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e-net

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FEATURES

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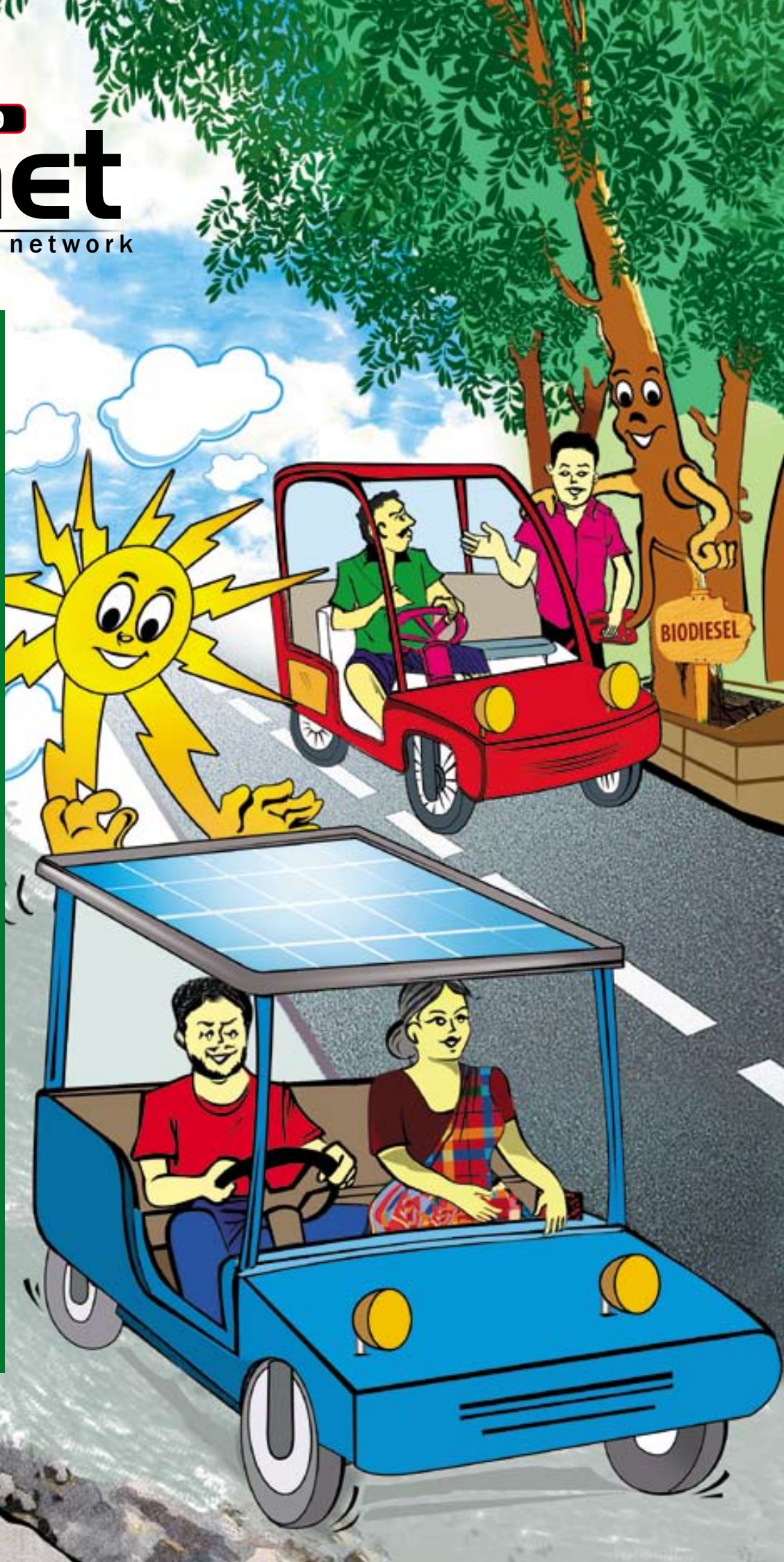

editorial

A good rural transportation system is necessary to end the social isolation of rural communities and for the movement of goods and services to enable a productive economic life. Most discussions on improving rural transportation cover the deeper penetration of the rural transport infrastructure, rural transport strategies, addressing capacity issues, etc. **e**-net is however different. It focuses on environmentally friendly energy for rural transportation and offers a perspective that is quite different from the conventional.

This issue of the **e**-net magazine covers a range of the problems and environmentally friendly transport solutions currently in the South Asian region. Articles highlight research and use of technologies such as biofuels, gravity ropeways, and solar/ hybrid and pedal-powered vehicles. Energy efficient transport solutions may also assist in waste management as in the case of the use of waste plastic for road construction. Apart from specific technology, environmentally friendly, energy efficient, transport solutions require conducive macro solutions in order to be effective. Policies promoting and facilitating energy efficient transport, the need to plan and manage land-use and infrastructure development, and dealing effectively with competing uses for transport fuel sources are part of the solution.

In spite of the wide variety of articles featured, the issue is limiting because it does not address solutions for travel or transport for subsistence purposes - collection of water, firewood, movement of agricultural produce, trips to market, travel to school, health centers. We have also not been able to feature any articles on water transport. We have carried out an exhaustive search for possible contributors from the South Asian region on the subject. While recognising the importance of transport energy, countries have yet to fully dedicate funds to energy efficient transport solutions. The SAARC Regional Multi Modal Transport Study is one of the initiatives taken in the region for regional collaboration to improve transport infrastructure and cut energy use and transport costs. Several sub-regional projects have been identified for implementation consisting of an intra-SAARC network of rail, road, aviation and waterways. It is hoped that this initiative will mark a milestone in the region's efforts to have energy efficient transport while addressing the needs of the poor.

A discussion on the same theme as the magazine – Energy and Rural Transport - was also launched through e-forum and is summarised in this issue. We realise that the subject of energy for rural transportation remains largely un-discussed and there is a need to explore why such an important aspect of energy use is not the subject of energy efficient or renewable energy interventions. We hope that this issue of e-net would stimulate more interest and action in the sector

IMPRINT

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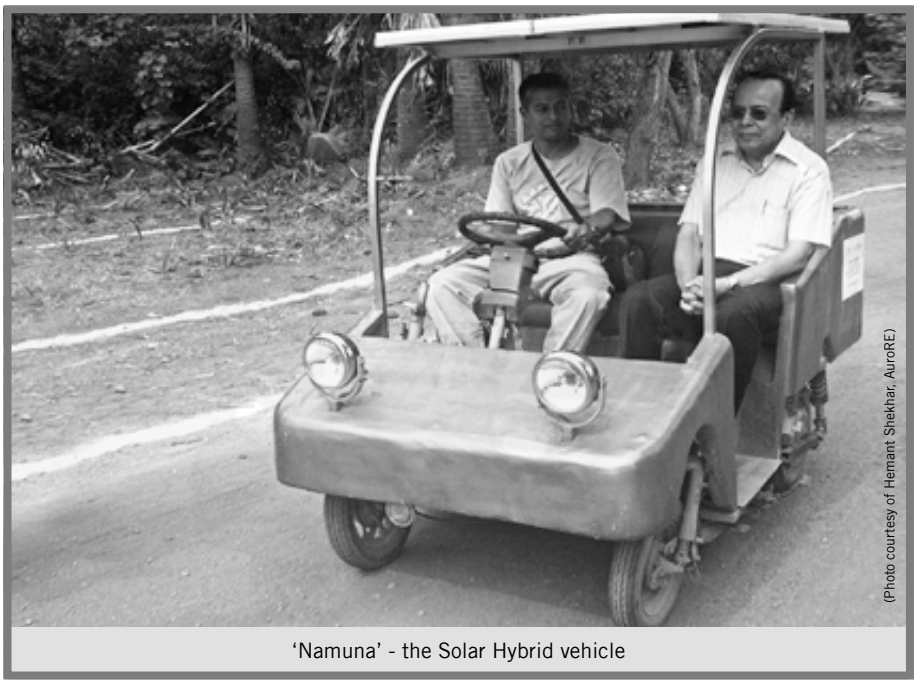
ECO-FRIENDLY AND SUSTAINABLE TRANSPORT IN AUROVILLE, INDIA

By Nina Sengupta and Alok Mallick

The research team at Auroville Renewable Energy and Auroville Center for Scientific Research (AuroRE/CSR), India, has embarked on several initiatives to provide their township with greener and more sustainable transport options. This article deals with some of the successful designs which have materialised from these efforts, such as a pedal-powered four-wheeler/quadricycle as well as a solar hybrid vehicle which are currently undergoing further improvements.



(Photo courtesy of Hemant Shekhar, AuroRE)

'Namuna' - the Solar Hybrid vehicle

As the sun's rays reach the dewy undercover and dirt roads on a typical misty morning, one can see bullock carts taking produce from the farms to the grocery centers, and people going about their daily chores using the network of shaded cycle paths which stretch across Auroville. Auroville, is a UNESCO - ratified international township in India dedicated to manifesting human unity in diversity. Reforestation and land reclamation work over the last 40 years has transformed a desert-like landscape into a green space which supports people, flora and fauna. The township constantly endeavours to find means of living lightly and sustainably on earth.[1] Part of this quest involves finding reliable and eco-friendly solutions for transportation.

There is a wonderful network of cycle paths that many people use in Auroville. However, for various reasons - such as the ruggedness of the terrain, dust turbulence on earth roads, intense heat, age factor and ability of the riders - the bicycle is not the ideal choice for everyone. Many are therefore compelled to use motorbikes and few use cars. However, most of those in Auroville who currently use fossil fuel powered vehicles would rather switch to more eco-friendly alternatives if they were available and affordable. Several groups in Auroville are trying to address this need for eco-friendly and sustainable means of transportation at various levels. It is also one of the main focus areas of research at the AuroRE/CSR. As part of this focus area, AuroRE is involved in experimenting and designing reliable eco-friendly vehicles for Auroville and other rural areas in the developing world.

The following are a few examples of AuroRE's ongoing efforts:

Solar/Hybrid Vehicle: The prototype called "Namuna", which means "an example" or "a character", is a hybrid four wheeler with an automatic transmission. It is capable of running entirely on either solar electricity or liquid fuel (petro or bio-based), or on a desired combination of either solar electricity or fuel. This hybrid feature that is both unique and useful was developed in Auroville. As much as 40% of the energy captured can be lost in transferring it from the solar-panel or grid to a battery system. To avoid this, Namuna attempts to use the energy directly from the solar-panel and meets any extra demand using the battery bank first, and then fuel if necessary. Battery storage is necessary when driving in shaded areas, less sunlight, cloudy days or during the night as well as when the power requirement is greater than the direct solar energy supplied from the vehicle's solar photovoltaic canopy (for example under fast acceleration, on sandy roads, or while carrying an extra load). This transition between direct power usage from the panel to substitution of power from the battery or fuel when necessary, occurs smoothly, without any involvement of the driver. The exemplary feature of Namuna is that it needs to be parked in a sunny spot – which also means less competition from any other vehicle for parking. While parked under direct sunlight it generates energy. When the vehicle is driven at a slow speed or when it is parked in the sun the net excess power gets stored in the battery. Namuna was launched officially on Earth Day in 2007. To date, Namuna has run 2000+ kms within Auroville. It can travel at a maximum speed of 60 kmph on a good (tarmac) road. Though the speed is lower while running on earth roads, Namuna has proven to be resilient enough to deal with very rugged road conditions.

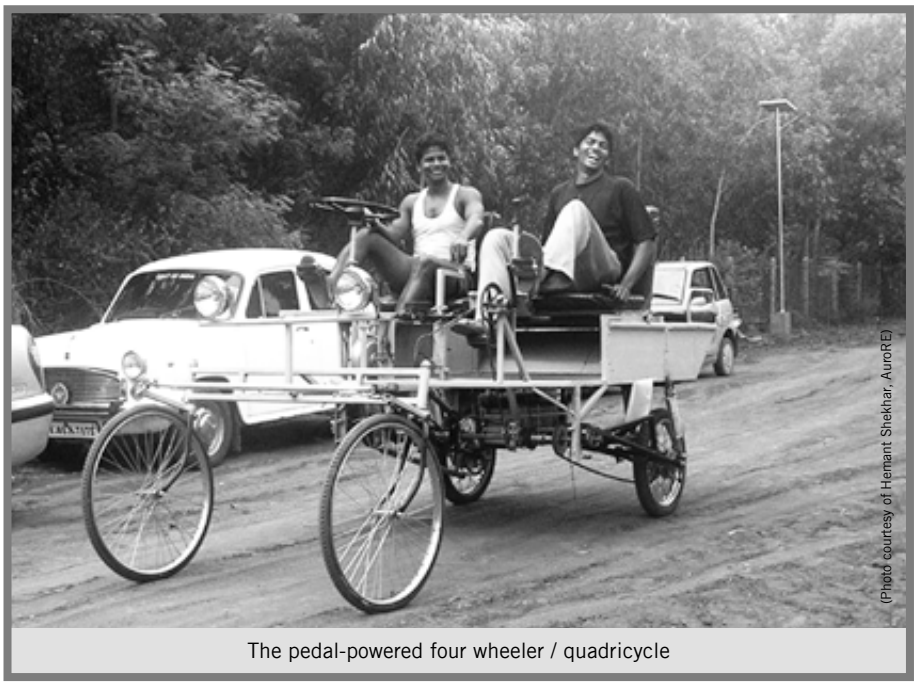
Solar/Electric vehicle: At AuroRE/CSR, we are now ready for the

[1]Several of Auroville's earth day initiatives focused on sustainable transportation along with carbon-neutral living options through seminars, exhibition, café-conversation, and films.

second generation Namuna based on the experience and learning gained from the first prototype. Our tests revealed that Namuna can run entirely on solar - approximately 50 km on a fully-charged battery. To fully charge an empty battery it takes about 5 hours if it is really sunny. However for normal daily driving in Auroville one hardly has to drive long distances. One either drives to work or to the solar kitchen[2] for lunch or to pour-tous[3] for groceries. The vehicle is parked at places where sunlight is ample and the battery gets an opportunity to recharge.

The second generation Namuna currently under construction is entirely solar/electric (by eliminating bio or fossil fuel engine, transmission system, and tank) making it somewhat lighter and therefore more efficient. It will be a truly zero emission vehicle with solar as its primary energy source. A backup recharging option from the grid or any other alternative energy source will however be provided for use during the monsoon season or for occasional driving needs that exceeds what the battery can sustain. Like its predecessor the new model will not have any frills but will have a rather simple look to highlight its robustness and reliability.

Pedal-Powered Four-wheeler/ quadricycle: A pedal powered vehicle is clearly one of the most eco-friendly alternatives. However, in Auroville and on use in other rural roads even the most ardent cyclist will find it difficult to carry another person or transport goods on a bicycle. Cycle rickshaws that exist in India and several other developing nations are probably an answer but they are not very easy on the rider. We have therefore designed and built our first pedal-powered four wheeler or quadricycle. It has a strong suspension, a tough chassis to take the structural stresses of travelling on a rugged terrain, a wide width that allows it to be more stable even on undulating roads, and a substantial height to minimise the ground turbulence which in turn reduces the kicking up of dust from the road. The vehicle can be pedaled by one or two riders. Each of the two riders has independent gears. Thus, while two people are riding, each rider is able to pedal according to his/her ability or strength by choosing the desired gear. The vehicle is large enough to carry two extra passengers or an equivalent load. A battery bank and motor is provided to assist in riding when desired. There are plans to add a canopy in the near future which will be equipped with a solar panel to recharge the battery while also providing shade.



The pedal-powered four wheeler / quadricycle

The above vehicles have been taken for test runs outside Auroville. The quadricycle has an average energy use of 200 Watts(W) and can be used outside Auroville in regular traffic. Namuna uses over 200W and therefore requires registration to be allowed on the road. Thus, so far, Namuna has been used only within the Auroville campus and can be used in other campus situations. In the future AuroRE/CSR hopes to forge partnerships with manufacturers, within India or elsewhere, who will produce and sell the vehicles. Apart from the above mentioned innovations, there are several on-going efforts in designing reliable eco-friendly vehicles for various users at AuroRE/CSR. Through these and other alternate energy work AuroRE/CSR also provides essential training opportunities for students and interns who come from various universities across the globe. Together we continue our quest to find better and greener options for all of us to live in harmony with the myriad of plants and animals with whom we share the earth.

Nina Sengupta is a researcher at Auroville Center for Scientific Research (CSR). She is an ecologist who works on integrating biodiversity conservation/ restoration with sustainable energy and development issues. Alok Mallick is a researcher at Auroville Renewable Energy (AuroRE) and CSR. He continues to work on his long term passion and interest of designing and fabricating innovative renewable energy systems. He leads the R&D at AuroRE.
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[2]Solar Kitchen: Is a community kitchen equipped to cook for 2000 people everyday using a hybrid fuel source that is primarily supplied through a large solar collector.

[3]Pour-Tous literally means "for all". It is the grocery store and distribution center for all living in Auroville.

LIQUID BIOFUEL FOR TRANSPORTATION IN SRI LANKA

By Dr. Sanja Gunawardena

Sri Lanka is a country totally dependant on imported petroleum products to meet transportation fuel requirements. Increased prices of crude oil in the past had negative impacts on the country's economy and society. This article exclusively focuses on Sri Lanka's experience in the use of liquid biofuels for transportation – of which bioethanol and biodiesel are the most common.

Three wheeler powered by biodiesel from neem seed oil, produced by the Department of Chemical and Process Engineering, University of Moratuwa

Sri Lanka spends a large amount of foreign exchange to purchase crude oil and refined products. The petroleum bill in 2006 was approximately Sri Lankan (SL) Rs. 250 billion which is equivalent to 20% of the total imports and 30% of the total export earning (Central Bank of Sri Lanka, 2006). High oil prices lead to increased cost of living, cost of production, and also adversely affects export products – dampening growth and possibly resulting in increased unemployment. Therefore systematic efforts need to be made to develop indigenous alternative fuels for at least partial replacement.

Biofuels derived from renewable sources are alternative forms of energy that can be produced locally. In the global context, biofuels have received rapidly growing interest for reasons concerning energy security, diversity, and sustainability as well as for greenhouse gas mitigation. In recent years, many countries have enacted regulations – and adopted aggressive goals – to encourage increased usage of biofuels. Many Asian countries have also started promoting biofuels. In an effort to face the energy crisis, it is timely that Sri Lanka also takes initiatives to look at these feasible alternative fuels for transportation – of which bioethanol and biodiesel are the most common.

Bioethanol

Ethanol produced from renewable resources is termed bioethanol, and is a good substitute for fossil petrol. Common feedstock for bioethanol production are sugarcane juice, molasses, sugar beet and starchy materials such as wheat, corn, cassava, etc. Most of these are food materials and therefore there is a huge debate regarding the use of food material for bioethanol and biodiesel production. Pilot scale studies have been carried out to produce bioethanol using cellulosic biomass (switchgrass, agricultural waste etc. - commonly known as third generation feedstock). Once this is fully established the use of food crops for bioethanol can be brought to an end.

Bioethanol has good properties for use in spark ignition engines. It has a higher octane number, broader flammability limits and higher flame speeds. These properties allow for a higher compression ratio, shorter burn time and leaner burn engine, which lead to theoretical efficiency advantages over petrol in an internal combustion engine. Disadvantages of bioethanol include its lower energy density than petrol (bioethanol has 66% of the energy that petrol has) (Balat,Balat, Oz, 2008), its corrosiveness, low flame luminosity, cold starts problems, miscibility with water, and toxicity to ecosystems. It has been found that ethanol petrol blends could successively harness the advantages of pure bioethanol while decreasing or eliminating the impact of its disadvantages.

Ethanol production in Sri Lanka is approximately 12 million litres per year and is produced using sugar-cane molasses at two sugar factories. Only 10% of the country's sugar requirement is produced locally due to the unavailability of sugarcane (Lankanewspapers.com, 2008). Hence, the amount of molasses available for ethanol production is also limited. Both sugar factories are located in an area where there is low rainfall and they lack proper irrigation systems - resulting in a seasonal supply and idling factory capacity. Ethanols produced locally are of potable grade and unfortunately this amount is not even sufficient to meet demand for the local ethanol. Therefore, another 5 million litres of potable ethanol are imported in addition to commercial grade ethanol.

Fuel grade ethanol should be produced locally at least for partial replacement of petrol in Sri Lanka. In order to do this more molasses should be available and more sugar-cane should be cultivated and processed. By doing so the amount of sugar produced locally can also be increased and a considerable amount of foreign exchange can be retained in the country in addition to savings resulting from reduced fuel imports. The farming and rural communities in the vicinity would also hugely benefit from the increased

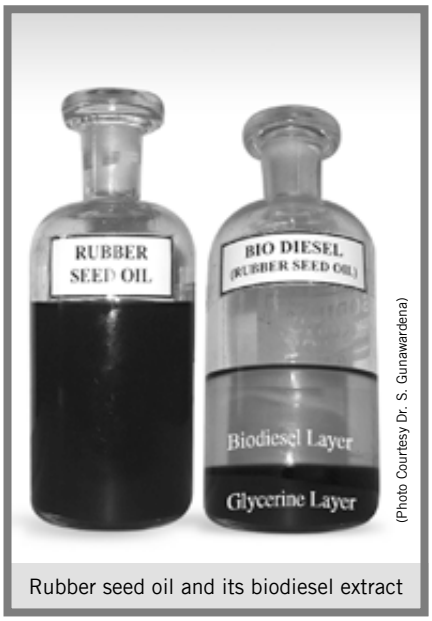
production of sugar and fuel ethanol. Employment, income generation and poverty alleviation would be some of these benefits. When the present government came to power, there were high level discussions on revamping the two sugar factories that were shutdown and on setting up new sugar factories in the country. Unfortunately these plans are only down on paper and have yet to be put into action.

At present there are 18,000 ha. of sugarcane cultivation (Sunday Observer, 2008). If proper cultivation techniques, irrigation and fertilisation practices are implemented a good yield can be obtained and increased amounts of ethanol can be produced. About 17-20% of the petrol consumed in the country can be replaced with ethanol when self - sufficiency in sugar is attained in Sri Lanka. A 17-20% petrol import reduction could save Sri Lanka a huge amount of money which can be used for other development purposes.

Biodiesel

Biodiesel can be produced from different types of locally available renewable biological sources such as vegetable oils and animal fats and can be used in diesel engines instead of petroleum diesel. Vegetable oils have comparable energy density, cetane number and low volatility with that of the petroleum diesel fuel. However, viscosity of vegetable oils is higher than that of petroleum diesel which could affect the flow properties of the fuel, such as spray atomization, consequent vapourization, and air–fuel mixing in the combustion chamber. It could also cause poor cold engine start-up, misfire, and ignition delay (Ramadhas, Jayaraj, Muraleedharan, 2005). Hence, these oils are chemically modified by transesterification[1] to bring their combustion-related properties closer to those of petroleum diesel.

Even though any type of vegetable oil or fat can be transesterified, non - edible seed oils like rubber, jatropha and neem as well as waste cooking oils and rendered fats are potential feedstock to produce biodiesel without a need to shift from food crops to fuel crops. However, in order to produce biodiesel on a commercial scale, sufficient quantities of feedstock should be available. At present quantitative information about the above feedstocks are not available and therefore the potential production capacities cannot be estimated.



Rubber seed oil and its biodiesel extract

Replacement of diesel with 10% biodiesel would require 1.5 x 105 MT[2] of biodiesel per year and therefore about 2.3 x 105 MT of oil or fat is required (considering 65% efficiency of conversion from oil to biodiesel). This is a considerable amount which requires large scale cultivation of oil bearing crops. At present Rubber Seed Oil (RSO) is the only non-edible oil feedstock available in Sri Lanka for the production of biodiesel on a reasonable scale.

Commercial Cultivation of Biofuel Crops

Sri Lanka is a small country with limited land and with a fairly high population density. Therefore, cultivation of crops other than food crops is a matter of concern. Cultivation of biofuel crops will cause public concern unless there are dual or multitude benefits. In this respect growing sugarcane will answer both the food and fuel issue.

According to the print and electronic media there has been a considerable interest from both public and private sector organisations in planting oil yielding seed plants such as *Jatropha curcas* and *Pongamia pinnata* for the production of biodiesel. Jatropha curcas plantations have not succeeded in many locations in Sri Lanka and should be therefore carefully studied before embarking on such initiatives. However, growing rubber is more economical for a country like Sri Lanka with limited land than growing other oil bearing crops. In addition, rubber cultivation has been done for decades and is familiar to the locals. Rubber has a multitude of benefits too: rubber latex for the rubber industry, wood for furniture and energy and oil from seeds for biodiesel (whereas most other crops would have to be dedicated only to producing oil for biodiesel).

Biofuel Production in Sri Lanka

Fuel grade bioethanol is not produced in Sri Lanka. Dehydration[3] techniques are not employed in the local distilleries and therefore bioethanol that is produced locally cannot be blended with petrol. The bioethanol produced is of potable grade and is sold at a high price because of the high cost involved in the purification and dehydration processes. However, fuel grade ethanol need not be subject to such a high degree of purification and thereby the production cost of fuel grade ethanol could be lowered. Hence bioethanol could be sold at a price lower than the potable ethanol currently sold in the market.

Biodiesel is also not yet produced on a commercial or pilot scale in Sri Lanka. However, various universities and researchers have carried out laboratory scale processing and engine trials. Extensive studies have been carried out at the

[1]Transesterification is the process of exchanging the alcohol group of an ester compound with another alcohol in the presence of a catalyst.

[2]MT – metric ton

[3]Dehydration – further removal of water from the azeotropic ethanol-water mixture.

Department of Chemical Engineering in the University of Moratuwa, in Sri Lanka, on biodiesel production using coconut oil, rubber seed oil, jatropha oil, neem seed oil, and waste cooking oils (WCO). Local hotels and restaurant chains have shown interest in converting waste cooking oil into biodiesel for their own uses. This is encouraging and is environmentally friendly. Otherwise, these WCO are used by small scale restaurants and hotels for further cooking purposes which create high health risks.

Energy Policy, Biofuel Guidelines and Regulations in Sri Lanka

In the 'National Energy Policy', Sri Lanka has identified fuel diversification in the transport sector and the promotion of biofuels as a high priority research and development need. The policy also encourages biofuel development for the transport sector. However, Sri Lanka does not have regulations for the use of liquid biofuels in transportation yet. Preliminary discussions and groundwork required for the preparation of regulations have been carried out and it is hoped that they will be available in the near future. Such regulations will address the biofuel specifications, blending and marketing strategies required. It is expected that once the guidelines and regulations are available local entrepreneurs will move into the biofuel market in Sri Lanka.

What has been done so far?

The National Engineering Research and Development Centre (NERDC) has tested a vehicle with blends of coconut oil (straight oil) and petrodiesel, and they were the first to initiate this kind of work. Despite a few drawbacks it was reported that running an unmodified diesel engine with blends of coconut oil was technically feasible. Recently, a diesel three wheeler was operated with biodiesel produced using various types of oil, at the University of Moratuwa, and the engine runs smoothly without operational difficulties. However, long term studies have to be carried out to check the compatability of material that is used in the fuel system of the engine with biodiesel and to investigate other operational problems that are reported in literature. The research team is happy to disseminate the knowledge to interested parties. At present there is a 5L biodiesel reactor at the University of Moratuwa and a fully controlled 50L biodiesel reactor unit with other ancillary units is currently being designed mainly for demonstration purposes. Once fabricated, the reactor system will be made available to prospective entrepreneurs for them to carry out their preliminary trials before embarking on large scale projects.


(Photo Courtesy Dr. S. Gunawardena)

A 5L biodiesel reactor presently available at the University of Moratuwa

Rural Transportation

Production of liquid biofuels especially ethanol requires knowledge, experience, and a substantial amount of capital investment. Therefore, setting up of small scale ethanol production units is neither economically nor technically viable. However, small scale biodiesel production facilities can be installed even at village level and run by persons with some scientific background. Feedstock required for these units can also be obtained locally. Yet the cost of production may be high in these units due to the scale of operation and the inability to recover unused reactants and by-products. The first ever rural level, community based, small scale biodiesel production facility in Sri Lanka was setup by Practical Action (Sri Lanka) with help from the Universities of Ruhuna, Peradeniya, Moratuwa and NERDC. There are plans to run a tractor and a generator using the biodiesel produced by this unit for community based activities without any charge. This facility can also be used to educate, encourage and motivate people towards the use of biofuels and help in breaking the myth and various concerns regarding the use of biodiesel.

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SAARC REGIONAL TRAINING WORKSHOP ON BIOFUELS

Sri Lanka had the privilege of hosting the first ever SAARC Regional Training Workshop on Biofuels from the 22nd to the 26th September 2008 at Hotel Heritance, Kandalama, Sri Lanka. This was organised by the SAARC Energy Centre and Sri Lanka Sustainable Energy Authority, in technical collaboration with the Sri Lanka Energy Managers Association. 49 eminent researchers, academics, practitioners and promoters of biofuels from the South Asian Region participated in the workshop.

The workshop commenced by providing an understanding of the background of the biofuels sector at the global and regional level. Plantation of energy crops for harnessing biofuels, and the agronomics, social and community aspects, were then discussed. Oil expelling / extraction, processing bioethanol and biodiesel, prospects for biobutanol and later generations of biofuels, and the application of biofuels in internal combustion engines were some of the other technical sessions held. Aspects of biofuel farming from a community based approach and downstream marketing considerations were also included in these sessions.

The SAARC country nominees made presentations giving snapshots of the existing situation with respect to the developments associated with biofuels in their respective countries and the main issues involved.

The highlight of the inauguration was the presentation of the booklet developed by the Ministry of Petroleum & Petroleum Resources Development in Sri Lanka on "Guidelines to be implemented for the formulation and usage of alternative fuels in Sri Lanka". The presentation was made by the Ministry Secretary, Mr. W.B.Ganegala to the Chairman of the Sri Lanka Sustainable Energy Authority, an establishment under the Ministry of Power & Energy. The guidelines were formed considering the production, economics, by-products, storage, specifications, quality control,

Chief Guest and Officials of the SAARC Energy Centre and Sri Lanka Sustainable Energy Authority

emissions and environmental concerns, pricing and marketing of specifically bioethanol and biodiesel for transport applications for blending with petroleum fuels. This provides a stepping stone to commence the production and use of liquid biofuels at a national scale in Sri Lanka.

At the workshop, a wide spectrum of aspects pertaining to the emerging biofuels sector was covered. The current status, research and development, future scenario,

Mr. Harsha Wickremasinghe, Deputy Director General of the Sustainable Energy Authority addressing the audience

projections, opportunities, costs, issues, constraints, threats and priorities for the future were the key areas considered. Sessions were highly interactive, and included presentations by the resource persons, as well as critical arguments and discussions that aroused further interest, while the sharing of knowledge and experiences paved the way for mutual learning.

Participants drew attention to the future and future technologies of biofuels. They also discussed and agreed upon the required related research priorities for the region. Areas of consideration included biofuels as a source of clean energy, its potential for it to be a Carbon asset, and a new link in the value chain of biofuel interventions for South Asia. The concluding session was chaired by Mr. Ananda Gunasekera, Chairman of the Sri Lanka Sustainable Energy Authority and Dr. Muhammad Pervaz, Programme Leader for Technology Transfer, of the SAARC Energy Centre. It was recommended that a position paper will be developed for the SAARC region in light of the potential solutions that biofuels could offer to partially challenge the energy crisis faced by the region so that future actions could be taken as necessary.

GRAVITY GOODS ROPEWAYS CHANGING LIVES OF HILL COMMUNITIES IN NEPAL

By Jun Hada

Nepal has extreme geographical conditions, ranging from high mountains in the North to plains in the South. The harsh topography hinders the mobility of people and they are forced to bear enormous physical burdens (head and backloads) to transport their goods. The construction of roads and air transport infrastructure poses huge economic and environmental costs for the country. The innovative green technology of gravity ropeways offers revolutionary solutions to these transport challenges, and brings change to Nepal's transport sector development.

(Photo Courtesy Practical Action, Sri Lanka)

A Gravity Goods Ropeway at work

The transport needs in Nepal

Until the late 50s, trails and mule tracks were the only means of transport and communication throughout Nepal. This remains the case in many hill and mountain districts today. Considerable efforts have been undertaken to link villages with important geographical areas and economic centres of the country with roads.

Only about 9,400 kms of national strategic roads connect the districts, and out of 72 there are 9 districts which are not yet connected byroads. (http://www.dor.gov.np/road_statistic_2008/Report%20Pages/tables/1.pdf). The road density is 6.39 km per 100 sq.km and the population with access to roads is only 2,463 per km of road. This clearly means that a majority of population still have no access to basic transport infrastructure.

The rugged topography combined with highly problematic hydro-geological conditions have made connectivity extremely difficult. During the monsoon, many areas with rough earthen roads are cut-off from the main road network and thus from food supply, health facilities, schools, important markets and other essential services. Mobility in rural areas fluctuates with the seasons leading to transport costs becoming irregularly high. Therefore, the majority of human settlements located in hilly and mountainous areas of the country will remain totally isolated for years to come. As a result, they will continue to depend on trail based transport and unreliable river crossing systems, which severely limits their socio-economic activities. The difficulty in mobility and resulting lack of access to essential resources, markets and services by the rural people of Nepal has been defined as one of the key reasons for poverty and a constraint to development efforts. There is considerable evidence to suggest that this lack of access is a major factor/parameter impeding the integration of the rural population into the national economy, restricting the pace of innovation, isolating rural communities and limiting potential for growth in production and income.

Carrying heavy burdens in the hills

National transport priorities and focus

The Government's Tenth Plan (FY2002-FY2007) considers poor transport connectivity to the rural areas as a key constraint to Nepal's economic growth. The Plan has identified integrated transport infrastructure development, linked to balanced regional development, as a powerful instrument of poverty reduction - given the close nexus between poverty and excluded development. Although the Plan has outlined the strategies to research and develop alternative transport systems, the major focus of almost all bilateral and multilateral agencies has been on the development of the road sector.

The Government's Three Year Interim Plan[1] has also recognised the importance of alternative transport systems, and cable ways

[1]The tenure of the plan is 2007/08 to 2009/10.

have been prioritised for transport sector development in Nepal which is extremely important.

Gravity Ropeways – technology, opportunities, and rationale

Practical Action Nepal[2] transferred gravity goods ropeway technology to Nepal from Northern India in 2002, in collaboration with the International Centre for Integrated Mountain Development (ICIMOD). The first gravity ropeways were installed in the Mustang District of Nepal, and were used for transporting apples from the orchard to road-heads. The slopes at which these gravity goods ropeways function range from 12^0 to 22^0. Nepal has numerous locations ideal for these ropeways. With successful application and demonstration, the gravity ropeways were replicated in Nepal in the mid-hills of Dhading, helping to significantly reduce (by 50%) the transportation costs of agro-based products. This has encouraged the communities living in the uphill villages to increase their productivity, and has also helped to boost the local economy by creating employment opportunities, and supporting businesses of local manufacturers and service providers.

> "Isn't it amazing? Without any energy, the operation of the ropeway is possible. Such a technology has great importance for the development of rural and urban areas of our country."
> *Honourable Ramakanta Gauro, Member of National Planning Commission, during the launch of the Transport project, Kathmandu.*

Gravity goods ropeways are an effective means of transporting goods. The system is an intermediate form of technology between walking and conventional motor vehicles. This option is very useful and affordable because of the socio-economic and geo-physical conditions of the people living in the hills. These ropeways are economical, as a running meter of a gravity goods ropeway is Nepalese Rs. (NRs.)1,000 compared to the cost of a running meter of a vehicle on green earthen roads which costs a minimum of NRs.3,000. The cost of fossil fuels to run the vehicles on green roads and the vehicular emissions will add additional environmental costs that can easily be mitigated through the construction and use of gravity goods ropeways.

Clean and natural energy

The system is absolutely clean and non-polluting as it is non-motorised which increases its appeal as a green and environmental friendly option. The construction process is eco-friendly as it does not destroy fragile eco-systems through deforestation and land cutting as in the case of building roads and other forms of transportation. They do not require any form of external fuel or energy. They simply work on a gravitational force. The force created by a load in the upper platform (upstation) sliding down pulls a lighter weight (not more than 1/3rd of the load) from the landing platform (bottom station). This carries the lighter load upwards as both the carrier trolleys are tied in a single loop made of a cable attached to the 2 flywheels fixed at top and bottom stations (please refer Diagram 1).

The system uses locally available resources both in terms of materials and skills in all cases except for the steel cables which are imported from neighbouring countries. Most importantly, these robust ropeway facilities can be installed within a very short timespan which will help accelerate local economic development at a relatively lower cost compared to road construction or even motorised cable cars which will require very specific and skilled technical inputs. In addition, the communities contribute in terms of land, labour and their time. All of these resources, when converted into economic and financial values, results in an average community contributing 35% to 40% for each ropeway, making this technology more viable.

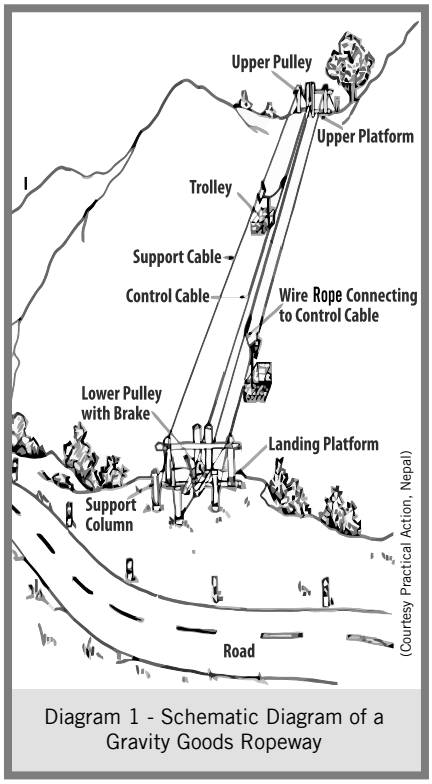


Diagram 1 - Schematic Diagram of a Gravity Goods Ropeway

Ropeways in operation – community participation, impact on livelihoods

Practical Action has supported the construction of 7 of these kinds of ropeways - 3 in Mustang district, 3 in Dhading district and 1 in Tanahun district. Each ropeway is being managed by a marketing group or a cooperative comprising of members of the beneficiary households. These groups/cooperatives are responsible for levying the ropeway user charges for transporting the loads up and down the hills by employing operators at both stations. They are also responsible for marketing the transported agricultural produce grown in the villages uphill, and also overseeing operation, maintenance and occasional repairs of the ropeway systems. The marketing group, or cooperative members, rely on daily market information for prices of produce before they negotiate with the middlemen and traders who come

[2]Involved in Nepal's transport sector since 1998, Practical Action Nepal has worked to improve and promote innovative transport alternatives such as cable river crossing bridges known as tuins, gravity goods ropeways for mountains and hills, and bicycle trailers and ambulances for plains.

to the bottom stations to purchase the agricultural produce. The user charges are based on the weight of the goods transported. Generally for a load of 50kg, the user pays. NRs. 15 per trip uphill. For a load of 100kg downhill, users pay NRs.10 per trip. On average users save NRs.1.55 per kg. The user charges collected are used for paying the expenses of day-to-day operations, regular maintenance and occasional repair of the ropeways.

With the financial support of The European Union, and the Trust Funds and Foundations in the United Kingdom, the gravity ropeway technology is being replicated in 4 districts – namely Achham, Kalikot, Gorkha and Tanahun. Technically facilitated by Practical Action, the process is being led by the beneficiary communities as users' committees, the district level partner non-government organisations, and the respective District Development Committees (DDC). The district level engineers and technical staff of partner organisations and DDCs are being technically trained on identify appropriate locations, conduct feasibility studies, as well as to plan and construct 16 new gravity goods ropeways in these 4 districts.

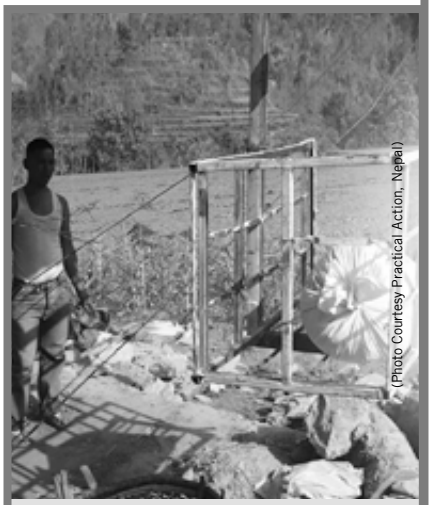
As in the previous ropeways projects, in these new districts too, the communities are being prepared to take ownership of the systems from the beginning of the process. They partake in decision making processes, regarding the choice of locations for ropeway establishment, contributing their share in terms of land, local materials, semi-skilled and unskilled labour, system operation and maintenance, fixing of rates for user fees, etc. The implementing organisations facilitate the nomination or election of management committees from among the ropeway users in which at least 30% female representation is ensured. This is given particular emphasis in each of the projects as women empowerment has become one of the key corner stones for development efforts to be equitable. From past experience in different ropeway projects, it is also apparent that committees which have more women in decision making roles function better than those having only men as decision makers.

Impacts on livelihoods – A Case from Janagaon Village:

Goods loaded and ready to move downwards at the upper platform

In Janagaon village, farmers hired porters to transport their agricultural produce to the markets downhill prior to the construction and operation of the gravity goods ropeways. Each porter normally took 3-4 hours to carry the loads (not more than 50-60kg) on his/her back for which the farmer is paid NRs.75 in addition to three meals. Now with the ropeway of approximately 1600 meters in span connecting Janagaon village with the road-head down at Prithvi Highway (in operation for over 3 years), farmers make a saving of 85% in transportation costs, with an additional time saving as it takes less than 5 minutes to carry loads up and down. Porters who served the villagers prior to the installation of the ropeway have moved to service other areas which still require their services. The time saved by the farmers has been utilised to increase production in the farms by diversifying high yielding crops and fruits. Improved incomes have also helped villagers afford better agricultural inputs including tools, fertilizers, seeds and improve irrigation.

The improvements in the quality of life brought about by the ropeway in the village are clearly visible. One of which is village electrification. Villagers are now able to afford electricity from the main Grid Connection, and therefore farmers' houses are now connected to the national grid. With electricity, the children now study comfortably during nights. Farmers engage in agro-processing (thus value addition) to their agricultural products and sell them during off-season to earn more. They can now pump up the water and store it in tanks for irrigating their farms during the dry seasons.



Goods ready to be off-loaded at the bottom station

Sustainability - economic viability and self-sustainability

The gravity goods ropeway technology is designed to be sustainable from three perspectives;

- building local capacities in designing and planning ropeways
- manufacturing the key elements, parts and supplies and installation of elements
- operation and maintenance of the installed system through on-the-job training and exchange visits.

This has created a cadre of experts at local and national level. This cadre of experts is capable of replicating the technology in new areas, and in some cases have adopted small innovations e.g. improving the braking system for better safety, which is highly commendable. The on-going demand from the Ministry of Local Development's multi-donor supported programmes for improving skills among the technical officers in the districts, programme officers in the local governments, and also local potential manufacturers from the private sector, are expected to ensure the preservation of knowledge, practice and skills for wider dissemination of the technology.

Community Ownership

Similarly, at the community level, the communities' ownership of the ropeway facility, their skills on day-to-day operations including business development, accounts keeping, marketing, negotiating and cooperative management are all well designed to equip and encourage them towards a range of future development initiatives. The self–sustaining mechanism for operation consisting of user charges and cooperative financing systems is likely to ensure their financial and organisational structure. The sustainability, and ability of this green gravity ropeway technology to overcome transport challenges and offer transport solutions to isolated communities living in the hills is inspiring. Its success highlights the strong link between appropriate technology and community involvement.

Ways forward – influencing policies to scale-up

The ropeway seems to be a practical transport option for countries having similar topography and geographical conditions to Nepal, where it is too costly to build roads and other transport systems. From the point of view of climate change and the environment, this is also a kind of technology that is not affected by climatic conditions and has no adverse environmental impacts. The future of gravity ropeways in Nepal depends on how these practices are translated into policies at district and national levels. Standards are currently being developed for gravity ropeways with the Department of Agricultural and Rural Roads in Ministry of Local Development. Similarly, efforts are being made to include gravity ropeways technology and its implementation and operation mechanisms into the transport sector's policies.

Practical Action, through its consulting wing is also intending to provide technical assistance services to countries like Bhutan, Northern Pakistan and Afghanistan to scale up this technology. Currently, there has been a lot of technical enquiries on the technology from Bhutan and in Northern Pakistan through partners like International Centre for Integrated Mountain Development and the Food and Agricultural Organization of United Nations.

In villages with ropeways in operation, Practical Action in Nepal has been working towards integrating other development activities in these terrains – for example sensitising villagers to adapt to changing climatic conditions, improving personal hygiene and sanitation, switching to efficient and cleaner cooking technologies in healthy kitchens. With increasing incomes, access to information and technology, many of these interventions have now become possible.

Apple Farmer in Marpha

Mr. Chandra Man Lalchan is a 66 year old apple farmer from Marpha village of Mustang District. He lives with his wife, three sons, and one daughter. His main source of income is agriculture and seasonal tourism. He has a small apple farm at Jhomsom village, and sells apples to the local traders.

The apple business was not profitable with marginal incomes due to the high cost of using porters for transportation. After the installation of Gravity Goods Ropeway in year 2004, he was able to cut costs and became more confident, and expanded his apple farm 3 folds from 10,952 sq. ft. to 32,856 sq. ft. Now he has more than 200 matured apple trees in his farm and has increased the production of apples. Thanks to the ropeway, he says, he is now saving NRs.40,000 per season from apple selling.

Mr. Chandra Man Lalchan of Marpha in his apple storage

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Case studies from Janagaon and Marpha villages, 2007.

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TRAVELLING ACROSS MOUNTAINS ON BIODIESEL

Travelling across the Nilgiri mountains in South India is a pleasure sought after by many. The Nilgiri Mountain Railway (NMR) has found a way to make part of this train journey using biodiesel mix fuel. The following is an interview conducted by N. Radhakrishnan and Chitra S. Raju with the driver of the train.

The Nilgiri mountains in South India are a popular destination for tourists seeking to escape into the hills. The NMR connects Mettupalaiyam town with Udhagamandalam city while passing through the town of Coonoor. The entire journey covers a distance of 46 km through some of the most beautiful misty mountains and valleys. This train route was opened in June 1899 and is now listed as a World Heritage site by UNESCO. One special feature of this train is that for a part of the journey, i.e. the 19 km between Coonoor and Udhagamandalam, the train is powered by 10% biodiesel mix fuel. The train journey is split into two parts. Through the journey from Mettupalaiyam to Coonoor, the train is hauled by a coal fired steam engine. At Coonoor the steam engine is replaced by a diesel locomotive, which hauls the train for the route between Coonoor and Udhagamandalam. The train services about 19,000 people every year consisting of both tourists and locals.

We had a chat with the driver of this train Mr. A.P. Mahalingam. Here are some excerpts from the interview.

1. Which fuel did the train run on before the 10% biodiesel mix fuel?

For this part of the journey, i.e. between Coonoor and Udhagamandalam, diesel was being used. However, about 5 years ago we shifted to 10% biodiesel mix fuel. The Chief Mechanical Engineer office in Chennai initiated this move as a step towards eco-con sciousness and towards encouraging renewable energy options.

2.Is there any difference in the performance of the train because of the change of fuel?

(Photo Courtesy N. Radhakrishnan and Chitra S. Raju)

The biodiesel powered train

I haven't noticed any change in terms of performance due to the change in fuel. A mixture of 10% biodiesel and 90% High Speed Diesel (HSD) is used to run the train. And with this mixture of biodiesel and HSD there was no need for any modifications to the engine.

3.What do you think of the use of biodiesel to power this part of the train journey?

I feel that using the 10% biodiesel mix fuel is good step towards protecting the environment when compared to using just regular diesel.

4.Has the shift to biodiesel influenced the cost of the train ticket?

No. There has been no increase in the ticket prices due to the change of fuel.

5.Has the fact that the train runs on biodiesel for a part of the journey created awareness among passengers? Have any of them asked you about biodiesel?

A lot of passengers have talked to me about the use of biodiesel. 'What is the difference between regular diesel and biodiesel?' is the most common question I am asked.

6.How much fuel is used per trip from Mettupalaiyam to Udhagamandalam?

We use about 4 tonnes of coal to run the steam engine from Mettupalaiyam to Coonoor. Around 150L of biodiesel is required for the 19 km stretch between Coonoor and Udhagamandalam.

7.Where is the biodiesel sourced from? What are the main raw materials that are used for producing the biodiesel?

The bio-diesel is procured from the Locoworks biodiesel factory located in Perambur, near Chennai. Pongamia seed oil and Jatropha seeds are the main raw materials used for the production.

Interviewers: N. Radhakrishnan and Chitra S. Raju, TIDE

e PAPERS

e-net welcomes articles for the next issue which will focus on: Education and Capacity building in decentralised renewable energy.

Articles should ideally be based on actual case studies and look at the implementation/ potential implementation of a specific technology using community participation.

The length of the article can range from 1500-2500 words (inclusive of footnotes and references). Illustration, graphs, tables, and photographs are welcome (with sources acknowledged). Please include a brief description of the author and the organization s/he represents.

Articles chosen for publication in the e-net magazine will be subject to editing. Contributors should make themselves available for any clarifications that may be necessary up to the point of publication.

Please e-mail all articles to e-net@sa-energy.net by 30th April 2009.

WASTE PLASTIC MIXED BITUMEN FOR ROADS: REDUCING ENERGY USE AND IMPROVING ROAD QUALITY

By Shamim Hasan

In Bangladesh, the annual demand of plastics is about 600,000 metric tons – a demand which is growing at the rate of 5% per annum. The Bangladesh University of Engineering & Technology (BUET) and Bangladesh Transport Foundation (BTF) have conducted studies to ascertain the applicability as well as techno-economic viability of using recycled waste plastics in road making in Bangladesh. Plastic waste can be used to produce polymers for road construction, repairs and other road work. The new modified polymer bitumen technology is innovative and has the potential to provide an eco-friendly, cost effective solution for road construction/maintenance using both bitumen and plastic which are sources of energy.

Due to the widespread use of plastic bags, bottles and containers, a substantial amount of plastic waste is available in Dhaka and other cities in Bangladesh. The per capita solid waste generation rate in Dhaka City Corporation (DCC) area is reportedly 0.524kg/capita per day and the total amount of solid waste generated in the DCC area is estimated at 3,315 tons per day. On average 4.15% of the total aforementioned waste is generated from plastics and this will increase over the years. However, the disposal of used plastic bags and other waste plastic materials has become a major problem in cities and towns, and is a matter of serious environmental concern. The use of processed plastic waste for road construction/maintenance not only provides a solution to the above generated waste in cities but also creates a cost effective method for road construction and maintenance work.

If a proper collection and recycling system can be organised at household, commercial and industrial levels with the help of municipal corporations, the large towns and cities can be cleared of the plastic waste menace. At the same time adequate raw materials can be gathered for producing polymers for road construction and repair and other road work at a lower cost compared to regular bitumen roads. If, by weight, 8% of waste plastic mixed bitumen is used for road construction, this could save 8% (by weight) bitumen for construction work. Usual road construction work uses only bitumen with gravel. Bitumen is produced from crude petroleum. In Bangladesh it is produced in Eastern Refinery (the lone refinery in Bangladesh) which cannot fulfill the country's requirement. Thus, it is also imported using valuable foreign exchange.

Paving the road with modified bituminous mix containing waste plastics

Waste plastic mixed bitumen for road construction is an innovative procedure started in Bangalore, India. It has been successfully used by Bangalore Municipal Corporation. In Bangladesh the demonstration of road construction using plastic mixed bitumen with gravel has been undertaken. Polymer modified bitumen roads can improve the road performance by enhancing asphalt bonding and the roads last longer by rendering them more impermeable to water due to heavy rainfall and flooding. In view of higher durability, better riding ability and lower maintenance cost it will be advantageous to introduce the new technology of recycling of waste plastic in road construction. This would particularly be the case for development of rural road networks at Upazilla and Union Parishad levels. Development of a good network of roads and road transportation system is very important for the growth of an economy - particularly for the economic development of rural areas, expansion of trade and commerce, and improving access to rural growth centres and remote villages. Unfortunately the poor serviceability of the roads requires their recurrent maintenance and often early rehabilitation or reconstruction.

Road maintenance basically includes minor road repairs such as repairing potholes/rough patches/broken edges, pavement repairs, as well as major repairs to laneways, road refurbishment, recoating bitumen surfaces, rebuilding/rehabilitation of roads. Availability of funds, particularly for maintenance and repair are highly inadequate, and roads in many areas, particularly in rural areas, remain pot-holed, broken, and inaccessible during the rainy season. Reduced maintenance cost and longer life of road network can only change the situation, which can partially be obtained by plastic mixed bitumen.

The BUET, Dhaka undertook a laboratory investigation in 2008 with support funding from Practical Action- Bangladesh on the use of plastic wastes in road construction. Their findings were encouraging, and they were of the view that a life-cycle analysis (with cost as the main parameter) would probably be a better way of judging the potential of using waste plastics in bituminous mix. Thus, a subsequent pilot demonstration was carried out. The demonstration area paved is about 600 sq.ft (55.75 sq.m. approximately) at BUET.

Strip of waste plastic mixed bitumen road at BUET, Dhaka

A detailed feasibility study was undertaken by BTF with support from Practical Action-Bangladesh. The basic objective of the feasibility study was to undertake multi-disciplinary investigative work encompassing Indian experience in order to determine the applicability as well as techno-economic viability of the use of recycled waste plastics in road making in Bangladesh. The feasibility study highlighted different issues such as technical aspects considering local context, potential of road maintenance, environmental impacts, climatic and socio- economic considerations. The feasibility study included the preparation of a project proposal for asphalting 5 kms of road by adopting the technology of using recycled waste plastic with bitumen.

The new modified bitumen technology is simple, eco-friendly, innovative and seems appropriate for adoption in Bangladesh. Heavy rainfall during monsoon, widespread flooding in the summer months, raw material scarcity and high cost, as well as dependence on import and foreign aid are convincing reasons for application of this new technology in Bangladesh.

Application of this technology is easy and cost-effective. Its application on Bangladesh roads can help create a better road network while also helping to preserve our environment. There is potential for the use of this technology in other countries in the region as well. For instance the socio-economic, weather and environmental conditions in Southern States of India are similar to Bangladesh and it may be possible to use the technology there as well.

Shamim Hasan is a Programme Manager under the "Access to Infrastructure Services" programme of Practical Action, Bangladesh. He has worked in the areas of water transport, and biofuel and is currently involved in the Brick Kiln Emission Management project
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eVENTS

Green Energy Summit 2009

Date: 3 - 7th March 2009

Venue: Palace Grounds, Bangalore, India

Organised by: Saltmarch Media In Association with Renewable Energy Action Forum (REAF)

World leaders such as Dr. Christopher Flavin, Governor Schwarzenneger, Dr. Abdul Kalam, Dr. R K Pachauri, Dr. Dan Arvizu, Dr. Marianne Osterkorn, Dr. Michael Eckart, Dr. Yogi Goswami, and several others will converge in Bangalore at Asia's most important summit for Green Energy, Renewables, Clean Technology, and Sustainable solutions to address a gathering of over 3000 qualified stakeholders. The summit also features a grand expo hall of 10,000 sq.m. with separate pavilions for Green Power (Solar, Wind, Biomass, etc), Green IT, Green Buildings & Architecture, and Green Fuels & Transportation. Sponsorships, Expo Booking, and Delegate registrations are now open. Further details are available at www.greenenergysummit.com or contact the summit hotline at +91 90 40051000.

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Date: 2nd - 4th April 2009

Venue: Pragati Maidan, New Delhi, India

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ENERGY AND ROAD TRANSPORT IN PAKISTAN: SITUATION, ISSUES AND OPTIONS

By Abdul Shakoor Sindhu

The following article is based on excerpts from a position paper with the same title which was posted on the The South Asia Electronic Forum on Energy (www.sa-energy.net) on 30th June 2008. It provides an informative overview of the major issues faced by Pakistan's transport sector and possible strategies which can be employed to overcome them and to be more energy efficient. It also highlights the increasing role of gas (LPG and CNG[1]) in Pakistan's transport and energy sectors and the importance of planned transport/energy development.

Transport is an important sector of Pakistan's economy as it contributes about 10% to the Gross Domestic Product and over 17% to the Gross Capital Formation. It is estimated that about 2.3 million people (6% of the total employed labour force of Pakistan) earn their livelihoods from this sector. Transport consumes 35% of the total commercial energy annually and receives 20-25% of the annual federal public sector development funds. The road sector has been the main recipient of these funds consuming about 69% of the Public Sector Development Program allocation for the Transport and Communication sector. The road related revenue collection is about Pakistan rupees (PRs) 32.5 billion per year (52% of which comes from surcharge on petroleum, oil and lubricant products). The total public expenditure on roads is over PRs. 30 billion per year, with 65% on national highways[2].

Pakistan's economy has been growing at an average rate of 6-7% in the last few years. The growth of the economy, and increase in population, markets for good and services, incomes of the middle class (in both rural and urban areas) and the expanding urban boundaries have contributed to an unprecedented increase in road transport. The transport sector in Pakistan is dominated by road transport as it carries 90% of the national passenger traffic and 96% of the freight movement. Over the past 10 years road transport has grown much faster than the country's economic growth. According to the National Transport Research Centre (NTRC), in 1991-92, the total number of vehicles on the road was 2,095,500. By 2006-07 the number had reached 8,063,600. Thus, during the last 16 years the number of vehicles increased by 285% while the increase in road length during the same period was 52%. Oil and gas are two energy sources for transport. Pakistan's total oil consumption in 2006-07 was recorded to be 12,114,000 tons. The transport sector is the biggest consumer of oil in Pakistan, accounting for half of the total consumption. However, during the last 10 years there has been a decline of more than 20% in the consumption of oil by the transport sector. This trend is consistent with the overall reduction in the share of oil in the commercial energy mix of Pakistan. The share of oil has reduced from 40% to 30% in the energy mix from 2000 to 2007. Pakistan spent US$ 5.23 billion in 2006-07 on oil import.

(Photo courtesy A. S. Sindhu)

A traditional form of transport usually used by urban and rural poor communities

The use of gas especially in the form of CNG in the road transport sector is witnessing a steady increase. Though road transport currently has a 4.4% share in total gas consumption in the country, there has been a more rapid increase in the consumption of gas by this sector during the last ten years (1996-97 to 2006-07). There are 1.7 million vehicles operating on CNG and 2063 CNG stations[3] operating in more than 80 cities across Pakistan. The growth in the CNG sector is impressive and Pakistan has become the leading user of CNG in Asia and the third largest in the world after Argentina and Brazil. Every month 29,167 vehicles are converted to CNG in the country[4]. The investment in the CNG sector is also increasing steadily. From July 2006 to March 2007, approximately PRs. 60 billion was invested in the sector compared to PRs. 20 billion invested until end March 2006 (registering a growth of 200% in investment). The sector has created 60,000 new jobs throughout the country[5].

The use of LPG is also increasing in the transport sector especially in areas where CNG is not available. However no reliable segregated data is available to assess its use in the transport sector.

Major Issues:

- The poor quality of roads and non-tuned engines contribute to a high consumption of energy. The ENERCON[6] has estimated that 20% energy conservation in the transport sector can be achieved simply by properly tuning the engines.

- Pakistan lacks a Comprehensive Transport Sector Development and Management Policy that has cross-sectoral linkages especially with energy and land use planning. The existing draft Transport Policy lacks strategies for sustainable rural and urban transport. Further the policy has not been made public to invite their input.

- The growth of the CNG sector in Pakistan is impressive as it has relieved the country from its dependence on imported energy sources (currently Pakistan is meeting more than 70% of its energy supplies using domestic sources). However, Pakistan's

[1]Liquid Petroleum Gas (LPG) – usually derived from fossil fuel sources being manufactures during the refining of crude oil or extracted from oil or gas streams as they emerge from the ground. Compressed Natural Gas (CNG) – a fossil fuel substitute for petrol, diesel or propane fuel and is a more environmentally clean alternative than the aforementioned. It is made from compressed natural gas. (Source: Wikipedia)

[2]Planning Commission of Pakistan, Mid Term Development Framework 2005-2010

[3]Hydrocarbon Development Institute of Pakistan

[4]Ministry of Finance, Economic Survey 2006-07

[5]Ministry of Finance, Economic Survey, 2006-07.

[6]ENERCON is the National Energy Conservation Center, under the Ministry of Environment, Pakistan.

increasing dependence on natural gas for various sectors (gas accounts for half of the primary energy supply in Pakistan substituting mainly oil) is alarming. Pakistan has to urgently look for options rather than importing gas from Iran and Turkmenistan to fulfill its rising energy/gas demand. Estimates by the Planning Commission, Hydrocarbon Development Institute of Pakistan and independent sources suggest that known domestic gas reserves will only last for the next 25-30 years. Further, the increasing share of transport in gas consumption has made it a competitor for the domestic/household sector. Questions like whether to provide CNG for running the 'vehicles of the rich on cheaper fuel' or 'for cooking food for poor on expensive fuel[7]' are increasingly becoming prominent. The shortage of gas especially during the winter last year can also be seen in this context as there was visibly more of a shortage of gas in areas where CNG stations are installed than where they are not.

- Hundreds of CNG stations have been installed in congested residential areas without paying any heed to planning or land use bylaws. At a number of places, the lure for earning attractive profits by investing in the CNG sector has resulted in undue competition and the concentration of CNG stations in already overcrowded urban areas. Apart from these stations causing traffic congestion, they are also posing public safety risks.

- CNG being a cleaner fuel to fossil fuels, holds great potential for reducing urban air pollution by replacing diesel-run intra-city public transport. However, the available technology for converting diesel engines to CNG is costly and suffers from a number of technical problems. The available diesel vehicle stock - especially buses - cannot be replaced with CNG on a cost effective basis under existing pricing and technological systems.

- Pakistan's public transport is overly biased towards road transport by neglecting other low cost, less-energy consuming, cleaner means of transport like intra and intercity railways.

- All the relevant government policies in general, and transport and human settlement development/management policies in particular, discriminate the zero-emission transport options like bicycles and animal-drawn vehicles which fulfil the transport and livelihood needs of millions of urban and rural poor. The neglect and discrimination is evident from the non availability of data on these means, and the lack of provision for separate lanes for slow moving vehicles and bicycles on urban roads and highways.

- There is no visible effort by the government and its policy makers to encourage the production or promotion of less energy consuming or low-powered vehicles especially for intra city travel as is being done in Europe and neighbouring countries like India to reduce congestion and to conserve energy.

- In Pakistan, there are no clear-cut and strict energy and emission standards for vehicle manufacturers and importers resulting in higher energy consumption and pollution.

- In Pakistan, land-use planning and management in general, and transport engineering and planning in particular, is lacking. The lack of land-use management and planning has contributed to an increased need for motorised transport to reach basic services. Long distances need to be covered in order to reach service providers – discouraging walking or cycling as simpler and cheaper modes of travelling[8]. These trends have in turn resulted in greater energy consumption.

Strategies to address the issues:

- The institution of 'Vehicle Examiner' needs to be strengthened by making available qualified and sufficient staff at competitive salary packages and enforcing stricter monitoring and accountability systems. The office of the Vehicle Examiner should be linked with the provincial Environment Protection Departments in provincial capitals and Executive District Officer environment or Environment Officers at the Districts and Tehsil levels.

- A separate but comprehensive and integrated policy for road transport covering both rural and urban transport should be made available. The proposed policy should incorporate inputs from sectors like education, health and women's development, energy and environment, housing, urban and rural development sectors. This will help ensure essential services are accessible to all in an energy efficient and environmentally friendly manner.

- The investment friendly CNG policy of the Government of Pakistan has no doubt resulted in an unprecedented growth of the CNG infrastructure and vehicles. However, some complimentary policies are needed immediately to address some of the following issues;

  – Some 85% households in the country are still dependant on some form of biomass fuel (wood, cow dung and crop residue) for cooking and heating using traditional stoves. Various studies point out that these households pay much higher price for the cooking fuel than their counterparts who have access to piped natural gas. The indoor air pollution caused by these traditional fuels creates many diseases. These poor households have an equal right to access the cleaner and cheaper fuels like natural gas as do the wealthy car owners.

  – Pakistan is slowly but surely increasing the intake of imported gas for meeting its energy demands, thereby maintaining its dependency on imported energy.

  – The CNG sector needs to be managed properly in terms of issuing licenses in areas where there is an over-concentration of such stations. The establishment of CNG stations in purely residential zones should be discouraged.

- The feasibility studies prepared by the provincial and city district governments, for instance, to gradually replace the diesel buses with CNG vehicles should be made available

[7]The rising demand for gas and increasing number of competitors of the commodity CNG, have resulted in a steady increase in the price of gas for the domestic consumers.

[8]The longer distances from the city centers and the non availability of shorter paths for pedestrian and cyclists, etc. are a common feature of this development.

for wider stakeholder discussion, and decisions in this regard should not be delayed any further. Pakistan's urban and suburban population is increasing rapidly and in future its urban population will be larger than its rural population. Pakistan thus urgently needs to adopt an 'across the board' mass transit system regime for inter and intra city travelling. There is public support for such an initiative, what is required is a strong political will to carry it out. The new bus companies in the private sector should be given licenses while the existing individual bus or public transport operators should be made to evolve cooperative companies so that they could be regulated and monitored.

- Pakistan Railways have great potential for revival and providing a cheaper, reliable and comfortable means of transport for inter and intra city travel. The freight section of Pakistan Railways in general and the passenger section in particular have been made helpless victims of railway and private transporters' mismanagement. Pakistan would also need to invest in intra city trains to address the issues of congestion and to discourage private vehicle use.

- Pakistan, like the rest of the world would ultimately have to return to low or no-emission systems like human or alternative energy propelled transport modes (bicycles, solar-energy or hydrogen cell fuelled vehicles, and walking etc.). However, instead of waiting for that time to come (which is of course not too distant) some practical steps can be taken immediately. Such as:

  – Discourage the use of private vehicles (motor cars, bikes, etc.) by providing reliable, comfortable, efficient and affordable mass transit solutions like clean fuel buses, trams and trains and also by raising parking fees, etc.

  – Encourage the use of bicycles by making available bicycle lanes on existing roads and above all by refuting the perception that bicycles are only for use by low income groups. Possible strategies towards this can be the high government officials/public representatives patronising cyclist associations, holding of cycling contests especially in the cities, allowing only bicycles on college or university campuses and encouraging school and college students to use bicycles to travel to schools in urban areas. The government along with civil society organisations and concerned citizens also need to break the taboo of women riding the bicycles. This will facilitate women's mobility, increasing their self-confidence and participation in wider social and economic life.

- Smaller, fuel efficient vehicles have been produced in Pakistan. For instance, a small 200cc city car was manufactured by an enthusiast back in 1967 which consisted of a hand-made-body and a second-hand scooter engine. The vehicle remained on the road for 10 consecutive years.


(Source: www.offroadpakistan.com/images/ho_red_car_1.jpg)

A 200cc car designed and manufactured by Hamid Omar back in 1967 in Pakistan

- Similar efforts have recently been made by various other individuals and corporate manufacturers. The photo on the next column shows a truck assembled in a local workshop by mechanics in the outskirts of Lahore using a locally manufactured diesel engine and second-hand vehicle parts. These trucks are now widely used for goods transportation in this area. The time is right to encourage such initiatives.


(photo courtesy A S Sindhu)

Truck assembled using locally manufactured engine and secondhand parts

- Countries around the world are introducing and ensuring stricter energy and emission standards for vehicle engines, with the European Union taking the lead. Pakistan also needs to take similar initiatives.

- Effective energy planning for the transport sector cannot bear fruit unless it is linked with land use planning and placement of social and economic services. For instance, by placing services closer to the people, their need to travel for longer distances can be reduced considerably.

The abovementioned issues need to be explored further. While these issues are not new to the region, the solutions need to be country specific and require urgent attention.

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South Asia Electronic Forum on Energy

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e- FORUM DISCUSSION ON ENERGY & TRANSPORT

23rd September to 2nd October 2008

The topic under discussion at the second e-net forum in 2008 was ***Energy and Transport*** with the focus being the fact that the transport sector is almost entirely dependent on petroleum fuels, having damaging effects on the economies of developing countries and their poor. The question for forum participants was **'What are the decentralised renewable energy (RE) resources, technologies, development models and approaches that can help eradicate poverty especially in South Asian countries to meet transportation needs, so that poor people can be independent of the effects of petroleum fuels?'** A variety of suggestions to find and promote renewable energy transport solutions for the South Asian region were aired. Not only was an increase in the use of public transport and the use of RE driven transport suggested but also the need to reduce travel overall.

Reducing the need to travel through improvements in technology and communication facilities was one of the points raised by several participants in this discussion. Spreading the availability of basic facilities – such as schools, hospitals, administration offices – will reduce people's need to travel. This would not only save energy but people's income as well. As one participant put it '…the solution is more in the "way of thinking" rather than in the technology'.

The above attitudinal changes were also linked to the type of technology used for transport. It was suggested that people's lifestyles and attitudes have drawn them away from intermediate technologies such as the bicycle. Improvements of these technologies and their use for short distance travel should be encouraged at all levels.

As always, the role that political bodies and governments play in this arena was highlighted. Comprehensive transport policies are required, covering (besides other issues) the transport needs of the rural and urban poor. These should be formed taking into consideration public inputs as well as inputs from other essential service providers (service providers of education, health, etc.).

Transport planning should not be limited to roads alone and should take into account other forms of travel, such as ropeways, waterways, etc. – which may be more energy efficient in different situations. Renewable energy sources which are easily accessible should be encouraged, and the use of the energy generated from such applications should be maximized. The sector needs to be open to finding energy efficient transport alternatives and letting go of the less inefficient ones. As one forum participant put it '… we are not ready or willing to rock the inefficient entrenched system. Creative destruction should be the order of day.'

Independence from petroleum fuel will not happen overnight. While purely technical interventions such as introducing biofuels, electric vehicles and efficient engines are recommended, there is also a need for a shift from private to public transport for commuter and goods traffic. The need to improve public transport and promote its use was expressed. Exploring possibilities of public transport being powered by solar electric, thermal electric power plants fed with bio-fuels and electric train combination were suggested as alternatives - for both the rich and the poor. It was noted that the present hybrid vehicles in the market should be improved, their price reduced and multi-purpose vehicles designed and mass produced. Governments need to tap companies and promote hybrid vehicles and make them affordable to the masses.

A participant working in an NGO helping communities in the rural and tribal belt of Rajasthan, India highlighted the dire, unaddressed transport needs of the poor in the South Asian region. With Rajasthan's geographical area consisting of the desert and Aravallis Hills, the rural communities in the area are still using bullock carts and "Jugars" (small tractor made by the pumping engine by the people on their own) for transport. Apart from these energy intensive modes of transport (requiring large amounts of human/animal effort to function) the only other transport system available is the public transport system. Such communities need to be served and given access to energy efficient modes of transport.

We thank all those who participated in the e-discussion. It is through such an exchange of views that ideas are born.

Look out for the summary of the e-forum discussion on 'Climate Change and Energy' which was underway at the time of going to print, as well as a summary of the subsequent discussion on 'Education and Capacity Building in Decentralised Renewable Energy' which will be printed in the next issue.

Let's keep the dialogue alive!

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