

# Smart Urbanization: Managing Energy Demand with Efficiency, Mitigation, and Future Trends

Prepared for SAARC Energy Center  
Webinar on "Urbanization-Energy Demand Nexus: Challenges and Mitigations"

25<sup>th</sup> October 2024

ABBAS IHSAN, PHD

APPLICATIONS ENGINEERING LEAD

ENERGY AUSTRALIA

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# Introduction - Urbanization and Energy Demand

## Urbanization in South Asia:

- Rapid urban population growth in countries like India, Pakistan, Bangladesh, Nepal, and other participating countries.
- Urban energy demand projected to increase by 60% in South Asia by 2040.

## Urbanization's Impact:

- Increasing demand for electricity, gas, and transportation fuels.
- Infrastructure strain and inefficiencies in energy supply.
- Need for innovative solutions to balance urbanization and energy demand

# Current Energy Management Challenges in Urban Areas



## Key Challenges:

Over-reliance on fossil fuels, especially coal and oil for power generation.

Outdated infrastructure in many cities leading to high transmission losses (~15-20% in some regions).

Inefficient use of energy in commercial and residential sectors (e.g., inefficient air conditioning systems).

## Urban Planning Gaps:

Unplanned urban migration

Minimal focus of timely infrastructure upgrade

Lack of energy-efficient building codes and weak enforcement in rapidly urbanizing areas.

# Urban load segmentation (Residential and Commercial)

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Space cooling  
(electric)



Space heating  
(electric or gas)



Water heating  
(electric or gas)



Cooking (gas)



Other (lighting,  
washing, drying..)



Transportation  
(fossil fuels)

# Smart Energy Efficiency Solutions for Urbanization

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## Energy efficient buildings



Reverse cycle heating and cooling (3x efficient then traditional space heating and cooling)



Hot water heat pumps (3x efficient then traditional water heating)



Induction cooktops (2x efficient then traditional cooking),

Insulation (1.5-2x reduction of energy usage)



LED lighting (2-3x efficient then traditional lighting)

***Case study: Victoria's rooftop solar PV, battery, hot water heat pumps and reverse cycle aircon programs***

## Smart grids



Efficient distribution networks

Demand response (strategies through network operation and consumer)



Smart meters (accuracy in management of electricity import/export)



Home energy management systems (HEMS)

Adoption towards application of Virtual Power Plants

# Mitigation Strategies to Reduce Urban Energy Demand

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## Distributed Energy Generation:

Programs to consider integration of solar PV and battery storage systems into residential and commercial buildings.

Infrastructure development to cater efficient utilization

Resulting in average 30% to 50% of energy savings annually

Poses challenges from generation side (duck curve in California, UK markets)



## Energy management

With efficient appliances in place strategies for better utilization can further contribute to reduce consumption

Demand response strategies including load shifting, consumption patterns at excess generation or low-price periods

Benefits would include energy reductions, less reliance on the grid and cost savings for consumers.



## Electrification of Transportation:

Electric Vehicle (EV) adoption, charging infrastructure, and integration with the grid (e.g., V2G).

Reduction of urban transportation emissions by replacing fossil fuel-based transport with EVs and public transit electrification.



## Orchestration of assets via VPP

Forming a smart urban energy nexus

Adopt and allow consumers to participate actively as both consumers and generators

Optimal utilization of generation and consumption assets in real time



## Reduce Carbon emissions

Planning towards renewable generation

Energy efficient utilization of assets

Reduction in energy consumption and smart strategies adoption in the urban energy nexus

Resulting in significant reduction of carbon emissions

# Future Trends in Smart Urbanization and Energy Demand

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## Renewable Energy Integration:

Scaling up solar PV, wind in urban grids while taking advantage of local resources (Example, record influx of rooftop solar PV in California CAISO, and Texas ERCOT markets). Hybrid distributed energy systems combining renewable energy with conventional power for urban resilience.



## Energy Storage Technologies:

The role of battery storage in balancing intermittent renewable energy (example: Tesla's Powerpack in Australia).



## Virtual Power Plants

Forming a smart urban energy nexus  
Predictive load management through AI and optimization in high-density urban areas.  
Using modern techniques like machine learning to anticipate and smooth energy demand fluctuations.

# Final thoughts and next steps..

- ▶ Smart urbanization is essential for balancing energy needs, especially as South Asia continues to urbanize at a fast pace.
- ▶ Smart solutions like renewable energy integration, smart grids, and efficient building systems are essential to manage growing urbanization needs.
  - ▶ Integration of rooftop Solar PV results in substantial energy savings and decrease reliance on the grid
  - ▶ Energy efficient appliances like reverse cycle aircons, hot water heat pumps, insulation, results in 2-3x reduction in energy consumption as compared to traditional methods
  - ▶ Electric Vehicle (EV) adoption, charging infrastructure, and integration with the grid (e.g., V2G) drastically reduces the transportation demand.
  - ▶ Smart urban energy nexus in the form of VPP can significantly reduce not only the load but also warrants its cost-effective utilization while reducing the carbon emissions.

## Next steps:

- ▶ Governments should implement building codes and promote energy-efficient technologies.
- ▶ Regional cooperation in urban energy management (sharing best practices across SAARC nations and other developed economies).
- ▶ Technology Recommendations:
  - ▶ Scale up rooftop solar and battery storage in urban areas.
  - ▶ Encourage adoption of smart grid technologies for real-time energy management.

Thanks..