

Resource efficient and clean urban technologies

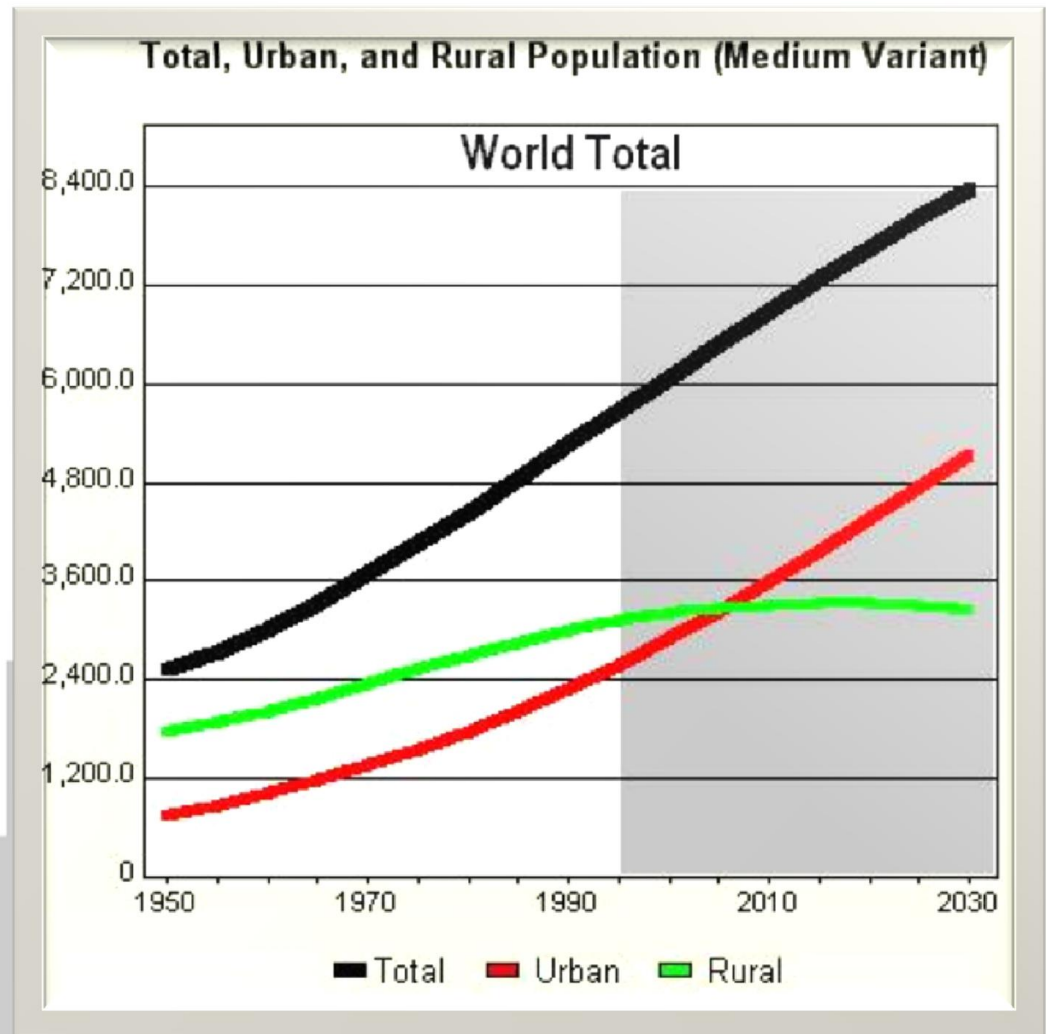
Hans Schnitzer



Urbanization is a global trend

There is a need for action!

- 📍 In cities live 60% of the world population
- 📍 Cities spend 75% of the energy
- 📍 Cities cause 80% of the global air emissions



A trend will continue until it doesn't

- 📍 In the late 1800's, there were 200,000 horses living in New York City. Each horse produced 24 pounds of manure a day.
- 📍 New York City had a serious horse shit problem. The streets were "literally carpeted with a warm, brown matting . . . smelling to heaven."



The problem was piling-up. City blocks, serving as collection areas for the manure, became thirty foot high mini-mountains. Planners couldn't even conceive a solution.

1st international urban-planning conference 1898

- 📍 When the world's first international urban-planning conference was held, in 1898, it was dominated by discussion on the manure situation. Unable to agree upon any solutions—or to imagine cities without horses—the delegates broke up the meeting, which had been scheduled to last a week and a half, after just three days.
- 📍 One commentator predicted that by 1930 horse manure would reach the level of Manhattan's third-story windows.



Cities Facts:

Source: World Resources Institute

- Up to 70% of global CO₂ emissions come from cities.
- There are 800 million vehicles on the road today. Without interventions, that number is set to grow to 2-3 billion by 2050.
- The world's cities produce about 1.3 billion tons of waste every year.
- More than 1.2 million people die in traffic-related deaths every year.

In 2007 the urban population exceeded the rural population in the world.

In 2050 almost 70 % of world population will live in urban areas
(source: UN).

In Europe already 68 % of the population lives in cities

The XXI century is called to be the century of cities

The future is in a critical ball



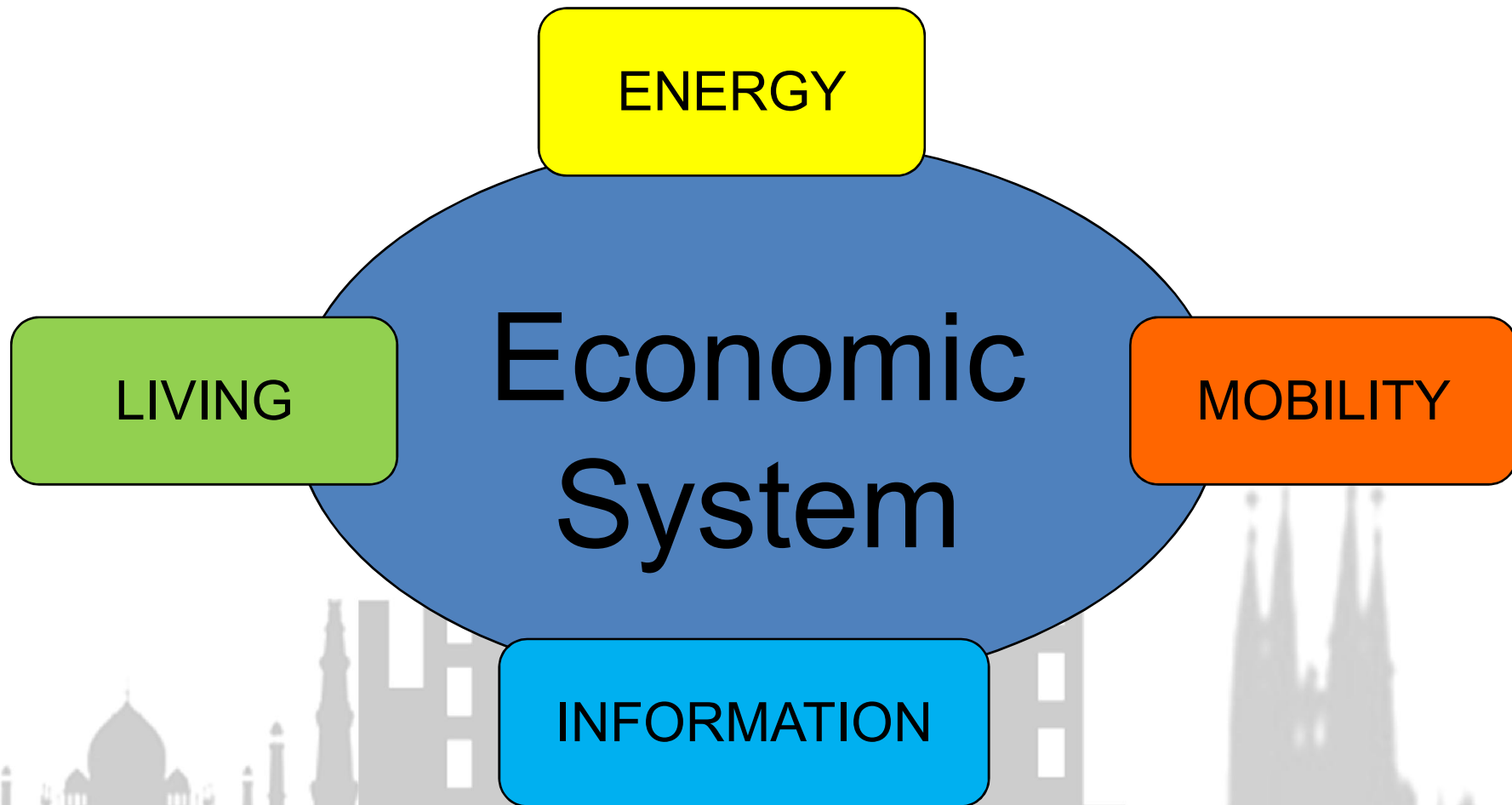
Energy transition and transition to a sustainable economic system will take place in cities

-

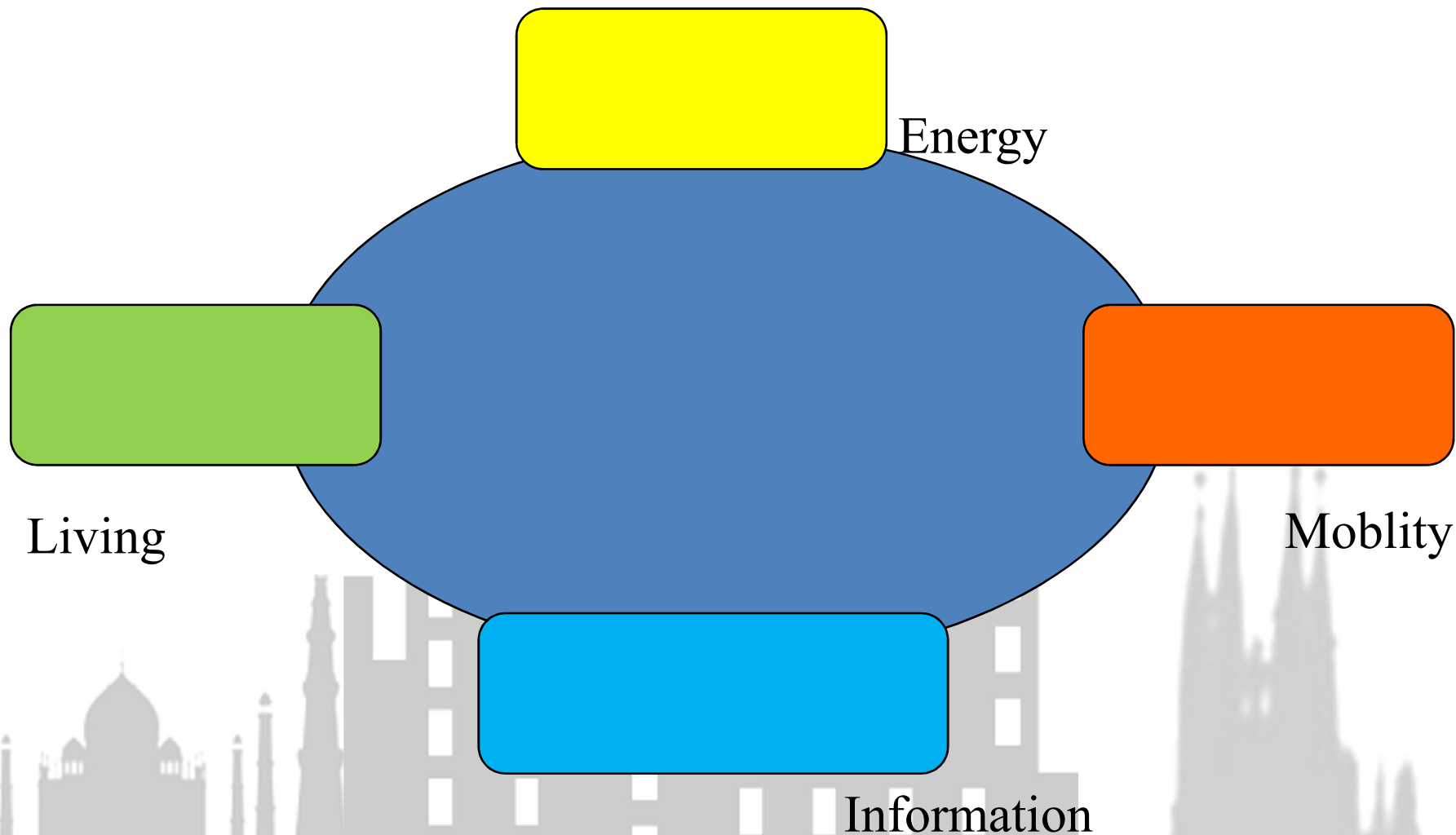
or it will fail

Energy – Society - Technology

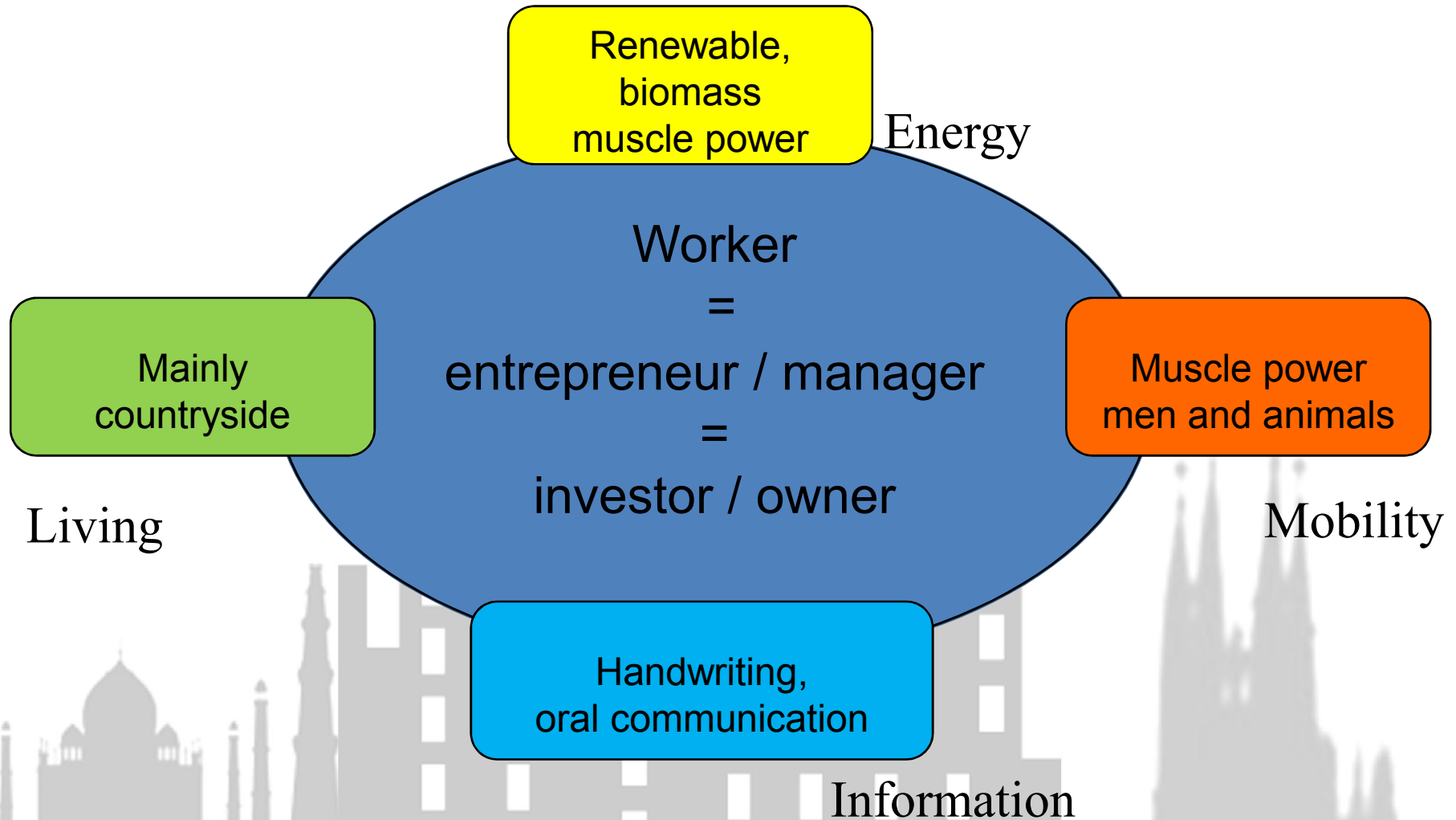
They always change simultaneously



Before the 1st Industrial Revolution



Before the 1st Industrial Revolution



Die europäische Zuckerfabrikation aus Runkelrüben

Franz Carl Achatz, 1809

Danger of
scarcity of
wood

NO!!!!
Wood can be
replaced by
peat

"Beantwortung der Frage ady. §. 521. Steht nicht zu besorgen, daß die beträchtliche Consumtion des Brennmaterial, die die Zuckerfabrikation erfordert, den Holz-mangel noch mehr vergrößern würde?

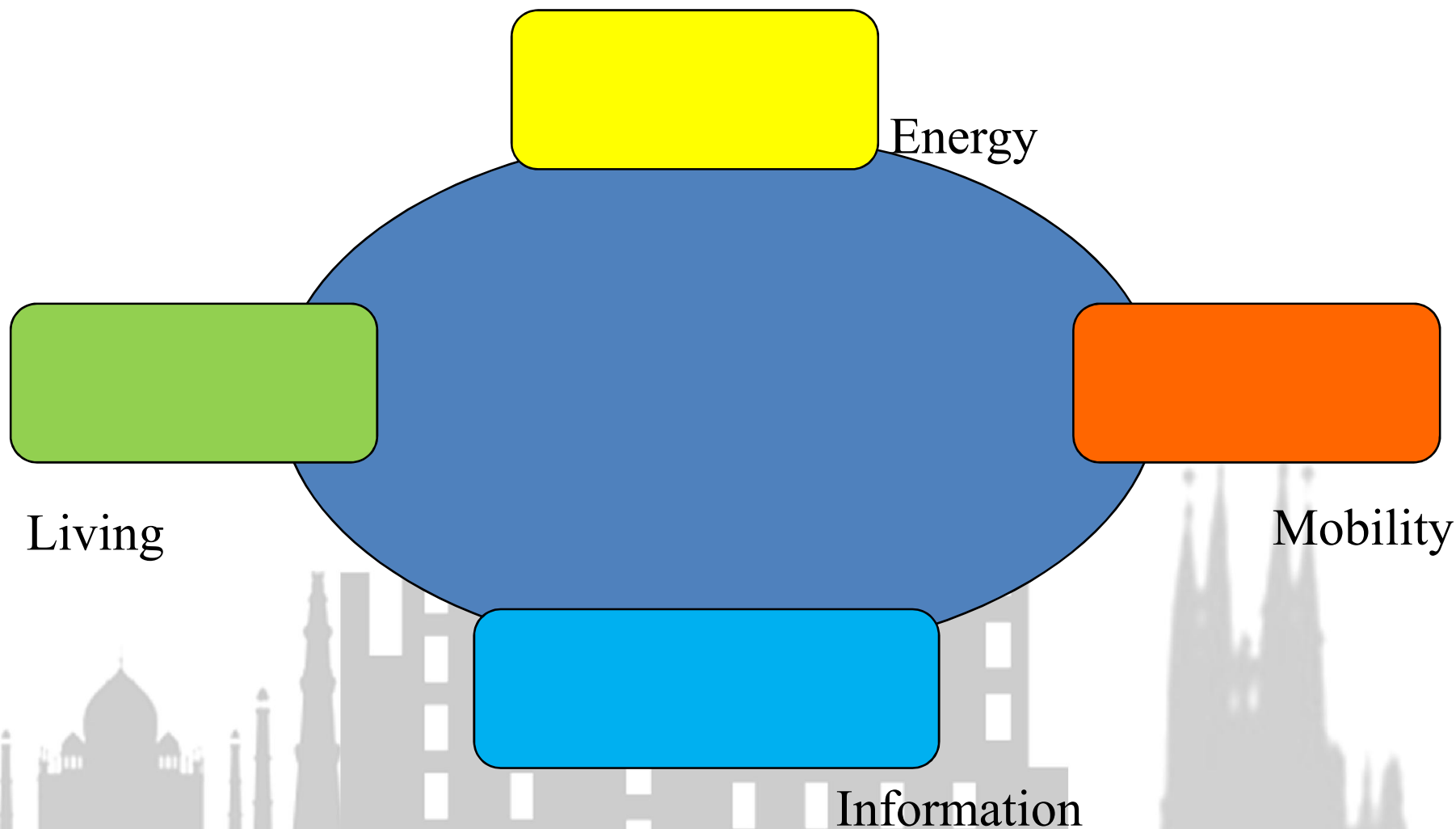
§ 611.

Diese äußerst wichtige Frage könnte nicht anders, als zum Nachteil der Runkelrübenzuckerfabrikation, die allerdings einen ansehnlichen Aufwand an Brennmaterial erfordert, beantwortet werden, wenn nicht der Torf bey allen dabey vorkommenden Brennmaterial erfordernden Arbeiten, die Stelle des Holzes vollkommen verträte. Daß solcher bey der Brandtweinfabrikation und zu Erwärmung geschlossener Räume, als der Essig-Kammern, der Wohnungen der Arbeiter u.s.w., so gut wie Holz gebraucht werden kann, wird keiner bezweifeln, und daß der Torf bey den Operationen, des Klärens und Verdampfens des Runkelrübensaftes, eben das leisten muß, was das Holz bey diesen Operationen leisten kann, geht schon daraus hervor, daß die Klär- und Verdampfungspfannen, nur durch, vom kochenden Wasser erzeugten Dämpfen erheizt werden, so daß es zur Erreichung des Zweckes nur darauf ankommt, Wasser durch kochen in elastische Dämpfe aufzulösen, darüber aber, daß dieses mit Torf so gut wie mit Holz geschehen kann, findet nicht das entfernteste Bedenken Statt.

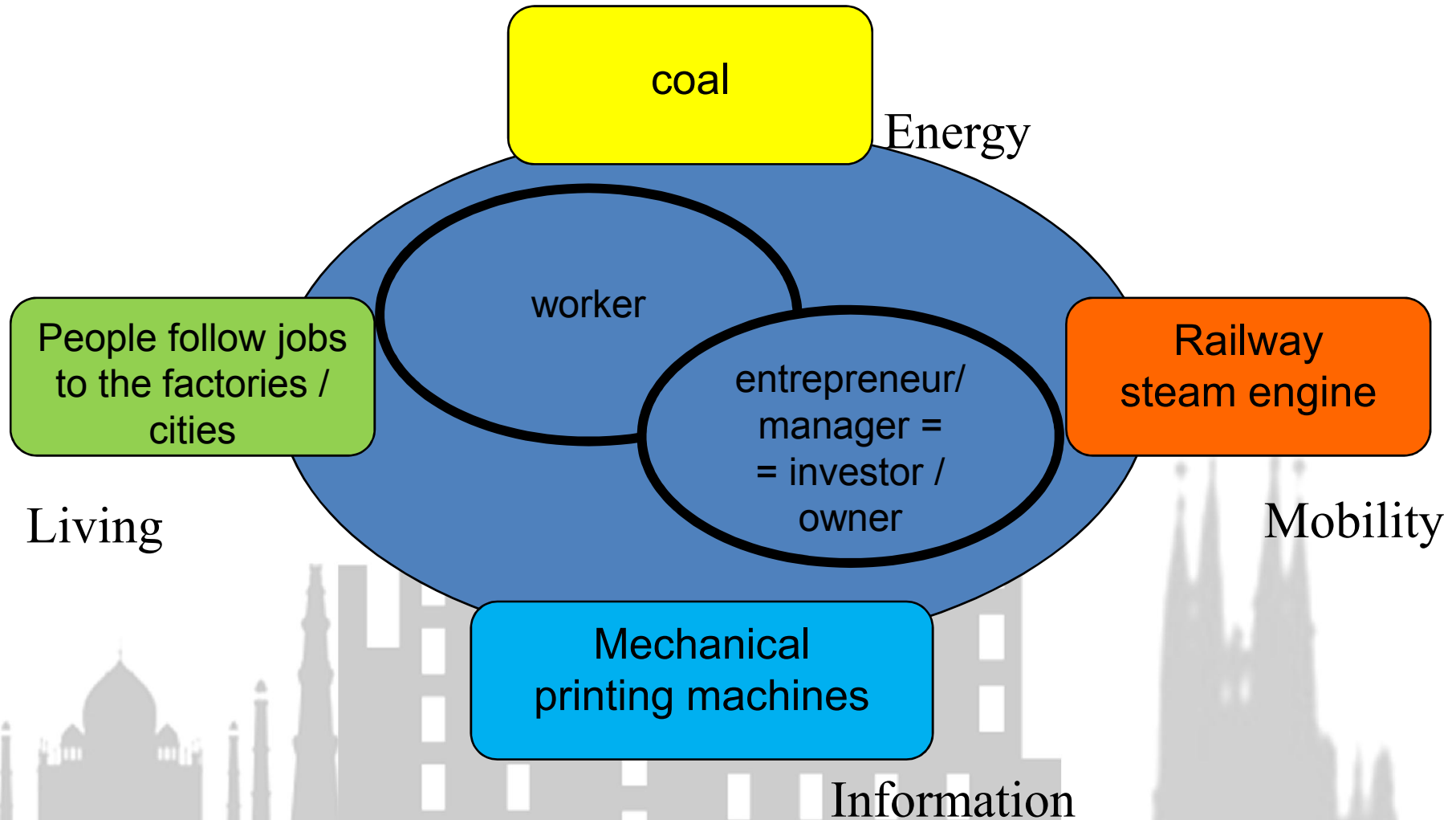
§ 612.

Weil der Torf, bey der Runkelrübenzuckerfabrikation ganz an die Stelle des Holzes treten, und solches völlig ersetzen kann, also zu dieser Fabrikation kein Holz, mit Ausnahme des unbedeutenden Quantum, das zum ersten Anzünden des Torfs erforderlich ist, gebraucht werden darf, fällt von selbst das sonst sehr gegründete Bedenken weg, daß die Runkelrübenfabrikation, eine zu große Holzconsumtion erfordern würde, um nicht besorgen zu müssen, daß dadurch der Holz-mangel noch mehr vergrößert werden könnte; daß auch in der Krainschen Fabrike zu allem was Brennmaterial erfordert, kein Holz, sondern Torf gebraucht wird, beweist die deshalb, auf mein Ansuchen gegebene Erklärung des Herrn Besitzers derselben, welche ich *sub Litt. E. §. 625.* beylege.

After 1st industrial revolution

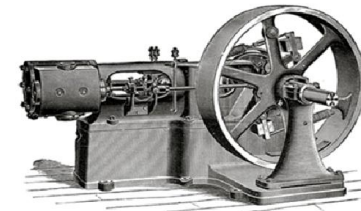
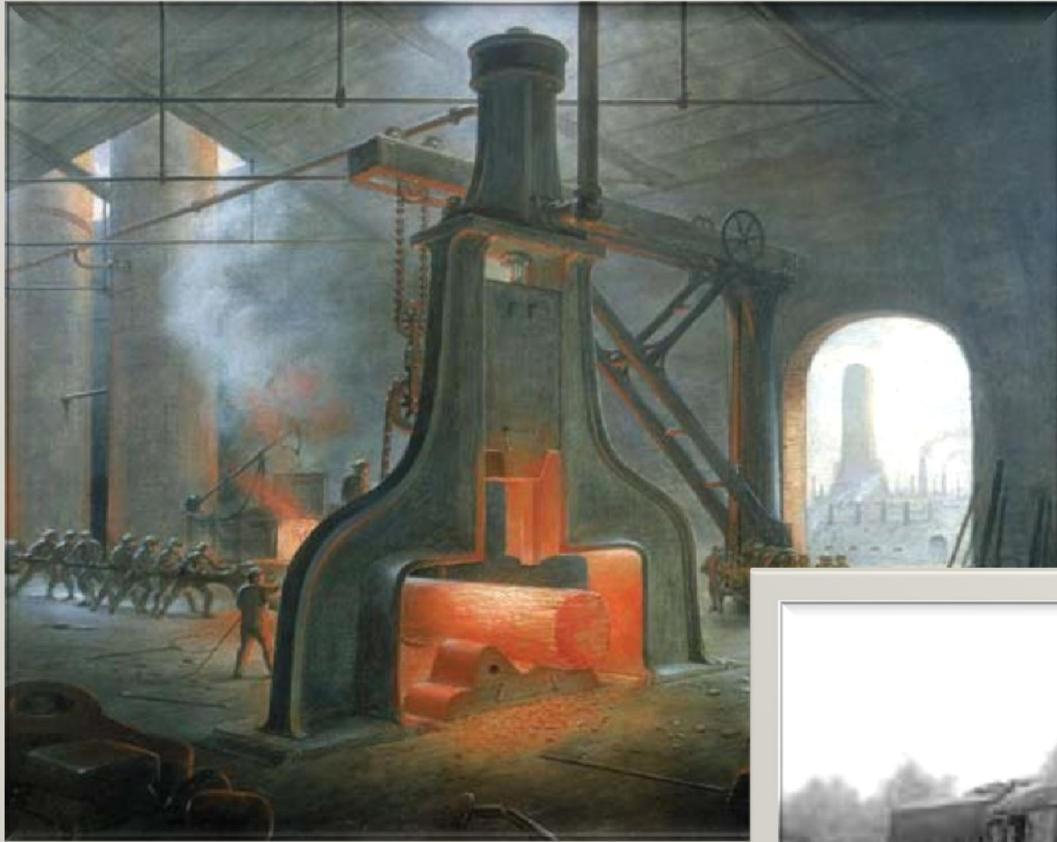


After the 1st industrial revolution



Industrial mass production

Fossil energy changed production, mobility, communication and living

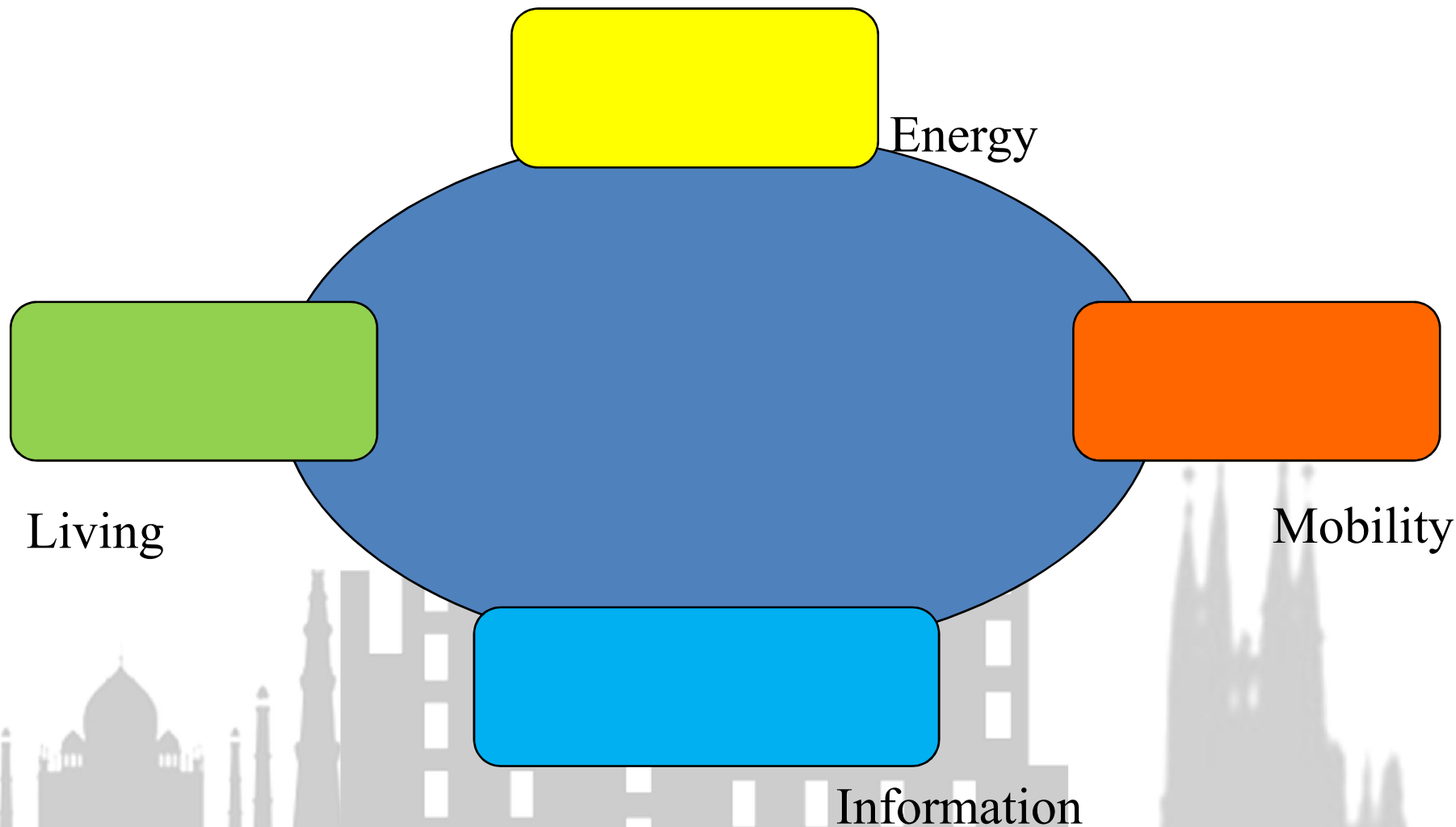


James Watt

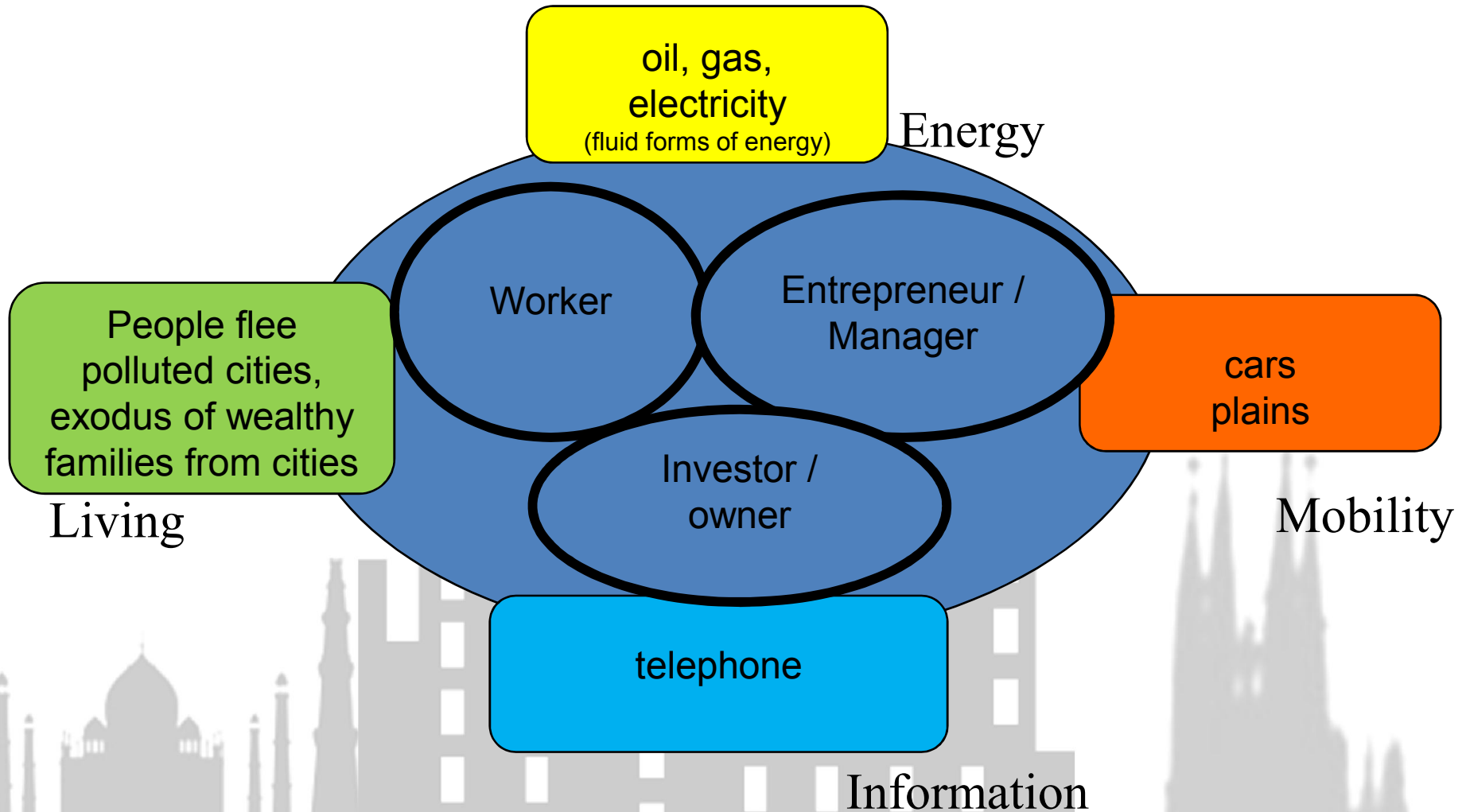
1736 - 1819



After the 2nd industrial revolution



After the 2nd industrial revolution



Cities were polluted

Great smog in London, 1952; approximately 12,000 people killed



Heavy smog in Piccadilly Circus, London. (December 6, 1952). (Photo by Central Press/Hulton Archive/Getty Images)

Athens Charta

What did the city-planners do?

- 📍 The Athens Charter was a document about urban planning published by the Swiss architect, Le Corbusier in 1943.
- 📍 The work was based upon Le Corbusier's Ville Radieuse (Radiant City) book of 1935 and urban studies undertaken by the Congrès International d'Architecture Moderne (CIAM) in the early 1930s.
- 📍 Functional urban quarters (living, shopping, work, culture, leisure, ...) should be separated and connected with high speed roads. The Ville Radieuse was a linear city based upon the abstract shape of the human body with head, spine, arms and legs

Environmental problems

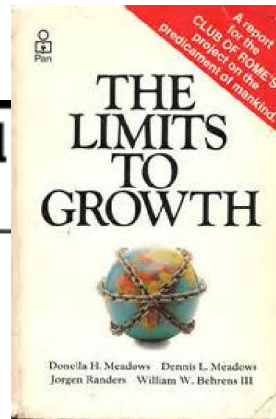
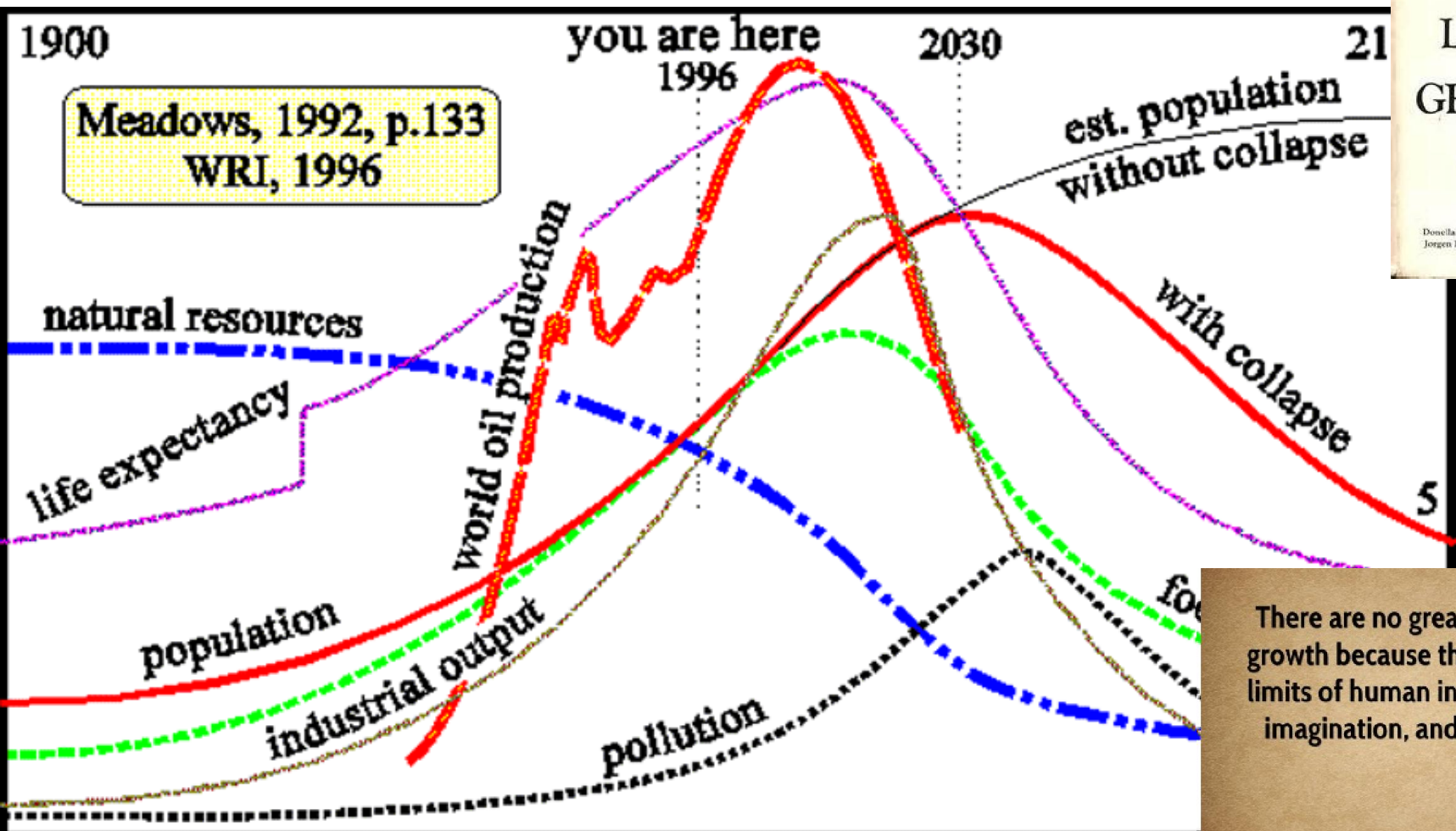
Some saw a need and a chance for change



1980: Waldsterben



Limits to growth



There are no great limits to growth because there are no limits of human intelligence, imagination, and wonder.



Ronald Reagan
40th U.S. President
(1911-2004)

German Enquete-Commission 1990

ENQUETE - KOMMISSION

Tabelle 7

Reduktionsplan der Enquete-Kommission zur Verminderung der energiebedingten klimarelevanten Spurengasemissionen der Bundesrepublik Deutschland für das Jahr 2005 (verbindliches Reduktionsziel) sowie für die Jahre 2020 und 2050 (Zielorientierung)

Spurengase	Ausgangswerte: Emissionen im Basis- jahr 1987 ¹⁾ in Mio. t (gerundet)	Reduktions- ziel: Reduktion bis 2005 in % gegenüber 1987	Zielorien- tierung: Reduktion bis 2020 in % gegenüber 1987	Zielorien- tierung: Reduktion bis 2050 in % gegenüber 1987
Kohlendioxid (CO ₂)	715	-30	-50	-80
Methan (CH ₄)	1,8	-30	-50	-80
Stickoxide (NO _x)	2,6	-50	-70	-90
Kohlenmonoxid (CO)	8	-60	-75	-90
flüchtige organische Verbindungen ohne Methan (NMVOC)	1,5	-80	-90	-95

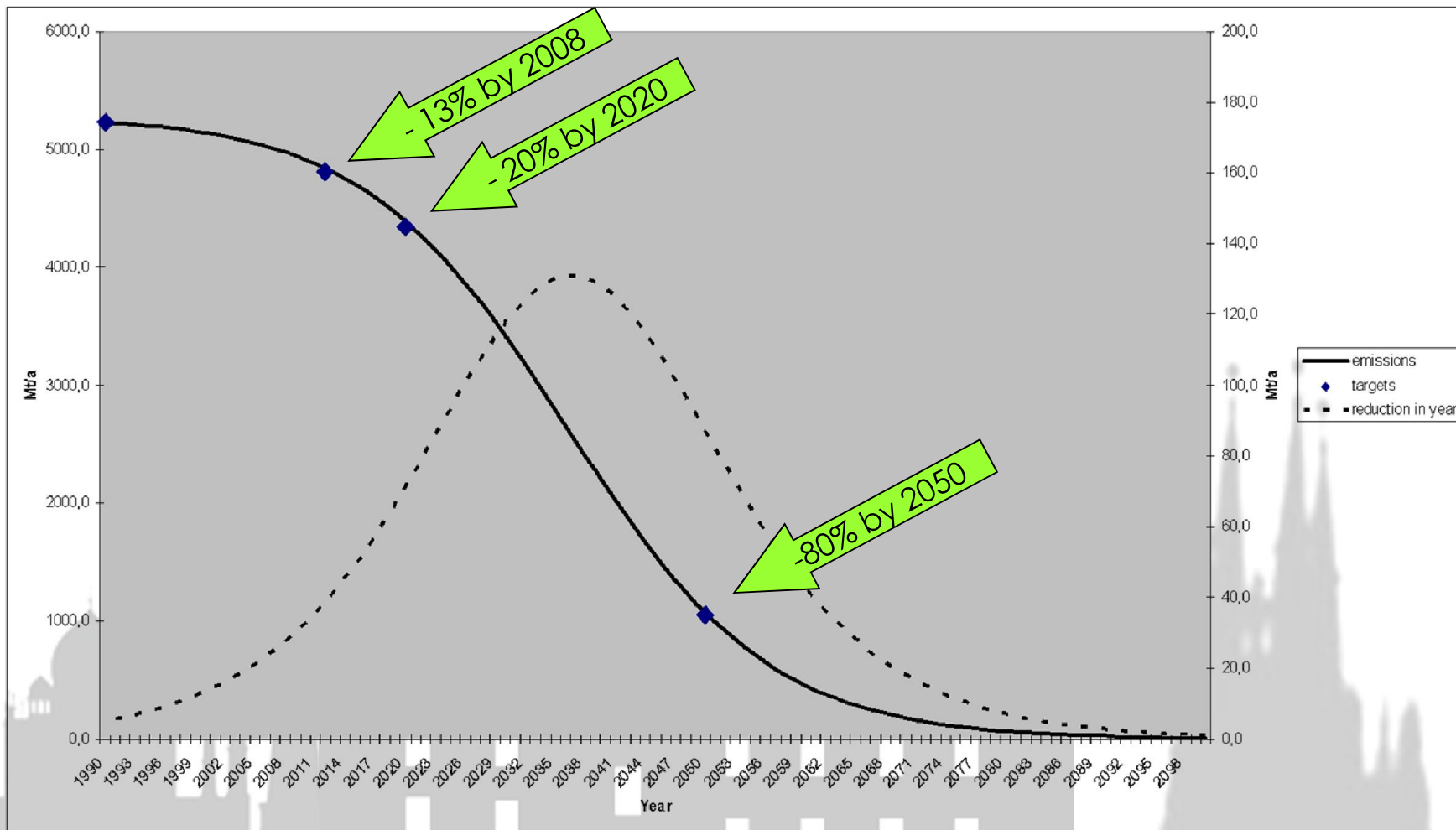
¹⁾ Die Ausgangswerte des Jahre 1987 sind aufgrund der exakteren Datenlage nur für die Bundesrepublik Deutschland (ohne ehemalige DDR) angegeben; die prozentualen Reduktionen beziehen sich auf die Bundesrepublik Deutschland einschließlich der ehemaligen DDR.

EU's ambitions

- One of the EU's key ambitions must be to develop a low-carbon economy^[1]. The EU has put in place a comprehensive policy framework, including among others: the climate and energy targets for 2020 and a carbon price through the Emissions Trading System (ETS). It was also working towards the successful conclusion of international climate change negotiations at Copenhagen at the end of 2009. Now, EU has to deliver, both in terms of the 2020 targets and, in the longer term, aiming for an 80% cut in greenhouse gas emissions by 2050 compared to 1990 levels.

^[1] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS: Investing in the Development of Low Carbon Technologies (SET-Plan) Brussels, 7.10.2009

European goals for the emission of greenhouse gases



**COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN
PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL
COMMITTEE AND THE COMMITTEE OF THE REGIONS**

**Investing in the Development of Low Carbon Technologies
(SET-Plan)**

(Text with EEA relevance)

1. INTRODUCTION

A critical challenge

One of the EU's key ambitions must be to develop a low-carbon economy. The EU has put in place a comprehensive policy framework, including among others: the climate and energy targets for 2020 and a carbon price through the Emissions Trading System. We are also working towards the successful conclusion of international climate change negotiations at Copenhagen¹ at the end of 2009. Now, we have to deliver, both in terms of the 2020 targets and, in the longer term, aiming for an 80% cut in greenhouse gas emissions by 2050 compared to 1990 levels.

Reinventing our energy system on a low carbon model is one of the critical challenges of the 21st Century. Today, in the EU, our primary energy supply is 80% dependent on fossil fuels. Networks and supply chains have been optimised over decades to deliver energy from these sources to our society. Economic growth and prosperity has been built on oil, coal and gas. But, they have also made us vulnerable to energy supply disruptions from outside the EU, to volatility in energy prices and to climate change.

There are different possible pathways to a low carbon economy. Clearly, no single measure or technology will suffice, and the precise mix in each country will depend on the particular

The leaders of the Group of Eight expressed the need for a reduction of Global Warming Gases (GHGs) like this ^[1]:

65. We reaffirm the importance of the work of the Intergovernmental Panel on Climate Change (IPCC) and notably of its Fourth Assessment Report, which constitutes the most comprehensive assessment of the science. We recognise the broad scientific view that the increase in global average temperature above pre-industrial levels ought not to exceed 2°C. Because this global challenge can only be met by a global response, we reiterate our willingness to share with all countries the goal of achieving at least a 50% reduction of global emissions by 2050, recognising that this implies that global emissions need to peak as soon as possible and decline thereafter. As part of this, we also support a goal of developed countries reducing emissions of greenhouse gases in aggregate by 80% or more by 2050 compared to 1990 or more recent years. Consistent with this ambitious long-term objective, we will undertake robust aggregate and individual mid-term reductions, taking into account that baselines may vary and that efforts need to be comparable. Similarly, major emerging economies need to undertake quantifiable actions to collectively reduce emissions significantly below business-as-usual by a specified year.

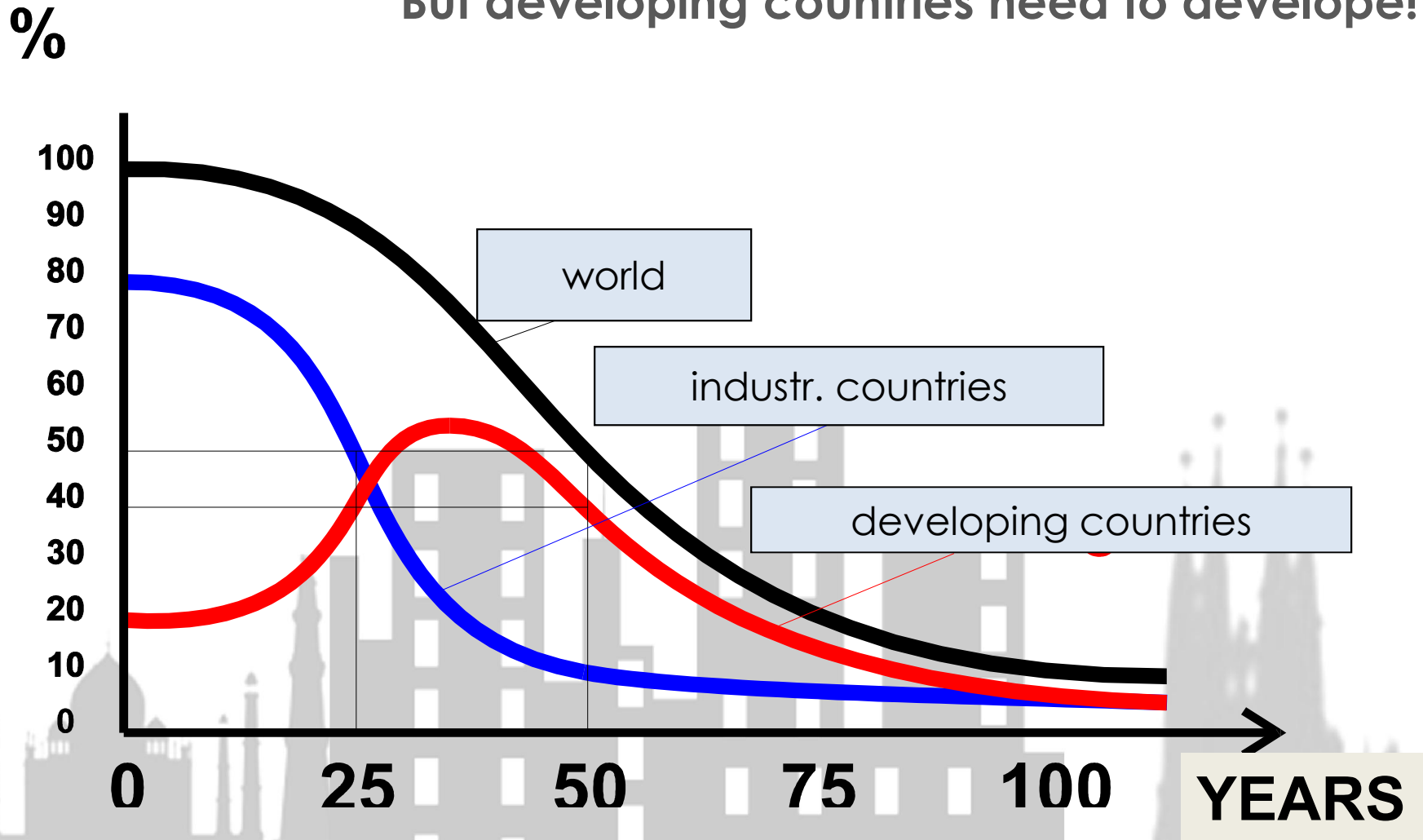
^[1] Group of Eight: Responsible Leadership for a Sustainable Future. L'Aquila, Italy, July 10, 2009

- 📍 The IPCC calls for global emission reductions of about 50 % by the middle of the 21st century in order to keep the objective of keeping global warming to less than 2°C above the pre-industrial temperature. This implies 60–80 % reduction of emissions by developed countries. Developing countries with large emissions, such as China, India and Brazil, will have to limit their emission growth. Europe will attempt to reassert its global leadership on climate change according to a two-day summit kicking off in Brussels (29-30 October 2009), with EU leaders set to back emissions reductions "of at least 80-95%" for the developed world by 2050, according to a draft statement obtained by EurActiv ^[1].

^[1] <http://www.euractiv.com/en/climate-change/eu-summit-back-95-emissions-reduction-goal/article-186843>

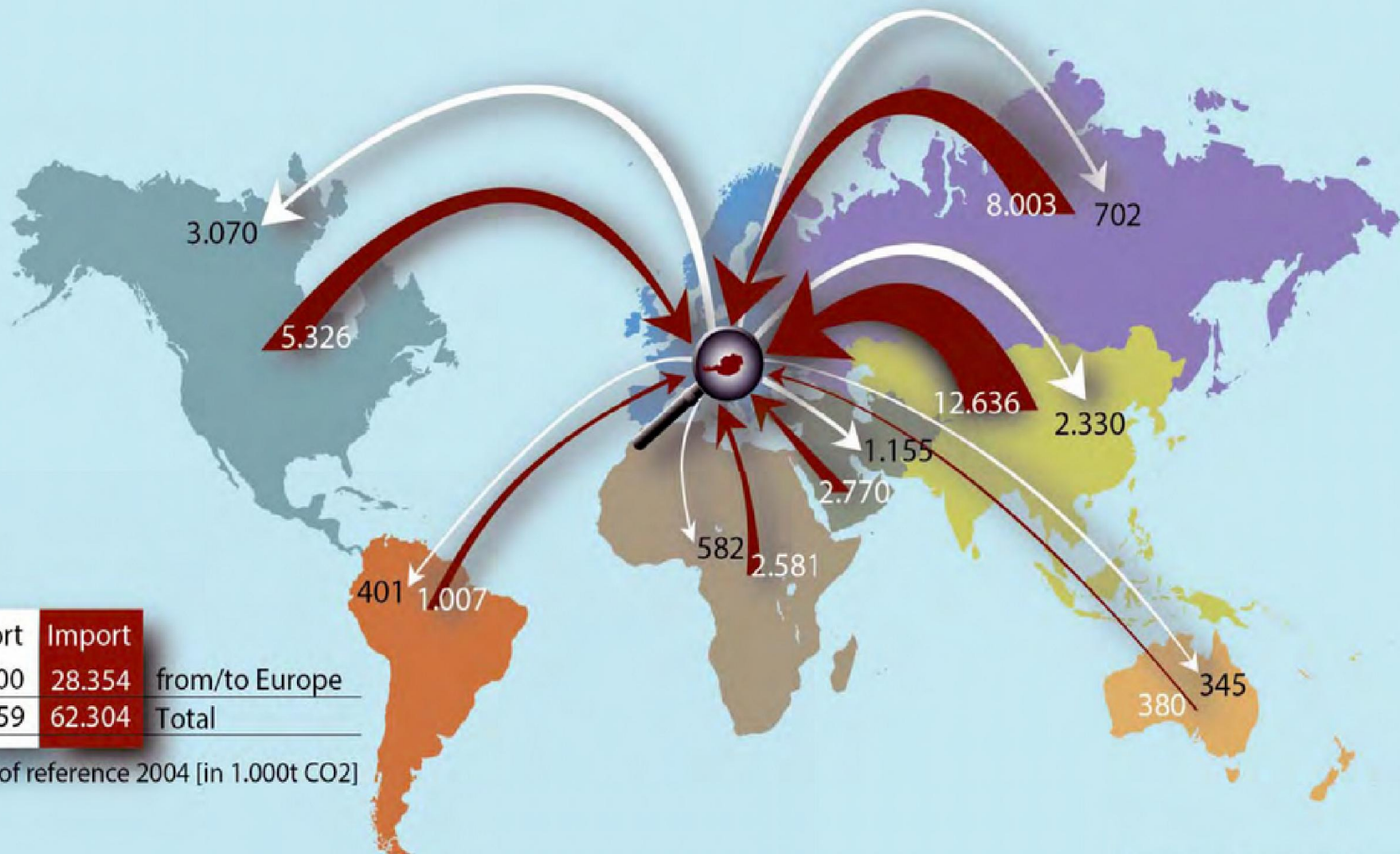
Industrialized countries have to lead

Reduction of mass flows by factor 10
But developing countries need to develop!



Europe is “exporting” emissions

CO2 balance for Austria (Source APCC´)

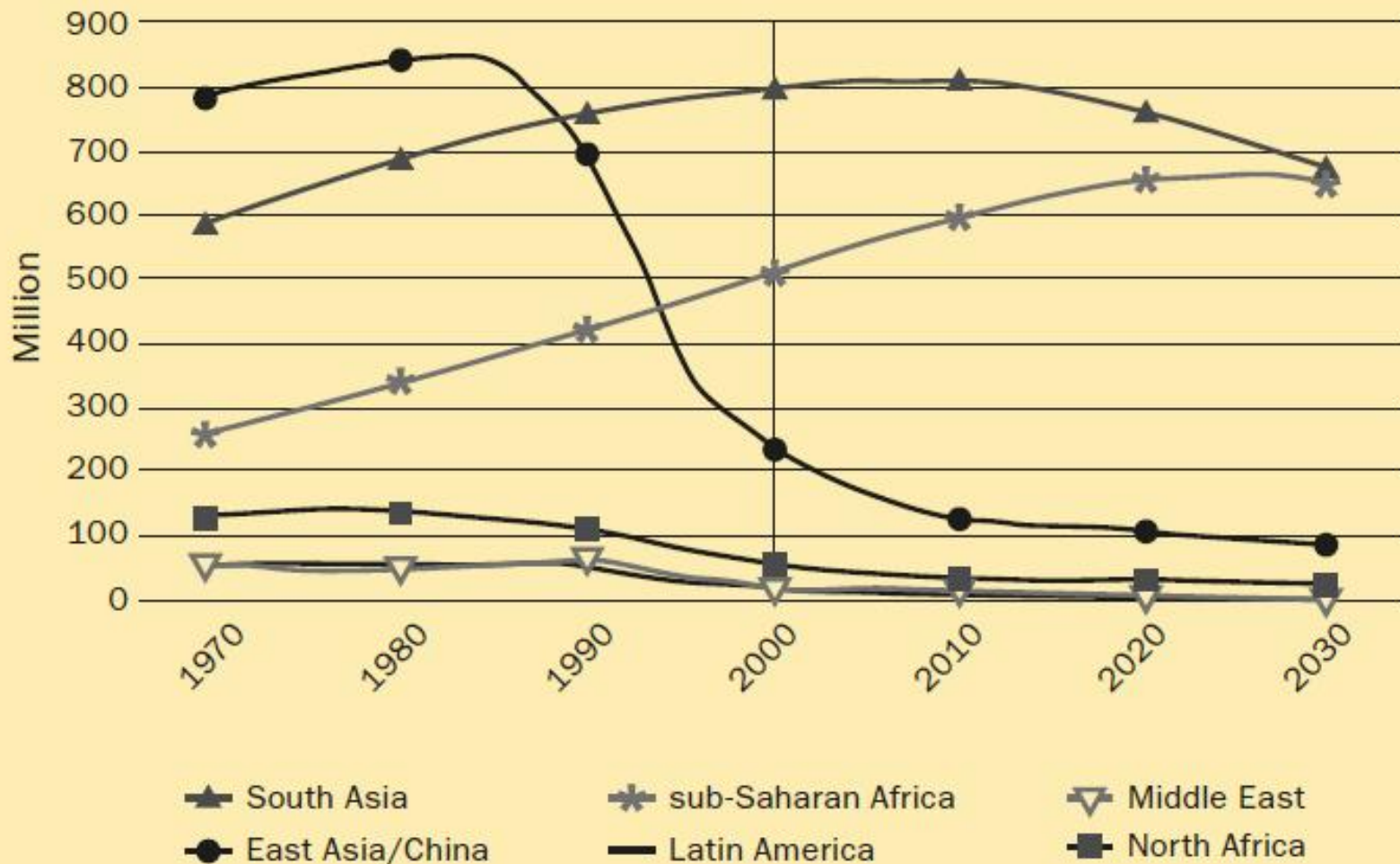


Export	Import	
18.500	28.354	from/to Europe
27.559	62.304	Total

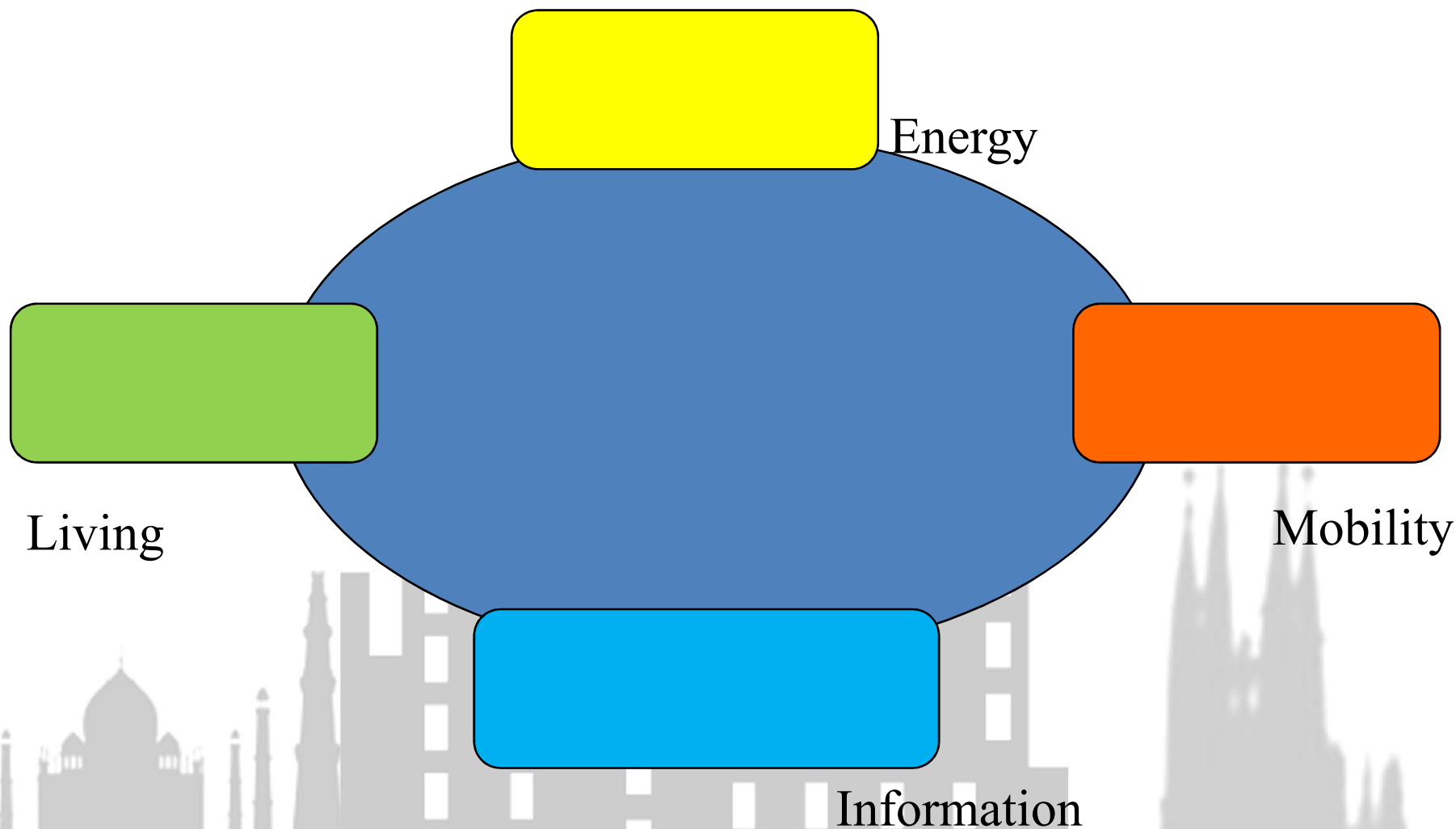
year of reference 2004 [in 1.000t CO2]

Number of people (actual and projected), without electricity, by region

Source: The UN Millennium Project: **Energy Services for the Millennium Development Goals**

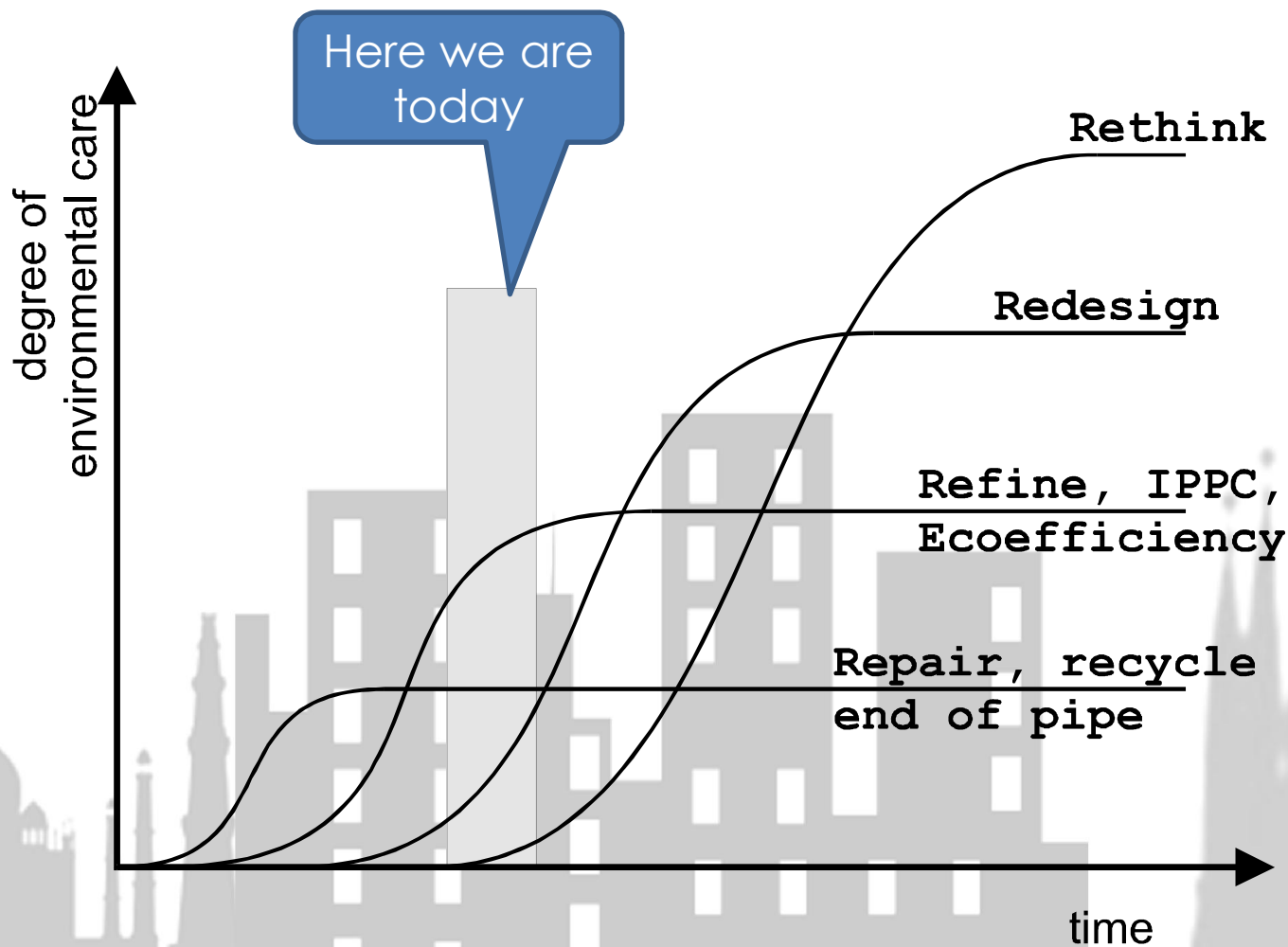


What will happen with the 3rd industrial revolution?



Improvement or innovation?

Doing better is not enough

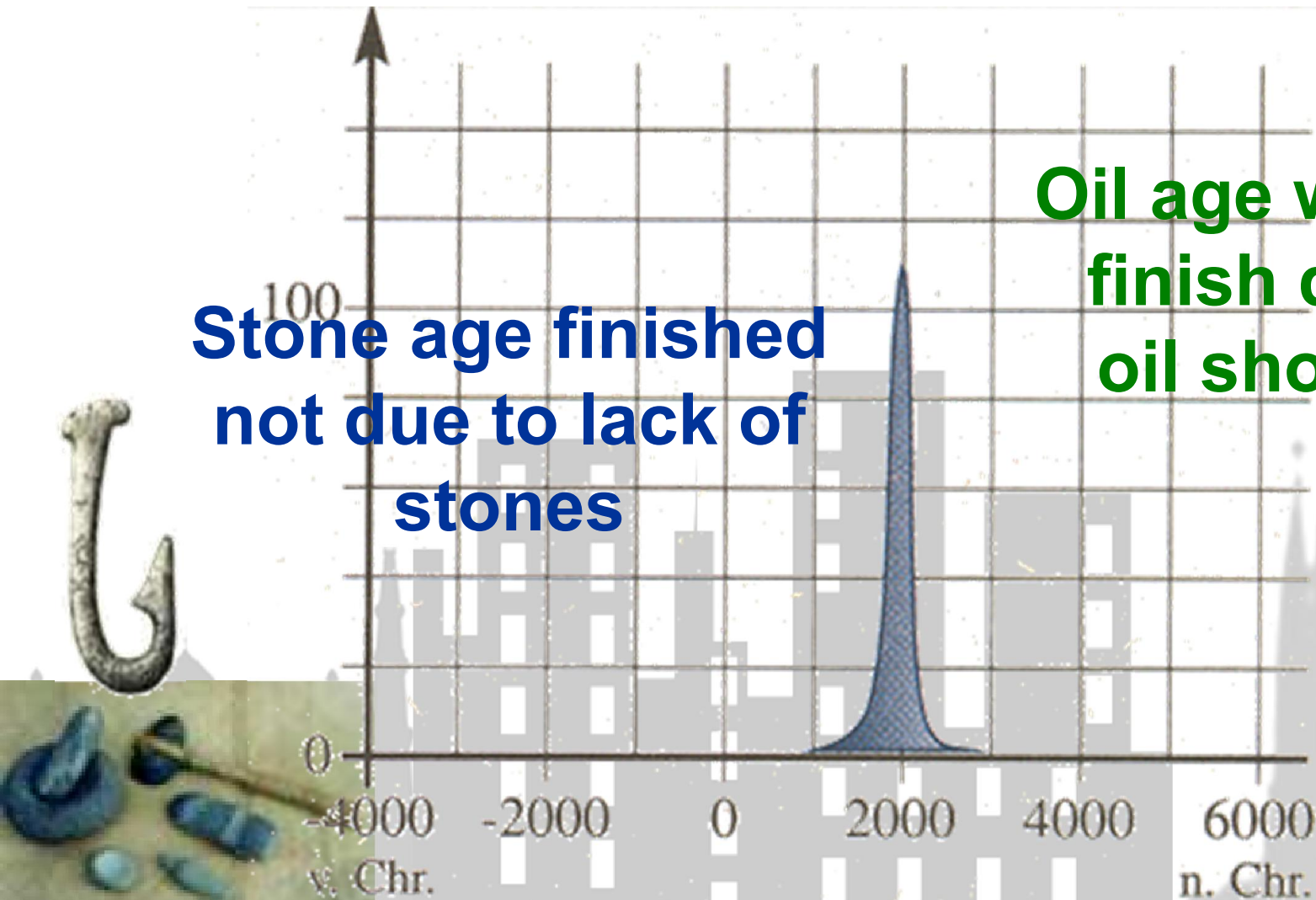


Fossil Energy

Intensity of use during history of mankind

**Stone age finished
not due to lack of
stones**

**Oil age won't
finish due to
oil shortage**



Scarce energy or scarce resources?

- Sunshine arrives free of charge at 14400 times the rate of global primary energy consumption

William Shepherd, Energy Studies. Imperial College Press, 2003, page 31

- New matter doesn't arrive at all, so waste means shrinking resources and lost wealth.

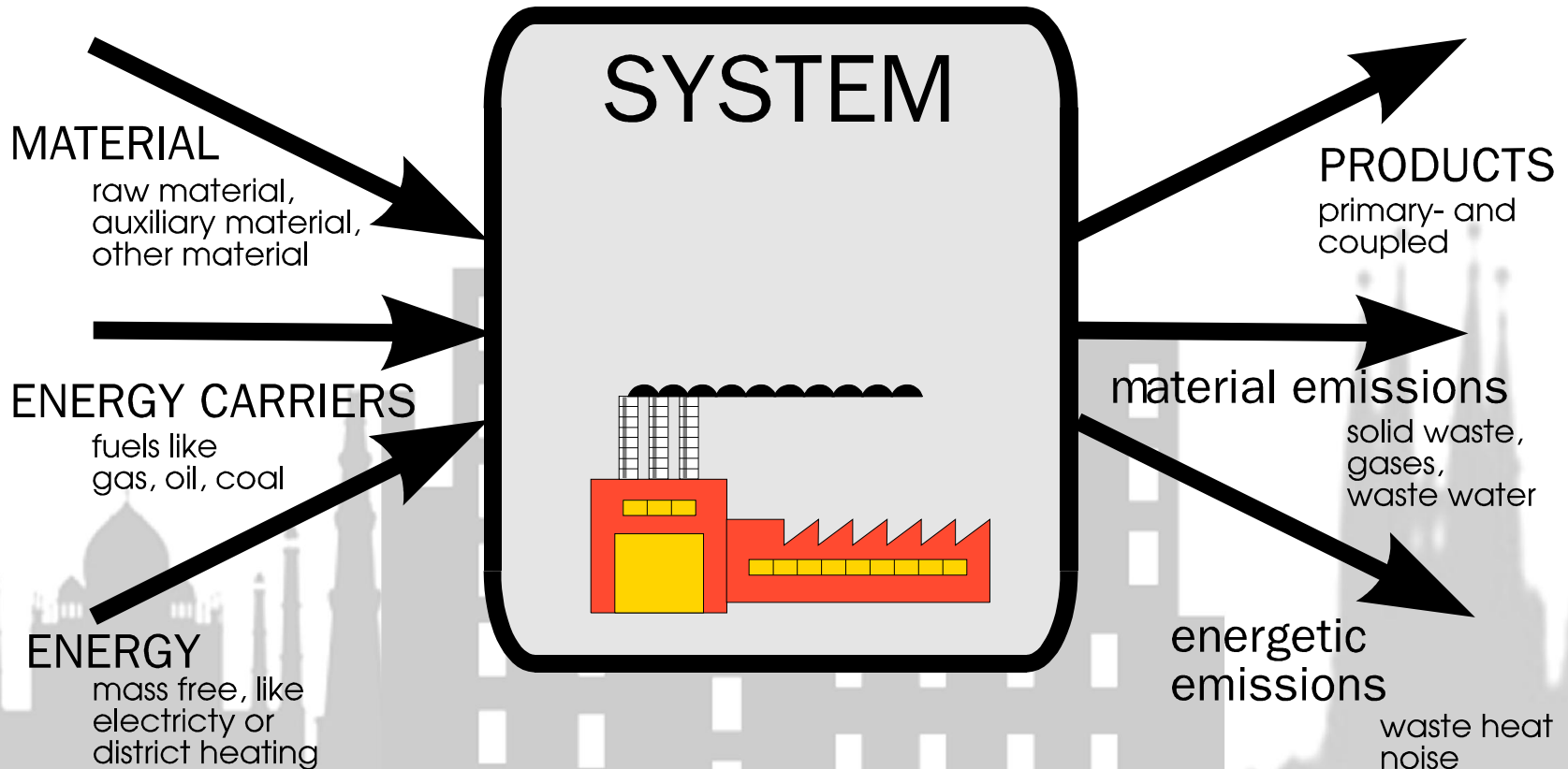


The company as a system

Company level

INPUT

OUTPUT

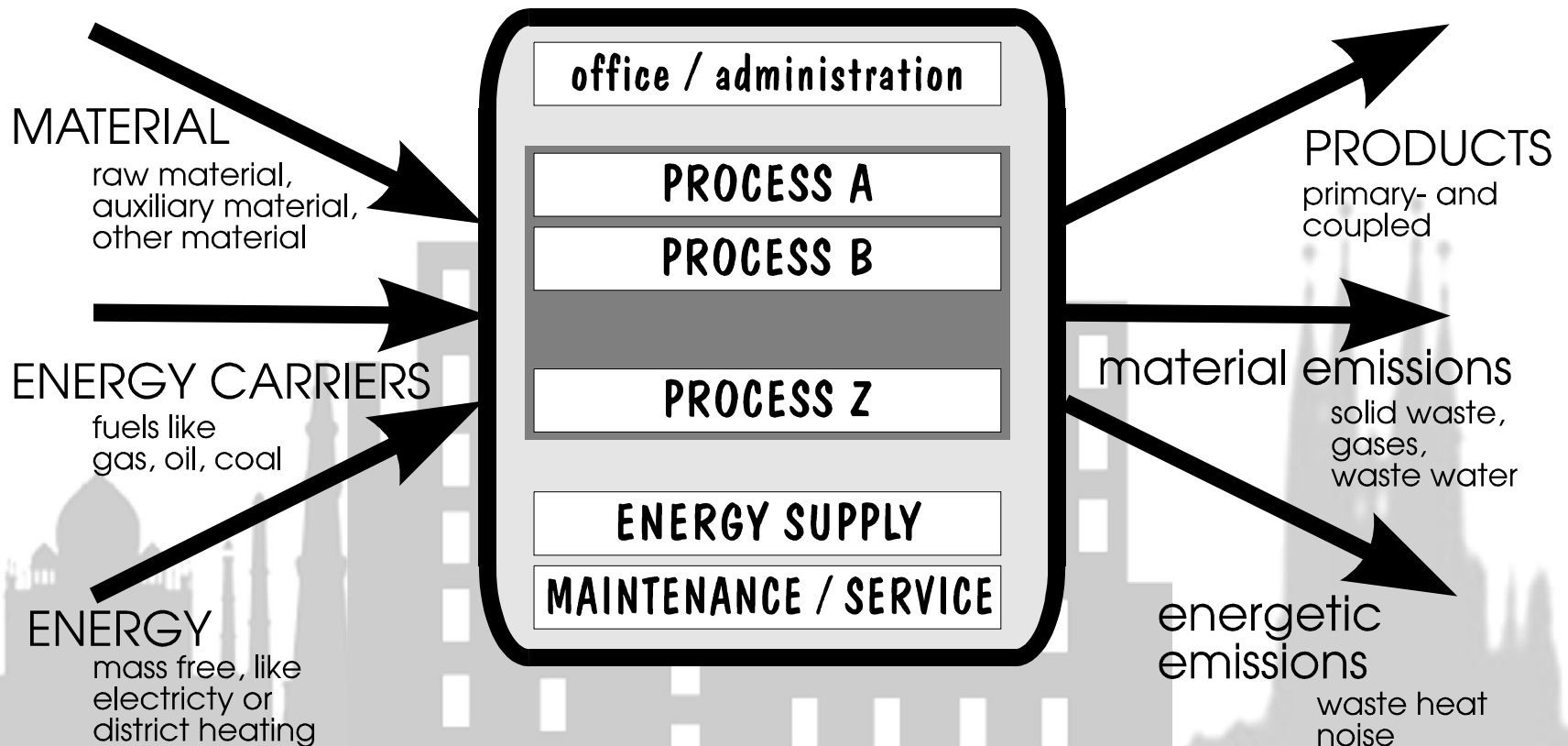


The company with sub-systems

Process level

INPUT

OUTPUT



The city seen as a system

What are the products and services?

INPUT

OUTPUT



Old cities were systems with clear boundaries



Source of figure: Brian D. Fath. Towson University, Maryland, USA
International Institute for Applied Systems Analysis, Austria

Why do people move to cities?

What services do cities provide?

📍 Expect job opportunities

- 📍 High quality if life
- 📍 High quality education
- 📍 Cultural activities
- 📍 ...



Urbanism charters

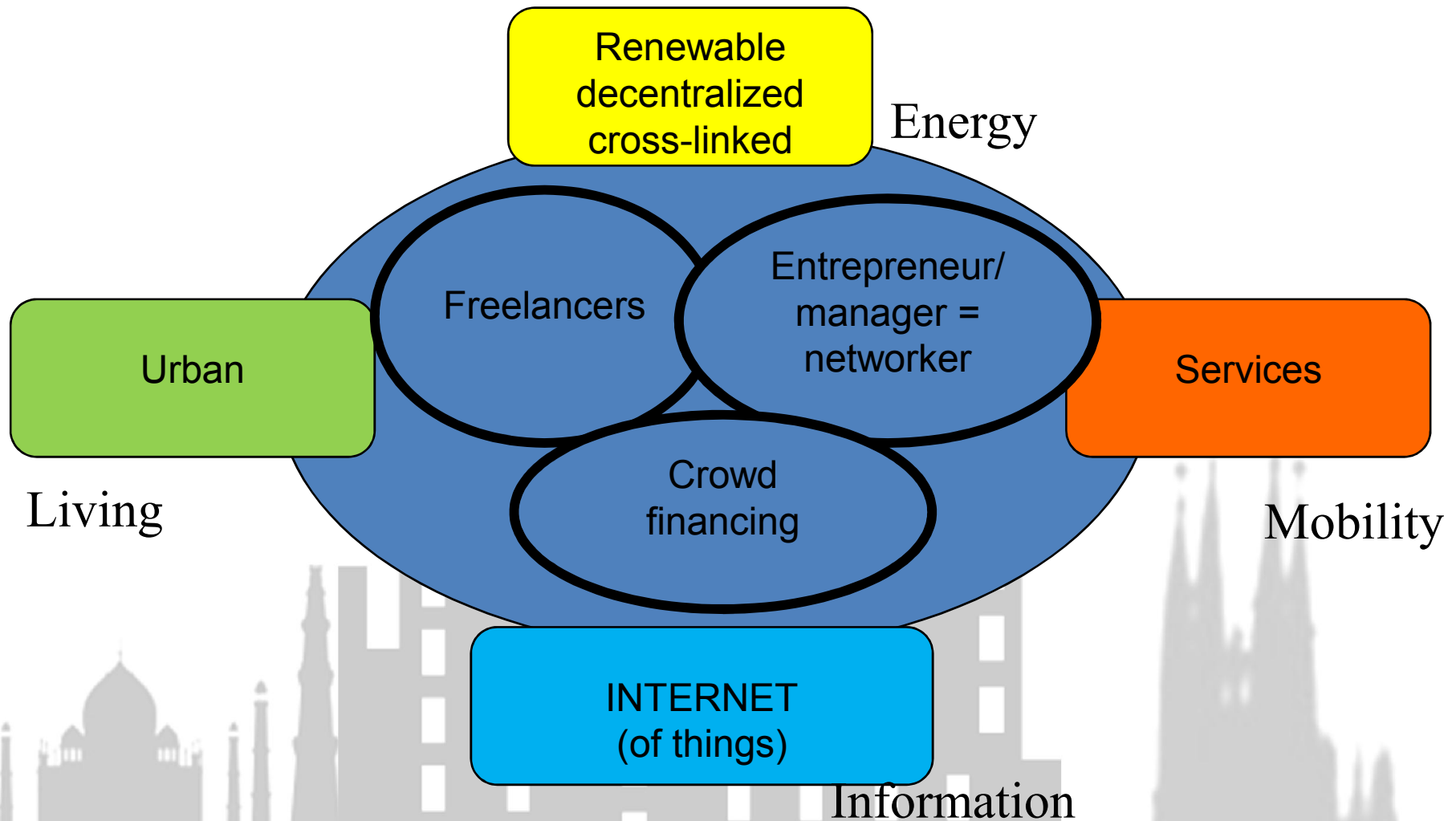
After 50 years new development guidelines for cities are published

- 📍 **Athens Charter 1943**
 - Separate functions of city quarters
- 📍 **Aalborg Charter 1994**
 - European Cities & Towns Towards Sustainability: Integrated development
- 📍 **Leipzig Charter on Sustainable European Cities 2007; the cities recommend:**
 - Making greater use of integrated urban development policy approaches
 - That special attention is paid to deprived neighborhoods within the context of the city as a whole.
- 📍 **Freiburg Charter for Sustainable Urbanism 1012**
 - The Charter has 12 principles to guide planning and development if a sustainable city is to be achieved.

Integrated means:

- 📍 **Living space**
 - From newborn to old
- 📍 **Job opportunities**
 - For all kind of qualification
- 📍 **Education**
 - From kindergarten to life-long learning
- 📍 **Culture**
 - Opera and festivals, museums, cinema, temples, ...
- 📍 **Leisure**
 - Sport, pubs, bars, meditaion,...
- 📍 **Medical services**
 - Doctors, hospitals, ...

3rd industrial revolution



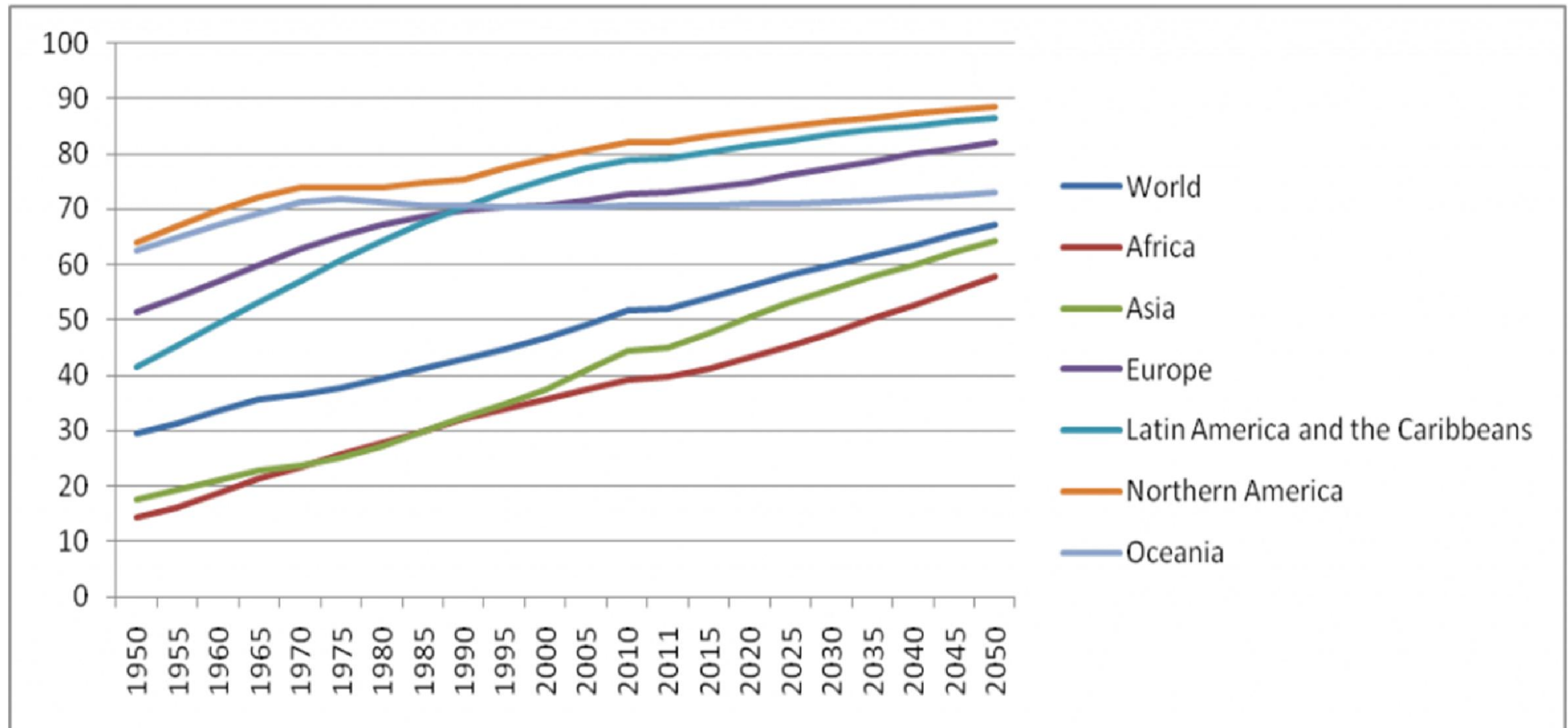
Why do we work with cities for a sustainable development:

Action is needed

- 📍 The decisions that national leaders, local officials, developers, and planners make today will determine how billions of urbanites will live over the next century.
- 📍 Traditional models of city development can hinder economic growth, spur greenhouse gas emissions, and endanger lives.
- 📍 Compact, efficient cities can alleviate poverty, combat climate change, and make services like water, energy, and transport more accessible.



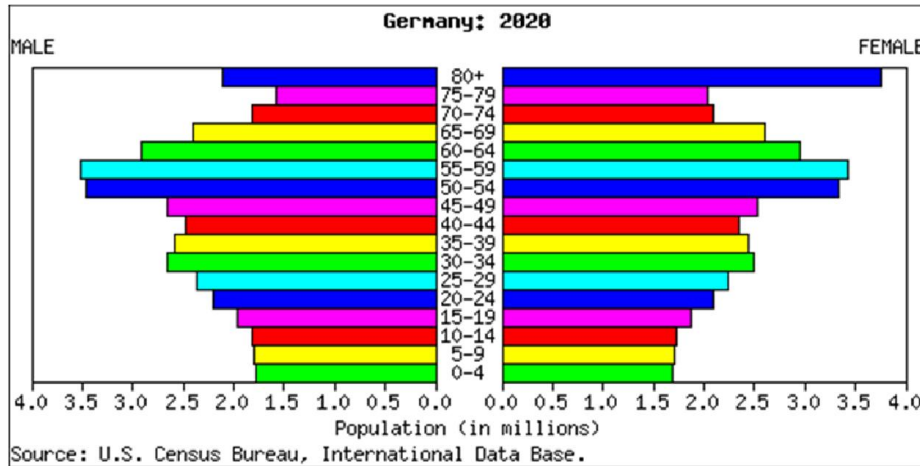
Urbanization as a trend will continue



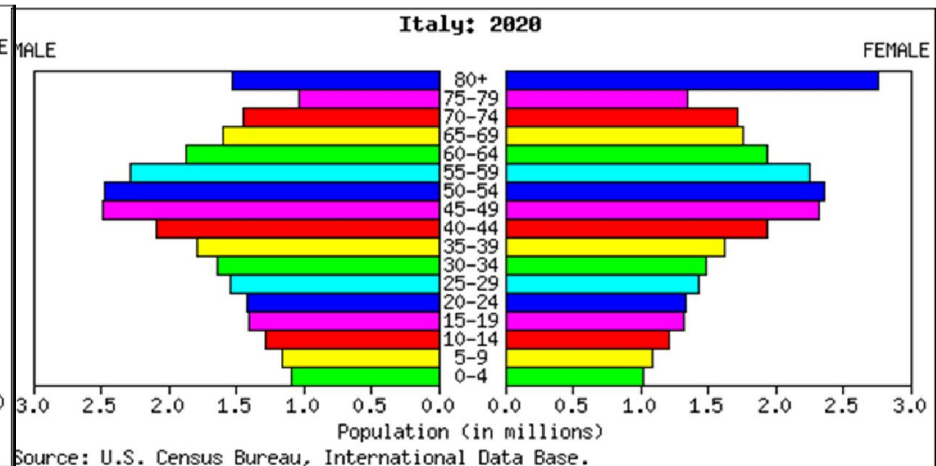
Source: Urbanisation trends and estimates in major regions of the world (in % from 1950 to 2050). Source: UN-DESA (2010) and UN-DESA (2011)

Demographic change

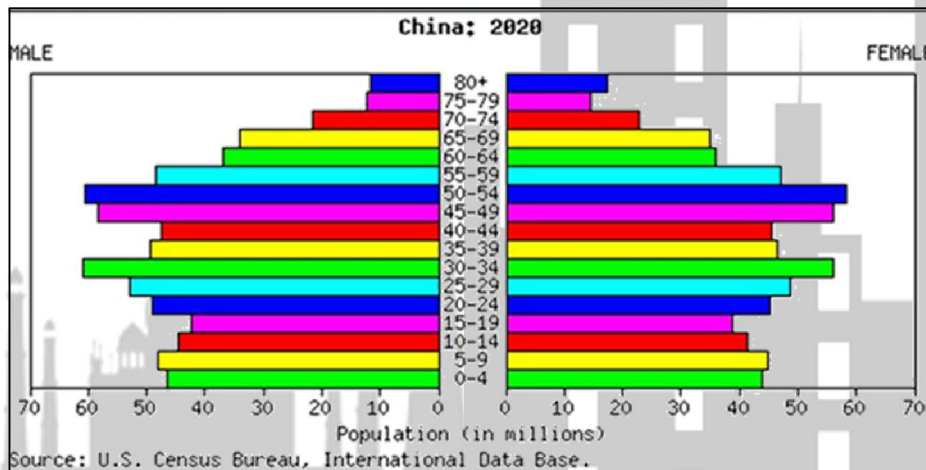
Similar trend in all industrialized countries



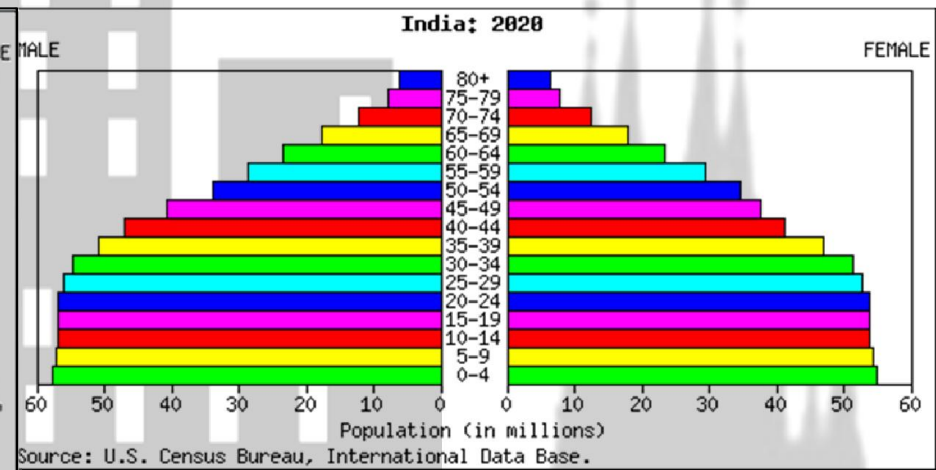
Germany



Italy

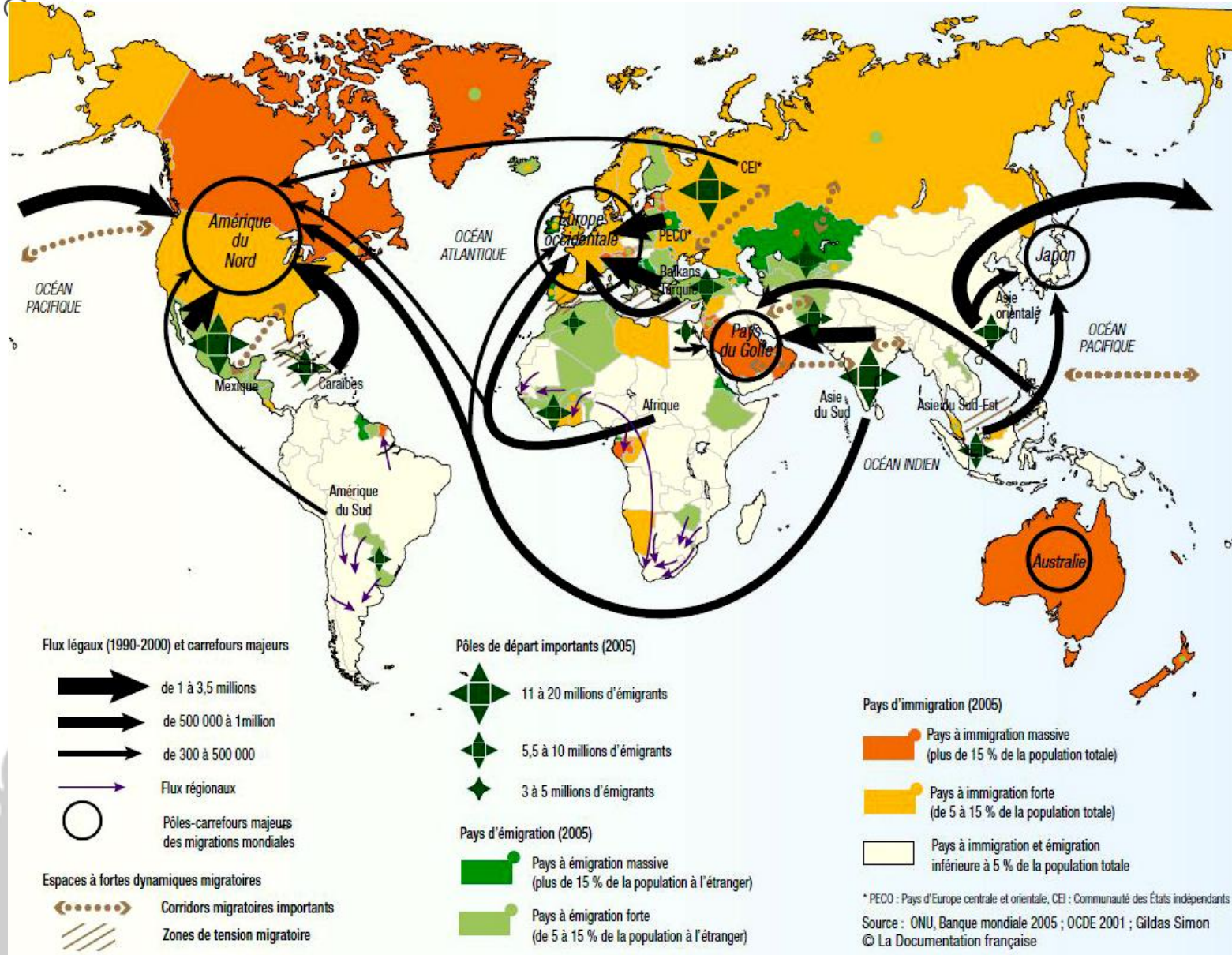


China



India

Global migration



Changes in the economic system

- 📍 Traditional production schemes will disappear
- 📍 The INTERNET of things
- 📍 Sharing economy
- 📍 Use or own
- 📍 Crowd financing
- 📍 Zero marginal costs (Rifkin)
- 📍 Increasing number of prosumers
- 📍 ...



Change in business

Crowds

- 📍 **Music**
- 📍 **Films (youtube)**
- 📍 **Electricity: PV poducers**
- 📍 **Mobility: UBER**
- 📍 **Hotels: airbnb**
- 📍 **Banks: crowd financing**
- 📍 **...**



Communication – INTERNET of things

Things will communicate without human participation

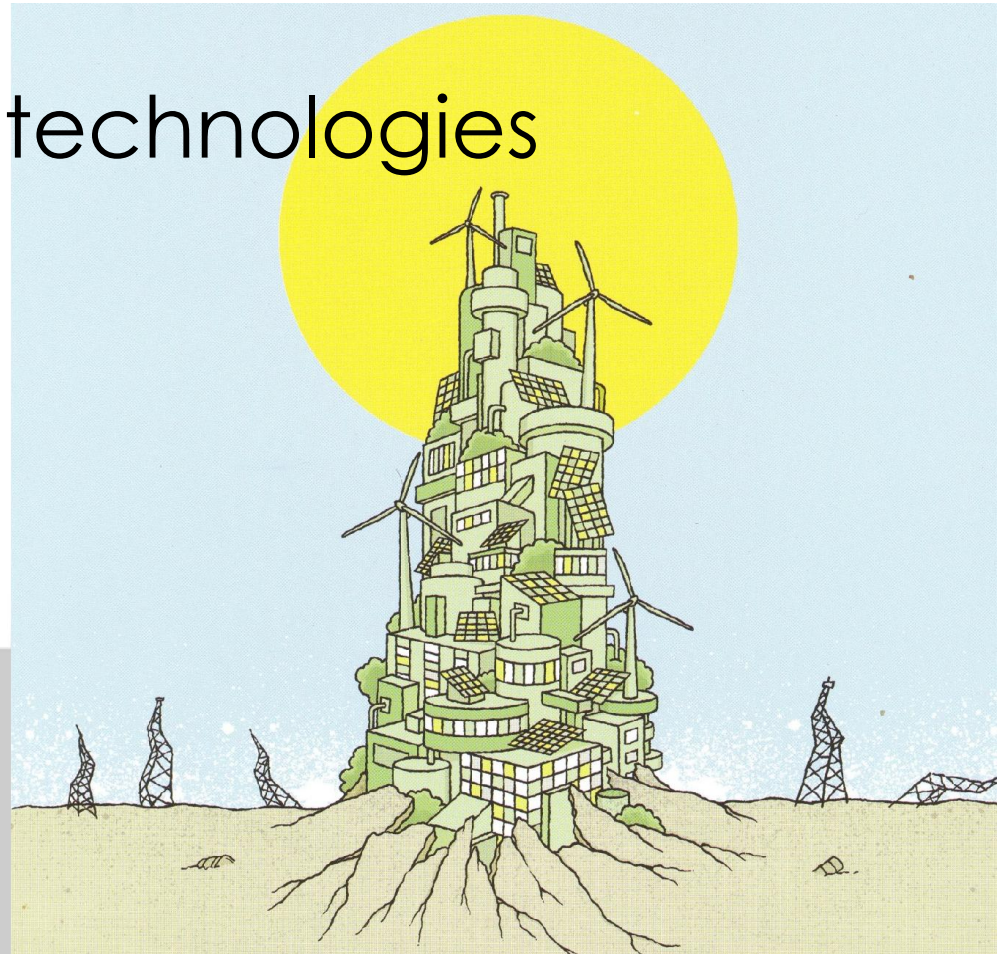


Smart City:

Often heard aspects

communication technologies
zero emissions
energy autarky
CO₂-neutral
free of cars
short distances

Source of figure:
Making It – Our Low Carbon
Future. UNIDO 2012



Short definition of a Smart City

A Smart City / District is an urban area where a

 **high quality of life**

is combined with

 **affordable living**



It is important to address the two aspects of the challenge:

📍 What is a Smart City?

**Low environmental impact:
How to reduce environmental
footprint?**

Less need for cars,
consumption of less energy,
less land surface needed,
higher biodiversity,
less waste produced...

**High quality of life:
How to increase the well-being
and the quality of life?**

More green spaces,
more tolerant and cohesive
communities, less commuting
times, more options for social
interaction, better
governance...

Achieving this requires an improved
institutional process framework ...

Some Aspects of Quality of Life

Smart Cities: high quality of life is combined with affordable living

- 📍 Infrastructure for daily transactions is available (short distances)
- 📍 Safe, also at night
- 📍 Green and blue
- 📍 Reachable
- 📍 Integrated mix of residential, commercial business facilities
- 📍 ...



The challenge: a multidisciplinary & participatory approach is necessary

- 📍 city planning, including all groups of society, also the vulnerable
- 📍 housing at all price levels
- 📍 mobility, traffic
- 📍 economy
- 📍 ecology, green & blue back to the cities
- 📍 dialogue with future residents and users on urban development of the district
- 📍 urban metabolism
- 📍 social life
- 📍 ...
- 📍 energy



A roadmap towards Smart Cities has to be designed individually

Items that have to be discussed:

- 📍 Starting point
- 📍 Vision, target and goal
- 📍 Megatrends
- 📍 Internal forces
- 📍 Limitations (financial, legal, ...)
- 📍 People's desires and fears
- 📍 Indicators, parameters, ...



Innovations are about finding:

- 📍 ... a new way of thinking
- 📍 ... a new way of working
- 📍 ... a new way of planning
- 📍 ... a new way of organization
- 📍 ... a new development path way
- 📍 ...



Innovation is not easy

You have to know where you want to go

Essay

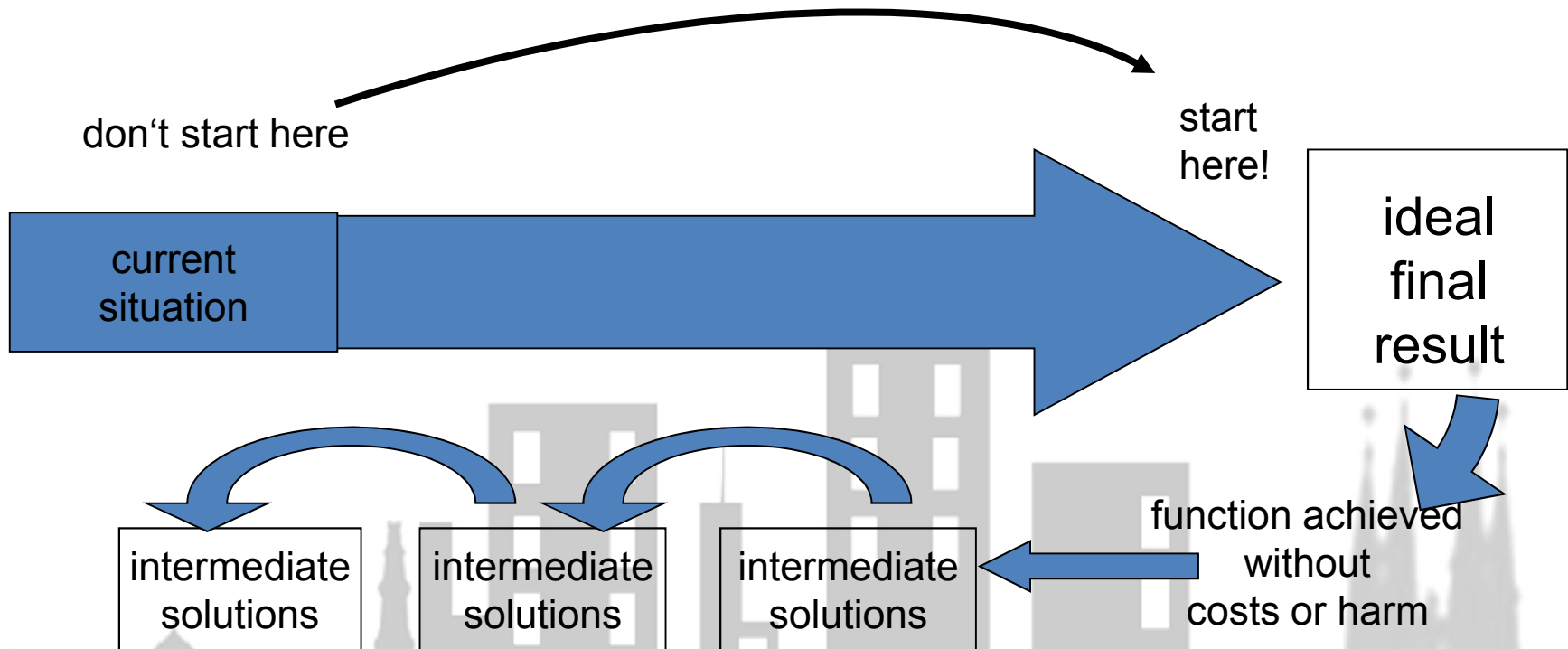
The author:
Theresia Vogel
General Manager,
Climate and Energy Fund



Learning from visions

Sustainability and energy efficiency – these are the values used to measure the future viability of a city today. The reduction of greenhouse gas emissions has replaced targets like low traffic congestion and habitat density as a goal of town planning. The future will not be worth living without climate protection.

Starting innovation with the ideal final result



Source: D. Mann, Hands on Systematic Innovation, CREAX Press 2002

You have to know where you start

- 📍 Existing data, indicators
- 📍 Existing programs and activities
- 📍 Local drivers and interests

Graz

Then you can design the roadmap



Megatrends that have to be considered

How will they influence the development of your city?

- 📍 Ongoing urbanization
- 📍 Demographic change
- 📍 Global migration
- 📍 Economic changes to business
- 📍 Information technologies, Internet of things, ...
- 📍 Global resource scarcity
- 📍 Climate change
- 📍 New work
- 📍 ...



SMART CITIES MEANS A PARADIGM SHIFT

Smart Cities

will become one of the most powerful tools in public policies aimed at cities sustainable development

SMART CITIES MEANS addressing the problems that cities face from the **multi-dimensional perspective, integrating interventions** rather than designing specific policies/programs covering specialized issues

Economist's theory

- 📍 Innovation will lead us out of any problem
- 📍 Prices will do the rest

There are no great limits to growth because there are no limits of human intelligence, imagination, and wonder.



Ronald Reagan

40th U.S. President

(1911-2004)

QuoteHD.com

Technological change or behavioral change

People don't
resist **CHANGE**
they resist being
CHANGED

Richard Beckhard; he was a pioneer in the field of organizational development

Smart City = participation

Neighborhood management

- 📍 People must have the possibility to express their desires, interests, fears and hopes



THINK-DENK

LABOR
Stadt Graz

Wo wollen wir hin?

Samstag 09. Mai - 11.00 bis 21.00 am Andräplatz



How to increase resource and energy productivity

EFFICIENCY	Technical: optimize processes, products and Infrastructures	
	Organizational: Services replace products; optimize logistics, distribution and effects	
Societal: new definition of quality of life		SUFFICIENCY

THIS IS GRAZ IN 2050

Result of the “I live Graz” participatory process

- ◉ In 2050, the metropolitan area of Graz is a dynamic city with compact building development and urban mixed usage, attractive public spaces and a high quality of life.
- ◉ By consistently following Smart City strategies and raising consciousness across the board, resource and energy consumption as well as their related emissions have been reduced and steps have been taken towards making Graz a zero-emissions city.
- ◉ The required energy comes 100% from the region and is produced from renewable energy sources.
- ◉ As an attractive location for research, training and business, Graz is an international benchmark for added value through innovative urban technologies and systems.
- ◉ Graz is a desirable place to live and work at every stage of life and has become a low-emissions, energy-autonomous and waste-free city. Soil and water quality as well as biodiversity have significantly improved while noise pollution has decreased in downtown Graz.

The *I live Graz* project defines 7 + 1 categories:

1. Economy
2. Society
3. Ecology
4. Mobility
5. Energy
6. Supply and disposal
7. Buildings
- +1 Urban planning**



Graz: Development of the roadmap through 7+1 sectorial working groups

Design of the working groups

- **Lead:** Representative of (semi-)public institution
- **Research:** representatives from 11 institutes from Graz University of Technology
- **Administration:** representatives from various departments of the City of Graz
- **Business**
- **NGOs**
- **Public**

Coordination and methodology: Hans Schnitzer, TU Graz



Realization of a „Smart City“?

Guarantee of a high quality of live and location

- **Reduction of energy consumption**
- **Reduction of emissions – in particular fine dust PM 10**
- **Sustainable mobility, e-mobility**
- **Urban mixed use**
- **Involvement of local players and multipliers**

How?

- Implementation of new planning instruments and strategies for urban development
- Use of new urban technologies for sustainable systems
- Support and funding for innovative pilot projects
- New participation models for increasing awareness and acceptability

Smart Cities are Zero Emission Cities

The Graz approach for planning:

LOWs

Short distances

Minimized buildings- and traffic space-usage

Low ghg emissions

Low material streams with ecological effects

Low ecological footprint

Low more costs

HIGHs

High productivity

High user density

high interaction

High biodiversity

High living quality

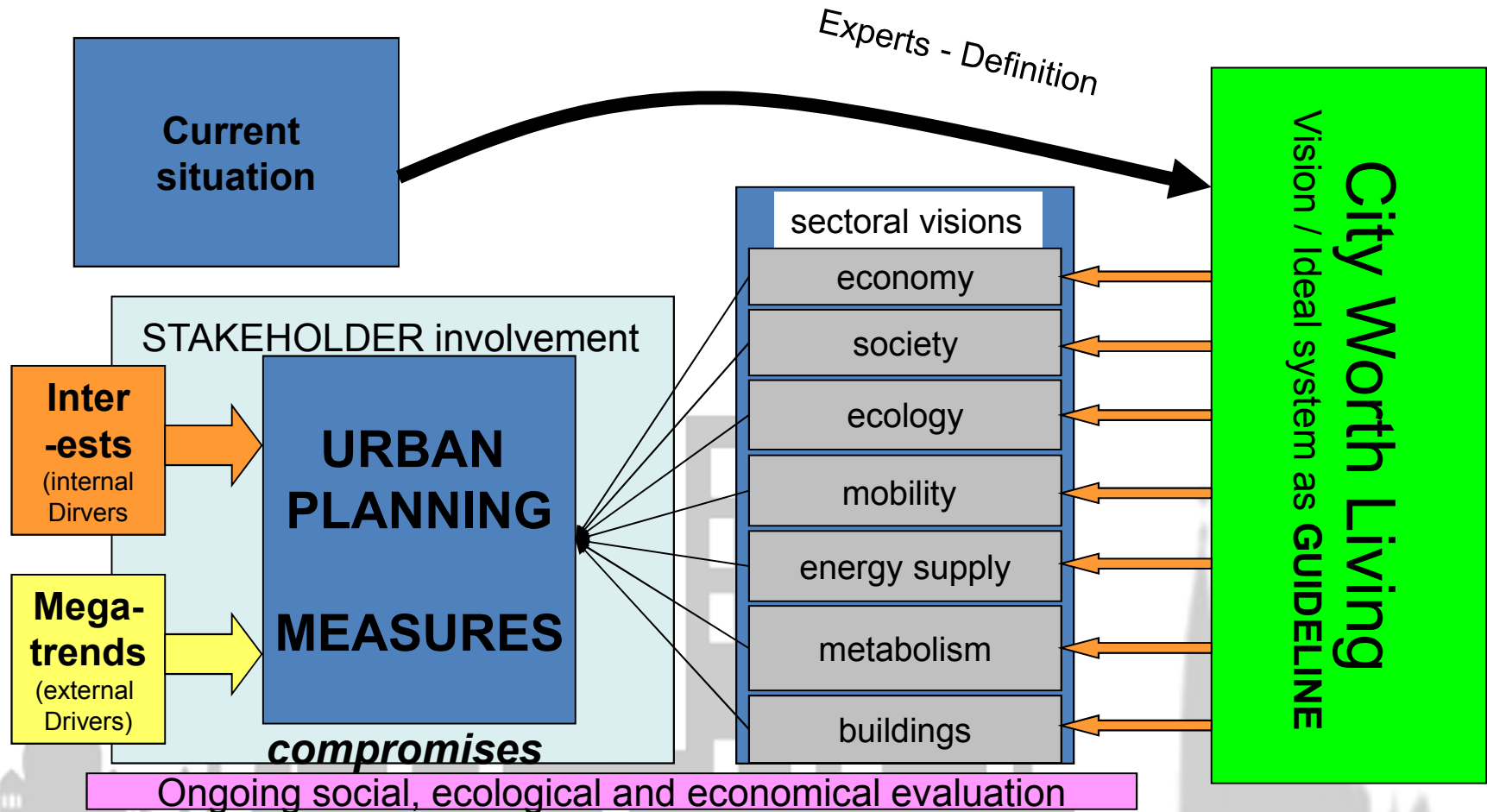
High development potential

Tasks for the working groups

- 📍 **Define the vision of the sector**
- 📍 **Build a set of indicators**
 - “hard” indicators that can be quantified by numbers
 - “soft” indicators, text only
- 📍 **Draw a roadmap**
- 📍 **Specify the main actors and assign duties to them**
- 📍 **Define the supporting (mega-)trends and most likely barriers**



Design of the roadmap



ENERGY VISION SMART CITY GRAZ

Result of the “I live Graz” participatory process

- 📍 In 2050, the city of Graz finds itself at a sustainable energy equilibrium.
- 📍 The total energy required is produced 100% from the region and from renewable energy sources.
- 📍 The citizens of Graz understand the value of energy and use it consciously and efficiently.



The city seen as a system

What are the products and services?

INPUT

OUTPUT



Smart cities are dense cities



📍 Short distances

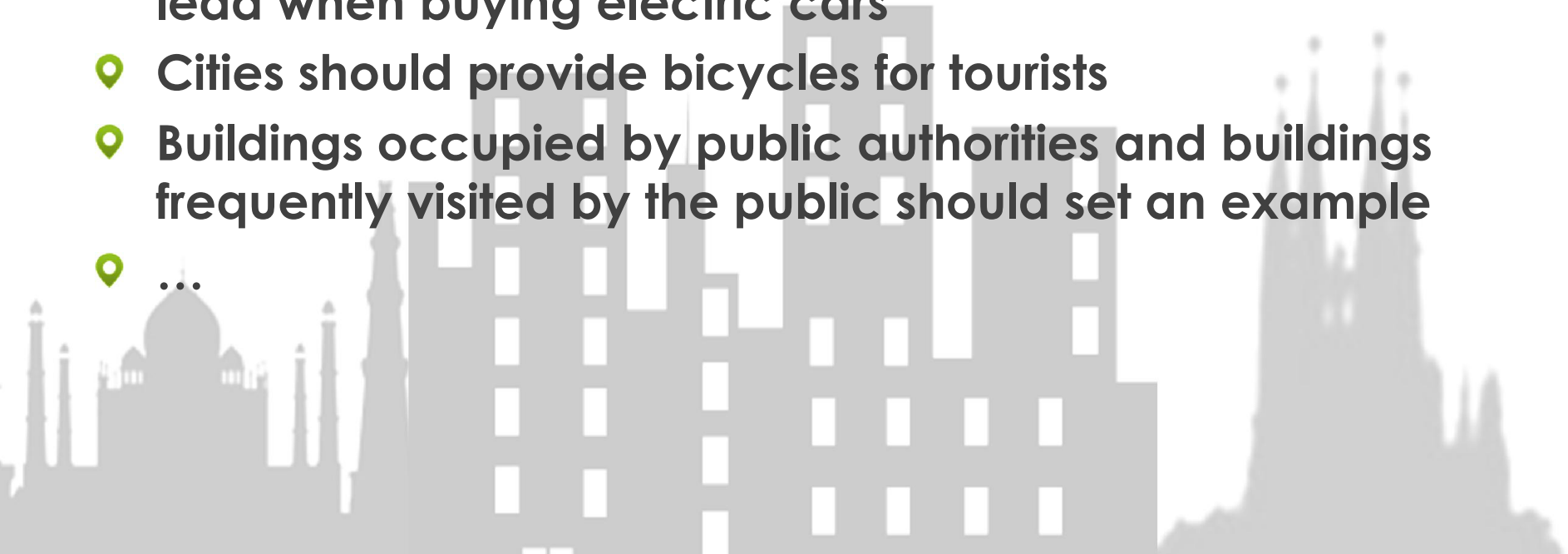
- Daily demand
- Schools
- Entertainment, culture
- ...

📍 Efficient infrastructure

- Public transport
- Water
- Sanitation
- Electricity
- Telecommunication
- ...

Behavior change: Public procurement

- 📍 Authorities have to lead in buying sustainable goods
- 📍 Public houses should be heated with renewable energy
- 📍 Electricity bought by public institutions should origin from renewable sources
- 📍 City administrations and public utility companies should lead when buying electric cars
- 📍 Cities should provide bicycles for tourists
- 📍 Buildings occupied by public authorities and buildings frequently visited by the public should set an example

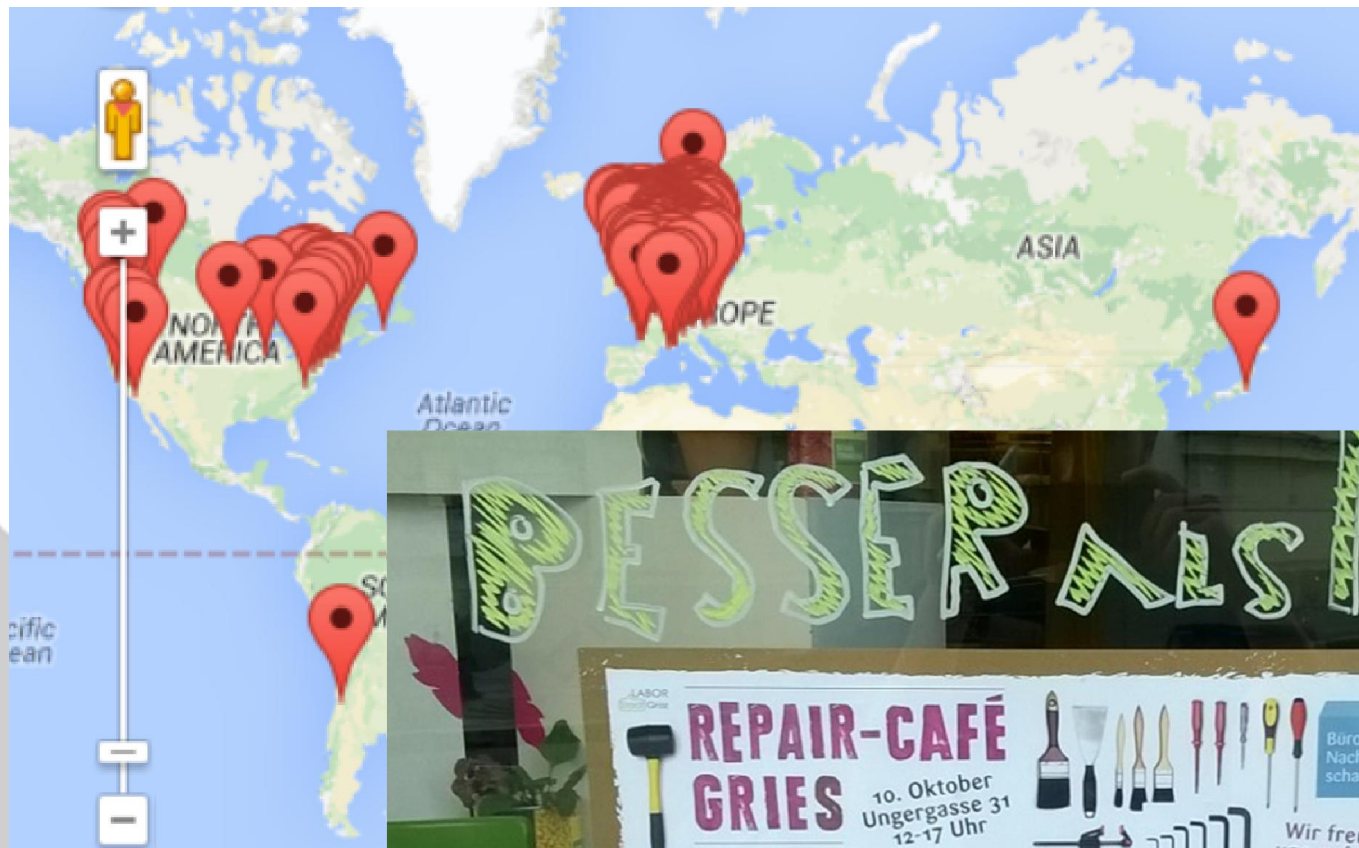


Circular economy

Extension of the life period of products



Toss it? No way!





“The creation of a renewable energy regime, loaded by buildings, partially stored in the form of hydrogen, distributed via smart intergrids, and connected to plug-in, zero-emission transport, opens the door to a Third Industrial Revolution”

City District Graz-Reininghaus



Baseline data:

- Project area 110 ha
- Full capacity 12.000 inhabitants
- max. 560 000m² net floor area
- ~ low energy house: 50 GWh/a heat demand (demand for warm water and heating), 4 GWh/a cooling
- ~ Passive house: 19 GWh/a heat demand (demand for warm water and heating), 6 GWh/a cooling
- ~ 30 GWh/a electricity demand
- Large seasonal load variations

Geo-
thermal

Tides

**Direct
utilization**

**Indirect
utilization**

**Photo-
synthesis**

Solar-
thermal

Photo-
voltaics

Therm.
Power.

Hydro-
power

Wind
Waves

dT, dc

Short
rotation

Wood

Waste
biomass

passive

active

Electricity

Storage

Hydrogen

Incin-
eration

Therm.-
Chem.-
processes

Bio-Tech.
processes

Solid,
gas,
& liqu.
Bio-fuels

Bulk &
fine
Chemic.

HP

Storage

Low-
temperature

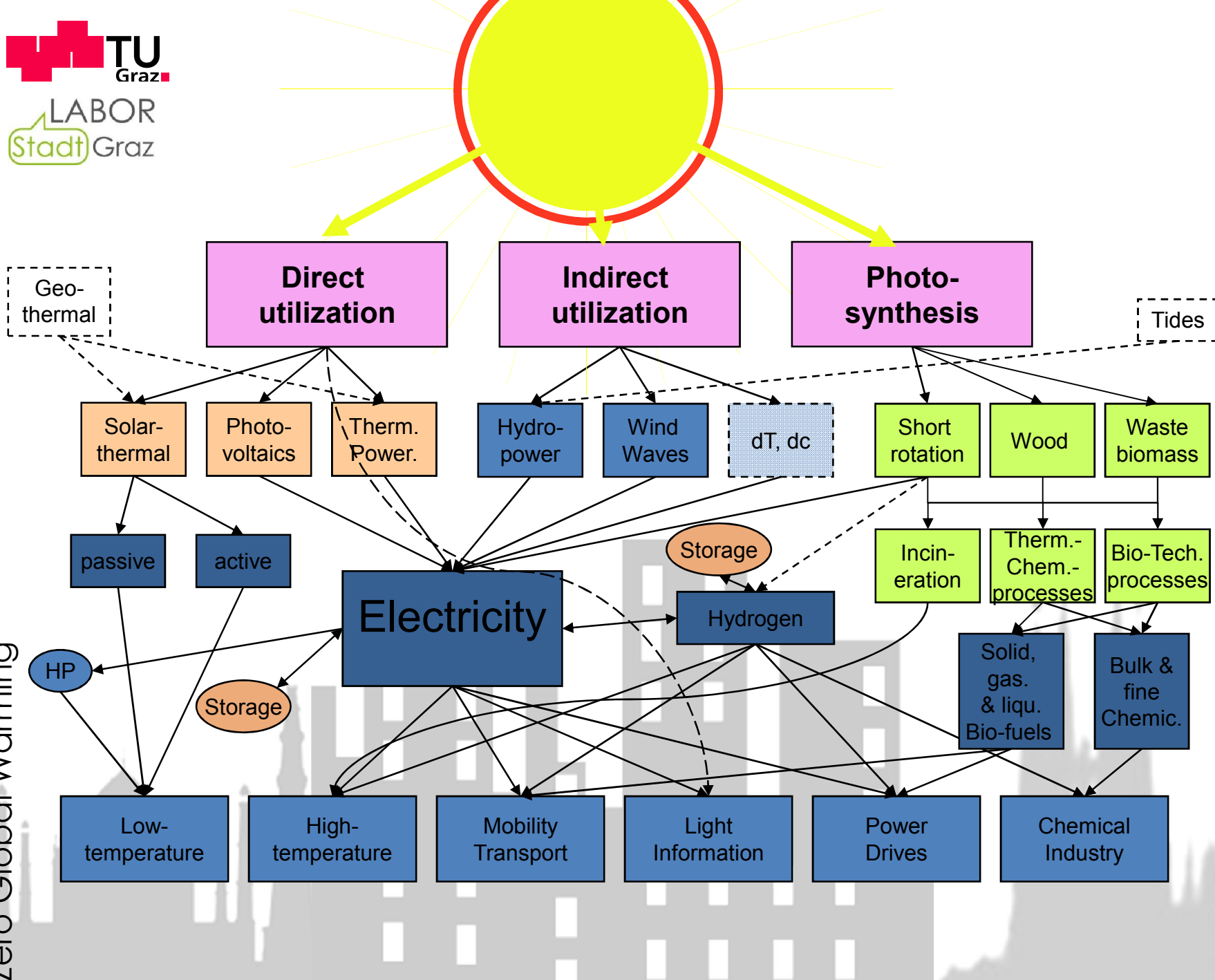
High-
temperature

Mobility
Transport

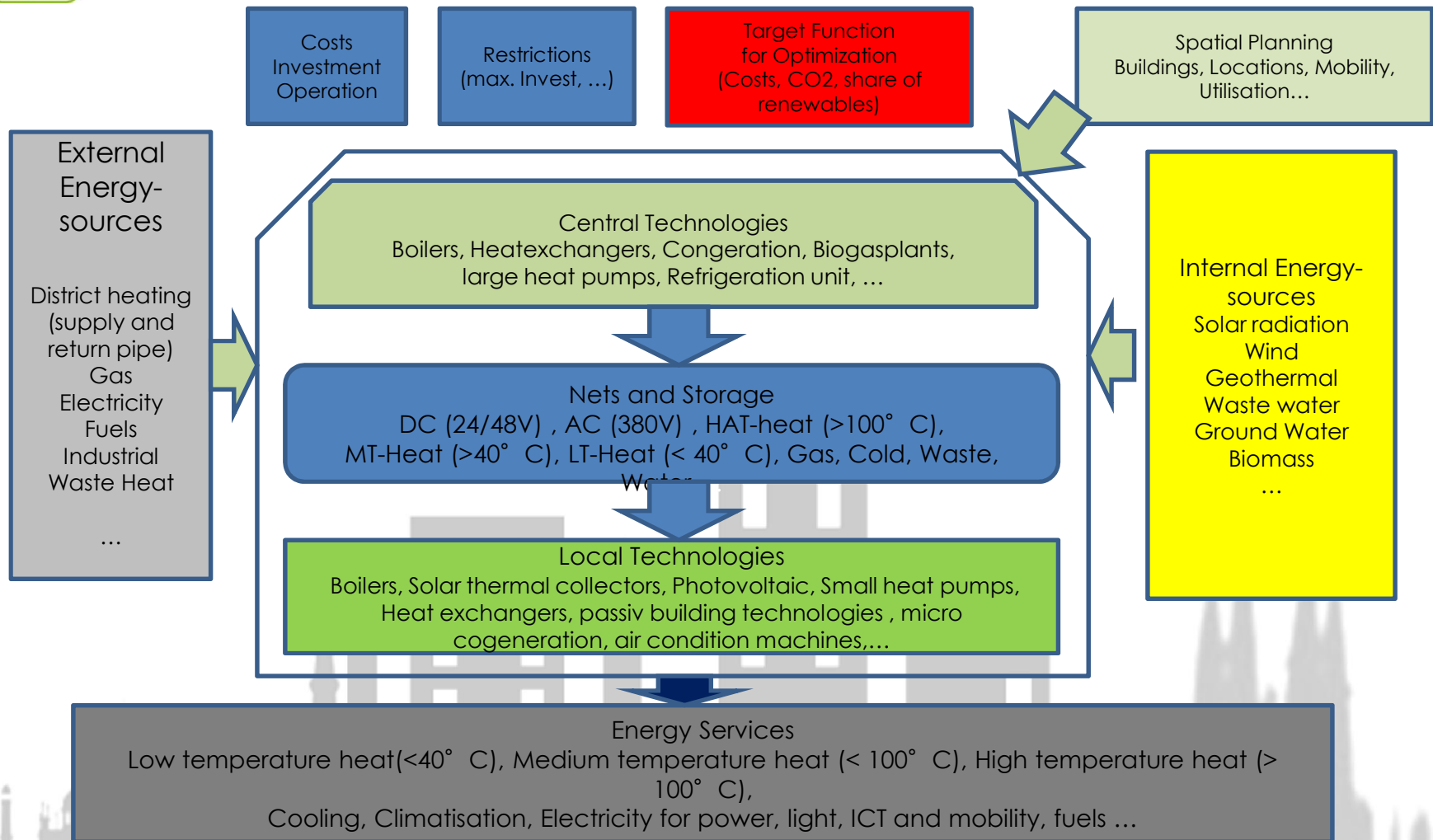
Light
Information

Power
Drives

Chemical
Industry



ECR Frameworkplan Energy



System approach
holistic energy concept

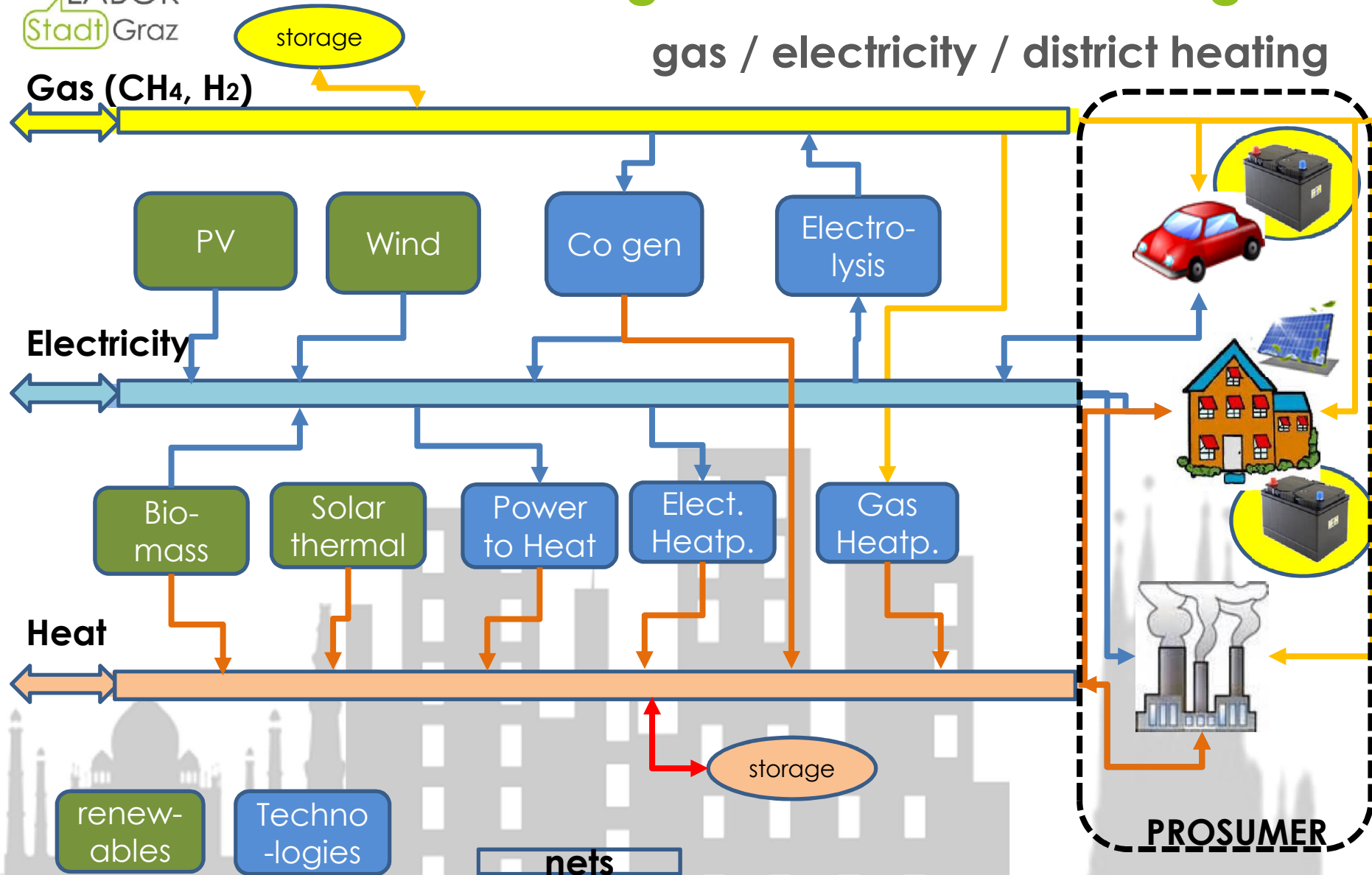
Energy production within the city

- 📍 Photovoltaics
- 📍 Solar thermal
- 📍 Biogas
- 📍 Urban wind
- 📍 Geothermal



The challenge: the internet of energies

gas / electricity / district heating



The Challenge:



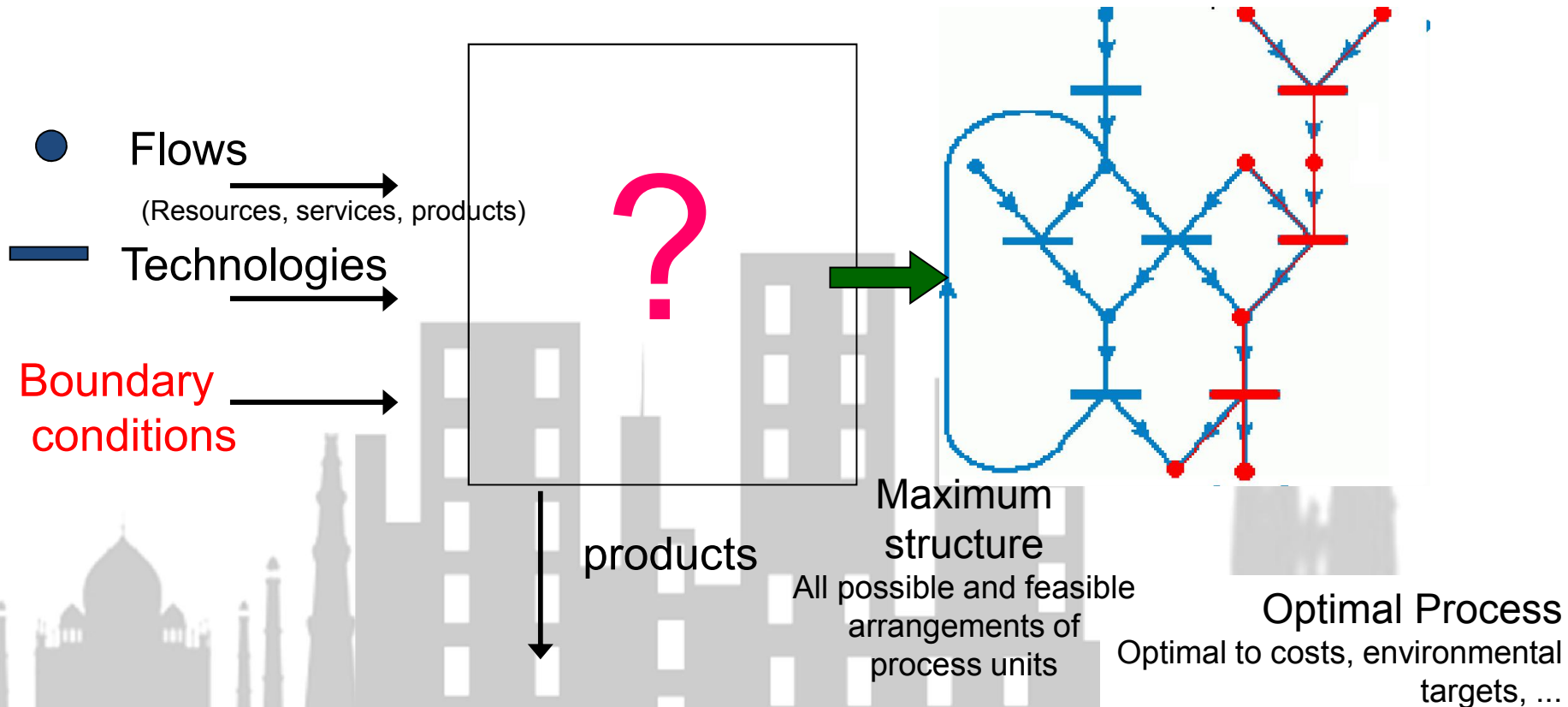
- 📍 **Aspiration: Energy- self-sufficiency for the city-district**
- 📍 **Supply security at any time**
- 📍 **Modular building structure of the city- quarters (concept for decades)**
- 📍 **Economical, political and legal framework - dialogue between stakeholders!**

ECR

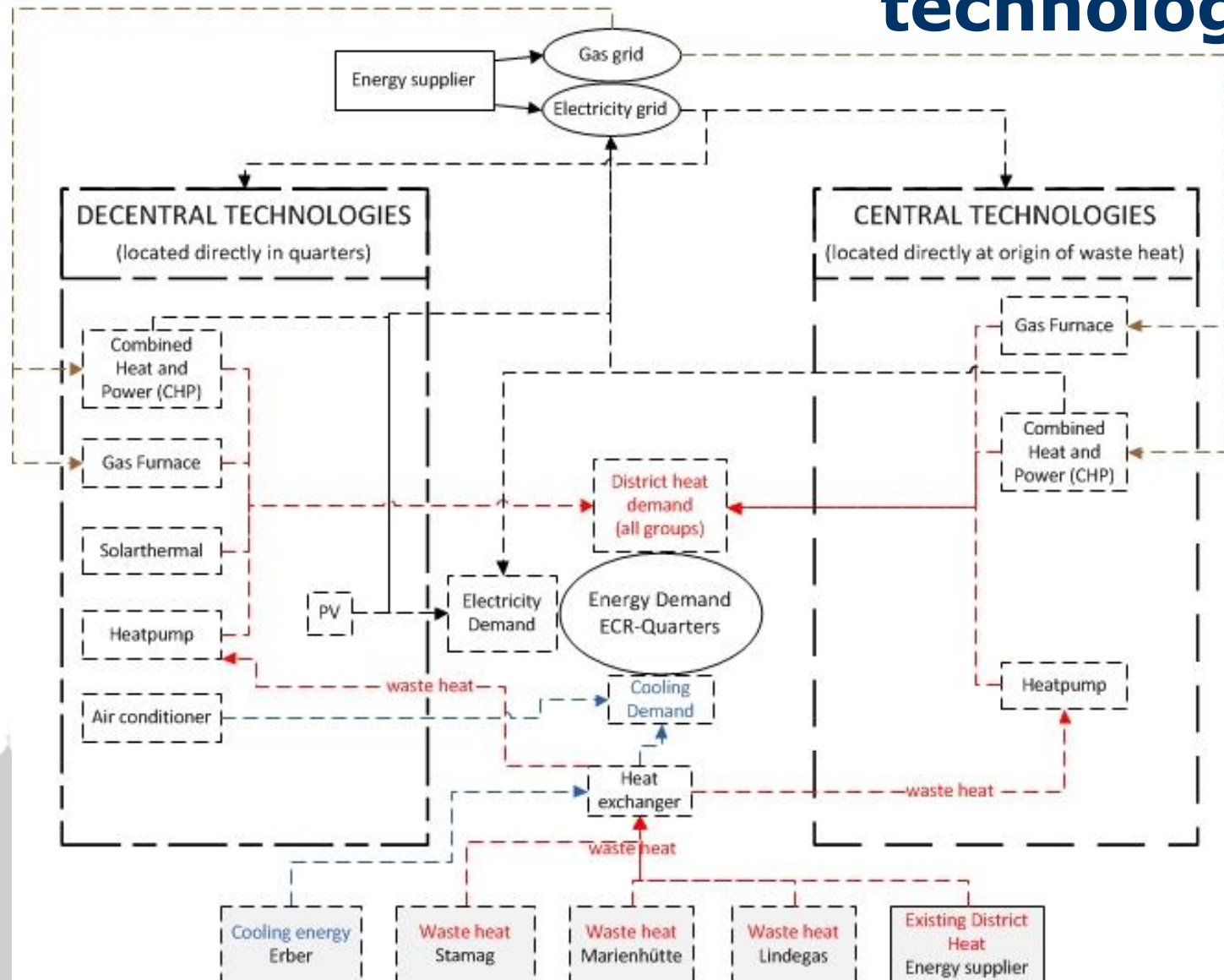
Frameworkplan Energy

- Method of bipartite graph method (p-graph) to optimise material and energy flow systems (www.p-graph.com) using a branch-and bound optimisation routine
- Main aim = find network consisting of operation of process technologies to transform raw materials (e.g. not utilised energy) into products (→ optimal energy systems)
- Optimisation of process structures and continuous flows (e.g. material flows) in a processing unit
- Process synthesis approaches used to generate complex process structures in regions, industries, urban areas ...

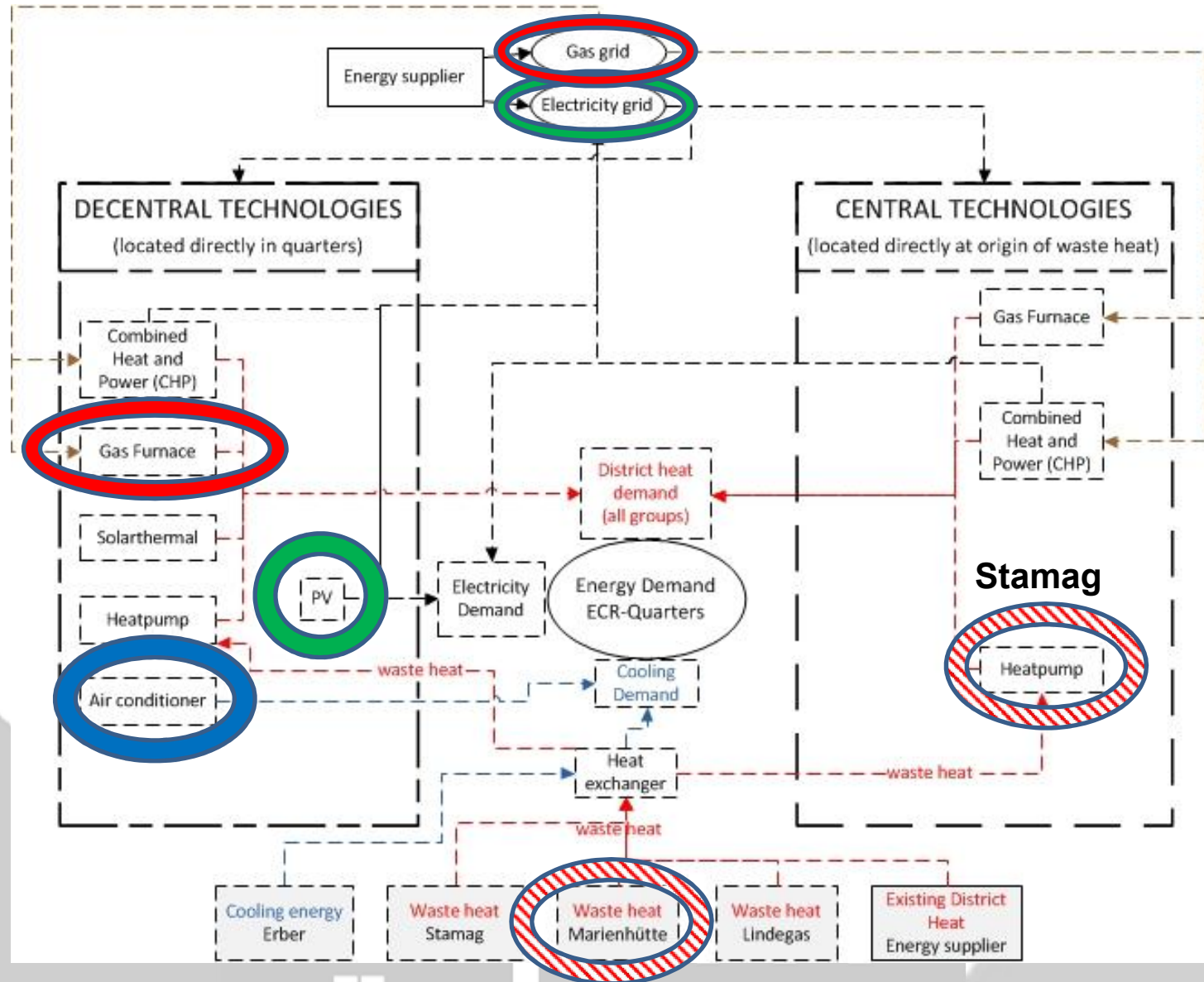
Using Process Network Synthesis to generate technology networks



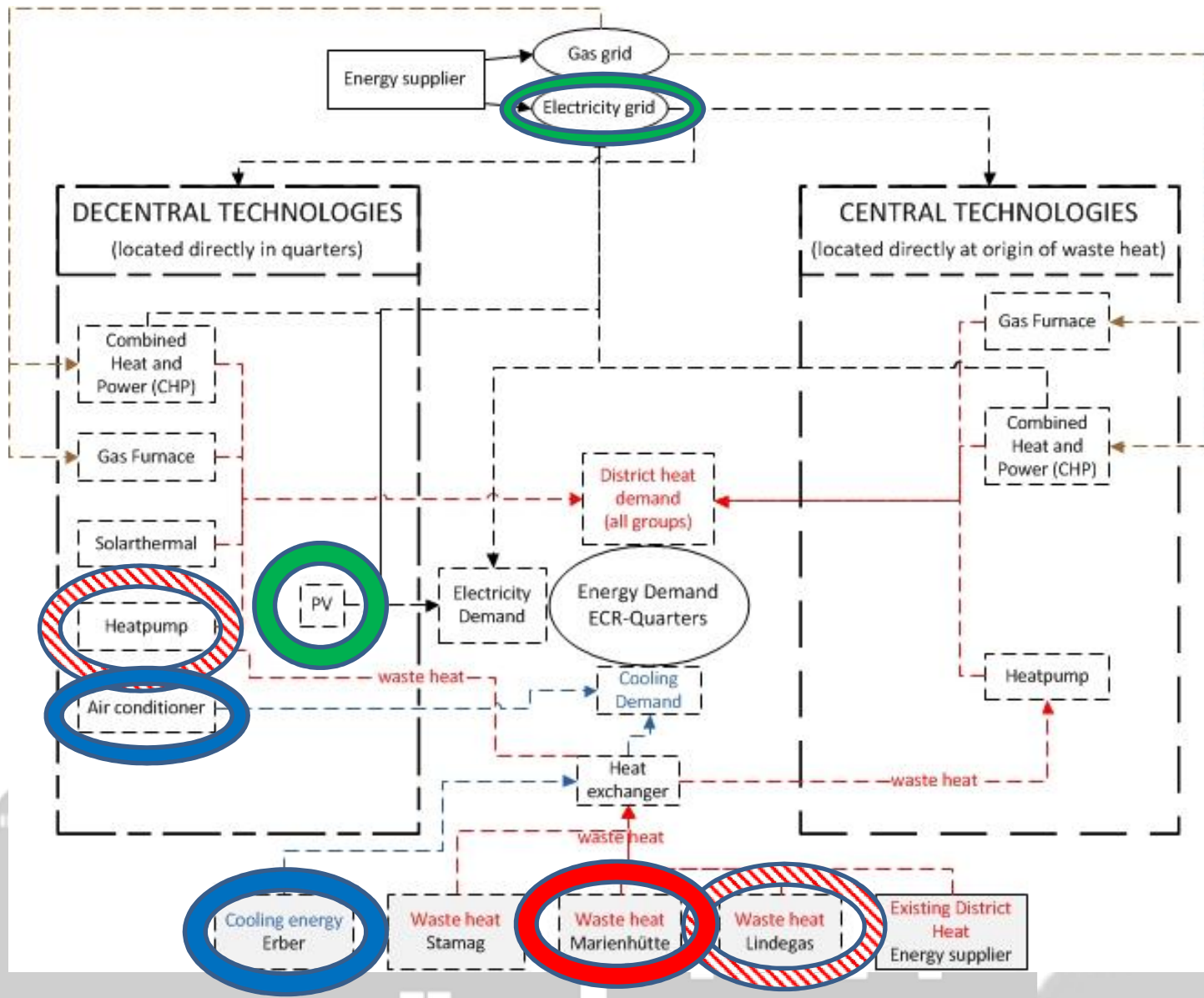
Maximum Structure of technologies



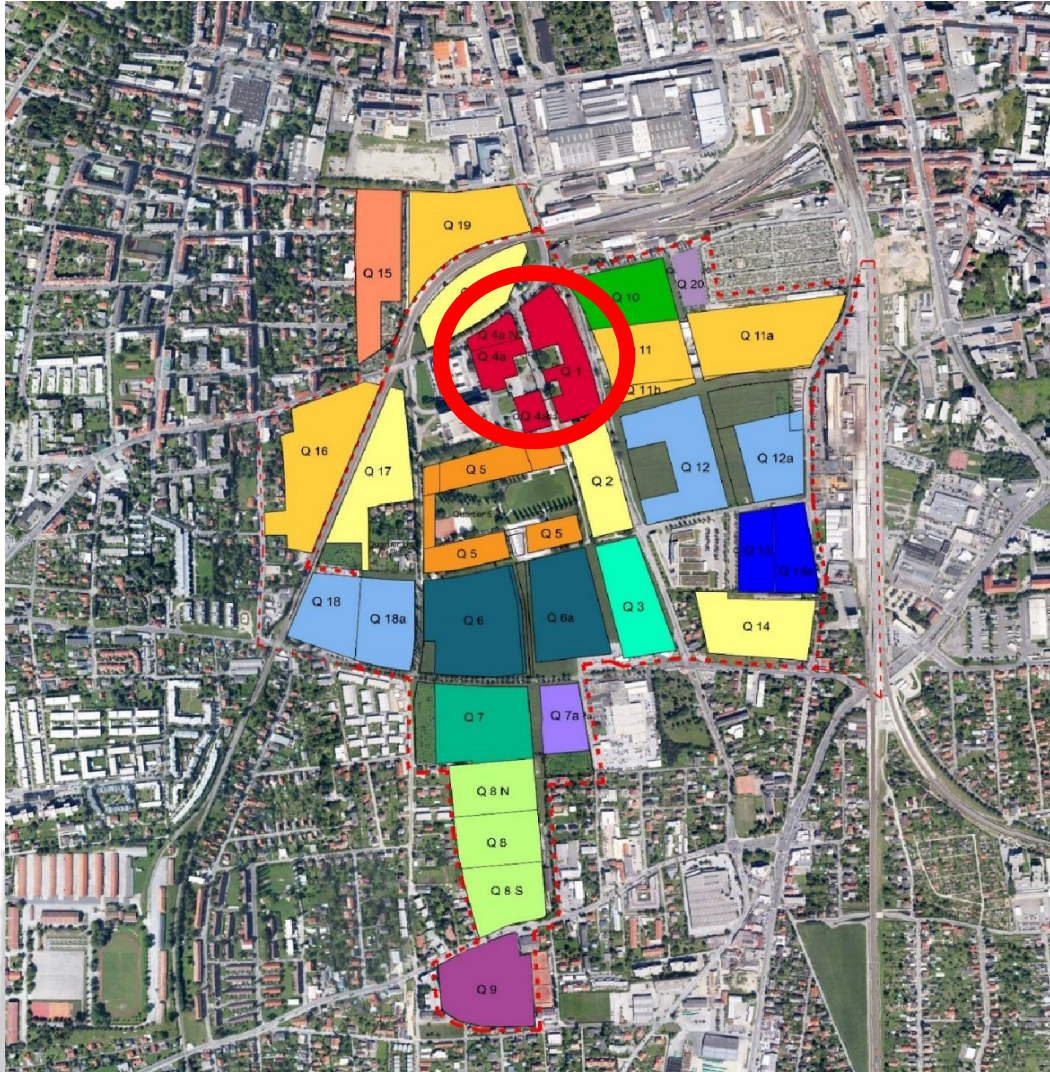
The optimum with current prices (PH)



Heat autarky (LEH / PH)



Dividing into „sub-quarters“



Quarters are defined by:

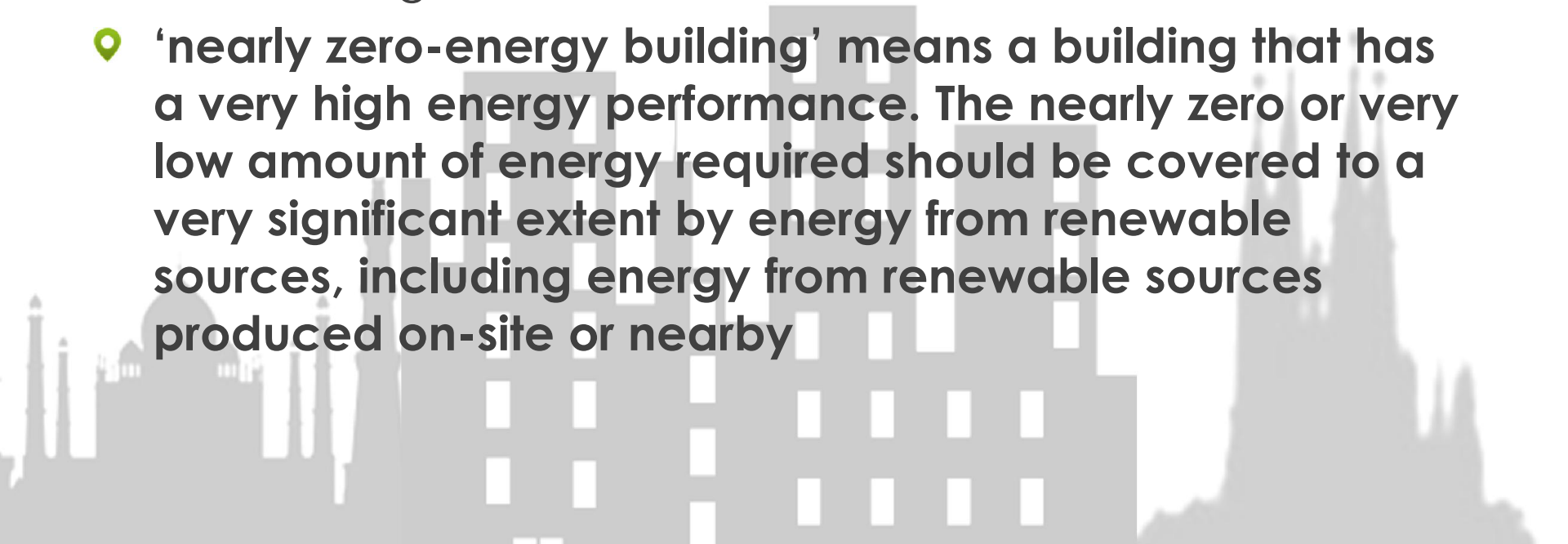
- 📍 Same energy need per square meter
- 📍 Same load profiles
- 📍 Averaged grid length
- 📍 Circled quarter: start of construction

EU Building Directive

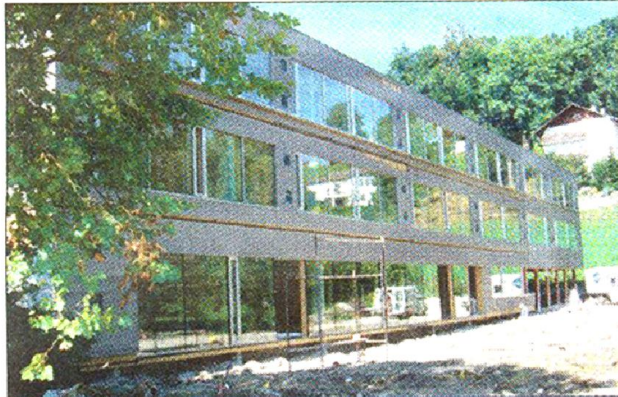
DIRECTIVE 2010/31/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 19 May 2010 on the energy performance of buildings

📍 Member States shall ensure that:

- a) by 31 December 2020, all new buildings are nearly zero-energy buildings; and
- b) after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings.

- ## 📍 ‘nearly zero-energy building’ means a building that has a very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby
- 

Passive house might look like:.....



Passivhäuser sind an keinen bestimmten Baustil gebunden. Es gilt aber: Je kompakter, desto effizienter.

Solar thermal

- 📍 Sanitary water
- 📍 Room heating
- 📍 Air conditioning
- 📍 Process heat
- 📍 Electricity generation
- 📍 Swimming pools



Bolaring Salzburg

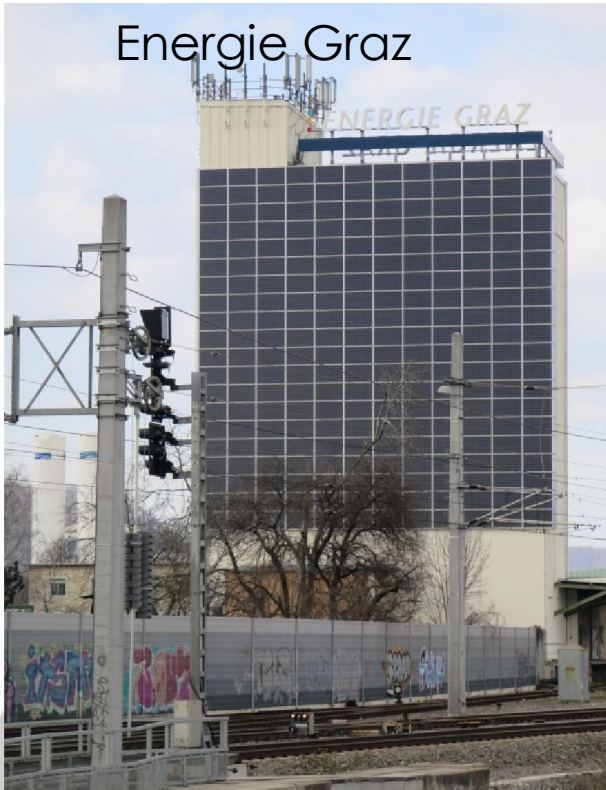
Photos: SOLID, Graz, Austria

Building integrated PV

PV modules might be cheaper than a classical facade

- 📍 **Building integrated PV does not need extra space**

Energie Graz



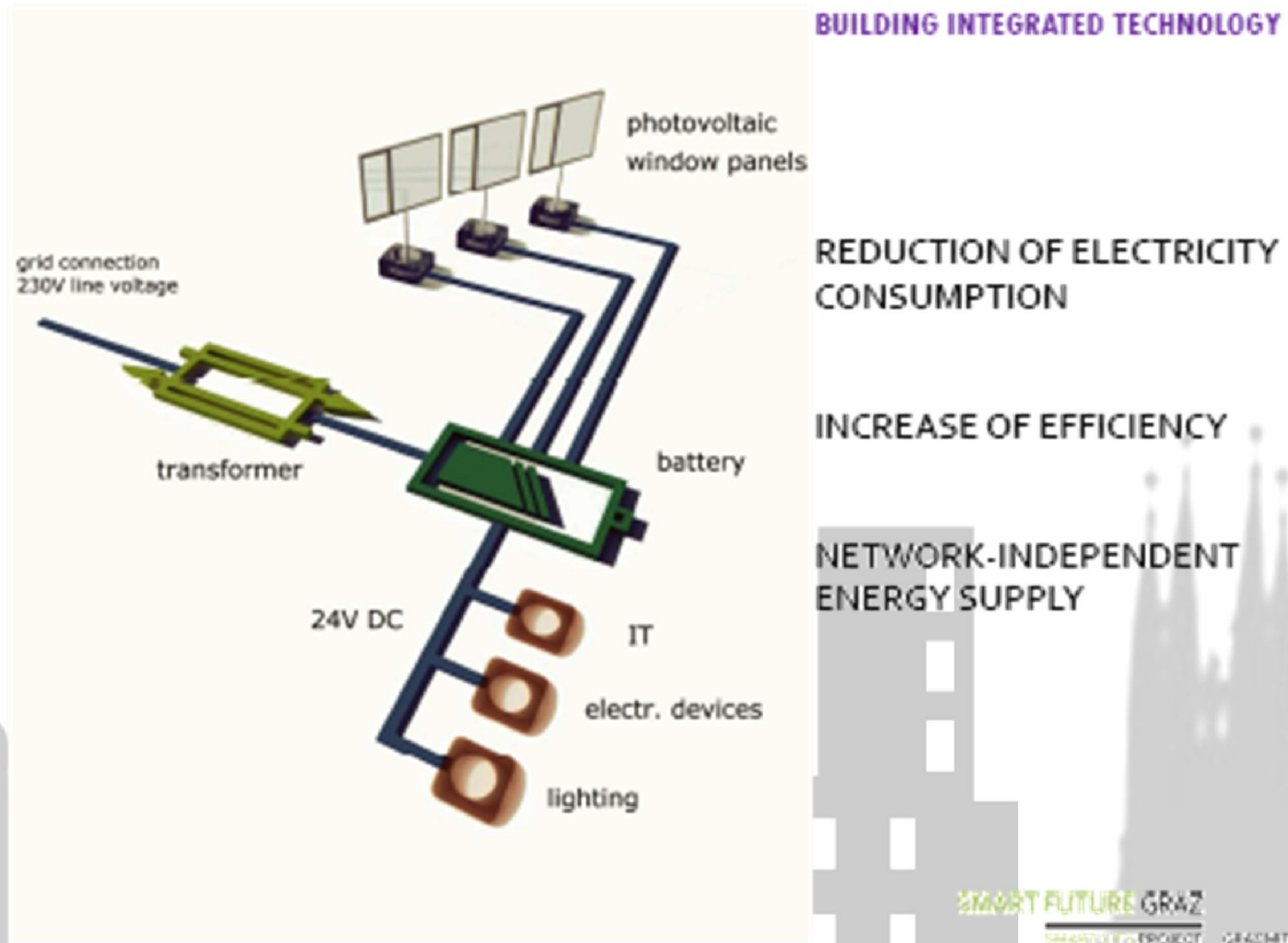
ONXY solar



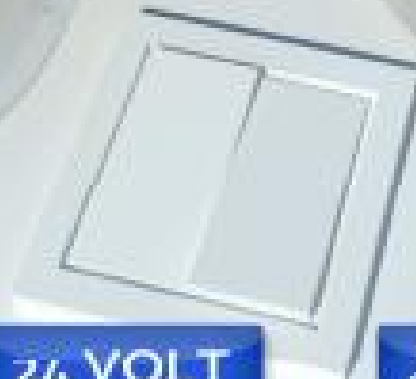
Facade integrated PV



Building integrated technologies



BUILDING INTEGRATED TECHNOLOGY
DSSL - DYE SENSITIZED SOLAR LAMPS



WIRELESS
SWITCH



24 VOLT

DSSC
GLASS



NETWORK
INDEPENDENT
LIGHTING

SMART FUTURE GRAZ

PROJECT - GRAZ METRO

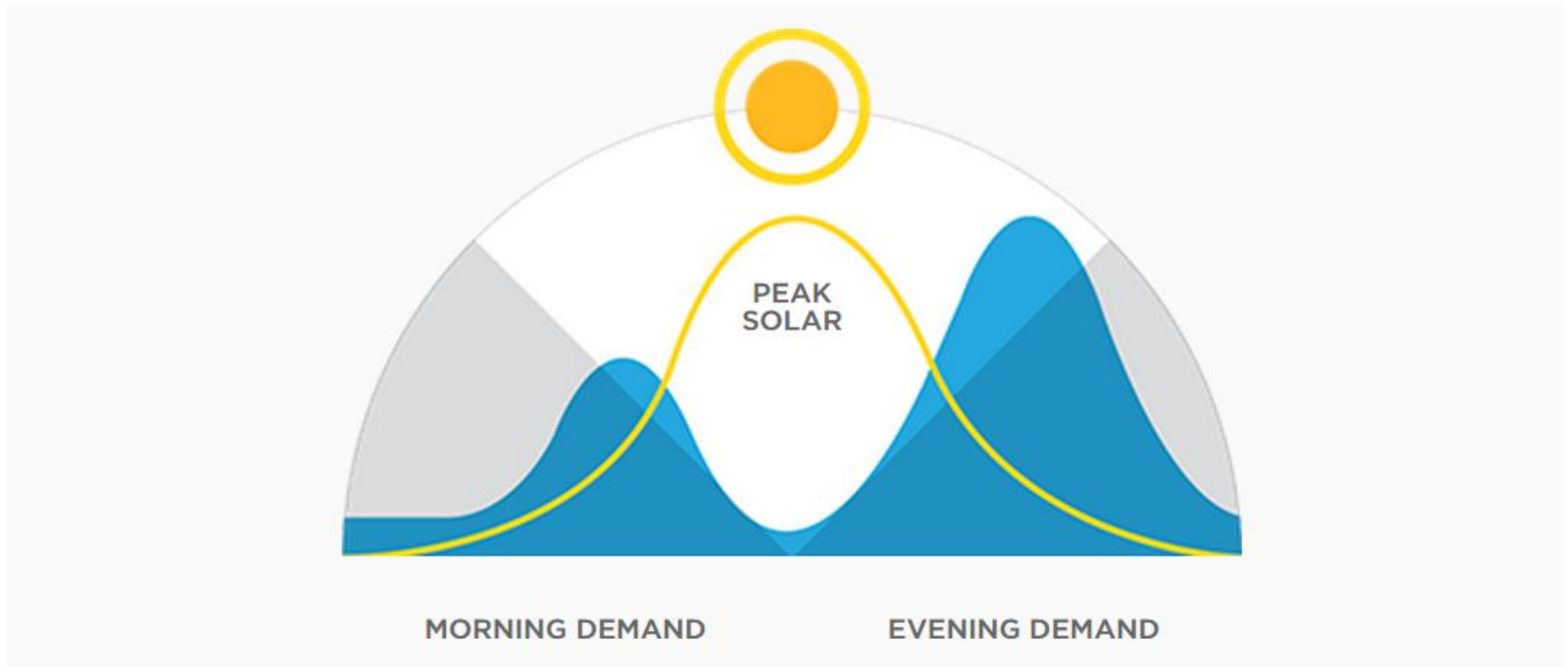
There is a general trend towards electricity

- 📍 Heating (power2heat)
- 📍 Mobility
- 📍 Production
- 📍 Information (bit2byte)



Solar powered day and night

Storage technologies needed

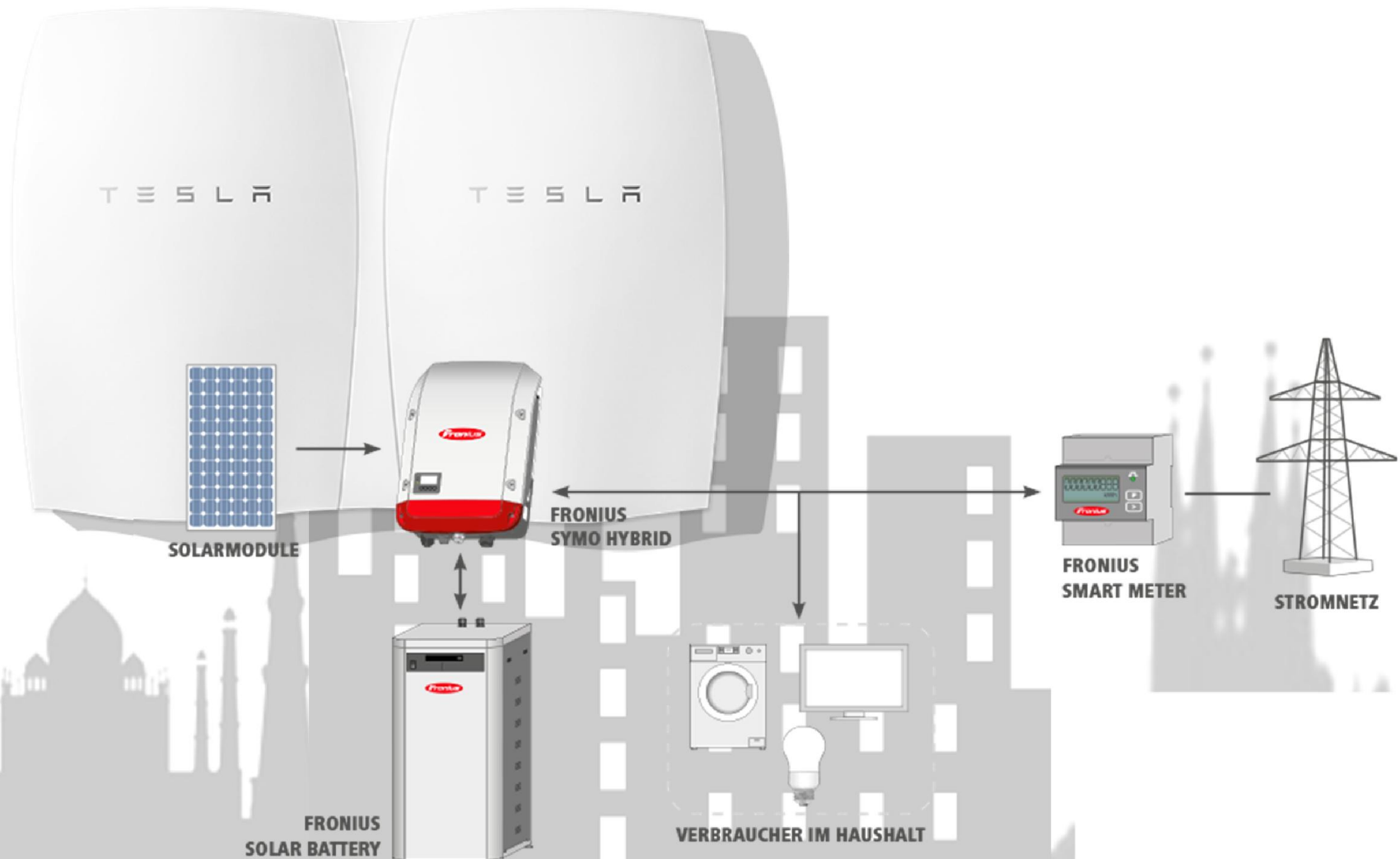


Source of figure: <http://www.teslamotors.com/powerwall>

Electricity storage

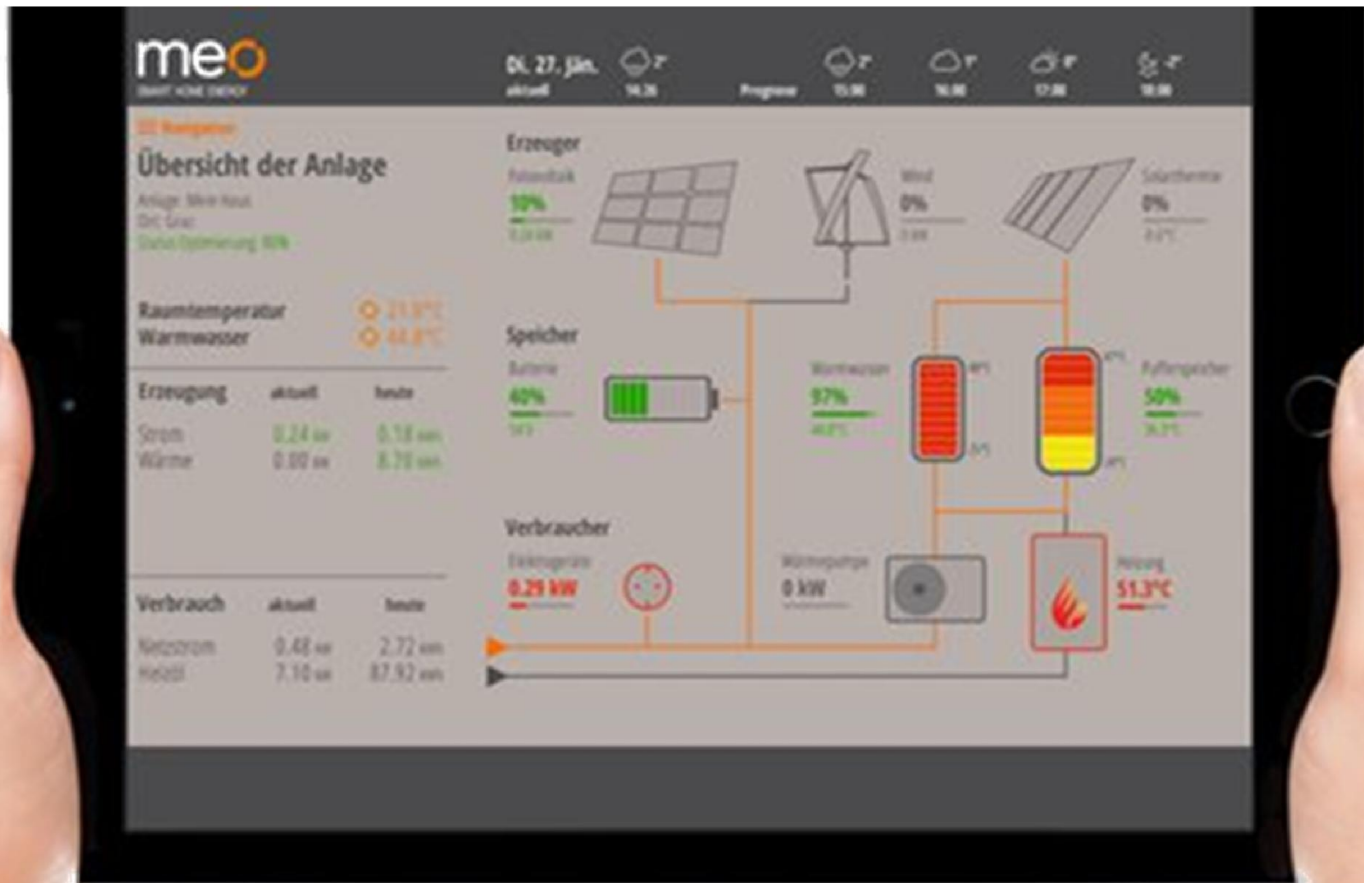
Tesla powerwall

At 38,000 reservations, Tesla's Powerwall is already sold out until mid-2016



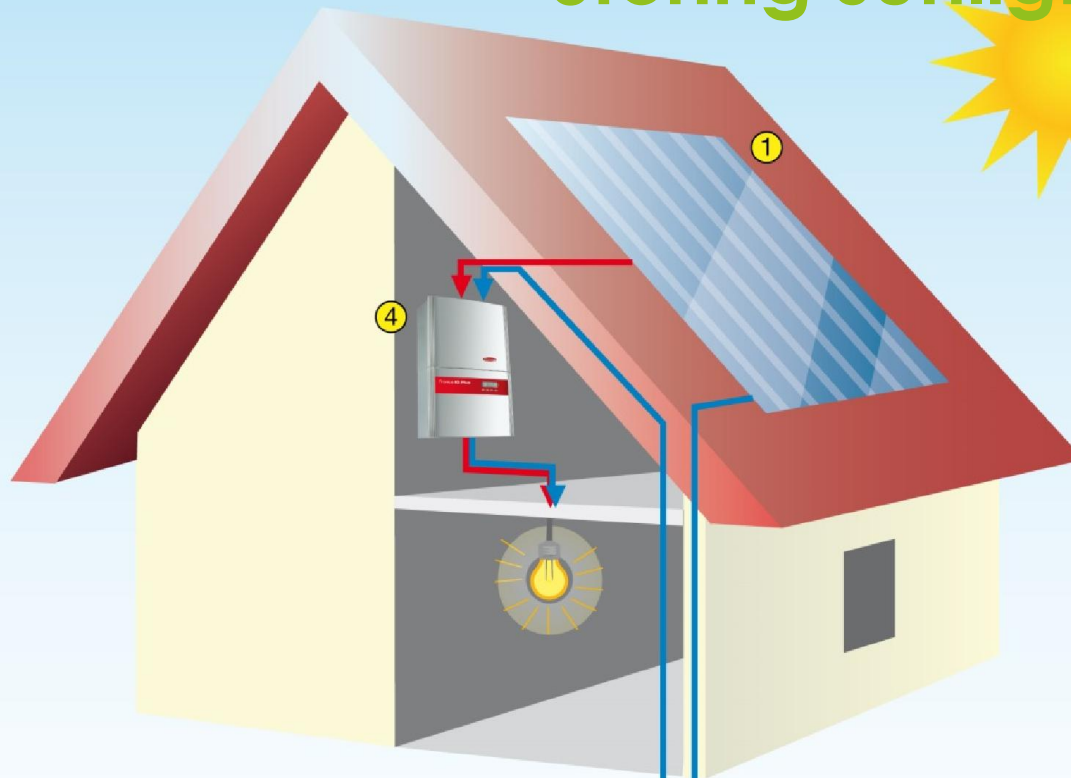
ICT for domestic energy management

ICT as a facilitator



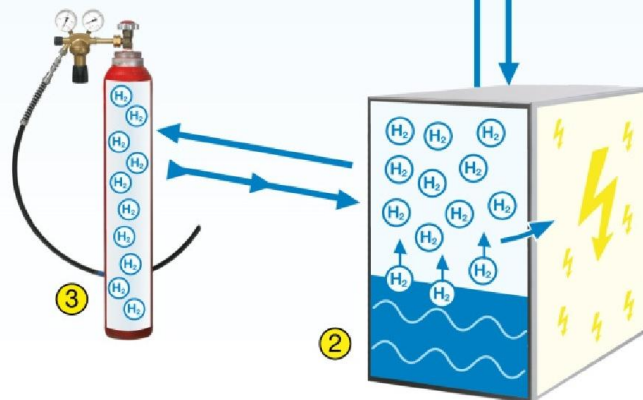
Storing sunlight in hydrogen

Fronius product



→
Direct consumption of
the electricity generated

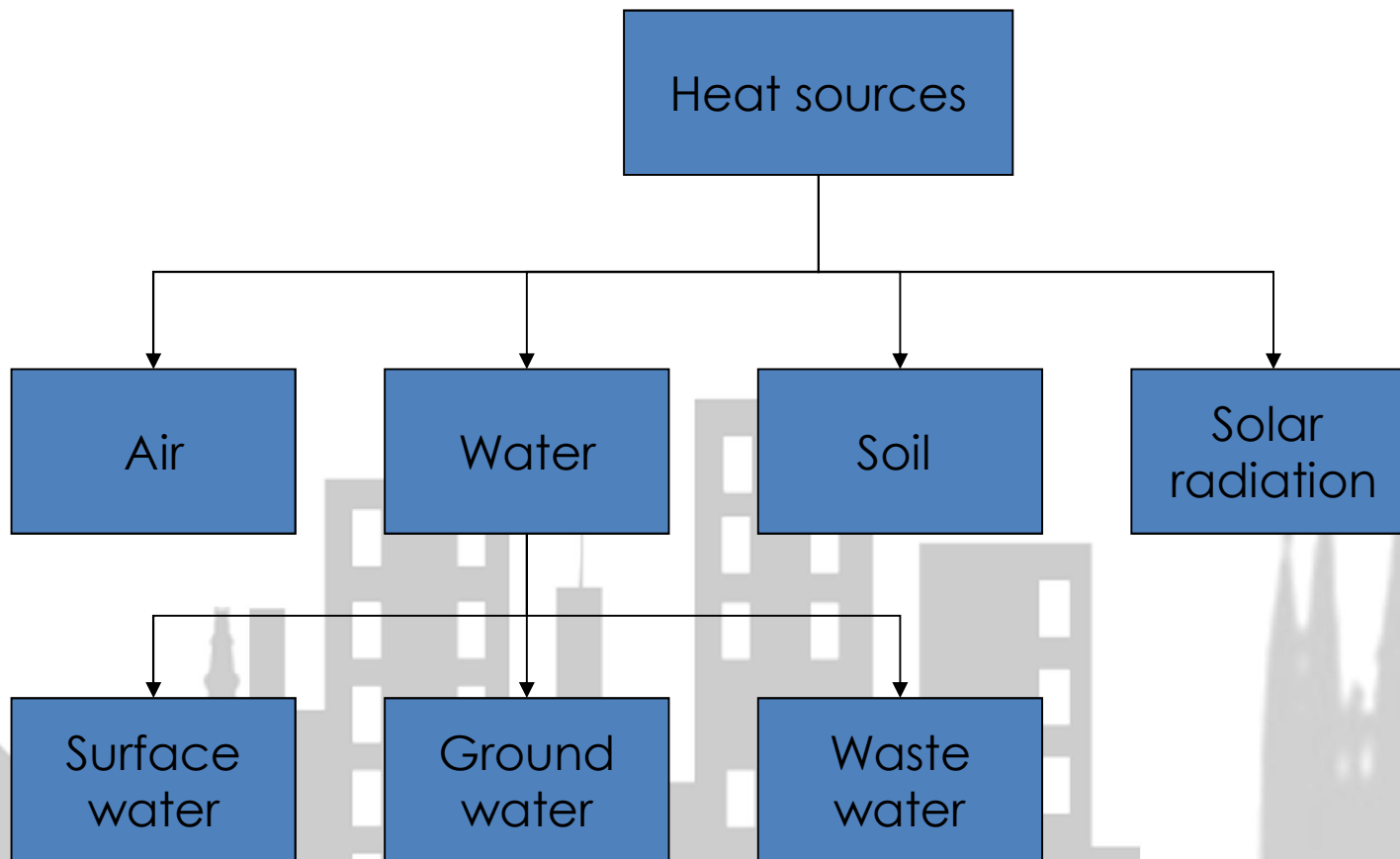
→
Circuit via Fronius Energy Cell



- ① Photovoltaic system
- ② Fronius energy cell
- ③ Hydrogen storage system
- ④ Inverter

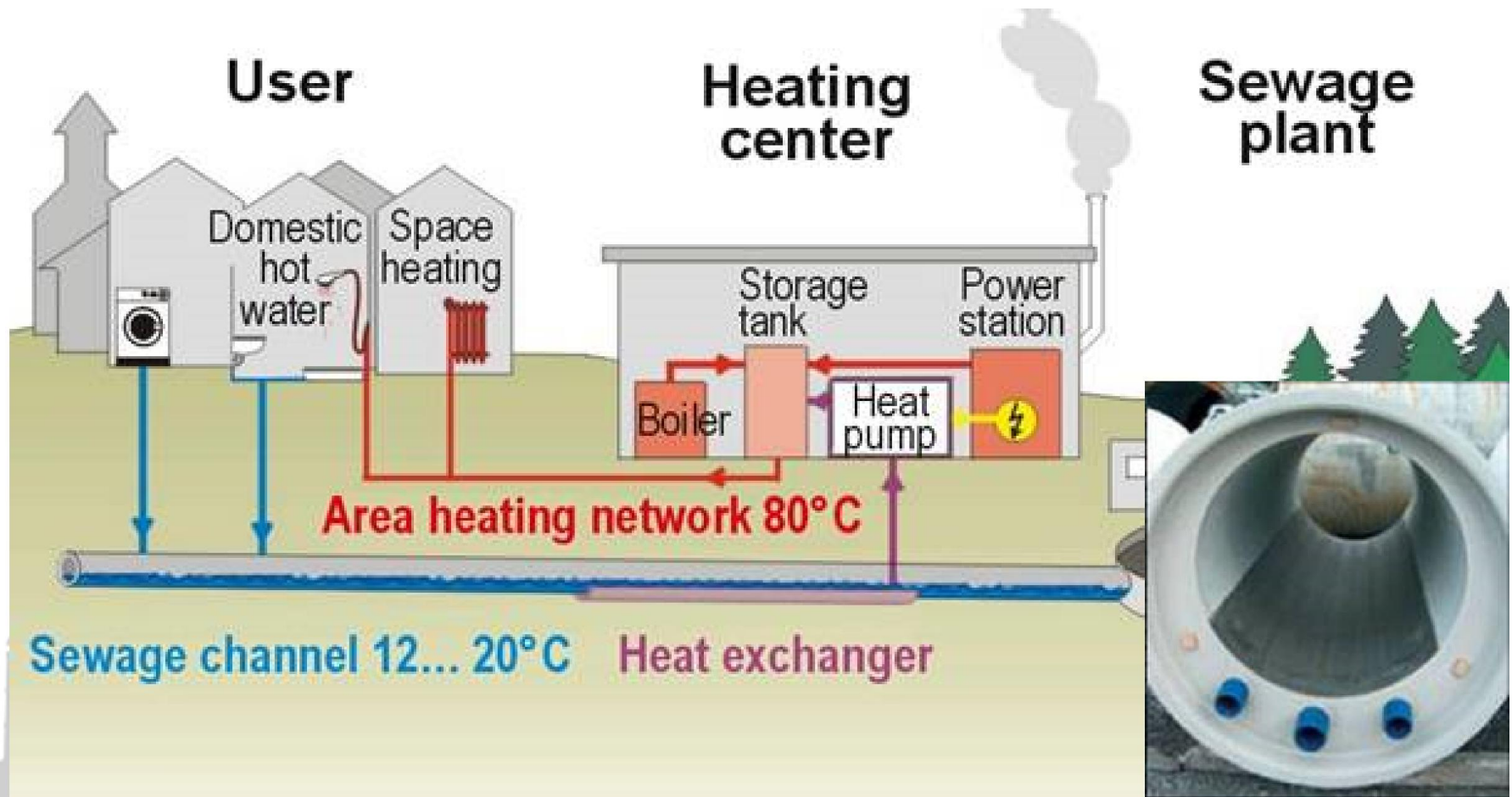
Electricity for heating: heat pumps

For heating and cooling

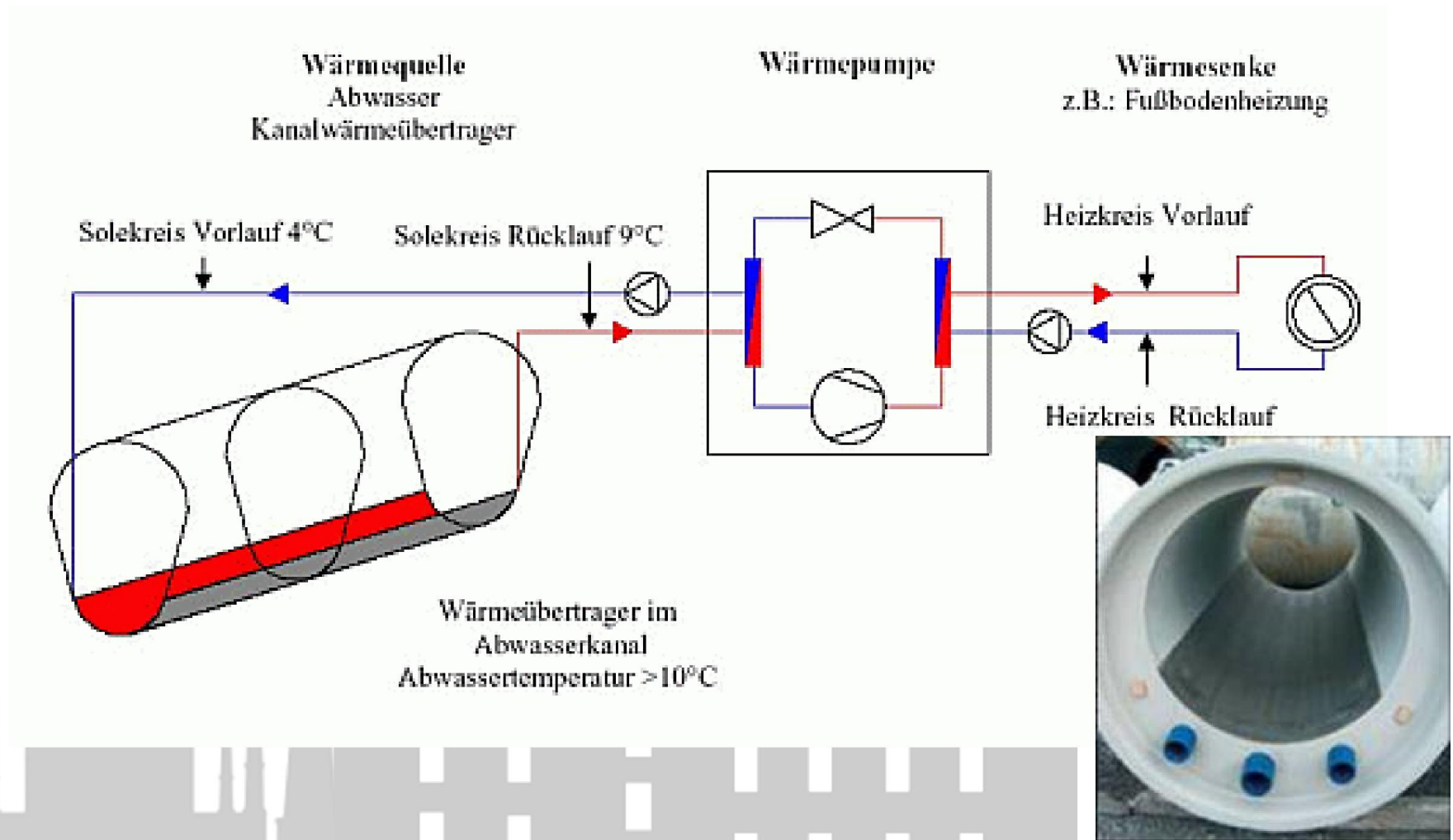


Heat recovery from waste water

hvac-journal/2012/052012/waste-water-as-heat-source-of-heat-pump/



Waste water as an energy source



**Envision Green Hotel is proposed for
the city of Miami-based Michael
Rosenthal Associates Radical
Innovation in design competitions.**



Large building integrated



The Bahrain World Trade Centre is a good example of building-integrated wind turbines in a large-scale commercial building application. The high-rise building integrates three HAWTs, each with a 29m rotor diameter, into sky-bridges linking two 50-storey towers. Total cost for the wind turbines were reported to be around 3.5% of the total project cost. The three wind turbines generate between 1,100MWh to 1,300MWh annually, meeting about 11% to 15% of the building's electricity demands.

Urban wind



NL Architects is attempting to domesticate, or urbanize, wind energy design by creating aesthetically pleasing wind turbines.



These small generators can be integrated into urban landscapes, and provide clean, renewable energy without creating any disturbing noise.

The quiet 'Power Flowers' are designed to look like trees and capture renewable wind energy.



The basic concept relies on [Urban Green Energy's 'Eddy' turbine](#). The Eddy turbine is a small turbine that is designed for residential use. Power Flowers use either 3 or 12 Eddy's on their wind tree to capture as much emission-free energy as possible.

Use available areas for energy production



The idea come from a student from Arizona State University, and each turbine would be capable of generating enough power to light up a medium sized apartment, even if the wind speed is only at a low 10 mph.

<http://keetsa.com/blog/eco-friendly/new-take-on-wind-farming/>

Urban biomass as an energy resource

Feedstock for biogas plants

- 📍 Food waste from markets, shops, households, restaurants, gardening,...
- 📍 Urban biomass from green areas, bushes, ...
- 📍 Waste water (organic content)



Biogas from organic waste for homes and cities

The 2 WM plant at the Stelling Moor near Hamburg / Germany produces about 330 m³ gas / hour that is used in a cogeneration unit for the production of electricity and heat



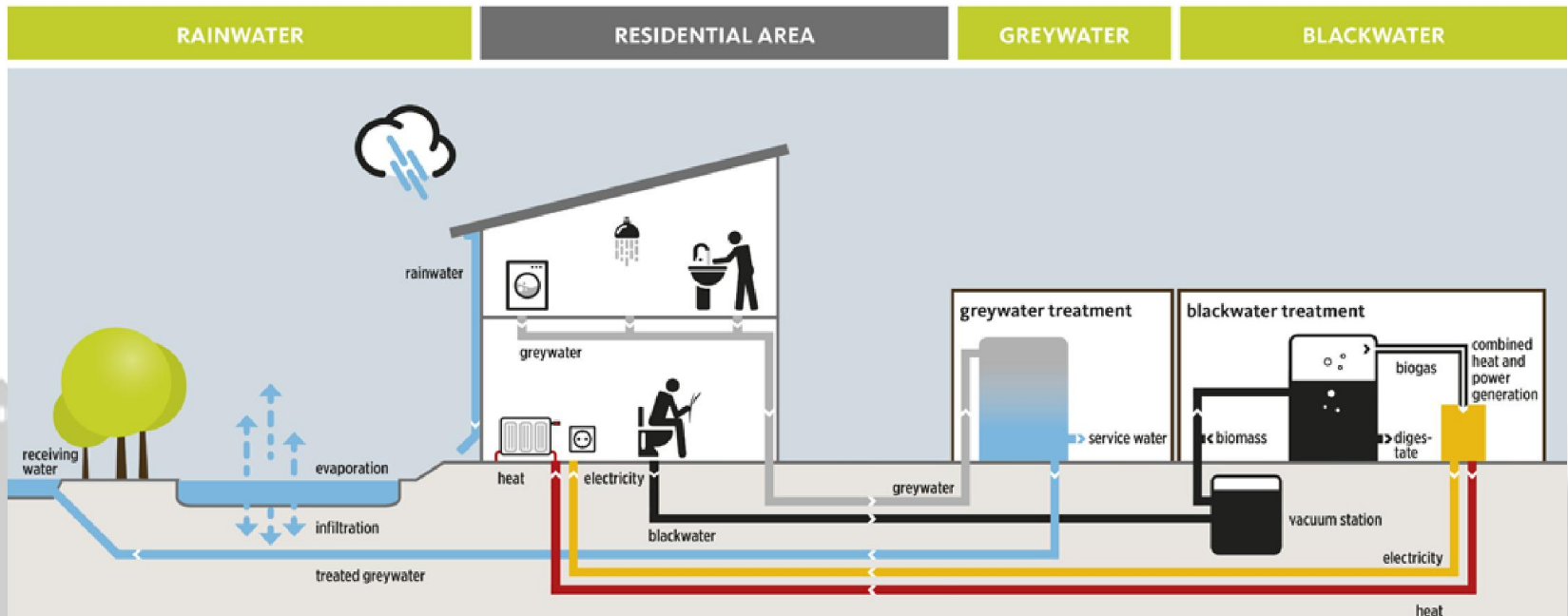
Plus-energy waste water treatment

Vienna



The Jenfelder Au project in Hamburg

- All toilets are on a vacuum system, so that only about one liter of water is used per flush. This is expected to save about 7300 liters of fresh water per year per person in 700 households (that's a non-negligible 12,500 m³ per year).
- The vacuum system will convey the waste to an anaerobic digester. The digester will produce biogas that will generate both heat and electricity for the complex.
- The biogas system (with combined heat and power) is expected to produce 100 kW of electrical power and 135 kW of thermal power, enough to supply 30% of the heating needs and 50% of the electricity. The rest of the energy will come from a combination of solar panels and a geo-exchange heat pump system.



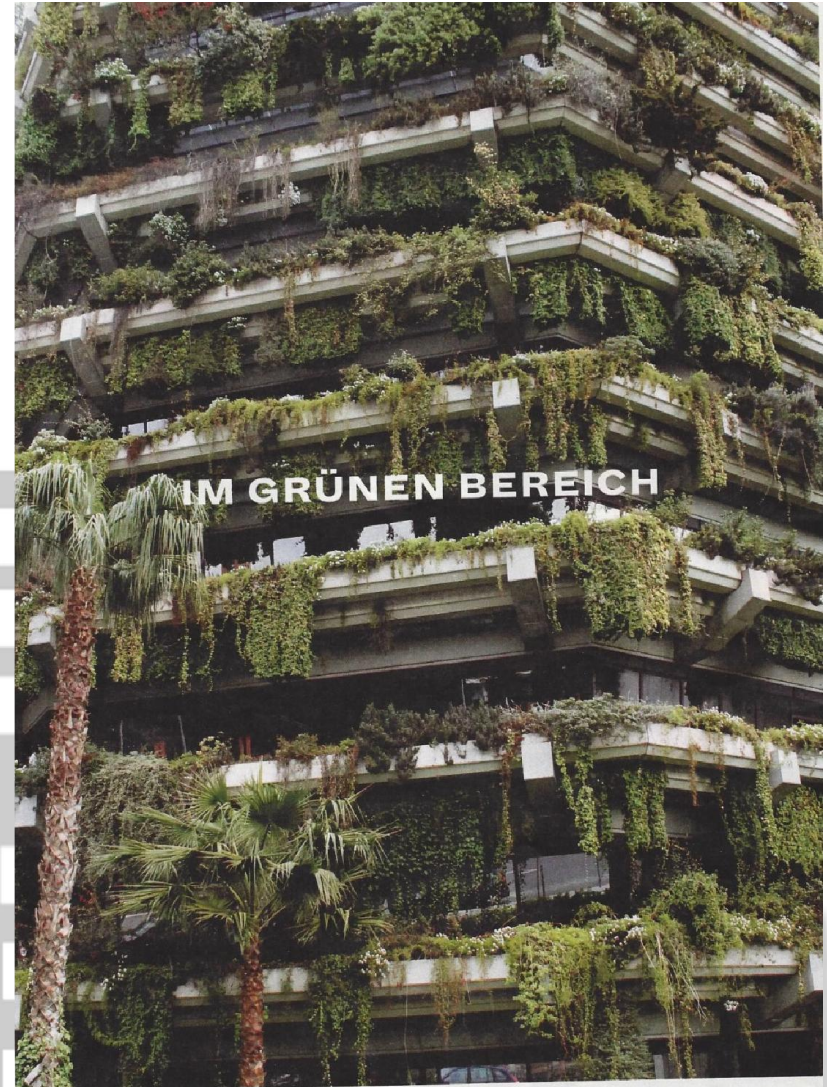
Water efficiency at homes

- 📍 Water free urinals
- 📍 Water efficient showers
- 📍 Urine diverting toilets
- 📍 Water cascading
- 📍 Dry, water efficient toilets



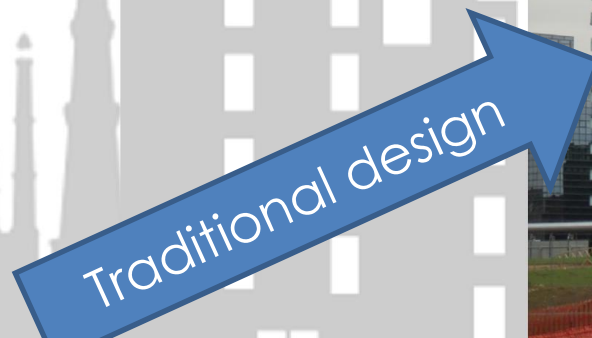
Technologies for reduction of energy demand for heating and cooling

- 📍 In the 20th century people moved out of the cities to the green
- 📍 In the 21st century, we will move the green into the cities
- 📍 green facades reduce heating and cooling demand



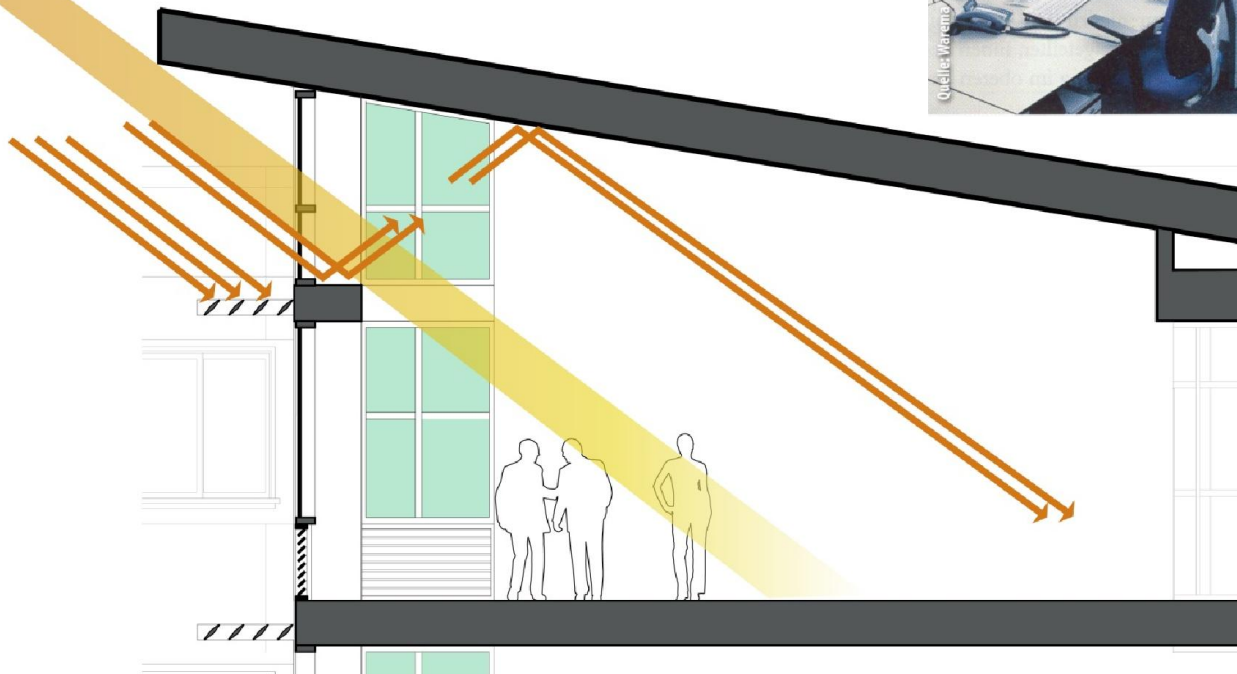
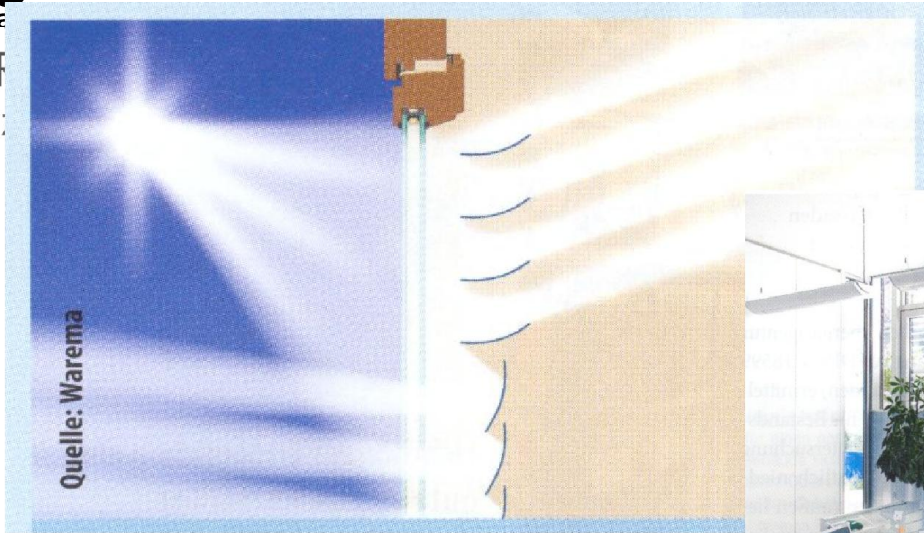
Bosco verticale, Milano Italy

Designed by Stefano Boeri Architetti



Traditional design

Daylighting



Technologies for reducing urban traffic for goods

- 📍 **Waste collection**
- 📍 **Last mile**
- 📍 **Modern buses**



Waste collection and treatment

Minimizing intra-urban traffic

- 📍 Vacuum collection systems for solid waste in Malmö



Urban food production

Vertical urban farm

Urban gardening



Growing vegetables underground

<http://www.zerocarbonfood.co.uk/>

- 📍 Zero Carbon Food is growing leafy greens, herbs and microgreens in a World War II bomb shelter in London



Urban food production

Growing underground - μ -greens

AT GROWING UNDERGROUND WE UNDERSTAND THE CONSUMER DEMANDS MORE!

That's why we're proud to be taking steps to ensure that we not only satisfy your every demand, but our steps acknowledge the environment we live in as well.



INCREDIBLE FLAVOUR

We can control precisely how much water, light and nutrients the crops get, meaning they're not only perfectly healthy, but also taste utterly divine – the perfect boost to any salad or sandwich or meal.



YEAR-ROUND AVAILABILITY

The cool tunnels (naturally always 16°C) are an ideal place to grow. We can farm at the same consistent quality all year, which means we don't have to source crops from countries with better climates.



LOW FOOD MILES

We're growing in (or under) London for Londoners. Our produce is picked, packed and delivered to London markets within just four hours, and could be on your plate within eight.



NO PESTICIDES

There are no pests living this far underground, so we have no need for pesticides at all. We will also use protection in ventilation shafts as a precaution. This is better for the



ENERGY EFFICIENT

The LEDs we use are 3 times more efficient than traditional high pressure sodium lights (HPS) used in commercial agriculture, and the perfectly insulated tunnel environment requires no extra



WATER EFFICIENT

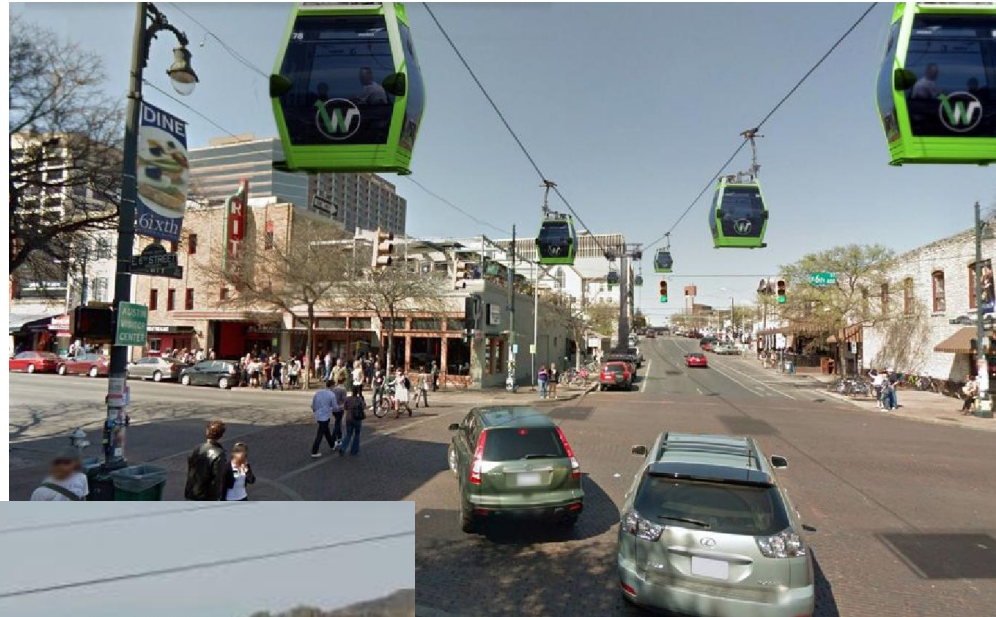
The hydroponics system uses and wastes 70% less water than conventional open-field farming. Water will come from rain-water harvesting on the surface and direct from the water table via the sump.

- 📍 **There is more gold in a mobile phone than in 1 m³ of gold ore**
- 📍 **The concentration of gold in New York is higher than in a usual Brazilian gold mine**
- 📍 **What can be mined:**
 - Precious metals
 - Phosphor, nitrogen, sulfur, ...
 - Houses are important resources for the future (stones, gravel, bricks, wood, glass, tiles,)
 - Polymers
 - Organic waste

Electricity based intra-urban traffic

Use the 3rd dimension: Cable cars

<http://gizmodo.com/watch-how-bolivia-built-the-worlds-longest-urban-cable-1623280417>



<http://forum.skyscraperpage.com>

Electricity based buses



Super Capacitor Buses

It is a new form of electric bus powered via energy stored in large onboard super-capacitors. A connector in the roof connects to the stationary electrical installation when the bus stops to let the passenger on to the bus.

- Electric Bus Technology
 - Super / Outer Capacitors (Energy Storage device)
 - Collector (fitted on the top)
- Super capacitors can be charged much faster than batteries, but hold less energy (at the current time).



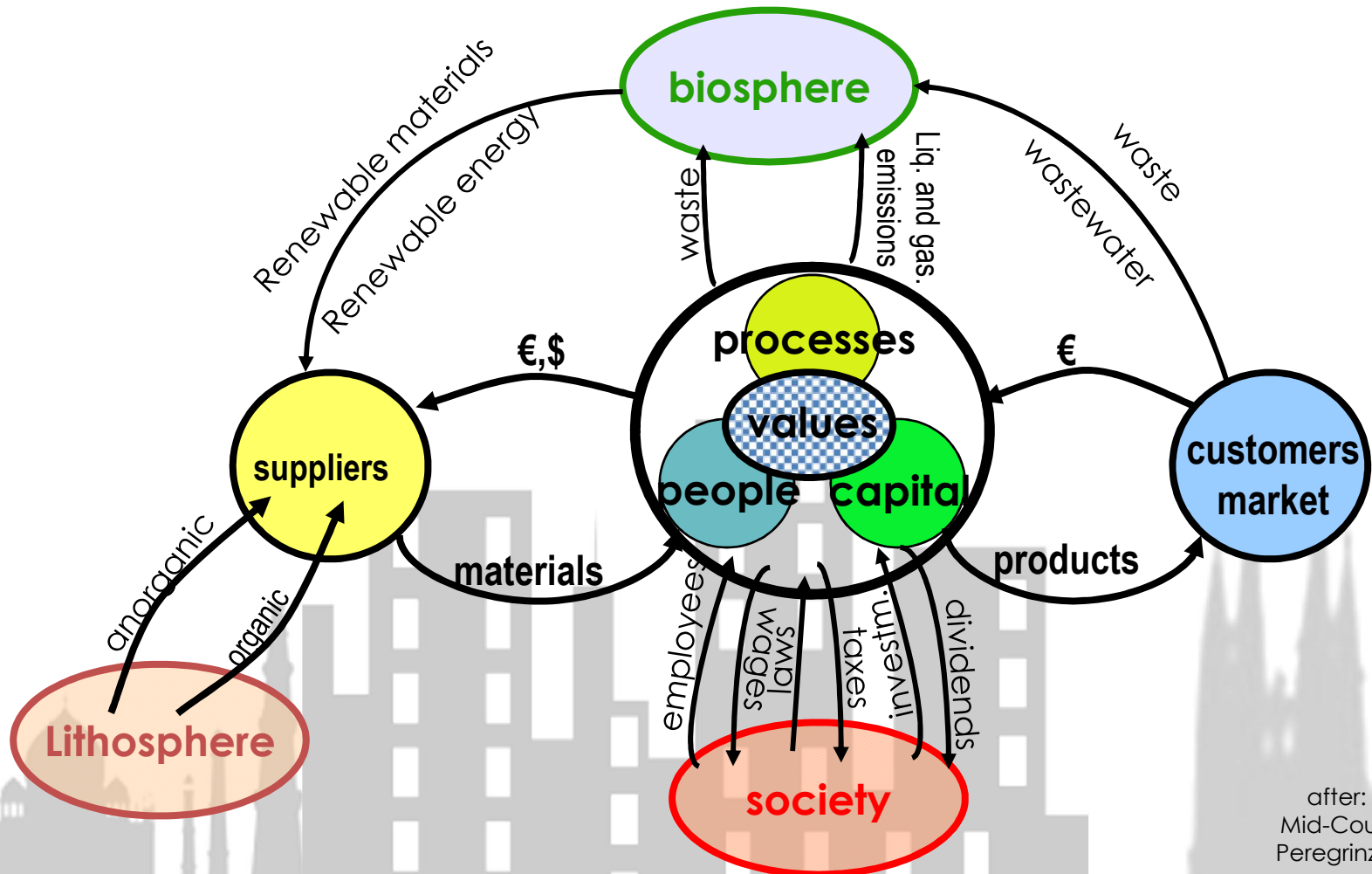
The role of industry

Key role

📍 Industry has to become city-fit



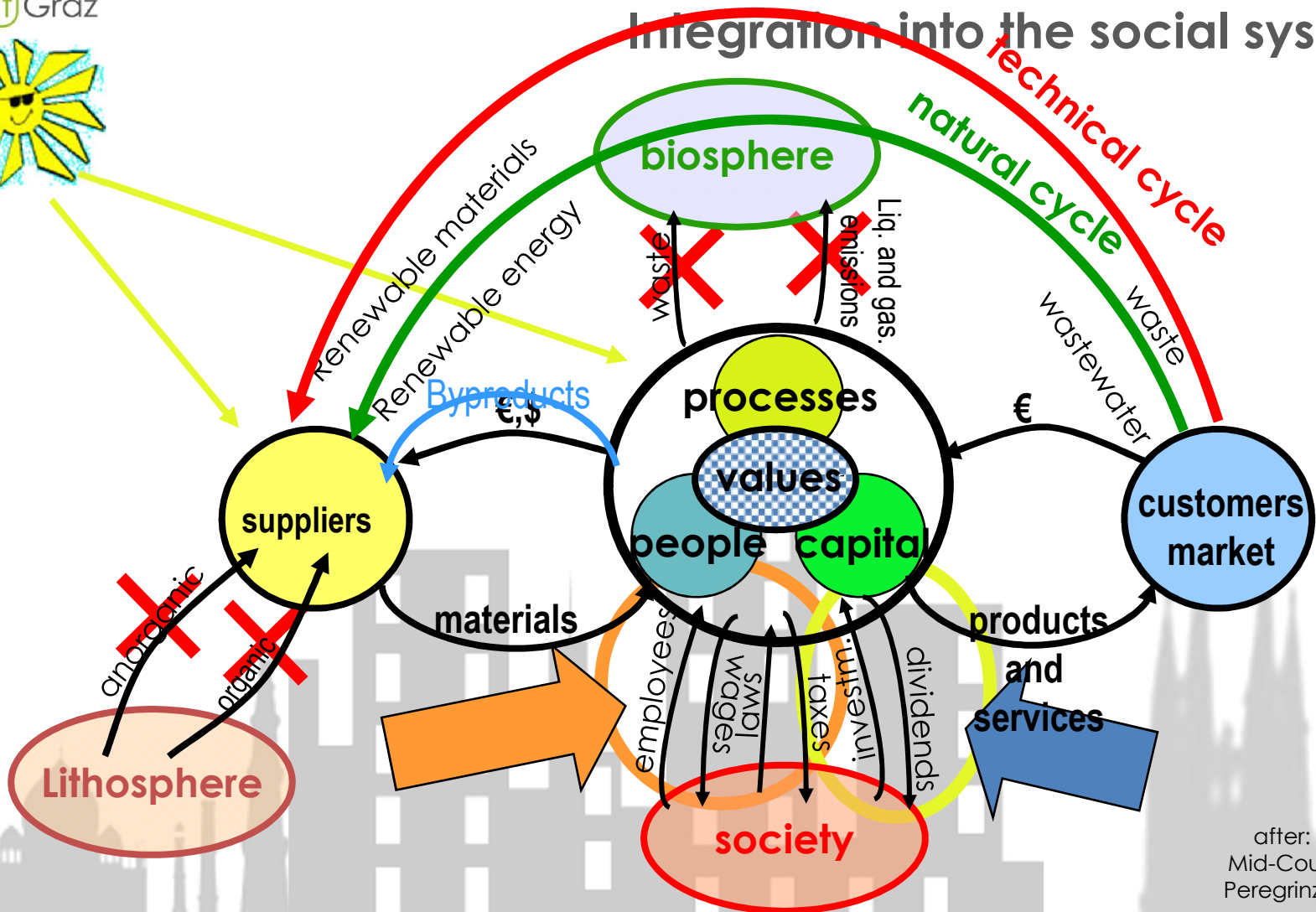
Typical Company of the 20th Century



after: R.C. Anderson
Mid-Course correction
Peregrinzilla Press, 1998

The company of the 21st century

Integration into the social system



after: R.C. Anderson
Mid-Course correction
Peregrinzilla Press, 1998

Green brewery

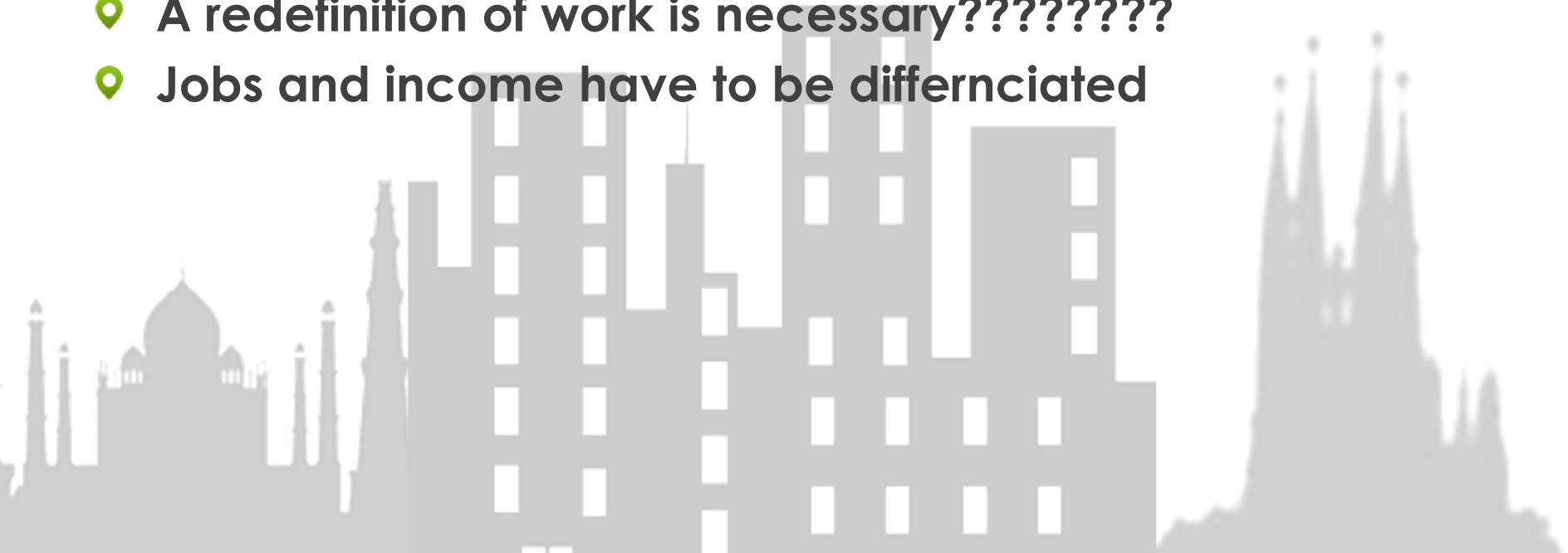
1st lage brewery 100% on renewable energy



Jobs through REs?

People move to the cities in order to find jobs

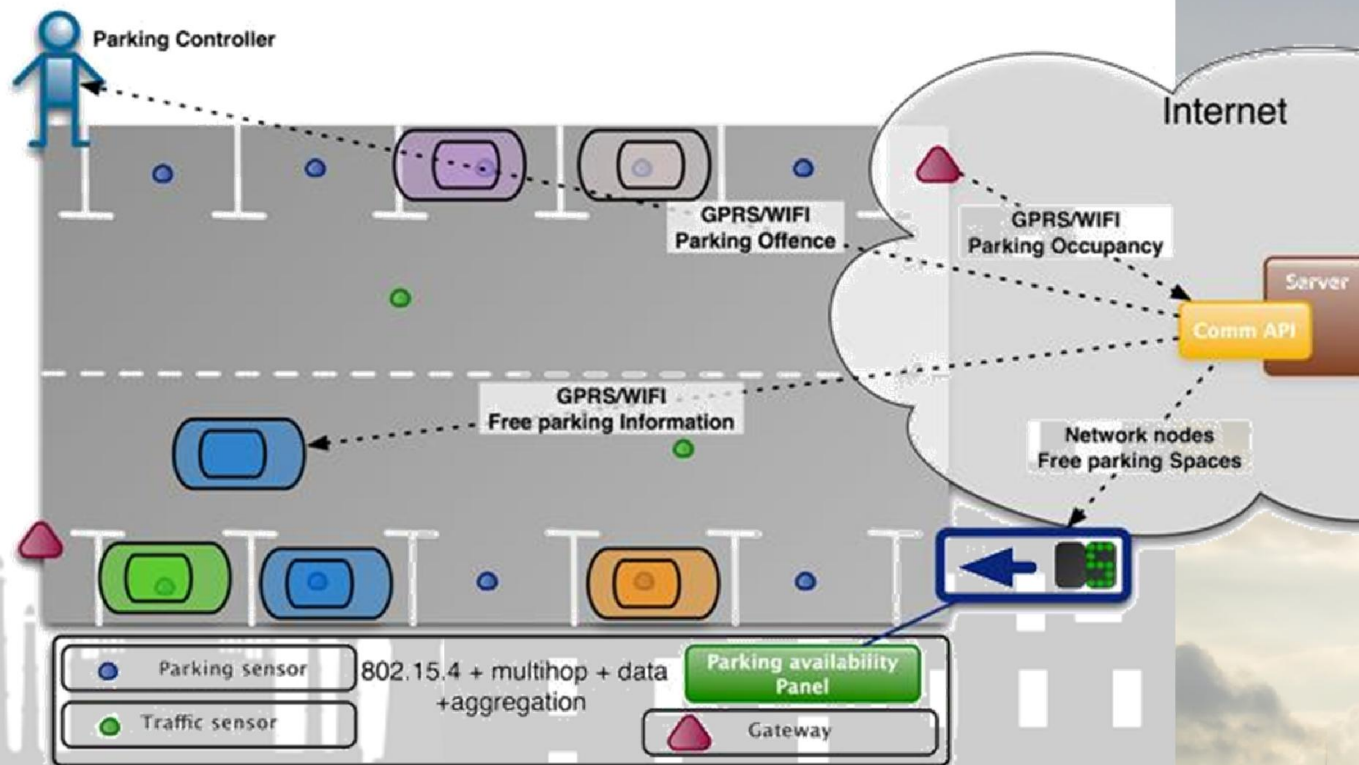
- 📍 New technologies will demand / create new business models
- 📍 New technologies will create new jobs
- 📍 New technologies will kill (more?) jobs
- 📍 A redefinition of work is necessary?????????
- 📍 Jobs and income have to be differentiated



And ICT?

ICT is an enabler

- 📍 **Parking info:** Figure below shows the communication infrastructure with the sensors for parking detection embedded in the ground.

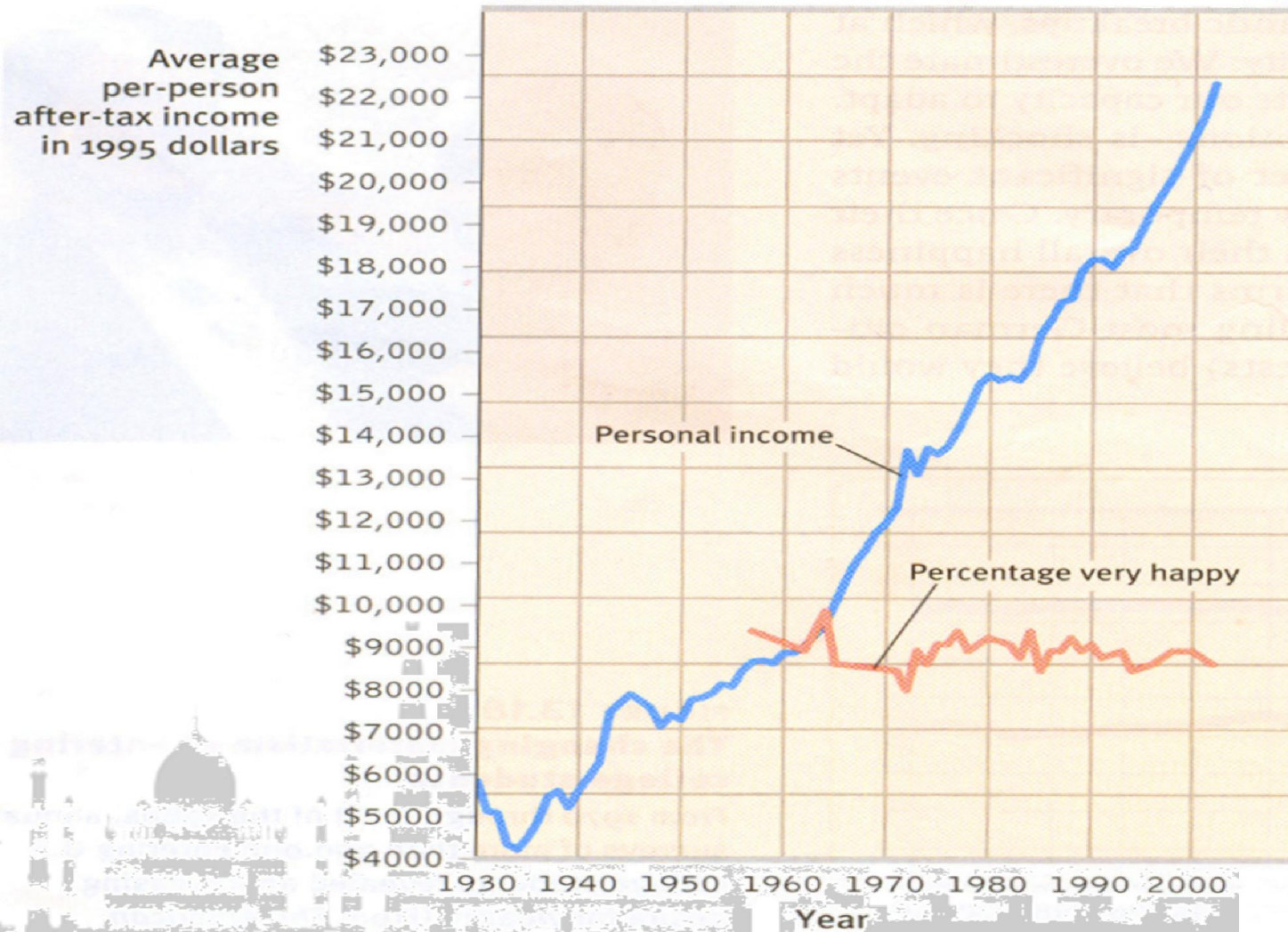


Tax reform needed

- 📍 A circular economy is an industrial system that is restorative by intention and design. In a circular economy, products are designed for ease of reuse, disassembly and remanufacturing – or recycling – with the understanding that it is the reuse of vast amounts of material reclaimed from end-of-life products, rather than the extraction of new resources, that is the foundation of economic growth
- 📍 Moreover, the circular economy shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior and innovative design of materials, products, systems, and, within this, business models

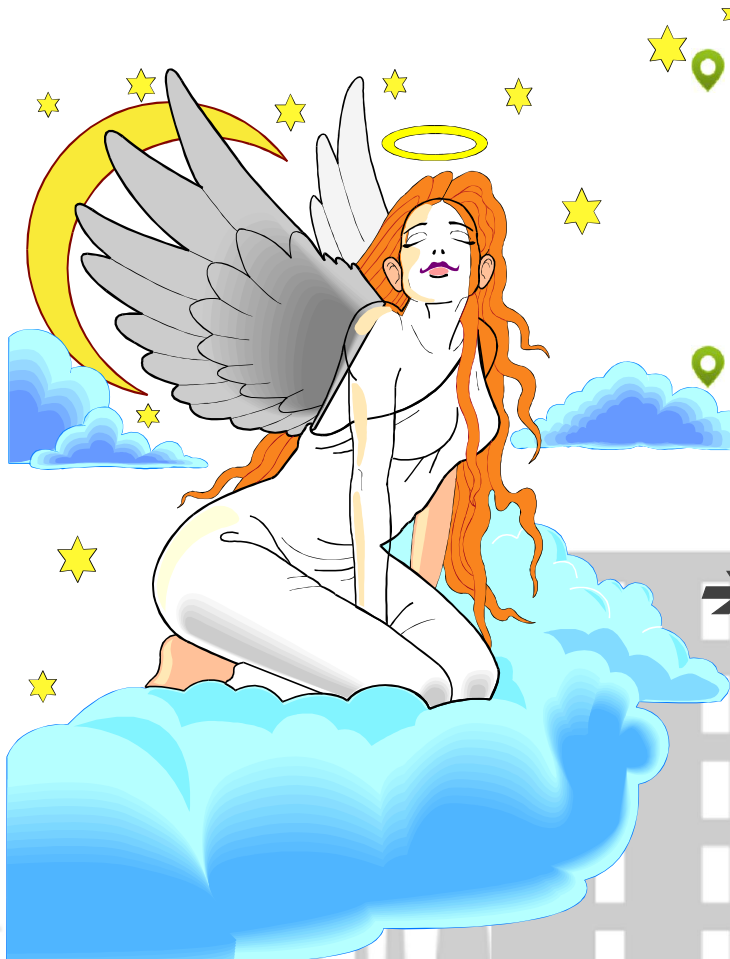
Happiness versus income

Source: <http://www.davidmyers.org/>



Percentage describing themselves as very happy

The gross national product in heaven



📍 Everything is available in abundance - therefore prices are low

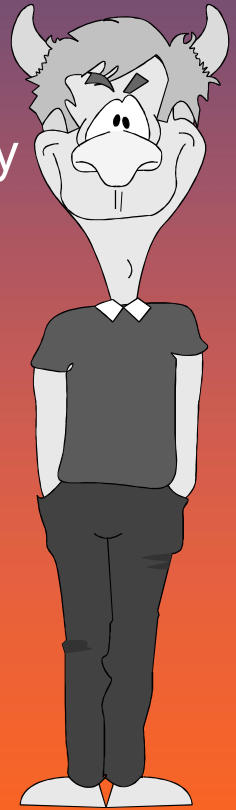
📍 the main occupation is singing hallelujah - without being paid

➔ *The GNP is therefore very low*

The gross national product in hell

- Everything is scarce – luxury is practically unaffordable .
- The heating is not properly tuned and – because it is ineffective – uses too much energy.

→ *GNP is very high.*



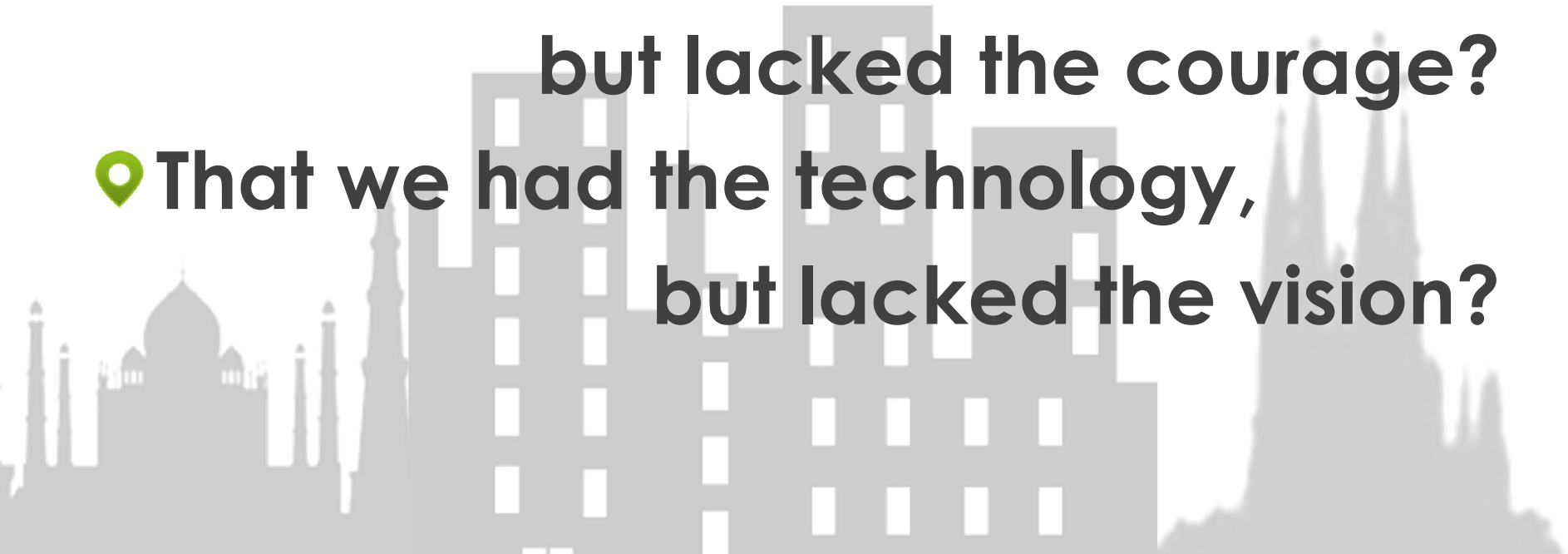
Forget GDP – but there is no way back

- 📍 In developed countries GDP and use of energy are growing since years without increasing the quality of life
- 📍 Are there services and products that do not contribute to the quality of life? Let`s get rid of them!
- 📍 How can the material and energy demand for the services wanted be reduced?



Will we look into the eyes of our children and confess

- 📍 That we had the opportunity but lacked the courage?
- 📍 That we had the technology, but lacked the vision?





Thank YOU !

And don't
forget to
reduce
your
footprint

