IGES
Institute for Global Environmental Strategies

Strategic Air Quality Management for Mongolian Cities:
Training Workshop on the Guidance Framework for Better Air Quality in Asian Cities, 9-12 April 2019

Co-benefits of Air Quality & Climate Change Policies: Identification, Quantification & Integration

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COURSE OUTLINE

Identifying Co-benefits

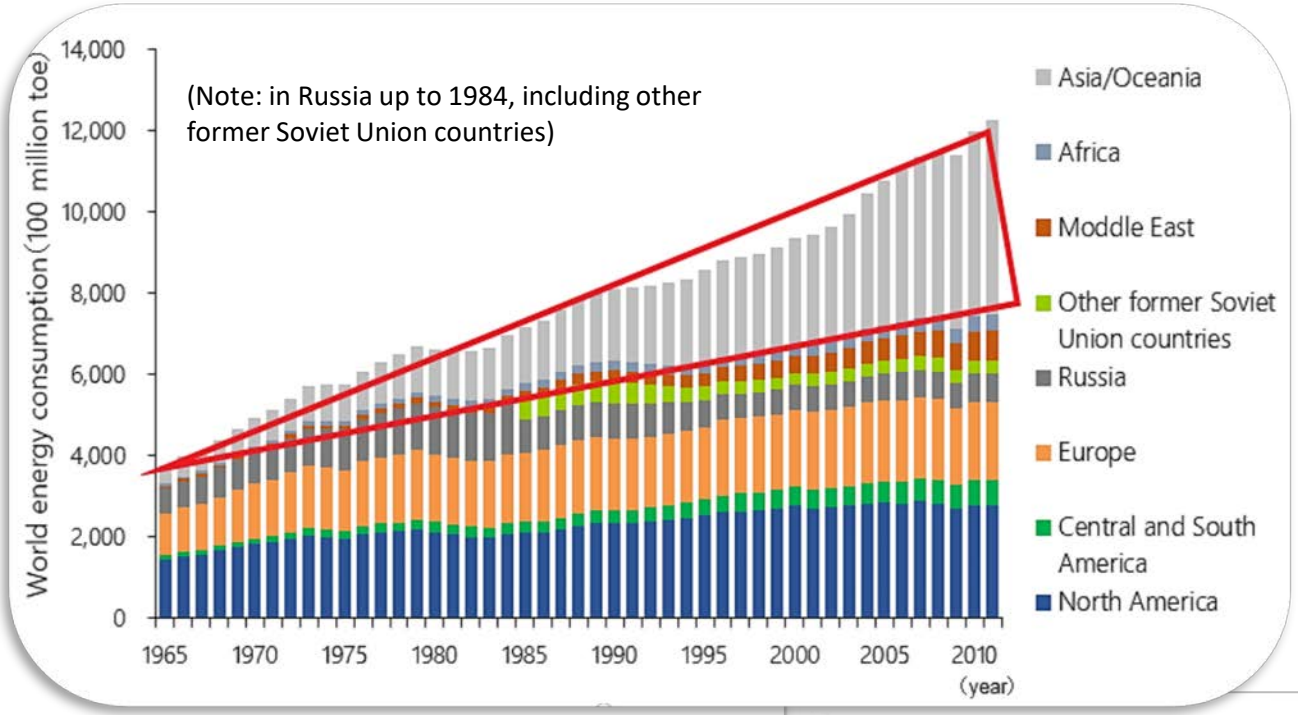
What are co-benefits?
Why are co-benefits important?
How can co-benefits be illustrated?

Quantifying and Applying Co-benefits

Why is it important to quantify co-benefits?
How can co-benefits be quantified?
Case studies

Integrating Co-benefits into Policies

How have co-benefits been integrated into policymaking process?
Institutions and Process with Case Study
Enabling Environment with Case Study

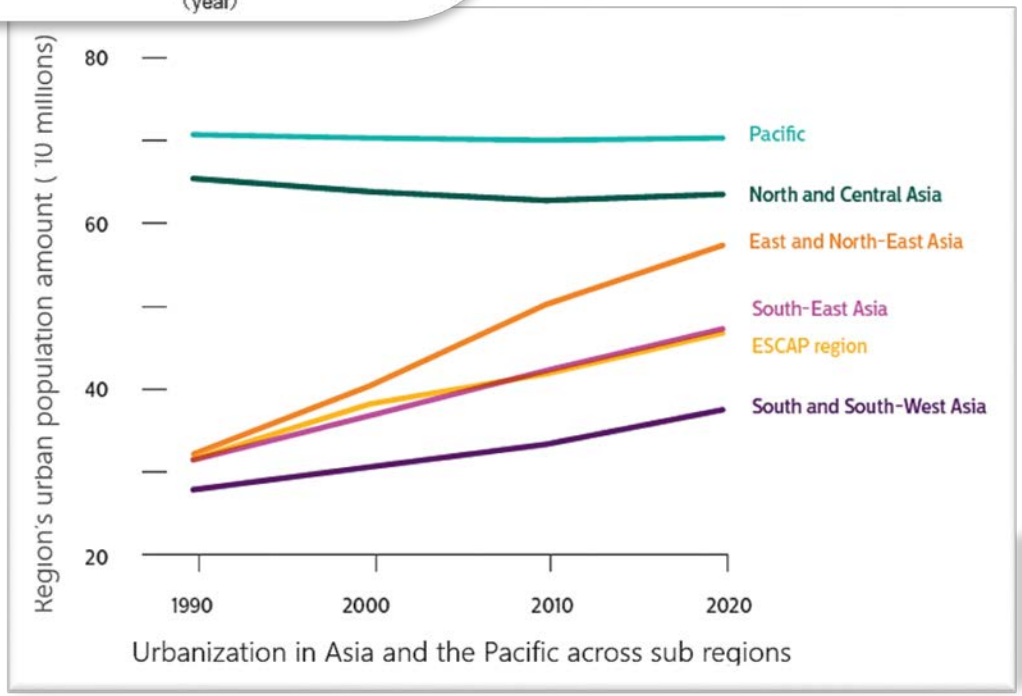


Energy Consumption in Asia 1965-2010

(Source : Based on 2012 Statistical review of world energy)

Urbanisation in Asia

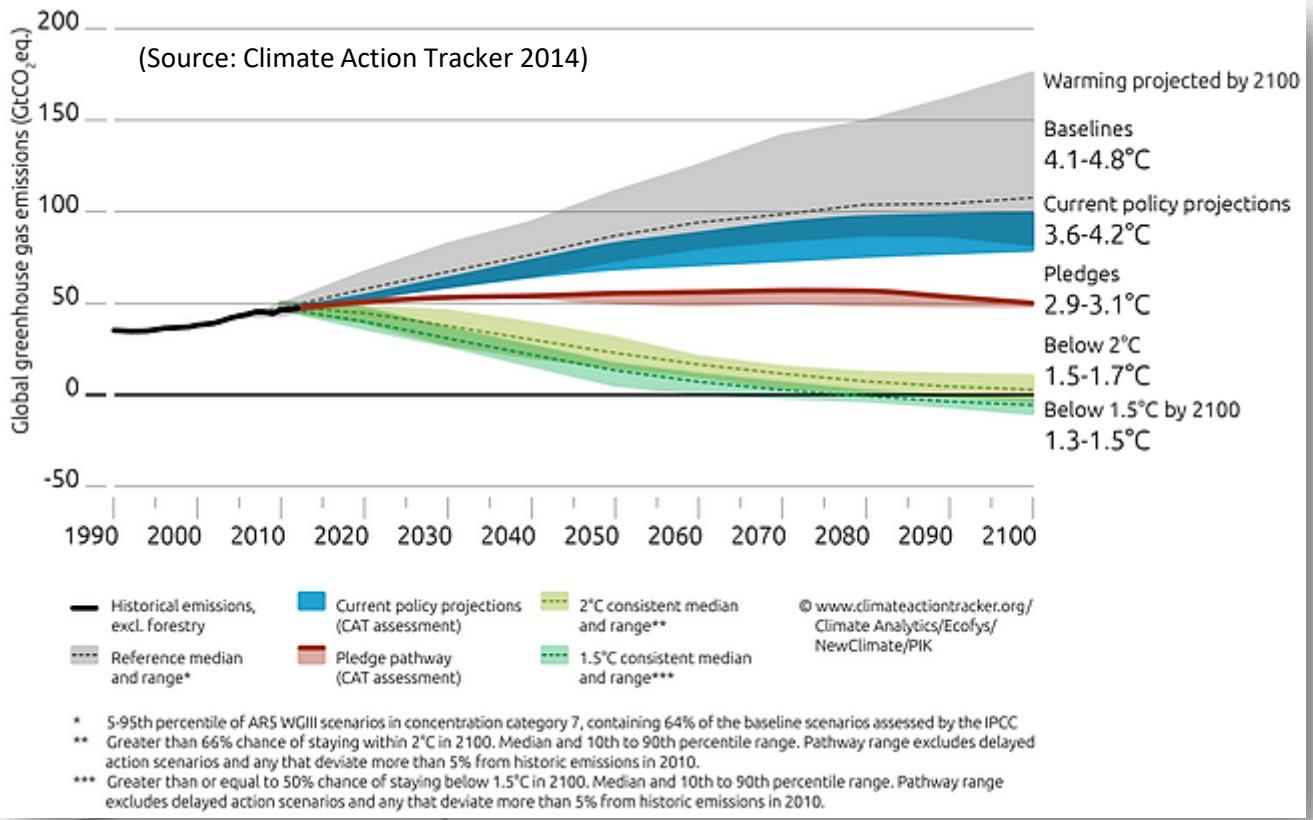
(Source : UN 2012 World Urbanization Prospects)

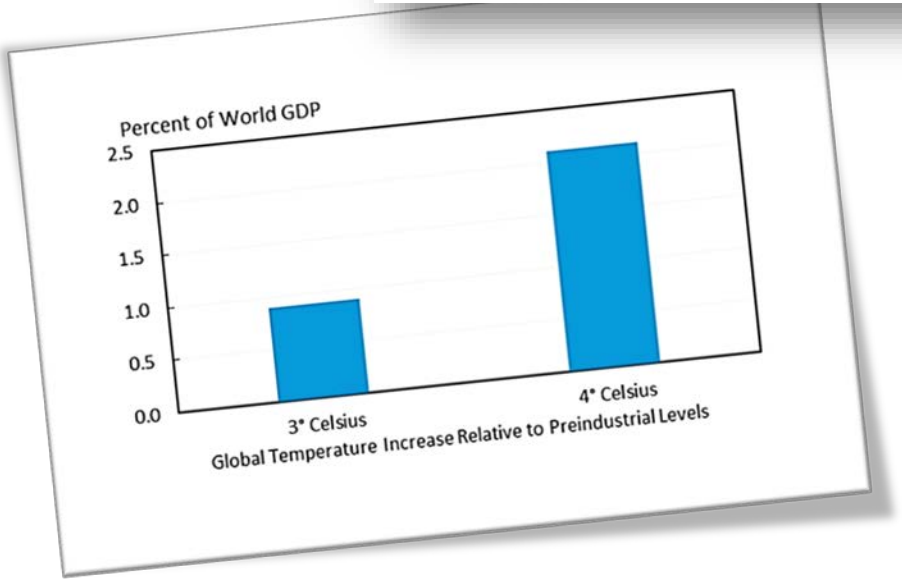


Impacts of Climate Change

Emission Scenarios and Projected Changes in Temperature

(Source: Climate Action Tracker 2014)





Costs of Climate Change

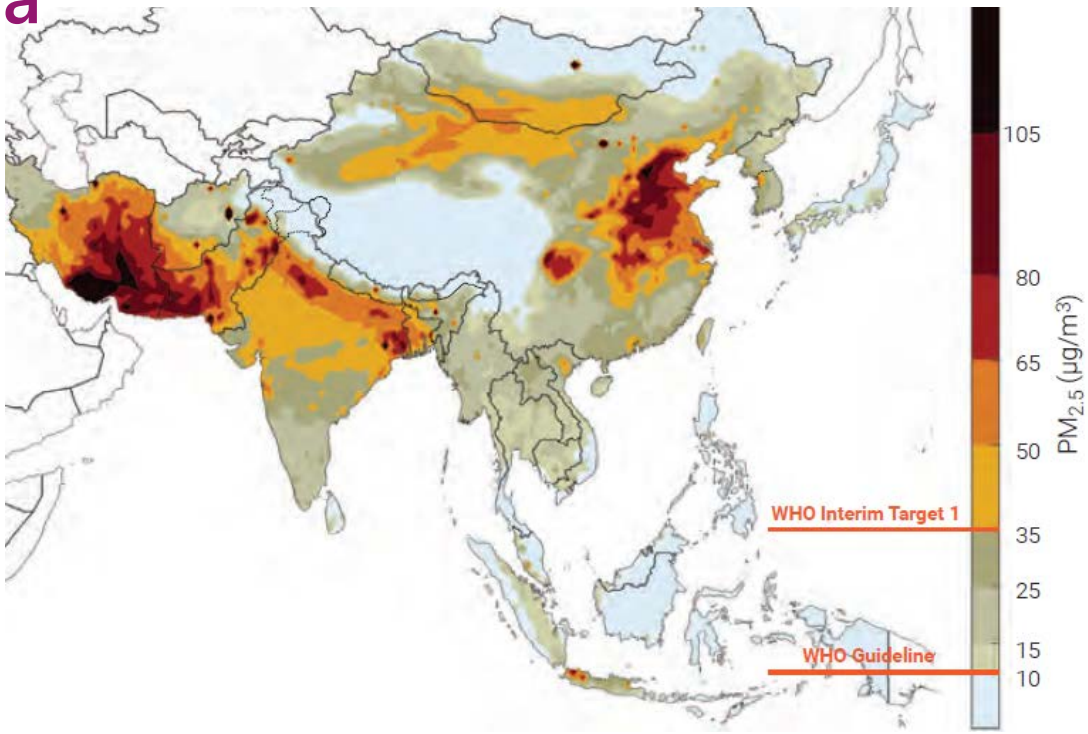
(Source: Nordhaus 2013 & CEA calculations)

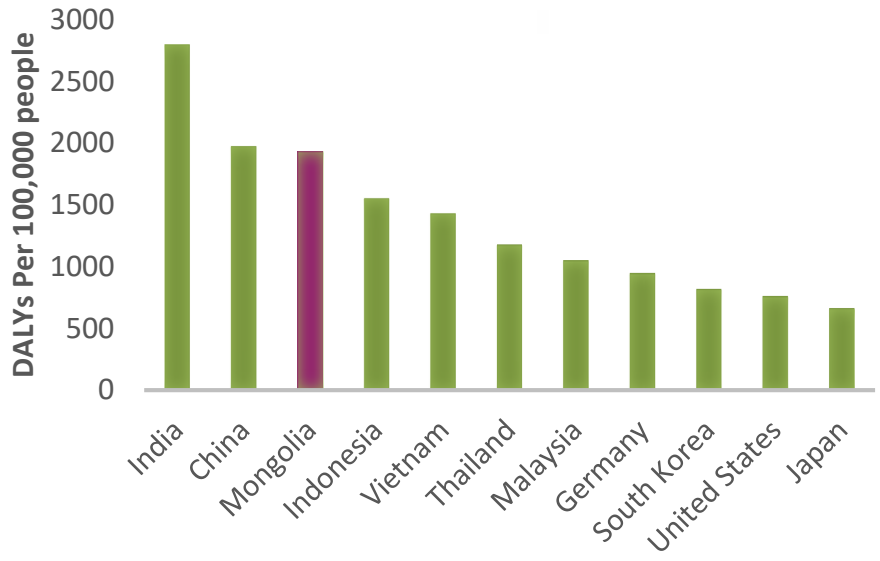
A Different View on Climate Change Impacts

Air Quality in Asia

Ambient Levels of $PM_{2.5}$ in Asia in 2015

(Source: UNEP 2019 Solutions Report)

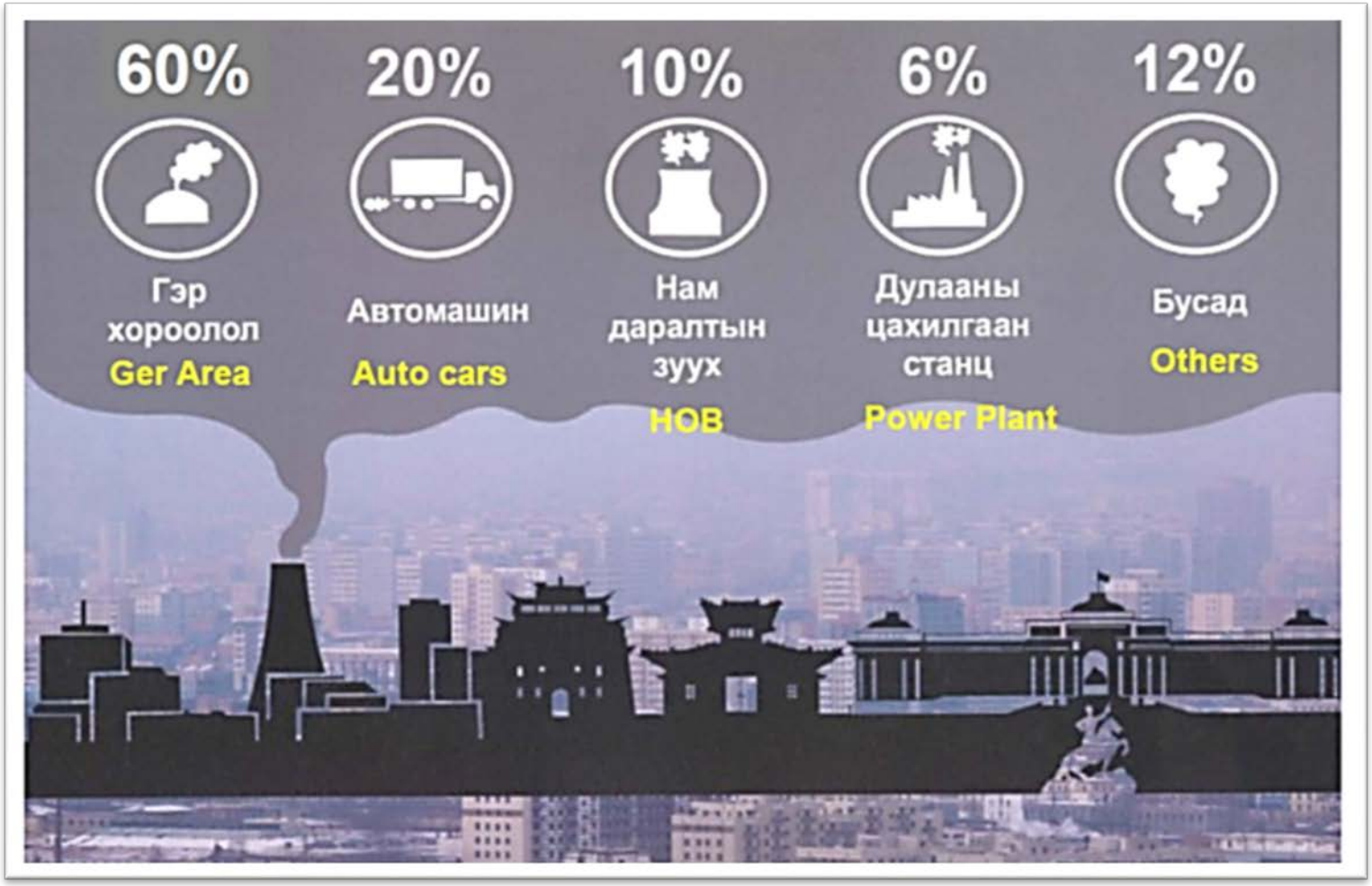




Number of Disability-Adjusted Life Year (DALYs) from air pollution

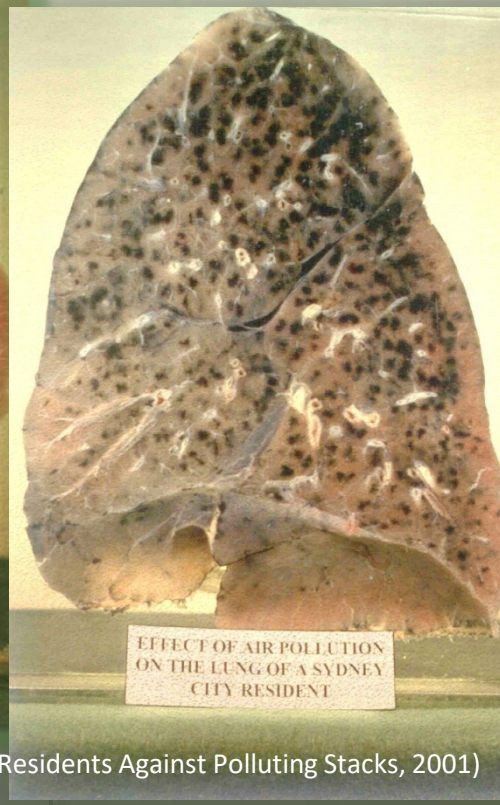
(Source: Global Burden of Disease Study 2017)

Source of Air Pollution in Mongolia



(Source: Ulaanbaatar Clean Air Project 19th CAREC Energy Sector Coordinating Committee Meeting 2015)

Air pollution Impacts



(Source: Residents Against Polluting Stacks, 2001)

(Source :China Baidu)

How much should policymakers spend on mitigating climate change

Depends on benefits

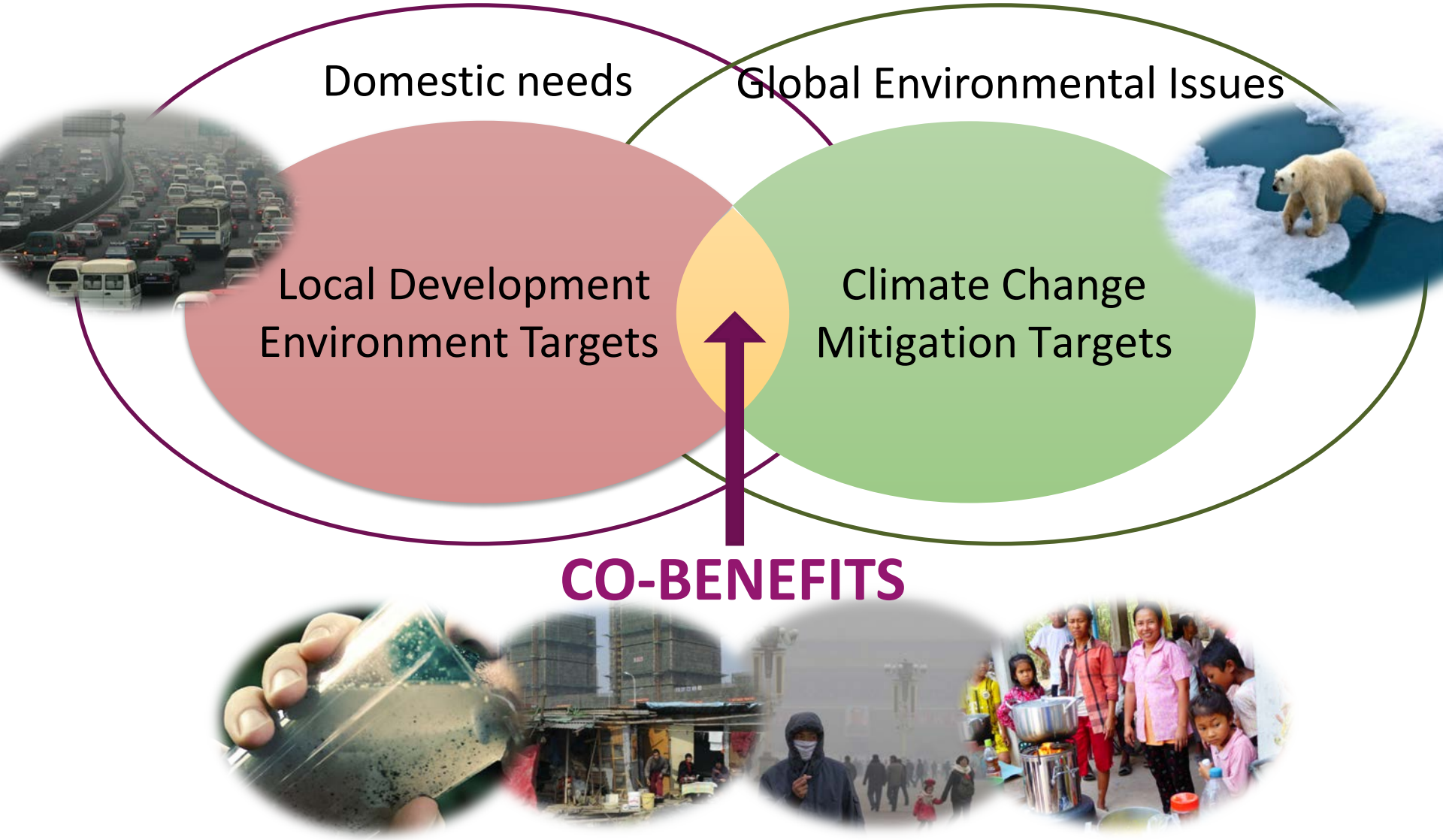
What are co-benefits?

Some define co-benefits broadly: Benefits that accrue as a side effect of targeted policies are known as *secondary benefits, policy spillover effects, 'co-benefits'* or *ancillary benefits*. (Pearce 2000)

Others look mostly at synergies between mitigating climate change and controlling air pollution: In the process of controlling GHGs, the benefits from other pollutants that are also abated e.g. SO_2, NOx, PM. In the process of abating air pollution, the benefits from CO_2 and other GHGs that are also mitigated. (PRCEE)

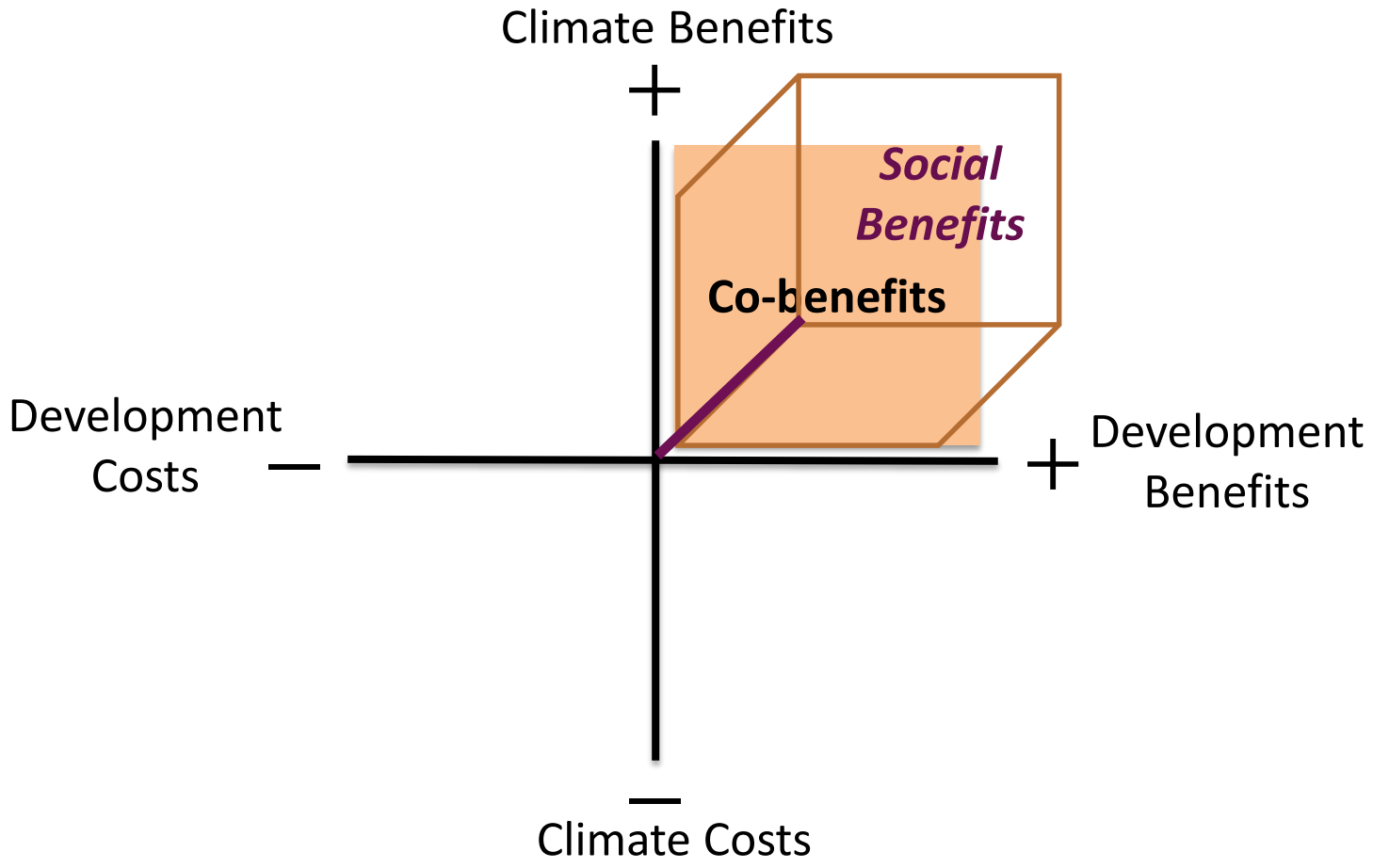
Yet others focus on the link between climate mitigation and sustainable development: The benefits of polices that are implemented for various reasons at the same time – incl. climate change mitigation – acknowledging that most policies designed to address GHG mitigation also have other, often at least equally, important rationales e.g. related to objectives of development, sustainability and equity. (IPCC 2001 TAR)

Visualising Co-benefits

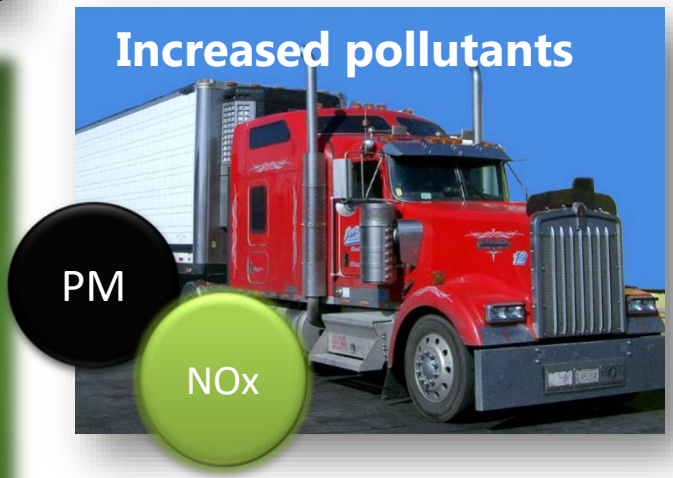


Expand our view of co-benefits…

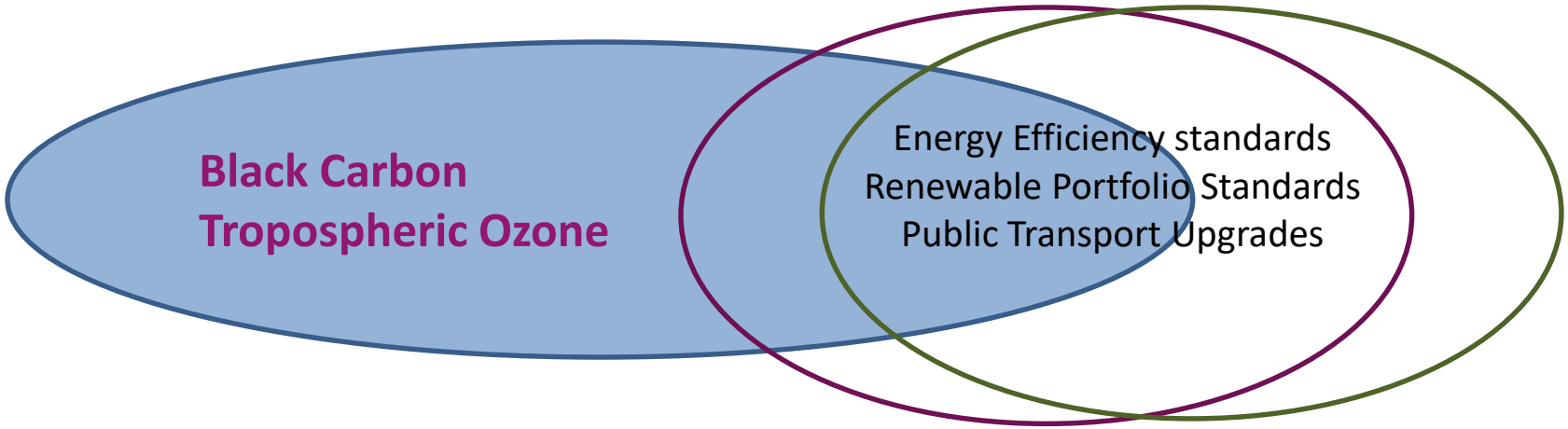
Illustration of co-benefits in terms of costs and benefits



Some examples of negative consequences



Visualising Co-benefits with SLCP



SLCP Impacts

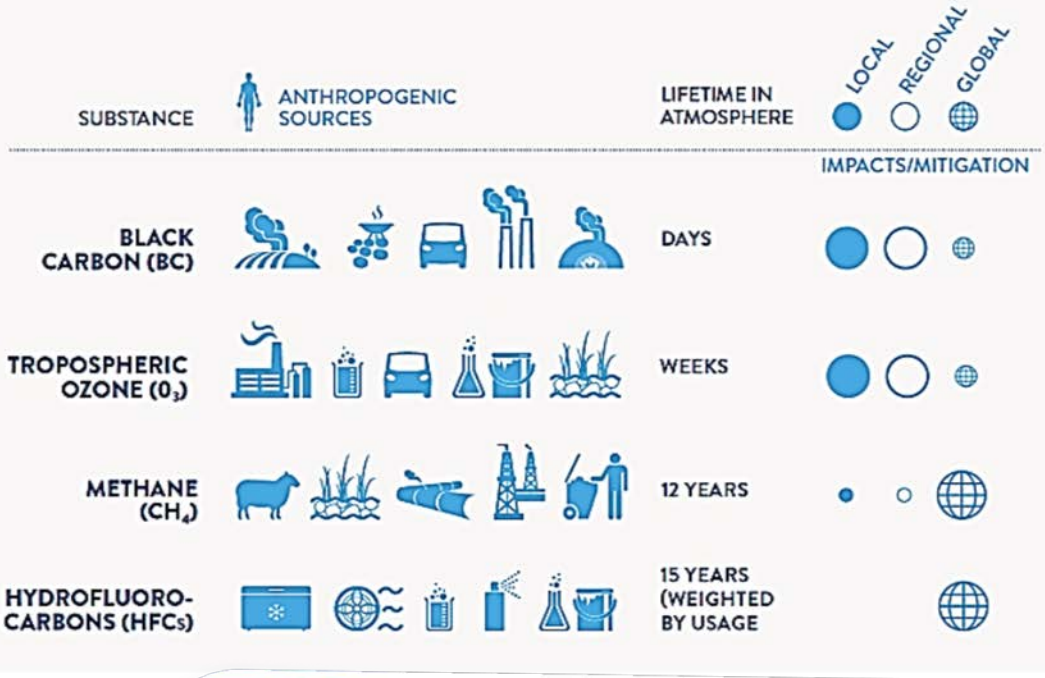
What are SLCPs ?

(Source: www.ccacoalition.org/en/science-resources)

SHORT-LIVED CLIMATE POLUTANTS

Near term response to mitigation

(Note: modified by IGES)



ANNUAL BENEFITS

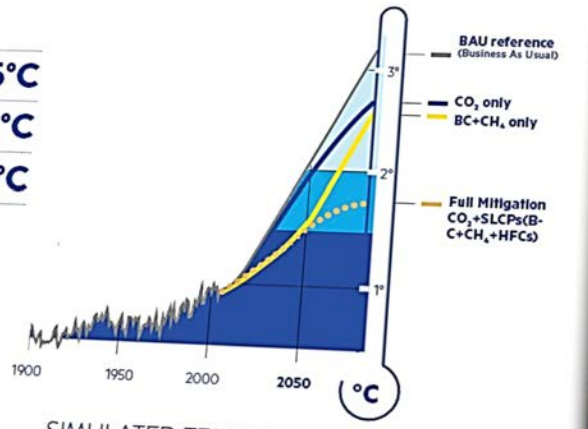
From large-scale mitigation **by 2030**

CLIMATE	AVOIDED WARMING	REDUCED RATE OF SEA-LEVEL RISE BY ~20% BY 2050	REDUCED RATE OF MELTING	REDUCED RATE OF SEA-LEVEL RISE BY ~20% BY 2050
HEALTH	2.4 MILLION	AVOIDED PREMATURE DEATHS ANNUALLY FROM OUTDOOR AIR POLLUTION	REDUCED AIR POLLUTION - WORLD'S LARGEST ENVIRONMENTAL HEALTH RISK	
CROPS	52 MILLION	TONNES OF AVOIDED CROP LOSSES FROM 4 MAJOR STAPLES YEAR		

SLCP CLIMATE BENEFITS

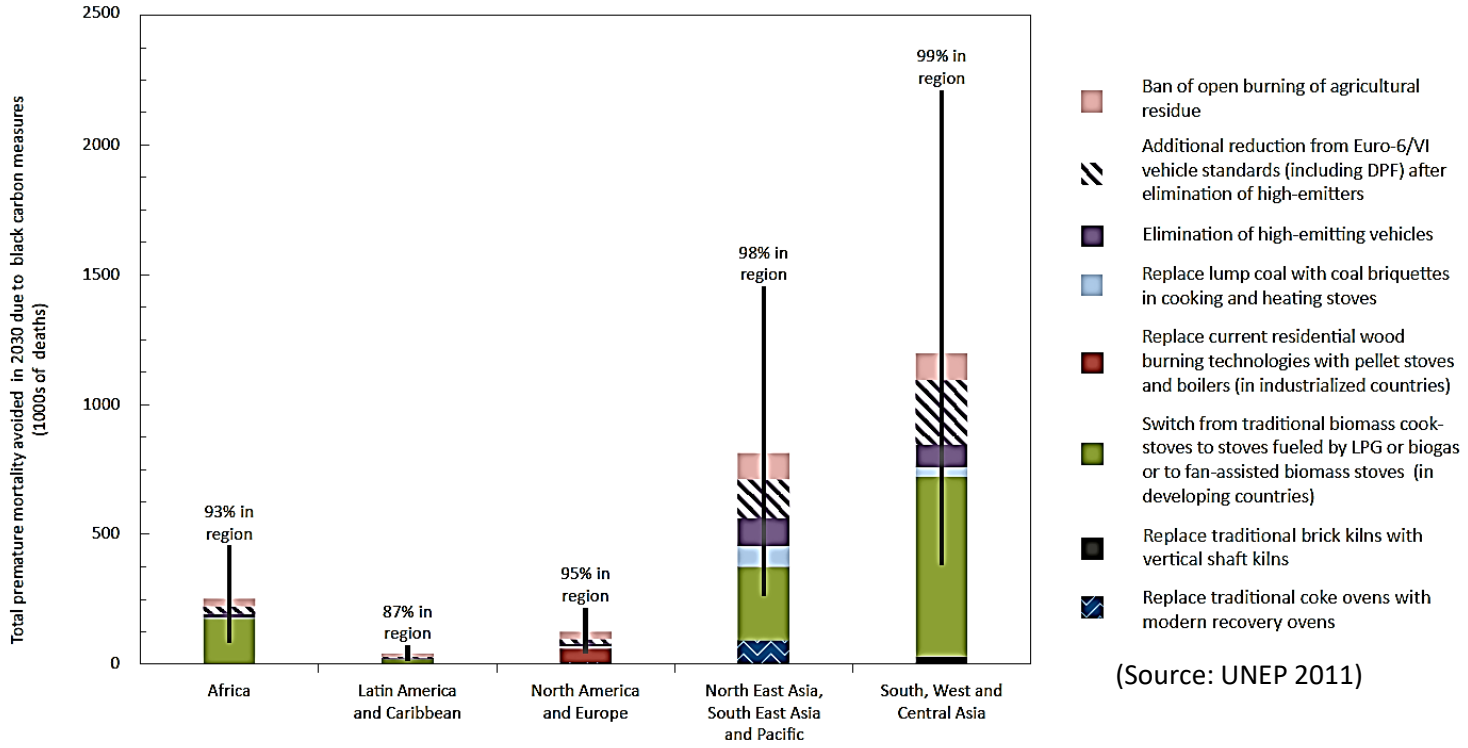
Avoided Global Warming **by 2050**

BC + CH_4	0.5°C
HFCs	0.1°C
SLCPs	0.6°C



SIMULATED TEMPERATURE CHANGE UNDER VARIOUS MITIGATION SCENARIOS

Why are SLCPs Important in Asia ?



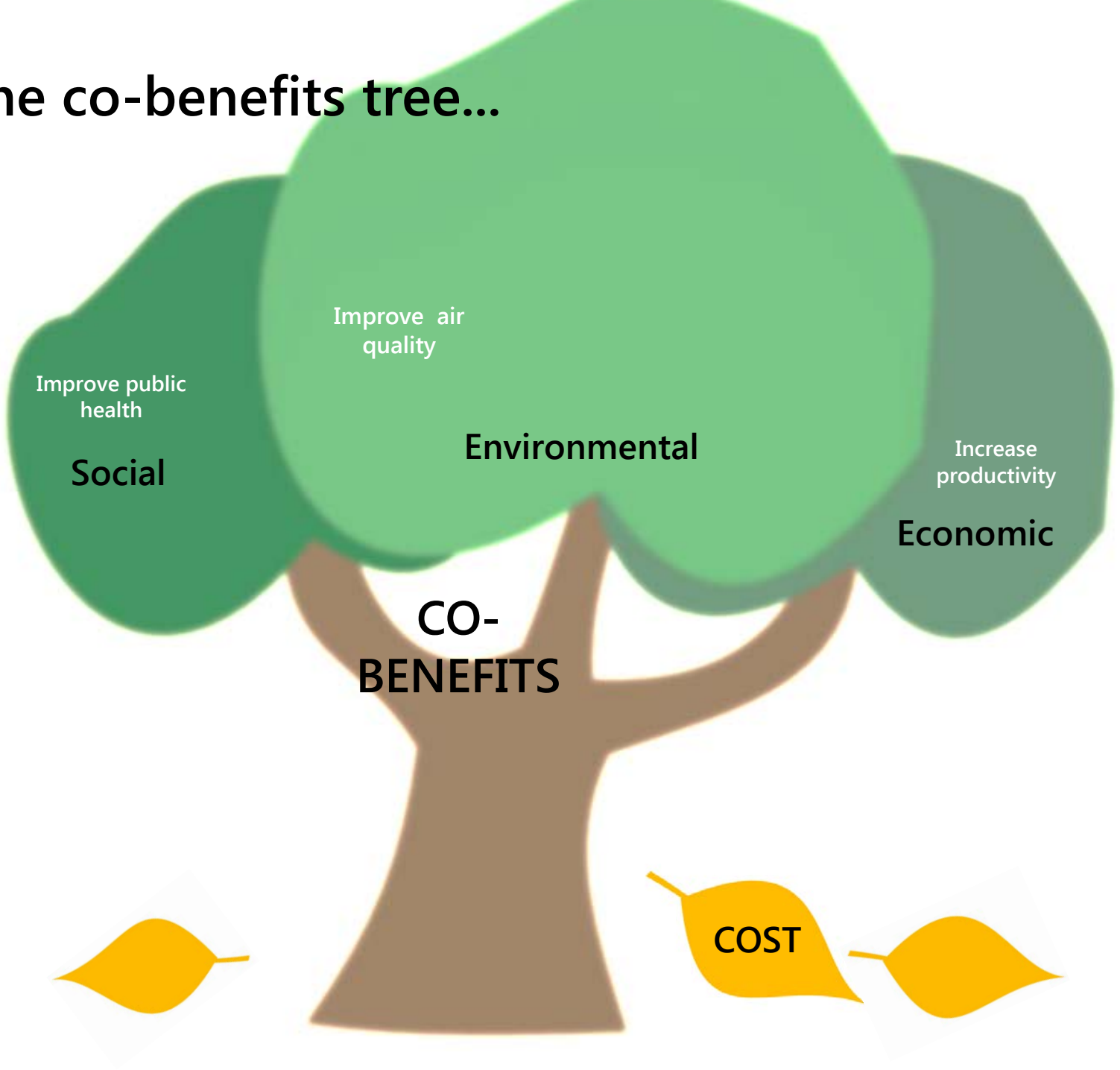
(Source: UNEP 2011)

- Asia is significant source of SLCP emission region in the world.
- Asia needs to: **reduce climate change in near-term as well as long-term**
  reduce burden of air pollution
  feed a growing population

Co-benefits action plan phase I

- Form a team of up to 6 people
- Select a project or policy with possible co-benefits
  - ✓ **Consider the sector(s)**
  - ✓ **Location(s)**
  - ✓ **Scope**
- Begin to develop a presentation that:
  - ✓ **Explains why co-benefits are important**
  - ✓ **Describes the difference between co-benefits and costs**
  - ✓ **Use the co-benefits tree to list the co-benefits and costs associated with your action plan**

Meet the co-benefits tree…



Reference…

(Source: www.undp.org)

COURSE OUTLINE

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- How can co-benefits be illustrated?

Quantifying and Applying Co-benefits

- Why is it important to quantify co-benefits?
- How can co-benefits be quantified?
- Case studies

Integrating Co-benefits into Policies

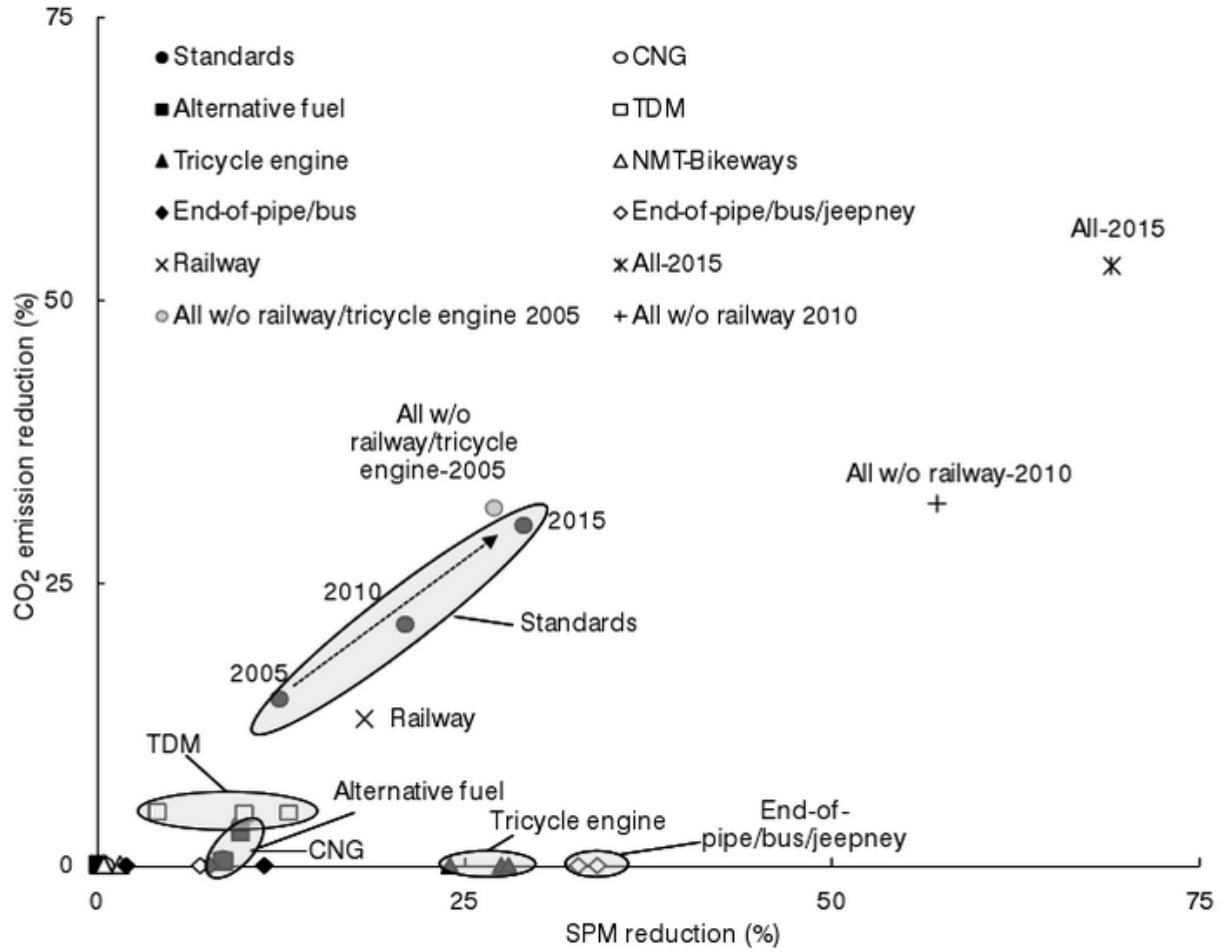
- How have co-benefits been integrated into policymaking process?
- Institutions and Process with Case Study
- Enabling Environment with Case Study

Why is it important to quantify co-benefits?

- It can demonstrate whether there are co-benefits or trade-offs between climate change mitigation and pollution control
- It can clarify the size of possible reductions in pollution and GHGs
- It can illustrate which technologies and/or policies can deliver the greatest reduction in pollution and GHGs

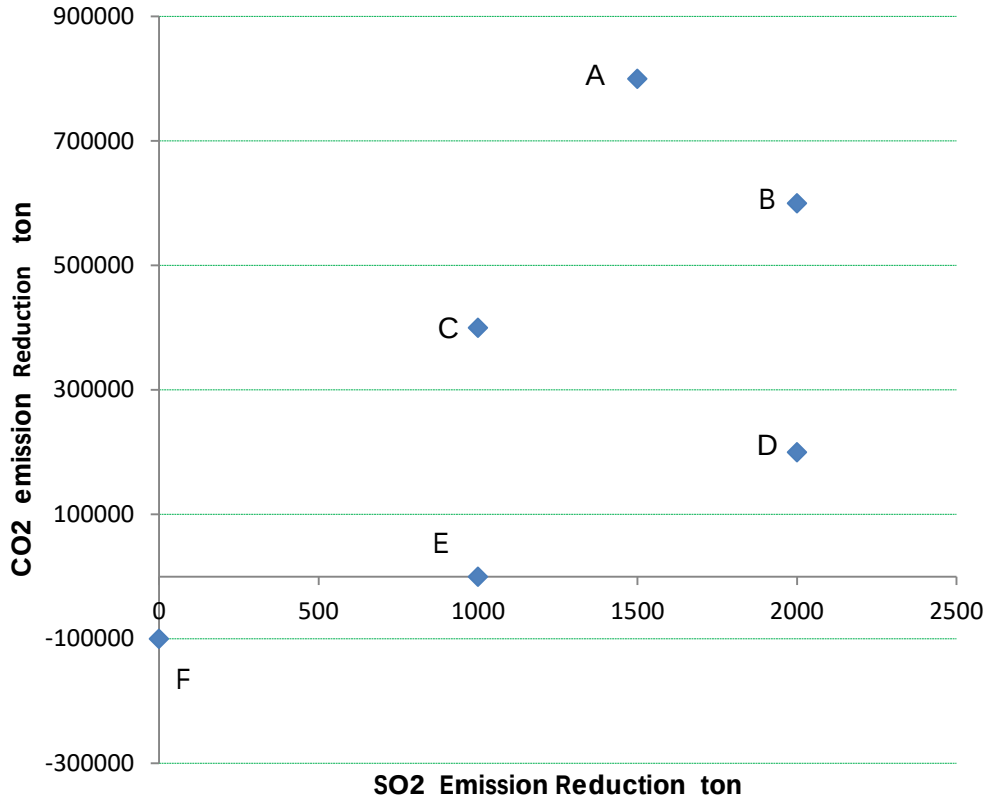
Quantification allows adding and comparing benefits and costs

Another way to illustrate co-benefits is a co-benefits plot



(Source: Herran and Matsumoto, 2012)

Let's pause for a relaxing quiz



- Which of the projects would you invest in if you were a city policymaker?
- What other considerations might be important in deciding your investment besides reductions in pollutants?

Main steps to quantify co-benefits

1. Identify problems and set objectives
2. Develop scenario
3. Gather data for baseline
4. Modelling/estimating multiple benefits
5. Policy integration and implementation

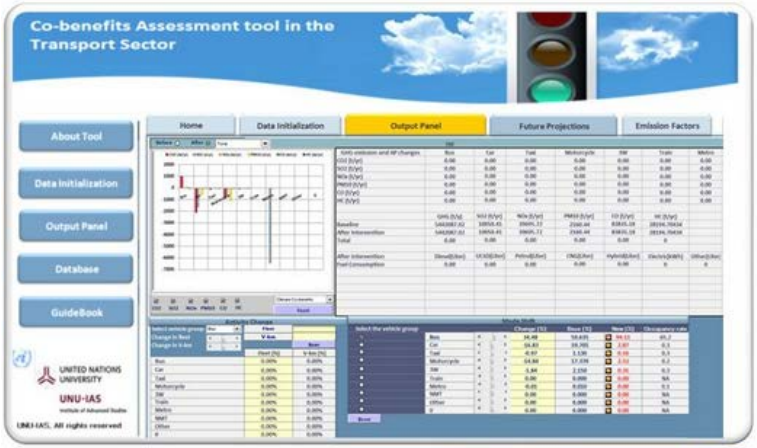
Case Study 1: Manila's Transport Sector

1 Want to save time and reduce GHGs!

Tools to quantify co-benefits

- TEEMP
- LEAP-IBC
- GAINS
- UNU co-benefits tool
- BenMAP

www.cobenefit.org



$$E = A \times F$$

2 Developing the scenario

Avoid unnecessary travel

Shift to more efficient modes

Improve vehicle technologies and design

$$BT = BT_{wo} - BT_{w}$$

BT: Benefit of time savings

3 Develop baseline: data needed

Traffic Volume (vehicles/day)

Without Project

	1	2	3	4	5
Passenger Car	115,678	77,921	70,152	76,472	87,635
Public Utility Vehicle	4,632	3,714	7,505	5,158	7,182
Public Utility Bus	1,495	1,389	1,449	1,448	1,722
Truck	1,671	1,713	1,653	1,675	1,422

$$BT_i = \sum_j \sum_l (Q_{ijl} \times T_{ijl} \times \propto_j)$$

Q_{ijl}: Quantity of vehicle on link l

With Project

	1	2	3	4	5
Passenger Car	104,111	70,129	63,137	68,825	78,871
Public Utility Vehicle	2,316	1,857	3,752	2,579	3,591
Public Utility Bus	747	694	725	724	861
Truck	1,671	1,713	1,653	1,675	1,422

$$BT_i = \sum_j \sum_l (Q_{ijl} \times T_{ijl} \times \propto_j)$$

T_{ijl}: Average time of vehicle j on link l

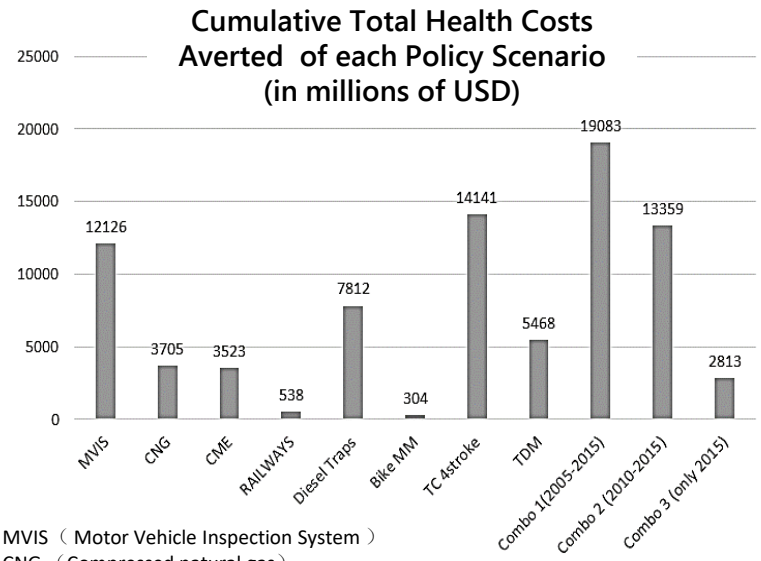
Vehicle Type	Value of Time
	USD/vehicle-minute
Passenger Car	0.02
Public Utility Vehicle	0.02
Public Utility Bus	0.09
Truck	-

$$BT_i = \sum_j \sum_l (Q_{ijl} \times T_{ijl} \times \propto_j)$$

$\propto_j$: Value of time of vehicle j on link l

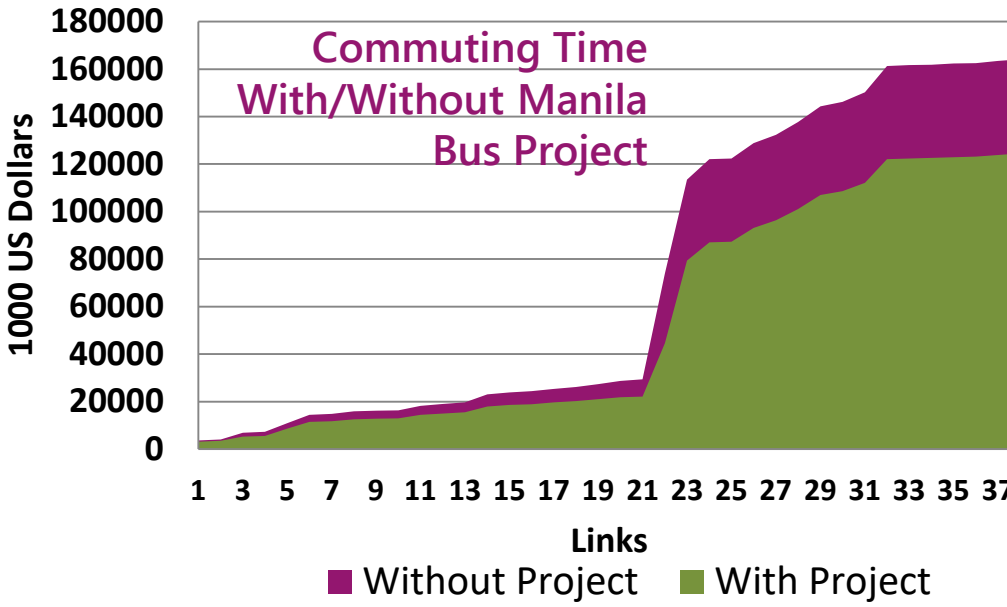
4 Estimating multiple benefits

Health Impact Assessment



MVIS （ Motor Vehicle Inspection System ）
CNG （Compressed natural gas）
CME（Coco-methyl esters）
RAILWAYS
Diesel Traps
Bike MM
TC 4stroke (Two stroke tricycles switching to four-stroke engines)
TDM （Transportation Demand Management through license plate scheme ）
Combo1 （ Combination of policies: all policies except railways and switching of two stroke to four stroke tricycles
Combo2（All policies except railways ）
Combo3（All policies including railways）

(Source: IGES based on IES 2005)



(Source: CAA 2013)

Case Study 2: Heat Only Boiler in Ulaanbaatar

1 Want to reduce air pollution and GHGs!

2 Develop the scenario

$$ER_p = RE_p - PE_p$$

ER_p : Emission reductions during the period p [tCO_2/p]
RE_p : Reference emissions during the period p [tCO_2/p]
PE_p : Project emissions during the period p [tCO_2/p]

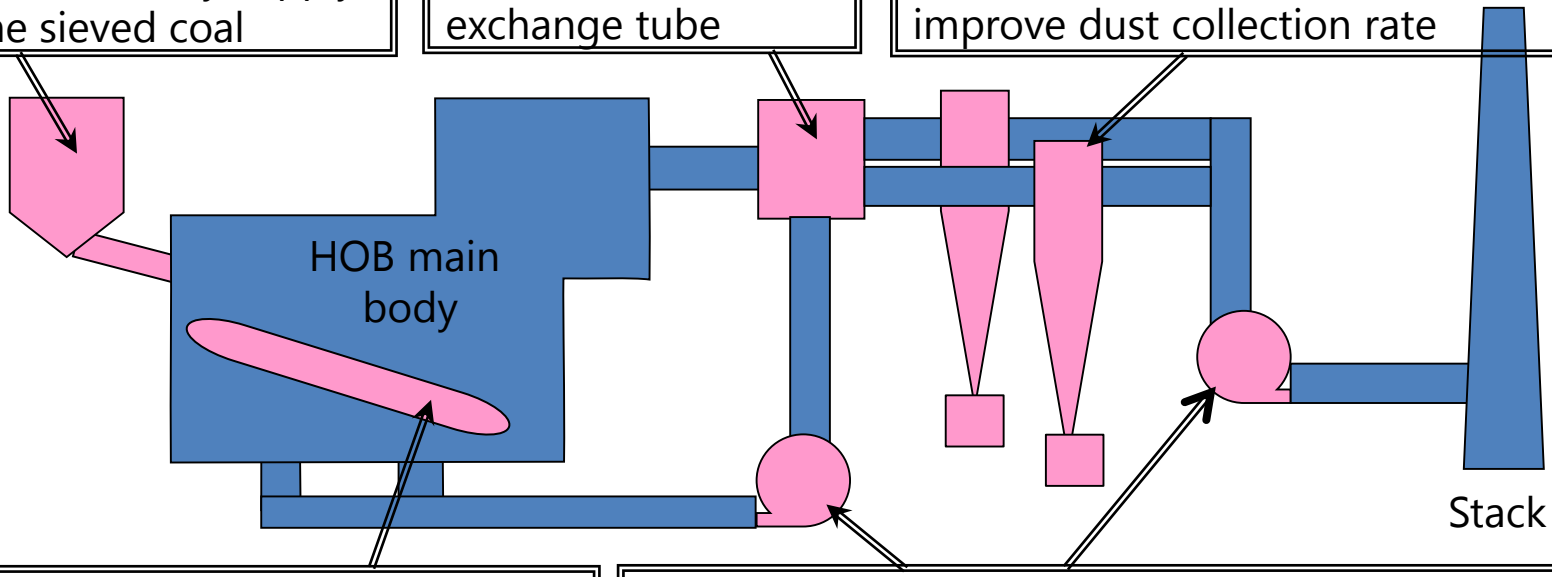
2 Develop the scenario

⑥ Coal Storage Area
Attach the roof for the rain protection

① Coal Feeder
Automatically supply the sieved coal

③ Air Preheater
Improve the heat exchange tube

⑤ Cyclone
Parallel tower system in order to improve dust collection rate



② Rotating Combustion Bed
Install mechanical rotation

④ Forced Draft Fan & Induced Draft Fan
Optimize air flow rate & change material of the fans

3 Develop baseline (reference case)

$$ER_p = RE_p - PE_p$$

$\boldsymbol{RE_p = PHp/\eta_{RE,\,HOB} \times EF_{CO2,Coal}}$

PHp: Net heat quantity supplied by the project HOB during the period p [GJ/p]

$\eta_{RE,\,HOB}$: Boiler efficiency of the reference HOB [%]

$EF_{CO_2,Coal}$: CO_2 emission factor of coal [tCO_2/t_{Coal}]

$$ER_p = RE_p - PE_p$$

$\boldsymbol{PE_p = (PHp/\eta_{RE,\,HOB} \times EF_{CO2,Coal}) + (ECp \times EF_{CO_2,\,grid})}$

ECp: Electricity consumption of the project HOB during the period p [MWh/p]

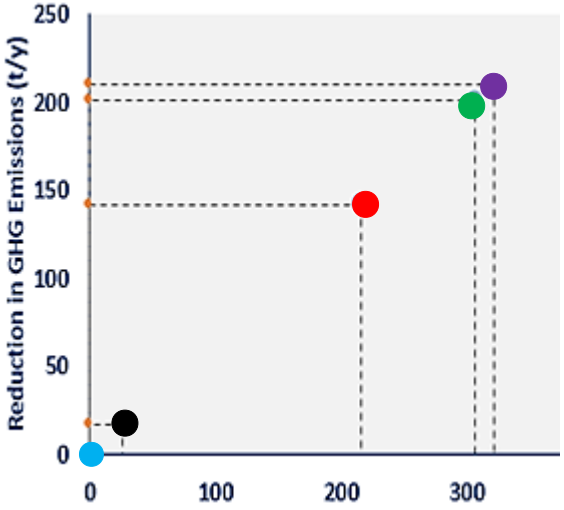
$EF_{CO_2,\,grid}$: CO_2 emission factor of the grid electricity consumed by the project HOB [tCO_2/MWh]

$EF_{PM,Coal}$: PM emission factor of coal [tPM/GJ]

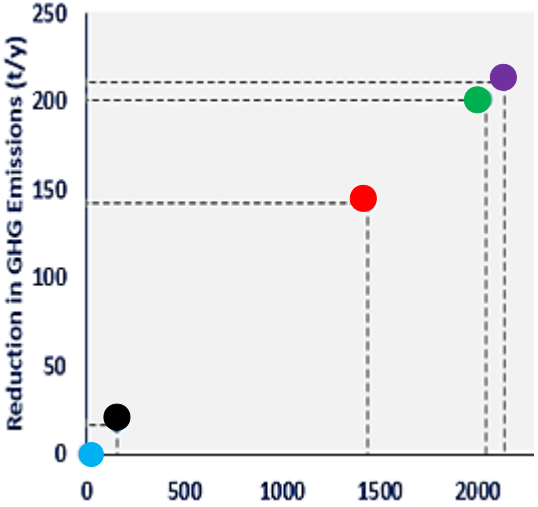
Note: GJ is a Gigajoule=1 billion joules, 1 GJ=278 MWh

4 Quantified Co-benefits from HOB

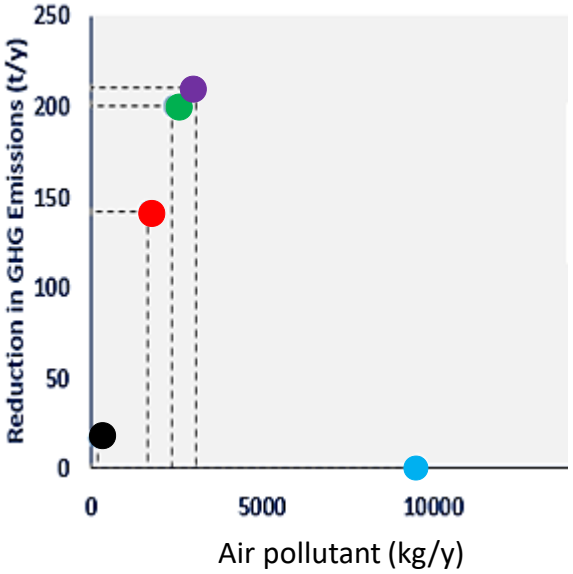
GHGs & NOx



GHGs & SO_2

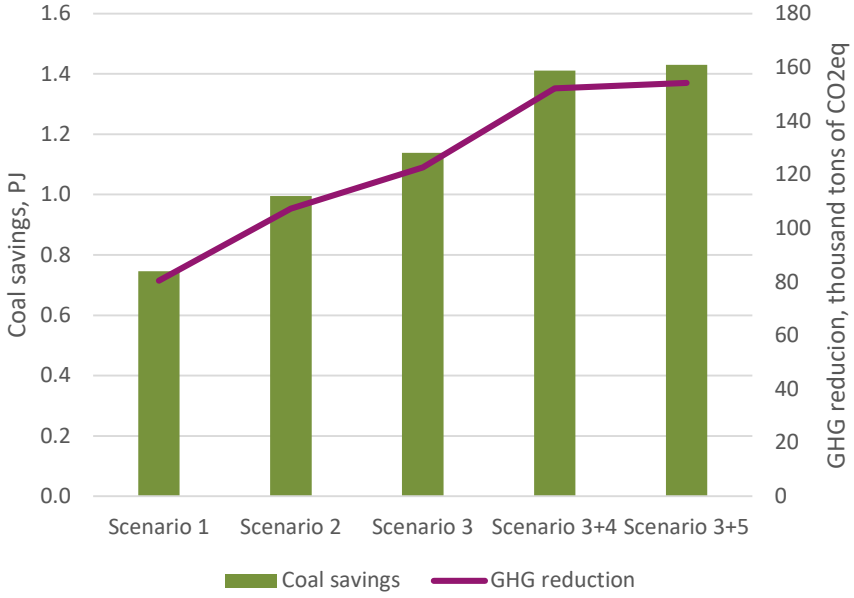


GHGs & PM



- Coal Storage
- Air Preheater
- Air Feed Adjustment
- Coal Feeder Selection
- Cyclone Dust Collector

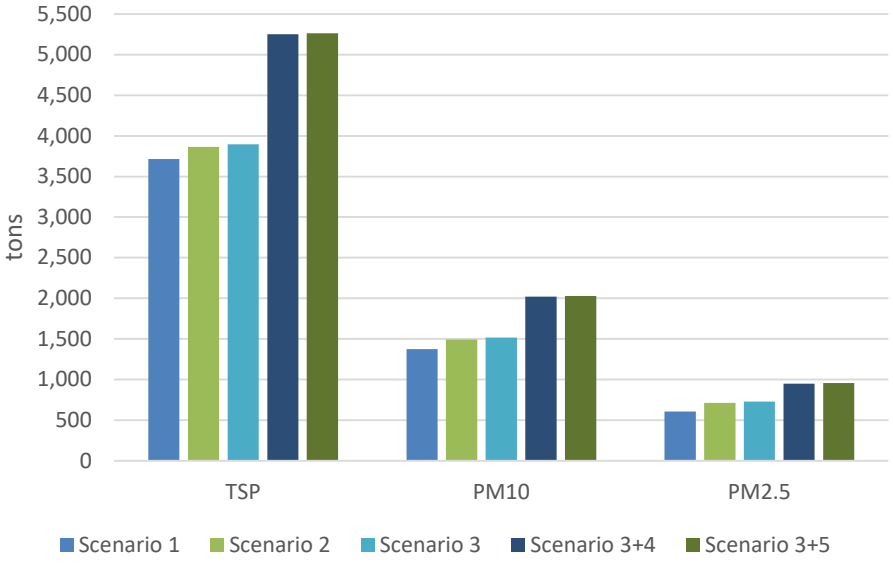
Coal savings and reduction of GHGs by scenario



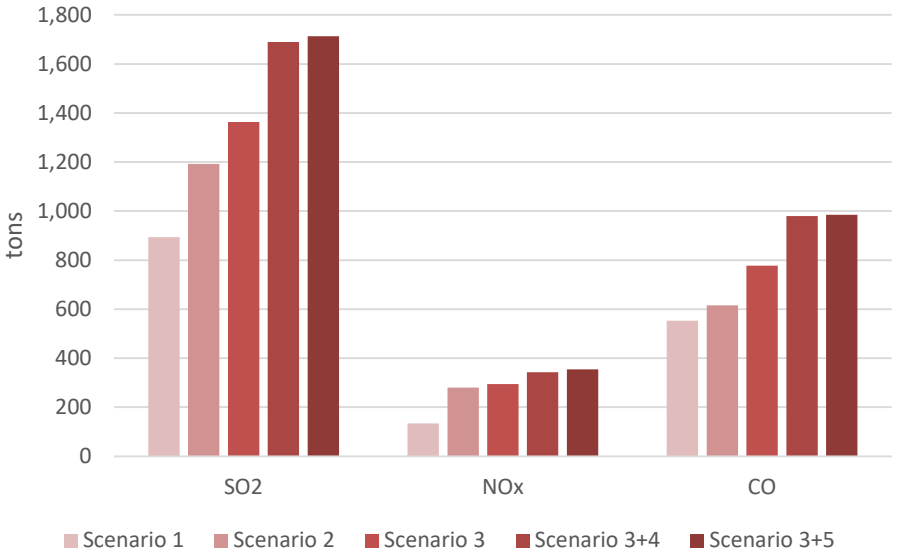
SCENARIOS FOR SCALED UP

1. Replacement of conventional HOB with improved ones
2. Connection of buildings using small boilers to the local 30 MW heating plant
3. Connection to the district heating network serviced with large boilers of about 300 MW
4. Replacement of conventional HOB with the improved ones in other Mongolian towns
5. Connection of buildings heated with small boilers in other towns to the local 30 MW heating plants

Reduction of emissions of total particles, PM_{10} and $PM_{2.5}$ by scenario



Reduction of emissions of SO_2, NOx and CO by scenario



Co-benefits action plan phase II

- Please add to your group's action plan by deciding on the following:

  - ✓ **The main benefits you will quantify**
  - ✓ **The tools and methods you might use to estimate the benefits**
  - ✓ **The data that you will need to estimate the reductions in GHGs, air pollutants and other benefits**
  - ✓ **The scenario you will estimate and how you will develop that scenario**
  - ✓ **The types of challenges or constraints you may confront in estimating the benefits**

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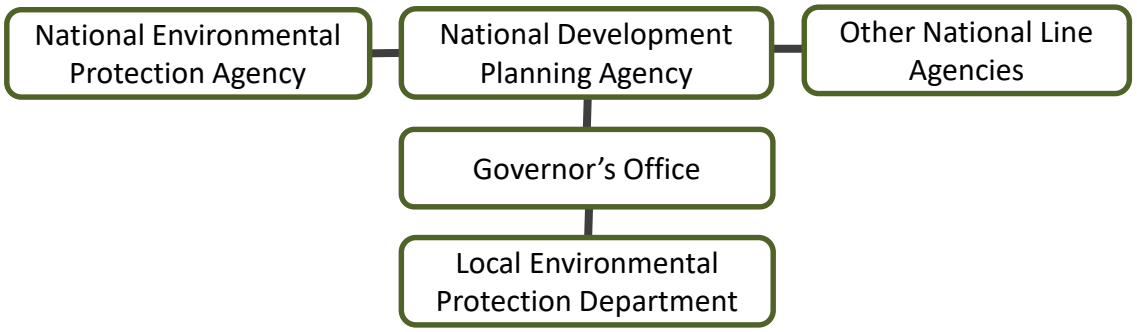
Case studies

5 Integrating Co-benefits into Policies

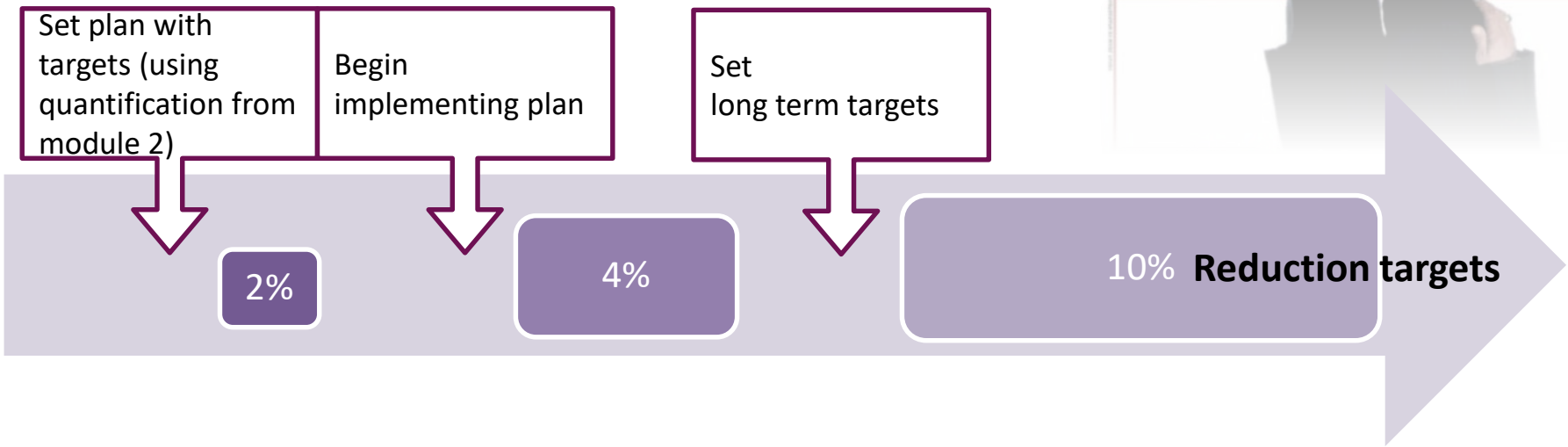
How have co-benefits been integrated into policymaking process?
Institutions and Process with Case Study
Enabling Environment with Case Study

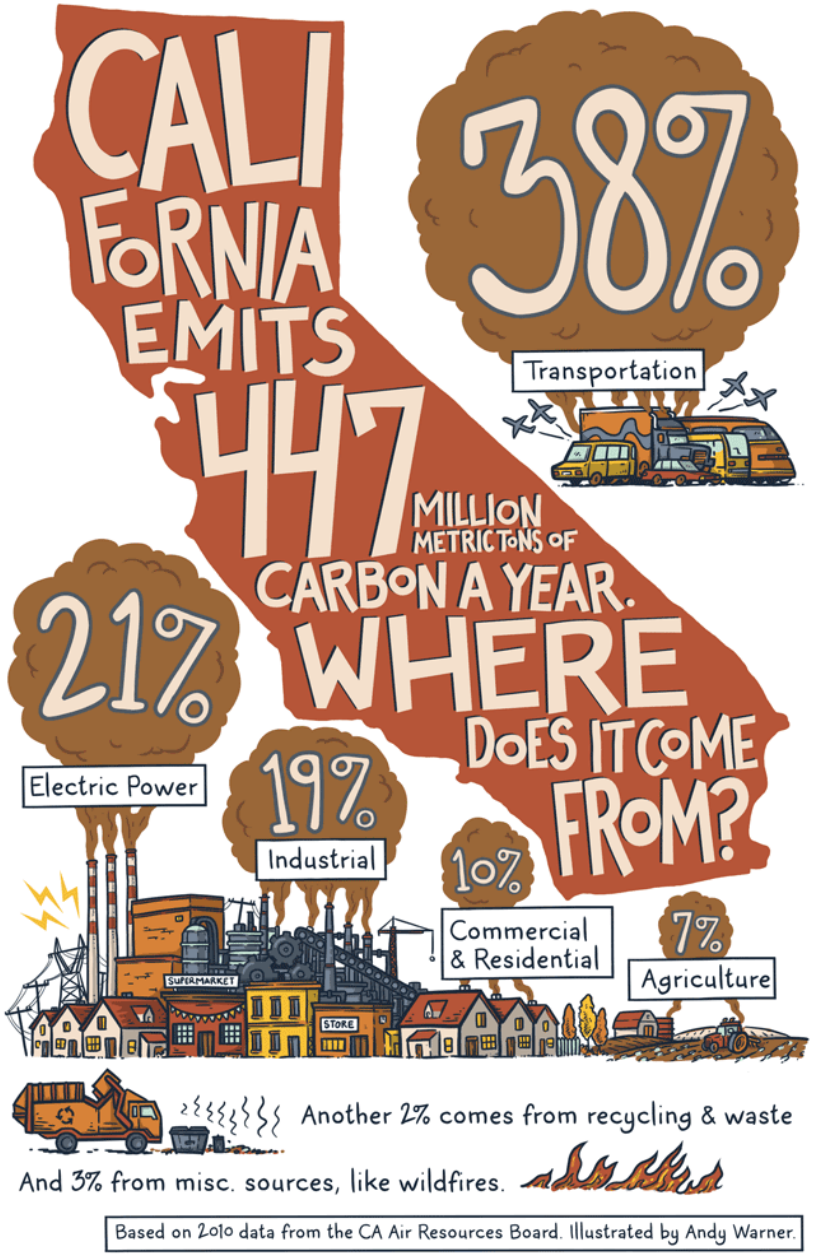
Case Study 3: California Global Warming Solutions Act, Assembly Bill (AB) 32

Lets start by thinking about INSTITUTIONs



Lets continue by thinking about PROCESS

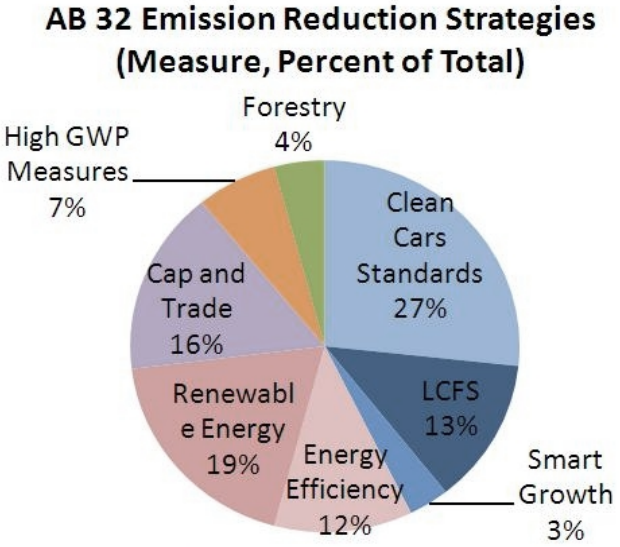




Objective of AB 32

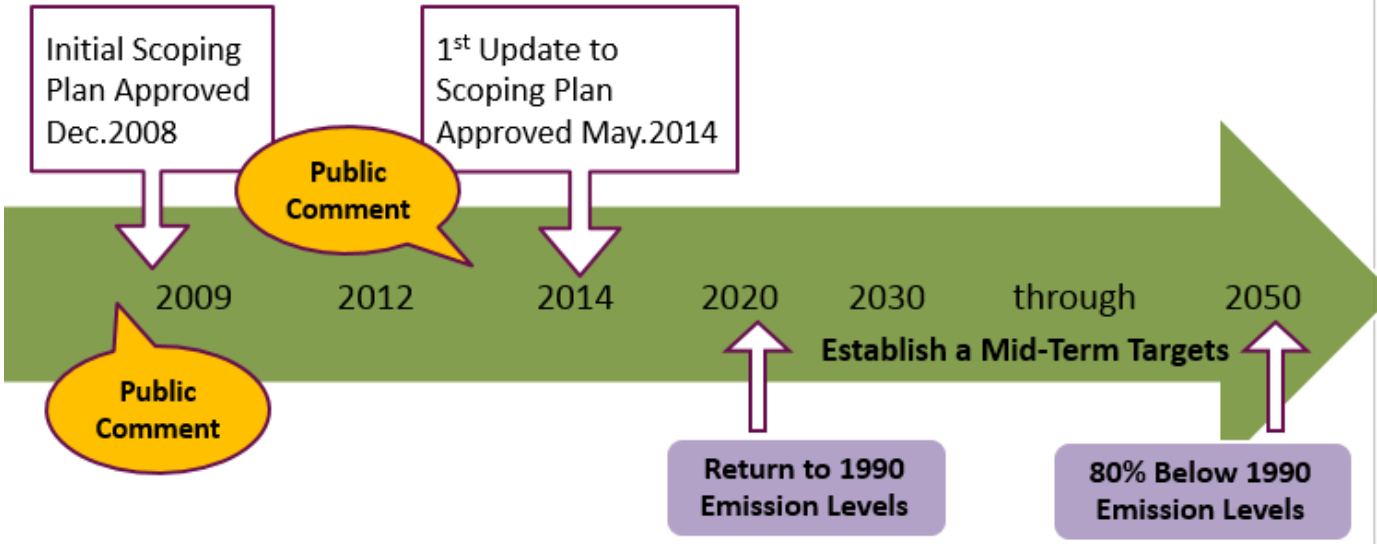
Mandates development of rules and regulations to return California's GHG emissions to 1990 levels by 2020 (Reduction of ~43 $MMTCO_2E$ by 2020).

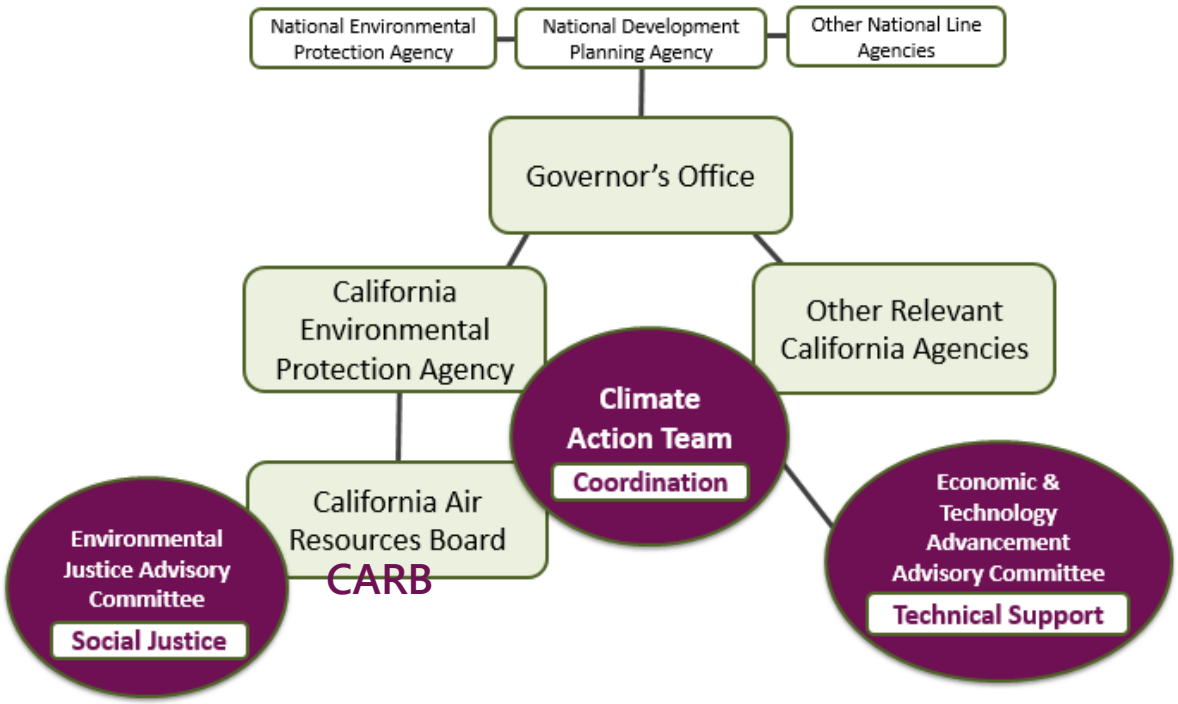
AB32 Starts with 2020 targets



Source: CARB, Emissions Reductions from Scoping Plan Measures; 2020 GHG Emissions Forecast

The process introduced a path to 2020 and beyond



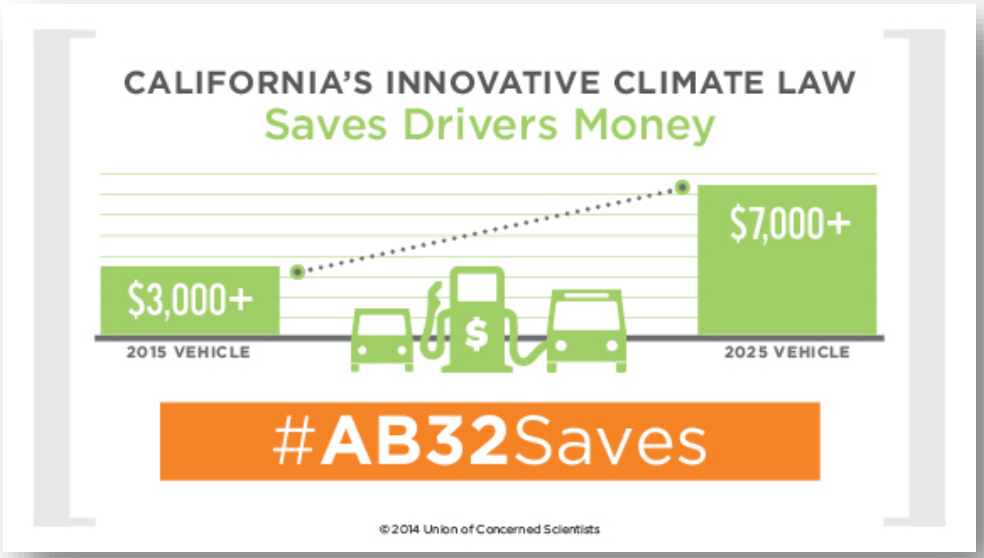


The Institutions supporting this process were important

- ✓ Method: 44 sector-specific climate strategies in 5 sectors
- ✓ Estimation: The cost of mitigating a ton of GHG in 2020,
  The benefits of energy savings, The benefits of reduced air pollution

Selected & Estimated Co-benefits

Economic	**Energy Efficiency, Energy Access, Economic Development** • Homeowners can save about $200/year through energy efficiency • $76 billion increase in Gross State Product (GSP) • $48 billion increase in real household incomes
Environmental	**Improved Air Quality, Land use, Ecosystem Services** • Air Quality • Reduce combustion-generated soot (PM2.5): 15 tons/day • Reduction of nitrogen oxides: 61 tones/day
Social	**Public Health, Green Jobs (Job Creation)** • $4.3 billion in 2020: 770 fewer premature deaths and 76,000 fewer work days lost • The creation of 403,000 new efficiency and climate driven jobs



Lets look at how those benefits were communicated

Case Study 4: Jakarta BRT

After a slow start, TransJakarta delivers benefits

We need an effective enabling environment…

Case Study 4: Jakarta BRT

1999-2004
Pre-BRT

Governor's Office

Jakarta Transportation Agency (DisHub)

2004-2006
BRT-Lines 1-3

Governor's Office

Jakarta Transportation Counsel

Jakarta Transportation Agency (DisHub)

TransJakarta

2007-2008
BRT-Lines 4-7

Governor's Office

Jakarta Transportation Counsel

Jakarta Transportation Agency (DisHub)

TransJakarta

Case Study 5: Seoul's One Less Nuclear Plant

As of 2012, 94.6% of Seoul's energy came from oil, LNG and electricity for households, commercial, transport (86.2%).

Reducing the city's energy demand equals to the capacity of 1 nuclear power plant (1GW, 2 million TOE) by 2014.

The longer-term objective was reaching 20% energy self-sufficiency by 2020.

[Electricity Consumption of Nation and Major Cities]

(Unit: GWh)

	2011	2012	2013	2014	Rate (2011→2014)
Nation	455,070	466,593	474,849	477,592	4.9
Seoul	46,903	47,234	46,555	45,019	-4.0
Daegu	14,822	14,955	15,080	14,859	0.2
Gwangju	8,047	8,131	8,274	8,197	1.9
Daejeon	9,060	9,160	9,225	9,103	0.5

Seoul, Energy Self-Sufficient City where Citizens Produce Energy and Consume Them Efficiently

Energy Self-Sufficient

Energy Saving

Energy Public Participation

Phase 2

Energy Revitalising City, Seoul

Decentralized Energy Generation
Seoul's energy needs are met by our own energy production.

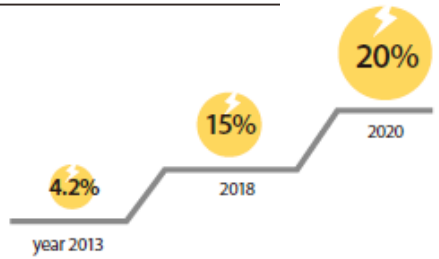
Efficient and Low Energy Consumption
Citizens use energy efficiently and wisely.

Innovation and Energy Jobs
Promoting energy industry means that more energy can be generated.

Energy-Sharing Community
Energy produced by citizens is shared with other citizens.

Total Energy Production and Savings

4 Million TOE



By 2020

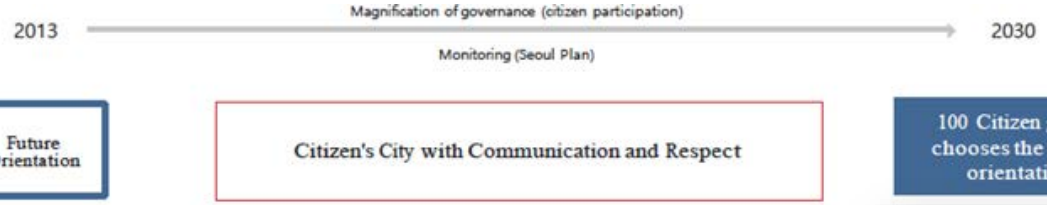
20% Energy Self-Reliance

Reduction of GHG Emission

10 Million Tons CO_2/uiv.eq

- All 10 million Seoulites lead the energy self-sufficiency movement by turning themselves from energy consumers to energy producers.
- Energy production and efficiency consumption of energy become entrenched in citizens' daily lives.
- Sustainable, quality jobs are created by promoting the energy industry.
- A virtuous cycle is created in which citizen participants to energy production make profits and donate back to the society.

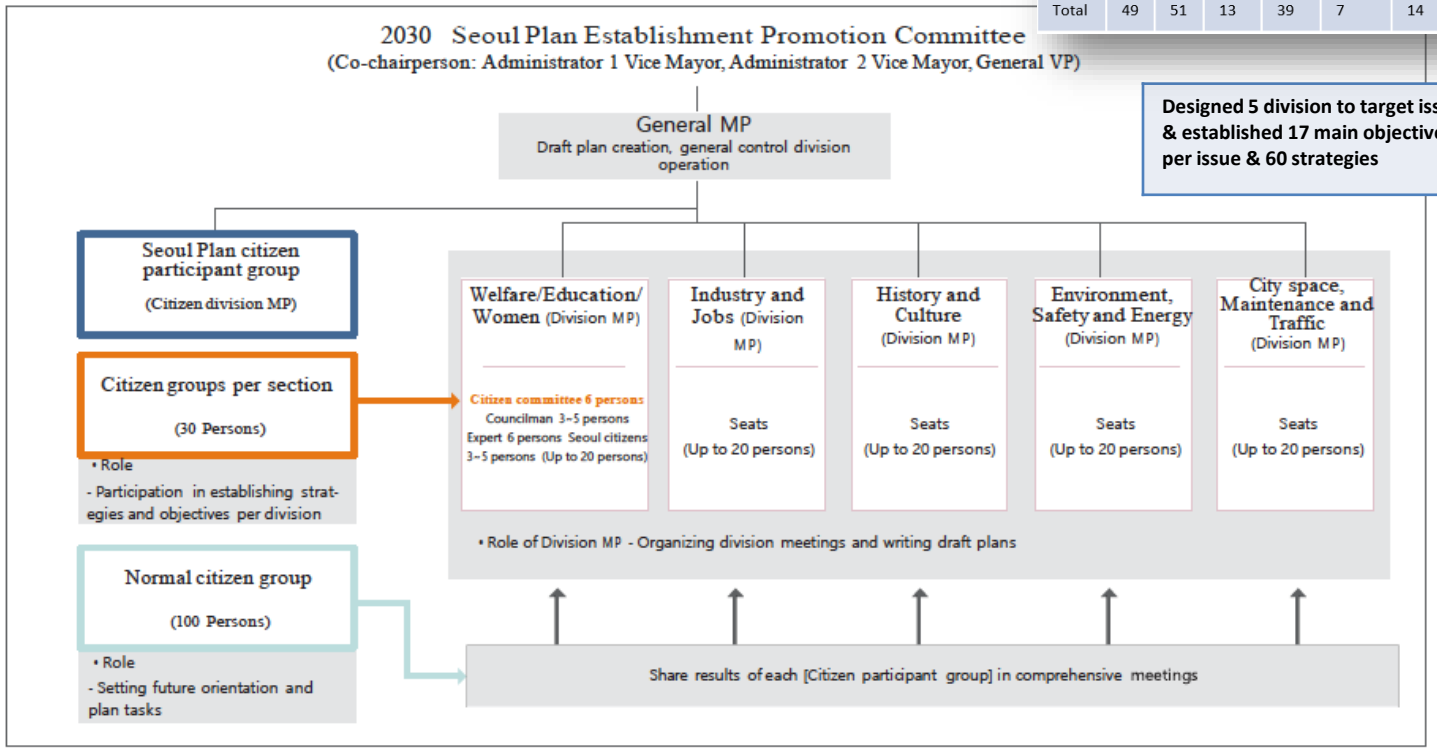
The Comprehensive Plan for One Less Nuclear Power Plan was finalized by citizens. A draft was made in April 2012 as a result of 16 three-way talks between SMG, the Hope Policy Advisory Group and civil society over the course of 4 months. The draft was reviewed at the Policy Listening Forum as well as town hall meeting which had more than 400 citizens' participation through 22 group discussions and presented a total of 109 ideas those later reflected in the municipal policies. To devise projects in Phase 2, the opinions of citizens were actively collected through discussions and internet forums.



Age	Sex		Occupation					Others			it
	M	F	Student	Worker	Businessman	Self-employe	House wife	Senior	Disabled	Foreig ner	
20s	9	11	13	5						2	20
30s	7	10		14		1	2				17
40s	15	11		8	6	6	5		1		26
50s	10	15		10	1	5	7		2		25
60s+	8	4		2		2	2	6			12
Total	49	51	13	39	7	14	16	6	3	2	100

The process introduced a path to 2030

The Institutions supporting this process are important



Designed 5 division to target issues & established 17 main objectives per issue & 60 strategies

(Source: modified from www.seoulsolution.kr/en/content/2030-seoul-plan)

Co-benefits action plan phase III

- Please add to your group's plan by deciding on the following:
  - ✓ The institutional structure(s) that will support the design and implementation your action plan
  - ✓ The policymaking process that will support your action plan
  - ✓ Other elements of an enabling environment that will support your plan

Asian Co-benefits Partnership (ACP)

www.cobenefit.org

COURSE OUTLINE

Identifying Co-benefits

- What are co-benefits?
- Why are co-benefits important?
- How can co-benefits be illustrated?

Quantifying and Applying Co-benefits

- Why is it important to quantify co-benefits?
- How can co-benefits be quantified?
- Case studies

Integrating Co-benefits into Policies

- How have co-benefits been integrated into policymaking process?
- Institutions and Process with Case Study
- Enabling Environment with Case Study

Linking

Clean Development Mechanism


(Source: www.fairclimatefund.nl)

The Indian Bagepalli Biogas Program

Introduced 5,500 biogas units that convert cow dung into cooking fuel in poor households. Local women and communities benefited from the income generated by selling emission credits


(Source: www.wordorg.net)

Co-benefits


(Source: www.goldstandard.org)

Nationally Appropriate Mitigation Action

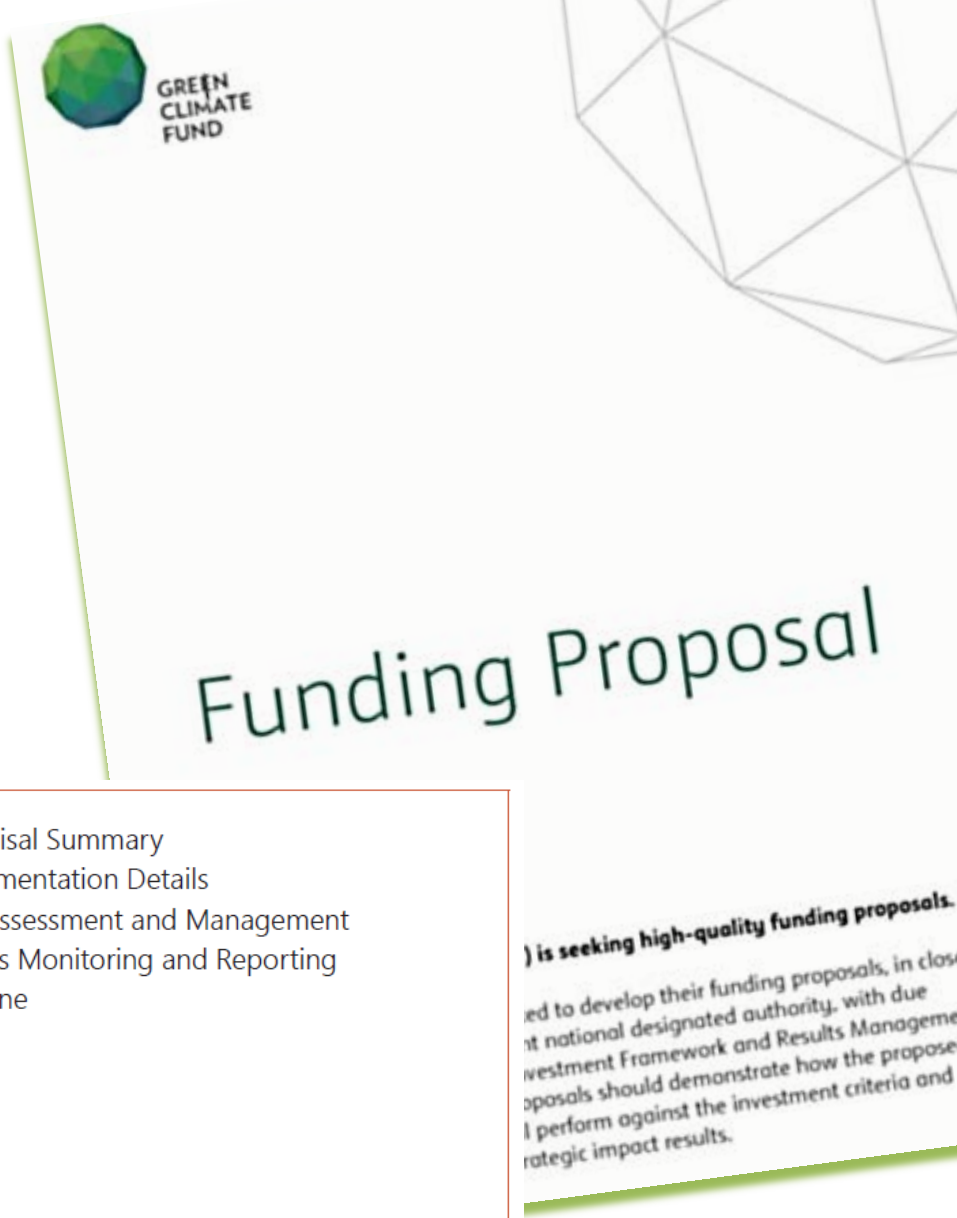
Bus Rapid Transit for Kampala

Aims at reducing transport-related GHG emissions by building 9 BRT routes and non-motorized transport lanes linked to the BRT

Bio-energy in Pakistan

Seeks to develop and disseminate environment-friendly and cost-effective technologies and management practices of bio-energy generation from organic waste

GCF released $183 million for the initial 8 project in SIDS & LDCs (as of 2015)



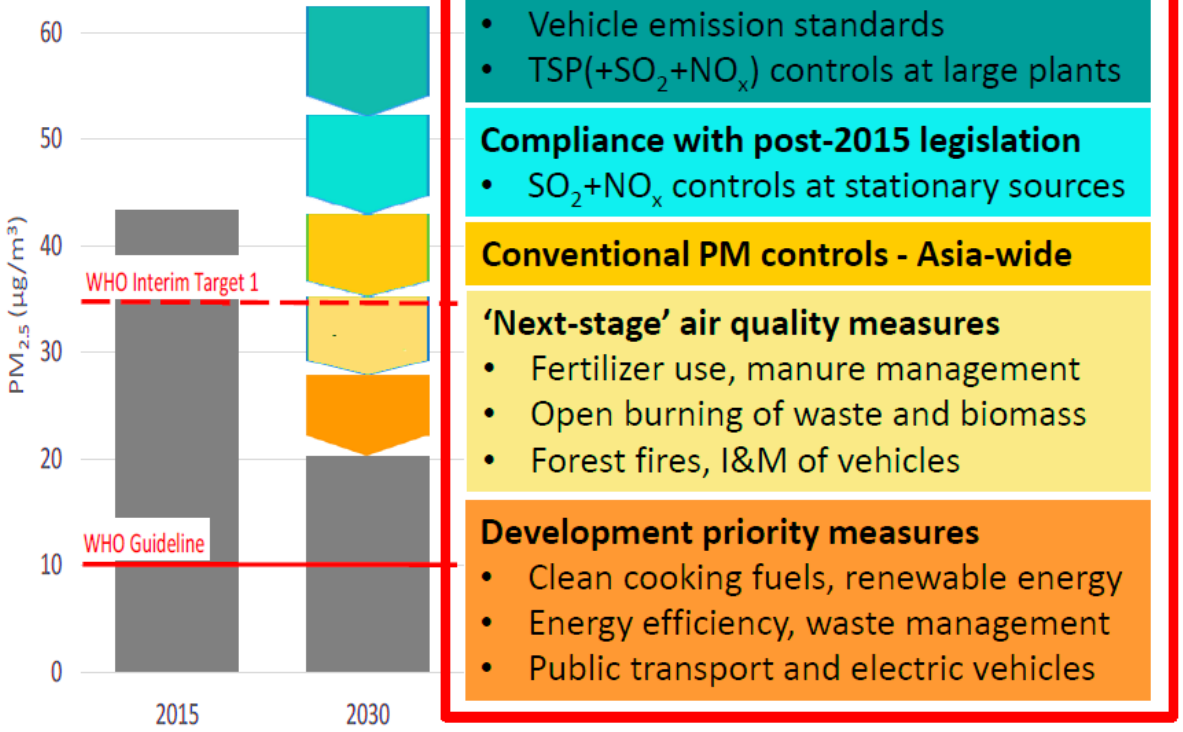
Proposal Outline

A. Summary
B. Detailed Description
C. Rationale for GCF Involvement
D. Expected Performance against Investment Criteria
    D.1. Impact Potential
    D.2. Paradigm Shift Potential
    D.3. Sustainable Development Potential.
        Describe environmental, social and economic co-benefits including the gender-sensitive development impact.
    D.4. Needs of the Recipient
    D.5. Country Ownership
    D.6. Efficiency and Effectiveness
E. Appraisal Summary
F. Implementation Details
G. Risk Assessment and Management
H. Results Monitoring and Reporting
I. Timeline

Source: Author's simplification of GCF, 2015b

25 Clean Air Measures by UNEP in 2019

Potential Contributions of the Measures to Population-weighted mean exposure to $PM_{2.5}$



(Source: IIASA 2019)