



## Case Study

# How to practice low-carbon energy conservation and environmental protection in private universities –Take Xi'an Siyuan University as an example

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## Abstract

*Since 2001, Xi'an Siyuan University has always adhered to the original intention of environmental protection, emancipating the mind, free oneself from old ideas and daring to be the first in the practice of sewage treatment, recycled water reuse and distributed heating energy saving, consumption reduction and promote scientific and technological progress. Use "quota management, metering and charging" to promote water and electricity saving for college students. Use the way of inviting in and going out to create low-carbon and energy-saving exchange demonstration platform to give back and serve the society.*

**Keywords:** Low-carbon energy saving and environmental protection; Promote scientific and technological progress; Serving the community.

## Introduction

General Secretary Xi Jinping's golden sentence "green water and green mountains are golden mountains and silver mountains" proposed in 2005 to 2021 to reaffirm China's commitment to "carbon peaking and carbon neutrality" have revealed that low-carbon energy conservation and environmental protection are a Chinese must. Participated in extensive and profound economic and social systemic change<sup>1,2</sup>. It goes without saying that colleges and universities play an irreplaceable and important role in the construction, education, and development of in-depth reform. Since its establishment, Xi'an Siyuan University has been constantly practicing low-carbon energy conservation and environmental protection from the three aspects of promoting scientific and technological progress, cultivating talents, and serving the society, adhering to innovation, and achieving good results.

## Promote scientific and technological progress

Xi'an Siyuan University is a private university that is working hard in the direction of "scientific research and strong school", and still emancipates its mind and dares to be the first in promoting the progress of low-carbon energy-saving and environmental protection science and technology. Xi'an is a city with extremely short water resources, with a per capita share of 310 cubic meters of surface water resources, only 1/6 of the country's total. In 2000, when the school moved from the city to Bailuyuan, the board of directors of Xi'an Siyuan College stood at the height of protecting the environment and taking the road of sustainable development and used limited self-owned funds

to build a domestic sewage treatment station. Lay a dedicated rainwater collection pipe network of more than 300 meters, the rainwater within a range of about 20,000 square meters, as well as an 1800 cubic meter swimming pool, three 600 cubic meters of landscape fountains are regularly replaced by the remaining water, using the terrain drop and the pump all collected for secondary reuse. Over the years, we have continuously increased investment, invested 13 million yuan to complete the civil infrastructure of the MBR membrane bioreactor with a 4000 cubic meters daily processing capacity, installed 2000 cubic meters per day of treatment equipment and successfully put into operation in September 2011. The Figure-1 presents the installation of the hollow fiber membrane in MBR wastewater treatment plant in Xi'an Siyuan University.

In November 2019, the school invested another 5.8 million yuan to install and put into use the 2,000 cubic meters membrane treatment facility originally reserved for the sewage treatment plant. So far, the MBR membrane bioreactor remains the technology of choice for large-scale advanced sewage treatment to ensure that the concentration of nitrogen and phosphorus discharged in the reclaimed water meets the national standard. The flow diagram of MBR process is shown in Figure-2.

The school currently has 5 large and small reclaimed water reservoirs, including a 3,500 cubic meter artificial lake, with 12 pumps of various types and 25 kilometers of reclaimed water pipelines. The reclaimed water is transported back to the campus by lift pump pressurization, which is used to flush more than 1,000 toilets and water 480,000 square meters of green land in 32 buildings of 32 buildings, such as teaching buildings,

laboratory buildings, and student dormitories. At present, the first phase of the MBR membrane bioreactor has treated 6.7 million cubic meters of sewage, producing 4.4 million cubic meters of reclaimed water that meets the national standard and reused all of them. Recycled water reuse not only improves the efficiency of water use and saves valuable clean water resources, but also saves schools water and sewage fees<sup>3-6</sup>.

In addition to insisting on zero sewage discharge and all recycled water reuse for 20 years, Xi'an Siyuan University has once again promoted the scientific and technological progress of winter heating, energy conservation and environmental protection<sup>7,8</sup>. Emancipate the mind and dare to be the first. According to the high and west low terrain of the campus, Xi'an Siyuan University has built 4 centralized coal-fired boiler stations, 9 coal-fired boilers, a total tonnage of 42 steam tons, and a heating pipeline of 3800 meters, responsible for the

heating of the school's 270,000 square meters building and hot water for teachers and students to bathe. In 2015, when implementing the national "coal to gas" policy, the board of directors once again used limited self-owned funds to transform the coal-fired central heating into the gas central heating. Since the utilization rate of natural gas boilers is higher than that of coal boilers, gas central heating saves calorific value by 31.83% compared with coal-fired central heating. After two years, Xi'an Siyuan University has once eliminated traditional central heating and innovate independent heating - distributed heating system for each building according to the original intention of low-carbon energy conservation and environmental protection. After nearly 6 years of construction, the school has 33 gas boiler rooms, 5 heat exchange stations, 53 gas heating boilers, and each building of the school has achieved independent heating<sup>9,10</sup>.



Figure-1 : Installation of the hollow fiber membrane in MBR wastewater treatment plant.

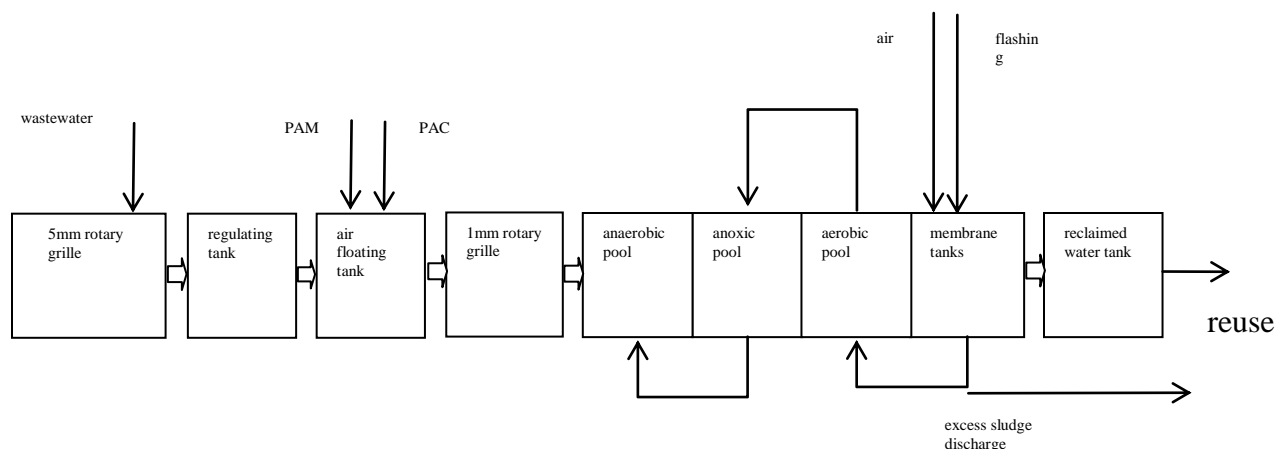


Figure-2: The flow diagram of MBR process.

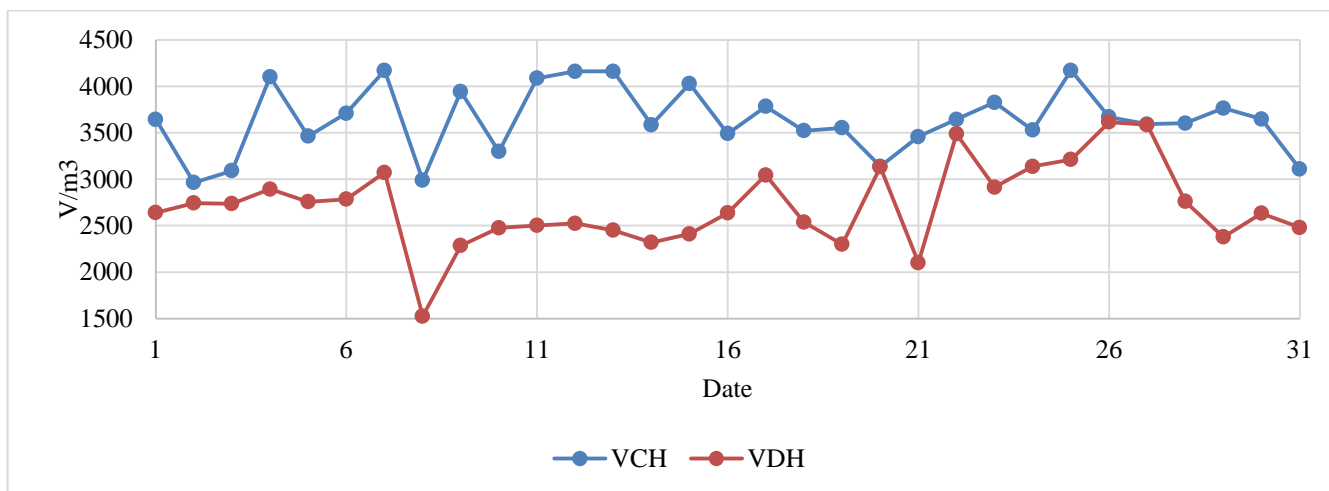
The heating season in Xi'an begins on November 15 and ends on March 15 of the following year. Throughout the heating season, the whole month of December is the month when the university is running at full capacity, so December is taken as the time unit for energy consumption comparison.  $V_{CH}$  is the volume ( $m^3$ ) of gas consuming for central heating in that day.  $V_{DH}$  is the volume ( $m^3$ ) of gas consuming for distributed heating in that day. Table-1 is the comparison between the two years

average of  $V_{CH}$  and  $V_{DH}$  for all buildings covered by the original 4<sup>#</sup> heating boilers station.

Due to the reduction of heat loss in the underground long-distance pipe network transmission, the reduction of hydraulic imbalance, and the new role of developers, distributed heating saves 23.48% of gas consumption compared with central heating. The comparison of Table-1 is depicted in Figure-3.

**Table-1:** The comparison between the two years average of  $V_{CH}$  and  $V_{DH}$ .

| Date | $V_{CH}$ | $V_{DH}$ | Date | $V_{CH}$ | $V_{DH}$ |
|------|----------|----------|------|----------|----------|
| 1    | 3643     | 2639     | 17   | 3783     | 3045     |
| 2    | 2963     | 2743     | 18   | 3522     | 2538     |
| 3    | 3091     | 2737     | 19   | 3553     | 2298     |
| 4    | 4102     | 2893     | 20   | 3137     | 3133     |
| 5    | 3463     | 2757     | 21   | 3458     | 2101     |
| 6    | 3709     | 2784     | 22   | 3643     | 3487     |
| 7    | 4171     | 3072     | 23   | 3827     | 2914     |
| 8    | 2988     | 1526     | 24   | 3528     | 3137     |
| 9    | 3944     | 2285     | 25   | 4171     | 3212     |
| 10   | 3298     | 2476     | 26   | 3669     | 3615     |
| 11   | 4087     | 2502     | 27   | 3592     | 3585     |
| 12   | 4161     | 2524     | 28   | 3602     | 2760     |
| 13   | 4161     | 2451     | 29   | 3764     | 2378     |
| 14   | 3585     | 2320     | 30   | 3648     | 2633     |
| 15   | 4028     | 2410     | 31   | 3110     | 2479     |
| 16   | 3491     | 2637     |      |          |          |



**Figure-1:** The comparison between the two years average of  $V_{CH}$  and  $V_{DH}$ .

The energy consumption of the three heating methods should be sorted: coal-fired central heating > gas-fired central heating > gas-fired distributed heating.

Through macroscopic campus planning, green landscape ecosystem planning, to the specific sewage treatment, reclaimed water reuse system and distributed heating system decision-making, design, and implementation process, Xi'an Siyuan University realizes that the more difficult and challenging it is, the more it is necessary to strengthen the strategic determination of ecological civilization construction, and the more it is necessary to promote scientific and technological progress to low-carbon energy conservation and environmental protection.

### Cultivating talents

Education is about teaching by example, answering questions and answering questions, and cultivating talents. Xi'an Siyuan University, like many other universities, not only incorporates low-carbon education into the curriculum of students, such as the "Science and Technology Civilization Module" in the public elective course, including the status quo and challenges of energy, the significance of low-carbon energy conservation and environmental protection, low-carbon economy and green life; Carry out the construction of low-carbon culture through campus networks, radio, television, special lectures, etc., create a low-carbon environmental protection atmosphere, and carry out low-carbon environmental protection publicity and education and knowledge popularization work<sup>11-13</sup>. Xi'an Siyuan University also further enhances the combination of speech and teaching in the following four details according to its own advantages to cultivate awareness and standardize behavior.

Every year, students are organized to visit the on-campus reclaimed water plant, deeply understand the sewage treatment process of our school, and reflect on cherishing water resources and protecting nature by "building a water-saving city and promoting green development". Advocate energy conservation and emission reduction, and create a harmonious campus design competition, essay contest, and environmental protection research activities. Before and after the "Water Conservation Publicity Week" every year, Xi'an Siyuan University will organize college students to volunteer environmental protection and walk into the school's reclaimed water plant to gain an in-depth understanding of the whole process of sewage treatment and reclaimed water reuse.

In the scientific research of the reclaimed water plant for several years, teachers have consciously organized some students who are interested and have a certain foundation to participate in the experiment of water quality analysis, collect data, and understand the process. At present, in the implementation of the Shaanxi Provincial Water Conservancy Science and Technology Project "Research on the Technical Standard System of Reclaimed Water Reuse System in Colleges and Universities", Xi'an Siyuan University also absorbs some students to directly

participate in laboratory operations and trial production of pollutant removal equipment. The school will recruit environmental volunteers to meet the needs of visits, studies, and practical examples of environmental protection conferences held in Xi'an, such as the 22<sup>nd</sup> National Urban Water Conservation Publicity Week and the 5th Silk Road International Expo and the 2021 International Conference on Renewable Energy, Environmental Protection and Economy.

Teaching by example is more important than words. First, improve the energy-saving awareness of teachers and employees, enhance the sense of urgency, responsibility, start from the small things around them, establish a sense of conservation, and carry forward the virtues of diligence and thrift. Practice the concept of low carbon and advocate green life. Turn off the lights, turn off the faucet, turn off the computer and appliances, and print on both sides of the paper. Improve campus electronic document management and paperless office system. Implement a "low-carbon experience day", that is, the lighting and air conditioning in the office area are turned off for one day. Let the teacher become a practitioner and teacher of low-carbon energy conservation and environmental protection.

At present, students in colleges and universities, like society in previous years, are accustomed to the welfare-based water supply model, that is, the price and value of water resources are seriously deviated. For example, among college students, there is a general tendency to talk about pomp, excess, and high consumption, and they do not save water and electricity. To this end, in addition to strengthening political and ideological education, Xi'an Siyuan University also actively promotes quota management as a means, quantitative assessment as the goal, starting from the details of campus student life, and compulsorily carrying out low-carbon energy-saving and environmental protection management. For example, the use of IC card charging system, to achieve the teaching building direct drinking water supply facilities swipe card to open the water, toilet water flushing toilet and public bathroom intelligent water-saving device, mobile phone We Chat scan code automatic laundry, intelligent bathing card in the dormitory all-in-one water-saving device. These reform measures and methods to implement the "quota management, metering and charging" of water and electricity used by university students have forced students to "become accustomed to nature".

### Serving the community

At present, Xi'an Siyuan College is evergreen and beautiful and picturesque. The green area reached 480,000 square meters, and the green space coverage rate reached 48%. Fountains are like notes, and the surface of the artificial lake is rippling with blue waves. Throughout the campus, teaching and life are in order. With the continuous improvement of social popularity, Xi'an Siyuan College attaches more importance to the obligation and responsibility of "serving the society", and strives to make sewage treatment, reclaimed water reuse and distributed heating

into low-carbon energy-saving and environmental protection Exchange demonstration, teaching, and education platform.

Communication is a two-way street, come in and go out. In the past 20 years, the Ministry of Environmental Protection, the Ministry of Water Resources, provincial and municipal leaders, domestic and foreign experts, various news media and other sectors of society have inspected and visited Xi'an Siyuan University's sewage treatment, reclaimed water reuse, distributed heating, and low-carbon energy-saving and environmental protection management of campus students' lives. Foreign experts include the Director General of the Asian Department of the EU Directorate-General for Development and Cooperation, the President of the International Water Association, etc. In September 2011, the large-scale international conference "Integrated Management Technology of Urban Water Environment" sponsored by the International Water Association made the reclaimed water plant of Xi'an Siyuan University a typical demonstration project for wastewater utilization in Shaanxi Province. At that time, more than 200 experts and scholars at home and abroad visited the sewage treatment and reclaimed water reuse system of Xi'an Siyuan University and exchanged and discussed specific scientific and technological issues.

Xi'an Siyuan University has published more than dozen papers in Chinese and English in various journals such as China Water Supply and Drainage and Water Purification Technology to introduce the experience and experience of the operation technology and economic problems of MBR membrane bioreactor sewage treatment and regenerative water reuse to prevent film pollution and prolong the life of the film to domestic and foreign counterparts.

On June 16, 2019, Xi'an Siyuan University participated in the 12<sup>th</sup> IWA International Conference on Water organized by the International Water Association in Berlin, Germany, with the paper "A case study of 7 years operation of A<sup>2</sup>/O-MBR in Xian Siyuan University" Reclamation and Reuse. The exchange of this article attracted the attention of many participants. Dozens of times to participate in the school's provinces, cities, and districts of environmental protection and energy conservation meetings, exchange experience and experience.

In addition to the sewage treatment and reclaimed water reuse system, which is open to students of the university for related technical teaching, it is also open to students of Northwest A&F University, Xi'an Polytechnic University, and the national water-saving type Representatives of the Social Construction Pilot Experience Exchange Meeting, representatives of the Shaanxi Provincial Environmental Protection Work Forum, representatives of the Xi'an Municipal People's Congress, and representatives of the Environmental Protection Work Conference of Baqiao District of Xi'an City opened their doors, led the visit to various facilities and equipment for sewage treatment, and gave detailed answers to the questions raised

about the source and composition of sewage, treatment technology, reuse of reclaimed water and economic benefits, so as to facilitate understanding of the process and regeneration of sewage treatment Water reuse process, introducing the experience of wastewater reuse in sewage treatment.

## Conclusion

Since 2001, Xi'an Siyuan University has always adhered to the original intention of environmental protection, emancipating the mind, daring to be the first, and promoting scientific and technological progress in the practice of sewage treatment, all recycled water reuse and distributed heating energy saving and consumption reduction. Use "quota management, metering and charging" to promote water and electricity saving for college students. Use the way of inviting in and going out to create a low-carbon and energy-saving exchange demonstration platform to give back and serve the society.

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