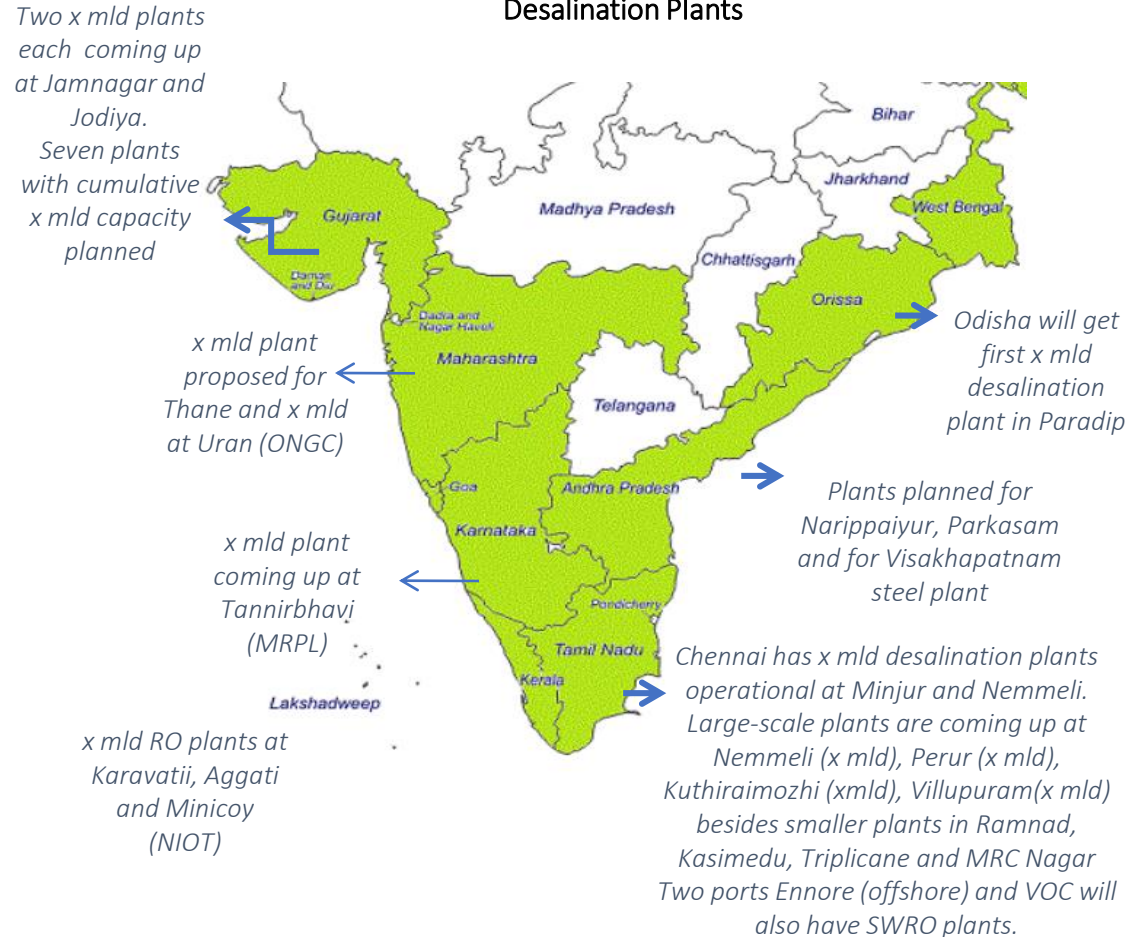


DESALINATION MARKET: INITIATIVES, ECONOMICS AND FUTURE POTENTIAL

Current Capacity

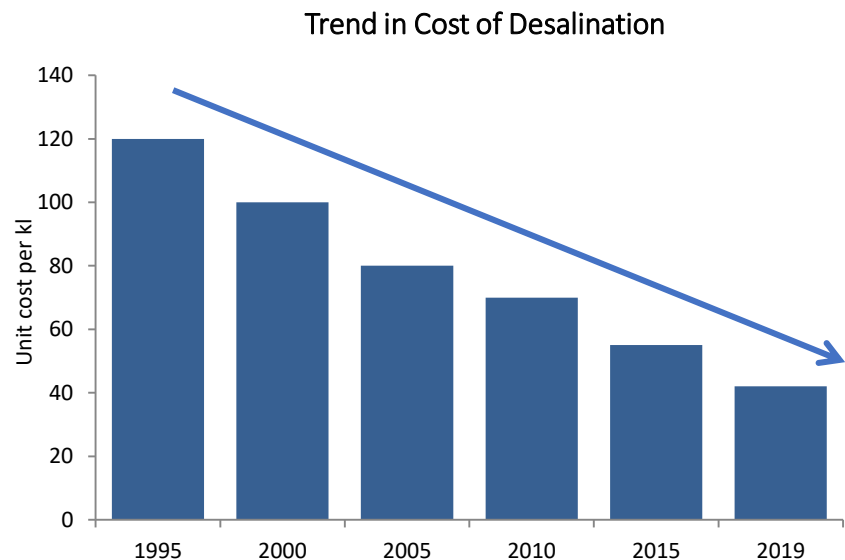
Coastal Districts Map Showing Key Upcoming and Operational Desalination Plants



Note: The pictorial representation doesn't show all industrial desalination plants operational in the country
 SIPOT: State Industries Promotion Corporation of Tamil Nadu Limited, MRPL: Mangalore Refinery and Petrochemical Corporation Limited
 Source: India Infrastructure Research

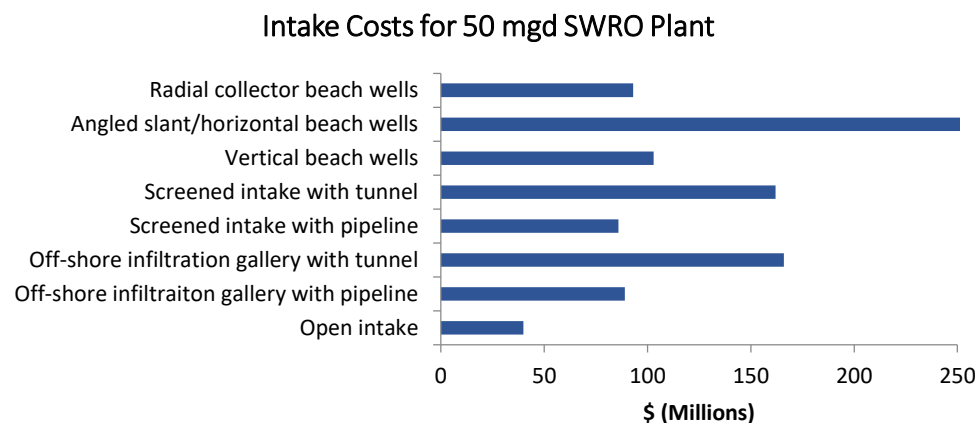
- India, with only about x% of freshwater reserves and a vast x% of saline water, leaves little for consumption. However, as demand is rising, alternative water source like desalinated water is being explored for both municipal as well as industrial water use.
- In the municipal segment, two SWRO plants were operationalised during 2010-13 in Chennai with cumulative capacity of x mld. Further, an additional capacity of over x mld and about x mld has been planned for development in municipal and industrial segment respectively.
- Gujarat too is developing two x mld plants at Jodiya and Dahej for municipal and industrial use respectively with another seven SWRO plants currently in the pipeline.
- In Andhra Pradesh, municipal and industrial plants of x mld have been planned for development.
- Other states like Odisha, Maharashtra, Karnataka also have plans to develop x mld, x mld and x mld capacity plants.
- PSU's such as NTPC, MPRL, ONGC and private players like Reliance, Adani and SIPCOT have also set up desalination plants. Besides, a slew of pilot projects have been undertaken by National Institute of Ocean Technology (NIOT) at Lakshadweep Island Karavatti, Agatti and Minicoy.

Trend in Capex



Source: KPMG and India Infrastructure Research

- The cost of developing a desalination plant is high as compared to cost of drawing water from freshwater sources.
- However, in the last decade or two, capital cost as well as operating expenditure (opex) have come down significantly.
- The cost has come down to Rs x per kl as of 2019 with improvements in desalination technologies, in membrane design and introduction of system integration leading to less power consumption, reduction in capital cost and in power tariffs.



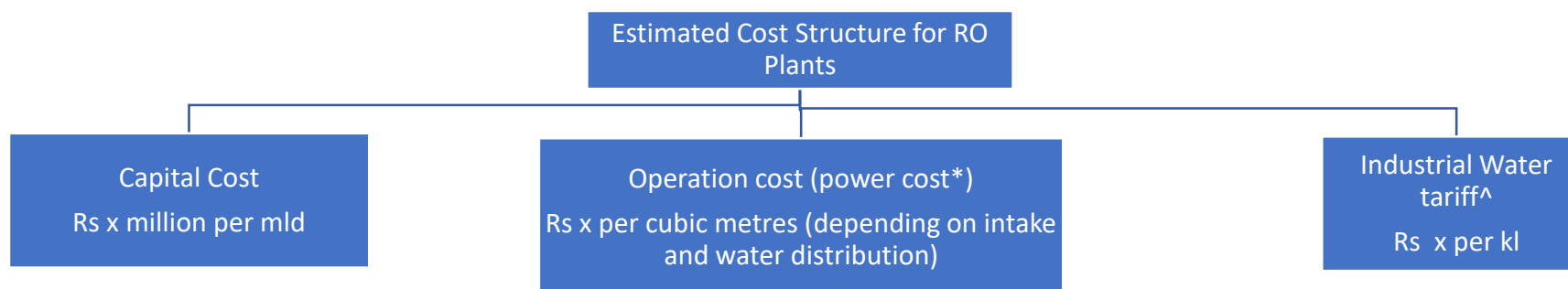
Source: WDR

- Cost of water intake is a major component of the desalination plant.
- Therefore, type of desalination technology deployed has significant impact on this cost component.

Cost Structure of Desalination

Cost of Desalination Plants

- The cost estimation of a typical plant is dependent on the location, end-use, source and quality of water, economics of scale, type of tanks and buffer storage required, location specific intake and outfall system, prevailing tax structures etc. Therefore, it varies from plant to plant.
- Nevertheless, *India Infrastructure Research* has analysed feasibility studies of key plants and provided the cost comparisons.



^Indicative cost as in the case of BWSSB and might vary across water agencies having different tariff structures

*Power cost accounts for about 75% of the operational cost of desalination plant

Source: IDE Technologies and India Infrastructure Research

Cost Structure for 100 mld Desalination Plant at Bharuch

Particulars	Units	Note
Seawater RO membranes	xx	Approximate cost for purchasing all equipments and for carrying out feasibility studies : ~Rs 2 billion
Pressure vessels	xx	
Pressure exchanges	xx	
High pressure pumps	xx	
Pressure filter vessels	xx	
Civil and electrical works, automation and control systems		
Environment impact assessment study, environment management plan, DPR, and other clearances	xx	
Cost for Intake and Brine disposal system		



Total Capital Investment	Cost (Rs billion)
Equipment cost/engineering cost	xx
Land lease rent and development (x square metres x x)	xx
Working capital (O&M, Cost of consumables and chemicals) for next 5 years	xx

Note: The Government of Gujarat derived the estimates based on similar projects executed in India. The total price can vary based on plant size and need of additional equipment's.

Case Study of Nemmeli Desalination

Nemmeli Water Desalination (100 mld)

Scope of work	Contractors	Construction cost (Rs billion)	O&M (for 7 years) (Rs billion)
Construction of 100 mld capacity plant	V.A.Tech Wabag Limited in consortium with IDE Technologies, Israel	xx	xx
Project management consultancy	Mecon Limited in consortium with ADECO Technologies Limited	xx	xx
Conveyance system	Larsen and Tuobro	xx	xx
Total		xx	xx

Source: MOHUA's presentation on Chennai's water initiatives

Operational Requirements

Power consumption	xx
Water intake	xx
Brine reject	xx

Issues

High water intake requirements.
Environmental degradation due to brine rejects

Operational cost

Production cost	xx
Current operational capacity	xx
Water purchase tariff* paid by CMWSSB	xx
Water tariff paid by domestic users (10 kl to 25 kl)	xx
Municipal bulk supply	xx

*secondary sources

Source: MOHUA's presentation on Chennai's water initiatives and CMWSSB website for existing water tariffs

Cost of production from other sources	Cost per kl (in Rs)
Surface Water (KPS – 270 mld)	xx
Surface Water (Red Hills – 300 mld)	xx
Surface Water (Veeranam – 180 mld)	xx
Surface Water (Chembarambakkam- 530 mld)	xx
Surface Water (Surapet – 14 mld)	xx
Ground Water (Well Fields – 15 mld)	xx
Recycled water	xx

Source: MOHUA's presentation on Chennai's water initiatives

Desalination plant is more expensive as production cost is in the range of Rs x per kl as compared to other sources such as surface water and ground water.

Also, as compared to cost of production of recycled water which is in the range of Rs x per kilo litre, desalinated water is expensive

Cost Structure of Desalination

Cost of Components of Desalination Plants

Component of work	% cost for a 3-mld plant	% cost for a 10 mld plant	% cost for a 20 mld plant	% cost for a 40 mld plant
Inlet and outfall pipeline and civil work	xx	xx	xx	xx
Desalination plant (Electro-mechanical)	xx	xx	xx	xx
Pump house and reservoir	xx	xx	xx	xx
Land purchase (for approximately 4 acres)	xx	xx	xx	xx
Total cost	xx	xx	xx	xx
Cost per mld (excluding land)	xx	xx	xx	xx

Source: Based on estimates given by Swachh Environment

Key Players



Parameter	Details
Company	IDE Technologies
Headquarter	Israel
Founded	1965
Services	Focussed on offering waste water treatment, desalination and operation and maintenance services for municipal and industrial users
Details	<ul style="list-style-type: none"> It is one of the key player in desalination market and has so far implemented about x plants in 40 countries. In India, the company has set up several desalination plants with a cumulative capacity of about x mld capacity. These plants are based on proprietary multi-effect distillation (MED) and mechanical vapor compression (MVC) technologies.

Key Projects Executed in India

Project	State	Technology	Capacity (m3/d)	Implementing agency	Completion date
Reliance desalination plant, Jamnagar	Gujarat	xx	xx	xx	xx
Essar, Jamnagar desalination plant	Gujarat	xx	xx	xx	xx
E.I.D. Parry (Chennai) desalination plant	Tamil Nadu	xx	xx	xx	xx
Desalination Project (NDDP) for NCPIL	Tamil Nadu	xx	xx	xx	xx

Source India Infrastructure Research

Planned Additions- Municipal Desalination

The NITI Aayog is working on a proposal to set up a string of floating desalination plants in marine water along the country's 7,500-km coastline to address the current water crisis.

Gujarat Offers Immense Opportunity

Location	Status	Capacity (mld)	Detailed status	Mode of execution	Implementing Agency
Mundra	Bidding	xx	In March 2019, bids were invited for development of the plant on hybrid model (design, build, operate and transfer). The last date of bid submission was August 27, 2019. No further update is available	xx	xx
Mandvi	Bidding	xx		xx	xx
Dwarka	Bidding	xx		xx	xx
Sutrapada	Bidding	xx		xx	xx
Ghogha	Bidding	xx		xx	xx
Porbandar	Bidding	xx		xx	xx
Pipavav	Bidding	xx		xx	xx

Planned Additions- Municipal Desalination

Planned SWRO Plants in Tamil Nadu

Location/ Plant	Expected investment	Capacity (mld)	Detailed status	Mode of implementation	Implementin g Agency
Perur	xx	xx		xx	xx
Kuthiraimozhi (Ramanatha puram)	xx	xx		xx	xx
Villupuram (Marakkana m)	xx	xx		xx	xx
Three Seawater RO desalination Plants	xx	xx		xx	xx
Ennore Port	xx	xx		xx	xx
VOC Port	xx	xx		xx	xx

Planned Additions-Industrial Desalination

Upcoming Industrial Desalination Plants

Project Name	State	States	Capacity (mld)	Status	Implementing Agency
ONGC Ankleshwar colony RO Plant	xx	xx	xx		xx xx
Uran Water Desalination Plant Project (ONGC)	xx	xx	xx		xx xx
Gopalpur Desalination Plant for Ferro Chrome Plant	xx	xx	xx		xx xx
Hybrid Desalination Plant at IREL Complex, Chatrapur		xx	xx		xx xx
Gopalpur at Multi-product SEZ/Industrial Park		xx	xx		xx xx

Source: India Infrastructure Research

Planned Additions-Industrial Desalination

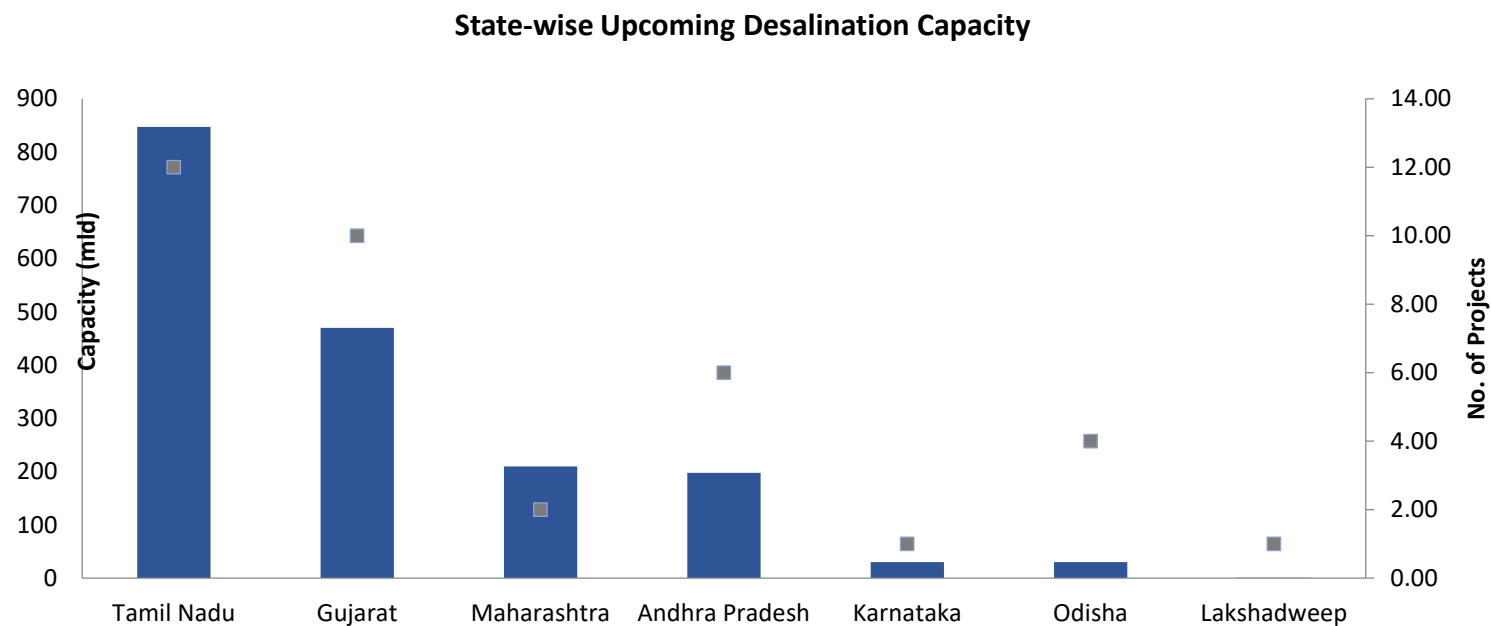
Upcoming Industrial Desalination Plants

Project Name	States	Project Cost (Rs billion)	Capacity (mld)	Status	Implementing Agency
Thermal plants of TANGEDCO	xx	xx	xx		xx
Tuticorin/Mullak adu Desalination Plant Project (Thootukudi)	xx	xx	xx		xx
Cuddalore SIPCOT Industrial Park desalination plant	xx	xx	xx		xx
Tuticorin Power Station Desalination (LTTD)	xx	xx	xx		xx

Source: India Infrastructure Research

Planned Capacity (State-wise)

- According to *India Infrastructure Research*, there are x projects together worth over Rs x billion that will be upcoming in the coming three to four years. These are either under construction at present, have recently been awarded, or at very initial stages - such as under bidding or just have been announced. Both, municipal and industrial desalination projects have been considered.
- State-wise, maximum capacity over x mld is upcoming in Tamil Nadu, followed by Gujarat (x mld) and Maharashtra (x mld).
- The biggest upcoming desalination project is Perur Water Desalination Plant Project worth over Rs x billion. Once operational, it will add x mld of desalination capacity.

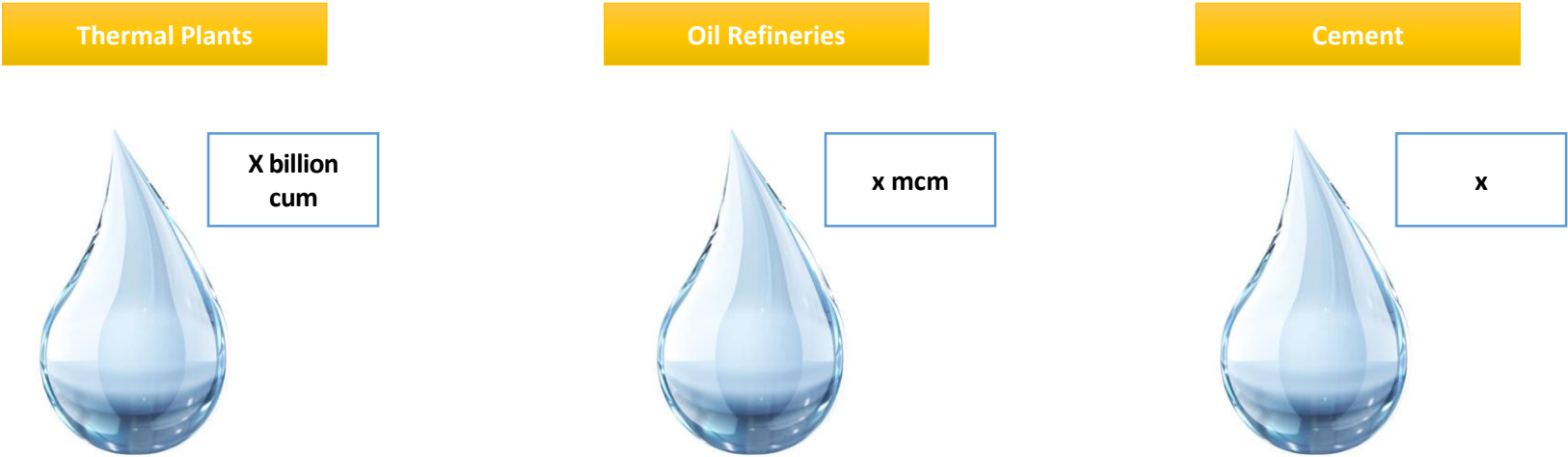


Source: India Infrastructure Research

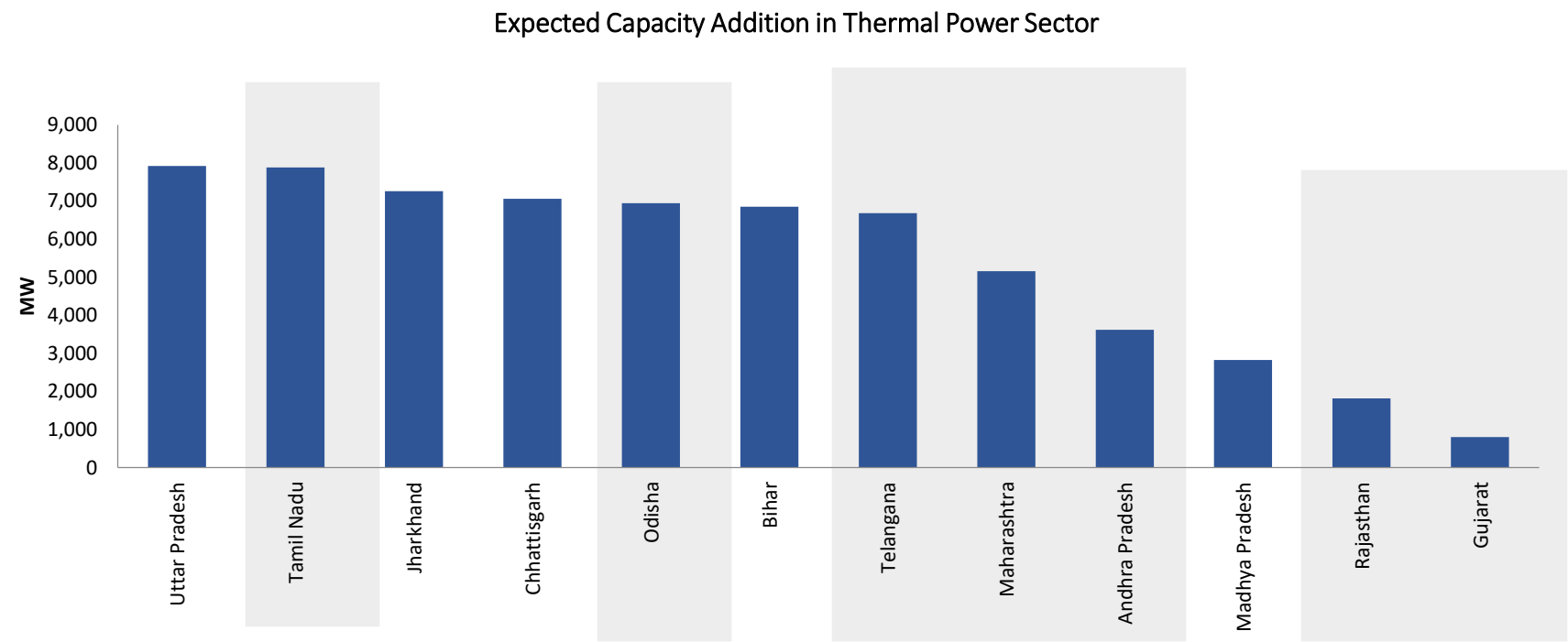
Emerging Requirements by Key Industries

- Desalinated water meets the requirements of both industrial and domestic/household segments. Within the industrial space, desalination projects have been executed primarily to meet water requirements for thermal power plants as they are one of the biggest consumers of water, accounting for about x% of the total industrial water consumption. This is followed by oil refineries and cement industries.
- For the purpose of this section, these three industries have been considered, as they are usually developed in coastal states, which, in turn, would offer potential for desalination projects to meet their growing demand. Besides, together they account for the majority of the industrial water consumption.
- Over the years, acceptability of desalination has gained ground and the industrial uptake has been fairly encouraging. Industries with large water footprints find desalination a feasible option to meet their water requirements efficiently and at a lower cost as compared to other water treatment modes.

Emerging Water Requirements by Industries (Based on expected capacity addition)



CBPG



Note: Shaded portions pertain to coastal states, providing a lucrative market for desalination units.
Source: Central Electricity Authority

- Uttar Pradesh has the highest coal-based capacity under construction at x MW accounting for x% of the total.
 - Tamil Nadu closely follows next with about x MW under construction.
 - The states of Jharkhand, Chhattisgarh and Odisha too have significant capacities of about x MW each. Together these five states account for x% of the total capacity under construction.
- Please refer the database for a list of these projects.*

Cement

At least 10 mtpa of cement manufacturing capacity is likely to come up in the near-medium term, most of which is expected to be witnessed in Andhra Pradesh and Rajasthan.

Planned Capacity Expansion by Key Cement Players

Company	Plant location	State	Capacity (mtpa)
Emami Cement	Jajpur	Odisha	xx
Penna Cement	Boyareddypalli	Andhra Pradesh	xx
Chettinad Cement	Guntur	Andhra Pradesh	xx
JSW Cement	Jajpur	Odisha	xx
Wonder Cement	Mangrol	Rajasthan	xx
Ramco Cements	Jayanthipuram	Andhra Pradesh	xx
Ramco Cements	Odisha	Odisha	xx
Ramco Cements	Kolaghat	West Bengal	xx
Ramco Cements	Vizag	Andhra Pradesh	xx
UltraTech Cement	Pali	Rajasthan	xx
JK Cement	Mangrol	Rajasthan	xx
JK Cement	Aligarh	Uttar Pradesh	xx
JK Cement	Balasinor	Gujarat	xx
Sanghi Cement	Gujarat	Gujarat	xx
Ambuja Cements	Marwa	Rajasthan	xx

Source: Compiled through various sources by India Infrastructure Research; Edelweiss

Key Features

Comparison Between Technologies (In-terms of Fixed and Variable Cost)

Parameters	Thermal Technology	Membrane technology
Land (square metres/mld)	xx	xx
Capex (Rs/m3)	xx	xx
Variable O&M cost	xx	xx
Energy consumption	xx	xx
Chemicals, membranes, waste disposal	xx	xx
Fixed O&M Cost	xx	xx
Environmental, monitoring and indirect cost	xx	xx
Labor and maintenance	xx	xx

- Both technologies are at par with respect to the land and capex requirements.
- Thus, O&M cost, the major cost component of a desalination plant, becomes a deciding factor.
- About x% of the opex is spent on energy consumption. Membrane technology utilises less energy and the energy costs account for about x% of the plant cost whereas with thermal desalination it rises to x

Note: The estimates exclude the financing cost of the project which will also impact the capital cost. Also, the cost estimates will keep varying based on location of the project and proximity of water sources

Source: KPMG and India Infrastructure Research

Key Features

Comparison among Key Technologies (Other parameters)

Operational Temperature	Ambient	High Temperature	Low Temperature		
Process	SWRO	MSF	MED	TVC-MED	MVC
Electricity consumption (kWh/cum)	3.3-4.2	3.0-3.5	1.3-1.4	1.0-1.3	8.0-9.0
Motive steam pressure at (min) (ATA)	NA	2.2-2.5	0.35	2.2-2.5	NA
Electric equivalent for thermal energy (Kwh/cum)	NA	10-15	4.5-5	7-8	NA
Equivalent thermal energy cost relative to electricity cost* (%)	NA	40%	40%	40%	NA
Total equivalent energy consumption/normalised to actual electricity cost (kWh/cum)	3.3-4.2	7-9.5	3.1-3.4	3.8-4.5	8-9.0
Possible unit size (up to) (cum/day)	50,000	60,000	25,000	35,000	5,000
Possible/achievable GOR	NA	10	10-Nov	14-15	NA
Possible number of effects	NA	30	15-17	15-17	5

Process	SWRO	MSF	MED	TVC-MED	MVC
Specific capital cost (US\$ cum/day)	800 -1,300	1,100-1,200	1,000-1,100	800-1,000	1,100-1,300
Product quality received (ppm TDS)	First stage: 400 Second stage: 40-0		<5	<5	<5
Electricity cost= 40% fuel cost + 40% capital + 20% operational= US cents 5.0 kWh					
Limiting factors	Seawater quality	Pumps, valves and plant weight	Vessel size	Vessel size	Compressor
Minimum intake requirement	Deep water or beach wells	Shallow water	Shallow water	Shallow water	Shallow water
Fully automatic and unattended operations	Possible but risky	Possible	Possible	Possible	Possible
Tolerance to operator's fault	None	Medium	High	High	High

Source: India Infrastructure Research and IDE Technologies

Current State of Deployment

- R&D activities on desalination were initiated in the 1970s and were based mainly on thermal processes.
- Thereafter, plants on a pilot basis were demonstrated by Bhaba Atomic Research Agency (BARC) besides institutes like IIT and National Institute of Ocean Technology mainly for industrial use.
- Large-scale industrial desalination plants were also developed for companies like Adani, Reliance, EID Parry involving a mix of membrane and thermal technologies.
- With respect to the municipal segment, so far only two plants based on membrane technology have been operationalised and several others are currently in the pipeline.

Treatment Technologies Deployed in Completed Municipal Desalination Plants

Plant	State	Technology	Capacity (mld)	Implementing agency	Contractors	Commissioning
Nemmeli Desalination Plant Project	Tamil Nadu	xx	xx	xx	xx	xx
Minjur Desalination Plant	Tamil Nadu	xx	xx	xx	xx	xx

Plants Developed by Institutes For Private Use

Plant	State	Technology	Capacity (mld)	Implementing agency	Contractors	Commissioning
Low temperature thermal desalination (LTTD) Plant at Karavati	Lakshadweep	xx	xx	xx	xx	xx
LTTD Plant at Agatti	Lakshadweep	xx			xx	xx
LTTD Plant at Minicoy	Lakshadweep	xx			xx	xx
Ramanathapuram desalination plant	Tamil Nadu	xx	xx	xx	xx	xx
Kanyakumari Solar-Powered Desalination Plant	Tamil Nadu	xx	xx	xx	xx	xx

Source: India Infrastructure Research

Current State of Deployment

Treatment Technologies in Industrial Desalination Plants

Plant	State	Technology	Capacity (mld)	Implementing agency	Contractors	Year of commissioning
7 mld desalination at Adani Power SEZ , Village Tunda & Siracha, Mundra	Gujarat	xx	xx		xx	xx
6 mld desalination plant at Sewagram, Kutch	Gujarat	xx	xx		xx	xx
NPCIL, Kudankulam Nuclear Power Plant Desalination	Tamil Nadu	xx	xx		xx	xx
Desalination plant at Narippaiyur, Chennai	Tamil Nadu	xx	xx		xx	xx
Gujarat Electricity Board (GEB) Sikka desalination plant	Gujarat	xx	xx		xx	xx
Reliance desalination plant, Jamnagar	Gujarat	xx	xx		xx	xx
Chennai Petrochemical Corporation Limited desalination plant, Chennai	Tamil Nadu	xx	xx		xx	xx
6.3 mld nuclear seawater desalination plant at Kalpakkam	Tamil Nadu	xx	xx		xx	xx
Essar, Jamnagar desalination plant	Gujarat	xx	xx		xx	xx
E.I.D. Parry (Chennai) desalination plant	Tamil Nadu	xx	xx		xx	xx

Source: India Infrastructure Research

Current State of Deployment

Treatment Technologies in BARC Desalination Plants

Plant	State	Technology	Capacity	Year of commissioning
MSF experimental facility for seawater desalination	NA	xx	xx	xx
Low Temperature Evaporation (LTE) desalination unit using waste heat	NA	xx	xx	xx
MSF desalination plant	NA	xx	xx	xx
Thermo Compression (TC) desalination unit	NA	xx	xx	xx
Horizontal Tube Thin Film (HTTF) desalination unit for MED	NA	xx	xx	xx
Multi-Effect Distillation-Vapor Compression (MED-VC) desalination plant	NA	xx	xx	xx
Nuclear Desalination Demonstration Project (NDDP) at Kalpakkam	Tamil Nadu	xx	xx	xx
LTE desalination unit using waste heat of nuclear reactor (CIRUS)	NA	xx	xx	xx
Brackish water RO plants providing drinking water in villages of Andhra Pradesh & Gujarat	Andhra Pradesh & Gujarat	xx	xx	xx
Desalination for industrial effluent treatment plant at RCF, Mumbai	Maharashtra	xx	xx	xx
RO plant at VECC for production of low conductivity water	Kolkata	xx	xx	xx
Nanofiltration plant for pharmaceutical industry	NA	xx	xx	xx
Brackish water desalination for providing drinking water in village Sheelgan, Barmer, Rajasthan	Rajasthan	xx	xx	xx
Desalination Plant at Trombay	Maharashtra	xx	xx	xx
Desalination plant for providing drinking water in village Satlana, Jodhpur, Rajasthan	Rajasthan	xx	xx	xx

Source: India Infrastructure Research