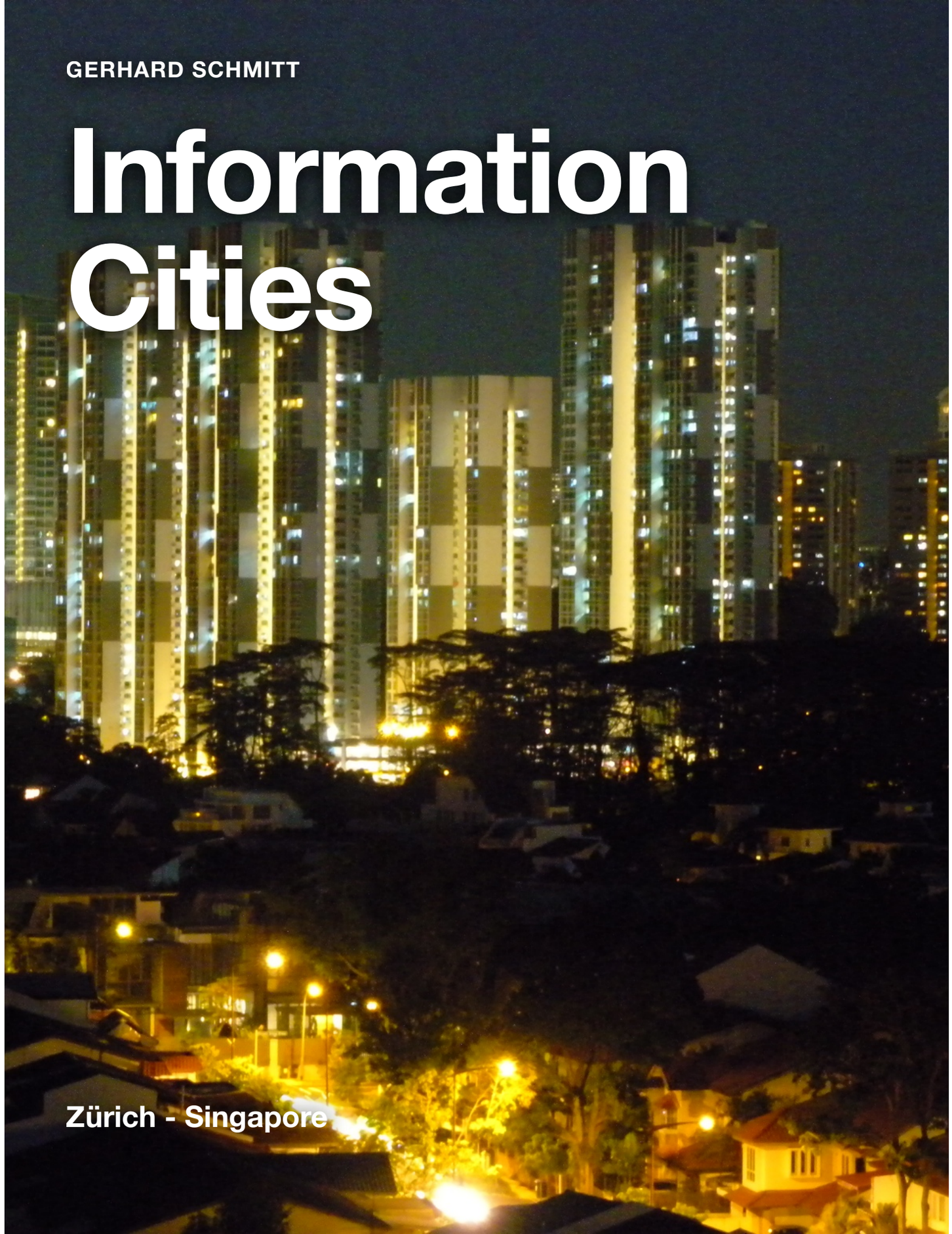
GERHARD SCHMITT

Information Cities



Zürich - Singapore

Chapter 4

Stocks and Flows

The concept of stocks and flows helps to bring some order into the complexity of a city. While the concept of stocks and flows was not invented in for architecture, but in economics, it constitutes a useful way of looking at and abstracting of parts of the urban system. The chapter on city models will place it in its historical context.

Section 1

Stocks and flows

DEFINITION

The stocks and flows concept originated in economy in the 1960s, and best known today are the stocks and flows of finances. Stocks are quantities that do not move, whereas flows are quantities that move. Flows of measured quantities per time. This simple differentiation makes the principle applicable architecture, urban design and territorial planning. The stocks and flows via most interested in are those of people, water, material, energy, density, and information. Stocks and flows are also basic building blocks of system dynamics.

This chapter is merely an overview, in-depth description of the individual stocks and flows is given towards the end of the book.

The Irrawaddy river in Myanmar and the ecosystem it creates is a good example for stocks and flows in architecture, urban design, and territorial planning. The river changes its volume drastically twice a year. The water it brings from the mountains carries sand and other sediments that settle in the areas it floods. Once the water level recedes, the river has deposited a small stock of material in the form of fertile earth on its banks that can then be used for a few months. People move in and erect temporary housing and shelter: a stock of material and low-density emerges for a few months. Animals accompany the peasants and deposit fertiliser, becoming another contributor to the stocks and flows of the land. Information on the usability of the land and of the best places to settle is transferred via mobile telephones, creating a flow of information. Peasants grow vegetables and bring them to market, thus creating a small flow and possibly stock of finances. The entire landscape is changing over the years, and as a result creates a stock and flow of landscape elements such as land, bodies of water, trees, and other vegetation.

Yet the example also shows how a single stock and flow cannot be isolated from the others. The water mixes with the material and the sand deposits. Later people use the clay to burn pots, and they harvest the send and ship it to the city to construct buildings.

Stock stocks and flows of energy

Every country and every city has the specific way to acquire, transform and distribute energy. The chapter on infrastructure will describe the physical necessities to transform and transport energy. In this chapter, we are interested in the different sources and uses of energy.

A comparison between Switzerland and Singapore reveals significant differences. While Switzerland has a broad mix of different energy sources or supplies, ranging from hydropower to gas, crude oil, nuclear and biomass, Singapore is relying mostly on natural gas and on crude oil. As a result, Switzerland‘s electricity production is almost carbon free, whereas in Singapore there is almost no carbon free electricity production.

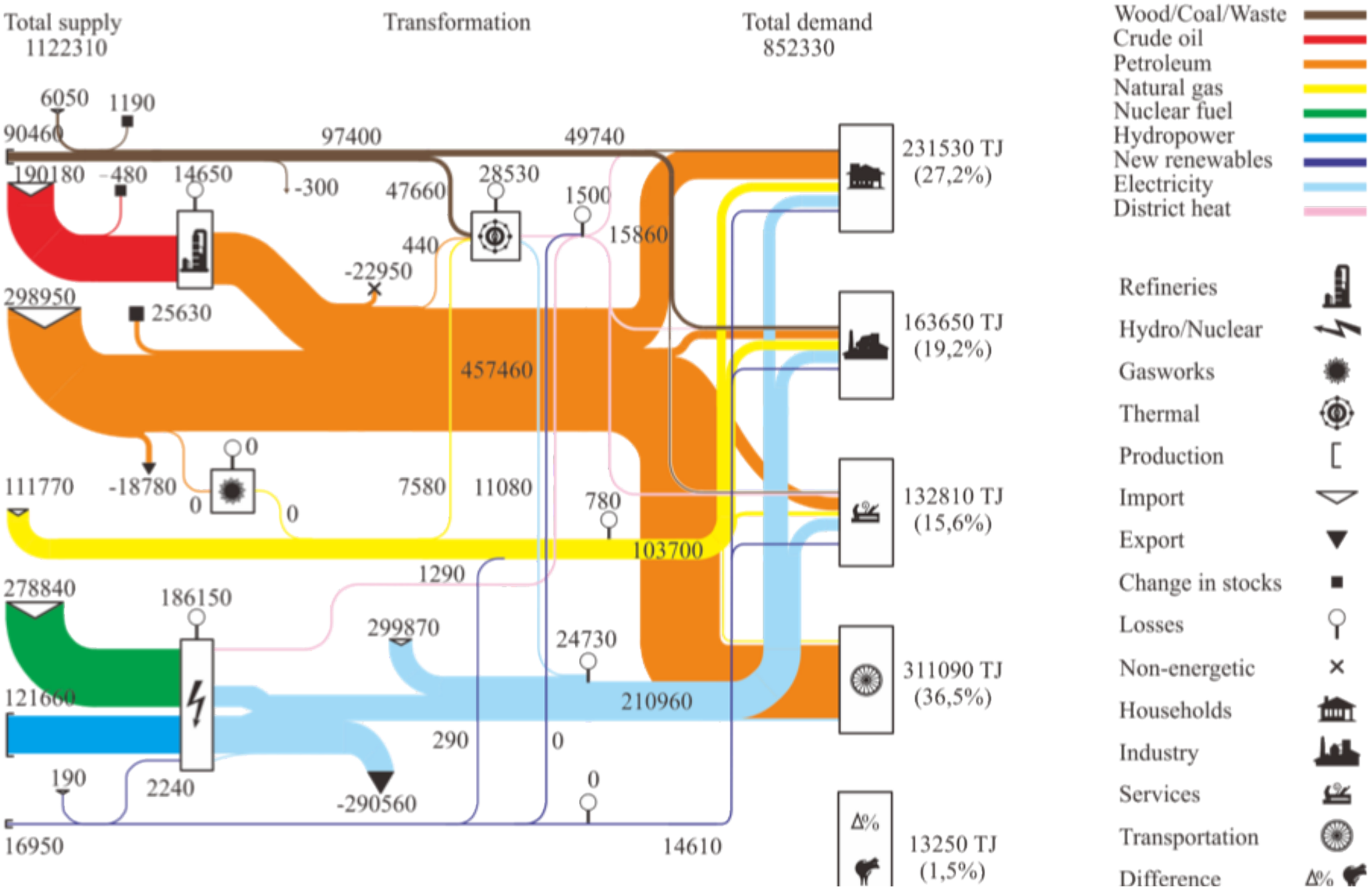
The uses of or demands for energy are also different in the two countries. Whereas in Switzerland a large percentage of the energy is used to heat residential buildings, offices and factories, the need for heating fuel in Singapore is zero. Instead, electricity is needed to cool factories, residential buildings and offices. Large differences are also visible in transportation. Whereas Switzerland is a mountainous country with a multitude of centres, Singapore is a small island with short paths and no mountains. As a consequence, the per capita energy use for transportation is smaller than that of Switzerland.

The storage of energy is also different. In Switzerland, artificial lakes with dams in high altitude serve as energy reservoirs and energy buffers during times when excess energy can be generated. This water can later be used to generate electricity that can be produced exactly then when it is needed. The water in the reservoir is at the same time a stock of water for drinking purposes, but also for energy storage purposes. The flow of water for drinking purposes is normally from higher areas into the lakes, whereas the flow of water for energy storage purposes can be reversed, and large amounts of water are pumped from lower situated lakes into higher situated ones.

For example, Lake XXX is situated at the height of 2500 m above sea level. The water pipes descend through the mountain to a height of 1300 m above sea level. The resulting water pressure drives turbines that are as powerful as an entire nuclear power plant. The artificial lake is used mainly for storage purposes and to respond to peak demands in times when not enough natural inflow of water is available.

The stocks and flows of other energy sources are not as spectacular, but also interesting. For example, the stock of wood is growing in forests. After harvesting, it turns into a stock of heating materials. The stock and flow of oil begins its cycle as a stock in the subterranean caverns of Saudi Arabia, flows into tankers or pipelines, ends up as temporary stock in oil tanks, and is finally transported as a flow into the individual heating appliances.

Gallery 4.1 Stocks and flows of energy



Energy supplies, energy transformation, and energy demand in Switzerland 2012. Matthias Berger, ETH Singapore, Future Cities Laboratory.

Stocks and flows of material in the city

Concrete is a good example to explain the concept of stocks and flows of materials in a city. The components of concrete are mixed with water, concrete is then poured, hardens and becomes a stock. This is almost a literal translation of the stocks and flows principle. What happens with concrete after the lifetime of the structures in which it is used has expired? In an era when recycling was neither an ecological nor an economical necessity, it was exploded, torn down, crashed, and dumped in the city itself or, more often, in its hinterland.

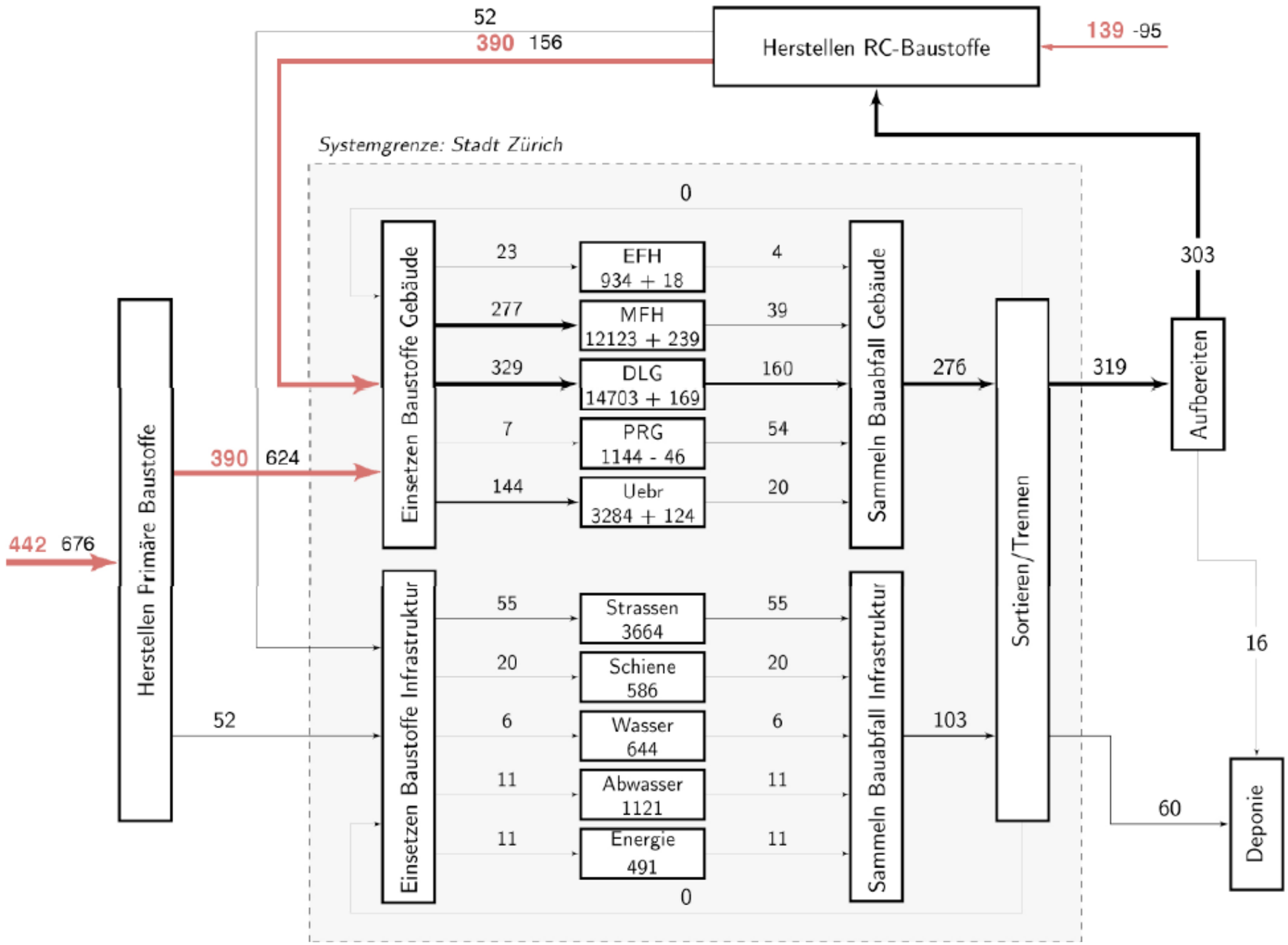
But concrete is a very valuable material with high energy embodiment and thus a major cause for greenhouse gas emission during the production of its components. When a city is built or expanded, they need for concrete is immense. Every emerging economy and country shows this extensive need. At the beginning of the 21st-century, this is the case in Asia, Africa, and South America, while in Europe and North America the need for concrete has decreased.

Recycling of concrete is a relatively new concept and describes the decomposition and crushing of a stock of concrete to prepare its parts for reuse in another context. If a city is not growing very much any more, such as in Europe, the recycling of concrete makes very much sense for ecological and also economic reasons. In the new emerging cities in China that grow from a few hundred thousand to several millions inhabitants within a few decades, there is no possibility to recycle, because the stock of material does not exist beforehand. In other cities, such as in Singapore, where there is a consistent scarcity of building materials, especially sand, there is a high economic incentive to recycle every tonne of concrete when a building is torn down or broken infrastructure is renewed.

A concrete example might show dimension of the stocks and flows of concrete in a city. The first step is to define the system boundary within the observation and the measurements are to be made. In Zürich, for example, this would be the city boundary. Looking at the particular year, in this case 2005, researchers from ETH Zürich have analysed the stocks of flow and flows of concrete precisely. They found that 676,000 t of concrete gravel flow into the city and that 379,000 t of concrete material left the city boundaries. Almost half of the inflow – 329,000 t – went into new office buildings, which at the same time produced with 160,000 t also the highest outflow. The present increase of population into Zürich is reflected in 277,000 tons of concrete flowing into the city for apartment buildings, and only 39,000 t from demolished apartment buildings leaving the city. Only 7000 t of concrete went into the construction of the new factory buildings, while 54,000 t of demolished factory buildings left the city.

This glimpse of material flow in and out of the city shows how closely related it is to the history of the city.

Gallery 4.2 Flows and stocks of concrete material in Zürich in 2005



From: „Entwicklung einer Ressourcenstrategie für mineralische Baustoffe für die Stadt Zürich“, Martin Schneider, Stefan Rubli, Heinrich Gugerli, 16. Status-Seminar «Forschen und Bauen im Kontext von Energie und Umwelt», 2010, http://www.stadt-zuerich.ch/nachhaltiges-bauen

Stocks and flows of water in the city

There is no city without water. Water decides on the survival of the city, and always has. In ancient times, water was transported in aqueducts over large distances, when the city internal water resources dried up or were not sufficient any more. In the city, water is used as a stock in lakes, drinking water reservoirs or in individual water tanks on, in and below buildings. Water is a technical, an artistic, an architectural, and a landscape architecture element.

Gallery 4.3 Stocks and flows of water in the city

The Marina Bay Singapore, previously open sea, now a freshwater reservoir. Photo: Eva Schmitt, January 4, 2013.

Stocks and flows of wood in the city

Would used to be a crucial stock and flow contributor in early cities. It was at the same time construction material and heating resource. Its overuse around cities might have caused climate changes in the cities and in some cases led to the demise of the city. Wood is prone to fire and was therefore replaced, if possible, by more fire resistant materials. It has a comeback today in terms of construction and heating material. It stores CO2 in large quantities.

Gallery 4.4 Stocks and flows of wood in the city

Krakow: stock of wood as a building material in the ceiling, in the stairs, and for the furniture. Photo: Gerhard Schmitt, December 9, 2008.

Stocks and flows of food in the city

Food used to be grown directly around buildings. With the growth of cities, its production moved further away from the centre. Today, food in almost any city comes from global sources. This causes high levels of CO2 during its production, its processing, and its transportation. In Singapore, more than 96% of the food needs to be imported. As „Urban Farming“, food in the city is making an important comeback in cities that had completely lost the direct relation with food production.

Gallery 4.5 Stocks and flows of food in the city

On the way to the market in the morning, Mandalay, Myanmar. Photo: Gerhard Schmitt, April 4, 2011.

Stocks and flows of capital in the city

There is no city without capital, and the stocks and flows of capital are a decisive factor in the development of the urban system. As capital is a virtual entity, it has a different effect on the shape, size, and livability of a city than material stocks and flows, such as concrete or water. Yet there is a strong relation between the location and the spatial quality of the city and the flows and stocks of capital.

Gallery 4.6 Stocks and flows of capital in the city

World exhibition Shanghai, June 1, 2010. Photo: Gerhard Schmitt

Stocks and flows of land in the city

Land appears to be a stable stock at first sight, with little flow possible. Yet if we take a closer look at any of the ancient or newer cities, we will find significant flow of land, either to increase the buildable area into the sea or into a lake, or buy natural accumulation of material which leads to vertical growth of land. Singapore, for example, has increased its land area by several hundred square kilometres, but also in Zürich has claimed land from the lake of Zürich.

Gallery 4.7 Stocks and flows of land in the city

Artificial land made in Singapore. The entire Marina Bay area is reclaimed from the sea. Photo: Felicia Bettschart, November 9, 2012.

Stocks and flows of people in the city

It is not correct to place people in the same category as other stocks and flows in the city, but there are similarities. Areas of the city, for example, which have been inhabited for a long time by generations of people from similar backgrounds could be called to represent a stock of people. The flow of people is characterised by by those newly coming to the city from the outside and by those who leave the city or die in the city.

Gallery 4.8 Stocks and flows of people in the city

People, cars and motor scooters mixing as a stock and flow in the street. Ho Chi Minh City, December 25, 2012. Photo: Felicia Bettschart is

Stocks and flows of density in the city

It appears surprising at first to list density or space under the stocks and flows characteristics of the city. Yet the concept becomes immediately clear if we imagine the difference between a mediaeval Italian city, such as Siena, and that of a suburban sprawl area in Phoenix Arizona. The example of Detroit in the beginning of the 21st century demonstrates that density does not remain a stock for ever, but that there can be rapid changes of density within few years.This

Gallery 4.9 Stocks and flows of density in the city

From low-density to high density: Riyadh, Saudi Arabia, January 27, 2010. Photo: Gerhard Schmitt

Stocks and flows of information in the city

In the information city, stocks and flows of information are almost as important as water or material. A stock of information is any library or data warehouse, the flow of information is ubiquitous and continuously increasing in all cities of the world. In many places, the storage of information has led to its own infrastructure, which is increasingly consuming space and energy and thus influences the other stocks and flows of the city, as the chapters on information architecture and information city show. I

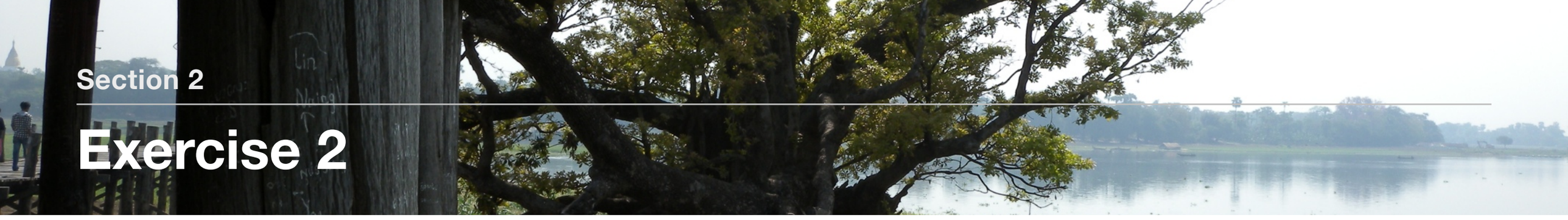
Gallery 4.10 Stocks and flows of information in the city

Enabling the flow of information in the city: communication tower in São Paulo, Brazil. Photo: Gerhard Schmitt, June 30, 2012.

Chapter 15

Exercises

This chapter has 2 purposes. It gives the opportunity to revisit the most important thoughts presented in this book, to reflect on them, and to set them in relation with other topics. It also gives the opportunity to project the lessons learnt into the future: by following the trends established over the previous years, decades or centuries; or by developing quantitatively well founded or speculative design scenarios. Those might become parts of successive editions of this book.



Section 2

Exercise 2

URBAN DESIGN SCALE

The liveability of a city describes one of its main qualities. The urban design scale contains many characteristics for the liveability of a city. International organisations have established criteria that measure and compare cities and their liveability. Examples are:

- **The Global Liveable Cities Index**
- **The EIU's Global Liveability Report**
- **Mercer's Quality of Living Survey**
- **Monocle's Most Liveable Cities Index**
- Ranking the Liveability **oft the World's Major Cities**

Factors of liveability

Livability is one of the key characteristics that every city and urban system is struggling for. The exercise has 3 parts:

I. List the most liveable cities that you know, building on your own experience and judgement, with the most liveable city at the top of the list

II. Describe in your own words 5 characteristics for the livability of a city and order them with the most important at the top of the list 5th

III. Draw a diagram depicting the connections between those characteristics. Express the importance of the connections by graphical means

See this as a personal design exercise. You do not have to follow the official rankings for the livability of cities, but you should know the criteria they apply.