GOVERNOR'S OFFICE
OF THE CAPITAL CITY
ULAANBAATAR

Northeast Asian MAYORS' FORUM

Low Carbon City Development:

Improving Air Quality & Reducing Greenhouse Gas Emissions

18-19 JUNE 2018 | **ULAANBAATAR**

ULAANBAATAR AIR POLLUTION

BARRIERS TO DEPLOYMENT OF CLEAN TECHNOLOGIES FOR AIR POLLUTION REDUCTION

Dr. Oyun Sanjaasuren
Director-Designate for External Affairs,
Green Climate Fund

Critical Need for Planetary Health

- Unhealthy environments already linked to 23% of global deaths
- Unprecedented scale of global environmental change

- Pressures on health are increasing (e.g. food, water, natural disasters, pollution, infectious disease, toxin exposure)

- A more preventive approach is critical
- Critical need for coordination/integration for long-term environment and health issues

Trend: Consumption Current and Future

300%

2030:

- 300% growth of Middle classes in developing countries
- Middle-class consumers will triple

325%

- World GDP is projected to grow by

325% between 2007 and 2050

60%

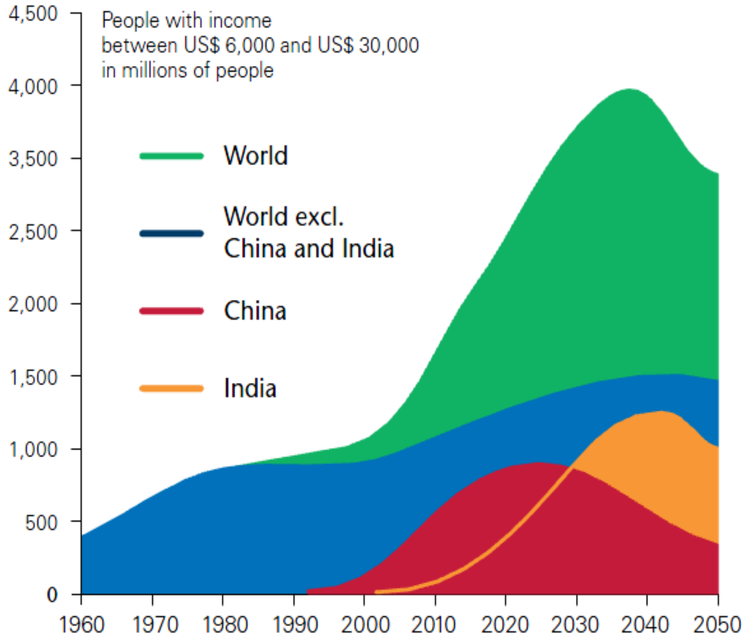
- 60% of GDP is consumer spending on goods & services
- 70 million people each year are

$ 30K

entering an income bracket

equivalent to between $ 6 000 (US)

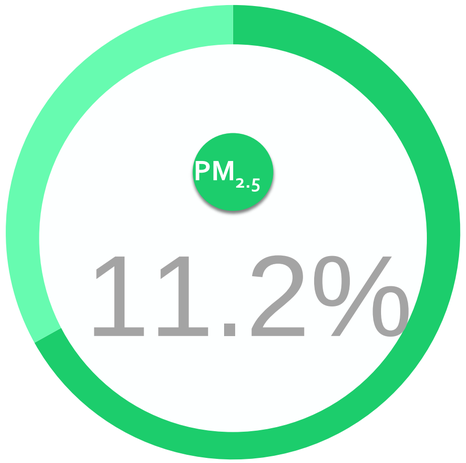
and $ 30 000 (US)



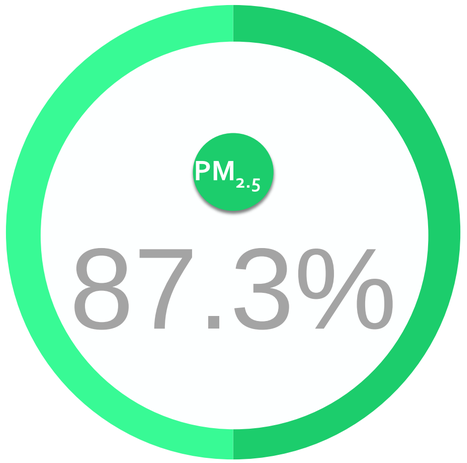
Source: Goldman Sachs, 2008

The expanding world middle class

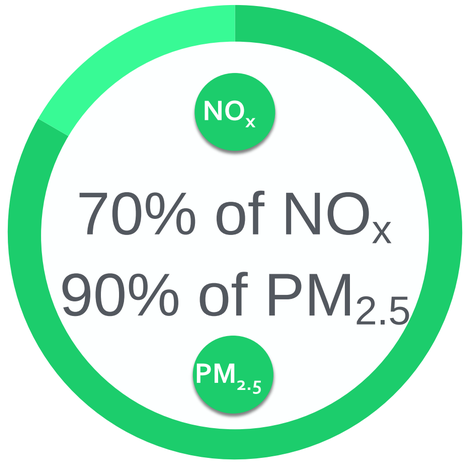
Global Statistics from Lancet Countdown on Health & Climate Change



- Global population $PM_{2.5}$ exposure has increased by 11.2% since 1990



- $PM_{2.5}$ concentrations in most cities (87.3%) exceed the suggested annual guideline of WHO which is 10µg/m^3



- Energy sector is responsible for 70% of NO_x and 90% of $PM_{2.5}$ emissions

- Each year, the number of premature deaths caused by outdoors and indoor activities are 3 and 4.3 million people respectively

China Daily

19 January, 2018

… In 338 cities in China, PM2.5 had been reduced by 6.5 percent from 2016 levels, reaching 43 micrograms per cubic meter,…

Beijing, nation get breath of fresh air

By **ZHENG JINRAN**
zhenjinran@chinadaily.com.cn

Beijing residents experienced a December unlike any in recent memory, with the air quality as good as in southern coastal regions like tropical Hainan island. The clean air placed the capital for the first time among the 10 best cities for air quality, the top environment authority said on Thursday.

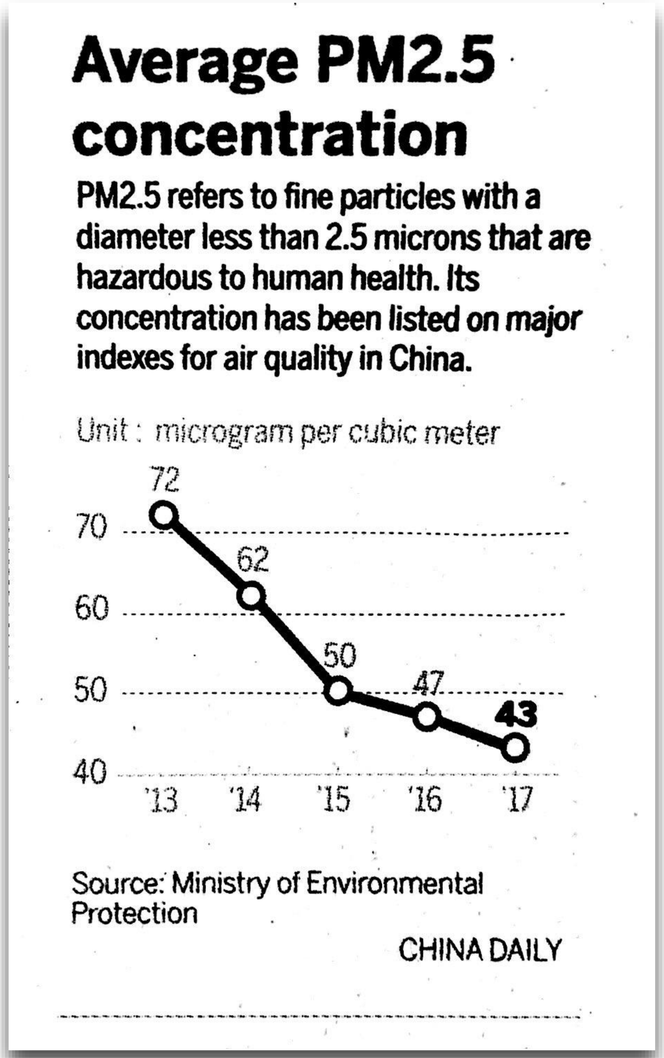
Like the capital's, the country's air quality also underwent improvements in 2017, the Ministry of Environmental Protection said.

In 2017, the average concentration of PM2.5 — particulate matter that measures 2.5 microns or less and is dangerous to humans — in 338 cities in China had been reduced by 6.5 percent from 2016 levels, reaching 43 micrograms per cubic meter, the ministry said. There were 284 blue sky days last year, it said.

Blue sky days refer to the days with good air quality, when the day's average air quality index is lower than 100.

"By 2035, China will see the fundamental turn for good in the environment," Li Ganjie, minister of environmental protection, said when presenting the ministry's goals in October. One index that should illustrate the improved air quality by then is the PM2.5 concentration, which is projected to fall to 35

See ***Smog****, page 3*



2 400 000 Deaths Averted from Measures Aiming to Reduce Black Carbon Emissions *(UNEP 2011)*

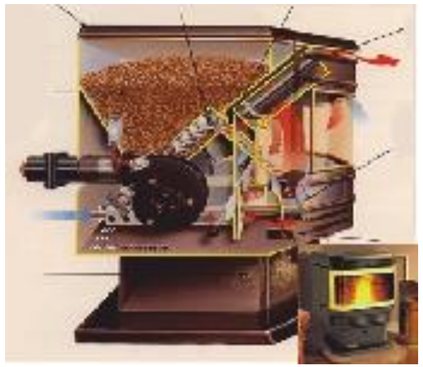
Improved biomass stoves

Cooking with clean fuel

Coal briquettes replacing coal

Modern coke ovens

Pellet biomass heating stoves



Reduce agricultural burning

Remove big smokers / DPF

Improved brick kilns

Reduce flaring

Ulaanbaatar
Capital of Mongolia

UB City Population

- 2017 1.4 million
- 2010 1.25 million
- 2000 0.8 million

UB City Households

- 2017 380 800
- 2010 302 200
- 2000 161 300

Households Living in the Ger District

- 2017 220 000
- 2010 180 000
- 2000 100 000

45% of the country's population lives in *Ulaanbaatar*

60% of *UB's* households lives in the *Ger District Population* of the *Ger Districts* doubled since 2010

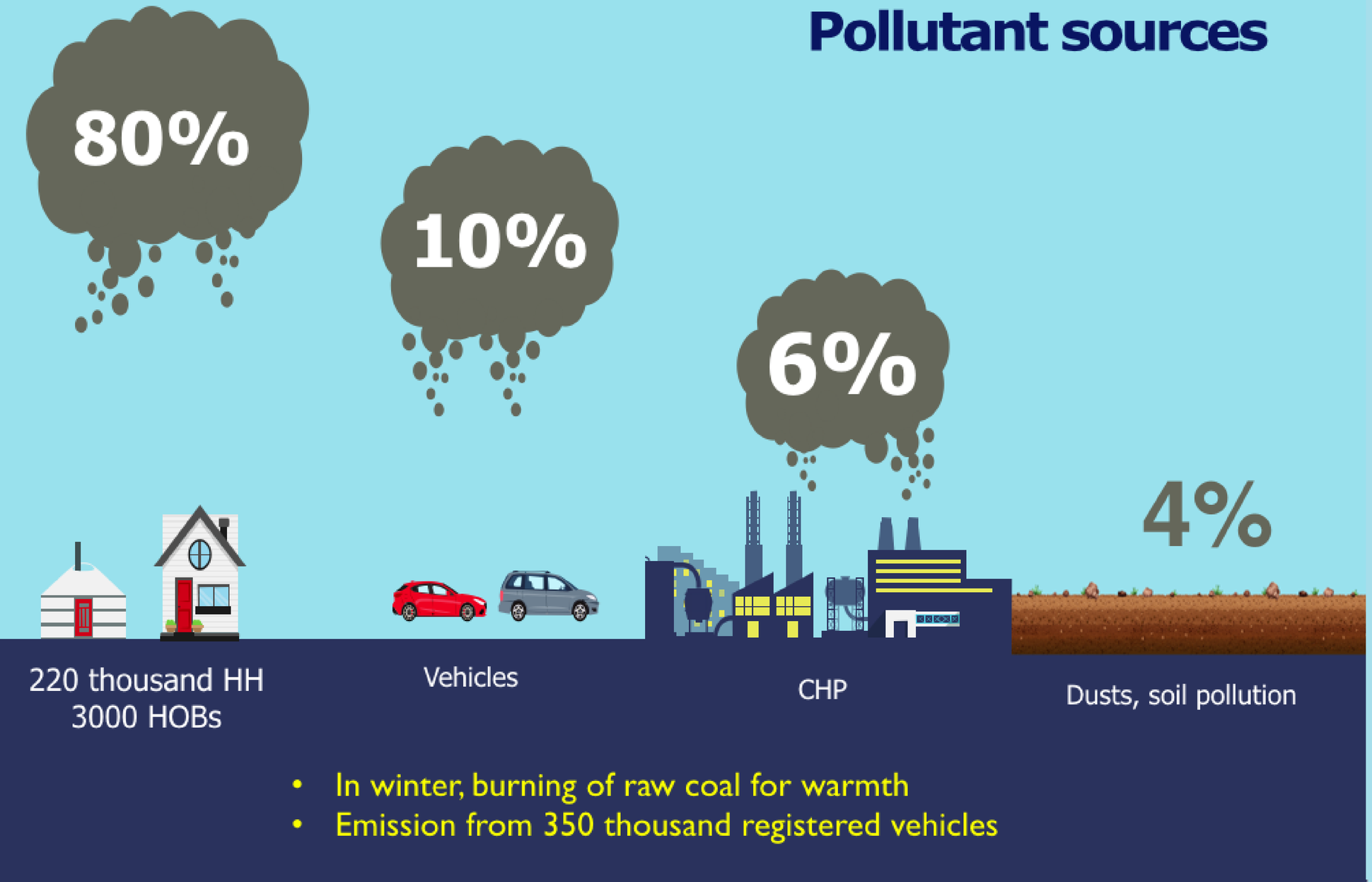
1/3 of the population still lives below poverty line

Air quality data for winter months (Oct – Dec)

Ulaanbaatar 2012-2017

Pollutant	Mongolian National Air Quality Standard		Oct-Dec Average Concentration in ($\mu g/m^3$)		Number of Days which Exceeded the Standard in October and December in (Percentage)	
	Threshold in ($\mu g/m^3$)		2016	2017	2016	2017
	24h	Annual				
PM_{10}	100	50	178	159	68%	70%
$PM_{2.5}$	50	25	137	117	76%	81%
SO_2	50	20	44	28	31%	12%
NO_2	50	40	49	51	42%	46%

Pollutant Sources



- In winter, burning of raw coal for warmth
- Emission from 350 thousand registered vehicles

GER

Nomadic pastoralism

URBAN MIGRATION

•An estimated 600,000 former herders have moved to the country's capital Ulaanbaatar in the past 30 years

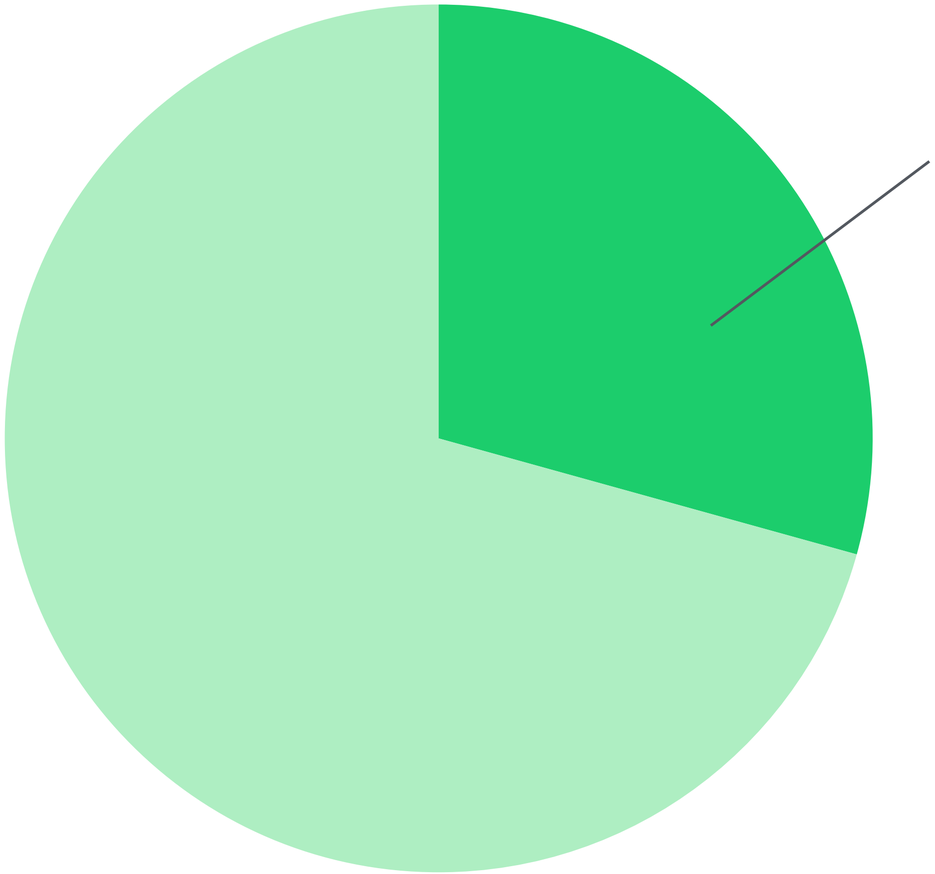
Ger District in the Summer

Ger District
originally not meant for permanent settlements

- The ger districts that radiate from the centre of Ulaanbaatar are the result of the impromptu planning, the rapid and uncontrolled urbanization of people migrating to the capital in search of economic opportunities

UB City in January

Statistics of 2016



29.6% or 907.5 thousand people are poor

Most of the low-income households live in the ger district of Ulaanbaatar

As of 2016, Mongolia had a population of 3.1 million

Traditional nomadic herders

Climate Change:+2.24

Leading to more Desertification,

Pasture degradation, melting glaciers and permafrost thawing

More frequent natural disasters — dzud (drought+ cold winter = livestock perishing)

220 000 Chimneys

Practical actions

- ✓ **Clean Stoves /distribution of ~170,000 clean stoves to ger district households/**

Projects	Distribution of Clean stoves	Explanation
Millennium Challenge Corporation, Clean air fund	97787	TOTAL USD 30 mln MCC; 15 mln WB 30 mln Govt CAF During 2011-2013 average of 91% subsidy and during 2014-2015 66% subsidy of price was given to every household purchase of clean stoves
Clean air fund	29518	
Ulaanbaatar Clean Air project, (WB) Clean air fund	40813	
Total	168118	

Results of Clean stove project

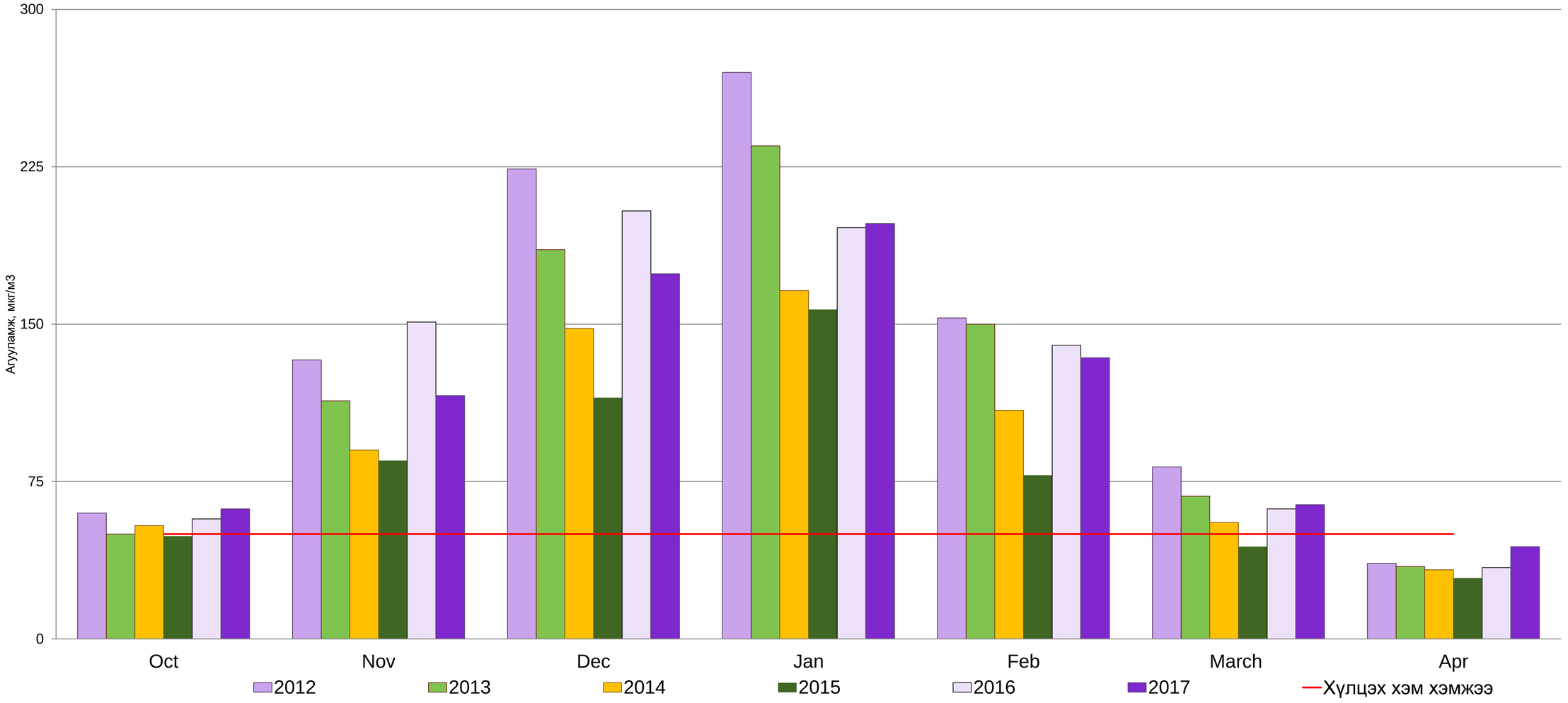
- The EEP stove subsidy program had 65% lower emissions of $PM_{2.5}$ compared to traditional stoves under typical usage conditions.
- Ulzii stoves significantly reduced $PM_{2.5}$ emissions by 74% in houses and 83% in gers. Smaller reductions were also observed for Khas stoves in houses (46% reduction) and Dul stoves in both houses and gers (reduction of 31% and 38%, respectively) compared to traditional stoves.
- (MCC project monitoring report, 2014)

MCC EVALUATION REPORT

- **The EEP stove subsidy program reduced ambient $PM_{2.5}$ concentrations over UB attributable to heating stoves by an estimated 30%, with largest reductions in highly polluted areas that were more heavily targeted by the program**

- **There was no sustainability of the stove policies which resulted in the retraction of the emissions reduction after 2014**

2012-2017 Winter $PM_{2.5}$ Monthly Average in (mkg/m³)



PM_{10} - Monthly Average in ($\mu g/m^3$)

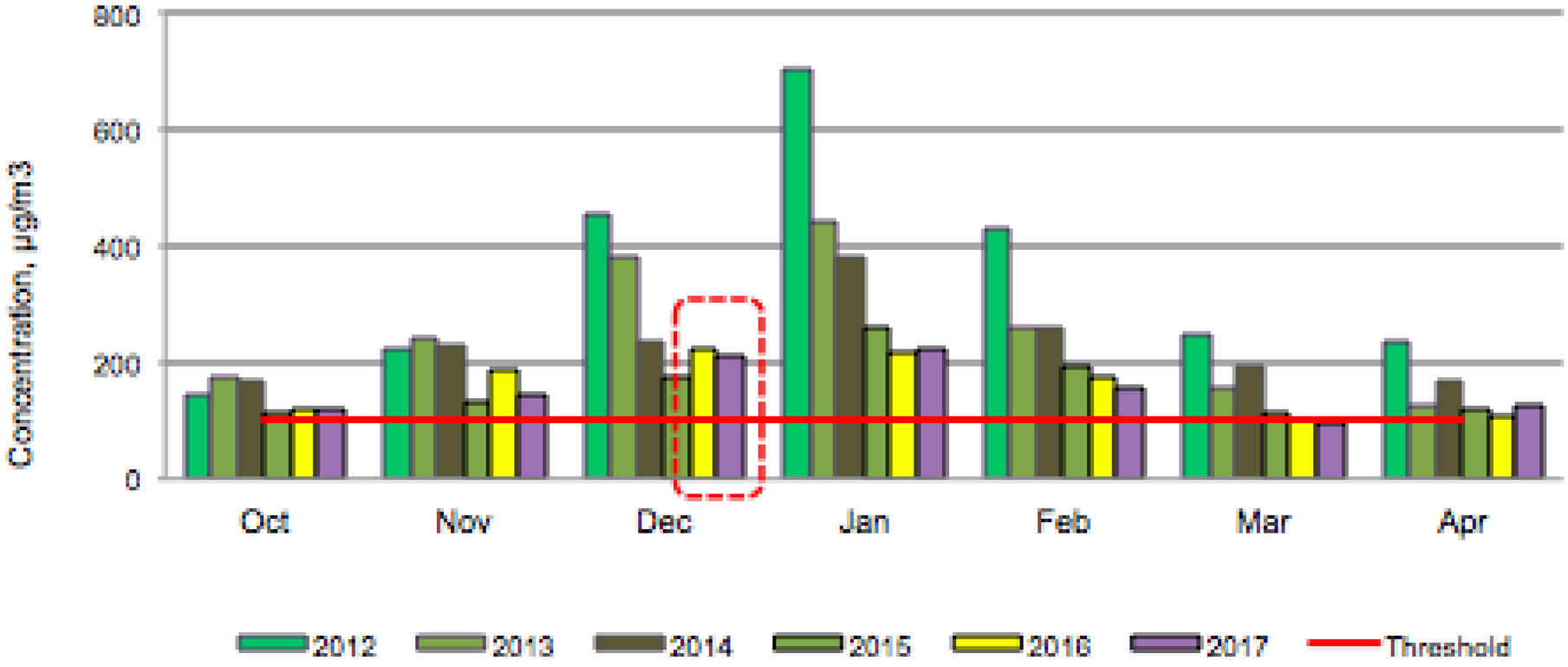
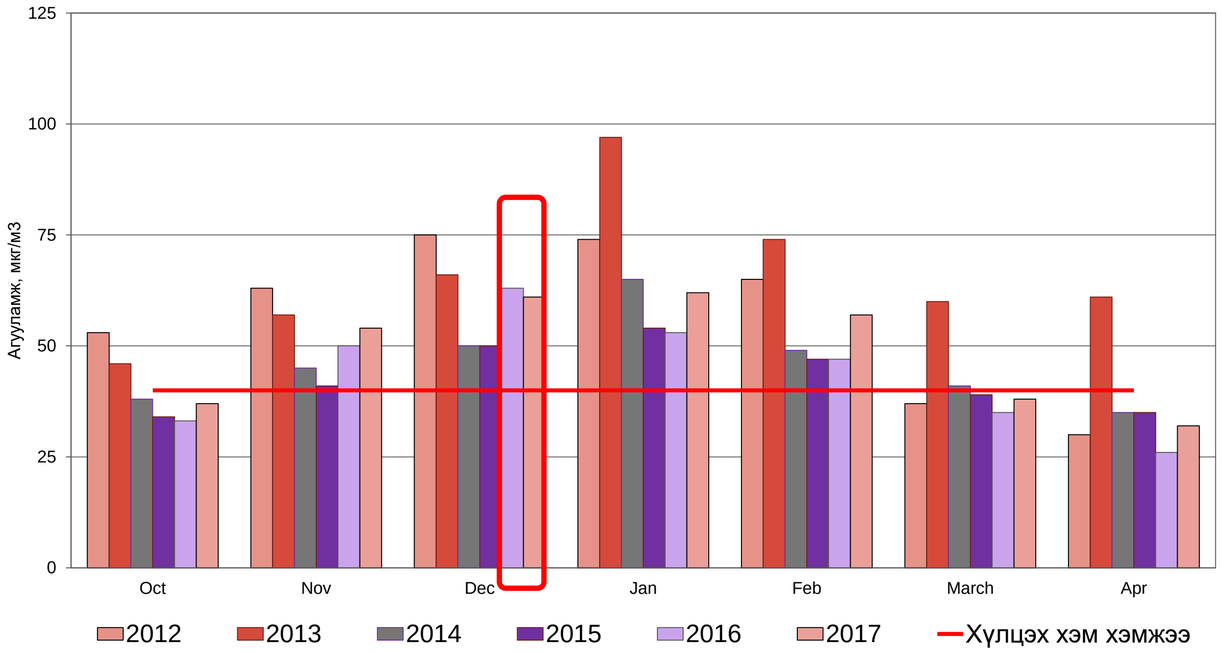


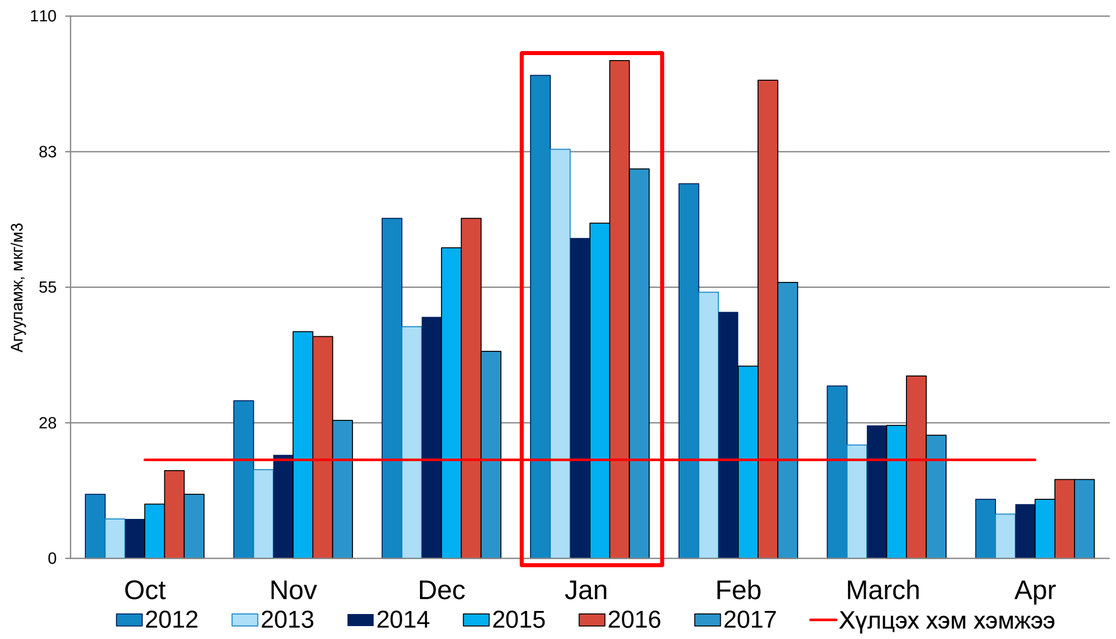
Figure1. Monthly average concentration of PM10 in winter, 2012-2017

2012-2017:
Last 6 Winters Dynamics for SOx and NOx

NO_2
Monthly Average
in (mkg/m^3)



SO_2
Monthly Average
in (mkg/m^3)

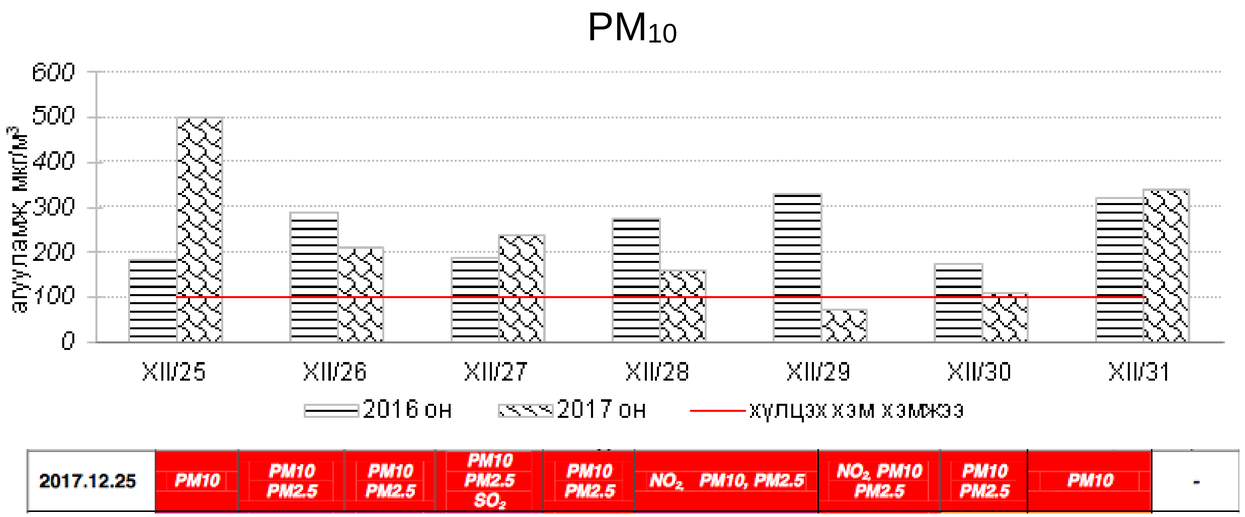


JICA Study on Low-Emission Stoves & Fuel

Type of stove and fuel	Av. Dust concentration in (mg/Nm^3)	Difference in (%)
Baganuur's coal + Traditional stove	293	
Baganuur's coal + Improved stove	122	-58
Semi coke + Traditional stove	55	-81
Semi coke + Improved stove	27	-91

Air quality monitoring stations in UB City

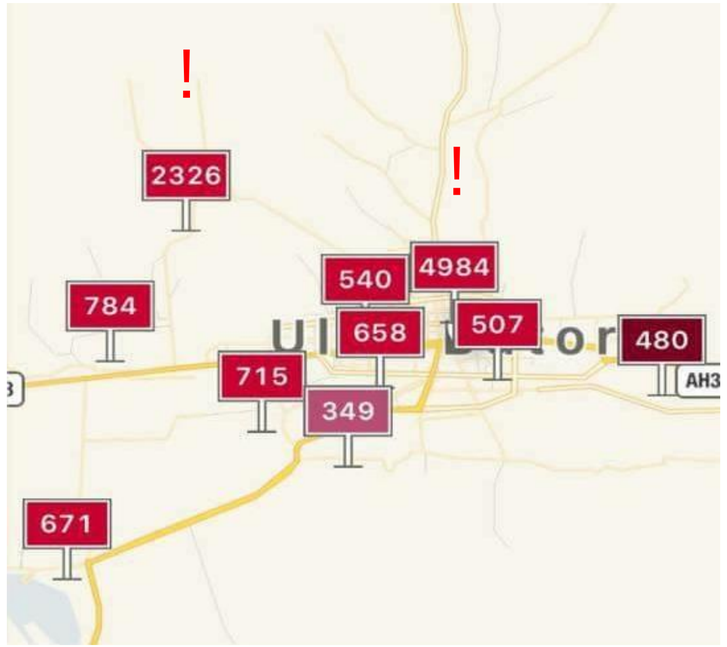
2017. 12. 25



PM_{10} Average daily and
average of 11 monitoring stations: 500

PM_{10} Peak heating hour in the evening:

- 2326 Bayankhoshuu Area
- 4984 100 Ail Area

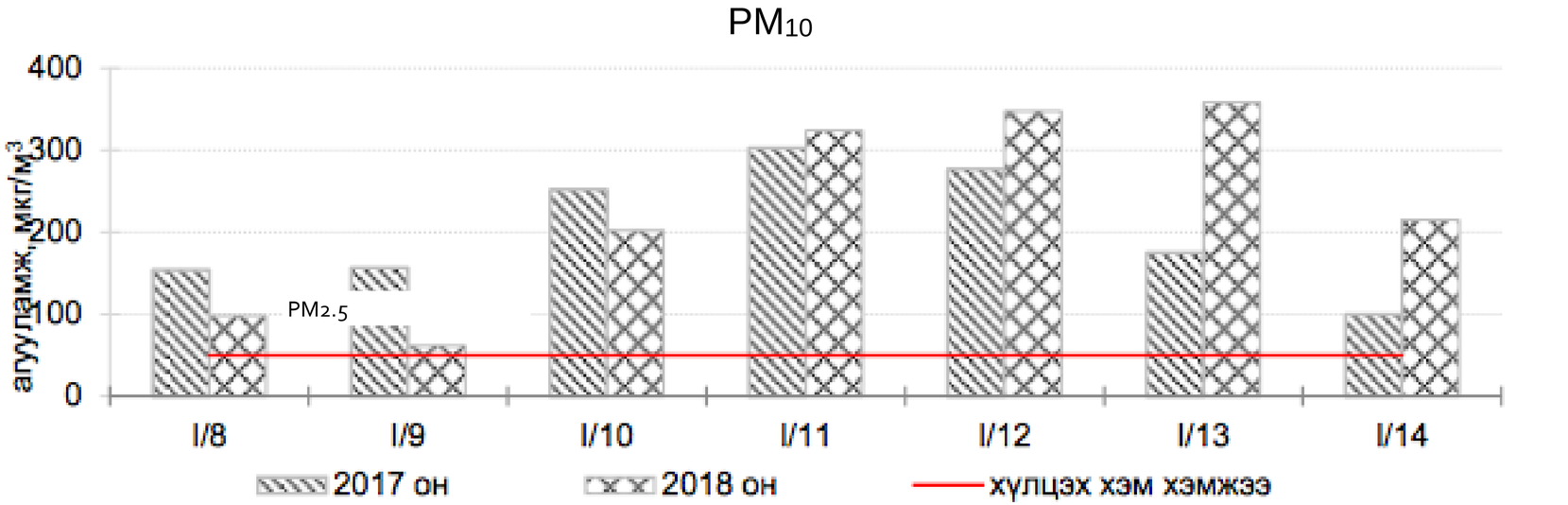


Examples of very polluted days this winter

$PM_{2.5}$ μg/m³

(Average of 11 Monitoring Stations)

January, 12th



2018.1.12	PM10 NO_2	PM10 PM2.5, CO	PM10 PM2.5	PM10 PM2.5 SO_2	PM10 PM2.5	NO_2 , PM10 PM2.5	PM10, PM2.5	PM10 PM2.5	PM10	PM10

AFFORDABILITY- MAIN CHALLENGE

FROM all the initial pilots, tests and studies — one of the main barriers is: Affordability

- Almost all the other interventions are more expensive than the current raw coal burning option and therefore subsidies, at least initial, are needed for deployment of clean technologies

A step-by-step approach to setting up an affordability mechanism is needed

- Not possible to go solo (infrastructure) for heating only – integrated solution is a must — and that becomes expensive

GCF-ADB project AHURP:

Example of Addressing Barriers

- Ulaanbaatar Green Affordable Housing and Resilient Urban Renewal Project
- to deliver **10,000** green housing units that are energy efficient, affordable, and designed to maximize the use of renewable energy. 100 hectares of *ger* areas will be redeveloped into green eco-districts
- GCF funding would be used to reduce the barriers towards the implementation of AHURP
- “Integrating modern energy efficiency technology into prevailing standards for design, construction and operation of buildings, and utilities services. The policy and legal framework for energy efficiency in building construction and renewable energy are mostly in place, but the regulatory framework and the institutional capacity to implement these policies are still in development. Most importantly, the economic and environmental benefits that are recognized at government levels have not been translated into economic incentives for building owners and developers to adopt energy efficiency measures”

Let's fight Air Pollution together!

5 panel ger
Mongolian national traditional dwelling

50m² - 100m²

101m² - 150m²

April 2017 - September 2017
Concept
(The best solution(s) selection process)

September 2017 - June 2018
Piloting and Development

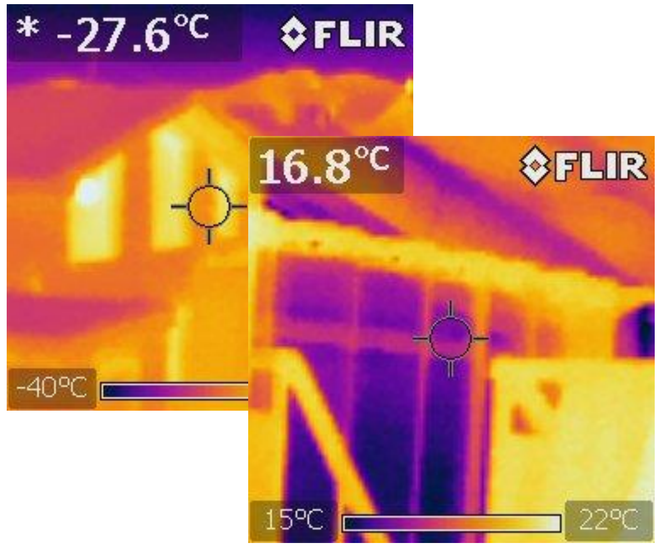
June 2018 -September 2021
Scale up
(Application in practice and monitoring)

April 1, 2017
sustainable.arigbank.mn

Instability of policies - barrier

- Political aspects – political will, public attitude, unstable policies, public awareness raising
- President’s office 2011-2013 – in charge of NC
- Then PM’s office 2014-till now
- CAF 2012-2014; dissolved 2015; recreated 2018
- Secretariat to NC created in 2011 and dissolved 2015
- A new agency may be created in 2018

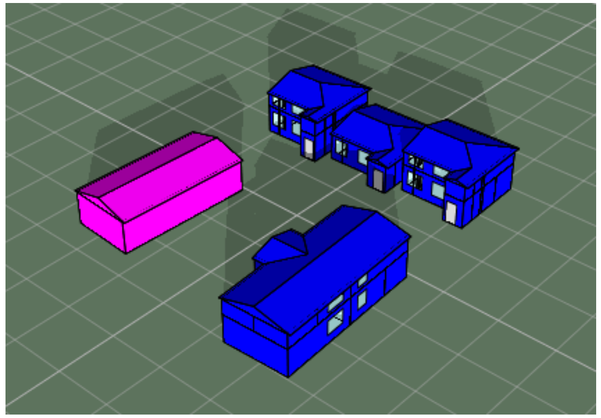
Design



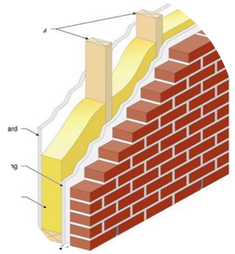
Measurement and Verification

- To ensure the actual building performance fulfil the as-design performance
- To identify the energy performance gap and improve the building performance

Construction



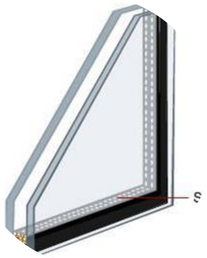
Calibrated Energy Simulation



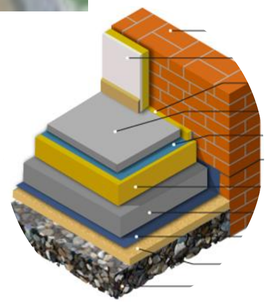
Insulated Wall
U- 0.21

Insulated Roof
U- 0.40

Khashaa Baishin



Double-glazed Window
U- 1.25



Insulated Floor
U- 0.13

		Current Project	China	UK	Germany
Government's Policy		Khashaa Baishin	Design Standard for Energy Efficiency in Residential Buildings in Severe Cold and Cold Zones	Building Regulations 2010	Energy Conservation Regulations (EnEV)
Insulation Requirements – U-value (W/m2K)	Wall	0.21 ✓✓✓	0.33-0.48	0.30	0.28
	Window	1.25 ✓✓	0.70	2.00	1.30
	Floor	0.13 ✓✓✓	0.48	0.25	0.35
	Roof	0.40 ⊖	0.33-0.40	0.20	0.20

In general, the insulation quality is better than the international code requirements!

Cost estimation

- Upfront costs - MNT1,765,4 60,380 / **26.21%** higher than a standard kindergarten building.
- Investment recovery period 11-14 years

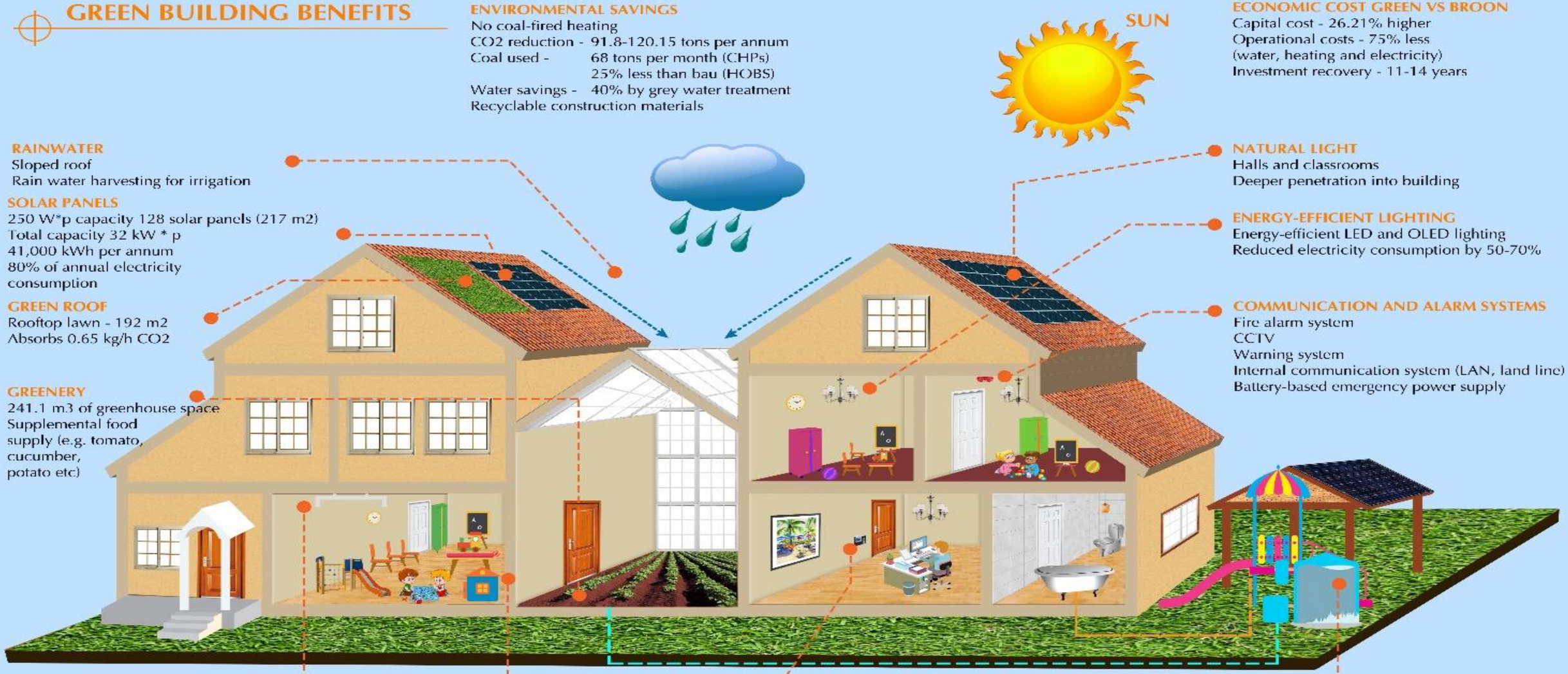
- **O&M costs decreased by 75%** (water, heating and electricity savings)

DEMONSTRATION GREEN KINDERGARTEN

GREEN BUILDING BENEFITS

ENVIRONMENTAL SAVINGS
No coal-fired heating
CO_2 reduction - 91.8-120.15 tons per annum
Coal used - 68 tons per month (CHPs)
25% less than bau (HOBS)
Water savings - 40% by grey water treatment
Recyclable construction materials

ECONOMIC COST GREEN VS BROON
Capital cost - 26.21% higher
Operational costs - 75% less
(water, heating and electricity)
Investment recovery - 11-14 years



RAINWATER
Sloped roof
Rain water harvesting for irrigation

SOLAR PANELS
250 W*p capacity 128 solar panels (217 m2)
Total capacity 32 kW * p
41,000 kWh per annum
80% of annual electricity consumption

GREEN ROOF
Rooftop lawn - 192 m2
Absorbs 0.65 kg/h CO_2

GREENERY
241.1 m3 of greenhouse space
Supplemental food supply (e.g. tomato, cucumber, potato etc)

NATURAL LIGHT
Halls and classrooms
Deeper penetration into building

ENERGY-EFFICIENT LIGHTING
Energy-efficient LED and OLED lighting
Reduced electricity consumption by 50-70%

COMMUNICATION AND ALARM SYSTEMS
Fire alarm system
CCTV
Warning system
Internal communication system (LAN, land line)
Battery-based emergency power supply

INDOOR AIR QUALITY
Ventilation equipment with heat transfusion
Air filters and fully automatic controls
Reduced incidence of disease amongst children

WALL AND FLOOR HEATING SYSTEMS
Thermally active building system pipelines within concrete floors and walls
Retains building heat
Reduced exposure to air pollution from coal-fired HOBS

AUTOMATIC CONTROL
Reduces OPEX and maintenance expenses

WATER
Grey water treatment capacity - 1.5 m3/day
Drinking water from district network
Independent sewerage system

HOME INSULATION PILOT PROJECT

UBCAP PMU

ДУЛААЛАХААС **ӨМНӨ**

ДУЛААЛСНЫ **ДАРАА**

Б. Баттулга *БЗД, 22 хороо, 22-345*

Манайх жаахан хүүхэдтэй. Өмнө нь хүүхэд маань шалаар тоглоход даарах байх гэж айдаг байсан бол одоо айх зүйлгүй болсон.

Achievement

Mr. Battulga:
Owner of house:
“Before he never put his child to play at floor because he was afraid that gets cold ……Now it is different”

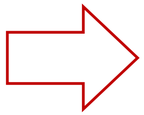
Heat pumps

- A **heat pump** is a device that **transfers** heat energy from a source of heat to a destination called a "heat sink".
- Heat pumps are designed to move thermal energy in the opposite direction of spontaneous heat transfer by absorbing heat from a cold space and releasing it to a warmer one.

Improvement by changing compressor

- Enhanced capacity in cold ambient conditions

Traditional single stage compressor (one cylinder)



- COP is up to 2.0+ at the outdoor temperature of -20℃
- Can run normally at the outdoor temperature of -35℃
- Includes automatic defrost
- Working fluid is R-32, (HFC-32); ODP=zero

Household #1: Ger (4 kW)

Prototype No.	Equipment Name	Building Type	Area (㎡)	Building Size	Resident	Address
1#	air heater	Ger	28	radius 3m, center height 2.2m , outer circle height 1.4m		Number22, Dambadarjaa Street, Sukhbaatar District

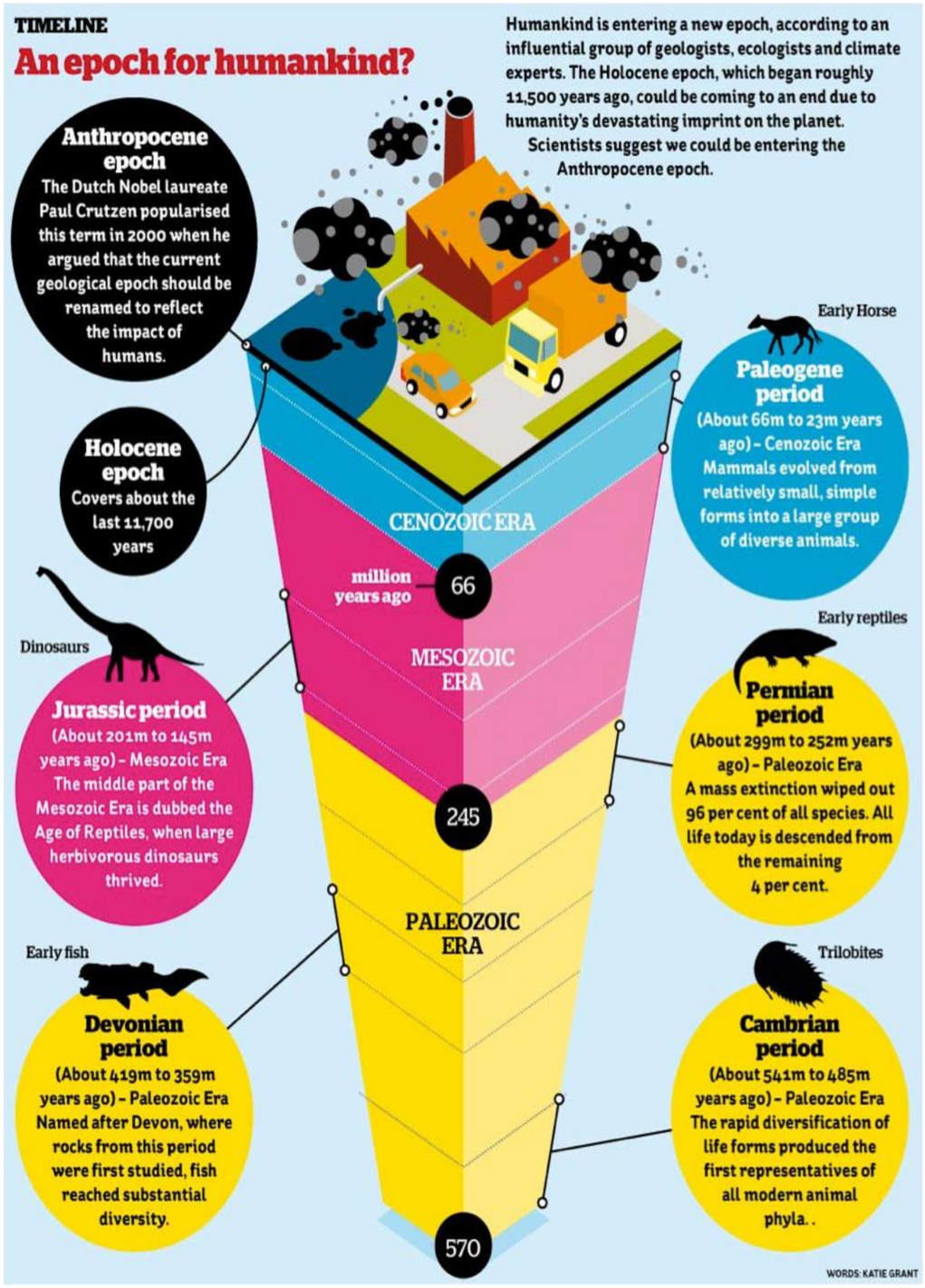
Household #3: Small Bungalow (8 kW)

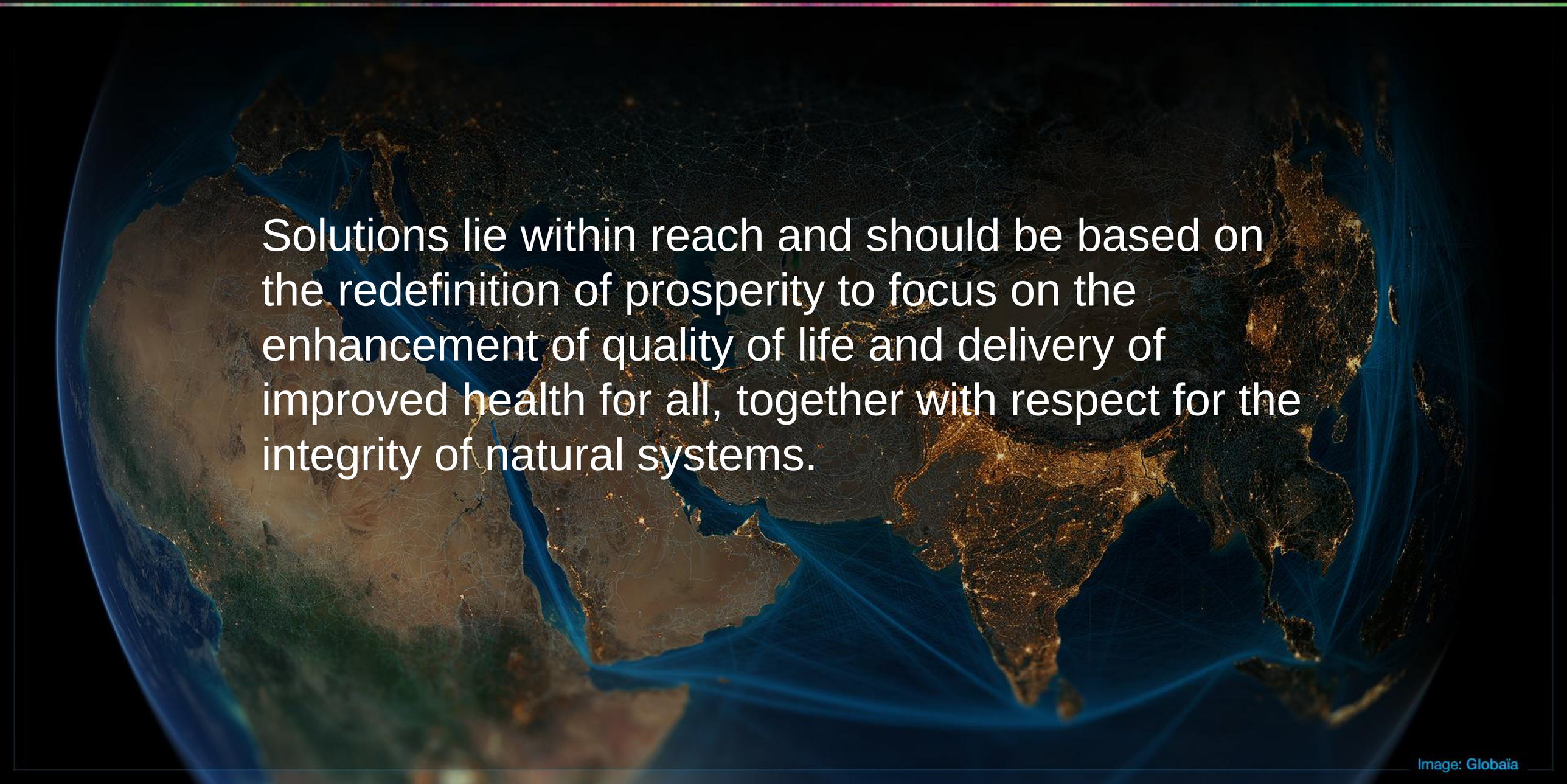
Prototype No.	Equipment Name	Building Type	Area (㎡)	Building Size	Resident	Address
3#	cabinet air conditioner	bungalow	20	length5.4m×width3.5m ×height1.9m	3	Number15, Dambadarjaa Street, Sukhbaatar District

SOLUTIONS & WAY FORWARD

- GOVERNANCE, political will and public participation
- Low-emission stoves
- Clean fuel (e.g. semi-coke briquettes)
- Electrical and gas heaters
- Insulation and energy-efficient buildings
- Re-development of ger district/infrastructure
- Moving to flats/mortgage schemes
- Renewables including geothermal

The **Anthropocene Epoch**





Solutions lie within reach and should be based on the redefinition of prosperity to focus on the enhancement of quality of life and delivery of improved health for all, together with respect for the integrity of natural systems.

Image: Globaïa