

## Chapter 2:

# Using scenarios to explore responses to restricted fossil energy supplies

We decided at the start of the project not to forecast the impact of changing energy prices on Ireland, but to use scenario planning to develop a number of different possible futures. Scenario planning is a technique for exploring the future that creates several plausible but challenging alternative futures rather than making a single prediction. It has been used by commercial companies since the 1970s after Shell had used the technique and, as a result, was the only oil company prepared for the oil shocks of that decade. We adopted scenario planning because:

- **A prediction is (almost) never right.** The unexpected always happens and the assumptions, conscious and unconscious, that we can apply today may not apply tomorrow. At the end of the last century, London could see no solution to the ever increasing amounts of horse manure on the roads, and then came the motor car. This highlights the difficulty with using forecasts. We carry forward the current trends, problems and constraints and apply them to the future. Alternatively, we can look at the future and carry out backcasting, asking how we can get to where we want to be, rather than how will we be carried along by the tide.
- **Scenarios are versatile.** Scenarios can be used not only to prepare plans for the future, but to check existing plans for robustness. Will a plan work in more than one scenario or will it fail if any of the underlying assumptions change?
- **It is difficult to get consensus for a prediction.** You can either agree or disagree with other people's predictions - and we usually disagree. Scenario planning is about building plausible futures, a much less contentious task because we only need to agree that a scenario is possible to be able to use it. We don't even have to agree that it is likely. If we can develop flexible plans that will work with multiple scenarios, when the unexpected does happen, there is a better chance that the plan can be adapted to the new circumstances.
- **Good scenarios challenge one's thinking and stimulate discussion.** The human species has spent most of its history telling stories rather than looking at graphs and spreadsheets. As a result, the implications of a rich story about the future can be more easily understood by most people. It is surprising how much information a scenario can convey in a few words. For example, the following classified advertisement can tell us a lot about what 2016 might be like under a particular scenario:

*For Sale: 4x4 with axle suitable for conversion to wind turbine.*

This can be interpreted as:

*Increases in the price of transport fuel have meant that vehicles with high fuel consumption are no longer in demand and it is becoming difficult to sell these vehicles. However, with increasing prices of home electricity, there is a boom in DIY windmills. A component of these windmills is the back axle of a car.*

Developing an internally consistent scenario forces one to **think about the impact of change, not just on one industry, but on the whole economy**. There is a tendency at present for each industry to think that it will change by adopting new energy sources, new production methods etc. - but that its customers and suppliers will continue just as they are. This of course, is not the case. Change in one area stimulates change in others and so an iterative thought process is required to explore the impact of the initial change and the changes brought about by those changes and so on.

For example, in our interviews we found that the road transport industry hopes that moving to biofuels will allow it to continue operating as usual, though with higher prices. But at the same time, its customers, looking at the increased delivery charges, can be expected to start to keep larger stocks so that they can take fewer deliveries. They will also turn to cheaper methods of delivery, such as transport by ship, again taking few larger deliveries to compensate for longer lead times. This means the road hauliers will need fewer but larger trucks to operate most efficiently and will make shorter journeys with more goods going by sea and rail. A business opportunity will be created for warehouse expansion as more goods are being stored. This is not necessarily the way the future will pan out, but it shows the knock-on effect of change.

## **How our scenarios were developed**

In a scenario planning process, it is customary to choose two key areas of uncertainty related to the area of study and to look at the extreme cases of each. This produces four scenarios. Accordingly, our four scenarios were chosen because they represent the extremes of key uncertainties in relation to Irish energy prices. Timing was one key uncertainty. While it is certain the oil and gas production will peak at some time, there is disagreement about when. In 2005, when these scenarios were written, the government, on the advice of the International Energy Agency (IEA) were working on the basis of a peak in 2030, while oil geologists, such as Colin Campbell were predicting 2007-2010. While the timing of the peak is still a contentious issue, it now seems unlikely that oil and gas prices can remain stable and low for the foreseeable future.

The other key uncertainty was the way the Irish government and the international community would respond to the knowledge that the supply of oil was going to peak some time in the future or had already done so. Would they be proactive or reactive? For example, if a government accepted the IEA position that it had until 2030 to prepare for oil peak, would its attitude be proactive "It's taken over a century for us to reach our present level of dependence on oil, so a quarter century doesn't seem very much time to get that dependence drastically reduced, particularly as gas supplies are going to be tight, too, and the use of coal needs to be restricted for climate reasons. Moreover, as the power stations, transport infrastructure and buildings we are planning now will still be in use when the shortages begin to bite, we need to make the right choices as a government and to give households and businesses an appropriate combination of incentives and restrictions so that they make the right choices too"? Or would it be reactive and say "Twenty-five years is a long time. Who knows what will happen then? We can't afford to distort the Irish economy on the basis of a projection like this. Some new source of energy might turn up.

In any case, we'll all be long gone if that day arrives. We can't distort competition and reduce the growth rate. We have to let things run on as they are"

If oil peak is reached in the next four or five years, would the government be proactive and say: "A scarce commodity as vital as oil cannot be left to the market to distribute. If that were to happen, the rich, the people who have boosted their productivity by using oil, would be able to buy it all up, leaving the poor with no heating, no lighting and no energy for production at all. We need to work with other countries to bring about an international agreement for sharing the oil out so that prices do not go through the roof, impoverishing millions and destroying the world economy." Or would its reaction be: "Global central planning is not only impossible, but it's also very inefficient. We've got to leave things to me market to sort out. That might be painful, but it's the only way."

These four cases gave us our four scenarios in each of which we took it as given that

- Demand for energy would increase other things being equal
- Ireland has limited local supplies of fossil fuels and must import an increasing proportion (90% in 2004)
- Fossil fuel supplies are finite

	REACTIVE	PROACTIVE
Oil Peak 2030	<p><b>Business As Usual</b> Growth at all Costs Ireland continues to use current assumptions until close to peak</p>	<p><b>Enlightened Transition</b> Ireland actively prepares by encouraging efficiency and ensuring energy prices increase predictably.</p>
Oil Peak 2007	<p><b>Localisation</b> Market determines allocation of remaining oil and gas. Unstable economy. Back to the land.</p>	<p><b>Fair Shares</b> Introduction of controlled distribution of remaining oil and gas. Economy slow but stable.</p>

We then used the ECCO model described in the next chapter to determine the economic characteristics of each of these scenarios and to write a rich story about Ireland in 2016 for each of them. The stories include details of what government policies would be in place, what we would be eating, watching, driving, where we would be living, what we would be working at, and what we would be buying and selling.

If we have developed these scenarios well, you will find them:

- Plausible
- Uncomfortable
- Very different from each other
- Very different from today

- Vivid pictures of what the future might be like

More information about them can be found at <http://www.energyscenariosireland.com>

## Assumptions

Bad plans are usually the result of bad assumptions, whether conscious or unconscious. The conscious assumptions underlying the scenarios are that, during the next 50 years, there will be

- No significant and rapid climate change
- No significant wars or increase in terrorism
- No worldwide economic collapse/depression not related to higher energy prices
- No significant action to reduce carbon emissions.

We also assumed that

- The market will not signal long term changes
- Ireland is part of the world economy and cannot act unilaterally to any great extent

The first three assumptions were made, not because we think they will not happen, but because scenarios cannot contain too many significant variables. We will examine each assumption in turn.

**No significant and rapid climate change.** While the case for accelerating climate change due to man-made greenhouse gas emissions is now very strong, it is very unclear about when and what the impact will be. There is a very real possibility that the Gulf Stream could switch off, returning Ireland to a climate like that of Nova Scotia and that this could happen over a period of a decade (see <http://www.wunderground.com/education/abruptclimate.asp>). This would obviously have a profound impact on all our lives. The impact of this, or other types of rapid and significant climate change would lead to an Enforced Localisation type scenario. (ref Stern Report)

**No significant wars or increase in terrorism.** The possible scenarios are endless but to give a feel for scenarios that included increases in insecurity in the world, look at the Shell scenarios ([www.shell.com/scenario](http://www.shell.com/scenario)). Again, for Ireland, war and terrorism is likely to lead to an Enforced Localisation type scenario.

**No worldwide economic collapse/depression not related to higher energy prices.** The markets of the world have, despite many dire predictions, managed to keep the economy of the world on a relatively even keel since 1945. This may continue, but there are no

guarantees especially given the imbalances in the US economy. An Enforced Localisation scenario would again emerge if a depression happened.

**No significant action to reduce carbon emissions.** While we could make this assumption with confidence in 2005, the greater urgency being expressed in 2006 means there is a small possibility of that stringent steps will be taken to control emissions in the post-Kyoto period. This would fit well with an Enlightened Transition/Fair Shares type scenario.

**The market will not signal long term changes.** Modern markets are driven by dealers trading in order to achieve short term gain. They have no incentive to take the long view. Even in 1914, the markets were not looking ahead.

One of the most interesting financial lessons of the run-up to World War I is that, contrary to today's popular history, no-one saw it coming. Second, when the apocalypse became apparent, the financial markets - rather than reacting quickest - actually went into a collective state of denial for weeks.

See David McWilliams article at <http://www.davidmcwilliams.ie/2005/10/10/financial-markets-blind-to-worldwide-risk>

**Ireland is part of the world economy and cannot act unilaterally to any great extent.**

While Ireland has shown the ability to lead the world in minor matters by introducing the Plastic Bag Tax and the Smoking Ban, we are unlikely to make changes that significantly affect our short-term international competitiveness.

# The Energy Scenarios

## Business As Usual

### Overview

This scenario is based on the oil and gas output projections prepared by Dr. Fatih Birol and his colleagues at the International Energy Agency (IEA). In *World Energy Outlook 2004*, they write:

*“Global oil production will not peak over the projection period [i.e., before 2030] so long as necessary investments in supply infrastructure are made. New capacity will be needed to offset production declines and to meet demand growth. About \$3 trillion will need to be invested in the oil sector from 2003 to 2030. Financing that effort will be a major challenge.”*

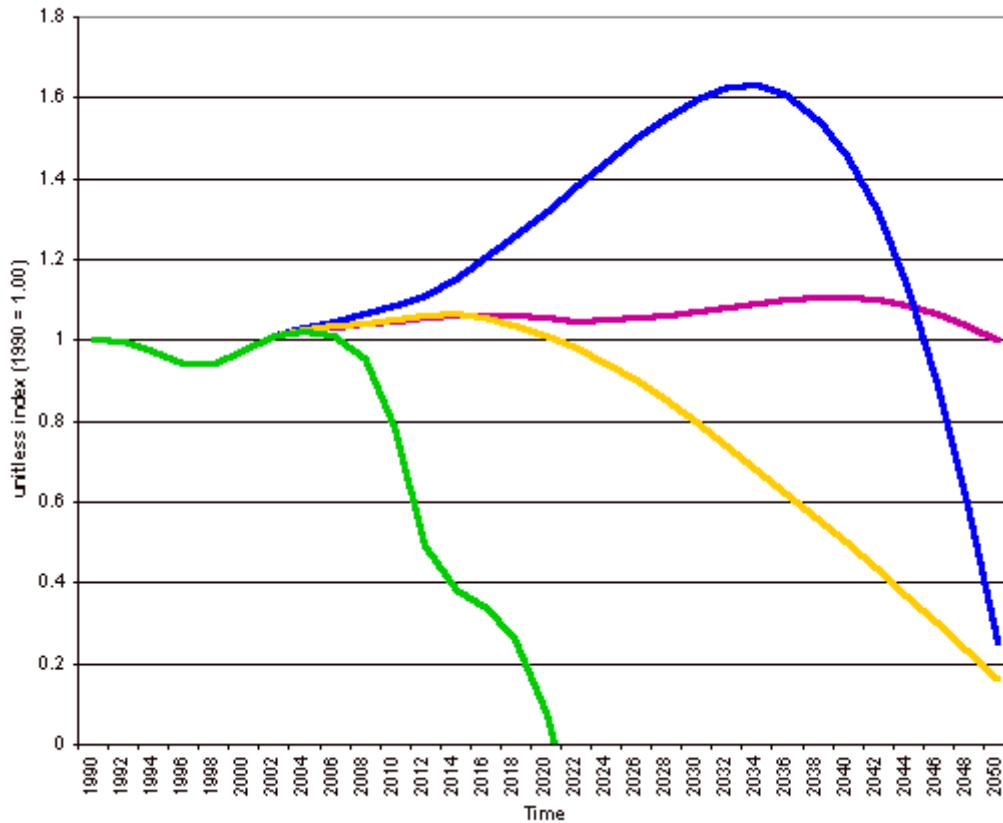
However, if the investments are made, the IEA thinks that oil output will be able to match demand, which it expects to grow from 77 million barrels a day (mb/d) in 2002 to 121mb/d in 2030. This is an annual growth rate of 1.6%, rather less than demand is growing at the moment.

For gas, the IEA team says that “resources can easily meet the projected increase in global demand” provided that \$2.7 trillion, or about \$100 billion a year, is invested in gas supply infrastructure between now and 2030. This level of investment would allow world gas consumption to rise at 2.3% a year to just less than double its present level.

In our scenario we imagined that, following the oil price shocks of 2005/2006, a significant find of oil and gas in the Siberian Arctic restores confidence in the market and oil prices return to \$60, thereafter growing by an average of 3% year year



## Manufacturing Output



*The graph shows the manufacturing output of the Irish economy in relation to its current level as a guide to the overall level of economic activity under each of the four scenarios. Business as Usual (BAU) is the blue line, the mauve line is Enlightened Transition, Fair Shares is yellow and Enforced Localisation is green. BAU delivers rapid economic growth until energy prices make Ireland uncompetitive in relation to other European countries, which have invested significantly more in developing non-fossil energy supply. Only Enlightened Transition enables living standards to be maintained but this is at the expense of further economic growth. This graph was produced by an early run of our ECCO model (see next chapter). A later run is discussed in Chapter 5.*

## Characteristics of Business as Usual

### Government Policy

The IEA's reassurances about future supplies have made it easy for governments to continue with their current policies and we assume that this will continue to be the case in Ireland until 2030. During this period, we assume that long commutes increase as people seek a better quality of life and cheaper housing. This is facilitated by road improvements.

## **Business As Usual Timeline**

### **2005 - 2015**

- Energy prices grow at 3% per year to 2012.
- Research continues at its present level into alternative energy sources and into the development of better methods of energy storage. The costs of photovoltaics fall as production volumes build up
- The Kyoto Protocol has no noticeable effect of levels of fossil energy use in the countries covered by it as emissions trading and offsets under the Clean Development Mechanism, plus the switch to natural gas for electricity generation together with the movement of heavy industry to countries outside the OECD enable countries to meet their targets on paper.
- 2011 First commercial airliner in service that has a hybrid fuel cell/jet fuel engine. (<http://www.netl.doe.gov/publications/proceedings/03/seca/DavidDaggett.pdf>)

### **2016 - 2035**

- Energy prices grow at 6% including an additional 3% to cover the cost of purchasing climate change emissions permits. This means that people begin to notice that they have less of their wages left for other purchases once their energy bills have been paid.
- Ireland's population continues to grow in step with its economic growth as the government maintains its policy of keeping wages down and thus boosting Ireland's export competitiveness by attracting people from all over the world. The growing population helps drive the construction industry.
- The fact that the oil and gas peak will occur some time in the next five years is accepted in 2030 and serious investments in energy alternatives begin.
- Because it anticipated the steady rise in the real cost of energy, the business sector has implemented all the energy efficiency measures that are profitable at the prices currently ruling

### **2036 - 2055**

- Oil and gas prices now start to grow at 9%
- Ireland becomes uncompetitive compared to many EU countries because its energy mix incorporates a greater proportion of oil and gas than is the case in countries such as Britain, Germany, Denmark and Spain which use more renewables, or Finland and France which took the nuclear route.
- The higher energy prices take more and more purchasing power out of the country each year. Living standards begin to fall sharply. Ireland moves into depression

## **A Life in 2015 - Business As Usual**

I'm a knowledge worker with Microsoft Ireland. About the only thing that is not change

for me in the last ten years is the company I work for. In 2005 I was a techie working in Dublin and commuting three hours every day. Now I live in a small village outside Tralee in County Kerry and commute to my purpose-built office next door.

We built this luxury eco-home on the edge of the village looking out to sea in 2007, just before the end of housing boom. Like everyone else, we moved our money out of Irish property and into Eastern Europe and I think this is what caused a soft landing for the property market. Even in 2007 we could see that energy prices were only going to go up so we put in all latest technology to make our house really efficient and we find it costs no more to run than our neighbours' little house built by a local developer.

We chose this area because it is unspoiled. None of the big farmers have managed to buy the land here, or don't want it! It is mostly mountain and small fields. The problem is, the local farmers don't seem to have much interest in keeping the farms tidy, so some areas are starting to look run down. The village has kept its quaint old Irish look, even though many of the people living here are now Chinese! We try to buy something in local shop each week to show we support the village, but with Lidl doing free delivery with online ordering, it's usually only a litre of milk or the newspaper on Sunday.

## **Key Business As Usual Facts in 2015**

### **Government Policies**

- Growth at all costs
- Continued investment in roads and airports
- No carbon taxes
- Energy from current sources - gas, oil, peat
- Comply with EU directives but no more and never in a rush to do so

### **Economy**

- Energy prices growing at 6% per year in 2015
- Petrol prices have increased by 37% since 2005
- Electricity prices have increased by 40% since 2005

### **Business**

- Renewables now 15% of electricity generation
- Waste a big issue - much is exported
- 5 Incinerators built since 2005

### **Households**

- We are running to stand still - many people have 2 or 3 jobs
- Long commutes are common though working from home part-time is increasing

- Housing boom ended in 2009 but soft landing

## **Culture in 2015**

What are we eating?

- Same menu as 2005 but different sources.
- Irish Beef
- Chips from Eastern European potatoes
- Peas from Israel
- Ice cream from Irish milk powder

What are we watching?

- Big Cars 3
- We All Want to Be Millionaires
- Greed is Good

Most popular Websites

- [www.AAtrafficwatch.ie](http://www.AAtrafficwatch.ie)
- [www.buildyourhomeonline.com](http://www.buildyourhomeonline.com)
- [www.celebs.com](http://www.celebs.com)

What are we selling

- Cork-Dublin road permit - 4 months to run. EUR 240.
- Hybrid car, 2009, 169,000km save 50% on your fuel bills!
- I want to start a new car pool for those travelling from Mallow to Cork weekdays. Anyone interested call.

## **Headlines**

**New incinerator reduces waste export bill** - We have finally given in and built incinerators as we seem unable to find any other alternative. This has reduced the cost of waste, much of which was previously exported.

**Irish Muslim council deplores government stance on Libyan accession** - Libya joins the EU

**Protests and nostalgia as UK finally joins Euro** - The EU has become a more popular currency, more and more contracts are written Euros instead of Dollars. The UK, not wanting to be left out of a good thing, finally switches from the Pound to the Euro.

**Fly Waterford to Iraq** - Air travel has continued to grow and with new business links between Ireland and Iraq, even small airports such as Waterford are offering flights.

**Irish grand slam marred by doping scandal** - Sport continues to be a serious subject and winning more important than ever. Drugs are found in all sports.

**Group Four end of year results show fifth year of consecutive growth** - With the rich getting richer and the poor getting poorer, security firms are doing well.

**Local Government Bill abandoned - Localisers on retreat** - Moves to put more power in local government have not succeeded.

**Hydrogen economy still very promising** - There has been no real drive to replace oil with hydrogen and the costs of using hydrogen still remains high, so the hydrogen economy is still an idea for the future.

**French fusion demonstration plant already over budget** - The dream of nuclear fusion is having significant amounts of money thrown at it.

**Child abduction foiled by GPS watch** - Another security story.

**One-off rural housing now half of new development** - The trend for building large, isolated and energy demanding houses in the countryside.

**Domestic heating cost rise - renewed call for insulation grants** - Ireland still not offering householders financial incentives to become more energy efficient.

# Enlightened Transition

## Overview

In this scenario, the combined oil and gas peak is reached in twenty five years, just as it was in the Business as Usual one. However, in this case, the government gives leadership from 2005 onwards, enabling the business sector and the general public to avoid making stranded investments (that is, investments that are totally inappropriate to a high energy cost world) and, instead, to use energy which is much cheaper now than it will ever be again to develop Irish energy sources and to reduce the amount of energy required to maintain and run the Irish economy.



## Economy

The move to renewable energy sources causes the economy to reach a steady state. The reduced dependence on fossil fuels causes a very moderate decline in the economy after 2030. There is a moderate decline in manufacturing output after 2040 because fewer capital products are needed for the transition to a fossil-fuel-free economy as most of the investment has already been done.

## Characteristics of Enlightened Transition

### Government Policies

- The security of Ireland's energy supplies is put ahead of immediate low energy prices. The IDA recognises that while the low-energy cost approach was appropriate in an energy abundant world, a guaranteed energy supply at a predictable price is a better strategy in an energy scarce one.
- The government negotiates long-term, fixed price supply contracts with oil and gas producers. This enables it to let energy-users know what prices they will have to pay in the future.
- In 2006, Ireland catches up with the rest of the EU-15 and introduces a feed-in law which offers an attractive fixed price for the next 15 years to anyone able to supply electricity from renewable sources to the national grid. Eirgrid is mandated to take this power. Net metering is introduced to encourage households to install small wind turbines and PV panels which supply power to the grid when it is not required for the household's own use. (Net metering means, essentially, that the electricity meter runs backwards when the household has a surplus of power)

- Every building constructed after 2008 has to be built to ZED (i.e. Zero fossil Energy Demand) standards. In other words, the developers have to show that their buildings can be lit and heated without the use of fossil energy and that their location will still be appropriate when the cost of transport, and running a car becomes very much higher than at present.
- No new contracts for major road-building projects or airport expansion are awarded. Instead, congestion charging is introduced where it is necessary to limit road or runway use and the proceeds are used to improve bus and rail transport.
- Site value taxation is brought in to encourage compact settlement development.
- Except where there are acute skills shortages, the recruitment of labour from outside the EU ceases.
- Public pension investment policies change to favour local renewable energy development.
- Tax incentives comparable to those for property in the 90s are introduced to encourage private and community investment in local renewable energy.
- Eirgrid is directed to begin the transformation of the electricity grid to a distributed system.

### **The Business Sector**

- Business starts to make decisions on the basis of steadily rising energy costs if they are buying power, and steady rising energy prices if they are selling it. Some energy-intensive manufacturing operations close. Others, such as Auginish Alumina, develop wind farms and only fall back on fossil fuels when the wind is not blowing. The closures are offset by firms expanding to meet the demand for equipment from the renewable energy sector.
- Helped by government research contracts, Irish firms set out to develop and export new energy saving/generation technologies
- Air travel becomes steadily more expensive. The tourist sector reacts by offering longer-term activity and special interest holidays rather than weekend breaks.

### **Household**

- All houses now have smart metering which allows for variable pricing of electricity
- Devices attached to appliances can be set to run when a certain price band is reached so the less urgent tasks wait for the lowest prices but there is also a "I need it and I need it now" button for urgent tasks!
- Many households have battery backup to provide electricity when the price is high or if the mains supply goes off and which can be charged when the price is low.
- Some apartments have shared facilities such as washing machines
- The standard of insulation and draught-proofing in homes countrywide now rivals Sweden
- Homes now require 50% of the energy to run them that they did in 2005. This is

- through efficiency gains and people setting their thermostats lower. .
- High energy tasks now carried out when power is cheap rather than when it is convenient. Washing is done when the wind blows and the cheapest power is available.

## **Timeline for Enlightened Transition**

### **2005-2015**

- Steps towards a planned transition to indigenous energy sources are taken immediately.
- Flood of wind farm projects connected to grid.

### **2015-2035**

- Ireland becomes world leader in developing tidal stream and electricity storage technologies.
- Massive windfarms off the west coast enable Ireland to become a major exporter of electricity to Britain.
- Two cement factories close as the level of new building falls and the construction sector switches to techniques involving materials with less embodied energy.
- The timber frame sector expands as does other low embodied energy construction systems such as hemp / lime construction. Retrofitting for energy efficiency becomes a booming industry covering all building trades.

### **2035-2055**

- Irish energy prices drop below the European average. Energy-intensive manufacturing processes move back.

## **Living in 2015**

I hate politicians. Back in 2005, the coalition government they had then got a bee in its collective bonnet about how oil and gas were going to run out in 25 years' time and how we'd better get ready for it. Talk about Chicken Little and the sky falling! Anyway, they started distorting the market by putting up energy prices and giving subsidies, grants and tax breaks to encourage the generation of all sorts of renewable energy. The big firms like Airtricity did well out of the taxpayer, of course, but a lot of smaller people did as well, particularly after a scheme came in which enabled communities to start generating their own heat and electricity and distributing it through their own networks of pipes and cables.

The present government is no better, it says that the higher prices we are paying for our power here are enabling the business sector and the general public to avoid making “stranded investments”. by which they mean investments that are totally inappropriate to a high energy cost world. Have you ever heard such jargon? And such nonsense! It’s them that are creating the high prices to reward their political supporters. It’s not a high cost energy world and other countries without these silly policies are growing faster than we are.

It's not up to government to worry about what will happen in the long terms. The market can do that and, when shortages really do appear, then firms can make money honestly by sorting them out.

## **Key Enlightened Transition Facts in 2015**

### **Government Policies**

- The security of Ireland’s energy supplies is put ahead of immediate low energy prices.
- No new contracts for major road-building projects or airport expansion
- Congestion charging is introduced
- Aviation fuel is taken into the EU Emissions Trading System as a result of an EU Directive

### **Economy**

- Energy prices have grown at 6% per year since 2005
- Petrol prices have increased by 80% since then
- Electricity prices have also increased by 80%

### **Business**

- Renewables now 30% of energy generation
- Waste a big issue - much is exported
- 5 Incinerators built since 2005

### **Households**

- Saving money by reducing waste of all kinds is part of the psyche
- We no longer expect to get all kinds of fruit and vegetables throughout the year
- Housing boom ended in 2009 but there was a soft landing

### **Culture**

*What are we eating?*

More seasonal and local produce because the cost of transport increases.

- Organic turkey from integrated farm.
- Irish potatoes
- Frozen veg etahles from Holland
- Oranges from Spain

*What are we watching?*

- A makeover programme that shows you how to reduce cost of running a house by 90%
- Build Your Own Windfarm
- Back to the city

*Most popular Websites*

- [www.moreforless.ie](http://www.moreforless.ie)
- [www.earncashfromhome.com](http://www.earncashfromhome.com)
- [www.sellonline.com](http://www.sellonline.com)

*What are we selling?*

Second car that runs on oil or linseed oil. Would swap for 2 quiet house cows.

10 speed bicycle for sale with electric motor assist. €400 ono.

Electricity-generating rowing machine for sale. Produces up to 3 hours of lighting per hour of exercise in a non-converted house, several more in a converted house. 8 gears, Price €1000. Saves €800 per year for regular users.

## **Headlines**

**Minister for Sustainable Energy announced** - Sustainable energy becomes a hot political issue, deserving of a new department

**Private wire schemes encroach on national grid** - Community companies have started businesses generating electricity which they supply direct to homes and businesses, by-passing the national grid.

**Property prices fall as pensions funds shift to renewable energy projects** - property was long seen as a safe investment - "safe as houses" - but energy is now seen as a better long term investment with good returns. People will always want energy.

**Deposit for milk bottles increased to 50c** - For many years glass was simply thrown away, then it was recycled and finally the returnable bottle made a return. Since then, the value of the returnable bottle has increased.

**Airships to fly over Ireland again** - Airships are a cheap form of transport where speed is not required. They do not require energy to lift them, only to move them forward, they require almost no infrastructure and are now very safe.

**District heating now favoured by planners** - A method popular on continental Europe has finally made it to Ireland.

**Closing time for Just in Time** - As transport prices increase, the warehouse makes a return as it becomes cheaper to take fewer deliveries and store goods until needed.

**Ryanbikes slams price increase for public bike storage racks** - Michael O'Leary saw a new business opportunity as people moved out of their cars and onto their bikes. Long known for slamming airports for trying to charge Ryanair for the use of their services, he brings the same stance to the new Ryanbike business.

**Eco-village properties relieved of stamp duty** - Eco-villages are recognised as a good way forward.

**Two incinerators to convert to energy production** - A reduction in the volume of waste, particularly waste with high embodied energy, forces some facilities to look for alternative sources of income by buying biomass to burn for energy production.

**New rail lines on central reservation of motorways** - Light rail is much more flexible in its requirements and being installed on dual-carraigeways and motorways.

**Walk to school "bus" mowed down by Ryanbike** - Children walk to school in organised groups or "walking buses".

# Enforced Localisation

## Overview of Enforced Localisation

The world is unprepared for the oil peak when it occurs in 2007. The European central bank panics and instead of allowing the increases in energy prices to work their way through the markets to reflect the new structure of relative costs, it increases interest rates in order to control inflation. Business is stifled by the combination of higher interest rates and energy prices and lower consumer demand. Many private sector investment projects are shelved. This reduces energy demand and causes a drop in the price of oil, but at the expense of stagnation and high levels of unemployment.

As the economy picks up after several years, the need for fossil-fuel generated energy increases and since there has been no investment in alternatives, this quickly leads to supply shortages and the cycle repeats itself.

By 2015, oil prices are low, but unemployment is high and business people are reluctant to invest having been stung by the instability of the previous years. Those businesses that survive are focused on delivering locally sourced products to local markets.

## Economy

The world economy collapses as a result of the central banks' actions against inflation. Every time a recovery begins and energy demand increases, supply constraints are encountered at lower and lower levels, and inflationary price spikes result. Unemployment gets higher and higher with every cycle and people begin to rely far more on their own production than the floundering formal economy.

## Characteristics of Enforced Localisation

### Government Policies

- Investment in capital projects, incinerators, renewables, roads etc. cease through lack of funding
- Interest rates are increased to counter inflation caused by high fuel costs.

### Business Sector

- Property values collapse in the face of increased interest rates and the depressed economy. Construction ceases completely.
- Businesses which adapt to doing business with local suppliers and local customers



survive. Those with the knowledge and skills to repair machinery are in particular demand.

- Everyone with a patch of land starts growing food for personal use and to barter for other services.
- Urban residents invade and squat well-located agricultural land.
- Local currencies develop to provide purchasing power
- Multinationals decentralise to try and adapt to changing supply and demand.

## **Household**

- Foods we have become used to are rarely available: bananas, cheap frozen meals, coffee!
- Maintaining a car and obtaining fuel for it becomes increasingly difficult, although periods of low oil prices help. We no longer travel on a whim, but plan our trips to make best use of fuel. Neighbours share their rare trips to town for shopping.
- Most food is grown at home or supplied from local producers.
- People develop micro-businesses to supply goods or services that can be used to trade for essential needs.
- We become obsessed with keeping warm in winter. New range of fleece developed from plants which is turned into housecoats that are both warm and stylish!
- The poor struggle to keep warm.
- More people live in the average household. Large houses built during the boom times now have 2 or 3 families living in them.
- Variable pricing for electricity with changes available on the internet and reported on radio.
- Conservatories become greenhouses.

## **Timeline for Enforced Localisation**

### **2005 - 2015**

- Worldwide depression develops due to central bank policies coupled with the failure of the oil- and gas-producing countries to spend their windfall profits back into the global economy.
- Ireland hit more seriously than most other EU countries because of its higher dependence on imports of fossil fuels and on export markets for its products. Unemployment soars.
- Rapid collapse of activity in construction sector. Housing market plummets. Banks in difficulties as house buyers are unable to repay loans and find themselves deeply into negative equity.
- World food prices drop because the marginal buyers cannot afford to pay as much as previously. Farms quickly start to produce locally required foods as they can get better prices for them. Farmers' markets open in every town.

- Internet access is unreliable as many servers are no longer available 24/7.
- Oil prices peak and then drop back to around \$12 a barrel. Exploration and reserve development projects are cancelled. Shell mothballs its Athabasca tar sands project. Ireland finds itself with excess electricity generating capacity. No further wind farms are permitted to connect to the national grid.

## 2016-2055

- By 2020, another 2-year oil price peak has happened, only to see prices collapse back to the \$12 a barrel level.
- The world economy is contracting, with firms closing and their equipment being scrapped during each downturn of the cycle. A limited amount of investment takes place during the recovery phase of the cycle but previous output levels are never achieved again. Each peak in global production, and in total energy use, is lower than the one ten or fifteen years previously.
- People do what they can to meet their own needs. Energy is expensive in their own terms because their earnings are low.
- A transition to low energy, labour-intensive ways of doing things takes place because money (and energy) for capital equipment is not available.
- Households repair possessions as they do not have the money to dump worn or broken goods and buy new ones. Machines are made to last a lot longer. Cannibalisation for parts is common.
- Travel is limited because it is expensive and people have less need to travel anyway.
- Local and regional governments, strapped for money to pay their workers, will begin to issue their own currencies as happened in Argentina.
- The Internet will be an important source of information about ways of adapting to the new conditions. E-commerce will be almost entirely local except for the supply of rare parts to maintain equipment
- Local sources of energy such as biomass will be developed where possible.
- Little used, the national electricity grid proves too expensive to maintain in view of the high cost of repairs and the loss of 13% of the power passing through it.
- Local energy supplies develop that use the local electricity distribution system but not the grid. Slowly a new grid develops from a web of interconnecting mini-grids.
- Almost no new building is carried on. Most of what little construction activity there is involves the adaptation of existing buildings for new uses, usually by the occupants and local builders, using recycled materials. Big houses are partitioned and shared.
- The massive drop in energy use removes the pressure to act to prevent climate change.
- Localised famines develop because of the difficulties with long-distance transport

- Transport by sea becomes more important - and settlement patterns more coastal. Irish Rail runs its trains on rapeseed oil. Tractors are run on biodiesel and (a very few) cars are run on methane from digesters.
- The government finds it increasingly difficult to maintain control because it has less money to spend and it is harder for people to travel. This gives an impetus towards a real decentralisation.
- Very little production is based on 'new' resources. Most materials are recycled. For example, what little steel production is carried on is based on scrap metal.

**2055:**

- New things becoming possible with the growing sophistication of local economies.

## **Key Enforced Localisation Facts in 2015**

### *Government*

- Investment in capital projects has ceased through lack of funding
- Interest rates increase to counter inflation caused by high fuel costs
- Government is destabilised due to restless impoverished citizens

### *Economy*

- Energy prices fluctuate widely and wildly.
- need some percentages in here sim to other factsheets
- Unemployment is widespread

### *Business*

- Multinationals decentralise to try and adapt to changing supply and demand
- Construction ceases almost completely due to the high cost of materials and the large number of properties on the market.
- Businesses with local suppliers and customers thrive; repair services also in demand

### *Households*

- Many more people grow food for personal use
- Local currencies develop
- Debt crisis as home-owners caught in negative equity

## **Culture**

*What are we eating?*

- Local farm & home grown produce

- Nuts, berries & roots
- Tinned goods stockpiled by survivalists
- Atlantic seaweed

*What are we watching?*

- Ground Force tearing up decking and converting gardens for vegetable growing
- Starship MicroEnterprise
- Jim'll Fix It

*Most popular websites ?*

- [www.growyourownfood.com](http://www.growyourownfood.com)
- [www.creditunions.ie](http://www.creditunions.ie)
- [www.fas.ie](http://www.fas.ie)

*What are we selling?*

- Working horse for sale. One owner, in good condition with new set of steel shoes. Doesn't eat much and high emissions will help grow your cabbages! Loves to work.
- Best wheelbarrows in town for exchange for cars in sound condition.
- Mobile Super Shop Bank - Post Office - Library See our new timetable at <http://www.shopcometou.cork>
- Bouncy Castles - Closing Down Sale - Everything Must Go
- Veg growing classes start next Wednesday at 7pm in the Community Centre.
- We own an old landfill. Do you want what's in it?

## **Headlines**

**Irish draft horse prices now higher than those of new tractors** - Horse make a return to the farm.

**Survey reveals Irish now slimmer and fitter than 2005** - We are living healthier lives - better food and more exercise.

**Liffey hand-dredged for bikes and prams** - One of the big differences between 2015 and 1805 is that we have Junk. All kinds of junk is being given a new lease of life.

**Castlecomer coal mine reopened** - Ireland's limited coal mines are being reopened.

**Cork warlords declare independent state** - Law and order has broken down in some areas.

**Riots at allotments over cabbage** - Food supplies can be very limited at the end of the

winter and in some areas there are fights over remaining food supplies.

**Foreign correspondents sacked as Ireland loses interest in outside world** - We are forced to become virtually self-sufficient for our essential needs and therefore have little interest in what is happening out there.

**Bicycle factory fuelled by biomass and wind opens in Westport** - Many businesses are gone bust, but many more, usually small scale and local, are opening.

# Fair Shares

## Overview of Fair Shares

Oil peaks by 2007, but the response to the shortage of oil is immediate. Governments realise that, without an international agreement to share out the limited amount of oil and gas on a non-market basis, over-high oil prices will threaten both oil-producing and oil-consuming countries with depression and financial ruin.

A system called Cap and Share is put in place which adopts the position that everyone has an equal claim to be able to use the atmosphere as a dump for his or her greenhouse gas emissions and issues permits for them to do so. These permits are, in fact, an entitlement to burn the limited supply of fossil fuel. Recipients sell them through financial intermediaries to fuel producers who need to acquire enough to cover the emissions from their output. By keeping the supply of permits somewhat below the amount of fossil fuel that it would be possible to produce each year, the producers compete to buy the permits, bidding their price up and ensuring that, rather than the windfall gain from the restricted energy supplies going to them, it is shared out equally among the energy users. For more details of Cap and Share see <http://www.capandshare.org>



## The Economy

Fair Shares minimises the extent of the economic decline that a reduction in fossil energy will inevitably bring and ensures that what energy use is possible is fairly shared out around the world. It leads to more localised, smaller-scale, less energy-intensive industries which enable countries and communities to survive in a far better state than is the case with Enforced Localisation.

## Characteristics of Fair Shares

### Government Policies

- The high energy prices and the certainty that they will tend to rise still further causes a rush of renewable energy projects to go ahead. Eirgrid is mandated to take their power. Net metering is introduced to encourage households to install small wind turbines and PV panels which supply power to the grid when it is not required for the household's own use.
- Every building constructed after 2008 has to be built to ZED (i.e. Zero fossil Energy Demand) standards. In other words, the developers have to show that it can be lit and heated without the use of fossil energy and that its location will still be appropriate when the cost of transport, and running a car becomes very much higher than at present.
- No new contracts for major road-building projects or airport expansion are

awarded. Instead, congestion charging is introduced where it is necessary to limit road or runway use and the proceeds are used to improve bus and rail transport.

- Except where there are acute skills shortages, the recruitment of labour from outside the EU ceases.

### **The Business Sector**

- Business starts to make decisions on the basis of steadily rising energy costs if they are buying power, and steady rising energy prices if they are selling it. Because of Ireland's favourable renewable energy potential, some energy-intensive manufacturing companies move their operations here and develop their own supplies.
- Irish consumer demand falls because of the increased amount of everyone's income going to pay for imported energy and for emissions permits. However, this fall is offset by increased demand from poorer countries who are now able to afford Irish goods and by demand from the renewable energy sector which is developing rapidly.
- Helped by government research contracts, Irish firms set out to develop and export new energy saving/generation technologies
- Air travel becomes steadily more expensive. The tourist sector reacts by offering longer-term activity and special interest holidays rather than weekend breaks.

### **Household**

### **Education**

- Third level education moves towards a distributed model with many lectures, particularly in regional colleges, being provided via video link. Students spend more time in self-directed study using internet based programmes.
- Links are established with Colleges and Universities across the world to provide complete courses using various electronic media. Lectures are transmitted live to students, wherever they are, at home or at their local college, and they can participate by submitting questions to the lecturer and in online discussions afterwards.
- Content of courses at third level is mainly vocational with particular focus in skills for growing energy sector.
- Primary and Secondary education takes advantage of the many services provided by the internet but is focused on providing an education for life.

## Timeline for Fair Shares

### 2005 - 2015

- An international oil consumers' cartel agrees a \$50 per barrel price for oil with the producers, and prices for gas and coal based on their historic relationship with the price of oil. It is also agreed that these prices will rise by 3% a year, the rate at which the output of all three fuels is to be reduced, so that the producers are guaranteed a constant income into the future.
- Emissions permits are distributed worldwide for the first time, giving each person on the planet the right to emit the amount of carbon dioxide released by one tonne of oil or the equivalent in coal or gas a year. Recipients sell them immediately and receive over \$200, making the effective price of oil \$80 a barrel, since each tonne of oil is equivalent to 7.2 barrels.
- Electricity interconnector to Wales completed, allowing rapid increase in the number of windfarms connected to the grid as surplus power can now be exported and power from Britain brought in when wind in Ireland drops.
- Massive increase in demand for consumer goods and foodstuffs from the poorer parts of the world, where the sale of emissions permits has effectively doubled the incomes of the poorest people.
- Farmers benefit from higher food prices but cut back on fertiliser applications due to high cost.
- Inflation tops 10% as higher energy costs work their way through the European economy. Salaries and wages fail to keep up although demand for labour is high.
- House prices tend to fall as people have less money left over to pay rent or a mortgage once their basic needs are met. Energy rating, introduced in 2006, means that the price of big houses and poorly insulated ones fall by above-average amounts. So do the prices of houses far from employment centres and those of holiday homes.
- Activity in the house construction sector declines. Many small companies are established to assess exactly where a house is wasting energy and to undertake remedial measures.
- Car sales fall and the market moves to lower engine sizes.
- Home generated electricity can now be sold back to the grid but the income from it is taxed. .
- Community buying systems develop, based on the internet, for goods that have to be imported.
- Car sharing schemes become the norm.

### 2016 - 2035

- Energy prices still rising at 6% a year relative to incomes.
- Number of cars on roads continues to fall. Bus and train services become more frequent. Cycling returning to levels last seen in the 1950s.

- Network of regional factories set up to convert forest thinnings and other biomass into ethanol for use in cars. The yield is boosted by adding hydrogen made using surplus wind electricity.
- Tidal lagoon developed in Galway Bay to feed electricity into the grid. Massive developments in offshore windfarms.
- Horse breeders find that it is more profitable to breed heavy horses for use in city deliveries and on farms than to produce show-jumpers and racers.
- Many communities set up ESCos – energy supply companies, to provide themselves with heat, light, cooling and vehicle fuels from local resources. Legislation passed which enables local authorities to take over the electricity distribution networks in their areas for use by ESCos so that the latter do not have to install their own sets of wires.
- Air travel becomes too expensive for casual use. Sections of Dublin airport are taken out of use. Excess capacity in the hotel sector. Many hotels close.
- Out-of-town shopping centres with poor public transport links suffer declining sales. Ireland turns out to be seriously over-shopped and many outlets close, particularly those selling inessentials. The rentals charged on retail properties plummet. All shops now offer delivery services because of the growing number of customers without cars.
- Bakeries distributing over wide areas replaced by local ones. Local breweries and brew-pubs flourish.
- The number of people employed in horticulture begins to rise as Irish produce replaces imports. Most livestock farms have biogas digesters.
- Plastic packaging becomes progressively expensive. Non-returnable glass containers are banned. An EU directive standardises the sizes and shapes of glass bottles and jars, limiting the total number to 60. An Irish law is passed making it compulsory for a returnable deposit to be charged on glass containers and several small companies are set up to collect glass containers from shops, sort and wash them, and supply them to local food and drink manufacturers.

#### **2036 - 2055:**

- Energy prices still increasing at 6% a year in relation to wages. As a result, by 2042 it takes eight times as long to earn enough money to buy a unit of electricity than in 2006. Petrol and diesel prices have risen by even more as alternative ways of powering road vehicles, trains, ships and aircraft are still inefficient and expensive.
- Sail-wing ships increasingly used to carry freight around the world. Airfreight now too costly for all but exceptionally high value items. IKEA goes into liquidation. Production becomes smaller scale and more local but computer-controlled machinery gives the flexibility for a wide range of products to be made economically in one factory.
- Jobs are still plentiful as people are increasingly being used instead of machines. Range of consumer durables becomes more limited and customers look for long-life products which can be readily repaired. When non-EU products are offered, they are suspicious because they worry about the availability of spare parts in a few

years' time.

- Sales of processed food fall as more preparation work is done at home. Richer people take on servants. Fewer and fewer people live alone because of the cost of running a house. It becomes common for older, unattached people to share a house just as young people do today.
- Many isolated houses are boarded up and abandoned. However, most people want a garden to grow some of their food and councils are compelled to provide allotments.
- Arable farmers switch to no-till methods of production and use horses rather than tractors for field work. Many more people are employed on all farms and a more diverse range of crops and animals are kept.
- Very few people can afford their own cars. Instead, older people belong to car clubs and hire electrically-powered models when they need to go somewhere without adequate public transport. Younger people cycle.

## **Key Fair Shares Facts in 2015**

### **Government Policies**

- Maintaining economy on even keel the priority
- Little money to invest as being used to purchase energy permits.
- Home generated electricity can now be sold back to the grid but is taxed as income.

### **Economy**

- Energy prices have grown at 6% per year since 2005
- Petrol prices have increased by 80% since then
- Electricity prices have also increased by 80%
- Inflation tops 10% as higher energy costs work their way through the European economy. Salaries and wages fail to keep up although demand for labour is high.

### **Business**

- Renewables are now 30% of energy generation, much of it individual or locally generated
- Resurgence of local business with lower overheads than global corporations

### **Households**

- Plastic packaging becomes progressively expensive. Non-returnable glass & aluminium containers are banned
- Dramatic decrease in number of cars on the road
- Decline in number of single person households

## Culture

### What are we eating?

- More local & seasonal due to increase in transport costs.
- Semi-organic cabbage (fertilizers and pesticides expensive)
- Irish farmed fish
- Pasta (dried) produced in Ireland
- Oranges from Spain (by boat)

### What are we watching?

- Ground Force are now converting gardens for vegetable growing
- Community TV
- Neighbours from Heaven

### Most popular Websites

- [www.sharensave.org](http://www.sharensave.org)
- [www.c&c.gov.ie](http://www.c&c.gov.ie)
- [www.bus&rail\\_timetables.ie](http://www.bus&rail_timetables.ie)

### What are we selling

- Cold press for rapeseed.
- Wood burning stoves for sale, conversions from beer barrels add style.
- Turnips in exchange for 1/2 ton of topsoil
- For sale, 10 boxes of Organic Apples.

## Headlines

**Census shows poverty halved in last five years** - Those previously on the poverty line are well suited to making the best of tight times and do better than the middle class unprepared for making do with very little.

**Out of town shopping centre bankrupt** - People can no longer want to make a special journey just to do the shopping - they want to combine many tasks for each journey so prefer going to a town or city.

**Crack down on loan sharks intimidation of pensioners for their permits** - Everyone has emissions permits to sell and older people do not always understand their value or how to sell them.

**Kilkenny farmers' market raided** - Farmers' Markets are now found in all towns but this

makes it hard to check everyone is paying their taxes!

**Tenant farming is new form of slavery** - The rich are always with us. The rich have land and use tenant farmers to work the land. In some cases they offer very little to the tenant farmers.

**Salmon caught in Liffey again** - Lack of waste has reduced the pollution going into the river that flows through Dublin, enough that salmon are now using the river again.

**100mpg family car launched** - There are still people who can afford new cars but there has not been significant development in car technology because of lower demand.

**Return to sail** - Sailing ships are a cheap form of transport and ships are being retrofitted with sail to to used when conditions allow.

**Road deaths fall again** - Less cars, less danger.

## Chapter 3:

### The use of the ECCO model to assess the scenarios.

The ECCO (Evaluation of Capital Creation Options) modelling approach was originally developed by Jane King & Malcolm Slesser (Slesser & King 1993; Slesser et al, 1994, 1997). It provides a broad-brush sketch of the entire economy which allows the user not only to calculate the direct impacts of renewable energy sources on the electricity-generating sector, but also the synergies that may exist between renewable generation of electricity and other technologies and economic activities. The ECCO model uses energy analysis theory as one of its main tools, and many of the variables it employs are expressed in energy terms.

Money is not used as the numeraire in the model as its value changes over time and it cannot account for voluntary or unpaid activities. The unit of energy the Joule, on the other hand, is fixed in value regardless of time, place and any variation in currency value or economic state. However changes in the price of energy in relation to the price of labour do have an impact on the way the various sectors of the economy use it and the ECCO model tracks these energy flows.

The model can be described in physical, dynamic and holistic terms:

#### A) Physical

ECCO is primarily a physical account of the economy. Energy analysis theory, as defined in the proceedings of the IFIAS workshop of 1975 (IFIAS, 1975) underpins the model. It explicitly recognises the importance of the second law of thermodynamics in limiting the options available to the economy. According to this law, any transformation to a system incurs a net dissipation of energy and an overall increase in the entropy (which can be thought of as a measure of disorder) of the system. Within a system, the entropy of a local region can decrease if it is able to export the entropy increase elsewhere. In industrialised economies, we generally order our built environment by exporting huge volumes of disorder to natural ecosystems, as dissipation of energy resources and as pollution. This behaviour was first formally described in these terms by Ilya Prigogine and colleagues as 'open systems' (Prigogine & Stengers, 1984). National economies such as the Republic of Ireland are very much open systems, interacting not only with natural environments, but with the global political environment through trading goods, services and financial flows. (Financial flows have no direct physical presence themselves but determine the direction in which physical effort is expended).

By describing the economy in such physical terms we get a direct handle on some of the key interactions with nature, such as rates of fossil fuel extraction, use of materials and emission of atmospheric pollutants, as well as many interactions that occur within the economy.

## **B) Dynamic**

ECCO is a dynamic model. It does not describe the state of the economy at a single point in time, but the unfolding of events in the economy over a period of decades. It is suited for describing long-term economic patterns over such timescales, but less suited for explaining short-term fluctuations over periods of months or quarters. The computational techniques used to describe these dynamic relationships are classical system dynamics, as developed by Jay Forrester & colleagues in the 1960s at MIT (Forrester 1968, 1971; Meadows et al, 1973).

The dynamic nature of the model is important in deeper ways than simply allowing us to describe key indicators as time series rather than snapshot values. A simple linear programming model can accomplish this. System dynamics, however, excels at describing complicated feedback interactions between many factors, and the ECCO model contains many feedback loops. These often lead to counterintuitive behaviour in the model, that is, behaviour that may seem to be unexpected at first glance, but, when its causes are traced back through the model structure, does make sense.

When we engage with the model in this way, we are encountering questions about the way our economy operates, and gaining insights that are qualitative as much as they are quantitative. Qualitative insight is often as important as the numerical time series data that the model generates.

## **C) Holistic**

ECCO is a holistic model. Rather than covering one part of the economy in fine detail, the entire economy is described in coarse detail. Specific sectors may be developed to a greater level of detail than others (electricity generation and energy conservation, for example), but all sectors are represented at some level of detail. Because the model determines its own growth rate it is important that we know the demands and supplies associated with all parts of the economy in order to assess the overall growth potential.

A sector described at the lowest level of detail can be thought of as a placeholder. It is unlikely to do anything surprising during a simulation. When developing a model for specific purposes, we need to evaluate where we wish to apply detailed policy options, and from there, what level of detail is appropriate for the other major sectors. For example, if we were to develop a model with the aim of studying water usage, we would need a high level of detail in the industrial, domestic, agricultural and possibly electricity generation sectors. Services and transport sectors could be simpler, taking their cues from the ups and downs of the more detailed sectors. In some studies, the broad overview offered by ECCO has been usefully combined with more detailed static analysis (Crane & Foran, 2000).

# The Irish ECCO model

The model divides the economy into a number of broad sectors, following the sectoral divisions provided by the main data sources that we used to calibrate it. These are:

## **Agriculture, Forestry & Fishing**

This sector is sketched-in in terms of fixed capital stocks, and energy resource use. Future growth is driven by domestic requirements and export markets. No attempt was made to distinguish between types of agriculture, or to assess land use. This latter would be required were we to factor in the land-use requirements of a large-scale biomass initiative (and, to a lesser extent, land-based wind generators, although it can be argued that these can happily coexist with many types of crops).

## **Mining, including gas and peat extraction**

Our primary focus here was on describing the reserves of natural gas and peat, and the fixed capital stocks employed to extract them. Investment in these sectors was driven by domestic demand and world export markets (significant only in the case of gas).

## **Industry & Manufacturing**

This sector was treated as a single entity, although in reality it covers a range of activities from heavy industry to food processing and the construction industry. The effects of investment in fuel-efficient technologies in this sector were characterised.

**Utilities, primarily electricity generation** Electricity generation was divided into a number of technologies, covering conventional fossil-fired plant, combined-cycle plant (a more modern technology with greater efficiency of use of fuel), conventional hydro-electricity, and renewables. Separate sub sectors were drawn up to characterise wind generation, photovoltaics, biomass-generated ethanol and methanol plant, and wave energy, although our analyses here focussed primarily on wind power. User defined policies for future uptake between existing technologies were developed, with Business-As-Usual policy allocating 90% of new plant built beyond 2000 to combined-cycle fossil plant, and 10% to renewables. The differences between technologies were characterised primarily as:

## **Services**

The services sector was characterised in terms of fixed capital and physical resource consumption (e.g. thermal fuels, electricity). Demand for services was limited to the three major consumer sectors, industry, domestic dwellings, and the services sector itself.

## **Domestic dwellings**

These again were characterised in terms of fixed capital and resource requirements. Effects of domestic energy efficiency technologies were taken into account (and here the payback could be significantly greater than in the industrial sector, owing to the poor starting position of the Irish housing stock in terms of simple energy efficiency 'quick wins' such as insulation), as well as potential for electricity-powered ground source heat pumps.

## **Transport**

The transport sector does not maintain its own capital stock, as national accounts data describes the fixed capital in transport machinery as belonging to the owning sector e.g. industry, services, domestic. Energy use by transport is defined separately, though, and we were able to calculate demand based on passenger and freight volumes. Policies describing potential future modal splits between transport sectors are in place, as well as future fuel mixes, including electrically-powered passenger vehicles utilising fuel cell technologies.

## **International Finance**

This sector defines the net impact upon the growth of the economy of international trade. Some parts of this can be characterised well by the model, such as the necessity of fuel imports, others are defined as user policies, such as future levels of international investment capital. Over the calibration period, Ireland enjoyed an unusually high influx of international capital, which we have allowed to decrease somewhat in the Business-As-Usual profile for the model.

## **The Irish ECCO model's Data Sources**

The model is initiated for the year 1990 and is run over a 10 year period against real historical data to calibrate it and extrapolated up to 2050.

Data Information sources:

- National Accounts Data From the Central Statistics Office
- Energy Balance Data
- ESB Annual Statement
- The final report of the EU funded ALTENER report "Total Renewable Energy Resources in Ireland"

## **Running the ECCO Model**

The ECCO model does not provide future prediction about the economy or give snapshots of the economy in the future based on linear extrapolations. Instead is it dynamic, containing many complex feedback loops where changes in one sector of the economy in response to energy usage (which is influenced by energy prices) impacts on other sectors. As a result the model determines how an economy's growth evolves into the future over long time scales (decades). The ECCO model was run under the following scenarios Business as Usual, Enlightened Transition, Fair Share and Localization. The individual scenarios were described in the previous chapter. The results from the ECCO model can be summarised as follows:

***Business As Usual*** - Assumes that oil will not peak before 2030 and the Irish economy continues to run as it does today i.e. economic growth is the priority. Manufacturing output takes a nose dive in this scenario soon after the 2030 oil peak when the cost of imported fossil fuels rise sharply.

***Enlightened Transition*** - Assumes that oil will not peak before 2030 but a proactive approach to prepare the economy for the oil peak is taken by reducing dependence on fossil by moving to renewable energy sources and the economy manages to just about achieve a long term steady state.

***Enforced Localisation***- Assumes oil peak is occurs by 2007 but that the economy tries to continue on a business as usual basis. The result is an economy that collapses to a state from which from which it cannot recover.

***Fair Shares*** - Assumes oil peak is occurs by 2007 but the global response is immediate. Economic decline occurs eventually as manufacturing turns small scale and local, although it survives longer than in the case of Enforced Localisation

There will be more discussion of these results in Chapter 5.