Towards long-term carbon neutral Asia:
Growing importance of forestry and land use management
- frameworking the session-

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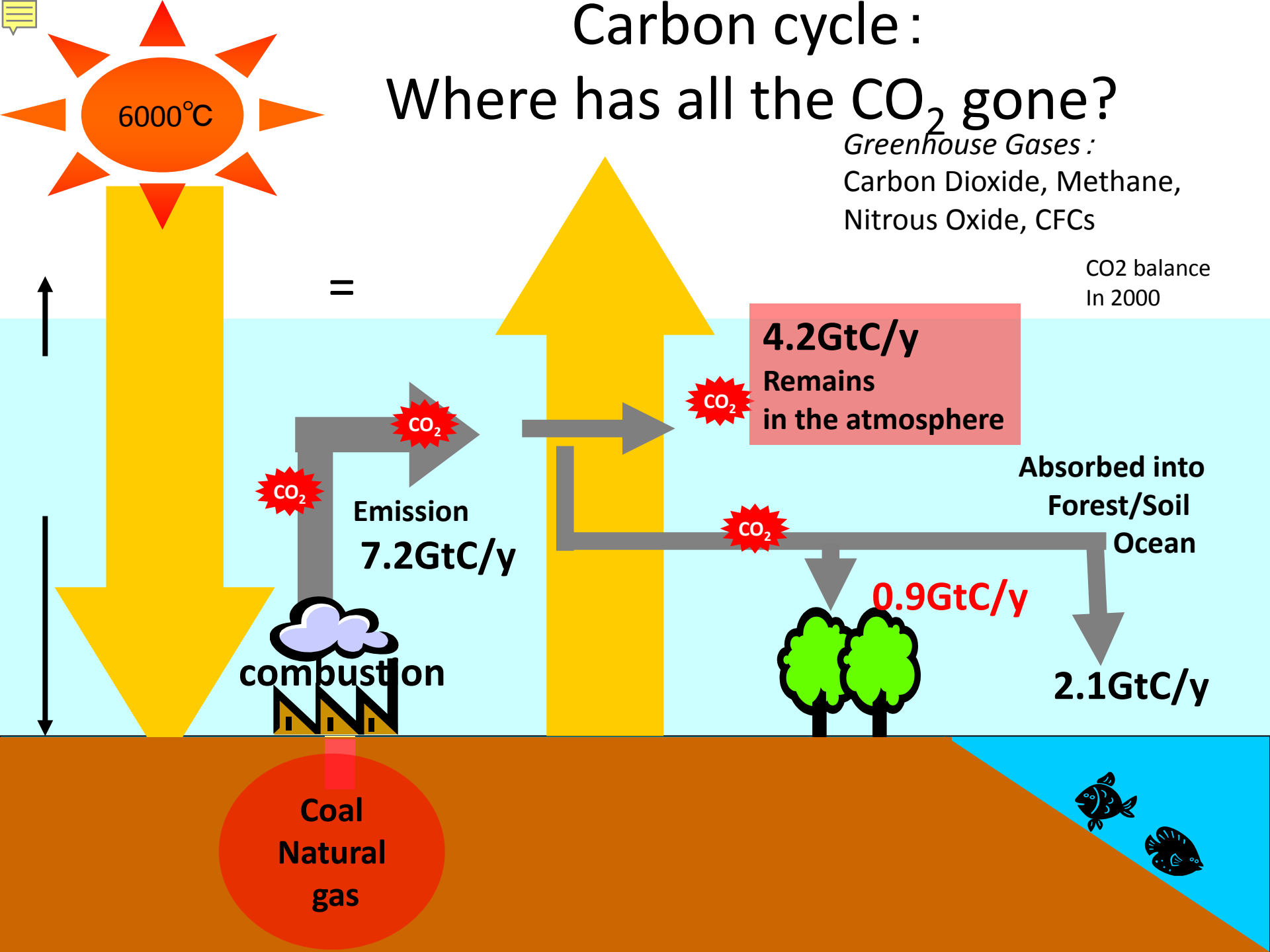
Institute for Global Environmental Strategies
October 2017 Bangkok

Azumino in early su

Carbon cycle :
Where has all the CO_2 gone?

Greenhouse Gases :
Carbon Dioxide, Methane,
Nitrous Oxide, CFCs



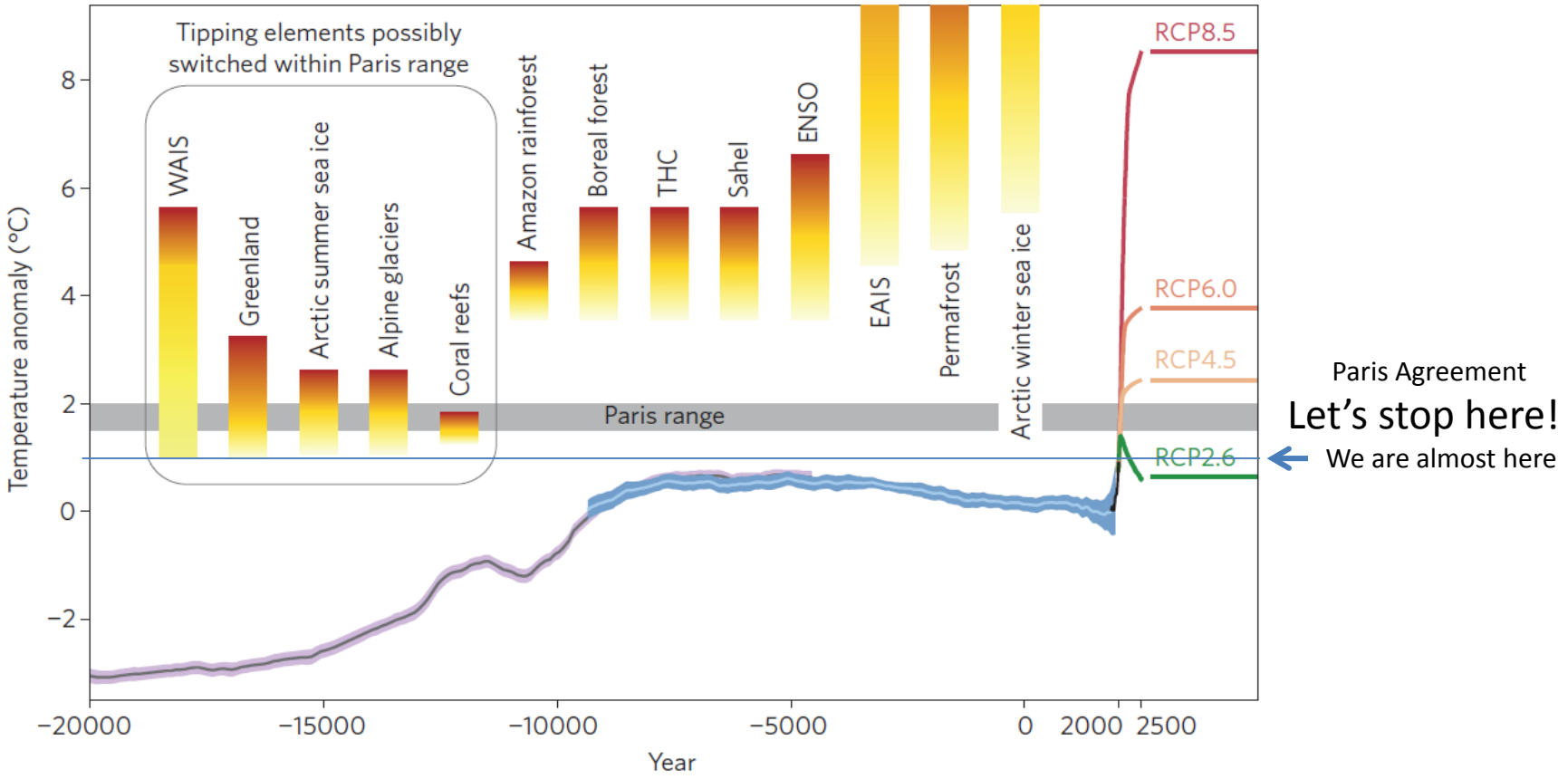


Figure 1 | Tipping elements in context of the global mean temperature evolution. Shown is the global-mean surface temperature evolution from the Last Glacial Maximum through the Holocene, based on palaeoclimatic proxy data35,36 (grey and light blue lines, with the purple and blue shading showing one standard deviation), instrumental measurements since 1750 ad (HadCRUT data, black line) and different global warming scenarios for the future (see ref. 37 for the latter). Threshold ranges for crossing various tipping points where major subsystems of the climate system are destabilized have been added from ref. 8, 14 and 37–40.

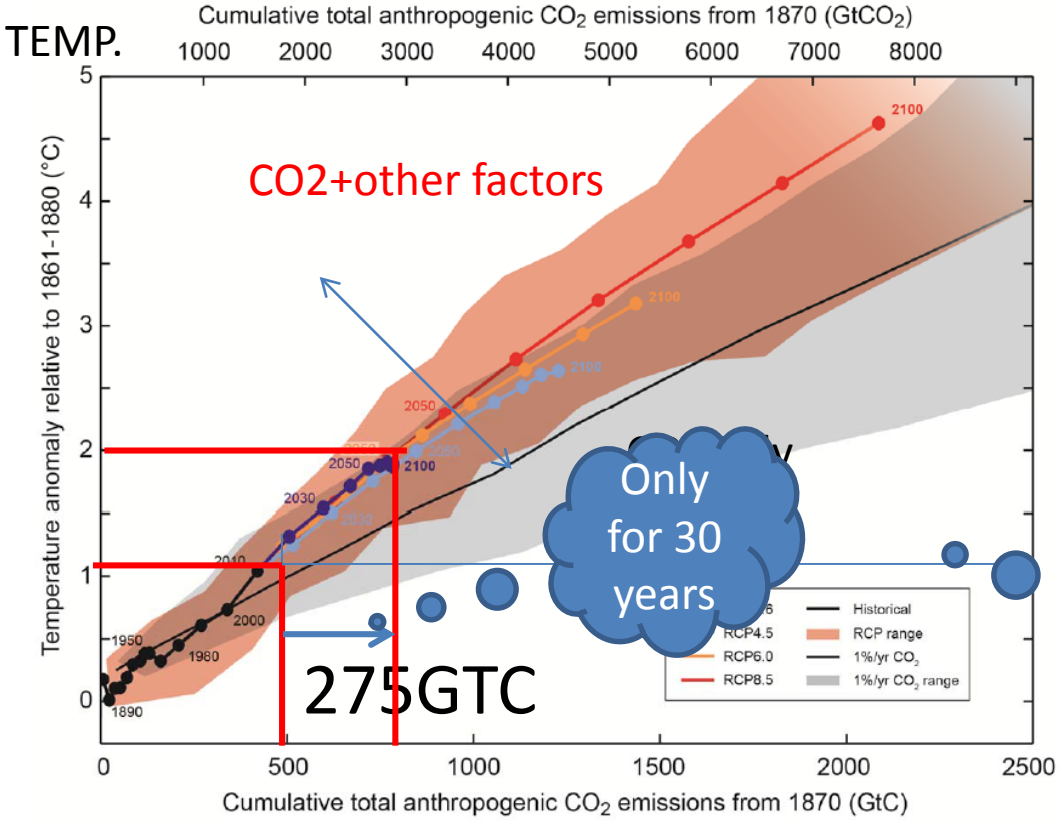
出典：Hans Joachim Schellnhuber, Stefan Rahmstorf and Ricarda Winkelmann, Why the right climate target was agreed in Paris, COMMENTARY: NATURE CLIMATE CHANGE, VOL 6, JULY 2016 , 649-653

Note: WAIS:West Antarctic Ice Sheet, THC: Thermohaline circulation

Temp. rises in relation with cumulative GHG emission

⇒Temp. rises as long as emission continues

⇒ Zero emission is only one ultimate solution to stabilize climate



Allowable budget

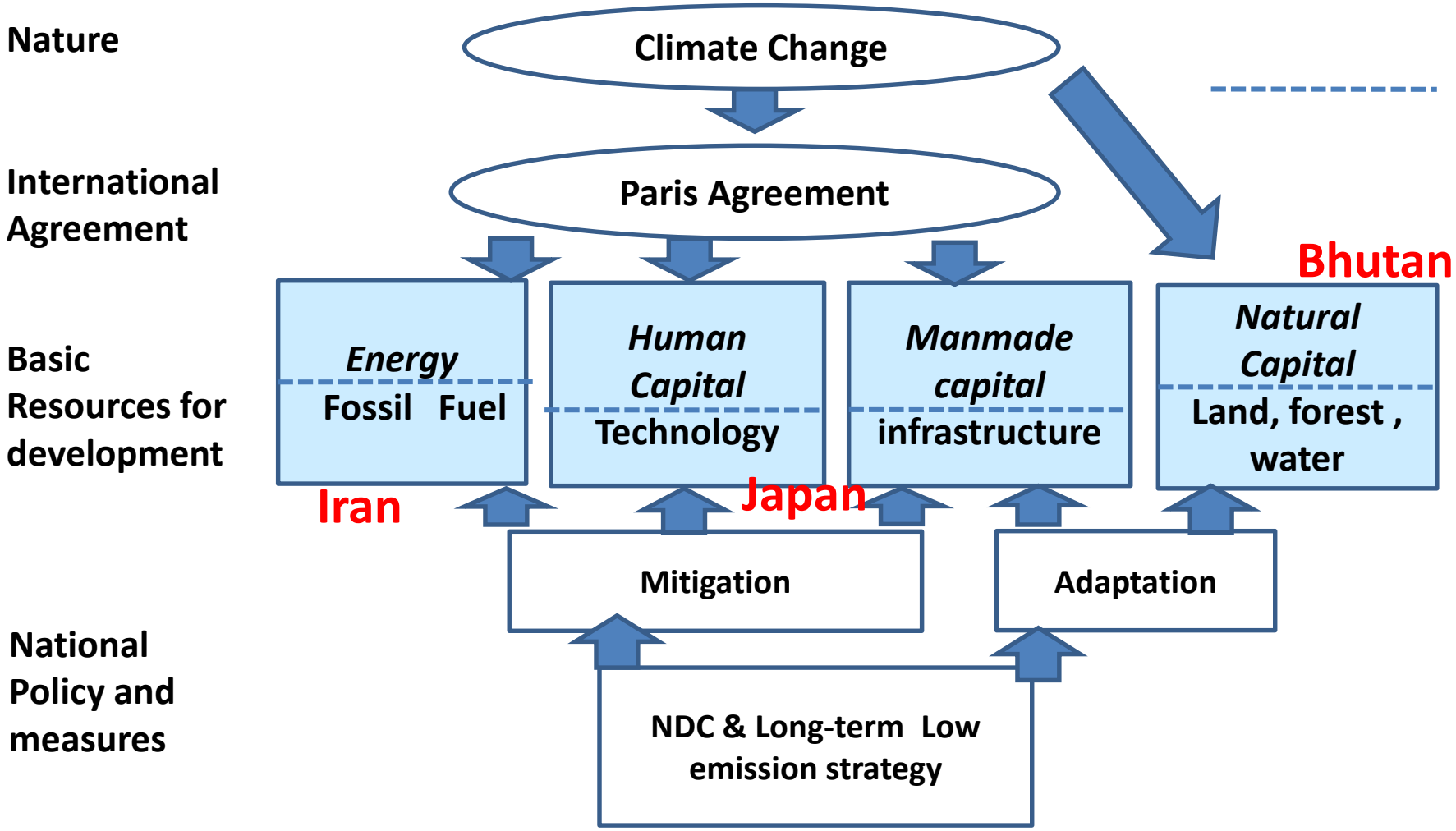
- 2℃ ⇒ 790 GtC
- 515GtC emitted already
- only 275GtC remained
- 2013 emission= 9.9GtC

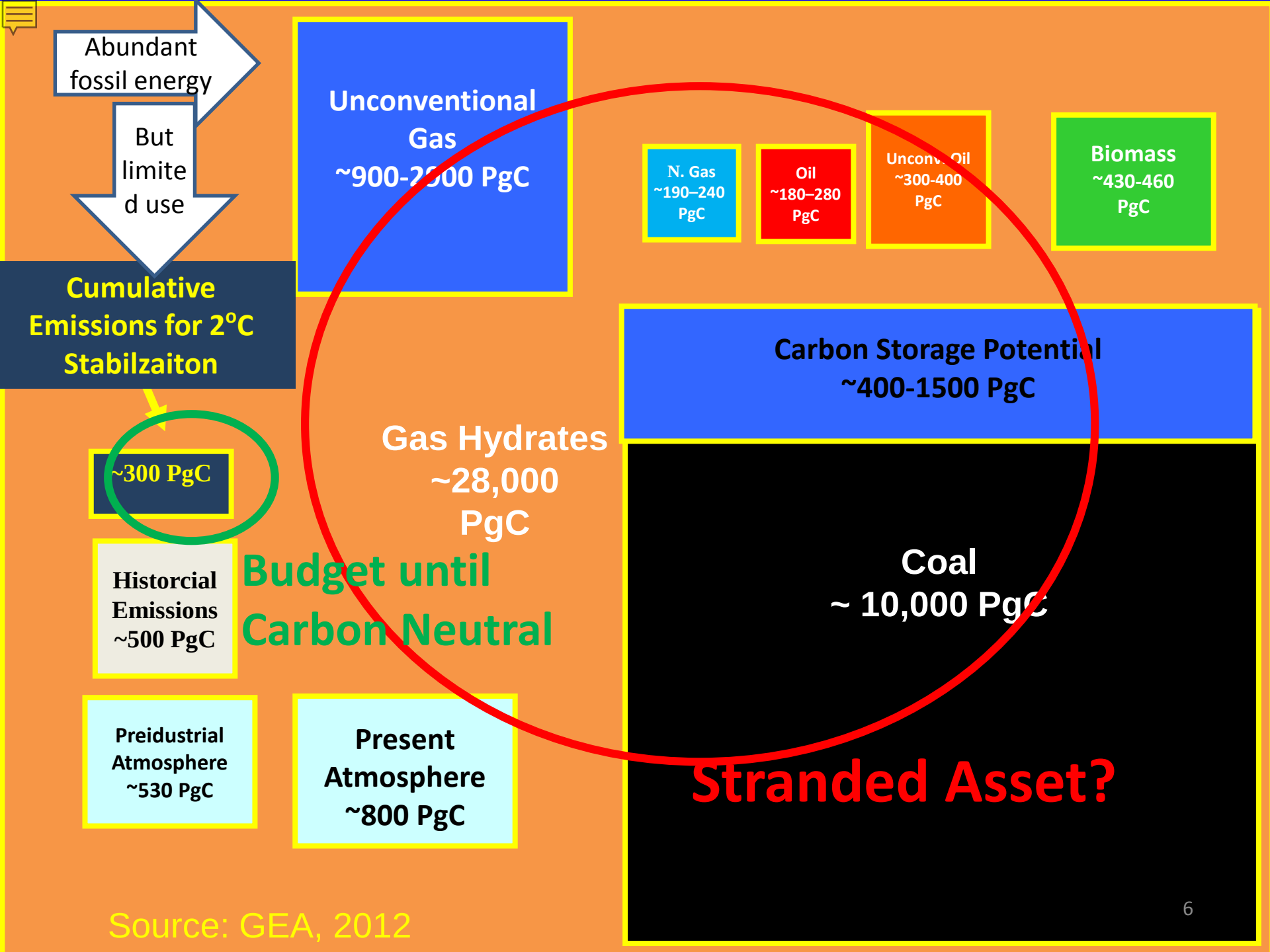
Transition to low carbon society within 50-100 yr.

Cumulative total anthropogenic CO2 emission from 1870 (GtCO2)

(IPCC AR4 and Emori, NIES)

Climate Change Impacts
Values of National Development Resources

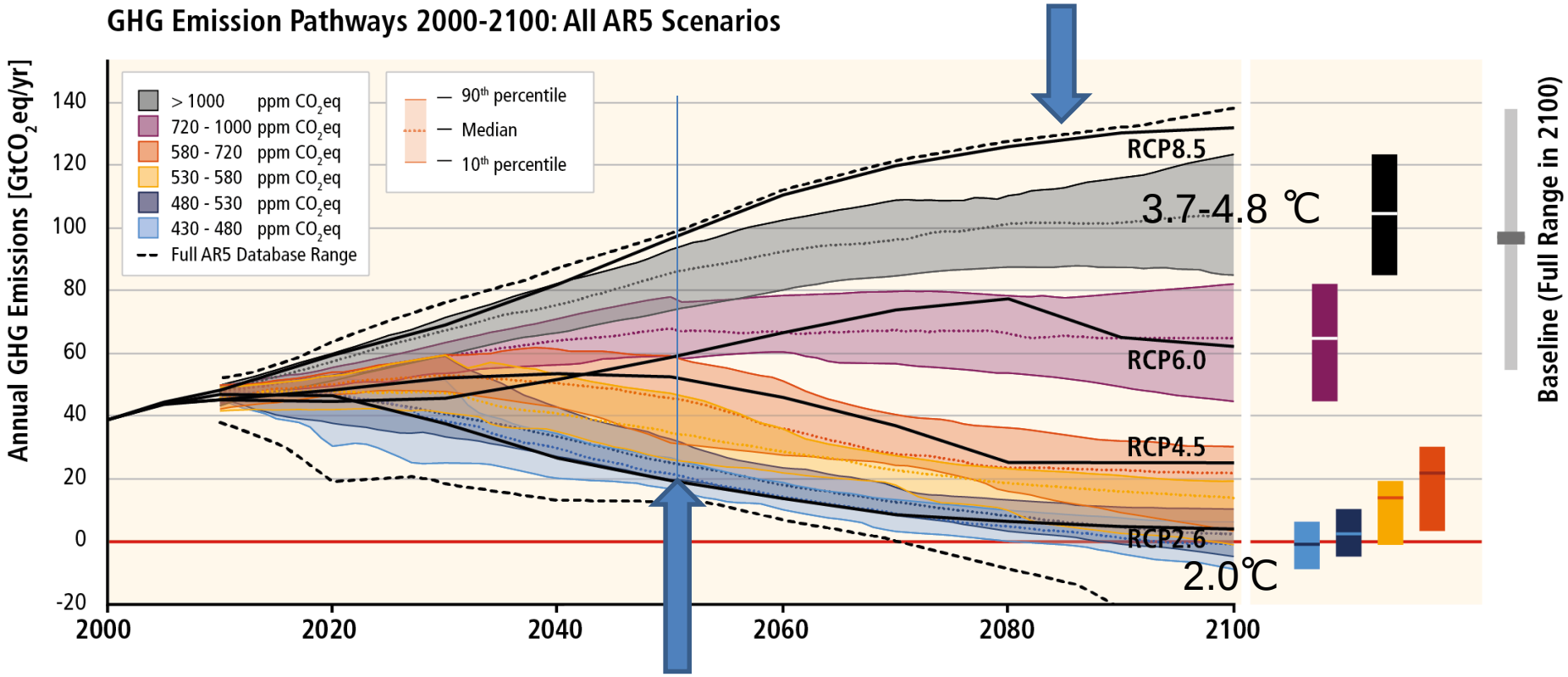




Source: GEA, 2012

Global target: Halving current emission by 2050

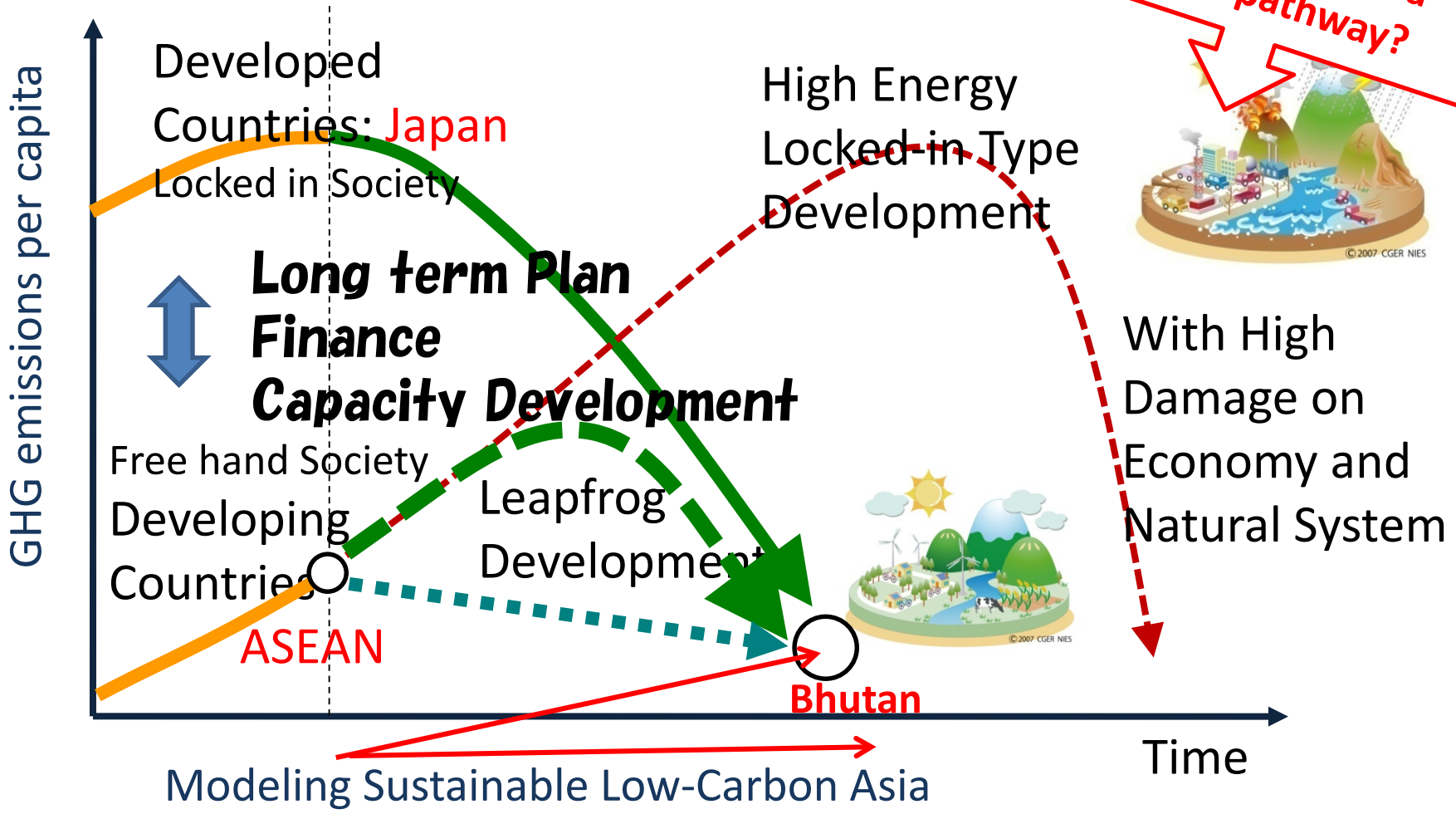
Without more mitigation, global mean surface temperature might increase by 3.7° to 4.8°C over the 21st century



To avoid 2 degree rise, path of passing 50％ reduction from now in 2050 is feasible and reasonable .

IIPCC AR5 2013

Leapfrogging Asia



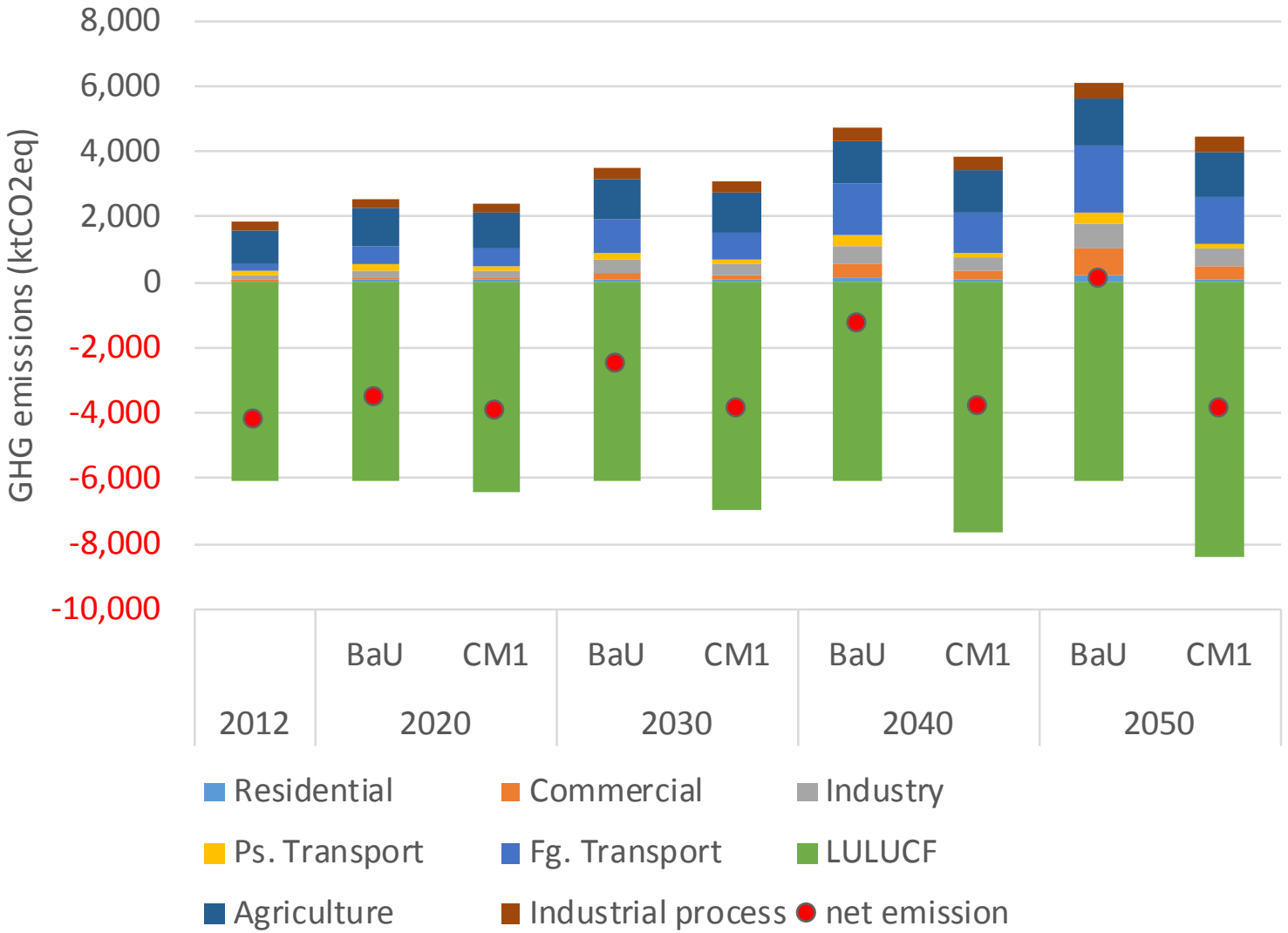
"Asian Low-Carbon Society Scenario Development Study" FY2009-2013, funded by Global Environmental Research Program, MOEJ

http://2050.nies.go.jp/index.html

Keeping Carbon neutral Bhutan: Preliminary results: GHG emissions

Projection was done in every 10 years from 2020 to 2050.

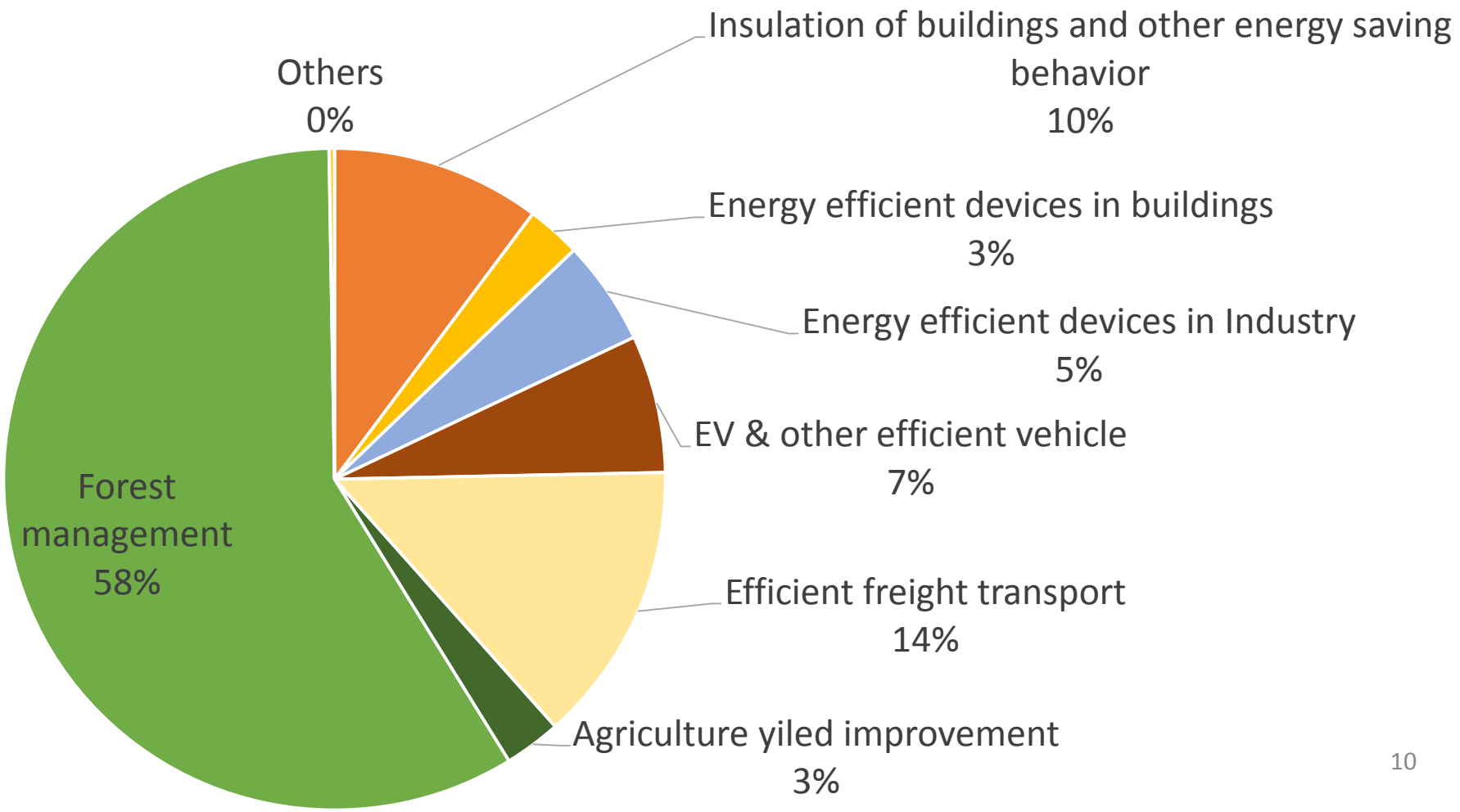
Net GHG emission become slightly POSITIVE in 2050 BaU. Low-carbon measures are necessary in order to keep being a net NEGATIVE emission country.



Kei Gomi 2016

Emission reduction contribution in 2050

The largest contributor to emission reduction was forest management, which occupies more than half of the emission reduction. It is followed by “Efficient freight transport” and “Insulation of buildings and other energy saving behavior”.
The result shows measure in both LULUCF and Energy sectors are necessary.



Natural resource & its management in Bhutan

Hydro-Power

Forest for
Biomass &
absorption
Soil

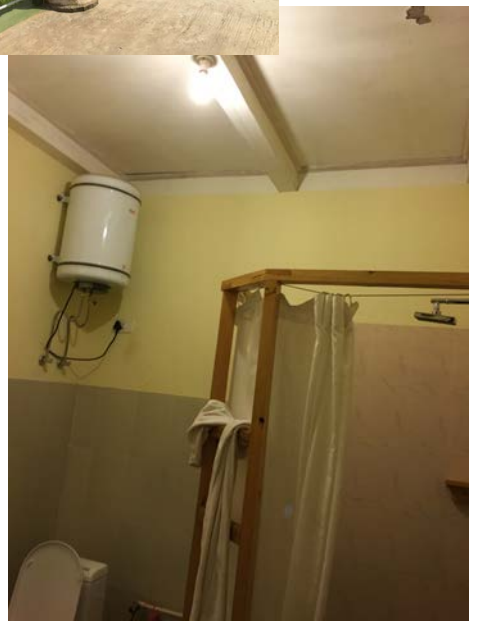
Biodiversity

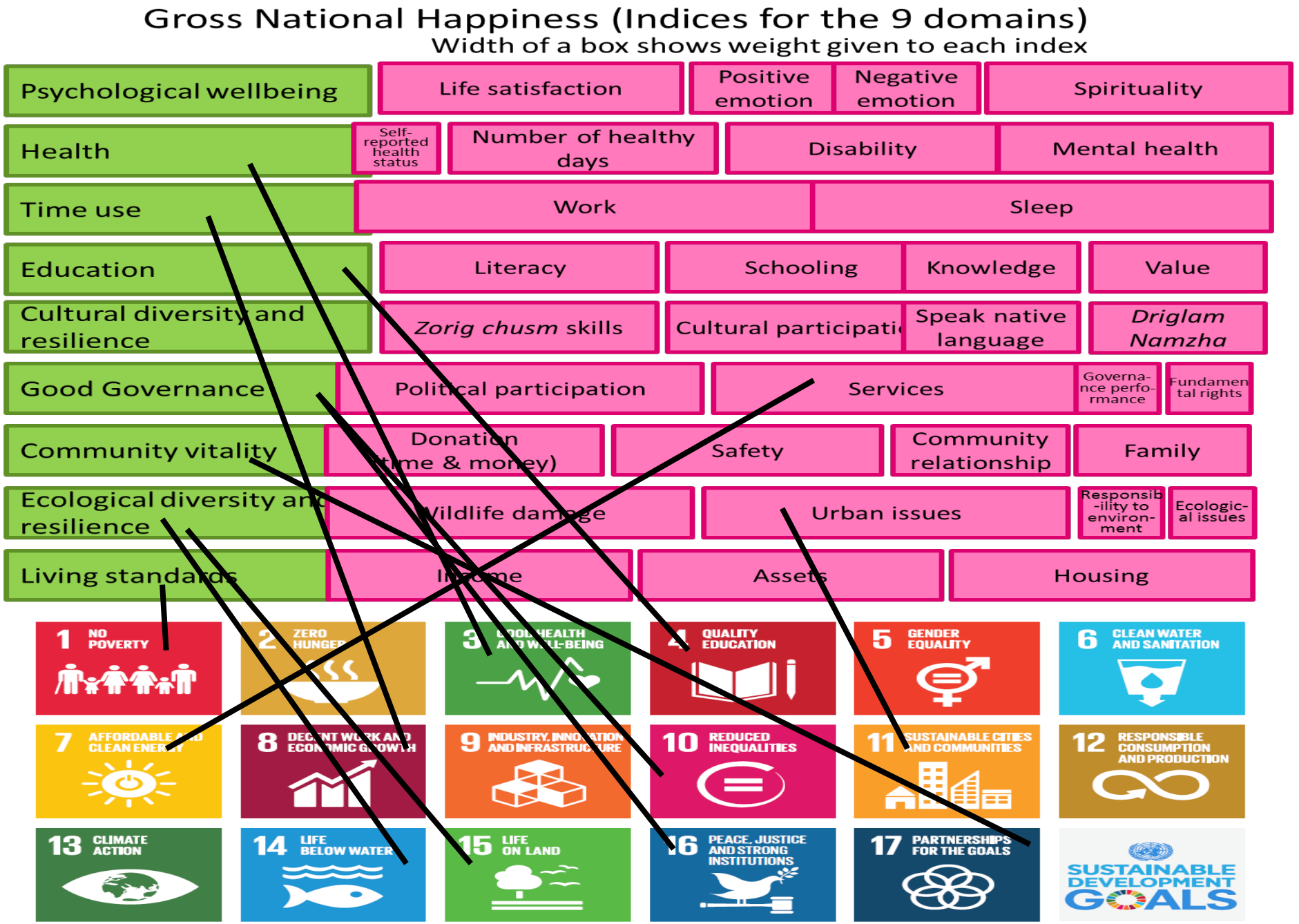
Power line
reaches 97%
of residence

National Park shares
half of land area

National survey of carbon
stock of forest and soil

Energy sources & access





Challenge5 : How to strengthen good governance under Gross National Happiness target?

Governance

- Development Plan of Bhutan bases on "Gross national Happiness (GNH)" concept
- GNH Indices for 9 domains:
  - Psychological well-being, Health, Time use (Work, Sleep), Education, Cultural diversity and resilience, Good governance, Community Vitality, Ecological diversity and resilience, Living standard (Income, Asset, housing)
- Nine areas with same weight are defined ⇒

Indices for the 9 domains

Width of a box shows weight given to each index

Psychological wellbeing	Life satisfaction	Positive emotion	Negative emotion	Spirituality
Health	Self-reported health status	Number of healthy days	Disability	Mental health
Time use	Work	Sleep		
Education	Literacy	Schooling	Knowledge	Value
Cultural diversity and resilience	*Zorig chusm* skills	Cultural participation	Speak native language	*Driglam Namzha*
Good Governance	Political participation	Services	Governance performance	Fundamental rights
Community vitality	Donation (time & money)	Safety	Community relationship	Family
Ecological diversity and resilience	Wildlife damage	Urban issues	Responsibility to environment	Ecological issues
Living standards	Income	Assets	Housing	

- Nation-wide surveys (9,000 sample) in 5 years cycle monitors peoples satisfaction in detail index.

At 2015 survey *[7]:

- Deeply or extensively happy 43.4%, narrowly happy 47.9%, unhappy 8.8%.
- men> women, urban resident> rural , more educated> less educated tend to be happier
- Increased satisfaction on services: electricity, tap and sewage water and housing
- psychological well-being and government performance degraded 2-25% from 2010

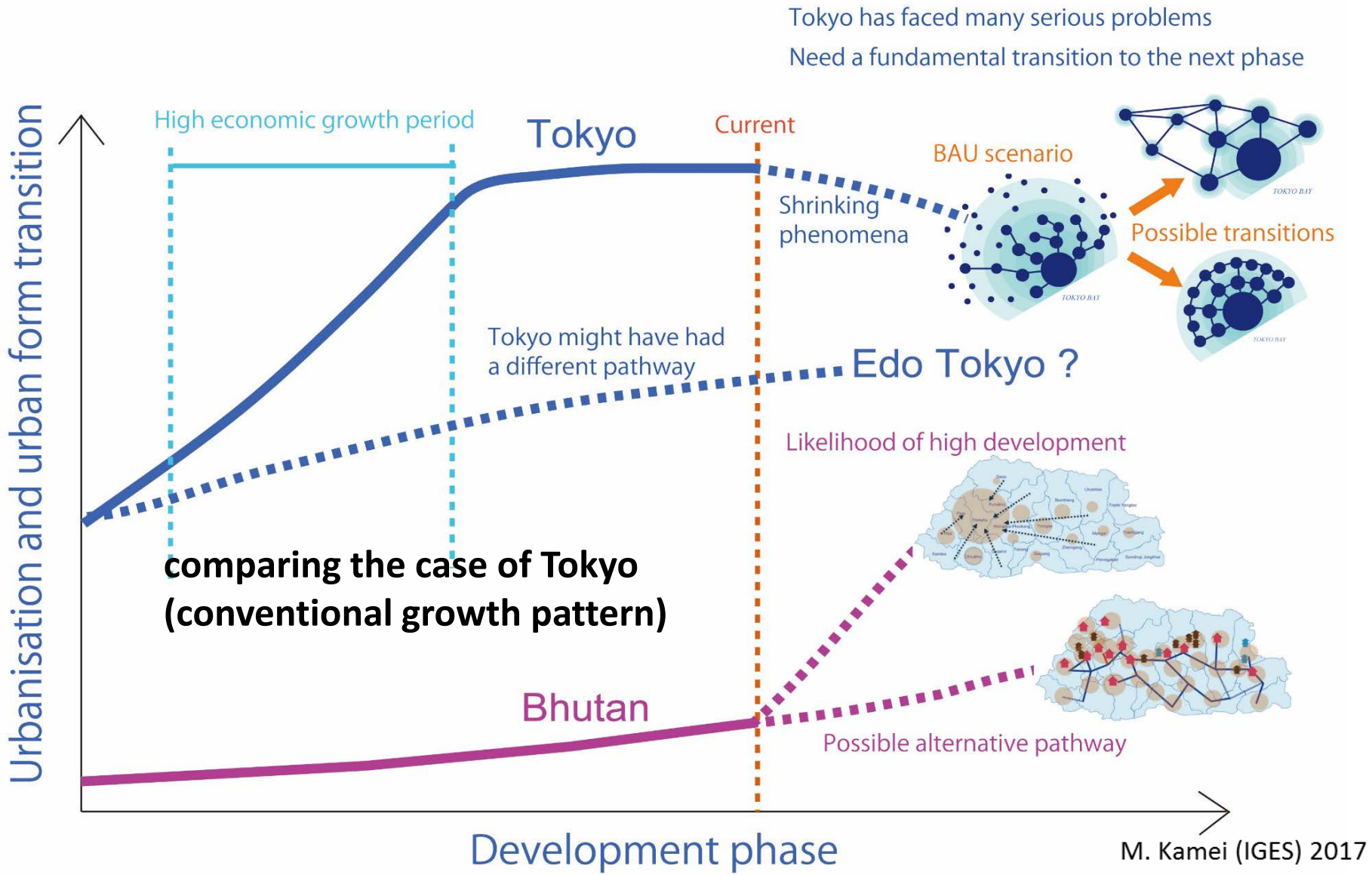
Relationship between GHH and develoment

Relationship between GNH and Development path

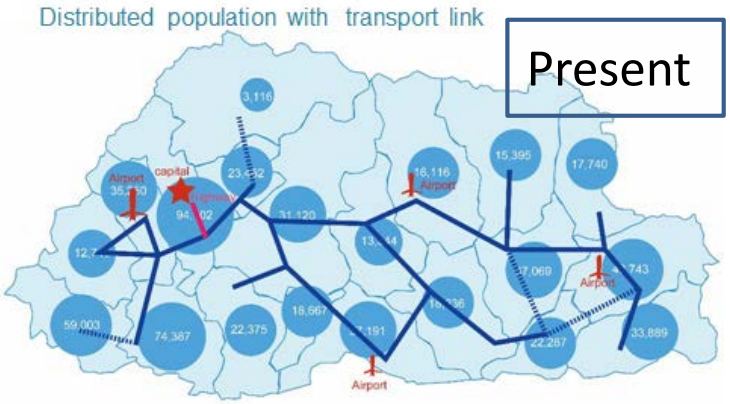
GNH Index	No. of Pop. /Household	Economy	Transport ation	Energy	Agri-culture	Land-use	Waste	GHG
Psychological Wellbeing	Family structure			Electrification rate				
Health	Age distribution		Walking trip					
Time use		Labor Hour						
Education		Promoting Education						
Cultural diversity & resilience					Domestic production rate			
Community vitality	Family structure	Income						
Good governance			Public transportation	Electrification rate		Forest Area	Waste management	
Ecological diversity & resilience						Forest Area	Waste management	GHG emission
Living standard	Family Structure	Income	Modal share					

Gomi & Ochi 2016

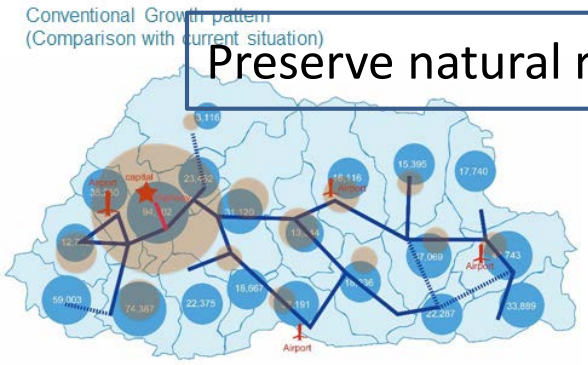
How to keep local population to preserve natural resources, tradition, heritage and culture : Dynamic & integrated national land-use plan is indispensable



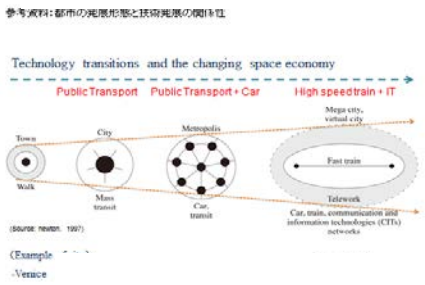
Land use plan under carbon neutral & Gross National Happiness



Present

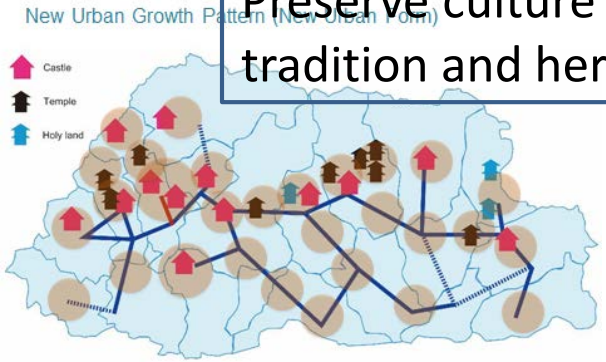


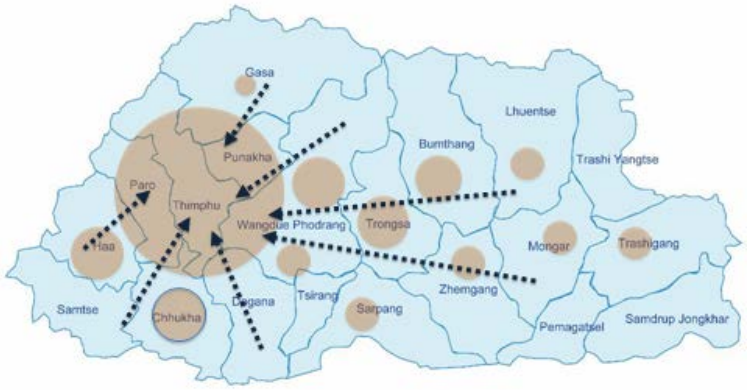
Preserve natural resources



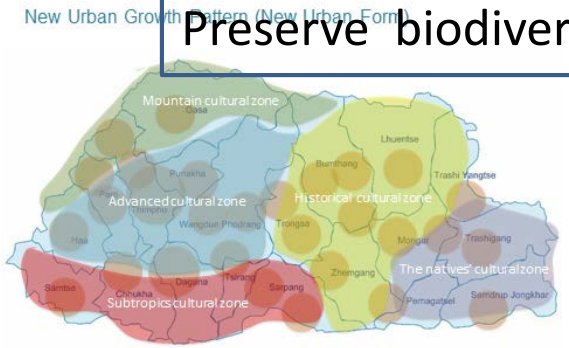
BaU

Preserve culture , tradition and heritage



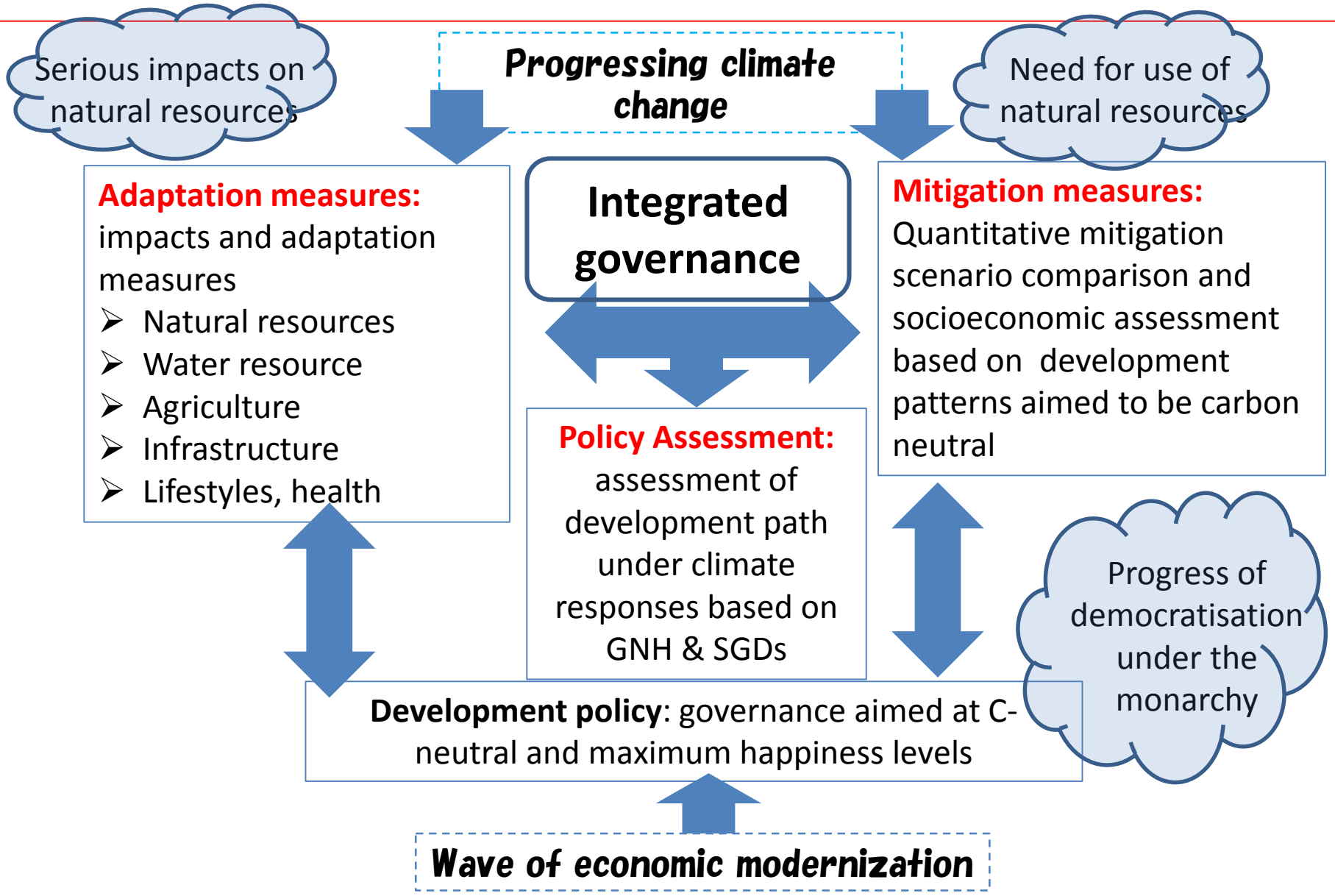


Preserve biodiversity



M. Kamei (IGES) 2017

Factors of Carbon Neutral & Sustainable Bhutan under CC



Our challenges towards Carbon Neutral Asia

Reality of Asian carbon neutral situation

- GHG/CO2 emission, usage of renewable energy, land-use situation,,,,
- How NDCs and long-term low carbon strategies are integrated into national development plan?,

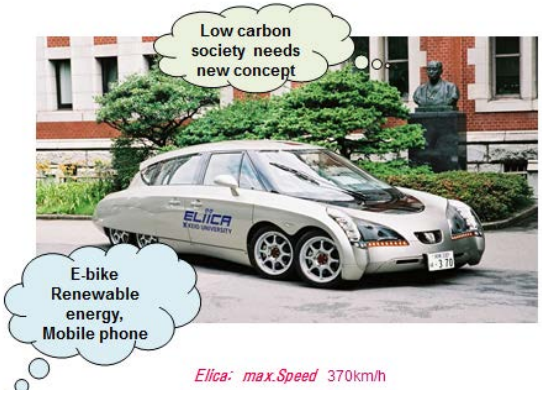
How natural resources are used, preserved, regulated,,,,,,?

- Concrete measures: agroforestry, participatory monitoring, national land-use plan, subsidization, response policy to depopulation by urbanization, land-use competition among urbanization and agriculture production, huge dam construction, small size hydro-power, biomass use,,,,,
- Possibility of BECCS (biomass+CCS)

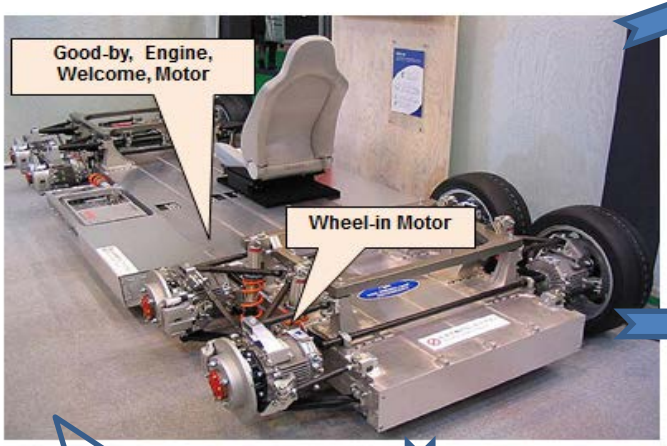
What area research and technology should focus on?

- Climate impacts to natural resources and adaptation
- Carbon cycle, utilization of satellite data
- Carbon neutral pathway
- Economic evaluation, economic measures , carbon pricing
- National land-use plan: how to keep enough population to keep natural resources
- International context: How to give more value to natural resources?

Climate change brought innovation



Shanghai E-bike to ASEAN big market?



Platform of SIM-Drive

Number of parts decreases by 2/3

Employment decreases by 2/3

Easy slow mobilization

New energy-mobility infrastructure in Berlin

Clear Sky

Morocco

Thank you very much for your attention!

LCS-RNet/LoCARNet Secretariat
http://lcs-rnet.org/index.html

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What about Asian countries?

Asia (China, ASEAN, India, Japan,,) :

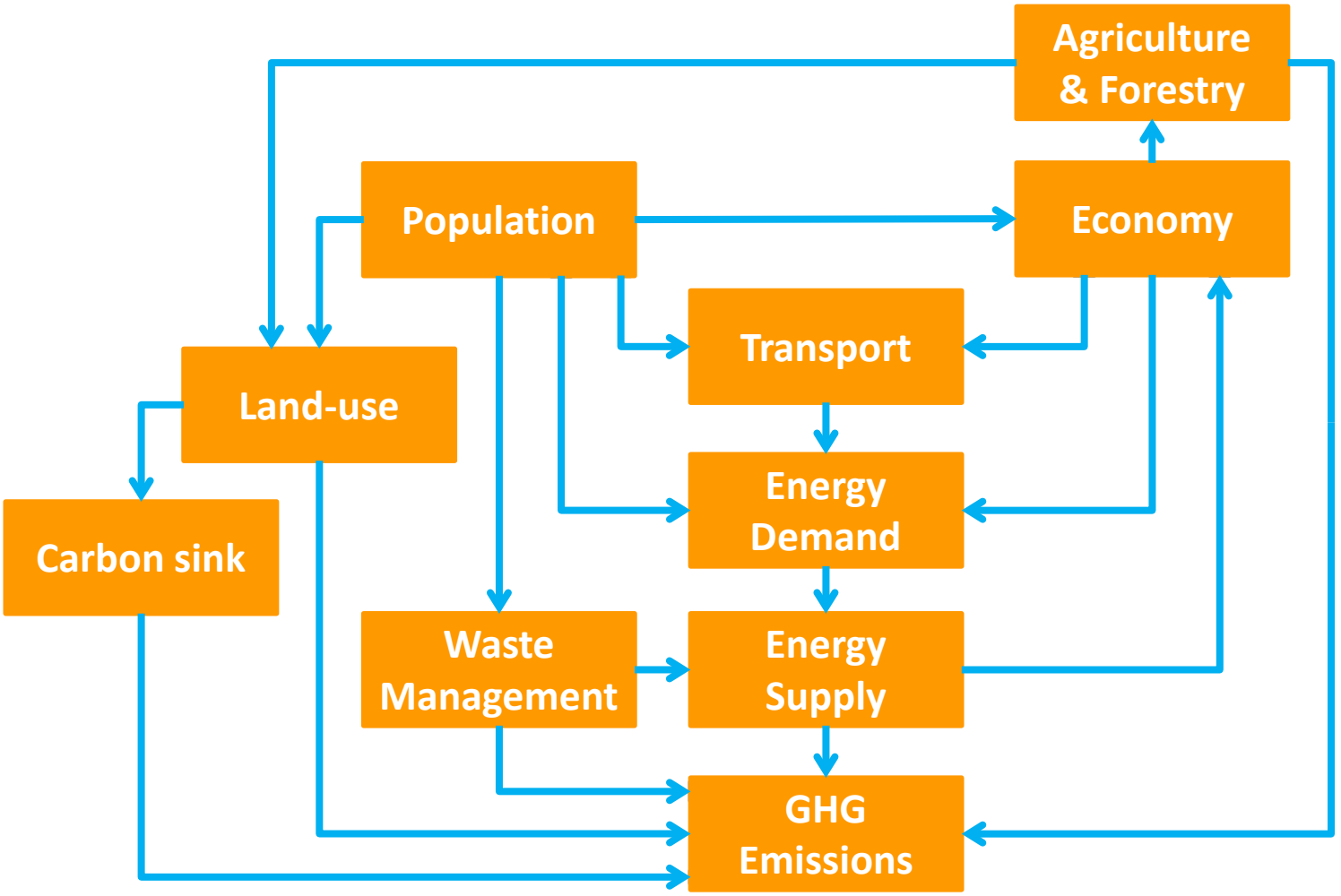
- Half of global emission in 2050 (BaU)
- Center of global economic growth, High investment in infrastructure & industry⇒lock-in to conventional high-energy consuming technologies, in coming next 30-50 years
- Already exceeded 2 ton/capita

- "leapfrogging": new development pathways?
- A good example: China's late comer's advantage

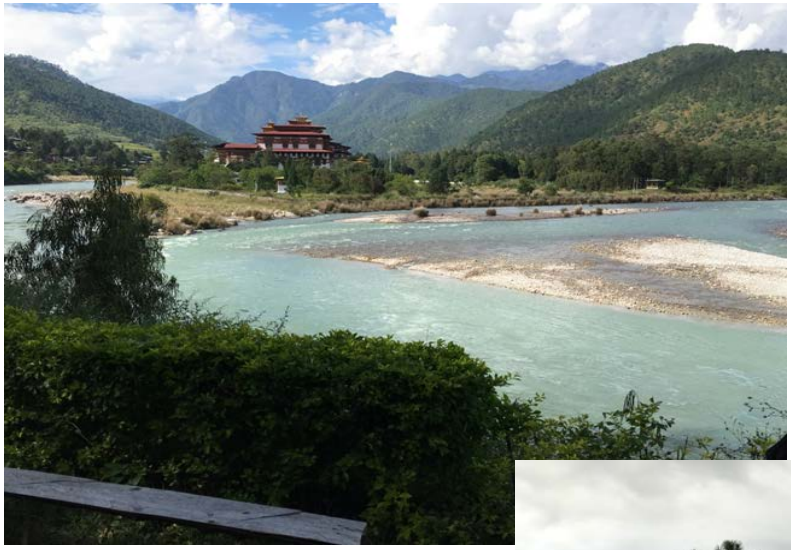
- Mobil-phone: difficulty in wired telephone, IT age, ⇒No.1 user and producer of mobile phone
- Renewable energy: vast national territory, low-carbon trends, energy security, air pollution by coal use⇒No.1 in the world producer of renewable energies and devices
- Electric Bike in Shanghai (good engineering capability, engine technology needed, air pollution, potential market in Asia
- Subway in Shanghai: 14 route after International Exhibition in 2010

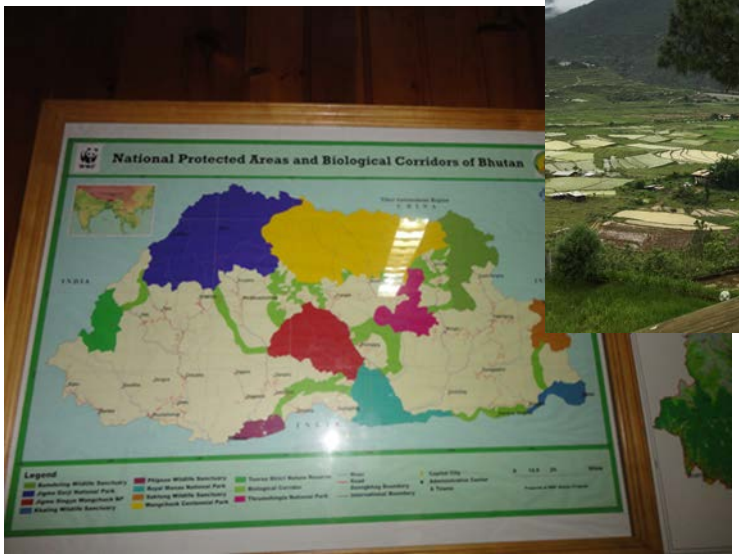
Bhutan Low-carbon Scenario Model

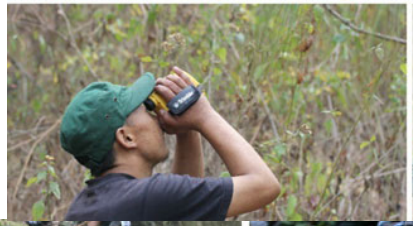
The model called “Extended Snapshot Tool” simulates future socio-economic activity, transport demand, land-use, waste management, energy demand and supply, agriculture, and GHG emissions and emission reduction contributions.
It was customized in order to consider Bhutan’s emission structure.

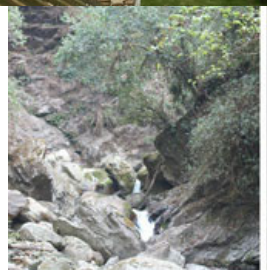


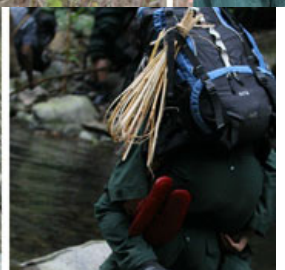
Bhutan's Natural resource & its management



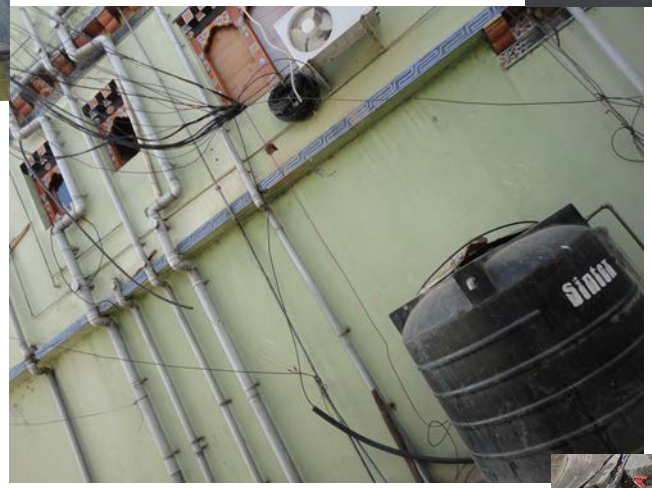








Infrastructure



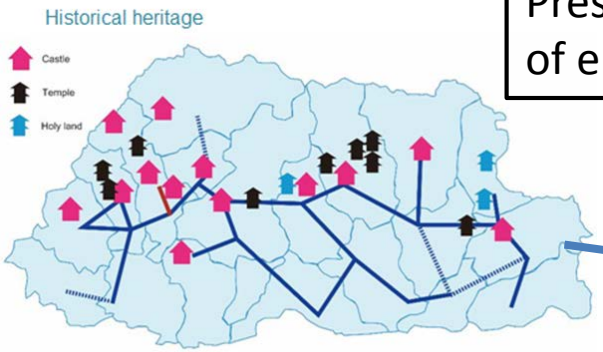
How can natural resources be preserved?
Importance of national level land- use planning

Maximize Gross National Happiness

Maintain vernacular culture and tradition

Preservation of environment

Good Governance
National Development plan



Changing climate

How to develop with less carbon?

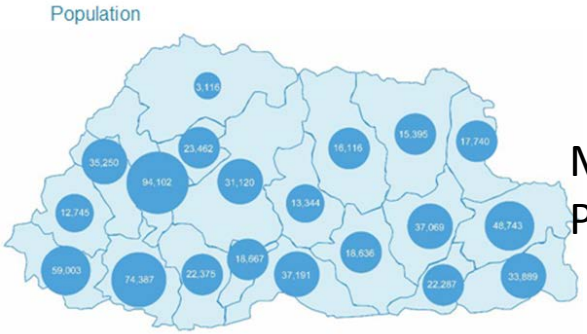
National Low carbon development path way

Industry
Business
Population
Agriculture
Absorption, hydro-power
Biomass,
Biodiversity

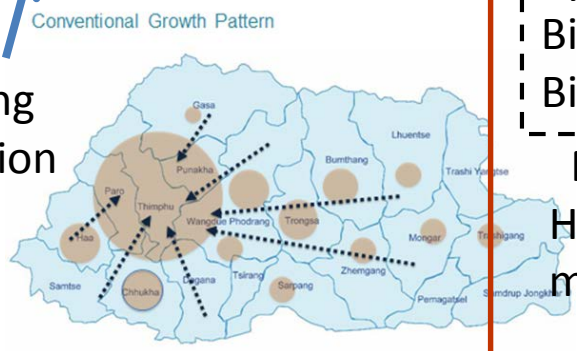
Top-down

Dynamic Dialogue

Bottom-up



Migrating Population



National Land-use plan

How to settle population for maintain natural resources?

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Impacts by globalizing economy, urbanization and democratization

Current Trend

Economy

・GDP/cap (2011) US$ 2,590

・Growth rate (2006年～2011) 7－8%/y

・Unemployment rate 3%,

・National income： domestic 65%, assistance 35%

・Working Population: Agriculture (subsidized) 69%, 2nd & 3rd industry are still small

Domestic migration

・Increasing population and migration to urban area, especially to Thimphu

・With increasing investment on infrastructure and industry, air/water /waste pollution increasing in urban area. Stable safe drinking water provision is at risk.

・Country side suffers from human- animal conflict

Literacy

・Literacy in young generation is 95%, elder than 65 is 20%. School education performed by English.

・Electricity is provided 97% of household, TV75%, mobile 98%, which deliver world newest information to home

Governance: Development Plan

Democratization

Maximize GNH:

・Sustainable and equitable social and economic development

・Preservation of natural environment

・ Maintenance/promotion of culture/ tradition

・Good governance

Development Plan:

・High value, low volume
High–tech, Medical industry, Education business,

・Self resilience & full employment.
Enhance variety of export industry under “Brand Bhutan“:

・Carbon Neutral policy

NDC for CC

Land use plan:

・Decentralization policy, Dry port

Can Bhutan develop with full satisfaction of peoples by preserving it vernacular culture and affluent natural resources? A big challenge.

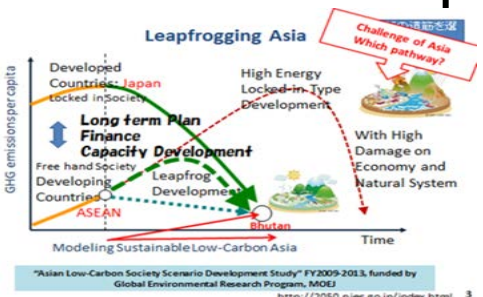
Characteristics of Old and New "Mission-Oriented" Projects

Source: Soete and Arundel (1993, p. 51)

Old: Defence, Nuclear and Aerospace	***New: Low Carbon Technologies***
The mission is defined in terms of the number of technical achievements with little regard to their economic feasibility	The mission is defined in terms of **economically feasible technical solutions** to particular environmental problems.
The goals and the direction of technological development are defined in advance by a small group of experts	The direction of technical change is **influenced by a wide range of actors** including the government, private firms and consumer groups
Centralised control within a government administration	**Decentralised control** with a large number of involved agents
Diffusion of results outside the core of participants is of minor importance or actively discouraged	**Diffusion of the results** is a central goals and is actively encouraged
Limited to a small group of firms that can participate owing to the emphasis on a small number of radical technologies	An emphasis on the **incrementalist** development of both radical and incremental innovations in order to permit a large number of firms to participate
Self-contained projects with little need for complementary policies and scant attention paid to coherence	**Complementary policies vital** for success and close attention paid to coherence with other goals

Can Bhutan leapfrog? Some leading runners, leverage, tailwind

Issue	*Country*	*Internal factors*	*External factors*
Industrial structure	India: '90s IT industry, Bangalore	Education/ human resources	Soft technology start Globalization
Energy structure	Japan: '70s Low energy intensity	Technology Rapid growth /pollution	Oil crisis Energy security
Bioenergy	Brazil: '70s Bioethanol	Sugar cane Scarce oil	Oil crisis Energy security
Information technology	China: '00s- Mobile phone	Rapid economic growth, poor telephone-grid	IT technology globalization
Renewable energy / EV	China: '00s Wind/solar energy/EV	Big land area Technology/ pollution	Decarbonizing trend Climate change
Develop-ment path?	Bhutan ～2050s High dependence to external fund High transportation cost Inadequate infrastructure	Political stability Natural and Pristine environment Competitively pricing energy Nation of GNH Wide use of English language * 8	Carbon neutral world International cooperation climate finance capacity building



	1	2	3	4	5
POWER					
Renewable power (incl. hydro)	**China**	United States	Brazil	Germany	Canada
Renewable power (not incl. hydro)	**China**	United States	Germany	Japan	India
Renewable power capacity *per capita* (among top 20, not including hydro[3])	**Denmark**	Germany	Sweden	Spain	Portugal
Biopower generation	**United States**	China	Germany	Brazil	Japan
Geothermal power capacity	**United States**	Philippines	Indonesia	Mexico	New Zealand
Hydropower capacity[4]	**China**	Brazil	United States	Canada	Russian Federat.
Hydropower generation[4]	**China**	Brazil	Canada	United States	Russian Federat.
CSP	**Spain**	United States	India	Morocco	South Africa
Solar PV capacity	**China**	Germany	Japan	United States	Italy
Solar PV capacity *per capita*	**Germany**	Italy	Belgium	Japan	Greece
Wind power capacity	**China**	United States	Germany	India	Spain
Wind power capacity *per capita*	**Denmark**	Sweden	Germany	Ireland	Spain
HEAT					
Solar water heating collector capacity[5]	**China**	United States	Germany	Turkey	Brazil
Solar water heating collector capacity *per capita*[5]	**Austria**	Cyprus	Israel	Barbados	Greece
Geothermal heat capacity[6]	**China**	Turkey	Japan	Iceland	India
Geothermal heat capacity *per capita*[6]	**Iceland**	New Zealand	Hungary	Turkey	Japan

Challenge 6: How to design development path fit to transforming world?

Current Trend

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Literacy

- Literacy in young generation is 95%, elder than 65 is 20%. School education performed by English.
- Electricity is provided 97% of household, TV75%, mobile 98%, which deliver world newest information to home

Governance: Development Plan

Democratization

Maximize GNH:

- Sustainable and equitable social and economic development
- Preservation of natural environment
- Maintenance/promotion of culture/ tradition
- Good governance

Development Plan:

- High value, low volume
  High–tech, Medical industry, Education business,
- Self resilience & full employment.
  Enhance variety of export industry under “Brand Bhutan“:
- Carbon Neutral policy

NDC for CC

Land use plan:

- Decentralization policy, Dry port

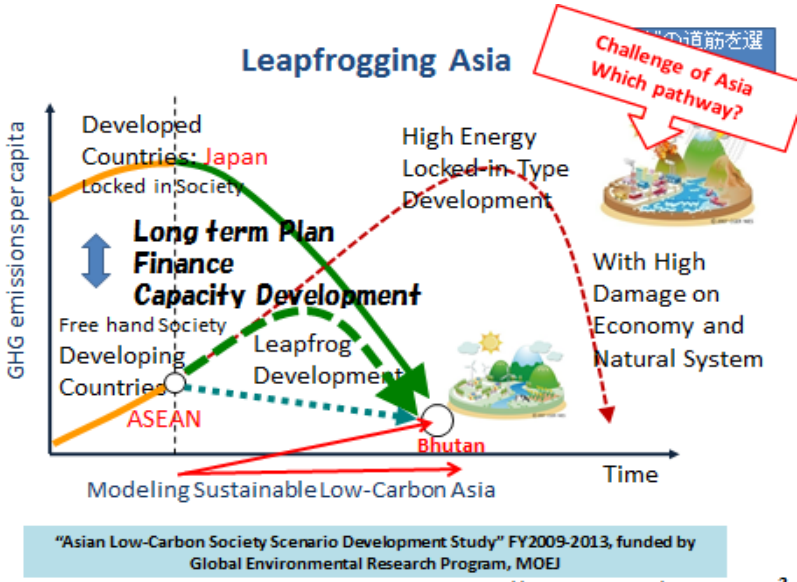
Can Bhutan develop with full satisfaction of peoples by preserving it vernacular culture and affluent natural resources? A big challenge.

Thank you very much for your attention!

Bhutan's leapfrogging challenge in energy access aiming at carbon-neutral society

Shuzo Nishioka/Miho Kamei/Tomoko Ishikawa（IGES)
Kei Gomi (NIES), Yuki Ochi (E-Konzal)

- Lately coming developing countries can not (needs not to) track same hi-carbon development pathway to carbon neutral world
- How natural resources dependent development countries challenge to carbon neutral world and confront to energy access issue?
- Can they create alternative development pathway, technologically, economically and socially, by leapfrogging beyond high-energy intensive modern society, taking this transition as leverage?
- What impacts climate change and responding strategies give to countries' sustainable development pathway?
- Can case of Bhutan be transferable to other developing countries?



"Asian Low-Carbon Society Scenario Development Study" FY2009-2013, funded by Global Environmental Research Program, MOEJ

http://2050.nies.go.jp/index.html

Challenge 2: How to introduce appropriate technology into its development path?
Biomass, pollution, electricity & absorption

- **Total energy** demand in 2005（& 2040 baseline projected* ）387(730) 10^3toe, per capita 0.5(0.75) toe/Cap.(almost same as India)
- **Supply:** fuel wood 60% (22%), hydro-power13%(44%) , imported gasoline/ diesel/ kerosene 20%(25%), coal 7% (6%) ⇒self sufficiency 3/4 (2/3). Accessibility to electricity is 97%.
- **Consumption:** residential: rural 32%(14%), urban 4%(15%), energy intensive industry 9%(17%), other industry 12%(25%), tertiary industry 10%(17%), agriculture/forestry 14%(1%), Transportation 14%(12%)
- **In 2040**, total energy increases 2.4 times, fuel wood stable, hydro-power increases 8 times, fossil fuel increases 2.6 times ⇒self -sufficiency decreases
- **Absorption:** Forestry, coverage of 70% of land area (National target: 60%) keeps absorption.
- Biomass : fuel wood for cooking and warming causes indoor/urban air pollution.
- **Bio-diversity:** Half of land area designated as national park, preserving bio- diversity, and contributing to eco-tourism.

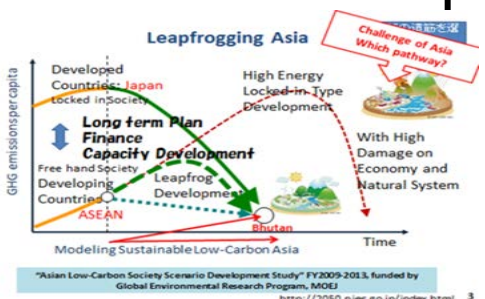






Can Bhutan leapfrog? Some leading runners, leverage, tailwind

Issue	*Country*	*Internal factors*	*External factors*
Industrial structure	India: '90s IT industry, Bangalore	Education/ human resources	Soft technology start Globalization
Energy structure	Japan: '70s Low energy intensity	Technology Rapid growth /pollution	Oil crisis Energy security
Bioenergy	Brazil: '70s Bioethanol	Sugar cane Scarce oil	Oil crisis Energy security
Information technology	China: '00s- Mobile phone	Rapid economic growth, Weak telephone-grid	IT technology Gobalization
Renewable energy / EV	China: '00s Wind/solar energy/EV	Big land area Technology/ pollution	Decarbonizing trend Climate change
Develop-ment path?	Bhutan ～2050s High dependence to external fund High transportation cost Inadequate infrastructure	Political stability Natural and Pristine environment Competitively pricing energy Nation of GNH Wide use of English language * 8	Carbon neutral world International cooperation climate finance capacity building



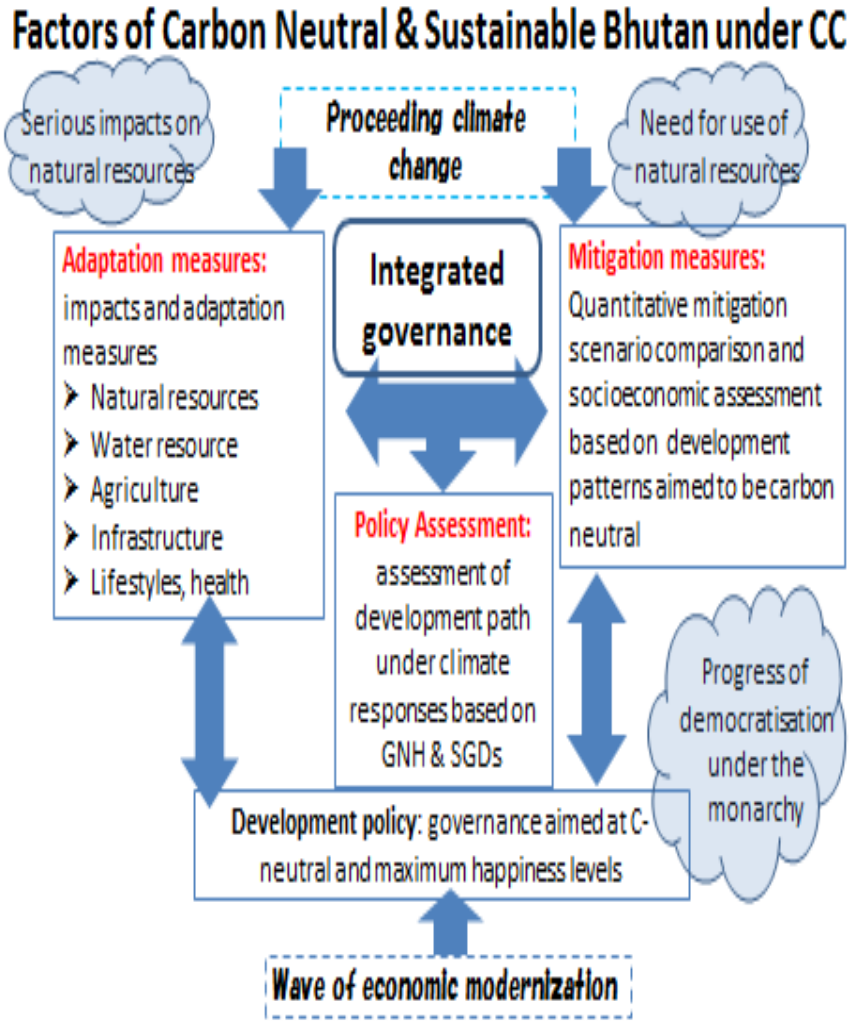
Bhutan: What affects carbon neutral path and energy access?

External factor : climate change

- Change of precipitation and hydrology: impact to capacity and stability of hydropower, Disaster: land slide, soil erosion, burst of glacier lake
- Degradation of : forest /soil/agricultural land ⇒carbon sequestration & biomass capacity
- Paris agreement
- Wave of globalization

Internal factor: development path under democratization and globalization

- Democratization: high educational level/ informational environment
- Industrialization/ Globalisation:
- Urbanization/ depopulation in rural area
- Governance under GNH concept



Thank you very much for your attention!

LCS-RNet/LoCARNet Secretariat
http://lcs-rnet.org/index.html

c/o Institute for Global Environmental Strategies (IGES)
2108-11 Kamiyamaguchi, Hayama, Kanagawa 240-0115, Japan

E-mail: lcs-rnet@iges.or.jp
Fax: +81 (0)46 855 3809

Scenario assumptions

Two preliminary scenarios were developed: BaU (targeted economic growth will occur without low-carbon measures) and CM (targeted economic growth with low-carbon measures)

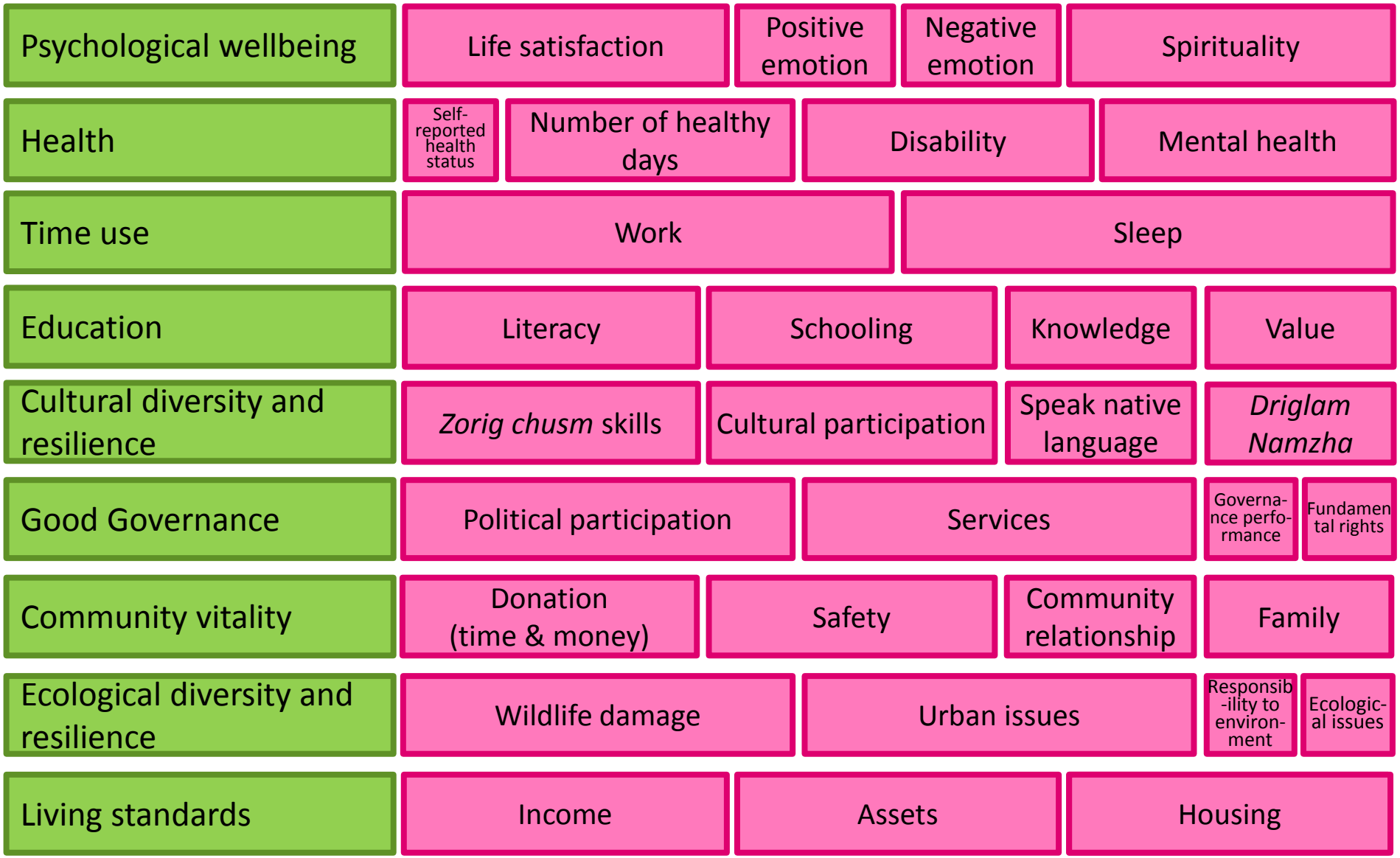
		BaU	CM1
Demography	Population	Increase	Same as BaU
	Household	HH size decreased	Same as BaU
Economy	Agriculture	Increase production as population increase	Yield improved
	Manufacturing	Increase as planed target (by 2020) Growth rate declines after 2020	Same as BaU
	Construction	Increase as planed target (by 2020) Growth rate declines after 2020	Same as BaU
	Services, etc	Increase	Same as BaU
	Power	Hydro: increase as planed	Hydro: Increase as planed Other RE for domestic supply
Transport	Passenger	Provate car increases as income increase	Private car increases as income increase Share of bus is larger than BaU
	Freight	Increase as economic growth	Increase as economic growth
Energy	Res/Com Energy service	Increase as income increase & urbanization	Increse, but growth rate is lower than BaU
	Res/Com/Ind effficiency	Same as base year	Improved
	Transport technology	Same as base year	Fuel cost improved EV introduced
	Demand side fuel composition	Same as base year	Reduce fuel wood, increase electricity
	Power supply	Composition and efficiency: same as base year	Efficiency improved PV, Biomass, Small hydro introduced
	Fosil fuel	Composition and efficiency: same as base year	Efficiency improved
	Dispersed systems	-	District heat supply (biomass) Smart grid (for mountain villeges)
Land use	Settlement	Density same as base year	Density higher than base year
	Cropland	Yield same as base year	Yield improved
	Forestland	Same as base year	Increase managed forest land

Main points

- Two scenarios by 2050 were developed with current information and existing future plans.
- In Bhutan, GHG emission will exceeds carbon sink in 2050 in BaU (business as usual) scenario.
- Hydro power will always be main energy source, however, oil demand will increase by 5 times in 2050 in BaU.
- GHG emission can be reduced about 22% in CM (counter measures) scenario. More than half of the emission reduction is by forest management.
- The projection is solely based on currently available data and plan. If the information is updated, the result will differ.

Indices for the 9 domains

Width of a box shows weight given to each index



GHG emissions in BaU scenario

By sectors, freight transport has a large share of GHG emissions. However, this is caused by estimation of current energy consumption from indirect data. If more detailed information of fuel consumption is obtained, it is likely to change.

In BaU scenario, per capita GHG emission (without LULUCF) will be 5.9tCO2eq in 2050. This is more than double from current level.

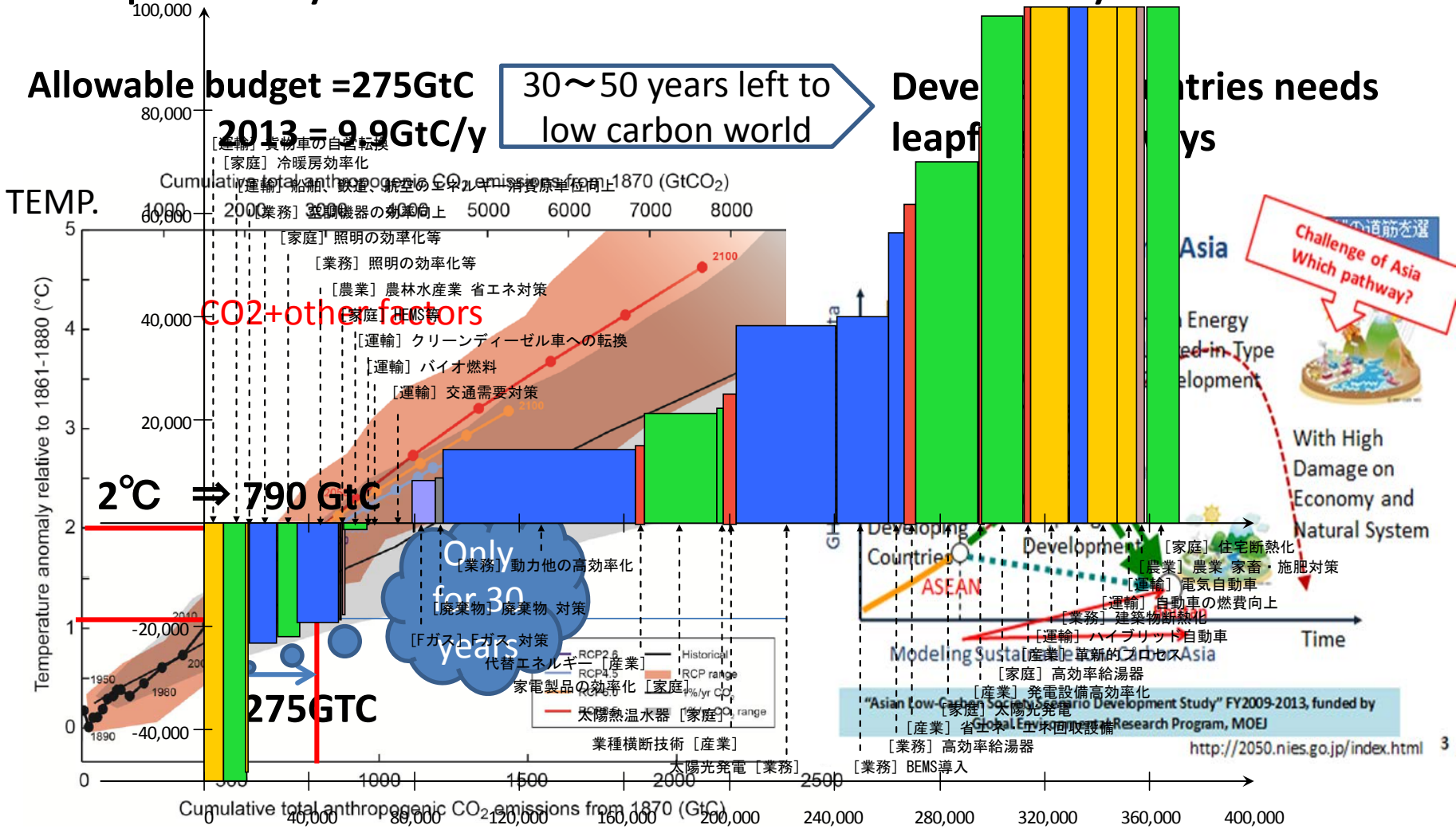
ktCO2eq

		BaU				
		2012	2020	2030	2040	2050
Energy	Residential	27.8	45.0	75.7	128.8	184.6
	Commercial	30.2	76.5	204.1	451.8	830.5
	Industry	174.9	246.7	376.5	547.4	738.8
	Ps. Transport	85.1	160.0	226.8	298.0	376.0
	Fg. Transport	261.0	573.1	1,020.1	1,563.2	2,038.2
	(subtotal)	*578.9*	*1,101.3*	*1,903.2*	*2,989.2*	*4,168.1*
LULUCF	LU change	−6,072.8	−6,072.8	−6,072.8	−6,072.8	−6,072.8
Agriculture		1,000.0	1,136.1	1,244.6	1,351.3	1,440.9
Waste						
Industrial process		238.0	280.5	341.9	408.6	478.9
Total		−4,255.9	−3,554.9	−2,583.1	−1,323.7	15.2

tCO2eq

Per capita emissions (w/o LULUCF)		2.5	3.1	3.9	4.9	5.9

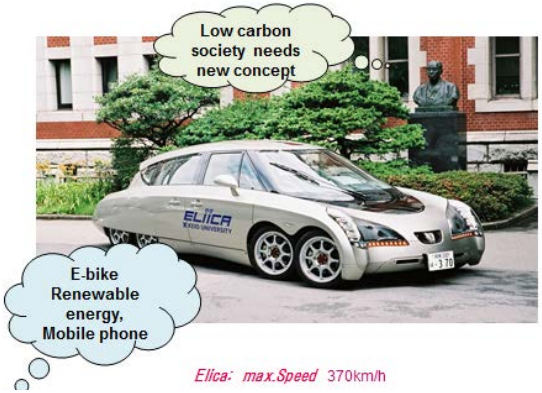
How to design leapfrogging development pathways towards carbon neutral society?



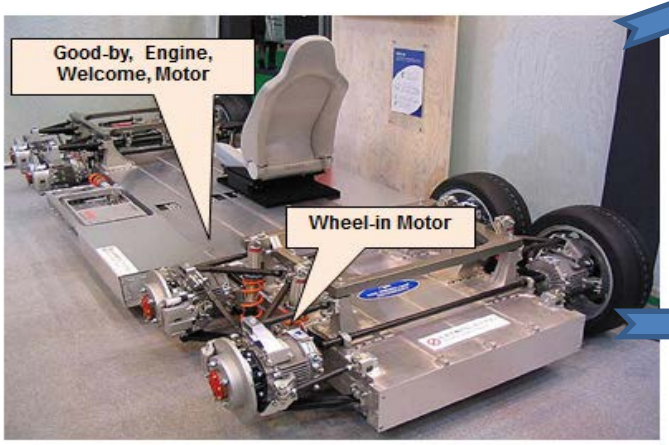
Cumulative total anthropogenic CO2 emission from 1870 (GtCO2)

(IPCC AR4 and Emori, NIES)

Climate change brought innovation



Shanghai E-bike to ASEAN big market?



Platform of SIM-Drive

New energy-mobility infrastructure in Berlin

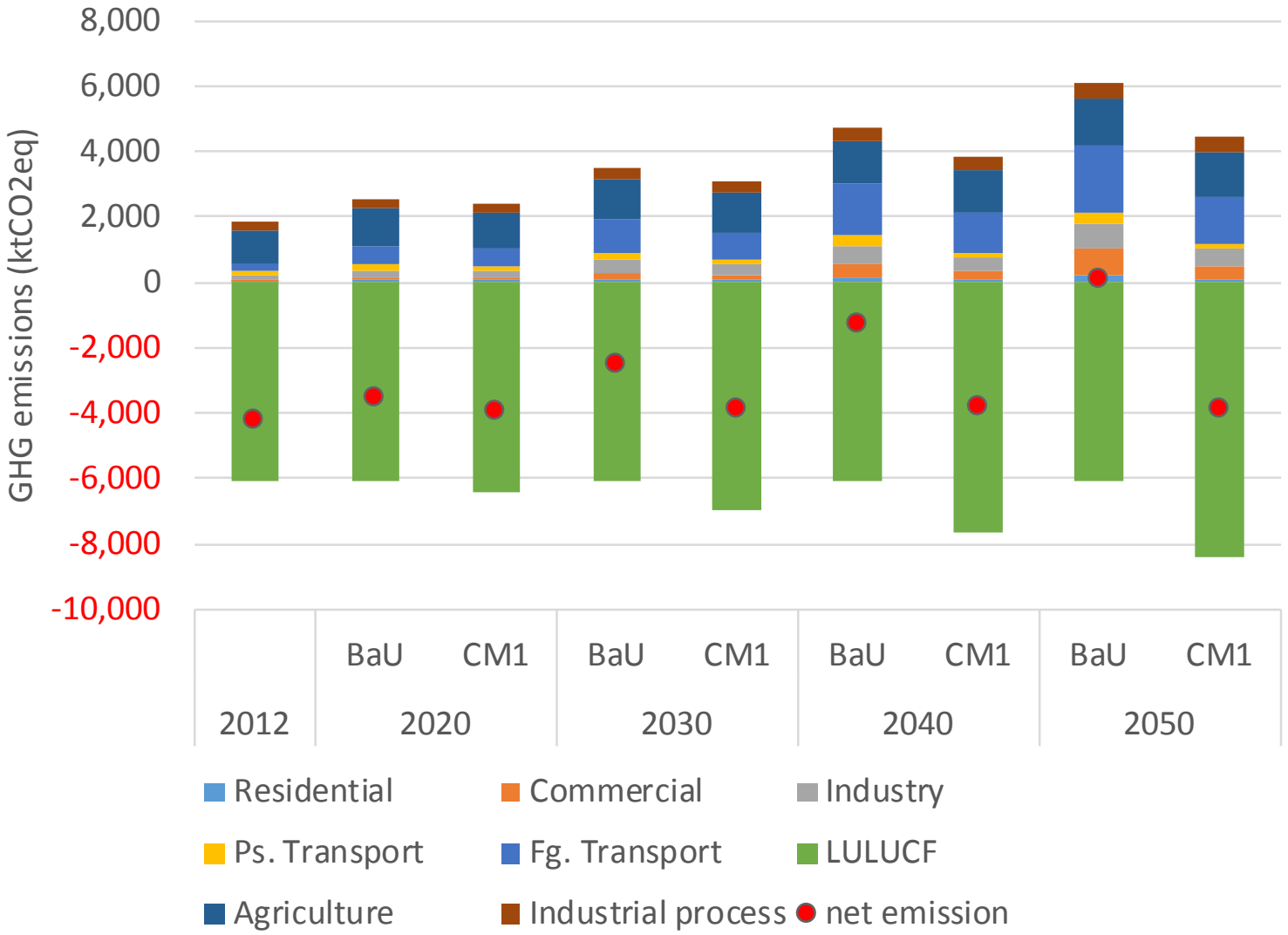
Clear Sky

Easy slow mobilization

Morocco

Carbon neutral pathway of Bhutan: (Preliminary result)

Net GHG emission become slightly POSITIVE in 2050 BaU. Low-carbon measures are necessary in order to keep being a net NEGATIVE emission country.



How does Transition to De-carbonized Society Benefit Challengers?

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  - It is Development itself.
  - It is “must”: nature’s logic: limited carbon budget, carbon value up, promised market, early comers take all
  - World wide system change: challengers opportunity

- Similarity between Japan at Oil Crisis (1970’s) & China at Climate Change (2010’s)
  - Energy security: growing consumption, low self-sufficiency rate, rapid oil price up
  - Economy entering mature stage
    - Growth rate leveling off
    - Industrial structure: heavy industry to manufacturing
    - Welfare : Serious pollution: industry to urban
    - Urbanization (and rural depopulation)

- Japan’ current challenges
  - Aged society: social security & its finance, local infrastructure
  - Conservation of local society &natural resources: aged population & infrastructure,
  - Long-term financial deficit by short sighted economic stimulation: Long-term vision for social and health security and inter-generational equity
  - Can keep competence in technology in shifting paradigm?
  - Political readership/ Political will/ Long-term development strategy

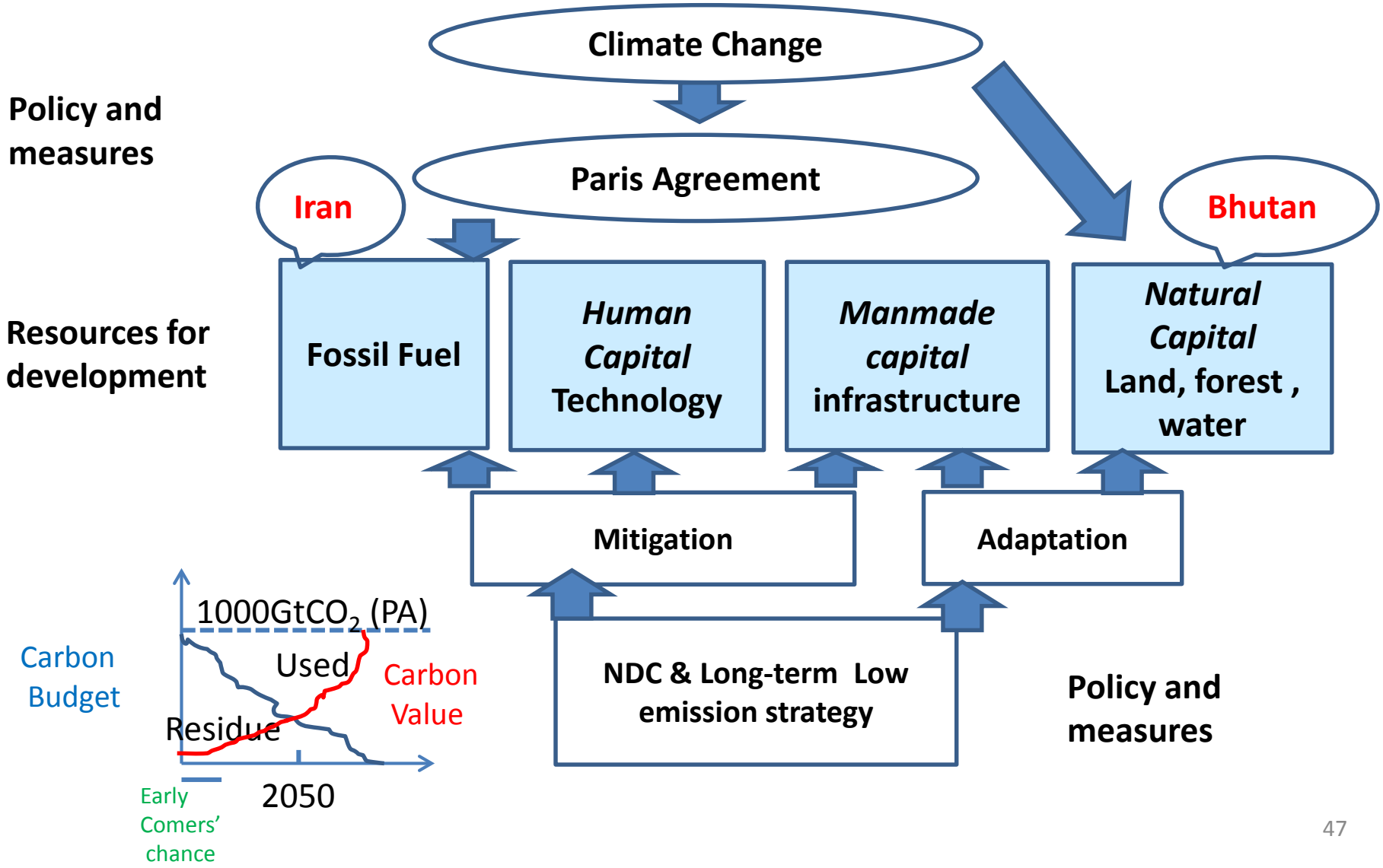
What are the co-benefits of policies for stabilizing climate?

Climate change and Development

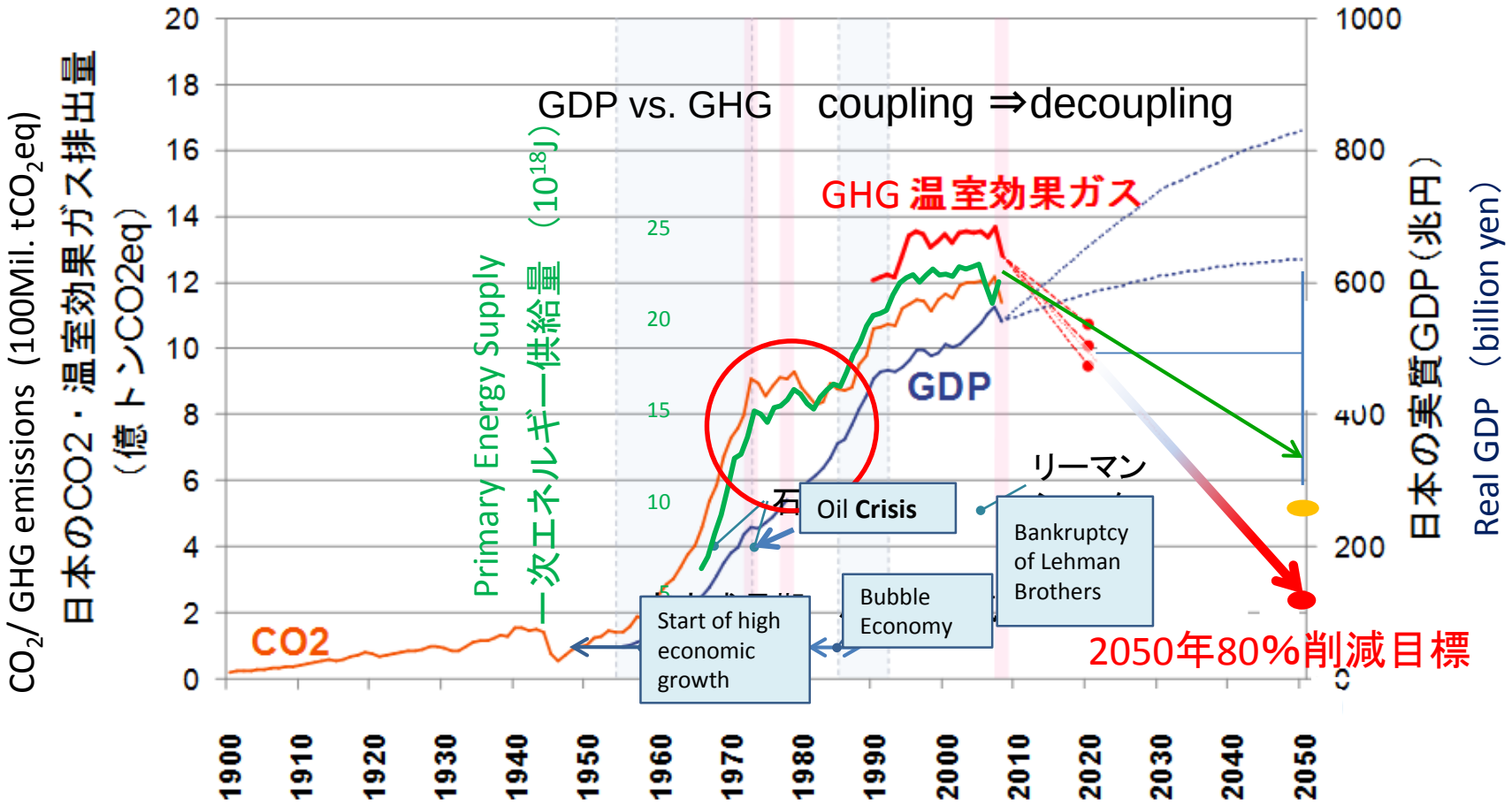
- More than co-benefit. Decarbonizing transition= **development itself**
  - nature's logic **"must" :** "Promised market",
  - Economic logic : Limited carbon budget ⇒ "Carbon value" increase
  - Contribute to **SDGs,** if well designed/implemented.
  - **Major elements of development:**
    - **Economy and industrial structure**: energy intensive industry to change / electricity major secondary energy/electric・hydrogen car/ pollution control
    - **Energy security**: land based energy/renewable energies
    - **Natural resources:** (forestry& soil)conservation: for the absorption of CO2
    - **Infrastructure:** Urban system (transportation/ building/ information)
    - **Finance**: a few percent of additional investment (in Japan's case)
    - **Knowledge resource**: technology, human resource, education

- use it in **win-win** relation
  - World scale system change: **Huge niche** in technology and social system
  - **Equal start line**: yet not locked-in society rather advantageous (case of mobile)
  - Good opportunities to push development elements forwards simultaneously
  - Early comers take all : China in solar panel market, wind power, EV?

Climate Change:
Impact to Resources for Development

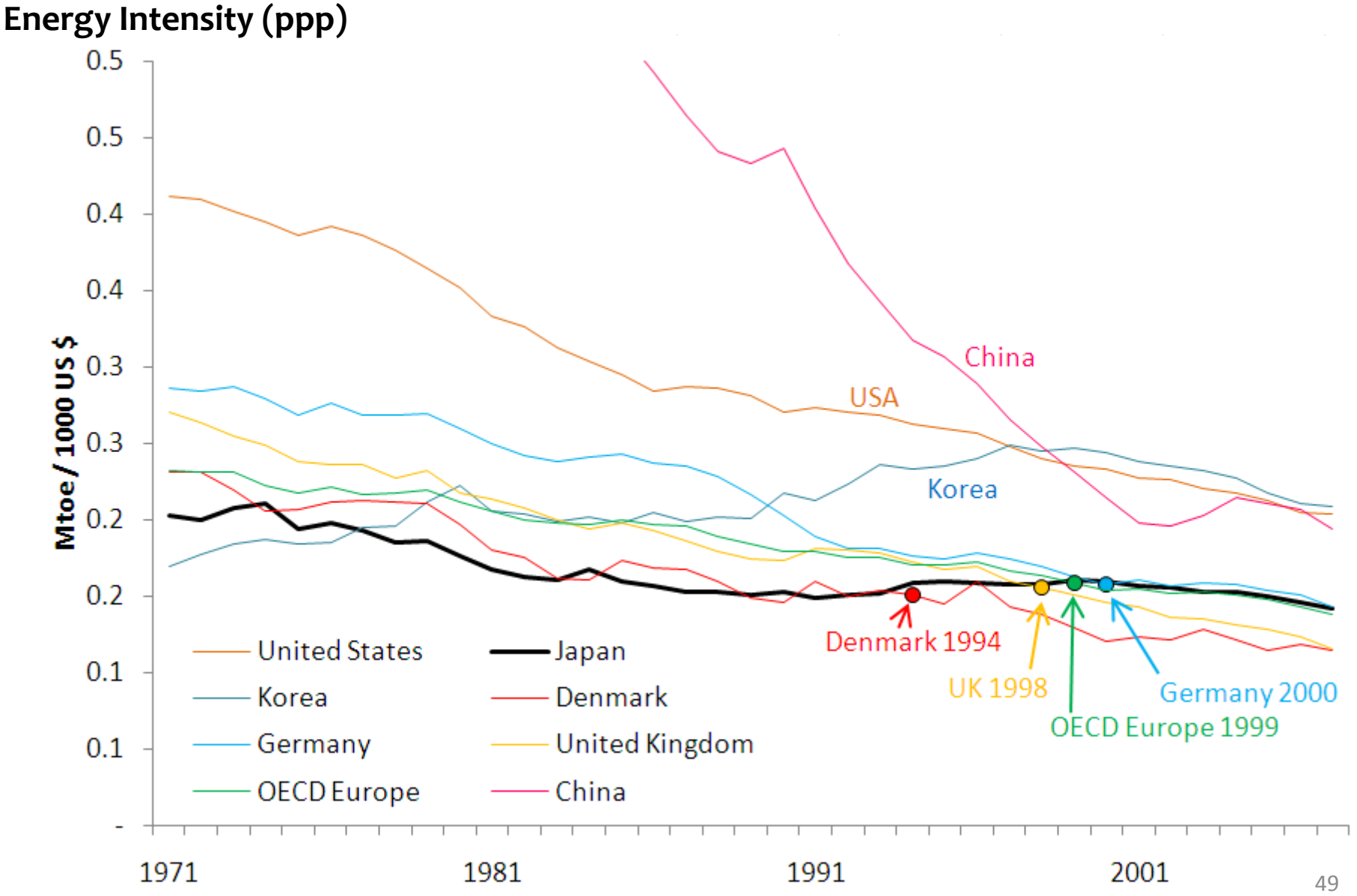


Japan 1970's in Oil crisis vs. China 2010's in climate change: Transient period to mature economy



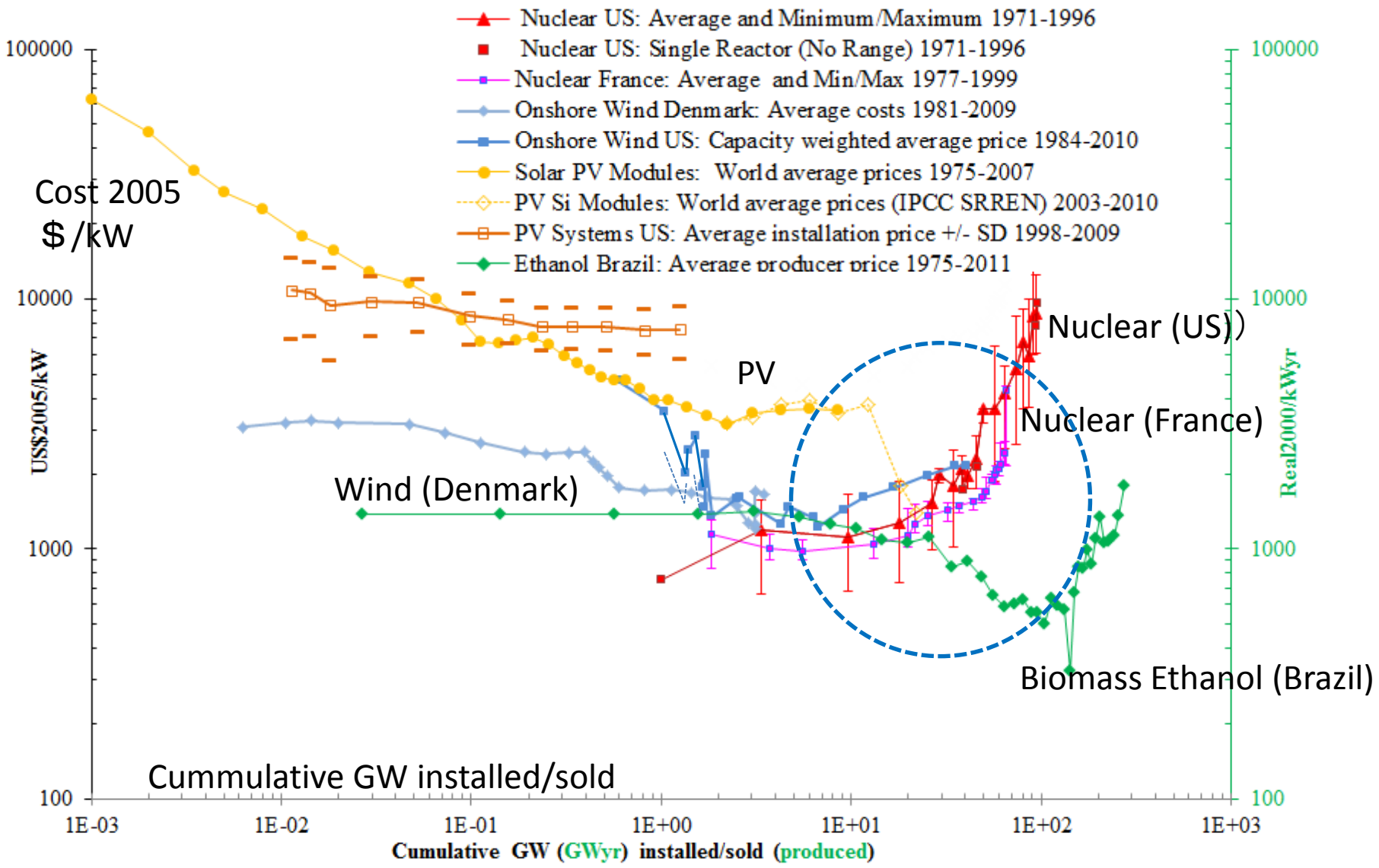
) GDPの将来値は国立環境研究所 脱温暖化2050プロジェクト A･Bシナリオの想定値

Glory of the past
"Japan as saving-energy frontrunner"



Original Data: IEA (2009) CO_2 Emissions from Fuel Combustion - Highlights

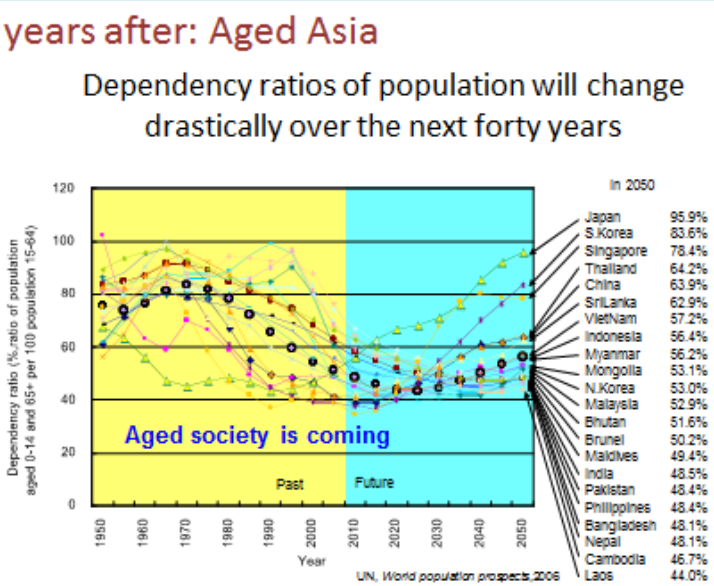
Post Fossil Energy Supply Technologies Cost Trends



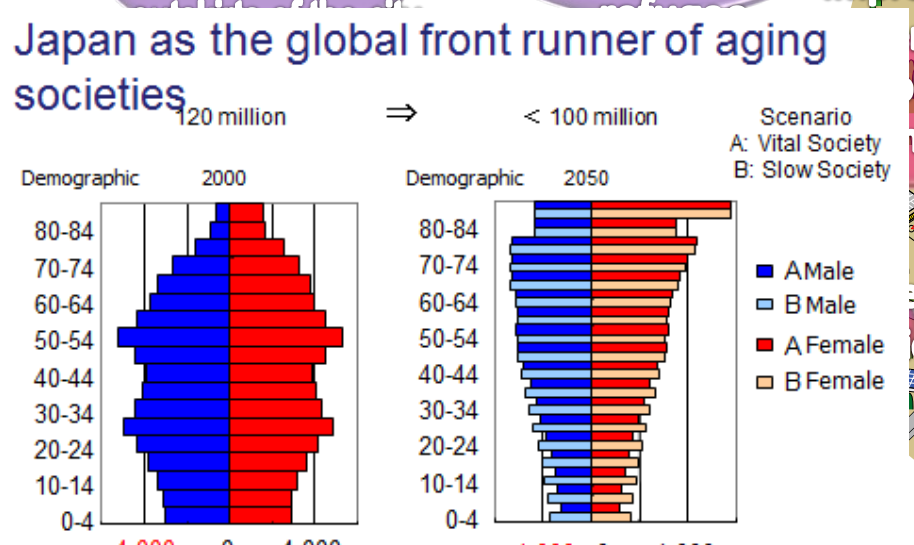
Source: Grubler/Wilson, Cambridge University Press, 2014

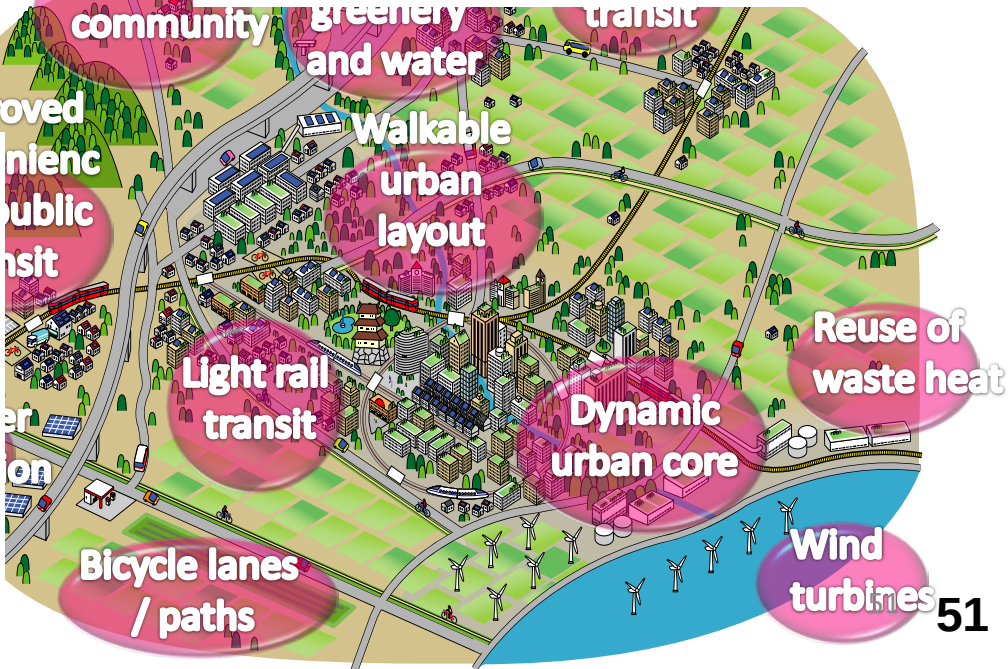
Japan now: hi-energy locked-in and aged society

Now restoring to compact city



From Matsuoka, 2009

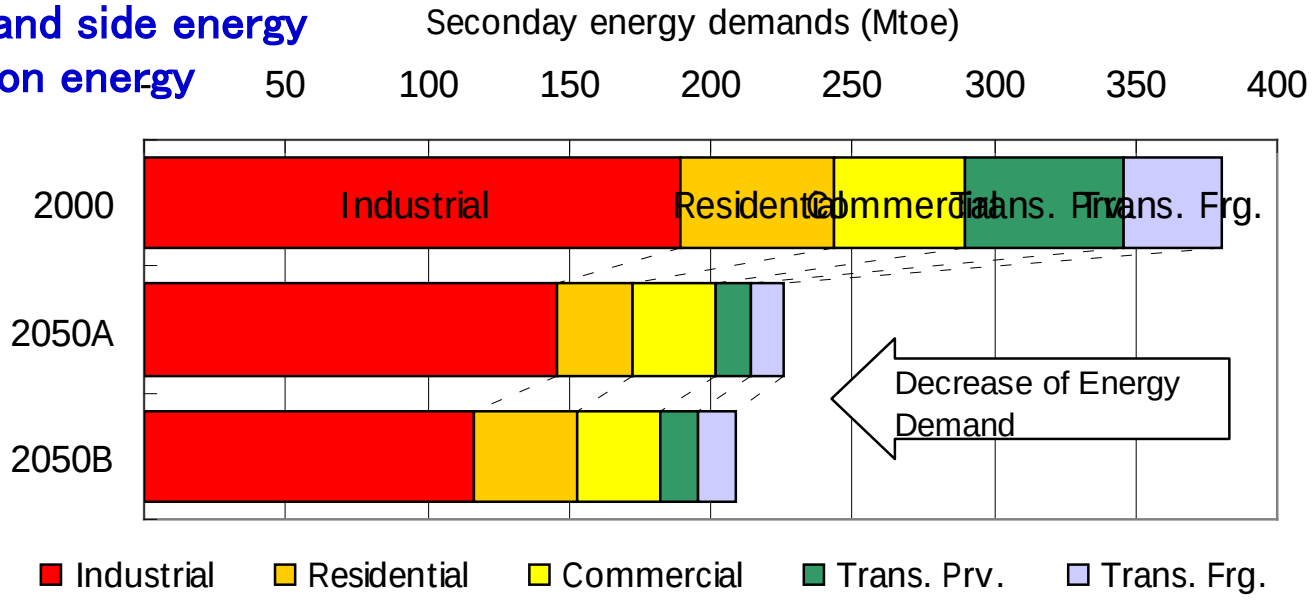




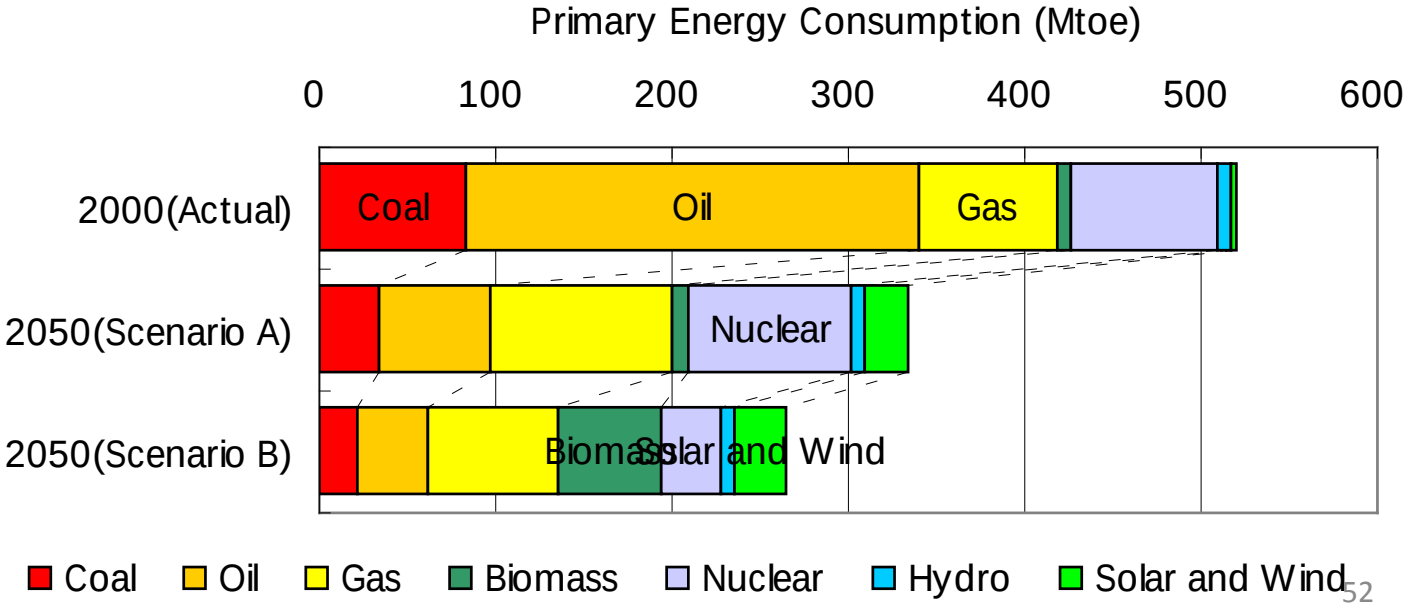
Conclusion: 70% reduction feasible: Direct cost: 1% of GDP/Y

Combination of demand side energy reduction ＋low carbon energy

Final energy demands



Primary energy supply



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Similarity between Japan in 1970's and China 2010's
How worldwide big transition benefit to challenger?

	Japan in 1970's	China in 2010's
Cause	Oil crisis: Oil production control by OPEC	Climate crisis: Total allowable carbon emission control by Paris Agreement
Threat	Sudden and huge increase of oil price and its fluctuation 1$ ⇒5-7$⇒20$ ⇒150$	Increase of climate change Limited and decrease of remaining 'carbon budget'⇒Carbon values (price) increases as budget decreases
Final solution	Bargain between supply side and demand side	Zero emission (No bargain between human being and nature)
Challenge	How to transform to energy saving society to have advantage in bargain	How to transform to decarbonized society within a few decades
External situation	・saving energy technology required especially to oil scarce countries ・	・Energy and its associated system change required (fossil to RNE) ・All nations equally required transformation to unexperienced de-carbonized world (same start line)
Internal situation	・Small land area ・No oil reserve at all ・Entering into growing economy (5% ⇒10%) ・Arising pollution problem ・Strong technological capacity	・huge land area for solar energy and CO2 absorption ・entering into maturing economy［10% ⇒7%) ・Arising pollution problem ・Increasing energy consumption under insufficient supply ・Leading REN technology/less locked-in/huge investment ・Late comer's advantage in technology
Responds	・Development of saving energy technology ・Diversify energy type & import countries (industry, home electricity, automobile, behavior) ・investment decision based on high oil price	・strong political will and governance for energy security and climate response ・Carbon Pricing policy already started as carbon market ・
benefit	・Oil import decrease: energy security up, improve international financial balance ・degradation of pollution ・leading world fuel efficient/ clean car & energy saving technology	・Energy security up: nationally and locally ・Leader of RNE technology and system ・pollution reduction

What about Asian developing countries?

Asia (China, ASEAN, India, Japan,,) :

- Half of global emission in 2050 (BaU)
- Center of global economic growth, High investment in infrastructure & industry⇒lock-in to conventional high-energy consuming technologies, in coming next 30-50 years
- Already exceeded 2 ton/capita

- "leapfrogging": new development pathways?
- A good example: China's late comer's advantage

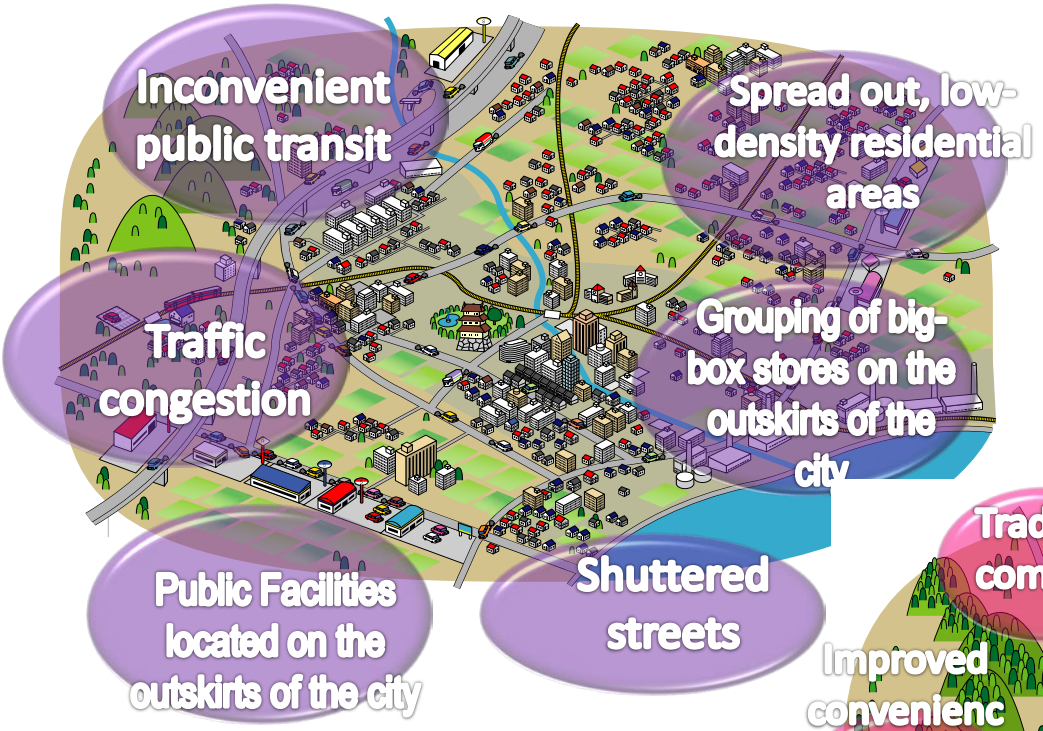
➢ Mobil-phone: difficulty in wired telephone, IT age, ⇒No.1 user and producer of mobile phone

➢ Renewable energy: vast national territory, low-carbon trends, energy security, air pollution by coal use⇒No.1 in the world producer of renewable energies and devices

➢ Electric Bike in Shanghai (good engineering capability, engine technology needed, air pollution, potential market in Asia

➢ Subway in Shanghai: 14 route after International Exhibition in 2010

2050 vision of compact city and rural life for aged society



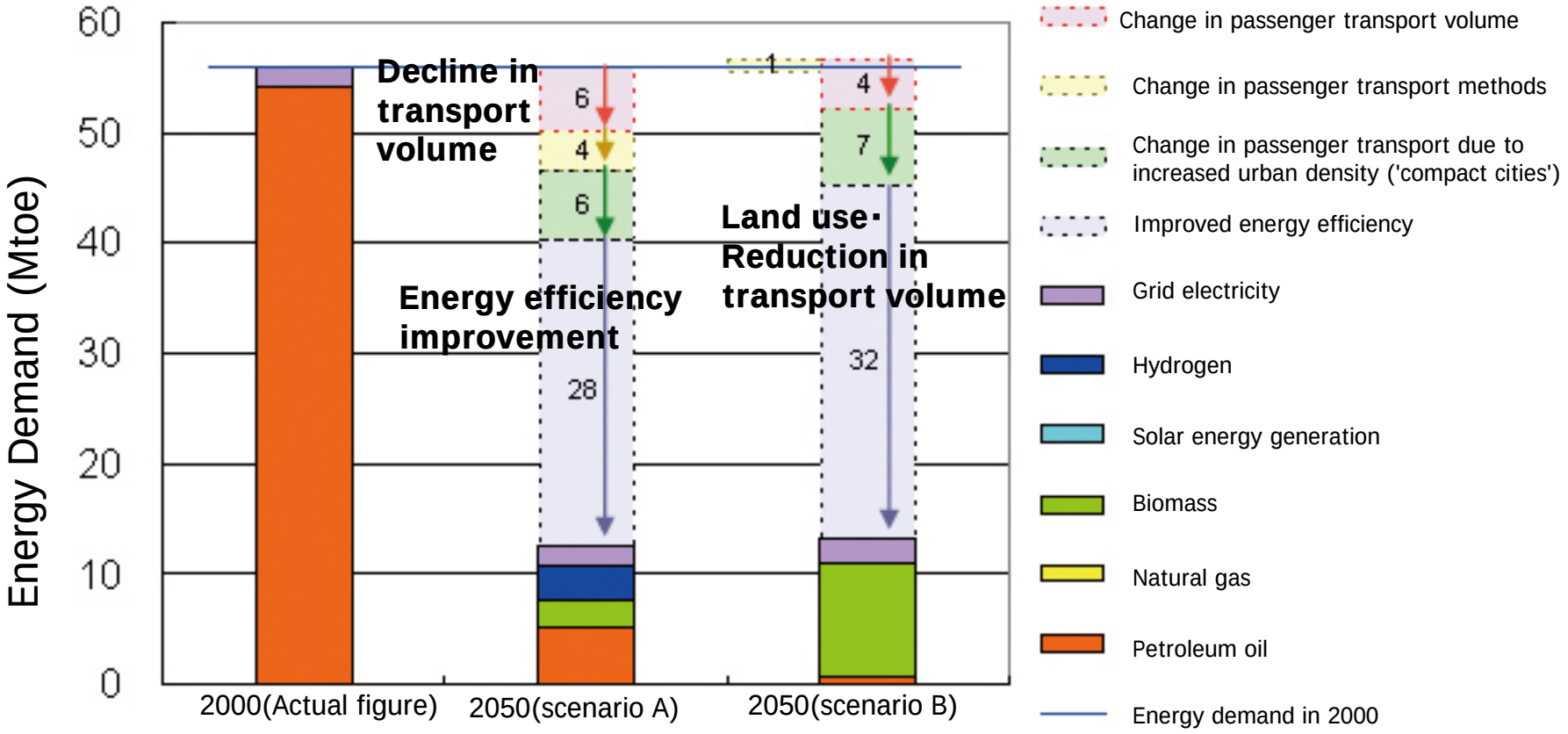
Before

and

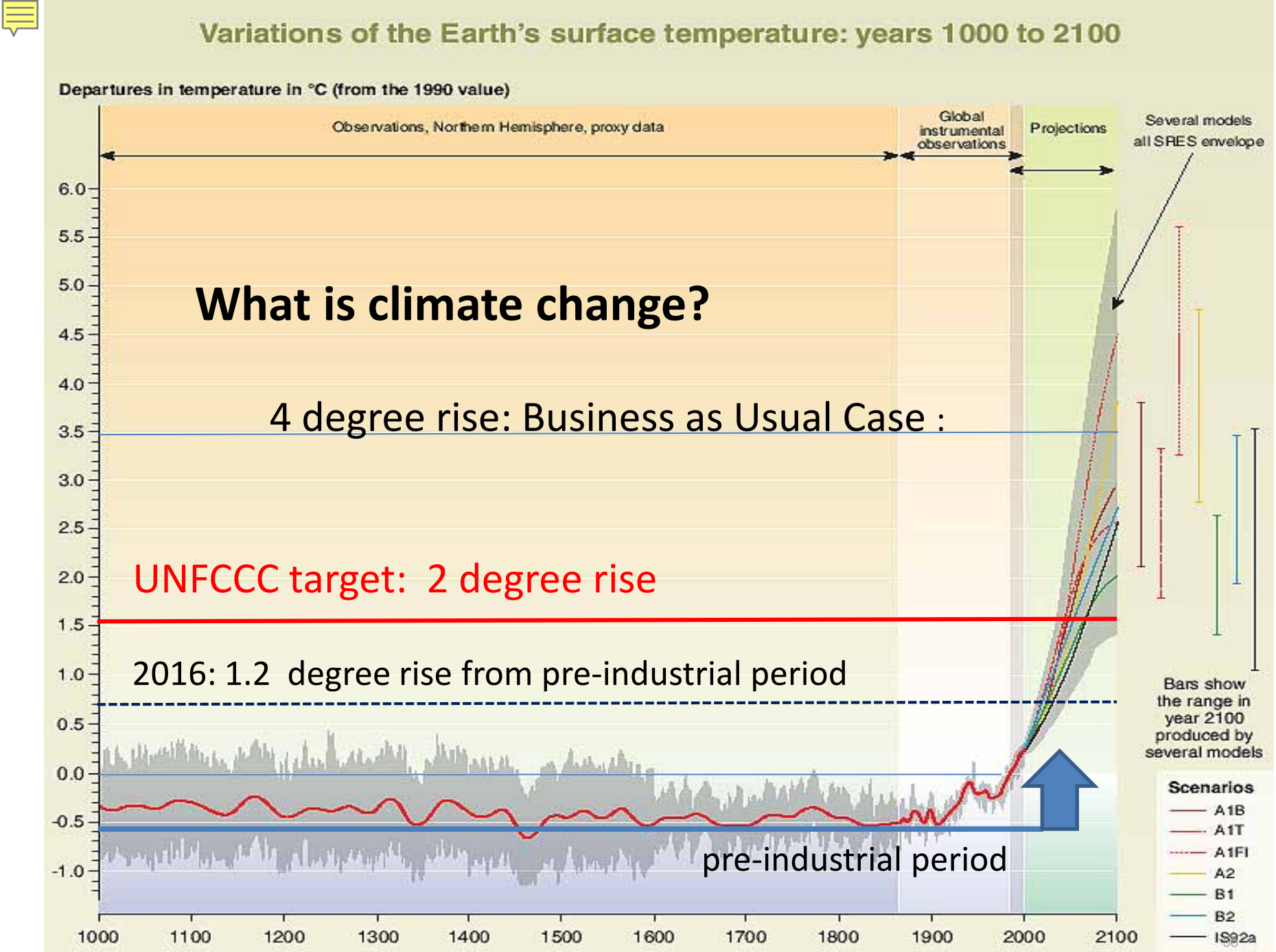
After

Source: Local Development WG team

Example: Passenger transport sector can achieve 80% reduction in energy demand via suitable land use & improved energy efficiency



Change in passenger transport volume: reduction in total movements due to population decline
Change in passenger transport methods: modal shift using public transport system (LRT etc.)
Change in passenger transport due to increased urban density ('compact cities'): reduced travel distance due to proximity of destination
Improved energy efficiency: improvements in automobiles & other passenger transport devices (hybrids, lightweight designs etc.)



IPCC Synthesis report 2001

Major Decision of Paris Agreement at COP21 (2015)

- Set target of less than 1.5/ 2.0 degree temperature rise from pre-industrial period

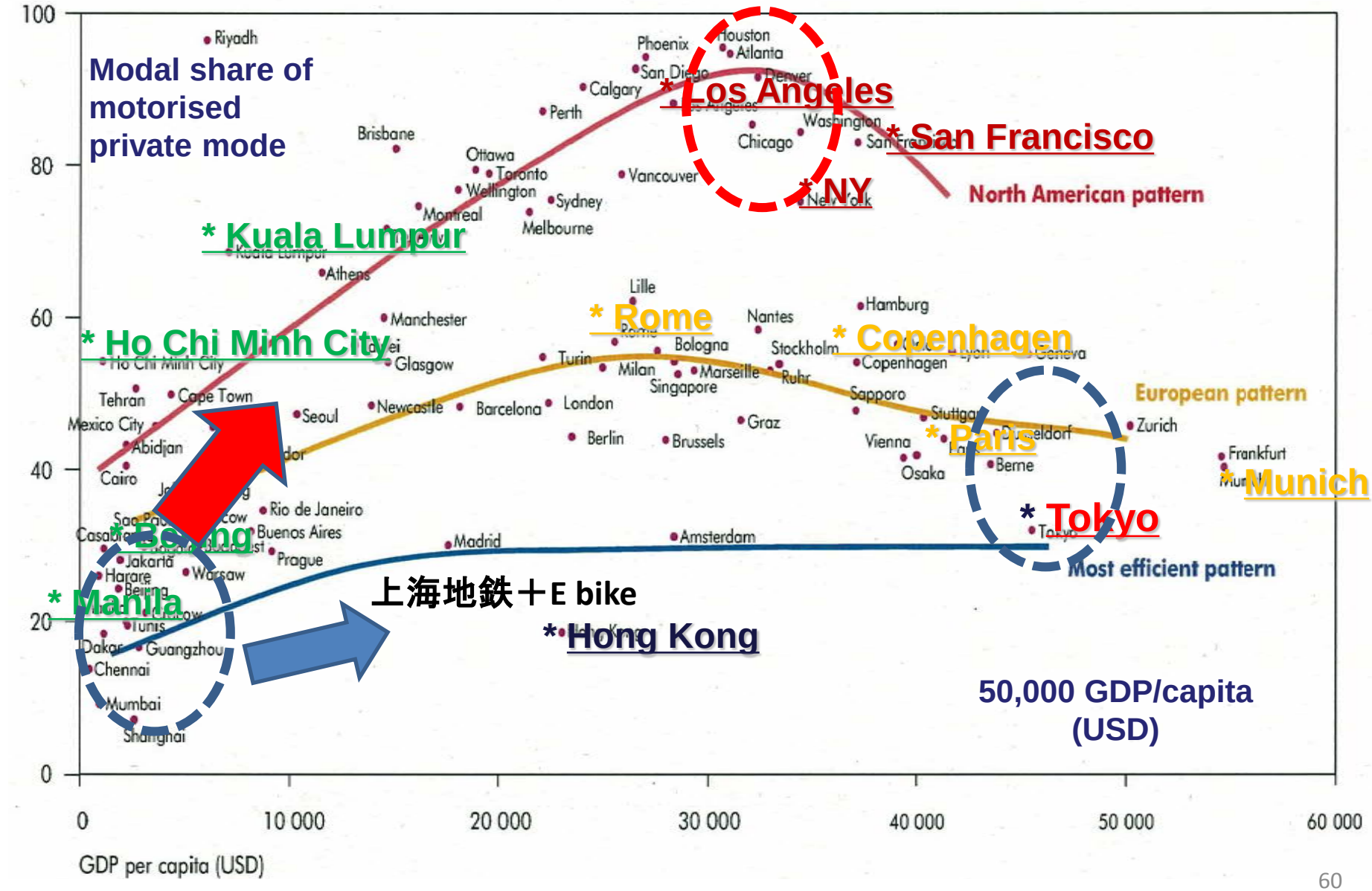
- All parties participate to take action under NDC

⇒Transform to Zero-emission society by the end of this century

- Strengthen cooperation for capacity building in mitigation and adaptation

- Mobilize stakeholders in all levels to act immediately

Co-benefit of prioritizing public transportation system for safe, punctual, clean and efficient mobilization



Source: IEA (2008)

60

Implication of 2 ℃ target to countries

- UNFCCC agreed to limit temperature less than 2℃ increase, avoiding dangerous climate change(Article 2).

- IPCC report : a path to halve the current GHG emissions by 2050 is reasonable in order to attain this goal.

- When halved GHG emissions in 2050 is allocated equally, per capita CO2 emissions is about 2 tonCO_2/ capita

- Currently: about 5ton world average (Japan 10t, US 19t, China 5.5t, Iran 5.4t)

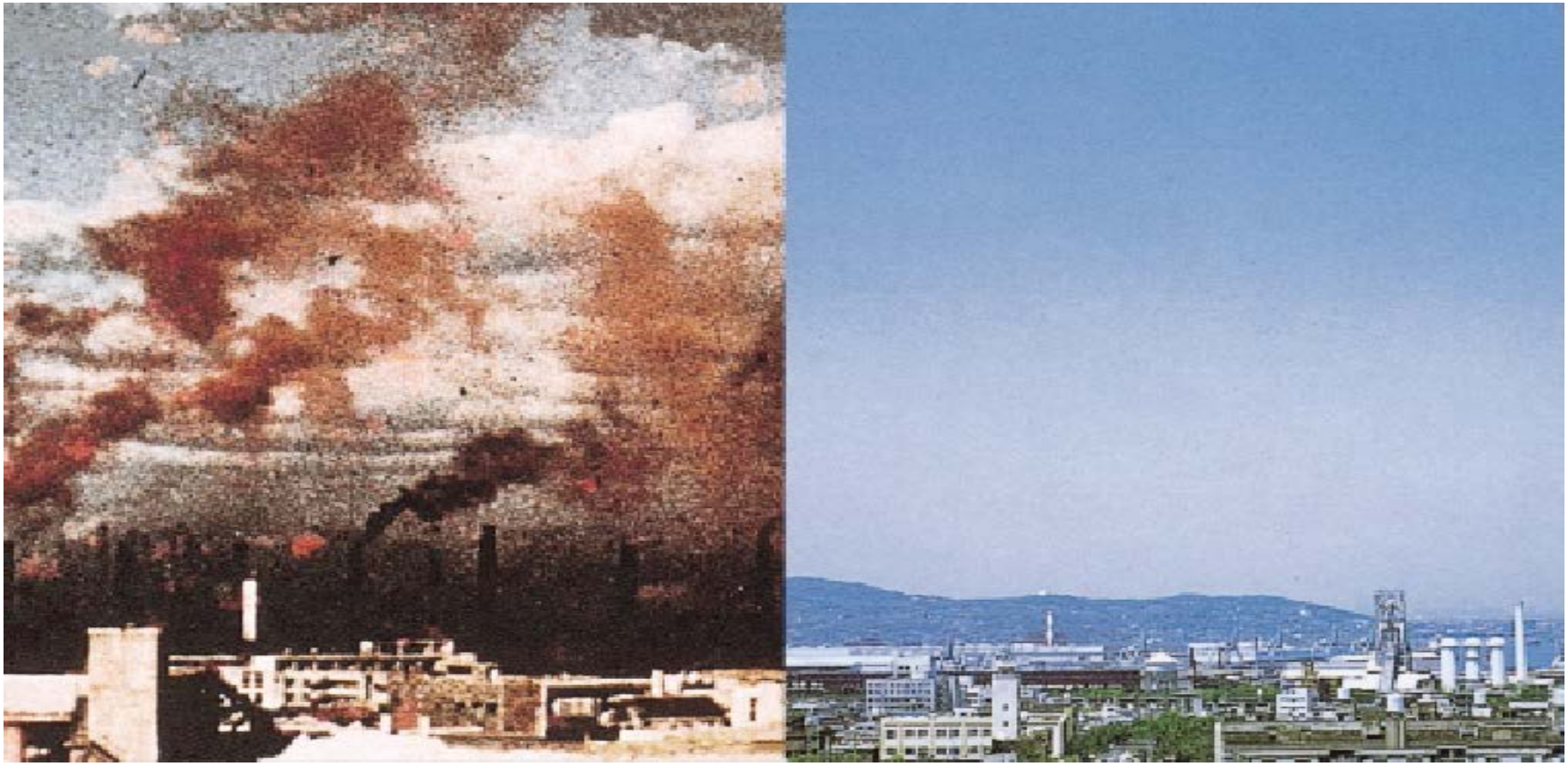
- Significant reduction is essential for all countries, including developing countries

- Developing countries:
- Difficult to follow high energy-dependent technologies
- Need their own unique development path, quite innovative one fit for this huge transition..

Co-benefit of low carbon development

Case of City of Kita-Kyushu: Before and after 1970s'transition :

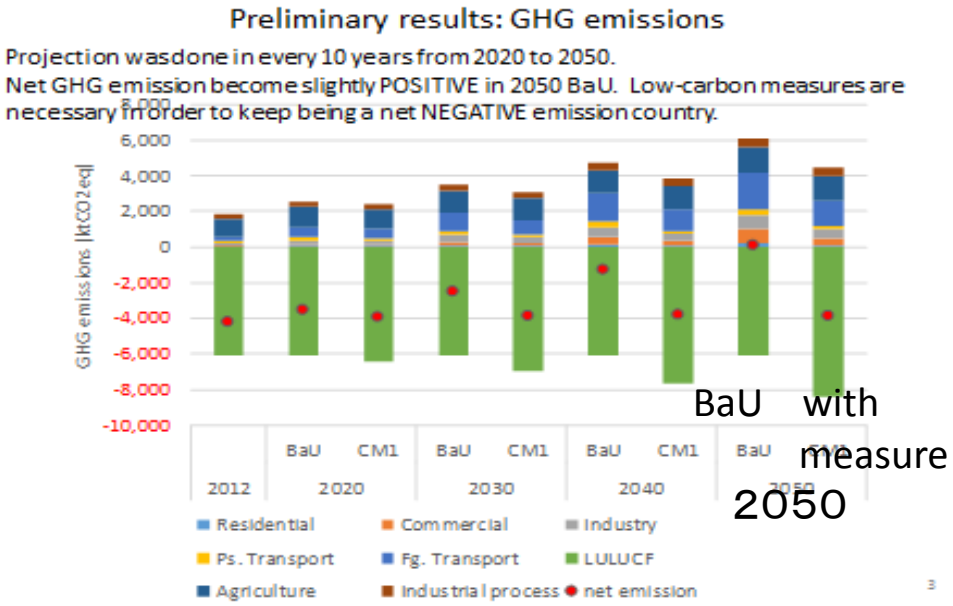
Switch from coal to oil & gas, improve energy efficiency to cope with oil crisis and innovation in pollution control technology



The atmosphere in Kitakyushu, Japan: before and after the clean up (SOE2000).

Nature dependent Bhutan*3*4

- Population: 0.8 Million (2015: WB)　Area: 40, 000km^2 (half of Island of Ireland)
- GDP/cap. US$ 2532 (PPP US$ 7,653）Foreign assistance shares 1/3 of national revenue
- Food security: Rice, livestock & vegetables are self sufficient（under subsidy)
- Energy almost based on Biomass (60%of total energy consumption) and Hydropower, (13%) : imported oil for cars and industry (Cement, Ferro-alloy)
- Hydropower: domestic demand + export to India (account up nearly 1/4 of national revenue) . More than 10 times potential of present capacity
- Already carbon minus (absorbing) & declare to be Carbon Neutral country (INDC: 2015） tCO$_2$/Cap: 2.9 (2005)⇒ BaU 4.9 (2040)



Gomi &Ochi 2016

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- Ex. Japan’s experience at Oil Crisis (1970’s)
  - Energy security: oil price up
  - Economy entering mature stage
    - Growth rate leveling off
    - Industrial structure: de-heavy industry to manufacturing
    - Welfare : Serious pollution: industry to urban
    - Urbanization (and rural depopulation)

- Japan’ current challenge
  - Political readership/ Political will
  - Aged society: social security & its finance, local infrastructure
  - Conservation of local society &natural resources: aged population & infrastructure,
  - Long-term financial deficit by short sighted economic stimulation: inter-generational equity

Similarity between Japan in 1970's and China 2010's
How worldwide big transition benefit to challenger?

	Japan in 1970's	China in 2010's
Cause	Oil crisis: Oil production control by OPEC	Climate crisis: Total allowable carbon emission control by Paris Agreement
Threat	Sudden and huge increase of oil price and its fluctuation 1$ ⇒5-7$⇒20$ ⇒150$	Increase of climate change Limited and decrease of remaining 'carbon budget'⇒Carbon values (price) increases as budget decreases
Final solution	Bargain between supply side and demand side	Zero emission (No bargain between human being and nature)
Challenge	How to transform to energy saving society to have advantage in bargain	How to transform to decarbonized society within a few decades
External situation	・saving energy technology required especially to oil scarce countries ・	・Energy and its associated system change required (fossil to RNE) ・All nations equally required transformation to unexperienced de-carbonized world (same start line)
Internal situation	・Small land area ・No oil reserve at all ・Entering into growing economy (5% ⇒10%) ・Arising pollution problem ・Strong technological capacity	・huge land area for solar energy and CO2 absorption ・entering into maturing economy［10% ⇒7%) ・Arising pollution problem ・Increasing energy consumption under insufficient supply ・Leading REN technology/less locked-in/huge investment ・Late comer's advantage in technology
Responds	・Development of saving energy technology ・Diversify energy type & import countries (industry, home electricity, automobile, behavior) ・investment decision based on high oil price	・strong political will and governance for energy security and climate response ・Carbon Pricing policy already started as carbon market ・
benefit	・Oil import decrease: energy security up, improve international financial balance ・degradation of pollution ・leading world fuel efficient/ clean car & energy saving technology	・Energy security up: nationally and locally ・Leader of RNE technology and system ・pollution reduction

What about Asian developing countries?

Asia (China, ASEAN, India, Japan,,) :

- Half of global emission in 2050 (BaU)
- Center of global economic growth, High investment in infrastructure & industry⇒lock-in to conventional high-energy consuming technologies, in coming next 30-50 years
- Already exceeded 2 ton/capita

- "leapfrogging": new development pathways?
- A good example: China's late comer's advantage

➢ Mobil-phone: difficulty in wired telephone, IT age, ⇒No.1 user and producer of mobile phone

➢ Renewable energy: vast national territory, low-carbon trends, energy security, air pollution by coal use⇒No.1 in the world producer of renewable energies and devices

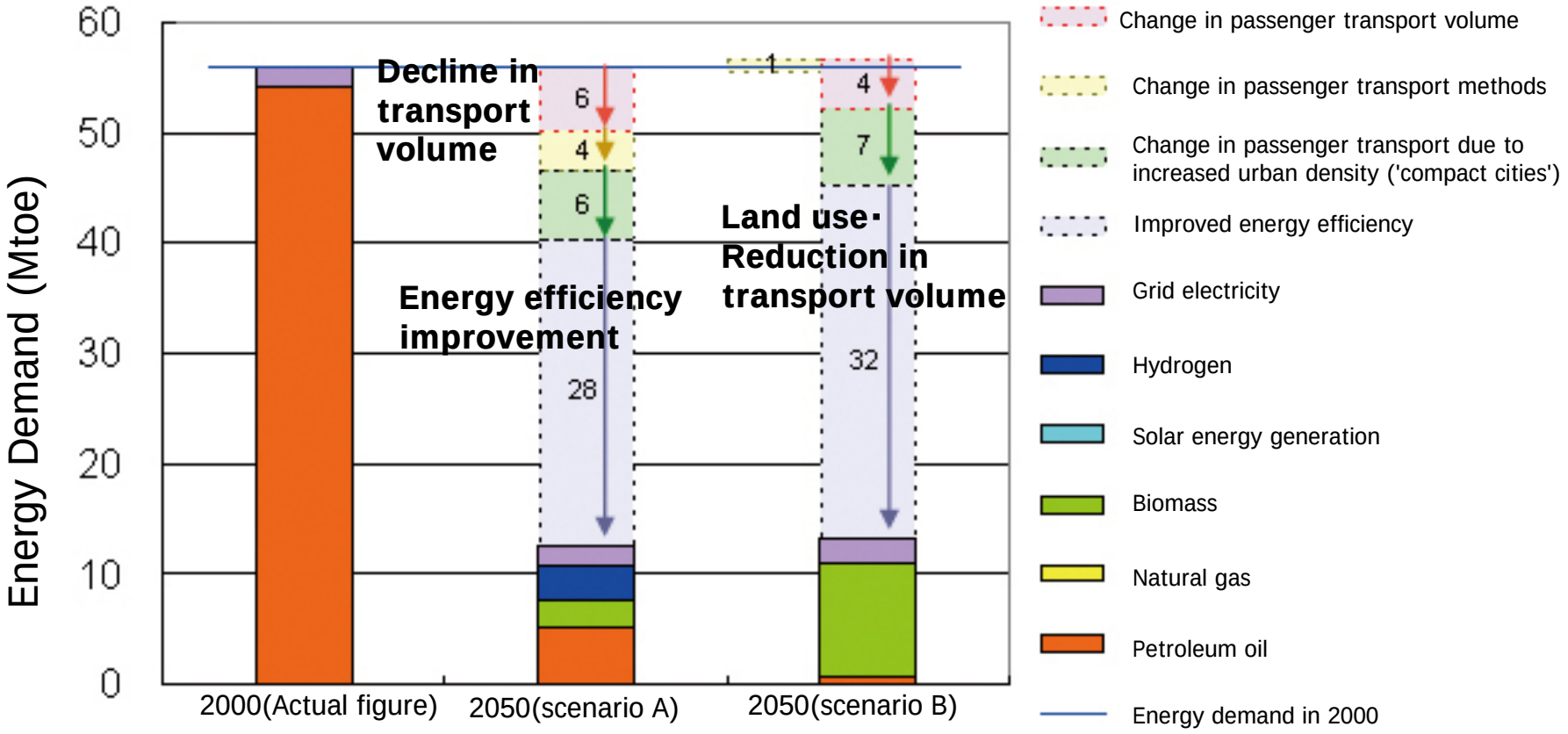
➢ Electric Bike in Shanghai (good engineering capability, engine technology needed, air pollution, potential market in Asia

➢ Subway in Shanghai: 14 route after International Exhibition in 2010

Dependency of resources /capital (Subjective Judgement by SN)

Resource	Fossil Fuel	NG	Hydro power	Forest	Land/ Sea	Hi-Ene Infra	Financial Capital	Human Capital
Value Trend	−−−	−	++ −	++ −	++	−−−	+ −	+++
Bhutan			○○	○○				○
Iran	○○○				○○			○
Bahrain	○					○○	○○	○
Indonesia	○○	○	○+ Geo	○○○	○○	○		○
Thailand				○	○	○		○
Malaysia	○			○	○	○	○	○
Vietnam	○○			○	○			○
China	○○○	○	○	○	○	○○	○○	○○
Japan						○○○	○	○○

Example: Passenger transport sector can achieve 80% reduction in energy demand via suitable land use & improved energy efficiency



Change in passenger transport volume: reduction in total movements due to population decline
Change in passenger transport methods: modal shift using public transport system (LRT etc.)
Change in passenger transport due to increased urban density ('compact cities'): reduced travel distance due to proximity of destination
Improved energy efficiency: improvements in automobiles & other passenger transport devices (hybrids, lightweight designs etc.)

Major Decision of Paris Agreement at COP21 (2015)

- Set target of less than 1.5/ 2.0 degree temperature rise from pre-industrial period

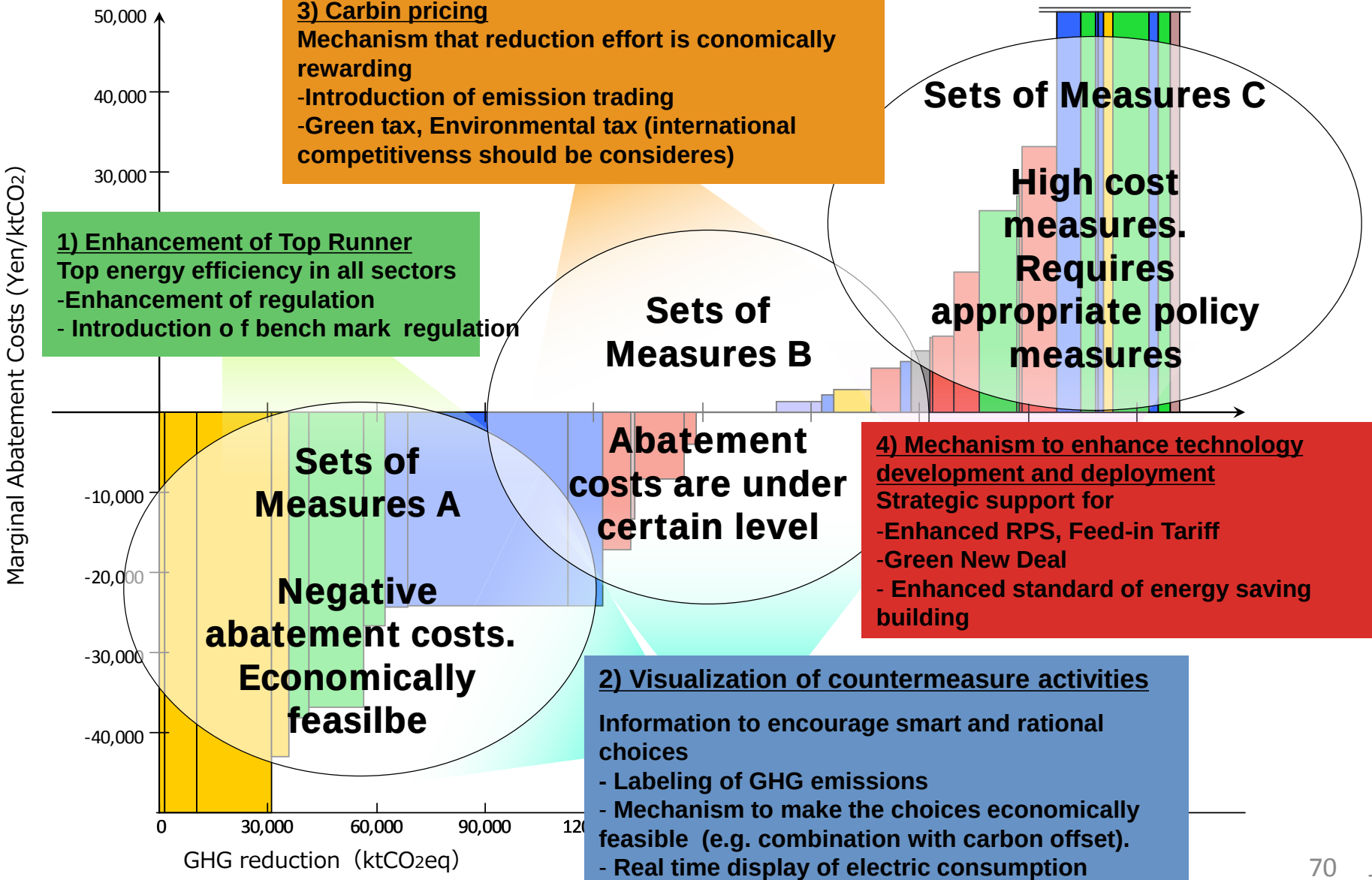
- All parties participate to take action under NDC

⇒Transform to Zero-emission society by the end of this century

- Strengthen cooperation for capacity building in mitigation and adaptation

- Mobilize stakeholders in all levels to act immediately

Ex) Recommended Countermeasures



3) Carbin pricing
Mechanism that reduction effort is conomically rewarding
-Introduction of emission trading
-Green tax, Environmental tax (international competitivenss should be consideres)

1) Enhancement of Top Runner
Top energy efficiency in all sectors
-Enhancement of regulation
- Introduction o f bench mark regulation

4) Mechanism to enhance technology development and deployment
Strategic support for
-Enhanced RPS, Feed-in Tariff
-Green New Deal
- Enhanced standard of energy saving building

2) Visualization of countermeasure activities

Information to encourage smart and rational choices
- Labeling of GHG emissions
- Mechanism to make the choices economically feasible (e.g. combination with carbon offset).
- Real time display of electric consumption

Based on Report on Mid-/Long-term Roadmap

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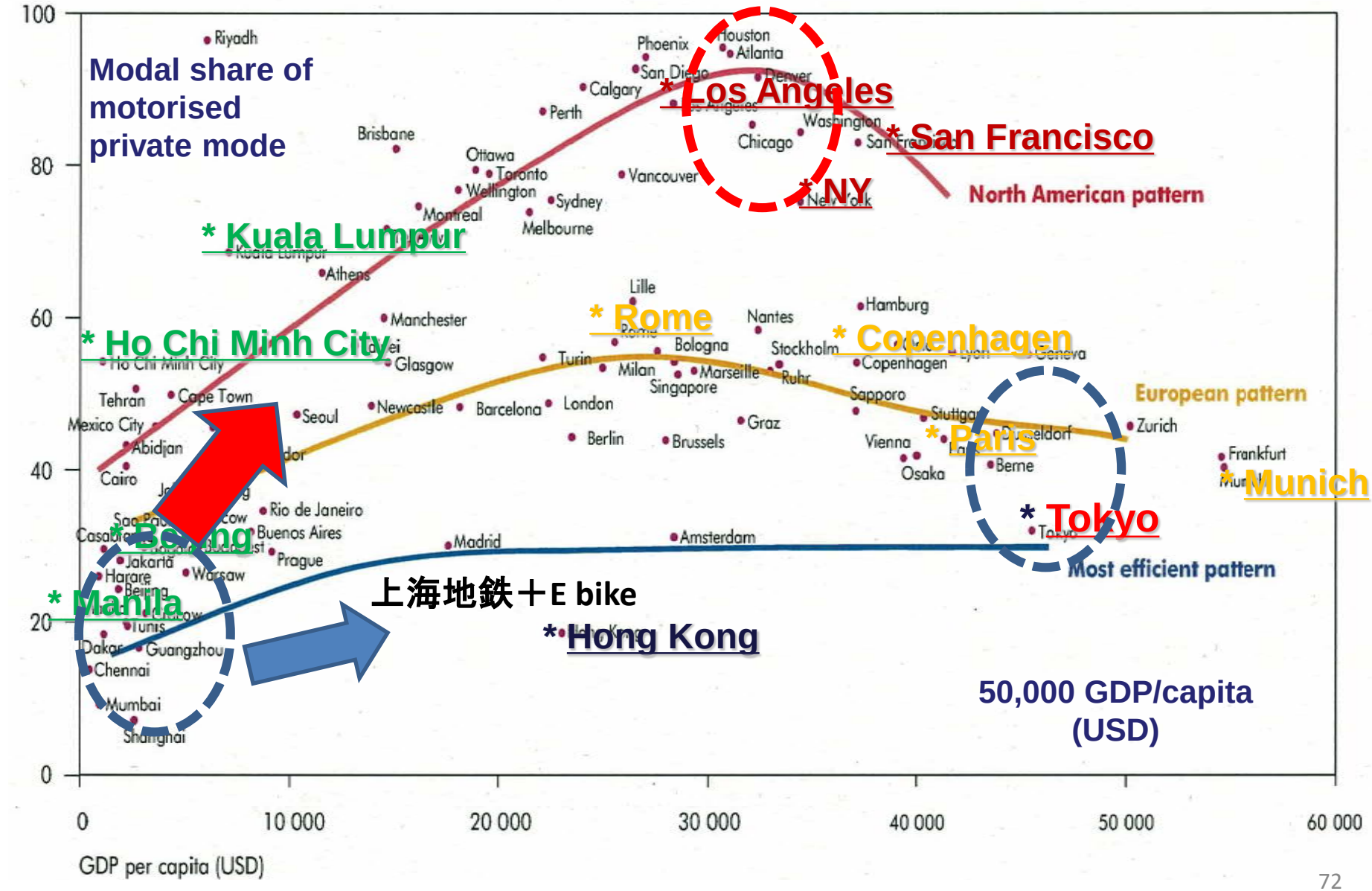
Co-benefit of prioritizing public transportation system for safe, punctual, clean and efficient mobilization



Source: IEA (2008)

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Implication of 2 ℃ target to countries

- UNFCCC agreed to limit temperature less than 2℃ increase, avoiding dangerous climate change(Article 2).

- IPCC report : a path to halve the current GHG emissions by 2050 is reasonable in order to attain this goal.

- When halved GHG emissions in 2050 is allocated equally, per capita CO2 emissions is about 2 tonCO_2/ capita

- Currently: about 5ton world average (Japan 10t, US 19t, China 5.5t, Iran 5.4t)

- Significant reduction is essential for all countries, including developing countries

- Developing countries:
- Difficult to follow high energy-dependent technologies
- Need their own unique development path, quite innovative one fit for this huge transition..

Governance

- Development Plan of Bhutan bases on "Gross national Happiness (GNH)" concept
- GNH Indices for 9 domains:
  - Psychological well-being, Health, Time use (Work, Sleep), Education, Cultural diversity and resilience, Good governance, Community Vitality, Ecological diversity and resilience, Living standard (Income, Asset, housing)
- Nine areas with same weight are defined ⇒

Indices for the 9 domains

Width of a box shows weight given to each index

Psychological wellbeing	Life satisfaction	Positive emotion	Negative emotion	Spirituality
Health	Self-reported health status	Number of healthy days	Disability	Mental health
Time use	Work	Sleep		
Education	Literacy	Schooling	Knowledge	Value
Cultural diversity and resilience	*Zorig chusm* skills	Cultural participation	Speak native language	*Driglam Namzha*
Good Governance	Political participation	Services	Governance performance	Fundamental rights
Community vitality	Donation (time & money)	Safety	Community relationship	Family
Ecological diversity and resilience	Wildlife damage	Urban issues	Responsibility to environment	Ecological issues
Living standards	Income	Assets	Housing	

- Nation-wide surveys (9,000 sample) in 5 years cycle monitors peoples satisfaction in detail index.

At 2015 survey *[7]:

- Deeply or extensively happy 43.4%, narrowly happy 47.9%, unhappy 8.8%.
- men> women, urban resident> rural , more educated> less educated tend to be happier
- Increased satisfaction on services: electricity, tap and sewage water and housing
- psychological well-being and government performance degraded 2-25% from 2010

Relationship between GHH and develoment

Relationship between GNH and Development path

GNH Index	No. of Pop. /Household	Economy	Transport ation	Energy	Agri-culture	Land-use	Waste	GHG
Psychological Wellbeing	Family structure			Electrification rate				
Health	Age distribution		Walking trip					
Time use		Labor Hour						
Education		Promoting Education						
Cultural diversity & resilience					Domestic production rate			
Community vitality	Family structure	Income						
Good governance			Public transportation	Electrification rate		Forest Area	Waste management	
Ecological diversity & resilience						Forest Area	Waste management	GHG emission
Living standard	Family Structure	Income	Modal share					

Gomi & Ochi 2016