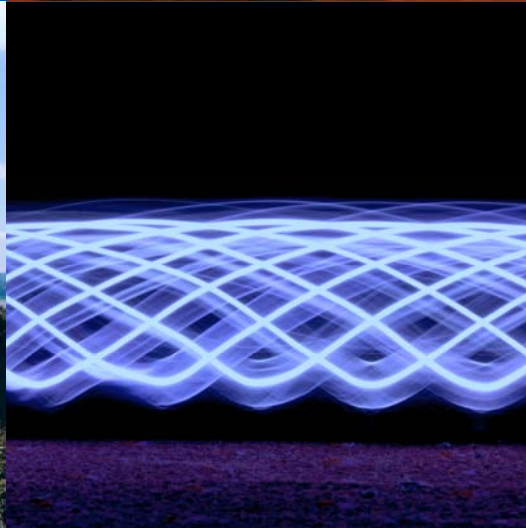
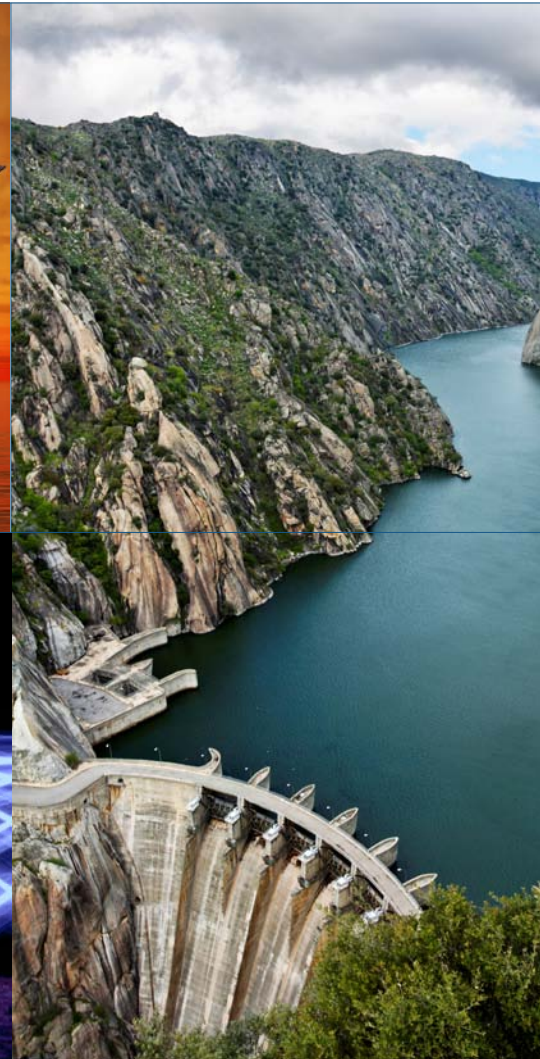




**WORLD ENERGY COUNCIL**  
CONSEIL MONDIAL DE L'ÉNERGIE  
*For sustainable energy.*

# White Paper: Scenarios

World Energy Council 2010



# White Paper: Scenarios

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## White Paper: Scenarios

World Energy Council 2010

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# Foreword

The wish to know the future is as old as mankind itself. Unfortunately, we are not able to predict the future, which does not necessarily mean that the future must always be unknown. The main purpose of this White Paper is to introduce readers to the concept of scenario thinking and the idea of a new set of scenarios that the World Energy Council wants to develop after the Montreal Congress. It briefly outlines the generic process of making scenarios and how they can be used. It also summarises the proposed structure and process of this new WEC flagship project, as presented by the Senior Fellow for Scenarios to the WEC Studies Committee in Beijing on June 9th, 2010. To provide a historical reference, a summary of the energy scenarios work done by the World Energy Council since 1989 is provided. The White Paper ends with illustrative examples of headline events that have influenced the energy space in recent times and which raise important questions that are best dealt with in a scenario context. Finally, it is also hoped that this document will provoke and stimulate debate and discussion around the future of energy and meeting the demands of the world in a sustainable manner.

# Section 1

## Introduction

### What are Scenarios?

The desire to look into the future is as old as mankind itself. One only has to look at ancient Greece and the stories around the Oracle of Delphi to be reminded of this. Unfortunately, we are not able to predict the future...which does not necessarily mean that the future must always be unknown. Some important factors that influence future developments are well known, many others are just as important but more uncertain. Hence, we tend to make assumptions about the future when developing strategic plans. Many of the tools we use like 'trend extrapolation', work under the assumption that we know the structure of the system we are studying and can therefore reliably predict outcomes or outputs. The environment of today, however, is often too complicated to be captured within a framework of workable laws. We are therefore faced with a dilemma – how does one formulate strategy in the face of seemingly overwhelming uncertainty? Determining the future of energy pathways and resolving the climate debate are good examples of such dilemmas. It is in situations like this that the use of scenario planning makes a valuable contribution through challenging our assumptions and benchmarking our vision about the future.

In essence, scenarios are plausible, pertinent, alternative stories of the future, which portray a range of conceivable outcomes and help us understand how different factors may interact to shape the future. Forecasters extrapolate from the past, imposing patterns from the past onto the future. The general purpose of building scenarios is

to widen the perspective of decision-makers, and in doing so, widen and clarify their options for action.

“... the purpose of scenario planning is not to pinpoint future events but to highlight large-scale forces that push the future in different directions. It's about making these forces visible, so that if they do happen, the planner will at least recognize them. It's about helping make better decisions today.”

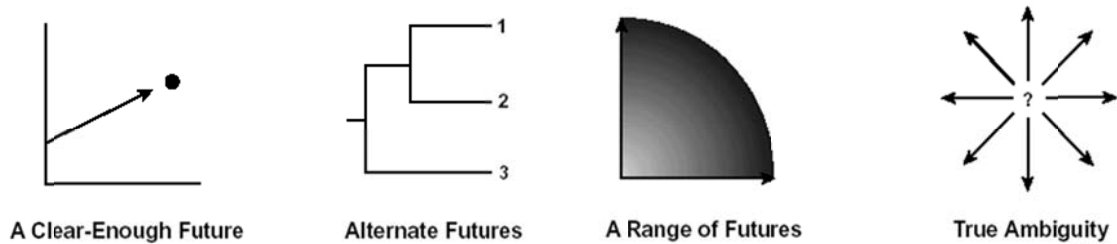
Lawrence Wilkinson<sup>1</sup>

Forecasting does not focus on discontinuities – scenario thinking does. Scenarios are more concerned with strategic thinking than with strategic planning, and more specifically with the quality of the thinking. Scenarios attempt to look beyond our limited mindsets, recognising that possibilities are influenced by a wide range of people and views different from our own.

<sup>1</sup> Wilkinson, L. 'How to Build Scenarios'. Wired. Accessed at <http://www.wired.com/wired/scenarios/build.html>

**Figure 1.1**

Source: McKinsey - Hugh Courtney, Jane Kirkland, Patrick Viguerie



## Scenarios as an aid to decision-making

In order to formulate viable strategic solutions, a planner needs to have a good understanding of the environment. However, most of the tools that planners use, work under the assumption that we know the structure of the system we are studying and can therefore reliably predict outcomes. Unfortunately, only a very limited class of phenomena can be accurately predicted. These are the phenomena of which the laws are clearly understood. The environment however, is often too complicated to be captured in a framework of workable laws. The planner therefore arrives at the seemingly insurmountable question – how does one formulate strategy in the face of overwhelming uncertainty?

Lawrence Wilkinson, co-founder of the Global Business Network (GBN), states that a “deeper dilemma” exists, where one attempts to “strike a balance between prediction...and paralysis<sup>2</sup>”.

Figure 1.1 portrays a few ways in which the future can be looked at. Trend extrapolation and a resulting single forecast (far left in Fig.1.1) has been the mainstay of traditional strategy toolkits. Alternate futures describe a few discrete outcomes which can be defined through techniques like decision tree analysis, option valuation models, and game theory. A range of futures which attempt to outline possible outcomes are the remit of methods like technology forecasting, latent-

demand research, and scenario planning. In cases where there is no basis to forecast the future (far right in Fig.1.1), the planner can adopt techniques like analogies and pattern recognition or nonlinear dynamic models.

What makes scenarios so powerful, if done rightly, is that they seek the critical “what if?” questions to explore a range of possible futures. By doing so, they can change the way people think about the future and the assumptions they hold about it. Scenarios, if they are insightful and have an impact, can change people’s view of how the world works and even encourage them to rethink their own roles and contribution. It should be kept in mind that for this to hold true, scenario thinking must be carried out in its entirety, and not be limited to the consideration of one more or more “preferred” scenarios – as is unfortunately, the case sometimes.

<sup>2</sup> Wilkinson, L. ‘How to Build Scenarios’. Wired. Accessed at <http://www.wired.com/wired/scenarios/build.html>

## Four facets of scenario methodology

The individual steps of scenario construction are loosely sequential and at the same time iterative – it is necessary to continuously return to previous work and incorporate what has been learnt. The steps are,

- ▶ Uncovering and widening perspectives
- ▶ Understanding interactions
- ▶ Crystallising insights into stories
- ▶ Generating and testing

People can make assumptions without ever imagining that their view may be inconsistent with the views of others, or for that matter, inconsistent with reality. Assumptions are rooted in people's own histories. Sometimes it is almost by accident, that these assumptions are revealed.

One important element of scenario methodology is, therefore, to make assumptions explicit: to understand the current perspectives of relevant stake holders who are most likely decision-makers. In particular, it is critical to understand what is considered to be important, and beyond that, assumptions about what is likely to persist and what is likely to change.

Pierre Wack recommended separating the future into “predetermined and uncertain elements”<sup>3</sup>. Predetermined elements are those events which are “already in the pipeline” and can be expected to persist.

This first stage of scenario building is very intensive and requires careful studying to determine what is predetermined and what is uncertain. This helps in comprehending the driving forces of an environment's future which often fall under five categories – society, technology, economics, politics, and environment. After determining an environment's predetermined elements the planner is faced with the challenge of identifying “critical uncertainties” whose resolution results in the manifestation of different futures or scenarios. When we can distinguish between what might persist and what might change, this knowledge can be used to expand our understanding of how the world works. This is important for both activists and entrepreneurs, as Ged Davis, former head of scenario planning at Royal Dutch Shell puts it, “...a trend is a trend until it bends...”, and at the bends are risks and opportunities for change.

Immediately following the identification of predetermined trends and critical uncertainties, it is important to make interactions explicit. It is often here where the greatest opportunity for learning lies. In the context of scenarios as opposed to chemistry, interactions are not always consistent over time. The possibility of interactions changing could form the very basis for alternative scenarios of the future.

<sup>3</sup> Wack, P. ‘Scenarios: shooting the rapids’, *Harvard Business Review*. November - December 1985

This facet of the scenario method requires strong analytical skills and a capacity to understand systems. Specialist knowledge of subject matter is a crucial input in this work, although a multi-disciplinary approach is also needed to cover the breadth of issues at hand. Insight is also required to distil the mass of detail now available, into a few themes upon which the scenario stories will be based. The outcome is a set of explicit assumptions about how relevant systems work and how they may change in the future.

Once scenarios are built, they face a communications challenge. How can the complexity of alternative futures be made transparent and the insights contained therein, be conveyed? How can the breadth of alternative futures be captured whilst maintaining relevance to the practical questions at hand? How can stories be made challenging and compelling without a loss of credibility? Depending on the subject matter and the audience, the answer usually lies in a combination of words, pictures, and numbers.

The last stage of scenario building is the evaluation of implications and the generating and testing of options. Scenarios are very useful in helping to draw out discontinuities and insights, which can then be turned into new strategies. Looking at implications is therefore part-and-parcel of any scenario process, but not part of the scenario planning methodology as such.

## Section II

# Scenarios and the World Energy Council

The World Energy Council (WEC) has been involved with energy futures for more than two decades. WEC's first energy futures study, *Energy 2000-2020: World Prospects and Regional Stresses* (ed. J-R Frisch), was commissioned for the 1983 New Delhi World Energy Congress. Following the enthusiastic reception for this study, a second study was conducted from 1986 to 1989 under the aegis of the WEC Conservation and Studies Committee. The summary of this study, *World Energy Horizons: 2000-2020*, was published in 1989 under the title *Global Energy Perspectives 2000-2020*.

### Global Energy Perspectives 2000 - 2020 (1989)

This study was published in the context of oil market volatility, the Chernobyl disaster, and a rising demand for energy which was not reflected in price. The study was a top-down effort where a total of 30 experts from 18 Member Committees and 9 international organisations supported a centrally located project team. This was a global, decentralised, and coordinated consultation approach. The energy system was not considered in isolation but was linked to the development of related systems, e.g. financial, economic, demographic, geological, atmospheric, etc., through a variety of quantified indicators. Two scenarios were drawn up based on levels of economic development. The key conclusions envisioned under these two scenarios are pertinent even today, more than 20 years later.

### Energy for Tomorrow's World (1993)

This energy scenarios study is perhaps WEC's landmark energy futures publication. It was aimed at policy makers, industry players, and was lucid enough for the general public. Its purpose was to "achieve changes in energy policy which bring about realistic and desired goals in the most effective ways".

Following the presentation of the *Global Energy Perspectives 2000-2020* study at the 14th World Energy Congress at Montréal, it was felt that the study's supply and demand projections were objective, and that a division of the world into five regions was needed in order to highlight regional perceptions and concerns. Additionally, a more detailed examination of the parameters relevant to future energy developments was called for. As a result of these decisions, a commission was set up to develop the next set of energy scenarios.

The commission set up to produce the 1993 study was guided by a board of 50 energy experts drawn from all over the world. The methodology adopted for this study was a combination of a top-down and bottom-up approach. The bottom-up approach was implemented through the formation of 8 regional groups which were led by regional coordinators and produced regional reports.

The report is divided into two sections, detailing the global and regional perspectives of the energy system leading up to 2020. The 1993 study places emphasis on the fact that "energy issues should be viewed in their total, global, social, and institutional,

as well as economic and environmental perspective". This has been interpreted by the commission as follows, "...what people demand is not energy as such but the services which energy can provide – heating, cooling, cooking, lighting, mobility, and motive power". The four energy "cases" (or scenarios) in this study represented different assumptions in terms of economic development, energy efficiencies, technology transfer, and the financing of development around the world.

The 1993 study was a landmark study since it divided future energy perspectives into two parts – global and regional. This helped serve as a balancing factor for global perspectives which could be checked against regional priorities, to determine whether envisioned goals were realistic in the set time frame and whether suggested solutions were workable at all.

## Global Energy Perspectives to 2050 and Beyond (1995)

This study was conducted by WEC in collaboration with IIASA (International Institute for Applied Systems Analysis). The scenarios detailed in this study are based on the scenarios produced in the 1993 study, *Energy for Tomorrow's World*. While the 1993 study looked ahead till 2020 using four scenarios, the 1995 study looks ahead till 2050 using six scenarios.

The study makes use of five factors which determine at a fundamental level, the future of energy systems. The first three factors are described as "human driving forces" – population

growth, economic growth, and technological change & energy intensity improvements. The remaining two factors account for nature's role – resource base, and the environment. World population is expected to increase across all scenarios, and most of the growth is expected to take place in the global "South"<sup>4</sup>. According to then available World Bank projections, the population of the world is expected to double from 5.3 billion (1990) to 10.6 billion by 2060. This study holds that beyond 2050 world population is expected to slow down and stabilise around 12 billion. Across the scenarios, a weak relationship between population growth and economic growth is expected. The economic take-off is visualised to be the mainstay of developing countries, with the world looking very different by 2100. Economic growth is projected to occur across all countries, in all regions around the world. However, the growth rates for OECD countries are expected to decline, while those of non-OECD developing countries mirror the trend experienced by OECD countries in the past.

The study makes explicit implications facing the energy industries. Coal faces an uncertain future ranging from an absolute boom to a total bust. This uncertainty is in part due to technological progress and in part due to environmental policy. That coal has the largest reserves of all conventional fossil fuels is its Achilles heel, both its strength and weakness. The oil industry appears to have a long future ahead of it. Oil products will continue to hold their own for decades to come due to their high energy density and existing infrastructure. Natural gas has the best prospects among the fossil fuels.

<sup>4</sup> Developing economies and economies in transition today.

Gas production at least doubles in all the scenarios, and could increase as much as four or five times. This however depends on the development of infrastructure ranging from production to storage, to re-gasification, to shipping. The potential for renewables is high, with a significant expansion across all scenarios. A model of slow initial growth, followed by rapid expansion is expected. OECD countries will dominate this market, and the South will only adopt these technologies if investment and technology transfer is made from the North. Finally, the range for nuclear development remains broad. What determines its fate will ultimately depend on when and how proliferation, waste, and safety concerns are resolved, and whether the climate issue will add additional weight to nuclear power's characteristic as zero carbon.

## Global Energy Perspectives (WEC-IIASA, 1998)

This study presents the output of the second phase of the WEC-IIASA scenarios study that began in 1993. The first phase, from 1993 to 1995, developed 6 scenarios which were detailed in the preceding study, *Global Energy Perspectives to 2050 and Beyond*. The second phase, from 1995 to 1998 involved an extensive review of the 1995 study, and also incorporated a regional outlook that lent further granularity to the global outputs specified in the first phase study.

The 1998 study details the implications of these scenarios on 6 areas: investments and financing, international trade, energy costs, technology, energy industries, and the environment.

### The study arrives at the following conclusions:

- ▶ World energy needs will increase.
- ▶ Energy intensities will improve considerably.
- ▶ Resource availability will not be a major global constraint.
- ▶ Quality of energy services and forms will increasingly shape future energy systems.
- ▶ Energy end-use patterns will converge, even as energy supply structures diverge.
- ▶ Technological change will be crucial for future energy systems.
- ▶ Rates of change in global energy systems will remain slow.
- ▶ Interconnectivity will enhance cooperation, systems flexibility, and resilience.
- ▶ Capital requirements will present major challenges for all energy strategies.
- ▶ Regional differences will persist in global energy systems.
- ▶ Local environmental impacts will take precedence over global change.
- ▶ De-carbonization will improve the environment at local, regional, and global levels.

## Energy for Tomorrow's World – Acting Now (2000)

This study revisited the original *Energy for Tomorrow's World* (ETW), 1993 study. In 1998 a WEC Commission Board was set up to take a fresh look at the conclusions drawn in the ETW 1993 study in light of developments over the past 7 years.

ETWAN (*Energy for Tomorrow's World – Acting Now*) focussed ten policy actions based on the outcomes of looking again at the ETW study and keeping in mind WEC's three core energy goals of accessibility, availability, and acceptability.

1. Governments should withdraw from directly managing energy markets and should reap the benefits of market reform and appropriate regulation.
2. All energy options should be kept open, viz. energy diversification, regional integration of energy systems, and enhanced trade in energy services. It should be kept in mind that market criteria must prevail in the development of all energy resources.
3. The political risk of key energy project investments must be reduced, for example, by contemplating the modalities of a global co insurance scheme.
4. Energy must be priced to cover costs and ensure payment. Removing energy subsidies and cross subsidies, especially in transport and electricity sectors, should be a priority, along with a consistent energy taxation system.

5. Greater energy efficiency must be promoted, using policies that use direct or indirect price mechanisms.
6. Financing partnerships linked to environmental goals should be fostered.
7. Affordable energy for the world's poor must be made a reality through economic and social policies aimed at equitable income distribution.
8. RD&D must be funded in the following areas:
  - a. Energy efficiency in production and end use
  - b. Renewables at the development stage
  - c. Cleaner fossil fuel systems
  - d. LWR nuclear plants
  - e. Superconductivity (to reduce transmission costs and increase storage)
  - f. Integrated decentralised energy systems
9. The advancement of education and public information.
10. The incorporation of ethics as a strong component in the governance of energy systems.

## Drivers of the Energy Scene (2003)

Drivers of the Energy Scene was the first report of the WEC Work Programme for 2002-2004. This study is different from all previous WEC energy future studies, in that it looks at the 'drivers' of the energy system and does not attempt to propose an energy model or projection about the future - but aims instead to stimulate a reflection on how the energy system has worked in practice, what the dynamics of the energy markets have been, and how energy availability has impacted GDP growth and accessibility. The study aims to determine whether the impacts of these drivers in the future would be consistent with past and present developments. It also seeks to highlight the important economic, social, environmental, and technological feedbacks. The report concentrates on oil and natural gas markets due to their importance in energy supply and pricing as a whole.

This study examines the role of energy in economic development, the evolution of the demand for increasingly sophisticated and acceptable energy services, and the availability of primary energy in terms of quantity and quality. They are studied under three groups of drivers: GDP, energy demand, and energy supply. The GDP driver is in turn studied under three components: demographic trends, institutional capacity, and technology. Energy demand is examined with respect to the trends experienced by services for electricity, mobility, and stationary fossil fuels.

### The study concluded the following:

- ▶ Based on economic trends and feedback over 30 years, annual GDP growth is posited to be substantially below 3% in comparison to most scenarios which assume an average GDP growth rate of 3% to 2030.
- ▶ The evolution of the energy scene is likely to be characterised by "stop and go" episodes in which the price of energy declines and then rises with positive and negative feedback effects on GDP growth and new technology.
- ▶ Real progress in providing commercial energy access for the poor will depend on national governments who will have to create an investor-friendly environment, promote regional trade, and foster links with the international community.

The study also raised the following questions it considered critical for the future of the world's energy security and sustainability:

- ▶ If hydrocarbon supplies do not grow much, what will the sources of new energy be, and how soon might they shift once again among oil, natural gas, coal, nuclear power, hydro, and other renewables?
- ▶ In a world of lower global economic growth and higher real energy prices, what is the precise nature of the climate change threat, and if it requires further action, what are the least cost carbon mitigation strategies, technologies or regulations to address it?

## Deciding the Future: Energy Policy Scenarios to 2050 (2007)

This study is the latest energy scenarios study produced by the World Energy Council. At the Sydney Congress in 2004, WEC decided to commission a new scenarios study with the following three important aims in mind:

1. The scenarios will be based on policy and on the “bottom-up” regional and specialist work of the WEC member committees.
2. The storylines developed in the study should be measured against the 3 WEC goals of energy ‘accessibility, availability, and acceptability’.
3. The scenarios developed should have a sufficiently long-term focus to underpin clear recommendations on policies and actions that will achieve targeted results by 2050.

Four key “pressures” have been covered in this study - supply pressures, demand pressures, environmental pressures, and political pressures. These pressures are collectively analysed with the application of two axes which describe the policy environment, viz. government engagement and cooperation/integration. Four scenarios result from the plotting of engagement and cooperation between governments, private sectors, regions, and nations. The study reflects on three aspects of government engagement in energy development: engagement, involvement, and interference. Cooperation and integration is examined in the form of government to government collaboration,

private-public partnerships, and company to company agreements.

The study was carried out across five regions – Africa, Asia, Europe, Latin America and the Caribbean, and North America with each region carrying out its own analysis. The Enerdata POLES<sup>5</sup> energy simulation model was used to provide the regional groups with a consistency check on their internal thinking. The model is top-down, aimed at projections, and is also aimed to a large extent at showing the need to reduce carbon emissions from energy use. During the study, the default assumptions made by the POLES model were modified based on feedback received from the regional groups. Several different alternatives were explored, e.g. price of oil, amount of nuclear power, to examine the strength of some variables.

The study ends with a set of policy recommendations which can be distilled into seven policy areas. Each region will have to promote energy efficiency, raise public awareness of the role of the transport sector, move towards setting a global price for carbon, work towards the closer integration of energy markets, assist in creating a new international framework for technology transfer, foster dialogue on security of supply and demand, and, construct taxation, legal, and commercial frameworks which lower investment risk.

<sup>5</sup> The model is a global simulation model with a year-by-year recursive simulation and partial equilibrium framework, endogenous international energy prices, and lagged adjustments of supply and demand by region. It has a hierarchical structure of interconnected regional and national sub-models.

## Section III

# The new WEC Energy & Strategy Scenarios to 2050: turning critical uncertainties into strategies for the future

The World Energy Council has decided to launch a new global energy scenarios exercise following the Congress in Montréal 2010. The last WEC energy scenarios, “Energy Policy Scenarios to 2050” were published in 2007. WEC’s energy scenarios are flagship publications, outlining WEC’s own vision of developments in global energy. They are meant to increase visibility for WEC and to allow the inclusion of new developments and insights into WEC thinking in a structured way. They are also a platform for engaging policy makers and energizing WEC Member Committees in regular discussions on topics of special interest, e.g. mobility, impact of renewable energies, water energy nexus etc. Finally, and most importantly, they are directed towards policy-makers in government and decision-makers in industry who are faced with choices in an uncertain environment. WEC Scenarios are also meant for the general audience who seek to inform themselves of potential risks and opportunities in the global energy system.

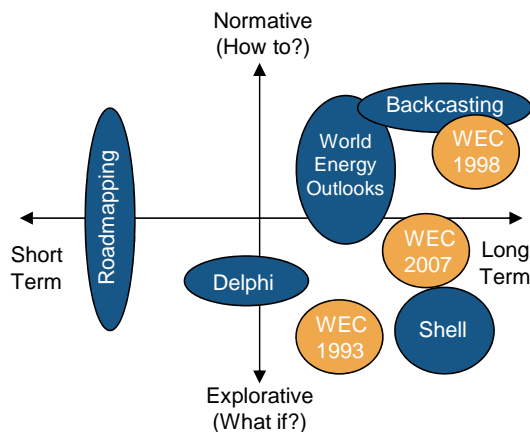
Energy systems, and critical uncertainties like transport and mobility, are complex issues whose resolution will be impacted by diverse factors. This high complexity, combined with uncertainty, constrains the predictability of traditional forecasts. By using scenarios to look into the energy future up to 2050, WEC can provide a significant contribution to the important discussions that have to take place currently between many different stakeholders, in order to better prepare us for the future. Extrapolating the past can be highly misleading, especially when looking for new approaches to effective energy policy and leadership. Drawing on the wisdom and experience of its global membership to develop a small set of distinct but

consistent scenarios – “plausible stories of pathways into the future” – the World Energy Council, in the interest of our sustainable energy future, wants to provide a tool for stake-holders to test the robustness of their own assumptions and to benchmark the potential outcome of policies and strategies in governments and industries.

### The WEC scenario approach

The biggest methodological challenge is often to find the right mixture of methods and approaches (see Figure 3.1). In foresight terms we can differentiate between qualitative (or explorative) and quantitative (or normative) methods/tools. Classical scenario exercises are mostly explorative in nature and ask the all-important “what if?” questions. Politicians and decision makers in business, however, often require answers to critical “how to?” questions, underpinned by some form of quantitative analysis. WEC studies have taken varied approaches over time, as described in the previous section, and considering its varied membership base, WEC’s customers will need a qualitative view on questions that make a difference, combined with quantitative analysis as a basis for discussion and dialogue. It is therefore the intention that the new WEC Scenarios will provide an explorative framework to widen perspectives and clarify potential options, and also to provide an analytical and quantitative assessment of those options based on an “open source” approach.

Figure 3.1



## The concept of “open source architecture” for quantification and modelling

In order to provide quantification, scenario stories need to be translated into assumptions and captured in a global energy model. It is our intention to build a web-accessible open source framework/global energy model, which can be used and expanded on by third parties like companies, governments, and experts. For this innovative approach to be made possible, the framework has to be structured applying modular architecture whereby third parties can develop and “dock” their own modules as they see fit.

The objective is not to have an extremely detailed energy systems model, but a big-picture model that connects relevant energy system variables and provides a fully transparent and comparable platform for dialogue. It is envisioned that an industrial partner with relevant experience in software development and providing web based solutions will be a critical partner during this phase of the project.

## Project organisation and governance

Energy foresight often tends to focus on expert opinions and future global pictures with little or no visible regional input from affected stake holders. WEC’s approach is different - it makes use of feedback from its members in 93 countries around the world (through regional groups), which is then

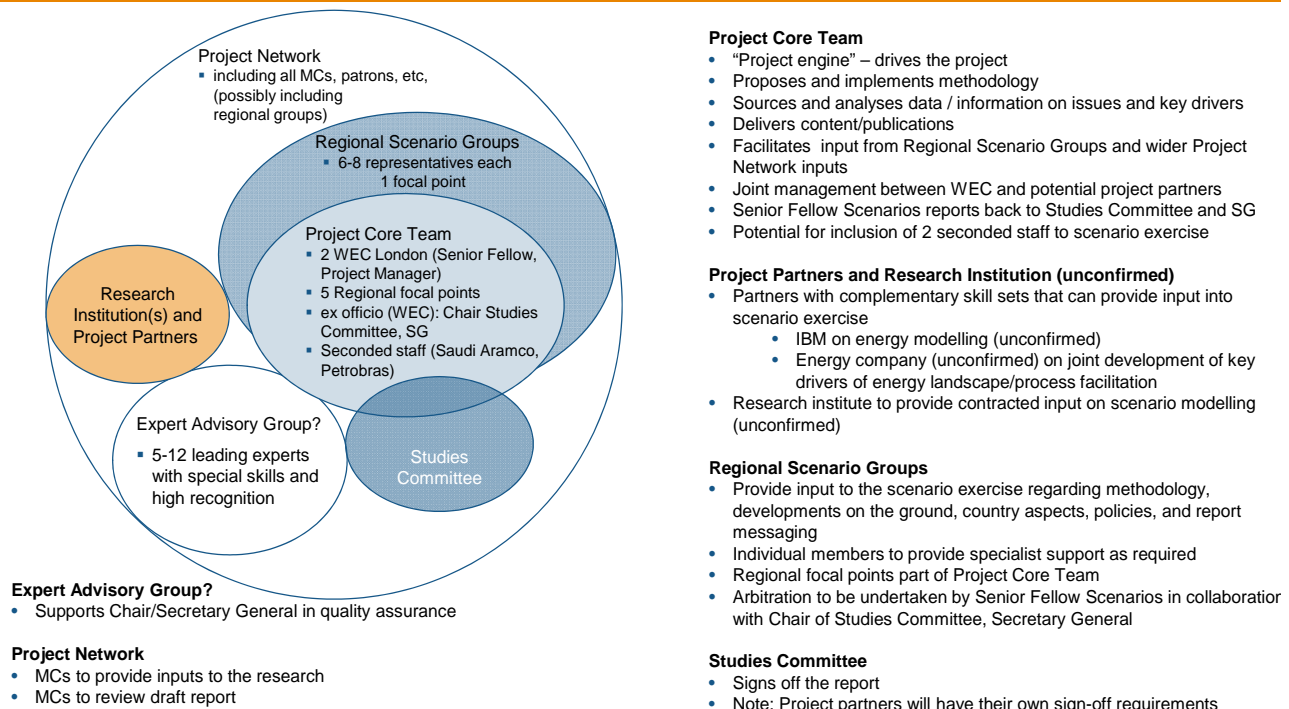
distilled into important messages that guide the development of scenario storylines. This bottom-up, multi-stake holder approach has been used for the development of the most recent WEC Scenarios, (2007) and ensures that critical uncertainties spread across the world are well represented. The diverse network of motivated and knowledgeable WEC members, who come together in regional groups to enable the transmission and exchange of knowledge, ensures that WEC scenarios are unbiased, holistic, well balanced, and most importantly, relevant for decision makers and stake holders. In a world of increasing complexity and uncertainty, this approach is a particularly great strength of WEC.

The new WEC Scenarios exercise will also be bottom-up, harnessing the knowledge embedded within the WEC network of Member Committees. The proposed governance and organisational structure (see Figure 3.2) has been kept similar to other flagship projects, like the Policy Assessment study. The project core team will consist of two staff members in London, supplemented by 6-8 regional members. It is planned that in each region, a scenario team is set up. WEC is also in discussion with potential industrial partners and research institutions to obtain additional resources for the scenario exercise. Energy companies, Saudi Aramco and Petrobras have already confirmed their participation and will commit staff resources to the scenario effort.

An Expert Advisory group will act as a sounding board for the project team, and will consist of senior WEC members that have been involved in some of the previous scenario efforts, plus potentially, some external experts.

Figure 3.2

## Proposed governance and organisation – new WEC Scenarios exercise



## Process and project timeline

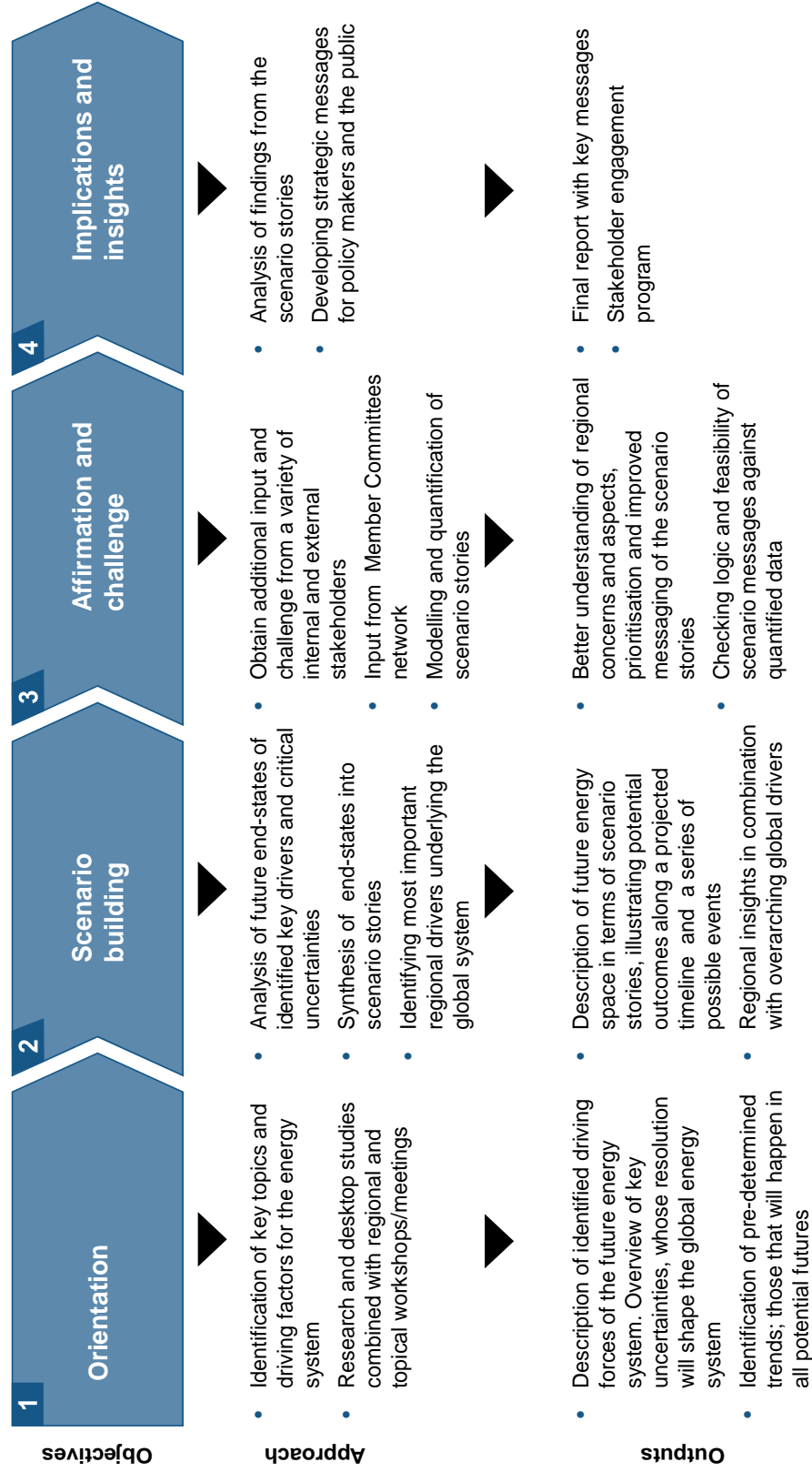
The scenario creation process will follow the steps of orientation and research, scenario building, affirmation and challenge, and the final step of looking at implications and strategic options (see Figure 3.3). In the beginning, the core team will frame the scenario exercise and identify the key questions that need to be addressed ("what is important"). Once that is agreed by the WEC Studies Committee, the main predetermined trends and critical uncertainties and drivers will be identified. The project team will then analyze interactions and describe the potential future end-states of those key drivers, which together, in logical combinations form the scenario space.

It is planned to hold at least five scenario workshops and several meetings on topics of special interests and concerns for WEC members, like urbanization and mobility, access to energy and water/energy linkage etc. The workshops and meetings will be evenly spread across WEC regions and special topics will be chosen based on current significance for the region. This will allow for the deepening of regional insights and options for action. The chart below (see Figure 3.4) shows

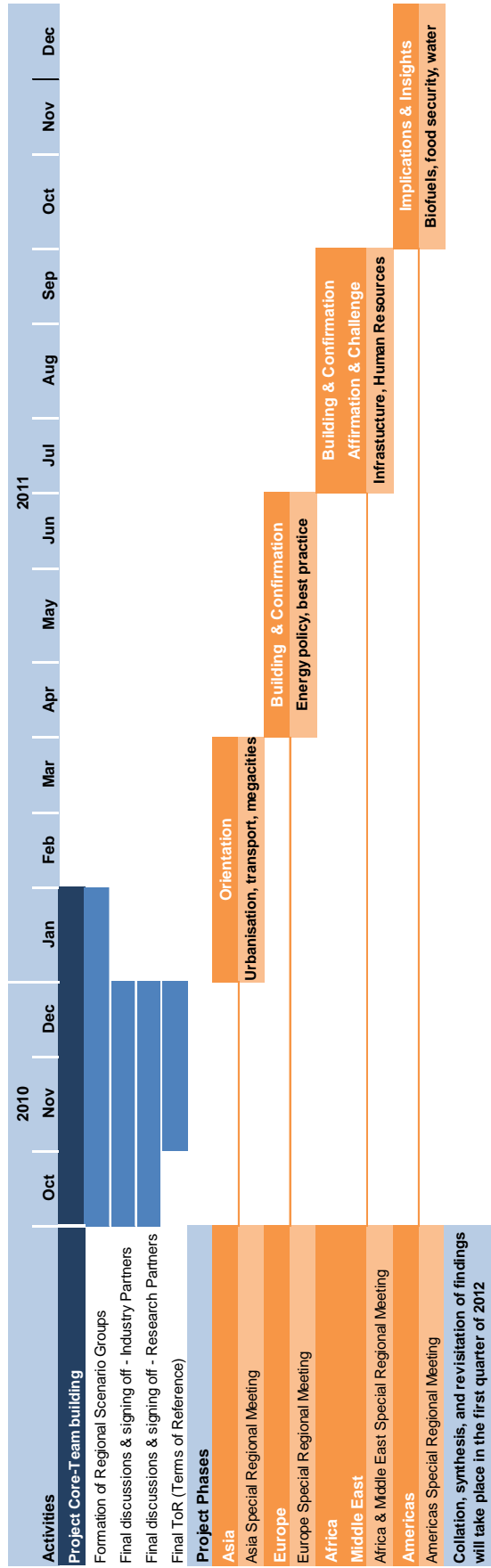
a tentative timeline for the scenario process following the Montreal Congress.

It is also important to note that at the end of each stage, the WEC Studies Committee will be apprised of the project's progress. This will ensure that the project is on course and is in-keeping with WEC guidelines and policy.

**Figure 3.3**  
Proposed steps of scenario creation for the new WEC Scenarios exercise  
- comprising four stages



**Figure 3.4**  
**Project Timeline**



Scenario building stages  
Special Regional Meeting

This timeline is for illustrative purposes only and should not be taken as final.

## Section IV

# Embedded Reality: Potential impact of recent headline events on energy

Since the publication of the EPS 2050 Scenarios in 2007, major events have occurred that may have a significant impact on the way the future of energy unfolds. In this section we want to briefly review the significance of four major events, namely:

- ▶ Copenhagen and its consequences for industry and global climate policy
- ▶ The impact of the 2007/08 financial recession on energy investments
- ▶ The emergence of unconventional gas and its impact on global gas markets
- ▶ The BP Gulf of Mexico oil spill and its impact on the oil & gas industry

The chosen topics are only a small and illustrative sample of the type of uncertainties we are facing in the energy space on a regular basis, and are not meant to represent all or even the most important factors determining potential pathways into the energy future. Those will be the subject of much deeper and wider analyses work, as outlined in previous sections of this paper. They are examples, however, of the type of uncertainties whose resolution is best dealt with in the form of scenarios.

### Copenhagen and its consequences

The multilateral negotiating process at the Copenhagen conference failed to produce an agreement and the conference was deadlocked when the heads of governments arrived for its final

two days. Unprecedented for such an international conference, an accord was produced by a series of bilateral and multilateral negotiations by the leaders of 5 countries (United States, China, India, Brazil, and South Africa). It was then endorsed by most – but not all – parties of the UNFCCC, with 5 countries (Bolivia, Cuba, Nicaragua, Sudan, and Venezuela) challenging the accord and only “taking note” of it.

Not only did the negotiating process break from the past, so did the accord’s architecture. It abandons the top-down Kyoto-style targets and timetables enforced through a legally binding agreement. In their place are now unilateral pledges of emission reductions and mitigation actions that will be verified through a mixture of domestic and international compliance measures. The Harvard Project on International Climate Agreements has called this a “<sup>6</sup>portfolio of domestic commitments approach”. It is also similar to the bottom-up, “pledge-and-review model” that Japan had proposed before the Kyoto conference and the “schedule approach” recently proposed by Australia. It also very importantly produced pronouncements on energy security, poverty, and the economy, for the first time in the UNFCCC process.

Although Copenhagen did not result in a legally binding agreement, the ensuing developments have shown that climate change is firmly on the global political agenda. Industry will be challenged

<sup>6</sup> Robert Stavins, “A Portfolio of Domestic Commitments: Implementing Common but Differentiated Responsibilities”, Belfer Center, Kennedy School of Government, Harvard University, 19 October 2009.

to reduce their own emissions, as well as understand key issues, such as adaptation and geo-engineering that will impact the public and private sector.

The accord includes, as an aspirational goal, the limiting of global warming to below 2 degrees Celsius and commits countries to take action to meet this objective. It accepts the need for enhanced action on adaptation to climate change, with developed countries committing to provide adequate financial and other kinds of support to developing countries. The accord also recognises the importance of 'Reducing Emissions from Deforestation and Degradation' (the so called REDD-plus process), and the need to provide incentives for such actions in developing countries. For Latin American and the Caribbean, this is a critical issue, considering that deforestation accounts for a large percentage of regional emissions, and countries such as Brazil and Guyana are key negotiators on these issues. The countries of Latin America, combined, are responsible for just five per cent of global emissions of carbon dioxide, due in large part to a greater dependence on hydroelectricity over coal-fired plants, but the region is one of the most vulnerable to the detrimental effects of carbon emissions. The region's power sector generates 40 per cent less CO<sub>2</sub> emissions per unit of energy than the world as a whole. Taking in account the fact that these emissions are 74 per cent less than those of China and India, and 50 per cent less than

the average for developing countries, this region is already at the forefront of low-carbon growth<sup>7</sup>.

The core of the accord relates to country commitments on mitigation targets and actions on climate financing. Specific commitments by countries have been submitted to the UNFCCC by end-January 2010. Developed countries, including the transition economies of Central and Eastern Europe, will commit to emissions reduction targets from base years that they specify. Developing countries will commit to implementing mitigation actions but without a quantitative emissions reduction target.

The emission reductions of developed countries will be subject to measurement, reporting and verification (MRV) according to UNFCCC guidelines yet to be established. The actions of developing countries will be subject to domestic MRV, but subject to international consultation and analysis. In addition, developed countries pledged USD 30 billion of new and additional resources approaching between 2010 and 2012 to support "fast-start" adaptation and mitigation actions. Conditional on meaningful and transparent mitigation actions by developing countries, developed countries also committed to the goal of mobilising USD 100 billion annually by 2020 to address the needs of developing countries.

Africa in particular is highly vulnerable to the effects of climate change. In our lifetimes, climate shifts will likely inflict severe damage to human welfare in

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<sup>7</sup> Laura Tuck, Director for Sustainable Development Latin America, World Bank, "Latin American interests are key at Copenhagen", Miami Herald

a continent already battling with entrenched poverty, degraded ecosystems, and civil strife. More than 40 percent of the continent's inhabitants live in extreme poverty and 70 percent of them live in rural areas, depending largely on agriculture for their livelihoods. Climate change will affect farmers from the Sahel, to the highlands of Lesotho. Rising temperatures could lead to new epidemics of mosquito-borne diseases in countries such as Kenya and Uganda. Storms and floods are likely to intensify, wiping out vital infrastructure and housing in Madagascar, Mozambique and many other coastal areas. Any concerted effort to tackle climate change in Africa must also focus on poverty reduction and the UN's Millennium Development Goals.

Further, Africa's potential to help tackle climate change is both largely unrecognized and unrealized. For instance, thanks to the forest cover and rich topsoil found in many countries in Africa, the region is a major carbon storehouse. If properly reformed, the Clean Development Mechanism (CDM) and other carbon market schemes could play a significant role in funding a broad portfolio of renewable energy and energy-efficient options in Africa. These could represent more than 180 gigawatts of additional power generation. That is more than twice the region's total existing capacity<sup>8</sup>.

<sup>8</sup> Tegegnetwork Gettu, UN Development Program, „Copenhagen: The Africa Dimension“, Policy Innovations, Carnegie Council

### Assessment of Copenhagen<sup>9</sup>

The Copenhagen Accord achieved three important steps forward:

- ▶ Provision for emission mitigation by all large emitters, blurring the distinction between developed and developing countries as outlined in the Kyoto Protocol and committing developing countries to mitigation actions.
- ▶ Establishment of a transparent framework for evaluating countries' performance against their commitments, albeit differentiated between developed and developing countries.
- ▶ Unprecedented flow of resources to developing countries from developed countries for adaptation and mitigation actions, including REDD-plus.

While the commitments on emission reductions by developed countries and on mitigation actions by developing countries remain to be specified, they are likely to fall well short of what science indicates is needed to limit the rise in global temperature to 2 degrees Celsius. According to ClimateActionTracker.org<sup>10</sup>, the portfolio of existing

<sup>9</sup> See also David Doniger, „The Copenhagen Accord: A big step forward“, Natural Resources Defense Council, 21 December 2009, Christian Egenhofer and Anton Georgiev, „The Copenhagen Accord, A first stab at deciphering the implications for the EU“, Centre for European Policy Studies, 25 December 2009, Sarah Ladislav, Center for Strategic and International Studies, 11 January 2010, and Robert Stavins, „What Hath Copenhagen Wrought? A preliminary assessment of the Copenhagen Accord“, Belfer Center, Kennedy School of Government, Harvard University, 20 December 2009.

<sup>10</sup> Nilas Höhne *et al.*, „Copenhagen Climate Deal – How to Close the Gap?“ Briefing Paper, Climate Analytics and Ecofys, 15 December 2009.

domestic commitments would lead at best to a global temperature rise of 3.2 degrees Celsius by 2100.

Lastly, the accord is a non-binding political document rather than a legally binding treaty. Moreover, there are no sanctions specified, if countries are found to fail to meet their commitments.

## The impact of the financial recession on energy investments

The size of the economic shock and its transmission through trade and financial links across countries worldwide was much greater than expected. This reflects not only the unusually severe financial crisis, but also the potential role of global media and information technology in communicating the collapse in consumer and business confidence and in accelerating output cuts by producers.

Variations in the pace of economic recovery are significant, with the US and China emerging relatively quickly from the downturn, with the Eurozone and possibly India lagging, while the economies of the former Soviet Union and Latin America (except Brazil) may remain depressed for longer. Budgetary stress as a consequence of the recession seems most acute in Venezuela, Mexico, Iran, Iraq, Nigeria and Angola, with Kazakhstan and Russia also facing abrupt cutbacks in external financing.

The extraordinary policy responses by governments and central banks have achieved significant short-run success which comes at a very high cost. The associated risks of that continue to loom large. Renewed financial stresses could dampen or derail recovery. Moreover, governments and central banks must exit from their extraordinary macroeconomic stimulus and financial-sector supports, and the window to do this successfully will be narrow and difficult to judge.

The impact of the crisis on underlying global trend growth rates also remains uncertain. Tighter financial regulation and greater risk aversion will be some obvious consequences of the crisis. Somewhat less likely, policy makers could seek to protect domestic industries against a prolonged downturn by erecting trade barriers, maintaining competitive exchange rates, and running external surpluses. All in all, compared to the current popular sentiment, recovery seems relatively fragile and risks appear slanted to the downside. The negative implications of further/renewed economic crisis would be very serious, especially for developing countries. As seen in previous global recessions, increased protectionism by developed countries, rising external interest rates, decline in the inflow of capital, and an overall deterioration in the terms of trade, will especially worsen the poor economic conditions in places like Sub-Saharan Africa, for example. In most African countries the vulnerable groups tend to be most affected both by the impact of recession and reduced economic growth and crucially by the consequences of economic recovery measures.

Also many factors supporting the growth of economies in Latin America in recent years, such as access to capital markets, foreign investments, remittances from emigrants, the price of natural resources, depend on the health of the global marketplace. Countries that are dependent on commodities are being severely affected. Nations such as Venezuela, Argentina, and Ecuador are not only heavily reliant on commodities but also unable to issue debt to raise money, and are already responding to the adverse conditions with nationalizations and controls.

Given the poor medium-term outlook for public finances and public services for many states there is substantial scope for political controversy in the years ahead. In this regard, not all countries are in the same place, and a wide spectrum of political and societal developments can be expected over the coming years as a consequence of recession and recovery measures. There will be value in responding effectively to emerging regulatory regimes associated with energy efficiency and greenhouse gas emissions not only through capital investment but also through trading/arbitrage opportunities. In general there will be a combination of anticipated market and political volatility with the increased capital intensity of many energy infrastructure projects.

The recession has shifted global energy demand backwards by some 2-3 years, with overall 2008 demand levels expected to return by 2010-2011. It has also brought uncertainty in expectations for long term growth in energy demand, as trend economic growth is expected to be structurally lower post-recession.

Energy industry responses have been mixed, with some companies upholding their investment levels, while others have scaled back, notably the smaller and some state owned companies.

Overall, the unprecedented turbulence of the past year may have “reset” many of the parameters shaping the future energy landscape.

## The emergence of unconventional gas

North American natural gas prices in 2009 were the lowest since 2002 due to a coincidental fall in demand by close to 2% as a result of the financial recession, and also due to a surge in US domestic gas production. The idea that US gas production had passed its peak was thereby proven false by a wide margin, bringing a renewed focus on North American gas and forcing the market to re-evaluate its assumptions about the relative roles of domestic and imported gas (LNG) in the US gas market in the years to come.

Growth in gas output has been driven predominantly by unconventional sources (shale gas, tight sands, and coal-bed methane (CBM)) where there has been extensive developmental activity over the past years as a result of higher prices and technological advancements. Significantly more gas may be available than was apparent a few years ago, potentially supporting historical market growth rates through to 2030. Until recently, many of these unconventional sources were either uneconomic or marginally economic- recent announcements of new shale gas plays are more of a commerciality declaration

rather than a discovery of a new play. The future outlook for how these existing and emerging unconventional gas plays will evolve is not a simple story, it is one that could progress on several different fronts in response to price, technology, and regulatory changes.

With growing confidence in the assumption that the unconventional gas resource base in North America will be able to provide sufficient indigenous supply to fulfil demand, Henry Hub gas prices are likely to be determined by local supply-demand balances, underpinned by the average cost of marginal long run supply. LNG imports will be a price-taker in such a market and cargoes could become available for supply into Europe, providing an alternative to Russian gas imports.

The growth in unconventional gas has been uneven, with shale gas production growing much faster than tight gas or coal-bed methane (CBM). In part, this reflects the relative maturity levels of three plays in the United States, with tight gas and CBM being more mature than shale gas, but also the impact of the application of different types of subsurface technology. Well productivity gains from new investment are highest in shale gas, whereas in tight gas and CBM, subsurface technology improvements tend to reduce costs rather than increase production volumes<sup>11</sup>.

The highest uncertainty in global gas has to do with the potential growth of unconventional production beyond the favourable conditions of North America, where longer-term resilience still needs to be

demonstrated. Some of the success can be attributed to the lack of any significant risk from regulatory oversight or resource availability, which isn't necessarily replicable in new shale plays in other basins abroad.

While, in general, there is still a significant unconventional gas resource base available, there are risks to future production growth from currently existing sources or those that are emerging in different basins which could make the future look a bit different. The main risks for the different unconventional gas plays are becoming increasingly apparent:

- ▶ Water disposal volumes in CBM developments
- ▶ Environmental and regulatory concerns about impact of closer well spacing in tight sands gas developments
- ▶ Resource access in shale gas developments

Despite some of the risks above, the US onshore gas supply outlook is promising, although the exact trajectory for unconventional gas will depend on the strategies companies choose to employ in different plays in addition to regulatory challenges. Price support will likely continue for the next several years. It is most likely that future production from existing unconventional gas plays will be more linear rather than following the exponential trend of the last five years. Washington based energy analysts, PFC Energy, estimate that onshore gas production in the United States will continue to grow through the beginning of the next decade as a result of high prices and technological

<sup>11</sup> For more information, please see the WEC Congress report on Shale Gas.

advancements. Driving this is not just the success in North America, but the growing belief that conditions for unconventional gas are also ripe in areas in Europe, China, and Australia. The scale of the prize is difficult to estimate, however technically recoverable volumes could be very significant. Non-US companies have focused on a number of 'hotspots' such as Queensland (Australia), Poland (Europe), and China. In Queensland, local unconventional gas players and multinationals are teaming up with more than 5 LNG schemes in planning, whilst in Europe, where only 2-3 small players existed 5 years ago, now over 30 companies are chasing unconventional gas opportunities.

## The BP Gulf of Mexico oil spill and its consequences

It has been several months since the Transocean Ltd. Deepwater Horizon oil rig exploded on April 2010, killing 11 workers and unleashing a torrent of crude oil into the Gulf of Mexico: termed by many as the worst environmental disaster to ever occur in the United States. President Obama even extended a ban on new deepwater permits and exploration in the Alaskan Arctic for six months following the accident. It is a couple of weeks since BP eventually succeeded in capping and plugging the oil flow and attention has now moved to assessing the permanent damage above, and more importantly, below the surface of the Gulf of Mexico.

While BP has adequate liquidity and financial headroom to meet the immediate costs of the clean-up exercise and initial compensation

payments, it is still too early to estimate with any degree of confidence, the full future impact on BP from the spill. The causes of the incident will be the subject of litigation involving the well's owners and various contractors, and will take several years to play out. The effectiveness of BP's actions to mitigate the environmental impact of the spill will be important in the final assessment of the incident and in minimizing any long-term reputational and financial damage to BP.

But what about the rest of the oil & gas industry who depend on the Gulf of Mexico for their success? Although many companies say it is too early to predict their damages, it is clear that companies are bracing for a variety of losses. There is wide spread expectation that the spill could prompt new regulations, with unpredictable results. It is too early to tell how government agencies will respond to the incident in detail, and whether changes in laws and regulations concerning operations in the Gulf of Mexico are forthcoming, including the ability to obtain drilling permits. However, it seems very likely, that in light of recent calls from government officials and federal agencies for increased inspections of deep-water drilling operations in the Gulf, together with a potential extension of the moratorium that substantial cost increases and delays in offshore exploration can be expected. Stricter regulation may add \$5 a barrel to long-term oil contracts, according to Deutsche Bank, while a one-year worldwide delay in deepwater drilling may cut as much as 500,000 barrels a day from 2013 supply levels, according to Bernstein analysts.

Another aspect will be a general increase in insurance premiums for offshore operations, potentially leading to increased difficulties for the industry in obtaining insurance coverage on economically manageable terms. What is much more difficult to assess is the indirect impact this incident will have on the overall role of oil, and to a lesser extent gas, in the energy mix of the United States and globally. It is undoubtedly true that significant reputational damage has been suffered, not only by BP, but by the oil industry as such. It looks likely to become an iconic event, a touchstone and rallying flag for opposition to the oil industry across a wide series of fronts and issues for years to come.

## Section V

# Messages and their significance

### Key messages from WEC Studies (2008-2010 study cycle)

In addition to reviewing the potential impact on energy from recent external events, the key messages of in-house WEC studies were reviewed and are listed below:

#### Pursuing Sustainability: 2010 Assessment of country energy and climate policies

- ▶ The scale and complexity of the energy sustainability challenge is increasing. This in turn, has constrained the pursuit of energy sustainability measures.
- ▶ The adoption of the environmental agenda is patchy across OECD countries, while in non-OECD countries, the take-up is still in early stages.
- ▶ Unstable market conditions and national priorities have lent themselves to increasing volatility in policymaking and policy implementation.

#### Water for Energy

- ▶ Agricultural practices and measures are placing stress on the supply of useable water. This will impact the needs of energy production and conversion.
- ▶ Increasingly attractive unconventional sources of energy (shale gas, oil sands) have a large water footprint. Policy makers must ensure adequate water reserves for maintaining current levels of human activity before committing to unconventional energy projects.

- ▶ Asia represents the greatest challenge for water planners, with its growing population which is embarked on a path of industrialisation. The potential for hydropower is untapped in many areas and should be explored.

#### Biofuels: Policies, Standards and Technologies

- ▶ The impact of biofuels on world agriculture needs to be examined in a holistic light. The UNFAO estimated that in 2008, biofuels accounted for approximately 10% of the food price increases. Other factors like poor agricultural management, distorted agricultural markets, and lack of production and investment capacity have detrimentally affected the world food situation.
- ▶ Although land devoted to fuel production could reduce land available for food cultivation, second generation biofuels, viz. lignocellulosics, which are based on the conversion of cellulosic resources like grasses, sawdust and fast growing trees will diminish the requirement for arable land dedication.
- ▶ Biofuels cannot transform the transportation sector by themselves. Broader measures will be needed to transform the transport sector.

#### Energy and Urban Innovation

- ▶ Rapid urbanisation is taking place around the world. In the next 20 years, the equivalent of seven cities with 10 million people will be added each year.
- ▶ In spite of mature technical solutions which can combat the negative effects of uncontrolled urbanisation, consideration needs to be given to

building stock, climate, urban shape, cultural behaviour, and financing possibilities.

- ▶ Subsidies for the poor have to be subsidised for a long time if access rates to urban services are to improve.

#### Logistics bottlenecks

- ▶ From a logistics point of view, the most important fuels are those whose volumes need to be transported over long distances, viz. coal, oil, and gas. These three fuels in terms of total volume carried will dominate through to 2050.
- ▶ Of critical importance, is the proper management of oil movement, natural gas and LNG movement, and electricity movement. It is imperative that significant investments should be made in infrastructure, e.g. oil/gas pipelines, tanker networks, and smart grids. The figures show an average annual outlay of \$21.4 billion.

## Significance of external/internal messages to WEC

Many implications and indicators from the small sample of external headline events reviewed and many messages from current WEC studies point to a period of high uncertainty, and potential transformation for parts of the energy space. Economic, political and social events are unfolding that will impact energy in ways we cannot easily predict. If one also takes into account the expected rapid diffusion of technology in areas like energy efficiency gains or renewable energies, it more than anything else, stresses the need to take a fresh look at the critical uncertainties we face in the

pursuit of supplying energy in a sustainable way to populations worldwide. The new WEC scenarios exercise will be an important tool, allowing us to shed new light on how to navigate the rapids of the coming years.

It is the stated intention of the scenario project to provide strong regional perspectives in close co-operation with the relevant WEC member committees, for example, to take note of the suggestions<sup>12</sup> received from WEC Member Committees with regard to focus areas, viz. energy and mobility – Sweden, Switzerland, Romania, Austria, Argentina; sustainable biomass technologies – Brazil; effect of the economic crisis – South Africa.

Finally, it is hoped that this new energy scenarios work will provoke and stimulate debate and discussion around emerging uncertainties and the potential solutions for meeting the energy demands of the world in a sustainable manner.

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<sup>12</sup> Studies Committee Report, Beijing 2010



## Member Committees of the World Energy Council

Albania	Indonesia	Poland
Algeria	Iran (Islamic Republic)	Portugal
Argentina	Ireland	Qatar
Australia	Israel	Romania
Austria	Italy	Russian Federation
Belgium	Japan	Saudi Arabia
Botswana	Jordan	Senegal
Brazil	Kazakhstan	Serbia
Bulgaria	Kenya	Slovakia
Cameroon	Korea (Rep.)	Slovenia
Canada	Kuwait	South Africa
China	Latvia	Spain
Colombia	Lebanon	Sri Lanka
Congo (Democratic Republic)	Libya/GSPLAJ	Swaziland
Côte d'Ivoire	Lithuania	Sweden
Croatia	Luxembourg	Switzerland
Cyprus	Macedonia (Republic)	Syria (Arab Republic)
Czech Republic	Mexico	Taiwan, China
Denmark	Monaco	Tajikistan
Egypt (Arab Republic)	Mongolia	Tanzania
Estonia	Morocco	Thailand
Ethiopia	Namibia	Trinidad & Tobago
Finland	Nepal	Tunisia
France	Netherlands	Turkey
Germany	New Zealand	Ukraine
Ghana	Niger	United Arab Emirates
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