ICCA Building Technology Roadmap

The Chemical Industry's Contributions to Energy and Greenhouse Gas Savings in Residential and Commercial Construction

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INTERNATIONAL COUNCIL OF CHEMICAL ASSOCIATIONS

Executive Summary

According to the International Energy Agency's Energy Technology Perspectives 2012 report, the building sector is directly or indirectly responsible for about 32% of global energy consumption and for 26% of global total end-use energy-related carbon dioxide (CO_2) emissions. Huge amounts of energy – over 970 million tonnes of oil equivalent in 2009 - are required for space heating and space cooling in the global building stock due to heat gains and losses from building envelopes. The energy requirements and associated greenhouse gas (GHG) emissions are substantial in cold and hot climates alike. Overarching climate goals (reduction of GHG emissions by 80 to 95% by 2050) can only be reached with major contributions from the building sector.

The Chemical Industry is indispensable in providing solutions that increase energy efficiency in buildings and pave the way towards the near-zero energy buildings of the future. Many effective chemical industry products – including a range of energy efficient plastics – are already available and in wide use today and new and better technologies are constantly being developed. In this analysis, the potential energy and GHG savings due to use of chemically derived building products are projected out to 2050. The analysis focuses on building stock in Europe, Japan, and the U.S. The report also includes a brief analysis of growing build stock in emerging economies, including Brazil, China and India.

The amount of residential and commercial building stock in Europe, Japan, and the U. S. is projected to increase from 59 billion square meters in 2000 to 93 billion square meters in 2050. With this growth in building stock, energy use for building heating, cooling, and water heating would increase by almost 60% and GHG emissions would rise from 3,400 million metric tonne carbon dioxide equivalent ($MtCO_2e$) in 2000 to 5,200 $MtCO_2e$ in 2050 if no improvements were made to the energy efficiency of new and existing buildings.

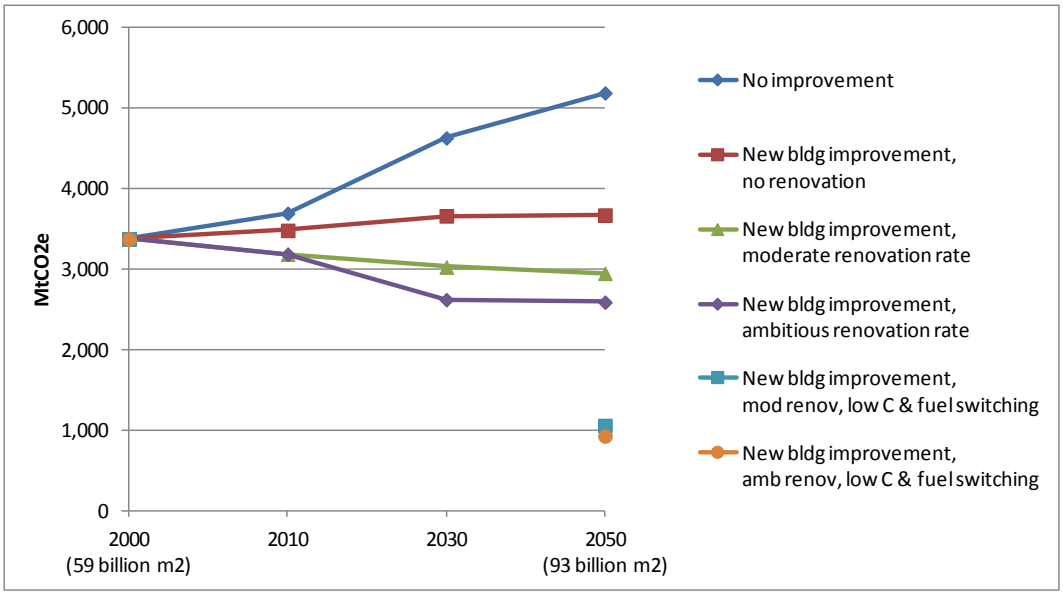
Improvements in new stock and gradual removal of older, less efficient stock are not enough to offset the growth in stock. Although tightened standards for new construction would hold the increase in GHG to 300 $MtCO_2e$ from 2000 to 2050, this is still a net increase of nearly 10% in building sector GHG emissions. In order to achieve net reductions in building energy use and associated GHG emissions while building stock increases, the energy efficiency of the large existing stock of residential and commercial buildings must also be improved. **Combining better energy efficiency standards for new buildings with a moderate rate of renovation of 2000 building stock would result in a 12% decrease in energy and GHG by 2050, while tighter new building standards combined with a more ambitious renovation rate could result in a 23% reduction in energy use and GHG compared to 2000.** [1]

The savings projections described above are due solely to improvements in energy efficiency of the building envelope and hot water piping. When these improvements are combined with projected shifts to lower carbon fuels, including decarbonization of electricity through carbon capture and storage and greater use of renewable fuels, the GHG reductions in 2050 decrease by about 70% from 2000 levels.

Executive Summary 1 shows the changes in GHG emissions for the different future scenarios.

[1] Renovation rates per decade by region and building type for the moderate and ambitious scenarios are described in Chapter 1. Savings are based on renovations improving the energy efficiency of the building envelope to 70% of the efficiency of new buildings in each decade.

Executive Summary 1. Potential GHG Scenarios for Growth in Building Stock from 2000 to 2050 (combined residential and commercial building stock in Europe, Japan, and the U.S.)



The figure above illustrates the GHG emissions results for use of all types of wall and roof insulation, hot water piping materials, air barriers and air sealing materials, cool roofing, and windows used to improve building energy efficiency, by chemically derived, as well as alternative products in these categories. In 2050, the amount of GHG savings attributed to the value chain for chemically-derived building products (insulation, piping, air barriers and sealing materials, cool roof coatings and pigments) is based on their expected market shares by decade. **By 2050, the GHG savings attributed to these products is 970 ($MtCO_2e$) for the moderate renovation rate and over 1,100 $MtCO_2e$ for the ambitious renovation rate. Use of energy efficient plastic-frame windows adds another 300 to 370 $MtCO_2e$ of GHG savings,** where the chemically derived content of the window assembly plays a major role for to the overall performance of the window.

Over time, the emission savings realized by the users of chemically derived building products are many times greater than the energy and GHG impacts for their production. The products continue to accrue use phase savings throughout their life in the building. **By 2050, the cumulative net GHG savings (use phase savings minus production impacts) for the chemically-derived building products installed in the buildings from 2000 and 2050 could be 30,000 $MtCO_2e$ for Europe, Japan, and the U.S.**[2]

Clearly, products from the chemical industry play a vital role in achieving substantial energy and GHG reductions for the building sector.

The chemical industry has already made great strides in providing energy efficient solutions to the building sector, and continues to advance acceptance and use of energy efficient building products through efforts such as:

- Participating in projects that demonstrate how low energy houses, passive houses and zero emission buildings are realistically achievable and cost effective over time for society and the individual investor alike;
- Sponsoring life cycle assessment studies to provide credible, science-based data quantifying the net energy and GHG benefits over the full life cycle of chemically derived building technologies;
- Continuing to invest in research and development of new and improved products that achieve higher levels of energy efficiency over longer lifetimes, leading to greater GHG savings;
- Cooperating with the value chain – from architects to craftsmen – with the objective of ensuring proper use and installation of energy efficient building products.

[2] See **Error! Reference source not found.**in Chapter 4.

In addition to the chemical industry's own activities, it is critically important that other stakeholders such as governments, policymakers, institutions, associations and buildings energy efficiency value chain also take actions needed to ensure that the full potential of energy saving building technologies are realized. These actions include:

- Ensuring that the regulatory environment and building codes support inclusion and enhanced deployment of energy-efficient chemically-derived technologies;
- Providing incentives needed to increase renovation rates and foster new technologies;
- Utilizing international forums as a platform to harmonize building standards, exchange key information resources, and facilitate dialogue between policy makers, industry experts, and other stakeholders regarding energy efficient buildings;
- Creating greater awareness of the economic and social benefits of high energy efficiency in buildings through collaborative efforts of governments, industry, institutions, and associations.

Working together, stakeholders can achieve the vision of a built environment that meets the needs of occupants worldwide in all types of geographic and climate zones while at the same time minimizing global warming impacts to ensure a sustainable future.

Foreword

Through the development of new, innovative products and more efficient technologies, the chemical industry is playing an important role in addressing challenges related to energy and GHG savings, at national, regional and international levels. In 2009, ICCA published a study entitled *Innovation for Greenhouse Gas Reductions: A life cycle quantification of carbon abatement solutions enabled by the chemical industry,* which analyzed the chemical industry's role in reducing GHG emissions across a wide range of industry sectors.

The ICCA Buildings Technology Roadmap report focuses on the chemical industry's contributions to energy and GHG savings in the buildings sector, including the benefits of high performance plastic foam insulation, plastic pipe and pipe insulation, reflective roofing, products and materials used to reduce energy loss due to air infiltration and heat loss, and chemically-derived components of energy-efficient windows. The objective of this report is to provide thorough, credible, scientifically based analyses that quantify the net benefits of the production and deployment of chemically derived building products. Industry and regulators can use this information to guide decisions and actions needed to achieve the substantial reductions in global warming impacts that are possible through greater use of chemically-based building products.

While use of chemically-derived products enables significant reductions in energy requirements for building space conditioning energy and associated GHG emissions, it is also important to consider the global warming impacts associated with the manufacturing of chemical products, extending all the way back to raw material extraction. The analyses in this report show that the emissions reductions attributed to the use of chemically derived building products far exceed the amount of GHGs emitted during their production, resulting in large net GHG savings over the useful life of the products.

ICCA would like to thank **Franklin Associates, A Division of ERG**, for their role in overall management of the project and leading the development of the life cycle energy and GHG analysis, including guidance on methodology and 2050 scenario modeling. In development of the roadmap, **AEA** contributed expert analysis of potential challenges to greater implementation of chemically-based building products, and in-depth knowledge of international policies, opportunities for collaboration, and strategies for overcoming these challenges. **Building Insight, LLC** provided market analysis, building code and building science support. ICCA also thanks the **International Energy Agency** for providing critical background data to support this report. This effort would also have been impossible without the knowledge and insights of many who supported the ICCA common views and played an active role in providing the necessary product and application information.

The policy implications and recommendations in this report are solely the views of the ICCA.

Sincerely,

Mr. Otsuka Shigenori
Executive Consultant, Mitsubishi Chemical Holdings Corporation and
Chairman, ICCA Energy and Climate Change Leadership Group

The International Council of Chemical Associations

The International Council of Chemical Associations (ICCA) is the worldwide voice of the chemical industry, representing chemical manufacturers and producers all over the world. Responding to the need for a global presence, ICCA was created in 1989 to coordinate the work of chemical companies and associations on issues and programs of international interest. It comprises trade associations representing companies involved in all aspects of the chemical industry.

ICCA now accounts for more than 75%of chemical manufacturing operations with a production exceeding USD 1.6 trillion annually. Almost 30 percent of this production is traded internationally. ICCA promotes and co-ordinates Responsible Care® and other voluntary chemical industry initiatives.

ICCA has a central role in the exchange of information within the international industry, and in the development of position statements on matters of policy. It is also the main channel of communication between the industry and various international organizations that are concerned with health, environment and trade-related issues, including the United Nations Environment Programme (UNEP), the World Trade Organization (WTO) and the Organisation for Economic Co-operation & Development (OECD).

ICCA operates by coordinating the work of member associations and their member companies, through the exchange of information and the development of common positions on policy issues of international significance.

Three main issues focused on by ICCA are:

- Chemicals Policy & Health
- Climate Change & Energy
- Responsible Care®

ICCA also serves as the main channel of communication between the industry and various international entities, such as inter-governmental organizations (IGOs) and NGOs that are concerned with these global issues.

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ICCA Website

Further information about the Council and its activities, including various materials for downloading, can be found on the ICCA website:

www.icca-chem.org

Introduction

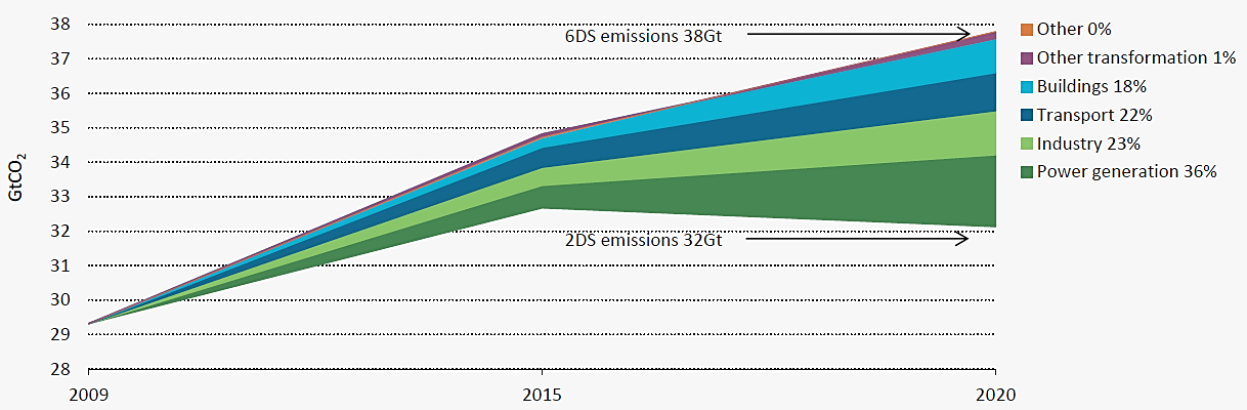
Roadmap rationale, purpose and vision

Since 1980, global energy demand has almost doubled and, if the current trend continues, energy demand will rise by another 85% (i.e. almost doubling again) by 2050. This is a cause for concern in terms of climate change, as energy-related CO_2 emissions make up around two-thirds of total global GHG emissions. Scientific evidence suggests that an increase of such magnitude would set the world on the road to a 6 degrees Celsius (°C) rise in average global temperature. The current increasing energy demand, and associated GHG emissions, is therefore unsustainable and improvements in energy technologies and energy efficiency will have a major role to play in reducing this growth.

Energy Technology Perspectives 2012 (ETP 2012), published by the International Energy Agency (IEA), focuses on a scenario that looks to limit the average global temperature increase to 2°C, a globally agreed target. The scenario looks to cutting energy-related CO_2 emissions in half by 2050 compared to 2009. The 2°C Scenario (2DS) notes that, while transforming the energy sector is vital, reducing GHG emissions from non-energy sectors also has a vital role to play. It highlights that there are substantial opportunities to increase energy savings, improve energy efficiency and increase knowledge on the use of energy across sectors, including the buildings sector.

ETP 2012 shows that, in order to meet the 2DS, 18% of the total emissions reductions come from the buildings sector (see Figure). Overall, the 2DS calls for a CO_2 emissions reduction of over 60% by 2050 within the buildings sector [3].

Figure 1: Key sector contributions to global CO_2 emissions reductions



Source: ETP 2012, Figure 2.1

In 2009, the buildings sector consumed 2,759 million tonnes of oil equivalent (Mtoe), representing 32% of total global energy use and almost 10% of total direct energy-related CO_2 emissions. With electricity generation emissions and district heat included, buildings are responsible for just over 30% of total end-use energy-related CO_2 emissions.

The global share of energy demand from buildings is expected to grow rapidly, with ETP 2012 indicating that energy demand from the buildings sector will more than double by 2050. In large cities, building energy use can account for up to 80% of carbon emissions. Many of the buildings that will exist to 2050 have already been built. While many of these buildings were not designed for energy efficiency, a typical building can realize significant energy savings by retrofitting with up-to-date technologies and systems, as well as by optimizing operations. ETP 2012 recognizes that there is large potential for countries to put policies in place to enhance the energy performance of buildings; deploy energy efficient end-use technologies and improve energy performance codes and standards for new and existing buildings.

[3] http://www.iea.org/media/etp/FactsheetETP2012EndUseSector.pdf

The Chemical Industry has an important, if not crucial, role to play in increasing energy efficiency in buildings and in helping to pave the way towards the near-zero energy buildings of the future, with many technical solutions that are already available or are in development.

The intent of this report is to complement IEA's work in finding solutions, by creating a zero or low emission building roadmap that defines and communicates the chemical industry's present and future technological contribution to energy efficiency and GHG emissions savings in the buildings sector. Technology and policy solutions needed to achieve these savings are also highlighted in this report. .

The report develops a potential growth path for the product groups it covers from today to 2050. The overarching goal of the report is to inform the public of the potential energy savings achievable through these product groups, and aid them in realizing their full potential. The report outlines the challenges to achieving these goals and lays out actions needed to overcome these obstacles.

Roadmap scope and structure

The roadmap was developed in two phases. The goal of Phase I was to determine the potential energy efficiency and GHG emissions savings that are technically achievable by 2050 from available building technologies implemented in the residential and commercial building sectors. This phase is discussed in Chapters 1 to 5 of this report.

Phase II discusses the challenges and opportunities for increasing use of chemically-derived building products, and from this, a set of recommended activities for achieving the projected savings has been developed. Outputs from this phase are outlined in Chapters 6 to 9. It should be noted that the primary focus of Phase II is on issues that are specific to the building sector. Although there are larger issues that affect all sectors of global economy, such as policy and legislation around total carbon emissions, in-depth exploration of how these wider policy issues affect production and use of chemically-derived building products is beyond the scope of this analysis.

The report focuses on the built environment in Europe, Japan and the United States (U.S.) relative to the year 2000, which is used as a baseline. The savings projections are focused on established products and technologies. In the IEA ETP 2012, a large percentage of the GHG reductions out to 2050 is expected to come from emerging economies where there is population growth and rapid urbanization (e.g., Brazil, China, and India). Information on building stock in these countries is not available at the same level of detail that is available for Europe, Japan and the U.S. For Brazil, China, and India the report includes only some high-level projections regarding the potential for energy and GHG savings from improvements in energy efficiency of the building stock in these emerging high-growth regions.