Staff White Paper on
Stationary Fuel Cells for Power Generation

Prepared Pursuant to HB 2845 (77th Legislature),
Commercialization of Fuel Cells

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Public Utility Commission of Texas

Table of Contents

Figures

Tables

Executive Summary

This paper describes a policy strategy to expedite the commercial development of stationary fuel cell electric power generation that is consistent with the state's newly restructured electric market. Based on its knowledge of the electric industry, the commission makes the following recommendations with regard to fuel cell commercialization.

1) The state should seek to develop fuel cells as a grid-connected, economically viable distributed generation (DG) option, as this is the most likely way for fuel cell developers to achieve economies of scale and subsequent cost reductions. Incentives for fuel cell distributed generation (FCDG) should be paid per kWh of output metered by the independent system operator (ISO).
2) The state should also seek to develop residential, off-grid and other small-scale applications of fuel cells, as declining costs for FCDG applications should enable similar cost reductions for small-scale applications. Incentives for small-scale applications should be paid as a lump-sum rebate once the fuel cell is activated.
3) Incentives under both programs:
   A) should be larger for "early adopters," decline over time, and reach zero at a specific date;
   B) should be adjusted automatically to account for federal fuel cell subsidies if and when such subsidies are created; and
   C) should include a trigger that reduces the incentive if the market proves robust enough to be self-sustaining.
4) The incentive programs should reflect the state's expectation that fuel cell developers will aggressively reduce costs as the technology matures.
5) The incentive programs should be funded in a way that leverages the objective of encouraging fuel cell development. Those who bear the cost of the program should be relieved of part of that burden if they install and use fuel cells.

Benefits

As a stationary source of electric generation, fuel cells offer a number of benefits both to individual users and to society as a whole. The social benefits – less air pollution, reduced transmission congestion, and the ability to add new generation capacity within an area not in attainment with federal clean air standards – provide the main rationale for public efforts to accelerate fuel cell commercialization. The public benefits are discussed at length by the State Energy Conservation Office in its report to the Legislature on fuel cell commercialization.[1]

The private, owner-specific benefits help identify the quickest and least-cost path to commercial viability, as they constitute elements of built-in value that need no subsidy.

The relative importance of each kind of benefit will vary from one customer to the next, but generally speaking, they include:

- *Secure back-up power in the event of grid failure;*
- *Efficient power production;*
- *Cushion against natural gas price spikes (less fuel required to produce a kW of power);*
- *Fewer kWh purchased off the grid;*
- *Lower peak kW usage and lower demand charges;*
- *Heat cogeneration; and*
- *The potential for revenues from sale of ancillary services.*[2]

Significant Obstacle

Of all the obstacles to the widespread economic deployment of fuel cells, cost is by far the most significant. *Without significant cost reductions by fuel cell developers, no large-scale economic deployment of stationary fuel cells will be possible.*

Electric Restructuring

State fuel cell policy must be cognizant of and congruent with the changes brought about in the electric industry by Senate Bill 7 (76th Legislature), and should aim to find market solutions to address known challenges.

- *Renewable energy as a study of success*. Senate Bill 7's Goal for Renewable Energy has been so successful that it is being used as a template for similar federal legislation.[3] Simply cloning the Goal for Renewable Energy and the Renewable Energy Credit Trading Program would not be a good idea, however, because there are important differences in the economic maturity of fuel cells and that of renewables – specifically wind power, which is driving the success of renewables in Texas. Nevertheless, lessons can be learned from the success of renewables that, if properly understood and applied, would increase the chances of a similar success with fuel cells.
- *Importance of entrepreneurial effort*. Sustainable commercialization cannot happen without entrepreneurial effort. Financial incentives should therefore reward efficiency and should be designed in such a way as to prevent subsidization of unused or overpriced equipment.
- *Distributed generation*. Large FCDG installations would have a natural market in non-attainment airsheds such as Dallas-Forth Worth and Houston, where reliable electric power is needed but is limited by air quality standards and transmission constraints. For some large customers, FCDG could provide additional flexibility to respond to wholesale power price signals and participate actively in the ERCOT market for ancillary services.

Proposed Legislative Measures

- *Production incentive*. The FCDG incentive would be paid over a ten-year period on the basis of kWh metered and delivered to the grid. The incentive rate for fuel cells installed during or before the first year of the program would be determined in a proceeding at the commission the year before the incentive was to be available. The commission would set the rate according to the following formula.

  incentive rate = average FCDG market cost – price to beat – federal incentives

  The price to beat rate would be the average general service rate and fuel factor in effect at the time of the commission proceeding, converted to a per kWh equivalent and averaged across all affiliated retail electric providers (REPs). The subsidy level would then decline and would phase out by 2010.

- *Rebate for residential and other small-scale applications.* The small-scale incentive would be paid on the basis of kW capacity. The initial rate would be determined in a manner similar to the per kWh production incentive, except that cost, price to beat, and federal subsidies would be converted to kW equivalents.

- *Goals for new fuel cell capacity.* The goals would represent benchmarks for self-sustainability in the fuel cell market. If the goal for any year were exceeded, the production incentives and rebates would be reduced.

  Funding. Economic activity within the electric sector should be used to finance the state's fuel cell program. Funding mechanisms should be designed so that those who install fuel cells have a smaller obligation to pay for the program. Possible approaches include an emission-based dispatch fee, a flat-rate dispatch fee with credits for fuel cell generation, System Benefit Fund, awarding tradable emission reduction credits for fuel cell generation, and redirecting transmission congestion charges towards fuel cell generators located at points that ease transmission congestion.

I. Why Fuel Cells?

Fuel cells generate electricity by combining hydrogen and air. This electrochemical process is more thermally efficient than burning fuel to spin a turbine, although some advanced natural gas technologies such as microturbines and modern combined cycle gas turbines have efficiencies comparable to fuel cells. The main byproducts are water vapor and trace amounts of nitrogen oxides, although carbon dioxide can also be released depending on the process used to obtain the hydrogen.

Fuel cell technology lends itself to decentralized, consumer-owned generation ranging in scale from single-home use to larger distributed generation applications. Power generated by the consumer's fuel cell can reduce or replace power that otherwise would have been purchased from a retailer.

As a stationary source of electric generation, fuel cells offer a number of benefits both to individual users and to society as a whole. The social benefits constitute the main rationale for spending public funds to accelerate fuel cell commercialization. The private, customer-direct benefits help identify the quickest and least-cost path to commercial viability.

Social Benefits

- *Less air pollution.* Fuel cells produce power with significantly less NO_x and particulates than is the case with conventional combustion power plants. Table 1 compares emission rates for three distributed generation technologies and Texas averages for total generation.
- *Less transmission congestion*. Fuel cell units are small and relatively easy to site near consumers inside a power distribution area. By reducing the reliance on power imported from outside the area (from West Texas to

Table 1: Emission rate comparison

	Average emission rates (pounds per net MWh generated)		
	NO_x	*SO_2*	*CO_2*
Distributed generation technologies			
Fuel cells (solid oxide)	**0.01**	**0.005**	**950**
Natural gas powered microturbine	0.44	0.008	1,596
Diesel generator	4.7	0.45	1,432
Texas generation from natural gas (1998)	2.18	0.007	1,144
Texas generation from coal (1998)	4.06	9.90	2,349

Sources: Regulatory Assistance Project/National Renewable Energy Laboratory, workpapers for Distributed Resource Emissions Collaborative (http://www.rapmaine.org/DGEmissionsMay2001.PDF); U.S. Environmental Protection Agency, E-GRID 2000 database.

Dallas-Fort Worth, for example), mass deployment of fuel cells can reduce costs incurred at the wholesale level due to transmission congestion, thereby reducing overall power costs for all customers within a transmission congestion zone.

Private Benefits

- *Security.* Like other types of distributed generation, fuel cell distributed generation (FCDG) provides an electric consumer with insurance against grid failure or power curtailment. Hospitals and other emergency services, for example, own distributed generation back-up because of their must-run power requirements. Companies that depend on uninterrupted communication or continuous operation of equipment may also invest in backup power.
- *Efficient power production*. Fuel cells produce more power from the same quantity of natural gas than do most conventional combustion power plants.
- *Cushion against natural gas price spikes.* Because they require less natural gas to produce a kilowatt-hour of electricity, fuel cell generators are less vulnerable to the kind of natural gas price volatility that drove electric bills up in 2000 and 2001. Upswings in natural gas prices result in smaller upswings in total electricity costs for fuel cells powered by natural gas.
- *Demand reduction.* For commercial and industrial customers, charges that are based on peak kW demand can be reduced to the extent that customer-owned FCDG operates when power usage is greatest.
- *Heat cogeneration.* Some types of fuel cells generate heat as they generate electricity. For electric customers who also need heat, a fuel cell can reduce the need to use grid power or natural gas to generate heat at the same time it is generating electricity for the customer's own use.
- *Revenues from sale of ancillary services.* This benefit would most likely be limited to large installations, or to loads acting as resources. FCDG capacity that is consistently greater than what the owner needs can be bid in the ancillary electric services market, where reserve capacity prices are typically between $5 and $15 per MW. Eventually, a large electric customer in ERCOT capable of switching between grid power and on-site FCDG will actually be able to bid part of its *load* on the ancillary services market. If the market price of power is high enough, a customer would be paid by ERCOT to use less grid power as needed to manage the reliability of the system.[4] On-site FCDG could provide some large-use customers in non-attainment areas an additional degree of flexibility that could enable them to participate in these markets.

Table 2: Distributed generation interconnections reported by utilities

	Number of facilities	*Year-end 2001* *MW*	*Most common fuel*
Oncor (TXU)	47	154.5	Diesel
Reliant	18	35.1	Natural gas
AEP	7	18.0	Natural gas
Rest of Texas	2	5.0	Natural gas
Total	74	212.6	

Source: Utility reports pursuant to P.U.C. SUBST. R. 25.211(n) on applications received for interconnection and parallel operation of distributed generation.

Distributed Generation

Many of the benefits that an individual customer could obtain by operating fuel cells are the same as for most other distributed generation technologies. Indeed, the strength of the distributed generation market evident in Houston and in the Dallas-Fort Worth area demonstrates a robust market demand for small on-site generation units. (See Table 2.)

Distributed generation (DG) is self-generation. PUC rules define a distributed resource as "a generation, energy storage, or targeted demand-side resource, generally between one kilowatt and ten megawatts, located at a customer's site or near a load center, which may be connected at the distribution voltage level (below 60,000 volts), that provides advantages to the system, such as deferring the need for upgrading local distribution facilities."[5] As customers use more DG, the less power they need to buy and the less power needs to flow through the grid.

Fuel cell technology makes possible a clean and highly controllable distributed generator. The controllable aspect means that it is possible for a fuel cell, with its inverter, to produce firm electrical capacity just as a large gas-fired combined cycle generating plant produces its capacity, but the fuel cell is not as complex. These attributes give FCDG great market potential. Customers who must have clean, dependable power would benefit from this technology to keep critical processes moving. Large fuel cell installations are a natural for non-attainment areas such as the Dallas-Forth Worth area and the Houston area where clean, reliable electric power is needed.

A strong demand for distributed generation already exists in Texas. Moreover, this demand happens to be located in areas of the state with the worst pollution problems and significant transmission congestion. Pollution reduction and alleviation of transmission congestion constitute the two most significant public benefits that are likely to accrue from wider use of fuel cells for power generation. Consequently, a public policy that strategically targets distributed generation applications will coincidentally target the state's worst pollution problems and some of the most serious transmission problems.

The main constraint on future DG is the requirement that new generation meet air emission standards. Setting cost issues aside, these environmental requirements leave fuel cells (along with natural gas microturbines) as the preferred DG option due to its low emissions and high reliability. This would be especially true for DG applications that combine power generation with heat. The fact that it achieves all the benefits of distributed generation with negligible pollution gives FCDG a strong competitive advantage in the state's two most lucrative distributed generation markets: Dallas-Fort Worth and Houston

The Texas Commission on Environmental Quality has put in place streamlined air permitting procedures that allow quick approval of FCDG power plants. For example, when municipally owned Austin Energy installed a 200 kW demonstration DG fuel cell, it received its state air permit in less time than it took to obtain the city building permits it needed.[6]

Ensuring Adequacy of Electric Supply

Perhaps the biggest challenge facing the electric industry in the new world of competition is ensuring that the state's major metropolitan areas will continue to be served by an adequate amount of generation and transmission capacity well into the future. In-migration continues to drive growth in the DFW and Houston metropolitan areas. But installed capacity at major generation plants in these areas will remain virtually the same for many years to come due to the failure to attain air quality standards.

The critical period for electric supply problems is the peak demand months, which in Texas occurs from June through September. The grid must have enough generation capacity to accommodate the one moment during the summer when the most air conditioners are turned on, the most number of refrigerators are running, and the overall demand for power is the highest.

As increasing electric demand pushes ever harder against the limits of nearby generation capacity, the transmission system also begins to press its operating limits at more locations more often. Transmission congestion makes it difficult to move power to everyplace it is needed, and makes it easier to manipulate local shortages and artificially drive wholesale power prices higher.

An effective strategy for staving off supply shortages combines three elements: less consumption, more generation, and more power imports from elsewhere in ERCOT. FCDG is an effective means of reducing the use of grid power, and is one of the few ways of adding more generation in areas where emission standards limit the construction of new fossil fuel generating plants. The major benefits to the grid would include:

- Less need to import power from elsewhere in ERCOT;
- Fewer local distribution bottlenecks; and

Table 3: Power demand, generation and transfer capacity in 2002

	DFW[a]	*North Zone*	*Houston Zone*
Peak demand (MW)	16,145	24,234	19,584
Available generating capacity (MW)	5,849	24,954[b]	16,524
Excluding plants older than 50 years	5,547		n.a.
Excluding plants older than 30 years	1,745		10,394
Total transmission capacity between major congestion zones at commercially significant constraints (MW)			
South to North (Sandow-Temple)		675	
West to North (Graham-Parker)		884	
South to Houston (South Texas Project-Dow)			758[c]

[a]Dallas, Tarrant, Collin and Denton counties.
[b]Another 2,647 MW is expected to be off-line.
[c]The South Zone is expected to have a generation surplus of about 3,600 MW, most of which will serve demand in the Houston zone via transmission lines that are not congested.

Note: Data are the most current used by ERCOT system planning staff as of this writing and are subject to change. These figures do not take into account plans by AEP and CenterPoint Energy to mothball about 7,000 MW of capacity in Texas. Updated data may be found at http://www.ercot.com/Participants/CSC/index.htm.

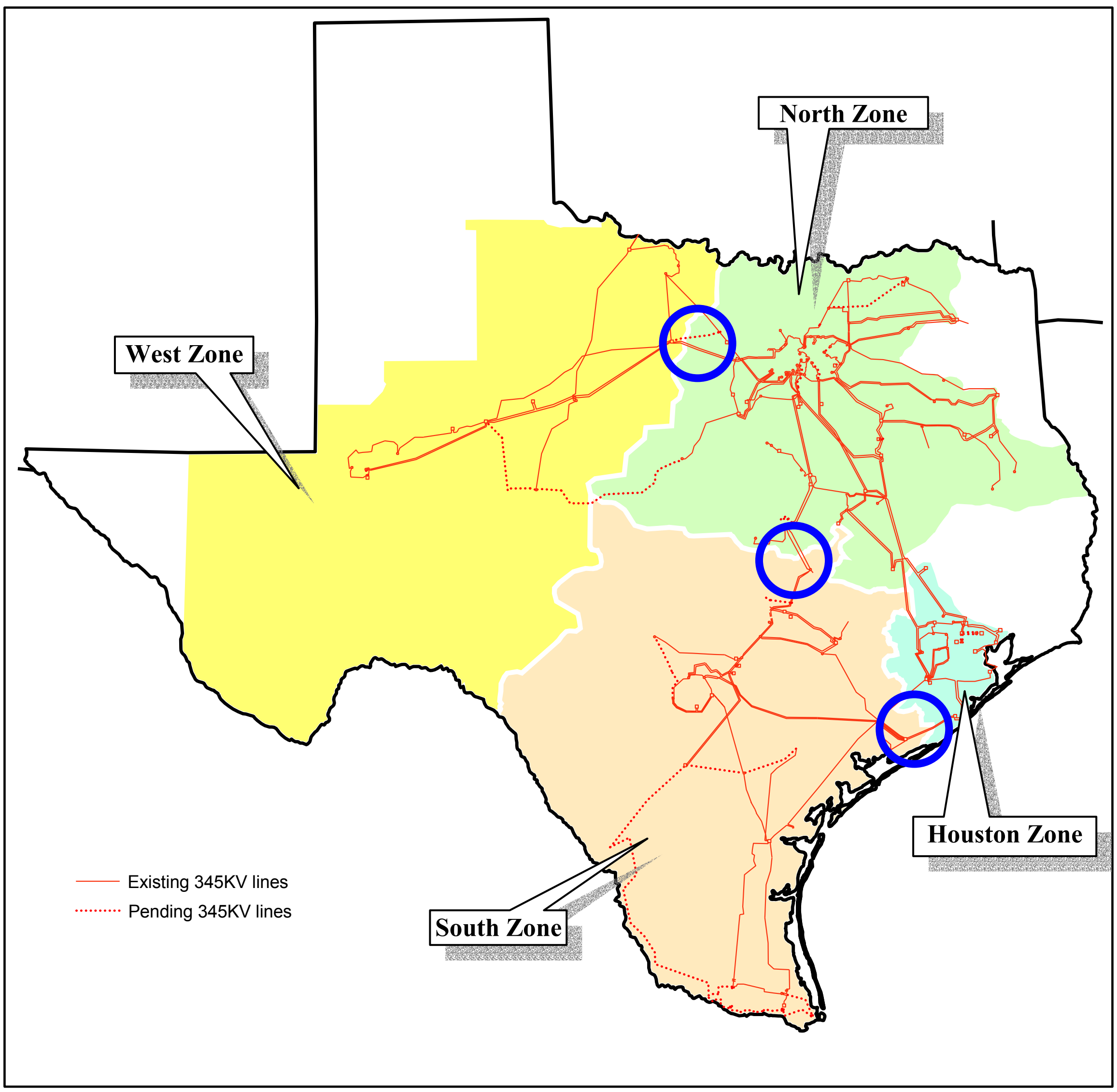
- Fewer opportunities for market manipulation, as a market with many small decentralized resources is harder to monopolize than one with a few large resources.

Table 3 shows how tight demand, generation and transfer capacity are in the four-county Dallas-Fort Worth region (which is part of ERCOT's north congestion management zone) and in the Houston area. ERCOT forecasts that local generators will provide only 36% of that DFW's 2002 summer peak demand. The rest will have to come from elsewhere. There will not be much slack across the north zone, however, as zonal demand is only slightly less than the capacity expected to be available. In addition, transporting power into the north zone is constrained at two points: near Temple to the south and near Graham to the west. Transmission into Houston from the South Zone is constrained on the line from the South Texas Project in Matagorda County to Brazoria County. (See Figure 1.)

Bidders have paid more than $45 million for the right to send power across the two transmission constraints into the north zone, and $30.2 million for rights to the constrained south-to-Houston line. This reflects the scarcity value of transmission into the zone generally, but it also suggests the market value of reducing peak demand through large-scale deployment of FCDG. Eventually, the $45 million will have to be paid by entities serving retail customers throughout the north zone, and these costs will not go away any time soon. Peak demand in the DFW area is expected to grow by 380 MW annually throughout the early part of the decade, but it will be difficult for the area to add new generation to replace its aging capacity. The Commission and ERCOT have identified priority transmission projects that are to be in service by the end of 2002, but a long-term solution needs to include aggressive conservation measures and capacity additions.

FCDG can play an important role in ensuring adequate electric service for the state's metropolitan areas. For this purpose, it is not necessary for FCDG to replace large amounts of conventional generation, because the critical supply problems are most likely to occur at the margin. The incremental capacity that can be provided by FCDG could provide enough of a margin to help avert serious market problems.

Figure 1: ERCOT major transmission lines and 2003 congestion management zones



Circles designate commercially significant transmission constraint points.

II. Obstacles

Cost

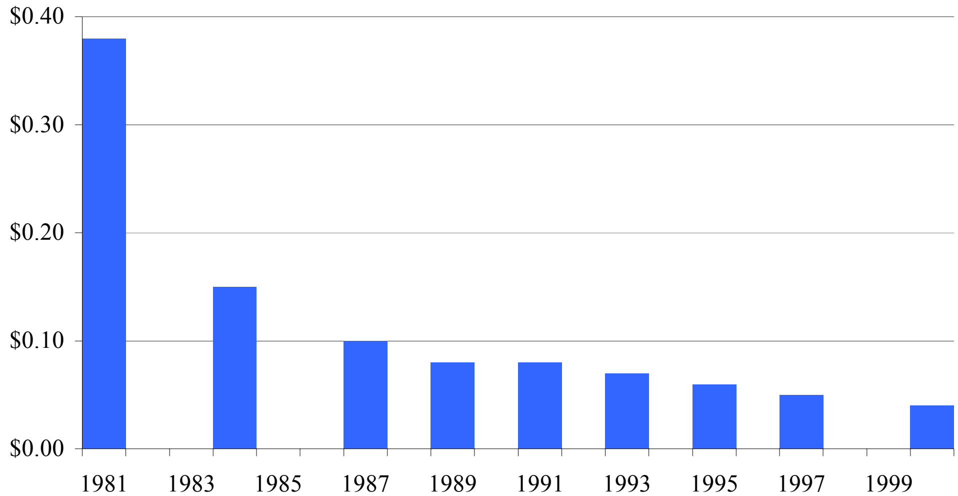
The numerous items on the benefit side of the fuel cell ledger are, at least for now, overwhelmingly outweighed by cost. Commercial fuel cell units available today cost around $4,000 per kW of capacity, excluding site costs. Although unit costs are coming down, it will be some time before FCDG is economically competitive.

Many of the fuel cell research and development projects now being funded by DOE's involve finding ways to reduce the cost of key components.[7] The budget proposed for DOE includes a 32% increase in funding for fuel cell research and development. DOE's goal is to achieve a cost of $1,000 to $1,500 per kW by the end of 2003, with an ultimate goal of $400 per kW by 2015.[8]

DOE's future cost-reduction targets follow the normal pattern of a commercially maturing technology. As costs fall, unit sales increase. Eventually the industry achieves critical mass: demand is large enough to make economies of scale possible, and costs fall even more.

While this pattern of critical mass has been evident in personal computers and many other high-technology industries, wind power provides an example more apropos of fuel cells. Like fuel cells, wind turbines have been around for a long time. Partly as a result of the OPEC oil embargoes, the federal government accelerated R&D funding for wind turbines in the 1970s. As Figure 2 shows, costs began to fall dramatically in the 1980s, and by the end of the 1990s wind turbines had achieved a magnitude of cost reduction similar to what now is targeted by DOE for fuel cells.

Figure 2: Historical cost of producing wind power (per kWh equivalent)



Assumes levelized cost at excellent wind sites, and does not take into account the production tax credit ($0.015 per kWh from 1992 through 2001).

Source: American Wind Energy Association, "The Most Frequently Asked Questions about Wind Energy," 1999.

Interconnection

Distributed generation (DG) resources must meet interconnection standards so that they do not pose a reliability risk to the rest of the electric power system. A DG site can include primary energy generation equipment (such as fuel cells); power converters such as induction generators; or power control center and voltage level equipment such as protective devices, metering, and step-up transformers. Connecting these facilities to the electric power system must satisfy the following objectives:

- *Safety*. A DG unit should not create any undue safety hazard for utility personnel, customers or the public.
- *Voltage quality*. The unit must not cause objectionable power quality, voltage regulation or voltage flicker on the utility system and for any customers.
- *Reliability*. The unit should not degrade the reliability of the power system.
- *Utility system over current devices*. The unit must not interfere with the operation of the utility system over current protection equipment.

- *Safety to utility and customer equipment*. The unit should not cause damage to utility and customer equipment during steady state and faulted system-operating conditions.
- *Restoration*. The unit must not interfere with restoration of power on the utility system.
- *Utility system operating efficiency*. The unit must operate at power factors and at generation density levels that maintain utility system efficiency.

In areas where electric utilities are still vertically integrated, it is sometimes difficult for DG customers to obtain an interconnection to the grid. All else being the same, an integrated utility has a fundamental disincentive for DG because it means the customer is buying less of the utility's power. In a restructured market, however, the utility providing the grid connection is not the entity that sells the power.

While concerns have arisen elsewhere in the country, the commission has received very few complaints about transmission and distribution service providers in Texas making interconnection difficult. The commission has attempted to facilitate DG generally by promulgating a set of uniform interconnection standards for all utilities under its jurisdiction. (Municipally owned utilities and electric cooperatives are not subject to these rules, however, and may have different standards.) In short, while interconnection may be a problem elsewhere, it is not a problem in Texas.

III. Roadmap to Commercialization

The Lessons of Renewable Energy Development

If one looks at how Texas has performed in the area of renewable energy development, two facts are readily apparent. First, a tremendous amount of renewable energy generation – mostly wind power – is being installed in Texas. In its report on wind power development in 2001, the American Wind Energy Association noted that Texas installed more new wind capacity in 2001 (915 MW) than had been installed in the entire country during any previous year. The group observed that "The state more than tripled its wind capacity, and would rank sixth among the nations of the world in wind capacity if it were a country, based on one year's development alone."[9]

Second, unlike most other states, Texas does not directly subsidize the purchase of wind turbines, photovoltaic panels or any other renewable-powered generating equipment. Instead, the Texas approach has been to assure renewable energy developers that they will have a market once they get their hardware up and running. But the developers have to find their own road to that market. And while the market as a whole is guaranteed, no individual's piece is. Developers have to compete among themselves for a share of that market.

The success of wind power in Texas is attributable to three specific factors: a firm and specific legislative goal for renewable energy, a federal renewable energy production tax credit, and – most important of all – aggressive efforts by the wind power industry to reduce its costs of production, as shown previously in Figure 2. These three factors have converged to put wind power developers within profitable striking range of a large market, a significant piece of which is guaranteed until 2019. (Authorized under PURA §35.904, P.U.C. SUBST. R. 25.173 requires retail electric providers to maintain a renewable portfolio standard until 2019).

State policy should encourage the fuel cell industry to follow the example of the wind power industry: a model that relies on entrepreneurial effort and competition. However, ***the state should not simply clone the SB 7 goal for renewable energy and apply it to fuel cells***. ***This would be a recipe for failure.*** It would also be a misunderstanding of the most important lesson of wind power's success: the greatest results tend to occur when entrepreneurial effort and public policy meet each other halfway. The wind power industry reduced its costs, and public policy helped span the rest of the economic gap. This expectation must be built in to the state's fuel cell policy.

One should be mindful of two facts. First, the success of public policy toward renewable energy in Texas has been limited to wind power; technologies that remain costly have not shared in that success. Second, nowhere did wind power enjoy more success in 2001 than it did in the policy environment found in Texas. In other words, the particulars of the state's policy prescription were well-suited to the circumstances of one renewable technology, but not all of them.

The success of wind power provides insight into *fundamental policy principles* that are applicable to fuel cells, but by no means do these lessons validate using the same program design. The details of what has worked for wind power are not suited to fuel cells, just as a medical treatment that cures one illness may not work against another disease that has similar symptoms but different causes. A fitting policy prescription for fuel cells needs to take into account where the industry is today on its own cost reduction curve. It took the wind power industry many years to turn government-funded research and development into reduced production costs. The current level of federal funding for fuel cell R&D will also require time to mature economically. *The best way for Texas to help hasten the industry's progress down the cost curve is to offer incentives that reflect the expectation that costs will fall over time and that offer the greatest rewards to entrepreneurs who do the best job of reducing their costs*.

Market Principles

In order to be consistent with the new world, state fuel cell policy should recognize the following principles.

- *There can be no sustainable commercialization without entrepreneurial effort*. Good technology and good business strategies are two different things, and both are necessary for the widespread economic deployment of fuel cells. Without entrepreneurial innovation, good technology will remain a high-priced novelty.
- *Entrepreneurs respond to market-pull incentives*. If there is a profit potential, entrepreneurs will find ways to permanently reduce costs and improve services so that they can reach their target market and expand it over time. "Market-pull" incentives are those that improve an investment's anticipated profit stream.
- *Incentives should reward entrepreneurs who do the best job of bringing products to market*. Competition among entrepreneurs accelerates innovation. If the greatest rewards go to those who get to the market first, then each entrepreneur will put forth a greater effort to be first.
- *Incentives should not subsidize unused equipment*. Capital equipment does not produce benefits either for the purchaser or for the economy at large if it is not put to use. Equipment subsidized at the time of purchase allows developers to go home before the job is done; they're no longer "on the hook" to make sure their products replace conventional generation.
- *Incentives should not subsidize overpriced equipment*. If a good idea is executed inefficiently, the inefficiency should not be rewarded. A program that merely offsets economic dead weight will not stimulate long-term commercialization.
- *Commercialization must be consistent with electric restructuring in all respects*. In the new world, regulated electric utilities do not own or dispatch generation. A fuel cell commercialization program that contemplates "electric utilities" in the traditional sense would therefore be inapplicable and irrelevant in Houston, Dallas and Fort Worth – the state's biggest potential markets for fuel cells.

Policy Outline

The commission recommends that state fuel cell policy include the following elements:

a) Goals for Stationary Fuel Cells

1) 750 MW of FCDG capacity and 250 MW of small-scale capacity by January 1, 2009 with annual intermediate goals[10]:

Year	FCDG Goal (MW)	Small-Scale Goal (MW)	Total
January 1, 2004	37.5	12.5	50
January 1, 2005	150	50	200
January 1, 2006	300	100	400
January 1, 2007	450	150	600
January 1, 2008	600	200	800
January 1, 2009	750	250	1,000

2) If any intermediate goal is exceeded, the incentive level for that category that year would be reduced. For example, if by the beginning of 2005 the state had anywhere between 100 and 150 MW of small-scale capacity successfully installed, the buy-down for additional fuel cells installed in 2005 would be set at the 2006 level, which would be less. (Section (c) describes the proposed buy-down.)

b) Fuel Cell Distributed Generation Production Incentive

1) The incentive would be paid to FCDG owners based on the gross kWh of metered output. The incentive would be paid for a period of ten consecutive years at the rate in effect for the first year of the payment period.

2) The incentive rate for 2004 would be determined by the commission on the basis of three inputs: cost of a typical fuel cell, 2003 price to beat for general service customers (weighted average of all affiliated REPs), and available federal production incentives, all expressed in cents per kWh.

   initial incentive rate = average market cost – price to beat – federal incentives

3) The incentive rate for new installations would decline in equal increments each year after 2004, reaching zero in 2010.

4) Fuel cells earning the production incentive described in this section would not be eligible for buy-down incentive described in section (c).

c) Fuel Cell Buy-Down Incentive for Small-Scale Applications

1) The buy-down incentive would be paid to fuel cell owners at the time the unit was activated, based on the rated capacity of the unit (in kW).

2) The buy-down incentive rate for 2004 would be determined by the commission on the basis of three inputs: cost of a typical fuel cell, 2003 price to beat for residential customers (weighted average of all affiliated REPs), and available federal production incentives, all expressed in dollars per kW.

   initial incentive rate = average market cost – price to beat – federal incentives

3) The incentive rate would decline in equal increments each year after 2004, reaching zero in 2010.

4) Fuel cells that earned the buy-down incentive described in this section would not be eligible for the production incentive described in section (b).

d) **Funding options**. Fuel cell commercialization involves changing the behavior of generators, retailers and customers in the electric sector. Therefore it is appropriate that incentive programs intended to change behavior within the sector be funded from economic activity within that sector, and that the funding be structured in such a way that it augments the public policy goal. Aside from the agency resources needed to put them in place, the alternatives suggested here would not require any commitment of state general revenues.

1) **Emission-based dispatch fee.** Each generating plant in the state would be assessed for each MWh delivered to its transmission grid. The assessment rate would be graduated according to the plant's NO_x emission rate (pounds per MWh) using the following formula

plant assessment rate = plant NO_x emission rate × statewide annual coefficient

The statewide annual coefficient would be adjusted each year so that total projected revenues would equal actual expenses under the incentive programs during the previous year. Current-year expenses under the incentive programs would be paid under state general revenues, to be reimbursed the following year by revenues from the dispatch fee.

Advantages: Would leverage the policy objective of encouraging fuel cell development. A generator that replaced high-NO_x capacity with low-NO_x fuel cells would both earn the production incentive and reduce the cost of the fee. Annual adjustment would eliminate waste, ensuring that funding was never in excess of what was required. Assessment at the generator level enables the behavior-changing effects to flow throughout the market: retailers would have a greater incentive to buy from low-NO_x suppliers, and customers would have a greater incentive to sign up with retailers who bought from low-NO_x suppliers.

Disadvantage: Would exclude nuclear plants and hydroelectric plants.

2) **Flat-rate dispatch fee**. Per-MWh assessment would be at the same rate for all generators, and would be set each year so that total projected revenues would equal actual expenses during the previous year. Generators who installed fuel cells would receive a credit on the fee based on the amount of fuel cell capacity installed and operated, partially offsetting the cost of the dispatch fee.

Advantages: Similar to emission-based assessment, but would include nuclear and hydroelectric plants in the assessment.

Disadvantage: Price signal would not be as broad as with emission-based assessment, but would be limited to installation of fuel cells.

3) **System Benefit Fund**. Customers would be assessed the cost of the program on a per-kWh basis through the non-bypassable SBF fee.

Advantages: Similar to how some other states fund fuel cell programs. Mechanism already exists.

Disadvantages: Would remove all program burden from generators (they would not be paying any program costs) and would place it entirely on customers. Generators would therefore have less direct financial incentive to adopt fuel cell technology. Would require an increase in the SBF fee.

4) **Emission reduction credits (ERCs)**. Generators and customers who install fuel cells and can document the offset of conventional generation would earn ERCs that could then be sold.

   Advantage: Would link incentives to the market value of emission reduction, which is the main public benefit of fuel cells.

   Disadvantages: Would be limited to areas where emission credits are used. EPA and TCEQ have not yet worked out a method of awarding ERCs for indirect emission reductions. Would require a different incentive structure than what is proposed here. Incentives would have no fixed value because they would vary according to the value of ERCs, making it difficult for a prospective purchaser to accurately assess the costs and benefits of buying a fuel cell.

5) **Redirect transmission congestion charges**. Revenues collected by ERCOT for congestion management would be set aside for fuel cell incentives, rather than being redistributed on a load-share basis as is done now.

   Advantages: Leverages the distributed generation benefits of fuel cells by sending location-appropriate price signals. Higher incentives would be paid to fuel cells installed at transmission-constrained locations.

   Disadvantages: Computationally complex, and would be affected by how transmission congestion costs are assigned. Would require a different incentive structure than what is proposed here. Would not work in non-ERCOT portions of Texas where there is no direct assignment of local congestion costs.

These general elements form a cohesive policy strategy in which the fiscal mechanism leverages the policy objective. On all other details, the Commission makes no recommendation.

Notes

1 State Energy Conservation Office (SECO), "Accelerating the Commercialization of Fuel Cells in Texas," report to the Texas Legislature pursuant to H.B. 2845, Texas Comptroller of Public Accounts, September 15, 2002.

2 Ancillary services constitute electricity that is reserved and dispatched for grid reliability rather than for customer use. The ability to participate in ancillary service markets would depend on the amount of unused capacity that could be bid and the presence of control systems on the fuel cell assembly that would enable dispatch by the ISO. Only large fuel cell generators would be able to offer ancillary services.

3 See the Daschle-Bingaman Energy Bill, S. 517, 107th Cong., 2d Sess., Sec. 265, "Renewable Portfolio Standard."

4 At the direction of the Commission, ERCOT established its Demand Side Task Force to find ways of enabling load resources – i.e. large customers with interruptible loads – to participate in the ERCOT energy markets. See *Petition of the Electric Reliability Council of Texas for Approval of the ERCOT Protocols*, PUC Docket No. 23220 (Final Order), 2001.

5 P.U.C. SUBST. R. 25.5(19).

6 Larry Alford, Austin Energy manager for distributed generation, presentation to PUC on fuel cells and renewable energy, September 2002.

7 A listing of fuel cell research projects being funded by DOE may be found on the department's Web site at http://www.fe.doe.gov/coal_power/fuelcells/index.shtml.

8 Rita Bajura, Director, National Energy Technology Laboratory, U.S. Department of Energy, remarks in "Workshop Proceedings, Solid State Energy Conversion Alliance," June 2000, Baltimore, Maryland, p. 5 (http://www.seca.doe.gov/Events/Baltimore/SECAFINA.PDF). Also see DOE's Office of Fossil Energy, http://www.fe.doe.gov/coal_power/fuelcells/index.shtml.

9 "Wind Energy Grew Globally at Record Clip in 2001, Report Finds," News release, American Wind Energy Association, March 19, 2002.

10 SECO, p. 24.