ENVIRONMENTAL SCIENCE [EV20001]

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Course objectives

Course objective is to ensure that students incorporate the concept of 'sustainable development' in their daily lives and decision-making processes and are sensitive to various environmental issues and the impacts of pollution

Learning objectives

1. *To understand the relationship between humans and their environment*
2. *To quantify the relationship between population growth, resource consumption and pollution*
3. *To identify sources of pollution in the environment, their impacts and remedial measures*
4. *To apply the laws of conservation of mass and energy in understanding and solving environmental problems*

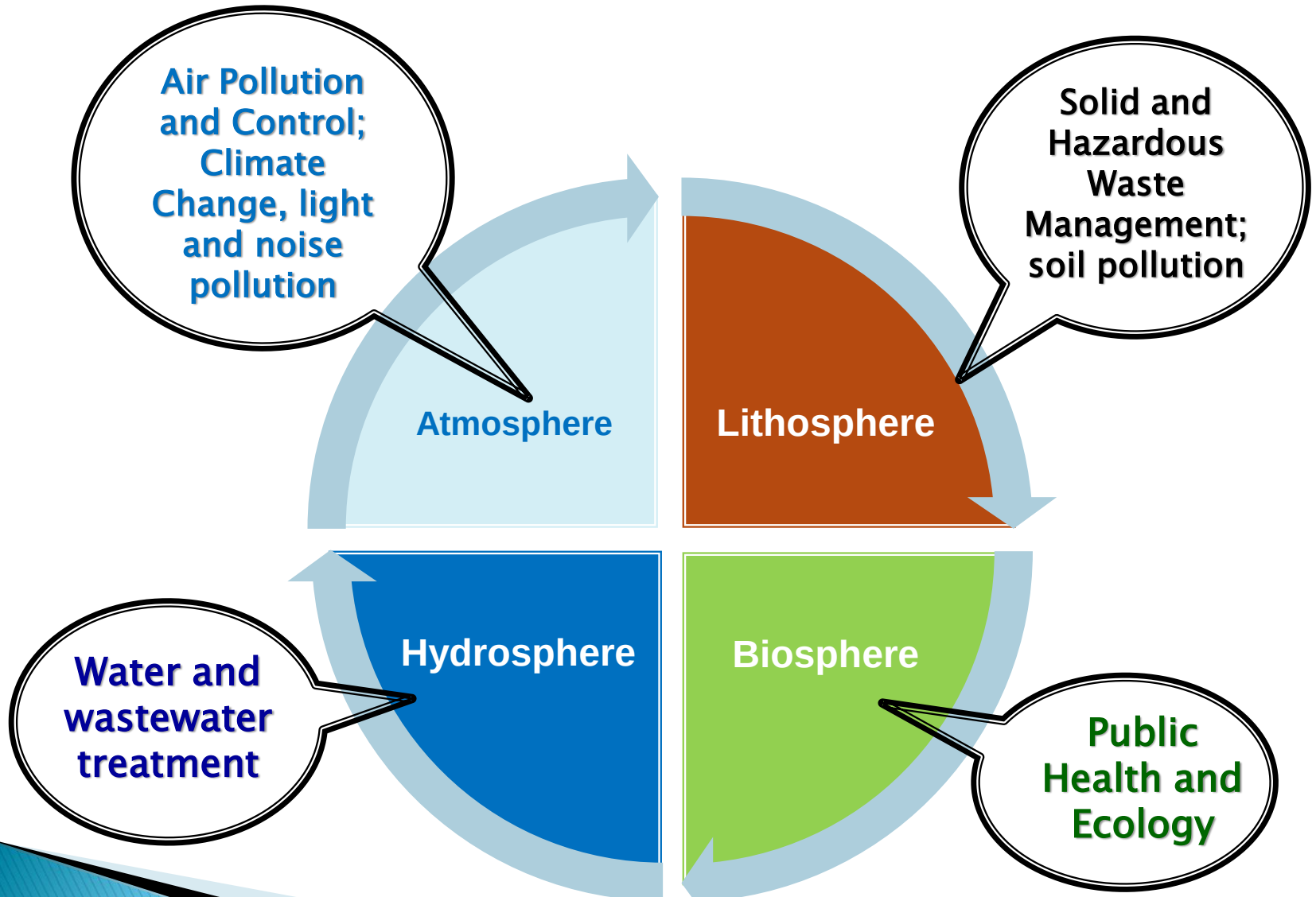
Textbook and reference materials

- Masters G and Ela WP (2012). *Introduction to Environmental Engineering and Science.* Prentice Hall, NJ, US.
- Kormandy EJ (1995) *Concepts of ecology*, Prentice Hall of India, New Delhi.
- Pepper IL, Gerba CP and Brusseau ML (2006) *Environmental and Pollution Science*, Academic Press, Elsevier.
- Khoiyangbam RS and Gupta N (2015) Introduction to Environmental Sciences, TERI Press, Delhi
- Davis ML and Masten SJ (2009) Principles of Environmental Engineering and Science, McGraw Hill Education, Indian edition.
- Garg, SK (2006) Ecology and Environmental Studies, Khanna Publishers, New Delhi.
- Slides and other uploaded materials

Syllabus (post-midsem, Spr 2018)

Week	Topics
1	Population growth and resource consumption
2	Ecology
3	Hazardous waste management
4	Solid waste management
5	Solid waste management
6	Soil and noise pollution
7	Environmental Impact Assessment
8	Class test

The Environment and its domains



Sustainable development

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland Report – Our Common Future, 1987)

- **Implications:**
  - Societal emphasis has to shift from a **destructive, exploitative philosophy (The Tragedy of the Commons*)** to one that **fosters long-term protection of the environment and its inhabitants (we have to protect The Golden Goose!)**
  - Two conflicting objectives have to be reconciled
    - improving quality of life vs. protecting the environment

*Hardin, Garrett [1968] The Tragedy of the Commons, *Science*, 162:1243-1248.

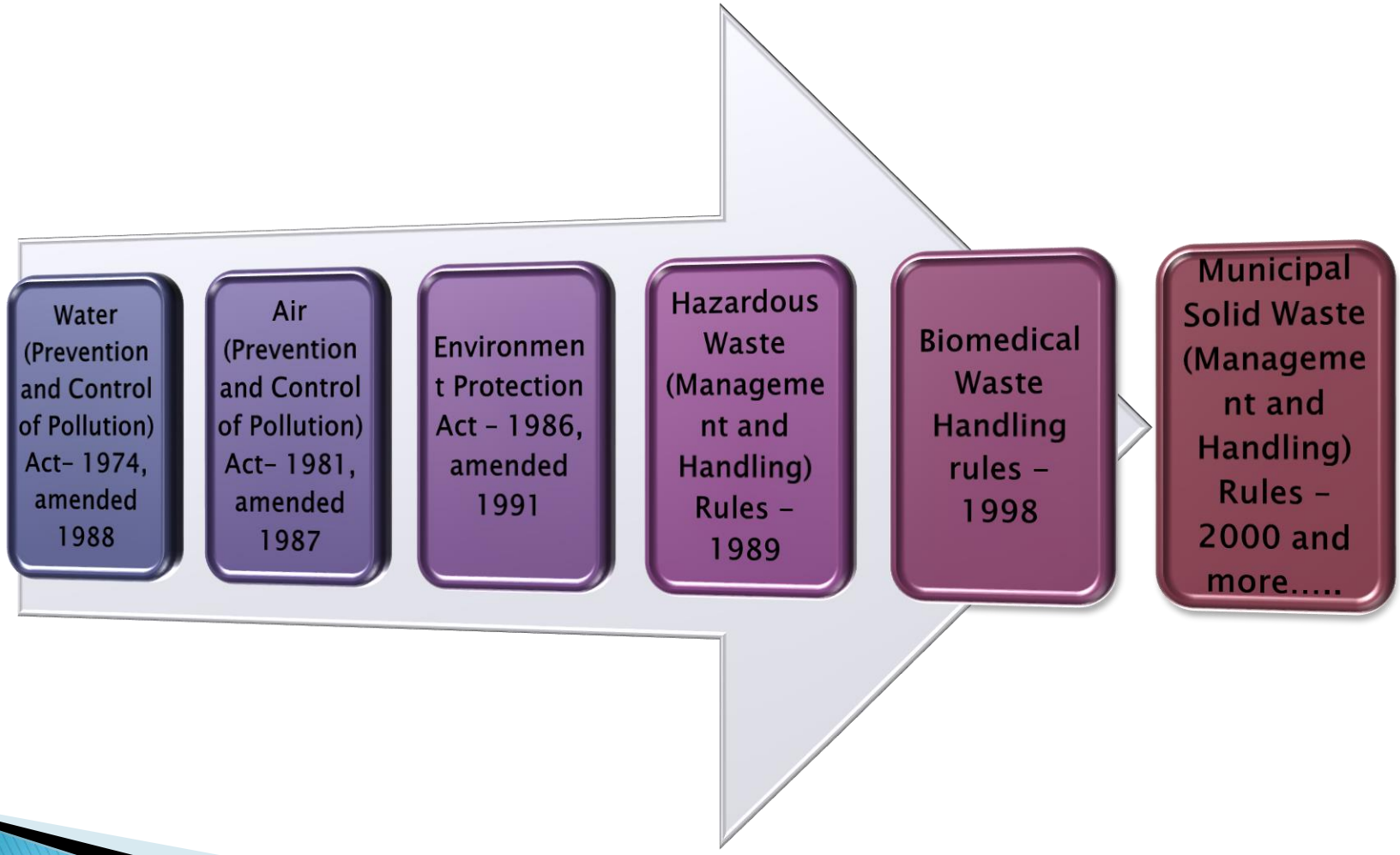
Driving forces for sustainability

- **Health and safety: human and other organisms**
- **Financial: property values, profits, taxes**
- **Aesthetics**
- **Civic pride and values**
- **THE LAW**

  All the good intentions in the world are not equal to the arm of law

Our biggest challenge in this new century is to take an abstract idea like sustainable development and turn it into reality for all the world's people – Kofi Annan, 2001

The Law and its course



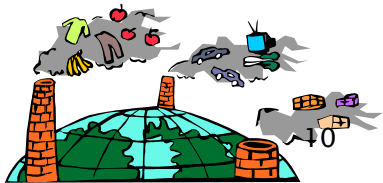
More about the law.....

Regulations	Year of notification	Year of last amendment
Water (Prevention and Control of Pollution) Act	1974	1988
Air (Prevention and Control of Pollution) Act	1981	1987
Environment Protection Act	1986	1991
Hazardous Waste (Management and Handling) Rules	1989	2009
Biomedical Waste Handling Rules	1998	2003
Flyash Rules	1999	2007
Recycled Plastics Usage Rules	1999	2003
Municipal Solid Waste (Management and Handling) Rules	2000	2001/ 2016
Batteries (Management and Handling) Rules	2001	
Plastic Waste (Management and Handling) Rules	2011	
E-waste (Management and Handling) Rules	2011	2015
Construction and demolition waste management rules	**2016**	

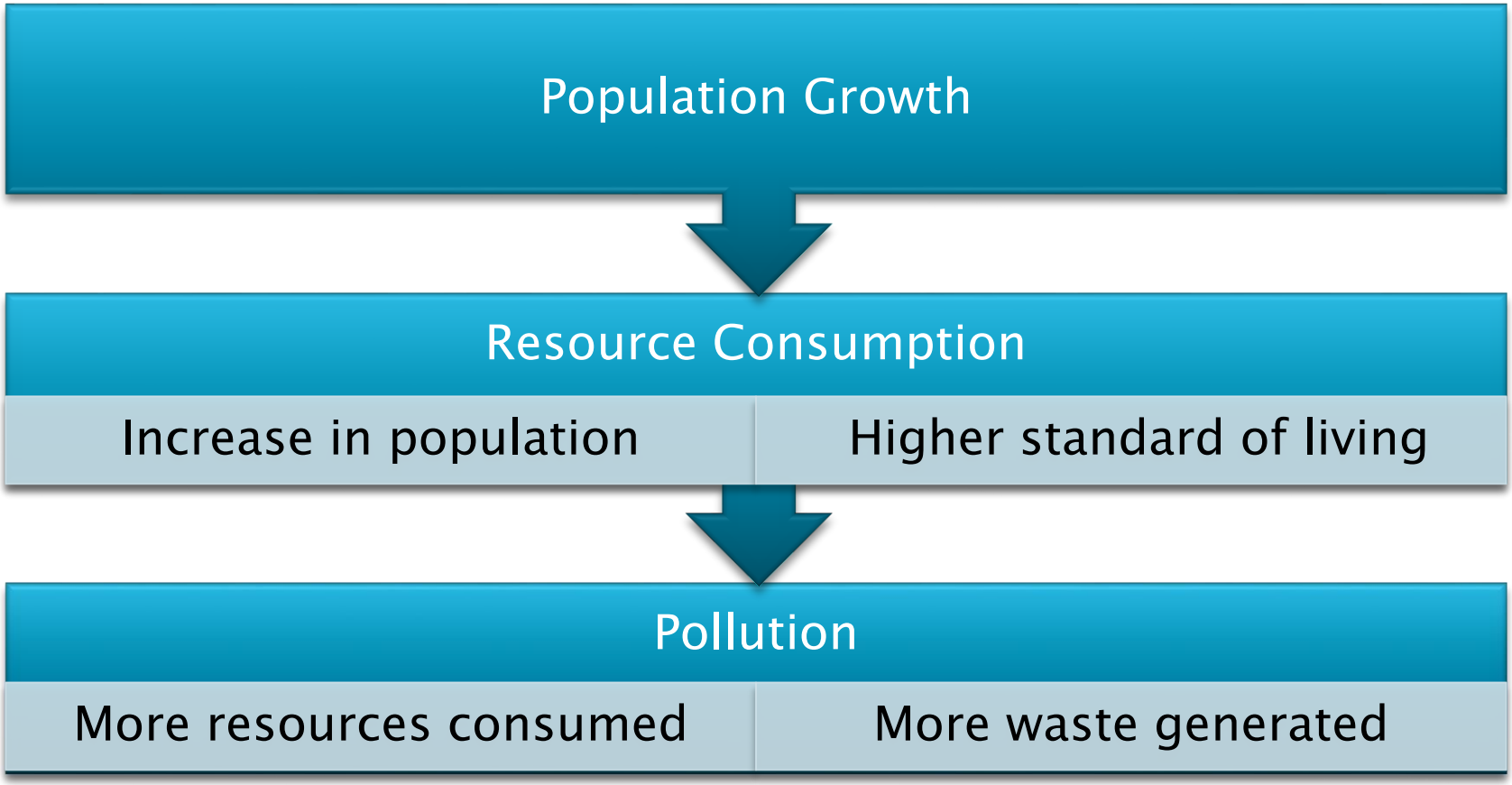
What is a pollutant or contaminant?

- A pollutant is a chemical species in the environment that causes **undesirable effects** on the environment or any of its components.
- Can be natural or anthropogenic
- Undesirable effects
  - Endangers health of humans and other organisms
  - Endangers safety
  - Causes financial and aesthetic losses

Contamination is simply the presence of a substance where it should not be or at concentrations above background. Pollution is contamination that results in or can result in adverse biological effects to resident communities.



Why is pollution increasing?



Population growth

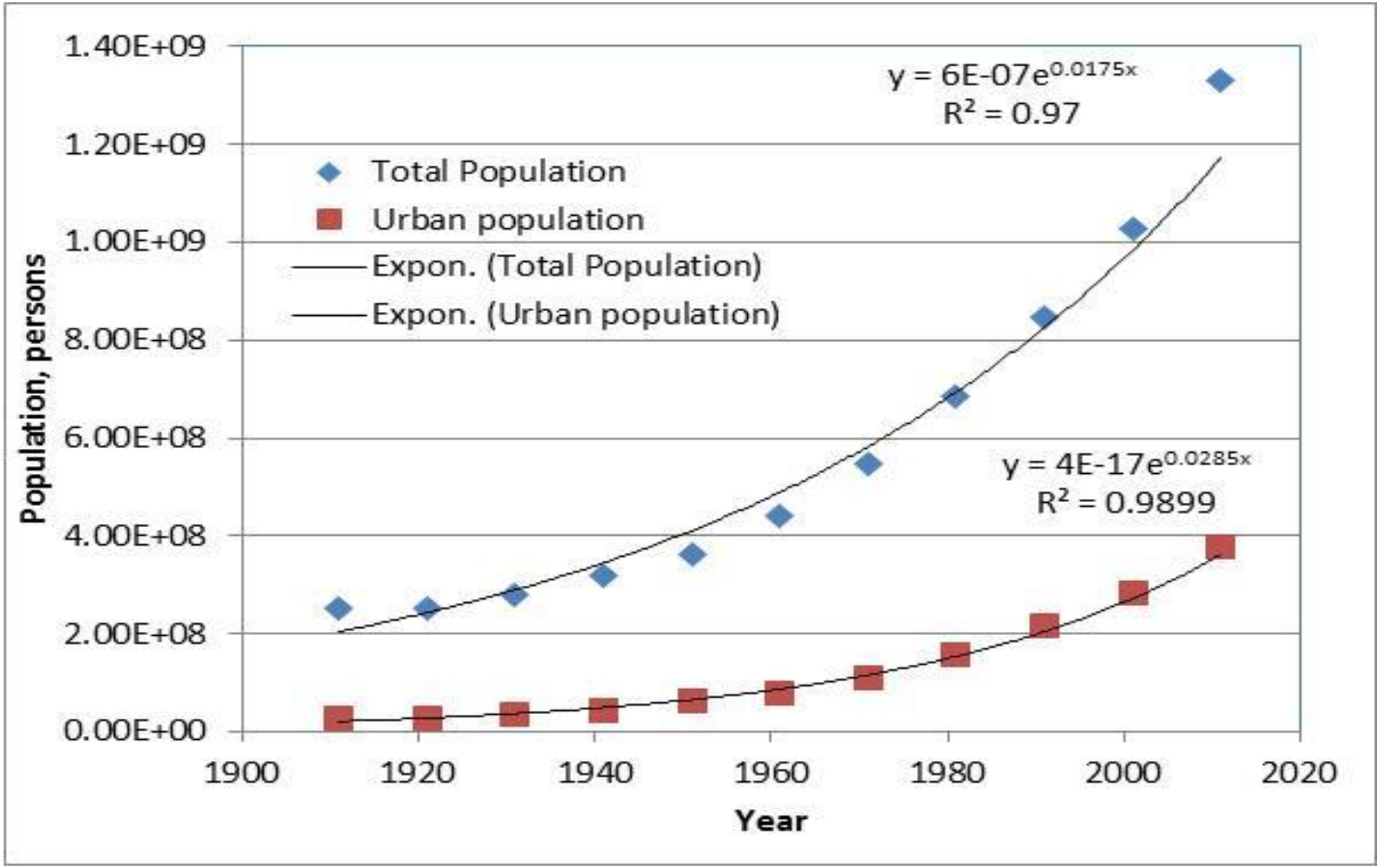
- World Population = 7.44 billion
- India's population = 1.33 billion
- West Bengal's population = 90.3 million
- Kharagpur's population = 4.0 lakhs

If data from 1911 to 2011 are used

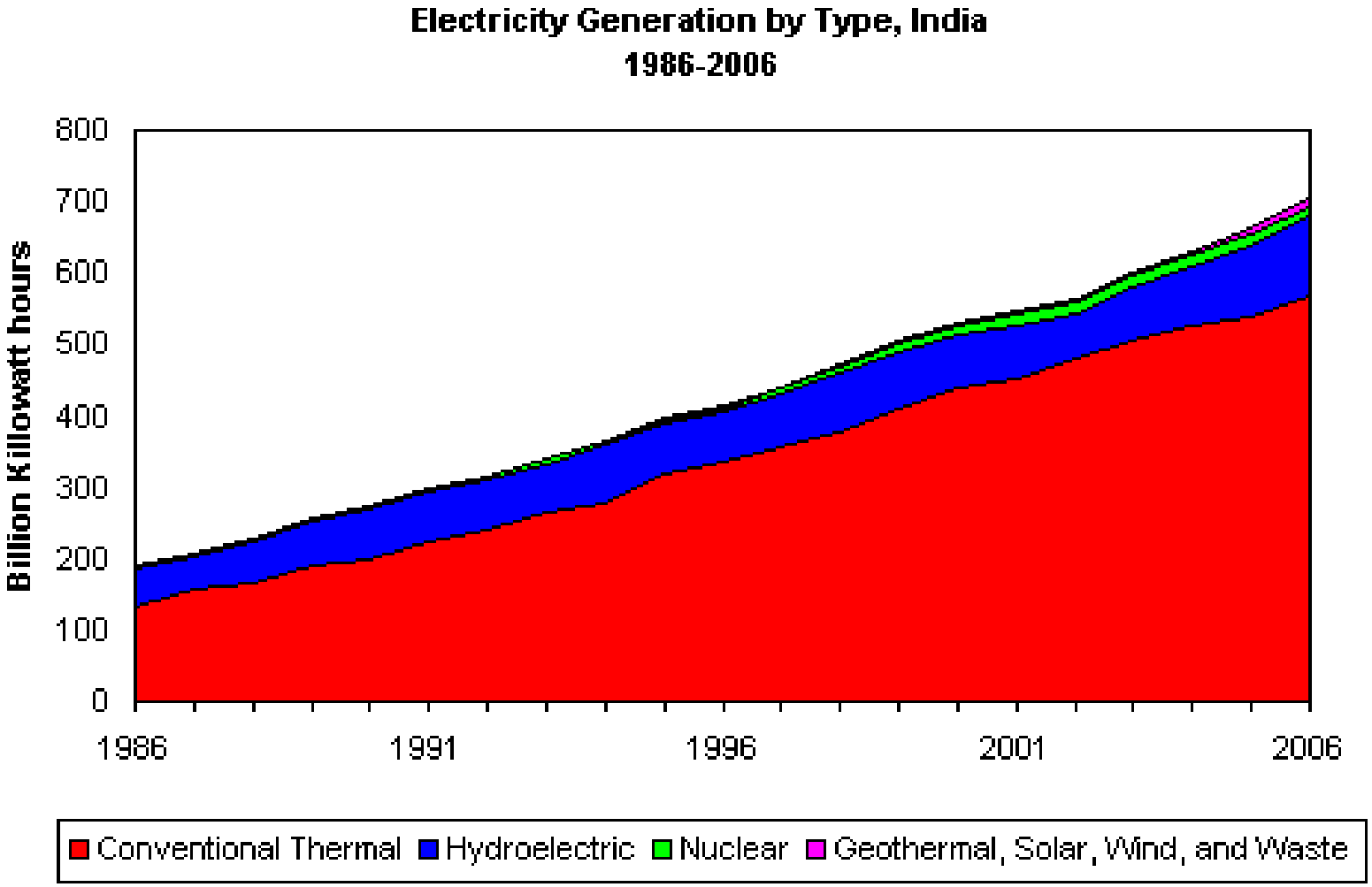
- Average annual **total** population growth rate = 1.75%
- Average annual **urban** population growth rate = 2.85%

http://www.census.gov/popclock/

All figures for 19 July 2016


1.40E+09
1.20E+09
1.00E+09
8.00E+08
6.00E+08
4.00E+08
2.00E+08
0.00E+00
Population, persons
1900
1920
1940
1960
1980
2000
2020
Year
Total Population
Urban population
Expon. (Total Population)
Expon. (Urban population)
y = 6E-07e^0.0175x
R² = 0.97
y = 4E-17e^0.0285x
R² = 0.9899

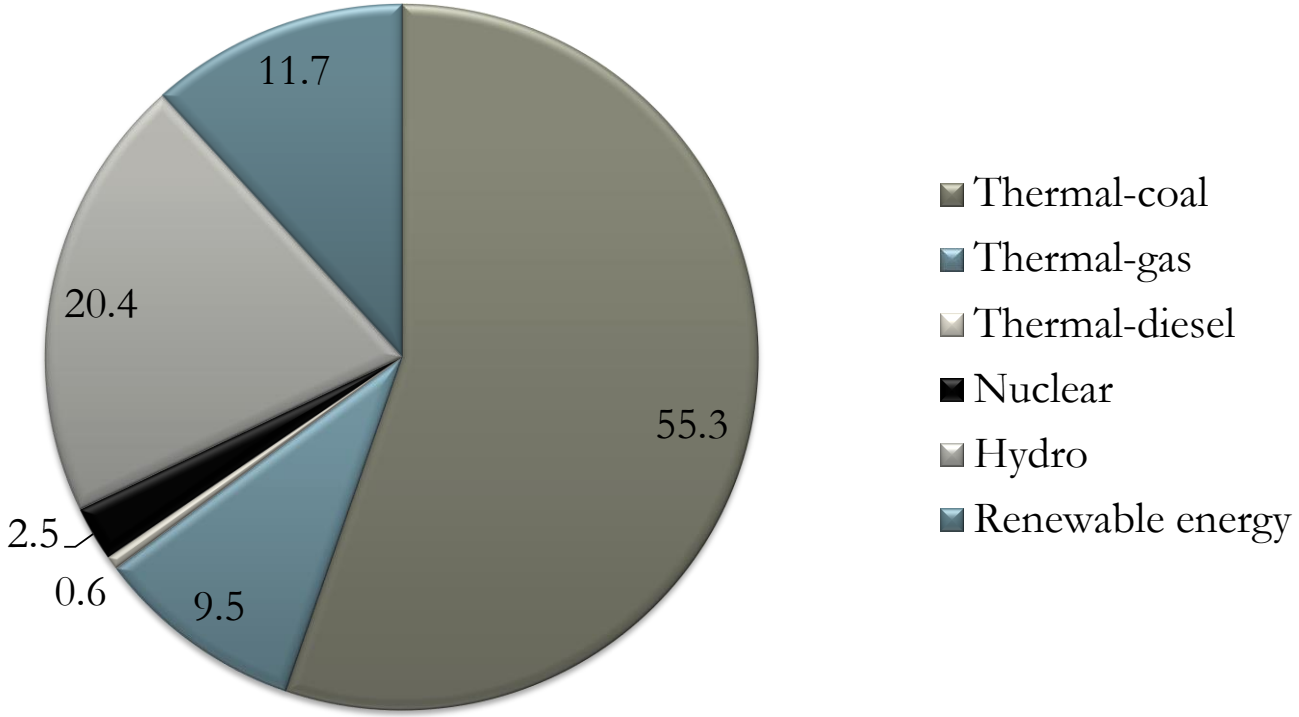
Resource consumption



http://www.eia.doe.gov/[illegible]/India/Full.html

Power generation in India

% capacity installed (as on 29 Feb 2012, CEA)



Annual increase in per capita power consumption in India = 4.61%

PLANETARY BOUNDARIES

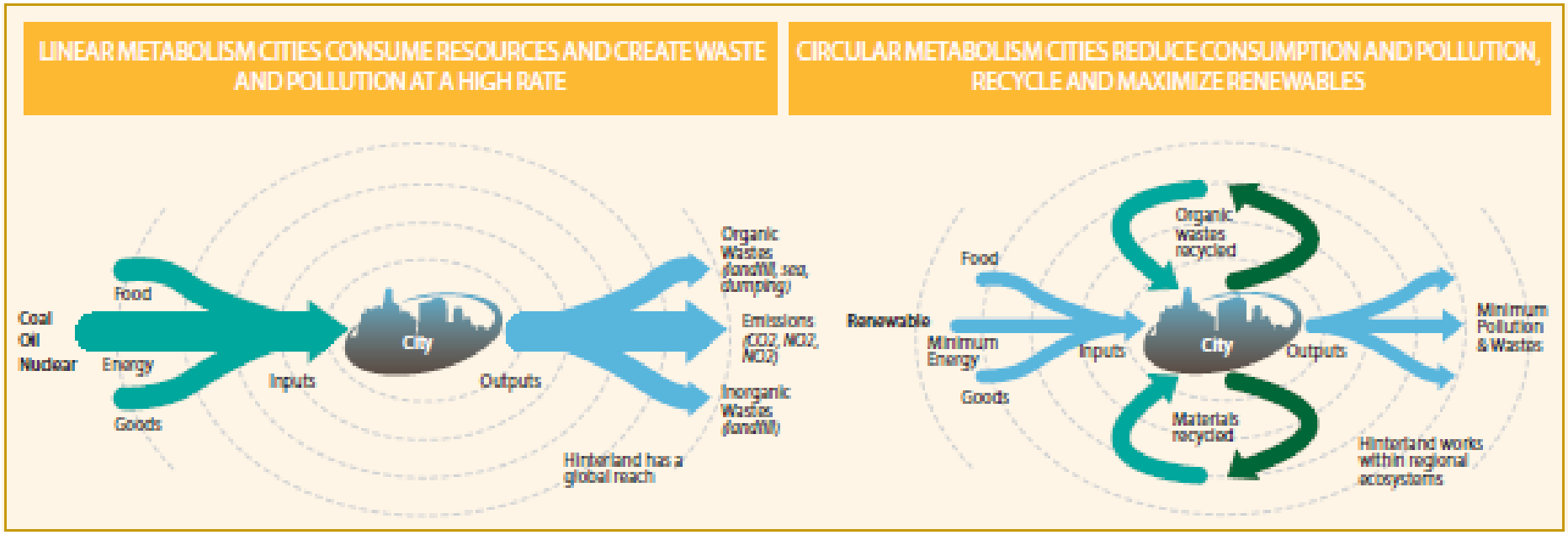
Earth-system process	Parameters	Proposed boundary	Current status	Pre-industrial value
Climate change	(i) Atmospheric carbon dioxide concentration (parts per million by volume)	350	387 **409**	280
	(ii) Change in radiative forcing (watts per metre squared)	1	1.5	0
Rate of biodiversity loss	Extinction rate (number of species per million species per year)	10	>100	0.1–1
Nitrogen cycle (part of a boundary with the phosphorus cycle)	Amount of N_2 removed from the atmosphere for human use (millions of tonnes per year)	35	121	0
Phosphorus cycle (part of a boundary with the nitrogen cycle)	Quantity of P flowing into the oceans (millions of tonnes per year)	11	8.5–9.5	~1
Stratospheric ozone depletion	Concentration of ozone (Dobson unit)	276	283	290
Ocean acidification	Global mean saturation state of aragonite in surface sea water	2.75	2.90	3.44
Global freshwater use	Consumption of freshwater by humans (km^3 per year)	4,000	2,600	415
Change in land use	Percentage of global land cover converted to cropland	15	11.7	Low
Atmospheric aerosol loading	Overall particulate concentration in the atmosphere, on a regional basis		To be determined	
Chemical pollution	For example, amount emitted to, or concentration of persistent organic pollutants, plastics, endocrine disrupters, heavy metals and nuclear waste in, the global environment, or the effects on ecosystem and functioning of Earth system thereof		To be determined	

Boundaries for processes in red have been crossed. Data sources: ref. 10 and supplementary information

Rockstrom et al., 2009. A safe operating space for humanity, *Nature,* 461: 472–475

TAKE – MAKE – DISPOSE

TAKE – MAKE – RECREATE



A key component of the sustainable city is a 'circular metabolism' which assures the most efficient possible use of resources
© Herbert Girardet / Rick lawrence

CRADLE – TO – GRAVE

CRADLE – TO – CRADLE

Girardet, H (2009) *Regenerative cities*, World Future Council, Germany

Conventional

Little or no consideration is given to the environmental impact of the design.

Designs generally aim to meet minimum legal requirements for the lowest first-cost price.

A rapidly expanding segment of business-as-usual is 'green' and moving towards to sustainable.

Eco-efficiency

Green design:

Does not challenge current production methods or consumption patterns that have negative environmental impact.

Minimises energy use, pollution and waste (termed 'less bad' design.

Sustainable design:

Acelves neutral environmental impact and maximum efficiency.

Current focus of the New Zealand Green Star rating scheme.

Regenerative development

Sees humans, human developments, social structures and cultural concerns as an inherent part of ecosystems.

Questions how humans can participate in ecosystems using development to create optimum health.

Seeks to create or restore capacity of ecosystems and bio-geological cycles to function without human management.

Understands the diversity and uniqueness of each place (socially, culturally and environmentally) as crucial to the design.

Sees the design process as ongoing, indefinite and participatory.

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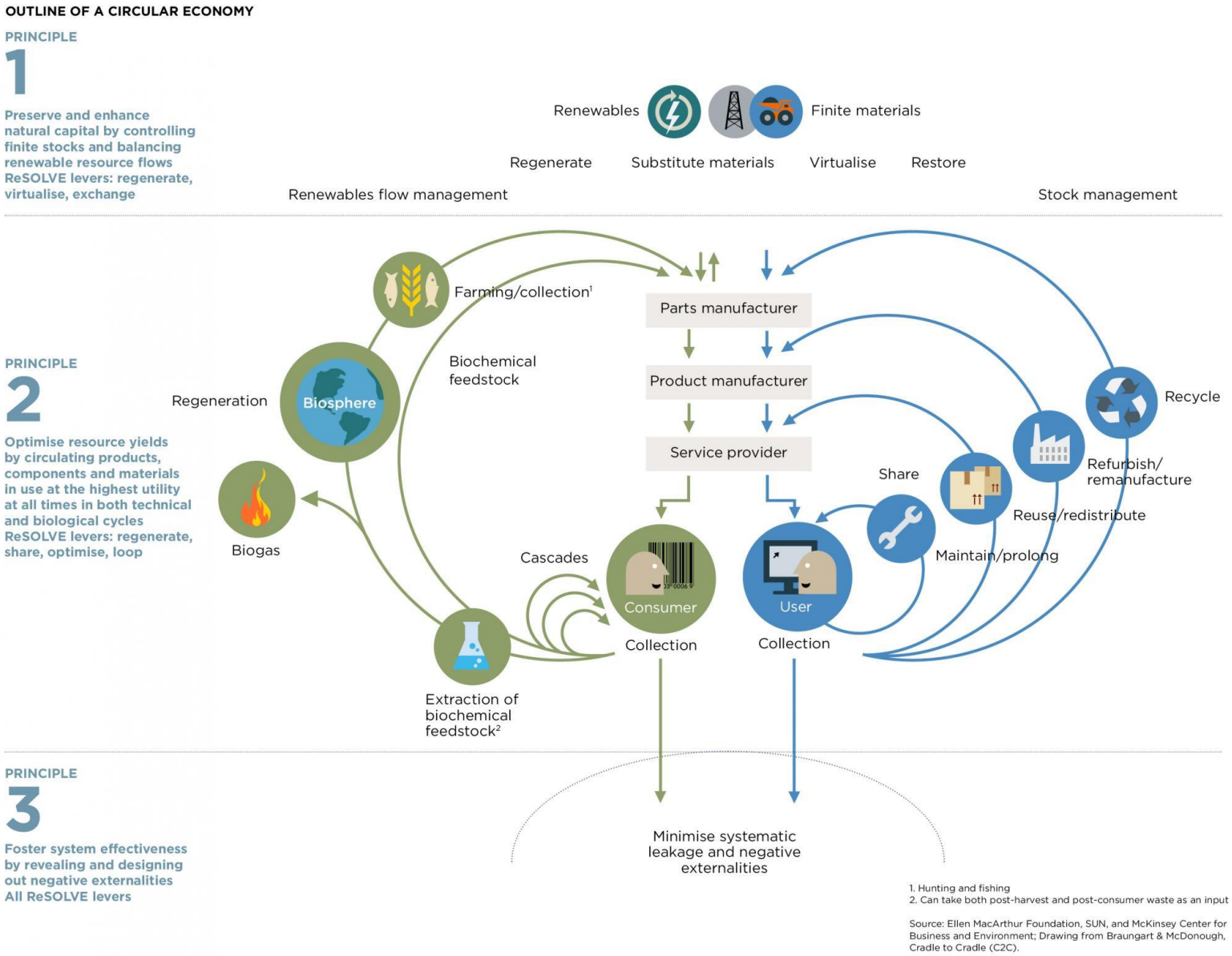
Girardet, H (2009) *Regenerative cities*, World Future Council, Germany

Circular Economy: A System Diagram



https://www.ellenmacarthurfoundation.org/circular-economy/interactive-diagram

Problems

- World population in 1975 was 4 billion and in 2015 it was 7 billion. Determine the annual exponential population growth rate and predict the world's population in 2030.
- The average annual exponential population growth rate for India is 1.84% and the urban population growth rate is 3%. The total population in India in 2011 was 1.21 billion and the urban population was 0.38 billion. If these growth rates continue in future, determine the year in which the urban population will be 50% of the total population in India.
  - Why is the urban population growth rate higher than the total population growth rate?
  - What can be done to slow this growth?
- In 2010, the total installed electricity generating capacity of thermal power plants in India was 125 GW. The current annual exponential per capita growth in electricity consumption is 4.6%. Assuming 'business-as-usual', what is the thermal power plant capacity requirement for 2030 and 2050?
- The current (2017) carbon dioxide concentration is 408.84 ppmv and the following data are available for the past:

  1965 – 320 ppmv, 1975 – 331 ppmv, 1985 – 346 ppmv, 1995 – 361 ppmv; 2005 – 384 ppmv. Based on these data, estimate concentrations for 2018; how close is your estimate to the concentration measured today.

  Predict the concentration in 2030 and 2050 at current growth rates.

THANK YOU