能源资源使用状况分析及能源方案建议

ANALYSIS OF ENERGY AND RESOURCE CONSUMPTION AND PROPOSAL FOR ENERGY SCHEME

注:本部分内容摘自国家住宅工程中心研究报告。

Note: the content of this part is taken from research report of national housing engineering center.

本项目立足四川地区，充分考虑到四川当地的能源使用构成和使用习惯，选取四川省广元市苍溪县岳东镇勇士村为例，选取该村两组村民，其经济状况在全村中分别处于高中低水平，并且家庭成员均处于当地家庭构成的 3~5 名范围内。

1. 经济情况

该村农民的主要收入是农业收入和外出打工收入，部分家庭有个体经营收入。调查的 5 户样本除在使用沼气这一点上有选择外，无其他限制，均满足随机选取原则，基本能代表全村情况。全村用户在农业收入上差别不大，每户年收入在 5000 元左右。部分用户耕种了别人家的土地，农业收入适当增加。调查中，用户3就耕种了别人的土地，农业收入达到 10000 元，是其他用户的 2 倍左右。

随着近几年来成年劳动力外出打工人数迅速增加，打工收入占总收入的比例日益增大，并超过农业收入。全村用户外出打工收入平均每家每年 14000 元，是农业收入的 2~3 倍。但每家外出打工收入相差巨大。调查发现，家庭外出打工收入从 6000 元到 40000 元不等。用户 3 家里有 2 人打工，其打工收入占总收入的比例高达 80%，人均年收入也达到 10000 元。没有打工收入的家庭，经济能力则十分有限，人均年收入仅 2000 元左右，远远低于全国农村人均年收入的 3587 元。调查中的用户 5 只有农业收入，人均年收入仅为 1667 元。

2. 住宅特点及能源使用与住宅的关系

农村住宅一般由正屋和次屋组成，正屋主要由堂屋、卧室、起居室、厨房等组成;农机具存放、家畜、家禽、厕所一般都结合庭院布置在次屋。堂屋较大，约 35~45m^2，是家庭的公共活动空间，有大事时可容纳 3、4 桌的酒席。老人卧室一般在一层，二层为子女卧室。农村家庭一般饲养少量鸡、鸭等家禽，供自家食用;多数家庭饲养有少量猪、羊等家畜。有的家庭屋前的道路比较宽，有大片空地可以晾晒粮食，有的家庭有专门的晒场，有些农村住宅二楼也设有晒台。菜地有的在房屋的前院或后院，有的在离房屋稍远的地方有菜园。

The project is based on Sichuan and taking into full account the composition and habit of energy consumption. Therefore, Yongshi Village of Yuedong Town in Cangxi County, Guangyuan City of Sichuan Province is chosen as an example. The project chooses two groups of villagers, their economic status ranks high level, middle level and low level in the village, and the number of family member is typical and in the range of three to five.

1. Economic situation

The main income of the village is agricultural income and migrant work income; some families have income from individual business. There is no restraint on the investigated sample of five families, except there is a choice on using marsh gas; they all stratify the principle of random selection. They basically represent the situations of the whole village. The agricultural income of the users in the village is roughly the same, it is about RMB5,000, but some users cultivate other lands, thus increasing agricultural income. The user 3 cultivates other people's land, the agricultural income reaches RMB10,000, it is as twice as other users.

In recent years, with the rapid increase in mature labor force working outside, the migrant work income has taken up a larger proportion in the overall income and surpassed the agricultural income gradually. The average migrant work income of the users in the village is RMB14,000 for each family, it is two to three times as much as agricultural income. But the difference of migrant work income in each family is great. In the survey, it is found that the migrant work income of the family is from RMB6,000 to RMB40, 000. The user 3 has two men working outside, the migrant work income takes up 80% of the total income, per capita annual income also reaches RMB10,000. The users who have no migrant work income have very limited economic capacity, per capita annual income is only about RMB2,000, which is much less than national rural per capita annual income of RMB3, 587. The user 5 in the survey only has agricultural income, per capita annual income is only RMB1,667.

2. The relationship between housing characteristics and energy use and housing

The rural housing is usually composed of principal room and secondary room, main room is mainly composed of main room, bedroom, living room and kitchen; the storage of agricultural implements, livestock, poultry and toilet are laid out in the secondary room according to the courtyard. The bedroom of old people is usually on the first floor, and the second floor is the living room of children. In the countryside, each family usually raises a little poultry including chicken and ducks. The poultry is used to be eaten by the family. Many households raise a little livestock including pigs, sheep. Some roads in front of the houses are very wide, there is large vacant land that can be used to dry grains, some roads are special, and there is drying stage on the second floor in some rural housing. Some vegetable plots are in the foreyard or backyard of the house, some have vegetable garden in the slightly far place.

在材料使用方面，虽然国家早就禁止使用实心黏土砖，但黏土砖仍是农村新住宅建设的主要墙体材料。通过调查发现，镇政府相关部门的工作人员对国家禁实政策虽有所了解，但具体实施尚无办法，农民对该政策了解不多。因此，在农村住宅建设过程中新型墙体材料的使用还不多见。

我们选作样本的村落，住宅均系村民自建，无固定朝向，沿路、依林或几家组成一个院落分布。该村现有住宅多兴建于 1995 年之后。被调查的 5 户村民的住宅建造年代分布于 1994 年到 2007 年间。其外墙墙体均为实心砖，厚度约为 200mm，住宅外墙都没有保温层。住宅屋顶厚度约为 150mm，平顶房的屋顶最外层材料均为水泥和油毛毡，坡顶房的为砖瓦，均无隔热层。住宅的窗户均为单层玻璃窗，窗框材料有木头、铝合金和塑钢，以木框为主。住宅外的遮阳措施一般为屋檐。目前，村里有两种构造不同的房屋，一种是过去的老瓦房，目前仍占大部分；一种是近几年修的二层楼房。由于气候较温和，两种房子均未考虑保温（隔热）材料的使用。不过修建楼房的家庭一般比其他家庭经济条件好，这是由于近年来，村民打工赚的钱多用于修建楼房。由于经济条件有所改善，为了保持楼房的外观和生活的方便、卫生，这些家庭愿意使用沼气或煤（参见下表）。

在房屋结构上，过去的老瓦房墙体材料为土坯，屋顶用瓦覆盖，窗户为木质单层玻璃。这种房屋气密性较差，不仅不能有效保暖，且屋内较暗。薪柴燃烧是长久以来一种有效的取暖方式。煤炉是该村在经济条件允许的情况下所采用的辅助方式。由于村民节约用电，一般都避免在白天用电照明，或者用瓦数较小的灯泡。但夏天瓦房较凉爽。

近来的楼房墙体采用实心砖，屋顶采用水泥或者砖瓦，窗户也采用了铝合金单层玻璃。房屋气密性较好，冬天保暖较好，屋内较亮。冬天采暖已改为煤炉方式。这也与在楼房内燃烧薪柴不便有关。

村民普遍反应：冬季室内温度较低，与室外温度并无太大差异；夏季顶层温度太高。因此，村民对夏季制冷和冬季取暖的要求会随着生活水平的不断提高而提高，这种保温隔热功能低的住宅在一定程度上将会增加能源的消耗。

In terms of material use, under the principle of prohibiting the use of solid clay brick put forward for a long time in the world, clay brick is still the main wall materials in new rural house construction. Although the staff of town government knows something about the national policy of prohibiting use, there are still no specific measures for implementation, and peasants know a little about the policy through survey. Therefore, the use of new wall materials in the process of rural house construction is rare.

As a sample of the village, the houses of the village are all built by the villagers; there is no precise orientation; the houses are along the road or the river, or several houses constitute a courtyard. The houses of this village have been built since 1995; the houses of the five investigated villagers are built between 1994 and 2007. Its external walls are all solid bricks, the thickness is about 200mm, and external walls of the house all have insulating layers. The roof thickness of the house is all 150mm; the materials of outermost layer on the single-storey dwelling roof are cement and asphalt felt. The slope crest of the house is brick and tile without heat insulation layer. The windows of the house are single glass window; the materials of window frame are wood, aluminum alloy and plastic steel, with wooden frame playing a dominant role. The sunshade measures of the house commonly have eaves now; there are two kinds of houses in the village: one is the tile-roofed house, which is still common to see, and the other is two-storey building built in recent years. As the climate is temperate, the two kinds of houses adopt no heat-insulating materials. The families that built storied buildings have much better economic conditions than other families. This is due to the increase in the number of small storied buildings built by the villages using the migrant fund. These families prefer to use marsh gas or coal to keep the appearance of the storied house, the convenience, and healthy life (See table below).

In building structure, the wall of past old tile-roofed houses is adobe, the roof is covered with tiles, and the window is wooden with a single glass sash. This kind of house has poor air tightness, and cannot retain heat effectively in winter; and it is darker in the room. The combustion of firewood is an effective way of heating for a long time. The coal stove is an auxiliary way adopted under available economic conditions in the village, eliminating the need of using electricity for lighting in the daytime; or villagers use lamp bulbs with a less wattage. And this type of building structure is much cooler in summer.

Recently, the walls of the storied buildings adopt solid bricks, the roofs adopt cement or brick and tile, and the windows use aluminum alloy single glass. The house has better air tightness, and keeps warm in winter, and the room is brighter. The heating method in winter has been changed to using coal stove. This has something to do with the fact that the method burning firewood in the building remains unchanged.

村民房屋建筑结构情况列表

用户	住宅形式	面积（m^2）	建造时间（年）	墙体材料	屋顶材料	窗户形式 / 单层玻璃	采暖
1	瓦房	170	1943	土坯	瓦	木头	薪柴
2	瓦房	300	1977	土坯	瓦	木头	薪柴
3	二层楼房	300	2001	实心砖	砖瓦、水泥	铝合金	煤炭
4	二层楼房	200	1985	实心砖	水泥	铝合金	煤炭
5	瓦房	250	1980	土坯	瓦	木头	煤炭、薪柴

Architecturd structure of Villagers' Houses

User	Type of residence	Area（m^2）	Construction time (Year)	Wall material	Roof material	Window typess/single glass	Heating
1	tile-roofed house	170	1943	adobe	tile	wood	firewood
2	tile-roofed house	300	1977	adobe	tile	wood	firewood
3	two-storey building	300	2001	solid brick	bricks tiles,cement	aluminum alloy	coal
4	two-storey building	200	1985	solid brick	cement	aluminum alloy	coal
5	tile-roofed house	250	1980	adobe	tile	wood	coal,firewood

3．生活用能变化的分析

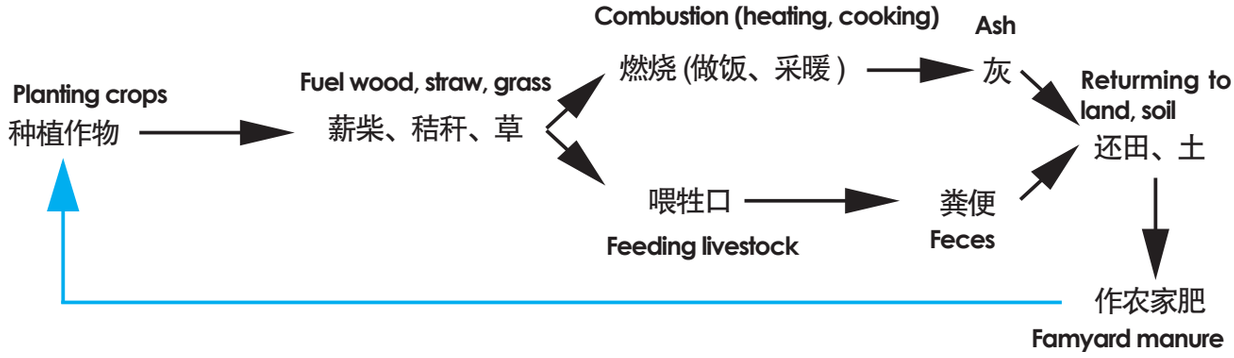
整体而言，该村的生活用能变化较小，农户对改变用能的需求不强。在制冷与照明两项中，用能方式一直未改变。在做饭一项中，虽然有 50 户使用了沼气，但是沼气的推广速度缓慢。调查发现这些沼气池的建造时间跨度较大。例如，用户 2 是在 7 年之前就建好了，而用户 3 是在 2005 年修建新房的同时建造了沼气池。传统能源如秸秆和薪柴，依然发挥着重要作用。由于取暖主要依靠薪柴和煤炭，村民使用煤炭的量受价格变化影响很大，用户 4、用户 5 都反映今年煤价上涨，都有转向薪柴取暖的愿望。

在沼气应用方面，有三个因素发挥着重要作用：一是经济能力，经济收入制约了对新能源的投入，虽然新能源有诸多好处，但毕竟是一项不小的投入；二是政府的宣传和支持，人们有时安于已有的能源方式，政府的宣传可以让人们认识更好的用能方式，支持的做法则能激发人们采用新能源的愿望；三是实际需要，现在村民修建新房都是二层楼房，由于新房是水泥地板、白墙，屋里宽敞明亮，不便再用薪柴来取暖，做饭也改用沼气作燃气。

3. Analysis of changes in household energy consumption

The changes of household energy consumption in the village are insignificant, and the peasants households have a low demand for household energy. The ways of energy usage for cooling and lighting remain changed. In the item of cooking meals, although 50 families use marsh gas, the promotion and application of marsh gas are very slow. It was discovered in the survey that the construction of marsh gas has a bigger stretch of time, for example, user 2 built the marsh gas seven years ago, while user 3 built the new building in 2005, and meanwhile built marsh gas. Traditional energies, such as straw and fuel wood, still play an important role. In heating, the main materials are fuel wood and coal. The usage of coal by villagers is greatly influenced by prices, for example, it is reflected in both user 4 and user 5 that coal price is rising this year, and both of them have the wish of turning to fuel wood for heating.

In the aspect of biogas application, three factors play an important role: first, economic capability and economic income restrict the investment in new energy, although new energy has many advantages, it is not a small investment; second, the publication and support of the government, people sometimes are content with the realistic energy utilization patterns, the publication of the government can make people to realize the better energy utilization patterns, the support can motivate the wish of using new energy; third, actual needs, the new buildings built by villager are two-storey buildings, the new building is cement floor and white wall, the room is capacious and bright. It is difficult to use fuel wood for heating, cooling is also changing into biogas.



4．沼气利用现状

政府鼓励村民建造家庭沼气池，大力推广“粮 – 牲畜 – 沼气”生态农业模式，通过建设高产农田，增加粮食产量，把秸秆、麸皮作饲料喂牲畜，再利用牲畜粪便和部分农作物秸秆生产沼气作燃料，沼渣和沼液作肥料。每户养殖 2~3 头猪，建一个 8m³ 的沼气池，可以解决 4 口之家 80% 的生活燃料，供应 0.3hm² 土地所用的有机肥料，并改善农村卫生条件。其优惠措施是政府拨款，单个沼气池政府补助 1000 元。而单个 8 m³ 沼气池平均造价是 2000 元，需要个人出钱 1000 元。现全村共有 50 个家庭建有沼气池。

从村民的角度出发，已使用沼气的家庭对沼气利用表示满意。这些家庭都认为使用沼气方便干净。填料主要是秸秆、牲畜粪便，每年主要填料一次，猪粪直接流入。使用后产生的废渣运到田地里当肥料用。沼气主要用作厨房的燃气。

4. Biogas utilization

The government encourages the villagers to build biogas digesters, and energetically promotes the ecological agricultural model of 'grains-livestock-biogas' . Peasants can increase grain yield by constructing high yield farmland. The straws and wheat bran can used to raise livestock, then the excrement of livestock and some crop straws can be used to produce the biogas as the fuel, biogas residues and biogas slurry can be used as fertilizer. Each household raises two to three pigs, build one 8m³ biogas digester, it can solve 80% living fuels of the family with four people, supply organic fertilizer for farmland of 0.3hm² and improve rural health conditions. The preferential policy is that the government will give a grant; each biogas digester will get government subsidies of RMB1,000. The average construction cost of each 8m³ biogas digester is RMB2,000, it is necessary for the individual to invest RMB1,000. Now there are 50 families that built biogas digesters in the village.

According to the villagers, the families that built biogas digesters are satisfied with the biogas utilization. These families believe that biogas utilization is convenient and clean. The filling is mainly straw and livestock excrement, the filling should be filled

而没有建沼气池的农户对此积极性不高。用户1、4、5 则认为使用沼气没必要，原因在于当地薪柴丰富、经济条件有限、沼气改造不方便等。沼气应用有限，除了做饭，并不能解决冬季取暖等问题。沼气池的维护和使用对一般村民来讲有难度。调查中，建有沼气池的用户 3 认为，政府在沼气池建好以后未继续给予支持，自己遇到困难时很难及时得到帮助。另外的原因是:沼气池的建设工程复杂，农户无法长期为沼气池提供大量原料。最主要的原因是每到雨季，当地容易发生洪灾，河水几乎能淹没村庄。沼气池一旦被水淹没，就无法使用，必须再投资重建，因此以前建有沼气池的多数居民放弃了这一环保做法。

成功案例:

该村村民周学云一家，是沼气合理使用的成功范例。该户主要从事豆筋家庭作坊式生产。每天制豆筋产残渣 25 千克左右，配以新鲜蔬菜，作为 11 头猪（调查时数据，包括 2 头母猪,9 头仔猪）的饲料，猪的排泄物每 2~4 天投进沼气池，产出的沼气作为做饭和制豆筋的燃料，形成一个能源循环利用模式——“猪 + 沼 + 豆筋”三位一体的模式（见下图所示意）。全过程废弃物极少，沼气池建好近两年来，还没有出过废渣。经济效益可观，每年纯收入在 20000 元以上。

这是一个节能、无废弃物、无污染的模式，以沼气为纽带，沼气作为主要生活能源和生产用能，同时猪的排泄物产生残渣少，产气量大，实现“变废为宝”，值得推广和应用。现在村内已经另有 2 户也在开始采用“猪 + 沼 + 豆筋”三位一体的模式。随着沼气的推广，将会有更多村民参与这一产业。

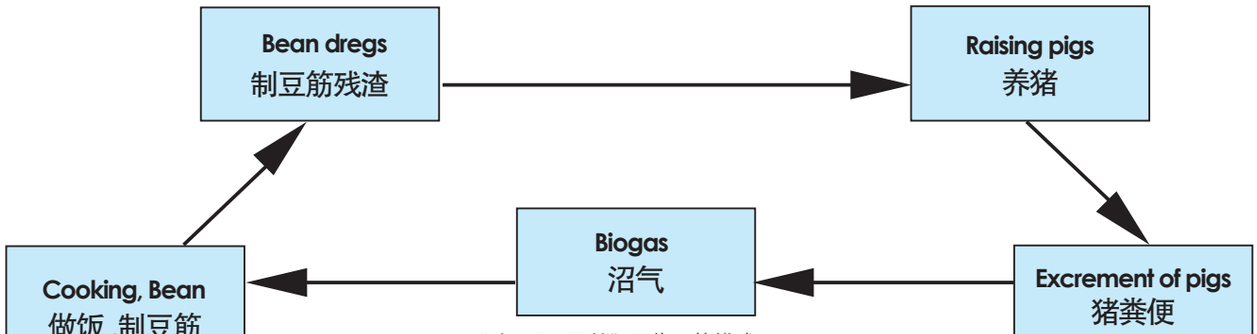
once in a year, pig manure will flow directly. The process of filling is to transport to the farmland as the fertilizer. The biogas is mainly used to cooking.

But the peasants who did not construct biogas digesters are less keen on it. Users 1, 4 and 5 think that it is unnecessary to use biogas; the reason is that local fuel wood is adequate, the economic condition is limited, and the biogas transformation is not convenient. In addition, the biogas utilization is very limited; it can not solve heating in winter except cooking meals. The maintenance and use of biogas is difficult to common villagers. In the survey, user 3 who has biogas believes that after the biogas is constructed, the government doesn't give support continuously, it is very difficult to solve promptly while he comes across difficulties. Other reasons are that the construction project of biogas is complicated, and it can not provide raw materials in the long run. The primary reason is that it will flood easily when it is rainy season, the river water will almost submerge the village. Once the biogas digester is submerged by the water, it can not be used and has to be rebuilt. Therefore, most residents who built biogas digesters before give up the environmental protection scheme.

Successful cases:

The family of villager Zhou Xueyun is a successful case of utilizing biogas. The family mainly works on the production of bean gluten in the family workshop and everyday, they produces about 25 kg of bean dregs, which, mixed with fresh vegetables, can serve as feed for eleven pigs (data valid during the survey: 2 sows and 9 piglets); the excrements of the pigs will be put into the biogas digester every two to four days, and the produced biogas can be used as the fuel for cooking and making bean gluten, thus forming an energy recycling model, namely the 'pig + biogas + bean gluten' – trinity (See the following diagram); the waste produced in the whole process is little. Over two years since the biogas digester was built, no waste dregs have been produced. The economic benefit is considerable, with an annual income of over RMB20,000.

This is an energy-saving model that produces neither waste residue nor pollution. It takes biogas as ligament. And biogas is the main household energy and production energy use. In the meantime, the excrements of the pig have few residues, they can produce a great amount of gas and realize ' Ma'erkang waste profitable ', it is worth being promoted and applied. Now two users in the village have adopted the ' pig + biogas + bean gluten' –trinity. The bean gluten has bright market prospects, and the models of pig, toilet and biogas, pig, biogas and vegetable, pig, biogas and fruit, pig, biogas and fish also have broad development prospects; the excrements of poultry and livestock can be used as raw materials, and excrements can be processed into biogas; biogas residues and biogas slurry can used as fertilizer to be applied in farmlands, orchards, fish ponds etc, thus promoting poultry breeding. And along with the promotion of biogas, there will be more villagers participating in the industry.



“猪 +沼 +豆筋”三位一体模式
'Pig + Biogas + Bean Ghuten' Trinity Model