**Mathematical Write-up**

**Problem Description**:

The problem involves combinatorics and linear programming to minimize costs while achieving a target reduction in emissions **(Φ**). There are R assets, each with E energy levels, contributing to **Φ** emissions. The goal is to find the optimal combination of solutions **(Vs)** with associated costs **(P)** to meet a target emission reduction set by the owner.

**Background Information:**

In the context of resource optimization and emissions reduction, the problem aims to find an optimal combination of assets and energy levels to meet environmental targets. The motivation lies in achieving cost-effectiveness and sustainability in resource allocation.

Formulation of the Problem:

The problem is mathematically formulated as a combinatorics and linear programming challenge. Key parameters:

R (Number of Assets): Represents the assets available for resource allocation.

E (Energy Levels): Signifies the energy levels associated with each asset.

Φ (Target Emissions): Defines the emissions target that needs to be achieved.

**Approach/Methodology**:

A dynamic programming approach is employed to efficiently calculate optimal solutions while adhering to specified constraints. The algorithm iteratively fills a dynamic programming table, considering the cost and optimal values for each state.

**Trade-offs:**

Trade-offs are considered, balancing the reduction in emissions with associated costs and available resources.

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| --- | --- | --- | --- | --- | --- | --- | --- |
| Assets/Target | 0 | 141.55 | 179.15 | 174.1 | 188.65 | 99.5 | Target phi |
| 1 | 0 | 50 |  |  |  |  |  |
| 2 |  |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |  |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| 5 |  |  |  |  |  |  |  |

The problem at hand involves optimizing a system with the following key elements:

**Objectives:**

Minimize emissions (Φ) while meeting a target reduction factor (k).

Optimize the selection of V solutions to achieve the target reduction.

**Constraints:**

Limited by the number of assets (R).

Constrained by energy levels (E).

Associated costs (PV) for each solution (V).

Variables and Parameters:

k - Target reduction factor.

Φ

Φ - Emission levels to be minimized.

R - Assets involved.

budget $2,000.00 Total combination (|V(j,r)|) 17,100,720 Target =391.5 Total cost $1,002

k 50%

R =5

E =4   
V = 6  
**Input Data**:

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **R** | **E\_1** | | **E\_2** | | **E\_3** | | **E\_4** | |
| 1 | 48 | | 20 | | 93 | | 43 | |
| 2 | 66 | | 70 | | 78 | | 53 | |
| 3 | 98 | | 96 | | 53 | | 40 | |
| 4 | 89 | | 51 | | 67 | | 93 | |
| 5 | 83 | | 35 | | 36 | | 30 | |
| **Φ** | **δΦ\_V1** | | **δΦ\_V2** | | | **δΦ\_V3** | | | **δΦ\_V4** | | **δΦ\_V5** | **δΦ\_V6** | | **Max-potential** | |
| 141.55 | 50 | | 7 | | | 23 | | | 49 | | 9 | 46 | | 1.30 | |
| 179.15 | 17 | | 22 | | | 36 | | | 42 | | 45 | 18 | | 1.00 | |
| 174.1 | 39 | | 37 | | | 25 | | | 9 | | 50 | 16 | | 1.01 | |
| 188.65 | 35 | | 33 | | | 27 | | | 13 | | 42 | 31 | | 0.96 | |
| 99.5 | 9 | | 3 | | | 38 | | | 11 | | 50 | 35 | | 1.47 | |
| **PV1** | **PV2** | | **PV3** | | **PV4** | | **PV5** | **PV6** | |
| $ 29 | $ 41 | | $ 53 | | $ 18 | | $ 49 | $ 12 | |
| $ 52 | $ 16 | | $ 14 | | $ 35 | | $ 39 | $ 26 | |
| $ 26 | $ 20 | | $ 20 | | $ 22 | | $ 54 | $ 49 | |
| $ 39 | $ 41 | | $ 51 | | $ 20 | | $ 42 | $ 14 | |
| $ 41 | $ 45 | | $ 37 | | $ 52 | | $ 32 | $ 13 | |
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**Results:**

Computed |V (j, r) |: The algorithm yields 106 distinct ways for the owner to achieve the target reduction using different Vs combinations

Optimal array for V: [2, 6, 2, 6]

**Conclusion:**

This mathematical approach, blending combinatorics and linear programming, effectively navigates the solution space. The dynamic programming algorithm ensures a systematic exploration of potential combinations, ultimately revealing the most cost-effective pathway to attain the desired reduction in emissions