APPENDIX 17-A. REGULATORY IMPACT ANALYSIS SUPPORTING MATERIAL

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17-A.1 MARKET PENETRATION CURVES DEVELOPED BY XENERGY

Xenergy, Inc., developed a re-parameterized, mixed-source model of information diffusion to estimate market impacts induced by financial incentives for energy efficient appliances. The basic premise of this mixed-source model is that information diffusion drives technology adoption. There is extensive economic literature discussing the diffusion process of new products as technologies evolve. Some of the literature focuses primarily on the development of analytical models of diffusion patterns of new products for individual consumers or for technologies from competing firms.[1, 2, 3] One study records researchers' attempts to investigate underlying factors that drive diffusion processes.[4] Because of the distinct characteristics of diverse new products, few studies have conclusively developed a universally applicable model. Some key findings, however, seem to have gained wide recognition in academia and industry.

First, all potential users may adopt new technologies, regardless of their economic benefits and technological merits. Many products face a ceiling on their adoption rate. Second, not all adopters purchase new products at the same time. Some act quickly after the introduction of a new product, while others respond slowly, waiting for products to become more mature. Third, diffusion processes can be approximately characterized by asymmetric S-curves, depicting three stages of diffusion: starting, accelerating, and decreasing as the adoption ceiling is reached.

One important diffusion model, the *epidemic model*, is used widely in marketing and social studies on diffusion. It assumes that (1) all consumers value the benefits of a new product identically and (2) the cost of a new product is constant or declines monotonically over time. What induces a consumer to purchase the new product is information about the availability and benefits of the product. In other words, it is information diffusion that drives individual consumers' adoption of new product.[3] By superimposing a logistic function on an exponential function, the model incorporates information diffusion from both internal sources (news spread by word of mouth from early adopters) and external sources (the "announcement effect" by government, other institutions, or commercial advertising).[1, 4]

The relative degree of influence by internal and external sources determines the general shape of the diffusion curve for the specific product.[1, 4] For instance, if the adoption of a product is influenced more by external sources of information diffusion (announcement effect) than by internal sources (word of mouth among early adopters to prospective adopters), the rate of diffusion at the beginning of the diffusion process is much higher. This effect reflects the immediate information exposure to a significant number of prospective adopters brought about by external sources, in contrast to the more gradual exposure of early adopters, a small proportion of the population, to other prospective adopters. Graphically speaking, a relatively dominant external source of information diffusion gives an immediate jump-start to the adoption

of a new product in the first years, forming a concave curve with respect to the Y axis (the exponential curve in Figure 17-A.1.1). Adoption of a new product influenced more strongly by internal sources of information diffusion (such as a social network formed by prospective adopters) may start with a few early adopters and increase gradually as the number of adopters increases. This process forms a convex curve (the logistic curve in Figure 17-A.1.1).

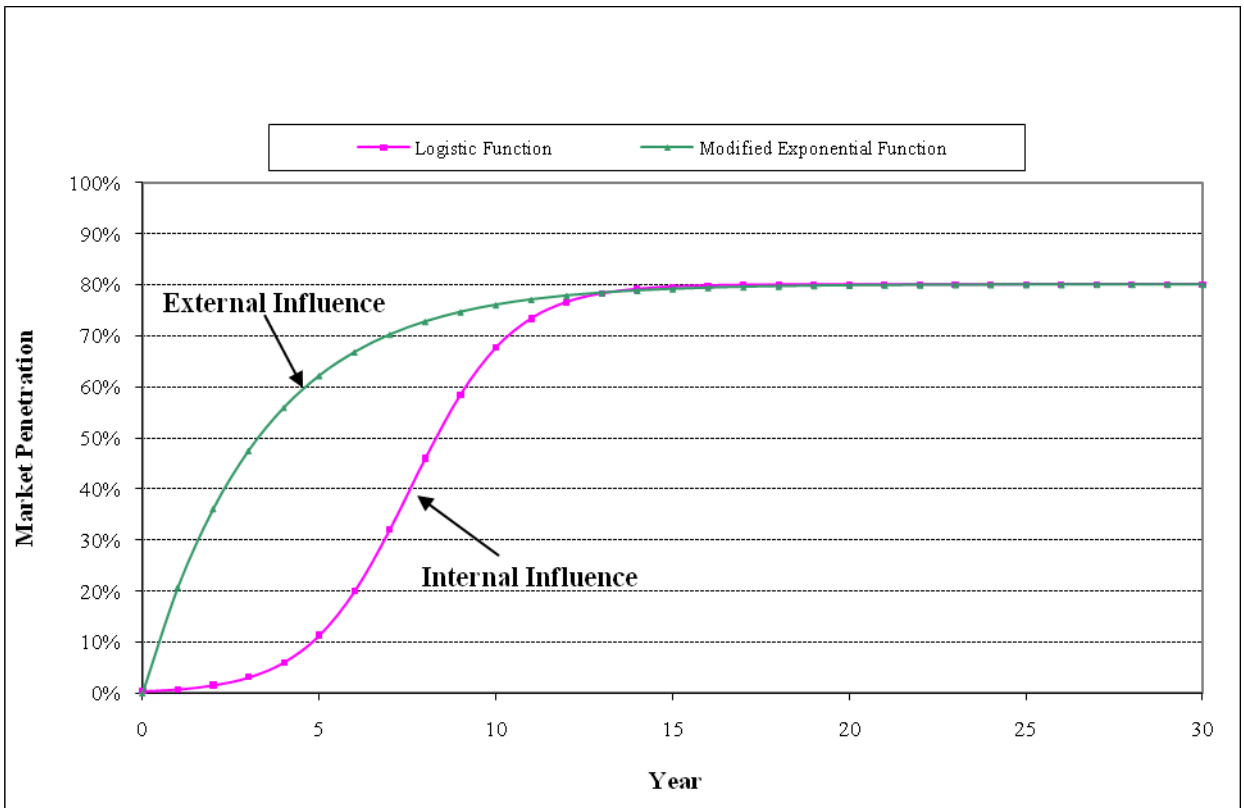

Figure 17-A.1.1 Comparison of Exponential and Logistic Curves Showing External and Internal Influences on Consumers

17-A.2 IMPACTS OF CONSUMER TAX CREDITS

Because there have been no consumer tax credits for microwave ovens, DOE analyzed data from Oregon's Residential Energy Tax Credit (RETC) for dishwashers as an analogous kitchen product. DOE calculated that for 2006 Oregon taxpayers claimed credits for 14 percent of dishwasher shipments to the State. DOE found no data comparing sales of efficient dishwashers in Oregon and Washington. To estimate how many of the tax credit claims likely were due to utility rebates and to market impacts, DOE reviewed a report by Itron on utility rebate programs in California. That report compared the percentage of residential clothes washer and dishwasher rebate programs in 2005.[5] Free riders are consumers who would have purchased efficient appliances without a tax credit or rebate incentive but claimed the credit. Itron found that the penetration rate of ENERGY STAR dishwashers (85 percent) was much higher than that

of ENERGY STAR clothes washers (40 percent). Itron also found that the percentage of free riders was greater for dishwasher programs than for clothes washer programs. DOE's previous estimates showed that the incremental cost compared to a baseline unit was much smaller for high efficiency dishwashers than for high efficiency clothes washers,[6, 7] which could explain the higher penetration rate for efficient dishwashers. An incentive program for a product having a higher market share would tend to have more free riders. Based on these various factors, DOE estimated that market impacts (partly due to free riders) were responsible for a higher percentage of tax credit claims for dishwashers than for residential clothes washers.

Itron's report contained two estimates of free riders for ENERGY STAR dishwashers in 2005. DOE took the simple average of the supplier estimate of 93 percent and the self-reported consumer estimate of 59 percent, yielding 76 percent. DOE also developed a simple average of estimated free riders for residential clothes washers, averaging 77 percent from suppliers and 43 percent from consumers to yield 60 percent. DOE assumed that the difference in numbers of free riders between the two products would be on the order of the difference between the two estimates (16 percent).

DOE interpreted the higher percentage of consumers purchasing dishwashers as free riders, and the lower percentage of taxpayers influenced primarily by rebates, to estimate that 49 percent of Oregon's 2006 dishwasher tax credits claimed (6.9 percent of total dishwasher shipments to the State) were due to market impacts. It estimated that utility rebates were responsible for 32 percent of tax credits claimed (4.5 percent of total shipments). DOE attributed the remaining 20 percent of tax credits claimed (2.8 percent of total shipments) to the ability of the consumer to claim a tax credit.

17-A.3 EPACT 2005 FEDERAL TAX CREDITS FOR CONSUMERS AND MANUFACTURERS OF RESIDENTIAL APPLIANCES

This section describes the products that qualified for Federal tax credits for consumers and manufacturers of energy efficient residential appliances under EPACT 2005.

17-A.3.1 Tax Credits for Consumers of Residential Appliances

EPACT 2005 included Federal tax credits for consumers who installed efficient air conditioners or heat pumps; gas or oil furnaces; furnace fans; and/or gas, oil, or electric heat pump water heaters in new or existing homes.[8,9,10] These tax credits were in effect in 2006 and 2007, expired in 2008, and were reinstated for 2009–2010 by the American Recovery and Reinvestment Act (ARRA). There was a $1,500 cap on the credit per home, including the amount received for insulation, windows, and air and duct sealing. Congress extended this provision for 2011 with some modifications to eligibility requirements, and reductions in the cap to $500 per home**.**

Residential appliances must meet the following specifications, as applicable, to qualify for Federal tax credits.

- Furnaces and Boilers:
    - Until December 31, 2010: Natural gas & propane furnaces must meet an Annual Fuel Use Efficiency (AFUE) 95 or higher, oil furnaces and gas, oil and propane boilers must meet an AFUE of 90 or better.
    - From January 1 through December 31, 2011: Natural gas & propane furnaces must meet an Annual Fuel Use Efficiency (AFUE) 95 or higher, oil furnaces and gas, oil and propane boilers must meet an AFUE of 95 or better. In addition, the credit only covers costs up to $150.
- Central Air Conditioning Units:
    - Until December 31, 2010: Central air conditioning units and air-source heat pumps must meet the highest tier standards set by the Consortium for Energy Efficiency (CEE) as of February 17, 2009, which in most cases requires a Seasonal Energy Efficiency Ratio (SEER) of 16. SEER measures performance throughout the cooling season.
    - Until December 31, 2011: same specifications, the credit only covers costs up to $300.
- Fans for heating and cooling systems:
    - Until December 31, 2010: fan uses no more than 2% of total heating system energy use, as defined by DOE test procedure.
    - From January 1 through December 31, 2011: $50 for any advanced main air circulating fan
- Water Heaters:
    - Until December 31, 2010:
        - Gas or propane water heaters—Energy Factor of at least 0.82, or a thermal efficiency of at least 90%
        - Heat pump water heaters—Energy Factor of at least 2.0
    - From January 1 through December 31, 2011: same specifications, the credit only covers costs up to $300.

17-A.3.2 Tax Credits for Manufacturers of Energy Efficient Appliances

EPACT 2005 provided Federal Energy Efficient Appliance Credits to manufacturers that produced high-efficiency refrigerators, clothes washers, and dishwashers in 2006 and 2007.[11] The Emergency Economic Stabilization Act of 2008[12] amended the credits and extended them through 2010. The credits were extended again to 2011 with modifications in the eligibility requirements. Manufacturers who produce these appliances receive the credits for increasing their production of qualifying appliances. The credits were available for models produced in 2008, 2009, and 2010 and 2011.

The credit amounts applied to each unit manufactured. The credit to manufacturers of qualifying clothes washers, refrigerators and dishwashers is capped at $75 million for the period of 2008-2010. However, the most efficient refrigerator (30%) and clothes washer (2.2 MEF/4.5 wcf) models are not subject to the cap. The credit to manufacturers is capped at $25 million for

2011. The most efficient refrigerators (35%) and clothes washers (2.8 MEF/3.5 WCF) are exempted from this cap.[13]

REFERENCES

[1] Geroski, P.A. Models of Technology Diffusion. 2000. *Research Policy*. 29: 603–625.

[2] Hall, B.H., and B. Khan. *Adoption of New Technology*. 2003. Department of Economics, University of California, Berkeley, CA. Working Paper No.E03-330.

[3] Lekvall, P., and C. Wahlbin. A Study of Some Assumptions Underlying Innovation Diffusion Functions. 1973. *Swedish Journal of Economics*.

[4] Van den Bulte, C. Want to Know How Diffusion Speed Varies Across Countries and Products? Try a Bass Model. 2002. Product Development and Management Association. PDMA Vision. October. XXVI, No

[5] Itron and KEMA. 2004/2005 Statewide Residential Retrofit Single-Family Energy Efficiency Rebate Evaluation. 2007. Prepared for the California Public Utilities Commission, Pacific Gas and Electric Company, San Diego Gas and Electric Company, Southern California Edison, and Southern California Gas Company. Itron, Inc., and KEMA, Inc.: Oakland, CA. CPUC-Id#: 1115-04.

[6] U.S. Department of Energy. Technical Support Document: Energy Efficiency Standards for Consumer Products and Commercial and Industrial Equipment: Residential Dishwashers, Dehumidifiers, and Cooking Products, and Commercial Clothes Washers. November 2007. Washington, D.C. Chapter 8. (Last accessed May 6, 2011.) http://www.eere.energy.gov/buildings/appliance_standards/residential/home_appl_tsd.html

[7] U.S. Department of Energy. Final Rule Technical Support Document (TSD): Energy Efficiency Standards for Consumer Products: Clothes Washers. December 2000. Washington, D.C. Chapter 7. (Last accessed May 6, 2011.) http://www.eere.energy.gov/buildings/appliance_standards/residential/clwash_0900_r.html

[8] Tax Incentives Assistance Project, *Consumer Tax Incentives: Home Heating & Cooling Equipment.* (Last accessed May 6, 2011.) <www.energytaxincentives.org/consumers/heating-cooling.php>

[9] Energy Policy Act of 2005, *119 STAT. 594 Public Law 109–58. Section 1333, 26 USC 25C note,* (Posted August 8, 2005) (Last accessed May 6, 2011.) <http://frwebgate3.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109_cong_public_laws&docid=f:publ058.109.pdf>

[10] Consortium for Energy Efficiency, CEE High-Efficiency Specification: Central Air Conditioners and Air Source Heat Pumps, January 1, 2009. (Last accessed May 6, 2011.) <http://www.cee1.org/resid/rs-ac/res-ac_specs.pdf>

[11] U.S. Department of the Treasury, *Internal Revenue Service, Form 8909,* (Last accessed May 6, 2011.) <www.irs.gov/pub/irs-pdf/f8909.pdf>

[12] *Emergency Economic Stabilization Act of 2008.* (Last accessed May 6, 2011.) <http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_bills&docid=f:h1424enr.txt.pdf

[13] Tax Incentives Assistance Project, *Manufacturers Incentives,* (Last accessed May 6, 2011.) <http://energytaxincentives.org/builders/appliances.php>