Awareness creation and capacity building-

DC Guidelines and Economic Assessment for DCS

14th Mar 2024

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of
Federal Ministry for Economic Affairs and Climate Action
of the Federal Government of Germany

Alliance for an Energy Efficient Economy

Energy is Life, Conserve it

District Cooling Guidelines

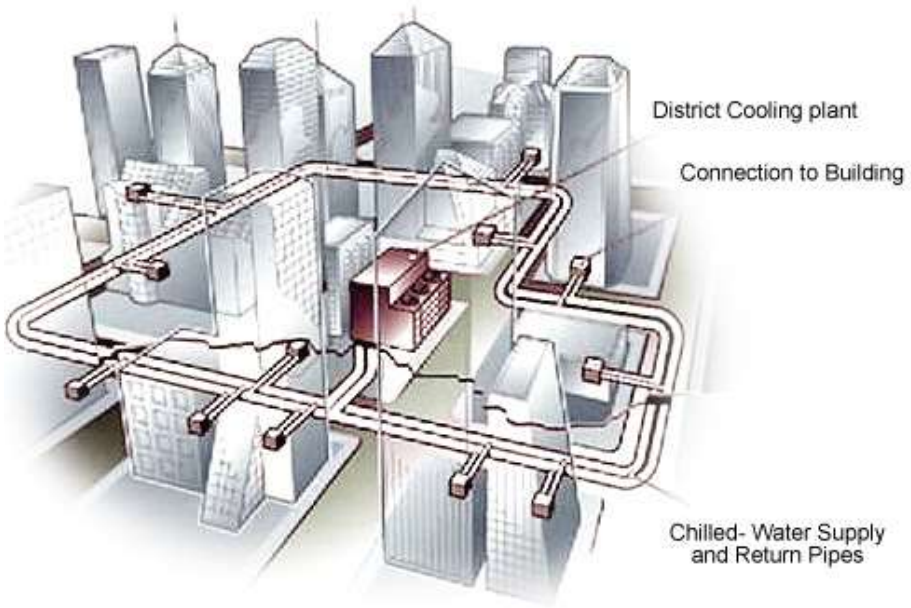
Key Highlights – District Cooling Guidelines (launched at CEM-14/MI-8 in Goa)

- The guidelines act as an information handbook on DCS for a range of stakeholders
- Define District Cooling Systems (DCS) and its multiple benefits
- Provide guidance on different stages of DC project development
- Present roles and responsibilities of key stakeholders in DCS in India
- Recommend state-level actions to promote DCS
- Provide case studies of operational DCS projects in India

**The guideline is not intended to be a DC Code, however, it can be a precursor to the DC Code as and when developed*

District Cooling Systems (DCS) and its Multiple Benefits

"One Single Cooling Network, Distributing Chilled Water to a Cluster of Buildings as a Self-Sustaining Service"



- **Reduction in Installed Cooling Capacity**: Up to 50% reduction
- **Reduction in Peak Energy Demand** (up to 40% reduction) **and Avoidance of New Power Infrastructure**
- **Energy Savings:** Due to high-efficiency equipment and professional O&M
- **Cost Avoidance**: Chillers, Cooling Towers, etc. are not required at the building level; ~20% lifetime cost reduction
- **Monetisation of Increased Leasable Area:** Freed up rooftop and basement spaces
- **Better Refrigerant Management:** Leakages could be completely eliminated and promotes transition to natural refrigerants
- **Reduction in Urban Heat Island Effect:** Elimination of hot pockets within the liveable spaces
- **Complements Resource Circularity:** Integration with other utilities, anchor loads for STP, waste to energy, distributed renewable energy, etc.

Key Components of DCS

1. District Cooling Plant

- Chillers, Refrigerants, Thermal Energy Storage, Heat Rejection Systems, Other Plant Auxiliaries

2. Distribution Network

- Underground and Above-ground Systems.

3. Energy Transfer Stations

- Direct and Indirect Connection types

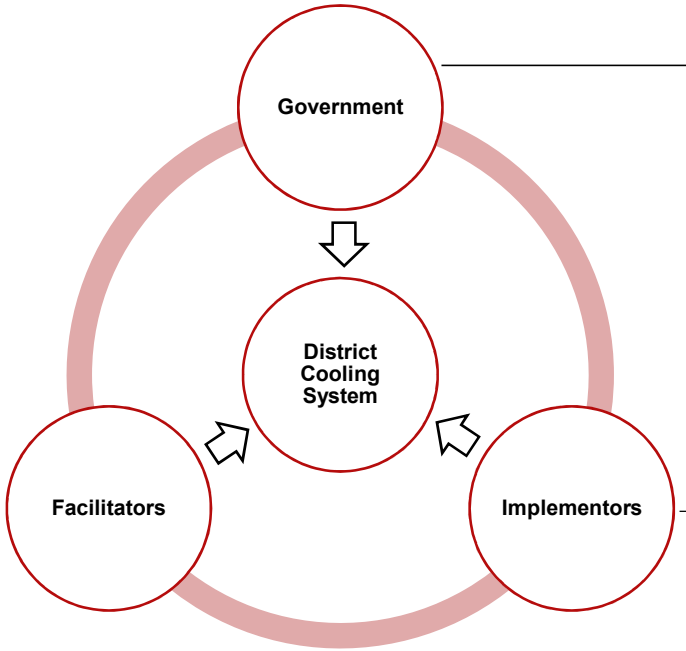
4. Instrumentation, Monitoring, and Control System

- Management layer, System layer, Automation layer, and Instrument layer

5. Measurement and Billing System

Key design considerations while referring to nationally/globally accepted technical codes and standards

Key Stakeholders in DCS In India



Prioritizes actions in accordance with national policies

BEE, MoHUA, CPWD, NBCC, MoEF&CC, State Level Development Authorities, ULBs

Facilitate a project and provide means for the development of a project

Investors, Multilateral / Bilateral Institutions, Associations

Brings project to a reality

Design Consultants & Contractors, Technology Providers, Real Estate Developers, DC Project Developer / Service Provider / Operators

“Collaborative approach necessary for successful implementation”

Enabling Actions Required from the Government

Designating DC service as a utility: Applicable taxes and incentives for DCS be treated on par with other public utilities such as PNG, electricity, and water.

Guidance on DC tariffs to ensure fairness and transparency: considering interests of all three key players, i.e., end-customers, real estate developers, and DC service providers.

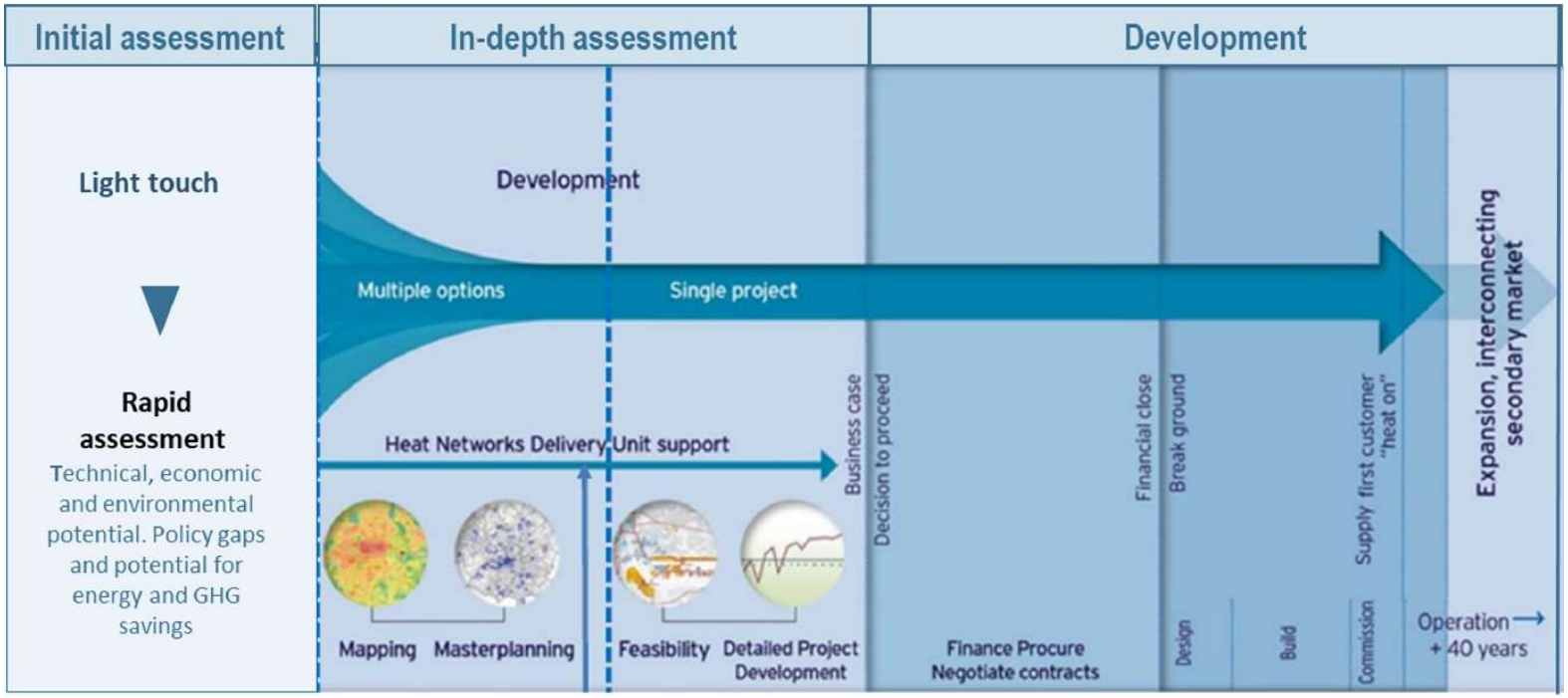
Competitive electricity and water tariffs for DCS: Commensurate with prevailing tariffs for similar category of consumers.

> **Regulatory Mechanism can propel the adoption of DCS In India**

Project Evaluation Criteria and District Cooling Project Cycle

Provides guidance on site selection criteria and evaluation methodology

Different stages of District Cooling Project Cycle



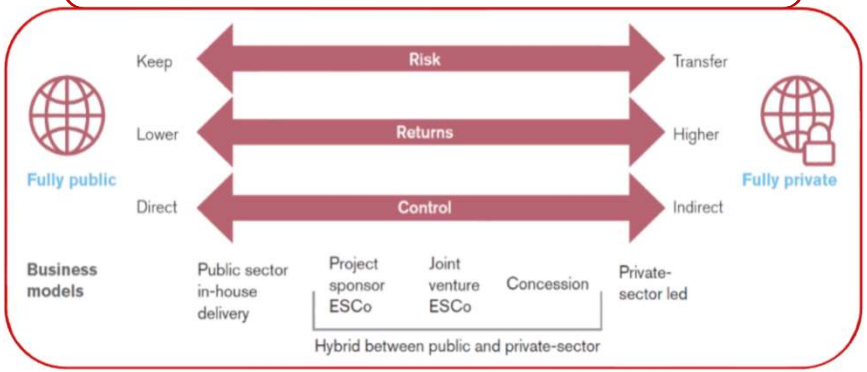
Source: DBEIS Heat Networks Delivery Unit

Economics of DCS and Bidding Choices

District Cooling Tariff Structure:
Consumption charge, Demand/fixed charge, Connection charge, etc.

Contracting between Customers and DC Service Provider

Business Models for DCS:



The selected models can be tailored to meet the project objectives and align with stakeholders needs

Bidding Objectives

Case Studies of Bidding Contracts:
Solar Grid Power and Transmission Projects

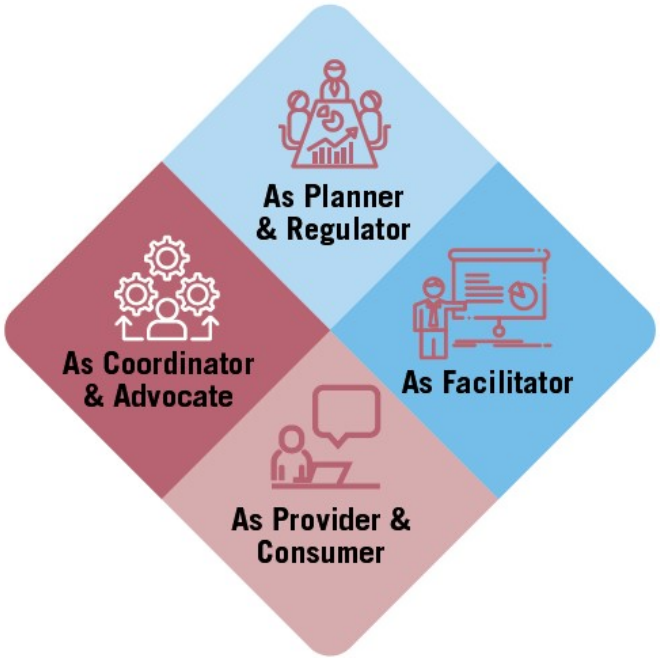
Bidding for DC Projects

State Level Actions for Promotion of DCS

Role of Municipalities / Town Planning Department

Integrate DCS in the city master plans; designate areas for district cooling

Coordination between different players; advocate for supporting policies and funding commitments

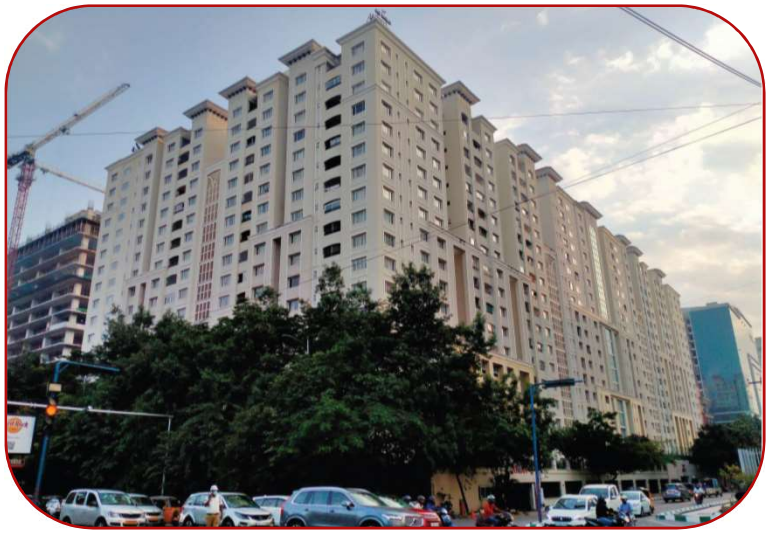


Access to low-cost finance

Provide cooling-as-a-service; provide anchor loads

Case Studies of Operational DCS in India

Gift City, Gandhinagar



My Home Abhra, Hyderabad

both design and operational energy efficiency data are provided

Details of GIFT City Case Study

	DC System Details
Location	Gandhinagar, Gujarat
Building Types	Mixed-use development: offices, residential towers, hotels, retail, institutional, etc.
Business Model	Full public ownership
Operational Since	The first phase GIFT DC system has been operational since March 2015.
Total Master Plan Land Area	886 acres
Total Built-Up Area	Planned: (>62 Mn sqft; Current: (>3 Mn sqft)
Number of Buildings Connected to DC System	Planned: (130); Current/under progress: (20+)
Underground utility tunnel	8+ km
Required vs installed cooling capacity	40% reduction from vapor 240,000 TR to 145,000 TR
Thermal Energy Storage System	10,000 TR-h
Required vs installed power demand	~50% from 240 MW to 130 MW

Normative References

- Load Calculations
- Sustainable Building Design and Air-conditioning Systems
- HVAC Systems for District Cooling
- Chillers
- Air Handling Units and Coils
- Energy Recovery Ventilation
- Dedicated Outdoor Air Systems (DOAS)
- Plate Heat Exchangers
- Water Pumps
- Cooling Towers
- Motor
- Fans
- Pipes and Fittings
- Thermal Energy Storage
- Refrigerants
- Thermal Energy Meters
- Commissioning
- System Energy & Efficiency
- Energy Services & Management
- Risk Management
- DC Guides and Other References

Comprehensive compilation of normative references for all technical design and operational aspects related to DCS projects

Knowledge Products by UNEP for More Details on DCS

- Rapid Assessment and Prefeasibility Studies in India
- District Energy in Cities Initiative: National District Cooling Potential Study for India
- District Energy Projects: MRV Framework Guidance MRV framework guidance
- District Energy in Cities: Unlocking the Potential of Energy Efficiency and Renewable Energy
- District Cooling Systems eTraining – India

Key Takeaways of DC Guidelines

Help address the information gap especially dealing with relevant government departments

Introductory resource to know about DCS benefits and the key design and operational considerations

Anchor future discussions on framing supportive policies and regulations for greater adoption of DCS in India

Economic Assessment of DCS

Benefit-cost analysis of DCS compared to traditional cooling systems

Introduction

Economic assessment to evaluate the life cycle costs of DCS vis-à-vis comparable traditional “standalone - chilled water” cooling systems

For a mixed-use development - hotel, retail, and office areas - totaling 34 lakh square feet, coming up in a phased manner

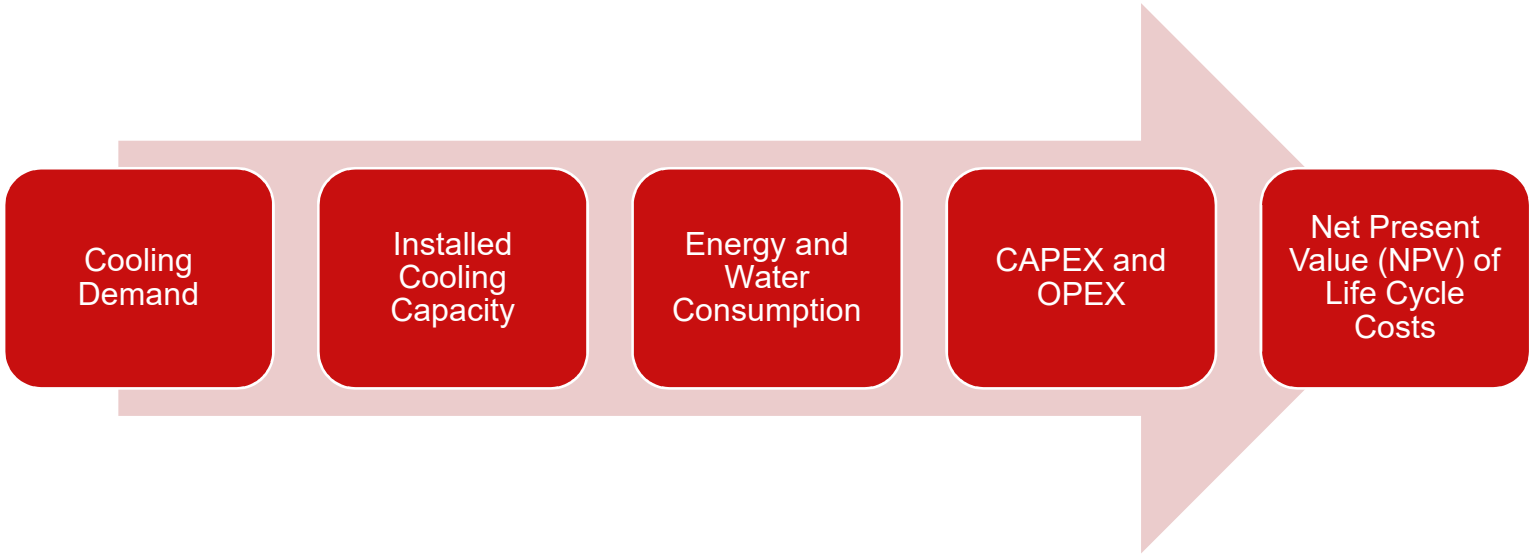
NPV analysis of the life-cycle costs for owning and operating a cooling system was carried out for both scenarios- for both high side and low side

Parameters like cost of capital, interest on loans, depreciation, GST, and income tax were not considered in the initial assessment for both scenarios

All the inputs and assumptions have been validated through consultations with subject matter experts- facility management firms, OEMs, industry associations, dealers and distributors, DC service providers

Methodology

Steps to calculate the NPV of life-cycle costs



Sizing Assumptions

There is a ~40% reduction in the installed cooling capacity in the DCS scenario

	Reference Scenario	DCS Scenario
Cooling Requirement (TR)	9,714	9,714 (realised as 6,800)
Installed Cooling Capacity (TR)	11,600	7,200

Energy and Water Consumption

Improvement in operational energy efficiency: DCS 0.9 kW per TR; Traditional system 1.1 kW per TR

EFLH: 1500

	Reference Scenario	DCS Scenario	Saving or Reduction
Power Demand (MW)	12.29	7.11	5.18
Annual Electricity Consumption (MWh/year)	16,029	13,398	2,631
Cumulative Electricity Consumption in 30-years (MWh)	4,79,400	4,06,215	73,185

Reduction in power demand: 42%, saving ~2.5 Crore INR per year in demand charges alone

Reduction in annual electricity consumption: 16%, saving ~4 Crore INR per year

Reduction in potable water consumption: 5 Litre/TR-h from 7 Litre/TR-h, saving 0.8 Crore INR per year

CAPEX Assumptions

Input Parameter	Unit	Reference Scenario	DCS Scenario
High Side CAPEX	INR/TR	50,000	62,500 to 87,500
Low Side CAPEX	INR/TR	50,000	50,000
Additional Power Infrastructure	INR/kW	12,500	12,500
DG Infrastructure (attributable to HVAC)	INR/kW	15,000	15,000
CAPEX for DC Plant land (only applicable for DCS)	INR/sq.ft.	NA	3,200

OPEX Assumptions

Input Parameter	Unit	Reference Scenario	DCS Scenario
High Side Operations	INR/TR/year	1,000	700 to 900
Low Side Operations	INR/TR/year	800	800
High-Side Maintenance (done by OEMs)	INR/TR/year	2,100	1,050
Low-Side Maintenance (done by OEMs)	INR/TR/year		1,050
High-Side Asset Management	INR/TR/year	250	50
Low-Side Asset Management	INR/TR/year		125
High-Side Insurance Rate (including Distribution Network in DCS)	% of CAPEX	0.25%	0.25%
Replacement CAPEX Required over a 30-year contract duration	% of CAPEX	85%	85%
Refrigerant Top-up Cost due to Operational Leakages (excluding accidental leakages)	INR/TR/year	9.8	-
Fixed Electricity Demand Charges	INR/kW/month	300	300
Variable Electricity Tariff (with taxes & cesses)	INR/kWh	11.50	11.50
Treated Sewage Effluent (TSE) Water Cost	INR/Litre	0.20	0.20
Potable Water Cost	INR/Litre	0.24	0.24

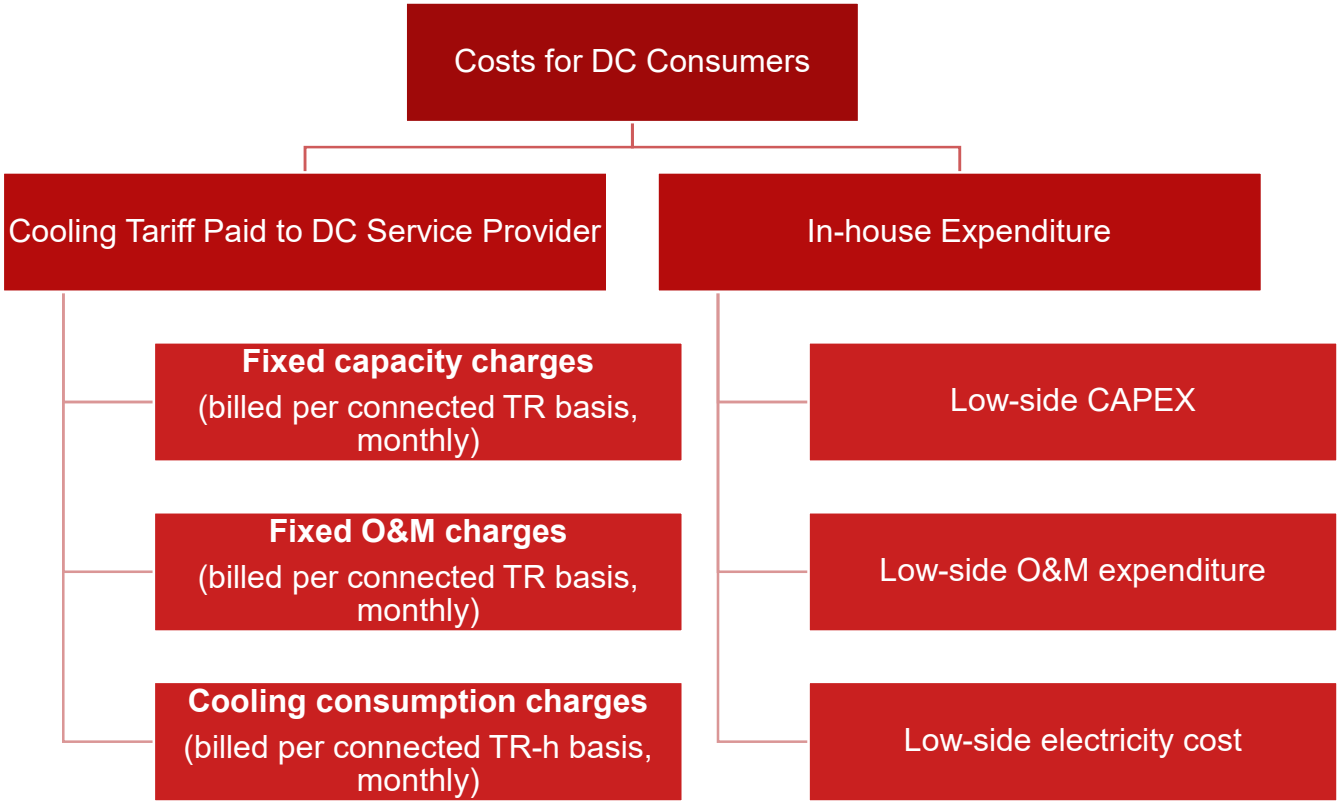
Other Assumptions

Input Parameter	Unit	Reference Scenario	DCS Scenario
DCS contract duration (only applicable for DCS)	years	NA	30
Distribution Network Losses	°C per km of network length	-	0.1
Annual Cost Escalations (CAPEX, O&M, Electricity & Water Tariffs, Monetisation of Freed-up Space)	%	5%	5%
Discount Rate (for NPV analysis)	%	12%	12%
Space Required for Chilled Water Plant Installation	sq.ft./TR	2.00	2.00
Opportunity Value of Freed-up Space	INR/sq.ft./month	NA	25.00

- In DCS scenario, the rooftop and/or basement space at the individual building level, otherwise required for chilled water plant, can be released and repurposed

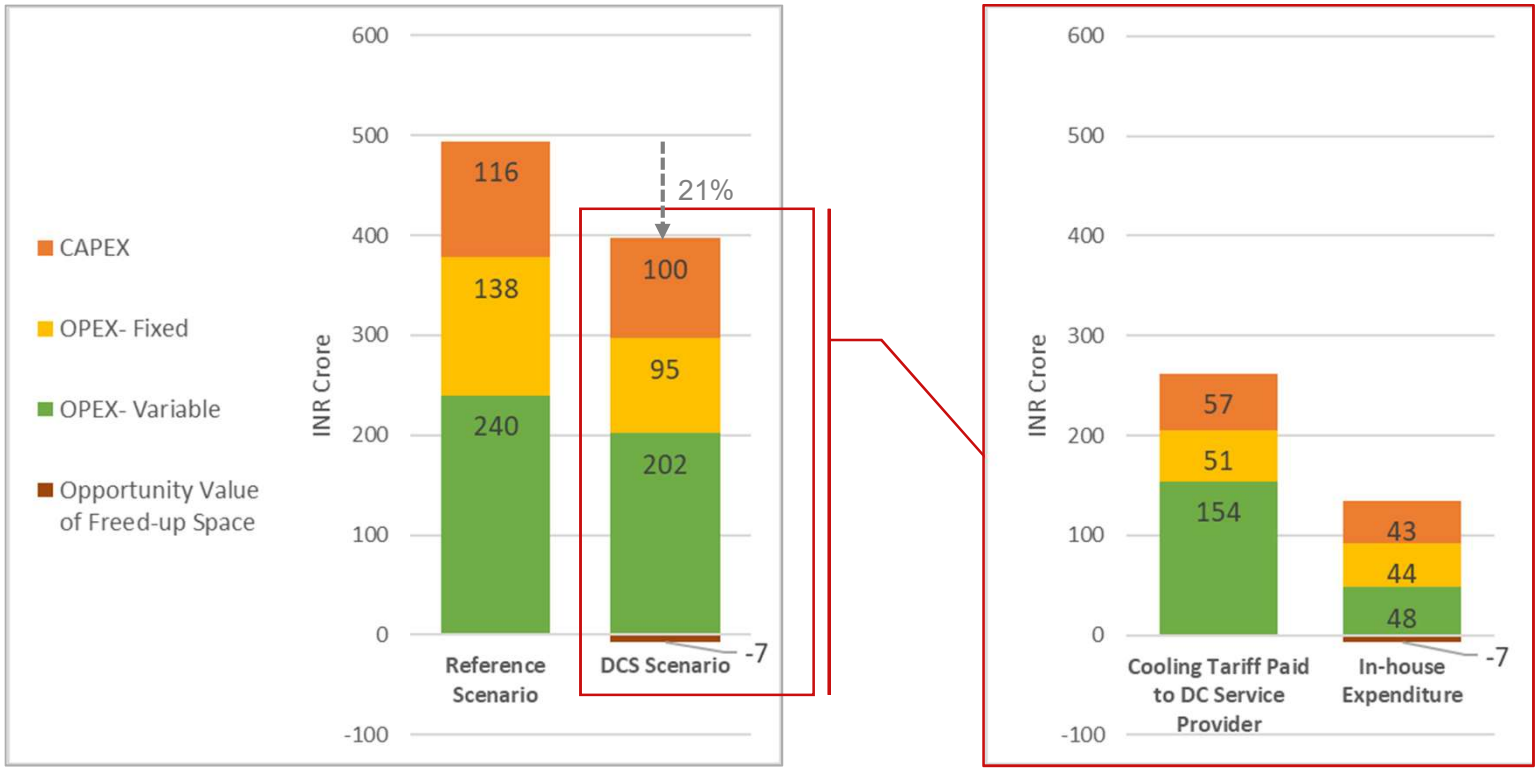
Overall Cooling Costs for DC Consumers

Apart from Cooling Tariff, DC consumers also have to pay the costs of installing, maintaining, and running the air-side equipment at the building level



Results of Benefit-Cost Analysis (from DC Consumer's Viewpoint)

- The NPV of DCS over the 30-years life of the project is 21% better compared to standalone chilled water systems



- Incorporating GST and service fees levied by the DCS company will affect the cost advantages of DCS

THANK YOU

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