Final Report
Phase One of Florida Cap-and-Trade Project: Economic Analysis

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This paper is a first step in Florida Department of Environmental Protection's planning for a state cap-and-trade program for greenhouse gases (GHGs) to fulfill their assigned task under Section 403 of the Florida Climate Protection Act. The document begins by discussing the rationale for reducing GHG emissions and the general strengths and weaknesses of a cap-and-trade approach. It then moves to an overview of the central issue of how such an approach could work for a single state, and of how such a program could be linked to other state and regional programs.

The document then lays out the essential elements of cap-and-trade design – the details wherein lurks the devil – and explores each issue. The analysis results in the identification of areas for formal modeling and further investigation.

Controlling and Reducing GHG Emissions

The fundamental driver for public policies that reduce GHGs is the scientific consensus about climate change, which has both strengthened and broadened consistently over the past two decades. While there remains substantial uncertainty about many aspects of the relationship between human activities and unprecedented effects on climatic systems, this consensus[1] overwhelmingly finds that:

- the Earth's climate has already changed discontinuously beyond normal historical bounds;
- these changes will become significantly greater over time;

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[1] An excellent general reference is the *IPCC Fourth Assessment Report on the Physical Basis of Climate Change – Summary for Policymakers* available at http://www.ipcc.ch/. Another source, the *Stern Review*, provides a readable and comprehensive, although somewhat controversial, reference on economics and policy. http://www.hmtreasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm

- a major part of observed and predicted changes comes from human activities that have increased the concentration of greenhouse gasses (GHGs) in the atmosphere; and,
- the effects of predicated changes in the earth's climate will have serious and negative environmental and economic consequences.

This scientific consensus has in turn driven a strong normative finding by both social and natural scientists that the prudent course of action is to reduce the level of GHG emissions with the aim of stabilizing GHG concentrations. This central idea has been widely endorsed by political leadership around the world. The actions needed to actually bring about significant reductions in GHGs are politically difficult and have economic costs. Industrialized countries are in various stages of planning and implementing policies to enact legislation with the purpose of reducing GHGs.

Legislation to control GHGs through a cap-and-trade system was first introduced in the United States Senate in 2001, and the subsequent number of bills and interest increased significantly. President Obama has consistently supported a cap-and-trade policy before and since his election, but there remains uncertainty about the prospects for passage and the details of what successful legislation might look like.

In the meantime the states have taken the lead. The only functioning cap-and-trade system for carbon dioxide (CO2) is the Regional Greenhouse Gas Initiative (RGGI), comprising ten states in New England and the mid-Atlantic. California is part of the planning for two cap-and-trade systems – one a self-contained program for the state, and another as part of the Western Climate Initiative (WCI), a group of eleven western states and Canadian provinces. Neither of these programs has set definitive policy details or a binding start date. A proposed cap-and-trade program for a subset of Midwestern states as part of the Midwest Regional Greenhouse Gas Reduction Accord is in an even earlier stage or development.

Why Cap-and-Trade

Cap-and-trade policies can be understood as working in three steps:[2]

1) An overall cap on emissions is defined for a set of entities. In a cap-and-trade program for GHGs, the cap will most likely be defined in terms of CO2 equivalents.[3] The set of entities could be as limited as those in the electric generation sector, or as broad as all fossil fuel users plus major emitters of other GHGs like methane. For Florida's planning, the essential choices will be:

    a. Whether to restrict the system to electric generation or to also cover large industrial sources; and,

    b. Whether to base emissions limits on the electricity *generated* in Florida or on the electricity *used* in Florida.[4]

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2 There are many permutations and complications in these three steps, the most important of which for utilities are explained below. For a straightforward but more detailed explanation of the mechanics of cap-and-trade, see pages 1-3 of Ellerman and Joskow (2003), Emissions Trading in the U.S.: Experience, Lessons and Considerations for Greenhouse Gases, available at http://www.pewclimate.org/docUploads/emissions_trading.pdf

3 Global warming potentials (GWPs) are used to compare the abilities of different greenhouse gases to trap heat in the atmosphere. Methane, for example, has a GWP over a hundred years of 23, meaning that one ton has the same effect as 23 tons of CO2. A good overview of the methodology and full listing of GWPs can be found at http://www.eia.doe.gov/oiaf/1605/gwp.html.

4 CO2 accounts for almost all of the direct GHG emissions of the electric industry. In this report we will use the terms CO2 and GHG interchangeably in referring to electric industry emissions and to allowances.

2) The right to emit the quantity of emissions defined by the cap is translated into emissions allowances. The unit of trade for allowances in a GHG cap-and-trade is likely to be one metric ton of CO_2. Depending on choices in program design, the responsible government agency allocates allowances to specified entities at no cost, sells the allowances to the affected entities or to other parties, or does a combination of allocation and sales. All GHGs emitted by the entities in the program must be accompanied by the surrender of an equal amount of allowances.

3) The allowances can be exchanged among any parties at any price mutually agreeable to buyers and sellers.

A cap-and-trade policy combines the certainty of a quantitative limit with the flexibility and economic efficiency of market decision-making. This basic design has worked well for sulfur dioxide and nitrogen oxide regulation in the United States, and has been central to quantity controls systems for CO_2 under the Kyoto Protocol, the European Union as a whole, and planned or implemented systems in the UK, Canada, New Zealand, and Australia.

A key metric used to discuss GHG limitation policies, both for cap-and-trade and tax policies, is the "carbon price". In the context of a cap-and-trade system, the carbon price is the same as the allowance price – the value of the right to emit one metric ton of GHGs, expressed in terms of $ per metric ton of CO_2 equivalent. All else being equal, more stringent caps mean higher carbon prices because they translate directly into an overall lower supply of CO_2 allowances. The higher the carbon price, the higher the cost of generating electricity from sources that emit GHGs.

The Elephant in the Room

There is an elephant in the room as Florida studies and makes decisions about a state cap-and-trade program for GHGs. That elephant is the likelihood of a national economy-wide program that will cover the same entities as the state's program as a small part of its overall reach. There are substantial advantages in a federal program over state programs, linked or otherwise. These include the feasibility of all-sector coverage, vastly reduced leakage problems, overall economic efficiency, and far lower administrative and transactions costs than separate systems.

Florida is to be commended for its commitment to GHG reduction and its efforts to be forward looking and data-driven in understanding its options. The state should be aware that a significant train of thought among policy scholars and practitioners – including the author of this report – is that pricing carbon is a task best accomplished by the federal government, whether through a cap-and-trade or a carbon tax policy. If such a system were to be enacted, Florida could achieve more by leaving carbon pricing to the US government and devoting its administrative resources to energy efficiency programs, improved transmission investments, technology demonstration programs, and the other policies which perform the nuts and bolts work of reducing the GHG intensity of economic activity.

Design Issues for Florida

This paper now turns to the essential issues in designing a cap-and-trade system for Florida. The effect of policy components must be understood in the context of the whole system; the elements discussed below affect each other in setting the conditions faced by emitters. For example, measures to contain costs have a very different effect with a large emissions cap than they do with a very stringent one.

Setting the Cap

Florida will have to set a quantitative limit on the number of tons of GHGs for which allowances will be issued. Most approaches to setting this cap have set it in reference to historical GHG emissions quantity. The Kyoto Protocol's system, for example, used 1990 as a base year and set emissions limits at given percentages below that year's emissions. RGGI, the closest existing model for Florida's planning, set its limits relative to 2009 levels. The choice of a reference year and a reduction level is arbitrary – what matters for the program is the number of allowances issued.

The Governor's climate change goals call for a reduction to year 2000 emissions levels by 2017 and a further reduction to 1990 levels by 2025. This provides a rough target, but does not settle the question of the targets for a cap-and-trade program for electric utilities. Such targets could serve as one of the means toward reaching the stated goals if they were more stringent, exactly proportional, or less stringent than the history-based targets. Realistically, the Governor's targets set an important aspirational goal but are highly unlikely to be achieved given the difficulty of achieving reductions in the transportation sector.

If a cap-and-trade program covers only the electricity sector, then an explicit decision will have to be made of what share of the Governor's reduction goal should come from that sector. One option is to make the reduction proportional – the electricity sector should reduce its emissions by the same percentage as the entire economy. While straightforward, this is unlikely to be efficient because different sectors – electricity, transportation, industrial emitters, etc. – face different costs, technological challenges, and behavior patterns. Another option is to try to establish separate 2000 and 1990 baselines for each sector and base reduction goals from those separate baselines. The point is that a number of electricity sector caps could be consistent with the Governor's economy-wide goals.

Planning and investment efficiency require that caps be set and known well in advance of the year in which they are effective. This means that Florida will need to set not just a single-year cap but also a trajectory. RGGI, for example, aims for a 10% reduction below 2009 levels by 2018, with 2.5% per year reductions in the cap from 2015 to 2018. If Florida were to adopt the 2017 and 2025 targets based on utility-sector baselines, then specific caps for all the other years would still need to be established.

Florida will also have to determine which GHGs will be covered by the system. CO2 is the most important GHG overall and from the electricity sector, will certainly be the focus of any system. Electric utilities emit small amounts of NO as well, and the state will have to decide whether tracking this emission is worth the added complexity. Since generation facilities already possess continuous emissions monitors (CEMs), the additional measurement complexity for this sector is not a significant impediment to the system. While utilities are not significant direct emitters of methane, underground coal mining does cause methane emissions. The complexity and administrative difficulty of trying to include these emissions in a state based cap-and-trade are daunting and Florida should be very cautious about which pollutants to include in a cap-and-trade system.

Considerations for Setting the Cap

The fundamental decision is what cap to set for each year of the program. The supporting analysis most useful is modeling of the price, cost, and broader economic implications of alternatives. The results will depend synergistically on the interplay of the cap with other fundamental policy choices – e.g. offset rules, links to other programs, and cost containment mechanisms.

Administration of the System

Point of administration is the choice of exactly which entities are required to hold allowances equal to their GHG emissions, and will be held liable if their emissions exceed their allowance holdings. Florida faces relatively straightforward choices here – the feasible options are more limited than in a nationwide or economy-wide system.

The most straightforward way to do this is to administer the system at the level of individual generation units. GHG emissions are tracked with CEMs using a system based heavily on the existing system of air quality reporting for sulfur dioxide and nitrogen oxides. This system will work well for the electricity sector, and will also be effective for large industrial sources in the state that have CEMs if the cap-and-trade system is to cover them as well.

An emissions source-based system cannot function well for transportation, home use of natural gas, and other dispersed sources. The expense and difficulty of monitoring emissions is just too great. These sectors are best covered through an *upstream* system – one that requires those selling fossil fuels into the economy to hold allowances to cover the GHG content of those fuels. While practical and effective at a national level, such a system would be exceedingly difficult to implement at the state level given the complexity of interstate commerce in petroleum and natural gas. For example, Florida would need to track and collect allowances for bottled gas deliveries into Florida from Georgia and Alabama, and similarly track all tanker trucks based outside the state that service gasoline stations.

If Florida were to elect to base its system on the electricity *used* rather than the electricity *generated* in the state, then an emissions source-base system becomes more difficult. Florida would have to regulate entities in other states that sell electricity into the state. In theory this could be dealt with in two ways. One is to add an additional regulatory structure for electricity imports where the first seller of electricity into the state has to hold permits for the GHG emissions of that generation. The second is to administer the system at the level of Load-Serving Entities (LSEs). Each LSE would have to hold allowances for the emissions in all of the electricity they deliver to customers through Local Distribution Companies (LDCs).

Both of these systems suffer from the same problem: the difficulty of attributing emissions quantities to electricity imported into the state. This is a significant methodological problem – identifying the source and emissions associated with a particular set of electrons is exceedingly difficult.

Considerations for System Administration

The basic decision is how to administer the system. This decision cannot be made independently of whether to base a Florida system on electricity generation or electricity use. If the program will cover electricity use, then administration could sensibly take place at the LSE level, or could be at the generation level with separate set of administrative structures to handle imports and exports. An analysis of the coverage of Florida generation by CEMs that do or could easily report CO2 emissions would be helpful. A study of current electricity imports, the market structure of the exporting areas, and the potential for expanded imports under carbon-constrained scenarios would be helpful in Florida's decision between a use- and a generation-based cap.

Allocating or Auctioning Allowances

Allocating allowances is the single most contentious issue in designing a cap-and-trade system for GHGs. This is because allowances have monetary value in a market and can be easily converted to cash (albeit at a price whose exact level in not known *ex ante).* If Florida designs a cap-and-trade system that is limited to the electricity sector and bases the system on in-state generation (as opposed to use) then its choices are relatively easy and not vital. This is because the investor-owned utilities within Florida's electricity sector have their rates set by the Public Service Commission (PSC) through embedded cost regulation. This gives the PSC the ability to determine how the value of allowances is used in setting rates and funding energy efficiency programs. If Florida were a wholesale competition state then the issue would be far more difficult.

We discuss central issues based on the above assumptions. We then discuss allocation to out-of-state generators and industrial sources that might be included in Florida's system.

There are three important decisions to be made in allowance allocation, and it is essential to understand that they are distinct issues. The first issue is who actually receives the allowances. The second issue – and one that is more important than the first – is how the allowance value is used. The third issue is –*if allowances or* *revenues are to be allocated based on historical patterns of energy use* – what specific formula is used to make that allocation?

Auction vs. Free Allocation

Allowances could be given to generation units, LSEs, or LDCs. Given that Florida is a traditionally regulated state, this choice should not significantly impact the overall efficiency of the system or matter for changes in generation owner profits. If any share of allowances were to be allocated to cover out-of-state emissions from imported electricity, then a LSE or LDC would have to receive those allowances – it would not be administratively feasible to regulate their use by an out-of-state entity.

It is vital to understand that allocation and administration are separable. The system could be administered at the generator level and allowances could go to LDCs, for example. Generators would have to purchase allowances to meet their obligation to cover their GHG emissions, and LDCs would receive revenue for selling their allowances.

Allowances could also be given to state and independent entities in order to provide revenue for specific public purposes. The recipients would sell the allowances in the market.

Allowances could also be sold by the government through an auction process or some other mechanism that allows a market price to be established. The revenues from this auction could be used in any way that the state decides (see next section). RGGI chose to auction allowances rather than allocate to the electricity sector. This is a strategy that is perfectly consistent with good public policy, but it is important to note that the context for the RGGI states is quite different than for Florida. Electricity rates in RGGI states are set through wholesale competition (organized markets), and so allocation to generation units would have resulted in windfall profits for generators. Florida rates are set through embedded cost regulation, and therefore the PSC has the authority to control allowance values that is absent in the RGGI states.[5]

It is entirely possible to allocate allowances through any combination of the above mechanisms – they could be given to electricity sector entities and other organizations and auctioned in any percentage designated by the state.

How to Use Revenue from Allowances

The revenue from the sale of auctioned allowances could be used for any purpose the state decides is appropriate. RGGI has auctioned allowances and states are using revenues for broadly defined "consumer benefits". These have mainly been investments in energy efficiency and conservation programs. In theory, Florida could choose to use auction revenues for any purpose at all – investments in alternative energy, adaptation to climate change, or programs that have nothing to do with climate change. Revenues could also be simply treated as general revenues in Florida's state budgeting process.

Similarly, allowances allocated to agencies and NGOs would be spent under terms directed by the state. There are significant pitfalls to going this route – revenue is fungible, and Florida would have to exercise careful design, oversight, and evaluation to ensure that funds were spent efficiently, transparently, and in accord with its wishes. From a technical standpoint, there is little to recommend this course of

[5] For a fuller discussion of this issue, see *Keeler, NRRI*

action relative to auctioning allowances and allocating through the state budget process.

Revenues could be used to limit the price increases faced by ratepayers for electricity. This could be done if allowances are auctioned – the state could transfer money to LDCs under PSC regulation and apply those funds to reduce the revenue requirement. However, it is likely that Florida would allocate allowances to entities under PSC regulation - rather than auction them and transfer funds - if the state were to determine that some share of allowances should be used for this purpose.

Allocations could be made to generation owners or LDCs – entities under the regulatory authority of the PSC – and the revenues could be used as directed by the PSC. The most likely uses for these funds are for two purposes: limiting rate increases by applying allowance value to the revenue requirement, or investing in energy efficiency and conservation programs.

The state should directly consider the equity implications of the way it chooses to use allowance value in a cap-and-trade system. A cap-and-trade system functions as an effective tax on fossil energy, and energy taxes are regressive: they represent a larger share of income for lower-income citizens than those with higher incomes. There are three basic strategies that can provide solutions to this problem.

1. Use the allowance value to limit rate increases as much as possible. Generation units will still incur costs to meet GHG limits that will raise rates, but ratepayers will pay only these additional costs and not the full marginal cost of generation including GHG allowances.

This strategy has the advantage of being popular with ratepayers. It also serves to limit leakage by reducing the differential in electricity rates relative to other states that do not have GHG limits.

It has two significant disadvantages. The first is related to efficiency – by not passing through the full marginal cost of generation (including allowances) to end-users, it weakens the price signal for consumers to change behavior and invest in new technology to reduce their energy use. There is considerable debate about the magnitude of conservation that will be induced by a given rate increase, but there is widespread agreement that there is some definite and measurable effect. The second relates to equity – across-the-board rate reductions may reduce the impact of the program on low-income ratepayers, but they reduce the impact even more on wealthier ratepayers with higher electricity consumption.

2. A second strategy is to target allowance value use specifically to low-income consumers. In a national cap-and-trade program this could be done by earmarking revenues for an expansion of the earned income tax credit program. Florida might wish to explore using its tax system for a similar purpose, but it would entail substantial complexity. The other option is to use allowance value in a way targeted to low-income consumers and disadvantaged industries through either specific lower electricity rates or by funding targeted conservation and efficiency programs. An example of aid to low-income residents is weatherization and subsidized energy efficient appliances for those meeting an income screen. An example of aid to

industries is special rates or technology subsidies in economic sectors that face significant competitive disadvantages from the rate increases caused by the state's cap-and-trade system.

3. A third strategy is to rebate all or some of the revenues raised through allowance auctions to every taxpayer in the state. British Columbia rebates the revenue raised by its (relatively small) carbon tax in equal shares to all taxpayers. There are two advantages to this strategy. First, it improves the equity of the system – lower-income taxpayers receive the same amount of rebate as wealthier ones, even though they paid less into the system because of their lower energy use.[6]

   Second, there is a potential advantage in gaining political support for the system – many citizens prefer to have direct access to revenue rather than additional government spending, and people like to get checks in the mail.

   Relative to reducing rates, rebates do not distort conservation incentives and thus achieve a better balance of supply-side and demand-side GHG reduction than does a policy of applying allowance value to the revenue requirement. This means that the overall economic costs of the cap-and-trade program will tend to be lower with rebates than with using allowance value to reduce the revenue requirement.

How to Allocate Free Allowances: Emissions or Generation

If some share of allowances is allocated at no cost to the electricity sector, there will have to be a decision made about how to

[6] It will be the regulated entities – generation units or LSEs/LDCs – that actually pay the money for the allowances. However, under Florida's system of embedded cost ratemaking these costs will be passed along to ratepayers, who will bear the actual burden.

apportion those allowances among the generation units (or LSEs / LDCs) that receive them. There are two options that receive the most attention in allocating based on historical patterns: allocation based on emissions, and allocation based on generation. The choice is mostly one of equity; there is little difference in efficiency.

Table 1 demonstrates how allocation rules affect different fuel types. If allowances are allocated on the basis of emissions, coal generation is favored (and its end users are favored to the extent allowance value is applied to the revenue requirement). Petroleum does less well, and gas worse still. Nuclear customers receive no benefit from this allocation scheme.

If allowances are allocated based on generation, then consumers of nuclear energy do best: the costs of generation do not rise and they receive a substantial share of allowance value. Coal is the most disadvantaged source.

If nuclear (and the very small amount of hydropower) generation in Florida were to be excluded from no-cost allocations, then gas would be the most advantaged and coal would remain the most disadvantages, but all fossil generation would fare better than when nuclear is included.

Table 1. Illustrative Percentages of Electric Industry Allowance Allocation by Fuel Type: Emissions vs. Generation as a Basis for Allocation.

Fuel Source	Allocation by CO2 Emissions (2006)	Allocation by Generation Quantity (2007)	Allocation by Generation Quantity (excluding nuclear and hydro) 2007
Coal	51%	39%	46%
Oil	17%	15%	18%
Gas	32%	31%	36%
Nuclear	0%	16%	0%
Hydro	0%	0%	0%

Sources: generation data for 2007 from Table 1, Statistics of the Florida Electric Utility Industry 2007, Florida Public Service Commission, September 2008. Emissions data are estimates for 2006 from US Energy Information Administration, State Historical Tables for 2006, available at http://www.eia.doe.gov

Historical Allocation vs. Updating

A second issue for no-cost allocation to the electric sector is whether allocations should remain based on a single base year, or whether they should be annually "updated" to reflect the performance of different generating units and changing composition of the industry. Updating is generally suggested for allocations based on generation; units that produce more electricity (with system GHGs now covered by the GHG cap) are rewarded with a larger share of allowances. Critics find that updating functions as an implicit subsidy to generation, resulting in overinvestment in generation capital and inefficiently low reliance on price-induced conservation and efficiency.

Allocation over Time

There are two issues that Florida needs to recognize relating to allowance allocation in a dynamic context. The first is that GHG cap-and-trade programs are fundamentally designed to bring about a reduction in GHG emissions over time, and are therefore designed with a cap that shrinks over time to achieve that goal. Whatever allowances there are to be allocated to the electricity sector, or to be allocated generally, will have to shrink each year and allocation formulas will have to reflect this fact.

The second issue is whether to continue using allowance value to reduce the revenue requirement in perpetuity. The argument that rate relief is needed in the short-run to ease consumer burdens during a time of adjustment is consistent with a transition away from such uses and toward using allowance value for the other public purposes – for example, as a source of general revenue or for funding energy efficiency programs.

Allocation, Rates, and Efficiency: Empirical Examples

This section has two purposes. First, we show how different choices about allowance allocation and use of allowance value affect electricity rates, total resource use, and the state's fiscal position. In doing so, we pay particular attention to how different fuel sources fare under alternative policy choices. This provides a concrete demonstration of the factors discussed in the previous section.

Second, we provide a basis for discussion on how to focus future modeling effort. Section 403 of the Florida Climate Protection Act calls for explicit answers to questions about economic effects. Performing this modeling in a short timeframe will require some explicit strategic choices. The analysis presented here holds constant or makes simplifying assumptions about market equilibrium, offset allowances and other off-generation sources of increased allowance supply, and movement of generation across existing divisions (e.g. from vertically-integrated utilities to coal generation owned by public power companies). Decisions about how to handle these parameters based on actual generation data and projected generation scenarios will need to be addressed more explicitly in the next phase of this project.

Example 1: Allowance Allocation and Use of Allowance Value: Simple Illustration

This section uses an example to illustrate two essential related points in program design. The first is that alternate allocation / auction decisions can achieve the same results in regulated electricity markets if they are designed to do so. The second point is that it is how allowance value is used that is critical, not simply who receives the allowances or revenue.

Our example is based on a generator that produces 100 MWh of electricity at a cost of $12,000 and emitting 80 t of CO2. We assume that the generator continues the exact same operations after a cap-and-trade is introduced[7], and will therefore need a total of 80 one-ton allowances. We further assume that the GHG reduction embodied by the cap is associated with an allocation of 70 t for this quantity of generation.[8]

We examine five alternatives for allowance allocation: 1)auctions, 2) allocation to the generator, 3) allocation to the LDC (the entity which delivers electricity to end-users and collects revenue to pay for that electricity under PSC regulation), 4) 50% auction, 50% allocation to generators, and 5) 50% auction, 50% allocation to LDCs. Table 2 (Page 51) shows the situation where the policy directs that all allowance value be used to reduce the burden on the policy of ratepayers.

Column 1 shows what happens when allowances are auctioned. The generator must spend $800 for the allowances to cover its emissions. It received $12,800 from the LDC for this power. The LDC

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[7] We assume that the system is administered at the level of generation – generators must surrender allowances for each ton of CO2 they emit.

[8] The allocation to any given entity or associated with any quantity of generation could be any quantity designated by the program – we choose a 12.5% reduction from 80 to 70 t for across these scenarios to have a common reduction for comparison.

receives $700 of auction revenue from the state as directed by policy, which reduces the amount it bills ratepayers from $12,800 to $12,100.

Column 2 shows the situation where allowances are allocated to generators. The generator has 700 of the 800 allowances it requires, purchases the other 100, and receives $12,100 from the LDC. The LDC required $12,100 from ratepayers.

Column 3 shows what happens when the allowances are allocated to the LDC. The generator must spend $800 for the allowances to cover its emissions. It then receives $12,800 from the LDC for this power. The LDC receives $700 from the sale of allowances, which reduces the amount it bills ratepayers from $12,800 to $12,100.

Columns 4 and 5 demonstrate the effects of split allocations. In both cases the effect on electricity rates is identical to the above three allocation schemes as long as all allowance value is applied to reducing the amount of revenue recovered from ratepayers. In column 4, the 50% of allowances allocated to generators reduce the amount it must recover from the LDC, and the 50% auctioned provide revenue that is transferred to the LDC directly to lower its revenue requirement. Column 5 demonstrates that a split allocation between auction and LDCs simply provides two separate revenue streams for the LDC. The key is that we are demonstrating a particular policy decision that the state uses its auction revenues to limit rate impacts; the revenues *could* be used for any other purpose.

The effects of all five scenarios are identical for ratepayers. The key part of the policy is how allowance value is used, not which entities receive the allowances or revenue.

Table 3 (Page 52) demonstrates that this is also true when allowance value is used for demand side management (DSM) programs when all other assumptions remain identical.[9] We assume that generators are directed by the PSC to spend $700 on DSM programs. Column 1 shows this for auctioned permits. The generator must buy $800 worth of permits *and* pay for $700 worth of DSM programs. The generator receives $700 from the states allowance receipts to cover the costs of the DSM program. This means that the generator would be authorized to recover $12,800 from the LDC who in turn would receive $12,800 from ratepayers.

The second column shows what happens when allowances are allocated to generators. The generator must purchase $100 in allowances to cover its emissions (having received 70 allowances at no cost) and spend $700 on a DSM program. It therefore recovers $12,800 for the electricity it transmits to the LDC, who in turn recovers $12,800 from ratepayers.

Column 3 shows the situation when allowances are allocated to LDCs. The generator must buy $800 worth of allowances *and* pay for $700 worth of DSM programs. This means that the generator would be authorized to recover $13,500 from the LDC. The LDC sells its allowances for $700, and therefore needs to only recover $12,800 from ratepayers to be able to pay the generation owner for its power.

Columns 4 and 5 again demonstrate the results of split allocations where the state uses its auction revenue to invest in DSM activities. When the generator gets 50% of the allowances, it passes on the full cost of electricity and uses its allowance value to fund half of the DSM program. The other half comes from auction revenue

9 We ignore the effects the DSM program would have in reducing electricity use and therefore emissions to focus on the use of allowance value in this illustration.

transferred by the state. When the LDC receives 50% of allowances, the generator receives only the $350 from the state to defray DSM expenses and must pass the other $350 on to the LDC. The LDC then reduces its revenue requirement by $350 by using the revenue it receives from allowance sales. In both cases the end result on ratepayers is identical with all of the other scenarios in Table 3.

Again, in all five scenarios ratepayers pay an identical amount -- $12,800 in this illustrative example – for their electricity. The DSM program has been paid for with $700 in allowance value, and the full cost of all CO2 allowances has been passed on to ratepayers.

Table 4 (Page 53) shows that allowance value can split among multiple uses – in this example, an even division between limiting rate impacts and funding DSM programs. Under all of the allocation options examined, the effects on ratepayers are identical.

These scenarios in Tables 2-4 (Pages 51–53) illustrate that it is the way allowance value is used, and not to whom they are allocated, that determine the outcomes on electricity rates and the funding of energy-sector programs. This does ***not*** mean that the incidence of a cap-and-trade program will always be independent of allocation decisions; it ***does*** mean that the program design should focus on how allowance value is used rather than simply on whether allowances are auctioned or allocated without charge.

Example 2: Allowance Allocation and Use of Allowance Value: Different Fuel Sources and Compliance Strategies

This example provides a richer representation of how allowance allocation and the use of allowance value affect cap-and-trade program outcomes. It includes the differential effects of allocation formulas and compliance strategies, and is relevant for framing the modeling effort in Phase 2 of this project. This example is based on a 5% reduction in GHG emissions from *status quo* levels.

Choices Made

We look at three scenarios for allowance allocation: based on 2006 CO2 emissions quantities (Table 5, page 54), based on 2006 generation quantities including an allocation for nuclear power(Table 6, page 55), and based on 2006 generation quantities excluding nuclear power (Table 7, page 56).

For each of these scenarios, we compare rate increases and cost implications of 4 options:

a) A full auction, where all revenue goes to the state Treasury and generation units buy allowances to cover all of their emissions. This scenario gives identical results in Tables 5, 6, and 7 (Pages 54-56). We assume that electricity use stays the same and that zero-carbon generation is available for 50% more than the cost of current generation.

b) Full application of the value of allowances to the revenue requirement (i.e. to reducing end user rates). We assume that electricity use stays the same and that zero-carbon generation is available for 50% more than the cost of current generation.

c) Full application of allowance value to utility-run energy conservation programs under public management. We assume that allowance value is used to pay for energy conservation within the fuel sector to which those allowances are allocated. If the value of allocated allowances is not enough to achieve the demand reductions sufficient to meet GHG limits, the balance of reductions comes from alternative generation. If there are revenue left over after demand reductions meet GHG goals, these are applied to reducing rates for all ratepayers within that fuel category.

d) An even 3-way split between an auction (as in a)), application of allowance value to the revenue requirement (as in b)), and application of allowance value to energy conservation programs (as in c)). The same assumption as in c) is made: additional GHG reductions beyond what can be achieved with energy efficiency funding are made with alternative generation.

Key Simplifying Assumptions

This illustrative analysis makes simplifying assumptions that are clearly unrealistic. While I believe that the implications are reasonably robust to these assumptions, they need to be kept in mind and should be treated more realistically in future iterations of this analysis.

1) There is no demand-side response induced by price changes. Electricity demand is changed **only** by public investment in energy reduction programs.
2) There is no movement from the status quo customers switching from one fuel source to another. This means that there is no substitution of zero-GHG generation (nuclear) or low-GHG generation (gas) for high-GHG generation (coal and oil).
3) We abstract from complications of fixed vs. variable cost in generation, and assume that all generation carries a constant marginal cost.

Baseline Parameter Assumptions

We assume that in the status quo all electricity is generated and markets at a cost of $120 per MWh ($0.12 per kWh). We choose costs of demand-side reduction of $150 per MWh (25% greater than existing generation) to be lower than the costs of zero-carbon generation at

$180 per MWh (50% greater than existing generation) to illustrate points about the divergence of electricity rates and overall costs in evaluation alternative allocation and allowance use choices. Zero-carbon generation could come from new energy sources like wind, from efficiency increases at existing plants, or from electricity not covered by a Florida cap-and-trade system (e.g. imports from out-of-state under some potential program rules).

Metrics

We look at three metrics that may be of interest for policy analysis. The first is the effect of allocation and allowance use choices on electricity rates. The second is the net position of Florida's treasury in various plans. The third is the total resource cost of electricity provision. This third measure provides a particularly useful comparison in scenarios where programmatic demand-side reduction is assumed. Since the underlying scenarios all assume that electricity use does not change unless public resources are used to reduce demand at no cost to consumers, the comparison of overall resource costs is the closest analog to economic efficiency.

Prices

When allowances are auctioned, price increases result directly from the emissions intensity of each fuel source: coal has the highest increase and nuclear power has no increase.

When allowance value goes directly to rate reduction, allocation based on emissions unsurprisingly favors consumers of coal-fired electricity (about $3 per MWh less) relative to allocation based on generation. Gas (about $1 less) and nuclear (almost $5 less) are the winners when allowance allocation is based on generation rather than emissions. Nuclear power actually becomes cheaper when it receives an allocation applied to rate relief, since its generation requires no allowances and therefore the entire allocation is sold to produce revenue that defrays generation costs.

When allowance value goes to demand-side reduction programs, the effects on rates are surprisingly independent of allocation formulas. This results from the divergence of price and total resource costs as metrics for energy efficiency programs in traditionally regulated states like Florida. Coal receives more allowances when allowances are allocated based on GHG emissions, and therefore has more resources to invest in conservation than under allocation based on generation. This results in a lower overall quantity of electricity sold when allocation is based on emissions, and therefore the lower total costs are spread over a smaller quantity of electricity sold. This same result occurs in reverse for gas – the greater resources available when allowances are allocated to generation result in greater reductions, but the rate is determined by dividing the smaller total resource cost by a smaller quantity of generation.

When allowance value is split evenly among general revenue, energy conservation programs, and rate relief, there tends to be less difference among the various allocation schemes in terms of the effect on rates.

Effect on the Florida Treasury

When revenue is allocated to rate reduction or to energy efficiency programs, there are no direct effects on the Treasury. Whatever allowances are auctioned enhances the Treasury position. In this example, 100% auction provides about $1.2 billion and the 1/3 auction provides exactly 1/3 that amount, or $400,000. This revenue is a transfer from ratepayers to the state. It is a direct result of program decisions about the quantity of allowances auctioned and how the revenue is used.

Effects on Overall Efficiency

This criterion looks at the overall level of resources needed to meet the state's electricity needs. It is based on the assumption that the only reduction in demand comes from the energy efficiency programs funded out of allowance value. It nets out transfers to the Treasury. This means that the same level of service is being provided to Florida consumers in all scenarios, and so the comparison of the total resource costs of providing that level of service is a relevant piece of information.

In all allocation scenarios, overall costs are the same in the cases of 100% auction and 100% application to rate reduction. This is because the identical set of actions is taken across scenarios: existing generation is replaced by zero-carbon generation by the same amount across fuel sources. In the case of the auction, ratepayers pay about $1.2 billion / year more and the Florida Treasury receives it. In the case of applying allowance value to the revenue requirement, total ratepayer costs are exactly reduced by the amount of allowance value. The distributional consequences of allocation among fuels are exactly proportional to the allocation scheme – coal benefits from an emissions-based approach and gas from one based on generation quantities.

Our assumption that demand-side reduction is less expensive than zero-carbon generation allows us to examine the divergence between efficiency and price. The lowest overall resource cost to meet the GHG cap comes with 100% allocation to energy efficiency in all three allocation cases. However, this case also has higher rates for coal, gas, and oil generation than any of the allocation schemes except for 100% auction. The reason is because demand side reduction benefits consumers by saving them money on reduced energy bills, but reduces the amount of generation over which total costs must be spread. In terms of individual generator incentives, this perverse result has driven calls for decoupling, fixed-variable rate design, and other ways of ensuring strong incentives for energy conservation programs.

Here we are not concerned with generation incentives, only with comparing the implications of alternative uses of allowance value. The lesson of this example is that a focus on rate increases (possibly driven by expected political reaction by ratepayers) can cause less efficient overall decisions than a broader focus on total expenditures to meet the state's electricity needs. In this example the result is explicitly driven by the assumption that energy conservation is cheaper per mWh than alternative zero-carbon generation.

Banking and Borrowing Rules

GHG caps are likely to be set on an annual basis, and there is great value in allowing year-to-year flexibility to account for uncertainty in demand and emission intensity. Banking is the ability to retain unused allowances to cover emissions in subsequent years. There is almost no disagreement that banking is a good policy element, and it has been a feature of other cap-and-trade programs and is widely regarded as having been a positive factor in explaining the success of those programs.

Borrowing refers to mechanisms through which future allocations of allowances can be used in the present. The effect is to allow more emissions in the present, thus reducing the cost and difficulty of compliance via a reduction in the allowance price. In other GHG cap-and-trade programs and proposals, the terms under which borrowing is allowed have been contentious. Environmental advocates have been concerned that borrowing weakens the incentives to make demonstrable progress toward GHG reduction. Those concerned with the economic risk of high costs maintain that a well-structured borrowing program achieves the same GHG reduction goal but adds flexibility and efficiency. We discuss specifics about borrowing below in the section on cost containment / risk mitigation.

Offset Programs and Rules

The idea behind offsets is that actions taken voluntarily outside the cap-and-trade system can reduce GHG concentrations. These reductions can substitute for reductions made by the regulated entities, and should therefore create the equivalent quantity of allowances that can be used for compliance. As an example, consider the case of carbon sequestration in the forestry and agricultural sectors.[10] If a farmer takes action that increases the amount of CO2 stored in his soils by one metric ton, this could qualify as an offset. An allowance would be created and given to the farmer, who would then be able to sell it to a business covered by the cap-and-trade. This concept increases the supply of allowances, and thus decreases the allowance price, without increasing net contributions to total GHG concentrations.

Carbon sequestration in U.S. soils and biomass is expected to be a significant source of offsets for almost any cap-and-trade program, including a state program in Florida. There are a number of issues

[10] Carbon sequestration is the storage of CO2 in soils, biomass, or any other location that prevents it from entering the atmosphere. No-till agriculture and afforestation are two widely practiced means of sequestration. For a good overview of issues concerning this subject see EPA's website at http://www.epa.gov/sequestration/index.html

inherent in a state program that is not economy-wide that require specific policy choices.

Reductions from GHG-emitting sectors (not just carbon sequestration) could provide significant quantities of offsets. For example, the transportation sector could be included in an offset program, and could create offset allowances by demonstrating reductions in GHG through mass transit investments. While this would have the attractive characteristic of reducing electric industry compliance costs, it raises some serious policy issues:

1. Additionality, Permanence, and Leakage[11]

i. Offsets are inherently more methodologically difficult to administer because of establishing *additionality* - the reduction in GHGs relative to what would have happened in the absence of the offset project. To calculate offset reduction quantities it is necessary to establish a baseline of *what would have happened in the absence of the offset program.* To do this rigorously is both conceptually and operationally difficult, because it is impossible to know what would have happened in a counterfactual reality. Assume that a city implements a mass transit project to gain offset credits. Quantifying those credits assumes that the GHG savings of the system – the GHG emissions avoided from car travel avoided less the emissions from the transit system's construction and operational emissions – can be calculated. There is no way to know how many car trips would have been taken, and in what kind of vehicles, has the system not been built. If federal incentives are available to

[11] A useful overview of additionality, permanence, and leakage issues is provided in Murray, Sohngen, and Ross (2006), "Economic consequences of consideration of permanence, leakage and additionality for soil carbon sequestration projects," *Climatic Change* (2007) 80:127–143

build the system, then it is possible it might have been built anyway and (at least conceptually) should not qualify as providing additional GHG reductions under rules.

ii. Permanence – This is a particular problem for offset projects in agriculture and silviculture that earn credit for carbon sequestration. Carbon stored in soils or biomass can later be released – for example, if land is tilled or timber is burned. This reverses the environmental gain for which offset credits were awarded. Policy options suggested to deal with this problem including bonding schemes and systems for mandatory payback, but in any event they will be difficult to administer and probably even more difficult to enforce.

iii. Leakage – Leakage is discussed in general later in this report. The problem is serious for offset projects as well. As an example, consider a Florida community that qualifies for offset credits by implementing a smart growth plan that limits new road development. If one effect is to increase demand for new housing and new roads in other communities, then the GHG reduction benefits of the smart growth plan have at least partially "leaked" away.

2. Avoidance of future coverage. An additional risk of offset programs is that the create expectations and entitlements that will make it difficult to bring GHG emitters under mandatory control in the future. If transportation sector entities earn significant amounts of money by supplying offsets to the electric sector, then it will be politically more difficult to evolve a cap-and-trade program to include an actual cap for the sector. Because state control of transportation GHG emissions is

relatively unlikely relative to their coverage in a national program, this is probably not a significant issue for that sector. It could be a concern for small-scale electricity generation.

3. Geographic coverage. In addition to concerns about permanence, leakage, and additionality, Florida faces a geographical choice in any offset policy it would choose to pursue: should offsets be limited to projects within the state, or should GHG reductions from other states and other countries be accepted. The advantage of broader geographical reach for offsets is greater supply, which would cause lower allowance prices and lower rate increases *ceteris paribus*. The disadvantage is the increased administrative cost and difficulty of monitoring and verifying offset projects and actions outside of the state.

Florida could choose to accept offsets certified by other organizations – for example, the offset mechanism administered by the Intergovernmental Panel on Climate Change (IPCC), which might be from the Clean Development Mechanism (CDM) or some successor offset program. They could also choose to recognize offset allowances certified by RGGI or by a future program of the WCI. Florida would have little control over the terms or prices of these allowances, and their participation in the market could drive those prices marginally higher. However, there would be definite advantages in terms of the avoided costs and hassles of administering a program outside of the state.

Stricter rules for measuring and verifying offsets – for example, from carbon sequestration in agriculture and forestry – reduce the supply of offsets coming into the cap-and-trade system and therefore increase the price of allowances, making compliance more expensive.

Fair and consistent rules increase the environmental integrity of the cap-and-trade program and are consistent with its broader purpose. Rules that are reasonable and not unnecessarily complex or burdensome will increase the efficiency of offset provision. The policy challenge is to craft offset rules that accurately track and measure real GHG reductions while still promoting efficient offset supply.

Considerations for Offset Policy

Florida will have to determine the sectoral and geographical extent of its offset program. It will also have to decide whether to rely on measurement protocols and rules developed for other programs (e.g. RGGI) or whether to modify these or develop new ones.

Cost Containment

Florida has a strong interest in achieving GHG reductions at the lowest possible cost, and also in making sure that its program does not cause unacceptable economic hardship or dislocation. In this section we discuss the policies that mitigate economic risk of implementing a cap and trade program. Some of those choices reside in the basic outlines of the program – for example, the stricter the GHG emissions cap, the lower the economic risk, but the lower the state's contribution to mitigating climate change risk. The policies we discuss here are those that have the strongest ability to affect program costs given a set of basic choices about the cap-and-trade program.

One set of policies lowers costs by reducing the emissions of Florida's electricity sector (and large industrial emitters if included). A second set reduces costs by expanding the supply of allowances through offsets and linking with other GHG programs. The third set is perhaps the most critical – policies that directly intervene in the allowance market to keep allowances, and therefore end-user rates, from rising to unacceptably high levels.

Policies to Lower Allowance Prices through State Managed and Regulated Efficiency Programs

A consistent finding of both technological and economic research into GHG reduction is that the most cost effective reductions come from demand-side reductions in energy use. While the effects of increased electricity prices will be sufficient to achieve some of these reductions, there is considerable evidence that market failures and consumer behavior patterns prevent the price mechanism from being fully effective. Public programs that bring about energy reduction through direct action (e.g. retrofitting buildings), changes in public policies (e.g. changes in building codes), and incentives (e.g. tax credits or subsidies for the purchase of energy-efficient appliances) will lower the demand for electricity and therefore the demand for GHG allowances, which in turn will reduce the price of those allowances.

Policies to Lower the GHG Emissions of Electricity Generation

The role of state policy here is a balance. The GHG limits and the price signal contained in the cap-and-trade policy should serve as a strong incentive to improve generation efficiency (GHG emissions per MWh produced). This could take place through any combination of efficiency improvements in existing generation and transmission, switching generation from high-emitting to lower-emitting units (e.g. switching some share of generation from coal to gas), and the installation of new generation capital (e.g. wind energy). The extent to which Florida has an interest in directly mandating or investing in these technologies depends on a host of complex factors, including the extent of leakage expected in the program, the choices that IOUs and public power operations would make in the absence of policy, and the role of legislative strategies relative to PSC regulation in achieving these aims. It also depends on the existence and nature of state and national Renewable Portfolio Standard (RPS) policy and federal investments and incentives for new low-carbon energy generation and transmission infrastructure improvements.

The higher the price of allowances, the higher the incentives for both demand-side and supply-side changes conveyed through the price system, and the more value is produced by the kinds of public investments and policies listed above that further lower GHG emissions. The higher the costs of meeting GHG caps, the more these kinds of programs are justified *ceteris paribus.* One concern to keep in mind is ensuring that energy efficiency programs are efficient and well run if there is a dramatic expansion of such programs over a short period of time.

Expanding Allowance Supply Through Offset Programs and Linkages to Other State and Regional Programs

Both of these mechanisms have been discussed elsewhere in this report. Offsets expand the supply of allowances available to Florida entities in a (theoretically) GHG-neutral way. The higher the price of allowances, the more offsets will be available to the Florida system to provide price relief. How strong this effect will be depends both on the details and extent of Florida's offset program and on the time scale over which high prices persist. To the extent that Florida is competing for a larger pool of offset allowances (e.g. if it were to partner with RGGI or allow IPCC-approved international offset allowances), then the offset market can function more like a safety valve, creating significant new supply in the event that the Florida allowance price should rise to the offset system's allowance price.

Linking with other systems is a two-edged sword. In a fully linked system arbitrage should create a single price for allowances. If Florida's system were to have higher stand-alone prices than its partner systems, then linkage would lower allowance prices and compliance costs. If, however, Florida's cap and other program details were to create a lower price than partner systems (if each were separate), then allowances would flow out of Florida and its system would be characterized by a higher price. Whoever sold the allowances would receive revenue to more than compensate them for higher costs, but it could still cause higher electricity rates (depending on allocation choices and PSC use of allowance value)

Policies that can Mitigate Unexpectedly High Prices

Limiting GHG emissions from the electric power industry (and other large stationary emitters) is inherently an uncertain enterprise. It is possible that even with aggressive pursuit of energy efficiency and a robust offset program, meeting the GHG cap could require very high prices to choke off end user demand. If Florida adopts a cap-and-trade program, the state has an interest in making sure that there is a limit to how high electricity rates – driven by allowance prices – can rise in the short run. This is particularly true because GHGs are a global stock pollutant – variation in the emissions from one state in one or two years will have a negligible effect on climate change risk. The state could choose to implement policies that intervene directly in the allowance market to limit the extent to which the carbon price can rise.

There are two flavors of direct market intervention. The first, which has been referred to as a safety valve or price collar[12] makes unlimited quantities of allowance available at a predetermined and pre-announced price. This sets an effective ceiling on the allowance price because no entity would purchase an allowance from another source for more than the safety valve price. The upside of this policy is absolute price certainty. The downside is that the cap is exceeded by the quantity of the safety valve allowances sold.

The second policy is based on borrowing from future-year allocations of allowances. The borrowing takes place through the mechanism of the government (or its agent) selling allowances to buyers when a pre-determined trigger price (or some other trigger condition) is met. An advantage of this policy is that the long-term collective GHG cap is not exceeded: any increase in current emissions beyond the cap is made up by shrinking future-year caps by the same amount.[13]

A choice that is at least as important as the price intervention mechanism is the intervention price itself. A price that is at or below the expected price of allowances functions more as a tax than as a risk mitigation mechanism – the intervention price will be the expected price in the market. This was the case for the national cap-and-trade proposal from the National Commission on Energy Policy (NCEP) that was the basis of legislation introduced by Senator Bingaman in the 110th Congress as the Low Carbon Economy Act. A price that is

[12] Price collar refers to the institution of both a minimum price (at which the government or its agent will buy allowances and thus shrink the cap), and a maximum price (which functions as the safety valve discussed in this section.

[13] In some proposals, borrowed allowances reduce the cap by a multiple greater than one so that borrowing results in a net shrinking of the long-run GHG cap.

intended to be a last resort to avoid undue economic hardship without weakening GHG reduction incentives should be set significantly about the expected price of allowances, and should be set with reference to the state's judgment about how high allowance prices can be allowed to rise before the consequences become unacceptable.

Choosing a mechanism involves a choice between environmental and economic certainty. The safety valve provides absolute economic certainty – the price can never rise above the price chosen as part of the policy. It does not provide environmental certainty – use of the mechanism involves exceeding the chosen GHG cap.

Borrowing schemes provide greater environmental certainty than does the safety valve: in theory, any allowances from future allocations used in the present will be made up by reductions in the future. This certainty should be tempered by the unavoidable fact that future caps could be changed in response to changing future conditions – if there is significant borrowing in early years so that allowance prices look like they will be high in the future, program details could be legislatively or administratively changed to accommodate these changed conditions. The economic certainly of borrowing schemes depends on the extent of borrowing that is allowed. If the pool of allowances is small, then prices will be tempered but not limited. If the pool is unlimited, then the trigger price will effectively become the price ceiling. Choosing limits on borrowing is a difficult policy choice that depends on specific economic modeling and other program details.

All of this may be academic – if Florida chooses a relatively non-aggressive system (like RGGI), if significant numbers of offset allowances are available, and if out-of-state generation is available to fill gaps in the case of allowance shortages, then the design of this kind of risk mitigation mechanism is less critical. Similarly, if the Florida system is linked with larger systems of cap-and-trade and offset markets without limits, those markets can effectively function as risk mitigation measures. This remains an absolutely critical issue for a national GHG policy; the extent to which it is important for Florida depends on other policy parameters of the program.

Considerations for Mitigating Unexpected High Costs

Florida must decide whether to explicitly fund energy efficiency programs out of allowance value, and make higher level decisions about how to fund, administer, and target state-run and state-sponsored energy efficiency programs in the state. Consideration should be given to the implications of different levels of GHG reduction through efficiency, at differing levels of cost, in terms of the effects on key cap-and-trade program details like allowance price and total cost.

Determining optimal safety valve and allowance reserve (borrowing) programs is a bit trickier. The effect of these policies depends entirely on the results of uncertain outcomes – if there were no uncertainty, there would be no reason to use these policies. If the use of these mechanisms to mitigate economic risk is deemed an important option by DEP, then the approach suggested here is to examine these questions last in the modeling effort.

Links with Other Programs

This section discusses the mechanics, benefits, and risks of linking a Florida cap-and-trade program with other state and/or regional cap and trade programs. There are two kinds of systems that Florida could link with: other cap-and-trade systems (e.g. RGGI) and offset credit systems (e.g. the CDM).

Linking with Other Cap-and-Trade Programs

If Florida were to reach an agreement with one or more cap-and-trade programs to allow two-way buying and selling of emissions allowances, the result would be lower total resource costs for the state's economy *ceteris paribus*. However, electricity prices could end up higher or lower, and the transfer of total resources out of Florida could be positive or negative. Florida needs to be clear that it will be influenced by its partner programs choices about offsets, cost containment, and other program rules. In addition, the *ceteris paribus* assumption has to be examined carefully with regard to the choice of targets.

We illustrate these points with a very simple example[14]. Suppose Florida were considering linking with a different state's cap-and-trade program and each state had chosen its targets and program rules. The effect on Florida depends on which system's allowance price would be higher if the systems were separate.

Table 8a (Page 57) presents an example where allowance prices in separate systems are higher in Florida than in the partner state. Allowing trading means that there will be a single allowance price - separate prices cannot persist because arbitrage profit opportunities would make sure that the lower cost allowances would be bought in the partner state and then sold in Florida. This result lowers the allowance price (and therefore electricity prices) in Florida, and raises the allowance price (and therefore electricity prices) in the partner state.

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[14] This example is illustrative only, and the magnitude of changes in the example has no particular significance – only the direction of change is indicative of actual results. Further, this example assumes that 100% allowance value is applied to keep rates low and all allowances are allocated to this purpose. Other assumptions are easily demonstrated and could be formally modeled.

The fact that allowance prices are lower in one location strongly implies that there are lower-cost compliance options available in that location. In this example, Florida is able to reduce its compliance costs by $300 million by purchasing $200 million of allowances from the partner state. That state – because more cost effective abatement options exist, as signaled by the lower price – is able to reduce emissions for only $100 million and sell the allowances freed up.

The end result is that $200 million in resources flow out of Florida, but the state saves $300 million dollars in compliance costs and therefore ends up ahead. The lower allowance price and lower total resource costs imply lower electricity rates for the state's end users than in the partner state.

The partner state also ends up ahead in terms of total resources spent. The $200 million it receives for selling allowances more than makes up for its additional $100 million in compliance costs. In this example, we show a high electricity price resulting from the higher allowance price. This is direction of change expected if the partner state prices electricity through a system of wholesale competition (like the RGGI states). If, however, the partner state were under embedded cost regulation (like Florida) the lower level of resources spent would have resulted in lower electricity rates for end users even though allowance prices would increase.

For (possibly unnecessary) completeness we go through the opposite situation: Table 8b (Page 57) shows what happens when Florida has a lower allowance price than the partner state. Florida sees it allowance prices rise, but its total costs go down because the inflow from allowance sales is greater than additional compliance spending. In contrast with the above example, Florida's electricity prices go down because of Florida's structure of electricity regulation.

The partner state's prices go down (still assuming that its rates are set through wholesale competition) as a result of the falling allowance price. Otherwise, the results of the previous example are simply reversed.

Implications for Florida

Linking with another cap-and-trade system will in theory always result in lower costs than remaining unlinked. This results from the same logic as cap-and-trade – linking the systems allows the lowest-cost abatement opportunities to be exploited brings down overall costs. Resources for allowances will only flow out of the state when they bring down the overall costs of compliance. For this reason linking also serves as a cost containment mechanism – having access to a broader allowance market provides a check on how high allowances can go for Florida's electric generation sector. However, this general result needs to be tempered by a few real-world considerations.

Offsets, Cost-containment, Banking and Borrowing

If Florida links with other systems, then their policies will automatically apply to Florida because of arbitrage opportunities. For example, if Florida were to only recognize in-state offsets and the partner state were to accept CDM allowances, then Florida would *de facto* be accepting CDM allowances. The partner state would only sell regular allowances to Florida, but could correspondingly increase its purchases of CDM allowances. Similar considerations apply to safety valve policies or banking and borrowing schemes - whichever program has rules and policies that are more advantageous to buyers (e.g. the lower safety valve price) would end up setting the price for both systems.

Setting Targets

When systems are linked, then each participant gains financially by having relatively less strict caps. Higher cap numbers mean more allowances sold (less purchased from) the partner system; more stringent cap numbers mean the opposite. All governments entering into a linking agreement must be satisfied with the relative levels of stringency and other program rules of all partner systems. In particular, if Florida were to wish to join a system like RGGI, the RGGI states would likely have requirements for the stringency of Florida's cap and might also seek harmonization on other program rules.

Considerations for Joining RGGI

The obvious decision Florida faces is whether to become part of RGGI or to go it alone. This section has emphasized this is not a straightforward decision, and depends on other choices made about how to structure a Florida program (cap stringency, offset rules, etc.). However, joining RGGI would probably cause enormous administrative efficiency if its rules could serve as the basis for a Florida's system, thus allowing scarce administrative and analytical effort in Florida's state government to be used for other essential purposes.

Leakage and a Florida Cap-and-Trade Program

Florida DEP is required to consider leakage in its planning for a state cap-and-trade program. Leakage refers to GHG emissions displaced but not mitigated by GHG reduction policy. For example, if Florida reduces GHG emissions to meet its cap, and as a result GHG emissions from electricity generation in Georgia and Alabama increased by 40% of Florida's total reduction, then the real effect on GHG concentrations is only 60% of Florida's reduction. The other 40% is said to have "leaked" out of the system.

For an electricity generation system, there will be primary and secondary leakage effects. Primary leakage effects are those where Florida’s reductions are creating increases in electricity generation to satisfy Florida’s demand. The extent to which these occur depends on how Florida’s system covers imported electricity and on the potential of the cap-and-trade system to induce substitution of imported generation for in-state generation.

The system design question has been covered above – in general, it is technically and methodologically complex to impose allowance requirements on out-of-state generation. RGGI has chosen to not attempt this in its initial phases because of complexity and enforceability.

The substitution question depends on infrastructure and on the response of Florida generation and demand to the cap-and-trade system. Florida currently has relatively limited import infrastructure and volume. If its GHG control system were to impose significant price impacts, then this could change significantly if infrastructure existed to import and distribute increasing quantities of electricity from out of state.

An additional leakage concern comes from the likely sectoral nature of a Florida program. If large industrial consumers of electricity were to decide to produce their power directly rather than buy it from the grid, and if that power were exempt from the state’s GHG program, then significant leakage could occur within the state. Similarly, if the cap-and-trade program were to apply only to generation of a given size level, then there would be a risk of leakage to new generation capital built just below that size limit.

Secondary leakage occurs if industrial and commercial activity move out of Florida because of price increases due to the cap-and-trade system. There is an enormous amount of uncertainty in predicting how serious this problem would be, but there are two reasons to think it would not be critical. First, price increases would likely be well within the state-to-state variation that already exists for commercial and industrial electricity prices. Second, the widespread expectation of a national cap-and-trade system would decrease the likelihood of industrial relocation given the short-term nature of expected electricity rate differentials.

Finally, it is worth noting that aggressive energy efficiency programs that cost-effectively reduce electricity use will also serve to limit both primary and secondary GHG leakage by reducing GHG allowance demand, allowance prices, and electricity prices in Florida.

Considerations for Addressing Leakage

Florida needs to decide how aggressively it wants to try to prevent leakage in its system. Supporting empirical analysis could attempt to estimate leakage volumes based on alternative program design parameters. Such an analysis would be complex, time- and data-intensive, and in the opinion of this writer have relatively low payoff in terms of helping Florida design a good system. It is well worth thinking through program rules on leakage incentives, but detailed estimates may not be the best use of scarce modeling resources.

Conclusions

This report has outlined the major choices Florida faces in designing a utility-sector cap-and-trade program as a means of meeting the state's GHG reduction goals. It has stressed that the likelihood of an economy-wide federal cap-and-trade policy creates unavoidable uncertainty for Florida's policy development process, and the state will have to pay close attention to making sure its actions make sense if such a federal policy is implemented.

Administering the cap-and-trade system at the point of individual generating units is a reasonable and pragmatic choice. The state will have to determine the minimum size of generation unit that will be covered, which will require trading off comprehensiveness against the cost and complexity of the program. The state will also have to set specific caps over time that it sees as consistent with the Governor's GHG reduction goals. A further decision will have to be made about how to deal with electricity imported into Florida from outside the state.

The most visible and contentious issues about which the state will have to make decisions are those of allowance allocation and the use of allowance value. The report lays out a range of options for these choices, emphasizing that the way allowance value is used is more critical than the allocation scheme *per se.* It uses numerical examples to illustrate the effects of alternative choices on ratepayers, energy efficiency programs, and the state's fiscal position. It also suggests issues for more detailed modeling of a cap-and-trade program's economic effects that would help the state to make informed decisions about allowance allocation and how allowance value is used.

Overall costs and economic impacts of the program will also be affected by rules for generating offset allowances, and by the formation of and rules for links with other state of regional GHG cap-and-trade programs. The report discusses the key issues affecting the state's choices in these critical areas.

Even with careful planning and a robust set of policies toward offsets, linking with other programs, and energy efficiency, there remain economic risks of a cap-and-trade program in a new area like GHGs. The report addresses policies that directly address downside economic risk through the release of additional allowances when predetermined conditions are met.

Florida is justifiably concerned with leakage from the reductions achieved by a cap-and-trade program. The report discusses the issue, and is not optimistic that a Florida policy can be completely successful in limiting the problem. A federal cap-and-trade policy is much more likely to effectively prevent leakage.

Florida is examining cap-and-trade as one of a suite of policy initiatives to reduce GHG emissions in the state and prepare for a low-carbon economy in the future. The state is to be commended for the breadth of its approach. Continuing policy development in energy efficiency programs, portfolio standards and/or feed-in tariffs, and other areas is a good strategy given that an individual state cap-and-trade program may not be the best use of Florida's administrative and economic resources.

Table 2. Illustration of Allowance Allocation and Use of Allowance Value: All Value Used to Reduce Electricity Rates.

	Auctioned allowances	Allocated to Generator	Allocated to LDC	50% Auction, 50% Generator	50% Auction, 50% LDC
Cost of generation 100 MWh	$12,000	$12,000	$12,000	$12,000	$12,000
Allowance price	$10	$10	$10	$10	$10
Allowances per MWh	0.8	0.8	0.8	0.8	0.8
Total allowances required	80	80	80	80	80
Allowances allocated to generator	0	70	0	35	0
Allowances allocated to LDC	0	0	70	0	35
Allowances auctioned	70	0	0	35	35
Allowances bought by generator	80	10	80	45	80
Cost of allowances	$800	$100	$800	$450	$800
Cost of power to LDC	$12,800	$12,100	$12,800	$12,450	$12,800
Revenue received from allowance sales	$0	$0	$700	$0	$350
Revenue transferred from state to LDC for auctioned allowances	$700	$0	$0	$350	$350
Cost of electricity to consumers	$12,100	$12,100	$12,100	$12,100	$12,100

Table 3. Illustration of Allowance Allocation and Use of Allowance Value: All Value Used to Fund Demand-Side Management Programs.

	Auctioned allowances	Allocated to Generator	Allocated to LDC	50% Auction, 50% Generator	50% Auction, 50% LDC
Cost of generation 100 MWh	$12,000	$12,000	$12,000	$12,000	$12,000
Allowance price	$10	$10	$10	$10	$10
Tons CO2 per MWh	0.8	0.8	0.8	0.8	0.8
Total allowances required	80	80	80	80	80
Allowances allocated to generator	0	70	0	35	0
Allowances allocated to LDC	0	0	70	0	35
Allowances auctioned	70	0	0	35	35
Allowances bought by generator	80	10	80	45	80
Cost of allowances	$800	$100	$800	$450	$800
Cost of generator-run DSM program	$700	$700	$700	$700	$700
Revenue transferred from state for DSM program	$700	0	0	$350	$350
Cost of power and DSM passed to LDC	$12,800	$12,800	$13,500	$12,800	$13,150
Revenue received from permit sales	$0	$0	$700	$0	$350
Revenue transferred from state to LDC from auctioned allowances	$0	$0	$0	$0	$0
Cost of electricity to consumers	$12,800	$12,800	$12,800	$12,800	$12,800

Table 4. Illustration of Allowance Allocation and Use of Allowance Value: Half of Value Used to Limit Rate Increases, Half to Fund Demand-Side Management Programs.

	Auctioned allowances	Allocated to Generator	Allocated to LDC	50% Auction, 50% Generator	50% Auction, 50% LDC
Cost of generation 100 MWh	$12,000	$12,000	$12,000	$12,000	$12,000
Allowance price	$10	$10	$10	$10	$10
Tons CO2 per MWh	0.8	0.8	0.8	0.8	0.8
Total allowances required	80	80	80	80	80
Allowances allocated to generator	0	70	0	35	0
Allowances allocated to LDC	0	0	70	0	35
Allowances auctioned	70	0	0	35	35
Allowances bought by generator	80	10	80	45	80
Cost of allowances	$800	$100	$800	$450	$800
Cost of generator-run DSM program	$350	$350	$350	$350	$350
Revenue transferred from state for DSM program	$350	0	0	$175	$175
Cost of power and DSM passed to LDC	$12,800	$12,450	$13,150	$12,625	$12,975
Revenue received from permit sales	$0	$0	$700	$0	$350
Revenue transferred from state to LDC from auctioned allowances	$350	$0	$0	$175	$175
Cost of electricity to consumers	$12,450	$12,450	$12,450	$12,450	$12,450

Table 5. Implications for Rates and Resources of Allocation and Use Decision: Allocation Based on Emissions (Illustrative Example).

Policy	Fuel	Initial rate - no cap-and-trade	Rate increase due to allowance purchases	Rate increase due to increased generation costs	Rate increase due to Energy Efficiency programs	Final Rate	Total New Resources Expended (million $)	Resources Expended on Alt Gen (million $)	Resources Expended on Use Reduction (million $)	Net Addition to Florida Treasury (million $)	Ratepayer Bill (million $)
No Allocation - 100% Auction							$1,942	**$1,942**	**$0**	$1,175	**$32,246**
	Coal	$120.00	$7.60	$3.00	---	$130.60	$765	$765	0		$11,105
	Oil	$120.00	$6.21	$3.00	---	$129.21	$175	$175	0		$2,506
	Gas	$120.00	$3.67	$3.00	---	$126.67	$1,002	$1,002	0		$14,109
	Nuclear	$120.00	---	$0.00	---	$120.00	$0	$0	0		$4,526
Allocation to Revenue Requirement							$1,942	**$1,942**	**$0**	0	**$31,071**
	Coal	$120.00	---	$3.00	---	$123.00	$765	$765	0		$10,459
	Oil	$120.00	---	$3.00	---	$123.00	$175	$175	0		$2,386
	Gas	$120.00	---	$3.00	---	$123.00	$1,002	$1,002	0		$13,700
	Nuclear	$120.00	---	$0.00	---	$120.00	$0	$0	0		$4,526
Allocation to Energy Efficiency Programs							$1,709	**$542**	**$1,167**		**$30,657**
	Coal	$120.00	$8.00	---	-$0.10	$127.89	$638	$0	$638		$10,331
	Oil	$120.00	$6.48	---	$0.00	$126.48	$150	$30	$120		$2,352
	Gas	$120.00	$3.76	---	$0.00	$123.76	$921	$512	$409		$13,448
	Nuclear	$120.00	$0.00	---	$0.00	$120.00	$0	$0	$0		$4,526
1/3 auction, 1/3 energy efficiency, 1/3 to revenue requirement							$1,864	**$1,472**	**$392**	$392	**$31,139**
	Coal	$120.00	$5.15	$1.01	$0.00	$126.16	$722	$507	$215		$10,547
	Oil	$120.00	$4.20	$1.10	$0.00	$125.30	$167	$126	$40		$2,397
	Gas	$120.00	$2.47	$1.27	$0.00	$123.73	$975	$839	$136		$13,670
	Nuclear	$120.00	$0.00	$0.00	$0.00	$120.00	$0	$0	$0		$4,526

Table 6. Implications for Rates and Resources of Allocation and Use Decision: Allocation Based on Generation (Illustrative Example).

Policy	Fuel	Initial rate - no cap-and-trade	Rate increase due to allowance purchases	Rate increase due to increased generation costs	Rate increase due to Energy Efficiency programs	Final Rate	Total New Resources Expended (million $)	Resources Expended on Alt Gen (million $)	Resources Expended on Use Reduction (million $)	Net Addition to Florida Treasury (million $)	Ratepayer Bill (million $)
No Allocation - 100% Auction							$1,942	**$1,942**	**$0**	$1,175	**$32,246**
	Coal	$120.00	$7.60	$3.00	---	$130.60	$765	$765	0		$11,105
	Oil	$120.00	$6.21	$3.00	---	$129.21	$175	$175	0		$2,506
	Gas	$120.00	$3.67	$3.00	---	$126.67	$1,002	$1,002	0		$14,109
	Nuclear	$120.00	---	$0.00	---	$120.00	$0	$0	0		$4,526
Allocation to Revenue Requirement							$1,942	**$1,942**	**$0**	0	**$31,071**
	Coal	$120.00	$2.96	$3.00	---	$125.96	$765	$765	0		$10,711
	Oil	$120.00	$1.58	$3.00	---	$124.58	$175	$175	0		$2,416
	Gas	$120.00	-$0.97	$3.00	---	$122.03	$1,002	$1,002	0		$13,593
	Nuclear	$120.00	-$4.64	$0.00	---	$115.36	$0	$0	0		$4,351
Allocation to Energy Efficiency Programs							$1,707	**$532**	**$1,175**		**$30,658**
	Coal	$120.00	$7.84	---	$0.00	$127.84	$686	$292	$394		$10,534
	Oil	$120.00	$6.41	---	$0.00	$126.41	$157	$67	$90		$2,376
	Gas	$120.00	$3.79	---	$0.00	$123.79	$899	$383	$516		$13,362
	Nuclear	$120.00	$0.00	---	$0.00	$120.00	-$35	-$210	$175		$4,386
1/3 auction, 1/3 energy efficiency, 1/3 to revenue requirement							$1,864	**$1,472**	**$392**	$392	**$31,150**
	Coal	$120.00	$6.12	$1.20	$0.00	$127.32	$739	$608	$131		$10,715
	Oil	$120.00	$4.72	$1.20	$0.00	$125.92	$169	$139	$30		$2,417
	Gas	$120.00	$2.15	$1.20	$0.00	$123.35	$968	$796	$172		$13,598
	Nuclear	$120.00	-$1.56	$0.00	$0.00	$118.44	-$12	-$70	$58		$4,421

Table 7. Implications for Rates and Resources of Allocation and Use Decision: Allocation Based on Generation with No Nuclear Allocation (Illustrative Example).

Policy	Fuel	Initial rate - no cap-and-trade	Rate increase due to allowance purchases	Rate increase due to increased generation costs	Rate increase due to Energy Efficiency programs	Final Rate	Total New Resources Expended (million $)	Resources Expended on Alt Gen (million $)	Resources Expended on Use Reduction (million $)	Net Addition to Florida Treasury (million $)	Ratepayer Bill (million $)
No Allocation - 100% Auction							$1,942	**$1,942**	**$0**	$1,175	**$32,246**
	Coal	$120.00	$7.60	$3.00	---	$130.60	$765	$765	0		$11,105
	Oil	$120.00	$6.21	$3.00	---	$129.21	$175	$175	0		$2,506
	Gas	$120.00	$3.67	$3.00	---	$126.67	$1,002	$1,002	0		$14,109
	Nuclear	$120.00	---	$0.00	---	$120.00	$0	$0	0		$4,526
Allocation to Revenue Requirement							$1,942	**$1,942**	**$0**	0	**$31,071**
	Coal	$120.00	$2.15	$3.00	---	$125.15	$765	$765	0		$10,642
	Oil	$120.00	$0.77	$3.00	---	$123.77	$175	$175	0		$2,401
	Gas	$120.00	-$1.78	$3.00	---	$121.22	$1,002	$1,002	0		$13,502
	Nuclear	$120.00	$0.00	$0.00	---	$120.00	$0	$0	0		$4,526
Allocation to Energy Efficiency Programs							$1,707	**$532**	**$1,175**		**$30,658**
	Coal	$120.00	$7.88	---	$0.00	$127.88	$673	$210	$463		$10,479
	Oil	$120.00	$6.45	---	$0.00	$126.45	$153	$48	$106		$2,364
	Gas	$120.00	$3.81	---	$0.00	$123.81	$881	$275	$607		$13,290
	Nuclear	$120.00	$0.00	---	$0.00	$120.00	$0	$0	$0		$4,526
1/3 auction, 1/3 energy efficiency, 1/3 to revenue requirement							$1,864	**$1,472**	**$392**	$392	**$31,139**
	Coal	$120.00	$5.85	$1.15	$0.00	$127.00	$734	$580	$154		$10,669
	Oil	$120.00	$4.45	$1.15	$0.00	$125.60	$168	$132	$35		$2,407
	Gas	$120.00	$1.88	$1.15	$0.00	$123.03	$962	$760	$202		$13,538
	Nuclear	$120.00	$0.00	$0.00	$0.00	$120.00	$0	$0	$0		$4,526

Table 8. Illustrative Example of Linking Cap-and-Trade Systems (a)

	Allowance price (S/t CO2)	Net flow of money ($million)	Electricity price ($/kWh)	Total Resources spent on compliance ($million)	Total Resources (compliance & interstate-allowance transfers) ($million)
Separate systems					
Florida	$10		$0.12	$1,000	$1,000
Other State	$8		$0.08	$500	$500
Total				$1,500	$1,500
Linked system					
Florida	$9	$200	$0.10	$700	$900
Other State	$9	-$200	$0.09	$600	$400
Total				$1,300	$1,300

Table 9. Illustrative Example of Linking Cap-and-Trade Systems (b)

	Allowance price	Net flow of money	Electricity price	Total Resources spent on compliance ($million)	Total Resources (compliance & interstate-allowance transfers) ($million)
Separate systems					
Other State	$10		$0.12	$1,000	$1,000
Florida	$8		$0.08	$500	$500
Total				$1,500	$1,500
Linked system					
Other State	$9	$200	$0.10	$700	$900
Florida	$9	-$200	$0.07	$600	$400
Total				$1,300	$1,300