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"Social capitalism" in renewable energy generation: China and California comparisons☆

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ABSTRACT

With a population of over 1.3 billion people, demand for renewable energy is expected to grow to a USD $12 billion market in the near term. Under Renewable Energy Law (REL) in February 2005 in the People's Republic of China (PRC) passed by the National Congress, renewable energy projects will be able to receive a range of financial incentives starting in 2006, which will more than double the PRC current renewable energy generation from 7% to 15% by 2020. Most of the increase will be in hydroelectric generated power. Nonetheless, the nation and especially the provinces are moving rapidly to develop a wide range of renewable energy generation including solar, wind, geothermal and run of the river.

Because China practices "social capitalism" as expressed in it's recurrent Five Year National Plans since 1999, the national government and all the provinces have programs, unlike many western and industrialized nations, to "plan" and provide for infrastructures. This paper concerns only the energy infrastructure sector and renewable energy generation in particular. The planning process includes financial incentives and investments which are a major part of the Chinese law focused on "encouraging foreign investment industries". The key part of the law is to guarantee long-term power purchase agreements with state owned and controlled "utilities". In short, China may have gotten the economics of the energy sector correct in its concern for planning and finance.

The paper develops these energy infrastructure ideas along with the legal and financial requirements as "lessons" learned from the USA and especially California. These lessons now apply to China and allow it to learn from the American mistakes. Empirical data will be drawn from work done in China that examine the renewable energy generation and infrastructures and hence allow the RPC and its Provinces to "leap frog "the mistakes of other developed nations. Further lessons will be learned from provinces and related infrastructures in China, such as water, transportation, environment, waste and telecommunications. More significantly, the USA and western industrialized nations may now learn from the Chinese.

1. Background

China has established itself as "social capitalist" nation over the last decade as it moves away from a strict communist nation into one that combines western capitalism with socialist principles (Clark and Li, 2003). Meanwhile meeting the challenges of an economic annual growth rate reported at 9% annually for two decades, the nation confronts serious structural reform. Energy is a significant and core sector. The PRC has the second largest electricity supply system in the world. Since implementation of reform and opening-up policy in the early and mid-1990s, the power industry has grown over 8% per year in terms of installation capacity and generation. The country has 385 GW in installed capacity (at the end of 2003) and a total length of 803,505 km of above 35 kV transmission lines (at the end of 2002). The hydro, the

☆ Clark gave this paper given at the Western Economic International Association Annual meeting in San Diego, CA in July 06 about one year into the ABD Project on IMAR. Basic concepts apply now and for the future of the IMAR and PRC. Comparisons and perspectives are needed for the EU, Japan and USA due to the significance of energy and the global economic crises continuing in 2009.

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thermal, and the nuclear power capacity amounted to 92.17 GW (24%), 285.64 GW (74%), and 6.19 GW (2%) respectively (Han et al., 2005).

"China faces a challenge similar to that it did two decades ago – it aims to quadruple GDP before 2020 while only doubling energy use to meet energy security, social welfare, and environmental imperatives" (Sinton et al., 2005). The PRC's electricity generation in 2003 amounted to 1910.58 TWh and electricity consumption was 1889.12 TWh. Industry is the largest consumer of electricity with a share of 77%. The shares of agriculture, residential, and other consumers are estimated at 3.6%, 12.3% and 6.7% respectively. Currently, China's electric power industry has entered a new development phase with large grid, large generation plants, high-voltage transmission, and advanced automatic control systems (Han et al., 2005, see Appendix A).

"In order to solve the energy problem, Chinese government works out two solutions. One is to promote the energy conservation, speed up the construction of a thrifty type economic system and society, largely improve the efficiency of energy utilization, lead the social production and consumption to a sustainable pattern, thus to bridge the gap of the energy resource. The other is to enhance the exploration and development of domestic energy resource, accelerate the generation of coal, electricity, oil, natural gas, as well as the construction of renewable energy strive to adjust and optimize the energy structure. At the same time, China should proactively participate international energy development and collaboration, take advantage of foreign energy resource as to ensure the civil energy supply." (Han et al., 2005, see Appendix A).

Under social capitalism, the PRC seeks to open up targeted sectors, like energy, to private capital, foreign investment and entrepreneurial economic development. However, lessons from developed nations are important. In Denmark and other Nordic countries who have similar social-economic overall policies about "social capitalism" like the PRC. For example, in order for private and public sectors to collaborate successfully in what Clark and Lund (2001) call "civic-markets", the central government must set up finance programs that have certain requirements. The key was that the government remains at least a controlling equity partner in the newly established venture for an established period to time (Clark and Jensen, 1997). The same concept applies well to developing nations and new members to the European Union, such as Hungary who were "privatizing" their energy sector in the mid and late 1990s with "difficult results" (Clark, 2000a,b).

In the case of California's "de-regulated" (similar to privatization and liberalization elsewhere) energy sector that took effect in 1996, publicly controlled power plants were 100% sold to private companies outright from 1996 to 2001 resulting in disastrous consequences including State-wide rolling black outs, State Government budget deficits and the State going bankrupt. Nonetheless, there were both good results or new opportunities found (Clark and Bradshaw, 2004) and bad lessons learned (Clark and Demirag, 2005; Clark, 2001, 2002a,b) and that have helped change public policies in California and America in general.

Reform is top on the PRC agenda as well. Sinton et al. (2005) among others have analyzed the energy sector and made recommendations. In China, the national transmission lines belong to two state-owned grid companies founded in December 2002 in compliance with the State Council's power system reform strategy and program. The country's power generation capacity belongs to five state-owned power generation group companies founded in December 2002 and other generation companies. Despite significant growth in installed capacity and generation, the country continued to face shortages of electricity supply in 2003 (Han et al. 2005).

Consequently, some 22 provinces, autonomous regions, and municipalities had to cut off electricity at peak times. In order to guarantee more power supply, China is accelerating construction of new electricity plants and power grids. One of the core issues is, are these new plants environmentally friendly? That is will they help or hinter environmental protection for the regions and cities that are demanding more energy generation, but hopefully not at a long-term atmospheric cost. At the same time, the government has adopted a series of incentive and punitive measures encouraging balanced electricity consumption. According to the forecast of the China Electricity Industry Association, China's power generation capacity will grow by 9% in 2004, while the consumption of electricity will increase by 12% (Xinhua News, 2004).

China's electricity consumption per capita is very low compared to most other developed nations. However, the forecasted demand increase for electricity will be huge in the future. According to the forecasts of Energy Research Institute, the demand for electricity will increase with annual growth rate over 6% in the next 20 years and could be even about 7%. Based on that, national demand, China would need energy generation between 2400 and 2800 TWh in 2010 and between 4000 and 5400 TWh by 2020 (Han et al., 2005).

To meet this demand, the required installed capacity is from 850 to 1000 GW in 2020. The ERI study suggests that the hydro electricity capacity has to be increased to 200 GW in 2020 from the present size of 84.55 GW (Han et al., 2005). The PRC has abundant natural coal resources (see Atwood et al., 2002 for clean coal options) and the "nuclear power" option as well to consider in meeting its energy demands.[3] Nonetheless, increased capacities from other renewable energy sources are also top on the national policy agenda.

As Han et al. (2005) note, "the new reform plan approved on April, 2002, a regulatory committee would be set up to encourage competition and issue licenses to environmentally qualified operators." While Sinton et al. (2005) argued for a Ministry of Energy (MOE) where all energy issues would be coordinated, much like the USA Department of Energy, the PRC created The State Electricity Regulatory Commission (SERC), which was officially established with the following missions:

- Developing operating rules for the electric market; regulating operation of the electric market and ensuring fair competition
- Providing reference of electricity adjustment for National Development and Reform Commission (NDRC) which is in charge of electricity price
- Regulating and monitoring production quality of power industry
- Issuing license of and managing production of power industry
- Managing disputes of power industry
- Regulating implementation of social public benefit policies (Han et al., 2005).

As Han et al. (2005) discuss, the "SERC is also the first regulatory commission in the public utilities sector in China. In late 2003, the

[3] Coal-based thermal generating capacity in 2020 will reach 600–650 GW. Natural gas generating capacity will rise up to 60–80 GW. The size of nuclear capacity and other sources of energy are expected to increase as well during this period. In China, energy resources for electric generation are mainly scattered in the west, while electricity consumption is concentrated in the center, east, and south. So China needs transmitting power from west to east, exchanging power between south and north, and enhancing nationwide interconnection. As coal is expected to play an important role, promotion of clean coal technologies (including high efficient decoking and dust eliminating equipment and sealed equipment for coal transmission) for new power plants is essential from environmental perspectives. Large-scale power construction and hydroelectric construction without damaging the local environment is also an area of concern (Han et al., 2005, See Appendix A).

SERC set up two regional electricity trade centers on trial basis in Northeast China and East China. This is for paving the way towards a competitive national market by forcing energy companies to reduce production costs. In 2004 the SERC has set up six branches in Northern, Northeastern, Northwestern, Eastern, Central, and Southern regions to supervise power production and marketing activities and carry out relevant administrative jobs. The six offices are located in Beijing, the national capital, and five regional centers, Shenyang, Xi'an, Shanghai, Wuhan, and Guangzhou.

These branches are under direct control of the SERC. In the past, power prices were distorted because a State monopoly, which controlled half of the nation's power plants and almost all its grids, tended to buy power off its own plants rather than cheaper alternatives. From the later half of 2002, China also began the work on power price reform, but the work is ongoing. Nonetheless, the SERC and its offices represent a serious issue for China's reform of the energy sector.

As California experienced during the energy crisis from 2001 to 2002, there is a vast difference between the needs of a state, such as California or Provinces, Cities and Autonomous Regions in the PRC, and the national government in Washington DC and Beijing respectively (Clark and Bradshaw, 2004). There are both inherent conflicts and specific finance, policy and program strategies that can be both conflictual and destructive to both political regions (Clark and Morris, 2002). The approach that the PRC appears to be taking is far more regionally sensitive, unlike the USA model of a central department or ministry.

Nonetheless, there are several critical issues confronting the new PRC reform structures that need to be highlighted and considered, especially when overall central government energy policy according to a variety of sources (DeLaguil et al., 2003; Sinton et al., 2005; Han et al., 2005) includes the need for energy security and independence (China needs to use its own natural resources so as not to be dependent on foreign and unstable supplies), environmental protection (China wants to reverse pollution and environmental degradation that is causing climate change) and support sustainable development (China advocates environmental protection while encouraging economic development which need to be both balanced and strategic).

Critical to reform is maintaining these overall policy goals and objectives while implementing and monitoring them at the local and regional levels. In short, the central government needs to maintain a firm and constant oversight position while allowing and encouraging local demands and needs. This is one of the key points of conflict and disagreement in the current Asian Development Bank (ADB, 2006) supported project for energy analysis of Inner Mongolia Autonomous Region (IMAR).

The results are not in but a key issue is the debate over local regional autonomy and central government policies. There are global lessons learned from other developed countries in energy (and other) infrastructures due to power crises such as those in California during 2001–02 and in Europe the next year (2003) which all point to reform needed that is neither the status quo (state control of energy) nor de-regulation – privatization – liberalization (that is, private sector control of energy).

2. Renewable energy finance into agile systems

During the past two decades, the Chinese power sector has undergone significant structural and regulatory changes. The state-owned single monopoly power company has been unbundled into a number of activity-specific entities. A regulatory body has been established and the reform targets and strategies for the future have been identified and approved by the government. The power sector faces tremendous challenges in terms of capacity expansion to ensure adequate supply of power to the consumers. The possibility of power shortage looms large in view of high rate of demand growth, which can be a major threat to the sectoral reform. Moreover, the reform has not yet addressed the essential issues of tariffs, ownership of assets and customer choice. While the power sector reform has entered a new phase in China, it has a long way to go before a sustainable industry develops (Han et al., 2005).

In February 05, the National People's Congress, which is the Central Chinese Government, passed the Renewable Energy Law (REL) calling for more "renewable energy" throughout the Country. The law would take effect on 1 January 06. The country has an inadequate supply of electricity with current estimates of 80 billion kilowatts annual shortfall. The demand now but rising is for 2456 billion kilowatts. From 70% to 80% of all electricity in China is generated by coal and other fossil fuels. Implementing regulations will be developed and issued in the fall of 2005. Appendix B shows the renewable energy situation in China today (China, 2006).

Chadbourne and Parke (2005) note that the law creates enormous investment opportunities for renewable energy in China. Industries in general are divided into three categories by the government depending on priorities: 1) encouraged foreign investment industries, 2) restricted foreign investment industries, and 3) prohibited foreign investment industries. Renewable energy is considered the number one area of focus and hence, the central government strongly encourages foreign investment industries.

According to the REL, renewable energy is defined as wind, solar, water (most likely to not be hydroelectric or large dams, but instead hydropower 50 MW or less), biomass, geothermal, ocean energy, "etcetera" which was purposely left vague. Currently China has established renewable sources in hydropower of 110,000 MW, wind of 760 Ms and 60 MW of solar power. As a percent of China's total, renewable energy accounts for only 7%, which is the lowest among all other Asian nations. The annual current rate of renewable consumption is 25% annually. The target for a national renewable energy goal is to have 15% of total consumption by 2020, most of which will be from hydropower with a three fold increase. Many provinces have set more aggressive goals.

Article #24 of REL provides a new "renewable energy development fund" which will make grants to pay for feasibility studies into projects for rural areas as islands. Article #25 directs Chinese banks and other financial institutions to provide low-interest loans from a pre-approved list of "national renewable energy development guidance catalog." Some projects have already received loans under a 1999 "Circular Regarding Issues on Further Supporting the Development of Renewable Energy" published by the National Reform and Development Commission and the Ministry of Science (Chadbourne and Parke, 2005).

At a Conference in China (ACORE, 2006), an agreement was made between the PRC Central Government and the renewable energy companies in China to seek a Renewable Energy Portfolio Standard of 25% by 2020. One key goal for the Government is "to ensure that renewables projects have an outlet for their output at prices that will make it possible to finance the projects." (Chadbourne and Parke, 2005: 43). The law basically requires a long-term power purchase agreement. The concept is similar to another legal requirement know as a "mandatory purchase regime for gas and heat (combined heat and power or distributed energy) which can be produced from biological resources.

Under the new law, the state utilities that control access to the grid will be required to sign interconnection agreements with any renewable projects in their service territories that have received all the government approvals required to start construction (Chadbourne and Parke, 2005, p. 43).

3. Lessons learned from California, USA and developed nations

The California energy crisis produced many lessons that were learned (Clark, 2002a,b, 2001). These lesson need to be passed on to other developed and developing nations (Clark and Bradshaw, 2004) Above three critical lessons were noted. First is the need for reform to be clearly defined. And as other nations and states such as California discovered, there needs to be a continuing role that is reflected in the concept of civic market between the public and private sectors. Be that role one of creating regulatory schemes, programs or governance, it must be legally defined and in operation. Neither market forces alone nor government in-actions can be tolerated in a globally competitive work for key sectors like energy. Market manipulation of supply as well as illegal financial actions have stopped most de-regulatory and privatization actions in developed nations (Clark and Demirag, 2005).

Second, there are inherent differences and serious conflicts between the national government and almost all regional, city and states with a nation. California is an excellent example of this. For example, it established a Renewable Energy Standard (RPS) of 20% by 2017. Eighteen other states did so as well. But the national government in Washington did not and even if it did, the percentage of renewables would be lower for the nation as politicians tend to negotiate to "lower", rather than higher regulations and percentages. Moreover, California under a new governor even expedited the time frame moving it to 2013.

The issue of areas is also regionalism, which goes beyond states versus nations. In the USA, California is part of the western states versus south, middle and eastern regions. Each is different. Moreover cities, communities and counties are sub-sets of states and provinces have established their own "Green Cities" alliances and even more aggressive RPSs. In southern California, Santa Monica has declared itself "green" while Los Angeles has a RPS of 20% by 2010 and Santa Monica will be "Fossil Free by 2030".

Finally, there is the issue of long-term commitment be it in public policy or finance or simply regulations. Government and business alike need to know if there will be policies in place along with funding so that they can plan. Without long-term financial commitments, neither the public nor private sectors can plan and implement. This key reason why the "civic market" approach to policy making and planning is important as demonstrated by a variety of decisions to get California through its energy crisis (Clark and Morris, 2002; Clark and Bradshaw, 2004).

When Clark and Lund (2001) first articulated the concept, much theory on public-private partnerships existed. However, few practical examples were explored and rarely put into practice. The California energy crisis provided that need and application. There was no way that the State would get through the crisis without such collaborations and mechanisms. There needed to be consensus through constructive debate, confrontation and dialogue to construct public policies and implement them.

4. Economic themes, strategies as opportunities for renewable energy

When lessons learned in developed nation-states are compared, applied and implemented in the PRC for example, a number of themes appear. One of the most critical themes is definition of terms and numbers (Clark and Fast, 2005, 2008). This is not just a matter of language translation, but even deeper in understanding basic ideas. For example, one of the most often used terms in renewable energy today is "market". The term means different things to different people who are even native speakers of the same language.

English speakers from the UK and USA often have different meanings attached to the word, which can be confusing to native language speakers in China and other countries. However, even among native English speakers, the concept has different meanings. For example, many economists see markets as open and free business arenas in which to compete without government interference and regulation. While this is a particular neo-classical economic argument, it does not exist in reality anywhere.

The UK and USA are prime examples of promoting this definition of market but practicing something very different. For Americans particularly, there are market forces or business that have both economic and political domination in sectors. But more importantly, developed countries like Germany, France, the Nordic countries and others, have "government driven markets" where goods and services are funded, procured and demonstrated well before the "mass market." In fact, this "market" model is also true of the USA governments massive debt mechanism used to purchase goods and services, many of which are NOT and perhaps should NOT (for military purposes) be on the mass market are clearly a different definition of market than what most economics would expose.

Clear basic definition of renewable energy generation, technologies, policies and programs are what is needed in any nation-state for providing guidelines in finances, and public policies. The government market provides structure and certainty in its ability to stipulate market rules, regulations and standards in order for the business to respond through procurement, demonstrations and finally mass-market business opportunities. Moreover, as noted above, public policies and economic mechanisms of nation-states will differ from one another and within their own regions, cities and communities. Nonetheless, ate one level there must be clear and basic definitions. For the PRC, there are seven themes that emerge in its efforts to achieve national energy goals.

4.1. Social capitalism

Social capitalism itself is the key theme for the PRC and in a different manner by most developed nations (Clark and Li, 2003). The exception is that the PRC and Nordic nations share the same theme in terms of both definitions and policies. In short,

> Social capitalism is conceptualised as a hybrid or combination of the private market mechanisms characterised by the ownership of common industries for the good of all citizens. The three forms of global industrialisation do not reflect this new economic paradigm. When the state considers what it must 'control' for the good of all citizens, social capitalism becomes very apparent: water, waste, environment and energy. Some social capitalist countries might also argue that medicine and education must be guaranteed to all citizens as well.
> For example, the current debate in most countries over the telecommunications or digital infrastructure focuses on a similar economic debate: can any country have a 'digital divide' between its citizens – the haves and have-nots — dependent on whether someone can afford the technology? The energy crisis in California can be viewed in the same manner: can some citizens (or even businesses and other infrastructure sectors) afford power while others cannot? Social capitalism would agree that denying its citizen's power, for example, based on market or other forces should not exist.

Definitions of social capitalism are critical for China and other nations. That is why social capitalism in itself represents a paradigm shift:

> What the social capitalism paradigm argues is, that states or governments cannot be 'invisible' or leave certain societal areas

and sectors open to 'market forces.' Government must be active and even protective in certain areas that impact on all citizens, including businesses and new enterprises. Government's role is to provide guidance through some regulation, oversight and investment stimulation policies and programs (Clark and Li, 2003).

Basic definitions are one reason why the third theme in renewable energy financing is focused on "sustainable development" (SD) itself. The concept is often expressed as a key theme but for USA it means a focus on environmental concerns whereas in other nations, it often means economic development. The two concepts and definitions can be totally opposite in practice and a cause of considerable concern. While not reviewing all the definitions of SD, there does appear to be more and more consensus globally (Clark and Lund, 2006).

4.2. Sustainable development

Second, sustainable development is very much a comprehensive theme in that like its original usage in the Brundtland Report (1987); it retains the more general meaning of:

> 'The objective of sustainable development and the integrated nature of the global environmental/development challenges pose problems for institutions, national and international, that were established on the basis of narrow preoccupations and compartmentalized concerns…. The challenges are both interdependent and integrated, requiring comprehensive approaches and popular participation.'…
> 'The concept of sustainable development provides a framework for the integration of environment policies and development strategies—the term 'development' being used here in its broadest sense. The word is often taken to refer to the processes of economic and social change in the Third World. But the integration of environment and development is required in all countries, rich and poor. The pursuit of sustainable development requires changes in the domestic and international policies of every nation.'
> 'As a minimum, sustainable development must not endanger the natural systems that support life on Earth: the atmosphere, the waters, the soils, and the living beings.'

4.3. Agile systems

A third theme that has arisen in the energy literature is "agile systems" (Clark, 2006). The reform of the energy sector has numerous results. Sinton et al. (2005) argue for one model while others propose others for China. If there are lessons learned from the developed nations about reform as being the extreme of deregulation, privatization or liberalization, for the PRC, there are very distinctive results that have already begun to form its own unique energy infrastructure model. For one thing, the PRC model is based on its philosophical approach to everything: social capitalism. That is the concern of every citizen's social welfare, rather than leaving energy or any sector wide open to private individual or businesses.

While this basic approach to energy or any other infrastructure does not follow the developed nation's, it certainly benefits from their mistakes. The ADB (2006) study of IMAR addresses this issue as did the ABA (2006). Martinot (2006) makes this point in his analysis of renewable energy in China while Lewis (2006) confirms the issues looking at IMAR specifically. The goal of energy independence or security applies to regions, communities as well as nations.

The conflicts and wars today over now increasingly scare natural resources caused by "peak oil and gas" for example are bound to get worse. These costs, let alone those for reversing global warming and climate change (if that is possible) will take an entirely new "paradigm" from that of the developed nations thus far. Indicators are that the PRC may indeed be the embodiment of that new paradigm to which the developed nations will now follow suit.

4.4. Infrastructures

Infrastructures are a fourth theme that needs to include renewable energy generation in their calculations and systems. Models and software need to be used in such calculations. DeLaquil et al. (2003) used the MARKAL model specifically to look at China's energy needs. They were able to analyze China for a fifty-five year period of time in terms of energy demands and alternative future scenarios compared to a "business as usual strategy that relied on coal combustion technologies (no matter how advanced) [which} would not enable China to meet all of its environmental and energy security needs" (DeLaquil, 2003: 40).

What is interesting about this model and others (see Isherwood et al., 1998 for the META NET economic model or Berry, 1996; Berry et al., 1999) is that they provide base line data from which to plan. In particular, they look at the variations of needs for infrastructures that include energy along with other structures like water, waste, transportation. The California Commission for the 21st Century did that in 2002 in order to set goals and strategies for the needs of the entire state (Commission, 2002).

More recently, the state did the same thing focused on a Hydrogen Highway RoadMap (California, 2006). When looking at the financing of infrastructures, the civic market approach is a key organizing and implementation element. From that analytical framework, policy makers can begin to define ideas and strategies which can become part of the planning and implementation process (Clark and Yago, 2005).

4.5. Renewable energy

The fifth theme is renewable energy itself. Once defined as solar, wind, geothermal, biomass or whatever, renewables today are created from a variety of sources. More often than not, however, each of these areas is seen as separate technologies (Clark, 1997, 2000a,b). Wind farms stand alone in large numbers remotely located from the communities that need their power. Rarely are renewable technologies combined, linked or operated as hybrid technologies, much like the hybrid cars today: electric combined with gasoline motors. The problem is that the costs of these isolated systems become extremely high. Solar and wind, for example are "intermittent resources" requiring storage technologies to make them dependable for base load financial or other monetary calculations (Clark and Morris, 2002).

A far more economic approach, for example, would be to combine wind and solar power with storage devices or other technology in order to create a base load and hence a constant source of funds (Clark and Paolucci, 2000). Wind when generated in local communities and combined with other technologies (biomass or storage) becomes economically dependable and financially competitive with fossil fuels (Lund and Clark, 2002). A number of studies had analyzed this approach to renewables for financial and environmental protection purposes (ABA, 2006). In remote communities, villages, island nations, or defined urban communities, such distributed systems are cost effective, efficient and environmentally friendly (Isherwood et al., 1998).

More recently, some experts and scholars have advocated "green hydrogen" as a hybrid solution that focus on energy storage

for local power needs today (Clark et al., 2005) while the hydrogen fuel cell car comes to market in 2010 as several auto manufacturers have announced. Throughout California, green (and others including natural gas reforming) hydrogen stations are coming online and operating. The City of Santa Monica opened one in mid-June 2006 as part of its declaration to be a "Green City".

4.6. Finance

Finance is the sixth theme. The place to start with finance is again definitions. While this paper is not intended to review all of literature in economics to define terms, a few critical comments need to be addressed. For one, sustainable development must be defined including its economic component as above. However there are significant other issues that relate specially to finance. Consider the strategic planning concepts of short and long-term goals when related to finance. More often than not, few studies define short and long terms as costs and time. This is a serious mistake for many reasons. But the primary one is that the concepts mean different things to different people which will lead to misunderstandings and ultimately to inaction.

Furthermore, short and long-term need to be defined in order to consider the costs for energy today for the long term. That is a power plant costs today need to be repaid over a long period of time. Such finance, either through debt or equity capital means that a region or nation will make a commitment to certain energy generation power plants over others. Hence, an energy policy that promotes coal power generation means costs are sunk for decades in this energy source and its technological enhancements (Atwood et al., 2002).

This short-term demand, for example, is clear in the increasing worldwide demand for natural gas. The short-term solution (defined as 3–5years) for natural gas is liquefy (liquefied natural gas or LNG) it and ship around the world. LNG terminals are being proposed and build in almost every area of the world. But that strategy means for regions and nations enormous stranded costs (in the tens of billions) over the long term (15–20 years) before the facilities are paid for. Moreover the communities are now "energy dependent" on fuel supplies that are often not secure and due to increasing demand likely to be volatile and costly.

Other strategies are far more appropriate for both short and long-term energy generation which do not strand or lock regions and nations into a single and hence costly energy generation infrastructure. Renewables are one solution for many reasons. As indicated, the PRC appears to be moving in that direction. As a new paradigm, rather than continuing to be dependent on the fossil fuel and conventional central plant paradigm is a significant approach to achieving the national and local PRC energy goals and objectives. The use of hybrid technologies for infrastructures (such as green hydrogen stations) as noted above enhances, ensures and makes that short and long-term viable and cost effective.

4.7. Knowledge capital

The last theme is knowledge capital and concerns the future commercialization of technologies. Research and development (R&D) must continue, but become more applied as well through the commercialized and demonstration of technologies for a government driven market. What that means is that the PRC has an opportunity to create new businesses through technologies that are beyond the conceptual and patent period of R&D and ready to be demonstrated in the public sector market. Once that is done, and then commercial mass markets will result. This approach to innovation and economic development is exactly what the Japanese, British, French, Germans and Americans do but in different ways and to different strategies.

For example, due to the Bayh–Doyle Act in the late 1980s, the USA government permitted and encouraged the commercialization of knowledge capital (patents, inventions, publications) from USA tax generated funds for national laboratories, academic researchers and others into the private sector (Clark, 1996). The model had various degrees of success and failure (Clark and Paolucci, 1997a,b). One of the critical conclusions and lessons learned then was that the government had to be a "market force" and play a role in taking innovation to the mass market (Clark and Jensen, 1997).

For example, when the American idea of converting public funds to private sector commercialization, the problem was that the government needed to continue to play a "supportive role" (e.g. "social capitalism"). Some European nations and the Japanese in particular had figured that strategy out and been implementing it for decades. What they did was look a government as the "market driver" for innovation. Hence, financial structures and mechanisms were put into place including purchase of goods and services from companies demonstrating and commercializing new technologies.

After the Framework Convention on Climate Change was formed, for example, Clark became Director of a six-nation study on the transfer of "environmentally sound technologies" from developed to developing nations (Clark, 1997, 2000a,b). The focus was entirely on renewable energy technologies and documented the government as the market driver. The finance mechanism for the USA research community was likewise documented as to how intellectual property becomes commercialized.

There are many examples over the last ten years about how this social capitalism approach to innovation and technologies can work. But the critical strategy was to link innovation and education. Clark and Feinberg (2003) produced a "White Paper" for the Governor of California, titled "California's Next Economy" that both identified the upcoming economic development areas and the needs for education and training with specific universities and programs.

That paper identified critical areas or "waves" for economic growth in California, of which sustainable development, as new environmental and energy technologies are significant. The other waves are significantly related, such as infrastructures, nanotechnology, telecommunications, and digital and computing sciences among others. In order for any area to grow, education and training are of prime importance. Without an educated workforce as all levels, the new technologies cannot become ingrained in the State and cost effective to civic-markets.

5. Conclusions as opportunities

Under the social capitalism paradigm, China is able to develop reforms in the energy sector that impact the short and long-term development of its infrastructures. A specific focus on renewable energy in the energy sector means through the REL a sizable financial commitment over many years. This strategy re-enforces the national and local goals of the nation so that renewable energy becomes a significant element in the PRC energy infrastructure as well as providing environmental mitigation and reversing global warming and climate change.

The paper discussed the need for definitions of concepts, terms and numbers as they mean different things to different people. And it identified seven themes that enable the PRC to implement renewable energy projects which meet and even exceed the national energy and environment goals and objectives.

Social capitalism was discussed as the overall theme for the PRC but with specific importance to achieving the environmental and energy goals of the nation and its regions.

Sustainable development is clearly one of the key areas and when defined, it must consider both specific sectors but also be agile and flexible in how energy systems can be financed and implemented. Clearly the fourth theme of infrastructures allows renewable energy (theme five) technologies and plans to be hybrids or combined in order to be financed, operated and maintained more efficiently.

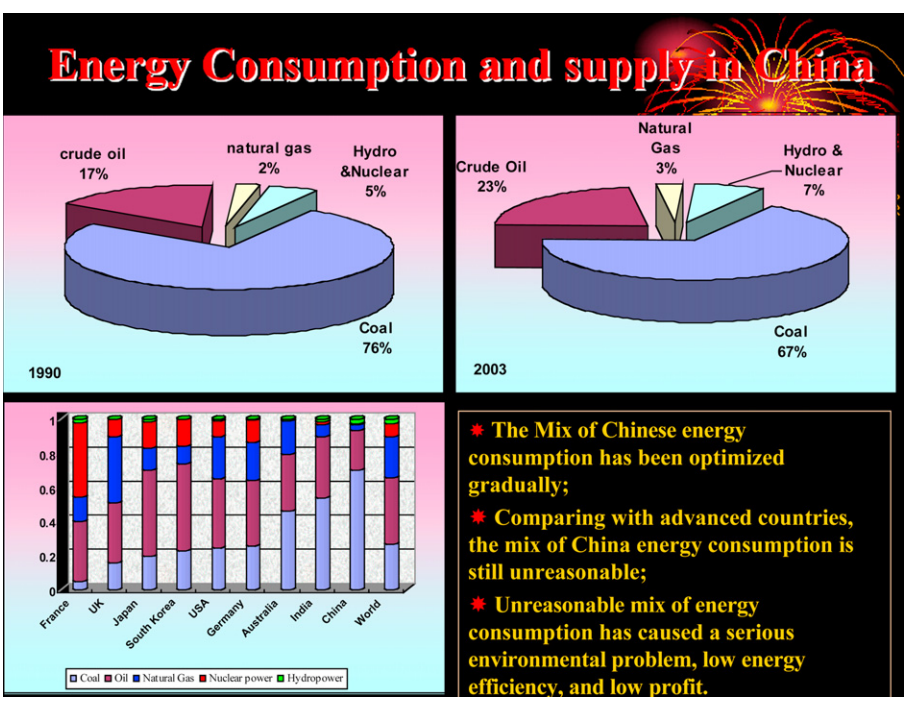
The last two areas of finance and knowledge capital are perhaps the "bottom line" in terms of making renewable energy a driving force in the PRC. Debt and equity funding have now become viable in the PRC as long as the government maintains oversight and even considerable ownership in the enterprises. In order for the nation to achieve and exceed its goals, it must provide long-term leadership from a government perspective for the private sector to have both confidence and stability. This "investment" from the PRC is for the long term (defined as from 10 to 50 years) in which finance and education (knowledge capital) are the most critical themes.

Appendix B: Renewable energy projections

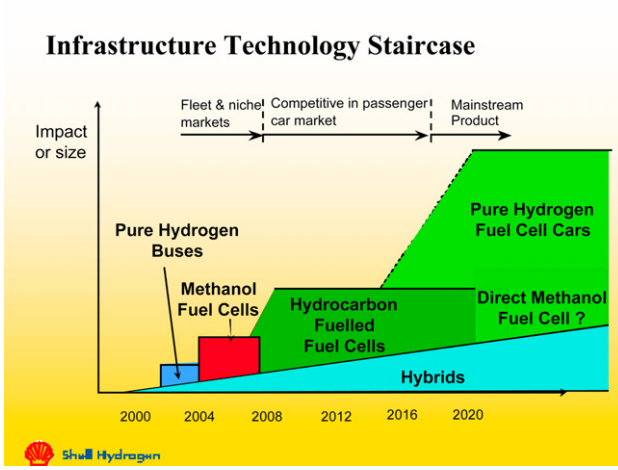
Expected Growth of Renewables in China Under REL (electricity)

Sector	Capacity, end of 2005	Expected Capacity 2020
Wind power	1,260 MW	30,000 MW
Solar electricity solar hot water not incl.	70 MW ~1/2 rural	1,800 MW incl. solar thermal elect
Biomass	2,000 MW	20,000 MW
Small hydro	37,000 MW	100,000 MW

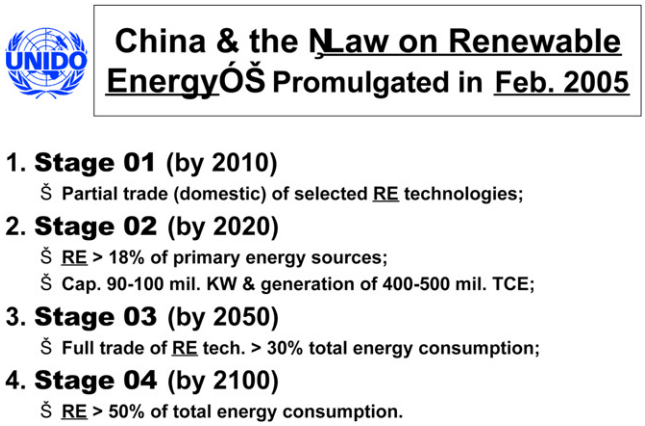
Appendix A: China's energy needs



Appendix C.



Appendix D.



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