MORE
Multimodal Optimisation of Roadspace in Europe

D3.3

Future scenarios for TEN feeder routes

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1 Introduction

Transport planning was never easy. Practitioners needed to balance a host of different goals which often conflicted; they had to respond to a variety of stakeholder groups whose interests were not necessarily in alignment; and this all had to happen within tight financial, spatial and often temporal constraints.

These days, the task seems harder still. When the municipality before controlled most aspects of the transport environment, this is no longer the case. Ride-hailing providers, dock-less bike companies, purveyors of e-scooters and others are altering the transport "offer" rapidly and without necessarily first consulting the public authorities. Forecasters, who previously predicted with confidence patterns in population and employment, are increasingly uncertain about the future. And there is ever more talk about how new and emerging technologies such as the automation of driving could disrupt the transport world in profound ways.

The purpose of this document is to provide practitioners with some meaningful support as they attempt to do their job in the face of these new challenges. In particular, it will address the issue of planning transport against a future made even more uncertain by the developments just mentioned. The emphasis is on practical advice and not necessarily on large volumes of analysis, though forecasting tools definitely have their place.

1.1 The challenge

"It is difficult to make forecasts, especially about the future" (Samuel Goldwyn).

The consistent inaccuracy of forecasts has been widely reported and should come as no surprise to anyone in the transport sector (see Figure 1). But we continue to produce forecasts because we rely on them to justify our transport decisions: we do not wish to implement a major scheme on the basis of faith alone. The real problem, though, is not the inaccuracy of the forecasts but our tendency to be surprised by it. Time and again, we treat the latest forecasts as accurate statements about the future and set our strategies accordingly. The tendency to get demand forecasts wrong is well established (Flyvbjerg, Skamris Holm and Buhl, 2005) and this arises partly from the lack of accuracy in underlying forecasts of such things as base population. The methods for these have improved but remain imperfect and the degree of inaccuracy remains unclear or, as Booth puts it, "uncertainty estimation is highly uncertain" (Booth, 2006, p. 547).

The emphasis in MORE is upon the potential of technological advances to assist cities in managing corridors more successfully. But this is a double-edged sword: as identified in the case of ride hailing etc, technological advances can equally arise in the form of challenges to the city's sovereignty and/or the situation they must manage. In fact, technological change may have become a greater source of uncertainty for the transport policy maker than at any time in the past.

The message of MORE is that a new approach is needed. We must move on from a singular view of the future based on an attempt to deny uncertainty. We must instead embrace uncertainty and work constructively with it in order to make sounder decisions.

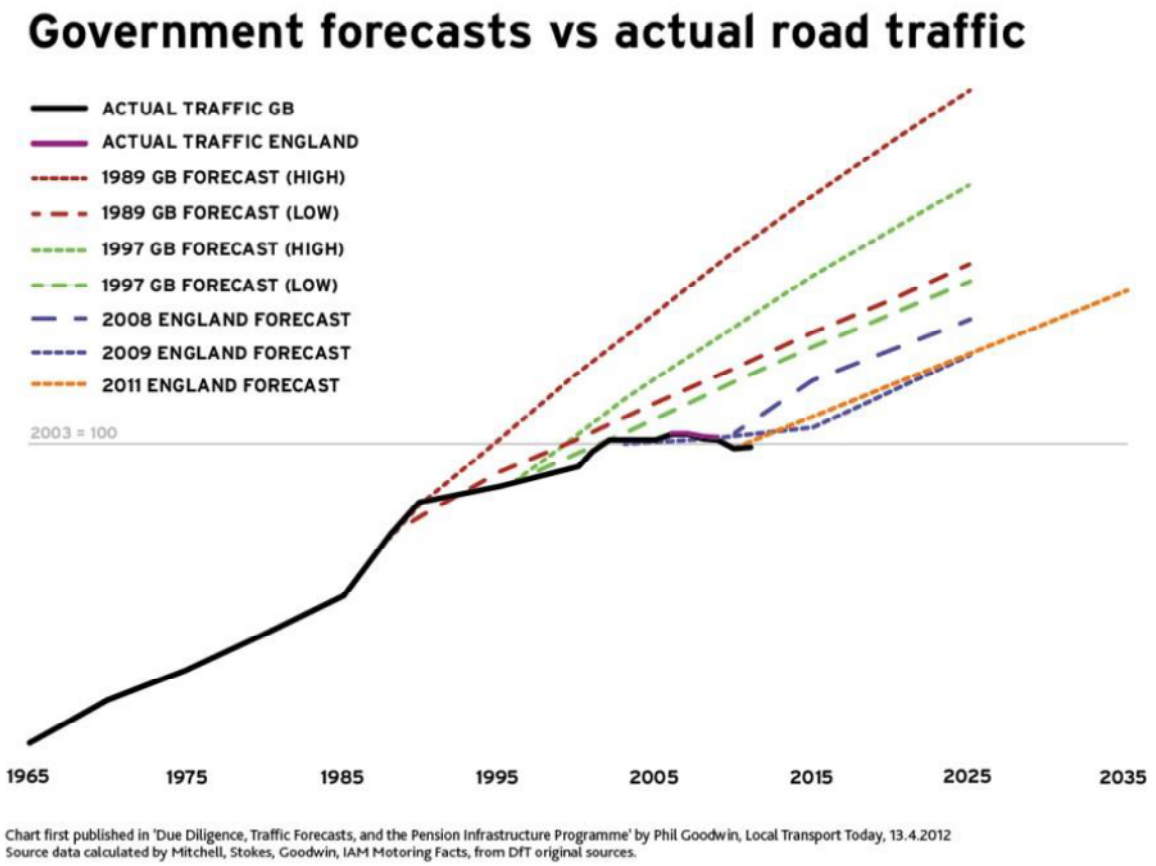


Figure 1: The consistent inaccuracy of UK traffic forecasting

1.2 What is "futures"?

"'Futures' is an approach to identifying the long term issues and challenges shaping the future development of a policy area and to exploring their implications for policy development. It provides a set of research and modelling tools that policy makers can use to support development of policy that is resilient to a range of possible outcomes" (Waverley Consultants, 2017, p. 2).

So, futures is in fact a set of methods. There is no definitive list of these methods – the source quoted above includes 12, of which three are introduced as "tools for describing what the future might be like"; Conway (2015) has ten, with some degree of overlap with the previous source. This aim – describing what the future might be like and then making practical use of those descriptions – is central to our task in MORE. In particular, in embracing uncertainty, we need to develop multiple views of the future.

1.3 Why use futures?

You might ask, if using singular forecasts gets us into trouble, how can adopting multiple views of the future possibly help? Won't it just cause confusion? Instead of considering a package or scheme against a single forecast in order to understand if it is a good idea, it is now necessary to assess it multiple times. How are we expected to decide what to do if the package looks good against one future and bad against another?

The answer is *robustness*. As pointed out above, our reliance on singular forecasts often leads to major mistakes. If we consider multiple possible futures, we can identify potential weaknesses in our strategies and may be able to make adjustments so that they would perform well in a *range* of situations; in other words, they would be *robust.* Looked at narrowly, this may appear to involve more work. But, if a longer view is taken, the increased probability of a robust decision means that using futures is very likely to repay the up-front investment simply because bad decisions tend to be very expensive and time-consuming. In fact, there is a growing body of evidence concerning the effectiveness of using futures (Schwenk and Shrader, 1993; Phelps, Chan and Kapsalis, 2001; Chermack, 2004; Visser and Chermack, 2009).

1.4 Key terms

Here we introduce three concepts that will play a central role in the rest of this deliverable.

1.4.1 Vision

Every city government has a purpose. This may be set out in statute or may not in fact be written down. It may be well defined or quite vague. It may be broad in its reach or relate to a small number of areas of impact. But, in some sense or other, every city knows where it is trying to go. In this document, we use the term **vision** for *a picture of the future as the city would like it to be*. This may, for example, involve healthy and prosperous citizens living in a thriving place and enjoying a high-quality environment. Such pictures may be somewhat abstract, making it hard to know whether the city is moving towards the achievement of its vision or not. Some cities deal with this by setting quantified targets instead. For example, the Mayor of London has adopted a target of achieving a share of 80 per cent for sustainable modes by 2041. Both approaches have strengths and weaknesses but, whichever is adopted, a city will struggle to benefit from using futures without a vision and/or set of targets. Of course, the concept of vision is fundamental to sustainable urban mobility plans (SUMPs) so should be familiar to many readers.

1.4.2 Measures and packages

In this document, we use the term **measures** to describe the range of actions open to a city to help them achieve their vision. **Note that** these measures are much more wide ranging than the ones being tested in the street layout design exercises, but many will be relevant to the future conditions impact area analysis (e.g. including rail provision and fares policies).

All cities have a set of measures available to them. The size of this set will be a function of a wide range of factors, including funding, jurisdiction and institutional capacity. The practical

range will also be partly determined by political appetites, the power of vested interests, and culture. But cities will always have certain decisions to make about what to do, even if it is a simple matter of deciding whether or not to carry on as before. We acknowledge that single measures are rarely applied in isolation but that cities will ordinarily combine them into **packages** of measures that, in combination, are designed to achieve a particular goal.

Though it lies outside the strict scope of this document, the business of identifying the largest possible set of feasible measures is critical to good transport planning. Far too often, cities limit themselves to the types of measure that have been used before or that feel comfortable. But cities should instead cast their nets widely, including in their set measures those which are unfamiliar or, potentially, uncomfortable.

1.4.3 Scenarios

In this document, we use the term **scenarios** to talk about things that might happen *to* a city. This recalls our introduction above to futures.

Scenarios require a certain amount of explanation[1] and so we go into more detail on this in the next section. For now, we say that a scenario is a picture of one possible future set of circumstances to which the city may need to respond. It consists of a combination of elements that lie *largely* outside the city's control – the nature and use of technology, the structure of the wider economy, major trends such as climate change, to give some examples – but which will greatly affect what the city needs to do and what it is able to do.

In order for scenarios to be useful, we need more than one of them and they must be quite different. This diversity forces policy makers to accept the inherent uncertainty they face in preparing for the future and to concentrate on making *robust* selections of measures accordingly

[1] "Scenario" is a word used to mean different things so it is important to be clear about the definition we are adopting in this document. See the next section for a fuller explanation.

Are You Ready?

Carrying out a futures exercise requires resources and commitment and it will not be beneficial in all cases. We set out below a self-diagnosis questionnaire which may help you to determine whether your city is ready to embrace uncertainty

Does your city have a well-defined vision? *Futures methods will be of very limited value if the city lacks a shared understanding of the desired future.*

Does your team have the resources to take on this task in addition to its existing workload? *Whilst a futures method such as scenario-based planning does not need to involve a great deal of effort, even the "lightest-touch" exercise will require a significant number of person-hours, especially if stakeholders are brought into the process.*

Do you have the skills to carry out the task? *Futures methods may not be 'rocket science', but there is an art to them. If your team does not include individuals who are willing to have a go, would there be scope to pay a third party to facilitate the process? There are considerable side benefits, as someone external to the organisation can ask difficult questions and may detect important characteristics in the city that insiders would miss.*

Do you have senior support? *To be most useful, a futures exercise needs to enjoy the sponsorship of individuals sufficiently senior within an organisation to persuade (or instruct) others to participate. If the necessary leverage is lacking, it may be more sensible to choose a method that is more exploratory, such as horizon scanning.*

Are you/your organisation motivated? *There is no point in embarking on a futures exercise if there is little belief in the exercise. You should only devote the effort if you are committed to embracing uncertainty. Futures methods have tended to take root in organisations either because key individuals are enthusiastic or because the organisation has undergone some form of crisis associated with pursuing a singular view of the future.*

2 An overview of scenario-based planning

2.1 Introduction

Because we cannot do justice to all futures techniques in this deliverable, we are looking at one technique – scenario-based planning – in detail. We have chosen scenario-based planning because it is well established, relatively straightforward to understand, and can be done with different levels of intensity. Thus, the techniques explained in this document can be applied by a city in a series of half-day workshops involving only the immediate team, or over the course of years, drawing in a wide range of stakeholders and possibly involving independent consultants.

We are not presenting scenario-based planning as the only futures method or, for that matter, the best futures method. It simply provides us with a practical way of setting out the fundamentals of doing futures at a city level. We urge cities to investigate other methods and seek out a way of doing futures that best suits their circumstances and culture. See Section 5 for a range of resources concerning other methods and Section 5.4 for case studies of organisations that have derived value from using futures.

In the rest of this section, we introduce the key ingredients of scenario-based planning at a general city level. We then turn in the next section to the question of how to apply it at a corridor level.

2.2 A fuller description of scenarios

We have already defined a scenario as a picture of one possible future to which the city may need to respond and we have said that it is necessary to have more than one scenario in order to derive benefit from the exercise. In this section, we start with some examples, before going into more detail.

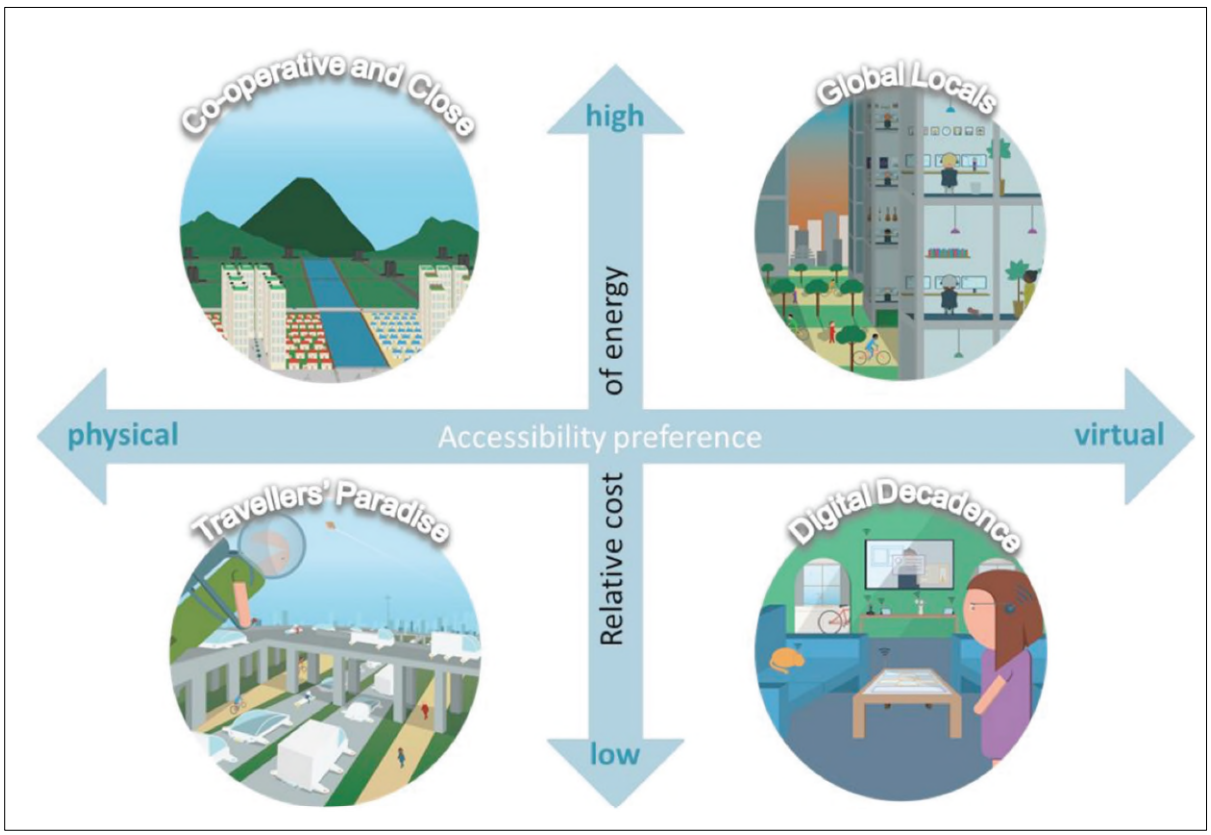


Figure 2: Example scenarios from (Lyons, 2016)

Figure 2 shows a summary of the four scenarios created as part of the FUTURES project carried out by the UK's Chartered Institute of Highways and Transportation (Lyons, 2016). This set was created "deductively" (see Section 2.2.3).

Transport for London (2019) used an "inductive" process to develop its three scenarios, described briefly in Figure 3.

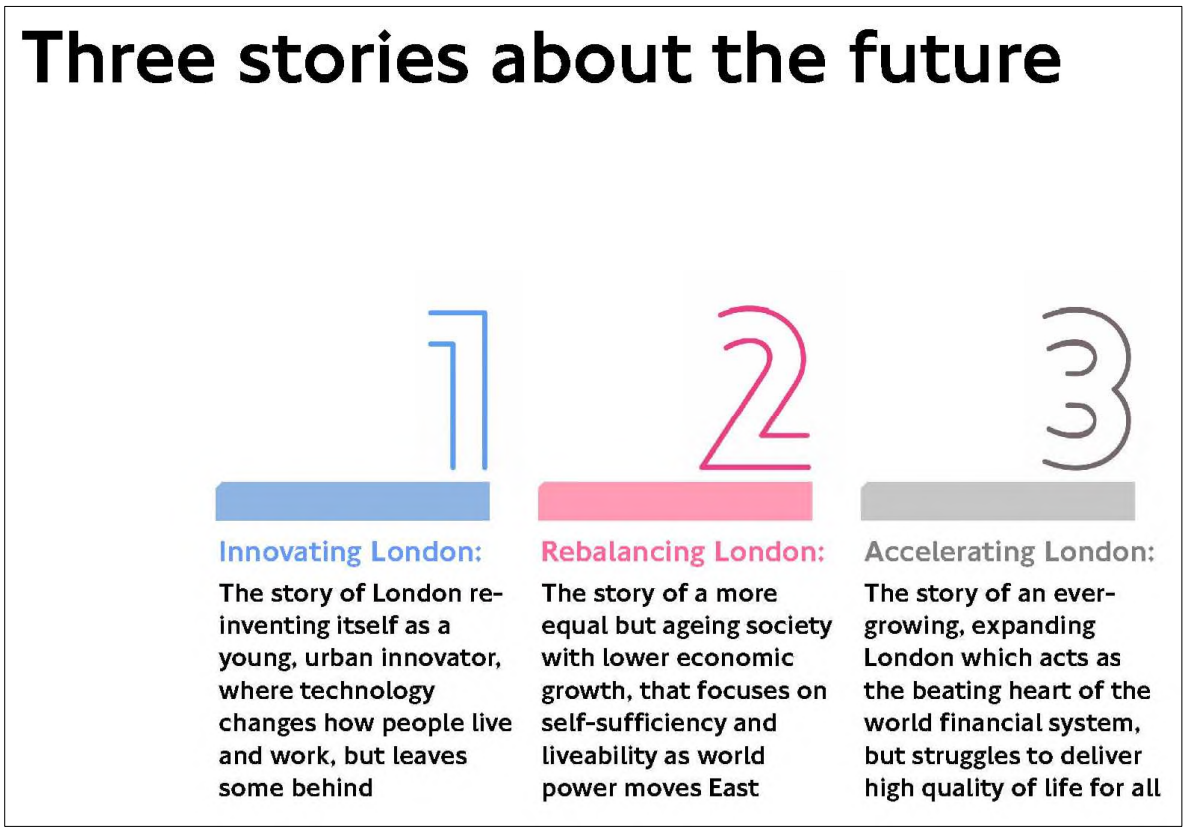


Figure 3: Brief descriptions of TfL's three scenarios (source: Transport for London 2019)

2.2.1 Transactional and contextual environments

One important concept is the distinction between the "transactional" environment and the "contextual" environment. Cities conduct *transactions* with a wide range of other "actors" – their employees, their tax-payers, neighbouring authorities, suppliers, local politicians etc. Because they conduct these transactions, they have some influence over these actors. This influence varies, of course: it is easier to influence the behaviour of one's employees than that of the central government. The group of actors with whom the city conducts transactions (and over which the city has some influence) is called the "transactional environment". Beyond this group lie numerous factors over which the city has little or no influence but which have the capacity to affect the city significantly. This may be other countries' policies, environmental changes, technological advances, socio-economic shifts, migration, developments in the energy sector etc.

The boundary between the two environments is somewhat fuzzy but this should not cause any difficulty. **The key point is that scenarios relate to the wider contextual environment.** That is, they consist of events over which the city has little if any influence and to which the city may have to respond. In doing so, the city would also interact to a greater or lesser extent with the actors in its transactional environment. This idea – that scenarios consist of events beyond the city's control – is crucial to their being useful to the planning process. In particular, a clear separation must be maintained between *scenarios* –

things that might happen to a city – and the city's *vision* – the future that the city actually seeks. Note that, if the vision has been appropriately formulated, it will consist to a great extent of elements which the city is well placed to affect.

The items that are identified in either the contextual or the transactional environment are collectively referred to as **drivers of change**.

See Figure 4 for Transport for London's representation of these two environments from the perspective of its organisation. See also Section 2.4 for a description of Transport London's experience of using scenario-based planning.

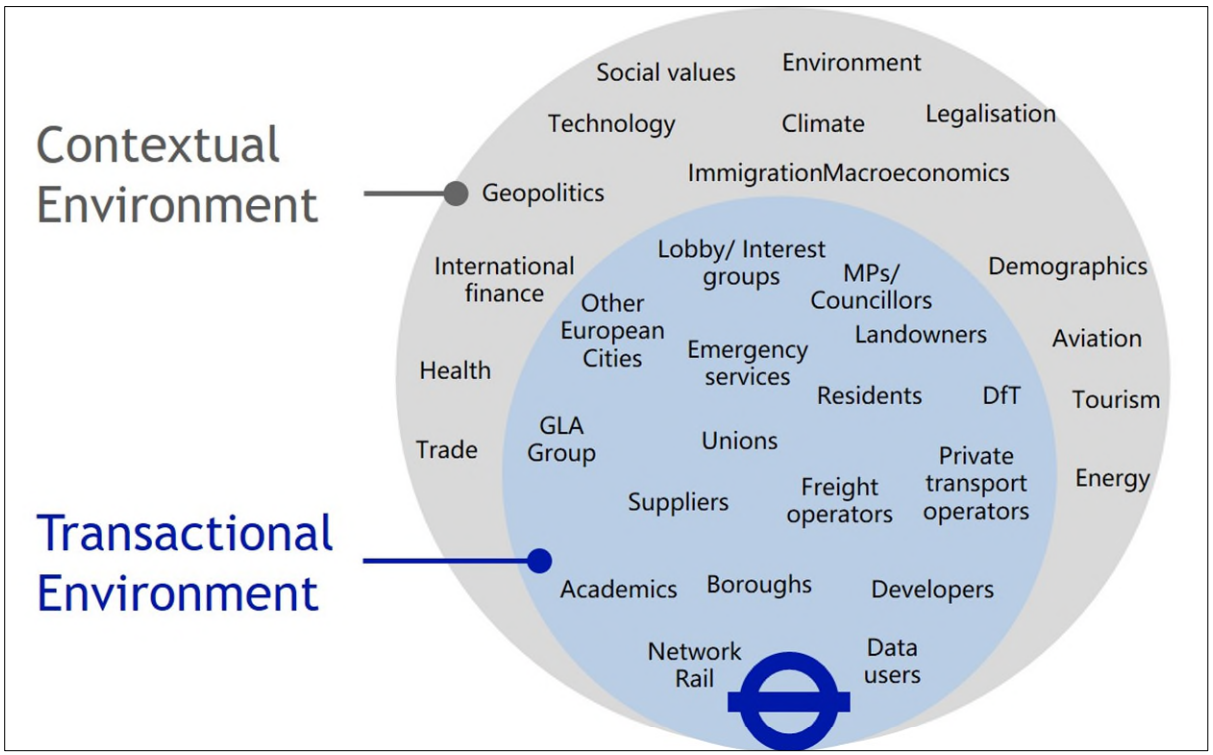


Figure 4: Transport for London's representation of its transactional and contextual environments (source: Transport for London 2019)

2.2.2 Scenarios: of what kind and how many?

Each scenario needs to combine events or developments **plausibly**. This is important because, if any influential stakeholder says of a scenario that they do not believe it could happen, its usefulness will be greatly reduced. But there is an important difference between *could* and *will*. All that is required is for stakeholders to see a given scenario as *possible*, not necessarily *likely* or *desirable*. In fact, a scenario will be most useful if it lies at the very edge of what is considered plausible, because it will subject any package of measures to the most rigorous test.

Task: map your ‘contextual’ and ‘transactional’ environments

Referring to Figure 4 above, carry out a similar exercise for your city. The goal is to arrive at a comprehensive list of factors and actors which make up your city’s operating environment, separated into the two groups, transactional and contextual, reflecting the extent of influence you have over them. This is a task that can be carried out within your team but a more complete understanding will be reached if you are able to discuss this with a number of selected stakeholders both within and outside the organisation. (This would have the advantage of “warming up” those stakeholders for future involvement in the scenario-building and –using exercises that may follow.)

When attempting to identify elements of either the transactional or contextual environment, it can be helpful to use an aide-memoire of some kind. One such is the so-called PESTLE framework, which places items in a set of categories: Political, Economic, Socio-Cultural, Technological, Legal, Environmental. If you spend some time thinking about each of these categories in turn, you are likely to arrive at a reasonable list in a short time. You may also find helpful the division of factors in Figure 9.

For each item you identify, you need to ask whether it belongs in the transactional or contextual category. In fact, it can be helpful to think instead of a continuum of influence. As Transport for London’s example shows, large public entities have very large transactional environments: if Transport for London discontinued running transport services, for example, a large part of the UK’s south-east would be profoundly affected. By implication, there are relatively few factors over which a city can be said to have absolutely no influence. It can therefore be a challenge to find factors that definitely belong in the contextual environment and you are therefore advised to put in that list factors over which the city has at most limited influence. Thinking again of Transport for London (TfL), it would be possible for TfL to have an impact on migration patterns through its management of transport. For example, if the transport network developed a reputation for being unmanageably overcrowded, this might affect individuals’ decisions to relocate to the city. But the decision to relocate is a function of many considerations of which transport is only one. For this reason, migration should be seen as belonging in the contextual environment.

Having said that, organisations typically understate their influence over phenomena and other actors so it is a useful exercise to test whether any item you propose to put in your contextual environment really belongs there: is your influence over it really so slight?

This exercise can be of use to your organisation as part of a strategic planning exercise, whether or not you go on to produce and use scenarios.

You can find sources of guidance on doing this in Section 5.2.

We said above that there need to be two or more scenarios in order for them to be useful to the planning process. This is because scenarios describe possible futures rather than what we think most likely to happen. As soon as there are two scenarios, we know that they cannot *both* come to pass. And, because we *cannot* choose between them, we are forced to ask whether our plans are likely to succeed in *both* scenarios. The more scenarios we develop, the more robust our plans need to be, because they have to succeed against a greater number of distinct possible futures. At the same time, the more scenarios we develop, the more cognitive load we place on ourselves.

In practice, the recommendation is not to exceed five scenarios because, if the number is any larger, stakeholders will struggle to retain in their minds the distinctive characteristics of each, which will make it difficult to use the scenarios productively. On the whole, most practitioners find **three or four scenarios** to be optimal – enough to provide a sufficiently exacting test of any measure or package, but not so many that stakeholders get lost.

In addition to lying at the edge of plausibility, scenarios need to be as different as possible from each other. This combination of characteristics is illustrated in Figure 5, which shows the plan of a baseball field used to represent the "possibility space" (sometimes also referred to as the "envelope of uncertainty"), with scenarios represented as red stars. We note that each scenario lies at the edge of this possibility space, reminding us that the most useful scenarios lie at the limit of what is considered plausible. We also note that the scenarios are located far from each other, which emphasises that each will be distinct. We will learn less from scenarios that are very similar to each other because a plan that will succeed against one is very likely to succeed against the other.

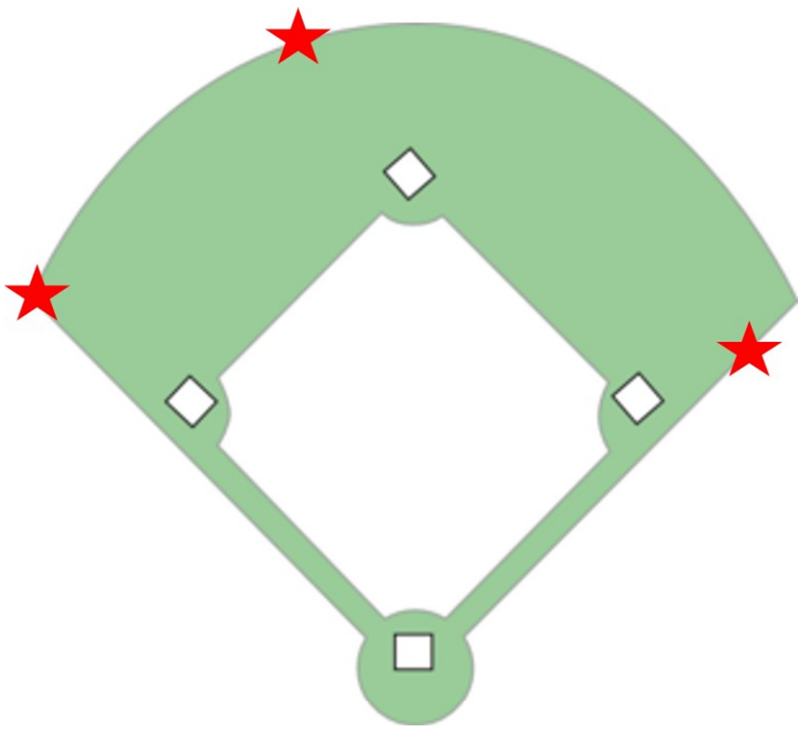


Figure 5: Maximising difference between scenarios

There is a natural temptation to make one scenario a projection into the future of "business as usual" (BAU). We advise against doing this, because it is likely to prove a distraction. When compared with scenarios that represent the extremes of what is possible, stakeholders are apt to think the BAU scenario more likely, because it is both familiar and less extreme. It is not helpful to think about the relative likelihood of scenarios so, whilst it is possible to control this tendency, it is easier all round if there is no BAU scenario in the first place, not least because it would not conform to the principle of putting all scenarios at the edge of the possibility space.

Having said that, transport appraisal tends to be carried out against an agreed prediction of future conditions. This is variously called a *central forecast*, *BAU* or *assumed future* (Transport for London's term for it). We shall return to this later but, at the scenario-development stage, BAU has no role to play, so cities should try to omit it from their thinking. For more on this, see the box entitled *What is business as usual?*

What is business as usual?

Cities tend to need a working picture of the future for a variety of purposes, including the appraisal of transport packages. Packages tend to be appraised against a supposedly neutral future, often called the "do minimum" in the UK. But there's slightly more to this than meets the eye so it deserves a little explanation.

Do minimum turns out to have two sets of ingredients:

- One set is the received wisdom concerning relevant trends – population, jobs and car ownership, for example
- The other set is the collection of committed schemes – measures which the city considers will definitely go ahead

These sets are brought together in forecasting models and the division between them may then be lost but it is helpful to note that the first set lives in the contextual environment and the second in the transactional environment. This is important when working with scenarios because, as we have said, scenarios inhabit the contextual environment. We return to this topic in our discussion of appraisal.

2.2.3 What do scenarios look like?

There are numerous approaches to developing scenarios but two are used most extensively – "deductive" and "inductive". Scenarios developed using the deductive method are typically plotted on two axes. The process by which they are developed is as follows:

- Stakeholders agree on two areas of uncertainty that are particularly important for the city
- These are form axes and placed perpendicular to each other
- Four scenarios are then created, one for each possible combination of "high" or "low" on the two axes.

In the inductive approach, stakeholders build up stories by combining brief storylines into larger narratives, iterating until a small set of useful and distinct scenarios emerge. Scenarios developed using the inductive method will not automatically be linked in the same way as those developed using axes, though it can be useful to find a succinct way of summarising how the scenarios differ from each other. For example, Transport for London characterises the three scenarios it has developed as differing in terms of which of three sets of actors (the market, the state, the citizen) holds the power (see Figure 6).

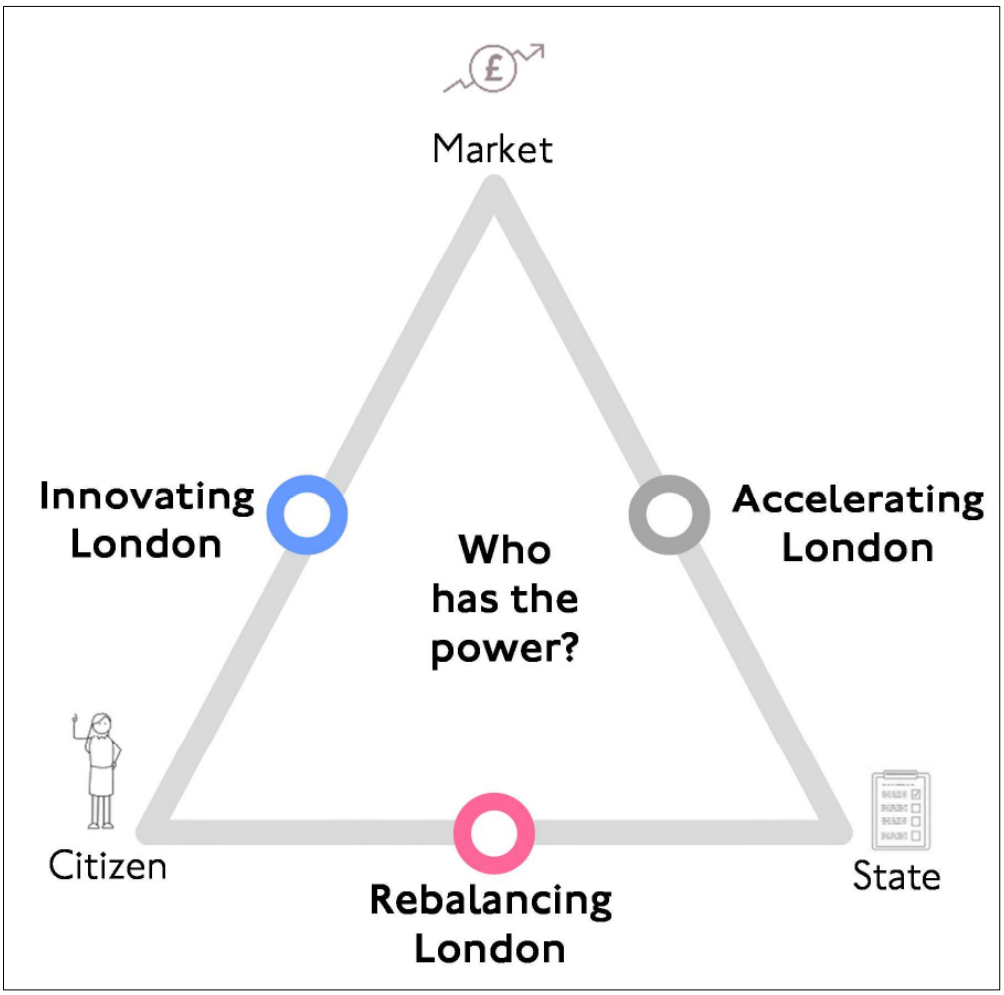


Figure 6: TfL's scenarios in terms of the balance of power between the market, citizen and the state (source: TfL, 2019)

In terms of form, scenarios vary in their length, the level of detail provided, and their presentation (see Section 5.3 for references to some examples) though it is very common to see descriptions of example individuals living within a scenario as this can help to bring it to life. See, for example, pages 88 and 89 in Waverley Consultants (2017) for a written description of one scenario about the global economy created as part of a deductive scenario-development process. One key differentiator is whether quantities are estimated as part of the scenario-development process. Some organisations do not go this far, being satisfied that a qualitative description of the scenarios will be sufficient for their needs.

Organisations with a culture of working with numbers commonly develop sets of indicators to accompany their scenarios, to support their use in package development (see next section). As to presentation, many organisations see value in "selling" the scenarios they have developed to internal and external stakeholders and therefore devote effort to producing polished and attractive reports that set out both the development process and the scenarios that resulted. Whilst this may be a very sensible course of action, it is not essential to making use of the scenarios in planning activities.

2.2.4 What scenarios are *not*

Having spent some time talking about what scenarios are, it is worth making some brief points about what scenarios are not, to avoid confusion.

First, scenarios are neither "good" or "bad". As we have said, a clear distinction needs to be made between scenarios and the city's vision. We would expect the vision to be good – why else would the city be pursuing it? – but we must remember that scenarios are things that may happen *to* a city. A *useful* scenario will be a mixture of things that the city might welcome and things that city would find difficult or challenging. If you find yourself developing one scenario you like and another you dislike, you should deliberately put some unwelcome elements in the "nice" scenario and some developments you would welcome in the "nasty" scenario to help remove the imbalance. If you do not do this, you and other stakeholders are likely to start "rooting for" the scenario you find more attractive and this is likely to undermine the whole scenario-based planning exercise. At the risk of sounding repetitive, the purpose of scenarios is to help you make good decisions about what you are going to do. You should have already answered the question of which future you desire as part of setting your vision, before embarking on a scenario-development process.

It is also essential to understand the difference between scenarios and *sensitivities*. For the purposes of this document, a sensitivity is a slight variation of an existing forecast. For example, many cities will produce "central" forecasts of population or traffic. Sensitivities will then be produced, differing from the central forecast by perhaps five per cent. Whilst these may be useful for some tasks, they will not serve the purposes for which scenarios are developed. In fact, because sensitivities often constitute the central forecast plus or minus *x* per cent, they can easily serve to reinforce faith in the central forecast, as stakeholders see it as the happy medium.

See Figure 7 for an example of what are clearly sensitivities around a central traffic forecast.

This example makes our point about happy medium well, because there are three lines above the "reference" case and three below. If the lines represented scenarios as we use the term (rather than sensitivities), they would diverge very much more by 2050 and there would be at least one line that represented a fall in traffic!

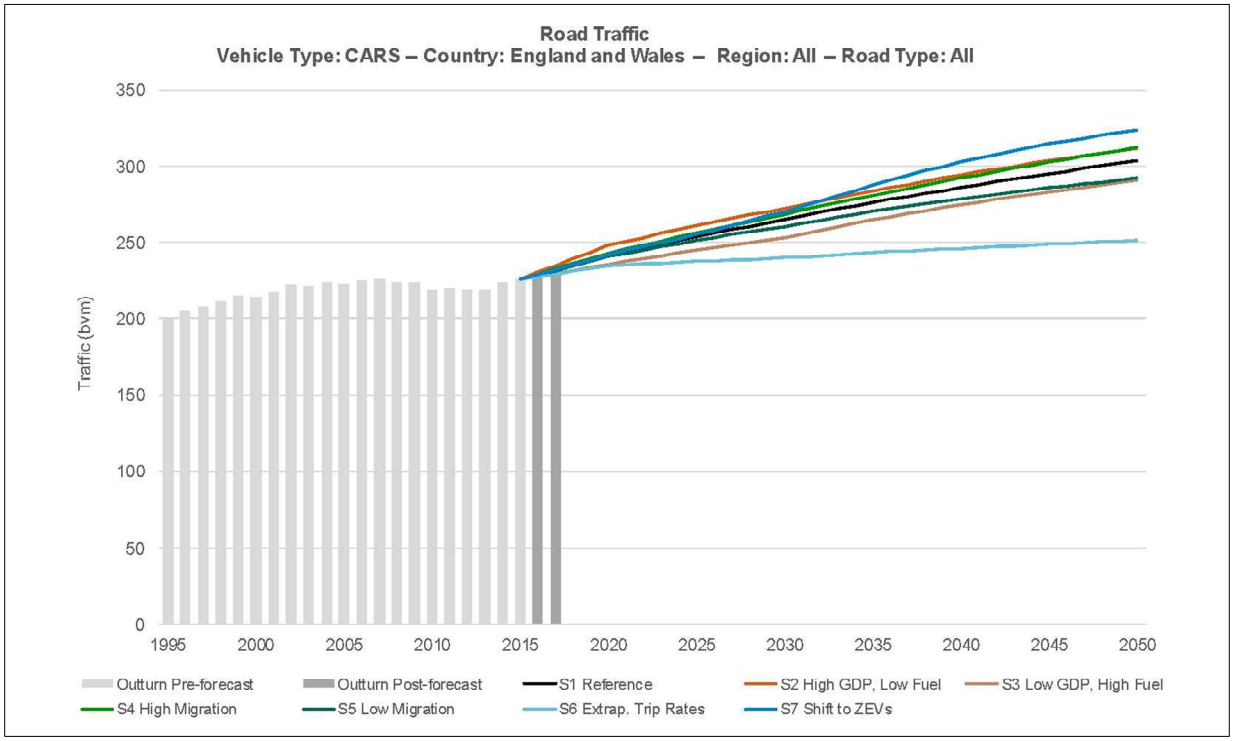


Figure 7: Example of sensitivities in traffic forecasting (Department for Transport, 2018, p. 53)

2.3 How to use scenarios to support planning transport

We have argued above that the value of using scenarios (and other futures methods) lies in the robustness that it will impart to your city's plans. How does this happen? We identify three ways in which cities can make practical use of scenarios. These can be applied individually, in sequence, and/or iteratively, to reflect the city's needs.

2.3.1 Wind-tunnelling

The term "wind-tunnelling" has become the standard way of referring to the use of scenarios to test a given measure or package of measures. It derives from the use of wind tunnels to test the aerodynamic properties of vehicles or buildings when they are at the prototype stage. In this case, the package or measure represents the prototype vehicle and the scenarios represent different wind speeds and directions. Cities should be looking to see whether their draft package will perform satisfactorily under each scenario.

This can be a qualitative exercise: for example, if the measure is a major expansion of the city's light-rail system, the sorts of question that should be asked for each scenario include:

- Would there be enough passengers to make the system viable?
- Would there be too many passengers for the system to carry?
- Would passengers be able to afford the fares?
- Would passengers' desire lines be well matched by the network?

It can equally be carried out using modelling tools, with the sets of indicators developed for the scenarios used to test demand etc for the expanded system.

The wind-tunnelling exercise should, if conducted in earnest, produce useful findings concerning the scope of the package to perform satisfactorily in each scenario, respectively.

2.3.2 Package refinement

This leads on naturally from wind-tunnelling: if the candidate package appears weak against one or more of the scenarios, the immediate question is whether it can be revised so as to perform better. If not, this suggests that the city needs to make a fresh start. But, if there is reason to believe that the package can be remedied, the scenarios can be used as a basis to refine it, referring to questions of the sort set out above. For example, if passengers' desire lines would not be well matched by the network under Scenario B, say, the city should ask whether alterations to the network or service could be made which would both improve the match under this scenario and retain the existing good match under the others.

It is very important to avoid falling into the trap of thinking that, if a package appears to perform well against all scenarios a city has developed, it is bound to be a success. We must all remember, instead, that scenarios are nothing more than examples of possible futures and that they cannot exhaust the envelope of uncertainty. Having said that, it is very likely that a package that does indeed appear to perform well against all the scenarios will be more robust than one which has a more mixed performance.

2.3.3 Formal appraisal

By this term, we mean the methodical assessment of a package's potential impacts under the different scenarios (which might affect levels and patterns of demand and some aspects of private-sector transport provision). But, whereas with conventional appraisal this is generally done against a single view of the future (the business-as-usual future discussed above), here the appraisal is conducted against each scenario in the set. In this respect, this process resembles wind-tunnelling described above but, whereas wind-tunnelling is asking more immediate questions about feasibility and viability, appraisal can be expected to cover the package's potential effects in terms of safety, environment, the local economy etc. This means that appraisal ordinarily depends on a degree of quantification and so is conventionally carried out when a set of numbers has been associated with each scenario (though meaningful appraisal is possible without recourse to quantified results). The greater breadth of appraisal also implies that more data will be generated through this exercise than through wind-tunnelling.

In conventional appraisal, there may be an acknowledged "pass mark" by which a city would normally decide whether a package deserves to be taken forward. In the absence of a pass mark, there may instead be a set of informal rules of thumb which enable a decision concerning the package to be taken. When appraisal is undertaken against multiple scenarios, however, each package receives a set of "scores" (see Table 1). How should this be interpreted?

Table 1: Matrix of three packages' performance against three scenarios

	Summary of package performance		
	Package A	Package B	Package C
Scenario 1	+	++	-
Scenario 2	+	0	--
Scenario 3	--	-	+

Table 1 presents the scores of three packages[2] (A, B and C) against three scenarios (1, 2 and 3). Each package's performance against a scenario is summarised using a five-point score ranging from ++ (very positive) to -- (very negative).

There is a natural temptation to calculate the average of a package's scores across scenarios; in the case of Table 1, this would make Package B the "winner". But this should not be done because the value of the scenario-wise appraisal is to show particular strengths and weaknesses (which can of course be used to refine a package as described above); if the average of a set of values is calculated, it is likely that this detail will be overlooked.

Moreover, we need to remember that the scenarios are only example futures and must not be thought of as representing the range of possible futures. To take averages across a set of scenarios is therefore to be avoided also because the resulting numbers are not *meaningful:* they will not be a reliable indication of how "future-proof" a package is.

Given that averages are not to be used, the city should instead look at a package's set of appraisal scores and, first, ask whether any poor scores can be tackled through refinement (as discussed above). Post-refinement, the set of scores should be again reviewed.

A package that appears to perform well across the set of scenarios looks stronger than one that is weak in at least one scenario (as with wind-tunnelling) and the city may feel justified in cautiously adopting that package, though the point made above about future-proofing holds: there are almost certainly other scenarios (not part of the city's existing set) against which this package would perform poorly. The city can in fact use this question – in what circumstances would this package be a failure? – as a the basis for creating a further scenario, if this is thought helpful.

It is less straightforward to make a decision about a package whose performance across the scenarios (even after refinement including risk mitigation) is more mixed. Here, if the

[2] Whether the city appraises a single package or a set of packages will be its decision. We use a set of three packages here for the purposes of illustration. There is, though, a strong argument in favour of developing and testing multiple packages when working with scenarios: because few packages can be expected to achieve the "pass mark" in all scenarios, *relative* performance becomes very important.

package enjoys stakeholder support, it is essential to resist the temptation to play down the scenario(s) in which it underperforms, as this would be an instance of confirmation bias.

It is useful here to mention Transport for London's (2019) threefold approach – reconsider, adjust, proceed:

Reconsider: if a proposal does not meet the organisation's objective in any of the three scenarios, the presumed course of action is to look at other options

Adjust: if the proposal does not meeting the objective in two of the three scenarios, attempts should be made to adjust it so that it performs better

Proceed: a proposal that meets the objective in two or all of the scenarios should be cautiously taken forward

2.4 Transport for London's scenario-planning journey

A few years ago, Transport for London (TfL) identified something striking and unexpected: trip rates, time spent travelling and *per capita* mobility were all reducing. TfL's forecasting apparatus had not predicted this and staff were not immediately able to explain it. Some uncertainty remains, in fact, concerning the explanation for the trend. At approximately the same time, Uber, which had been operating in London since 2012, began to have a discernible impact on the transport network, with demonstrable increases in road traffic. Despite the fact that Uber was not radically new – London has had a relatively liberal "private-hire" market for a long time – the convenience and apparent low price of Uber had led to its gaining a significant market share in a relatively short time. These "shocks" led TfL leaders to question their previously deterministic forecasting techniques.

At this time, TfL was participating in CREATE (Congestion Reduction in Europe – Advancing Transport Efficiency), a Horizon 2020 project. One of CREATE's work packages was centred on addressing the future. As part of this, a two-day workshop was arranged at which four of CREATE's partner cities undertook a basic scenario-planning exercise. TfL stakeholders who were present concluded that this method could be useful to them and they began a comprehensive scenario-based planning exercise, with the assistance of a specialist consultancy.

TfL staff conducted numerous interviews with internal and external stakeholders in the run-up to a large stakeholder workshop drawing together senior people from across the organisation as well as a number of relevant external stakeholders. At this day-long event, participants worked in teams to review a number of presentations concerning relevant or challenging trends identified in the research phase. They then began to build up storylines (see Section 3.2.5) before working up fuller scenarios (Section 3.2.6).

The four scenarios that were developed at the workshop were then finessed by the core scenario team (in TfL's City Planning directorate) together with the consultants and three more distinctive scenarios emerged. These were the subject of a second, "validation" workshop at which a similar group was convened to review and critique the embryonic scenarios.

Following this, members of City Planning embarked on a carefully planned dissemination and communication strategy, working towards a point at which the scenarios would be adopted by the organisation as a whole. This process is well advanced and TfL has now placed the results in the public domain (Transport for London, 2019).

In parallel with this process, staff embarked on a quantification process that will enable proposals (measures, packages) to be tested against each of the three scenarios, alongside the central forecast (which TfL calls its "assumed future").

The view of the consultant who assisted TfL through this process is that it has become a scenario-planning organisation. Given the size of the organisation and the unfamiliarity of this method amongst the majority of its senior staff, this is a remarkably rapid transition.

3 Developing and using scenarios for MORE impact areas[3]

***Note**: the majority of this chapter is dedicated to creating and using scenarios of the sort that has been described and discussed in the previous section. But, because this can be a resource-intensive process and may require skills which the city cannot readily acquire, we offer in Section 3.5 a "lighter-touch" alternative method for cities that wish to obtain some of the benefits of working with uncertainty but cannot at this stage commit the resources necessary to fully-fledged scenario development. These alternatives are summarised below in flowchart form, in Figure 8.*

The previous section talked about the development and use of scenarios in generic terms and most of the examples mentioned related to "whole-organisation" scenarios. Whilst the techniques described could all apply in a MORE context, we talk in this section about developing and using scenarios with feeder routes and their wider impact areas particularly in mind. Before we proceed, it is worth saying a word to justify inviting cities to develop their own scenarios rather than providing a set of ready-made scenarios: as Miller puts it, "the journey is more important than the destination" (Miller, 2018, p. 221). That is, a major benefit of developing scenarios comes from the development process itself and the usefulness of the scenarios themselves will depend on the extent to which the city (or teams within the city) have been invested in the process.

We start by identifying what differentiates impact area-orientated scenarios in MORE from more conventional scenarios, before offering guidance on developing such scenarios and then using them constructively in the planning process.

[3] In MORE, we deliberately use the term "impact area" very widely to reflect the fact that it will never be a single road or railway line. Instead, movement into and out of a city within a sector will have a large impact area and this should always be borne in mind. In particular, scenarios must *not* be narrowly conceived.

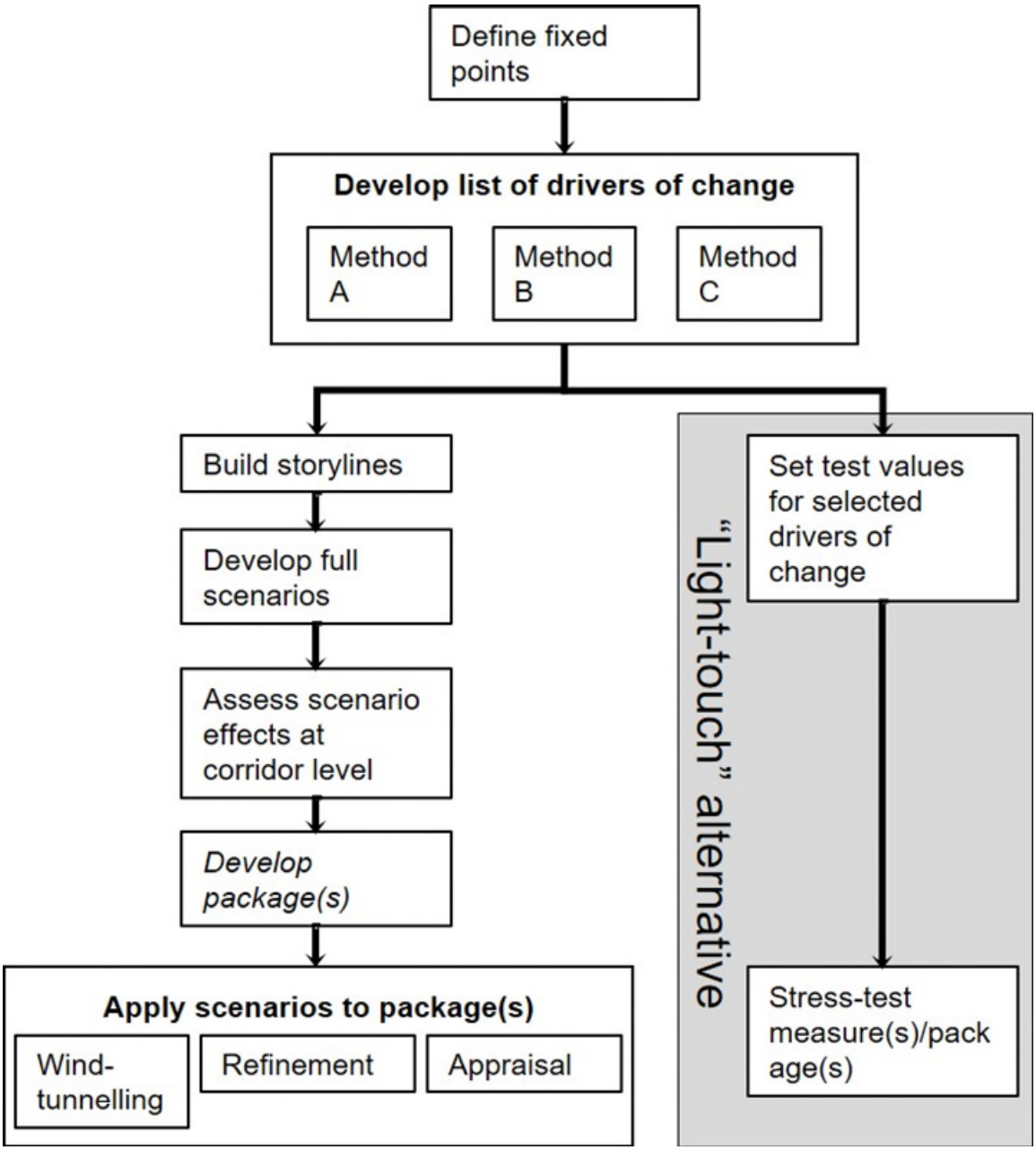


Figure 8: Developing and using scenarios - process

3.1 Impact area-orientated scenarios in MORE – specific characteristics

Impact areas are special cases when developing and using scenarios in at least two ways:

- **A local focus** – even a feeder route (and its associated impact area) that passes from one side of a jurisdiction to another has a much smaller total area than the jurisdiction as a whole. This necessitates a higher level of detail than at the city level when thinking about how a scenario might play out and how a package might perform against it.

- **A natural emphasis on movement** – whilst the "place" element of MORE feeder routes is of course crucial to their success or failure, the very fact that we are talking about major routes rather than neighbourhoods implies close scrutiny of the role of movement as well.

We can add to this the fact that the focus in MORE on technological advance implies an interest in this side of scenarios in particular and readers should regularly refer to Deliverables 3.1 and 3.2 as they develop and use them as a resource in their scenario development. Though this should not mean that non-technological aspects of scenarios, such as socio-demographic change, are given only cursory attention, it suggests an additional level of scrutiny for technological aspects, partly because there is a natural interaction between the technological context and the sorts of measures that are being considered in MORE. For example, the uptake of electric vehicles would have a major influence on the need for and type of charging infrastructure that the city may plan to deliver or enable as part of its strategies.

3.2 Developing scenarios at the impact area level in MORE

3.2.1 Define fixed points

Whichever way in is adopted, a useful initial task is to list all known "fixed points" that are relevant to the wider impact area: these are any future events about which the city is sufficiently confident that it makes sense to incorporate them in all scenarios. This recalls the box entitled *What is business as usual?* Fixed points will for the most part inhabit the transactional environment.

They are likely to include:

- Major housing developments
- New committed transport infrastructure
- Land-use changes, e.g. rezoning or release of new land for development

It is natural that confidence concerning fixed points will diminish as one looks further into the future, so the list is likely to consist mainly of near-term developments.

You are urged to be sceptical in developing this list, and to include only those items about which there is general consensus. To give an example, whilst construction has started on HS2, the high-speed rail line between London, the West Midlands and the north of England, it remains possible that the scheme will be abandoned. From London's perspective, this would have massive effects on likely patterns of demand at Euston and Old Oak Common (HS2's two proposed London stations). It would therefore be rash for Transport for London to treat HS2's completion as a certainty when developing scenarios.

Having defined any fixed points, the next step is to develop a list of drivers of change. There are several potential "ways in" to this process. We describe three below, each of which will produce a list of drivers of change that will form the basis of scenarios.

3.2.2 Method A: Using the city's vision as a reference point

Of the three methods we describe, this is definitely the strongest.

If your city has an overall vision (a picture of the future world that city stakeholders would like to see) or a transport-specific vision, this is a sensible place to start.

Having created this translation of the vision to the impact-area level, the next step is to ask which changes in the contextual environment[4] (see Section 2.2.1) would have greatest effect on the city's ability to achieve its vision.

Task: define what the vision looks like at the impact-area level.

For each element of the city vision/city transport vision, attempt to articulate how this would be manifested in the impact area you have in mind, being as specific as possible. For example, if there is a presumption of good air quality in the city vision, how would this translate to the impact area? If a given maximum level of pollutants has been stipulated, should this apply at the impact-area, or the feeder-route, level or would there be grounds for tolerating a slightly higher level given the expectation that the feeder route will carry relatively large volumes of traffic? If the vision talks of a good quality of life, what does this mean for the residents of the impact area and the feeder route and those who work within or along it? Is it possible to quantify defensibly this element of the vision?

In the case of London, the central target of the current Mayor's Transport Strategy is across London as a whole, 80 per cent of journeys should be made by sustainable means by 2041, so an immediate question for London in working towards scenarios for its MORE impact area is whether this modal target should be different for this particular part of London.

It is almost certain that some aspects of the vision will appear beyond the reach of any mobility/transport package (particularly if it is a general city vision) but a comprehensive job should be done nonetheless; later on, decisions can be made concerning which aspects of the vision may lie beyond the reach of any package the city might implement in its impact area.

It is worth saying that there is a significant side-benefit to approaching scenarios in this way: it will provide the core of any appraisal framework that might be used to assess candidate strategies (see Deliverable 4.4).

[4] The interpretation of "contextual environment" may be the same for the city and the corridor, in the circumstances that the jurisdiction is the same for both. But it is possible that the team with responsibility for the corridor does not control the agenda for the wider city. If this is the case, items that would appear in the city's transactional environment may appear in the corridor's contextual environment, reflecting a lower degree of influence on the part of the corridor team. Such items could then reasonably feature in any corridor scenarios created.

In Figure 9, a city's contextual and transactional environments are divided into three segments, representing drivers of change that are a) non-technological; b) transport; and c) technological (not transport). Such divisions can help cities to avoid missing important drivers of change as they develop their lists.

This process should be carried out iteratively (see Box below), with each element of the corridor-level vision (improved air quality, reduced traffic injury) considered in turn. This will produce a series of lists of most relevant drivers of change. The lists should then be aggregated and all duplicates removed. The result will be a **comprehensive set of drivers of change** in the contextual environment of greatest relevance to the city's vision at the corridor level.

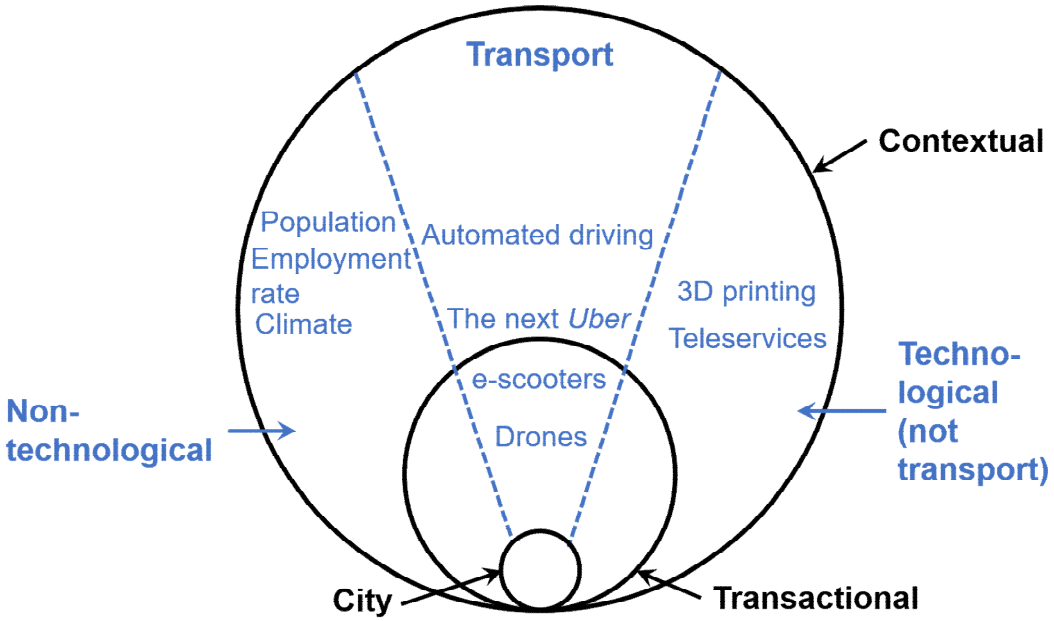


Figure 9: Three categories of drivers of change in the contextual and transactional environments

Changes in the contextual environment bearing on the vision at the impact area level.

Let us suppose that one component of the impact area-level vision is improved air quality. Factors in the contextual environment that could influence the air quality in the area include:

- Advances in new fuels, engine efficiency
- Development of battery/fuel cell technology, electric vehicle design
- Development in charging infrastructure
- Relative capital and running costs of various vehicle types and technologies
- Socio-demographic changes (e.g. population size, age structure, level of economic activity)

This exercise should be repeated for each component of the corridor-level vision.

3.2.3 Method B: Developing your own list of drivers of change

This method is less effective than Method A, but it will produce useful results in the event that your city does not have a sufficiently clear vision to enable Method A to be used.

Here we assume that you have carried out the task of developing a diagram (or list) of your city's or impact area's transactional and contextual environments (see Task in section 2.2.2).

Having done that, the next step is to look through the drivers of change that were placed in the *contextual* environment and to ask, of each, what changes would have an effect on the status and operation of the impact area and the feeder route. For example, suppose *tourism* features in your (impact area) contextual environment. The first question is how significant a factor tourism currently is to the study area. This will help to determine whether it is necessary to consider both a sizeable increase in tourism and a sizeable decline, rather than growth alone. In addition to the volume of tourism, it is also appropriate to consider its nature, in case this would be likely to have a bearing on conditions in the area – weekend trippers being a different type of tourist than the package market.

Another example is *social norms:* there's somewhat more work involved in exploring the various ways in which changes in these might influence conditions on the study area and it will not be possible to do this exhaustively, so a small number of changes should be identified as a way of thinking about the topic. These might include the widespread adoption of a "sharing" mentality, accompanied by a reduction in propensity to own private vehicles. They might also include a greater propensity for people to lead "mobile lifestyles", migrating between cities and countries more readily than in the past.

This exercise will produce a list of drivers of change that have the potential to affect significantly conditions in the impact area and feeder route. Next, though the city may lack a vision, it should nevertheless be possible to highlight those on the list whose impact is likely to be most relevant to the city's aspirations. That is, some things will almost certainly matter more to city stakeholders than others and it is appropriate to put an asterisk against those as you go into the next stage.

3.2.4 Method C: Working from the MORE "starter" list of drivers of change

This is the weakest of the methods but is not without value.

If you have not been able to use either of the previous two methods, it is possible to take as a starting point a pre-existing set of potential drivers of change. We offer one that may be appropriate at the impact-area level in Figure 10 and Table 2. You may also wish to consider the contextual environment as TfL defined it (Figure 4). Other drivers of change will be found in MORE Deliverables D3.1 on 'Analysis of Technological Advances' and D3.2, on 'Future Road User Needs'.

The items in Figure 10 are organised as follows: those towards the top are likely to have the largest influence on conditions in your study area, but they are at the same time the slowest to change; items towards the bottom may change more rapidly but have a smaller influence on conditions in the impact area and feeder route.

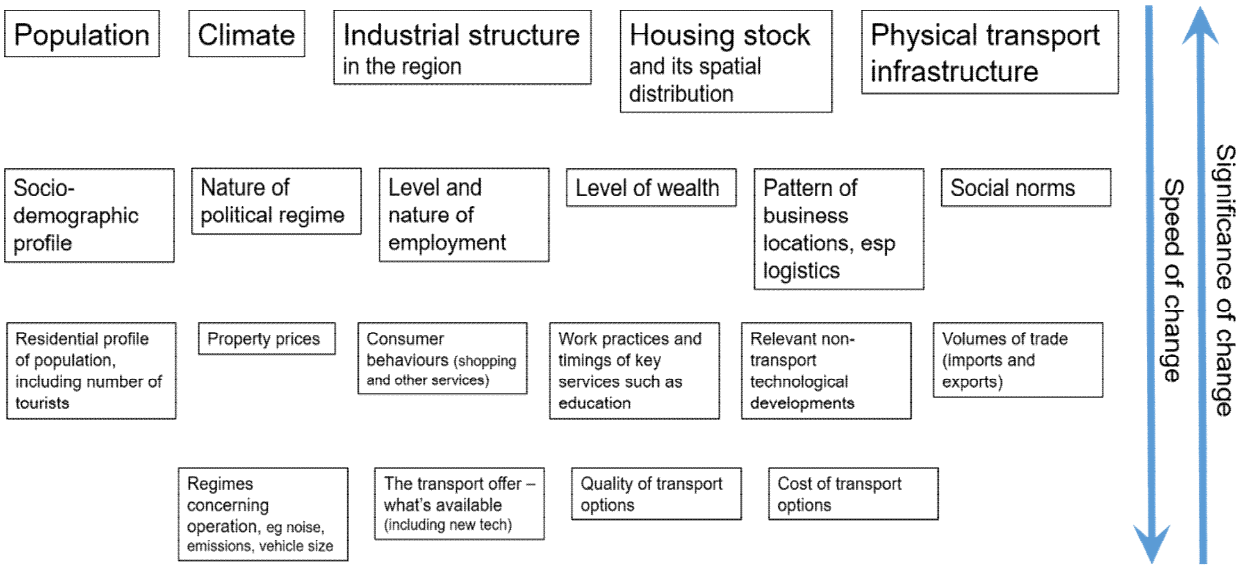


Figure 10: High-level depiction of drivers of change

Table 2, on the other hand, is intended to assist you in featuring transport and technological change in the scenarios you develop, with the theme of MORE in mind. It provides a finer-grained list of drivers of change for two of the categories featured in Figure 10: *the transport offer*; and relevant *non-transport technological developments*.

Table 2: Specific transport/technological drivers of change

The transport offer	Relevant non-transport technological developments
Automated driving (road, water)	3-D printing
Drones for carrying goods	Teleservices, including telehealth
Automated personal air transport	Virtual presence
Micromobility	The sharing economy
Microtransit	New/evolving energy systems
PIPENET/Hyperloop	Blockchain
"Mobility as a Service" (MaaS)	
Private-sector entry into transport provision	

If you choose this method, the first task is to critique the list of drivers of change with your city and impact area in mind: what is missing? Which items are not relevant? It can be helpful, when doing this, to refer to the so-called PESTLE framework, which places items in a set of categories: **P**olitical, **E**conomic, **S**ocio-Cultural, **T**echnological, **L**egal, **E**nvironmental. Whilst not fool-proof, this will encourage you to think about a wide range of possibly relevant issues.

Having done that, you should work towards a list of drivers of change that seem most relevant to conditions in your feeder route and impact area. Your city may not have a well-defined vision but you should nevertheless be able to identify those drivers of change that could most affect conditions of greatest interest to stakeholders. Use an asterisk to mark these.

3.2.5 Reviewing and normalising outputs

Once you have compiled a list of relevant drivers of change in the contextual environment (having used Method A, B or C above), the next task is to review your list, identifying a) those changes which you think would have the **largest potential effect** on the study area and b) those changes about which there is **greatest uncertainty**. There is likely to be some overlap between these sets.

Now, for each of your list of drivers of change, think about change in two directions. For example, if you were looking at resident population, imagine significant growth and significant reduction. For each of these, write a short statement (a few sentences at most) which describes a future state in which this might happen.

Again, with population in mind, this might be:

- Political unrest in neighbouring states brings 200,000 refugees to the city
- The resurgence of rival city X draws away 70,000 individuals who move and settle there because of the quality of life and economic opportunity

In each case, what you write must be **plausible but challenging**. That is, there is no value in writing something that stakeholders will reject as outlandish; but you will gain little from something that talks only about marginal change – remember the difference between scenarios and sensitivities explained above. Also bear in mind the time horizon you are working with (e.g. 2040), and the speed of change displayed in Figure 10, and ask yourself how much can feasibly change in that time period.

While cities could work individually with each of these drivers of change and explore the robustness of measure packages to each one, there is value in bringing these together, as discussed in the following section.

3.2.6 Building storylines and developing full scenarios

Once you have created your opposing statements for each of your drivers of change, start putting together “storylines” by choosing approximately three statements that appear compatible and seeking an underlying narrative that might explain this set of changes. This is best done in a workshop format, ideally involving a broad range of (friendly) stakeholders, both internal and external. Let us suppose you choose the following three statements:

- The resurgence of rival city X draws away 70,000 individuals who settle there because of the quality of life and economic opportunity
- Improvements in virtual presence technology have led to a ten per cent reduction in commuter trips to the central business district

- The explosion of affordable live-work “pods” in the centre has reversed the previous trend of increasing average age

First, you should ask whether the coincidence of these three changes is plausible. If you conclude that it is, you need to find a narrative that makes this combination of changes compelling. In this case, it might be that the city is losing ground to its more prosperous rival but is becoming more bohemian in response, with a thriving arts scene driven by young people living cheaply, and a general embracing of technology by all.

This process of building storylines should continue until either the set of change statements has been exhausted or twenty to thirty storylines have been created.

The next step involves combining storylines into full scenarios. This, again, is best done in partnership with a broad range of stakeholders in a workshop setting.

You will need the items associated with the largest potential effects and/or greatest uncertainty to be as evenly distributed across the scenarios as possible. Otherwise, you risk creating one or more bland scenarios that are unlikely to be particularly helpful. So start by identifying storylines that contain one of more of these “hot” changes and look to distribute them, if possible, across three or four coherent combinations. For example, it is common to see combinations of technological advance, so you might put the rapid development of automated road transport together with reduced trip rates resulting from teleservices.

Having created these “starter” scenarios, you should revisit your set of storylines, looking for compatible additions. This is bound to be an organic process and one that involves some iteration. Further, you are not obliged to retain any storyline or to leave it unaltered. The goal is to create plausible and challenging scenarios so, if a given storyline is not a good fit, you can either remove it or alter it to hone the scenario.

It is crucial at this stage to (continue to) resist the temptation to create a “nice” scenario or a “nasty” scenario. Bearing the points made about the purpose of scenarios in mind (see above), make a concerted effort to ensure that each developing scenario is a combination of changes that the city might welcome and others that it would see as threats.

Over the course of a few hours, coherent and distinct scenarios should begin to emerge. This process can be assisted by assigning teams to the “starter” scenarios and having periodic sets of short presentations during which each scenario team updates others at the workshop on progress. As part of the scenario-development process, each team should be seeking to address the following questions:

1) What are the global and European landscapes underpinning this scenario?
2) What would it be like to live in this world?
3) Who would win and who would lose in this world?
4) Who would set the tone?
5) What would the *impact area* be like in this world?

As scenarios take shape, they will feel increasingly well-rounded and engaging stories; a good test of a scenario is whether it is enjoyable to read it.

What happens next depends on the city's resources and aspirations. It is possible to spend many person-hours on iterating and honing scenarios, presenting them to a range of stakeholders in the process. Some organisations conclude that, in order for the scenarios to have as much influence as possible, it is desirable to produce "glossy" documents that explain the development process and present the scenarios in some detail. Some convert the words of the scenarios into quantities to support their use in forecasting models If, however, the aim of creating scenarios is to support the well-defined work of an internal team, there may be no need to go any further in defining or presenting the scenarios, provided they will serve the purpose of wind-tunnelling etc discussed above.

3.3 Using impact area-orientated scenarios

We return to the point that we create scenarios for a reason – to help us make better decisions. In the case of MORE, scenarios are intended to help cities to think very broadly about the situations that might arise in their impact areas and feeder routes in the future, so that the measures they take forward will be as robust as possible against possible futures.

3.3.1 Assessing scenarios' effects at the impact area level

Therefore, in order to derive maximal value from the scenarios, cities need to spend some time assessing what the scenarios are likely to mean in terms of the indicators that are of greatest concern in the study area. This will greatly assist all of wind-tunnelling, package refinement and appraisal, by providing a detailed context for assessing packages.

These indicators may include:

- Amenity
- Accessibility
- Road safety
- Personal security
- Public health, physical activity
- Economic vitality
- Congestion
- Air quality
- Noise, vibration
- Carbon emissions

Those who have used Method A in working up their scenarios will already have a list of indicators that characterise the city's vision at the corridor level. This should form the starting point but we urge you to add to it: the vision generally articulates what the city wants but tends to say less about what the city does *not* want, so indicators that capture the latter certainly need to feature if unanticipated and unwelcome consequences are to be avoided.

If you decide to create a quantitative version of your scenarios, the obvious way of identifying some of the scenarios' effects would be to run your forecasting model(s) with the scenarios translated into inputs (e.g. population and employment levels, by traffic zone) and outputs (e.g. in terms of numbers of trips, population levels, trip origins and destinations, times of travel and modal preferences). The richness and reliability of the emerging picture will be a

matter of the coverage and quality of your modelling tools. Transport models are in general better equipped to show the effects on the demand side of socio-economic drivers of change than transport supply changes: it is comparatively easy to represent an upsurge in population as an increase in the total number of trips, for example, whereas the effects of an explosion of micro-mobility is more difficult to forecast and more effort – as it may require the coding of a new mode, together with associated links and costs. This imbalance, though, is beginning to change, with more recent modelling tools being specified to include new modes such as automated vehicles.

Whether you model quantified versions of your scenarios or not, it will still be necessary to think through their potential effects across the set of outputs that most concern you and colleagues. If you have used a model, you will need to ask which impacts the model is likely not to have captured or to have captured only partially. Amenity (the quality of places), for example, is in general poorly represented in transport models so effort will be required first to identify those model outputs that are relevant to amenity and then to fill in the gaps.

If you have not used a model, the task is more simply defined: for each scenario, go through the indicators of interest, ask yourselves whether the situation is likely to improve or worsen and, if possible, estimate the extent (see Table 3 for an example of presenting this).

Note that this scenario assessment first involves a comparison with the base case or "business as usual": it should use as its reference current conditions (or conditions in an assumed future/central forecast, if your city has developed one); and it should take account only of measures that are in the set of fixed points (see Section 3.2.1) and must not yet include any new measures (which come in the next stage).

Table 3: Effects of scenarios on indicators of interest (qualitative assessment, comparing with business as usual)

	Impact area of interest					
	Road safety	Air quality	Congestion	Accessibility	Amenity	Economic vitality
Scenario 1	+	0	0	-	-	0
Scenario 2	-	+	+	+	++	+
Scenario 3	--	-	+	-	-	+

In Table 3, the cells are populated according to the expected change in conditions compared with business as usual, with scores ranging from ++ (significant improvement) to -- (significant deterioration). At this point, one scenario may appear "better" than the others in terms of its likely effects compared with the status quo. Here it is necessary to remain disciplined and to ignore this, remembering that no scenario is either good or bad, but that they each simply represent possible futures. More to the point, if developed correctly, the scenarios will consist of developments that lie beyond the city's control so it is folly to become attached to any of them!

3.3.2 Developing packages with the scenarios in mind

The idea of developing packages with the scenarios in mind is likely to be unfamiliar and so deserves brief explanation.

Packages are ordinarily developed with the intention of helping the city to achieve (or move towards the achievement of) its vision. And this typically happens under an implicit assumption either that background conditions will remain as they are or that they will change in accordance with an assumed future/central forecast. An "optimal" package will therefore be one which performs well in appraisal (i.e. appears to promise good progress towards achieving the vision) against that business-as-usual baseline. When the city then goes on to test the package against scenarios, it may turn out to perform poorly, for the simple reason that it has not been designed with any of those futures in mind.

If the city instead attempts to go further and develop a package that would perform well (in terms of pursuing the vision) against multiple possible futures, this can speed up the planning process by skipping the step of having to refine a package that has performed poorly when tested against scenarios. A second reason for doing this is the fact that (as pointed out in Section 1) central forecasts consistently turn out to be wrong; this means that good performance against central forecasts has limited value.

Developing packages that are robust against multiple (challenging) futures is easier said than done, and few packages will perform well against three or more very different futures. Having said that, bearing a set of futures in mind will encourage cities to attempt to build resilience into packages from the outset.

3.3.3 Using the scenarios with the packages

At this point, we return to the set of three exercises (Section 2.3) that are recommended for using scenarios:

- Wind-tunnelling
- Package refinement
- Formal appraisal

Having described these all in some detail already, we refer readers to Section 2.3 above, pointing out that the exercise described in Section 3.3.1 should provide a rich basis for learning in detail how a package could be expected to perform.

All being well, the threefold process of wind-tunnelling, refinement and formal appraisal will help you to reach a position of confidence. If you have worked up multiple packages, you should feel able to put one (refined) package forward – maybe including elements from some other packages - as the strongest candidate for support. Or you may, conceivably, have concluded that the best way forward is retain the status quo. In either case, you should have a strong case to support your recommendation.

3.4 An ongoing role for scenarios

It is typical for an organisation that has developed and used scenarios to become “a scenario-planning organisation”, i.e. for scenario-based planning to become part of its culture. The benefits of the process will have been acknowledged by the leadership and, because the skills acquired will hopefully remain within the organisation, future scenario work will be easier than the first attempt was. Some organisations choose to revisit their set of scenarios periodically to update them in order that they remain relevant and challenging. Others have a development cycle. Shell, for example, generates scenarios over several years and then uses them across the organisation for a period of time before restarting the process.

3.5 A less intensive alternative to scenarios

As mentioned in the opening of this chapter, not all cities will be able to marshal the resources necessary for developing full scenarios. For this reason, we set out in this section a simpler and less resource-intensive way of exploring uncertainty in order to increase the robustness of any packages that the city develops.

In order to use this method, you need first to follow elements of one of Methods A, B and C above (Sections 3.2.2 to 3.2.4), so as to produce a list of relevant drivers of change. You should have marked those that are likely to have the greatest impact on conditions in the study area. Depending on resources available, you should then select a manageable set of these drivers of change to use in your analysis. Try to select drivers which “point in different directions”, i.e. that are likely not to move consistently. For example, if you choose GDP as one of your drivers, its development is likely to be positively correlated with overall travel and consumption more generally. You are therefore not likely to learn much in addition if you choose either of those to accompany GDP.

For each of your selected drivers of change, ask yourself what is the largest plausible change that could take place over the timescale you have in mind. Bear in mind earlier remarks about going to the limits of the possibility space and try to challenge both yourself and your colleagues. Think about change in all conceivable directions. Most variables can go both up and down but some will have multiple dimensions and it is important to consider the range of what is possible.

What you do next will depend on whether you use forecasting models to support your transport planning. If so, you can create a series of “tests” for measures or packages of measures, by adjusting the parameters of your forecasting model(s) and/or modifying matrices to represent the values you have chosen. If model runs do not take too long, it is probably best to simulate the changes one at a time. For example, let us suppose you have chosen three drivers of change, and that you specify two values for each, one a “high” and the other a “low”. This suggests six model runs in all, each producing outputs that can inform an understanding of how robust the package/measure under examination is. If model runs are too time-consuming or resource-intensive to allow as many as six for each measure/package being tested, you will need to create composite tests that combine high/low values for multiple drivers of change.

This requires care for two reasons:

- Two changes could, in effect, cancel each other out, with the effect that you are not really testing the robustness of any package
- Whilst you will hopefully have chosen values that are individually plausible, there is a risk that combinations of values will stretch credulity too far and this may undermine the exercise in the eyes of certain stakeholders

Do therefore try to combine values in a way that avoids the above two pitfalls.

If you do not use a forecasting model, you will probably need to use qualitative methods to assess the likely performance of any measure/package in each of your tests. You will probably be limited to using quite simple (e.g. seven-point) scales, based on professional judgement, to enable the relative performance of multiple measures or packages to be seen - but this process should nonetheless be informative.

4 Other futures methods

In this document, we have discussed in some detail the futures methods known as 'scenario-based planning'. We are keen to emphasise that we have not done this because we consider it superior to other methods and we certainly do not suggest that cities considering futures work should feel obliged to use scenarios. In fact, the government of Singapore (famous for its long-standing use of scenarios to support planning) has adapted its approach to a hybrid based on scenarios and other futures methods precisely because scenarios were concluded no longer to meet the city's needs fully (Public Service Division, Singapore, 2011).

We cannot describe other futures methods to the same level of detail as we have scenarios but we attempt in this section to offer a flavour of some of the alternative ways of bringing the future into planning. Some are reviewed in more details in the Appendix. Whether all will conform, strictly speaking, to the definition of futures offered in the introduction is open to debate but we think it reasonable to be inclusive. A general source for ideas is *The Futures Toolkit* (Waverley Consultants, 2017). Another is *Foresight: an introduction. A Thinking Futures Reference Guide* (Conway, 2015).

4.1 Horizon scanning

"Horizon Scanning is the process of looking for early warning signs of change in the policy and strategy environment" (Waverley Consultants, 2017, p. 27). This technique can be characterised as a "light-touch" way of opening discussions about identifying possible futures and it can lead into a variety of more involved processes, including Delphi and scenario methods.

Horizon scanning involves setting up a team of "scanners", each of whom produces regular (perhaps weekly) short notes (or "scans") that summarise what she/he has found of relevance to the topic assigned to them. It falls to an editor to assimilate the set of scanners' notes and identify any useful themes that could inform the organisation's planning.

The UK's Government Communication Service provides a short leaflet summarising the horizon-scanning process (Government Communication Service, 2016).

4.2 Delphi

The Delphi technique is based on first gathering the opinions of subject experts then comparing and ranking the views expressed, in order to find priority themes and areas of significant disagreement.

Delphi is a relatively resource-intensive method but has the advantages of challenging any fixed views within the organisation and creating a group of advocates for the strategy that later emerges.

For a brief description, see Waverley Consultants (2017, pp. 35–40).

4.3 Morphological analysis

(General) morphological analysis is "a method for structuring and investigating the total set of relationships contained in multidimensional, non-quantifiable, problem complexes" (Ritchey, 2002, p. 1). Its originator, Fritz Zwicky, conceived it as a way of tackling complexity where modelling and simulation appear to fall short.

Morphological analysis involves identifying the set of parameters/dimensions relevant to the problem and assigning to each a range of possible values. A systematic approach is then taken to identifying feasible combinations of values across parameters, with the aim of arriving at a comprehensive set of potential solutions to the problem.

A brief description with examples is provided by Ritchey (2002). Those with access to academic journals may find Duczynski's (2018) application of the method to traffic congestion interesting.

4.4 Backcasting

Not formally a method that embraces uncertainty, backcasting is instead about steps necessary to reaching a desired future state (achieving a vision). Where uncertainty features is in identifying the boundaries of an organisation's control and building possible external events into the set of actions. But, unlike scenario planning, a more interventionist approach is taken to factors that lie outside: a formal step in backcasting is the assignment of responsibility for attempting to influence events that lie outside the organisation's control.

For a fuller description, see Waverley Consultants (2017, pp. 68–72).

5 Resources

Most of the sources listed below are publicly available. A few lie behind "paywalls" but are included because those who are able to obtain them may find them helpful; none is essential reading.

5.1 Futures

Waverley Consultants (2017) *The Futures Toolkit. Tools for Futures Thinking and Foresight Across UK Government*. 1.0. London: Government Office for Science. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/674209/futures-toolkit-edition-1.pdf (Accessed: 7 November 2019).

Conway, M. (2015) *Foresight: an introduction. A Thinking Futures Reference Guide*. Melbourne, Australia: Thinking Futures. Available at: https://thinkingfutures.net/downloads/foresightintro (Accessed: 18 December 2019).

5.2 Guidance on developing and using scenarios

Wack, P. (1985) 'Scenarios: Uncharted Waters Ahead', Harvard Business Review, 1 September, pp. 73–89.

Wack, P. (1985) 'Scenarios: shooting the rapids', Harvard Business Review, (November), pp. 139–150.

Van der Heijden, K. (1996) *Scenarios: the art of strategic conversation*. Chichester, England; New York: John Wiley & Sons.

Shell (2008) *Scenarios: an explorer's guide*. London: Shell. Available at: https://www.shell.com/energy-and-innovation/the-energy-future/scenarios/new-lenses-on-the-future/earlier-scenarios/_jcr_content/par/expandablelist/expandablesection_842430368.stream/1519772592201/f5b043e97972e369db4382a38434d4dc2b1e8bc4/shell-scenarios-explorersguide.pdf (Accessed: 19 December 2019).

Ilbury, C. and Sunter, C. (2001) *The mind of a fox: Scenario Planning in Action*. 1st ed. Cape Town: Human & Rousseau/Tafelberg.

Ramírez, R. and Wilkinson, A. (2016) *Strategic reframing: the Oxford scenario planning approach*. First edition. Oxford: Oxford University Press.

Ringland, G. (2002) *Scenarios in public policy*. Chichester ; New York: Wiley.

Federal Highways Administration (2011) *FHWA scenario planning guidebook*. Washington DC: Department of Transportation. Available at: https://www.fhwa.dot.gov/planning/scenario_and_visualization/scenario_planning/scenario_planning_guidebook_2011/index.cfm (Accessed: 19 December 2019).

NCVO (2017) *Scenario planning*, *Know How*. Available at: https://knowhow.ncvo.org.uk/organisation/strategy/externalanalysis/scenario-planning/scenario-planning# (Accessed: 6 November 2019).

5.3 Example scenarios and case studies

Lyons, G. (2016) *Uncertainty Ahead: Which Way Forward for Transport? Final Report from the CIHT FUTURES Initiative*. Available at: https://www.ciht.org.uk/media/4809/ciht_futures_-_final_report_doc_a4_final_linked.pdf (Accessed: 8 October 2019).

Shell (2013) *New lens scenarios: a shift in perspective for a world in transition*. London: Shell. Available at: https://www.shell.com/energy-and-innovation/the-energy-future/scenarios/new-lenses-on-the-future.html (Accessed: 19 December 2019).

Shell and Centre for Liveable Cities (2014) *New lenses on future cities: a new lens scenarios supplement*. London: Shell. Available at: https://www.shell.com/energy-and-innovation/the-energy-future/scenarios/new-lenses-on-future-cities/_jcr_content/par/relatedtopics.stream/1519786784443/4af0dbaee78537131e05449aaf5f63b3b953b52c/newlensesonfuturecities-june-2014.pdf (Accessed: 19 December 2019).

Sadatsafavi, H. *et al.* (2017) 'Using scenario planning for identifying major future trends and their implications for state transportation agencies', *International Conference on Sustainable Infrastructure 2017*. (Proceedings). doi: 10.1061/9780784481202.022.

Habegger, B. (2010) 'Strategic foresight in public policy: Reviewing the experiences of the UK, Singapore, and the Netherlands', *Futures*, 42(1), pp. 49–58. doi: 10.1016/j.futures.2009.08.002.

5.4 Governments that have used futures methods

The list of such organisations is growing but the best known is very likely Singapore, which started its scenario-based planning work decades ago and continues to develop its method as the government learns what works best for the context. Singapore is in some respects atypical given that it is a nation state but it faces many of the same problems that confront European cities, including very high population density.

The approach is summarised here:

The Centre for Strategic Futures (2019) *Our Approach*. Available at: https://www.csf.gov.sg/our-work/our-approach/ (Accessed: 19 December 2019).

Relevant additional reading includes:

Public Service Division, Singapore (2011) *Conversations for the future (volume 1): Singapore's experiences with strategic planning (1988-2011)*. Singapore: Public Service Division, Prime Minister's Office. Available at: https://www.csf.gov.sg/files/media-centre/publications/conversations-for-the-future.pdf (Accessed: 19 December 2019).

Centre for Strategic Futures, Prime Minister's Office (2018) *Conversations for the future (volume 2): Singapore's foresight journey since 2011*. Singapore: Public Service Division, Prime Minister's Office. Available at: https://www.csf.gov.sg/files/media-centre/publications/conversations_vol2-publication-web.pdf (Accessed: 19 December 2019).

Another interesting example is Finland's national parliament, which convenes a *Committee for the Future*, consisting of cross-party members of parliament whose "counterpart cabinet member" is the Prime Minister. The Committee's work is introduced here:

Parliament of Finland (no date) *Committee for the Future*. Available at: https://www.eduskunta.fi:443/EN/lakiensaataminen/valiokunnat/tulevaisuusvaliokunta/Pages/default.aspx (Accessed: 19 December 2019).

Finally, it is worth mentioning the work of the UK's government, introduced here: Government Office for Science (2019) *Foresight projects*, *GOV.UK*. Available at: https://www.gov.uk/government/collections/foresight-projects (Accessed: 19 December 2019).

5.5 Relevant research on drivers of change

Government Office for Science (2017) *Technology and Innovation Futures 2017*. London: Government Office for Science. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/584219/technology-innovation-futures-2017.pdf (Accessed: 19 December 2019).

Duckenfield, T. (2019) *The impact of demographic, social & technological trends on travel behaviour*. Available at: https://www.steergroup.com/insights/news/impact-demographic-social-technological-trends-travel-behaviour (Accessed: 19 December 2019).

Highways England (2017) *Connecting the Country. Planning for the long term*. Guildford, Surrey: HIghways England. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/666876/Connecting_the_country_Planning_for_the_long_term.pdf (Accessed: 19 December 2019).

Government Office for Science (2019) *Foresight projects*, *GOV.UK*. Available at: https://www.gov.uk/government/collections/foresight-projects (Accessed: 19 December 2019).

6 References

Booth, H. (2006) 'Demographic forecasting: 1980 to 2005 in review', International Journal of Forecasting. (Twenty five years of forecasting), 22(3), pp. 547–581. doi: 10.1016/j.ijforecast.2006.04.001.

Chermack, T. J. (2004) 'Improving decision-making with scenario planning', Futures, 36(3), pp. 295–309. doi: 10.1016/S0016-3287(03)00156-3.

Conway, M. (2015) Foresight: an introduction. A Thinking Futures Reference Guide. Melbourne, Australia: Thinking Futures. Available at: https://thinkingfutures.net/downloads/foresightintro.

Department for Transport (2018) Road Traffic Forecasts 2018. London: Department for Transport. Available at: https://www.gov.uk/government/publications/road-traffic-forecasts-2018 (Accessed: 19 September 2018).

Duczynski, G. (2018) 'Investigating traffic congestion: Targeting technological and social interdependencies through general morphological analysis', Technological Forecasting and Social Change, 126, pp. 161–167. doi: 10.1016/j.techfore.2017.05.019.

Flyvbjerg, B., Skamris Holm, M. K. and Buhl, S. L. (2005) 'How (in)accurate are demand forecasts in public works projects? The case of transportation', Journal of the American Planning Association, 71(2), pp. 131–146.

Government Communication Service (2016) What is horizon scanning? London: Government Communication Service. Available at: https://gcs.civilservice.gov.uk/wp-content/uploads/2016/07/Horizon-Scanning-Leaflet-Spring-2016.pdf.

Lyons, G. (2016) Uncertainty Ahead: Which Way Forward for Transport? Final Report from the CIHT FUTURES Initiative. Available at: https://www.ciht.org.uk/media/4809/ciht_futures_-_final_report_doc_a4_final_linked.pdf (Accessed: 8 October 2019).

Miller, R. (ed.) (2018) Transforming the future: anticipation in the 21st century. Abingdon, Oxon ; New York, NY: Routledge.

Phelps, R., Chan, C. and Kapsalis, S. C. (2001) 'Does scenario planning affect performance? Two exploratory studies', Journal of Business Research. (Dynamics of Strategy, No. 3), 51(3), pp. 223–232. doi: 10.1016/S0148-2963(99)00048-X.

Public Service Division, Singapore (2011) Conversations for the future (volume 1): Singapore's experiences with strategic planning (1988-2011). Singapore: Public Service Division, Prime Minister's Office.

Ritchey, T. (2002) 'General Morphological Analysis. A general method for non-quantified modelling'. Available at: http://www.swemorph.com/pdf/gma.pdf (Accessed: 18 December 2019).

Schwenk, C. R. and Shrader, C. B. (1993) 'Effects of Formal Strategic Planning on Financial Performance in Small Firms: A Meta-Analysis', Entrepreneurship Theory and Practice, 17(3), pp. 53–64. doi: 10.1177/104225879301700304.

Transport for London (2019) Travel in London 12. London: Transport for London (12). Available at: https://tfl.gov.uk/corporate/publications-and-reports/travel-in-london-reports (Accessed: 18 December 2019).

Visser, M. P. and Chermack, T. J. (2009) 'Perceptions of the relationship between scenario planning and firm performance: A qualitative study', Futures, 41(9), pp. 581–592. doi: 10.1016/j.futures.2009.04.010.

Waverley Consultants (2017) The Futures Toolkit. Tools for Futures Thinking and Foresight Across UK Government. 1.0. London: Government Office for Science. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/674209/futures-toolkit-edition-1.pdf (Accessed: 7 November 2019).

Appendix: Scenario planning and backcasting – a review of approaches

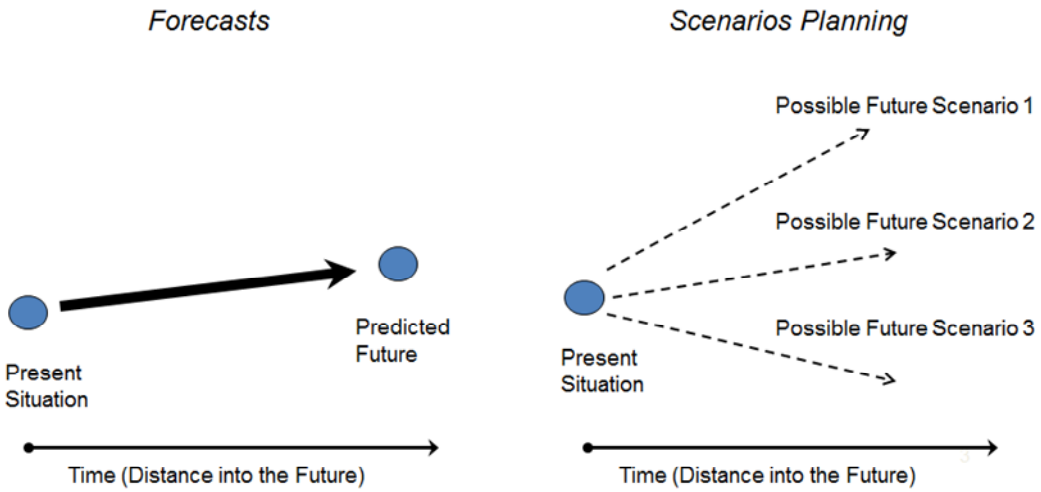
Marco Dean, UCL

Contents

1. Introduction and History of Scenario Planning

Scenario planning is a strategic planning method which can be employed to explore possible future situations and development paths, typically over a medium-term horizon (Schoemaker, 1995; Lindgren and Bandhold, 2003; van der Heijden, 2005). Compared with other strategic planning tools and techniques, especially those ones based on the extrapolation of existing trends and patterns and the use of quantitative, single-point forecasts, scenario planning accounts more explicitly for the complexity and uncertainty of the environment (Porter, 1985; Mintzberg, 1994; Gordon, 2013). Its aim is not to accurately predict the future, but rather to devise different possible pictures of the future (Figure 1) so as to make policy-makers and business leaders more aware of the new potential trends, the key factors and players that may produce major shifts in the existing conditions, and the hitherto unknown opportunities and threats entailed by each anticipated future conditions (Wack, 1985a; Schwartz, 1991; Grant, 2003). This, is turn, helps executives develop more comprehensive and robust strategies, capable of dealing with different contingencies (Wack, 1985b; Schwenker and Wulf, 2013; Martelli, 2014).

Figure 1 – Comparison between single-point forecasts and scenario planning.



Source: Authors' own elaboration.

The first systematic use of scenario planning dates back to the late 1950s when the US RAND ('Research ANd Development') Corporation started to study different possible states of the world within which alternative weapons systems and military strategies would have to be employed (e.g. Kahn and Weiner, 1967; Kahn *et al*., 1976). Starting from the late 1960s, scenario planning spread outside the RAND and companies like the Royal Dutch/Shell introduced such techniques in their corporate planning procedures (Wack, 1985a). Scenarios came to the attention of the general public in the 1970s with the publication of Club of Rome's report, *The Limits to Growth* (Meadows *et al*., 1972), highlighting the possible future environmental risks entailed by the current growth path. In the course of time, events such as the turmoil that followed both the first and the second oil shocks in 1973 and 1979, the crisis of the traditional rational planning school during the 1980s and the structural turbulence associated with globalization processes have greatly emphasized the theoretical importance of managing uncertainty through scenario thinking (Lindgren and Bandhold, 2003; Schwenker and Wulf, 2013; Martelli, 2014). Nowadays, scenario planning is used in a wide range of contexts, by a number of different companies, agencies and governmental bodies (van

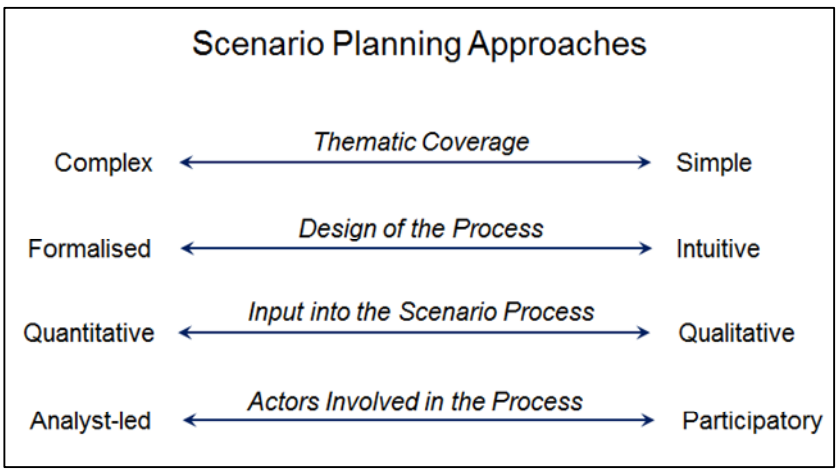
Notten, 2006; Gordon, 2013). However, this broad variety of applications has spawned a large diversity in the types of scenarios that have been developed. The term ‘scenario planning’ has thus progressively become a rather comprehensive concept, encompassing the most varied possible assortment of approaches, techniques and tools with different degrees of complexity (Bishop *et al*., 2007; Börjeson *et al*., 2006; Kosow and Gaßner, 2008; EEA, 2009). Against this backdrop, this document provides an overview of scenario planning techniques and offers some practical guidelines for employing scenario planning in its basic form.

2. Types of Scenarios

A scenario can be defined as a consistent and plausible description of a possible future reality, including also information about paths of development which may lead to that future situation, which can serve as basis for action (Porter, 1985; Schwartz, 1991; van Notten, 2006; Parson *et al*., 2007; Kosow and Gaßner, 2008; EEA, 2009). The last 50 years have seen the rise of a number of different approaches to scenario planning, spanning from sophisticated methods to very simplistic approaches. On the one hand, this diversity makes scenario planning a rather flexible strategic planning technique, which can be tailored to suit the needs of the problem at hand (van Notten, 2006, Martelli, 2014). On the other hand, this multitude of ways to create scenarios, the lack of standardization in most scenario planning methods (Cairns *et al*., 2004; Schwenker and Wulf, 2013) and, in many cases, the unwillingness of scenario experts to fully disclose their methodology (Chermack *et al*., 2001), confer on this discipline a high degree of subjectivity, making the outcomes of many scenario planning processes hard to replicate and incapable of third party audit (Schwartz, 1991; Desmerais, 2008).

Several classification systems have been proposed in the attempt to analyse and compare scenario-planning methods, bringing order to this 'methodological chaos' (Millet, 2003; Bradfield *et al.*, 2005). Figure 2, based on the typologies devised by Rotmans and colleagues (2000), van Notten and colleagues (2003) and van Notten (2006), distinguishes scenario planning techniques according to four main parameters related to goals, content and process design. For each parameter it is generally possible to identify a continuum, with different methods ranging between two extremes.

Figure 2 – Types of scenario planning techniques.



Source: (Adapted from) van Notten and colleagues (2003) and van Notten (2006).

Thematic Coverage

Firstly, scenarios can be distinguished with regard to their content and thematic coverage, ranging from *complex* to *simple*. Simple scenarios, as their name suggests, are rather limited in scope and tend to focus only on one particular theme and sector. Complex scenarios, on the other hand, are much broader and wider in scope, and thus more demanding of resources. They cover different issues and attempt to describe the possible future correlation between multiple events and processes (van Notten, 2006).

Design of the scenario process

There are many types of scenario planning approaches in use at the moment ranging from *formalised* techniques to *intuitive* methods (Martelli, 2014). Formalised scenario planning techniques develop scenarios in a systematic way, according to rigorous principles and analytical procedures, sometimes supported also by computer software (van Notten, 2006). Intuitive methods consider instead scenario development as an art form and are thus characterized less by formalization than by the explicit implementation of creativity, intuition and implicit knowledge (Kosow and Gaßner, 2008).

Inputs into the scenario process

Scenario planning techniques can also be classified according to the typology of data used to construct scenarios. In principle, *quantitative* input can be more appropriate for more analytical scenario planning procedures, focusing on relatively short planning horizons. *Qualitative* inputs can be instead conveniently employed for the analysis of complex and longer-term planning problems characterised by high levels of uncertainty (van Notten, 2006; Kosow and Gaßner, 2008). In the attempt to produce more robust scenarios, several scenario planning techniques adopt a hybrid approach, in which both qualitative and quantitative data are gathered, and where quantitative information is translated into qualitative knowledge and vice versa (Kosow and Gaßner, 2008). Sometimes, however, the fusion of quantitative and qualitative data represents a methodological challenge (van Notten, 2006).

Actors Involved in the Process

Scenario planning techniques also range from *analyst-led* to *participatory* approaches, according to the manner in which scenarios are developed. In analyst-led (or, perhaps, model-based) scenario planning methods, scenarios are developed autonomously by a team of specialists. By comparison, participatory approaches to scenario planning involve workshops and focus group discussions in the attempt to explore different stakeholders' perspectives. The latter approaches are suitable for generating creative ideas for the scenarios, although, compared with analyst-led methods, they generally require longer times to process and combine all the different stakeholders' points of view in some consistent and coherent descriptions of alternative hypothetical futures (van Notten, 2006). Some methods (e.g. Alcamo, 2008; Kok and van Vliet, 2011) also combine stakeholder-led and model-based scenarios with a view to offering more flexibility and adaptability to different problems and conditions.

3. Basic Steps of Scenario Planning

In a typical scenario planning process plausible futures are sketched out based on assumptions regarding the possible evolution of present factors and conditions (Kosow and Gaßner, 2008; Martelli, 2014). The scenarios developed as a result of the process are presented as the context within which the system operates and policy making and strategy formulation take place (Becker, 1997; Greeuw *et al*., 2000). As highlighted in the previous section, a number of scenario planning approaches exist (*i.e*. complex or simple; formalised or intuitive; quantitative or qualitative; and analyst-led or participatory methods), even though they share some common steps. Below a basic approach to scenario planning is presented. This approach, which has been made popular by RAND and Shell Oil, is based on the identification of two main driving forces from which the overall logic of the scenario storylines is derived. Although presented in a linear fashion, the steps of the process are generally undertaken in an iterative manner, involving some feedback loops.

a) Scoping

This step creates the foundation for the subsequent analysis by specifying key elements such as the scope of the exercise, the thematic coverage, the key stakeholders, the timeframe and the geographical scope of scenarios (Schwartz, 1991; Kosow and Gaßner, 2008; Schwenker and Wulf, 2013).

b) Information Search

The scenario planning team is then required to collect the basic data and information regarding the present condition and all the factors and variables potentially influencing future development paths (van der Heijden, 2005). Various sources of data and information can be used, including key planning and policy documents regarding the problem at hand, relevant books, journal articles and reports, newspapers, and interviews, workshops or surveys with experts and project stakeholders (Schwenker and Wulf, 2013).

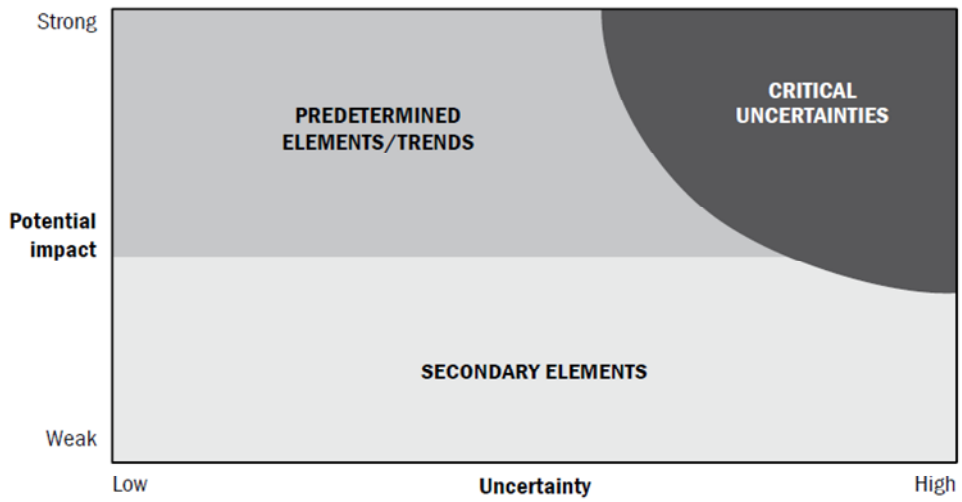
c) Trend and Uncertainty Analysis

Once the basic data and information have been collected, factors potentially affecting future developments have to be analysed with a view to identifying the most relevant ones (Schwartz, 1991; Schoemaker, 1995). One common way to undertake this task is to rank the various factors according to their degree of uncertainty and potential impacts on the system under investigation (Schwenker and Wulf, 2013), by employing an impact/uncertainty grid (van der Heijden, 2005). As illustrated in Figure 3, the impact/uncertainty grid is divided into three sections (van der Heijden, 2005; Schwenker and Wulf, 2013):

- The bottom section of the grid contains factors that are judged to have a relatively minor impact on the future development paths. Hence, these ‘secondary elements’ are not further considered in the scenario planning process.
- The upper left-hand section of the grid contains factors which are considered to be capable of significantly impacting future developments, but whose future behaviour is relatively easy to predict. These ‘significant trends’ are then used in the development of scenarios.
- Finally, the upper right-hand section of the grid contains the ‘critical uncertainties’. These are factors with both a major impact on the future development paths and a high degree of uncertainty, and thus represent the most important elements for scenario development

The position of the various factors in the matrix is established directly by the scenario team, in the case of an analyst-led scenario planning approach. Conversely, in the case of a participatory approach to scenario planning, this can be determined with a Delphi exercise involving an expert panel or by the average evaluation by the problem stakeholders (van't Klooster and van Asselt, 2006 Schwenker and Wulf, 2013).

Figure 3 – Example of impact/uncertainty grid.



Source: Schwenker and Wulf (2013), van der Heijden (2005)

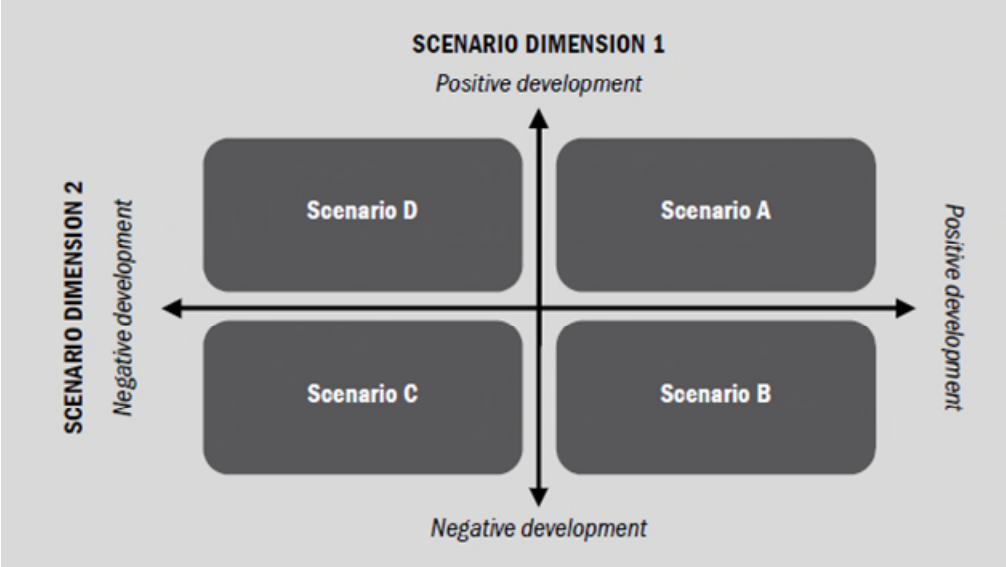
d) Scenario Building

In this step, the identified trends and critical uncertainties are converted into various plausible scenarios that describe different possible future states of the world (Schwartz, 1991; Schoemaker, 1995). There are numerous ways in which this can be achieved. As highlighted above, one of the most popular scenario planning approaches is the deductive technique, also known as the scenario-axes technique (van der Heijden, 2005; van't Klooster and van Asselt, 2006; Schwenker and Wulf, 2013). With this technique, the two most important critical uncertainties included in the upper right-hand section of the impact/uncertainty grid are selected. The potential future developments of these uncertainties, ranging from an extremely positive (favourable) development to an extremely negative outlook, are plotted respectively onto the *x* and *y* axes of a 2x2 matrix. As shown in Figure 4, expressing each uncertainty in terms of its dual possible future outcome will produce four possible scenarios (van der Heijden, 2005).

To improve scenario richness and breadth of outcomes, in principle, an additional main critical uncertainties can be used, whose inclusion leads to a 2x2x2 scenario matrix with eight possible scenarios (van der Heijden, 2005).

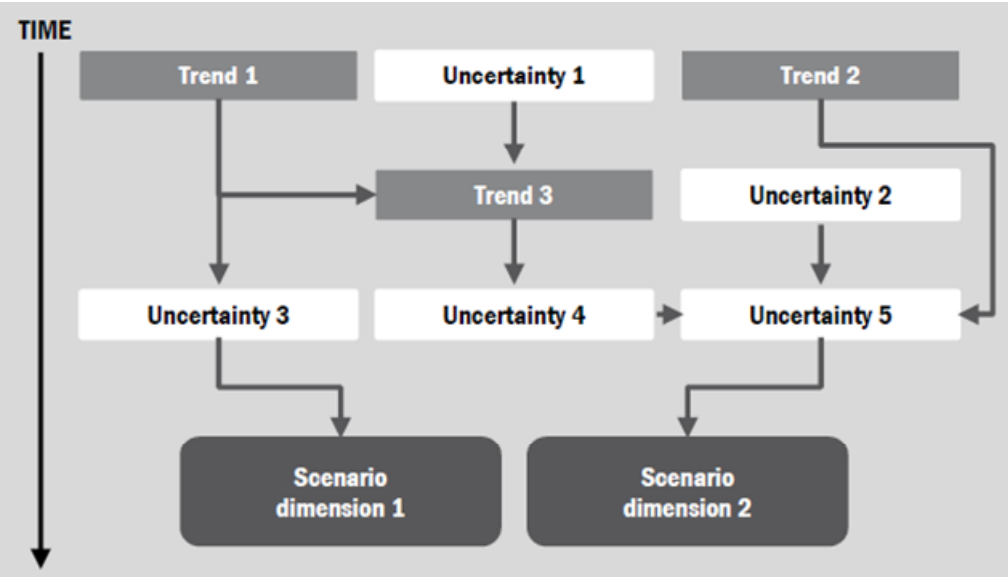
Having located the four scenarios initially in the "corners" of the matrix, they then need to be further specified. Other critical uncertainties and trends are added to create some consistent and plausible stories about the future. Some diagrams similar to the one displayed in Figure 5 can be used to illustrate how the different factors interact with each other to produce different outcomes (Schwenker and Wulf, 2013).

Figure 4 – Example of a 2x2 scenario matrix.



Source: Schwenker and Wulf (2013), van der Heijden (2005).

Figure 5 – Example of influence diagram.



Source: Schwenker and Wulf (2013), van der Heijden (2005).

The literature proposes some criteria as central in evaluating the quality of scenarios produced, independently of the respective goal and type of the scenario process. According to several authors (e.g. Godet, 1993; Banister *et al*., 2000; Lindgren and Bandhold, 2003; van der Heijden, 2005; Kosow and Gaßner, 2008) scenarios should have the following characteristics:

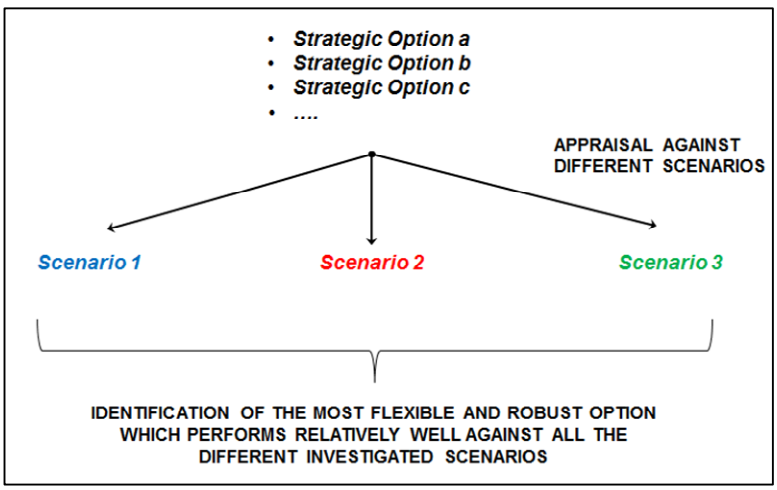
- *Manageability*: the number of scenarios considered in the process should be comprised between two (i.e. at least two scenario are needed to reflect uncertainty) and four. Working with more than four (or five) scenarios has proven to be counterproductive and organizationally impractical.
- *Plausibility*: each future scenario and path of development which may lead to that future situation must be regarded as conceptually feasible.

- *Consistency*: the events described within a scenario must be related through logical cause/effect lines of argument and must be consistent with one another.
- *Comprehensibility*: scenarios must be detailed enough to be traceable. At the same time, in order to avoid unnecessary analytical effort, scenarios should not contain an excessive number of factors and dimensions.
- *Relevance*: scenarios must be relevant to the area of study and quite dissimilar from a 'business-as-usual' future, so as to trigger unconventional thinking.
- *Differentiation*: the selected alternative scenarios must clearly differ from one another so that they can be examined and compared with each other as separate and distinct sketches of the future.
- *Transparency*: as a means of increasing the degree of verifiability and legitimacy of scenarios, the scenario planning approach adopted and all the assumptions, hypotheses and choices made during the scenario development process should be made explicit and described clearly.

e) Strategy Definition

Once scenarios have been developed, different decisions and strategic options are tested against the various possible future conditions (Schwartz, 1991, van der Heijden, 2005). In this step traditional appraisal and evaluation tools and techniques can be employed to identify the most flexible and robust strategy (see Figure 6).

Figure 6 – Strategy Definition.



Source: Authors' own elaboration.

f) Monitoring

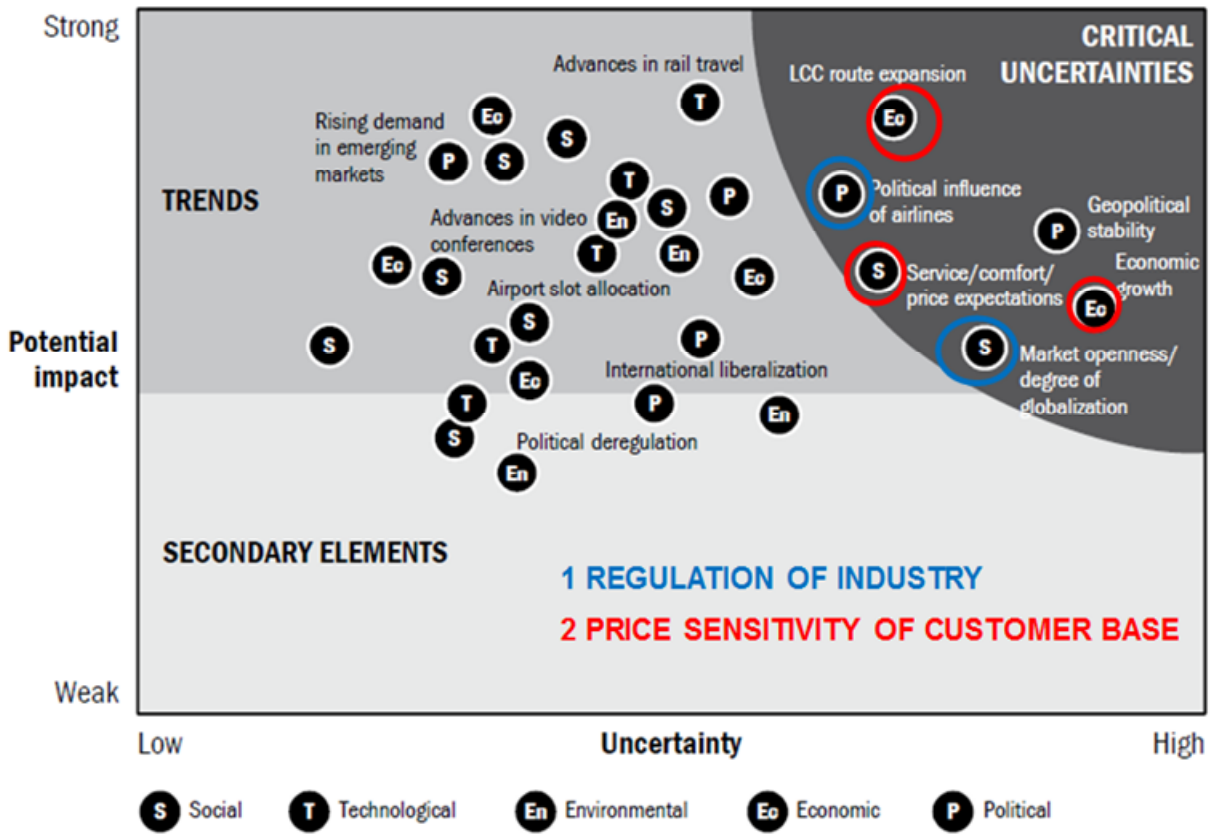
As emphasized by several authors (e.g. Schwartz, 1991; Schoemaker, 1995; and van der Heijden, 2005; Schwenker and Wulf, 2013), at the end of the process it is important also to define some indicators (e.g. GDP growth; government spending on some specific areas; population growth and demographic age distribution) to help policy-makers and business leaders to monitor continuously the environment (and particularly the future development of the critical uncertainties and key trends), check if the scenarios devised are still valid and decide whether some changes in the selected strategy are needed.

4. A Practical Example of Scenario Planning

Schwenker and Wulf (2013) illustrate a practical application of the scenario-axes technique to explore possible futures for the European airline industry. Several factors and variables which are likely to impact the airline industry in the future (identified through a media scanning process) are identified and ranked through the impact/uncertainty grid so as to determine 'secondary elements', 'significant trends' and 'critical uncertainties' (Figure 7). Two main critical uncertainties are selected, namely:

- '*Price Sensitivity of Customer Base*' (defined as the combination of three distinct critical uncertainties: 'low-cost carrier expansion in terms of routes and services'; 'economic growth' and 'service/comfort/price expectation'); and
- '*Regulation of industry in Europe'* (defined as the aggregation of two critical uncertainties: 'Political influence of airlines' and 'market openness/degree of globalization').

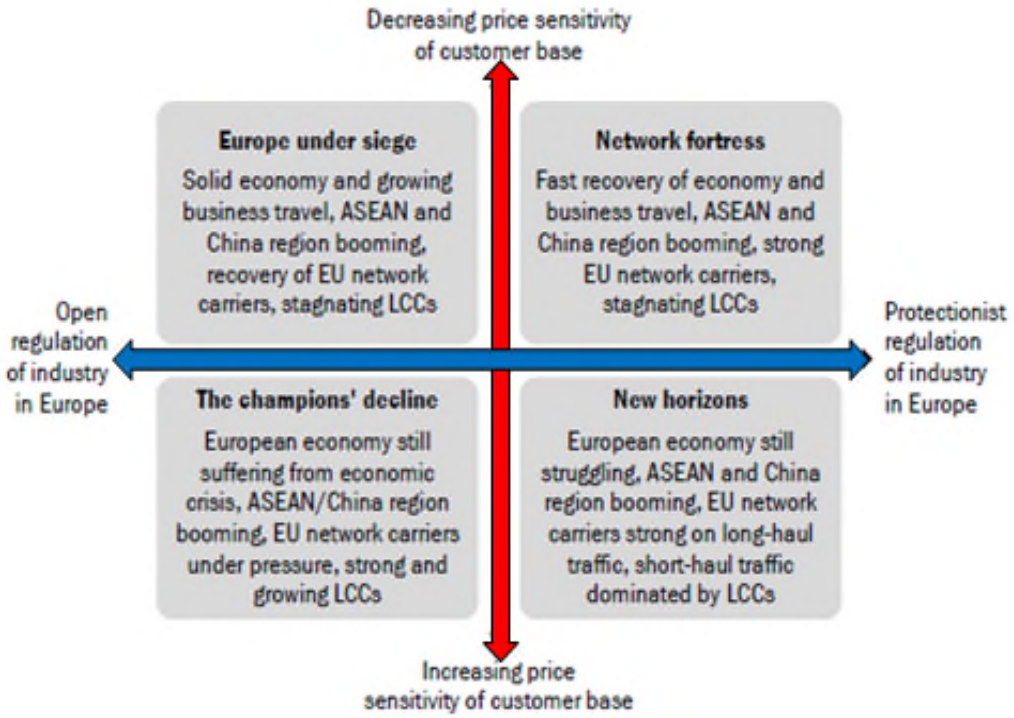
Figure 7 – Impact/uncertainty grid for the European airline industry.



Source: (Adapted from) Schwenker and Wulf (2013).

The potential future developments of these two critical uncertainties are plotted respectively onto the *x* and *y* axes of a 2x2 matrix, thus generating four possible scenarios (Figure 8). In each scenario the outcomes of the two critical uncertainties represent the overall framework within which consistent and plausible stories about the future are created.

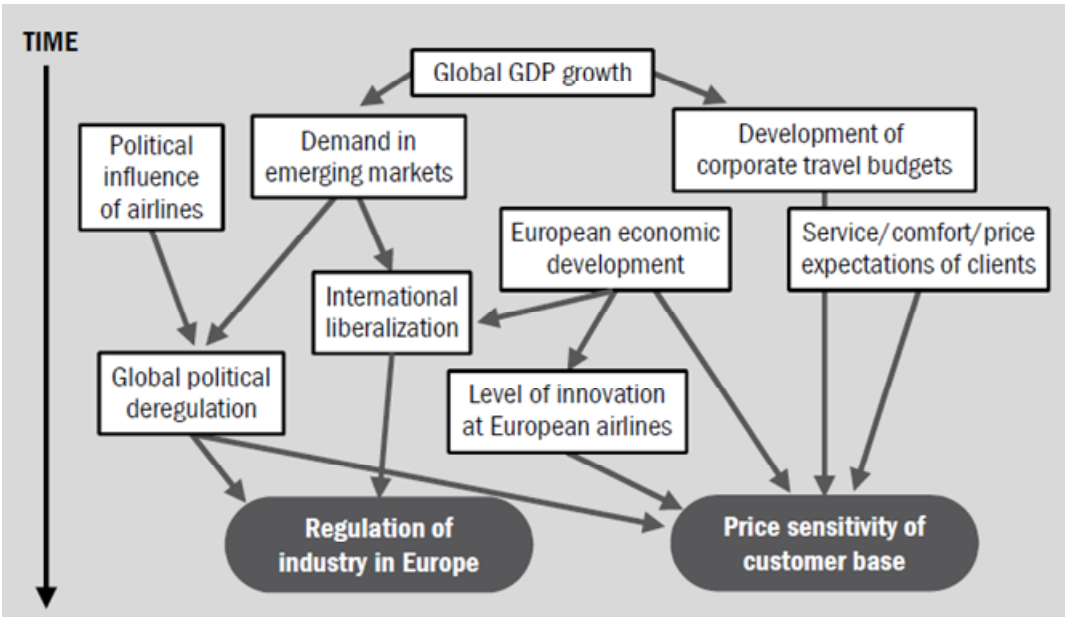
Figure 8 – Scenario matrix developed for the European airline industry.



Source: (Adapted from) Schwenker and Wulf (2013).

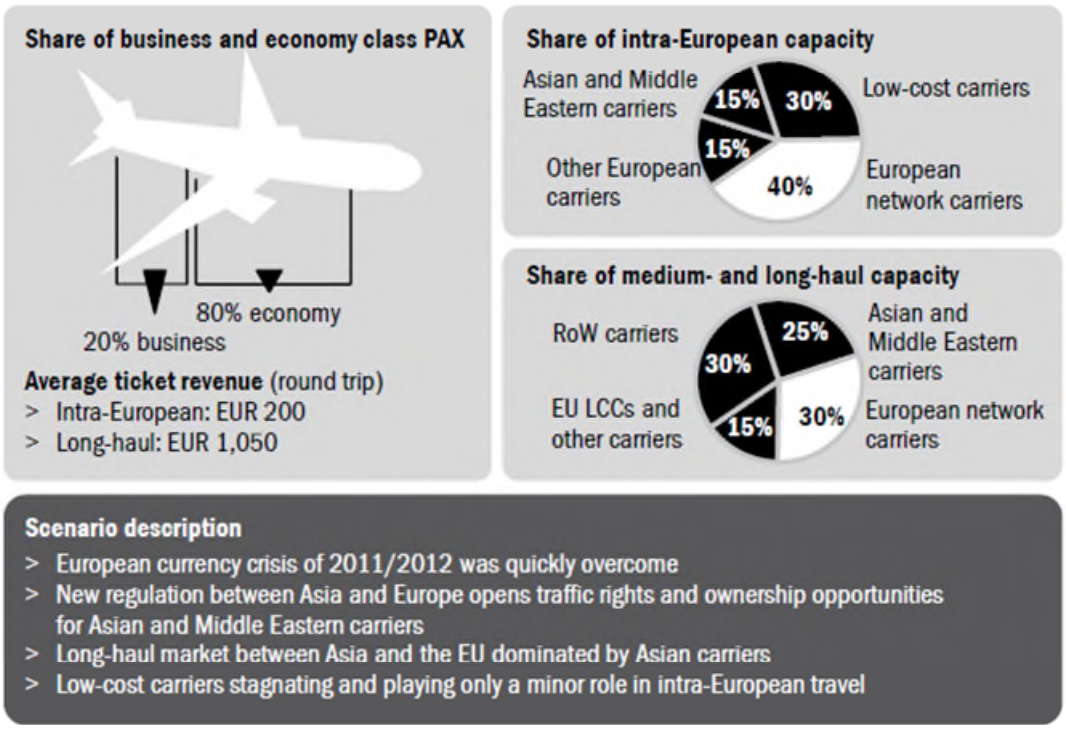
The scenarios are further developed by including in this framework also considerations about the possible future evolution of other uncertainties and trends, and are ultimately used as basis for informing strategic actions (Figures 9 and 10).

Figure 9 – Influence diagram for the European airline Industry.



Source: Schwenker and Wulf (2013).

Figure 10 – Fact sheet for one of the devised scenarios (the 'Europe under Siege' scenario).



Source: Schwenker and Wulf (2013).

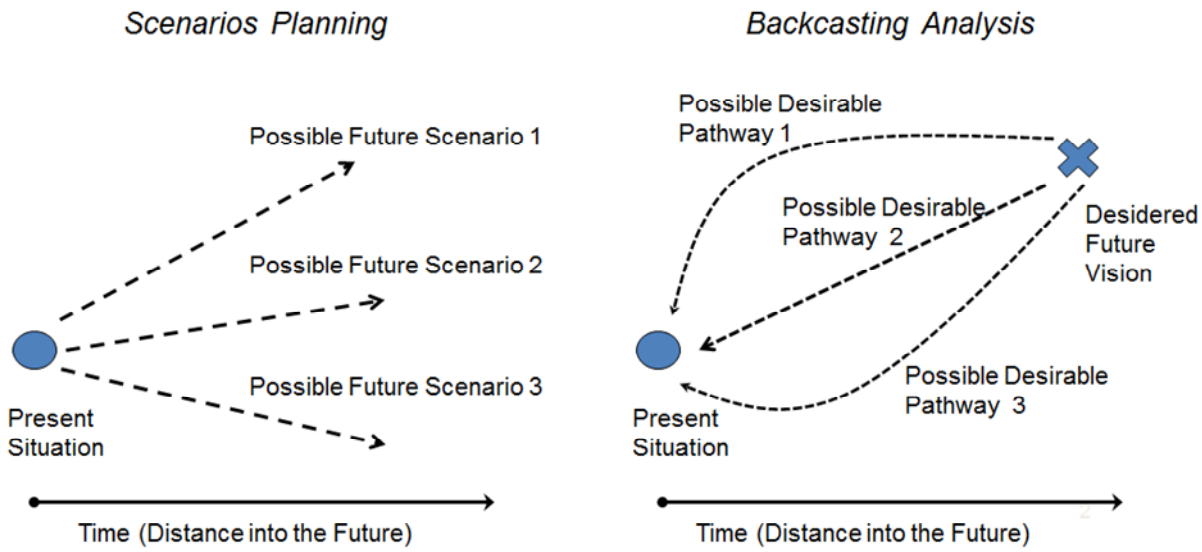
5. Backcasting analysis: desired future visions and possible transition pathways

Scenarios, in the conventional form presented in the previous sections, can be described as objective or neutral future studies as they illustrate possible future events regardless of their desirability (Greeuw et al., 2000; Martelli, 2014). Indeed, they take the present situation as a starting point and, based on considerations regarding significant trends, major uncertainties and driving forces, describe the possible future effects of the evolutions of present factors and conditions (Becker, 1997; Kosow and Gaßner, 2008).

Another approach to the exploration of possible future situations and development paths, which in the literature is generally also included under the umbrella term of 'scenario planning' (e.g. Dreborg, 1996; Becker, 1997; Greeuw et al., 2000; Lindgren and Bandhold, 2003; van Notten et al., 2003; Börjeson et al., 2006; van Notten, 2006; Kosow and Gaßner, 2008; Balula and Bina, 2013; Martelli, 2014), but which, for the purpose of this document will be referred to as 'backcasting analysis', as originally termed by one of its proponents (see Robinson, 1982 and 2003), takes an opposite stance. This approach, which has an ideological and political character, looks back from an intended future state of affair (i.e. a desired future development vision) to the present with the view to devising opportune strategies which may lead from the present situation to the desired future conditions (Greeuw *et al.*, 2000; Martelli, 2014). The major distinguishing characteristic of backcasting analysis is thus its attempt to explore the future in terms of what it should be, rather than what is likely to be, and a concern with how desirable futures can be obtained (and undesirable future can be avoided) (Becker, 1997; Greeuw et al., 2000; Kosow and Gaßner, 2008). Hence, while a typical scenario planning approach respond to the 'what can happen?' question, a backcasting

analysis deals with questions such as 'what do we want the future to be like?' and 'what must happen in order for it to become reality? (Börjeson *et al*., 2006; Kosow and Gaßner, 2008). Figure 11 and Table 1 below summarises the key features of scenario planning and backcasting analysis.

Figure 11 – Comparison between scenario planning and backcasting analysis.



Source: Authors' own elaboration.

Table 1 – Key features of scenario planning and backcasting analysis.

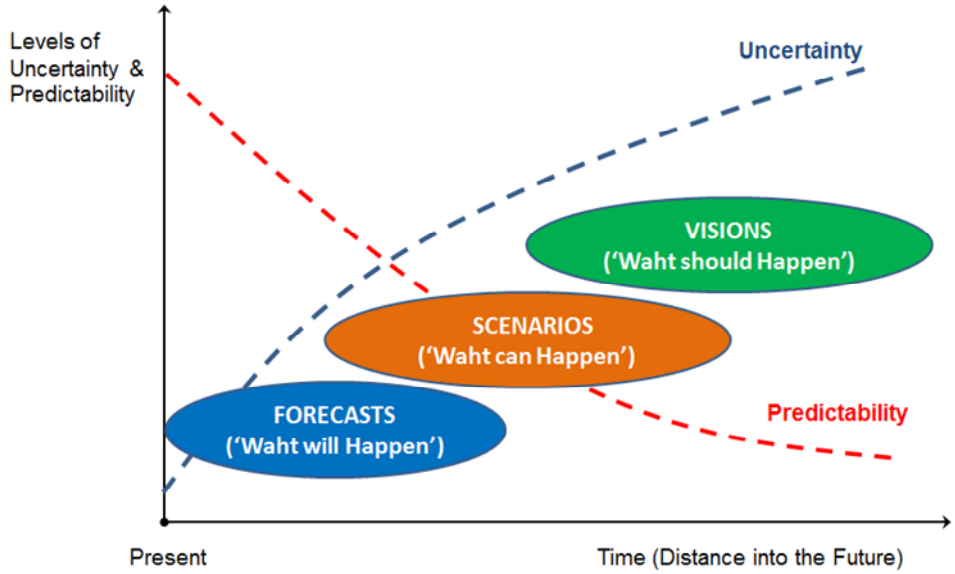
Category	**Conventional Scenario Planning**	**Backcasting Analysis**
Central questions	'What can happen?'	'What should happen and how can we get there?'
Philosophical Views	Limited possibility to influence current trends and future development	Planning can change future development
Perspectives	Uncertainty based	Value based
Types of Future	Possible, plausible futures	Desired futures
Time Horizons	Particularly strong in the medium-term perspective	Particularly useful in the long-term perspective
Purposes	To help develop flexible and robust strategies capable of coping with different possible futures	To help devise desired and sustainable visions of development and identify strategies to achieve those visions
Approaches	Description of future conditions, starting from the present situation, based on consideration regarding significant trends, major uncertainties and driving forces	Definition of a desired future and analysis of the conditions for this future to materialise

Sources: Lindgren and Bandhold (2003); Kosow and Gaßner (2008); and Dreborg (1996).

According to Dreborg (1996), backcasting analysis is particularly useful for major and complex societal problems, when dominant trends are part of the problem and there is thus a desire to drastically change the current development path. It offers a method for exploring the implications of

alternative development scenarios, stimulating a debate in society and widening the perception of what it may possible to achieve in the long run (Robinson, 1990 and 2003; Banister *et al*., 2000; Hickman *et al*., 2009). Compared to the traditional scenario planning approach, backcasting analysis focuses on a much longer time horizon (Figure 12), typically 25 to 50 years (Robinson, 1990; Balula and Bina, 2013). This temporal scale is sufficiently extended to make major societal changes plausible (Vergragt and Quist, 2011). Indeed, in the long term, the potential for society to influence development in a desired direction is relatively large (Dreborg, 1996).

Figure 12 – Levels of uncertainty and predictability over time and zones of effectiveness of forecasts, scenario planning and backcasting analysis.



Source: (Based on) van der Heijden (2005).

The origin of backcasting analysis dates back to the 1970s (Lovins, 1976, 1977) and since then this methodology has been applied in a wide range of studies regarding sustainable development, especially in Europe (Quist, 2007). Similar to scenario planning, whilst a number of different approaches to backcasting analysis exist, it is possible to identify some basic steps, generally undertaken in an iterative manner, which are common to all methods.

a) Problem Analysis

The process starts with an analysis of the present situation and the current development path since, as highlighted above, the desired future vision must be firmly anchored to a description to the current system being studied (Robinson, 1990). In this step problems which needs to be solved are also identified (Quist, 2007). Indeed, the necessity to explore alternative futures is explained in terms of present or anticipated problems which seem to be unlikely to be addressed in a business-as-usual future (Robinson, 1990).

b) Scoping

This step consists in the definition of the temporal, spatial and substantive scope of the analysis, so as to allow a distinction to be made between what is included in the backcasting analysis itself and the exogenous variables (Robinson, 1990). In addition, important aspects such as the approach and

methods to be used (i.e. formalised or intuitive; quantitative or qualitative; and analyst-led or participatory methods), and the key assumptions, future goals and policy objectives, specific targets and constraints, which will guide the construction of the desired future vision, are also determined (Robinson, 1990; Quist, 2007).

c) Scenario Development

The central step of the process consists in the development of the desired future development vision. Being a more mind-stretching process than explorative scenario planning, backcasting methods tend to rely on less formal and more creative processes and activities (Dreborg, 1996). Possible tools and techniques that can be conveniently employed in this phase include stakeholder interviews, creativity workshops and Delphi methods (Quist, 2007).

d) Strategy Development

Once the desired future has been defined and agreed upon, different alternative strategies, representing potential development paths capable of connecting the present situation with the desired future, and milestones, which need to be achieved to realise the end-point, are devised (Greeuw *et al*., 2000; Martelli, 2014).

e) Strategy selection, follow-up and implementation

Finally, the economic, political, social and environmental implications of each alternative strategy are assessed and compared to the goals, objectives, targets and constraints defined at the beginning of the process (Robinson, 1990). Appraisal and evaluation techniques can be used to test more comprehensively the desirability and feasibility of the devised strategies and development paths. This step thus leads to the identification of a preferred strategy which may be subject to further elaboration before being implemented (Quist, 2007).

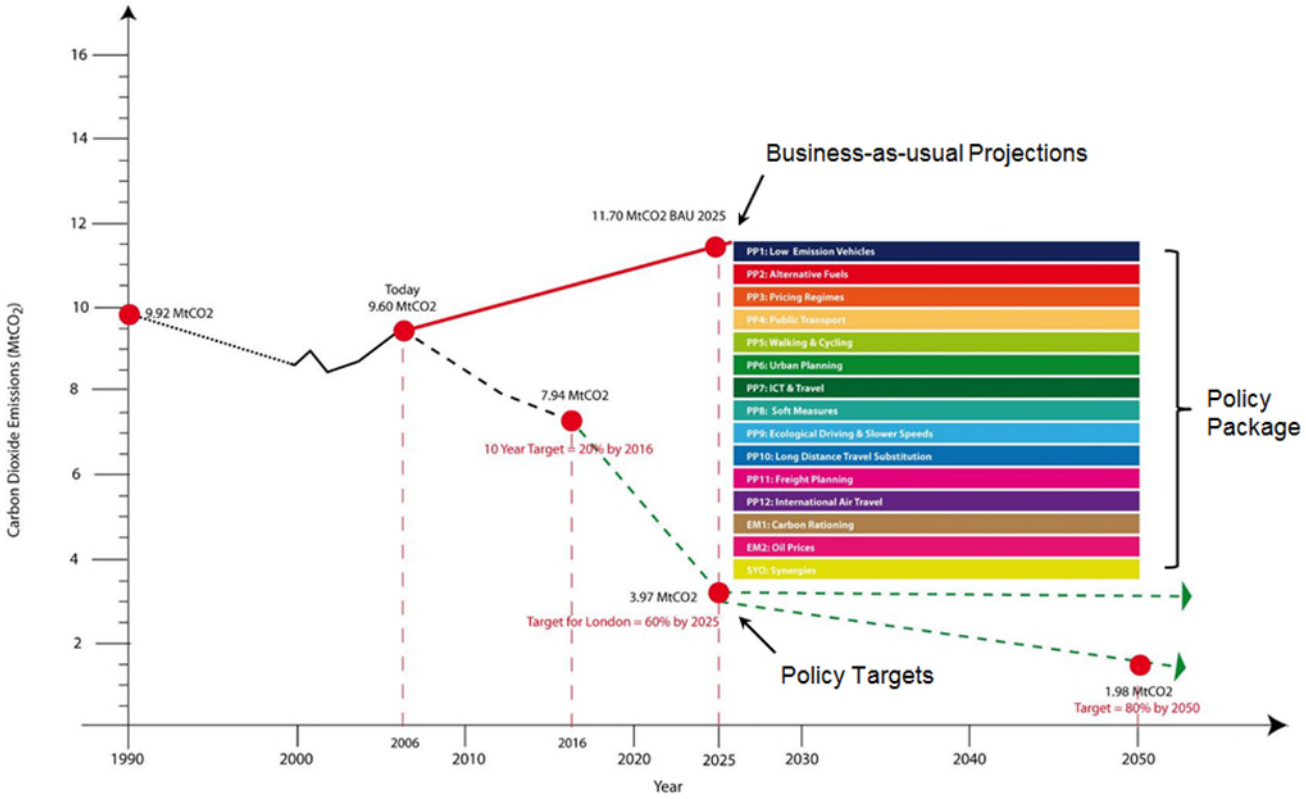
6. A Practical Example of Backcasting Analysis

Hickman and colleagues (2009) describe a participatory backcasting analysis which considers the role of the transportation sector in reducing CO_2 emissions in London. The analysis consists of five steps as presented below.

- *Step 1*: the first step involves an analysis of the current levels of CO_2 emissions in London and the contribution of the transport sector to total emission. Business-as-usual projections regarding CO_2 emissions are determined based on factors such as future population and economic growth.
- *Step 2*: a desired future state of affairs is developed based on specific policy targets as identified by key planning and policy documents and insights from practitioners and experts. Figure 13 highlights the huge gap between the business-as-usual scenario and the desired end-point.
- *Step 3*: strategies, describing pathways towards substantial improvements in carbon efficiency in the transport sector and comprising a package of different policy measures, are devised.

- *Step 4:* the impacts and implications of these policy packages are assessed and an optimal strategic policy package capable of meeting the desired CO_2 emission targets is assembled (Figure 13).
- *Step 5:* follow up activities and recommendations are discussed.

Figure 13 – Policies to Shift from Business-as-Usual to Desired Trajectory.



Source: (Adapted from) Hickman *et al*. (2009).

7. Combination of Conventional Scenario Planning and Backcasting Analysis

Both conventional scenario planning and backcasting analysis have their advantages and disadvantages. Scenario planning illustrates how the future might unfold, depending on the evolution of several external drivers. However, the possible strategies developed as a result of the scenario planning process are intended mainly to cope with these dominant trends and driving forces so as to minimise losses, rather than encouraging innovations and radical transformations (Dreborg, 1996; Becker, 1997). Backcasting analysis, by comparison, aims at challenging the dominant, conventional perspectives and broadening the scope of solutions to be considered. However, without a proper consideration of how current and emerging trends may evolve over time starting from the present situation, this approach risks becoming a purely utopian exercise.

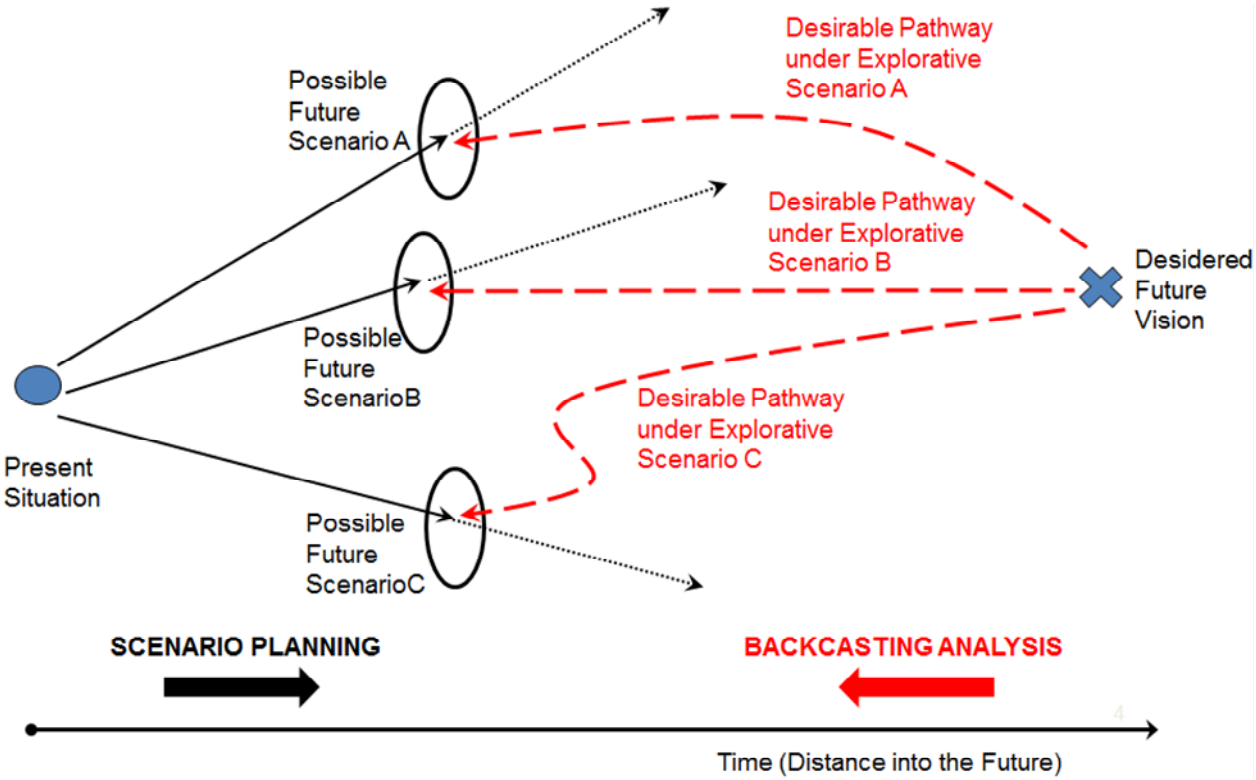
Hence, despite scenario planning and backcasting analysis stemming from contrasting planning paradigms and, in principle, seeming suited to different types of problems (Dreborg, 1996; Becker, 1997), in recent years, some authors have attempted to combine these two techniques in the attempt to shed light on different aspects of the problem being examined and compensate the limits of each method. In the methodology proposed by Kok and colleagues (2011) van Berkel and Verburg (2012), Milestad and colleagues (2014) and van Vliet and Kok (2015), conventional explorative scenarios,

taking the present situation as starting point, are developed first, based on the possible evolution of significant trends and the analysis of major uncertainties and driving forces. Such scenarios, illustrating the framing conditions beyond the control of the scenario planning team and all the relevant actors involved in the exercise, represent the context for the subsequent backcasting analysis. The latter analysis starts with the identification of a long-term, desired future vision of development. Various possible pathways, focusing on desired goals, targets and strategies to achieve this desired future are, then, developed within the context of different plausible exploratory scenarios.

Compared with a typical and pure form of backcasting analysis, the strategies thus developed with this hybrid approach allow the uncertain dynamics of the contextual environment to be better captured. Strategies which are deemed to work effectively in different contexts can be considered sufficiently robust (van Vliet and Kok, 2015).

This combined explorative and normative scenario planning process, summarized in Figure 14, is not, however, immune from issues and methodological challenges. In particular, the connection points between conventional explorative scenarios and desirable pathways leading to the desired future vision may give rise to inconsistencies and contradictions (Kok *et al*., 2011).

Figure 14 – Combination of conventional Scenario Planning and Backcasting Analysis.



Source: (Adapted from) Kok *et al*. (2011) and van Vliet and Kok (2015),

8. References

Alcamo, J. (2008). The SAS Approach: Combining Qualitative and Quantitative Knowledge in Environmental Scenarios. In: Alcamo, J. (Ed.), *Environmental Futures: The Practice of Environmental Scenario Analysis*. Amsterdam: Elsevier, pp. 123-150.

Balula, L. and Bina, O. (2013*). Summary - Literature Review of Key References for Scenario Building*. WP4 Brief, URBACHINA, 21 October 2013, Instituto de Ciências Sociais da Universidade de Lisboa.

Banister, D., Stead, D., Steen, P., Akerman, J., Dreborg, K. and Nijkamp, P. (2000). *European Transport Policy and Sustainable Mobility*. London: Spon Press.

Becker, H. (1997). *Social Impact Assessment*. London: UCL Press.

Bishop P., Hines A., Collins T. (2007). The Current State of Scenario Development. An Overview of Techniques. *Foresight,* Vol. 9, No. 1, pp. 5-25.

Börjeson, L., Höjer, M., Dreborg, K.-H., Ekvall, T., Finnveden, G. (2006). Scenario Types and Techniques: Towards a User's Guide. *Futures*, Vol. 38, pp. 723–739.

Bradfield, R., Wright, G., Burt, G., Cairns, G. and van der Heijden, K. (2005). The Origins and Evolution of Scenario Techniques in Long Range Business Planning. *Futures, Vol.* 37, pp. 795–812.

Cairns, G., Wright, G., Bradfiled, R., van der Heijden, K. and Burt, G. (2004). Exploring e-Government Futures through the Application of Scenario Planning. *Technological Forecasting and Social Change*, Vol. 71, pp. 217-238.

Chermack T.J., Lynham, S.A. and Ruona, W.E.A.. (2001). A Review of Scenario Planning Literature. *Futures Research Quarterly*, Vol. 17, No. 2, pp. 7-31.

Desmerais, E. (2000). The Art of Scenario Planning: a Review of Two Books. *Journal of Business & Economic Studies*, Vol. 6, No. 1, pp. 81-85.

Dreborg, K.H. (1996). Essence of Backcasting. *Futures*, Vol. 28, No. 9, pp. 813-828.

EEA (European Environment Agency) (2009). *Looking Back on Looking Forward: A Review of Evaluative Scenario Literature*. EEA, Copenhagen.

Godet, M. (1993). *From Anticipation to Action: A Handbook of Strategic Prospective.* UNESCO Publishing, Paris.

Gordon, A. (2013). *Adaptive vs. Visionary: Advocacy Approaches in Scenario Planning: Implications of Contrasting Purposes and Constraint Conditions*. PhD Dissertation. Graduate School of Business, Faculty of Commerce, University of Cape Town.

Grant, R.M. (2003). Strategic Planning in a Turbulent Environment: Evidence from the Oil Majors. *Strategic Management Journal,* Vol. 24, No. 6, pp. 491-517.

Greeuw, S., van Asselt, M., Grosskurth, J., Storms, J., Rijkens-Klomp, N., Rothman, D and Rotmans, J. (2000). *Cloudy Crystal Balls: An Assessment of Recent European and Global Scenario Studies and Models*. Copenhagen: European Environment Agency.

Hickman, R., Ashiru, O. and Banister, D. (2009). Achieving Carbon-Efficient Transportation: Backcasting from London. *Transportation Research Record,* Vol. 2139, No. 1, pp. 172-182.

Kahn, H. and Weiner, A. J. (1967). *The Year 2000: A Framework for Speculation on the Next Thirty Years.* MacMillan, New York.

Kahn, H., Brown, W. and Martel, L. (1976). *The Next 200 Years - A Scenario for America and the World*. William Morrow and Company, New York.

Kok, K. and van Vliet, M. (2011). Using Participatory Scenario Development Toolbox: Added Values and Impact of Quality Scenarios. *Journal of Water and Climate Change*. Vol. 2, No. 2-3, pp. 87-105.

Kok, K., van Vliet, M., Barlund, I., Dubel, A. and Sendzimir, J. (2011) Combining Participative Backcasting and Exploratory Scenario Development: Experiences from the SCENES Project. *Technological Forecasting & Social Change*, Vol. 78, pp. 835–851.

Kosow, H. and Gaßner, R. (2008). *Methods of Future and Scenario Analysis: Overview, Assessment, and Selection Criteria*. DIE (Deutsches Institut für Entwicklungspolitik) Research Project 'Development Policy: Questions for the Future'.

Lindgren, M. and Bandhold, H. (2003). *Scenario Planning: The Link between Future and Strategy*. Palgrave Macmillan.

Lovins, A. (1976). Energy Strategy: The Road not Taken? *Foreign Affairs*, Vol. 55, No. 1, pp. 186–217.

Lovins, A. (1977). Soft Energy Paths. FOE/Ballinger, New York.

Martelli, A. (2014). *Models of Scenario Building and Planning: Facing Uncertainty and Complexity*. Palgrave Macmillan.

Meadows, D.H., Meadows, D.L., Randers, J. and Beherens III, W.W. (1972). *Limits to Growth*. Universe Books.

Milestad, R., Svenfelt, A. and Dreborg, K.H. (2014). Developing Integrated Explorative and Normative Scenarios: The Case of Future Land Use in a Climate-Neutral Sweden. *Futures*, Vol. 60, pp. 59–71.

Millet, S. (2003). The Future of Scenarios: Challenges and Opportunities. *Strategy and Leadership*, Vol. 31, No. 2, pp. 16-24.

Mintzberg, H. (1994). *The Rise and Fall of Strategic Planning*. New York: Free Press.

Parson, E., Burkett, V., Fisher-Vanden, K., Keith, D., Mearns, L., Pitcher, H., Rosenzweig, C. and Webster, M. (2007). *Global-Change Scenarios: Their Development and Use*. *US* Department of Energy Publications.

Porter, M.E. (1985). *Competitive Advantage: Creating and Sustaining Superior Performance*. New York: The Free Press.

Quist, J. (2007). *Backcasting for a Sustainable Future: The Impact after 10 Years.* Eburon.

Robinson, J. (1982). Energy Backcasting: A Proposed Method of Policy Analysis. *Energy Policy,* Vol. 10, No. 4, pp. 337–344.

Robinson, J. (1990). Future Under Glass: A Recipe for People who hate to Predict. *Futures*, Vol. 22, No. 8, pp. 820–842.

Robinson, J. (2003). Future Subjunctive: Backcasting as Social Learning. *Futures*, Vol. 35, pp. 839–856.

Rotmans, J., van Asselt, M., Anastasi, C., Greeuw, S., Mellors, J., Peters, S., Rothman, D. and Rijkens, N. (2000). Visions for a Sustainable Europe. *Futures, Vol.* 32, pp. 809- 831.

Schoemaker, P. (1995). Scenario Planning: A Tool for Strategic Thinking*. Sloan Management Review, Vol.* 37, No. 2, pp. 25-40.

Schwartz, P. (1991). *The Art of the Long View: Planning for the Future in an Uncertain World.* Doubleday.

Schwenker, B. and Wulf, T. (2013). *Scenario-Based Strategic Planning: Developing Strategies in an Uncertain World.* Springer Gabler*.*

van Berkel, D.B. and Verburg, P.H. (2012). Combining Exploratory Scenarios and Participatory Backcasting: Using an Agent-Based Model in Participatory Policy Design for a Multi-Functional Landscape*. Landscape Ecology, Vol. 27, No. 5, pp. 641–658.*

van der Heijden, K. (2005). *Scenarios: The Art of Strategic Conversation. John Wiley & Sons Ltd* (*2nd Edition).*

van Notten, P. (2006). Scenario Development: A Typology of Approaches. In: OECD (Ed.).*Think Scenarios, Rethink Education.* OECD Publishing, Ch. 4.

Van Notten, P., Rotmans, J., Van Asselt, M and Rothman, D. (2003). An Updated Scenario Typology. Futures, Vol. 35, pp. 423–444.

van Vliet, M. and Kok, K. (2015). Combining Backcasting and Exploratory Scenarios to Develop Robust Water Strategies in Face of Uncertain Futures. *Mitigation and Adaptation Strategies for Global Change*, Vol. 20, No. 1, pp. 43–74

Van't Klooster, S., van Asselt M. (2006). Practicing the Scenario-Axes Technique. *Futures*, Vol. 38, pp. 15–30.

Vergragt, P. J. and Quist, J. (2011). Backcasting for Sustainability: Introduction to the Special Issue, *Technological Forecasting and Social Change*, Vol. 78, No. 5, pp. 747-755.

Wack, P. (1985a). Scenarios: Shooting the Rapids. *Harvard Business Review, Vol.* 63, No. 6, pp. 139-150.

Wack, P. (1985b). Scenarios: Uncharted Waters Ahead. *Harvard Business Review, Vol.* 63, No. 5, pp. 73-89.