For office use only	Team Control Number	For office use only
T1 ________________	**76735**	F1 ________________
T2 ________________		F2 ________________
T3 ________________	Problem Chosen	F3 ________________
T4 ________________	**A**	F4 ________________

2018
MCM/ICM2
DRNB

Our Title

Summary

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Keywords: keyword1; keyword2

Contents

1 Introduction

1.1 Other Assumptions

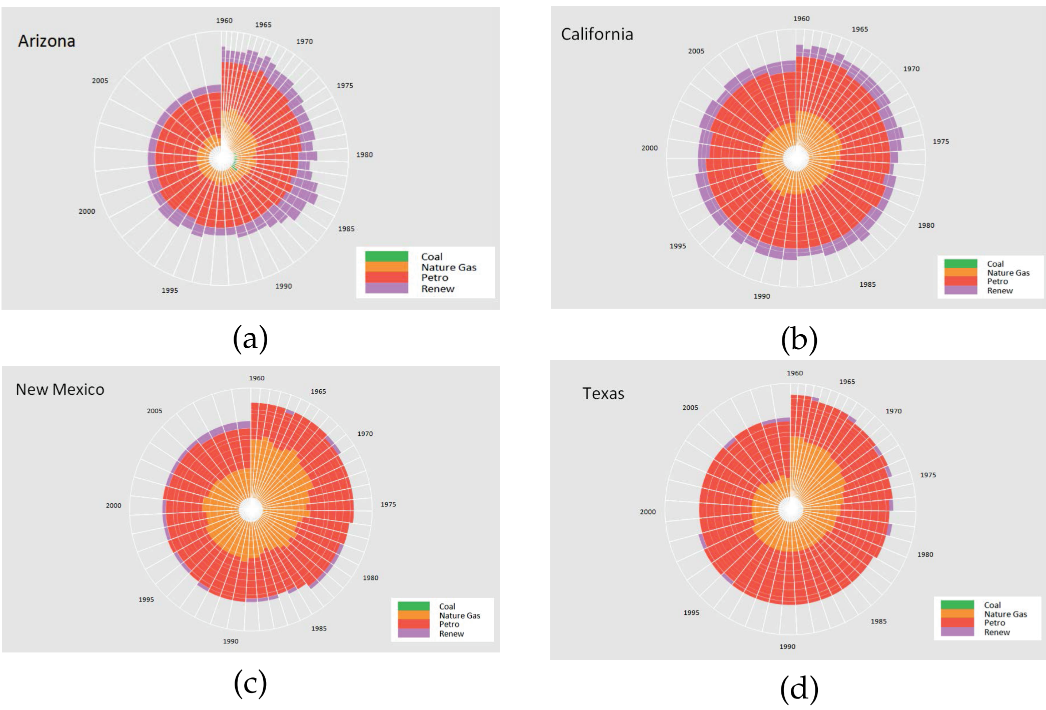
2 Analysis of the Problem

3 Calculating and Simplifying the Model

3.1 Part I

A

Firstly, we want to study the energy configuration of each state. We divide energy sources into primary energy including oil, natural gas, coal, renewable energy, nuclear energy and secondary energy.



(a) (b)

(c) (d)

Figure 1: Primary Energy Sources.

We can observe the primary energy allocation of each state from the image

- Similarity:
  1. Coal consumption is very low in the proportion of total energy consumption

2. Petroleum products consumption accounts for the highest percentage of total energy consumption
3. Natural gas consumption decreases as the year increases

- Divergence:
  1. California has the highest energy consumption
  2. The use of renewable energy of Arizona and California is higher than the other two states
  3. In New Mexico and Texas, the consumption of natural gas is similar to that of petroleum products

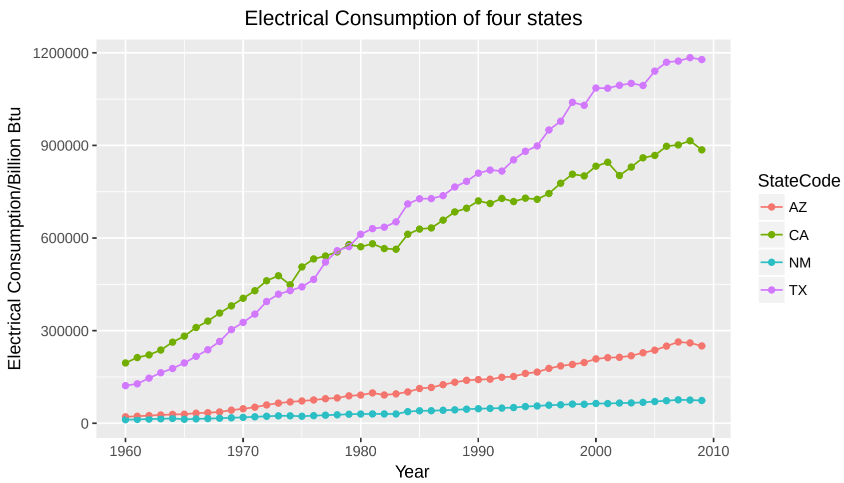


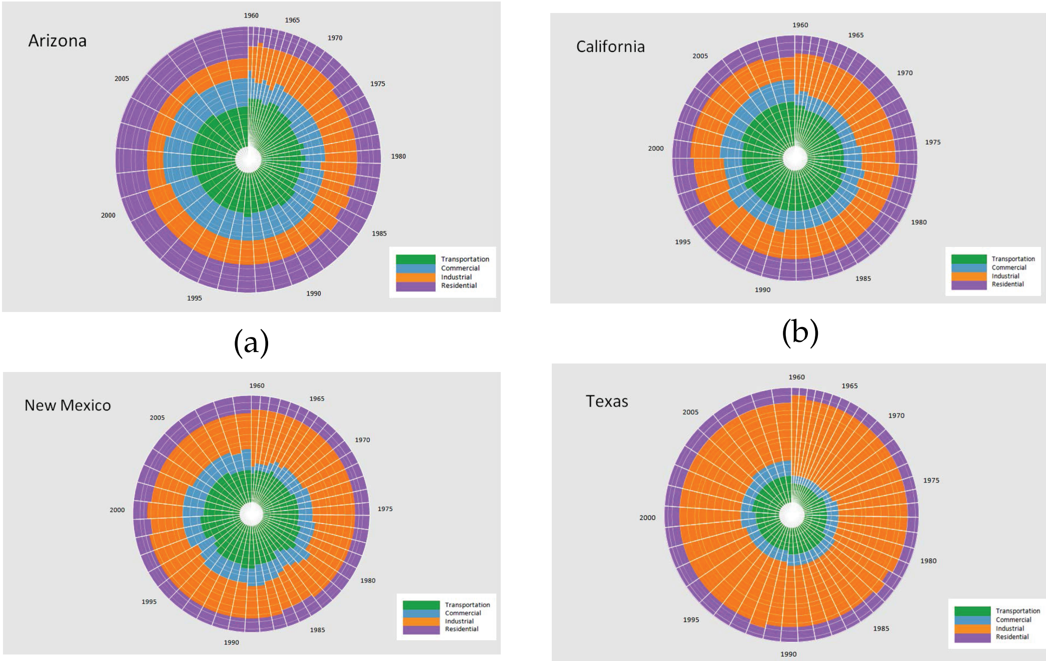
Figure 2: Electricity Total End-Use Consumption.

Secondly, we can observe that the electricity consumption of Texas and California far exceeds that of Arizona and New Mexico. Among them, New Mexico has been in a steady low-state during 1960-2009, while its energy consumption in Arizona increased but not significantly from 1960-2009 , California and Texas have been growing and larger.

Thirdly, we study the whereabouts of energy consumption of each state. Divided by end-use sectors, there are residential sector, commercial sector, industrial sector and transportation.

We can observe that the energy uses and trends of each state are different. In general, the consumption of industrial sector of the four states has decreased while the other three sectors have increased. In particular:

- Arizona has a more evenly distributed energy use across all four sectors
- California consume more energy in industrial sector and transportation



(a) (b) (c) (d)

Figure 3: Energy Consumption by End-Use Sector.

- New Mexico and Texas, the energy consumption of Industrial sector occupies the most part, of which the Texas is more prominent

Lastly, we want to describe the total energy consumption of each state.

We can observe from Figure 4 that the expenditures of energy of four states all show an increasing trend with the increase of the years. And we also observe from Figure 5 that the energy production and the energy consumption of each state are different.

- Energy consumption is out of energy production in Arizona and California, with the California exceeding a greater proportion
- The energy production exceeds energy consumption, and beyond in New Mexico
- The energy consumption in Texas shows an upward trend with time, energy production showed a downward trend. And since the 20th century the two have been flat

In terms of the energy consumption in these four states, coal, petroleum products and natural gas are the majority, while renewable energy accounts for a small proportion. These lead to some urgently problems such as high energy consumption per unit of output, low energy efficiency and environmental pollution. In order for a better energy prospect, the development of renewable energy

Figure 4: Total Energy Expenditures.

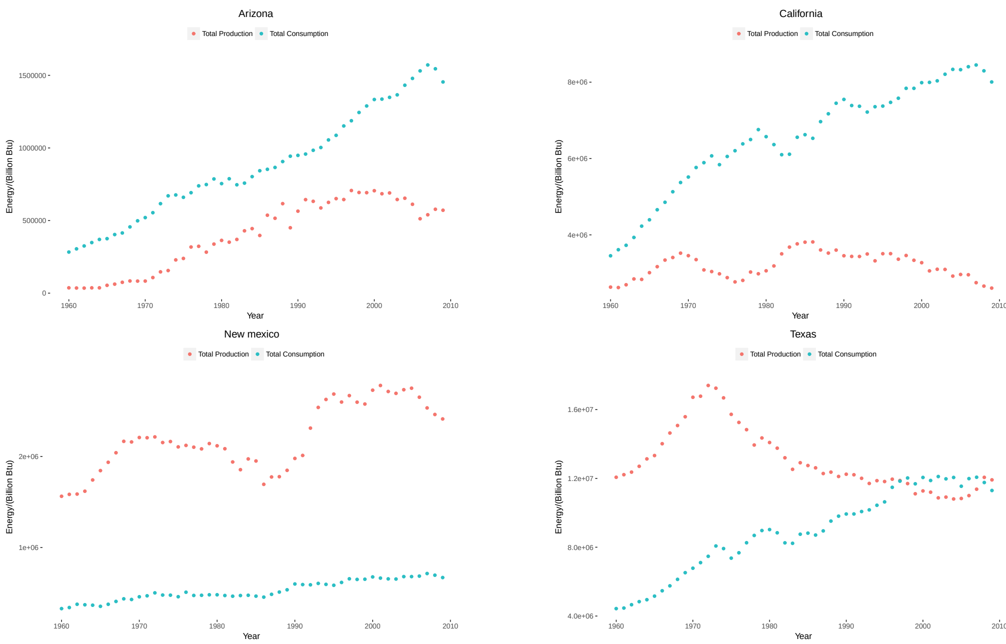


Figure 5: Total Energy Consumption&Production.

is particularly important. Currently, the renewable energy includes solar energy, biomass, geothermal energy, hydropower, wind energy and so on. Although the prospects for renewable energy are promising, there are still too few of them for the time being.

California High energy consumption, high energy expenditure, high proportion of oil consumption, average usage of energy, better prospects for renewable energy, high consumption of electricity

Arizona Low energy consumption, low energy expenditure, high proportion of oil consumption, average usage of energy, great prospects for renewable energy, low consumption of electricity

New Mexico Low energy consumption, low energy expenditure, a similar proportion of oil and natural gas consumption, mainly usage of energy for industry, poor prospects for renewable energy, low consumption of electricity

Texas High energy consumption, high energy expenditure, a similar proportion of oil and natural gas consumption, poor prospects for renewable energy, high consumption of electricity

B

In order to describe the energy profile of each state, especially the usage of cleaner, renewable energy sources, we take 3 variables, TETCB, NUETB and RETCB, we interested in from all 605 variables as the reference. We add up the data of NUETB and RETCB, coded as CRTCB. We define TETCB as Y1 and CRTCB as Y2.

Definition 1. *CRTCB = NUETB + RETCB*

- $Y1 = TETCB$ Total energy consumption
- $Y2 = CRTCB$ Clean and renewable energy total comsumption

In order to study Y1 and Y2, we listed 16 variables below that we thought might be relevant according to the energy profile of each state in Part 1 A

Table 3.1.1: X

MSN	Description
NNACB	Natural gas consumed by the transportation sector.
NNCCB	Natural gas consumed by the commercial sector.
NNICB	Natural gas consumed by the industrial sector.
NNRCB	Natural gas consumed by the residential sector.
PAACB	All petroleum products consumed by the transportation sector.
PACCB	All petroleum products consumed by the commercial sector.
PAICB	All petroleum products consumed by the industrial sector.
PARCB	All petroleum products consumed by the residential sector.
NGACV	Natural gas expenditures in the transportation sector.
NGCCV	Natural gas expenditures in the commercial sector.
NGICV	Natural gas expenditures in the industrial sector.
NGRCV	Natural gas expenditures in the residential sector.
PAACV	All petroleum products total expenditures in the transportation sector.
PACCV	All petroleum products total expenditures in the commercial sector.
PAICV	All petroleum products total expenditures in the industrial sector.
PARCV	All petroleum products total expenditures in the residential sector.

We plot X, Y1, Y2 against time respectively, discovering that most of them have general linear relationship. Consequently, we decide to apply the general linear regression model. In order to pick out the variables that are significant correlated with Y1 and Y2 respectively among 16 variables, we used a statistical method named step forward-backward. The result are shown below.

Table 3.1.2: Arizona

variable	*Function*	R^2
Y∼X	Y1 = 2.672e + 00 PAACB + 7.598e + 02 PARCV + 8.822e + 04	0.99
Y∼X	Y2 = 1.843e + 00 PAACB - 2.816e + 01 PAACV - 2.504e + 05	0.79
X∼Year	PAACB = 9.005e + 03 Year - 1.758e + 07	0.94
X∼Year	PARCV = - 3.581e+02 Year + 9.056e-02 Year^2 - 4412.7658	0.77
X∼Year	PAACV = - 3.640e+04 Year + 9.205 Year^2 + 3.599e+07	0.87

Table 3.1.3: California

variable	*Function*	R^2
Y∼X	Y1 = 1.900e+00 PAACB + 2.177e+06	0.96
Y∼X	Y2=1.601 JKTCB+ 2.036e+05	0.8923
X∼Year	PAACB = 37550 Year - 72108586	0.95
X∼Year	JKTCB=1.178e04 Year - 2.301e+07	0.9347

Table 3.1.4: New Mexico

variable	*Function*	R^2
Y∼X	Y1 = 3.452e+00 PAACB + 2.800e+06	0.92
Y∼X	Y2 = 3.243e-01 PAACB + 4.402e+00 PAACV - 4.440e+05	0.83
X∼Year	PAACB = 2191.3 Year - 4203950.9	0.87
X∼Year	PAACV = - 1.265e+04 Year + 3.201 Year^2 +1.250e+07	0.83

Table 3.1.5: Texas

variable	*Function*	R^2
Y∼X	Y1 = - 688.2 NGRCV + 2.280 PAACB + 1.748 PAICB + 1.926e+06	0.97
Y∼X	Y2 = 310.73 NGRCV - 79626.11	0.70
X∼Year	NGRCV = 49.839 Year - 97939.195	0.87
X∼Year	PAACB = 39914 Year - 77366230	0.96
X∼Year	PAICB = 46513 Year - 90187886	0.89

We find that in California all 16 variables are not significant correlated with Y2, so we take SIS method to solve it.

- We use BCor-SIS, a generic non-parametric sure independence screening procedure based on ball correlation, is able to pick out explanatory variables related to response. The linear, non-linear or linear interaction effect relationship can be captured by BCor-SIS even though data is heavy tail or existing outliers. More importantly, BCor-SIS is able to retain all of the important features in the model with probability tending to 1 under mild conditions. Ball correlation is defined as follow in reference

  The detail procedure has been programmed in the R package Ball, so we utilize the core function **bcorsis** to find out several X which are correlated to CA's Y2. Then we use the stepwise procedure to narrow down the range of X. Finally we establish a simple linear regression model indicating the relationship between Y2 of CA and JKTCB.

In order to characterize how the energy profile of each of the four states has evolved from 1960 2009, we regress time and the X we selected.

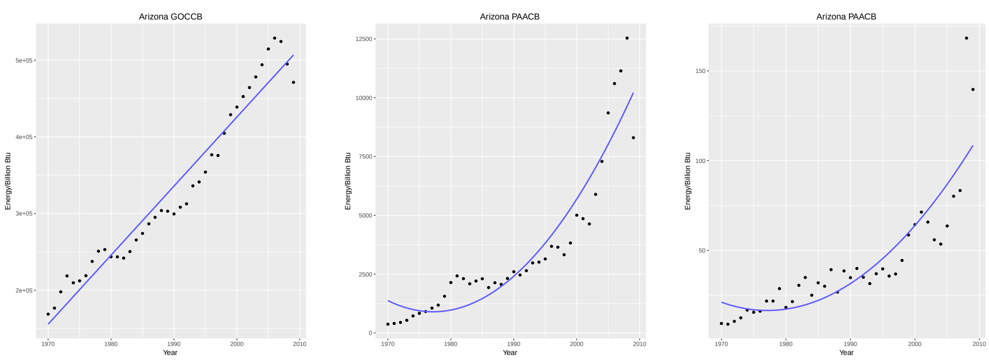


Figure 6: Arizona

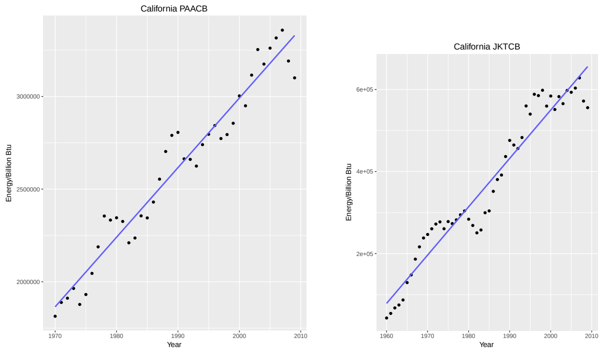


Figure 7: California

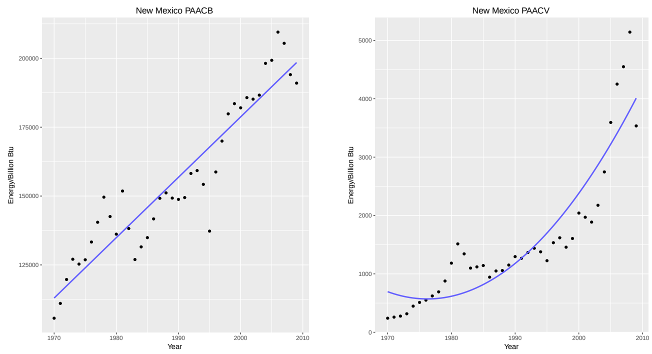


Figure 8: New Mexico

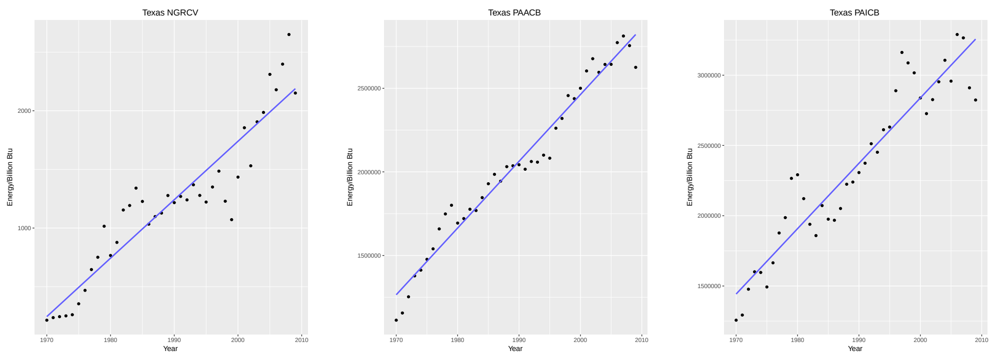


Figure 9: Texas

From Figure 6-9, we can see how the energy profile of the four states has evolved from 1960-2009.

In order to clarify the usage of cleaner, renewable energy sources, we use the model we developed above, choosing Y2 to observe.

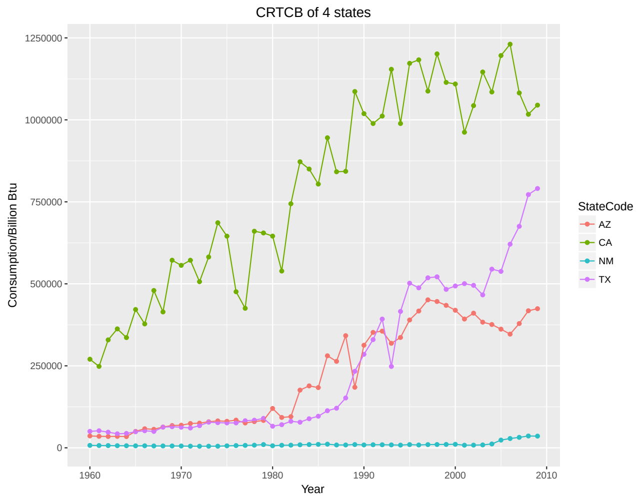


Figure 10: CRTCB of Four States

As theses images shown, California triumphs and has much larger CRTCB than other states. Taxes and Arizona are in the middle, while New Mexico is left behind. There clearly distribute as three groups. In order to evaluate the similarities and differences, we introduce several X and other possible influential factors.

Table 3.1.6: Arizona

MSN	Description
PAACB	All petroleum products consumed by the transportation sector.
PAACV	All petroleum products total expenditures in the transportation sector..

Table 3.1.7: California

MSN	Description
JKTCB	Kerosene-type jet fuel total consumption.

Table 3.1.8: New Mexico

MSN	Description
PAACB	All petroleum products consumed by the transportation sector.
PAACV	All petroleum products total expenditures in the transportation sector.

Table 3.1.9: Texas

MSN	Description
NGRCV	Natural gas expenditures in the residential sector).

From the chart, we notice that All petroleum products consumed by the transportation sector is highly correlated with CRTCB in both Arizona and New Mexico, while in Texas, Natural gas expenditures in the residential sector (including supplemental gaseous fuels) influence the CRTCB most. But in California, it's unusual that the Kerosene-type jet fuel total consumption is highly correlated to the CRTCB, which is not included in the primary 16 putative variables.

Table 3.1.10: Influential Factors Ranking

Factors	AZ	CA	NM	TX
Population	3	1	4	2
Precipitation	4	2	3	1
Industrial Consumption	3	1	4	2
CRTCB	3	1	4	2

For other possible influential factors, we notice that both the population and industrial development in California and Texas are greater than other states, and the precipitation of them is more than others too.

On the contrary, the population and industrial development in New Mexico and Arizona are a lot less than other states and the precipitation of them is less than others too. These may indicate that the precipitation is helpful for cleaner and renewable energy like hydroelectricity, and the industrial development and large number of people will help to improve the technique for efficiently utilizing cleaner and renewable energy.

C

To measure the use of clean, renewable energy of each state, we construct two parameters with several items in ProblemCData (TETCB, TPOPP, NUETB, RETCB) .We note that the nuclear energy is classified as a clean energy.

- NUETB Electricity produced from nuclear power.
- RETCB Renewable energy total consumption.
- CRTCB Clean and renewable energy total consumption.

$$\mathrm{P} = \frac{CRTCB}{TETCB - CRTCB} \tag{3.1.1}$$

$$Q = \frac{CRTCB}{TPOPP} \tag{3.1.2}$$

- P The coefficient of energy structure.
- Q Per capita renewable energy consumption.

Energy structure coefficient measures the ratio of clean, renewable energy and non-renewable energy, and then reflects the pros and cons of energy structure.

Per capita renewable energy consumption measures the per capita possession and use of clean and renewable energy of each state.

Extract the 2009 data in the table to calculate the two parameters

Table 3.1.11: Clean and Renewable Energy Profile of each state

Parameter	StateCode	Data	Unit
P	AZ	0.411821567	
P	CA	0.150124942	
P	NM	0.056166556	
P	TX	0.075256654	
Q	AZ	64.39565759	Billion Btu/Thousand
Q	CA	28.32804045	Billion Btu/Thousand
Q	NM	17.75276113	Billion Btu/Thousand
Q	TX	31.92083625	Billion Btu/Thousand

We can observe that the energy coefficient of Arizona is 0.411821567, which shows that clean renewable energy is an important component of the state's energy structure. It shows that the energy structure of Arizona is the best among the four states. At the same time, the per capita renewable energy consumption in Arizona is 64.39565759, which shows that the per capita renewable energy in Arizona is the largest of the four states. Combined, Arizona appears to have the best overview of using clean renewable energy.

D

Table 3.1.12: Arizona

item	2025	2050
P	0.1988755	0
Q	40.23352	0
Y1	1997790	2807026
Y2	331403.5	0
Population	8237.146	11290.476
PAACB	650952.2	876085.5
PARCV	224.0283	497.3537
PAACV	21942.52	49701.16

Table 3.1.13: California

item	2025	2050
P	0.1923257	0.2156428
Q	34.20705	35.40854
Y1	9643963	11427588
Y2	1555600	2027139
Population	45476.83	57250.74
PAACB	3930179	4868929
JKTCB	844500	1139000

Table 3.1.14: New Mexico

item	2025	2050
P	0.08057396	0.1680417
Q	24.19249	44.5802
Y1	792942.3	954717.7
Y2	59126.45	137351.6
Population	2443.953	3080.872
PAACB	233505.7	288289.1
PAACV	8187.221	17995.202

Table 3.1.15: Texas

item	2025	2050
P	0.0609829	0.07278817
Q	28.80626	32.62128
Y1	14754519	18204769
Y2	848056.4	1235185
Population	29440.25	37864.39
NGRCV	2985.782	4231.769
PAACB	3460351	4458210
PAICB	4000992	5163818

3.2 Part II

A

Based on our criteria for the usage of cleaner, renewable energy sources, we calculate the average growth rate of P and Q from 1960 to 2009. In this way, we can get the number of P and Q in 2025 and 2050 respectively. Compare the number with the predict one we get in Part1C

Our rule is: If the calculation number is lager, we set it as the goal for this new four-state energy compact, else we enlarge the predicted number to a reasonable value and state it as goal for this new four-state energy compact.

The results are shown in the form below.

Table 3.2.1: Average Growth Rate

	P	Q
AZ	0.021315071	0.017599788
CA	0.011696542	0.010447306
NM	0.018457856	0.017116619
TX	0.039182484	0.037680338

Table 3.2.2: Calculated & Predicted Value

	2025		2050	
	Calculated value		Calculated value	
	P	Q	P	Q
AZ	0.57711842	85.13119123	0.977818952	131.6782089
CA	0.180824429	33.45301437	0.241831986	43.37874788
NM	0.075260448	23.2915244	0.118889463	35.60136662
TX	0.139191909	57.68882105	0.363839159	145.4391596
	Predicted value		Predicted value	
AZ	0.1988755	40.23352	0	0
CA	0.1923257	34.20705	0.2156428	35.40854
NM	0.08057396	24.19249	0.1680417	44.5802
TX	0.0609829	28.80626	0.07278817	32.62128
	Goal		Goal	
AZ	0.57711842	85.13119123	0.977818952	131.6782089
CA	0.2	35	0.241831986	43.37874788
NM	0.09	25	0.17	45
TX	0.139191909	57.68882105	0.363839159	145.4391596

B

3.3 Part III

4 Evaluate of the Model

5 Conclusions

6 Strengths and weaknesses

6.1 Strengths

- **Applies widely**
  This system can be used for many types of airplanes, and it also solves the interference during the procedure of the boarding airplane,as described above we can get to the optimization boarding time.We also know that all the service is automate.

- **Improve the quality of the airport service**
  Balancing the cost of the cost and the benefit, it will bring in more convenient for airport and passengers.It also saves many human resources for the airline[1].

-

References

[1] D. E. KNUTH The TEXbook the American Mathematical Society and Addison-Wesley Publishing Company , 1984-1986.

[2] Lamport, Leslie, LATEX: " A Document Preparation System ", Addison-Wesley Publishing Company, 1986.

[3] http://www.latexstudio.net/

[4] http://www.chinatex.org/

Appendices

Appendix A First appendix

Aliquam lectus. Vivamus leo. Quisque ornare tellus ullamcorper nulla. Mauris porttitor pharetra tortor. Sed fringilla justo sed mauris. Mauris tellus. Sed non leo. Nullam elementum, magna in cursus sodales, augue est scelerisque sapien, venenatis congue nulla arcu et pede. Ut suscipit enim vel sapien. Donec congue. Maecenas urna mi, suscipit in, placerat ut, vestibulum ut, massa. Fusce ultrices nulla et nisl.

Here are simulation programmes we used in our model as follow.

Input matlab source:

```
function [t,seat,aisle]=OI6Sim(n,target,seated)
pab=rand(1,n);
for i=1:n
    if pab(i)<0.4
       aisleTime(i)=0;
    else
        aisleTime(i)=trirnd(3.2,7.1,38.7);
    end
end
```

Appendix B Second appendix

some more text **Input C++ source:**

```
//===========================================================================
// Name        : Sudoku.cpp
// Author      : wzlf11
// Version     : a.0
// Copyright   : Your copyright notice
// Description : Sudoku in C++.
//===========================================================================

#include <iostream>
#include <cstdlib>
#include <ctime>

using namespace std;

int table[9][9];

int main() {

    for(int i = 0; i < 9; i++){
```

```
        table[0][i] = i + 1;
    }

    srand((unsigned int)time(NULL));

    shuffle((int *)&table[0], 9);

    while(!put_line(1))
    {
        shuffle((int *)&table[0], 9);
    }

    for(int x = 0; x < 9; x++){
        for(int y = 0; y < 9; y++){
            cout << table[x][y] << " ";
        }

        cout << endl;
    }

    return 0;
}
```