5th International Conference on Smart Energy Systems
Copenhagen, 10-11 September 2019
#SESAAU2019

Fast Decision Making Tool for District Cooling Project Development in Urban Planning Stage: an Application in India

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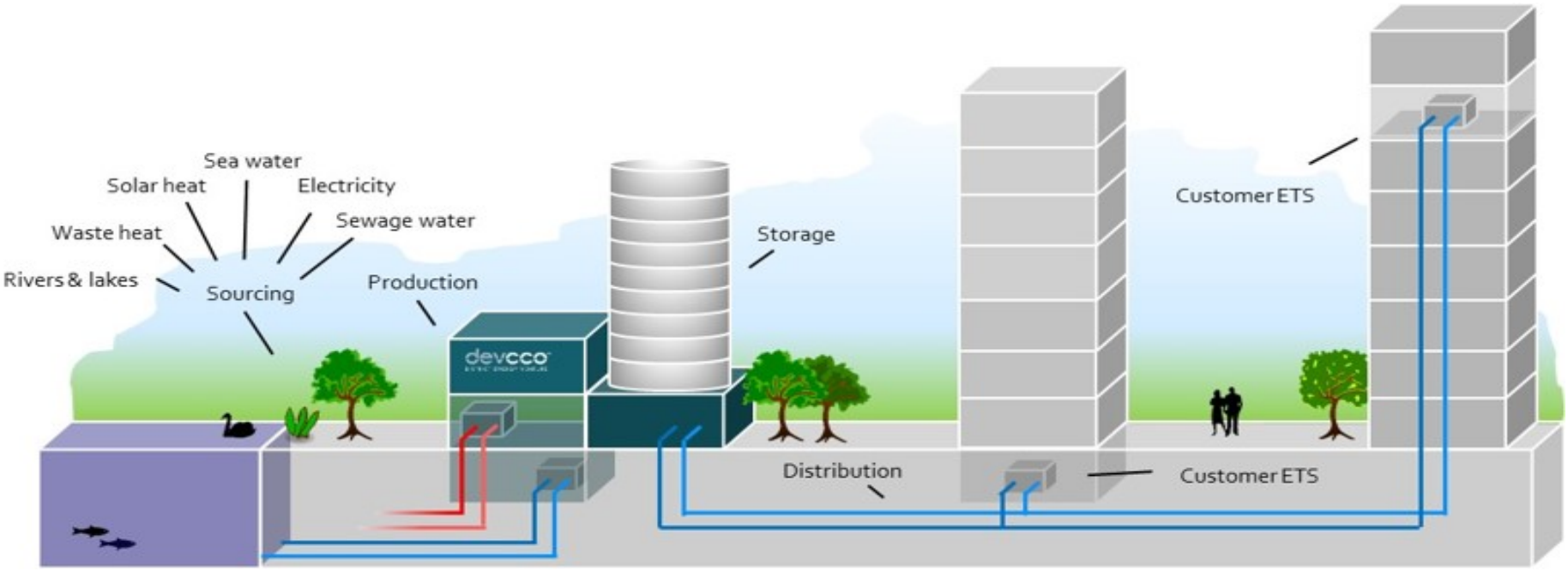

District cooling aims to use **local energy sources** that otherwise would be wasted or not used, in order to offer for the local market a **competitive and high-energy-efficient alternative** to the traditional cooling solutions.

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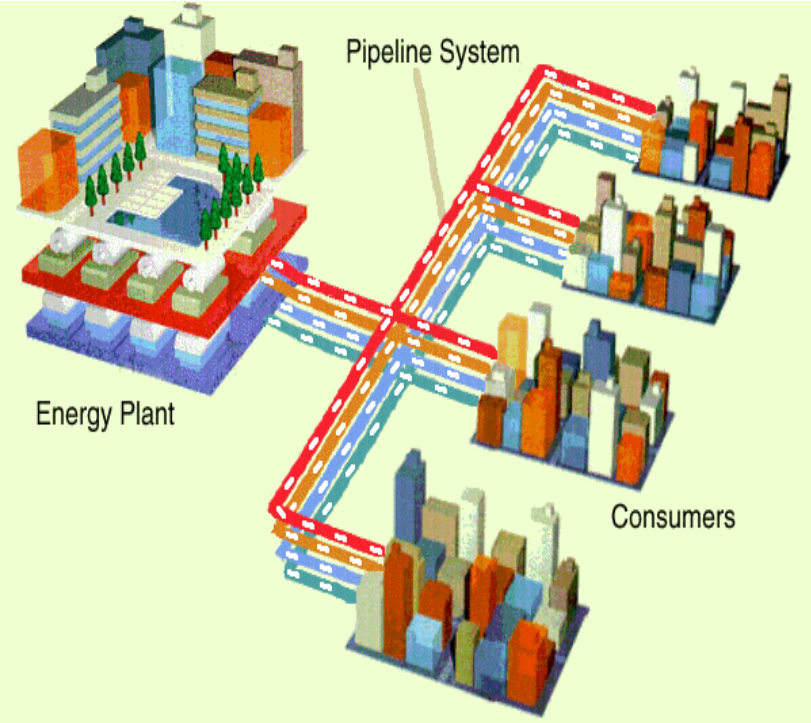
Definition of District Cooling:

- A system to combine heating/cooling station and end-users through pipeline network
- Is defined as **public service**, similar to electricity, water, gas etc.
- Cooling sources could include waste heat, electrical cooling, free cooling etc.
- Targeted customers: industrial/process cooling (warehouse, data centre), city complex, public buildings (hospital), commercial buildings, luxury residential buildings



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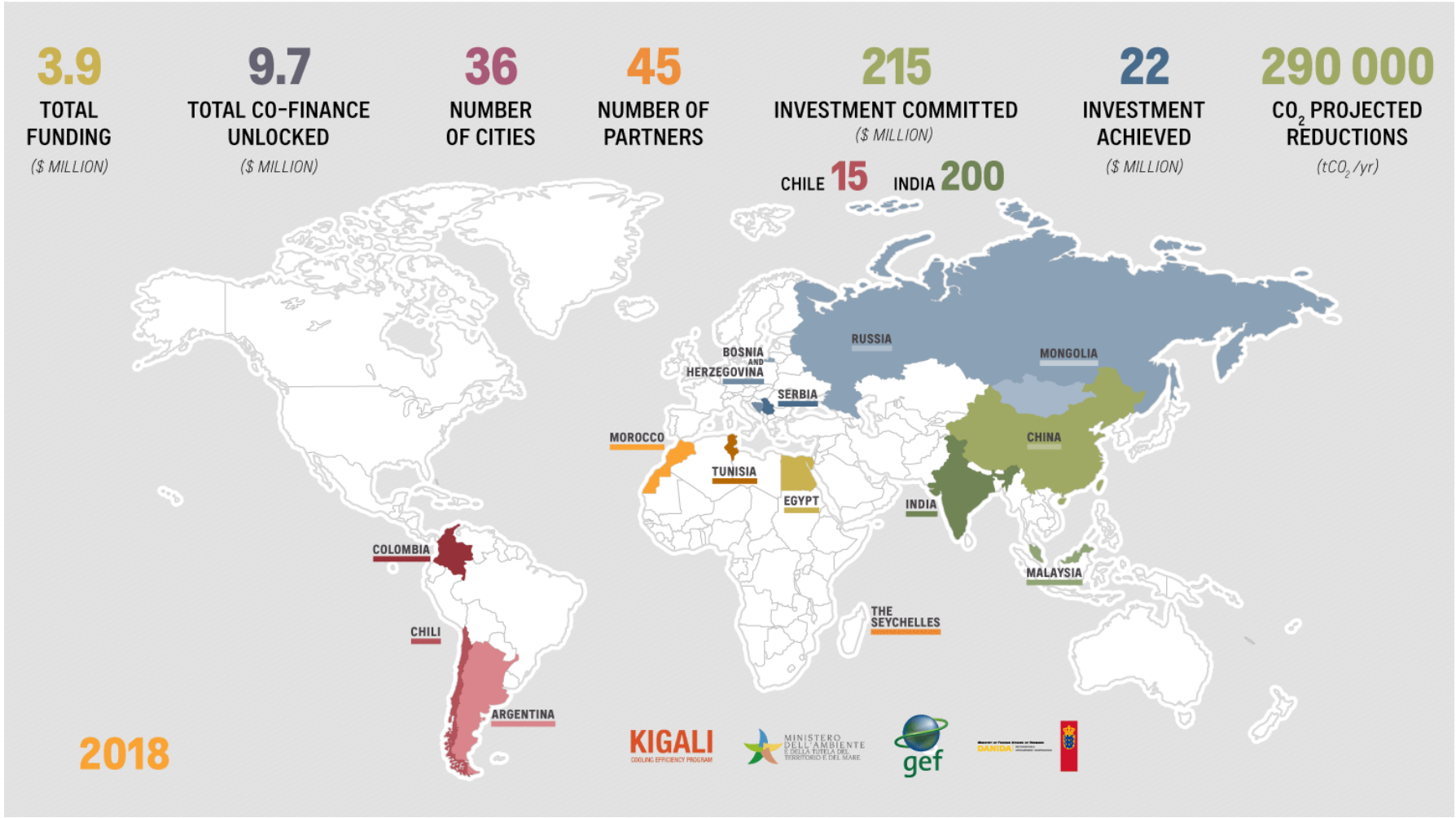

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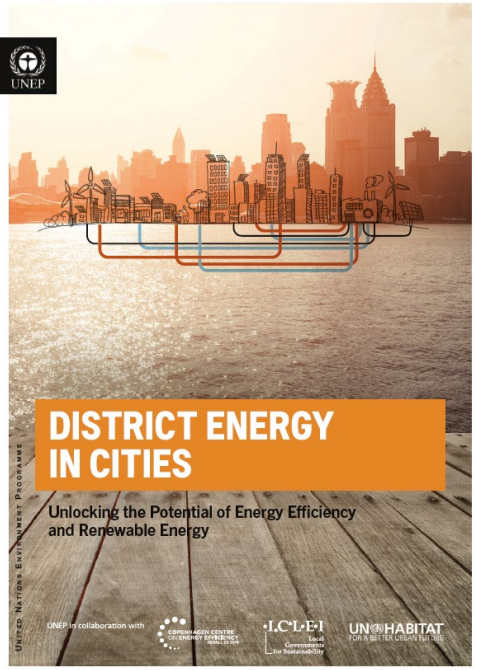
HOW TO DEVELOP DISTRICT COOLING?

1.	**ASSESS** existing energy and climate policy objectives, strategies and targets, and identify catalysts
2.	**STRENGTHEN** or develop the institutional multi-stakeholder coordination framework
3.	**INTEGRATE** district energy into national and/or local energy strategy and planning
4.	**MAP** local energy demand and evaluate local energy resources
5.	**DETERMINE** relevant policy design considerations
6.	**CARRY OUT** project pre-feasibility and viability
7.	**DEVELOP** business plan
8.	**ANALYSE** procurement options
9.	**FACILITATE** finance
10.	**SET** measurable, reportable and verifiable project indicators



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1

Mapping & planning

- Local energy source: free cooling? Waste heat? Renewable? Geothermal?
- Demand: Industrial or space heat/cool? Reliability
- Short/medium/long term development plan

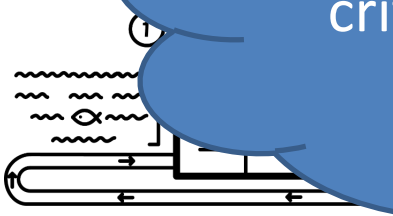
2

Tech-eco analysis

- Rapid assessment: narrow down potential zones, possible tech solutions, economic payback and environmental impacts
- Combination of technical solutions for high reliability and economic viable

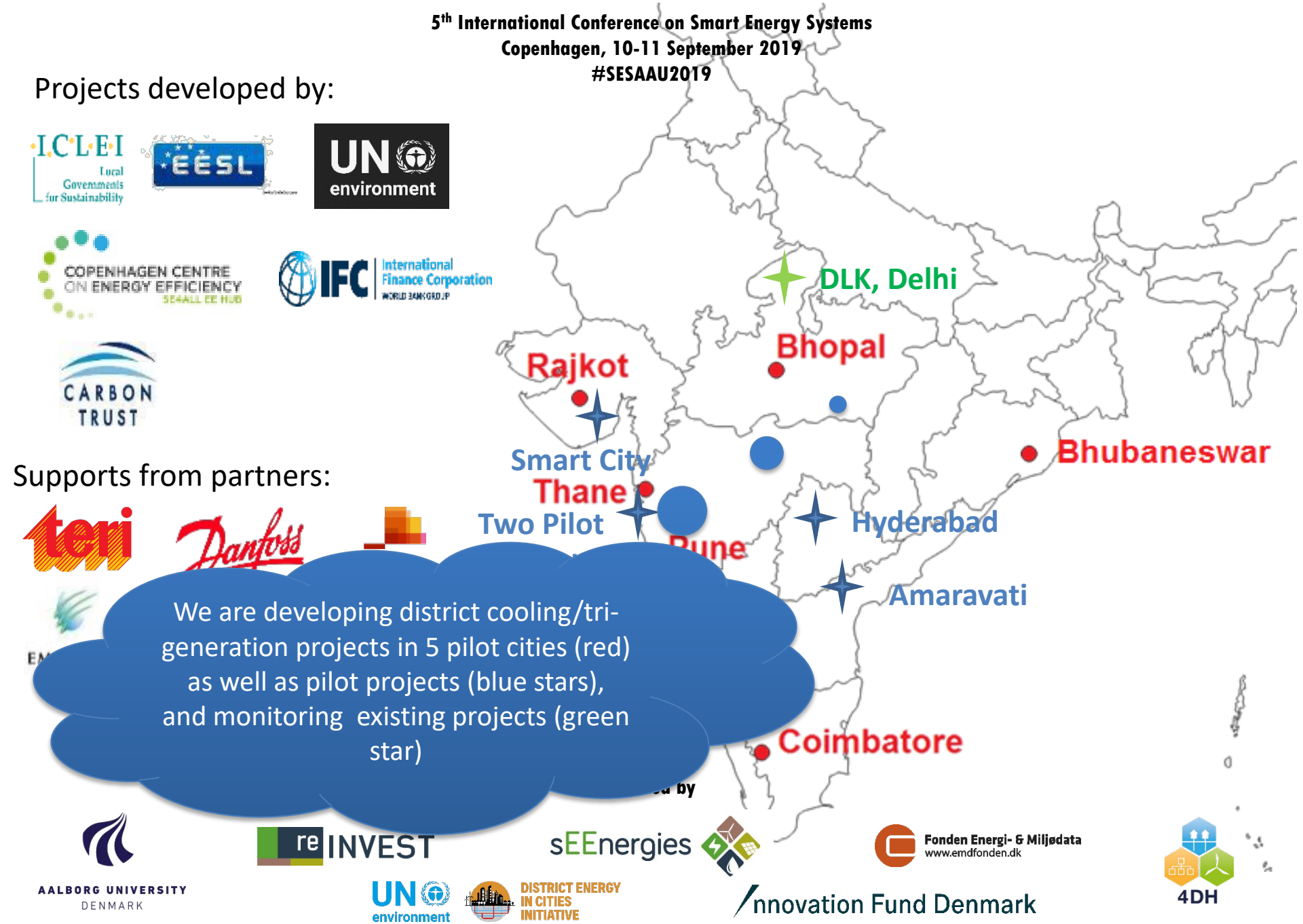
Making correct decisions through urban planning is critical to integrate district cooling.

- Business model
- Guidelines and standards (Design, MRV etc.)
- Financial support mechanism (Bankable projects)



Projects developed by:

Supports from partners:



We are developing district cooling/tri-generation projects in 5 pilot cities (red) as well as pilot projects (blue stars), and monitoring existing projects (green star)

National energy conservation target for 2030

Refrigerant phasing-out target

National Cooling Action Plan

National District Energy Potential Study

National Steering Committee: ministries and Energy Efficiency Service Ltd. (EESL)

Urba

Sm

Incentive po

We are working on getting support from central government, city municipalities to project level, from incentive policy to business models and/or financial support

Energy mapping & benchmark

Policy analysis

Rapid assessment tools for tech-eco

Training modules

City Steering Committee: UNEP unicipalities, EESL, other partners

Pre-/ feasibility study

Business model, technical / financial analysis

Funding opportunities

Call-for-tender, procurement plan

Design guidelines, standards, MRV & metering strategy

Knowledge transportation

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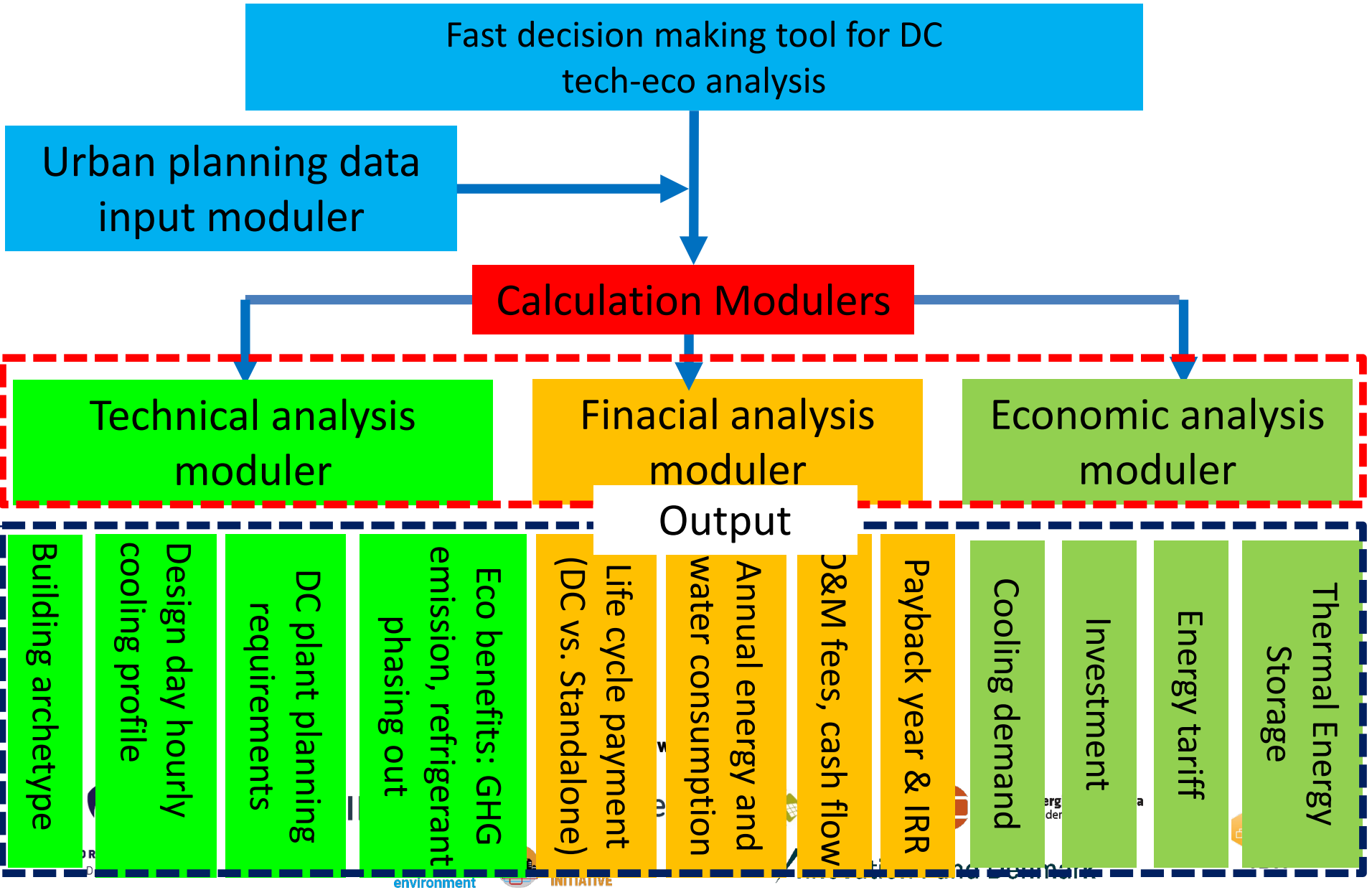
What data we can get from urban planning?

Index/information in urban planning:

- Land use
- Land size
- Building density
- Building controlled height
- Distance retreating to property line
- Floor area ratio, FAR
- Greening landscaping ratio

What data we can get from urban planning?

- Infrastructures: roads, utilities (water/electricity/CCTV/heating/gas/cooling), transportation etc.
- Buildings: type, built-up-area (FAR), land scale
- Future development plans (short/medium/long-term)
- GIS and/or AutoCAD and/or Sketchup etc.

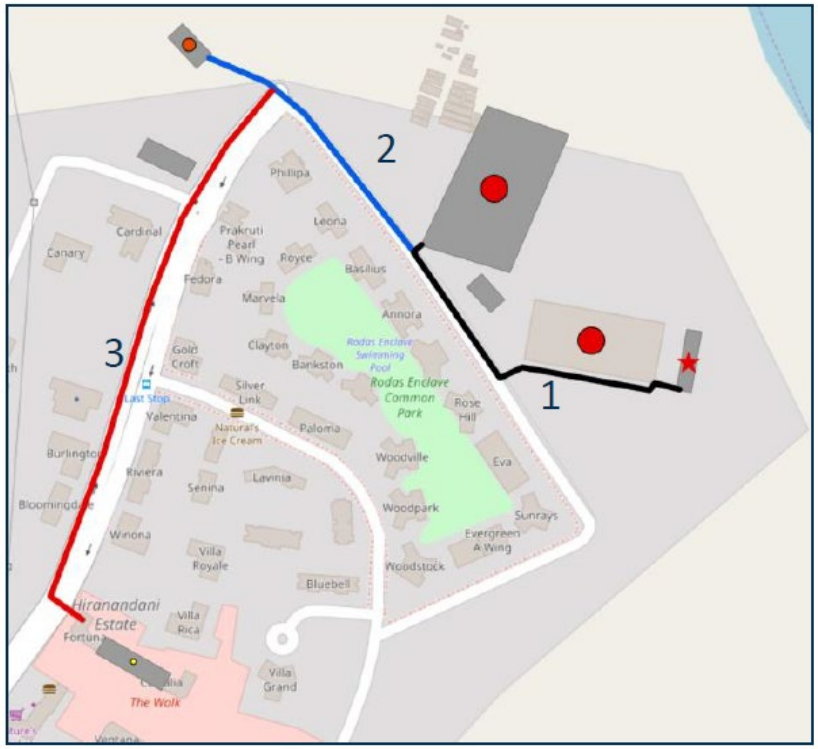

Fast decision making tool for DC tech-eco analysis
Urban planning data input moduler
Calculation Modulers
Technical analysis moduler
Finacial analysis moduler
Economic analysis moduler
Output
Building archetype
Design day hourly cooling profile
DC plant planning requirements
Eco benefits: GHG emission, refrigerant phasing out
Life cycle payment (DC vs. Standalone)
Annual energy and water consumption
O&M fees, cash flow
Payback year & IRR
Cooling demand
Investment
Energy tariff
Thermal Energy Storage

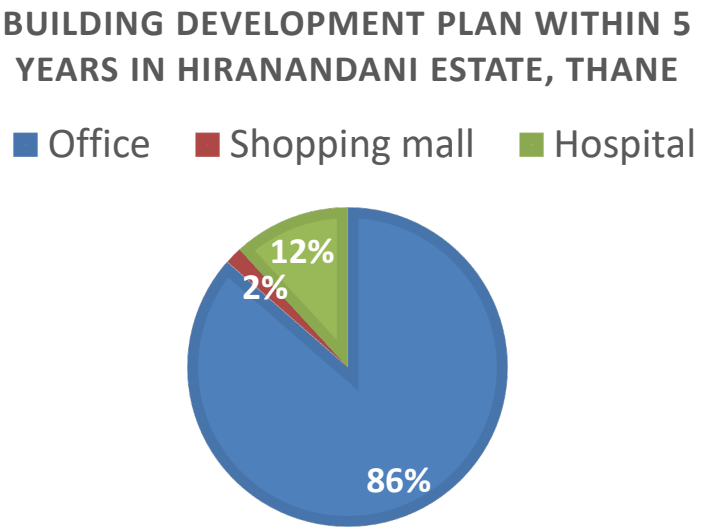
Output of the tool: DC project details

	Office	Shopping mall	Hospital	Sum
Area (sq m.)	280803	5646	38432	324881

Length of Route/Trench work: 1401.6m

Total Linear Heat (cool) Density: 37.78





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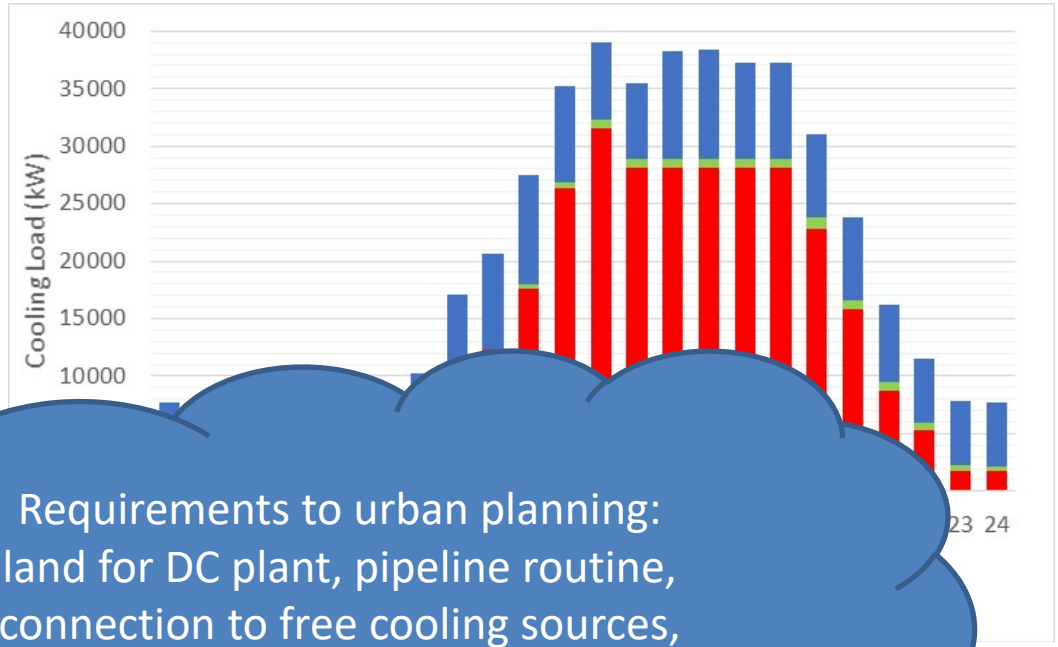
Output of the tool: DC project details

Cooling load estimation

- For standalone systems, the total capacity of these buildings is 47167kW (13411TR)
- For district cooling systems, [illegible] to the diversity, the total capacity estimate [illegible] be 39020kW (11095TR)



DC plant built-up area (m2)	Outdoor space for cooling towers (m2)	DC plant land requ[illegible]
3989	1277	2[illegible]

Requirements to urban planning: land for DC plant, pipeline routine, connection to free cooling sources, possible impacts of noise from cooling towers, etc.

	Hospit[illegible]			
Cooling load (W/sq m.)	125	165	[illegible]	/
Area (sq m.)	280803	5646	38432	324881
Standalone capacity (kW)	35114	929	11125	47167

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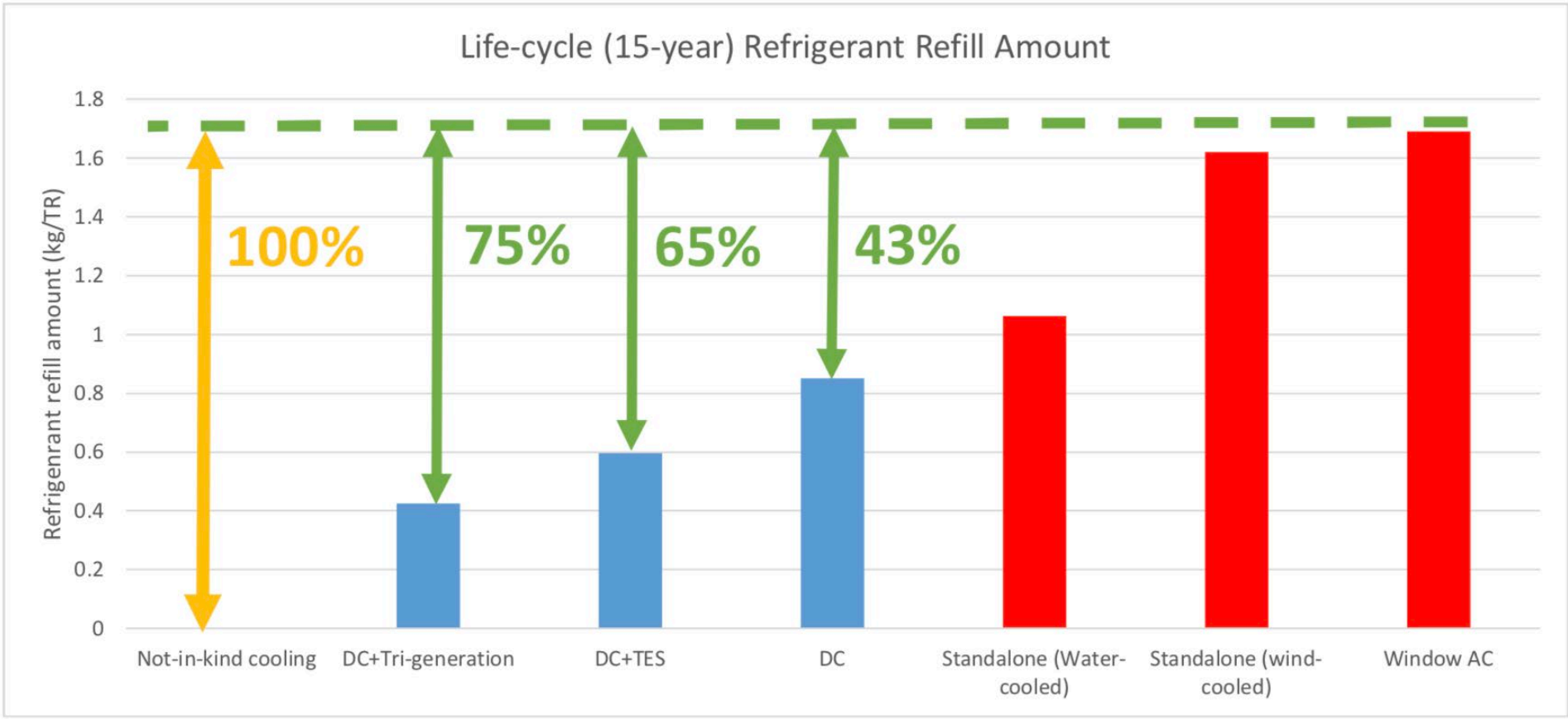
Output of the tool: scenario comparison

Cooling system type	Primary Energy Efficiency	Peak load shifting factor-Electricity
Split AC, VRF/VRV	25%-30%	0
Conventional Central (water-cooled elec. chiller+ FC/AHU)	20%-30%	10%-15%
Conventional Central (air-cooled elec. chiller+ FC/AHU)	15%-30%	10%-15%
District cooling (all elec. chiller)	25%-30%	15%-25%
District cooling (free cooling+elec. chiller)	30%-60%	30%-50%
Tri generation (electricity, district heating, district cooling, domestic hot water)	60%-80%	30%-50%
Tri generation (30%TES)	55%-75%	40%-60%

*Assumption: Grid electricity PEF=35%, cooling factor=0.15, heating factor=0.2, electricity=0.5, all equipment reaches A-level under Energy Star or ASHRAE/ASME

Output of the tool: scenario comparison



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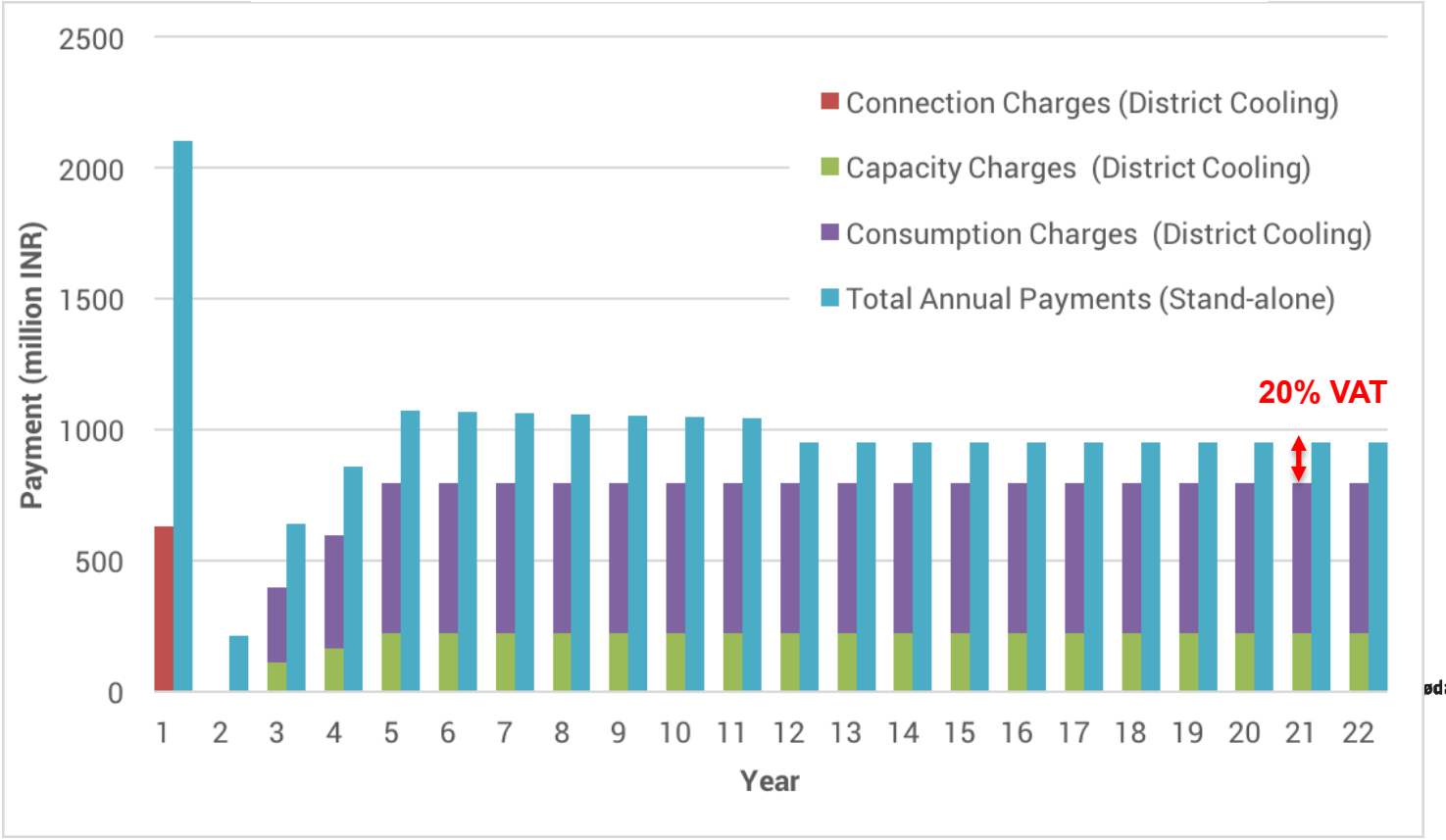
Output of the tool: economic analysis

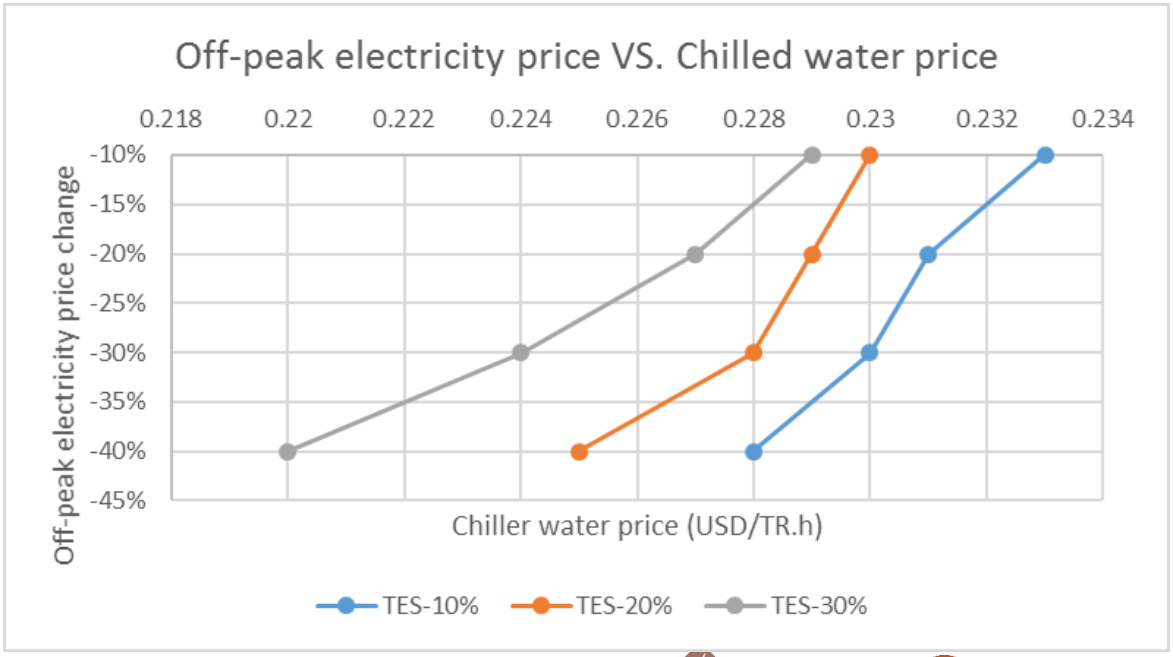
Annual cooling supply	kWh	52,971,387
Annual electricity consumption	kWh	15,061,526
Annual electricity fee	Rs.	175,333,729
	USD	2,630,006
Annual water consumption	m^3	433,772
Annual water fee	Rs.	17,350,878
	USD	260,263



Output of the tool: cost-effective analysis

Integration of cooling storage (ice/water) and/or free cooling, renewable:

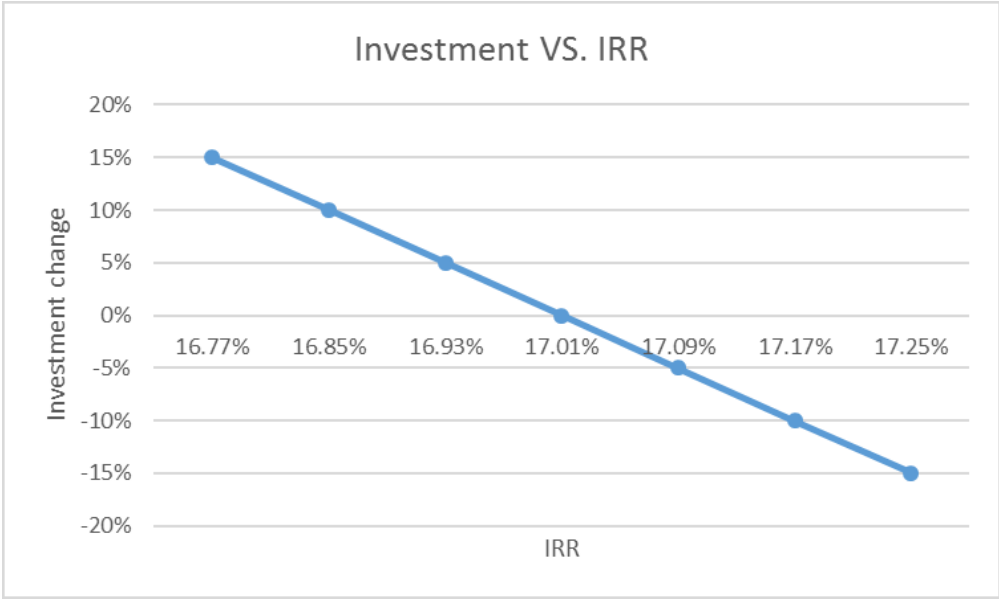
- Under various off-peak electricity tariff (-10% to -45%)
- Under various storage percentage (10% to 30%)
- Impacts on chilled water price (USD/TR.h)

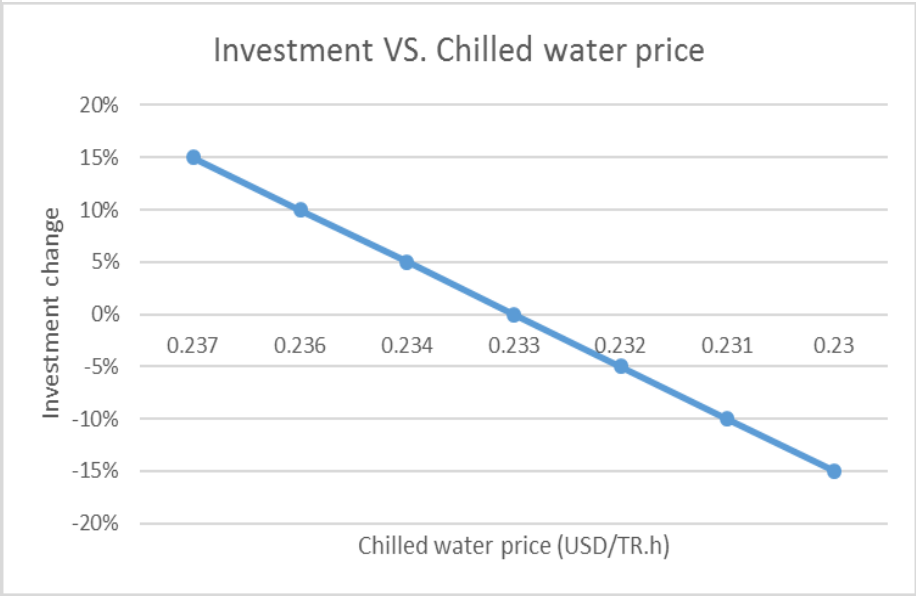


Output of the tool: parametric analysis

Major parameters to impact economic viability (IRR & chilled water price):

- Investment (15% to -15%)
- Cooling demand (15% to -15%)
- Electricity price/primary energy price (15% to -15%)





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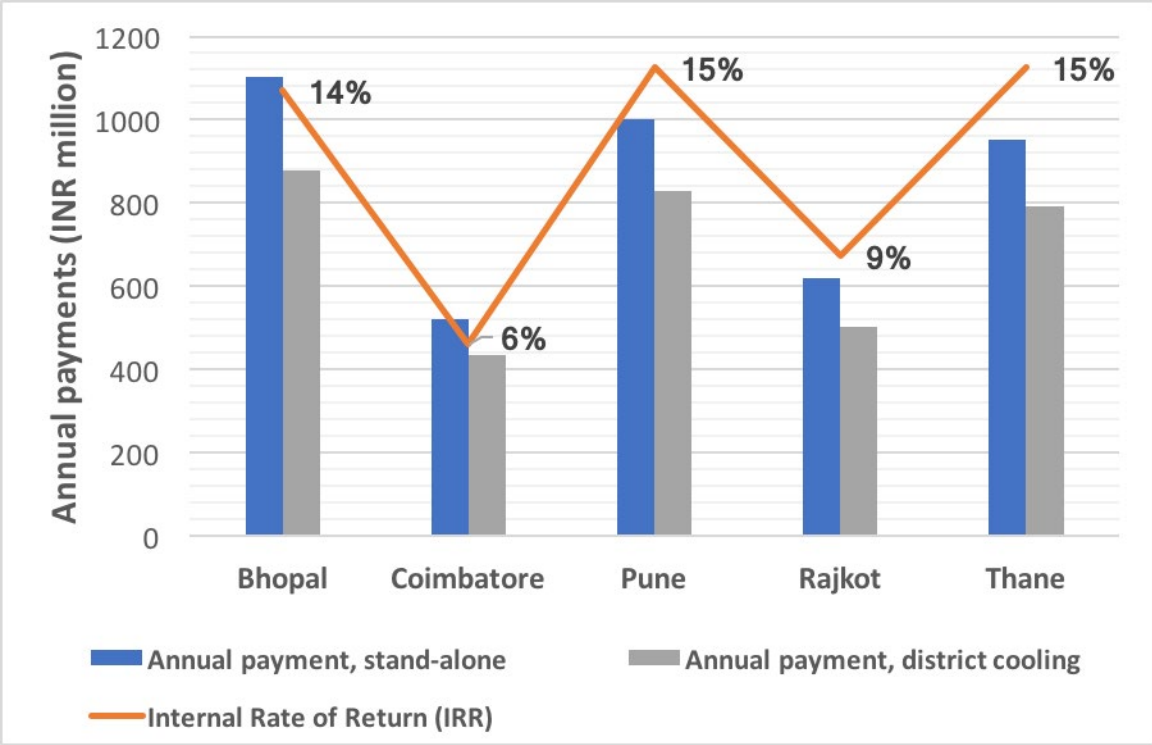
Output of the tool: economic analysis



Drivers:

- Power prices
- Cooling load

Improving IRR:

- Lower power costs (e.g. solar provision)
- VAT pricing
- Project design

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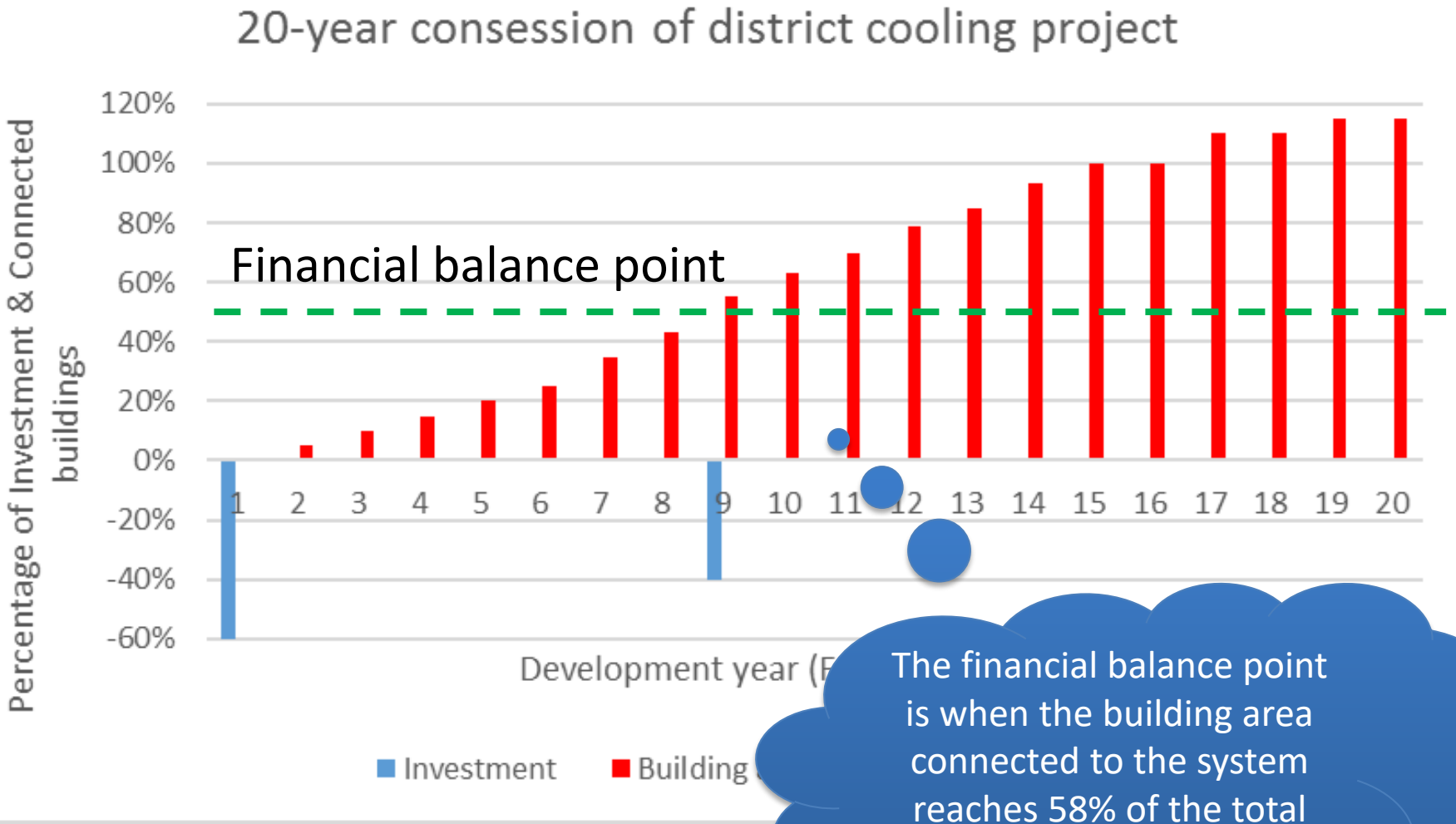
Output of the tool: financial support analysis



The financial balance point is when the building area connected to the system reaches 58% of the total planned area (at 9th year)

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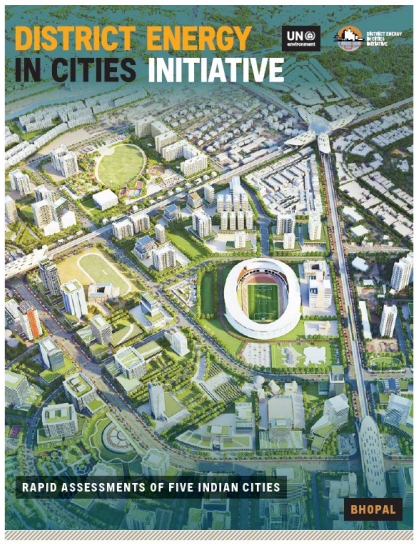

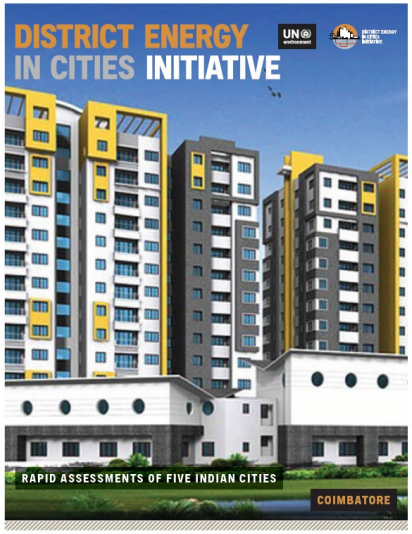

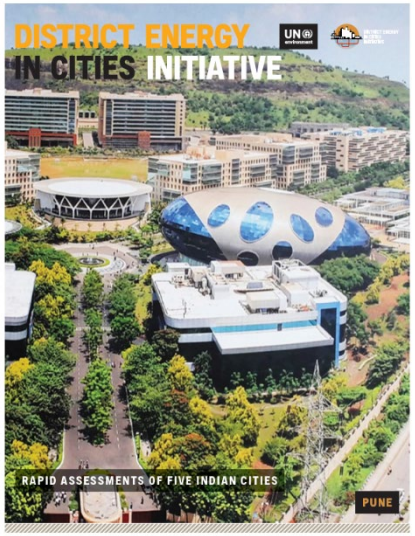

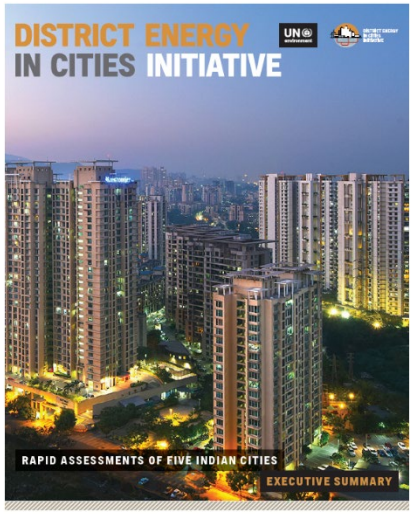

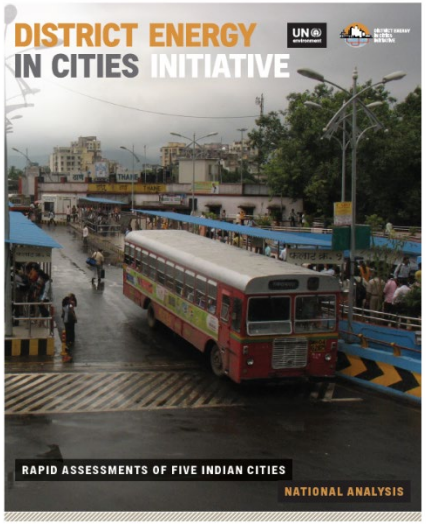

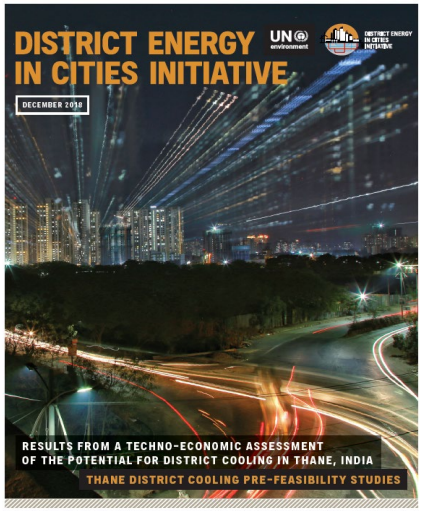

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