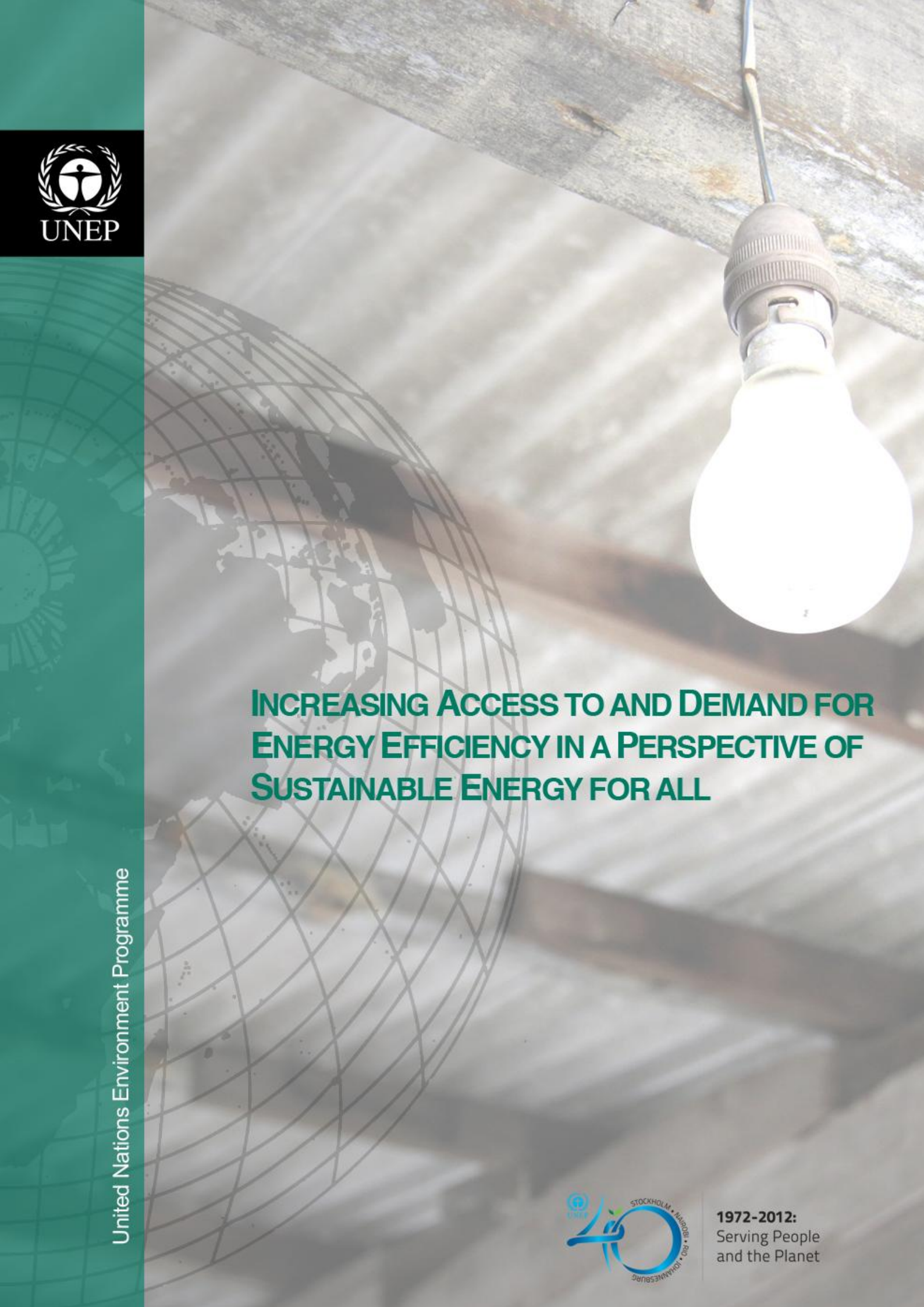

UNEP

INCREASING ACCESS TO AND DEMAND FOR ENERGY EFFICIENCY IN A PERSPECTIVE OF SUSTAINABLE ENERGY FOR ALL

United Nations Environment Programme

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Increasing access to and demand for energy efficiency in a perspective of Sustainable Energy for All

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Supervision and coordination: Charles Arden-Clarke, Head of the Goods and Services Unit, SCP Branch, Fabienne Pierre, Programme Officer, SCP Branch, and Djaheezah Subratty, Programme Officer, Energy Branch, United Nations Environment Programme (UNEP)

Author: Professor Nigel Lucas, Fellow of the Royal Academy of Engineering, UK

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The full report can be found at:
http://www.unep.org/internationalyearofsustainableenergyforall/resources.asp
http://www.unep.org/climatechange/mitigation/EnergyEfficiency/RelatedDocuments/tabid/29344/Default.aspx

Contents

Acronyms

10YFP	Ten Year Framework of Programmes on Sustainable Consumption and Production
ANME	Tunisian National Agency for Energy Conservation
AREED	African Rural Energy Enterprise Development
CDM	Clean Development Mechanism
CECED	European Committee of Domestic Equipment Manufacturers
CER	Certified Emissions Reduction
CFL	Compact Fluorescent Lamp
CSD	Commission on Sustainable Development
DC	Developing Country
DSM	Demand Side Management
DTIE	Industry and Economics
ESCO	Energy Service Company
ETDE	Energy Technology Data Exchange
GFEI	Global Fuel Economy Initiative
GHG	Greenhouse Gas
IEA	International Energy Agency
IFI	International Financial Institution
IRP	International Resource Panel
LCA	Life Cycle Analysis
LED	Light Emitting Diode
M&T	Monitoring and Targeting
MCDA	Multi-criteria Decision Analysis
MIF	Mediterranean Investment Facility
MRV	Monitoring, Reporting and Verification
NAMA	Nationally Appropriate Mitigation Actions
NCPC	National Cleaner Production Centres
NCPP	National Cleaner Production Programmes
NLTC	National Lighting Test Centre
OECD	Organisation for Economic Cooperation and Development
PCFV	Partnership for Clean Fuels and Vehicles
SCP	Sustainable Consumption and Production
SE4A	Sustainable Energy for All
SEFI	Sustainable Energy Finance Initiative
SME	Small and Medium Sized Enterprise
SSREN	Special Report on Renewable Energy Sources

STEG	Société Tunisienne de l'Electricité et de Gaz
UNDESA	United Nations Department of Economic and Social Affairs
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
UNWTO	United Nations World Trade Organisation
USAID	U.S. Agency for International Development
WEF	World Economic Forum
WSSD	World Summit on Sustainable Development

Executive Summary

Summary

Unprecedented rates of technical change have created much prosperity, but also a range of daunting challenges. Mitigation and adaption to climate change, enhancing resource efficiency, achieving food security, the sustainability of agriculture, forestry and marine resources, demographic imbalances all present risks and challenges to the global economy and to social stability. Response to these complex and interconnected challenges is all the more difficult because of the uneven and growing inequality of income that is visible among countries and within their populations

This paper aims to evaluate how stronger policies towards energy efficiency can contribute to meeting the challenges. It seeks to draw lessons about best practice in energy efficiency policy, picking out key constraints and effective responses to implement energy efficiency. Drawing on this analysis, it assesses the work by UNEP on energy efficiency within the wider practice and on that basis it explores the options for UNEP in positioning its future work in the area. It covers both the implementation of policies for energy efficiency in the economy as a whole and the specific case of ensuring access to energy efficient goods and services in communities recently connected to modern energy systems, normally to electricity distribution and clean fuels for cooking and simple industrial processes.

The analysis is founded in the principle that public policy interventions should be addressed to identified market and regulatory failures that prevent commercial interests from behaving in the socially desirable manner and that the various forms of intervention attempt to correct or compensate for these failures. A market failure frequently observed is the attribution of direct and indirect subsidies to the price of energy and the failure to account for the costs of pollution; in the absence of correct pricing the implementation of policy for energy efficiency is complicated and finally ineffective.

The difficulties experienced in implementing policies for energy efficiency are not confined to developing countries, although they are generally more pronounced in that context. Energy efficiency is a difficult area of policy because energy is used by everyone in almost all human activities; there are many actors to influence and intervention has to cover a very wide ground. The context may also differ from country to country, and even between communities within countries; the response to instruments of intervention is not always as expected. Verification of regulatory compliance is always difficult and again this is especially the case in developing countries, especially where there is incidence of corruption.

UNEP has compiled an impressive portfolio of experience that is relevant to energy efficiency that extends over most forms of public intervention and over a wide range of economic sectors including sustainable production, sustainable products including buildings and vehicles, sustainable lifestyles and coalition-building in support of innovative finance. Twenty-nine initiatives and projects are reviewed, but this is not intended as an exhaustive list. Of this set, twenty-two are chosen as case-studies, the selection being intended to reflect the coverage of the UNEP portfolio.

The case studies revealed:

- A large volume of high quality work, well-balanced with a good coverage of the spectrum of various aspects of EE and access to energy efficient goods and services
- Generally well-managed projects that mostly achieved the specific results intended
- An impact that without being disappointing often seems a little below what one might have hoped from the quality of the work
- The institutional base, the capacity in UNEP (except for economic analysis) and the networks are in all place for a much larger roll-out with much higher impact
- A weakness in conventional economic analysis – important in real decision-making

Tentative hypotheses why impact was not as great as might have been hoped are:

- Projects are not always as embedded in government policy as is desirable, driven sometimes more by donor interest than government's perceived need
- Projects are often small and not sustained long enough to achieve all the synergies that seem possible on paper. In many developing countries there is frequently little real interest until there are results and by that time the project has ended
- Although technical cooperation agencies do cooperate in many respects, they still have their own agendas and there can still be overlaps, gaps and even conflicts in their approach to a given topic
- The perennial instrument of energy price subsidies conflicts with and effectively blocks results from even the best of programmes

The significance of the activities of UNEP in the context of other international and national programmes is assessed according to the following criteria: effectiveness, efficiency, equity, implementability and replicability. Although generalisations are beset with difficulty, some robust lessons can be deduced and they are summarised in the Table, along with a short note on how UNEP's work has contributed.

The skills that underpin the comparative advantages of UNEP as they emerge from this analysis are:

- Advocacy and communication: especially with consumers and especially in changing behaviour and values.
- Building of coalition and consensus: the environment is intrinsically complex and context sensitive and the need to cope with these characteristics imposes a temperament that is conducive to coalition building. UNEP has been successful in building partnerships among public and private interests and civil society, but also in negotiating the cooperation of sectoral Ministries in mainstreaming the ideas of sustainability for example in policies for government procurement; it has also developed and maintained a substantial capacity and expertise in working with the private sector and in influencing domestic and international markets.
- Innovative finance: Insufficient private finance in support of energy efficiency is one of the biggest obstacles to implementation and UNEP has found an important niche in this matter. It does not control large funds, but as a non-competitive, independent actor with authority in environmental matters it has been successful in working with the finance industry to determine how commercial deals can be constructed around energy efficiency.
- The multi-disciplinary and multi-dimensional analysis of problems that can provide the intellectual underpinning of smarter and more coherent (joined-up) regulation.

How UNEP decides to build on these skills to position its future work will be conditioned to some extent by what is going on elsewhere. There are many such activities with which links will need to be created, but four that will be especially influential are the UN Secretary General's initiative on Sustainable Energy for All (SE4A); the adoption of Nationally Appropriate Mitigation Actions (NAMA[1]s) within the UNFCCC; the proposed Ten Year Framework of Programmes on Sustainable Consumption and Production (the 10YFP) and the Rio+20 conference in June; and the Energy+ initiative that would help make NAMAs effective. The implications for UNEP of these programmes have been assessed and included with some other considerations in a list of criteria by which to judge possible future options for UNEP.

There are strong arguments for differentiating technical assistance according to the extent to which countries have reformed pricing policy for energy. If prices are reasonably cost-reflective then UNEP's strengths would be useful in supporting their implementation of post-Kyoto mechanisms, including NAMAs and sectoral mechanisms. Such a line would be problematic in countries where energy prices are subsidised. In this case UNEP's skills might be better deployed through programmes that stood in continuity with past SCP programmes, but with a particular emphasis on promoting more energy efficient products (as measured along the life cycle), including demand side measures.

[1] Unless the context specifically excludes it, the term NAMAs is taken to cover all post-Kyoto mechanisms including sectoral crediting and sectoral trading

Analysis of the way in which UNEP's skills can best support the creation of access to energy efficient goods and services suggests that one effective path would be to promote and implement ideas of SCP suitable for communities that have been newly given access to modern energy services. The aim would be to ensure that access to energy is complemented by measures that raise incomes and improve livelihoods in a sustainable manner.

There is also an important role for the advocacy skills of UNEP in raising awareness among public opinion and potential partners to SE4A. Large industrial commitments will be essential if the goals of SE4A are to be achieved; the determining factor will be whether a commercial case can be constructed, but there will also be a need to for innovative and effective campaigns covering fund raising, standards, procurement, training and behavioural change. UNEP's experience, particularly with the UNEP/UNESCO YouthXchange initiative and associated programmes is of value here.

There will also be a comprehensive need for monitoring and verification across all programmes. This will be needed to monitor regulatory compliance in energy efficiency and to ensure that better energy services actually reach the poor. Techniques of regulatory compliance and regulatory risk analysis are well-developed in environmental agencies and although UNEP does not appear to have drawn on this experience in its energy efficiency work, they are practices that could very usefully be deployed here.

Table 1: Summary by criteria with note on UNEP contribution

	Effectiveness	Efficiency	Equity	Implementability	Replicability	UNEP contribution
Regulations and standards	Very effective if regulations are appropriately set and compliance is assured.	Efficient in developed countries. International collaboration could help.	May disadvantage DCs through licence fees or loss of market. Offset by transfer of technology.	There is a threshold of effort (standards setting, testing). Compliance is the main problem.	In principle, but countries may define different standards that cause trade barriers.	Good capacity for coalition and consensus building in support of standards.
Voluntary agreements	Thought to be generally less effective than regulation. Prone to free-riding.	Low cost and low impact. Efficiency hard to judge.	No obvious equity implications.	Easier to implement than regulation and requires less enforcement.	Rare in developing countries.	Mostly done through partnerships with need for scaling up. UNEP has the necessary skill set.
Financial and fiscal incentives	Variable: depends on terms. Essential instrument to leverage private finance. Subject to interest group capture.	Variable. Well-designed programmes can leverage 15 times the volume of private finance.	Progressive – especially when for access or for EE in low-income groups.	Easy to implement; all countries have taxation and budgetary policies.	Programmes must be tailored to national circumstances. General lessons are replicable.	Substantial contribution through coalition building in support of innovative finance.
Information Instruments	Effective when combined with other instruments. Reduced value in isolation.	Efficient when well-combined with regulations or financial incentives.	Progressive as low-income groups have less good access to information or trouble interpreting it	Easy to implement, although impacts on behaviours can only be measured in the long run.	Much information is transferable but often requires adapting to national circumstances. International networks exist.	Good production and dissemination of innovative materials. Strong advocacy work.
Provision of public goods	Essential need for training, research and infrastructure. Effectiveness is project-dependent.	Leverage of expenditure on R&D and training is high. As is also knowledge and technology transfer.	Progressive as tax-payer funded and poorer people pay less tax.	Implementability depends on strength of competence in education, science and planning.	High degree of replicability. Depends on effective international networks.	Contribution to research and innovation through NCPCs. Well-directed training effort.

From these considerations a tentative proposal for the future positioning of UNEP is made that would:

- Build on demonstrated competences from UNEP's past work
- Support SE4A in its objective regarding energy efficiency
- Be coherent with the objectives of the SCP programme and the 10YFP
- Build more links between SE4A initiative and the Rio+20 process
- Offer support to a prompt deployment of CDM and sectoral mechanisms

Structurally it would comprise four themes: "Support to NAMAs"; "EE enhanced SCP"; "Advocacy for Access"; "SCP for post-access communities". "Support to NAMAs" is taken here to encompass CDM if appropriate. Two of these themes address the implementation of energy efficiency and two address extending access to energy efficient goods and services. Their relationship to the main themes of UNEP's past programmes is shown in the matrix. The first theme is intended for countries that have cost-reflective energy prices.

Table 2: Linkages of proposed themes to key aspects of past programmes

	Support to NAMAs	EE enhanced SCP	Advocacy for access	SCP for post-access communities
Sustainable production	High	High	Low	High
Sustainable products	High	High	Low	High
Sustainable lifestyles	Low	Medium	High	High
Innovative finance	High	High	High	High

Conclusions

Firm

1. UNEP has a solid portfolio of experience that spans much of the scope of energy efficiency policy and it can build on this experience to make an important contribution to the pressing need to accelerate energy efficiency to cope with climate change and to provide access to efficient modern energy services.
2. In addition to its specific technical achievements, UNEP enjoys a set of managerial skills that are of substantial value to the promotion of the complex interdisciplinary programmes addressing many stakeholders such as are necessary for energy efficiency. The set includes skills in: building coalitions of interest and consensus on complex technical issues; innovative finance; advocacy and communication.

3. A programme in the framework of the 10 Year Framework of Programmes on SCP (10YFP), or programmes or other global platforms for action on SCP, that emphasised energy efficiency within the general concept of SCP would provide valuable support for SE4A and would create useful links between such a framework or platform and SE4A to the benefit of both.
4. The programme could and should address both the implementation and the access to energy efficiency measures.
5. A long-term framework is essential for such a programme in order: to assure continuity of action on the ground and to provide medium-term visibility to countries and donors of the prospects and needs.
6. Predictable and sustained funding for SCP over a significant (multi-year) period would be beneficial in order to bridge gaps in programme funds and to assure continuity of support to SE4A and to country activities. A period of sustained effort for perhaps ten years is needed to move from policy design, through necessary capacity building up to effective implementation.
7. Equally, if the proposal for Sustainable Development Goals that will be examined by the Rio+20 conference is approved, then the same activities on energy efficiency and access to energy efficient goods and services can support an SDG on Sustainable Energy for All.
8. The introduction of NAMAs into the global framework for mitigating climate change provides an opportunity for UNEP to enhance its contribution to that important effort. The focus of NAMAs on sectoral strategy and policy is particularly amenable to UNEP's capacities. Regulatory compliance is an essential element of environmental management and UNEP is well positioned to develop these techniques as MRV tools and methodologies to support NAMAs in specific sectors, such as buildings (see Section 4.3.3).
9. Delivering energy efficiency on the scale envisaged by SE4A will require very large investments by the private sector and for this to happen there must be a viable business case. As a non-competitive agency, with authority in environmental policy, UNEP is well-placed to work with the financial sector and business to identify opportunities and obstacles and to negotiate with governments and civil society acceptable paths forward. It has already done this successfully in different ways with lighting, electrical equipment and buildings (and in improving specifications of transport fuels) and it is important to continue.
10. Fashioning private sector commitments to improved access to efficient energy services will benefit from skilful advocacy and the creation of favourable public opinion. UNEP's work on sustainable life styles and the supporting networks could be adapted for this purpose.

11. The particular skills of UNEP need to be evaluated as a part of the total offer of skills from the technical assistance community and particularly other agencies of the UN family. In this respect the multi-disciplinary character of UNEP with authority in environmental policy has advantages. It can, as a neutral and non-competitive actor, organise coalitions of government, manufacturing industry, the financial sector and civil society to deal with complex problems both within a country and internationally. There are many outstanding issues to which this can be applied.
12. To the maximum extent possible, new activities of UNEP should build upon the existing delivery channels. It has in its past activities created effective and appropriate networks and participates in the institutional infrastructure provided by the NCPCs. The emphasis in the future should be on deploying these assets to the best possible effect in pursuit of well-established objectives.

Tentative

13. There is a strong argument for discriminating between activities designed for countries that have successfully reformed prices and those that have not. In the former case, a clear focus on helping countries implement NAMAs and sectoral mechanisms would be a valuable contribution to the global effort of mitigation. In the second case, it may be more effective to concentrate on strengthening capacity to design, implement and monitor policies in parallel with activities (from other programmes) to reform prices.
14. For the implementation of energy efficiency, a dual track comprising a line for "support to NAMAs" and another line comprising "EE enhanced SCP" would meet the differentiated need between country groups. It also has the advantage of demonstrating a clear continuity with the historic SCP activities, whilst still providing for adaptation to new ideas and needs.
15. For extending access to energy efficiency, there are two main lines of action that show promise. One is to extend the ideas and tools for SCP, mainly developed for conventional production processes and products, to the challenges that face communities newly connected to modern energy services. These SCP ideas and tools will provide guidance as to how these communities can ensure that they adopt the most efficient technologies consistent with their needs. The other is to deploy the networks created to further sustainable lifestyles to the new challenge of creating supportive public opinion to the right of universal access to modern energy services.

Recommendations on the business case for energy efficiency

As elaborated in Annex 1 of this paper, there are also many areas where UNEP could contribute to strengthening the business case for energy efficiency in developing countries.

16. UNEP has proven skills in the building of coalitions and the creation of consensus among manufacturing industry, financial interests, other international organisations, officials and civil society to deliver workable solutions to some of the constraints facing the private sector in creating a business case for energy efficiency in developing countries. Four clear historic examples of this are the En.lighten project, the Global Fuel Economy Initiative, the Sustainable Building and Climate Initiative (as well as its sister programme the Sustainable Social Housing Initiative) and work within the Task Force on Sustainable Products that led to the establishment of the IEA Implementing Agreement for a Cooperating Programme on Efficient Electrical End-Use Equipment. Other work on finance and advocacy contributed also to these successful undertakings.
17. UNEP should build on these successes. The En.lighten project still has far to go to achieve its immediate goal although it is well on track; when the phase-out of incandescent bulbs is completed there will still be much work to do for the promotion of new cost-effective efficient lighting schemes.
18. The Global Fuel Economy Initiative (GFEI) needs to be transformed to a more operational mode, working with developing countries to ensure standards for new vehicles are brought to the levels consistent with best practice elsewhere and extending membership to a wider range of industry interests.
19. The work of the Task Force on Sustainable Products has come to an end, but a similar programme building also on the experience with En.lighten and directed to air-conditioning could be of great value. As is indicated earlier, air-conditioning is a very important contributor to energy use, the market is growing rapidly and much of the supply to this market has poor energy performance that can easily be improved.
20. Business will be reluctant to risk their capital in circumstances where the enforcement of standards is poor. UNEP might consider developing a programme to help transfer best-practice in the enforcement of regulations and compliance with product standards.
21. The possibilities of public procurement to directly improve the energy efficiency of the public and to contribute to the development of innovative products are increasingly recognised. As an element to support the business case for energy efficiency, UNEP may consider expanding its current capacity building activities on the design and implementation of sustainable public procurement policies in developing counties.
22. Development of policy and tools by UNEP's Sustainable Buildings and Climate Initiative can support financing mechanisms for large scale investment in energy efficiency for buildings, especially in public buildings and social housing.
23. The possibilities of ESCO for building renovation are still under developed. Technical assistance has tended to emphasise industrial applications of ESCOs which are not the easiest market to address. Buildings, especially public buildings, are a much better

target. UNEP may wish to consider extending its Finance Initiative to cover this topic.

24. For business to fully develop and capture new green markets in the four key sectors examined in this paper (lighting, appliances, transports, buildings), technological innovation should go hand in hand with marketing strategies based on consumer research and information.

Increasing access to and demand for energy efficiency in a perspective of Sustainable Energy for All

1. Energy efficiency and global challenges

Unprecedented rates of technical change have created much prosperity, but also a range of daunting challenges. Mitigation and adaption to climate change, enhancing resource efficiency, achieving food security, the sustainability of agriculture, forestry and marine resources, demographic imbalances all present risks and challenges to the global economy and to social stability. Response to these complex and interconnected challenges is all the more difficult because of the uneven and growing inequality of income that is visible among countries and within their populations; this is not only a feature of developing, but also developed countries (OECD, 2011). Many people are largely excluded from the benefits of modern life, yet often suffer disproportionately from its costs. Severe income disparity was identified in a paper produced for the World Economic Forum (WEF) as one of the top global risks, greater both in likelihood and impact than climate change, (World Economic Forum, 2012). Solutions to global environmental challenges must be found that help to remedy and do not exacerbate these disparities.

The WEF study identified rising greenhouse gas emissions as the principle environmental risk with greater likelihood and greater impact than any other. Most authorities would probably concur with this judgement if only because if climate change cannot be mitigated then the consequences for other parts of the environment would be catastrophic with disruption to water systems, loss of biodiversity, desertification and erosion and consequent impacts upon agriculture, forestry and fisheries resources.

Abatement of the greenhouse gases (GHGs) that cause radiative forcing and therefore global warming and climate change can be achieved by: a) using energy more efficiently (energy efficiency); b) by shifting to means of energy supply that cause fewer emissions (low carbon energy); c) by better management of biomass resources to reduce emissions where they occur and to create sinks for carbon where possible (management of terrestrial emissions); d) by changing behaviour towards lower energy lifestyles – which might also be said to be a form of

energy efficiency. All these changes in the sources and use of energy can make a fundamental contribution to the achievement of patterns of sustainable consumption and production (SCP). Shifting to SCP patterns is both an overarching objective and prerequisite for sustainable development (WSSD, 2002). This paper addresses the first and last options, i.e. energy efficiency and behavioural change, examining their contributions in economic, environmental and social terms and also how approaches that have been pursued separately under the different rubrics of SCP and energy efficiency could be merged effectively, in particular by UNEP.

1.1 The purpose and structure of this paper

The aims of this paper are to:

1. Show, based on concrete examples of national and local policies, initiatives and projects, how energy efficiency can be a key driver for market transformation and to demonstrate its social, economic and environmental benefits through clear indicators of success;
2. Position UNEP as a key player in the field of energy efficiency.

The remainder of this first Chapter sets out the background. It summarises why energy efficiency and behavioural change are important and what they can be expected to contribute to the mitigation of climate change and a transition to a green economy. It then reviews some important aspects of initiatives that will bear on future technical cooperation in energy efficiency that will condition the context for UNEP's future work.

Chapter 2 sets out some of the key aspects of public policy intervention in energy efficiency. It analyses why intervention is justified and what instruments have been used to influence productive activities and consumer behaviour and how they have generally performed.

Chapter 3 recapitulates some of the past achievements of UNEP that are relevant to energy efficiency and present some selected case studies of activities that may be suitable for a long-term programme. Chapter 4 reviews the lessons of practice in energy efficiency as demonstrated by projects of UNEP, other international agencies and national governments.

Chapter 5 examines options for the future positioning of UNEP's work, taking into account its past experience of energy efficiency, its general mission and capabilities, the development of the field as a whole and the competences of other players. Chapter 6 draws some conclusions.

1.2 Why energy efficiency is important

The international consulting company McKinsey has published a global greenhouse gas abatement curve that ranks in order of cost some 200 measures for abating GHGs up to a time horizon at 2030, (McKinsey, 2009). The analysis is founded in a comprehensive data base compiled from evaluations of the potential and costs of greenhouse gas abatements in 10 economic sectors and 21 regions; it concludes that by 2030, 38 GtCO2 per year of abatement could theoretically be achieved from energy efficiency, low carbon energy and improved management of terrestrial sources at a cost below €60 per tonne of CO2 equivalent. This volume of savings would lead to emissions in 2030 that were 35% below those of 1990 or 70% below those predicted for 2030 on a Business as Usual scenario. The reductions would give a good chance of keeping the average global temperature rise below the 2 degrees Celsius that is generally seen as the most suitable compromise between ambition and feasibility, (IPCC, 2007). Of this total, 14 GtCO2 per year of savings came from energy efficiency measures, 12 GtCO2 per year from an expansion of low carbon energy supplies and 12 GtCO2 per year from reduced terrestrial sources.

On top of these technical savings a further 4 GtCO2 per year might be achieved by behavioural change; the financial cost of these behavioural changes is presumed to be low. As the authors acknowledge, the assessment of the impact of behavioural change was made after the calculation of the impacts of technical changes. There is a degree of ambiguity in what constitutes energy efficiency and what constitutes behavioural change and if the estimates had been prepared the other way around then the partition between the two sets of measures would be different, but the total savings of 18 GtCO2 per year is probably a fair estimate. This is very nearly one half of the total mitigation potential.

The sheer volume of potential savings is already a strong indicator of the significance of energy efficiency, but there are other factors that contribute to its vital importance. Many energy efficiency savings can be achieved at low (it is sometimes said negative) cost and a part of them can in principle be achieved quickly. These are useful features. Low carbon energy supply is with some exceptions not commercially competitive and depends upon subsidy (in industrialised countries) or donor support (in developing countries). A certain reluctance to recognise the true social cost of GHGs together with the allocational problems that arise in treatment of global common goods means that the rate of development of low carbon energy supply will inevitably be below what is desirable on the basis of global social welfare. A large part of the potential for energy efficiency escapes these problems.

It is not the case that energy efficiency can be deployed overnight. For example, improvement in appliances or industrial equipment is to some extent conditioned by the rate of retirement of obsolete items. Behavioural change arises out of multiple forms of education and learning and operates over a medium to long term perspective. However, many practices require little or low investment and can be achieved rapidly, like more efficient lighting or better maintenance of heating systems.

According to the IEA, energy demand on present trends will increase by one-third from 2010 to 2035. The dynamics of energy markets are increasingly determined by countries outside the OECD. In the IEA forecast, non-OECD countries account for 90% of population growth, 70% of the increase in economic output and 90% of energy demand growth over the period from 2010 to 2035, (IEA, 2011). It is reasonable to ask, if energy efficiency can be done quickly and pays back without subsidy, why it has not all been done and why such a large potential remains. The reasons are varied and are discussed in the section 2.1.

1.3 The present context

Technical cooperation in sustainable energy and climate change is complex and dynamic. There are many international and national programmes underway. Four initiatives that are especially relevant to the future positioning of UNEP within this effort are summarised here. The first is the Sustainable Energy for All initiative of the UN Secretary General; this is critical as it sets out the vision and the main strategic lines of the UN mission in the areas of energy access, renewable energy and energy efficiency. The second is the post-Kyoto world of instruments to support developing country participation in climate change as these will determine the operational mechanisms that will govern much technical cooperation in this area. The third is the Energy+ initiative sponsored by the Government of Norway that aims simultaneously to support Sustainable Energy for All and to blaze the trail for a wide-scale roll-out of post-Kyoto instruments. The fourth is the Marrakech process and by extension the 10 Year Framework of Programmes on Sustainable Consumption and Production and the Conference on Sustainable Development to be held in June 2012, because this process has determined much of UNEP's past work on SCP and there is a potential in a future 10YFP or other global platform for action on SCP to put in place new policies, incentives and awareness-raising and information tools to increase energy efficiency as a central plank of the shift to SCP patterns. These initiatives are discussed below together with some other programmes that are underway around the world.

1.3.1 Sustainable Energy for All

The risks that the increasing disparities in income pose to the stability of the global system have been noted earlier. In the specific case of energy this takes the form of poor access to poor quality fuels.

The World Energy Outlook 2011 of the International Energy Agency estimates that:

- Over 1.3 billion people are without access to electricity and 2.7 billion people are without clean cooking facilities. More than 95% of these people are either in sub-Saharan Africa or developing Asia and 84% are in rural areas.

- In 2009, $9.1 billion was invested globally in extending access to modern energy services. In the absence of significant new policies, investment between 2010 and 2030 will average $14 billion per year, but will still leave 1.0 billion people without electricity in 2030; population growth means that 2.7 billion people will still be without clean cooking facilities, (IEA, 2011).

In December 2010, the United Nations General Assembly declared 2012 the International Year of Sustainable Energy for All, recognizing that "… access to modern affordable energy services in developing countries is essential for the achievement of … the Millennium Development Goals and sustainable development", (UN, 2011). In response, the UN Secretary-General, with support from UN-Energy and the United Nations Foundation, created a new global initiative - Sustainable Energy for All (SE4A) to engage governments, the private sector, and civil society partners globally. His initiative was first set out in a vision statement that sets goals for the global community in its efforts to cope with the simultaneous needs to extend energy access and to limit emissions of GHGs, (UN Secretariat, 2011) and further developed in a speech to the World Future Energy Summit 2012 in Abu Dhabi during which the International Year of Sustainable Energy for All was launched.

In his vision statement, the UN Secretary General notes that developing countries have the opportunity to leapfrog conventional energy options in favour of cleaner energy alternatives that will drive growth and enhance economic and social development. He proposes three linked objectives to underpin the goal of achieving sustainable energy for all by 2030:

- Ensuring universal access to modern energy services
- Doubling the rate of improvement in energy efficiency
- Doubling the share of renewable energy in the global energy mix

The statement of the Secretary General recognised many barriers to the achievement of these goals that will need to be overcome. Path dependence, or technological lock-in, often mean that policies and politics protect existing institutions and existing practices rather than seek new and better alternatives. There can be financial obstacles, particularly when operating costs are paid directly by consumers and investments are made by third parties, even if lower

operating costs would yield net savings in the long run (known to economists as the agent-principal problem). Sources of financing – including multilateral institutions, bilateral assistance, national development banks, the private sector, and carbon markets – are insufficient and not well coordinated and small-scale renewable energy and energy efficiency projects can be particularly difficult to finance because of their high transaction costs relative to their size. Perverse pricing and regulatory policies and practices that diminish financial rates or return on investment are a major disincentive to private capital. Insufficient recognition of external costs will distort economic analyses. Historic business models based on grid-extension have achieved high rates of energy access in many countries, but they may not be suited to sparsely populated or remote areas. New business models are needed that are commercially viable and innovative financing mechanisms will be necessary to support them.

Despite the magnitude of the challenge and the daunting barriers, Sustainable Energy for All envisages the possibility of success. There are many examples of activities that have overcome the barriers and that have extended access to modern energy services and improved efficiency. The key for future programmes is in scaling up and replicating these successes. To do this will require: better leadership and stronger commitment; stable policy and regulatory frameworks; a greater financial effort; strengthened capacity; increased support for innovation and improved communication and awareness that empowers stakeholders to make more sustainable individual decisions.

Elaboration of the SE4A initiative has been entrusted to a High-Level Group with representatives from the private sector, government, UN/intergovernmental organizations and civil society to develop a global strategy and concrete agenda for action to reach the three objectives. The roadmap should be endorsed at the Rio+20 conference in June 2012. The initiative seeks to engage stakeholders through formal commitments. Governments should commit to develop national energy plans and targets, provide financial support, and reform pricing policies. The corporate sector can employ more fully sustainable and clean production and make new investments in public-private partnerships to expand the offer of sustainable energy products and services. Civil society organizations can enhance outreach and education efforts, encourage transparency and action on the part of government and the private sector, and build capacity among local communities, (UN, 2012).

1.3.2 Post-Kyoto instruments

It is likely that much of the incremental effort to be made in energy efficiency in developing countries over the next 10 years will be in some way linked to or influenced by the new sectoral mechanisms that are slowly taking form within the UNFCCC. The project based Clean Development Mechanism has been the main mechanism until now for linking developing

countries into the global mitigation effort. The scheme as originally conceived will run until the end of 2012 although projects registered before the end of that year will continue to receive credits and the idea of some extension of the CDM has also some support.

The CDM was an enormous step forward in the search for an equitable procedure for distributing the costs of mitigation, but its restricted scope and practical problems, especially in the interpretation of baseline conditions and additionality have limited its effectiveness. The main perceived weaknesses are:

- Take up has been low and dominated by a few countries and a few technologies
- Being a project-based approach, the CDM cannot support policy implementation or mitigation action at the sectoral level that potentially could have far greater impact
- CDM projects do not reduce net global emission reductions because the emission induced in the host country is off-set against the inventory of the purchaser

The COP 17 in Durban addressed the question how best to continue international cooperation in climate change policy after the conclusion of the initial programme under the Kyoto protocol. It agreed to adopt: a) a roadmap to a new legally binding treaty covering all parties on emissions reductions by 2015 to take effect by 2020; b) a second commitment period of the Kyoto Protocol from 1 January 2013; c) a $100-billion a year Green Climate Fund for developing countries, to become fully operational in 2012. Although much still remains uncertain it is probable that a main instrument of the participation of developing countries will be Nationally Appropriate Mitigation Actions (NAMAs), including specific policies (e.g. on standards for appliances), investments and possibly the introduction of emission trading systems in developing countries.

NAMAs were anticipated in the Bali Action Plan some years earlier that had launched “a comprehensive process to enable the full, effective and sustained implementation of the UNFCCC through long-term cooperative action” (UNFCCC, 2007). The idea of NAMAs was first introduced in this Action Plan and was confirmed by the Cancun Agreements under COP 16, (UNFCCC, 2011). These agreements recognise two types of NAMAs – “unilateral” and “supported”. Unilateral NAMAs are voluntary undertakings that are cost-effective in their own right and do not require financial support from developed countries – these would not be subject to rigorous monitoring, reporting and verification (MVR); in the view of some there would be no MVR at all. Supported NAMAs are those that require technical cooperation with developed countries and / or financial transfers and would normally be appropriate when the costs of the actions exceed the financial benefits. Financial support could come from carbon markets or conventional financial instruments. The tie-in to carbon markets is contentious and

would generate a third kind of NAMA – a "credited" NAMA – that would generate emission reduction certificates eligible for trade on a carbon market. The EU is especially interested in the possibility of sectoral crediting mechanisms and has made provision in the revision of the European Trading Scheme for this possibility, (EU Commission, 2009). The MRV requirement increase in rigour in passing from voluntary, through supported to credited NAMAs. The majority of effort in energy efficiency would probably be mainly, but not exclusively, under voluntary NAMAs because it can be achieved without external subsidy.

Much still remains to be done to make NAMAs operational. Country reporting under existing obligations is patchy and the value of the data is not always clear. If there is to be a change in reporting requirements then there may be an opportunity to merge and simplify existing requirements and focus on information of clear operational value. The data might advantageously be made available on the web. This would release scarce administrative resources in governments of developing countries. UNEP's expertise in specific sectors and its well-established partnerships with the private sector, specifically in the buildings sector, provides unique opportunities to develop the tools necessary to facilitate NAMAs, while supporting capacity building efforts at country and regional levels.

The shift to NAMAs offers richer opportunities than does the CDM to deploy the capacities of UNEP. The CDM revolves around concrete energy efficiency projects with the main actors being developers often supported by development banks. NAMAs depend more upon the implementation of policies, strategies, and programmes initiated by national governments in partnership with the private sector; the expertise of UNEP in coalition building to develop similar environmental activities would be valuable as would its capacity in the monitoring of reporting and regulatory compliance. At a city-wide level, UNEP's efforts to assist in the development of an urban CDM methodology can continue to provide support for large-scale energy efficiency programme by operationalizing CDM for cities.

1.3.3 Energy+

Energy+ is an international energy and climate partnership initiated by the Government of Norway in support of "Sustainable Energy for All". The Partnership aims to ensure access to sustainable energy for all and avoid greenhouse gas emissions through the use of renewable energy and energy efficiency; it was launched in October 2011 by the Norwegian Prime Minister Jens Stoltenberg at a conference entitled "Energy for All: Financing Access for the Poor, (Government of Norway, 2011).

Energy+ recognises the fundamental needs identified in Sustainable Energy for All, to simultaneously provide access to affordable, reliable energy to the several billion people of the

developing world that lack access to modern energy services and at the same time to reduce emissions of global greenhouse gases. It notes that current levels of financing and existing programmes and initiatives are inadequate. USD 7 billion of overseas development aid goes to energy projects, but this does not leverage private investment in the poorest countries. The principle barriers identified in the rationale for the programme are the unattractive risk/return profile and consequently inadequate access to capital. Investment may also frequently be restricted by an inadequate legislative and regulatory framework and the absence of competent technical and administrative agencies.

Energy+ will cooperate primarily with governments to develop commercially viable business opportunities for the private sector and so to leverage private capital. Engagement with countries will be in three stages. The first stage is to provide support for strategic planning, policy and regulatory reforms where needed; this is to be followed by a second stage of capacity building to implement the required policies and incentive mechanisms and to make the monitoring, reporting and verification (MRV) necessary to permit performance-based support at sector level. In the third stage, results-based financing will create and expand markets and leverage private sector investment. Finance will be delivered through carbon-finance triggered by compliance with agreed country-level indicators. The concept is to be tested in pilot countries, selected on the basis of political willingness and a positive assessment of the probability of success.

The procedure is coherent with the idea of credited NAMAs discussed in the previous Section and indeed is intended to accelerate the planning and implementation of NAMAs and to develop a basis of practice for a sectoral approach that can facilitate the development of guidelines for MRV of emission reductions and develop methodology and experiences in establishing new carbon markets.

The government of Norway has declared its intention to focus its clean energy support on a few delivery channels and actors where a high impact potential exists and to improve coordination and cooperation.

1.3.4 The Marrakech process

The Marrakech Process was launched in 2003 with the objectives to support the implementation of policies for Sustainable Consumption and Production (SCP) and to provide inputs for the elaboration of the 10 Year Framework of Programmes on SCP (10YFP). Establishment of this framework was considered by the Commission on Sustainable Development (CSD) during its 2010-2011 implementation cycle. Following the failure of CSD to adopt a formal decision, even though there was an agreed text on the 10YFP, there is now a

clear possibility that the 10YFP could be established as one concrete outcome from the United Nations Conference on Sustainable Development, or Rio+20, to be held in June 2012.

The Process depended on an informal partnership of national governments, development agencies, and civil society lead by UNEP and UN DESA. Activities were implemented through seven Marrakech Task Forces; these were voluntary initiatives led by governments, focusing on specific themes of SCP, namely: sustainable products, sustainable lifestyles, education for sustainable consumption, sustainable building and construction, sustainable tourism development, sustainable public procurement, and cooperation with Africa.

The outcomes of the process were reviewed in 2011, (UNEP, 2011). The review found that the broadly-based coalition of stakeholders performed well and was successful in generating synergies, sharing information, transferring knowledge and promoting innovation. The process has helped design and pilot new policies, technical tools, management practices and capacity building activities promoting SCP. It also established national and regional consultation processes based on multi-stakeholder groups to identify needs and priorities for the transition to SCP. These elements could be expanded to support implementation of the 10YFP. The review recognised diverse priorities across countries, a wide range of performance in terms of cleaner production and supply and a general paucity of tools and procedures to raise awareness of SCP in many countries. It warned of the need to focus and to identify priority areas where international cooperation has the greatest impact on resource efficiency and where it can most effectively achieve decoupling of resource use and environmental degradation from economic activities while simultaneously increasing human welfare gains from those activities.

Experience of the process was helpful in identifying gaps in the available support for SCP. These included the following.

- Research and scientific knowledge: There is still a need for relevant and good quality evidence for policy making and for methods of measuring resource efficiency and progress towards SCP goals.
- Coordination and networking: There is a very wide range of programmes and activities dealing with SCP and similar concepts. More effective links within this community would improve efficiency and effectiveness.
- More work on the demand side and lifestyles: Behavioural change and social innovation are as important as technological innovation. Better understanding of consumer values and how better to motivate choices is needed.
- Capacity building and policy tools: There is insufficient awareness of and competence on relevant policy tools including life-cycle analysis, measuring “footprints” of goods and

services on the environment; internalizing environmental and social costs; and mobilizing finance for strategic investments.

- Stronger inter-ministerial collaboration and a better integration of SCP into economic and development policies is needed.
- Technology development and transfer. More effective mechanisms for technology cooperation and sharing are needed and more attention should be given to the potential of and means for technological leapfrogging (or tunnelling as it is also known).
- Investments: More engagement of finance and planning ministries, development agencies, and IFIs is needed to mainstream SCP objectives and resource efficiency practices and measures in these policy areas.
- Communication: Cooperation is necessary with mass media, educational institutions and policy makers to shift people towards sustainable lifestyles.

If the achievements of the Marrakech Process are to be sustained and expanded then certain conditions must be met. These include:

- Bringing more political commitment: High-level endorsement is necessary now to mainstream SCP objectives into economic, financial and line Ministries in the productive sectors.
- Delivering a 10YFP: The 10YFP is needed for better coordination and cooperation in the promotion and implementation of SCP, it would also help to mobilize the necessary technical and financial support
- Replicating and Scaling up: The scope of activities to date has been restricted by resources; to achieve a significant impact their scale needs to be much increased.
- Increasing Financial support: Additional financial support is needed for scaling-up and capacity building.
- Measuring Progress: The 10YFP could usefully include more formal measures of success and of the costs and benefits of SCP policies and actions.

There is considerable coherence between these findings and the analysis of obstacles and needs contained within Sustainable Energy for All. The perceived need for high-level endorsement is delivered by SE4A (at least within the energy aspects that are an important part of SCP). SE4A also leans heavily on the fact that there have been many local successes and the need now is for global replication and scaling up, which would be one of the central objectives of a future 10YFP. The aims of SE4A are formulated over the long-term to 2030 and this would be coherent with the clear need detected by the review of the SCP for a long-term framework expressed in the 10YFP. The very high profile of SE4A should promote the adherence of government, the corporate sector and civil society to a long-term framework and to the

provision of adequate funding, identified in the review of the Marrakech process as necessary preconditions for successful work in the future. Formal measures of success could be incorporated in the 10YFP and will be needed also for SE4A; the set should cover not only impacts, but include intermediate indicators of outputs and outcomes. There is therefore significant complementarity between the possibilities, needs and ambitions of the two initiatives and the 10YFP could help support the aims of SE4A and their successful achievement.

1.3.5 Other initiatives

There are many other initiatives that have a similar overall goal either in place or planned, but which it is not possible to cover here in detail. The Asian Development Bank has for some years lead partnership of governments, civil society and the corporate sector to share knowledge, build capacity, and to develop projects that will extend access to modern energy services, (ADB, 2010). The Clean Energy Ministerial is a high-level global forum launched by the U.S. at the Copenhagen Convention on Climate Change with the goal of promoting clean energy technology and sharing lessons learned and best practices, (CEM, 2012). The U.S. government has also instituted a programme of technical assistance led by USAID for the development and implementation of Low Emission Development Strategies, (USAID, 2011). Lighting Africa is a joint programme of the IFC and the World Bank program that supports commercial off-grid lighting markets in Sub-Saharan Africa; it aims to build sustainable markets to provide safe, affordable, and modern off-grid lighting to 2.5 million people in Africa by 2012 and to 250 million people by 2030, (IFC World Bank, 2010). The Energy for the Poor Initiative is a venture by the OPEC Fund for International Development, (OFID, 2010). The Paris-Nairobi Climate Initiative was launched by France and Kenya at the 16th Conference of the Parties in Cancun in December 2010; it aims to promote access to clean energy in Africa and other countries vulnerable to climate change, (MDD, 2012). Access to secure, affordable, clean and sustainable energy services is a main focus of the energy programme set out in the recent Agenda for Change that charts future EU technical cooperation, (EU Commission, 2011).

2. Energy efficiency and public policy

2.1 Why intervention is justified

In most economies of the world the basic paradigm for resource allocation is the market. There are both theoretical and empirical reasons for the convergence on this model. In a free market goods are exchanged by consent, prices adjust to reflect scarcity; competition ensures efficiency and innovation. Of course, the notion of a completely free market is a fantasy and inconsistent with most people's ideas of social justice. On the other hand most alternatives have not proved successful, so we live in a world of regulated markets. The market underlies most exchanges, but there is a superimposed network of regulation.

The normal justification for public policy is that it seeks to correct market and / or regulatory failures. Public policy should be subject to *ex ante* impact assessment and the first step in this process is to identify and characterise the failure to be remedied; see for example the EU guidelines for policy assessment, (EU Commission, 2009) or those of the UK Treasury (HM Treasury, 2011). Similar tools for developing countries are from the World Bank (2012) and UNDP (2012). The most common market failures can broadly be divided into six groups:

- Market prices do not reflect social and environmental costs
- Insufficient supply of public goods
- Market dominance
- Missing or incomplete markets
- Agent-principal conflicts
- Imperfect information

Regulations are introduced to correct market failures, but they themselves may fail and need revision. Cases of regulatory failure include:

- Inadequately defined property rights
- Poorly defined targets and objectives
- Unintended consequences of regulation such as barriers to entry
- 'Regulatory capture'
- Implementation and enforcement failure

In the case of energy efficiency the failures are numerous and often severe. All classes of market failure and several regulatory failures are present. The most important are reviewed below.

2.1.1 Market failures

Distorted market prices. There are two very important aspects of market failure that have an immense implication for energy efficiency policy. Universally, the market prices for energy fail to incorporate external social and environmental costs and in particular the external costs of energy production, indoor and outdoor pollution and climate change. It is contentious as to what the social and environmental cost of carbon may be, but it is generally agreed that it is high compared to the prices of fossil fuels, see for example the Stern Report, (Stern, 2007). Externalities can be internalised by taxes or by cap-and-trade mechanisms. The EU has made major strides in internalising the costs of CO2 in the European Emissions Trading Scheme (EU Commission, 2009), but no market in the developed or developing world fully incorporates these costs into prices.

Of more immediate practical significance, many developing countries have heavily subsidised energy prices even in simple financial terms. The IEA, as a part of its annual series of World Energy Outlooks, measures fossil-fuel subsidies; its latest estimates indicate that fossil-fuel consumption subsidies worldwide amounted to $409 billion in 2010, up from $300 billion in 2009, with subsidies to oil products representing almost half of the total, (IEA, 2011). Work by the International Institute for Sustainable Development suggests that the IEA methodology provides a lower limit and that true subsidies may be higher (Koplow, 2009).

The ostensible reasons for fuel subsidies are that they alleviate poverty in countries where other redistributive mechanisms are weak or do not exist and that they promote economic development. In fact, where distorted prices exist, revision of prices to reflect economic costs of supply is firmly in the interests of national economies. There is an immense amount of literature on this topic (see for example (IISD, 2006), (Chomitz, 2008), (Lucas, 2009)). The evidence shows that subsidies encourage inefficient use; increase imports of energy (or decrease exports); weaken state budgets; lead to higher GHG emissions and local pollution; encourage smuggling; benefit the well-off more than the poor and distort infrastructure investment. Despite the economic logic, there are certainly political difficulties in raising energy prices, but there is some evidence that if the increases can be clearly associated with improved medical, educational and other social facilities then they can be successfully introduced. In the absence of proper pricing policy for energy the implementation of policy for energy efficiency is extremely difficult and there is little that international technical cooperation can do to remedy this in the absence of domestic political will.

Insufficient supply of public goods. If a good is public then consumption by one person does not reduce the amount available for others and once created it is available to be consumed by all. Few goods are entirely public, but the funding of public research, development and innovation has some of that quality. California for example imposed a public goods charge on electricity from 1997 until it was recently rescinded. The proceeds were used to fund alternative energy research and support innovative industries, (California Public Utilities Commission, 2011). National governments (and international agencies) can contribute to the supply of relevant research and methodology. Many governments in developed countries struggle to maintain public R&D expenditures at the levels that are thought to be optimum and in developing countries it is still more difficult to maintain an adequate level of funding.

Market dominance. This can be an important failure in energy efficiency policy. Integrated state-owned utilities will frequently give priority to their mainstream task, as they see it, of increasing the supply of energy. This is often true even when the marginal supply of energy costs more than the utility receives in revenues and when economic logic would then suggest that their interest lies in selling less through energy efficiency. In reality their losses are often covered by the state and economic logic does not apply. The picture is not entirely black and white; some utilities have made efforts, but overall their situation is ambiguous and their participation in programmes of Demand Side Management (DSM), Energy Service Companies (ESCOs) and smart grids may be half-hearted; this is regrettable as they are often the major repositories of technical expertise in the area. Integration and state-ownership of utilities does have some advantages in extending grid access because the high costs and low revenues of grid extension can be rolled-up into a universal price for electricity through which urban communities subsidise rural. This not altogether bad, but it is bought at the cost of a serious lack of transparency and cost reflectiveness; there are better ways of proceeding.

Market dominance may also be a concern in smaller markets where one or more suppliers of appliances and equipment dominates the market and can continue to supply inefficient devices. This may be associated also with “regulatory capture”.

Missing or incomplete markets. The markets for finance of energy efficiency investments often do not work well; capital stringency in households and companies may mean that less efficient appliances are bought in full knowledge that the purchase is not cost-effective. Failures in financial markets are especially acute in developing countries where the commercial financial sector is less mature, arising from asymmetric information between borrowers and lenders and high transactional costs (LSE Grantham Research Institute, 2009).

Agent-principal conflicts. These are important in energy efficiency, especially for buildings. The user of a building or plant is often not the owner, for instance in rented accommodation. The owner seeks to minimize the investments in the building, because he does not directly perceive the benefits of energy savings; the user may prefer an efficient solution, but does not have the choice. In theory, if the owner is properly informed he may recognise the problem and find another building, but the conflict of interest does introduce a considerable inefficiency.

Imperfect information. This notion should be generalised to include poor analytical capacity (for example in investment) and a lack of understanding of issues. Even when energy prices are correctly set, people may still choose low-efficiency products. Sometimes this is because they do not have the money (see above), but often it will be because they do not have the information on which to make a more informed purchase or because they cannot process that information. Voluntary or regulatory labelling scheme can overcome this problem as can standards.

It is increasingly recognised that solutions to the interlinked grand global challenges cannot come from technical innovation alone, but will also require social innovation and an adaptation of behaviour. It is necessary to facilitate the dissemination of successful initiatives in this respect, promote the sharing of ideas amongst communities engaged in these experiments and create access by the as yet uninvolved so that they can learn and later contribute. A whole new set of communication tools and information exchange is needed to support these processes.

2.1.2 Regulatory failures

The main regulatory failure that affects energy efficiency is the simple problem of implementing the energy efficiency regulations themselves. Relatively straightforward instruments such as mandatory energy audits, labelling, standards, energy reporting or even following up on the correct use of grants can be challenging for developing countries. This is an important failing for which the obvious remedy is capacity building and methodology transfer. There are some parallels here with ensuring environmental compliance and UNEP's experience in that field could be usefully transferred.

The second main regulatory failure is the difficulty of mainstreaming ideas of SCP (and in particular energy efficiency) across Ministries. Ministries operate under all kinds of political and financial stress and they naturally tend to be restrictive in their perception of their responsibilities. So, for example Ministries of Transport tend to see their responsibilities as managing congestion, operating the licensing of activities and providing infrastructure. Sustainability and energy efficiency are secondary and the regulations that they promulgate will not normally give priority to the objectives of sustainability.

There are also inevitably conflicts between regulations in different fields. The installation of solar water-heating in communal dwellings for example may infringe building regulations or may be impeded by property rights to the roof space. This kind of constant adjustment and accommodation is inevitable in regulated markets and probably no more serious for energy efficiency than elsewhere, but still needs to be addressed.

There are some dangers of regulatory capture. It is always a possibility that utilities have disproportionate influence over their regulator and that this could inhibit energy efficiency regulation. There does not appear to be much evidence for this in practice at present, although participation in obligations imposed by the regulator may be half-hearted. Another area affected by such influence is the adoption of new standards for appliances. Such a move could be conceived by incumbent manufactures as a threat to their markets because they do not have the resources to redesign and restructure assembly lines and do not have the technology to match new requirements; they therefore fear the loss of their markets to foreign imports from multi-nationals already equipped and enjoying significant economies of scale. The domestic manufacturers might well put pressure on local officials and politicians to resist the introduction of standards. This can sometimes be countered by providing protection through a requirement for local content, but there may be implications for free trade legislation.

2.2 Instruments of intervention

There is a variety of instruments by which governments can intervene to correct market and regulatory failures. The background paper for discussion at the High-Level Intersessional Meeting of the Commission on Sustainable Development in Panama in 2011 identifies five tool sets: (1) administrative instruments, laws and regulations; (2) fiscal and economic instruments; (3) planning and public investment in infrastructure; (4) information and analytical tools; and (5) voluntary tools and approaches, (UNDESA / UNEP, 2011). A somewhat similar taxonomy was used by UNDP in their analysis of key points of the Bali Action Plan, (UNDP, 2008).

We adopt the UNDP classification, with a slight change of titles for the classes. The characteristics of each class are summarised in the Table below. The categories are by no means water-tight, for example, labelling, which is an instrument to provide information is introduced by regulation; information programmes in general can be seen to be public goods and so on, but some categorisation is useful as a means of organising the discussion.

Table 3: Policies to encourage energy efficiency

Regulations and standards	
Standards for appliances	Standards for appliances and equipment. Can be introduced as minimum energy performance standards (MEPS) for specified classes of product or as an obligation for the entire range of a manufacturer's output.
Building standards	Buildings are an important special case because they account for 40 per cent of primary energy in most countries and consumption is rising fast.
Mandatory audits and reporting requirements	Industry can be obliged to undertake energy efficiency by mandatory measures. These can be cover: auditing, management, measurement and reporting; training; compliance with norms.
Obligations on suppliers	Obligations can be placed on suppliers in competitive markets to demonstrate programmes that save specified amounts of energy related to their total supply volume.
White certificates	White certificates are issued by an authorized body to certify energy savings; they are used to demonstrate compliance and may be traded.
Energy agency	Regulatory responsibility must be assigned to appropriate institutions; some activities can often be handled by existing institutions, but a specialised energy agency may be created.
Voluntary agreements	
Agreements to reduce energy use	Agreements are negotiated with major users of energy, or trade associations to reduce energy use below some specified target. They may be associated with incentives or threats of regulation.
Agreements to raise efficiency of products	Agreements can also be made with associations of appliance manufacturers to improve efficiency.
Financial and fiscal incentives	
Fiscal incentives	Fiscal incentives reduce the cost of an investment in energy efficiency through tax rebates; they are not directly funded, but still constitute a diminution of state revenues from taxation.

Grants	Funds from central government budgets have historically been common sources for energy efficiency and are still widely used. They have a wide range of applications: to encourage audits, to build capacity, as seed finance for ESCOs; to support investment; to encourage technical and social innovation; to explore lifestyle changes.
Concessional finance	Concessions include low interest rates and/or interest-free grace periods; concessional finance is helpful if banking sector activity in the energy efficiency sector is weak and/or where bank liquidity is poor.
Loan guarantees	Under a loan guarantee the guarantor to pay in the event of default by the borrower. There is evidence that this instrument exerts strong leverage on private finance.
Public procurement	Public procurement is a large part of final demand. There are direct impacts on energy efficiency and high potential to transform the market and encourage. At the same time, governments must ensure value for money and observe world trade rules.
Information Instruments	
Dissemination of best practice / training	This is a very common instrument in which technical assistance (TA) has played a large part. It tends to be low cost, but is most effective when it supports other incentives.
Networking	Stimulation of information exchange within a community (as opposed to didactic transfers) is very important and can benefit from modern media and ICT.
Labelling	Labelling compensates for asymmetric information between users and suppliers of equipment.
Debate on life-style changes	Economic behaviour is largely determined by social values; revision of those values is in the long-term essential to sustainability.
Provision of public goods	
Planning and public investment in infrastructure	More than half of the global population now live in cities; the nature and extent of public infrastructure has a huge impact on energy use and poor practice is difficult to reverse.
Research and Development (R&D)	Research and development into new technologies and new methodologies for assessment contribute to the stock of public goods through spillovers. Research should cover also social innovation and lifestyle changes.

3. Activities of UNEP in energy efficiency

The logic of this paper is that the legitimacy of UNEP's activities in public policy (as for any other actor) must be assessed by the extent to which they contribute to the design of effective and efficient tools of intervention to correct the perceived failures in the way in which the economy works at present.

This section therefore comprises: first, a brief overview of the activities, structured on a programmatic basis; second, a mapping showing how all those activities in principle make sensible interventions or contribute to the design of future interventions; third case studies to demonstrate the practical value of selected activities within each category of tool.

3.1 Overview of activities

UNEP is involved in various ways in numerous projects that have a bearing on energy efficiency and access to clean energy. In many cases energy is a prime focus of the work, generally in the wider context of sustainability; in other cases the emphasis is on a broader approach, where energy is one aspect among many and in a few cases the relationship to energy is relatively weak. The following Table provides a summary of projects and programmes that are relevant.

Table 4: Non-exhaustive catalogue of UNEP work in energy efficiency and access to energy efficient goods and services

Title of the initiative / project	Scale	Description and relevance
National Cleaner Production Centres	Global, regional, national NCPCs in 40 countries	UNEP and UNIDO launched the International Project on establishment of National Cleaner Production Centres (NCPCs) in 1995; there are now Resource Efficient and Cleaner Production services in more than 40 developing countries and economies in transition. Energy efficiency is a priority along with other aspects of environmental and resource use. *http://www.unep.fr/scp/cp/*
Resource Efficient and Cleaner Production / UNEP-UNIDO joint programme	Global, regional, national Ethiopia and Vietnam	In 2009 UNEP and UNIDO launched a new Joint Resource Efficient and Cleaner Production (RECP) Programme as a framework for collaboration with and support to NCPCs/NCPPs. Energy efficiency is a priority along with other aspects of environmental and resource use. *http://www.unep.fr/scp/cp/*
Sustainable product design / Design for sustainability	Global	UNEP promotes design for sustainability and other product related interventions such as product service systems to implement more sustainable consumption and production patterns. Energy efficiency is one consideration, assessed through life-cycle analysis. *http://www.unep.fr/scp/design/*
Task Force on Sustainable Products	Global	The Task Force focused on: science, policy, and convergence towards standardised test procedures (to measure energy performance and to introduce harmonized energy efficiency labels and standards). This led to the establishment of the IEA Implementing Agreement for a Cooperating Programme on Efficient Electrical End-Use Equipment. *http://www.iea-4e.org/* *http://esa.un.org/marrakechprocess/tfsusproducts.shtml*
Lifecycle thinking / assessment	Global	Life cycle assessment assesses the direct and indirect resource use (including energy) of products and practices. *http://www.unep.fr/scp/lifecycle/*
Sustainable Lifestyles	Global	Most activities have been developed under the Marrakech Process Task Force on Sustainable Lifestyles. They explore ways to engage, exemplify, enable and encourage people, civil society organizations and governments to further sustainability in people's everyday lives. The projects are diverse and some have a strong component of energy efficiency and increasing access to energy efficient goods and services. *http://www.unep.fr/scp/marrakech/taskforces/lifestyles.htm*
Sustainable Public Procurement	Global, regional and national - Costa Rica, Uruguay, Mauritius, Tunisia, Chile,	Developed under the Marrakech Process. Sustainable public procurement is a tool which allows governments to leverage public spending (between 15 to 25 % of GDP) in order to promote the country's social, environmental and economic policies. Energy efficiency is one of many aspects to be considered, and would normally be a significant feature. *http://www.unep.fr/scp/procurement/*

	Colombia, Lebanon	
Buildings and Construction	Global	UNEP is working on the development of baselines for sustainable practice in the sector through the implementation of the pilot projects and interactions with other stakeholders. Energy efficiency is one of many aspects to be considered, but would normally be a significant feature. UNEP-SBCI is also developing the tools needed to meet MRV requirements to facilitate building sector-specific NAMAs. *http://www.unep.fr/scp/bc/*
Sustainable Tourism	Global, regional and national	Many activities were developed under the Marrakech Task Force on Sustainable Tourism, and are now continued under the Global Partnership on Sustainable Tourism. Energy efficiency is one of many aspects to be considered and is in many cases a feature. *http://www.unep.fr/scp/tourism/*
Energy Management and Performance Related Energy Savings (EMPRESS)	National	The EMPRESS project, funded by the GEF, was undertaken from 2003-2006, to promote Monitoring and Targeting (M&T), in the Czech Republic and Slovakia. A direct bearing on energy efficiency in the process industries.http://www.unep.fr/energy/activities/empress/index.htm
Industrial Energy Efficiency through a Cleaner Production Framework	Global and national China, Vietnam, India, Hungary, the Czech Republic and Slovakia	The project helped participating NCPCs integrate energy efficiency activities as a part of their core programmes. http://www.unep.org/climatechange/mitigation/EnergyEfficiency/Activities/CPEEProject/tabid/29342/Default.aspx
Developing Financial Intermediation Mechanisms	National Brazil, China and India	The project aimed to substantially increase investments in energy efficiency by the domestic financial sectors in. Important and direct bearing on energy efficiency. http://www.unep.org/climatechange/mitigation/EnergyEfficiency/Activities/FinancialIntermediationMechanisms/tabid/29343/Default.aspx
Sustainable Energy Finance Initiative	Global	SEFI was the UNEP Sustainable Energy Finance Initiative - a platform providing financiers with the tools, support, and global network needed to conceive and manage investments in clean energy technologies, including for energy efficiency applications. The work of SEFI has now been taken over by UNEP's Frankfurt School Collaborating Centre. Important and direct bearing on energy efficiency. ***http://sefi.unep.org/english/home.html***
Training for Energy Efficiency in Buildings (UNEP-FI)	Financial institutions	The objective of the Course is to promote the transition towards a low-carbon economy, through the financing and investment in energy efficiency projects, specifically in Buildings. Important and direct bearing on energy efficiency. *http://www.unepfi.org/training/energyef_training/index.html*
Mediterranean Investment Facility (MIF)	Egypt, Macedonia, Montenegro, Morocco, Tunisia	The MIF develops and tests different options to increase available financing for renewable energy and energy efficiency systems, such as Solar Water Heating and Compact Fluorescent Lamps in Morocco. Direct bearing on energy efficiency. http://climatefinanceoptions.org/cfo/node/282

Energy Efficiency and the Finance Sector (UNEPFI)	Financial Institutions	A survey of lending activities and policy issues of energy efficiency in financial institutions. Direct bearing on energy efficiency. *http://www.unepfi.org/fileadmin/documents/Energy_Efficiency.pdf*
Improving Energy Efficiency in Industry in Asia	Bangladesh. China, India, Indonesia, Mongolia Philippines, Sri Lanka, Thailand, Vietnam	This report was prepared as part of UNEP's Energy Efficiency Guide for Industry in Asia - emphasis is on financing. Important and direct bearing on energy efficiency. *http://www.energyefficiencyasia.org/docs/tools/training_materials/Financing_EE_Review_2006.*pdf
The Partnership for Clean Fuels and Vehicles (PCFV)	Global	The Partnership for Clean Fuels and Vehicles (PCFV) assists developing countries to reduce vehicular air pollution through the promotion of lead-free, low sulphur fuels and cleaner vehicle standards and technologies. Mainly aimed at reducing pollution, minor implications for energy. *http://www.unep.org/transport/pcfv/*
The improvement of urban planning to promote inter-modality	Global	Facilitates a shift from private motorization to public and non-motorized transport modes in urban areas by raising awareness and building institutional capacities. Long-term bearing on energy efficiency and access to energy efficient goods and services. *http://www.unep.fr/energy/transport/activities/*
UNEP Handbook for drafting laws on Energy Efficiency and Renewable Energy Resources	Global	Helpful initiative of direct relevance to energy efficiency. *http://www.unep.fr/energy/efficiency/documents/pdf/UNEP_Energy_Handbook.pdf*
Energy Efficiency Technologies Knowledge Base	Global	Designed to promote and disseminate information on efficient industrial technologies. Intended to stimulate and initiate energy efficiency market transformation. Direct relevance to energy efficiency. *http://62.160.8.20/eetkb*
En-lighten Initiative (Global Market Transformation for Efficient Lighting)	Global National : Morocco, Vietnam	Aims at Global phase out of inefficient incandescent lamps by 2016 and creation of mechanisms for disseminating efficient lighting technologies (CFLs, LEDs). Important and direct emphasis on energy efficiency. *www.enlighten-initiative.org*
Technology Needs Assessment	Global	Aims to identify and support deployment of mitigation and adaptation technology priorities of countries. Energy efficiency is only a part of the coverage, but likely to be important. *http://climatetechwiki.org/*
Supporting Action on Climate Change through regional networks	Regional: South East Asia, Central Asia, Latin America and the Caribbean	Supports the development and exchange of knowledge among climate change professionals. Strong focus on promoting energy efficiency. http://www.unep.org/climatechange/mitigation/sean-cc/
Integrated Approach for Zero Emissions Project Development in the New Town of Boughzoul, Algeria	National : Algeria	Uses the design and development of a new town as an opportunity to introduce best practices in architecture and urban planning including energy efficiency and renewable energy. Large GEF project with UNEP as implementing agency. Potentially important.
Global Solar Water Heating	Global	Aims to accelerate commercialization and market transformation of solar water heating. UNEP

Market Transformation and Strengthening Initiative		contributes global knowledge management; UNDP implements country programmes.
Greenhouse Gas Emission Reduction from Industry in Asia and the Pacific (GERIAP)	Regional	Development of the Energy efficiency guide for industry in Asia and capacity-building of the national focal points and industrial plants; implementation of cleaner production and energy efficiency options; dissemination of the project results and findings; and sharing of knowledge across national boundaries. *http://www.energyefficiencyasia.org/aboutgeriap.html*
Sustainable Alternatives Network	Global	United Nations initiative that offers an advisory service with access to local experts and online information resources, including case studies of businesses that have successfully switched to cleaner technologies.

3.2 Mapping of activities

The manner by which the activities of UNEP contribute to the formulation and implementation of viable instruments of intervention is summarised in the Table 3.

Table 5: Mapping of projects and instruments of intervention

	Regulations and standards	Voluntary agreements	Financial and fiscal incentives	Information Instruments	Provision of public goods
Resource Efficient and Cleaner Production UNEP / UNIDO joint programmes	Input through advice and evidence to the elaboration of policies and regulations, mainly at national level.	Helps support application of sectoral voluntary agreements through active public - private partnerships.	Incentives provided through policy related mechanisms or targeted credit lines.	Many innovative training materials, as well as database on sustainable production practices and technologies.	Generates information tools and research that are public goods. Contributes to awareness raising in the private sector of the respective social and environmental responsibility.
Lifecycle assessment	LCA aids clarity of thought in the design and assessment of regulation.				The dissemination of LCA increases the stock of public tools for analysis.
Sustainable product design	Contributes to improved design that underpins new generations of standards			Potentially influential in transferring ideas	As non-protected ideas the innovative design principles contribute to the public domain of knowledge
Sustainable Lifestyles	In the long-run such work may affect what are perceived as acceptable standards and regulation			Provides information and support to the exploration of new ideas and contributes to social transformation	Contributes to public understanding of social innovation in ways that could reduce energy use.
Sustainable Public	Helps support manufacturers		Provides funding directly to		

Procurement	in meeting more demanding standards		manufacturers and indirectly finances market transformation		
Buildings and Construction	Helps inform the construction of regulations and standards – the social housing aspect are especially useful			Contributes to the dissemination of knowledge about energy use in buildings and its control	
Sustainable Tourism		Helps foster voluntary compliance to certain standards of sustainable(and energy efficient) practice		UNEP's work on sustainable tourism has focused a lot on information instruments, awareness-raising campaigns	
The Enlighten Initiative	This is a multi-instrument activity that includes regulation.	This is a multi-instrument activity that includes agreements with business	Provides recommendations for financial incentives to overcome barriers	This is a multi-instrument activity that includes much dissemination of information	
Energy Management and Cleaner Production	Can contribute to mandatory practices of EE	Encourages voluntary improvements in production practices		Strong emphasis on the dissemination of best practice	Information tools contribute to the stock of public goods
UNEP Finance Initiative	Informing regulation	Led by financial institutions, with UNEP as Secretariat	Influencing financial institutions on investment choices and innovative financial mechanisms.	Innovative training courses	Good empirical work – increasing public understanding
Energy Finance	Activities in countries may result in domestic regulations	Influence business activity and partnerships	Partnerships or advocacy with Governments and private sector to build innovative financial mechanisms	Many training materials Including by collaborating centre	

3.3 Case studies

3.3.1 Efficient Production

National Cleaner Production Centres. Since 1994 UNIDO and UNEP have cooperated to establish and support National Cleaner Production Centres and Programmes (NCPCs/NCPPs) and they now operate in more than 40 developing countries and economies in transition. They cover not only energy efficiency, but a range of topics pertinent to Clean Production including efficient use of resources, waste management, chemicals management and responsible production, Environmental Management Systems, clean technology assessment, development and adoption. Energy efficiency has therefore been a central aspect of their activities and the technical expertise of the centres has been important for the execution of several of the specific energy efficiency projects discussed below. Implementation of energy efficiency projects are part of the normal portfolio of services provided by the Centres and Programmes to the counterparts in the respective countries, where they operate in close cooperation with government, private sector and academia, as well as under the guidance of the project's donor. These projects contribute to the development of the capacities of Centres and Programmes which in a number of countries have been operating for more than 15 years. For example with the projects with GEF, SIDA and the Government of Norway that are described below. An independent evaluation in 2008 noted that there was no overarching programme strategy and implementation agreement between UNIDO and UNEP, (UNIDO-UNEP, 2008).

The evaluation enquired through a survey of a large group of stakeholders, which have been engaged in the development and implementation of Cleaner Production activities since the establishment of the UNEP and UNIDO initiatives in 1994, as to the relative applicability and interest of the various areas of work and found that energy efficiency and renewable energy was rated as 'high' potential by 18 respondents and 'medium' by the remaining 5 respondents. The achievements of the Centres, some of which were analyzed through more direct and in-depth national evaluations, are diverse and vary among countries, but there are some interesting features. The assessment of information dissemination for example found the outputs to be generally between "good" and "excellent", but the outcomes to be less impressive and the impacts to be "unknown", "unavailable" and "weak"; the picture is very similar for training and for policy advice.

Following this review UNIDO and UNEP introduced in 2009 a reviewed joint programme entitled Resource Efficient and Cleaner Production in Developing and Transition Countries. This extended somewhat the remit of the Centres and provided a comprehensive strategic and coherent framework intended to facilitate the scaling-up and mainstreaming of activities and results. This framework included, inter alia, a medium-term budget plan of 70 M€ over five-year period, 75% of which would come from development partners, (UNIDO-UNEP, 2009).

Energy efficiency guide for industry in Asia. This was a principal output of the Greenhouse Gas Emission Reduction from Industry in Asia and the Pacific project funded by the Swedish International Development Cooperation Agency and coordinated by the United Nations Environment Programme. It was implemented in Bangladesh, China, India, Indonesia, Mongolia, the Philippines, Sri Lanka, Thailand and Viet Nam. The Guide comprises a variety of information materials about energy efficiency in process plants and is available in English and several Asian languages; it includes a methodology for auditing, case studies for more than 40 Asian companies in 5 industry sectors, technical information for 25 types of energy equipment, training materials and a contact and information database.

One of its principal features is the presentation on a CD ROM and the possibility to interact with the material. This has some advantages when dealing with senior management who may wish to feel more in control of the dialogue than they would be with more conventional presentations structured around a linear exposition according to the external logic of the presenter. A formal evaluation of the guide found that the work had largely achieved its objectives through: the development of the Guide; capacity-building; implementation of cleaner production and energy efficiency options; dissemination of the project results and findings; and sharing of knowledge among countries, (Bhattacharya, 2006). The cost of the project was a little under $2 million and according to the evaluation a little over 1 million tonnes of CO2 emissions were saved per year. At a nominal value of $20 / tonne that implies remarkable social cost-effectiveness. The evaluation noted that the coordinated network of national focal points was a strength in implementation, although the involvement of government authorities and industry representatives was less than expected and this reduced dissemination and impact. In general terms the project shows what immense potential exists for emission reductions through relatively simple measures, but underlines the great difficulty of getting the information to the potential users, even after it has been prepared.

The PRE-SME project. The PRE-SME project is somewhat similar to the above, but is aimed at supporting Small and Medium Sized Enterprises. It was piloted in Cuba, El Salvador, Costa Rica, Tanzania, Kenya, Uganda, Lebanon, and Sri Lanka. The objective is valid because SMEs contribute substantially to the economies of developing countries and are important sources of innovation and growth, but often struggle to justify allocating time and resources to discretionary activities such as energy efficiency whilst they face many problems in their core business. The kit is primarily targeted at technical support institutions (service providers, CEOs and plant operation managers) involved in promoting Resource Efficient and Cleaner Production in developing and transition economies. The Kit also provides with the rational for implementing more resource efficient operations as well as a management tool for setting-up an industrial Resource Efficient implementation plan. The resource kit includes interactive software tools for diagnosis and management; operational indicators, sector specific benchmarks and training materials. They are well-designed and imaginative

and the project web-site lists some companies in which they have been applied. The project appears not to have been formally evaluated and it is hard to estimate with certainty the impact, but it seems to have been modest. The dissemination of tools was carried out through 4 Regional events (Africa and Asia regional roundtables in 2010, Latin America and Europe. ICC (International Chamber of Commerce) and FIDIC (International Federation of Consulting Engineers) are also partnering to further disseminate the resource kit. Further dissemination and adoption might be achieved upon translation of the resource kit into a number of languages. The impression is of a good and interesting project that has just started its implementation and therefore did not reach out to a critical mass of potential users.

Energy Management and Performance Related Energy Savings (EMPRESS). EMPRESS was a three year project that began in October 2003 and was funded by the Global Environment Facility (GEF); it was designed to promote Monitoring and Targeting (M&T) of energy use in industrial companies in the Czech Republic and Slovakia in association with an adapted financial model using the business model of an Energy Service Companies (ESCO). In this model the ESCO takes the capital risk for an energy efficiency investment in exchange for a share in the cash flow accruing from energy savings. Private sector financing had not been used before in Central and Eastern Europe in this manner. Monitoring and Targeting is a proven, low-cost energy management tool that is almost indispensable in any programme of industrial energy efficiency. ESCO finance is more problematic and its success depends on certain pre-conditions in the financial sector of the host country.

The independent evaluation of the project was positive, although the evaluator noted (with some justification) that buildings are an easier ESCO prospect than industry and that the project would have been better directed to that market. After a slow start, because of the unfamiliar nature of the financial instrument, project objectives were partly met. The numbers of service providers and service contracts were within specification, but GHG emission savings were about half the target. The total investments made were nearly $27 million, of which a little more than $0.5 million was public finance (UNEP and host governments). This is an excellent level of leverage. The project developed a simplified M&T tool that was then made available to National Cleaner Production Centres elsewhere, (Lahbabi, 2010).

Industrial Energy Efficiency through a Cleaner Production Framework. The objective of this GEF-funded project was to reduce emission of Green House Gases (GHGs) in SMEs in six countries – China, India, Vietnam, Czech Republic, Hungary and Slovak Republic - through energy auditing and consequent associated investments. The total cost of the project was $2.7 million and the aim was to reduce the emission of carbon dioxide by 225,000 tons/year. The independent evaluation determined that the emission target was reached and that 87 audits were accomplished by participating NCPCs out of the planned target of

90. Most audit recommendations were for either low cost or no cost measures that were financed in-house. The total investment for projects executed within the project was a little over $7 million, of which a large proportion was in India. The financial leverage does not appear to have been calculated, but it was apparently rather low. Training greatly exceeded expectations and the project supported the publication of a CP-EE manual by UNEP-DTIE and the NCPC in India. This is good material, freely available as a CD-ROM manual with hyperlinks that helped contribute to knowledge exchange networks amongst the participating NCPCs during the duration of the project, (Karrir, 2008).

3.3.2 Efficient Products

Priority Products and Materials: Assessing the Environmental Impacts of Consumption and Production. This study is one of a series of scientific assessments published by the International Resource Panel (IRP) of the United Nations Environment Programme (UNEP). The objective is to assess the state of scientific understanding of the origins of environmental impacts within the economy in a global perspective and to identify priorities among industry sectors, consumption categories and materials. One of the most interesting results of the study is the insight that it gives into the way consumption patterns drive production and how they vary between developed and developing countries. In industrialized countries housing, mobility, food and manufactured products typically determine over 70% of the impacts of household consumption. Government consumption, although significant, and investment in infrastructure is less determinant. For developing countries outside Asia, the public sector is often a large part of the economy and government procurement can be important for the life cycle impacts of final consumption. Many emerging economies in Asia currently make large investments in infrastructure, which makes this final expenditure category influential, (UNEP, 2010). Such analysis can help to determine regional priorities for technical cooperation.

The International Task Force on Sustainable Products: This activity was led by the Government of United Kingdom. The Task Force focused its work on three aspects of globally-traded energy consuming products: science, policy, and convergence towards standardised test procedures (to measure energy performance and to introduce harmonized energy efficiency labels and standards). Specific networks were established for: lighting; home entertainment products; electronic motors; and market surveillance and compliance. Collaboration within the Task Force helped to establish International Energy Agency Implementing Agreement for a Cooperating Programme on Efficient Electrical End-Use Equipment (“4E”), which is now the principal mechanism for international collaboration on the topic (IEA-4E, 2011). The Implementing Agreement brings together electrical equipment and energy efficiency policy makers from the industrialised countries and the large emerging economies together to identify and tackle barriers in the efficiency of electrical equipment and the implications for global trade and harmonisation; 4E can consequently provide informed policy advice to member governments. The Implementing

Agreement has been especial influential in motor systems, stand-by power and solid-state lighting. The Task Force also organised jointly with the IEA a workshop intended to share best practices on compliance and enforcement against product standards. This is a very important topic where UNEP with its broad experience of regulatory compliance and regulatory risk management could contribute more.

Sustainable government procurement: The work on this topic has mainly been performed under the Marrakech Task Force on Sustainable Public Procurement launched by the government of Switzerland in 2005. The basic idea is that public procurement should take sustainable environmental, social and economic considerations into account. By this means governments can directly affect their own impacts on the environment, but also contribute to a transformation of the market towards less damaging products by underwriting through their purchases some of the costs of retooling and restructuring distribution. To do this requires tools that accurately reflect the cumulative environmental impacts along the value chain and for this purpose Life Cycle Analysis is an appropriate scientific tool, but a management tool to implement the procurement process is also needed. As no suitable existing tool was found, the task force created a new tool building on the methodology of the UK Sustainable Procurement Task Force; this was then disseminated within a training and guidance package and the approach is currently being tested in 11 pilot countries. Although no formal evaluation of the project has been undertaken the Activity Report of the Task Force presents a convincing account of its achievements, (UNEP / FOEN, 2011). The work accomplished is substantial and provides an excellent basis for replication; the potential impact could be high.

Design for Sustainability (D4S) a practical approach for Developing Economies: This is a good treatment of how life-cycle analysis can be used in practice to reduce lifetime energy costs through an appropriate focus at the design stage, (UNEP TU Delft, 2006). In the longer-term this is a critical input into making more energy efficient products. Good design is not necessarily expensive and can have a big influence on energy use. The guide is based on an earlier review published as “Design for Sustainability: A Global Guide”, (UNEP, 2006), but modified for the specific needs of small- and medium-sized companies in developing economies; it identifies and describes a practical, step-by-step approach through needs assessment, redesign and benchmarking; reference information and case studies are also provided. The manual is the product of a long-term partnership between UNEP, Delft University of Technology and a range of international experts. The intention was to disseminate the D4S concept through the NCPCs, but it is unclear whether that ever happened. There seems not to have been the follow-up which the importance of the topic and quality of the work deserve.

Sustainable Buildings and Climate Initiative. The UNEP-SBCI is a partnership between public and private sector stakeholders in the building sector, working to promote sustainable

building policies and practices worldwide. It has a variety of goals and objectives including: advocacy within and outside the building community; the development of tools for performance assessment; the support of policies for sustainable buildings; piloting of tools. One of its principle outputs was the release at COP 15 of the report, "Buildings and Climate Change: a Summary for Decision-Makers", (UNEP SBCI, 2009). Buildings account for more than 30 percent of worldwide energy use and the rate of construction in developing countries is very high - especially in Asia, but also Latin America and South Africa. Buildings generate 8.6 billion tons of CO2eq per year and this will double over the next two decades.

There are substantial possibilities to reduce energy consumption in existing buildings, but especially in the design of new stock. None of these findings are new, but the report does propose practical actions for creating a carbon-neutral building sector involving national and international policy makers, municipalities, the construction and finance industries and civil society; it also makes recommendations for realistic and potentially effective actions post-Kyoto such as: performance-based indicators to use for project approval and monitoring; the development of performance-based baselines for different types of buildings; devising means to support activities aiming at providing poor people with access to energy to meet their basic needs for shelter; using statistical means of MRV rather than direct measurement. In these matters, bearing on what the international community can do to support better performance in buildings, the report is innovative and significant.

en.Lighten Initiative: This is a partnership initiated in 2009 between the United Nations Environment Programme (UNEP), OSRAM AG and Philips Lighting with the support of the Global Environment Facility (GEF); the National Lighting Test Centre (NLTC) of China joined in 2011. The objective is to reduce energy use in lighting through a global market transformation achieved by a coordinated global strategy and by providing technical support. A core activity of the partnership is the conduct of Country Lighting Assessments to demonstrate to decision-makers the financial and environmental benefits of improved lighting and in particular the replacement of incandescent lights by CFLs with equivalent light output. The annual global savings in emissions from phasing out incandescent lamps is roughly equal to that from the electricity sectors of the United Kingdom and Denmark combined.

The partnership seems to have had some policy influence; regional seminars in 2011 for South East Asia, Latin America and the Caribbean and the Middle East and North Africa attracted government representatives from 56 countries and gave support to the concept. To support the process UNEP has created a Centre of Excellence on Efficient Lighting, comprised of international experts from some 30 countries to provide guidance and technical support. A toolkit to provide guidance for countries on how to transform their markets to efficient lighting is expected to be published in early 2012. In 2011, at the Durban Climate Change Conference UNEP and GEF jointly announced that the en.Lighten

initiative had set a target of 2016 for the global phase-out of incandescent lamps and at the same time the South African Government committed to a 2016 phase-out of incandescent lighting, becoming the first African nation so to do.

The Partnership for Clean Fuels and Vehicles: This partnership was launched at the WSSD in Johannesburg in 2002 and now has over 90 partners from government, research institutions, international agencies and civil society. It is primarily intended to help developing countries to reduce vehicular air pollution from lead and combustion products and has been especially successful in phasing-out leaded petrol, (Todd & Todd, 2010). This is relevant to the determination of pertinent skills for energy efficiency because it shows how the multi-disciplinary nature of UNEP permits it to build coalitions of industrial and regulatory interests to determine effective, but commercially viable routes to environmental goals. Recently the PCFV has extended its activities to include fuel economy and is a participant, along with the IEA, the FIA Foundation and the International Transport Forum in the Global Fuel Economy Initiative (GFEI) that aims to improve automotive fuel economy in developing countries by the collection and distribution of best-practice. In particular the GFEI: collects and analyses data pertaining to fuel use by country and region; supports national and regional policy-making efforts; conducts outreach and awareness raising to stakeholders. This is a vital initiative because the global vehicle fleet on recent trends will triple by 2050 and over 90% of the increase will be in developing and transition countries. The initiative has defined a "50by50" goal (an improvement of 50% in average worldwide new car fuel economy by 2030, leading to a 50% improvement in average worldwide on-road fleet fuel economy by 2050), (GFEI, 2011).

3.3.3 Sustainable lifestyles

YouthXchange climate change and lifestyles guidebook. A Task Force on Sustainable Lifestyles was created in 2005 by the Swedish Ministry of the Environment as part of the Marrakech Process; its aim was to engage with governments and civil society to further sustainable lifestyles by gathering and disseminating best practice. The Task Force formally concluded in 2009, although some activities continue. The output of the Task Force is prolific and covers 43 regions and 11 different languages, (MoE Sweden UNEP, undated). Most of it has some connection to energy efficiency, but sometimes peripheral. One of the most interesting activities in relation to energy efficiency and access to energy efficient goods and services is the UNEP/UNESCO "YouthXchange" programme and in particular the Climate Change and Lifestyles Guidebook, (UNESCO and UNEP, 2011a). The idea preceded the Swedish funding and was initiated jointly by UNEP and UNESCO in 2001 with an original target audience of young people in developed countries. The main target of the Swedish funding through the Task Force was youth in developing countries and the tools have consequently been revised and implemented in Asia Pacific, Europe, Latin America and the Caribbean and West Asia and are currently being adapted for Africa.

The objective is to empower youth to take action on sustainable lifestyles through information that respects local culture. It is a complex project using a range of ideas to reach young people including peer-to-peer communication, a variety of media, celebrity endorsement and high visibility events. The concept seems useful and potentially influential over the long-term; middle-class young people in developing countries can have high carbon footprints and they act as role models for the less fortunate. If their attitudes can be shifted to a stronger emphasis on sustainability then it will be important. The problem is that accurate measurement of impact is hard to make. The internal evaluation of the project recognised the difficulties, but concluded that many people in many countries have been reached, capacity and partnerships have been built, and lessons learnt. The empowerment of local organisations that have put significant voluntary time and effort into the project has leveraged further spontaneous initiatives.

Sustainable Tourism: Excellence in Energy for the Tourism Industry. UNEP has a substantial body of work on sustainable tourism, much of which quite correctly addresses biodiversity and local environmental pollution, but there are some elements that also bear on resource efficiency. The project "Marketing Assistance to Nepal for Sustainable Tourism Products" was to demonstrate that sustainable tourism can be a market asset; it was very successful in that respect and had immediate impact through reduced waste flows, lower electricity bills and higher incomes among women, (UNEP, 2009). A separate project 'Excellence in Energy for the Tourism Industry', promotes energy efficiency and the rational use of energy resources in hotels. A user-friendly tool for benchmarking and capacity building for energy efficiency in the hotel sector has been developed in conjunction with the UNWTO and Intelligent Energy Europe. The target groups are hotels, hotel associations, national tourism bodies, tour operators, suppliers and manufacturers in the field of energy efficiency and renewable energy use. The notion is good, but there seems to have been no systematic evaluation and no published evidence about the effectiveness of the project.

African Rural Energy Enterprise Development (AREED) Programme. The AREED Initiative was implemented by UNEP to extend access to energy among the rural poor of five countries of Western and Southern Africa, (Ghana, Mali, Senegal, Tanzania and Zambia). The aim was to foster new sustainable energy enterprises supplying clean, efficient, and renewable energy technologies. The initial phases of the programme from February 2000 to December 2002 offered technical assistance, but a later phase offered start-up financing to local organizations and SMEs engaged in social enterprises and sought participation by microfinance institutions and local banks. The independent evaluation found that despite initial difficulties the project was successful in building capacity among local partners, particularly local NGOs and SMEs. There was evidence of a range of successful enterprises including rural photovoltaic lighting (energy saving when it replaces kerosene lamps); efficiency stoves, efficient light bulbs and LPG stoves that replace charcoal, wood and dung, (N'Guessan, 2009).

Global Network on Energy for Sustainable Development. This is a world-wide network facilitated by UNEP and designed to analyse energy options and policies that can help meet the Millennium Development Goals (MDG). It comprises 9 institutions in Africa, Asian and Latin America. Work on particular aspects is contracted to member institutions and reviewed in regular meetings. Considerable work has been done on ways of extending energy access to the urban and peri-urban poor. An independent mid-term review found that the network was financing pertinent research in several important niche areas and that the quality and relevance of outputs was high although the target audience for the outputs was not always clearly defined. The evaluation found anecdotal evidence that there had been some influence policy processes, but that there needed to be a more sustained and sophisticated strategies of dissemination and better access to policy making circles, (Mann, 2010).

3.3.4 Innovative Finance

Sustainable Energy Finance Initiative (SEFI). UNEP has created a partnership the (UNEP Finance Initiative) with some 200 financial institutions and a variety of partner organisations to develop and promote linkages between sustainability and financial performance. The Sustainable Energy Finance Initiative is a joint venture of the UNEP Finance Initiative and the Energy Branch to create a platform for financiers that will provide them with the tools, support, and global network needed to further their investment strategies for clean energy technologies. Its functions are to provide timely information, to facilitate the negotiation of deals, to develop partnerships, to catalyse public-private alliances and to mainstream sustainable energy within the energy investment community. Its main activities are networking and the publication of detailed and timely reports drawing of the pooled expertise of its network members; the 2006 report on financing energy efficiency is especially pertinent, (BASE SEFI, 2006).

Developing Financial Intermediation Mechanisms for Energy Efficiency Projects in Brazil, China and India: This was an ambitious project designed to stimulate increases in energy efficiency investments by the domestic financial sectors in Brazil, China and India, the three largest economies in the developing world. It sought to identify and to overcome barriers to finance of energy efficiency investment and to identify financial mechanisms adapted to each country's conditions. It started in November 2002 and finished in 2006. An independent review of the project concluded that the level of investments in energy efficiency has been improved through the project activities, at least in Brazil and India, but that it was not possible to make quantitative estimates because the records of the financial institutions were not adapted to such an investigation. In Brazil, several public and private banks have integrated energy efficiency within their portfolios as a result of the project; in India the project encouraged five banks to draft dedicated credit lines for energy efficiency and three were actually implemented; in China, a pilot project was launched to convince

banks to adopt EE financing schemes and to demonstrate a project appraisal methodology, but the banks would not finance any of the 12 projects identified by the project. The main recommendation of the evaluation was that in future similar projects concerned with the design of financial instruments it is essential to include monitoring tools to document the volume of investments, the foreseen energy savings, and the GHG emissions reduction, (Morel, 2008).

Energy Efficiency Financing in Buildings Online Course: The UNEP Finance Initiative runs several on-line training courses for the financial sector. The buildings training course is designed to enhance the capacity of financial institutions to investment in energy efficiency projects, specifically in buildings and to encourage a greener outlook its clients generally. It is an innovative project with apparently a very high capacity for replication, but there seems to be no public evaluation of its success or measurement of its impacts.

Using Carbon Finance to Promote Sustainable Energy Services in Africa (CFSEA). This project was designed to accelerate the implementation of CDM projects in Africa; it was funded by UNEP and the Carbon Finance Unit of the World Bank and implemented in Ghana, Mozambique, Zambia, Mali and Cameroon. According to the independent evaluation, Designated National Authorities were established in all the countries together with the legislative framework and operational capacity and four CDM projects were registered, but no Certified Emissions Reduction (CER) deal flow was established, (Frydenberg, 2010).

Mediterranean Investment Facility (MIF). This is a joint initiative of UNEP and the Italian Ministry for Environment Land and Sea that aims to introduce financial mechanisms in Mediterranean countries (Tunisia, Egypt, the Former Yugoslav Republic of Macedonia, Montenegro and Morocco) to support renewable energy and energy-efficiency systems, such as solar water heaters, photovoltaic systems and compact fluorescent lamps, and to ensure their sustainability by strengthening the capacity of local stakeholders. Money provided by the Italian government was used to support financial intervention by UNEP in a variety of contexts; the value of project was modest, $10.2 million, but in some cases the results were substantial.

In Tunisia, the MIF project supported the very successful Prosol project for solar water heating through a loan facility arranged jointly by the MIF, the Tunisian National Agency for Energy Conservation (ANME) and the Société Tunisienne de l'Electricité et de Gaz (STEG). Under the arrangement the investments in solar water heating benefitted from a 20% subsidy plus a credit line from the electricity utility over five years repaid through the electricity bill. This had a strong impact; by 2009, 400,000 m2 of solar collectors had been installed in the residential sector and 5,000 m2 in the tertiary sector; 45 manufactures had been approved and more than 1000 installers. The success of the financial intervention owed much to the strong government policy and the high competence of the Tunisian

Energy Agency. The success of the Prosol project has led to similar approaches in 11 other countries. The project shows very clearly how financial support can be determinant when combined with supportive and sustained government policy and locally competent institutions.

Cleaner Production Financing. In 1999 UNEP started a four-year project aiming at stimulating investments in cleaner production through demonstration projects designed to help local experts in cleaner production to develop creditworthy investment proposals. The project, focused on five demonstration countries: Guatemala, Nicaragua, Tanzania, Vietnam and Zimbabwe and was conducted under a trust fund created by the Norwegian Government. The intentions were: to demonstrate how to initiate and facilitate the financing of cleaner production investments through case studies of these countries; to develop financing instruments along with strategies for supporting public and private financial institutions and the industrial community to adopt them; to motivate key decision-makers.

Core teams of national experts were created in each country and trained to facilitate the preparation of cleaner production investments. Portfolios of cleaner production loan applications were prepared in each country and some have since been financed. Reviewing the experience, a UNEP staff member concluded that the project demonstrated that: cleaner production is frequently an investment with a return; prevention of loss of materials or products is a mainstream business concern; cleaner production is concerned with long-term profitability; it is a strategy that requires a change in attitude and behaviour, (UNEP DTIE, 2002). It is not clear which if any of the financed projects were intended for energy efficiency, but in any case the same lessons apply.

3.3.5 Overview

This review reveals:

- A large volume of high quality work, well-balanced with a good coverage of the spectrum of various aspects of EE and access to energy efficient goods and services
- Generally well-managed projects that mostly achieved the specific results intended
- An impact that without being disappointing often seems a little below what one might have hoped from the quality of the work
- The institutional base, the capacity in UNEP (except for economic analysis) and the networks are in all place for a much larger roll-out with much higher impact
- A weakness in conventional economic analysis – important in real decision-making

The reasons for the problematic impact are hard to determine. Tentative hypotheses might be:

- Projects are not always as embedded in government policy as is desirable, driven sometimes more by donor perceptions and interest than government's perceived need
- Projects are generally not sustained long enough and do not achieve all the synergies that seem possible on paper. In many developing countries there is often little real interest until there are results and by that time the project has ended, so that there is often insufficient transmission of knowledge to local counterparts.
- Although technical cooperation agencies do cooperate in many respects, they still have their own agendas and there can still be overlaps, gaps and even conflicts in their approach to a given topic
- The perennial tool of energy price subsidies conflicts with can effectively counteract or nullify the effect of even the best of programmes

Some of these issues could be resolved in an agreed long-term donor-country-agency programme as intended for the 10YFP, especially if technical assistance was made conditional on price reform.

4. Assessment of UNEP's position

This section assesses the significance of the activities of UNEP in the context of completed and continuing international and national programmes. It first defines the criteria and indicators of assessment, and then it reviews the experience of UNEP and other actors under the various categories of instruments. It concludes by identifying strengths and weaknesses of the UNEP programmes in this area, the opportunities and possible threats.

4.1 Criteria and indicators of assessment

The terms indicators and criteria are sometimes used interchangeably, but strictly a criterion is the rule or principle on which a judgement is made and an indicator is a property that can be measured qualitatively or quantitatively to demonstrate whether or not the criterion is met. Performance of policy interventions should be assessed against the objectives of the policy and against relevant criteria and indicators of success.

The criteria adopted by the Multilateral Development Banks to assess and prioritize proposed programmes and projects are described in the guidelines of the Clean Technology Fund, (CTF, 2009). They are:

- Potential for GHG Emissions Savings
- Cost-effectiveness
- Demonstration Potential at Scale

- Development Impact
- Implementation Potential
- Additional Costs and Risk Premium

The set is broadly consistent with the five criteria used by the Special Report on Renewable Energy Sources of the IPCC to judge the success of policies in renewable energy, i.e. Effectiveness, Efficiency, Equity, Implementability and Replicability, (SRREN, 2011).

The criteria employed by SRREN seem better adapted to the assessment of strategies and policies so that is what will be used here.

4.1.1 Effectiveness

This is the extent to which the intended development objectives of a policy are achieved. It is distinct from cost-effectiveness which measures the relationship between impact and inputs and is included within the criterion of efficiency.

The objective of energy efficiency policy might be to save energy or alternatively to reduce the amount of energy used per unit of output. To convert these criteria into suitable indicators is not straightforward. It is necessary to separate the influence of the policy measure from all other factors and it is also necessary to be able to compare the impact of the measure with the potential.

4.1.2 Efficiency

Efficiency measures the relationship between the resources employed and the results achieved. An efficient policy will achieve its objectives with minimum resources. It will need to be measured differently for different instruments. For example in measuring the efficiency of using public funds to provide concessional financing important criterion will be the extent to which public money leverages private funding. The large volumes of investment necessary for wide-scale adoption of energy efficiency will need to come mainly from private investment; the necessary leverage is best achieved by targeting public funds at key obstacles to deployment.

4.1.3 Equity

Sustainable development is not simply a matter of solving technical problems of depleting resources; it also depends on building fair and equitable societies. As noted at the beginning of this paper societies are not becoming more equitable, rather the reverse, to the point where in the view of some the consequent threats to global socio-economic system are as serious as those of climate change. Equity can be pursued through policies designed explicitly for that purpose, but it should also be a criterion of policy design in general.

The optimal technical design of a regulation may need to be modified, or compensating mechanisms introduced if it threatens to impose costs disproportionately on those who are already poor. Equity is sometimes distinguished as horizontal or vertical. “Horizontal equity" measures the extent to which people in similar income groups are affected by a new tax or measure. "Vertical equity" measures how the burden is distributed among different income groups. In this case a measure that affects the rich more than the poor is “progressive," and a measure that does the reverse is "regressive".

If public funds, that might be used to improve housing in poor areas or to provide health care and education, are instead used to subsidise energy efficiency investments in the middle-class then there may be negative impacts in terms of equity. Because the wealthy use more energy than the poor there is a general danger that expenditures on energy efficiency policy that are funded by consumers will be regressive. This needs to be balanced by programmes aimed specifically at the needs of those who are less well-off and the least likely to afford energy efficiency improvements. This is not only an issue for developing countries; in 2009, about 21 per cent of all UK households were in fuel poverty according to the official definition, (DECC, 2011). Programmes that are funded from taxation have a tendency to be progressive, because the rich should, but do not always, pay proportionally more tax than the poor.

4.1.4 Implementability

Policies are not necessarily transferable from one country or sector to another. Reforms may not survive without continual support from technical cooperation. Implementability reflects the extent to which an intervention is viewed as legitimate, gains acceptance and is adopted by the target country or community. Certain pre-conditions favour implementability. A policy is more acceptable if it is likely to help achieve pre-existing policy objectives and targets. It is more likely to succeed and to be sustainable if there is clear ownership in the host country and the institutional capacity to continue to satisfy the technical and administrative needs of the measure over the long-term, (CTF, 2009).

4.1.5 Replicability and scaling-up

Technical cooperation projects should stimulate lasting changes in the structure or comportment of market. They should ideally be capable of spontaneous replication by commercial entities, or failing that they should be replicable and capable of up-scaling with rapidly decreasing needs for external intervention. The Clean Technology Fund has formalised the concept of “transformation potential” to mean the extent to which the deployment, diffusion and transfer of technologies and the implementation of policy reforms result in significant reduction in emissions growth against a national, regional or sector baseline, (CTF, 2009). UNEP’s contributions to the development of sector-specific MRV methodologies and the promotion and demonstration of NAMAs, for example in the building sector, could provide potential for considerable scale-up and replicability regionally

and globally.

4.1.6 Trade-offs

Normally, no policy will be superior in all respects; there will be trade-offs to be made and the criteria are non-commensurate. There are three main ways by which non-commensurate criteria can be managed. The first is by establishing clear interpretations as to what is sought under each criterion and then reaching a consensus through debate. This can work when the community involved is rather small and shares common values and ideas, but there is a practical limit to the number of criteria than a decision-maker can successfully consider together.

Analysis of large, complex systems is facilitated by scientific techniques such as Life Cycle Analysis, but the results will be take the form of a set of quantitative and qualitative indicators that may be discontinuous, non-linear, and constrained. To process this information and come to a decision is probably beyond the capacities of most people. One option is to monetise some of the otherwise non-commensurate quantities – environmental externalities have been much studied in this respect. Utility theory has theoretical attraction in this respect, but there are few practical applications.

Multi-criteria Decision Analysis (MCDA) is another tool that can be combined with LCA as for example in the NEEDS project funded by the EU. In a first stage of this methodology several hundred individual stakeholders completed an iterative MCDA analysis of their preferences regarding energy technologies. These final choices were then used to map how the sustainability performance of different technological options varied based on stakeholder preference profiles with the aim of providing to a decision-maker a consolidated account of the positions of the various groups affected by the available options. It supports decision-making, but it still leaves the decision-maker to make a final judgement, (NEEDS, 2009).

4.2 Assessment of current practice

There is a vast quantity of experience of policy instruments for energy efficiency that cannot be easily summarised and assessed. This section reviews some of the main practices and indicates where they have been successful and the factors that make them successful. An important reference for this analysis is the Policies and Measures Databases held by the IEA; information in the database for IEA members is reviewed by national governments; there is also some information on Brazil, China, India, Mexico, Russia and South Africa, but this is not reviewed; most developing countries are excluded (IEA, 2012).

4.2.1 Regulations and standards

Equipment standards: The main regulations and standards used to promote energy efficiency are standards and labels for appliances, mandatory measures for industrial practice and obligations laid upon utilities. We exclude other instruments that are

implemented by regulation such as labels (which come under information instruments) and fiscal incentives that also reviewed separately.

There are two approaches to setting standards for appliances and equipment. One way is to establish minimum energy performance standards (MEPS) for different classes of products (e.g. refrigerators of a certain size and design), so that every unit within a certain class has to meet or exceed that standard; the second way is to set an average performance for the entire range of a manufacturer's output; compliance is more difficult because it involves aggregating across classes of product and requires more market information and more extensive testing. The first approach is more common. Standards have been an important and wide-spread instrument of policy. The IEA database lists 165 standards in place in 30 countries including Brazil, China, India and Russia.

There has been relatively little post hoc evaluation of MEPS. One difficulty is that programmes take effect over a long period and it is not obvious what would have happened if the standards had not been introduced. A detailed examination of standards for refrigerators in Australia and the UK concluded they had been effective and efficient, (Lane, Harrington, & Ryan, 2009). It is possible that performance in developing countries would be less, given the weaker enforcement. The general conclusion that standards work and are cost-effective probably still holds, but some clear evidence to that effect would be helpful.

The GEF Climate Change focal area strategy and strategic programming for GEF-4 from 2007 – 2010 listed the promotion of energy-efficient technologies and practices in appliances and buildings as the number one long-term objective, (GEF, 2007). The GEF has subsequently financed very many projects of this kind, but there seems to have been no consolidated evaluation of the efficiency and effectiveness and this would be useful to have.

The efficiency of standards in developed countries is high, because the costs of testing and monitoring are spread over large markets and because regulatory compliance is generally efficient. This may not be true of developing countries where test facilities are more difficult to arrange and regulatory compliance if often poor, with serious problems of smuggling and sale of non-compliant equipment to the detriment of honest manufacturers. There is a tendency for donors to support the establishment of standards, but not the test facilities and the monitoring. The implementability is very dependent on the ability to fund the testing facilities and to achieve regulatory compliance.

Better international cooperation on energy performance standards, (ECEEE, 2008) could improve efficiency, effectiveness. It would be helpful to have an international alignment of testing procedures and protocols, comparable definitions and common approaches to establishing specifications. This would support developing countries and reduce the chances of creating non-tariff trade barriers. Regional testing facilities could also reduce costs, but

countries tend to prefer to control their own processes.

The costs of standards normally fall on the consumer; the higher costs of the more efficient products are passed on by the manufacturer. In the long-run, most consumers should save money, because the operating costs of the appliances are lower. Lower income groups have higher implicit discount rates so standards have a slight tendency to be regressive, but it is unlikely that the effect is significant.

In terms of international equity, standards may disadvantage DCs in the short-term through payment of licence fees to make the more efficient models, retooling cots or production lines and loss of markets if they do not match standards. In the longer-term, higher standards should improve the competitive position of the industry internationally. Much depends on how the industry responds and state help for retooling and innovation is a useful adjunct to standards.

UNEP has contributed to this area through its Task Force on Sustainable Products, in particular through its work on the IEA Implementing Agreement for a Cooperating Programme on Efficient Electrical End-Use Equipment. UNEP's particular contribution was the creation support of a global network that developed consensus around the idea and a coalition of interests to promote it. UNEP has also contributed to recommendations for strengthening enforcement and monitoring compliance which is an area that still needs more work. The en.Lighten initiative is another example of the capacity of UNEP to develop partnerships of critical mass to implement global agreements, in this case on the phasing out of inefficient lighting.

Building Standards: Buildings are an important special case because: the way they are built will largely determine their energy use throughout their life; large improvements in the energy efficiency of buildings can be achieved at low cost; developers may not make those improvements because of capital stringency and the principal-agent dilemma. Building standards are widely applied across the developed world. The IEA database list 127 measures in 29 countries.

The matter is especially important for developing countries because the present of construction is very rapid. The Asia Business Council scrutinised building regulations and practice in Asian countries including China, India, Indonesia, Japan, Hong Kong, Malaysia, Philippines, Taiwan, Thailand and Singapore. This analysis is a valuable resource that provides an accurate diagnosis of the failings of energy efficiency programs in these countries; it identifies the main problems as poor enforcement of regulations. While all eleven economies covered in the study have building energy standards on paper, most have failed to produce significant energy savings; the Chinese government itself has estimated half of new buildings do not comply with official energy standards, (Asia Business Council.,

2007).

UNEP has made a substantial contribution to this debate through the work of the Sustainable Building and Climate Initiative and in particular the "Buildings and Climate Change: a Summary for Decision-Makers", (UNEP SBCI, 2009). This study proposes practical actions that would engage central and local governments, the corporate sector and civil society. It also makes recommendations for realistic and potentially effective mechanisms for project approval and monitoring, identified by the Asia Business Council as the main problem in improving practice. Further UNEP-SBCI efforts to develop the MRV tools for the building sector, specifically in the Asia region, will contribute to additional practical actions and engagement with governments.

Mandatory measures for industry: Such regulation would normally include an obligation to make energy audits at regular intervals (for enterprises exceeding a defined threshold of energy consumption); it may also require reporting to government at various levels of detail; mandatory appointment of energy managers; mandatory comparison to reference values (norms, benchmarking) for energy use in typical unit processes. Mandatory measures have not been common within OECD countries although they do exist in Japan and Australia and strongly interventionist measures such as mandatory audits and reporting are envisaged in the most recent proposal of the EU for an Energy Efficiency Directive, (EU, 2011). The Japanese energy law imposes very strict obligations including norms for processes; it has been influential elsewhere in Asia (Thailand and China). Mandatory measures are demanding to administer; compliance needs to be monitored and this is demanding in administrative and technical terms.

Supplier obligations: In liberalized energy markets an obligations may be placed on suppliers to invest in energy efficiency. These are mainly used in European countries; The IEA database notes ten schemes in five countries all members of the EU. For example, the Energy Efficiency Commitment in the UK placed on suppliers of gas and electricity an obligation to demonstrate programmes for domestic consumers that saved specified amounts of energy related to their total supply volume. The supplier is motivated to achieve this target at least cost and therefore the programmes should be efficient. Failure to comply is penalized. The UK scheme has since been replaced by the Carbon Emissions Reduction Target, which is a similar commitment for a reduction in carbon emissions generated by the domestic sector. The most recent extension to the programme also encompasses access to energy efficient goods and services as it requires that 40% of savings must be delivered within a priority group of lowest income households; the impact assessment indicates that benefits are around twice the costs, (DECC, 2010). White certificates (used for example in France) are somewhat similar; suppliers are obliged to demonstrate that they either accomplished energy savings directly or have bought certificates from others who can show they have made savings. The proposal for a new

Energy Efficiency Directive of the EU would require national energy efficiency obligation schemes in all Member States. The Impact Assessment associated with the proposal found this to be both an efficient and effective option, (EU, 2011b).

An earlier evaluation of the experience of white certificates in Europe addressed the question of their value in developing countries, (Lees, 2007); it judged that trade in white certificates required financial infrastructure and knowledgeable and skilled market players that might be lacking. White certificates and efficiency obligations work best in competitive electricity markets and these are uncommon in developing countries.

4.2.2 Voluntary agreements

Voluntary agreements between government and industry allow industry a more flexible response than that which can be achieved by regulation and they avoid the adversarial relationship implied by regulation. Industry will often agree to voluntary agreements to avoid regulation and for the administration they are much less arduous to develop than legislation and can reduce the compliance costs. Agreements can be about equipment or plant performance. In the former case, government and representative bodies of appliance manufacturers agree specified improvements in the performance of appliances; the approach has also been extended to vehicles. In the second case individual process industries agree to specified improvements to their own on-site energy performance.

Voluntary agreements have been widely used in the IEA member states. The IEA database records 158 such measures that cover fairly evenly appliances, buildings, industry and transport. They are widely used in North America. The character of the measures is very variable and it is hard to generalise on their effectiveness. There are significant problems of "free-riding" from those who stay outside of the scheme. For example, in the case of appliances, the EU Commission entered into a series of agreements with the European Committee of Domestic Equipment Manufacturers (CECED) that covered 90 per cent of the market for washing machines, refrigerators and freezers, dishwashers and water storage heaters. The concept lost some credibility when CECED decided not to renew the agreements in 2007 and declared a preference for binding standards, because they felt that free-riding non-CECED importers were gaining an unacceptable market share, (CECED, 2007).

A rather inconclusive assessment of voluntary agreements for industrial practice was made by the Joint Research Centre of the European Commission, that the lower costs of preparation and implementation meant that voluntary agreements were in many ways more effective and efficient than a mandatory approach, (Bertoldi & Rezessy, 2010). This conclusion is somewhat at variance with the proposal for a Directive subsequently developed by the Commission, which as noted above, leans towards a mandatory approach.

In developing countries, voluntary agreements are rare. An early pilot project in China was implemented to test the viability of voluntary agreements through a trial in two iron and steel companies in Shandong Province, but it does not seem to have prompted replication. While the general concept of a negotiated agreement was apparently acceptable in principle, it was difficult to reconcile with the traditional practice of annual quotas for energy consumption that were accompanied by fines and penalties if exceeded, (Price, Worrell, & Sinton, 2003).

A study for the UNEP-Sustainable Buildings and Construction Initiative of policy instruments for buildings also concluded that the effectiveness of voluntary agreements was hard to judge, because the evidence was disputed and complicated by the tendency of companies to accept voluntary agreements in order to avoid regulatory measures which tends to contradict the idea of voluntary. Overall, the study concluded that although voluntary agreements could have an impact, mandatory regulations for buildings were more effective, (Koeppel & Urge-Vorsalz, 2007).

There would be few equity implications because of the voluntary nature of the agreements.

4.2.3 Financial and fiscal incentives

Fiscal incentives: These are delivered through the taxation system, either through relief on corporate or personal taxation or as dedicated taxes designed to shift from environmental harmful activities towards cleaner and more sustainable alternatives. Subsidies accorded directly or through the tax system to encourage producers and consumers to choose the inputs and goods that have favourable properties are often included under the heading of fiscal incentives.

Fiscal incentives reduce the cost and therefore indirectly the risk of investing in energy efficiency. Direct subsidies to investment by fiscal means may be effective if they are large enough, but they create little incentive to operate plant efficiently. Performance-related incentives that are linked to savings encourage efficient operation and may be preferred, but they are less likely to reduce perceptions of risk. This is generally less of an issue with energy efficiency than with renewable energy because operational issues are less critical.

Compared to regulations, taxes and other market-based instruments should be efficient; in principle they induce a reduction in impact to the point where the cost of the impact equals the tax and permit the subjects of the tax to adjust their behaviour in the most cost-effective manner. Despite these advantages, tax instruments will generally not be sufficient alone because they cannot cope so easily with market failures other than external costs, e.g. failures in information or market dominance. They will generally need to be complemented by other fiscal instruments, (Kosonen & Nocodeme, 2009).

Tax credits have also the advantage that they are flexible and can be adjusted as markets develop and can be targeted to specific technologies and applications. They are relatively straightforward to implement, all countries have taxation and budgetary policies, and are available to all who qualify according to the terms of the exemption; there is no application and award process. For this reason, they are preferred by some as being less susceptible to corruption and to political manipulation. Their effectiveness depends on the prevailing level of taxation; tax levels in developing countries tend to be low and this limits the effectiveness. For the same reason tax concessions can be criticised as inequitable because they only benefit those who pay tax.

Financial incentives: These divide into investment subsidies and concessional finance; investment subsidies change the perceived cost of an investment and concessional finance changes the financing conditions. The successful development of energy efficiency projects starts with an initial audit then moves through successive stages of project identification, feasibility study, planning and design, construction and operation and finally, evaluation. Instruments to provide support from public finance should be adapted for the special needs of the different stages of the process. Effectiveness depends on the volume of funds made available, the extent to which they leverage private investment and the extent to which they are used wisely. The efficiency will depend also on the leverage achieved and the appropriate allocation.

The World Bank has estimated that its lending programmes in energy efficiency and renewable energy leverages five dollars from elsewhere (World Bank, 2006). The Norwegian Public Finance Mechanism (NorFund) aims to achieve an approximate 10:1 direct leverage effect, (NORAD, 2008). UNEP found that the leverage on public funds could range from 3 to 15, (UNEP and partners, 2009), (UNEP-SEFI, 2008). Credit lines had a relatively poor performance with a leverage of 3 or 4 to 1; the leverage potential of equity funds is medium to high; loan guarantees have variable performance depending on how they are structured. When effectively structured GEF funds can directly leverage USD12−15 of commercial investment into EE projects; technical assistance programmes in general remove contingent barriers to investment and consequently may leverage disproportionately large amounts of commercial financing.

There is much available literature on the need for financial support for energy efficiency and the best way to provide it. A detailed description of experience with public financing instruments throughout the investment cycle was provided by the Basel Agency for Sustainable Energy on behalf of UNEP Sustainable Energy Finance Initiative, (BASE SEFI, 2006). UNEP has also published an analysis of risk implications in renewable energy projects in developing countries that is relevant in many ways to energy efficiency, (UNEP, 2006). The World Bank GEF Energy Efficiency Portfolio Review and Practitioners' Handbook is also interesting because GEF has funded much work in energy auditing, energy service

companies and revolving funds across the world, (World Bank, 2004).

The general theme of most of this work is that the difficulty in scaling-up the volumes of investment in energy efficiency in developing countries arises not from any absolute shortage of funds, but from the reluctance of lenders to make those funds available under acceptable conditions. Banks in developing countries have difficulty in recognising that savings in energy constitute a revenue stream as surely, if not more surely, than a new source of sales. They often lack the technical ability to assess risks and benefits from investments in energy efficiency. The relatively small size of projects may also be a disincentive because it increases the proportional cost of the transaction between the bank and the customer. Banks are similarly cautious about the concept of Energy Service Companies (ESCOs); they typically require equity investment from the ESCO that it may be unable to make because often such companies are very often consulting companies whose balance sheets cannot support substantial investment. The means to overcome these obstacles include the training of banks, the provision of performance norms for typical energy efficiency projects, standardised contracts, proven methodologies of assessment and the provision of guarantees for credit risk.

In equity terms there is no prejudice to the poor. Public funds come from taxation and that is paid disproportionately by the wealthy. The leveraged private funds have no unambiguous equity implication. In so far as financial incentives make money available to those who find it hard to raise finance otherwise, the programmes are slightly progressive. They are highly progressive if directed to support of low income groups.

In this context the Sustainable Energy Finance Initiative of UNEP is relevant. It provides precisely the tools that financiers need to understand better the problems and to stimulate the necessary investment. The joint programme with the World Bank to stimulate increases in energy efficiency investments by domestic banks in Brazil, China and India provides a successful application of the ideas. The partnership between UNEP and private finance networks has intensified since and has delivered a series of reports elaborating the scale of the need, the practicality of meeting the need and innovative private finance mechanisms to do so, (UNEP and partners, 2009), (UNEP-SEFI, 2008).

Public procurement: The public sector is responsible for a substantial share of GDP and can influence energy directly and indirectly by its purchases. If it procures efficient equipment then it has a direct bearing on its own consumption, but maybe more importantly, by procuring equipment at the cutting edge of technological development it can reduce the risks of innovation in design and manufacture and can affect the offer of efficient equipment throughout the market. In that sense it can be seen as a form of public financial support.

A detailed study of public procurement practices world-wide has been published by the World Bank, (Singh, Limaye, Henderson, & Shi, 2010). It includes a range of case studies, overwhelmingly from the developed world. Sustainable public procurement has been practised in a somewhat disorganised manner in the EU and its member states for some time and the Joint Research Centre of the European Commission has reviewed the experience, (JRC, 2010). The review concluded that in most cases energy efficiency was subsumed within wider concepts of sustainability and it was therefore difficult to make an accurate assessment of the impact on energy use. However, the proposed new EU Directive on energy efficiency focuses strongly on requirements on the public sector to renovate buildings it owns and apply high energy efficiency standards to the purchase of buildings, products and services.

Use of public procurement in this way in developing countries is relatively rare although the opportunities are large, as identified in the UNEP project on Priority Products and Materials. The reasons for the limited application are not difficult to find. There is little incentive to cost-reduction in public agencies; little expertise in assessment; complex procurement processes; severe budgetary stringency and limited borrowing capability. The Marrakech Task Force on Sustainable Public Procurement has prepared the ground for implementation through the tools that it has developed and the training performed. Procurement programmes at scale would benefit from linkages to the sustainable finance initiative to overcome some of the funding constraints.

4.2.4 Information Instruments

Technical information: Providing information to people who would otherwise not have easy access is a form of public good, but it is normally seen as a separate activity. It is an important promotional activity in policy for energy efficiency and is widely undertaken. A study by UNDP and the GEF of policies for energy efficiency in buildings recognised that one of the main reasons for the slow spread of energy efficiency is the lack of consumer awareness of what can be done and the costs and benefits of different actions, but the study also listed some reservations. There are few evaluations of the efficiency and effectiveness of general information campaigns, but what there is indicates that public information programmes are less effective than regulatory instruments and are most effective when they complement other initiatives, such as financial incentives, (GEF / UNDP, 2010). This view receives some support from an evaluation of the UK Energy Efficiency Commitment programme which concluded that the information and marketing skills of the suppliers were a valuable adjunct to the subsidies from the programme, (Oxera, 2006).

Equity implications are generally positive as the funds come from the state (or from private companies under an obligation or voluntary programme) and the less well-off will have a tendency to have poorer access to information than more prosperous groups. The impact will be more progressive when directed specifically at low-income groups, but then the

information needs to be complemented by financial incentives.

It is possible that manufacturing industry is a little more proactive than the owners of buildings, but it is likely that the provision of general information will be relatively ineffective, and its impact of short duration, unless accompanied by other initiatives such as financial incentives or obligations. In this respect the materials produced by UNEP such as the *Energy Efficiency Guide for Industry in Asia*, t*he PRE-SME Project* and materials developed under the project on *Industrial Energy Efficiency through a Cleaner Production Framework* have the advantage that they can be disseminated within the context of the NCPCs and their continuing work.

Labelling: Labelling is intended to overcome the market failure caused by asymmetric information. Users of equipment may not have the skills and information to understand the consequences of their choice. Manufacturers may not have an incentive to provide this information if their products are less efficient than their competitors.

Labelling is virtually universal throughout the industrialised world, but there have been some difficulties in introducing it into developing countries. The negotiation of agreements on specifications and legislation may come up against the interests of local manufacturers. The investment and training required for testing and the organization and verification of compliance are big challenges. For example, monitoring and compliance was a problem with the voluntary scheme in China; experience with a voluntary scheme in Thailand suggests that manufacturers and distributors choose not to label their products if they achieve a poor rating; in Egypt (and other countries) suitable testing facilities were not be available and needed to be built.

The transfer of energy-efficient technologies has been a main strategic objective of the GEF since its inception. From the third replenishment of the GEF Trust Fund the strategy has emphasised market-based solutions in buildings, appliances, and industry; the promotion of standards and labelling has been an important part of this work with the UNDP as the main implementing agency. Projects have been implemented in very many countries with the aim to transform the markets of household and office appliances (refrigerators and air-conditioners); electric motors and fans; and lighting products (CFLs and ballasts). Some evaluation of the programme has been made, but the consolidated report is disappointingly anecdotal with no real attempt to assess efficiency and effectiveness, (GEF, 2010).

Nevertheless, labelling appears, on the face of things, to be an effective low-cost measure, certainly for industrialized countries. Current standards and labelling schemes within the OECD are credited with reducing total energy bills across the residential sector by between 10 and 20 per cent, (Waide & Bernasconi-Osterwalder, 2008). Better evidence of their impact in developing countries would be useful.

UNEP has been engaged in 4-year project starting in 2007 that promotes eco-labelling in Brazil, China, India, Kenya and the South East African Region, Mexico and South Africa. (UNEO DTIE, 2011). The Marrakech Task Force on Cooperation with Africa has also promoted the idea of an eco-labelling mechanism for Africa to allow it to compete more effectively for niche markets in the industrialised world and to meet the requirements of retailers wishing to demonstrate environmental compliance along their value chains, (UNEP ARSCP, 2012). Eco-labels are voluntary; qualified participants are licensed to certify their products meet the requirements of a given agency for a particular product category based on life-cycle considerations; they are not primarily aimed at energy efficiency, but at a range of considerations. They do not employ the same kind of testing equipment and test protocols as are need for appliance energy efficiency labelling programmes.

Advocacy: A feature of the UNEP to its portfolio of outputs under sustainable and clean production has been the contribution of the Task Force on Sustainable Lifestyles and its efforts to engage with governments and civil society to further sustainable lifestyles among young people in developing countries, notably through the support given under the UNEP/UNESCP YouthXchange initiative. There seem to be few other initiatives of this sort within the world of technical cooperation, perhaps because lifestyle change is considered too difficult to address and especially in developing countries where the environmental footprint of most people is far too small to be a threat. It is however important. There is a young elite set in developing countries that is strongly consumption-oriented and that has a significant environmental impact. More importantly they are the group from which many leaders of the future will be drawn and they are frequently role-models for other less well-off young people. It is therefore very important to influence them.

Similarly, the Creative Communities for Sustainable Lifestyles project deals with social innovation through grass-roots it contrasts and relates European experience with that from emerging economies like China, India and Brazil and, in particular, their poorer urban populations, (UN DESA, 2012). The impacts of these efforts are rather difficult to evaluate, but they are relatively inexpensive and potentially may be very effective. They are also rather relevant to extending access to energy efficient goods and services because advocacy efforts of this kind could also be deployed to support the commitments that are sought under SE4A.

4.2.5 Provision of public goods

Research, development and Innovation: The extent to which research related activities are public goods depends on to what extent the results are reserved through intellectual property rights, but also to what extent they are successfully disseminated to potential users. In developed countries, pure science tends to have less direct commercial application than applied science and is closer to a ‘public good’; applied science relies more on private

research. In developing countries were commercial research may be weak; there is also a role for government funds in applied research. Governments can stimulate research on energy efficiency either through "demand pull" that creates incentives to improve performance by imposing efficiency standards and regulations or through "technology push" that encourages research through R&D funding dedicated to the purpose. Often a combination of the two approaches is effective. There is some possibility that obliging developing countries to adopt energy efficient practices will lead to a greater dependence on technology from the developed world to the detriment of local manufacturers. Equity considerations suggest that the process should be accompanied by adequate technology transfer and support for local innovation.

Whilst recognising the inherent difficulties in assessing the beneficial consequences of research, the Stern Review examined the role of R&D in climate change and concluded that it was effective and government has an important role to play. It recommended also that international co-operation can help to reduce the costs and accelerate the process of innovation, (Stern, 2006) .

UNIDO has conducted a comprehensive study of the state of research in energy efficiency in developing countries, (UNIDO, 2011) and concurred with the Stern review that international cooperation on research and development (R&D) can support sharing knowledge, coordinating R&D priorities and pooling risk. International cooperation, as UNIDO recognises, is not confined to developed and developing country interactions, but there is increasing R&D cooperation between developing countries also.

The efficiency of public funds in R&D depends on the leverage exerted on private investment and the quality of the work done. Both are hard to assess. The EU *ex ante* Impact Assessment of the new research framework programme – Horizon 2020 – finds value of between 1.7 and 0.4, depending on the industry and time scale. There are also knowledge spillovers that definitely exist, but are also hard to quantify, (EU, 2011). Despite the difficulties of measurement, all industrialised countries see publically funded research as an essential public function. More stimulation of R&D and innovation is need in developing countries to ensure innovative capacity that can respond to modern challenges. Energy efficiency and renewable energy are two areas that would benefit.

The technology cooperation programme of the IEA is an important contribution to linking energy R&D networks and to fostering collaboration with stakeholders in finance and business. The IEA has several Implementing Agreements designed to help share the results of technology research among members and non-member countries. The most relevant to energy efficiency are the Implementing Agreements for Efficient Electrical End-Use Equipment (4E) and for the Establishment of the IEA Energy Technology Data Exchange (ETDE). The IEA4E agreement was reached within the work of the Task Force on Sustainable

Products. The ETDE database includes over 4.3 million research literature citations and links to full research documents. The facility is increasingly used by developing countries; the number of requests from non-member countries, which was only 465 in 2007, rose to 9,967 in 2009, (IEA, 2010).

The work of the NCPCs is potentially very relevant here as they provide an institutional base to contribute to technology transfer, to share best practice and to contribute to cooperation among the countries where they are located. The work of UNEP has also contributed to methodology development of LCA and its dissemination to user groups in developing countries. This is a valuable activity as it strengthens the understanding and negotiating position of developing country sub-contractors to international companies in dialogue over the life-cycle reduction of environmental impacts. The work done under the Design for Sustainability is also a strong contribution to the dissemination of ideas on efficient design.

Provision of efficient infrastructure: More than half of people now live in cities, and according to UN Habitat (2008) by 2030, it will be 60 per cent. The population in cities of the developing world increases by an average of 5 million every month, i.e. by the equivalent of one large city. Cities consume enormous amounts of energy and have great inertia; road systems and land use decided now will influence energy use for a hundred years, Transport in cities creates a third of total greenhouse gas emissions. Promotion of public transport options is critical.

Massive renewal of existing cities cannot be realistically considered, but new planning should recognise the relationship between spatial configuration and energy use and design to reduce it, (Theys, 2008). Transport use per capita in different cities can vary from one to 100; cities in the U.S. are the least efficient with per capita consumption four to six times higher than in Europe. Asian cities achieve levels roughly half of Europe. Research is needed to identify effective decision-making strategies regarding the management of urban space (in the developed world) as well and on how social needs interact with spatial organization.

There seems to be no systematic programme of technical cooperation to improve planning in developing countries with an aim to reduce energy use, although there are many specific infrastructure projects that include improved energy use in their justification.

Training: It is disputable whether training is a public good, because in publically funded training programmes, taxpayers are bearing the costs of training the main benefits of which may accrue to an individual or a firm. On the other hand, investments in public infrastructure are generally considered as public goods and investment in human capital can be seen in the same way. There are also spillovers from training just as there are from R&D and the provision of training materials through public funds can leverage subsequent privately-funded training.

There is remarkably little evaluation of the efficiency and effectiveness of training in general as a policy measure, although plenty of evaluations of specific training activities. It seems to be generally assumed that publically-funded training is a valuable activity necessary for the successful execution of other policies. Trained people are necessary for the design and implementation of regulations, for the design and building of efficient investments, for the construction of financial incentives and contracts and indeed all other measures.

Nevertheless it would be useful to have a training needs assessment for technical cooperation, perhaps along the same lines as that prepared by the Lawrence Berkeley National Laboratory for the Department of Energy in the US, (LBNL, 2010). The conclusions of that analysis for the U.S. do seem intuitively to be relevant also for developing countries. They include:

- Provide energy efficiency education and support targeted at building and construction contracting and trades people
- Coordinate and track training efforts; share best practices
- Increase funding to "train the trainers"
- Increase access to on-the-job training for mid- and senior-level engineers and managers

Against these criteria the UNEP training activities show some strength. Almost all of the activities included in catalogue in Table 2 contain significant training components. Many of the projects also produce good, innovative materials for use by others that constitute a useful basis for training trainers. The existence of the NCPCs provides continuity and helps share best practice; there is a strong emphasis on training of managers and professionals including financiers.

4.2.6 Summary

The Table contains a summary of this assessment according to the criteria identified earlier along with a short note on UNEP's contribution under each heading. For some important instruments it is not possible to generalise about effectiveness because much depends on the way that the initiative is designed and the extent to which it is congruent with national circumstances. This is especially true of the financial instruments. The identification and transfer of best-practice is important, whilst recognising the need for flexibility and adaptation to local circumstances.

It is also clear from the Table that a set of instruments may work better than just one. The dissemination of information by itself is unlikely to change much, but new regulations establish new obligations, then information as to how to comply will be useful. If there is also financial help to make the adjustment that will be better still.

Table 6: Summary by criteria with note on UNEP contribution

	Effectiveness	Efficiency	Equity	Implementability	Replicability	UNEP contribution
Regulations and standards	Effective if regulations are appropriately set and compliance is assured.	Efficient in developed countries. In DCs compliance is a difficulty. International collaboration could help.	May disadvantage DCs through licence fees or loss of market. Offset by transfer of technology. Slight tendency to be regressive.	There is a threshold of effort (standards setting, testing). Compliance is the main problem.	In principle, but countries may define different standards that cause trade barriers.	Good capacity for coalition and consensus building in support of standards. IEA4E is a case in point.
Voluntary agreements	Thought to be generally less effective than regulation. Prone to free-riding.	Low cost and low impact. Efficiency hard to judge.	No obvious equity implications.	Easier to implement than regulation and requires less enforcement.	Rare in developing countries	No substantial contribution.
Financial and fiscal incentives	Variable: depends on volume, leverage and wise use. Leverage requires good design. Appropriate use can be helped by regulation and information.	Variable. Well-designed programmes can leverage 15 times the volume of private finance.	Progressive – especially when for access or for EE in low-income groups.	Implementation of highly leveraged programmes depends on interest of the financial sector. May be low. Advocacy and training of the sector should help.	Programmes must be tailored to national circumstances. General lessons are replicable.	Substantial contribution through coalition building in support of innovative finance.
Information Instruments	Effective when combined with other instruments. Reduced value in isolation.	Efficiency is enhanced when well-combined with regulations or financial incentives.	Progressive as low-income groups have less good access to information.	Easy to implement. Much information is available from technical assistance programmes.	Much information is transferable. International networks	Good production and dissemination of innovative materials. Strong advocacy work. Contribution to eco-labels
Provision of public goods	Essential need for training, research and infrastructure. Effectiveness is project-dependent.	Leverage of expenditure on R&D and training is high	Progressive as tax-payer funded and poorer people pay less tax.	Implementability depends on strength of competence in education, science and planning.	High degree of replicability. Depends on effective international networks.	Contribution to research and innovation through NCPCs and IEA Implementing agreement on efficient electrical equipment. Well-directed training effort.

4.3 UNEP's comparative advantages

4.3.1 Strengths

UNEP's comparative advantage lies not so much in its technical skills, although these are not insignificant, but more in its capacity to conceive and mount multi-disciplinary and multi-dimensional initiatives that embrace a wide range of actors and ways of thinking. This is an advantage that can be traced directly to its fundamental mission to "provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations". The promotion of energy efficiency and access to energy efficient goods and services fit comfortably within that scope.

UNEP's portfolio of activities as summarised and assessed in the preceding Sections mainly depends upon the creation of coalitions of interest among more specialised agencies, governments, manufacturing industry and the financial sector, together with civil society to define in partnership common goals and mechanisms to achieve those goals. These strengths in building coalitions and consensus are important in defining policy for energy efficiency where political will, technical competence, money, public and private interests and administrative compliance have to be combined to achieve results. The work done with the financial services sector on innovative finance mechanism for energy efficiency is a case in point.

UNEP's capacities extend throughout the project cycle from conception and design, through management to dissemination and communication. The materials for dissemination are imaginative and innovative and embrace a variety of media (web-sites, publications, CD ROMs). This is true both of technical materials designed for professional actors, but also for the materials intended to influence final consumers. The emphasis on personal values and personal behaviour in the lifestyle materials, that is something of a hallmark of the environmental community, is also refreshing.

4.3.2 Weaknesses

There is local evidence of successful application of conventional economics and cost-benefit analysis, for example in the Mediterranean Investment Facility and in en.lighten, but it seems not to be systematically applied across the portfolio. This is a weakness because decision-making in real life is much influenced by economic ideas. The reasons were given earlier; economic and financial analysis employs a single numeraire (a currency) that simplifies decision-making and that is congruent with budgetary disciplines that are expressed in the same unit. So a decision maker knows how much something will cost, how long he has to wait to get a return and what part of his budget it represents. LCA is a powerful tool for diagnosis, but it is not of direct value for decision-making. Often the most valuable insights come from contrasting the scientific and the economic perspectives to identify where the economic analysis is distorting and therefore where correction may be

needed.

Another weakness, detected earlier, is the lack of continuity and coherence among the various activities. This has had some advantages in that it has allowed many options to be explored and competence to be developed over a wide field. The view that now prevails and is articulated in SE4A is that focus and programmes at scale are now what is needed. In this context there needs to be some selectivity and a more visible coherence.

It also appears to be the case that although websites are well-designed and functional, they are not always updated as the projects proceed. Information is often available only in English which reduces the target audience and this is often the case for publications. A web-based search tool that could access project results on SCP and possibly results from other agencies is in preparation and this is commendable.

4.3.3 Opportunities

The comparative advantages of UNEP as exhibited in its work on energy efficiency are its skills in:

- Advocacy and communication: especially with consumers and especially in changing behaviour and values
- Building of coalition and consensus: this covers partnerships among public and private interests and civil society, but also in negotiating the cooperation of sectoral Ministries in mainstreaming the ideas of sustainability for example in policies for government procurement. UNEP has developed and maintained a substantial capacity and expertise in working with the private sector and in influencing domestic and international markets
- Innovative finance: Particularly important are the partnerships around finance for energy efficiency and SCP in general. Insufficient private finance in support of energy efficiency is one of the biggest obstacles; UNEP has done valuable work with the finance industry to identify how the commercial prospects of energy efficiency can be grasped through innovative financial arrangements
- The multi-disciplinary and multi-dimensional analysis of problems that can provide the intellectual underpinning of smarter and more coherent (joined-up) regulation

These advantages arise naturally from UNEP's broad environmental mission in which such skills are fundamental. There is another skill present in UNEP that does not seem to have been deployed extensively in the energy efficiency work and that is the monitoring and assurance of regulatory compliance. This is a demanding task in any country, but especially in developing countries. Indeed UNEP in its policy review associated with the Energy Efficiency in Asia programme found that "the structures to enforce legislation, including energy conservation laws, are limited", (UNEP, 2006). Better MRV will be needed to make

sectoral mechanisms work. Regulatory compliance is best developed for taxation and environment and it would be good to apply UNEP's experience in regulatory compliance and regulatory risk assessment to EE.

UNEP has, in the past, been much involved in disseminating best practice in environmental management, including regulatory compliance, at the level of pollutant, industry and country; see for example (UNEP, 1996). More recently, the Division of Environmental Law and Conventions has been active in supporting compliance with Multilateral Environmental Agreements through a series of manuals, including an on-line version, (UNEP, 2007), (UNEP, 2006), (UNEP, 2012) and the Dams and Development Project has produced guidelines for monitoring environmental compliance (Environmental Law Institute, 2007). There has been some application to energy; the Renewable Energy and Energy Efficiency Investment Advisory Facility (now closed) addressed the issue from the perspective of commercial banks and private investors considering investments in sustainable energy, mainly for renewable energy, but also for ESCOs, (UNEP, 2012). A substantial study on the harmonization of energy efficiency standards for air conditioners and refrigerators in South East Asia conducted by UNEP and the International Copper Association also touches upon compliance, (ICA, 2011). These activities have been sporadic, but are applicable to the MRV requirements of NAMAs and sectoral mechanisms and also to the successful completion of access projects.

4.3.4 Extending access to energy efficient goods and services

SE4A aims to mitigate climate change through greater resort to energy efficiency and energy substitution by renewable energy, but it also aims to extend access to modern energy services. What constitutes access is controversial, but certainly includes household access to affordable electricity and clean cooking facilities. A definition might also include the idea that consumption can increase over time at affordable prices and that it might extend to some productive activities. The High Level Group appears to include productive activities in its concept of access, because of their implications for economic growth and employment.

It is clear from the simple idea of "access" that efficiency is secondary to supply. There can be no access without a supply. The reason that there is no supply in most cases will be because it is not commercial and so requires financial support. Much rural electrification is in some way subsidised, often cross-subsidised by other consumers. In this sense, creating access to energy is unlike implementing energy efficiency where energy supplies are easily available. Energy efficiency for urban households, large buildings, factories is in large part commercial or can be made commercial if the proper legislative, regulatory and market framework is in place. Different instruments will be needed to extend access to energy efficiency to those that are required to implement energy efficiency in communities that have enjoyed access for a long time.

This does not mean of course that energy efficiency has no place in extending access to modern energy services. Some cases are obvious; efficient lighting is practically essentially for any power-limited supply as well as being cost-effective and in general any solution to provide access should be as efficient as possible. It does mean however that some analysis is required to extrapolate from UNEP's experience with implementing energy efficiency projects to what it might contribute to extending access to energy efficient goods and services

The substantial financial requirement will mean that the private sector will be critical in ensuring success. Governments will have to work with business to identify barriers, design solutions and provide the pricing strategies and incentives to implement solutions. They will have to develop advocacy packages to attract the participation of the private sector and civil society organisations. UNEP's expertise in advocacy and in working with the financial sector to create innovative financial mechanisms for energy efficiency will be relevant here. It will be necessary also to ensure compliance with regulations and financial conditions; UNEP's experience with environmental regulation and environmental risk management could be useful in establishing appropriate monitoring mechanisms of both technical and financial compliance.

It appears that the High Level Group will recognise the importance of productive uses of energy and the opportunities that they create for income generation in local industry and agriculture. Access to modern energy services will also increase the range of possibilities for community development in schools, hospitals and other communal facilities. Such activities should be consistent with the norms of sustainable clean production and it may be useful for UNEP to develop guidelines for best-practice in those sorts of relatively simple applications.

5. Future options

The preceding Sections demonstrate that UNEP has acquired a strong portfolio of competences in energy efficiency, mainly through its work on SCP and Climate Change that can form the basis of a substantial and coherent long-term programme to implement energy efficiency on a large-scale in the interests of mitigating climate change. It is also a partner within many networks and can coordinate other relevant actors in agencies, governments and the corporate sector; as a partner in the NCPCs it has an institutional basis in many client countries. Some of the same skills and assets could also make a valuable contribution to ensuring that when access is created for new users this is done in the most efficient way.

This Section examines the options available to UNEP to develop activities to promote energy efficiency and improve access to energy efficient goods and services within its future programmes. It sets out criteria for choice; it defines and assesses options according to the chosen criteria; it considers the balance of activity between implementing energy efficiency policies in countries that have well-developed access to modern energy services for a long time and improving access to energy efficient goods and services in those that and finally it considers some particular aspects of implementation.

The analysis is performed at two Levels: Level 1 considers whether there is a case for discriminating among countries according to whether prices are reasonably cost-reflective; Level 2 defines and assesses some thematic options.

5.1 Criteria for choice

A judgement among future options must be based on objective and transparent criteria. The criteria used here are set out in the Table below along with a brief discussion of the meaning and interpretation.

Table 7: Criteria for future activities

Criterion	Comment
Conformity with SE4A	Conformity can be measured by the extent to which actions support the objectives of reducing GHG emission and promoting access to modern energy services, i.e. electricity and clean fuels
Conformity with Rio+20	The focus of UNEP's activities in SCP has been the Rio conference and the envisaged 10YFP; future activities must progress this agenda
Builds on competences	Future programmes must use the acquired skills; acquisition of new competences if needed is not excluded

Congruent with country needs	Technical cooperation will not succeed (in the short-term) unless it responds to needs of government that are perceived and for which solutions are sought.
Congruent with donor preferences	Donor preferences are set by contingent national attitudes, but must be accommodated. They may also be influenced.
Mobilisation of the private sector	The participation of the private sector is fundamental. The volume of investment that is required can come from nowhere else.
Mobilisation of the consumer	Has a critical role to play, given the interest in maximising the contribution of demand side measures, and the growing interest and engagement of civil society in climate change and other environmental issues related to energy.
Effectiveness	The option should deliver large savings in GHG emissions or substantially improve access to energy efficient goods and services
Efficiency	The value of the impact should be much less than the costs of the actions

5.2 Level 1 analysis: Price reform

Pricing policy for energy is the main factor that determines the commerciality of energy efficiency. Technical cooperation in support of energy efficiency in countries with subsidised prices is less likely to succeed than in countries with market-related prices. It is therefore logical that different programmes of cooperation should be envisaged according to the prevailing level of energy prices, because the needs are simply different. Prices might be judged against a threshold (say 90% of the opportunity cost) to determine whether a country met the criterion. The first-level analysis therefore examines whether activities should or should not be composed of two tracks, one for countries with prices that broadly reflect costs and one for countries where they do not.

- **Conformity with SE4A:** a programme that discriminates among countries on this basis may deliver the objectives of SE4A better than one that does not as it will enable programmes to be tailored more closely to country circumstances
- **Conformity with Rio+20:** this criterion does not appear to discriminate strongly. It may favour the non-discriminatory option in that it appears to permit a stronger focus on pure SCP activities, but the discriminatory option may deliver EE more effectively and this is an important part of SCP
- **Builds on competences**: UNEP would be competent to implement either option equally
- **Country needs:** There is little point for the countries in trying to implement programmes that cannot function commercially at prevailing prices; it is at best a distraction and a diversion of scarce technical skills
- **Donor preferences:** There is increasing concern among donors that in the absence of price reform policies for energy efficiency will be difficult to implement. It is likely that donors would accept this discrimination
- **Private sector:** The involvement of the private sector is fundamental to the roll-out at scale of energy efficiency, but it will be very difficult to engage the public sector unless there is a commercial case and in the absence of price reform this will not be

easy

- **Consumer mobilisation:** the consumer is the ultimate user of energy and whatever regulation might be in place will generally have some scope for choice that will affect energy use; it is important that consumers make sound choices; this can be supported by participative decision-making processes and strong advocacy
- **Effectiveness:** Impacts will be restricted to specific cases where there is donor support; there will be little spontaneous replication
- **Efficiency:** the conversion of inputs into results will be easier if the commercial environment is supportive

The majority of indicators appear to favour adapting activities according to the status of the country with respect to price reform.

5.3 Level 2 analysis: Emphasis

The second level analysis addresses the options for the principle emphasis of the programme. It is assumed that a future programme aiming at the twin objectives of efficiency across the economy and access to energy efficient goods and services would have separate components with those goals, although of course many of the skills and facilities would be shared. The two concerns are therefore considered separately.

5.3.1 Options for energy efficiency (price reformed countries)

We consider three options for the first track (for countries that have achieved price reform). These are designated O1, O2 and O3 and are defined below:

- **O1: Support for NAMAs:** In this option the emphasis is on engaging with countries in the implementation of unilateral or voluntary NAMAs. These actions would require no financial support and little or no MRV, but would benefit from UNEP's experience in: regulations and strategy; internal monitoring and verification; working with the local finance sector to understand the commercial possibilities of energy efficiency (Section 4.3.3). Conventional financial and economic methodology would provide the main analytical tools.
- **O2: EE enhanced SCP:** The second alternative is not to engage directly in the implementation of NAMAs, but to concentrate on laying the basis for policy for energy efficiency through design of regulations, capacity building (regulatory, financial and technical), much as in the recent past, but with more focus and a more sustained effort established within a long-term programme.
- **O3: Donor driven:** The third option is continue with a policy that is shaped by short-term donor preferences and that is adapted to country needs and circumstances as donor preferences shift.

5.3.2 Assessment of options (price reformed countries)

- Conformity with SE4A: O1 conforms best as it will aim directly at GHG mitigation; O3 conforms least as coordination and focus will be hard to achieve
- Conformity with Rio+20: O2 conforms best as that is its main focus; O1 conforms least because its pragmatic focus will distract from some of the longer-term aims of SCP
- Builds on competences: O2 is best as it stands in closest continuity with the past and O3 conforms least as it requires continual adaptation to new donor concerns. UNEP can though make a strong contribution to the implementation of NAMAs and O2 is a strong second.
- Country needs: Given that participants are those that have already reformed prices there is likely to be strong country intent to implement energy efficiency; O1 is therefore best; O3 is the least easily adaptable to country needs.
- Donor preferences: This is hard to judge, but it is possible donors prefer to be unconstrained by external objectives and that O3 conforms best. Most donors attach high importance to GHG mitigation so O1 comes next.
- Private sector: The private sector will respond best to a commercial framework, best provided by O1 and then by O2 because of the likely greater transparency and continuity.
- Consumer mobilization: Price reform needs flanking measures through welfare policies as noted, but also polices that can ease the adoption of efficient goods and services will be helpful. Programmes that are better adapted to the prevailing price environment should provide more effective mobilisation of consumers.
- Effectiveness: O1 will have highest effectiveness in mitigating GHG. O2 will be more effective than O3 because of the continuity.
- Efficiency: O1 will convert inputs into results well because of the good commercial framework; O2 will be more efficient than O3 because of the continuity.

The results are summarised in the Table. Three stars indicate the best conformity.

Table 8: Assessment of policy options for energy efficiency (price reformed countries)

Criterion	O1 Support for NAMAs	O2 EE enhanced SCP	O3 Donor driven
Conformity with SE4A	***	**	*
Conformity with Rio+20	*	***	**
Builds on competences	***	***	*
Country needs	***	**	*
Donor preferences	**	*	***
Private sector	***	**	*
Effectiveness	***	**	*
Efficiency	***	***	*

The conclusion of this analysis is that the "Support for NAMAs" option has many attractions, but that the "EE enhanced SCP" approach is also largely acceptable according to the chosen criteria.

5.3.3 Options for energy efficiency (subsidised prices)

In this case we also consider three options. An option to support the implementation of NAMAs has little sense because prices will not allow successful implementation of voluntary NAMAs and donors are unlikely to collaborate in supported NAMAs in an environment of price subsidies. The proposed options in this case are:

- **O1 Support to price reform:** The logic of this option is that as this is the main barrier to efficiency it is the appropriate focus of activity.
- **O2: EE enhanced SCP:** as above
- **O3: Donor driven:** as above

We eliminate the donor-driven approach as it will suffer from the lack of coherence and continuity identified above. The assessment therefore is of options O1 (Support to price reform) and of O2 (EE enhanced SCP)**.**

- Conformity with SE4A: O1 may be favoured under this option as if successful it would contribute to GHG mitigation
- Conformity with Rio+20: A1.2 conforms best as that is its main focus
- Builds on competences: A1.2 is best as it stands in closest continuity with the past; it is not at all clear that UNEP alone has strong capacities in this field. A serious programme of price reform needs to be associated with improved welfare services

(health, education, social security) that would extend far beyond the scope of UNEP's SCP work. It is an important activity, in which UNEP could usefully participate, but it is not an appropriate focus for a UNEP led programme.

- Country needs: Price reform would correspond strongly with country needs (but maybe not perceived needs by government for whom the social and political opposition to price reform would be a source of apprehension)
- Donor preferences: Donors are unlikely to see this as a suitable vehicle for price reform and are likely to prefer continuity with the SCP work
- Private sector: If successful the price reform option would conform well to the need to mobilise private finance
- Consumer mobilization: A programme aiming at price reform will not easily mobilise consumers in support without the flanking policies in education, health etc. The SCP option can do this if it is designed to engage consumers as many of the previous programmes have successfully managed to do.
- Effectiveness: It is unlikely that a programme of price reform mounted from a perspective of SCP would succeed
- Efficiency: As above, it unlikely that activities to cause price reform would be efficient

The results are summarised in the Table. Three stars indicate the best conformity.

Table 9: Assessment of policy options for energy efficiency (unreformed prices)

Criterion	O1 Price reform	O2 EE enhanced SCP
Conformity with SE4A	***	**
Conformity with Rio+20	*	***
Builds on competences	*	***
Country needs	***	***
Donor preferences	*	***
Private sector	**	**
Consumer mobilisation	*	***
Effectiveness	*	**
Consumer mobilisation	*	***
Efficiency	*	***

The analysis suggests that, important as price reform may be, it is unlikely to be achieved within an energy efficiency programme led by UNEP and situated within SCP.

5.3.4 Summary of the assessment of options for energy efficiency

Taken together, the two previous assessments define a programme of energy efficiency that is based in two tracks:

- A track supporting the implementation of NAMAs that is designed for countries with reformed prices where successful implementation can be expected
- A track designed to create an enabling environment (i.e. legislation, regulations, institutions, technical and financial capacity) for energy efficiency policy that will complement programmes of price reform supported by other technical cooperation activities

The first track should be confined to countries with cost-effective prices; the second track could be open to all.

5.3.5 Options for extending access to energy efficient goods and services

The decisions that need to be made in establishing priorities for work in this area are unlike those that apply to promoting energy efficiency in the bulk of the economy. The interventions required to promote better access to energy efficient goods and services will often involve subsidy regardless of the pricing structure. The distinction that is observed in energy efficiency, between countries with cost-reflective pricing that have the option for commercially viable programmes and those that do not, is not of the same significance in this matter and differentiation of programmes according to the degree of price reform is less likely to be useful. In fact countries with poor access will often be those that have wide-scale subsidies, because the two things are correlated with poverty. Subsidies are a mechanism for redistribution of wealth in the absence of a working welfare system. It is not a good mechanism, but it may be operational where other tools are not.

In the case of energy efficiency, its large-scale deployment is generally agreed to be the cheapest, fastest solution to the most pressing global environmental challenge. Therefore, to give to energy efficiency some priority within the wider idea of SCP is acceptable. This argument does not transfer to the question of extending access to energy efficient goods and services. Whilst it is obvious that the systems constructed to provide access should be efficient, the amounts of energy consumed by the target groups are generally a small part of the national energy balance and impact on the mitigation of climate change is low. Too strong a focus on energy efficiency may miss some of the intricacies of a rural economy. In rural communities there is an intimate interaction between agriculture, water, materials and energy that is not easily understood by focussing on a single component; more may be lost than is gained by privileging energy efficiency within SCP. Accordingly, one way of distinguishing options in this area would be as “creating access to energy efficiency to energy efficient goods and services” or “creating access to SCP goods and services”. The second option implies that UNEP would extend its work on SCP to encompass the kinds of systems and technologies that would follow the creation of access. This might be seen as an opportunity or it might be seen as an excursion into rural development where other players are better established.

UNEP has certain skills that could be of immediate service. These are: its ability to work with the financial sector to develop innovative financial mechanisms consistent with SCP; advocacy (important to create the commitments in the private sector) and monitoring and verification. Novel indicators would need to be constructed that measured welfare benefits rather than energy saved. Taken together these constitute a solid package of support for the creation of the necessary financial mechanisms and private sector commitment. Emphasis on these contributions would constitute an "enabling" option – using UNEP's skills to the most effect to create a coalition of support of value to many actors beyond UNEP itself.

A second option would be to stay more within the core activity of SCP and to work towards the construction of sustainable communities following on from the connection to modern energy services. This tactic would probably eschew the sole focus on energy efficiency and take a wider SCP-based view. Such an approach would be congruent with the findings of the recent UNDP review of seventeen energy access projects across Asia and the Pacific, (UNDP, 2011). The review confirmed that the access projects had reduced the energy costs of communities and improved health, education, communication, access to information and women's empowerment, but determined that the impact on livelihoods and incomes was less visible. The study attributed this weakness to the fact that most projects focussed on meeting basic needs and only a few went on to complement the energy service with measures that raise incomes and improve livelihoods through improving access to information, market linkages, business development services, access to micro-credit and activities that generate cash incomes.

It is probable that one of biggest impacts that UNEP can have is in ensuring that these new productive activities follow SCP patterns and are consistent with global objectives in mitigation. Specific concepts to include would be design of low-carbon transport and buildings, land-use planning to optimise production of food, fuel and materials, and determination of the preferred cooking practices in a given rural context.

The UNDP study identified several aspects of good practice to all of which UNEP, in conjunction with other agencies, could contribute. In particular, good practice involves the creation of commercially viable markets for energy products and services and this should be done in a manner that is sustainable within the constraints of the community. The review also stressed the need to monitor projects through indicators and measureable targets and to this also UNEP can contribute. Among its relevant skills are: its ability to work constructively as a non-competitive partner with the financial services industry; advocacy (important to create the commitments in the private sector) and monitoring. Taken together these constitute a solid package of support. Emphasis on these contributions would constitute an "enabling" option – using UNEP's skills to the most effect to create a coalition of support of value to many actors beyond UNEP itself.

A second option would be to stay more within the core activity of SCP and to work towards the construction of sustainable communities following on from the connection to modern energy services. This approach would probably eschew the sole focus on energy efficiency and take a wider SCP-based view. The options can be described as:

- **O1: Advocacy for access:** deploying the tools that UNEP has developed within its SCP energy programmes to mobilise business and civil society to the practical implementation of providing access to energy efficient goods and services
- **O2: SCP post-access:** elaborating the ideas of SCP to fit the post-access communities

Following the same procedure as before:

- Conformity with SE4A: O1 is favoured by this criterion as it contributes immediately to the direct objectives of the initiative
- Conformity with Rio+20: O2 conforms best as it promotes SCP in the longer-term
- Builds on competences: Both options build on existing competence in different ways. O1 through the relevant tools noted above and O2 through past work on SCP
- Country needs: Both options would be important to the countries
- Donor preferences: There is no obvious reason why donors would have a preference
- Private sector: O1 would conform better to this initiative as it is designed to stimulate private sector involvement; O2 in itself would probably not attract so much interest
- Consumer mobilization: Advocacy as conceived here is advocacy at the level of corporates. O2 that envisages the design and dissemination of guidelines for communities with recent access to modern energy services may engage the consumer more effectively
- Effectiveness: O1 is likely to be effective in the short-term; O2 if properly done would be effective over the long-term
- Efficiency: There is no obvious preference here; they would both be efficient, but with different inputs and outputs

Table 10: Options for promoting access to energy efficient goods and services

Criterion	O1 Advocacy for access	O2 SCP for post-access communities
Conformity with SE4A	***	*
Conformity with Rio+20	**	***
Builds on competences	***	***
Country needs	***	***
Donor preferences	***	***

Private sector	***	*
Consumer mobilisation	*	***
Effectiveness	***	***
Consumer mobilisation	*	***
Efficiency	*	***

The analysis shows that both options have important strengths; they are not mutually exclusive – indeed they are complementary. Both should be retained.

5.3.6 Summary of options

From these considerations we can construct a proposal for a substantial effort in implementing energy efficiency and extending access to energy efficiency. It would:

- Build on demonstrated competences from UNEP's past work
- Support SE4A in both of its objectives regarding energy efficiency
- Be coherent with the objectives of the SCP programme and the 10YFP
- Build links between SE4A and the Rio+20 initiative
- Offer support to a prompt deployment of NAMAs under the post-Kyoto arrangements

Structurally it would comprise four themes two of which address the implementation of energy efficiency and two that address extending access. Their relationship to the main themes of UNEP's past programmes is shown in the matrix.

Table 11: Linkages of proposed themes to key aspects of past programmes

	Support to NAMAs	EE enhanced SCP	Advocacy for access	SCP for post-access communities
Sustainable production	High	High	Low	High
Sustainable products	High	High	Low	High
Sustainable lifestyles	Low	Medium	High	High
Innovative finance	High	High	High	High

5.4 Implementation issues

5.4.1 Long-term framework

The time from accepting the need for policy and seeing the results and impacts can be long. Support for planning, policy and regulatory reform needs to be followed by building capacity, institutions and coalitions of interest to implement the instruments and to provide for regulatory compliance. Finally, the commercial and market environment is created that permits private investment at scale. Continuity between these stages is at present imperfect; different stages will often depend on different donors, maybe on conflicting time-schedules and often with conflicting advice. To some extent this is inevitable, but it would be improved if there were a long-term indicative framework broadly agreed by countries, donors and agencies along which individual initiatives were aligned. In the case of SCP, a 10 Year Framework Programme is envisaged to be agreed at the Rio conference in June. This would be a major advance and it would greatly strengthen the effort in energy efficiency if it were included within this long-term frame.

5.4.2 Donor commitment

The budgets of donor agencies are not generally defined in a long- or even medium-term perspective. Volumes, and especially preferences, can change. It is therefore difficult for donors to make long-term commitments. A compromise between this practical problem and the idea of a longer-term vision is that the 10YFP be constructed in stages of say 3+3+4 years, with review after each stage. This would give greater visibility to long-term plans of the programme and could improve the articulation with donor support.

5.4.3 Private commitment

The papers on SE4A note quite correctly that the volumes of investment required go far beyond what can be expected from budgets for technical cooperation and will require that private capital be committed. Even finding the money to facilitate the creation of the correct commercial and market environment that will release private investment is a challenge. SE4A has ambitious aims of obtaining commitments from the private sector in

support of the aims. Much energy efficiency is cost-effective and if the conditions are right private capital will follow. The challenge is greater for extending access to energy efficient goods and services in new communities because often the conditions are not propitious for private investment. The private sector will not normally engage in activities that do not contribute to profit. There is of course a growing tendency to private philanthropy and the private sector is certainly capable of taking a broad view of where its interests lie in terms of new markets and products, but the main focus of private companies (correctly) is the interests of their shareholders. The conception of these interests has been broadened in the past and most companies recognise a corporate responsibility towards the environment, child labour, human rights and other social concerns. This shift has been brought about partly by legislation, but in large part also by public opinion to which legislation responds. Obtaining commitments for the private sector for extending energy access will be helped by supportive public opinion and strong advocacy. UNEP's work on sustainable lifestyles and creating networks of sustainable communities could contribute significantly to this process.

5.4.4 Funding

Present funding for SCP is relatively low and unpredictable, depending on irregular provision of funds from individual donors for much programme activity. Substantially greater funds and improved medium-term clarity on funding is desirable. A long-term programme would facilitate these aims.

5.4.5 The need for economic expertise

The present work on SCP is often unsupported by good economic analysis. Policies designed to cause change through inducing people to invest (as most energy efficiency policies aim to do) must be based on sound economic analysis. This will be especially necessary if the work programme is to include support to NAMAs, because they will need to be economically viable at the level of the country and of the individual or firm. A central economics department servicing different programmes is probably not the best arrangement. The economic thinking needs to be close to the realities on the ground and linked to the specificities of the particular interventions.

5.4.6 Visibility of results

The websites for the various components of the energy efficiency related work are well-designed and attractive, but do not see always to be updated with results. Better visibility of results would be helpful and contribute to the overall impact of the work. It is a key aspect of UNEP’s support to technical and social innovation. A web-based clearinghouse for SCP is in preparation and this is a useful start. A tool with a search function covering all UN operations on energy efficiency would be a very helpful contribution.

6. Conclusions

Conclusion are divided into a set of firm conclusions that relate to the capacities of UNEP and a second set of tentative conclusions that pertain to the possible character of future work and that are intended mainly to promote dialogue among concerned stakeholders.

Firm conclusions

1. UNEP has a solid portfolio of experience that spans much of the scope of energy efficiency policy and it can build on this experience to make an important contribution to the pressing need to accelerate energy efficiency to cope with climate change and to provide access to efficient modern energy services.
2. In addition to its specific technical achievements, UNEP enjoys a set of managerial skills that are of substantial value to the promotion of the complex interdisciplinary programmes addressing many stakeholders such as are necessary for energy efficiency. The set includes skills in: building coalitions of interest and consensus on complex technical issues; innovative finance; advocacy and communication.
3. A programme in the framework of the 10 Year Framework of Programmes on SCP (10YFP), or programmes or other global platforms for action on SCP, that emphasised energy efficiency within the general concept of SCP would provide valuable support for SE4A and would create useful links between such a framework or platform and SE4A to the benefit of both.
4. The programme could and should address both the implementation and the access to energy efficiency measures.
5. A long-term framework is essential for such a programme in order: to assure continuity of action on the ground and to provide medium-term visibility to countries and donors of the prospects and needs.
6. Predictable and sustained funding for SCP over a significant (multi-year) period would be beneficial in order to bridge gaps in programme funds and to assure continuity of support to SE4A and to country activities. A period of sustained effort for perhaps ten years is needed to move from policy design, through necessary capacity building up to effective implementation.
7. Equally, if the proposal for Sustainable Development Goals that will be examined by the Rio+20 conference is approved, then the same activities on energy efficiency and access to energy efficient goods and services can support an SDG on Sustainable Energy for All.
8. The introduction of NAMAs into the global framework for mitigating climate change provides an opportunity for UNEP to enhance its contribution to that important effort. The focus of NAMAs on sectoral strategy and policy is particularly amenable to UNEP's capacities. Regulatory compliance is an essential element of

environmental management and UNEP is well positioned to develop these techniques as MRV tools and methodologies to support NAMAs in specific sectors, such as buildings (see Section 4.3.3).

9. Delivering energy efficiency on the scale envisaged by SE4A will require very large investments by the private sector and for this to happen there must be a viable business case. As a non-competitive agency, with authority in environmental policy, UNEP is well-placed to work with the financial sector and business to identify opportunities and obstacles and to negotiate with governments and civil society acceptable paths forward. It has already done this successfully in different ways with lighting, electrical equipment and buildings (and in improving specifications of transport fuels) and it is important to continue.
10. Fashioning private sector commitments to improved access to efficient energy services will benefit from skilful advocacy and the creation of favourable public opinion. UNEP's work on sustainable life styles and the supporting networks could be adapted for this purpose.
11. The particular skills of UNEP need to be evaluated as a part of the total offer of skills from the technical assistance community and particularly other agencies of the UN family. In this respect the multi-disciplinary character of UNEP with authority in environmental policy has advantages. It can, as a neutral and non-competitive actor, organise coalitions of government, manufacturing industry, the financial sector and civil society to deal with complex problems both within a country and internationally. There are many outstanding issues to which this can be applied.
12. To the maximum extent possible, new activities of UNEP should build upon the existing delivery channels. It has in its past activities created effective and appropriate networks and participates in the institutional infrastructure provided by the NCPCs. The emphasis in the future should be on deploying these assets to the best possible effect in pursuit of well-established objectives.

Tentative

13. There is a strong argument for discriminating between activities designed for countries that have successfully reformed prices and those that have not. In the former case, a clear focus on helping countries implement NAMAs and sectoral mechanisms would be a valuable contribution to the global effort of mitigation. In the second case, it may be more effective to concentrate on strengthening capacity to design, implement and monitor policies in parallel with activities (from other programmes) to reform prices.
14. For the implementation of energy efficiency, a dual track comprising a line for "support to NAMAs" and another line comprising "EE enhanced SCP" would meet the differentiated need between country groups. It also has the advantage of demonstrating a clear continuity with the historic SCP activities, whilst still providing

for adaptation to new ideas and needs.

15. For extending access to energy efficiency, there are two main lines of action that show promise. One is to extend the ideas and tools for SCP, mainly developed for conventional production processes and products, to the challenges that face communities newly connected to modern energy services. These SCP ideas and tools will provide guidance as to how these communities can ensure that they adopt the most efficient technologies consistent with their needs. The other is to deploy the networks created to further sustainable lifestyles to the new challenge of creating supportive public opinion to the right of universal access to modern energy services.

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Annex I - The business case for energy efficiency

Contents

Executive Summary

From now until 2030 and for the foreseeable future thereafter it will be necessary to spend a great deal of money on investments in energy efficiency in developed and developing countries if very serious consequences of climate change are to be avoided. One estimate is that investments in clean energy of around $864 billion a year will be needed in 2030, increasing thereafter. Of this sum somewhat more than half will be invested in goods and services used in developing countries and probably somewhat over half will be in energy efficiency. The market for energy efficient goods and services in developing countries in 2030 can therefore be estimated at around $200 - $250 billion a year. This is mainly composed of the incremental investment to retrofit existing buildings, to improve the performance of vehicles and appliances and to improve process efficiency in manufacture. Investments in these sectors will provide substantial returns.

Evidently this volume of funds on a regular basis can only come from the private sector. The private sector also has the technical skills, the knowledge, the capacity for research and innovation and the management capability to implement the necessary actions.

The private sector will only do this if there is a sound business case for the investment. Business will construct that case according to the regulatory and market conditions in which it operates. The task of the state is to provide the market and regulatory framework that will make that business case coherent with social needs. The main requirements of this framework are cost-reflective pricing, a sympathetic business environment in general, appropriate regulation and the provision of some public goods such as research and development, and some infrastructure. Cost-reflective pricing can helpfully include the internalisation of externalities, as is rapidly happening in Europe, but this is not actually essential to the cost-effectiveness of many activities in energy efficiency.

This paper is based on a small set of case-studies of energy efficiency in four areas: lighting, appliances, building and transport. It identifies the cost-effectiveness of practices and what is needed to bring them about. Practice in energy efficiency is extremely diverse and it is not possible to cover the whole gamut of technologies and circumstances, but the case-studies are rather typical and the results are broadly indicative of the policy needs. On the basis of the results some conclusions are drawn as to what UNEP can bring to strengthening the future business case for energy efficiency, and offering tailored support to interested in developing countries.

The set of examples reviewed in this paper is diverse, but taken as a whole they demonstrate that business has immense innovative capacities and the financial means to

implement cost-effective policies of energy efficiency across the global economy.

Technical assistance can contribute to the creation of a business case for energy efficiency in developing countries by helping the public authorities manage the environment in which business operates. The most immediate aspect of that environment is the price for energy. Business has a fiduciary duty to its shareholders to use their money to maximise profit. If resources are mispriced then the principal mechanism that aligns private and public interests in a market system is gravely weakened. Distorted pricing can be partially compensated by other regulations and financial incentives, but inevitably it leads to second-best decisions, smuggling, free-riding and is an incentive to corruption.

The second critical factor is the general business environment in developing countries. The prospects for foreign direct investment will be improved if there is: a transparent, efficient and fair legal system not given to retrospective legislation; transparent planning, regulation, licensing and taxation; no corruption; possibilities to expatriate funds and a sound and stable macroeconomic environment. Technical assistance can help create this environment and a great deal is done, especially by the World Bank and IFC to this end.

Technical assistance can also help developing countries design policies, regulations, standards and financial instruments that will influence the business case as perceived by the private sector. This is very important work and much has been done by the bilateral and multilateral donors and implementing agencies along these lines.

Activities to improve the asymmetric access to information in developed and developing countries can also be beneficial. It is important that officials and business in developing countries are aware of the opportunities that technological innovation provides. Activities such as the Implementing Agreements of the IEA are useful in this respect, but more needs to be done to involve developing countries in the exchange.

Another reasonable expectation of business from the state is the proper enforcement of regulations and compliance with standards. The critical role of standards in ensuring the quality of products is undermined if enforcement is not sufficient. Enforcement is not an easy business, but experience in China for example, where very low historic levels of enforcement are now being remedied, shows that improvements are possible.

Public procurement can reduce perceived risks for business in marketing new products and in stretching design ambitions. Obligations on public authorities to upgrade their building stock can also be helpful. Given the difficulty that public institutions may have with tight capital budgets, such an obligation may be easier to discharge where there are competent and well-funded ESCOs.

Supplier obligations are an effective way to fund certain improvements, especially in buildings. This instrument draws on the capital strength and management and technical expertise of energy supply companies and is an effective way in which these resources can contribute to efficient solutions.

There is also a need to manage the interaction between international business, national business and national governments. International business is often the best equipped to bring energy-efficient solutions. It has the experience, the technological range, the funds and the management capabilities. Accessing this resource is clearly an opportunity, but it generates also threats by creating a technological dependence within the developing country. A harmonious resolution of these asymmetric interests is not easily achieved and bilateral donors very often have a clear agenda to promote their national commercial interests. Independent, credible partners such as the UN agencies have an important role to play in brokering the diverse interests.

There is much to be said for stronger international cooperation in standards, testing protocols and in accessing testing centres. The development of independent standards for appliances and independent testing protocol and rigs for every country in the world is very inefficient. It creates barriers to trade and it delays the successful design and implementation of regulatory regimes. International bodies have attempted to harmonise standards in various areas, but without noticeable success.

The relationship between business and industry, and consumers is two-way: on the one hand, business entities develop energy efficient product and services in response to consumer needs and expectations; on the other hand, business operations can transform markets to trigger a consumer shift towards more energy efficient lifestyles.

Business also has a role as interlocutor between the social and economic ambitions for the nation or world as expressed by the state and the immediate desires of its citizens. Business can act catalytically to create the goods and services that bring these sometimes conflicting preferences into balance. One should also recognise that business has no desire to destroy the world in which it operates. It is true that the activities of business are generally motivated by profit and, if unregulated, will cause damage; it is up to the state to regulate them. But individual business people are often people of vision, able to grasp the consequences of actions, able to weigh different options and to make decisions. They have much to offer.

There are many areas where UNEP could contribute to strengthening the business case for energy efficiency in developing countries.

- UNEP has proven skills in the building of coalitions and the creation of consensus among manufacturing industry, financial interests, other international organisations,

officials and civil society to deliver workable solutions to some of the constraints facing the private sector in creating a business case for energy efficiency in developing countries. Four clear historic examples of this are the En.lighten project, the Global Fuel Economy Initiative, the Sustainable Building and Climate Initiative (as well as its sister programme the Sustainable Social Housing Initiative) and work within the Task Force on Sustainable Products that led to the establishment of the IEA Implementing Agreement for a Cooperating Programme on Efficient Electrical End-Use Equipment. Other work on finance and advocacy contributed also to these successful undertakings.

- UNEP should build on these successes. The En.lighten project still has far to go to achieve its immediate goal although it is well on track; when the phase-out of incandescent bulbs is completed there will still be much work to do for the promotion of new cost-effective efficient lighting schemes.
- The GFEI needs to be transformed to a more operational mode, working with developing countries to ensure standards for new vehicles are brought to the levels consistent with best practice elsewhere and extending membership to a wider range of industry interests.
- The work of the Task Force on Sustainable Products has come to an end, but a similar programme building also on the experience with En.lighten and directed to air-conditioning could be of great value. As is indicated earlier, air-conditioning is a very important contributor to energy use, the market is growing rapidly and much of the supply to this market has poor energy performance that can easily be improved.
- Business will be reluctant to risk their capital in circumstances where the enforcement of standards is poor. UNEP might consider developing a programme to help transfer best-practice in the enforcement of regulations and compliance with product standards.
- The possibilities of public procurement to directly improve the energy efficiency of the public and to contribute to the development of innovative products are increasingly recognised. As an element to support the business case for energy efficiency, UNEP may consider expanding its current capacity building activities on the design and implementation of sustainable public procurement policies in developing counties.
- Development of policy and tools by UNEP's Sustainable Buildings and Climate Initiative can support financing mechanisms for large scale investment in energy efficiency for buildings, especially in public buildings and social housing.
- The possibilities of ESCO for building renovation are still under developed. Technical assistance has tended to emphasise industrial applications of ESCOs which are not the easiest market to address. Buildings, especially public buildings, are a much better target. UNEP may wish to consider extending its Finance Initiative to cover this topic.

- For business to fully develop and capture new green markets in the four key sectors examined in this paper (lighting, appliances, transports, buildings), technological innovation should go hand in hand with marketing strategies based on consumer research and information.

Introduction

In its 2010 World Energy Outlook, the International Energy Agency (IEA) forecast that US$13.5 trillion in clean energy investment above BAU levels will be needed between 2010 and 2035; this equivalent to an average expenditure of around US$500 billion per year (IEA, 2010). The total includes both renewable energy and energy efficiency. McKinsey, in its most recent assessment of the global greenhouse gas abatement curve, estimated that the investments required to achieve adequate abatement of GHG emissions, over and above investments inferred from projected trends, would be about €490 billion / year by 2020 and €864 billion per year by 2030 (Mckinsey and Co., 2012). Again, the figure is not explicitly divided between renewables and efficiency, but it appears from the sectoral breakdown to be very roughly half and half. The IEA and McKinsey figures are broadly comparable and imply a market for energy efficiency (over and above present trends) of several trillion US$ over the next two decades.

The estimate by McKinsey of an annual expenditure of $864 billion in 2030 breaks down by sector and region as shown in the Table.

By Sector	$bn	By region	$bn
Power	182	North America	119
Petroleum and gas	16	Western Europe	100
Cement	12	Eastern Europe	45
Iron and steel	65	OECD Pacific	38
Chemicals	34	Latin America	49
Other industry	35	Rest of developing Asia	73
Transport	245	Africa	34
Buildings	207	China	280
Waste	9	India	72
Forestry	43	Middle East	37
Global air and sea transport	17	Global air and sea transport	17
Total	**864**	**Total**	**864**

From the regional breakdown it is apparent that most of this investment will be in the developing world. From the sectoral breakdown it appears that buildings and transport are the main sectors; this will mainly be in energy efficiency.

Two things are clear from these estimates. First, that the volume of funds required far exceeds the volume of concessional finance that governments can afford to assign to policy interventions in the area; the bulk of investment must come from private sources. Second, that there are huge prospects for profitable activity by private enterprise if regulatory and market conditions permit.

These are not novel insights, but despite widespread understanding of the potential of energy efficiency and many admirable individual efforts, progress is insufficient. The IEA in its 2011 World Energy Outlook judges that:

> "the door to 2°C is closing. …. New energy efficiency measures make a difference, but much more is required. ….. We need to achieve an even higher pace of change, with efficiency improvements accounting for half of the additional reduction in emissions." (IEA, 2011).

This paper begins to explore how UNEP might contribute to that increased pace of change, especially in developing countries, by fostering partnerships among private capital, governments and civil society to promote opportunities, dismantle obstacles and facilitate acceptance. The paper identifies a small set of case studies in lighting, appliances, transport and buildings to illustrate some of the main areas where the immense financial and technical power of private enterprise has been profitably deployed to improve energy efficiency to the benefit of the private sector actors and to the global environment. It seeks to link these case studies to the wider market through the specific motivations and achievements identified in each case.

The private sector in this paper is interpreted to include government acting in its corporate role and government-owned corporate enterprises such as energy utilities. Government is an important user, and often owner, of buildings and an important procurer of services and goods. When acting in this role the behaviour of public authorities is broadly similar to that of private capital and they are subject to similar, though not identical financial constraints. Corporatised utilities have independent balance sheets, cash-flow and technical skills that can be usefully deployed in energy efficiency.

It is also useful to distinguish different forms of private sector actors. A productive investment is generally financed by debt and equity. The provider of debt, most often a bank, needs to be convinced that the owner of the investment will pay the money back with interest and the providers of equity (the shareholders represented by management) need to believe that the balance of potential rewards and risks is favourable. The contractors must also see a profit, as must the consulting engineers and possibly other financial and management consultants. In the case of developing countries, change is often a threat to the manufacturing sector, because better equipped and better financed international companies can cope more effectively and faster with change. The paper attempts to reflect

this diversity of interest where feasible.

This section focuses on the business case for energy efficiency but does not explore the important role that consumer choice can play in promoting the adoption of energy efficient goods and services. As an example of this, the most recent OECD report on *Greening Household Behaviour: The Role of Public Policy* (OECD, 2011), based on a survey conducted among 10,000 households in 10 countries (Australia, Canada, the Czech Republic, France, Italy, Korea, Mexico, the Netherlands, Norway and Sweden), demonstrates the importance of the right incentives and information to trigger behavioural change towards energy efficient preferences as well as to develop energy efficient products or services that best stimulate demand and meet consumers' needs. The results of the OECD survey confirmed that those who are concerned for the environment are more likely to adopt environmentally-friendly and energy efficient practices as well as to make investments which reduce the environmental impacts of their lifestyle.

1. Lighting

Technology and economics of lighting

The lamp bulb is one of the most important and ubiquitous tools of man; it is estimated by the IEA Programme on Energy Conservation in Buildings and Community Systems that there are now 33 billion lamps across the world, consuming more than 2650 TWh of energy annually, equal to 19% of the global electricity consumption, (ECBCS, 2010). Lighting is responsible for close to 6 per cent of worldwide greenhouse gas (GHG) emissions.

Eliminating inefficient lighting (incandescent lamps) on the African continent would save nearly 20.5 Twh of electricity and eliminate almost 13 Mt of CO2 emissions. The electricity saved would allow connecting 14.5 million African homes to the grid, 4 million in South Africa only. Emissions saved would be equivalent to removing about 3 million vehicles off the road. The cost for the region to transition to efficient lighting is around $1.8 billion USD, with a simple payback of 2.2 years. A country, such as India, would be able to electrify 35 million homes resulting from the power saved from shifting all existing incandescent lamps to energy-efficient alternatives. The global demand for artificial light is expected to be 60% higher by 2030 if a switch to efficient lighting does not occur.

Many of the lamps and fittings in use are unfortunately not very efficient and this includes the popular incandescent lamp. There exist several low-cost and easy alternatives to the inefficient devices and systems that are still prevalent. Conversion to efficient modern systems could produce electricity savings and greenhouse gas emission cuts of around 50%, very cost-effectively.

The main technical options for improvement are, (ECBCS, 2010):

- A proper choice of lamps and fittings:
    - incandescent lamps should be replaced by CFLs, infrared coated tungsten halogen lamps or LEDs;
    - mercury lamps by high-pressure sodium lamps, metal halide lamps, or LEDs;
    - ferromagnetic ballasts by electronic ballasts;
    - choice of efficient T5 fluorescent lamps; and
    - use of controllable electronic ballasts with low losses.
- Lighting design: the use of efficient luminaires and localized task lighting:
    - the control of light with manual dimming, presence sensors, and dimming according to daylight;
    - effective use of daylight; and
    - high efficiency LED-based lighting systems.

The economic comparison of different luminaires is straightforward; the efficient luminaires have higher capital costs and lower energy costs. The options need to be compared by discounted cash-flow and allowance made for replacement, disposal and maintenance. The result of the comparison is sensitive to the utilisation of the lamp, because the more efficient lamps will lead to greater energy savings per year that will off-set more rapidly the incremental capital cost than if the lamp is rarely used.

A typical comparison of incandescent lamps, Compact Fluorescent Lamps (CFLs) and Light Emitting Diodes (LEDs) is given in the Table below that is reproduced from the Programme on Energy Conservation in Buildings and Community Systems. The comparison assumes a discount rate of 5% and running hours of 2000 hours. Even with this relatively short period of burning hours the incandescent lamp is the most expensive choice. The more efficient options use between 16% and 25% of the energy consumed by the incandescent lamp, so the energy and GHG savings are very large. The calculations assume a price of 15 ¢/kWh, which may be high compared to prices in most developing countries. Evidently, if consumer prices are subsidised then the comparative advantages of efficient lighting are reduced. Calculations for real buildings become complex, but the general principles will remain the same.

Costs €/yr	Incandescent	CFL	LED
Capital	1.05	1.84 – 2.31	4.62 – 11.55
Energy	18.00	4.50	4.50 - 3.00
Total	19.05	6.34 – 6.81	9.12 – 14.55

LEDs have an especially long-life. They can potentially provide highly efficient lighting that can last for more than a decade of continuous use. At present their efficiency is similar to that of modern fluorescent tubes, but it is believed that higher efficiencies are possible, whereas with fluorescent tubes it is likely that further progress will be difficult. Mixing red, green and blue LEDs can create bio-dynamic lighting systems that allow the intensity and colour temperature to be varied, creating different lighting effects that can have practical and aesthetic applications. Alternatively, white light can be generated using blue LEDs and a coating. Organic LED (OLED) technology is used in TVs and mobile phone screens, but energy efficiency and lifetime are poorer than conventional LEDs at present. Ultra-Efficient Lighting is predicted to grow very rapidly in the near-term and the market has been estimated at $33 billion by 2013; the market for LED lighting will be a large part of this, growing by 22% annually from 2009-2013 according to the Department for Business, Innovation and Skills, UK (BIS, 2009).

Government procurement

Government in its many forms is a major user of buildings and there is much to be gained by more aggressive procurement by government. Much of the savings will arise from the cumulative impact of small projects. As an example, at a police station in Wales the existing T8 fluorescent lighting was replaced with more energy efficient T5 lighting. This retrofit cost £26,000 and reduced energy use for lighting by about one third. Financial saving was £7.500 per year equivalent to a payback of 3 – 4 years. An annual saving of 42 tCO2 is estimated, (WAO, 2012). This is a small project, but replicated across similar installations worldwide the saving would be huge, In addition to the energy savings, the T5 lamp has low mercury content and has a coating on the inside of the glass wall that prevents the glass and phosphors from absorbing mercury. This barrier coating reduces the amount of mercury needed from approximately 15 mg to 3 mg per lamp. The reduced absorption of mercury causes helps to keep light level close to initial output and the lower mercury loading has direct environmental benefits of its own.

On a somewhat larger scale, and using a different technology, the City of Westminster has contracted to upgrade its 14,000 street lights. The ‘Smart Lights’ initiative will cost 3 million and will save 20% of present use. The scheme will enable streetlights to be automatically dimmed or brightened using wireless technology and a computerised central management system. The light intensity of the lamps can be controlled on a street-by-street basis and lights can be dimmed by 75% when streets are not in use. The system also reduces the need for visual inspection to check whether lights are working. The combined energy and operational savings are estimated to be worth estimated £8 million over the 20 year lifespan of the lighting infrastructure. This is equivalent to a payback period of about 7.5 years, (Westminster City Council, 2012). The use of LED lamps for street-lighting is also being trialled by the Council.

Government procurement policies can be used effectively to stimulate innovation and the manufacture of improved products as well as to support the market in state-of-the art technology. An example of this is the Forward Commitment Procurement model in the UK, designed mainly for the public sector, which starts from a definition of the actual need to create an "outcome based specification" instead of procuring from immediately available sources. The procedure addresses the "chicken and egg" dilemma where the product does not exist because no-one wants it and no-one wants it because it does not exist. The Forward Commitment Procurement alerts the market to the procurement need and offers to purchase the solution, if the needs are met, once they are available, at an agreed price and specification. This provides the market pull to create the conditions needed to deliver innovative, cost effective products and services and unlocks investment to deliver the requirement, (BIS, 2011).

A good example of the use of the Forward Commitment Procurement model for efficient lighting is the 'Hospital of the Future' project of the Rotherham NHS Foundation Trust in the UK. The Trust, adopted the approach to develop a £2 million high efficiency lighting system for hospital wards. The new wards use LEDs and organic LEDs for bio-dynamic lighting; systems are responsive to daylight and easy to maintain. Energy consumption is reduced by 30% and maintenance costs by 88%, because of the long life of the luminaires. It is not easy to calculate a payback on the lighting system itself as it is incorporated in a redesigned ward with many other features, but the cost of the "Future Ward" is the same as a standard ward.

Government procurement is considered across the EU as an important tool to promote energy efficiency and innovation more generally. Article 5 of the Energy Efficiency Directive specifies that Member States shall ensure that public bodies purchase only products, services and buildings with high energy efficiency performance, (EU, 2012). Where a product is covered by a labelling Directive then the product should belong to the highest class – this would mean only the most efficient forms of lighting.

Standards and labels

As for appliances, that are discussed later, standards and labels are a powerful policy tool to improve lighting efficiency. There are several well-known schemes. Energy Star is an international standard for consumer products initiated by the US during the early 1990s, but subsequently recognised by many other countries. The programme works with manufacturers, retailers, central and local governments and utilities to establish energy efficiency criteria, label products, and promote the manufacture and use of certified products; it covers numerous product categories, one of which is lighting. The Energy Star web-site lists products that meet the criteria of the programme, (Energy Star, 2012). For example, in the case of CFLs, the qualified products use about one-quarter of the energy to produce the same amount of light as an incandescent lamp; last about 10 times longer; produce 75 percent less heat; save about $30 or more in electricity costs over the lifetime of

the bulb; have manufacturer-backed warranties.

The Top Runner programme in Japan is designed to achieve continuing improvement; it takes as a baseline the performance of the product with the highest energy efficiency on the market and sets standard by considering the impacts of feasible technological improvements. The best available becomes the new norm. Manufacturers are must insure that the weighted average performance of their products meets or exceeds targets.

The EU Energy Labelling Directive is a mandatory scheme that requires the packaging of lamps sold to the residential sector to display an energy efficiency ranking between A (highest) and G (lowest). Other information that must be displayed includes light output in lumens and average lifetime. At present this does not cover directional lighting, such as halogen lamps and LEDs, (EU, 2009). The EU Eco-Label logo is a voluntary Europe-wide scheme for products that meet specific energy efficiency and quality specifications. EU Eco-design for Energy Using Products Directive sets requirements for energy-using products. For lighting this includes the phase-out of incandescent lamps between September 2009 and September 2012; standards on performance, lifetime and ultraviolet light emission for CFLs from September 2009; the phase-out of low efficiency fluorescent tubes and electronics between April 2010 and April 2017, (EU, 2009).

Lighting in developing countries

- **On-grid**

The en.lighten initiative has been established specifically to accelerate the global market transformation to environmentally sustainable lighting technologies by developing a coordinated global strategy and providing technical support for the phase-out of inefficient lighting. It is implemented by a public-private partnership between UNEP, the GEF, Philips Lighting, OSRAM AG and the National Lighting Test Centre of China (NLTC), in collaboration with international lighting experts from over 40 organizations to provide guidance for countries to develop and implement successful national efficient lighting strategies. UNEP as a technically credible and neutral partner for developing countries is well-placed to manage such a coalition; it has convened officials and experts from forty organizations to guide the development and implementation of successful national efficient lighting strategies that will permit the global phase-out of all incandescent lamps by 2016.

Among the deliverables of the en.lighten initiative are:

- A roadmap for global lighting market transformation including key policy and technical recommendations.
- A set of global harmonized guidelines for quality, performance-based standards, and certification procedures for energy-efficient lighting products.
- Comprehensive tool kit to promote market transformation on a national level.
- Guidance and training materials for governments, the private sector and civil society.

- Country Lighting Assessments.
- Support for national and regional strategies and policies.
- Model end-of-life treatment strategy and guidance for efficient lighting products.

In the future, en.lighten is planning to support countries on efficiency policy frameworks in other key lighting sectors, such as commercial, industrial and street lighting.

En lighten represents a considerable achievement that relies on the correct combination of national policies and private sector interest to promote efficiency through commercial activity supported by national policies that create appropriate and effective regulation and fair market conditions. Its ambitions should not be confined to the elimination of incandescent bulbs, but should clearly envisage an on-going improvement of lighting performance far beyond that date. It is also an interesting precedent that might be adapted to other product groups and especially to air-conditioners that are a major consumer of energy and whose significance will increase in the future (see later section on appliances).

– **Off-grid**

The en.lighten initiative, if sustained and adequately resourced, should be an effective mechanism to improve lighting performance where electricity is available. In large parts of the developing world, people do not have access to electric light, but rely on kerosene lanterns or other fuel-based lighting. This is expensive, provides poor quality light and poses a health and fire risk. LEDs are well suited to replacing fuel-based lighting as they are long lasting, require little power that can be delivered by solar panels and so are suitable for off-grid use in rural and peri-urban areas.

The Solar and LED Energy Access initiative (SLED) was initially announced in December 2009 and was formally launched at the first Clean Energy Ministerial meeting in Washington in July 2010, (CEM, 2012). Its objective is to facilitate access to improved lighting services for 10 million people within five years and transform the global market for affordable, clean and quality-assured off-grid lighting by addressing fundamental barriers to market development and challenging the resources and capital of the private sector. The related Lighting Africa Initiative of the World Bank aims to provide electric lighting for up to 250 million people in Sub-Saharan Africa by 2030.

Underpinning the initiative is a robust quality assurance program that has examined over 40 off-grid lighting products of which eight met or exceeded the quality and performance targets. Five test laboratories have been established in China, Germany, the United States (2) and Kenya. The test programme appears to have created a significant stimulus to sales; as of April 2011, the cumulative commercial sales of the lighting products that met performance targets exceeded 200,000; sales growth has exceeded 90% since the inception of the programme.

The Solar and LED Energy Access initiative complements the technical work with flanking activities to raise awareness through consumer education, to improve availability of information amongst other things by preparing market assessment reports, and to improve financial conditions. The market assessment reports are detailed and cover costs of the technology, costs of existing practices, finance and willingness-to pay by potential users. The assessment report concluded that off-grid users of glass-covered paraffin lamps in the five countries studied (Ethiopia, Ghana, Kenya, Tanzania, and Zambia) spend a little less than $1 billion a year on buying and operating paraffin lamps. This is an approximate indication of the potential market size for improved lighting systems. The total potential demand for modern lighting products was estimated at 50,000,000 units, (World Bank, 2011). IFC is working to stimulate finance across the supply chain through investor forums and structuring credit lines with commercial banks.

Conclusions about lighting

Taken together, these examples demonstrate several aspects of the commercial dynamics of efficient lighting. The technology exists to make dramatic improvements in efficiency that is cost-effective and often extremely cost-effective and that will have very positive environmental benefits. Commercial companies along the value chain from manufacturer to consultant to contractor are perfectly well-equipped to deliver these efficient services. Where clients understand the possibilities and have the resources such systems are being rapidly adopted.

Barriers to more prompt uptake in developed countries include the lethargy and ignorance of some clients, capital stringency (that is often even more severe in the public sector than in the private sector) and risk aversion among all parties. The solutions to these problems are well-known; these include labels and standards, information and training, obligations on public authorities and regulated subjects, and government procurement. There is much experience of these instruments and if properly applied in a normally functioning commercial environment there should be continued progress.

Capital stringency is perhaps the most binding constraint especially in parts of the public sector where the demands on capital budgets are very numerous (e.g. education, health, policing etc.). Private public partnerships have not succeeded in alleviating that constraint.

The same barriers, perhaps higher, exist in developing countries and are often reinforced by consumer subsidies to prices that weaken the economic case and in some cases also by poor or corrupt enforcement. The En.lighten initiative essentially attempts to transfer the technical and policy experience from developed countries to enable the usual mechanism of private business to operate and is very well focused. It should be sustained, its resources increased and the scope extended to cover improved compliance.

There is also great potential for commercial forces to contribute to improving access to high quality efficient lighting. LED technology, perhaps coupled to solar panels, could provide affordable, good quality light. The willingness to pay for light by isolated communities is high as can be seen from expenditure on kerosene lamps and fuel. If financial structures can be put in place and private enterprise convinced then it may be possible to establish a viable self-sustaining business sector. This is not yet proven, but is a goal well worth seeking.

2. Appliances

The present status of standards and labelling policies

The principal instruments to manage appliance efficiency are labelling and standards. They are both policy measures that are designed to compensate the market failure caused by asymmetric information. Under a labelling regime, manufacturers are obliged to describe the energy performance of their products according to some defined criterion, such as energy use or energy cost. Standards oblige manufacturers to meet certain criteria of minimum performance. In some cases, the goods that meet the standard are marked as such and inferior goods are allowed to remain on the market; in other cases, goods that do not meet the criteria are banned from the market. Labelling and standards both require testing facilities and protocols; both require rigorous and competent enforcement.

Labelling of energy use was introduced in France in 1976 and now there are many programs throughout the industrialized world. The Energy Star program in the U.S. and the Top Runner programme in Japan were described earlier for lighting and they cover a very wide range of appliances also. In the EU, labelling is implemented through a series of energy labelling directives governed by a Framework Directive. The concept of standards and labels has spread far; at least 61 countries—representing 80 per cent of the world's population—use energy performance standards or labels for at least one product, (Waide & Bernasconi-Osterwalder, 2008).

Assessment of the effectiveness of standards and labelling schemes is complicated by the difficulty of assessing what would have happened if there had been no standard. A study of the impact within OECD countries concluded that programmes had reduced total energy bills across the affected end-user sectors by between 10 and 20 per cent (Waide & Bernasconi-Osterwalder, 2008). An assessment of standards for refrigerators in Australia and the UK concluded they had been effective and efficient, (Lane, Harrington, & Ryan, 2009).

There is a very large potential market for cost-effective improvements

The promulgation of labelling and standards more widely in developing countries could create very large markets for the manufacture of improved appliances and save corresponding large volumes of energy and GHG emissions. An indication of the quantities involved is given by a recent, detailed study of the appliance market in China by the Lawrence Berkeley National Laboratory, (Zhou, Fridley, McNeil, Zheng, Letschert, & Ke, 2011)some results of which are summarised below.

China has a long-standing programme of minimum energy performance standards (MEPS) that covers more than 30 appliances. In addition there are voluntary energy efficiency labels for 40 products and a mandatory label for 19 products. The study by the Lawrence Berkeley National Laboratory estimated the energy saving and CO2 emission reductions for a set of scenarios to 2030 that described possible future developments of the standards and labelling activities. They examined:

- a baseline scenario termed "Frozen Efficiency" in which standards were kept at the levels prevailing in 2009;
- a "Continued Improvement Scenario" that described what was likely to be the development from 2009 based on present trends; and
- a "Best Practice Scenario" in which standards reached by 2014 the level of current international best practice efficiency in broad commercial use today.

The analysis was very detailed in terms of its representation of appliance ownership and the turnover of stock that was modelled by 37 product categories for both the Frozen Efficiency and the Continued Improvement Scenario. The results indicated that in the Continued Improvement Scenario, by 2030, annual electricity savings would be equivalent to the output of 145 GW of power plants and annual CO2 emissions from appliance use would be 15% lower than in the frozen scenario. Cumulative electricity consumption could be reduced by 9503 TWh. The energy saving is equivalent to a cumulative reduction in coal usage by 2030 of 3338 million tonnes and a cumulative reduction of 9 billion tonnes in the emission of CO2.

Under the Best Practice Scenario for a subset of eleven products, cumulative electricity savings would be another 5450 TWh (about 65 GW of power plant) and annual CO2 emissions reduction of energy used for appliances would be 31% lower than in the frozen scenario. Of the reduction from the standards for these products, the air conditioner standard dominates the reduction potential and accounts for 44% of the total reduction in 2020 and 41% in 2030. The second largest contributor is refrigerator standard, which accounts for 16% to 18% of the reduction; they are followed by standby power, TVs, and clothes washers.

Unfortunately the model does not represent cash flows and investment; it simply assumes that the incremental cost of the efficient appliances will be offset by their energy savings. An approximate idea of the market size for new appliances can nevertheless be inferred from the results. By 2030 the annual savings from the more efficient appliances are about 800 TWh per year. Assuming a retail price for electricity of US10¢ per kWh, the savings are worth $80 billion. Further assuming a payback period on the incremental investment of 5 years, which is typical, the value of the incremental investments in energy efficiency by 2030 is about $400 billion. This gives a very rough indication of the market size for the incremental efficiency. The market value of the basic appliances is of course a lot more. This estimate is broadly consistent with the estimates given at the beginning of the paper for the overall investment market in clean energy.

Voluntary or mandatory agreements

Voluntary agreements concerning appliance efficiency and labelling were negotiated in many industrial countries in the 1990s and expanded and strengthened subsequently. The EU Commission made a series of agreements with the European Committee of Domestic Equipment Manufacturers (CECED) to reduce energy use that covered 90 per cent of the market for washing machines, refrigerators and freezers, dishwashers and water storage heaters. These agreements were generally perceived to have been progressive and proactive and to have stimulated substantial investment by European manufacturers over the ten years that they were in place. However, CECED decided not to renew the agreement in 2007, on the grounds that enforcement of the labelling scheme had been inconsistent and had undermined the industry's willingness to go to another phase of voluntary measures (CECED, 2007). The industry was also concerned that non-CECED importers had gained a growing share of the market. The combined consequence was that the cooperating industries felt that they were being squeezed out by “free-riders.” They preferred new binding energy efficiency standards.

The case is interesting as it suggests that international private capital prefers the clarity of mandatory schemes to voluntary schemes that can be more easily adjusted in the interests of particular parties.

Technical assistance is needed to create the conditions for private investment

Since the 1990s, the GEF has funded several projects aimed at transforming markets for appliances in developing countries through standards and labelling and according to the IEA it has been observed that the energy efficiency of appliances has improved to some extent in each project, but the IEA also notes that the scales and effects of GEF projects have sometimes been insufficient due to the limits of GEF funds, (IEA, 2007).

The case of Egypt illustrates some of the obstacles to implementing labelling schemes and the role of technical assistance in preparing the ground for private investment. There are three difficult stages to implementing standards and labelling: the first is in defining the

standards or criteria for labels; the second is providing testing facilities and elaborating the testing protocols; and the third is ensuring compliance, which also requires access to testing facilities.

In 1998, the GEF and the UNDP provided $5.9 million to Egypt through the Energy Efficiency Improvement and Greenhouse Gas Reduction (EEIGGR) project to improve energy efficiency, including the elaboration of a labelling program. The EEIGGR successfully developed the energy efficiency criteria for room air conditioners and refrigerators. The Ministry of Industry, responsible for standards setting in Egypt then issued a regulatory decree to enforce the programme, (Government of Egypt., 2002). Enforcement in practice was prevented by the absence of a testing laboratory for appliances. A World Bank study assessed the viability of labels, among many other energy efficiency options, and recommended the development of appropriate facilities. The government of Egypt agreed to pay to upgrade existing facilities at the New and Renewable Energy Authority and the UNDP agreed to provide a further grant to provide training and supplementary equipment for enforcement, (UNDP, 2004). The case illustrates how well-articulated technical cooperation with different bodies is needed to drive the process forward, but also how there is a need in many countries for a sustained effort.

Low standards may offer protection to small, less technologically equipped, local manufacturers who feel unable to cope with the financial and technical demands of more efficient equipment. The air-conditioning market is such a case. Assembling air-conditioning plant from purchased components is a fairly low-technology business and local markets may be served in large part by small local companies. Practice varies somewhat from country to country. Some Chinese domestic manufacturers are already well-equipped, because of the very large domestic market. In Thailand, attempts to develop a labelling scheme for air conditioners where thwarted by the local industry; labels were successfully introduced in consultation with the small number of manufacturers of fluorescent tubes and refrigerators, but the Thai air conditioner industry included 55 manufacturers and an agreement industry could not be reached, (IEA, 2007).

There could be advantages in international standards that would simplify the definition of national standards, avoid unintended barriers to trade and facilitate procuring of testing services from neighbouring countries. To achieve large volumes, cost-reductions and to stimulate innovation the global trade in appliances is important. International co-operation and coordination is needed to ensure that barriers to trade do not emerge.

International companies in the private sector would normally be in favour of cooperation in the setting and development of standards as it helps them streamline production and sales internationally, but the position of domestic manufacturers may be more nuanced as noted above. Grants for upgrading facilities and training of design staff and management may

need to be foreseen. Some consolidation of a fragmented manufacturing sector will also be inevitable.

There would seem to be a role for a neutral partner such as UNEP in facilitating coalitions of private actors, governments and civil society organisations such as the Collaborative Labelling and Appliance Standards Programme (CLASP) to help governments bring more coherence to standards programmes, facilitate testing and enforcement and ensure as far as possible that market consolidation and restructuring occur with a minimum of disruption. UNEP's has some excellent precedents for this kind of activity. The work conducted by the Task Force on Sustainable Products to foster convergence towards standardised test procedures for electrical equipment led directly to the establishment of the IEA Implementing Agreement for a Cooperating Programme on Efficient Electrical End-Use Equipment designed to provide a platform for countries to share expertise and to ensure coordination of international initiatives aimed at implementing efficiency improvements in electrical equipment, (IEA-4E, 2011). Similarly, the En-lighten Initiative (Global Market Transformation for Efficient Lighting) has contributed significantly to the planned global phase-out of inefficient incandescent lamps by 2016 and creation of mechanisms for disseminating efficient lighting technologies.

Conclusions about appliances

From the above discussion we can draw some important conclusions.

Private capital has a clear reason for demanding high and effective standards for energy efficient appliances. The relevant manufacturing industry exists to make such devices; higher quality products will lead to higher prices and normally to greater revenues. The general sensitisation of the market associated with the accompanying government interventions will also tend to provoke faster rates of turnover in the sector that is unambiguously good for manufacturing.

The savings in energy, and therefore in GHG emissions, are potentially very substantial indeed.

Enthusiasm for higher standards will tend to be greatest among the most efficient and advanced manufacturers as they will be the most confident that they can be competitive in more stringent conditions. Less well-equipped manufacturers, and this group may well include many local manufacturers on domestic markets in developing countries, may resist the process.

Private companies will be reluctant to risk their capital in circumstances where the enforcement of standards is poor. In these conditions they will not achieve acceptable rates of return on investment in new production lines because of poor sales arising from smuggling and sale of sub-standard appliances on a black market.

The established role of technical assistance is to create the market and regulatory conditions in which the private sector can invest with confidence; this includes design of standards, assurance of adequate testing protocols and equipment, creation of a convincing regime of compliance and training of staff. In this role technical assistance has been only partially successful because of limited funds and insufficiently long periods of support.

There is an emerging role for technical assistance to create a platform through which the vast capital resources of the private sector can be deployed to support the established tasks of technical assistance as enumerated above, to ensure a degree of coherence in international practice and to support advocacy among governments.

Developing countries have much to gain from this as it will improve the supply of appliances to their population, decrease energy use and in the right circumstances contribute to domestic capacity for innovation and manufacture. They also have much to lose if domestic markets are swamped by superior imported goods, lower cost domestic products are eliminated from the market by regulation, jobs are lost and the trade balance affected.

Credible, neutral partners for developing countries that can help balance opportunities and threats are essential and UNEP, in cooperation with other agencies, is in a very good position to contribute.

3. Transport

Trends in transport and fuel efficiency

Transportation consumes more than half of global liquid fossil fuels and about 25% of emissions of CO2 come from transport. Cars and trucks are responsible for about 75% of emissions, but those from aviation are growing rapidly. Not only is transport a major user of energy, but demand for mobility, especially in developing countries is growing rapidly and if there are no changes in current practices then energy use can be expected to grow proportionally. On present trends energy use in transport could double by 2030 and then further increase by more than 80% by 2050, (IEA, 2009). According to the IEA, there were an estimated 800 million light duty vehicles (LDVs) worldwide in 2005. Vehicle numbers increase much faster than population; the stock grew by 60% from 1990 to 2005 compared to a population increase of 25%.

The faster growth rates are found in developing countries and this trend is likely to be strengthened by the production of low-cost vehicles such as the Tata Nana in India. There is a strong correlation between income and vehicle ownership; ownership rises steeply at an income of around $5000 / year, which is a threshold that many people in developing countries will cross between now and 2050. Although trends are difficult to project, by 2050 developing countries will certainly account for the largest share of energy use and

GHG emissions.

To achieve the level of mobility that most people desire in a way that is consistent with resource and environmental constraints will require both technical innovation and behavioural change. Some of the possibilities and the way in which the private sector has contributed in the past and can contribute in the future are described below.

Technical innovation

Technical innovation proceeds through two, not entirely distinct ways; it can occur through incremental innovation whereby existing practice is tweaked in some small way, or by radical innovation in which there is a disruptive change in practice that introduces a novel way of doing something that was done less well before. Because radical innovations are disruptive of existing practices they face barriers to adoption and generally have to exhibit strong advantages if they are to penetrate markets fast. Incremental innovation is the most common source of innovation, but of course it always builds on some radical innovation that came earlier.

Incremental innovation

The internal combustion engine is an improbable device. It contrives explosions to drive pistons in a reciprocal linear motion, which is then transformed into power at a rotating shaft that is further transformed to rotating power on a perpendicular alignment and eventually used to move a vehicle forward; it is not at all an obvious process. A century of incremental innovation has made this unlikely invention into the universal, reliable, versatile, powerful tool that we are familiar with. Incremental innovation will also be the main source of efficiency improvement over the next few decades.

There are few industries where the innovative capacities of private enterprise are as evident as in the automobile industry. The original radical innovation of the vehicle itself and the mass production techniques that made it accessible to many originated from private capital. Likewise, the incremental innovation that has continuously improved the product since then has been driven by competition and the free market. The results have been astounding; they have just not been very energy efficient. This is because energy efficiency is not what customers have traditionally looked for in a car. Selling points are power, performance, speed, style, comfort and these are the factors on which the industry has focused.

Things are of course changing and the industry now pays, and has paid for some time, much attention to improved efficiency and the consumer now gives the matter some priority also, but it is very likely that consumer preferences are insufficient to bring about the changes that are required. Government intervention through standards is therefore needed and this is discussed later. The point to be made in this part of the argument is that the private

sector has demonstrated immense innovative capacity in the past and. if properly directed and encouraged, is capable of bringing to market much more efficient products in the future.

UNEP has joined with the IEA, the FIA Foundation and the International Transport Forum in the Global Fuel Economy Initiative (GFEI); this is an initiative to improve vehicle efficiency worldwide. The partnership has produced an excellent account of the options available to achieve this objective and this section draws heavily on that account, (GFEI, 2011), and on the IEA study cited earlier, (IEA, 2009).

According to the GFEI study, the average fuel economy of the global vehicle fleet can be improved by at least 50 percent by 2050, from the current average of ~8L/100 km to ~4L/100 km, through cost-effective measures. The calculations of cost-effectiveness were based on an oil price of $60/bbl and no fuel tax, using a social discount rate that would normally be well below the discount rate used by industry or consumers. Oil prices are much higher than that at present and are generally thought likely to stay that way, (EIA, 2012). The increased oil price and possibly fuel taxes will compensate a little for the social discount rate and will nudge consumers and the industry towards more efficient choices, but that is a secondary issue; the main point is that the calculations done at the social discount rate are a legitimate underpinning of government policy and a sound basis for the establishment of regulations that will bring about the necessary efficiency changes.

The technologies involved mainly envisage incremental change to conventional internal combustion engines and drive systems, weight reduction, new materials and better aerodynamics; they are fully described by the IEA, (IEA, 2009). A faster rate of improvement to achieve a 50% reduction by 2030 could also be possible, through hybridisation of a wide range of vehicles.

Because of the convergence internationally of technology and the globalisation of much of the industry, improvements of this order are possible in non-OECD countries where car fleets are growing fastest, as well as in OECD countries. Such changes will be equally cost-effective at varying opportunity costs for energy, but this may be disguised by consumer price subsidies in some countries.

An improvement of 50% in vehicle efficiency by 2050 would approximately compensate for the expected increase in vehicle usage by that date and would effectively keep emissions from LDVs constant. This has the potential to result in savings in annual oil import bills alone worth over USD 300 billion in 2025 and 600 billion in 2050. The improvements would save 1 GtCO2 per year by 2025 compared to BAU levels and over 2 Gt of CO2 per year by 2050. Local pollution from NOx and particulates would also be reduced, which would make a big contribution to the quality of air in cities, especially in developing countries. Emissions

of black carbon would fall; black carbon is estimated by UNEP and the World Meteorological Organization to be the second largest contributor to global warming after CO2, (UNEP-WMO, 2011).

- **Radical innovation**

Radical innovation in vehicle design could come from electric vehicles or fuel cells. The Global Fuel Economy Initiative does not depend on the emergence of these technologies to achieve the 50% reduction by 2050 for which it aims, but sees these advanced technologies as capable of further extending efficiency gains and CO2 reductions if they succeed in achieving mass-market commercialisation. The reductions in fossil-fuel use from electric vehicles (plug in as opposed to hybrids) are predicated on the availability of low carbon electricity. Associating the incremental electric vehicle with a purely renewable increment of electricity is practically unrealistic and this should be recognised in assessing the CO2 reductions that are really achievable.

- **Fuel cells and hydrogen**

Range and power of pure electric vehicles are very unlikely to match the performance of cars that travel with their own supply of chemical fuel, because high energy chemicals have a far greater power density than the best batteries and this is unlikely to change. For car owners in a CO2 constrained world who prefer large cars and who travel long distances the fuel cell vehicle with on-board hydrogen or with liquid fuels and an on-board reformer may be attractive.

There is a considerable effort throughout the world to commercialise fuel-cell drive trains for LDVs. Commercialisation is anticipated by some authorities in Europe by 2015, initially in Germany, and in Asia, (South Korea and Japan). Optimistic estimates are that global growth of the fuel-cell electric vehicle market of a little less that 50% per year is possible, from around 60,000 cars in 2015 to just below 400,000 in 2020, (SETIS, 2012). This estimate of penetration seems to bear out the view of the GFEI that the numbers will not be sufficient to make a significant impact on energy use and emissions globally by 2030.

There are though many problems to overcome before a mass-market can be achieved; the efficiency of fuel-cells is still below what would be needed for mass-market exploitation; the cost needs to be much reduced; durability and life-time of the fuel-cell stack needs to be extended; hydrogen storage is a limitation and the availability of hydrogen infrastructure is a major constraint. There are some optimistic estimates in the literature; McKinsey & Co. (2010) for example predicts a 90% reduction in average stack cost by 2020, and a reduction in the cost of hydrogen from €17 / kg in 2020 to below €5 / kg by 2030, but this rate of progress cannot be guaranteed.

Much research is still needed; the industry is engaged in such research, but there are very good reasons why they are unlikely to proceed at a rate compatible with the public interest

(vested interests, market failures in the provision of public goods). There is a sound justification for public research funding and this is evident in the large programmes run by the DoE in the US, (DoE, 2012), the EU Commission, (EU, 2012) and in Japan, (FCDIC, 2012), (JHFC, 2011). There is also a significant international cooperation through the International Partnership for Hydrogen and Fuel Cells in the Economy, (IPHE, 2011).

- **Electric vehicles**

Electric vehicles are not new; the first practical vehicle was probably that of Davenport and Davidson around 1842 and by in 1899 ninety percent of New York City's taxi cabs were electric vehicles. By 1904 one third of all the cars in Chicago, New York City and Boston were electric powered and production of electric vehicles reached its (then) peak in 1912, (carhistory4u, 2012). It lost out to the internal combustion engine that through the process of incremental innovation described earlier achieved much greater power and range.

For a range of environmental reasons interest in electric cars has revived and great advances in battery technology have brought it to, or close to, commercialisation in several applications. Electric vehicles do not produce emissions while driving and this alone is an advantage in urban conditions where it can contribute to better air quality. It is more difficult to know what the emissions are when the production of the electricity required to move the vehicle is taken into account. If the electricity comes from nuclear power or renewable energy then it causes very little incremental emissions of GHGs. If on the other hand the electricity comes from coal then the savings in emissions could be much reduced. The environmental advantages of electric vehicles depend very much on how the power system develops.

Plug-in electric vehicle (EV) and plug-in hybrid electric vehicle (PHEV) technologies are modern options that have the potential to use electricity for all or part of their journey. Plug-in electric vehicles use an electric motor powered by an energy storage system and only use electricity from the utility grid. A plug-in hybrid electric vehicle has an internal combustion engine, but also the ability to recharge its energy storage system with electricity from the grid; when batteries are charged the control system will give priority to electrical propulsion.

The main obstacles to the penetration of plug-in electric vehicles and plug-in hybrids (as opposed to simple hybrid vehicles discussed below) are the cost and performance of batteries, and the need for a charging infrastructure. The National Renewable Energy Laboratory of the Department of Energy in the US has made a detailed study of the cost-effectiveness of electrical vehicles at present and how it might evolve, (NREL, 2010). The NREL study concluded that with the cost and performance of batteries now available, the consumption of gasoline would decreases significantly from use of electric vehicles, but, no electrification pathways were cost-effective compared to hybrids (see below) or

conventional vehicles except under a scenario where the vehicles connected to an external source of energy along the roadway; this seems unlikely to be a practical proposition in most cases. The extra battery costs in PHEVs and EVs outweighed the fuel savings. Battery prices need to fall from the $700 $/kWh assumption used by the NREL to about $300 / kWh for EVs to be cost-effective. Whether this can be achieved is a contentious issue.

Automobile manufacturers are more optimistic; most electric cars in the next ten years will use lithium-ion batteries, which in consumer electronics are about $250 to $400 per kWh. And this suggests that the cost of an automotive lithium-ion battery pack might fall from the present 1,000 to 1,200 $ / kWh to the lower level when produced at scale. The Boston Consulting Group has published a study of the outlook for batteries that notes that car batteries specifications are very demanding on safety and durability, so the breakthrough may take longer than foreseen although some increase in sales will certainly materialise, (Boston Consulting Group, 2010).

The availability of infrastructure for charging is another difficult issue. Plug-in electric vehicles are unlikely to penetrate markets very much if they are obliged to return to station to recharge. The study by the Boston Consulting Group estimates that the cost of the charging infrastructure for the limited penetration that it foresees would be about $20 billion (in the US, Europe, China and Japan). Considerable support for this investment is likely to be necessary from public funds as private contractors are unlikely to take the risk (chicken and egg dilemma).

- **Hybrid electric vehicles**

Hybrid electric vehicles (HEV) are now commercially available and widely used. The HEV combines a conventional internal combustion (IC) engine propulsion system with an electric propulsion system and batteries. The battery permits the IC engine to operate at economic conditions for longer than it otherwise could do; it stores energy from regenerative braking and surplus power output from the IC engine which the electric propulsion system then can use in conditions that are not optimal for the IC engine. In this way an improvement in fuel economy is achieved. The IC engine can also be smaller than would otherwise be necessary.

The hybrid electric vehicle might well not be classed as a radical innovation because it is not disruptive; it requires no new radically new components, no new fuel system or infrastructure. HEVs are now common; the best-selling hybrid is the Toyota Prius and this has now sold more than 2 million units world-wide and more than 1 million in the US, (Toyota, 2011). Hybrid electric trucks (pickups and tractors) and buses also exist, but they are not as common as cars. More rapid introduction of hybridisation and its extension to a wider range of vehicles was seen by the GFEI as an option to increase the rate of improvement of efficiency of the global vehicle fleet to achieve the goal of 50% by 2030 instead of the basic target using only incremental innovation of 2050.

The report by the Boston Consulting Group cited earlier, (Boston Consulting Group, 2010), envisages a substantial penetration of hybrid vehicles that would include some developing countries. Their central forecast is that 14 million electric cars will be sold in 2020 in China, Japan, Europe and the US of which some 1.5 million will be fully electric, 1.5 will be range-extenders and 11 million will be hybrids. The associated market for batteries would be $25 billion.

Behavioural change

The use of energy in transport may also be influenced by a variety of measures to influence behaviour by managing growth in travel demand and encouraging modal shift to more efficient modes such as mass-transport for passengers and railways for freight.

In the IEA scenario analysis that is included within the 2009 study, the baseline scenario suggested a tendency for the least efficient modes of transport to dominate by 2050. The use of individual cars and air- transport grew faster than rail and mass-transit. This was true of both OECD and non-OECD countries. The IEA expressed the view that it would not be easy to achieve a significant level of modal shift away from this trend, but that strong policies would have some effect. The impact of modal shifts (and the need for them) is affected by the extent of success in decarbonising the less efficient transport modes. If decarbonisation proceeded reasonably well, then the IEA calculated that modal shifts could help achieve by 2030 the same reduction as would otherwise only be achievable by 2050. This is a significant benefit. The benefit is proportionately greater if decarbonisation of the less efficient modes is achieved.

Urban planning

From an economic perspective, cities exist because of the increasing returns to scale inherent in large labour markets. In its extreme and simplest terms, this function means that all jobs should be easily accessible from all residences. Empirical evidence suggests that dominantly monocentric cities with well-defined central districts reduce journey times and therefore the environmental emissions. Because the local pollution is concentrated in a small space, the exposure to pollution may be high even though emissions will be lower than in dispersed cities. Over time, large cities tend to become less monocentric and journey times increase and the efficiency of public transport declines. Private transport becomes more attractive and this, combined with longer journeys, causes the use of energy to rise to the point today where cities contribute to 67% of world's primary energy demand and are projected to increase this share to 73% by 2030, (IEA, 2008).

But modern cities respond to a wide variety of needs and their capacity to respond is conditioned by culture, legacy structures, income disparities, climate and many other factors. The complexity of the issues is well illustrated by the recent European study of

Cites of Tomorrow, (EU, 2011). The benefits to be obtained in energy efficiency from improved planning are difficult to disentangle from other aspects of city planning.

There are also many constraints. The inertia of existing city infrastructure is immense; the human resources for the huge design and reconstruction effort that would be required will be hard to find and there is an absence of a real scientific basis for the design principles. The opportunities in developing countries are in some ways greater than in the industrialised world, because there inertia of existing developments is somewhat less. A report by the European Commission of research towards a post-carbon society suggested one way to improve the efficiency of energy use in cities, (EU, 2007), based on three principles.

- Rapid reaction.
- Massive renewal.
- Rethinking the planning of cities

Rapid reaction means limited interventions with a minimum disruption; this could include the promotion of innovative transport solutions. The intention is not to disrupt the normal life of the city and this tends to mean that technologies cannot function to their full potential.

Massive renewal is extremely expensive; it means the rethinking and redesign of transport systems and the built environment. Such interventions would be complex, difficult, and contentious and would only be practical for dense urban structures.

Rethinking the planning process means beginning from an analysis of the relationship between spatial configuration and energy use and how it can be influenced. It is also increasingly necessary to look at the regional interactions between cities and to reconcile urgent needs and long-term benefits. Such an undertaking requires intervention at multiple levels of governance.

Decisions on city design and planning have to be made in consultation with users of the city if they are to succeed. Mechanisms need to be found to do this. Here there is a role for business. Business is itself a user of city functions, but can also catalyse the relationship between politician and citizen. The citizen has certain short-term preferences for the commercial services that the city offers, including transport; the political class has a long-term vision of how it believes the city should evolve. Business can moderate this relationship because business understands the practicalities of delivering services and can indicate ways by which both sides can be satisfied. In a sense that is what business always does – it finds the efficient path to consumer needs through the complex structure of regulation by which political priorities are expressed.

Policy instruments

The automobile industry has shown itself to be extraordinarily innovative in the past and no doubt will continue to be so in the search for returns to shareholders. It is up to policy-makers to ensure that the market and regulatory frameworks and, to some extent the infrastructure and knowledge base, are in place to direct the innovative potential in ways that conform to social needs.

The main instruments available are: various forms of regulation to affect the performance of new additions to the fleet (standards, labels, taxes, incentives), research and development, provision of infrastructure and to make business an effective partner in the social dialogue about the future.

- **Standards**

Fuel economy or CO2 emissions standards are an obvious way of bring the decisions of consumers (and therefore the industry) in line with what analysis based on social discount rates and a long-term outlook would advise. Standards for the efficiency and the emissions of new cars are in place in most OECD countries.

The United States introduced Corporate Average Fuel Economy (CAFE) standards in 1975 following the first oil crisis and this was done for reasons of energy security rather than environmental protection. The standards were not noticeably effective as the average fuel economy of new vehicles in 2007 was not much different from that measured in 1975. Vehicle technology in general since 1975 has shown a natural rate of improvement of around 1% a year; in the US this potential has been used to improve power and weight. In Europe, about half of the potential was used for performance and half to improve fuel economy, (Heywood, 2008). This is evident in the effect of standards in Europe, and also in Japan, where experience has been positive and significant improvements have been recorded (IEA, 2009). Further tightening of standards is intended in both Europe and Japan and recent legislation in the US required a 40% increase in new car and light truck efficiencies over 2007 levels by 2011.

Among non-OECD countries, only China currently appears to have fuel economy standards in place. As noted earlier, much of the new car market in the future will be in developing countries and it is important that standards be developed rapidly. Business, on the whole is likely to welcome such initiatives as it permits a higher standardisation of practice and therefore lower costs.

Standards for car performance necessarily require testing protocols that tests simulate a range of driving conditions. These tests may discriminate against certain efficiency features such as technologies that cut fuel consumption and emissions in “off-cycle” driving conditions. It is incumbent on government agencies to ensure that test protocols accurately reflect what policy results the standards are intended to achieve. There is also a range of

protocols across the world that can be significantly different. There would be benefits from a degree of harmonisation as it would simplify the compliance process by business.

Very demanding standards that cannot be met by incremental innovation could help stimulate the market for electric cars. Tyres affect fuel consumption considerably and up to 5% fuel savings can be achieved in the medium-term, (GFEI, 2011). Regulatory standards and labelling are appropriate here also; low-friction oils, air-conditioners and lighting could also be subject to similar regimes.

- **Taxes and Incentives**

Taxes can be levied on purchases, ownership and use. Taxes on purchase and ownership (road tax licences) are not theoretically the best to encourage efficiency. There is no particular problem in buying or owning an inefficient vehicle; the problem is in using it. Fuel taxes are theoretically more effective. Tax incentives are a slightly different instrument because they are intended as a temporary measure to stimulate the penetration of fuel efficient vehicles. They have been used successfully in Japan.

- **International cooperation**

The World Forum for Harmonization of Vehicle Regulations was founded more than 50 years ago. Secretariat is provided by the UNECE. It is a permanent working party in the institutional framework of the United Nations with a specific mandate and rules of procedure. It works as a global forum allowing open discussions on motor vehicle regulations. Any member country of the United Nations and any regional economic integration organization, set up by country members of the United Nations, may participate. The intent is work towards harmonised regulations on vehicles including regulations on environment and energy, (UNECE, 2012).

The Forum brings together governments and automobile manufacturers and potentially should be able to develop harmonised test procedures that would benefit business and also developing countries that otherwise have to work on specific procedures of their own that may take many years to agree and that would not fully benefit from past experience.

Conclusions about transport

Business has shown immense innovative capacity in moving from early horseless carriages that were only attainable by the rich to the immense variety of reliable, high-performance vehicles affordable by a large part of the population of the world.

This success has brought with it heavy external costs and created problems of resource depletion and environmental damage that must now be solved. There is no reason to doubt that the same innovative capacity of business can be channelled to find solutions to these problems.

The role of government is to support and control business where it is needed. The tools are available. Regulations and standards have are the central element of any policy because they can be directly aligned on the performance levels congruent with social targets. Taxes and incentives are useful supplements on both the supply and demand side. The state also has a role to play in the provision of public goods where they are needed. The two principal areas in this case are research and development and in the facilitation or creation of infrastructure.

The closer that technology comes to commercialisation the greater the value of the intellectual property generated by research and the less likely is business to cooperate with public authorities in joint research. The situation with electric vehicles is probably close to that now. With fuel-cells and hydrogen, commercialisation is more distant and a closer cooperation is possible.

Plug-in electric vehicles and hydrogen powered vehicles will both need new charging infrastructure if they are to be widely adopted. Business will build these facilities if there is a commercial benefit, but that may not be the case. Public authorities would certainly need to facilitate construction by supportive planning and licensing; they may also need to contribute to the initial investments in order to reduce risk.

4. Buildings

The market for energy efficiency in buildings

Many of the biggest opportunities for profitable energy saving are in the design and operation of buildings. In 2008 the IEA estimated that energy use in buildings accounted for up to 30% of all energy-related greenhouse gas (GHG) emissions, or a little less than 40% of global final energy consumption. Of this 45% was in OECD countries, 10% in countries in transition and 46% in developing countries, (IEA, 2008). In all regions, residential energy use is the largest contributor, but proportions vary considerably according to the state of economic development. In OECD countries in 2005, consumption in residential buildings was typically 50% greater than in commercial buildings, whereas in non-OECD countries the ratio could be 10 to 1 or more. IEA forecasts suggest that by 2050 the residential sector will still be the largest even in OECD countries, although the margin will be less and in non-OECD countries the ratio will still be high, typically around 5. In absolute terms by 2050, energy use in residential buildings in non-OECD countries will be about double that in the OECD and use in commercial buildings will be roughly the same in both groups. Buildings also consume energy indirectly through their very large requirements for energy intensive materials such as cement, glass, steel and aluminium.

A study by the World Business Council for Sustainable Development (WBCSD) of the

markets in Brazil, China, Europe, India, Japan and the US concurred with the IEA that servicing buildings is the largest use of energy and accounts for around 40% of final energy use. It estimated that growth by 2050 at present trends over the six regions would be 76%, (WBCSD, 2009). A variety of case-studies included in this account demonstrated that in all kinds of buildings energy efficiency improvements are feasible at current energy prices.

In the six regions studied by the WBCSD, energy efficiency investments of US$ 150 billion annually (on average) would reduce energy use and corresponding GHG emissions by 40% and would give a discounted payback of five years or less[2]. An additional US$150 billion per year investment would give discounted paybacks between five and 10 years and would reduce energy use and emissions by more than half. Further reductions would be technically possible, but not economically advantageous. These figures indicate a huge market, of between $6 trillion and $13 trillion over the next 40 years.

Energy use in buildings is strongly affected by climate, especially for residential buildings, and in the case of residential buildings by culture, income and tradition. Technically, for large commercial buildings the differences between cultures will not be significant in terms of potential for energy savings; the technologies and practices are alike. The case of residential occupation is more complex, but some similar principles will apply.

This section of the paper attempts to capture some indication of how it can be done through some concrete examples. Buildings of course constitute an immensely heterogeneous set and generalisation within a short paper is a hopeless undertaking. The largest part of the global building stock can be divided into residential building (single family and multi-family occupation), offices and retail space. The stock can be further differentiated by ownership and billing procedures, climate zone and we need also consider new build and retrofit.

Retrofit of office space

Retrofit of any large asset is usually a painful and costly process. Given the very large building stock that exists in the world and its commonly poor thermal performance, but low turnover, there is a compelling need for some models as to how retrofitting might be done. A significant contribution to this endeavour has been made by the Rocky Mountain Institute that has been involved several innovative retrofit projects including the IMF Headquarters and the Empire State Building (RMI, 2012). The retro-fit of the Empire State Building was the first of these ventures and the best documented, (RMI, 2012a).

Technically the improvements were achieved through a combination of advanced windows, radiative barriers, direct digital controls, a retrofit of the chiller-plant, variable air volume air

[2] A discounted payback measures the time taken to recover the investment if the revenues are discounted at some specified rate.

handling units and a set of energy management tools for tenants. All of these are proven and well-demonstrated technologies. The project financing was achieved through a mixture of equity financing from the building owner and ESCO time funding from the supplier of control systems. Financing was significantly facilitated by the inclusion of the energy efficiency modifications within a much larger programme of regeneration for the building as a whole.

The total cost of the project was reported at $13.2 million with annual energy cost savings of $4.4 million, giving an average payback period of around 3 years, although the range of paybacks for the separate measures was quite wide. Savings are estimated at 32-38% of the historic consumption. Achievement of savings depends on the performance of three separate groups of actors – the ESCO (61% of total savings), the Empire State Building (22%) and the tenants (17%).

The ESCO is rewarded under a set of performance contracts; the building owner pays the ESCO a guaranteed maximum lump sum for the capital cost of the projects and then if the savings are below the expected level the ESCO must reimburse the owner. The guarantee on savings lasts for 15 years. The ESCO makes its money from the sale of plant and installation; the building owner benefits from the future savings. The building owner is responsible for helping and incentivizing tenants to pay for and achieve the 17% expected from short-term energy management; this includes sub-metering all tenant spaces and providing feedback and reporting tool about their energy use.

There is much to be learnt from this example regarding the effective involvement of the necessary range of private sector actors. The coordination of the energy upgrade with a major renewal programme permits the sometimes severe structural interventions that are needed to the building fabric to be undertaken at lower cost; it also allows a holistic approach that enables reduction of load through better lighting and modern materials for the fabric to be considered together with the improvement of thermal conditioning and ventilation systems in a way that is often not possible with piecemeal remedies.

The use of the ESCO and performance contract to share in an effective way is also instructive; the ESCO accepts the risk that energy gains will not be achieved, which is correct practice, but in this example he is not rewarded when the gains are met, but penalised if they are not. This reduces the financing burden on the ESCO, who in many cases is a consulting engineer whose balance sheet will not support large capital investments; it does though create a counter-party risk for the building owner.

The example also demonstrates the value of ESCOs in the building sector. There has been a substantial effort through technical assistance to create ESCOs in developing countries working in industry, but this is a difficult area. The most successful examples of ESCO work

have been in North America in the building sector. Office buildings have many advantages for ESCOs. Energy efficiency is not a high priority for the owners and occupiers and they have little technical capacity so there is little inclination to do such projects in-house. Projects in this market can easily be replicated because of the great similarity among the facilities of different clients. This lowers costs or increases profits, depending on circumstances. Public buildings are especially attractive because they are credit-worthy customers, eventually backed by the state, but they are not comfortable borrowing, so performance contracting works well.

The experience of the Empire State Building retrofit demonstrates the need to engage tenants and the possibilities. Two models coexist within the building – pre-built spaces where the utilities are paid for by the building owner and other spaces to be accommodated to tenants designs and there where tenants have a significant influence on energy use. In the latter case tenants are made responsible, but are assisted by the owner through pre-existing energy management systems, including real time consumption data, and guidelines as to how to reduce bills. This is a sensible approach to the "agent-principal" problem that is often identified as a significant barrier to energy efficiency in buildings.

Lastly, there is an important lesson regarding the motivation of the building owner, who is reported to have judged that his business objective to replace many small tenants the building with fewer, larger businesses would benefit from a green rebranding that would permit them to meet their own corporate sustainability objectives and to demonstrate that they had done so (Harvard Magazine, 2012).
So in short, the example shows a need for management with foresight, coordination of energy with building renewal, imaginative approach to the agent-principal problem; and the best of existing technology and appropriate finance.

Retail space
Retailing practices tend to become more energy-intensive with development as the emphasis shifts from small shops to large supermarkets and shopping centres. The top 100 retail companies in the US take 34% of total retail revenue, whereas in China the top 100 companies manage only 10.5%. Concentration in developing markets is likely to increase. The tendency of modern practice to higher energy intensity contrasts with most economic activities where consolidation and vintage effects tend to lead to lower intensities. In the US, energy intensity in the retail sector increased from an average 310 kWh/m2/yr in 1995 to an average of 351 kWh/m2/yr in 2003 (almost a 15% increase). The increase in electricity intensity was even more spectacular, reflecting higher levels of lighting and equipment, (WBCSD, 2009). The historical reasons for the increase are:

- Retail managers know little and care less about energy use
- Lighting sells
- Thermal comfort supports sales; customers do not stay if it is too hot or too cold

- Longer opening hours increase energy use

A good example of how attitudes are changing in the retail sector and how private capital is investing its own funds is the Greener Living programme of the supermarket chain Tesco in the UK. The corporate aim, declared at a speech delivered by the Chief Executive Officer just before the Copenhagen COP, is to become a zero-carbon business by 2050 (Tesco, 2009). On the road to this goal, the company opened a store at Cheetham Hill in January 2009 that reduced the carbon footprint by 70% compared to its other stores of similar type and then a 'zero-carbon' store at Ramsey, in February 2010, built on similar principles, but with LED lighting. Within the limitations imposed by the UK planning system, this model will be used for all future stores.

The reduction in carbon footprint was reportedly achieved (ClimateChangeCorp, 2012):

- 31% through energy efficiency measures
- 20% by using CO2 as a refrigerant
- 19% by using a combined heat and power plant running on "recycled vegetable oil"

The main energy efficiency features of the approach are (SCI, 2010):

- Better utilisation of daylight for lighting
- Reducing summertime solar gain: the store has special windows in the roof, allowing natural daylight to reach the sales floor and are filled with a gel that allows light through without over-heating the store.
- Installing natural ventilation systems
- More precise monitoring of requirements for lighting and ventilation
- Accepting a wider range of operating conditions, so reducing cooling demand
- Reducing energy exchanges between refrigerated display cabinets and the store environment
- Installing more efficient motors and compressors
- Utilising renewable energy sources, notably biomass and wind energy

Some of the features listed above are specific to the temperate climate of the UK. For example, space-cooling is an expensive activity in temperate climates, because the utilisation of the capital is low. So, if space-cooling loads can be reduced by better use of natural cooling this has a big impact on cost that may not be so relevant elsewhere. But there will always be climate-specific features that can be exploited to improve performance and there is no reason why overall similar levels of performance should not be achieved elsewhere. Indeed, similar projects and commitments are envisaged by most supermarket chains and large retailers across the US, Japan and Europe, which covers a large climatic range.

For the purpose of this paper the motivation of the private sector in undertaking these

investments is important. There are certainly financial savings; energy consumption from the zero-carbon Tesco model will be reduced by 48% compared to similar stores, but the calculation goes wider. The speech of the CEO noted earlier creates an association with the desire of consumers to participate in green living, even vicariously through their supermarket. And in some sense this is surely a strong driver. Given the opposition to new supermarkets in the UK, such zero-carbon stores may also increase the likelihood of obtaining planning permission for future stores, which is the main constraint on expansion within the UK market. The company may also profit under the UK's Carbon Reduction Commitment.

The lessons from this case are: cost-effectiveness goes far beyond the tangible. It goes beyond even the immediate intangibles of climate change. The savings are real, that is not in dispute, but the cost effectiveness probably involves a subtle off-setting of some incremental cost in Net Present Value against the need to position the company in a social climate that requires, through a complex interaction of factors, evidence of corporate submission to sustainability goals. The relevance to developing countries may not seem immediately evident, but the pressures of international opinion, climate change and energy security are likely to create similar pressures in the larger developing economies and UNEP stands in a good position to help broker the relationship among stakeholders.

The residential sector

Although large office blocks and retail spaces are the biggest individual users of energy in buildings, the residential sector as a whole is larger and especially so in developing countries. The pattern of energy use differs widely between as a consequence of culture, climate and income. Space heating is dominant in cold and temperate climates such as Europe, large parts of North America and Russia, and northern China. Water heating is significant in Japan; in rural India, and in most tropical and sub-tropical regions where there is no access to electricity the main energy use is cooking with biomass. Development and enhanced access to energy will lead to higher energy use for cooking, lighting, appliances and electronic goods. We look here at examples of private-sector investment in single family homes and in multi-occupancy dwellings.

- **Building codes**

Fragmented ownership and a general ignorance of the potential for energy efficiency, together with high implicit discount rates are important obstacles to energy efficiency in single family houses. The way in which energy is used varies considerably according to climate and culture. In hot areas, air-conditioning is increasingly prevalent; in cold and temperate regions space heating is the main use.

Developed countries face a particular challenge in retro-fitting old building stock. This is a hugely complicated task because of the technical problems and rather high costs, the highly

diverse nature and age of the stock and capital stringency among many-owner occupiers. These problems are exacerbated for rental properties.

The main policy instruments for controlling energy use are the building code and boiler standards. Financial incentives for retrofitting insulation are also common. The building code is particularly useful for new buildings, because interventions in design and construction are much easier and cheaper than retro-fits. A properly constructed and well-enforced building code will ensure that private capital is deployed profitable into energy efficiency, because it will have no choice. Profitability will be assured because the incremental capital return will be incorporated into the sales prices and as long as the developer is not under-cut by non-compliant developers that price will be competitive.

Unfortunately, a major problem in developing countries (and not unknown elsewhere) is the weak enforcement of building regulations. For example, in China compliance with the 1995 building standard was only 6 percent across the heating zone in 2000, rising to 30% in 2004, and it appears that it is still only in the Northern cities that compliance is good, (ESMAP, 2008). In Brazil, 75% of single-family homes are believed to be built by the informal sector, (WBCSD, 2009), and the same is probably true of many other developing countries.
Proper design and enforcement of building codes is by far and away the most effective instrument for ensuring a proper deployment of private capital in new build in the residential sector. Codes are normally prescriptive (define how efficiency is to be achieved in the building envelope and equipment) or performance-based (require a maximum energy use according to specific indicators). Many countries allow a choice of methods or a combination of prescriptive and performance methods.

The work of UNEP's Sustainable Buildings and Climate Initiative (UNEP-SBCI), which seeks to promote sustainable building policies worldwide, supports these conclusions. UNEP-SBCI's report, *Assessment of Policy Instruments for Reducing Greenhouse Gas Emissions from Buildings,* completed with Central European University, also concluded that among the policy tools available, regulatory and control instruments (building codes), were both "most effective and normally also most cost-effective", based on 80 case studies (UNEP-Central European University – UNEP SBCI, 2007*).* The report assessed the effectiveness of regulation as well as economic and market-based instruments, voluntary certification, and fiscal instruments and incentives, and highlighted the need for sufficient enforcement and implementation of regulations as being critical to effectiveness.

Enforcement is difficult, but it is possible. China, it was noted above has had low levels of compliance and still does to a large extent, but the improvements have been marked as a consequence of a strong political will. It is interesting also that China places a strong reliance on private sector compliance institutions. A design verification company must review the design of the building and certify that it complies with the code; a separate

construction supervision company supervises construction to check that construction complies in reality. The whole comes under state supervision (Pacific Northwest National Laboratory, 2010).

- **Supplier obligations**

Another source of private capital that can be made to contribute to improving the energy efficiency of the building stock is through energy suppliers. Since the liberalization of energy markets, there has been a tendency in industrialized countries to turn away from financial incentives and funds towards obligations placed on suppliers. An example is the Energy Efficiency Commitment in the UK, which was intended to improve the energy efficiency of existing households. This scheme placed on suppliers of gas and electricity an obligation to demonstrate programs that save specified amounts of energy related to their total supply volume, (OFGEM, 2008). All supply in the UK is competitive, so the supplier simply builds the costs into his cost-base and has the usual interest of a commercial company in keeping his cost-base as small as possible. The requirement was enforced by the regulator; failure to comply is penalized in proportion to the deficit between the target savings for the supplier and the amount achieved.

This has subsequently been replaced by a Carbon Emissions Reduction Target (CERT) that is very similar but requires suppliers to take measures to reduce the carbon footprint of households through increased energy efficiency, reduced energy consumption or microgeneration. At least 40% of the carbon saving obligation has to be achieved in a priority group of low income, vulnerable and elderly households.

The impact assessment of this measure includes an account of the expected economic and environmental impacts. The total cost of the programme over three years from 2010 to 2012 will be some £5.5 billion, while the net present value of benefits is assessed as about £14 billion (which includes some benefits taken as greater comfort and the value of GHG emissions) (DECC, 2012). This is an example of the involuntary deployment of funds by the private sector in which the business case is created by a government obligation. It is a mechanism that works best where there is competition among suppliers, because that leads to a search for the most cost-effective measures of compliance, but it can be adapted to non-competitive supply regimes. Of course, the net effect is a transfer from the majority of electricity consumers to those that benefit from the investments, because the suppliers recover their expenditures through higher prices. The equity implications of this are not obvious, but they will not be very much different from tax-payer funded transfers and high tax because high electricity consumption are to a large extent correlated.

Brazil has had a supplier obligation in place since 1998, when the Agencia Nacional de Energia Eletrica (ANEEL) was appointed regulator. This places a charge of 1% of annual utility revenues which must be used (primarily by the utilities themselves) for the public

benefit investment in energy efficiency, research and development and energy planning. Initially the utilities focused on public lighting where the tariff was low and below costs. In 2005 the arrangement was supplemented by an obligation to spend at least 50% on low income programmes. Ex-post evaluation has focused mainly on expenditure verification rather than energy savings, but the evidence suggests that there have been significant benefits in energy savings and reduced peak demand, (Lees, 2010).

We note also that the proposal for a new EU Directive on energy efficiency places a strong emphasis on supplier obligations. It would require every Member State to oblige all energy distributors or all retail energy sales to achieve annual energy savings equal to 1.5% of their energy sales, by volume, in the previous year from activities performed for their final customers (EU, 2012). The likelihood is that most of this would be in buildings.

The approach could be an important constituent of a strategy to implement Sustainable Energy For All. Many of the investments required will not be cost-effective in a simple financial sense, because of the low incomes of the new consumers. The use of supplier obligations that deploy the capital and expertise of utilities in this task could prove effective.

- **Multi-occupancy buildings**

Many apartments in multi-occupancy blocks do not have individual heating systems or meters to measure consumption. Heating costs are often included in the rent or charged on criteria such as floor space; so the tenant has no incentive to save energy. Such arrangements are found across the world, but are especially common in Russia, Eastern Europe and in China; such systems had no metering or possibilities for control by the user. Furthermore, prices were regulated at a low level, considerably less than the costs of production.

Following the break-up of the Former Soviet Union, heating practices were slowly reformed. In some countries such as Lithuania it was recognised that private-sector funding would be essential for the rehabilitation of the dilapidated infrastructure and that to attract private-sector participation it would be necessary to reform prices. Individual meters and two-part tariffs were introduced with fixed and variable components that gave an adequate return on capital and an incentive to the consumer to be efficient.

Between 1996 and 2001 the World Bank created a credit-line to finance residential building energy efficiency improvements by homeowners and homeowner-associations under the Lithuania Energy Efficiency and Housing Project. Investments included the rehabilitation of DH substations, change of windows and weather proofing of roofs and exterior walls. In 96 projects, the monitored energy savings covered large range, with an average value 17 percent, but also with increased comfort. It is a common observation that many homeowners prefer to take a part of potential savings as increased comfort. If all the

benefits of the investment had been realised as energy savings the reduction in use would have been about 25%. With the benefit of some subsidy element, the average payback time of the investments was 12 years. The example demonstrates that with a suitable price regime, reasonable financing conditions and the correct information, home-owners are willing to take on the financial responsibility of improving their own homes, even in a multi-occupancy apartment (World Bank., 2002).

For similar reasons, space heating in most existing buildings in China is extremely inefficient; typically buildings use from 50 to 100% more energy than comparable buildings in similar climatic zones in Europe and North America. This is a consequence of inefficient heat distribution and the absence of consumer control and incentives to save. A major difference with Eastern Europe is that the rate of construction is still very high and it is important that heating systems in the new stock should adopt modern technologies, with buildings built according to advanced energy efficiency standards and with correct incentives to users.

In northern China reform of urban housing to individual ownership has proceeded strongly since 1996. Now, 80% of urban apartments are privately owned, but heat supply remains largely a public welfare entitlement. The government of China has the intention to reform pricing and introduce private-sector participation. The ESMAP programme World Bank has assisted this process and partnered the central and municipal authorities in a pilot project in Tianjin. The results from five years of piloting heat metering and billing in Tianjin under a two-part tariff show that a reduction of gross heat supply requirements by 20 to 30 percent is typical (ESMAP, 2008). The successful introduction of the two-part tariff is a perquisite for the development of a commercial, competitive and efficient centralised heating sector operated and funded by private capital, but still remains to be done in terms of clear practices of accounting and taxation, clarification of asset ownership, licensing and regulation, consolidation and commercialisation, but the potential for private sector investment is very large.

Public buildings

As noted earlier, the government in its various forms and various dependent agencies are a large owner of buildings and there are advantages to an aggressive policy of renewal of public buildings. Not only does it have direct economic benefits through the savings achieved, but it sets an example and helps stimulate the development of good practices and models of renovation. The EU Energy Efficiency Directive for example proposes that public bodies, including local authorities, should, starting from the 1st January 2014, renovate 3% of the total floor space of buildings that they own and that the renovation should meet at least the minimum the minimum energy performance requirements set by the Member State concerned, (EU, 2012). This has met with understandable concern from local

authorities because of the financial implications and the already severe pressures on local authority budgets.

The strain on capital expenditure budgets can be relieved if resort is made to some form of Public Private Partnership whereby procurement uses private sector capacity to deliver public sector infrastructure. There is scope for a much wider deployment of ESCOs for renovating buildings in general and public buildings in particular.

In developing countries especially, the potential for implementing sustainable building practices in public buildings is quite high, if the barriers to financing those practices can be overcome. One barrier has been the difficulty of international financing mechanisms (mostly related to carbon) to support building sector-specific initiatives in developing countries. In part, the measurable, reportable and verifiable (MRV) standard to support international mechanisms has been difficult to achieve due to the fragmentation of the sector. UNEP-SBCI continues to work to develop policy instruments and tools, such as the Common Carbon Metric, which measures energy consumption and reports GHG emissions from operation of a building stock. Such tools can be applied to meet the MRV standard, providing the support for large scale investment in public building, including retrofits of schools, government offices, and social housing.

UNEP-SBCI also piloted the Sustainable Social Housing Initiative (SUSHI), which seeks to embed sustainable building practices in social housing. Among the goals is to increase the energy efficiency of affordable housing units, reducing the operating costs, but also increasing the "liveability" and quality of life for residents. This initiative was supported through funding from Norway for the first pilot in Bangkok and Sao Paulo, and is expanding through a second pilot in Bangladesh and India.

Conclusions about buildings

The examples demonstrate a range of business models in which private sector funding can be mobilised to improve building efficiency in a cost-effective manner in both developed and developing economies. The examples demonstrate funding through corporate equity, ESCOs, supplier obligations, infrastructure investment and credit-lines to support borrowing by private individuals and homeowner associations.

Some common themes that unite the very diverse examples are:

- Business leadership that makes energy efficiency a priority is essential in most successful ventures in commercial buildings; this often happens in response to political pressure for corporate commitments to sustainability in turn responding to civil society and expert opinion
- Political will to create proper market and regulatory conditions for investment is indispensable for private sector participation over a range of activities; by definition

the private sector cannot achieve the returns it requires on capital if prices do not reflect the value of that capital in other uses

- Financing models need to allow for a fair and realistic distribution of risks and rewards and to recognise the capabilities and limitations of partners – corporate equity, finance houses, ESCOs and individuals

Whereas this annex has not explored the role of building occupiers in enhancing the demand for energy efficiency in buildings, it is worth note the conclusions of an OECD report in 2008. The report on *Household Behaviour and the Environment*, which had residential energy demand as one focus area, concluded that *"Empirical analysis of residential energy demand teaches two general lessons of significant policy importance. First, that human behaviour matters decisively for energy consumption; when shaping a more efficient energy policy, it is not enough to consider the various energy-saving technologies that exist. Secondly, that human behaviour varies considerably with regard to energy demand [...]"* (OECD, 2008). Consumer research, looking at the various factors influencing energy consumption and lifestyles - including price but also natural and socio-cultural environments, as well as at the effectiveness of information and awareness-raising operations to influence purchasing decisions, should complement, if not be integrated with, product development and technical innovation for energy efficiency. It is a key to understand consumers and communicate better with them so as to promote the choice of energy efficient products over non efficient ones, thus creating a demand for such products.

5. Conclusions and recommendations on the business case for energy efficiency

Technical assistance and building the business case

The set of examples reviewed in this paper is diverse, but taken as a whole they demonstrate that business has immense innovative capacities and the financial means to implement cost-effective policies of energy efficiency across the global economy.

It is not the role of public authorities to create business cases for the private sector, although of course when they spend public money such a business case (for investments) or impact analysis (for policy and regulation) should be obligatory.

The private sector will construct its own business case; it is aware of its markets, its costs, its technology, and its financing conditions. It is familiar with the range of opportunities open to it and can make the proper trade-offs between risk and reward. It may not always do it very well, but there is no evidence that the state does it better. The role of the state is to create the circumstances in which business will make choices congruent with national, and increasingly, global preferences.

Technical assistance can contribute to the creation of a business case for energy efficiency in developing countries by helping the public authorities manage the environment in which business operates. The most immediate aspect of that environment is the price for energy. Business has a fiduciary duty to its shareholders to use their money to maximise profit. If resources are mispriced then the principal mechanism that aligns private and public interests in a market system is gravely weakened. Distorted pricing can be partially compensated by other regulations and financial incentives, but inevitably it leads to second-best decisions, smuggling, free-riding and is an incentive to corruption.

The second critical factor is the general business environment in developing countries. The prospects for foreign direct investment will be improved if there is: a transparent, efficient and fair legal system not given to retrospective legislation; transparent planning, regulation, licensing and taxation; no corruption; possibilities to expatriate funds and a sound and stable macroeconomic environment. Technical assistance can help create this environment and a great deal is done, especially by the World Bank and IFC to this end.

Technical assistance can also help developing countries design policies, regulations, standards and financial instruments that will influence the business case as perceived by the private sector. This is very important work and much has been done by the bilateral and

multilateral donors and implementing agencies along these lines.

Activities to improve the asymmetric access to information in developed and developing countries can also be beneficial. It is important that officials and business in developing countries are aware of the opportunities that technological innovation provides. Activities such as the Implementing Agreements of the IEA are useful in this respect, but more needs to be done to involve developing countries in the exchange.

Another reasonable expectation of business from the state is the proper enforcement of regulations and compliance with standards. The critical role of standards in ensuring the quality of products is undermined if enforcement is not sufficient. Enforcement is not an easy business, but experience in China for example, where very low historic levels of enforcement are now being remedied, shows that improvements are possible.

Public procurement can reduce perceived risks for business in marketing new products and in stretching design ambitions. Obligations on public authorities to upgrade their building stock can also be helpful. Given the difficulty that public institutions may have with tight capital budgets such an obligation may be easier to discharge where there are competent and well-funded ESCOs.

Supplier obligations are an effective way to fund certain improvements, especially in buildings. This instrument draws on the capital strength and management and technical expertise of energy supply companies and is an effective way in which these resources can contribute to efficient solutions.

There is also a need to manage the interaction between international business, national business and national governments. International business is often the best equipped to bring energy-efficient solutions. It has the experience, the technological range, the funds and the management capabilities. Accessing this resource is clearly an opportunity, but it generates also threats by creating a technological dependence within the developing country. A harmonious resolution of these asymmetric interests is not easily achieved and bilateral donors very often have a clear agenda to promote their national commercial interests. Independent, credible partners such as the UN agencies have an important role to play in brokering the diverse interests.

There is much to be said for stronger international cooperation in standards, testing protocols and in accessing testing centres. The development of independent standards for appliances and independent testing protocol and rigs for every country in the world is very inefficient. It creates barriers to trade and it delays the successful design and implementation of regulatory regimes. International bodies have attempted to harmonise standards in various areas, but without noticeable success.

Business also has a role as interlocutor between the social and economic ambitions for the nation or world as expressed by the state and the immediate desires of its citizens. Business can act catalytically to create the goods and services that bring these sometimes conflicting preferences into balance. One should also recognise that business has no desire to destroy the world in which it operates. It is true that the activities of business are generally motivated by profit and, if unregulated will cause damage; it is up to the state to regulate them. But individual business people are often people of vision, able to grasp the consequences of actions, able to weigh different options and to make decisions. They have much to offer.

Recommendations

There are many areas where UNEP could contribute to strengthening the business case for energy efficiency in developing countries.

- UNEP has proven skills in the building of coalitions and the creation of consensus among manufacturing industry, financial interests, other international organisations, officials and civil society to deliver workable solutions to some of the constraints facing the private sector in creating a business case for energy efficiency in developing countries. Four clear historic examples of this are the En.lighten project, the Global Fuel Economy Initiative, the Sustainable Buildings and Climate Initiative and work within the Task Force on Sustainable Products that led to the establishment of the IEA Implementing Agreement for a Cooperating Programme on Efficient Electrical End-Use Equipment. Other work on finance and advocacy contributed also to these successful undertakings.
- UNEP should build on these successes. The En.lighten project still has far to go to achieve its immediate goal although it is well on track; when the phase-out of incandescent bulbs is completed there will still be much work to do for the promotion of new cost-effective efficient lighting schemes.
- The GFEI needs to be transformed to a more operational mode, working with developing countries to ensure standards for new vehicles are brought to the levels consistent with best practice elsewhere and extending membership to a wider range of industry interests.
- The work of the Task Force on Sustainable Products has come to an end, but a similar programme building also on the experience with En.lighten and directed to air-conditioning could be of great value. As is indicated earlier, air-conditioning is a very important contributor to energy use, the market is growing rapidly and much of the supply to this market has poor energy performance that can easily be improved.
- Business will be reluctant to risk their capital in circumstances where the enforcement of standards is poor. UNEP might consider developing a programme to help transfer best-practice in the enforcement of regulations and compliance with product standards.

- The possibilities of public procurement to directly improve the energy efficiency of the public and to contribute to the development of innovative products are increasingly recognised. As an element to support the business case for energy efficiency, UNEP may consider expanding its current capacity building activities on the design and implementation of sustainable public procurement policies in developing counties.
- Development of policy and tools by UNEP's Sustainable Buildings and Climate Initiative can support financing mechanisms for large scale investment in energy efficiency for buildings, especially in public buildings and social housing.
- The possibilities of ESCO for building renovation are still under developed. Technical assistance has tended to emphasise industrial applications of ESCOs which are not the easiest market to address. Buildings, especially public buildings, are a much better target. UNEP may wish to consider extending its Finance Initiative to cover this topic.
- For business to fully develop and capture new green markets in the four key sectors examined in this paper (lighting, appliances, transports, buildings), technological innovation should go hand in hand with marketing strategies based on consumer research and information.

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About the UNEP Division of Technology, Industry and Economics

Set up in 1975, three years after UNEP was created, the Division of Technology, Economics (DTIE) provides solutions to policy-makers and helps change the business environment by offering platforms for dialogue and co-operation, innovative policy options, pilot projects and creative market mechanisms.

DTIE plays a leading role in three of the six UNEP strategic priorities: **climate change**, **harmful substances and hazardous waste**, **resource efficiency**.

DTIE is also actively contributing to the **Green Economy Initiative** launched by UNEP in 2008. This aims to shift national and world economies on to a new path, in which jobs and output growth are driven by increased investment in green sectors, and by a switch of consumers' preferences towards environmentally friendly goods and services.

Moreover, DTIE is responsible for **fulfilling UNEP's mandate as an implementing agency for the Montreal Protocol Multilateral Fund** and plays an executing role for a number of UNEP projects financed by the Global Environment Facility.

The Office of the Director, located in Paris, coordinates activities through:

- **The International Environmental Technology Centre** - IETC (Osaka), which implements integrated waste, water and disaster management programmes, focusing in particular on Asia.
- **Sustainable Consumption and Production** (Paris), which promotes sustainable consumption and production patterns as a contribution to human development through global markets.
- **Chemicals** (Geneva), which catalyses global actions to bring about the sound management of chemicals and the improvement of chemical safety worldwide.
- **Energy** (Paris and Nairobi), which fosters energy and transport policies for sustainable development and encourages investment in renewable energy and energy efficiency.
- **OzonAction** (Paris), which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition to ensure implementation of the Montreal Protocol.
- **Economics and Trade** (Geneva), which helps countries to integrate environmental considerations into economic and trade policies, and works with the finance sector to incorporate sustainable development policies. This branch is also charged with producing green economy reports.

DTIE works with many partners (other UN agencies and programmes, international organizations, governments, non-governmental organizations, business, industry, the media and the public) to raise awareness, improve the transfer of knowledge and information, foster technological cooperation and implement international conventions and agreements.

For more information,
See **www.unep.org/dtie**

For more information, contact:
UNEP DTIE
Sustainable Consumption and Production Branch
15 rue de Milan
75441 Paris Cedex 09
France
Tel: +33 1 44 37 14 50
Fax: +33 1 44 37 14 74
Email: unep.tie@unep.org
www.unep.fr/scp/

www.unep.org

United Nations Environment Programme
P.O. Box 30552 Nairobi, Kenya
Tel: ++254-(0)20-762 1234
Fax: ++254-(0)20-762 3927
E-mail: uneppub@unep.org

The Sustainable Energy for All initiative combines the objective of ensuring universal access to energy with that of ensuring that this energy is derived as far as possible from clean and low-carbon sources. This paper aims to evaluate how stronger policies towards energy efficiency can contribute to meeting these interlinked challenges, also examining the business case for energy efficiency. The paper draws out lessons on best practice in energy efficiency policy, picking out key constraints and effective responses. Drawing on this analysis, it assesses work by UNEP on energy efficiency that covers most forms of public intervention and a wide range of economic sectors, exploring the options for positioning UNEP's future work in this area to contribute to the goals of the Sustainable Energy for All initiative. The paper covers both the implementation of policies for energy efficiency in the economy as a whole and the specific case of ensuring access to energy efficient goods and services in communities recently connected to modern energy systems. It examines both supply and demand side approaches, including stimulating consumer choice of energy efficient goods and services.

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