Low-Carbon Energy Sector Outlook for Cities: Cases from South and Southeast Asia

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Project Introduction
Cluster Technical Assistance

Integrated High Impact Innovation in Sustainable Energy Technology (Regional Cluster Technical Assistance)

Subproject 1: Energy System Analysis, Technology Road Maps and Feasibility Studies for Pilot Testing (Technical Assistance 9690 – Delivered by PwC India)

Subproject 2: Prefeasibility Analysis for Carbon Capture, Utilization and Storage (Technical Assistance 9686)

Subproject 3: Pilot Testing of Innovative Energy Technologies and Business Models (Technical Assistance 9960)

## Activities under Subproject 1

### Energy system scenarios and technology road maps
- Regional and subregional
- Country-specific
  - India
  - Indonesia
  - Bangladesh
  - Pakistan
  - People’s Republic of China
  - Vietnam

### City-level feasibility studies low-carbon energy technologies and business models
- Yancheng Country, PRC (small-sized city)
- Denpasar, Indonesia (medium-sized city)
- Dhaka, Bangladesh (large-sized city)

### Regional knowledge-sharing events and publications
- Asia Clean Energy Forum
- Workshops on green mobility, high-level innovative technology
- Reports on sustainable COVID-19 vaccine cold chain, hydrogen for energy, and energy trade between DMCs
- Workshops on the energy system scenarios and technology road maps

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Background and Objectives of the Study
Globally, major cities around the world account for around 78% of total energy consumption and over 60% of total GHG emissions*. Low carbon assessments help identify potential emission sources, alternative strategies for mitigation and associated costs, thus contributing to global efforts to mitigate climate change.

Low Carbon assessments also help cities in optimizing resource efficiency and improve health outcomes by lowering carbon emissions associated with resource use.

Implementing low carbon strategies developed through low carbon assessments also enable cities to become more resilient to impacts of climate change. Further, cities can also improve their economic competitiveness by attracting low carbon investments and green jobs.

Low carbon assessments are therefore instrumental for guiding cities toward a more sustainable, resilient, and equitable future.

Objectives of the Study

- Develop city-level low carbon energy mix outlook pathways towards 2050 by analyzing energy scenarios of i) meeting universal energy access by 2030, and ii) enhanced policies for implementing national NDCs under Paris Agreement.
- Identifying investment-associated costs and financing requirements considering the developed low-carbon energy pathway.
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Modelling Framework and Approach
Developing a City-level Energy Model

Data Collection Framework

Data Collection (desk research) and reference from available databases, calculators

Data Synthesis

Sectoral Data sheets

City’s Energy Balance Sheet

Reference Energy System

City Energy Database

Model Baseline Scenario

Planned & Potential Sectoral Interventions

Stakeholder consultation and literature review

Data input for model

Data validation by stakeholders and City Experts

Data Synthesis

Scenario to comply SDGs and NDCs implementation

Optimal model output

Final validation of scenarios by stakeholders and experts

City Low Carbon Outlook

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City Low Carbon Outlook

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City-specific Assumptions

- City-level population and GDP were projected based on available forecasts and historical growth rates.
- Dhaka’s population is expected to grow from 10.2 million in 2020 to 14 million by 2050.
- Denpasar’s population is expected to grow from 0.96 million in 2020 to 1.23 million by 2050.

- Dhaka’s GDP at nominal prices is expected to grow from USD 213 million in 2019-20 to 292 million by 2050.
- Denpasar’s GDP is expected to grow from 33 trillion* in 2020 to 199 trillion* by 2050.

* Indonesian Rupiah 2010 prices
Assumptions

Scenario Storylines

Business-as-Usual (BAU) scenario

Draws upon based a combination of factors to project future energy and emissions trajectory, such as the objective of least-cost, historic trends, trends in installed capacities and utilization, resource potentials, growth in end-use energy demands.

Projections are based on the current and historic utilization patterns of various energy commodities, emerging renewables and cleaner technologies such as solar, wind, and nuclear without any forced constraint.

Low Carbon (LC) scenario

Some demand-side management and/or behavioural interventions assumed in the Low-carbon scenario are reflected at the useful energy or end-use level. The final to end-use energy conversion efficiencies reflects the process/technological efficiencies.

Takes into consideration a set of policy and technology measures at both supply and demand side for low carbon pathway. Outcomes are evaluated to analyze the potential of interventions in meeting NDC targets without any explicit application.
Outcomes of Dhaka City Assessment
Dhaka City Profile

More people are coming and settling in Dhaka every year because of education, health facilities, employment, and livelihood opportunities; Unplanned urbanization, high traffic congestion and air pollution.

Population

In 2011, population of Dhaka metropolitan was 8.9 million, which in 2022, rose to 10.2 million (Dhaka north 5.9 million and Dhaka south 4.3 million), growing at a CAGR of 1.25%.

In 2019-20, Dhaka’s GDP at nominal price was USD 213 billion and GDP per capita was USD 7,712 at nominal price. Dhaka city contributes a share of 35% towards the national GDP of Bangladesh.

In 2021, Bangladesh updated NDC to target 21.85% emissions reduction (6.75% unconditional and additional 15.12% conditional) by 2030.

Commitments

Source: List of cities by GDP, Wikipedia; Daily Sun, Dhaka contributes to 35pc of GDP: DCCI, 3 September 2023
By 2030, Under Energy Efficiency and Conservation Master Plan, government aims to lower energy intensity (national primary energy consumption per unit of GDP) in 2030 by 20% compared to the 2013 level.

National Solar Energy Roadmap under High deployment scenario anticipates future solar capacity of 30 GW of which 40% would be covered by large-scale solar PV and around 40% by rooftop solar PV systems.

Automobile Industry Development Policy 2021 aims to transform majority of passenger cars, bus, trucks and 3-wheeler auto rickshaws to EV by 2030.

Dhaka Transport Coordination Authority (DTCA) developed a 20-year strategic transport plan (STP) in 2005, revised in 2016, to develop a more integrated transit system for Dhaka city.

High Priority Climate Mitigation Actions*

Source: Dhaka Transport Coordination Authority (DTCA), 2016
## Summary of Energy Outlook Results

### Investments
- Dhaka city would need to invest USD **14.44 billion** between 2020 and 2050, under the BAU scenario.
- An additional investment of USD **28.36 billion** (0.9 Bn USD/yr) would be required to support decarbonisation efforts under LC scenario.

### GHG Emissions
- In LC scenario, total emissions would reach **16.1 MtCO2e** by 2030 (**17% lower than BAU**) and **22.8 MtCO2e** by 2050 (**40% lower than BAU**).
- About **98.7%** of the total emissions reduction are expected in the demand-side by 2050.

### Primary Energy (PE) Supply
- Under LC scenario, PE is projected to be **4.1 Mtoe** by 2030 and **10.2 Mtoe** by 2050.
- Import dependency for PES would be **88%** by 2050 under LC scenario.

### Final Energy (FE) Demand
- FE would reach **8.81 Mtoe** by 2050, under the LC scenario – 8.5% reduction from BAU
- Electricity would occupy a share of **87%**, followed by oil at **8%** by 2050.
- Off-grid electricity demand would need to grow at a CAGR of **20.3%** between 2020 and 2050 vis-à-vis 5% under BAU

### Installed Capacity & Generation
- Grid-connected solar PV capacity would reach **5 MW** by 2030 and **34 MW** by 2050, under LC scenario.
- Off-Grid solar PV capacity would reach **6.8 GW** by 2050.
- Total Generation would reach **0.32 TWh** by 2030 and **11.99 TWh** by 2050; rest imported

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*In billion USD, 2023 prices*
Conclusions and Recommendations for Dhaka City
Conclusions and Recommendations (1/2)

Ramping up off-grid PV capacity for power generation

• **Ramping up off-grid PV capacity** for power generation for clean energy transition and reducing import dependency. Installed off-grid solar capacity within city boundaries to reach **6.84 GW by 2050** to reduce share of imported electricity in electricity from 99.6% to 88%.

• Installment of **about 7 GW** of distributed solar, as envisaged in the LC scenario, is a formidable task for Dhaka city. A host of fiscal, policy and regulatory measures would be necessary to achieve this scale of transition which enhances urban resilience and energy independence.

Need for collaborative process

• **A 'collaborative' process** for monitoring and evaluating progress in low-carbon pathways.

• The 'collaborative' comprising energy company, city officials, local trade organization(s), NGOs and power cell representative(s) could meet at regular intervals to enable and ensure transparency, real-time M&E, and assessment of outcomes.

Innovative low-carbon business models and role of governments

• **Innovative business models** such as a city-level demand aggregation and bulk procurement model can be considered for boosting uptake of low carbon technologies.

• City administration can **support better implementation** of these schemes/programs by providing the information of vendors for various kinds of services associated, fast-tracking government approvals, promoting best practices and developing demonstration projects.
Conclusions and Recommendations (2/2)

Fuel Shift

- Almost 99% of the residential cooking would be met through electric cooking technology like (Induction cookers) at the final energy level by 2050;
- More than 30% electric vehicle (EV) penetration in the road transport sector by 2050 at final energy level;
- Use of natural gas in industries to be replaced by electricity

Renewable Energy

- Under LC pathway, about 20% of the total energy demand in the residential buildings (excluding cooking) would be met by solar rooftop PV by 2050;
- Around 25% of the total electricity demand in the commercial buildings would be met by solar rooftop PV by 2050;
- 3% of total energy demand in industry would be met by solar-off grid by 2050

Investments

- Additional investment of USD 28.36 Billion** would be required between 2020 and 2050 compared to the BAU scenario
- It is therefore important to identify initiatives enabling access to finance and various ways of mobilizing finance for city-level climate action at scale.

* https://idcol.org/home/solar; **In billion USD, 2022 prices
Outcomes from Denpasar City Assessment
The city of Denpasar, capital city of Bali province, is a widely renowned tourist hub.

Tourism therefore has a significant impact on the city’s economy and energy needs, with wide seasonal variations.

Sustainable tourism will be an essential element for the low carbon energy transition and hence encouraging sustainable tourism will be critical for the city economy, its people, and the environment.

In 2019, Denpasar had a GDP of USD 3.93 billion and per capita GDP of USD 4,160.

Denpasar recently passed a regulation which directs city to use clean energy to meet energy demand. The city is a signatory to the ‘Global Covenant of Mayors’.

Total population of Denpasar is around 1 mn in 2023. It is Bali’s capital and most populous city with 4 districts (North, South, East and West).

The city is almost entirely dependent on imports for meeting its energy needs. The city is a tourist hub and needs to support its growing energy demand.

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Denpasar City’s Climate Efforts and Commitments

Indonesia’s National Climate Commitments

- Latest NDC* commits to higher GHG reduction target of 31.89% (unconditional) and 43.2% (conditional) as compared to 29% and 41% respectively in previous NDC.
- The Long-Term Low Carbon and Climate Resilience Strategy (LTS-LCCR) 2050 lays out a vision to achieve net-zero emission by 2060 or sooner.

In 2019, Bali Provincial Government issued two regulations to realize a clean energy supply: the ‘Bali Clean Energy’ and the ‘Use of Battery-Based Electric Motorized Vehicles’ acts.

The Bali Net-Zero Emissions 2045 Initiative consists of various efforts aimed at low carbon development in Bali through transition to renewable energy, electric mobility, and climate entrepreneurship, all geared towards achieving Bali Net Zero Emissions by 2045.

University partnership for Community-Based Renewable Energy (CORE Udayana) to support development of a technical guideline for effective implementation of Bali Clean Energy Governor Decree in a project endorsed by Bali Provincial government.

Denpasar City’s Climate Mitigation Actions to support national commitments

Source: Indonesia Enhanced NDC 2022; Institute for Essential Services Reform (IESR), 2023

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### Summary of Energy Outlook Results

#### Final Energy Demand
- FE demand would reach **1.82 Mtoe** by 2050, under LC scenario (10% lower than BAU in 2050).
- Oil demand would hold a share of **51%**, followed by electricity at **42%** by 2050.
- Off-grid electricity demand would grow at a **CAGR of over 15%** between 2020 and 2050.

*In billion USD, 2023 prices

#### Installed Capacity & Generation
- Grid-connected solar PV capacity would reach **6 MW** by 2030 and **101 MW** by 2050, under LC scenario.
- Off-Grid solar PV capacity would reach 310 MW by 2050.
- Total generation would reach **0.04 TWh** by 2030 and **0.7 TWh** by 2050; rest imported

#### Investments
- Denpasar city would need to invest **USD 3.64 billion** between 2020 and 2050, under the BAU scenario.
- An additional investment** of **USD 595 million** would be required to support decarbonisation efforts under the low carbon scenario.

#### GHG Emissions
- In LC scenario, total emissions would reach **1.3 MtCO2e** by 2030 (1.5%) and **3.9 MtCO2e** by 2050 (17.6%) – 2% and 18% lower than BAU scenario.
- About **93%** of the total emissions reduction are expected in the demand-side by 2050.

#### Primary Energy (PE) Supply
- Under LC scenario, PE is projected to be **0.64 Mtoe** by 2030 and **2.05 Mtoe** by 2050.
- Import dependency for PES would be **96.8%** by 2050 under LC scenario.

*In billion USD, 2023 prices
Conclusions and Recommendations for Denpasar City
Conclusions and Recommendations (1/2)

**Key opportunities**

- Key low carbon transition opportunities for Denpasar city are **uptake of RE and electrification of transport, industry, and cooking**.
- The interventions in the transport and buildings requires involvement from both national & local government and private sector, while power sector interventions, such as scaling up solar PV, are mainly driven by national policies.

**Renewables for power generation**

- Ramping up **off-grid PV capacity for power generation** for clean energy transition and reducing import dependency
- **Installed off-grid solar capacity** within the city boundaries to reach 0.31 GW by 2050 to reduce the share of imported electricity in electricity from 99.3% to 93%.

**Fuel Shift**

- Under LC scenario, more than 25% of the residential cooking would be met through **electric cooking stoves** at final energy level by 2050
- More than 15% **electric vehicle (EV) penetration** in the road transport sector by 2050 at final energy level
- **Biofuel blending of more than 20%** in the conventional petroleum supply for transport by 2050
- More than 80% of total cooling demand will be met through **efficient chillers** by 2050

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Conclusions and Recommendations (2/2)

**Renewable Energy**
- About 10% of total electricity demand in residential buildings (excluding HVAC demand) met by solar rooftop PV in 2050.
- 7% of the total electricity demand in commercial buildings (excluding HVAC) met by solar rooftop PV by 2050.

**Innovative low-carbon business models and role of governments**
- Innovative business models such as a city-level demand aggregation and bulk procurement model can be considered for boosting uptake of low carbon technologies.
- City administration can support better implementation of these schemes/programs by providing the information of vendors for various kinds of services associated, fast-tracking government approvals, promoting best practices and developing demonstration projects.
- Influencing behaviour e.g., developing supporting charging infrastructure & fast charging terminals, financial incentives to electric vehicle owners like waving off parking charges and municipal tax wavers, promoting non-motorised transport.

**Investment and financing needs**
- Additional investment of USD 595 million** would be required between 2020 and 2050 compared to BAU scenario.
- A city-level low-carbon transition requires close collaboration between city administration, Provincial and Federal government, and private investors to build institutional and technical capacity for implementing low carbon strategies, and to identify appropriate sources of finance.

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* https://idcol.org/home/solar; **In billion USD, 2020 prices

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Thank you

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PE/December 2024/M&C 33411