# Submission to the Stern Review


By: **Harry Cripps** MA MSc DMS CEng CEnv FIChemE MEI

Organisation: **HRC Consultants Ltd**

Address: 2a Leafield, Road Disley, Cheshire, UK, SK12 2JF

Tel: +44(0)1663 765080

Email: hrccons@cix.co.uk


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## 1.0 Introduction

This is a short comment from the perspective of an independent process/chemical engineering consultant with extensive experience in the energy efficiency field.

I address a number of issues relevant to the terms of reference of the Stern Review, in particular:

- *The implications for energy demand and emissions of the prospects for economic growth over the coming decades […]*
- *The impact and effectiveness of […] policies and arrangements in reducing net emissions in a cost-effective way and promoting […] equitable and sustainable global economy […]*

My comments are restricted to the process industry sector which is the area to which most of my professional experience relates. Nevertheless I would expect several of my observations to translate to other sections of the economy.

## 2.0 Context: emissions reduction targets

The Royal Commission on Environmental Pollution and the Energy White Paper suggest that a 60% reduction in per capita greenhouse gas (GHG) emissions will be required by the year 2050 in order to reduce to acceptable levels the risk associated with anthropogenic climate change. In the UK at least, we are aspiring not only to achieving the emissions reduction target but also to do so in a manner consistent with sustained economic growth.

Ultimately, this needs to be treated holistically in the wider context of population targets, a matter meriting wider debate as a matter of urgency but beyond the remit of this review. Barring catastrophe, there is no realistic expectation that the number of UK (or World) consumers will fall significantly by 2050. Thus, based on current climate science, aiming for the 60% per-capita GHG reduction would appear to be the only responsible course of action open to us.

Even a modest (1-1.5 % per annum) economic growth compounded over 55 years results in a doubling of economic activity. This translates the 60% target into an approximately 80% reduction in emissions per unit which is a formidable challenge.

## 3.0 Scope to reduce emissions in the process sector

Reduction of GHG emissions from the process sector can be tackled on a number of different fronts; a suggested preliminary classification follows :

1. Relatively straightforward improvements within the existing process concept.
2. More significant processing changes in the manufacture of the existing products within the same or similar overall process concept.
3. Significant improvement in the provision of energy utilities, in particular optimum use of combined heat and power (CHP) within and between manufacturing sites.
4. Fundamental change of manufacturing process, eg different raw materials or chemical reaction path.
5. Use of low carbon and/or renewable energy sources.
6. Developing alternative low energy products to satisfy the same underlying needs.

The extent to which any one of these approaches can be applied varies from industry to industry and product to product. Whereas very large energy savings are sometimes possible on individual sites, there are many situations where processes are already designed and operated to very high standards of efficiency.

Personal experience as a process energy integration consultant suggests that the process sector as a whole will find it extremely difficult to achieve average savings of more than approximately 20% in any of the first three categories (1, 2 & 3 above). Moreover, although this scale of improvement may be technically feasible, there are several economic and operational reasons why many of the opportunities identified are not being implemented.

Fundamental change to use more efficient process routes is a long-term aspiration through much of the chemical engineering industry. However, even where fundamentally more energy efficient synthesis paths are available for specific products, the investment in plant necessary to exploit them is not always justifiable. The research & development needed to find cheaper alternatives also requires long term investment with no guarantee of success. It is therefore unrealistic to expect fundamental changes of process to deliver significantly more energy savings than any of the other categories of measures across the sector as a whole.

Recent debate regarding renewable and nuclear energy suggests that to substitute significantly more than 20% of the UK's present carbon fuel consumption over the time scale considered is likely to be problematic. It is progressively more difficult to integrate larger percentages of intermittent renewable energy (eg wind) into the overall mix. Many people have serious reservations regarding the wisdom of a large increase in nuclear fission capacity. Even if these concerns can be overcome, the nuclear option is likely to be very expensive and a large nuclear baseload will increase the difficulty of integrating intermittent renewables into the electricity grid. Moreover, the history of the past 40 years suggests that it would be irresponsible to rely on any contribution from nuclear fusion until its technical and economic feasibility has been thoroughly demonstrated.

Some fundamentally new low energy products will be undoubtedly developed to satisfy existing needs but these are unlikely to make rapid inroads into overall energy consumption without leading to some loss of convenience. Unfortunately, some of the products which have seen most growth in recent years are amongst the most energy intensive to manufacture, soft absorbent tissue being a good example.

If an average energy savings potential of approximately 20% is assumed for each of the 6 fronts identified for improvement, compound savings of approximately 75% would be just about attainable. The conclusion is that any realistic chance of meeting the 2050 GHG reduction targets will require vigorous action on all of them.

## 4.0 Identifying and realising improvements in the process sector

### *4.1 Relatively straightforward improvements within the existing process concept*

From personal experience, I believe that in the UK, many of the straightforward opportunities for improvement in the process sector have been or are now being identified. Most, though not all, competent process companies have the expertise to do this with in-house expertise. Following many years of downsizing, far fewer have the time to devote to tasks which are not essential to maintaining ongoing production.

A significant amount of support has been available in recent years to identify basic energy saving opportunities. In particular, the Carbon Trust provides free initial opportunities assessments which, though variable in quality, generally identify many of the more straightforward opportunities, eg:

- General improvements in energy effective lighting
- More efficient space heating
- More efficient compressed air systems
- General improvements to refrigeration systems
- Straightforward heat recovery projects
- Improving efficiency of simple boilers and steam systems
- Correcting steam and condensate leaks, etc

Unfortunately many fewer projects are implemented than identified. There remains an entrenched reluctance to invest even relatively small sums unless a very rapid payback is predicted.

There are many reasons for reluctance to invest in energy efficiency. Those most frequently given to the writer are inadequate return on investment and lack of availability of funds.

Increasing energy prices improves the payback for a given project but there remains a reluctance to invest funds in projects which do not lead to an increase in business.

So long as companies are less prepared to invest in energy efficiency improvements than in production developments, output will tend to grow more rapidly than energy efficiency.

Funding made readily available at competitive rates but ring-fenced for investment in improved energy efficiency might improve matters. If this contravenes national or international competition rules, the rules need to be changed.

### *4.2 More significant process changes in the manufacture of existing products*

Most recent government-supported energy efficiency funding in the process sector (eg Carbon Trust surveys) has been directed at the more straightforward savings (ie category 1 above). Much less support has been evident to address improvements within the processes themselves.

This is an area where significant energy efficiency improvements can be obtained in some, though not all processes. It requires a much more systematic approach with more emphasis on methodology and process analysis, both to identify and quantify the savings potential and to optimise the projects required.

Whereas a number of the more sophisticated companies (eg some, but not all major chemical engineering-based industries) have made much progress in this area, a large number of other process plants have not.

There are several reasons for this.

- Ignorance in the operating company and/or funding agencies of the nature of opportunities and the methodology required to identify them.
- When in-depth analysis is required to identify opportunities, the cost of the analysis stage may be significant.
- Whereas many companies will invest in projects guaranteed to result in savings, there is a reluctance to spend money speculatively on analysis because the benefits to be identified by the analysis cannot be determined in advance.
- Lack of funding support for assistance at this level
- In some cases, implementation of major energy efficiency improvements is too expensive to justify on energy cost savings alone. Therefore it only happens when other process improvements are required, eg debottlenecking of production capacity.
- Energy efficient technology is often perceived as being entirely equipment based. Operating companies and funding agencies concentrate on support for installation of more efficient items of equipment but do not adequately examine opportunities for improvement by better optimisation of the process and/or site as a whole.
- Companies may not expect to be in business long enough to benefit.

### *4.3 Significant improvement in the provision of energy utilities and CHP*

The observations in section 4.2 also apply to this category but there are some significant additional issues:

#### *4.3.1 Long life cycle of energy utility systems v short term investment criteria*

On the majority of process plant sites investment in energy utility systems is substantial and the equipment is expected to remain in service for many years. This applies typically to boilers, steam systems, hot water circuits, cooling water systems, combined heat and power, etc. Companies are understandably reluctant to spend money replacing equipment which still works and though there may be significant scope to improve its efficiency, the payback on replacing equipment on energy efficiency alone is often quite long. On many sites, the utility systems pre-date the present and sometimes even the previous generation of production plant.

Because process utility systems being constructed are likely still to be in service long into the future, it is vitally important that they are configured to be both efficient and flexible in order not to be embarrassingly inefficient in two decades time.

Unfortunately, very few process plants undertake a fully systematic energy integration approach to new and/or upgraded utility systems or CHP plant. In the present economic climate, the tendency is to invest in the least capital cost method of providing the energy necessary for production in the short to medium term.

Assistance and incentives are needed to ensure that the industry invests wisely in its process energy systems. As a minimum, whenever a major investment is planned, there needs to be a strategic review of alternative scenarios and a “road map” developed to chart optimum provision of energy utilities over the foreseeable future.

### *4.3.2 Combined heat and power (CHP)*

It is well known that CHP can result in greatly reduced GHG emissions. CHP has long been promoted as a major building block in the UK’s overall climate change strategy. Unfortunately, the economic environment over the last 10-15 years has been unfavourable to CHP and many schemes with potential for substantial reduction in GHG emissions have failed to be implemented.

The situation is so bad that in many cases companies are no longer even interested in investigating the potential for CHP.

The principal barriers to uptake of CHP in the process sector are almost all economic rather than technical:

- Insufficient price differential between gas and electricity on the market.
- Electricity trading arrangements make it difficult for CHP generators to obtain prices for exported power which reflect the real efficiency/CHG benefits.
- Business thinking/economic climate only favours significant investment in activities directly related to company’s core business.
- Introducing third party CHP suppliers to invest on process plant sites dilutes the profits from CHP to the point that there may be insufficient incentive to proceed.
- Existing third party CHP contracts are often set up in such a way that there is no incentive for investment in further improvement.
- It is common to find situations where an efficiency improvement is technically feasible but the investment by one party to the CHP contract would result in profit only to the other party.
- Inability to think holistically – in many situations the potential benefits of site-wide, inter company or local area CHP networks are never realised. It can prove too difficult to fund a CHP analysis taking in several different companies, let alone to implement the findings.
- Maximum efficiency requires CHP schemes to be developed to match the processes served and the processes simultaneously optimised to match the CHP scheme.
- In the case of third party CHP investments, it is seldom that this optimisation is achieved in practice.

### *4.4 Remaining aspects of reducing energy in the process sector (4, 5 & 6)*

The remaining important fronts suggested above on which to tackle GHG emissions from the process industry sector include:

- Fundamental change of manufacturing process
- Low carbon and/or renewable energy sources
- Alternative low energy products to satisfy the same underlying needs

These are largely beyond the writer’s direct professional experience and thus no further comment is offered.

# 5.0 General observations

## *5.1 Traditional economics doesn't work for global energy & environment*

The principle of economic cost benefit analysis should lead to decisions being made which maximise overall benefit, but this is no longer the case.

Traditional economics derives from an era when the quantity of natural resources such as fossil fuels was large relative to the amount of human activity. Thus geological capital could be treated as effectively infinite. Likewise, the environment was large compared to the scale of human activity and, apart from local issues, it could be treated as an infinite sink for the waste products of economic activity.

Human activity has now expanded to the extent that the traditional economic model is founded on assumptions that are no longer valid. A paradigm shift is needed.

Effective markets have generally operated on relatively short time scales. The discount factors used by most organisations in order to justify investments are such that any effects more than 10 or 15 years into the future have a negligible impact on the decisions made. However, decisions made now will have a profound effect on the environment for many decades.

Thus neither depletion of natural raw materials nor the environmental impact of economic activities are treated realistically as costs or a loss of value. Consequently, unless modified, eg by Government intervention, the market will naturally lead to decisions continuing to be taken in the short term which result in long term over exploitation of resources and destruction of the environment.

## *5.2 Global trade issues*

High energy prices should provide an incentive for companies to invest in energy efficiency. Many companies struggling to compete with overseas competition object that additional expenditure on energy and environmental efficiency will make them uncompetitive. To the extent that prices are high globally, improved energy efficiency and subsequent reduction in operating costs largely invalidate this objection. To the extent that high energy prices are a product of local market effects or taxation issues, there is justification in their claim.

In particular, it is counter-productive for a country to put in place measures to improve energy efficiency of local manufacturers if the outcome is for the goods to be produced overseas where lower energy costs result in lower efficiency and higher emissions.

There may be a fundamental incompatibility between the requirements for free trade and attempts by individual countries to encourage longer term decision making by fiscal means.

This suggests the dogma that free trade is by definition *a good thing* needs to be exploded.

## *5.3 Time is critical*

Because of the long lead time and life cycle of process utility plant, improvements need to start being put in place now, not next time round, which may be more than 10 years into the future.

### *5.4 Developing economies*

The recent emergence of China and India as world scale economies is already leading to a rapid increase in global energy consumption and GHG emissions. Other developing countries are likely to follow and it is ethically unreasonable for economically developed countries not to expect and therefore plan for them to do so. Ultimately the overriding issues regarding population, affluence and the environment must apply to each and every country.

However, the rapid economic growth of populous but hitherto economically undeveloped regions presents a particular challenge. Most human economic development since the beginning of the industrial revolution has been founded on the exploitation of large quantities of (cheap) energy. With the passage of time, increased investment and more advanced technology has massively increased the efficiency with which this energy has been used, ie the standard of living sustained per kW of energy.

Because GHG emissions and depletion of fossil fuels are global issues, developed countries are inevitably affected by economic development in other regions. This development has to a considerable extent been catalysed by technology transfer from more economically advanced countries.

In order to minimise the global impact of such development, it is important that these rapidly growing economies are founded on the most environmentally appropriate technology.

Developed countries therefore have a responsibility to export only the most appropriate technology. In particular, if aid is provided, it should concentrate on helping the developing country achieve the most appropriate environmental path to increased prosperity – on a case by case basis, this may be appropriate alternative technology or state of the art conventional technology. Under no circumstances should developing countries be used as a dumping ground for inefficient technology no longer wanted in the nations from which it originated.

# 6.0 Conclusions

Meeting the White Paper target for 60% per-capita reduction in UK greenhouse gas emissions targets by 2050 will be a formidable challenge requiring strenuous efforts to improve all aspects of energy efficiency.

Allowing even for modest economic growth, a 60% per capita reduction will necessitate an 80% reduction of CHG emissions per unit production.

In the process industry sector there are a number of barriers to achieving this objective, in particular:

## *6.1 Analysis of energy saving opportunities*

Many of the simpler energy savings have already been made in this sector. More systematic analysis is needed in order to quantify the potential for savings attainable by making more significant changes to process and utility systems.

Companies and funding bodies need to understand that this analysis may necessitate significant expenditure before the potential for energy efficiency is even approximately quantified.

Much of the present effort towards energy efficiency is driven by suppliers of equipment. Whereas more efficient equipment is beneficial, the industry needs to adopt a systems approach to maximise energy efficiency of the process operations as a whole.

A more holistic approach is needed to develop optimal CHP schemes which transcend company boundaries and maximise opportunities inherent on a site or neighbourhood.

## *6.2 Funding and investment*

More funding support is required for analysis of longer term energy savings potential.

Funds need to be made available ringfenced for investment in energy savings.

Businesses must be prepared to invest in energy efficiency with longer term paybacks.

Process companies must develop strategies to satisfy their mid and long term energy needs in the most efficient manner.

Incentives are urgently needed to encourage investment in combined heat and power (CHP).

A minimum initial investment approach is frequently adopted when investing in process energy plant. This must be overcome.

Time is of the essence. The long life cycle of process energy utility plant requires investment taking place now to be compatible with energy efficiency requirements decades into the future.

## *6.3 Wider issues*

For global economic development to prosper without catastrophic climate change, developing countries need to have access to the most appropriate and efficient technology from the outset.

It is a major responsibility of developed economies to provide as much support as possible.

Optimising energy efficiency may be incompatible with the current presumption in favour of global free trade. World trade policy may need to be reconsidered.

Traditional economic models and cost benefit analysis may not be appropriate in the context of global energy and environmental problems. Relying on market mechanisms to reach energy and emissions objectives may therefore be fundamentally unsound.