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Decision making limitations from communication barriers in government structures in Chinese rural energy projects

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Decision making limitations from communication barriers in government structures in Chinese rural energy projects

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ABSTRACT

Field research was conducted in the Li Cheng District (about 1,200 km^2) of Shan Dong Province. Data collection occurred during a two-week period in July 2006. At that time, seven villages represented all relevant sites in the district that contained gasification technologies. Small-group interviews with village leaders, station managers, and community members were conducted locally. Contact with external government agencies and technology scientists completed the set of potential stakeholders.

This study analyzes the failure of state-owned energy development initiatives in China. Communication barriers in bureaucratic structures and culturally prescribed patterns of interaction were revealed as inhibiting information transfer, thus restricting capabilities for individual decision making, group decision making, and learning. These presented significant challenges to maintaining successful operation of community-level gasification technologies in rural Chinese villages.

1. INTRODUCTION

Development projects for countries with high poverty rates have been increasing in both research and application. Areas of focus include satisfying basic needs requirements and preserving environmental diversity (Stewart 1985). Identification of the end result and players involved are typically given the most attention while less effort is devoted to comparative analyses and development of effective implementation methodologies for specific situations. This limited experience with research or theoretically informed application inhibits effective decision making by development practitioners and policy makers (Shrum & Shenhav 1995). Comparative evaluations of past projects, particularly processes of project implementation, can be vital to successfully achieving goals.

Goal attainment in programs that address basic human needs is often assisted by some level of technological improvement or introduction. Decisions can be made to make technology the core component, or sole component, of the solution methodology. When little consideration is made regarding the suitability of technology for local environments, human customs, organizational structures, or economic systems, solution sustainability is low and rejection is high. Limited understanding of interdependent relationships between technology and society promotes poor choices and the emergence of technocratic solutions that do not fully account for human-based dependencies. As these integral elements are removed from planning and implementation, the risk of project failure increases from incomplete understanding of real world contexts for solutions (Johnson et al. 2006). Development initiatives that rely heavily on technical improvement can be

more successful through a greater breadth of analysis that encompasses principles derived from sociology, anthropology, and economics.

Representation of real world systems is improved by considering relevant theories in multiple disciplines (Betz 1984). This thesis emphasizes the need for multi-disciplinary analysis in technical development initiatives that involve both natural and social elements. The approach and methodology must incorporate elements of each discipline to provide more complete understanding of real world processes. In the natural sciences, mathematical models and quantitative formulas are the primary methodological tools for data analysis and the description of physical laws. These models are useful for analyzing thermodynamics, chemical states, pollution production, and financial flows, etc., but are weak in portraying relationships between social and technical phenomena. The interaction between social systems and technical systems becomes reduced to numerical representations that fail to describe underlying factors such as norms and values. In this thesis, social systems and qualitative analyses are the primary focus and natural system considerations with quantitative analyses provide supporting evidence. This multi-disciplinary approach investigates causality and the complex interactions leading to failure of technical development programs.

Modeling interdependent relationships of socio-technical systems can promote better planning and implementation. Appropriate policies and structures must be put in place to account for variability in the multitude of influences and consequences inherent in the real world. As the British industrial sociologist Joan Woodward states, “different technologies impose different kinds of demands on individuals and organizations, and those demands have to be met through an appropriate structure” (Woodward 1965:vi).

This statement clearly articulates the need for organizational structures suitable for the technology introduced. However, this statement is one-sided as technologies must also be designed or chosen to fit with existing social and organizational structures. Understanding the influence of changes in technological or societal systems will promote more synergistic organizational structures and help improve development programs.

China is undergoing numerous development initiatives with national goals producing cleaner energy to confront rising pollution concerns (People's Republic of China 1997). These programs are introducing a variety of renewable energy technologies to reduce reliance on fossil fuels (People's Republic of China 2005). Nuclear and biofuel power generation are leading the way in urban and rural areas, respectively. As seen rural villages of Shan Dong Province, gasification technologies are being introduced to produce cooking gas from solid biofuels. However, a significant portion of these projects are failing and no evaluation has been conducted to establish the cause of failure. This thesis discusses research designed to understand factors contributing to gasification station shutdown. The central research question is whether poor decisions leading to station failure were a result of formal and informal barriers to communication. Structural influences in communication break-down are examined to provide recommendations for improved information transfer and decision making. Theories from organization structure, public administration and governance, conflict and negotiation, communication structures, technology adoption, decision making, and discourse analysis are utilized to develop an interdisciplinary appreciation for the multi-faceted problem. Considerable weight is given to cultural and political concepts rooted in Eastern viewpoints to more accurately describe the context of the problem in China.

Figure 1. Shan Dong Province is darkened area. Star is Beijing.[1]

[1] Image retrieved on April 20, 2007 [www.china.org.cn/images/en/privince/gesheng/shangdong2.gif]

2. TECHNICAL BACKGROUND, PROBLEM STATEMENT AND RESEARCH APPROACH

This chapter introduces the science and operation of gasification technology, provides a description of the research problem, and gives an overview of the approach used to conceptualize interactions between technology and science.

Station shutdown is the central problem focus in this study. The research approach uses theories of formal and informal structure to describe social influences of station shutdown as reflected in technical, economic, and natural resource failures. Theories from organization structure, public administration and governance, conflict and negotiation, communication structures, technology adoption, decision making, and discourse analysis are utilized to develop an interdisciplinary appreciation for the multi-faceted problem. Considerable weight is given to cultural and political concepts rooted in East Asian viewpoints to more accurately describe the context of the problem in China.

2.1 TECHNICAL BACKGROUND

An overview describes gasification application and introduces the technical elements for consideration with social elements for better understanding station failure.

2.1.1 Description of Gasification Process

Gasification stations described in this thesis produce a combustible gas that is burned in the home for cooking and heating. The process of creating this gas is known as *pyrolysis*. As solid organic material is heated in the absence of oxygen, solid char is left behind while hydrogen, methane, carbon and oxygen compounds, and tar are released in

gaseous form. The resulting mixture is commonly referred to as *stack gas*. This process is most effective with pyrolysis in the range of 200–500ºC (Borman & Ragland 1998). The reaction occurs within a fire box that limits the supply of oxygen to promote higher levels of pyrolysis while a restricting complete combustion. The resulting stack gas can be burned directly with the introduction of oxygen at high temperatures or can be sent through water to remove tar that can "gum up" storage containers or pipes and be released in the household kitchen. After tar has been removed, the gas is pumped into storage containers and later distributed to households through buried piping. Inside the home, a conventional LPG or natural gas burner is used for cooking. Additional household equipment includes a meter to measure gas consumption, and a valve to regulate gas flow and flame intensity. A flow diagram illustrating gas production is shown in Figure 2.

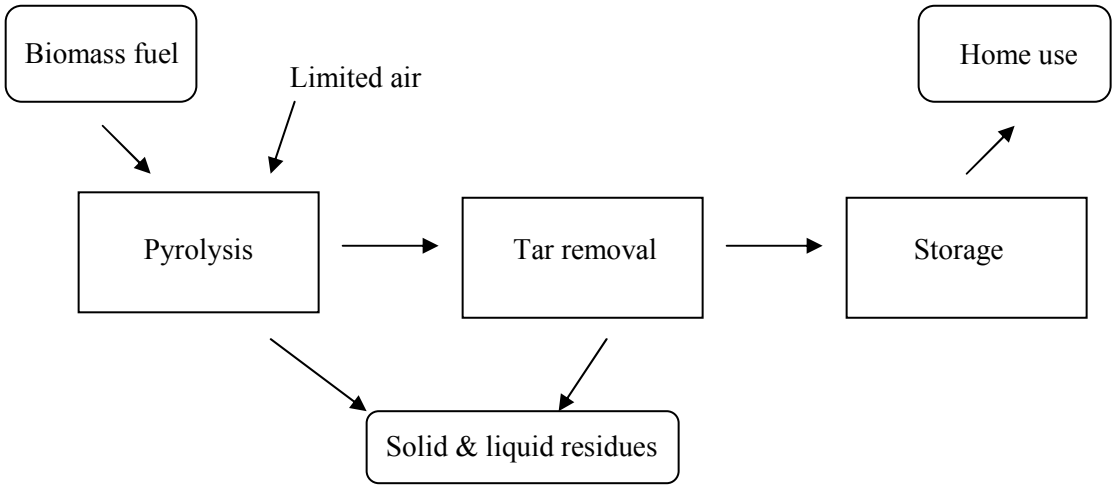

Figure 2. Gasification process from pyrolysis to the home.

Another form of combustible gas produced from organic matter occurs through anaerobic digestion. This process involves biodegradable waste or feedstock that

ferments to yield a gaseous mixture composed principally of methane and carbon dioxide. This combustible mixture is typically referred to as *biogas* or swamp gas. Although biogas and stack gas can be stored, distributed, and utilized in much the same way, production methods and fuel requirements are dissimilar (Anderson et al. 1999). Infrastructure required to support each is different, making analysis of the two as a single technical group unwise. Therefore, this paper focuses on stack gas production in pyrolized gasification stations and does not include a comparative assessment in biogas.

Natural resources are the primary fuel for pyrolized gasification plants. In agricultural areas, feedstock is typically waste residue, such as straw or stalks. More industrial or commercial areas may instead use raw fuel or manufacturing wastes such as charcoal, sawdust, wood chips, peanut shells, and fungus. Dense biomass that is coarsely ground (woodchips, sawdust, peanut shells) is a more appropriate feedstock while less dense biomass (straw or grass) is less effective. Although feedstocks have varying effectiveness (energy content, ash / moisture content, density, etc.), selection of fuel is also related to cost, availability, waste removal, reducing outdoor / indoor air pollution, reducing workloads, and decreased overall cost of cooking gas.

2.1.2 Reasoning for Gasification

Using centralized gasification of biomass for cooking and other household energy needs can significantly improve human life in the developing world. The most important benefit of using centralized gasification of biomass is the reduction in smoke and airborne particulate matter. Centralized gasification of biomass has the potential to decrease outdoor air pollution and, if used for cooking, indoor air pollution as well. Outdoor pollution is decreased from the removal of open fires in fields or along roads;

indoor pollution is decreased through using a gaseous cooking fuel with lower levels of particulates and emissions than when burning rice or straw. Significant levels of smoke and ash is removed from the air that can otherwise restricts vision and be hazardous when working or operating vehicles. An additional benefit of gasification is disposal of sawdust, peanut shell, coffee husk, or other commercial wastes that would use space in a landfill or be piled along roads.

Benefits of gasification are also seen within the home. Poorly combusting straw, wood, or charcoal burned within the home can be substituted with a clean-burning gas. The removal of solid biomass for cooking in the home helps address indoor air pollution, which is ranked as the world's eighth largest health risk by the World Health Organization (Baris et al. 2002). Eye infections, respiratory diseases, and infant deaths from smoke inhalation are greatly decreased (Desai et al. 2004; Ezzati & Kammen 2002), leading to better livelihoods for families. Gasification technologies can also reduce cooking hazards attributed to burning solid biomass (Johnson et al. 2005), decrease time needed to gather fuel and cook (Heltberg 2005), and empower women through a better working environment (Mahat 2003).

2.2 PROBLEM STATEMENT

The central problem in this study is understanding the conditions and forces causing shutdown of the majority of gasification stations in the Li Cheng District (about 1,200 km^2) of Shan Dong Province, China, after a short period of operation time (six months to three years). Shutdown is commonly attributed to lack of funding due to low

income and high equipment costs, though additional factors concerning technology, economics, policy, and the consumer interest must also be considered.

The pyrolysis process is technically difficult to maintain. Ease of operation and gas quality is highly influenced by maintenance level of the equipment and feedstock quality. The machine requires regular maintenance and cleaning. Replacement parts are also necessary as the equipment degrades – an operation that is normally required more frequently when proper maintenance and cleaning is not completed. The selection of feedstock, storage, and pre-processing is also important. Feedstocks should have high energy values, low moisture content, and a low ash content, while also being high density but formed into small particles (e.g., sawdust is better than wood chips).

Equipment quality can be 'hit or miss' as research is ongoing and testing occurs in the field. Technological advancements can make operation and management easier, but this process is far from complete. Experimental designs placed in the field can perform much differently than in the laboratory. Additionally, new designs created every few years do not provide long-term testing or support for models implemented.

Supporting technologies required for utilizing the gas can pose further problems. Gas storage containers, piping, meters, regulators, and home-use cookers are other components of the technical system in addition to the gasifier itself. Proper selection of materials and suppliers can be difficult for persons with little background knowledge in the area. Residents of rural development projects may need to make decisions in unfamiliar areas, increasing the chance of failure.

Economic regulations may also cause problems for gasification station success. Price regulation of the feedstock (input) or the cooking gas (output) can economic

viability difficult for stations. Price fixing by station managers may create unfavorable conditions for station success. Large-scale maintenance is another issue because funds cannot be saved if the station breaks even or is losing money. Corruption and financial squandering is yet another economic and governance issue that can lead to failure through poorly monitoring. Even station managers with good governance practices face difficulties in allocating funds and maintaining equipment from limited technical understanding.

Consumer interest and opinion must also be addressed to maintain demand and sales revenue. If gas quality decreases, consumers may switch to another form of fuel or simply stop paying for gas. This problem can be amplified if gas prices are fixed and consumers pay a flat rate regardless of varying gas quality. Lower-quality gas can be attributed to difficulties in maintaining good pyrolysis, experimental nature of the equipment, lack of understanding of gas production, feedstock quality, poor operational maintenance, and little funding available for large-scale maintenance or upgrades.

2.3 RESEARCH APPROACH

Technical development initiatives should be modeled to include the interrelationships between natural and social science systems. Technology introduction that considers affected sub-systems as interdependent (Wallerstein 2004) can integrate theories and factors within and between each system (Bertalanffy 1976). In this research, a similar approach is used to understand the influence of formal and informal social institutions on the technical initiative.

3. CONCEPTUAL APPROACH: INFLUENCES OF STRUCTURE ON STATION OPERATION

This chapter presents the theoretical basis for explaining problem areas introduced in Chapter 2. A range of issues influence station operation and success (Figure 3). This thesis describes a variety of these influences on station success through decision making practices in operation and governance. Communication systems and norms are included in developing the conceptual model to understand the influence of formal and informal communication structures on decision making and station operation (Figure 4).

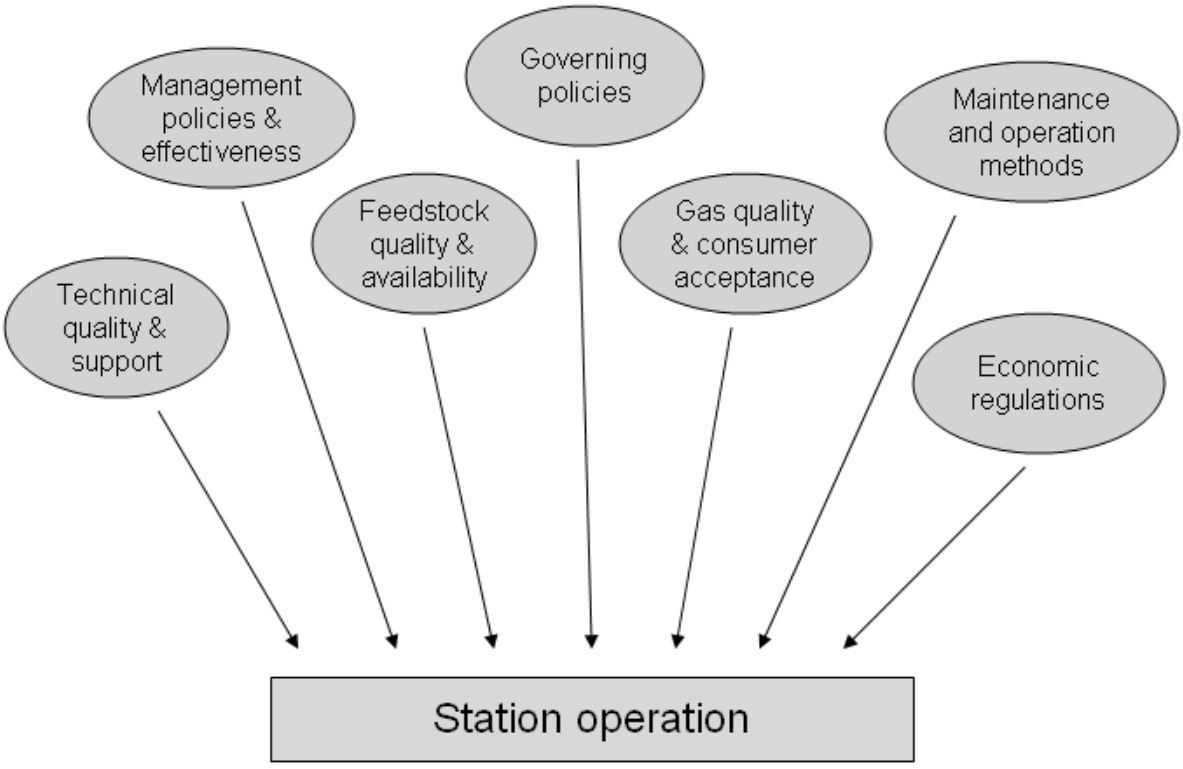

Figure 3. Diverse influences on station operation.

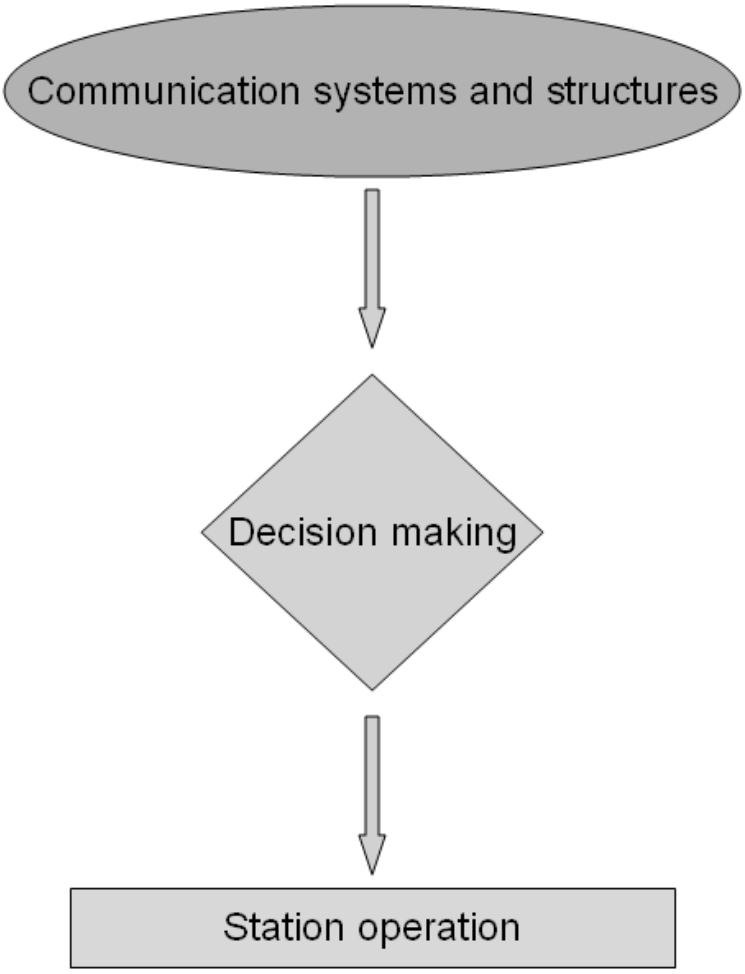

Figure 4. Conceptual model illustrating casual links between communication structure, decision making, and station operation.

The central conceptual problem is to identify communication barriers that inhibit information exchange and utilization, and thereby increase the probability of poor decision making that leads to station shutdown. The effects of behavior and individual thought processes are no doubt influential in explaining decisions (Weber et al. 2004), but focus here is placed on communication structures. Understanding the structural influences presents an integral part of the picture that can also serve to evaluate individual actions.

The casual impact of decision making on station operation is assumed. The degree to which various decisions influence station success, and the effect of communication structures upon those decisions, is presented in the analysis chapter. This chapter develops the first causal link to describe how communication structures influence decision making. Three concepts are discussed to illustrate the effect of communication frequency and content on decision making: (a) connectivity and relationship structure; (b) orientations of conduct and tendencies in human interaction; (c) conflicting perceptions among stakeholders. The latter can be understood through appreciating cultural discourse relationships and establishing differences between development program perceptions and practice.

3.1 COMMUNICATION IN DECISION MAKING

Developing the influence of structure on decision making requires conceptualization of (a) formal and informal structures, (b) the effect of structure on communication, and (c) how communication influences decisions.

3.1.1 Conceptualizing Communication Structures

The influence of formal or informal communication structures must be analyzed together to capture interdependencies (Durkheim 1947; Thompson 1963). This coupled nature is acknowledged by conceptualizing communication structures as (a) networks of connectivity or relationships, and (b) shared beliefs and orientations that guide conduct (Blau & Scott 1962). Established networks of connectivity can be formal bureaucratic structures or relationships based on the cultural significance of status (kinship, career, gender, age). Communication exchanges that occur within these networks are influenced

by shared beliefs -- conduct orientations can be written procedures of interaction in organizational charts or general tendencies representative of cultural practices.

3.1.2 How Structures Influence Communication

Networks of connectivity and behavioral orientations shape communication through the frequency of interaction and information exchanged among actors. With greater communication frequency, there is greater potential for new information to be relayed, decisions to be assessed, and stakeholder interests, capabilities, and concerns to be addressed. Communication content is pertinent as it defines what information is transferred and available to influence decisions. Communication context is relevant in understanding potential discourses that determine what is perceived based on what is stated.

3.1.3 Roles in Decision Making

Networks of connectivity and conduct orientations shape individual and group decision making practices through frequency and content of communication. Networks enable access to information or persons to influence decisions. Behavioral orientations shape the degree of influence in decision making by any individual or group through roles and responsibilities. Inequalities in formal and informal group structures produce varying degrees of individual influence on decision making. The frequency, content, and context of communication are reliant upon these factors. Communication is an extension of this model to include how individuals struggle to influence one another through implicit social understanding of their roles in decision making. A similar concept is described in the work of Pierre Bourdieu who described decision making by individuals in a social situation with a specific system of dispositions influencing actors (1977). In

his view, actors compete for social capital in political or economic environments to gain power but simultaneously reinforce legitimacy of the system of operation by not challenging its validity. Therefore, decision making is assessed through understanding information transfer and interaction within an established and reinforced field that may need structural modification to support effective operation.

Participatory communication and decision making in organizations. The effectiveness of an organization's decisions is dependent on the communication systems used to transfer information. Greater interaction between stakeholders is present in participatory approaches that employ downward vertical links to incorporate many persons instead of only one or a few actors (Krishna et al. 1997). With committees and assemblies that involve a variety of people, there is a tendency to increase the effectiveness of local organizations to achieve goals (Esman & Uphoff 1984). This is done by increasing information transfer, discussing ideas, and establishing trust (Bina 1983).

Learning and decision making. Feedback is an important element of learning whereby an individual's action invokes a response in a system that informs the actor of the consequences of the initial action. Feedback is a form of communication that occurs personally (between two or more people) or impersonally (from the environment or technology to the actor). Understanding the meaning of feedback and accounting for responses in the environment can significantly alter an individual's decision-making ability. Feedback provides a form of control over action by influencing decisions when information is acknowledged and processed. Feedback allows for assessment of actions and modifications if adjustments are required.

3.2 NETWORKS OF CONNECTIVITY AND RELATIONSHIPS

Including relevant stakeholders in the network of connectivity enables discussion that illuminates information to guide decision making. Understanding needs and interests of consumers are integral to successful firm action (Oudshoorn & Pinch 2003). This helps develop understanding of daily life activities to advance production of a viable technology (Bernardo & Kilayko 1990). Interacting with technology users is also beneficial for development success through monitoring any adaptations that occur on the ground once a product is introduced. Expanding the network of connectivity to include technology designers helps bring human resource support for complex projects. Including program policy makers and funding sources in local communication networks promotes better policy creation. Involving higher-level political players also ensures supportive, or at least non-competitive, policies for station operation. Stakeholders and communication links are shown in Figure 5 for informed and inclusive decision making.

3.2.1 Vertical and Horizontal Connectivity

There are two primary directions for information to flow within a network: vertically and horizontally. Understanding the uses of vertical and horizontal information flow can demonstrate which links are effective at promoting effective decisions.

Vertical connectivity. A hierarchy of authority is characterized by centralized decision making in which vertical links dictate rules, guidelines, and actions from upper levels to lower levels of the organization (Daft 2004:89). This centralized empowerment of authority is generally referred to as “command and control,” and is effective in governing routine tasks designed for efficiency. Individual influences in organizational actions primarily flow downward. This captures the benefit of guidance by superiors, but

lacks upward vertical links that can be used by persons in lower levels of the organization to influence persons in positions of authority.

Vertical relationships can be drawn in communication systems from the bottom up if conduct protocol allows persons of lower hierarchy to provide feedback or input to persons of higher social roles. These upward vertical links can provide support mechanisms to development managers in the form of advice or expertise (Johnson et al. 2006; PEMBINA 2005), if protocols are in place to acquire and utilize the information. Relationships to higher levels of government can promote local organization effectiveness with appropriate guidelines and procedures, and an adequate supply of resources.

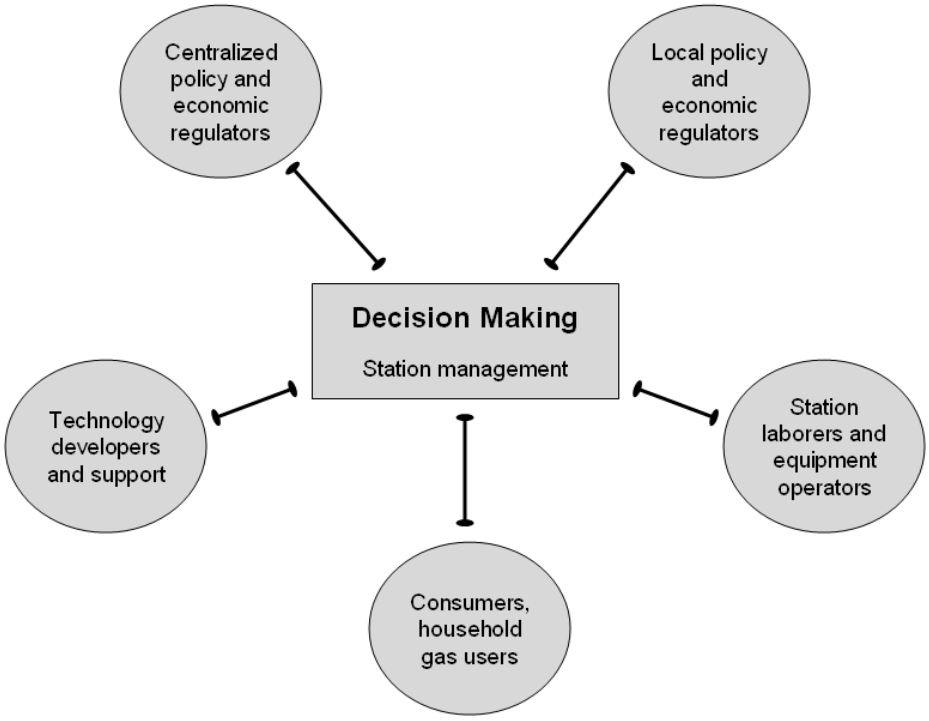

Figure 5. Network of stakeholders for effective communication in decision makers.

Distributed horizontal networks of decision making. Horizontal networks of organizational structure allow for collaboration and exploratory problem solving through a high degree of shared information (Daft 2004:28-31). Decentralized decision making is often attributed to organizations with a horizontal communication structure. This arises in the movement away from the hierarchy of authority and top-down approach of organizational action. Interactive management is instead emphasized and incorporates practices essential to unique contexts with problematic situations that involve complexity (Warfield 2006). This act of adaptation is a central trait in a learning organization (Katz and Kahn 2006), which incorporates new information to promote better decision making.

Promoting involvement of stakeholders removes connectivity barriers that are present in centralized organizations. As such, these newly-forged communication pathways enable discussion of a wider range of actions and interpretations. Greater recognition of diverse feedback mechanisms also allows horizontally-structured organizations to respond better to turbulent environments. This is useful for interaction between station operation management, local policy makers, and technology developers. Furthermore, persons in similar positions in an organization can collaborate to share experiences and make comparisons between decisions as useful for station management in different townships. An ideal structure of connectivity is shown in Figure 6 with horizontal and vertical linkages connecting each existing stakeholder within a structure relevant for supporting successful station operation. Dotted lines indicate connectivity to additional stations and townships.

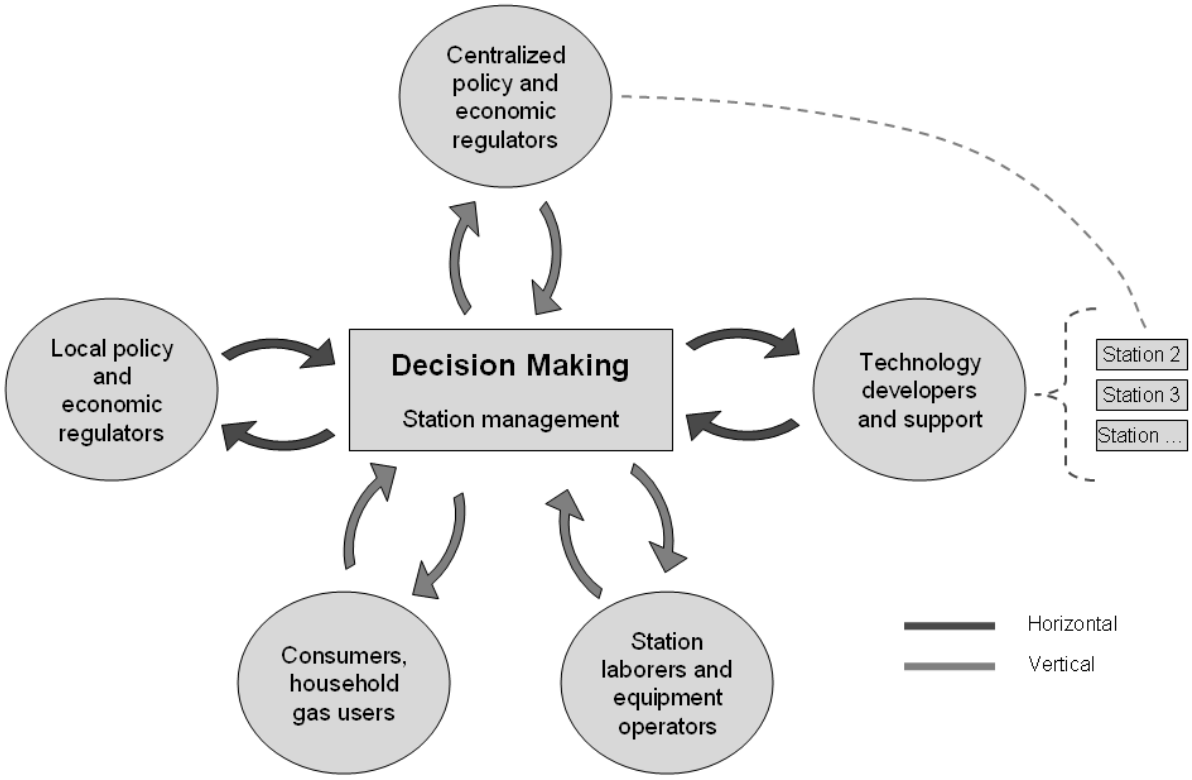

Figure 6. Ideal forms of connectivity and feedback for existing stakeholders.

Figure 6 illustrates the ideal model for formal connectivity by which problems can be assessed and solved by decision makers. The model illustrates communication pathways for feedback and information transfer by each stakeholder to support station operation. Concepts used to evaluate this model and the role of individuals to promote station success is developed through subsequent analyses to support effective structure and protocol for transferring information. Local habitus and Chinese dispositions are used to develop this connectivity and evaluate its benefit to mitigate station failure. Suggestions can be made for changes to organizational structure, formal roles and responsibilities, reporting mechanisms, etc. to work effectively with cultural elements that are unchangeable and inherent to the socio-technical system.

3.2.2 Bureaucratic Structures of Connectivity

Two of Max Weber's fundamental concepts in formal bureaucratic structures add understanding to connectivity in this study: hierarchy of authority and the division of labor (Weber 1947, 2003). Rules, regulations, and policies are written down and made legitimate. People can be differentiated by their achieved power as social roles are fulfilled (Bourdieu 1977). This contributes to differentiation between members of an organization and dictates patterns of connectivity. Formal lines of authority via written rules and regulations establish channels through which communication flows and authority is expressed in decisions (Rice & Bishoprick 1971).

3.2.3 Cultural Systems of Connectivity

Culturally constructed roles and corresponding ranks differentiate levels of influence or authority. Establishment of social status and rank defines a person's influence in his or her network while integration determines the social acceptability and expanse of his or her connectivity (Blau & Scott 1967). These informal factors of Bourdieu's habitus alter communication pathways and decision making by changing the shape of connectivity and authority. Understanding these unwritten patterns of connectivity is instrumental to understanding the influence of a formalized structure of relationships in society (Parsons 2003), and that power to make effective decisions is transferred as knowledge between stakeholders (Foucault 1980).

***Guanxi* and *mianzi*.** *Guanxi* (personal relationships) can be ascribed through locality, kinship, or career, or be embodied though the actual experience of two people (Yang 2000); they encompass "dispositions and practices that emphasize pragmatism, interpersonal dependence, bodily discipline, gender and age hierarchies, and other ethnic-

specific modes of social production and reproduction" (Ong 1999:116). Establishment of *guanxi* entails strong intra-group connections that create a "particularistic relationship between people that leads Chinese to be more likely to engage in conflict with out-group members" (Chen 2002:4). This is done through acts of "connection-building deal-making, haggling and shielding of all with and against all at every level of society" (Chen 1998:93). Establishing guanxi requires social networks, and as such these networks are central to Chinese lifestyle (Lowe 2003). The observance of *guanxi* has been instilled through

> living so closely involved with family members, neighbors and other people has accustomed the Chinese people to group-oriented collective life that gives high priority to interpersonal connections and community life (Chen 1998:93).

Mianzi is social prestige, or face (Huang 1988). It can be conceptualized as the "social position and prestige one earns or gains from the recognition of group members" (Chen 2002:4). *Mianzi* is an informally ascribed status similar to respect given to elders, persons in positions of authority or importance, those with valued jobs or education, foreigners or newcomers, to name a few. A person's relative social position can be modified by given or taking away *mianzi. Mianzi* is an important contextual feature of communication as those in higher areas of social prestige are given precedence in conveying thoughts and often not contradicted or disagreed with, especially in a public setting. As such, there can be significant discord between reality as told to the public and reality as believed or perceived by individuals.

3.3 NORMS OF INTERACTION

The expectation that individuals conform to social roles promotes a formalized structure of conduct in which each acts in accordance with the political system and abstains from disruptive or deviant behavior (Parsons 2003). Interactions among people in similar roles and among different classes entail systems of dispositions based in large part on cultural norms and fulfillment of these social roles. Understanding the effects of culture on communication provides a useful context by which to examine discourse-based relationships and potential barriers to information transfer that hinder decision making. This is done through appreciating the cultural logics that make actions "thinkable, practical, and desirable" (Ong 1999:5). In political organizations, these informal mechanisms and codes of behavior can be as important, if not more so, than formal rules put in place by established authority (Fukui 2000).

3.3.1 High-Context and Low-Context Communication Dispositions

A high-context structure is often used to describe interaction in Eastern societies, while a low-context structure is a popular typology for Western societies. Eastern high-context cultures engage in communication that is laden with meaning that would need explicit wording in Western low-context cultures. This means that more information than is spoken is transferred in high-context cultures (Hale 1976). This additional meaning is gained through understanding the context of the setting or person whereby meaning is internalized and not be explicitly given. Low-context cultures instead emphasize meaning more explicitly in the form of words. This dichotomy provides helpful information about two possible extremes in communication. However, this concept can lead to a stereotypical view of Chinese culture and communication (or for that matter, Western

culture and communication). Instead of utilizing either extreme as a static characteristic that is unchangeable by individual interest / action, they are taken as general patterns by which individual communication and culture are interrelated and exert mutual influence on one another (Lu 2002). These dynamics can be present in any society and, as such, the context of communication is conceptualized more appropriately as being in a state of flux (Chuang & Hale 2002) and not absolute.

3.3.2 Characterizing Social Roles and Dispositions

Culture is the product of history and defines individual and collective practices, forming a system of dispositions that people generally follow (Bourdieu 1977). It is embedded in human action, and contributes to social behavior that "is conditioned by the roles and statuses that we accept, the groups to which we belong, and the institutions within which we function" (Schaefer 2004:104). As such, societal culture has direct influence on collective norms and individual behaviors (Daft 2004) that must be considered in communication analysis.

Diverse geographies, stages of economic development, languages, religions, and histories characteristic to China make generalizing social structure throughout the whole of China difficult. Nearly one and a half billion people bring great diversity in culture, thereby creating a range of standards in relationships and communication. Though much work is needed to differentiate styles of negotiation among the peoples of China (Cai & Waks 2002:188), a review of basic concepts is helpful to better understand the interrelationships between connectivity and shared belief systems in communication.

***Li* – the gentleman's game.** Another cultural structure that influences individual behavior and disposition is *li*, or the "gentleman's game." *Li* can be conceptualized as the

practice or propriety, rite, ceremony and rules of conduct (Xiao 2002) that typify the Confucius model of man, *junzi* (gentleman). The *junzi* practices the game of *li* by "being loyal to and considerate of one another and interacting purely based on the principle of propriety" (Yang 2000:90). Yang states that below this top layer of social interaction exists an intrapersonal level where "people's personal needs and desires are pursued and fulfilled through some carefully calculated exchanges, while they are cultivating themselves to have less such demands" (2000:90). On the intrapersonal level hidden from public view, a person attempts to fulfill the desires of their *xiaoren* (mean person, or literally, little person). This second layer is different from the "respect" or "proper behavior" of being a *junzi*, and employs reciprocity to fulfill one's individual goals (interests of the *xiaoren*) through the culturally appropriate method of "I do this for you and you this for me." As such, the two main rules in *li* are respect and reciprocity.

Li influences communication by offering appropriate conduct rules based on the position of oneself and the other in society (rank, family, official, generation, sex, etc.). Following guidelines of social interaction, or expressing "competence and skill in the performing of *li*" (Xiao 2002:42), gives power to the "gentleman." This concept is not limited by class, status, or race, but can be practiced by all members in Chinese society. Discord in information transfer is created through the roles and dispositions of those involved, the topic of interaction, and the environmental circumstances (public vs. private). Disagreeing viewpoints must be considered in the context of rules of conduct and discontent management.

3.3.3 Managing Discontent

Understanding power relationships is essential to developing a framework that incorporates imbalances in decision-making capability between individuals and how information is contextually embedded in communication while observing *li* and respecting *mianzi*. Situations of debate and open discussion have poor communicative rationality (Habermas 1971) due to tendencies in respect, social acceptance, cohesion, and self-confidence that prevent unrestricted communication of ideas. Discord in this situation occurs because of a disconnect between what is displayed externally and what is understood internally. These cultural dispositions and formal processes for negotiation and conflict management are essential for understanding communication breakdown and the effects of individual behaviors (Liu et al. 2005) that can either improve or degrade objective information transfer.

Preservation of *mianzi* and recognition of authority and seniority appear to be additionally important in averting conflict (Chen 2002; Chen & Starosta 1997). Observance of another's prestigious social status may decrease the occurrence of public conflict but in turn creates discontent that must be managed. Discord in perceptions of reality is created when information is not relayed or is falsely given to preserve face for a person of higher status. Meaning can instead be internalized rather than stated in the public sphere.

Differences between Western and Eastern conflict scenarios are evident in that conflicts in Western societies are often characterized by confrontation, directness, objectivity, and logic whereas conflicts in Eastern societies favor avoidance, indirect communication, and intuition in construction of truth (Chen 2002). This extreme

viewpoint is accepted on certain fronts but rejected on others that state that Chinese conflict is more confrontational and competitive than peaceful (Blackman 1997; Faure 1999). However, in either case, little empirical research has been done to conceptualize or construct general theories on the relationship between Chinese negotiation and Chinese cultural structure (Cai & Waks 2002).

Yuan. Examining how discontent is handled presents a starting point for understanding discord and resolution between individuals. *Yuan* can be conceptualized as the behavior that expresses discontent (Peng 1993). This term is also used to describe the state of a person who is in discontent but issues no reprisal onto another. This feeling of discontent is often internalized and does not come to the surface in direct interpersonal exchanges. Instead, face-to-face conflict is often avoided in favor of indirect methods to handle discontent. Peng performed a series of interviews to assess why persons prefer to be tactful or "say nothing" as opposed to being direct in their discontent. Peng found four main reasons that people choose the indirect approach. As summarized by Gao & Xiao these are:

> (1) concern for ethics (e.g., to show respect for others), (2) concern for strategy (e.g., an indirect method is believed to achieve a better result), (3) concern for *mianzi* (i.e., to not let others lose face), and (4) concern for self-interest (i.e., fear of revenge) (2002:28).

Positive management of discontent in China is centered in *guanxi* relationships and in striving for harmonious living with others (Chen & Chun 1994; Kirkbride et al. 1991; Liu et al. 2005; Yang 2000:88).

Variation in handling discontent. Peng distinguished between how people deal with *yuan* based on whether they are included or excluded from a *guanxi* (relationship)

circle. Those within the circle tend to express discontent and grievances more directly due to the established trust, while discontent to outsiders not in the relationship circle is expressed with self-control and restraint to maintain harmony. Strangers are given their own category as they have not yet been included or excluded from the relationship circle. Direct expression with strangers is acceptable because there is little likelihood of future encounters (from translated summary of Peng 1993 given by Gao & Xiao 2002). This thought is extended by Chuang & Hale: "[in conflict situations] not all Chinese are inclined to employ an indirect approach." They go on to state that "when observing Chinese in their interactions with relatives or acquaintances, one finds that most Chinese are out front and less concerned with tactfulness" (2002:74), supporting the direct conflict management theory in certain situations and with certain people.

3.4 INTERPRETING DISCOURSE IN PLANS AND PRACTICE

The discursive nature of perceptions can be attributed to how individuals interpret and utilize information within varying social contexts. These contexts, as characterized by culture and the situational environment, define how people make realities out of abstract concepts. This is characterized here in the implementation of planned communication and decision-making frameworks. Understanding how social contexts influence individual perceptions of plan enactment is influential in discerning areas of communication breakdown, whether they arise from poor planning or poor practice.

3.4.1 Flexible Contracts and Formal Plans

Contracts in China are considered more flexible than those made in Western societies. This is related to the cultural belief in Chinese that contracts are not "final" but

are expected to change and that promises may not be upheld. Strong interpersonal relationships are seen as having greater value and being more reliable that written documentation (Chen 1993:148). This creates a decision process that occurs in stages rather than a decision point that is characterized by a solidified and stable agreement (Cai & Waks 2002:184). Discord between the formal plan and its enactment can occur from differences in individual interpretation and how to best maintain *guanxi* networks.

3.4.2 Decision Making and Communication in China

Scholars often emphasize the pluralistic and non-analytical aspects of Chinese decision making, focusing more on obtaining subjective, self-ascribed understanding rather than objective truth and rational thought (Chen 2002). Though aspects of pragmatism in Chinese thinking (Lowe 2003:13) and interpersonal relationships (Chen 1998:93; Ong 1999:116; Yang 2000:88) may generally be true, the wholesale acceptance of this extreme is stereotypical if considered as a universal standard in Eastern societies. Little room would be left for rational choice by confining decision making completely within the interest of preserving harmonious relationships. Instead, a continuum that can vary in degree between singular or pluralistic extremes, depending on the context of the situation and the person of interest, is considered representative of Chinese decision making.

4. CONCEPTUAL MODEL AND ANALYSIS

The central purpose of this study was to *assess whether poor decision making contributed to station failure and if structural barriers to communication prevented making better decisions.* This central research question is addressed by considering four related factors: (1) difference between actual formal connectivity and ideal structure introduced in Chapter 3, (2) how formal reporting mechanisms, roles, or codes of conduct influence information transfer and decision making, (3) the effect of decisions on station operation and success, and (4) how culture influences the frequency and content of communication. Answering these questions will help explain how connectivity, interaction tendencies, and differing perceptions may restrict the capability of making good decisions. These formal structures may be re-designed to work more effectively with present technology, culture, policies, and resources to promote station success.

This chapter begins by describing key questions used to assess the conceptual model. Evaluation occurs with the community as the principal unit of analysis. Field research is conducted for data collection in rural Chinese villages while qualitative comparisons and discourse analysis are used to interpret data. Ethical considerations during field research and reporting complete the chapter.

4.1 INDICATORS OF STRUCTURAL INFLUENCE ON DECISIONS

The influence of structure on decisions is assessed by examining three forms of information exchange and levels of interaction: (1) knowledge transfer between stakeholders (vertical and horizontal) to inform individual decision making, (2)

collaboration to confront multi-level problems that require action by more than one stakeholder, and (3) feedback or assessment methods to address the quality of decision making or the authority of those in power.

4.1.1 Decisions and Authority

By discerning the authority and extent of each stakeholder to make decisions, it is possible to gain insight into the prevalence of centralized and decentralized governance in China. Discovering the fragmentation of decision-making responsibilities and varying degrees of stakeholder influence can help demonstrate where additional connectivity and information is needed to make better decisions, and whether the level of decentralization is appropriate. This formal connectivity is related to the content of communication and roles of authority which stakeholders can use to influence decisions.

Cultural influences on authority and decision making are represented by actors' interest to build *guanxi* between stakeholders instead of creating public discourse, questioning authority, disrupting harmony, and generally breaking rules of the "gentleman's game". Instead of shaming a person by directly or publicly stating disproval, the issue may be kept private and left unresolved. Persons of authority may not obtain critical advice due to unwillingness to provide information that goes contrary to the present state of operation and decisions.

4.1.2 Limited Information Transfer to Individual Decision Makers

This point of analysis addresses how connectivity and behavioral orientations shape decision making. The main topic of interest is to understand which patterns of interaction prevent information transfer between actors. Sub-topics concern information content and defining which stakeholders have information that can promote better

decisions, and assessing whether key decision makers understand the information and are applying it to promote station success.

Connectivity must be present between station management and key stakeholders (consumers, scientists, and policy makers) to allow information exchange to aid decision making. Connectivity and content of the ideal conceptual model is compared against the planned organizational structure and its implemented structure to evaluate where barriers in communication detract from individual decision making ability. Even if formal connectivity exists, the frequency and content of interaction must be assessed. Examining discord in perceptions of the decision-making process and decision quality between key stakeholders is useful in understanding areas of poor communication or disagreement. A non-expression of opinions is characteristic of *guanxi* and *mianzi* during communication between persons of different social roles, especially when levels of authority or seniority are dissimilar.

4.1.3 Lack of Collaboration for Multi-Level Problems

Multi-level problems are expressed as situations requiring action by more than one type of stakeholder. Areas of concern for multi-level problem solving are similar to those expressed in individual problem solving. Mechanisms of connectivity and communication dispositions are necessary components to understanding information transfer between stakeholders for collaborative problem solving on issues requiring actions from stakeholders in different positions of authority. This implies that decisions affecting station success are not central to any one unit but are dispersed throughout several stakeholders as in the fragmented bureaucracy. Evaluating the decision-making responsibilities of all stakeholders is necessary to understand whether a lack of

collaboration between relevant decision makers promotes station failure. If all decision making is conducted by one stakeholder, then no opportunity exists for coordinating decisions between many stakeholders.

Similar influences of connectivity and dispositions in communication for individual decision making apply here. Although additional considerations include cultural tendencies present in the two-tiered system of social interaction, centralized decision making promoted by persons of authority as being for the good of the group may instead arise from personal interests in power. A dictatorship may result with discourse manifested as power struggles that restrict collaboration between stakeholders necessary to address multi-level problems. Disagreement over formal plan interpretation and flexibility in rural governance strategies can also demonstrate elements of personal interest in the public good.

4.1.4 Existence of Decision Assessment

Decision evaluation promotes station success by assessing decision quality for correcting present actions and enabling learning to improve future action. Although personal evaluations of decisions can be conducted, formal connections that offer the opportunity and capability to challenge authority may be necessary to obtain viewpoints of other stakeholders. It is important to note that cultural dispositions for avoidance or indirection in conflict resolution may prevent decision assessment from occurring. Even if formal programs exist for questioning key decision makers, implementation of this assessment policy may not produce the intended results due to cultural tendencies of avoidance or indirection. This absence of feedback on decision assessment decreases the

potential for better socio-technical system understanding that could lead to better actions for success of the gasification station.

4.2 COMMUNITY-LEVEL ANALYSIS

In this study, the effect of communication on decision making is best addressed through community-level analysis. Important information pertaining to labor use, local policy, energy produced / used, operational funding, technology maintenance, individual action, and socio-technical change can all be documented within communities. Because local villages operate the station, emphasis is placed on structures surrounding decision making at this level. Implementation of gasification facilities would not be possible without actors outside the village, but regular operation lies in the hands of the community. Therefore, the community is the primary unit of analysis with decision makers at this level being important stakeholders. Further support for community-level assessment is warranted because between 90% and 100% of families use the gas. Connectivity extends from the community to external stakeholders and internally to those persons within the geopolitical bounds of the village.

Villages in the study region are defined by administrative divisions that have distinct decision-making structures. Station management was the responsibility of leaders from a single village and the supply of gas was given solely to members of that community. Geography defined communities with roads or fields acting as boundaries between villages.

4.2.1 Data Sites

Small, rural communities, containing 150–400 families, were examined in this study. Most, if not all, families in the town participated in agriculture-related occupations. Villages in the study were situated at varying distances from large cities and good roads. The principal economic activity in all communities was agrarian labor on lands owned and tended by individual families.

Finding specific field sites to investigate was not a straightforward process. Interviews with bio-renewable energy personnel in Ji Nan City, capital of Shan Dong Province (156,700 km^2), yielded two potential field sites. From these two initial locations, interviews with community leadership at the field sites led to identification of more villages with biogas stations in surrounding areas. This technique of finding data sites is termed the "snowball" method. More interviews were conducted and more leads acquired until all data sites had been visited in the northern region of the Li Cheng District (about 1,200 km^2), located northwest of Ji Nan (Figure 7 and Figure 8). Analysis of all available villages within this district was corroborated by community leaders at various villages. Out of seven total villages, six were used in this study. One data site was not included because it produced electricity instead of cooking gas. Electricity generation technology is different in resource use, technology, and interactions with social systems, excluding it from the data set.

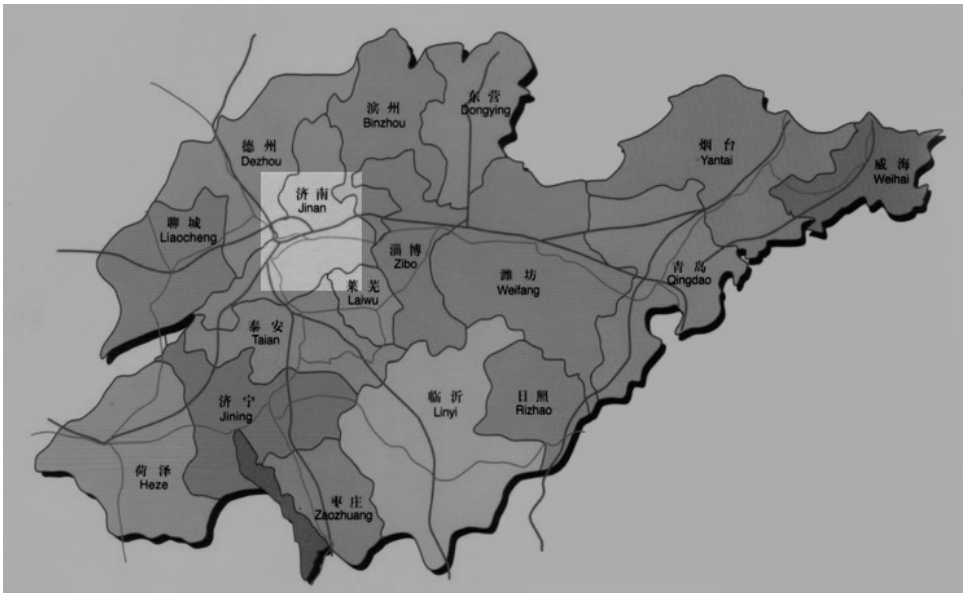

Figure 7. Shan Dong Province.[2] Highlighted area shown in Figure 8.

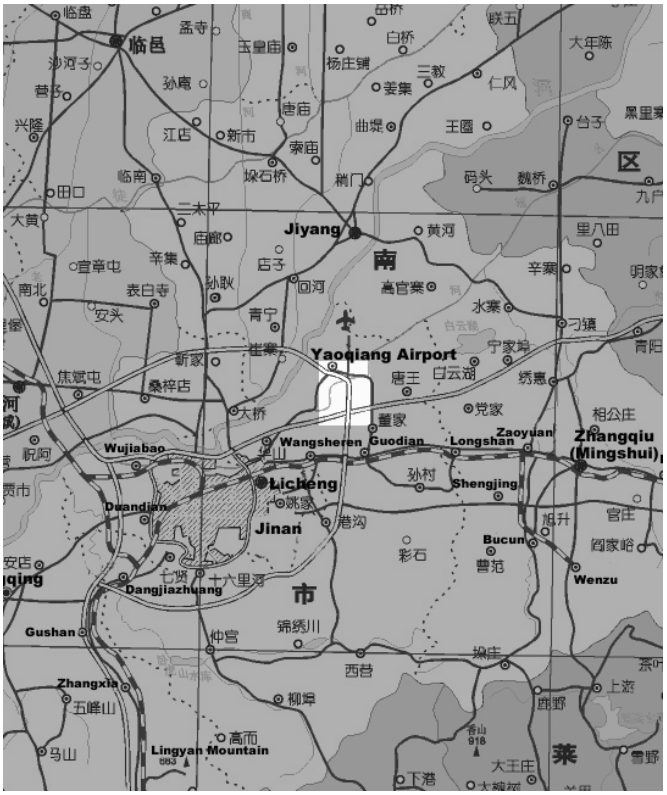

Figure 8. Field sites located in highlighted region.[3]

[2] Image retrieved on April 20, 2007 [www.ccpitsd.org/english/images/sd_map.jpg]
[3] Image retrieved on April 20, 2007 [www.china-sd.net/eng/sdcities/map/jinan.gif]

4.2.2 Relevance of Data Sites

No single province can be considered typical for generalization to all of China (Gao 1999); they range from the developed, rich coast, to the undeveloped, poor northwest, and have topography that changes from grassland to desert to mountains with a variety of rural livelihoods. Random selection of data sites from throughout China would have allowed for greater generalization of results; however, this selection method was not feasible due to numerous complications, including accessibility limitations. Random selection in larger areas would have produced problems with analytical complexities arising from different dialects, regional cultures, lifestyles, demographics, and occupational characteristics. Potential of these differences to affect operational decisions lie outside the framework of analysis. However, the formalized communication systems developed in this study to promote learning and problem solving can address contingencies in the environment, allowing one example to serve as a base that can be tested and adapted throughout future applications.

Field sites are typical rural villages in the Shan Dong province. Agrarian living, available work, and resources are similar. Even in remote areas of the province where technology may differ, the feedstock is similar due to like-farmed goods and natural resources. However, comparing the results to areas in other provinces would introduce more confounding variables. Provinces in the north or south have different crops or even none at all, introducing technological considerations that are not fully considered within the study framework. The diverse topography of rural China and lack of transportation systems also confounds result generalization. These characteristics have promoted the rise of cultures with values, lifestyles, and ways of thinking that are likely to differ from

those found in this study. Nonetheless, the results demonstrate issues that may be influential for developmental success both within China and in other regions of the world.

4.3 DATA ACQUISITION AND MEASUREMENT

4.3.1 Description of Research Methodology

Field research with small group interviews and short surveys were used to obtain data for addressing research questions derived from the conceptual model. The complexity of interacting components in technology, sociology, anthropology, and economics made semi-structured research methods appropriate and efficient in adjusting for contingencies and new data obtained in each site. In this manner, semi-structured methods were used to explore unique data points and find comparisons between sites that may not otherwise have been apparent. Field research has the additional value of direct interaction to enhance interpretation of cultural contexts of information and relationships to concepts in the model. Additional usefulness of this method was found in discerning actors' perceptions within their own environment (Neuman 2003), which is necessary to understand the elements of discourse discussed in the research questions. Field research provided rich data about formal and informal communication barriers that inhibit effective decision making. Obtaining information on actions taken at the station allow inferences to be drawn between communication structures and station success. Causal inferences cannot be made because observations were made at one point in time and not over the entire course of the gasifier project. Most often, the station was shut down one or more years prior to this study's completion. Testing the effect of changes in communication structure was therefore not possible.

4.3.2 Gaining Access, Establishing Contact, and Exit Strategy

Contact was established with a host institution in China that provided a national level of context to begin work. The head of Resource Management and Policy at the Chinese Academy of Sciences welcomed the research topic. Prof. LU Yonglong provided a translator (Mr. HAN Jingyi) and contacts that facilitated access to field site locations. During all interviews, researchers presented themselves with similar dispositions of polite inquisition to minimize bias from respondent perception of researcher characteristics.

Field work in the communities began by establishing trust with the village leader through conversation over food and drink according to customs in the research area. Throughout the day, stories of common Western lifestyles and comparisons to rural life in China were effective at establishing relationships. The presence of a Caucasian in the communities seemed beneficial in establishing contact because nearly all interviewees were interested in speaking to a foreigner. Because the translator and researcher were outsiders unlikely to ever return, we were not included in or excluded from the relationship circle. Therefore, the influence of *guanxi* or *mianzi* on the interview was minimized as we would not be present to transfer information to disrupt harmony or lose face (Peng 1993). Furthermore, having two scientists researching to improve the quality of life proved useful in gaining confidence of local leadership and community members. Conversations were brief enough that simply a handshake or wave goodbye was appropriate for breaking contact and exiting the community.

4.3.3 Field Research and Interviewee Descriptions

Interviews with all relevant stakeholders give a variety of perspectives to broaden understanding of connectivity and dispositions in communication structures, the forms

and frequency of information transferred, decisions made that influence the station, discourse between stakeholders, and discord between perceptions of the decision-making structure and reality. Three groups of actors are associated with station implementation, operation, and use in Shan Dong Province. General question frameworks used during interviews are presented in Appendixes A-E.

One influential group was state government officials and gasifier technology designers. Provincial and other government levels provided financial backing for most of the capital costs and were in charge of completing feasibility studies, introducing energy policy, and organizing external stakeholders involved in project implementation. Technology designers conducted pyrolysis research in government academies and universities. Often they were paired with manufacturers that constructed the technology, forming partnerships that submitted bids to government agencies for obtaining contracts for village projects.

The second group of actors consisted of community leaders and gasifier station managers. Ten interviews were conducted with members of this group. They were charged with maintaining operation of the plant and establishing supporting structures or local policies as deemed necessary. Station managers were under the authority of the main community leader, the Communist Party Secretary. On occasion, the secretary doubled as the station manager and enlisted a few workers at the plant. Managers and community leaders were middle-aged men. Some secretaries had been in position for over three decades while others were relatively new to the job with five to ten years of experience. Station managers were typically new to the community and left if the station was closed.

The third group of actors included individuals within the community who use gas for cooking or heating (though only a few wealthy families could afford the latter). Sixteen small-group interviews were conducted with data being collected from 53 villagers. Interviewees were an equal mix of men and women ages 40–70. Most had returned from the fields for lunch, midday socializing, and a short rest. Interviews with villagers provided the best method to contrast information obtained from Party Secretaries; other stakeholders had little contact with the local cadres.

Interviews focused on establishing commonalities among data sets and exploring singularities that arose, allowing freedom to extend questions for deep examination of root causes of station failure. Interview content was structured to obtain both objective and subjective data. This provided information for cross-referencing results horizontally among similar actors in different towns, and vertically within the same community (e.g., farmer, mayor, station manager) or to external actors (administrative offices, technology designers).

4.4 ANALYSIS METHODOLOGY

Data was analyzed as cases instead of parameterized variables. This process involved establishing themes based on similarities and discrepancies in the data within the context of the interview (stakeholder role and question content). Two main categories were used to organize obtained data: one aggregated across communities, and another community-specific. For community-specific questions, no one person, or set of people, can be assumed to have given accurate information about a negative topic (e.g., station failure) that could damage face. A chance for inaccuracy, lies, or misinformation required

interpretation of data within the context of the interviewee's position in the social structure, surrounding environment, type of question, and the situation of the station at the time of the interview.

Accounting for differences in stakeholder perceptions of a single community offers better understanding of the data. This was done by including discursive influences of the situational context and the broader cultural and political contexts that affect individual action and meaning interpretation. These considerations provide a better representation and analysis of human interaction in different contexts and can give evidence of specific problems in communication and how they contributed to station failure.

Problems in communication can be identified by how individuals interact and express meaning in varying power relationships (Fairclough 1995:132). Instead of discussing contentious issues with persons in positions of authority (decision makers), stakeholders more freely provide their opinions to persons inside their relationship circle (family, friends) or those outside their social context (interviewer). Differences in interviewee perception of the decision-making process and actions leading to station failure are compared within their discursive contexts to more accurately determine reasons for station failure and causal inferences of communication and decision making on station failure.

4.5 ETHICAL CONSIDERATIONS

An approved statement in English was translated to Chinese for modified informed consent. All interviewees were instructed of the voluntary nature of their

participation, confidentiality provisions, and their option to cease discussion at any time. Names of towns, departments, and individuals have not been provided in this or any other related work to ensure continued confidentiality. Permission to interview villagers was established with local leadership to avoid possible conflicts and establish trust.

5. STATION FAILURE AIDED BY INAPPROPRIATE GOVERNMENT STRUCTURES

This chapter introduces multiple reasons for station failure observed through field visits and discussed during interviews. A lack of interaction and information transfer between stakeholders is predicted to increase the occurrence of poor decision making and station failure. Key elements of the conceptual model are reiterated and related to communication and the decision-making process found in each instance of station failure. This gives an evaluation of model accuracy on its ability to make predictions about circumstances promoting failure.

5.1 PREDICTIONS OF THE CONCEPTUAL MODEL

The central prediction of the conceptual model is that connectivity and conduct orientations decreased the ability to make decisions for successful station operation through ineffective communication. Three supporting hypotheses regarding communication barriers are: (1) limited information transfer between stakeholders (up, down, or horizontally) inhibits the quality of individual decision making, (2) a lack of collaboration between stakeholders leads to the inability to address multi-level problems affecting station success, and (3) the absence of attempts to evaluate and discuss decisions between stakeholders leaves poor practices in place and contributes nothing towards addressing similar problems in the future, whether they occur in the same project or in others. These hypotheses were ‘tested’ by examining avenues of interaction between stakeholders, norms of interaction, information transfer and use, differences in perception and practice to characterize potential effects on decision making. After determining the

breakdowns in communication systems that limit good decision-making practices, these problems can be further interpreted by understanding discourse between interviewee responses to attribute errors to project design or project implementation.

5.2 COMMUNICATION AND DECISION MAKING

Evaluating the conceptual link between communication structure and station failure begins by understanding how actual communication practices influenced decisions. Then specific reasons for station failure can be introduced and explained in terms of the quality of decision making.

5.2.1 Interview Content

Five stakeholders are accounted for in model evaluation. These include government officials and policy makers, technology designers, village leaders, gasification station managers, and villagers using gas for cooking. Outlines of interview questions are provided in Appendices A–E. Responses aiding in assessing the accuracy of model predictions are given in Appendix F. The following two sections on decision making and communication are built from data collected from interviews. Similarities and discrepancies in the data were interpreted using discursive contexts of societal culture and situations influencing interaction between stakeholders.

5.2.2 Structures Present in Communication and Decision Making

Management of the gasification station was the responsibility of village leaders, the Communist Party Secretaries. It was their duty to produce laws, obtain operational finances, hire labor, advise the station manager, obtain feedstock, interact with customers (villagers), and organize maintenance and small-scale repairs. Rural governance

strategies also advocated decentralization and the inclusion of Village Committees (VCs) in the decision-making structure [4]. Planning included the Party Secretary, station management, and VC as decision makers, and government personnel, scientists, and villagers as potential influences or support for decision making. However, this communication and decision-making structure was not implemented in any village. Instead, the structure shown in Figure 9 was in place, producing low connectivity and information transfer between stakeholders with decision making being sole responsibility of the Party Secretary.

Problems related to project planning. Government personnel had no influence on station operation after the equipment had been installed. Their responsibilities included assessing village capabilities to support a station, allocating funds for initial capital costs, and organizing communication between technology scientists and village leaders. Although they managed dozens of projects, they did not interact with or advise village leaders on successful management practices. They were also capable of encouraging interaction between leaders of different villages but were not charged with this responsibility.

With no direct link between communities and the technology designers, there was also little opportunity to obtain advice for addressing technical problems or requesting maintenance assistance.

[4] Organic Law on Villagers' Committee (VC) enacted in November, 1998. Some of the responsibilities listed in the Organic Law for the VC include management of collective property (Article 4) and public welfare (Article 2), and mediation of disputes (Article 2). This committee allows competitive election for positions, and nominees can be party members or not – making opposition of a Party member not a criminal act. The law supports self-government and village elections. The amount of authority given to the committee varies between regions with issues pertaining to the village economy relatively more autonomous from the village government administration (Jakobson 2004).

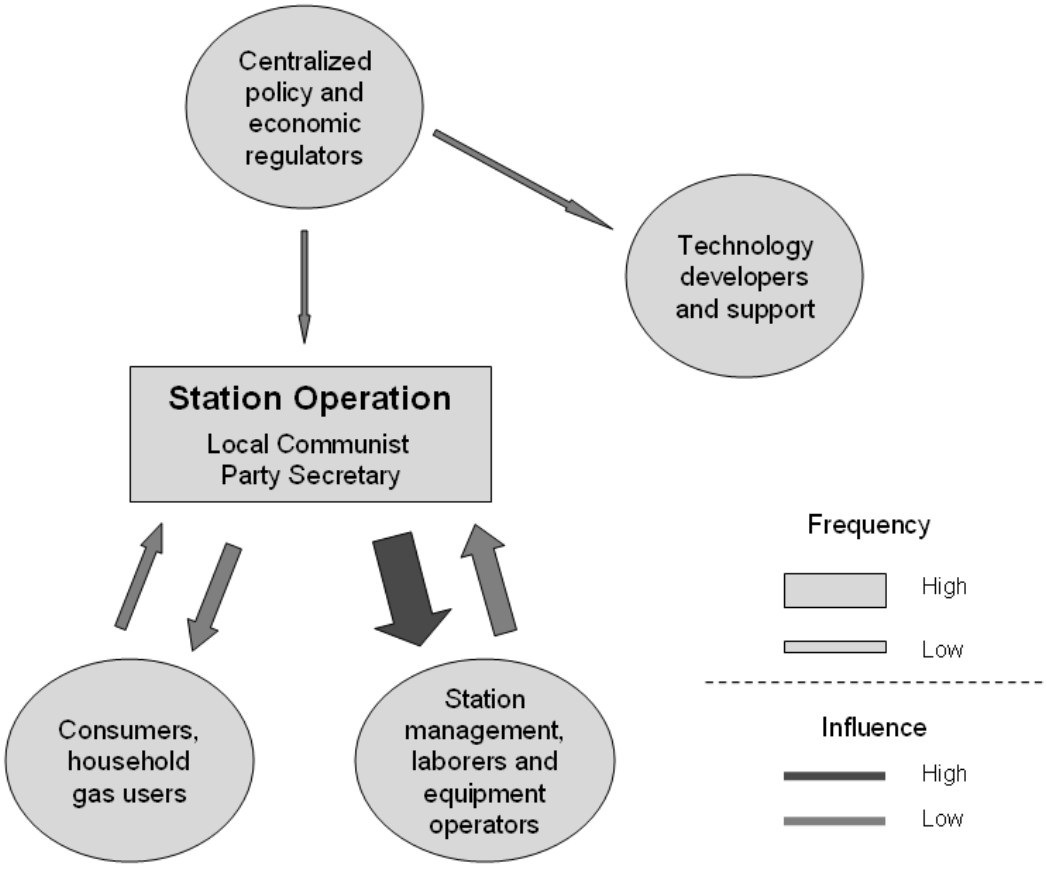

Figure 9. Communication with intent to influence stakeholder decisions.

Villager leaders were required to contact government personnel before communicating with scientists, which decreased connectivity and augmented information transferred due to norms of interaction by including an additional actor in conversations. Party Secretaries would not want to appear incapable of managing the station, nor scientists to appear responsible for producing poor equipment when dealing with government personnel who financed the project and might provide future financing.

Gasification station managers fell under the authority of the Party Secretary and had little influence in major decisions. With guidelines for operating the station (technically, fiscally, and politically) near absent, little direction was available for the

Party Secretary or station management to make better decisions. Only basic responsibilities concerning "enforcing birth control, procuring state grain, and collecting taxes" (Jakobson 2004:100) and broad behavioral expectations to "be punctual, be cooperative, be diligent" (Chow 1993b:118) are given, while no specific guidelines for satisfactory completion of a job are given as criteria to rate the quality of action.

Problems related to project implementation. The formal voice of villagers in governmental affairs was not included in the decision-making structure. The VC and other forms of villager representation were not given influence in the project. Typically they have influence in collective properties of the village (Jefferson et al. 2000:787), but this is an interpretation of the law that varies widely between villages[5]. In the present case, the station could be considered more characteristic of a state-owned enterprise because the majority of capital costs came from the state, instead of being labeled a collective enterprise influenced by the VC because its production is available only to the community and not all Chinese. The resulting implementation in all cases gave authority to the Party Secretary. Without the influential body of the VC to present villager opinions, there was no formal method within the town to question or advise the Party Secretary's decision making.

Connectivity between the Party Secretary and families was present in all villages with day-to-day interactions and the general responsibility of the leader to hear villager needs. This provided villagers with an opportunity to express thoughts to the decision maker and influence station operation. However, this form of interaction was not used to

[5] There are substantial disagreements about the types of reforms that should occur at the local level. Also, it is estimated that some ten to 60 percent of villages actually employ VC in their intended capacity, though it is hard to compile accurate statistics because Chinese officials often provide information they believe the central government wants to hear (Jakobson 2004:99).

discuss the station. This can be attributed to norms of interaction and differences in power that were manifested by indirectness or avoiding opinions when speaking to a person of higher authority or seniority. Non-use of this connectivity due to cultural and political norms is supported when the information would have involved discontent that caused loss of face, broke interpersonal relationships, and created disharmony in the village.

5.2.3 Local Dictatorship and Fragmented Authority

Station management was essentially a "local dictatorship" (Vermeer 1998:11) characterized by the sole decision-making authority of one or two village officials and an absence of input from other stakeholders. All responsibilities for maintaining successful station operation were left to local leaders. The structural influences of low connectivity and norms of interaction on decision-making practices were perpetuated through a lack of effort by local leaders to reach out to others. This may have arisen out of fear of losing their local dictatorship and power of authority (Fairclough & Wodak 1997; Heracleous 2006).

Although decisions that directly altered station operation were made by the Party Secretary, a few indirect policies made by higher government offices influenced station operation. First, price ceilings set by the provincial government influenced station revenue by putting limits on how much could be charged per unit of gas consumed. Second, government policies that subsidized alternative uses for feedstock decreased its availability. Third, district and township governments above the village authorized other forms of enterprises (e.g., cattle farms) that also utilized the feedstock, leading to scarcity and increased price of inputs. Last, governmental procedures that monitored or directed

interaction between the village and scientists reduced the flow of information as previously described.

5.3 REASONS FOR STATION FAILURE

Reasons for station failure can be explained through communication structures that inhibited information transfer influential to better decision making. These communication barriers are attributed to poor formal connectivity in the political system and cultural norms of human interaction that direct dialogue content away from critical feedback or input. Situations contributing to station failure are introduced and deficits in communication demonstrate how decision making could have been improved through greater flows of information between stakeholders. Box 1 introduces four circumstances contributing to station shutdown as gathered from the data set.

Box 1. Circumstances contributing to station shutdown.

Problem 1: Technological misunderstanding and maintenance

Problem 2: Fuel acquisition and storage

Problem 3: Local policy and procedures governing gas use

Problem 4: Economic mismanagement

5.3.1 Technological Misunderstanding and Maintenance

Management of gas production technology and the equipment used for supplying raw fuels and distributing / utilizing gas proved to be the most important factor in station

shutdown. Problems revolved around the ability of local leadership to acquire good technology, maintain operational quality, and choose additional technologies that promoted easier management.

Problems with gas production. Over time, the frequency of routine cleaning and maintenance became tedious or too time consuming for several station managers. This included removing tar from the system that became lodged in pipes (a task that could be done in less than five hours per week). Village leaders who had difficulty recognizing the importance of this process also had difficulty maintaining operation of their station. Cleaning was not strictly followed as equipment became older, leading to decreased gas quality, and ending in dissatisfied consumers and fiscal problems (often exemplified by an increased number of people stealing gas). All gasification technologies had the potential to degrade over time, leading to decreased gas quality. However, this was hastened by not adhering to a strict maintenance regimen of cleaning the system or replacing parts as they aged. These activities could have been maintained, but their apparent importance decreased over time as tending the technology became tedious. Regular correspondence with technology manufacturers could stress the necessity of this maintenance regimen to promote better gas production. Also, greater interaction with the technology scientists could be used to address more complex technical problems that arise instead of trouble-shooting by persons in the village with little technical background. Awareness of design flaws to be improved in future models would be a related benefit.

Problems with gas distribution. Gas production, storage, and home range equipment suppliers were determined by intermediate-level government institutions

above the village, being outside the influence of local leadership. Distribution systems were instead the responsibility of village leaders to acquire and install. The quality of distribution piping had a direct effect on station failure. As materials in the piping network degraded, the entire gasification system suffered from gas leaks around poor joint assemblies and corroded piping. Stations ultimately closed down from a lack of village funds to replace distribution networks.

This problem was not present in all towns, so a lack of good distribution equipment can therefore be traced to poor supply or supplier. Because the selection of companies is the responsibility of village leadership, their lack of experience in contracting companies or knowledge of good suppliers leads to poor decision making. Government officials did not train the Party Secretary on how to make better selections or even provide names of trusted suppliers of distribution systems. Lack of established connectivity between villages with other stations also contributed nothing to providing useful information on selecting supporting technologies. Nearly all necessary technical components are decided by persons outside the community while distribution systems are left to village leaders. Poor decisions resulted from lack of experience and knowledge in this area.

Problems with gas consumption. Absences in seemingly non-essential technologies also contributed to station failure. It is profound that all failed plants lacked lock boxes or sealed containers around household gas meters. Villagers in towns without lock boxes learned to steal gas by removing gears in the meter that recorded consumption. These same villages also did not punish gas thieves (either from lack of law or its enforcement). With no means of prevention or punishment, leaders could do

nothing to stop individuals from stealing gas. The situation lowered the morale of station workers and village leadership, giving them little faith in a technology they deemed "too difficult to manage." All gasification stations were eventually closed due to a lack of funds and interest in maintaining them.

It should be noted that a majority of those stations still in operation had lock boxes and laws to punish persons for breaking meters, demonstrating the importance of this additional piece of equipment. The use of lock boxes was another decision left to local leadership, demonstrating a lack of understanding by both village leaders and government officials of the importance of such equipment. Poor decision making resulted in the absence of lock boxes and a lack of laws to punish persons stealing gas. Although the establishment of local law is the responsibility of village leaders, the absence of lock boxes can be attributed to more than one party. Government offices did not make the Party Secretary aware of the importance of a lock box; in fact, they did not even mention it. More collaborative communication between villages and government offices could have determined the necessity of lock boxes for inclusion in project implementation or advice to local leaders. Also, the absence of communication between villages with the technology provided no information on its necessity for successful station operation.

5.3.2 Fuel Acquisition and Storage

Fuel acquisition. The capability of village leadership to acquire and maintain usable fuel presented challenges to successful station operation. Initial problems with a lack of local straw supply (grasses in cropland) were solved by purchasing straw, agricultural wastes, and sawdust from regions outside the town. However, the introduction of other technologies and programs into surrounding areas brought new uses

for feedstock, resulting in higher prices and scarcity of good quality fuel. This occurred from government programs that subsidized straw for use as fertilizer and nearby ranchers who competed for feedstock use. The acquisition and subsequent use of poor fuel decreased gas quality, leading village leadership to shut down operation. A lack of connectivity and information transfer between the local village and government agency did nothing to advise that new legislation enacted by higher administrative levels was negatively affecting station operation. The cultural norm of internalizing discontent or contentious thoughts about persons in higher level administrative offices also reduced awareness of this issue.

Fuel storage. Yet another issue involved keeping fuel dry. Some villages had absolutely no buildings to house fuel. During periods of rain, gas production ceased and gas was of poor quality for several days thereafter[6]. This fluctuation in gas supply decreased confidence in local leadership and promoted further stealing of gas in areas without lock boxes. Several leaders claimed to lack the funds necessary to construct buildings to house fuel while others had no problems with securing finances. Leaders from different areas had different concepts on acceptable buildings and costs, leading some to construct cheap buildings to protect fuel and others not to.

Village leadership that chose not to purchase buildings to house fuel had continued problems with quality, stealing, and revenue, eventually leading to shutdown. Instead of building cheap buildings to protect fuel from rain, local leaders desired finances from government agencies for unnecessarily expensive fuel storage. A lack of innovation, creativity, and responsibility in local leadership contributed to failure where

[6] Wet fuel is inefficient to burn as water needs to be driven off before combustion can occur, wasting large amounts of heat and generating much more tar and lower-quality gas.

others succeeded. Connectivity to other villages that had developed methods to keep fuel dry would have provided information to make better decisions and construct similar low-cost facilities.

5.3.3 Local Policy and Procedures Governing Gas Use

Villages that lacked lock boxes and disciplinary measure against steeling were the only stations to fail, while other villages fared far better. Failures in purchasing lock box technology have already been discussed, though the lack of disciplinary actions against steeling deserves greater focus. Although it has been shown that the absence of laws promoted station failure, there is no straightforward explanation for why local leaders did not put these laws in place. Two basic premises are that they didn't know these rules were possible or that they didn't feel the laws were necessary. In either case, there is a deficit in human capital for understanding the importance of such laws and tools. The government agency could have addressed this by stating the importance of these laws and re-assessing village leadership to ensure that laws were in place. Additionally, this information could have been made available had connectivity and dialogue been encouraged between villages that understood the importance of these laws and technologies.

Communication deficits between villagers and local leaders did little to help resolve the situation. In ideal situations, opinions from villagers on community-wide decisions were gathered by representatives in the town. Each representative was responsible for 10–15 families and relayed their thoughts to town leaders for decision making. However, interviews with common villagers showed that no more than a handful knew their representative and less than 5% actually interacted with them to influence

issues. Given the ineffectiveness of representatives to gather opinions from villagers, the town leadership had incomplete and inaccurate portrayals of community sentiments. Issues related to stealing gas, raising prices, gas quality, and many more public concerns could have been addressed if leaders had better facilitated communication formally, using the available representative system, or informally, with day-to-day interactions within the small village.

5.3.4 Improper Fiscal Management

Managers stated the most common problem leading to station shutdown was lack of money, but this was often the last link in a longer casual chain. Poor decisions already discussed concerning lock boxes, laws against stealing, housing for fuel storage, technology maintenance, and gas distribution networks contributed to a financially unsustainable situation. However, several community leaders expressed discontent that revenue never provided full recovery for costs of station operation, even before other problems lead to fiscal instability.

When interviewed, all Party Secretaries stated that the price of gas was set by them locally to allow revenues to closely match the costs required to maintain station operation, though this was obviously not the case because prices were not increased in any town to reflect increases in cost. In fact, village leadership rarely, if ever, raised the selling price. This demonstrated a major error in decision making. If gas prices had been raised, greater revenue would have been available for purchasing feedstock or keeping up with station maintenance.

It is interesting to note that although each Party Secretary stated it was his responsibility to determine gas price, it was found that gas prices were the same

throughout all villages, leading the researcher to believe that price was influenced by an authority above the village. Prices were never raised above a certain level that all villages operated at, demonstrating existence of a government-imposed price ceiling even though local Party Secretaries did not recognize the price as outside of their control (possibly because they had the option to set the price lower if they so desired). By obtaining additional information that showed gas produced from the village pyrolysis plant was significantly cheaper than liquid-petroleum gas (LPG) and much more user friendly than coal, consumer interest for the gas as an alternative fuel seemed high. With high levels of user interest in utilizing gas instead of other cooking fuels, it is likely that gas prices could have been raised. This decision would have provided towns with added revenue to avert station shutdown from issues involving losses in money. However, no cost-benefit analysis of gas use was conducted by local leaders or government officials to assess possible consequences of this action. Poor communication between villagers, the Party Secretary, and government agencies inhibited addressing this issue. Additionally, a lack of collaboration between the Party Secretary and government workers to assess the potential to raise prices showed poor decision making contributing to station shutdown.

5.4 SUMMARY OF KEY FINDINGS

A common theme throughout these issues was that organizational structures inhibited effective communication for better decision making practices in station operation. A lack of connectivity and norms of human interaction were confirmed as barriers to communication as given in the conceptual model. This promoted poor decision-making practices leading to station shutdown from (1) limited information

transfer among stakeholders (vertically or horizontally) for individual decisions, (2) lack of collaboration among stakeholders for multi-level or group decisions, and (3) the absence of attempts to evaluate and discuss decisions between stakeholders for learning and improvement.

Lack of communication with superiors outside the village and with supporting organizations was a significant concern throughout each problem. Communication structures led to difficulties in assessing problems within the influence of the local Party Secretary and those multi-dimensional problems that required actions of multiple actors. Any one group in the project was forced to communicate through a central core that regulated information transfer. This hindered the co-development of all parties involved. First, no encouragement or advice was provided to the villages. Second, no feedback was given to technology designers about the operating performance of their equipment in the field using diverse fuels. Third, government agencies did not become aware of the ineffectiveness of their policies at producing positive results on the ground.

6. IMPROVING DECISION MAKING WITH EFFECTIVE STRUCTURES AND COMMUNICATION

More successful station operation can be made with political structures that promote higher frequency of communication and transfer of critical information or advice. A new management structure is needed to better correspond with Chinese cultural values and norms and technological, economic, and environmental conditions. Adjustments are recommended to increase decision-making capacity to better address variability in the natural environment, technology, individual initiatives, leadership style, and villager actions. Table 1 provides a comparison of present communication and decision making structures with suggested improvements. Formal connectivity and conduct orientations must promote these goal characteristics for more sustainable stations. Communication cannot prevent all problems related to station failure (e.g., feedstock shortage, poor technical quality, corruption), but structures designed to exchange accurate information, share decision making responsibility and advice, and increase assessment may decrease risk of failure.

6.1 ESTABLISHING AN EFFECTIVE POLITICAL STRUCTURE

The proposed political and management structure offers guidelines for stakeholder connectivity and conduct orientations. These guidelines may improve communication and decision making as developed in the conceptual model and analysis. New structures must bring benefit of improved characteristics shown in Table 1. Connectivity must be established to provide a pathway for communication between

relevant stakeholders. Roles and responsibilities also determine how this network will be used to support station operation. Considering differences between the ideal network (Figure 6) and the actual network (Figure 9) of stakeholders, modifications are suggested in connectivity with modified roles and responsibilities. As the Party Secretary is the main decision maker, suggestions for improvement are provided in reference to this central role.

6.1.1 Party Secretary and Scientist

Direct interaction between the Party Secretary and gasification scientists is useful for tracking the experimental technology and providing advice on proper operation and maintenance requirements. This also removes the barrier that government offices indirectly place on communication through their responsibility as funding both scientists and the village – if either scientist of village produces negative evidence, it may harm funding for in the future.

Weekly or bi-weekly reporting of regular maintenance schedules and key operational quality indicators highlight problems at an individual unit and illustrate technical issues arising at multiple sites. Better village-level decisions can be made through advice on feedstock selection, feedstock storage & preparation, peripheral technology, gas production and storage, maintenance methodology, and refurbishment schedules. Scientists also gain input to improve future technologies for easier operation and higher quality output.

Table 1. Summary of present and proposed structure, communication, and decision making.

Focus & description	**Present characteristics leading to station failure**	**Improved characteristics to promote station success**
Political & cultural structure *(stakeholder connectivity, conduct orientations)*	No direct links between villages and technology scientists for technology upkeep No contact between villages using gasification technology to assess policy and management Village Committee/ Representatives not involved, no voice for villagers Low reporting of failing station, causes of failure, and discontent with other stakeholders due to saving face	Easier flow of communication and greater frequency between stakeholders (town-town, town-technology scientists, town- upper government bodies and agencies, town-villagers) More involvement of village representatives or villagers in decision-making at the local level Impersonal monitoring mechanisms for station operation to address lack of station reporting and improve transparency for all stakeholders
Communication *(frequency of contact, content of information exchanged)*	No contact between Party Secretary and scientists No use of Village Committee/ Representatives Little contact with central government agencies, only in asking for financial support Infrequent contact with villagers, centered around inability to pay for bills or general worries not specific to station decisions Semi-regular or regular contact with station laborers for amount of gas produced and fixing household gas meters	Direct interaction between Party Secretary and scientists to maintain tracking and correct operation of experimental technology Discussion between town leaders over effective economic and legal policy, feedstock; companies to contract for peripheral equipment Villager input taken by Village Committee Collaborative policy assessment between town leaders and central government
Decision making *(authority of station operation, stakeholder influence upon another's decisions)*	Local dictatorship by Party Secretary for station operation and policy Low advocacy or no influence of any stakeholder on Party Secretary decisions No influence of village on higher government No or little influence/ attempt of Party Secretary to mitigate theft of gas by villagers Station operators follow own set of maintenance not prescribed by technology scientists	Collaborative policy decisions with higher government agency to support station continued operation Village Committee involved in decisions to include village input and concerns Checks and balances to evaluation past and present decisions for improvement and learning Records and checks by scientists to evaluate operational and maintenance quality, suggest actions

6.1.2 Party Secretaries from Different Villages

Local economic and policy can be discussed between Party Secretaries from different villages. At present there is no formal encouragement for village leaders to collaborate or discuss the station. A regular monthly meeting with key economic and operational findings with open discussion may help mitigate poor choices repeated throughout many villages and may promote good decisions (selection of distribution piping company, use of lock boxes and fines, low-cost storage for keeping fuel dry). Unfortunately, avoidance for admitting mistakes or providing critical advice of others may occur due to cultural observance of *mianzi*. As this can be present in any organization or formal structure, other recommendations in addition to establishment of the formal connection and meeting schedule may be required to obtain use from this relationship. Possibilities include a log of critical information made accessible to all persons, an outside agency to organize discussions, or impersonal rating mechanisms of station performance; see Section 6.2 for continued discussion.

6.1.3 Party Secretary and Villagers

There is little or no influence of villagers on station decisions. Likewise, the influence of Party Secretaries on villager decisions is unlikely to change the course of action (e.g., gas thieves). A public forum is necessary for group discussion to agree upon common guidelines for station management and villager conduct. Additionally, members of the Village Committee and family representatives can convey information between parties without causing loss of face in a public forum. This can relate to sensitive matters of stealing gas or economic policy. Dialogue is also beneficial for negotiation to establish gas prices that allow the station to continue operation without fiscal loss.

6.1.4 Party Secretary and Government Offices

Local influences of policies from higher governmental offices must be addressed through more active communication by the local Party Secretary. Village leader involvement on proposed legislation can help mitigate negative conditions and even create positive conditions to support station success. Monthly interaction with assessment of key operational and economic policies (price regulation, zoning, environmental / resource, etc.) is recommended to understand possible direct or indirect influences on station operation.

6.2 CONSIDERING ADDITIONAL MODIFICATIONS

Even with improved communication and decision making structures, little effect may be noticed unless they are implemented properly. Strong cultural tendencies of avoidance or indirection for social evaluation may limit local improvements that a new political structure provides. Three additional recommendations are introduced to support the new structure to work with cultural norms and individual choice (a) transparency of information to any and all parties, (b) outside monitoring, and (c) impersonal assessment mechanisms.

6.2.1 Information Transparency

Greater transparency can guide decision making and avert station failure through sharing accurate information in a way that is uninhibited by cultural and political norms of human interaction with *mianzi* or personal interest. Transparency assists to accurately evaluate the appropriateness of past decisions, provide useful advice for present decisions, and direct future decisions and project design. Economic data is an excellent

start, as this is commonly stated as the cause of failure. Making transparent and comparing the cost and revenue of stations between all towns illustrates local issues and poor village-level decisions making compared to problems that must be addressed in multiple towns through better planning.

6.2.2 External Monitoring

External monitoring through non-governmental organizations (NGOs) or other non-partisan bodies can obtain evidence from all parties to properly assess root causes of failure. This thesis operates in part under this principle. Transparent documentation is best for obtaining accurate information while the outside institution can help direct networking and decision making to implement the knowledge. Increased connectivity and transfer of accurate information may help incorporate checks on individuals with decision-making authority to discern whether they are taking appropriate actions. If transparency is an issue, impersonal recording mechanisms not affected by human disposition can be used for evaluation.

6.2.3 Quantitative Data Analysis

Analysis of quantitative data that measure performance can include the amount of gas produced, amount of tar build-up and quality of care / maintenance, quality of feedstock, data on gas use by each home or neighborhood, and water quality after it is used to remove tar from producer gas. Problems in communication may still serve as barriers to station improvement if those who compile data do not share information transparently with others. Information technology to record and report data can assist where individuals are not forthcoming.

7. DISCUSSION AND IMPLICATIONS

7.1 DISCUSSION

Based on the results of this study, it is proposed that gasification stations in rural villages of Shan Dong Province, China, can decrease likelihood of failure by modifying communication and decision making structures to take into account variability in information accuracy, technology quality and use, the environment, policy, and individual choice. Structural forces were thought to increase risk of station failure through (1) limited information transfer between stakeholders (vertical and horizontal) that inhibited the quality of individual decision making, (2) an absence of collaboration between stakeholders that led to the inability to address multi-level problems that affected station success, and (3) a lack of discussion and evaluation of decisions that allowed poor practices to continue and contributed nothing to preparing for similar problems in the future, whether they occur in the same project or in others. New political structures were recommended to change stakeholder connectivity, roles and responsibilities, and reporting frequency and mechanisms to improve individual and group decision making. Collaboration among stakeholders who have diverse knowledge, capabilities, and resources is especially beneficial when working with complex technologies that require troubleshooting and constant maintenance, such as the gasification technologies in this study.

7.2 IMPLICATIONS FOR DEVELOPMENT INITIATIVES

Political and cultural variables must be considered in the design of technical development initiatives. Focusing solely on technical factors may lead to unintended results that promote initiative failure. Depending on the project, social structures can have lesser, equal, or greater weight than technical factors in determining sustainability. Both the social and technical sides must be examined individually and interdependently to provide appropriate specifications. This will require greater participation from developers to understand influential components in several disciplines, such as sociology, economics, anthropology, engineering, and public administration.

7.2.1 Problem of Decentralization without Knowledge or Learning

Decentralization is typically believed to improve the success of development projects by emphasizing local decision making and empowering local actors. This decentralized viewpoint emphasizes local action and becomes more successful if two conditions essential to making effective decisions are met: (1) local persons have the knowledge required to understand activities and the consequences of actions taken, and (2) individual and collective learning is employed to address new information and circumstances that arise in the environment. If these two conditions are not met, decentralization from a body of potentially greater knowledge and learning capacity may produce worse results due to uninformed decisions and lack of capabilities in localities.

Managing complications arising from gasification complexity, lack of supporting technologies, competing policies from higher governmental offices, local policies and villager law breaking, and variability in feedstock and the natural environment was difficult for local leaders. The decentralized nature of the project and lack of sustained

interaction from influential stakeholders contributed to barriers in communication that restricted guidance from either government agencies or gasification scientists. Village leaders were found either to not know which actions to take or to be unwilling to make decisions that may cause some initial discontent but still preserve the efficacy of the station. A centralized authority that utilizes formal communication pathways for decision-making assessment and transfers advice or other information would serve as a useful guide to positive results.

7.2.2 Designing Technology for Social Influences

Findings confirm that the introduction of experimental technology without resource support contributes to initiative failure. Organization theories have long contributed to the notion that a formal structure of interaction must be designed to correspond to the needs of group members and variability present in the environment (Thompson 1963). The study of technology must make this same leap and include greater understanding of political and cultural environments to develop an effective socio-technical system characterized. As noted in this thesis, gasification technologies are difficult to operate. Given the state of political, cultural, and environmental systems for interaction, gasification stations may not have been an appropriate choice for providing a sustainable means for rural energy production.

7.2.3 Implications for Energy Development

Energy systems are of increasing interest in development. They have been cited as instrumental in meeting the Millennium Development Goals (DFID 2002) by providing a necessary resource to technologies that increase human welfare. This thesis demonstrates that greater success of energy projects in the study region is attainable by design of an

appropriate structure for increasing interaction and information transfer between stakeholders. Similar plans could be used to improve technical development initiatives elsewhere in the world. Examples include technologies in food production (harvester, tractor), sanitation and health (refrigerators, medical equipment), and education (computers, lighting).

7.3 IMPLICATIONS FOR SOCIAL SCIENCE RESEARCH

This thesis provides an analysis of rural Chinese governance strategies by incorporating influential elements from organizational theory, public administration, rural development, communication structures and decision making, social norms and interaction culture in China, discourse analysis, and technological systems. By developing theories applying to Eastern societies and using fundamental aspects of organization and social interaction theories, an interdisciplinary conceptual model was developed that was not ethnocentrically rooted in a Western viewpoint. Nearly 15 years ago, the issue of using a strictly Western methodology in the East was explained by Zhang: “If current scholars continue to borrow ideas, the development of theories to explain and predict administrative phenomena in China will be problematic” (1993:14). This study implies that further research is needed to understand Chinese social structures beginning from the bottom-up and not telescoped using viewpoints from the West. This is especially true when no single province can be considered typical (Gao 1999) and theories within China are difficult to generalize due to vast differences in geography, social habits, resources, degree of influence by external actors, language, and wealth.

The influence of communication and decision making structures on station operation was a key result of this thesis. Communication effectiveness was characterized as the level of interaction and content of information conveyed during interaction. This conceptualization provided elements of social structures of connectivity and cultural and political structures of interaction norms or context. Inclusion of both elements was necessary to understand barriers to information transfer. These barriers, in turn, demonstrate where communication breakdown occurs and how inaccurate or incomplete information promotes poor decision making. Continued representation of communication using these variables can promote better understanding of information flows between peoples using the objective element of connectivity and the subjective element of social contexts. More applications of this conceptualization are needed to determine whether information flow and decision making can be accurately described in other situations. This will help assess problems in project planning and implementation because "the gap between objectives and what is happening on the ground remains relatively large, especially at local levels" (Organization for Economic Co-operation and Development 2005:64).

BIBLIOGRAPHY

Anderson, T., Doig, A., Rees, D. & Khennas, S. (1999) *Rural Energy Services: A Handbook for Sustainable Energy Development*. Chippenham, Wiltshire: ITDG Publishing.

Argote, L. (1999) *Organizational Learning: Creating, Retaining and Transferring Knowledge*. Boston, MA: Kluwer Academic.

Asian Development Bank (1995) *Governance: Sound Development Management*. Manila: Asian Development Bank.

Baris, Y.I., Hoskins, J.A., Seyfikli, Z. & Demir, A. (2002) "'Biomass lung': Primitive biomass combustion and lung disease," *Indoor and Built Environment* 11(6):351-358.

Barnett, A. (1990) "The Diffusion of Energy Technology in the Rural Areas of Developing Countries: A Synthesis of Recent Experience," *World Development* 18(4):539-553.

Batchelor, J., Best, J., Malhotra, P., Dawson, O.S., Scott, N. & Sinha, S. (2003) "Extension Processes for Rural Energy," *R7660*. University of Reading & Gamos Ltd.

Bernardo, F.P. & Kilayko, G.U. (1990) "Promoting Rural Energy Technology: The Case of Gasifiers in the Philippines," *World Development*, 18(4):565-574.

Bertalanffy, L. von (1976) *General Systems Theory: Foundations, Development, Applications*. New York, NY: George Braziller.

Bina, A. (1983) "Diffusion of Rural Innovations: Some Analytical Issues and the Case of Wood-Burning Stoves," *World Development*, 11:359-376.

Blau, P.M. & Scott, W.R. (1962) *Formal Organizations*. San Francisco, CA: Chandler Publishing Company.

Blackman, C. (1997) *Negotiating China: Case Studies and Strategies*. St. Leonards, Austrailia: Allen & Unwin.

Bourdieu, P. (1977) *Outline of a Theory of Practice*. R. Nice (trans.) Cambridge, UK: Cambridge University Press.

Borman, G.L. & Ragland, K.W. (1998) *Combustion Engineering*. Columbus, OH: McGraw-Hill Companies.

Brown, A. (1977) "Introduction" in A. Brown & J. Gray (ed.) *Political Culture and Political Change in Communist States*. London: Macmmillan. Quotation obtained from Liu, G. (1998) "Political Culture and Social Change: Rethinking China's Experience"

(2:19-34) in J. Zhang & X. Li (eds.) *Social Transition in China*. Lanham, MD: University Press of America.

Bureau of East Asian and Pacific Affairs, U.S. Department of State (2007) "Background Note: China" January 2007. [http://www.state.gov/r/pa/ei/bgn/18902.htm#gov] Accessed March 22, 2007.

Burns, J.P. (2004) "Governance and Civil Service Reform" (3:37-57) in Howell, J. (ed.) *Governance in China*. Lanham, MD: Rowman & Littlefield Publishers.

Cai, D.A. & Waks, L. (2002) "What We Still Need to Know about Chinese Negotiation," (11:177-193) in W. Jia, X. Lu & D.R. Heisey (eds.) *Chinese Communication Theory and Research: Reflections, New Frontiers, and New Directions*. Westport, CT: Ablex Publishing.

Chen, M. (1993) "Understanding Chinese and Japanese Negotiating Styles," *The International Executive*, 35:147-159.

Chen, W. (1998) "Economic Reform and Social Instability in Rural China," (5:87-101) in J. Zhang & X. Li (eds.) *Social Transition in China*. Lanham, MD: University Press of America.

Chen, G.M. (2002) "The Impact of Harmony on Chinese Conflict Management," (1:3-17) in G. Chen & R. Ma (eds.) *Chinese Conflict Management and Resolution*. Westport, CT: Ablex Publishing.

Chen, G.M. & Chung, J. (1997) "The 'Five Asian Dragons': Management Behaviors and Organizational Communication," (317-328) in L.A. Samovar & R.E. Porter (eds.) *Intercultural Communication: A Reader*. Belmont, CA: Wadsworth.

Chen, G.M. & Starosta, W.J. (1997) "Chinese Conflict Management and Resolution: Overview and Implications," *Intercultural Communication Studies*, 7:1-16.

Cherni, J.A. (2005) "What Energy Systems are Appropriate for Poor Villagers?" *id21 Research Highlight: April 29, 2005*. [http://www.id21.org/society/s1bjc1g1.html] Accessed October 2, 2006.

Chow, K.W. (1993a) "Conceptualizing Administrative Organization in China," (3:31-48) in M.K. Mills & S.S. Nagel (eds.) *Public Administration in China*. Westport, CT: Greenwood Press.

Chow, K.W. (1993b) "The Politics of Performance Appraisal," (8:105-122) in M.K. Mills & S.S. Nagel (eds.) *Public Administration in China*. Westport, CT: Greenwood Press.

Chuang, R. & Hale, C.L. (2002) "A Critical Examination of the Eurocentric Representation of Chinese Communication," (4:67-84) in W. Jia, X. Lu & D.R. Heisey

(eds.) *Chinese Communication Theory and Research: Reflections, New Frontiers, and New Directions*. Westport, CT: Ablex Publishing.

Coser, L. (1956) *The Functions of Social Conflict*. Glencoe, IL: Free Press

Daft, R.L. (2004) *Organization Theory and Design*. 8th ed. Belmont, CA: Thomson South-Western.

Desai, M.A., Mehta, S. & Smith, K.R. (2004) *Indoor smoke from solid fuels: Assessing the environmental burden of disease at national and local levels*. Geneva, WHO.

DFID (Department for International Development) (2002) "Energy for the Poor: Underpinning the Millennium Development Goals," *08/02 2K*. London: Future Energy Solutions.

Downs, G.W., Jr. & Mohr, L.B. (1980) "Toward a Theory of Innovation," (75-100) in J.A. Agnew (ed.) *Innovation Research and Public Policy*. Syracuse, NY: Syracuse University Press.

Durkheim, E. (1947) *The Division of Labor in Society*. G. Simpson (trans.) Glencoe, IL: Free Press.

Esman, M.J. & Uphoff, N.T. (1984) *Local Organizations: Intermediaries in Rural Development*. London: Cornell University Press.

Ezzati M. & Kammen, D.M. (2002) "Household energy, indoor air pollution and health in developing countries: Knowledge base for effective interventions," *Annual Review of Energy and the Environment,* 27:233-270.

Fairclough, N. (1995) *Critical Discourse Analysis.* London: Longman.

Fairclough, N. & Wodak, R. (1997) "Critical Discourse Analysis" in T.A. van Dijk (ed.) *Discourse Studies: A Multidisciplinary Introduction*. Vol. 2:258-284. Beverly Hills, CA: Sage.

Faure, G.O. (1999) "The Cultural Dimension of Negotiation: The Chinese Case," *Group Decision and Negotiation*, 8:187-215.

Feuchtwang, S. (1998) "What Is a Village?" (2:46-74) in E.B. Vermeer, F.N. Pieke & W.L. Chong (eds.) *Cooperative and Collective in China's Rural Development*. Armonk, NY: M.E. Sharpe.

Foucault, M. (1980) *Power/Knowledge*. C. Gordon (trans.) New York: Pantheon.

Fukui, H. (2000) "Introduction: On the Significance of Informal Politics," (1-19) in L. Dittmer, H. Fukui & P.N.S. Lee (eds.) *Informal Politics in East Asia*. Cambridge, UK: Cambridge University Press.

Gao, M.C.F. (1999) *Gao Village: A Portrait of Rural Life in Modern China*. Honolulu, HI: University of Hawai'i Press.

Gao, G. & Xiao, X. (2002) "Intercultural/Interpersonal Communication Research in China: A Preliminary Review," (2:21-35) in W. Jia, X. Lu & D.R. Heisey (eds.) *Chinese Communication Theory and Research: Reflections, New Frontiers, and New Directions*. Westport, CT: Ablex Publishing.

Gelfand, M.J., Nishii, L.H., Holcombe, K.M., Dyer, N., Ohbuchi, K.I. & Fukuno, M. (2001) "Cultural Influences on Cognitive Representations of Conflict: Interpretations of Conflict Episodes in the United States and Japan," *Journal of Applied Psychology*, 86(6):1059-74.

Gurgand, M., Pederson, G. & Yaron, J. (1994) "Outreach and Sustainability of Six Rural Finance Institutions in Sub-Saharan Africa," *World Bank Discussion Papers 248*. The World Bank: Washington, D.C.

Guthrie, D. (2005) "Organizational Learning and Productivity: State Structure and Foreign Investment in the Rise of the Chinese Corporation," *Management and Organization Review*, 1(2):165-195.

Habermas, J. (1971) *Toward a Rational Society*. London: Heinemann.

Hale, E.T. (1976) *Beyond Culture*. New York, NY: Doubleday.

Harvey, D. (2005) *A Brief History of Neoliberalism*. New York, NY: Oxford University Press.

Harvey, M. (2005) *Essential Business Process Modeling*. Sebastopol, CA: O'Reilly Media, Inc.

Hatch, M.J & Cunliffe, A.L. (2006) *Organization Theory: Modern, Symbolic, and Postmodern Perspectives*. New York, NY: Oxford University Press.

Heal, G. (1998) "Interpreting Sustainability," (3-22) in G. Chichilnisky, G.M. Heal & A Vercelli (eds.) *Sustainability: Dynamics and Uncertainty*. Dordrecht, The Netherlands: Kluwer Academic Publishers.

Heltberg, R. (2005) "Factors Determining Household Fuel Choice in Guatemala," *Environmental and Development Economics*, 10:337-361.

Hercleous, L. (2006) *Discourse, Interpretation, Organization*. Cambridge, UK: Cambridge University Press.

Homans, G.C. (2003) "Social Behavior as Exchange," (46:295-304) in P. Kivisto (ed.) *Social Theory: Roots and Branches*. 2nd ed. Los Angeles, CA: Roxbury Publishing Company.

Hong, Z. (1998) "The Role of Villager Committees in Rural China's Stability" (4:63-85) in J. Zhang & X. Li (eds.) *Social Transition in China*. Lanham, MD: University Press of America.

Howell, J. (2004) "Governance Matters: Key Challenges and Emerging Tendencies," (1:1-18) in J. Howell (ed.) *Governance in China*. Lanham, MD: Rowman & Littlefield Publishers.

Huang, G. (1988) "Daily Addressing Ritual: A Cross-Cultural Study," presented at the annual meeting of the American Sociological Association, Atlanta.

Jakobson, L. (2004) "Local Governance: Village and Township Direct Elections" (6:97-120) in J. Howell (ed.) *Governance in China*. Lanham, MD: Rowman & Littlefield Publishers.

Jefferson, G.H., Rawski, T.G., Wang, L. & Zheng, Y. (2000) "Ownership, Productivity Change, and Financial Performance in Chinese Industry," *Journal of Comparative Economics*, 28:786-813.

Jeston, J. & Neils, J. (2006) *Business Process Management: Practical Guidelines to Successful Implementations*. Burlington, MA: Butterworth-Heinemann.

Johnson, N.G., Bryden K.M. & Xiao, A. (2005) "Risk Analysis and Safety Evaluation of Biomass Cookstoves," *Proceedings of the 2005 ASME International Mechanical Engineering Congress and Exposition*. Orlando, Florida.

Johnson, N.G., Hallam, A., Conway, S. & Bryden, K.M. (2006) "Sustainable and Market-Based Analyses of Cooking Technologies in Developing Countries," *Proceedings of the 2006 ASME International Mechanical Engineering Congress and Exposition*. Chicago, Illinois.

Katz, D. & Kahn, R.L. (1966) *The Social Psychology of Organizations*. New York, NY: John Wiley & Sons.

King, V.T (1999) *Anthropology and Development in South-East Asia: Theory and Practice*. New York, NY: Oxford University Press.

Kirkbride, P.S., Tang, F.Y. & Westwood, R.I. (1991) "Chinese Conflict Preferences and Negotiating Behavior: Cultural and Psychological Influences," *Organization Studies*, 12:365-386.

Korten, D.C. (1980) "Community Organization and Rural Development: A Learning Process Approach," *Public Administrative Review*, 40(5):480-511.

Krishna, A. (1997) "Participatory Watershed Development and Soil Conservation in Rajasthan, India," (255-272) in A. Krishna, N. Uphoff & M.J. Esman (eds.) *Reasons for*

Hope: Instructive Experiences in Rural Development. West Hartford, CT: Kumarian Press.

Layton, R. (1997) *An Introduction to Theory in Anthropology*. Cambridge, UK: Cambridge University Press.

Li, P.P. (2005) "The Puzzle of China's Township-Village Enterprises: The Paradox of Local Corporatism in a Dual-Track Economic Transition," *Management and Organization Review*, 1(2):197-224.

Lieberthal, K.G. (1992) "Introduction: The 'Fragmented Authoritarianism' Model and Its Limitations" (1:1-30) in K.G. Lieberthal & D.M. Lampton (eds.) *Bureaucracy, Politics, and Decision Making in Post-Mao China*. Berkeley, CA: University of California Press.

Liu, L.A., Friedman, R.A. & Chi, S.C. (2005) "'*Ren Qing*' versus the 'Big Five': The Role of Culturally Sensitive Measures of Individual Difference in Distributive Negotiations," *Management and Organization Review*, 1(2):225-247.

Lowe, S. (2003) "Chinese Culture and Management Theory," (1-26) in Alon, I. *Chinese Culture, Organizational Behavior, and International Business Management*. Westport, CT: Praeger Publishers.

Lu, X. (2002) "Introduction: Chinese Culture and Communication: Diverse Contexts and Comparison with the West," (1-14) in X. Lu, W. Jia & D.R. Heisey (eds.) *Chinese Communication Studies: Contexts and Comparisons*. Westport, CT: Ablex Publishing.

Mabbett, I. (1985) *Modern China: The Mirage of Modernity*. New York, NY: St. Martin's Press.

Mahat, I. (2003) "Gender Dimensions in Household Energy," *Boiling Point*, 49:27-29.

Miner, A.S., Bassoff, P. & Moorman, C. (2001) "Organizational Improvisation and Learning: A Field Study," *Administrative Science Quarterly*, 46(2):304-337.

Moran, J. (2002) *Interdisciplinarity*. London: Blackwell.

Munier, N. (2006) "Economic Growth and Sustainable Development: Could Multicriteria Analysis Be Used to Solve this Dichotomy?" *Environment, Development and Sustainability*, 8:425-443.

Oudshoorn, N. & Pinch, T. (2003) "Introduction: How Users and Non-Users Matter," (1-25) in Oudshoorn N. & T. Pinch (eds.) *How Users Matter*. Cambridge, MA: The MIT Press.

Organization for Economic Co-operation and Development (2005) *Governance in China*. Organization for Economic Co-operation and Development.

Parsons, T. (2003) "The Functional Prerequisites of Social Systems" (31:188-193) in P. Kivisto (ed.) *Social Theory: Roots and Branches*. 2nd ed. Los Angeles, CA: Roxbury Publishing Company.

PEMBINA Institute for Appropriate Development (2005) "Best Practices in Sustainable Rural Energy Development: Five International Case Studies," *Rural Electrification Project*. University of Calgary.

Peng, S.Q. (1993) "'Man' yuan yu jie yuan: Zhong guo ren ren ji bu man qing xu biao da fang shi de chu bu tan xi (Complaints and their resolution: An initial analysis of expressions of Chinese interpersonal discontented sentiment)," (171-192) in Q.S. Li (ed) *A Collection of research on Chinese Social Psychology*. Hong Kong: Hong Kong Shi Dai Wen Hua Press.

Perrow, C. (1986) *Complex Organizations: A Critical Essay*. 3rd ed. New York, NY: Random House.

People's Republic of China, The (1997) *National Report on Sustainable Development*. Presented to the United National General Assembly in June 1997.

People's Republic of China, The (2005) *The Renewable Energy Law*. Endorsed at the 14th Session of the Standing Committee of the National People's Congress. February 25, 2005.

Pike, D. (2000) "Informal Politics in Vietnam," (11:269-289) in L. Dittmer, H. Fukui & P.N.S. Lee (eds.) *Informal Politics in East Asia*. Cambridge, UK: Cambridge University Press.

Qiu, D., Gu, S., Liange, B. & Wang, G. (1990) "Diffusion and Innovation in the Chinese Biogas Program," *World Development* 18(4):555-563.

Rice, Jr., G.H. & Bishoprick, D.W. (1971) *Conceptual Models of Organization*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Schaefer, R.T. (2004) *Sociology: A Brief Introduction*. 5th ed. New York, NY: McGraw-Hill.

Schein, E.H. (1985) *Organizational Culture and Leadership*. San Francisco, CA: Jossey-Bass.

Selden, M. (1998) "Household, Cooperative, and State in the Remaking of China's Countryside," (1:17-45) in E.B. Vermeer, F.N. Pieke & W.L. Chong (eds.) *Cooperative and Collective in China's Rural Development: Between State and Private Interests*. Armonk, New York, NY: M.E. Sharpe, Inc.

Shrum, W. & Shenhav, Y. (1995) "Science and Technology in Less Developed Countries," (627-651) in S. Jasanoff, G.E. Markle, J.C. Petersen & J. Pinch (eds.)

Handbook of Science and Technology Studies. Thousand Oaks, CA: SAGE Publications, Inc.

Stewart, F. (1985) *Planning to Meet Basic Needs*. London: The Macmillan Press Ltd.

Tompson, J. D. (1967) *Organizations in Action*. New York, NY: McGraw-Hill.

Vermeer, E.B. (1998) "Introduction: China's New Rural Organization," (3-13) in E.B. Vermeer, F.N. Pieke & W.L. Chong (eds.) *Cooperative and Collective in China's Rural Development: Between State and Private Interests*. Armonk, NY: M.E. Sharpe, Inc.

Wallerstein, I. (2004) *World-Systems Analysis: An Introduction*. Durham, NC: Duke University Press.

Walder, A.G. (1995) "Local Governments as Industrial Firms: An Organizational Analysis of China's Transitional Economy," *The American Journal of Sociology*, 101(2):263-301.

Walder, A.G. (1998) "Zouping in perspective," (16-23) in A.G. Walder (ed.) *Zouping in Transition: The Process of Reform in Rural North China*. Cambridge, MA: Harvard University Press.

Wang, X. (1997) "Mutual Empowerment of State and Peasantry: Grassroots Democracy in Rural China," *World Development* 15(9):1431-42.

Wang, Z. (1998) "Village Committees: The Basis for China's Democratization," (9:239-255) in E.B. Vermeer, F.N. Pieke & W.L. Chong (eds.) *Cooperative and Collective in China's Rural Development: Between State and Private Interests*. Armonk, NY: M.E. Sharpe, Inc.

Warfield, J.N (2006) *An Introduction to Systems Science*. Singapore:World Scientific Publishing Co. Pte. Ltd.

Weber, M. (1947) *The Theory of Social and Economic Organization*. A. Henderson & T. Parsons (trans.) Original 1922.

Weber, M (2003) "Bureaucracy," (13:82-87) in P. Kivisto (ed.) *Social Theory: Roots and Branches*. 2nd ed. Los Angeles, CA: Roxbury Publishing Company.

Weber, E.U., Ames, D.R. & Blais, A.R. (2004) "'*How* Do I Choose Thee? Let me Count the Ways': A Textual Analysis of Similarities and Differences in Modes of Decision-Making in China and the United States," *Management and Organization Review*, 1(1):87-118.

Woodward, J. (1965) *Industrial Organization: Theory and Practice*. London: Oxford University Press.

Woolcock, M. (1999) "Learning from Microfinance: What Unsuccessful Cases Tell Us About How Group-Based Programs Work," *American Journal of Economics and Sociology*, 58(1):17-42.

Xiao, X. (2002) "*Li*: A Dynamic Cultural Mechanism of Social Interaction and Conflict Management," (3:39-49) in G. Chen & R. Ma (eds.) *Chinese Conflict Management and Resolution*. Westport, CT: Ablex Publishing.

Yang, C.F. (2002) "Psychocultural Foundations of Groups: The Issues of Loyalty, Sincerity, and Trust," (4:85-105) in L. Dittmer, H. Fukui & P.N.S. Lee (eds.) *Informal Politics in East Asia*. Cambridge, UK: Cambridge University Press.

Yang, M.M.C. (1969) *Chinese Social Structure*. Taipei, Taiwan, Republic of China: The National Book Co.

Zhang, C.F. (1993) "Public Administration in China," (1:3-20) in M.K. Mills & S.S. Nagel (eds.) *Public Administration in China*. Westport, CT: Greenwood Press.

Zheng, Q. (1989) "Quanguo cun ji zuzhi zhuangkuang de diaocha (national survey of the state of village-level organization)," *Zhongguo Minzheng (Chinese Civil Administration)*. Reference cited from W. Chen (1998) "Economic Reform and Social Instability in Rural China," (5:87-101) in J. Zhang & X. Li (eds.) *Social Transition in China*. Lanham, MD: University Press of America.

APPENDIX A. INTERVIEW QUESTIONS FOR GOVERNMENT PERSONNEL AND POLICY MAKERS

Government and policy

1. How has the interest in renewable energy evolved?
2. Has biogas been grouped with other forms of energy or are there initiatives specific to biogas?
3. Describe the current policies that affect renewable energy use in rural communities, how they work, and who they affect.
4. Describe the differences and tradeoffs between public and private energy sources.
5. Does the government help communities create the power stations? In what ways? (money, equipment, labor, policy, land, planning, etc.)
6. Does the government hold a role in sustaining the technology? (continued finance, equipment, labor, etc.)
7. Do you believe there are any limiting factors or barriers that prevent provincial and national government influence at the local level?
8. Do you feel current government methods in rural energy could be altered to be more effective? If so, how?

Organization specifics

1. Describe the rural communities before they obtain the new energy form.
2. Do you feel there is a need for assisting rural communities to develop means of power?
3. What are your organization's interests for seeing rural communities get power?
    a. Are these interests specific to biogas, renewable energy, or is any form of power acceptable?
    b. Are these interests similar on a provincial or national level?
4. What is your role in helping rural communities get new forms of energy?
    a. What are the responsibilities of yourself or your organization in regards to biogas power?
    b. What is your relationship to persons in the rural communities? When do you engage in conversation?
    c. How did your organization establish communication and trust with the rural communities?
    d. Do you feel that the rural people have more interaction outside of their communities now that they have a new means of energy? In what ways?

Local Resources & Needs

5. What do you believe are the interests of the rural persons to obtain energy?
    a. Are they specific to renewable energy or biogas?
    b. Are they aware of the differences, costs, and benefits between the forms of energy?
6. How are rural persons involved in the project? (planning, implementation, maintenance)

7. What do you believe are the main barriers to renewable technology in rural areas?
8. What community groups exist to support coordination and maintenance of the community source of energy?
    a. Are these groups that create local understanding or policy new or how have they evolved from the old leadership?
    b. Have you seen if there are sub-groups within the community that control and use most of the energy?
    c. Are there any differences in authority or power between members of the community?
9. Are social norms or cultural understanding important in the group energy projects? Do energy projects have different social influences than other forms of group activity?
10. Do you feel flexibility of the local community is important to new ideas? In what way?

Project Sustainability

11. What do you feel makes a project successful?
    a. Who is involved?
    b. What resources are necessary?
    c. What agreements and understanding is needed between members in the community?
12. What do you believe are some factors that can cause a project to fail?
    a. Lack of resources for maintenance?
    b. Disagreements between members of a community?
    c. Lack of supporting groups inside the community to run the project?
    d. Lack of local policy to regulate production and consumption?

APPENDIX B. INTERVIEW QUESTIONS FOR GASIFICATION SCIENTISTS

Government and policy

1. Describe the current policies that affect renewable energy use in rural communities, how they work, and who they affect.
2. Does the government help communities create the power stations? In what ways? (money, equipment, labor, policy, land, planning, etc.)
3. Does the government hold a role in sustaining the technology? (continued finance, equipment, labor, etc.)
4. Do you feel current government methods in rural energy could be altered to be more effective? If so, how?

Rural community description

5. Describe the rural communities before they obtain the new energy form.
6. Do scientists tour the communities to learn more about local needs and capabilities?
7. What benefits do rural communities have from obtaining power?
8. How are rural persons involved in the project? (planning, implementation, maintenance)

Organization overview

9. What are your organization's interests for seeing rural communities get power?
    a. Are these interests specific to biogas, all biomass, all renewable energy, or is any form of power acceptable?
10. Why was your organization started?
11. How long has the organization been developing biomass technologies?
12. What are the top three factors you take into consideration during research and design? (cost, local surveys and interests, natural resource availability, education and skills, equipment availability, maintenance issues, etc.)
13. What is your relationship to persons in the rural communities? When do you engage in conversation?

Resources

14. How is the price of biogas and electricity set?
15. What forms of biomass do you include as resources for biogas production?
16. Where do you obtain finances for the equipment and labor during research?
17. How are scientists trained for biomass research? Does most of the training occur at the research center or do they go to a specific school or have a specific curriculum?
18. Do you feel there are economic, political, educational, or equipment limitations that inhibit research and development?

Sustainability

19. What do you feel makes a successful biogas project?
20. What do you believe are the main barriers to implementing biogas technology in rural areas?
21. After implementation, what situations can lead to failure of the biogas projects?
22. During design and implementation, is there consideration of local social and cultural characteristics? Which do you feel are most important for a successful project?
23. Do you feel the ability of the local community to adapt to new ideas is important to sustainability? In what way?

APPENDIX C. INTERVIEW QUESTIONS FOR COMMUNITY LEADERS

Leadership roles

1. What is your role in the community? How long have you had the position?
2. What responsibilities do you have in relation to biogas production and consumption?
3. How does the government interact with the community? Is it with you directly or also with the villagers?
4. Do villagers come to you if they have difficulties in daily life? Have they approached you with issues related to energy use?
5. In addition to the gasification station, has there been additional development in the past ten years? Did the upper government initiate these projects?

Community definition and structure

6. Describe how persons in the village define themselves as being a member. Is it geographic, socio-political, genealogical?
7. How do you believe the community has changed after bringing the station and biogas to the village?
8. Have any changes occurred to politics or economics within the community due to the introduction of the biogas station?
9. Do you feel there has been more business or better business as a result of the station? Why? Which businesses?
10. What resources or institutions are available to the public?
11. Do you feel there has been more interaction with people and companies outside of the community after introduction of the biogas plant?
12. How do families interact on the community level? (social gatherings, businesses, education, etc)

Biogas station implementation and use

13. Describe what you think are the main trade-offs between using renewable energy (solar, wind, water) and non-renewable energy (fossil fuels).
14. What have been the forms of energy available to the community over the past 20 years?
15. Has marshgas ever been used?
16. What led to the development of this biogas station? Who was involved?
17. Were there any constraints or difficulties during implementation?
18. Is the biogas used directly in burning or made into electricity? Or both?
    a. Is the biogas used for community projects?
        i. If Yes: What types of group facilities if the power for?
        ii. If No: What ideas do you have in using the power for group facilities?
    b. What uses do families have for the biogas?

c. What uses do enterprises or companies have for the biogas?

19. How is the price of biogas / electricity set?
20. Is the biogas station connected to a larger grid? If not, has there been interest in the community or within the government for connecting it to a larger grid?
21. Who makes decisions that affect the station? What types of decisions are made? Who is involved?

Sustainability and expansion

22. What have been the benefits of a biogas station to the community as a whole?
23. What have been the benefits to the individual families?
24. Do you foresee any other benefits in the future?
25. What do you believe there are areas of concern for sustaining the biogas source? Factors that may lead to its failure.
26. Do you have an interest to expand biogas production? If so, for what means?

APPENDIX D. INTERVIEW QUESTIONS FOR GASIFICATION MANAGERS

Government and policy

1. Describe the current policies that affect the biogas station. How they work, and who they affect.
2. Does the government help communities create the power stations? In what ways? (money, equipment, labor, policy, land, planning, etc.) What level of government?
3. Does the government hold a role in sustaining the technology? (continued finance, equipment, labor, etc.)
4. Do you feel current government methods in rural energy could be altered to be more effective? If so, how?
5. Do you feel that scientists understand the needs and capabilities of local people?
6. Do you feel that policy makers understand the needs and capabilities of local people?

Organization overview

7. How did this biogas project originate?
8. How long has it been since it was created?
9. Who makes decisions that affect the station? What types of decisions are made? Who is involved?
10. How has your relationship to the villagers changed since you were appointed manager?

Resources

11. What forms of biomass do you use as feedstock for biogas production?
12. How do you obtain feedstock? (inside or outside town) Do you need to purchase it?
13. Do you obtain financial support for the equipment and labor?
14. Do you include consideration daily habits when deciding how to produce and supply the biogas?
15. How often is the equipment run? For how long each time? What level of supply?
16. How are the workers trained? Is this a difficult process? Who provides the cost for training?
17. What is the type and model # of the equipment?

Energy production and supply

18. How is the price of the biogas determined?
19. What is the cost of biogas production?
20. Are there revenues from producing the biogas?
21. How do you utilize the biogas? Convert it to electricity or provide it as a gas?
    a. Who uses the electricity or biogas?
    b. What do they use it for?

Sustainability

22. What do you feel can make this station successful?
23. What do you believe are the main barriers that could lead to failure of this station?
24. Do you feel the ability of the local community to adapt to new ideas is important making the project work? In what way?

APPENDIX E. INTERVIEW QUESTIONS FOR COMMUNITY MEMBERS

Family relationships

1. How do families interact in the village? Is it social or also for business?
2. In difficult times do families work together and help each other? In what ways?
3. How is trust shown between families? (loaning money, gifts, marriage, sharing tools, children playing together, group meals)
4. Do you feel there social groups inside the village that are composed of just a small number of families?
    a. If so,
        i. How are these smaller groups defined? (closer family ties, similar profession, live close together)
        ii. Do some groups have more resources or influence than others?
5. Do you feel your relationship to other families has changed with the introduction of the public energy source? In what ways?
6. How are decisions reached that affect the community?
7. How much influence does a family or individual have on community or group decisions?

Resources available

8. What sources of biomass are available for biogas creation?
9. After introducing biogas, do you feel you know more about how energy can be produced and used? In what ways?
10. What level of education is available to your children?
11. Do you believe that government understands the needs of families?
12. Do you believe that scientists understand the needs of families?
13. Do you feel it is easy to discuss with the mayor or secretary if there are difficulties in acquiring resources? And with disputes between families?
14. Has anyone approached you about how the station can meet your needs? Who?
15. Which persons have the most contact with others outside of the community?

General energy use

16. What forms of energy do you use in your home?
    a. What are they used for? Does this depend on time of year?
    b. About how much of these fuels and energy do you use in a typical month?
    c. How much do these fuels cost? Do the prices fluctuate? How much have costs risen in the past five years?
    d. Why do you use these forms of energy and not others?

e. What equipment uses these fuels? How much does it cost?

f. Have you had any difficulties with using these forms of energy?

g. Do you have any interest in other forms of energy? Why?

17. Do you believe there are benefits in switching from biomass to biogas use?

a. What changes would occur within your household?

b. How would the daily life of family members change?

c. What are the barriers that may constrain you from obtaining or using biogas?

Household dynamics

18. How many members are in your family? What are their daily activities?
19. Who is responsible for collecting or purchasing energy?
20. Who uses the energy or is responsible for creating energy out of the fuel?
21. Do you feel the lifestyle of yourself and other family members has changed after introduction of biogas energy?

APPENDIX F. KEY QUESTIONS FOR CONCEPTUAL MODEL EVALUATION AND DATA OBTAINED

Aggregate and macrolevel considerations

A. Communication Systems

E1. *What are the characteristics of communication links between citizens and local leadership?*
One representative for every 10-15 families is supposed to take information and opinions from citizens and relay it to the secretary. However, the secretaries rarely use the representatives and the representatives don't interact with the families, often families do not know who their representative is.

E2. *What are the characteristics of communication links between local leadership and government agencies?*
Converse when officials and scientists visit the town but rarely otherwise.

E3. *What are the characteristics of communication links between citizens and government agencies?*
Relationship is good with the rich, but the poor cannot travel to the city to discuss with exterior actors. When government and scientists visit they do not interact with the families.

E4. *What are characteristics of horizontal linkages between communities?*
None were promoted, exist only if personally established by the secretaries themselves. More on social basis.

E5. *What are characteristics of horizontal linkages between government agencies?*
Difficult for them to openly converse, all dialogue needs to be routed through the medium organization that finances a large percentage of the project. Therefore little conversation occurs between scientists and various government agencies, including those who assess the villages. Basically only interact during an assessment and implementation.

E6. *What are characteristics of horizontal linkages between villagers?*
Families in the village have no special relationship. Common last name, but that is about it. They are all farmers, no business relationships. Social gatherings are not commonplace. Gather for a wedding but rarely for anything else. Occasionally play cards and sit out to chat, mostly older people though.

B. Viewpoints from Government Officials and Scientists

B1. *What do you believe are the main reasons for continued success (or failure) of the station?*
Government is holding up its end of the bargain but not supplying finances to the villages on time. Also, more investment in R&D is needed.

Policy should be more specific and focus on long term achievements, not short term goals that in fact limit success. The policy decision makers at province and city levels do not pay enough attention, do not adapt policy for new technologies.

Sustainability of the project occurs when important persons on each level of government pay attention. People who can make decisions, like the mayor or secretary at the local level. Even improving awareness among villagers is useful.

Barriers are the willingness of local people to accept new technology, affordability, and the extent to which the technology can adapt to the local situation.

Management at the local level is important in sustainability, however as the equipment gets better, management becomes easier.

B2. *Systems fail when there is no economic benefit for the project, coupled with a lack of government funding. What criteria are used to assess villages for funding?*
Communities are assessed to receive funding on three primary elements, 1) if there are enough local resources to sustain energy production, 2) economic need, 3) education level and technical knowledge to determine if leaders / personnel can run and upkeep the facility.

Community specific information (responses in tabular format following)

C. General

C1. What is the approximate size of the town?

C2. Is the gasification station still in operation?

D. Household Dynamics

D1. Who prepares meals within the home?

D2. Which fuels are preferred for cooking? Why?

D3. How have household activities changed after biogas became available?

E. Viewpoints from Community Members

E1. What do you believe are the main reasons for continued success (or failure) of the station?

E2. Do you support the judgment and capability of scientists?

E3. Do you support the judgment and capability of local leadership?

E4. How are decisions reached that influence the station?

F. Viewpoints from Local Leadership and Gasification Management

F1. Why do you believe a biogas station was brought to this town?

F2. How was the initial project investment funded? (price of buildings and equipment)

F3. What do you believe are the main reasons for continued success (or failure) of the station?

F4. What do you believe could be done to improve the project? How could this be accomplished?

F5. How are decisions reached that influence the station?

F6. What is your responsibility in station operation?

F7. Were any new policies established with the station?

F8. Has the price of biogas ever been adjusted?

Responses

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
C1	400 families	150 families	130 families	260 families	330 families	110 families
C2	yes	no	no	no	no	yes
D1	women or men without a job	normally women and children are in charge of cooking and heating	women who are at home do most of the cooking	grandmother	mother and child returned from college for time being	elderly women who are staying at home
D2	propane is great but too expensive, electricity is good for boiling water	coal is cheap but dirty, willing to switch to propane if cheaper	straw can be used because it is free, propane is expensive	no difference between using biogas or LPG, both good but biogas much cheaper; use electricity in summer and coal in winter	coal used for cooking bread and heating; LPG for urgent use; straw cooks most dishes; biogas when it was available, it was cheap & as good as LPG	coal is ok, biogas is working well and cheaper than propane, otherwise use straw since it is free
D3	middle-aged persons that would need to go collect fuel can now go out for school or a job	people spend less time cooking; biogas is cleaner and safer so less cleaning and worrying about injury	no need to collect biomass fuel	more socializing can occur now that cooking is easier	save time using gas fuels, more time to earn money	can take more time for rest and play cards

Responses (continued)

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
E1	station is new, gas is good and helpful	supply not stable; staff at station were poorly trained; people would not pay when asked; poor weather made fuel wet	village government did not get any money from families, some had 'rigged' their meters	biogas stopped because equipment was broken, government wants everyone to move into new apartment buildings, so no bother to fix	failure due to shortage of fuel; station did not have enough money; poor management and villagers 'rigging' gas meters; government did nothing to solve meter problem or get fuel	new technology has made better quality fuel, good management decision
E2	think scientists know what they are doing	most thought they understand the needs of local people, though one couple thought otherwise	scientists are in contact with the local government	yes, scientists showed what can be done with biomass	no idea of scientists understand what is going on; biogas was perfect match, they did good job	upper government and scientists understand the needs of local people through the local government
E3	trust local leaders to help when they can	yes, go to mayor / secretary if there are problems with daily life or paying bills	local government is easy to meet with but not sure if they can help	both upper government and scientists understand needs of the people	try not to bother secretary, thinks it is in vain, they can't or won't bother to help	if village government has the capability to help, they will
E4	no villager is used in decision-making, representative is supposed to give their opinion, but they not around	decisions made by secretary and mayor; individuals seldom have influence in community-wide issues	leaders make decisions without consulting local people	representative system is in place but not used; secretary makes decision	leaders make all community decisions	normally individuals have no influence on group decisions

Responses (continued)

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
F1	bring benefit of clean renewable energy	village government was stable, plenty of resources, and to remove smoke from a local roadway	stop people from burning straw on the road, creates lots of smoke	village had economic need, good management, and fuel available; protect roadway from smoke	good for clearing smoke from airport and road that leads to airport	promoted as test case because it is such a small, remote town
F2	2/3 funded by upper level government agencies and 1/3 by the community	half of project costs covered by village government, half by provincial government	-	half by local government, half by scientists and upper government	equipment provided by scientists while land and buildings by local government	village government provided 1/4 cost, and upper government provided 3/4 cost
F3	Management and quality of equipment have been fine	villages interested at beginning but they lost interest; equipment broke or became clogged in the home; tar plugged station equipment every 2 months; villagers broke meters to steal gas	villagers rigged the meters to steal gas; wet fuel; project difficult to manage	steal in the gasifier warped once a year and needed to be replaced; project closed as biogas cannot meet needs of an urbanization, apartments going up, farmers moving out; we fuel	lot of tar, equipment caught fire after only 6 months of operation; maintenance levels were high; distribution pipes rotted away, causing leaks; villagers broke meters to steal gas; wet fuel	good quality gas, easy to maintain; modified some parts of the design after it was installed; villagers are happy; first set of equipment was bad, got better technology
F4	project is fine, why look to improve; not interested in expanding	more faith from villagers; greater finances from upper government	-	more advancements in technology	-	better technology has been helpful

Responses (concluded)

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
F5	Community members not involved in decisions though leaders go out to find their needs	decisions by local government leaders	decisions made by combination of local government, upper government, and scientists	decisions made by local government leaders	community leaders make the decisions	leaders make decisions
F6	Not simple to separate gas station from local government, one in the same	oversee implementation; station part of government, manage station and workers	government oversees the station	oversee implementation; manage workers and direct decisions	station ran by village government	manages the station manager
F7	no new policies	no	no	yes, boxes around meters and policies against stealing	no	yes, boxes around meters and policies against stealing
F8	no, very recently established station	no	no	no	-	Yes