Low-energy urban infrastructures for the City of Nefta (Tunisia)

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ABSTRACT

This article provides a detailed account of a project work carried out by students of 'Applied Environmental Engineering in Urban Planning' at the School of Architecture in the University of Navarra during the academic year 2006-2007. The project explores and explains a number of strategies for the renewal, improvement and implementation of urban infrastructure in the Tunisian city of Nefta, located very close to the edge of the Sahara desert. The final report on the project was delivered to the Tunisian Embassy in Spain for its development.

1.- Technical Proposals: An Analysis and Summary

The inspiration for this project was concern among teaching staff at the School of Architecture that the project work assigned as part of a university academic program may often have little bearing on real social need. This led to the formulation of an ambitious project task: to design a system of low energy urban infrastructures to meet the specific social and economic needs of Nefta. This renewal scheme was developed with all the technical vision of the School of Architecture at the University of Navarra, which is located in one of the most highly developed regions of Europe in terms of sustainable energy supply and resource management.
The project is intended to provide practical solutions to real problems, and seeks to combine maximum energy conservation with minimum consumption and CO_2 emissions in terms of the city as a whole, not on a building per building basis. The solutions comprise different areas of resources and energy: water supply management and cold water production (in a district cooling system); the generation of electricity using only renewable sources of energy such as solar energy capture systems, photovoltaic panels, low-power urban wind turbines, and biomass energy from the palm-tree matter abundant in Nefta.

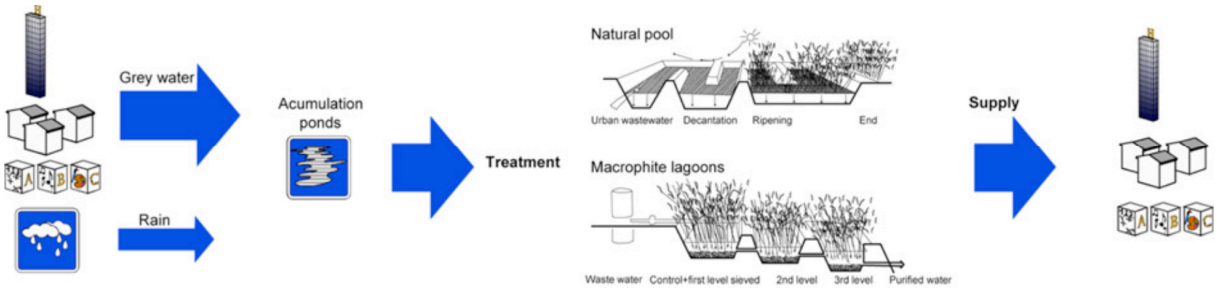
2.- Water Management

Nefta has a minimum rainfall and a characteristically dry climate which makes water a precious element. This city must necessarily avoid any waste in the main sectors of agriculture, residential areas, and tourist facilities (fig.1).

- The creation of a new pond is proposed in which a system of purification occurs through the use of macrophyte plants that would improve the quality of the water used to irrigate crops.
- The creation of more ponds using residual waters along with those accumulated from rainfall that can be later used for irrigation.
- Macrophyte lagoons perform a purifying effect on water by making it circulate through different ponds of increasing depth possessing water-proof bottoms and walls.

Current irrigating techniques use ditches or channels which waste large amounts of water. The implementation of a drip irrigation system would entail:

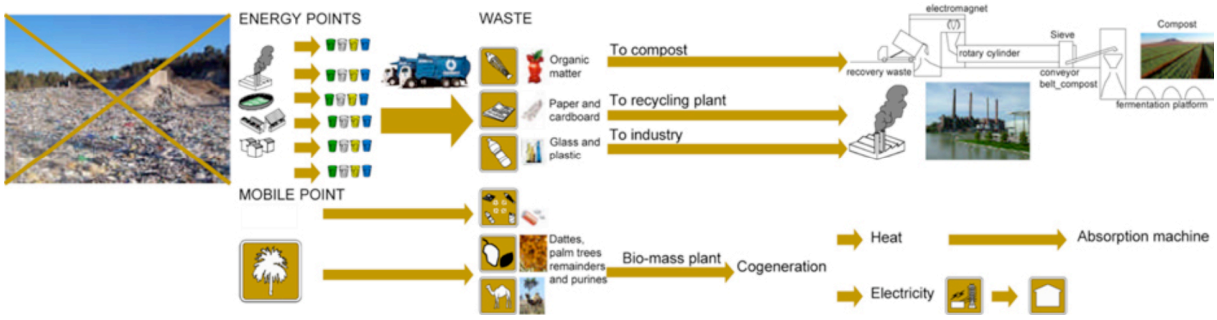
- A 40% to 60% increase in savings.
- An increase in the quantity and quality of products.
- Adaptability to all types of surfaces and uneven land.



(fig. 1. Water Management diagram)

3.- Urban Solid Waste

The accumulation of waste in dumps means a loss of valuable landscapes in the area. The objective, therefore, is to achieve a recycling percentage of 100%. Glass, paper and cardboard is transferred to a recycling plant for treatment and its subsequent re-use. Similarly, organic residual waste is transferred to a compost plant. In a central tri-generation plant energy is generated through the burning of the leftover biomass (fig.2).



(fig. 2. Urban Solid Waste diagram)

Classification of Domestic Waste Products:

- Separation in the place of origin of all waste material into organic, plastic, glass and paper classifications.
- Energy points serving as rubbish or garbage collection points. A truck or lorry will collect all organic material from these points and transport it to a compost plant. On a weekly basis all glass, paper, and cardboard will be taken to the nearest recycling plant. There will also be a mobile collecting service travelling throughout the city and to the diverse energy points to facilitate the collection of any residual waste products of bigger dimensions along with any domestic toxic waste products.

The Creation of a New Compost Plant:

- Allows for the recycling of organic residual waste which originates in dwellings and the mud derived from the purifying process of residual waters.

- The obligatory instalment of semi-dry toilets in all hotel industry services is recommended along with a depot for all compost.

The Creation of a New Biomass Plant:

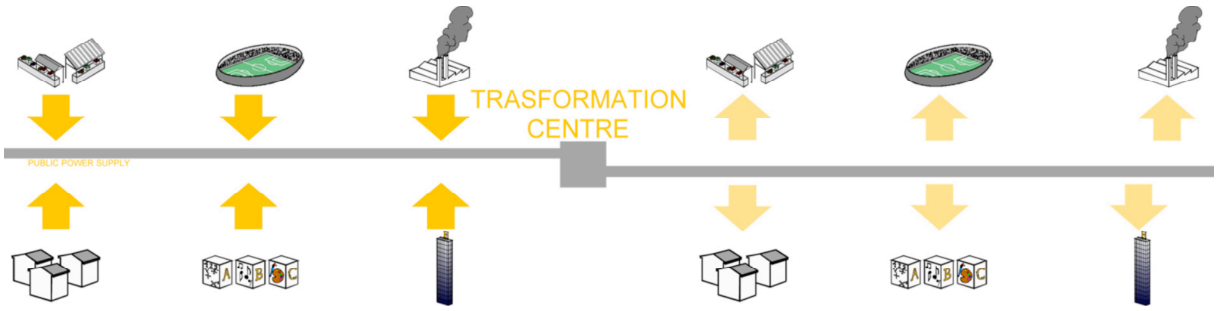
- Two sources exist for the production of biomass: the cultivation of dates (using residual pits and dry branches), and the livestock manure from all livestock. Electricity can be produced from the combustion of this waste material and is a potentially renewable source of energy.
- The implementation of these systems would mean a reduction in carbon dioxide emissions, an improved landscape with the disappearance of uncontrolled garbage dumps, and an increase in jobs.

4.- Electricity Production

It is proposed that the production of electricity in Nefta develop into a system of production based on renewable energy (solar, wind and biomass) adapting to the cultural, social, economical, and political conditions of the city.

De-centralized Production of Electricity (fig.3):

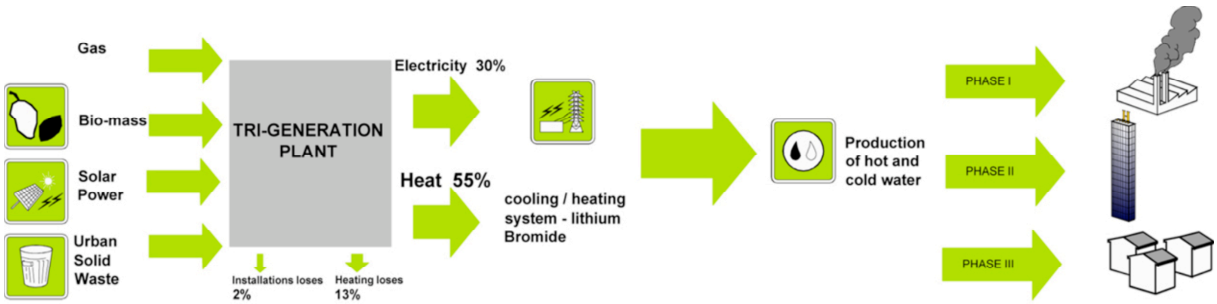
- The production of electrical energy within the city itself will be promoted as a means of compensating for the loss associated with its transport from far-away power plants.
- Six energy points have been proposed which are never further than five hundred metres apart from each other. The type of renewable energy for each point is to be determined by the point's strategic location [1].



(fig. 3. Electricity Production diagram)

5.- Hygrothermal Conditioning

This city's extreme climate which is characterized by pronounced temperature variations within a very short time span makes the production of heat and cold a necessity. Most of the facilities used for such production are individualized and consume large quantities of electricity. Concentrating all of these individual units into one central plant producing both hot and cold water and situating it near the industrial area has provided a cut in both costs and carbon dioxide emissions.
The production of both hot and cold water is concentrated in one central tri-generation plant situated in the industrial zone thus facilitating distribution to the rest of the city in addition to hotels and residential areas. The energy necessary for the plant is obtained from solid urban residue and the biomass waste. Its distribution is carried out via an underground passages distributed throughout the entire city (fig.4).



(fig. 4. Hygrothermal Conditioning diagram)

The Characteristics of Tri-generation:

- Independence from the network.
- Reduction of cost for consumers.
- Greater protection of the environment.
- Reduction of CO_2 emissions.
- Greater efficiency in the generation of energy with the subsequent reduction of its cost in transport and distribution.
- The caloric fluid is water and not CFCs.
- Easier to incorporate new facilities.

6.- Actuations by sectors

Hotels. It is proposed that hotels produce five times the amount of energy they consume in order to supply power to the city of Nefta. The total cost for the city is zero in Euros.

- Educating the Tourist: fomenting leisure without wasting water.
- Hotels should recycle their own grey waters.
- Instalment of faucets or taps with timers and semi-dry toilets.
- Creation of underground passages which connect with the main points in Nefta and the secondary networks to distribute the water produced.

Marketplace.

- The use of an electricity-producing, photovoltaic pergola would help organize and protect the market posts.
- The Creation of areas with shade.
- The instalment of small wind turbines of little height proportionally respecting the city's minarets.
- The energy points would be installed wherever residual waste is collected and would be evenly distributed throughout the city.

Industry.

- The electricity generated is consumed by the factory producing it and any excess energy production would be supplied to the public sector.
- A tri-generation plant is set up and fuelled by biomass which could also be supplied to the rest of the city.

New Neighbourhoods.

- Energy points in the new neighbourhoods can also serve as a visual reference.

Progressive action that slowly integrates energy-saving systems.

- Faucets/taps with timers.
- Semi-dry toilet tanks.
- Individualized water consumption counters.
- Encouraging the rational use of water by penalizing any abuse of its consumption.
- Solar panels for heating water in hospital.
- Obtaining benefits from the district cooling-heating system.

Provisions.

- Social awareness of renewable energy and their use in public buildings.
- Instalment of faucets/taps with timers.
- Implementation of educational campaigns: children bring paper and cardboard waste from their homes once a week (a day previously agreed upon with the recycling plant). Children are taught from an early age to look after their city and involve their families in the recycling process using such measures.

Transport. The scarcity of available services with respect to the number of inhabitants in Nefta makes it obligatory for them to make long commutes. It is proposed that this approach be changed so that these services commute to the city instead of its inhabitants doing so.

7.- Conclusions

The ultimate objective of the project is to provide a low-energy urban infrastructures plan capable of driving sustainable development in a community with a high rate of consumption of non-renewable energy sources in an area with limited natural resources.

All of these measures can be exported to other cities and it is even possible to set up both the compost plant and biomass plant to serve many communities within a specific territory.

The most important consuming sector is the hotel industry where major action must be taken, with the final objective to achieve the recycling of 100% of the residual waste produced in the city

The use of renewable energy guarantees an ecological balance and also prevents the loss of energy associated with its transport from the electrical power plants to the city receiving it.

REFERENCES

[1] For additional data, consult the poster presented at the Congress.

ACKNOWLEDGMENT

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