The interface between a carbon budget approach and a carbon tax

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Final Report

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EXECUTIVE SUMMARY

Objective and scope

The National Climate Change Response White Paper released in 2011 formally introduced the use of a 'carbon budgeting approach' as an element of the broad mix of different mitigation instruments, approaches, policies, measures and actions that will make up South Africa's mitigation policy. According to the Department of Environmental Affairs ("DEA"), the terminology 'carbon budget' and 'carbon budget approach' were used primarily in the White Paper to introduce a quantity dimension to South Africa's mitigation effort, and thus to draw attention to mitigation performance relative to a predetermined emissions reduction objective or outcome. The use of these terms does not necessarily imply the imposition of absolute quantitative emissions constraints on a sector (sub-sector, company or entity), and the White Paper does not propose the determination and allocation of an absolute national carbon budget. Rather, the White Paper focuses on flexibility as a key characteristic of all mitigation policy instruments, and for these reasons, the following definition of a 'carbon budget approach' is adopted for the purposes of the current study:[1]

> A carbon budget approach is characterised by the use of flexible[2]quantity-based policy instruments to achieve a 'desired emission reduction outcome' ("DERO") at a sector, sub-sector, company, or entity level.

Following from this definition, the main purpose of the instruments that would flow from a carbon budget approach is that they must draw attention to mitigation performance relative to a predetermined emissions reduction goal (the DERO).As such, they must include a quantity dimension. Considering the universe of available climate change policy instruments, the following instruments are identified as quantity-based instrument ("QBIs") based on their ability to directly affect either absolute or relative (intensity-based) emissions levels.

This report begins with the premise that a carbon tax will be introduced as the mainstay of South Africa's carbon mitigation effort. **The purpose of this report is to then consider how QBIs can be combined with a carbon tax to support the effective and efficient achievement of DEROs.** The report, thus, does not deal with the design of overall climate change mitigation policy in South Africa, but rather with a very specific subset of mitigation policy.[3]

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[1]The term 'carbon budget' is primarily used in climate change policy literature to denote the allocation of a national carbon budget between sectors. The carbon budget approach, for the purposes of this study, in contrast, centres on the use of QBIs to move towards predetermined desired emissions reduction outcomes ("DEROs"), and not on the determination of the allocation implied by the DEROs. The DEROs would have been determined through a separate process, which may or may not be called 'carbon budgeting', but which lies outside the scope of this report.

[2]Flexibility in this context refers to the ability to allow least-cost GHG abatement.

[3] In accordance with sound mitigation policy design, this landscape is also assumed to include a suite of non-QBIs like support for research and development, subsidies for energy efficiency, etc.

Table 1: QBIs within the universe of mitigation policy instruments

	Price instruments	QBIs	Other
Regulation (command and control)	N/A	**Emissions cap (A), Performance standards, Technology standards**	Information disclosure rules
Economic instrument	Broad-based carbon tax, Subsidies, Other proxy carbon taxes	**Emissions trading scheme (A), Baseline and credit trading scheme, White certificates trading schemes, Green certificate trading schemes**	
Voluntary Commitments		Agreement to reach target within timeframe, early reduction credits, offsets	Investment in clean technologies, Information disclosure, Installing monitoring systems

Note: (A) Denotes QBIs that place an absolute restriction on emissions. All other QBIs strive to reduce emissions on a relative or intensity (ie emissions per unit of output) basis.

In particular, the study assesses the different interface options for combining a broad-based[4] carbon tax and QBIs to increase the likelihood that DEROs will be met[5] compared to a scenario where a carbon tax is implemented in isolation (or where QBIs, if they exist, have been implemented for purposes other than meeting DEROs).[6] As will become evident when the different frameworks for combining these two types of instruments are addressed, this does not mean that a carbon tax and QBIs have to apply to each sector.

The inclusion of DEROs in South Africa's mitigation policy approach implies that certainty in achieving a quantity goal at a sector (sub-sector or entity level) is important. QBIs can play an important role in this regard in determining the specific quantity of emission reductions that will be achieved (assuming there are no enforcement constraints). This certainty may however come at the expense of higher mitigation costs if QBIs are applied indiscriminately. Policy makers therefore need to strike a balance

[4] The term 'broad-based', whether used in context of a carbon tax or more generally relating to a carbon price, is used in this report to denote the fact that a price is placed on most (or at least a very substantial) portion of national emissions. The term is thus used to distinguish broad, national (or at least multi-sectoral) policies or instruments from narrower policies or instruments that only relate to one (or at most a few) sectors or sources of emissions.

[5] Apart from the project brief requiring that a carbon tax be considered as part of the interface, the presence of a broad-based carbon price is supported by economic theory that indicates it is the most efficient (i.e. least-cost) instrument to achieve emissions reductions and is therefore justified as a cornerstone of mitigation policy. A broad-based carbon price can be set by a carbon tax or an ETS. Local conditions, however, dictates that a carbon tax creates this broad-based carbon price in short term (see Section 10.1). Furthermore, a carbon tax is given a central role in driving mitigation action in the short term in the 2011 National Climate Change Response White Paper, and the National Treasury has indicated that a national carbon tax will be introduced in South Africa in the near future (although the expected implementation of the tax in 2014 is looking increasingly unlikely due to the delay in publishing a second carbon tax discussion paper that was expected in 2012).

[6] Performance or technology standards, or instance, could be in place concurrently with a carbon tax with the primary purpose of increasing energy efficiency or the roll-out of renewable energy technologies. If these instruments increase the likelihood of meeting DEROs, it will be by coincidence rather than by design.

between sometimes competing quantity and efficiency objectives. Absolute quantity certainty at the cost of significant economic inefficiency is unlikely to be desirable.

Relationship between DEROs and QBIs

DEROs indicate the level of emissions reductions practically achievable within the carbon budget approach. The DEA has indicted that an initial set of DEROs will be put forward once their analysis of South Africa's mitigation potential has been concluded,[7] but before the review of the National GHG Emissions Trajectory specified in the White Paper. However, the precise nature of the relationship between the DEROs and the Trajectory has yet to be determined. There is therefore great uncertainty at this stage as to how the DEROs will be set and measured.

The unit of account for the DEROs has also not been defined as yet; it will be at a sub-economy level, but could be at the sector, sub-sector or even individual company or entity level. It is also not yet clear whether these outcomes will be mandatory or voluntary (i.e. whether there will be penalties or other enforcement mechanisms that come into play should the DEROs not be achieved). In addition, there may be scope for DEROs to be defined on a relative (i.e. intensity) rather than an absolute (fixed amount) basis.

According to the DEA, these initial DEROs will be defined by the end of 2013, and will be implemented for a set period of time that is as yet undetermined.[8] They will be reviewed periodically, but it is not known whether emissions will be measured cumulatively against these DEROs over a period of time, or whether they will specify a final emissions reduction goal to be attained by a certain future date. It is also not certain how many DEROs will be specified, or what level of mitigation effort they will imply. Finally, the DEROs may all be similarly defined, or there may be a mix of different types of DEROs.

The White Paper calls for climate change policies to be assessed against their wider socio-economic impact, and this must also apply to DEROs. It is therefore assumed that the DEROs will be set at an optimal level of mitigation for each sector, cognisant of environmental imperatives, cost effectiveness and the impact of such instruments on jobs, energy security and international competitiveness, etc.

In the South African carbon budget approach to climate change mitigation, the DEROs will determine the mitigation policy goals (which will define desired mitigation effort by sector), to be achieved through the implementation of mitigation policy instruments.

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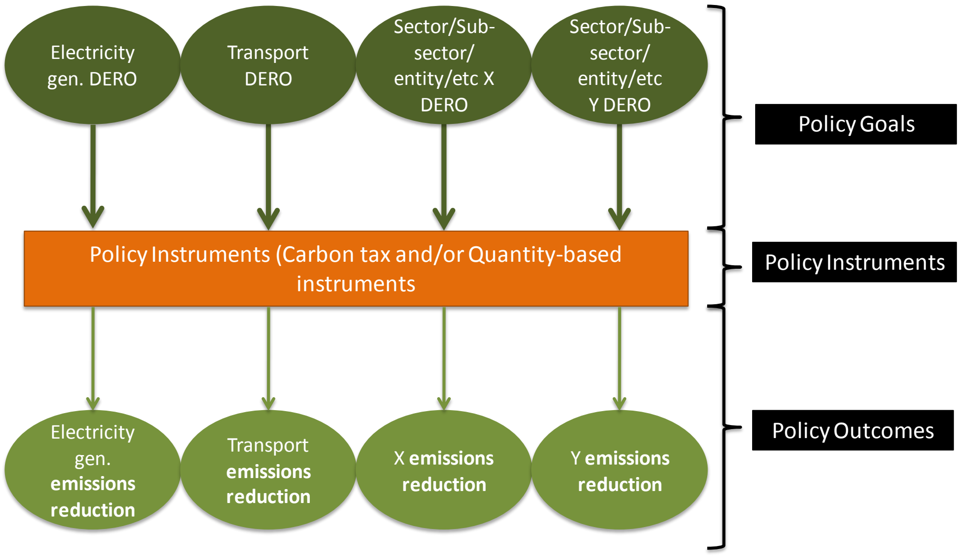
[7]A study to this effect, administered by the DEA and funded by GIZ, is currently being undertaken.

[8]The White Paper will be reviewed every five years, so it is unlikely that DEROs will be defined for more than five years.

Figure 1: Relationship between DEROs and mitigation policy instruments



Source: Project team

The substantial uncertainty surrounding the nature of the DEROs outlined in this section imposes significant complexity on a study of the mitigation instruments most appropriate to achieve them. Whether a DERO is set for two or 10 years is material in determining whether a tax or a QBI is the more appropriate policy mitigation instrument. Similarly, the instrument to achieve a cumulative DERO over a period of time is likely to differ from that to achieve a long term absolute DERO. In light of this uncertainty, this study focuses on understanding and describing the necessary process for identifying an optimal carbon tax-QBI interface in South Africa, as opposed to delivering definitive options.

Guidelines for simultaneous application of a carbon tax and QBIs

In theory, the number of policy instruments should be restricted to the number of targets policymakers are trying to achieve. This is to avoid unintended consequences that may arise from instruments interacting with each other and the various policy targets. Economic instruments like carbon taxes are economically efficient in that they create a broad-based carbon price that efficiently distributes the burden of emissions reductions between economic agents, leading to lowest-cost abatement.[9] For this reason they are well-suited to being the core instrument in a mitigation policy suite. There are sound reasons, however, for using additional instruments to meet a particular policy goal (i.e. reducing GHG emissions) in certain circumstances.

[9] The preference for a carbon tax rather than an ETS to create a broad-based carbon price in South Africa in the short-term is widely acknowledged the concentrated nature of local emissions sources. The focus is thus on a carbon tax as a way of creating a broad-based carbon price.

When **multiple market failures** are present, for example when information asymmetries lead to the main instrument being less efficient than theory would predict, or when sub-optimally low levels of energy efficiency or renewable energy investment are generated, the use of more than one instrument to meet a specific emissions reductions' goal may be justified. Moreover, where the **initial carbon price is low and there is uncertainty** about the future path of carbon prices, additional measures to incentivise energy efficiency or change long term investment decisions, may be required. In such cases, multiple instruments can be used to strengthen the carbon price signal and facilitate additional mitigation.

There is also an argument for **supplementing a broad-based carbon tax with QBIs if policymakers place a high value on meeting short-term targets**. A carbon price can be adjusted over time to lead to less or more mitigation, and therefore should enable quantity targets to be met in the long term, so a QBI is not required to meet a quantity target per se. However, time is required to gather and analyse emissions data and assess the impact of a tax, and a tax is typically only adjusted once a year in the national budget. Also, to prevent uncertainty, swings in market prices, and the possibility that emissions may overshoot a target, a carbon tax is likely to be adjusted in relatively small increments. In the short term, therefore, additional mitigation instruments may be required.

Even if multiple instruments are justified, there is still a need to reduce unintended interactions. The following guidelines should therefore apply when implementing multiple instruments:

- **The number of instruments combined should be kept to a minimum** to reduce the risk of unintended interactions and consequences;
- Instruments aimed at reducing emissions should be applied to **address specific and identified (different) market failures and/or applied to target specific sets of emissions;**[10]
- **The carbon price signal (which consists of both the explicit carbon price and the implicit or shadow carbon price created by the cost of mitigation action) should be as consistent between sectors (both upstream and downstream) as possible**. If this is not the case, different carbon price signals in different sectors could lead to some firms emitting too much and others too little compared to the economy-wide marginal cost of meeting a certain level of emissions reductions – thereby reducing economic efficiency and increasing the cost of mitigation action. Where sector discrepancies in carbon prices in sectors are justified for the reasons mentioned above, these discrepancies should be kept as low as is needed to achieve the desired result;

[10]In practice instruments could also interact with instruments aimed at other market failures in that the competitiveness of a firm could be reduced by the cumulative impact of cost increases, for instance, even if they address different market failures. For this reason it is important that the likely impact of new policy instruments always be assessed in a holistic manner taking account for all existing policy instruments.

- **The added benefits in terms of mitigation outcomes of having a strengthened carbon price signal in some sectors needs to be weighed against the loss of economic efficiency (increase in mitigation cost) implied by having a non-uniform carbon price signal;**
- **Additional instruments must be strictly transitional and be phased out as the value of the carbon price increases over time**;
- **Policies that are going to be implemented jointly need to be developed with due cognisance of their impacts on each other to ensure policy coherence; and**
- **When deciding how to implement different policy instruments simultaneously, the focus must fall on the functionality of the overall combined interface rather than on the individual instruments.** These interactions are often highly context specific and their likely impact in South Africa across different sectors needs to be evaluated and understood.

Frameworks for simultaneous application of a carbon tax and QBIs

Three possible frameworks for creating an interface between a broad-based carbon tax and QBIs were identified.

Layering involves applying an instrument on top of the same set of emissions already covered by an existing instrument. The use of multiple instruments 'stacked' on top of one another does not ensure that the instruments are necessarily complementary or will meet the desired effect of the combination. It is therefore important that the instruments are jointly developed, or at a minimum that the possible outcomes of the interaction between the two instruments are thoroughly analysed.

A **carve-out** refers to a situation where different instruments are applied to different sets of emissions. In contrast to layering, there is thus no direct overlap between instruments. This would entail, for example, exempting some sectors from a broad-based carbon tax and instead subjecting them only to a QBI.A carve-out increases the probability that instruments are complementary by reducing the risk of unintended consequences between instruments. From an economic efficiency perspective, however, a carve-out reduces the coverage of the broad-based carbon price signal created by a carbon tax. To reduce the efficiency loss inherent in the combined framework, it is advisable to design the QBI so that the carbon price (for economic QBIs) or shadow carbon price (for regulatory QBIs) is set at or near the broad-based carbon price.

Hybrid schemes involve the tailored combination of price and quantity instruments to ensure complementarity. Hybrid schemes are thus a mixture of both price and quantity instruments, and are fully integrated. The two instruments thus coexist and the obligations set by the one instrument are modified as a result of meeting the obligations of the other instrument. For example, while any tradable permit scheme, for instance, involves some form of penalty for non-performance, it only qualifies as a hybrid instrument if the payment of the penalty is an alternative to compliance (i.e. if the payment is made there is no further expectation that a firm comply with the cap). One of the main benefits of a hybrid scheme is that, depending on how the interaction is defined, firms can be subject to a shadow carbon price that is equal to the carbon tax rate. Also, the ability to avoid tax on all units of emissions, mean that firms may be willing to implement projects with higher marginal abatement costs than the tax level, if the cost of implementing these projects is less than the amount of tax they would have to pay on their remaining emissions. If the target level in a hybrid instrument can be set to match the DERO, then this may increase the probability of the DERO being met.

The South African Carbon Tax

The use of a carbon tax as South Africa's broad based pricing instrument is widely accepted, and work by the National Treasury on the tax is already at an advanced stage. The current design includes a number of 'basic' elements: it will be implemented on direct emissions of GHGs, has two phases (2013/14- 2019/20 and 2020-2025), starts at R120 per tonne of CO2e, escalating at 10% per annum in the first phase, to be reviewed in the second phase. An additional mechanism for adjusting the tax rate is provided in the form of a tax exemption for 60% of emissions. This is applied across the board, and will be reviewed in the second phase. Also included in the current tax design is tax relief, provided through threshold exemptions for trade exposure, process emissions and offsets.

In addition, relative QBIs in the form of sector performance standards (through so-called 'z-factors') are included in a hybrid QBI-tax framework. These QBIs incentivise additional mitigation, but by virtue of their design, will not necessarily result in achievement of a DERO. The z-factors, on top of the 'basic tax design', therefore already comprise one carbon tax-QBI interface option, but not one which achieves the purpose of ensuring that individual sectors meet their DEROs.

For analytical clarity, when assessing alternative (to the current tax design) tax-QBI interface options, the 'basic carbon tax' is specified (excluding the relief, which will be explicitly accounted for in the DERO design, and z-factor design aspects).

Identifying carbon tax – QBI interface options for South Africa

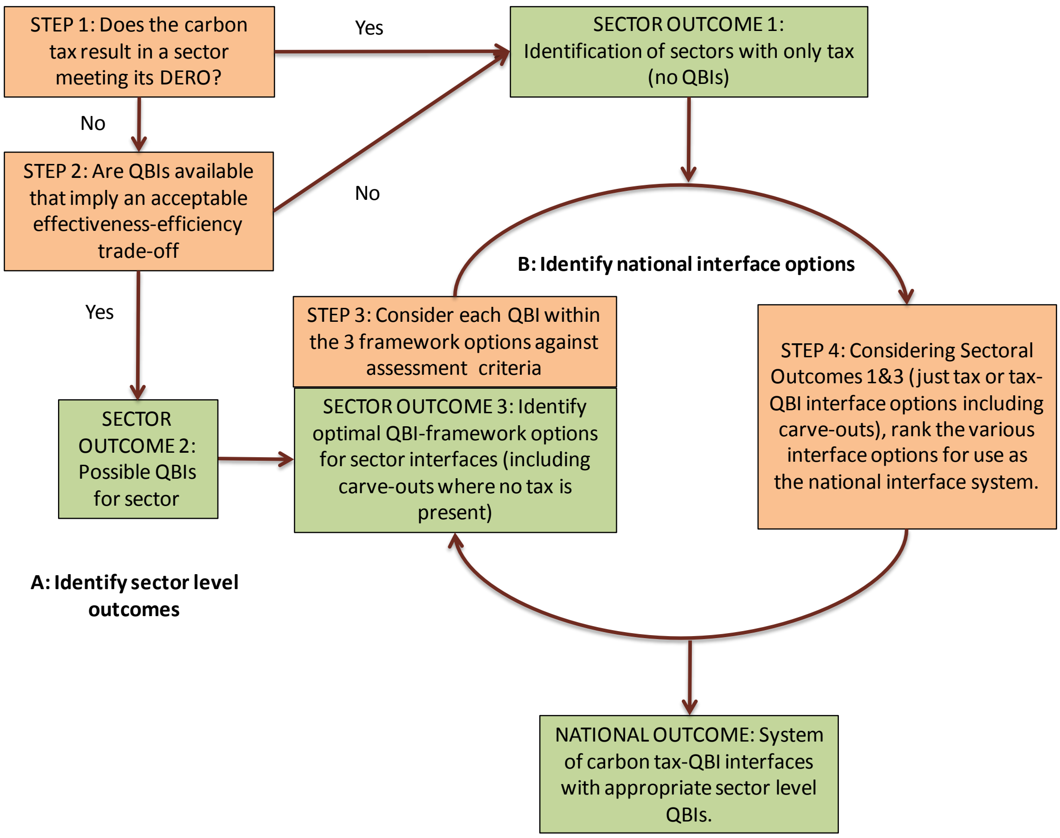
Identifying both appropriate QBIs and the appropriate carbon tax-QBI interface options to achieve DEROs depends primarily on the level and nature of the DEROs, which are currently unknown. In addition, at a sector level the appropriate instruments and interface frameworks will depend on sector characteristics. At a national level, the issue becomes more complex, with the overall system of interfaces depending on the design of sector interfaces (primarily the frameworks used to combine instruments), the number of sector interfaces, the potential for fracturing the broad-based carbon price, and the desired balance between efficiency and effectiveness.

In the absence of knowing the level and nature of the DEROs, a process to develop possible carbon tax-QBI interface options appropriate to the local context has been developed, and is depicted below. This process comprises two phases, the first deals with the sector level, and the second deals with the national level. Four 'steps' are articulated in total, delivering three 'sector level outcomes' and one 'national level outcome'.

Phase A: Identifying sector level outcomes (to be undertaken for each sector individually)

STEP 1: Does the carbon tax result in a sector meeting its DERO? The first consideration in this process is whether the 'basic carbon tax' and any other instruments that are already in place[11] are likely to result in individual sectors / sub-sectors meeting their DEROs. This is likely to involve a modelling exercise, which will in turn require detailed and specific information on sector characteristics and the availability and cost of mitigation options. At this stage, the necessary policy relevant climate mitigation information, specifically data on GHG emissions, abatement opportunities and mitigation costs, is not yet readily available for South Africa. The forthcoming DEA-study on mitigation options is expected to address this information gap.

Figure 2: Identifying optimal carbon tax – QBI interface options



Source: Project team

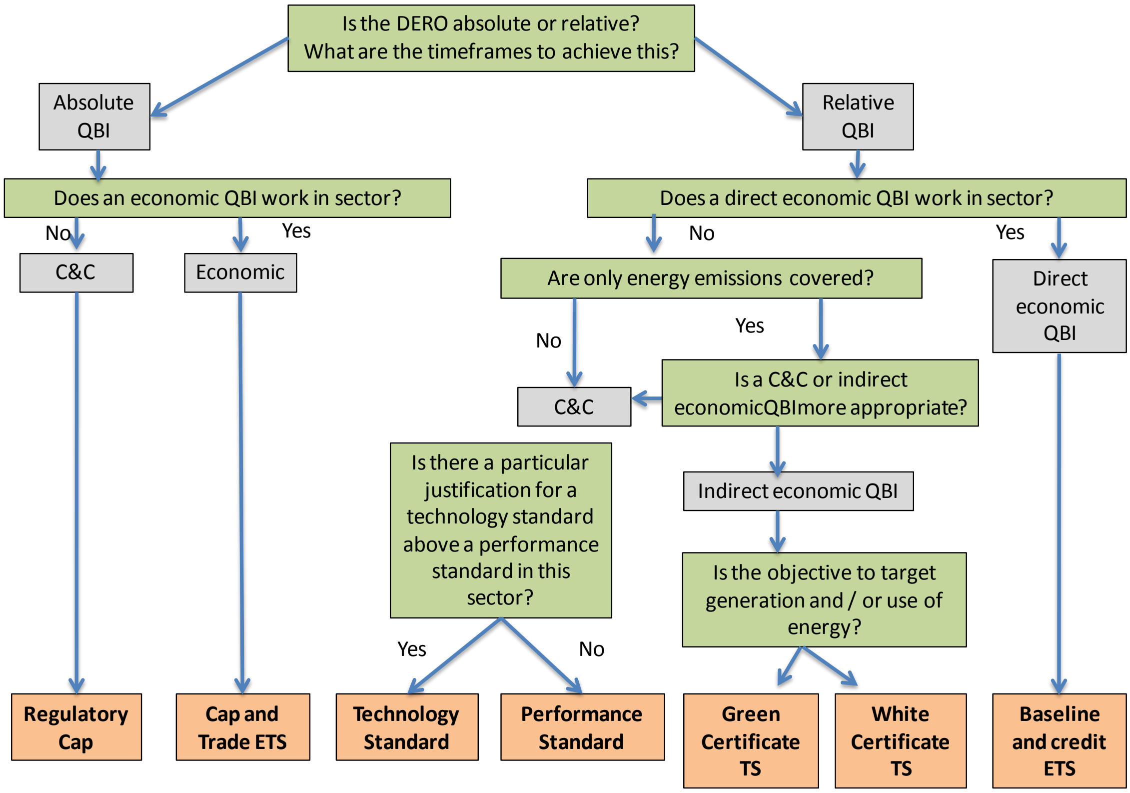
If the 'basic carbon tax' in addition to existing mitigation instruments is forecast to result in a sector DERO being largely achieved, then it would not be beneficial to include a QBI in the sector, as the desired mitigation level is likely to be achieved at least-cost through the tax. For such sectors, the

[11] The impact of both policies that apply across sectors, and policies that only apply to individual sectors (like environmental levies) need to be taken into consideration.

sectoral level analysis is complete, with the 'tax only' outcome (Sectoral Outcome 1) feeding into the national analysis.

STEP 2: What QBIs could achieve DERO at acceptable effectiveness-efficiency trade-off? STEP 2 applies to sectors where the basic carbon tax is unlikely to enable the DERO to be reached. In this case, further analysis is required to ascertain what possible QBIs to utilise in the sector.[12] For efficiency and flexibility reasons, economic instruments are always preferable to command and control instruments, unless there is strong evidence that the economic instrument will not work in a specific sector. Whether a QBI is relative or absolute will be determined by the nature of the DERO in force. The decision tree that follows demonstrates the process of identifying the most appropriate QBIs for a sector.

Figure 3: identifying appropriate sector level QBIs



Source: Project team

[12] Should a DERO not be met because regulatory, institutional or other barriers prevent the broad-based carbon tax from incentivising the appropriate mitigation response in producers and consumers, it would be prudent to first consider whether these barriers can be removed before the decision is taken to add more instruments (QBIs) to the policy mix.

As with the analysis of the impact of the carbon tax in STEP 1, a high degree of sector expert knowledge will be required to determine whether QBIs will be effective in guiding a sector towards its DERO Information is required not only on the cost and availability of mitigation options, but also on how QBIs are likely to impact firm-level decision-making. Information relating to the latter would include market structure and dynamics, regulatory structure (not just in theory, but how it impacts day-to-day decisions), the ability of firms to pass on carbon costs etc.

Following the decision tree shown above may result in more than one QBI being identified as appropriate for the sector. The QBIs identified, however, need to adhere to the principles of good mitigation policy-making. The following factors would therefore need to be considered in weighing up the costs and benefits of each option: environmental effectiveness; economic efficiency; encouragement of substitution; impact on technology development; administrative burden; information requirements; the distributional/equity impact of the mechanism; public support for the mechanism; international competitiveness; interaction with other policies; fiscal affordability; and flexibility. QBIs that are not considered feasible on the basis of these evaluation criteria will obviously not remain in contention for inclusion in an interface. Of particular importance is the trade-off between the increased emissions reductions arising from the QBI and the cost of achieving these additional reductions (i.e. the trade-off between environmental effectiveness and economic efficiency). In some cases the cost of implementing a QBI may simply be prohibitive and the level of the DERO may have to be reconsidered.

Alternatively, the choice of framework option in Step 3 can be used to reduce the expected cost of the QBI. Any framework option that caps the possible cost of the QBI (as measured by the carbon price signal), will however reduce the probability that the DERO will be met. Provided that the probability of meeting the DERO is increased relative to the carbon tax only scenario, this may still be more attractive to policymakers than not implementing a QBI and accepting that the DERO is unlikely to be met in the current period.

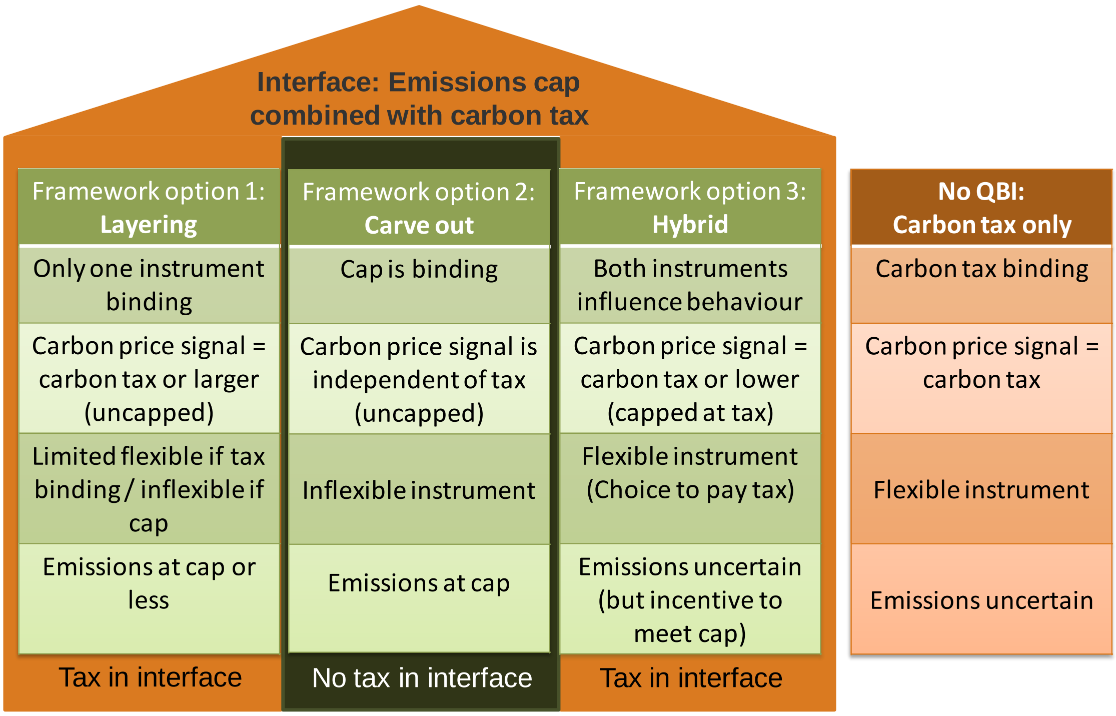
STEP 3: Consider each QBI within the three framework options against assessment criteria. Step 3 involves considering each possible QBI identified in Step 2 within the theoretical frameworks for combining a carbon tax and QBIs identified in above. Note that under the ‘carve-out’ framework, a QBI can stand alone in a sector without the carbon tax. The nature of the DERO in each sector is again relevant here. If the DERO is absolute, with a short to medium term timeframe, then a hybrid framework will not be appropriate. Only a layered, or carve-out framework, can deliver an absolute level of emissions reduction in the short to medium term.

To minimise the possibility of unexpected and perverse outcomes, all existing mitigation instruments in the sector across all spheres of government will need to be considered at this point. Next, each of the possible QBIs to be embedded in the framework must be assessed against the sector objective. Assessing the instruments and the frameworks together is important as the choice of framework may change the characteristics of the interface.

The figure that follows illustrates the impact of the framework itself on the characteristics of the resulting interface, using the example of an emissions cap. Depending on the framework chosen, the carbon price signal can be smaller, equal or larger than that of the carbon tax alone. Also, the carbon price signal (and thus the mitigation effort implied by the interface) can either be capped at the carbon tax or uncapped (i.e. as large as required to meet the regulatory emissions cap).

In this example, it is proposed that the same criteria used to evaluate individual instruments in Step 2 be followed here to compare different interface options. In practice the final criteria utilised, together with their weighting will be determined by the relevant stakeholders in the policy process. Given that this evaluation includes both individual instruments and the interaction of these instruments within a specific sector, the outcome of this assessment will be highly context specific. Step 3 will result in a ranking of the possible QBI-framework options which constitutes sector outcome 3.

Figure 4: Impact of framework choice on characteristics of interface



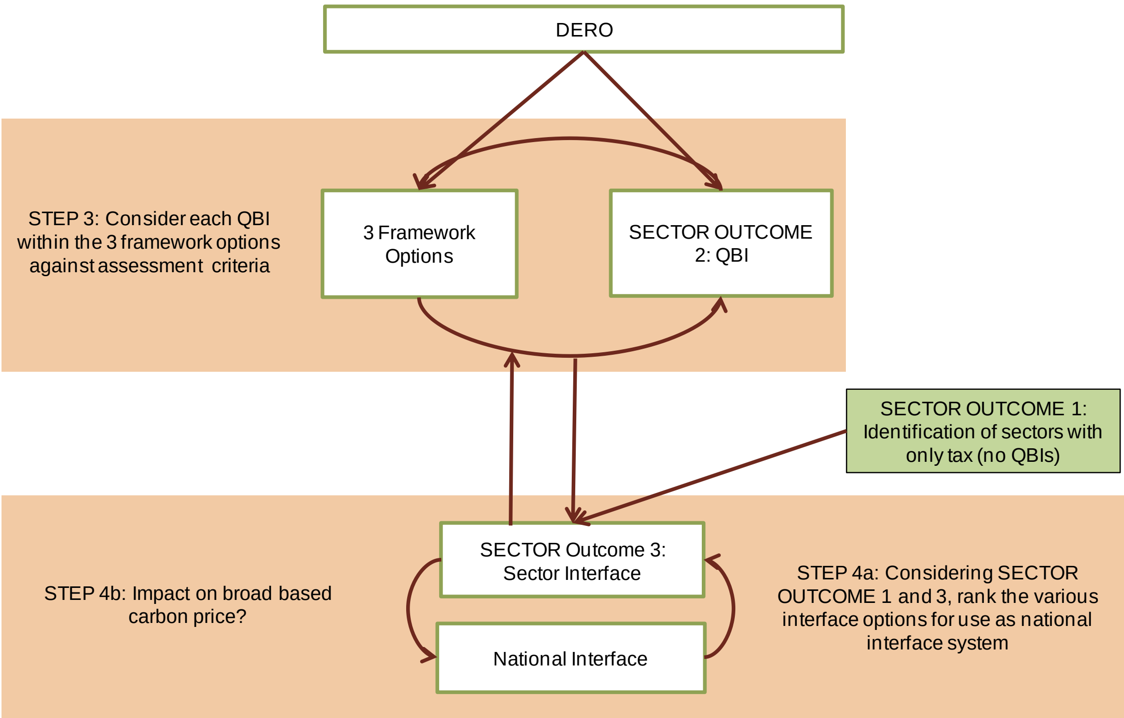
Source: Project team

Phase B: Identifying national interface options (applied to all available sector interface options jointly)

Step 4: Identify and select national interface options. Once the sectoral interface options have been identified, it is necessary to consider the overall system of carbon tax-QBI interfaces. Sector outcomes 1 and 3 from each sector provide the starting point. Next, the impact of the proposed sectoral interfaces (sector outcome 3) on the functioning of the broad-based carbon price arising from the carbon tax must be considered. Of particular interest are the number of interfaces, the frameworks used in each, and the number of sectors without QBIs.

Whilst a particular ranking of carbon tax-QBI interfaces may emerge at an individual sector level, a different ranking may be appropriate for the economy as a whole. Overall, the benefits of the system (which may include a number of QBI-tax interfaces) need to be compared to the loss of economic efficiency inherent in the fracturing of the carbon price signal originating from the carbon tax. At this stage it may be necessary to limit the number of QBI interfaces (or at least the form they can take) to preserve the integrity of the broad-based carbon price. Either a modelling exercise, or an expert workshop, or both will probably be required to assess this issue. It will also be necessary to consider the more general impacts that the use of different interface options may have on the functioning of the carbon tax system in South Africa, particularly the use of revenue recycling.[13]

Figure 5: Step 3 and 4: Identifying sectoral and national interface options



Source: Project team

[13] If significant revenue recycling is used to address the distributional impact of a carbon tax, or to support mitigation programmes, for instance, it may be problematic if the use of QBIs in tax-QBI interfaces leads to a significant reduction in carbon tax revenues. Whether this is a problem will depend on the type of QBIs used. A reduction in available funds to address the distributional impacts of mitigation policy will be particularly problematic if the QBIs used lead to similar or higher carbon price signals. In this event the prices of downstream goods would increase as much (or more) than would have been the case under only a carbon tax regime. But there may not be the same level of funds available to address the negative distributional impact materialising from higher consumer prices than would have been the case had a carbon tax been implemented in isolation.

If this analysis reveals problems and distortions to the underlying price, thereby changing the sector level ranking of options, the analysis may need to return to Step 3. The iterative nature of Steps 3 and 4 is illustrated in Figure 5 above.

Conclusions and recommendations

The purpose of this study was '**to consider how QBIs can be combined with a carbon tax to support the effective and efficient achievement of DEROs'**.

Within the carbon budget approach of the White Paper, DEROs will indicate the optimal level of emissions reductions and will thus provide the mitigation policy goals, which are implemented by mitigation policy instruments. Since DEROs are as yet undefined, it is not yet possible to assess what the optimal policy instrument mix for South Africa would be.

The study has, however, shown that the simultaneous use of a carbon tax and QBIs to meet sector-level targets like DEROs is an intricate and complex exercise which should not be entered into lightly. This is for two main reasons.

Firstly, the extensive use of QBIs to meet sub-national emissions reduction goals is theoretically at odds with the use of a broad-based carbon price. Creating a higher shadow carbon price in some sectors through the use of QBIs can lead to additional mitigation, but the cost of mitigation might be increased by forcing firms in specific sectors to implement more expensive mitigation options than warranted by the carbon price signal, while potentially less expensive options in sectors subject to a lower carbon price signal are left unexploited. This trade-off between environmental effectiveness and economic efficiency becomes more severe as carbon price signals diverge, and the unchecked use of QBIs could eventually increase costs to a point where there is no longer a net benefit to having a broad-based carbon price in place.

Secondly, in developing an optimal interface between a carbon tax and QBIs, great care needs to be taken to avoid unintended interactions between instruments. This will require significant consultation and analysis. As is clear from the methodology shown above, this process significantly increases the information requirements needed to make the right policy decision, especially when compared to a broad-based carbon tax used in isolation (or simply applied on pre-existing instruments that target different outcomes).

This does, however, not mean that there can be no role for QBIs if a broad-based carbon tax is in place. When used selectively, sparingly and temporarily to tweak the carbon price, or to address other externalities to a carbon tax, QBIs can increase the efficiency and effectiveness of the overall mitigation policy suite. However, a policy approach that seeks to achieve sector level DEROs through QBIs in combination with a broad-based carbon tax will be complex to design and implement. Achieving an appropriate balance between national effectiveness and efficiency objectives will be difficult, costly and time consuming. Identifying and outlining the role of DEROs in the overall mitigation policy mix is critical to understanding whether this approach can be justified.

Should this approach be justified, the following guidelines are recommended to minimise the trade-off between environmental effectiveness and economic efficiency:

- **Ideally the instruments that are to be implemented jointly in an interface should be designed simultaneously** to ensure that unintended interactions are minimised and that the interface goals are internally consistent.
- In practice, however, it may not always be possible to design and implement the relevant instruments simultaneously as they may be at different stages of development for historical reasons. **If it is not possible to design instruments simultaneously, the characteristics of both instruments need to be considered when the interface is designed.** The instruments should be compatible and a suitable framework for combining the instruments should be chosen to form the interface. The target levels at which the instruments are implemented should be aligned to ensure that an efficient level of emissions (the sector DERO) is achieved. Furthermore, the impacts of any existing instruments that may affect mitigation or socioeconomic outcomes (levied at all levels of government (should be taken into consideration when designing the interface to ensure that the resulting interface is not overly stringent (or too lenient if instruments that counteract the goals of the interface are in place).
- **The number of QBIs used to meet DEROs must be kept at a minimum, and should be of a transitional nature** to avoid jeopardising the integrity of the broad-based carbon price over time.
- **The discrepancy in the carbon price signal (which includes both explicit and implicit/shadow carbon price) between sectors should be kept as small as possible** to allow DEROs to be met while reducing the economic inefficiency created by non-uniform carbon prices.
- **When evaluating interface options for inclusion in the overall mitigation policy framework the focus must fall on the functionality of the overall combined interface rather than the individual instruments that constitute the interfaces.** The reason for this is that interactions are often highly context specific and may differ based on the framework for combining instruments that is included in an interface option.

1 INTRODUCTION

The National Climate Change Response White Paper ("White Paper") released in 2011 formally introduced the use of a 'carbon budgeting approach' as an element of the broad mix of different mitigation instruments, approaches, policies, measures and actions that will make up South Africa's mitigation policy. Ideally, how a carbon budget approach and a carbon tax will interface in South Africa should be informed by a sound understanding of the theory of combining different types of mitigation instruments, international experience in this, the aims of the National Climate Change Policy and the particular characteristics of the South African climate change mitigation environment.

This report begins with the premise that a carbon tax will be introduced as the mainstay of South Africa's carbon mitigation effort. The purpose of this report is to then consider how QBIs can be combined with a carbon tax to support the effective and efficient achievement of DEROs. This report thus aims to provide research and analysis on the interface between a carbon budget approach and carbon tax which will inform on-going DEA discussion and activities around the implementation of the National Climate Change Response Policy. The report, does not, however, deal with the design of overall climate change mitigation policy in South Africa, but rather with a very specific subset of mitigation policy. In accordance with sound mitigation policy design, this landscape is also assumed to include a suite of non-QBIs like support for research and development, subsidies for energy efficiency, etc.

Section 2 of the report provides an overview of the carbon budget approach. This is followed by a brief overview of mitigation policy instruments. Section 4 identifies QBIs. The rationale for a broad-based[14] carbon price forming the central instrument in a climate change mitigation policy suite is addressed in Section 5. This is followed by an overview of carbon taxes before a framework for comparing carbon taxes and QBIs to guide policy implementation is provided in Section 7. Some examples of where these instruments have been (or is planned to be) implemented simultaneously is provided in the following section. In Section 9 the literature dealing with the application of multiple instruments is presented, and then the possible frameworks for creating carbon tax-QBIs interfaces are identified. The penultimate section applies the theory on combining instruments to the development of carbon tax-QBIs interfaces in South Africa. The report ends with a brief conclusion and policy recommendations.

[14] The term 'broad-based', whether used in context of a carbon tax or more generally relating to a carbon price, is used in this report to denote the fact that a price is placed on most (or at least a very substantial) portion of national emissions. The term is thus used to distinguish broad, national (or at least multi-sectoral) policies or instruments from narrower policies or instruments that only relate to one (or at most a few) sectors or sources of emissions. Environmental levies that place a price on carbon only in a specific sector, for instance, do thus not create a broad-based carbon price.

2 A CARBON BUDGET APPROACH

2.1 Defining a carbon budget approach

An explicit definition of a carbon budget approach is important to ensure stakeholders have a common understanding of what the term means and how this fits in with the wider universe of mitigation actions, measures and policies.

During interactions with the DEA it became clear that the terminology 'carbon budget' and 'carbon budget approach' was used primarily in the White Paper to imply a quantity dimension to the mitigation effort of the country, and thus to draw attention to mitigation performance relative to a predetermined emissions reduction objective or outcome. It does not necessarily imply absolute quantitative emissions constraints imposed on a sector (sub-sector, company or entity), nor does it necessarily imply the process of allocating an absolute national carbon budget.

Given the focus on the quantity dimension implied by the carbon budgeting terminology, it follows that quantity-based policy instruments will be another important element of the carbon budgeting approach to mitigation policy. The focus of this project is at the policy instrument level, where a range of flexible QBIs or policy tools can be utilised to achieve the objectives set by DEROs.

Given the White Paper's focus on flexibility as a characteristic of mitigation policy instruments, the following interpretation of a 'carbon budget approach' is proposed for the purposes of the current study:

> *A carbon budget approach is characterised by the use of flexible[15] quantity-based policy instruments to achieve a 'desired emission reduction outcome' at a sector, sub-sector, company, or entity level.*

This definition is intentionally broad to allow the inclusion of a number of policy instruments applied on both a mandatory or voluntary basis, and with the quantity dimension defined in either an absolute or relative (intensity) basis.

The main characteristic of instruments that could be utilised under a carbon budget approach is that they include a quantity dimension, and thus draw attention to mitigation performance relative to a predetermined emissions reduction goal. The instruments which fall into this category are addressed in Section 4.

[15] Flexibility in this context refers to the ability to allow least-cost GHG abatement.

2.2 Clarification of terms

This section outlines how a carbon budget approach, as defined in this report, relates to other related climate change mitigation concepts. The purpose of this section is to avoid possible confusion inherent in the terminology used.

2.2.1 Carbon budget

International and national literature on 'carbon budgets' primarily use the term in relation to the allocation of a national carbon budget between sectors (see for example WWF (2011), ERC (2012), and the National Planning Commission's ("NPC") First Development Plan). Much of the value of the term 'carbon budget' is derived from the way it frames the mitigation problem as one of sharing a scarce resource (WWF, 2011; ERC, 2012). The term has not yet been used to denote directly an instrument which achieves a particular allocation.

In its common use, a carbon budget is defined as the area under a trajectory of GHG emissions. It is by definition cumulative; it is the total carbon space available over a period of time expressed as one figure of CO_{2e}. While the budget is a finite quantum, the trajectory which makes up this quantity may vary (WWF, 2010).

A carbon budget is thus typically used to denote a mitigation target and not a policy instrument. A carbon budget sets out the level of emissions to be achieved over a period, not how this level will be achieved. Specific instruments (or bundles of instruments) are needed to implement the budget, which can be quantity- (i.e. ETS), price- (tax) or regulation-based (i.e. performance or technology standards).

The carbon budget approach, for the purposes of this study, in contrast, centres on the use of QBIs to move towards a set carbon allocation, not the determination of the allocation itself.

The carbon budget approach will be implemented in an environment where the quantity targets for sectors, sub-sectors or firms (or even potentially grouped sectors or firms) have already been set by DEROs. The DEROs would have been determined through a separate process, which may or may not be called 'carbon budgeting', but which lies outside the scope of this study

2.2.2 Emissions caps

One possible interpretation of the use of carbon budgets as a mitigation instrument, however, is through the use of emissions caps (ERC, 2012). An emissions cap is a common regulatory ('command and control)' mitigation instrument that restricts the quantity of emissions a sector (or sub-sector / company / entity) can emit.

However, the use of the term cap and carbon budget differs in three ways which are important for this study. First, a cap typically dictates an emissions constraint on an annual or short-term (two to three years) basis while a carbon budget implies a constraint over a greater time period (e.g. a decade), with flexibility as to how the constraint is met in individual years. Second, a statutory emissions caps lack flexibility and would lead to high mitigation costs if implemented in isolation. For this reason regulatory caps are typically combined with some form of a market mechanism to increase flexibility (e.g. an emissions trading scheme) and third, emissions caps typically refer to mandatory limits on emissions which may or not be consistent with the way carbon budgets are envisaged in South Africa.

Emissions caps are therefore only one of a number of quantity-based mitigation policy instruments that can be utilised as part of a carbon budgeting approach.

3 OVERVIEW OF MITIGATION POLICY INSTRUMENTS

An overview of the main climate change mitigation instruments is provided in this section to highlight the main characteristics of instruments, differences between instruments, and allude to some of the complications that may be encountered when instruments are combined. This overview is indicative only and serves as background information to the sections that follow.

3.1 Regulatory (Command and Control) Instruments

3.1.1 Performance Standards

A performance standard involves the setting of a limit on the amount of CO_{2e} emitted per unit of production, of which firms must comply and can do so either through investing in new low carbon machinery or reduce their use of fossil fuels (Dissou, 2004). In other words it is typically implemented as a regulatory (i.e. mandatory) requirement specifying a maximum amount of greenhouse gas (“GHG”) emissions allowable per unit (or value) of output (Cloete *et al.,* 2010). However, in striving to achieve CO_{2e} reductions, cost-effectiveness may not be optimised given the disparate marginal cost of abatement across emitters which can, conceptually by corrected if a regulator allocates intensity limits on a case-by-case basis (Dissou, 2004). Performance standards also lack dynamic efficiency in that there is no incentive for firms to continue reducing emissions once the standard has been met. While performance standards do provide an incentive to develop new technologies to meet standards at lower cost, this incentive is tempered by two factors. Firstly, there is no benefit to reducing emissions below the current standard, meaning that the full value of research and development activities may not be captured. Secondly, and more importantly, firms may fear that the development of cheaper technologies to meet current standards will lead regulators to tighten standards in future (Duval, 2008).

Given the nature of a performance standard, it is relative and mandatory, however the outcome in reductions are not necessarily certain in the event that output increases to the point that overall CO_{2e} emissions end up higher than before the standard being implemented.

3.1.2 Carbon Emissions Cap

An emission ‘cap’ involves the setting of an absolute upper limit on CO_{2e} emitted into the atmosphere (Cloete *et al.*, 2010). For example, each firm would be allowed to emit a certain tonnage volume of CO_{2e}. This is regardless of the firms’ output. Beyond this threshold, penalties, taxes and other such deterrents may apply. An emissions cap directly targets the volume of GHG emissions into the atmosphere, and thus leads to high degree of certainty with respect to the future level of emissions from a sector. In order to place a cap on emissions, it must be possible to accurately monitor and verify GHG emissions. If monitoring systems are in place, the quantum of emissions can be restricted through the use of mechanisms like emissions permits or allowances. Any emissions over and above the allowance emissions allocated to a firm will then incur either a very high monetary penalty, or some form of regulatory penalty that prevents a firm from operating (i.e. the removal of a statutory license required to operate). The number of allowances given to firms over time can be gradually reduced to enable national or sectoral emissions targets to be met (Feldman, 2007).

3.1.3 Technology Standards

Technology standards are a form of command and control, or regulatory based enforcement of CO_{2e} emissions reduction. It essentially involves the mandatory adoption of technology which is designed to result in lower emissions (Cloete *et al.*, 2010). The technology employed can range from the actual equipment to the manufacturing process itself (Stavins, 1997); for instance being required to implement specific types of energy efficient electronics systems or specified production processes.

Technology standards can be viewed as a subset of performance standards, but since are restricted to only one technology to meet the standard, they typically lead to higher mitigation costs than performance standards (which provide greater flexibility to choose the technology best suited to firm conditions). Unlike performance standards, technology standards provide no incentive for firms to innovate since there is no scope to implement technologies other than that specified in the standards. For these reasons, performance standards are typically preferred to technology standards. Performance standards, however, require accurate measurement of emissions to be enforced while technology standards do not. Technology standards may thus be preferred to process standards in cases where emissions are difficult or expensive to monitor and where mitigation technologies are mature and well-known (Duval, 2008).

3.1.4 Information Disclosure Rules

Information disclosure relates to publicly disclosing the amount of greenhouse gasses emitted in the production of a specific good or service (Cloete *et al.*, 2010). This is similar to the nutritional information we see on the product labels for food products, except it informs the purchaser of emissions levels. This instrument is dependent on how environmentally conscious the consumer is, and thus the effectiveness of this instrument depends largely on whether consumers will actually factor in emissions levels in their purchasing decision (Cloete *et al.*, 2010). According to Anbumozhi *et al* (2011), information disclosure regulation may compliment market approaches (discussed below), and can work through different channels including the product, capital and insurance markets. More specifically (Anbumozhi *et al*., 2011:4) state:

> *"In the product market, environment-conscious consumers can express their support for responsible companies by boycotting environment-damaging products, if information is provided for different products."*

3.2 Economic instruments – creating markets

3.2.1 Emissions Trading Scheme (ETS) / Cap-and-Trade

An emissions trading scheme ("ETS") entails a process of buying and selling the right to emit greenhouse gasses. In this way, market forces determine the value of GHG emissions. When a limit is set on GHG emissions within a certain jurisdiction, it becomes a finite resource. Within this context, carbon space automatically gains value which can be traded much like any other commodity. The underlying rationale behind this mechanism is to allow for mitigation flexibility. For example, each firm would be permitted a certain allowance of CO_{2e} and would hold the requisite certificates to emit a given level of CO_{2e} (Cloete *et al.*, 2010). If the firm finds that it is below the absolute emissions cap, it can sell off surplus carbon space thereby generating a financial benefit to additional mitigation action undertaken. Conversely, if it exceeds its threshold it can purchase additional certificates from firms with excess allowances. The absolute amount of emissions covered by an ETS thus remains constant, but the distribution of emissions between firms can change. Firms with high mitigation costs will thus prefer to purchase additional credits or certificates rather than reduce their emissions, while firms with low mitigation costs will choose to reduce their emissions in order to be able to sell their surplus credits at a profit. In this way mitigation costs are equalised between firms, and the emissions cap is reached at the least possible cost to firms within the scheme. The ETS is a mechanism which serves to add flexibility to the absolute cap instrument by allowing firms to minimise their mitigation cost and vary their emissions over time in response to demand conditions (Cloete *et al.*, 2010).

3.2.2 Baseline and Credit ETS

A baseline and credit scheme is similar to an ETS. The key difference is that it works off a baseline emissions intensity, i.e. CO_{2e}/unit of production rather than a hard cap. Credits are earned for reducing emissions intensity below the baseline (McLennan and Magasanik, 2009) which can then be traded based on the principles of demand and supply (Department of Climate Change and Energy Efficiency, Australian Government ("DCCEE"), 2010). The basic design of the scheme is that each tonne of CO_{2e} below the baseline is worth one credit.

Since this scheme is not enforcing a hard cap, it will not be known exactly how much CO_{2e} emissions will be generated. This is simply owing to the fact that production may increase to the point that even lower emissions intensity may result in higher overall emissions (DCCEE, 2010). Other characteristics are required for the scheme to work, these include i) identifying participants, annually earmarking number of credits to be purchased; ii) identifying and crediting valid (only) abatement measures; iii) the scheme needs to be monitored and enforced (DCCEE, 2010).

3.2.3 White certificate trading

Bertoldi (2011:5) describes white certificate schemes as follows:

> *"A white certificate is both an accounting tool, which proves that a certain amount of energy has been saved in a specific place and time, and a tradable commodity, which belongs initially to the subject that has induced the savings (implemented a project) or owns the rights to these savings, and then can be traded according to the market rules, always keeping one owner at the time."*

Energy efficiency may be described as producing the same output but using less energy to do so, or holding output constant while lowering energy usage. For example, in recent years, computer central processing units ("CPUs") and other components have increased energy efficiency year-on-year, which means they draw less power, but are still able to hold the same or better computational power than the previous year. This is an example of ‘green’ computing principles (Murugesan, 2008). It is this process of reducing energy consumption that results in the awarding of a white certificate. According to Tyler *et al* (2011:19), “*participants of [white certificate schemes] are typically suppliers or distributors of electricity, gas and oil, and are required to perform energy efficiency measures that are consistent with a pre-defined percentage of their annual supply.”*

It is an indirect QBI as it indirectly has the effect of reducing emissions through reducing energy consumed. This is typically a mandatory instrument set and based on a relative value in that it reduces the intensity of emissions per unit of output. An incentive is created in this scheme by allowing those who exceed their energy reduction goals (which is typically set relative to a pre-determined baseline), to on-sell surplus certificates. The aim is to allow maximum energy reduction in the most efficient way through the trading of white certificates. It is argued that without such a scheme, firms may not have the incentive to make large capital investments upfront in order to reduce costs in the long-run (indirectly reducing emissions as a by-product), which is why a white certificate trading scheme is a valuable QBI (Cloete *et al.*, 2010).

3.2.4 Green Certificate Trading

Green or Renewable Energy Certificates are issued to certify a renewable energy source was used to generate a certain amount of electricity. Since electricity is fungible, it is not possible to distinguish renewable from non-renewable electricity once it has been fed into the national grid. Holding green certificates provide a way for firms or utilities to claim the environmental benefits of renewable energy generated in another geographic location while drawing electricity from the grid. Since firms have to pay for green certificates (i.e. the right to claim the embodied environmental benefit), green certificates increase the returns to renewable energy generators and incentivises increased investment in renewable electricity generation. It thus mimics the impact of government subsidies to support the renewable energy generation. The market, rather than the government, however, determines the value of the subsidy and generates the resources to fund it (Brick and Visser, 2009; Cloete *et al*., 2010).

This system may be enforced as a mandatory requirement, in which firms are required to utilise a certain portion of renewable energy or face penalties. Trading in green certificates may help in fulfilling this mandate. Conversely this scheme may be applied in a voluntary manner for reputational reasons and has been applied in major countries such as the United States, Australia and various European countries (Brick and Visser, 2009; Cloete *et al.*, 2010).

3.3 Economic instruments - using markets

3.3.1 Emissions taxes

Emissions taxes are per ton charges levied on emitters of CO_{2e}. In this case, the individual firm is obliged to pay a per unit tax irrespective of the level of CO_{2e} abatement (IPCC, 2007). From a cost-benefit perspective, each firm will compare the cost of abatement to the cost of polluting and paying tax. A firm will be incentivised to reduce its GHG emissions up to the point where the cost to abate the next unit of CO_{2e} is more than the cost of paying the tax on that unit of CO_{2e} (IPCC, 2007). A carbon tax is a price-based instrument, where the level of the tax should be equal to the externality cost of emissions. In theory, however, it is difficult to accurately calculate the externality cost from CO_{2e} emissions (Metcalf and Weisbach, 2009).

'Product charges' are a penalty applied to a specific polluting product (Perman *et al*., 2003), for example vehicles in South Africa have had a CO_{2e} vehicle emissions tax levied on the cost of new vehicles based on the amount of CO_{2e} a vehicle emits per kilometre driven above a threshold.

3.3.2 Subsidies

Carbon subsidies fall within the broader universe of energy subsidies. Cloete *et al*. (2010) describe a subsidy aimed at lowering GHG emissions as follows. Subsidies are aimed at creating incentives to lower GHG emissions by funding abatement costs. At the correct level, a subsidy can function as efficiently as a carbon tax in reducing the dead weight loss and achieving least cost abatement. In this case, abatement will continue until the subsidy equates the marginal cost of abatement. In other words, the firm will not have an incentive to abate beyond this as abating one additional unit of emissions will cost more than what the subsidy is worth. An issue however, is that the taxpayer pays the cost of abatement and not the polluter, so polluters are still not facing the full cost. Furthermore, taxes are more efficient over time than are subsidies as incentives to enter the market become distorted by attracting more entrants than would otherwise enter. More players mean more GHG emissions, even with the subsidy to abate. Thus a subsidy is arguably more efficient in the short-term rather than the long-term.

An energy subsidy can take more than one form. It can *inter alia*, either take on the form of i) creating a subsidy to conduct research and development ("R&D") into low-carbon technology and production processes (in which case it is better referred to as a "carbon" subsidy) (Schneider and Goulder, 1997); or ii) removing a subsidy for high-carbon fuel such as fossil fuels in order to achieve the desired lower-carbon outcome (Bacon *et al*., 2010). The former is the point of focus below.

The underlying idea regarding a subsidy for R&D is embedded on the premise that private companies would spend less on R&D for low-carbon technology than is socially optimal, particularly in cases where there are spill-over effects of information and the associated free-rider problem (Schneider and Goulder, 1997). In other words, a firm which undertakes to invest in lower-carbon technologies could benefit other firms which don't take the risks associated with making the initial investment. This in itself is regarded as a form of market failure justifying the use of a (carbon) subsidy as an indirect method for adjusting the price of carbon (Schneider and Goulder, 1997). This differs from the typical market failure seen to give rise to the need for a carbon tax which directly modifies the price of carbon. Being part of a voluntary subsidy program involving R&D into low-carbon technologies is a voluntary scheme.

Cloete *et al* (2010) describe another version of a subsidy known as 'investment tax credits' which is not a straightforward subsidy to abate. Rather, the way this works is to reduce taxable income by the value of investments regarding abatement. This has the same problems as the subsidy described above. On the other hand, subsidies can be granted to incentivise use and development of renewable energy and energy efficiency.

3.4 Voluntary mechanism

3.4.1 Voluntary commitments

Voluntary mechanisms are commitments made by firms to reduce GHG emissions in the absence of any statutory requirement or use of economic instruments to force them to do so. The method to achieve the emissions reduction is determined by the firm, and it would be rational for firms to choose abatement options that minimise abatement costs. The quid-pro-quo is typically a delay in official regulation (Cloete *et al.*, 2010). They are sometimes regarded as an agreement/contract between the firm and the government on agreed reductions, or a less formal commitment on the part of the firm to reach certain targets within set timeframes (Price, 2005). Voluntary commitments are usually quantity-based linked to emission targets that give firms the chance to stagger their carbon reduction over time and facilitate information gathering on abatement costs and potential, but in theory can also include a wider range of mechanisms (i.e. investment in efficient technologies, voluntary information disclosure, targets for R&D spending on clean technologies, putting monitoring systems in place, etc.). Within the universe of voluntary agreements exists a number of variations, namely, i) 'self-regulation' which essentially entails the process of engaging in abatement of the firms' own accord; ii) 'negotiated agreements' which involves a case-by-case round of negotiations between the firm and government on targets, timetables, rewards and penalties; iii) 'public voluntary programs' are an instrument by which the government steps forward to provide financial and non-financial (technical, marketing etc.) assistance in reaching a defined 'green' target; and iv) 'early reduction credits' which is premised on the idea that early adopters of green projects that reduce their GHG emissions are rewarded with credits which can be swapped for tradable permits *"… if and when a mandatory cap-and-trade programme is created"*[16] (Cloete *et al.*, 2010:23).

[16] Early reduction credits themselves are earned if voluntary action is taken early enough before the implementation of a mandatory cap-and-trade scheme. However, because these must be traded for tradable permits under a cap-and-trade scheme, they ultimately form part of an ETS.

Table 2: Summary of mitigation policy instruments

Instrument type	Instrument name	Description	Mechanism	Mandatory/ Voluntary	Absolute/ Relative
Regulation (Command and Control)	Performance Standard	An efficiency target is set by an authority for specific technologies or processes, if target exceeded, penalties apply	Quantity	Mandatory	Relative
	Carbon Emissions Cap	Hard cap is set on volume of emissions, if cap is exceed, penalties apply	Quantity	Mandatory	Absolute
	Baseline and Credit	Intensity baseline established. Emissions intensity below baseline earns credits which can be traded	Quantity	Mandatory	Relative
	Technology Standards	Statutory requirements placed on technologies that can be adopted	Technology	Mandatory	Relative
	Information disclosure rules	Information regarding the volume of carbon emitted during the production of a good or service must be publicly disclosed	Consumer preferences		
Creating Market (economic instrument)	Cap and Trade	Hard cap is set by authority, but permits can be traded to meet targets by entities collectively subject to the cap	Quantity	Mandatory	Absolute
	White certificate	Energy savings are certified and traded between firms subject to energy efficiency targets	Quantity	Mandatory	Relative
	Green certificate	Certificates that identify a certain amount of energy as having been generated from renewable sources are traded between firms	Quantity	Either	Relative
Using Market (economic instrument)	Taxes	Tax charged per tonne of GHGs emitted.	Price	Mandatory	Relative
	Subsidies	Payment structure designed to incentivise abatement of emissions mainly through R&D	Price	Voluntary	Relative
Voluntary mechanisms	Emissions targets/ emissions reductions/ Information disclosure/ Offsets/ etc	Voluntary commitments made by the firm to meet certain targets – quid pro quo typically a delay in official regulation	Quantity/ Technology/ Consumer preferences	Voluntary	Absolute/ Relative

Source: Project team

4 IDENTIFYING QBIS

The main characteristic of QBIs is that they include a quantity dimension, and thus draw attention to mitigation performance relative to a predetermined emissions reduction goal (the DERO). Specifically, considering the range of available climate change policy instruments, the following instruments are identified as QBIs from the universe of instruments presented in the previous section, based on their ability to directly affect either absolute or relative (intensity-based) emissions levels:

- Performance Standards;
- Carbon Emissions Cap;
- Baseline-and-Credit ETS;
- Cap and Trade;
- White Certificate;
- Green Certificate; and
- Technology standards

In the short term, it is easier to meet absolute DEROs with QBIs that restrict absolute (total) emissions, and relative DEROs with QBIs targeting relative (or intensity-based) emissions reductions, because of the direct link between targets and instruments. For this reason, absolute and relative QBIs are identified in the table below.

Table 3: QBIs by category

	Price instruments	QBIs	Other
Regulation (command and control)	N/A	***Emissions cap (A), Performance standards, Technology standards***	Information Disclosure Rules
Economic instrument	Broad-based carbon tax, Subsidies, Other proxy carbon taxes	***Emissions trading scheme (A), Baseline and credit ETS, White certificates trading schemes, Green certificate trading schemes***	
Voluntary Commitments		Agreement to reach target within timeframe, early reduction credits, offsets	Investment in clean technologies, Information Disclosure, Installing monitoring systems

Source: Project team

Note: (A) Denotes QBIs that place an absolute restriction on emissions. All other QBIs strive to reduce emissions on a relative or intensity (ie emissions per unit of output) basis.

4.1 Regulatory (Command and Control) Instruments

4.1.1 GHG performance Standards

A performance standard is quantity-based as it limits the quantity of CO_{2e} emitted per unit of output. It is thus able to put a relative cap on CO_{2e} emissions. A key characteristic is that there is no trading element with a performance standard.

A recent example of the use of performance standards was implemented by the California Energy Commission ("CEC") in response to State Senate legislation (Senate Bill 1368) in 2006 (NRDC, 2007).

The performance standard applies to all providers of electricity, whether they are state or privately owned, whether they are old or new, including power stations outside California which export energy into California (Ramseur, 2008). The threshold that applies to plants is based on annual utilisation rate of 60%; these are essentially power utilities that operate year-round (termed 'base load' plants) and cannot increase or decrease output rapidly (Simpson *et al*., 2010). To adhere to GHG performance standards, emissions of no more than approximately 500kgs of GHG per megawatt-hour ("MWh")of electricity generated can be emitted (NRDC, 2007). Conventional coal-fired power stations will not meet the performance standard unless they employ technologies that capture and safely store GHG emissions (i.e. carbon capture and storage technologies) (NRDC, 2007).In terms of the law, non-compliance carries the risk of non-renewal of contracts between base load plants and energy service providers (NRDC and Sierra Club, 2011). Since 2006, similar performance standards have been implemented in a number of US states, namely Washington State, Oregon and Montana.

4.1.2 Pure Carbon Emissions Cap (Inflexible system)

An emissions cap directly targets the allowable quantity of CO_{2e}that can be emitted. It is thus clearly a QBI.

An example of an absolute cap on CO_{2e} emissions is evident in, the Canadian province of Nova Scotia. In 2010 this province introduced an absolute cap on electricity sector emissions (Department of Environment ("DoE"), 2009). The commitment, according to Nova Scotia's Environmental Goals and Sustainable Prosperity Act of 2007, is that:

> *"… greenhouse gas emissions will be at least ten per cent [10%] below the levels that were emitted in the year 1990 by the year 2020"*(DoE, 2009:1).

The design is relatively straightforward and implies an absolute cap applicable to its electricity sector (mainly Nova Scotia Power Inc. which holds roughly 95% of the energy generating market (Feldman, 2009). The cap is staggered as follows: 9.7 Mt in 2010, 8.8 Mt in 2015 and 7.5 Mt in 2020. This would be a reduction of about 2.5 Mt from 10 Mt in 2007 to 7.5 Mt in 2020.

4.1.3 Technology Standards

Technology standards have a quantity dimension in that the chosen technology will be based at least in part on its GHG emissions within a mitigation policy context. As such, technology standards can thus be used to meet quantitative emissions reductions targets.

Technology standards are in force in, for example, UK, China and Queensland (Productivity Commission, 2011).These are chiefly in place regarding the building and operation of power generators. In the UK, carbon capture and storage (CCS) technology is required for coal-fired stations which generate 300MW or more (it appears that the CCS will only initially cover the first 300MW, and will cover more as the technology improves) (WWF-UK, 2009). China has a policy entitled 'Large substitute for Small' which requires the mothballing of inefficient smaller power stations to make way for larger more efficient power stations that are lower in carbon emissions.

The rules for China's technology standard are as follows:

- Close all small power plants (less than 50MW output);
- Close larger older plants (less than 100MW output but more than 20 years old); and
- Close large very old plants (less than 200MW output but at end of life).

In South Africa, in addition to specifying specific standards for heat gain or loss (which constitute performance standards), new building standards include a technology standard that stipulate that at least half of the hot water requirements of new buildings be provided by renewable energy options like solar water heaters, heat pumps, heat recovery from other sources or renewable combustible fuels (DTI, 2011; Lazenby, 2011).

4.2 Economic Instruments

4.2.1 Emission Trading Scheme (ETS) / Cap-and-Trade

An ETS places an absolute limit on the quantity of CO_{2e} that can be emitted by covered entities within a fixed period of time (equal to the amount of emissions covered by issued permits).

According to Congressional Budget Office ("CBO") (2008), the world's foremost ETS is currently in force in Europe, which started around 2005 and underwent various stages of implementation. The first phase was from 2005-2007, the second phase from 2008-2012. The European ETS applies to roughly 12,000 firms from 27 countries across the EU (CBO, 2008; Matisoff, 2010). The main types of firms which are part of the program include iron, steel, cement, glass, ceramics, pulp, paper, electric power and petroleum products.

With regards to permit allocation, Matisoff (2010) explains that it differs between countries within the EU but generally allocated based on historical emissions data. For example the process in Germany entails the allocating of permits but a certain percentage of the historical emissions data is excluded from the awarding of these permits in large generators of GHGs. This means that these firms do not receive freely allocated permits reflecting their full emissions data. The point of this system is to compel large emitters to reduce their GHGs while leaving smaller business to continue without the same burden to reduce GHGs (Matisoff, 2010).

Matisoff (2010) explains that some of the challenges the EU faced during its first phase of the ETS program in 2005-2007 was over-allocation of permits resulting in abuse by some firms which led them to earn windfall profits. The problem lay in the free allocation of these permits where business did not have to pay for the permits when they first received them. In order to correct this problem, emissions permits will be fully auctioned off from 2013-2020. Only firms which are subject to international competition may still obtain freely allocated permits based on a benchmarking mechanism and utility providers in the EU may still receive a proportion of freely allotted permits (Matisoff, 2010).

Given the importance of an ETS, we summarise in the table below some of the key design features of the European ETS for Phase III of their program running from 2013-2020.

Table 4: Design features of European ETS

Design Feature	European ETS: Phase III (2013-2020)
Status	Phase III is proposed to begin in 2013, some design features may still change.
Scheme objective	Reduce GHGs efficiently and cost-effectively.
Long-term emissions reduction targets	50% below 1990 levels by 2050.
Short- and medium-term reduction targets	At least 20% below 1990 levels by 2020; as much as 30% provided other developed countries performing similarly and developing countries performing adequately.
Sectoral coverage	Combustion installations with thermal input of 20MW and 10,000t CO_2/yr. Mainly ferrous metals, mineral, timber, paper pulp, aluminium and certain chemical industrial process industries based on specific thresholds in each sector.
Domestic offsets	Permitted, ie firms which reduce GHGs in the atmosphere can issue allowances as long as they do not destabilise the EU ETS.
Banking of permits	Yes, can be banked and utilised in subsequent cycles.
Borrowing of permits	Can borrow within a trading cycle, but not from cycle to cycle.
Verification	Committee to provide common requirements for verification to ensure quality standards met.
Reporting and compliance	Committee to replace current guidelines to ensure consistent reporting and compliance across EU member countries.
Linking to international schemes	Permitted with EU countries party to the Kyoto protocol; other EU members outside of the Kyoto protocol can be considered.
Acceptance of international units	Only once international agreement is ratified.
Acceptance of non-Kyoto units	In Phase I and II not possible, in Phase III this is now possible under the right circumstances and global agreements.
Exporting permits	Permitted as long as there is a mutual arrangement in place.
Permit allocation	Full auctioning from 2013 for the power sector and carbon capture and storage. Outside of electricity generation, sectors will receive 80% freely allocated permits, decreasing yearly until 0% by 2020. 5% shall be kept for new entrants.
Use of auction revenue	The following suggestions are made: i) reduce emissions, ii) adapt to climate change impacts, iii) fund R&D, iv) fund renewables, v) fund carbon capture and storage; amongst others.
Treatment of households	Proposal to assign a portion revenue for income distribution distortions for low to middle income households.
Assistance to strongly affected industries	Aviation sector.
Governance arrangements/ independent scheme regulator	Allowances to be held in the Community registry established under Decision No 280/2004/EC of the European Parliament.
Complementary measures	20% energy from renewable sources and 20% more energy efficient by 2020.

Source: DCCEE, 2010

4.2.2 Baseline-and-Credit ETS

Baseline and credit schemes sets the average CO_{2e} intensity of entities covered by the scheme and can thus enforce relative or intensity-based emissions reduction targets.

An example of a baseline-and-credit ETS has been in operation in Canada's Alberta province since 2007. The basic way in which a baseline-and-credit scheme works is to first establish on a firm-by-firm basis, the status quo baseline CO_{2e} per unit of production (CO_{2e} intensity). Thereafter, in each cycle, the CO_{2e} intensity is recorded and measured against a reducing baseline. Regulated entities found to be below the baseline will generate credits which can either be sold or banked for use in the next scheme cycle. Firms that are above the baseline need to purchase credits to meet the target CO_{2e} intensity level (Boyd *et al*., 2008). A key difference between baseline-and-credit scheme and a cap-and-trade scheme is the timing of when permits are allocated. With cap-and-trade they are allocated upfront because the target is set in absolute terms, whilst with a baseline-and-credit system credits can only be earned once production intensity is compared to the baseline, and as a result are only allocated at the end of the compliance cycle (Boyd *et al.,* 2008).

In Alberta, Canada, the baseline-and-credit ETS design essentially involves a 12% improvement in CO_{2e} intensity over an average status quo baseline intensity calculated based on data from 2003-2005. Regulated industries are defined as large industrial facilities generating at least 100,000 tons of CO_{2e} per year. The following table outlines the key features of the Alberta baseline-and-credit scheme.

Table 5: Alberta GHG Emissions Targets

Date	Target	Projected Reduction Relative to 1990 Levels	Megatons Reduction from 2005 Levels	Projected Reduction as a % of Canada's Target
2020	Intensity 50% below 1990 levels; emissions stabilized.	20-35% above 1990 levels	~ 17-27 Mt above 2005 levels	N/A
2050	50% below business as usual levels, or 14% below 2005 levels.	~18% above 1990 levels	32	6%

Source: Fickling (2010); Pembina Institute (2007) and Alberta Environment (2008).

4.2.3 White Certificate Trading Schemes

White Certificate schemes promote more efficient energy usage. Energy efficiency obligations have been put to use in Britain, Italy, France, Ireland, amongst other countries (Langniss and Praetorius, 2004; Tyler *et al*., 2009). In Britain it is referred to as the "Energy Efficiency ("EE") Commitment" and applies to suppliers of energy to households.[17] Firms must apply for eligibility for savings measures to officially count and the regulator determines which EE measures are acceptable such as compact florescent lamps. Furthermore, the UK regulator itself is *not* involved in the furnishing of fully tradable white certificates. However, a degree of flexibility is permitted through trading of regulator approved

[17] Those that supply more than 15,000 households.

'energy savings'[18] and 'individual obligations'[19] only approved by the regulator (Langniss and Praetorius, 2004). In other words

> *"…in the UK, certified energy savings can be traded between obliged parties without formal certificates and obliged parties may purchase certified savings or projects from third parties"*(Bertoldi and Rezessy, 2010:2).

To put this into context,

> *"…in the EU; Italy and France are the only countries where the policy portfolio includes energy savings obligations in combination with fully tradable white certificates"* (Bertoldi and Rezessy, 2010:2).

Table 6: Design features of Britain, Italy and France White Certificate / Energy Efficiency Obligation Schemes

Design Feature	Britain	Italy	France
Start date[20]	April 2002	January 2005	July 2006
Targets[21]	64 TWh/year	31 TWh/year	18 TWh/year
Point of regulation or obligation[22]	Energy *suppliers* (electricity and gas)	Electricity and gas *distributors*	Energy *suppliers* (all types except gasoline)
Compliance period[23]	Annually	Every 3 years	Every 3 years
Eligible customers[24]	Residential only	All including transport	All including transport, but excluding EU trading
Penalty[25]	Related to size of deviation	Related to size of deviation	20 Euro / MWh
Nature of savings[26]	Cumulative primary energy	Lifetime cumulated 4% discounted	Lifetime cumulated 6% discounted

Source: Harmelink (2007); Giraudet and Finon (2011)

While in Britain only the household sector is covered by this scheme, in Italy and France it extends to most end-use sectors and while in Britain and France energy suppliers (upstream) have the onus of promoting EE among users, in Italy the onus is on energy and gas distributors further downstream (Giraudet and Finon, 2011). Giraudet and Finon (2011) further outline the extent to which EE obligation applies in the three countries; in Britain it applies to six energy and gas suppliers, in Italy it

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[18] Energy savings refers to the savings which have been quantified by the regulator.
[19] Individual obligations refer to the amount electricity providers are obliged to save.
[20] Harmelink (2007).
[21] Giraudet and Finon (2011).
[22] Giraudet and Finon (2011).
[23] Harmelink (2007).
[24] Harmelink (2007).
[25] Harmelink (2007).
[26] Harmelink (2007).

applies to 30 gas and electricity distributors while in France more than 2,500 suppliers of energy are obliged.

Each of these countries has varying degrees of strictness on the obligations, France being the least strict and Britain the most. To reiterate, the measure of strictness is based on the amount of 'energy savings' which must occur in total and *"… refer to the units of energy saved, accumulated over the theoretical lifetime of the technology supported"* (Giraudet and Finon, 2011:12). This can be distilled into kWh of energy saved and compares as follows; Britain (64 TWh/year), Italy (31 TWh/year) and France (18 TWh/year).

4.2.4 Green Certificate

Green certificate schemes currently exist for example in Britain, Italy, Belgium, Sweden and Netherlands (Osterkorn and Lemaire, 2009). The following table outlines the design of green certificates schemes in Europe.

Table 7: Summary of European green certificate systems

Country	Initiation	Supported Renewable projects	Demand Driver	Certificate Size	Validity	Target	Flexibility	Imports
Belgium Flanders	2002	Wind, hydro, biomass, solar, tidal, waves, geothermal	Suppliers	1 MWh	5 years	3% (2004) 5% (2010)	Banking	No
Belgium Wallony	2002	Wind, hydro, biomass, solar, biogas, geothermal	Suppliers	1 MWh	5 years	5% (2010)	Banking	Yes, under the condition of reciprocity
Italy	2002	Hydro, waste, biomass, solar, wind, tidal	Producer / Importer	100 MWh	1 year	2% (2002) 6% (2006) 8% (2008)	Borrowing against a penalty price	Yes, if accompanied by actual electricity import and reciprocity
Netherlands	2001	Solar, hydro, biomass, wind.	Suppliers	1, 10, 100, 1000 MWh	1 year	5% (2010) 10% (2020)	No banking	Yes, if accompanied by actual electricity import
Sweden	2003	Wind, solar, hydro, geothermal, biofuels, waves.	End users	1 MWh	Unlimited	Additional 10 TWh until 2010	banking, borrowing	No
UK	2002	Hydro, wind, solar, biogas, biomass, waves	Licensed Suppliers	1 MWh	Unlimited	From 3.1% (2002) to 7.7% (2010)	Limited banking and borrowing	No

Source: (Osterkorn and Lemaire, 2009:8)

Taking a closer look at Belgium for example, it has three states including Flanders and Wallony (shown in the table above). Belgium has a total of five separate green certificate mechanisms, four at a regional level and one at a national level. However, there exists a common thread among them which forms the basis of their programs, as follows (Van Stappen *et al*., 2007):

- An increasing quota of renewable energy production grounded on electricity sales per annum applicable to each supplier of power;

- Any share of power produced which is not covered by a valid certificate is subject to penalties (charged per non-existent green certificate);
- Green certificates may be traded to meet obligations;
- Regulators in each region are the custodians of granting and monitoring the green certificates; and
- Certified bodies scrutinise the ‘green’ power stations and bio-fuel supplies.

5 CARBON PRICING AS CENTRAL POLICY ELEMENT

Carbon pricing is seen as a more effective (or preferred) method for ensuring a reduction in emissions, when compared to other regulatory (or command-and-control) interventions. It is also important to note (as Hepburn (2006) indicates) that using a quantity instrument, either through command-and-control regulation (e.g. quantitative restrictions or banning activities) or through the creation of a market (such as an emissions trading scheme), always imposes an implicit price on carbon. The more restrictive the regulatory instrument, the higher the implied price of carbon emissions.

Putting an explicit price on carbon emissions is a cornerstone in climate change mitigation for two interlinking reasons. First, explicit pricing ensures that emitters effectively internalise the public cost of producing carbon emissions, resulting in firms, effectively reducing the negative externalities associated with carbon emissions.

Second, setting the carbon price at the right level encourages emitters to invest in more efficient technologies (so as to reduce the cost of production) and incentivises consumers to consume less carbon-intensive goods because the explicit cost of these goods has risen. This is illustrated by Parry and Pizer (2007), who, by viewing the carbon emissions as a good, shows that carbon pricing creates a more direct association between the emissions that do occur and the cost of these emissions. This occurs because the price of carbon emissions (and the cost to “use” carbon in production processes) is explicitly increased, encouraging both producers and consumers to conserve production and consumption of carbon emissions. As Hood (2011) highlights, explicit carbon pricing is preferred over other regulatory (command-and-control) instruments. This is because appropriate pricing produces the right incentives over the whole economy, with both producers and consumers incentivised to reduce production (and consumption) of carbon intensive goods.

Finally, there is also an inherent flexibility in carbon pricing as it allows a wider selection in the choice of approaches (and technologies) to reduce carbon emissions.

There are compelling arguments for a single, stable carbon price to be the central element of any suite of climate change policies. As Nordhaus (2008) indicates the optimal approach to climate change mitigation is ensuring that the marginal costs of reducing carbon emissions is equalised across sectors (and countries). This is best achieved through a single, uniform carbon price across the economy. A single carbon price would, in principle, equalise the marginal abatement cost across the economy as economic agents in different sectors reduce their emissions until their marginal cost of abatement is equal to the carbon price.

Hood (2011) notes that carbon pricing encourages abatement first; where it is cheapest to do so. A single carbon price would therefore incentivise the implementation of the cheapest abatement strategies across the whole economy, thereby ensuring that overall abatement is cost-effective. A single carbon price also reduces the need to identify the marginal abatement cost for each sector, which would be both administratively and knowledge intensive – and difficult to achieve. Pizer *et al.* (2005) also demonstrate that imposing an economy-wide carbon price may be far less expensive (from a welfare and carbon cost perspective) than the use of narrower, non-price instruments that target specific areas of intervention or tighten standards in specific industries.

Volatile carbon prices can negatively impact on investment in long-term R&D into abatement technologies as it raises the risks of investment. Hood (2011) cites a number of studies that show the importance of price certainty over a long-term period to ensuring optimal low-carbon investment by firms. The use of a pricing instrument shifts this price risk to the government, effectively providing firms with an implicit subsidy to internalise the public (external) benefits of investing in abatement technologies (Hepburn, 2006).

Apart from the project brief requiring that a carbon tax be considered as part of the interface, local conditions, dictate that a carbon tax is more suitable to providing a broad-based carbon price in South Africa in the short term than an ETS (see Section 10.1). Furthermore, a carbon tax is given a central role in driving mitigation action in the short term in the 2011 National Climate Change Response White Paper, and the National Treasury has indicated that a national carbon tax will be introduced in South Africa in the near future (although the expected implementation of the tax in 2014 is looking increasingly unlikely due to the delay in publishing a second carbon tax discussion paper that was expected in 2012). Finally, from a practical perspective, since an ETS explicitly requires the allocation of GHG emissions to individual sectors (and potentially sub-sectors), there would be no need to supplement an ETS with addition QBIs to meet DEROs. The DEROs can directly influence the setting of the emissions allocations under an ETS. For these reasons, the rest of the paper assumes that a carbon price will be created in South Africa in the short to medium term by a carbon tax.

6 AN OVERVIEW OF CARBON TAXES

It is assumed that a carbon price in South Africa will be implemented in the short to medium term through the use of a carbon tax for the reasons outlined in the last paragraph of the previous section. This section elaborates on the theory of carbon taxes and highlights some of the international experience with this policy instrument.

6.1 Introduction

Economic carbon pricing instruments used to reduce carbon emissions, as shown in Section 3, are divided into price and quantity targeting instruments. Carbon taxes are a price instrument which force firms to effectively internalise the full cost of carbon emissions through a tax on emissions. Quantity instruments (such as emissions trading schemes) place a cap on the amount of emissions emitters are allowed to produce, requiring them to internalise the full cost of carbon emissions through implementing mitigation actions, reducing output or purchasing emission allowances (certificates).

Carbon taxes can be used to address the negative externality generated by carbon emissions by ensuring that firms face the full marginal cost of emissions (including the negative costs associated with climate change). Essentially, the cost of emitting carbon becomes a factor of production that changes relative prices in an economy, ensuring that the true costs of emissions are reflected in the decision-making of producers and consumers. Provided emissions are priced correctly, this causes GHG emissions to be reduced to a socially optimal level.

In the following analysis, the prevalence of trading schemes and carbon taxes means that these terms are used interchangeably with the terms quantity and price based instruments, though the arguments for the different types of instruments can be considered for other types of price and quantity measures.

6.2 The case for a carbon tax

In practice, the choice of policy instruments depends on a number of competing considerations, and is highly context specific. These issues are covered in section 7. Typically the justification for using carbon taxes centres on three issues: economic efficiency, cost and price certainty, and transparency and administrative issues. For this reason these factors are addressed below.

6.2.1 Economic efficiency

From an economic efficiency perspective, the seminal work by Weitzman (1974) showed that uncertainty about the marginal cost of abatement results in either a price or quantity control resulting in the most efficient outcome, depending on the relative slope of the marginal cost and benefit curves. Price mechanisms are favourable when the marginal benefit of abatement is constant relative to the cost of abatement. Conversely quantity mechanisms are preferable when the marginal cost of abatement is rising (and higher than expected) relative to the marginal benefit. Intuitively, the outcome is that price mechanisms achieve a more efficient outcome where the increase in benefits derived from each additional unit of abatement are lower than the incremental costs of abatement, while quantity mechanisms are more efficient when incremental abatement costs are higher than the additional benefit received by each unit of abatement.

Carbon taxes, as noted by Ramseur and Parker (2009), are often seen to be more economically efficient over economic QBIs which is ultimately rooted in the assumption that the slope of the marginal benefit curve is comparatively flat (based on the “stock” nature of GHG emissions) – an argument that is keenly debated and for which poor information makes it difficult to ascertain.[27]

The aspect of economic efficiency arises owing to the disparity in marginal abatement costs (“MAC”) of firms in the marketplace. The MAC is the cost of abating one additional unit of output. When

[27] The authors indicate another scenario where a quantity mechanism (emissions cap) would be preferable: in a case where the uncertainty of costs and benefits are positively correlated. There is also debate around the static nature of Weitzman’s (1974) conclusions. While Ramseur and Parker (2009) suggest that, in general, these results hold in a dynamic setting, Parsons and Taschini (2011) suggest otherwise.

marginal abatements costs are uncertain, it is argued that, for example, a carbon tax is more efficient than a QBI; the converse is also argued to be true when the MACs are known (Ramseur and Parker, 2009).

To expand on this, Philibert (2006) argues that a carbon tax and QBI are not equally efficient in an uncertain universe. In economic terms, carbon tax and QBI instruments will not equally harmonise MAC and marginal benefit with information uncertainty. It is also important to know when it is worth going through the exercise of garnering sufficient data in order to efficiently implement a QBI or when it is not worth the cost, meaning a carbon tax will suffice. In light of this, Philibert (2006) argues that if the marginal benefit curve (for implementing the mitigation policy) is steeper than the MAC, then emissions damage (cost to environment) increases at a faster rate than mitigation costs. Under these circumstances, it is worth garnering sufficient data to efficiently implement a QBI to stave environmental damage. On the other hand, if the marginal cost curve (for mitigating emissions) is steeper than the marginal benefit curve then the rate of damage caused by emissions is lower than the cost of mitigation. In this circumstance, a QBI is likely to be more wasteful than efficient and thus a carbon tax will be more economically efficient.

6.2.2 Cost and price certainty

Given that price mechanisms effectively allow for fluctuations in quantity, while quantity controls fix (or cap) emission allowances with prices adjusting, firms will have better certainty of the carbon price where a tax is in place. The ability to ensure a degree of certainty and explicitness in the carbon price faced by firms is considered a key policy advantage of price instruments. The certainty allows better planning by firms and provides a better signal for the level of investment firms should be making in emission abatement activities and R&D initiatives.

While taxes may also be subject to short-term changes and political influence or may be structured to respond to the level of emission reductions (rising when emission reductions fall below target levels and falling when targets are exceeded), Goldblatt (2010) notes that carbon taxes still provide a level of price stability that is unlikely to be found in quantity-based mechanisms, with less volatility seen in quantity instruments, such as emission trading schemes.

Cloete and Tyler (2012) note that one of the main objectives of carbon pricing is to provide a signal of the future price of the externality. The authors argue that the future price of path is as important as the current price level to ensure that investors have a clear and credible signal for future capital investment purposes. In this sense, carbon taxes are likely to provide price certainty than would be the case for QBIs. In addition, Cloete *et al* (2010) note that taxes provide a long-lasting incentive to find cheaper and more effective ways to reduce emissions, and in this sense have a strong dynamic efficiency component.

6.2.3 Transparency and administration

Taxes are practically seen to be more administratively easier to implement than QBIs, given that carbon taxes can often be built into existing tax instruments and methods of collection. Taxes may also be administratively beneficial due to the relative ease with which tax policy can be modified over time, compared to QBIs which may be more difficult to change or adjust. The administrative burden is also dependent on the point of regulation, where carbon pricing is applied upstream, the administrative burden is limited since the number of firms required to monitor emissions is smaller. Goldblatt (2010) suggests that in practice, emissions trading schemes are less likely to be implemented upstream, while tax instruments may often be concentrated at this point. Inglesi-Lotz and Blignaut (2011) also indicate that for quantity instruments (and cap-and-trade systems in particular) new administrative infrastructure may be required, though the cost of the system can be moderated if efficiently established.

Ramseur and Parker (2009) also note that a carbon tax is intuitively easier to explain and understand and can be considered relatively more transparent than a QBI, especially where QBIs are loaded with more flexible design elements. However, this may be true only up to a point, as carbon taxes can be designed to equally complex, through the inclusion of various mitigating circumstances or the creation of different tax layers that may apply to different levels of emitters.

6.3 Carbon taxes globally

The use and implementation of carbon taxes are summarised in Table 8. In practice there is wide variation in the way in which carbon taxes are implemented and this is briefly highlighted below.

6.3.1 The tax rate and base

Table 8shows a wide variance in the rate of taxation both across countries and often also across sectors within a country. The point of regulation also differs, with some tax regimes operating only at an upstream level, while others are more inclusive in nature. For example, in Finland, international transport fuels are exempted, while in Sweden, biofuels and peat and fuels for electricity generation are exempted, with both countries also setting different tax levels for energy intensive sectors. In Australia, the tax is levied only on the largest emitters.

The way in which taxes are implemented may also be significantly different. Winkler *et al* (2010) highlights some of these differences, noting that Finland's tax is based on a combination of carbon content and energy content in a 60:40 ratio; while Sweden's tax levels are set in relation to the average carbon content of the fuel. In the UK, a charge is levied on electricity, gas and coal used for energy. In China and India, taxes are more generic environmental taxes, focusing on levying taxes on a specific resource rather than on carbon emissions.

It is clear that carbon taxes differ across countries in a number of ways:

- The point of taxation differs, with some countries choosing to only focus on upstream emitters. Thus the breadth of the tax can vary significantly, and where taxes cover a wide range of sectors the actual tax rate may be different for each sector; and
- The actual tax being levied is different. The tax can be levied in a number of different ways, as indicated by Inglesi-Lotz and Blignaut (2011). A tax can be levied directly on emissions, based on the carbon content of resource materials (or on the actual resources themselves) or on the downstream consumers through a levy on products with a carbon-intensive origin.

6.3.2 Revenue distribution and recycling

While, as previously noted, carbon taxes should aim to be revenue neutral, the practical application of these taxes shows that this appears to be the exception rather than the rule. Many countries appear to use revenues from carbon taxes to supplement overall tax budgets, while a few specifically earmark revenues from these taxes for climate mitigation activities or make appropriate reductions in other taxes to ensure revenue neutrality. This appears to be especially true for countries where the tax is more environmental in nature (e.g. a resource levy such as those in place in India and China) rather than specifically focused on carbon emissions. The earmarking of funds generated from carbon taxes may provide an easy and simple solution to ensuring revenue neutrality, though this may often not be politically feasible, or may require legislative changes to tax law.

6.3.3 Behaviour change and impact

Sumner *et al* (2009) provide a summary of global tax regimes and reviews the overall impact of carbon taxes. Countries with a carbon tax in place have, on average, seen significant decreases in either the relative or absolute amount of emissions produced. The authors note however, that untangling the actual impact of a tax from other contributing factors is usually difficult, and for this reason is rarely attempted in evaluations of carbon taxes.

Table 8: Carbon and resource tax regimes in selected countries

Country	Start date	Tax rate	Revenue distribution	Sectoral target
Australia	2012	\$23.67 / tonne (AUD 23)	Reduction in household taxes, climate change programmes, subsidies to heavily affect firms	This tax is levied on large emitters (generating over 25,000 tonnes of CO2-e emissions each year).
China	2010	5% - 10% sales based tax	Not clear though this appears to be part of China's overall reform of its energy related taxes and is likely to be a general revenue generating tax.	The sales tax currently applies to crude oil, natural gas, rare earth minerals and coking coal. This policy was piloted in western provinces of China first and the resource tax is to be extended nationally and is expected to eventually cover a wider range of natural resources.
Costa Rica	1997	3.5% (originally 5%) levy	Portion of revenue is allocated through the central budgetto FONAFIFO (Fondo Nacional de Financiamien to Forestal) the Program of Payments for Environmental Services (PSA)	The tax is a levy on hydrocarbon fuels.
Denmark	1992	\$16.41/metric ton CO2 (90 DKK)	Environmental subsidies and returned to industry	This is a specific CO2 tax combined with an energy tax for light fuel oil, heavy fuel oil, natural gas and pit coal. Differential rates applied to each fuel source for households and industry
Finland	1990	\$30/metric ton CO2 (€20)	Government budget; accompanied by independent cuts in income taxes	The tax applies to gasoline, diesel, light fuel and heavy fuel oil, jet fuel, aviation gasoline, coal, and natural gas, with differential rates for each sector. Electricity is taxed at a flat rate with rebates available for renewable electricity generation.
India	2010	\$1.07 / tonne of coal (50 rupees)	General budget	The tax is for all coal produced in or imported into India.
Netherlands	1990	~\$20/metric ton CO2 in 1996	Reductions in other taxes; Climate mitigation programs	The tax applies to a number of fuel and energy sources including natural gas, electricity, blast furnaces, coke ovens, refinery and coal gas, coal gasification gas, gasoline, diesel, and light fuel.
Norway	1991	\$15.93 to \$61.76/metric ton CO2(NOK 89 to NOK 345)	Government budget	The tax is estimated to cover approximately 68% of Norway's CO2 emissions, or approximately 50% of Norway's GHG emissions, with taxed sectors including: gasoline, light and heavy fuel oil, and oil and gas. Sectors including the pulp and paper industry, fishmeal industry, domestic aviation, domestic shipping of goods, and the continental shelf (supply fleet) industries pay reduced rates.

Sweden	1991	Standard rate: \$104.83/metric ton CO2(910 SEK)Industry rate: ~\$23.04/metric ton CO2(~200 SEK)	Government budget	Industries, including manufacturing, agriculture, co-generation plants, forestry and aquaculture, pay a lower proportion of the general level.
United Kingdom	2001	\$0.0078/kWh for electricity; \$0.0027/kWh for natural gas provided by gas utility;\$0.0175/kg for liquefied petroleum gas or other gaseous hydrocarbons supplied in a liquid state; and \$0.0213/kg for solid fuel	Reductions in other taxes	The levy imposes a tax on electricity, natural gas supplied by a gas utility, liquefied petroleum gas and other gaseous hydrocarbons. The levy only applies to industrial and commercial energy supplies to the industrial, commercial, agricultural, public and service sectors.

Source: Adapted from Sumner et al. (2009) with additional information from Mani et al. (2012), Russo and Candela (2006), US EIA (2012), Pu and Hayashiyama (2012) and Australian Government (2011)

6.4 Characteristics of an effective carbon tax

Carbon taxes are seen to be, for a number of reasons, a better option (over the use of QBIs) for carbon pricing and the reduction of emissions. A key exception may be the fact that with QBIs there is likely to be greater certainty as to the extent to which carbon emissions may be reduced over time.

Two key characteristics can be summarised from the analysis when developing an effective carbon tax. The first is the selection of the point of taxation. In terms of administrative ease and implementation, an upstream tax may be considered the simpler alternative with fewer negative welfare implications for households, though the overall welfare implications may be dependent on industry concentration and the extent to which firms are able to pass through the tax to consumers. In practice, countries where carbon taxes have been implemented have seen the tax focused on both a narrow range of upstream emitters and across a broader range of industries and sectors.

The second key characteristic is the principle of revenue neutrality of a carbon tax, ensuring that there is a concurrent reduction in other taxes (or a direction of revenue generated from carbon taxes to carbon mitigation and welfare alleviation activities) to ensure that the tax remains neutral. Again, evidence from international application of carbon taxes is mixed with regards to revenue neutrality, with many countries either implicitly using carbon taxes to supplement national budgets or explicitly imposing taxes for revenue generation purposes.

From an implementation point of view, Cloete and Tyler (2012) also suggest a number of practical characteristics that may be considered to ensure the introduction of a carbon tax are both economically feasible in the short-run but still environmentally effective over the long-run. These include introducing the tax rate at a sufficiently low level (but escalating in the future) to ensure vulnerable sectors have time to adjust to the impact of carbon pricing in the short-term and developing Temporary Mitigation Support Agreements (“TMSAs”) to provide temporary relief from carbon pricing and incentivise early mitigation action. While providing a transition method for heavy emitters, the additional layers of relief add complexity to the carbon tax and more have other unintended consequences.

7 COMPARING QBIs TO A CARBON TAX

There are a number of criteria or indicators which dictate the usefulness of various policy instruments in reducing emissions. Each instrument will have its strengths and weaknesses in fulfilling these criteria. Owing to this, where one instrument is weak, another complementary instrument used in combination may address the weakness. Further, because there is no single instrument which is strong in every criterion, a South Africa-specific combination of instruments is likely to emerge within a carbon tax framework.

Depending on their design, a carbon tax and an economic QBI that creates a broad carbon price (like an ETS or baseline-and-credit scheme) can be designed to have very similar impacts (Cloete and Tyler, 2012; Goldblatt, 2010).Effectively, in the face of a carbon tax, emitters will reduce emissions up to the level where MACs are close to the equivalent of the carbon tax. Under a quantity mechanism, such as a trading scheme, firms will reduce emissions up to the point where the cost of emissions reductions equal the market price of emissions permits. Under assumptions of complete knowledge and information certainty the two mechanisms would lead to an equivalent “carbon price” and reduction in emissions (and would be equally efficient) in the economy.

The basis for price / quantity instrument equivalence is grounded in a number of, often unrealistic and impractical, assumptions. In addition, different (and often conflicting) policy objectives and the ease with which policy instruments can be implemented mean that certain mechanisms may be favoured over others. In practice, thus, the merits of instruments need to be compared based on the context in which they will be utilised. To assist with this assessment, Cloete *et al* (2010) lay out the following criteria namely: i) environmental effectiveness, ii) economic efficiency, iii) encouragement of substitution, iv) impact on technology development, v) administrative requirement vi) information requirements, vii) distribution, viii) support for the mechanism, ix) competitiveness, x) interaction with other policies, xi) fiscal affordability and xii) flexibility. In light of each of these criteria, an assessment of QBI (economic instruments) versus QBI (command and control) versus carbon tax will occur in order to identify advantages and disadvantages.

7.1 Environmental effectiveness

Environmental effectiveness talks to the overall ability of the instrument to meet predefinedCO_{2e} emissions reductions goals(i.e. its ability to cause firms to reduce their GHG emissions). This effectiveness relies on the strength of monitoring and enforcement.

QBIs are generally better at reaching emissions reduction targets than a carbon tax owing to their direct targeting mechanism (Cloete *et al.*, 2010). Given that they limit the overall quantity of emissions, absolute QBIs (be they economic or regulatory instruments) are more environmentally effective than relative QBIs in terms of environmental effectiveness since the overall level of emissions is known. A relative QBI does not cap overall emissions, but only the emission per unit of output (i.e. the intensity of emissions).

A carbon tax in the short-term is unlikely to be effective in reaching reduction goals since firms can respond to market conditions to emit more or less than envisaged when the carbon tax level was set. (Goldblatt, 2010), but over the long-term, the prospects of a carbon tax in reaching environmental goals improves. This is because a carbon tax can be adjusted over time in order to ensure the targets are met.[28] For a carbon tax to be as effective at reaching emissions reduction goals as QBIs, however, a high degree of policy credibility and certainty about the future path of carbon tax levels needs to be achieved.

7.2 Economic efficiency

Economic efficiency refers to the ability of an instrument to lead to the abatement of a certain amount of emissions at ‘least cost’ (Cloete *et al*., 2010). Least cost abatement is achieved when each

[28]This issue is addressed further in Section 9.

economic agent abates the socially optimal amount. Firms with cheaper abatement options should thus abate first, and only once all the abatement options at a certain level of marginal abatement costs have been exhausted should more expensive options be implemented. In order for this to happen, mechanisms must exist that allow mitigation costs to be equalised among sectors. The pool of emissions covered by the mechanism must also be as large as possible to allow for a higher probability that the cheapest available abatement options are exploited first. It is due to the ability of economic instruments to allow the cheapest abatement to happen first that this class of instrument is generally preferred to regulatory instruments.

A carbon tax and economic QBIs are thus generally preferred to regulatory QBIs on economic efficiency grounds. Command and control QBIs possess little flexibility and ignore different abatement costs across firms and sectors and thus thought of as being less efficient than a carbon tax.

Whether a carbon tax or an economic QBI is more efficient is a more difficult question to answer, and depends on the conditions under which the instruments are used. When MACs are uncertain, it is argued that, for example, a carbon tax is more efficient than an economic QBI. When abatement costs are known, the converse is true (Ramser and Parker, 2009).

7.3 Encouragement of substitution

Awareness of environmental damage from GHGs has increased the importance of buying green from both the public and private sector (APO News, 2010). Encouragement of substitution refers to the ability of an instrument to incentivise a switch to lower carbon production processes and products. If enough consumers switch to greener products, firms will react and supply greener goods which hopefully will reduce the costs of such products due to economies of scale (Darnall *et al*., 2012).

An example includes the UK introducing, in 2002, an ‘aggregate levy’ (tax) designed to induce the use of recycled construction and demolition waste thereby reducing emissions (Breugel *et al*., 2011). By raising the cost of emitting, a point will be reached where it is cheaper to switch to less carbon-intense products and production processes.

A carbon tax will generally be effective in encouraging substitution to greener technologies, as it makes them relatively cheaper to pursue, given that it can lower carbon tax payments (Makube, 2010). In addition, because a carbon tax generally gives rise to a more stable CO_{2e} price, this certainty enhances the desire for investment in the supply of low-carbon products and the development and adoption of low-carbon production processes (Parry and Pizer, 2007).

Command and control QBIs can also encourage substitution in order to meet the requirements of the regulations. The more restrictive the regulation, the less the impact on substitution is likely to be. Technology standards, for instance, will only encourage the use of prescribed technology rather than broader dynamic innovation (Parry and Pizer, 2007).

Economic QBIs that create a broad-based carbon price are very effective at encouraging substitution. The more focussed the instrument, however, the less this effect becomes. Green and white certificate schemes are designed to induce either substituting away from use of fossil fuels towards using renewable energy or more energy efficient production technology. An ETS or baseline-and-credit scheme would encourage both (and other) switches.

7.4 Impact on technology development

Dutz and Sharma (2012:2) believe that*"… rapid green growth is inconceivable without innovation"*. Policy instruments should thus create incentives to develop new low carbon products and technologies. These incentives are typically linked to the extent to which the desired new products become more valuable, and the certainty which this value increases in future. Mechanisms that reduce the cost and risk of R&D will also encourage technology development.

All instruments that increase the cost of emitting will encourage technology development. The higher and the more certain the cost increase, the greater the impact on innovation is expected to be. A low carbon tax, in the short-term is unlikely to create a strong enough incentive to prompt investing in greener technology standards (Cloete *et al*., 2010). Carbon taxes that increase over time with a high degree of certainty, however, are expected to be very effective at driving innovation. The impact of command and control QBIs on innovation will depend on the implicit price signal they create (i.e. how costly resultant mitigation is to firms) and their longevity.

Economic QBIs are fairly similar to a carbon tax in supporting innovation, except that the price signal may not be as stable, of which less certainty lowers investor appetite to spend on R&D.

7.5 Administrative burden and Information requirements

Administrative burden is an important consideration when choosing policy instruments, as some tools possess a higher encumbrance than others. Command and control regulations (quantity-based) such as cap-and-trade typically have a high administrative burden (ILO, 2011). Conversely,

> *"… taxes are widely used as environmental policy due to their relatively low administrative burden and ease of implementation"* (ILO, 2011:10).

Command and control QBIs are viewed as administratively burdensome owing to their need for technical and detailed information and specificity on activities and production processes in order to ensure compliance (ILO, 2010). Monitoring and enforcement is critical in terms of effectiveness of the instrument and can be costly to do, which can lead to an arrangement between the regulator and industry for self-reporting by industry thereby lowering overall effectiveness.

In contrast, in terms of a carbon tax, the level of information required is significantly less than command and control QBI, thereby reducing the administrative burden. Chiefly, what is required by the administrator of a carbon tax is to set the tax rate that will lower overall CO_{2e} emissions and will likely need to increase on a staggered path in order to achieve the target reductions.

On the one hand, command and control instruments tend to require a high degree of information regarding abatement costs on a case-by-case basis between the public and private sector; conversely, a carbon tax applies to all firms which eliminate the need for case-by-case interfacing, thereby reducing their administrative burden (National Treasury ("NT"), 2010).

Command and control QBIs, although they have a high information requirement, are typically relatively straightforward to administer once in place; conversely, economic QBIs will have a lower information requirement but are more administratively burdensome than regulatory QBIs since setting up and monitoring the trading system can be complex.

Any analysis of the administrative burden and information requirements of instruments needs to consider the practical realities of the context in which the instruments will be implemented. This includes, amongst other factors, the institutional arrangements and capacity required to implement the instruments.

7.6 Distributional/equity impact

The distribution criterion refers to the matter of which parts of society are affected by an emissions reduction policy instrument (Cloete *et al*., 2010). This is an important consideration in the choice of instruments and their design as poorer households typically spend a larger proportion of their disposable income on products such as energy that will be strongly affected by an increase in mitigation costs (or the cost of emissions), in comparison to richer households; which means mitigation costs may be regressive (ILO, 2010; Cuevaro and Gandhi, 1998).

It is however possible to offset the regressive impact of mitigation policy by either changing the design of instruments, or using revenues recycling (if there are any) to directly offset the impact on the poor (NT, 2010). Parry and Goulder (2008:166) states that:

> *"… recycling schemes can help achieve a fairer distributional burden, for example by imposing a more equitable pattern of burden-to-income ratios across different income groups."*

It is not clear whether a price or quantity mechanism would have a greater (negative) welfare impact. Goldblatt (2010) suggests that the likely greater coverage achieved by a carbon tax would imply that a tax instrument may be more regressive than a quantity mechanism such as a trading scheme. However, carbon pricing through either price or quantity mechanisms will affect the level and distribution of the real income of households and the extent to which households are impacted by carbon pricing is determined by the structure of the economy, the ability of firms to pass through costs and the ultimate design of the carbon instrument.

In terms of design, it should be possible to address distributional issues in most instruments. Any instrument that raises revenue creates the opportunity for revenue recycling. A carbon tax is the most obvious example, but any fully auction trading or permit schemes could potentially raise similar revenues. Given their higher administration costs, less revenue may however be available for recycling from these schemes. As schemes are in place for longer, however, these costs are expected to be reduced and this discrepancy disappears.

7.7 Support for the mechanism

Koustaal *et al* (1997) make the point that in order to be effective; the mechanisms to reduce emissions should have a certain level of political acceptance. They further argue that the following factors contribute to political acceptability, namely, environmental effectiveness, total costs of policy, distribution of burden, and implementation and enforcement issues. Flexibility is likely to be an important predictor of support for mechanisms, with more flexible and less restrictive schemes garnering greater support. Pure instruments such as a hard cap with no tradable permits, does not tend to have a high degree of support.

Goldblatt (2010) highlights that in practice, carbon pricing in developed countries appears to have trended towards emissions trading mechanisms and may be due to a number of factors including:

- More political acceptability of emissions trading than new taxation, particularly given the negative stigma attached to the introduction of new taxes;
- Support from industry players. From an industry point of view, QBIs, particularly in the form of a cap and trade system, may be seen as preferable because of the likelihood and expectation that a significant number of users may receive emissions permits (allowances) at no cost. Additionally, Parker and Ramseur (2009) suggest that QBIs may provide room for industry to drive down the overall cost of compliance, since the price of compliance is not fixed; and
- Preference for quantity instruments by environmental activists. QBIs theoretically provide greater certainty and more guarantees that emissions will be reduced to a particular level, and this certainty may dovetail with activists' views that the perceived guaranteed reduction in emissions overrides other concerns that could be addressed through a price based mechanism. In addition, trading schemes may fit better with global agreements on quantifiable emissions reductions.

Cloete and Tyler (2012), however, believe that there is no longer a general preference for one type of instrument over another. They believe the level of support for an instrument will rather depend on the design features of the instrument in question. Support is thus likely to be very context specific and depend on the characteristics of competing instruments. Support may also vary over time.

7.8 Competitiveness

An effective emissions reduction instrument is also a function of how it impacts on the competitiveness of domestic firms.

> *"Many countries are worried that strong unilateral reductions could foster 'carbon leakage', leading to domestic welfare losses and undermining the international competitiveness of domestic industries"* (Dellink et al., 2012:2).

Carbon leakage refers to the notion that neighbouring countries which do not have carbon reductions policy in place may become a new point of origin for energy use if domestic energy becomes relatively more expensive (Cuevaro and Gandhi, 1998). An argued solution is to reduce the burden from mitigation policy on industries which are subject to strong competitive pressures from outside its borders (Cuevaro and Gandhi, 1998). This risk of a loss of competitiveness is primarily determined by the ability of the firms to pass on carbon costs to consumers without losing a significant portion of their market share, and this, ultimately, is what determines the impact of carbon policies on a sector (Mohr *et al*., 2009).

The impact on competitiveness is highly dependent on instrument design, and particularly the level of the implicit and/or explicit carbon price signal generated by the instrument (for a discussion see Cloete *et al*, 2010). Cloete and Tyler (2012), for instance, believe that the impact on competitiveness of a carbon tax and an ETS can be largely identical depending on the design of the instruments.

7.9 Interaction with other policies

Policies aimed at mitigating climate change or lowing carbon emissions should interact coherently and complement broader macroeconomic sectoral and national policies rather than conflict with them. For example, mitigation policies should be balanced with social concerns such as income distribution issues discussed above. This would be an example of **inter-**policy interaction. In addition, policies within the mitigation space (i.e. **intra-**policy) should also be coherently designed. The issue of interaction between policies is addressed in detail in Sections 9.1 and 9.2.

7.10 Fiscal affordability

Fiscal affordability refers to how costly carbon reducing instruments can be on the state. Hence, instruments which generate revenue (such as carbon tax) rather than cost the state funds (such as a subsidy aimed at lowering emissions) tend to be preferred (Cloete *et al*., 2010). However, affordability of an instrument can be extended to include considerations on the part of societal, individual and policy administrators (Koeppaland Urge-Vorsatz, 2007). An example of an instrument which is thought of as being affordable and simple to implement, and which can be aimed at avoiding negative distributional social impacts is the Energy Efficiency Obligations (“EEO”) system (Lees, 2006), which are essentially similar to White Certificate schemes. Therefore, both a carbon tax and a White Certificate scheme are likely to be relatively lighter on the fiscal burden over other instruments such as a subsidy.

As a first pass, instruments with low administration costs and high revenue raising potential are likely to perform best on fiscal affordability.

While environmental theory suggests that carbon pricing instruments used should focus on changing behaviour and not on raising revenue, the practical implementation of carbon instruments suggests that one of the primary advantages of a carbon tax (over quantity instruments) for policy makers is the greater ability of tax instruments to raise revenue (Cloete and Tyler, 2012). Ramseur and Parker (2009) show revenue generation from either price instruments or quantity instruments can be theoretically equivalent, but Goldblatt (2010) infers that in practice, the scale and predictability of carbon tax revenue is likely to be greater than from QBIs such as emission trading schemes, mainly because few QBIs are implemented with a full auction of permits. In many cases a large proportion of these permits (quotas) are distributed freely at the outset of implementation. By comparison, carbon taxes are seen to account for a significant proportion of tax revenues where they have been implemented and are likely to generate a more certain public revenue stream.

The ability for governments to mitigate against the potential negative welfare and regressive impacts of carbon pricing is, to a large extent, dependent on the revenue raised by governments from the carbon pricing instrument. Given the practical likelihood of taxes generating more revenue than QBIs, one can assume that price instruments may be better suited to providing governments with a public finance alternative to compensate for the negative impacts of any carbon instrument. In practice, this is not always implemented, with revenue from carbon prices often simply supplementing the general public budget.

7.11 Flexibility

Instruments that allow emitters the flexibility to vary their emissions over the economic cycle reduces the economic impact of mitigation policy and reduce the risk that mitigation goals may act as a constraint on economic growth in the short term (Cloete *et al*., 2010).

A carbon tax can reduce mitigation costs by allowing firms the flexibility to choose when to abate less and pay more tax in instances or trading periods when abatement costs are high (i.e. at the top of an economic cycle when market demand is strong – implying a high opportunity cost to cutting back on production to reduce GHG emissions) and choose to abate more and pay less tax during times when abatement costs are relatively lower (Cloete *et al*., 2010; Goldblatt, 2010). Firms may therefore be forced to buy permits at inopportune times when the market price is higher than an option that could have been available under a carbon tax. Command and control QBIs are simply inflexible as they are hard caps, either overall emissions or intensity-based.

Economic QBIs have the potential to be as efficient as a carbon tax owing to their trading nature; however, they may not be as flexible as a carbon tax because caps may have to be met within a trading cycle in the absence of banking or borrowing of certificates (Goldblatt, 2010). In other words at the end of trading cycle, regardless of whether your abatement costs (due to economic fluctuations) are relatively high or low, the firm will have to purchase credits if it falls short of the emissions target. The flexibility of economic QBIs is thus closely linked to their design.

7.12 Summary

Table 9: Illustrative instrument comparison across key criteria

Criteria	Carbon tax	QBIs: Economic instruments	QBIs: Regulation (Command-and-control)
Environmental effectiveness	**	***	***
Economic efficiency	***	***	*
Encouragement of substitution	***	***	*
Technology development	***	***	*
Administrative requirement	**	*	***
Information requirements	***	**	*
Distribution	***	**	*
Support for the mechanism	*	**	**
Competitiveness	**	**	**
Interaction with other policies	unclear	unclear	unclear
Fiscal affordability	***	**	**
Flexibility	***	**	*

Source: Project Team

Key: ****High* ***Medium* **Low*

The table above shows an illustrative ranking of the different instruments based on the criteria set out earlier in this section. In practice the ranking will be context specific and will probably differ from that presented below. Also, rankings for many of the criteria are subjective.

8 COMBINING CARBON TAX AND QBIs: INTERNATIONAL EXPERIENCE

Internationally, a number of policy instruments are implemented simultaneously. While considering this experience provides useful lessons as to what instruments can practically be implemented together, it is important to remember that policy development often happens in an incremental and ad hoc manner. The mitigation policy regimes seen internationally thus often develop by accident rather than by design (Helm, 2011; Hepburn, 2010). Fankhauser *et al* (2011:4) emphasise this point by stating that multiple instruments are often introduced in a *"… piecemeal, overlapping way ... driven more by politics than by economic considerations"*.

8.1 Voluntary Mechanism, ETS White Certificate Scheme and Technology Standard and a Carbon Tax

In 2001 the UK implemented a carbon tax system entitled the 'Climate Change Levy' which chiefly included (on a mandatory basis) in its tax base, natural gas, coal, coke, liquid petroleum and electricity (OECD, 2012). In terms of this tax, *"… fuels supplied for transport, for non-fuel uses, for electricity generation and to the household sector are exempted from the tax"* in addition to energy produced from waste in high standard combined heat and power plants, and renewables such as solar and wind (OECD, 2008:41).

As part of the overall framework introduced in 2001, the UK also introduced the 'Climate Change Agreement' ("CCA") which entails the voluntary improvement of energy efficiency (Price, Rue de Can and Lu, 2010). The manner in which these instruments interface, lies in the reduction of tax payable by an amount of 80% should the agreed upon energy efficiency targets be met (Price *et al*., 2010). The CCA appears to have been updated which now *"… allow eligible energy-intensive businesses to receive up to a **65%** discount from the Climate Change Levy in return for meeting energy efficiency **or carbon-saving targets**"* [own emphasis] (DECC, 2012). CCA addresses international competitiveness concerns. If local firms are subject to a significant degree of external competitive pressure from outside countries, then a carbon tax without a relief mechanism such as that provided by the CCA, could decrease local industry competitiveness relative to other trading countries. The CCA just tries to maintain an even playing field should international firms export without the burden of a carbon costs.

The CCA incorporates a two-tier structure, one at a sectoral level and the other at the firm level. Sectoral-level agreements set out sector-wide targets, obligations and procedures for carrying out agreements and are made between the DECC and industry association, while firm-level agreements translates this to obligations at the individual entity level (DECC, 2012). CCAs are actually administered by the UK Environmental Agency (UK EA, 2012). Currently, this includes 54 industry sectors (UK EA, 2012).[29]

The UK CCAs interact with both the broad-based trading mechanism that applies to the UK. It is fully integrated with the UK-ETS in that firms participating in a CCA are able to make up for any target shortfall by purchasing allowances in the UK-ETS market while any overachievement against targets lead to allowances that can be traded within the UK-ETS (DECC, 2011). The UK-ETS closed to new direct participants in 2007, but the scheme continues to operate as part of CCA. The Emissions Trading Registry was re-branded the CCA Trading Registry to reflect its CCA focus in 2007 (DECC, 2011a). An additional element that provides flexibility to the CCL and CCAs is that allowances can also be purchased from the EU-ETS to assist in meeting CCAs. Unlike the UK-ETS, however, overachievements on CCA targets do not generate credits that could be traded in the EU-ETS (NAO, 2007).

Since 2007 the UK has been considering CCS technology implementation for a number of new and existing coal-power stations (WWF-UK, 2009). Consequently, the 2011 Overarching National Policy Statement for Energy (EN-1) (DECC, 2011b) and the 2011 National Policy Statement for Fossil Fuel Electricity Generation (DECC, 2011c) requires that all fossil fuel power plants of 300 MW and over (including gas, coal, oil and biomass) be constructed to accommodate the addition of CCS technology in future (i.e. that they are Carbon Capture Ready (CCR)). All new coal-fired power plants built in England and Wales (or significant extension to existing coal-fired power plants) must also include CCS

[29] Eligibility is defined in the *Environmental Permitting (England and Wales) Regulations 2010*and the *Climate Change Agreements (Eligible Facilities) Regulations* (UK EA, 2012).

on at least 300 MW of its generating capacity in order to be licensed. Smaller plants must include CCS on their total capacity. As a supplementary measure, the UK Draft 2012 Energy Bill includes a performance standard that specifies a statutory limit on the amount of annual CO_2 emissions allowed from new fossil fuel generating stations. The limit is set at 450g of CO_{2e} per kWh until 2045 and will only be achievable in coal-fired power plants with CCS in place (DECC, 2012).

In 2010, the UK introduced the 'Carbon Reduction Commitment Energy Efficiency Scheme' which is similar to a White Certificate trading scheme (OECD, 2012). UK EA (2009) reports that the first year of the scheme will only be a reporting phase, the two years thereafter will see uncapped allowances sold to participants, and subsequently the capital raised through the sold allowances in the first two years will be re-distributed through a system designed to reward emissions reduction. The scheme is applicable to entities in the public and private sector which utilise more than 6000MWh per annum. It is argued that this scheme alone could prevent as much as 11.6 million tonnes of CO_{2e} in the atmosphere.

8.2 Baseline and credit system and a Carbon Tax

8.2.1 Alberta, Canada

In the Alberta province of Canada, a carbon tax was introduced in 2007. Emitters of 100,000 tonnes (or greater) of CO_2 would have to pay $15 per tonne of CO_2 (Rivers and Schaufele, 2012). The tax is payable when emissions are above the baseline of emissions intensity (McMillan, 2008). The penalty is leveraged on CO_2 emissions **over the target** threshold and therefore does not apply to all CO_2 emitted (Ministry of Energy, 2012). To reiterate from section 4.2.2, emitters of 100,000 tons of CO_2 or more are subject to the scheme; firms active for 8 years (prior) need to reduce intensity of emissions by 12%, while new entrants only require an annual 2% reduction after the first three years. As far as can be ascertained, there are no exempted firms or sectors above the 100,000 tons of **direct** CO_2 emissions. However, **non-direct** emissions such as imported electricity are not included in the program (Specified Gas Emitters Regulation, 2008).

Despite being positioned as a carbon tax and baseline-and-credit scheme, however, the design of the scheme closely resembles a baseline-and-credit scheme with a penalty for not meeting scheme targets. As such, a more theoretically sound example of a baseline-and-credit scheme functioning in conjunction with a carbon tax is the policy regime in Switzerland addressed below.

8.2.2 Switzerland

Switzerland introduced a carbon tax in 2008 on fossil fuels such as oil, natural gas, coal, and petroleum coke (while petrol and diesel are exempt) (Federal Office of the Environment ("FOEN") - Switzerland, 2012). The tax was introduced because the voluntary reductions were not sufficiently forthcoming. The tax rate charged is written into the Swiss legislation[30] and was 12 CHF / tCO_2 in 2008, 24 CHF / tCO_2 in 2009, and 36 CHF / tCO_2 from 2010.

Companies can also exempt themselves from the CO_2 tax if they voluntarily partake in the Swiss ETS (FOEN, 2012). Schürch (2011) describes the Swiss ETS as follows. The mechanism by which the Swiss ETS works, is that the firm will have to successfully conclude an agreement with the Federal Customs Administration (of Switzerland) to voluntarily reduce their CO_2 emissions by a set target. The entity will then be allocated a number of permits which equates to the emissions reduction target. Thereafter, in order to comply, the firm must meet the target or purchase permits from the market. The Swiss ETS follows a baseline-and-credit approach whereby firms are allowed a certain level of CO_2 emissions. Emissions below the baseline result in credits being earned. Surplus credits earned can be used in the next trading cycle or sold on the ETS market.

Unlike the Alberta program, the Swiss case of non-compliance results in a tax being charged retrospectively on all units of CO_2 emitted since the date the exemption is granted which originally gave passage into the ETS program (FOEN, 2012). This can be contrasted with the Alberta program which only charges a fee on units of emissions above the threshold.

8.3 Performance Standard and a Carbon Tax

Canada’s policy framework regarding lowering carbon includes policy at the federal (or national)and provincial level (IISD, 2011). At a federal level, a performance standard (non-tradable) is proposed to start on 1 July 2015 (Canada Gazette, 2011). Since each province in Canada has its own policies and legislation regarding carbon reduction, this performance standard will work in conjunction with those policies. For example, some of the provincial level policies include, Alberta’s Specified Gas Emitters Regulation; Quebec’s Carbon Levy; Nova Scotia’s cap on electricity sector emissions; Ontario’s coal phase-out and importantly for this section, British Columbia’s Carbon Tax (IISD, 2012a).

The proposed performance standard will apply to coal-fired power stations and is entitled ‘Reduction of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations’ (Canada Gazette, 2011). To encourage a move towards lower carbon power generation, it is mainly aimed at coal-fired power stations which have become close to the end of their lifespan (defined as “the later of 45 years from the units’ commissioning dates or the end of their power purchase agreement” (IISD, 2012a:1). The performance standard itself is indicated to be 375 grams of CO_{2e} / KWh and with approximately two-thirds of current coal-fired power stations reaching their end of life threshold by 2025, it is estimated that as much as 5 Mt of CO_{2e} can be prevented from entering the atmosphere (IISD, 2012a).

British Columbia introduced a carbon tax in 2008 starting at $10 per tonne of CO_{2e} (increasing to $30 in 2012) covering most fossil fuel combustion in the province (IISD, 2012b). The tax coverage does

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[30] The Swiss legislation also talks the certain circumstances in which firms are exempt from the tax.

not include non-combustion emissions, including emissions such those from methane from landfills, production of clinker (part of cement), or from natural gas production. Combustion emissions which are covered include home and buildings, transportation (personal, freight and industry) and industry (combustion) (Horne, Petropavlova and Partington, 2012). Currently, it appears that coal burnt in British Columbia is included in the coverage while coal which is exported and burnt elsewhere is excluded (Lee, 2012). This therefore appears to give rise to some degree of regulatory overlap (IISD, 2012b) which will have to be addressed. For example, the performance standard for coal-fired power stations in British Columbia is argued to arrive at an average cost of $26 per tonne of CO_{2e} reduced (IISD, 2012) while the carbon tax is currently $30 per tonne of CO_{2e}(Horne *et al*., 2012).

8.4 Carbon Cap and proposed Carbon Tax

Nova Scotia is one of Canada's provinces located off the east coast of Canada. In 2010, this province introduced an absolute cap on electricity sector emissions (DoE, 2009). The commitment, according to Nova Scotia's Environmental Goals and Sustainable Prosperity Act of 2007:1, is that

> *"… greenhouse gas emissions will be at least ten per cent [10%] below the levels that were emitted in the year 1990 by the year 2020."*

The design is relatively straightforward and set out by the DoE of Nova Scotia as follows: an absolute cap of 9.7 Mt in 2010, 8.8 Mt in 2015 and 7.5 Mt in 2020. This would be a reduction of about 2.5 Mt from 10 Mt in 2007 to 7.5 Mt in 2020. A power generating company by the name of Nova Scotia Power Inc. ("NSPI") is responsible for as much 50% of the provinces' GHG emissions of which the absolute cap covers roughly half of the provinces overall emissions (DoE, 2009).

Policymakers in Canada are considering a federal carbon tax (New Glasgow News, 2012). Within this context, MacNeil (2011) considers a carbon tax as an alternative to the Nova Scotia emissions cap. Drawing on the experience of the British Columbia carbon tax MacNeil (2011)comes to the conclusion that a carbon tax could feasibly achieve the commitment of 10% reduction of 1990 CO_{2e} levels more efficiently than the cap.

9 COMBINING CARBON TAX AND QUANTITITY-BASED INSTRUMENTS: THEORY

'QBI' is a non-standard term in the literature (where instruments are typically segmented based on whether they are economic or regulatory instruments). This section is thus based on the general literature covering the interaction between climate change policy instruments.

9.1 Rationale for combining instruments

Economic theory predicts that the number of policy instruments should be restricted to the number of targets policymakers are trying to achieve (Hepburn, 2006; Hood, 2011; Knudson, 2009). Instruments tend to interact not only with one another, but may also influence multiple policy targets. The more instruments, thus, the more opportunity for unintended interactions. The complexity that comes with the inclusion of multiple instruments also increases the risk of regulatory capture (i.e. where policies are designed in order to confer economic rents to certain stakeholders, like the owners of certain types of technology, rather than to maximise effectiveness and efficiency). Given the ability of market-based instruments to impose an economy-wide carbon price that efficiently distributes the burden of emissions reductions between economic agents, leading to lowest-cost abatement, and the lower risk of regulatory capture that comes with simple policy frameworks, in an ideal world a carbon price would be the only policy instrument used to reduce GHG emissions (Helm, 2010; Hood, 2011; Parry and Pizer, 2007)).

When multiple market failures are present, however, for example when information asymmetries lead to the main instrument being less efficient than theory would predict, the use of more than one instrument to meet a specific emissions reductions goal may be justified (Fankhauser *et al.,* 2011; Parry and Pizer, 2007). Two examples of market failures that may justify additional policy measures being deployed in the presence of a carbon price is less than optimal investment in energy efficiency (due to non-price barriers) and R&D into low carbon technologies (where the public good nature of innovation prevents inventors from appropriating the full benefit of their activities) (Bowen, 2011; Hood, 2011). Duval (2008) warns that policymakers should be careful not to use additional instruments to address what are not true market failures, but merely instances of high transaction costs, since in these instances the choice not to implement certain mitigation actions is rational – and there can thus be no guarantee that forcing economic agents to implement these actions will lead to net benefit to society.[31]

Multiple instruments can also be used to strengthen the carbon price signal in the short to medium-term for particular sets of emissions (sectors) when the broad-based carbon price increases slowly over time. Since this effectively amounts to using more than one instrument to address one (the greenhouse gas) externality, Duval (2008) believes that there is "little or no role" for supplementary policy measures applied to the same set of emissions covered by a broad-based carbon price.[32] Within an emissions trading scheme additional policy measures increase mitigation by the entities covered, but the additional mitigation reduces the cost of emissions certificates since less additional mitigation is required to meet the overall cap on emissions, thereby leaving overall emissions

[31] The failure to implemented contracts that allow both tenants and landlords to share the benefits that accrue from energy efficiency measures, for instance, may be due to hidden transaction costs rather than true market failure. The cost of negotiating, monitoring and enforcing these contracts may outweigh the benefits of implementing the measures. As carbon costs, and energy prices, increase, the value of the transaction costs relative to the value of energy efficiency benefits is reduced. Consequently, it will be more efficient to use instruments to address transaction costs directly rather than using instruments to incentivise the activity that is not occurring at (what may be wrongly believed to be) optimal levels (Duval, 2008). Furthermore, market failures may not always be independent of the level of a carbon price. As carbon prices and energy bills increase, for example, the incentive to find information about possible energy efficiency measures increases for all parties involved. In instances like these additional instruments are superfluous (Duval, 2008).

[32] Duval (2008), however, believes additional policy measures can be justified for reasons other than addressing the greenhouse gas externality. Policies aimed at promoting renewable energy, for example, can be justified based on addressing positive spill-over effects or even energy security concerns – but the instruments should then be designed to meet those objectives and reducing greenhouse gas emissions should not be put forward as part of the justification for the policies.

unchanged (Duval, 2008; Fankhauser *et al.,* 2011; Hood, 2011). In the presence of a carbon tax, in contrast, additional measures do lead to lower emissions, but this outcome can be achieved more efficiently by simply increasing the carbon cost.

In practice, however, it is not always politically feasible to increase the carbon price at the pace that is implied in the previous paragraph. Considering the issue from a more practical perspective, Hood (2011), for instance, states that when the initial carbon price is low and there is uncertainty about the future path of carbon prices, additional measures to incentivise actions like energy efficiency are justified.[33] But additional policy instruments should only be used as a transitional measure until the carbon price (or future carbon price expectations) reaches a sufficiently high level to start incentivising these actions. Furthermore, measures that incentivise actions beyond the current carbon price level should be *"the exception rather than the rule"* (Hood, 2011:49). Any measures that circumvent the functioning of a carbon price could potentially undermine it in the longer term as policymakers will always be faced with the temptation to make the supplementary policies more stringent rather than allowing the carbon price to rise over time. When the reason for using multiple instruments is to incentivise early action, there is no reason to limit the mitigation policy instrument considered to QBIs. The most effective instrument to incentivise the early action desired should be used irrespective of whether it is a QBI.

A carbon price can be adjusted over time to lead to less or more mitigation. It is thus incorrect to assume that a QBI is required to meet a quantity target (Helm, 2010; Hood, 2011; Winkler and Marquard, 2009). Time is however required to gather and analyse emissions data, and a tax is typically only adjusted once a year when the national budget is tabled in Parliament. Also, to prevent uncertainty, swings in market prices, and the possibility that emissions may overshoot a target, a carbon tax is likely to be adjusted in relatively small increments. Thus while it is true that a price instrument like a carbon tax should enable quantity targets to be met in the long term, there is an argument for supplementing a carbon tax with QBIs in the short term to increase the probability that DEROs will be met. This argument however depends on the length of DEROs and the level of emissions certainty required.

9.2 Guidelines for combining instruments

Even if the use of multiple instruments is justified, the aforementioned caveat still applies. As the number of instruments increase, so too does the possibility of unintended consequences reducing the efficiency of the overall policy package.[34] It is important that this risk is managed to ensure efficient policy. Instruments (like QBIs and a carbon tax) can interact in four ways. If there is no overlap in the application of instruments, there should be no direct interaction. When instruments are applied to the

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[33] This is particularly true if more stringent additional policies prevent future 'lock-in' effects in long-lived assets (Hood, 2011). A credible future path for carbon prices, however, should reduce the risk of carbon lock-in (Cloete and Venter, 2012).

[34] Apart from raising the cost of mitigation, Fankhauser *et al.* (2011) hold that uncoordinated policy potentially wastes political capital, undermines the credibility of the policy packages and changes distributional outcomes.

same set of emissions, however, they can reinforce each other, work against each other, or some instruments can be rendered redundant when emissions outcomes are determined by other instruments (Hood, 2011). Knowing what the outcome of interactions will be *ex ante* is not simple. While some instruments tend to be inherently complementary (i.e. energy efficiency measures and carbon pricing[35]), and others inherently counterproductive (i.e. technology standards and an emissions cap), the outcome of the interaction between many instruments will be context-specific (Gunningham and Sinclair, 1998; Oikonomou and Jepma, 2008; Oikonomou *et al.,* 2010).

The previous section suggested that the **number of instruments combined should be kept to a minimum** to reduce the risk of unintended interactions and consequences. An additional factor to consider is the impact of different instruments on the broad-based carbon price. Theoretically, in order to ensure that instruments are complementary and can be combined to form a more cost-effective regulatory framework than the use of a single instrument, **instruments should be applied to address different market failures and/or applied to different sets of emissions** (Hood, 2011). If instruments overlap, Duval (2008) holds that mitigation costs are increased since not only does double regulation unnecessarily increase administration costs, but it typically implies a curtailment of flexibility to pick the (least-cost) abatement options best suited to a particular firm's conditions.

The situation is exacerbated if there is only partial overlap between instruments. In this scenario the ability of an economy-wide carbon price to efficiently distribute mitigation effort is reduced since different firms face different incentives to mitigate, raising overall mitigation costs. **Different carbon price signals in different sectors mean that some firms end up emitting too much and others too little compared to the economy-wide marginal cost of meeting a certain level of emissions reductions.** This is a problem even where firms in some sectors are covered by regulatory instruments, since in these cases the implicit carbon price (shadow cost of mitigation) is added to the explicit carbon price to form the carbon price signal in a sector. These differential carbon price signals create an incentive to try and substitute emissions that carry a high price signal (say electricity in a system where electricity generators face overlapping instruments) with emissions that are subject to a lower price signal (like other sources of energy that may be subject to only one or even none instruments) (Duval, 2008). This problem is worsened if some sectors are not covered by any instruments, as the zero carbon price signal in these sectors mean that additional mitigation is required in the sectors that are covered by one (or more) instruments.

As mentioned in the previous section, there may be instances where the use of multiple instruments that cause a divergences in carbon price signals between sectors are justified (i.e. to incentivise additional mitigation while the broad-based carbon price is low, or to increase emissions reduction certainty). There is, however, always a trade-off between the potential benefits of using multiple price signals (i.e. increasing short term emissions reductions or increasing the likelihood of meeting an

[35] A carbon price and energy-efficiency policies are mutually reinforcing as the carbon price will serve to reduce rebound effects in energy use (i.e. an increase in electricity use driven by its lower effective cost due to increased efficiencies in its use) (Hood, 2011).

emissions reduction) and a loss of economic efficiency due to a fragmented carbon price signal. **Furthermore, each time a supplementary measure is used to tweak the impact of the carbon price it creates a precedent for doing so in future. This may undermine the ability to use predictable incremental increases in a carbon price to incentivise lowest-cost abatement over time**.[36] For this reason, Hood (2011) emphasises that each supplementary instrument must be assessed not only against its own costs, benefits and interaction with the carbon price, but also against the likelihood that it will undermine the support for the use of an increasing carbon price in future. Finally, all these factors need to be weighed against the benefits of having a strengthened carbon price signal in some sectors.

In order to keep the carbon price signal intact, **regulatory instruments applied to sectors exempt from the carbon price, and supplementary economic instruments used to adjust the carbon price signal, should be designed to ensure that the shadow carbon price is set at as close as possible to the explicit carbon price (while still fulfilling the purpose of the multiple instruments)**. This is not as efficient an approach as uniformly applying a carbon price since the absence of perfect knowledge about the availability and cost of mitigation options makes it unlikely that all options that would have been incentivised by a carbon price will be captured by regulatory instruments (and addition higher-cost mitigation options will be forced into the mitigation mix by the supplementary economic instruments), but it is at least an attempt to equalise mitigation effort across the economy (Duval, 2008; Hood, 2011).To maximise the cost-effectiveness of mitigation, policies aimed at energy efficiency, for instance, should lead to these activities being undertaken where the cost per unit of emissions reduction is equal or less than the current carbon price (or current discounted price of future expected carbon prices, should they be higher) if no market failures are present.

Where it is not possible to set the shadow carbon price equal to the carbon tax in a sector not subject to the carbon tax, or where a policy decision is made to set the shadow carbon price higher or lower than the carbon tax through the use of QBIs, supplementary instruments may be required downstream. **In cases where carbon costs would have been passed on, and the pass-through of carbon costs are reduced due to a lower shadow carbon price upstream than would have been the case had a carbon tax been implemented in isolation, additional policy instruments may be required to correct for the incorrect carbon price signal downstream.** This of course depends on the extent to which the lower carbon price signal changes behaviour downstream, and how costly it would be to implement an instrument to correct for this effect. An upstream emissions cap, for instance, even if set at exactly the level that would have been achieved had only a carbon tax been in place, will stop the carbon price that would have been levied on remaining emissions from being passed on downstream – thereby reducing the impact of the carbon price signal on energy efficiency activities downstream. In this scenario an additional instrument that incentivises energy

[36] This risk is particularly acute when the carbon price is set by a carbon tax. This issue is addressed in Section 9.4

efficiency activities downstream (which may or may not be a QBI, depending on conditions), is required to deliver the socially optimum amount of energy efficiency investment downstream.

Both the short-term trade-off between economic efficiency and environmental effectiveness (or other policy goals) and the possibility of supplementary measures undermining the functioning of a broad-based carbon price in the long term calls for **additional instruments to be strictly transitional, and to be phased out as the value of the carbon price increases over time** (see previous section).

Instruments need to be developed together, rather than being developed independently and then instruments simply layered on top of each other, to ensure that the combined framework is more effective at achieving its objective than when either of the instruments is used in isolation (Hood, 2011; Fankhauser *et al.,* 2011). In practice it is not always possible to perfectly align policy-making processes. In this case special attention needs to be paid to aligning existing and new policy instruments. If a carbon price is set high enough, the impact of additional instruments to incentivise energy efficiency or renewable energy, for instance, may be negligible.[37] Also, if the supplementary instruments lead to higher emissions reductions; that in turn affects the level of carbon price required to meet a specific emissions reduction target. A lower carbon tax can thus be set to meet the same emissions target. **Policies that are going to be implemented jointly thus need to be developed with due cognisance of their impacts on each other to ensure policy coherence (Hood, 2011).** The impacts of any existing policy instruments that may affect mitigation or socio-economic outcomes (levied at all levels of government)[38] should also be taken into consideration when adding new instruments to the policy mix. This is necessary to ensure that the resulting interface is not overly stringent (or too lenient if instruments that counteract the goals of the interface are in place).

Hood (2011) mentions that **when managing the interaction between instruments, the focus must fall on the functionality of the overall combined framework**, including coordinating the targets of the instruments and the goals (i.e. market failures) they're trying to achieve and designing the instruments to explicitly take account of any possible interactions.

9.3 Frameworks for simultaneous application of a carbon tax and QBIs

A broad-based carbon tax is supported by economic theory that indicates it is the most efficient (i.e. least-cost) instrument to achieve emissions reductions and is therefore justified as a cornerstone of mitigation policy (see section 5). Furthermore, a carbon tax is given a central role in driving mitigation action in the short term in the 2011 National Climate Change Response White Paper (RSA, 2011);

[37] As a practical example, if a quantity-based economic instrument like tradable green certificates is used in conjunction with a carbon tax, the level of the mandatory renewables commitment needs to be set by taking the impact that the carbon tax already in the system will have on renewable energy provision. This avoids a situation where the carbon tax may be sufficiently high to incentives all the required renewable energy investment (Hood, 2011).

[38] The impact of both policies that apply across sectors, and policies that only apply to individual sectors (like environmental levies) need to be taken into consideration.

and the National Treasury has indicated that a national carbon tax will be introduced in South Africa in the near future (NT, 2012). The discussion on combining instruments thus assumes that a broad-based carbon price is in place when QBIs are added the policy mix to achieve DEROs.

There are a number of ways in which a tax and QBIs can be combined. Given the non-standard nature of the term QBIs, the literature on the possible interaction of general mitigation instruments was drawn on to create the categories below.

9.3.1 Layering

Layering involves applying an instrument on top of the same set of emissions already covered by an existing instrument. The use of multiple instruments 'stacked' on top of one another does not ensure that the instruments are necessarily complementary or meet the desired effect of the combination (Fankhauser *et al.,* 2011). It is therefore important that the instruments are jointly developed, or at a minimum that the possible outcomes of the interaction between the two instruments are thoroughly analysed as suggested in Section 9.2 above).

9.3.2 Carve-out

A carve-out, or parallel functioning (as termed by Oikonomou and Jepma (2008)), refers to a situation where different instruments are applied to different sets of emissions. In contrast to layering, there is thus no direct overlap between instruments. This would entail, for example, exempting some sectors from the carbon tax and instead subjecting them only to a QBI.A carve-out increases the probability that instruments are complementary by reducing the risk of unintended consequences between instruments.

From an economic efficiency perspective, however, a carve-out reduces the coverage of the broad-based carbon price signal created by a carbon tax. To reduce the efficiency loss inherent in the combined framework, it is advisable to design the QBI so that the carbon price (for economic QBI) or shadow carbon price (for regulatory QBIs) is set at or near the carbon tax level.[39] From a political economy perspective, a carve-out has the potential to undermine the prospects for a unified long-term carbon price framework due to the risks of any carve-outs becoming permanent. This risk is reduced in the case of an economic QBI like an ETS used as a supplementary instrument by way of a carve out, since an explicit carbon price, which is easily compared to the broad-based carbon price already in place.

Oikonomou and Jepma (2008) mention that in some frameworks, target groups are given a choice as to the instruments they are to be subjected to. The example they provide is the EU-ETS, where some target sectors have the choice of opting in or opting out of the trading scheme. In European countries

[39] Should the intention of the quantity-based instrument be to strengthen the carbon price signal in the short term, this would obviously not apply since the short-term economic efficiency loss is deemed to more than be offset by the benefit of meeting the short-term target, or any long-term benefits that may arise by overcoming market failures.

where national carbon taxes are in place, this amounts to a choice of whether firms want to be subject to a carbon tax or an ETS. For the purpose of this study this design can be viewed as a voluntary carve-out. Whether or not voluntary carve-outs will increase the probability of meeting DEROs depends on how the instrument choice is presented, the instrument availability, and how their characteristics compare to that of the DEROs (i.e. whether targets are absolute or relative, at what level of aggregation they are set, etc.). Allowing firms to opt out of a tax and into a regulatory cap, for instance, is likely to increase the likelihood of achieving DEROs in the short term. The opposite change, leaving a carve-out and choosing to be subjected to the tax, however, reduces emissions certainty in the short term.

From the perspective of trying to maintain the integrity of carbon price signals, however, a hybrid system (see below) offers a more attractive policy framework than allowing voluntary carve-outs, as they ensure that the shadow carbon price is set equal to the actual carbon tax.

9.3.3 Hybrid scheme/Operational interaction

One way of doing this, is the use of *hybrid schemes*. Hybrid schemes involve the tailored combination of price and quantity instruments to ensure complementarity (Fankhauser *et al.,* 2011; Hepburn, 2006). Hybrid schemes are thus a mixture of both price and quantity instruments, and are fully integrated. Hepburn (2006) provides the following example. Any tradable permit scheme involves some form of penalty for non-performance. If the payment of the penalty is an alternative to compliance (i.e. if the payment is made there is no further expectation that a firm comply with the cap in a scheme), it qualifies as a hybrid scheme. Should a penalty be insufficient to signal compliance, as for example in the EU-ETS, where despite paying a penalty firms are still expected to offsets excess emissions in one compliance period in the following period, it does not quality as a true hybrid scheme.

A hybrid scheme is a special mandatory case of what Oikonomou and Jepma (2008) refer to as operational interaction. This refers to a situation where two instruments coexist and when the obligations set by the one instrument are modified as a result of meeting the obligations of another instrument.[40] Examples of hybrid systems include the baseline-and-credit schemes in Alberta (Canada) and Switzerland where an emissions tax is paid on part (Alberta) or all CO_2 emissions (Switzerland) if set targets are not met. Firms thus have the option of simply paying the tax; or of trying to meet the targets in order to not pay the tax.

One of the main benefits of a hybrid scheme is that, depending on how the interaction is defined, firms can be subject to a shadow carbon price that is equal to the carbon tax rate. In Switzerland, for example, the opportunity cost of not meeting the baseline-and-credit scheme target is the full carbon tax on every unit of emissions. Firms should thus be willing to implement projects with a marginal

[40] Oikonomou's and Jepma's (2008) definition of operational interaction also covers situations where target groups have a choice of to which instrument they want to be subjected. As mentioned in the previous section, that scenario is analogous to a voluntary carve out.

abatement cost up to the level of the tax to avoid paying the tax. In fact, depending on their marginal abatement curve, they may even implement projects with slighter higher MACs than the tax level if the cost of implementing these projects is less than the amount of tax they would have to pay on their remaining emissions. This can be a useful feature if sectors or entities are subject to a common carbon price but have targets that differ in ambition. This is off course not economically efficient, since these additional reductions could potentially have been incentivised at lower cost elsewhere in the economy had the carbon tax been slightly increased, but it does increase the probability of policy goals(like DEROs) being met. Also, this critically depends on where the target level is set. If an emissions reduction target is set that is less than the amount of abatement that would have been undertaken had only the carbon tax applied, the hybrid instrument will lead to a reduction in environmental effectiveness. Importantly, however, the target level can be set to match a DERO.

While a hybrid system does potential incentivise firms to mitigate more, the carbon price signal that is transmitted downstream maybe weakened. Any saving the firm receives on carbon tax they would have had to pay in the absence of the hybrid instrument (likely if the costs required of meeting the target level of mitigation implied by the supplementary instrument are lower than those of paying the tax) could potentially translate into less carbon costs being passed on to downstream firms and consumers. On the plus side, however, hybrid instruments could lead to better outcomes in sectors where as a result of market structure, competiveness dynamics, etc., firms would not have been able to pass on a significant portion of carbon costs.

In hybrid systems, the instruments (including their targets) are typically fully developed and firms simply have a choice of how they comply with them. Hybrid versions where the base instrument is fully designed, but the alternative instrument is designed in consultation with covered sectors or firms, however, also exist. This situation is analogous to the Temporary Mitigation Support Agreements (T-MSAs) proposed in Cloete and Tyler (2012).[41] An example that is applicable to the current discussion is the use of Climate Change Agreements (“CCA”) in the UK which influence the level of the Climate Change Levy (“CCL”) firms that firms have to pay.[42]If the targets negotiated as part of the CCA are met, firms pay the CCL at a significantly lower rate than if the targets are not met. The targets are defined as either individual or sector-level quantitative targets, expressed in either absolute or relative (per unit of output) terms, and pertain to energy efficiency improvements or CO_2 emissions reductions (Glachant and De Muizon, 2006). For illustrative purposes, depending on how the targets are defined, the CCL-CCA combination of instruments can be viewed as a hybrid instrument where the attainment of an emissions cap or performance standards influences the level of carbon tax payable (although the CCL’s base is too small to quality as a true broad-based carbon tax, the comparison remains valid).

[41] The term Temporary Mitigation Support Agreements is used to distinguish voluntary agreements used within carbon pricing frameworks from pure voluntary arrangements where no formal compliance mechanism are in place mechanisms (apart from the threat of future regulation) (Cloete and Tyler, 2012).

[42]The Climate Change Levy (CCL), a downstream levy charged on energy carriers used as fuel, including electricity, natural gas, petroleum and coal (HMRC, 2011)

The use of negotiated targets is not deemed beneficial given the purpose of QBIs to increase the likelihood of meeting DEROs. The use hybrid instruments and T-MSAs can, however, be reconciled by having the DEROs explicitly influence the target levels of instruments combined with a carbon tax in a hybrid framework. For the two approaches to be conceptually similar, however, there would need to be a high degree of stakeholder interaction in the setting of DEROs. This would ensure that the informational benefits stemming from the T-MSA approach is realised.

9.4 Interaction between carbon tax and QBIs

From a technical perspective, it is relatively simple to combine additional mitigation policy instruments with a carbon tax since, unlike under an ETS, the additional emissions reductions incentivised by the supplementary instrument do not change the level of the carbon price. The carbon price signal and expected emissions reductions attributed to the tax thus remain constant (Hood, 2011). In addition to the price signal from the carbon tax, however, the actions incentivised by the additional instruments may increase the mitigation costs of the firms covered by the carbon tax and supplementary policies. If this cost is positive and passed on to downstream firms and consumers, the carbon price signal is strengthened and additional downstream mitigation action is expected.

The use of additional instruments, however, can still increase or decrease the overall cost/economic efficiency of meeting any given emissions reduction target when added to a carbon tax framework. If the supplementary measures lead to lower cost options being undertaken than would have been the case had only the carbon price been in place[43], the overall mitigation cost of meeting a particular target is reduced (or, alternatively, the same level of cost would lead to higher mitigation). If the additional measures lead to more expensive mitigation options than warranted by the carbon price being implemented, like certain renewable energy options, mitigation costs will be increased to meet a predefined target. Even if the purpose was to increase the level of mitigation, the efficiency benefits of a carbon price means that the additional short-term emissions reductions could most likely have been found cheaper elsewhere in the economy (Fankhauser *et al.,* 2011; Hood, 2011).

The latter case illustrates a more general point and one which is central to the current report. The combination of additional mitigation policy instruments with a carbon tax is likely to increase overall emissions reductions (provided the supplementary measures are stricter – i.e. imply a larger implicit carbon price – than the carbon tax), but this increase in mitigation could have been achieved at lower cost by simply raising the carbon tax (Duval, 2008). As a transitional measure this higher mitigation cost may be justified (as argued in Section 9.1), but this does not change the fact that there is a trade-off between environmental effectiveness and economic efficiency in the short-term. In the long-term the issue is less clear cut and depends on the instrument.

[43] By for example causing firms to implement low (or potentially even negative) cost energy efficiency options that were not being implemented due to some form of market failure (and not simply hidden transaction costs – see Footnote 31).

An additional reason to restrict supplementary policies combined with a carbon tax to transitional measures is evident in the political economy of taxes. Given a natural resistance from a wide range of stakeholders to raising taxes, it may be difficult to raise a carbon tax over time to its efficient levels in the presence of supplementary measures. The additional policy instruments, if correctly applied, should incentivise additional mitigation to the carbon tax. In order to attain a specific emissions reduction target, this allows the carbon tax to initially be set lower than would have been the case had the tax been implemented in isolation. The use of additional instruments to bolster the carbon price signal may create the temptation to tighten these instruments over time rather than increase the carbon tax.[44] While not increasing the carbon tax over time may be politically expedient, this will raise the cost of mitigation since the broad-based carbon price cannot drive least-cost abatement throughout the economy. Supplementary instruments intended to provide temporary support to a broad-based carbon tax may thus undermine the carbon tax in the long term. Supplementary instruments should thus be deployed with caution (Hood, 2011).

9.4.1 Carbon tax and regulatory emissions cap

There is little justification for subjecting the same set of emissions to both a carbon tax and a regulatory emissions cap. If the level of emissions is already set by the carbon cap (i.e. the implicit carbon price set by the cap is higher than that of the explicit carbon tax), the tax will not lead to additional mitigation reductions. If the carbon tax creates a carbon price higher than the implicit price linked to the cap, additional mitigation will happen, but then the cap becomes redundant and any monitoring or other costs associated with it are a wasted expense.

A regulatory cap applied to a carbon tax would, however, increase the implicit carbon price signal faced by firms since the implicit cost of meeting the cap is combined with the explicit carbon price on remaining emissions. A more effective way of increasing the carbon price signal, however, would be simply to increase the tax.

In terms of choosing a framework for combining an emissions cap and a carbon tax to form a coherent interface, it is worth reiterating that an emissions cap is a relatively inefficient instrument that exposes firms to potentially very high mitigation costs unless the regulator has very accurate information on both a firm’s emissions and its abatement options (since there is no mechanism for equalising marginal mitigation costs between firms). It is questionable whether the use of such an inflexible instrument to increase the short-term price signal would be wise given the informational requirements to implement it effectively. It is thus not a good candidate for a layering framework or carve-out framework where the cap is always binding. Within a hybrid framework, however, it can be an

[44] While the use of sector- or source-specific regulatory instruments may appear to reduce the cost of emissions reductions by not, for instance, causing energy prices or the cost of other widely used products in the economy to increase, Parry and Pizer (2007) mentions that this is a false economy. The total cost to society after consideration of the non-transparent cost of regulatory instruments is likely to be higher (and potentially much higher) than the use of a higher carbon price.

attractive instrument given the possibility to incentivise additional mitigation activity (should that be the reason why instruments were combined).

It should be noted, however, that this benefit is unlikely to materialise if a carbon tax is only levied on emissions above the regulatory cap. The reason for this is that there is effectively a zero carbon price on all emissions under the cap, even if the cap is breached. There is thus never an incentive to emit less than the emissions cap if the carbon tax is levied only on excess emissions. Also, if the emissions cap is breached and the carbon tax is payable, then the carbon price signal transmitted downstream will obviously be stronger in the case where the carbon tax is levied on all emissions rather than only on the excess emissions. In fact, given that the tax is never paid on the emissions below the cap, and no implicit carbon price is created, the resulting combination more closely resembles the traditional use of an emissions cap as a regulatory instrument (when a penalty is paid on non-compliant emissions only) than a hybrid instrument.

Adding the flexibility to pay the carbon tax should the emissions cap be breached (i.e. when emissions exceed the cap) does however reduce the environmental and emissions certainty. The latter, while intuitively problematic in the context of QBIs being used to meet DEROs), does provide a mechanism to ensure that the trade-off between economic efficiency and environmental effectiveness is not unexpectedly severe since a cap is placed on the carbon price signal at the level of the carbon tax. If it is more cost-effective to pay the tax than to mitigate, firms have the option to simply pay the tax.

9.4.2 Carbon tax and an Emissions Trading Scheme (cap and trade or baseline and credit)

As in the case with a regulatory emissions cap, the level of emissions can be set by one of two instruments, either the tax or the quantity-based economic instrument, not both. If the trading scheme is the instrument that sets the level of abatement, changing the level of the tax will simply change the level of the price of the certificate (in the ETS) or credits (in the BCS). Any additional unit of abatement that happens in response to an increase in the carbon tax is one less unit of abatement that has to be covered by a certificate or credit (and *vice versa*). Any incentive to abate created by the carbon price is thus fully offset by a reduction in the incentive to abate as a result of lower certificate/credit prices (Duval, 2008; Fankhauser *et al.,* 2011; Hood, 2011). If the carbon tax is sufficiently high to incentivise more abatement than the ETS or BCS, the value of certificates and credits will fall to zero and the ETS or BCS will become redundant.

An ETS or BCS can be used to increase the effective carbon price in a sector if it is set at a level that implies a larger reduction in emissions than the tax alone, but the same carbon price signal can be achieved by increasing the carbon tax or by exempting the sector from the carbon tax and only subjecting it to the ETS or BCS at the same level.

Given the inherent contradictory nature of a carbon tax and emissions trading or baseline-and-credit schemes, the only desired option for combining the two types of instruments is through a carve-out. If this route is followed, the caveats mentioned above with respect to ensuring a consistent carbon price signal throughout the economy apply. Here it should be noted that, by not placing a value on every unit of emissions, a BCS is expected to transmit a weaker carbon price signal downstream than an ETS.

9.4.3 Carbon tax and white or green certificate schemes

White and green certificate trading schemes can be used to incentivise additional energy efficiency or increased uptake of renewable energy if combined with a carbon tax. As mentioned in the introduction of this section, they can increase or decrease overall mitigation costs.

If a white certificate scheme leads to energy efficiency actions, which, in turn leads to a reduction in emissions from the energy sector that substitutes for more expensive mitigation action that would have been undertaken elsewhere at the current carbon tax rate, overall mitigation costs will be reduced (Hood, 2011). For this to happen, however, the energy efficiency activities must have previously been prevented by a genuine market failure at current carbon tax levels and not just hidden transaction costs – otherwise there is no guarantee that mitigation costs have truly decreased (see Footnote 31).

A green certificate scheme will lead to an increase in the cost of meeting a predefined emissions target by forcing more expensive renewable energy into the mitigation mix than warranted by the carbon tax to be implemented.[45]All other things being equal, the use of a green certificate scheme in addition to a carbon tax should lead to additional mitigation, but the increased abatement is unlikely to be achieved at least cost. The efficiency nature of a broad-based carbon price means that the additional short-term emissions reductions could most likely have been found cheaper elsewhere in the economy by increasing the carbon tax rate (Fankhauser *et al.,* 2011; Hood, 2011).

This does not necessarily mean that there is no role for green certificates. There may be an argument that they can be used to correct for market failures that retard the development and large-scale roll-out (and concomitant reduction in costs) of renewable energy technologies. If this is the case, the use of green certificates is expected to reduce the marginal cost of abatement over time. There is thus a trade-off between a certain short-term increase and a possible long-term reduction in mitigation costs when combining green certificate schemes with a carbon tax.

White certificates can potentially decrease the carbon price signal for covered and downstream sectors if they do lead to a decrease in mitigation costs. If this is not the case, increased mitigation costs may end up strengthening the carbon price signal.

In the short term, green certificate schemes increase the cost of mitigation and raise the uptake of expensive renewables. This strengthens the carbon price signal. In the long-term, however, economies of scale and maturing renewable technologies may reduce the cost of mitigation and the carbon price signal.

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[45] If the implicit carbon price inherent in the green certificate scheme cap is lower than the carbon tax level, mitigation costs will not be increased. But neither will emissions be reduced, meaning the scheme is redundant.

Given that a carbon tax and white certificates or green certificates address different externalities, they can be successfully layered. In fact, given that white certificates or green certificates on their own impact a smaller set of emissions than the carbon tax, they are not good candidates for either a carve-out or forming a hybrid instrument. Unless a DERO is defined in terms of renewable energy use or energy efficiency gains, white certificates or green certificates in a carve-out or hybrid regime will not lead to a DERO being met.

White certificates and green certificates address different market failures and can thus theoretically both be layered on top of a carbon tax simultaneously. This would require careful design, though, since by reducing the demand for energy, energy efficiency measures would also reduce the demand for renewable energy. This problem could be addressed by, for example, specifying an absolute, rather than a relative target for electricity generators (Del Rio, 2009).

9.4.4 Carbon tax and performance or technology standards

Performance standards are typically preferred to technology standards since they provide more choice in technologies to employ to reduce emissions (and are thus expected to incur lower mitigation costs) and provide better incentives for innovation. Under specific conditions, however, when emissions are difficult or expensive to monitor and where mitigation technologies are mature and well-known, technology standards may lead to better outcomes. Performance standards may also be difficult to implement where the output from industrial facilities can vary between a number of products; and where the differences between the types of output is not easy to detect (Parry and Pizer, 2007).This section thus focuses on performance standards, while noting that technology standards should be considered if the conditions mentioned above hold.

Performance standards can increase the environmental effectiveness of a carbon tax by causing additional mitigation options to be implemented. They do this, however, by forcing more expensive mitigation actions to be implemented than would be the case in their absence, and thus increase both mitigation costs and the carbon price signal in a market.

In theory, performance standards can incentivise the same energy efficiency and renewable energy activities targeted by white and green certificate schemes. Since performance standards lack a trading element, it may be more cost effective to combine a carbon tax with green or white certificate schemes rather than performance standards to address market failures relating to energy efficiency and renewable energy.

Performance and technology standards suffer from the same lack of flexibility as other regulatory instruments. For this reason a hybrid instrument would be the preferred framework for combining them with a carbon tax unless a high degree of certainty exists on the availability, risk, implementation time frames, cost etc. of mitigation options in a sector. If this information is available, a layering or carve-out approach can be considered. The former in the case of where it is believed a carbon tax alone won't incentivise sufficient mitigation (and raising the broad-based carbon tax is not an option), and the latter in cases where it is deemed undesirable to expose a sector to the full carbon price (either due to competitiveness concerns or a desire to avoid pass-through of the full carbon price signal created by the carbon tax).

9.4.5 Summary: Framework Choice

The optimal framework used to simultaneously implement a carbon tax and QBIs to meet DEROs will be context specific, so the theoretical discussion above provides general guidelines only.

Table 10: Indicative guide to framework choice

Instrument	Layering	Carve-out	Hybrid
Emissions cap			X
Emissions trading scheme		X	
Baseline an credit scheme (if ETS not considered suitable)		X	
White certificates	X		
Green certificates	X		
Performance standards			X
Technology standards (if performance standards not considered suitable)			X

Source: Project team

The characteristics of the relevant sector and the design of the DEROs will determine the optimal framework choice in practice. The table above, however, provides a useful departure point from which to take practical considerations into account.

10 APPLICATION TO SOUTH AFRICA

Having developed a general perspective on the interface between QBIs and a carbon tax, it is important to see how well this fits with local realities. This section considers the South Africa-specific context and literature, together with views of local stakeholders, to assess the appropriateness of the interface options identified in section 9.4above for the South African context.

10.1 The South African context

Context is all important when identifying an optimal mix of mitigation policy instruments. Technical issues, the structure of the economy, individual sector structures, socio-economic issues together with policy and institutional considerations are critical in understanding the eventual impact of different policy options. The South African characteristics relevant to carbon pricing and mitigation instruments have been covered extensively elsewhere (Cloete *et al*., 2010; Cloete and Tyler, 2012; Goldblatt, 2010; Winkler, Jooste and Marquard, 2010; Robb, Tyler and Cloete, 2010). This section provides a brief summary of this literature, augmented with insights gained from the stakeholder interviews conducted during the course of this study (for a full list of stakeholder interviews, together with a synopsis of the issues raised at each interview see Appendices A and B), and discussions on policy direction and interpretation with both the DEA and the National Treasury.

- South Africa's emissions profile is dominated by emissions from energy (79%) (RSA, 2009). The rapidly rising electricity price is fast reducing any low or no-cost mitigation options in this sector, and more medium-term mitigation options are characteristically capital intensive, 'lumpy' and concentrated in a few sectors or institutions (Cloete *et al*, 2011; Cloete and Tyler, 2012).

- There is a lack of policy relevant data relating to current emissions sources and the cost, risk and commercial viability of mitigation options at a sector (and particularly sub-sector) level in South Africa (Cloete *et al*., 2010; NPC, 2011). It is hoped that the study recently commissioned by DEA to consider mitigation options in various sectors will go some way towards remedying this.[46]
- The energy sector is characterised by uncompetitive market structures: a regulated monopoly in electricity generation and transmission, and a regulated oligopoly in liquid fuels. A crisis in electricity generation capacity in 2008 led to the end of an era where South Africa enjoyed some of the lowest electricity prices in the world. The electricity price has escalated steeply since 2007, and will continue to do so until at least 2018.[47]Electricity supply remains tight throughout this time period, and ensuring security of supply is a concern for energy intensive industry.
- The sector is regulated by the National Energy Regulator of South Africa ("NERSA").Amongst other responsibilities, NERSA administers the electricity generation build planning process, the Integrated Resource Plan ("IRP"), Eskom's tariffs and the licensing of generators connecting to the grid. The first IRP was undertaken in 2010, and will be reviewed every two years. Together with feasibility plans, it forms the basis on which the Minister of Energy determines the type of generation plant built. The IRP currently envisages a significant ramp up in renewable energy, together with a sizeable nuclear procurement to meet electricity demand until the end of its planning horizon in 2030. The renewables component will largely be undertaken by Independent Power Producers ("IPP") through the Renewable Energy Independent Power Producer (REIPP) programme which enables preferential access to the grid. It is unclear how the nuclear fleet will be financed, resulting in significant uncertainty around whether the build plan will be as currently envisaged.[48] The IRP is to be reviewed every two years.
- The Energy Policy White Paper of 1998 included government's intention to liberalise the energy sector. Whilst this process came to a halt in the early 2000s, it remains the overarching policy intention, which is reflected in the IRP and the various IPP procurement programmes.
- Because of South Africa's reliance on coal as an energy source, the energy embodied in exported products is carbon intensive. Energy intensive trade exposed sectors are therefore vulnerable to domestic carbon pricing in the absence of an international carbon pricing regime.
- The South African government is already incorporating a transition to a lower carbon economy into its plans and policies. The first IRP for the electricity generating sector incorporates an absolute emissions constraint from 2025-2030. New motor vehicles are subject to an emissions tax. A partial carbon price is levied on electricity generated from non-renewable sources, tax allowances for investments in energy efficiency are proposed, preferential grid access for independent power producers generating electricity from renewable resources is in place through the REIPP programme, and many municipalities have adopted energy-efficient building

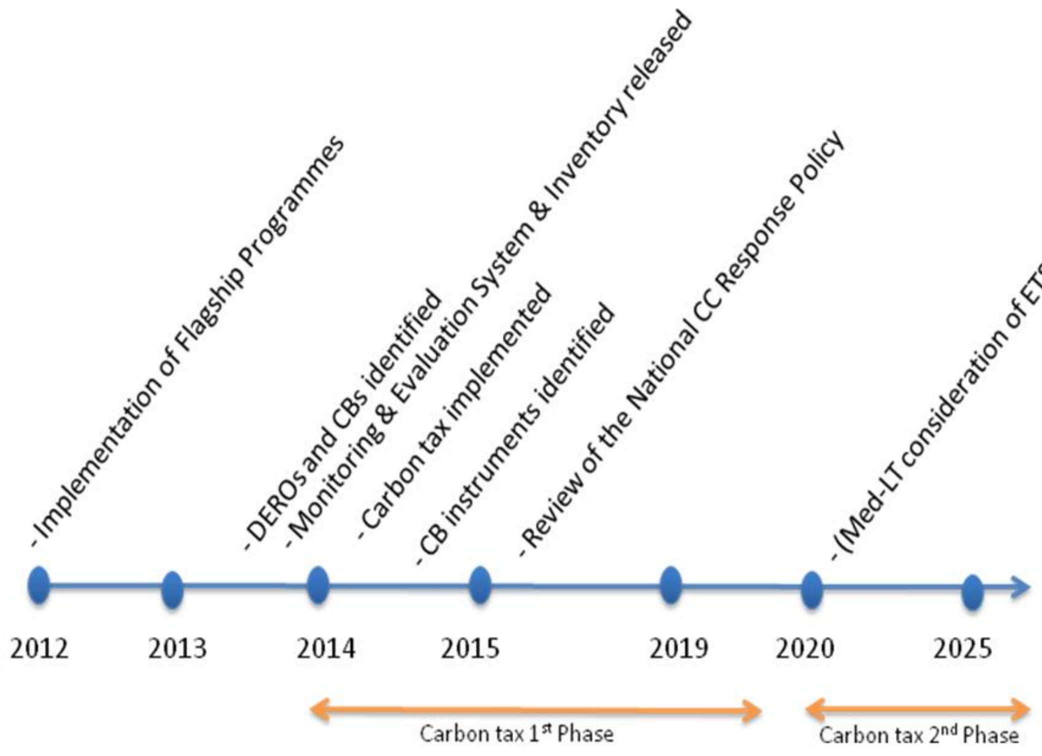
[46]The lack of mitigation and emissions data was an issue that was raised during the stakeholder engagement.
[47]Since 2008 Eskom electricity prices have more than tripled (see Eskom, 2012).
[48]Issue raised during stakeholder engagement.

standards and by-laws. As mentioned in section 4.1.3, new national building standards introduced in 2011 specify standards for heat gain or loss and require that at least half of the hot water requirements of new buildings are provided by renewable energy options.

The National Treasury is in the process of designing a carbon tax as the central broad based price mechanism for South Africa (see section 10.3). It is widely accepted that this is the more appropriate mechanism, as opposed to an emissions trading scheme (NT, 2010; NT, 2012; NPC, 2012, Cloete *et al*., 2010) due to the concentrated nature of local emissions sources and information and administrative challenges.

- The first discussion document on the carbon tax option for stakeholder comment was released in 2010. The proposed tax was elaborated on in the 2012 Budget, and a second discussion document is pending.
- The National Climate Change Response White Paper (RSA, 2011) sets out South Africa’s mitigation policy approach, which includes a performance benchmark in the National Greenhouse Gas Emissions Trajectory Range; sector, sub-sector and entity level Desired Emission Reduction Outcomes (“DERO”); a carbon budget (“CB”) approach and mitigation plans to achieve DEROs; economic instruments, a Greenhouse Gas Inventory and Monitoring and Evaluation System.
- A timeline of mitigation policy elements (understood thus far) appears below.

Figure 6: Timeline of Mitigation Policy Elements



Source: Project Team

- Policies in other spheres are relevant to mitigation policy. These include industrial policy (the Industrial Policy Action Plan),the IRP in electricity, a pending Integrated Energy Plan ("IEP") for the energy sector, the New Growth Path outlining South Africa's economic development policy and the Development Plan of the National Planning Commission (see Trollip and Tyler (2011) for a discussion on the alignment of these policies).
- South Africa is a developing country, with significant poverty and inequality challenges. The National Planning Commission cites poverty and inequality as the country's twin policy objectives (NPC, 2012).Generating employment is a key component of meeting these objectives.[49]

[49]For an overview of how mitigation policy may influence South Africa's other policy goals, see Segal and Cloete (forthcoming).

10.2 Carbon budget approach

10.2.1 Desired Emission Reduction Outcomes (DEROs)

Within the carbon budget approach of the White Paper, DEROs indicate the optimal level of emissions reductions. The unit of account for the DEROs has not been defined as yet. It will be at a sub-national level, but could be at the sector, sub-sector or even individual company or entity level. It is also not yet clear whether these outcomes will be mandatory or voluntary (i.e. whether there will be penalties or other enforcement mechanisms that come into play should the DEROs not be achieved). In addition, there may be scope for DEROs to be defined on a relative (i.e. intensity) or an absolute (fixed amount) basis. According to the timelines in the White Paper, the initial DEROs will be established by the end of 2013.DEROs will be defined for a set period of time, and as such will be reviewed periodically. How long DEROs are expected to be in place for has not yet been determined.[50]

It is also not clear whether, if they are absolute in nature, they are cumulative over a period of time, indicating a carbon budget for a period, or whether they are a goal to be attained by a point in time. Relative DEROs are assumed to be an intensity goal at a point in time.

The DEROs may all be similarly defined, or alternatively there may be a mix of different types of DEROs.

The White Paper calls for the impact on broader socio-economic development indicators to be assessed during the development of the optimal mix of climate change policies, and that the DEROs will be defined based on *"… a full assessment of the costs and benefits"* (RSA, 2011:25). This study therefore assumes that the DEROs will be set at an optimal level of mitigation for each sector, maximising cost effective mitigation cognisant of the impact on factors such as jobs, energy security and international competitiveness.

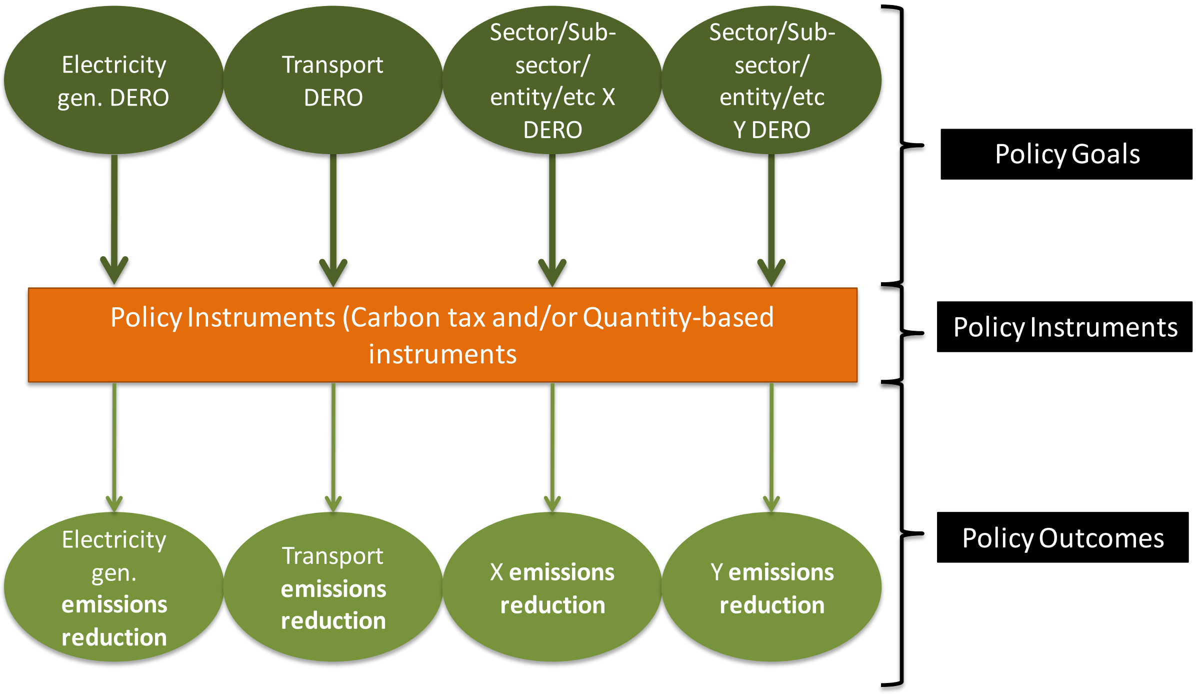
Initial DEROs will be developed after the finalisation of the analysis of South Africa's mitigation potential which is currently being undertaken as part of a GIZ-funded study administered by the DEA, but before the review of the National GHG Emissions Trajectory identified in the White Paper (RSA, 2011). The DEROs may therefore provide information pertinent to this and future reviews of the Trajectory. The precise nature of the relationship between the DEROs and the Trajectory has yet to be determined.

10.2.2 Clarifying the relationship between DEROs and mitigation policy instruments

In South African carbon budget approach to mitigation policy, the DEROs are therefore the mitigation policy goals, which are implemented by mitigation policy instruments. This relationship is depicted in the diagram below.

[50] The White Paper will be reviewed every five years, so it is unlikely that DEROs will be defined for more than five years.

Diagram 1: Carbon budget approach: the relationship between DEROs and mitigation policy instruments.



Source: Project Team

This mitigation policy approach requires that the level of mitigation contained in the DERO is the level of mitigation which the mitigation instruments must deliver.

The substantial uncertainty surrounding the nature of the DEROs outlined in this section imposes significant complexity on a study of the mitigation instruments most appropriate to achieve them, and their interface. Whether a DERO is set for two or 10 years is material in determining whether a tax or a QBI is the more appropriate policy mitigation instrument. Similarly, the instrument to achieve an absolute, cumulative DERO is likely to differ from that to achieve a long term absolute DERO. An absolute DERO may be effectively achieved by an absolute QBI, but is less likely to be achieved by a relative QBI or a tax in the short or medium term. In the long-term, however, a tax is more likely to allow for cumulative absolute targets to be achieved, but an absolute QBI is still preferred due to its greater flexibility to increase or reduce emissions temporally (achieving the same effect with a tax may require politically difficult large swings in the tax from year to year, which also reduces the certainty of the long term carbon price path).

The table below attempts to illustrate this complexity and strongly suggests that the starting point in identifying appropriate mitigation policy instruments to implement DEROs must be the definition of the DEROs.[51]

Table 11: Implications of the nature of DEROs for the choice of mitigation policy instrument

Nature of DERO	Likely appropriate mitigation policy instrument
Absolute, short term	Absolute QBI
Relative, short term	Relative QBI
Absolute, cumulative, medium term	Absolute QBI
Absolute, non-cumulative, medium term	Tax with QBI design elements
Relative, medium term	Tax with QBI design elements
Absolute, cumulative, long term	Absolute QBI
Absolute, non-cumulative, long term	Tax transitioning to absolute QBI
Relative, long term	Tax / relative QBI

Source: Project Team

In light of this uncertainty, this study focuses on understanding and defining the necessary process of identifying an optimal carbon tax-QBI interface for South Africa, as opposed to delivering definitive options.

10.3 The current preferred carbon tax design

Carbon pricing, and in particular a carbon tax has been identified by the National Treasury (and supported by all climate mitigation policy documents (ANC, 2007; RSA, 2011; NPC, 2012), as an important element of mitigation policy. The literature strongly recommends that any mitigation policy instrument suite has a broad based pricing instrument as its central feature. That this price should be a tax in South Africa, at least initially, is widely accepted, and work on the tax is already advanced within National Treasury.

The tax has been in planning since 2006 when the National Treasury released the policy discussion document around using market mechanisms for environmental fiscal reform (NT, 2006).Then the first Carbon Tax Discussion Document (NT, 2010). Further indications as to the tax design were announced in the 2012 National Budget (NT, 2012) with a further discussion document pending at the time of writing.

[51]Note that this table only intended to shed light on the relationship between DEROs and the mitigation policy instruments, contextual issues may change the most appropriate mitigation policy instrument to implement a type of DERO. Only mandatory DEROs are considered, because when a DERO is voluntary, a price instrument is likely to be superior in all instances for efficiency reasons.

From these NT documents, the following can be identified as the current preferred design of a local carbon tax (of relevance to this study):

- The tax will be implemented on direct emissions of greenhouse gases.
- Two phases of the tax are identified. The first is 2013/14 – 2019/20, and the second 2020 – 2025.
- The land-use, agriculture, forestry and waste sectors will be eligible for 100% relief in the first phase.
- The tax rate starts at R120 per tonne of CO_{2e}, escalating at 10% per annum in the first phase, to be reviewed in the second phase. An additional mechanism for adjusting the tax rate is provided in the form of a tax exemption for 60% of emissions. This is applied across the board, and will be reviewed in the second phase.
- Tax relief is provided through three mechanisms, all of which specify a percentage of a firm's annual emissions which are exempt from the tax. Firms in different sectors will thus face a different tax rate, depending on which mechanisms apply to the sector. Firms which are 'trade exposed' can secure up to a maximum additional (to the 60%) 10% exemption in the first phase. On top of this, firms which have 'process emissions', can achieve an additional allowance of up to 10% in the first phase. Finally, offsets can be purchased to further increase the exempt percentage of emissions (up to 5 or 10%).
- An adjustment to the basic 60% relief through Z-factors (essentially GHG performance standards) related to a base year or industry benchmark acts as a carrot to further incentivise companies to reduce their emission intensities during the first phase. Since the basic relief is applied retrospectively to all emissions, Z-factor adjustment means that firms that perform better than the specified performance standard for their sector will face a lower effective tax rate (i.e. given a larger basic relief portion) than firms that simply meet the sector performance standard. In contrast, firms that perform worse will face a higher effective tax rate.
- The tax free thresholds will be reduced during the second phase and may be replaced with absolute thresholds thereafter.
- Revenues will not be earmarked, but consideration will be given to spending to address environmental concerns.

This tax has been designed thus far in the absence of any detail about the nature and level of the DEROs. Whilst the use of percentage thresholds in and of themselves does not amount to the inclusion of a QBI in the tax design, the use of Z-factors to adjust the basic tax-free threshold (60%) does in the form of a performance standard. The Z-factors, as defined by the National Treasury (NT, 2012), are determined by comparing a firms carbon emissions intensity factor for output against an agreed sector benchmark: Z=Y (the agreed benchmark carbon intensity for the sector) / X (the average measured and verified carbon intensity of the output of the firm).These Z-factors are then applied to the basic 60% to arrive at an adjusted tax free percentage of emissions.

The 'trade exposure' threshold, the 'process emissions' threshold and the offset percentage are mechanisms to provide relief from the impact of a carbon tax to those sectors and entities considered vulnerable to the tax impacts through inability to pass the price on, or limited mitigation options. This type of relief is typical in carbon tax design. In the carbon budget approach to mitigation policy being undertaken in South Africa, the need for relief from mitigation costs must also necessarily be reflected in the level of the DEROs themselves.[52] As such, the only way to ensure that the DEROs are achieved without significant duplication of policy instruments, or inconsistency between instruments and targets, is to design traditional tax relief in the form of QBIs (set at the level of DEROs). The South African carbon tax has been designed prior to the DEROs being developed or the carbon budget approach to mitigation policy being clearly defined as including the use of QBIs to meet DEROs. National Treasury does, however, identify that *"… [a]lignment [of the tax] with the proposed carbon budgets as per the national climate change response white paper ...will be important"*, and that the tax-free thresholds may be replaced with absolute emission thresholds in the third phase (NT, 2012:56).[53]

The use of Z-factor adjustments (performance standards) were included as an additional incentive to mitigate and not to meet predetermined DEROs. Given that a Z-factor is defined as an *"… agreed benchmark carbon intensity for [a] sector"*, they will by design be relative QBIs (NT, 2012:187).

This adjustment is thus unlikely to be useful in meeting absolute DEROs in the short-term. Also, given the low initial level of the tax (once the various thresholds are included), it is not clear if the incentive created will be sufficient to lead to relative DEROs being met in the short-term (since this in part depends on the levels of DEROs). The unequal carbon price created by the Z-factor adjustment will increase overall mitigation cost since firms with higher mitigation costs are incentivised to do more mitigation than they would have under a uniform carbon price (while firms with lower mitigation costs do less mitigation).

Therefore, from the perspective of this study, the current tax design creates hybrid instruments (according to the lexicon in Section 9.4.4) as an interface between a carbon tax and a relative QBI (in the form of a performance standard) in every sector covered by the carbon tax.

In order to assess other possible options of tax – QBI interface it is however necessary to consider alternative designs of the carbon tax. Both the use of Z-factors, and the provision of tax relief unconnected to QBIs which could then reflect relief already inherent in the DEROs complicate the analysis of alternative interface options. We will therefore use the terms 'current tax design' to refer to

[52] Section x outlines the assumption that DEROs will be set at levels which reflect issues such as competitiveness vulnerability, and expensive and lumpy mitigation options.

[53] It should be noted, however, that the combination of a regulatory cap (absolute emissions thresholds) with a carbon tax in the way envisaged here (ie that a tax is only levied on emissions above the threshold set by the cap) is not consistent with the guidelines for carbon tax-QBI interface options outlined in section 9.4.1 since no shadow or implicit carbon price applies to the emissions covered by the regulatory cap.

the entire tax design as proposed in the 2012 Budget; and 'basic tax design' to refer to the proposed tax excluding the relief thresholds and Z-factor component.

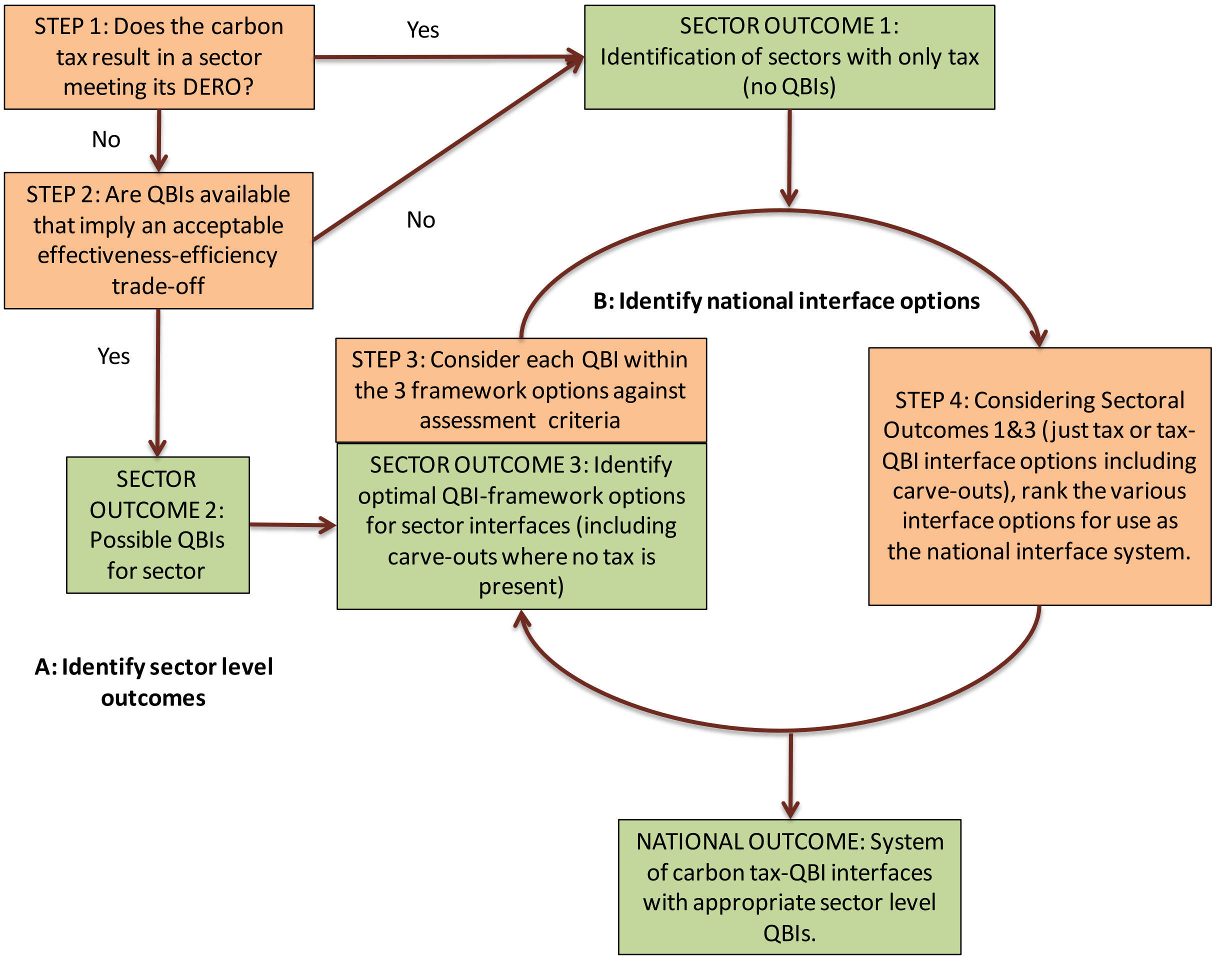
10.4 Identification of possible QBIs

The theoretical discussion on the difference between price instruments and QBIs highlights that price instruments excel in efficiency whilst QBIs provide more certainty in achieving specific emission reduction targets. The inclusion of DEROs as part of South Africa's mitigation policy approach implies that certainty in achieving a quantity goal at a sector (sub-sector or entity level) is important. If quantity is all-important within a relatively short period of time, then including a QBI instead of, or in addition to a carbon tax becomes imperative. However, we assume that a balance between quantity and efficiency is desired, and that absolute quantity certainty at the cost of significant economic inefficiency in instrument design is unlikely to be desirable. Hence achieving a good balance between quantity certainty and efficiency becomes a central objective when developing and considering carbon tax-QBI interface options for South Africa.

This study identifies a number of steps involved in the process of developing and analysing possible carbon tax-QBI interface options appropriate to the South African context. These are depicted graphically below, and will be explained in the remainder of the section. The first step involves identifying what the DEROs look like. As this is not possible yet, it is also therefore not possible to proceed with a practical analysis of the interface options. Our approach here is then to clearly articulate the process of doing so, and to undertake as much of the analysis as possible with existing information. Where additional information is required, this is clearly identified.

For the purposes of the study, DEROs will mainly be considered as occurring at the sector level. If a sub-sector or entity level DERO raises additional issues, these will be addressed

Diagram 2: Identifying optimal carbon tax – QBI interface options



Source: Project team

The process comprises two phases, the first (A) which deals with the sector level, and the second (B) which deals with the national level. Outcomes from the sectoral analysis are inputs into the national analysis, which in turn can change some of the sectoral level outputs in an iterative analytical process. The process assumes that the DEROs have been identified as an outcome of a policy process, and will be established by DEA with input from the GIZ mitigation costs study, by the end of 2013.

10.4.1 Phase A: Identifying Sector Level outcomes

There are three steps to identify possible QBIs at a sector level:

STEP 1: Does the carbon tax result in a sector meeting its DERO?

This step is likely to involve a modelling exercise of the impact of the tax on future emissions (potentially an extension of that already undertaken by National Treasury), to consider whether the 'basic carbon tax' is likely to result in individual sectors / sub-sectors meeting their DEROs. There could be a number of reasons for the tax failing to meet the level of the DERO. For example, the carbon tax could be ineffective in achieving mitigation in that sector due to market failure (such as non-price barriers to mitigation, price regulation, an uncompetitive sector structure, or failure to incentivise sufficient R&D), or the DERO could include strategic considerations (such as energy security or distributional issues) requiring a far slower or faster level of mitigation in one sector than that dictated by the pure least cost mitigation objective of the carbon tax. Considering the impact of mitigation instruments that are already in place in the sector is an important part of the analysis.[54]

The impact of regulated prices is important to consider when evaluating the likely impact of the carbon tax. Taxes and levies imposed on Eskom by government, for instance, are considered "exogenous and will be treated as a pass-through cost in the MYPD" (NERSA, 2012:30). If passed straight on to electricity consumers, a carbon tax will not be effective in changing the day-to-day activities of Eskom (although the increased carbon price signal may still incentivise additional energy efficiency activities by customers). Structural issues that prevent the carbon price signal from remaining intact when being transmitted through the economy will also reduce the effectiveness of a broad-based carbon tax. Again within the context of the local electricity market, for instance, the EIUG (2012) believes that an over-reliance on fixed demand charges by municipalities has the potential to reduce the incentive for industrial users supplied by them to implement energy efficiency measures. Energy efficiency measures, while reducing the energy component of electricity bills, cannot offset high fixed demand charges.[55]

It is important to bear in mind that the predictive power of any model is constrained by, amongst other things, the accuracy of the data it works from. The modelling of the potential impact of the carbon tax will require detailed sector specific information on sector characteristics and the availability and cost of mitigation options. It has been shown elsewhere that detailed policy relevant climate mitigation information, specifically data on GHG emissions, abatement opportunities and mitigation costs is not yet readily available for South Africa (Cloete *et al*, 2010; NPC, 2011; Rossouw, 2012). The forthcoming DEA-administered study by Camco on mitigation options is expected to improve this situation.

When considering the impact of a carbon tax (or additional QBIs in the steps that follow), it is important to consider the mechanism through which mitigation action can cause mitigation, and how conditions

[54] In the South African electricity sector, for instance, the following mitigation instruments are already in place or planned: a levy on electricity generated from non-renewable resources, proposed tax incentives for energy efficiency investments, direct support for energy efficiency through the Demand Side Management Fund managed by Eskom, and the REIPP programme providing preferential grid access for renewable energy

[55] This issue may affect a significant percentage of electricity demand in South Africa. The EIUG study only looked at industrial demand from municipalities, so it is not clear if the same issue applies to sales to domestic customers. 42% of Eskom's sales in 2011 were to municipalities (Eskom, 2012a). According to NT (2011) 64.5% of municipalities' electricity sales in 2006 were to non-domestic customers. Provided that sales patterns haven't changed since 2006, and assuming the issue is restricted to non-domestic users, more than 27% of Eskom's sales could thus be affected (although the extent of the problem is expected to vary by municipality).

in a sector may impact on these mechanisms. Mitigation in the electricity generation sector, for instance, is achieved through a reduction in the carbon intensity of the grid, and a reduction in electricity use (ideally achieved through an increase in the efficiency of electricity use rather than through a decline in economic output). In terms of changing the carbon intensity of the grid, mitigation instruments can work in three ways. Firstly, the efficiency of the current mitigation fleet can be increased through undertaking energy efficiency improvements. Secondly, an implicit or explicit carbon price increases the cost of emitting GHGs. This additional cost will be taken into consideration when future investment decisions are made. Thirdly, a carbon price also impacts cost of emitting GHGs in the day-to-day activities of an electricity generator.

Locally, it is believed that there is limited scope to improve the emissions efficiency of the existing Eskom fleet, is particularly true for the least efficient ‘return-to-service’ coal-fired plants brought on line to help cope with capacity constraints. These plants have relatively short expected useful lives. This reduces the expected value of any further investments to increase efficiency improvements, making them less likely (Stakeholder engagement, 2012). Given that most emissions efficiency opportunities in the existing fleet have been undertaken or are prohibitively expensive, the only remaining option to increase the emissions intensity of the existing fleet is to retire the more inefficient plant before the end of their economic life (Stakeholder Engagement, 2012). This is however not currently an option, since the electricity generation system has been running being run at, and beyond, generation capacity since at least 2007. This situation is anticipated to continue at least until the second new coal fired power plant, Kusile, is completed. Electricity supply constraints also mean that many of the typical ‘day-to-day’ options for reduce carbon costs, like dispatching lower carbon electricity first, is not available since all installed generation capacity is required to meet demand. Should electricity demand be lower than forecast over the next decade, a not unlikely occurrence[56], however, the early retirement of plant and flexibility in dispatch of electricity may become viable mitigation options.

If the ‘basic carbon tax’ plus existing mitigation instruments[57] result in a sector DERO being largely achieved, then it would not be beneficial to include a QBI in the sector, as the desired mitigation level is already being achieved at least-cost through the tax. Should the DERO level be revised upwards or downwards, a similar revision in the tax rate should enable the revised DERO to be achieved.[58]For such sectors, the sectoral level analysis is complete, with the ‘tax only’ outcome (Sectoral Outcome 1)feeding into the national analysis. However, should a QBI be required to achieve a DERO in a sector, then the next step is to identify possible QBIs for the sector.

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[56] The demand forecast in the IRP ‘is at the higher end of the anticipated spectrum’ (IRP, 2010). Electricity sales by Eskom were 2.9 percent lower in the six months to end September 2012 that in the same period in 2011 despite estimated economic growth of 2.5 percent (Creamer, 2012)

[57] The impact of both policies that apply across sectors, and policies that only apply to individual sectors (like environmental levies) need to be taken into consideration.

[58]Note that in the sectors where there is no need for a QBI to meet the DERO (i.e. the tax suffices), it is assumed that the DEROs for these sectors are not anticipated to revised in competing directions, or to very different levels. A change in the common tax rate would not be able to cope with multi-directional changes at the sectoral level. Were such a situation to arise, a QBI would need to be considered for the sector, in addition to the tax.

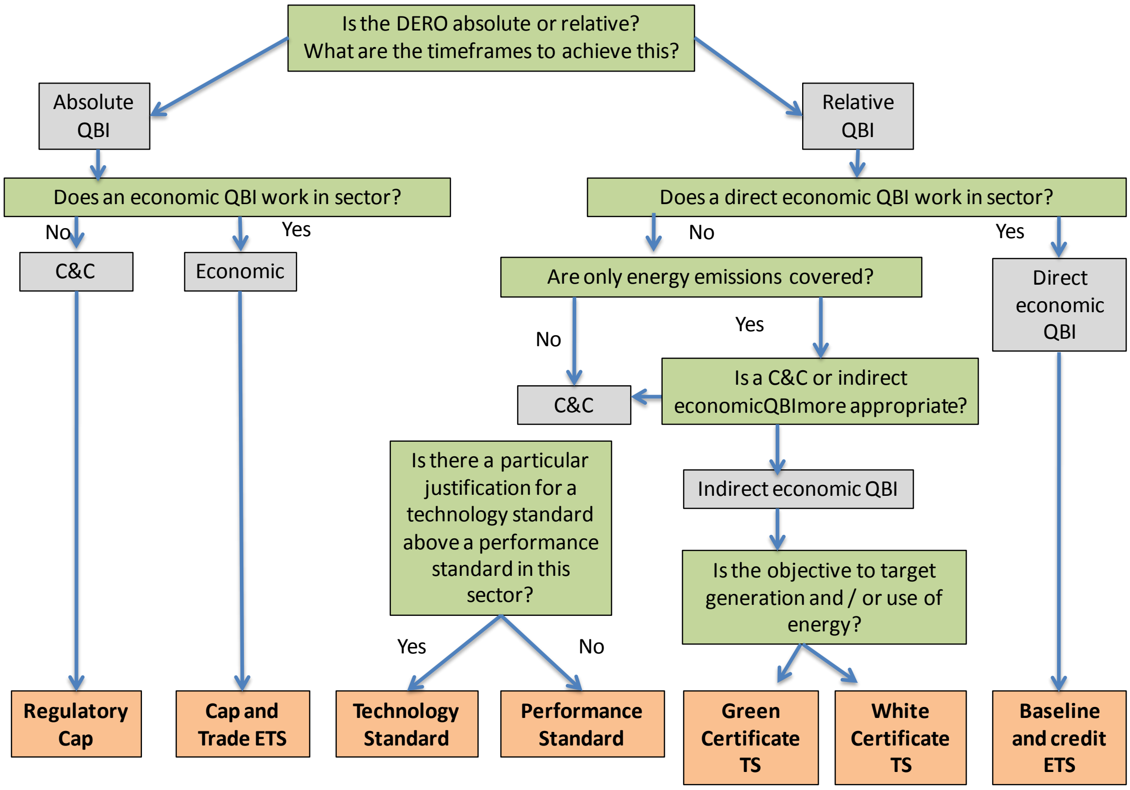
STEP 2: What QBIs could achieve DERO at acceptable effectiveness-efficiency trade-off?

STEP 2 only applies to sectors where the basic carbon tax will not enable the DERO to be reached. In this case, further analysis is required to ascertain what possible QBIs to utilise in the sector.[59] Given their efficiency and flexibility benefits, economic instruments are always preferable to command and control instruments, unless there is a reason why the economic instrument will not work in a sector. Whether a QBI is relative or absolute will be determined by the nature of the DERO it is implementing. As with the analysis of the impact of the carbon tax in STEP 1, a high degree of expert sector knowledge will be required to determine whether QBIs will be effective in cost-effectively guiding a sector towards its DERO. Information is required not only relates to the cost and availability of mitigation options, but also to how QBIs are likely to impact decision-making. Information relating to the latter would include market structure and dynamics, regulatory structure (not just in theory, but how it impacts day-to-day decisions), ability to pass on carbon costs etc.

In the electricity sector, for instance, increasing the level of the carbon price signal passed on to consumers may incentivise additional energy efficiency activities which in turn reduce the demand for electricity (at least in the short term before rebound effects can erode electricity savings). In South African, however, the electricity price has risen steeply since 2007.In period from 2007 to 2012 average Eskom tariffs have more than tripled (Eskom, 2012). If tariff increases Eskom has applied for under the MYPD3 in October 2012 is granted, electricity tariffs will double again by 2015. Cumulatively this would mean average electricity tariffs increased six-fold in nominal terms from 2007 to 2017. The elasticity of demand to the electricity price in South Africa is not clear, but economic theory predicts that the price elasticity of demand will increase as the price of a good increases (WWF, 2011).There has been a significant increase in energy efficiency in industry (Cloete et al, 2011) since 2008, and it appears that further efficiency increases may be increasingly expensive (potentially prohibitively so in some industries) (DNA, 2011; The Green House, 2012; Stakeholder Engagement, 2012).Efficiency options in the commercial and residential sectors are largely being targeted by building standards (insulation requirements and the use of solar for water heating), but it appears that the majority of residential customers at least have few efficiency options left (NERSA, 2011). While an increase in the carbon price signal could thus lead to further increase in energy efficiency activities, this seems likely to be an expensive way of reducing emissions, and it is debatable whether the resulting reduction in emissions will be achieved at a tolerable environmental effectiveness-economic efficiency trade off.

[59] Should a DERO not be met because regulatory, institutional or other barriers prevent the broad-based carbon tax from incentivising the appropriate mitigation response in producers and consumers, it would be prudent to first consider whether these barriers can be removed before the decision is taken to add more instruments (QBIs) to the policy mix.

Diagram 3: Step 2: Decision tree for identifying appropriate sector level QBIs



Source: Project team

The decision tree above illustrates how possible QBIs could be identified at a sector level. If an absolute QBI is required, then the decision is very simple. If a cap and trade ETS will not work in a sector, then the only alternative is to use a regulatory cap. There is more complexity if a relative QBI is required. If a baseline-and-credit trading scheme can work, then this is the most flexible instrument available. However, if direct emissions trading is not appropriate to the sector, and if the emissions under question are energy emissions, there are two further economic emissions mitigation instruments which indirectly target GHG emissions mitigation; white certificate trading (which directly targets energy efficiency) and green certificate trading (which directly targets renewable energy) which should be considered. In the South African situation where energy is predominantly derived from fossil fuels, and there is very little existing renewable energy capacity, these indirect instruments have sufficiently similar effects to direct mitigation instruments to include them in the analysis.[60] If neither of these are appropriate, or if the emissions covered by the QBI are not energy emissions, then the remaining options are command and control instruments, either a performance standard or a technology

[60] A more detailed discussion of the implications of using indirect mitigation instruments is outside the scope of this study.

standard. In that a performance standard is inherently more flexible than a technology standard, this should always be the preferred choice of the two.

The analysis may result in more than one QBI being identified as appropriate for the sector. This is advantageous, as will be seen in the next Step (3). The QBIs identified, however, need to adhere to the principles of good policy-making.[61] They thus need to be evaluated against the criteria outlined in Section 7 QBIs that are not considered feasible on the basis of the evaluation criteria will obviously not remain in contention for inclusion in an interface. Of particular importance will be the analysing the trade-off between the increased emissions reductions and the cost of achieving these additional reductions (i.e. the trade-off between environmental effectiveness and economic efficiency). In some cases the cost of implementing a QBI may simply be prohibitive and the level of the DERO may have to be reconsidered.

Alternatively, the choice of framework option in Step 3 can be used to reduce the expected cost of the QBI. Any framework option that caps the possible cost of the QBI (as measured by the carbon price signal), will however reduce the probability that the DERO will be met. Provided that the chance of meeting the DERO is increased relative to the carbon tax only scenario, this may still be more attractive to policymakers than not implementing a QBI and accepting that the DERO is unlikely to be met in the current period.

STEP 3: Consider each QBI within the 3 framework options against assessment criteria

Step 3 involves considering each possible QBI identified in Step 2 within the theoretical frameworks for combining a carbon tax and QBIs identified in Section 9.3. Note that under the ‘carve-out’ framework, a QBI can stand alone in the sector, i.e. without the carbon tax. The nature of the DERO for the sector is again relevant here. If the DERO is absolute, with a short to medium term timeframe, then a hybrid framework will not be appropriate. Only a layered or carve-out framework can deliver an absolute level of emissions reduction in the short to medium term. Existing mitigation instruments in the sector within all spheres of government must also be considered at this point, to identify any possibly perverse outcomes when combined with a QBI.

Each possible QBI embedded in a possible framework then presents an option for the mitigation policy instrument approach in that sector. Each of these must then be assessed and compared as to how they achieve their objective. Assessing the instruments and the frameworks together is important as the choice of framework may change the characteristics of the interface.

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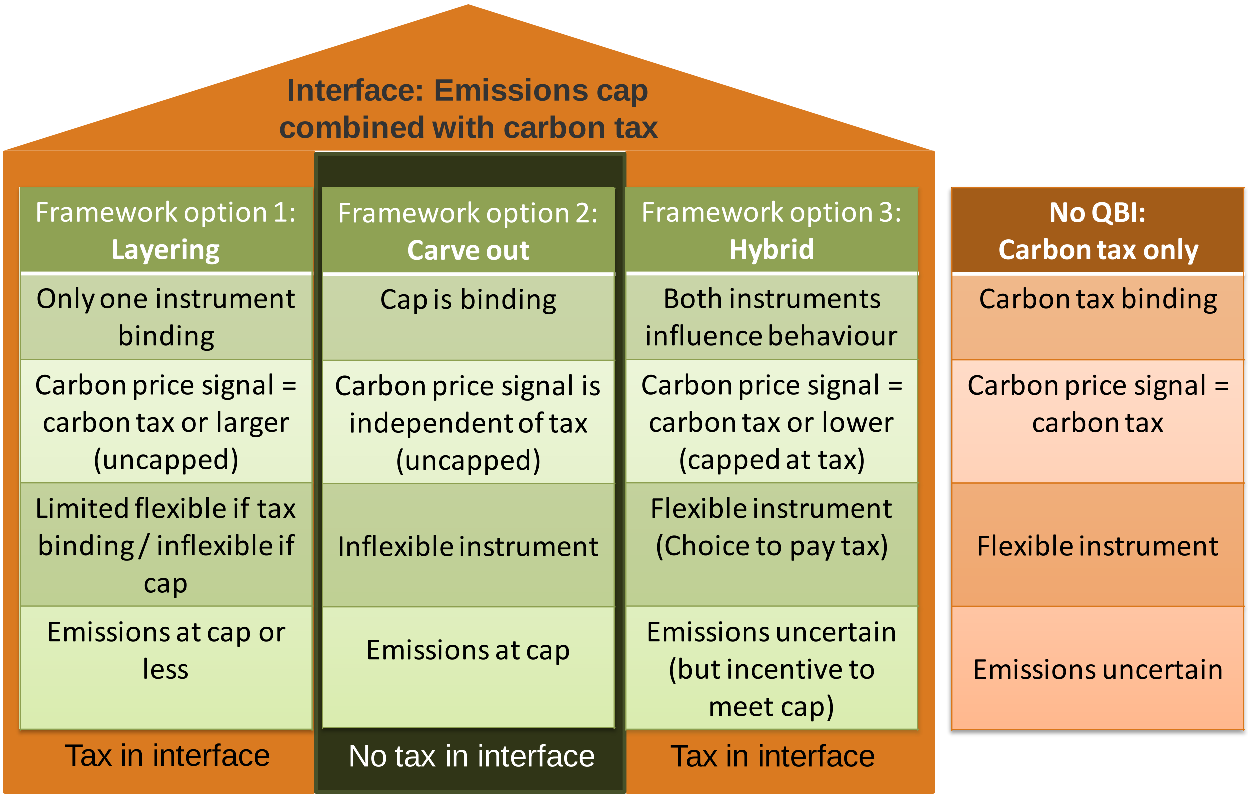
[61] Considering the possibility that QBIs can lead to unforeseen impacts such as exacerbating existing (or creating new) market failures, like for instance allowing firms to pass on more cost than justified by the carbon tax (or carbon price signal created by QBIs) as a result of asymmetric information concerning the cost impact of policies, would thus need to be included in the analysis in Step 2.

Figure 7: Impact of framework choice on characteristics of interface



Source: Project team

The figure above illustrates the impact of the framework used to combine instruments on the characteristics of the resulting interface. The characteristics of an interface that combines an emissions cap and a carbon tax differs depending on what framework is used. Depending on the framework chosen, the carbon price signal can be smaller, equal or larger than that of the carbon tax implemented in isolation. Also, the carbon price signal (and thus the mitigation effort implied by the interface) can either be capped at the carbon tax or uncapped (i.e. as large as required to meet the regulatory emissions cap.

Two more examples of how instrument and context together will determine the choice of interface within a South African context are the possible use of green certificate trading or performance standards in the electricity sector.[62]

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[62] These are indicative examples only, whether these QBIs are justified based on the analysis in Step 2 has not been considered.

Renewable energy, no matter how successful the green certificate scheme, is likely to only make up a relatively small proportion of local electricity supply in certainly the short and possibly the medium term. A green certificate scheme is thus unlikely to be able to avoid the broad based carbon price from being fractured if the Electricity sector is excluded from the carbon tax base. A carve-out is thus not an attractive framework. Also, since it only covers one type of mitigation action (and an indirect one), the link between the carbon prices signal created by the carbon tax and a green certificate is probably too tenuous to support a hybrid instrument.[63] It is thus expected that layering would probably be the preferred framework of implementing green certificates simultaneously with a carbon tax.[64] Unless the DERO is defined in terms of a renewable energy quota (i.e. percentage renewable electricity generated in the country), however, it will not be a foregone conclusion that a green certificate scheme will be able to meet a DERO in the short term .In other words, an indirect QBI could only reliably implement a similarly ‘indirect’ DERO.[65]

Performance standards, like most regulatory instruments, are relatively inflexible and there is a risk that the cost of meeting the instrument goal can be significantly higher than anticipated if the assumptions on which the DERO were based turns out to be incorrect in practice. This risk is increased in South Africa, since there is currently uncertainty around future electricity demand, and the timing and structure of the build plan in the electricity sector. The timing of investment in low-carbon nuclear capacity, in particular, seems to have diverged from that envisaged in the IRP2010. In the local context, a framework which reduces the risk associated with inflexible regulatory instruments is thus attractive. A hybrid instrument, where no carbon tax is payable if the performance standard is met, and the full carbon tax on every unit of emissions is charged if the standard is not met, therefore looks appealing. Under a hybrid instrument the carbon price signal is capped at the carbon tax since the choice to pay the tax and ignore the performance standard is always available. There is however a strong incentive to try and meet the performance standard since success entails not having to pay the carbon tax on any remaining emissions. There is thus a stronger incentive to meet a DERO than in the absence of a QBI (where mitigation will only be undertaken up to the point where the marginal cost of mitigation equals the tax rate).However, the hybrid framework does not guarantee that a DERO will be met in the short-term since the option of only paying the tax still remains.

[63] Given the large pool of emissions on which a carbon tax would be payable if the RE targets underlying the green certificate scheme is not met, firms may be willing to massively overinvest in green certificates to avoid this outcome. While the cost of firms may be reduced in this way, the overall cost of mitigation to the economy could be significantly increased – undermining economic efficiency to beyond an acceptable environmental effectiveness-economic efficiency trade-off point.

[64] In addition to the issues mentioned above, electricity generators will pay and pass on the carbon tax, while consumers will be subjected to the renewable energy requirement underpinning the green certificate scheme. Carve Out and Hybrid out and hybrid schemes are not feasible without some form of rebate to consumer on their electricity purchases. Whether this is feasible or politically acceptable will need to be investigated before these interface options can be considered.

[65] Since the scheme would probably cover Eskom, IPPs supplying the national grid and IPPs providing electricity directly to customers bypassing the national grid, defining DEROs in terms of emissions reduction equivalent to the amount of emissions saved by a set amount of renewables displacing electricity consumed from the grid is probably not feasible.

For a hybrid system to effectively change the behaviour of a firm whose output is subjected to a regulated price, however, full pass-through of the tax must not be allowed. An interesting side-effect of implement a hybrid approach is that a carbon tax is no longer an unavoidable certainty. By implementing certain activities, firms can avoid having to pay a carbon tax. This may theoretically cause regulators to reconsider the automatic pass through of a carbon tax used in a hybrid interface. Whether or not this will be the case in practice, however, can only ascertained through consultation with the relevant regulator.

Since the main objective of the QBIs are to support the achievement of DEROs, it is proposed that the same criteria used to evaluate individual instruments used in Step 2 (namely: Environmental effectiveness, Economic efficiency, Encouragement of substitution, Impact on technology development, Administrative requirement, Information requirements, Distribution, Support for the mechanism, Competitiveness, Interaction with other policies, Fiscal affordability and Flexible) be applied to evaluate possible interface options. In practice the final criteria utilised, and individual weightings, will be determined by the stakeholders to the policy design process. Given that it is not only individual instruments that are evaluated, but the interaction of multiple instruments within a very particular sector context, the outcome of this assessment will be highly context-specific and will require an in-depth knowledge of the sector being analysed.

The assessment will result in a ranking of the possible QBI-framework options which is then Sector Outcome 3.

10.4.2 Phase B: Identifying national interface options

STEP 4: Identify and select national interface options

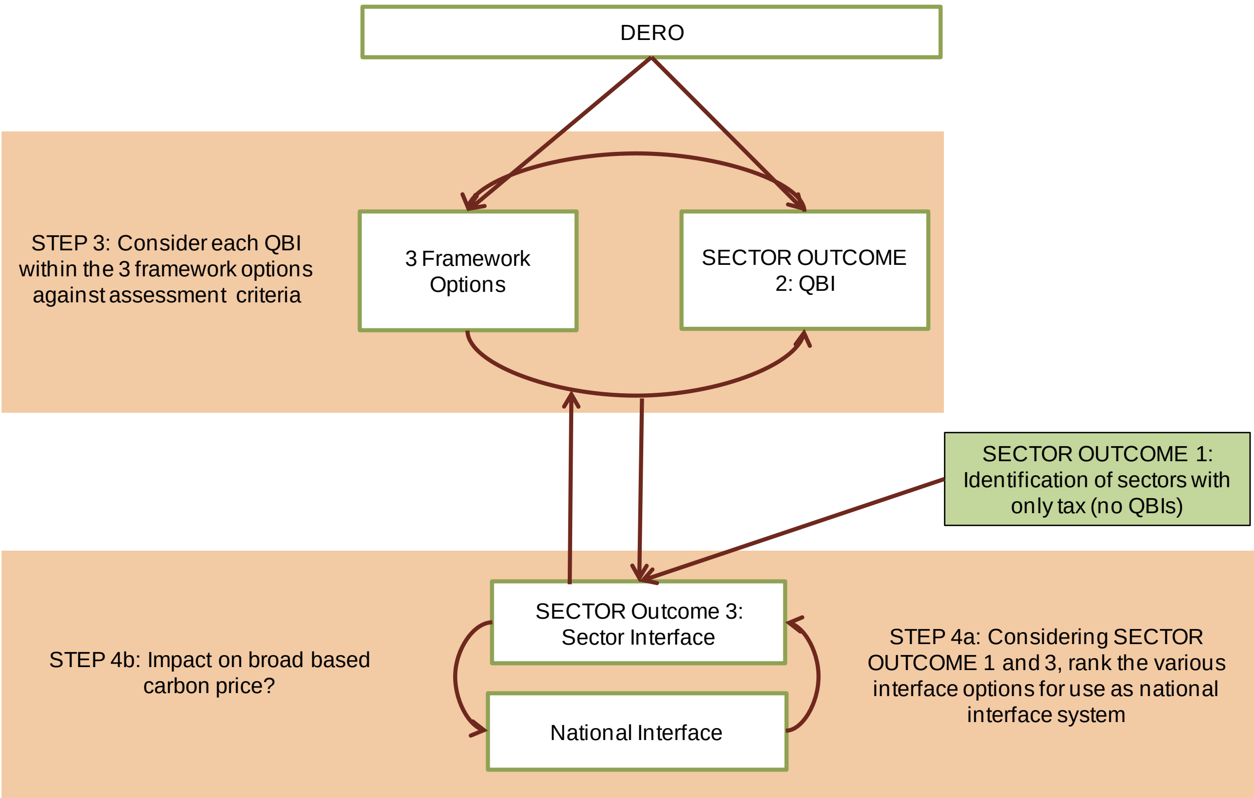
Once the sectoral interface options have been identified, it is necessary to consider the overall system of carbon tax-QBI interfaces. Sector Outcomes 1 and 3 from each sector provide the starting point of the national level analysis. Here, the combination of the top-ranking sectoral QBI-frameworks (Sector Outcome 3) are considered, in the context of the nature and number of sectors which are only taxed (Sector Outcome 1), for their impact on the functioning of a broad-based carbon price.

Whilst a particular ranking of carbon tax-QBI interfaces may emerge at an individual sectoral level, a different ranking may be appropriate for the economy as a whole. Overall, the benefits of the overall system (which may include a number of QBI-tax interfaces) need to be compared to the loss of economic efficiency inherent in the fracturing of the carbon price signal originating from the carbon tax. At this stage it may very well be necessary to limit the number of QBI interfaces (or at least the form they can take) to preserve the integrity of the broad-based carbon price created by the carbon tax. Either a modelling exercise or an expert workshop will probably be required to assess this issue.

At this stage it may also be necessary to consider more general impacts that the use of interface options may have on the functioning of the carbon tax system in South Africa. If significant revenue recycling is used to address the distributional impact of a carbon tax, or to support mitigation programmes, for instance, it may be problematic if the use of QBIs in tax-QBI interfaces leads to a significant reduction in carbon tax revenues. Whether this is a problem will depend on the type of QBIs used. A reduction in available funds to address the distributional impacts of mitigation policy will be particularly problematic if the QBIs used lead to similar or higher carbon price signals. In this event the prices of downstream goods would increase as much (or more) than would have been the case under only a carbon tax regime. But there may not be the same level of funds available to address the negative distributional impact materialising from higher consumer prices than would have been the case had a carbon tax been implemented in isolation.

In that this analysis may reveal problems and distortions to the underlying price which will change the sector level ranking of options, the analysis may need to return to Step 3.This accounts for the iterative nature of Steps 3 and 4 illustrated in the figure below.

Figure 8: Step 3 and 4: Identifying sectoral and national interface options



Source: Project Team

11 CONCLUSION AND RECOMMENDATIONS

The purpose of this study was '**to consider how QBIs can be combined with a carbon tax to support the effective and efficient achievement of DEROs'**.

Within the carbon budget approach of the White Paper, DEROs will indicate the optimal level of emissions reductions and will thus provide the mitigation policy goals, which are implemented by mitigation policy instruments. Since DEROs are as yet undefined, it is not yet possible to assess what the optimal policy instrument mix for South Africa would be.

The study has, however, shown that the simultaneous use of a carbon tax and QBIs to meet sector-level targets like DEROs is an intricate and complex exercise which should not be entered into lightly. This is for two main reasons.

Firstly, the extensive use of QBIs to meet sub-national emissions reduction goals is theoretically at odds with the use of a broad-based carbon price. Creating a higher shadow carbon price in some sectors through the use of QBIs can lead to additional mitigation, but the cost of mitigation might be increased by forcing firms in specific sectors to implement more expensive mitigation options than warranted by the carbon price signal, while potentially less expensive options in sectors subject to a lower carbon price signal are left unexploited. This trade-off between environmental effectiveness and economic efficiency becomes more severe as carbon price signals diverge, and the unchecked use of QBIs could eventually increase costs to a point where there is no longer a net benefit to having a broad-based carbon price in place.

Secondly, in developing an optimal interface between a carbon tax and QBIs, great care needs to be taken to avoid unintended interactions between instruments. This will require significant consultation and analysis. As is clear from the methodology shown above, this process significantly increases the information requirements needed to make the right policy decision, especially when compared to a broad-based carbon tax used in isolation (or simply applied on pre-existing instruments that target different outcomes).

This does, however, not mean that there can be no role for QBIs if a broad-based carbon tax is in place. When used selectively, sparingly and temporarily to tweak the carbon price, or to address other externalities to a carbon tax, QBIs can increase the efficiency and effectiveness of the overall mitigation policy suite. However, a policy approach that seeks to achieve sector level DEROs through QBIs in combination with a broad-based carbon tax will be complex to design and implement. Achieving an appropriate balance between national effectiveness and efficiency objectives will be difficult, costly and time consuming. Identifying and outlining the role of DEROs in the overall mitigation policy mix is critical to understanding whether this approach can be justified.

Should this approach be justified, the following guidelines are recommended to minimise the trade-off between environmental effectiveness and economic efficiency:

- **Ideally the instruments that are to be implemented jointly in an interface should be designed simultaneously** to ensure that unintended interactions are minimised and that the interface goals are internally consistent.
- In practice, however, it may not always be possible to design and implement the relevant instruments simultaneously as they may be at different stages of development for historical reasons. **If it is not possible to design instruments simultaneously, the characteristics of both instruments need to be considered when the interface is designed.** The instruments should be compatible and a suitable framework for combining the instruments should be chosen to form the interface. The target levels at which the instruments are implemented should be aligned to ensure that an efficient level of emissions (the sector DERO) is achieved. Furthermore, the impacts of any existing instruments that may affect mitigation or socioeconomic outcomes (levied at all levels of government (should be taken into consideration when designing the interface to ensure that the resulting interface is not overly stringent (or too lenient if instruments that counteract the goals of the interface are in place).
- **The number of QBIs used to meet DEROs must be kept at a minimum, and should be of a transitional nature** to avoid jeopardising the integrity of the broad-based carbon price over time.
- **The discrepancy in the carbon price signal (which includes both explicit and implicit/shadow carbon price) between sectors should be kept as small as possible** to allow DEROs to be met while reducing the economic inefficiency created by non-uniform carbon prices.
- **When evaluating interface options for inclusion in the overall mitigation policy framework the focus must fall on the functionality of the overall combined interface rather than the individual instruments that constitute the interfaces.** The reason for this is that interactions are often highly context specific and may differ based on the framework for combining instruments that is included in an interface option.

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13 APPENDIX A: STAKEHOLDERS ENGAGED

A number of stakeholders were engaged as part of the process to develop this report, not all of which provided input. Inputs were received from the following stakeholders:

- ArcelorMittal South Africa
- Business Unity South Africa[66]
- Department of Environmental Affairs
- Eskom
- Industry Task Team on Climate Change
- National Planning Commission
- National Treasury
- Sasol
- The Paper Manufacturers Association of South Africa
- World Wide Fund for Nature (South Africa)

14 APPENDIX B: INSIGHTS FROM STAKEHOLDER ENGAGEMENT

The following issues were raised during the stakeholder consultation process. The purpose of this appendix is to highlight stakeholder concerns and suggestions, the inclusion of content in this appendix in no way indicates that the project team supports the idea or even consider it feasible. The issues are presented in no particular order.

- Much of the value of carbon budgets as a policy tool stems from the fact they diverge from the standard approach of reducing emissions from a 'business as usual' baseline. Carbon budgets ask the fundamental question of how the available carbon space can be used most effectively to maximise socio-economic benefits to all the citizens of South Africa. By not taking the status quo as a given, carbon budgets allow for novel and creative mitigation approaches to be considered. It was felt by stakeholders that the narrow focus on instruments in the report missed this important benefit to including carbon budgets in the South African approach to mitigation policy.
- A number of sectors have detailed emissions monitoring and reporting systems in place that simplify the practical use of QBIs. A good example is the Forestry Industry Carbon Accounting Tool (FICAT) that is widely used in South Africa by the forestry, paper and pulp industries.

[66] Apart from the official BUSA response, verbal input was also provided by BUSA members at a workshop. Although these members are not explicitly listed above, the project team wish to thank them for their input.

- Even though a carbon tax may not immediately be effective in all sectors, it is important to consider the long-term perspective. The carbon tax will increase over time and new mitigation options will be developed. In the meantime, a carbon tax will generate revenue that can be used to fund projects to support transition to a green economy, or to counteract negative distributional impacts of mitigation policy.
- There are existing mitigation policies in the system (i.e. building standards and renewable energy portion or IRP), so it is no longer possible to have ‘only a carbon tax’ even if policy-makers wanted to. It is therefore important to consider all instruments that are in place (even if they don’t explicitly aim to reduce emissions) when designing interface to ensure that the burden on some sectors or firms are not disproportionately high.
- A carbon tax is a suitable instrument in South Africa, but it would be desirable to include more flexibility in the proposed design. The proposed use of offsets is supported. In addition some form of ‘banking’ to give firms credit for reducing their emissions to below the carbon tax threshold levels should be considered. An ETS in South Africa is not supported due to concentration in the electricity sector increasing the risk of windfall profits.
- Any instruments that increase the cost of carbon emissions to firms need to be implemented carefully, particularly if they do not include structured relief of the form proposed in the carbon tax. The reason for this is that firms vary in the amount of ‘value-add’ they gain per unit of GHG emissions, and also in their ability to pass these costs on to customers. QBIs in particular can be very costly if the assumptions regarding what mitigation options are available to firms turn out to be wrong. Also, the timing for implementing instruments should take into consideration the business cycle. Some industries are currently struggling to the extent that additional costs could threaten their viability.
- Given that the Peak Plateau and Decline (PPD) trajectory, intensity-based instruments are sufficient up to 2025. After this date a move to emissions that restrict absolute emissions will be required.
- The optimal use of carbon budgets would be as indicative tools to show whether or not sectors are reducing their emissions in line with what is required by PPD. Current and proposed instruments (like the carbon tax and energy efficiency subsidies) are sufficient to keep economy on the PPD trajectory. Carbon budgets should thus have a monitoring and verification role.
- The most significant mitigation actions of many firms relate to Scope 2 emissions. It is thus suggested that carbon budgets (or QBIs) include Scope 2 emissions.
- There is a concern that absolute QBIs will place a constraint on economic growth if new mitigation technologies and efficiency improvements do not materialise fast enough. Relative QBIs carry the risk of distorting production decisions when firms make more than a few products. This risk is evident when there are large discrepancies in the value added per output of products. Relative QBIs may reduce the value added on processes that generate smaller amounts of higher value products, and cause firms to produce lower value products that generate larger volumes of output. This risk is also prevalent in the z-factor adjustments included in the current carbon tax design.

- The inflexible nature of many QBIs increase the risk that mitigation cost may become very large if some options do not materialise when expected. In particular, looking only at the marginal cost of mitigation options will give a misleading picture of the actual effort required since issues like the availability of capital to implement options are not taken into consideration. Because of the complexity of determining mitigation potential, DEROs may not be set realistically. If this is the case, mitigation costs may be excessively high.
- For the reasons mentioned in bullet point above, it is important that systems are put in place to generate the information required to design effective mitigation policies (including the use of QBIs).
- Important to highlight the fact that the use of QBIs do not imply no cost to firms. Costs will be incurred to implement mitigation issues. Because these costs are less transparent than that of a carbon tax, they are problematic from a cost pass-through perspective. Possible that either too little (if customers don't believe disclosed cost information) or too much (windfall profits) costs may be passed on.
- Any interface between QBIs and a carbon tax would need to be designed very carefully to avoid the QBIs undermining the carbon price.
- QBIs aimed at incentivising energy efficiency are unlikely to be effective as the sharp increase in electricity prices have already caused large energy users to implement most of their energy efficiency options. Smaller energy users may still have options left, but impact on emissions will be limited because their indirect emissions are relatively low.
- There are likely to be opportunities for efficiency gains left in use of transportation fuel, but the carbon tax on its own is unlikely to lead to a sufficiently large increase in price to change behaviour. There may be role for QBIs here.
- It is important that QBIs focus on changing behaviour. If this is not the case, they won't add much to mitigation policy.
- Mitigation policy, including the use of QBIs, need to be designed for the long term and should not focus disproportionately on the current situation. The electricity sector is a case in point. Eskom currently provides 96% of electricity generated in South Africa, but this number is expected to fall as the market is deregulated and IPPs play a larger role in electricity generation.

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