From Resource Efficient Cleaner Production (RECP) to Circular Economy (CE)

Applications in the Indian metal finishing & steel rolling industries

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Focus of this presentation

Resource efficiency

Closed loop technologies

https://s3-eu-west-1.amazonaws.com/europarl/circular_economy/circular_economy_en.svg

Background of Indian metal finishing & steel rolling sectors

- Metal finishing (e.g. electroplating, painting) - surface treatment processes to improve wear and tear resistance, impart corrosion resistance and enhance aesthetics
- Electroplating
  - Mainly small and medium enterprises (SMEs)
  - Part of the supply chain for automobiles, 2-wheelers, engineering equipment and consumer goods
  - Estimated 12,000 organized & approx. 300,000 small scale units in clusters across India
  - Generate highly acidic waste streams and hazardous sludge
  - Classified by Central Pollution Control Board (CPCB) as one of the major polluting industries
- Steel rolling
  - Employs acid pickling
  - Around 1800 small and medium sized steel rolling enterprises across India
  - Contribute ~70% of long steel output (bars, sections, industrial products etc.)

ACIDLOOP
(2012-2016)

Indian metal finishing SMEs

(electroplating, powder coating, steel rerolling)

664
SMEs briefed

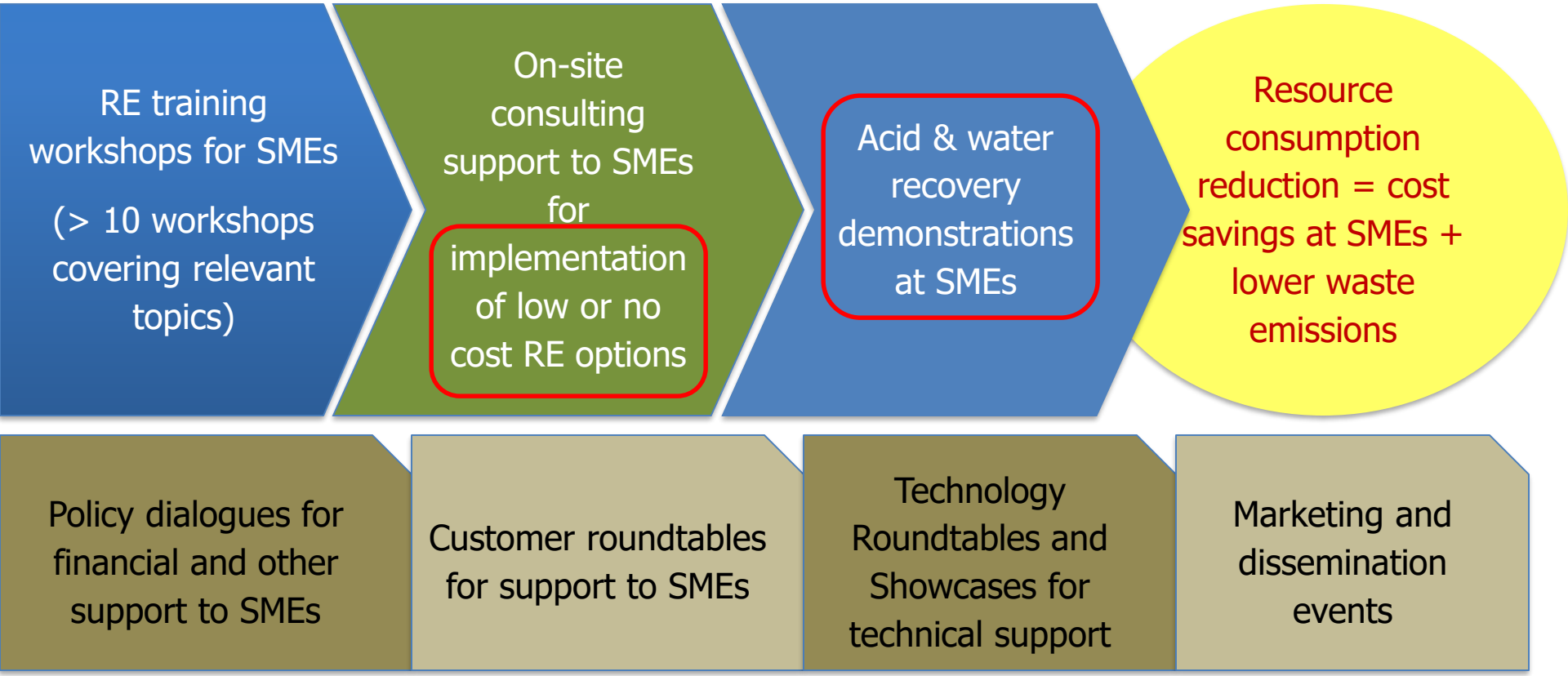
385
SMEs trained initially

106
SMEs selected

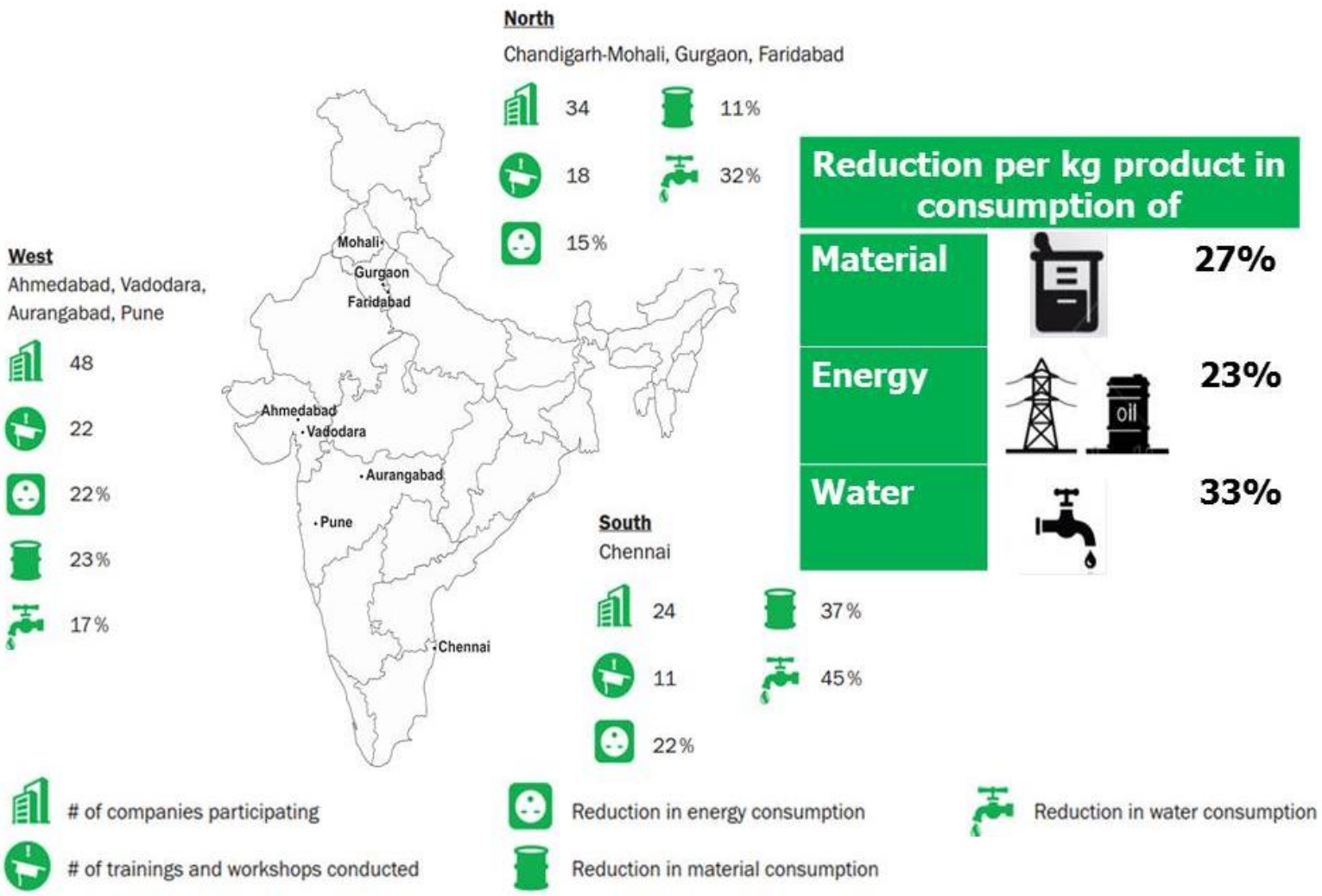
PROJECT FUNDED BY
switchasia

PROJECT IMPLEMENTED BY
adelphi AUSTRIA ASSIST BFI Stahl SIAM teri

Project methodology



Achievements – resource efficiency (I)



Achievements – resource efficiency (II)

Energy (electricity & fuel) **kWh/year**

Electricity	1,607,361	kWh
Diesel	2,479,605	MJ
LPG + PNG	14,406,911	MJ
Coal + wood	4,587,246	MJ

CO_2 emission avoided 25% ↓ **2,289** **ton/year**

with low cost or no cost interventions by the MSMEs themselves. Most interventions payback period **less than 9 months**

Acid and water management in process baths

Current practice

- Neutralization of used acid and rinsing water
- Dewatering of sludge and disposal in landfills
- Discharge or evaporation of filtrate

Effects

- High water and acid consumption

State-of-the art technology options

Resource efficient rinsing water management

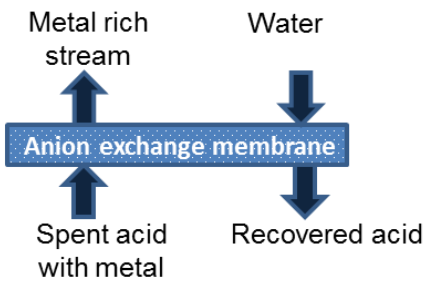
- Separation of metal ions with **nanofiltration** or **reverse osmosis**
- Recycling of the rinsing water (up to 80%)
- Discharge or reuse of the concentrate

Resource efficient acid management

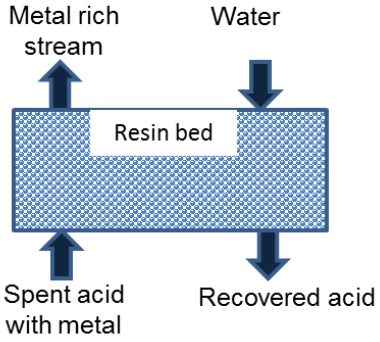
- Separation of the metal ions with **nanofiltration**, **diffusion dialysis** or **retardation**
- Reuse of the treated acid (up to 30%)
- Disposal or reuse of the concentrate
- Reduced sludge amount (up to 30%)

Technologies for acid, water recovery in metal SMEs

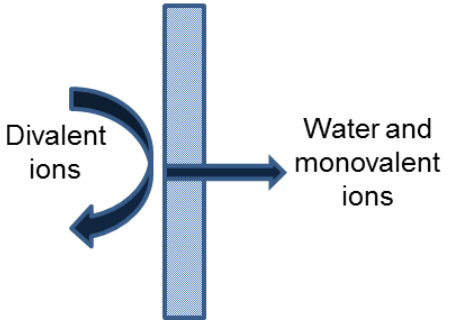
Diffusion dialysis



Acid retardation



Nanofiltration

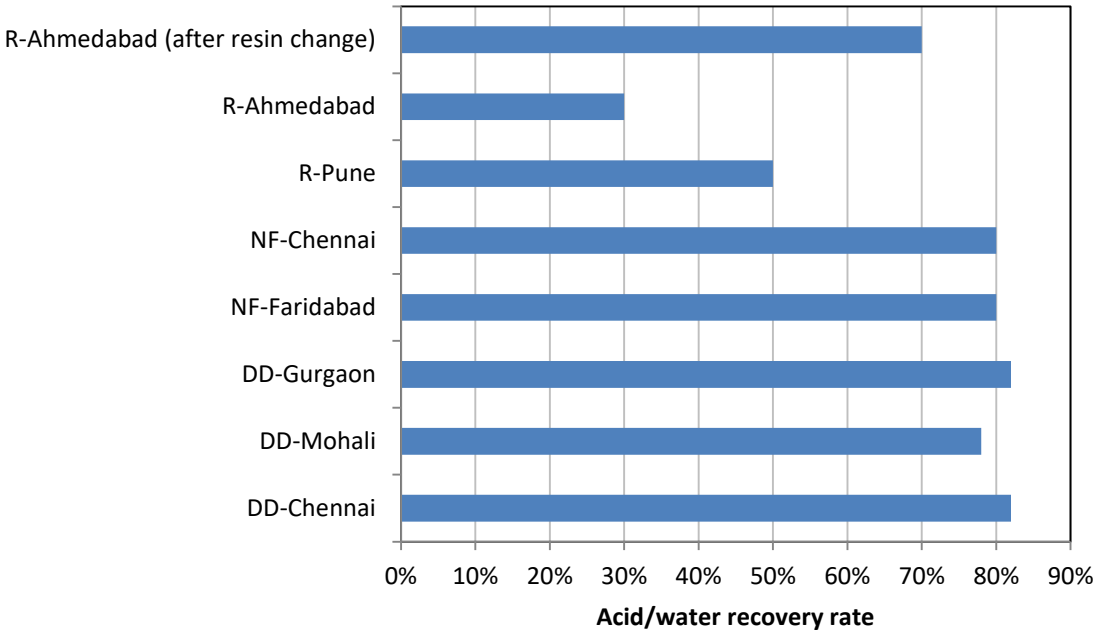


Balakrishnan et al., *Demonstration of acid and water recovery systems: Applicability and operational challenges in Indian metal finishing SMEs*, Journal of Environmental Management (2018) 217, 207-213

Demonstration details

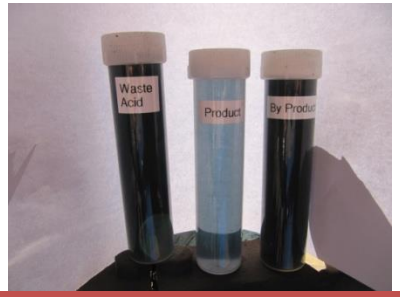
Technology	Location	Process	Feed
Diffusion dialysis	Chennai	Electroplating	Hydrochloric acid
	Mohali	Electroplating	Sulphuric acid
	Gurgaon	Electroplating	Sulphuric acid
Acid retardation	Pune	Electroplating	Non-fuming hydrochloric acid
	Ahmedabad	Pickling (steel rerolling unit)	Mixed acid (sulphuric H_2SO_4, nitric HNO_3,and hydrofluoric HF)
Nanofiltration	Faridabad	Metal finishing common effluent treatment plant (CETP)	Effluent after chemical coagulation/flocculation and clarification
	Chennai	Electroplating	Rinse water from zinc plating
	Aurangabad	Electroplating	Rinse water from zinc plating

Achievements: closed loop technologies (I)



Recovery rate of acid/water by the demonstration plants at different locations (DD-diffusion dialysis; NF- nanofiltration; R-retardation)

Retardation: HCl recovery (Pune)

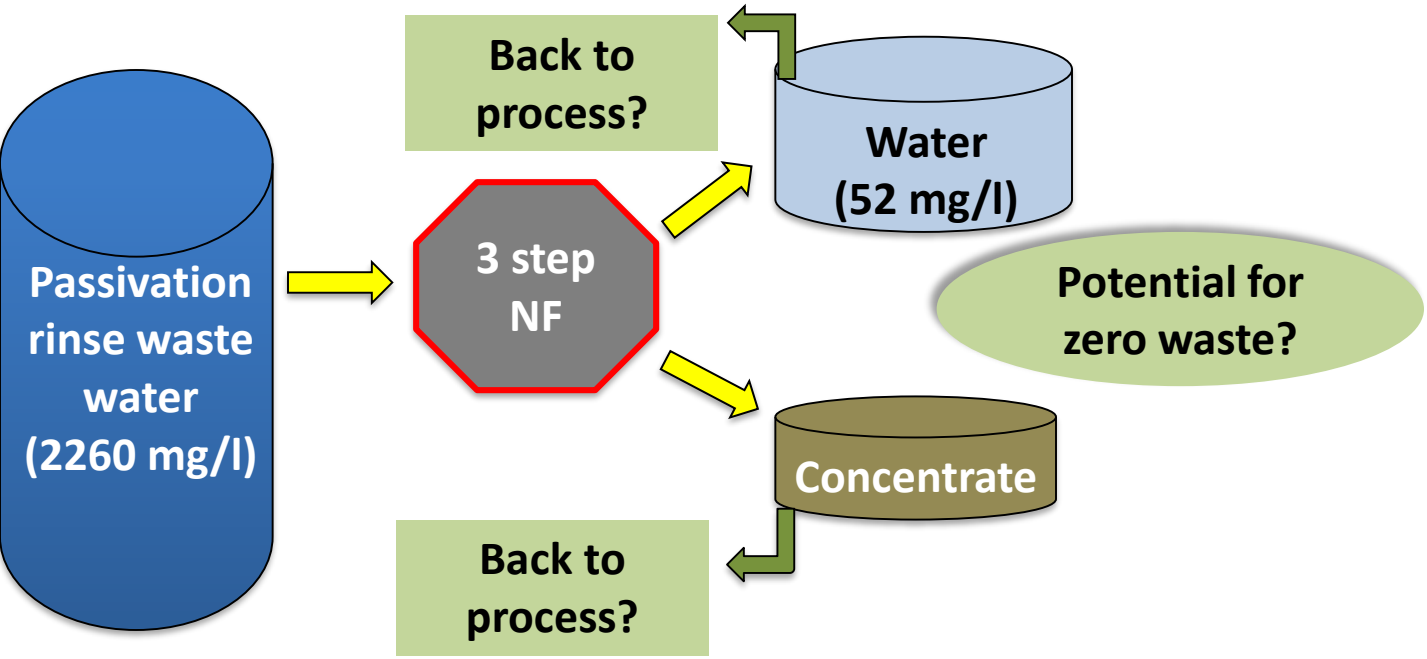


Retardation: mixed acid recovery (Ahmedabad)

- Product contains active acid which can be reused
- By-product contains nickel which can be recovered

Achievements: closed loop technologies (II)

Chemical recovery using NF (Faridabad)



Challenges

- Efficient pre-treatment (oil/particulate matter free feed)
- High material and temperature compatibility
- Operation within SME limitations (e.g. limited infrastructure and operational & analytical capacity)

Solutions?

- Local manufacturing combined with plant customizing to suit local requirements
- Cluster level service

In conclusion

- RE approach can successfully reduce resource consumption
- Pollution can be minimised – through process improvements at no/low cost
- Remaining waste streams can be treated to recover useful components for feeding back to process

Need to replicate and multiply … for near zero discharge

Contribution to various SDGs

Acknowledgements

switchasia GRANTS PROGRAMME

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- Mohali Industries Association (Mohali)
- Pune Metal Finishers Association (Pune)
- Stainless Steel Re-Rollers Association (Ahmedabad)




Thank You