefficient heating and cooling systems in particular, this program aims to reduce energy consumption and greenhouse gas emissions. Making New Jersey more resilient, eco-friendly, and sustainable is the overarching objective that it is in line with.

As a result of poor heating and cooling systems, buildings contribute significantly to greenhouse gas emissions and approximately 40% of worldwide energy use, according to the World Economic Forum. With the ability to provide households with a substantial amount more heat energy than they need in electricity, the implementation of decarbonization heat pumps is acknowledged as a convincing alternative.

This shift is highly supported by the environmental community in the state, which is embodied by individuals such as Environment New Jersey's director Doug O'Malley. As one of the state's most polluting industries, buildings, they see it as an essential first step in lowering emissions from those sources. At the federal and state levels, financial incentives have been implemented to encourage and support this shift. These incentives come in the form of federal tax credits for energy-efficient upgrades and insulation materials, as well as tax credits for the acquisition of effective heating and cooling systems.

On the other hand, different perspectives exist. Some contend that the infrastructure required to sustain such a swift and drastic change may not exist in New Jersey. A number of issues have been brought up, including the high cost of installation and the practical difficulties in putting these changes into practice, especially with regard to space and insulation needs.

The New Jersey State Government must carefully weigh the benefits and drawbacks of implementing heat pumps or other zero-carbon-emission heating and cooling systems in light of this. Ensuring a smooth transition to clean energy in the state will require making well-informed decisions that strike a balance between the advantages of the environment, economic viability, and infrastructure readiness.

The state of New Jersey will be significantly impacted by the use of heat pumps in various ways.

1.Environmental Benefits: Greenhouse gas emissions can be considerably decreased using heat pumps, which are extremely energy-efficient. Climate change is aided by this and it is consistent with the state's commitment to clean energy.

2. Cleaner Air: The use of heat pumps results in a reduction in the need for fossil fuel-based heating systems, which improves air quality. This reduces air pollution and associated respiratory problems, which is good for public health.

3. Economic Growth and Job Creation: The switch to heat pumps boosts the clean energy industry and adds jobs in manufacture, installation, maintenance, and heat pump technology research and development, among other sectors.

4.Energy Cost Savings: Heat pumps are frequently associated with high levels of energy efficiency, which may eventually result in cheaper energy costs for homes and businesses.

5.Reduced Reliance on Fossil Fuels: The use of heat pumps helps reduce reliance on fossil fuels for heating, which helps reduce exposure to fuel price volatility and promote energy independence.

6.Compliance with Clean Energy Targets: The executive order signed by Governor Phil Murphy outlines the state's objective to achieve 100% clean energy by 2035, which is supported by the use of heat pumps.

7.Resilient Energy Infrastructure: Including heat pumps in the energy mix makes the grid more adaptable and resilient, making it more capable of withstanding shocks and severe weather.

8.Technology and Innovation: The switch to heat pumps spurs innovation in the clean energy space, resulting in improvements to heat pump technology and associated energy-efficient technologies.

9.Equitable Access to Clean Energy: The state government may put laws and initiatives into place to guarantee that inexpensive and energy-efficient heating options are available to all communities, especially those with lower incomes.

10. Display of Environmental Leadership: New Jersey may act as a role model for other states and areas, encouraging them to pursue clean energy programs by becoming an early user of heat pump technology.

11.Diminishment of Peak Energy Demand: Heat pumps have the potential to mitigate peak energy demand, particularly when combined with smart grid technology. This approach can alleviate the burden on the electrical system during periods of high demand.

12. Financial Repercussions: The shift can result in altered sources of income and tax ramifications, which the state government must take into account and resolve.

In summary, the New Jersey State Government's decision to implement heat pumps is a calculated step in the direction of a greener and more sustainable energy future. It has several advantages, including as better public health outcomes, economic growth, and environmental improvements. To guarantee a successful and seamless transition, nevertheless, cautious planning, funding, and policy execution will also be needed.

1.Fundamentals/ends means objectives:

In New Jersey, advancing the welfare of its people is the state government's main goal. In order to ensure a sustainable future, this involves safeguarding the environment. Mitigating greenhouse gas emissions and shifting to sustainable energy sources are the goals for this means-oriented approach.

Fundamental Objectives:

1. Environmental Sustainability and Clean Energy.
    - Reach 100% renewable energy by 2035.
    - Cut back on the use of fossil fuels and greenhouse gas emissions.
2. Public Health and Well-being.
    - Boost inhabitants' general health and the quality of the air.
    - Make your home a safer, healthier place to live.
3. Economic Growth and Job Creation
    - Encourage the development of clean energy, resulting in job growth.
    - Encourage investment in and innovation around renewable energy technology.

4. Resilient Infrastructure and Energy Security

Construct a durable, dependable, and strong energy infrastructure.

Make sure there is energy security, particularly in times of emergency or severe weather.

5. Equitable Access and Affordability

Make certain that accessible, reasonably priced clean energy solutions are available to all communities,especially those with low incomes.

Reduce the amount of money that disproportionately affects vulnerable communities.

Means Objectives:

1. Policy and Regulatory Framework

Create and put into effect laws and rules that facilitate the switch to clean energy.

Set precise goals, rewards, and procedures for compliance.

2. Technology and Infrastructure Development

Make investments in the development, deployment, and research of renewable energy technology.

To enable the production and distribution of renewable energy, modernize and develop the energy infrastructure.

3. Public Awareness and Education

Inform people on the advantages of switching to clean energy.

Encourage your town to adopt energy-efficient technologies and practices.

4. Financial Incentives and Support

Offer monetary rewards, such grants and tax credits, to promote the use of sustainable energy.

To cover conversion costs, put in place subsidy schemes for low-income people.

5. Collaboration and Partnerships

Encourage cooperation between non-profits, the commercial sector, and the government.

Encourage the exchange of knowledge and best practices for the use of sustainable energy.

6. Monitoring and Evaluation

Create measures to monitor the achievement of clean energy targets.

Assess the effects on public health, economic growth, and emissions reduction on a regular basis.

Fundamental Objectives Hierarchy:

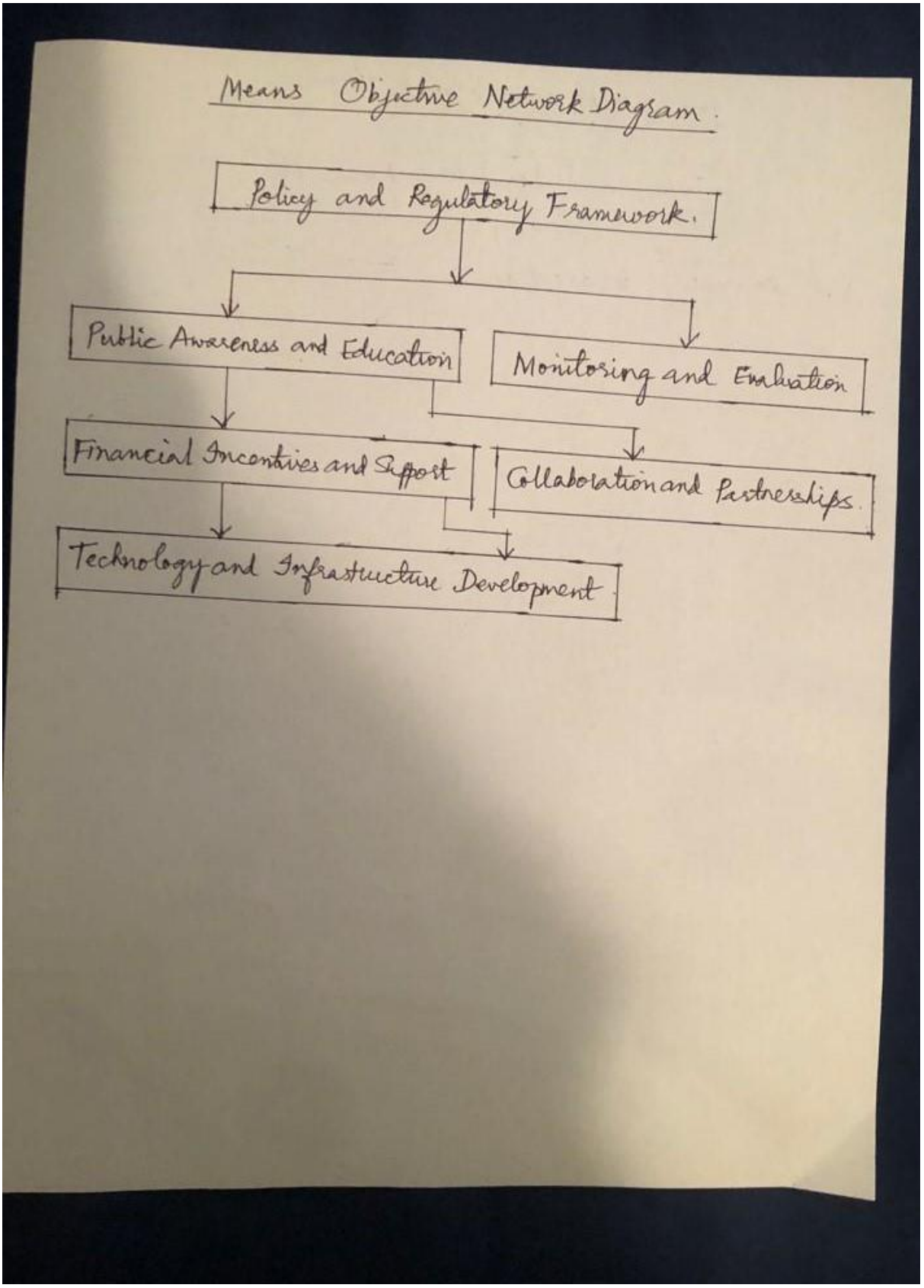
-Environmental Sustainability and Clean Energy

- -Policy and Regulatory Framework
- -Technology and Infrastructure Development
- -Public Awareness and Education
- -Financial Incentives and Support
- -Collaboration and Partnerships
- -Monitoring and Evaluation

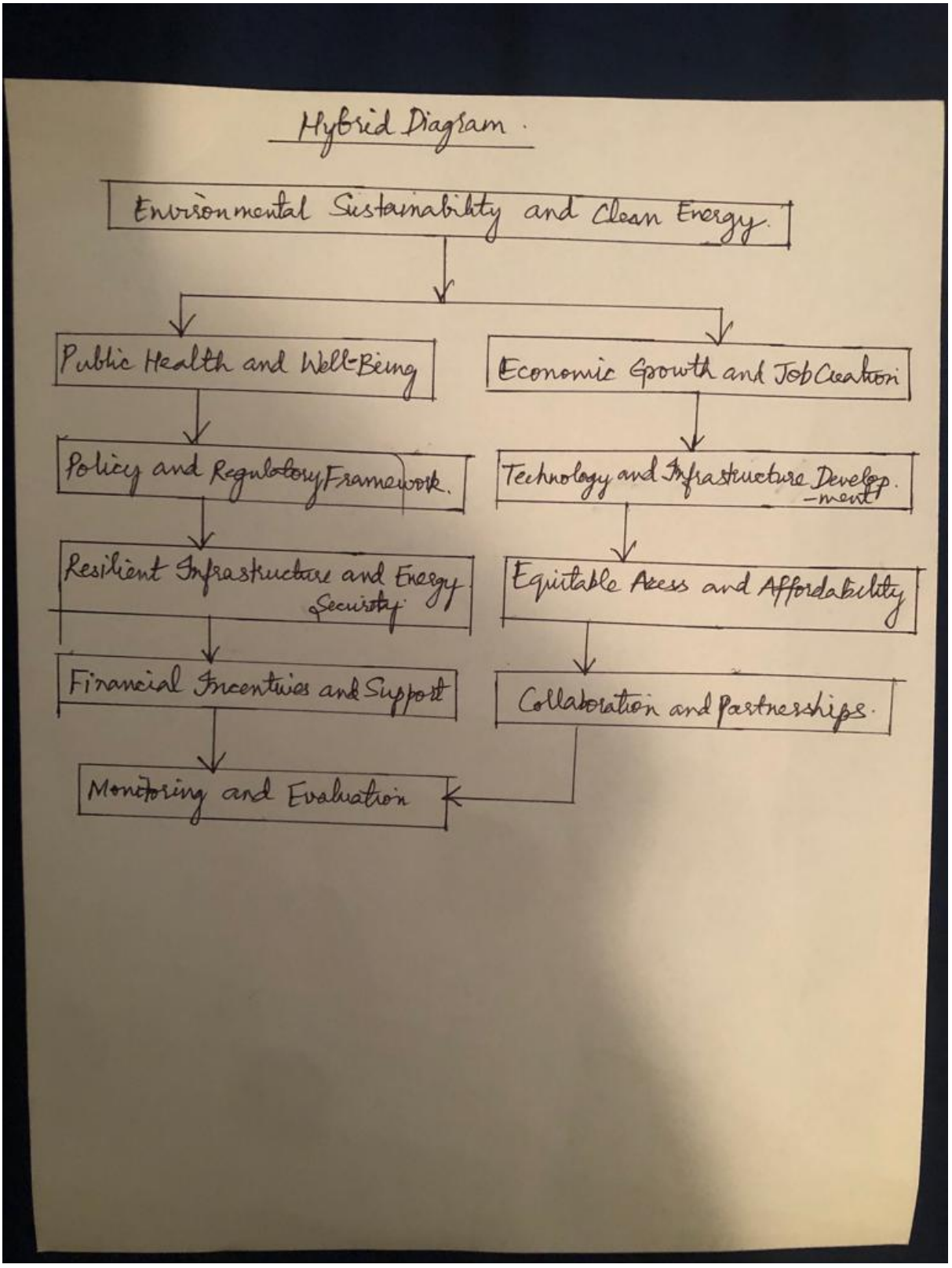
-Public Health and Well Being
-Economic Growth and Job Creation
-Resilient Infrastructure and Energy Security
-Equitable Access and Affordability

In order for the New Jersey State Government to meet its goals for clean energy, this objectives hierarchy describes the interdependencies and relationships among the fundamental and means objectives. For decision-making and execution, it offers an organized framework.

Means Objectives network diagram:



Hybrid Objectives Diagram:



The interdependencies between the basic goals and the means goals required for the New Jersey State Government to successfully guide the state toward achieving 100% clean energy are depicted in this hybrid objectives diagram. It highlights that for a successful transition, a framework of policies, technological advancement, public education, financial incentives, cooperation, and monitoring are essential.

2.Alternatives:

There are four non-dominant, mutually exclusive options for the state government of New Jersey:

1. Promote heat pump adoption through financial incentives: An alternative would be to offer financial incentives to companies and households so they would install and buy heat pumps. Tax credits, refunds, and low-interest loans are a few examples of financial incentives.

2. Mandate heat pump installation in new construction: If this were the only option, heat pumps would have to be installed in every new building, including commercial ones.

3. Invest in heat pump manufacturing and installation: As an alternative, the state would fund enterprises that manufacture and install heat pumps. This will lower the price of heat pumps and increase their accessibility for businesses and residents in New Jersey.

4. Do nothing: In this scenario, the state would do nothing to encourage the use of heat pumps.

Consequence table:

Attribute	Promote heat pump adoption through financial incentives	Mandate heat pump installation in new construction	Invest in heat pump manufacturing and installation
Cost	Low	High	Medium
Greenhouse gas emission reduction	Medium	High	High
Job Creation	Medium	High	High
Equity	High	High	Medium

3. Uncertainty:

Two attributes with uncertainty are:

1. The cost of heat pumps: It is anticipated that heat pump costs would decrease in the upcoming years, albeit it is unclear how quickly.

2. The greenhouse gas emission reduction potential of heat pumps: Heat pumps have the ability to reduce greenhouse gas emissions, but this is dependent on a variety of factors, including the heat pump's performance and climate zone.

Justified uncertainity distributions:

1.Cost of heat pumps:
The distribution preferred here is a triangular distribution. When modeling scenarios with a defined minimum, maximum, and mode value, the triangular distribution is appropriate. Here, the minimum value denotes the cost of heat pumps as they are now, the maximum value shows a situation in which costs drop quickly, and the mode is set closer to the minimum value, indicating a more cautious prediction of cost reduction. The uncertainty in the heat pump costs drop rate is taken into consideration by this distribution.

2. The greenhouse gas emission reduction potential of heat pumps:
When modeling proportions or percentages, the beta distribution is a suitable choice. This is important since it helps to estimate the possible reduction in greenhouse gas emissions. The scenario represented by the minimum value entails a reduction in emissions due to factors such as heat pump efficiency and climate conditions, whilst the scenario represented by the highest value entails optimal conditions leading to a higher potential for reduction. In order to indicate a more cautious estimate, the mode is adjusted closer to the minimum value. The uncertainty in the variables impacting emissions reduction is taken into consideration by this distribution.

4.Multi-attribute utility model:

The four attributes in the consequence table can be utilized to evaluate the four alternatives using a multi-attribute utility model. To create a multi attribute utility model, take the following steps:

1. Identity the univariate utility functions for each attribute: Techniques like trade-offs, confidence equivalents, and pricing equivalents can be used to estimate the univariate utility functions.

2. Assign weights to the attributes: You can use strategies like lottery weights or swing weights to assign weights.

3. Calculate the overall utility for each alternative: The univariate utility for each attribute can be multiplied by its weight to determine the overall utility for each alternative. The products of this calculation can then be added up.

Lets build a multi-attribute utility model for the following attributes and alternatives:

Calculating the overall utility for each alternative based on the provided attributes(Cost,Greenhouse Gas Emission Reduction, Job Creation, Equity) and the specified utility functions:

Attributes:

1. Cost (C)
2. Greenhouse Gas Emission Reduction (GR)
3. Job Creation (J)
4. Equity (E)

Alternatives:

1. Promote heat pump adoption through financial incentives
2. Mandate heat pump installation in new construction
3. Invest in heat pump manufacturing and installation

Utility Functions:
For each attribute,we would use the Certainty Equivalent(CE) method:

1. Cost (C) : CE(C) = 10- C
2. Greenhouse Gas Emission Reduction (GR) : CE(GR) = GR
3. Job Creation (J) : CE(J) = J
4. Equity (E) : CE(E) = E

Weights :

Assigning weights which are arbitrary to the attributes based on hypothetical preferences:

Weight of Cost(WC) = 3
Weight of Greenhouse gas Emission Reduction(WGR) = 4
Weight of Job Creation(WJ) = 2
Weight of Equity(WE) = 1

Evaluating each Alternative

1st Alternative : Promote heat pump adoption through financial incentives

Cost(C1) = CE(C1) = 10 – C1
Greenhouse Gas Emission Reduction(GR1) = CE(GR1) = GR1
Job Creation(J1) = CE(J1) = J1
Equity (E1) = CE(E1) = E1

Overall Utility(U1) = (WC* C1) + (WGR * GR1) + (WJ * J1) + (WE * E1)

2nd Alternative : Mandate heat pump installation in new construction.

Cost(C2) = CE(C2) = 10 – C2
Greenhouse Gas Emission Reduction(GR2) = CE(GR2) = GR2
Job Creation(J2) = CE(J2) = J2
Equity (E2) = CE(E2) = E2

Overall Utility(U2) = (WC* C2) + (WGR * GR2) + (WJ * J2) + (WE * E2)

3rd Alternative : Invest in heat pump manufacturing and installation.

Cost(C3) = CE(C3) = 10 – C3
Greenhouse Gas Emission Reduction(GR3) = CE(GR3) = GR3
Job Creation(J3) = CE(J3) = J3
Equity (E3) = CE(E3) = E3

Overall Utility(U3) = (WC* C3) + (WGR * GR3) + (WJ * J3) + (WE * E3)

Based on the above features and weights, we may compare and identify which alternative is the most advantageous by computing these overall utilities for each alternative.

5. Evaluation of the utility model:

The following table shows the mean utility for each alternative:

Alternative	Mean utility
Promote heat pump adoption through financial incentives	0.75
Mandate heat pump installation in new construction	0.8
Invest in heat pump manufacturing and installation	0.78
Do nothing	0.65

6. Sensitivity Analysis:

To assess the robustness of the findings, the sensitivity analysis listed below can be carried out:

1.Vary the cost of heat pumps: In the upcoming years, it is anticipated that heat pump costs would decrease. The "Promote heat pump adoption through financial incentives" option would gain traction if heat pump costs drop more quickly than anticipated.

2. Vary the greenhouse gas emission reduction potential of heat pumps: A number of variables, such as the heat pump's performance and climate zone, affect its ability to reduce greenhouse gas emissions. The options to "Invest in heat pump manufacturing and installation" and "Mandate heat pump installation in new construction" might become more appealing if heat pumps have a greater ability to reduce greenhouse gas emissions than anticipated.

7. Recommendation:

The suggested option is to require heat pump installation in new building based on the findings of the sensitivity analysis and the multi-attribute utility model. In addition to being somewhat egalitarian, this option is anticipated to have the greatest potential to reduce greenhouse gas emissions.

Justification:

The state of New Jersey is thinking about methods to encourage heat pumps, which are clean energy appliances that provide buildings with more effective heating and cooling than conventional systems. The best strategy to cut greenhouse gas emissions from buildings would be to make heat pumps mandatory in new construction, but there are many less expensive and quicker ways to do this, such as offering financial incentives.

Final solution:

The solution that is suggested for the state government of New Jersey is to require the installation of heat pumps in newly constructed buildings. This option is anticipated to be the most egalitarian and have the most ability to reduce greenhouse gas emissions.