Chapter XI: Physical Infrastructures

Introduction

This chapter addresses physical infrastructures in Israel, including land transportation (roads and of railways); seaports and airports; energy; water; as well as the engineering manpower infrastructure in construction and infrastructure sectors. Planning and budgeting for most of these areas are under the state's responsibility. Following discussions and consultation with experts, we decided not to address the subject of communications infrastructure in this chapter, as this field is developing primarily in the private market, and because the required investment for creating an advanced national communications infrastructure is significantly lower than that of other national infrastructure components.

Well-developed infrastructures are a prerequisite for the existence of a modern economy. Strategic planning of infrastructure development is crucial, because of the relatively long time periods involved in planning, obtaining licenses, funding and implementation, and the need to identify and keep open options for long-term development and preserving the rights of future generations. The infrastructure industry is a large economic sector in itself. Land transportation alone in the EU for example, encompasses about 8% of the continent's employment and accounts for 11.5% of its GDP.

Investment in infrastructures is an accelerating factor in economic growth, but accelerated growth requires broad integration of additional development policy components across economic, social and environmental realms and national planning policy. Israel's national infrastructures also have an important geo-political aspect vis-à-vis relations with neighboring countries and integration into European planning to ensure good accessibility between the EU and the Mediterranean countries.

In contrast to most of the world's developed countries, Israel has a number of unique characteristics that are directly linked with some of its infrastructure industries. First, Israel is one of the only developed countries with relatively high population growth, as opposed to the demographic standstill that characterizes most developed countries. This creates a great challenge, due to the need to expand and add infrastructures rather than merely make improvements in existing infrastructures. Second, Israel is a physically small country with high population density. Development of infrastructures has, therefore, a direct impact on quality of life and on maintaining environmental values.

The most influential factors in infrastructure development in Israel include the absence of long-term planning, the lack of national infrastructure strategy, and the absence of a central institutional structure responsible for planning, budgeting and implementation. There is no national body responsible for state infrastructures; rather, the responsibility is split among several government ministries.

Therefore, a "business as usual" approach (i.e., keeping development at the currently accepted level) for land transportation infrastructures, seaports, energy supply, water and industrial waste treatment, will constitute an **obstacle** to economic growth. By this script, the rate and manner of implementation of infrastructure development processes will not satisfy the projected rise in demand, and particularly will not respond to the challenges posed to Israel's economic and social development for the next twenty years.

In order to satisfy the expected demand until 2028, and to allow for a reasonable quality of life for Israel's residents, investments in infrastructure are required of a scope of nearly NIS 490 billion for the coming twenty years. We emphasize, however, that supplementing the budget is not the only lever for development. Serious factors that hinder and possibly prevent development, even when financial resources are available, include legislation, problematic institutional structure and bureaucracy. This chapter will present ideas for planning, technology and organization that should be promoted in the future, in order to respond to the needs of individuals and society as regards mobility and physical communications, water and energy.

Israel's Infrastructures: A View to 2028

According to the Central Bureau of Statistics' population forecast, Israel's population will reach over 9 million in twenty years' time. Currently, some 2.2 million vehicles use Israel's roadways; this number is expected to reach about 4 million by 2028. Israel's motorization rate is currently about 300 vehicles per thousand residents, at least 50% lower than that of the developed nations. Twenty years from now, assuming an annual economic growth rate of about 6%, it is expected to reach its saturation point of between 400-500 at least; the kilometrage rate will double. Even today, Israel's road density is among the highest in the world: about 115 vehicles per road kilometer. If we compare Israel to small, densely-populated countries in Europe, such as Holland and Belgium, we shall see that the gap is already vast: Belgium has about 39 vehicles per kilometer, and Holland has about 70. We emphasize that these countries, unlike Israel, have zero population growth and highly developed public transportation systems, especially railways. In the absence of substantial change in the "Modal Split" (travel distribution between means of transport) towards increased public transportation of all kinds, the practical meaning of these figures is the need to double Israel's roads system. In a small, densely-populated country such as Israel, whose land resources are dwindling, particularly in metropolitan areas, such a scenario is unfeasible for physical and environmental reasons. These constraints are even more prominent if we do not include the Negev area. Therefore, we have no choice but to invest a majority of resources in developing public transit systems, and to set as a guiding vision for 2028, a target whereby 50% of travel to large urban centers will be done via public transportation, accompanied by an increase in population density in population centers and peripheries around railway centers.

In the energy realm, according to an accelerated growth path, electricity consumption is expected to reach annual peak demand levels of 25 megawatts, as compared with current peak demand levels of under 10 megawatts. Increased electricity production until 2028 is planned in the framework of the Electric Company's five existing sites along the coastline, in addition to 33 working or planned units throughout the country run by various natural gas technologies. It appears that Israel will join world trends to attempt to develop sources of alternative energy, particularly in the realm of renewable energy, due to both the high cost of fossil fuel as well as increased monitoring of greenhouse gas emissions. At the same time, on the basis of our current knowledge, even if new developments occur over the next twenty years, they will not yield sufficient output to substantially replace today's dominant energy sources.

In the realm of seaports, Israel Ports' master plan for 2030 projects that 9.7 million containers (TEU) will reach Israel's ports, as opposed to 2.0 million containers in 2007. This expected increase requires building terminals for Haifa and Ashdod ports beyond their existing area. There exist, however, complex planning conflicts as regards the power plant site situated in the heart of Haifa port, the gas terminal and Haifa's northern coastline. Planning conflicts at Ashdod port are vis-à-vis the Eshkol and Rogozin power plants, a nature reserve and a free-fire zone north of the port. Furthermore, the air travel forecast exceeds the capacity of Ben Gurion airport; an additional international airport will be needed. Inquiries regarding its precise location are currently being made.

Among other factors, infrastructures' increased pressure on land resources caused the National Council for Planning and Building to issue a tender for artificial islands for infrastructure, some years ago. The winning project was presented before the Council's plenum, and provided it with tools for assessing future initiatives in this direction. At this stage, no plans exist for the creation of artificial islands for infrastructure on Israel's coastline.

Infrastructure: Integration

The various infrastructure components influence each other. There is a clear interaction, for example, between transportation and environment. A rise in the number of private vehicles and increased kilometrage augment the "external costs" of environmental damage, congestion and road accidents, all of which increase the "Social Cost". Motor vehicles are the primary "contributors" to air pollution. According to the US Department of Transportation, they are responsible for 70% of carbon monoxide (CO), 33% of ozone-damaging gases (O3), 50% of nitrogen oxides (NOx) and 21% of suspended particulates. Despite the significant reduction in pollutant emissions from vehicles due to engine improvements and the use of catalytic converters, overall pollutant emissions are expected to rise, due to the increased number of vehicles. In Israel, there has also been a rise in engine displacement, which exacerbates environmental damage (it is still difficult to assess the pace at which electric-run vehicles will penetrate the market, and their overall environmental impact).

Within the transportation realm as well, there is interdependency among various means of transport at the level of development. The need to increase the share of users of public transportation and its preference over private vehicle use must have implications for the priority given to developing rail transportation (light and conventional rails) at the expense of roads development, at least in metropolitan areas.

In the energy realm, mutual environmental influences are found along three axes: a) Sources: We require a policy to replace polluting energy sources with more environmentally-friendly sources. The plan for the Haifa power plant's transition to natural gas is one example. The use of renewable energy in Israel is in its initial stages. Without government intervention in the form of subsidies, it appears that the use of this form of energy will remain modest over the next two decades. b) Management of demand reduction: the potential for conservation is large, but this issue has hardly been addressed. c) Power plant distribution: the concentration of power plants near the coast burdens the state's coastline, and creates planning conflicts with other land uses that require direct contact with the coastline, such as ports. By 2028, production development will not exceed the currently-active coastal plants; subsequently, however, other solutions will be required.

In recent years, Israel has begun to promote water desalinization as a means to ensure its water supply. At the same time, however, we must remember that the desalination system is a polluting industry in terms of its energy-dependency and greenhouse gas emissions. It is reasonable to assume that Israel will participate in global trends as they were articulated in the 2007 Bali Conference; thus, in the framework of the overall balance of greenhouse gas emissions at the state level, the desalinization process will have to compete with private vehicles, industry and home heating. It should not be viewed as method of water-supply that is restricted by cost considerations alone.

Infrastructures: A Multi-Lateral Problem

Lack of budgets is not necessarily the only obstacle to infrastructure development: problematic legislation; deficient institutional structure; lack of integration within the infrastructure world, particularly between it and other planning and implementing factors; lack of investment in human capital as regards professional training and research and development; shortage in implementation capabilities; excessive bureaucracy; and the lack of multi-annual budgeting for the infrastructures sector, are all serious factors in the failures. Continuation of these trends will intensify future failures and will constitute an obstacle to economic development.

The absence of basic principles for future national infrastructure development, such as a national perspective (the institutional aspect); a systemic approach; a long-term view and fulfillment of the need to set planning policy and strategy; integration between infrastructure systems and economic, social and environmental issues – will all lead to **development that is unplanned or short-sighted, which may create an irreversible negative physical situation in Israel and impede planning options for the coming generations. We must not leave our transportation-economic-social lag for future generations. We have an obligation to close the gap, through rational but determined measures, to lead the nation forward and maintain high-quality infrastructures in a state that aspires for a place in the society of leading countries.**

Recommendation for Changes in Institutional Structure

To facilitate coordination between planning, budgeting and implementation we propose to consider creating a body that will concentrate the powers and multi-annual budget for planning and implementation, following a government decision and the completion of statutory procedure at the national level. It may be appropriate and advisable to establish a cabinet for physical development, in which the relevant ministers will participate. Until such a body is created, we propose that the Ministry of Transportation establish a **supreme intra-ministerial committee for multi-disciplinary strategic planning**, in coordination with the Ministry of the Interior, the Ministry of Finance and other agencies, that will aim to take integrative action in all realms of infrastructure and overall physical planning. After preparing a national master plan that defines the image of the state of Israel, and in order to ensure its fulfillment, it will be important to take action towards encouraging development of physical and social systems conducive to the plan's realization, establishing projects and obtaining funding. Otherwise, it is reasonable to assume that national and local political and economic pressures will impose changes on the plan that will disintegrate its principles and goals. Therefore, **the task is not the frequent preparation of new plans, but rather the preparation of one plan to be implemented**.

Land Transportation

Vision and Strategy

Transportation deals both with individuals' day-to-day lives and with long-term economic, urban and demographic processes that are at the soul of the state. Israel's infrastructure road map is based on a vision that integrates the aspirations of the individual and society with the existing situation, including its physical, social and budgetary limitations. The integrated development of all systems that dictate life in Israel – for open and built-up areas, for roads and railways, and for additional infrastructure and communications systems - must take environmental factors into consideration and utilize all technical and technological means that are currently in initial stages of development and that will be available to the citizens in the future. **For the intermediate term, integrated planning will be based primarily on existing technologies, but without neglecting Israeli and international technological development, particularly "Intelligent Transportation Systems" (ITS).** The primary effort required is that of re-organization**,** not only of transportation issues, but also fundamentally of physical planning, distribution of land use and population, and coordination of development. **Physical development must be comprehensive and integrate policy for developing northern and southern Israel, while creating an urban-metropolitan structure that will satisfy the demands of individuals and society and respond to the accessibility needs of a technological economy, as expected and advisable for Israel.** Implementation of the plan will be done in coordinated, budgeted phases, and followed up and updated in an ongoing manner.

Priorities regarding mobility and travel behavior in Israel must be altered. We must recognize that in view of its small size, Israel cannot tolerate additional massive expansion of length- and width-wise roads systems, nor can our metropolitan areas contain the quantity of private vehicles expected to enter them daily. Our situation in this regard is similar to that of most of the world's metropolitan areas. Clear priority must be assigned to developing mass transport systems including railways, light rail, and high-capacity buses, or BRT systems (bus rapid transit). A target should be set for 2028, that half of the commuters to metropolitan areas will use the various types of public transportation.

Dilemmas and Problems

1. Physical Area

Israel is a physically small country. As opposed to other Western countries, its population is growing continually at a high rate, and its motorization rate, which is still low, is also rising at an accelerated pace. The density of central Israel (in terms of residents per square kilometer) is high, and will continue to increase at an accelerated pace in the coming years.

At the same time, the various transportation systems - city and inter-city roads as well as railways- lag considerably behind European countries (including the small countries, such as Belgium and Holland).

2. The "Business as Usual" Scenario

In this scenario, building is sparse, scattered and inappropriate for the transportation system; the mass transit system is developed too late and its influence on development of land use is also belated; there is no integration between the various systems; and there is no development or promotion of smart transportation or alternative communications systems. In this situation, despite the development of roads to the level of a national master plan (National Master Plan No. 3), they will not provide a high level of service for Israel's 4 million vehicles expected in about twenty years' time. The entrances to cities are congested with traffic, bringing about additional dispersal of land use and building on every empty space and in turn, increasing dependency on vehicles. Resources are wasted on long road delays, which significantly damage quality of life and indirectly cause increased air and other environmental pollution. This trend is almost irreversible, and changing it is a long, costly, ongoing process. As a result, both GDP growth and investments suffer. As in many countries in the world, Israeli planners have reached the conclusion that the trend must be changed and an alternative scenario adopted.

3. National Master Plan

National master plans for roads and railways exist in principle only. They determine what is permitted to build/pave and where, **but do not define priorities regarding advisable and advantageous timing, in terms of the overall national master plan**. In addition, the master plans cannot ascertain the allocation of required budgets for fulfilling the plan in its entirety. The Ministry of Transportation, the body responsible for developing transportation systems, has not yet adopted multi-annual budgets, and therefore has not had adequate opportunity to impact upon shaping Israel's image. Only now has the procedure begun to institute a five-year budget plan for Israel's overall land transportation system.

4. Shortage in Engineering Manpower (engineers and practical engineers) in recent years

This shortage may become a real bottleneck in other areas of development as well. Today, the shortage is felt more in infrastructure and less in construction, especially as regards implementing projects on the ground, which is the most difficult and demanding aspect. The shortage will worsen in coming years, because even if immediate action is taken, its initial results will be manifested only after five years or more (see appendix for more on this issue).

Recommendations

Primary Recommendations

1. Extensive development of mass transit systems: suburban and inter-city railways, light rail and BRT systems (high-capacity buses that use an exclusive path, similar to the light rail) and coordinated city bus service. This development requires a turn about in mind-set: expanding the railway network while investing less per unit of length and penetrating into city centers and to the level of pedestrian, i.e., more light trains on roads and streets, over longer distances, and fewer tunnels and heavy trains in metropolitan areas.

2. Using economic tools for regulating and limiting (via congestion tolls) private vehicle use in metropolitan areas, but only after supply of modern and competitive public transport systems has been augmented. Reducing the use of private vehicles and increasing transition to public transportation is a complex behavior change, which constitutes one of the greatest challenges in the realm of land transportation for the coming years.

3. Enhancing integrative planning and implementing, as regards to the following three spheres: a) among transportation systems (roads, various types of railways, seaports and airports); b) between transportation, land use and urban planning and c) between transportation systems and environmental and energy systems.

4. Creating or authorizing an official body to be responsible for taking a comprehensive national view of the state's physical infrastructures systems, including determining budget items, resolving conflicts of interest, and setting priorities for implementation.

5. Planning of transportation infrastructure systems that employs a broad regional perspective and takes into consideration the possibility of integration with the Palestinians and neighboring countries, even if its realization will occur in the intermediate or long term only.

Additional Recommendations:

1. Establishing metropolitan transportation authorities to be responsible for the entire realm of metropolitan transportation development. They will receive their powers from government ministries and (primarily) city municipalities. These authorities will deal with physical development and operations, and will manage traffic control centers and integrated transportation centers.

2. Restricting development of roads systems in central Israel (such as Ayalon Highway and Geha Road), at least until mass transit systems penetrate the market and travel behavior changes to the advantage of public transportation.

3. Using and promoting advanced technologies for the long term. Traffic control, traffic

management and "intelligent transportation systems" (ITS) will serve as professional tools for increasing road efficiency and safety.

4. City centers will be planned for user-friendliness; parking spaces will be restricted; whatever is necessary will be done in order to provide a competitive public transportation service and adequate pedestrian and bicycling systems.

5. Overall construction will be denser in certain areas. Existing areas, metropolitan areas and areas surrounding mass transit system terminals will all be augmented, and land use will be concentrated at interaction-intensive points.

Required Investment

The estimated public investment required for land transportation issues (not including private resources), is about NIS 350 billion for the next two decades.

This total is comprised of the following:

- Inter-city and suburban railways NIS 86 billion
- Public transit systems including urban mass transit NIS 86 billion
- Inter-city roads systems including maintenance NIS 79 billion
- City and metropolitan road and street systems NIS 94 billion

This budgeting is reasonable for the current five-year period; its four parts are well-balanced, between developing inter-city roads networks and city and metropolitan transportation systems and the various means of public transportation and paving of roads.

Sea Transportation

Vision and Strategy

In the area of seaports, we have an opportunity to integrate between the needs of the domestic economy and sea transportation, and Israel's unique geographic location in the world maritime trade system. The Haifa and Ashdod ports are situated in very close proximity to one of the world's largest trade lines, between the Far East and Europe. The largest cargo ships currently go through the Suez Canal, adjacent to Israel's Mediterranean ports. On their way from Asia to Europe or to the East Coast of the US, these huge ships typically stop at one or two transshipment ports in the Mediterranean Sea, where cargo is transported by smaller feeder ships to the cargo's final destinations in the Mediterranean's eastern basin and the Black Sea.

Israel's ports combine an excellent strategic location with a market in the eastern Mediterranean basin. These two advantages are among the most important location factors that ship-owners consider when seeking a transshipment port. A controlled level of transshipment cargo, about 30% of total port cargo, integrates well into cargo terminal strategy. Supplementing seaport infrastructure will not only remove the existing risk of impeding economic development, but can even embody economic advantages for Israel, stemming from investments by global seaport operators or domestic factors, increased employment and realization of high economic multipliers.

Israel's ports already lack docks, operational rear yard areas, equipment and skilled manpower. Developing additional container terminals at Israel's Mediterranean ports will enable the absorption of hundreds of operations and maintenance workers at the ports, investment of billions of shekels, and employment of hundreds more employees in construction and port development in years-long projects.

Dilemmas and Problems

Seaports are the dominant gateway to Israel's economy. Nearly 98% of Israel import and export in terms of weight are transported by sea and go through seaports. In recent years, the seaports have had great difficulty to serve as an efficient gateway for cargo, and the seaports suffer – among other factors - from a severe shortage of infrastructure. The serious disruptions at the seaports, overcrowding and waiting ships, which characterize the seaports, cause enormous damage to importers, exporters and ship-owners. These damages are usually rolled back to the consumers and the Israeli economy.

Recommendations

- Additional development of port terminals, operational rear yard areas and improved accessibility of the land transportation system (roads and railways) to seaports are a prerequisite for Israel's economic growth.
- Developing transshipment services at seaports: In the short term, additional seaport infrastructure may exceed the domestic market's requirements; construction of breakwaters and docks are intended for long-term development. This is one of the advantages of transshipment based on international cargo in transit, which is added to domestic market cargo and contributes to the increasing profitability of investing in ports. In addition, transshipment will bring a high frequency of large, fast ships into Israel, with an expanding destination list, which will enhance competitiveness and improve import/export conditions in the Israeli market.

Required Investment

Forecasts for developments in cargo for the coming two decades require an investment of about NIS 6 billion to increase port capacity for each of the coming two decades – a total of NIS 12 billion.

Air Transportation

Vision and Strategy

Ben Gurion airport currently handles about 10 million passengers a year. According to the higher estimates, this airport may serve about 35 passengers in twenty years' time. If this forecast is realized, the capacity of the new Terminal 3, along with Terminal 2 (if it is renovated), will be insufficient for the demand for airport services. In addition, when *Natbag 2000* was opened, it was determined that due to noise and environmental restrictions, the airport would not handle more than 16 million passengers. In view of the projected demand (35 million passengers within twenty years), there will be a need to locate a site and plan another international airport.

Dilemmas and Problems

The projected scope of passengers exceeds the airport's capacity, but the alternatives for increasing capacity are complex and problematic:

- Placing a third runway in parallel to the existing runways is impossible due to space limitations.
- As far as the airport is concerned, it may be possible to create a perpendicular runway, but there is a significant danger as regards access to the runway.
- As per the demand of the National Planning Council, efforts have been made to locate a site for an additional international airport. Three sites have been chosen: Nevatim, Zaklag (near Beit Kama) and a sea area to be dried out, near Netanya. No decision has been made yet as to the site; objections have been raised to each of the sites proposed.

Recommendations

- Terminal 2 may be developed and its capacity expanded, so that along with the new Terminal 3, the airport will be able to provide solutions for the next 15 years.
- Toward the beginning of the 2020s, it will be necessary to discuss the creation of an additional international airport, whether in southern Israel, in a dried-out sea area, or in northern Israel (for a regional airport). Initial investments will be made before 2028.

Required Investment

The existing system is expected to reach the limits of its capacity vs. expected demand near the project's target year. However, in order to increase the system's output and to prepare and plan for increased capacity (and the possibility of an additional airport), investment will be required of the scope of about NIS 7 billion. If the option of drying out the sea is chosen for the additional airport, a significantly higher investment will be needed.

Energy

Introduction

To date, there has been no process of long-term strategic planning for Israel's energy infrastructure or overall energy system. Israel's energy system lacks an approved national energy master plan upon which to base assessment of infrastructure needs and that conforms to this plan's accelerated economic growth scenario of over 6% a year. There is no agreed-upon government policy regarding long-term development of the energy system, or even concerning the types of fuels that Israel should consume. The Ministry of National Infrastructures and Electric Company have made forecasts, typically for two or three scenarios (high, mid-range and low), but these have been based primarily on an extrapolation of past trends.

The electricity system has a significant impact on Israel's environment, affecting air, land and water sources, nature and landscape, sea and coastline, and electromagnetic fields. Thus environmental considerations have had an increasing impact on the location of infrastructure facilities in general and electricity infrastructure in particular, as well as electricity production processes (see Chapter X). As for future energy infrastructures, environmental considerations are not sufficiently powerful to significantly change the course of infrastructure development meant to provide the primary share of the economy's demands. On the other hand, environmental considerations may place limitations on power plants' potential location or determine emissions restrictions, thereby impacting upon the choice of production technology. In a collaborative paper written in 2005 by experts from the Ministry of the Environment and the Ministry of National Infrastructures, a number of specific sites were defined for creating integrated recycling units. An additional restriction on power plant placement is the proximity to water sources, such as the Kinneret basin, the mountain aquifer and the coastal aquifer, which were designated as sensitive areas. Clearly, power plants or transmission facilities cannot be placed in areas of special natural or scenic value, but it is impossible to define ahead of time where placement is prohibited due to these considerations. Environmental considerations for electricity production produce priorities as regards the following issues: use of natural gas vs. other fuels; use of renewable energy sources; strengthening existing production facilities by improving production efficiency and reducing toxic emissions; production of electricity using efficient technologies with low toxicity.

Electricity and natural gas are two sources of energy that require intensive government involvement, and there is considerable uncertainty regarding these industries' future. The issue of natural gas depends upon the needs of the electricity industry. The electricity industry's organizational structure and the government's role in this industry are not clear. Electricity network operations are expected to be taken over by new company separate from the Electric Company. Following the Czamanski Commission's report, "Sustainable Development in Israel's

Energy System", government decisions have been made and a law has been passed by the Knesset (1996), but implementation of structural changes is progressing at a very slow pace.

Vision and Strategy

Given the present technological system or that projected for this paper's time horizon, we do not expect that Israel be liberated from dependency on imported energy sources. Even accelerated development of renewable sources will not provide a response to the large increase in energy consumption. This notwithstanding, clean energy should be promoted, by full pricing of conventional energies. We expect that if Israel's energy system is run by consumers' and producers' responses to prices that reflect "marginal social costs", Israel's dependency on primary energy import will be reduced, as will pollution.

Aiming to diversify Israel's energy sources, we should consider establishing nuclear plants. These plants offer economic and environmental advantages, but clearly economic aspects are not the sole relevant aspects, due to the issue's political dependency on external energy sources. Nuclear power plants are very costly, and in terms of life-cycle cost, require government funding as well. However, considering the external influences of coal plants, nuclear plants offer economic advantages.

Dilemmas and Problems

1. In order to meet the projected demand under the accelerated scenario, an average capacity of about 1000 megawatts must be added each year, i.e., an additional 20,000 megawatts over the next twenty years.

2. A deficiency in Israel's electricity production capacity is expected for the first time in 2009. Existing plans for the system, including current efforts to set up additional power plants, cannot respond to the projected demands of the accelerated scenario in the short term. The main question as regards energy infrastructure policy is: who will set the future course of development? **In the absence of clear policy for the energy system, and of strategic planning for the electricity system in particular, we will experience a shortage in electricity production in the coming years, expected to cause real damage to nearly all sectors of Israel's economy, reaching hundreds of millions of shekels, and to curb economic growth.**

3. If a new company does not begin operating in the summer of 2008 as required by law, and if existing decisions are not changed, it is expected that the electricity industry's "rules of the game" will be unclear, and that new electricity producers will not begin to invest in additional production capacity. Adapting production and supply capacities requires investment over long time periods; the uncertainty will cause the electricity system serious damage. Therefore

the "rules of the game" in the electricity industry must be quickly set, in order to increase certainty and reduce risks.

4. Plans for international investments in Jordan, to be based on the Israeli market as well: In this plan, we have not taken into consideration the developments in neighboring countries' energy infrastructures, such as those in Jordan, which could provide some of Israel's needs. If a large power plant (for example, a nuclear or a natural gas-driven plant) is constructed in Jordan, the region will have surpluses in electricity production capacity, enabling a reduction in Israel's production needs. In such a case, we will have to invest in a transmission system.

5. There is a shortage of land designated for infrastructure development. Planning procedures and statutory decision-making in Israel are cumbersome, and go on for many years. There is a need to change decision-making processes in this realm and accelerate land allocation for infrastructure.

6. Israel's electricity system has a reciprocal relationship with its water economy: on the one hand, the water system provides water to power plants. On the other hand, the water system consumes electricity, especially for desalinization and waste-water treatment. According to the Electric Company's data, in 2010 the total output required for the water system, including *Mekorot*, private operators and desalinization facilities will be about 1,000 megawatts. This is about 8% of the Electric Company's production capacity for this year.

7. Gas – the existing pipeline satisfies projected demands of the accelerated scenario until 2013 only. The options of running a pipeline from Turkey or establishing a plant for import of liquefied natural gas (LNG) should be examined as alternative solutions for transporting gas from the north. The cost of doubling the existing pipeline vs. LNG solutions should be examined as well. There are two primary obstacles to developing a system to disperse natural gas as per the accelerated scenario:

- Lack of strategic planning and policy-making that would enable Israel's Gas Authority to prepare development programs;
- Lack of land as a result of faulty master planning and environmental considerations.

Recommendations

The electricity system is beginning a re-organizational process, by which a new company is supposed to start to manage the production system. The required changes and reforms should be implemented quickly, so as to reduce the uncertainty that damages the electricity system and investment decisions. One reason that electricity system reform is crucial is because of the need to reduce government involvement in the industry.

Primary Recommendations

1. "Rules of the Game" and incentives should be adopted to encourage investments in production capacity that will satisfy future demand. Modern electricity systems operating in competitive markets include an insurance policy and incentives to establish power plants that exceed capacity for projected demand. It is important to develop a doctrine of supervision over the new electricity transmission company to be set up.

2. There is a need for strategic planning of infrastructures by the new company that is expected to start operating the system, following the 2007 legislation. This planning should include making decisions in principle regarding the advisable formula **for types of fuels to be used for electricity generation** (especially coal vs. natural gas and nuclear) and the optimal course of development for electricity generation (presently in the hands of the Electric Company). On the basis of these decisions, development plans will be made and infrastructure facilities agreed upon, as required for satisfying the projected demand according the accelerated growth scenario.

3. We recommend supporting renewable energy programs (wind, solar, nuclear, pumped-storage hydroelectricity, etc.) and investing in new technologies that produce clean energy, although we do not expect that renewable energy will significantly change the supply-demand balance. Renewable energy represents a tiny proportion of total energy consumption. Where renewable energy consumption is state-funded, the growth rates are relatively high. In Israel, the only change expected in the energy formula is the significant entry of natural gas. In contrast, it makes sense to consider initiating nuclear power plants, for economic considerations and considerations of source diversification. The decision of the government and the private sector whether to participate in advancing new technological development in the energy context is no different from that regarding any other economic industry. The question is whether the proposed technology has economic potential and if so, whether government funding will accelerate development such that an advantage will be created vs. competitors. It does not appear at present that Israel has an advantage in this realm. On the other hand, in the very narrow realm of tertiary oil recovery it makes sense to utilize Israel's advantage as regards the high concentration of petrochemical engineers.

Additional Recommendations

1. Changes must be made in the Electricity Authority's supervisory authority, to create a basis for competition in electricity production. The Israeli Electric Company's supervisory method was constructed in a piecemeal fashion on a framework appropriate for a monopoly that never considered the possibility of competition. This is Bonbright's philosophy from the 1950s, according to which superfluous investment (gold-plating) is not a concern, and prices

do not reflect marginal costs. The supervisory method required for the age of competition must reflect real marginal costs on the basis of a future test year, taking all costs into consideration, including for the land below electric lines. The cost of capital must be real; unjustified costs, such as excess manpower, should be paid by owners, not rate payers.

2. Above all, supervision must establish a basis for competition by creating appropriate "rules of the game ". Towards this goal, a rate comprised of at least three parts is needed: separation of energy costs, insurance costs for providing production by "Capacity Charges", actual consumption vs. and potential consumption, etc. Naturally, there will be differentiation between different "qualities of electricity" and a basis for competition between companies dictated by technological considerations on the one hand, and service considerations on the other.

3. We must shape policy, manage demand and reduce burdens to prepare for a situation in which demand for electricity will exceed production capacity.

4. Decentralizing production facilities is a strategic/security issue. The Electricity Law authorizes the Ministry of National Infrastructures to locate sites and shape strategic planning for the electricity system. As the ministry has been unable to implement policy over the past eleven years, other ways should be considered for advancing the issue. In this context, we emphasize that the National Planning and Building Council is having difficulty dealing with the challenge of locating sites for different types of infrastructure, and there is a need to shorten the response time of planning decisions.

5. We should aspire to have the price of electricity reflect the marginal costs of electricity production and supply, in order to carry out efficient management of the system and to allow the demand to give a reliable indication of the required scope of capacity.

6. The issue of oil shale (heavy oil, oil sands and tar sands) should be examined in depth. Oil shale is produced in large quantity, especially in Canada and South America. It is not clear whether Israel's quantity of oil shale enables using the production methods used abroad, and what its costs are (relatively large-scale production is profitable as long as oil's market price exceeds $30 a barrel).

Required Investments

1. Electricity

In order to meet the demand projected by the accelerated growth scenario, two alternative investment routes are proposed for electricity production (not including the infrastructure for electricity transmission).

- The 50% coal-50% natural gas alternative:
  total cost of establishing the power plant - NIS 76 billion.
- The 60% coal-40% natural gas alternative:
  total cost of establishing the power plant - NIS 80 billion.

2. Alternative Energy - Gas

Infrastructure for transmission of natural gas, currently under construction, is expected to satisfy the projected demand of the accelerated growth scenario until 2013 only. By 2028, additional investment will be needed for establishing a pipeline in the northern segment and doubling the existing pipeline in certain segments, at a total investment of about $200 million.

Water

Introduction

Water has a horizontal impact and interaction with other realms such as: energy; agriculture; desalinization technologies; water-saving technologies; forecasts and scenarios for relations with Jordan, Syria and the Palestinian Authority; legislation; and population distribution in Israel.

1. **Water Transport**

   The water system is currently based on transporting of water from the Kinneret and the north to the entire country. This water system provides water to all of Israel's territory and to a certain degree to that of the Palestinian Authority as well. We expect the water-collecting Kinneret basin to be disconnected from the Mediterranean area; its water supply will be directed to the eastern area: upper Galilee, Jordan Valley and Beit She'an, as well as territories of Jordan and the Palestinian Authority. From a planning perspective, this may be a relatively water-abundant area, perhaps enabling a different kind of agriculture than elsewhere in Israel.

   The coastal plain will receive water for agriculture from the aquifer and desalinized urban water; the remainder of allocation of desalinized water and water for irrigation, needs to be based on an appropriate system of economic regulatory rules.

   The southern area will be based on desalinized water (some from saltwater drilling), treated water, reclaimed water, and groundwater.

2. **Water Consumers**

   Until recently, agriculture was the state's primary consumer of potable water. The agricultural sector impacted upon the planning of the water system, water prices, etc. Today, and even more so in the future, urban areas and industry will be the primary water consumers. As domestic water consumption is increasing, urban water consumption will utilize all or most of the potential of renewable water (measures may be taken to prevent increased consumption and perhaps even to reduce consumption). Treated water can be used for irrigation and other uses, depending upon the quality of water treatment. Israel has decided that its standard of water treatment will enable unlimited irrigation. However, this definition may be invalidated by a failure in the treatment system or the discovery of components in the water that cause illness, even cancer. An additional principle of Israel's water system is the provision of a reliable standard of drinking water at every point in the system, although much of it serves for irrigation. We recommend addressing the present conception and considering separate networks for drinking water and irrigation water.

   Israel's water system has reciprocal relations with the electricity system: On the one hand,

the water system uses electricity, especially in desalinization and waste-water treatment facilities, and on the other, the water system provides water for power plants. In addition, new technologies such as pumped-storage hydroelectricity use large amounts of water in the electricity production process. The electricity system consumes water in two main processes: processing water for steam production and for cooling. Process water needs to be high-quality potable water. Cooling water consumed in considerable quantities by coal power plants is seawater, and the water system does not have the capacity to provide the required amounts at a distance from the sea. Power plants heated by liquefied fuel or natural gas consume much less water, about 10 million cubic meters a year. As far as the water system is concerned, it will be possible to provide an adequate amount of water for such power plants anywhere in Israel.

Vision and Strategy

Water system planning must take into consideration the extreme uncertainty that stems from climate conditions and the amount and distribution of precipitation. Great variability exists over the years, with years of abundance that yield surplus water, and years of drought, sometimes even a succession of drought years. The future carries even greater uncertainty. Evidence exists that global climate change will decrease the amount of precipitation, shorten the rainfall period and increase its intensity. In such a case, the amount of water available for use will decrease, while the amount of water required for sustenance will increase.

In view of the increased use of desalinized water, it is important and crucial to reduce dependency on climate conditions, but this has built-in limitations. Desalinization requires a great deal of electricity (some 5 kw/hour per cubic meter water). Projected increases in energy costs and severe world-wide restrictions on greenhouse gas emissions will create a close connection between the ability to provide sufficient water and progress in renewable/clean energy production. From the strategic perspective as well, the water system's increased dependency on imported energy is a factor that needs to be addressed.

Water for environmental needs should also be taken into consideration, for maintaining nature as well as agriculture, an essential element in Israel's environmental protection.

Dilemmas and Problems

Israel borders the desert, and its location offers limited water resources. The water system must be managed accordingly.

1. If no technological, educational, economic or legislative measures are taken to reduce residential water consumption, it is likely that all Israel’s renewable potable water will be used for residential consumption. Potential reduction in water consumption should be considered.

2. The National Water Carrier, established in the early 1960s, is already obsolete from a planning perspective. We expect that in the not-distant future, investments will be required to renew the system. Investment will also be needed to establish and maintain lateral connection lines from desalinization facilities along the coastline to the municipal system.

3. We have almost certainly lost the battle over the protection of water quality in the coastal aquifer's groundwater reservoirs. The underground layer that feeds the groundwater has been polluted for decades, and this water will be polluted to some degree in the coming years. Pollution of the mountain aquifer, which is still in good condition, is also very possible, in the absence of infrastructures and adequate maintenance of the mountainous areas that feed the aquifer. In any case, we will have to prepare for careful treatment of the entire water supply system to remove pollutants from the water.

4. Desalinization is often cited as a solution to the water shortage, but it involves a number of problems that we must address:
   - Desalinization is an energy-intensive process. Assuming that overall energy costs will rise (due to the fuel shortage, global competition, and especially the demand for a carbon tax because of the greenhouse effect), then the overall price for desalinized water will increase considerably (cost needs to be calculated according to various alternative scenarios for energy costs). Therefore, planning the water system on the basis of today's prices may be misleading, even very much so. Expanding water desalinization will be contingent upon the existence of a renewable/clean energy only minimally dependent upon imports.
   - Another problem is that of the system's reliability. We are currently discussing the addition of desalinized water at a rate of 20-25% of potable water. The higher the proportion of desalinized water, the more vulnerable the Israeli economy will be to disrupted water supply in the event of war or other failures in fuel supply. As far as food safety, foodstuffs can be stored for a longer time period, but water cannot be stored. It will be difficult to establish a transport system for the event of failure of the desalinization system, if significant portions of Israel depend on the supply of desalinized water.

Data

The potential for renewable water in Israel (including the Palestinian Authority) is about 1.5 million cubic meters a year. Residential water consumption is increasing. Assuming a population of 12 million in the area of the land of Israel:

Yearly consumption	**Treated***	**Reclaimed**
	(In millions cubic meters)	
For consumption of 80 cubic meters/ per person/year	960	672
For consumption of 100 cubic meters per person/year	1200	840
For consumption of 130 cubic meters per person/year	1560	1092

(Water Commissioner's estimates)

* The quantity of treated water was submitted on the assumption of 70% utilized for urban consumption (not including watering gardens and leaks).

- The above figures do not take into consideration that Jordan lacks any alternative water source. Jordan already has the lowest amount of water per capita in the Middle East. Israel will have no choice but to assist in supplying water to Jordan, apparently by desalinization of water in the Mediterranean Sea and transporting it to Jordan**. This will add about 600 million cubic meters of water consumption a year**.
- Israel's agriculture, which is needed to supply fresh produce to the populace and to protect the landscape, clean air, green spaces and more (Neaman Institute assesses the external benefit at about $73 per dunam a year), **requires about a billion cubic meters of water,** some potable water but mostly high-level treated waste-water.

Recommendations

1. It is crucial to develop **technologies and policy** for reducing and making more efficient use of water, improving the quality of waste-water treatment and promoting desalinization technology (also as an industry capable of generating income for the country). Policy should be implemented to obligate and reward water conservation.

2. Water desalinization is cited as the solution to the water shortage (in Israel, the Palestinian Authority and Jordan), and has considerable quantitative and qualitative advantages: first, it is an addition to the deficient water balance. In addition, the added water is saline-free, thus diluting groundwater and decreasing the risk of salinity. Thus for example, treated water is currently saline (approximately: supply water + more than 100 mg/liter of chlorine). If the city's water source will be desalinated water, it will be treated water with a low saline concentration.

3. **Treated water**
    - It should be specified that water be treated to the level at which irrigation and diverting the water into streams pose no environmental risk, while requiring that irrigation of sensitive crops (strawberries, parsley, etc.) be done with completely potable water.
    - Another option is that treated water be processed to the standard of drinking water (by desalinization). This is technologically and socially challenging, but should be considered.
    - Yet another option is separating the water network into water for residential use and water for irrigation, which may lead to establishing a completely separate system for mostly treated water.
4. There will be a need for treatment beyond chlorination of all water sources. This is not technically difficult or very costly, as far as treating water for urban use, but there may be a need to consider a water supply system for smaller communities that are not connected to the municipal network.
5. **Agriculture** – agriculture planning should include vegetable and other irrigated crops in the Eastern corridor (including winter/summer agricultural areas); in the south, appropriate crops are those that do not require large amounts of water such as field crops and olives, and pasture. State support of agriculture can be viewed as payment for the environmental services that agriculture provides. By the same token that justifies state support for agriculture's environmental services, it justifies directing agriculture towards the needs set forth above, including water limitations. Any discussion of water policy must address agricultural planning.

Required Investment

Investments in water are needed for rehabilitation or establishment of a transporting and redistribution system, a treatment system for water that that has been polluted by years of economic activity (groundwater and above ground), waste-water treatment systems and desalinization facilities.

Water desalinization is a developing technology, and is becoming less costly in itself. However, in the absence of a low-cost alternative energy source, energy costs will rise significantly, due to competition over the world fuel market and the external cost of greenhouse gas emissions. (The direct cost of desalinization is about $0.5 per cubic meter. Desalinating 500 million cubic meters of water requires 2.5 million kw/hour, which comprise about 5% of Israel's total energy production.) Total investment in water and waste-water treatment is estimated at about NIS 40 billion for the entire twenty year period.

Appendix to Chapter XI:

Engineering Manpower in the Construction & Infrastructure Sectors

Introduction

Construction is a leading economic industry that directly and indirectly impacts upon potential economic development in every other realm. We must make sure ahead of time, that the infrastructure and construction sector does not impede progress in other realms. This sector has a slow reaction time, for manpower training processes at the various levels; unique inputs of materials and equipment; and licensing, planning and building processes. Therefore, a good, thorough examination should be done to identify all potential obstacles, and to propose remedies and actions to remove them.

The goal of this appendix is to estimate the demand and supply for engineering manpower, in view of the expected increase in infrastructure work over the coming years, and the concern about a shortage of such manpower. For this purpose, it was necessary to address the similar industry of building construction, which competes for the same type of manpower, such that the forecast relates to the entire united sector of construction and infrastructure.

Risks and Warnings

For the past twenty years, there has been a shortage in domestic construction and infrastructure manpower, including basic-level workers, machinery operators and work managers. These jobs have been filled mostly by foreign workers. **In recent years, there has also been a shortage of engineering manpower – engineers and practical engineers – which may become a real bottleneck in the state's development in other areas as well**. The shortage is more prominent in infrastructures, less so in building construction, particularly as regards the most difficult and demanding task of executing projects on site. In the coming years, the shortage is expected to worsen, because even if immediate measures are taken, the initial results will take at least five years to be manifested.

Despite the developing shortage, the number of civil engineering graduates is lower than in the past, even though a number of colleges have recently begun training in civil and construction engineering. The number of students in the profession is still affected by the recession suffered in recent years by the construction and infrastructure sector, when many civil engineers could not find work in their field, and the pay was (and still is) relatively low. There has also been a decline in the number of students in the construction fields in practical engineering programs. We must remember that engineers' formal training period along with accumulating experience and knowledge, takes about a decade. Engineers require at least four years of training, and practical engineers require at least two to three years.

One of the study's surprising figures is that about half of Israel's civil engineers originate from the former Soviet Union, immigrants from the last wave of the 1990s. About one million immigrants brought with them more than 7,000 civil engineers (seven civil engineers per thousand immigrants), while among Israel's five million residents in the beginning of the 1990s, there were only 5,000 civil engineers (one civil engineer per thousand residents). It is not surprising, then, that on the one hand, a shortage of engineers has not been created in Israel despite the accelerated construction of the 1990s, and on the other hand, that engineers' pay has also decreased, as a result of the surplus of civil engineers in the labor market.

The study's important conclusion in terms of the state economy is that this situation is currently at a crossroads: almost all existing engineers (and practical engineers) are employed; the need for additional engineers and practical engineers is increasing; higher education institutions, chiefly the Technion, are not yet accepting a sufficient number of candidates to respond to the projected demand. The number of engineers reaching retirement age every year exceeds the number of yearly graduates. The considerable reinforcement provided by Soviet-trained engineers who joined Israel's labor force has been nearly exhausted, and now is the time that we, as a state, prepare ourselves for the task of training the required number of professionals for the state of Israel.

The resulting practical significance and recommendation is the urgent need to double or even triple the present output of about 250 engineers and 150 practical engineers a year. The projected rise in compensation due to the emerging shortage provides an excellent opportunity to improve the image of the civil engineering profession.

Primary Conclusions

1. Infrastructure Industry Activity

Most of the increase in the activity of the infrastructure industry is expected to occur over the next ten years. During these years, the economy's structural changes will be manifested, enabling the infrastructure bodies to operate at a scope more appropriate for the economy's needs. Add to this the business sector's increasing involvement in financing, planning and establishment of infrastructures, which will increase implementing capability from both a management and a financing perspective. In the longer term, sector activity will most likely increase at a more moderate pace, similar to the GDP growth rate.

2. Assessing the Sector's Needs for Engineers/Practical Engineers

Following is an estimate of the total inputs of engineer/practical engineer years for planning and executing a NIS 100 million investment.

- **Phase I – job ordering phase 26.2**
- **Phase II - implementing phase 19.5**

- Total input 45.7 engineering years

Beyond this, additional engineers are required for overall planning, statutory planning in planning authorities, licensing and management.

We estimate that **implementing infrastructure investments of a scope of NIS 100 million will require some 50 engineer/practical civil engineer years.**

According to the current formula, we assume that this includes about 60% engineers. **That is, the economy requires thirty engineers and twenty practical engineers per NIS 100 million in implementation value.**

3. Construction and Infrastructures Sector

As the building construction industry (as opposed to infrastructure) is a larger consumer of civil and construction engineers and practical engineers, and because building and infrastructure compete for the same manpower (except for unique specializations, such as transportation engineering, etc.), we must look at the demand that stems from the increase in overall activity of the united sector: construction plus infrastructure.

Table 1: Required addition of construction and infrastructure activity & required addition of engineers and civil engineers

Year	Total activity in billions NIS (2005)	Additional cumulative activity in billions NIS	Cumulative required additional engineers/practical engineers
2005	50.0		
2010	66.1	16.1	8,052
2015	76.3	26.3	13,157
2020	88.9	38.9	19,472
2025	103.7	53.7	26,857
2028	113.8	63.8	31,880

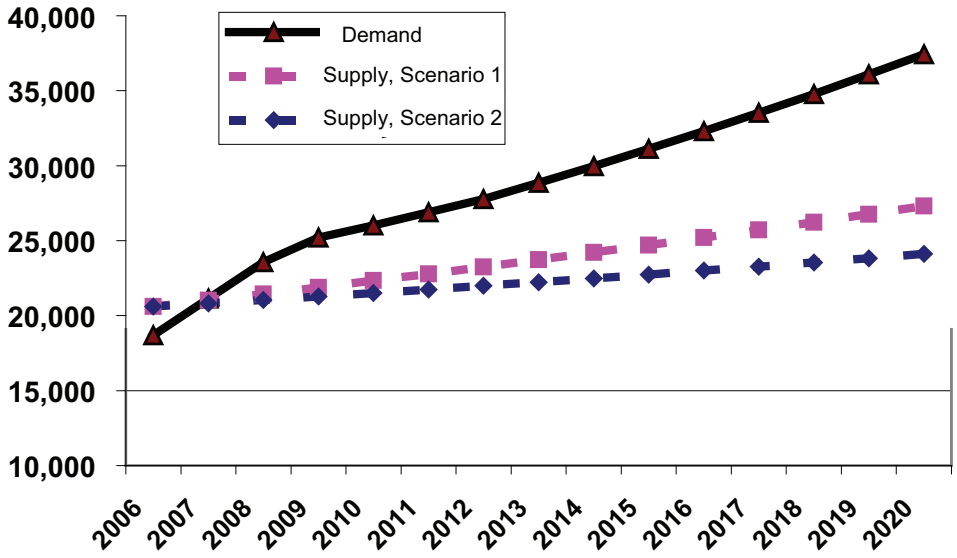
That is, until the target year of 2028, the number of engineers/practical engineers in Israel needs to be increased by 168% - an average net yearly change of 4.4% a year, given the current inventory of about 19,000. The required increase significantly exceeds the projected increase according to the present state of affairs: only 1.2% by the regular scenario, and 1.6% in the more optimistic scenario. In either scenario, the net increase in the number of engineers and practical engineers (that is, new professionals minus retirees) will be insufficient to cover the net increase in activity. The present scope of yearly training of engineers and practical engineers in Israel may perhaps hardly cover natural retirement from the sector, of about 500 individuals a year. It does not respond at all to the projected increase. A "business as usual" scenario is not possible. For the next twenty years, we must produce about 2,000 engineers and practical engineers a year every year, as opposed to only 500 today.

4. Comparing Demand and Supply

For the coming years, the data clearly project a shortage in engineers, and to a lesser degree, in practical engineers, in view of the expected increase in construction and infrastructure activity.

Especially high rates of increase are expected in the sector's activity during the coming decade (becoming more moderate in subsequent years), meaning that the engineer shortage will be felt increasingly in the coming years.

Chart 1: Supply & Demand of Engineering Manpower



Conclusions and Recommendations

In order to arrive at a balance between the projected demand and the supply, we must **triple the number of engineering graduates and double the number of practical engineering graduates** (vs. the present situation). A foundation exists for training sufficient numbers of engineers, but the emphasis needs to be on attracting appropriate manpower, in order to strike a real balance between demand and supply. This increase requires enhancing the profession's image and compensation, in order to attract high quality manpower to the industry. In the previous decade, about 7,000 immigrant engineers joined the construction sector, mostly from the former Soviet Union. This created a surplus of engineering manpower, especially in view of the low level of activity during the construction industry's decade-long recession. Now, as the industry is awakening, and increased activity is projected (alongside population growth and GDP growth), **there are not even sufficient new graduates to replace retiring engineers**. Local training institutions produce together less than 500 graduates a year.

A special emphasis should be placed on the infrastructures realm, particularly infrastructure project management, which is expected to increase more rapidly than the construction industry, especially in the coming decade, and in which a shortage is already felt.