

# Foresight

Making the future work for you

## Energy Futures



Report of the Foresight Consultation Seminar

Stirling Highland Hotel

15th February 2001

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## Executive Summary

The Energy Futures seminar was intended to provide a starting point for a futures-related development process in Scotland that acts as a focus and catalyst for strategic, long-term thinking around Scotland's future energy needs. In addition, it aimed:

- ▶ to develop understanding of the longer-term opportunities and challenges likely to be faced by the energy sector to 2040 and the actions required to address them;
- ▶ to help share ideas across relevant interests from the oil and gas, renewables, power generation, environmental and Governmental communities; and
- ▶ to stimulate additional Scottish responses to the Foresight Energy Futures Task Force's consultation document.

Around 50 representatives from business, academia and the public sector from across Scotland came together to consider the issues raised in the Task Force's consultation document. The Task Force had built upon four scenarios, developed by the previous Foresight Environment Panel. For each, the document describes the key issues and examines the potential implications for a range of energy and other policies and for R&D.

The seminar began with an introductory presentation by Professor John McMullan, Chair of the Foresight Energy Futures Task Force, who explained the work of the Task Force and its ideas as described in the four scenarios. Sam Galbraith MSP, Minister for Environment, Sport and Culture, outlined the Scottish Executive's key policies relating to the energy sector and supported the work of Foresight.

Two sets of workshops took place. The morning workshops focused on eliciting responses to the Task Force's consultation document and developing understanding of the potential ways in which the energy sector may develop over the next 40 years. The afternoon workshops, by contrast, were tasked with outlining the actions that need to take place to help shape a desirable future.

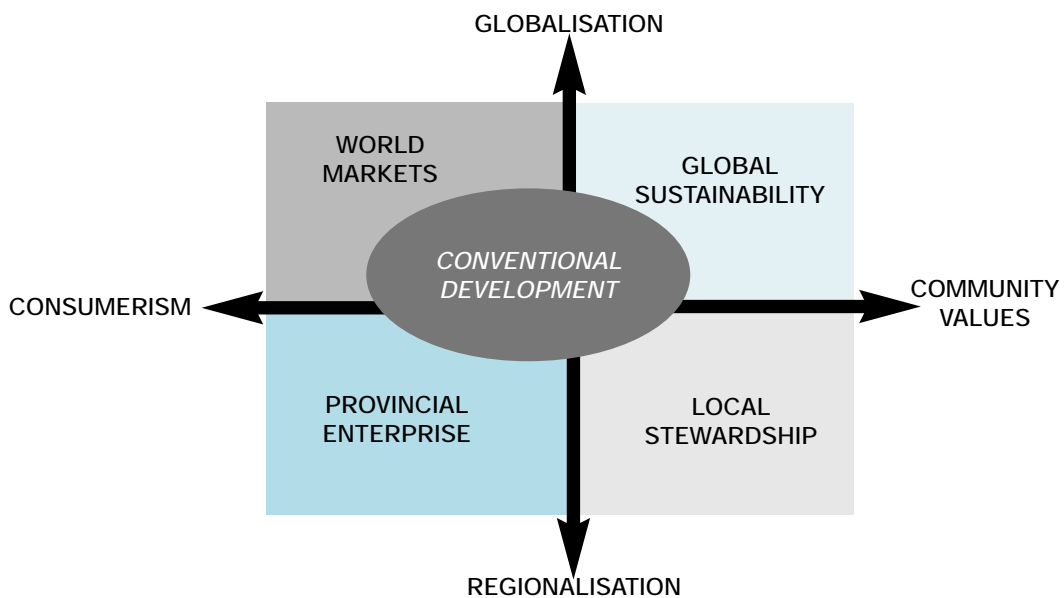
Between the two sets of workshops there were presentations by representatives of two large UK companies, who each set out their thoughts about how they saw the future unfolding for the energy sector.

Throughout the day's discussions, participants were urged to attempt to come to a consensus about the main challenges and opportunities facing Scotland's energy sector to 2040. With some relatively minor exceptions, the groups were reasonably

happy that the Task Force had identified the key issues for the future. They agreed that the current situation in the UK is best described by a combination of the World Markets and Provincial Enterprise scenarios.

The trend, however, would appear to be moving away from Provincial Enterprise towards World Markets – ie from energy systems which are dominated by Nation State concerns to ones which are far more strongly shaped by an integrated world trading system. While it was more difficult to clearly agree on the kind of world we might be living in by 2040, they generally felt that a combination of the World Markets and Global Sustainability scenarios would be most likely. In other words, this is a world where integrated, global energy systems were strongly shaped by environmental concerns.

Perhaps the key recommendation that emerged was the need for a longer-term vision – a 40- or 50-year rather than a 10-year time horizon – upon which Scottish and UK energy policy should be based in future. Foresight provides an appropriate framework for developing this vision and engaging participants from all relevant interests.



The key recommendations suggested by participants included:

*Key recommendations for action:*

- ▶ creating a powerful and visible 'National Forum for Energy Development' which could assist strategic thinking and policy development;
- ▶ urging Government to set longer-term targets for energy supply from various sources; and
- ▶ establishing a more focused agenda for further 'Energy Futures' seminars, bringing key interests together again to discuss policy development, human resource development and R&D.

It was agreed that the Scottish Energy Environment Foundation, together with key business intermediaries, could become the necessary catalysts to address these key recommendations. The Scottish Foresight Coordinator should support their work.

## Introduction - What is Foresight?

1.1 The UK Foresight programme was launched in 1994 following a major review of Government science, engineering and technology policy. The Office of Science and Technology in the Department of Trade and Industry manages it. The second phase of Foresight, which began in April 1999, encompasses a broader focus on social, economic, environmental and political as well as technological drivers for future UK competitiveness.

1.2 The purpose of Foresight is to:-

- ▶ develop visions of the future – looking at possible future needs, opportunities and threats and deciding what should be done now to make sure that we can meet these challenges
- ▶ build bridges between business, science and government bringing together the knowledge and expertise of many people across all areas and activities : in order to
- ▶ increase national wealth and well being.

1.3 The Foresight programme is structured around a system of panels that bring together representatives from business, the science base, the voluntary sector and government. Panels are of two kinds – thematic or sectoral – and both address two underpinning themes as summarised below:-

### **Sectoral Panels**

Built environment and transport  
Chemicals  
Defence, aerospace and systems  
Energy and natural environment  
Financial services  
Food chain and crops for industry  
Healthcare  
Information, communication and media  
Materials  
Retail and consumer services

### **Thematic Panels**

Ageing population  
Crime prevention  
Manufacturing 2020

### **Underpinning themes**

Education, skills and training  
Sustainable development

1.4 The results of Foresight and the Foresight process are:-

- ▶ being used by companies, large and small, to re-shape their business strategies and build sustained competitive advantage
- ▶ breaking down barriers to collaboration across business sectors and academic disciplines and between business and the science base
- ▶ focusing business and the science base on key issues for quality of life in the 21st century
- ▶ informing policy and spending decisions across Government.

1.5 Foresight priorities underpin a wide range of activities including:-

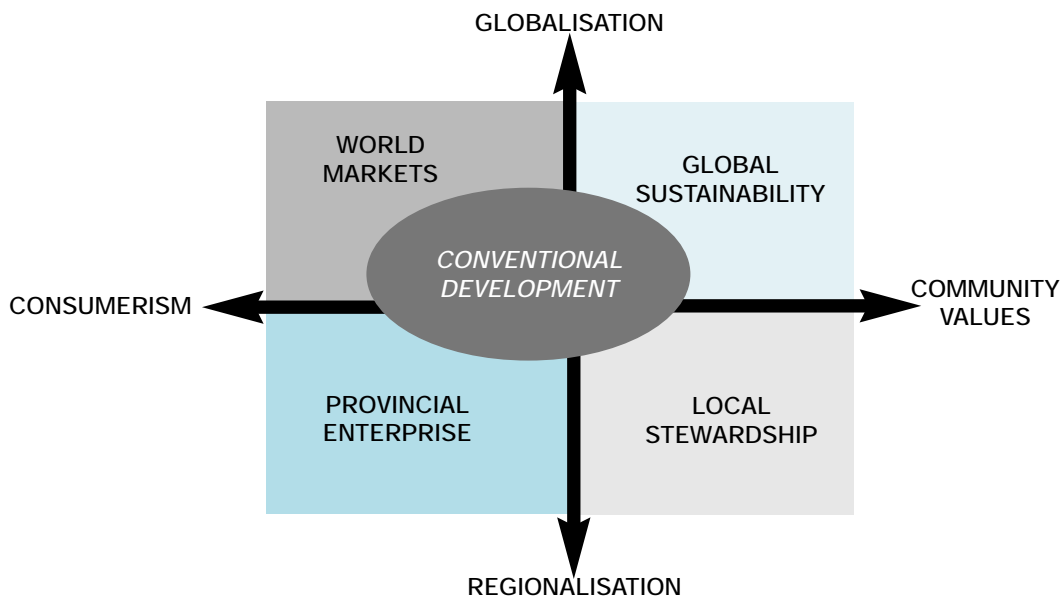
- ▶ a portfolio of collaborative research worth almost £200 million (under the Government's LINK scheme)
- ▶ the £90 million Foresight Challenge initiative which provided support for partnerships between business and the science base to address Foresight priorities
- ▶ the £30 million of government funding for a second round of Foresight LINK Awards which was announced in December 1998
- ▶ a new £10 million Foresight Challenge fund announced in the recent Science and Innovation White Paper.

1.6 In Scotland Foresight is co-ordinated by the Scottish Foresight Forum combining representatives from the Scottish Executive, Scottish Enterprise, Highlands and Islands Enterprise, CBI Scotland, the Royal Society of Edinburgh, Universities Scotland and the Scottish Higher and Further Education Funding Council. On a day to day level, Ewan Mearns is the Scottish Foresight Co-ordinator, based at Scottish Enterprise, helping to facilitate the implementation of Foresight by:-

- ▶ integrating Foresight into existing mechanisms and structures;
- ▶ working through intermediaries to engage the business community;
- ▶ supporting longer-term Foresight processes;
- ▶ building on Panel outputs; and
- ▶ turning Foresight findings into action.

## 2 The Foresight Energy Futures Task Force

- 2.1 The Energy Futures Task Force, a sub-group of the Energy and Natural Environment Panel, set out to identify the key opportunities and challenges to UK competitiveness and quality of life posed by future changes in the supply and demand of energy. The 40-year timescale was deliberately chosen since this matches a time when the overwhelming majority of current energy-related infrastructure will have reached the end of its life and will have been superseded. This timescale, therefore, purposefully looks beyond normal commercial and Governmental planning horizons.
- 2.2 The Task Force held discussions with a number of key individuals and organisations, and used the four scenarios developed by the former Environment Panel as a framework for focusing their deliberations.



**World Markets:** a world defined by an emphasis on private consumption and highly developed trading systems

**Provincial Enterprise:** a world of consumerist and short-termist values coupled with policy-making systems that asset national and regional concerns and priorities

**Global Sustainability:** a world in which social and ecological values are considered in economic decisions, and in which strong collective action through global institutions tackles environmental problems

**Local Stewardship:** a world where stronger national and regional governance allows social and ecological values to play a strong role in the development of markets and behaviour.

2.3 Their consultation document, published in November 2000, outlined the group's initial thoughts. In particular, they described in some detail the four scenarios and indicated the main implications of each for the energy sector and wider UK economy. The document invited responses to a range of questions :-

- ▶ were the right technological and social issues identified?
- ▶ what was missed?
- ▶ how could the Task Force's conclusions be improved?

2.4 Following the consultation period the final report of the Energy and Natural Environment Panel will contain focused recommendations for future action across the UK.

2.5 Besides its specific aim of consulting a wide cross-section of Scottish organisations, the seminar on 15 February 2001 (at the Stirling Highland Hotel) also aimed to :-

- ▶ develop understanding of the longer-term opportunities and challenges faced by the energy sector, and the actions required to address them;
- ▶ help share ideas across organisations with an interest in energy production and supply : oil and gas, renewables, power generation, environmental bodies, local and central Government, and economic development agencies; and
- ▶ initiate a futures-related development process that acts as a focus and catalyst for strategic, long-term thinking around Scotland's future energy needs.

2.6 Around 50 senior representatives of business, academia and public bodies participated in the consultation seminar, with much of the discussion taking place in workshops. The event was designed to reflect the specific interests and issues of Scotland's energy sector, with its strong representation by the oil and gas and emergent renewables industries in particular.

2.7 Three parallel groups were asked to address the same questions. The morning workshops discussed reactions to the four scenarios and attempted to develop consensus around a desirable future vision for the energy sector. In the afternoon they discussed how Scotland should

respond to ensure it is positioned positively in order to address future challenges and opportunities.

- 2.8 This seminar was intended to act as the beginning of a longer-term process to understand, explore and address the implications of Energy Futures. Key to sustaining the momentum of this process is the effective involvement of a range of intermediary organisations – particularly business representative organisations (such as the Industry Technology Facilitator, OPITO, Industrial and Power Association) and academic bodies (such as the Scottish Energy and Environment Foundation). Foresight plays a catalytic role but relies heavily on the support of intermediary organisations and others, to take individual actions forward. In turn, the process is designed to influence the future behaviour of a much wider range of individual companies and researchers.

## 3 Workshop Proceedings

### 3.1 Programme

- 09:45 Registration. Tea/coffee
- 10:00 Welcome & Introduction  
Prof Jim McDonald /Chair
- 10:10 Foresight and Energy Futures  
Prof John McMullan
- 10.45 Minister for Environment, Sport and Culture  
Mr Sam Galbraith MSP
- 10.55 Tea/coffee
- 11.10 Workshops: Reactions/responses to the consultation document
- ▶ what do we agree with in the 4 scenarios?
  - ▶ where do we disagree?
- 12.15 Feedback (in plenary)  
Prof Jim McDonald /Chair
- 12.30 Lunch
- 1:30 Presentations : "The world in 2040 – Corporate Responses"
- ▶ Nick Welch, Head of UK External Relations, Shell International Ltd
  - ▶ Garth Graham, Group Contingency Planning Manager, Scottish and Southern plc
- 2:15 Workshops : Making it happen
- ▶ what do we need to do to address future challenges/opportunities in terms of energy supply, energy use and R&D?
- 3:15 Feedback & Next steps  
Prof Jim McDonald /Chair
- workshop feedback and discussion :
- ▶ is a consensus beginning to emerge?
  - ▶ where are the key disagreements and how could we address these?
- next steps :
- ▶ would a longer-term development process be valuable in Scotland?
  - ▶ are there any obvious 'early action' projects worth developing?
- 4:00 Close

### 3.2 Welcome and Introduction

Professor Jim McDonald, University of Strathclyde and Member of the Energy Futures Task Force (Chair)

Professor McDonald welcomed participants to the third of four consultation events organised by the Foresight Energy Futures Task Force. As a Task Force member he was keen to be involved in stimulating wider discussion and debate across Scotland about the future for energy use and supply.

He summarised the three objectives of the seminar :-

- ▶ To develop understanding of future challenges and opportunities for the energy sector and to discuss actions required to address them;
- ▶ To help share ideas across interested organisations
- ▶ To initiate a development process that acts as a focus for strategic, long-term thinking around Scotland's future energy needs.

All relevant interests were represented at the seminar, from industry, Government, environmental bodies, local authorities and academia. He urged participants to get involved in these discussions and to feed back their views on the Energy Futures consultation document.

### 3.3 Foresight and Energy Futures

Professor John McMullan, University of Ulster and Chair of the Foresight Energy Futures Task Force

Professor McMullan provided an overview of the Foresight Energy Futures Task Force and outlined the four scenarios highlighted in its recent consultation document.

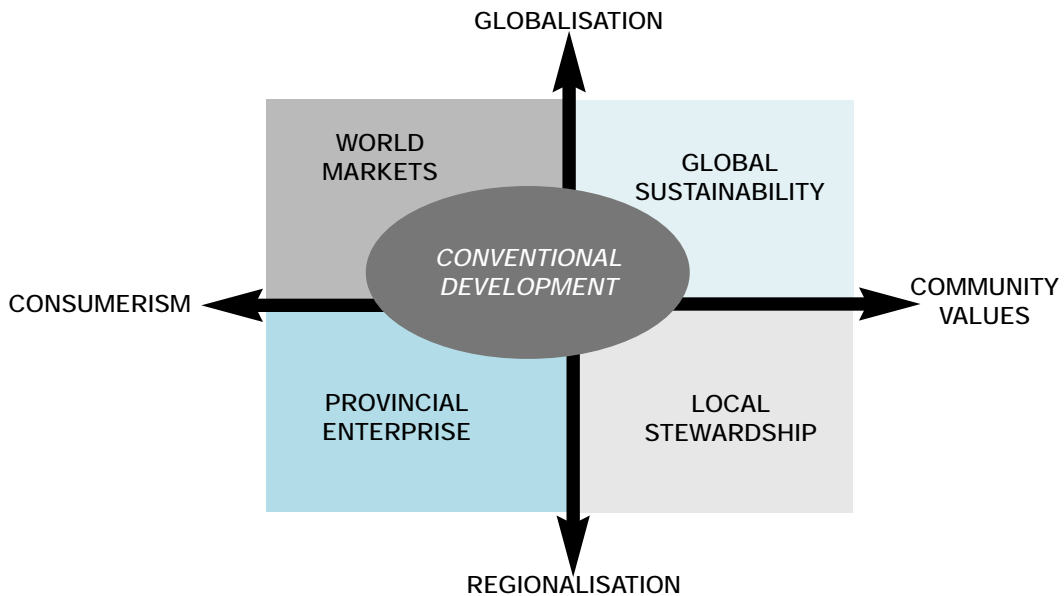
The Energy Futures Task Force has been created by the Foresight Energy and Natural Environment Panel to :

inform today's decision makers by providing an insight into the energy-related technologies and challenges which could present opportunities and obstacles to UK business and society over the next forty years.

So why did the Task Force choose such a long time-horizon for its work? The first reason is that by 2040, the UK will be a net importer of fossil fuels; all of the present energy infrastructure will be gone and current oil reserves exhausted. Second, by this time the current debate over global warming will be resolved; it will either have been

disproven or its effects will be readily apparent. Finally, given the ever-increasing global demand for energy, society will be more than ever dependent on the future security of energy supplies.

The approach taken by the Task Force was to develop some possible visions of energy supply and demand in 2040, based on the four Foresight Environmental scenarios.



### The four scenarios

#### World Markets

Emphasis on private consumption and a highly developed and integrated world trading system

#### Provincial Enterprise

Private consumption values with assertion of local, regional and national concerns

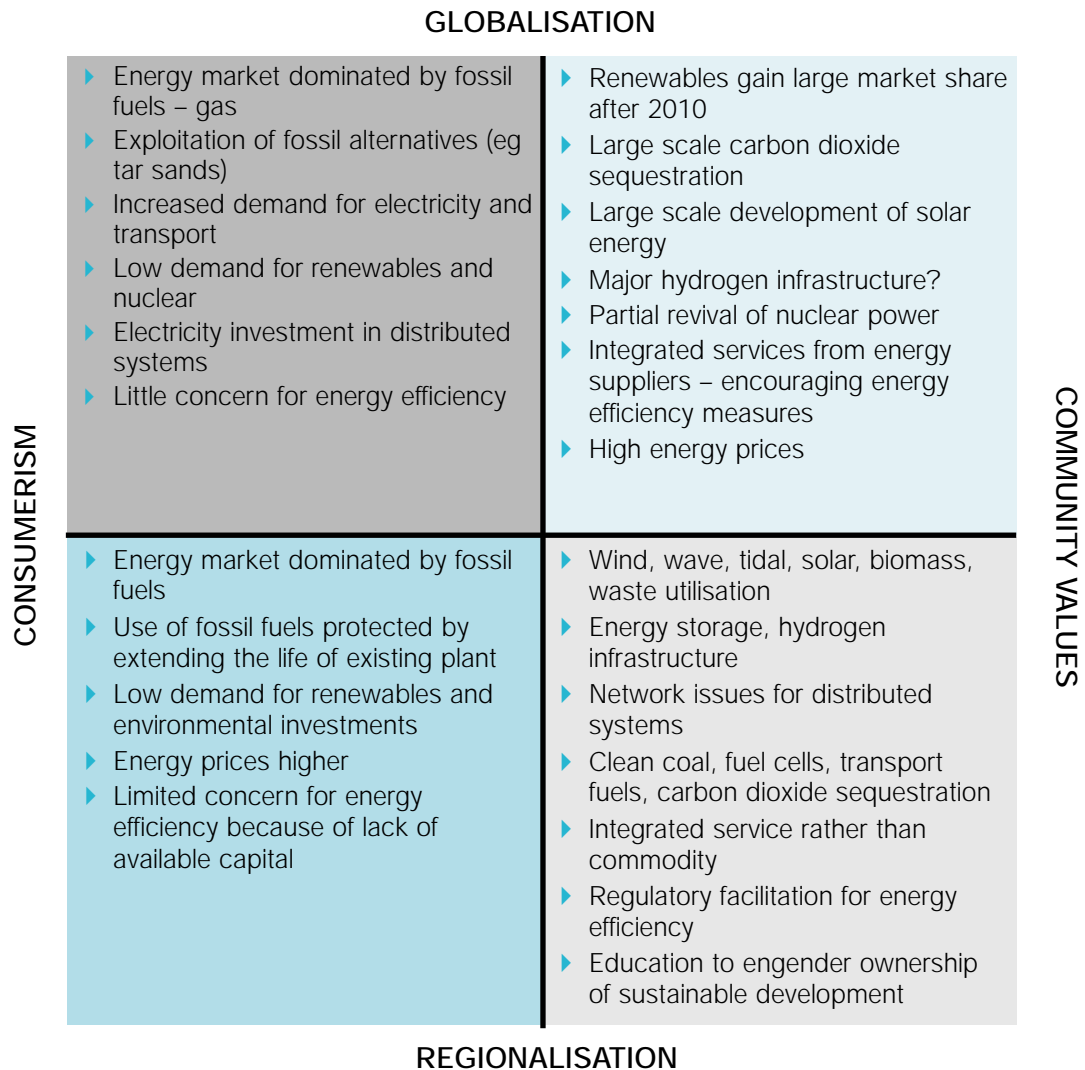
#### Global Sustainability

Social and ecological values are emphasised; global bodies are more effective in dealing environmental problems

#### Local Stewardship

Strong local and regional governments acting at local level

The Task Force developed the four scenarios from a UK perspective but set firmly within a global context. The consultation document outlines in some detail the implications for sectors (industry, transport, power generation) as well as factors (economic growth, energy consumption, environmental policies). These are some of the broad characteristics for each scenario.



The Task Force consultation document also attempts to identify the research and development implications arising from each of the four scenarios : what technologies would be important in each 'world' ? While the specific R&D issues vary there appears to be a significant degree of common ground, issues which are likely to be important whatever the future shape of energy supply and demand.

### Common R&D Requirements

- ▶ Network and emissions issues for distributed systems
- ▶ Efficiency of generation and end-use technologies; clean coal; fuel cells; biomass and waste; storage
- ▶ Social behaviour and attitudes; education
  
- ▶ Hydrogen economy
- ▶ Carbon dioxide sequestration
- ▶ Small-scale nuclear
- ▶ Service rather than commodity
- ▶ Regulatory facilitation of investment
- ▶ Emissions trading mechanisms

The Task Force's consultation process is intended to stimulate feedback from a wide audience. The final report will incorporate targeted recommendations for all sectors.

### 3.4 Opportunities and challenges for Scotland's energy sector

Mr Sam Galbraith MSP, Minister for Environment, Sport and Culture

Sam Galbraith MSP welcomed both delegates and speakers to the Foresight Energy Future seminar and thanked them for contributing their valuable time and experience.

#### Foresight

*"I would like to begin by emphasising the importance of working together in partnership to achieve common, but different objectives. Indeed, today's event has been organised jointly by Scottish Enterprise and the Scottish Executive.*

*Foresight is all about partnerships. The UK's Government-led Foresight programme brings people, knowledge and ideas together to look ahead and prepare for the future. Business, the science base, Government, the voluntary sector and others work through thirteen Foresight panels to think about what might happen in the future and what we can do about it now to increase prosperity and enhance the quality of life for all.*

*Foresight helps us all get ready for the future by :*

- ▶ *giving us the chance - at events like this - to get involved in Foresight networks*
- ▶ *providing access to a wide range of information about the future*
- ▶ *offering the opportunity to discuss and consider the outcomes and recommendations emerging from the recent Foresight consultation exercise.*

*In a UK context, of course, Foresight is recognised as one of the main programmes*

*for strategic thinking and planning for possible futures. That challenge faces us all – as individuals and as nations - here in the UK, in Europe and across the globe.*

### *Scotland in a UK and International Context*

*This is an exciting time in Scotland's history - with the establishment of the Scottish Parliament with a wide range of powers devolved from Westminster. We have the capacity to develop Scottish policies and actions to meet the needs and aspirations of the people of Scotland. I am proud to be part of that.*

*Scotland – and small countries like us – needs to work at a range of levels. On many issues – we need to be responsible for our own local actions, while also working in partnership with the UK Government and the European Union to agree and implement international Frameworks and Protocols. The programme of work outlined in the Scottish Executive's publication - Making it work together - said just that.*

*I am personally committed to integrating the principles of environmentally and socially sustainable development into all Government policies. We will take a strategic approach to environmental issues. We will work with people in Scotland to bring understanding that sustainable development offers benefits now and protects them in the future.*

### *Energy - threat and opportunity*

*We have already heard about some of the current thinking of the Energy Futures Task Force this morning. I would like to briefly comment on why businesses should be thinking about energy futures with the Panel.*

*Two interconnected issues of technological development and the environment, especially climate change, will probably determine the future shape of the energy industry. In energy terms of course the 40-year forward look should not be such a leap in the dark. It is or should be an industry geared to the longer more than shorter term. But it is clear that we have a need in the short term to address climate change issues.*

*Evidence of Climate Change is all around us : mudslides in Italy; floods in Bangladesh; droughts in Sudan; churning rivers in Mozambique; mud- silted homes in Southern England.*

*What is causing climate change? What are we in Scotland doing to tackle this problem? And what role does renewable energy have to play?*

*Climate change is a reality - the single greatest environmental threat currently facing us. Its effects will be felt by all, at all levels of society. It stems from spiralling demands for more energy. The more energy, the more coal, oil and petrol burnt then the more carbon we release into the atmosphere, and carbon emissions are at the heart of climate change. Climate change doesn't just threaten the environment. It poses a serious risk to business as well as public health.*

*The world's governments are alert to this threat. The agreements signed at the Kyoto summit are testament to the gravity of the situation facing us. The need to act is inescapable. The European Union is committed to reducing its share of greenhouse gas emissions over the next decade. The UK share of this commitment is legally binding. The Scottish Executive will play its full part in this process. We are working in partnership with the UK Government to place this issue high on the agenda. Indeed, we have set a target of 18% of all energy to be produced by renewable sources by 2010 (the figure currently stands at 11%).*

*We take our responsibilities very seriously. We know that we have to work hard to bring an environmental focus into the mainstream of everything that we do. In order to reduce emissions, we have to turn our attention to alternative forms of generation, forms that produce little or no carbon. We have to focus on renewable energy.*

*Whether in renewables or "mainstream" technologies Scotland can boast an abundance of relevant technical and practical expertise. We have a record of being at the forefront of energy technological development. Even now we have indigenous companies successfully establishing themselves. For instance the pioneering work of Wavegen on the shoreline at Islay. This is the only commercial-scale wave power scheme anywhere in the world.*

*There is a great information resource out there. Our universities are themselves centres of excellence whether in marine, land based or fuel cell technologies. This is an asset that must be utilised. The establishment of the Scottish Energy Environment Foundation involving public/private sector participation along with Strathclyde and Edinburgh Universities is another centre of excellence.*

*How can we marry these strands to ensure that Scotland benefits from the potential developments in the energy industry?*

*We need to consider very carefully the actions that can be taken now as well as the longer term processes that could ensure that we realise economic benefits as well as security, diversity and sustainability in our energy supplies.*

### *Think today, act tomorrow - shape the future*

*It is important that we in Scotland participate fully in the process of thinking through some of these longer-term issues and then taking decisions about action today. It is equally important that your input to Foresight continues in the longer-term. And I stress that it is vitally important that over time your ideas and insights are converted into actions.*

*Foresight is about thinking about the future today in order to take better decisions tomorrow. It's about shaping our future. That is a big challenge - but I have confidence in your capacity to succeed".*

### 3.5 Parallel workshops : Reactions and responses to the Energy Futures consultation document

The aim of the first set of workshops was to help develop a shared understanding of the key issues raised in the consultation document and, thereby, to elicit responses. Participants were allocated to one of three workshops that were all tasked with addressing the same questions :

- ▶ The four scenarios are each intended to provide a plausible vision of how the future may play out. Do you agree with the Task Force's assessment of the key characteristics of each scenario?
- ▶ Are there important issues which have been missed or which receive insufficient emphasis?
- ▶ Which aspects seem to be common within each of the scenarios – ie are there issues that seem to offer a 'win-win' situation in any future?
- ▶ Which scenario seems closest to today? And which do you think is most likely by 2040?

World Markets was felt to provide a fairly realistic assessment of many aspects of today's situation, particularly in the developed world. The scenario is weakened, however, by its lack of consideration about how to meet the fossil fuel shortfall that most observers anticipate towards 2040. Over the long-term, therefore, it perhaps does not represent a sustainable future, being predicated on the assumption that future fossil fuel supplies would be plentiful within this timeframe. Also, might a market-dominated world eventually lead to international instabilities between energy-rich and energy-poor nations?

The workshops were divided on the plausibility of the Global Sustainability scenario. One group thought that it provides a fairly realistic scenario for the future and is

perhaps most similar to the Danish or Swedish situation today. The current market-oriented energy system is tempered by increasing public acceptability of “green” issues in the developed world (and now also in many developing countries), and the realisation that global environmental considerations are paramount concerns for individual nations’ strategies. In the UK, opinion appears to have changed over the last ten years. The view that we are rich in fossil fuels is giving way to a stronger commitment to investing in renewables as a key plank of our longer-term energy strategy.

The second camp, however, doubted whether this would be a plausible situation in future, particularly looking at it from today’s perspective. They considered that a major ‘trigger’ would be required (perhaps a global environmental disaster) for the political and business will to emerge to ensure that economic, social and environmental values are genuinely balanced. It is a desirable world certainly but paints rather a rosy picture where consideration of wider negative aspects (poverty, ill health) is downplayed.

Provincial Enterprise provides a plausible scenario for a decade or so, but the world would eventually need to face up to its global environmental responsibilities. The scenario illustrates the kind of ‘siege mentality’ found in wartime Germany or the UK during the 1970s miners’ strike. For a while, different nations and regions would be able to function – as long as they could gain assured access to energy supplies – but conflicting priorities and a lack of regard for wider implications would eventually lead to environmental problems and social unrest. Rather than be described as ‘provincial enterprise’ this scenario is essentially about ‘provincial protectionism’.

**Local Stewardship** in some ways provides an attractive world, with many aspects that are plausible. In the final analysis, however, it is inconceivable that our current economy, based on global free trade, would be willing or even able to turn the clock back to locally based systems. Even if national, regional or local governments were able to move towards community level systems, the conflict with global markets would almost inevitably lead to strong tensions. Would a purely local focus be durable into the longer-term ?

In discussion, a range of other important issues were discussed:

A key element missing from the four scenarios is consideration of the future security of energy supplies over the next 40 years. Often, the most politically, socially and economically unstable areas of the world are also those which possess large oil and gas supplies (Middle East, Russia). Moreover, it is clear that Governments take energy-related decisions as much for political and economic reasons as for environmental and scientific. Issues such as concern for the environment, for example, tend to have a political life span that endures for a decade perhaps before

they fall out of favour. The inclusion in the scenarios of security and political concerns would help inject an added degree of realism.

Whether or not you accept that global warming has been caused by mankind's actions, the importance of global sustainability is irrefutable. This has to be addressed on a global scale, although the vast majority of individual Governments are incapable of effecting significant improvements by their own actions. It was suggested, however, that the greatest contribution that the UK could make to improve global sustainability is to influence China's energy efficiency.

As a general point, the consultation document seems to underplay the importance of reducing or mitigating the growth in future energy demand. Energy conservation, particularly within the developed world, can make a very important contribution towards the future sustainability of world energy supplies.

Current methods of analysing the costs and benefits of energy use do not accurately take into account the wider impacts at a global scale. Our current frameworks and boundaries are too parochial. A good example of this relates to the disposal of nuclear waste, which the consultation document has not considered.

The costs of renewables development are tumbling and costs (for wind power, for example) compare favourably with conventional energy sources. Currently, the greatest economic driver for renewables comes from the restructuring of generation contracts (eg costing them over 10 years rather than 3 years). However, where the costs of energy generated from renewable sources cannot benefit from economies of scale (small-scale biomass plants in peripheral or island communities, for example), will we still be willing to pay a premium for environmental sustainability?

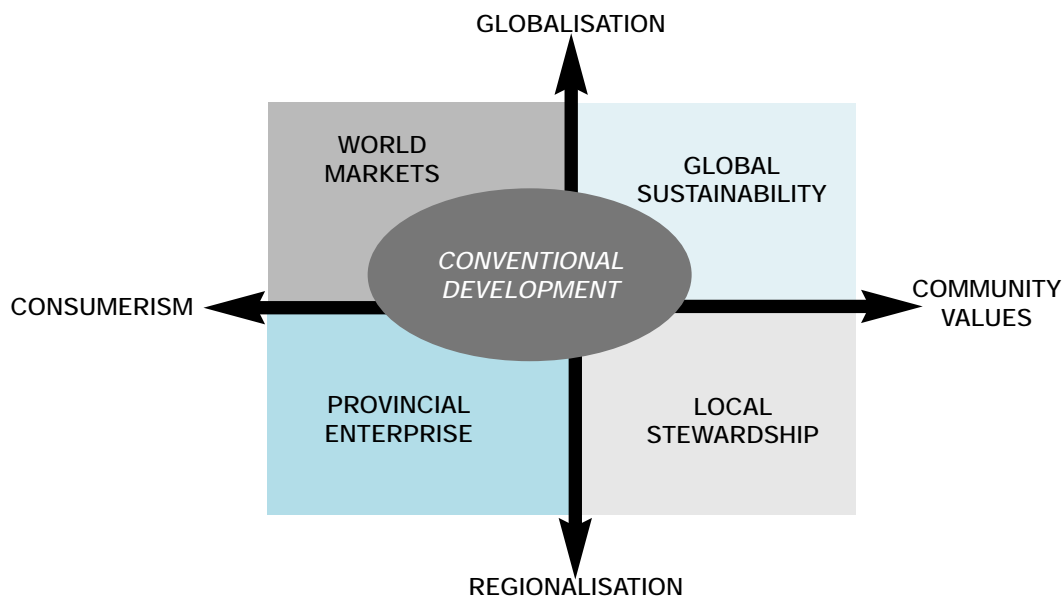
#### **Where are we now?**

In summary, the consensus of the three groups was that the current situation in the UK is best described by a combination of the World Markets and Provincial Enterprise scenarios. The trend, however, would appear to be moving away from Provincial Enterprise towards World Markets – ie from energy systems which are dominated by Nation State concerns to ones which are far more strongly shaped by an integrated world trading system.

#### ***Where are we likely to be in 2040?***

It was more difficult to arrive at a strong consensus about the kind of world in which we might be living in 2040. The general feeling of the three groups was that in 40 years' time we are likely to be living in the World Markets scenario but which demonstrates far more heightened concern for the global environmental issues

highlighted within Global Sustainability. One group was attracted by the communitarian aspects of Local Stewardship and wondered whether it would also be desirable to move to a situation combining aspects of all three, where global and local energy systems could co-exist.



### 3.6 The world in 2040 – Corporate Responses

Two representatives of major UK energy-related companies provided presentations on the role of energy in society in 2040. These provided both a corporate perspective – from Nick Welch, Head of UK External Relations at Shell International Ltd – and an individual perspective – from Garth Graham, Group Contingency Planning Manager at Scottish and Southern Energy plc.

Their presentations are summarised in Appendix 1.

### 3.7 Parallel workshops: Making it happen

The morning workshops were intended to help develop understanding about four possible future scenarios for the energy sector as well as identify a desirable path from today to 2040. Having achieved these two broad aims, the afternoon discussions focused on how to influence or shape a desirable future for Scotland's energy industry :

- ▶ Which R&D themes are most relevant to Scotland's energy sector? What do we need to do to ensure that Scotland can retain or develop a lead in these areas?
- ▶ What actions should businesses be taking to ensure longer-term competitiveness?
- ▶ What are the best ways to ensure that businesses, academia and Government are more aware of future issues affecting the energy sector?

An overall conclusion from the afternoon discussions was that there is a need to develop understanding and consensus about likely future energy supply and demand. A more visible and more transparent discussion should engage energy companies, researchers as well as Government in order to provide a more robust basis for taking investment decisions today.

In making the following proposals for action by the Scottish Executive there was an acknowledgement of the rather peculiar place occupied by energy within the devolution settlement. Whilst energy policy in general is reserved there are elements, such as the promotion of energy efficiency, which are devolved and the promotion of renewables, other than R&D funding, which is “executively” devolved. That means that overall responsibility for policy is reserved, but the Scottish Executive has powers delegated to make orders to achieve these policy objectives within the Scottish context. In addition, key policy issues related to energy, such as the environment, are devolved.

Together, the three groups suggested the following strategic actions for the energy sector :

**The Scottish Executive should:**

- ▶ Develop constructive dialogue with Westminster to promote a longer-term perspective to UK energy policy in terms of:
  - ▶ managing our current UK hydrocarbon resources; and
  - ▶ promoting future security of energy supply over the longer-term by supporting a diverse fuel mix
- ▶ Demonstrate leadership by establishing a longer-term framework for promoting the use of renewable energy by:
  - ▶ making stronger commitments to environmental targets
  - ▶ setting long-term targets for renewable energy use (ie beyond 2010) to provide greater certainty for research, technology and demonstration
  - ▶ addressing issues connected with the development or adaptation of energy infrastructure needed to accommodate alternatives to fossil fuels
- ▶ Establish a Scottish Forum for Energy Development comprising senior representatives from business and academia to provide forward-looking leadership for the energy sector in the medium- and long-term. The Forum would perform a distinctive role in:
  - ▶ providing strategic direction and advice to the Scottish Executive, business and researchers about longer-term issues;

- ▶ acting as an umbrella body, providing strategic oversight to existing fora – including PILOT (for the UK oil and gas industries), the Scottish Utilities Forum and the Scottish Renewables Forum;
- ▶ providing advice to the Scottish Executive on funding for new energy-related developments, potentially also including demonstration projects
- ▶ Encourage the UK Treasury to adopt approaches to the appraisal of infrastructural investments (eg housing, transport) that start to take into account whole life cost analysis
- ▶ Promote greater awareness of the role of energy and issues connected with a more diverse fuel mix among society generally and among school children in particular
- ▶ Develop greater demand for science and engineering related courses in further and higher education to address the current skills shortfall
- ▶ Take a lead, through Future Skills Scotland, in identifying anticipated future skills shortages within the energy sector (particularly the oil and gas industries)
- ▶ Identify and then actively develop export markets for energy-related technologies where Scotland has a current or potential future competitive advantage

#### Researchers and academic institutions should:

- ▶ Be supported to undertake more research into key energy-related technologies such as power electronics, fuel cells and energy storage materials
- ▶ Replicate ideas and enabling technologies used in the oil and gas industries in other energy industries (eg renewables)
- ▶ Design new courses to help address anticipated skills shortages in the oil and gas industries (and potentially, renewables also)
- ▶ Promote academic centres of excellence in energy studies.

#### Business should:

- ▶ Engage with academia in more joint research and demonstration projects
- ▶ Share knowledge in terms of future business strategies and approaches to developing energy technologies
- ▶ Collaborate across supply chains and across sectors to speed up the cross-fertilisation of innovations.

If these key recommendations are acted upon they would help provide the following benefits to Scotland's energy sector:

- ▶ Clear, long-term frameworks for policy, technology and infrastructure development within which business and researchers have the confidence to invest and collaborate
- ▶ Greater transparency around expected future supply and demand from various energy sources
- ▶ More collaborative research and demonstration projects involving business and academia, generating more industry demand for research
- ▶ Increased cross-fertilisation of innovation within Scotland's energy industry
- ▶ Continued supply of skills from further and higher education.

### 3.8 Conclusions and Next steps

In discussion, consensus began to emerge around the main priorities for action. A longer-term vision is required – a 40 or 50 year rather than a 10 year time horizon – upon which Scottish and UK energy policy is based. The process of developing this vision should involve participants from all relevant interests – business, Government, researchers, development agencies and environmental interests. Foresight provides a very useful starting point for this process but requires the support and participation of others.

It was agreed that the Scottish Energy Environment Foundation could provide the necessary catalyst to develop this process, supported by the Scottish Foresight Coordinator. Two separate strands of activity were suggested :

- ▶ Developing a longer-term time horizon to Scottish and UK energy policy:
  - ▶ investigating the creation of a Scottish Forum for Energy Development, a powerful and visible body to provide strategic direction and advice to the Scottish Executive, business and researchers
  - ▶ urging Government to set longer-term targets for energy supply from various sources
- ▶ Continuing the 'Energy Futures' strategic conversation
  - ▶ bringing seminar participants – and others – back together again to continue discussions around a clear agenda relating to policy development, human resource development and R&D.

Professor McDonald concluded by thanking all participants for their contribution and, especially, the organisers and all speakers.

## 4 Appendix 1 – The world in 2040 : Corporate responses

Using scenarios to plan for future global energy markets

Nick Welch, Head of UK External Relations, Shell International Ltd

Nick Welch presented some of the research undertaken by Shell International Ltd in anticipating future demand for energy over the next 50 to 100 years. The research has led Shell to identify two plausible scenarios for the period to 2050, helping to inform their own global business decisions.

There are four key strategic issues from Shell's perspective that would seem to shape the long-term evolution of the world's energy system:

- ▶ Energy transitions and new competitors
- ▶ Energy supply to non-OECD countries
- ▶ The response to carbon constraints
- ▶ Technology strategy in an era of innovation.

It is perhaps worth starting by considering the wider global social and economic context in terms of population demographics and development trajectories of some developed and developing world countries.

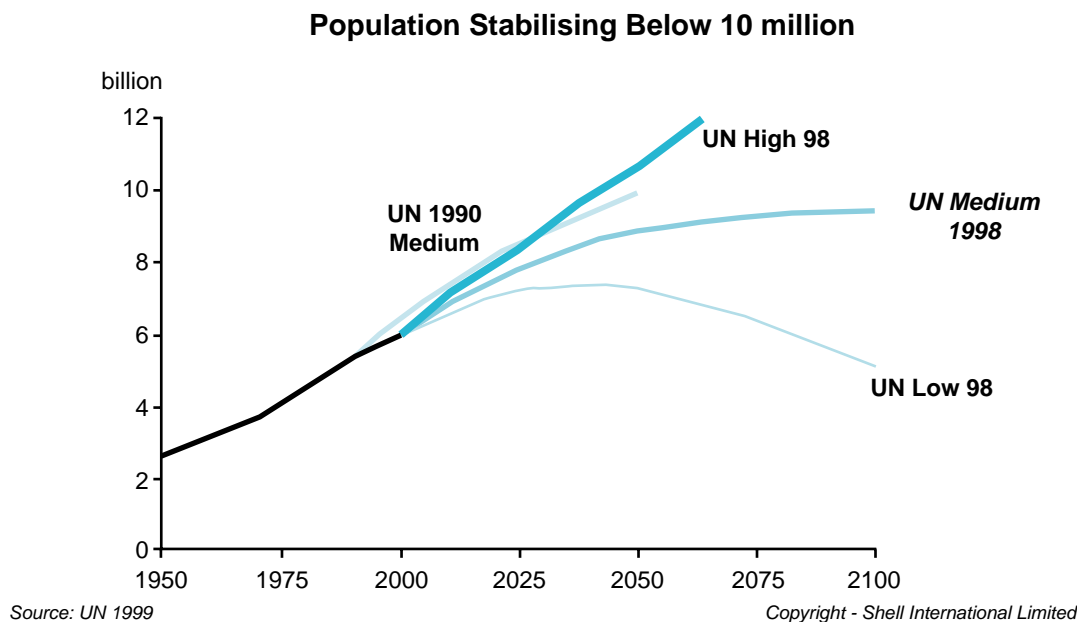
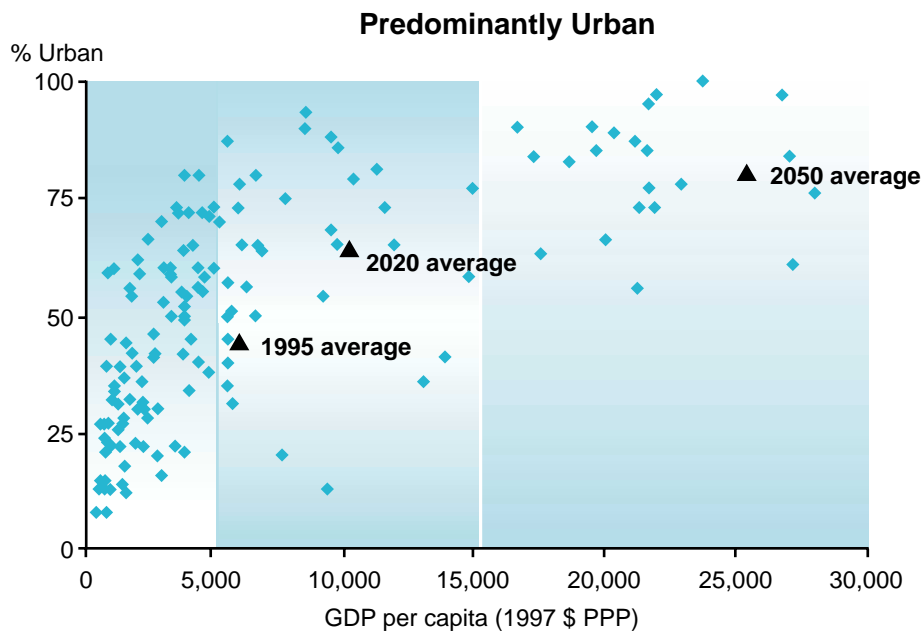


Figure 1 – World population projections, 2000-2100

The current wisdom, from the UN population projections (see Figure 1) indicates that world population will grow by 2050 to around 10 billion people. The UN's 'medium'

projection estimates that this will then stabilise at about this figure, but the 'high' and 'low' projections follow different trajectories thereafter.

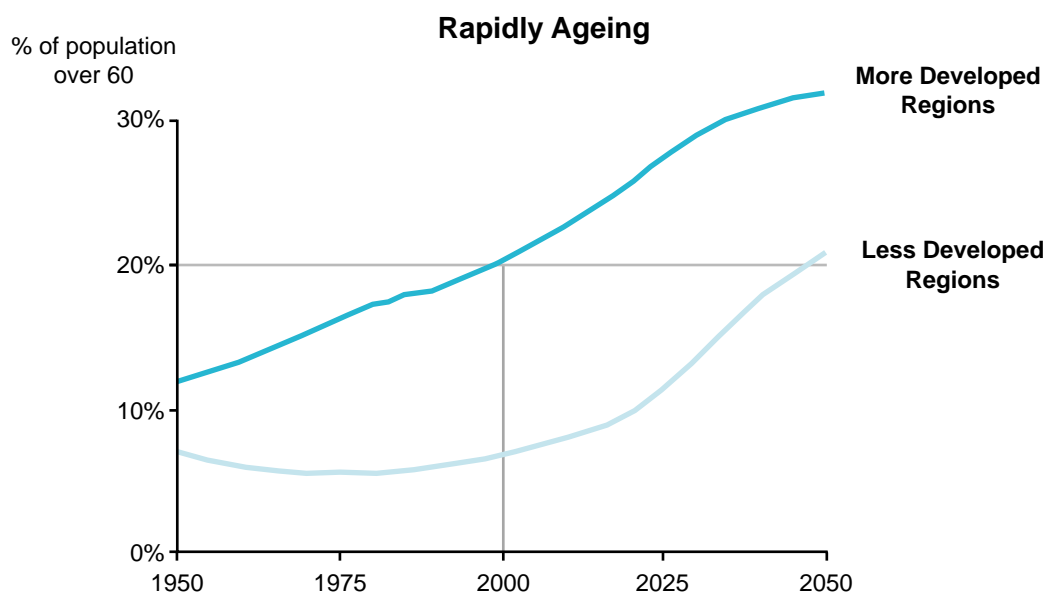
Figures 2 and 3 suggest that the world will continue to become more rapidly urbanised and generally older. Just as the developed world is currently experiencing the age shift, developing countries' age profiles will similarly alter, particularly in the period 2025-2050. Generally speaking, an ageing population correlates with lower energy use.



Source: figures for 1995, World Bank, 1997

Copyright - Shell International Limited

Figure 2 – A more wealthy, urbanised population



Source: UN 1999

Copyright - Shell International Limited

Figure 3 – An ageing world population

A key question is whether developing world economies will follow the same path as the developed world in the transition from a largely agricultural to largely service-based structure. Figure 4 plots energy use against income for a range of countries. Interestingly, Malaysia shows signs of following a different trajectory to Korea in using less energy per capita as its population becomes richer. Might China and India also follow this 'alternative' model, and what role might renewable sources of energy and new energy technologies play in their development? We should not necessarily assume that the rest of the world will follow the same energy patterns as the West<sup>1</sup>. Nevertheless, it seems evident that the greatest growth in energy demand will come from Asia; in fact, Asia will add the equivalent of total current demand from all OECD countries between 2000 and 2030.

Taking a long view, oil has become the primary world energy source only relatively recently (see Figure 5). Recent US Geological Survey data indicates that significant reserves of oil will remain to at least 2050 (Figure 6). In fact, they estimate that the current 2% growth in world oil production may well continue for the next 25 years, leading to an increase from around 70 million barrels/day to almost 125 million barrels/day. Shell, who support these estimates, believes that they are perhaps conservative, owing to the effect of technological developments. Others disagree, however.

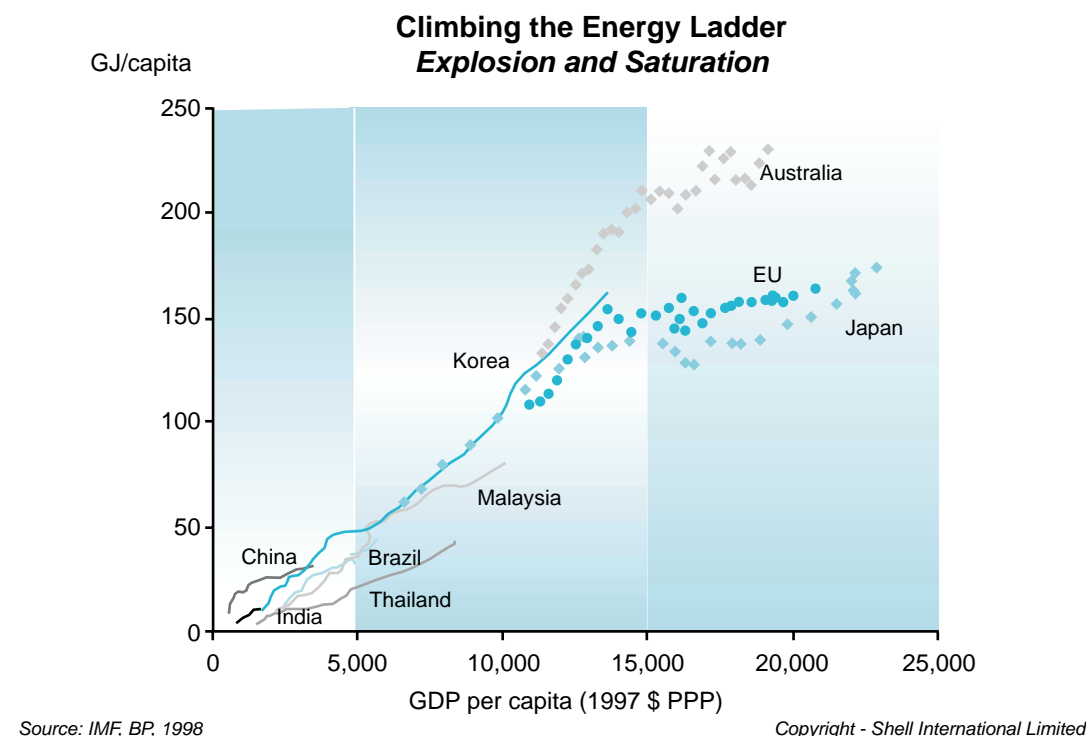


Figure 4 – Tracing national development trajectories

<sup>1</sup>This is underlined by rising environmental concerns within developing countries. A survey by Environment Monitor in 1999, for example, highlighted that 74% of Chinese respondents agreed with the statement that "Environmental laws don't go far enough" compared with 69% in Korea and 54% in India.

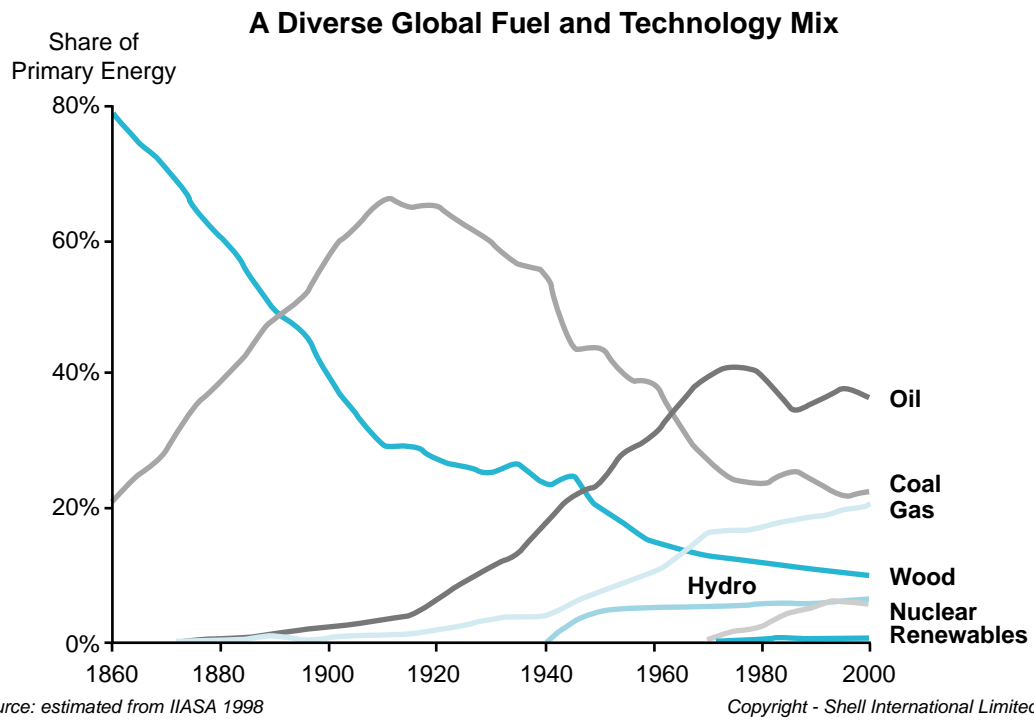


Fig.5 – Sources of primary energy supplies, 1860-2000

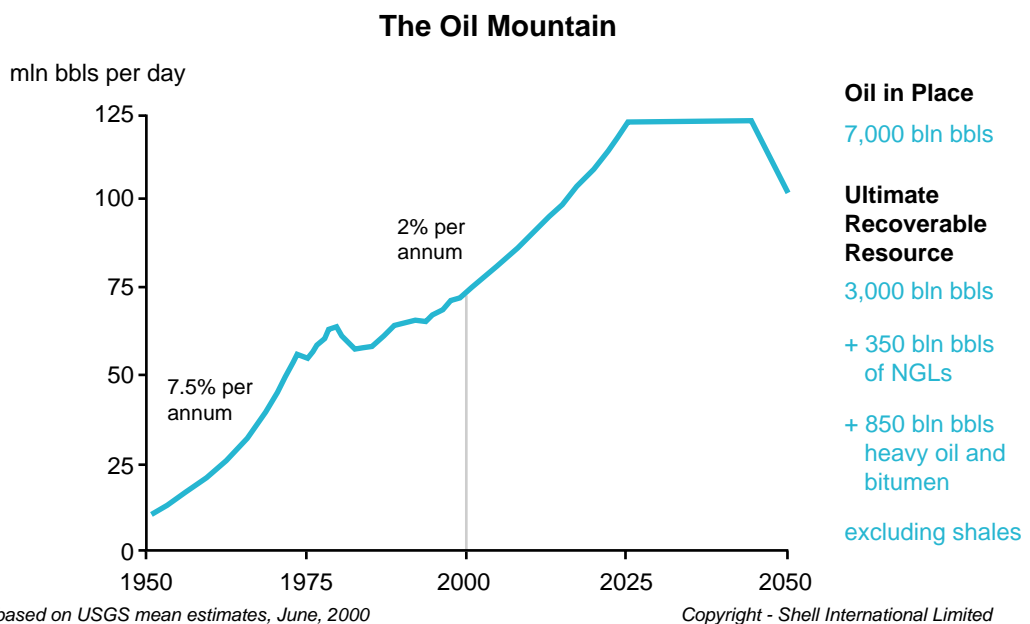


Fig.6 – Actual and forecast world oil production, 1950-2050

Certainly, non-fossil energy sources are becoming more economic and therefore, more attractive as a primary source of energy (Figure 7). However, improving their development and cost-effectiveness is a gradual and long-term process. Renewables currently account for only a tiny fraction of total world energy supply and are unlikely – in Shell’s view – to provide any significant proportion until 2020 at the earliest. Only from about this time onwards will the relative scarcity of oil drive its cost upwards, with renewables becoming more attractive.

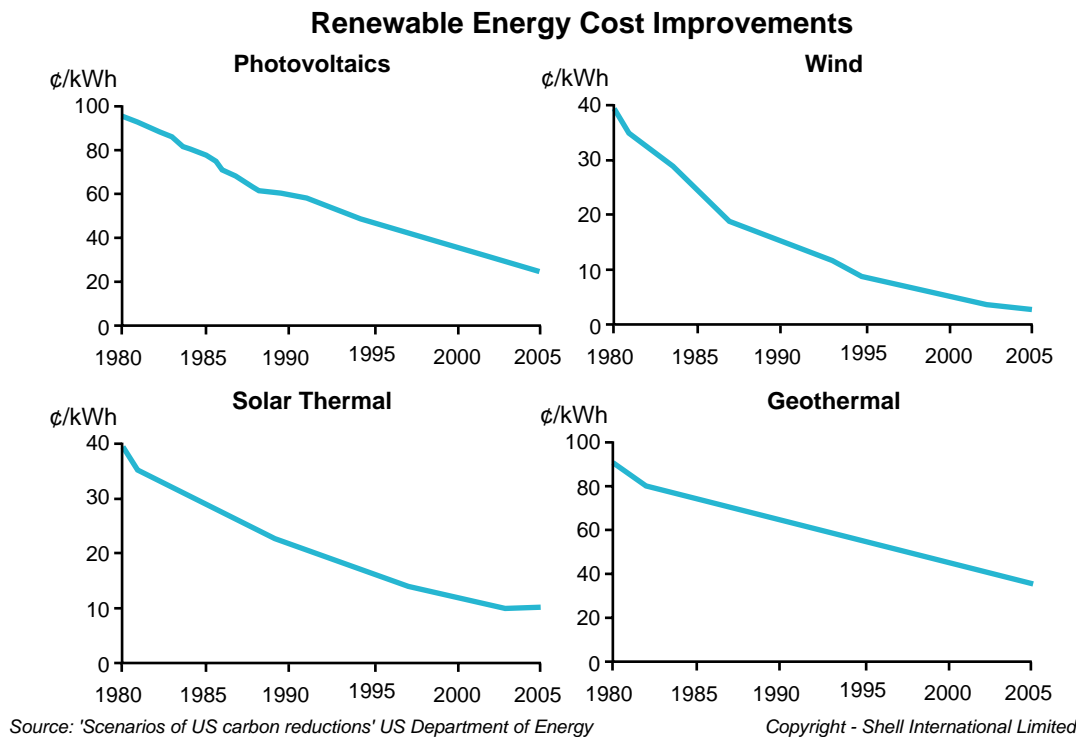


Fig.7 – The tumbling cost of renewable energy production

Predicting the demise of oil is not a new phenomenon. In fact, as Figure 8 demonstrates, forecasters have consistently overestimated the price of oil since the 1980s. Rather than following a gradual increase from the low of the mid-1980s to 2020, they have stayed low. Given an environment whereby the primary energy source remains plentiful and cost-effective there seems little incentive – at least in the short-term – for most investors to develop alternatives.

### Oil Prices Have Not Followed Expectations

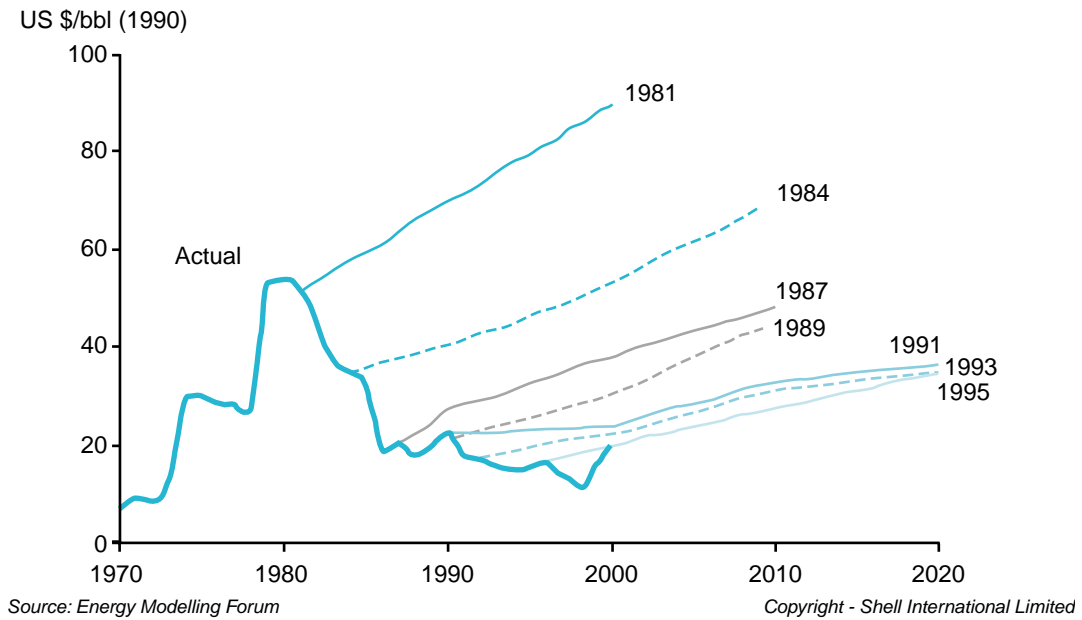


Fig.8 – Actual and forecast oil prices, 1970-2020

Throughout recent history, in fact, this has been the case. New energy sources generally do not appear once the previous primary source runs out completely. Rather, alternative sources gradually substitute for existing sources and at any one time a number of types of fuels drive the economy (Figure 9).

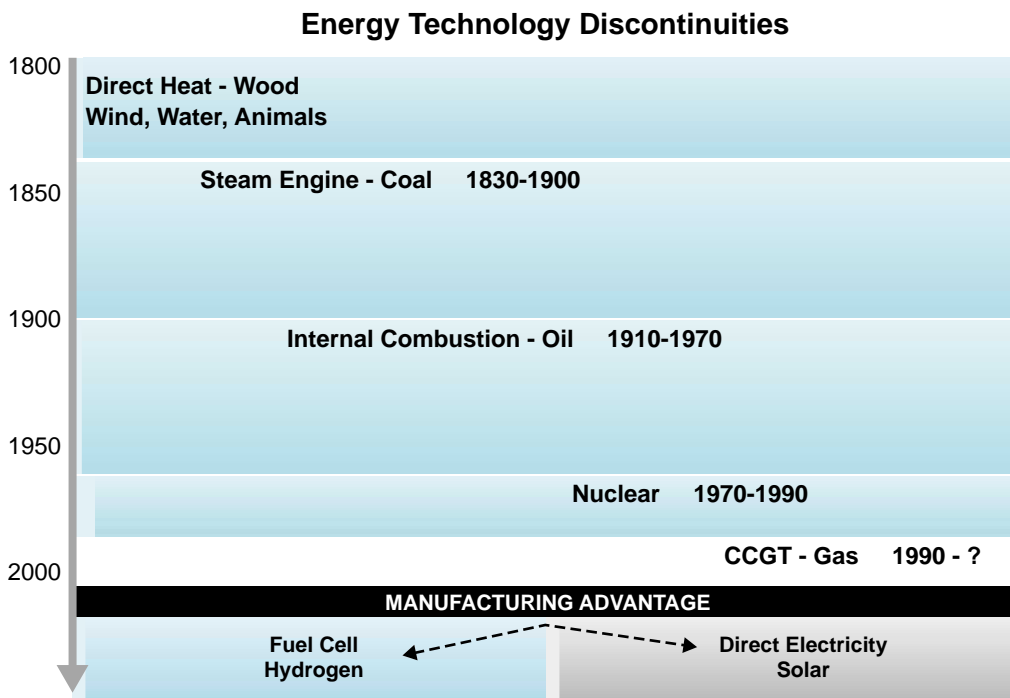
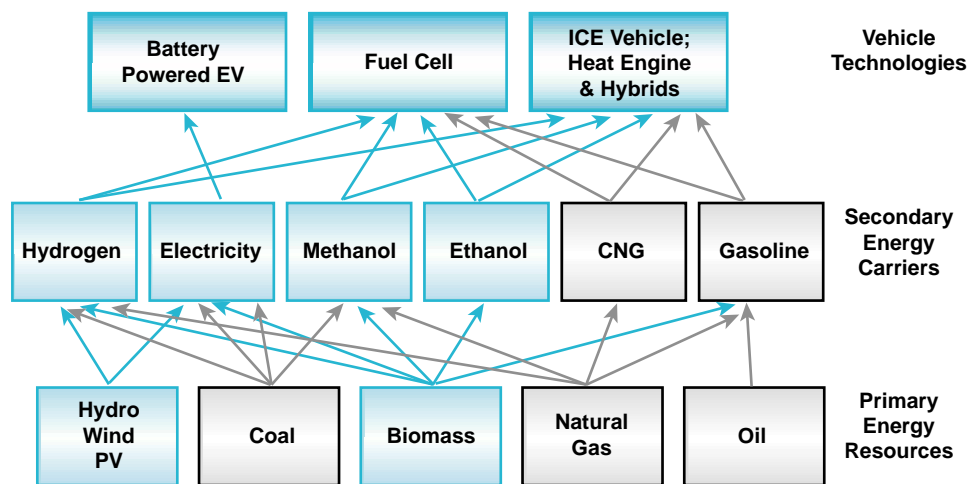


Figure 9 – The wax and wane of energy technologies in recent history

We are now in an era when the energy debate seems far more complex than at any time in history. On the one hand, we are developing new, ever more sophisticated technologies that allow us to exploit both fossil fuels as well as renewable sources (see Figure 10). On the other, increasing acknowledgement of the environmental costs of energy production and use, driven by public concern, help inform judgements about environmental regulation and ultimately, the economics of energy. It is this complex interplay between technology and societal acceptance that is shaping the future of energy far more strongly than in the past.

### Proliferation of Transport Options



Source: *Energy Technology R & D: What Could Make a Difference?*, Oak Ridge National Laboratory, 1997

Note: Renewable energy pathways are shown as green lines  
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Figure 10 – An increasing range of energy technology developments in the transport field

To help Shell International simplify these many, complex trends affecting their business they have, since the 1970s, pioneered the use of scenario planning. Scenarios are a tool to help provide a framework for thinking about complex and uncertain external drivers of change which, when applied to a particular organisation, can help focus minds around key issues of strategic importance<sup>2</sup>. Ultimately, scenarios are a tool for developing models of an organisation's view of the business environment, allowing the development of more robust strategies and better decision-making.

<sup>2</sup> For further reading on scenario thinking refer to :  
"Scenarios – The art of strategic conversation", Kees van der Heijden  
"Scenario planning – Managing the future", Gill Ringland  
"The art of the long view", Peter Schwartz

Shell currently apply two scenarios to their global business:

- ▶ Dematerialisation  
*human needs met by less energy-intensive technologies*
- ▶ Sustained growth  
*abundant energy supply provided at competitive prices.*

### The Sustained Growth scenario

This scenario can very simply be summarised as “business as usual”. It describes a continuation of the current fossil fuel-driven society in the Western world, where oil and coal are both relatively cheap and plentiful and continue to provide the dominant sources of power across the globe. Oil production peaks by 2025 but scarcity does not become a very significant issue until around 2050 (see Figure 11).

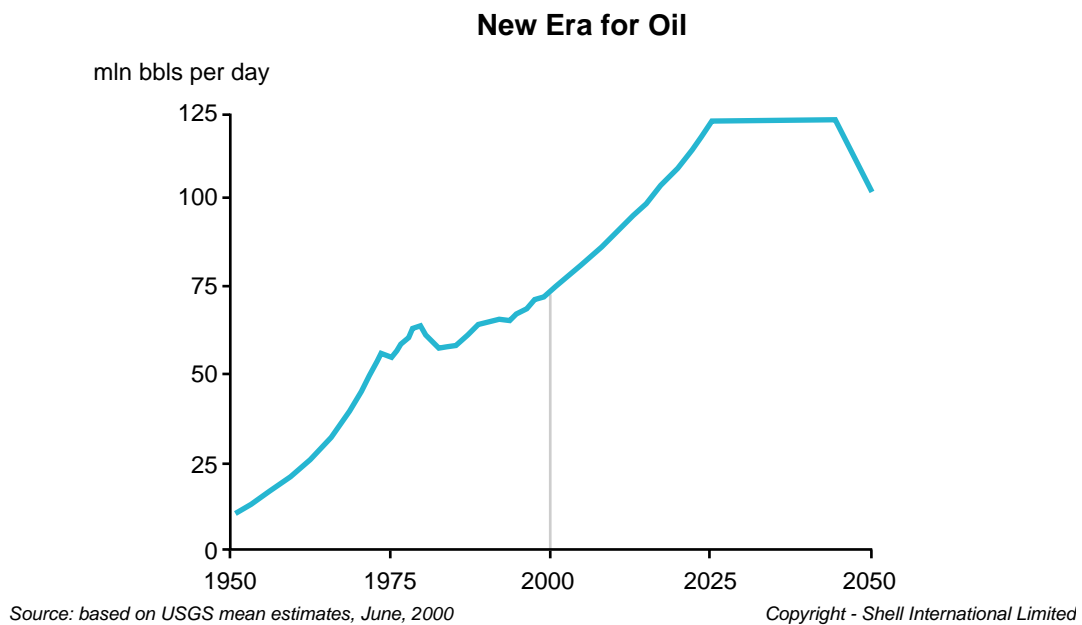


Figure 11 – Strong continuing demand for oil combined with plentiful supplies to the mid-21st Century

Gradually, however, a number of factors begin to challenge the continued sustainability of this fossil fuel-based energy system, and alternative (renewable) forms of energy production start to provide cost-effective, large-scale substitutes. In the burgeoning Chinese economy, for example, the sheer logistical difficulties of moving coal to and from power stations begins to call into question the cost-effectiveness of a model based on coal-fired power stations. The proportion of gas imports rises to at

least 50% in Europe and developing Asia by about 2015 and 2025 respectively; security of gas supplies becomes an increasing political and economic issue. The cost of renewables reduces substantially for wind, biomass and photovoltaics so that by around 2020, they may collectively account for 10% or so of world energy production.

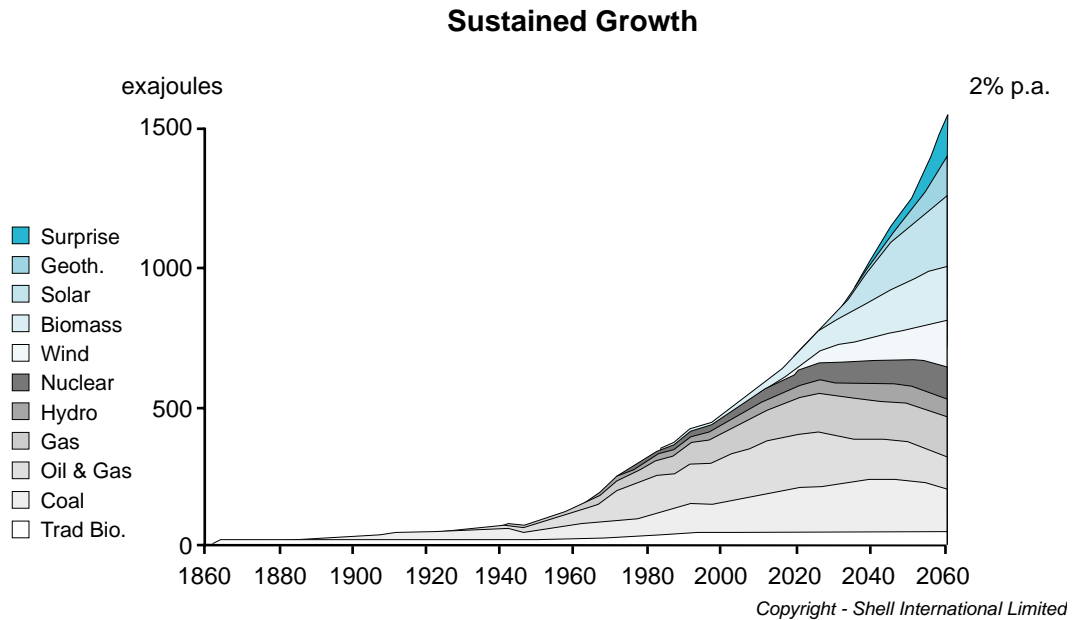


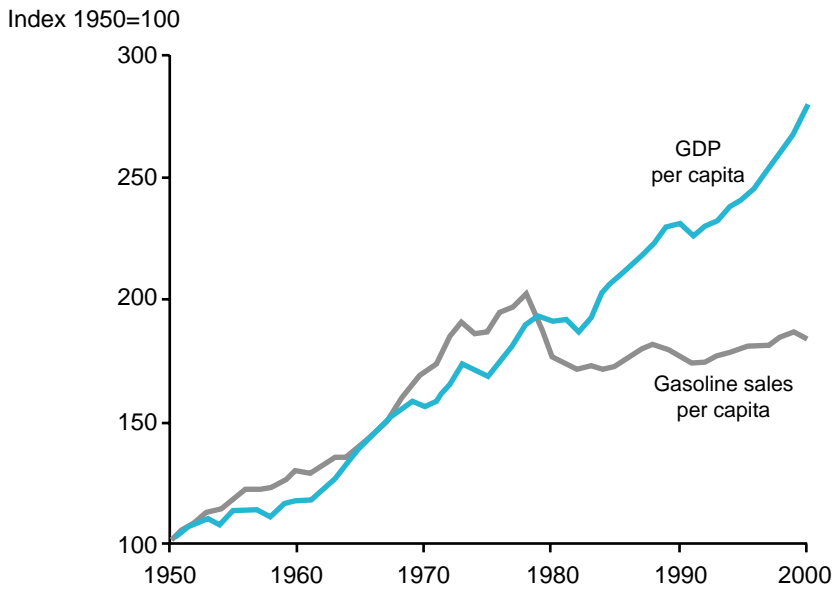
Figure 12 – Forecast mix of energy production under the Sustained Growth scenario, 1860-2060

In summary, therefore, the Sustained Growth scenario is based on a high energy-use world and where the contribution of renewable supplies does make an appreciable contribution until at least 2020 (see Figure 12).

#### The Dematerialisation scenario

The Dematerialisation scenario is a very different kind of environment whereby strategies are pursued to scale back overall world consumption of energy. In a rapidly developing world, countries are very alive to the need to reduce demands for energy consumption (owing largely to environmental concerns). Collective regulation is strong and significantly more investment is channelled into developing alternatives to fossil fuels.

### US Petrol Demand Decoupling from Income



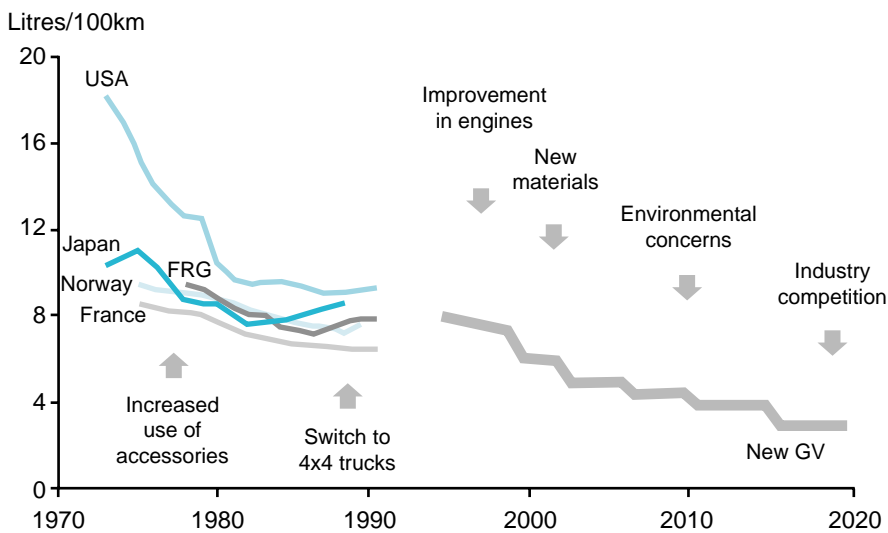
Source: US EIA, 1998

Copyright - Shell International Limited

Fig.13 – De-coupling of US petrol demand from income

Already we are beginning to see a de-coupling of petrol demand from income in the USA (Figure 13) which, combined with developments in engine technologies, could result in driving up fuel efficiency across the world (Figure 14) over the next 20 years.

### New Car Road Fuel Efficiency



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Fig.14 – Developments in vehicle technologies

Forecast demand for oil could be significantly less under this scenario than for Sustainable Growth; Figure 15 shows a tailing-off of world oil production after 2025 as alternative sources substitute for oil. The two salient issues affecting the overall energy mix (Figure 16) are therefore lower world energy demand and the more significant contribution of renewables (particularly biomass and wind) in place of oil and coal after 2020.

### Oil is Not Needed

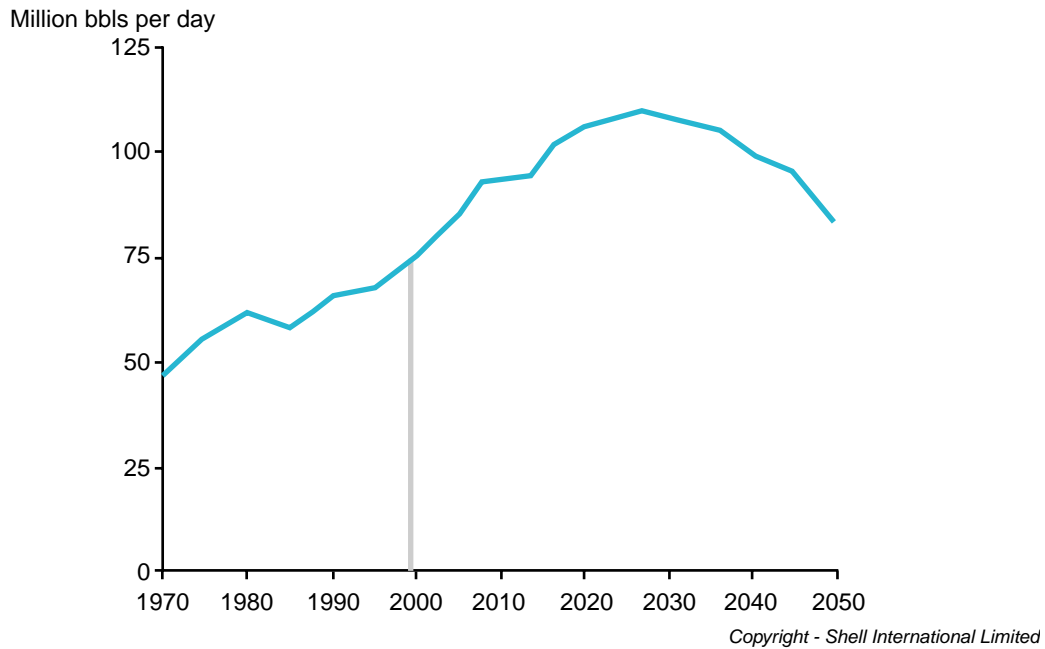


Fig.15 – A tailing-off of demand for oil

### Dematerialisation

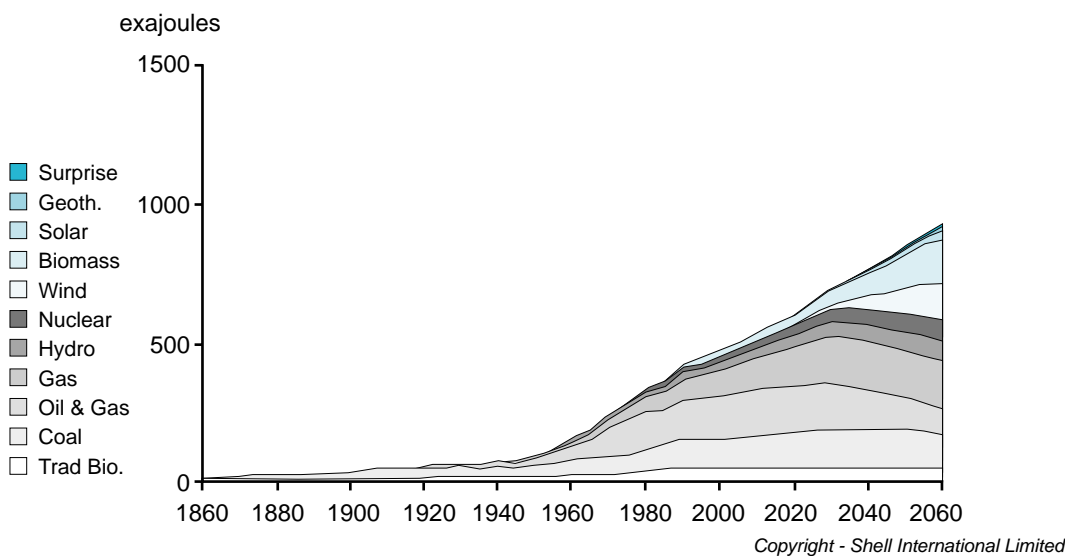


Figure 16 – Forecast mix of energy production under the Dematerialisation scenario, 1860-2060

Fuel cells and the hydrogen economy? A personal perspective on the future of energy

Garth Graham, Group Contingency Planning Manager, Scottish and Southern Energy plc

Scottish and Southern Energy plc is a leading British power generation company which produces almost half of the UK's renewable generation capacity and over 90% of Scotland's renewable electricity. It is also the UK's largest electricity distribution company, supplying 4 million electricity and 1 million gas customers.

Garth Graham began by reminding delegates that he was expressing his personal views about the future of energy and not necessarily those of Scottish and Southern Energy plc.

Before taking the bold step of looking to the future it might be worth spending a moment to look at the past. Many great minds in history have tried – and failed – to predict the future; hindsight is a wonderful thing.

For example, twenty years ago a group of eminent American scientists known as the Union of Concerned Scientists considered what the future might bring. They forecast that there would be *“minor increases in electricity consumption in the future”*. Since then, electricity consumption has risen by more than 60% as computers and other high tech appliances in homes and workplaces have become widely adopted.

Some have argued that as a result of these and similar predictions at that time, policy-makers and opinion-formers were so blinded by these ‘forecasts’ that they did not foresee the need to grow the electricity infrastructure to meet this growing demand. In part, this has contributed to the recent electricity crisis in California, where no significant new electricity generation plant has been built in the last 10 years.

But enough of the past – what about the future?

The US Central Intelligence Agency's *“Global Trends 2015”* report (December 2000) forecasts a 50% growth in world energy demand, saying that *“fossil fuels will remain the dominant form of energy despite increasing concern about global warming”*. Figure 17 below, for example, suggests that oil demand could grow from 75 million barrels/day now to 100 million/day in 2015 – an increase almost as large as OPEC's current production – that bodes well for Scotland's oil exploration and production capabilities.

This conclusion is also shared by the Washington D.C based Center for Strategic and International Studies who observed that, *“One of the ironies of the turn of the century*

... is that in an age when the pace of technological change is almost overwhelming, the world will remain dependent, during 2000-2020 at least, essentially on the same source of energy – fossil fuel – that prevailed in the 20th Century”.

In Garth Graham’s personal opinion the more likely scenario identified by the Foresight Energy Futures Task Force is one that links some of the aspects of *Global Sustainability and Local Stewardship*. In particular, he supported the view that natural gas will be the dominant UK energy source up to 2010 with renewable energy sources gaining a large share of the market thereafter. Further into the future, hydrogen could well become a significant energy carrier by 2030.

New technologies and fuel cells in particular could come to revolutionise the way the energy market operates, particularly in the developed world. There will be changes in the way electricity companies deliver energy to their customers with the advent of distributed generation and even semi-autonomous distribution networks.

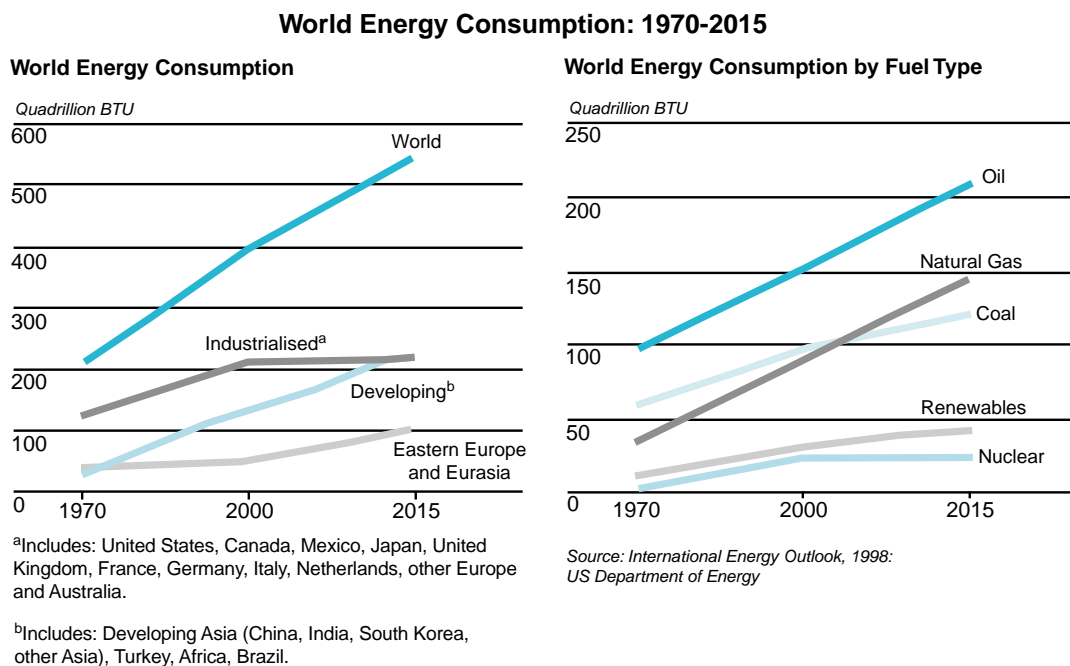


Figure 17 – Forecast world energy consumption, 1970-2015  
Source – CIA Global Trends 2015 : A dialogue about the future with non-governmental experts, December 2000

Fuel cells are not new - a Welshman, Sir William Grove invented them over 160 years ago - and it seems that the technology has, for many years, been ‘just’ some 5 years away from being commercialised. Well, now in the 21st century, we may really be within 5 years of the successful commercialisation of fuel cells.

Why should this be the case? Take a look at some of the positive features of fuel cells:

### The advantages and disadvantages of fuel cells

#### Positive

- ▶ High energy conversion efficiency relatively independent of size or load
- ▶ Size flexibility
- ▶ Modular design
- ▶ Very low environmental emissions
- ▶ Very quiet in operation
- ▶ Co-generation capability
- ▶ Siting ability
- ▶ Fuel flexibility
- ▶ Rapid load following capability

#### Negative

- ▶ Sensitivity to certain fuel contaminants
- ▶ High market entry price
- ▶ Endurance/reliability is still being demonstrated

Many of the fuel cells' negative aspects are currently being addressed by those in the field, which include most major car manufacturers and many other large corporations. In fact, eight of the world's top ten revenue-earning companies are involved in fuel cell development.

DaimlerChrysler, for example, hopes that its fuel cell powered 'A' Class car; based on its NECAR series of prototypes; will be available from your local Mercedes dealer in less than four years time. If so, it promises to be one of the first publicly available zero emission fuel cell passenger cars, capable of travelling some 280 miles between refuelling.

If we are to address as a nation and as a world the growing threat of global warming, we need to look at all sources of emissions, including transportation. We also need to consider domestic generation and here too fuel cells, by providing heat and electricity at the point of use, can play a part in helping us towards a sustainable future. It is also worth remembering that fuel cells, when powered by hydrogen, emit H<sub>2</sub>O – water – which is much less damaging to the environment than CO<sub>2</sub>!

And what does this mean for Scotland in 2040?

Studies have shown that Scotland has an abundant potential for renewable energy. However, the cost of exploiting this resource and transmitting it to the centres of demand, together with their intermittent nature, hinder us from fully benefiting from this potential resource.

Turning ourselves into a hydrogen economy may well be the way forward. The production of hydrogen, via electrolysis, could be done in crofts, villages and towns for local use in cars, homes, schools, offices etc. using local renewable resources; such as intermittent wind, solar, wave or tidal power. Alternatively, it may be produced at centralised locations for cities using either renewable electricity transmitted to these locations or exploiting centralised generation such as nuclear or clean coal.

In concluding, Garth Graham put forward the idea that in 2040 the hydrogen powered fuel cell car could not only be getting us from A to B, but also providing us with heat and electricity when we get to B.

The fuel cells planned for cars are in the 30 to 50 kW range, more than adequate for domestic electrical and heating needs or, when combined with other cars in say an office car park, more than enough to meet the electrical and heating/cooling requirements of a workplace.

Let us debate today and beyond whether we can help turn this potential into reality.

## 5 Appendix 2 – List of participants

George Marsh	AEA Technology Ltd
Rab Wilson	AEEU
Ron Peddie	AMEC Process and Energy Ltd
Andy McCann	Argyll and Bute Council
Rory Menzies	Baker Oil Tools
Harry McMillan	BP
Dr Graham Ault	Centre for Economic Renewable Power Delivery
Alan Gallacher	Cordah Limited
Fenella McEwan	CoSLA
John Cockaday	DTI
Tom Ridge	DTI
Jane Johnston	EDS Limited
Craig Durham	EGIS
Iris Kirkpatrick	Forward Scotland
Andrew Lyon	Forward Scotland
Ken Bamborough	Highland Council
Elaine Hanton	Highlands and Islands Enterprise
Jim Webster	HLM Design Ltd
Charles Shields	Industrial and Power Association
David Ellix	Industry Technology Facilitator
Charles Gallacher	OFGEM Scotland
Lawrie Bain	OPITO Limited
Dr David Clarke	Rolls Royce plc
Garth Graham	Scottish & Southern Energy plc
Peter Cullen	Scottish Energy Efficiency Office
Chris Bronsdon	Scottish Energy Environment Foundation
Ewan Mearns	Scottish Foresight Coordinator/Scottish Enterprise
Blair Armstrong	Scottish Enterprise Energy Team
Hamish Dingwall	Scottish Enterprise Energy Team
James Curran	Scottish Environment Protection Agency
Bob Sargent	Scottish Environment Protection Agency
Evan Williams	Scottish Environment Protection Agency
Samantha Baker	Scottish Executive
Alistair Montgomery	Scottish Executive
Ben Maguire	Scottish Executive Energy Team
Bill Band	Scottish Natural Heritage
Ruth Wolstenholme	SNIFFER
Dr Marc Rands	The Royal Society of Edinburgh
Professor Bert Whittington	University of Edinburgh
Lori McElroy	University of Strathclyde - ESRU
Professor Jim McDonald	University of Strathclyde - ESRU
Professor John McMullan	University of Ulster
J McIntosh	Vertec Engineering Limited



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