Energy and its sustainable development for India, Editorial Introduction and commentary to the Special Issue of Energy – The International Journal

Energy, *Volume 34, Issue 8*, *August 2009*, *Pages 923-927*

Jyoti Parikh, Noam Lior

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Abstract | Figures/Tables | References

No abstract is available for this article.

Article Outline

2 ## Natural Gas requirement by fertilizer sector in India Original Research Article

Energy, *Volume 34, Issue 8*, *August 2009*, *Pages 954-961*

Jyoti Parikh, C.R. Dutta Biswas, Chandrashekhar Singh, Vivek Singh

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Abstract | Figures/Tables | References

Abstract

Natural Gas is one of the important fossil fuel energy resources in India. Anchor customers of natural gas are the power sector and nitrogenous fertilizer. It is the cleanest form of energy derived from the fossil fuel basket. Because of clean combustion characteristics, natural gas is the fuel choice for many sections of Indian industry. The demand for natural gas will grow with time. Currently natural gas accounts for 7% of the primary energy consumption of India. The Government of India has its commitment to food security and energy security. The policies are directed toward greater allocation of natural gas on a priority basis to fertilizer and the power sector. Natural gas is the main and preferred feedstock for urea manufacture. This paper analyzes and estimates projected demand of natural gas in the next two decades. The demand

projections have been reviewed in the context of changing government policies regarding the fertilizer industry, such as farm gate price regulation and self-sufficiency level of indigenous urea production. The current growth plan of natural gas supply and evolving supply scenario in the future are also considered in the study.

Article Outline

3 **CO_2 emissions structure of Indian economy** Original Research Article

Energy, *Volume 34, Issue 8*, *August 2009*, *Pages 1024-1031*

Jyoti Parikh, Manoj Panda, A. Ganesh-Kumar, Vinay Singh

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Abstract | Figures/Tables | References

Abstract

This paper analyses carbon dioxide (CO_2) emissions of the Indian economy by producing sectors and due

to household final consumption. The analysis is based on an Input–Output (IO) table and Social Accounting Matrix (SAM) for the year 2003–04 that distinguishes 25 sectors and 10 household classes. Total emissions of the Indian economy in 2003–04 are estimated to be 1217 million tons (MT) of CO_2, of which 57% is due to the use of coal and lignite. The per capita emissions turn out to be about 1.14 tons. The highest direct emissions are due to electricity sector followed by manufacturing, steel and road transportation. Final demands for construction and manufacturing sectors account for the highest emissions considering both direct and indirect emissions as the outputs from almost all the energy-intensive sectors go into the production process of these two sectors. In terms of life style differences across income classes, the urban top 10% accounts for emissions of 3416 kg per year while rural bottom 10% class accounts for only 141 kg per year. The CO_2 emission embodied in the consumption basket of top 10% of the population in urban India is one-sixth of the per capita emission generated in the US.

Article Outline

4 **Demand projections of petroleum products and natural gas in India** Original Research Article

Energy, *Volume 32, Issue 10*, *October 2007*, *Pages 1825-1837*

Jyoti Parikh, Pallav Purohit, Pallavi Maitra

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Abstract | Figures/Tables | References

Abstract

Indian economy has moved into a dynamic phase. It is necessary to see how energy demand will grow in this phase. In this paper, econometric models are developed for the various petroleum products separately with the aim of capturing variables that are specific to the individual fuel. This study projects the demand of fuels up to 2011–2012, end period for the 11th Five Year Plan, under two scenarios of annual gross domestic product (GDP) growth of 6% and 8%. The demand of petroleum products for the year 2011–2012 is estimated to be 147 and 162 million tons in the business as usual scenario of 6% and optimistic scenario of 8% GDP growth, respectively. Similarly, the demand of natural gas for the year 2011–2012 has been estimated to be 46 and 49 billion cubic meters for 6% and 8% growth, respectively. The projections suggest the level of preparedness that will be required from the oil and gas sector to enable India achieve the GDP growth target that it aims to.

Article Outline

Phir Milenge
The Lancet Infectious Diseases, *Volume 5, Issue 8*, *August 2005*, *Page 478*

Jyoti Parikh

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Abstract

No abstract is available for this article.

6 **Carbon emission coefficient of power consumption in India: baseline determination from the demand side** Original Research Article

Energy Policy, *Volume 33, Issue 6*, *April 2005*, *Pages 777-786*

Barnali Nag, Jyoti K. Parikh

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Abstract | Figures/Tables | References

Abstract

Substantial investments are expected in the Indian power sector under the flexibility mechanisms (CDM/JI) laid down in Article 12 of the Kyoto Protocol. In this context it is important to evolve a detailed framework for baseline construction in the power sector so as to incorporate the major factors that would affect the baseline values directly or indirectly. It is also important to establish carbon coefficients from electricity generation to help consider accurate project boundaries for numerous electricity conservation and DSM schemes. The objective of this paper is to provide (i) time series estimates of indirect carbon emissions per unit of power consumption (which can also be thought of as emission coefficient of power consumption) and (ii) baseline emissions for the power sector till 2015. Annual time series data on Indian electricity generating industry, for 1974–1998, has been used to develop emission projections till 2015. The impacts of generation mix, fuel efficiency, transmission and distribution losses and auxiliary consumption are studied in a Divisia decomposition framework and their possible future impacts on baseline emissions are studied through three scenarios of growth in power consumption. The study also estimates and projects the carbon emission coefficient per unit of final consumption of electricity that can be used for conducting cost benefit of emission reduction potential for several electricity conserving technologies and benchmarking policy models.

Article Outline

7 **Transport scenarios in two metropolitan cities in India: Delhi and Mumbai** Original Research Article

Energy Conversion and Management, *Volume 45, Issues 15-16*, *September 2004*, *Pages 2603-2625*

Anjana Das, Jyoti Parikh

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Abstract | Figures/Tables | References

Abstract

With rising population and increasing migration to the cities, it is expected that the urban population will increase and many more metropolitan cities will arise. Urban transport will also increase due to the high growth in population, travel demand and vehicles. In this paper, we look at the growth in vehicles and travel demand up to 2020, assuming business as usual, high GDP growth and low GDP growth scenarios for Mumbai and Delhi assuming a certain population growth. The consequent energy needs and local and global environment implications are studied.

The case studies demonstrate that despite similar population and higher per capita GDP, due to the higher share of public bus transport and suburban railway system, the Mumbai transport results in 60% less energy and emissions compared to Delhi. This picture may change in the future with the introduction of metro in Delhi, but basic differences remain even in 2020, perhaps also due to the different urban design.

The vehicle stock increases nearly three times in both cities in 23 years due to the increase in population, migration and economic growth. However, the vehicle ownership per 1000 persons only doubles and is far lower in 2020, even compared to the present world average ownership. Emissions, however, do not rise as much due to the introduction of more efficient vehicles and fuels, such as CNG or battery operated vehicles. The high share of public transport also helps. The effects of various policies, such as urban

design, suburban railway system, transport management, control practices, etc. are very important.

Article Outline

8 **Household energy, women's hardship and health impacts in rural Rajasthan, India: need for sustainable energy solutions** Original Research Article

Energy for Sustainable Development, *Volume 7, Issue 1*, *March 2003*, *Pages 50-68*

Vijay Laxmi, Jyoti Parikh, Shyam Karmakar, Pramod Dabrase

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Abstract | References

The use of unprocessed bio-fuels for cooking is interlinked with many other factors such as socio-economic conditions, availability of alternative fuels, cooking practices, health impacts, gender equality, and housing characteristics. To examine these factors and their linkages, we collected data through a large and comprehensive survey covering perhaps the largest sample of 58,768 individuals in 10,265 rural households from three states in northern India, viz., Uttar Pradesh, Rajasthan and Himachal Pradesh. We included socio-economic variables, smoking habits, fuels used, characteristics of the kitchen, cooking practices, 19 types of health symptoms, etc.

In this paper, we report on analysis of the data collected only from the rural areas of Rajasthan, covering 6,403 females and 5,552 males from 1,989 households in 13 villages. The results reveal that women undergo a lot of drudgery due to the use of bio-fuels. They walk approximately 2.5 km to collect fuel-wood. About 50 hours per month per household are expended in fuel-wood collection and transportation. The use of kerosene for cooking is negligible in the area, because of unavailability more than non-affordability. The people in the rural areas of Rajasthan are willing to pay for kerosene, the next fuel on the energy ladder above bio-fuels. It is estimated that even at a price of Rs. 13 per litre, which is higher than the market price, about 34 % of households are willing to buy additional quantities of kerosene for cooking. Therefore there is a need to meet this unmet demand by addressing market failures.

The health impacts of the use of bio-fuels are quite high for adult women. The linkages between many socio-economic variables and respiratory symptoms in adult women show that health impacts can be reduced by increasing female literacy, reducing the use of bio-fuels, and changing the housing design by, for example, introducing ventilation or separating the kitchen from the living area.

The losses incurred because of cooking fuels, including work days spent, expenditure on illness and lost working days due to illness are Rs. 29 billion per year in the rural areas of Rajasthan. By minimizing these losses even by some fraction, one can give a boost to the rural economy and improve women's welfare. For this we need coordinated, consistent and focused cooperation of all the stakeholders at the grassroots, policy-making and implementation levels. Action-oriented programmes should include a treatment strategy at public health centres to help suffering women.

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9 **Linkages between climate change and sustainable development** Review Article

Climate Policy, *Volume 2, Issues 2-3*, *September 2002*, *Pages 129-144*

Noreen Beg, Jan Corfee Morlot, Ogunlade Davidson, Yaw Afrane-Okesse, Lwazikazi Tyani, Fatma Denton, Youba Sokona, Jean Philippe Thomas, Emilio Lèbre La Rovere, Jyoti K. Parikh, Kirit Parikh, A. Atiq Rahman

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Abstract

Climate change does not yet feature prominently within the environmental or economic policy agendas of developing countries. Yet evidence shows that some of the most adverse effects of climate change will be in developing countries, where populations are most vulnerable and least likely to easily adapt to climate change, and that climate change will affect the potential for development in these countries. Some synergies already exist between climate change policies and the sustainable development agenda in developing countries, such as energy efficiency, renewable energy, transport and sustainable land-use policies. Despite limited attention from policy-makers to date, climate change policies could have significant ancillary benefits for the local environment. The reverse is also true as local and national

policies to address congestion, air quality, access to energy services and energy diversity may also limit GHG emissions. Nevertheless there could be significant trade-offs associated with deeper levels of mitigation in some countries, for example where developing countries are dependent on indigenous coal and may be required to switch to cleaner yet more expensive fuels to limit emissions. The distributional impacts of such policies are an important determinant of their feasibility and need to be considered up-front. It follows that future agreements on mitigation and adaptation under the convention will need to recognise the diverse situations of developing countries with respect to their level of economic development, their vulnerability to climate change and their ability to adapt or mitigate. Recognition of how climate change is likely to influence other development priorities may be a first step toward building cost-effective strategies and integrated, institutional capacity in developing countries to respond to climate change. Opportunities may also exist in developing countries to use regional economic organisations to assist in the design of integrated responses and to exploit synergies between climate change and other policies such as those designed to combat desertification and preserve biodiversity.

Article Outline

10 **Study of efficiency and productivity growth in opencast and underground coal mining in India: a DEA analysis** Original Research Article

Energy Economics, *Volume 24, Issue 5*, *September 2002*, *Pages 439-453*

Mudit Kulshreshtha, Jyoti K. Parikh

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Abstract | **Figures/Tables** | **References**

Abstract

This paper attempts to study efficiency and productivity of coal mining in the Indian coal sector using detailed input and output data for underground and opencast coal mining for the period between 1985 and 1997. The non-parametric approach of data envelopment analysis (DEA) is adopted for

performance analysis of different coal mining regions. Total factor productivity growth was analysed using the Malmquist index by decomposing productivity change into efficiency and technical change. Results of the analysis do not conform to the prevailing notion of opencast (OC) mining having shown more productivity growth than underground mining in India. An increasing percentage of OC mining regions showed a decline in efficiency over the period of analysis. Approximately 58%, 59% and 67% of the mining regions showed decline in productivity between 1985 and 1990, 1990 and 1995 and 1995 and 1997, respectively. Technical progress seems to have been the major driving factor behind productivity growth in opencast mining, while efficiency growth has been the most important factor in growth of underground mine productivity. Underground mines seem to have adopted a more efficient practice of operation to compensate for the lag in technical change. On the other hand, operational efficiency of opencast mines seems to have been overlooked in the process of increasing production through technological improvement in OC mining.

Article Outline

11 **Development of a purpose built landfill system for the control of methane emissions from municipal solid waste** Original Research Article

Waste Management, *Volume 22, Issue 5*, *August 2002*, *Pages 501-506*

Sudhakar Yedla, Jyoti K. Parikh

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Abstract | Figures/Tables | References

Abstract

In the present paper, a new system of purpose built landfill (PBLF) has been proposed for the control of methane emissions from municipal solid waste (MSW), by considering all favourable conditions for improved methane generation in tropical climates. Based on certain theoretical considerations multivariate functional models (MFMs) are developed to estimate methane mitigation and energy generating potential of the proposed system. Comparison was made between the existing waste management system and proposed PBLF system. It has been found that the proposed methodology not

only controlled methane emissions to the atmosphere but also could yield considerable energy in terms of landfill gas (LFG). Economic feasibility of the proposed system has been tested by comparing unit cost of waste disposal in conventional as well as PBLF systems. In a case study of MSW management in Mumbai (INDIA), it was found that the unit cost of waste disposal with PBLF system is seven times lesser than that of the conventional waste management system. The proposed system showed promising energy generation potential with production of methane worth of Rs. 244 millions/y ($5.2 million/y). Thus, the new waste management methodology could give an adaptable solution for the conflict between development, environmental degradation and natural resources depletion.

Article Outline

12 **Exposure from cooking with biofuels: pollution monitoring and analysis for rural Tamil Nadu, India** Original Research Article

Energy, *Volume 26, Issue 10*, *October 2001*, *Pages 949-962*

Jyoti Parikh, Kalpana Balakrishnan, Vijay Laxmi, Haimanti Biswas

Abstract | Figures/Tables | References

Abstract

In this paper, statistical analysis to examine the links between pollution and the types of kitchen and fuels is carried out for rural houses by first monitoring the indoor air quality (IAQ) followed by regression analysis of 418 households in Tamil Nadu, India. Exposures to the chief cook (females, who are mainly involved in the cooking during monitoring) are measured with personal monitors. The result shows that the values of respirable particles (PM10) ranged from 500–2000 μg/m^3 during a two-hour cooking period from burning biofuels. The range depends on the type of kitchen and fuel use. Stationary monitors,

placed two metres away from the stove, also recorded similar concentrations. Thus, the individuals who stay inside the houses using biofuels also face high concentrations even if they are not cooking. They could be senior citizens, children or adult males. Thus, there are two major findings from this analysis. Improved house designs that pay attention to kitchen location and put up partitions should also be considered in the intervention portfolio. Secondly, the exposure is not limited to the cooks alone. The rest of the family in the vicinity is also exposed through a “passive cooking effect”.

Article Outline

13 **A study of productivity in the Indian coal sector** Original Research Article

Energy Policy, *Volume 29, Issue 9*, *July 2001*, *Pages 701-713*

Mudit Kulshreshtha, Jyoti K. Parikh

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Abstract | Figures/Tables | References

Abstract

In this paper, non-parametric index number methods are used to investigate the overall productivity growth and also the disaggregated factor productivity performance in the Indian coal sector. An attempt has been made to do an in-depth analysis of the productivity growth in the Indian coal sector during the period 1980–92. Total factor productivity (TFP) Tornqvist indices are calculated from the output and input indices for Coal India Ltd. (CIL) and its major subsidiary companies. The partial labour and capital productivity indices are decomposed into components to study interactions between labour, capital,

output and techniques of mining in the coal sector that might explain their long run trends. Results of the analysis indicate that in spite of the output index indicating a two-fold increase during the period of analysis TFP declined by around 50% due to the sharp increase in the input index by about four times. Partial productivity analyses of capital and labour productivity reflect the massive capital accumulation in the Indian coal sector to the extent where it does not contribute to additions in output. The labour productivity increase of around 37.6% is not to the extent of capital deepening of around 150%. Study of the individual subsidiaries indicate that companies with larger share of underground mines have shown slower growth in productivity. The poor performance can be attributed to the underutilization of capital, surplus labour, power shortages in the underground mines, inability to adapt to modern technologies and a pricing structure of coal, which does not provide incentives to the producers to increase production.

Article Outline

14 **Indian agriculture and climate sensitivity** Original Research Article

Global Environmental Change, *Volume 11, Issue 2*, *July 2001*, *Pages 147-154*

K. S. Kavi Kumar, Jyoti Parikh

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Abstract | Figures/Tables | References

Abstract

This study estimates the relationship between farm level net-revenue and climate variables in India using cross-sectional evidence. Using the observed reactions of farmers, the study seeks to understand how they have adapted to different climatic conditions across India. District level data is used for the analysis. The study also explores the influence of annual weather and crop prices on the climate response function. The estimated climate response function is used to assess the possible impacts of a 'best-guess' climate change scenario on Indian agriculture.

Article Outline

15 **Indicators of carbon emission intensity from commercial energy use in India** Original Research Article

Energy Economics, *Volume 22, Issue 4*, *1 August 2000*, *Pages 441-461*

Barnali Nag, Jyoti Parikh

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Abstract | **Figures/Tables** | **References**

Abstract

This study tries to analyze the commercial energy consumption evolution patterns in India in terms of primary energy requirements and final energy consumption and their implications for overall carbon intensity of the economy. The relative contribution and impact of different factors such as activity levels, structural changes, energy intensity, fuel mix and fuel quality on the changes in aggregate carbon intensity of the economy has been studied, taking into account coal quality which has declined drastically in the last two decades. The major findings of the study are: firstly, from the 1980s onwards, income effect has been the major determinant of India's per capita emission increase, although prior to that, energy intensity used to be the most important factor. Secondly, there has been a major shift towards electricity from primary energy carriers in the major energy consuming sectors, and the higher end use-efficiency of electricity has been able to compensate for the high emission coefficient of electricity consumption. Thirdly, emission intensity of thermal power generation shows a substantial decline when the data is controlled for the declining quality of coal used in power generation.

Article Outline

16 **Modeling demand for coal in India: vector autoregressive models with cointegrated variables** Original Research Article

Energy, *Volume 25, Issue 2*, *February 2000*, *Pages 149-168*

Mudit Kulshreshtha, Jyoti K. Parikh

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Abstract | Figures/Tables | References

Abstract

In this paper, long-run structural relationships of coal demand with price and income variables have been estimated for the four major coal consuming sectors in India using annual time series data from 1970–1995. Some of the recent developments in multivariate dynamic econometric time series modeling techniques have been used, including the estimation of long-run cointegrating relationships, short-run dynamics and measurement of the effects of shocks and their effect on the evolution of dynamic coal demand system. The models have been estimated using cointegrating VAR framework, which allows for endogeneity of regressors. Results indicate that coal demand is likely to grow more than proportionately with economic growth due to high GDP elasticities and low price elasticities. Further, coal prices are found to be weakly exogenous in all the sectors except cement. Persistence profiles indicate that coal demand systems in the four sectors seem to be stable and converge to equilibrium within a period of around 4–7 years after a typical system-wide shock.

Article Outline

17 **Housing paradoxes in India: is there a solution?** Original Research Article

Building and Environment, *Volume 35, Issue 1*, *January 2000*, *Pages 59-75*

Piyush Tiwari, Jyoti Parikh

Abstract | Figures/Tables | References

Abstract

If providing a decent shelter is an immediate concern for developing countries, the reduction of global emissions such as carbon dioxide is a cause of concern for industrialized countries. A short focused policy prescription for a country like India would be to provide a decent shelter for its more than 15% citizens, who do not have adequate housing. However, a sustainable path would be to develop a well strategized path to meet current needs of housing and also to reduce absolute contribution to global emissions through those construction techniques which are environment friendly. We develop an optimization framework to analyse a sustainable path to meet housing shortages in India, considering that the sustainable path should not be at the cost of engineering design criteria. The criteria to measure sustainability in this paper is cost effectiveness, efficient utilization of resources and environment friendliness. A computer model called ‘MHOPE’ has been developed to estimate resources and construction techniques required to achieve housing for all in India. The technologies incorporated in the model are suitable for India, however, the model can be upgraded to include the house construction technologies suitable for any other country of interest. The results indicate that it is not possible to provide housing for all in India with the present set of construction techniques which are predominantly cement and brick based. However, if low cost housing techniques, which use locally available materials,

are used, we can achieve this target of ‘Shelter for all’. It will not only reduce cost, but also reduce CO_2 emissions because locally available materials are less energy intensive. The paper quantifies the level of investment, resources and employment required to provide shelter for all.

Article Outline

18 **Linkages among energy, agriculture and environment in rural India** Original Research Article

Energy Economics, *Volume 21, Issue 6*, *1 December 1999*, *Pages 561-585*

Jyoti K. Parikh, R. Ramanathan

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Abstract | Figures/Tables | References

Abstract

The interconnections between energy, agriculture and environment in rural India are analyzed in this paper using a systems perspective. Rural areas of developing countries use biomass for fuel, fodder, fertilizer and other purposes, and it is necessary to understand the fuel-fodder–fertilizer relationships for optimal biomass allocation. The allocation is explored using a linear programming model. First, the model is validated by simulating it using data for the year 1990–1991. The model is then applied for the

year 2000, and several scenarios are generated to obtain answers to various policy questions. The results show that it is necessary to increase fertilizer consumption, to increase efficiencies of cooking stoves, to improve livestock feed, and/or to decrease population growth for maximizing the revenue generated in the rural system of India. It shows that when the prices of fertilizers increase, a large increase in kerosene requirements can be expected. It also points to the necessity to increase kerosene consumption to reduce emissions (due to non-commercial fuels) and soil fertility loss. For example, the carbon dioxide emissions associated with the scenarios range from 137.50 to 62.50 million tons (in carbon equivalent terms) for the high and low cases, respectively. Correspondingly, kerosene consumption ranges from 0.18 to 15.49 kilotons (kT).

Article Outline

19 **Plantation programmes through people's participation: a case study from India** Original Research Article

Biomass and Bioenergy, *Volume 17, Issue 3*, *September 1999*, *Pages 257-271*

B. Sudhakara Reddy, Jyoti K. Parikh, P. V. Srinivasan

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Abstract | **Figures/Tables** | **References**

Abstract

This paper provides a framework for analysing land regeneration programmes combining financial, economic and environmental aspects as applied to a wood plantation programme undertaken by a Tree Grower's Cooperative Society (TGCS) established by the National Tree Growers' Cooperative Federation (NTGCF), Anand, India. Mallanahally TGCS, situated in the southern part of Karnataka state in India was selected and a survey was carried out. Benefit–cost ratios and internal rate of return are worked out for various situations. The paper also examines the role of cooperatives in managing plantation activities and assesses the distributional aspects of the benefits of the plantations. The survey elicited information on the villagers' perceptions regarding benefits from and barriers to implementation of plantation programmes. It is shown here that despite apparently unequal distribution of benefits, the present arrangements preserve cooperation as each of the stakeholders derive positive benefits.

Article Outline

20 **Transmission planning for Indian power grid: a mixed integer programming approach** Original Research Article

International Transactions in Operational Research, *Volume 6, Issue 5*, *September 1999*, *Pages 465-482*

Rajeev Chaturvedi, Kankar Bhattacharya, Jyoti Parikh

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Abstract | **Figures/Tables**

Abstract

The paper presents a modeling framework to analyze some important issues associated with operation planning of a power system. Major activities involved in operations planning of large integrated power systems are considered simultaneously to ensure optimal utilization of generation and transmission capacity. The model also examines optimal transmission expansion plans vis-à-vis fuel supply issues. A mixed integer programming model is developed for this purpose and the Indian power system considered. Specific emphasis is on spatial transmission expansion plan for the existing Indian inter-state transmission grid and new transmission links, coordinated operation of the isolated regional grids and system benefits accruing from transmission expansion, enhanced fuel production and supply re-scheduling to ensure efficient operation of various generating stations.

Article Outline

21 **Transport sector in India: an analysis in the context of sustainable development** Original Research Article

Transport Policy, *Volume 6, Issue 1*, *January 1999*, *Pages 35-46*

R. Ramanathan, Jyoti K. Parikh

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Abstract | Figures/Tables | References

Abstract

A brief review of the Indian transport sector in the past few decades is provided in this article. It is shown that the period has witnessed a gradual transformation from rail-dominated transport to road-dominated transport. Infrastructure bottlenecks such as lack of roads and railways network and aircraft are the limiting factors. Emission of local pollutants and carbon dioxide (CO_2) because of fuel consumption in transport were estimated. Future transport performance is projected using cointegrating econometric models. The models project that passenger traffic in India is likely to grow at more than 8% per year and freight traffic at more than 5% per year during the period 1990–2021. This will increase the energy consumption and CO_2 emissions at equivalent rates. The effects of various policy options aimed at reducing energy consumption and CO_2 emission were analysed using a scenario approach. The scenario analysis shows that efficiency improvements can reduce future energy consumption and CO_2 emissions by 26%. If the modal split is promoted in favour of public transport modes (rail and public road transport), about 45% reduction in energy requirements and CO_2 emissions is expected.

Article Outline

22 **Socioeconomic development and demand for timber products: A Panel Data Analysis** Original Research Article

Global Environmental Change, *Volume 8, Issue 3*, *October 1998*, *Pages 249-262*

G.S. Haripriya, Jyoti K. Parikh

Abstract

Abstract

The present paper analyses the relationship between consumption of timber products and socioeconomic variables by estimating timber consumption functions, using fixed and random effects methods. To this end, we regress the per capita consumption of timber products (roundwood equivalent) of a sample of developed and developing countries over the period 1976 to 1989 on various national indicators relevant to the development transition. The panel nature of the data facilitates us to track trends in consumption as economic development proceeds. The results suggest that the response of the timber consumption with respect to changes in the variables is sensitive to factors specific to the country concerned. The coefficients of all the variables are inelastic and it is found that income, density and price

are the main determinant variables although other variables also affect the consumption. The observations of this study are expected to assist the policy makers in projecting future requirements of timber with more reliability.

23 **Economic development, poverty reduction and carbon emissions in India** Original Research Article

Energy Economics, *Volume 19, Issue 3*, *July 1997*, *Pages 327-354*

N. S. Murthy, Manoj Panda, Jyoti Parikh

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Abstract | **References**

Abstract

This paper analyses carbon dioxide (CO_2) emissions from energy consumption using an input-output (I-O) model, for different sectors of the Indian economy in 1990. Alternative scenarios are developed for 2005. The I-O model considers structural changes in aggregate consumption behaviour and sectoral composition of output between 1990 and 2005. Alternative energy efficiency programmes are compared for their potential CO_2 reduction in 2005. Under ambitious poverty reduction targets, the annual growth rate of CO_2 emissions increases from 4.8% to 5.9%. However, energy efficiency programmes could reduce the average annual growth rate of CO_2 emissions back to 4.9%. It is also seen that reducing CO_2 through oil conservation is a preferred policy for India compared with saving coal.

Article Outline

24 **Demand for housing in the Bombay Metropolitan Region** Original Research Article

Journal of Policy Modeling, *Volume 19, Issue 3*, *June 1997*, *Pages 295-321*

Piyush Tiwari, Jyoti Parikh

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Abstract | **References**

Abstract

We estimate the demand function of housing for Bombay Metropolitan Region in a two-step econometric analysis. The first step estimates the hedonic price index for different regions in Bombay, and in the second step the demand for housing is estimated as a function of economic and household characteristics. The results indicate that housing demand is inelastic with respect to income and price. The income elasticities for owners and tenants are around 0.33 and 0.38, respectively, while the price elasticities are −0.21 and −0.75, respectively, for owners and tenants. We also estimate income and price elasticities for different income classes. The paper concludes with policy prescriptions.

Article Outline

• References

25 **Economic and environmental impacts of demand side management programmes** Original Research Article

Energy Policy, *Volume 25, Issue 3*, *February 1997*, *Pages 349-356*

B. Sudhakara Reddy, Jyoti K Parikh

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Abstract | References

Abstract

This paper studies 12 DSM options which could be implemented in various categories of industries in India. It examines their costs and economic and environmental impacts, and estimates yearly targets for the next 15 years (1995–2010). The results indicate that savings of 24 616 MW and 122 991 GWh can be achieved over the base line growth with a cost of Rs 325 568 million (in present values). Finally, the potential environmental trade-off between system cost and power plant emission reductions is discussed. This is an effort to carry out bottom-up modelling, which mainly looks at programme costs where much of the funds come from customers themselves. However, they require extra support through DSM programmes.

Article Outline

• References

26 **DSM survey in India: Awareness, barriers and implementability** Original Research Article

Energy, *Volume 21, Issue 10*, *October 1996*, *Pages 955-966*

Jyoti K. Parikh, B. Sudhakara Reddy, Rangan Banerjee, S. Koundinya

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Abstract | References

Abstract

This paper provides results of a survey on DSM programs for the high-tension industries of Maharashtra. Technical potentials, costs, savings and the need for financial mechanism are covered. The types of programs industries prefer and needed incentives, extent of participation, agencies suitable for implementation, and barriers to implementation are highlighted. Policy measures are suggested for the efficient implementation of DSM plans.

Article Outline

• References

27 **Forecast and analysis of demand for petroleum products in India** Original Research Article

Energy Policy, *Volume 24, Issue 6*, *June 1996*, *Pages 583-592*

Raghavendra D Rao, Jyoti K Parikh

Close preview | PDF (861 K) | Related articles | Related reference work articles

Abstract | **References**

Abstract

This paper analyses the demand for petroleum products in India. For this purpose, econometric models based on time series data are generated for individual products so as to capture product specific factors affecting demand. The models generated follow the non-homothetic translog functional form. The models are validated against historical data by testing them for *ex post* forecast accuracy. Demand forecasts till the year 2010 are obtained for the various petroleum products using these models. The forecasts indicate a high rate of growth in demand for motor gasoline, high speed diesel oil, kerosene, liquid petroleum gas and aviation turbine fuel. However, the demand for fuel oils, light diesel oil, naphtha and lube oils is expected to grow at a relatively lower rate. To arrive at an optimal refinery process configuration, an analysis of alternative means of satisfying the demand, which include product import options and domestic refining options with alternative process configurations, need to be done. Thus, investment plans for augmenting domestic refining capacity will have to take into account the future pattern of demand, to arrive at an optimal product mix. Forecasting demand forms a crucial aspect in the overall policy analysis of the oil and gas sector.

Article Outline

• References

28 **Performance evaluation of cost effective buildings—A cost, emissions and employment point of view** Original Research Article

Building and Environment, *Volume 31, Issue 1*, *January 1996*, *Pages 75-90*

Piyush Tiwari, Jyoti Parikh, Vinod Sharma

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Abstract | **References**

Abstract

Given the uphill task of providing housing for all within a short time frame and making it affordable, the

construction industry has to look into various low cost options of construction using locally available building materials. This paper evaluates various dimensions of low cost techniques. For the same engineering criterion to be satisfied, a room of dimensions *3.5* m × *3.5* m × *3.14* m constructed using low cost techniques costs only *66%* of the conventional construction cost. Since these materials are low energy consuming, the associated CO_2 emission is also low. The CO_2 emission with the conventional method of construction is *5.88* tonnes compared to *2.42* tonnes in the low cost method of construction. There is a possibility of further reducing the emissions by *23%* with *0.03%* increase in the cost. Another implicit advantage for a country like India with surplus labour force, is that employment increases with greater use of methods of construction involving reduction in CO_2 emission due to the switch towards labour intensive techniques.

Article Outline

29 **Gender issues in energy policy** Original Research Article
Energy Policy, *Volume 23, Issue 9*, *September 1995*, *Pages 745-754*
Jyoti K Parikh

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Abstract | References

Abstract

Gender issues have received attention at micro level in terms of technological interventions such as cookstoves, biogas, solar cookers, wood plantations and so on. They have yet to be addressed in macro level policies. Women's needs for energy vary depending on whether they are in urban or rural areas, their stage of economic development and whether they are economically active. This article emphasizes the need for better understanding of these issues for women engaged in different sectors, whether agriculture, transport, industries, household and the energy sector itself (ie charcoal making, fuel gathering and fuel marketing). Deeper enquiries, analysis and action for gender issues are needed through surveys, laboratory experiments, macro policy modelling and analysis, and technology development and production. This article makes a plea to include gender issues in macro level energy policies such as energy investment, imports and pricing. The latter are discussed in detail. A lot more work lies ahead.

Article Outline

30 **Cost of CO_2 reduction in building construction** Original Research Article
Energy, *Volume 20, Issue 6*, *June 1995*, *Pages 531-547*

Piyush Tiwari, Jyoti Parikh

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Abstract | References

Abstract

The construction sector accounts for the highest share (17%) of CO_2 emissions by final demand in the Indian economy because it uses highly energy-intensive materials and the need for shelters is very high. This sector is highly vulnerable to changes in pricing structure. Various construction techniques have been analysed and it is shown that a room of length 3.5 m, breadth 3.5 m and height 3.14 m would lead to about 6 tonnes of CO_2 emissions if constructed at the minimum possible cost. These costs are distributed as follows: foundation—25%, walls—46%, roof—16%, floor—4.8%, and plastering—8.6%. If cement is replaced by lime, the cost of construction increases by 0.14% for a 3% reduction in emissions. Further reduction in emissions is achieved by using stone instead of bricks. The cost increases by 0.54% for a 4% reduction. However, for a 21% reduction, the cost escalates by 27%. We also examine impacts on employment, materials used etc., due to changes in techniques.

Article Outline

31 **Urbanization, energy use and greenhouse effects in economic development : Results from a cross-national study of developing countries** Original Research Article

Global Environmental Change, *Volume 5, Issue 2*, *May 1995*, *Pages 87-103*

Jyoti Parikh, Vibhooti Shukla

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Abstract | References

Abstract

This paper seeks an exploratory assessment of the possible global greenhouse consequences of economic development in general and urbanization in particular, especially insofar as they relate to changing patterns of energy use. First, the nature of the relationship between urbanization and increased resource use is elaborated upon, and the impact of the development transition upon levels of energy consumption is empirically analysed in a multiple regression framework, using cross-national variations in urbanization and other development indicators to estimate a fixed-effects model of the determinants of energy usage. The same set of hypothesized determinants is then used to measure their contribution to estimated greenhouse gas (GHG) emissions for the full set of countries. Next, we focus upon the subsample of developing countries to study the effects of urbanization upon their evolving profiles of energy use, disaggregated by final use sector and fuel type, and estimate the

magnitude of the greenhouse effects attributable to each of these component fuel uses. Finally, we present some of the implications of the results for policies toward urbanization and energy strategies for developing countries in the context of global environmental management imperatives.

Article Outline

• References

32 **A rural energy-agriculture interaction model applied to Karnataka state** Original Research Article

Energy, *Volume 20, Issue 3*, *March 1995*, *Pages 219-233*

J. P. Painuly, Hemlata Rao, Jyoti Parikh

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Abstract | References

Abstract

A comprehensive approach that considers fuel, fodder and fertiliser relationships has been used to analyse the rural energy system of Karnataka. A linear programming model that incorporates these relationships has been used to simulate and study the effects of various policy options on the rural energy system in 2000 A.D. Increased efficiency of non-commercial fuel use and provision for improved and increased quantities of feeds to animals emerge as the most desirable options to meet the energy requirements that maximize the gains to rural Karnataka.

Article Outline

• References

33 **Simulation of national grid operation in India** Original Research Article

Utilities Policy, *Volume 5, Issue 1*, *January 1995*, *Pages 65-74*

Jyoti Parikh, D. Chattopadhyay, U. Nandapurkar

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Abstract | References

Abstract

The formation of a national grid is a promising option for improving upon the current status of power shortages and uneconomic operations in India. A linear programming simulation model (NATGRID) is used to analyse the key issues related to national grid operations. A simulation exercise for the year 1989/90 shows that the power shortage could be reduced by 22.9 TWh and total generation could be increased by 26 TWh (10.9% of actual generation) through better capacity utilization. Four additional

interregional transmission links are identified to reduce power shortages in the southern states. The short-run marginal costs for all states vary considerably across peak and off-peak periods, indicating the need for a time-of-day pricing mechanism for inter-utility power trading.

Article Outline

34 **Climate change and India's energy policy options : New perspectives on sectoral CO_2 emissions and incremental costs** Original Research Article

Global Environmental Change, *Volume 3, Issue 3*, *September 1993*, *Pages 276-291*

Jyoti Parikh, Subir Gokarn

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Abstract | References

Abstract

This paper presents an analysis of CO_2 emissions in the Indian economy and examines the implications of alternative policies to reduce them. This analysis goes beyond the conventional approaches of looking at energy supply structure and end-uses of energy. Instead, it examines flows of energy in the economy of India through a 60-sector input-output mode). The authors show that direct emissions of CO_2 are highest in the electricity sector followed by iron and steel, road and air transport, and coal tar. If a similar analysis by final demand is carried out, incorporating both direct and indirect emissions, the highest emitting sector is construction, followed by food crops, road and air transport, and so on. This indicates that, in addition to energy efficiency, improving construction efficency could also lead to CO_2 savings (by using less energy-intensive materials or by making optimal use of them). It is also shown, by generating alternative energy policy scenarios, that if India saves energy from coal rather than from imported oil to reduce CO_2 emissions, then savings foregone are more than Rs 5634 million for only 10% of energy saving. Sectoral priorities also change. To save coal, the power sector, iron and steel, coal tar, etc will require attention. To save oil, transport, refinery and fertilizers will require attention. Similar arguments are made for substitution of coal by oil and gas. Additional costs of Rs 10 billion would be incurred for 10% substitution of coal by oil and gas as compared to the current policy of substituting oil and gas with coal. This article offers another Interpretation of the notion of ‘incremental costs’ though comparison of two alternative development strategies.

Article Outline

35 **Policy analysis of oil substitution by natural gas in India : Transport and**

industry sectors Original Research Article
Energy Policy, *Volume 21, Issue 1*, *January 1993*, *Pages 43-52*
J. P. Painuly, Jyoti Parikh
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Abstract | References

Abstract

Diesel and fuel oil are the two major petroleum products consumed in the Indian economy. They are predominantly used in the transport and industry sectors. Both of these products can be partly substituted by natural gas (NG), which is indigenously available. The paper explores levels of substitutions that should be planned for diesel by compressed natural gas (CNG) driven vehicles and for fuel oil by natural gas. Such an approach would require maximization of consumers' and producers' surplus so that economic costs to the country and financial costs to the users are realistically assessed. It is shown that when international crude prices and refinery margins increase, the natural gas allocated to the transport sector increases, followed by the industry sector. This leads to savings of US$ 460–3700 million for crude price of $14 per barrel to $32 per barrel respectively. Such a strategy would require a vehicle programme of 100 000 to 250 000 CNG vehicles ie 4.6–11.5% of total vehicles to be converted to CNG by 2000.

Article Outline

36 **Policy alternatives for western and southern power systems in India** Original Research Article
Utilities Policy, *Volume 2, Issue 3*, *July 1992*, *Pages 240-247*
Jyoti Parikh, S. G. Deshmukh
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Abstract | References

Abstract

Utility policy issues addressed in this paper include: how much could be gained by interconnecting two regional grids?; what are the implications if the Indian eighth plan targets for capacity additions are reduced?; and, what is the role of energy conservation and reductions in peak power demand? A non-linear optimization model is used for simulating interconnection of two regional grids. The area under consideration includes seven major state utilities and six central sector plants, each having a pool of installed capacities of various types of plants and the transmission lines in place. The model minimizes the total variable costs for the total power system with physical constraints on the demand and supply side. The model is validated for the base-run for 1987–1988. Simulations are carried out for the terminal

year of the eighth five-year plan (1994) assuming the capacity expansion plan already formulated by the government. The model is also capable of identifying the additional peaking capacity required for each utility. The simulation results for the eighth plan quantify the gains from interconnection and need for effective transmission linkages required between western and southern regions. This has to be backed-up by a suitable hardware programme, if the gains from interconnected systems are to be realized.

Article Outline

37 **From farm gate to food plate : Energy in post-harvest food systems in south Asia** Original Research Article

Energy Policy, *Volume 14, Issue 4*, *August 1986*, *Pages 363-372*

Jyoti K. Parikh

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Abstract | References

Abstract

This paper estimates energy consumed in the post-harvest food systems of India, Pakistan, Burma and Sri Lanka. The components of the post-harvest food system are: food processing, food transport and cooking. It is shown that they represent a significant share of national energy consumption and that variations among countries depend on variables such as urbanization, income, cropping patterns and whether a country is a food importer or food exporter. The policies to reduce energy consumption would involve measures for increased energy efficiencies, reduced food losses and careful consideration of markets *vs* food production areas for perishable commodities.

Article Outline

38 **Modeling energy and agriculture interactions—I: A rural energy systems model** Original Research Article

Energy, *Volume 10, Issue 7*, *July 1985*, *Pages 793-804*

Jyoti Parikh

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Abstract | References

Abstract

Since many of the factors related to rural energy systems are gradually being quantified, there is a need

to construct a model that integrates a number of these factors simultaneously in a consistent framework. Therefore, a general linear programming model is developed to capture energy and agricultural interactions existing in the rural areas of developing countries. Energy used for agriculture includes fertilizers, irrigation, and mechanization. Several technological choices of each of the above are considered and so are several crop commodities, several types of livestock, and farmers of different income groups along with their assets, i.e. land holdings, livestock, etc. The by-products of agriculture, i.e. biomass, such as crop residues, animal dung, wood, etc., can be used to generate energy. On the demand side the use of them for feed, fuel, and fertilizer must be considered. Thus, the household sector (which is the largest user of noncommercial energy), as well as the rural industries sector, is intimately related to the agriculture sector. Twelve different energy sources and several conversion technologies, such as biogas, charcoal kilns, alcohol distilleries, etc., are considered. The model is applicable to low-income, biomass-scarce developing countries. However, different types of countries will require different approximations, and their needs for detailing some aspects or other may vary. The model is suitable for policy purposes because it considers several income groups separately and considers how different changes affect each of them.

Article Outline

39 **Household energy assessment: Integration of approaches and additional factors** Original Research Article

Biomass, *Volume 7, Issue 1*, *1985*, *Pages 73-84*

Jyoti K. Parikh

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Abstract | References

Abstract

An appropriate household energy assessment for developing countries, which use substantial biomass, requires a coordinated effort between surveyors, experimentalists and analysts. This paper describes the role of each and also the additional factors which need to be considered, recorded, measured and analysed to account for variations in energy consumption across countries, income classes, etc. These range from seasonal and regional differences, fuel scarcities and coping strategies, dietary and cooking practices, food and fuel processing, to the role of women.

Article Outline

40 **Energy from biomass by socio-economic groups—a case study of**

Bangladesh Original Research Article
Biomass, *Volume 4, Issue 3*, *1984*, *Pages 209-234*
Walter Kennes, Jyoti K. Parikh, Herman Stolwijk
Close preview | PDF (1101 K) | Related articles | Related reference work articles
Abstract | References

Abstract

The paper provides a detailed quantitative description of the biomass energy situation in Bangladesh. An attempt is made to relate the biomass energy situation to income distribution by subdividing the economy into nine basic socio-economic classes. For each of these classes demand and supply of biomass resources — firewood, several types of crop residuals and animal dung — are examined. A consistent quantitative picture is constructed of production, trade and use of energy by these classes. Studies of the effects of policy measures or investments projects dealing with biomass energy resources on particular groups of the population require this information. Although the presentation suggests major information gaps in this area, it still makes clear that actual endowments of energy resources are very skewed. Therefore it is likely that programmes to increase the supplies of traditional energy are no exception to the rule that their income distribution effects may be skewed as well.

41 **Energy Requirements for India: A Systems Approach** Original Research Article
Studies in Environmental Science, *Volume 16*, *1982*, *Pages 535-546*
Jyoti K. Parikh
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Excerpt | References
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42 **Renewable energy options: What could developing countries expect from them?** Original Research Article
Energy, *Volume 4, Issue 5*, *October 1979*, *Pages 989-994*
Jyoti K. Parikh
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Abstract | References

Abstract

In order to make a realistic assessment of the energy alternatives for the developing world, the present conditions of the developing region, consisting of Africa and Asia (excluding South Africa, Japan and China), are studied first. Highlights include: low commercial energy consumption (0.2 kW/*cap*), heavy dependence on oil and noncommercial energy, and especially poor conditions of the rural energy supply.

Since fossil fuels need to be conserved and nuclear energy is not an option for many of the developing

countries, what renewable options could bring is evaluated in detail. Socio-techno-economic parameters for developing and employing renewable energy sources are identified for biogas, wood plantation, solar, and hydropower. The study concludes that the developing countries could obtain 35% of the energy in 2030 with the low-demand scenario of 0.9 kW/*cap*. However, with the high-demand scenario of 1.4 kW/*cap*, active policies in nuclear energy and fossil fuels as well would be required.

43 **Energy use for subsistence and prospects for development** Original Research Article

Energy, *Volume 3, Issue 5*, *October 1978*, *Pages 631-637*

Jyoti K. Parikh

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Abstract | **References**

Abstract

This paper focuses on the present use of energy in the developing countries in order to estimate the energy required for subsistence-level activities and to see how much surplus is available for economically productive activities, taking into account both commercial and non-commercial (firewood, farmwaste) sources of energy. The energy required for subsistence is estimated to be in the range of 0.3 to 0.4 tce per capita. The consumption of most low income groups countries is below this level if only commercial energy is considered. Relations are derived to explain the uses of each of these energy forms in terms of economic and demographic variables from a sample of 82 countries. These relations are then employed to show that the dependence on non-commercial energy is likely to continue beyond 2000 AD and that, inspite of the annual rise of commercial energy consumption by 6%, the improvements in *per capita* consumption are small because of an increase in population and a decrease in *per capita* non-commercial energy.

44 **Assessment of solar applications for transfer of technology a case of solar pump'** Original Research Article

Solar Energy, *Volume 21, Issue 2*, *1978*, *Pages 99-106*

Jyoti K. Parikh

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Abstract | **References**

Abstract

For the large and increasing rural population in the developming countries, decentralized solar applications could be relevant. However, new solar technologies being developed in the laboratories presently have to ultimately be acceptable in the field conditions. The conditions which have to be satisfied before the solar applications could be acceptable are discussed. The solar pump is examined in detail in particular due to the interest expressed by many developing countries in this specific application. A comparative techno-economic analysis is carried out for solar pumps and diesel pumps

which considered escalation of the diesel price and factors related to climate, geography, locale, social and institutional environment for two types of uses namely for drinking water and for irrigation. It seems unlikely that a solar pump could compete with the diesel engine before the costs are brought down by a factor of 20–50 for irrigation purposes. However, for obtaining the drinking water the cost reduction required is by a factor less than 10 than currently charged for the prototypes. Although specific example of India is taken the matters are relevant to most developing countries. The issues discussed for the case of a solar pump are also relevant to other solar applications used only for seasonal purposes since the capital costs are high and operating diesel pumps during the season would be cheaper for several decades.

Resumen

Para la población rural grade y creciente en los paises en desarrollo, las aplicaciones solares descentralizadas pueden ser apropiadas. Sin embargo, las nuevas tecnologías solares siguen desarrollándose actualmente en laboratorio para llegar a ser aceptables a las condiciones de campo. Se discuten las condiciones que deben reunirse antes que las aplicaciones sean aceptables. Se examina la bomba solar dado el interés expresado por muchos paises en desarrollo por esta aplicación específica. Se lleva a cabo un análisis tecnoeconómico comparativo para bombas solares y diesel, el cual considera el aumento de precio del diesel y factores relacionados al clima, geografía y ambiente social e institucional locales para dos tipos de uso: agua para bebida y para riego. Parece imposible que la bomba solar compita conla diesel antes de que sus costos bejen en un factor de 20–50 para propósitos de riego. Sin embargo para agua de bebida se requiere una reducción de costo en un factor menor a 10 sobre el cargado a los prototipos corrientemente. Aunque se toma el ejemplo especifico de la India, lo tratado es extrapolable a la mayoría de los paises en desarrollo. Los puntos discutidos para el caso de la bomba solar son apropiados también para otras aplicaciones solares estacionales ya que los costos de capital son grandes y operar bombas diesel durante la estación podría ser mas barato.

Résumé

Les applications solaires, donc décentralisées, devraient intéresser la population rurale importante et en expansion des pays en voie de développement. De plus, de nouvelles technologies développées actuellement en laboratorie devraient pouvoir, en fin de compte, être acceptables dans ces conditions. On discute des conditions à satisfaire avant que les applications solaires soient acceptables. On examine en détail le cas de la pompe solaire à cause, en particulier, de l'intérêt exprimé par de nopbreux pays en voie de développement pour ce genre d'applications. On en tire une analyse techno-économique comparatives pour les pompes solaires at les pompes diesel, analyse qui tient compte de l'augmentation du prix due fuel et de facteurs relatifs au climat, au site, aux conditions locales et à l'environnement institutionnel pour deux types d'utilisations à savour l'eau potable et l'eau pour l'irrigation. Il semble peu probable qu'une pompe solaire soit compétitive avec une machine disel avant que les prix n'aient baissé d'un facteur 20–50 pour les besoins de l'irrigation. Cependant, pour obtenir

l'eau potable, la diminution du prix nécessaire doit être dans un facteur inférieur à 10 au prix couramment imputé pour les prototypes. Bien que l'on prenne l'example particulier de l'Inde, ceci concerne la plupart des pays en voie de développement. Les résultats discutés dans le cas d'une pompe solaire concernent aussi les autres applications solaires ayant seulement un but saisonnier puisque les capitaux sont élevés et les pompes à fonctionnement diesel pendant la saison seraient meilleur marché.

Article Outline

45 **Mobilization and impacts of bio-gas technologies** Original Research Article
Energy, *Volume 2, Issue 4*, *December 1977*, *Pages 441-455*
Jyoti K. Parikh, Kirit S. Parikh

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Abstract | References

Abstract

At present, energy and fertilizer requirements of many of the developing countries are largely met by locally available, non-commercial sources, such as firewood and farm wastes. Extensive use of firewood is one of the factors that can lead to deforestation. When organic farm wastes are burnt, soil nutrients, which should return to soil, are lost and this can severely affect agricultural production. The problem of efficient utilization of these locally available resources, therefore, needs to be studied in a systematic manner. As an option for efficient utilization of local resources, bio-gas plants are considered, taking India as a case study. In these plants, animal dung and agricultural byproducts are utilized to obtain both methane and fertilizer through anaerobic fermentation. This is an example of appropriate technology for rural environments, which requires low investment, which does not need highly skilled labor and which can be operated with local materials and self-help in the 576,000 villages of India. The economic benefits to a family using a bio-gas plant and the impact of its widespread acceptance on a national scale are evaluated. It is felt, however, that the scope of such individual family bio-gas plants is likely to be limited for a number of reasons. To realize the potential of bio-gas fully, village plants of about 200 m^3 capacity for approx. 100 families are needed.

The introduction of such seemingly sensible new technologies has failed in the past for want of appropriate management and organizational structures and, consequently, for want of social participation by persons of various income groups in the successful operation of such community plants. To remedy this, a pricing policy for purchase of farmwastes and distribution of gas and fertilizer has been suggested as an essential tool to ensure that no-one is worse off by the introduction of bio-gas plants and thus to motivate the required participation in the scheme. Given a different organizational set-

up, the idea could also be tried out for providing energy and sanitation in urban areas.

The impact of full-scale adoption could mean that, by 2000 ad, almost 90% of the rural energy requirements of the domestic sector could be met; at present, this accounts for about 45% of the total energy consumption in India. The consequent reduction in firewood consumption would help to prevent deforestation. In addition, organic manure containing two million tons of additional nitrogen would be available every year to enhance soil nutrients, hence boosting food production and helping to solve the problem of sanitation at the same time.