Paper No: 4621

Resident Carbon Credit Incentive Decision-Making Method to Promote Valley Filling

Tianao Zheng
Nanjing University of Posts and Telecommunications
b20041418@njupt,edu.cn

CONTENT

Background

- The carbon market, as a crucial policy to combat climate change, can contribute to achieving peak carbon and carbon-neutral strategic goals.
- The carbon credit, as a carbon emission measurement unit used for carbon trading, can promote the carbon saving behavior of each user.
- Considering the large base of residents, its potential to reduce total carbon emissions cannot be ignored.


广东省发展和改革委员会

粤发改气候函〔2017〕2834号

广东省发展改革委关于印发省级碳普惠方法学（第一批）备案清单的通知


乐清市财政局
温州市生态环境局乐清分局
乐清市发展和改革局
乐清市经济和信息化局
文件

乐清市财政局 温州市生态环境局乐清分局 乐清市发展和改革局 乐清市经济和信息化局 关于印发《乐清市建设碳普惠机制实施方案（试行）》的通知

Method

An incentive decision-making method to promote valley filling is proposed for residential carbon credits. Firstly, a residential carbon credits-oriented incentive model is introduced for "peak load shaving" behavior. Then, residents are classified according to the carbon valley electricity consumption ratio to achieve targeted incentives. Lastly, the performance of the proposed method is verified by numerical examples.

Residential carbon credits-oriented incentive model → Classify residents to achieve targeted incentives → The performance of the proposed method is verified

Residential carbon credits-oriented incentive model			Classify residents to achieve targeted incentives	The performance of the proposed method is verified
Population	Electricity consumption	Incentive carbon credits	K-means clustering method	Numerical examples

Resident Carbon Credit-Oriented Incentive Model for Promoting Carbon Valley Response

The existing monthly carbon credits of residents involves such elements as carbon quotas, dynamic carbon emission factor, and electricity consumption of residents at different periods. In this paper, the incentive carbon credits is considered for "peak load shaving" behavior.

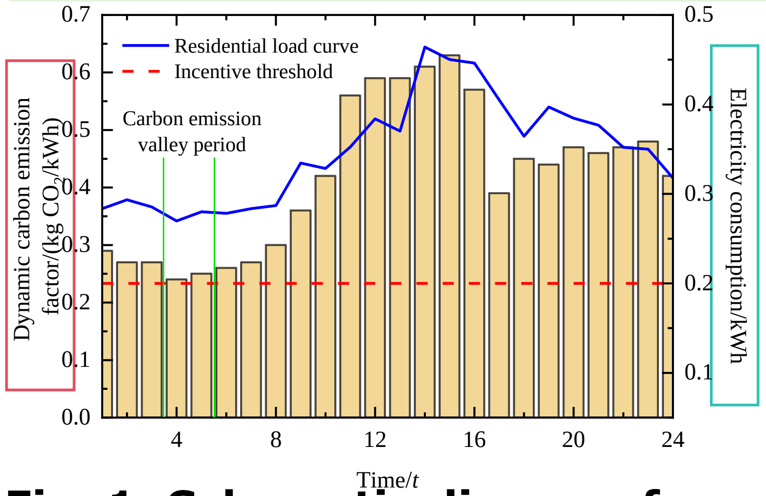

Fig. 1. Schematic diagram for carbon emission valley period

Monthly initial carbon quotas

$$\boxed{C_m^{\text{given}}} = \begin{cases} C_1^{\text{given}} \\ C_2^{\text{given}} \\ C_3^{\text{given}} \end{cases}$$

m=1,2,3 represent the population of the resident are four and below four, five and above, seven and above respectively.

Existing monthly carbon credits of residents

$$C_i = \boxed{C_i^{\text{given}}} - \sum_{d \in D} \sum_{t \in T} \boxed{\lambda_t} \boxed{p_{d,t,i}}$$

Monthly carbon credits of residents proposed

$$C_{m,i} = \boxed{C_{m,i}^{\text{given}}} - \sum_{d \in D} \sum_{t \in T} \boxed{\lambda_t} \boxed{p_{d,t,m,i}} + C_{m,i}^{\text{inc}}$$

Incentive carbon credits

Resident Carbon Credits Decision-making Model

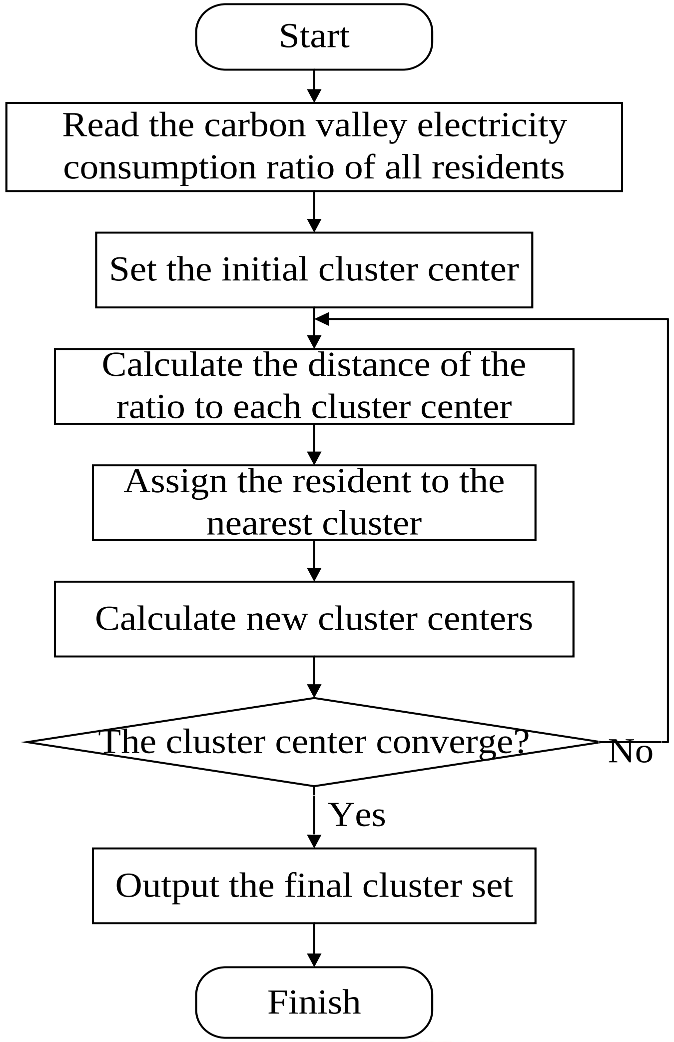

Fig. 2. Solution process based on K-means cluster

Based on the residential daily load curve, the carbon valley electricity consumption ratio is used to characterize the residential carbon valley electricity consumption characteristics. K-means clustering method is used to classify residents according to the ratio.

Distance between the resident and the cluster center

$$\begin{cases} dis(w_i, \mu_j) = \left| w_i - \mu_j \right| \\ \mu_j = \dfrac{\sum_{i \in S_j} w_i}{S_j} \end{cases}$$

Center value of cluster *j*

From the first cluster to the final, the cluster center decline.

Resident Carbon Credits Decision-making Model

Incentive coefficients $\alpha_1 > \alpha_2 > \cdots > \alpha_J$

$$C_{m,j,i}^{\text{inc}} = \sum_{d \in D} \sum_{t \in T^{\text{valley}}} \alpha_j \cdot (p_{d,t,m,j,i} - p_m^{\text{inc}})$$

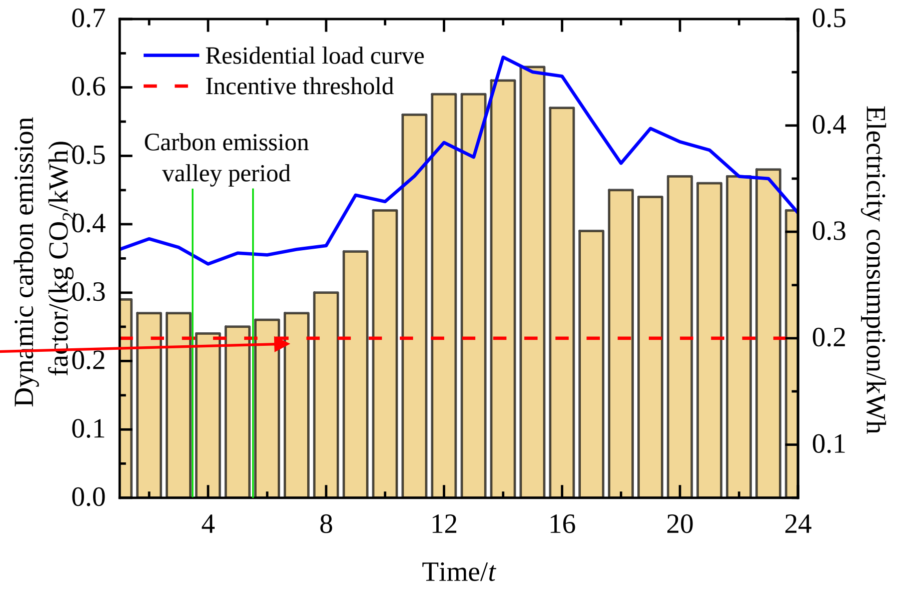

Fig. 1. Schematic diagram for carbon emission valley period

Model Construction

Optimization goal

Residents with a higher carbon valley electricity consumption ratio should get more incentive credits.

$$F = \max \sum_{m \in M} \sum_{i \in I} C_{m,j,i}^{\text{inc}}$$

Constraints

1) Average monthly carbon credits constraints

$$\sum_{i \in I} C_i / I \le C^{\max}$$

2) Proportion of residents with zero credit constraints

$$f(C_i \le 0) \le \eta$$

3) Difference of mean carbon credits between clusters

$$\overline{C_{m,j-1,i}} - \overline{C_{m,j,i}} > C^{\text{thr}}$$

Results

Data source: The simulation analysis is carried out with 2000 residents in August 2020. Residential electricity consumption is measured per hour.

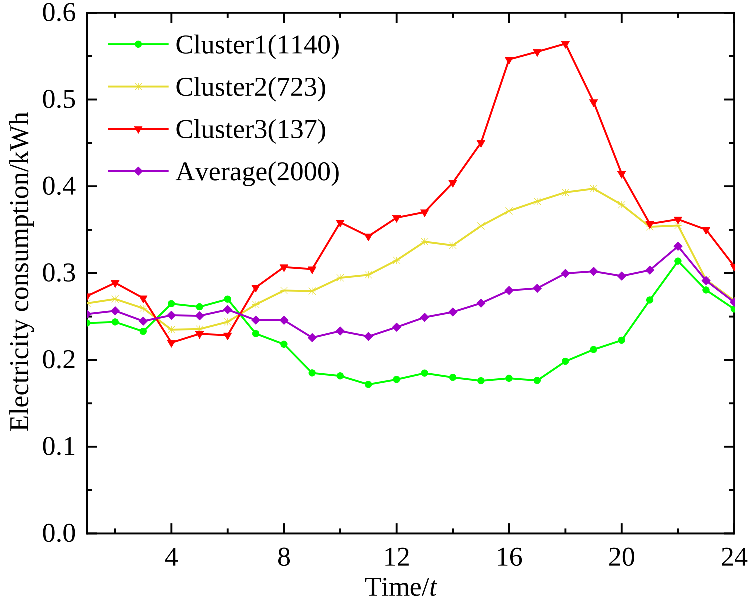

Fig. 3. Average electricity consumption curves

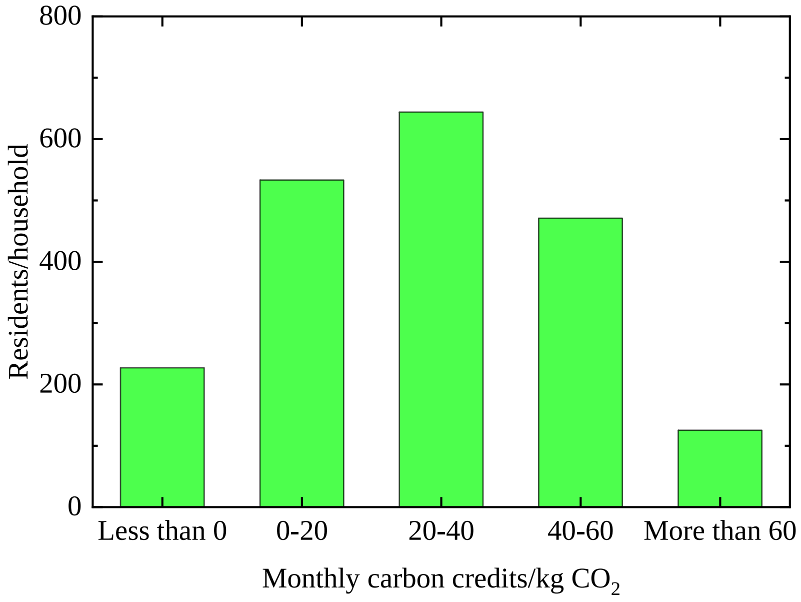

Fig. 4. Monthly carbon credits and number of residents

- Carbon valley electricity consumption ratio gradually increases
- Total electricity consumption and peak-valley difference increased

- Most of residents fall into the range between 0-20 kg CO_2 and 20-40 kg CO_2

Results

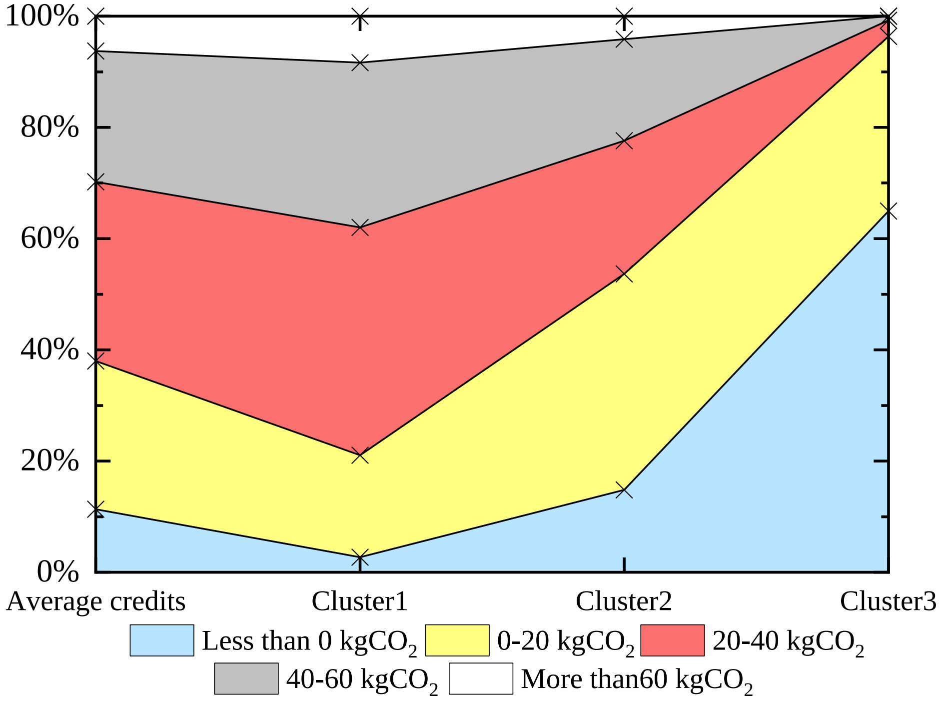

Fig. 5. The distribution of residents' carbon credits of 3 clusters

- Cluster 1 distributed with most carbon credits
- With the increase of clustering level, residents gather fewer carbon credits

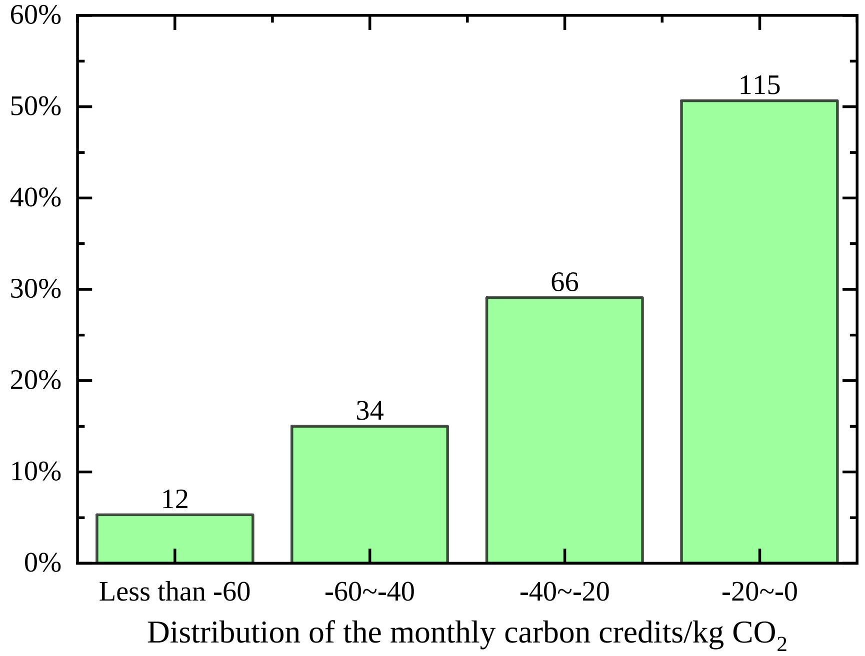

Fig. 6. Distribution and share of below-zero carbon credits

- Number of users with carbon credits between 0-20 kg CO_2 are the largest
- Residents in all clusters with below-zero carbon credits are in this interval

Conclusions

- Firstly, the monthly carbon quotas, basic carbon emission and incentive carbon credits are fully considered for **resident carbon credit-oriented incentive model**.
- Secondly, by using the clustering method, **different clusters of residents are set up** to set different incentive threshold and incentive coefficients.
- Moreover, through **case study**, it is found that the monthly carbon credits of residents are mostly in the interval of 0-40 kg CO_2. It can not only reduce government investment, but also increase the residents' satisfaction.
- Besides, more carbon credits can be obtained for residents with higher carbon valley electricity consumption ratio. Therefore, **effective targeted incentives** are met.
- Lastly, it is concluded that there is some **potential for further incentive**.

Paper No: 4621

Thank you!

Tianao Zheng
Nanjing University of Posts and Telecommunications
b20041418@njupt,edu.cn