



EcoCity roadmap for Egypt

Actions for eco-efficient urban development



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ISBN 978-951-38-8241-9 (URL: <http://www.vttresearch.com/impact/publications>)

VTT Technology 215

ISSN-L 2242-1211

ISSN 2242-122X (Online)

<http://urn.fi/URN:ISBN:978-951-38-8241-9>

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JULKAISIJA – UTGIVARE – PUBLISHER

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Preface

The aim of this publication is to provide an EcoCity roadmap for Egyptian cities. The roadmap covers issues related to urban planning, energy systems, water and waste management, transportation planning and awareness-raising. The roadmap has been created in co-operation between the Egypt-Japan University of Science & Technology, E-JUST and VTT Technical Research Centre of Finland Ltd. Experts from Alexandria University and Cairo University have also contributed to the work. This publication is part of the joint project “EcoCity Capacity building in NBC” which aims to raising the capacity of the EcoCity know-how within E-JUST. The project is funded by the Ministry for Foreign Affairs of Finland.

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1. Introduction

This document introduces an EcoCity roadmap for the development of Egyptian cities into EcoCities. The EcoCity approach is a multidisciplinary approach for developing cities to sustainable, ecologically friendly communities, spanning topics such as urban planning, energy systems, water and waste management, transportation planning and awareness-raising. This document is part of the joint project “EcoCity Capacity building in NBC” funded by the Ministry for Foreign Affairs of Finland.

Figure 1 presents the outline of the roadmapping work, adapted for the EcoCity project from Kazi (2007). This work represents the first time the method presented by Kazi (2007) has been used in the context of EcoCities. The aim of the roadmap is to match short-term and long-term goals with specific technology solutions to help meet those goals. The development of the EcoCity roadmap has three major uses: it aids in producing a consensus about a set of needs and the technologies required to satisfy those needs, it provides a mechanism to help forecast technology developments and it functions as a framework to help plan and coordinate future technology developments.

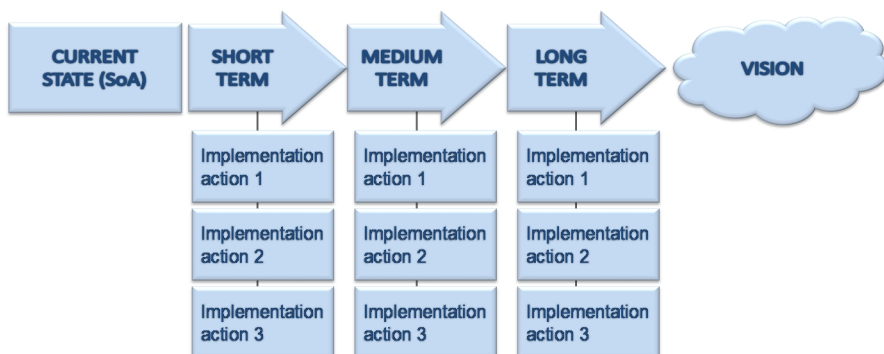


Figure 1. Simplified conceptual outline of a roadmap adapted from Kazi (2007). This report provides the results of the second workshop that was tasked with outlining the roadmap for the short, medium and long term.

The EcoCity roadmap was produced in a series of consecutive workshops that included experts from the Egypt-Japan University of Science & Technology (E-JUST) and VTT Technical Research Centre of Finland. Other experts from Alexandria University and Cairo University also contributed to the work. The topic of the first workshop was forming a common vision for EcoCity. The second workshop produced an outline for the roadmap spanning the short, medium and long terms. The third workshop produced recommendations for implementation actions to realize the envisioned roadmap. The starting point of the roadmap, termed current state in Figure 1, is provided by the previously published State of the Art (SoA) report (Hedman et al. 2014).

The group was in agreement that the EcoCity vision needs to be realistic about possibilities so that it can be reached. Setting overly optimistic goals that are too far to be reachable can be counterproductive. Furthermore, it was agreed that a proper timeframe for the vision will extend to around the year 2050. This is because there has to be enough time to reach ambitious goals considering the relatively slow pace of urban development. Also, a number of policies are under consideration in Egypt that will coincide with this timeframe.

2. Methods

The roadmap was developed in a series of three multidisciplinary workshops held in Egypt in 2013 and 2014 and commenting rounds following those events. Here the methods used in these workshops are described.

2.1 Workshop 1: EcoCity vision

The EcoCity vision was produced as group work using the following means of contribution:

- Task sheets were filled by the team members prior to the workshop event on 24–27 November 2013.
- A workshop for the EcoCity roadmap was held on 25 November 2013 using the roadmapping method described by Kazi (2007).
- A workshop for the EcoCity feasibility study was held on 26 November 2013. Applicable results are included in this vision for the EcoCity roadmap. The results of the feasibility study will be independently reported in the project.

The vision workshop, held on 25 November 2013, consisted of three sessions. The first session was a common roundtable discussion aimed at scoping the vision work before separating into smaller groups. The second session was held in two smaller groups, where the participants wrote answers, on sticker notes, to the following questions:

- What do I like of our situation today?
- What do I not like of our situation today?
- What do I want in the future?
- What do I not want in the future?

First there were a few minutes for individual work, then writing continued as a group activity. Once the group was satisfied with the amount of answers produced, the answers were prioritized. This was done in two phases. First, voting was conducted, four votes per each participant, by marking with a dot the answers that

people saw as the most important ones. Second, deciding as a group, the participants placed the answer notes on a line of priority ranking them from the less to more important ones. Finally, in the third session, the results of both groups were combined on four lines of priority that had the following themes: nature, well-being, economy, society.

2.2 Workshop 2: EcoCity roadmap outline

The EcoCity roadmap outline was been produced as group work using the following means of contribution:

- Task sheets were filled by the team members prior to the workshop event.
- A workshop for the EcoCity roadmap was held on 17 February 2014 using the roadmapping method described by Kazi (2007).
- A workshop for the EcoCity feasibility study was held on 18 February 2014. Applicable results are also used in the roadmap work. The results of the feasibility study will be independently reported in the project.

The work conducted in the workshop on 17 February was divided into three timeframes: short (2–5 years), medium (5–10) and long term (10–20). Four small groups were formed around themes decided in the beginning of the workshop: energy; water and waste; transportation and traffic; buildings and construction. For each timeframe the groups completed the following tasks:

1. Identify key **business driver** for change and
2. Define key **actions** and **enablers** needed for the vision to be achieved.

With business drivers are meant things that spur growth and allow enterprises to reach success. They can mean things that create new demand, create better value to consumers, allow making more competitive products or any other factor that pushes a business forward faster. Key actions mean things that need to be done and key enablers conditions that need to be present to facilitate change.

Templates for writing down the group's findings were provided. When the groups were ready with their input, they presented them to the whole team. A round of commenting ensued where everybody had the opportunity to include their ideas to the templates with sticky notes. All input, be it from the group work or from the commenting round, are included in the results presented here.

2.3 Workshop 3: Implementation actions

The implementation actions for the EcoCity roadmap were developed as group work using the following means of contribution:

- Task sheets were filled by the team members prior to the workshop event.
- A workshop for the EcoCity roadmap was held on 21 October 2015 using the roadmapping method described by Kazi (2007).

The work conducted in the workshop on 21 October was divided into three timeframes: short (2–5 years), medium (5–10) and long term (10–20). Four small groups were formed around themes decided in the beginning of the workshop: energy; water and waste; transportation and traffic; buildings and construction. For each timeframe the groups completed the following tasks:

1. Development of implementation actions (IA) as individual work,
2. Commenting and further development of IAs as group work,
3. Implementation plan for IAs as group work, meaning placing them on a timeline and
4. Presentation, commenting and finalizing the results, all together.

Implementation actions mean concrete actions to help realize the roadmap. They are related to the thematic outline roadmaps developed in Workshop 2. Each IA includes a listing of the main parties responsible of realizing the action as well as a detailed definition of the action. The IAs were developed using a formalized template that worked as a checklist so that no important aspects are omitted in the description.

3. EcoCity vision for Egypt

The development of the EcoCity roadmap started from the definition of the current state, published in Hedman et al. (2014), and a vision for the EcoCity. An EcoCity is essentially seen as a community that has high ecological quality, but at the same time it is technologically advanced. However, there is not just one EcoCity concept but a variety of possibilities that need to be adjusted so as to fit the local context, local culture and local economic realities. This is the way to achieve a possible solution with regard to the local resources, but at the same time meet the high goals set for an EcoCity. High-tech solutions are one way to the EcoCity, but they are not the only goal of an EcoCity.

Here the specific goal was envisioning an EcoCity under the Egyptian conditions. A general summary of important topics that came up multiple times during the work is given in the word cloud in Figure 2. Questions of public awareness, a better organized and more public transport oriented transportation system, energy efficiency and renewable energy were seen to be among the most pressing.



Figure 2. The most commonly cited things when defining the Egyptian EcoCity.

The major topics recognized by the experts as central to the EcoCity vision are shown in Figure 3 arranged on a line of priority according to their relative importance. These comparisons should be seen as an approximate presentation of the average estimate of the experts participating, and not necessarily applicable to all circumstances. Nevertheless, they provide an insight into what kind of priorities the various actors should espouse when implementing the roadmap.

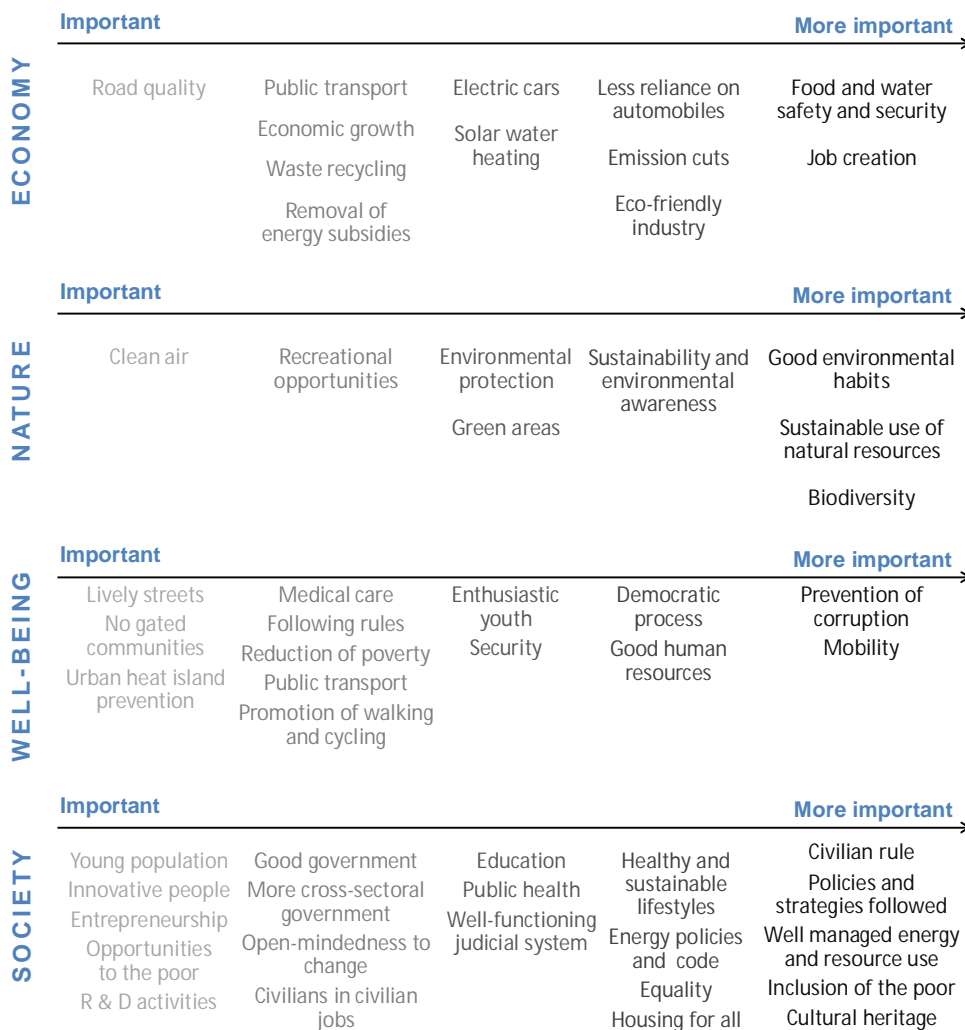


Figure 3. The lines of priority representing the relative importance of issues facing cities. Being more to the right on the horizontal line indicates higher priority.

A thematic description of the EcoCity vision for Egyptian cities is presented in the following. The vision aims to describe an idealized state of what cities will be like once the EcoCity roadmap has been realized.

3.1 Society

The government of the EcoCity is based on democratic process and good governance practices including transparency in decisions and hearing of the people affected. The government actively promotes sustainability through energy and environmental policies and codes that are followed. Strategic thinking leads to policies and regulation that support each other's aims. Corruption is low due to active policies and practices to prevent it.

The society is based on active, participating and well-educated and healthy citizens that also form a competitive work-force. This is achieved on continuous investment to human resources, especially health and healthy lifestyles and education that leads to professional workers on all levels. Citizens are treated equally and local culture is protected and cherished.

3.2 Awareness

Awareness about sustainability, environmental and energy issues is a high priority. People have good environmental habits and the lead healthy and sustainable lives. Awareness is a natural part of all education, but on the city level the local energy office coordinates campaigns and other awareness-raising activities. These include energy issues, water issues, good behaviour towards the environment and cleanliness of the city.

3.3 Nature

Biodiversity and local ecosystems are protected through practices followed in city development and by the local industries. There are protected areas around especially valuable nature and natural green cover is actively maintained. Planned and natural green areas offer recreational opportunities to the people of the EcoCity.

3.4 Buildings

The EcoCity is able to provide proper housing to all. The city is planned and built to ensure the social inclusion of everyone, including the poor, and segregation is minimized. There are public green areas and recreational opportunities to all.

Buildings are planned so that they preserve views and natural illumination to others. Renewable energy is integrated to the buildings so that passive solutions and solar and wind energy are used for heating and cooling. Domestic hot water is mostly provided by solar heating.

3.5 Industry

Industries are designed and run in an eco-friendly way. Compared to present, emissions are at a much lower level, reaching sustainability ecologically and health wise by 2050. The industries participate in creating near full employment.

Industries employ policies and practices to ensure well-managed energy and resource use. Energy efficiency is a high priority and there are audits and efficiency programs that include continuous improvement goals.

3.6 Transportation

Compared to present, there is far less reliance on automobiles so as to reduce congestion, accidents, pollution and cost to families. Thanks to the promotion of alternative modes of mobility, there is better mobility and yet less traffic and less emission. Walking and cycling are promoted with things like dedicated lanes, a good network coverage and car free zones. There is also a good public transportation system. For longer distances fast rail connections are the preferred mode of transport. In dense urban areas, there is light rail. Rest of the EcoCity is covered by busses and taxis. Informal public transport such as minibuses and tuk-tuks are better organized and electrified when possible.

For both public and private transport, alternative fuels are used. These include natural gas, biogas from wastes and electricity. Traffic is made especially attractive and safe for walking and cycling with prioritized lanes. Streets in general are good, wide and well-paved and have well-designed intersections. The need for paving is considered in each case also in view of water eco-system and comfort for walking and cycling modes. There is oversight and enforcement of traffic rules. Intelligent traffic systems are used for monitoring, signalling, safety and providing information to travellers. Car-pooling is promoted with things such as priority lanes.

3.7 Water

Food and water safety and security are a priority and they are well taken care of. There is safe drinking water available to all and sanitation to all. Sustainability of water-use is ensured with efficient use of water, recycling and reuse of water and the use of non-conventional water resources such as solar desalination and rain-water harvesting.

3.8 Wastes

Less waste is produced and more of it is reused and recycled on site. All wastes are sorted, reused and recycled as far as possible. Energy is produced of the wastes that cannot be recycled and all wastes collected and managed professionally. There are measures against littering, including sorting bins around the city.

3.9 Energy

The planning of energy use starts from minimizing consumption through efficient use of energy. This includes efficient technologies, good planning and efficient practices. LED lights and efficient appliances are among the technologies used. Smart energy management is used to reduce peak consumption, enable energy storage, allow load matching and load control.

The Egyptian conditions offer an abundance of renewables that should be made use of. Solar and wind power are produced within and in the vicinity of the EcoCity to reduce transmission needs and improve energy security. The use solar energy directly in buildings especially for DHW and solar cooling is commonplace. Adequate legislation is introduced to allow and regulate the use of renewable energy including the possibility of selling electricity to the grid.

4. Thematic roadmaps

4.1 Water and waste

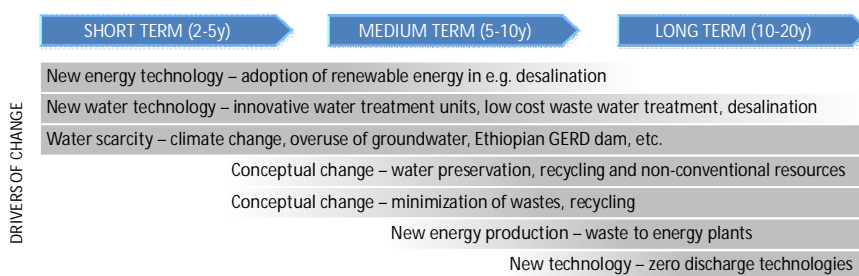


Figure 4. Drivers of change for water and waste.

Water is a scarce resource in the Egyptian conditions and climate change and overuse of existing resources are likely to make the situation more difficult. This condition is the major driver of change until a sustainable level and mode of water consumption is reached. In the short term irrigation systems should be improved and crops planned to conserve water. This is also in the best interest of farmers as it allows cost savings due to smaller volumes and ensures a sustainable supply of water.

New water treatment and desalination methods together with the use of renewable energy are some of the technological factors that can drive change towards sustainable water use starting in the short to medium term. This will require availability of financing and funding, awareness and professionalism from designers, new research conducted in the field and the availability of qualified personnel and labourers. Desalination should be started in pilot plants in the short term to provide experiences with the various technologies involved. To provide practical training and promote the application of new technologies, MOU's between education and research institutions and industry should be signed. In the medium to long term full-scale desalination should begin. Other non-conventional water resources should also be utilized as a part of the solution.

Another very short term action necessary is that the existing guidelines and rules for water discharge are followed. The government should make sure that sufficient incentives and penalties are in place for actor to follow environmental regulation concerning both water and wastes. In medium term the regulation should be reviewed and amended to further ensure sustainable water use and the availability of clean and safe water. For the long term the adoption of zero discharge technologies should be the goal.

Concerning wastes a conceptual change is needed where waste generation is minimized and recycling is increased until it is near complete. This change should be incentivised and overseen by the regulators. It requires the inclusion of producers, consumers and waste handlers alike. The process will take time and should start in the short term, spanning the whole timeframe of 20 years. For non-recyclable materials, waste-to-energy solutions should be enacted.

Awareness is key for both sustainable water and waste management and the related issues should be promoted in education, media and to businesses and the general population. In this regard NGO's can be particularly helpful. Government should be involved from the municipal to the ministerial level. Political stability will support the necessary changes. In the long term strategic planning anticipating future challenges is needed.

4.2 Energy

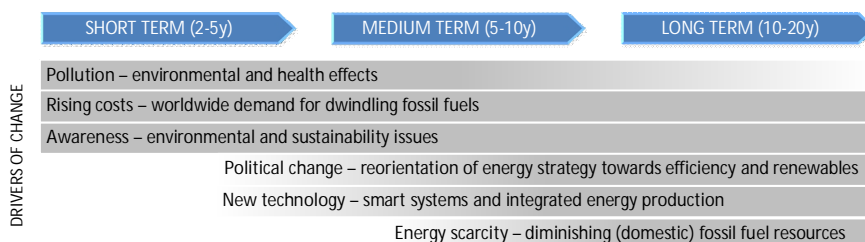


Figure 5. Drivers of change for energy.

Energy is most valuable at the point of consumption, for it has undergone a number of transformations and transmissions to reach there. Moreover, every unit of consumed energy has required a much greater amount of primary energy to produce. Thus energy efficiency in end use is the most effective way to improve the way the society consumes energy. More efficient end use avoids investments that otherwise would have had to take place in transmission and production of energy. Businesses, public sector and citizens all must participate in making energy use more efficient. There should be an objective of continuous improvement in buildings, transportation, industries etc. To this end, awareness of all actors should be heightened through education, information dissemination and campaigns. Profes-

sonals need to have access to training and guidebooks. The participation of NGO's and educational and research institutions is key to success in this regard.

In the medium to long term there should be energy efficient products and concepts for e.g. efficient buildings available in the market. Domestic production of related technologies should be preferred over imports. For industries and businesses energy auditing services should be made available, provided either by agencies or corporations.

Major drivers for change are the health and environmental effects of energy production, including climate change. Also dwindling fossil fuel resources will raise the price of energy, as will the necessary reductions in energy subsidies. Since subsidies are anyway in the end paid by the consumers in taxes, it makes more sense that they rather pay the same amount in correct market prices of energy. Thus correct price signals will be sent and investments in efficiency and renewables appear more profitable.

At the same time as energy prices rise, new technology will bring down the price of renewable energy. In the short term the use of integrated renewable energy and smart control should start in pilot projects to gain experience and practical expertise. In the medium to long term the large scale adoption of such systems should begin. Some systems are ready for direct adoption, such as solar water heating. Their use should be promoted and accelerated. Business and especially small business should be promoted in the field and barriers reduced. Chambers of commerce and industry should be active in this regard. Financing should be made available to allow the poor to also benefit from affordable technologies to improve their energy security.

In the short to medium term the government energy policy needs to be updated and reoriented towards energy efficiency, renewable energy and smart systems. Political parties must be active policy reformers, NGOs need to participate in the process and government agencies need to change the old ways of doing things in practice. Political stability should improve to allow strategic long-term thinking.

4.3 Transportation and traffic

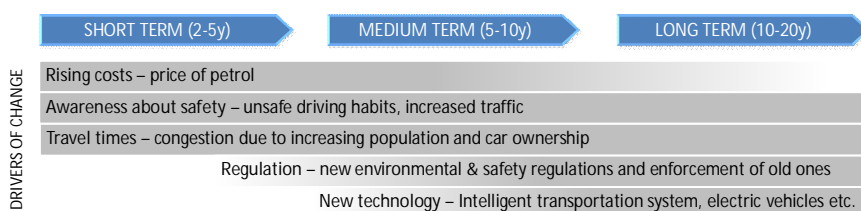


Figure 6. Drivers of change for transportation and traffic.

Population growth and increasing automobile ownership and use are driving the transportation problems in Egyptian cities toward a crisis. As these trends continue the situation is bound to become worse over time. Increasing travel times, pollution, health and safety issues will be the main drivers of change for a long time. Some alleviation is available already in the short term: existing public transport infrastructure such as tracks should be used more effectively and scheduling should be optimized based on demand and user preferences. Use of public transport, collective taxis, carpooling, walking and cycling can be promoted starting immediately. Government can support the change with preferential treatment in things such as taxes and reserved lanes. In the medium to long term the introduction of an intelligent transportation system (ITS) for better traffic control can also help.

City planners should be given guidelines for bike lanes, parking, public transport etc. for execution in the medium term. Land use decisions, planning and zoning can all affect transport needs and should also be considered. In medium to long term new rail, tram and metro lines should be planned and built especially in densely populated areas to alleviate traffic problems for all. Existing systems can be modernized and run more effectively. When estimating overall benefits to the traffic situation, all travellers should be considered instead of a narrow profitability calculation. Change will need committed political decision makers, including budget decisions and strategic planning, and long term change will require improved political stability. Functioning cooperation between different actors, including international cooperation, can also support the change.

The vehicle fleet can also be updated in medium to long term to include more low-consumption, hybrid and electric vehicles. The use of alternative and renewable fuels can be promoted where effective. Taxation and regulation can be used to promote change and corporate and government vehicle fleets can be used for piloting. Public-private partnerships and the inclusion of the private sector are important to safeguard the interests of the investors.

4.4 Buildings and construction

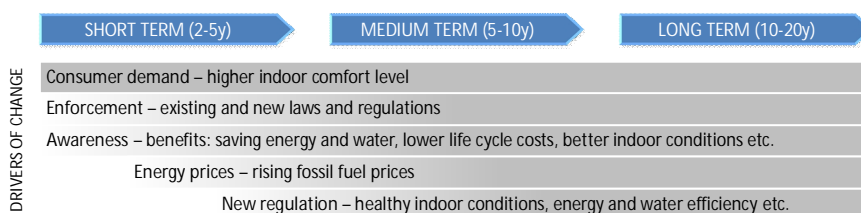


Figure 7. Drivers of change for buildings and construction.

In the building sector it is typical that the initial investment is high and defines for a long period the energy and water consumption of a newly constructed building.

Even a rather small increase in the initial investment can produce major benefits for the coming decades in terms of sustainability and comfort. Moreover, other investments can thus be avoided in the infrastructure needed to provide energy and water to the buildings. Nevertheless, the buyers of new buildings can be reluctant to make even small extra investments as it needs to be paid up front, unlike energy and water bills. Therefore the enactment and enforcement of regulation is especially effective in the building sector: when all new buildings are built more efficient, mass production will reduce the extra investment.

Experience from countries where this has been done has shown that when efficiency improvements are done *en masse*, the price difference is very low, nearly non-existent. An incremental tightening of building regulations concerning energy and water over the whole timeframe and improvements in the enforcement are suggested. Incorporation of renewable energy production in buildings should be encouraged. In the long term energy consumption of new buildings should be minimal and covered by renewable energy. Regulation should also aim at improving health and safety in buildings with e.g. safe and sustainable materials. At the same time awareness should be promoted. This can be done e.g. by informing permit-seekers about best practices in design and construction.

Existing building stock should be improved in terms of energy and water consumption when they are renovated in any case. This minimizes the extra cost of the improvements. In the short term methods to do this and renovation concepts should be planned, tested and piloted. In the medium to long term regulation should be updated so that all renovations include energy and water use improvements when applicable.

Financing support can be included e.g. in the form of loans with favourable terms for the extra investment into the sustainability features of buildings. This can be done with public-private partnerships with the government functioning as a guarantor of loans provided by private financiers. To improve the profitability of investments, energy subsidies should be phased out. The subsidies are paid by the consumers in taxes in any case, it makes more sense that they rather pay for the energy they consume so that correct price signals are sent in the markets.

To support more sustainable design of buildings and the successful realization of the building projects, the expertise of designers and builders alike need to be strengthened. Cooperation between research institutions, educators and business is necessary to guarantee the application of new technology and accumulation of practical expertise. In the short term, pilot projects are needed as is the development of new products, preferably domestically produced. To spread the information about products available in the marketplace and lessons learned in pilot projects, a database with public access should be constructed. In the medium to long term, tightening regulation will reshape the whole industry to producing sustainable buildings only.

5. Implementation actions

In this chapter concrete implementation actions will be presented for realizing the EcoCity roadmap. Each implementation action is a concrete recommendation for practically advancing the realization of the roadmap. However, the roadmap is a wide-ranging plan that requires coordinated actions from a number of actors in the society. The implementation actions should be seen in this context and should be supported by changes not limited to these actions alone.

5.1 Water and waste

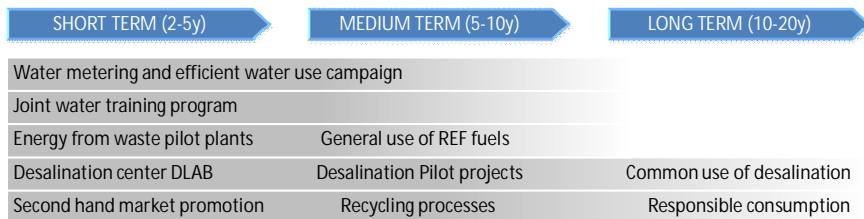


Figure 8. Implementation actions for water and waste.

5.1.1 Water metering and efficient water use campaign

Purpose Installing water meters Billing per actual consumption Reducing water consumption	Main realizers Ministry of Housing Local authorities Water utilities
Timeframe Short to medium term (2–10y)	
Description Water metering in individual apartments will allow billing for water use based on realized consumption. This action will take place by requiring all new apartments to have a water meter, and all existing apartments getting one in conjunction with the next renovation of the water pipes. The action will be accompanied with a publicity campaign that also promotes easy ways to reduce water consumption in the household. The scheme will be promoted with cost-savings: as less water is consumed, less infrastructure investments and running costs will be needed. Ultimately all these are covered by the consumer in any case. Thus the small cost of installing the meter will be more than compensated over time. Proper metering will make reliable billing easier and increase income for the utility. Money collected thus will be used for improving the quality, safety and sustainability of the delivered water.	

5.1.2 Joint water training programme

Purpose Improving education Providing a skilled work-force Supporting green growth	Main realizers Ministry of Education Educational institutions Industry associations
Timeframe Short to medium term (2–10y)	
Description Industry and educational institutions of all levels work together to combine the newest know-how with practical on-site training to produce qualified experts and workers. Content of educational modules will be planned together with the industry to guarantee their applicability in the industries. Moreover, courses will include on-site training. University-level students will work on actual industry projects by e.g. conducting studies and participating in planning. Students from vocational schools will do short and medium-length internships in the industries to learn practical skills. Thus the students will get an education that better corresponds to actual industry needs and will also gain contacts to the industry that will help in finding jobs after graduation. On the other hand, universities have a direct channel to introduce some of the newest technology and ideas to the industries. Funding will be arranged as a public-private partnership (PPP).	

5.1.3 Waste-to-energy development programme

Purpose Reducing the trash problem Reducing fossil fuel use Improving energy security	Main realizers Ministry of Industry Local authorities Energy industry
Timeframe Short to medium term (2–10y)	
Description Waste generation and treatment in communities is a large and pressing problem, as is energy security. Both can be helped with increasing the use of waste-to-energy solutions. In the short term pilot plants can be introduced with two approaches: 1) using bio wastes in reactors to produce biogas that can be sold instead of natural gas or used directly in a power plant, and 2) mechanically producing RDF (refuse-derived fuel) from solid municipal wastes for use in power plants instead of fossil fuels. These pilot plants will provide experience on how to best organize the collection of wastes and their use as fuels. At this point a plan will be devised to expand the program to include the use of biofuels and RDF in the energy mix of the city in question. The plan shall take into account the waste hierarchy, meaning the primacy of reuse and recycling before energy use. The plan shall also provide a plan for the scaled-up scheme to fund itself from sales of energy and waste collection fees. For pilot plants, funding will be sought from national and international funders supporting the development and piloting of new technology.	

5.1.4 Desalination development programme

Purpose Reducing water scarcity Advancing sustainable water use	Main realizers Ministry of Water resources Universities and research centres
Timeframe Short to long term (2–20y)	
Description Egypt struggles with a shortage of water resources and the sustainable use of the existing ones, while the sea could offer abundant water if the problem of desalination could be solved in large scale. On the short term, a national desalination center, DLAB, should be established to study the different methods. On the medium term pilot plants based on the most promising techniques should be established. With the increasing scarcity of traditional water resources and the lowering costs of desalination with improving technology, the price of the two should meet at some point in the medium to long term. Once this critical point is reached, the large-scale introduction of desalination stations can take place. Thus the development phase should be seen as an investment: development costs now will be covered by lower costs of water in the future. In the development phase outside funding will be necessary and sought from national and international funders supporting the development and piloting of new technology.	

5.1.5 Campaign to reuse and recycle

<p>Purpose Reducing the trash problem Improving resource efficiency Promoting sustainable lifestyles Promoting SMEs and NGOs</p>	<p>Main realizers Ministry of Environment Local authorities Local businesses NGOs</p>
<p>Timeframe Short to long term (2–20y)</p>	
<p>Description The trash problem is in part aggravated by large amounts of products that could still be used as well as recyclable materials. A campaign to tackle this problem will be introduced with two parallel approaches: reuse and recycling. The first aims to increase the reuse of products by promoting second-hand markets. This will be operated by local SMEs (small and medium-sized enterprises) and NGOs (non-governmental organizations) by establishing marketplaces where used products are resold. The organizations will arrange the collection of goods as best fits to their neighbourhood, be it e.g. by paying a small fee to anyone bringing goods with resale value or arranging collection campaigns. The local government supports the activities by providing premises with affordable or zero rent, helping with promotion and organizing meetings where best practices can be disseminated among the organizers. Another branch of this activity will be the promotion of online second-hand selling to be organized with a business model similar to eBay.com. The second approach is the promotion of recycling. At the first stage collection points are organized for metals and other high-value wastes to start the recycling process. This action will be coordinated with the waste-to-energy development programme. Once a system of recycling has been established it will be gradually expanded in the medium to long term until all households have access to sorting bins for different wastes available to them and 70–100% of wastes are recycled. The programme will be funded with profits from realizing the resale value and waste collection fees.</p>	

5.2 Energy

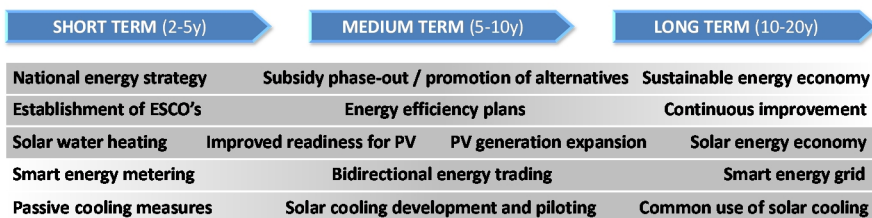


Figure 9. Implementation actions for energy.

5.2.1 National energy strategy

<p>Purpose</p> <p>Coordinated energy investments</p> <p>Sustainable energy use</p> <p>Efficient use of resources</p>	<p>Main realizers</p> <p>Ministry of Energy</p> <p>Other ministries</p> <p>Energy experts and stakeholders</p>
<p>Timeframe Short to long term (2–20y)</p>	
<p>Description</p> <p>Energy use in cities is linked to the national energy system through the electricity grid and the energy chains of the various fuels. Changes in one location affect the whole, therefore the development of the energy system should be done in a coordinated manner guided by a national energy strategy. Recommended actions include the proposals of this document. Moreover, an emphasis should be given to shifting to domestic, renewable energy sources that promote jobs and growth in Egypt and reduce pollution, climatic effects and dependence from energy imports. In the medium to long term this shift can be best supported by a moving funding from energy subsidies from fossil fuels to sustainable, renewable energy sources and energy efficiency. This shift should be done gradually and planned by experts so that it aims to cost-neutrality to the end-consumer, meaning that as people move away from fossil energy use to efficient energy use and renewable alternatives, their total energy bill remains roughly the same. As only a shift in funding is suggested, the net effect for the state budget is zero. A positive effect in the form of green growth can be expected as funds previously used for energy imports will be domestically used.</p>	

5.2.2 Energy efficiency improvement programme for businesses

Purpose Promotion of energy efficiency Driving growth with lower costs	Main realizers Ministry of Industry Ministry of Energy Industry associations
Timeframe Short to long term (2–20y)	
Description Presently there are few incentives for reducing energy use in the industries and businesses. Subsidised energy prices have meant that energy efficiency investments are seldom profitable. However, overall efficiency could be improved if part of the energy subsidy funding would be used for improving energy efficiency of industrial processes while keeping or reducing the overall cost level. Therefore, as part of the national energy strategy, some funds should be diverted to establish ESCOs (energy service companies). ESCOs study the energy use in companies and produce plans, together with the company in question, to improve the energy efficiency of their process. This service will be paid for part of the savings in energy costs, whilst the rest of the savings will be left as a profit to the company. This work will leave the companies with energy efficiency plans where future maintenance and planned renovations will include energy efficiency improvements. Together with periodic energy audits, this leads to continuous improvement of energy efficiency in the long term.	

5.2.3 Solar energy expansion programme

Purpose Increased use of renewable energy Increased energy security Promotion of local jobs	Main realizers Ministry of Energy Local authorities Local businesses
Timeframe Short to long term (2–20y)	
Description Even though Egypt has abundant solar energy available, it tends to have few users in Egyptian cities. This is in part caused by the energy subsidies, which make investments to solar energy unprofitable. As energy subsidies are phased out, part of the funds should be channelled to promoting the use of solar energy, thus reducing the cost of diminishing subsidies to customers, improving energy security and creating jobs locally in the production, instalment and maintenance of the required equipment. In the short term solar domestic water heating (DHW) should be promoted with investment subsidies to people opting to install a solar DHW system. Similar subsidies should be made available for photovoltaic (PV) systems. Also, new buildings should be required to have the necessary electric wiring for PV on the rooftop, where applicable, to guarantee that the electric connection is not a limiting factor. On the medium term the building code should be amended to require new buildings to be near-zero-energy buildings (NZEB) with most of their needed energy produced on location with solar heating, cooling and electricity production (see Antuña et al. (2015) for details about NZEB construction in Egypt). This allows cities to develop over time to have a high level of energy independence, energy security and sustainability.	

5.2.4 Smart grid action plan

Purpose Increased efficiency in energy use Improved energy security	Main realizers Ministry of Energy Energy utilities
Timeframe Short to long term (2–20y)	
Description Smart grids can help efficiently control the production, transmission and consumption of energy. This leads, over time, to a lower need for investments in production and transmission capacity, more economical energy production and a lower risk of blackouts. In the short term the change is started by installing smart meters to buildings. New buildings will be required to have smart meters, whereas existing buildings will have them installed in conjunction with renovations on their electric system. Occurring at the same time with the expansion of PV production, this will allow bi-directional energy trading in the medium term, coupled with the introduction of a feed-in tariff. Also occurring in the medium to long term will be investments to both the grid and building energy systems to allow the development of a smart grid. This will take place with a combination of regulation, subsidies and voluntary actions. A task force will be formed from energy experts in the ministry level to coordinate the action. Funding will be made available from reduced energy subsidies at a modest level, while most of the investments should be profitable at their own.	

5.2.5 Solar cooling development programme

Purpose Reducing fossil fuel use Improving energy security Better indoor comfort	Main realizers Ministry of Energy Local authorities Universities and research centres
Timeframe Short to long term (2–20y)	
Description Egypt has a combination of high level of cooling needs and abundant solar energy. This creates the ideal conditions for the introduction of solar cooling systems. In the short term passive solar cooling measures will be introduced by mandating buildings that have AC equipment installed to use reflective paint, that is regularly maintained, on roof surfaces that get solar irradiation, and windows to have proper shading arrangements to them. The costs will be recovered from the lower need for the use of AC. Active solar cooling alternatives are to be studied in a national research programme for solar cooling to be distributed among the relevant universities and research centres. Pilot buildings will be selected to test the most promising technologies. With the rising energy prices and the lowering costs of solar cooling with improving technology, the price of the two should meet at some point in the medium to long term. Once this critical point is reached, the large-scale introduction of solar cooling can take place. Thus the development phase should be seen as an investment: development costs now will be covered by lower costs of water in the future. In the development phase outside funding will be necessary and sought from national and international funders supporting the development and piloting of new technology.	

5.3 Transportation and traffic

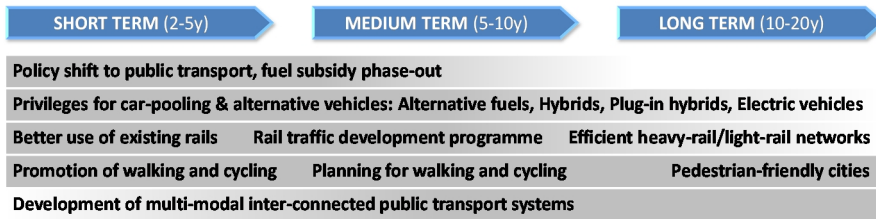


Figure 10. Implementation actions for transportation and traffic.

5.3.1 Policy shift to public transport

<p>Purpose</p> <p>Increased mobility in cities Better service for citizens Reduction of pollution and accidents</p>	<p>Main realizers</p> <p>Ministry of Transport Local authorities Transport businesses</p>
<p>Timeframe Short to medium term (2–10y)</p>	
<p>Description</p> <p>Egyptian cities tackle with growing traffic problems. With fast increasing populations and increasing car ownership the current trend leads to worsening congestion, worsening pollution, more accidents and increasing dependence on imported fossil fuels. Therefore a policy shift to public transport is recommended. Some funds will become available as fuel subsidies are phased out. In the short term bus and micro-bus services will be improved with lane priorities and increased capacity. This will be coupled with part of the funds available from the phasing out of fuel subsidies being used to provide each citizen with a limited number of free tickets in the form of coupons or smart cards. In the medium term bus and rail services will be drastically improved as is described in the following implementation actions. The funds for this will become available from the phase out of fuel subsidies. Improved mobility using public transport coupled with limited free ridership will make reductions in fuel subsidies more acceptable. As traffic situation improves in cities with more people opting to not use their cars, motorists also will benefit from a better access to the city.</p>	

5.3.2 Multi-modal integrated public transport planning initiative

Purpose Increased mobility in cities Better service for citizens Reduction of pollution and accidents	Main realizers Ministry of Transport Local authorities Transport businesses
Timeframe Medium to long term (5–20y)	
Description A well-functioning public transport system provides people with a selection of transport modes. Fast main rail or bus arteries connect major parts of the city to each other, while a dense local network of busses, light rail and light vehicles guarantees high accessibility in all neighbourhoods. Given the very high population densities in Egyptian cities, public transport lines reach high ridership and profitability relatively easily. However, realizing this potential requires well-coordinated planning on the city and regional levels. A national planning initiative will take place to improve the quality of public transport in cities. This is important to provide acceptability for the phase out of fuel subsidies by providing a vastly improved public transport alternative. At the same time the traffic situation in cities improves, reducing accidents, pollution and improving access to the city. Less investment to streets and motorways will be needed, which makes funds available for the development of public transport.	

5.3.3 Privileges for car-pooling and alternative vehicles

Purpose More efficient use of investments Reduction of congestion Reduction of fossil fuel dependence	Main realizers Ministry of Transport Local authorities
Timeframe Short term introduction (2–5y)	
Description Normal cars have the capacity for transporting five people, yet often most cars have but one person riding in them – the driver. Even having two or three people in each car could halve the amount of traffic on streets, practically eliminating congestion. Less investment to both the automobile fleet as well as streets would be needed. Of course this is an extreme example and it will not be possible to require all cars to have more passengers, but the practice of car-pooling could be promoted to realize some of the benefits. This can be done by giving car-poolers lane and parking privileges. Automobiles with at least three people in them could share priority lanes with busses and have partly subsidised access to paid parking facilities. Similar benefits could be given to alternative fuel vehicles, hybrid and electric vehicles to promote their introduction, for as long as they are not too common in the traffic. This action can be taken in the short term with very little costs that can be covered with cost savings derived from the reduced use of the public roads.	

5.3.4 Rail traffic development programme

Purpose More efficient use of investments Reduction of road traffic Reduction of fossil fuel dependence	Main realizers Ministry of Transport Local authorities
Timeframe Short to long term (2–20y)	
Description Egypt has optimal conditions for the use of rail traffic: high urban populations and a landscape where rail construction is usually relatively easy. Compared to this, the rail system right now is underused. In the short term the existing infrastructure should be used more efficiently, meaning increased service on rail connections such as the one from Alexandria to Borg El Arab. To increase ridership, a well-functioning connection to and from stations should be organized (see <i>Multi-modal integrated public transport planning initiative</i>). Inside cities modern, fast light rail lines should be introduced. These can offer fast, high-quality rail service to people with a fraction of the cost of underground rail lines and much shorter construction times. Intersections with roads should be improved to under or overpasses to reduce irregularities in the service and accidents. Again, the cost is minimal compared to underground rail. In the long term, cities should have efficient and well-connected heavy and light rail networks.	

5.3.5 Walking and cycling promotion programme

Purpose More efficient use of investments Reduction of road traffic Reduction of fossil fuel dependence	Main realizers Ministry of Transport Local authorities Egyptian National Railways
Timeframe Short to long term (2–20y)	
Description Road planning has often concentrated on cars with the facilities for pedestrians and cyclers being inadequate and in poor condition. This, combined with scarcity and lack of respect for pedestrian crossings, has made walking and cycling unattractive and thus contributes to the congestion of streets. Yet, the infrastructure needed by pedestrians and cyclers per passenger-kilometre is much less compared to automobiles. Thus cities can actually save in infrastructure funds by making sure that planning is done to promote walking and cycling and making it attractive in different ways. In the short term small changes should be done to the existing road infrastructure: adding pedestrian crossings, monitoring them to ensure compliance in heavily trafficked areas, using markings and obstacles to demarcate pedestrian and cycling routes, improving lighting, improving the upkeep of sidewalks etc. In the medium to long term over and underpasses, pedestrian-only areas, fast lanes for cyclists and other such improvements should be made standard in city planning.	

5.4 Buildings and construction

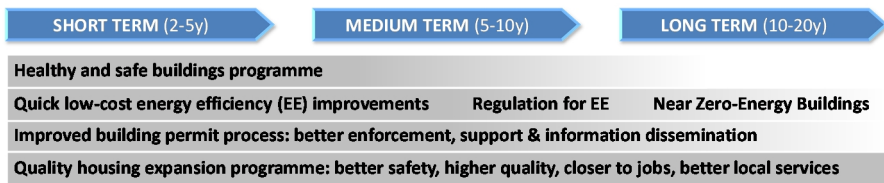


Figure 11. Implementation actions for buildings and construction.

More implementation actions applicable to buildings are included under the water and waste and energy headings.

5.4.1 Healthy and safe buildings programme

<p>Purpose</p> <p>Better worker and occupant safety Higher quality buildings</p>	<p>Main realizers</p> <p>Ministry of Housing Local authorities Building industry</p>
<p>Timeframe Short to medium term (2–10y)</p>	
<p>Description</p> <p>Building materials and construction practices should be updated so that buildings are safe to construct and use. A programme to promote health and safety in buildings is proposed that has three main approaches: 1) updating regulation and guidelines concerning buildings, 2) educating and informing planners, builders and supervisors, and 3) regulating and enforcing safe construction practices and materials. Updated regulation and guidelines should be devised by a panel of experts based on science and measurable effects, under guidance from the ministry and with consultation of the stakeholders. The cost-effectiveness of regulation will be shown in terms of avoided health problems compared to costs. Planners, builders and supervisors will have mandatory training paid for by their employers to ensure knowledge of regulation and guidelines. Enforcement will be done including on-site inspections. All aspects of this action will be coordinated with the <i>Improved building permit process</i> action.</p>	

5.4.2 Energy efficiency improvement programme

Purpose Increased energy security Better indoor comfort Cost savings	Main realizers Ministry of Housing Local authorities Building industry
Timeframe Short to medium term (2–10y)	
Description Buildings consume a major portion of the energy in cities, typically about one third or more. Therefore they have great potential for improvements in energy efficiency. As living standards in Egypt rise, people have more electric appliances in their homes and more people use heating and cooling devices. Energy efficiency in buildings is improved with two approaches: improving the building envelope and improving the appliances and devices. In the short term easy actions include switching to energy saving light bulbs and doing simple maintenance operations in the buildings such as fixing window and door frames and cleaning filters in heating and cooling machines. These actions should be promoted with an information campaign paired with the phase-out of energy subsidies to show people that they can avoid increases in their electricity bills by making smart choices. In the medium term new regulation should be introduced to require better energy efficiency levels from new buildings, ultimately aiming to near-zero energy buildings (see Antuña et al. (2015) for details about NZEB construction in Egypt). This goal is simultaneously approached with the implementation of the <i>Solar energy expansion programme</i> . For consumer electronics, energy labelling will be used similar to the EU Energy Label to inform consumers.	

5.4.3 Improved building permit process

Purpose Promotion of energy efficiency Promotion of renewable energy Promotion of health and safety	Main realizers Ministry of Housing Local authorities Building industry
Timeframe Short to medium term (2–10y)	
Description The building permit process offers the opportunity to inform builders about issues relating to safe and healthy buildings, energy efficiency and use of renewable energy in buildings timed optimally when planning is still taking place and construction has not yet begun. This opportunity can be used to provide support and information to the builder and planners when the permit is sought. Depending on the type of building and location, pertinent information can be provided about how to best develop it into a sustainable building. This requires training the permit authorities so that they have relevant expertise and an access to more information as needed. It will be made standard practice that every permit-seeker gets relevant information on making cost-saving and energy-saving improvements to the new building. This will be coupled with a general improvement of the building regulations and guidelines and their enforcement (see <i>Healthy and safe buildings programme</i>).	

5.4.4 Quality housing expansion programme

Purpose Increased access to housing Better quality dwellings Better access to jobs and services	Main realizers Ministry of Housing Local authorities Building industry
Timeframe Short to long term (2–20y)	
Description With a growing population and increasing urbanization, Egypt has an urgent need for more housing. Quality housing expansion programme aims to improve the planning of new housing projects. It also provides coordination for the realization of the various implementation actions presented here in new projects. In the programme, planning is developed through training for planners that will be organized in cooperation with the building industry, universities and the relevant authorities. Guidelines are given for developing housing close to jobs, with adequate locally distributed services, mobility with public transport and green areas and recreational opportunities. These guidelines will include sustainability as a goal. Private developers will be required to allocate a reasonable share of the construction budget for developing the living environment.	

6. Conclusions

An EcoCity roadmap for Egypt was developed using a collaborative work method based on three major workshops and minor revision rounds in between. The first workshop formed a vision for EcoCities in Egypt, the second outlined thematic roadmaps for the short, medium and long terms while the third and last workshop defined implementation actions needed to realize the roadmap. Thus the roadmap takes the form presented in Figure 1.

The EcoCity vision, discussed in Section 3, included issues such as food and water security, job creation, awareness and habits, sustainable use of resources, biodiversity, protection of cultural heritage, prevention of corruption, mobility, civilian rule, strategic policymaking, enforcement of regulations and policies and inclusion of all members of the society in the process. The importance of investments in human capital, health and education was underscored as an enabler of both growth and sustainability.

To realize the thematic roadmaps, presented in Section 4, concrete implementation actions are recommended. They are listed in Table 1, while a more detailed explanation is given in Section 5.

A pressing issue in Egyptian cities is the need for proper housing for a growing population. Many improvements in energy efficiency and energy security do not need high investments, such as increasing the use of solar energy for heating domestic hot water. More technical details are available from Antuña et al. (2015). New buildings should have steadily improving indoor conditions as well as well-maintained surroundings with an access to green areas for all. Preservation of natural greenery holds important value for both well-being and ecology.

Industries need to develop towards reduced emissions and energy and resource use. This process can start with energy auditing and efficiency programs for specific industries and move towards continuous improvement goals.

Transportation should have less reliance on automobiles to reduce congestion, accidents, pollution and cost to families. Alternative modes of mobility should be promoted in various ways, as is presented in Section 5.3 and Table 1. In short distances walking should be made more attractive, in longer distances cycling and public transport. Similar policies can be used to promote alternative fuels and electricity in plug-in hybrids and electric vehicles.

Table 1. List of proposed implementation actions for realizing the roadmap.

<p>Water and waste</p> <p>Water metering and efficient water use campaign Joint water training programme Waste-to-energy development programme Desalination development programme Campaign to reuse and recycle</p>
<p>Energy</p> <p>National energy strategy Energy efficiency improvement programme for businesses Solar energy expansion programme Smart grid action plan Solar cooling development programme</p>
<p>Transportation and traffic</p> <p>Policy shift to public transport Multi-modal integrated public transport planning initiative Privileges for car-pooling and alternative vehicles Rail traffic development programme Walking and cycling promotion programme</p>
<p>Buildings and construction</p> <p>Healthy and safe buildings programme Energy efficiency improvement programme Improved building permit process Quality housing expansion programme</p>

Wastes should be treated in the order of the waste hierarchy: reduce the formation of waste by and efficient processes and smart consumption choices, reuse products when they are still usable, recycle more materials, and start the use of refuse derived fuels.

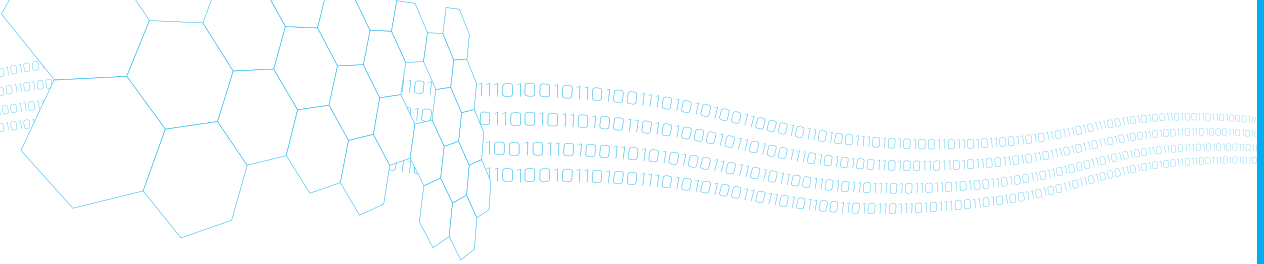
In energy policy the phase-out of subsidies for electricity of fuels should be administered so that some of the saved funds are used to reduce the burden of consumers while advancing a smart energy policy that reduces environmental impacts, saves energy resources, promotes local jobs and reduces dependence on imports. In practice this means promoting public transport and making it more affordable as an alternative to cars and supporting energy efficiency and renewable energy investments in homes and businesses.

Egypt faces many challenges at the present related to fast growing cities, economic difficulties and sustainable development. EcoCities should be seen as a way to answer all three, rather than pushing to promote one over the others. The proposed implementation actions aim to reduce the reliance on imported energy, reduce pollution, reduce congestion, conserve resources and valuable nature while promoting local business and jobs, improving mobility, improving the urban environment, increasing the use of renewable resources and promoting the participation of citizens.

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Title	EcoCity roadmap for Egypt Actions for eco-efficient urban development
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Abstract	<p>Egypt's fast population growth together with economic development is causing drastic pressures on infrastructure, quality of life and the environment. Effectively responding to this challenge requires a strategic approach based on solutions that rely on research and scientific evidence. This document introduces an EcoCity roadmap for the development of Egyptian cities into EcoCities.</p> <p>The EcoCity approach is a multidisciplinary approach for developing cities to sustainable, ecologically friendly communities, spanning topics such as urban planning, energy systems, water and waste management, transportation planning and awareness-raising. This roadmap was developed in a series of three multidisciplinary workshops held in Egypt in 2013 and 2014 and commenting rounds following those events.</p> <p>The development of the EcoCity roadmap has three major uses: it aids in producing a consensus about a set of needs and the technologies required to satisfy those needs, it provides a mechanism to help forecast technology developments and it functions as a framework to help plan and coordinate future technology developments.</p> <p>The roadmap is presented in three parts: a vision for EcoCities in Egypt, thematic outline roadmaps to guide long term development and a listing of concrete implementation actions for realizing the roadmap. Each implementation action is a concrete recommendation for a practical action.</p> <p>Egypt faces many challenges at the present related to fast growing cities, economic difficulties and sustainable development. EcoCities should be seen as a way to answer all three, rather than pushing to promote one over the others. The proposed implementation actions aim to reduce the reliance on imported energy, reduce pollution, reduce congestion, conserve resources and valuable nature while promoting local business and jobs, improving mobility, improving the urban environment, increasing the use of renewable resources and promoting the participation of citizens.</p>
ISBN, ISSN, URN	ISBN 978-951-38-8241-9 (URL: http://www.vttresearch.com/impact/publications) ISSN-L 2242-1211 ISSN 2242-122X (Online) http://urn.fi/URN:ISBN:978-951-38-8241-9
Date	April 2015
Language	English
Pages	36 p.
Name of the project	EcoCity Capacity Building in NBC
Commissioned by	Ministry for Foreign Affairs of Finland
Keywords	EcoCity, roadmap, city planning, renewable energy, sustainability
Publisher	VTT Technical Research Centre of Finland Ltd P.O. Box 1000, FI-02044 VTT, Finland, Tel. 020 722 111



EcoCity roadmap for Egypt

Actions for eco-efficient urban development

Egypt is growing fast. In the last five years, from 2009 to 2014, Egyptian population has increased by 2% annually, a dramatic pace indeed. Together with economic development, increasing urban areas, increasing cars, increasing air conditioning and household appliances, this means drastic pressures on infrastructure, quality of life and the environment. Effectively responding to this challenge requires a strategic approach based on solutions that rely on research and scientific evidence. In this roadmap document for EcoCities in Egypt, researchers from VTT Technical Research Centre of Finland Ltd together with researchers from E-JUST Egypt-Japan University of Science and Technology, Alexandria University and Cairo University suggest a pathway for ecologically, socially and economically sustainable urban development in Egypt.

ISBN 978-951-38-8241-9 (URL: <http://www.vttresearch.com/impact/publications>)

ISSN-L 2242-1211

ISSN 2242-122X (Online)

<http://urn.fi/URN:ISBN:978-951-38-8241-9>

