SAFE PARAFFIN APPLIANCES AND THEIR CONTRIBUTION TO DEMAND SIDE MANAGEMENT

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ABSTRACT

Many accidents have resulted from using of paraffin as a fuel for cooking and heating. These accidents were caused because of leaks and the paraffin appliances could consequently burst into violent flames. As a result, compulsory standards for the construction and operation of these appliances have been introduced, and the sale of the unsafe appliances has been banned. Safe paraffin appliances could contribute to the management of the electrical demand. Domestic cooking makes up about 4% of the total demand during the daily peak in electricity consumption. The widespread introduction of safe paraffin cookers to replace electrical cookers would save about 1 500MW. It would cost about R25bn to install generating capacity of that magnitude. Replacing electrical stoves would cost about R8bn.

1. INTRODUCTION

Paraffin has developed an unfortunate reputation as a dangerous household fuel. Analysis of this has shown that the fault lies primarily in the design of the appliances and secondly, in the way the fuel is used rather than the fuel itself [1]. With this in mind, new standards for the design of such appliances have been developed [2], [3]. The sale of the previous, unsafe appliances is now prohibited, and appliances meeting the revised standards are beginning to become available in quantity. These new, safe appliances create opportunities to address aspects of domestic energisation that could not previously be contemplated.

2. SAFETY ASPECTS OF HOUSEHOLD FUELS

While it is evident that the use of paraffin as a fuel is a significant contributor to household incidents and injuries in lower income homes, it is clear that the basic problems are common to all energy carriers, namely**:**

- Overcrowded, cramped living conditions
- Poor maintenance of cooking and heating appliances
- Fatigue associated with a combination of adult stresses and economic survival
- Substance abuse, particularly alcohol
- Domestic violence
- Leaving appliances unattended while in operation
- Leaving children, especially infants, unattended

The Paraffin Safety Association is monitoring the cause of hospital admissions at a few hospitals [4]. Results to date are summarised in Figure 1:

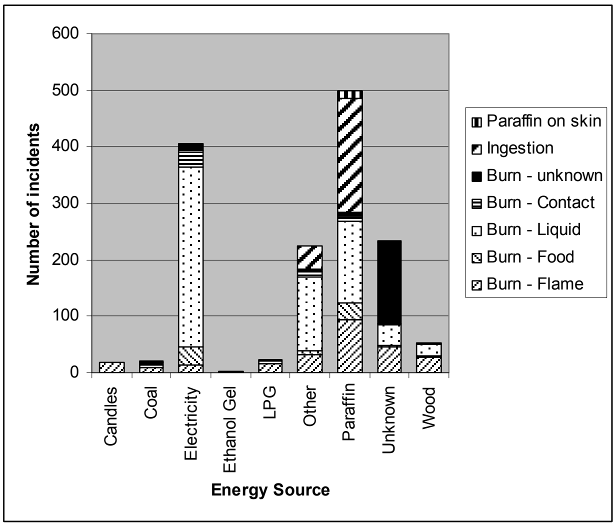

Figure 1: Hospital admissions from low-income households [5]

Liquid burns are a significant cause of admissions, regardless of the energy source. The number of injuries from the ingestion of paraffin is striking, and strongly suggests that greater accent on the safe packaging of the fuel is desirable. Burns from flames are particularly prevalent in the case of paraffin, which, when contrasted with the low incidence for LPG, suggests that safer appliances are desirable.

The shack fire data are also worthy of note. The Cape Town fire department recorded 1327 incidents of fire in informal settlements in 2005 (including false alarms), which resulted in destruction of 8693 dwellings and loss of 112 lives [6]. Many of these probably had paraffin-fuelled appliances as their cause, because it is known that such appliances can release as much as 1MW when they fail. That much energy will result in an immediate, fierce conflagration such as is often observed when fires break out in settlements.

Thus, while it is clear there are many causes of energy-related incidents in low-income homes that are independent of the source of the energy, it is also clear that paraffin and, in particular, paraffin-fuelled appliances are responsible for a significant fraction of such incidents, and there is merit in enquiring whether it is responsible to suggest wider use of these appliances as part of the resolution of the present energy crisis.

3. SAFETY ASPECTS OF PARAFFIN- FUELLED APPLIANCES

Until recently, the market has been supplied with unsafe appliances. In 2002, the Paraffin Safety Association commissioned Test House, the South African Bureau of Standards (SABS) testing facility, to test the nine most widely available paraffin stoves [7]. In summary:

- All nine stoves tested failed the then-current SABS standards;
- All the stoves failed an average of six or more of the SABS requirements;
- The most commonly used paraffin stoves, non-pressure or wick stoves, failed all the key safety tests including fuel container, fuel temperature, combustion, marking and instructions; and
- The Paraffin Safety Association added an additional test to the SABS tests "After operating the stove for 1 hour, knock it over while it is in operation and note the consequences". All the stoves immediately burst violently into flames when knocked over.

As a result of this, the standards were extensively revised. The standard for wick stoves, SANS 1906:2006 [2] and that for pressure stoves, SANS 1243:2007 [3], both cover:

- Preventing any leakage of fuel
- Self extinguishing if knocked over
- Ensuring the fuel remains below the flash point
- Preventing harmful emissions to the atmosphere
- Ensuring stability and durability of the appliance
- Ensuring sustained power over time
- Preventing the appliance from being filled when in use
- Preventing the controls from getting too hot to touch
- Including safety instructions with pictograms

The Department of Trade and Industry made the standard SANS 1906:2006 compulsory as of 1 January 2007. However, appliances meeting the standard are only now beginning to reach the market, so enforcement of the standard is not yet effective. It is expected that the standard for pressure stoves, SANS 1243:2007, will similarly be made compulsory in the very near future.

We believe the new standards are a considerable improvement on their predecessors, and will go a long way towards ensuring that paraffin can be used safely in the home. As new appliances are delivered for test, new safety issues arise. It is however clear that the new generation of stoves and heaters are a vast improvement on anything that was previously available on the local market.

4. SAFETY ASPECTS OF PARAFFIN DISTRIBUTION

The absence of appropriate packaging and labelling is largely to blame for ingestions, chemical burns on the skin and contamination of fuel. Contamination can lead to increased indoor air pollution or, worse, exploding appliances and uncontrolled fires. As little as 1% petrol in paraffin drops the flash point of the mixture to below room temperature. This results in violent conflagrations when the appliance is used.

The paraffin supply chain is presently under-regulated. It is based on bulk supply to consumers who are forced to take responsibility for the packaging needed to transport paraffin between the point of sale and their paraffin appliance. As a result, paraffin is decanted many times, with each occasion presenting a new opportunity for contamination. The final container can be a cool drink or milk bottle, which increases the risk that infants will drink paraffin. Because liquid paraffin attacks the lining of the lungs, as little as 0.5*ml* can cause potentially fatal pneumonia.

The evidence is overwhelming that certain basic steps will make a significant difference to the safe use of paraffin. These include;

- The introduction of appropriate packaging and labelling early in the paraffin supply chain
- Regulation of the supply chain
- Increased enforcement of regulations
- Skills transfer to users via safety education

There are voluntary standards which will soon be made compulsory for paraffin, which address the issues of packaging and supply-chain regulation. These include;

- SABS 0265:1999, The classification and labelling of dangerous substances and preparations for sale and handling.
- SANS 10229-2:2007, Transport of dangerous goods — Packaging and large packaging for road and rail transport
- SANS 10234, Globally Harmonised System for classification and labelling of hazardous substances

Once these are enforced, we expect to see a significant drop in the record of incidents arising from contamination, spillage and ingestion. Some major tests of packaging systems are being undertaken to ensure that, once the standards are made compulsory, there can be a rapid change from the existing distribution system.

The Paraffin Safety Association is active in education [8]. It has recently developed a number of resources directed at preventing paraffin-related domestic incidents. Specialists in adult basic education participated in the development of the resources. Age, language, literacy levels, gender issues, rural and urban needs, and socio economic status were taken into account. Many of the resources have been translated into different languages. The materials have been designed to meet the requirements of training and equipping the trainer as well as being suitable for audiences with an adult basic level of education. The materials have been used with a wide range of audiences including primary and high school learners, educators, nurses and community health workers. Extensive consultation processes, as well as pre-testing materials, occurred before the resources were finalised.

The safety and skill development messages are delivered through facilitators using a “train-the-trainer” model. A number of master trainers have been equipped with skills to conduct training of other trainers. The trainers in turn conduct training workshops for end users and community messengers.

It is still too early to determine the impact of this initiative, but preliminary indications are very positive, and there will be quantitative evaluation of the programme once it has been used more extensively.

5. THE IMPACT OF SAFER PARAFFIN

With improvements in paraffin appliances and the distribution of the fuel, paraffin would be better placed to play a role in relieving the demand for electrical energy. Statistics SA notes that there are presently approximately 13 million households in South Africa, of which approximately 60%, or 7.8 million homes, employ electricity for cooking [9].

Domestic energy makes up 35% of the peak demand, as shown in Figure 2. Cooking makes up about 11% of the domestic energy peak, as shown in Figure 3, or about 4% of the total peak demand, approximately 1500MW. In the current context, a possible reduction of 1500MW in the peak demand is not to be ignored.

Replacing 7.8 million electrical appliances with modern, dual-cooker safe paraffin-fuelled appliances would cost about R1000/household, or about R8

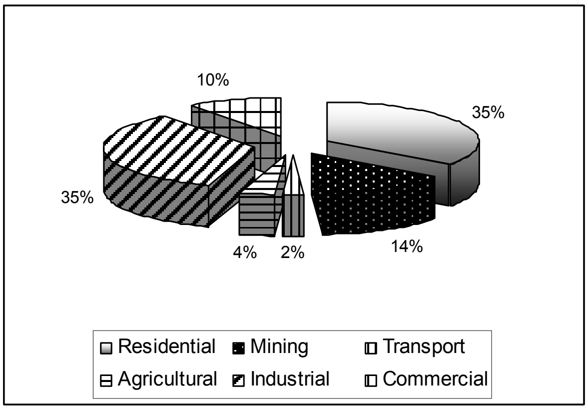

Figure 2: Makeup of peak demand [10]

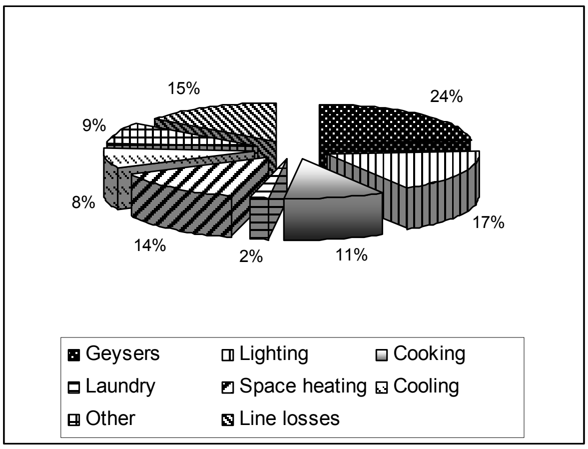

Figure 3: Makeup of residential peak demand [11]

billion in total. The 1500MW of generating capacity would cost about R30 billion to build, so a replacement programme would certainly be economic.

It has to be asked whether such a step is practical. During 2006, about 100 000 electrical stoves in low-income homes were replaced with appliances fuelled by LP gas [11]. About 40MW was saved. However, the demand for LP gas was such that the liquid-fuels industry was unable to produce sufficient gas to sustain the change. Many users were forced to abandon cooking on LP gas.

In estimating whether changing from electricity to paraffin for cooking might be sustainable, we have to take account of the difference in efficiency. Electrical cooking is about 80% efficient, whereas a modern paraffin cooker is only about 45% efficient. The daily peak of some 1500MW is equivalent to about 11TJ of electrical energy, which would be equivalent to about 19TJ/d of paraffin. For a lower heating value of 44MJ/kg, this is about 430t/d or 160 000t/a. At present we consume about 700 000t/a of paraffin and 2 400 000t/a of jet fuel [12]. Thus the demand for domestic cooking would represent quite a modest increase in the demand for light distillate.

This is entirely practical. Recall that the paraffin would replace peak electrical energy, and much of the peak is supplied by open-cycle gas turbines fired with distillate. Open-cycle gas turbines have only about 27% thermal efficiency, and there would be losses in transmission and distribution of the electricity generated. So it is a question of either burning distillate directly at about 45% efficiency, or burning distillate to generate electricity and then using the electricity for heat, at an overall efficiency of about 20%. Clearly it would be preferable for refineries to slightly boost production of the lighter paraffinic fraction and reduce significantly the quantity of heavier distillate needed to fuel the gas turbines needed for peak power generation.

Solar water heaters are widely proposed for reducing the electrical demand. Eskom notes [13] that solar heaters should save about 4.5kWh/d per household. The domestic energy consumption is about 18% of the total energy consumption, which is a little under 200 000GWh per annum. Geysers make up 24% of the household demand, of which 6% is already controlled, so 18% can contribute towards savings. Thus water heaters consume about 6500GWh annually.

Solar water heaters are relatively expensive, and cost between R6000 and R20 000 per household. For this reason they are proposed primarily for the upper-income homes, which amount to about 1 million in total. Thus the saving would be about 1650GWh annually, or about 16TJ/d. Comparing this to the benefits of replacing electricity for cooking, solar water heaters would cost about R13bn and save 16TJ/d, whereas paraffin cooking would cost about R8 billion and save 11TJ/d. Clearly the opportunities presented by changing South Africa's cooking habits should not be overlooked.

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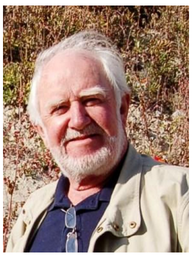

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Presenter: Philip Lloyd will present the paper