WORLD RESOURCES INSTITUTE

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TARGET: INTENSITY

An Analysis of Greenhouse Gas Intensity Targets

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FOREWORD

Climate change is real, and the world needs urgently to reverse the trend of rapidly rising emissions of greenhouse gases. That will require strong action by the United States and by the other major industrialized nations of the world. But action by industrialized countries will not be enough if we are to escape the worst case scenarios being put forward by leading scientists.

While the Kyoto Protocol began the process of securing commitments to reduce greenhouse gas emissions by many countries, the commitments of developing countries do not include such specific reductions. Several of those countries are now industrializing at a pace that the diplomats and the scientists who forged the Kyoto structure did not anticipate. And, of course, Kyoto architects did not anticipate that the largest emitter of GHGs, the United States, would withdraw from the Protocol and allow its emissions to increase even more.

At the same time that the international community seeks to address the challenges of climate change, it is also making significant efforts to address the corrosive problem of abject poverty. Almost one third of the world population lives on less than $2 per day, centered primarily in countries where economic growth is most needed.

The challenge facing us is to make sure, as we address the global threat of climate change, that we don't craft policies that force developing countries to make a choice between reducing GHG emissions and meeting the legitimate needs and aspirations of their people. Many approaches have been suggested to bridge this gap, some of which are discussed in *Growing in the Greenhouse,* a WRI report published in 2005.

This paper explores the use of GHG intensity targets as tools to help nations achieve real reductions in GHG emissions. It looks at examples of how intensity targets have sometimes masqueraded as real reductions, and it presents examples of how, properly set and enforced, intensity can result in real and meaningful reductions. It argues dispassionately and objectively that intensity targets should be part of the toolkit available to governments exploring reduction policies.

Intensity targets are especially pertinent to developing countries. Correctly set, they can lead to absolute reductions in GHG emissions by creating incentives for energy efficiency and the development of clean energy technologies. Intensity targets can also accommodate the need for economic growth—growth that we must accept and embrace—especially in the poorest of nations. Intensity targets can help that growth to occur efficiently and sustainably.

This report comes at a critical time. We are entering a difficult stage in our efforts to craft global solutions to the impending threat of climate change. We are neither rich enough nor clever enough to embark on this next phase without every tool at our disposal.

JONATHAN LASH
PRESIDENT
WORLD RESOURCES INSTITUTE

Executive Summary

Greenhouse gas *intensity targets* are policies that specify emissions reductions relative to productivity or economic output, for instance, tons CO_2/million dollars GDP. By contrast, *absolute emissions targets* specify reductions measured in metric tons, relative only to a historical baseline. This report looks specifically at intensity targets and explores their underlying indicators, rationales, real-world applications, and implementation issues. Our conclusion is that even though intensity targets are often dismissed as being environmentally lax or deceptive, they nonetheless could be useful instruments, when properly used, for furthering significant and real commitments to reduce greenhouse gas emissions.

There are many real-world examples of emissions intensity targets, which can and do operate at the corporate, sectoral, and national levels. At the corporate and sector levels, intensity targets may be defined in terms of emissions per product produced, such as CO_2/ton cement. Other intensity targets may be more complicated—and more ambiguous—if the product mix is not uniform, for instance, CO_2/$ of sales for a multinational conglomerate. National targets are almost always measured as emissions per unit of GDP.

Emissions intensity indicators have two primary drivers. The first is *energy intensity,* or the amount of energy used per unit of GDP. Energy intensity embodies energy efficiency and, at the national level, economic structure. The second driver is *fuel mix,* or the carbon content of the energy used, expressed as CO_2 per BTU or joule. This report finds that across countries, *absolute* emissions and emissions *intensity* have little correlation; countries with high total emissions often have relatively low emissions intensity and vice versa. Within countries over time, energy intensity and fuel mix may increase or decrease, with compounding or offsetting effects on overall emissions intensities. In major economies, however, emissions intensity has generally declined over time, even in the absence of explicit intensity policies, due to economic incentives to improve efficiency.

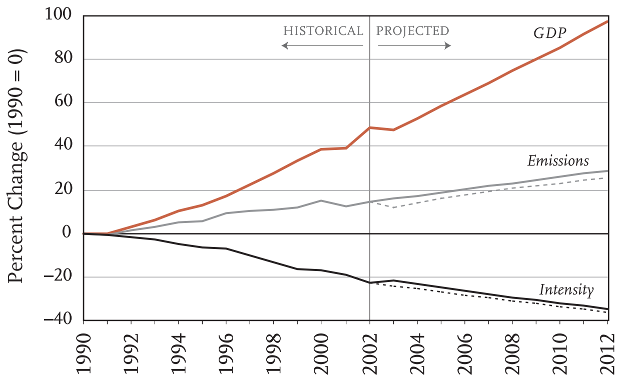
An important aspect of emissions targets is that to a large degree absolute targets can be converted to intensity targets and vice versa. Thus, the *form* of target is just one evaluative criterion, and other factors apply when assessing a particular target. This report looks at emissions targets using four criteria:

- *Target metric or Form:* "absolute" or "intensity." Some policies employ *both* absolute and intensity instruments in some fashion.
- *Stringency:* the magnitude of reductions specified by the target, with implications for the level of effort—and therefore the cost—required to meet them. The actual level of effort required to meet a given target is often difficult to determine from the target itself.
- *Scope:* the breadth of emissions covered by the target. Scope may be national, sectoral, companywide, or limited to specific facilities. Targets may also encompass some greenhouse gases (e.g., CO_2) but not others (e.g., methane or nitrous oxide).
- *Legal character:* whether the target is legally binding or voluntary and what the consequences of noncompliance are. Legal character may also encompass measurement, reporting, and auditing regulations.

Within the broader context of these criteria, this report finds several interesting aspects of intensity targets and arrives at the following conclusions:

- **Stringency and legal character are more important criteria than the form of an emissions target for assessing its environmental effectiveness.** Both absolute and intensity targets may be strong or weak with respect to how emissions may have changed in the absence of a target. Targets are not necessarily good simply because they are expressed as reductions; what matters is historic performance in the absence of a target. The Bush administration's climate policy illustrates this point, as shown in figure A. Along the same lines, legal character has more to do with the effectiveness of a target than whether or not it is an intensity target. Voluntary targets have not succeeded in slowing GHG emissions, but this shortcoming does not in any way implicate intensity targets in general.

FIGURE A | **U.S. HISTORICAL AND FUTURE TRENDS: GHGs, GDP, AND INTENSITY**



Note: Dashed lines show Bush Administration target projections.
Source: WRI (based on U.S. government projections and Bush administration statements).

- **Scope is an important consideration in assessing the desirability of an intensity target.** Intensity targets may work well at the national level when non-controversial GDP data are available. They also may work well in sectors and firms whose production units are simple and comparable, such as cement, basic metals, and electricity. But intensity targets are less attractive when employed *across* sectors that use different proxies for production or that use production measurements that are difficult to define or understand.

- **Intensity targets can address and reduce long-term cost uncertainty in some respects, particularly for developing countries.** The projections for both emissions and economic growth vary significantly for all countries, but especially for developing countries. Future uncertainty greatly complicates climate change policy, since to some degree the future levels of effort implied by a particular absolute target are unknown. While uncertainty ranges are sizable for projections of future *absolute* emissions, projections of emissions *intensity* are small, and uncertainties in developing countries approximate those of developed countries. But intensity targets appear to be more appropriate and beneficial to developing countries, since uncertainties in absolute emissions projections are smaller in developed countries. This conclusion comes with caveats; it applies more to long-term targets than to short-term targets and more to CO_2 emissions than to methane and nitrous oxide.

- **Intensity targets can work alongside absolute targets in regulatory schemes such as emissions trading, but there is not a clear advantage to doing so.** The theoretical advantage of mixing intensity and absolute targets is to gain the economic benefits of intensity targets—greater cost certainty and cost-effectiveness—for policies such as emissions trading. But even though this approach may be superficially attractive, it does not deliver the benefits imagined. There are other policies that may more effectively mitigate costs and address short-term uncertainty.

- **Intensity targets are attractive instruments for framing climate change policies and linking them to other policy goals. But the potential for confusion creates an imperative for clear communication.** Intensity targets address a political framing issue; they are less likely to be construed as obstructive to economic progress, and intuitively, more amenable to "clean growth." This framing advantage suggests that policymakers may accept more stringent intensity targets than comparable absolute targets, which would be a better outcome. The downside of framing is that intensity targets are easily mistaken as being more stringent than they really are, which—intentionally or not—can result in ambiguity.

1. Introduction

In 1999, the Republic of Argentina announced its intention to adopt a target that would lower greenhouse gas (GHG) emissions to address global warming. This target would exist alongside those targets adopted by the industrialized world as part of the Kyoto Protocol. The Argentine target, however, was unlike the absolute, or "fixed," targets agreed to in Kyoto. Instead, it was designed to allow emission levels to adjust to the underlying fluctuations in economic activity, as measured by gross domestic product (GDP).

Several years later, in 2002, U.S. President George W. Bush pledged a GHG "intensity" target for the United States which, like the Argentine target, did not lock in a fixed emission level. Since then, other countries, companies, and industry associations have adopted, and in some cases implemented, various kinds of GHG intensity targets. In some instances, the intensity target approach was proposed as a desirable alternative to absolute targets, for a variety of reasons.

This report analyzes and evaluates the use of GHG intensity targets as a tool of climate change policy. Numerous other studies have also evaluated the general characteristics and viability of intensity targets (e.g., Baumert et al. 1999; Dudek and Golub 2003; Ellerman and Sue Wing 2003; Philibert, 2002; Pizer 2005). Other works have examined a specific application of intensity targets (e.g., Bouille and Girardin 2002; WRI 2003). This report differs from previous studies in that it analyzes and evaluates intensity targets more broadly on the basis of experiences to date, both in the United States and internationally. It also examines practical implementation issues, such as the interaction of intensity targets with other climate policy tools, in particular emissions trading.

Section 2 of this report describes the concept of GHG intensity through a theoretical overview and international comparisons. Drawing on the literature and actual experiences, section 3 examines the rationales for using GHG intensity in setting targets. Section 4 looks at the specific GHG intensity targets and programs that governments, companies, and industry sectors have adopted and proposed to date. These targets are classified according to a variety of characteristics to enable their comparison. Section 5 evaluates the effectiveness of GHG intensity targets across a range of criteria. This evaluation draws on different rationales for using intensity targets (section 3) and experiences with these targets (section 4). Finally, section 6 presents policy conclusions, with the aim of providing guidance to policymakers on whether and how to adopt GHG intensity targets.

2. What Is GHG Intensity?

2.1. THE CONCEPT

GHG intensity is a simple concept. It is an indicator that measures the quantity of emissions per unit of economic output:

$$\text{GHG Intensity} = \frac{\text{GHG Emissions}}{\text{Economic Output}}$$

GHG emissions are almost always measured in tons of carbon dioxide (CO_2) or CO_2 "equivalent" tons if other GHGs such as methane (CH_4) or nitrous oxide (N_2O) are factored in.[1] The measure of economic output, however, can vary significantly. If the indicator pertains to an industry or firm, output is usually expressed in terms of either physical output (e.g., tons of steel, cement, or aluminum) or an economic metric that approximates physical output (e.g., revenue, sales value). At the national level, economic output is usually quantified as GDP.

In this way, GHG intensity is not unlike performance measures commonly used in environmental policy and everyday life. The efficiency of a motor vehicle, for example, is typically measured in *gallons per mile* (if lower numbers indicate greater efficiency). GHG intensity is a similar kind of performance metric for GHG emissions, as it measures the quantity of emissions *relative to activity levels* and is driven by changes in efficiency and fuels (box 1, page 4).

2.2. INTERNATIONAL COMPARISONS

At the country level, as noted earlier, GHG intensity is typically measured as emissions per unit of GDP. Although emissions and intensity data are publicly available for more than 165 countries (WRI 2006), this section focuses primarily on the top twenty emitting

BOX 1 | DRIVERS OF GHG INTENSITY

The primary factors influencing GHG intensity are energy efficiency and the fuels consumed. As a metaphor, consider the roles of efficiency and fuel use in the "intensity" of automobile use. Emissions intensity will be lower if the car is either more energy efficient (uses less fuel per mile) or is operating on a low or zero carbon fuel. Altering either factor—efficiency or fuel mix—will alter GHG intensity (and absolute emissions). Output (or activity) levels, however, do not directly influence intensity. In the car metaphor, whether one drives a short distance or a long distance will affect fuel consumption and overall GHG emissions, but it will not affect intensity levels.

This equation shows how these factors interrelate on a national level for CO_2, the most significant GHG:

CARBON INTENSITY ↓ ENERGY INTENSITY ↓ FUEL MIX ↓

$$\frac{CO_2}{GDP} = \frac{Energy}{GDP} \times \frac{CO_2}{Energy}$$

National carbon intensity depends first on a country's *energy intensity*, or the amount of energy consumed per unit of GDP. This reflects both a country's energy efficiency levels and its overall economic structure, including the carbon content of imported and exported goods. An economy dominated by heavy industrial production, for instance, is more likely to have a higher energy intensity than one whose service sector is dominant, even if the two countries' energy efficiencies are identical. Likewise, a country that relies on trade to acquire (i.e., imports) carbon-intensive goods has—other factors being equal—a lower energy intensity than do those countries that manufacture those same goods for export.

The second component of emissions intensity is *fuel mix,* or the carbon content of the energy consumed, typically measured in CO_2 per BTU or joule. Coal has the highest carbon content, followed by oil and then natural gas. Accordingly, if two entities are identical in energy intensity, but one relies more heavily on coal than does the other, its carbon intensity will be higher.

Finally, it is important to note that when *non*-CO_2 gases are included in GHG intensity calculations, additional factors beyond energy intensity and fuel mix affect intensities and trends, since emissions of these gases are generally due to processes other than fuel consumption.[1] For instance, CH_4 and N_2O emissions from agricultural sources might be significantly influenced by commodity prices and shifts in international livestock and grain markets.

Notes

1. The same is the case for non-energy related CO_2 emissions, such as CO_2 from land-use change and forestry. These emissions are not likely to correlate well with economic activity.

countries in the absolute sense. This focus is primarily based on magnitude—these twenty countries alone account for more than 75 percent of global GHG emissions—although with respect to intensity, several countries that are not major emitters that are nonetheless significant with respect to intensity (Baumert, Herzog, and Pershing 2005).

Table 1 shows GHG total emissions, emissions intensity, and trends for the top twenty emitting countries. When comparing total emissions and emissions intensity, it quickly becomes apparent that they are quite distinct. Only one country, Ukraine, is in the top twenty with respect to both absolute emissions and intensity. (The top countries with respect to intensity, which table 1 does not show, are either "small island" or least developed countries, in which extreme intensity appears to driven by low GDP.) Among the twenty greatest emitters, GHG intensity varies almost sevenfold. Ukraine is the highest in this group at 2,386 tons per million dollars, while France, at 343, is among the lowest countries in the world. Countries with high absolute emissions may have relatively low intensities and vice versa. For example, Japan ranks fifth in terms of absolute emissions, but 142nd in terms of emissions intensity. On the other hand, Uzbekistan (not shown) with absolute emissions of 181 tons CO_2 ranks 31st in terms of absolute emissions but third in intensity (4,828 tons/million $).

TABLE 1 **ABSOLUTE EMISSIONS AND EMISSIONS INTENSITY**
Top Twenty Emitting Countries, Six Greenhouse Gases, 2000

	Absolute Emissions		GHG Intensity	
Country	**$MtCO_2$ Equivalent**	**World Rank**	**Tons CO_2 eq./ $mil. GDP-PPP**	**World Rank**
United States of America	6,928	1	722	96
China	4,938	2	1,023	150
Russia	1,915	3	1,857	49
India	1,884	4	768	102
Japan	1,317	5	396	61
Germany	1,009	6	482	131
Brazil	851	7	679	63
Canada	680	8	809	77
United Kingdom	654	9	416	127
Italy	531	10	368	75
South Korea	521	11	684	44
France	513	12	338	116
Mexico	512	13	577	95
Indonesia	503	14	805	72
Australia	491	15	1,001	92
Ukraine	482	16	2,369	21
Iran	480	17	1,353	15
South Africa	417	18	999	42
Spain	381	19	436	37
Poland	381	20	946	142
Developed countries	**17,355**		**643**	
Developing countries	**15,701**		**896**	
World	**33,662**		**763**	

Source: WRI, CAIT 3.0 (2006).
Note: GDP-PPP is a gross domestic product measured in purchasing power parity (in constant 2000 international dollars).

A specific look at energy use—an activity dominated by emissions of CO_2 alone, as opposed to the full basket of greenhouse gases—is especially interesting in light of emissions intensity. Table 2 (page 6) shows the drivers of CO_2 intensity— energy intensity and fuel mix—for the top twenty emitting countries. Several European Union (EU) member states, as well as Brazil, have extremely low energy intensities, in part due to economies dominated by lower-emitting service-sector enterprises. By contrast, Russia and Ukraine, with high CO_2 intensities, are characterized by energy inefficiency and larger shares of industrial activities in their overall economies.

Fuel mix likewise has a major influence on national CO_2 intensities (table 2). Coal dominates in some countries (e.g., Poland, China, South Africa); gas prevails in others (e.g., Russia); and other energy sources—like hydropower, biomass, and other renewables presumed to be carbon neutral—are significant in still other countries (e.g., Brazil). France's very low emissions intensity is due in large part to its heavy use of nuclear power.

TABLE 2 | **CO_2 INTENSITY: TRENDS AND DRIVERS**

Country	Carbon Intensity: Tons of CO_2 / \$mil. GDP-PPP	Carbon Intensity: Percent Change, 1990–2002	Energy Intensity: Tons of Oil eq./ \$mil. GDP-PPP	Energy Intensity: Percent Change, 1990–2002	Fuel Mix: Tons of CO_2 / Ton of Oil eq.	Fuel Mix: Percent Change, 1990–2002
Ukraine	1,368	-14	569	-1	2.40	-13
Russia	1,332	-15	537	-13	2.48	-3
Iran	899	17	326	19	2.76	-1
South Africa	823	-2	257	-2	3.21	-1
Poland	757	-43	226	-39	3.34	-7
China	675	-51	219	-54	3.08	7
South Korea	633	-2	258	10	2.45	-10
Australia	630	-16	210	-15	2.99	-1
United States	579	-17	230	-16	2.52	-1
Canada	575	-14	278	-15	2.07	0
Indonesia	513	22	241	1	2.13	20
Mexico	453	-9	180	-10	2.52	1
India	410	-9	200	-21	2.05	16
Germany	400	-29	161	-20	2.49	-10
Spain	381	5	155	6	2.46	-1
Japan	369	-6	157	0	2.35	-6
United Kingdom	363	-29	152	-19	2.39	-12
Italy	306	-10	118	-5	2.60	-5
Brazil	263	17	146	6	1.80	10
France	244	-19	171	-6	1.43	-14
Developed countries	**511**	**23**	**212**	**3**	**2.41**	**-4**
Developing countries	**549**	**12**	**224**	**-10**	**2.47**	**5**
World	**529**	**15**	**218**	**-13**	**2.43**	**-2**

Source: WRI, CAIT 3.0 (2006).
Note: The figures for Russia and Ukraine cover the period from 1992 to 2002, owing to the lack of data for 1990. CO_2 excludes land-use change and forestry and international bunker funds. GDP-PPP is a gross domestic product measured in purchasing power parity (in constant 2000 international dollars).

The impact of fuel mix on CO_2 intensities is often most apparent at the sectoral level. In the electric power sector, CO_2 intensities vary by a factor of more than 20, which largely reflects the differences in the carbon content of fuels favored in different countries (see table 3). Fuel mixes, we should note, are highly correlated with countries' natural endowments of coal, oil, gas, and hydropower capacity (Baumert, Herzog, and Pershing 2005 chap. 8). As a rule, countries tend to use those energy resources that are most readily available. Other factors being equal, countries with large coal reserves rely to a greater degree on coal as a fuel source and therefore emit more CO_2 per unit of electricity than do countries with large natural gas reserves.

Cross-country intensity comparisons and an analysis of intensity trends yield additional observations. First, with with the exception of very low income countries, intensity levels tend to decline over time, driven by efficiency gains from increased economic productivity and, in some cases, sectoral shifts away from resource-intense

TABLE 3 **CO_2 INTENSITY OF ELECTRICITY PRODUCTION, 2002**
(Top twenty GHG Emitting Countries)

Country	Grams CO_2/Kilowatt-hour
Poland	1,071
Australia	946
China	916
India	896
South Africa	849
United States	588
Russia	569
Iran	563
Mexico	542
Indonesia	541
Ukraine	530
Germany	525
Italy	485
South Korea	456
United Kingdom	430
Spain	343
Japan	323
Canada	218
Brazil	67
France	47
Developed countries	**478**
Developing countries	**649**
World	**533**

Source: WRI, CAIT 3.0 (2006).

industries. A declining intensity level means that GDP (or some other measure of economic output) grows faster than emissions. Between 1990 and 2002, intensities fell in most of the major emitting countries (table 2). Globally, CO_2 intensity dropped by 15 percent; the decline was greater in industrialized countries (23 percent) than in developing countries (12 percent).

Second, intensities can *decline* even when absolute emissions *rise*. Although the intensities of most major-emitting countries fell, absolute emissions rose at the same time. In the United States, CO_2 intensity dropped by 17 percent between 1990 and 2002 while CO_2 emissions grew by 18 percent over the same period. Similarly, emissions intensity in China dropped 51 percent while emissions grew 49 percent in absolute terms. By contrast, the European Union (and several of its member states) reduced *both* CO_2 intensity (-23 percent) and absolute emissions (-2 percent) between 1990 and 2002.

Third, the inclusion of non-CO_2 gases boosts all countries' intensity, but at different levels of significance. Emissions intensities—using CO_2 only—are similar when comparing developed and developing countries in the aggregate. But when comparing all six greenhouse gases (without contributions from land-use change and forestry), emissions intensities in developing countries are about 40 percent higher than those in developed countries, owing to higher proportions of non-CO_2 gases—methane (CH_4) and nitrous oxide (N_2O)—in developing countries.

2.3. GHG INTENSITY TARGETS

The concept of "intensity" is commonly used in environmental policy, including in the setting of targets and standards. For example, the Corporate Average Fuel Economy (CAFE) standards in the United States set minimum vehicle performance levels in terms of the number of miles that can be driven per gallon of gasoline. Technology mandates, which are commonly used in clean air policy, are indirectly based on intensity, as any given technology has an implicit and predictable level of emissions performance (Ellerman and Sue Wing 2003).

GHG intensity indicators likewise can be used as the basis of a target. As discussed later, GHG intensity targets can have many variations, including simple linear formulas like the GHG/output equation shown earlier, and more complex variations. Targets can apply at the firm, sector, or national levels.

GHG intensity targets contrast with absolute targets, which limit *total* emissions. Absolute targets are expressed simply as a fixed number of tons of CO_2 equivalent, to be achieved at some point in the future (usually expressed as a change relative to a base year that has a known quantity). As suggested earlier, intensity targets are expressed as emissions *per unit of output* (e.g., GDP, physical production). An intensity target seeks to achieve a particular emissions rate, or level of performance, rather than a specific level of emissions.

3. Rationale for GHG Intensity Targets

Governments, the private sector, and nonprofit analysts offer several rationales for intensity targets. These rationales, all interrelated, include uncertainty reduction, "clean growth," and public perception, each of we examine in this section. Developing countries, industrialized countries, and private entities have different but often related rationales for intensity targets. Whether any of these rationales are adequate justification for *adopting* an intensity target—as opposed to some other form of target—is open to debate and is evaluated in section 5 of this report.

3.1. UNCERTAINTY REDUCTION

The presumptive approach to GHG target setting, as used in the Kyoto Protocol and other climate policy contexts, is a fixed—or absolute—target that specifies a level of emissions to be achieved at some point in the future. This can be problematic, given that business-as-usual (BAU, or "baseline") scenarios—which are necessary to gauge the stringency and economic acceptability of a particular emission target—are inherently uncertain. Achieving a fixed level of emissions at some future year might be very easy under conditions of low economic growth and industrial stagnation but exceedingly difficult if economic growth were robust. Thus, fixed emission targets can entail widely varying levels of effort and cost, depending on prevailing economic conditions. If the target is too stringent, it may constrain economic growth. But if the target is too loose it will have no or even an adverse effect.

The sustained interest in intensity targets has largely been a response to this dilemma (Baumert et al. 1999; Baumert, Herzog, and Pershing 2005; Bouille and Girardin 2002; Kim and Baumert 2002; Philibert 2002; Philibert and Pershing 2002). Intensity targets may reduce the economic uncertainty associated with particular targets by adjusting to economic changes; that is, they allow faster-growing economies (or firms) more emissions and contracting ones fewer emissions. As production increases, allowable emissions also increase; as output contracts, allowable emissions contract. The attractiveness of using intensity targets to reduce uncertainty is demonstrated by the UK Climate Change Levy Agreements (section 4.2). Under that policy, when given a choice between absolute and "relative" (i.e., intensity) targets, nearly all UK companies opted for the latter (de Muizon and Glachant 2004). Uncertainty reduction was also the primary rationale advanced by Argentina for its intensity target (section 4.1).

3.2. CLEAN GROWTH

A second rationale for adopting intensity targets is that they may be more amenable to "clean growth." This argument starts from the position that for many countries, climate change is a less immediate concern than other policy priorities. Developing countries in particular tend to place higher priority on economic expansion, poverty reduction, energy security, and increased mobility (transportation) than on addressing global warming (Bradley and Baumert 2005). Unfortunately, economic growth, along with population growth (considered difficult to influence through policy), exert upward pressure on GHG emissions (see box 2), although emissions reductions and economic growth need not be mutually exclusive.

The "clean growth" rationale is an attempt to reconcile these conflicting priorities and overcome political obstacles. Instead of focusing on growth as the problem, advocates of clean growth focus on policies that accommodate growth while pursuing low-emissions pathways, through improved economic efficiency and the uptake of low-carbon energy and fuels. GHG intensity targets are consistent with this approach, since they frame emissions levels relative to economic activity rather than in absolute terms.

3.3. FRAMING THE TARGET

A final rationale for intensity targets is that they may be a better way to "frame" GHG reduction policies. The rationale arises from the unfortunate fact that emissions almost everywhere across the globe are projected to grow under BAU scenarios, and most dramatically in developing countries, driven (in the absence of dramatic policy changes) by economic growth. As section 6 elaborates, absolute and intensity targets do not by themselves confer any degree of stringency. But absolute targets are frequently construed as "caps," not only on emissions but also on economic prosperity, and are thus deemed undesirable. By contrast, emissions intensity, as discussed in section 2, can be reduced while absolute emissions continue to grow. Given that growth in poorer countries is likely and even necessary, intensity targets might bet-

BOX 2 | FACTORS AFFECTING EMISSIONS GROWTH

One approach to emissions analysis is a formula that expresses emissions as a function of several contributing factors. For example, emissions at a national, economywide scale can be expressed as a function of *population, income* (GDP per capita), and *intensity* (emissions per unit of GDP). As a formula, this relationship may be expressed as follows:

$$CO_2\ \text{Emissions} = \text{Population} \times \underbrace{\frac{\text{GDP}}{\text{Population}}}_{\text{INCOME}} \times \underbrace{\frac{CO_2\ \text{Emissions}}{\text{GDP}}}_{\text{INTENSITY}}$$

This approach illustrates how different economic factors, either individually or in consort, can affect absolute emissions levels. For example, if a country's population and intensity remain constant while its per-capita income increases, emissions likewise will increase.

As discussed in box 1, emissions intensity itself may be expressed as a function of two factors: *energy intensity* (energy per unit of GDP) and *fuel mix* (emissions per unit of energy):

$$\frac{CO_2\ \text{Emissions}}{\text{GDP}} = \frac{\text{Energy Use}}{\text{GDP}} \times \frac{CO_2\ \text{Emissions}}{\text{Energy Use}}$$

Energy intensity encompasses economic efficiency, energy conservation, and overall economic structure. Fuel mix represents the carbon intensity of the fuels that an economy uses to produce energy. Putting the two formulas together expresses CO_2 emissions as a function of all four factors:

$$CO_2\ \text{Emissions} = \text{Population} \times \frac{\text{GDP}}{\text{Population}} \times \frac{\text{Energy Use}}{\text{GDP}} \times \frac{CO_2\ \text{Emissions}}{\text{Energy Use}}$$

This formula is known as the *Kaya identity*, and it shows that different factors can have compounding and mitigating effects on total emissions. For example, relatively small increases in income, population, and fuel mix can result in large increases in total emissions. Conversely, large increases in income growth can be at least partially offset by improved energy intensity or fuel mix. The table below shows how these four factors contributed to changes in emissions over time for selected countries, using a technique called *decomposition analysis*.[1] In this approach, the changes in the contributing factors sum to the change in total emissions; the factor changes are not percentage changes in the factors themselves (outside the context of emissions growth).

	1990–2002 CO_2 Change		Percent Contributions to CO_2 Change			
Country	**$MtCO_2$**	**Percent Change**	**Income (GDP/Pop)**	**Population**	**Energy Intensity (Energy/GDP)**	**Fuel Mix (CO_2/Energy)**
China	1,247	49	15	122	-96	8
United States of America	863	18	16	23	-20	-1
South Korea	246	97	15	84	12	-15
Brazil	125	57	21	17	7	13
Thailand	113	125	16	63	19	27
France	2	0	5	17	-6	-15
United Kingdom	-36	-6	3	24	-20	-13
Ukraine	-291	-48	-5	-32	0	-11

Source: Baumert, Herzog, and Pershing, 2005, chapter 2.

Note

1. Methodology was adapted from Ang 2001 as applied in Baumert, Herzog, and Pershing 2005.

ter reflect the real challenge, namely, the decoupling of economic growth and emissions growth. Philibert (2002) argues that intensity targets could likewise be considered compatible with the environmental strategy adopted by the industrialized countries, which is based mainly on the concept of "de-coupling environmental pressures from economic growth."

Similarly, Pizer (2005) contends that "intensity targets are valuable in terms of how emissions targets are *framed*" (italics in original), including those for the United States and other industrialized countries. Intensity targets, he notes, may be viewed as a kind of performance standard across the entire economy. As discussed in section 4, both the Bush administration and the National Commission on Energy Policy use this rationale for intensity targets in the United States, albeit with very different approaches.

4. Experiences and Proposals

Governments, firms, and industry bodies all have adopted various GHG intensity targets in the worldwide effort to address climate change. The most prominent of these policies are described briefly in this section and then evaluated in section 5. Table 4 summarizes some of the main GHG intensity targets that have been adopted or proposed to date and classifies them according to four characteristics:

- *Target metric* refers to how a target is measured. A target may be measured in absolute (e.g., tons of CO_2 equivalent) or intensity terms. "Simple" intensity targets prescribe a level of emissions per unit of output (e.g., tons of steel, dollars of GDP). Other intensity targets are more complex (see section 4.7). Some policies employ both absolute and intensity instruments in some fashion.
- *Stringency* refers to the level of reductions (absolute or intensity) required for a target over a specified timeframe. The actual level of *effort* required to meet a given target may be difficult to measure and cannot always be easily determined from the target itself.
- *Scope* refers to the emissions covered by a particular target. The scope of a target may be national, sectoral, or companywide, or it may cover only specific facilities. Scope may also be limited with respect to the GHGs covered (e.g., CO_2 only or six GHGs).
- *Legal character* refers primarily to whether or not the target is legally binding. Whether a target is considered to be legally binding, in turn, depends on the consequences for entities if they fail to comply with the target. Legal character also relates to the requirements that a government may impose for measurement, reporting, and auditing.

4.1. Argentina's Voluntary Commitment

In 1999, Argentina sought to adopt an intensity target under the Kyoto Protocol (Argentine Republic 1999). In doing so, Argentina was trying to advance an approach for developing country participation in the Protocol that other countries might then follow. Under Argentina's proposal, its "voluntary" GHG intensity commitment would become legally binding once it was accepted by the Conference of the Parties under the Climate Convention.[2]

Argentina's proposed target was designed to adjust to the country's actual economic growth, measured by GDP. However, the Argentinean intensity target was not linear. Instead, it adjusted emissions by the *square root* of GDP.[3] In other words, emissions could grow according to GDP, but at a slower and declining rate. In part, this approach tried to accommodate Argentina's agriculture sector, which accounted for about 40 percent of its GHG emissions, and whose effect on emissions was different from that of other economic sectors (Bouille and Girardin 2002).

One of the main reasons for adopting this controversial and complex approach was to try to achieve some level of certainty regarding the level of effort required by the target (Bouille and Girardin 2002). To help formulate the target, Argentina undertook technical studies that analyzed nine different scenarios for future economic growth as well as growth in the agriculture sector. Policymakers then examined three different forms of target options for Argentina: fixed (absolute), "simple" intensity, and the square root of intensity. Only the last approach entailed no risk of an overly stringent target and no possibility of "hot air" (whereby Argentina would not have to take any action to meet the target) (Bouille and Girardin 2002).

Argentina ultimately abandoned its proposal for several reasons. First, other developing countries resisted it in order to avoid being pressured to follow Argentina's example. Second, there was no procedural opportunity to advance the proposal under the Kyoto Protocol, given that the treaty was not in force at the time (precluding the

TABLE 4 | SELECTED GHG INTENSITY TARGETS

Entity/Agreement/Proposal	Target Metric	Stringency	Scope	Legal Character
Kyoto Protocol (1997)	Absolute	Country-specific targets; collectively 5% below 1990	International/ national	Binding
Argentine Target (1999)	"Dynamic" intensity	2%–10% below BAU in 2008–2012[1]	National	Provisionally binding[2]
United Kingdom Climate Change Levy Agreements (CCLA)(2002)	Intensity (energy or GHG)[3]	4.5% to 59% below historical levels by 2010 (average of 12% below 2000)	Firms and industrial facilities	Binding once agreed
Bush Administration (2002)	Intensity	-18% GHG intensity, 2002–2012	National	Voluntary
National Commission on Energy Policy (NCEP)(2004)	Intensity and absolute	-22% GHG intensity, 2010–2019 (–2.4%/year)	National	Binding
Voluntary Aluminum Industry Partnership	Intensity	-25% GHG/ton aluminum, 2000–2010	Sectoral (international)	Voluntary
Portland Cement Association	Intensity	-10% CO_2/ton cement, 1990–2020	Sectoral (U.S.)	Voluntary
General Electric Company	Intensity and absolute	-30% intensity, 2004–2008 -1% total GHG, 2004–2012	Firm (international)	Voluntary
Holcim (U.S.) Inc.	Intensity	-12% GHG/ton cement, 2000–2008	Firm (U.S.)	Voluntary

Notes: The Kyoto Protocol is shown for comparison purposes. See also figures 5 and 6 for additional sectoral and firm targets.
[1] The Argentine stringency cannot be expressed as a pure intensity reduction owing to its non-linear formulation.
[2] Argentina proposed a "voluntary" target that would be binding after being accepted by the Conference of the Parties to the UNFCCC.
[3] Some UK CCLA targets were also agreed to in absolute terms.

possibility of an amendment). Eventually, changes in government and economic collapse in Argentina removed the proposal from discussion.

4.2. UK CLIMATE CHANGE LEVY AGREEMENTS

Intensity targets formed one component of the UK Climate Change Programme, which was promulgated in 2000. This rather complex program included a climate change levy,[4] negotiated agreements with industry, and emissions trading. A cornerstone of the program was a series of negotiated agreements—called Climate Change Levy Agreements (CCLAs)—to deal with emissions in energy-intense industrial sectors such as metals, chemicals, paper, cement, and glass. CCLAs were eventually concluded with dozens of industry associations, as well as subagreements covering thousands of firms or industrial sites.

In essence, CCLAs entitled industry to an 80 percent rebate on the climate change levy in exchange for adopting a GHG or energy consumption target (ranging from -4.5 to -59 percent reductions below historical levels by 2010). Participating sectors were given the option of agreeing to the target in terms of energy use, GHG emissions, or *intensity* (either energy or GHG intensity). All but two industry sectors opted for intensity targets (or, in the parlance of the UK system, "relative" targets), given that these targets were viewed as more "growth friendly."

By signing a CCLA, a firm became eligible to participate voluntarily in the UK Emissions Trading Scheme (ETS), which also included a cap-and-trade component and other provisions for other firms not covered by CCLAs. If CCLA participants exceeded their target, they could sell credits to other entities in the system. Conversely, participants could also purchase credits or allowances from certain other entities to help achieve compliance with the CCLA targets (see section 5.4 and box 4).

As of 2007, the UK ETS will cease to operate and will be subsumed by the EU-wide trading system.[5] The EU ETS—in operation since January 1, 2005—covers 11,500 emitting sources across the EU, but does not include any kind of intensity targets.

4.3. BUSH ADMINISTRATION TARGET

In 2002, U.S. President George W. Bush announced a national GHG intensity goal. Specifically, the president's initiative called for an 18 percent reduction in GHG intensity between 2002 and 2012, which would lower emissions from 670 metric tons per million dollars of GDP in 2002 to 553 metric tons per million dollars of GDP in 2012 (Bush Administration 2002, converted to CO_2 equivalents).

The administration's reason for adopting this target is a mix of the "clean growth" and framing rationales discussed in section 3. The administration supported its choice of target as a "better way to measure progress" on emissions reductions, presumably because an intensity indicator "expands" along with economic growth. The administration's suggestion that economic growth could be "tapped" to reduce emissions also suggests a clean growth rationale. The use of framing is reflected in the administration's suggestion that its target did not pit "economic growth against the environment."

Another aspect of the Bush administration's target is that it is voluntary. Instead of mandatory regulations, it relies on sector- and corporate-level initiatives (discussed in part in sections 4.5 and 4.6). It is unclear what consequences would result if the target were not attained. According to the administration, "If, in 2012, we find that we are not on track toward meeting our goal, and sound science justifies further policy action, the United States will respond with additional measures" (2002).

4.4. NATIONAL COMMISSION ON ENERGY POLICY

Founded in 2002, the National Commission on Energy Policy (NCEP) is a bipartisan group of twenty leading energy experts representing industry, government, academia, labor, consumers and environmental protection.[6] In 2004, the NCEP published "Ending the Energy Stalemate: A Bipartisan Strategy to Meet America's Energy Challenges," a plan to address the interrelated challenges of energy, national Security, and climate change.

To limit U.S. emissions, the NCEP (2004) recommends an "environmental target based upon annual reductions in emissions intensity." According to the NCEP, "between 2010 and 2019, the target should be set to reflect a 2.4 percent annual reduction in GHG emissions per dollar of GDP. Meeting this target would slow emissions growth from the currently projected rate of 1.5 percent per year to 0.4 percent per year." After the 2010–2019 phase during which GHG growth would slow, the NCEP (2004) includes a post-2020 "stop phase," during which intensity would decline at 2.8 percent per year, roughly equal to economic growth forecasts (thereby implying stabilization of U.S. emissions). The proposal also calls for a "reverse phase" sometime after 2020.

The NCEP intensity target would be national in scope, mandatory, and implemented through an economywide permit trading program, with emissions levels determined in advance "based on available GDP forecasts." The use of GDP forecasts to set emissions levels, rather than actual GDP, means that in practice the NCEP proposal is an absolute target, with target levels that reflect a desired intensity reduction path. The NCEP's recommendations suggest that actual economic performance would not adjust the emissions limit once its regulations were implemented, and thus that the target's intensity-based emissions path would have no operational effect on the policy. Therefore, "framing" appears to be the operative rationale for the NCEP's use of the intensity target.

4.5. SECTORAL TARGETS

Sectoral intensity targets are relatively common in European and other countries that use negotiated agreements, under which industry avoids regulation only by voluntarily conforming to certain emissions or other standards. This was the case with the UK CCLAs, discussed earlier.

In the United States, nine industrial sectors—aluminum, automobile manufacturing, cement, chemicals, electric power, forest products, lime, minerals, and railroads—have intensity targets (see table 5). Two sectors—steel and oil and gas—have energy efficiency targets. These targets (and several other sectoral pledges) are part of Climate VISION, a public–private partnership initiative launched by the U.S. Department of Energy in 2003.[7] Under Climate VISION, industry trade associations and other groups pledge targets and other policies as contributions to the Bush administration's GHG intensity target. Again, these are voluntary targets and are not enforced by any regulations. Some industry associations, however, undertake evaluations and request data from their member companies.

Aluminum is the only industrial sector that has committed to voluntary GHG targets at the international

TABLE 5 | INTENSITY TARGETS UNDER U.S. CLIMATE VISION INITIATIVE

Sector	Target Metric	Stringency/ Timeframe	Pledging Industry Group	Percent Sector Covered (U.S.)
Aluminum	GHGs (excluding energy) per ton of aluminum	53% below 1990 levels by 2010	Voluntary Aluminum Industry Partnership	98
Automobile manufacturing	GHGs per vehicle produced	10% below 2002 levels by 2012	Alliance of Automobile Manufacturers	90
Cement	CO_2 per ton cement product	10% below 1990 levels by 2020	Portland Cement Association	95
Chemicals	GHGs per unit production	18% below 1990 levels by 2012	American Chemistry Council	90
Electric power	GHGs per megawatt hour	3% to 5% below 2000–2002 levels by 2010–2012	Six different trade associations ("Power Partners")	100
Forest products	Not specified	12% below 2000 levels by 2012	American Forest & Paper Association	—
Lime	CO_2 from fuel combustion per ton product	8% below 2002 levels by 2012	National Lime Association	95
Minerals	GHGs from fuel combustion per ton product	4.2% below 2000 levels by 2012	Industrial Minerals Association, N. America	60–100[1]
Oil and gas (refining)	Energy per unit production	10% below 2002 levels by 2012	American Petroleum Institute	—
Steel	Energy per ton steel produced	10% below 1998 levels by 2012	American Iron and Steel Institute	70
Railroads	Transport-related GHGs per mile	18% below 2002 levels by 2012	Association of American Railroads	100[2]

Sources: Climate VISION (http://www.climatevision.gov/) and association websites.
Notes: [1] 80% of soda ash, 100% of borates, and 60% of merchant sodium silicates. [2] Represents Class I freight railroads. "—" means unknown.

level. This was done through the International Aluminium Institute (IAI), which represents twenty-six member companies which collectively account for 80 percent of global primary aluminum production. Key climate change targets include an 80 percent reduction in PFC emissions per ton of aluminum produced and a 10 percent reduction in smelting energy usage per ton of aluminum produced. Both targets apply to the industry as a whole and are to be reached by 2010 (using 1990 as a base year). The IAI has a team of experts that advise and assist member companies and report the results.

4.6. CORPORATE TARGETS

Many companies have adopted GHG intensity targets. In the United States in particular, the federal government has encouraged the private sector to adopt such targets voluntarily, in the absence of mandatory regulations. Many companies that have adopted GHG intensity targets have done so through the EPA Climate Leaders program.[8] Forty-six Climate Leaders companies have adopted GHG limitation goals, twenty-five of which are intensity-based targets. With the exception of four multinational companies, all targets are limited to U.S.-based emissions.

Corporate intensity targets vary in many ways, including their apparent stringency, time table, and production unit used in the "denominator" (see table 6, page 14). Although more than half the Climate Leaders participants adopted GHG intensity goals, some of these are likely to lead to absolute reductions in emissions. In particular, the EPA "projected that four of the five firms that were expected to reach their goals in 2005 would also achieve absolute emissions reductions, even though only one of them has an absolute target" (GAO 2006).

TABLE 6 | **SELECTED CORPORATE INTENSITY TARGETS, U.S. EPA CLIMATE LEADERS PROGRAM**

Company	Target Metric	Stringency/Time Frame	Scope/Applicability
Baxter International, Inc.	GHG per unit of production value (plus an absolute target)	16% below 2000 levels by 2005 (5% absolute reduction by 2012 relative to 1990)	U.S. production
Caterpillar, Inc.	GHG per dollar revenue	20% below 2002 levels by 2010	Global operations
General Electric Company	GHG per dollar revenue (plus an absolute target)	30% below 2004 levels by 2008 (1% absolute reduction by 2012)	Global operations
Holcim (U.S.) Inc.	GHG per ton of cement	12% below 2000 levels by 2008	U.S. production
SC Johnson	GHG per pound product	23% below 2000 levels by 2005	U.S. production
Volvo Trucks North America, Inc.	GHG per truck produced	23% below 2000 levels by 2010	U.S. production

Source: U.S. EPA, 2006 and company websites.

4.7. OTHER APPROACHES

The literature on GHG intensity targets suggests additional options beyond the experiences discussed above. First, several analysts discuss GDP *indexed* targets, under which "for every percentage point in GDP growth that is higher or lower than forecast, the [absolute] emissions target is raised or lowered by a corresponding amount" (Frankel 1999). An indexed target is thus conceptually similar to a simple intensity target, but it has more flexibility. Frankel (1999) and Philibert and Pershing (2002) suggest that the indexation could be "less than proportionate." Thus, a target could be more stringent in the event of high economic growth, but less stringent in the event of economic contraction. This is one way to avert the risk—as pointed out by Müller, Michaelowa, and Vroljik (2001) and Dudek and Golub (2003)—that an intensity target would require the greatest effort when economic growth—and therefore capacity—is lowest.

Second, Lutter (2000) and Kim and Baumert (2002) modified the basic formula for an intensity target as follows:

$$\text{Intensity Target} = \frac{\text{GHG}}{\text{GDP}^{\alpha}}$$

Here, α is an exponent that determines the degree to which the allowable emission level changes in response to GDP. If the α coefficient is 1, the relationship is linear; a 1 percent increase in GDP raises the allowable (absolute) emissions by 1 percent. If α is less than 1 (but still positive), increases in GDP allow increases in allowed emissions, but at a lower, decreasing rate. Statistical tools could be used to determine an "optimal" coefficient value, based on the historic relationship between emissions and GDP in a given country. Argentina used a variant of this approach (section 4.1), in which α was set at 0.5, which is the same as the square root of GDP. Based on a statistical analysis, Lutter (2000) proposed an α value of 0.6 for universal application to all countries.

These techniques—"less than proportionate" indexing and GDP coefficients—are quantitative refinements of a linear intensity target. Both techniques attempt to reduce the uncertainty associated with target setting in general, and avoid economic harm from intensity targets during economic decline in particular.

5. Evaluation

This section evaluates GHG intensity targets across several criteria. Are intensity targets an effective approach to setting targets? Are the various rationales for adopting intensity targets valid, and if so, under what circumstances? How would intensity targets be implemented and made consistent with emissions trading programs?

A cross-cutting feature in the evaluation is reference to *absolute* targets. As discussed in section 3, intensity targets are often advanced as an alternative to absolute targets. Accordingly, an important task for policymakers is deciding which approach is more effective and appropriate, and for this reason, the two approaches are frequently contrasted.

5.1. ENVIRONMENTAL EFFECTIVENESS

The predominant policy question concerning intensity targets is their environmental integrity. On this point, there is significant confusion and misunderstanding. At the most basic level, as discussed in section 4, intensity targets should be understood as a *form* (or metric) for a target. A target's form is distinct from its stringency and legal character, and as will be illustrated, these last two factors are greater determinants of environmental effectiveness than the target's form.

A notable feature of intensity targets is that the ultimate environmental outcome cannot be known in advance with certainty. (The only exception to this is if the intensity target is "fixed" in advance using GDP projections; see the NCEP proposal in section 4.4). This "environmental uncertainty" is due to the fact that actual output (e.g., GDP, steel production) determines the quantity of emissions ultimately allowed. This characteristic, which does not apply to absolute targets, is often criticized as a shortcoming of intensity targets. For instance, Dudek and Golub contend that an intensity target "increases the risk of climate change, as [it] leaves the emission levels uncertain" (2003). This commonly held view, however, is the product of two fallacies.

First, it confuses the *certainty* of an outcome with the *quality* of an outcome. A precise environmental outcome, which might be achieved through an absolute target, may be precisely good or precisely bad. Given the long-term nature of the climate problem, achieving exact near-term GHG emission levels is not an essential feature of an environmentally effective target (Pizer 1999). Many fixed targets adopted under the Kyoto Protocol by former Soviet Union and Eastern European countries, such as Russia and Ukraine, may provide certain environmental outcomes, but perhaps not particularly good ones.

Second, and related to the first fallacy, this view confuses the *form* of a target with its *stringency*. An intensity target is not inherently weaker with respect to stringency. If GDP growth (or another output metric) is higher than expected, that the amount of allowed emissions will be higher. However, if GDP growth is less than expected, the amount of allowed emissions likewise will be less. Thus, intensity targets per se cannot be less environmentally effective than absolute targets. In the same vein, environmental effectiveness depends more on the target's legal character than on its form. A target with voluntary or lax compliance measures is less likely to be effective than one with strong compliance measures, regardless of its form.

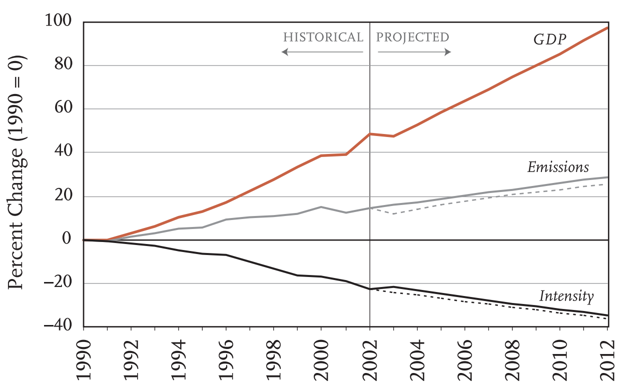
Philibert (2002) even contends that the use of an intensity measure (or other flexible approaches) may result in *more* stringent targets and, therefore, better environmental outcomes. This contention arises from the prospect of reduced uncertainty over abatement costs from using intensity rather than absolute targets (see section 5.3). Given governments' aversion to risk, an absolute target could create an incentive for countries to negotiate towards a weak target that ensures no economic harm. From a theoretical perspective, Jotzo and Pezzey (2005) reach the same conclusion.

The reaction to the Bush administration's target illustrates these important distinctions. The World Resources Institute analyzed the Bush administration target in 2002, the year after it was announced (WRI 2003). To assess its environmental effectiveness, WRI used the U.S. government's GDP projections to estimate what the allowable emissions would be (in absolute terms) under the target. The results showed that under the Administration's intensity target, absolute emissions would be allowed to grow more than 14 percent over ten years, nearly identical to historical trends, and therefore the target implied negligible stringency (see table 7, page 16). The government's own economic forecasts also suggest that the target does not imply significantly different outcomes from what would happen under "business as usual" scenarios (see figure 1, page 16). Thus, although the Bush

TABLE 7	HISTORICAL CHANGES VERSUS BUSH ADMINISTRATION TARGET	
Indicator	**Historical (1990–2000)**	**Bush Target (2002–2012)**
GDP	37.0%	38.6%
GHG emissions	14.2	14.3
GHG intensity	-16.7	-17.5 [1]

Source: WRI, 2003 (based on U.S. government data).
Notes: All figures are percentage changes over a 10 year period.
[1] The stated target is -18 percent, but the actual figure (to the first significant digit) is -17.5 percent.

FIGURE 1 | U.S. HISTORICAL AND FUTURE TRENDS: GHGs, GDP, AND INTENSITY



Note: Dashed lines show Bush Administration target projections.
Source: WRI (based on U.S. government projections and Bush administration statements).

target is framed as a reduction, it does not represent a stringent policy with respect to historical trends in either total emissions or emissions intensity. This, however, is a feature of the magnitude of the target, not the form of the target itself.

The environmental community and other observers have criticized the Bush target on several grounds. One of their main lines of criticism is that the chosen form of target shows a reduction that likely would have been achieved even without any policy, implying that intensity targets are therefore intrinsically flawed. But these criticisms pertain more to the policy's *stringency* than to its *form*. To illustrate, it is unlikely that environmental advocates would have been opposed to the target had it been a mandatory 35 or 40 percent reduction in GHG intensity over ten years. Using the administration's GDP assumptions, such an intensity target would have implied significant absolute reductions, about 10 percent below 2002 levels by 2012.

Thus, when evaluating any GHG limitation policy, it is important to distinguish among the form, stringency, and legal character of the proposed actions. A particular form of target, such as intensity, may be environmentally strong or weak and may be mandatory or voluntary. Indeed, the Argentina case illustrates a reasonably stringent intensity target for a developing country, calling for real reductions relative to all future scenarios examined, and which would become legally binding upon acceptance by the international community (see section 4.1).

For environmental performance, what matters overall is that targets are set at reasonably stringent levels and subsequently are met. This may be achieved with absolute or intensity targets. The more difficult challenge for environmental effectiveness is simply ascertaining what a target's stringency is, and what level of effort is required by governments or companies to achieve that target.

5.2. COMPLEXITY AND PUBLIC UNDERSTANDING

From a technical standpoint, intensity indicators are no more complex than absolute indicators. Assuming the underlying data are robust, both forms are easy to calculate and convert from one to another. But intensity targets do present difficulties with respect to how they are communicated and perceived by both the public and policymakers, and these additional challenges have implications for their application and usefulness.

One difficulty arises from the simple definition of intensity; it is defined in terms of production in the denominator, which can be quantified in several ways. Some measurements of production may not be well understood or transparent, such as "sales revenue" or "production unit," or they may not entirely circumscribe emissions from all production processes. Even GDP may not be entirely clear in countries where robust economic data are not available.

A second difficulty arises from the fact that although absolute and intensity indicators are fundamentally different, they are used to analyze and communicate the same policy terrain, sometimes side by side. The difference between the two can and has been lost, especially if communicators do not fully understand the policy context. For example, in some instances, it appears that editors have removed the word *intensity* from the text, because they consider it either superfluous or confusing. For instance, several years after the Bush administration first announced its intensity target, major media outlets continue to refer to the target as an "emissions" reduction.[9] In other instances, public and private policymakers themselves may—intentionally or not—perpetuate this distortion.

A final difficulty relates to historic trends in intensity and the baseline by which policymakers tend to evaluate progress. As shown previously, national level emissions intensity tends to decline over time, regardless of whether total emissions rise or fall. As figure 1 suggests, the stringency of an intensity target should therefore be evaluated with respect to historic trends and projections, not whether the target is positive or negative in the absolute sense. This requirement poses unique challenges. Intuitively, policies that depict reductions are construed as "good" in some abstract sense. But this is not the case with intensity targets; analysts must account for historic trends to assess them accurately.

The additional complexity inherent in intensity targets has at least three implications, all of them potentially adverse from a climate protection point of view. First, and perhaps most important, a complex target may make it easier for companies or governments to adopt targets that lack stringency. Dudek and Golub (2003), for instance, consider that intensity targets may be "a way to simply wrap up a weak environmental policy and make it look better." In this way, policymakers that are averse to significant action on climate change might gravitate toward a complex approach like intensity targets. Furthermore, when intensity targets are communicated, they can be framed positively as "reductions" even when absolute emission levels are likely to increase. Given some stakeholders' inability to comprehend the policy (and the media to report it), accountability may be elusive.

A second implication is that the stringency of some intensity targets is hard to evaluate. This is particularly true when the denominator of an intensity target is something like "sales revenue" or a composite production index, the details of which may be known only to insiders. For example, the target adopted by Baxter International Inc., under the U.S. Enviornmental Protection Agency's Climate Leaders program, is expressed as emissions per unit of "production value," which "equates to cost of goods sold, adjusted for changes in inventory, business acquisitions, divestitures, and inflation" (U.S. EPA, 2006).[10] The difficulty is determining whether the improvements result from the actual efforts to reduce emissions and improve efficiency or from exogenous changes, such as the market value of products, changes in accounting, or fluctuations in taxes, tariffs and exchange rates. At the national level, some of the more complex variants of intensity targets—such as the Argentine or other indexing proposals—entail particular challenges for judging stringency, since the target does not have a linear relationship to production levels. By contrast, intensity targets specified as uniform commodities—for instance, tons of produced steel, cement, or aluminum—are relatively easy to evaluate.

A third and final implication of complexity is the added difficulty it could bring to climate negotiations, especially if intensity targets were being proposed by many parties. At the international level, countries might advance both different percentage reduction commitments (as in Kyoto) *and* different GDP adjustment provisions, as did Argentina. Negotiations would become exceedingly complex in such a case, to the point that nonspecialists, or indeed anyone other than a few climate negotiators, would have difficulty understanding the proposed commitments. Indeed, such a negotiation might never get off the ground. In the words of one observer, "complexity can kill even the most intellectually brilliant proposal" (Depledge 2002). At the sectoral or firm level, intensity targets might complicate the coordination of sectoral or corporate commitments, since targets would likely be expressed in terms that would be difficult to compare, such as tons of steel or cement or volumes of finished products.

5.3. COST UNCERTAINTY

The issue of cost *magnitude* (which is related to stringency) is distinct from the issue of cost *certainty*. As discussed in section 3.1, one of the rationales for using intensity targets is to minimize the cost uncertainties that arise from unknown future economic growth rates. Any fixed emissions target would likely be more ardu-

BOX 3 | ALTERNATIVE APPROACHES TO REDUCING COST-UNCERTAINTY

A commonly suggested mechanism for addressing cost uncertainties is a *price cap*, sometimes known as a safety valve (Pizer 1999). A price cap applies to emissions trading programs, in which a government creates and distributes a limited amount of emission allowances. Market forces determine the price of emissions and, by implication, the cost of abatement. A price cap places an upward limit on the price of emission allowances, thereby increasing in advance the certainty concerning the costs for a given target. If allowance costs exceed the cap (e.g., $50 per ton of CO_2), the government may issue additional emission allowances rather than require more costly emission reductions. In such an instance, using the price cap would allow GHGs to exceed the target level, effectively transforming an absolute target into a dynamic target.

A second approach to reducing cost uncertainty is dual targets (Kim and Baumert 2002), under which a country (or regulated entity) has two emission targets instead of one. The lower (more stringent) target is provides an incentive to reduce emissions, since reductions below this target would enable the sale of emission allowances. The higher (less stringent) target has a punitive function; emitting in excess of this target results in non-compliance. Thus, the lower target would be a selling target, and the higher one, a compliance target. No penalty (or benefit) would be assessed if emissions fell between the two targets. This area would be a "safe zone," in which the country or regulated entity would be neither out of compliance nor able to sell allowances through emissions trading. Assuming that this zone is designed to accommodate the range of uncertainty in growth projections, the dual target approach would address many of the concerns regarding costs, while still providing an incentive to reduce emissions beyond the minimum required.

ous—and thus more costly—under rapid economic growth than under relatively slow or negative growth. By inference, if future economic performance is unknown, then the cost implications of a fixed emissions target also are unknown. Intensity targets thus have been suggested as one means of addressing this cost uncertainty, although other options are available to policymakers as well (box 3).

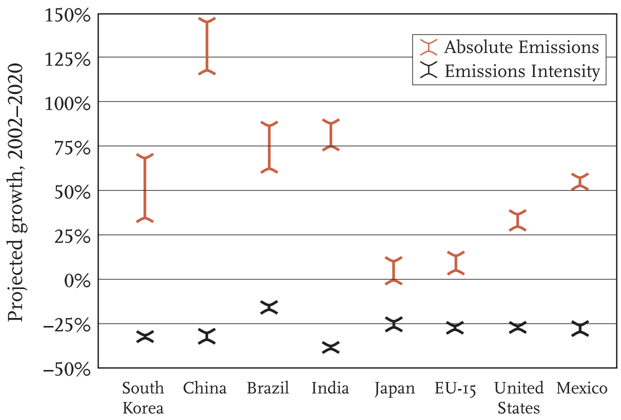
The question of whether intensity targets actually reduce cost uncertainty relative to absolute targets has several different dimensions. First, do intensity targets provide greater cost certainty for countries considering national targets? Second, do intensity targets provide a more predictable pathway for countries to achieve a future emissions level? Finally, do intensity targets at the corporate or sectoral level provide greater cost certainty for firms?

To ascertain the feasibility of any emissions target, countries must consider projections of future economic and population growth, since both are strong drivers of emissions. By nature, however, projections of population growth and especially economic growth entail at least some degree of uncertainty. Consequently, emissions projections are uncertain as well, and vary significantly depending on underlying assumptions. In the face of uncertainty, countries are—understandably—reluctant to embrace emissions targets that would entail unknown costs.

Figure 2 shows the emissions growth of selected countries and regions, in both absolute and intensity metrics, for economic projections developed by the U.S. Energy Information Administration (EIA). The height of each bar indicates the significant yet still plausible differences reflected in the underlying scenarios. As the figure shows, different countries have significantly different ranges of outcomes concerning *absolute* emissions projections, and developing countries generally have greater ranges than do developed countries. For instance, the ranges of emissions in China and South Korea are four to five times as large as those in the United States, Mexico and Europe. These ranges are substantial; the range in China is the equivalent of half its CO_2 emissions in 2002. The ranges are even greater in out-year projections, 2025 and beyond.

By contrast, the uncertainty ranges in projected *intensity* levels exhibit much less variation, especially for developing countries. The uncertainty bands range from one percentage point (United States, India, and South Korea) to four percentage points (Mexico). In addition, research by Lutter (2000) concluded that forecast errors decline as the size of an economy grows, suggesting that the projections of more developed countries may exhibit greater certainty than those of less developed countries. Thus, although greater cost certainty has at least some benefit

FIGURE 2 | **UNCERTAINTY IN CO_2 EMISSIONS PROJECTIONS**



Source: U.S. Department of Energy 2006, app. A.

for most countries, developing countries seem to benefit more than do developed countries in this respect.

These observations merit two caveats. First, there is reason to doubt the reliability of all projections, both intensity and absolute, and the EIA's past CO_2 projections have a mixed success record. Indeed, for its projections made in 1995 for the year 2000, none of the eventual emissions in 2000 were even within the EIA's high-to-low range of forecasts (Baumert, Herzog, and Pershing 2005).[11] It also seems doubtful that the extreme precision seen of the EIA's intensity forecasts reflects the full range of plausible outcomes. Overall, the uncertainty levels shown in figure 2 are probably understated. Second, the forecasts shown are for energy-related CO_2 only, not for non-CO_2 emissions and CO_2 from land-use change and forestry. These other gases and sources have a much weaker correlation with GDP, suggesting that intensity projections are less reliable for those countries with significant shares of these emissions. The Argentine case supports this, as policymakers had to resort to a complex intensity formulation in order to mitigate uncertainty.

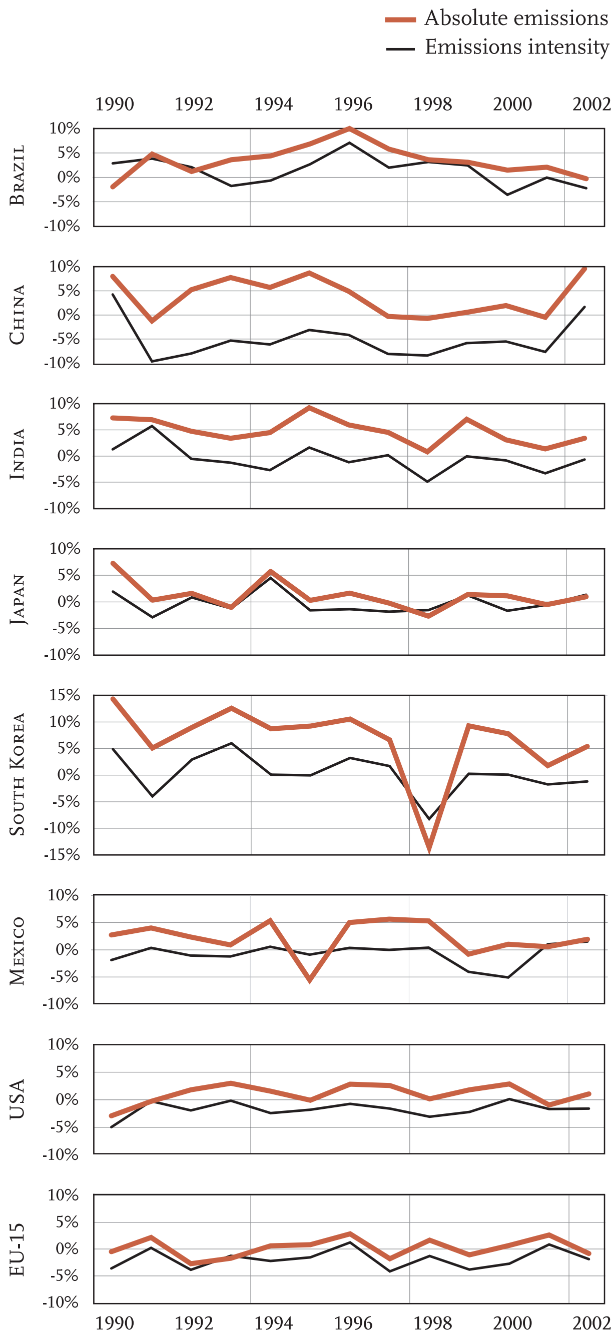
A second country-level consideration is whether intensity targets might provide a more certain *pathway* to emissions reductions (e.g., X percent per year over several years), as distinguished from a future emissions *target* (e.g., X percent by a future date with no intermediate yearly commitments). For example, the Chicago Climate Exchange, an emissions trading system, set an overall reduction goal of four percentage points below baseline between 2003 and 2006, thereby reducing emissions by 1 percent per year with annual compliance periods. Other proposed policy mechanisms, such as the trading system proposed by the NCEP, imply an emissions target that rises in annual increments to reach a longer-term target (NCEP 2004).

In this respect, the consideration is whether intensity targets provide more certainty than do absolute targets on an intermediate basis, as opposed to a long-term basis. To assess this type of certainty, we must look at year-to-year emissions growth compared with year-to-year changes in emissions intensity. Figure 3 (page 20) shows annual changes in absolute emissions and emissions intensity for the same countries and regions shown in figure 2. Each line's height shows the *rate* of growth (or decline), and each line's evenness shows the *predictability* of growth (or decline). Hypothetical perfect certainty for either absolute emissions or emissions intensity would appear as a flat line, either above zero for positive growth or below zero for negative growth.

Even though it may be intuitive to assume that intensity offers smoother performance in regard to certainty, this does not appear true to the degree we might expect. In all countries and regions, intensity as well as emissions varied significantly on an annual basis. In China and India, intensity varied more than absolute emissions; in the European Union, variation was the same. In Mexico and South Korea, intensity performance was noticeably better during significant but short-term economic shocks. For the remaining countries, the performance difference between intensity and absolute emissions growth was perceptible but slight.

A final consideration is whether intensity targets provide greater cost certainty to firms at the corporate or sectoral level. In firms and sectors with carbon-intensive production inputs, such as energy or resource extraction, the correlation between emissions and production is undoubtedly strong. Consequently, intensity targets would be especially attractive in these sectors since the target would remain constant even in the face of higher (or lower) than projected growth. This theory is supported by the industry sectors that have made voluntary intensity-based commitments under the U.S. Climate VISION program, almost all of which involve manufacturing or natural resource extraction. Under the UK Climate Change Levy Agreements (section 4.2), nearly all firms opted for in-

FIGURE 3 | ANNUAL CHANGES IN HISTORICAL CO_2 EMISSIONS



Source: WRI, CAIT 3.0 (2006).

tensity targets when given a choice between an absolute or intensity (de Muizon and Glachant 2004).

However, intensity targets may not appeal equally to all firms. For diversified corporations that produce a variety of products, an intensity target may not provide sufficient cost certainty if, for instance, energy use varies widely across their production processes. For example, 3M, General Electric and several other diversified manufacturers have adopted voluntary, absolute emissions targets under the U.S. EPA's Climate Leaders program. Service firms and firms for which a large share of emissions come from building use (such as retailers) may find that their emissions do not correlate well to production levels, and consequently, may opt for absolute targets.

5.4. IMPLEMENTATION: INTERACTIONS WITH EMISSIONS TRADING

Emissions trading has emerged as one of the preferred policy instruments to address climate change. Emissions trading programs have emerged in Europe, the U.S. states, and Australia and also have been used by firms as internal policies. The proximate goal of any emissions trading programs is to reduce the cost of implementing a particular emission target or other legally binding obligation.[12] Accordingly, policymakers would want a smooth harmonization between intensity targets and emission trading for both intergovernmental and private (domestic) entities. At the intergovernmental level, how would trading work between *countries* that have adopted intensity targets? At the entity level, how would trading work across domestically *regulated entities* that may have intensity targets?

At both levels, the tradable unit requires a definition. In practice, the tradable unit with intensity targets should be identical to that of absolute targets, with "allowances" or "credits" denominated in units of CO_2 equivalent (i.e., there are no tradable "intensity units"). Thus, even where intensity targets are used, actual trading must be in absolute units. But this requirement presents a difficulty for intensity targets, which are based on production levels at some point in the future. For an emissions market to work, emissions levels must be transformed into a tradable commodity, even though the ultimate number of allowed permits would be unknown during the market operation.

In this context, trading with intensity targets can be implemented in at least two ways. One way of addressing trading shortcomings is by determining the allowable emissions volume immediately prior to the commitment period, based on GDP or other output projections (similar to the approach suggested by the NCEP; see section 4.4). In this way, an intensity target is transformed into an absolute commodity. Although this approach addresses the trading challenge, it may require political negotiations on how to convert targets into absolute quantities (i.e., what projections should be used?). The second option is a postverification trading system, whereby transfers take place *after* GDP or other output measures are verified. Here, trades can still take place prior to the conversion through derivatives contracts (e.g., futures, options) through which the market operates based on expectations of how many allowances would be available at a future date.

To date, the only experience with GHG emissions trading involving intensity targets is under the UK Emissions Trading System (see box 4, page 22). Given the particularities of the UK system, it is difficult to draw lessons applicable to other potential trading systems. But we can make some general observations based on the UK system and the the preceding discussion.

First, emissions trading involving entities with intensity targets is undoubtedly possible, no matter if the framework uses national-level intensity targets, entity-level intensity targets, or a mix of absolute and intensity targets. It is equally clear that a Gateway mechanism like that used by the UK is not required for trading between entities with absolute and intensity targets. To the extent that a policy aims to achieve an absolute emission target in the aggregate, however, such a mechanism may be helpful.[13]

Second, it is possible that some of the cost-reducing benefits of trading could be lost and that liquidity and market performance could be diminished if trading were implemented under intensity targets. This may be particularly true in the initial stages of an immature market. Whether these shortcomings come to pass would depend on how brokers and regulated entities respond to the recognition that the total quantity of allowances is unknown.[14] Could market actors make reasonable expectations about the future quantity of allowances? Would market makers produce appropriate derivative financial products? Would a thick, liquid market develop? What kinds of additional information (e.g., industrial production levels) would the market require?

The answers to these questions will determine whether the market can achieve reasonably stable prices that approximate marginal abatement costs. It is noteworthy that the European Union, with agreement from the UK and major industry groups, decided not to use any intensity targets under the EU trading system that has been under way since January 2005.

5.5. IMPLEMENTATION: DATA VERIFICATION AND COMPLIANCE

Any kind of emissions target entails the measurement and assessment of GHG emissions. Intensity targets, however, require additional data, namely, whatever measure is chosen as the denominator of the emissions target (e.g., physical output or GDP). The burden of measuring and assessing these production data depends on many factors, although the target's legal character is perhaps a threshold consideration. If the target is not binding or part of any trading system, it probably requires little or no regulatory assessment (of either emissions or production data). This is the case with the voluntary sectoral and corporate targets discussed in sections 4.4 and 4.5. Of course, companies may audit their own compliance or hire a third party to do so.

If an intensity target is legally binding or part of a trading system, a higher level of public assurance is needed regarding data quality, including that for production data. Theoretically, intensity targets create an incentive to overstate production levels and/or revenues, thereby artificially lowering reported intensity levels. Most likely, the same level of scrutiny needed for emissions estimates is required for production data (or GDP, at the national level). This might involve third party verification, harmonized accounting standards, and various other regulatory requirements.

Data requirements, of course, depend on the kind of intensity target adopted. Intensity targets for corporate or facility production of a relatively homogeneous product—such as cement, steel, aluminum, or electricity—likely impose relatively light requirements. But for sectors such as chemicals, pulp and paper, and others with heterogeneous product mixes, this assessment may be more complex and ambiguous.[15]

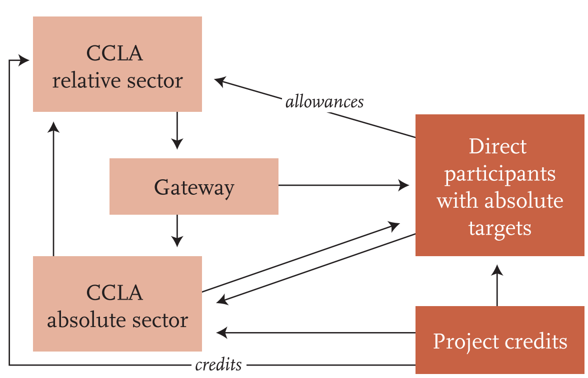
National intensity targets using GDP pose two issues: (1) what is the *unit of measure* for GDP and, (2) can GDP estimates be reliably *verified*? First, unlike cement or

BOX 4 | INTENSITY TARGETS UNDER THE UK EMISSIONS TRADING SCHEME

As discussed in section 4.2, the UK ETS includes both an absolute (capped) and a relative (intensity) sector. The thousands of firms and industrial sites with an intensity target under a CCLA can participate in the trading system (i.e., buy units to help comply with the CCLA or, in the event of overcompliance, receive credits that can then be sold to other entities). During the first two years of the system (2002 and 2003), 946 entities made at least one trade. Most of these entities were firms with intensity-based targets under CCLAs (NERA 2004).

Any trading in the UK ETS between entities in the absolute and relative sectors takes place through a "Gateway" mechanism, under which trades require approval by a public authority (see figure). Transfers are approved only if the net flow of allowances and credits to the relative sector is *positive* (i.e., the capped sector is selling to the relative sector).

UK ETS INTERNAL INTERFACES



In theory, connecting the relative sector with the absolute (cap-and-trade) sector helps reduce costs by allowing marginal abatement costs to be equalized across a greater number of entities. However, because of the gateway mechanism, which provides for "one-way" trading, this benefit is achieved only if the relative targets are more stringent than the absolute targets (in which case the relative sector is collectively a net buyer). In the event that the absolute sector has more stringent targets, the Gateway will prevent the absolute sector from taking advantage of the lower prices that would exist in the relative sector (de Muizon and Glachant 2004).

From an economic perspective, the latter scenario results in higher compliance costs and a less cost-effective market. From an environmental point of view, however, the gateway mechanism is a means of preventing the "contamination" of the caps by intensity targets, which were considered by some to be less environmentally robust (de Muizon and Glachant 2004). During the first two years of the UK ETS, in fact, most CCLA participants with intensity targets were net *buyers* in the market. Overall, the absolute sector was a net seller of allowances worth 1 $MtCO_2$ equivalent to the relative (intensity) sector (NERA 2004). These observations suggest that the gateway has not had a significant adverse effect on cost-effectiveness, although it does entail an administrative cost.

The first two years of experience with the UK ETS, however, suggest that entities with CCLAs (including those with intensity targets) are not price sensitive in the same way as their counterparts with absolute caps. The main purpose of trading for entities with CCLAs is to ensure exemption from the extremely costly Climate Change Levy. Accordingly, most trading activity has taken place near compliance deadlines. With small average purchases and very large consequences for noncompliance, "it would not matter to most firms whether the price were £5, £10, or even £20 per tonne" (NERA 2004). Indeed, some brokers in the UK system have expressed doubt that the market prices accurately reflect actual marginal abatement costs (NERA 2004).

steel, which are measured simply by mass, GDP can be measured in many ways: local currency, U.S. dollars (using market exchange rates), or international dollars (using purchasing power parities). Each of these measures, can be expressed in either "constant" or "current" terms (i.e., adjusted for inflation or not). Experience to date, past analysis, and common sense all suggest that national intensity targets should be expressed in terms of *constant local currency* (Argentine Republic 1999; Baumert and Kete 1999; Bush Administration 2002; Kim and Baumert 2002).[16] This was the case for the Argentine proposal, which used "constant 1993 pesos" for calculating GDP.

A second and more significant issue relates to monitoring and verifying GDP. At the international level, emission estimates are already subject to a range of measurement standards, reporting requirements, and review provisions. If GDP is used in emission targets, it will also be subject to scrutiny. As a practical matter, most governments have more expertise and experience with national economic statistics such as GDP than they do with measuring GHG emissions. Furthermore, the standards and methods for national income accounting have been developing for more than fifty years and are periodically updated by international institutions such as the International Monetary Fund (IMF) and the United Nations Statistical Commission. For each system that has been set up to account for GHGs, one or more analogous systems for GDP accounting already exists (Kim and Baumert 2002).

Despite the availability of standards and oversight systems, using GDP in national intensity targets still may be difficult, particularly if that target is part of an international agreement. Many countries still do not report timely, internationally reliable GDP estimates. Other countries, especially China, have been accused of purposefully inflating their GDP statistics to promote foreign direct investment (Waldron 2002). Statistical agencies are not functionally independent in many countries and can be subject to political influence. Overall, even with little incentive to "game" GDP estimates,[17] these issues would likely need to be addressed before the international community could have confidence in many countries' nationally reported GDP data.

6. Policy Conclusions

Intensity targets are considered somewhat novel in the climate change policy arena, and they are frequently dismissed as being environmentally lax or deceptive. Although these criticisms may be justified in particular instances, they do not intrinsically apply to intensity targets in general. Indeed, when fully understood and properly applied, intensity targets could be valuable tools for furthering significant and real commitments to reduce greenhouse gas emissions.

- **Stringency and legal character are more important criteria than the form of an emissions target for assessing its environmental effectiveness.** Both absolute and intensity targets may be strong or weak with respect to how emissions may have changed in the absence of a target. Targets are not necessarily good simply because they are expressed as reductions. Although from an environmental perspective, reductions are commonly construed as a desirable outcome, a target's performance relative to historic trends and projections is a superior basis for assessment. This presents a challenge for intensity targets, since additional information is necessary to fully evaluate the target.

  Likewise, legal character has more to do with the effectiveness of a target than whether or not it is based on intensity. Voluntary targets have not succeeded in slowing GHG emissions in the United States or other countries. However, a target's legal character does not in any way implicate its form. For example, criticisms of the Bush administration's climate policy, were based not so much on its intensity target as on its lack of stringency compared with the status quo and on its lack of mandatory controls.

- **Scope is an important consideration in assessing the desirability of an intensity target.** Experience suggests that intensity targets and absolute targets can coexist in several ways, and intensity-based corporate or sectoral policies can support an overarching absolute target or vice versa. Intensity targets may work well at the national level when non-controversial GDP data are available. They may also work well in sectors and in firms whose production units are simple and comparable, such as cement, basic metals, and electricity. But intensity targets are less attractive when employed *across* sectors and business entities that use different proxies for production, or that use production measurements that are difficult to define or understand.

- **Intensity targets can address and reduce long-term cost uncertainty in some respects, particularly for developing countries.** The projections for both emissions and economic growth vary significantly for all countries, but especially for developing countries. Future uncertainty greatly complicates climate change policy, since to some degree the future levels of effort implied by a particular absolute target are unknown. By comparison, the range of variation is significantly smaller for projections of emissions *intensity,* and the uncertainty ranges for developing countries approximate those of developed countries. Therefore, with respect to uncertainty, intensity targets are more appropriate and beneficial to developing countries than to developed countries.

  This conclusion has three caveats. First, the uncertainty reduction benefits apply only to long-term intensity targets, that is, targets that span decades. Changes in year-to-year emissions intensity are similar to those for absolute emissions for all major emitters, so intensity targets have little benefit as short-term policy instruments. Second, emissions of non-CO_2 gases, which come mainly from agriculture, and contributions from land-use change and forestry do not appear to correlate well with economic expansion. Therefore, intensity targets are less useful to developing countries in which agriculture is a significant economic sector. Finally, the use of GDP in an emissions intensity target requires robust economic indicators, objectively obtained and commonly accepted. This may be problematic for developing countries that lack such capacity.

- **Intensity targets can work alongside absolute targets in regulatory schemes, and in particular, emissions trading. But data and experience suggest that there is not a clear advantage to doing so.** Intensity targets have frequently been used in setting performance standards and other regulations, so they already are familiar to policymakers. The theoretical advantage of mixing intensity and absolute targets is to gain the economic benefits of intensity targets—greater cost certainty and cost-effectiveness—for policies such as emissions trading systems. But even though this approach may be superficially attractive, it does not deliver the benefits imagined. The UK Emissions Trading Scheme includes an intensity target option, but participants with intensity targets do not appear to have reduced compliance costs compared to those with absolute targets. In the emissions trading system under the NCEP proposal, the intensity target is used *only* to specify a long-term emissions path; year-to-year compliance is implemented through absolute targets.

  Furthermore, historical emissions and economic trends suggest that even though intensity targets are beneficial for internalizing long-term uncertainty, they offer no apparent benefit for mitigating short-term (annual) uncertainty. The annual variations in emissions for the major emitters have been similar regardless of whether they were measured in absolute or intensity metrics, so intensity targets offer no clear advantage in this regard. In any case, several policy alternatives, such as dual targets and price caps in emissions trading, may be more effective tools for mitigating costs and addressing short-term uncertainty.

- **Intensity targets are attractive instruments for framing climate change policies and linking them to other policy goals. But the potential for misunderstanding and misperception creates an imperative for clear communication.** Absolute and intensity targets can theoretically represent the same level of effort and cost. But because intensity targets are based on rates and not absolute caps, they are less likely to be construed as obstructing economic progress. As such, intensity targets may be more palatable to policymakers trying to balance climate change with other priorities, in particular "clean growth." Since economic growth is often a priority in developing countries, intensity targets may be a pathway to develop new emissions reduction strategies. Furthermore, because intensity targets are perceived as being compatible with economic growth, research suggests that policymakers may accept more stringent intensity targets than comparable absolute targets, which would be a better outcome.

  The downside of the "framing" advantage are that intensity targets can be framed to appear more stringent than they really are, making it difficult for policymakers and the public to evaluate them without a broader context. Intentionally or unintentionally, intensity targets have been used to depict the status quo as a significant reduction policy, and the important distinction between the two types of targets is sometimes obscured. Thus, policymakers must take care to articulate intensity targets clearly and frame them objectively and with adequate context. For example, an intensity target might be expressed as a reduction relative to *the historical trend*, not a single point in time.

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NOTES

1. The six main anthropogenic greenhouse gases are CO_2, CH_4, N_2O, sulfur hexafluoride (SF6), perfluorocarbons (PFCs), and hydrofluorocarbons (HFCs). Emissions figures typically are expressed in CO_2 equivalents, using 100-year global warming potentials from the IPCC (1996).
2. Argentine Republic 1999. "The present commitment shall constitute a binding international commitment once the Conference of the Parties to the UNFCCC implements a new option that may enable Non-Annex I countries which, like the Republic of Argentina, wish to assume an emission target."
3. Specifically, Argentina's commitment was expressed as: $E = I * \sqrt{GDP}$, where emissions (*E*) are measured in tons of carbon equivalent and *GDP* in 1993 Argentine pesos at market prices. The value chosen for *I* was 151.5, which was "aimed at ensuring an effective GHG emission reduction for Argentina, in a wide range of scenarios, which includes the most likely macro-economic and Agriculture and Livestock Production baseline scenarios" (Argentine Republic 1999).
4. The levy is essentially an energy tax applied to downstream energy consumption by industry. According to de Muizon and Glachant, the tax "covers all types of energy sources (electricity, gas, coal, and LPG) except fuel oil, which is targeted by another tax" (2004).
5. See DEFRA, "UK Emissions Trading Scheme," at http://www.defra.gov.uk/environment/climatechange/trading/uk/documents.htm. The United Kingdom requested, and the European Commission granted, an exclusion of certain UK facilities under the EU ETS until the UK system expires at the end of 2006.
6. "About NCEP." at http://www.energycommission.org/site/page.php?node=60 (May 3, 2006).
7. "Climate VISION" (Voluntary Innovative Sector Initiatives: Opportunities Now), at http://www.climatevision.gov/ (May 8, 2006).
8. "Climate Leaders," at http://www.epa.gov/climateleaders/index.html (May 8, 2006).
9. Dan Vergano, personal communication, June 13, 2005, referring to his June 12, 2005, article in *USA Today* on the Bush target "aimed at cutting greenhouse-gas emissions by 18% by 2012."
10. Baxter, however, also has an absolute target, which does not seem to pertain to its participation in the Climate Leaders Program. See "Next-Generation Environment, Health and Safety Goals" at http://www.baxter.com/about_baxter/sustainability/our_environment/programs/sub/goals.html.
11. Between 1995 and 2000, the EIA overestimated emissions for the EU-15, Japan, former Soviet Union, Mexico, and China, and it underestimated U.S. projections (i.e., actual emissions were higher than forecasted).
12. In the UK ETS, for instance, the primary purpose of trading for CCLA entities (with intensity targets) was to avoid the UK Climate Change Levy, not to reduce the cost of achieving the target.
13. This would be the case if a country had an absolute target at the national level but aimed to achieve that target through intensity-based targets for some national entities. This is the situation with the United Kingdom.
14. Philibert and Pershing suggest that this allowance uncertainty may not be a significant problem, that if the link between emissions and GDP holds, "the uncertainties on both will essentially compensate. In fact, the uncertainty regarding the availability of [allowances]...would likely be reduced, not increased, by [intensity] targets in comparison to fixed targets" (2001).
15. Accordingly, an important question of regulatory design is whether the entity adopting the target is a *facility* or a *firm*. Facilities are more likely to produce homogeneous products, whereas firms are more likely to produce a multitude of products.
16. The reasons are spelled out in more detail in Kim and Baumert 2002. In brief, *constant* currencies would be used because of the need to make comparisons across time. *Local* currencies would be used because there is no need for international comparisons of intensity levels, and it would avoid controversies over currency conversions.
17. Kim and Baumert write: "Intentionally inflating, or 'gaming,' GDP is a legitimate concern because it would weaken emission targets. However, it is difficult to imagine that climate change policy could motivate such actions. GDP is used for a myriad other purposes, including by international organizations to determine eligibility for loans, aid, or other funds. GDP and derivatives of GDP (such as debt/GDP ratios) are used frequently as part of the terms and conditions for obtaining commercial loans. GDP also is used to determine financial contributions that support international institutions, such as the UNFCCC Secretariat. If a country wanted to cheat using a dynamic target, it would probably be more tempting to purposefully understate emissions rather than overstate GDP" (2002). However, overstating output may be a concern at the corporate level.

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ABOUT WRI

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- To reverse damage to ecosystems. We protect the capacity of ecosystems to sustain life and prosperity.
- To expand participation in environmental decisions. We collaborate with partners worldwide to increase people's access to information and influence over decisions about natural resources.
- To avert dangerous climate change. We promote public and private action to ensure a safe climate and sound world economy.
- To increase prosperity while improving the environment. We challenge the private sector to grow by improving environmental and community well-being.

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