

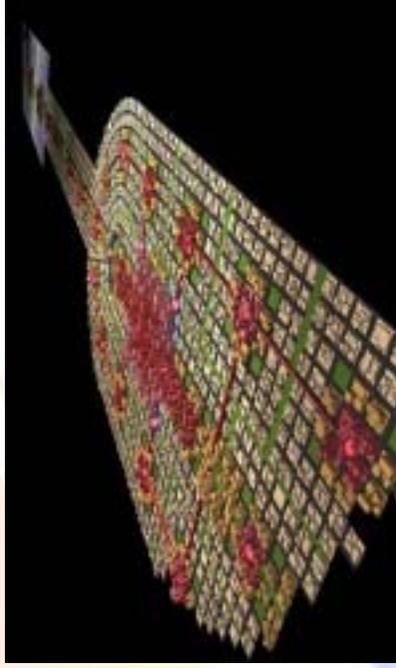
U.S. TEAM ENTRY

***Greater San Diego-Tijuana
Binational Metropolitan Region***



**INTERNATIONAL COMPETITION
FOR SUSTAINABLE URBAN
SYSTEM DESIGN**

February 28, 2003



**COORDINATED BY THE
SUSTAINABLE ENERGY PLANNING OFFICE
GAS TECHNOLOGY INSTITUTE
1700 SOUTH MOUNT PROSPECT ROAD
DES PLAINES, IL 60018-1804, USA
PHONE: 847-390-7800
WWW.GASTECHNOLOGY.ORG**

**Sustainable Urban System Design
for the
Greater San Diego-Tijuana Binational
Metropolitan Region**

Official U.S. Team Submission
to the
International Competition
for Sustainable Urban System Design

Prepared by

Gas Technology Institute
Sustainable Energy Planning Office
With the Assistance of the U.S. IC-SUSD Team

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INTRODUCTION

This document is respectfully submitted on behalf of the United States team to the International Competition for Sustainable Urban System Design. It outlines the content of the design that will be more fully expressed in a multimedia presentation at the World Gas Conference in Tokyo, Japan, in June of 2003.

The U.S. team selected the greater metropolitan border region of San Diego, California, United States, and Tijuana, Baja California, Mexico—the **San Diego-Tijuana Binational Region**—as the “Subject City” for this design. San Diego was originally selected as the subject after it won the preliminary U.S. Competition for Metropolitan Energy Design, conducted in 2001 and 2002. The team added the Municipality of Tijuana when it became clear that a truly comprehensive sustainable urban design requires consideration of all settlements sharing the same bioregion and urban economic base. For the same reason, the design area also includes the 17 incorporated municipalities of San Diego County, with a total land area of 10,880 square kilometers (km²) and a land area of the Municipality of Tijuana of 1,229 km². The document is structured in 3 sections:

1. An **overview** of the region’s current characteristics and the multiple environmental, economic, and social challenges it faces in the coming years.
2. A 100-year **vision** for sustainability—depicting the binational metropolitan area’s ideal state in the year 2103. This section contains a description of a sustainable energy system that has been integrated with other resource management technologies to provide efficient, economical, and environmentally benign energy utilization.
3. A **road map** outlining the governmental, economic, technological, and social developments necessary to realize that vision.

Design Goals

The design communicates the need for fundamental changes in the way American and Mexican cities are designed, developed, and managed and in the way urban residents utilize natural resources. These changes are articulated in 5 overriding design goals:

1. **Sustainable Energy Resources and Practices.** All future public and private development within the Greater San Diego and Tijuana Metropolitan Region should be pursued in a manner that maximizes the efficient utilization of energy resources and minimizes or eliminates local and global environmental degradation. In addition to the reduction of CO₂ and other greenhouse gas emissions, future development and use of energy resources in our cities should also consider direct and indirect impacts on the marine and terrestrial environment.
2. **Ecological Urban Form and Function.** Greater San Diego and Tijuana must be developed and managed in a fashion that preserves and restores the natural environment for the benefit of both human and nonhuman inhabitants. Additionally, both cities should be designed and developed to emulate nature and to maximize the benefit of natural systems such as wind and water flows, sunshine, precipitation, and the absorbency of land and vegetation. Further, urban functions should be managed to reinforce these natural flows and characteristics wherever possible, thereby creating a balance and mutually supportive cycle of interaction between the built and the natural environments.
3. **Community-Based Resources Management.** Simply stated, urban sustainability is not possible without the commitment and collective action of the individual communities that comprise the Binational Region. This design replaces the centralized model of resources management with a model that relies upon local communities for sustainable resources development, services delivery, and recycling. Future advances in technological systems integration and miniaturization will enable the cost-effective decentralization of energy, water, and waste management systems to the neighborhood community level. Further, advances in

materials development and reuse will render the concept of waste obsolete, as our communities take an active role in closed-loop cycling of the materials they use.

4. **Land Use Optimization.** The San Diego-Tijuana Region will minimize the consumption of natural resources by restructuring and more efficiently utilizing the existing urban footprint. We also see greater opportunities for social and economic diversity by increasing culturally acceptable housing densities and types within our urban areas. In addition to increasing access to local goods and services, densification of the urban population will promote a more walkable urban community and will support a cost-effective transportation system that will eliminate the vast majority of the region's air pollutants.
5. **Social and Economic Parity.** For the Binational Metropolitan Region to function optimally as a sustainable whole, its constituent communities must become more socially and economically integrated. Communities on both sides of the international border must enjoy equivalent access to affordable housing, social services, and economic development opportunities supported by adequate infrastructure and environmental quality management systems. This will enable communities across the entire region to more coherently focus their attention on creating the sustainable society and region of the future.

Unified Design Concept

Our sustainable urban design for 2103 proposes to control urban sprawl by limiting growth to existing urbanized and selected undeveloped areas. The design directs development and redevelopment away from sensitive environmental lands and toward zones that reinforce urban vitality and use of mass transit. Implementation of a “sustainable village and neighborhood” concept offers a balance among affordable quality housing and employment opportunities, economic development, education and training, recreation, community development, and ecological stewardship. At the same time, this design concept allows for preservation of historic buildings and neighborhoods and maintains a range of choices for individuals in terms of housing, transportation, and consumer purchases.

* * *

Globally, we hope this design will contribute to the ongoing dialogue among urban designers, planners, and municipal managers seeking solutions to improve and sustain the quality of urban life around the world.

Regionally, we offer this design to further promote continued and expanded cooperation between the United States and Mexico to ensure the environmental, economic, and social prosperity of our border communities.

Locally, we offer this design as a starting point for discussion among community leaders and stakeholders from across the Greater San Diego-Tijuana Binational Metropolitan Region. Our hope is that through these discussions, the evolutionary road map will be refined to become the basis for a nearer-term strategy and, eventually, a plan with policies, programs, and project investments that will guide the region toward a more sustainable future.

I. REGIONAL OVERVIEW

a. Study Area

The Greater San Diego-Tijuana Binational Region is located on the Pacific coast of North America and includes diverse urban and rural areas of Southern California and northern Baja California (Figure 1). Sharing natural systems in a well-defined ecoregion, the international boundary bifurcates the region into distinct U.S. and Mexican human systems that include elements such as culture,



Figure 1: Study Area

language, family and society, governance, use of urban space, and economic practices. These structures and practices are beginning to converge and harmonize. The study area is anchored by the City of San Diego (1.3 million population) in California, and Tijuana (1.3 million) in Baja

California. The study area also includes the 17 additional incorporated cities and unincorporated areas within San Diego County, as well as the Mexican cities of Tecate (80,000) and Rosarito (69,000), which are rapidly converging with urbanized areas of Tijuana. The total population of San Diego County, with all its constituent parts, is 2.8 million. The total current regional population of the study area is about 4.3 million people.

The binational study area—of more than 12,400 km² in extent—has a varied topography. Most of the population is concentrated in the coastal valleys and flat mesas to the west. To the east, there are foothills and mountain ranges with peaks over 1,800 meters in elevation. The region's benign Mediterranean climate produces most of the annual rainfall during the winter months of November through February, with more precipitation in the mountains than on the coast. Variations in topography and rainfall have produced a pattern of many different microclimates and an extraordinarily rich biodiversity. As human populations have occupied the coastal valleys and mesa tops and have spread into the foothills and interior valleys, the impact of urbanization on natural areas has been profound. Today, the region is one of the world's biological "hot spots," based on the large number of threatened and endangered species.

While contained within one natural region, the study area includes 2 very different human systems that meet at the international border. Mexican culture, Spanish language, and legal traditions based on Roman law contrast with U.S. culture, the English language, and the Common Law legal tradition. The Mexican political and public administration systems are centralized; much of the power is concentrated in the national capital with little devolved to the local entities. U.S. governments are more decentralized, with greater powers at the local level. Furthermore, the economic asymmetries present in the San Diego-Tijuana border region are significant. The United States is one of the most developed countries of the world and Mexico is a developing country. The regional economic activity of San Diego is about 20 times that of Tijuana despite similar-sized populations; minimum wages are more than 10 times higher in San Diego than in Tijuana; and local government budgets are about 25 times greater north of the international boundary.

At the same time, recent developments have led to a greater convergence between San Diego and Tijuana. Mexico is in the process of decentralization, with more responsibilities being allocated to the local governments. Mexico has made the transition from a central, state-controlled economy to an open economy linked to the United States and Canada through the 1994 North American Free Trade Agreement (NAFTA). This has enabled San Diego and Tijuana to benefit from some complementarities in their respective economic systems through trade, capital, technology, and labor flows. In the regional binational economy, San Diego is the site of much of the knowledge-based industries such as biotechnology and computer software. It is also the site of capital-intensive manufacturing. Tijuana, however, provides much of the manufacturing base of the region through the well-developed assembly industry (*maquiladoras*), currently employing some 147,250 workers. Tijuana also supplies 40,000 workers, who reside south of the border and commute to San Diego to work, mainly in the service industry and construction. Both San Diego and Tijuana have important tourism industries that are complementary rather than competitive. Finally, Tijuana and San Diego are geographically isolated from their national capitals, requiring much informal transborder cooperation to address local problems and opportunities. All these forces have combined to support economic integration across the border and increase local transborder cooperation, which will be vital for reshaping the region over the next century.

Despite planning efforts and growth management efforts that date from the 1970s, the Binational Region continues to experience significant population growth, reduced mobility, increased congestion, resource shortages, environmental degradation, economic inequities, and fragmented governance. Ten areas of concern must be addressed in order to sustain the region's quality of life. They include:

1. **Population Growth.** The most pressing concern is population growth and the challenge of providing adequate services to all residents. By 2030, the region's population is expected to soar to 8 million, which is almost double the 2003 population. This region is one of the most dynamic in the world in terms of demography. Fueled largely by migration, San Diego is

currently growing at 1.7% per year, while the figure for Tijuana is 4.9%. By 2030, a majority of the region's population will live south of the international border. The region's climate, quality of life, and economic opportunities have fueled most of the domestic migration to San Diego. As for Tijuana, its manufacturing and tourism industries, combined with its proximity to San Diego and Southern California, have attracted migrants unable to find similar economic opportunities elsewhere in Mexico. By 2103, the population is likely to increase to 15 million within the Binational Metropolitan Region. Given the expectation of significant advances in the medical sciences and healthcare and longer life spans as a result, this number could be considerably larger. Such growth far outstrips current infrastructure planning, financing capabilities, and available land. For example, in San Diego County, land zoned for development will be totally consumed by 2018. Using current development projections, Tijuana, whose population constitutes 60% of the projected growth for the Binational Region, will lose most of its ecologically sensitive and agricultural lands by 2025. The combination of continued growth, population expansion, and uncoordinated planning will exacerbate the existing pattern of urban sprawl (Figures 2 & 3). The following problems will only grow worse should current trends continue.

2. **Land Scarcity and Urban Sprawl.** Currently, energy-inefficient urban developments plague the region. San Diego's development pattern is designed to accommodate detached single-family residences and the automobile. Tijuana's urban growth is largely unplanned and has grown over the landscape in an ad-hoc fashion. Continuation of these growth patterns will consume all developable land within several decades.



Figure 2: Urban Spatial Pattern 2003



Figure 3: Sprawl Scenario 2103

3. **Habitat and Species Loss.** A direct consequence of urban sprawl is the loss of natural habitat and further stress on more than 200 species that are currently threatened or endangered (Figure 4) in this unique ecological region. San Diego has begun to implement a Multiple Species Conservation Program (MSCP) to preserve habitat through land acquisition, but the ability to raise money necessary for land purchases is far



Figure 4: Ecologically Sensitive Lands

outpaced by developers' ability to acquire these lands for residential and commercial development. Tijuana is only now beginning to plan for habitat and species protection. Furthermore, no transborder protected areas exist to protect flora and fauna corridors in the region.

4. **Traffic Congestion and Air Quality Degradation.** Although the growing number of automobiles did not result in greater pollution in San Diego during the last decade of the 20th century due to stricter emissions controls, the whole region continues to experience ever more air pollution, congestion, and lost productivity. Consumption of imported liquid fuels continues

to increase as the number of vehicles continues to grow. Additionally, access and mobility within the region is inhibited by a lack of alternate transportation options and sprawling development patterns. Growing transportation problems are cited both in San Diego and Tijuana as a factor in declining quality of life.

5. **Water Scarcity and Degradation.** Currently the San Diego-Tijuana Metropolitan Region meets its regional water demands through costly and distant imported sources from the Colorado River and Northern California, which account for more than 95% of the regional water supply. Approximately 50% of the San Diego-Tijuana Region's fresh water is used for non-drinking purposes such as landscape irrigation, commercial enterprise, and industrial processing. Tijuana, although using about 1/3 per capita as much water as San Diego, is facing severe shortages within a decade. Surface waters are contaminated and the region's aquifers are declining in quality and quantity of water production.

6. **Energy Security.** The Binational Metropolitan Region relies on energy imports for a significant portion of current needs. The region is almost entirely dependent on imported liquid fuels and natural gas for transportation needs and electricity production. California's recent energy crisis created economic disruption and marketed uncertainty that has temporarily delayed investments in additional infrastructure and the siting of transmission lines. However, electricity demand is expected to resume sharp growth in the region as local economic conditions begin to improve over the next few years. As local communities are generally opposed to the installation of new power plants in their areas, the region will soon be facing challenges on how to adequately meet its future energy needs. San Diego is located at the far southwest corner of the United States and is the effective end of the energy supply infrastructure for liquid fuels, natural gas, and electricity. Tijuana and its surrounding population centers are not connected to the Mexican natural gas distribution infrastructure or electricity grid; rather, they rely on their connection to the United States through southern San Diego and Imperial counties. San Diego and Tijuana are inextricably linked to the energy infrastructure along the

border and the region's energy future relies on regional cooperation and planning. Providing the necessary energy supply and infrastructure will be a critical challenge, especially given community opposition to locally sited power plants. Transitioning from heavy dependence on fossil fuel energy sources to more locally available renewable sources is a priority for all stakeholders in the region.

7. **Housing Affordability.** Both San Diego and Tijuana are in the midst of a long-term affordable housing shortage. San Diego, due to low wages and high cost of the type of housing constructed, has a chronic shortage of affordable housing—one of the worst in the United States. Tijuana, because of low wages, the lack of a well-developed mortgage market, and rapid population growth, has ongoing problems with housing shortages (as much as 50,000 units), substandard housing, and crowded housing. In Tijuana, much of the housing need is met through self-constructed buildings on land provided by the government. Currently, about 60% of Tijuana's urban development is occurring on what were formerly communal agricultural and grazing lands, known as *ejidos*. To meet current population and housing growth needs, *ejidos* are rapidly being privatized and developed in the eastern and southern parts of Tijuana, many with substandard infrastructure and communal amenities.
8. **Solid Waste Disposal.** Although there is adequate landfill space available in San Diego today, there will be a shortfall in capacity within the next 10 years. Tijuana is similarly positioned. The scarcity of land and community opposition to siting alternatives will make future landfill development difficult and continuation of present waste management practices unsustainable.
9. **Economic Disparity.** Despite the economic convergence between San Diego and Tijuana, significant disparities remain. The minimum wage in San Diego is at least 10 times higher than the equivalent base wage in Tijuana. Additionally, urban infrastructure investment in San Diego is 20-50 times greater than in neighboring Mexican cities. The Gross Regional Product for San Diego County is \$126 billion and the corresponding number for Tijuana is \$9.7 billion. Significant reduction in the economic asymmetries across the border will require 2-3

generations. As these asymmetries decrease, it is expected that Tijuana's ability to fund services and infrastructure will improve.

10. Fragmented Governance. Complex governmental structures inhibit the region's ability to address the many challenges described previously. San Diego has a county government, 18 incorporated cities, and some 200 special purpose districts. In addition, there are more than 20 American Indian tribes and their reservations have semi-autonomous political status. The layers of state and federal government also produce added complexities. Across the border in Mexico, lines of authority are clearer, but the preponderant power of the federal government, as well as the limited resources of local governments, inhibits state and local initiatives. Although political and administrative decentralization is moving forward in Mexico, the process is slow.

Different structures of governance in San Diego and Tijuana, along with U.S. and Mexican federal government preoccupations with sovereignty, have made local transborder cooperation and governance difficult. The major near-term challenge for the region is developing transborder governmental arrangements to address critical regional issues.

The Challenge Ahead

The previous description of basic conditions and issues in the Greater San Diego-Tijuana Binational Region illustrates that a business-as-usual approach will bring deteriorating environmental conditions, congestion, pollution, and other elements that constitute a declining quality of life. The immediate challenge will be to articulate a binational community vision of a sustainable future and the public policies, private stakeholder actions, and collective commitments necessary to realize the vision in the coming century. The next section provides a preliminary vision of a sustainable region in 2103, establishing a set of ideal goals as the focus for a road map of solutions presented in the final section of the design.

II. GREATER SAN DIEGO-TIJUANA IN 2103

a. Region of the Future: Spatial Design and Mobility

An aerial perspective affords a spectacular view of the Greater San Diego-Tijuana Region and its rugged 190-km coastline. The urban footprint of the Greater San Diego-Tijuana Region in 2103 is not much larger than a century earlier. The rivers and valleys have been protected and rehabilitated to function as nature preserves, green spaces, and recreational areas. Critical habitats on the mesas have been set aside and the inland mountainous areas are largely protected areas. The natural functioning of the watersheds of the region has been restored and the result is a flourishing of vegetation and animal species and improved water quality and water production. Natural filtering processes of riparian and aquatic vegetation have improved the quality of the surface waters and largely eliminated the contamination of the near shore marine environment.

The sustainable ethic that defines the Binational Region's urban design is evident throughout the landscape. Low-rise coastal development sits behind the brow of the beach, protecting the viewshed and preserving beach access. The establishment of the Binational Multiple Species Conservation Program protects an extraordinary diversity of plants and animals, which coexist alongside dedicated recreational areas. These dedicated land uses include porous areas to allow natural drainage of rainfall to recharge alluvial aquifers along streambeds.

Large, interconnected swaths of community gardens lie within the publicly owned open spaces closest to human settlements, replacing many of the large house lots and private gardens of a century earlier. While these organic gardens supplement the diets of the residents, their primary purpose is to cultivate a sense of community, and to root individual citizens in a concern for one another and for the natural environment.

San Diego-Tijuana has evolved into an articulated Binational Metropolitan Region that enjoys its many natural resources while it maintains a high quality of life. In 2103, this binational metropolis embraces 4 distinct urban zones, which conform to a resource efficient urban land use plan supported by a comprehensive regional transportation system. These 2 critical elements—the

land use plan and the transportation system—have proven to be the key to the region’s singular success in achieving sustainable development. Urban development policies have reinforced these design elements by concentrating growth into targeted urbanized areas of mixed-use development at transit nodes and along corridors. This development pattern is intended to reduce and, in many cases, eliminate the spatial separation among residential, employment, shopping, social, and recreational centers and thereby reduce or eliminate energy consumption and air emissions associated with travel among them. Similarly, preservation policies have led to the designation of significant portions of the Binational Region as agricultural and ecological preserves and green areas. This ecological balance is exemplified by restored environmental assets that include the Tijuana River-Alamar River system, the San Diego River, Chollas Creek, Rose Canyon Creek, and Santa Margarita River in northern San Diego County.

Regional Urban Structure

The efficient use of land has provided a hierarchical structure for 4 urban zones that consist of cities, villages, and neighborhoods.

Zones. The 4 urban zones in the region are: (1) Escondido, (2) Sorrento Mesa-University Towne Center, (3) Downtown San Diego, and (4) the International Border Zone (IBZ) (Figure 5). Each zone measures 24-32 km in diameter. Zones are defined primarily by their geographic, social, and economic spheres of influence. Zones have aggregate populations of up to 4 million. The 4 urban zones contain 60 targeted cities and adjoining areas that will accept and support all future growth in the region.

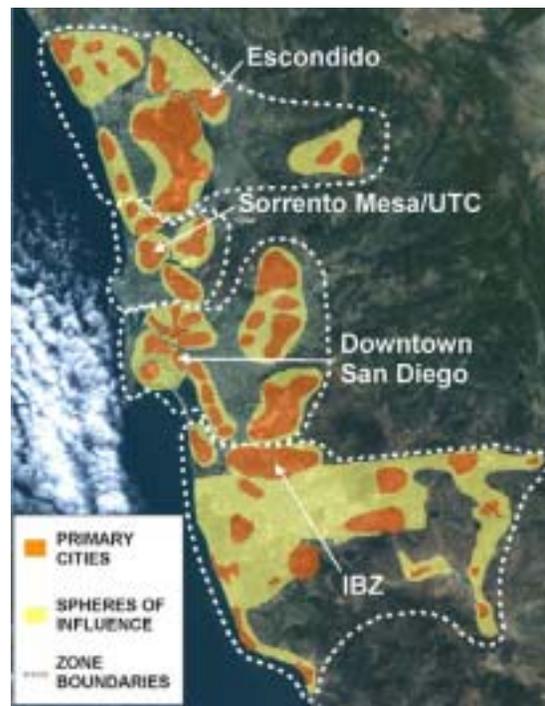


Figure 5: 2103 Urban Zones

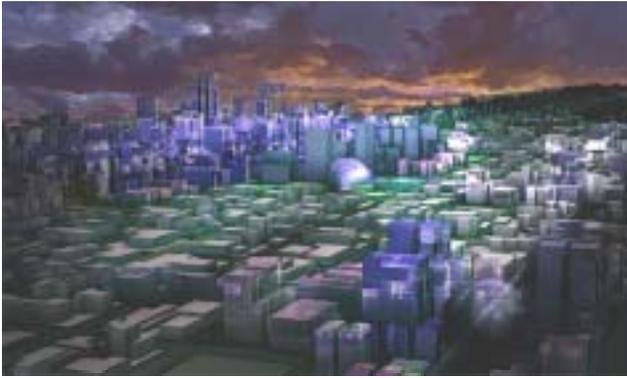


Figure 6: Central Business District of a Primary City

Cities. Each of the 4 zones contains several primary and secondary cities. The primary cities are the locus of economic and cultural activity for their urban zones. Additionally, primary cities serve as commercial, employment, and transit hubs. Primary cities range in size 16-24 km in diameter and have

725,000-1 million residents. The highest intensity land uses are found within the city centers, with residential densities of 308-432 units/hectare (Figure 6). Secondary cities have lesser intensity of land uses with densities at 70% of primary city centers. Throughout the region, there are remnant areas where traditional residences with individual lots remain, some as parts of historic districts.

Villages. Surrounding the cities are smaller-scale villages. Villages, defined by the geography of mesas, canyons, and drainage courses, provide the physical space for community life and distinctive cultural and historical characteristics. They provide the “sense of place” with which residents identify.

The average village is comprised of about 6 neighborhoods plus a village center. Villages are approximately 4 km in diameter and have 40,000-65,000 residents. The village center offers a diversity of housing alternatives for approximately 20,000 residents. The village center contains 4-5 story structures with residential densities of 100-185 units/hectare. Highest densities occur at the village core and along the primary commercial/transportation corridors that radiate out to the neighborhoods. Tapering rings of neighborhoods along these corridors support the core of mid-rise residential and commercial buildings. Village residential densities range 30-185 units/hectare, and create a diverse mixture of housing, including a number of detached single-family dwellings that have survived from a century earlier. The village center provides transit connections to the region’s larger commercial, employment, retail, and recreational/cultural centers and facilities. Secondary

schools, vocational schools, and community colleges are located within or adjacent to the village centers.

A network of green pedestrian boulevards or *paseos* that are connected to the community's common areas distinguishes the village center. These common areas are designed to meet the varied needs of residents and range from community gardens to formal play areas. The *paseos* serve as linear parkways that lead residents to the edges of the mesas and canyons at the periphery of the village. They also connect habitats throughout the region and serve to promote biodiversity.

Neighborhoods. The neighborhood represents the smallest scale in the regional spatial hierarchy. Design guidelines ensure structures and streets of human scale. Emphasis is placed on *paseos*, greenways, and sidewalks that promote walking and biking as viable alternatives to the use of motorized vehicles. Neighborhood common greens are emphasized to provide outdoor spaces for the clustered residences that face them.

The average neighborhood is 100-125 hectares in size, and has approximately 6-11,000 residents. Residential densities range from 120 units/hectare in the neighborhood center to 30 units/hectare at the neighborhood's periphery. A few areas of lower density remain from the previous century. Retail, civic, and office establishments, none of which exceeds 2 floors in height, anchor the neighborhood center. The center also features elementary schools, religious institutions, and Resource Management Centers (RMCs). The RMCs provide energy, heating, cooling, water, and recycling of sanitary and solid wastes for the neighborhood. By co-locating each of these functions, the neighborhood is able to maximize resource use efficiencies through the integration of energy and environmental technologies.

b. Transportation System

Over the preceding century, new public and private mobility systems evolved to support the new land use plan, which together transformed the Binational Metropolitan Region into an inherently more sustainable human settlement. In fact, these 2 interdependent elements account for the majority of the gains in energy efficiency, local and global air emissions reduction, waste



Figure 7: Advanced Transportation Technologies

minimization, and habitat protection. The mobility systems of 2103 consist of new elements and technology that emerged over the course of the 21st century and innovative elements that had been pioneered in Europe, Brazil, and Asia toward the end of the 20th century. The 4-tier public mobility system was designed to facilitate travel: (1) to and from the region; (2) between primary cities across the 4 urban zones; (3) between primary and secondary cities within the zones; and (4) between the cities and their associated villages and neighborhoods. The private mobility system provides alternative transportation for those willing to pay a premium for transportation-on-demand, or who choose to travel beyond the established public transit routes.

In addition to public and private passenger mobility, there is also an inter- and intraregional freight transportation component that has eliminated the substantial traffic congestion, energy consumption, and air emissions associated with surface trucking a century earlier. A description of each tier and the associated clean transportation technologies follows.

Tier 1. Interregional Mobility. There are 3 primary means of travel to and from the region in 2103, air, rail, and sea (Figure 7). The principal international airport for the Binational Region is now located in Kearney Mesa, within the Sorrento Mesa-University



Figure 8: Interregional Transit Network

Towne Center Zone. Vertical-Take-Off-and-Landing (VTOL) and blended wing aircraft provide supersonic shuttle service to and from all major urban centers around the world. Also co-located at the airport, is 1 of 6 stations providing access to the high-speed magnetic levitation rail system linking the 4 San Diego-Tijuana regional zones to Sacramento in northern California and Ensenada in Baja California (Figure 8). It provides the region's residents with the fastest inter-regional mode of transportation available. One rail station is co-located with the Port of San Diego, which continues in its historic role as the principal facility for oceanic travel, although most of it occurs just above the surface of the Pacific as high-speed hovercraft now service most passenger and cargo trips.



Figure 9: Tier 2 - High Speed Flex Trolley

Tier 2. Intraregional Mobility. Travel between primary and secondary cities across the entire Binational Region is facilitated by a Regional Rapid Express (RRE) service featuring high-speed (60-80 kph), computer-operated Flex Trolleys (articulated buses) operating on transit-only, magnetic guideways (Figure 9). Stations are located an

average of 5-8 km apart and trolleys serve them in 5-10 minute intervals. They are propelled by electric motors energized by fuel cells and emit only water that supports vegetation between the clay tracks of the guideways.



Figure 10: Tier 3 - Local Express Service Vehicle

Tier 3. Intra-Zone City Mobility. Travel between primary and secondary cities and outlying villages within urban zones is provided by a local express service featuring a longer version of the RRE Flex Trolley (Figure 10). These vehicles operate at moderate speeds of 30-50 kph and arrive at stations, spaced every 1.5 km, at

3-5 minute intervals. They travel on dedicated arterial transitways between stations and are guided by the same automated navigation system used in the faster Intraregional Flex Trolleys.



Figure 11: Tier 4 - Elevated Feeder Line

Tier 4. City/Village/Neighborhood Mobility. Travel between cities and their associated villages and neighborhoods is facilitated by a 3-part system consisting of: (1) a City-to-Village Tramway; (2) a Village-to-Neighborhood Feeder Line; and (3) an Inner Neighborhood Shuttle Service. The Tramway system runs

between city and village centers through dense urban corridors along dedicated grade-level lanes. The Tramways are similar in size, guidance, and propulsion characteristics to the RRE and local express vehicles, but operate at lower speeds of 20 kph. Tramway stations are spaced .5-.8 km apart and are served at 3-5 minute intervals. Residents reach the village center from neighborhood centers through a network of feeder lines (Figure 11). These lines are designed to support medium-speed operations between stations spaced .5-1.0 km apart and served at 1-2 minute peak time intervals. Feeder lines utilize track guidance and linear induction propulsion. For residents living in older low-density communities beyond a comfortable walk to a feeder line, auxiliary shuttles are available. These fuel-cell electric shuttles navigate along magnetically controlled pathways at low speeds. Optical sensors stop the shuttles for loading and unloading.

While the public mobility system was designed to dramatically increase efficient and affordable access throughout the region, the private mobility system was built to provide residents additional flexibility and choice in meeting their transportation needs, without contributing to air emissions. The system centers on the Personal Mobility Vehicle or PMV. These are autonomous, computer-guided vehicles that utilize both electric-hybrid and induction-charged electric engines that have replaced most privately owned vehicles and provide point-to-point transportation services on demand. The vehicles operate on clay tracks with imbedded solar-powered guidance transmitters. These are adjacent to the regional and local rapid transit lanes and on an extended network of trackways that enables residents to travel virtually anywhere in the region. The vehicles are funded through time-of-day and trip-and-distance user charges. A limited number of vehicles

with special configurations is owned by individuals or companies. All vehicles are stored, calibrated, fueled, and maintained within the neighborhood Resources Management Center. The PMVs are available at any time and their numbers are monitored and adjusted to account for the time of day, the day of the week, and special events. A central management system determines the speed for each track, controls acceleration and braking lanes, and enables entry and exit from faster tracks. The computer architecture supporting the management system features multiple redundancies for all command components to ensure operational integrity and passenger safety.

The guidance technology employs a trajectory map that determines optimal routing and synchronizes a specific vehicle's movements with all other vehicles traveling in the same corridor, thus enabling high-speed merging and travel of vehicles separated by only 5 centimeters. Two PMV models currently operate in the region:

- Fully automated PMVs. Guided by a region-wide, synchronized computer system, this vehicle is manufactured in a range of sizes providing 2-10-passenger seating capacities. All are handicapped accessible and offer special options such as luxury finishes, advanced communications, entertainment modules, and a variety of seating, lighting, and tabletop configurations.
- Dual-mode PMVs. Dual-mode units offer the option of manual pilot operation. Travelers use free-range, non-automated routing alternatives to reach leisure destinations well off the beaten path. Larger and heavier commercial and emergency services vehicles use these manual-controlled systems but also conform to the width of the same hardpack clay tracks used by the fully automated PMVs.

In addition to the public and private mobility systems serving the region, there is also a system dedicated to moving industrial and commercial freight. Freight is transported between industrial and commercial facilities within the region by a commercial version of the dual-mode PMV that utilizes the same network of clay tracks. For interregional import and export trips, these commercial vehicles connect to the high-speed magnetic levitation freight rail system that shares

the passenger rail right-of-way. This system serves the air and seaports and links San Diego to commercial centers between Sacramento in northern California and Ensenada in Baja California.

c. Community of the Future: International Border Zone (IBZ)



Figure 12: International Border Zone

While the majority of development is directed to existing urban areas, the U.S.-Mexican border zone, as conceived in our design, reflects the region's new transnational collaborative approach to sustainability through the development of a new urban center straddling the common border (Figures 12, 13, 14).

One of the two primary cities within the

International Border Zone provides the intellectual, political, and corporate base needed to advance sustainable development. With corporate, governmental, and academic partners, the Otay Mesa-Rodríguez primary city center serves as a research, training, demonstration, and venture catalyst center, matching development needs with funding sources and new technology. This binational resource will share its findings with a world hungry for new ideas and information about sustainable development. It will also market services and technology needed for sustainable development.

The IBZ is defined by its surrounding environmental corridors and preserves rather than by cultural, historical, or national boundaries. The Tijuana River lies to the south, the Otay River to the north. Otay Mountain and Cerro San Isidro form a natural eastern border while the Tijuana River National Estuarine Research Reserve bounds the IBZ to the west at the Pacific Ocean. The

immediate IBZ region is surrounded by more than 80 km² of natural reserves and restored open space. The developed area stretches 19 km from east to west, 9 km from north to south. The international border between the United States and Mexico has lost its barrier and restrictive functions, similar to



Figure 13: IBZ Primary City

borders within the European Community a century earlier. This is a direct result of the full integration of the economies of the North American region, including free movement of people.

The Tijuana River National Estuarine Research Reserve, located between the IBZ primary

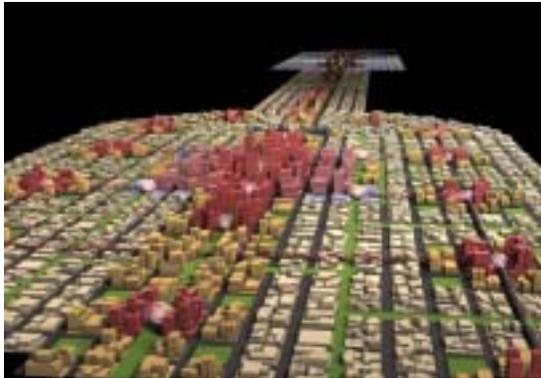


Figure 14: IBZ Primary City Center

city and the Pacific Ocean, functions as an international Ecopark and resort center. The Ecopark’s learning and interpretive centers offer visitors an interactive educational experience based on sustainable ecosystems design.

The IBZ is organized in the now-familiar

hierarchical pattern of city, village, and

neighborhood (Figure 15). Tijuana and the new Otay Mesa-Rodríguez city center represent the 2 primary cities of the IBZ. These cities are supported by the following secondary cities: Tijuana River Zone-Historic Downtown Center; Matamoros-El Florido; San Antonio de los Buenos-Rosarito; Tecate-Las Palmas Valley; New Port-La Misión; Chula Vista Eastern Urban Center; San Ysidro; and East Otay Mesa. The secondary cities contain residential villages of varying densities that occupy more than 4,047 hectares. Each village consists of 5-6 neighborhoods that are linked to a village center by an arterial roadway for the private PMV system, feeder lines, and shuttle systems. The villages range in size 30,000-60,000 dwelling units, depending on the density. The 2 primary cities contain a total population of 1.5 million. The 5 secondary cities combine for an additional population of 2 million.

The Otay Mesa-Rodríguez primary city is a high-density, mixed-use development. It serves as the international business, financial, cultural, and civic center of the IBZ and a magnet for the headquarters of major international corporations, drawn to the region by the synergies of the Mexican

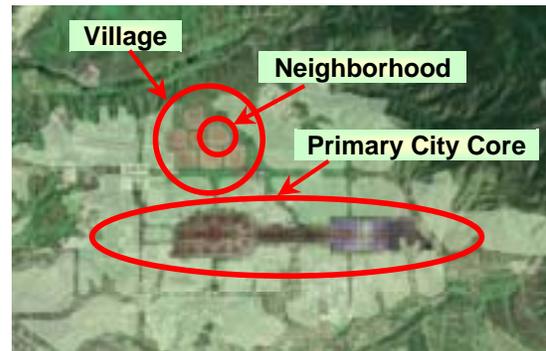


Figure 15: City, Village, Neighborhood Hierarchy

and U.S. components of this binational regional economy. The 200-hectare primary city center is expected to accommodate 4 million square meters (m²) of office space, when fully built out. The East Otay Mesa city center will support the Eco Employment Business Park that contains an

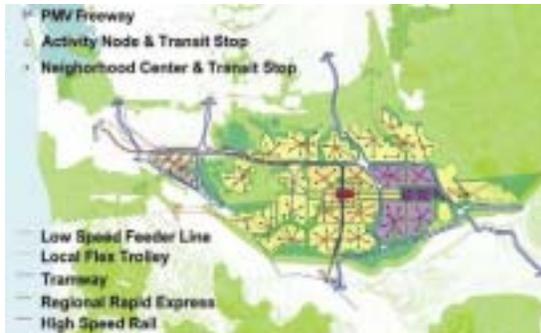


Figure 16: IBZ Transit Network

additional 3 million m² of office space. A tramway with multiple stops (approximately 400 meters apart) provides access between these 2 cores, as well as among the office and retail buildings along its route (Figures 16 & 17). The transit connection between the cores has been modeled after Las Ramblas of

Barcelona. Las Ramblas provides a wide central greenway for the recreational enjoyment of the IBZ’s residents and a central corridor for transit, pedestrian, and bicycle traffic. Las Ramblas is bracketed by high-density mixed use that includes housing, ground floor retail, restaurants, and outdoor cafes that have access to the greenway and wide pedestrian sidewalks. The IBZ Center has its identity reinforced by a unique landmark office tower. A similar structure anchors the Eco Employment Center core directly on axis with this tower. The mixed-use core of the employment center supports 10,000 dwelling units with additional retail and office uses.

The Otay Mesa-Rodríguez City has been designed around an accessible, convenient and flexible transit system that effectively serves residential densities (ranging from 124-370 dwelling units per hectare) along its routes. As a result, 90% of all trips taken within the City’s boundaries utilize this zero emission mode of transportation.

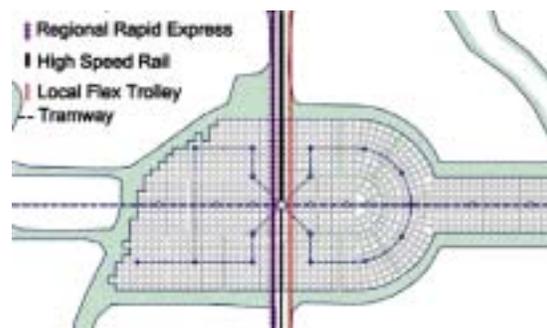


Figure 17: IBZ Primary City Transit Network

International Border Zone Building Systems

While older buildings in the region have been retrofitted for greater resource efficiency, new buildings in the IBZ are designed for maximum effective use of energy and water. Use of high technology construction materials and multistory buildings, along with other energy efficiencies and conservation measures, has reduced overall regional per-capita energy consumption by 2/3 compared to the previous century. This has been accomplished despite the more than threefold increase in the regional population. Automated technologies provide custom environments. Strong glass walls of double pane construction with vacuum insulation are competitively priced and completely recyclable. Some window coatings produce electricity from sunlight; others modify opacity on command, effectively allowing occupants to change window locations on a daily basis if desired.

Most residential units in the IBZ—on average, about 110 m²—are clustered into multifamily structures, although there are some single-family residences. Residential construction involves little more than on-site assembly of prefabricated modular units and enables greater energy saving opportunities. Every wall, floor, and ceiling unit features fiber optic and electronic circuitry. Materials are derived from composite recyclable materials such as wood, plant fibers and resins, and glass. Steel and concrete are only used in framing high-rise structures to meet earthquake standards and most of this material is harvested from old roadways and automobile depositories.

Buildings throughout the IBZ use rooftop wind scoops to funnel air into the cooling systems as well as other design elements for natural air-conditioning. Clerestory windows open automatically at night to draw cooler nighttime air and close during the day to maintain comfort levels. Cooling and heating are supplemented by chilled or heated water from the RMC. Hot water is supplied by solar thermal energy with small amounts of energy used to boost the final delivery temperature. Underground pipes are also used to provide cooling in the summer and serve as a heat sink for heat pumps in the winter months. Hydroponics on the rooftops of large commercial and

industrial buildings reduce interior temperatures, provide weather insulation, and moderate interior temperatures. Rooftop gardens also provide cut flowers and produce for local use.

Gray water and black water are reclaimed through advanced filtration technologies that also filter ocean water. Buildings channel rainfall to neighborhood storage basins that service community gardens. As a result of these and other conservation technologies, as well as sustained public awareness, per capita water use has decreased dramatically in the past century.

d. Sustainable Energy System

In 2103, the region, along with the rest of the United States and Mexico, is in the midst of a new energy era, one that is dominated by hyper-efficiency in energy consumption and sustainability of energy supplies. Overall per capita energy use and imported energy have decreased to very low levels compared to the energy use of 2003. This was achieved through the integration of energy production with other resource management technologies (such as water, wastewater, and solid waste), building efficiency, distributed generation, and the village design concept. Furthermore, the region's reliance on imported fossil fuels has disappeared in favor of harnessing regionally abundant renewable resources including ocean, solar, geothermal, wind, and enhanced methane recovery from waste. This transformation was driven by swelling populations in the 21st century, forcing a choice between investing in increased energy delivery or investing in sustainable practices to reduce energy demand. The San Diego-Tijuana Binational Region chose sustainability, and by 2103, it led the United States and Mexico in energy efficiency and management.

In 2103, the region's spatial design, energy infrastructure and distribution networks are radically different from the configuration that existed 100 years ago. The energy system of 2103 has 3 integrated elements: (1) micro-grids that support the energy flow within the villages and neighborhoods, (2) neighborhood Resource Management Centers (RMC) that operate the micro-grids and balance energy flows, and (3) energy production technologies. Electricity is the sole form of energy delivered to homes and commercial buildings. Most electricity is locally generated from renewable sources, but the region is not completely energy independent. Several superconducting

power lines bring remote energy to the region. The only other energy form in the region is hydrogen, which is used primarily for industry, transportation, and storage in the RMC.

The regional spatial design has established each neighborhood as a largely independent energy network serviced by the RMC via a micro-grid. These micro-grids differ from the electric grids of the 20th or 21st century. Instead of moving only from centralized generation plants to end-users, electricity now flows in both directions between end users and generation sources, balancing demand with production on an ongoing basis. This reciprocal flow of power is managed by computers housed within the RMC.

Each neighborhood has 1 RMC that is responsible for its energy needs, and these constitute the heart of the region's energy system. As an energy manager, the RMC integrates power production within and between neighborhoods. During periods of excess energy supply, the RMC uses the energy to create hydrogen, recharge energy storage devices for future energy need, or to fuel the personal mobility vehicles (PMVs). During periods of excess electricity demand, the RMC generates power from hydrogen-powered fuel cells, uses power from local energy storage, or draws from the regional electricity Supernetwork, a system of underground superconducting electricity lines that link RMCs to remote electricity supplies. In addition to its role as local energy manager, the RMC is also the central base of operations for the PMV, waste processing, and water supply systems. Thus, traditional energy utilities have evolved from commodities brokers to energy related service providers—running the RMCs and increasing their product range from just energy to include water, waste management, and transportation. The RMC integrates the energy and resource needs of the neighborhood to be as efficient as possible.

Regional energy supply is much more diversified than over the previous 2 centuries. In fact, the primary energy production technologies in 2103 are demand reduction technologies. All structures within the region have been constructed with maximum energy efficiency, including advanced lighting and product miniaturization. Furthermore, each building is designed to be an optimized, renewable distributed generation system. Solar photovoltaic materials (including

roofing, windows, paint, and building materials), micro-hydropower within water pipes, and small wind turbines are part of the overall building design and construction, with requirements to maximize these features codified in building regulations. Smart controls regulate these generation devices to automatically accommodate the energy use needs of the residents. Other energy savings systems, such as solar water heating, solar shading, and both natural and artificial air flow, are also widely used. This has resulted in net zero energy buildings that produce as much power as they consume on an annual basis.

The second energy production source is the RMC itself, which stores excess power from the micro-grid in batteries or converts it into hydrogen. When the micro-grid needs power, the RMC dispatches electricity from its energy storage devices or draws power from the fuel cells of the stored PMVs. The RMC also has other sustainable energy sources given its integration with the waste and water systems. The waste materials provide biological feedstock for hydrogen production as well as methane that can be reformed into hydrogen. The throughput of water allows for the installation of inner pipe hydropower systems within the water trunk lines. Pumped water stored in the rooftop of the RMC is heated with solar energy, and is also used to increase the micro-hydropower production. Finally, the RMC is equipped with computing technologies that allow it not only to manage the micro-grid electricity, water, waste, and transportation flows but also to maximize the RMC interaction with other RMCs within the Supernetwork.

The third source of energy for the region is remote electricity production that is sent via superconducting power lines to the Supernetwork. There are many sustainable and renewable electricity production sources outside of the neighborhoods and villages. Just offshore, the vast potential power of the ocean is harnessed through tidal, wave and ocean thermal technologies. Inland areas of the region also provide sustainable electricity generation with wind farms in the mountains and solar farms and geothermal facilities in the desert to the east. Outside of the Greater San Diego-Tijuana Region, sustainable energy such as fusion, solar and wind, and hydrogen-based

electricity are available from the North American Energy Security Grid—a superconducting grid that ensures energy supply to the North American Free Trade Area.

Along with the shift in energy supply, energy delivery methods have also radically changed. There are now 3 distinct forms of electricity delivery in the region. Small energy consumption devices—such as appliances and portable electronics—require so little energy that they are able to operate on wireless energy, based on the concept of wireless communication. The RMC transmits packets of stable potential energy that are converted into usable energy to power these devices. This breakthrough in technology eliminated the need for portable energy sources and home and street wiring for lights or appliances. The wireless energy is supplied by the RMC, which recoups its costs via a monthly energy user fee. The second form of electricity delivery is the micro-grid itself, which connects all buildings in the neighborhood to each other and to the RMC. This micro grid operates to maximize the efficiency of renewable energy before calling on other sustainable energy technologies. Finally, superconducting power lines of the Supernetwork link all RMCs to each other and to remote electricity sources, for a third means of energy delivery.

Hydrogen, the secondary fuel of the region, is used primarily to fuel the transportation system, some niche industrial applications, and for energy storage. It is obtained from electrolysis, reformation, and biological creation. Excess power from the micro-grid is collected by the RMC and used to recharge batteries or to electrolyze water into hydrogen. The waste collection process of the RMC captures the methane from organic wastes. This methane is reformed into hydrogen at the RMC to fuel the transportation fleet or produce electrical power. Biotechnology breakthroughs have developed processes of hydrogen creation that utilize genetically engineered microorganisms.

The emergence of local energy production technologies had a huge impact on the economy of Tijuana and its adjacent communities. Superior worker capability, resulting from investments in vocational technology training and technical education in the previous century, enabled these communities to become the dominant market force within NAFTA's new sustainable energy economy. Interestingly, Tijuana's concentration on sustainable energy services also linked it to the

northern region's concentration on biotechnology. The UTC-Sorrento and Tijuana-IBZ city centers both benefited from the successful bioengineering research and development (R&D) efforts by San Diego and Tijuana universities to produce hydrogen from genetically modified organisms. Similarly, their focus on energy crop development and enhanced biomass conversion to hydrogen through bioengineering played a key role in the entire region's emergence as an internationally known leader in sustainable energy resources and innovation.

The integration of energy and spatial design also helped ease the merging of Tijuana and San Diego into the unified region it is in 2103 and contributed significantly to the economic convergence of Tijuana and San Diego. Through capital investment and high-skill manufacturing of energy products and other advanced technology, Tijuana was able to significantly enhance its income levels and tax base to support public infrastructure and services expenditures.

The current sustainable energy system has provided zero-emission, abundant, reliable, and relatively inexpensive energy since the 2070s. Further, this system has enabled the region to become largely energy independent and fully integrated north and south, as one sustainable energy market across the border.

e. Sustainable Water Supply and Wastewater Management

In 2103, the region enjoys an adequate supply of potable water as a result of water conservation by households, businesses, landscaping, and agriculture, as well as through water reuse and desalination. By 2103, per-capita use in San Diego was 50% of levels of a century earlier. Tijuana's per-capita use, already low in 2003, declined slightly over the century. Less than 100 years earlier, as much as 95% of the region's water supply was from the Colorado River and other distant sources, and that supply was threatened by declining quality and competing uses. Saltwater desalination technologies now are not only economically feasible for the region, but are, along with its sustainable energy resource technologies and services, among the region's most important exports.

Super efficient desalination plants are also able to produce their own power. Advances in capacitive deionization filtration, membrane-based seawater treatment technologies, and systems miniaturization greatly reduced the energy requirements of desalination. Higher efficiencies in photovoltaics allow desalination to be powered primarily by solar electricity produced at the site of the desalination plant. Seawater is pumped from the ocean to inland distribution centers that forward the supply on to the RMCs where it is processed, and the only waste associated with these systems is concentrated salt. Fortunately, this salt has a variety of industrial uses and is mined for valuable materials.

Another source of potable water comes from the reclamation of urban wastewater in the RMC. Advanced treatment technologies and system miniaturization mean that all water from homes and offices can now be recaptured and reused. Dark wastewater (water contaminated by sanitary solids) streams received at the RMC are sent to an anaerobic treatment system that produces a sludge gas consisting of methane (70%) and carbon dioxide (30%). While the carbon dioxide is sequestered, the methane is sent to a reformation unit to produce hydrogen for use in fuel cell power generation units and for the PMV system. Grey wastewater streams are electrolyzed to produce additional hydrogen for these systems and pure oxygen for the wastewater sludge decontamination and vitrification process. This process requires no auxiliary energy beyond the initial methane-fueled ignition of the sludge melter, as the organic solids in the sludge maintain the combustion process. The intense heat of the melter transforms the sludge into molten glass, which is then quenched in water, fragmenting the mass into a glass aggregate for use as an additive for a variety of industrial and construction materials. After advanced tertiary treatment, the remaining wastewater is integrated with the desalination process to produce potable water supplies for neighborhood communities.

This recovery technology and reuse practice proves to be more sustainable than the use of sewage treatment sludge as land surface fertilizers, because they permanently remove trace metals and salt from the food chain. They have also eliminated the need for landfill disposal of pathogen

and metals contaminated sludge. These integrated water treatment and energy resource technologies are also found in RMCs serving the industrial centers that require extremely pure water quality for the electronic manufacturing, biotechnology, and biogenetic industries. The industrial RMCs replaced energy inefficient point-of-use industrial pretreatment facilities and provided economies of scale and incentives for similar industries to co-locate within the region.

A critical component of the region's sustainable water resources strategy is water conservation. The conservation ethic among residents has been handed down from generations that date back to the early 2000s, when a crisis in water supply sparked a region-wide call to action. Common water conservation practices were integrated into building designs and included built-in devices to capture and channel rainfall to underground storm water cisterns that replaced old underground parking structures. The captured rainfall is used for landscape irrigation and potable water after treatment in the RMCs. On-site capture and use or treatment of rainfall has eliminated non-point source pollution in storm water runoff and has improved the quality of water in surface streams and the near shore marine areas. Native drought tolerant plant species and turf varieties dominate public plantings and other landscaping in the region.

f. The Obsolescence of Waste

In the Greater San Diego-Tijuana Region, landfill-bound solid waste has been reduced to a trickle. Practically every physical commodity is recycled into its constituent components and reused in some fashion. This is due to product engineering that ensures reuse and recyclability of end products. It is also due to manufacturing processes that eliminate or minimize waste and pollution.

A significant economic activity of IBZ is this "green" design and engineering. New products and materials are designed, engineered, and produced in its Eco Business Park, not only for regional use, but also for export to national and international markets. Companies are aggregated in the Eco Business Park so that waste from some manufacturing processes is used as feedstock for other processes.

Following practices that began in the 1990s, many products for homes and businesses—such as carpets—are not purchased but are leased from manufacturers. The advantage of this system is that manufacturers build products for durability to provide long service and recyclability. The purchase price of many durable goods such as large appliances now includes the cost of manufacturers' take-back programs that enable them to refurbish or recycle appliances at the end of their useful lives.

Products that are not recycled through manufacturers' take-back and leasing programs, along with packaging materials, are collected for composting either at the neighborhood or village level. Of course, all of these non-recyclables—such as wood resin liquid containers and fiber packaging with organic ink—must meet the regional sustainable production code that ensures their composition is, in fact, biodegradable in a specified period of time so as to be useful to the neighborhoods and villages. Products that do not meet these standards are taxed to pay for ultimate disposal. These include hazardous waste that cannot be eliminated through design and pollution prevention techniques and that must be processed and confined in safe sites.

g. Economic Integration and Sustainable Development

The significant changes to the Binational Tijuana-San Diego Region over the 21st century were driven by the expansion of the regional and global economies. As national economies became incorporated into regional economic blocs such as NAFTA and the EU, regions such as San Diego-Tijuana came to compete on a global scale with other regional economies. In 2003, the Binational Region was the 20th largest economy in the world, with more than \$135.7 billion in economic activity. San Diego's economy was then based on high tech R&D industries (biotechnology, digital imaging, computer software, wireless communications, etc.), tourism, defense, and business services. Tijuana's economy was based on manufacturing, tourism, and services. Tijuana, for example, produced 25% of all the television sets sold in the NAFTA market. Although significant economic asymmetries as seen in wage differentials were present, there was a clear trend toward convergence of wage levels across the border. Beginning in the 1970s and accelerating with free

trade in the 1990s, by 2033 the differences between the 2 economies had been reduced to those seen within the European Union in 2000. By 2103 some wage differences remained between Tijuana and San Diego but were minimal and served to support complementary economic activities.

San Diego and Tijuana were able to use their different economic strengths and levels of development as a way to enhance the global competitiveness of the region. The knowledge-based sectors of San Diego and the increasingly skilled industrial labor force and manufacturing expertise of Tijuana enabled the region to develop technologies, services, and products for the global marketplace. Through extension of San Diego financial markets to Tijuana, capital became available for the small and medium companies that are crucial in the supply chain for final products. The new economy that emerged in the Binational Region in the 21st century included sectors such as medical technologies, medical devices, biotechnology, digital media, wireless communication, environmental technologies and services, desalination technologies and services, sustainable energy technologies and services, and others. Throughout the century, the emphasis was on high value added job creation so the tourism industry and other low wage service sectors receded in relative importance in the regional economy.

This restructuring of the regional economy was accomplished through a number of locally generated initiatives. Local universities (San Diego State University; University of California; Autonomous University of Baja California; Technological Institute of Tijuana; Cety's University; and others), with the support of local governments, chambers of commerce, economic development organizations, and industrial and business organizations, launched a process to transfer technology from research universities to the private sector. An important component of this was to restructure research and teaching activities to support research, development, and training in the high tech and high value added economic clusters.

A second locally generated effort involved restructuring of financial markets to serve Tijuana and San Diego for key activities such as small business loans, business incubator activities, and venture capital. This was particularly instrumental in providing start up capital to small and

medium firms in Tijuana that became a critical part of the supply chain for development and manufacturing of the high tech products. Many of these new products were those used in energy efficiency, desalination, and biotechnology. This local effort to reform financial markets required federal and state legislative and regulatory actions, but was propelled by private investment capital.

This restructuring of the regional, binational economy accelerated the process of economic convergence and wealth creation at the local level on both sides of the border. In turn, this provided the tax base and private development investment capital to finance key components of the new urban design for the region. The significant economic growth in the century prior to 2103 became increasingly sustainable due to specific policies encouraging clean energy, waste minimization, water reclamation and reuse, recycling, and protection of natural resources. These policies made economic sense and improved the bottom line of companies while minimizing the impact of economic and urban activities on the natural environment.

h. Sustainable Social and Governance Systems

In 2103, the Greater San Diego-Tijuana Metropolitan Region's governance is enabled by the influence of shared individual commitment to living a sustainable life. There is a broad consensus among the stakeholders of the region regarding the principles of sustainability that have guided development of the Binational Region over the past 100 years. A widely shared value in participatory governance is most clearly seen at the village level where sense of community and sense of place are articulated.

The prosperous economy that emerged in 21st century emphasized creation of knowledge-based industries and high skill, high value-added jobs in both the manufacturing and services sectors. This significantly improved income distribution, eliminating the large class of working poor that characterized the San Diego-Tijuana Region in 2003, and has spread prosperity widely among the population. The economic engine of the region has resulted in an expanded tax base providing the financial resources for the new urban infrastructure and redevelopment efforts. The

highly productive economy also supported enhancement of urban and social services that improved prosperity and quality of life for all citizens of the region. These services, by 2103, included:

- Efficient and low-cost transportation available to all;
- Parks, recreation areas, green areas, natural areas for benefit of all residents;
- Environmental protection and enhancement;
- Affordable and adequate housing for low income residents;
- A mixed public-private health care system, that reduced costs per capita, significantly improved the health of the population, and retained flexibility and choice;
- An integrated system of education that focused on producing skilled and productive citizens of the region. College, university, and technical education emphasized linkages with the regional economy, developing individuals with skills and knowledge in technical areas, management, and R&D. The formation of human capital became clearly linked to the region's economic and social needs.

This improved healthcare system has also been aided by advances in medical technology, which have extended the average life expectancy well into the late 90s. Home health diagnostic kits began to enter the market during the first part of the last century. Low cost, self-administered, and readily available home diagnostics soon evolved into self-help "Medcafes" where residents could access large databases to compare the results of their own tests to those of millions of others. Once diagnosed, an individual could then enter a pharmaceutical code into a system that would dispense the required medicine for an ailment. Traditional doctors and hospitals continue to exist for trauma and extreme medical conditions. The advent of home diagnostics and neighborhood Medcafes has also reduced the need for transportation to medical centers, which was a common practice for thousands of people in 2003.

By 2103, systems of governance in the transborder San Diego-Tijuana had undergone a remarkable evolution. The increasing scale and complexity of the Binational Region forced region-wide cooperation to address problems and issues that affected the entire region. This first

occurred within San Diego County and then spanned the international border to link with Tijuana in common governance efforts. In 2103 Tijuana has a distinct regional government supplemented by city and village councils and San Diego County has a broad regional government supplemented by city and village councils. This duality of local government preserves local traditions and cultures, yet allows for regional transborder collaboration to address regional needs and opportunities in an efficient and timely fashion. Boundary spanning governance functions are carried about by a series of commissions staffed by personnel designated by San Diego and Tijuana local governments. These have emerged around specific functions such as land use planning, urban service delivery (water, wastewater, energy, and solid waste), and transportation. National and state level representatives to these commissions address issues relating to sovereignty and provide liaison with state and federal agencies.

i. Sustainable Environment

By 2103, the region's environment has improved measurably from a century earlier, despite the addition of many millions of people to the region. Clean energy, efficient transportation, increased density that has stabilized the urban footprint, water reuse, solid waste reduction and elimination, reuse and recycling of all products, an economy with widely shared prosperity, and a social system that delivers adequate services to all residents have all contributed to the region's sustainability. The Greater San Diego-Tijuana Region of 2103 enjoys clean surface and groundwater, clean air, clean beaches and uncontaminated soils. Production of greenhouse gasses, particularly CO₂, has been brought under control by the new sustainable energy sources, particularly those used for transportation. Restoration of ecosystems and adequate water for natural vegetation has increased carbon fixation in the region as well. Thus, the Binational Region is participating actively and successfully in global greenhouse gas reduction efforts and has met the internationally recommended limits. The near shore marine environment is uncontaminated by land-based sources of pollution and produces a sustainable harvest of marine flora and fauna species.

As a result of a vigorous conservation, protection, and restoration program for critical habitats and species that began in San Diego and spread to Tijuana, the region's flora and fauna natural resources are in excellent, stable condition. Advancement of the region's sustainability agenda over the preceding century resulted in significant gains in the preservation of habitats and species and protection of open space for recreation. Residents are able to easily access protected areas and open spaces because of their location throughout the region, as well as the efficient and flexible transportation system. Management practices encourage direct contact with natural areas through hiking trails, interpretive centers and trails and picnic areas. This approach is more in tune with the view of nature held by indigenous peoples of the region, rather than typical approaches in the United States in 2003 that advocated separating people and nature.

III. EVOLUTIONARY ROAD MAP

a. Introduction

The previous section of this design described a vision for the region in 2103, 100 years into the future. Necessarily, its content is based on speculative notions about how society and technology would develop over the intervening years. This section of the design utilizes that ideal vision as a cardinal compass point—a true North—upon which to chart the evolution of the region to a fully sustainable metropolitan community. Specifically, we suggest scenarios and important benchmarks for key aspects of the Binational Region's progress toward a sustainable urban design. Important achievements and processes—such as society, governance, economy, land use and urban design, energy, transportation, water, and environment—will be noted for each planning period.

There were a number of basic conditions and forces in the Greater San Diego-Tijuana Region of 2003 that became drivers for the change and sustainability that characterized the region a century later in 2103. Part I, Regional Overview, of this design outlined a number of conditions and drivers that had set the region on the path to an unsustainable and declining quality of life. Rapidly growing human population and urban sprawl, water and air pollution, endangered species

and habitats, greenhouse gases and global climate change, energy and water crises, increasing congestion in the transportation sector, an unsustainable economy and inequality, a housing crisis, and significant transborder economic asymmetries all marked a downward trend in livability and sustainability in the Binational Region.

The relatively rapid deterioration in conditions that was well documented by research and well known by different stakeholder groups helped forge a broad political consensus that set the region on the path to sustainability. Stakeholders were able to look back 30-50 years to appreciate how much and how rapidly quality of life had declined. This helped shape a vision of what the region should be in the future and provided stimulus for immediate action. The action plan for achieving a sustainable Binational Region was accomplished through strategies and concrete actions visualized in planning and implementation periods of roughly 30-35 years. Key actions included public-private partnerships, tax and regulatory incentives, and education and technical support, among others. For most people in the binational community, plans for 100 years in the future did not have much meaning. Instead, a planning horizon of a third of a century was more realistic since many individuals and all of their children would experience the results of efforts at that temporal scale.

The region, then, moved forward to achieve the vision for 2103 in planning periods that were approximately 1/3 of a century each. The evolution of the region was a complex process characterized by simultaneous and interdependent movement and change on many fronts. For example, a strong economy was needed to support transportation developments that were required to enable implementation of increased densification to accommodate a growing population. This, in turn, enabled the protection of parks, open spaces, sensitive ecosystems, and habitats. The integration of innovative energy and environmental technologies ultimately supported all of these developments.

b. Planning Period I, ca 2003 to ca 2036

Society and Governance I. Deteriorating quality of life contributes to stakeholders forging a broad consensus in the Binational Region to create a 100-year vision and begin concrete steps to implement that vision. The strategic vision is the result of actions by local governments, universities, the private sector, and stakeholder groups that represent the larger society. Formal and informal education begins to focus on basic citizenship skills, technical and scientific education, and sustainability science. The San Diego primary and secondary education systems begin universal Spanish language instruction and the Tijuana counterpart does the same with English. The university systems begin to offer joint undergraduate and graduate courses of study in a range of subjects that include public administration, criminal justice, law, social work, energy management, environmental management, business administration, economics, history, and others. Technical education is enhanced and closely linked with regional needs of business and government. University R&D programs in technology and applications for the future are linked and coordinated.

Building on existing cross-border collaboration between government and nongovernmental entities, new multilevel governmental collaborations develop and/or strengthen in areas such as urban planning, transportation planning, water supply and delivery, wastewater treatment, and integrated waste management. These government-to-government collaborative ventures are strengthened as Mexico's governance structure decentralizes and Tijuana acquires more financial resources. At the same time, San Diego County begins the process of consolidating government services and functions to serve the entire county in order to reduce the fragmented nature of the existing local government.

Economy I. Analysis of the binational economy by public and private sector agencies and local universities concludes that the combination of knowledge-based activities and increasingly sophisticated manufacturing expertise in Tijuana offers the best opportunities to compete in the global economy. This approach links R&D efforts of local universities with venture capital,

engineering, and manufacturing to develop new technologies, products, and services for the regional and global marketplace. These areas include energy, pollution prevention, wastewater treatment and desalination, transportation, and biotechnology products and services. Financial markets are integrated across the border to set the stage for economic integration and convergence.

Land Use and Urban Design I. With the adoption of this design and support of the region's constituents, the region witnesses the first building blocks of the entire system in the first 33-year period. This occurs through the gradual rebuilding and densification of the existing central business districts, commercial corridors, and neighborhoods within the region, upon which many of the future extended urban zones are to develop. Urban planners also lay out future settlement zones and begin to build spatial design concepts to bridge them to the existing energy and transportation infrastructure and to the actual regional growth plans for these systems. In all, 4 urban zones in the Binational Metropolitan Region emerge centered on the existing cities of Escondido, Tijuana, downtown San Diego, and the UTC-Sorrento Mesa area.

Three of the zones—Escondido, UTC-Sorrento Mesa, and San Diego—experience the first attempts to combine transit with redevelopment of their underutilized lands. Kearny Mesa, a secondary city within the UTC-Sorrento Mesa zone, is rebuilt during this period to demonstrate and refine the efficiencies of systems integration, to gain further public approval, and to obtain necessary funding to pursue the development of subsequent zone settlements. Additional redevelopment occurs in the downtown areas of Escondido and San Diego. Downtown San Diego and its supporting city centers are the first to successfully integrate this redevelopment land use and transit strategy.

The IBZ also provides an opportunity to explore culturally distinct and appropriate approaches to both affordable housing and new building design and construction practices. Transit-related redevelopment occurs in San Ysidro, while new development occurs in areas south and east of Tijuana. During this period, local, state, and Federal governments begin discussions and preliminary planning of the IBZ in cooperation with private development companies and financial

institutions. Additionally, regional general plans identify and guide future development into 60 targeted urbanized areas that can support further investment in the regional transit system.

Energy I. Reliance on imported energy supplies, a burgeoning population, and integration with Tijuana demand that the region first reduce per capita energy use and then develop more local energy supplies. During this first planning period, residents witness significant reductions in per capita energy use. Energy supply largely remains imported natural gas, oil, and power, but the growth of these imports slows, eventually peaks, and then begins to fall. Legislation that promotes the penetration of energy savings devices is enacted. Gasoline use—higher than any other energy source—is reduced by mandates and incentives for hybrid, alternative fuel, and zero emission vehicles. Road congestion control and rerouting strategies also help to decrease regional gasoline consumption. Power use is slowed through new pricing rates—including time of use rates—and widespread implementation of energy efficient technologies such as LED lighting, advanced appliances, and peak load management. Efficiencies in heating and industrial processes slow natural gas demand, but increases in regional power generation and alternative fuel vehicles lead to an overall increase in natural gas use.

Within this period, demand for indigenous energy supplies increases. The region naturally looks to solar, wind, and methane recovery, but the supply is minimal compared to energy needs. To supplement local energy supplies and improve security, the region incorporates distributed generation—mostly natural gas fired—in its long-term energy planning. Utilities incorporate on-site distributed energy technologies to moderate peak power demand and further lower grid demand and increase overall grid efficiency. This increase in distributed energy systems also spurs the development of facilities that combine energy generation and district heating and cooling. These eventually evolve into the RMC widely used in 2103. Still, significant carbon emissions persist, raising concerns about global climate change. As a result, a system is implemented to ascribe a monetary value to carbon emissions. This increases the cost of fossil fuels and eventually leads to a robust and successful market for emissions trading.



Figure 18: Local Express Flex Trolleys

Transportation I. In consort with the development of new land use and energy systems, transportation technologies are developed and deployed. During the first planning period, the region witnesses the development of the interurban high speed rail system, the intraurban Flex Trolley system, and the dedicated private PMV infrastructure. The necessary rights-of-way are acquired and infrastructure for the high-speed rail and Regional Rapid Express (RRE) are constructed to allow the systems to be operable by the second half of the period. Additionally, the implementation of the Local Express Flex Trolleys and Tramways begin on existing roadways. New city developments, such as Kearny Mesa and the IBZ, enable the systems to be implemented more quickly and serve as further evidence of the system’s efficiency. At the same time, the transit system is introduced into Chula Vista Eastern Urban Center, San Ysidro, Otay Mesa, and East Otay Mesa.

During the first period, the Feeder Systems and neighborhood shuttle systems are developed where the necessary infrastructure becomes available. Elsewhere in the region, the first planning period witnesses the region-wide replacement of traditional internal combustion-only automobiles by hybrid vehicles from the United States, Japan, Korea, Brazil, Europe, and China. The simultaneous development of additional synthetic fossil and agrifuels complements this new automotive technology boom, as do the first commercially available fuel cell energized vehicles.

Although the fleet of private vehicles is cleaner, it is also larger, and, as a result, there is a widespread use of congestion pricing for vehicle corridor access. Other economic disincentive mechanisms to curb private vehicle use and encourage transit use also develop. This is the period in which advances in commercial truck technologies and freight handling reduce both their numbers and their associated air emissions. More specifically, the development of regional railroad connections to seaports, airports, and transit terminals on the outer edge of the region will facilitate these reductions.

These new systems are financed by a combination of transportation fuel taxes and fees, public bonds, public-private mass transit developments, and private concession infrastructure developing and leasing of equipment.

Water I. Perhaps the single greatest technological triumph the region experiences by the 22nd century is the development of a sustainable, regionally sourced, potable water supply. This is made possible by the desalination of its saltwater resources.

The first critical step toward this future state comes in the first planning period when an educational campaign informs and engages the public's interest in increased water conservation and reclamation practices. Simultaneously, the region begins to receive conserved agricultural water from a pipeline just east of its regional boundaries in the Imperial Valley. This temporary water resource is to provide potable water to San Diego County through 2078. This supply amounts to 20% of the demand for this area; the balance is comprised of other imported waters (60%) and local supplies, including recycled water and the first increments from desalination plants. The southern portion of the region—south of the border—continues to rely on imported Colorado River water and indigenous resources during most of this first planning period. Finally, the refinement of desalination technology is more easily utilized in Baja California due to lower installation and maintenance costs and the technologies become a commercial export of the region.

Environment I. Global warming has been a concern of the Greater San Diego-Tijuana Region since the early 1990s. Although consensus among the scientific community was lacking at the

beginning of the 21st century, projections at the time suggested as much as a 3° C increase in surface temperature, and a 33-48 cm rise in sea level in the region by 2100. Beginning in 1994, the City of San Diego launched a variety of initiatives to address this concern and by 2001, greenhouse gas emissions were reduced by 83,000 tons. In Tijuana, CO₂ reduction was not aggressively pursued; however, the average Mexican citizen was responsible for only 1/3 of the per-capita CO₂ emissions attributed to a citizen of the United States.

During the first planning period, continued energy efficiency and advances in physical, chemical, and biological carbon sequestration technologies lower the overall carbon intensity of the region. However, these gains are offset by increasing transportation-related emissions that account for 50% of all carbon emissions by 2030.

c. Planning Period II, ca 2037 to ca 2070

Society and Governance II. The primary, secondary, and higher education sectors of San Diego and Tijuana increasingly harmonize during the second two-thirds of the century with bilingual Spanish and English education adopted as the norm. Technical education as well as graduate education and pure and applied research programs are seamless across the international boundary and support the integrated economy of the region.

Consolidated government in San Diego County emerges during this period as delivery of county-wide government services such as social services, water and sewerage, urban planning, and education become well established. This replaces the highly fragmented situation of 2003. Village and neighborhood councils emerge to address strictly local issues. Tijuana's local government, already providing services for the entire municipality, improves service delivery as devolution of federal powers to the cities occurs and as local financial resources are improved through enhanced bonding capacity and revenue generating ability through property and other taxes. The strengthening economy supports the considerable local investment required for improved government services. At the neighborhood level, local elected councils address a growing list of local issues such as zoning, parks, and social service delivery.

Across the international boundary, there is increasing collaboration between San Diego and Tijuana local agencies for functions such as water and wastewater, transportation planning, and integrated waste management. These collaborations begin to acquire permanency as boundary spanning agencies with Mexican and U.S. sections that jointly make decisions but that report to San Diego County and Tijuana elected local governments.

Economy II. Increasingly, the knowledge-based and financial market resources of San Diego are integrated with the advancing sophistication of the manufacturing sector of Tijuana. The financial markets of the region are integrated, providing start-up capital for small and medium firms in Tijuana that are key in the emerging high technology sectors. Due to high value added job creation in Tijuana, wage levels improve significantly. The successful link between San Diego and Tijuana university R&D and high technology product and service development is strengthened.

Land Use and Urban Design II. During the second planning period, the population rate has peaked, and the region continues to grow within the first 30 of the 60 planned urbanized areas in the region. Construction of the new IBZ primary cities is now well underway. The implementation of the



Figure 19: Aerial Approach to IBZ Central Business District

multitiered urban design is now widely applied and gaining momentum. The necessary zoning and

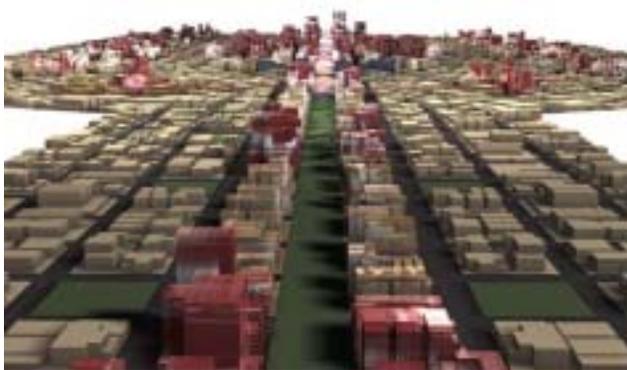


Figure 20: IBZ Central Business District – Primary Corridor

general plans within each of the 4 zones are updated to ensure consistent development across the region. The existing San Diego International Airport is relocated from its former location near the Central Business District of San Diego to a location at Kearney Mesa decided by the community during the

first planning period. Additionally, redevelopment within the urban areas of the region is directly tied to the transit plan. The most important land use planning achievement of this period is the concentration of new development into existing neighborhoods, which has been



Figure 21: IBZ Central Business District – Street Level

enabled through new policy and regulation as well as incentives for private developers.

Energy II. During the second planning period, stakeholder consensus and government action toward sustainability further reduce energy intensity and advance renewable energy technologies. The trend of increased energy efficiency continues, and the rewards become evident as the capital stock of vehicles and buildings turn over and energy intensity continues to fall. Also, research and investment have developed renewables at a scale to compete economically with traditional energy forms.

Solar, wind, and methane recovery from wastewater treatment plants, landfills, and farms now provide much of the energy in the region. Hydrogen also emerges during this period, but its use is limited due to continued storage and piping requirements and safety concerns. Photovoltaic (PV) solar cells are now integrated into building systems such as roofs, windows, driveways, and even some exterior wall paints, with the result that most buildings produce as much energy as they use. During this period, central utility power still flows through the established grids for industrial, transportation, and other baseload needs, but central power plants, primarily nuclear, are only built to keep existing transmission filled. Around 2060, central power infrastructure costs prove to be higher than the cost of distributed generation (DG) technologies, and transmission pipes and wires begin to disappear.

Significantly reduced peak and base-load demand leaves few large energy consumers, forcing energy utilities to rethink and diversify their business models. They begin to work with the

building materials, design, and construction industries to more fully integrate energy producing technologies into building materials and systems, and they participate in the development of micro-grids to aggregate and flatten their energy loads. Utilities begin to shape themselves as service providers offering energy, telecommunication, video, and other home services.

Fossil fuel usage continues to decline. The accelerated installation of renewables and carbon tax legislation drive this trend. The ocean becomes a source of energy as offshore wave, tidal, and ocean thermal power is harnessed and sent to the regional superconducting grid. The region is on the verge of creating a fully sustainable energy supply.

Transportation II. The second period brings about the region-wide implementation of the integrated transit systems and the rise of the PMV networks that connect the primary cities of the urban zones and the first 30 target settlement areas. The second period is most notable for the shift in transit mode from the hybrid automobile to an efficient region-wide transit network and gradual development of the PMV network. The hydrogen-cell based transit system between zones is now significantly developed and proves to be a more efficient means of travel than the private vehicle. Most importantly, the region's application of the new transit system has become a model of efficiency and has dramatically advanced the elimination of air emissions.

Also during the second planning period, there is a convergence of hybrid vehicle power plant and home energy system technologies that results in energy sharing between the 2 power platforms. This results in a de-emphasis on the expansion of an alternative fueling infrastructure that supports private vehicles, which is further complemented by the wider-scale deployment of the PMV system across the region. Ultimately, the public transit system evolves to provide a majority of the region's trips.

Water II. During the second period, advances in desalination technologies, particularly high-speed filtration processes, results in the installation of 3-4 more saltwater filtration plants. Manufactured "fresh" potable drinking water then flows east to the community RMCs. Additionally, the establishment of several water reclamation facilities associated with current sanitary systems also

go into operation, providing reclaimed water for community gardens, residential and commercial landscapes, and the regional agricultural areas. A substantial reduction in energy consumption is realized as this occurs, as the production and delivery of water from these sources require only 1 kilowatt hour (kWh) per cubic meter (m³) or less, as opposed to 2.6 kWh per m³ for imported water supplies from northern California.

Environment II. During the second planning period, the shift to renewable and natural gas energy sources and further advances in carbon sequestration technology produce acceptable levels of point-source emissions. However, the increasing number of mobile sources remains a challenge, despite increasingly strict emission standards and the dominance of lower emission hybrid vehicles on the market. Transportation accounts for 75% of all emissions and hastens the rapid commercialization of hydrogen fuel cell vehicles and advanced electric battery vehicles.

d. Planning Period III, ca 2071 to ca 2103

Society and Governance III. During the third planning period, local government consists of local representative councils, a unified San Diego government, and a unified Tijuana government. The boundary spanning commissions that began to emerge earlier in the century through transborder cooperation on specific issues and tasks are consolidated and institutionalized. The commissions have single or multi-purpose functions such as regional transportation, land-use planning, water and wastewater, energy, and social services delivery. They are overseen by the elected San Diego and Tijuana local governments and have appropriate federal and state representatives.

Economy III. Wage levels in San Diego and Tijuana have now converged. The economic base is supported by advanced technology products and services related to the environment, transportation, energy, biotechnology, and desalination. The university-industry link based on targeted education and focused R&D is critical to continuing the strong technological base of the regional economy.

Land Use and Urban Design III. The final period includes the refinement of the Urban Design to account for the adaptation of emerging technologies and the subsequent population growth of the region. Within the urban design, the 4 zones and their respective primary cities have become fully

established, including the new IBZ primary cities that become identified as physical symbols of the region's reputation as a center for sustainable urban system design. The public transit network has guided development along strategic corridors and centers. Each neighborhood and village is completed, with access to all civic, commercial, employment, and educational centers within walking distance or a short ride on the transit system. The urban design has successfully created affordable housing and complementary employment opportunities for all the residents of the region.

Energy III. In the 21st century, the region dramatically reduced energy consumption through energy efficiency and increased regional renewable energy production. However, populations swelled at the end of the century, and overall energy use began to increase once more. With the 22nd century approaching, the third planning period brings physical changes to energy use as systems integration, urban planning, and new transportation modes help meet increases in energy demand through the continued use of renewable energy.

Fossil fuels in the region are finally abandoned in favor of renewables and hydrogen. Additionally, R&D has made fusion energy and limited low voltage wireless energy distribution systems feasible in this planning period. The only imported energy is renewable energy supplied from remote areas within the region as well as fusion, hydrogen from coal and fossil fuels, and other renewable energy imported to the region via the National Energy Security Grid. Hydrogen has emerged as the portable energy of choice, and electricity is the sole energy source within homes. Renewably derived hydrogen or stored electricity powers all vehicles, resulting in zero emission travel. The region has evolved from a mega-city into a series of self-reliant communities. Each has its own micro-grid that has integrated all community energy systems. Utilities have expanded their service offerings to include energy, transportation, waste removal, water, and much more. Energy use within the region continues to grow but the growth will be met by sustainable energy sources.

Transportation III. By the end of the final planning period, all 60 targeted settlement areas are now serviced by the PMV system; the hydrogen fuel cell-based transit system has also been completed. Transportation-related air emissions have been reduced to practically zero.

Water III. During the final period, the region becomes entirely self-reliant on its desalination and reclamation facilities for all of its potable water needs. Technological advances (such as miniaturization, membrane, and advanced treatment techniques) allow for the decentralization of processing and commingling of waters at multiple levels of treatment within the community and industrial RMCs. Mexico no longer relies on the Colorado River nor needs to draw down its indigenous reserves. Waters now flow as freely across the border as people and capital in the fully unified metropolitan region.

Environment III. During the first half of the third planning period, the impact of the sustainable land use plan and the public and private mobility systems begin to produce significant results in the reduction of CO₂ emissions. The successful implementation of the plan adds substantial amounts of green space to the region, which then function as carbon sinks during most of the year and, by 2090, the regional goal of 1 metric ton of CO₂ per person is met. As the new paradigm of village living matures and the latest, sustainable technologies reach 100% penetration, the regional governments set and reach a new target of net zero carbon emissions by 2103.

IV. CONCLUSION

The sustainable Greater San Diego-Tijuana Binational Region of 2103 will come about based on the current recognition that without a binational consensus combined with likely technology improvements, quality of life will continue to decline in this rapidly growing area. Fortunately, the synergistic interaction of a broad public recognition of the crisis combined with new developments in renewable resources and energy efficiencies make our vision achievable.

The consensus of stakeholders in the Binational Region provides the political will and direction for policy decisions that will move the region in the appropriate direction for evolution of

the new urban design and building systems; innovative transportation system; new solutions for water, wastewater, and solid and hazardous waste issues; a new energy system; and delivery of urban, social, and health services. These same policy decisions will move the region into a process of sustainable economic development based on synergies of the Mexican and U.S. portions of the regional economy that emphasize R&D and advanced technology and services as well as skilled labor and manufacturing capabilities of the Binational Region. The emphasis on sustainable development and the creation of high-value added jobs will improve per capita income levels and will reduce economic asymmetries across the international boundary. At the same time, the regional economy will be competitive on a world scale and will provide the financial resources through private capital and public investment required for the sustainable region of 2103. The region will achieve full integration of capital and labor and collaborative governance across the international border. In this manner, the incremental implementation over the coming decades of innovative systems, technologies, and policies across multiple sectors will culminate in sweeping changes and long term sustainability for a region that is now confronting many challenges.