

KICKING AWAY THE ENERGY LADDER

How environmentalism destroys hope for the poorest

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About the author

Mikko Paunio, MD, MHS was born in Turku, Finland in 1961. He graduated and then completed and defended his doctoral thesis at the University of Helsinki in 1990. He has post-graduate training from the Free University of Brussels in 1991 and has graduated from the Johns Hopkins Bloomberg School of Public Health (Master of Health Science in 1993). He is a certified (University of Helsinki) specialist in public health (1999) and is an adjunct professor in general epidemiology at the University of Helsinki.

He comes from a family with academic traditions and is a third generation social democrat. He joined Finland's Social Democratic Party in 1977. He has worked in the following institutions: the Institute of Health and Welfare of Finland, University of Helsinki, Johns Hopkins Bloomberg School of Public Health, the European Commission, the World Bank and Finland's Ministry of Social Affairs and Health. He is a member of the American Council on Science and Health Board of Scientific and Policy Advisors. He has 40 publications listed in the US National Library of Medicine at the National Institutes of Health.

As a junior medical researcher in 1987–8, he was responsible for analysing health impacts of primary energy sources in the Energy Committee set up by the Finnish Prime Minister. Throughout his career, he has continued to work on energy issues.

Executive summary

Domestic combustion of solid (bio)fuels is by far the number one global pollution problem. 4.3 million deaths annually are directly attributable to indoor air pollution (IAP) according to the World Health Organization. Domestic combustion of solid biofuels kills almost six million people per year when its effects on ambient air quality are also taken into consideration.

The so called 'energy ladder' was introduced as a way of understanding how deaths from IAP might be prevented. The energy ladder seeks to reproduce the experience of rich countries, where households moved away from biofuels and were increasingly connected to electric grids or district heating systems, solving the IAP problem for good.

However, ever-growing resistance from the environmental movement has removed this beneficial approach from the development agenda. Environmentalists fear that by taking steps upwards on the energy ladder, from dirty solid fuels such as cow dung or crop residues, and towards use of electricity, poor countries would become wealthier and so increase their energy use and their carbon intensity. They have managed to persuade all important multilateral development bodies and the WHO to drop the energy ladder entirely. Instead, they are now coercing the poorest countries to adopt utopian energy policies based on renewables. The result is that combatting IAP in, say, sub-Saharan Africa, is becoming impossible.

Aggressive decarbonization is now high on the political agenda. Contrary to the widely disseminated claims of important global actors, this will not solve the problem of IAP. Moreover, it will hamper the expansion of electric grids, which is a critical prerequisite for delivering adequate water supplies, without which it will be impossible to reproduce the public health miracle experienced in the rich countries.

These 'ambitious' global climate mitigation policies leave environmental health problems amongst the poor unaddressed and will result in the loss of over 200 million lives by 2050. They are also unlikely – even in theory – to prevent the 250,000 annual deaths that the WHO speculates will be attributable to climate change between 2030 and 2050: high-quality IPCC-linked research has recently shown that solid biomass combustion actually *increases* CO₂ emissions, at least over the next 100 years, compared to fossil fuels.

1 Introduction: IAP and the developing world

Biomass and coal are dirty and dangerous, and burning them for domestic use causes pollution, both indoors and outdoors. Around three billion people are exposed to smoke from solid (bio-)fuels, often from open fires in their houses.^{1,2} I put the prefix 'bio-' in parenthesis, because in some places, notably China, low-quality coal is an equivalent source of pollution.^{2,3} Globally, biomass accounts for around 10% of total energy,⁴ and dirty solid biomass for domestic purposes accounts for almost 80% of this.⁵

Indoor air pollution (IAP) remains, by far, and by any standards, the world's worst pollution problem. IAP from domestic burning of solid biomass is a particular problem in South Asia and in sub-Saharan Africa (SSA). In SSA – excluding South Africa⁶ – around 90% of *total* energy consumption comes from solid biofuels such as crop residues, cow dung or wood, but most notably charcoal.^{7,8}

Although there is still great uncertainty about how accurate the figures are, the WHO estimates that 4.3 million people die annually because of IAP, especially in developing countries.¹ Estimates of how many people are affected have grown significantly; just ten years ago the death toll was put at 1.6 million per annum.⁹ The reason for this increase is that previously only two disease categories – childhood acute lower respiratory infections (ALRIs) and chronic obstructive pulmonary disease among women – were included in the estimates, but today lung cancer (272,000), ischemic heart disease (1,096,000) and stroke (1,462,000) are all part of the total.^{1,10} However, one should also not forget that the number of IAP-attributable deaths would probably be significantly lower were it not for the problem of undernourishment, caused by diarrhea as a result of poor hygiene, which is in turn a function of lack of adequate water supplies.^{9,11,12}

Recent estimates from observational studies suggest that coal-attributable IAP doubles the risk of lung cancer for a housewife in rural China.² Domestic combustion of low-quality coal was many years ago linked to lung cancer. The paper in *Science* in which the link was first made³ was an important milestone in raising awareness of the IAP problem in the developing world. Interest was especially aroused because there was a widespread belief amongst epidemiologists at the time that only active smoking could really cause lung cancer. However, heavy IAP from dirty coal made the story believable and it was thus widely discussed amongst public health scientists.

Domestic combustion of solid (bio)fuels not only affects indoor air quality; it also has a major impact on ambient air quality, particularly in urban settings, but in the developing world also in rural areas. The WHO estimates today that 2.2 million deaths annually are caused by ambient air pollution.¹³ Up to 90% of the ambient air pollution exposure in South Asian megacities is attributable to burning solid biomass in homes.¹⁴

Thus perhaps around six million deaths globally are attributable to domestic combustion of solid (bio)fuels. However, despite these appalling statistics, the development community has focused its efforts on mitigating global warming instead. Some of these policies are described in this paper. Elsewhere, I have explained how the *Lancet*, in a recent, politically motivated report,¹⁵ tried to claim – incorrectly¹² – that all these deaths from IAP were the result of pollution from transport and power stations. Others have even *encouraged* the burning of crop residues in homes.¹⁶ The effect of this headlong rush to 'save the climate' has horrifying implications for human health.

2 IAP and the developed world

Over the past ten years or so, environmentalists have been promoting solid biofuels as a way for the developed world to combat global warming: they consider burning biomass to be carbon neutral.^{7,17} Large old coal-fired power plants, like the UK's Drax, have therefore been reequipped so that they can use wood pellets as a primary energy source. New wood-burning plants have also been built. However, this move has had a devastating environmental impact because of the indirect land use impact:¹⁸ trees store only a tiny fraction of their photosynthesised energy as cellulose – wood – which means that a large condensing power plant requires a huge quantity of trees and vast land areas.¹⁸ Even after clearing enough of the forests in Europe and North America to meet the normal demand of power or heat production,¹⁹ European utilities can find themselves unable to supply customers. Unlike coal, wood pellets are difficult to store and during the cold snap in early March 2018 – the so-called 'Beast from the East' – the supply chain of wood pellets to European power stations was abruptly halted.²⁰ This is why any decision to switch from coal to wood pellets significantly reduces thermal security. It can be a decision with fatal consequences for those who live in almost Arctic conditions in, for example, Finland.²¹

Recently, environmentalists seem to have suddenly realised their terrible mistake of driving climate mitigation through the use of solid biomass fuels, and they are hastily reversing their positions in this area.²² They have been dismayed that wood pellets can now officially be produced from whole trees in the EU; they originally believed that these would only be made from forestry residues. At the same time, recent research has shown that solid biomass is not only *not* carbon neutral but that burning wood has a larger carbon footprint than fossil fuels.²³ Another recent study, encompassing the whole of Europe, has revealed that the decision to promote domestic combustion of wood on a large scale has been a major setback to ambient air quality in Europe: exposure to smoke from domestic use of wood is said to have caused 40,000 deaths in 2014.²⁴ Clean coal is actually much better on this score: as I pointed out in my previous report for the Global Warming Policy Foundation,¹² it can deliver excellent ambient air quality.²⁵

3 The solution: the energy ladder

The so-called energy ladder (Figure 1) was introduced to the World Health Organization as early as 1990.²⁶ This very useful concept was the brainchild of renowned American IAP researcher Kirk Smith.²⁷ The concept itself is easily understandable, being based on an understanding of how domestic energy use changes as countries become wealthier.

For example, in Finland, more than a century ago, it was not uncommon to find *savupirtti* – smoke huts without chimneys – in rural areas (Figure 2). This way of providing thermal security in Arctic conditions in Finland was quite similar to that of the Chinese *kang*, a traditional form of heating that is still very common in northern rural areas of China today. A large stove is situated in the centre of a one-room house, creating 'tropical' conditions all year round.²⁸

As Finland became wealthier, houses with chimneys became more common. At first, stoves more or less blew heat up the chimney and into the surroundings. However, eventually ways were found to improve their efficiency. It was found that by making the hot smoke leave via a zigzag or circular route, it would release its energy content to the wall and not to the ambient air. A hundred years ago, in blocks of flats in Helsinki, this type of stove was

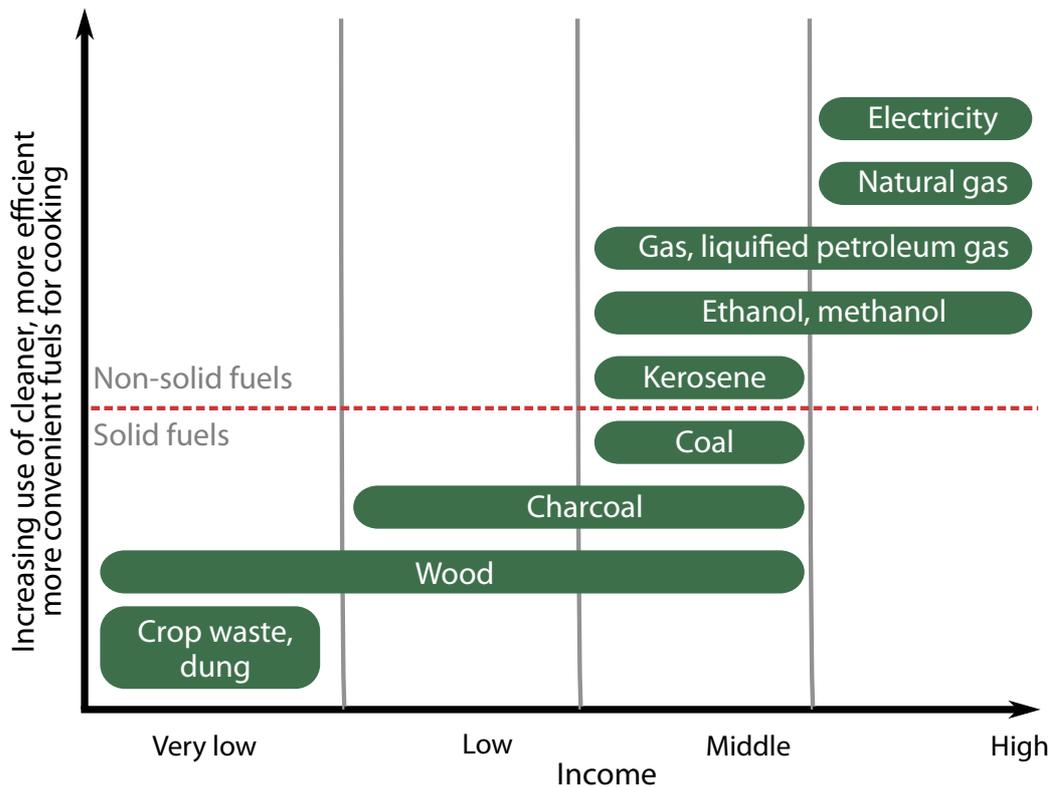


Figure 1: The energy ladder.

Household energy and development are inextricably linked.

known as a *kakluuni*. Similar ovens are now used in China.

In this way, we can see the steps on the energy ladder: first stoves without heat storage, then stoves with heat storage, and so onwards until ultimately modern houses appear, with their oil-fired boilers and electric heating. The process is ongoing, with district heating now another step on the ladder. The electricity grid in Finland now covers almost the entire country, and is supported by a mix of primary energy from nuclear, coal, hydro and biomass and to a small extent wind power.²⁹ In urban areas, a clean-coal strategy, combining heat and electricity production, now provides thermal security (Figure 3). District heating is widespread in urban areas. Heat can also be brought to dwellings from outside via heat pumps.

This is an effective strategy to combat both IAP and ambient air pollution simultaneously. High-level Chinese delegations have made numerous visits to Helsinki to learn about Finland's successful heat and power co-production approach. The IAP problems of the past, although fairly recently solved, have largely been forgotten.

4 How the energy ladder vanished from the development agenda

The concept of the energy ladder was initially well received by the global development community and, for example, at the turn of the millennium, the United Nations Development Program placed the idea at the center of its planning of energy issues in the developing world.³⁰ However, from early on environmentalists have felt uneasy with the concept; they



Figure 2: A Finnish smoke hut.



Figure 3: Hanasaari power station.

This coal-fired combined heat and power plant provides both heat and electricity to homes in Helsinki, which guarantees indoor air free of any significant particulate matter concentrations. Several Chinese delegations have visited these plants to learn about clean-coal technology and its ability to secure very low levels of ambient air pollution.

feared that as people in the developing world took steps up the energy ladder, they would increase their carbon intensity.^{7,17} A sinister underlying tone can be found in the highly influential political literature of environmental groups that vilify the use of fossil fuels:³¹ the fear is that as the poor became better off, they will start to use as much energy as rich countries do now.

As a result, the idea of the energy ladder has largely been 'disappeared' (although one recent courageous review still noted that access to modern energy sources is vital if people are to be lifted out of absolute poverty³²). The energy ladder cannot be found on the WHO's indoor air pollution site¹ – or else it is buried so effectively in this website, that I cannot find it – nor is it mentioned in the *Lancet* pollution report,¹⁵ which was written to give gold-standard advice to global leaders on how to combat pollution. Nor does the World Bank mention it, although it has now promised to fix the pollution problem with its partners.³³

It is worth taking a hard look at the thinking that led to the anti-ladder arguments and current policies, which greatly hamper efforts to abolish IAP and to save millions of lives, especially in the developing world. A report commissioned by the Dutch government entitled *Greening the African Energy Ladder – The Role of National Policies and International Aid*⁷ is a revealing example of the damage done by green bias. It demonstrates how bilateral development aid is used to force the poorest countries into policy choices that are catastrophic from a public-health perspective. The reader should recall here that close to 90% of *total* energy consumption in SSA comes from domestic combustion of biomass, and how it is impossible to cook food and provide thermal security using wind and solar power in either rural or urban areas in that region.

Direct quotes from the Dutch report include:

The Dutch government strongly supports the introduction and expansion of the use of renewable energy from solar, wind, geothermal and biomass sources as a tool for sustainable development and to step up international efforts against climate change.

As part of the policy, four main activities were identified: 1) promotion of direct investments; 2) promotion of sustainable use of biomass; 3) policy strengthening of development partners; and 4) capacity building at various levels.

Renewable energy technologies provide multiple benefits that can contribute to addressing vital local and global development challenges (World Bank, 2008). These include:

- Climate change mitigation and adaptation: Because they emit no or very low levels of greenhouse gases, renewable energy technologies can help mitigate global climate change impacts.
- Environmental and health impacts: Modern renewable energy technologies also reduce the negative health and environmental impacts of air pollution from both conventional power plants and traditional biomass cook stoves.

Although the energy ladder is not at all undisputed the concept is used here as a heuristic device to frame relevant research questions.

The key question to be answered... is how international, national and local organizations can promote the use of renewable energy in developing nations while improving access to energy and stimulating development.

Each step on the energy ladder can be viewed as a window of opportunity to divert from the traditional pattern of increasing carbon intensity and set into motion a substitution process towards less carbon intensive energy sources and technologies.

Another actor involved in this area – perhaps the most important of all – is the Climate and Clean Air Coalition (CCAC). This is a multilateral aid NGO, funded by governments worldwide and with its headquarters in UNEP's Paris office. CCAC's mission is to provide 100 million advanced cook stoves to the rural poor in the developing world by 2020.¹⁷ Although this can be justified because of the difficulty in expanding electricity grids in remote areas, collateral damage to efforts at IAP mitigation are unavoidable. CCAC's primary mission is related to black carbon issue; many environmental advocates believe that black carbon falling on glaciers will make them melt faster because it absorbs heat. CCAC therefore promotes the idea that domestic combustion of dirty solid (bio)fuels is *the* source of black carbon.³⁴ Thus cookstove programs are primarily directed at saving glaciers, with saving people through reductions in IAP seen as a potential co-benefit.

However, it has been agonizingly difficult – for many reasons and despite several large-scale programs over the years – to bring about pollution-free indoor environments using improved cookstoves.^{35,36} No large-scale cookstove program to date has achieved reductions in IAP or provided any health benefits.^{35,36} A 2012 report by CCAC-associated authors is revealing about its conflicting priorities in reducing IAP and fighting climate change:¹⁷

The existing theories on fuel preferences, technology adoption, and gender dynamics in determining cookstove adoption rates are addressed, including a critical examination of the 'energy ladder' model.

While the linearity of the energy ladder has been robustly critiqued, energy-stacking models remain poorly defined and unable to predict household behavior in terms of fuel efficient cookstove adoption.

...but underlying the discussion of feasibility is an ethical and development debate as to whether promoting petroleum products adheres to global development goals...

The authors even seem to admit this:

Furthermore, renewable biomass and the utilization of bioenergy – while avoiding the taboo of fossil fuel promotion – are not necessarily less harmful to the natural environment.¹³

Their comments are particularly pertinent now that we know that solid biomass is not carbon neutral at all, and is probably even less 'climate friendly' than fossil fuels.

Over the years, especially after the turn of the millennium, major NGOs – funded often by governments and multinational bodies – began their renewables lobbying. The result was that it became unacceptable to speak about climbing the energy ladder, because this meant reliance on fossil fuels. And as development departments of governments also greened their approaches, the energy ladder – the only way that millions of people can escape destitution – became a taboo.

5 Decarbonization and the paucity of health co-benefits

Most official bodies are now focused on climate change mitigation, rather than IAP. When the *Lancet* climate change countdown paper³⁷ was published last autumn, the General Secretary of the United Nations Framework Convention on Climate Change (UNFCCC), Christiana Figueres, declared:

Tackling climate change directly unequivocally and immediately improves global health. It's simple like that.

Within CCAC, there appears to be great enthusiasm for the idea that reducing so-called 'short-lived climate pollutants' sufficiently will slow projected global warming by 0.5°C over the next 25 years and that it should therefore be adopted as a near-term goal. There also appears to be a belief that this action will help in achieving the UN's Sustainable Development Goals (SDGs), most notably those related to public health.³⁸ Unfortunately, in the scientific advice provided by the WHO to CCAC, the energy ladder is nowhere to be seen.³⁹

Likewise there are now great expectations within UNFCCC that a global increase in the level of energy produced from biomass will bring about global equity. Among those in the IPCC/UNFCCC realm, a paper by Rao et al. (2016) is thought to provide strong 'evidence' that the public health co-benefits from climate mitigation increase the more stringent policy scenarios are assumed.⁴⁰ However, Rao et al. are quite clear that climate policy is going to make the fight against IAP even harder:

Traditional biomass consumption in the residential sector is only mildly impacted by a climate policy in all of the models, with most of the shifts already occurring in the baselines due to other policies and assumptions on energy access. For example, in the ['ambitious mitigation'] scenario, with relatively rapid rates of modernization in developing countries and a switch to cleaner or less polluting sources for cooking, climate policy does not bring additional reductions. Although not explored in detail here, we note that it is possible that climate policy may negatively impact emissions from this sector as a result of high carbon prices which may in some cases result in an increase in biomass use for cooking in developing countries in the short-term.

When we bear in mind that residential heating and cooking with solid (bio)fuels remains the root cause of almost all pollution exposure – both indoor and ambient^{1,14} – the health co-benefits of ever more stringent climate mitigation are revealed as wishful thinking; there is no way to reduce pollution from cooking except to switch to liquefied petroleum gas or electricity.³⁶

The WHO now predicts that between 2030 and 2050, some 250,000 additional annual deaths will be attributable to climate change.⁴¹ Obviously these figures are highly speculative. But 'ambitious' climate mitigation policies, based particularly on burning solid biomass, will certainly prevent the most vulnerable people in the world having the benefits of development to 'pollution'-free environments. At current rates,^{1,2,13,15} over 200 million deaths will be attributable to unhealthy environments and underdevelopment-related 'pollution' by 2050, if the development community continues to leave them unaddressed.

But even worse, as these 'ambitious' policies have, in reality, actually *prevented* poor people in the developing world from achieving the *public health* benefits of climbing the energy ladder, they have also prevented them from building up a basic health protection infrastructure, something that is a prerequisite to repeating the public health revolution that has so benefited people in rich countries.^{9,12,11}

6 Final comments

So far I have not discussed what is feasible and economically justifiable. The US policy analysts Strata⁴² have recently looked at how climate goals might be achieved in sub-Saharan Africa (SSA), by using fossil fuels or by renewables:⁴³

The estimates from this study in SSA show that if every country were to build enough to meet its domestic needs by 2040, generation would increase about four fold over 2010 levels, natural gas and coal would account for a majority of power, and the costs would

exceed \$835 billion dollars in investment. Of course, this focus on meeting demand and facilitating growth would lead to an increase in CO₂ emissions. If SSA countries instead pursued an aggressive renewable energy implementation plan, they could expect up to 27 percent less CO₂ emissions, but would see costs rise \$153 billion dollars (Castellano et al., 2015).

As a recent paper by mainstream energy analysts shows,⁴⁴ decarbonization of the US economy with wind, solar and hydro energy would be extraordinarily expensive. This implies that a similar policy in SSA would essentially be impossible, especially when once more recalling that around 90% of *total* energy consumption in SSA (excluding South Africa) comes from domestic combustion of solid biomass.

UN demographic projections reveal that Africa's population will be almost four billion by 2080,⁴⁵ which means that there will be a staggering increase in energy needs. The only feasible way to prevent IAP and disease on a mass scale, there and in other populous poor areas, is to accept the fact that cost-efficient clean-coal technology and grid expansion are key to promoting decent living conditions. One should not forget that the only way to address the current migration crisis in Europe is to accept that the poor should be allowed to develop and benefit from the fruits of industrialization, just as we did.

The views presented in this paper are mine alone, and do not necessarily represent those of my employer.

Notes

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About the Global Warming Policy Foundation

The Global Warming Policy Foundation is an all-party and non-party think tank and a registered educational charity which, while openminded on the contested science of global warming, is deeply concerned about the costs and other implications of many of the policies currently being advocated.

Our main focus is to analyse global warming policies and their economic and other implications. Our aim is to provide the most robust and reliable economic analysis and advice. Above all we seek to inform the media, politicians and the public, in a newsworthy way, on the subject in general and on the misinformation to which they are all too frequently being subjected at the present time.

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