Sustainable Communities

Woodrow W. Clark II
Editor

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Springer

Editor
Woodrow W. Clark II
Clark Strategic Partners
P.O. Box #17975
Beverly Hills, CA 90209
USA
wwclark13@gmail.com

ISBN 978-1-4419-0218-4 e-ISBN 978-1-4419-0219-1
DOI 10.1007/978-1-4419-0219-1
Springer New York Dordrecht Heidelberg London

Library of Congress Control Number: 2009937583

Thanks to Evelyn Bernstein for the photos that appear between chapters and to Lizabeth Fast for the cover.

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Foreword

This book would not have been possible without the dedication and commitment of each of the chapter authors. For some authors, writing a chapter was beyond their "9–5" job, and this book reflects their commitment to sustainability at the local level for their communities. To every chapter author and their staff, friends, and families, thank you. This dynamic and paradigm-changing volume on the topic of sustainable development is focused on communities such as cities, schools, and colleges where the future of our families and children are most at risk. We must act today as each of the chapters represents in their presentations. This book marks a new era: the Third Industrial Revolution.

The new age of the Third Industrial Revolution has been labeled by some as the "green era" or "green economy," but it had already started around the world, especially in Europe and Japan, for over a decade – since the end of the 20th century. More significantly, the book highlights people and communities who have a shared concern and vision along with the will and determination to enact programs and polices that make sustainable development real – not just political rhetoric or "branding" or even the current "buzz word" for obtaining funds and grants. The book presents "The Sequel to an Inconvenient Truth" – actual examples of how communities can and have changed in order to mitigate climate change. Again, thanks to everyone and their colleagues.

Professor Ted Bradshaw, who was the coauthor of *Agile Energy Systems: Global Lessons from the California Energy Crisis* (Elsevier, 2004) needs to share the credit for this book. He died of a heart attack about 2 years after our book was published, so he did not see this volume that was inspired by our work together. Ted's wife, Betty Lou, and their sons have, however. I want them to know and receive the acknowledgement, support, and respect that brought them and me together. May they share in the pride that I have for this book.

I must also thank my two grown children and their spouses, Woodrow W. Clark III (Debra) and Andrea Clark Lackner (David), for their insights, critical comments, and support in my work over the years. In particular, I know that it has not been easy for them, but they both have the intellect and concern that will make them continue to be wonderful children and the best parents.

In particular, I would like to recognize Larry Eisenberg, vice president for Facilities and Planning at the Los Angeles Community College District (LACCD).

While this book was done on my own time, our work together with LACCD over the last 5 years has brought dramatic changes to the nine LACCD colleges and inspired others to do likewise. Frankly, LACCD has become a national and international leader on making colleges (hence communities) energy independent and carbon neutral through renewable energy. This was done with Larry's leadership and support as that of the entire LACCD staff and Board of Trustees. I need to also thank Ms. Jatan Dugar and Russell Vare, who both worked on the final version of the book. Without them, the book would not be completed.

The support from Springer Press and Janet Slobodien in particular has been outstanding. Janet's support from the very beginning of the idea for such a book through the final publication has been remarkable and superb in every way imaginable.

This book is dedicated to my wife, Andrea Kune-Clark, and our son, Paxton Jacob Clark, who will be 2 years old at the time of publication. The book reflects my concern for Paxton. It is his generation to which we baby boomers and soon-to-be-retired elders have left a world that is polluted, quickly turning into an unliveable planet, and causing irreversible health problems.

The book presents actual cases of communities who have recognized these universal problems and done something about it. I hope that communities can use and implement this information for themselves. From what we see and know about the global economic problems, sustainable communities and their "green" development are the future. Hence, the next edition of the book will be four to five times the size of this one, with many more successful cases. It is to this end that I hope to give Paxton and his generation more than just hope, but strong aggressive examples on what they can do. Paxton needs to inherit a world that is extremely different than the one that others and I have created.

Beverly Hills, CA, USA Woodrow W. Clark II

Contents

Contributors

Lucas Adams JETRO, Los Angeles, CA, USA, lucas_adams@gmail.com

Teresio Asola PIANETA, Settimo Torinese, Italy, teresio.asola@asm-settimo.it

Claire Bonham-Carter EDAM AECOM, San Francisco, California, USA, claire.bonham-carter@aecom.com

Woodrow W. Clark II Clark Strategic Partners, Beverly Hills, CA, USA, wwclark13@gmail.com

Steve Done ARUP Corporation, Los Angeles, CA, USA, steve.done@arup.com

Jatan Dugar University of California, Los Angeles, USA, jatandugar@googlemail.com

Nick Easley Foundation on Economic Trends, Washington DC, USA, neasley@foet.org

Larry Eisenberg Facilities, Planning and Development, Los Angeles Community College District, Los Angeles, CA, USA, eisenblh@laccd.edu

Tony Fairclough Engineering Consultant, tonfair@cox.net

Ken Funaki JETRO, Los Angeles, CA, USA, kentaro_funaki@jetro.go.jp

Andrew Hoffman Los Angeles Community College District, Los Angeles, CA, USA, andrew.hoffmann@build-LACCD.org

Thomas Jensen Enterprise Futures Network, San Franco, CA, USA, tjensen@enterprisefutures.net

Calvin Lee Kwan School of Public Health, University of California, Los Angeles, CA, USA, clkwan@ucla.edu

Natalija Lepkova Vilnius Gediminas Technical University, Vilnius, Lithuania, LT, natalija.lepkova@st.vgtu.lt

Henrik Lund Aalborg University, Denmark, lund@plan.aau.dk

Christine S.E. Magar AIA, LEED AP, MED, cmagar@greenform.net

Brenden McEneaney Office of Sustainability and the Environment, City of Santa Monica, Santa Monica, CA, USA, brenden.mceneaney@smgov.net

Poul Alberg Østergaard Department of Development and Planning, Aalborg University, Denmark, poul@plan.aau.dk

Johanna Partin Renewable Energy Program Manager, Department of the Environment, San Francisco, CA, USA

Bill Radulovich Project EarthRise, Pleasanton, CA, USA, bradulovich@pleasanton.k12.ca.us

Alex Riolfo University of Genova, Genova, Italy, contact through Terssio Asola at ASM, Torino, Italy, teresio.asola@asm-settimo.it

Christine Meisner Rosen Haas Business School, University of California, Berkeley, Berkeley, CA, USA, crosen@haas.berkeley.edu

David Schoenberg Enterprise Futures Network, Haas School of Business, University of California, Berkeley, CA, USA

Patrick Stoner Program Director, Local Government Commission, Sacramento, CA, USA, pstoner@lgc.org

Phil Ting Assessor-Recorder of San Francisco, San Francisco, CA, USA

Russell Vare Policy Advisor Consultant, russellvare@gmail.com

Wang Weiyi Jiaxing University, Zhejiang, P. R. China

Li Xing Aalborg University, Aalborg, Denmark, xing@ihis.aau.dk

Stephanie Whittaker Sustainable Development Advisor, AECOM, San Francisco, CA, USA, stephanie.whittaker@aecom.com

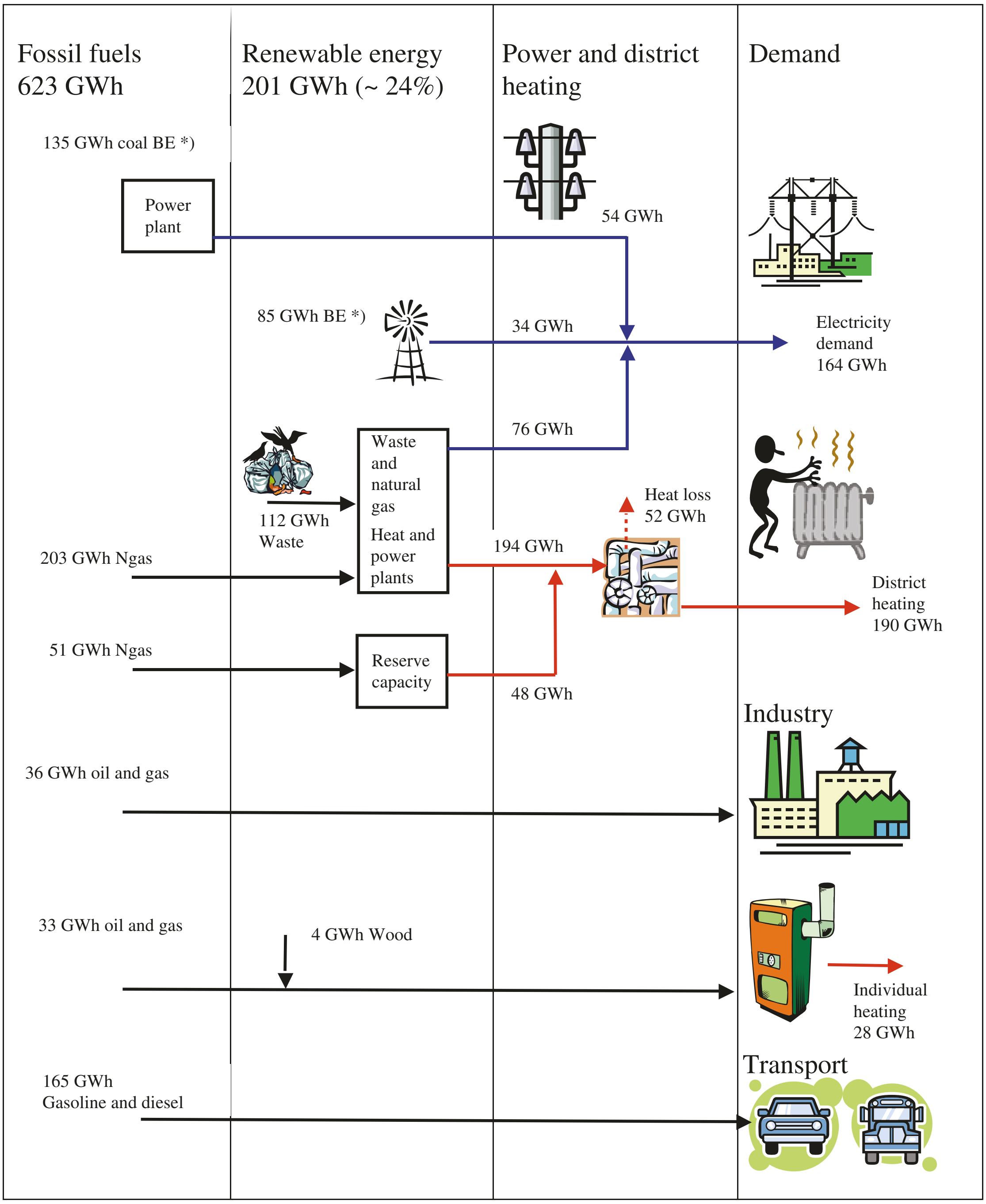


Fig. 11.1 Frederikshavn 2007 (20% renewable energy)
*Electricity as given in fuel equivalents of electicity production of a coal-fired steam turbine with an efficiency of 40%

The First Phase: Frederikshavn in the Year 2009

The year 2009 of phase one is chosen because the planned UN Climate Summit in Denmark will provide a good opportunity of promoting the project at an international level. The objective is to raise the share of renewable energy to approximately 40% by implementing the following four projects before the end of 2009:

- 12 MW wind turbines. The wind turbines are step one of a new offshore project of an expected 25 MW in total. The project has been decided, and the procedure of environmental impact assessments is in progress. The first 12 MW is expected to be implemented during 2009.
- 8000 m^2 of solar thermal in combination with additional 1500 m^3 of water heat storage and an absorption heat pump at the CHP plant at the small district heating supply of Strandby. At present the project is being implemented. The absorption heat pump will cool the exhaustion gas and raise the total efficiency from the present 94 to 98%, and the solar thermal will produce approximately 4 GWh of heat annually.
- Implementation of a facility to upgrade biogas from a local biogas plant outside the town to natural gas quality, and transport the gas into a biogas fuel station in Frederikshavn and invest in 60 bi-fuel cars. This will supply 7 GWh of biogas. The biogas that will not be used for transportation will be used in the CHP plant.
- Establishment of a 1 MW heat pump at the wastewater treatment plant of the town expected to utilise 2 GWh of electricity to take out 4 GWh of heat from the waste water and produce 6 GWh of heat for the district heating supply annually.

The total budget of this phase is approximately 200 million DKK (estimate), and as illustrated in Fig. 11.2, it is expected to raise the share of renewable energy to 38%.

The Second Phase Frederikshavn in the Year 2015: 100% RE on an annual basis

On a continuous basis, the EnergyTown Frederikshavn project is in the process of identifying a proper scenario for the implementation of a 100% renewable energy system by the end of year 2015. Here is a status on the results of such considerations. Each of the proposed projects will be subject to more detailed analyses in the coming period. However, the key components have been identified and are being planned for, since the planning and project phase itself takes up to several years.

New Waste Incineration CHP Plant

Municipal waste handling in Frederikshavn is based on the same principles as the rest of Denmark, that is giving priority to recycling of most of the waste, then incineration and only land filling of very small shares. However, the amounts of waste for incineration now exceed the capacity of the two existing plants in the area, and it is planned to build a new. Consequently, the EnergyTown project includes a new waste incineration CHP plant with an expected net-electricity efficiency of 23% and a heat production of 64% and with the capacity of burning 185 GWh/year equal to the available local resources.

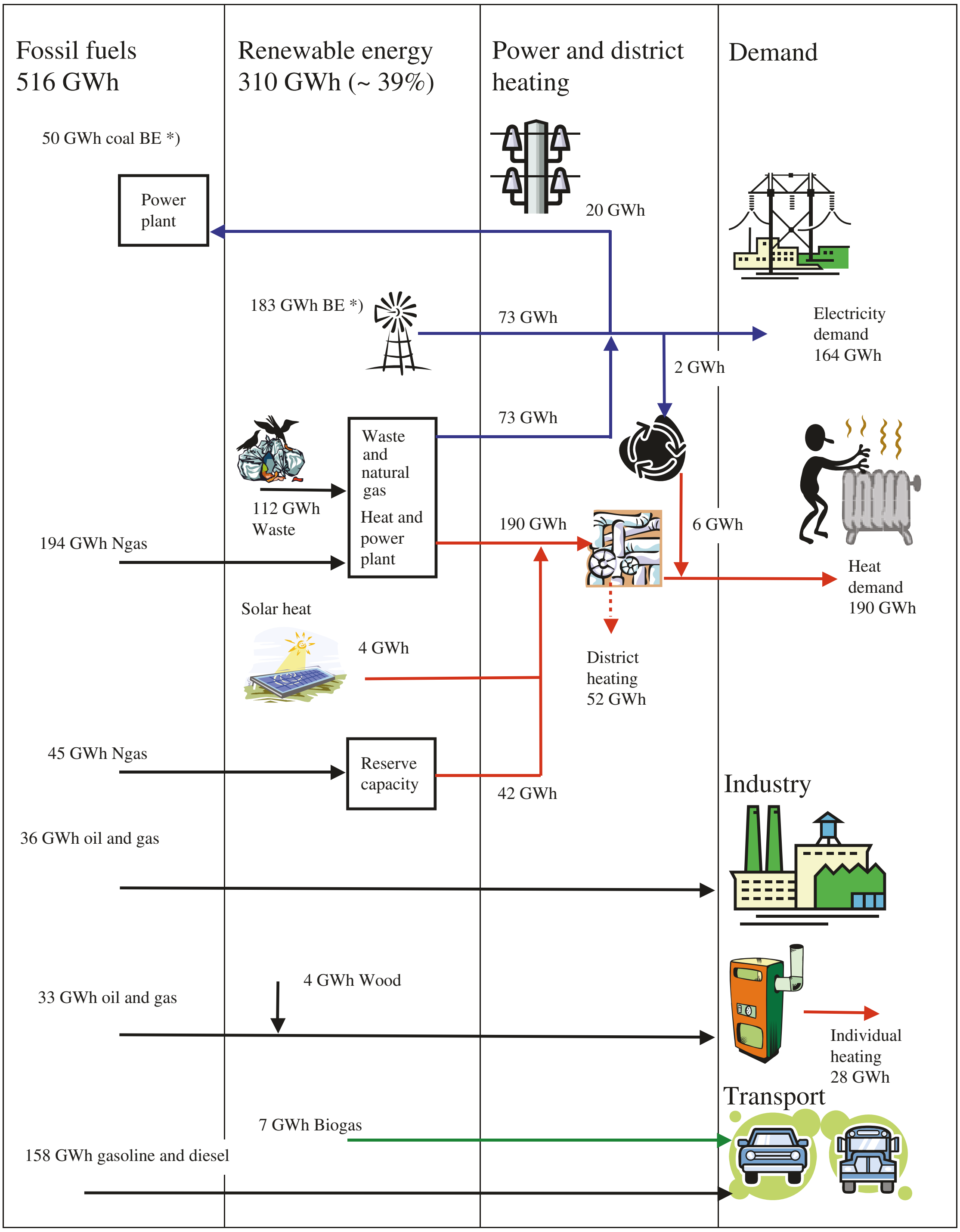


Fig. 11.2 Frederikshavn 2009 (40% renewable energy)

Expansion of District Heating Grid

The project also includes an expansion of the existing district heating grid from the present 190 GWh to a total of 236 GWh. Hereby 70% of the heat demand in industry and individual houses is replaced. The rest of the industry (process heating) will be supplied from biomass boilers, and the individual house heating is converted into a mixture of solar thermal and electric heat pumps.

Transportation

With regard to transportation the project is heading for a solution in which vehicles are converted into the use of biogas in combustion engines (bi-fuel cars), electric cars, and plug-in hybrid cars. In order to implement as much electric driving as possible it is suggested to implement cars which combine the use of batteries with fuel-cell driving based on either methanol or hydrogen. The following specific proposal calculated assumes that motor cycles (4 GWh) and vans and busses (25 GWh) are converted into biogas, hydrogen, or methanol in the ratio 1:1. Of the rest, 10 GWh is converted into biogas 1:1, and out of the rest, 50% is converted into electric driving (1 kWh electricity replaces 3 kWh gasoline) and the rest into FC driving based on replacing 2 kWh of gasoline by 1 kWh of methanol or hydrogen. In total, 165 GWh of gasoline and diesel are replaced by 10 GWh of biogas, 21 GWh of electricity and 61 GWh of methanol.

Biogas Plant and Methanol Production

Partly to be able to produce methanol for transportation and partly to replace natural gas for electricity and heat production, the project includes a biogas plant utilising 34 million ton manure per year for the production of 225 GWh biogas. The facility itself consumes 42 GWh of heat and 7 GWh of electricity.

The biogas can be converted into methanol with an efficiency of 70%. Consequently the production of 61 GWh of methanol is expected to consume 87 GWh of biogas. However, the production of methanol will provide 17 GWh of heat, which can be utilised for district heating.

The methanol may also be fully or partly produced by electrolysis. Moreover, in the end, the cars may consume hydrogen instead of some of the methanol. In such case some of the biogas will be replaced by wind power instead.

Geothermal and Heat Pumps

The town of Frederikshavn is located on top of potential geothermal resources which may be included in the project. The resources can supply hot water with a temperature of approximately 40°C. However, the temperature can be increased to district heating level by the use of an absorption heat pump, which can be supplied with steam from the waste incineration CHP plant. It has been calculated that an input of 13.3 MW steam in combination with a geothermal input of 8.7 MW can produce 22 MW of district heating. The steam input will decrease the electricity production from the CHP plant by only 1.3 MW and the heat production by 11.9 MW. Marginally the absorption heat pump then has a COP of more than 7.

Additional compression heat pumps may be used to utilise the exhaustion gases from the CHP plants and the boilers supplemented by other sources such as wastewater as already included in the plans for 2009. A potential of 10 MWh output is included by use of a heat pump with a COP of 3.

CHP Plant and Boilers

The project includes a biogas CHP plant of 15 MW and efficiencies of 40% electricity and 55% heat. The rest of the heat production will be supplied from a biomass boiler burning straw with an efficiency of 80%.

Wind Power

Finally the project included wind turbines enough to cover rest of the electricity supply, that is, a total of around 40 MW, of which already more than half is going to be implemented by year 2009.

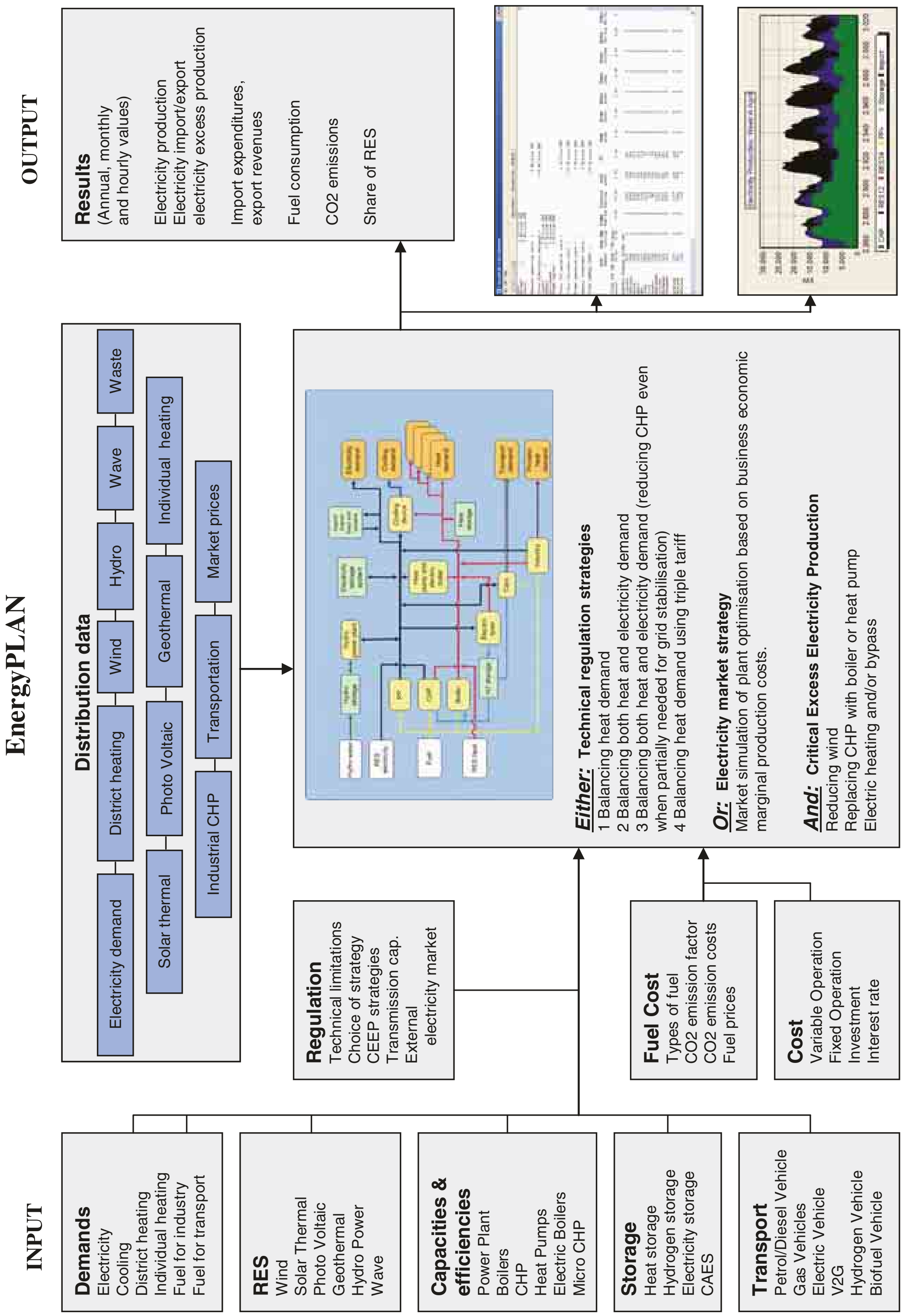
Energy System Analysis

By the use of the EnergyPLAN model some detailed energy system analyses have been conducted of the expected year 2015 system in order to identify the hour-by-hour balances of heat supply and exchange of electricity.

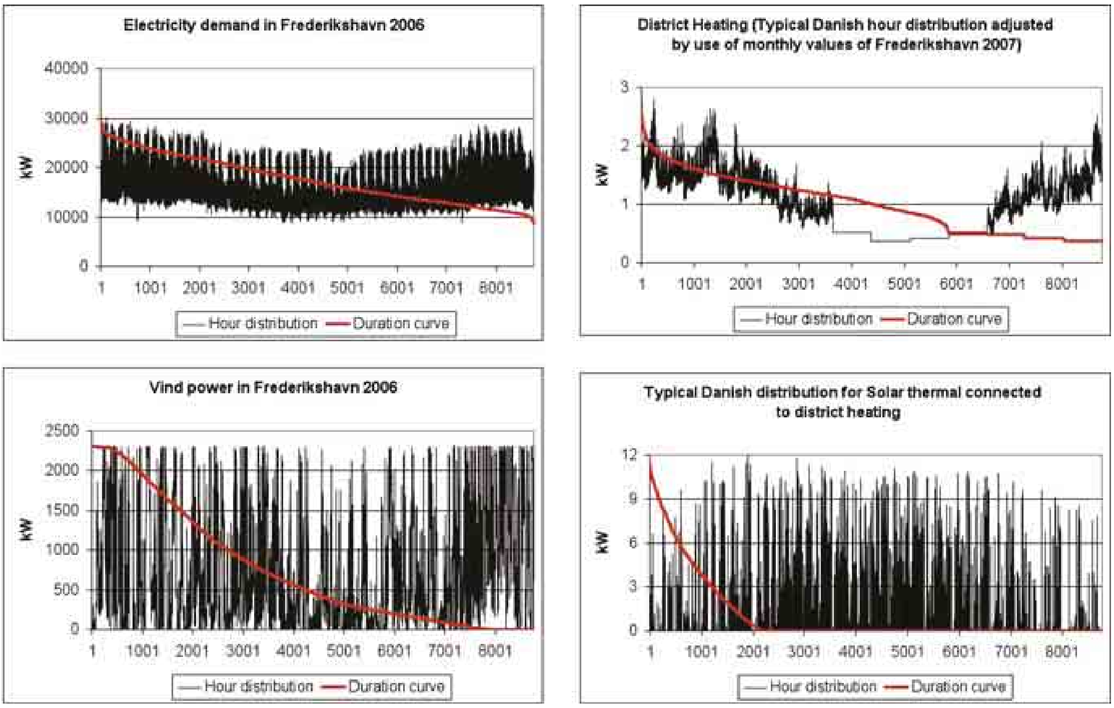
The EnergyPLAN model is a deterministic input/output model. General inputs are demands, renewable energy sources, energy station capacities, costs, and a number of optional different regulation strategies emphasising import/export and excess electricity production. Outputs are energy balances and resulting annual productions, fuel consumption, import/exports of electricity, and total costs including income from the exchange of electricity.

The model can be used to calculate the consequences of operating a given energy system in such way that it meets the set of energy demands of a given year. Different operation strategies can be analysed. Basically, the model distinguishes between technical regulation, that is, identifying the least-fuel-consuming solution, and market-economic regulation, that is, identifying the consequences of operating each station on the electricity market with regard to optimising the business-economic profit. In both situations, most technologies can be actively involved in the regulation. And in both situations, the total costs of the systems can be calculated.

The model includes a large number of traditional technologies, such as power stations, CHP and boilers, as well as energy conversion and technologies used in renewable energy systems, such as heat pumps, electrolysers, and heat, electricity and hydrogen storage technologies including Compressed Air Energy Storage (CAES). The model can also include a number of alternative vehicles, for instance sophisticated technologies such as V2G (Vehicle to grid) in which vehicles may supply the electric grid. Moreover, the model includes various renewable energy sources, such as solar thermal and PV, wind, wave and hydropower.


EnergyPLAN
INPUT
OUTPUT
Demands
Electricity
Cooling
District heating
Individual heating
Fuel for industry
Fuel for transport
RES
Wind
Solar Thermal
Photo Voltaic
Geothermal
Hydro Power
Wave
Capacities & efficiencies
Power Plant
Boilers
CHP
Heat Pumps
Electric Boilers
Micro CHP
Storage
Heat storage
Hydrogen storage
Electricity storage
CAES
Transport
Petrol/Diesel Vehicle
Gas Vehicles
Electric Vehicle
V2G
Hydrogen Vehicle
Biofuel Vehicle
Distribution data
Electricity demand
District heating
Wind
Hydro
Wave
Waste
Solar thermal
Photo Voltaic
Geothermal
Individual heating
Industrial CHP
Transportation
Market prices
Regulation
Technical limitations
Choice of strategy
CEEP strategies
Transmission cap.
External
electricity market
Fuel Cost
Types of fuel
CO2 emission factor
CO2 emission costs
Fuel prices
Cost
Variable Operation
Fixed Operation
Investment
Interest rate
Either: Technical regulation strategies
1 Balancing heat demand
2 Balancing both heat and electricity demand
3 Balancing both heat and electricity demand (reducing CHP even when partially needed for grid stabilisation)
4 Balancing heat demand using triple tariff
Or: Electricity market strategy
Market simulation of plant optimisation based on business economic marginal production costs.
And: Critical Excess Electricity Production
Reducing wind
Replacing CHP with boiler or heat pump
Electric heating and/or bypass
Results
(Annual, monthly and hourly values)
Electricity production
Electricity import/export
electricity excess production
Import expenditures,
export revenues
Fuel consumption
CO2 emissions
Share of RES

The key data in the analyses are hour distributions of demands and fluctuating renewable energy sources as shown in the diagrams. The fluctuations in electricity demand are based on actual measurements of the year 2006 demand of Frederikshavn, and the district heating demand has been based on a typical Danish distribution adjusted by monthly values of the Frederikshavn district heating demand in 2007. Wind power is based on the actual production of the existing wind turbines in 2006. However, the productions have been corrected and adjusted to the expected annual production of an average wind year. For solar collectors, a typical Danish annual production distribution has been used.



The results of the energy system analyses reveal that if the use of waste for incineration is increased from present 112 GWh to 185 GWh in a plant with the present efficiencies and the present district heating demand, the summer heat production will exceed the demand by 10 GWh. Such excess production will be even higher if heat generated from methanol production is included. However, by building a new plant with higher electric output, expanding the district heating coverage and adding biogas, excess heat production is avoided.

Moreover, the analyses show that on an annual basis all energy demands in the EnergyTown Frederikshavn can be met by 100% renewable energy, that is the use of: 185 GWh waste, 225 GWh biogas, 48 GWh straw, 5 GWh solar thermal, 48 GWh geothermal and 130 GWh wind power (fuel equivalent of 325 GWh). The production of electricity is not able to meet the demands in all hours. The analyses indicate that the system needs an exchange of approximately 25 GWh imported electricity. However, on an annual basis, such import is compensated by a similar export in other hours.

The system is shown in Fig. 11.3.

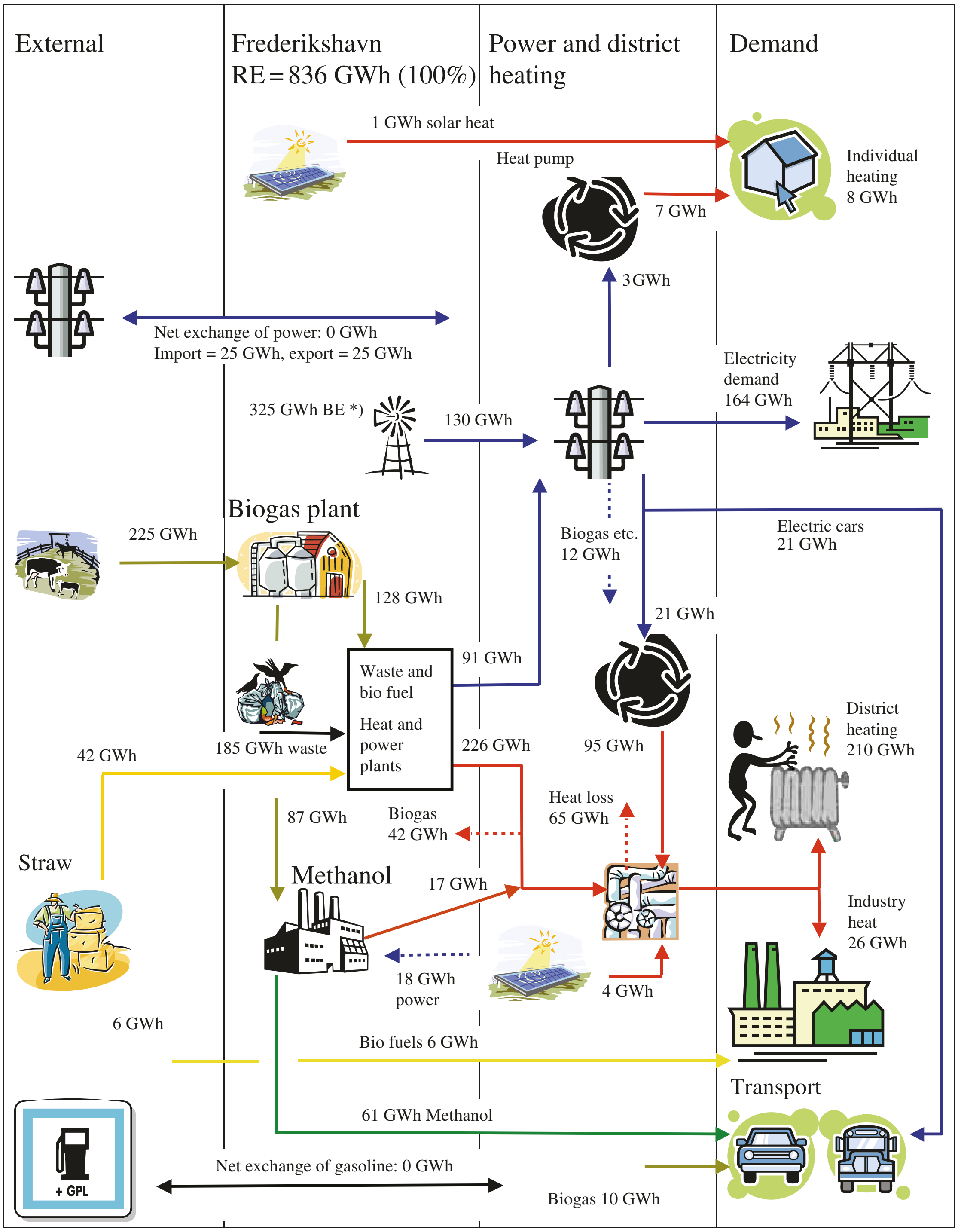


Fig. 11.3 Frederikshavn 2015 (100% renewable energy)

The Third Phase: Frederikshavn in the Year 2030: 100% Renewable Energy and Less Biomass

Phase 3 involves the reduction in biomass including waste to a level corresponding to Frederikshavn's share of the total resources. The potential domestic biomass in Denmark has been identified to 165–400 PJ depending on the scale of biocrops. The residual resources (straw, biogas, wood chips and waste) account for 165 PJ/year. The share of Frederikshavn based on population is then 220–500 GWh/year. The expected year 2015 system utilises around 450 GWh, which will then have to be adjusted accordingly. However, the use of biomass is in the right order of magnitude with regard to the long-term objective of the project.

Phase 3 will, among other things, include a better insulation of homes, power savings and an increased efficiency in the industry as well as further transition to electric cars in transportation. The changes in phase 3 must be coordinated with conditions and activities in the rest of the country. The changes are not made more specific, and no attempt has been made to asses the need for investments.

Climate Change Mitigation in Denmark - A bottom-Up Approach

Frederikshavn represents one out of many cases of towns, cities and areas which make ambitious climate change mitigation plans, involving sustainable or carbon neutral energy systems. In reviewing optimisation criteria for energy systems analyses of renewable energy integration, Østergaard [1] lists a number of such cases at the international level and also elaborates on the sustainable energy system. Moving from the international scene to the regional level, Denmark is one of the places where the level of activity in climate change mitigation is noticeably high. Following the initial steps or working in parallel with Frederikshavn, large cities like Copenhagen, Århus and Aalborg, medium-sized towns like Thisted, Sõnderborg and Skive, and islands like Samsõ and Lolland are all in the process of designing carbon neutral energy systems. At the national level, the Danish Association of Engineers, IDA, has completed an extensive work on Future Climate, an energy plan which draws on the expertise and voluntary work of more than 1000 of its members. The energy plan is described in detail, e.g., in [2] by Lund and Mathiesen, published in *Energy* - the international journal. In renewable energy strategies for sustainable development, also published in Energy, Lund [3] discusses the perspectives of converting the present Danish energy system into an energy system fuelled only by renewable energy sources.

In fact, the conversion of energy systems into renewable energy systems is a well-researched area; however, this research should not be limited to the technical issue of how to design the systems. The conversion to renewable energy also involves citizens and policy makers who make demands and set forth along new pathways. As argued by Lund [4], the mere awareness of alternatives to conventional fossil-based energy planning is one of the important steps to be taken in a transition towards sustainable energy systems. As demonstrated by the many cases of towns, cities and areas developing sustainable energy plans, this awareness is permeating Danish society. This has the effect that, rather than a government instigating top-down energy planning towards sustainable energy use, communities are actively pursuing goals far more ambitious than the country as a whole. Climate change mitigation is becoming a matter for the general public and, thus, the Danish case represents a bottom-up approach to climate change mitigation.

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Chapter 12
Sustainable Communities: The Piedmont Region, Settimo Torinese, Italy

Teresio Asola and Alex Riolfo

Abstract This chapter highlights the projects and achievements dealing with renewable energy and agile energy systems for sustainable communities in Italy.

Both the Piedmontese and Settimo Torinese projects, and other parallel projects in Milan, are regarded as sustainable communities because of their balance between energy consumption and the environment. Additionally, these projects were not only created out of mere respect for the environment, but to create economic value as well.

T. Asola (✉)
PIANETA, Settimo Torinese, Italy
e-mail: teresio.asola@asm-settimo.it

W.W. Clark II (ed.), *Sustainable Communities*, DOI 10.1007/978-1-4419-0219-1_12,

This Chapter

- Presents new energy paradigms in Northern Italy:

  a. Parallel experiences underway: Milano CityLife, Sesto San Giovanni (Falck), Settimo Torinese (Green Tech Park, Laguna Verde)
  b. Settimo Torinese: the R&D archipelago Green Tech Park, a new territory for the experimentation on energy innovation in Piedmont, northern Italy
  c. The use of sustainable, renewable resources and the implementation of new technologies and sustainable practices in Settimo Torinese as a sustainable town

- Introduces “Laguna Verde”: a new eco-town of the future in Settimo Torinese, from dream to reality

  d. Global sustainability, resources and technologies in Laguna Verde, Settimo Torinese
  e. Environment/energy balance in Laguna Verde

Innovative Paradigms for Ideas, Projects, and Practices

Energy production must derive from a dialogue with the environment. This seemingly simple concept implies dramatic cultural leaps when considering the design of urban areas as well as the type and amount of energy consumed. Essentially, everything must be reconsidered including how much energy is consumed in buildings, districts, cities, and the territory as a whole, as well as reexamining technologies employed for production and distribution of goods.

Applying new sustainable paradigms requires technical knowledge and design capabilities able to:

- Understand varied energy needs of a specific territory
- Enhance the combination of available resources (wind, sun, water, wastes, biomass, geothermal, etc.)
- Maximize the efficiency of buildings and of the territory as a whole

Settimo Torinese, only a few kilometers from the Piedmont regional capital of Torino, was a typical industrial town. Although it has acquired a definite image of its own, it has always been influenced by Milan, its neighbor to the east. Several railroads cross Settimo Torinese (both new and high speed) as well as several vehicular thoroughfares such as the recently refurbished Torino–Milano highway. Settimo Torinese is an ideal portal toward Milan and a concrete gateway to new eco-city concepts.

Parallel Experiences Underway: Milano CityLife, Sesto San Giovanni (Falck), Settimo Torinese (Green Tech Park, Laguna Verde)

CityLife is a project of redevelopment and requalification of the historic district of Fiera di Milano, signed by Pier Paolo Maggiora (Archa),[1] Zaha Hadid, Arata Isozaki, and Daniel Libeskind according to the guidelines of dialogue in architecture.

CityLife covers more than 250,000 m^2 and is located on one of the main growth thoroughfares of Milano, adjoining one of the most prestigious Milanese institutions, the Fiera. Situated next to several eminent Milanese districts, as well as the ancient network of Navigli waterways, CityLife could eventually prove to be a new city center for Milan.

A major ambition for Milan is to regain a primary role in design experimentation, formal research, and technology innovation. The environmental quality in Milan needs to be improved, which proves to be a remarkable effort. Heavy traffic and air pollution have to be contained in order.

Designing the transformation of the urban areas based on an ecological strategy is the only feasible treatment. Upon specific analysis, the most significant environmental impacts have been pinpointed in order to devote specific care to them as major environmental targets. The project choices have been carried out with particular care to the following items:

- Air
- Water
- Soil and subsoil
- Noise and vibrations
- Car traffic
- Green system and ecosystems
- Urban landscape

The objective of emission reduction due to car traffic is addressed by optimizing the road network and conditions.

Emission reductions are obtained by containing fossil fuel consumptions, along with other solutions adopted for energy efficiency. The solutions combine a use of materials and technological ideas focusing on building insulation, which will be able to guarantee high light transmittance and low thermal transmittance. The materials have been chosen according to their reusability, with a priority to those materials with limited energy needs in the manufacturing cycle.

The technological choices have been oriented to the utmost degree of energy saving and recovery, among them heat pumps (air and water), methane cogeneration (CHP) systems, and photovoltaic systems.

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[1] http://www.archiportale.com/progettisti/SchedaProgettista.asp?id=87013.

A New District for an Important Milanese Suburban City: Sesto San Giovanni (Formerly Falck Steel Mill)[2]

The requalification of areas in the former Falck steel factory area in Sesto San Giovanni near Milano is an ambitious new urban plan that will transform the town of Sesto, aimed (in Renzo Piano's project) at operating an "urban renewal" of parts of the town of Sesto San Giovanni so far divided by the railway and by the empty lots of the former Falck and Marelli industrial areas. Greenery is one of the distinctive features of Renzo Piano's[3] project.

The whole area, receiving a new population of about 15,000, is reclaimed to ensure the highest health standards, with specific attention to ecosustainability. The area will be provided with an independent energy system adopting a precise strategy based on the use of local resources and the optimization of energy distribution. Groundwater is to be collected and filtered to feed heat pumps, biomasses produced by the Park, and solar power will also be used, leaving the existing cogeneration plant to cover peaks of demand. This system of optimization of energy production and distribution plans to use trigeneration plants for the simultaneous production of electricity as well as heat and air conditioning and tunnels feeding all the blocks along the main streets.

PIANETA[4] (belonging to the utility group, Settimo-based ASM) has tightly cooperated with Buro Happold Ltd[5] to help create an energy masterplan of the new urban area project by Renzo Piano Building Workshop (RPBW) and the Physics Nobel Prize–recipient Prof. Carlo Rubbia.[6] The aspects related to urban planning and construction were assessed by Risanamento SpA.

The heart of the old industrial town is to be rebuilt based on a new, sustainable model, in which energies are produced in several sites and in several ways, and distributed by means of a network aimed at balancing demand and offer. The incoming 40,000 inhabitants will have energy consumption per person estimated to be nearly half as much as the other Milano inhabitants. Consequently, the resulting new city is bound to grow more rapidly than ever, because both people and companies will prefer a cleaner, more efficient, and cost-effective city to live and work in. The energy masterplan envisions an on-site production of a major quota (more than 75%) of the energy needs (electricity, heating, cooling) by means of high-performing, agile, small-scale energy systems, mainly based on the use of locally available renewable resources. The project aims at producing energy by maximizing resources and overall efficiency and minimizing the environmental impact, noise, and emissions.

[2] http://www.risanamentospa.it/upload/nenergiaOtt06.pdf; http://www.risanamentospa.it/web/start.asp?idLingua=2.

[3] http://rpbw.r.ui-pro.com.

[4] http://www.pianeta.eu/ITA/sesto.html.

[5] http://www.burohappold.com/bh/home.aspx.

[6] http://nobelprize.org/nobel_prizes/physics/laureates/1984/rubbia-autobio.html.

The design of the overall energy system has been developed on the basis of the following objectives (generating from such keywords as flexibility, independence, modularity, and innovation), aimed at developing innovative energy solutions in order to help meet modern standards of efficiency and savings required by law and by international protocols:

- Minimizing the environmental, dimensional, and economic impact of the installations.
- Energy independence and self-sufficiency, but at the same time compatibility and integration with existing neighboring urban areas infrastructures (cogeneration plant, district heating).
- Use of all existing resources within the site, both traditional and alternative/renewable.
- Efficiency and effectiveness of energy systems of production, distribution, and use of energy.
- Reduction in consumption of fossil fuels and polluting emissions, as well as a commitment to continue researching innovative solutions.
- Flexibility and adaptability to fast-changing technologies.

The method and the solutions used to address the above objectives have been as follows:

- Implementation of good sustainable design principles.
- Efficient use of on-site resources, most notably groundwater.
- Not an exclusive energy solution for the site; rather a flexible mix of systems and scales.
- Groundwater extraction and heat pumps for heating and cooling of buildings.
- Extension of existing district heating system for warm water in buildings.
- New trigeneration energy centers for electricity generation, heating, and cooling.
- Building basement technology rooms to minimize obtrusive roof-mounted plant.
- Good passive design of buildings to reduce energy consumption.
- Integration of alternative energy and renewable energy systems.
- Sustainable mobility.
- Environmental assessment schemes such as the Italian ITACA or US LEED to measure and score environmental performance for specific buildings.

As to energy production, there is no exclusive, single solution for the site, but rather a mix of two or three main primary energy strategies. The energy strategy focuses on combining the most efficient use of existing opportunities (e.g., district heating and the cogeneration plant) with the use of distributed generation systems, mainly trigeneration plants and alternative energies, particularly groundwater coupled with heat pumps. An efficient use of resources will reduce both energy consumption and noxious emissions, the target being to reduce carbon dioxide emissions by 50%, compared to conventional heating, cooling, and electrical systems.

Alternative energy systems can be implemented on a small scale as a demonstration of new technology matched to a specific use or on a larger scale integrated into buildings. Solar systems mainly concern conventional solar thermal collectors, high-intensity solar thermal collectors, and photovoltaic solar cells. Conventional solar thermal collectors can heat water up to 80–100°C for use in sanitary water systems for washing or swimming pool heating. PVs generate electricity to export to the electrical distribution grid to balance demand for street lighting. High-intensity solar thermal collectors using parabolic mirrors to intensely focus solar radiation onto oil-filled tubes can heat the oil to very high temperatures (500–600°C) and then generate electricity by means of steam turbines.

Biomass: Focus has been made on energy production out of biomass and organic waste from park maintenance "products" (pruning, chopping): drying and gasification allow for excellent energy recovery, as well as providing a viable solution to the problem of disposing of organic substances. In the longer term, as the landscape matures, it is possible to take wood off-cuts from trees for use in wood burning boilers to generate hot water for heating or to be utilized in a gasification or pyrolysis process to produce energy.

Hydrogen: Hydrogen is produced from either water in electrolyzer using electricity or methane (in natural gas) in a reformer. Fuel cell technology is still developing and its possible applications range from mobility to stationary. An interesting application for the site is to use electricity from PV solar cells to generate "green" hydrogen and oxygen from water in an electrolyzer. The oxygen can be used directly for purification of the groundwater, and the hydrogen combined with air, in a fuel cell to regenerate electricity.

Hydrogen will be used to experiment sustainable mobility in the new district of Sesto based on the use of hydrogen as fuel for motor vehicles (SHMS, Sesto Hydrogen Mobility System). The project envisages the creation of filling stations (SHRS Sesto Hydrogen Refuelling Station) and the means of transport[7] (buses and scooters like the Torino Environment Park's one) based on fuel cell technology.

The objective of the SHRS is to produce fuel (hydrogen) mainly for local public transport. The SHRS is implemented using the state-of-the art production and storage technologies. The supply section in the Falck project includes a 350-bar dispenser for the hydrogen supply of buses.

Hydrogen produced out of water electrolysis, like in two paradigm projects,[8] was realized by PIANETA in Settimo Torinese in 2005 for an ASM office building and in Cesana for the Winter Olympic Games ("Primo Settimo" and "HighHy", see box below), in tight cooperation with the Regional Government of Piemonte.

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[7] http://www.iaad.it/eng/gallery/gall_07/FormulaHYSY_gara_eng/index.html; http://www.envipark.com/index.php?option=com_frontpageItemid=1.

[8] http://www.pianeta.eu/ITA/primo_settimo.html; http://www.pianeta.eu/ITA/h2006.html.

In "Primo Settimo," the first integrated energy plant in Italy designed for the production, storage, and use of "green" hydrogen in an office building, the hydrogen power plant is utilized to give energy to the parking lot of ASM office building.

Electricity is produced by 2 PEM hydrogen fuel cells. Hydrogen is produced during day hours by an alkaline electrolyzer (utilizing a green 70 KW photovoltaic system) able to generate 200-bar hydrogen to be then stored.

The target of Primo Settimo is to store energy produced during day hours by electrolysis transformation into hydrogen and to utilize it at night hours, in order to light the parking lot. Production and utilization of hydrogen are not contemporary: during the day hydrogen is produced; at night the fuel cells operate. This system was created to generate clean energy for stationary use and, at the same time, to supply hydrogen for future fuel cell vehicles. The system was designed by PIANETA and ASM to also become an open-air laboratory for research activities for innovative technological solutions to be applied to the hydrogen supply chain (production, storage, and use), together with Politecnico di Torino Polytechnic University and Regione Piemonte.

"HighHy," a smaller-scale hydrogen stationary energy production plant, was developed by PIANETA and ASM for the 2006 Torino Winter Olympic Games on the same basis as "Primo Settimo," in the "Olympic mountains" of Cesana Torinese.

Settimo Torinese: The R&D Archipelago Green Tech Park, a New Territory for the Experimentation of Energy Innovation in Piedmont, Northern Italy

Piemonte, in northwestern Italy, borders Switzerland to the north, France to the west, the valley of Aosta to the northeast, and Lombardia (whose main city is Milano) to the east. To the southeast it borders Emilia Romagna, and Liguria to the south. The Piedmont government has been investing a lot on the new challenges of clean, sustainable energy. In particular, on May 24, 2008, the president of the Piedmont region, Mercedes Bresso, announced the beginning of the "Piedmontese energy oil independence war," promoting and signing the "manifesto for the petrol energy independence."[9] Said manifesto, begins with a proposition that states, "in order to reduce energy dependence from fossil fuels, it takes an extraordinary collective, daily commitment," and points out that "Piedmont has decided to accept the challenge by investing on renewable energies, energy saving and on sustainable technologies in order to secure a future to our sons, with a collective commitment

[9] http://www.regione.piemonte.it/energia/images/stories/dwd/manifesto.pdf.

of the whole population." In order to concretely become "the Italian ecological engine" a concrete, everyday commitment must be taken by everyone from now to 2020 in order to quickly abide by the EU targets (aimed at maximizing production from renewable sources, enhancing energy saving and production of biofuels not derived from food sources but out of cellulose and wood, and dramatically curbing the greenhouse gas emission). The goals pointed out by Regione Piemonte as mandatory ways to achieve the European targets are listed below:

- To enhance renewable energy sources and overall energy saving.
- To design houses and workplaces able to self-produce heat and electricity, granting comfort and respect for the environment.
- To support research and enhance energy savings and self-production.
- To use public means of transport, as well as highly efficient, nonpolluting vehicles.
- To support an agricultural production looking after ecological values and the resources locally available.
- To upbring the younger generations toward a more sober, rational, and fair energy culture.
- To give everyone a real chance both to draw on as well as to input energy by an open and widespread grid network, in which everyone is a producer and a consumer at the same time.

In Piedmont, particularly in some areas of Torino and in the suburban territory immediately northeast, there are already initiatives and realizations to be accounted for. The projects devoted to innovation and agile energy systems aimed at distributed generation are as follows:

– Energy recovery out of biogas in an AMIAT[10] garbage dump in Torino and in a SMAT[11] purifier site (the largest chemical–physical–biological treatment system of waters in Italy).
– Small-scale hydroelectrical and PV systems in the Environment Park[12] building.
– Medium-sized cogeneration plants in Torino, Settimo Torinese, and Chivasso as well as district-heating grids, both realized by SEI (ASM Group).
– Medium- to large-scale fuel cells production by Siemens[13] in Torino.

[10]Company for the complete waste treatment, disposal and recovery cycle; http://www.amiat.it/pagine.cfm?SEZ_ID=23

[11]Company leader in the field of integrated water services; http://www.smatorino.it/area_istituzionale_eng?id=1.

[12]It provides innovative solutions in the fields of energy/environment; http://www.envipark.com/index.php?lang=en.

[13]http://webdoc.siemens.it/CP/PW/ProdottieSoluzioni/PowerGeneration/CelleaCombustibile/default.htm.

– Medium-scale fuel cells production by EPS Electro Power Systems[14] near Torino.
– PV plant[15] for gas boxes, realized by PIANETA.
– Three-generation system with a PV system and microturbines integrating the first plant for production, storage, and use of hydrogen in Italy, in Settimo Torinese, realized by PIANETA for ASM Settimo Torinese[16]
– Microturbines, as well as other realizations, mainly in Settimo Torinese.

Within this framework, the Settimo Torinese town administration, a Piedmontese town with a population of 50,000, adjoining Torino, and 80 miles from Milano, has been actively and proactively working for at least the last 5 years.

In the suburban area northeast of Torino, an innovative energetic pattern has been developed, actively promoted by Aldo Corgiat Loia,[17] mayor of Settimo Torinese – a pattern arising from experiences and vocations existing in the territory, but not thoroughly structured yet before: the one regarding the renewable sources and the agile energy systems.

The model for the energy innovation network is implemented on a wide suburban area surrounding Torino pivoted on Settimo Torinese. A model was developed by PIANETA with many municipalities, with the Municipality of Settimo Torinese and Mayor Aldo Corgiat Loia as a leader and promoter, called "Green Tech Park." The target of the Green Tech Park is the implementation of new energy paradigms, starting from the territory, local resources, existing cultures, and experiences.

The pattern being developed on the wide area is the energy web: a network of sustainable energy paradigms, differentiated by technology and by application, where each and every knot of the network is able (like the Internet, peer-to-peer) to be a producer and a user at the same time, all of it on an environmentally correct background (a new park "Grande Parco 2011" crossing the towns being part of the Clean-Tech Park [CTP]), and to get more momentum out of its proximity with the Olympic city Torino, a city able to guarantee a proper welcome to possible visitors. The CTP is growing as an "open-air" laboratory and living energy museum.

Energy is seen as a concrete development factor and not as a mere environmental opportunity – an entrepreneurial development too and consequently, again, a renewed territorial plan. Energy as an occasion to match the development needs of economy with the environmental sustainability of territory. Energy opportunities are

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[14]Company for the production of fuel cells running on pure hydrogen, natural gas, LPG, and ethanol, for backup and stationary use in general. Based in Torino (Italy), it is an established player in the fuel cell systems sector having developed and commercialized the Electro7™ power system. Electro7™ is the first multi-output fuel cell system for business continuity applications and provides 100% clean power with virtually unlimited autonomy. www.electrops.it.

[15]http://www.pianeta.eu/ITA/sunjump.html.

[16]http://www.pianeta.eu/ITA/primo_settimo.html.

[17]Mayor of Settimo Torinese since 2005, formerly chairman of the Utility Company ASM Settimo.

designed and implemented in each and every form on the whole surface of the territory, in the form of an "archipelago-like" technological park (Green Tech Park) characterized by a manifold system of production "isles." In the Green Tech Park a rich open-air catalogue grouping the newest technologies – as far as renewable and new "intelligent" forms of energy are concerned – is experimented and permanently displayed and exhibited, in order to further nurture the "knowledge society." The use of resources locally available must be made on the basis of the capacity to integrate different innovative technologies into a network able to guarantee their overall governance and control.

One of the main objectives of the Green Tech Park (CTP) project led by Settimo Torinese on the suburban area is to create a widespread but consistent and coherent set of sustainable energy realizations based on the integration of different, highly innovative paradigms of energy production, distribution, and management.

A few examples of a set of energy "isles," good practices of energy efficiency and innovation, and integrating technologies are as follows:

– Photovoltaic systems, thermal solar systems
– Cogeneration (microturbines, natural gas endothermic engines, hydrogen fuel cells)
– Mini-/micro-wind systems
– Ground/water heat pumps
– Small hydroelectric systems, geothermal systems for electricity
– Waste/biomass gasifiers
– Fuel cell–based backup systems, stationary hydrogen plants

The Use of Sustainable, Renewable Resources and the Implementation of New Technologies and Sustainable Practices in Settimo Torinese as a Sustainable Town

Some of the planned, underway, or realized projects in Settimo Torinese are as follows:

- Recovery of energy out of fragmented waste treatment and treatment and recovery of energy out of urban solid waste, biogas, organic waste, biomasses, photovoltaic plants (small-scale to big PV plants), heat pumps, small hydro systems, and mini-wind systems
- New urban blocks and factories designed according to bioarchitectural principles, energy/environmental sustainability
- Low-cost ecofriendly new houses, which use active and passive technology, in order to transform the building into a bioclimatic engine
- Valorization of public buildings, according to the principles of ecosustainability (bioarchitecture and production plant efficiency)

- New regulatory systems: innovation in the sets of rules concerning the building and planning systems and energy certifications

In this way, the Municipality of Settimo Torinese is leading other neighboring municipalities to follow suit. It is bound to become an incubator of new initiatives (both public and private) and of case histories connected with eco-energies and the ecosustainability of buildings and towns: the creation of a new energy culture based on local experiences.

A word must be spared on the project of a new set of rules, being approved by the Municipality of Settimo Torinese and by other neighboring municipalities, aimed at enhancing good, ecological, energy-sensible practices: a regulatory document dealing with the requirements necessary for the “eco-energetical” and “bio-energetical” certification of buildings, as well as with incentives to be given out to good realized practices (both active and passive technologies).

PIANETA (see box below), an energy service company based in Settimo, has become a major ingredient of the “sustainability recipe” in Piedmont (in tight cooperation with the municipalities) – the engine for the development of challenging projects aimed at sustainable communities.

PIANETA (www.pianeta.eu) is an all-round energy-saving company, focused on ecosustainability of buildings, districts, and cities: energy self-sufficient, cost-effective buildings, districts, and cities

As the cook turns to ingredients of the territory, so PIANETA prepares its own energy production systems and passive solutions basing its efforts on the renewable energy resources that the territory offers.

PIANETA is entirely focused on design, implementation, and management of agile energy systems based on global sustainability and all-round efficiency. An energy system is “agile” when it can satisfy several energy needs in different sites, utilizing the resources immediately at hand on-site and the optimized mix of high-efficiency energy technologies. The agile energy systems of PIANETA provide different quantities of energy (from kilowatts to megawatts of electricity, heat, and cool) using natural, renewable sources (sun, wind, water, geothermic) locally available. PIANETA’s agile energy systems grant self-sufficiency to buildings, housing and commercial estates, industries, new city districts, new cities, and whatever urban area seeking cleaner and more efficient energy solutions. PIANETA produces energy where and when necessary, wastelessly, efficiently, effectively, and in the amount needed: a company specially devoted to design, realize, and manage small, innovative energy plants as compared to the traditional, big energy plants, integrating the most innovative technologies for the employment of the best, sustainable source to fit in the project. Right from the beginning of its existence, PIANETA has contributed to bridge the gap between university labs and the market, in many fields of renewable energies, being the first in Italy, for instance, to design and implement plants for H_2 out of renewable resources (Primo Settimo and HighHy, which have contributed to define the Torino 2006 Winter Olympics as "the first hydrogen Olympic Games").

Furthermore, PIANETA has been working on the assumptions that

- architecture must save natural resources (water), regenerate natural resources (O_2), and minimize CO_2 production; a building basically mustn't consume energy; it must produce it, utilizing renewable sources (sun, water, wind, motion) and minimizing wastes (to be used themselves as an energy source);
- the best green, clean energy is the one we neither produce nor use
- energy efficiency is a synthesis between sustainable production and its sustainable use and between active and passive technologies
- the building is a machine that shouldn't consume resources and energy, but rather saves and produces

"Laguna Verde": A New Eco-Town of the Future in Settimo Torinese, from Dream to Reality

A very important example of a global sustainability project, consistent with (and inside) the Settimo Torinese Green Tech Park, is a new, daring, greenfield development district of Settimo Torinese (a new area, a little eco-city – formerly an industrial district in Settimo Torinese – nearly as wide as 1 million m^2 in a suburban area of Settimo, some 10,000 fresh inhabitants, university, high-tech R&D Companies) called "Laguna Verde" (Green Lagoon).

Innovation, environment sustainability, project, and architectural dialogue are the main elements that make this new urban centrality in Settimo one of the most important requalification projects.

Laguna Verde

Settimo Torinese Mayor Aldo Corgiat Loia and architect Pier Paolo Maggiora created the guidelines for Laguna Verde according to their vision of a sustainable community (see Green Park). The design was outlined by Pier Paolo Maggiora's ArchA, along with the cooperation of eminent experts in various fields of sustainability. The challenge was to create a new concept of a town not merely out of an architect's pen, but instead out of a dialogue realized by a heterogeneous yet coherent team of specialists of different topics, bearers of different cultures and experiences.

Fig. 12.1 Laguna Verde

The sustainable energy project will be characterized by the newest and most innovative technologies for "passive" building performances and energy production, as well as resource savings, water reuse, photovoltaic and microeolic systems, "green" H_2 production, and agile energy systems.

The total surface area covers one million m^2 and, at the end of the operation, will offer 320.000 m^2 of public green space, a 60.000 m^2 "island" for R&D and higher education, sports facilities, a swimming pool and a museum (about 55 m^2), as well as a high-level, innovative energy-efficient housing estate.

Structural Details

The structure itself explains the name Laguna Verde (Green Lagoon). Some compact islands will be developed (16 just for the residential part); they will emerge from a lagoon made of parks and gardens below: a "natural," horizontal level of greenery (integrated with an artificial vertical garden and parking lots with technological plants hidden inside) in continuity with "Tangenziale Verde"[2] (Green bypass) north of Torino, a green area extending on several million meter squares, with the Torino Hill Park leading to Superga and the river Po.

All the buildings will be elevated from the ground and connected and highlighted by a large suspended central avenue fraught with public and private functions so that the existing greenery below can live alongside the structures instead of being interrupted and removed.