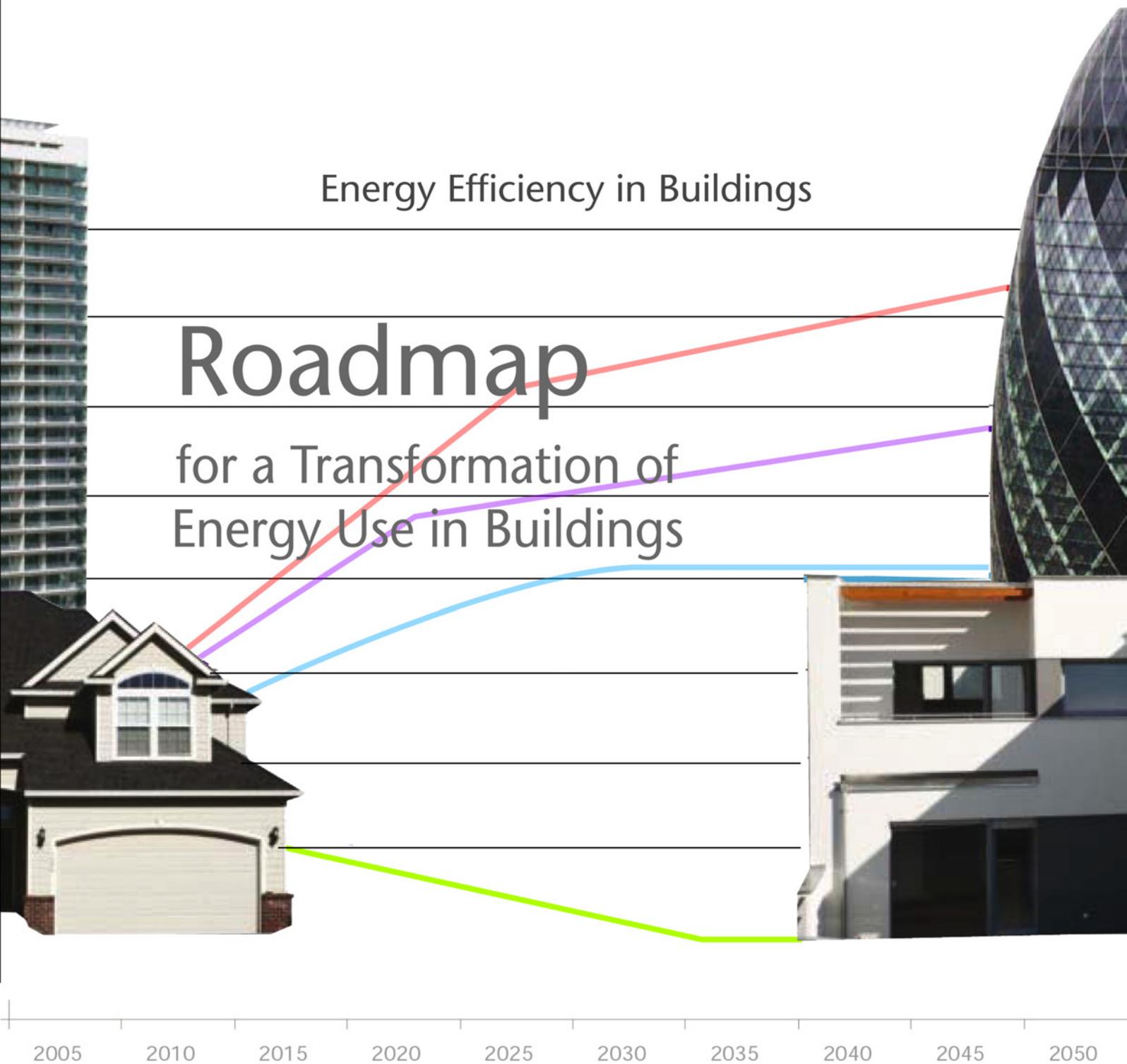


## Energy Efficiency in Buildings

# Roadmap for a Transformation of Energy Use in Buildings



# Introduction to the Roadmap

## for a Transformation of Energy use in Buildings

To achieve an energy-efficient world, governments, businesses and individuals in their private and professional lives must transform the building sector, which today accounts for 40% of the world's energy use. A multitude of actions are necessary to aggressively reduce energy consumption in new and existing buildings. This roadmap sets out the key actions in the short and medium term for the seven groups who can contribute to meeting this challenge, ranging from investors to government authorities.

The roadmap has been developed by the Energy Efficiency in Buildings (EEB) project of the World Business Council for Sustainable Development (WBCSD). It is designed to put into practice EEB recommendations, which are based on four years of extensive research.

EEB recommends a mix of measures tailored to specific geographies and building subsectors, including increased energy awareness globally. Recommendations cover building energy codes, labeling and reporting mechanisms, appropriate energy prices and carbon costs, investment subsidies, increased and trained workforce capacity, and evolving energy-efficient designs and technologies using passive and active approaches. EEB concluded that the necessary changes cannot and will not come through market forces alone.

This document is the printed version of the roadmap and is an addendum to the main report: "Transforming the Market". An interactive roadmap is available on the CD Rom that can be found in the report or on the WBCSD website ([www.wbcSD.org/web/eeb-roadmap.htm](http://www.wbcSD.org/web/eeb-roadmap.htm)).

### Acknowledgements

This roadmap was developed by representatives of the project's 14 Core Group companies and the WBCSD.



### Disclaimer

This publication is released in the name of the WBCSD. Like other WBCSD publications, it is the result of a collaborative effort by members of the secretariat and senior executives from member companies. A wide range of members reviewed drafts, thereby ensuring that the document broadly represents the majority view of the WBCSD membership. It does not mean, however, that every member company agrees with every word.

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Government authorities

Government authorities		Short Term Actions	Medium Term Actions	2050 Goals
Control & regularity instruments	Building energy codes	<ul style="list-style-type: none"> <li>- Introduce mandatory codes for new and existing buildings</li> <li>- Tighten requirements over time</li> <li>- Incentivize rapid adoption by state and local governments</li> </ul>	<ul style="list-style-type: none"> <li>- Accelerate the strengthening of codes</li> <li>- Establish codes to request zero net energy for new buildings</li> </ul>	<ul style="list-style-type: none"> <li>- Building energy codes for new and existing buildings are stringent and enforced</li> </ul>
	Appliance standards	<ul style="list-style-type: none"> <li>- Develop and update appliance standards and labeling with suppliers</li> <li>- Create common standards to facilitate data flow between appliances and utilities</li> </ul>	<ul style="list-style-type: none"> <li>- Tighten requirements on energy performance over time and address all plug loads</li> </ul>	<ul style="list-style-type: none"> <li>- Appliance energy use is minimized</li> <li>- Standards are stringent, enforced and drive improvement</li> <li>- Information flows freely between utilities and appliances</li> </ul>
	Energy performance labeling & measurement	<ul style="list-style-type: none"> <li>- Expand coverage of labeling regulations (e.g. EU Energy Performance Certificates)</li> <li>- Define and enforce common energy use measurement systems that include kWh/m<sup>2</sup>.year, total kWh and kWh/person.year</li> </ul>	<ul style="list-style-type: none"> <li>- Mandate energy label in every country</li> <li>- Develop "carrot and stick" measures based on label</li> <li>- Mandate retrofit or replace poor performing buildings based on label and actual energy use</li> </ul>	<ul style="list-style-type: none"> <li>- Labels set conditions for subsidies and other benefits or constraints, driving the uptake of low-energy buildings</li> </ul>
	Energy performance audits	<ul style="list-style-type: none"> <li>- Introduce energy performance inspections into health and safety procedures for existing commercial buildings</li> <li>- Train inspectors and carry out labeling of existing building stock</li> <li>- Introduce energy audits for new buildings (like structural checks)</li> </ul>	<ul style="list-style-type: none"> <li>- Carry out regular inspections in commercial buildings</li> <li>- Carry out energy audit of all existing buildings</li> </ul>	<ul style="list-style-type: none"> <li>- All buildings have been audited</li> <li>- Regular audits are mandatory</li> <li>- Energy audits are recognized and accurate</li> </ul>
	Metering	<ul style="list-style-type: none"> <li>- Mandate individual metering and controls in multi-tenant residential buildings, offices and shops</li> </ul>	<ul style="list-style-type: none"> <li>- Inspect metering and controls for compliance</li> </ul>	<ul style="list-style-type: none"> <li>- All residential and commercial units have individual metering and controls</li> </ul>
	Procurement regulation	<ul style="list-style-type: none"> <li>- Set fast-track applications for low-energy buildings</li> <li>- Set energy performance as a selection criterion in public procurement</li> </ul>	<ul style="list-style-type: none"> <li>- Ensure that energy efficiency is a key consideration in all purchases by the government</li> </ul>	<ul style="list-style-type: none"> <li>- Not applicable if proposed codes and regulations are enforced</li> </ul>
	Legal	<ul style="list-style-type: none"> <li>- Create empowered body to remove legal constraints that hamper energy retrofits (e.g. voting rights, envelope ownership, allow new building lines for insulation, etc.)</li> </ul>	<ul style="list-style-type: none"> <li>- Body to implement changes in the legal framework</li> </ul>	<ul style="list-style-type: none"> <li>- Legal barriers to energy efficiency are removed</li> </ul>





## Government authorities

Government authorities		Short Term Actions	Medium Term Actions	2050 Goals
Economic & market-based instruments	Utilities	<ul style="list-style-type: none"> <li>- Create mechanism to reward utilities for end-user energy savings</li> </ul>	<ul style="list-style-type: none"> <li>- Refine and expand reward-based energy-efficiency mechanisms</li> </ul>	<ul style="list-style-type: none"> <li>- Utilities have included end-user energy savings in their business model</li> </ul>
	Institutional Investors	<ul style="list-style-type: none"> <li>- Set targets on real estate portfolio based on energy performance for pension funds and other large investors and property owners</li> </ul>	<ul style="list-style-type: none"> <li>- Tighten targets over time</li> <li>- Control targets compliance</li> </ul>	<ul style="list-style-type: none"> <li>- Institutional investors demand energy-efficient buildings</li> </ul>
	Urban Planning	<ul style="list-style-type: none"> <li>- Set new rules that incentivize energy-efficient developments (ie. vary density depending on building energy performance)</li> </ul>	<ul style="list-style-type: none"> <li>- Identify best practices and promote their use on a regular basis</li> </ul>	<ul style="list-style-type: none"> <li>- New zero net energy buildings replace existing inefficient buildings</li> </ul>
Fiscal instruments & incentives	Capital subsidies, grants, subsidized loans, taxes, etc.	<ul style="list-style-type: none"> <li>- Introduce direct subsidies on first cost only for holistic retrofit packages</li> <li>- Grant tax exemptions based on a building's energy performance improvement</li> <li>- Incentivize renewable energy solutions for communities</li> <li>- Incentivize best available technologies to promote innovation and performance</li> </ul>	<ul style="list-style-type: none"> <li>- Subsidize zero net energy new buildings and renovation projects</li> <li>- Introduce a carbon price as a means to fund subsidies of energy-efficient new buildings</li> <li>- Use sustained price signals on energy to increase the amount of financially justified efficiency investments</li> </ul>	<ul style="list-style-type: none"> <li>- Financial support and penalties are linked to actual energy performance and improvements</li> <li>- Poor performing buildings are replaced by new zero net energy buildings</li> </ul>
	Research & development	<ul style="list-style-type: none"> <li>- Subsidize R&amp;D programs for new designs, technologies and materials for energy savings and support the transition from late-stage R&amp;D to commercialization</li> </ul>	<ul style="list-style-type: none"> <li>- Maintain subsidies as needed to achieve significant cost and performance improvements of the most promising technologies</li> </ul>	<ul style="list-style-type: none"> <li>- R&amp;D delivers high performing and affordable material and equipment that enable zero net energy buildings</li> </ul>
Support, information, & voluntary action	Tenant behavior	<ul style="list-style-type: none"> <li>- Property tax reduction for energy-efficient behavior compared to building label's expected performance</li> </ul>	<ul style="list-style-type: none"> <li>- Incentivize tenants to request energy saving investments from owners</li> </ul>	<ul style="list-style-type: none"> <li>- Tenants are more aware and reduce their energy consumption</li> </ul>
	Education & training of professionals & the general public	<ul style="list-style-type: none"> <li>- Launch extensive training programs for professionals</li> <li>- Communicate energy usage and performance information for all public buildings</li> <li>- Launch sustained information campaigns on energy use and savings in buildings</li> </ul>	<ul style="list-style-type: none"> <li>- Introduce energy awareness courses in education programs</li> </ul>	<ul style="list-style-type: none"> <li>- A new energy-aware culture exists among professionals and citizens</li> </ul>





## Investors

	Short Term Actions	Medium Term Actions	2050 Goals
Education, training & communication	<ul style="list-style-type: none"> <li>- Take part in the education and training effort on energy efficiency</li> <li>- Voluntarily adhere to globally recognized principles or codes of conduct</li> <li>- Transparently report on energy efficiency practices</li> <li>- Actively engage owners/fund managers in dialogue around energy efficiency</li> </ul>	<ul style="list-style-type: none"> <li>- Publicly share best practices</li> </ul>	<ul style="list-style-type: none"> <li>- Investors understand and value energy efficiency</li> </ul>
Specifications	<ul style="list-style-type: none"> <li>- Evaluate risks using broader measures such as energy price/availability, climate change, regulation</li> <li>- Add energy efficiency metrics and goals to investment practices</li> <li>- Explicitly require disclosure of energy efficiency strategies</li> <li>- Rank potential investments based on expected performance</li> <li>- Target fixed income investments in securities that address energy efficiency</li> </ul>	<ul style="list-style-type: none"> <li>- Actively seek creation of securities (new constructions or energy-efficient retrofits) backed by certified energy-efficient buildings or cash flow from energy savings</li> </ul>	<ul style="list-style-type: none"> <li>- Investors include energy efficiency as a key criteria in their specifications</li> </ul>
Asset portfolio	<ul style="list-style-type: none"> <li>- Carry out energy audits of all assets to identify energy savings</li> <li>- Review portfolio exposure to climate change-associated regulatory, reputation and environmental risk</li> <li>- Set energy performance targets on owned/managed buildings</li> <li>- Explicitly incorporate energy-efficiency goals into portfolio</li> <li>- Evaluate investments on the basis of risk/return vs. cost/return</li> </ul>	<ul style="list-style-type: none"> <li>- Tighten targets on number of owned/managed buildings based on their energy performance</li> <li>- Increase performance standards for owned/managed building operations and performance</li> </ul>	<ul style="list-style-type: none"> <li>- Investors have full information about energy performance of managed/owned assets</li> <li>- Investors demand zero net energy buildings</li> </ul>
Finance	<ul style="list-style-type: none"> <li>- Include energy performance in property valuation</li> <li>- Use financial institutions that have energy-efficiency retrofit lending programs</li> <li>- Use energy-efficiency analysis to enhance decision-making</li> <li>- Target investment funds that focus on energy efficiency</li> <li>- Model risk/returns with first costs, O&amp;M costs, and valuation based on supply/demand, design, quality &amp; brand</li> </ul>	<ul style="list-style-type: none"> <li>- Adopt life cycle cost approach to investment decisions</li> <li>- Assign value to energy efficiency through financial mechanisms and funding sources</li> </ul>	<ul style="list-style-type: none"> <li>- Investors include energy in their business model</li> </ul>





## Developers

	Short Term Actions	Medium Term Actions	2050 Goals
Education, training & communication	<ul style="list-style-type: none"> <li>- Take part in the education and training effort needed to promote energy savings for owners, users &amp; facility managers</li> <li>- Communicate energy performance targets of new developments</li> </ul>	<ul style="list-style-type: none"> <li>- Publicly share best practices</li> </ul>	<ul style="list-style-type: none"> <li>- Developers understand and value energy-efficiency and include it in projects as standard practice</li> </ul>
Finance	<ul style="list-style-type: none"> <li>- Address split incentive problem by engaging with new tenants to share cost and benefits of energy savings investments</li> <li>- Adopt life cycle cost approach when making design decisions</li> <li>- Demand preferred financial conditions from capital providers for near zero net energy new developments</li> </ul>	<ul style="list-style-type: none"> <li>- Demand preferred financial conditions from capital providers for near zero net energy refurbishments</li> </ul>	<ul style="list-style-type: none"> <li>- Developers have financial interest to develop energy-efficient buildings</li> </ul>
Specifications	<ul style="list-style-type: none"> <li>- Set ambitious energy performance target as primary design goal</li> <li>- Require the use of energy management systems and individual metering</li> </ul>	<ul style="list-style-type: none"> <li>- Tighten targets for building operations and performance</li> <li>- Use Integrated Design Contract (IDC) tender format with emphasis on energy performance requirements</li> </ul>	<ul style="list-style-type: none"> <li>- Developers include ambitious energy-efficiency targets as primary design goals</li> </ul>
Procurement	<ul style="list-style-type: none"> <li>- Restructure contractual terms to encourage early contractor involvement as part of the design team</li> <li>- Base design team fee structure and incentives on successful energy performance</li> </ul>	<ul style="list-style-type: none"> <li>- Introduce specific decision-making process on all components that affect operational energy use</li> </ul>	<ul style="list-style-type: none"> <li>- Developers include ambitious energy-efficiency targets in their procurement process</li> </ul>





## Occupiers

	Short Term Actions	Medium Term Actions	2050 Goals
Education, training & communication	<ul style="list-style-type: none"> <li>- Require information on energy performance through voluntary certification systems and programs</li> <li>- Seek training in how to operate one's building(s)</li> </ul>	<ul style="list-style-type: none"> <li>- Acceptance of new energy-efficiency features, including those that affect appearance</li> </ul>	<ul style="list-style-type: none"> <li>- Building occupants fully comprehend and value energy efficiency</li> </ul>
Behavior & mindset	<ul style="list-style-type: none"> <li>- Raise demand for high-performing buildings</li> <li>- Recognize personal behavior as the first step towards reducing energy usage</li> <li>- Develop energy-aware culture and respond to information about personal behavior and effect on energy usage</li> </ul>	<ul style="list-style-type: none"> <li>- End-users recognize change in demand</li> </ul>	<ul style="list-style-type: none"> <li>- Occupiers are at the origin of a new energy-aware culture</li> </ul>





## Utilities

	Short Term Actions	Medium Term Actions	2050 Goals
Education, training & communication	<ul style="list-style-type: none"> <li>- Stimulate customers to save energy by launching information and sustained advertising campaigns and by providing advice</li> <li>- Take part in the education and training effort needed to promote energy savings and efficiency</li> </ul>	<ul style="list-style-type: none"> <li>- Regularly survey customers and craftsmen to understand their proficiency and information needs</li> <li>- Reinforce current knowledge and deliver new information on a regular basis</li> </ul>	<ul style="list-style-type: none"> <li>- Utilities promote a new energy-aware culture among customers and other stakeholders</li> </ul>
Distribution & Supply	<ul style="list-style-type: none"> <li>- Develop smart meters for improving knowledge of final energy use</li> <li>- Transition to smart electricity grid using digital technology to save energy</li> </ul>	<ul style="list-style-type: none"> <li>- Provide customers with smart solutions to promote energy efficiency</li> <li>- Develop smart boxes to manage energy use of equipment</li> <li>- Integrate more local renewable energy with centralized low-carbon energy systems where possible</li> </ul>	<ul style="list-style-type: none"> <li>- Utilities manage existing smart grids</li> </ul>
Commercial offer	<ul style="list-style-type: none"> <li>- Set tariffs to incentivize energy savings</li> <li>- Launch offers for audits, technical and financial support</li> <li>- Develop Energy Performance Contracting</li> <li>- Develop financing schemes linked to energy savings</li> </ul>	<ul style="list-style-type: none"> <li>- Maintain successful commercial offers and adjust them to the changing customer needs</li> </ul>	<ul style="list-style-type: none"> <li>- Commercial offer and pricing rewards energy savings</li> </ul>
Demand-side management	<ul style="list-style-type: none"> <li>- Incorporate tools to allow local feedback to end users on consumption and expenses</li> </ul>	<ul style="list-style-type: none"> <li>- Integration of technology to allow information transfer between equipment and systems</li> <li>- Allow metering and bi-directional utility power flow</li> </ul>	<ul style="list-style-type: none"> <li>- Peak demand is better managed</li> <li>- Smart grid optimizes energy flow</li> </ul>
Energy mix	<ul style="list-style-type: none"> <li>- Make energy generation evolve toward lower carbon content</li> <li>- Invest in renewable energy solutions for buildings</li> </ul>	<ul style="list-style-type: none"> <li>- Execute strategy for lowering carbon content of existing generation and bringing clean generation assets online</li> </ul>	<ul style="list-style-type: none"> <li>- Energy mix has lowest possible carbon content</li> <li>- Suppliers use smart boxes to match final energy consumption with a "greener" energy mix (direct load control)</li> </ul>





## Suppliers and Manufacturers

	Short Term Actions	Medium Term Actions	2050 Goals
Education, training & communication	<ul style="list-style-type: none"> <li>- Provide contractors and end-users with training and operations support</li> </ul>	<ul style="list-style-type: none"> <li>- Ensure all customers receive and understand information and training</li> <li>- Simplify products where feasible to lower the skill level necessary for use</li> </ul>	<ul style="list-style-type: none"> <li>- Suppliers understand the crucial role they play in developing an energy-aware customer</li> </ul>
Appliance standards	<ul style="list-style-type: none"> <li>- Develop international definitions, standards and metrics</li> <li>- Cooperate with government authorities to create appliance standards and labels</li> </ul>	<ul style="list-style-type: none"> <li>- Adopt standards in all countries</li> <li>- Continue to advocate higher standards as technology capabilities allow</li> </ul>	<ul style="list-style-type: none"> <li>- International standards in place for “smart” appliances fully compatible with information communication technologies (ICT) solutions</li> </ul>
Marketing	<ul style="list-style-type: none"> <li>- Develop marketing campaigns to promote buildings’ energy performance rather than single components</li> <li>- Revisit equipment pricing in line with energy efficiency</li> </ul>	<ul style="list-style-type: none"> <li>- Sustain awareness throughout customer base with clear product labeling</li> </ul>	<ul style="list-style-type: none"> <li>- Suppliers and government authorities promote energy-efficiency message in customer communications</li> </ul>
Research & Development	<ul style="list-style-type: none"> <li>- Increase efficiency of current equipment</li> <li>- Develop economical new technologies and applications to support zero net energy buildings</li> <li>- Integrate technology to allow information transfer between equipment &amp; systems</li> <li>- Provide tools to allow local feedback to end users on consumption and cost</li> </ul>	<ul style="list-style-type: none"> <li>- Phase out low performing equipment</li> <li>- Incorporate new technologies into product lines for common use</li> <li>- Bring to market metering and controls to manage energy efficiency</li> </ul>	<ul style="list-style-type: none"> <li>- Suppliers provide market with affordable, next generation energy-efficient solutions</li> <li>- Continuous improvement culture in place</li> </ul>





Architects, engineers,  
contractors, craftsmen

	Short Term Actions	Medium Term Actions	2050 Goals
Education, training & communication	<ul style="list-style-type: none"> <li>- Enroll in energy-efficiency training</li> <li>- Include energy efficiency in educational programs and training for owners and occupiers</li> <li>- Reward those who attain a high level of proficiency</li> <li>- Provide voluntary certifications for projects to promote energy-efficient constructions and use</li> </ul>	<ul style="list-style-type: none"> <li>- Support continuing education on energy efficiency, eventually making it an essential job requirement or performance criterion</li> </ul>	<ul style="list-style-type: none"> <li>- Designers and contractors implement energy efficiency as a standard practice</li> </ul>
Design process	<ul style="list-style-type: none"> <li>- Apply common measurement system</li> <li>- Adopt an integrated design process with design team</li> <li>- Promote energy-efficient design and technologies</li> <li>- Incorporate ICT into design and construction process</li> <li>- Consider energy performance-based fee structure</li> </ul>	<ul style="list-style-type: none"> <li>- Adopt Integrated Design Contract (IDC) format with emphasis on energy performance requirements</li> </ul>	<ul style="list-style-type: none"> <li>- Zero net energy designs are the norm</li> </ul>
Design	<ul style="list-style-type: none"> <li>- Develop holistic design approaches for energy use</li> <li>- First, use passive design measures to reduce energy demand</li> <li>- Develop energy-efficient design solutions for retrofits</li> <li>- Implement energy efficiency in all new constructions</li> <li>- Plan local energy production to minimize grid energy where sensible</li> <li>- Design buildings for flexible use</li> </ul>	<ul style="list-style-type: none"> <li>- Adopt new, available, efficient technologies and design</li> </ul>	<ul style="list-style-type: none"> <li>- Know-how on zero net energy buildings is widely applied across the sector</li> </ul>

Architects, engineers, contractors, craftsmen

