

学校编码：10384

分类号_____密级_____

学号：15220091153926

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厦 门 大 学

硕 士 学 位 论 文

中国的能源发展和政策建议和可再生能源

China's energy development and policy recommendations

focusing on renewable energy resources

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论文提交日期：2011年4月

论文答辩日期：2011年5月

学位授予日期：2011年 月

答辩委员会主席：_____

评 阅 人：_____

2011年4月

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摘要

在本文中，我试图说明中国的可再生能源消耗的重要性。我认为，可再生能源部门的鼓励将大大有助于回答中国目前的能源问题。这些问题越来越严重，并且可能导致现有良好经济的减慢。他们可能威胁到中国经济增长的可持续性。为支持我的观点，我研究了增长理论的主要理论及其批评，并分析了中国当前的能源形势。我发现，技术进步是必要的，以保持经济增长速度尊重。我展示了技术进步和提高能效发展的密切关系。然后我进一步分析可再生能源发展与能源效率的发展。对可再生能源的重要作用是有目共睹，它可以在当前中国的能源和经济政策出现。中国政府宣布，到 2020 年可再生能源要达到能源消费总量的 15%。目前的能源消费约 8%，但是我坚信中国能够实现其雄心勃勃的目标。但还需要政府在不久的将来的进一步措施。

关键词：可再生能源；可持续发展；中国

Abstract

In this paper I try to show the big importance of the renewable energy consumption in China. I believe that the encouraging of the renewable energy sector could greatly help to answer China's current energy problems. These problems are more and more serious; they could slow down the recent, outstanding economic performance of the country. They could threaten the sustainability of China's economic growth. Supporting my opinion I researched the main theoretical growth theories and their critiques; and analyzed the current energy situation in China. I found out that the technological progress is necessary to keep the respectful speed of the economic growth. I showed a close relationship between technological progress and energy efficiency development. And then I connected the renewable energy development to energy efficiency development. The key role of the renewables can be seen in the current Chinese energy and economic policies. Chinese government announced a goal that it wants to reach the 15% of total energy consumption with renewable energy by 2020. At the moment it is around 8% and I strongly believe that China can achieve its ambitious goal, but it needs further governmental measures in the near future.

Keywords: renewable energy resources; sustainable economic development; China

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厦门大学博硕士学位论文摘要

Chapter 1. Introduction

The purpose of my thesis is to understand and give a clear view about China's current energy situation and energy development, with a focus on renewable energy resources. In recent years the Chinese government has given this topic a distinguished attention thanks to the ever-growing energy demand of the well-performing Chinese economy. China's impressive economic performance in the last three decades fundamentally influenced its energy market as well. Since the launch of the economic reform in 1978 China has needed more and more energy. The country has become the second largest energy consumer in the world¹, after the United States, and the largest one in the developing world.

The energy production could not keep pace with the rapidly increasing energy demand. That is the reason why China has become a net energy importer from the middle of 1990s². The import could not solve the energy shortage that has been growing and has caused several negative effects for the economy. China has continuously been looking for solutions to be able to sustain its rapid economic growth.

I start my paper with the theoretical backgrounds of the development studies. I don't endeavor to write down all the studies on this topic but I rather try to introduce the basic theories and highlight the importance of the continuous technological improvement. I assume that the technological improvement in the energy sector, such as better energy efficiency, or usage of renewable energy, etc., has a key importance in the economic growth.

After the theoretical phase of the thesis I go into details on the energy situation in China. I begin with the analysis of the current situation and the development in the Chinese energy sector. Through empirical evidence I prove the urgency of the technical development in this sector. Without improvement in the field of energy the

¹ Table 1., International Energy Agency, Characteristics of the world's top five energy consumers (2002) on the page 23.

² Table 2., China's energy production and consumption (million ton standard coal) on the page 25.

continuous, high speed development cannot be sustained.

In my last section I focus on a subtopic of the energy development. I will introduce and show the importance of the renewable energy and its development. I believe that renewable energy can be the right solution for the future energy shortages and for the serious environmental issues in China.

The Chinese government has announced its respectful goal; they want to boost the renewable energy consumption to 15% of the total energy consumption by 2020³. Currently this rate is around 8%⁴. Whether the goal is possible or not that is my question in this paper.

My hypothesis: China's renewable energy consumption could reach 15 per cent of the total energy consumption by 2020.

³ Renewable energies in China – legal update, Freshfields Bruckhaus Deringer, 2010

⁴ Reuters, National Energy Administration of China, 2010,
<http://uk.reuters.com/article/idUKTOE60J03Y20100120>

Chapter 2. Theoretical background

In my paper I would like to prove and emphasize the energy's role in the economic growth. Physical theory proved the common sense intuition that economic production needs energy, therefore economic growth is much dependent on energy production as well. Starting my paper I introduce the theoretical economic growth theories, schools and their critiques. The mainstream theories of economic growth, except for specialized resource economics models, pay no or little attention to the role of energy but rather focus on technological change/development. That is the reason why I continue the theoretical part of the thesis with other theories that focus on the linkage between energy and growth.

2.1 The concept of sustainable economic development

Before the introduction of main economic theories I would like to clarify the proper concept of sustainable economic development. I'm doing this in order to understand the economic rationale behind the extremely fast Chinese economic growth that has happened and will continue in the future.

According to the public opinion the notion of sustainable economic development means that the economy has a steady, long-lasting growth and maybe it evolves at a rapid pace, not interrupted by downturns or cyclical fluctuations. Western economists disagree with this opinion.

They connect the sustainable economic development with the long-term growth, in other words the growth could be sustainable only in the long run, and in short- and medium-term it can be affected by negative impacts. These are the recessions, the economic booms, cyclical fluctuations or other economic impacts. Transition path can be explained by the medium-term difference, if it exceeds the normal economic growth.

This track is sustainable only for a short period of time, it can't be sustained permanently. Such a transition track can be visible in those countries that make the so-called economic miracle, for instance in China since the economic reforms. (It is important to mention that the short transition path is often not as short as it could be imagined, it could even be a decade or several decades long).

According to economists sustainable development is pre existing in the economy and it can be associated with the growth potential and developmental rate, in which the economic growth potential is visible in the long-term.

But how much the development pace is, depending on what and how it can be speed up.

The growth opportunity, pace, potential is often traced by three factors. These are the labor quantity and its growth rate; the capital and its accumulation; and the technological development. These three factors indicate the potential of growth, in the long term these three variables' combined increase can't exceed the economic development. However, for a short time the economic growth could be greater because of the exploitable labor reserve and/or technical provisions, but this can only be temporary.

Western economists linked the concept of sustainable development to the "steady state" growth. This term refers to a hypothetical growth, for which a high degree of stability, continuity is true. By the status of the steady state growth the output per capita basis is growing as fast as the technology changes, in other words the concept of growth is essentially the same as in the case of sustainable economic development.

These three connected concepts (the sustainable economic development, growth potential, steady state growth) have to be clear for the understanding of my thesis's further theoretical parts.

2.2 Economic growth theories

2.2.1 Classical economic growth theory

Adam Smith, Malthus and Richard, the main representatives of classical economists, tried to research the vital significance of the accumulation of material wealth, focusing on the factors that can change a country's economic growth. Adam Smith reckoned that the powers of growth are the international division of labor and the accumulation of capital. Malthus and Richard thought that economic growth is highly influenced by the decrease of the population inflation and the essential factor marginal productivity. These classical theories did not deeply discuss the effect of the technology advancement and human resources that can answer the difference between different countries' economic growth. That is the reason why I don't examine further this school's achievements.

2.2.2 Neoclassical economic growth theories

The neoclassic economists are different than their „forefathers“. The method of neoclassic economics is comparative statics. It doesn't focus on the reasons of economic change. It misses the time and spatial dimensions and inures to institutions. The neoclassic school simplifies to be able to show important relations. It assumes perfect competition, perfect information, permanent return of scale, decreasing marginal productivity, Inoda conditions and closed economy. And this economy, which is in normal status, has complete employment, partial employment can be imaginable just in short term, but for that the theory doesn't pay big attention. With those presumptions the neoclassic economists created their growth model.

Solow and Swan wanted to know how far the capital of the labor unit can be increased. According to them, the answer lies in investments. In the Solow-Swan growth model - known as the neoclassical growth model – the economy must reach a stationary state. In this stationary state of the economy there is no additional investment. The growth is a transitional phase through which the country is going to

the stationary state. An underdeveloped economy can grow fast while it is building up its capital stock. But if the savings rate stays constant all economies will get to zero growth equilibrium. If the savings rate increases, the growth will occur for a while until a new equilibrium is reached. It is important to mention that the higher the savings rate, the lower the current standard of living of the population. According to all of these, the causes of continuous, economic growth are the investments and the technological progress / advancement. It is evident that if the technological knowledge increases than the rate of return to capital grows as well. With this the breakdown of the growth can be avoidable. The only problem with the Solow-Swan model is that it does not explain how improvements in technology happen. The technology progress is assumed as an exogenous variable.

Through the Solow-Swan model's basic assumptions the neoclassic economist explains the different countries' different growth results. In the growth difference they emphasize the different technology progress and the difference between the investments' rate. (The investment is needed indirectly to the technological change, it can be visible in the output.) The rate of investment plays a significant role in the economic growth because of its limitation, and it is also important that it changes the population/employment value.

In this paper I don't deal with investments, I rather focus on technological progress and how it could be understood.

2.2.3 Endogenous growth theory

The endogenous growth theory accepts the main conclusions of the neoclassical model and the proposition about long-term growth as well. However, it changes one important thing: it makes the technological progress an endogenous variable and thus it makes the economic growth more understandable than before.

It reveals that the technological development is in direct contact with research (direct contact with applied research and an indirect contact with basic research).

Economists also proved with the help of the products of research (high fixed costs) that monopoly is necessary and that is not a perfect market situation; however, it is essential to reach the adequate technological progress. And they give special emphasis to the inventions and the protection of patents; these are also necessary conditions for economic and technological growth.

The technological development depends on the research activity, its intensity and its efficiency and those depend on participants of the market who are part of the economy. In other words the technological development is no longer an independent variable from the market, is not exogenous. With the help of the above mentioned two things the followers of the endogenous growth theory tried to explain the economic growth.

Romer linked the pace of technological development with the growth rate of new knowledge. He simplified the calculation because of the complexity of the measuring, the growth rate of new knowledge and its concept, he did this to be able to show larger context of the connection. The calculations of his model were simplified, economists wrote about the proportional number of the research's effectiveness, the researchers, they also studied the impact of existing knowledge on the rate of invention, the productivity impact of researchers was also introduced.

Finally, they summarized their findings in an equation in which the growth rate of innovations was determined without the increase of variables were directly measured. The growth rate depends on three factors: the researcher population increase (and their organic joining), the productivity of the researchers' and the accumulated knowledge's efficiency that influences the research. (The model assumes that the higher technological knowledge needs more research base in the long run.) The most important conclusion is that these three factors do not depend on the state intervention, they could only be influenced by the government in the short term, but direction of the state measures is uncertain (the variables have an impact on each other), in other words the transition path is possible. According to the economists the

growth rate could be accelerated, but in the long run, it can't be sustainable. However on the transition path the quality of output and productivity will be higher than before, hereby the country has a higher technological level as well.

Development opportunities according to the endogenous model

In the endogenous model the developed and underdeveloped countries have different motivation on the research field; while the first emphasizes the discovery of new inventions, the other is more interested in the imitation. Theoretically, the adjustment policy could allow a large increase in development, but practical experience has showed in general that the „copy” of the technique is only possible at small backlog; however, only with imitation the catch-up can't be possible. Imitation also needs a certain level of development, human capital, savings, other factors, which are often unavailable for the poorest countries and therefore the distance increases between them and the developed. The spread of technology is affected by the international trade, patents and their charges, the international flow of labor, capital imports and direct export of capital and many other things, determined by the national and international economic policy.

Complete catch-up could be imagined if the two economies simultaneously reach the same technological level, in other words the imitation is not possible factor for the followers, and new things are needed to catch up the other. The economists note two conditions that the equalization could be possible. First, the leading country has the interest in the efficient technology and the other, the follower country has bigger willingness in the introduction of the new technology. (After the introduction of new technology a special case can occur, the follower can overtake the leader if it using the new technology better; this is the so-called "leapfrogging" effect. This case is unlikely, because the technological innovations, breakthroughs belong to the basic research more and in general this is more dominant by the leaders.)

2.2.4 Growth models with natural resources and technological change

The above mentioned theories do not concentrate on the problem of the resource limitation. There are nonrenewable and renewable resources that highly influence growth and sustainability. The theories focus on the substitution of capital for resources; technological change might permit growth or at least constant consumption in the face of a finite resource base. Growing total factor productivity (TFP)⁵ makes sustainability technically easier to reach and sustainability may be possible even with an elasticity of substitution of less than one. However, again technical feasibility does not imply that sustainability will occur. Technological improvements imply that production per unit resource will be higher in the future.

Studies that examine the roles of resources in growth models with endogenous technological change have not yet provided necessary conditions for the achievement of sustainability. The number of studies remains limited. Some models create very specific assumptions. For instance, Smulders and de Nooij assume that energy use has a positive growth rate apart from a possible onetime reduction in the level of energy use⁶.

Aghion and Howitt made the most general results. They created four different models, determining which allow for sustained growth and which do not. Two of the models use renewable resource and two with nonrenewable resources. Each set of two models includes models using the AK⁷ and Schumpeterian frameworks. “The renewable resource models require resources to be diverted from final goods production to reduce pollution, while environmental quality is an argument in utility. In the AK version, the long-run growth rate cannot be positive, which stands in

⁵ Total factor productivity (TFP) is a variable which accounts for effects in total output not caused by inputs. If all inputs are accounted for it, then total factor productivity (TFP) can be taken as a measure of an economy’s long-term technological change or technological dynamism.

⁶ Smulders provides a survey of earlier endogenous growth work and Smulders and de Nooij provide references to the more recent literature.

⁷ In the second class of endogenous growth model, the relationship between capital and output can be written in the form $Y = AK$, where A is constant and K is a composite of manufactured capital and disembodied technological knowledge thought of as a form of capital. Therefore, economic growth can continue indefinitely as this very broadly defined capital is accumulated, as output is not subject to diminishing returns. In AK models saving is directed to either manufactured capital accumulation or the increase of knowledge. However, the models do not explicitly model research and development activities (R&D).

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