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Abstracts

Urban energy networks and sustainability

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Abstract:
This paper presents ongoing research into the features and challenges of urban energy networks and their role in reducing cities' resource consumption and environmental impact. Technologies such as distributed or co-generation, which could make electricity and heat provision more efficient and less carbon-intense, have been discussed at length in many academic and policy forums. However, less has been said about their overall technical impact on the critical capital-intensive networks that supply urban areas. Understanding this impact is important, in order to evaluate the consequences for different stakeholders and assess the contribution that a particular energy technology could make towards urban sustainability. Additionally, it is an important step towards the optimisation of network planning in different city areas. The research presented here begins to tackle these issues in two parts: a conceptual framework that maps links between urban characteristics, infrastructure performance and sustainability; and a modeling tool that integrates the network load flow analysis of gas and electricity.

The proposed conceptual framework is being developed to place electricity infrastructure and its technical features in the context of urban sustainability. Taking a systems approach, it attempts to illustrate how characteristics of a city area (such as density) can influence the potential of different types of electricity infrastructure (such as network concepts), and how this in turn translates into technical, economic or environmental implications. In its current form, it is a qualitative tool. Work is now focusing on quantitative modeling, to explore the identified influences. In the future, the model could be extended to other networks such as gas or heat and the interactions between them.

Such network interactions could become a common feature in urban areas, but are not yet well understood. For example, natural gas based micro-CHP (Combined Heat and Power) units are among the technologies that could contribute towards future urban energy supply, potentially substituting boiler devices as the preferred choice for heating millions of domestic and commercial dwellings. However, distribution network planners have largely overlooked the combined technical effects that such generation will have on both natural gas and electricity networks.

This research therefore aims to integrate the analysis of gas and electricity networks, effectively an unexplored topic in academia. A program has been developed that analyses the flows in an urban gas network. The research now focuses on coupling this with the electricity network equivalent, via models of micro-CHP units that consume from one network and inject into the other. Such integrated modeling will serve as the cornerstone for further studies, in which working towards a planning roadmap for gas and electricity distribution networks that have a high penetration of distributed generation is the envisioned goal.

Central to both of the proposed models is the consideration and technical analysis of how energy technologies influence physical networks. By taking such an approach, the research hopes to provide insights into what infrastructures could support sustainable energy provision in different types of cities, and how planning of traditionally separate urban networks such gas and electricity could be optimally integrated in the future. As such, it will benefit network operators, regulatory bodies, policy makers, city developers, as well as end consumers.

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Radical vs. Incremental Innovation Pathways in Energy Technology: The Case of Low-Carbon Vehicles

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Abstract:
Increasing concerns for global warming, air pollution and security of oil supplies are currently driving an unprecedented surge of R&D and demonstration activity on alternative fuels (e.g. biofuels) and electric vehicles (e.g. hybrid-electric, battery-electric and fuel cell vehicles). In recent years, the development of fuel cell vehicles (FCVs) and related hydrogen infrastructures has been emphasised by the automotive and oil industries, with strong support from governments (e.g. by the EU, which recently approved a 1 billion Euro plan to kick-start the commercialisation of FCVs). These efforts follow previous initiatives to commercialise battery-electric vehicles (BEVs), notably in California, France and Japan. However, the commercialisation and diffusion of FCVs and BEVs continues to face technical, commercial and political barriers. The incumbent technological regime, based on petroleum and internal-combustion engine technology, remains deeply entrenched and benefits from a wide range of supporting resource, technological and institutional infrastructures. Only hybrid-electric and advanced diesel vehicles, which do not require any modification to energy supply infrastructures, have seen modest successes. As the latter technologies will not be sufficient to stabilise let alone reduce the long-run growth in greenhouse gas emissions and oil demand from transport, more radical solutions such as FCVs and BEVs are needed. Moreover, these latter technologies offer other benefits such as reduction of air pollution and related health impacts.

One factor that complicates policy and corporate strategy choices in this sector is the *plurality* of technological options, which compete not only with the dominant technological regime but also among each other. This competition is playing out at different levels, including in the energy policy and research community where there is increasing scepticism toward the hydrogen option, but also in industry and government where BEVs as well as "plug-in" (rechargeable) hybrids have seen renewed interest lately. There is much debate and speculation as to which of these options offers the highest greenhouse gas emission reductions, the most efficient use of resources, and/or the best cost-performance proposition.

While a number of studies have compared these options in terms of environmental and energy efficiency criteria, this paper focuses on their long-run technology and industrial dynamics. Recent technical and commercial developments relating to advanced

batteries, fuel cells, hydrogen storage and electric motors are reviewed, and their implications for the commercialisation of BEVs and FCVs are discussed. The paper also examines the relative infrastructure requirements of BEVs and FCVs.

In particular, it is shown that BEVs offer the potential for a relatively incremental and therefore more feasible pathway of technical change in road transport, "piggybacking" on on-going market-driven trends (e.g. the rapid growth of lithium battery technology, the long-term trend toward decarbonised electricity) and existing electricity infrastructures. Also, BEVs can and already are growing first in select market niches, while battery technologies are spreading in the automotive sector through hybridisation with internal-combustion engine technology. In a best-case scenario for BEV proponents, continued penetration of hybrid-electric vehicles (along with portable electronics devices) into global markets would drive cost reductions and performance improvements in lithium batteries as well as other electric-drive vehicle components, making possible a largely market-driven evolution from hybrids to increasingly electrified plug-in (rechargeable) hybrids, and finally to full-powered BEVs. If, as is likely, decarbonised electricity (including renewables, nuclear power, and carbon capture) continues to progress, this will enable a gradual shift to near-zero emission transport.

In contrast, the FCV agenda is characterised by more radical and hence more complex innovation pathways, with little scope for leveraging market trends or existing infrastructures. Our research suggests that relevant niche market developments are still very limited, and that fuel cell R&D is therefore funded mainly by internal funds at large corporations and by governments. Moreover, hydrogen infrastructure development will require centrally-planned and complex coordination structures, and may thus be very costly. Last but not least, the drivers for the development of decarbonised hydrogen are currently weak, with most hydrogen produced from natural gas.

While these differences do not exclude the possibility that FCVs could succeed one day, historical precedents (which are briefly reviewed) suggest that centrally-planned technological transitions are rare, and that most transitions occur through incremental change and hybridisation with existing technologies. The strength of the BEV agenda is that it doesn't require any major infrastructure investments to begin (although some might be needed later), nor any publicly-funded "strategic niches" or vision-guided transition master plans. It builds on much more *evolutionary*, bottom-up dynamics than the planning-intensive FCV agenda; simply decarbonise power generation (which is already happening) and let the evolution from hybrids to BEVs run its natural course.

In order to improve the effectiveness of policies and strategies for decarbonising road transportation, underlying innovation dynamics need to be understood and analysed in a holistic way. This study thus combines technology assessment, resource and environmental science and insights from innovation and organisational studies to address this gap in the energy technology and policy literature.

Powering Tomorrow's Metropolis by Green Electricity: Innovation in Energy Services

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Abstract:
Urbanisation will characterise world population in the first half of this century. By 2030, the proportion of urban dwellers to total population is expected to reach around 80 percent in the most prosperous countries and 60 per cent globally. The pattern of future energy demand will be increasingly characterised by the 'network of the city', since solutions to the grave challenges faced by cities in a world of over 8 billion all have implications for urban energy systems. The resource flows inherited from 20th century cities are based on un-integrated discrete systems with many legacy technologies and features of lock-in. In the past, neither the data nor systems technology were available to realise the economies from process integration. These two barriers are now surmountable through cutting-edge research and data handling technologies. As a consequence there is potential to deliver equivalent or better services in the world's cities at substantially reduced resources flows.

In this paper, we will present our case study of green electricity and will explore the energy challenges of tomorrow's cities and the take-up of new technologies to meet them. Environmentally friendly products can have a hard time diffusing into a market for many reasons. They might not offer the same functionality as non-green products, they may be more expensive when offering the same functionality, or they may require changes in consumer behaviour. Green electricity, generated from renewable sources such as wind, solar and biomass, is one new green product that has not been widely accepted by UK consumers.

In this paper, we will analyse the way consumers' environmental beliefs and norms are translated into attitudes towards a green innovation and intentions to adopt it. In order to understand how behavioural intentions are formed, we combine the existing innovation adoption-diffusion models, behavioural models and consumption theories. When consumers decides to adopt a new product, they consider technical functionalities, product attributes and outcomes of the adoption behaviour, but they also look for the symbolic meanings the product carries for them and consider the daily practices that lead to the need to adopt it. We also include the 'willingness-to-pay' element to our framework, as affordability is an important decision-making factor.

We will report findings of our empirical studies. First, we conducted focus group interviews to tease out issues consumers have regarding ‘being green’ and adopting green electricity. Then, a questionnaire survey is conducted to support and validate the theoretical constructs that emerged from interviews and also to investigate statistically the relationship between environmental beliefs, attitudes towards green energy and adoption intention. We intend to clarify the self-selection processes in which consumers elicit pro-environmental behaviour and adopt green products. Policy implications on the diffusion of green electricity will also be developed.

Advanced-Integrated Gasification Combined Cycle with Exergy Recuperation

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Abstract:
There has been a considerable increase in energy consumption and energy production over many centuries. Coal has been widely used over the world because coal is most widely available fossil fuel and has larger amount of resources compared with oil and natural gas.

In order to secure resources in sufficient amounts and resolve global environmental problems, the development of clean coal technology (CCT) for utilization of coal as a cleaner energy resource free of carbon dioxide (CO_2) emissions is imperative. Hence, it is extremely important to develop and promote high-efficiency systems such as integrated gasification combined-cycle (IGCC) or integrated gasification fuel cell (IGFC) power generation technologies.

In the conventional cascade utilization IGCC/IGFC systems are based on integration of gasifier with fuel cells, gas turbines, and steam turbines for power generation. In this system, heat required for gasification reaction, which is an endothermic reaction, is supplied by partial oxidation of coal, which is an exothermic reaction. In the partial oxidation of carbonaceous resource, considerable amount of exergy (i.e. the maximum amount of work that can be obtained from a given process, or from a given system by reversible processes) is lost in the oxidation process because the exergy rate of thermal energy is much lower than that of carbonaceous resources. This leads to reduction in the exergy efficiency of coal conversion. As an alternative to such cascade utilization systems, this study examines the principle and possibilities of advanced IGCC (A-IGCC) system making use of exergy recuperation technology for recycling of the waste heat from gas turbines or fuel cells in furnaces for steam gasification. This reduces the partial oxidation of coal. In addition, steam gasification reaction accumulates low-temperature thermal energy in a form of hydrogen energy and upgrades to a higher temperature level than the low-temperature heat because the produced hydrogen can be burned at a higher temperature than the low-temperature heat. Since the exergy rate of hydrogen is 83%, which is the lowest among conventional fuels, conversion of chemical energy of coal to hydrogen energy and combustion of the produced hydrogen can remarkably reduce exergy loss during the combustion process in a fuel cell and/or gas turbine for power generation compared with the direct combustion of the coal. Hence, the hydrogen and power co-production by using the exergy recuperation gasification

technology for recycling of the waste heat from gas turbines and/or fuel cells in gasifier of endothermic gasification could considerably increase the energy utilization efficiency.

In the present study, the concept of the advanced IGCC/IGFC for hydrogen and power co-production will be described based on exergy recuperative technology in conjunction with the fluidization technology of high density solid circulation systems for gasifier.

The role of indicators in improving the performance of urban energy systems

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Abstract:
Cities are becoming increasingly important centres for innovative policy making. While national and international initiatives will continue to shape life in urban environments, many have recognized that the concentrations of population, economic activity, culture, resource demands and built capital found in cities provides a unique opportunity to develop and assess new solutions to global problems. In the case of energy systems, it has been estimated that approximately 75% of global energy demand arises from urban activities and accordingly, cities that introduce their own innovations in the energy sector have the potential to improve both their local environment as well as encourage global innovation. For example approximately 150 local governments in the UK have adopted a planning rule that promotes the adoption of microgeneration technologies; this so-called 'Merton Rule' is widely acknowledged as having a contribution to innovation in distributed energy systems comparable with that of national policies.

For officials seeking to make their cities centres of energy system innovation, one of the first tasks is to understand the specific features of one's own local energy system. London for example has a mature infrastructure and an economy based largely on the provision of financial services; it will therefore have significantly different energy requirements and innovation opportunities compared with cities such as Singapore (i.e. a tropical city with new infrastructure and a shipping and oil refining economy) or Los Angeles (i.e. with its reliance on private automobiles for transport). There is therefore a need for policy tools which can summarize these complex narratives and identify the opportunities for change. This role is often fulfilled by indicators – i.e. "symbolic representations (e.g., numbers, symbols, graphics, colors) designed to communicate a property or trend in a complex system or entity" (Hák, Moldan, & Dahl, 2007). However a recent review of current practice in the related field of urban sustainability indicators has noted that indicators often fail to provide sufficient analytical insight to act as meaningful inputs to policy debates (Keirstead & Leach, in press). It was found that these metrics often provide largely descriptive assessments of the current situation, drawing upon readily available data to support ambiguous policy goals with a weak grounding in sustainability theory.

To resolve this dilemma, it was proposed that urban sustainability indicators should be developed around 'service niches' as an application of the strategic niche management

(STM) concept described in the innovation literature. In its original form, STM advocates the development of innovations within protected environments so that technical and institutional difficulties can be resolved before the new product or service is fully exposed to market forces. In the ‘service niche’ indicator approach, the failings of current urban sustainability indicators are viewed as a premature integration of indicators into the policy environment (i.e. market exposure). The proposed solution to this dilemma is to identify cross-cutting urban services such as energy or water provision as the basis of a set of niche indicators. These niches must have relevance to the wider goals of urban sustainability, but by focusing a tangible aspect of the urban environment, it is hypothesised that these indicators can clarify the goals of urban sustainability policy, provide greater analytical validity and thus set the stage for more effective policy analysis. Accordingly, the indicators developed for a particular service niche will also have special meaning for experts in that field. In the case of energy systems for example, the corresponding niche indicators should provide sufficient detail for an expert to diagnose and recommend solutions for a series of related urban energy system problems (e.g. fuel poverty, climate change, energy security).

In keeping with the aims of the symposium, this paper has two goals. First it will introduce participants to the service niche approach to urban indicators, providing a description of the methodology and then applying it to the energy systems of London and Tokyo. It is hoped that this will encourage debate about the relative merits of London and Tokyo’s energy systems as well as providing feedback on the method itself (which is still evolving). The second goal is to consider how innovation in urban energy systems might best be assessed. For example, are there specialist metrics from the innovation literature that need to be considered? Perhaps more fundamentally, how should policy makers account for energy system innovation within their decision-making processes? Are indicators even an appropriate tool in this context? By considering both energy system indicators themselves and their use within policy contexts, it is hoped that this paper will be of interest to many symposium participants.

References:

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Keirstead, J., & Leach, M. (in press). Bridging the gaps between theory and practice: a service niche approach to urban sustainability indicators. *Sustainable Development*.

Building Energy Monitoring System

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Abstract:
Since middle of 90's in last century, energy performance is one of the key issues in building design. However, energy performance assessed and demonstrated to the stakeholders of building is based on simulation with a set of assumptions. Therefore it is not unusual that there is a considerable gap between assessed energy performance and real performance. In order to generate and facilitate actions by stakeholders to improve real energy performance by utilization of potential capacity of building, the stakeholders need to be well informed on how much energy they use in designated period in the defined space where they live and work. In spite of such demand for specific information, very limited effort has been made to develop the system to monitor and measure energy use of building. Consequently, only analog based discrete data was available for building management practices.

This paper introduces the energy use monitoring system of building developed by the authors. It is network based system by which comprehensive set of object oriented data is automatically collected from any devices which can send digital data, even if it is locally formatted. Then the paper demonstrates how the monitored data is delivered through intra- or internet, and is presented to the stakeholders of building through user interface. Though every stakeholder uses common data base, user interfaces can be modified depending on stakeholders' concern.

The paper describes how these are used in building operational management with several case illustrations. Accumulation of monitoring data is a basis of certain prediction of energy use of building which enables proactive actions for improvement of COP in operation of building services. The paper illustrates the case where 8 % reduction of CO_2 emission was realized only by such a way of the improvement of COP.

Future Hydrogen Supply Chain Networks for the Netherlands

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Abstract:
Renewable fuels have been receiving increasing attention, both from the academic and industrial researchers, due to several pressing environmental and economical issues: 1) ever increasing global warming concerns, 2) increasing energy security concerns due to dwindling fossil fuel resources, 3) deteriorating urban air quality, and 4) relentlessly increasing oil prices year after year). Hydrogen is one of the most potential renewable fuels of the future due to: 1) The availability of wide variety of feed-stocks and, 2) It's potential to reduce green house gas (GHG) emissions, especially carbon dioxide (CO_2) emissions. However, several economical and technical hurdles (such as the high costs of fuel cell vehicles (FCVs) and on-board storage technologies, and the lack of refuelling infrastructure) need to be overcome to realize hydrogen economy. Though, the chicken and egg problem is still being talked about, the developments over the last couple of years, especially due to the automobile manufacturers' initiatives to start mass production in the near future, it is slowly becoming less of a concern.

Though several of the hydrogen technologies are becoming economically more attractive day by day, ultimately the economic feasibility of the entire hydrogen supply chain network is what drives the hydrogen economy. Thus there has been increasing attention from the policy makers and researchers on this aspect and, consequently the number of such studies is rapidly growing in the recent past. However, since the economic feasibility of the hydrogen supply networks and the network itself is region specific (due to the differences in several of the issues that drive the network - e.g., the available feed-stocks, policy considerations, and even the social factors such as consumer preferences), the results cannot be generalized.

In the present study, the future hydrogen supply chain network is designed for the Dutch transport sector. The Netherlands is one of the top 'petroleum non-producing and consuming countries'. Demand growth rate in transport sector is much more rapid and about 45% rise is reported between 1990 and 2004. Dutch transport sector consumes nearly 29% of the primary energy while most of it comers from the oil. On

environmental front, Dutch CO2 emissions rose by 10% since 1990 (to 176 million tons in 2005). The high energy dependency, GHG emissions and gasoline prices make it very necessary to deploy clean and secure renewable energy fuels/technologies in the near future. On a positive side, since the Netherlands is highly populated and economically advanced, it has the potential to become one of the first countries that make a transition towards hydrogen economy. Considering the aforementioned energy security issues and GHG emissions, Dutch Energy Transition Task Force set stringent targets on GHG emissions (i.e., reducing the GHG emissions by at least half by 2050, compared to 1990 levels) and oil usage, i.e., a reduction of 75% by 2050 as compared to oil usage in 2000.

In order to reap the utmost benefits of hydrogen economy, it is important to design these networks as optimally as possible. The hydrogen supply chain network itself is complex and involves several stages/entities – raw materials, production plants, transmission, intermediate storage or distribution centres, distribution and refuelling stations; and at each stage, there exists several possibilities. Thus, overall, there will be many alternative pathways. The addition of another dimension, i.e., the special variation/distribution of the network at a national level, makes it even more complex. In this study, present and near future hydrogen production technologies (i.e., steam methane reforming - SMR, coal gasification, biomass gasification and electrolysis) are considered. Both liquid and gaseous hydrogen networks are studied and the corresponding transport (road – tanker trucks/tube cars and rail), and storage technologies (liquefied and compressed storage) are considered. The methodology is generic, thus, it can be extended to consider other hydrogen technologies, such as pipeline transportation, electrolysis based on renewable electricity.

As mentioned above, due to the scale of the national level network and many possible pathways, there are a huge number of potential feasible alternative scenarios. Thus a systematic optimization framework based on MILP is used in our study to efficiently design future hydrogen supply chain networks. The objective is to minimize the total costs, i.e., the sum of the annualized capital costs and operational costs of the entire network. The decisions involved are the number, type and scale of production plants and storage facilities and the transport and distribution logistics. It is demand-driven network, and, since the future demand depends on the uncertain FCV market penetration rate, stochastic optimization is carried out with various possible demand scenarios (i.e., with varying penetration rates – 0.1% to 5%). In addition, in order to better understand the trade-offs in the various elements in the supply chain and the effect of technology learning and the uncertainties in the data, extensive sensitivity analysis is also carried out. The methodology is based on the demand-cluster based analysis and hence, 25 demand clusters are identified as the potential locations to set up hydrogen production plants, as initial roll out of FCVs is expected to be taking place in and around these demand clusters.

It is observed that the delivered price of hydrogen ($/km), without fuel tax, is found to be cheaper than the price of gasoline ($/km) in many of the scenarios considered. Though, mostly the production is based on SMR, at the higher demand levels, when the operating costs become more significant, the coal gasification is also being used. This is mainly due to the lower operating costs of the coal gasification compared to SMR (as coal is cheaper than natural gas). However, when the cost of carbon capture and storage (CCS) is also included in the objective function, SMR becomes preferred production technology as the CO_2 emissions from coal gasification are almost double that of from SMR. CCS has increased the price of hydrogen by 10-20%. CO_2 off-set due to the replacement of gasoline vehicles (by FCVs) is more or comparable to the CO_2 that is produced from the H2 production plant. Biomass gasification and electrolysis are not used to produce hydrogen in any of these demand scenarios.

In general, for the base-case scenario (1% FCV penetration rate), the network is totally decentralized and the production is based on the forecourts. However, as the demand level grows, the network is evolved into a centralized network consequently reducing the distribution costs and also the delivered price of hydrogen. These findings would be useful for policy makers and public and private stake-holders in decision making.

“Long-range” Strategic Technology Roadmap in Energy Field and Power Demand and Supply Planning Analysis Tools

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Abstract:

The environment of world energy and power has been changing dynamically under fuel resouce constraints, environmental constraints, the progress of the power industry’s deregulation and so on. It is now considered that the innovative enegy technologies should play an important role to solve or mitigate the issues and that, due to the long and uncertain features of the issues, the perspective of long range energy technology development and energy demand-supply planning is more important than ever, the definition of “long range” meaning in this paper “several tens of years” which is longer than “usual” long range for typical power system planning of 10 years.

Several sutudies on strategic energy technology roadmap are reported in the world including “Strategic Energy Technology Vision 2100” which was published by Ministry of Economy, Trade and Industry, Japan. The technologies which the Vision identified many electric-related ones such as Plug-in Hybrid Electric Vehicle/Electric Vehicle, heat pump for air conditioning and hot water supply, renewable energy generation.

The paper presents 1)the existing energy technology road map and 2)the impacts of the new teachnologies on the long range demand-supply balance, 3)Energy sector index of robustness, and 4)the required development of the long range power demand-supply balance plannning tool as follows:

(1) The Vision states that: In order to fix the energy issues such as of fossil fuel resource constraints and global warming, there are three possible ultimate paths to year 2100 of energy supply, A) maximum use of fossil fuel with CCS(Carbon dioxide Capture and Storage), B)maximum use of nuclear, and C)maximum use of renewable energy and ultimate energy saving. The current energy supply situation is the some point between Case A and Case B and will move toward somewhere between Case C and Case B(combination use of nuclear energy and renewable energy), because Case A of fossil fuel use is not the sustainable case even with CCS. The Vision identified energy technology development strategy for the 4 sectors of Residential and Commercial, Transporation, Industry, and Transforamation.

(2) From the Vision it is anticiapated that: 1)The portion of power sector in the total energy demand-supply balance will steadily increase and the shape of load curbe will change substantially due to the dissemination of new power demand and renewable

energy power generation such as photovoltaic generation, 2)nuclear and fossil power will remain the major porion of the power supply for tens of years, although, along with the disemination of renewable energy generation, its intermittent future of energy supply will need to be treated, 3)with the dissemination of distributed energy storage technology such as battery and distributed generation such as PV on a roof, energy management of various demand groups will affect and may cooperate with a power system. Accordingly, the long-range power system planning is required to involve these technologies.

(3) On the other hand, in order to secure the energy demand-and-supply balance, the energy system will require to be robust against uncertain risks such as short and long term fossil fuel embargo, or major disturbance on a energy distribution infrastructure. In order to enhance the robustness of the energy system, it is necessary to identify the risks and measure their potential magnitude by culculation of selected indices of the robustness. Accordingly, the long range power demand-supply planning is required to quantify those selected indices for robustness.

(4) Based on the anticipated directions of the development of the the long-range power demand-supply planning analysis is described for demand sector, supply sector, CCS and planning scope, the formulation is proposed: In power demand-supply planning is presented. The analysis is devided into two types of simulation method, time series simulation and load dulation curb simulation. In order to evaluate energy storage, the importance of time-series load curb simulation increases even in the long-range planning. On the other hand, load duration curb simulation will also be important in order to evaluate uncertain or probabilistic features of, for example, power plant outages and renewable energy generaton internittence.

The new end-use technologies such as PHEV/electric vehicle, heat pump hot water supply, fossil fuel distributed generation can be basically modeled by modifying the load curb for both simulation methods assuming the operation time for each technology based on the assumed operation pattern.

The intermittent feature of photovoltaic generation is treated directly in the time series siimulation using time series solar insolation data and feastures of PV generation. If necessary, a number of PV generation output can be assumed based on solar insolation data of many locations. In the load duration curb simulation, the PV output can be reflected by the equivalent load reduction, although the intermittency should be represented paroperly. With these models, both of the load dispatch and peak load balance will be evaluated collectly in the planning.

A power plant with CCS can be modeled, like a existing fossil power plant, by a plant with reduced efficiency or increased plant use and so on. But, the amout of the accumulated CO2 storage and other data are required to be analyzed.

The demand cluster which is managed by HEMS(Home Energy Management System), BEMS(Building and Energy Management System) or regional energy management system can be modeled by either a simple equivalent load or a dispatchable load/generation model like a pumped storage plant, depending on the features of the energy management system operation. For example, if the management system is assumed to operate using a signal of the power system, the dispatchable model might be better than simple equivalent load model.

Distributed and Combined Energy Generation in Greater London – Past Experiences and Future Prospects

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Abstract:
The utilisation of heat originating as by-product from electricity generation in systems of co- or tri-generation (combined cooling heat and power) has repeatedly been proposed as useful step towards improving the primary energy efficiency of urban - industrial systems. In fact many cities all over the world developed extensive networks of district heating infrastructure to distribute hot water or steam as carrier of thermal energy with varying success regarding energy efficiency improvements.
This paper looks at the case of Greater London and reviews previous experiences with such technology as well as future prospects for such systems, given the new interest in improving energy efficiency and reducing carbon emissions.
Changing trends in demography and energy demand structure, recent technological developments as well as the evolution of institutional framing conditions will be considered as variables to explain the current configuration of energy infrastructure in London.

An Activity-based System for Modelling Energy Consumption

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Abstract:
The transport sector contributes to nearly 30% of the total energy consumption in the world. Moreover, transport energy consumption has been growing steadily, and in many countries rapidly, over the last few decades. For instance, energy consumption by the transport sector in the EU states has increased by about 20% between 1990 and 2000, with most of this growth attributed to growth in road transport. The increase in energy consumption by the transport sector is an issue not only from the socio-economic perspective of resource depletion, but also from the environmental perspective of air quality and climate change. It is, therefore, very important for nations to implement energy-sensitive policies.

A review of the literature in transport-energy use indicates that there are virtually no tools out there to effectively assess behavioral responses to such energy-sensitive policies. While there have been several studies that estimate and/or project the levels of energy consumption by the transport sector, there are fewer studies to be found in the literature that examine the factors impacting transport energy consumption. Among the latter group of studies, most studies examine the relationship between transport energy use and GDP or some such aggregate economic measure. There have been few researchers who have attempted to relate transport energy demand to individual activity-travel patterns (exceptions include, for example, Haldenbilen and Ceylan, 2003, who relate transport energy demand to socio-economic indicators and vehicle-kilometres traveled).

In this paper, we will present a detailed conceptual and modelling framework of transport energy use by individuals. The proposed framework is based on the activity-based modelling paradigm and will relate the activity-travel pattern of individuals to transport energy use. Such a model, in the true spirit of an activity-based model, can capture varied behavioral responses such as trade-offs between in-home and out-of-home activities, increased trip chaining, and tele-commuting. The implementation of such an activity-based energy-use modelling system has greater data requirements than typical activity-based travel demand modelling systems. For instance, the synthetic population required for forecasting with the proposed modelling system must include

energy information in the form of specific vehicle holdings, residence types and their energy footprints. These data requirements will be discussed in detail in the paper.

Finally, as a starting point to develop the proposed energy-use modelling system we will estimate a model of in-home versus out-of-home activity participation. This model will consider the effects of policies such as congestion pricing and increased fuel prices on the time spent in in-home and out-of-home activities, and generate an estimate of the corresponding change in energy consumption taking into account the differences in energy use patterns across in-home and out-of-home activities. We are currently examining the value of various datasets in undertaking this estimation, including the Mobidrive data, the Bay Area Travel Survey data and the London Area Transport Survey data.

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Energy Material Co-production Systems for Minimizing the Exergy Loss and CO2 Emission

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Abstract:
Acording to the first law of thermodynamics the quantity of energy is conserved in chemical reactions and processes. Inherently energy is never consumed during processes; it changes from one form to another. However, the conversion of energy is inevitably accompanied with the deterioration of energy quality, i. e., exergy dissipation. Exergy difined as the maximum work possible during a process is alway dissipated due to the irreversibility of process caused by the increase in entripy, while energy is conserved. Especially, in fuel combustion process which chaneges chemical energy to thermal energy more than 50% of exergy loss takes place because of large irreversibility of combustion process. Therefore, it is most essential for the energy saving and efficient utilization to reduce the exegy loss in combustion processes.

Two principles of the reduction in exergy loss are considered in combustion processes. One is the exergy recuperation technology in which the degraded energy is recuperated by energy recycling. For example, in advanced IGCC/IGFC recycling the waste heat from gas turbine and/or fuel cell for endothermic gasification of coal increases the power generation efficiency of 3-10%. Another principle is the energy and material co-production.

In chemical reaction processes heat for preheating and endothermic reaction is supplied by the combustion of fuel. This causes a significant dissipation of exergy because the exergy rate of process heat is much lower than that of fuels. In the energy and material co-production system the integration of chemical reaction systems with energy production systems such as power cycle and heat pump can save fuel consumption. This paper will discuss the self-heat recuperation technology for sustainable chemical process which can eliminate furnace for preheating.

Energy Vison and Strategy for Sustainable Future: R&D Efforts in the University of Tokyo

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Abstract:
Institute of Industrial Science (IIS) has been collaborated with the Graduate School of Engineering of the University of Tokyo and four major Japanese companies of heavy industrial engineering on the future policy and engineering development of energy supply and demand in Japan and East Asia. The study was focused in making the energy vision of Japan at close future of 2030 year.

Recently, the Collaborative Research Center for Energy Engineering (CEE) was established on January 1, 2008 for the purpose of developing innovative energy science and technology. CEE consists of 3 research divisions: Energy Material Science, Energy System Engineering and Energy Process Engineering (run by 11 faculty members).

CEE aimes to make the energy vision and strategy of Japan and East Asia for sustainable development by means of developing innovative science and technology for energy and material cycle of production, demand and recuperation. The following eight research clusters have been featured.

1) Grand Design and Strategy for Sustainable Development
2) Sustainable Manufacturing
3) Material and Energy Co-production
4) Zero-Emission Efficient Energy Supply System
5) Environmentally Friendly Transportation System
6) Sustainable Life
7) Creating a Recycling-Oriented Society

Sustainable Energy Resources Development

Biomass Supply/Demand Chain Management Tools

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Abstract:
Biomass is carbon neutral renewable resource and is expected to substitute the use of fossil energy resources. Potentially available biomass resource in Japan is believed to be some 5-10 % of total fossil energy in Japan. However, there are several problems to be solved

For instance, bio-fuel is believed to solve the problem of fossil energy shortage. In reality, use of biomass by the way of bio-fuel, only around 15% if potentially available resource is converted to energy.

In addition, there is a dilemma between the energy use in collection of biomass and energy available from collected biomass. In conventional technology fossil energy engine is used in the automobiles to collect biomass. Thus, more wider collection area extend, more fossil energy is used though wider collection facilitate more efficient conversion.

Respecting on the problems above, the paper presents biomass supply/demand chain management tools developed by the author. It includes;

- GIS supported regional database on supply and demand of biomass
- Simulation tools to plan regional scale supply/demand chain network
- Real time base logistics monitoring system of biomass

User of the tool is assisted to identify regionally feasible conversion process of regionally produced biomass resources that includes not only energy conversion but also material conversion. Consequently the user can explore the way to upgrade the total fossil energy substitution efficiency from 15% to over 50 %.

In addition, the user of the tool can plan the feasible scale of supply/demand chain network and can manage the operation of transactions and logistics by building regional biomass e-commerce market.

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