# Developing Sustainable Infrastructure

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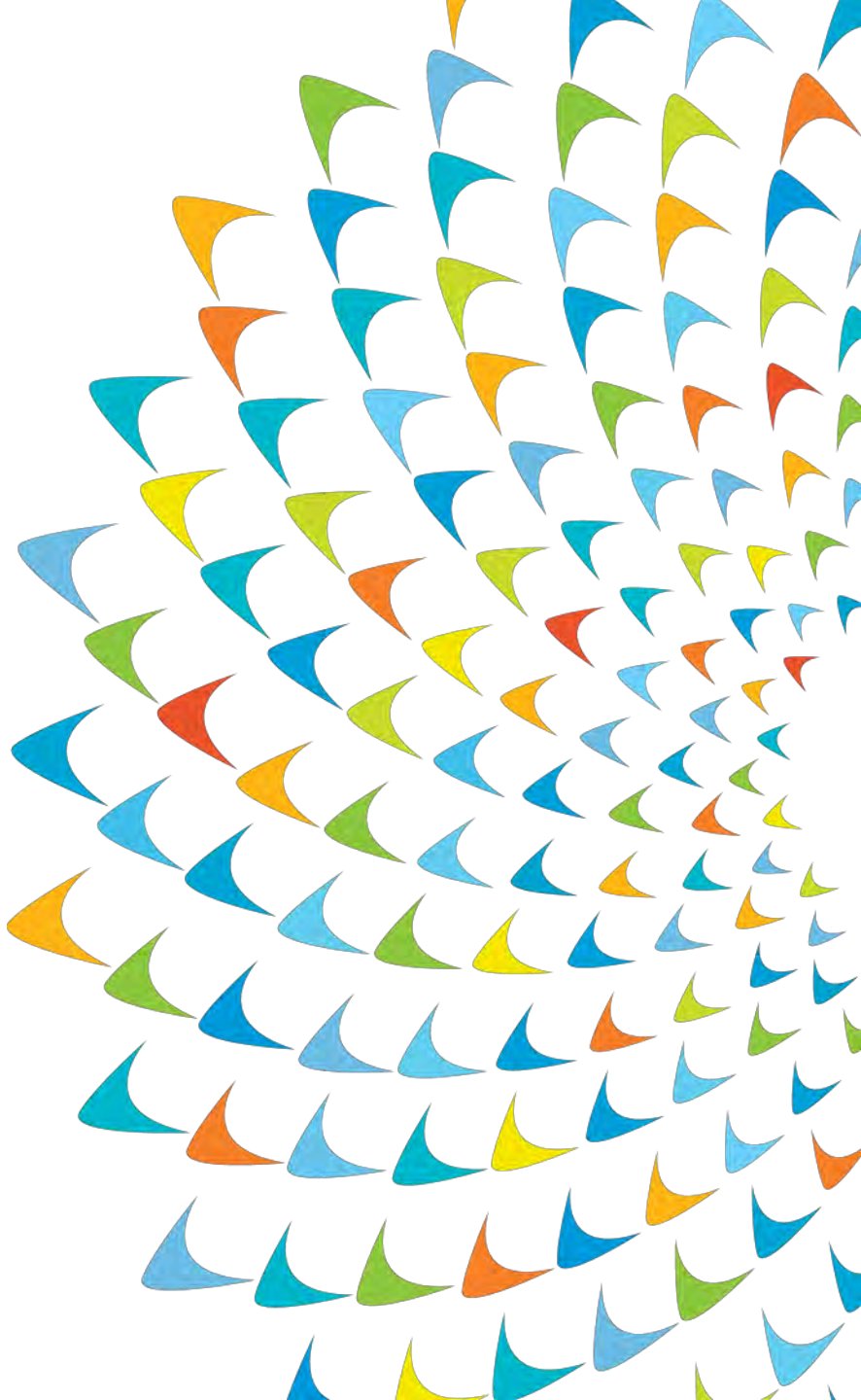


# Outline

- About Asian Development Bank
- Infrastructure – contributions and challenges
- Planning for sustainable infrastructure
- ADB experience

# ADB in brief

- Founded in 1966
- Goal is an Asia Pacific free of poverty
- 68 member countries – 49 regional, 19 nonregional
- HQ in Manila, 29 resident missions, 3 rep offices
- Provides loans, grants, TA, equity, policy dialogue
- In 2018, ADB provided $19.21 B total assistance
- Assistance to the PRC in 2018 reached $1.78 billion
- Sovereign and private sector operations
- Long-term ratings: S&P: AAA; Moody's: Aaa; Fitch Ratings: AAA

A multilateral development financier: dedicated to achieving a prosperous, inclusive, resilient and sustainable Asia and the Pacific

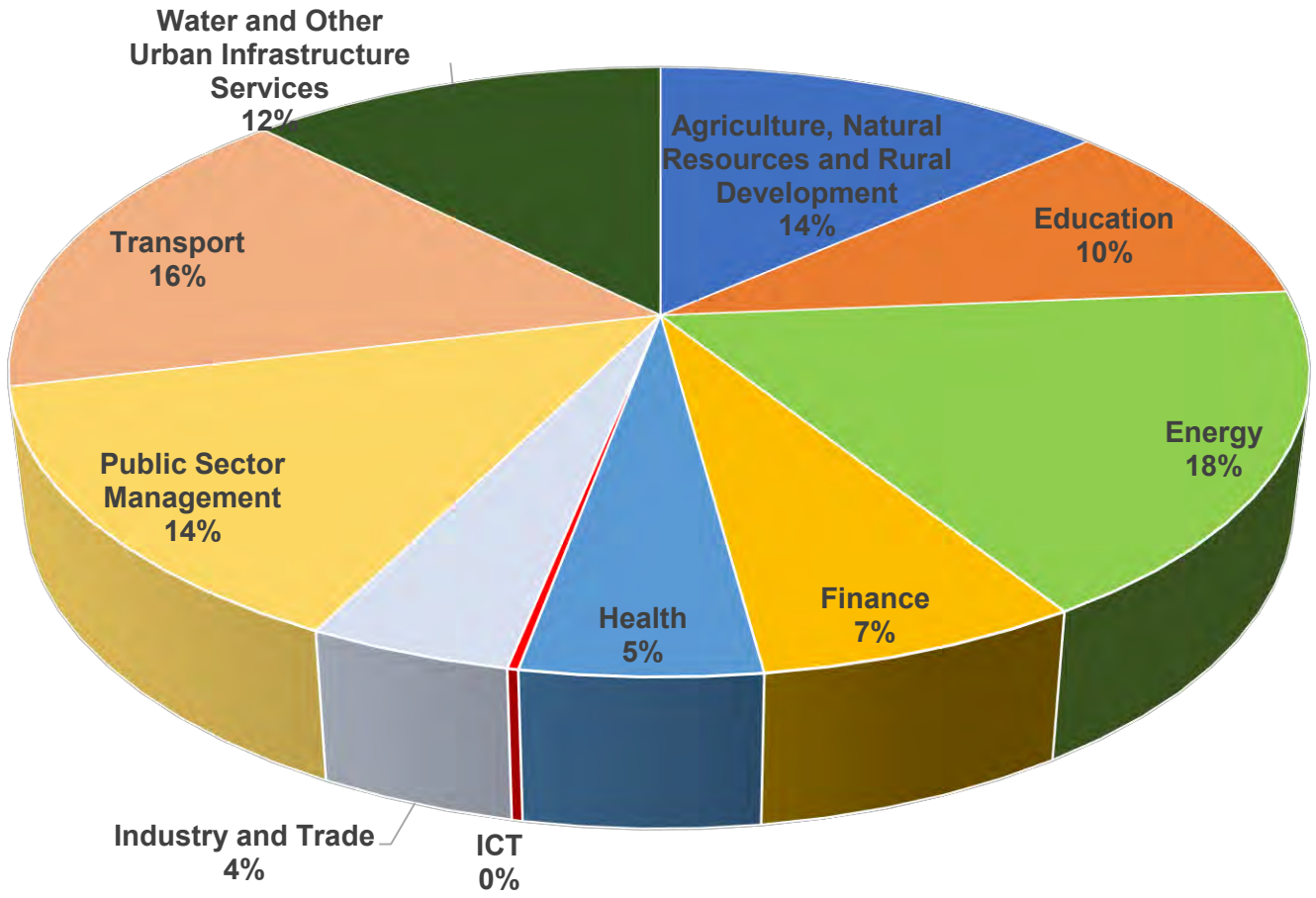
# Building a Prosperous, Resilient Asia

# ADB Strategy 2030:
## Achieving a Prosperous, Inclusive, Resilient, and Sustainable Asia and the Pacific

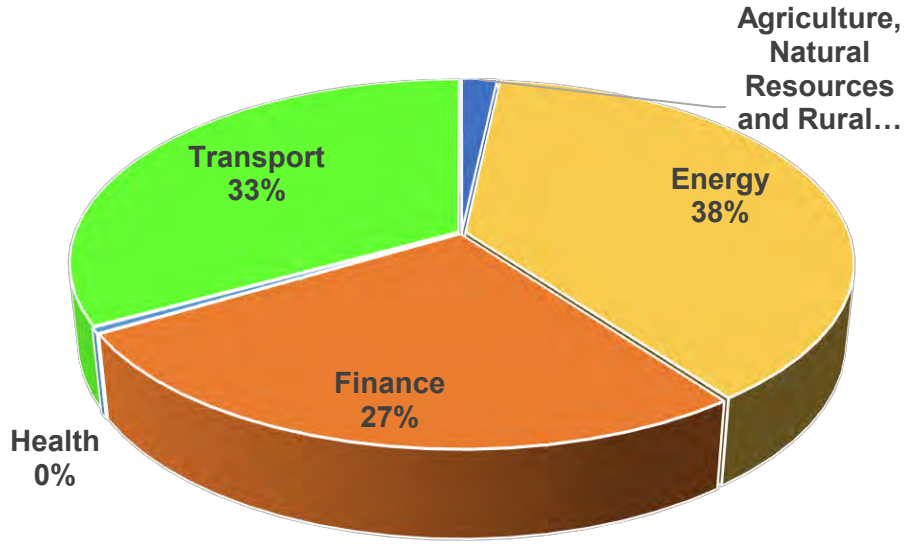
### Seven Operational Priorities

- Addressing Remaining Poverty and Reducing Inequalities
- Accelerating Progress in Gender Equality
- Tackling Climate Change, Building Climate and Disaster Resilience, and Enhancing Environmental Sustainability
- Making Cities More Livable
- Promoting Rural Development and Food Security
- Strengthening Governance and Institutional Capacity
- Fostering Regional Cooperation and Integration

# Share of different sectors in ADB lending, 2018




Total amount: $19.2 billion

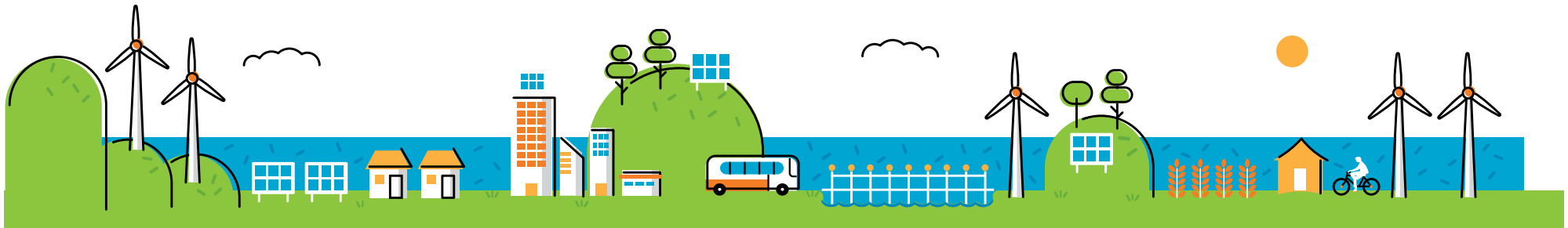



Total sovereign lending amount: $16 billion

Total non-sovereign lending amount: $3.2 billion

# Infrastructure

# contributions and challenges



# Infrastructure

- **Infrastructure** – *"the basic systems and services that are needed in order to support an economy, for example, transport and communication systems, electricity and water supply" – Cambridge Dictionary*
- Facilitates the production of goods and services
- Structures that support society
- Connects people and markets
- Mostly/typically owned and managed by governments or public utility companies

# Types of Infrastructure

## TRADITIONAL INFRASTRUCTURE

ENERGY

TRANSPORT

WATER

SANITATION

TELECOMMUNICATIONS

## NATURAL INFRASTRUCTURE

LANDSCAPE

WATERSHED

WETLANDS

## SOCIAL INFRASTRUCTURE

EDUCATION

HEALTH

PUBLIC SPACE

HOUSING

# Role of Infrastructure in Development

## Why countries develop and grow

- Use of resources
- Economies of scale and scope
- Specialization and comparative advantage

## Contribution of infrastructure

- Productive input
- Effects on labor and capital

## Socio-economic impacts

- Sector development
- Social development
- Transition from rural to urban production
- Creation of diversified modern economies

# The development context

## Problems

- Lack of connectivity – need to connect people and markets
- Lack of energy resources
- Poor infrastructure, high costs
- Poor sector governance, weak regulation

# What are the challenges?

- Scale, scope, resources, and geography
- Financial, technical, and managerial capacity
- Institutional and policy constraints
- Too many state enterprises
- Limited private sector
- Quality of regulation and oversight

# Role of infrastructure

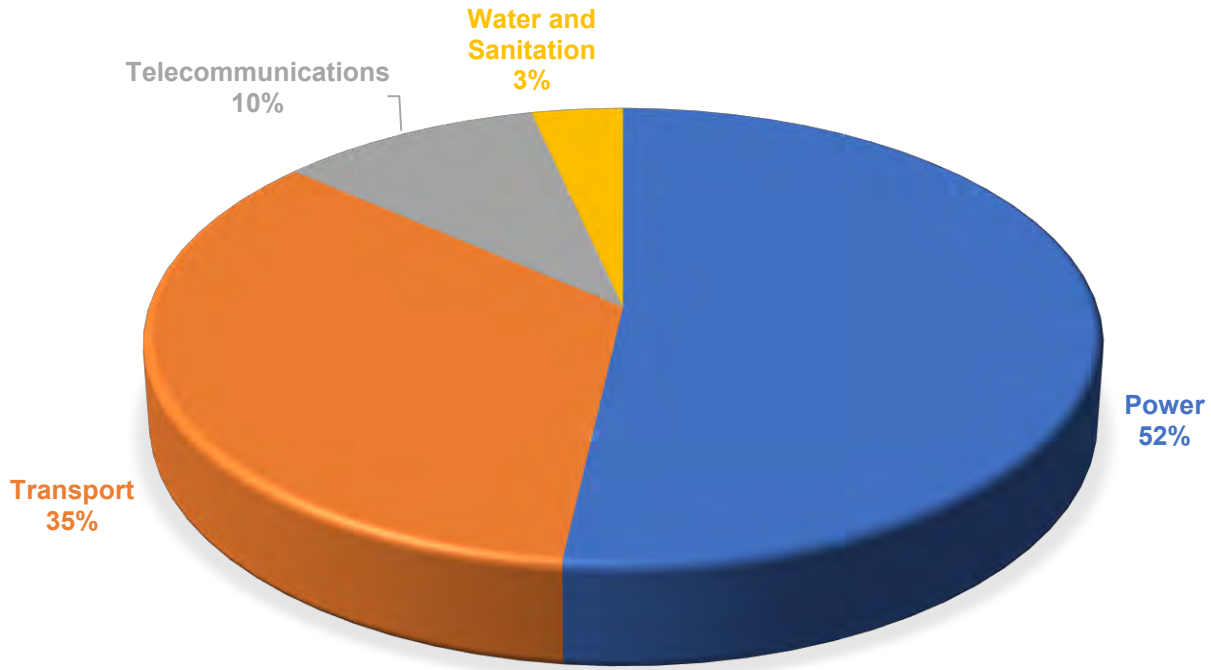
- Infrastructure underpins core economic activity – essential foundation for achieving inclusive sustainable growth.
- Infrastructure facilities and services are prerequisites to social and economic development.
- Indispensable for development and poverty elimination, as it enhances access to basic services, education and work opportunities, and can boost human capital and quality of life.
- Sustained growth requires continuous, predictable, and affordable infrastructure services.
- These conditions support productivity, investment, job creation, human development, and country competitiveness

# Infrastructure investment is the key

## Investment Needs for Infrastructure

- Estimated global infrastructure investment needs to be $94 trillion between 2016 and 2040.[1]
- Developing Asia will need to invest $26 trillion (2016-2030) if the Region is to maintain its growth momentum, eradicate poverty, and respond to climate change. [2]

**INFRASTRUCTURE INVESTMENT NEEDS IN ASIA AND PACIFIC BY SECTOR, 2016-2030**




- Source: ADB. 2017. Meeting Asia's Infrastructure Needs. Manila

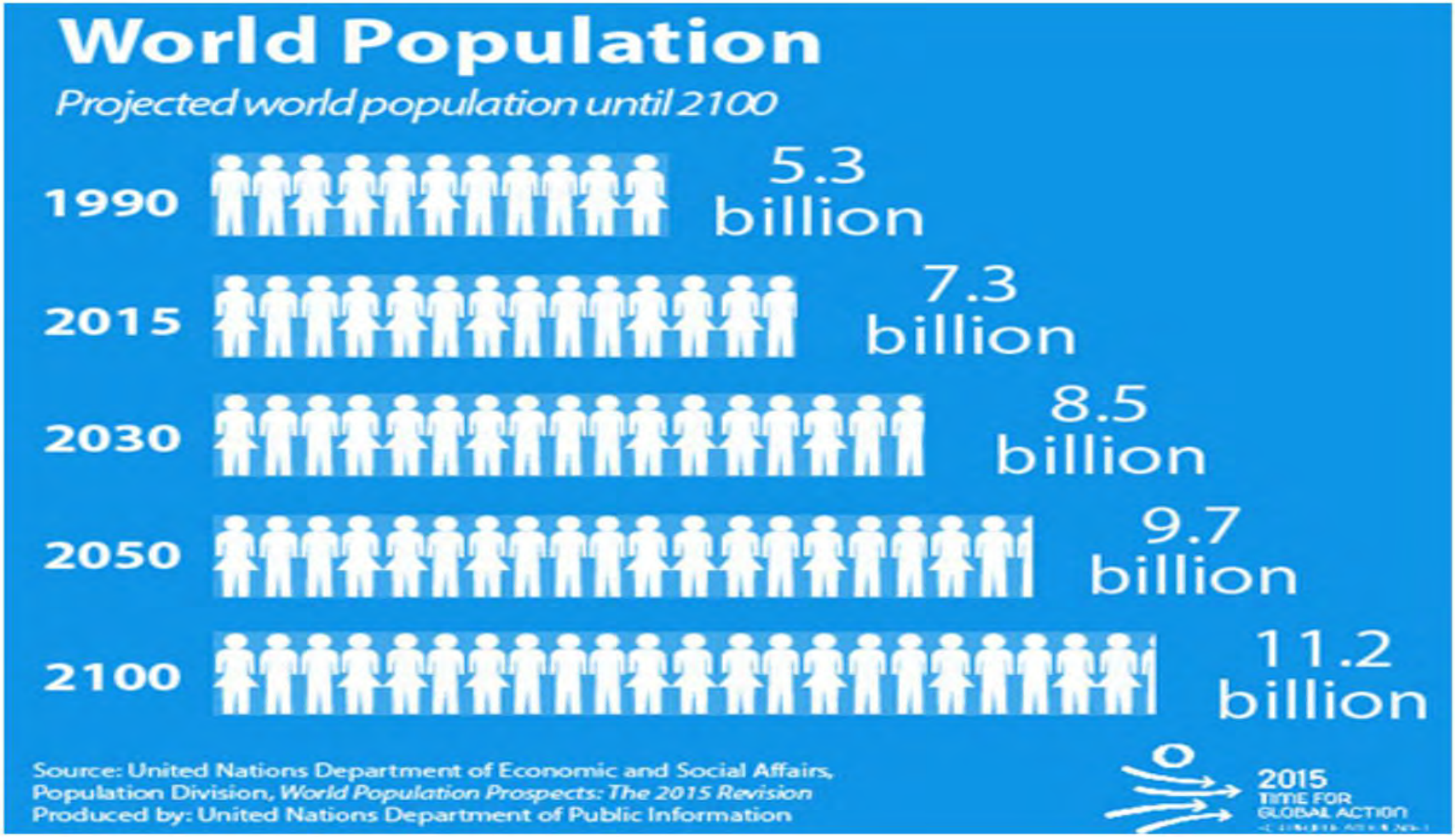
[1] Oxford Economics. 2017. Global Infrastructure Outlook.

[2] ADB.2017. Meeting Asia's Infrastructure Needs. Manila.

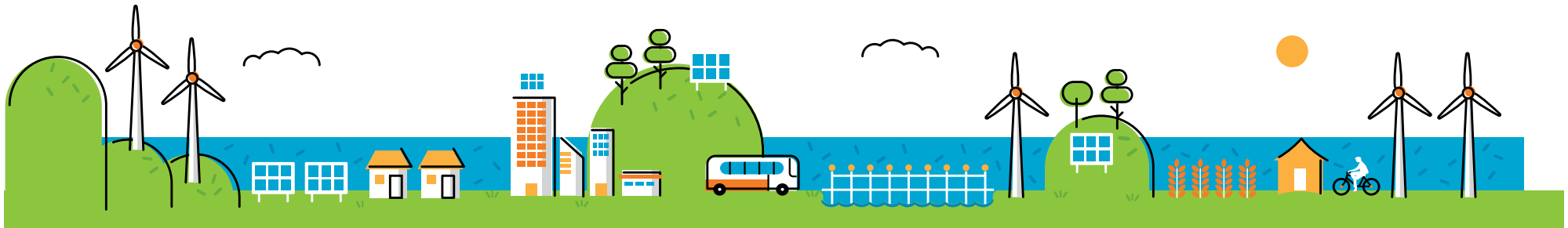
# Congestion

# Air pollution

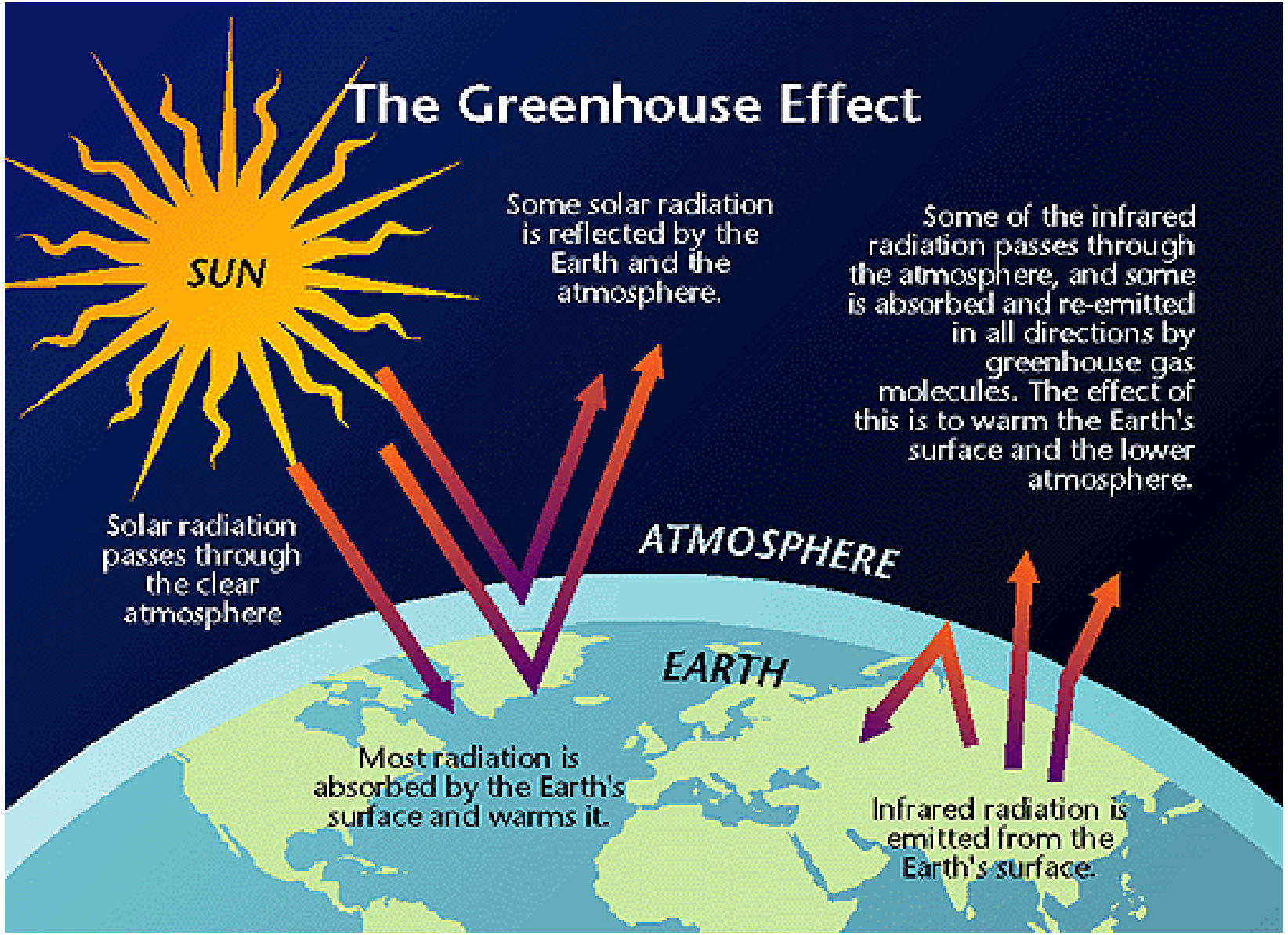
# World Population



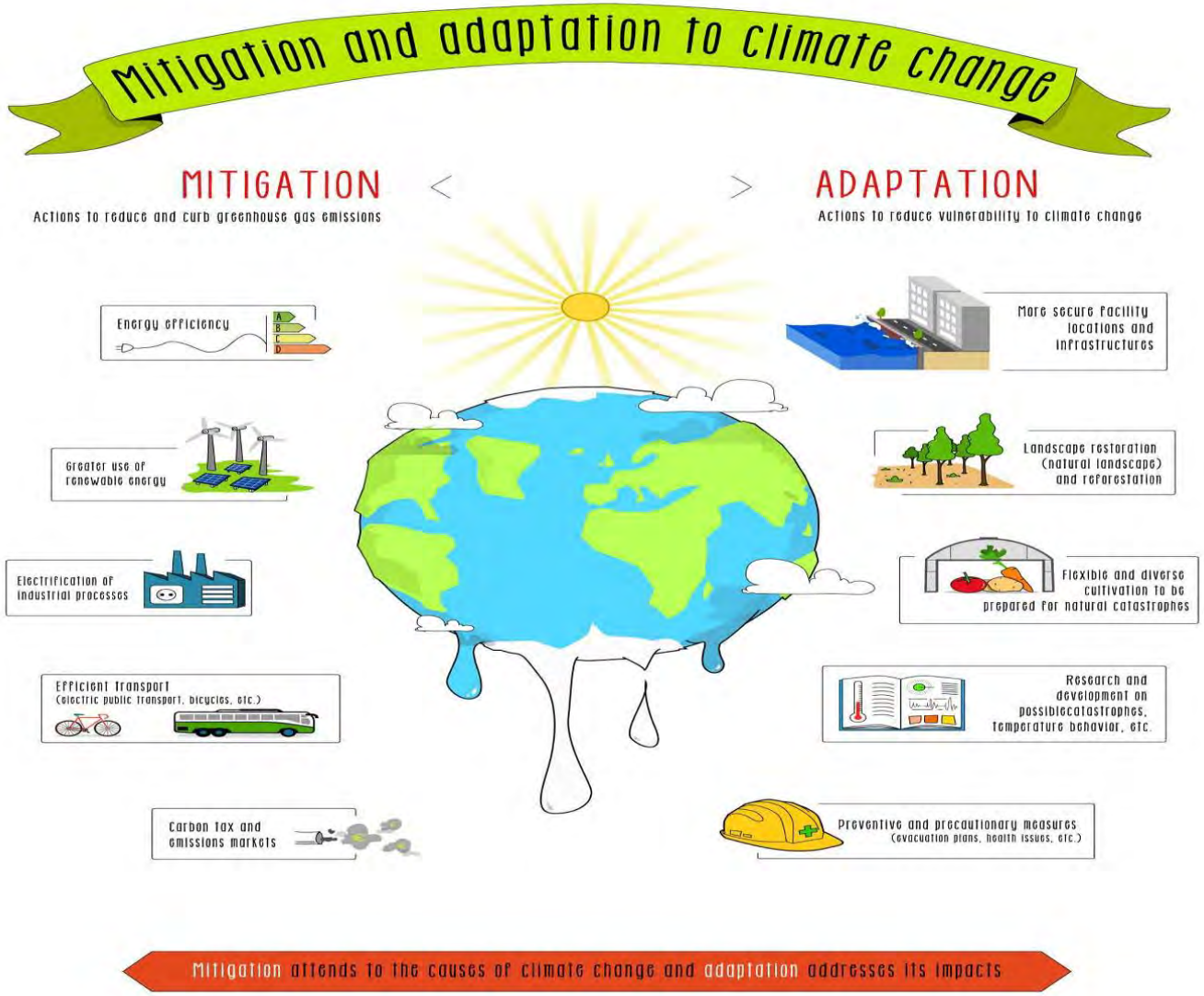
# Climate change



# The Greenhouse effect



# Climate Change Mitigation and Adaptation

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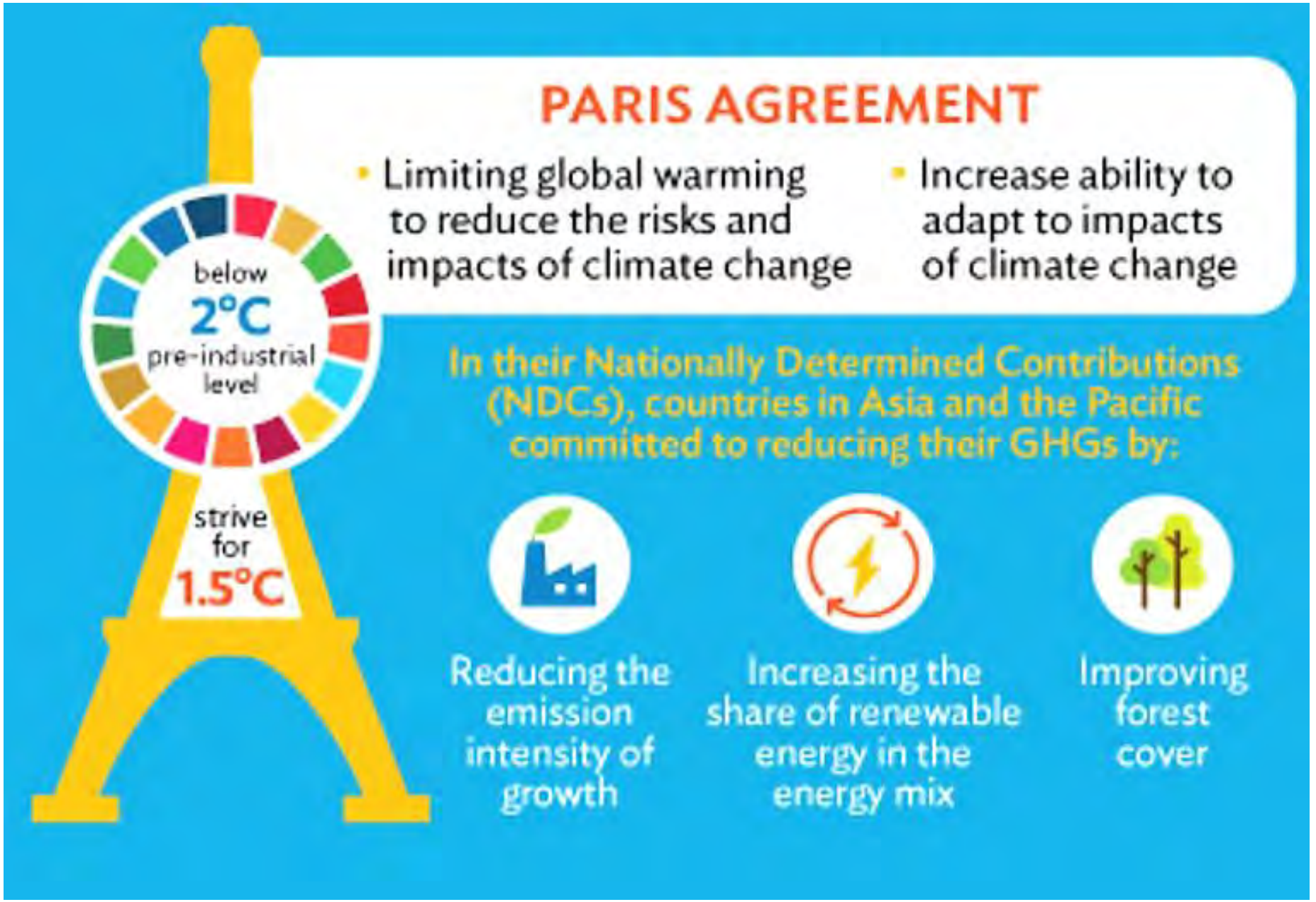
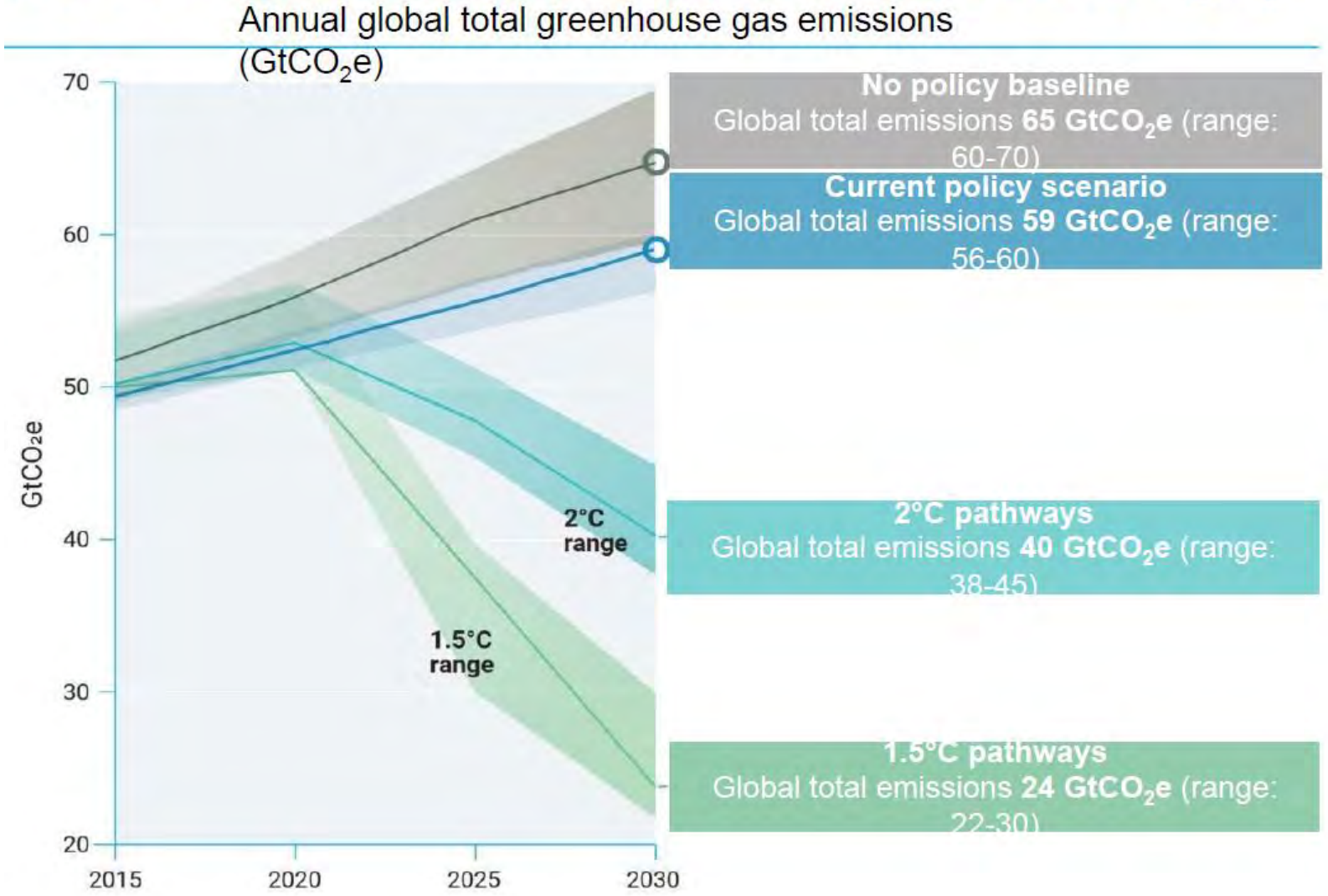
ADB


PARIS AGREEMENT
Limiting global warming to reduce the risks and impacts of climate change
Increase ability to adapt to impacts of climate change
below 2°C pre-industrial level
strive for 1.5°C
In their Nationally Determined Contributions (NDCs), countries in Asia and the Pacific committed to reducing their GHGs by:
Reducing the emission intensity of growth
Increasing the share of renewable energy in the energy mix
Improving forest cover

# NDC contributions and the emissions gap



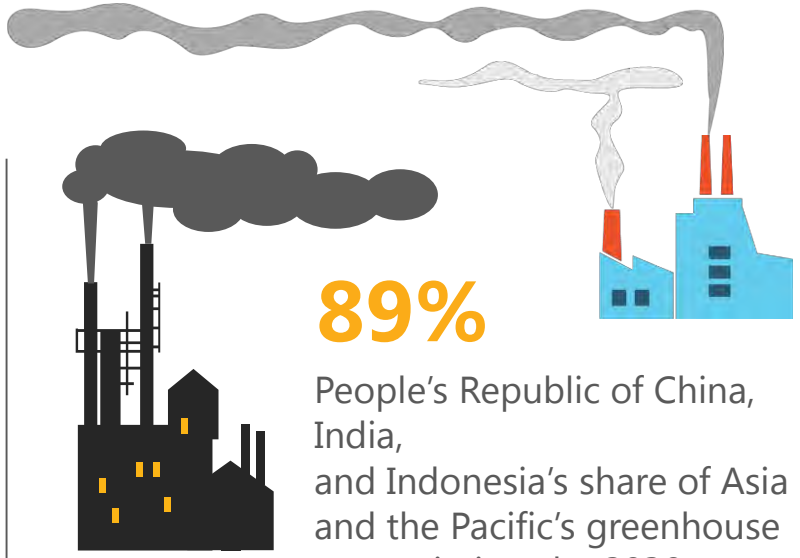
# Climate Change and DRM Challenges

## ASIA AND THE PACIFIC IS KEY

### 2017 $CO_2$ emissions:

**43%** Asia and the Pacific

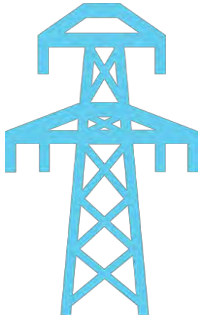
**57%** Rest of the world



**89%**

People's Republic of China, India,
and Indonesia's share of Asia and the Pacific's greenhouse gas emissions by 2030

### Developing Asia's share of world electricity demand will grow to*

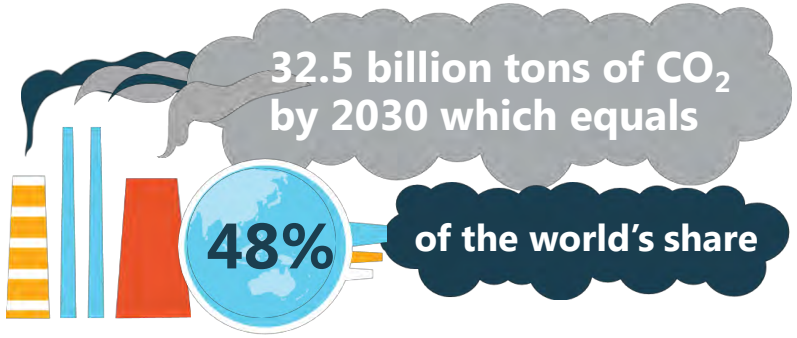


**43%**
**in 2030**

The PRC and India will make up
**64%**
of Asia's power consumption

*projection under New Policies scenario

### Without radical changes, Asia and the Pacific will emit



# Climate Change and DRM Challenges

## IMPACTS WILL BE COSTLY

**7 of the 10**

Countries with the highest disaster risk are ADB DMCs

**18 million**

Bangladeshis will be displaced by a

**1-meter rise**

in sea level by 2050

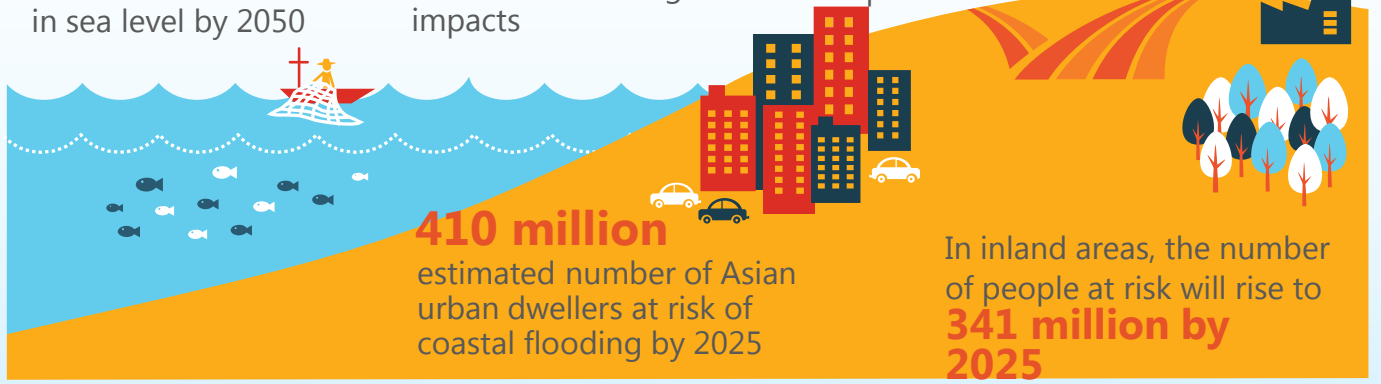
**>60%**

Of the region's population work in sectors most at-risk from climate change impacts

Climate change will hike food prices, thus

**64 million**

Asians will be pushed into poverty for every 10% rise in food prices



**410 million**

estimated number of Asian urban dwellers at risk of coastal flooding by 2025

In inland areas, the number of people at risk will rise to **341 million by 2025**

For the past 30 years, disasters in Asia and the Pacific has affected **5.2 billion people**, causing **one million deaths** and total damage of **$843.6 billion**

In the Pacific, sea levels rises **4X faster** than the global average. By 2010, sea level rise may reach **more than 1 meter**

# Mitigation Initiatives

## Clean Energy

- > $2 billion annual investments
- Sustainable Energy for All Program
- Review of 2009 Energy Policy

## Sustainable Transport Initiative

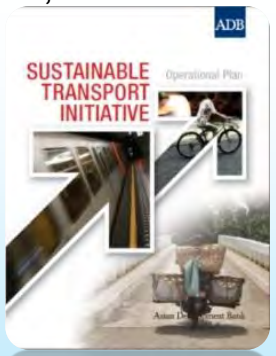
- 20% of investments for urban transport; 18% for railways by 2020

## Climate-Smart Agriculture

- enhanced management and climate resilience of natural resources

## Land Use and Forest Management

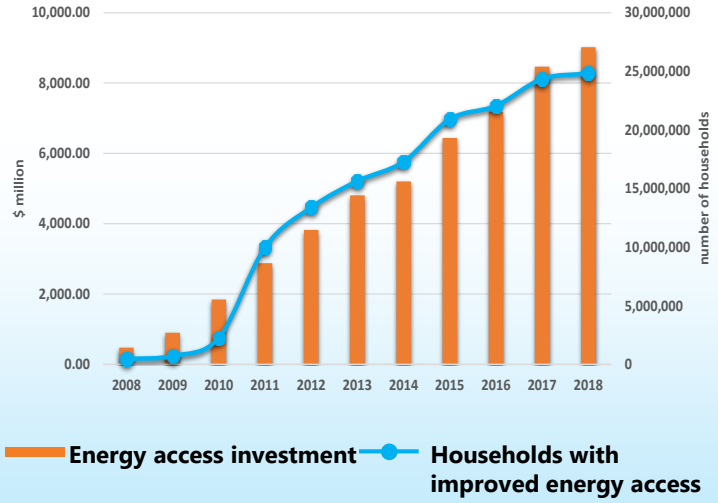
- Piloting REDD+/Forest Investment Program: Indonesia, Lao PDR


**Clean Energy Investment Indicators**
(2012–2018)

| | |
|---|---|
| Electricity saved | 17 gigawatt equivalent/year |
| Renewable energy capacity | 9.5 gigawatts |
| GHG reduction | 79.7 million tons of $CO_2$ equivalent/year |

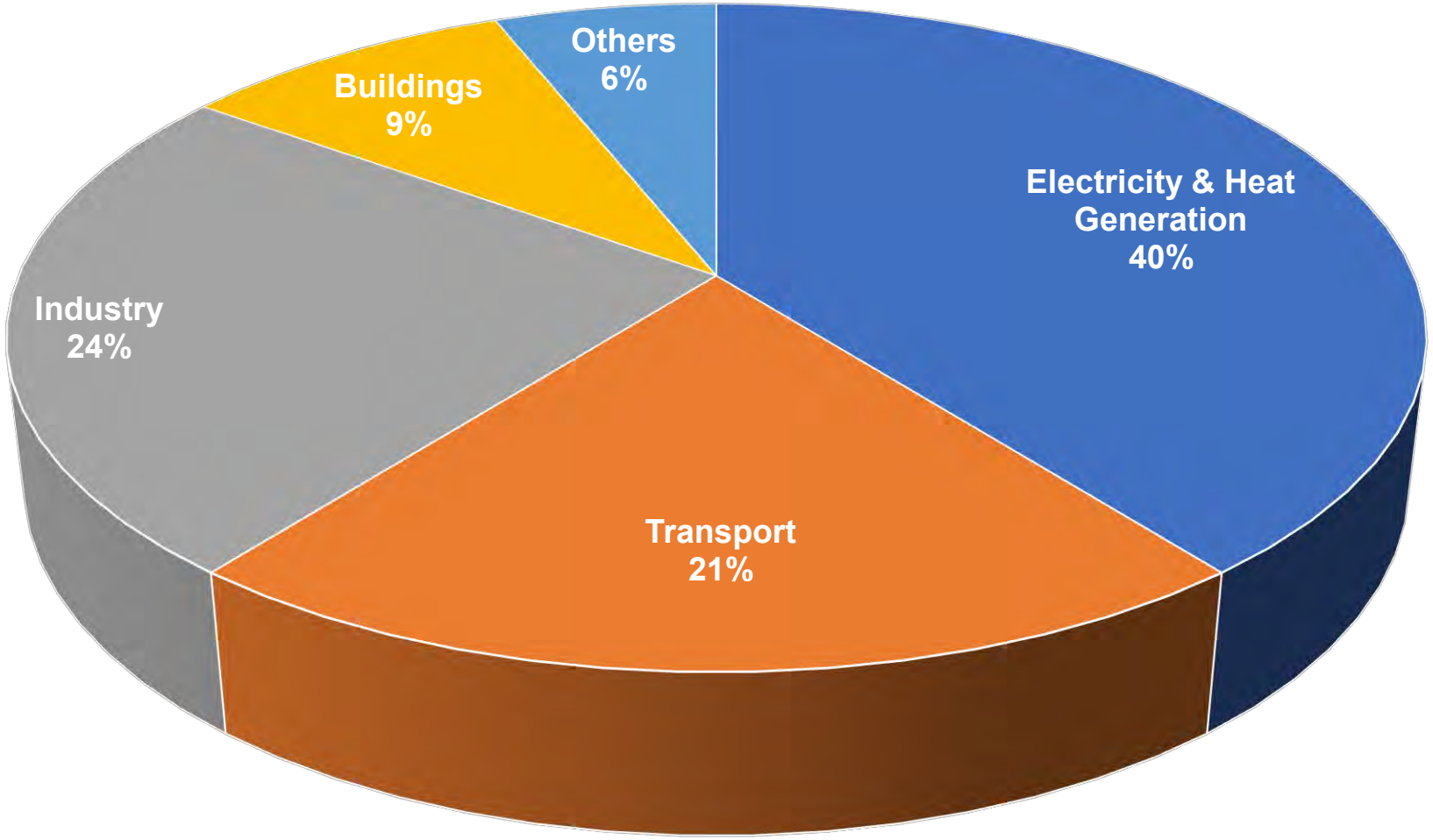
**Impact of ADB's Investment on Energy Access**
(2008-2018 cumulative)



# Adaptation Initiatives

- Mainstreaming climate resilience in core development planning
  - Pilot Program on Climate Resilience for Bangladesh, Cambodia, Nepal, Papua New Guinea, Tajikistan, Tonga and the Pacific Region
- Climate proofing vulnerable projects: energy generation, urban greenfield developments, water supply and irrigation systems, and transport infrastructure
- Ecosystem-based adaptation
- Knowledge support: regional climate projections consortium data facility , guidance and tools
- Addressing social dimensions: migration, gender, health impacts
- Greater emphasis on integration of adaptation and disaster risk management

# Global $CO_2$ Emissions by Sector, 2017



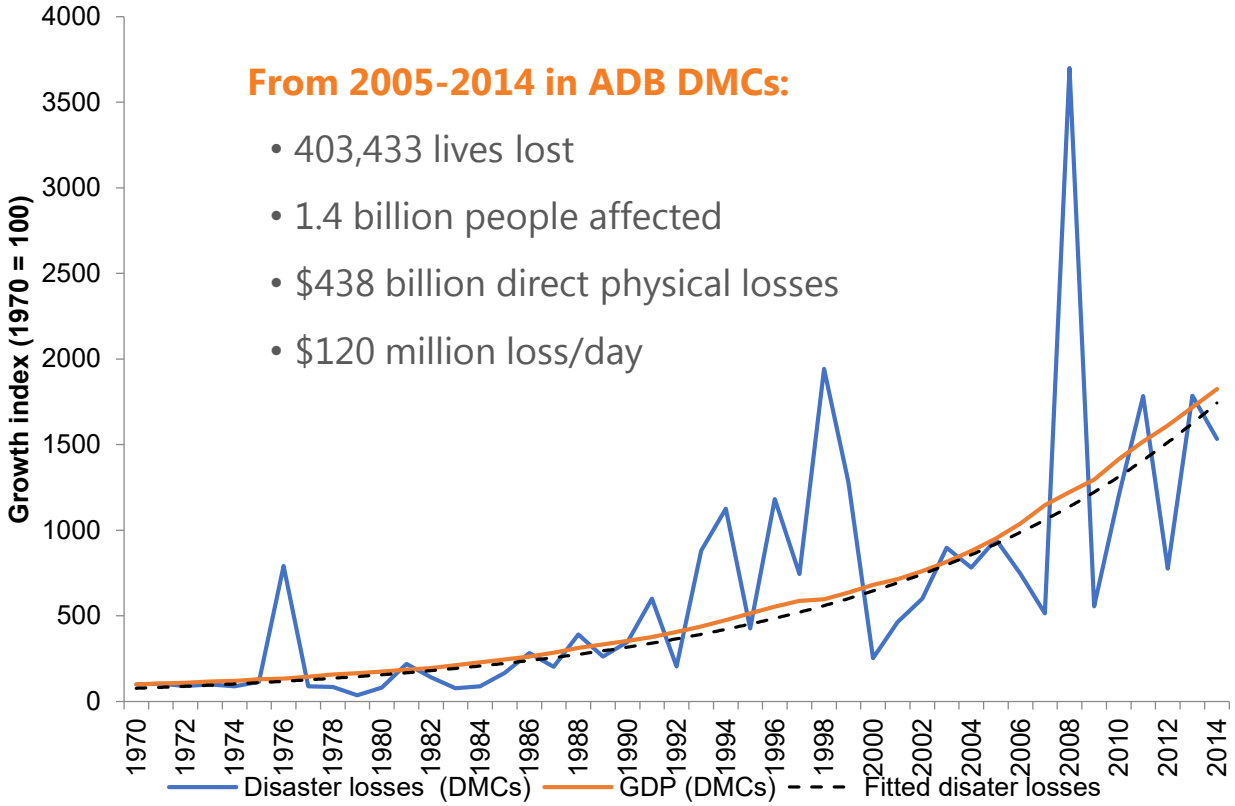





# Effects of Climate Change on Infrastructure

ADB

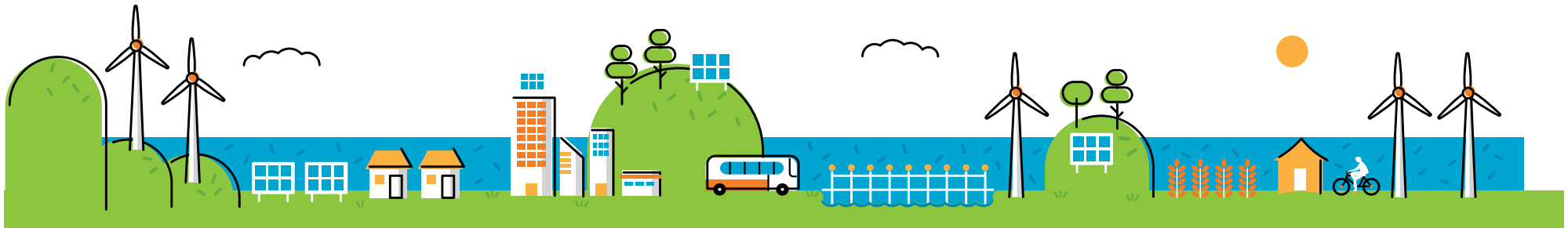
# Disaster losses are growing at the same rate as GDP in ADB's DMCs




**From 2005-2014 in ADB DMCs:**

- 403,433 lives lost
- 1.4 billion people affected
- $438 billion direct physical losses
- $120 million loss/day

*Based on ADB and CRED EM-DAT data*

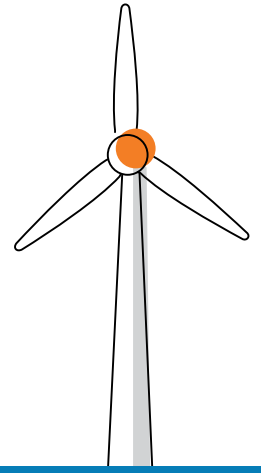


# ADB's Climate Finance Target by 2020

**Target under the Corporate Results Framework:**
ADB-assisted projects that support climate mitigation and/or adaptation: **45% for ADB, 35% for ADF**

Funding for tackling climate change will rise to **around 30%** of its overall financing

ADB will double its annual climate financing to **$6 billion**



## OUT OF THE $6 BILLION

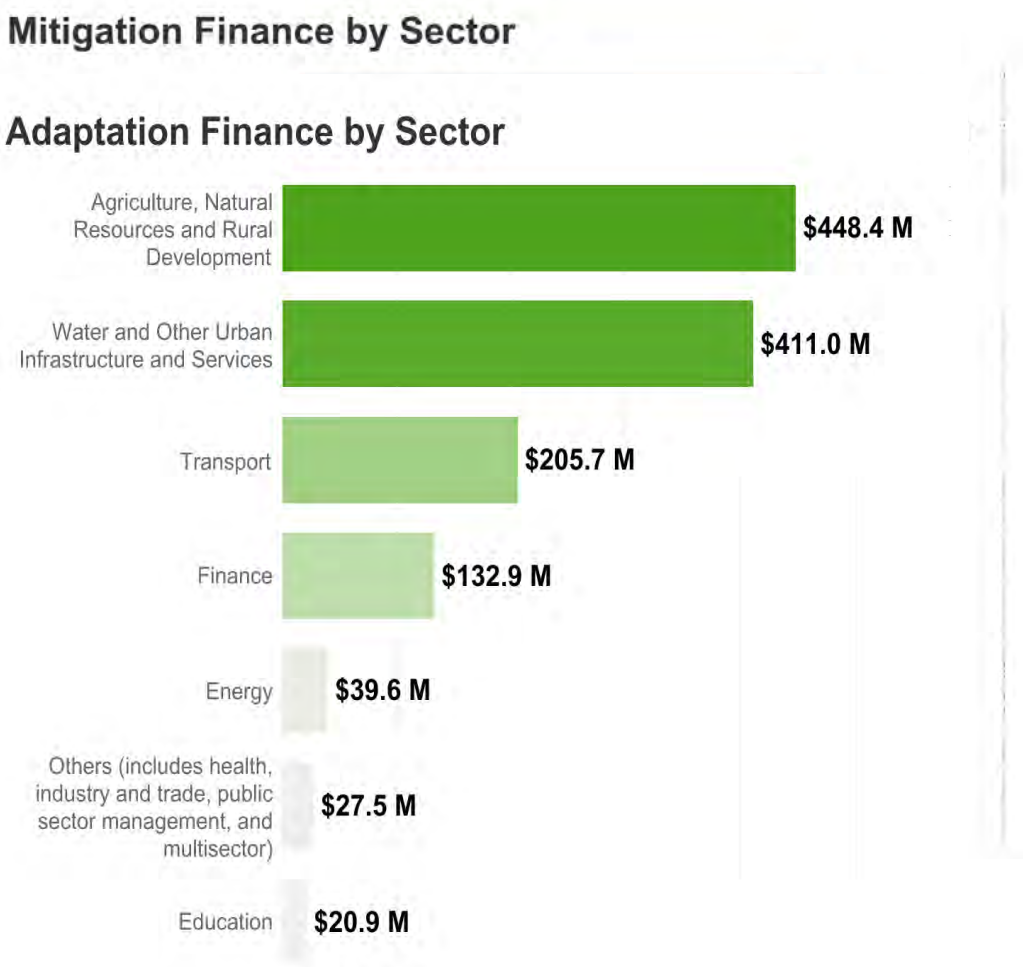
**$4 billion** will be dedicated to **mitigation** through scaling up support for renewable energy, energy efficiency, sustainable transport, and building smart cities.

**$2 billion** will be **adaptation** through more resilient infrastructure, climate-smart agriculture, and better preparation for climate-related disasters.

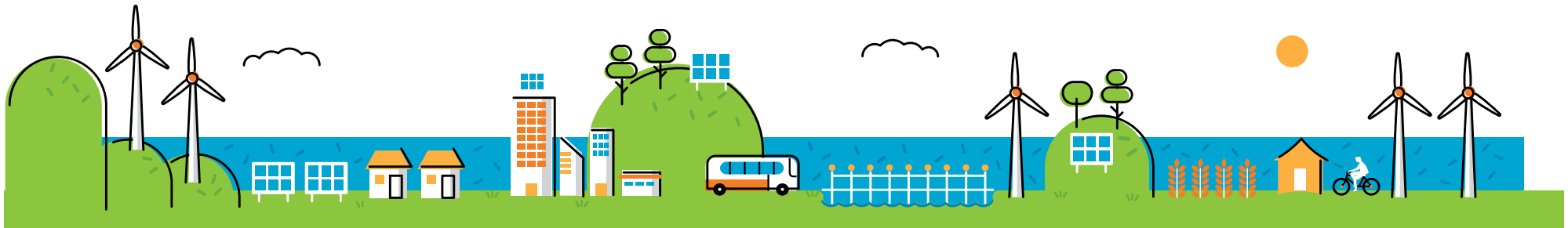
# ADB's Role in Tackling Climate Change

ADB's Strategy 2030: **Prosperous, Inclusive, Resilient, and Sustainable** Asia and the Pacific.

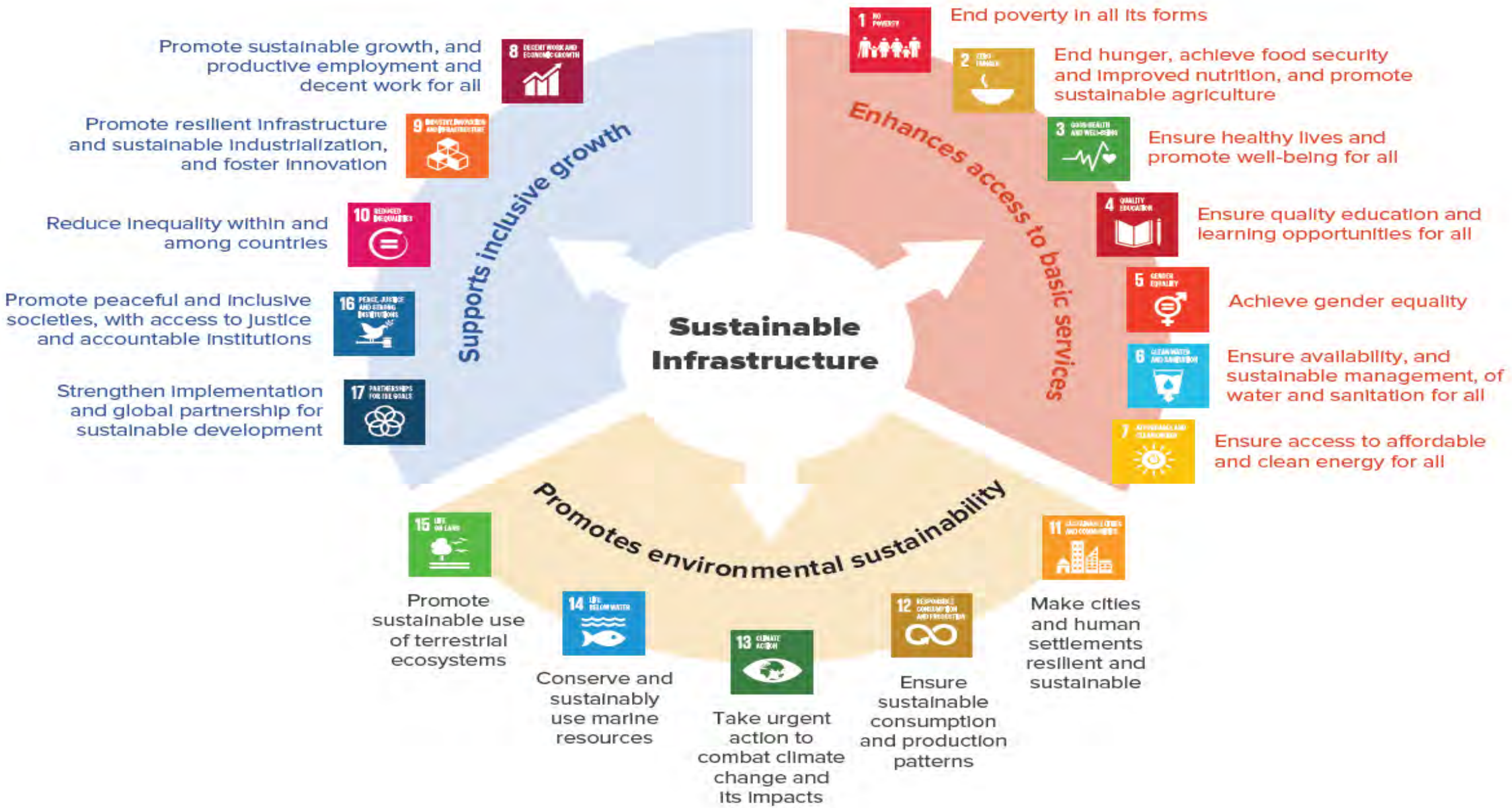
- Tackling climate change, building climate and disaster resilience, and enhancing environmental sustainability is a priority of ADB
- ADB committed **$80 billion** in climate finance cumulatively between 2019 and 2030
- At least 75% of its projects will address climate change mitigation and adaptation by 2030
- In 2018, ADB delivered **$3.59 billion** in climate finance from its own resources



# Sustainable Infrastructure

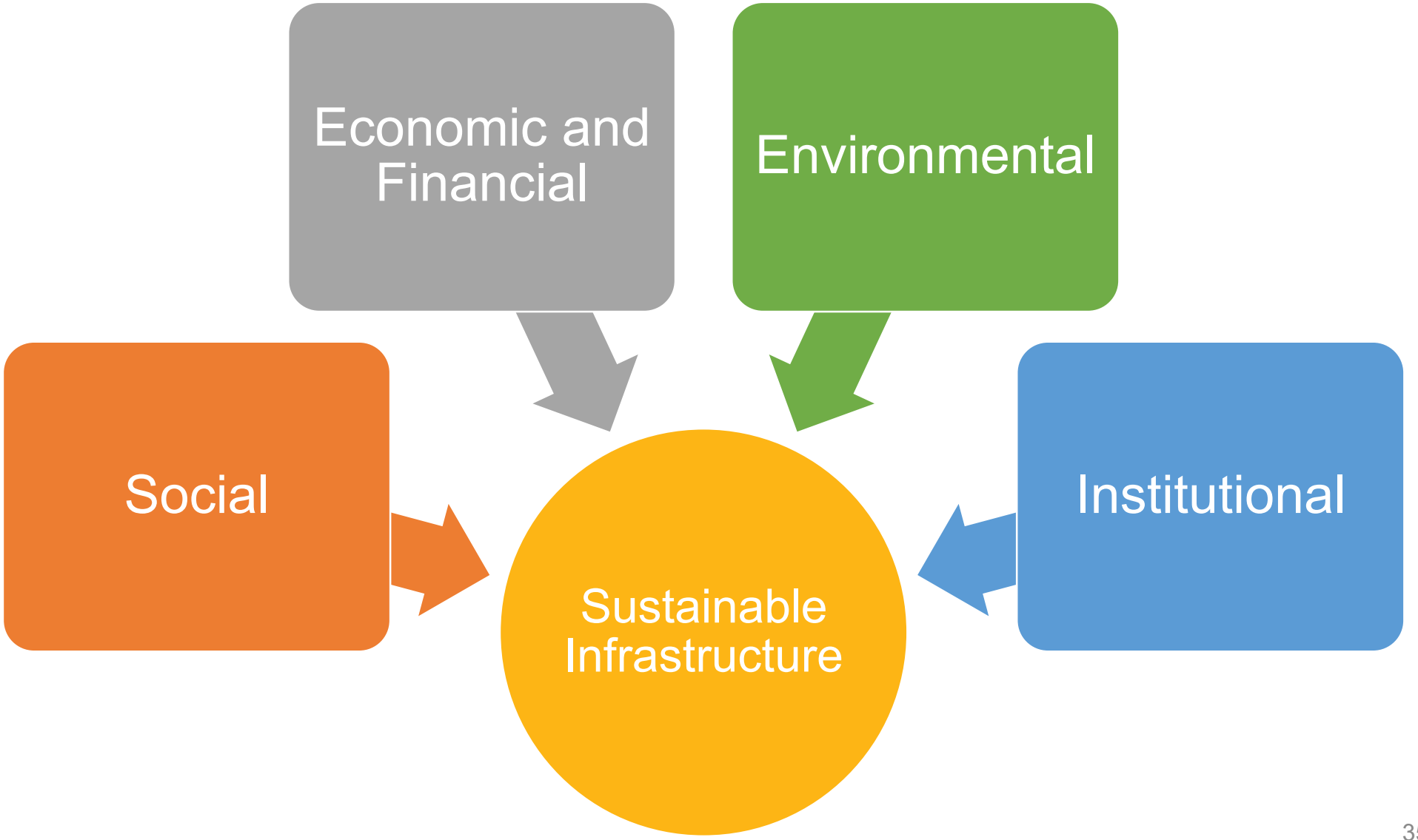


# SUSTAINABLE DEVELOPMENT GOALS (SDGs)




*Source:*
Bhattacharya et al., 2016. *Delivering on Sustainable Infrastructure for Better Development and Better Climate*.

# Four Dimensions of Sustainable Infrastructure



# Avoid-Shift-Improve Paradigm

Avoid
the need to
travel

Shift
to sustainable
modes

Improve
efficiency of
all modes

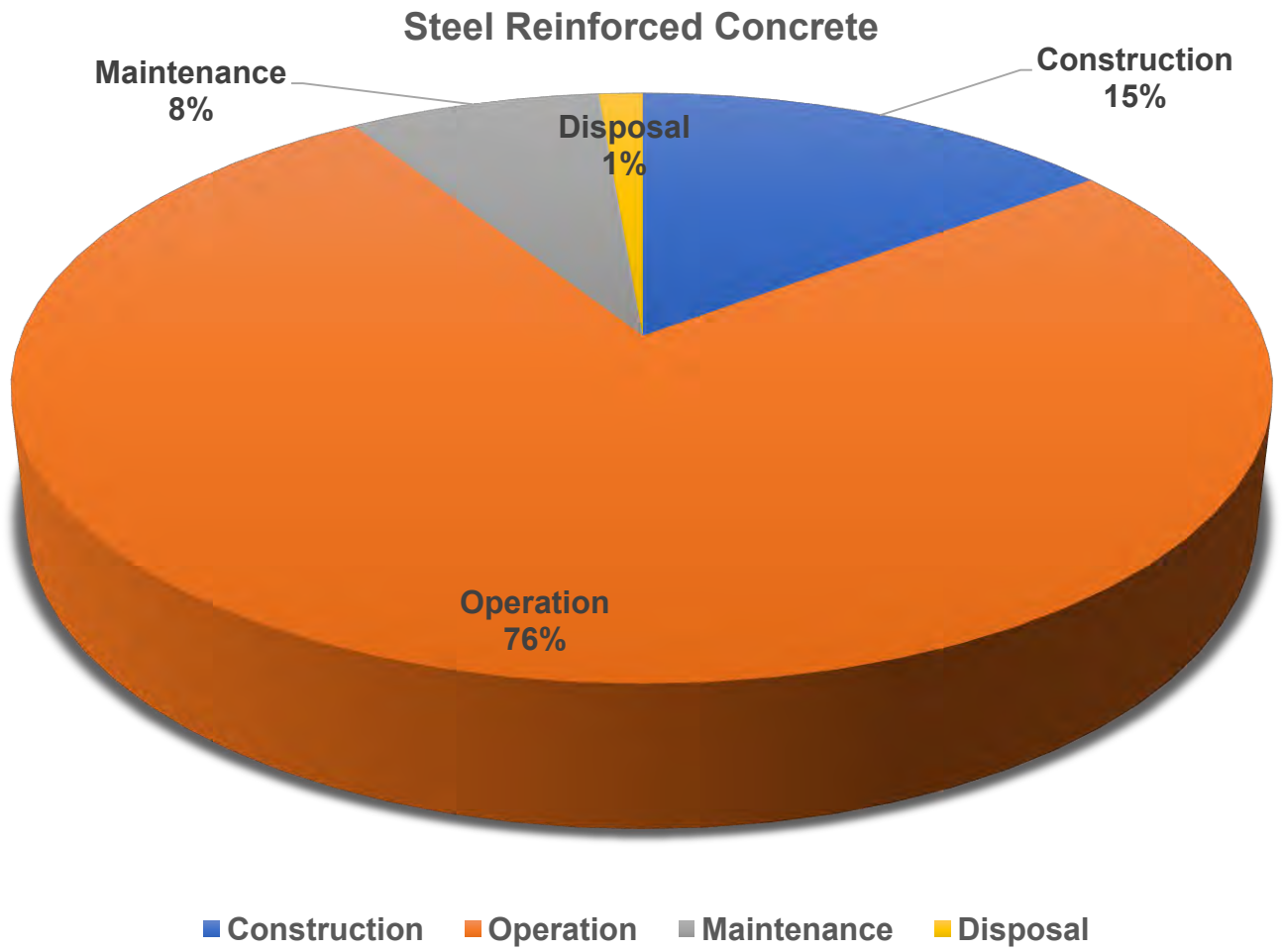
Lower congestion, emissions,
air pollution, road accidents
Better health

# Infrastructure Life Cycle


$CO_2$ Contribution of each life cycle

- Construction Phase: 5%-12%
- Operations phase: 70%-80%
- Maintenance and Decommissioning: 8%-10%

# Example of Life Cycle $CO_2$ Emissions for Residential Buildings



# Infrastructure Project Planning and Design

- In this phase, a thorough and systematic analysis of all factors that affect the possibility of success of a proposed project will be undertaken.
- Stakeholder consultations, needs assessment are include in this stage
- This will include a synthesis of separate studies usually dealing with different aspects of the project. This is the feasibility stage of the project cycle.

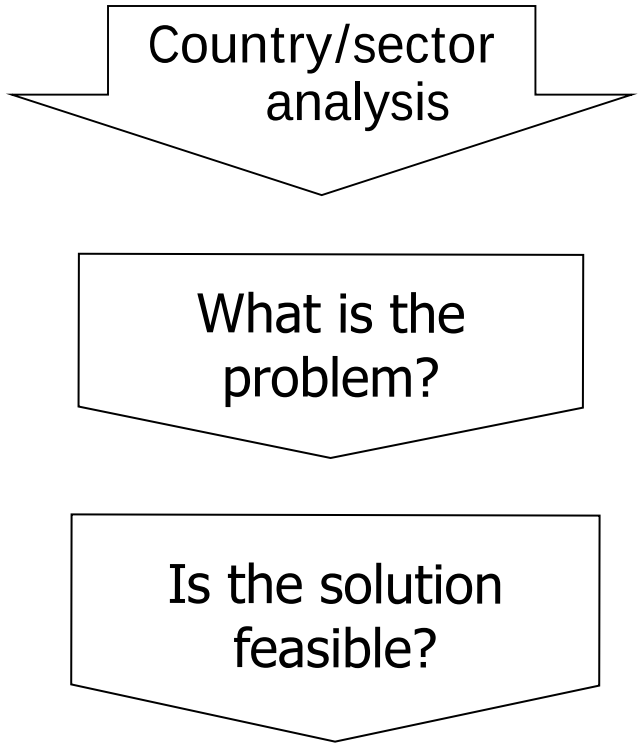


# Infrastructure Project Planning and Design

The feasibility study should tell management:

- How should the project be done?
- What are the alternative solutions?
- What are the criteria for choosing among them?
- Is there a preferred alternative?
- What are the benefits?
- How will this be financed?
- What is the life span of the project?

# Dimensions of Economic Analysis

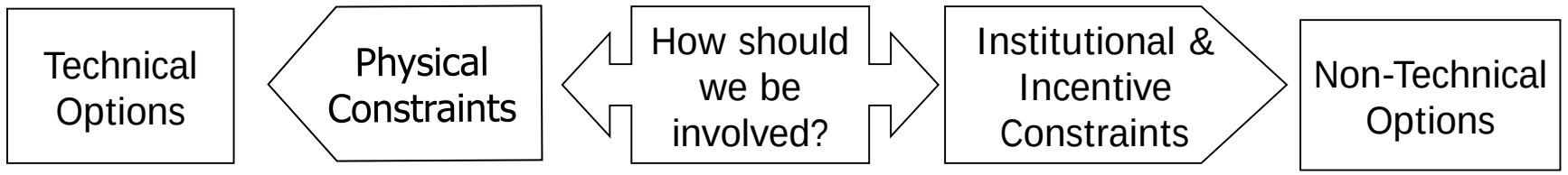



These questions identify basic problems/needs, underlying causes, and appropriate answers

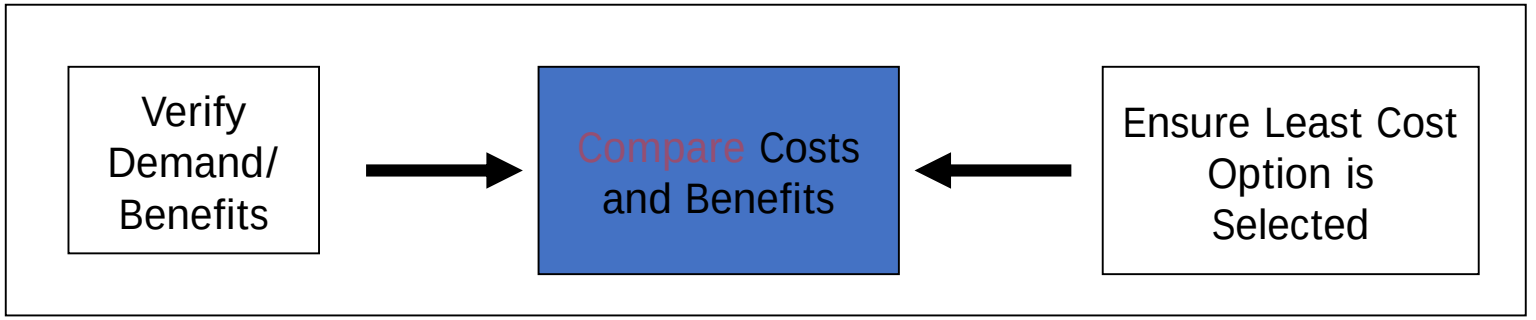
# Economic Analysis

- More than rate of return calculations; Integrated framework/tool to select and design good projects
- To help identify areas where investment is needed
- To establish the economic rationale for public sector involvement
- To help make the choice among alternative instruments and solutions
- To assess a project's economic benefits and costs, potential development impact, and potential risks

# Economic Analysis




There is a menu of choices for taking actions; solutions must be appropriate to achieve goals

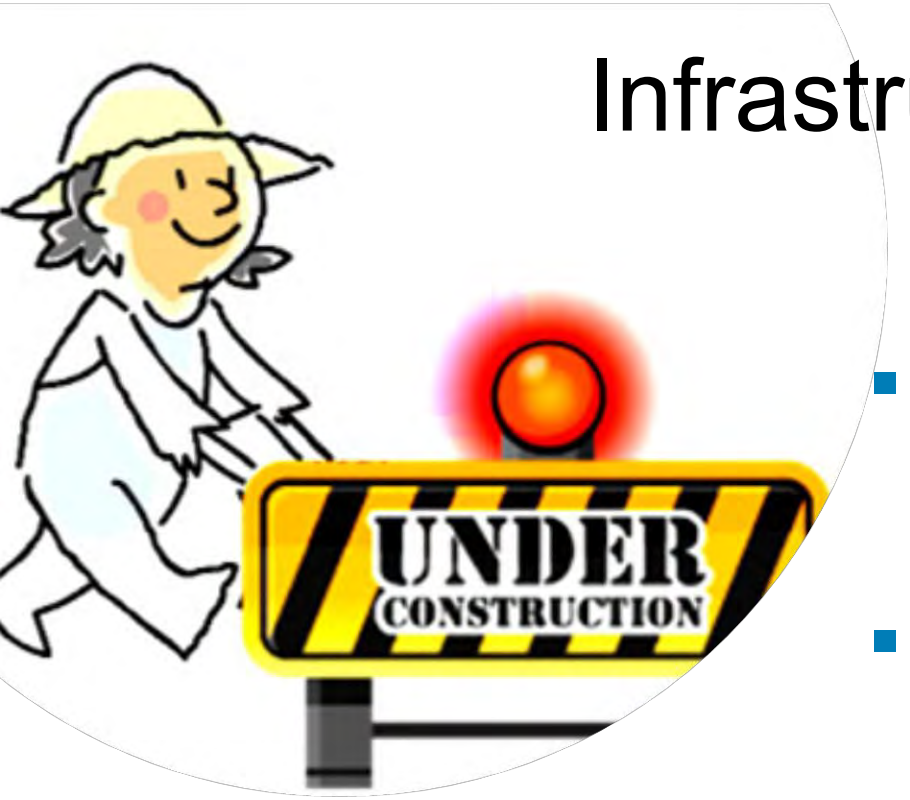


# Financial Analysis

- The financial analysis of a project examines the adequacy of returns to the project-operating entity and to the project participants
- FIRR
- Undertake risk and sensitivity analysis. The sensitivity analysis examines the likely effect of changes in forecasting assumptions on the project's financial viability

Source: ADB (2006), Financial Management and Analysis of Projects, ADB Manila

# Infrastructure  Project Implementation




- After the feasibility study phase has been approved, financing locked, the project implementation stage begins.
- Includes detailed design, procurement, and project construction
- Important to maintain control and communicate during implementation.
- Monitor progress continuously and appropriate adjustments (variance from original plan)

# Operations Phase

- This phase is the use of the infrastructure.
- It considers the capacity and level of service standards to be maintained
- Sustaining reliable service levels is the goal of any infrastructure service provider.

# Maintenance Phas

- This stage is after construction and during operation of the infrastructure.
- The maintenance phase involves making changes to the infrastructure to support its operational effectiveness.
- It includes making changes to improve a system's performance, correct problems, or address user requirements.

# Recycling/Decommissioning

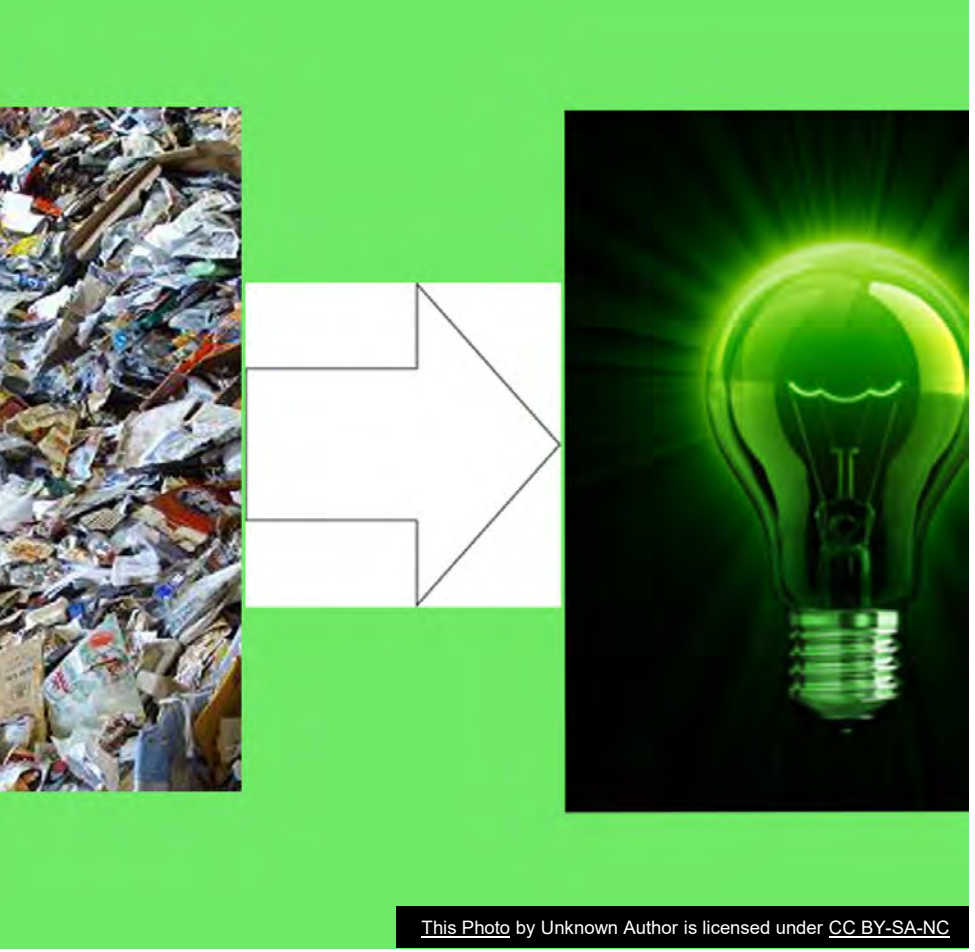



- Decommissioning (also called abandonment) is the process by which the owner-operator of an facility or infrastructure will plan, gain approval for, and implement the removal, disposal, or reuse of an installation when it is no longer needed for its current purpose

- This stage is the end of life of the infrastructure. Usually after 35 years. If designed and maintained properly, sustainable infrastructure can last 100 years.

- A decommissioning plan is usually produced and submitted to relevant authorities.

# Technologies for Sustainable Infrastructure






# Energy Technologies

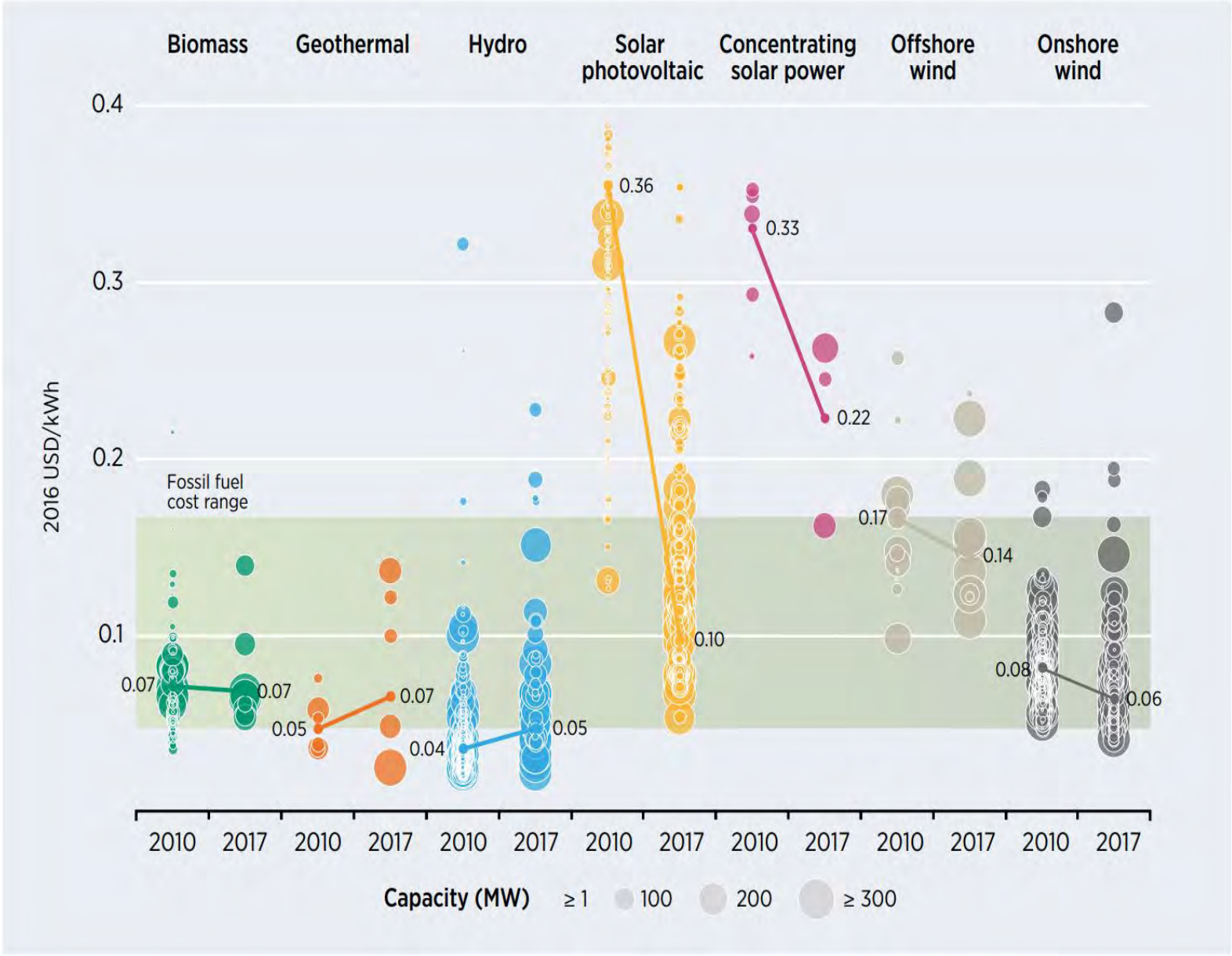
- Solar power
- Wind power
- Waste to energy technologies
- Hydrogen


# Clean Energy, Now a Popular Alternative

# Clean Energy, Now a Popular Alternative

# Cost of Electricity for Renewable Power Generation Technologies (2010-2017)

- Costs decreased from 2010 -2017 for solar and wind power
- 147% decrease for solar PV
- 33% decrease for CSP
- 18% decrease for offshore wind
- 25% decrease for onshore wind.




*Source: IRENA Renewable Cost Database.*

*Note: The diameter of the circle represents the size of the project, with its centre the value for the cost of each project on the Y axis. The thick lines are the global weighted average LCOE value for plants commissioned in each year. Real weighted average cost of capital is 7.5% for OECD countries and China and 10% for the rest of the world. The band represents the fossil fuel-fired power generation cost range.*

# Drivers for Renewable Energy

Solar

Wind

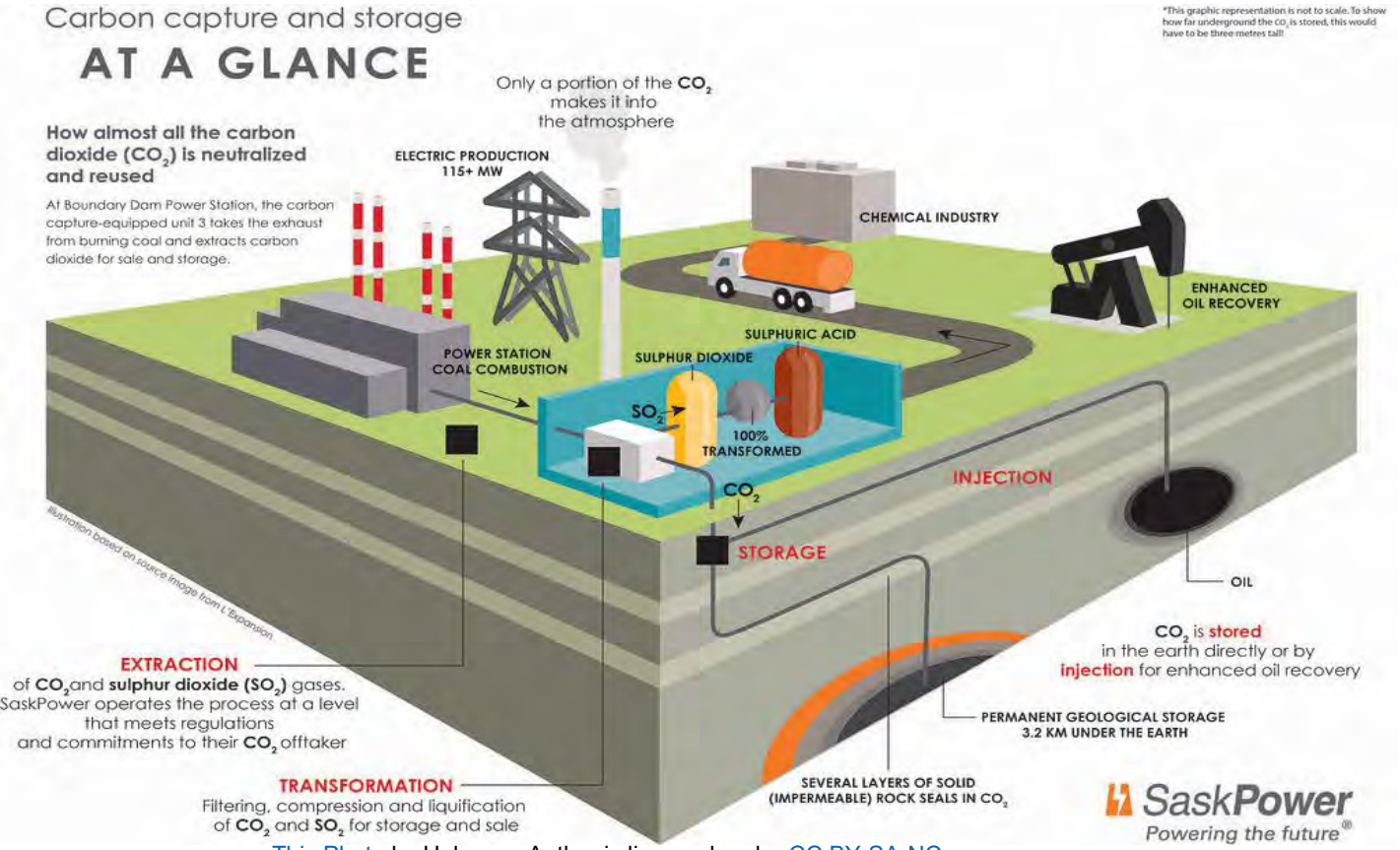
Hydro

Geothermal

- Technology improvements for solar and wind power technologies
- Competitive procurement
- Large base of internationally active project developers
- Renewable Energy Purchase Obligation
- Feed-in-tariff

# Carbon Capture Use and Storage

CCUS is the only technology on the horizon that can potentially decouple large coal-based capacity addition from GHG growth



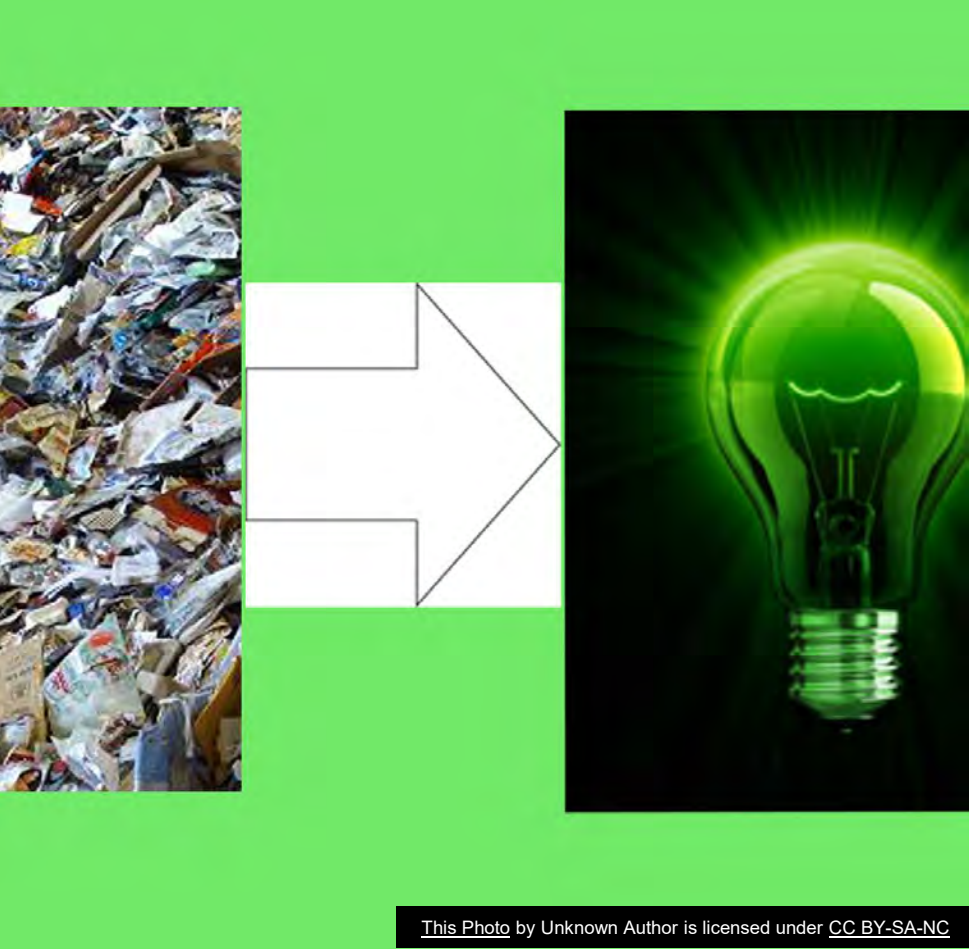



**Range of Levelized Costs of CCS Plants** (first-of-a-kind, depending on location)

| **Type of Plant** | **Levelized Cost** (USD/kWh) |
|---|---|
| PC supercritical | 0.120 - 0.190 |
| Oxy-combustion supercritical | 0.123 - 0.203 |
| NGCC | 0.049 - 0.150 |
| IGCC | 0.135 - 0.207 |

Source: Global CCS Institute: Global Costs of Carbon Capture and Storage, 2017 Update

ADB








# Transport Technologies

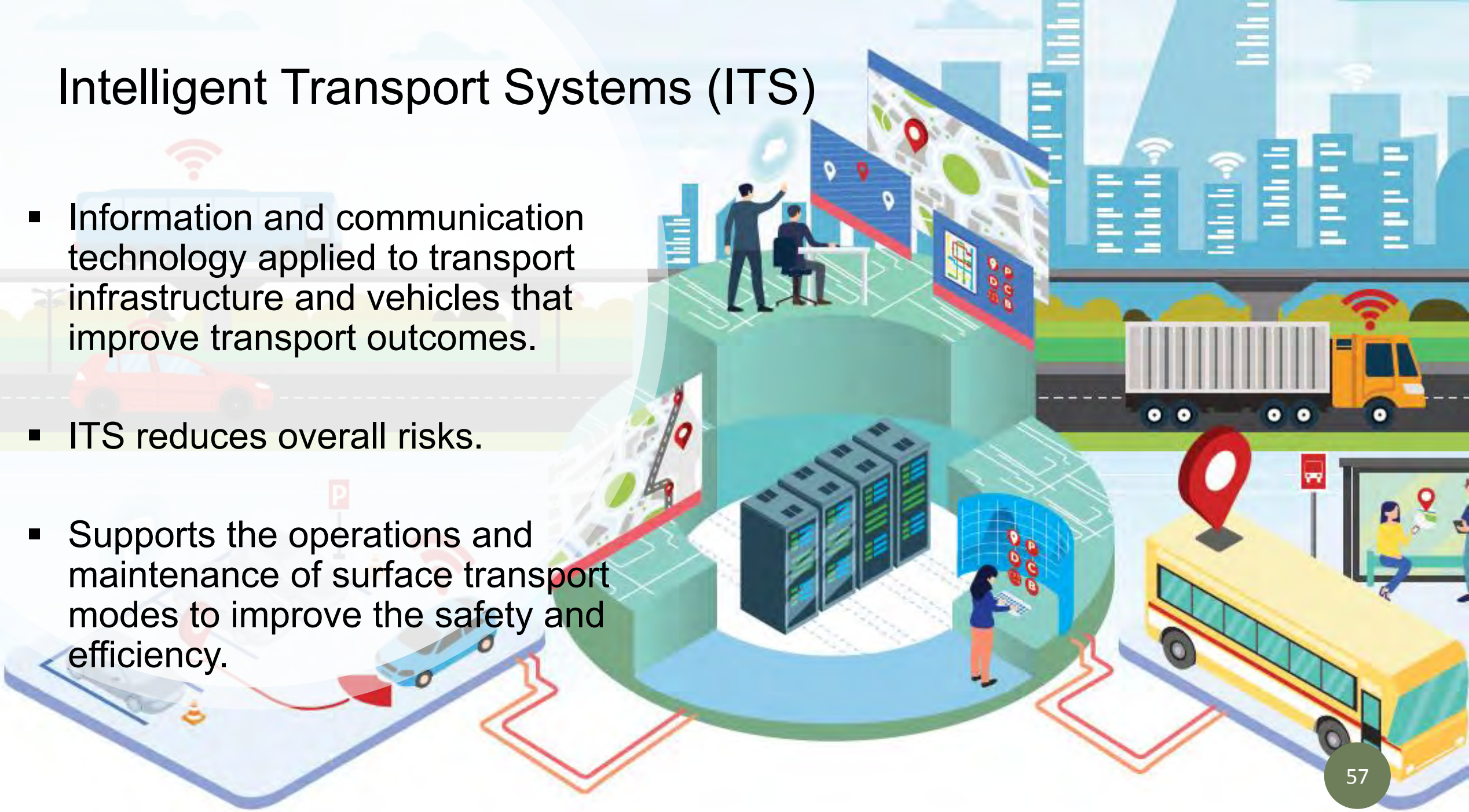
- Intelligent Transport Systems
- Electronic Road Pricing
- Hybrid to Full Electric Vehicles



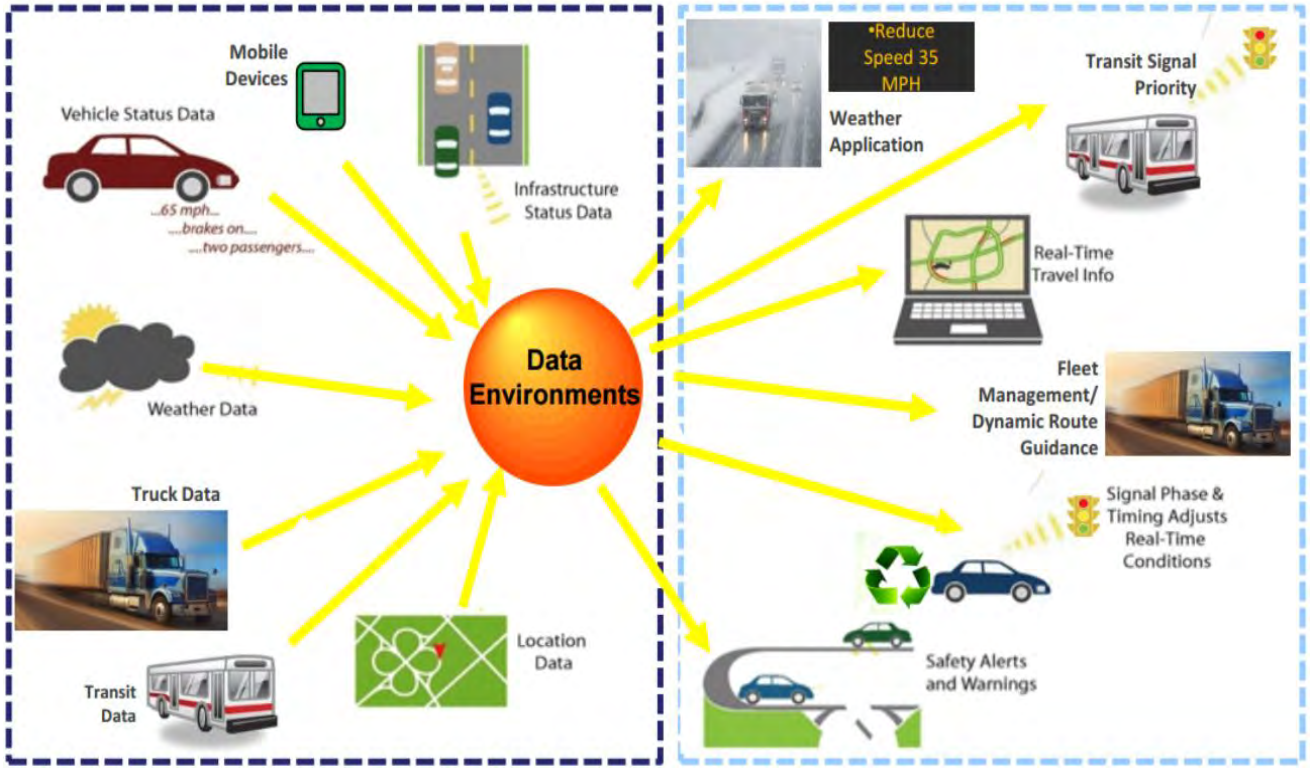
ADB

# Intelligent Transport Systems (ITS)

- Information and communication technology applied to transport infrastructure and vehicles that improve transport outcomes.
- ITS reduces overall risks.
- Supports the operations and maintenance of surface transport modes to improve the safety and efficiency.



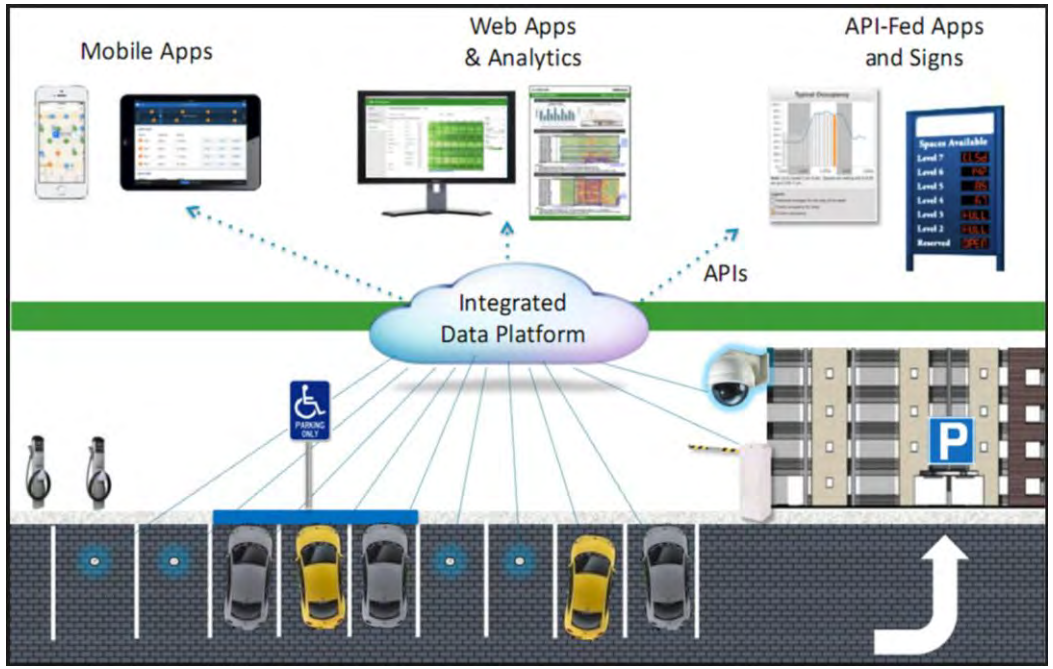
## 1. Real-time traffic and road weather monitoring system




## 2. Big data service center

# Guizhou Gui'an New District New Urbanization Smart Transport System Development Project

## 3. Multimodal transportation systems management and operations center




## 4. Integrated traffic operations, security and emergency management center

# Guizhou Gui'an New District New Urbanization Smart Transport System Development Project

# Project Benefits

| | Potential Benefits |
|---|---|
| Safety Objectives | 50% reduction in crash rate and 5% reduction in fatality rate per crash because of the enforcement of speed limits |
| Mobility Objectives | 10% reduced journey time by car due to reduced congestion, traffic signal coordination, parking management, weather warning, and<br>incident management |
| | reduced journey time by bus of 15% and an increased bus modal share of 10% resulting from a bus information management system, reduced congestion, bus<br>priority measures, traffic signal coordination, weather warning, and incident management |
| Low Carbon Objectives | an 8% reduction in VOCs and vehicle emissions as a result of less congestion and reduced<br>stop-start traffic conditions. |

see https://www.itsbenefits.its.dot.gov/its/benecost.nsf/BenefitsHome

# Human-Centered Design at the Heart of Transport Infrastructure Planning

# Low Carbon Technologies for Buses



- Hybrid buses – Buses with two sources of onboard power (e.g. diesel-hybrid or gas-hybrid) – small battery size
- Plug-in Hybrid – Buses with fuel-electricity combination (charged directly from the grid)
- Battery Electric Buses (full electric buses) – Buses with different charging systems
- Fuel Cell Electric Vehicle (FCEV) is a type of electric vehicle which uses a fuel cell, instead of a battery, or in combination with a battery, to power its on-board electric motor.

# Different charging technologies

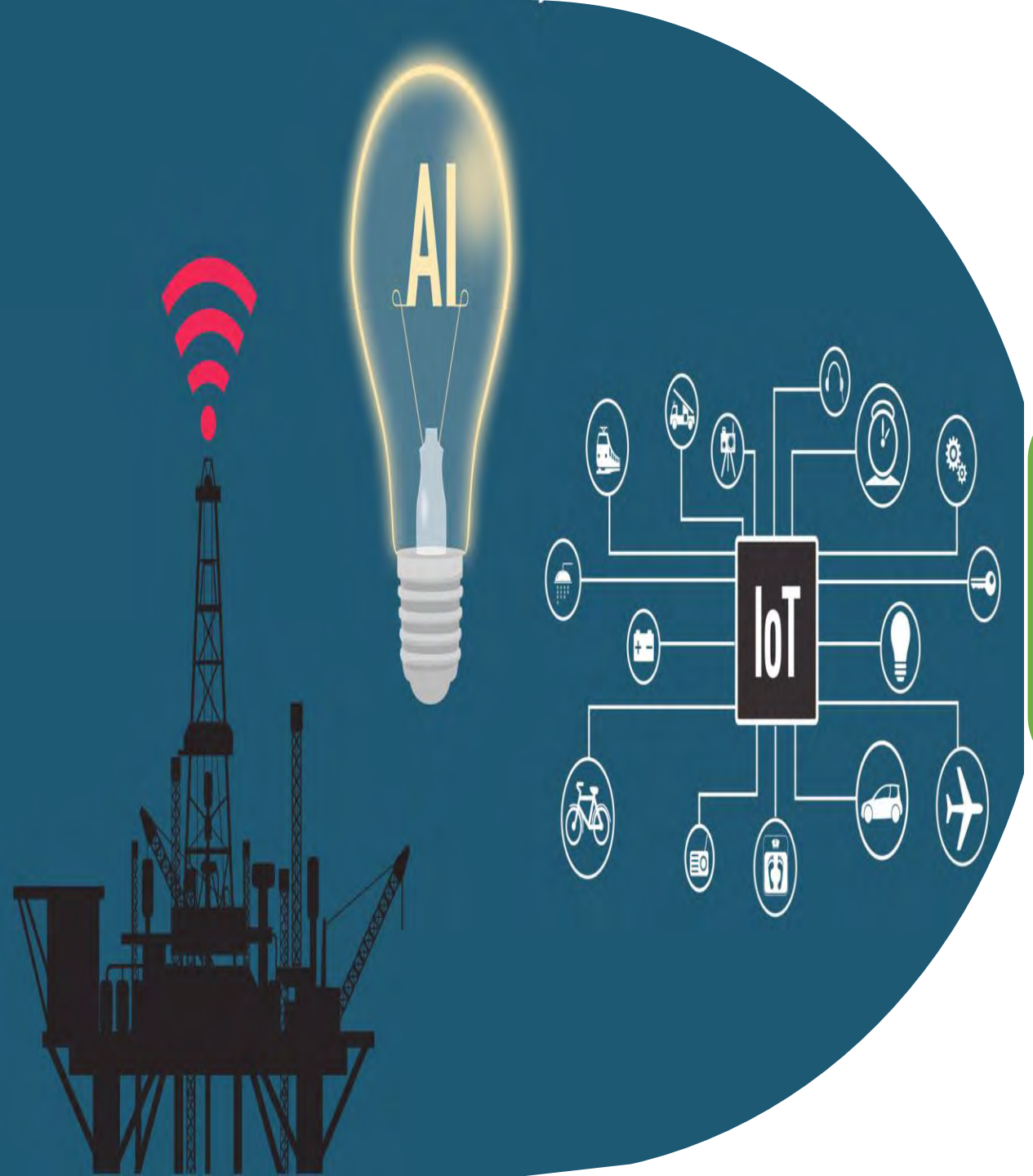
- Slow Overnight Charging
- Opportunity and Ultra-fast charging
- Overhead Wiring



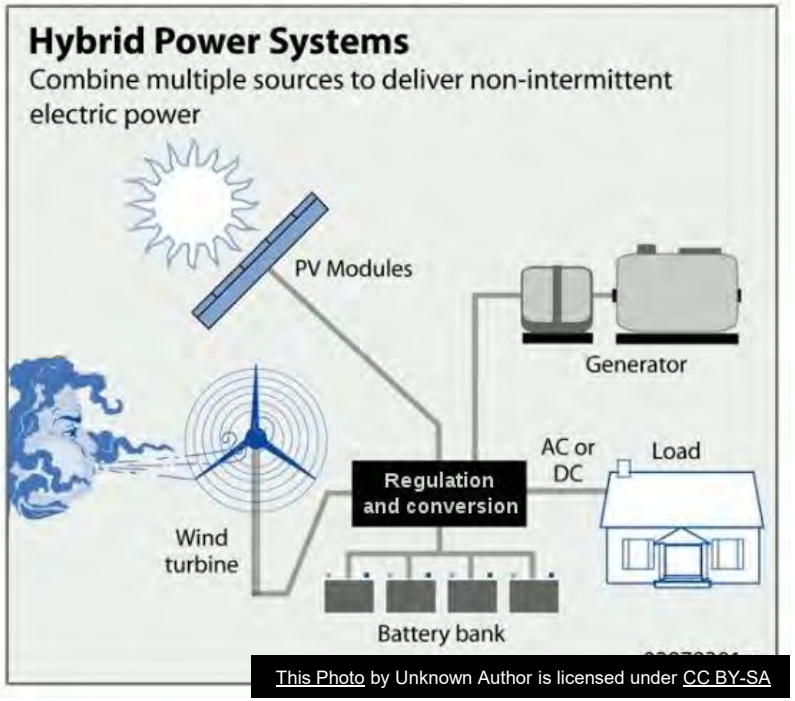
# Electronic Road Pricing

- Efficient, equitable and sustainable method of charging for road use and externality costs
- Pricing can moderate urban congestion and generate revenue to finance public transport
- Advanced systems for tracking and charging vehicles based on distance and/or time

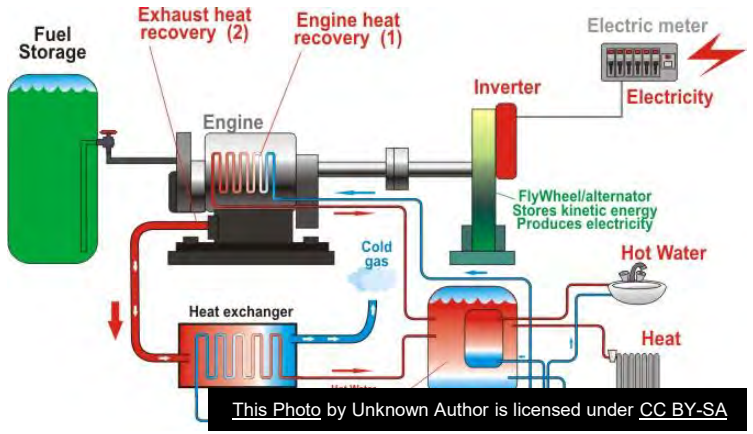


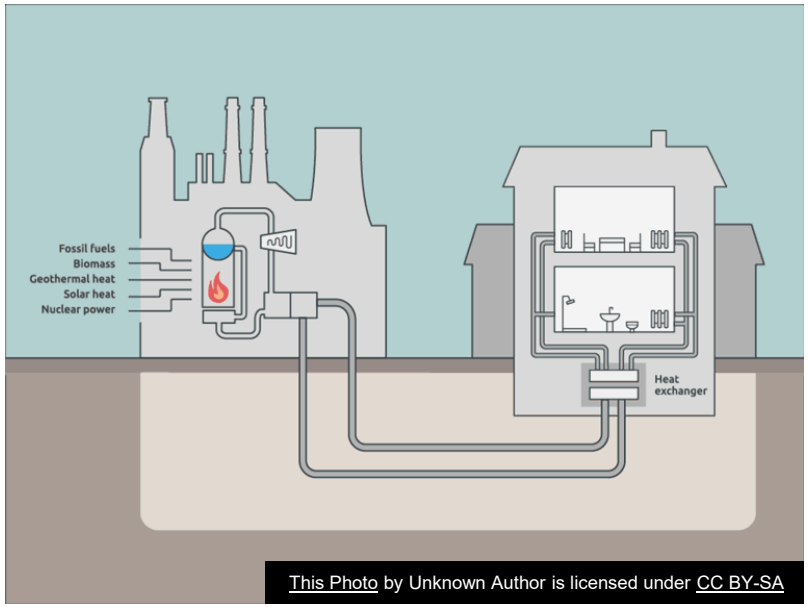

# Looking Ahead





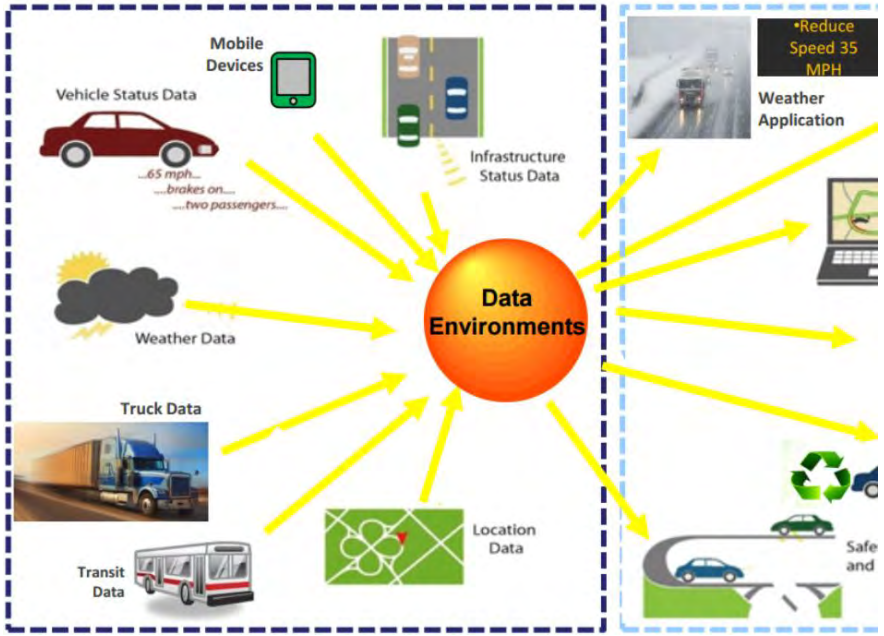










# Energy efficient and safer technologies


# Highways ITS

# Future opportunities: highways ITS

| | |
|---|---|
| **General rationale** | Using information on traffic, road conditions and hazards improves transport efficiency and safety |
| **Types of high-level technology** | Travel information systems, road safety systems<br>Vehicle registration systems |
| **Approved projects** | TA study of overall highway ITS architecture, PRC<br>TA study of ITS for highway safety, PRC |
| **Planned projects** | Highway ITS in Kazakhstan, Papua New Guinea |





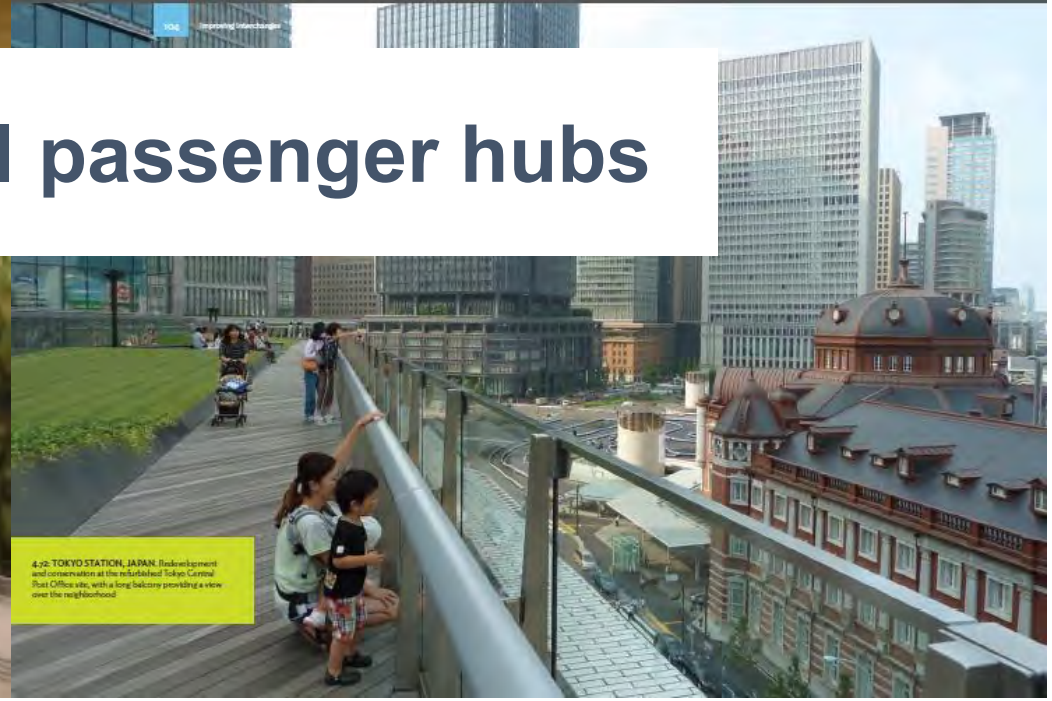



# Electric and $H_2$ vehicles

ADB

# Multimodal passenger hubs

5.103: MIDTOWN TOKYO, JAPAN. An underpass between the transport links and commercial areas. This feature is quite common in Japan.



4.72: TOKYO STATION, JAPAN. Redevelopment and conservation at the refurbished Tokyo Central Post Office site, with a long balcony providing a view over the neighborhood

| | |
|---|---|
| **General rationale** | Well-designed hubs ensure ease of passenger transfer between modes, and create complementary commercial opportunities |
| **Types of high-level technology** | Advanced passenger station/hub design |
| **Approved projects** | TA on improving interchanges, PRC |
| **Planned projects** | E'mei-Miyi rail project, PRC<br>Yuxi-Mohan rail project, PRC |

# Transit oriented development

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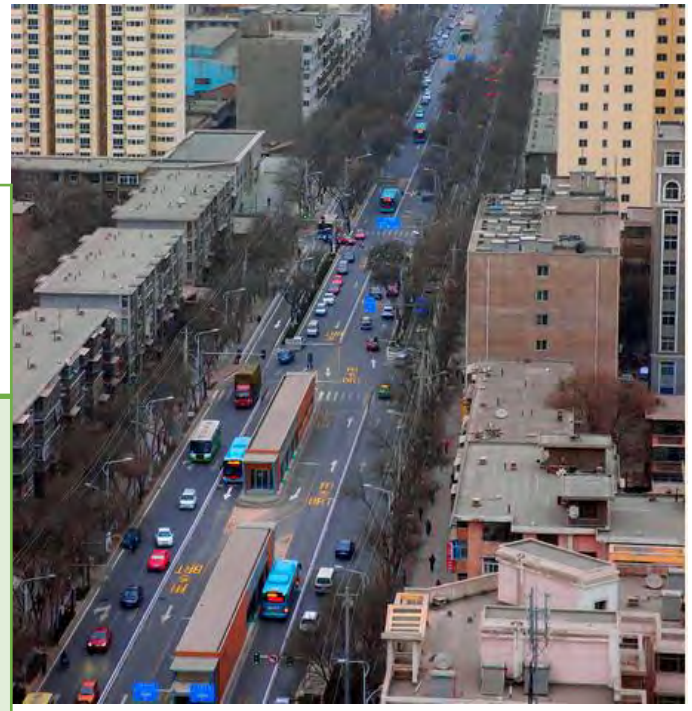
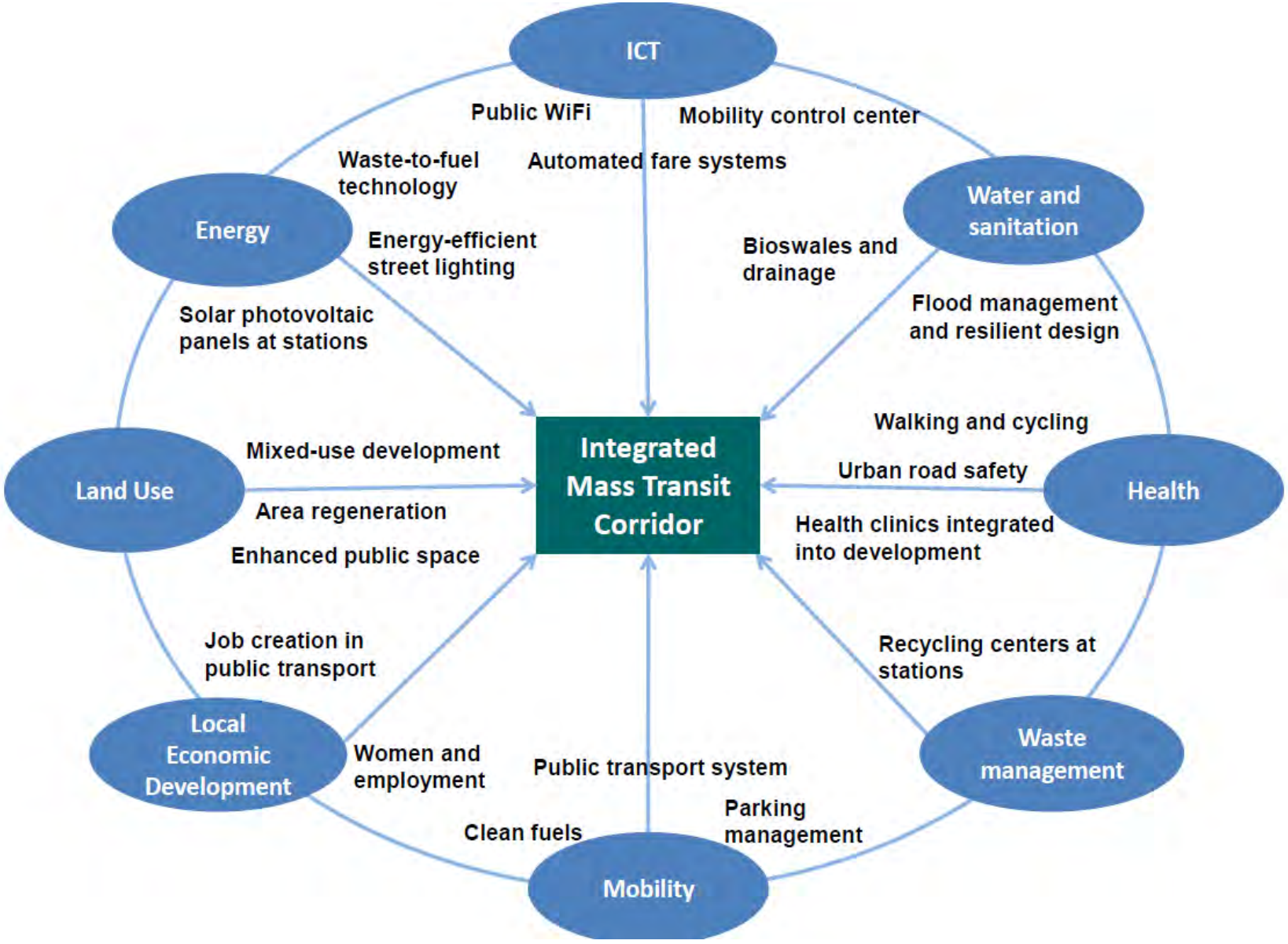
# Bus rapid transit

| | |
|---|---|
| **General rationale** | Cities need affordable quality transit option while still at low/middle income stage<br>Cost effective option for secondary cities |
| **Types of high-level technology** | Overall system design<br>BRT stations installation<br>Automated traffic management system<br>Bus management system<br>Electronic fare collection<br>Bus information system for users |
| **Approved projects** | PRC: Lanzhou, Yichang, Fuzhou and Ji'an<br>Dhaka, Bangladesh; Ulaanbaatar, Mongolia; Vientiane, Lao PDR |
| **Planned projects** | Karachi, Lahore and Peshawar, all in Pakistan; Astana, Kazakhstan; in dialogue with Philippines |



# Green urban corridors built around mass transit



# Metro and light rail mass transit

| | |
|---|---|
| **General rationale** | High quality high volume mass transit needed for large, densely populated cities |
| **Types of high-level technology** | Overall system design<br>Advanced tunneling<br>Traction system<br>Locomotives and rolling stock<br>Signaling and train control system<br>Telecom<br>Electronic fare collection<br>Train information system for users |
| **Approved projects** | Ha Noi and Ho Chi Minh metros, Viet Nam<br>Jaipur metro, Mumbai India; Tblisi metro, Georgia |
| **Planned projects** | Dhaka metro, Bangladesh; Colombo suburban light rail, Sri Lanka |

Structure/scale-up finance for large rail and mass transit projects e.g. combine bonds, syndicated loans, guarantees, ADB sovereign financing

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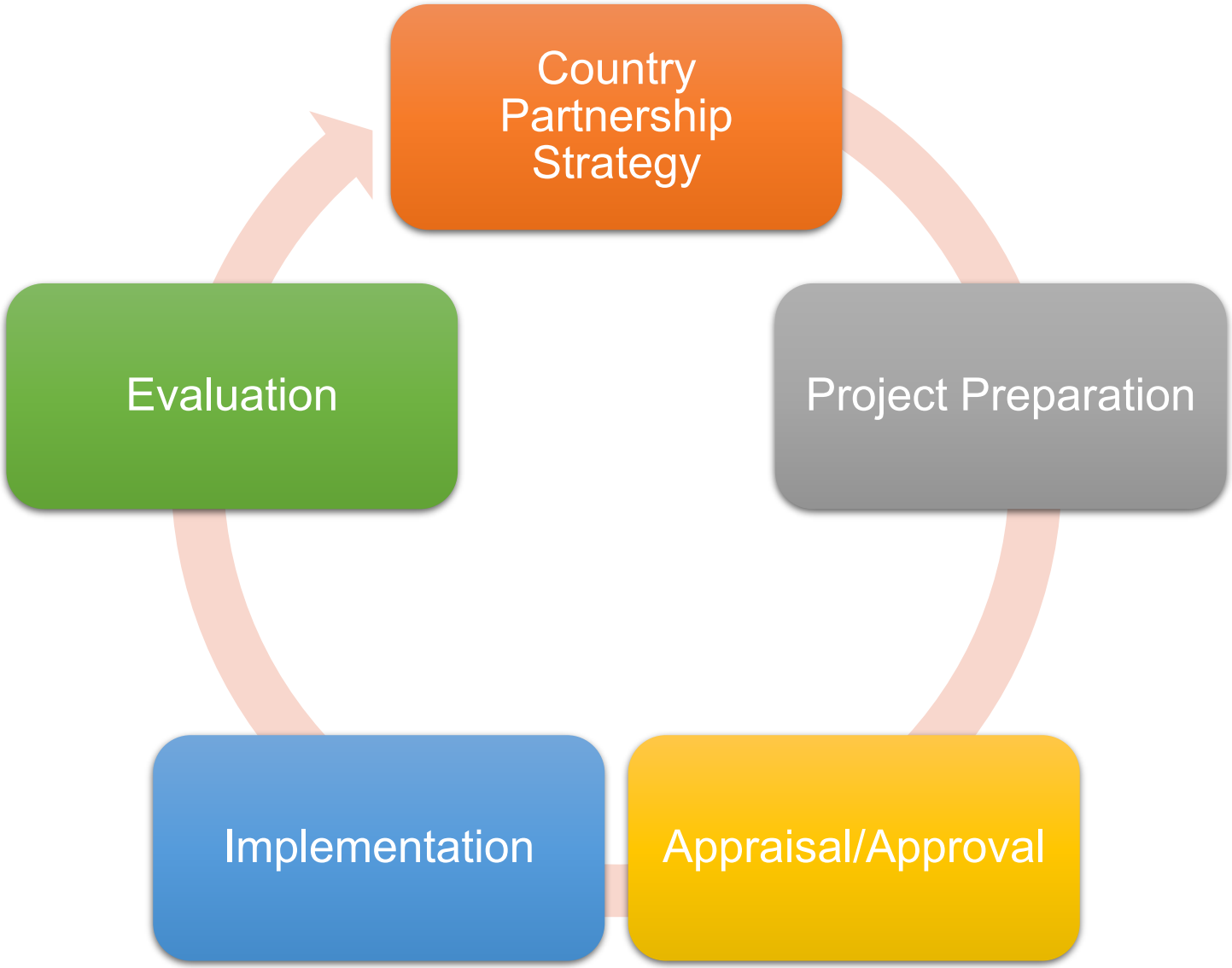
# Floating Solar Panels

The floating solar photovoltaic (PV) power generation panels at the Da Mi hydro power plant in Binh Thuan, Viet Nam.

The Floating Solar Energy Project finances the Da Nhim - Ham Thuan - Da Mi Hydro Power Joint Stock Company (DHD) to install floating solar photovoltaic (PV) power generation panels, on the man-made reservoir of its existing 175 megawatt (MW) Da Mi hydropower plant.

# ADB Project Cycle



# Asian Development Bank

# Sustainable infrastructure is…

- ✓ Accessible
- ✓ Affordable
- ✓ Environment friendly
- ✓ Safe
- ✓ Resilient

# 谢 谢 Thank you!


www.adb.org