RENKEI Programme Summer School

Energy Supply within Traditional and Environmentally Conscious Growth Models

– Student Workgroups Reports and Presentations –

TOHOKU UNIVERSITY
8-12 September 2014

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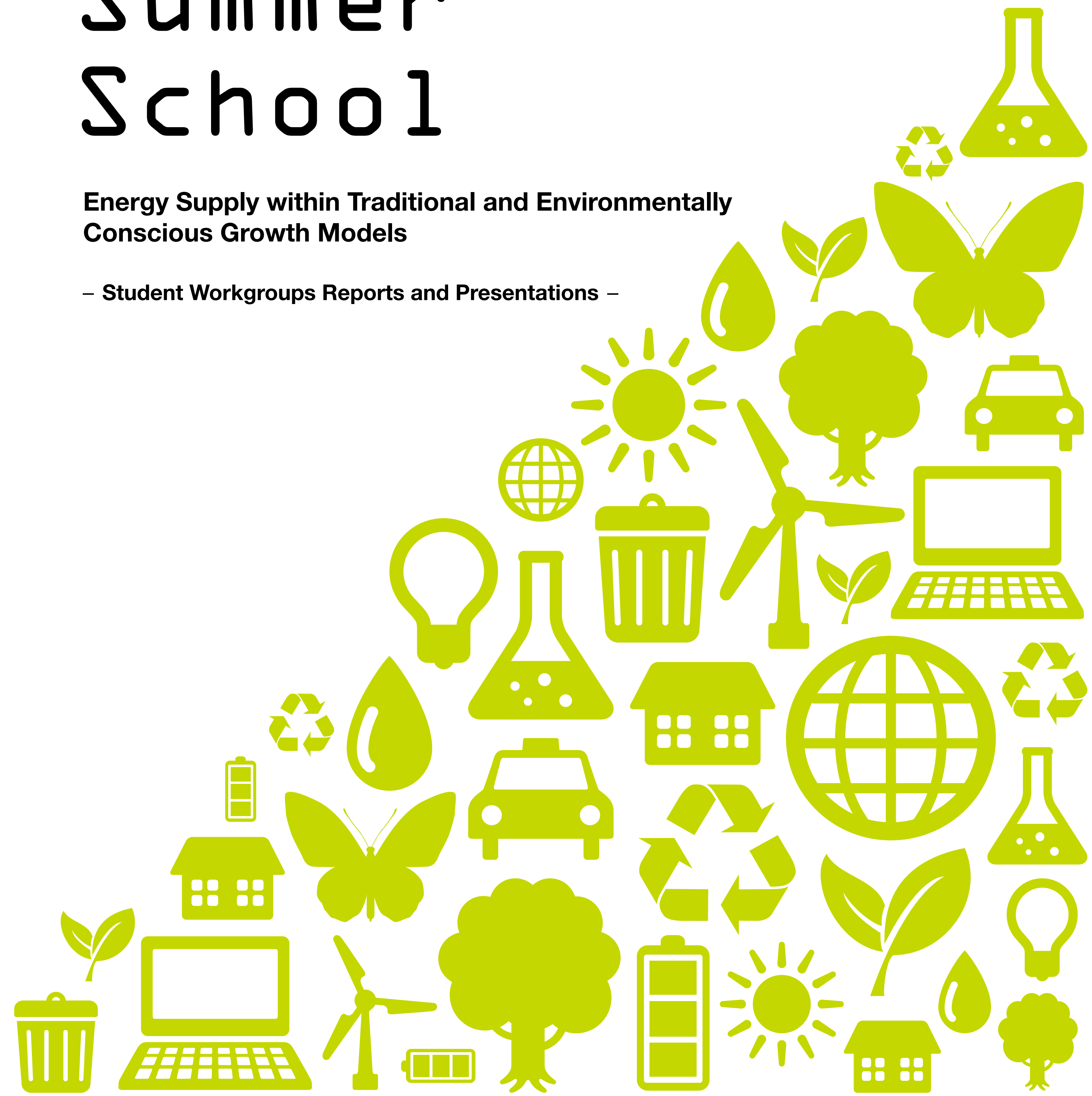

Greetings

This is to thank you for joining us on RENKEI Programme Summer School held at Tohoku University, Sendai, Japan during 8-12 September 2014. We appreciate your discussion and exchange views on energy supply within traditional and environmentally conscious growth models. The booklet includes reports and presentation materials developed by students by groups. Each group shows different idea and solution to design a sustainable city for some specific area in the world. We wish you continued achievement and success of both of us. I hope to be able to work with you in the planned next RENKEI School in the United Kingdom.

Sincerely,

Toshihiko Nakata

Theme

Energy Supply within Traditional and Environmentally Conscious Growth Models

Summer school objective

The summer school was held in Sendai, Japan within the period of 8 - 12 September 2014. The aim of the school was to bring together scholars of different cultural and sectoral backgrounds to address the theme of the school - Energy Supply within Traditional and Environmentally Conscious Growth Models. The scope of the school encompassed specific research tasks to be undertaken by the attendees, exploring the differences between the current traditional and environmentally conscious (green) energy supply systems culminating in the presentation of appropriate solution to support our energy needed for the 21st century and beyond.

Structure and approach

The school consisted of lectures, group work and site visits that span a period of one work week. Guest speakers were invited to give presentations on specific areas related to the theme of the Summer School. The aim of such presentations was to provide background as well as appropriate questions aimed at generating debate within the School's workshop.

The participants were divided into groups addressing appropriate topics within the Theme's scope. Each group consisted of participants with mixed backgrounds. Group members collaborated to solve a conceptual task involving technological and social challenges and developing strategies for public engagement for pre-defined research projects stemming from the theme. On the fourth day of the school, groups presented their work and the top three groups were given awards. The last day was assigned to excursion and local sightseeing.

Summer School Dates and Schedule

	7.Sep Sunday	8.Sep Monday	9.Sep Tuesday	10.Sep Wednesday	11.Sep Thursday	12.Sep Friday
9:00—10:30		Prof. Bahaj, University of Southampton	Mr. Suzuki, Fukushima prefectural government	Prof. Shukuya, Tokyo City University	Dr. Ashina, NIES (*3)	From 7:50 am Excursion
10:30—12:00		Prof. Nakata, Tohoku University	Mr. Tsuruoka, HOPE (*1)	Dr. Barrett, United Nations University	Group work	-Tsunami stricken area -Matsushima w/boatride
12:00—13:00		Lunch break	Lunch break	Lunch break	Lunch break	Lunch
13:00—14:30		Sendai municipal incineration plant in Matsumori visit/lecture	Dr. Kunimitsu, NARO(*2)	Prof. Kurokawa, Tokyo Institute of Technology	Group work	End of Summer school
14:30—16:00			Toyota factory visit/lecture	Group work	Group work presentations	
18:00—	Welcome ceremony w/banquet (*4)				Formal dinner w/ award ceremony (*5)	

*1 HOPE: Higashimatsushima Organization for Progress and Economy, Education, Energy
*2 NARO: National Agriculture and Food Research Organization
*3 NIES: National Institute for Environmental Study
*4 Hotel Metropolitan SENDAI
*5 Sendai Shozankan

Students
report
& presentation

Group A

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University College London, UK

Noelikanto Ramamonjisoa
Nagoya University, Japan

Leonidas Bourikas
University of Southampton, UK

Marisabel Cuberos Balda
Tohoku University, Japan

RENKEI Summer School 2014

Project title: *Pathways towards a community inspired city: the future is now!*

Jin Si[1], Noelikanto Ramamonjisoa[2], Leonidas Bourikas[3], Marisabel Cuberos[4]

[1] University College London, UK, [2] Nagoya University, Japan, [3] University of Southampton, UK, [4] Tohoku University, Japan.

Introduction

The following work summaries our ideas for developing an energy system for a sustainable city in a near future. We decided to add the word "now" to emphasize the urgency that we, as community, need to apply sooner than ever. Many projects have used 2020 as a target year however we are getting closer to the date with a significant global change. We propose to maintain an optimistic point of view while choosing a mix of technologies and policies, which we analyzed as the ones to take into account for a carbon neutral society.

Objectives

The project investigates pathways towards the creation of a community inspired city by immediate actions. It looks at the development of a community-based energy system and sustainable solutions for the future cities.

- Design an ideal city which can be referred to while comparing ideal with reality
- Propose the energy technologies and policies needed to achieve a carbon neutral society
- Recognize the risks and limitations when going "all renewable"

Motivation

After the March-2011 earthquake and tsunami in the east coast of Japan, many lessons were learnt about how unpredictable events can impact our community. Besides, several cities have been looking forward to become low carbon. When integrating such desire with known risks and past experiences around the world, we designed our city based on such knowledge. We decided to design a future city named Fukuhampton which will have the same climate as Fukushima and Southampton, warm temperate (6). Fukuhampton is about 400km^2 with a population of 270 000 people.

Main design principles

The main design principles are built upon the ideals of public wellbeing, community engagement, behavior shift towards a one earth living and highly efficient regionally designed power generation and consumption. Some key considerations are outlined:

- Climate change resilience and weather proof design: flexible urban structure with the capacity to recover fast from extreme events, allocate sources to the most efficient use and protect the citizens.
- Self-sufficient urban communities with local power generation according to the locally available resources and economical security through wide cooperation networks.
- Compact cities with mixed use, public transport and walkability that will inspire the minimization of fuel consumption and carbon emissions.
- Modularization of key urban infrastructure to shift
- Decentralized distribution networks in combination with micro-generation technology and smart management systems to increase energy use efficiency and maximize the potential of local resources.
- Waste management towards an integrated city metabolism based on a closed system with high rates of recycling to recover materials and energy while at the same time decrease the embodied carbon.
- Biodiversity conservation.

Fig. 1 Concept design of Fukuhampton（see in appendix）

Urban planning

1)**Land use:**

Efficient use of land resources

- Compact building: permits more open space to be preserved, encourages buildings to expand vertically rather than horizontally.
- Preservation of land and natural resources: compact building forms, moderation in street (Neuman, 2005). Total housing area is less than 50% of the total area.
- Density lowers the per capita costs of infrastructure capital and operating costs, and reduces per capita use of all types of energy including energy for transportation and heating and cooling buildings. A minimum density of 50 dwellings per hectare is applied as a necessary baseline to support public transportation (Applegath, 2012).
- Locate stores, offices and services within walking (cycle) distance
- Create local works that will ultimately reduce people mobility and transportation energy

Transport

Convenient and interesting; Encourage walking and cycling ; Provide a variety of transportation choice ;Include bicycle lane and transit; Promotion of public transport ;Use connected network with alternative routes and bypassing of heavy traffic (Neuman, 2005)

Building

- Promoting long lasting materials and well-designed sustainable habitation

Infrastructure

For the basic infrastructure of a city, such as water treatment and waste treatment, we can try to find ways to do contribution for energy area. Such as ecological water treatment using anerobic method; and we can also use waste to produce energy. The other thing is we can use green roof or green garden to drain the rainwater and absorb the CO_2.

Energy

Fukuhampton relies on renewable energy and is carbon neutral. The system components have enough independence so that damage or failure of one component of a system is designed to have a low probability of inducing failure of other similar or related components in the system. The city has co-generated district energy plants. Each plant provides power for its surrounding area but also can be called upon to provide excess power to back up neighboring plants, should a failure occur. Each piece is independent (modular) yet also networked (redundant), thus optimizing both energy production and security. Community owned energy management system controls the local power distribution between the districts (cf Appendix).

Fukuhampton relies on solar, geothermal, biomass, wind, ocean (wave and tidal) and hydro energies. The net use of fossil fuel for electricity and heat generation is close to zero. The city produces 125% of the required energy and 25% of this is exported to the national grid.

Conclusion and recommendations

Based on current green solutions available for energy system development, we have taken a whole perspective for a city, which is to look into several sectors, such as land use, transportation, buildings and infrastructure to explore the opportunities of energy saving and production. The other highlight of our approach is based on community, which is a decentralized way to develop the whole energy system, but at the same time, we also have built EMS in the central of the city, to monitor and manage the energy supply and demand. The model has been developed for Fukuampton, but can also be referred to other similar cities development. There do exist risks in real cases, such as willingness of the people participated, high cost of technological integration and as well as natural disasters and other possible unpredictable risks.

Appendix

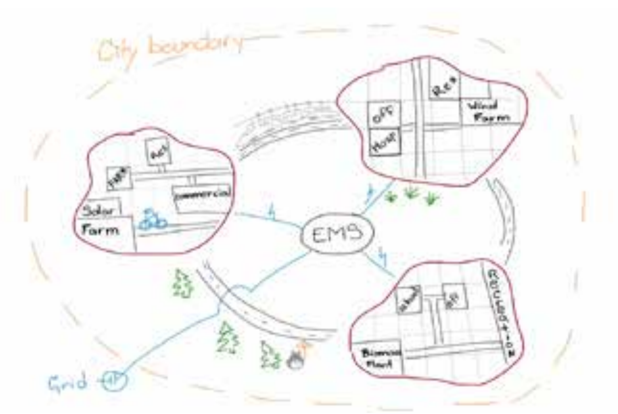


Figure 1: Concept design of Fukuhampton

References

[1] Center for International Earth Science Information Network - CIESIN - Columbia University, International Food Policy Research Institute - IFPRI, The World Bank, and Centro Internacional de Agricultura Tropical - CIAT. 2011. Global Rural-Urban Mapping Project, Version 1 (GRUMPv1): Urban Extents Grid. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H4GH9FVG as found in Watts Anthony (2010) Watts up with that? The world's most viewed site on global warming and climate change. Available from http://wattsupwiththat.com/2010/12/23/3-of-earths-landmass-is-now-urbanized/. Date Accessed 10 Sept 2014

[2] Bahaj A.S., James P.A.B. and Jentsch M.F. (2008) Potential of emerging glazing technologies for highly glazed buildings in hot arid climates. *Energy and Buildings,* vol. 40 (5), p.p. 720-731

[3] Applegath, C.F., 2012. Future proofing cities. Strategies to help cities develop capacities to absorb future shocks and stresses.

[4] Neuman, M., 2005. The Compact City Fallacy. Journal of Planning Education and Research 25, 11-26.

[5]OECD,2012. "The compact city concept in today's urban contexts", in Compact City Policies: A Comparative Assessment, OECD Publishing. http://dx.doi.org/10.1787/9789264167865-6-en

[6]Rubel F. and Kottek M. (2010) Observed and projected climate shifts 1901-2100 depicted by world maps of the Köppen - Geiger climate classification. Meteorologische Zeitschrift, vol. 19 (2), p.p. 135-141

RENKEI

BRITISH COUNCIL

Pathways towards a community inspired city for the future...now!

Marisabel
Leonidas
Noeli
Jin

ENERGY FOR THE FUTURE · TOHOKU · UNIVERSITY OF Southampton · Nagoya University · UCL

Outline

Outline

- Aim and objectives
- Baseline Condition
- Key design actions
- Community inspired "clean" city
- Conclusions

Aim

Develop the energy system for community based sustainable future cities.

Motivation

- Better city
- Problems of cities
- Case study of new and existing
- Opportunities
- Act now to build community and sustainability
- Set the global example

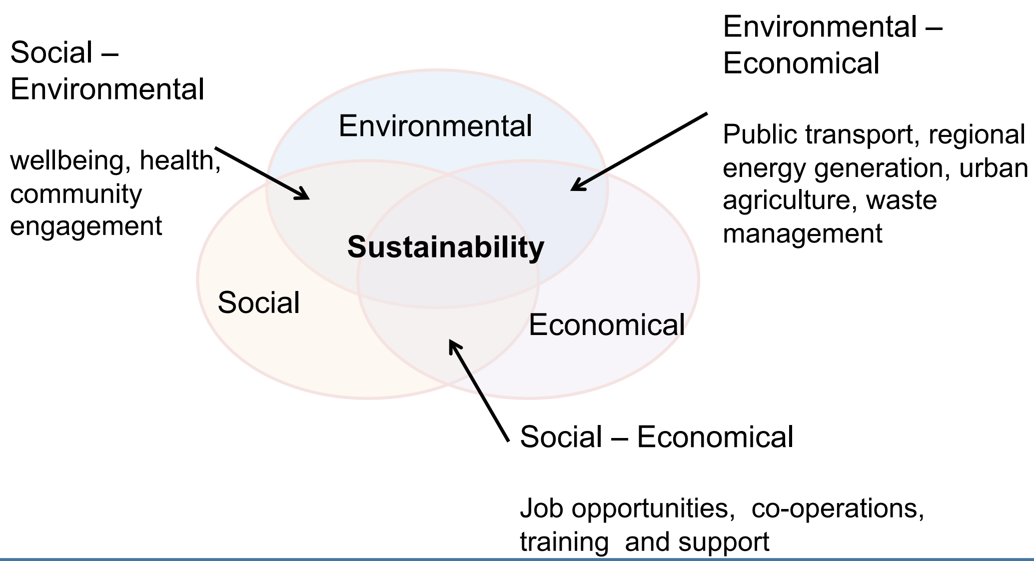
Objectives

To design an ideal city that can be a global example for regional resources management

To propose an energy mix and green technologies to achieve a carbon neutral society

To Recognize the risks and limitations when going "all renewable "

Urban Sustainability



Adapted from : Teli D & James P.A.B. 2013 *Urban Space*, MSc Energy and Sustainability ,University of Southampton

Key design actions

- ✓ Describe the current conditions
- ✓ Assess technological community-based solutions
- ✓ Evaluate different policy initiatives to attract private investment
- ✓ Build a framework for innovation and collaboration between universities, stakeholders and industry
- ✓ International paradigms
- ✓ Future plans : Fukuhampton

Fukushima and Southampton

Two cities looking forward to go "green"

Population	290,000	254,000
Area	747 km²	73 km²
Climate	Warm Temperate-Hot summer	Warm Temperate-Warm summer

Fukuhampton – closer to heaven

Population 270,000

Area 400 km²

Annual Electricity demand: 2,200 kWh/person

Annual Total Electricity demand: 594 GWh

Fukuhampton – closer to heaven

Population 270,000

Area 400 km²

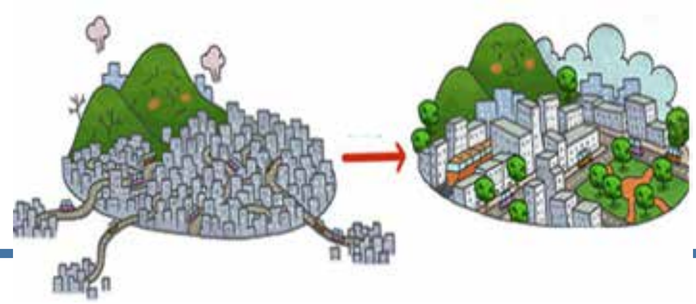
Climate Warm Temperate

Baseline mix – Business as usual

Technology	e^-	Heat	Japan Energy fuel mix (2012)*	UK Energy fuel mix (2012)*
Hydro	O	X	3%	2%
Solar	O	O	2%	
Wind	O	X		
Geothermal	O	O		
Ocean energy (tidal and wave)	O	X		
Biomass	O	O		
Oil			47%	37%
Natural Gas	O	O	24%	33%
Coal	O	O	23%	16%
Nuclear	O	O	1%	12%

•US Energy Information Administration (2012) Independent statistic analysis for Japan and UK

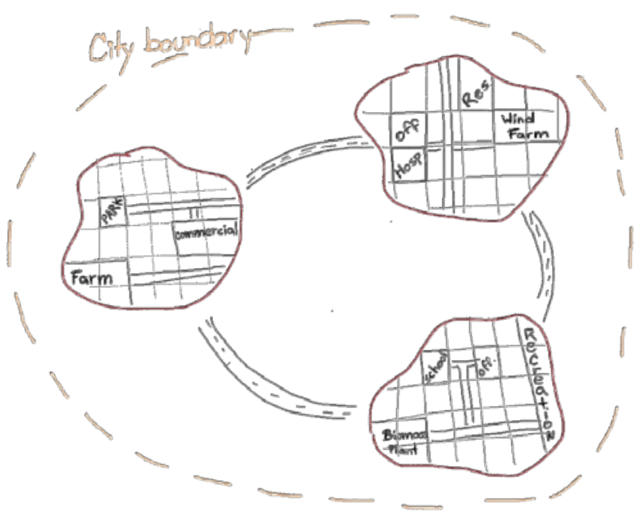
Urban planning - Land use



- Compact, walkable or cycle distance
- Mixed land use (agricultural, housing, green space and recreation),
- Preserve green space and critical habitat for biodiversity
- Total housing area < 60%

Source: theenvironmentalblog.com

Urban planning – A place to call home



✓ Protect and support biodiversity

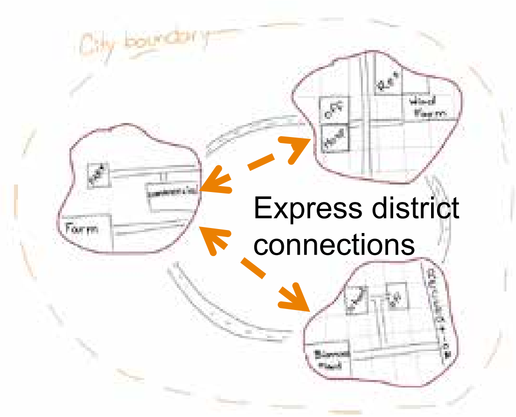
✓ Optimise density and enhance mixed-use

✓ Reassure Economic security for citizens

✓ Support cooperative networks

✓ Preserve local ecosystems and promote sustainable food production

Urban planning - Transport in the city



Express district connections

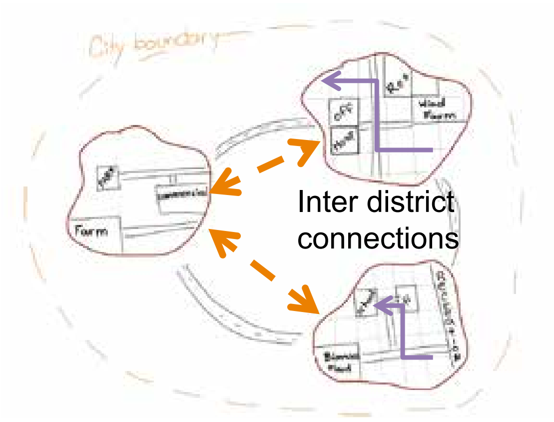
Primary roads – arteries (4 – 6 lanes with planted central reservation and side "green" verges.

Electric, H_2 fuel cell buses, tram

Catchment area the district/ community ~5,000 to 10,000 persons

Non local travel

Urban planning - Transport in the city



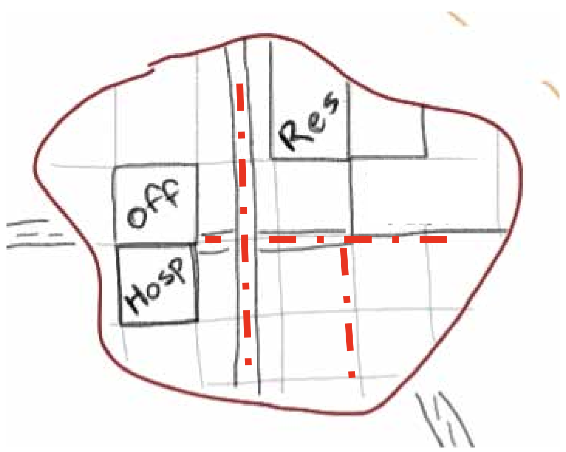
Fast Inter district connections - Electric buses

Secondary roads (2 – 3 lanes with side planted pedestrian walks (increased permeable surfaces with rain run off collection)

Catchment area parts of the district ~2,000 to 3,000 persons

Travel to schools, local commercial centre

Urban planning - Transport in the city



Bicycle lanes/ walkable distances (~800m to main local facilities such as grocery, post office etc)

Secondary and tertiary roads (1-2 lanes with pedestrian walks, public open space, local parking

Catchment area parts of the neighbourhood ~500 to 2,000 persons

Travel to shops, food supplies, entertainment

Urban design - Principles

Places with character and identity

Continuity and enclosure – Private space is distinguished from public

Quality of public places – attractive, well used space

Ease of movement – accessibility and safe connection with surroundings

Adapted from CABE "Commission for Architecture and the Built Environment

Urban design - Principles

Legibility – Easy to find and navigate around

Adaptability – Easy to change according to use needs

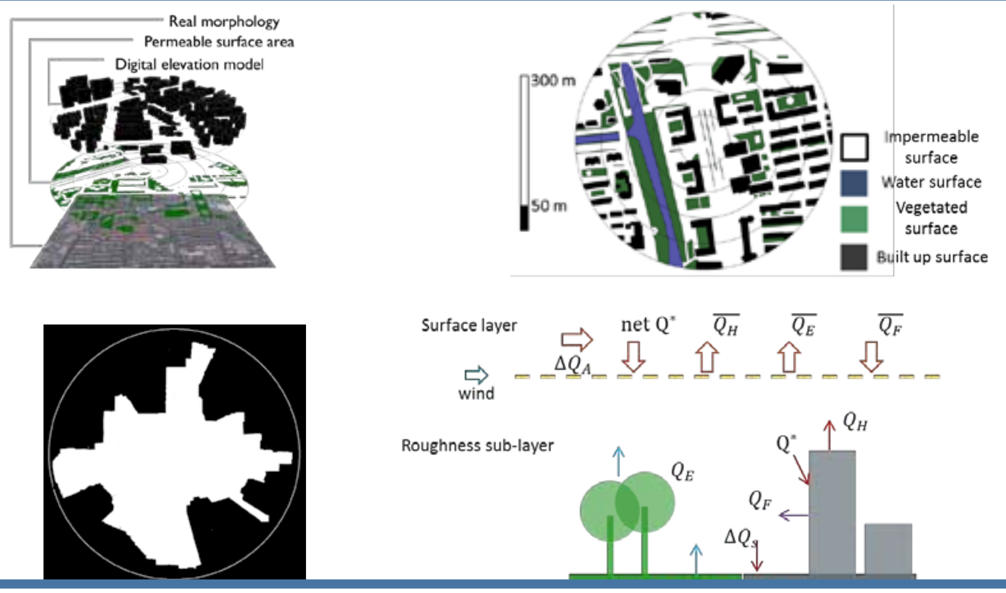
Diversity – Variety and choices

Resilient to climate change and extreme events

Promoting air quality, thermal comfort and energy savings

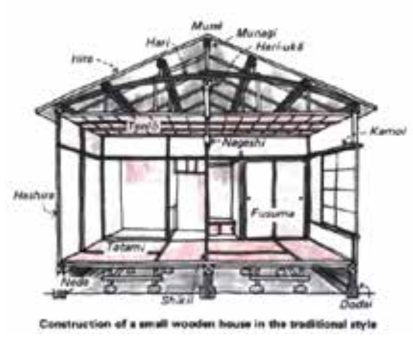
Adapted from CABE "Commission for Architecture and the Built Environment

Urban design – Microclimate



Adapted from CABE "Commission for Architecture and the Built Environment

Urban design – Building layout



Lessons taught from **traditional architecture**

Openings to South (solar gains)

Cold air recession – secondary use spaces to North

Daylight access

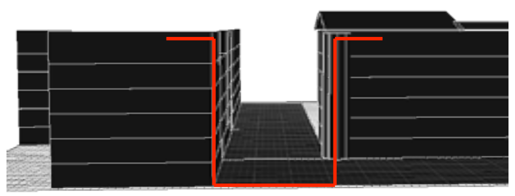
Change in the use of space

Cross ventilation

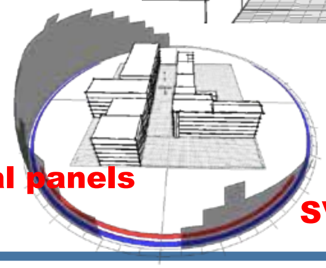
Urban design – Building layout

N

Optimum AR = ?



Consider ....
Daylight levels
Air quality
Pedestrian comfort
Integrated PV and solar thermal panels



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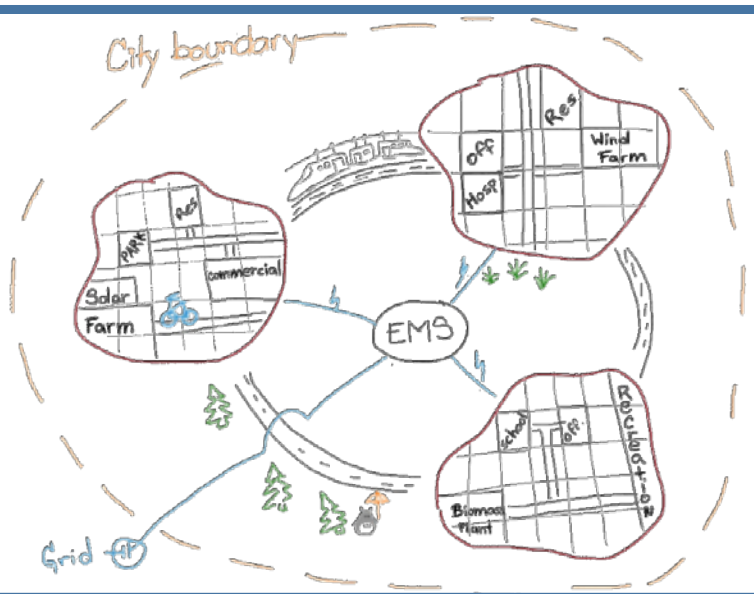
Urban design – Building layout

Regional – responsive to climate design

Use of local materials and recycling at the end of life – Life Cycle Assessment

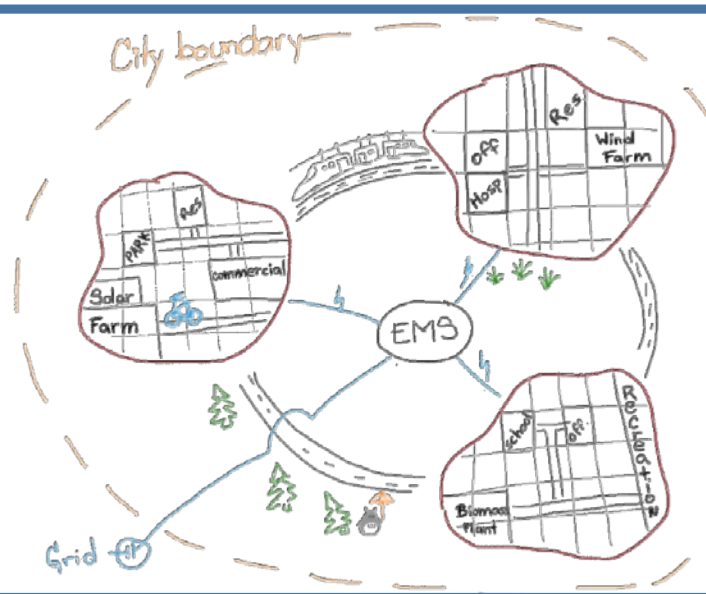
Energy – Management



Annual Total
Electricity
demand:
594 GWh

Energy management system for Fukuhampton

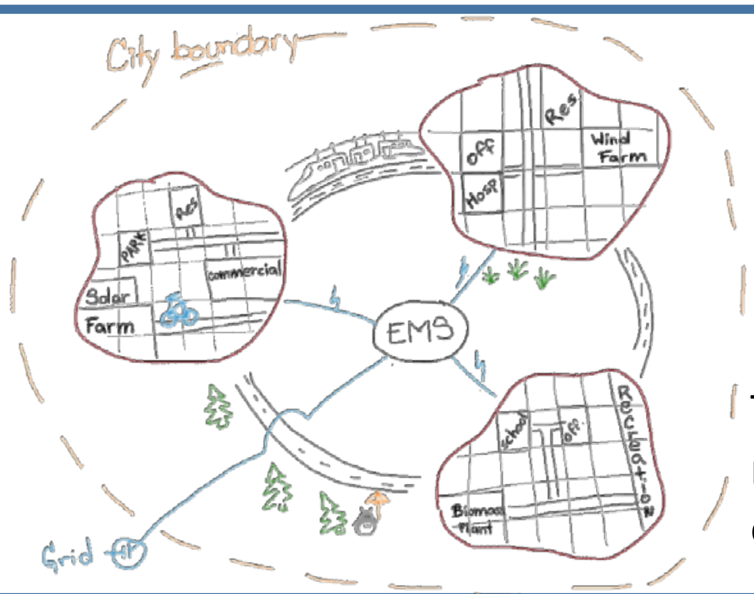
Energy – Management



Community owned energy management system controls the local power distribution between the districts

Local decentralised grid is connected to the national grid

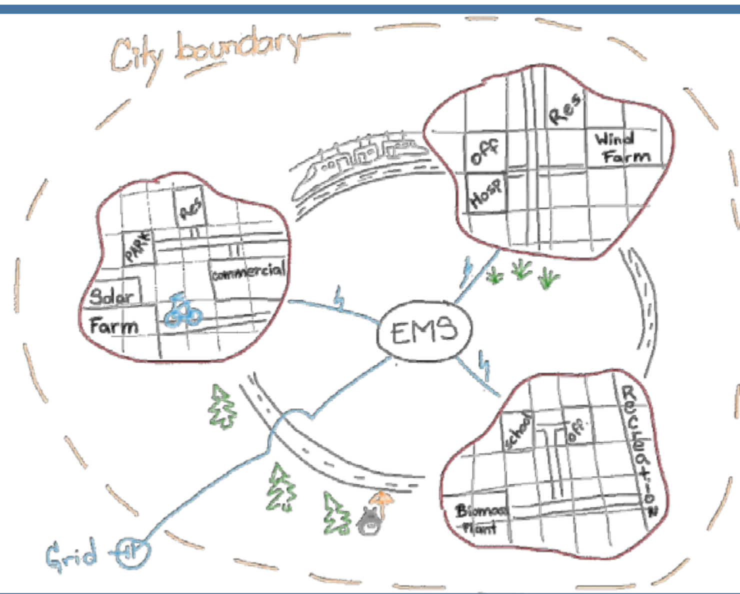
Energy – Hybrid approach



Annual Total
Electricity
demand:
742.5 GWh

Target: 125% net cover of energy demand

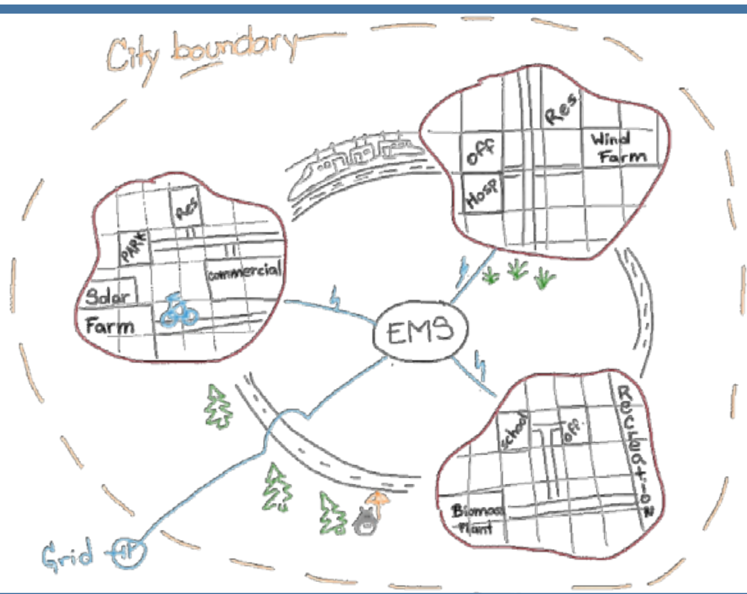
Energy – Hybrid approach



Surplus is exported to the grid.
Carbon offset for the CO_2 emitted by private vehicles and conventional energy generation.

At mature stage of the development average per capita demand does not exceed 2,200 kWh

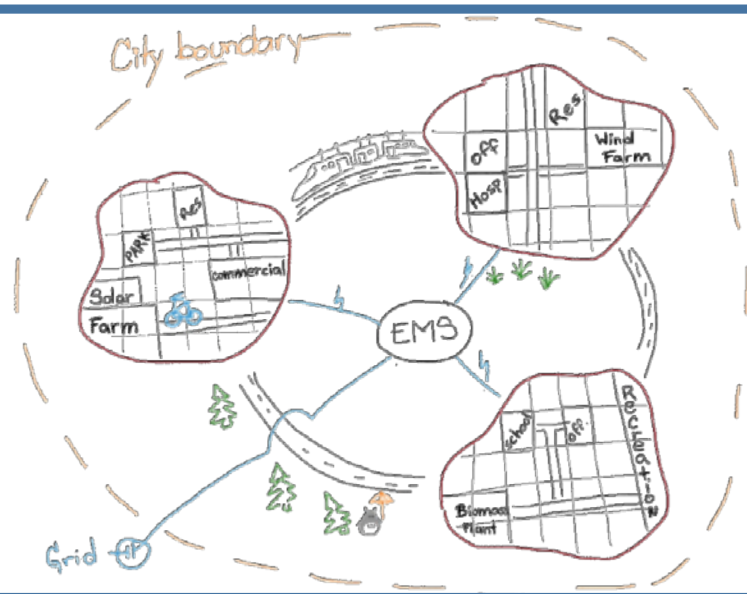
Energy – Hybrid approach



Solar PV potential...

Total A=400 10^6 m^2

Energy – Hybrid approach

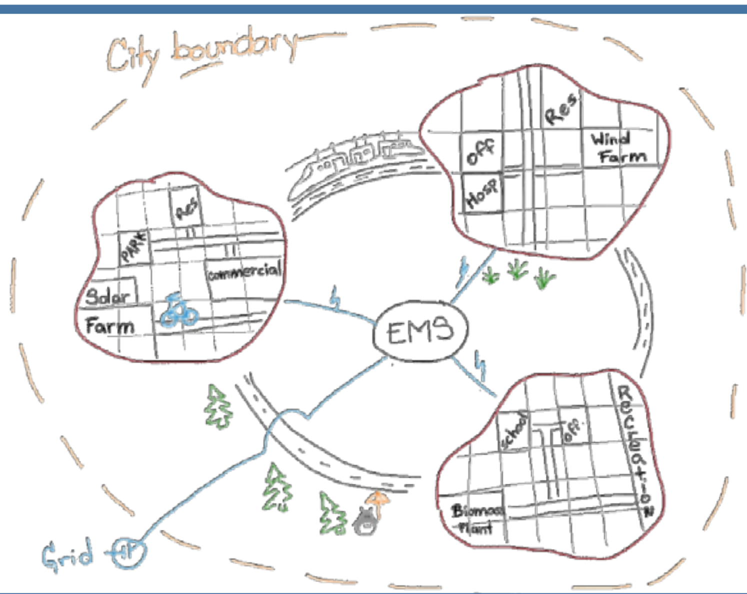


Annual Total Electricity demand: 742.5 GWh

Wind 10 MW onshore -> 15 GWh*

* World View. Wind Energy opportunities in Japan. www.worldview.co.nz

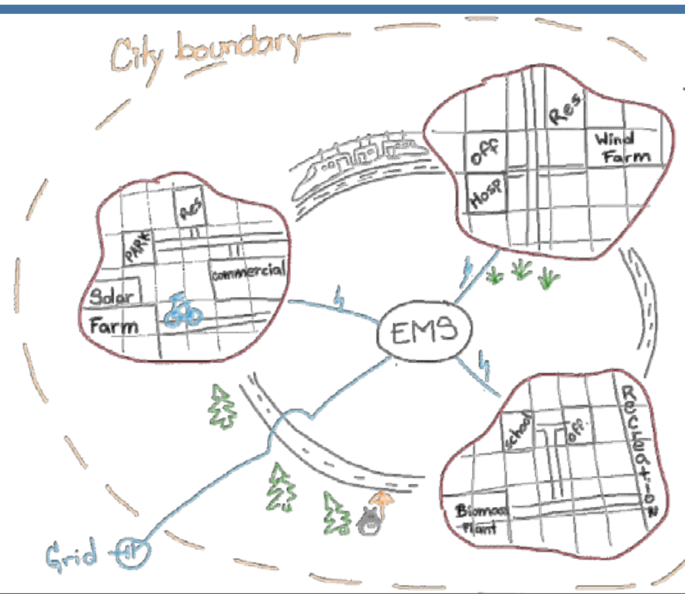
Energy – Hybrid approach



Annual Total Electricity demand: 742.5 GWh

50% Built x 400 10^6 m^2 x 5% suitable roofs x 800 kWh / kWp x 0.1 kWp/m^2 = 800 GWh!

Energy – Hybrid approach



Annual Total Electricity demand: 742.5 GWh

Waste 1.2 kg /person/daily =118,000 tons annually

0.4 incinerated in 5MW e^- total plants.

5MW x 0.2 effic. x 12hr/day x 365days = 22 GWh

Energy – Hybrid approach

FUKUHAMPTON	Energy	Cost
Biomass - waste incineration - CHP	0	0
Geothermal	627GWh/year	0.1070MM$
Hydropower - large-scale	0	0
Hydropower - small-scale	0	0
Solar photovoltaics - Large scale	0	0
Solar photovoltaics - Buildings	0	0
Marine	0	0
Wind onshore	0	0
Wind offshore	0	0

FUKUHAMPTON	Energy	Cost
Biomass - waste incineration - CHP	0	0
Geothermal	97.2	0.0166
Hydropower - large-scale	0	0
Hydropower - small-scale	0	0
Solar photovoltaics - Large scale	0	0
Solar photovoltaics - Buildings	0	0
Marine	0	0
Wind onshore	530.65	0.2423
Wind offshore	0	0

Sustainable infrastructure

- Water management infrastructure

Drinking water supply(save water usage)

Sewage treatment-Ecological treatment

- Solid waste management

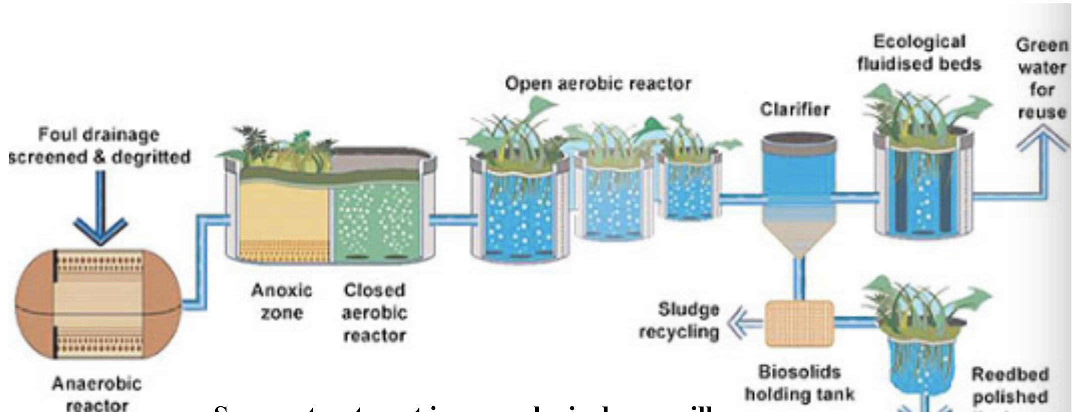
Solid waste gasification facilities

- Green infrastructure

Energy– risks and limitations

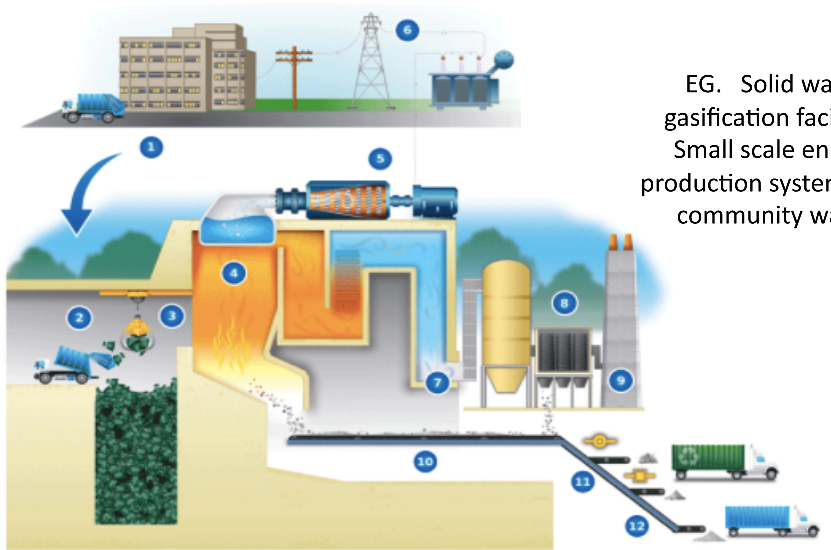
- Low community engagement - Not in my back yard syndrome
- Cost and initial capital stock
- Natural disasters
- Unpredicted climate conditions
- Finite primary energy resources
- Low rate of technological learning

Water management (water-energy nexus)



Sewage treatment in an ecological way will save energy compared to traditional treatment methods.

Solid waste management (energy production from waste)



EG. Solid waste gasification facilities
Small scale energy production system using community waste

Conclusion

- Energy demand reduction through behaviour shift and efficient city design.
- Emissions from Gas/Biomass CHP and grid carbon intensity are offset by energy export to the grid.
- Community cooperation networks have shares on the energy generation plants.
- Fukuhampton can set as a global example for community based generation according to regional resources.

Green infrastructure

Green belt in the city: early drainage of rainwater the rainwater, and at the same time, can be used to facilitate CO2 sequestration

Green roof: if there is some roof top space left, green roof can be used to save energy by increasing the insulation of the buildings.

Thank you very much
Q&A

Students
report
& presentation

Group B

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University of Bristol, UK

Ray Edmunds
University of Leeds, UK

Yang Wang
Osaka University, Japan

Hector Fernando Villatoro Flores
Tohoku University, Japan

Title: Energy Demand and Capacities in Economies: A case study of Cancun, Mexico

Group Members:

Hector Flores – Tohoku University

Yang Wang – Osaka university (r

Aisling Tierney – Bristol University

Ray Edmunds – Leeds University

Context:

Mexico is one of the four MINT countries, along with Indonesia, Nigeria and Turkey. Mexico with its large economic growth and growing power demand faces enormous challenges in the development of its power system. With increasing imports form US the cost of power in Mexico is unsustainable for a developing country and domestic production of energy is required to satisfy growing demand. Cancun was chosen as a city for analysis, because of its global reach with high tourism and attractive site for international conferences, for example the UNFCCC in 2010. Cancun surrounding land is undeveloped and ideal for large scale energy generation technologies. This will benefit both the local economy in terms of jobs and energy resilience in addition to encouraging Mexico's independence from reliance on imports.

Social and Environmental Considerations:

Dramatic social and economic inequalities exist in Cancun. The lack of fundamental social systems (clean running water, electricity, housing, and transport) compared to the wasteful luxuries of internationally-funded hotel chains lead to a sense of social injustice for the local Mayan population. Migrant workers travel from across the Yucatan peninsula to supply the cheap unskilled workforce required to support the tourism industry, but this leads to community fragmentation and a destruction of traditional cultural systems.

The environment suffers due to the waste created by the tourist industry. Over 450 tons of waste travels to landfills every day and is frequently burned as part of the disposal process. Hotel sewage is either stored in septic tanks and illegally dumped in the local lagoon or water systems, or is directly poured untreated into the drainage systems. Sewage purification industry is limited in Cancun.

Objectives:

1) Highlight the requirements for a sustainable energy system for a mint country taking as a case study a city in Mexico.

2) Provide an example for wholes system approach to system design for all MINT countries.

3) Assess the technical, economic, environmental and social aspects of energy system design in a MINT country.

Data Collection and Analysis:

- GIS was used to understand the wind, wave, geothermal and solar resource availability
- The regional demand was approximated by using national and provincial energy statistics
- An energy mix was decided based on the resource availability, efficiency of technologies and system compatibility
- Levelised costs of new technologies were compared to existing cost of the current fuel mix
- The market framework and current reforms were assessed to ensure that Mexico and the Cancun region provided an attractive commercial opportunity for both national and international investors
-

Conclusions and Recommendations

- Fantastic opportunity for development in Mexico
- Great resource and market potential
- Cancun an opportunity to provide example of decarbonised city in a MINT country.

This was pre-feasibility study. A further feasibility study is required, this will take into consideration the following

  - Detailed cost and resource analysis
  - Detailed analysis of the Mexican electricity and energy markets
  - Forecasting of future load requirements in the Cancun region
  - System adequacy analysis

Energy demands and capacity in developing economies: A case study in Cancun, Mexico

Group B

A. Tierney (Bristol), R. Edmunds (Leeds), Y. Wang (Osaka) and H. F. V. Flores (Tohoku)

RENKEI Summer School in Tohoku Univeristy
11-Sept-2014

Emerging economies

Brazil, **R**ussia, **I**ndia, **C**hina and **S**outh Africa
Mexico, **I**ndonesia, **N**igeria and **T**urkey

Regional problems

Social

- Demographics
- Labour, migration, community
  - Culture, tradition
- Housing
- (In)equality

Environmental

- Land use (interior)
- Waste, pollution

Rise of the MINTs
($ trillions)

Gross Domestic Product 2012		Ranking	Estimated GDP in 2050	
16.24	US	1	China	52.62
8.23	China	2	US	34.58
5.96	Japan	3	India	24.98
3.43	Germany	4	Euro Area	22.51
2.61	France	5	Brazil	9.71
2.47	UK	6	Russia	8.01
2.25	Brazil	7	Japan	7.37
2.01	Russia	8	**Mexico**	6.95
2.01	Italy	9	**Indonesia**	6.04
1.84	India	10	UK	5.69
1.82	Canada	11	France	5.36
1.53	Australia	12	Germany	5.22
1.32	Spain	13	**Nigeria**	4.91
1.18	**Mexico**	14	**Turkey**	4.45
1.13	South Korea	15	Egypt	3.61
0.88	**Indonesia**	16	Canada	3.47
0.79	**Turkey**	17	Italy	3.42
0.77	Netherlands	18	Pakistan	3.33
0.71	Saudi Arabia	19	Iran	3.19
0.63	Switzerland	20	Philippines	3.17
0.26	**Nigeria**	39		

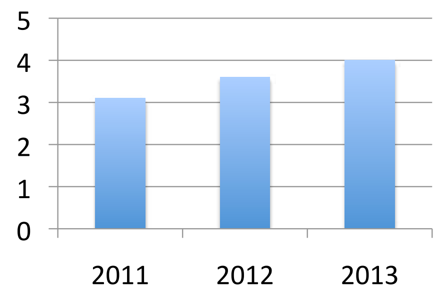
Source: World Bank, Goldman Sachs

United Mexican States

Area: 1,972,550 km^2 (14th)

Population: 118, 395, 054 (2013, 11th)

GDP: $1.927 trillion (2014 estimate, 10th)



Cancun International Airport

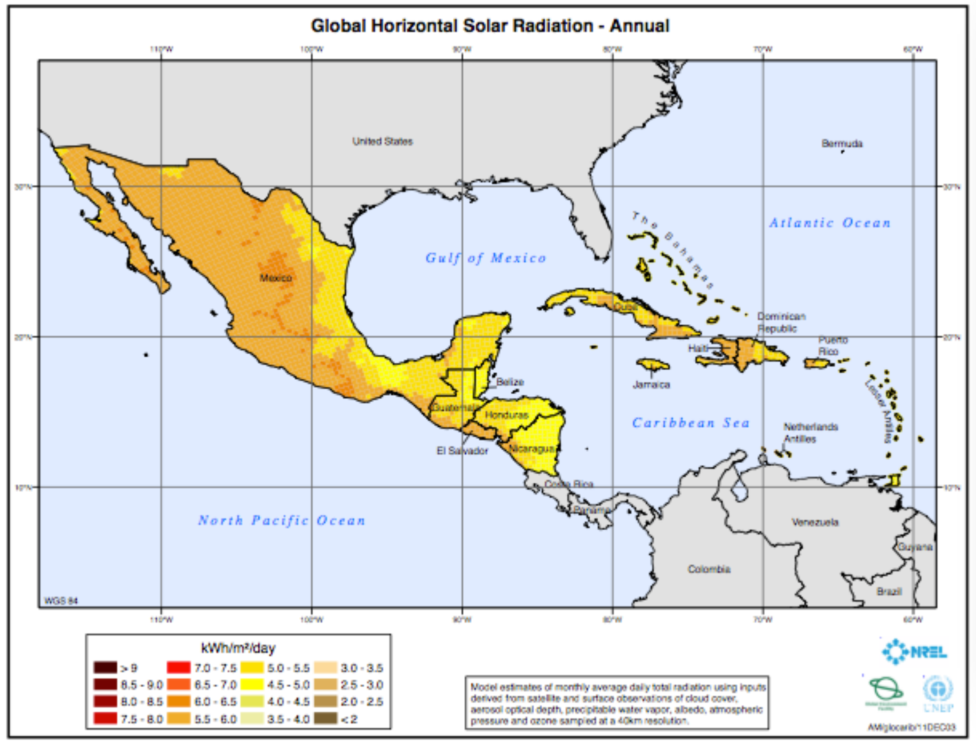
Second largest in Mexico
15, 962, 162 passengers in 2013

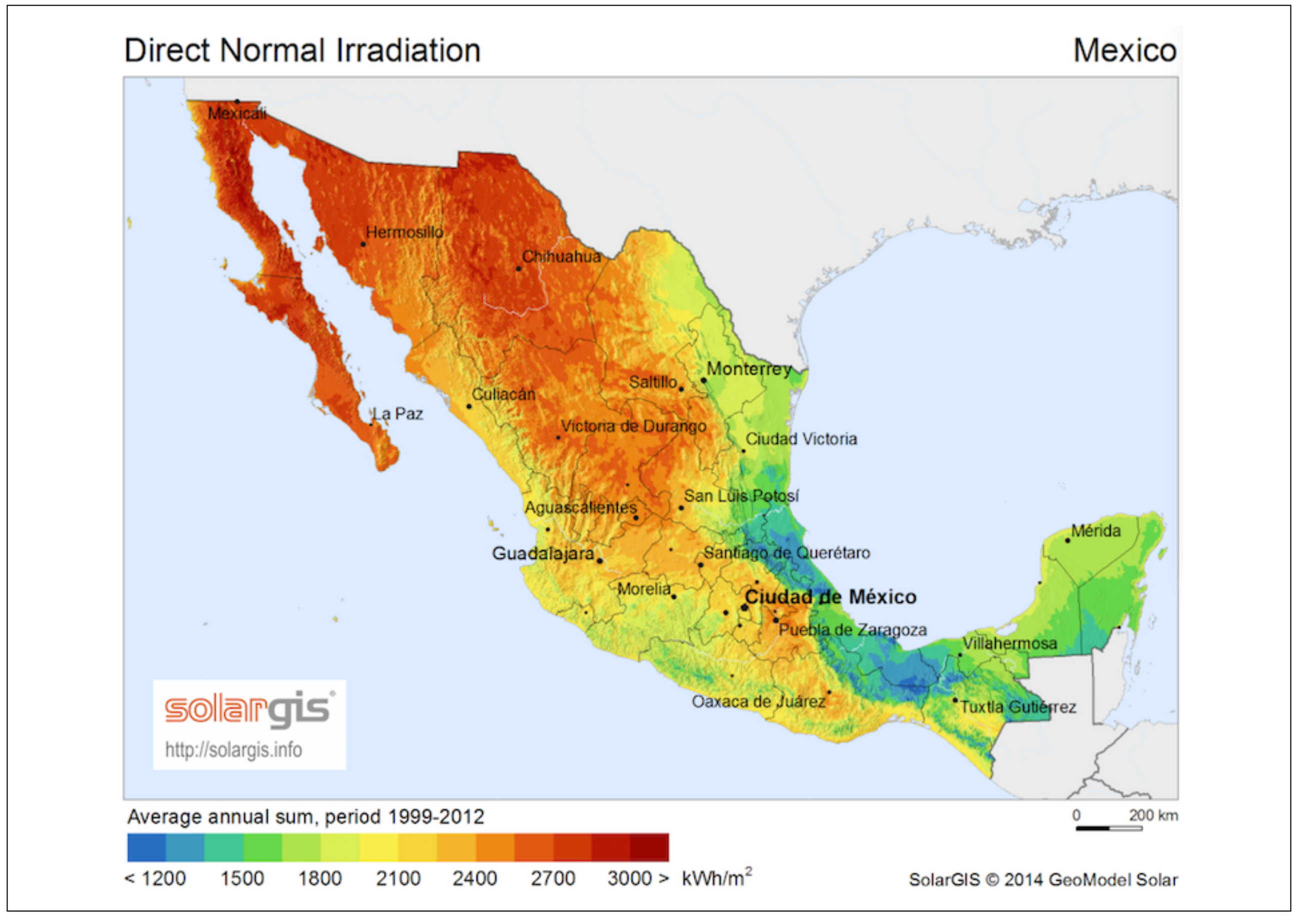
Local residence: 0.72 million

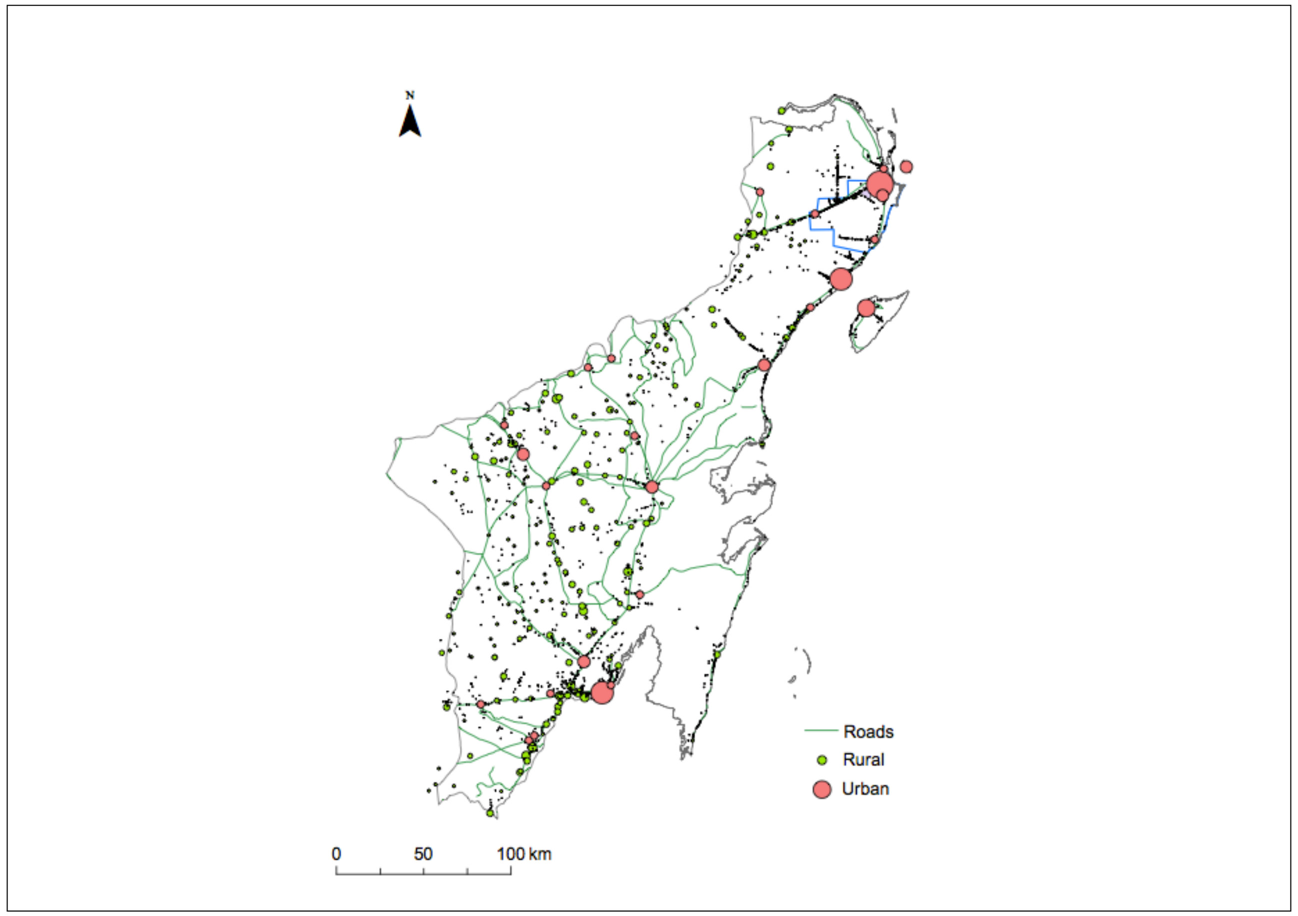
Cancun

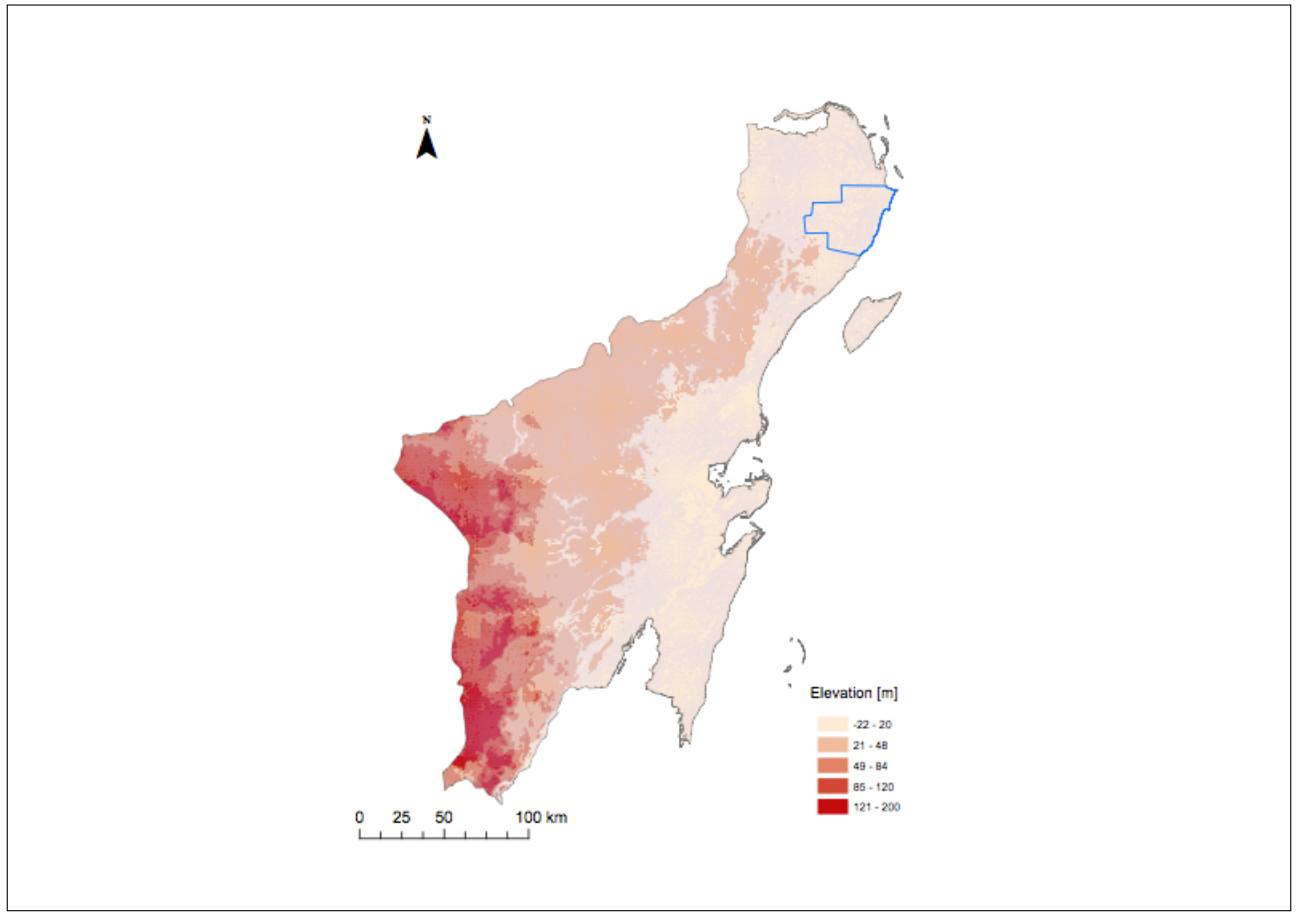
Found: 1970
Location: Yucatan Peninsula, south-east coast of Mexico
State: Quintana Roo
Climate: Subtropical climate, 27º C - 35º C, sunny days throughout most of the year
Population 722, 800 (2010).

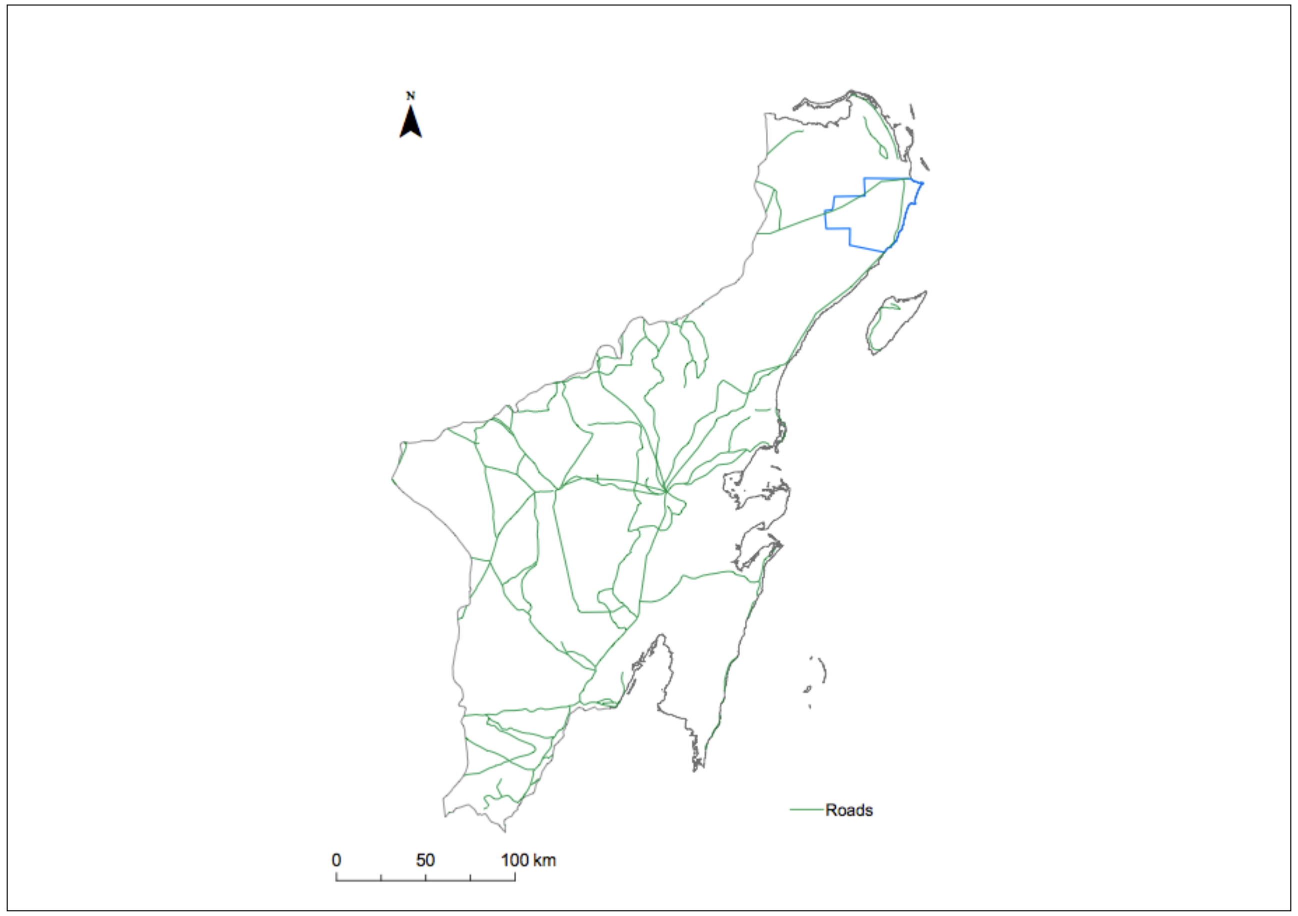
UN's Cancun climate conference was held in November 2010 and "Cancun Agreements"

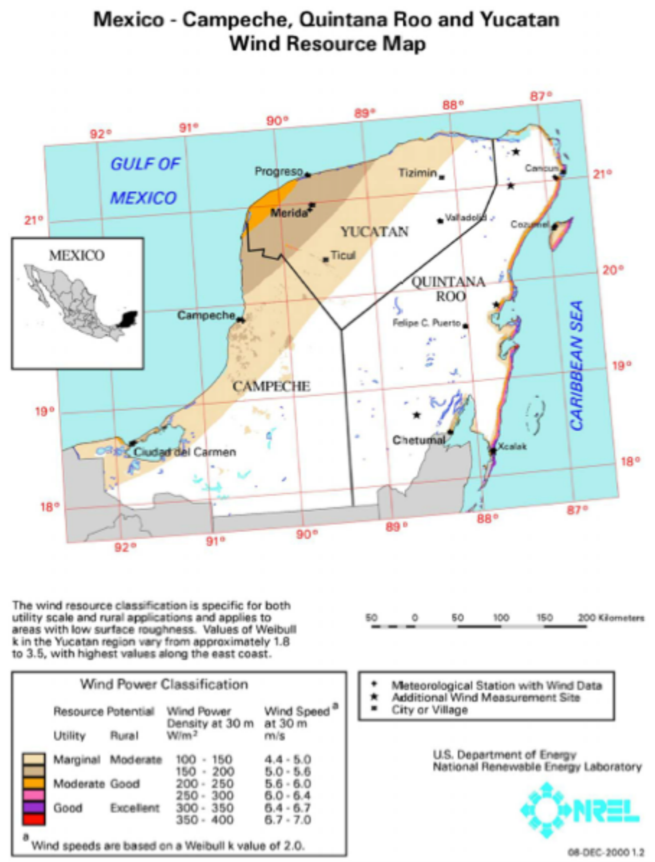



Direct Normal Irradiation
Mexico
Mexicali
Hermosillo
Chihuahua
Culiacán
La Paz
Saltillo
Monterrey
Victoria de Durango
Ciudad Victoria
San Luis Potosí
Aguascalientes
Guadalajara
Santiago de Querétaro
Mérida
Morelia
Ciudad de México
Puebla de Zaragoza
Villahermosa
Oaxaca de Juárez
Tuxtla Gutiérrez
solargis
http://solargis.info
Average annual sum, period 1999-2012
< 1200 1500 1800 2100 2400 2700 3000 > kWh/m2
0 200 km
SolarGIS © 2014 GeoModel Solar


N
Roads
Rural
Urban
0 50 100 km


N
Elevation [m]
-22 - 20
21 - 48
49 - 84
85 - 120
121 - 200
0 25 50 100 km

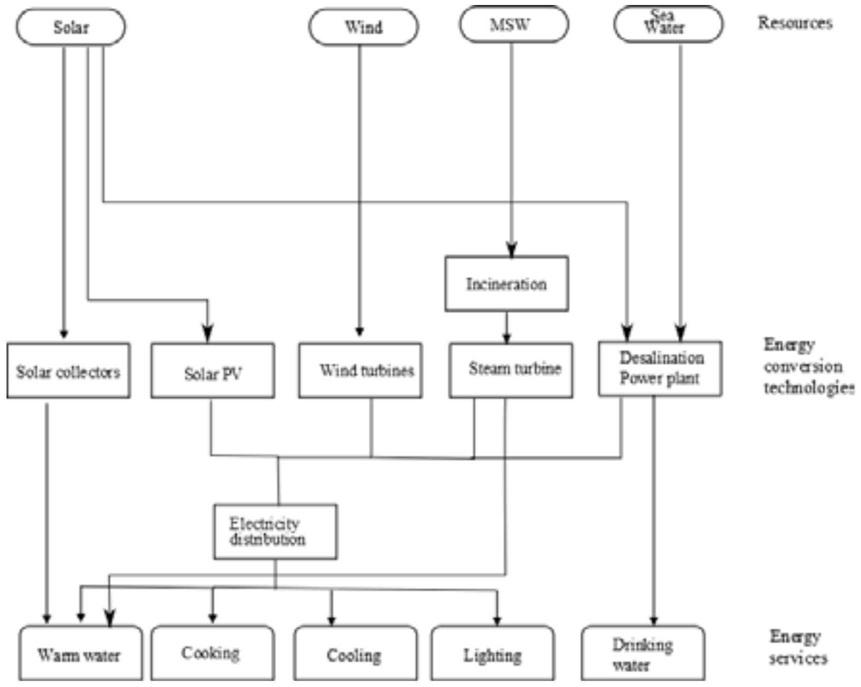

N
Roads
0 50 100 km



Economics

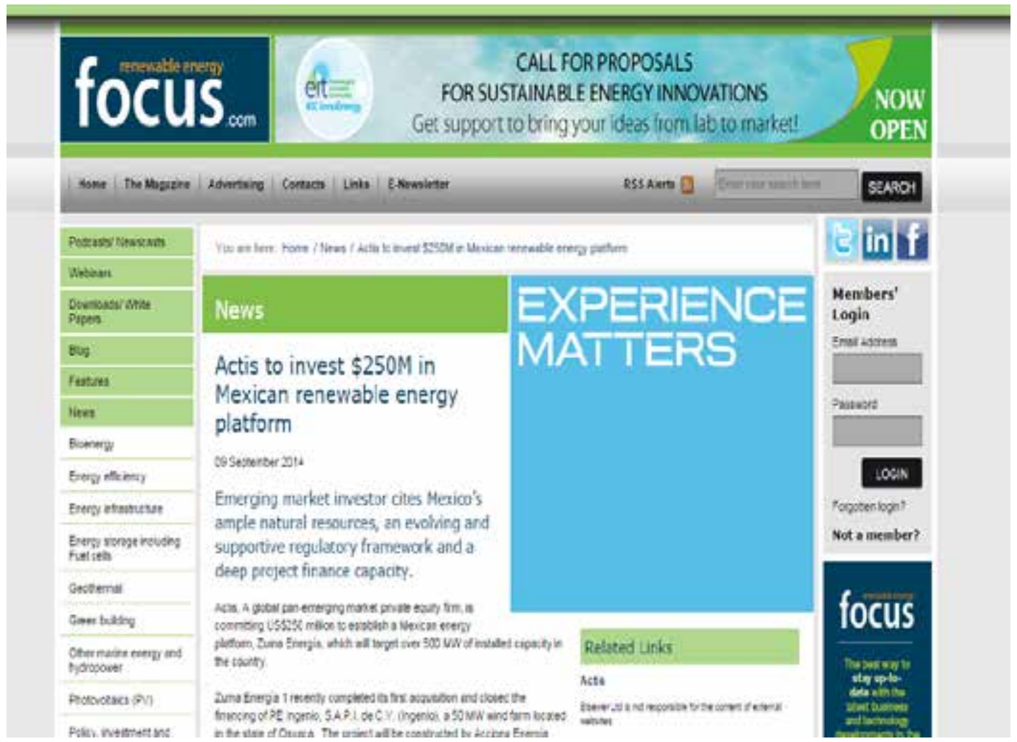
- Imported diesel and oil >200USD/MWh
- New Low Carbon Technologies
  - Solar PV:100-120USD/MWh
  - Onshore Wind: 80-100USD/MWh
  - Waste Incineration: 90 – 100USD/MWh
  - Anaerobic digestion: 100 – 180USD/MWh
  - Solar collectors
- Enabling Technologies
  - Grid reinforcement: 8-10USD/MWh
  - Storage: further analysis required

Technical



Political Support

- Mexicans pay 72% more for electricity than americans
- Reforming the energy market to allow greater private investment
- Target of 35% renewable energy by 2024
- Plans to take wind to 20GW+ capacity by 2024....and solar to 8GW by 2014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09 September 2014
Emerging market investor cites Mexico's ample natural resources, an evolving and supportive regulatory framework and a deep project finance capacity.
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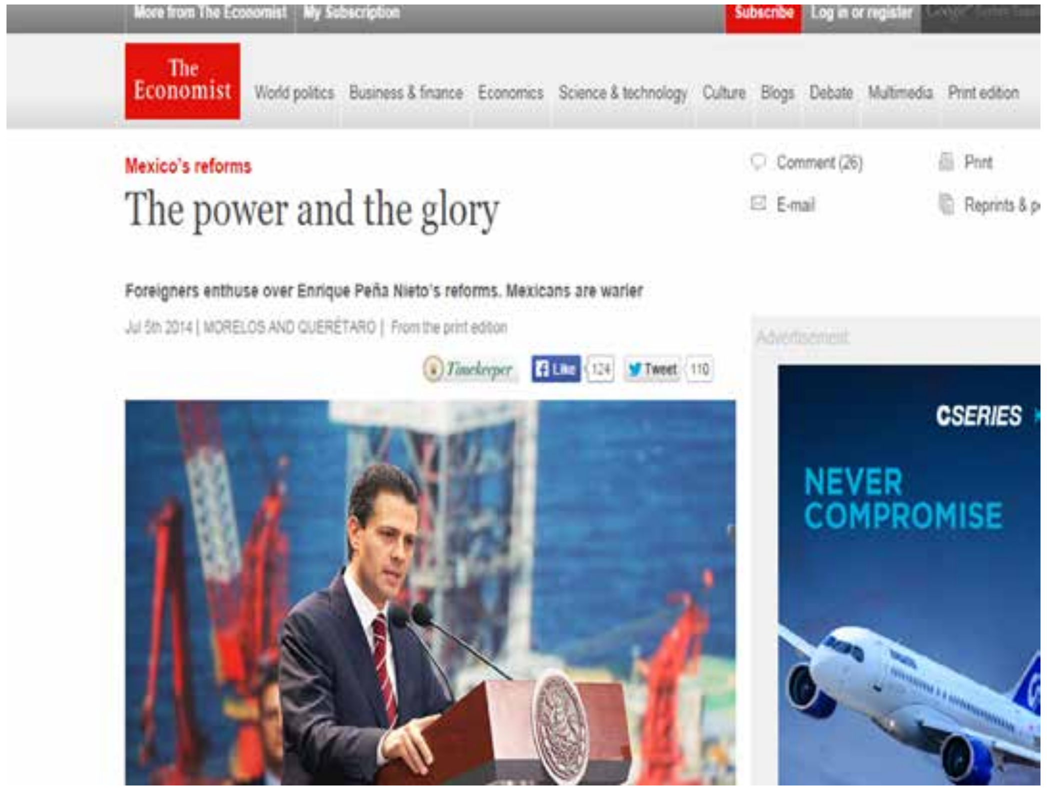
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The power and the glory
Foreigners enthuse over Enrique Peña Nieto's reforms. Mexicans are warier
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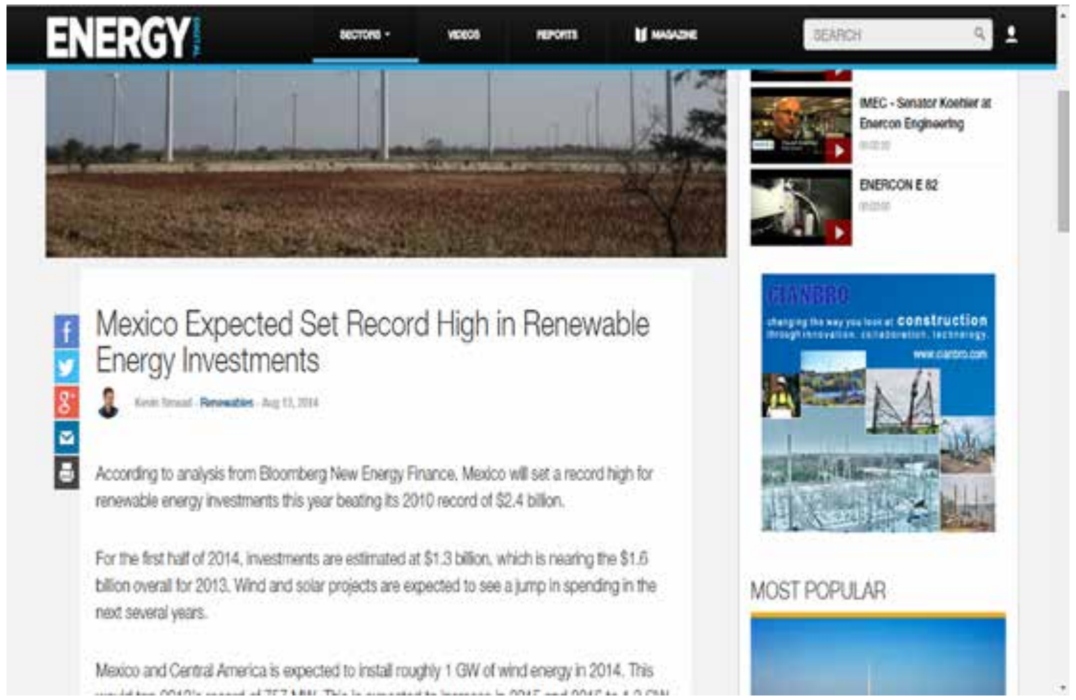
NEVER COMPROMISE


ENERGY
SEARCH
IMEC - Senator Koehler at Enercon Engineering
ENERCON E 82
Mexico Expected Set Record High in Renewable Energy Investments
According to analysis from Bloomberg New Energy Finance, Mexico will set a record high for renewable energy investments this year beating its 2010 record of $2.4 billion.
For the first half of 2014, investments are estimated at $1.3 billion, which is nearing the $1.6 billion overall for 2013. Wind and solar projects are expected to see a jump in spending in the next several years.
Mexico and Central America is expected to install roughly 1 GW of wind energy in 2014. This
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Mexico's Newly Opened Energy Market Attracts Renewables
Nathan Paluck, International Correspondent
May 08, 2014 | 3 Comments
REGISTER TODAY AND SAVE!
MEXICO CITY -- It is a good time to be in the renewable energy business in Mexico since landmark energy reform opened up the electricity market and prioritized renewables. The government has an ambitious 12-

Students
report
& presentation

Group C

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Yue Wu
University of Southampton, UK

Future City Design under extreme weather conditions

Ivar Baldvinsson (Tohoku University), Marina Ide (Osaka University),
Carmen Wouters (University College London), Yue Wu (Southampton University)

Introduction

Extreme climatic conditions resulting in heavy winters and hot summers are becoming more prominent due to climate change and global warming [reference]. Cities pressured by these extreme weather conditions are increasingly constrained in meeting their energy demands and form a challenging environment to create a sustainable city in all sectors.

Objective

To create a *sustainable* and *resilient* future energy system of a city bound by extreme climatological conditions, exploiting as much as possible the locally available (renewable) energy resources and the local environmental features.

Methodology

Transition theory is employed, as illustrated in the figure right. A future city design is envisioned based on the current status of the considered city. Back casting is then utilized to transition the current city structure to the future city design through retrofitting

City Profiles

Two cities are the scope of the study: Adelaide, South Australia and Hirosaki, Japan. The choice of cities is motivated by *climate*, *available resources* and *potential of improvement*. The characteristics and motivation of each city are given in the table below.

City	*Adelaide*	*Hirosaki*
Average yearly solar irradiation		
Max avg Temp. Min avg Temp.	29-30 degrees 7-8 degrees	15 degrees 5 degrees
RES	Solar – Wind - Biomass	Wind – Geothermal - Biomass
Population	1,203,200	183,473
Climate	Hot Mediterranean climate - mild winters with moderate rainfall and hot, dry summers	Mild humid summer and cold winters with heavy snowfall
Characteristics	- summer heat waves: >10 consecutive days >35 degrees - water usage restrictions - low household insulation standard - Stand-alone 1 floor houses – spread out living - car culture – barely public transport - peak cooling demand - Only major city in the state - 75% of population - access to the sea	- heavy accumulated snowfall winter: 2.4 m - low household insulation standard - compact residential living - peak heating demand - second biggest city in the region - land locked

Future city design

Although climatologically different, the basic future structure of both cities can be set up similarly. The urban areas will be designed based on a meshed network divided into zones of an equivalent of 50 to 250 households as seen on the figure below. The electrical network will follow the boundaries of the mesh and feeds to all residences in the urban area. Central generation plants can be installed outside the city centers feeding into the meshed network. A districting heating or cooling network will be installed following the streets. For Hirosaki this hot water distribution network can double for road heating and snow smelting during winter.

The district thermal network can be fed in from several sides, both centrally through waste heat of central generation plants as well as distributed through local waste heat generation. Each zone will be operated by the distribution system operator as a smart energy grid employing centrally controlled demand side to shave peak load and control household appliances. The buildings and households will be insulated appropriately to reduce end consumer demand further. Each zone will have a small scale CHP unit installed ranging from 100 kW to 500 kW, which feeds its electricity to the households in the zone as well as to the central meshed network. The waste heat will used to feed into the district heating system or in the district cooling system using small scale absorption chillers. Additionally ground heat and cooling pumps are installed in each household in the respective cities. The small commercial consumers will be integrated into the system similarly to the residential consumers. Large commercial and industrial consumers will have onsite CHP or CHPC generation both electricity and heat or cooling can be used locally as well as fed into the central system.The transportation sector will be transformed changing to hybrid electric vehicles as well as battery electric vehicles. The batteries of cars can be charged using excess electricity generation at night by CHP units, central generation as well as rooftop PV where applicable. A public transport scheme will be put into place using hydrogen fuelled busses. The hydrogen is generated in a hydrolysis plant outside of the city fuelled by excess generation at night.

Adelaide	Hirosaki
- smart energy grid meshed network with demand side management - house insulation - small scale CHP with absorption chillers CHPC in each zone - district cooling system - CHPC for industrial players and hospitals connected to the network - roof top PV and solar hot water exploiting large surface areas - waste incineration and biomass for cogeneration of heat to cooling an electricity -installation of large scale solar desalination plant and rain water storage tanks in each building to elevate water restrictions - hydrolysis plant for hydrogen generation - installation of central wind farm park outside city to feed in on central network	- smart energy grid meshed network with demand side management - house insulation - small scale CHP in each zone - district heating system also for road heating - CHP for industrial players and hospitals connected to the network - low exergy heat source through geothermal generation outside city center to feed in on district heating network - waste incineration and biomass for cogeneration of heat to cooling an electricity - installation of central wind farm park outside city to feed in on central network - hydrolysis plant for hydrogen generation

Transition pathway

The current situation of both cities is analysed and their future design is envisioned. Now the transition pathways and timeline to achieve the change have to be checked. The proposed pathway is to make distribution and transmission system operators in each city area key for the implementation and roll out of the smart energy network since they will provide the energy as well as own the local CHP generation units. The district thermal systems together with the electricity network will be owned and operated by them. The local government will be supporting the roll out through incentives under the form of tax reductions, subsidies for building insulation and local generation and feed-in tariffs for consumers as well as subsidies to roll out the smart network to the DSO and TSOs.

Conclusion

The cities considered are constraint in terms of their future design through climatic extremities. Nevertheless, a general meshed zone approach can be used to create a future smart and resilient network with different resources using transition theory. In terms of sustainability, the future city designs increase efficient use of locally available energy resources such as wind and geothermal as well as cogeneration. The energy demand is decreased through building insulation and smart network demand side management. In terms of resilience, the meshed network structure with multiple sources provides flexibility and smart usage of the generation sources.

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Japan bureau of meteorology
Australian bureau of meteorology

Future City Design under extreme weather conditions

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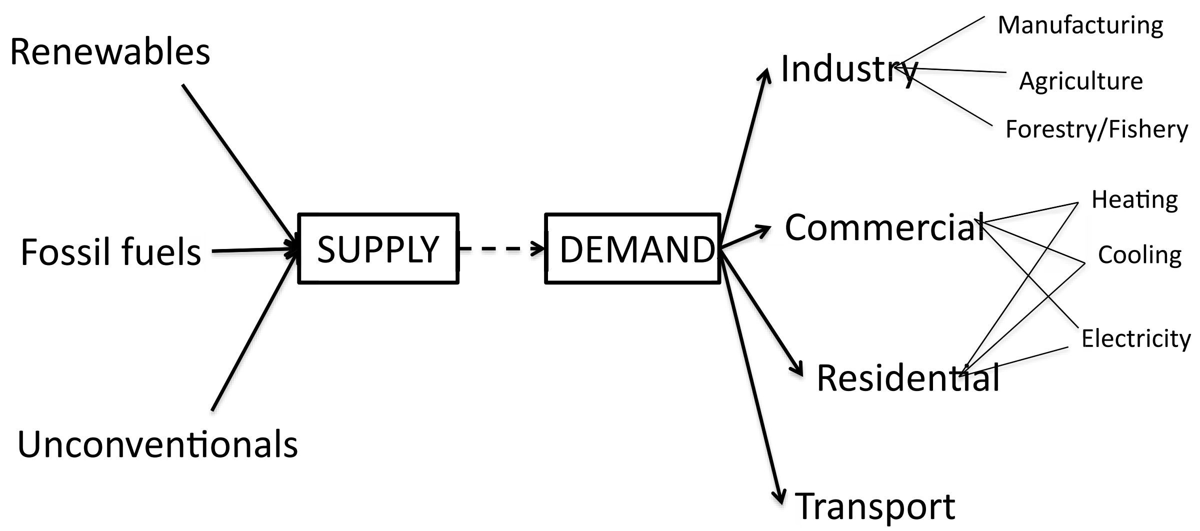
Energy balance system



Introduction

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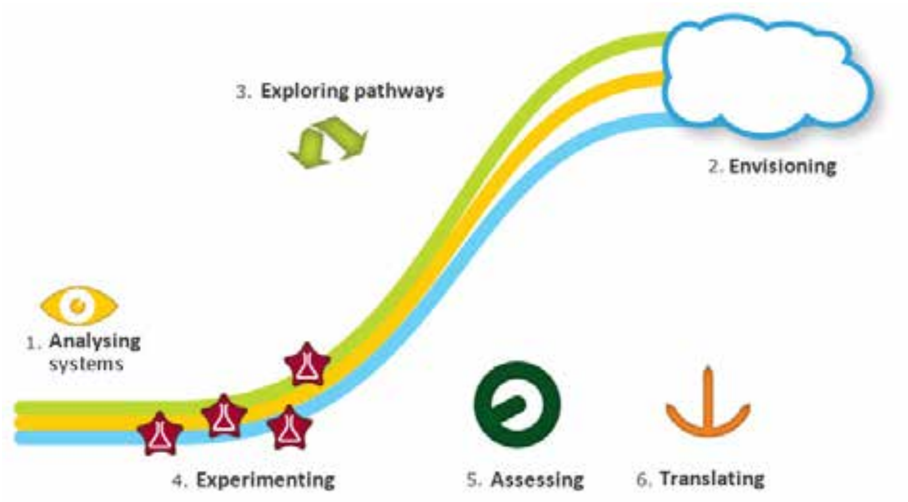
- Cities pressured by these extreme weather conditions
- Increasingly constrained in meeting their energy demands and form a challenging environment to create a sustainable city in all sectors.

Objective

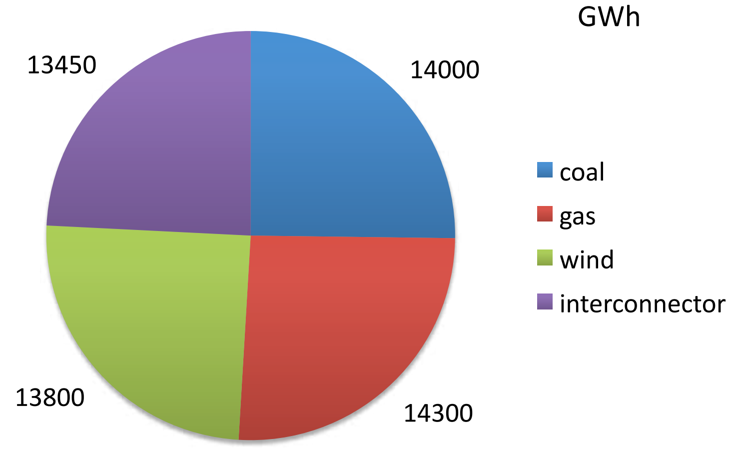
- To create a *sustainable* and *resilient* future energy system of a city bound
- Take into account extreme climatological conditions.
- Exploit as much as possible the locally available (renewable) energy resources and the local environmental features.

Methodology

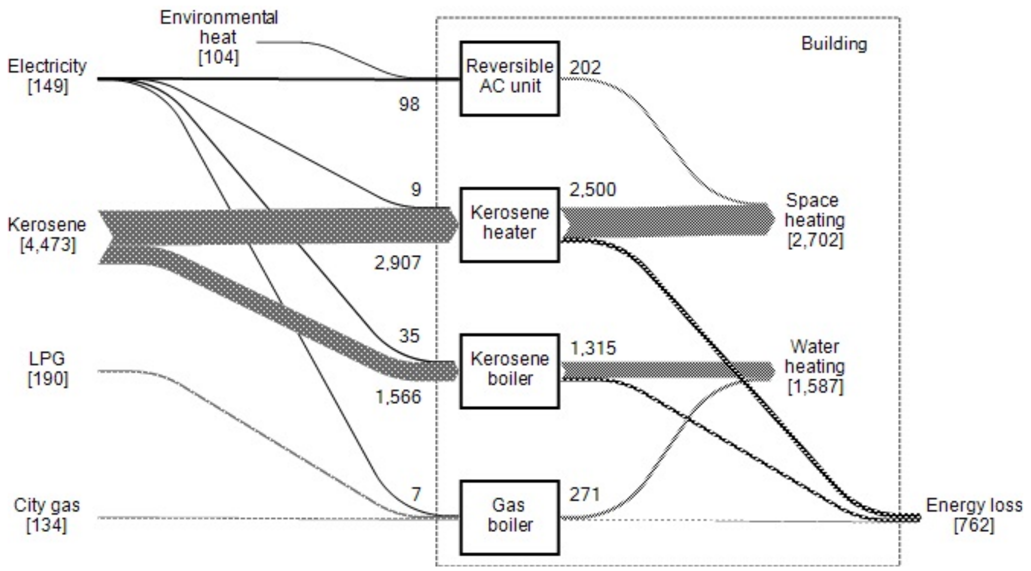
- Transition theory



Current electricity sources



Energy system (heat) of Hirosaki



City profiles

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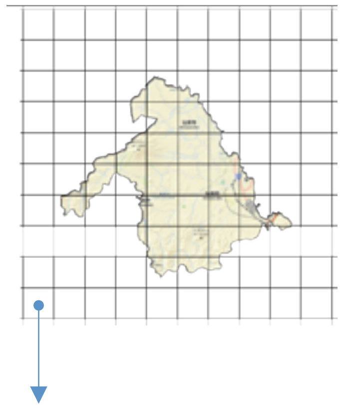
Meshed network

Hirosaki

523 km^2

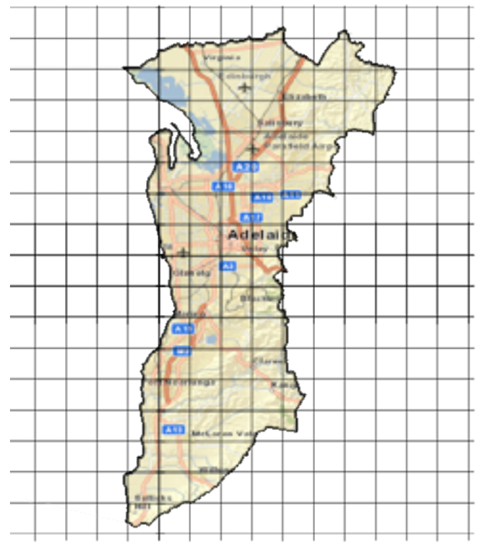


5

5 *(km)*

Adelaide

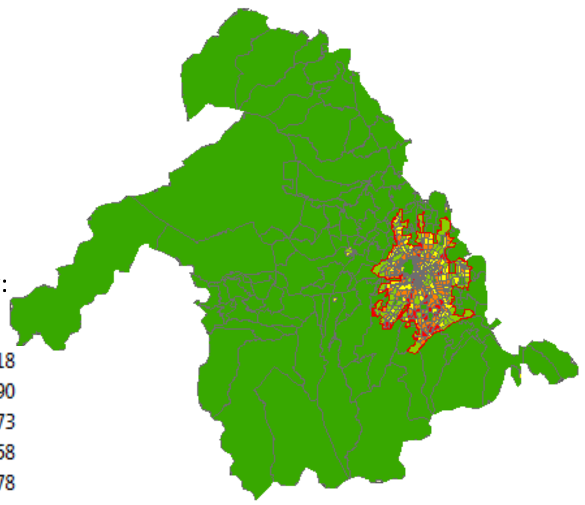
1,827 km^2



Understand the city - Hirosaki

The city centre occupies 6% in area, but accommodates 60% of the buildings.

Hirosaki



Building density:
(number/m^2)

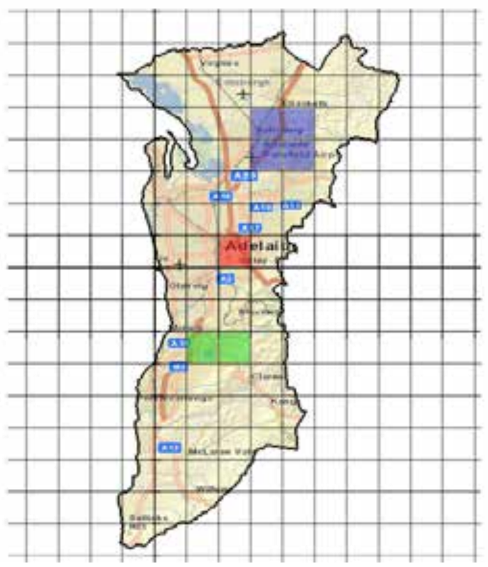
- 0.000000 - 0.000618
- 0.000619 - 0.001490
- 0.001491 - 0.002273
- 0.002274 - 0.002958
- 0.002959 - 0.005078

Source: Public map database of Japan

Understand the city

Use geo-divided grids to break down cities to areas.

Adelaide



Future city design

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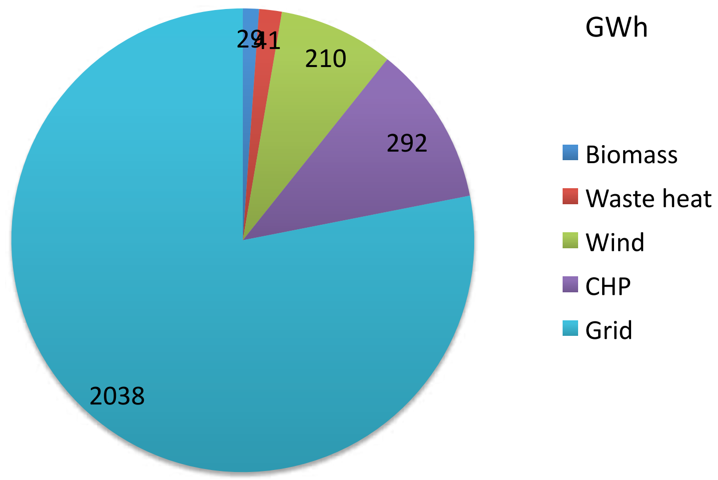
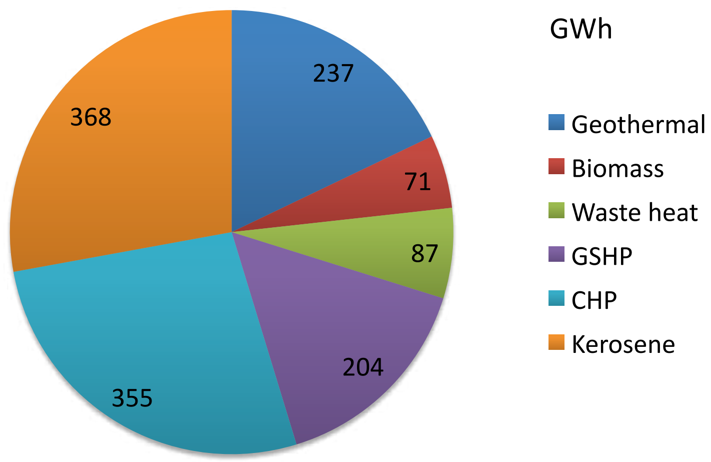
Potential electricity supply of Hirosaki



Potential heat supply of Hirosaki



Transition pathway

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- Transition pathways and timeline to achieve the change have to be checked.
- The proposed pathway is to make distribution and transmission system operators in each city area key for the implementation and roll out of the smart energy network since they will provide the energy as well as own the local CHP generation units.
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Conclusion

- The cities considered are constraint in terms of their future design through climatic extremities.
- Nevertheless, a general meshed zone approach can be used to create a future smart and resilient network with different resources using transition theory.
- In terms of **sustainability**, the future city designs increase efficient use of locally available energy resources such as wind and geothermal as well as cogeneration. The energy demand is decreased through building insulation and smart network demand side management.
- In terms of **resilience**, the meshed network structure with multiple sources provides flexibility and smart usage of the generation sources.

Students
report
& presentation

Group D

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Takaaki Furubayashi
Tohoku University, Japan

Murat Isik
Tohoku University, Japan

Kiminori Mashima
Nagoya University, Japan

Loren Tusara
Kyushu University, Japan

Title: **Byproduct utilization for transportation system in Valencia, Spain**

Name	**Affiliation**
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Takaaki Furubayashi	Tohoku University
Murat Isik	Tohoku University
Kiminori Mashima	Nagoya University
Loren Tusara	Kyushu University

Summary:

Valencia Community is located on the Mediterranean Coast in Spain. Its capital city, Valencia City, is the third largest city in the country. As of 2010, it has around 800,000 inhabitants. It has a land area of 134.65 km^2. The city's main agricultural products are rice and orange. Valencia produces around 57.6% of the orange production of the country. Spain has an estimated orange production of 2.8 million tons in 2011.

Transportation takes the largest portion of the electricity demand of the community at 39.9%. Industry, which includes farming and fishing, comprises 37.8% while residential and commercial use 12.5% and 9.8%, respectively, of its electricity [1].

In 2006, 5% of the total electricity demand of the community comes from renewable resources with 4% of it coming from biomass production. A large portion of the renewable resource comes from hydroelectric power at 75.7% while 19.3% and 0.95% come from wind and solar power, respectively [2]. 27.2% of the total primary energy supply of the community is produced locally while the 72.8% is imported [3]. Other sources of electricity of the community come from nuclear power and coal.

With the largest consumption of electricity coming from transportation and an abundance of orange production in the community, we propose the use of orange residue to produce bio-ethanol to fuel transportation system in Valencia City and to supply for heat utilization of the residences and industries.

In this report, we focus on the utilization of bio-ethanol from orange peel to fuel the transportation system in the city. We aim to decrease the carbon dioxide emission from transportation system and to decrease the cost of fuel for transportation. In an ambitious scale, we plan to attain energy independence on foreign resource, achieve European Union (EU) renewable energy standards, address precautions for global warming, and tackle oil price. The choice of orange residue to further production of bio-ethanol aims to reduce waste from consumption of orange.

Other sources of renewable energy such as solar power through photovoltaic cells and wind power are generally not accepted by the public, companies and the government. Electric companies have reported a deficit in terms of the supply and distribution of the electricity to the consumer due to the tariff imposed on solar power. The companies then put a high price for the individuals who wish to connect to the grid to sell the solar power they generated. The integration tariff has not been attractive for the consumers. Wind power, on the other hand, goes in the way of the preference of the people as it destroys the view of the environment.

The amount of local consumption of oranges in the community is around 0.746 million tons while 0.864 million tons is exported. Orange residue that can be recovered by weight is around 50-65% and when not used goes to waste. This comprises around 0.425 million tons of residue annually. This much amount of residue produces around 398,000,000 liters of ethanol.

In Spain, 33,888 TJ is spent for transportation system. An estimate of 580 TJ is utilized by Valencia City. The amount of energy generated from the residue is around 395.7 TJ. The demand of the transportation system in Valencia estimated to be around 579.2 TJ.

The Energy Return on Investment (EROI) of cellulosic ethanol, same mechanism which is applied for orange peel, has an average value of 5 [4]. 80% of the bio-ethanol production will be used to power the transportation system while 20% will be used to power the bio-ethanol plant for it to be self-sufficient.

Currently, a budget subsidy of 45% is directed to project cost for the production of renewable energy. An additional 10% is given for medium-sized companies and 20% for small companies. This incentive will attract further investors in the city.

Based on obtain data and the current support of the government, this project seems feasible for Valencia city.

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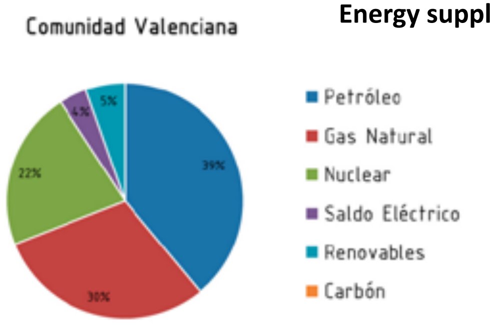
Energy systems for a city- Sustainable Valencia city (GROUP D)

- ❑ Valencia is a city at the west Europe located at the east part of Spain.
- ❑ Famous with its touristic places, beaches sea and sun.
- ❑ It has moderate winter and hot summer.
- ❑ One of the producers of orange in the world





Energy supply for Valencia

Resources and technologies to support these;

Resources

Biomass
Rice
Rice stark
Orange
Algaes

Solar energy
Tidal energy
Wind energy
Hydrogen energy

Nuclear energy

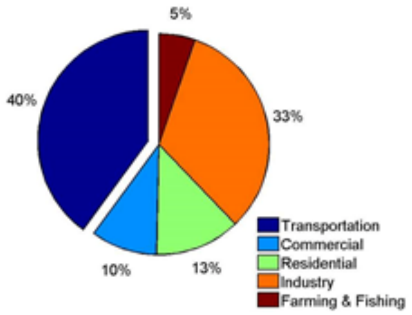
What are the things that need to be improved?

- ❑ Increase the percentage of renewable sources specially for transportation
- ❑ Decrease the dependency to imported energy sources.
- ❑ Increase the quality of life as decreasing carbon emission.

Energy systems for a city- Sustainable Valencia city

Total production of Spain: 116000 TJ
Domestic production: 33000 TJ → 14% is only renewable sources

Nuclear energy production: 14000 TJ
Wind: 4000 TJ
PV: 700 TJ
Geo: 18 TJ
Coal: 1300 TJ
BE: 7200 TJ



Distribution of energy consumption:
Transportation: 40%
Commercial: 5%
Residential: 13%
Industry: 33%
Farming and fishing: 9%

Properties about distribution;
Transportation depends on fossil based
Nuclear can cover need for electricity
Industry revenue compensate by tourism sector

What we should do for sustainable city?

- ❑ Replace energy supply for transportation to bioethanol.


Why we should do for sustainable city?

- ❑ Decrease the energy dependence on foreign sources.
- ❑ Achieve EU renewable energy standards.
- ❑ As precautions for global warming.
- ❑ Increasing oil prices




How we can change this?

- ❑ Building bioethanol plants for transportation
- ❑ Utilizing sources such as rice, orange.
- ❑ Build incineration plants for rice stark.
- ❑ Deploying eolic wind plants.
- ❑ Using tidal energy far away from sea.

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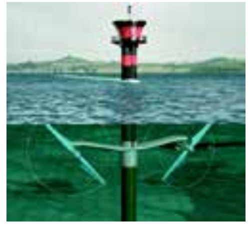



Biomass Energy

Utilizing orange peels for obtaining ethanol can create sources for transportation.

Total production of orange in Valencia city: 1.61 million tons
Exports: 0.1864 million tons
Consume: 0.746 million tons → 0.425 million tons orange peel can be obtained

According to this 4,675,000 gallons of ethanol can be produced as 200 proof.

A facility for processing ethanol costs 25-30 million dollars with a capacity of 100 million gallons;

Amount of energy can be generated is 396 TJ.

Procedure to Estimate Amount of BE

Energy Content from gasoline (34.2 MJ/L)
Energy Content from ethanol (22.57 MJ/L)
Amount of orange production (1.6million tons)

↓ Rate of residue's weight (57.6%)

Amount of residue (0.425 million tons)

↓ Amount of ethanol from unit of residue (11 gal/l)

Amount of energy content in bioethanol (BE) is...

<u>395.7 TJ</u>

Procedure to Estimate Amount of Demand

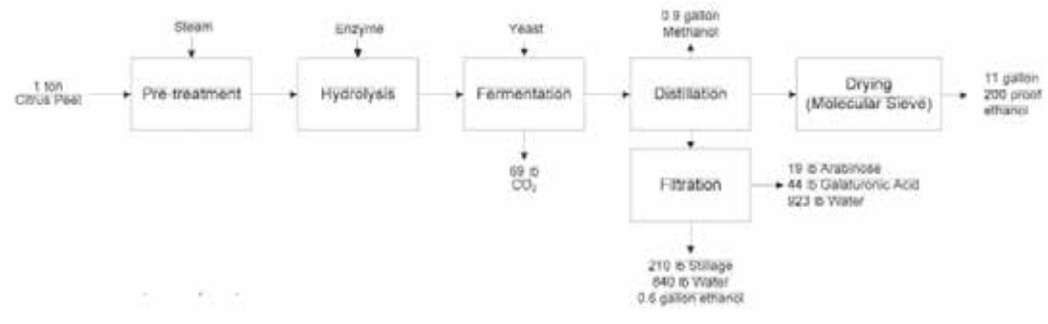
Population in Spain (46.81 million)
Amount of energy use for transportation in Spain (338.88 TJ)

↓ Population in Valencia city (8 million)

Amount of energy use for transportation in Valencia city is...

<u>579.2 TJ</u>

Process for obtaining bioethanol



With this process ethanol costs 1.23 $ per gallon[1] which is 3 times cheaper than gasoline.
Environmentally more friendly solution.
200 Proof ethanol which is pure ethanol more efficient than corn and rice source ethanol
Supplies from the aspect of purity.

[1] Weiyang Zhou, Economic Analysis of Ethanol Production from Citrus Peel Waste, Proc. Fla. State Hort. Soc.120: 2007. Proc. Fla. State Hort. Soc.120:310–315. 2007.

Biomass Energy

Utilizing rice stark for obtaining ethanol can create sources for transportation and generating electricity.
According to literature it is achieved to obtain ethanol using rice stark cost 0.45$ in Vietnam.

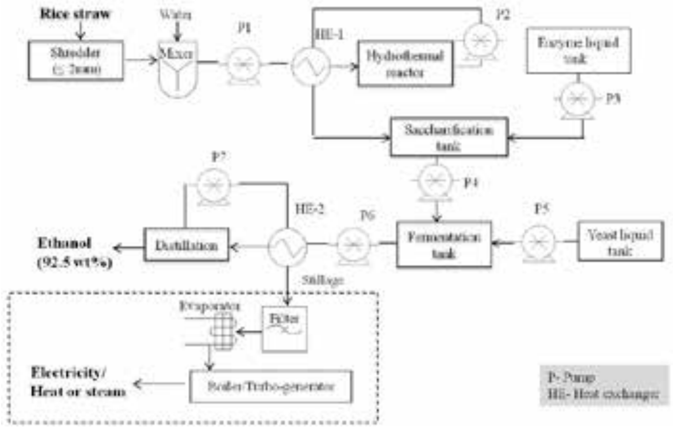


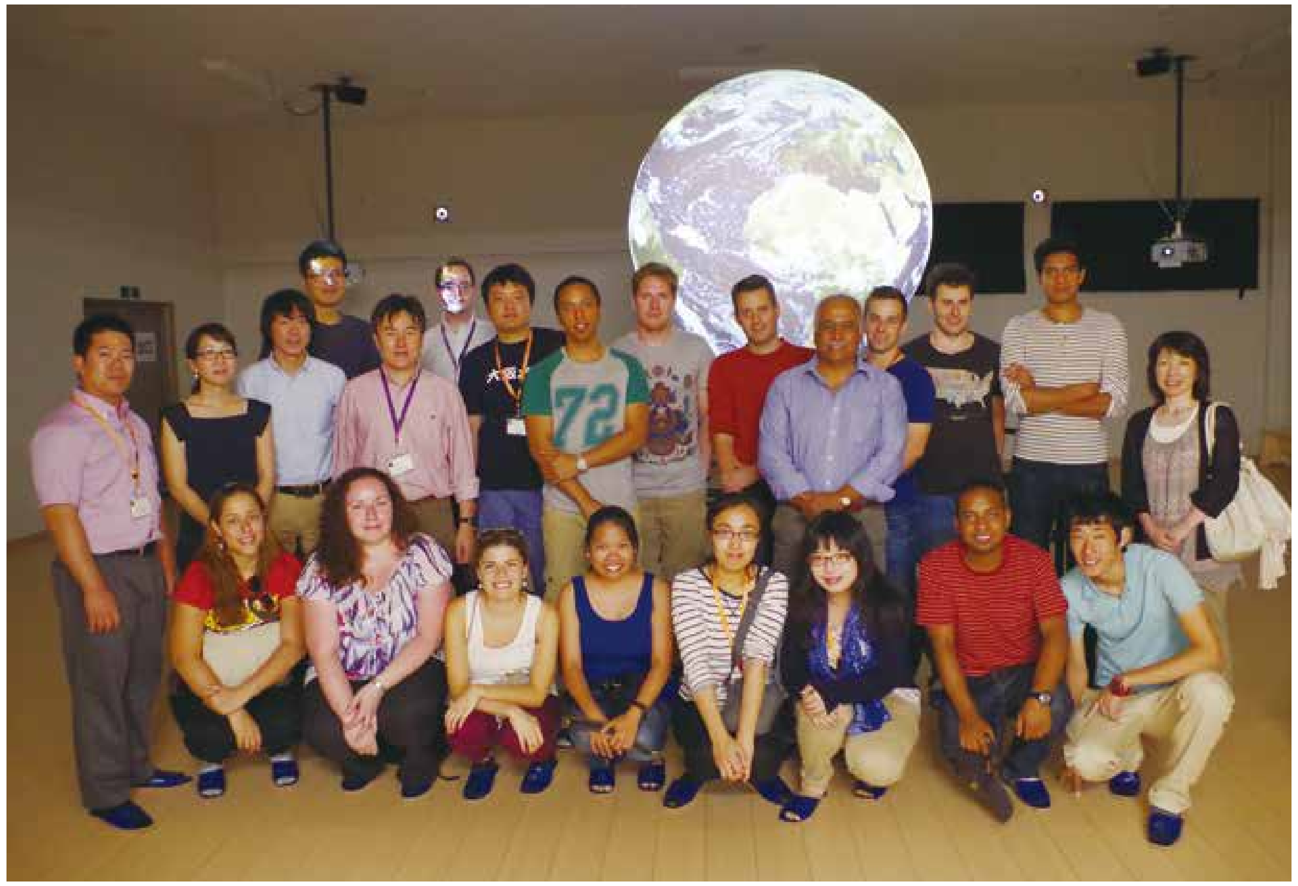
Figure shows the steps for obtaining ethanol using rice stark.

Also using rice starks for incineration is an option for producing electricity and heat energy.

Conclusion

- Valencia is a city the heavily relies on foreign energy supply
- Based on results Valencia could increase its self sufficiency by using the residues of one of its agricultural products, helping the city to achieve European renewable energy supply standards.

Photo Album



9/12 Discovery Center in Higashimatsushima

9/8 Sendai municipal incineration plant in Matsumori






9/11 Group work and Presentations









9/12 Excursion - Higashimatsushima









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