



# Climate change

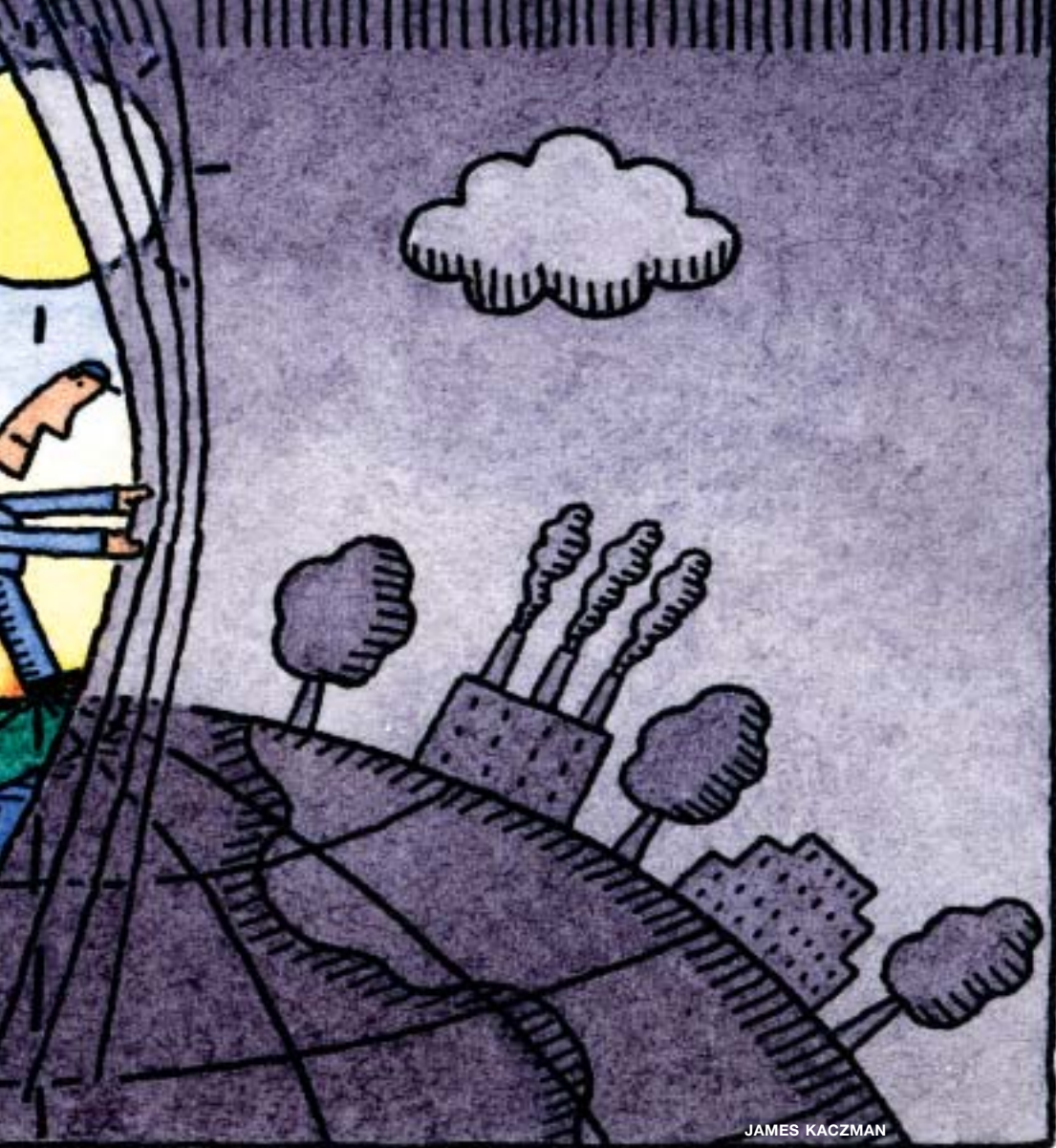
## for Europe's utilities

Enrique de Leyva and Per A. Lekander

Power producers should pay close attention to a European Commission proposal to curb greenhouse gas emissions. It could have paradoxical effects.

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**E**urope's plan to control the greenhouse gases responsible for global warming will probably lead to higher energy prices for both consumers and businesses and greatly accelerate the shift from coal (including

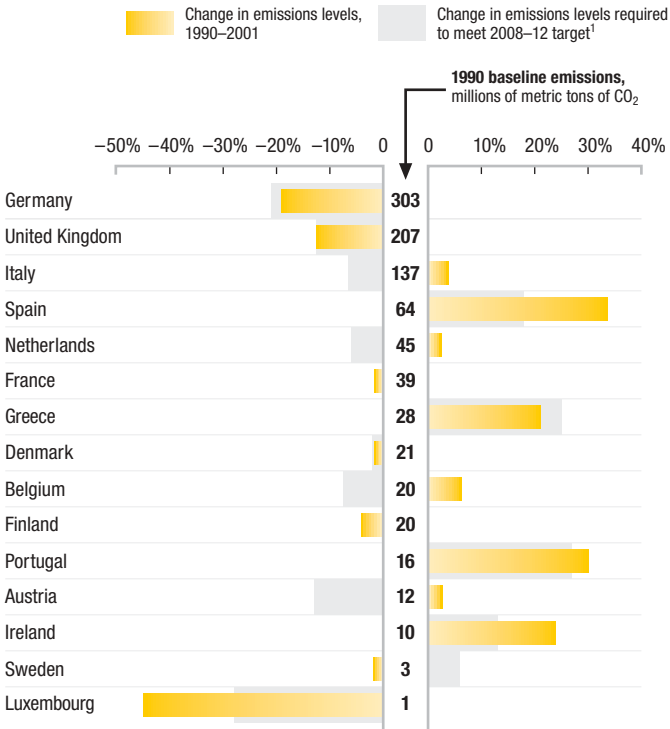


lignite) to gas as the primary fuel used in power plants. These are the main conclusions to be drawn from a McKinsey model of mainland Europe's<sup>1</sup> energy market as it would emerge under a European Commission scheme to cap the emissions of power and heavy-industrial plants. But the model also generated a paradoxical finding: unless utility regulators intervene, many power producers—including some of the fossil-fuel-burning generators that emit the largest amounts of carbon dioxide (CO<sub>2</sub>), the greenhouse gas that the European Union is trying to control—could receive unexpected financial gains under the scheme.

The proposal as it stands would lead utilities to invest in new gas plants and to write off obsolete coal plants. But in many cases, the cost would be more than covered by increased operating profits arising from a forecast 40 percent rise in wholesale electricity prices. Europe's power regulators have never given utilities a free ride, however, and are unlikely to do so now, when the

<sup>1</sup>The modeled region includes Austria, the Benelux countries, France, Germany, Italy, the four Nordic countries, and Switzerland.

## EXHIBIT 1

**Kyoto calling**

<sup>1</sup>As agreed upon in the EU burden-sharing agreement of 1998.  
Source: European Environment Agency (EEA); McKinsey analysis

whole point is to curb emissions. If, as the model suggests, some power plants would gain from the current proposal, modifications to the scheme—scheduled to take effect in January 2005—almost certainly lie ahead.

Given the far-reaching strategic implications of the plan, European power generators and heavy energy users have so far given its details surprisingly short shrift. Yet those details will determine which (and how many) coal- and oil-burning plants should be closed in favor of new gas-fired ones, how and when the remaining coal

and oil plants can be run most profitably, and the amount of additional gas Europe will need. What is more, higher electricity prices could force heavy energy users to consider new conservation methods, alternative energy sources, or other cost savings—all of which would affect producers.

The McKinsey model's projected higher electricity prices might be partly offset by the increasing efficiency of existing plants and by reductions in transmission and distribution charges over the seven-year (2005–12) duration of the plan. In any event, the model makes the expected cost of CO<sub>2</sub> regulation more transparent to all parties. Whatever final regulations emerge from Brussels, the European power generation business is likely to change fundamentally.

### Trading CO<sub>2</sub> to meet Kyoto targets

The stimulus behind the plan was the 1997 Kyoto Protocol, an international agreement intended to reduce the greenhouse gas emissions of developed economies, during the years from 2008 to 2012, by at least 5 percent from

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## How does a cap-and-trade scheme work?

The European Commission proposal is an example of a cap-and-trade scheme for meeting greenhouse gas emissions targets. If the cap itself is politically acceptable, allowing emissions rights to be traded is perhaps the most cost-effective way to meet it even if the ultimate cost isn't known at the outset. (By comparison, if a tax were placed on carbon emissions, their cost would be known but there would be no guarantee that the cap would be met.)

This theory has been tested in a number of schemes for managing scarce environmental resources, notably the schemes for reducing sulfur dioxide (SO<sub>2</sub>) emissions from US coal plants,<sup>1</sup> for managing blue-fin tuna stocks in the South Pacific, for reducing CO<sub>2</sub> emissions in Danish power plants, for promoting renewable energy technologies in the United Kingdom and Italy, and for reducing CO<sub>2</sub> emissions in the plants of BP and Royal Dutch/Shell, companies in which business units trade their emissions rights.

To date, these schemes have achieved their targets more cheaply than expected. The cost of reducing SO<sub>2</sub> emissions under the US scheme, for example, was forecast at from \$700 to \$1,500 a ton, yet the final market price of rights reflected a reduction cost of \$350 a ton.<sup>2</sup> The option to trade encourages companies to explore innovations that might reduce their emissions. If a company can cut its emissions for a cost lower than the market price for emissions rights, it has an incentive to do so and to sell its excess rights. Since other companies can then buy them, their market price falls to the cheapest cost of reducing emissions. The broader the scheme, the greater the incentive to innovate and the lower the probable cost.

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<sup>1</sup>Title IV of the US Clean Air Act Amendments of 1990 to control sulfur dioxide and nitrous oxide emissions creating acid rain.

<sup>2</sup>See A. Denny Ellerman, Paul L. Joskow, Richard Schmalensee, Juan-Pablo Montero, and Elizabeth M. Bailey, *Markets for Clean Air: The US Acid Rain Program*, New York: Cambridge University Press, 2000, pp. 256–96.

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their aggregate 1990 levels. Regardless of the protocol's legal status,<sup>2</sup> the European Union is pressing ahead to meet its own Kyoto target: emissions 8 percent below the levels of 1990 (Exhibit 1).

To that end, the European Commission has proposed a so-called cap-and-trade scheme (*see* sidebar, “How does a cap-and-trade scheme work?”) that would be mandatory for more than 5,000 energy and industrial plants,<sup>3</sup> accounting for about 46 percent of total EU emissions. The scheme sets an annual limit on the aggregate amount of greenhouse gases those plants may emit. Every year, the total emissions of each of them would be calculated,

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<sup>2</sup>For the protocol to come into force, it must be ratified by more than 55 countries, including those responsible for 55 percent of the emissions of developed countries. The United States, which accounts for 36 percent of these emissions, hasn't ratified the protocol, though 97 countries have.

<sup>3</sup>Power plants that have a capacity of more than 20 megawatts, as well as aluminum, cement, ceramics, chemicals, coal, glass, petroleum-refining, and steel businesses. However, the other main CO<sub>2</sub>-emitting sectors—agriculture, residential heating, and transport—are excluded.

EXHIBIT 2

**Modeling Europe's energy markets**

**Key inputs**

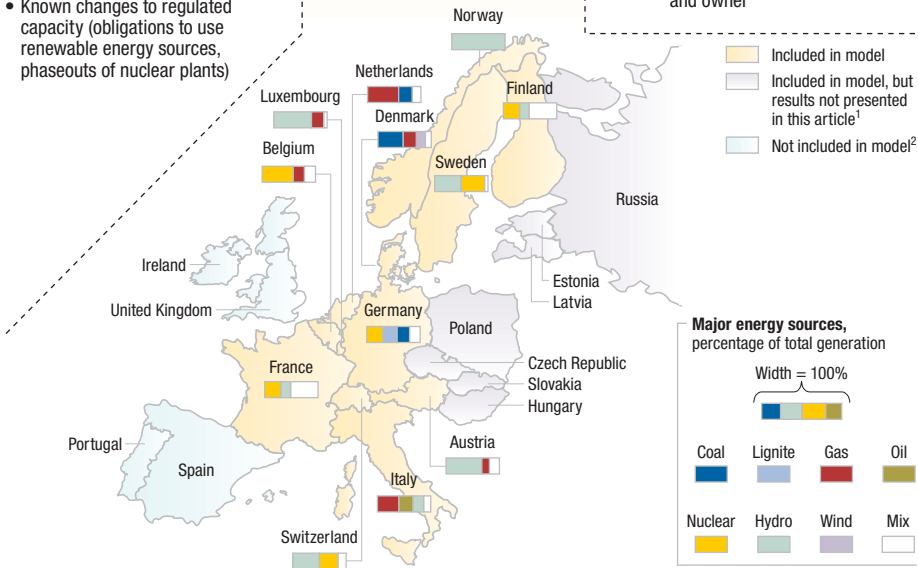
- Generation capacities at plant level
- Real transmission capacities
- Existing- and new-plant costs (capital, fuel, operations and maintenance, shutdown, start-up)
- Ownership of plants
- Pricing strategies in case of concentrated market
- Known changes to regulated capacity (obligations to use renewable energy sources, phaseouts of nuclear plants)

**Model**

- Hourly simulation of prices over 15-year period
- Assessment of pricing strategies, new builds, plant shutdowns that would optimize players' economic performance

**Key outputs**

- Market prices for region/country as well as for selected individual plants or companies
- Transmission utilization and constraints
- Utilization and operating margins per plant
- Net financial results for plant and owner



<sup>1</sup>No Kyoto target set at time of study.

<sup>2</sup>Countries indicated import total of 3 gigawatts of capacity per hour from modeled region.

and each would have to ensure that it had the right (known as an allowance) to emit this amount.

Plants would receive most of the rights at no charge but would have to buy the remainder on a market regulated by the scheme or pay a penalty. Those with excess rights could sell them on that market or use them on projects elsewhere, and some plants might try to reduce emissions to sell the resulting excess rights to other power generators or heavy users. The market price of the rights would become the cost of emitting greenhouse gases—and would be decided by CO<sub>2</sub> emissions, since they make up more than 95 percent of all greenhouse gas emissions covered by the scheme.

**CO<sub>2</sub> pricing and the switch from coal to gas**

Most studies of the expected market price of CO<sub>2</sub> emissions rights under variations of the European Commission scheme forecast a price of €15

(\$14.80) to €30 per ton<sup>4</sup> of CO<sub>2</sub> emitted. Our proprietary simulation model (Exhibit 2) supports that range for the mainland European market. After some initial volatility, we expect the price to settle at about €25 a ton by 2008 (Exhibit 3).

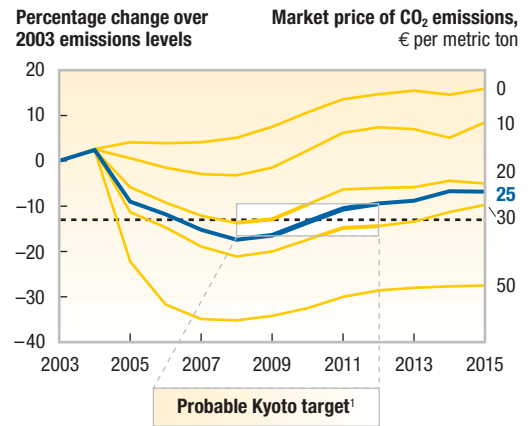
Price analyses tend to converge because, under the scheme, the demand for CO<sub>2</sub> emissions rights will exceed the capped supply by 14 to 30 percent as of 2008. The cap-and-trade approach seeks to close that gap at the lowest possible cost. Apart from including Russia in the plan,<sup>5</sup> Europe's cheapest path would be to switch from coal-fired to gas-fired power generation. Gas-fired plants need less than half of the rights required by their coal-fired counterparts—also called high-emissions plants—to produce the same amount of electricity, since they emit that much less CO<sub>2</sub>. (Gas contains a lower level of carbon, and modern gas plants are more efficient.)

Once the price of emissions rights approaches €25 a ton, it becomes more profitable to build and run high-efficiency gas-fired plants than to continue operating high-emissions ones, which will be closed and their rights released to the market, thereby driving the price back down. At lower prices, however, it will be worthwhile for high-emissions plants to continue in operation so as to meet the gradually rising demand for energy—demand that will push the price back to the €25-a-ton switching point.

Many high-emissions plants that remain in operation may be required only for regular peaks in demand, such as weekdays and winter. We estimate that from 2005 to 2012, about a third of these plants will switch to that role (which might require investments to change their operating patterns), while a third will remain at base-load capacity and a third will be shut down in

EXHIBIT 3

### Finding the price of pollution



<sup>1</sup>13% targeted reduction (relative to 1990 emissions) for modeled region.

<sup>4</sup>Metric ton: 2,205 pounds.

<sup>5</sup>Including Russia in the scheme, along with the European Union's proposed new members from the old Eastern bloc, would create an oversupply of rights for at least five years and keep the market price much lower. But Europe's actual emissions wouldn't fall. The surplus rights would result from the huge fall in Eastern bloc emissions of CO<sub>2</sub> from the 1990 baseline—the effect of a slump in energy demand during the industrial, military, and economic revolution that followed the political transformation of 1989–90.

favor of gas. Thanks to better gas technologies and to the availability of gas supplies, which now seem sufficient, coal might by then be giving way to gas in power generation. One effect of CO<sub>2</sub> regulation would be that gas will

take over coal's role as the backbone of Europe's nonnuclear electricity supply much more quickly.

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Switching from coal to gas is the only way to **reduce emissions** by the amount the targets require

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In fact, switching from coal to gas is the only realistic way to reduce emissions by the amount the targets

require.<sup>6</sup> Technological improvements in high-emissions generation produce only minor reductions of CO<sub>2</sub> emissions, since they, unlike particulate emissions such as nitrogen oxides and sulfur dioxide, can't be filtered out. Renewable energy technologies and carbon sequestration (reinjecting CO<sub>2</sub> into the sea or the Earth's crust or planting trees to counter emissions) would at best each deliver only 10 percent of the reductions needed. For wind generation to be competitive with gas, for example, the price of emissions rights would have to be €50 a ton, and solar energy would require a price of €100 a ton; moreover, it would be necessary to guarantee that both could generate a reliable supply of energy. While such technologies will be essential to keep emissions in check as energy use rises, they won't contribute greatly to the scheme's targets up to 2012.

## Rising energy prices

Under the current proposal, the cost of regulating emissions would be borne by consumers, by the industry, and by utilities whose operating margins didn't improve sufficiently to cover the cost of coal plant write-offs forced by the plan's economics.

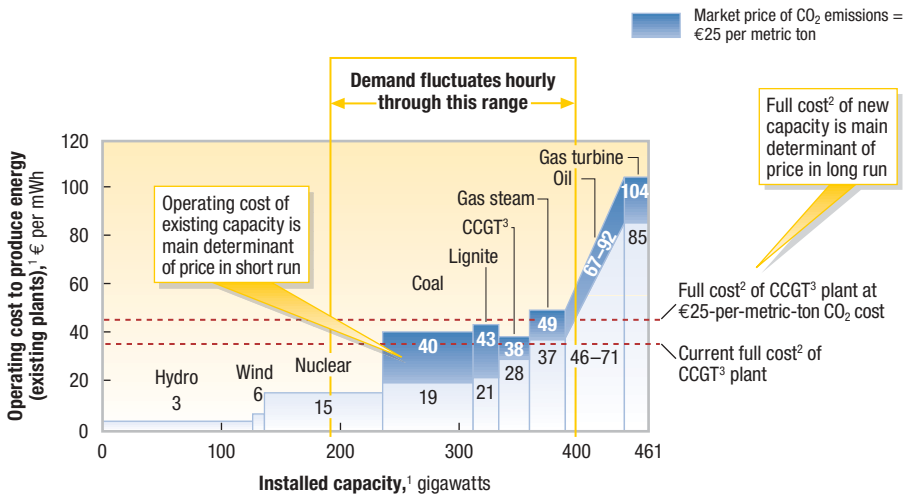
In a competitive commodity market such as the one for wholesale electricity, the spot market price is determined by the cost of producing the last unit needed to cover demand.<sup>7</sup> Exhibit 4 shows how, in most European electricity markets, the generator of that last unit of energy will often be a fossil fuel plant—one of those liable to pay the additional €25-a-ton cost of emitting CO<sub>2</sub>. If so, theory suggests that the wholesale price of electricity should rise by this additional cost, and the model confirms that the average wholesale spot price would indeed rise about 30 percent above the level that would prevail without CO<sub>2</sub> regulation. This increase would be incorporated in longer-term supply contracts as they rolled over.

<sup>6</sup>Our model assumes that environmental and other policy constraints will make it impossible to build any significant hydro or nuclear generators from now to 2015.

<sup>7</sup>In the short run, this marginal cost will be the variable fuel and operating costs. In the longer run, it will include plant maintenance and capital costs. Price levels might also depend on the market's balance of supply and demand and on concentration, particularly in periods of high demand.

## EXHIBIT 4

## As costs rise, so do prices



<sup>1</sup>For Austria, Belgium, Finland, France, Germany, Luxembourg, Netherlands, Norway, Sweden, and Switzerland; costs shown are simplified—actual model examines costs on a plant-by-plant basis.

<sup>2</sup>Includes capital costs.

<sup>3</sup>Combined-cycle gas turbine.

The model then forecasts a second-order effect. As generation shifts from coal to gas, the annual growth rate of European demand for the latter would rise to 3.8 percent, from 2.7 percent, requiring the development of new and less accessible gas fields and pushing up the price of gas by perhaps 15 percent. All else being equal, that increase would in turn increase the operating costs of gas plants, though efficiency improvements and other cost reductions might compensate. As compared with the business-as-usual case, the wholesale price of electricity would rise by a further 10 percent, producing a total increase of about 40 percent by 2008 (Exhibit 5, on the next page).

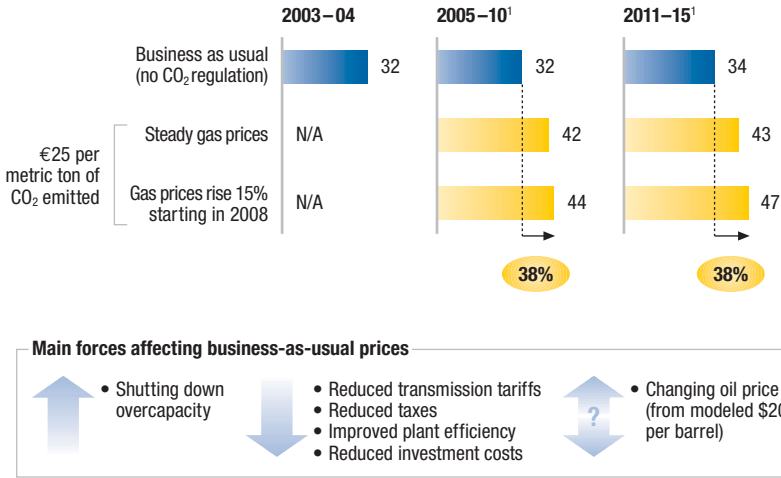
An increase of this order in the wholesale price would see households paying 15 percent more for electricity, since the wholesale price constitutes about 40 percent of the domestic retail price. Big industrial users pay significantly less than domestic ones for each unit of electricity, so the industrial price would rise proportionately more. These increases would vary from country to country and again are calculated relative to the absence of CO<sub>2</sub> regulation; the figures are not absolute. Retail prices, for example, could be reduced by cuts in grid transmission and distribution charges and in end-user taxes.

Although we examined the possibility that price rises would reduce demand for electricity, we concluded that any long-term effects would be marginal. Such demand is notoriously unresponsive to price changes: we cannot point to any example in which a price movement in the region of 15 percent

EXHIBIT 5

**Higher prices ahead?**

Average wholesale price of electricity, € per mWh



<sup>1</sup>Price increase relative to base case, with no CO<sub>2</sub> regulation, ranges from 20 to 46%, depending on the country.

shifted demand by more than a percentage point or two. In retail, there is little scope for switching from electricity to other energy sources: a computer, for instance, can't run on petroleum. Oil and gas compete for heating, but that accounts for less than 10 percent of electricity use, and the heavy cost of the switch makes it realistic only for new buildings and renovations. But though total demand may not budge, usage patterns might change as people avoided the peak prices of high-load hours and businesses gradually moved to places where energy is cheaper.

**The profitability of grandfathered rights**

Our model then springs a surprise: unless regulators intervene, price increases would actually help the owners of generating plants. Indeed, for most utilities, operating margins at existing plants could be expected to rise by 40 percent or more (Exhibit 6).

Where would the additional operating profits come from? The answer is that although prices are rising for all electricity, the cost of production would rise only by the cost of any emissions rights the producers needed to buy. Under earlier proposals, power generators would have had to buy, at the market price, all of the rights they needed to match their output. But under the current plan, proposed in October 2002, participants would receive free annual rights equal to 85 percent of their emissions in the year when the plan was implemented and would have to buy only the remainder on the market.

The allocation of so many grandfathered rights is intended to maintain a competitive balance among different power generation technologies. But it could also produce windfall profits. Hydro and nuclear plants would receive windfalls whatever the choice of allocation: although they have no emissions and thus no need to buy rights, they would benefit from the expected higher market prices. Existing gas plants would become up to 140 percent more profitable because their increased use and higher market prices would offset the additional cost of CO<sub>2</sub> rights. Even high-emissions plants would be more profitable, because of their grandfathered rights. And those rights are bankable, since under the current proposal they wouldn't be tied to a plant's continuing operation: the owner could either cash in by closing a plant and selling the rights to

another player or retain the rights and produce power more efficiently, probably by investing in gas plants. The only constraints on the speed with which plants are shut down might be the power industry's social obligation to provide power and the way owners and governments manage redundancies.

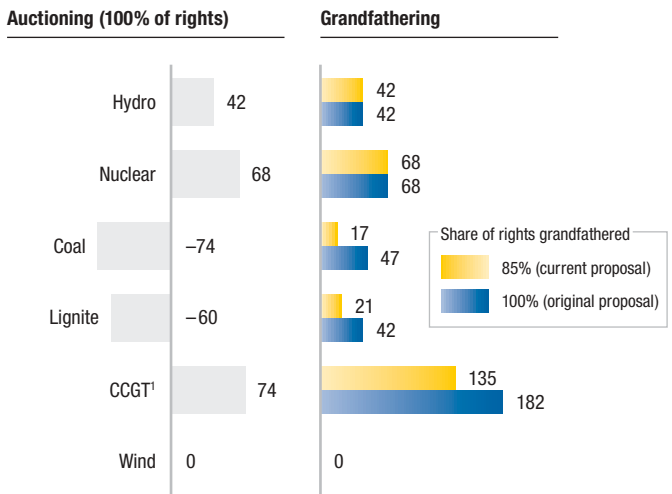
Regulators could tie the hands of the owners of high-emissions plants by awarding each year's grandfathered emis-

sions rights only to plants that continued to operate. The closure of a plant would then eliminate valuable rights for the next year—creating a strong incentive to keep plants open and operating. But that would defeat the scheme's purpose of lowering emissions. Reducing the grandfathered rights by a fraction each year would promote a shift from coal to gas, but at a more manageable pace.

EXHIBIT 6

**Grandfathered rights pay dividends**

Change in operating profits, percent



<sup>1</sup>Combined-cycle gas turbine.

**Rebalancing prices and profits**

Europe's policy makers must strike a balance among several objectives: maintaining a competitive generation industry, reducing CO<sub>2</sub> emissions, and capping retail prices. The politicians are unlikely to risk repeating California's

mistaken attempt to regulate retail prices too rigidly. Regulating wholesale prices wouldn't make much more sense, since restricting utilities to a "reasonable" profit (as defined by regulators) would spell the end of the liberalized energy market and risk future investment in capacity.

Including Russia in the scheme would cut prices but also limit the real emissions reductions that Europe could achieve. Another way to cap wholesale prices would be to subsidize fossil-fuel generation with the funds from a tax on the windfall profits of other electricity sources. But that would put

Europe back to square one—a trading scheme to favor cleaner energy, with a complex tax scheme to rebalance the market.

More likely would be a tax on the windfall profits of all generators, perhaps to finance subsidies for renewable energy sources.



By lowering taxes on end users, policy makers could curb steep price increases while keeping a competitive market and capping emissions. These taxes currently make up from 20 to 50 percent of the retail price of electricity, so halving them could in theory eliminate the price rise altogether. The tax treatment might vary to subsidize electricity users such as heavy industry and low-income households. Lost revenues could be replaced by taxing the windfall profits of nuclear and hydro generators or by auctioning additional CO<sub>2</sub> emissions rights.

## Eyes on the ball

Many of Europe's power utilities were caught unprepared by the last shock to the industry—deregulation, a decade ago—and the same thing might happen again. Despite a growing awareness of a carbon-constrained future, most utilities don't understand how the proposed cap-and-trade scheme could transform their market, let alone each particular business.

Yet almost any form of CO<sub>2</sub> regulation would enable utilities to make attractive adjustments to their portfolios—for example, by expanding into the gas sector. Other developments, such as acquiring high-emissions plants in Eastern Europe to secure access to cheap emissions rights, will depend on the final shape of the plan. Meanwhile, owners of coal-fired plants should be calculating how long they can remain competitive and perhaps consider limiting their use to periods of high demand. Managers of gas-fired plants should review ways of guaranteeing their access to energy supplies and hedge their exposure to rising prices. And since the scheme alone won't increase the demand for renewable energy, its producers might be wise to employ their improved margins to pursue other growth strategies. As for large users

of electricity, the time is right to consider conservation measures or to try locking in long-term supply contracts.

Uncertainty remains over how targets and rights will be allocated to individual plants, which countries will be included in the scheme, and whether investment in plants outside them may be included in it if emissions from those plants fall. Such details will be ironed out as European governments strive to meet their energy and environmental-policy needs and to address the economic and social consequences of the scheme. Rather than simply try to stop it, companies that own investments in power generation should ensure that the final details protect the rights of all stakeholders. Industry organizations are involved in the fray, but in view of the enormous economic value to be redistributed, individual utilities—not to mention heavy energy users—must attend to their own interests. **Q**

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