Energy, Sustainability, and the Built Environment

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SUMMARY

We are proposing a new inter- and multi-disciplinary research initiative we are calling "Energy, Infrastructure, and Sustainability" as a Texas A&M University Research Landmark Areas. This proposed landmark research area is both timely in terms of societal imperatives across the globe, and as integrative of much existing and proposed research on campus. Why? We know that energy, the economy, the environment, national and global security are intricately tied together and are determinant of nothing less than our future as a species.

We also know that world-wide, our planet's human population is now over 50% urban. The world's urban population is projected to reach five billion by the year 2030, representing a full 80% of the planet's inhabitants, according to the United Nations. "At the global level, *all* future population growth will thus be in cities" (UNFPA 2007, 8). We also know that human consumption in urban areas far exceeds that in rural areas. For example, over 50% of all electricity consumption and 60% of CO2 production is by buildings alone. Transportation in and between cities accounts for nearly 30% of all energy consumption. Globally, according to the UN, even though only half the world's population is currently urban, cities account for 75% of all energy consumption and 80% of green house gas emissions.[1] Imagine what cities and their metropolitan areas will account for in the year 2030, when five billion live in them, and when currently low-consuming societies such as China and India reach American levels of consumption.

Therefore, cities and metropolitan regions are determinant of our future. Moreover, in the United States, buildings consume approximately 40% of all energy, and transportation consumes an additional 28%. Clearly, the way we plan, design, and build them, and how we live in them on a daily basis, determines to a large degree the future sustainability of human activities on Earth.

This landmark research area has the potential to integrate much work on related topics across the TAMU campus, of which little is truly integrated in a territorial and built environment sense, through comprehensive, long term, and strategic analyses of multiple and reciprocal relations among energy, sustainability, and the built environment.

[1] Caroline Ash, et al., 2008. "Reimagining Cities" *Science* v. 319, p. 739.

This could be yet another area where the college can draw on its significant strengths and be a leader campus-wide by not only providing intellectual leadership, yet also an integrative, coordinating leadership, in part because we have faculty representing so many disciplines within our college who maintain proven track records of collaboration with other colleges and research unites, such as Engineering, Bush, AgriLife, TTI, Geosciences, and Business.

THE BUILT ENVIRONMENT

The built environment, including structures, infrastructures, and transportation, accounts for eighty percent of all energy consumption in the United States. The built environment for all intents and purposes is the urban environment. Over eighty percent of the American population lives in metro areas, and over eighty percent of all economic activity occurs in metro areas. Therefore, if we want to be sustainable as a society, then our cities, our buildings, and our infrastructure must be sustainable. To achieve this important yet until now elusive goal, we must retool our cities. This means concurrently retooling our economy and our lives. While this will lead to tremendous opportunities for economic growth and international leadership, first it will entail a change in the way we think about our built environment. In fact, we must begin to think about it explicitly, and not take it for granted or leave it as an afterthought, which is so common today. For example, why must buildings consume energy? Why can't they produce energy? Why must modes of transport consume energy, instead of produce it? These and other changes of perspectives precede action. We have the knowledge, we have and are developing the technologies, and we have the incentives to do so.

These facts and patterns of energy use in the areas of infrastructure and the built environment suggest the importance of the built environment in attaining sustainable cities, economies, and societies. While much research is being done in energy and sustainability, most of it is on individual technologies or systems, such as wind turbine blades, plug-in electric hybrid vehicles, heating and cooling systems for buildings, and so on. What is missing in most of this research is the built environment as a whole, whether an urban district or neighborhood, a city, or an entire metropolitan region. These other urban scales of the built environment are critical to consider in addressing the energy – infrastructure nexus.

The rest of this document consists of talking notes for a powerpoint slide presentation of about 10-15 minutes on the topic of energy, sustainability and the built environment.

TITLE SLIDE 1 – World's largest solar panel, 1.4 megawatts, Barcelona Spain. It does triple duty as a sculpture on the waterfront and shade provider for an outdoor amphitheatre.

SLIDE 2 HERE -

SLIDE 3 HERE – ENERGY CONSUMPTION BY THE BUILT ENVIRONMENT: TRANSPORTATION, INFRASTRUCTURE, AND BUILDINGS

So we can see that the way we plan, design, and build our cities makes all the difference in energy consumption. For example, in West Germany shortly after unification, nationwide its economic output per capita used half the amount of energy compared to the same economic output in the United States. That is largely due to their world-leading status on renewable energy use, building efficiency by design, and superb urban public transport coupled with ultra-modern high speed inter-city trains skimming the landscape at 300 kilometers per hour or more.

SLIDE 4 HERE – CARBON EMISSIONS BY BUILT ENVIRONMENT SECTOR

Not only does the built environment consume energy, but it also produces carbon dioxide and other green house gases and pollutants. Here we can see that commercial and residential buildings produce almost as much CO2 as the transportation and industrial sectors combined, an astonishing 800 million metric tons of CO2 per year!

We must learn, or better said, re-learn, how to build intelligently. Indigenous architectures around the globe over the millennia responded to challenging climates with elegant, livable, and bioclimatic buildings. In Texas, for example, we built with wrap-around porches to create shade and breeze, had low metal roofs to reflect the sun and prevent hot air build up under the roof. Main streets had wide overhangs to provide shade. Our current standard? We build skyscraper office buildings with unshaded windows that can't be opened, shopping mall buildings without windows at all, surrounded by seas of heat-island producing asphalt parking lots, and single family houses in residential-only suburbs from which we must drive in a single occupancy vehicle almost everywhere.

SLIDE 5 HERE – LONDON BEDZED

Elsewhere in the world, advances are being made. In London, a development called BedZed, or Beddington Zero Energy Development (BedZED), is an environmentally-friendly-housing development in the London Borough of Sutton. It was designed by the architect Bill Dunster, who was looking for a more sustainable way of building housing in urban areas.

Monitoring conducted in 2003 [1] found that BedZED had achieved these reductions in comparison to UK averages:

-Space-heating requirements were 88% less

-Hot-water consumption was 57% less

-Overall water consumption has been reduced by 50%

-The residents' car mileage driven is 65% less

In Spain a law was adopted that required all new buildings and all renovations over a certain threshold to use renewable energy, in the year 2000. The law was put into effect immediately.

SLIDE 6 HERE – TWO IMAGES: WIND TURBINE FIELD AND ELECTRIC GRID

How we design our infrastructure systems is just as critical, if not more so, as the German case attests. Did you know that up to 70 % of all electricity is lost in transmission and distribution through the grid? What if energy was produced locally? With each building and each car producing its own power, any surplus could be sold back to a local grid at going rates. Most houses have the surface area to support the square footage of solar panels needed to generate enough energy to support their needs. Small home-sized wind turbines cost about two to three thousand dollars today.

In the 20th century, American farmers and rural households relied on abundant wind energy to pump water from wells and other uses. Why are most of these windmills out of use today?

SLIDE 7 HERE – FOUR IMAGES OF ADVANCED HOME WIND TURBINES

Today, the newest blades can operate at wind speeds as low as 7 miles per hour, opening up vast regions of the country and the world to efficient wind energy production.

SLIDE 8 HERE – US, EUROPE, JAPAN TRAVEL MILES PER CAPITA

In transportation infrastructure, we can witness some interesting patterns. The American penchant for driving cars is famous, or infamous, throughout the world. This slide shows differences in vehicle miles per capita in selected areas of the world. Transportation energy demand in western Europe is projected to increase by only 0.2 percent per year, from current usage of 18.5 quadrillion Btu in 2004 to 18.9 quadrillion Btu in 2015 and 19.6 quadrillion Btu in 2030. Low population growth, high taxes on transportation fuels, and efficient high-speed rail and subway systems, plus freight rail, is expected to slow the growth of transportation energy demand in Europe.

SLIDE 9 HERE - Figure 25 from the US DOE's EIA.

In OECD countries, often referred to as the developed countries, the transportation energy demand is expected to increase by 1 percent per year over the next 25 years. This compares to the rest of the world, which is expected to more than double in the next 25 years.

China's energy use for transportation is projected to grow by an average of 5 percent per year, from 4.4 quadrillion Btu in 2004 to 7.7 quadrillion Btu in 2015 and 15.5 quadrillion Btu in 2030 – nearly quadrupling. Virtually all the growth in transportation energy consumption in China is projected to be fueled by oil, with significant impacts on our price of gas and on the global climate, much less urban air pollution in China.

SLIDE 10 – US HIGHWAY INVESTMENTS SINCE 1956

This slide needs no explanation, other than 1956 was the year that the national interstate highway system was authorized by Congress. This was an explicit choice made by bold leadership responding to needs and context of the time. We can make equally bold choices and investments to support our economy and society today. All we need is the leadership. And we are all leaders.

In the US in 2005, highway vehicles were responsible for about 80% of all transportation energy use. In the US in 2005, the average total operating cost for an automobile was $7,475 per 10,000 miles. You can calculate your own costs – the average Texan drives 20,000 miles per year, and don't forget to factor in today's cost of gas. I could continue with statistics, how much more we spend and pollute because we ship freight by truck not rail, air not sea. How much more because we drive not zip along in a metro or a train. How much more because we live in suburban sprawl not compact towns and cities.

SLIDE 11 – TRANSIT RIDERSHIP IN THE USA

Nine billion transit rides per year on all modes - subway, bus, rail - has been the nationwide average per year in the USA over the last decade. Nine million is the daily average ridership on Moscow's metro alone, not including buses and rail. Beijing is currently investing $ 11 billion to build a metro system that is expected to accommodate 9 million daily riders. Shanghai is investing $ 27 billion in a metro system with twice the track miles as Beijing that is expected to accommodate 12 million daily riders. These figures are more than London, Paris, and New York combined. CAN YOU SPELL INVESTMENT OPPORTUNITY? IN THE US AND ABROAD.

Transit use in the US in 2006 still saved enough gas - 3.4 billion gallons - to fuel 5.8 million cars and reduce CO2 emissions by 25.8 million metric tons. PIRG 2008.

SLIDE 12 – LAST SLIDE

SO WE CAN SEE THAT THE CHOICE IS CLEAR. WE CAN REDESIGN OUR BUILT ENVIRONMENT TO BE SUSTAINABLE IN THE FUTURE IN WAYS THAT

HAVE MANY POSITIVE BENEFITS TO ADVANCING OUR ECONOMY, AND AT THE SAME TIME MAKING OURSELVES ENERGY INDEPENDENT, AND FREE FROM THE TIES WITH UNSTABLE REGIONS IN THE WORLD.

The following six items represent examples of new approaches to understanding, modeling, and measuring the urban world which we plan, design, and construct.

Life cycle	Biomimicry
Close loops	Renewable
On-site or local	Nature services