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Strategies for Local Low-Carbon Development

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Strategies for Local Low-Carbon Development

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CONTENT

INTRODUCTION

Cities around the world are implementing policies and programs with the goal to reduce greenhouse gas emissions, as well as save energy, reduce costs, and protect the local, regional, and global environment. In China, low-carbon development is a key element of the 12th Five Year Plan. Pilot low-carbon development zones have been initiated in five provinces and eight cities and many other locations around China also want to pursue a low-carbon development pathway.

The key steps for low-carbon development are show in Figure 1. With the 12th Five-Year Plan leading the way, cities and provinces are already committed to reporting their energy consumption and energy intensity. A carbon emissions inventory follows from the energy data. The next step is to identify potential savings of energy and carbon, and to set specific targets. Then comes the task of choosing strategies and policies to achieve the targets; this booklet is designed to support Chinese cities in that task. Next is the hard work to implement the chosen policies. The final important step in low-carbon development is to monitor and evaluation progress, to improve strategies.

Figure 1. Steps in Low-Carbon Development

This booklet provides information for government officials, policy makers, program designers and implementers, provincial and city planners, and others who want an overview of the key options available for low-carbon development at local level. These *Strategies for Local Low-Carbon Development* draw from successful experiences from around the world.

Information is provided for low-carbon actions that can be taken in the sectors of (1) Industry, (2) Buildings and Appliances, (3) Electric Power, (4) Consumption and Waste Management, (5) Transportation and Urban Form, and (6) Agriculture and Forestry. A description of each policy is provided along with information on the stakeholders involved in implementation, the conditions for successful implementation, the expected energy and carbon savings, and the policy cost-effectiveness. Case studies show how each policy has been implemented somewhere around the world.

While there are many low-carbon options available for local implementation, this booklet aims to provide guidance on those that have been most successful, that have the largest impact, and that are cost-effective in order to support low-carbon development efforts in Chinese cities.

Summary of 23 Policies In 6 Sectors

1. INDUSTRY					
Recommended Policy	**1.1 Energy Management Programs**	**1.2 Benchmarking: How Does an Enterprise or City Compare to its Peers and to Standards?**	**1.3 Energy-Efficiency Assessments**	**1.4 Voluntary Energy-Savings Targets**	**1.5 Energy Tax & Rebate**
Policy Description	An enterprise-level, comprehensive program to improve energy efficiency in industrial facilities.	Benchmarking shows where a city or an enterprise stands compared to its peers and to national performance standards.	Energy assessments aim to understand how an enterprise is using energy as well as identifying areas where energy can be saved and related CO_2 emissions can be reduced. Preliminary or walk-through audits and detailed audits are two common types of energy assessments.	Industrial sectors or companies make voluntary commitments to energy savings or emission reductions either individually or through government programs.	Taxes on the energy consumed by industrial enterprises can be used to motivate enterprises to save energy as well as to reward those enterprises that are successful at energy-saving.
Stakeholders	• Enterprise officials. • Enterprise energy managers who implement the energy management program. • Government energy efficiency programs.	• Participating enterprises. • Government entities responsible for the energy or CO_2 emission targets, energy efficiency programs, or greenhouse gas mitigation efforts.	• Government or other entities responsible for energy assessment programs. • Energy service companies. • Participating enterprises.	• Participating enterprises. • Government entities pledging support.	• The entities whose energy is taxed. • The government taxation body and program-related entities that monitor and evaluate the progress of the enterprises in meeting their targets.
Conditions for Implementation	Support from enterprise officials, including financial support for development of energy management systems and sufficient funding, authority, and responsibility to energy managers.	Accurate data on energy consumption of participating enterprises or cities.	Strong policy guidance and supporting incentives, tools, training, etc., preferably from a national-level entity.	Information on the enterprise's production, energy consumption, and CO2 emissions along with a projection of future production trends and knowledge of the facility's energy efficiency potential.	A well-designed energy or CO_2 tax program in which revenues are recycled back into the economy, using a portion to finance energy efficiency or renewable energy improvements.
Energy & CO_2 Reduction Impact	Enterprises that implement comprehensive energy management programs can realize significant energy savings and reductions of CO2 emissions.	Benchmarking can have a high impact by motivating enterprises or cities to take actions to improve their ranking among their peers or to meet or exceed performance standards.	When done well, energy efficiency assessments can identify significant energy savings opportunities in most industrial facilities.	In the Dutch Long-Term Agreement (LTA) program, the average target was a 20% increase in energy efficiency over 1989 levels by 2000.	An analysis of energy or CO_2 taxes in European countries found substantial reductions in CO_2 emissions as well as emissions of NO_x, SO_x and other air pollutants.
Cost-Effectiveness	Successful energy management programs result in identification and implementation of cost-effective energy-saving technologies and measures.	Overall cost-effectiveness is high, if data for benchmarking is readily available.	A cost-effective way to identify energy-saving opportunities. Costs for assessments can be subsidized or provided free of charge to participants. Costs for implementation can be reduced through subsidies.	Evaluations of the Dutch LTA program found that the agreements helped industries to focus attention on energy efficiency and identify cost-effective options that met commonly used investment criteria.	The Intergovernmental Panel on Climate Change (IPCC) found that "emission taxes do well in both cost effectiveness and environmental effectiveness."
Barriers	• Lack of ongoing commitment and clear assignment of responsibilities. • Lack of train staff and capital • Lack of energy data • Targeting only symptoms, not root causes • Narrow program scope	• Lack of energy and production data • Lack of guidebooks and tools • Heterogeneous product output	• Lack of standardized methodology, tools & training • Lack of certified staff for energy auditing • Lack of funding	• Lack of understanding of the company's energy-saving potential • Lack of government support (e.g. technical support or funding) • Lack of effective incentives	• Lack of authority or ability to impose energy tax and rebate • Ineffective program design • Collected tax not redistributed appropriately for energy-efficiency or low carbon programs
Case Studies	CalPortland Cement Company in the U.S.	Dairy companies in Norway	Kaiser Aluminum in the U.S.	U.S. Department of Energy's Better Plants Program	UK Climate Change Levy and Climate Change Agreements

2. BUILDING & APPLICANCE				
Recommended Policy	**2.1 More Stringent Building Codes**	**2.2 Leading Appliance Standards**	**2.3. Target Net-Zero Energy Buildings**	**2-4 Tax Credits & Incentives**
Policy Description	Building energy codes are developed at the national level as a model or baseline code, but are typically adopted and enforced by local governments for their jurisdictions. The more stringent the building energy code, the higher the energy efficiency in the baseline for new construction.	Minimum energy performance standards (MEPS) are used in the appliance and commercial equipment sectors to set mandatory minimum requirements for appliance and equipment energy efficiency.	A Net-Zero Energy Building (NZEB) is a building with very high energy performance in which the very low amount of energy required can and should be covered by onsite renewable energy generation. The demand for external supply of energy can be so limited as to near zero.	Financial incentives in the form of tax credits and incentives are offered to spur greater adoption of energy efficient technologies, which tend to have higher up-front capital costs. Common forms of tax credits and incentives include personal or corporate investment tax credits, tax deductions and tax exemptions. In addition to direct subsidies and rebates, other forms of financial tax incentives for efficient technologies include loan guarantees and loans with preferential interest rates.
Stakeholders	• Architectural design community • Code enforcement community • Real Estate developers, builders and contractors • Building owners and operators • Industry and manufacturers for the building industry • Utility companies • Energy advocacy groups	• Government regulators, staff and contractors • Equipment manufacturers and related industries • Consumers • Utility companies • Environmental/energy advocacy groups	• Government and policymakers • Architectural design community: architects, designers, mechanical and electrical engineers • Builders and contractors • Building owners and operators • Industry and manufacturers for the building industry • Utility companies and	• Government (policymakers, taxation authority, energy-related programs such as ENERGY STAR) • Architectural Design community: architects, designers, mechanical and electrical engineers • Builders and contractors • Building owners and operators • Industry, manufacturers, distributors, retailers and installers for the building industry • Utility companies • Energy advocacy groups
Conditions for Implementation	Consistent adoption, implementation and enforcement of more stringent building code across all jurisdictions.	Authority for local jurisdictions to have the authority to adopt new standards for uncovered products or more stringent standards for products already regulated on a national level. Technical and financial capacity for conducting the techno-economic analyses needed to support and justify standard-setting and for monitoring and enforcing compliance with standards.	Need clear definitions of "zero net-energy" through specific guidelines on energy accounting boundaries, and supporting R&D to build a larger market for the cost-effective new designs, technologies and products needed to meet net zero-energy and carbon goals.	Sufficient funding for tax credits and incentives for efficient equipment and measures. Low transaction cost for filing tax credit or incentive claims. Strong efforts to promote awareness of the tax credit/incentive program and to educate consumers on the benefits of eligible efficiency measures.
Energy & CO_2 Reduction Impact	The adoption and effective implementation of building energy codes 30-50% more stringent than the 2006 International Energy Conservation Code model code across the U.S. would reduce primary energy use in buildings by 18 Mtce per year by 2015 and 126 Mtce per year by 2030.	Leading MEPS can directly reduce the electricity demand and electricity costs of households while providing the same if not better level of service. U.S. MEPS in place for 30 products are estimated to have saved 280 TWh in 2010, with cumulative potential energy savings of 7200 Mtce by 2035.	The EU recast impact assessment found that compared to other policy options for improving building energy performance, target for NZEBs had the largest energy savings and carbon reduction potential.	The impact of tax credits and incentives are often measured in terms market transformation rather than direct energy and related CO_2 emission reductions. The U.S. tax credit to homebuilders reduces the energy consumption of new homes by 50% and has estimated potential lifetime electricity savings of 876 TWh and fuel savings of 208 Mtce if extended over time.
Cost-Effectiveness	Building codes are considered one of the most cost-effective building efficiency policies. If a 30-50% more stringent building code was adopted across all states, U.S. building owners would save more than RMB 27 billion annually by 2015 and up to RMB 202 billion per year by 2030.	In the U.S., MEPS for products such as outdoor lighting fixtures, and commercial automatic ice makers have very high benefit-cost ratios of greater than 8.	Although target NZEBs have very low administrative burden and costs, targets set for achieving significant NZEB shares in the short-term may not be very cost-effective due to the high incremental costs for implementing the technologies and design needed to achieve net or low net-zero energy.	Cost-effectiveness varies, and may be affected by the value of the incentive relative to the effort exerted to receive the incentive (i.e., transaction costs) and if significant portions of credit or incentive recipients would have invested in the technology without the policy (i.e., free-rider effect).
Barriers	• No timely update in building energy codes • Ill-link between building codes and building performance • Disconnect between descriptive building codes and performance building codes • Local building energy codes not in place	• Opposition from the appliance manufactures • Lack of funding and resources from organizations • Under jurisdiction and responsibility of various government agencies in development and enforcement of the local standards.	• Lack of clear definition • Lack of investment in early-stage R&D and demonstrations • Lack of market incentives	• Unreasonable design in tax credits and financial incentives • Technical assistance unavailable
Case Studies	California's Title 24	California's Leading State Appliance Efficiency Standards	UK Targets for Achieving Zero Carbon Buildings Before 2020	Italy's Tax Credit Program for Energy Efficiency Improvements to Existing Buildings

3. ELECTRIC POWER			
Recommended Policy	**3.1 Renewable Portfolio Standards (RPS) & Environmental Generation Dispatch**	**3.2 Signal with Prices: Time-of-Use, Inverted Block and Differential Pricing**	**3.3 Utility Programs for Energy Saving: Utility DSM Programs and Public Benefits Funds**
Policy Description	RPS aims to increase renewable energy generation by requiring electric utilities and other providers to supply a specified minimum amount of customer load with electricity from eligible renewable sources. Environmental generation dispatch prioritizes renewable energy as source for electricity.	Dynamic and variable electricity pricing can be changed more frequently to send pricing signals to all customer classes (residential, commercial, industrial) based on fluctuations in real costs. Time-of-Use Rates, Inverted Block Pricing, and Differential Pricing are three common dynamic and variable pricing.	Utility demand-side management (DSM) program focuses on changing the level or timing of consumers' electricity demand through various activities related to energy efficiency. Public benefits funds (PBFs) provides consistent funding for energy efficiency programs through a small surcharge on every customer's electricity bill, with magnitude ranging from RMB 0.0002 to RMB 0.02 per kWh.
Stakeholders	• Government/policymakers • Electric and gas utilities • Utility regulators (public utility commissions) • Utility customers and ratepayers (residential, commercial and industrial energy consumers) • Renewable electricity project developers and generators • Environmental, energy and ratepayer advocacy groups	• Government/policymakers • Electric and gas utilities • Utility regulators (public utility commissions) • Utility customers and ratepayers (residential, commercial and industrial energy consumers) • Environmental, energy and ratepayer advocacy groups	• Government policymakers • Electric & gas utilities • Utility regulators (public utility commissions) • Utility customers & ratepayers (residential, commercial, industrial energy consumers) • Energy efficient technology/measures manufacturers, retailers, installers • Public and private sector energy efficiency providers & organizations • Energy, environmental & ratepayer advocacy groups
Conditions for Implementation	RPS requires availability of renewable resources, sufficient transmission capacity, existence of interconnection and priority dispatch requirements for renewable generation. Environmental generation dispatch requires development of policies supporting renewable generation and streamlined process for selecting and contracting renewable energy developer.	Strong efforts to educate and raise awareness among customers. Availability of technical assistance to larger industrial and commercial consumers.	Removal of disincentives for effective energy efficiency programs in cases where utility revenues and associated profits are linked to energy sales. Methods and protocols in place to evaluate the actual energy savings from utility DSM programs.
Energy & CO_2 Reduction Impact	The success of RPS will result in increased renewable generation (rather than direct energy reduction) and subsequent reductions in CO_2 emissions from power generation.	TOU pricing has proven successful in reducing system peak demand by 10% to 16% in New York. In China, the differential pricing policy for industry helped reduce electricity consumption by 115 TWh and CO_2 emissions by 82 million metric tons from 2004 to 2009.	The various efficiency efforts encompassed by utility DSM programs can result in significant energy savings, with estimates of annual savings of 50 to 59 GWh in the U.S. between 1994 and 2005. For 2002-2003, the total annual investment of RMB 5.86 billion from states with energy efficiency PBFs yielded 2.8 TWh of electricity savings and over 1.8 million metric tons of CO_2 emissions reduction.
Cost-Effectiveness	Studies show implementation of RPS has negligible impact on ratepayers, ranging from increases of less than 1% to savings of up to 0.5%. Cost-effectiveness of environmental dispatch is difficult to measure as it is often introduced along with other policy measures such as feed-in tariffs.	TOU rates' ability to realize the benefits of dynamic pricing and achieve cost-effectiveness is dependent on and closely related to the availability and introduction of low-cost enabling technologies to help customers respond to dynamic prices.	DSM programs have been generally considered highly cost-effective. 1996 U.S. utility DSM programs resulted in estimated saving of RMB 0.283 per kWh. PBFs have been considered very cost-effective. Of the 12 state PBF programs in 2002-2003, the median program cost was only RMB 0.02 per kWh saved, well below the typical costs of new power sources and average retail prices of electricity.
Barriers	• Volatility in energy prices and in renewable energy costs can undermine RPS goals • Trading of Renewable Energy Certificates (RECs) requires support from the market • Creating a mechanism for incentives and reimbursement is difficult	• Need to overcome obstacles posed by energy pricing reform • A major challenge inherent in the inverted block in terms of setting up electricity supply and pricing based on societal fairness and equality	• Lack of DSM technologies and information • Establishing pricing incentives is fundamentally crucial • Poor education and awareness among consumers • Levy, appropriation, management and supervision of PBFs
Case Studies	Texas RPS and Renewable Energy Certificates (RECs)Implementation	China's Differential Electricity Pricing Policy for Energy-Intensive Industries.	New York's System Benefits Charge Program

4. CONSUMPTION & WASTE MANAGEMENT			
Recommended Policy	**4.1 Source Reduction: Reduce and Re-Use Waste**	**4.2 Recycling & Composting**	**4.3 Landfill Methane Recovery**
Policy Description	This policy aims to reduce the amount and toxicity of waste at or before the point of generation. Key steps to achieving source reduction including promoting the adoption of strategies to use less material per product, extend the useful life of products and materials and reduce overall waste generation during the design manufacture, purchase and use of products and materials.	Policies that promote recycling include setting recycling goals and requirements, recycling grants, tax incentives, beverage container deposit laws, disposal fee surcharges and disposal bans. Policies to promote composting focus on creating high market demand for compost, including favorable procurement policies in local governments and large institutions, landscaping and green building policies, and rebates and free giveaways for compost.	Municipal solid waste management contributes 14% of global emissions of methane in the form of vented landfill gas (LFG). The main method for capture and recovering methane in LFG is to extract and collect it using wells and a vacuum system, where the gas can be used directly to generate electricity or to fuel combined heat and power systems.
Stakeholders	• City government and related agencies (environment, waste management) • Businesses, consumers, local community groups • Product supply chain: manufacturers, transport, distributors, retailers • Waste management companies • Non-profits& research organizations • Media	• City government &related agencies (environment, waste management) • Businesses, consumers, local community groups • Agriculture, environmental & sustainable development groups • Waste management companies, recycling & compost providers • Businesses providing recycling & composting services: haulers, processors, brokers of recovered materials; manufacturers of recycled materials & waste compost	• City government • Landfill gas energy project developers & supporting contractors • Regulatory and planning agencies and departments • Financial partners • Energy end-users (businesses, industry) and utilities
Conditions for Implementation	Regulatory focus looking beyond traditional "end-of-pipe" waste disposal options and recycling. Targeted participants informed and motivated. A mechanism for consistent monitoring and periodic evaluation.	Active education and outreach in different target groups to enhance public awareness in the need and resources for recycling and composting.	Government's active effort in promoting awareness among the stakeholders on the benefits of methane recovery and LFG energy projects. LFG project developers' access to financial support. Availability of technical and institutional capacity for landfill gas recovery and utilization as well as existence of supporting policies and regulations.
Energy & CO_2 Reduction Impact	Reducing waste generation directly reduces the energy needed to collect and dispose waste, while reuse help reduce the energy needed to extract new materials and manufacture and transport new products. Both have important impacts on reducing energy consumption and CO_2 emissions.	In 2005, the recycling program in the U.S. led to estimated 22 Mtce of energy savings and 48 $MtCO_2$ reduction. Composting under carefully controlled conditions for decomposition can lower emissions from compost operations.	A typical 3-MW electricity generation project using LFG can reduce 34,700 metric tons of carbon equivalent from methane and avoided CO_2 emission reductions per year, while a typical direct-use LFG energy project can reduce 32,300 metric tons of carbon equivalent per year.
Cost-Effectiveness	Studies show the true cost of waste is around 15 times the actual cost of disposal, thus strategies such as reduce and re-use can be very cost-effective. In Washington's King County, a mandate to purchase recycled and environmentally preferable products led to total savings of RMB 3.9 million in 2003.	Studies shows recycling results in ten times more jobs than waste disposal, diverting one additional ton of recyclable or compostable waste from landfills pays RMB 680 more in salaries and wages, produces RMB 1,851 more in goods and services and generate RMB 908 more in sales than landfill disposal. But cost-effectiveness of composting is less clear-cut.	LFG energy projects have proven to be very cost-effective in generating significant revenue from power or fuel sales that offset the project's capital costs.
Barriers	• Lack of information and education in environment protection • Poor alignment for Incentives offered by enterprises and governments	• No Infrastructure and proper channels for waste recycling • Low penetration of environment education • Consumers unaware of the end-use for composting and thus no market demand for compost	• No fair pricing mechanism in place for landfill methane trading • Professional program developers and contractors not available
Case Studies	North Carolina's Swap Shops	San Francisco Zero Waste Goals and Mandatory Recycling and Composting Ordinance	South Korea's Ulsan LFG Direct Use Project

5. TRANSPORTATION & URBAN FORM

Recommended Policy	5.1 Vibrant Neighborhoods & Streets for People	5.2 Integrated Transit Development	5.3 Less Distance, Better Flow	5.4 Efficient, Low Carbon Vehicles
Policy Description	"Mixed-use Neighborhoods" aims to create human-scale, mixed zone neighborhoods where the majority of residents can walk or bicycle to meet basic, non-work, daily needs. "Streets for People" aims to make streets safe and appealing for people. Cities can adopt small block (1.5 hectares) design.	Integrated transit planning, where commercial and residential development is concentrated along transit corridors, reduces vehicle kilometers travelled and CO_2 emissions. Improve connections across transit routes and consider bus rapid transit (BRT), and light rail or subway; encourage walking, biking, and public transit through easy access and payment on transit systems, along with transit information systems and public outreach.	This policy aims to reduce distance travelled, and keep traffic flowing for the distance that is travelled. Cities can optimize traffic flow through traffic signal timing, variable message systems, and High Occupancy Vehicles lanes; and optimize freight hubs through timing of entrance, location of transfer hubs.	This policy aims at improving vehicle efficiency and encouraging low-carbon vehicle technology and fuels. Cities can encourage penetration of fuel-efficient vehicles and support infrastructure for electric vehicles.
Stakeholders	• City Transportation Agency • Businesses • Developers • Community	• City government agencies • Developers	• City government agencies • Businesses involved in freight transport • General public	• Fleet owners, government &business • Private vehicle owners • Vehicle manufacturers & retailers • Fuel producers &fueling stations
Conditions for Implementation	Strong coordination across government agencies—planning, transport, investment, construction.	Prioritize funding for public transit infrastructure; create strong partnerships with real estate and business district development to ensure integration of public transit in development plans.	Multiple traffic measures implemented together in order to achieve shorter transport distances and better flow of traffic.	Strong coordination across government agencies, businesses, and vehicle manufactures.
Energy & CO_2 Reduction Impact	For existing urban neighborhoods that shift to mixed-use zoning and complete streets, cities may achieve 30% savings in VMT and CO_2 within 10 to 20 years.	In the U.S., 17 Transit-Oriented-Development projects in five medium- to large-sized metropolitan areas showed a 44% reduction in vehicle trips, compared to typical patterns of car-focused development.	Cities can achieve 10-15% savings in energy and CO_2 emissions by optimizing the flow of vehicle traffic. Controlling the number of automobile licenses could achieve even greater savings.	Hybrid vehicles emit roughly half the CO_2 emissions of a typical passenger car. Electric vehicles running on renewable energy emit up to 70% less CO_2 than the typical gasoline-powered vehicle.
Cost-Effectiveness	Implementing "Street for People" has moderate public costs and low private costs, for high savings of GHGs (more than 15%), compared to other sustainable transport measures.	Transit-Oriented Development has a relatively low public cost, medium private cost, and medium GHG savings (10-15%), for medium effectiveness overall.	Demand pricing and license fees, combined with traffic flow optimization, has net benefits rather than costs. Congestion charges and license fees generate revenue.	Since taxis drive as much six times more distance than private vehicles, utilizing fuel efficient, hybrid taxis can reduce GHG substantially. In New York City, hybrid taxis could save 296,000 tCO2e/yr, the equivalent of taking 35,000 cars off the road. Hybrid taxis also save money on fuel: RMB 35,000 /yr (based on NYC 2011 gas prices). .
Barriers	• More difficult to transform existing urban form than design new developments • Must coordinate development plans across agencies	• Requires coordination with other cities and system planning • Large capital investment and long construction time for rail infrastructure • Must persuade people to opt for public transportation	• Limited capability in technology and management • Needs rigorous planning, organization and coordination • Congestion charge is a hard sell to the general public • Must address cultural interest in motor vehicles	• Even with subsidies, hard to overcome high cost of hybrid and electric vehicles to deepen their penetration • Limited awareness and acceptance of renewable vehicles • Need investment in charging station infrastructure
Case Studies	City of Portland	Guangzhou's low carbon transportation	London's congestion pricing scheme	Mexico City's subsidy for fuel-efficient taxis. New York City hybrid taxi program.

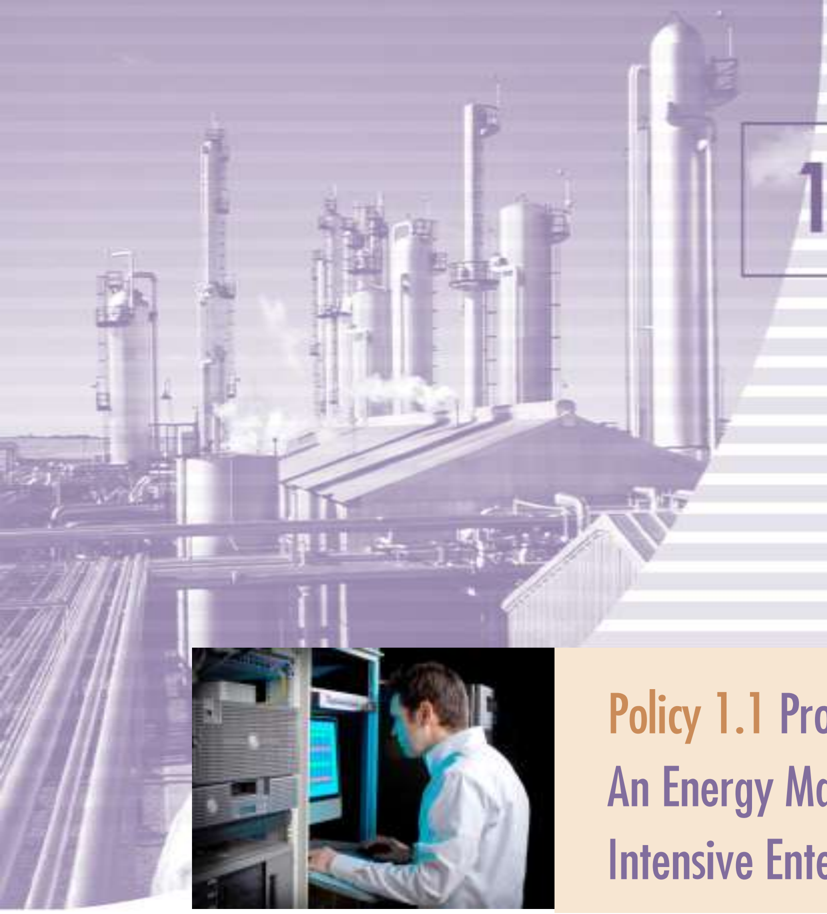
6. AGRICULTURE & FORESTRY				
Recommended Policy	**6.1 Local Agriculture, Healthy Food**	**6.2 Organic Agriculture, Safe Food**	**6.3 Urban Forestry: Protect & Clean**	**6.4 Urban Green Spaces**
Policy Description	Transportation accounts for 30% of food-related emissions in China, highlighting the importance of local food. Promote local food supply to save energy and greenhouse gas emissions from transportation, food processing, and food retail energy Shifting away from red meat to vegetable protein can improve health and significantly reduce the carbon footprint of food.	Agriculture in China has become dominated by synthetic fertilizers, chemically produced from coal or natural gas in energy-intensive, highly polluting processes. Excessive application of synthetic fertilizers has damaged land and water bodies. Cities can promote organic farming methods using bio-fertilizers, bio-pesticides, and integrated pest management, reducing needs for chemical fertilizers and chemical pesticides.	Urban forests provide shade in the hot summer and buffer cold winds in the winter, saving energy in buildings year-long and off-setting the urban "heat-island" effect, in addition to filtering the air for greater health. As storms and weather extremes become more common with climate change, trees are even more valuable as protection for a city.	Cities can increase the amount of per capita green space, set goals for public access to green space, recognize parks and preserves as "green infrastructure."
Stakeholders	• Farmers • Food markets • Government, business, school & restaurants engaging in food purchase • General public	• Farmers • Grocers • Public agencies involved in agriculture, food purchasing & food safety • Schools & neighborhoods	• City planning commission • City maintenance department • Arborists • Developers • Health agencies • Businesses • Schools & Neighborhoods	• City government • Developers • Businesses • The general public
Conditions for Implementation	Prioritize healthy, low-carbon food by encouraging local farmers markets and permitting urban agriculture in vacant lots and rooftops. Test urban soils before food is grown to avoid contamination.	Strong partnerships among public agencies, farmers, business, and the public. Organic certification standards and agencies.	City budgets for ongoing maintenance of urban forestry; inclusion of protection and expansion of urban forests in development plans; engagement of the public.	Require the creation, maintenance and restoration of green space a requirement in development plans, and land-use contracts.
Energy & CO_2 Reduction Impact	Increased share of local food reduces transportation energy; encouraging more vegetable proteins than red meat reduces GHG significantly, e.g. beef production emits 13 times more GHG than beans, lentils, or tofu.	The combination of fossil fuel savings and carbon sequestration by improved soils could offset 20-40% of agricultural greenhouse gas emissions.	Carbon sequestration in urban trees varies from 16 kg/year per tree for small trees, to 270 kg/year for Indirect savings from urban trees can reduce summer cooling demand 8-43%.	Green spaces buffer the urban heat-island effect, reducing demand for cooling and heating. Energy savings of 40-75% have been achieved in buildings with roof-top green space.
Cost-Effectiveness	Many groups can enjoy cost savings and enhanced income from the promotion of local, healthy foods.	Profitability is nearly three times higher with organic farms, compared to conventional farms, based on a 30-year international study.	Direct carbon savings are relatively small, while the indirect energy savings and health benefits from urban trees make them highly valuable.	While costs and savings are difficult to quantify, the multiple benefits of green spaces likely contribute net economic savings for a city.
Barriers	• Challenges posed by food safety • Challenges posed by awareness and acceptance of high-vegetable, low-meat diet • Challenge posed by the desire for food diversity	• Credibility of organic food certification • Impact on food production due to reduced or doing without pesticides or fertilizers • need coordination across agriculture and chemical industry to shift to bio-fertilizers	• Desired level of bio-diversity and choice of tree types; • Need devoted budget • Limited supply of vacant lot inside cities	• Need funding and professional staff for protection and maintenance of green spaces • Need to address competing land uses, to reserve land for green spaces
Case Studies	City of Portland	Cuba's City of Havana	MillionTreesNYC	PlaNYC

1

Industry

POLICIES:

1. Promote and Support the Use of An Energy Management Program in Energy-Intensive Enterprises
2. Benchmarking: How Does an Enterprise or City Compare to its Peers and to Standards?
3. Energy Efficiency Assessments: Understand Enterprise Potential for Energy Savings and CO_2 Emissions Reductions
4. Stretch Targets: Voluntarily Commit to Additional Energy-Savings Actions
5. Energy Tax and Rebate: Motivate and Reward



1 INDUSTRY

Policy 1.1 Promote and Support the Use of An Energy Management Program in Energy-Intensive Enterprises

POLICY DESCRIPTION

An energy management program is an enterprise-level, comprehensive program to improve energy efficiency in industrial facilities. The most successful energy management programs are based on the implementation of energy management standards and systems which are used to institutionalize continuous improvement in energy efficiency within industrial facilities. These systems are typically based on the "plan-do-check-act" approach with the goal of providing guidance to industrial facility managers related to how to structure their operations in a manner that continually identifies, adopts, and documents energy-efficiency opportunities. Energy management standards have been adopted in China, Denmark, Ireland, Japan, South Korea, the Netherlands, Sweden, Thailand, and the United States. The International Standardization Organization (ISO) recently published ISO 50001: *Energy Management Systems – Requirements with Guidance for Use*. Energy management programs have been adopted in numerous large industrial companies such as Dow Chemical Company, 3M, Eastman Chemical Company, and General Motors Corporation.

The U.S. Environmental Protection Agency has outlined the key elements of an energy management program:[1]

- Commit to continuous improvement in the facility's energy efficiency, including appointing an Energy Director, establishing a team of energy managers, and instituting an energy policy.
- Assess energy performance, including benchmarking (see Policy 1.2) and conducting energy assessments (see Policy 1.3).
- Set performance goals and targets (see Policy 1.4).
- Create an Action Plan to ensure implementation of energy-saving measures.

[1] U.S. EPA, 2012.

- Create a Communication Plan to raise awareness within the enterprise and motivate employees to participate in energy-saving activities.
- Evaluate progress by tracking and monitoring energy use and energy savings, comparing progress to the Action Plan, and making needed adjustments.
- Recognize and reward achievements.

STAKEHOLDERS

The key stakeholders include enterprise officials as well as the enterprise energy managers who implement the energy management program. Government energy efficiency programs, such as the U.S. Environmental Protection Agency's Energy Star for Industry Program, can provide information and training to support energy management programs.

CONDITIONS FOR IMPLEMENTATION

Enterprise officials must provide the needed conditions for successful implementation of an energy management program, including providing financial support for associated energy management systems within their enterprise. Enterprise officials must also be willing to support the use of energy managers and give them sufficient funding, authority, and responsibility to successfully implement an energy management program within the enterprise.

ENERGY & CO2 REDUCTION IMPACT

Enterprises that implement comprehensive energy management programs can realize significant energy savings and reductions in CO_2 emissions. For example, between 1990 and 2009, Dow Chemical Company reduced the energy intensity of its global facilities by 38% through its corporate energy management system which is supported by local energy managers in each facility, saving 61 Mtce or the equivalent of the annual electricity used by all residential buildings in California.[2] General Motors reduced the energy use in its global facilities by 30% between 2005 and 2010, reducing greenhouse gas emissions by 3.15 $MtCO_2$.[3]

COST-EFFECTIVENESS

Successful energy management programs result in identification and implementation of cost-effective energy-saving technologies and measures. For example, 3M saved more than RMB 289 million in energy costs in 2011 through the actions identified by its energy management program, including 177 energy efficiency projects that will save more than RMB 47 million /year.4 Eastman Chemical Company's energy management program installed energy meters at a cost of RMB 6.7 million, established a budget of RMB 28 million for investment in energy efficiency projects, and established an energy efficiency maintenance budget of about RMB 30 million to repair steam leaks, add insulation, and improve lighting. Eastman Chemical Company saved nearly RMB 80 million in

[2] Dow, 2012
[3] U.S. EPA, 2011a.
[4] U.S. EPA, 2011b.

2011 through implementation of energy efficiency projects.5 GM's U.S. energy management program monitors 2.5 million energy data points per minute in a dashboard system that identifies savings opportunities to increase efficiency of manufacturing operations. In 2011, this energy management program resulted in company savings of more than RMB 20 million in the U.S. operations. GM also allocated RMB 80 million for implementation of energy-efficiency projects and this investment was paid back in less than one year.[6]

BARRIERS & CHALLENGES

Possible barriers encountered during the design and implementation of energy management programs include: lack of ongoing commitment and clear assignment of energy management responsibilities, lack of trained staff and capital, lack of energy data, targeting only symptoms, not root causes of inefficiencies, and narrow program scope that does not address company-wide energy management.

CASE STUDY

The CalPortland Cement Company was awarded the U.S. Environmental Protection Agency's *Award for Sustained Excellence in Energy Management* in 2012.[1] CalPortland Company is a major producer of cement, concrete, aggregates, and asphalt in the western United States. Energy management is a key component of the company's sustainability strategy. CalPortland Cement Company's energy management program had the following accomplishments in 2011:

- Reducing energy intensity by nearly 1 percent while cutting total energy use by 3.2 percent despite challenging market conditions in the construction industry that negatively affect energy efficiency.
- Developing an extensive internal communication and information infrastructure to support energy management activities across the company and to facilitate extension of best practices and management strategies in all facilities.
- Revamping the company's purchasing policy to require purchasing only energy-efficient products according to specifications defined by the company.
- Supporting research into fuel use and driving patterns for its ready-mixed concrete trucks; this research resulted in changes to truck gearing, idle time policies, and truck routing for reductions in the use of diesel fuel, a significant energy source for the company.
- Building upon the success of the energy management organization by establishing a Green Team to support energy management as part of the company's sustainability efforts and to reach a greater number of employees.
- Supporting ENERGY STAR in the development of a new Industrial Focus on energy efficiency in concrete manufacturing.

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[5] U.S. EPA, 2011c.
[6] GM, 2012.

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Figure 2. CalPortland Cement Company Awarded the U.S. Environmental Protection Agency's *Award for Sustained Excellence in Energy Management* in 2012

Policy 1.2 Benchmarking: How Does an Enterprise or City Compare to its Peers and to Standards?

POLICY DESCRIPTION

The term "benchmarking" was coined by land surveyors and is used as a basis for measurement. In the mid-1980s, large companies such as AT&T, Motorola, and Xerox adopted benchmarking as a method for evaluating performance indicators to determine their company's ranking compared to other companies or to a set target, goal, or threshold. It was not until 1990s that governments and not-for-profit organizations started to use benchmarking as a means to improve knowledge and increase energy efficiency for the industry sector.

Benchmarking is an easy, low-cost way to show cities and enterprises where they stand compared to their peers and to national performance standards. When cities and enterprises see their rankings, they are motivated to improve – wanting to be "best in class" is a natural goal.

Peer-based benchmarking is as simple as plotting energy consumption per unit of production for a number of enterprises for a given year. Such benchmarking is especially applicable for enterprises that produce similar products, such as steel, cement, aluminum, etc. More complex benchmarking schemes that take into account the differences in production processes or differences in products produced at various enterprises are also possible, depending upon data availability.

In addition to peer-to-peer benchmarking, enterprises can be benchmarked to China's national industrial performance standards to see how they compare to the minimum and advance energy consumption levels. A program to ensure achievement of the minimum energy-intensity standards for industry could evaluate the potential savings from achievement of the standards, could identify the current efficiency levels of specific enterprises, cities or provinces, and could track progress toward reaching the standards through benchmarking.

STAKEHOLDERS

Stakeholders for enterprise-level benchmarking efforts include the enterprises and government entities responsible for energy efficiency programs or policies related to benchmarking. Stakeholders for city-level benchmarking efforts include the city government entities responsible for the city's energy or CO_2 emission targets, energy efficiency programs, or greenhouse gas mitigation efforts.

CONDITIONS FOR IMPLEMENTATION

One important consideration in such benchmarking schemes is the availability and quality of data on the energy consumption of each enterprise or city. If data are readily available and accurate, then benchmarking can be easily done. If data need to be collected and/or verified, then more effort and expense will be needed. Another important consideration is whether to disclose the participants to one another. Typically, at the city level, such disclosure is not an issue since city-level energy consumption data are usually publicly available. For enterprises, however, the issue of proprietary information is solved by giving each participant a number which is used instead of their name. In this way, each enterprise knows its own number (and benchmarking results), but doesn't know the names of the other enterprises plotted in the benchmarking charts. Even so, each enterprise can clearly see where they stand in relation to their peers.

ENERGY & CO_2 REDUCTION IMPACT

Figure 3 illustrates a method for comparing the level of achievement of the cement energy-intensity standards by province. Provincial governments can utilize such benchmarks to see their achievement in comparison with other provinces. The central government can use this type of benchmarking to identify which provinces need the most assistance in achieving the standards. This figure also compares the stringency of Chinese cement industry's efficiency standards to international best practices, which can inform "stretch" targets for greater energy and carbon savings (see Policy 1-3).

Benchmarking can have a relatively high impact if it results in motivating enterprises or cities to take actions to improve their ranking among their peers or to meet or exceed performance standards. The costs for undertaking a benchmarking program are relatively low and depend on whether the information has been or can easily be collected as well as what level of benchmarking is undertaken.

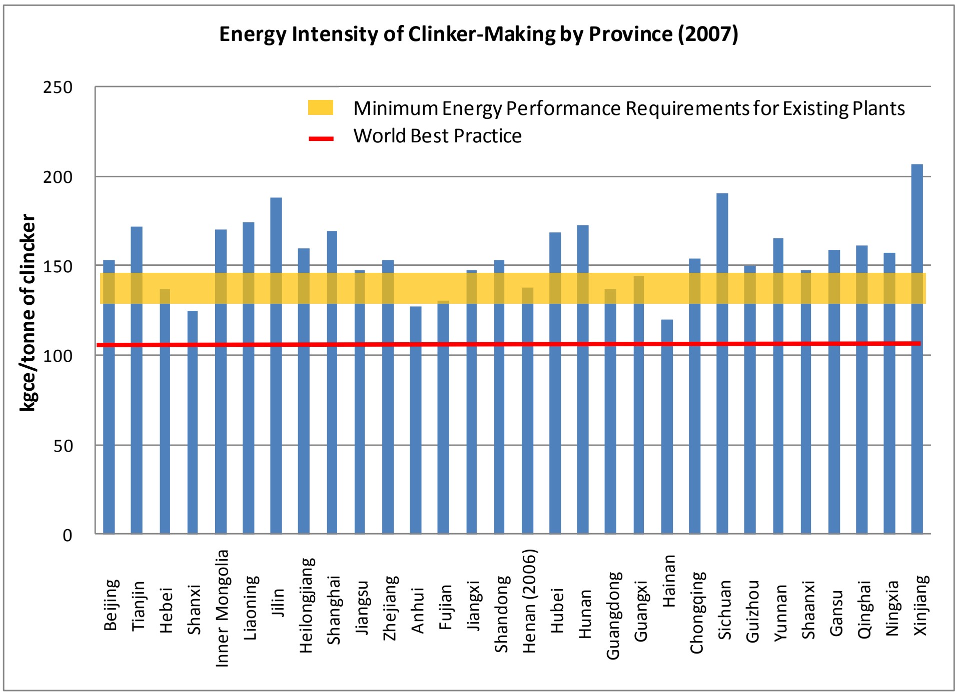

Figure 3. Benchmarking Energy Intensity of Cement Clinker Production in China

Sources: China Cement Association. 2008. China Cement Almanac 2008. Beijing, China.
General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) and Standard Administration Commission (SAC). 2008. The Norm of Energy Consumption Per Unit Product of Cement (GB 16780-2007).

Notes: the upper limit of the benchmarking bar (in yellow) indicates the minimum energy performance requirement (145 kgce/t of clinker) for existing cement plants with a capacity less than 1000 tonnes per day; the lower limit of the benchmarking bar indicates the minimum energy performance requirement (128 kgce/tonne of clinker) for existing plants with a capacity larger than 4000 tonnes per day. The red line indicates the energy intensity at the level of world best practice.

COST-EFFECTIVENESS

It is difficult to quantify the cost-effectiveness of benchmarking. Primary sources of cost for benchmarking are data collection and analysis. Benchmarking requires data, so if the data are readily available, then there are no costs associated with data collection. The data for Figure 3, for example, are collected by China's National Bureau of Statistics, so further data collection is not needed to benchmark using this data. If the desired data has not been collected, then surveys or other forms of data collection will be required. One low-cost option is for data to be voluntarily submitted by enterprises participating in benchmarking or other energy efficiency programs. Additional costs may need to be incurred if data are collected or verified by a third party. Once the benchmarking has been completed, the less efficient companies are typically motivated to undertake cost-effective energy efficiency improvements in order to improve their benchmarked ranking, so the overall cost-effectiveness of benchmarking programs can be very high.

BARRIERS & CHALLENGES

Possible barriers encountered during the design and implementation of benchmarking include lack of energy and production data in comparable units, heterogeneous product output that limits the ability to make comparisons, , and the lack of guidebooks and tools to assist in benchmarking.

CASE STUDY

Figure 4 illustrates how data can be used to motivate cities and enterprises into action and to monitor their progress year-by-year. The figure below benchmarks electricity use in dairies in Norway. Each dairy's electricity use per liter of milk produced is plotted and each dairy is given their company's individual identification number so that they can compare their performance to that of the other dairy companies. When a company manager sees that his or her company is one of the worst performers, the manager is motivated to identify and take actions to improve.

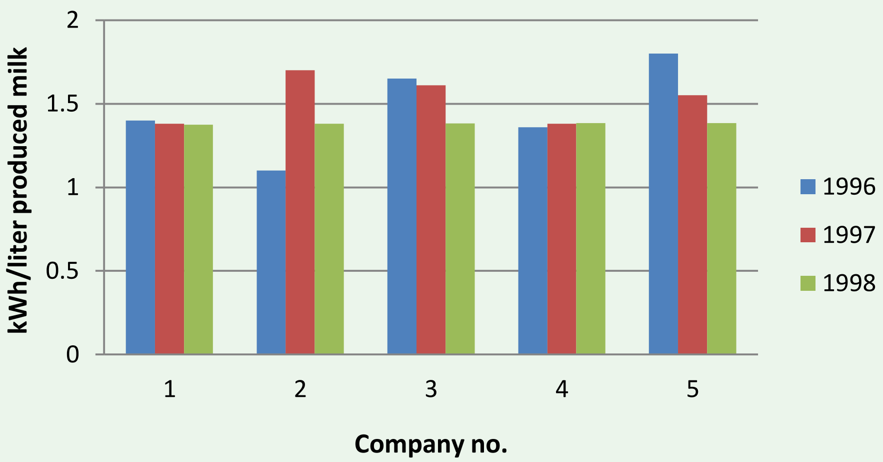

Figure 4. Electricity Use per Liter of Milk Produced by Selected Dairy Companies in Norway.

Source: Finden, 2000.

Policy 1.3 Energy Efficiency Assessments: Understand Enterprise Potential for Energy Savings and CO2 Emissions Reductions

POLICY DESCRIPTION

The energy crisis of the early 1970s increased awareness of energy efficiency assessments as a way to improve the energy efficiency of companies. In recent years, energy assessments have become a key tool in helping corporations realize energy savings and CO_2 emissions reduction.

Energy efficiency assessments (also called audits) are a commonly-used and effective means of understanding how an enterprise is using energy as well as identifying areas where energy can be saved and related CO_2 emissions can be reduced. The results of such assessments can be used to inform enterprises of actions they can take to improve their energy efficiency and reduce emissions or to reach performance standards.

There are two common types of energy assessments for enterprises: a preliminary or walk-through audit and a detailed audit. In a preliminary energy audit, readily-available data are mostly used for a simple analysis of energy use and performance of the plant. This type of audit does not require a lot of measurement and data collection, takes a relatively short time and the results are more general, providing common opportunities for energy efficiency. The economic analysis is typically limited to calculation of the simple payback period, or the time required for paying back the initial capital investment through realized energy savings. More extensive data and information are required for detailed energy assessments. Measurements and a data inventory are usually conducted and different energy systems (e.g. pumps, fans, compressed air, steam, process heating, etc.) are assessed in detail. The results of these audits are more comprehensive and useful since they give a more accurate picture of the energy performance of the plant and more specific recommendation for improvement. The economic analyses conducted for the efficiency measures recommended typically go beyond the simple payback period and usually include the calculation of an internal rate of return (IRR), net present value (NPV), and often also include life cycle cost (LCC).

STAKEHOLDERS

Stakeholders for energy efficiency assessments include government or other entities responsible for overseeing policies and programs related to energy efficiency assessments, energy service companies or other entities that provide energy efficiency assessment services, and enterprises that participate in energy efficiency assessment programs. Energy efficiency auditing guidelines, methodologies, and software tools are often developed and provided by government organizations, academic entities, or private sector firms. Industrial companies can engage certified or licensed energy auditors. For example, energy assessments offered through the U.S. DOE's IACs and Save Energy Now Program are conducted by Energy Experts or Best Practices Qualified Specialists. Training of these experts covers energy assessment tools and system-specific practices. Training usually takes three to five days. Trainees who wish to become a Qualified Specialists must not only meet prerequisites and take training programs, but also need to pass practical and written exams. If they successfully pass the tests, their names are then publicized by U.S. DOE on their website as a Qualified Specialist for specific cross-cutting energy consuming systems such as compressed air, fans, process heating, pumping, and steam.

Figure 5. U.S. DOE Qualified Specialist Arvind Thekdi performs an energy assessment at a cement plant in China with staff from the China Building Materials Academy

CONDITIONS FOR IMPLEMENTATION

Strong policy guidance is essential for the promotion of continuous, effective energy assessments. Without such guidance, it will be difficult to develop a long-term institutional strategy and implementation plan that could direct national and local efforts in establishing goals, designing programs, providing incentives, taking supporting measures, and building capacity related to energy assessments. International experience shows that having a national-level entity to organize and coordinate energy assessment activities can be effective in carrying out large-scale energy assessments. A national-level entity can take the lead in developing a national energy audit program with a wide range of activities including offering incentives, providing technical guidance, developing assessment tools, providing trainings, and disseminating information.

ENERGY & CO_2 REDUCTION IMPACT

When done well, energy efficiency assessments can identify significant energy savings opportunities in most industrial facilities. Between January 2006 and October 2011, the U.S. Department of Energy's Save Energy Now Program carried out energy assessments at 1,016 large, energy-intensive manufacturing facilities in the U.S. These assessments identified a total savings potential of 6 Mtce/year of primary energy savings, for an average of 6,000 tce/facility/year. The U.S. Department of Energy's Industrial Assessment Center (IAC) program has conducted over 15,000 assessments for small and medium sized U.S. manufacturers since 1974. From January 2006 to October 2011, the IAC program completed 2,286 energy assessments which identified 1.8 Mtce of primary energy savings.[7]

COST-EFFECTIVENESS

Energy efficiency audits can be a cost-effective way to identify energy-saving opportunities. In the U.S., energy audits undertaken at small and medium industrial facilities identified energy-efficiency opportunities that could save an average of RMB 1.5 million if implemented. For larger plants, energy audits provided through the Save Energy Now Program identified average potential energy savings of RMB 9.4 million per audit.[8] Of the 3,823 energy savings opportunities identified in the 680 Save Energy Now assessments conducted in 2006, 2007, and 2008, 70% had simple payback periods of 2 years or less.[9]

The costs associated with an energy assessment can be reduced through subsidies or energy assessments can be provided free of charge to participants. Governments can establish an upper limit for subsides, either as a percentage of the costs, or an absolute amount, or both. For example, the Energy Conservation Center of Japan (ECCJ), with funding support from the national government and the Japanese private sector, has carried out industrial energy assessments for factories in Japan since 1978.[10] These energy assessments are conducted at no cost for companies with capital less than 100 million Japanese Yen (about RMB 6.73 million) or less than 300 employees.[11]

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[7] ORNL, 2011.
[8] U.S. DOE, 2011a.
[9] Wright et al., 2010
[10] ECCJ, 2009
[11] Galitsky et al., 2004

BARRIERS & CHALLENGES

Possible barriers encountered during the design and implementation of energy efficiency assessments include a lack of standardized methodology for conducting audits and collecting assessment data and information, a lack of auditing and data analysis tools, lack of training of energy auditors, no certified staff available for energy auditing, and a lack of funding to conduct energy assessments.

CASE STUDY[12]

An U.S. Department of Energy-sponsored (DOE) Save Energy Now assessment was performed at Kaiser Aluminum's aluminum extrusion plant in Sherman, Texas, in 2006. Using DOE's Process Heating Assessment and Survey Tool (PHAST) software, DOE Energy Expert Richard Bennett of the Janus Technology Group worked with plant employees to analyze the plant's process heating systems. The assessment identified opportunities that would result in significant energy savings in some of the melting furnaces. By implementing these opportunities, plant personnel were able to achieve significant natural gas savings.

Employees at the Sherman plant wasted no time moving forward with the opportunities that had the greatest energy savings potential. First, they adjusted burner controls on one of the main reverberatory melting furnaces to lower excess oxygen levels. They also made some repairs to the furnace's door sill and jamb to prevent cold air from seeping into it. By implementing these measures the plant achieved annual energy savings of approximately 1,620 tce and improved the furnace's energy intensity by 11.1% between 2006 and 2007. With project costs of approximately 188,496 RMB and energy cost savings of 2.4 million RMB, the simple payback was under 1 month. In addition, Kaiser Aluminum adopted the PHAST as the corporate tool for assessing process heating applications. To date, the company has used the tool to evaluate furnace efficiency at five other plants with casting operations.

Figure 6. Kaiser Aluminum's Sherman plant operates three extrusion press lines like the one pictured above, which convert aluminum scrap and ingot into aluminum extrusions.

[12] Excerpt from U.S. DOE, 2008.

Policy 1.4 Stretch Targets: Voluntarily Commit to Additional Energy-Savings Actions

POLICY DESCRIPTION

Voluntary energy-saving or emission reduction targets or commitments are often made by companies either individually (and announced through websites or annual reports) or through government programs. Such target-setting for energy efficiency or GHG emissions reduction is a common practice; a recent survey identified 23 such programs in 18 countries around the world, including countries in Europe, the U.S., Canada, Australia, New Zealand, Japan, South Korea, and Chinese Taipei (Taiwan).[13]

Voluntary commitments are also made by industrial sectors. For example, the Cement Sustainability Initiative (CSI) of the World Business Council for Sustainable Development (WBCSD), which is made up of 23 cement companies operating in more than 100 countries, requires its members to sign a charter committing to using the CSI CO_2 protocol to publicly report baseline CO_2 emissions, develop a mitigation strategy, establish targets, and report CO_2 emissions annually.[14] The International Aluminium Institute has 14 sustainable development voluntary objectives including a commitment for its members – which represent about 80% of global aluminium production - to reduce emissions of perfluorocarbons (PFCs) per tonne of aluminium produced by at least 50% by 2020 compared to 2006 (which is equivalent to a 93% reduction compared to 1990), to reduce smelter electrical energy use per tonne of aluminium by 10% in 2010 compared to 1990, and to reduce energy use per tonne of alumina produced for the entire industry by 10% by 2020 compared to 2006.[15]

In China, Top-10,000 energy-savings targets have been distributed to enterprises and enterprises are required to undertake an energy audit. If a detailed energy assessment is conducted as recommended above, then the enterprise will have an understanding of their energy efficiency/carbon emission reduction potential. In this case, the enterprise can propose “stretch” targets beyond the Top-10,000 energy-saving targets and request additional government support for reaching such targets.

STAKEHOLDERS

Stakeholders for voluntary stretch targets include the enterprises that are willing to make such additional commitments along with government entities that pledge additional support to the enterprises in exchange for the additional savings goals.

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[13] Price 2005.
[14] CSI, n.d.
[15] IAI, 2009

CONDITIONS FOR IMPLEMENTATION

Making an energy savings or CO_2 emissions reduction commitment requires information on the enterprise's current production, energy consumption, and associated CO_2 emissions along with a projection of future production trends and knowledge of the facility's energy efficiency potential. The energy efficiency potential can be determined through an energy efficiency assessment (see Policy 1-3). With this information, the enterprise can enter into discussions with government entities or program administrators regarding the type of support needed for them to set voluntary stretch goals at various levels.

ENERGY & CO_2 REDUCTION IMPACT

In the Dutch Long-Term Agreement (LTA) program, the average target was a 20% increase in energy efficiency over 1989 levels by 2000. The LTA program ended in 2000 with an average improvement in energy efficiency of 22.3% over the program period.[16] The energy savings from this program are the result of a comprehensive effort to increase implementation and development of energy-efficient practices and technologies in industry by removing or reducing barriers. This highlights the importance of offering a package of measures that includes financial, technical, and informational assistance instead of a set of individual measures. A 2002 evaluation of the LTA1s found that 30% to 40% of the energy savings achieved during the program could be "considerable or entirely" stimulated by the signing of the LTAs. These savings were comprised of investments in the replacement of existing equipment (32%), investments in retrofit measures (18%), CHP investments (22%), good housekeeping (9%) and others non-categorized measures (22%).[17]

COST-EFFECTIVENESS

Evaluations of the Dutch LTA program found that the agreements helped industries to focus attention on energy efficiency and identify cost-effective options that met commonly used investment criteria.[18]

BARRIERS & CHALLENGES

Possible barriers encountered during the design and implementation of stretch targets include lack of a thorough understanding of the company's energy-saving potential, lack of government support (e.g. technical support or funding) for undertaking a more ambitious target, and lack of effective incentives.

CASE STUDY

Companies that participate in the U.S. DOE's Better Plants Program must commit to at least a 10-year, 25% energy intensity improvement target. Benefits companies receive by

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[16] Nuijen, 1998; Kerssemeeckers 2002; MEA, 2001.
[17] Kerssemeechers, 2002.
[18] Korevaar et al., 1997

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participating in the Program include national recognition and technical support from DOE. National recognition includes a welcome letter from DOE and feature on the DOE website, a congratulatory letter from DOE after achieving an annual improvement rate equal to or better than 2.5%, and a letter and plaque from DOE upon achieving 10-year target. In addition, promotional materials including the program logo are available to companies so that they can publicize their participation. Technical support includes access a technical account manager, help in establishing and analyzing key energy use data and metrics for the development of baselines and energy management plans, support in identifying emerging, energy-efficient technologies applicable to plant operation, in-plant trainings on how to identify, prioritize, implement, and replicate energy saving projects, training on financing options, advanced technology, energy analysis software, energy management, and other topics, and use of proven energy analysis software tools and other technical resources from DOE, states, utilities and other partner organizations.[19]

Companies that want to commit to additional energy-savings actions can also join DOE's Better Plant Challenge Program. In this program, in addition to the commitments and benefits made under the Better Plants Program, the Challenge Partners agree to assess their facilities to determine energy efficiency opportunities and publicly pledge an organization-wide energy savings goals for the next two to five years, announce and initiate a showcase project in one facility and develop an organization-wide plan to achieve the energy savings goal, and share experiences with energy efficiency solutions, organization-wide energy savings, and energy performance of individual facilities. In turn, DOE will provide Challenge Partners with expert technical assistance, connect Partners to a network of financial, technology, and service organizations that can help achieve the energy savings pledge, and provide national recognition for achieving energy and cost savings and for applying innovative solutions. There are currently over 300 plants participating in this program.[20]

Figure 7. U.S. DOE's Better Plants Program

Source: U.S. DOE, 2011b.

[19] U.S. DOE, 2012a

[20] U.S. DOE, 2012b.

Policy 1.5 Energy Tax and Rebate: Motivate and Reward

POLICY DESCRIPTION

Taxes on the energy consumed by industrial enterprises can be used to motivate enterprises to save energy as well as to reward those enterprises that are successful at energy-saving. Enterprises are motivated because the overall cost of using energy is increased by the tax. Additional motivation can be provided by using the tax proceeds in ways that reward enterprises for further energy savings. Energy or energy-related carbon dioxide (CO_2) taxes have been used in a number of countries to provide an incentive to industry to improve the energy management at their facilities through both behavioral changes and investments in energy efficient equipment.

Taxes on energy or energy-related CO_2 emissions were first adopted in a number of northern European countries in the early 1990s. Such taxes are now found in Austria, the Czech Republic, Denmark, Estonia, Finland, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland, and the UK. In target-setting programs that involve the use of energy taxes, such as the Climate Change Agreements in the UK and the Danish energy efficiency agreements, rewards for meeting agreed-upon targets are provided in the form of a reduction of the required energy tax.[21]

STAKEHOLDERS

Stakeholders include the entities whose energy is taxed – typically large industrial enterprises – along with the government taxation body and program-related entities (either government or third party) that monitor and evaluate the progress of the enterprises in meeting their targets. In addition, if the program includes support for achieving the targets, key stakeholders would then be any entities providing technical support related to adoption of energy efficiency or CO_2 emissions mitigation measures.

CONDITIONS FOR IMPLEMENTATION

The design of the energy or CO_2 tax program is extremely important; most programs recycle revenues back into the economy through lowering of other taxes such as social security, personal income, or value added taxes. A comparison of energy or CO_2 taxes in European countries found that "policy packages that include the use of a portion of the environmental tax revenues to finance energy efficiency or renewable energy improvements are more likely to result in positive employment and GDP impacts".[22]

[21] DEFRA, 2004; Togeby et al., 1999
[22] Hoener and Bosquet, 2001

ENERGY & CO_2 REDUCTION IMPACT

An analysis of energy or CO_2 taxes in European countries found substantial reductions in CO_2 emissions as well as emissions of NOx, SOx and other air pollutants.[23] A recent evaluation of the UK Climate Change Levy estimates that it will reduce CO_2 emissions by 13.6 $MtCO_2$ in 2010 over a business-as-usual case.[24] Companies that participate in the energy tax and rebate programs in the UK have consistently surpassed their energy-saving and CO_2 emissions targets (see Case Study).

COST-EFFECTIVENESS

In 2007, the UK's National Audit Office reviewed the Climate Change Levy and CCAs and found that the agreements, along with the monitoring schemes, raised awareness of the potential for energy efficiency within the participating sectors. The review found that in general the benefits of the CCAs outweighed the program administrative costs.

It is estimated that the cost-effectiveness (defined as benefit net of costs per ton carbon saved) of the UK Climate Change Levy is RMB 258.1 /tCO_2 saved.[25] The Intergovernmental Panel on Climate Change (IPCC) found that "emission taxes do well in both cost effectiveness and environmental effectiveness".[26]

BARRIERS & CHALLENGES

Possible barriers encountered during the design and implementation of an energy tax and rebate program include lack of authority or ability to impose energy taxes and to provide tax rebates, ineffective program design, and collected tax not redistributed appropriately for energy efficiency or low carbon development programs.

CASE STUDY

The UK Climate Change Program was established in 2000 to meet both the country's Kyoto Protocol commitment of a 12.5% reduction in GHG emissions by 2008-2012 relative to 1990 and the domestic goal of a 20% CO_2 emissions reduction relative to 1990 by 2010.[27] A key element of the Climate Change Program is the Climate Change Levy, a tax on the use of energy (natural gas, coal, liquefied petroleum gas, and electricity) applied to industry, commerce, agriculture, and the public sector. Through participation in Climate Change Agreements (CCAs), energy-intensive industrial sectors negotiated energy-efficiency improvement targets. The CCAs cover approximately 90% of industrial emissions in the UK.

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[23] Hoener and Bosquet, 2001
[24] DEFRA, 2006
[25] Cambridge Econometrics, 2005; DEFRA, 2006.
[26] Metz et al., 2007
[27] DEFRA, 2006

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The energy taxes that are collected are used in two ways: 1) to provide services to the participating companies and 2) to provide tax refunds to those companies that meet their targets. Services to companies that participate in the CCAs include the use of the Carbon Trust, the UK Enhanced Capital Allowance Scheme, the ability to participate in the UK's domestic emissions trading scheme, and a "light touch" on energy efficiency regulation. The Carbon Trust, which is funded from the proceeds of the Climate Change Levy, identifies carbon emissions reduction opportunities, provides resources and tools, provides interest-free loans to small- and medium-sized enterprises, funds a local authority energy financing scheme, promotes the government's Enhanced Capital Allowance Scheme, and has a venture capital team that invests in early-stage carbon reduction technologies as well as management teams that can deliver low carbon technologies.[28] In addition, companies that meet their agreed-upon target are given an 80% discount from the Climate Change Levy. Companies are highly motivated to obtain this tax refund. As a result, the negotiated targets have been consistently and significantly surpassed each year since the end of the first target period in 2002 (see Table 1).

Table 1. Target and Actual CO_2 Emissions Reductions of UK Climate Change Agreements, 2002-2010

Absolute Savings from Baseline	Target ($MtCO_2$/year)	Actual ($MtCO_2$/year)
Target Period 1 (2001-2002)	6.0	16.4
Target Period 2 (2003-2004)	5.5	14.4
Target Period 3 (2005-2006)	9.1	16.4
Target Period 4 (2007-2008)	11.1	20.3
Target Period 5(2009-2010)	18.0	28.5

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2

Buildings & Appliances

POLICIES:

1 More Stringent Building Codes

2 Leading Appliance Standards

3 Target Net-Zero Buildings: Promote Buildings with No or Low Net-Energy and CO_2 Emissions

4 Tax Credits & Incentives

2 Buildings & Appliances

Policy 2.1 More Stringent Building Codes

POLICY DESCRIPTION

Building energy codes set the minimum requirements for energy-efficient design and construction and applies to both new and renovated buildings, and typically to both residential and commercial buildings. The more stringent the building energy code, the higher the energy efficiency in the baseline for new construction.

Building energy codes regulate the energy efficiency of building envelope walls, floors, ceilings, doors and windows; heating, ventilating, and cooling systems and equipment (HVAC); lighting systems and equipment; and water-heating systems and equipment. For each of these categories of building components, building energy codes set mandatory requirements that vary. These may include:

- Building envelope: climate-specific requirements; insulation levels for floor, ceilings and walls; and sealing requirements against air leakage and moisture migration.
- HVAC: minimum criteria for sizes of systems and equipment that takes into consideration the building's energy demand, system efficiency, economizers that allow the automatic use of outside air
- Lighting and electrical systems: minimum criteria for effective lighting control, number and location of lights, motor and transformer efficiency (for commercial buildings)
- Water heating systems: minimum criteria for effective heating and delivery of hot water, efficiency of water-heating equipment, operational controls

Building energy codes are developed at the national level as a model or baseline code, but are typically adopted and enforced by local governments for their jurisdictions. Local governments can and have adopted local building energy codes that are more stringent than the national energy code requirements.

STAKEHOLDERS

- Architectural Design community, including: architects, lighting designers, mechanical and electrical engineers
- Code enforcement community, including: building code officials, code organization representatives, state and local regulatory agencies
- Real Estate developers, builders and contractors
- Building owners and operators
- Industry and manufacturers for the building industry
- Utility companies
- Energy advocacy groups

CONDITIONS FOR IMPLEMENTATION

Key factors for the successful implementation of stringent building energy codes include consistent adoption, implementation and enforcement across all jurisdictions. If building energy codes are not uniformly adopted across or within a jurisdiction (e.g. national and local government levels), then a patchwork of codes may result and undermine builders' ability to comply. As a mandatory policy, the effectiveness of building energy codes also relies heavily on existing capacity and resources for implementation and enforcement, including proper training for building professionals and code officials.

ENERGY & CO_2 REDUCTION IMPACT

The adoption and effective implementation of building energy codes that are 30-50% more stringent than the 2006 International Energy Conservation Code model code across the U.S. would reduce primary energy use in buildings by 18 Mtce per year by 2015 and 126 Mtce per year by 2030. For the United States, this would lead to a 3% reduction in the projected national CO_2 emissions in 2030.[29]

COST-EFFECTIVENESS

Building codes are considered one of the most cost-effective building efficiency policies. If a 30-50% more stringent building code was adopted across all states, U.S. building owners would save more than RMB 26.9 billion annually by 2015 and up to RMB 201 billion per year by 2030.[30] Similarly, adopting the 32% more stringent 2012 model code in the U.S. would result in average life-cycle consumer savings ranging from RMB 32,065 to RMB 222,863 depending on the climate zone.[31]

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[29] U.S. DOE 2010.
[30] U.S. DOE, 2010.
[31] U.S. DOE, 2012a.

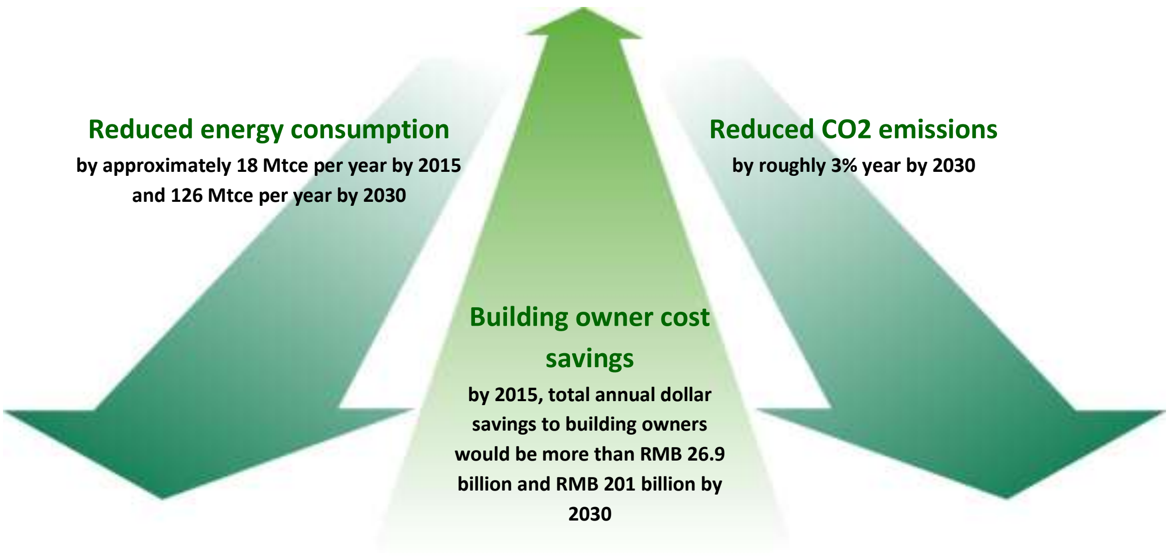

Figure 8. Stringent Building Codes lead to high energy & cost savings

BARRIERS & CHALLENGES

Possible barriers encountered during the design and implementation of stringent building codes include: no timely update in building energy codes, ill-link between building codes and building performance, disconnect between descriptive building codes and performance building codes, local building energy codes not in place.

CASE STUDY

California's Title 24: Most Stringent U.S. Building Energy Code[32]
In the United States, California's state-developed mandatory building energy code known as Title 24 has been considered one of the most stringent and best enforced codes. In 2005, California's state building energy code was estimated to have reduced annual energy demand by 180 MW with RMB 289 billion in electricity and gas savings by 2011. California's revised 2008 building energy code was more stringent than the 2009 international model code and mandates that all new construction reduce energy use by 15%, water use by 20% and water for landscaping by 50%. Today, Title 24 has one of the highest enforcement rates with field inspections to verify compliance. The success of California's Title 24 can also be attributed to its flexibility through performance-based specifications with active technical assistance provided for builders. California is continuing to strengthen its building energy codes with more stringent standards requiring 25% energy reduction in lighting, heating, cooling, ventilation and water heating expected to be adopted in 2013.

Tianjin's Leading Local Building Energy Code[33]
Tianjin adopted one of China's first mandatory local residential energy codes in 1997,

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[32] U.S. EPA, 2008; CEC 2012a; ACEEE 2012b.
[33] ESMAP, 2011.

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followed by a 30% more stringent revised code in 2004 with international assistance. Compared to the baseline of inefficient 1980s buildings, Tianjin's 2004 building energy code required 65% reduction in allowable heating intensity. The 2004 building energy code was further strengthened in 2007 with the addition of provisions for efficiency improvements such as cooling and ventilation, sun shading and structural integrity. Tianjin has also adopted an effective third-party compliance approach to oversee implementation and enforcement of the building codes, with close to 100% reported compliance rates by 2008. *Building Energy Conservation Codes of Tianjing*, effective July 1st, 2012, stipulates that renewables such as solar and ground source heat pump should be the prioritized energy sources for heating, cooling, water heating and lighting for new buildings; meanwhile, the use of renewables should be integrated into building design, construction and inspection all the way. Annual savings from Tianjin's more stringent building energy code is estimated to have save 870 GWh and 400,000 metric tons of CO_2 emissions per year. The more stringent local building code has also proven to be cost-effective, with low incremental costs and estimated short payback period of 5 to 7 years.

Policy 2.2 Leading Appliance Standards

POLICY DESCRIPTION

Minimum energy performance standards (MEPS) are used in the appliance and commercial equipment sectors to set mandatory minimum requirements for appliance and equipment energy efficiency. MEPS set a floor for pushing overall market efficiency upwards by eliminating the production, import and sale of energy-consuming equipment less efficient than the minimum requirements. As a mandatory regulatory policy, MEPS also help address market barriers to efficient equipment purchases such as imperfect information and split incentives. Since they were first introduced in the 1970s, MEPS have now been adopted by more than 24 countries for major energy-consuming products in most of the developed economies including the U.S., Canada, European Union, Australia, and Korea.

Although the structure and content of MEPS vary by country, MEPS typically include the following components:

- Product-specific definitions and classifications
- Energy efficiency metric or energy consumption criteria (e.g., kWh consumption per year, power consumption, energy efficient ratio)
- Standardized test procedures for measuring product's energy performance

MEPS are usually developed by the national government through techno-economic analyses and in consultation with stakeholders (e.g., industry, manufacturers, consumer groups) to prevent a patchwork of different local MEPS for the same product. In some case such as Australia and the U.S., local state governments may also adopt more stringent standards or new standards for products not covered by national MEPS.

STAKEHOLDERS

- Government regulators, staff and contractors
- Equipment manufacturers and related industries
- Consumers
- Utility companies
- Environmental/energy advocacy groups

CONDITIONS FOR IMPLEMENTATION

General conditions for implementing leading appliance efficiency standards include technical and financial capacity for conducting the techno-economic analyses needed to support and justify standard-setting and for monitoring and enforcing compliance with standards. A key condition for local regions to implement leading appliance efficiency standards is whether these jurisdictions have the authority to adopt new standards for uncovered products or more stringent standards for products already regulated on a national level. Some countries discourage the adoption of leading local appliance standards due to concerns over trade barriers, while others such as Australia encourage it.

ENERGY & CO_2 REDUCTION IMPACT

By improving the efficiency of energy-consuming household appliances, leading MEPS can directly reduce the electricity demand and electricity costs of households while providing the same if not better level of service. In many countries, MEPS are set at an efficiency level to ensure that consumers will actually benefit from lower life-cycle costs with the more efficient product. U.S. MEPS in place for 30 products are estimated to have saved 280 TWh in 2010, with cumulative potential energy savings of 7200 Mtce by 2035. On an annual basis, electricity savings from U.S. MEPS are expected to reach 720 TWh by 2035, a 14% reduction in total electricity consumption, and annual CO_2 emission reductions of 470 million metric tons of CO_2.[34]

[34] Lowenberger et al., 2012.

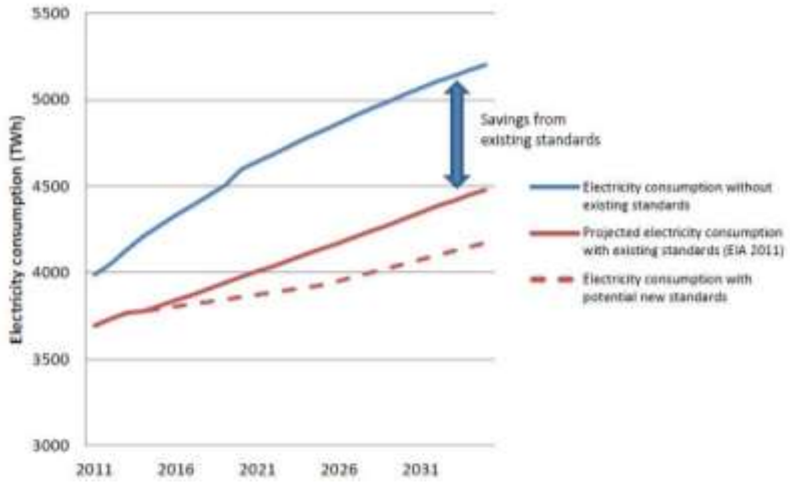

Figure 9. The Effect of Standards on Total U.S. Annual Electricity Consumption

OST EFFECTIVENESS

Because cost-effectiveness is often a key criteria for setting MEPS efficiency levels, MEPS have been considered a highly cost-effective policy. A recent ACEEE study[35] found that standards for a range of residential, commercial, industrial and lighting products were all cost-effective with a benefit-cost ratio of greater than 1. While benefit-cost ratios differ by product and can range from a low of 1.2 to a high of 18, on average, the lifetime savings from new standards outweigh the incremental upfront costs by a factor of 4 (i.e., benefit-cost ratio of 4.1). In the U.S., MEPS for products such as outdoor lighting fixtures, residential bathroom faucets, and commercial automatic ice makers have very high benefit-cost ratios of greater than 8.

BARRIERS & CHALLENGES

Possible barriers encountered during the design and implementation of leading appliance standards include: opposition from the appliance manufactures, lack of funding and resources from organizations, unclear jurisdiction and responsibility of various government agencies in development and enforcement of the local standards.

CASE STUDY

California's Leading State Appliance Efficiency Standards[36]
In 1974, California was the first state in the U.S. to initiate MEPS for appliances and equipment and has since then continued as a pioneer in adopting leading MEPS for over 50 products, many of which are subsequently adopted as federal standards. For example, California adopted state MEPS for air conditioners, heat pumps, refrigerators and freezers,

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[35] Lowenberger et al., 2012.
[36] CEC, 2012b; U.S. DOE, 2012c.

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hot water heaters, clothes dryers in the late 1970s but federal standards were not adopted until the 1990s. California's MEPS program has been attributed to reducing peak electric demand by 2000 MW, or 5% of the state's total peak load. Today, California's MEPS program includes some of the most stringent standards and continues to lead the nation by adopting new efficiency standards for unregulated products. By 2010, California's 2002 set of appliance efficiency standards is estimated to have reduced electricity demand by 2485 GWh and natural gas consumption by 20.9 cubic feet, equivalent to cumulative net savings of RMB 12.79 billion. The current set of appliance efficiency regulations were adopted in California in 2008 and include 23 categories of appliances for both federally-regulated and non-federally-regulated products. These include more stringent state standards for metal halide lamp fixtures and standards for commercial cooking appliances and televisions, products not covered by federal MEPS program. California is also in the process of developing the first MEPS in the U.S. for various battery charger systems, with adoption scheduled for 2013 through 2017.

Policy 2.3 Target Net-Zero Buildings: Promote Buildings with No or Low Net-Energy and CO_2 Emissions

POLICY DESCRIPTION

In addition to mandatory standards, targets have also been set for increasing the share of Net-Zero Energy Buildings (NZEBs) or low net-energy buildings in the buildings sector in different countries. Although the specific definitions for NZEBs[37] vary by country and context, it generally refers to a building that has a very high energy performance where the nearly zero or very low amount of energy required can and should be covered to a very significant extent by renewable energy. Because all of NZEB's energy consumption must be met through renewable energy, significant reduction in building energy consumption is a necessary first step. As a result, NZEB targets help promote high energy efficiency in buildings while promoting flexibility in reducing energy consumption by avoiding setting a fixed goal for energy efficiency.

The most recent example of setting targets for NZEBs is the 2010 recast of the European Union Energy Performance of Buildings Directive, which requires EU Member States to ensure that all new buildings are nearly zero-energy buildings by 2020 and all new buildings occupied and owned by public authorities are nearly zero-energy buildings by 2018. EU Member States have also set targets

[37] Other commonly used definitions of NZEBs include Net Zero Site Energy, where a site NZEB produces at least as much renewable energy as it uses when accounted for at the site; Net Zero Source Energy where NZEB produces or purchases at least as much renewable energy as it uses when accounted for at the source; Net Zero Energy Costs and Net Zero Emissions.

in line with meeting the EU-wide targets, including targets for net zero energy buildings by 2013 in Ireland, 75% NZEBs (at 2006 stock of floorspace) by 2020 in Denmark, zero emissions buildings by 2020 in Hungary and zero carbon residential buildings by 2016 in the United Kingdom. In the U.S., the state of California has committed to achieving zero net energy for all residential construction by 2020 and all commercial construction by 2030, while the state of Massachusetts plans to achieve NZEBs for all buildings by 2030.

STAKEHOLDERS

- Government and policymakers
- Architectural Design community: architects, designers, mechanical and electrical engineers
- Builders and contractors
- Building owners and operators
- Industry and manufacturers for the building industry
- Utility companies and renewable energy developers
- Energy advocacy groups

CONDITIONS FOR IMPLEMENTATION

For NZEB targets to be effective, the policy must first provide clear definitions of "zero net-energy" through specific guidelines on energy accounting boundaries, particularly when accounting for qualifying renewable energy supply. The cost issue also suggests that there needs to be supporting research and development to build a larger market for the cost-effective new designs, technologies and products needed to meet net zero-energy and carbon goals before NZEB targets can be successfully met.

ENERGY & CO_2 REDUCTION IMPACT

NZEB targets have the potential to significantly reduce building energy consumption as no or low net-energy buildings by definition must maintain a neutral energy balance where the building supplies the energy it consumes. Studies in the U.S. have shown that average reductions of 60-90% in energy consumption are needed for buildings to reach net-zero energy, depending on the building type.[38] Because nearly all NZEBs require energy demand to be met with energy supplied by renewable resources, targets for NZEBs can also achieve significant reductions in energy-related CO_2 emissions, possibly to the point of net zero carbon. The EU recast impact assessment found that compared to other policy options for improving building energy performance, target for NZEBs had the largest energy savings and carbon reduction potential.

COST EFFECTIVENESS

Although target NZEBs have very low administrative burden and costs, targets set for achieving significant NZEB shares in the short-term may not be very cost-effective due to the high incremental costs for implementing the technologies and design needed to achieve net or low net-zero energy.

[38] Voss et al., 2011.

Because NZEBs are a relatively new concept, there are limited technologies and design options capable of reducing building's total energy consumption by the significant magnitude needed to achieve net-zero energy and thus construction costs are relatively high. In the EU, price increases of 7% to 15% were estimated by the construction industry for building net-zero energy homes.[39] While some recently built buildings have approached net-zero energy with high cost-effectiveness, this is not yet feasible for all new construction and more research and development is needed to lower the cost of new technologies and increase the cost-effectiveness of NZEB.

BARRIERS & CHALLENGES

Possible barriers encountered during the design and implementation of target net-zero buildings include: lack of clear definition, lack of investment in early-stage R&D and demonstrations, and lack of market incentives.

CASE STUDY

UK Targets for Achieving Zero Carbon Buildings Before 2020[40]

The United Kingdom has set more specific national targets for NZEBs, committing to reach zero carbon targets for all new residential buildings by 2016, all public buildings by 2018 and all non-residential buildings by 2019. The announcement of the targets was followed by consultations on the definition of zero carbon in 2009. Zero Carbon Hub, a joint taskforce and the public-private partnership responsible for carrying out the target, then issued recommendations for maximum built performance emissions by type of new homes for 2016. These limits include 10 kg CO_2e/m^2/year, 11 kg CO_2e/m^2/year and 14 kg CO_2e/m^2/year for detached houses, other houses and low rise apartment buildings by 2016, respectively. An impact assessment shows that the policy can bring about reduction of 39 TWh in gas demand and 29.1 Mt CO_2 emissions, while increasing renewable electricity generation by 27 TWh over the policy's lifetime. The policy's total costs are estimated to be RMB 39.2 billion with total benefits of RMB 34.9 billion over a time period of 39 to 49 years, or a best estimate net present value of RMB 4.37 billion.

Policy 2.4 Tax Credits & Incentives

[39] ECEEE, 2011.
[40] UK Department for Communities and Local Government, 2011; ECEEE, 2011.

POLICY DESCRIPTION

Financial incentives in the form of tax credits and incentives are offered to spur greater adoption of energy efficient technologies, which tend to have higher up-front capital costs. By helping partially offset the higher capital and installation costs of energy efficient equipment, tax credits and incentives help reduce the initial cost barrier. Tax credits and incentives also help educate the public on benefits of energy efficiency and increase market penetration of efficient technologies. The level of the tax credit is typically based on costs, but in some cases, may be based instead on performance and level of achieved efficiency. Common forms of tax credits and incentives include personal or corporate investment tax credits, tax deductions and tax exemptions. In addition to direct subsidies and rebates, other forms of financial tax incentives for efficient technologies include loan guarantees and loans with preferential interest rates.

In the U.S., federal tax credit of 30% of the cost for efficiency improvements to windows, roofing, insulation and qualifying heating and cooling equipment are available to homeowners along with tax credit of RMB 13,464 to homebuilders for homes that achieved 50% energy savings relative to the model code. In the commercial sector, the U.S. offers federal tax deductions of RMB 4.04 to RMB 12.12 per square foot for the installation of efficient measures and heating and cooling energy savings of at least 50%. In Europe, Italy and France offer tax credits to households and companies for single efficiency retrofit measures or comprehensive retrofits covering up to 55% of the energy-related cost. The Netherlands also provides tax deductions covering up to 41.5% of the investment cost of qualified efficient technologies.

STAKEHOLDERS

- Government (policymakers, taxation authority, energy-related programs such as ENERGY STAR)
- Architectural Design community: architects, designers, mechanical and electrical engineers
- Builders and contractors
- Building owners and operators
- Industry, manufacturers, distributors, retailers and installers for the building industry
- Utility companies
- Energy advocacy groups

CONDITIONS FOR IMPLEMENTATION

Sufficient funding for tax credits and incentives for efficient equipment and measures is an important pre-condition for the policy's success because tax credits and incentives that are set too low are not effective in spurring market transformation and achieving energy savings. Similarly, low transaction cost (e.g., time and effort) for filing tax credit or incentive claims is also an important criterion for successful policy implementation. To maximize the impact of tax credits and incentives through greater participation, there also needs to be efforts to promote and raise awareness of the tax credit/incentive program and to educate consumers on the benefits of eligible efficiency measures

ENERGY & CO_2 REDUCTION IMPACT

As a market-based policy intended to accelerate the market adoption of efficient technologies and measures, the impact of tax credits and incentives are often measured in terms market transformation rather than direct energy and related CO_2 emission reductions. In most cases, the energy and CO_2 reduction impact of tax credit and incentives varies depending on the efficiency improvements and measures installed. The U.S. tax credit to homebuilders reduces the energy consumption of new homes by 50% and has estimated potential lifetime electricity savings of 876 TWh and fuel savings of 208 Mtce if extended over time.[41]

COST-EFFECTIVENESS

As with energy and CO_2 reduction impact, the cost-effectiveness of tax credit and incentive policies varies depending on the specifics of the policy. In some cases, tax credits and incentives' cost-effectiveness may be affected by the value of the incentive relative to the effort exerted to receive the incentive (i.e., transaction costs) and if significant portions of credit or incentive recipients would have invested in the technology without the policy (i.e., free-rider effect). An ACEEE study[42] shows that certain tax incentives, such as extending the existing new homes tax credit; increasing the commercial building tax deduction to RMB 20.2 per square foot; and extending and updating existing credit for high efficiency furnaces, air conditioners and heat pumps, water heaters can be highly cost-effective with costs of only RMB 3.74 Million to RMB 67.32 Million per 1 Mtce of energy saved.

BARRIERS & CHALLENGES

Possible barriers encountered during the design and implementation of tax credits and incentives include: Unreasonable design in tax credit and financial incentives as well as unavailable technical assistance.

CASE STUDY

Italy's Tax Credit Program for Energy Efficiency Improvements to Existing Buildings[43]
Since 2007, Italy has offered tax credits to households and companies for single or comprehensive retrofit measures to existing buildings. This tax credit program was intended to not only improve building energy performance, but also to stimulate growth in the construction industry and to motivate households to receive installation sources from legal sources. The tax credit can cover 55% of the energy-related cost, up to a maximum value that ranges from RMB 281,593 for replacing HVAC systems to RMB 938,643 for comprehensive retrofit measures. This tax credit program was successful in significantly

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[41] Nadel 2012.
[42] Nadel 2012.
[43] Neuhoff et al., 2012.

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boosting retrofit investments, particularly in the residential sector, with 240,000 tax credit claims submitted for total retrofit investments worth RMB 24.2 billion in 2009. The retrofit measures installed as part of the tax credit program resulted in important energy savings ranging from a low of 2626 kWh per year for window replacement to a high of 21,528 kWh per year for comprehensive retrofits. The retrofit measures supported by the tax credits were all very cost-effective, with average costs per energy unit saved all below RMB 1.68 per kWh per year and as low as RMB 0.27 per kWh per year for the most cost-effective comprehensive retrofits.

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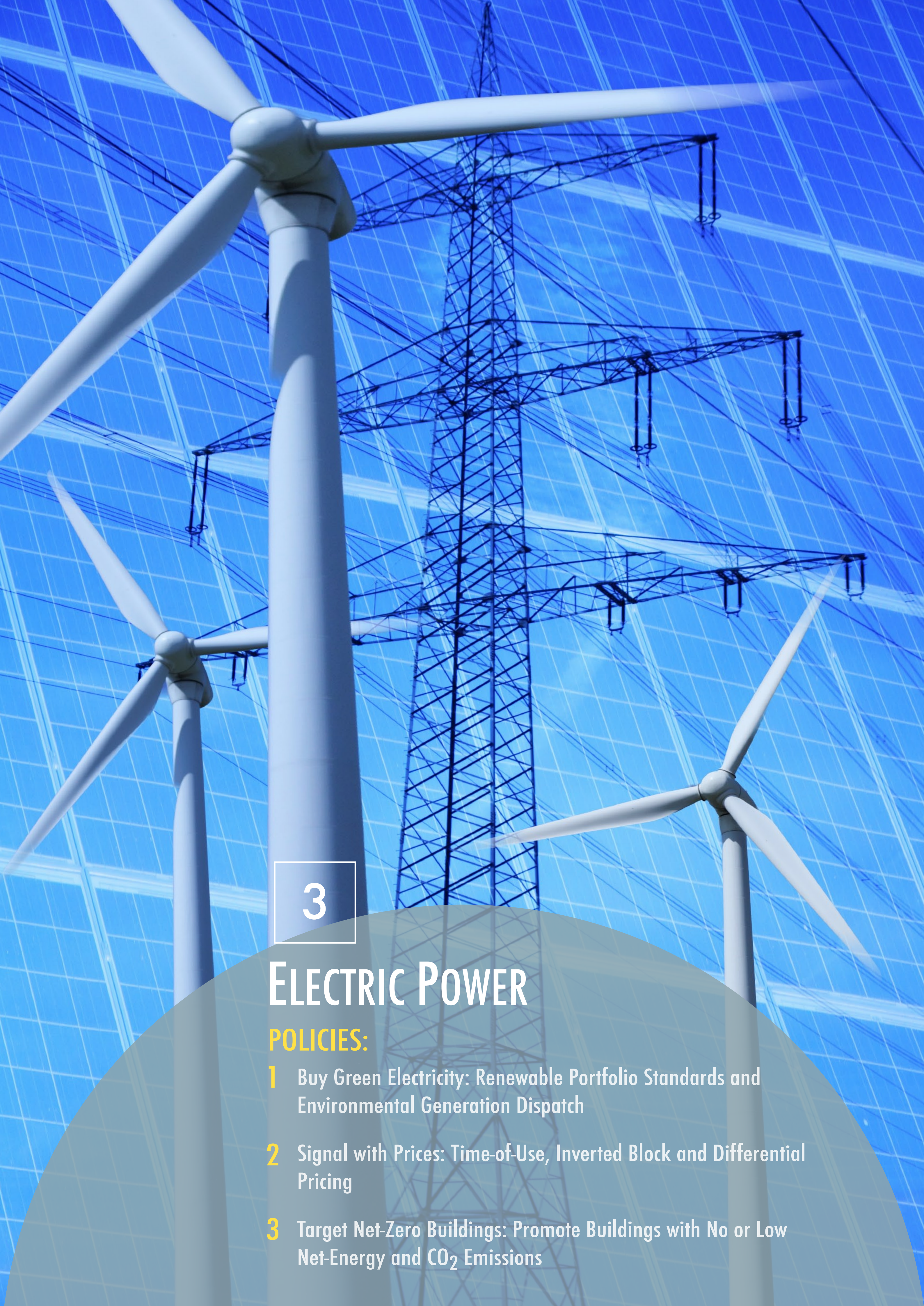

3

Electric Power

POLICIES:

1 Buy Green Electricity: Renewable Portfolio Standards and Environmental Generation Dispatch

2 Signal with Prices: Time-of-Use, Inverted Block and Differential Pricing

3 Target Net-Zero Buildings: Promote Buildings with No or Low Net-Energy and CO_2 Emissions

3 ELECTRIC

Policy 3.1 Buy Green Electricity: Renewable Portfolio Standards and Environmental Generation Dispatch

POLICY DESCRIPTION

Renewable Portfolio Standards (RPS) is a market-based policy approach used by national or local governments to increase renewable energy generation by requiring electric utilities and other providers to supply a specified minimum amount (in relative or absolute terms) of customer load with electricity from eligible renewable sources. RPS specifies who is responsible for obtaining qualified renewable energy from a renewable generation facility or tradable renewable energy certificates (REC) and penalties for non-compliance, but typically does not attempt to set prices for renewable energy. By setting a quantitative target of renewable energy to be included in the electricity mix, RPS seeks to stimulate renewable energy market and technology development to increase its competitiveness with conventional forms of electric power. In the U.S., RPS has been adopted by 21 states and Washington D.C. and voluntary RPS have been adopted by 8 states and 2 territories. In addition, RPS policies have also been implemented in Sweden, Italy, the U.K, Japan and Australia.

Environmental generation dispatch, also commonly known as priority dispatch for renewables, is a policy approach in which renewable energy sources are favored in the method and order in which electricity is dispatched to the system by generators. This includes guaranteeing that renewable generators are interconnected to the grid and that utilities purchase power from interconnected renewable generators and dispatch the power into the transmission and distribution system. In doing so, environmental generation dispatch ensures that renewable energy generators have grid access to the electricity system and can compete in an even playing field with conventional generation, which tend to have lower short-run marginal costs. This approach can be adopted explicitly through regulations that set a loading order in which new electricity generation needs must be met first with renewable and distributed generation resources, and then with clean fossil-fueled generation. Priority dispatch for renewable have been adopted in the European Union including in the United Kingdom, Germany, Spain; in Peru and in the state of California in the U.S.

STAKEHOLDERS

- Government/policymakers
- Electric and gas utilities
- Utility regulators (public utility commissions)
- Utility customers and ratepayers (residential, commercial and industrial energy consumers)
- Renewable electricity project developers and generators
- Environmental, energy and ratepayer advocacy groups

CONDITIONS FOR IMPLEMENTATION

Key conditions that are necessary for successful implementation of RPS policies are the availability of renewable resources, sufficient transmission capacity, existence of interconnection and priority dispatch requirements for renewable generation and strong and effective mechanisms with appropriately high penalty levels. In some cases, regional coordination may be needed to ensure RPS is effectively implemented if more cost-effective renewable resources are available in neighboring territories and existing transmission networks span across jurisdictional boundaries. If RECs are included as a potential path of compliance under RPS policies, a monitoring and tracking system for qualified REC needs to be established and used to ensure RPS enforcement and compliance. For environmental dispatch to be effectively implemented, there needs to be complementary support for expanding renewable generation through favorable policies for developing renewable generation (e.g., feed-in tariffs) and streamlined and efficient process for siting, selecting and contracting renewable energy developer. In addition, assurance of compensation for security of supply constraints when intermittent renewable sources such as wind cannot be dispatched is also important in sustaining the operation of renewable generators.

ENERGY & CO_2 REDUCTION IMPACT

Because the key goal of RPS and environmental dispatch policies is to replace fossil fuel generation with renewable generation while reducing the cost of renewable generation, the main impact of successful RPS will be through increased renewable generation (rather than direct energy reduction) and subsequent reductions in CO_2 emissions from power generation. Studies in the U.S. have shown that of the 15 states that exceeded the national average in using more renewable energy and less fossil fuel generation, 11 adopted RPS. The state of Texas in particular added 5.5 GW of new renewable capacity five years after the initial adoption of RPS in 2002, raising the share of renewable in the state's fuel mix from 0.6% in 2001 to 2.3% in 2007.[44] Although difficult to quantify, the impact of environmental dispatch is closely linked to RPS as it facilitates the successful integration and dispatch of increased renewable generation and replacement of fossil fuel generation.

[44] Hurlbut, 2008.

COST-EFFECTIVENESS

As a market-based program, RPS can help achieve renewable policy objectives in a cost-effective manner. Previous state analyses conducted in the U.S. show that implementing RPS requirements will have negligible impact on ratepayers, ranging from increases of less than 1% to savings of up to 0.5% and impacts of only a few dollars per year on residential bills.[45] The design and implementation of RPS programs can also be evaluated consistently to ensure that the target level is not set too high and incurring costs. Because environmental dispatch is often introduced along with other policy measures such as feed-in tariffs, its cost-effectiveness is more difficult to ascertain and may vary depending on the electricity system context.

BARRIERS & CHALLENGES

Possible barriers in the implementation of RPS may stem from volatility of energy prices and in renewable energy costs undermining RPS feasibility. For Renewable Energy Certificate (REC) trade, barriers include lack of market infrastructure and support, and difficulty in creating mechanisms for incentives and reimbursement.

CASE STUDY

Texas RPS and REC Implementation[46]
The U.S. state of Texas was one of the first states to establish RPS requirements and have since developed a successful RPS framework complemented with an expanding REC trading system. Texas adopted RPS requirements for 2000 MW of new installed renewable capacity by 2009 in 1999, which was allocated to all retail suppliers proportionally based on statewide retail energy sales. In 2005, Texas set new RPS requirements of increasing installed renewable capacity to 5880 MW (equivalent to 5% of state electricity demand) by 2015 and 10,000 MW by 2025. Texas also established a REC trading system in 2001 with a penalty of RMB 337 /MWh for non-compliance. The successful implementation of the Texas RPS has been accredited with increasing the rural tax base with more than RMB 6.732 billion investment in wind development and meeting its target four years ahead of schedule. Factors for success in the Texas program include high targets capable of driving market growth, use of RECS for meeting targets, credible noncompliance penalties and inclusion of all electricity providers.

[45] U.S. EPA, 2006.
[46] Texas State Energy Conservation Office, 2012.

Policy 3.2 Signal with Prices: Time-of-Use, Inverted Block and Differential Pricing

POLICY DESCRIPTION

Dynamic and variable electricity pricing differs from traditional static rates for retail electric utility service in that rates can be changed more frequently to send pricing signals to all customer classes (residential, commercial, industrial) based on fluctuations in real costs. Because dynamic and variable pricing can be adapted to better reflect true electricity generation costs, it is intended to help promote increased overall economic efficiency and reliability in the provision and consumption of electricity. Three common examples of dynamic and variable pricing include:

1. **Time-of-Use (TOU) Rates:** T OU rates are rates that typically vary on a specific schedule with predetermined rates set for each time period, including peak, part-peak and off-peak periods. Retail electricity rates will be set higher for peak and part-peak periods with higher generation costs, and set lower for off-peak periods. Unlike real-time pricing which are set using market prices for power, TOU rates are set using estimates of how utility's costs vary during each pricing period. A key goal of TOU rates is to influence customers to make long-term changes in their consumption patterns that help lower system peak demand and avoid building new peaking generation.
2. **Inverted Block Pricing:** rates are composed of a basic (fixed) customer charge, a fixed volumetric rate for first usage block (or baseline quota of electricity consumption) and higher fixed rates for subsequent blocks of electricity consumed. In Northern California, for example, the pricing scheme may charge RMB 0.86 per kWh consumed for the baseline usage, then RMB 1.01, RMB 2.02 per kWh consumed for 101% to 130% and 131% to 200%, respectively, of the baseline usage. By charging higher rates for consuming more electricity, inverted block pricing is intended to incentivize customers to save energy.
3. **Differential Pricing:** different rates are set for different customers based on a predetermined set of criteria. In China, differential pricing has become a policy tool to slow down the indiscriminative expansion of energy-intensive sectors and curb redundant and poor quality construction, phase out factories of outdated production capacities and push industrial restructuring and technology advancement, as well as ease the problem caused by short energy supply. Since 2004, differential pricing has been adopted for heavy industrial customers, with lower rates offered to more efficient enterprises and higher premiums charged for inefficient enterprises. As with inverted block pricing, differential pricing can be used to incentivize customers to save energy and become energy efficient in order to enjoy lower rates.

STAKEHOLDERS

- (Central and local) Government /policymakers
- Electric and gas utilities
- Utility regulators (public utility commissions)
- Utility customers and ratepayers (residential, commercial and industrial energy consumers)
- Environmental, energy and ratepayer advocacy groups
- Energy-intensive industries

CONDITIONS FOR IMPLEMENTATION

Efforts to educate and raise awareness are needed not only to help customers understand these non-traditional pricing schemes, but also to provide them with options to shift or reduce demand through enabling technologies such as programmable thermostats and smart meters. Similarly, for larger industrial and commercial consumers, technical assistance may be needed to help them adjust and respond to new pricing schemes. Equity concerns for low-income residential customers need to be considered and addressed when designing inverted block pricing schemes.

ENERGY & CO_2 REDUCTION IMPACT

The pricing signals sent by dynamic and variable pricing can influence customers to change their energy consumption patterns and subsequently result in energy and energy-related CO_2 emission reductions. While reduction in system peak demand can vary by TOU pricing schemes, TOU pricing have proven successful in reducing system peak demand by 10% to 16% in New York.[47] Differential pricing was adopted in China between 2004 and 2009; during that period, energy savings and emissions reduction from four industries out of the eight energy-intensive industries reached 115TWh and 82 million metric tons respectively. [48]

COST-EFFECTIVENESS

While difficult to quantify, TOU rates can result in various benefits that include lowering peak demand with associated avoided cost of building new peaking generation, lower fuel costs and transmission and distribution investment for generation, lowered electricity bills for customers that respond to dynamic prices. The main cost related to TOU rates is the enabling technology and metering infrastructure needed to provide two-way data communication between the utility and customer with costs of automated meters ranging from RMB 673 to over RMB 3,366 depending on signaling and demand control functions.[49] Thus, TOU rates' ability to realize the benefits of dynamic pricing and achieve cost-effectiveness is dependent on and closely related to the availability and introduction of low-cost enabling technologies to help customers respond to dynamic prices.

[47] Faruqui, 2010.
[48] Hu et al., 2012.
[49] IEE, 2009.

BARRIERS & CHALLENGES

Possible barriers include obstacles posed by energy pricing reform and increase in company operating costs A major challenge inherent in the inverted block pricing scheme is maintaining social fairness and equality in establishing electricity supply and pricing structures.

CASE STUDY

China's Differential Electricity Pricing Policy for Energy-Intensive Industries[50]

In 2004, China introduced a differential electricity pricing policy for six energy intensive industries including electrolytic aluminum, ferroalloy, calcium carbide, caustic soda, cement and iron and steel. Starting October 1, 2006, this policy was expanded to cover the industry of yellow phosphorous and zinc smelting. In 2010, the relevant ministries issued a joint statement, announcing increased effort in enforcement of differential electricity pricing policy among the above eight industries, in addition to increasing surcharge of differential pricing. For example, starting June 1st, 2010, for companies destined for phase out, the surcharge increased to 0.3 RBM/kWh from 0.2 RMB/kWh. Local governments are also able to increase their surcharges.

The effect on energy savings and emissions reduction has been significant, with non-ferrous metal smelting and rolling, and chemical industry topping all of the industries. A 2012 study estimates that four of the eight industries subjected to the differential pricing policy were able to reduce electricity consumption by 115TWh and CO_2 emissions by 82.3 million metric tons of CO_2 between 2004 and 2009.

In June 2007, Fujian province adopted differential electricity pricing policy for the cement industry. As of June 2009, the province had phased out up to 19.586 million tonnes of production capacities in the cement industry, 17.4% or 2.906 million tonnes more than the target 16.68 million tonnes set out by the 11th FYP. These actions saved1.78 Mt of coal and avoided 4.26 Mt of CO_2 emissions.

Policy 3.3 Utility Programs for Energy Saving: Utility DSM Programs and Public Benefits Funds

[50] Hu et al., 2012.

POLICY DESCRIPTION

Utility demand-side management (DSM) program is a common form of utility programs focused on changing the level or timing of consumers' electricity demand through various activities related to energy efficiency. Specifically, utility DSM programs can promote energy efficiency through general awareness and information campaigns, technical assistance to identify specific recommendations for improving efficiency, financial assistance for efficient technologies, direct or free installation of efficient technologies, and performance contracting. In the U.S., DSM programs have existed since the mid-1970s when state and federal regulators began encouraging or mandating regulated utilities to fund energy savings programs or achieve certain amount of energy savings. DSM programs involving energy audits, efficiency financing arrangements and installation of efficient technologies or measures have also been introduced to different countries in Europe, including in Austria, Denmark, United Kingdom, France, Ireland, the Netherlands, Spain and Sweden.

Besides DSM programs, public benefits funds (PBFs), also known as system or public benefits charges, is another important policy option that provides consistent funding for energy efficiency programs. The PBF is collected through a small surcharge on every customer's electricity bill, with magnitude possibly ranging from RMB 0.0020 to RMB 0.020 per kWh, and serves as an annual revenue stream for funding efficiency programs. PBFs for energy efficiency and renewables have been adopted in 19 states throughout the U.S. since their emergence in the 1990s, while similar PBFs also exist in Belgium, Brazil, Denmark, the Netherlands, Australia, Norway, Thailand and the UK.

STAKEHOLDERS

- Government and policymakers
- Electric and gas utilities
- Utility regulators (public utility commissions)
- Utility customers and ratepayers (residential, commercial, industrial energy consumers)
- Energy efficient technology/measures manufacturers, retailers, installers
- Public and private sector energy efficiency providers and organizations
- Energy, environmental and ratepayer advocacy groups

CONDITIONS FOR IMPLEMENTATION

For utility DSM programs to be effective in reducing energy consumption, there is a need to remove utilities' disincentive for effective energy efficiency program delivery given that their revenues and associated profits are traditionally linked to energy sales. This can be done by designating the administrative responsibilities for DSM programs to non-utility program operators, by providing performance incentives for achieving efficiency goals and/or by decoupling utility energy sales from revenues. In addition, there also needs to be methods and protocols in place to evaluate the actual energy savings from utility DSM programs.

Establishing a PBF requires giving the program administrator authority to levy a surcharge on ratepayers' bills. For a PBF to be effective, the program administration must also determine the funding mechanism, level and duration, allocation method for PBF resources (e.g., competitive bidding), and evaluation methods for estimating program impacts and cost-effectiveness

ENERGY & CO_2 REDUCTION IMPACT

The various efficiency efforts encompassed by utility DSM programs can result in significant energy savings, with estimates of annual savings of 50 to 59 GWh in the U.S. between 1994 and 2005. U.S. utility DSM programs have also been credited with generating energy savings equivalent to nearly 2% of annual national retail sales throughout the 2000s. On a state level, utility DSM programs in California and Vermont have achieved savings on the order of 1.2% and 2.5%, respectively, of total state electricity sales in 2008.[51] In the UK, efficiency efforts launched by its electricity and gas suppliers achieved cumulative energy savings of 91 TWh from mid-2002 to mid-2005 through building efficiency measures such as insulation and more efficient heating.[52]

As PBFs provide a stable level of funding for U.S. electric energy efficiency programs, ratepayer-funded efficiency program spending have continued to increase from RMB 9.1 billion in 2003 to RMB 30.3 billion in 2010.[53] For 2002-2003, the total annual investment of RMB 5,856 million from states with energy efficiency PBFs yielded 2.8 TWh of electricity savings and over 1.8 million metric tons of CO_2 emissions reduction.[54]

COST-EFFECTIVENESS

Although the cost-effectiveness of utility DSM programs varies depending on utility performance, measures and method for calculating cost-effectiveness, DSM programs have generally been considered highly cost-effective. Estimates of the average cost of energy savings from U.S. utility DSM programs include a 1996 estimate of RMB 0.283 per kWh saved for earlier U.S. programs and RMB 0.337 per kWh saved for DSM programs between 1992 and 2006.[55]

Energy savings achieved through PBFs have been considered very cost-effective with significant reductions in electricity demand and related emissions at a relatively low cost. Of the 12 state PBF programs in 2002-2003, the median program cost was only RMB 0.202 kWh saved, well below the typical costs of new power sources and average retail prices of electricity.[56]

BARRIERS & CHALLENGES

Possible barriers to the implementation of DSM policies include a lack of DSM technologies and information, the need for system-wide coordination, establishing appropriate pricing incentives, poor education and awareness among consumers; and challenges concerning levy, appropriation, management and supervision of PBFs.

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[51] Arimura et al., 2011.
[52] GEF, 2010.
[53] Sciortino, et al., 2011.
[54] U.S. EPA, 2006.
[55] Arimura et al., 2011.
[56] U.S. EPA, 2006.

CASE STUDY

New York's System Benefits Charge Program[57]

The state of New York established its system benefits charge program in 1996 to improve system reliability and increase peak demand reductions through efficiency, improve efficiency and access to energy options for underserved customers, reduce energy-related environmental impacts and facilitate competition in electricity markets to benefit end-users. The program is administered by the New Yrok State Energy Research and Development Authority (NYSERDA) with a 2011 energy efficiency program budget of RMB 3,358 million in 2011, with half of the budget allocated to commercial and industrial efficiency programs, 18% to residential efficiency programs, 13% to low-income efficiency programs and the remainder to workforce development, promoting awareness and administrative costs. Cumulatively from 2004, annual electricity savings through New York's program reached 5.615 TWh in 2011 with corresponding 2.01 GW of peak demand reduction. This translates into RMB 6.833 billion in cumulative annual energy bill savings to participating customers and 2.66 million metric tons of CO_2 in cumulative annual emissions reduction.

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[57] NYSERDA, 2012.

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4

Consumption & Waste

POLICIES:

1 Source Reduction: Reduce and Re-Use Waste

2 Recycling & Composting

3 Landfill Methane Recovery

4 CONSUMPTION & WASTE MANAGEMENT

Policy 4.1 Source Reduction: Reduce and Re-Use Waste

POLICY DESCRIPTION

Source reduction is a strategy to reduce the amount and/or toxicity of waste at or before the point of generation. Key steps to achieving source reduction including promoting the adoption of strategies to use less material per product, extend the useful life of products and materials and reduce overall waste generation during the design manufacture, purchase and use of products and materials. Similarly, encouraging the purchase of higher quality goods with longer lifetimes and the reuse of products and materials can also help reduce the volume of waste generated. Examples of source reduction policies adopted at the local level include:

- Implementing reduce and reuse programs in-house within local government facilities and operations
- Adopting policy on the reduction of a particular material or bans materials from collection or disposal
- Providing education and/or economic incentives for source reduction strategies targeted at businesses and consumers
- Establishing a source reduction or reuse program such as a salvage or re-use center, swap and trade events or centers

In the U.S., 47 out of 50 states have initiated different source reduction programs and efforts, including source reduction planning in 31 states, in-house state government programs in 27 states, residential programs in 23 states and commercial programs in 39 states.[58]

STAKEHOLDERS

- Local government and related agencies (environment, waste management)

[58] U.S. EPA, 1998.

- Businesses, consumers, local community groups
- Product supply chain: manufacturers, transport, distributors, retailers
- Waste management companies and industry
- Non-profits and research organizations
- Media

CONDITIONS FOR IMPLEMENTATION

The implementation of source reduction initiatives such as reduce and reuse programs will only be possible if the regulatory focus for waste management is able to look beyond traditional “end-of-pipe” waste disposal options and recycling. This shift away from the traditional framework for waste management and resulting openness to focusing on prevention and reduction before waste is generated is an important foundation for source reduction planning and implementation. Moreover, because behavior change is the key to making source reduction work, implementing successful reduce and reuse initiatives will be dependent on how informed and motivated the targeted participants (e.g., business, consumers) are. Consistent monitoring and periodic evaluation to maintain program success is also needed to document behavior change and achieved savings.

ENERGY & CO_2 REDUCTION IMPACT

While the primary goal of source reduction is to reduce the volume of waste generated, strategies such as reduce and reuse can also have important impacts on reducing energy consumption and CO_2 emissions. Reducing waste generation directly reduces the energy needed to collect and dispose waste, while reuse help reduce the energy needed to extract new materials and manufacture and transport new products. In both cases, reductions in energy demand for manufacturing and transporting new products and disposing waste also contribute to lower CO_2 emissions. Promoting the use of less energy-intensive products can also directly reduce CO_2 emissions, as exemplified by the 2.8 metric tons of carbon equivalent greenhouse gas emission reductions achieved by New York City’s substitution of electronic phone directories for print directories.[59]

COST-EFFECTIVENESS

Studies have shown that the true cost of waste is around 15 times the actual cost of disposal; thus suggesting that avoiding waste generation through source reduction strategies such as reduce and re-use can be very cost-effective.[60] Promoting the consumption and re-use of longer lasting and more durable products also benefits from lower or zero replacement costs when compared to one-time use or disposable products, resulting in significant cost savings. In King County, Washington, for example, a mandate to purchase recycled and environmentally preferable products including remanufactured toner cartridges, re-refined antifreeze and motor oil led to total savings of RMB 3.9 million in 2003.[61]

[59] New York Department of Environmental Conservation, 2012.
[60] NSCC, 2007.
[61] ICLEI, 2005.

BARRIERS & CHALLENGES

Possible barriers encountered during the design and implementation of source reduction include the lack of information and education on the environmental benefits of source reduction and poor alignment of incentives between producers and consumers.

CASE STUDY[62]

In the state of North Carolina, Chatham County integrated Swap Shops into the design of its solid waste and recycling collection centers to promote reuse and divert the greatest amount of usable items away from the waste stream. The first Swap Shop was introduced as early as 1993 and shops are now located in each of the county's solid waste collection centers. Residents can drop off unwanted but usable items at the Swap Shops for other residents to pick up, and items that are not swapped within two weeks are transferred to local thrift shops or mission. The Swap Shops were relatively low cost to establish, with low construction and administrative costs and estimates show sizable reductions in waste generated as a result of the Swap Shops. Staff estimates of all the materials dropped off, 60% of items in the Swap Shops are re-used, 30% transferred to thrift stores and other outlets for re-use and only 10% end up in the waste stream.

Policy 4.2 Recycling & Composting

POLICY DESCRIPTION

Two important policy options for diverting valuable materials away from the waste stream for landfills is recycling and composting. Setting and implementing targets for diversion of waste from landfill to recycling and composting in turn drives both local recycling and composting efforts. Recycling involves recovering discarded materials such as plastics, glass, metals, and paper in order to sort, clean and reprocess the used materials into new recycled products that can displace the need for new products made from virgin materials. Policies that promote recycling include setting recycling goals and requirements, recycling grants, tax incentives, beverage container deposit laws, disposal fee surcharges and disposal bans. These policies have been adopted by a number of states and cities in the U.S. and countries in the European Union.

Composting involves recovering organic wastes (e.g., yard trimmings, food waste) and combining it with bulking agents to accelerate the breakdown of organic materials and transformation into

[62] NRC, 1996.

fertilizers and mulch. Policies to promote composting focus on creating high market demand for compost, including favorable procurement policies in local governments and large institutions, landscaping and green building policies, and rebates and free giveaways for compost. In the U.S., the recovery rate of compostable yard trimmings and food residuals increased from only 12% in 1990 to 57.5%, with much lower compost rate of 2.8% for food waste due to high costs of food waste separation and collection.[63]

STAKEHOLDERS

- Local government and related agencies (environment, waste management)
- Businesses, consumers, local community groups
- Agriculture, environmental and sustainable development groups
- Waste management companies, recycling and compost providers
- Businesses providing recycling and composting services: haulers, processors, brokers of recovered materials; manufacturers of recycled materials and waste compost

CONDITIONS FOR IMPLEMENTATION

As with source reduction, the success of recycling and composting programs is also contingent on general public awareness of the need and resources for recycling and composting and actual behavior change. This will often require education and outreach targeted at different consumer subgroups, as challenges may differ between single-house occupants and multi-family dwelling occupants. The effectiveness of recycling and composting programs is also dependent on access to recycling and composting providers.

ENERGY & CO_2 REDUCTION IMPACT

Recycling and composting can both contribute to important energy savings and CO_2 emissions reduction, although the specific energy savings and emission reduction potential may vary depending on the type of material being recycled and the composting method. The energy savings of recycling is determined by the type of material being recycled and the energy requirements for primary (virgin) production versus secondary (recycled) production of the material. In the example of aluminum, recycling can save 95% of the energy needed to produce virgin aluminum. Overall, conservative estimates of energy savings of 22 Mtce in 2005 and reductions of 48 million metric tons of carbon emissions have been attributed to recycling programs in the U.S.[64] Diverting organic waste from breaking down in landfills to composting can prevent the breakdown of organic waste in landfills, which generates methane emissions, a potent greenhouse gas. Composting under carefully controlled conditions for decomposition lower emissions from compost operations and has additional benefits in reduced pressure to expand forestry and mining production, fossil fuel and metals extraction.

[63] U.S. EPA, 2012a.
[64] U.S. EPA, 2012b.

COST-EFFECTIVENESS

Recycling revenues of successful recycling programs help defray recycling costs and also benefit from avoided cost of building new disposal capacity by diverting waste from existing disposal capacity. Recycling has also been linked to positive benefits for job creation and economic development, with studies showing that recycling results in ten times more jobs than waste disposal. Studies have also shown that diverting one additional ton of recyclable or compostable waste from landfills pays RMB 680 more in salaries and wages, produces RMB 1,851 more in goods and services and generate RMB 909 more in sales than landfill disposal.[65] The cost-effectiveness of composting, particularly food composting, is less clear-cut and is influenced by the costs of waste separation and collection and type of composting system employed.

BARRIERS & CHALLENGES

Possible barriers encountered during implementation of landfill methane recovery include development of an appropriate pricing mechanism for landfill methane trading, and a lack of professional program developers and implementing contractors.

CASE STUDY

San Francisco Zero Waste Goals and Mandatory Recycling and Composting Ordinance[66]
After meeting the state mandated goal of 50% landfill waste diversion in 2001, the city and county of San Francisco proceeded to set more stringent waste diversion goals at the local level by adopting goals of 75% diversity by 2010 and zero waste to landfill or incineration by 2020 in March of 2003. In June of 2009, the city also adopted mandatory recycling and composting ordinance which requires all city businesses and residents to separate their waste into recycling, composting and landfill waste containers. The ordinance provides businesses, residential property owners and renters with free recycling and compost containers, toolkits, educational materials and trainings but also makes compliance enforceable through the use of fines if necessary. In addition to these two major recycling and composting policies, San Francisco has also adopted a variety of other complementary policies focused on producer responsibility for waste generation, plastic bag reduction, food service waste reduction, recycled content materials requirement for construction, debris recovery, and in-house recycling and procurement policies.

[65] US EPA, 2011.
[66] San Francisco Department of Environment, 2012.

Policy 4.3 Landfill Methane Recovery

POLICY DESCRIPTION

Municipal solid waste management contributes 14% of global emissions of methane, a potent and the second most significant greenhouse gas responsible for climate change after CO_2.[67] Methane is released in the form of vented landfill gas (LFG), which is produced through bacterial decomposition of organic waste in landfills and open dumps. Instead of allowing LFG to be released into the atmosphere, it can be captured, converted and used as an energy source. The main method for capture and recovering methane in LFG is to extract and collect it using wells and a vacuum system, where the gas can then be flared and used directly, to generate electricity, or to fuel combined heat and power systems.

In addition to expanding recycling and composting programs, regulatory targets for methane capture and recovery have been implemented in countries such as the U.S. and Canada to constrain methane emissions and slow the future growth of emissions. Other landfill methane recovery policies adopted in countries such as the U.S., UK, Germany, Luxembourg and South Korea include financial and tax incentives for methane recovery and use, including LFG in renewable portfolio standards or feed-in tariff programs, standardizing interconnection requirements to provide grid access for small LFG recovery projects and technology development and demonstration policies.

STAKEHOLDERS

- Local government officials and staff
- Landfill gas energy project developers and supporting contractors
- Regulatory and planning agencies and departments (environmental, land zoning and planning, public utility commissions, solid waste planning)
- Financial partners
- Energy end-users (businesses, industry) and utilities

CONDITIONS FOR IMPLEMENTATION

An underlying condition for landfill methane recovery and LFG project development is adequate awareness among the various stakeholders on the benefits of methane recovery and LFG energy projects. Government's active efforts in promoting education and awareness on methane recovery help sustain continued interest and commitment to LFG recovery and energy projects. In addition, LFG project developers' access to financial support through subsidies, renewable funds, tax credits and other financing mechanisms is also crucial in initiating and sustaining LFG energy projects.

[67] IEA, 2009a.

Similarly, technical and institutional capacity for landfill gas recovery and utilization is also needed for LFG energy projects. Lastly, supporting policies and regulations such as interconnection requirements for purchasing energy from LFG projects and mandatory control of LFG emissions from landfills play important roles in helping drive landfill methane recovery and LFG energy projects.

ENERGY & CO_2 REDUCTION IMPACT

LFG energy projects have direct energy reduction impacts by using recovered methane as an energy source to offset or replace traditional fuel sources such as natural gas in electricity generation and combined heat and power systems, or direct use in boilers, dryers, kilns, greenhouse or other thermal applications. In addition, LFG energy recovery projects also reduce substantial methane emissions from landfills, as landfill methane emissions reductions of 60% to 90% are feasible depending on the LFG energy project design and effectiveness. A typical 3-MW electricity generation project using LFG can reduce 34,700 metric tons of carbon equivalent from methane and avoided CO_2 emission reductions per year, while a typical direct-use LFG energy project can reduce 32,300 metric tons of carbon equivalent per year.[68] In the U.S., the 520 existing LFG energy projects have helped reduce landfill methane emissions and avoided CO_2 emission by a combined total of 44 million metric tons of carbon equivalent.

COST-EFFECTIVENESS

The main costs of methane recovery through LFG energy projects include costs for project evaluation, purchase and installation of LFG recovery and energy generation equipment and operating and maintenance costs. At the same time, however, LFG energy projects have proven to be very cost-effective in generating significant revenue from power or fuel sales that offset the project's capital costs. Examples of highly cost-effective LFG energy projects include[69]:

- 3.2 MW LFG electricity generation project in the state of Georgia: LFG system cost RMB 33.7 million but revenues from power sales are expected to recover all costs in less than 5 years.
- Community-based direct LFG use project in the state of North Carolina: end-uses benefited from direct savings through avoided fuel cost that far exceeds the project's RMB 6.7 million capital cost.

In addition, landfill methane recovery and LFG energy projects contribute to creating jobs at the LFG project facility and spurring new businesses near landfills to tap into LFG use, and to reducing environmental compliance costs for complying with landfill emission abatement requirements.

BARRIERS & CHALLENGES

Possible barriers encountered during implementation of landfill methane recovery include: no fair pricing mechanism in place for landfill methane trading; professional program developers and contractors not available.

[68] U.S. EPA, 2012c.
[69] U.S. EPA, 2012c.

CASE STUDY

South Korea's Ulsan LFG Direct Use Project[70]

In 2002, a methane gas recovery system located at the site of a municipal landfill in Ulsan, South Korea, became operational as one of the earliest LFG energy projects in the country. The Ulsan project captured and transported LFG from the municipal landfill to an adjoining chemical factory where the LFG is burned as a fuel in boilers. The project's benefits include increasing financial savings in parallel with rising traditional fuel prices, with estimated savings of RMB 38,931 per day when compared to a similar facility running on natural gas. This LFG energy project has also resulted in annual greenhouse gas emissions reductions of 101,475 metric tons of CO_2 equivalent. Besides illustrating the financial and environmental benefits of landfill methane recovery, the successes of the Ulsan plant also demonstrated the importance of strategic partnership between government and project partners that facilitated the financing, capacity building and training needed in establishing the project.

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[70] Larnel Heil and Ha, 2006

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5

TRANSPORTATION & URBAN FORM

POLICIES:

1 Vibrant Neighborhoods & Streets for People

2 Integrated Transit Development

3 Less Distance, Better Flow

4 Efficient, Low-Carbon Vehicles

5 TRANSPORTATION & URBAN FORM

Transportation emissions are strongly influenced by urban form—the design of a city—and decisions on infrastructure funding. Saving energy and carbon in the transportation sector requires coordinated land-use policies and prioritized funding for low-carbon infrastructure. Other transportation strategies—vehicle technology, fuel standards, incentives, traveler behavior—follow from urban form and infrastructure choices.

PRIORITIZE LOW-CARBON TRANSPORATION MODES

For all of the strategies recommended below, keep in mind the low-carbon priorities for transportation modes in Figure 10.[71] This hierarchy has been effective in lowering transport carbon in cities around the world, from Portland and New York to Buenos Aeries and Guangzhou.[72] These priorities direct land-use and infrastructure decisions, giving greatest attention to people and to lowest-carbon transport options: walking, biking, and public transit. Next in the hierarchy is freight transport, the efficient movement of goods in commercial vehicles and trucks. For passenger vehicles, high-occupancy vehicles (van pools, car pools) are favored over single occupancy vehicles, which have the lowest priority due to their high carbon per capita.

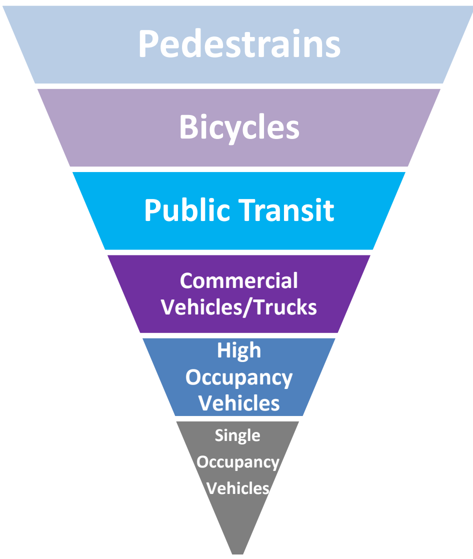

Figure 10. Transportation Mode Priority

Source: Portland Climate Action Plan, 2009

[71] Portland Climate Action Plan, 2009.
[72] Institute for Transportation and Development Policy, Sustainable Transport Awards: http://www.itdp.org/get-involved/sustainable-transport-award/

Policy 5.1 Vibrant Neighborhoods & Streets for People

POLICY DESCRIPTION

Mixed-zone Neighborhoods: Create human-scale, mixed-use neighborhoods where the majority of residents can walk or bicycle to meet basic, non-work, daily needs. Keeping these needs within a 20-minute walk or bicycle ride dramatically reduces vehicle travel, energy and CO_2 emissions.[73] Rather than towering concrete buildings separated from daily needs of people, gather together services, retail, recreation, and housing within walk-able distances and pedestrian-friendly configurations. For residents who must go outside the neighborhood for their job, provide safe access to walking and bike paths and public transit for the work commute. Residents and workers – and their employers and the businesses they shop at – benefit from clusters of daily destinations in mixed-use zoning.[74]

Streets for People ("Complete Streets"). All transportation and business begins and ends with people, on foot. Make streets safe and appealing for people. Turn away from the super-block design that causes danger and long distances for pedestrians. A block size of approximately 1.5 hectares is ideal for many cities.[75] Rather than huge multi-lane two-way intersections, pairings (couplets) of one-way streets can provide easier crossing for pedestrians while still facilitating traffic flow of vehicles. This strategy is used by densely populated cities such as San Francisco, New York City, Toronto, Seattle and Denver. Rather than forbidding concrete building fronts, sidewalks should easily access retail, restaurants, and other pedestrian services. Trees and vegetation, shaded entrance ways, and benches all contribute to pedestrian safety and appeal. A network of bicycle paths, along with bike parking and bike sharing programs—like Guangzhou, Hangzhou, and the Paris Velib—makes streets complete and beneficial for non-motorized transport.[76]

STAKEHOLDERS

- local Transportation Agency: coordinate with the Mayor's Office, local Development and Reform Commission, local Environment Dept., and regional Transportation Agency on planning, zoning, funding, and street improvements
- local businesses and developers: realize benefits of people-friendly streets, mixed-use zoning
- community: realize benefits of low-carbon, easy access neighborhoods

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[73] Portland Climate Action Plan, 2009; Calthorpe, 2010.
[74] Pollution-prone industries should be controlled and kept at a distance to protect health, but other businesses can be included in mixed-use zoning.
[75] Calthorpe Associates, 2010.
[76] National Geographic, 2011; SFMTA, 2011.

CONDITIONS FOR IMPLEMENTATION

Coordination across government agencies—planning, transport, investment, construction—is essential for low-carbon urban form and mobility. Setting near-term and longer-term targets is crucial for making progress on complete streets and neighborhoods.

ENERGY & CO_2 SAVINGS

High-density urban neighborhoods can save 40% of vehicle miles travelled (VMT) and CO_2 compared to less-dense urban areas (6 tCO2e/household compared to 10 tCO2e/household).[77] Dramatic savings of 70% are possible by avoiding long-distance commutes from low-density, residential-only, sprawl developments. For existing urban neighborhoods that shift to mixed-use zoning and complete streets, cities may achieve 30% savings in VMT and CO_2 within 10 to 20 years.[78]

COST-EFFECTIVENESS

Implementing "complete streets" has moderate public costs and low private costs, for high savings of GHGs (more than 15%), compared to other sustainable transport measures.[79] Locating markets, schools, and other public services within walking or biking distance is usually less expensive than any motorized transport infrastructure. Not only does the "complete streets" approach generate revenue for local business and government, it also improves quality of life for the neighborhood.

BARRIERS & CHALLENGES

Possible barriers encountered during the design and implementation of vibrant neighborhoods & streets for people include: more difficult to transform existing urban form than design new development; must coordinate development plans across agencies.

CASE STUDY

In 2009, the city of Portland and surrounding Multinomah county set a goal for vibrant 20-minute neighborhoods, where up to 90% of residents can meet basic daily needs by walking or biking. The city had already achieved improved urban form by establishing light rail in its downtown center rather than a freeway. To meet the goal, the city worked with local and regional agencies to identify the infrastructure investments, land-use plans, and public-private partnerships needed for each urban neighborhood. The city Plan was revised to incorporate these actions, set an implementation timeline and prioritize funding for low-carbon projects. One action already accomplished is the establishment of 10 miles of Neighborhood Greenways, which provide safe places to walk and bike, as well as treat storm water runoff and enhance safety around schools.[80]

[77] Calthorpe, 2010. Based on data from Northern California Bay Area (San Francisco, Oakland, San Ramon).
[78] Portland Climate Action Plan, 2009.
[79] SF MTA, 2011. For San Francsico, moderate public costs for Complete Streets are in the range of $100-500 million over a 25-year period. Costs would be lower for Chinese cities. High GHG savings of >15% are expected.
[80] Portland Climate Action Plan – Progress Report, 2012.

Policy 5.2 Integrated Transit Development

POLICY DESCRIPTION

Many of the world's highly regarded cities have found that Transit-Oriented Development (TOD) is a cleaner and more efficient transportation strategy than plans oriented toward private vehicles. Integrated transit planning, where commercial and residential development is concentrated along transit corridors, reduces vehicle kilometers travelled and CO2 emissions. Include transit improvements in new construction developments and finance them through development agreements. Bundle transit passes rather than parking spaces in housing developments, and encourage employers to offer transit benefits rather than parking. Include bicycle and car-share parking near transit centers. Discourage private vehicles through parking planning, parking fees, and programs to park and ride transit. Set targets for the mix of transport modes, and monitor progress. Improve connections across transit routes, to encourage ridership. Maintain or enhance transit infrastructure, considering bus rapid transit (BRT), and light rail or subway (more expensive options). Encourage walking, biking, and public transit through easy access and payment on transit systems, along with transit information systems and public outreach.

STAKEHOLDERS

Active partnership between local government agencies and developers is essential for integrating public transit into any construction.

CONDITIONS FOR IMPLEMENTATION

Funding for public transit infrastructure must be prioritized over funding for private vehicle infrastructure. Funds gathered from traffic reduction measures (e.g., license fees, congestion pricing; see Policy 5-3 below) should be ear-marked for public transit infrastructure, as well as for pedestrians and bicyclist infrastructure. The construction of infrastructure should coordinate with real estate and business district development, to ensure that public transit is integrated into those developments.

ENERGY & CO_2 SAVINGS

Shifting passengers from low-occupancy vehicles to public transit results in high energy and CO_2 savings. As illustrated in Figure 11, bus and rail transport can save close to 80% of vehicle emissions per passenger kilometer. In the US, 17 TOD projects in five medium- to large-sized metropolitan areas showed a 44% reduction in vehicle trips, compared to typical patterns of car-focused development.[81]

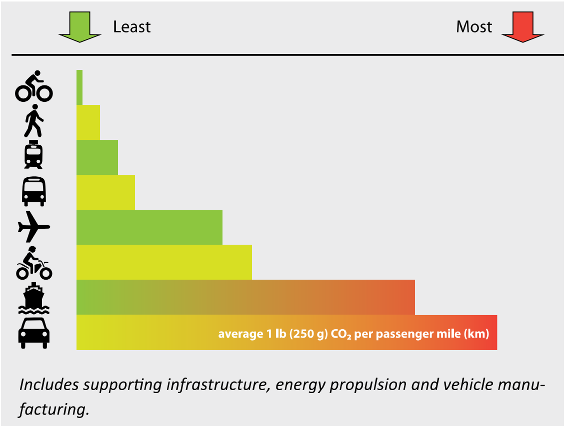

Figure 11. GHG Emissions per Passenger Mile by Transport Mode (San Francisco)

Source: SFMTA, 2011.

COST-EFFECTIVENESS

Transit-Oriented Development has a relatively low public cost, medium private cost, and medium GHG savings (10-15%), for medium effectiveness overall.[82] Among public transit infrastructure choices, busses have somewhat higher emissions per passenger kilometer than rail, yet their lower capital costs make busses an affordable public transit options. Electric rail, with its higher operating efficiency, is appealing for the highest-density cities. BRT offers the benefits of both: dedicated bus lanes gain improved efficiency at a lower cost than rail. To ensure sufficient revenue, transit agencies must carry out smooth operation, make easy connections and payment systems, and share information with the ridership.

BARRIERS & CHALLENGES

Possible barriers encountered during the development of integrated transit include: requires coordination with other cities and a system-wide planning; large capital investment and long construction time for rail infrastructure; must persuade people to opt for public transportation.

CASE STUDY

Integration of public transit with walking and biking is the key to low-carbon transportation in Guangzhou. After years of coordinated planning, in February 2010, China's third-largest city opened 22.5-kilometers of Bus Rapid Transit (BRT), the first BRT in Asia connected with

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[81] SFMTA, 2011; Cervero, 2009.
[82] SFMTA, 2011.

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the metro rail system.[83] The Guangzhou BRT system also includes bicycle parking in its station design and a greenway parallel to the corridor, integrating the city's bike share program of nearly 5,000 bicycles and 50 bike stations.[84] Within 18 months of opening the BRT, Guangzhou achieved the world's highest rate of BRT passengers—805,000 daily boardings—carrying more passengers per hour than any mainland Chinese metro outside of Beijing, and tripling the capacity reached by other BRT in Asia.[85] The efficiency improvements from BRT have reduced travel time for bus riders and motorists along the route by 29% and 20%, respectively. The fuel savings will in turn save 86,000 tCO2e annually.[86]

Policy 5.3 Less Distance, Better Flow

POLICY DESCRIPTION

With an urban form that encourages non-motorized transport (Policy 5-1), and a well-functioning public transit system (Policy 5-2), a city must then give attention to the flow of vehicle traffic, both for freight and passengers. The guiding idea for Transport Policy 5-3 is to reduce distance travelled, and keep traffic flowing for the distance that is travelled, resulting in fewer kilometers, less idling, less fuel, and lower CO_2 emissions.

Traffic flow can be optimized through traffic signal timing, variable message systems (roadway signs), and High Occupancy Vehicles (HOV) lanes. The volume of traffic can be restrained by controlling licenses through high fees, restrictions, and license-based driving bans. Demand pricing, or congestion pricing, imposes higher charges on vehicles at times and places of high demand, providing economic incentives to change routes or mode of transport. Freight transport, by truck, rail or ship, provides city residents with nearly everything they eat, wear, and use. Optimization of freight hubs, through timing of entrance, location of transfer hubs, and mode shifts from truck to rail can save distance and energy in bringing goods to a city. The connection with industrial areas and the regional transportation system is also crucial for reducing freight traffic. Commercial freight vehicles use more fuel to accelerate and idle, due to their larger size; the benefits of improved traffic

[83] Institute for Transportation & Development Policy, History of ITDP; Hughes and Zhu, 2011. http://www.itdp.org/
[84] National Geographic, 2011; ITDP Sustainable Transport Award.
[85] Hughes and Zhu, 2011; ITDP News, http://www.itdp.org/news/guangzhou-brt-reduces-co2-emissions-by-86000-tonnes-annually
[86] Hughes and Zhu, 2011.

flow are therefore even greater for commercial vehicles. Improved movement of diesel-powered vehicles has the added benefit of reducing soot, which has a strong warming effect on the climate.[87]

STAKEHOLDERS

Traffic control measures require the coordination of multiple government agencies, businesses involved in freight transport, as well as the public.

CONDITIONS FOR IMPLEMENTATION

Multiple traffic measures, implemented together, are needed to achieve shorter transport distances and better flow of traffic. For example, nearly 90% of freight in New York City was transported by truck, causing heavy congestion and pollution on city streets. Through PlaNYC, the city completed an expanded rail connection in the South Brooklyn Marine Terminal, and is expanding other rail terminals, to shift more freight to rail. Truck delivery hours were staggered at the Manhattan Central Business District, significantly reducing idling and emissions. The city is also undertaking a detailed study of food delivery patterns, looking for further savings.[88]

ENERGY & CO_2 SAVINGS

With a relatively low level of public investment, and moderate private costs, cities can achieve 10-15% savings in energy and CO_2 emissions by optimizing the flow of vehicle traffic.[89] Controlling the number of automobile licenses could achieve even greater savings.

COST-EFFECTIVENESS

Demand pricing and license fees, combined with traffic flow optimization, has net benefits rather than costs. Congestion charges and license fees generate revenue, which can be used to enhance public transit infrastructure.[90] These measures are essential for financing other low-carbon transit measures, as well as directly reducing energy and CO_2 emissions.

BARRIERS & CHALLENGES

Possible barriers encountered during the design and implementation of less distance and better flow include: limited capability in technology and management; needs rigorous planning, organization and coordination; congestion charge is a hard sell to the general public; must address cultural interest in motor vehicles.

87 Portland Climate Action Plan, 2009.
[88] PlaNYC Update, 2011; PlaNYC Progress Report 2012.
[89] SFMTA, 2011.
[90] SFMTA, 2011.

CASE STUDY

Shanghai's practice of auctioning license plates has controlled the number of automobiles near 2 million and kept traffic flowing, although only the wealthy can afford the auction. In contrast, Beijing's past policy of allowing access to certain license numbers on certain days did not sufficiently control traffic, and roads jammed with more than 5 million cars. Guangzhou has learned from these experiences, and is implementing a combination of auction and lottery for automobile licenses. This approach will reduce traffic, save CO_2, and enable more equitable access to licenses. Several Chinese cities are now exploring the use of congestion pricing as well.[91]

Congestion pricing[92] can have an important impact on reducing GHG emissions if it effectively reduces transport and promote modal shifts to low carbon public transport. In London, for example, city-center traffic was reduced by 12%, of which more than half shifted to public transport. In addition, vehicle distance traveled across London was also reduced by 211 million km per year with a RMB 52 charge (Timilsina and Dulal, 2008). If London's congestion pricing scheme was implemented in New York, studies estimate 9% daily traffic volume reduction in the city. Another study show that congestion charging by distance in Copenhagen could reduce annual car mileage in Copenhagen by 7%, with resulting annual CO2 emissions reduction of as much as 154 million tons possible (Rich and Nielson, 2007).

Policy 5.4 Efficient, Low-Carbon Vehicles

POLICY DESCRIPTION

Transport Policy 5-4 is aimed at improving vehicle efficiency and encouraging low-carbon vehicle technology and fuels. City-level government has authority over its own vehicle fleets, and can set efficiency and emission requirements for purchasing. For example, busses can be powered by low-carbon electricity, compressed natural gas (CNG), or bio-diesel blends. The city of Portland set a low-carbon fuel standard to reduce the lifecycle greenhouse gas emissions of transportation fuels in the city by 20 percent by 2030.[93] Cities can encourage private vehicle owners to adopt more efficient, low-carbon vehicles through local fees or rebates. Cities can support infrastructure for electric vehicles, including charging stations or battery swapping stations, and fueling stations for

[91] "Congested Chinese cities seek best way to issue license plates." WantChinaTimes.com. 2012.9.18.
[92] Excerpted from: Zhou et al., 2011.
[93] Portland Climate Action Plan, 2011.

alternative, low-carbon fuels. These policies have an indirect influence on vehicle manufacturers and fuel producers, by creating a bigger market for efficient, low-carbon technology.

Some cities have set vehicle requirements for taxi fleets and other commercial fleets through licensing. However, most city governments do not have the authority to directly regulate vehicle manufacturers or set vehicle efficiency or emission standards. New York, San Francisco, Washington D.C., and other U.S. cities are promoting "green taxi" programs, but still must overcome legal barriers from national legislation to fully implement the programs and achieve much-needed GHG emission reductions.[94]

STAKEHOLDERS

- fleet owners, government and business
- private automobile owners
- automobile manufacturers and retailers
- fuel producers and fueling stations

CONDITIONS FOR IMPLEMENTATION

As with all low-carbon transportation measures, coordination across government agencies is crucial. Where cities don't have the legal authority to directly set fuel economy or emission standards, they must work to change provincial or national laws, and utilize less direct methods to encourage more efficient, lower emitting vehicles.

ENERGY & CO_2 SAVINGS

Figure 12 shows the relative CO2 emissions and savings for different types of transport technology. Hybrid vehicles emit roughly half the CO2 emissions of a typical passenger car. Electric vehicles running on renewable energy emit up to 70 percent less CO2 than the typical gasoline-powered vehicle.[95]

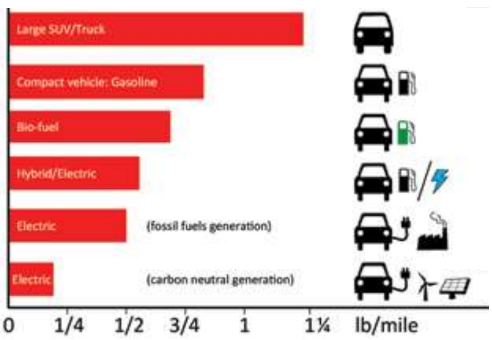

Figure 12. GHG Emissions by Vehicle Type

Source: Timothy Papandreou, SFMTA 2011.

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[94] New York City, Office of the Mayor, 2011.
[95] SF MTA, 2011.

If cities were to follow the new EU vehicle CO2 emission standards, they would see emissions from new cars drop to 130 g CO_2/km by 2015, and down to 95 g CO_2/km by 2020.[96] In terms of absolute emissions, the target for the EU CO_2 standard is a 40% reduction in CO_2 emissions from 1990 to 2007 levels. In the UK, CO_2 emissions could be reduced by 7 million tons of CO_2 annually in 2020.

COST-EFFECTIVENESS

Improvement of vehicle fuel efficiency and adoption of hybrid vehicles can achieve substantial savings in energy and money. For example, taxis in New York City travel 80,000 miles per year, while a typical passenger car travels roughly 15,000 miles per year. Utilizing fuel efficient taxis could reduce GHG by 296,000 tons, the equivalent of taking 35,000 cars off the road. At 2011 gas prices, drivers of hybrid taxis could save an average of RMB 35,343 in gas costs per year.[97] These efforts also improve air quality and human health; improved taxi efficiency can reduce lung-damaging nitrogen oxide emissions by 71 percent and hydrocarbons by 89 percent.

BARRIERS & CHALLENGES

Possible barriers encountered during the implementation of efficient, low carbon vehicles include: even with subsidies, hard to overcome high cost of hybrid and electric vehicles to deepen their penetration; limited awareness and acceptance of renewable vehicles among the general public; need investment in charging stations infrastructure.

CASE STUDY

In Mexico City, the municipal government set a requirement to replace taxis that are at least 8 years old with more efficient models. New taxis must have a fuel efficiency of at least 12.5 kilometers per liter. The local government provides a subsidy of nearly RMB 9,425 to drivers to buy a new taxi. To enable financing of the auto purchases, the municipal government formed a partnership with a local bank. The bank agrees to grant taxi drivers loans to pay off the typical remaining cost (approx. RMB 33,660), with a development bank acting as the guarantor of this loan. The government revokes the new car if the loan is not repaid by the driver (approx. 4 years). The first round of the program had a capital cost of RMB 28.3 million.[98]

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[96] Zhou et al., 2011; UK Dept. of Transport

[97] New York City, Office of the Mayor, 2011.

[98] C40 Climate Initiative, 2011; World Bank, http://einstitute.worldbank.org/ei/course/trace-how-use-tool-rapid-assessment-city-energy

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6 Agriculture & Forestry

POLICIES:

1 Local Agriculture, Healthy Food

2 Organic Agriculture, Safe Food

3 Urban Forestry: Protect & Clean

4 Urban Green Spaces

6 Agriculture & Forestry

Policy 6.1 Local Agriculture, Healthy Food

POLICY DESCRIPTION

With a long and rich food culture, formed around local specialties, Chinese cities are well positioned to embrace local, low-carbon food and agriculture. Many Chinese cities already have experience with urban agriculture, and encouraging this would benefit all Chinese cities, due to limited farmland.[99] Over the past twenty years, however, food-related carbon emissions have risen in China.[100] Life-cycle analysis shows the rise is due to greater consumption of meat, longer transportation, and increased kitchen energy consumption for refrigeration.[101] Improved efficiencies in food processing helped to counteract emissions, but overall the trend is troubling for low-carbon development. Transportation now accounts for 30% of food-related emissions in China; thus the importance of local food.[102] Red meat has three to ten times the carbon footprint of grains, and high meat consumption can lead to health problems; thus the encouragement for healthy foods.[103]

Promote local food supply to save energy and greenhouse gas emissions from transportation, food processing, and food retail energy. Local food can create better connection between farmers and food consumers, which can encourage shared responsibility and protection of land and food. Increase the number and frequency of farmers markets to provide better access to city residents to local produce. Reduce requirements for farmers market permitting. Reverse the trend of large food markets with heavily processed and packaged food. Require that public institutions (government,

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[99] Shenzhen, Beijing, and other cities already promote urban agriculture for better food quality and supply. The Chinese Urban Agriculture Association is one source of information: www.caass.org.cn.
[100] Three greenhouse gasses are emitted from food production: CO_2 from energy use, CH_4 from livestock and rice production, and N_2O from fertilization and manure. For simplicity, we use the term “carbon emissions” in this booklet.
[101] Zhi and Gao, 2009.
[102] Zhi and Gao, 2009. Food carbon is still lower in China than in the U.S. In China, roughly 3 units of energy are used to produce 1 unit of food. In the U.S., the ratio is 10 to 1 (Bomford, 2010).
[103] Weber and Matthews, 2008; Portland Climate Action Plan, 2009.

schools, hospitals, military, etc.) institute local food procurement guidelines to ensure most or all food purchased comes from the local food-shed. Label foods sold in stores with their place of origin. Encourage the public to eat healthy, less carbon-intensive foods.

STAKEHOLDERS

Encouraging local and healthy food involves: farmers, food markets, food purchasing groups in government and business, restaurants, schools—for local gardens and education on healthy food, and the general public.

CONDITIONS FOR IMPLEMENTATION

City officials must give priority to healthy, low-carbon, local famers in issuing permits and retails space. Vacant lots and rooftops should be permitted for urban agriculture. Urban soils must be tested before food is grown, to avoid contamination.

ENERGY & CO_2 SAVINGS

Local food reduces transportation energy and emissions. Shifting away from red meat, toward vegetable proteins has substantial savings of greenhouses gasses: beef emits twice as much as pork, almost four times as much as chicken, and 13 times more than beans, lentils, or tofu.[104] See Figure 13.

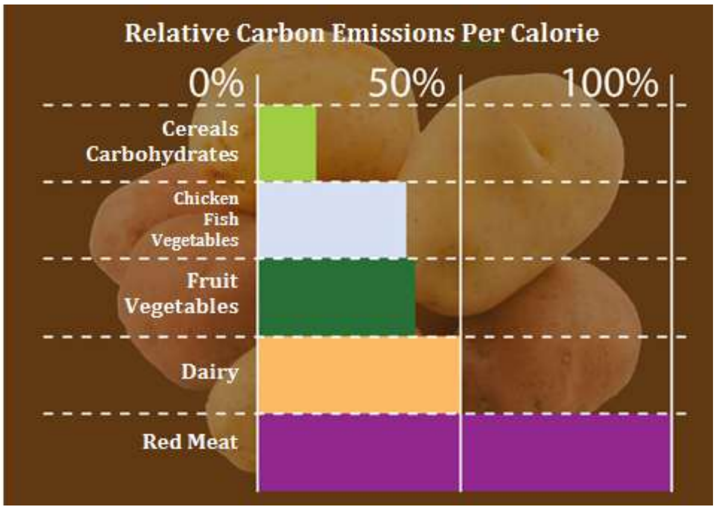

Figure 13. Carbon Footprint of Foods

Source: Weber and Matthews, 2008; as shown in Portland Climate Action Plan, 2009.

COST-EFFECTIVENESS

Many groups can enjoy cost savings and enhanced income from the promotion of local, healthy foods. For example, the Chicago metropolitan area identifies three economic benefits of local food:[105]

[104] EWG Meat Eaters Guide, 2011.
[105] CMAP, Local Food System Benefits.

1) Keep Money Local: A 20% increase in local food could generate nearly RMB 16.8 billion (based on experience in the Chicago area).
2) Better Jobs and Income for Farmers: Farmer revenue for fresh market vegetables is 5 to 50 times higher than for commodity crops (soybeans, corn, grains). Production of fruit and vegetables yields three to seven times more jobs than corn or soybeans.
3) Support Local Businesses: Purchasing local food supports local businesses that process, distribute, and sell local food, as well as farmers. Local business owners in turn spend money in the community.

BARRIERS & CHALLENGES

Possible barriers encountered during the implementation of local agriculture and healthy food include: development of integrated transit include: Challenges posed by food safety, awareness and acceptance of high vegetable, low meat diet, as well as the desire for food diversity.

CASE STUDY

The city of Portland made Food and Agriculture a prominent component of their Climate Action Plan, with two main goals: (1) reduce consumption of carbon-intensive foods; and (2) significantly increase the consumption of local foods.[106] The city found that if residents shift away from meat and dairy to grains and vegetables, for just one day every week, the city could save carbon emissions equivalent to driving 10% less per year.[107]

Policy 6.2 Organic Agriculture, Safe Food

POLICY DESCRIPTION

Agriculture in China has become dominated by synthetic fertilizers, chemically produced from coal or natural gas in energy-intensive, highly polluting processes.[108] Excessive application of synthetic fertilizers has damaged land and water bodies, causing suffocation of rivers and lakes and red tides along the coast, due to excess nitrogen in agricultural run-off. Chemical pesticides and herbicides are also used extensively, but require high energy to produce and are extremely toxic to humans and

[106] Portland Climate Action Plan, 2009.
[107] Portland Climate Action Plan, 2009; Weber and Matthews, 2008.
[108] Zhou et al. 2010.

other life. A shift to organic agriculture can save energy and carbon emissions, while making food safe.[109]

Promote organic farming methods using bio-fertilizers, bio-pesticides, and integrated pest management. Reduce chemical fertilizers and chemical pesticides. Provide government subsidies to cover organic certification costs to organic farmers, and provide training and consulting services. Phase out subsidies to the chemical ammonia industry and transition those companies and workers to organic methods. Promote local production of organic composts as a substitute for chemical fertilizers. Divert organic waste to composting centers, thus offsetting nitrous oxide emissions from ammonia-based fertilizers and increasing soil health.[110]

STAKEHOLDERS

Organic agriculture involves coordination among: farmers; grocers; public agencies involved in agriculture, food purchasing, and food safety; schools and universities, to showcase organic gardens and to research organic methods.

CONDITIONS FOR IMPLEMENTATION

Promotion of organic agriculture requires partnerships among public agencies, farmers and business, and the public. Polluted and un-safe food must not be allowed to undercut organic and safe food.

ENERGY & CO_2 SAVINGS

Organic agriculture saves significant amounts of energy, restores health of the soil, provides jobs, and is safer for people and ecosystems. Using biological fertilizers and pest controls to replace or reduce synthetic chemicals yields a net decrease in fossil fuel use of 15-45%, accounting for differences in machinery needs and yields.[111] Organic agriculture also enhances uptake of carbon by soils by roughly 20%.[112] The combination of fossil fuel savings and carbon sequestration by improved soils could offset 20-40% of agricultural greenhouse gas emissions.[113] In China, where excessive application of fertilizer and pesticides is common, improving the efficiency of application would also realize energy and carbon savings.[114]

COST-EFFECTIVENESS

Profitability is nearly three times higher with organic farms compared to conventional farms, based on a 30-year study.[115] The same study found that organic yields are similar or greater, and leguminous cover crops can provide enough nitrogen to replace synthetic fertilizer. A review of 286 projects in 57 countries found that organic farming methods especially improve yields in developing

[109] Cao et al. 2010; Zhi and Gao, 2001.
[110] See the section on Waste Management in this booklet.
[111] Scialabba and Muller-Lindenlauf, 2010.
[112] Azeez, 2010; Scialabba and Muller-Lindenlauf, 2010.
[113] Azeez, 2010; Scialabba and Muller-Lindenlauf, 2010.
[114] Cao et al. 2010.
[115] Rodale Institute, 2011.

countries, as much as 79% more, after a three-year transition period for the soils to revive from chemical damage.[116] Organic agriculture thus provides multiple benefits for cities, saving energy and carbon, reducing pollution, providing more robust food supplies during extreme weather, and providing more jobs.[117]

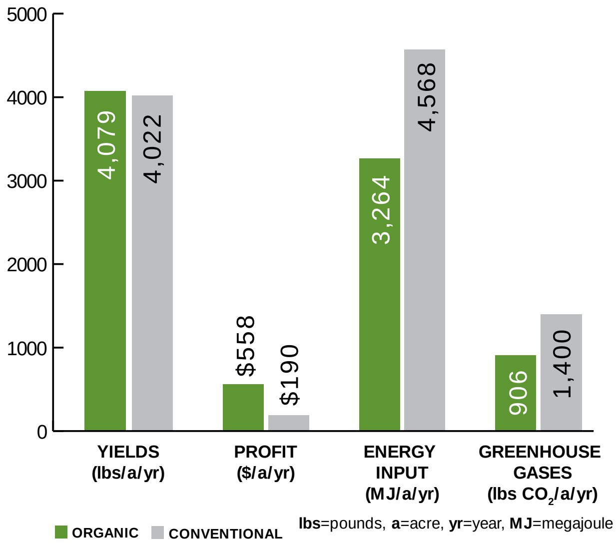

Figure 14. Comparison of Organic and Conventional Agriculture

Source: Rodale Institute, 2011.

BARRIERS & CHALLENGES

Possible barriers encountered during the implementation of organic agriculture and safe food include: credibility of organic food certification; impact on food production due to reduced or doing without pesticides or fertilizers; need coordination across agriculture and chemical industry to shift to bio-fertilizers.

CASE STUDY

The city of Havana, Cuba, shifted to urban organic agriculture when Cuba lost its supply of import oil. Within a few years, the city was supplying most of its produce with less than one-third of the oil formerly required. The entire country shifted from a heavy dependence on synthetic fertilizers and pesticides to nearly 80% organic agriculture. Local research led contributed to bio-fertilizers – including worm composting – and bio-pesticides, as well as multi-cropping methods. An accompanying change in diet, with more vegetables and fruits, less meat and starches, led to health improvement. This rapid transition to organic farming, with strong government support and allocation of land to food production, also led to increased jobs and incomes for farmers.[118]

[116] Seaman, 2011.
[117] Seaman, 2011.
[118] The Power of Community: How Cuba Survived Peak Oil. Documentary.

Policy 6.3 Urban Forestry: Protect & Clean

POLICY DESCRIPTION

Urban forests benefit a city in multiple ways, including energy and carbon saving. Trees provide shade and cooling in the hot summer, and buffer cold winds in the winter, saving energy in buildings year-long and off-setting the urban "heat-island" effect.[119] Trees create a more sheltered environment for pedestrians and bicyclists, encouraging non-motorized transport and public transport. Trees filter the air for greater health, reducing hospitalizations and lost work from respiratory illness. The air cleaning effect of trees also enables residents to open windows and dry laundry outside, saving more energy. Trees hold rainwater and reducing storm-water runoff, protecting a city's landscape and waterways, saving water and energy. As storms and weather extremes become more common with climate change, trees are even more valuable as protection for a city. Finally, trees take up carbon from the atmosphere, though this sequestration benefit is small compared to the other benefits of trees.

Provide programs and funding for maintaining existing urban trees, as well as planting new trees. Include urban forestry in development and construction plans. Employ knowledgeable arborists, landscape designers, and energy experts to plant the appropriate kinds of trees in the right places – for shading and shelter, for buildings and travelers, for schools and businesses, for ecosystem diversity. Create economic incentives for urban forestry by counting carbon sequestration from trees as a direct saving (offset) of carbon emissions.[120] Promote and protect larger stands of forest outside the city center, especially along riparian corridors, to achieve greater sequestration and protect the city's watershed. Cities and states, such as New York, San Francisco, and California, are including tree planting and forest maintenance programs as part of their climate action plans.[121] Engage and educate neighborhoods and businesses to maintain and protect local trees.

STAKEHOLDERS

Urban forests involve the city planning commission, city maintenance department, arborists, developers, health agencies, businesses, schools, and neighborhoods.

[119] U.S. Forest Service, 2008.
[120] CCAR, 2010.
[121] For example, see CAT, 2006; CARB 2008.

CONDITIONS FOR IMPLEMENTATION

Planting trees isn't enough; they must be given good soil, watered, protected from pests, and trimmed as needed. City budgets should include funds for ongoing maintenance. Development plans must include protection and expansion of urban forests. Engaging and educating the public can help to reduce costs and ensure viability of the trees. Carbon trading programs can also help to add value to urban forests, by counting the carbon sequestration provided by the trees.

ENERGY & CO_2 SAVINGS

Protocols are available to estimate the direct carbon savings from urban trees through carbon sequestration, as well as indirect savings. For example, the California Climate Action Registry has a protocol for sequestration benefits,[122] while the Tree Carbon Calculator (CTCC) developed by the Urban Ecosystems and Processes Team of the U.S. Forest Service estimates both direct and indirect savings.[123] Carbon sequestration in urban trees varies from 16 kg/year per tree for small, slow-growing trees, to 270 kg/year for larger trees.[124] Urban forest in the city of Portland currently covers 26 percent of the city and removes 88,000 metric tons of CO2 from the atmosphere per year, equivalent to about one percent of local carbon emissions.[125]

The indirect savings of energy, carbon, and money from trees includes those from shading and insulation and natural ventilation. These indirect savings from urban trees can reduce summer cooling demand from 8-43%.[126] In regions with cold winters and hot summers, overall indirect carbon savings were 3-15% from shading, evapotranspiration, and wind speed reduction on residential buildings, depending on the electricity generation mix and the positioning of tree cover.[127] Difficult to quantify are the additional benefits of cleaner air for clothes drying, and encouraging non-motorized transit with tree-protected pathways.

COST-EFFECTIVENESS

Indirect benefits should be taken into account as well as direct carbon savings in determining cost effectiveness of urban tree planting and maintenance. Note that direct carbon savings (through sequestration) are relatively small compared to other low-carbon policy actions (such as industrial or building efficiency improvements), and the sequestration-only cost-effectiveness is low. However, the indirect energy savings and health benefits from urban trees make them highly valuable.

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[122] CCAR 2010.
[123] U.S. Forest Service Tree Carbon Calculator; SMUD Tree Benefit Estimator.
[124] U.S. Forest Service, 2008.
[125] Portland Climate Action Plan, 2009.
[126] U.S. Forest Service, 2008.
[127] Jo and McPherson, 2001. In cold climates, plant trees densely on the north side of buildings, close to the west wall, and avoid on the south wall.

BARRIERS & CHALLENGES

Possible barriers encountered during the design and implementation of urban forestry include: desired level of bio-diversity and choice of tree types; need devoted budget; limited supply of vacant lot inside cities.

CASE STUDY

In New York City, trees are seen as an economic asset and local laws make it illegal destroy or damage any tree on a street or park or public land. In 2007, the city launched MillionTreesNYC with the goal of planting and sustaining one million additional urban trees. As part of the New York Restoration Project, the city included a "Trees for Public Health" program, targeting 60,000 of the trees for six neighborhoods with high asthma hospitalization rates among children and limited street trees.[128] The remainder of the trees will provide shading, wind breaks, and protection along water ways.

The city of Portland has set a goal to cover one-third of the city with an urban forest canopy. The city emphasized trees along water ways, since resilient watersheds are needed in response to changing climate. Portland set a related goal that at least 50% of total stream and river length in the city meet urban water temperature goals, as an indicator of watershed health.[129]

Figure 15. Urban Forestry in Cool Climates.

Source: Chicago Metropolitan Agency for Planning

Policy 6.4 Urban Green Spaces

POLICY DESCRIPTION

Urban green spaces—on the ground and on roof-tops—are essential for energy and carbon savings across multiple initiatives in a city's low-carbon development plan. Green spaces also enable a city to better adapt to changing climate, by providing cool spaces, off-setting the urban heat island effect,

[128] New York City, PlaNYC Update, 2011.
[129] Portland Climate Action Plan, 2009.

buffering against storms and gathering rainwater, reducing air pollution, and growing plants suited to an altered climate.[130]

Increase the amount of per capita green space, including parks, open public spaces, green preserves along water corridors, greenways connecting parks and preserves, and roof-top gardens. Set goals for public access to green space—every resident within 15 minutes of a park. Recognize parks and preserves as "green infrastructure," protecting the city's transport systems, water and flood protection systems, buildings, and biodiversity. Include investment for managing, restoring, and expanding green space. Encourage roof-top green spaces, for gardens, rainwater management, and energy saving.

STAKEHOLDERS

Promotion and protection of urban green space involves cooperation among city government, developers, businesses, and the public.

CONDITIONS FOR IMPLEMENTATION

Green space must be protected. Include a green space requirement for developments, along with restoration and maintenance requirements in permitting and land-use contracts. Green spaces must be connected:

> *No single park, no matter how large and how well designed, would provide citizens with the beneficial influences of nature; instead parks need to be linked to one another and to surrounding residential neighborhoods. —Frederick Law Olmsted*

ENERGY & CO_2 SAVINGS

Green spaces are "green infrastructure," providing live-ability and buffering of the urban heat-island effect, reducing the need for building cooling and heating. Green spaces create more permeable surfaces, for better management of storm-water runoff, protecting a city's infrastructure, which saves energy and carbon. Green spaces enable non-motorized transport and public transportation, reducing emissions from the transportation sector. Roof-top green spaces provide insulation for buildings, reducing energy demand for heating and cooling. Energy savings of 40-75% have been achieved with roof-top green space, depending on the location's climate and the type of green roof.[131]

COST-EFFECTIVENESS

From Chicago to New York, cities recognize that green spaces, specifically access to parks and open spaces, improve public health, increase the value of real estate, and attract businesses to the regional economy.[132] The direct energy and carbon savings may be small, but green spaces enable

[130] Chicago Climate Action Plan, 2008, section on Adaptation.
[131] NREL and U.S. DOE, 2004; greenbiz.com News, 2010.
[132] See, for example, CMAP, Go To 2040.

large indirect benefits. While costs and savings are difficult to quantify, the multiple benefits of green spaces as "green infrastructure" likely contribute net economic savings for a city.

BARRIERS & CHALLENGES

Possible barriers encountered during the design and implementation of urban green spaces include: need funding and professional staff for protection and maintenance of green spaces; need to address competing land uses, to reserve land for land for green spaces.

CASE STUDY

PlaNYC has the goal of putting all New Yorkers within a 10-minute walk of a park. New York thus far has more than 52,000 acres of City, state and federal parkland, covering 25% of the city's area.[133] The Brooklyn waterfront facing Manhattan has been revitalized with a greenway, playground, outdoor dining, and wetlands. One of the most innovative parks in the city is the High Line, which turned an abandoned elevated freight rail line into a Manhattan highlight.[134] This above-ground park saved energy and carbon by re-purposing old transport infrastructure, transforming it into a public gathering space and a living work of art. See Figure 16 Figure 17 for before and after views of the High Line. As another example, roof-top green space on the large New York Postal Service facility in Manhattan is saving 40% of energy demand and reducing polluted storm water by 75% in summer and 40% in winter.[135]

Figure 16. Before the High Line: unused elevated railway, 18th Street looking north

Source: thehighline.org

Figure 17. After the High Line: an urban oasis

Source: Stephanie Ohshita

[133] PlaNYC Update April 2011.
[134] See: thehighline.org
[135] greenbiz.com News, 2010.

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