# REINHOLD ENVIRONMENTAL ®

# 2023 Reinhold/PCUG Round Table Presentation

## Cohosted by Duke Energy and Vistra in The Westin Hotel, Cincinnati, OH on June 26-27, 2023

# Novel Approaches to ELG Compliance

Overview of Proposed ELG Amendment and Options to achieve Zero Liquid Discharge

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2023 *Reinhold/PCUG Conference*, Cincinnati, OH
Workshop 5, 9:15-11:15 June 26, 2023

# Acronyms

BAT – Best Available Technology economically achievable

BATW – Bottom Ash Transport Water

BPJ – Best Professional Judgement

CCR/CCP – Coal Combustion Residuals / Products

ELG – Steam Electric Power Effluent Limitations Guidelines

FATW – Fly Ash Transport Water

HRR – High Recycle Rate closed loop BATW

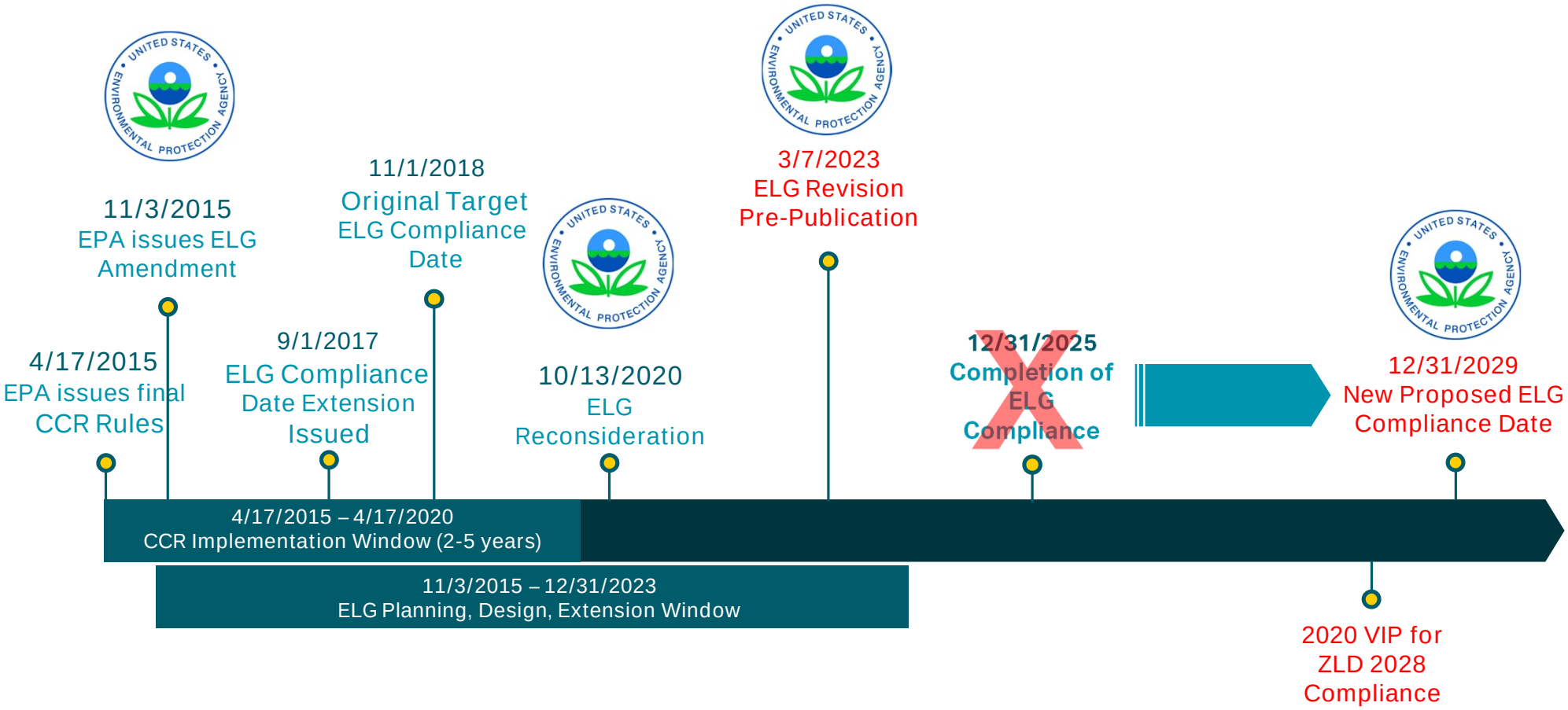
LRTR – Low hydraulic Residence Time Reduction biological treatment

LVW – Low Volume Waste

VIP – Voluntary Incentive Program

ZLD – Zero Liquid Discharge

# Effluent Limitation Guidelines : Regulatory Timeline



# Effluent Limitation Guidelines : Content Progression

## 2015

Numeric limits for Hg, Se, As, $NO_2/NO_3$ in FGD WW, FA / BA TW, Hg control WW

BAT = Phys/Chem + Anoxic/Anaerobic Fixed Film Bio

Existing & Legacy CCR leachate excluded after litigation

## 2020

Revised numeric limits for direct discharge

FGD BAT for direct discharge to Phys/Chem + LRTR (biological treat) + ultrafiltration

BATW BAT to HRR with 10% discharge

Revised EPA Voluntary Incentives Program

- Membrane separation and zero liquid discharge (ZLD)
- Numeric limits for total dissolved solids and bromide

# Effluent Limitation Guidelines : Content Progression

## 2023 (proposed)

Revised requirements for FGD wastewater and BA transport water / Included limits on CCR leachate from existing and legacy sources

- No change if coal use ends by 2028
- ZLD for FGD WW (BAT = phys/chem + membrane)
- ZLD for BA transport (BAT = dry handling/ closed-loop)
- Hg and As limits for CCR leachate
- High flow / low utilization sub-categorizations removed
- 'Early adopters' with 2032 shutdown – no ZLD required
- VIP Membrane + ZLD Adopters compliant by 12/31/2028
- Compliance NLT 12/31/2029

# ELG for FGD Wastewater

Early adopter with Biological or ZVI treatment by date of new revision and planned closure by 2032 may discharge with noted limits.

**Table 6 to Paragraph (g)(2)(iii)**

| Pollutant or pollutant property | BAT Effluent Limitations | |
|---|---|---|
| | Maximum for any 1 day | Average of daily values for 30 consecutive days shall not exceed |
| Arsenic, total (µg/L) | 18 | 8 |
| Mercury, total (µg/L) | 103 | 34 |
| Selenium, total (µg/L) | 70 | 29 |
| Nitrate/nitrite as N (mg/L) | 4 | 3 |

## ELG for BA Transport Water

Early adopters with permitted HRR BA Handling system that close by 2032 can continue to discharge 10% wetted volume for:

- Storm surge events,
- Water balance for other non-BATW streams,
- Water chemistry,
- Maintenance events.

## ELG for CCR Leachate

CCR Leachate includes:

- Surface impoundment (active/or inactive) decant wastewater
  - Water above CCR in impoundment that does not cause re-suspension when removed
- Surface impoundment (active/or inactive) dewatering wastewater
  - Contact water in impoundment or re-suspends CCR when removed

BAT = phys/chem precipitation

**Table 9 to Paragraph (1)**

| Pollutant or pollutant property | BAT Effluent Limitations | |
|---|---|---|
| | Maximum for any 1 day | Average of daily values for 30 consecutive days shall not exceed |
| Arsenic, total (µg/L) | 11 | 8 |
| Mercury, total (µg/L) | 788 | 356 |

# ELG for Legacy Wastewater

Legacy Wastewater = FGD WW, BA Transport Water, FA Transport Water, CRL, gasification WW, or FGMC wastewater generated before 2015 / 2020 rules

No BAT established – BPJ by states

**Table 9 to Paragraph (1)**

| Pollutant or pollutant property | BAT Effluent Limitations | |
|---|---|---|
| | Maximum for any 1 day | Average of daily values for 30 consecutive days shall not exceed |
| Arsenic, total (µg/L) | 11 | 8 |
| Mercury, total (µg/L) | 788 | 356 |

# Pathways to Compliance
# BATW

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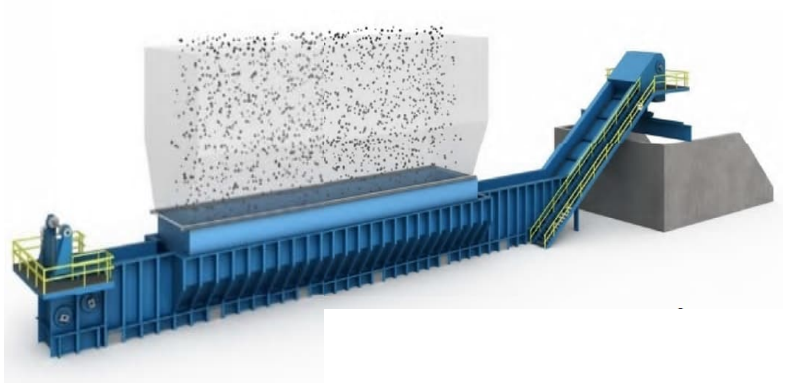
# Traditional BATW ZLD or HRR Options

## Open Loop Conversions

Submerged Flight Conveyor

Remote Submerged Flight Conveyor

Dry Conversion / Pneumatic Conveying



# Holistic Approach to ZLD - 4Rs

**Reduce:** Reduce pump seal water, segregate seal water, modify wash down duration/ frequecy, or adjust system setpoints to reduce wastewater volumes or concentrations

**Reuse**: Collect decanted sluice water for reuse, return BATW purge as makeup to FGD system

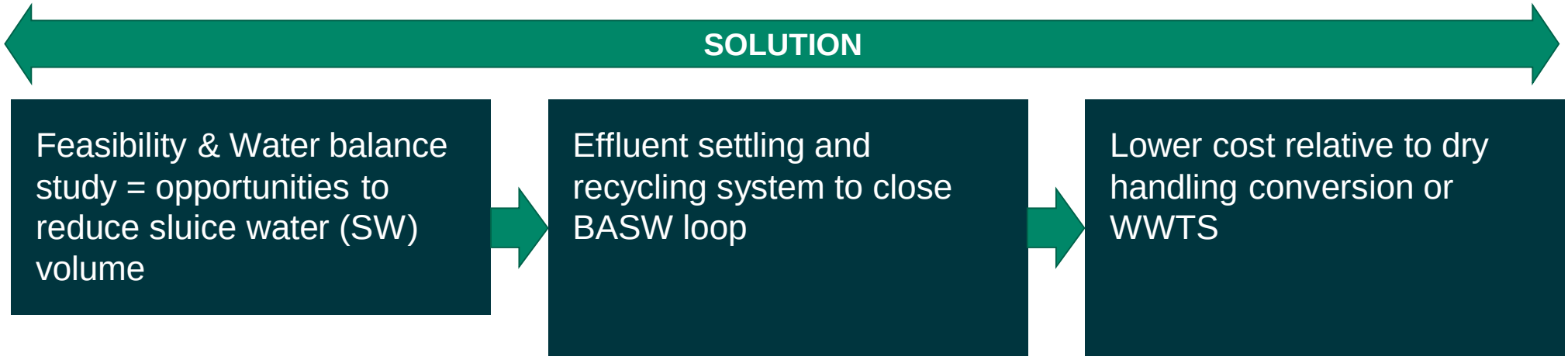
**Reconfigure**: Employ mechanical seals, implement sluice water clarification system

**Retrofit:** Install ash dewatering basin with sluice recycle, or implement in-duct wastewater evaporation system

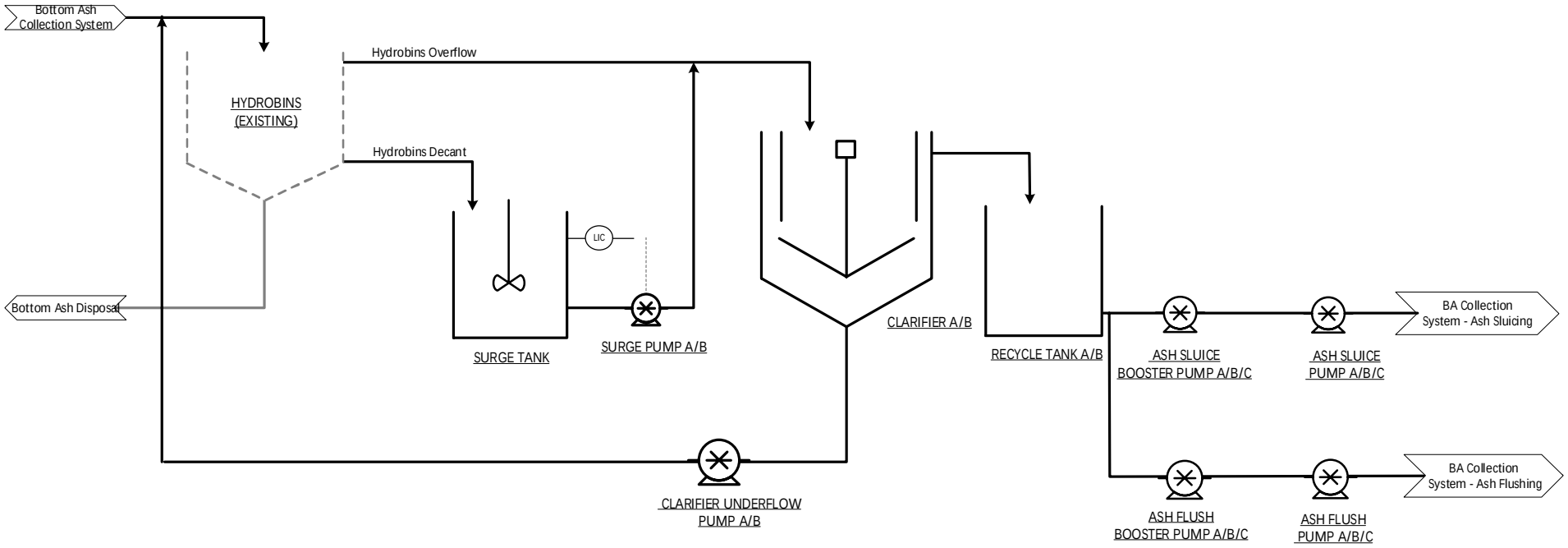
# Hydrobin System Reconfiguration

## Reduce, Reconfigure, Recycle

- Traditional hydrobin system for BA regularly overflowed BA into LVW sumps
- Low volume waste impacted for ELG compliance
- BA Disposal in CCR compliant pond



# BA Sluice Recycle PFD



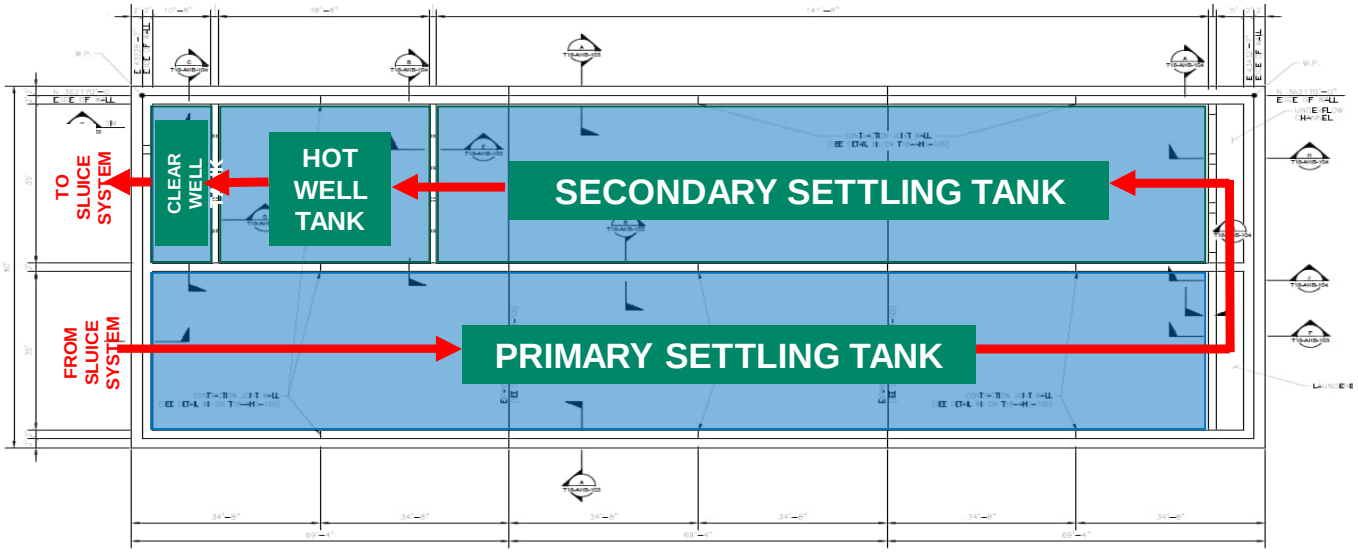
# BATW Reconfiguration

## Reduce, Reconfigure, Recycle

- 1200-MW coal fired plant with pond-based, open-loop slag removal
- Compliance with CCR and ELG required
- Physical limitations precluded under boiler SFC

**SOLUTION:**

- Water balance tightening plus Concrete Dewatering Tank (CDT)
- Continuous flow system with online excavation of ash and sluice water recycle
- Provision for temperature adjustment



# Concrete Dewatering Basin

# Pathways to Compliance
# FGD WW

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# Traditional FGD WW ZLD Options

## End of Pipe Solutions

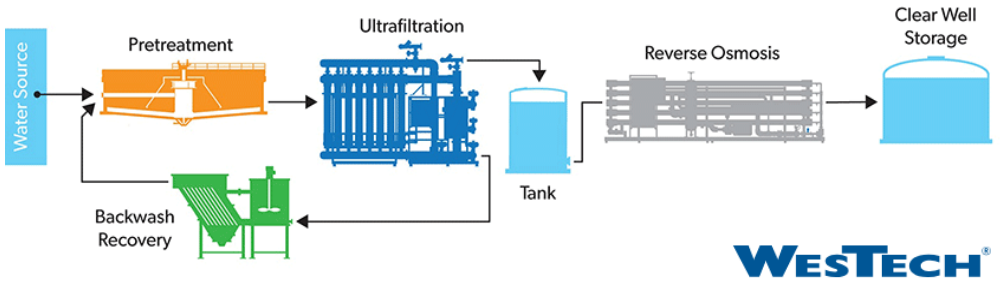
**Membrane Treatment – proposed BAT**

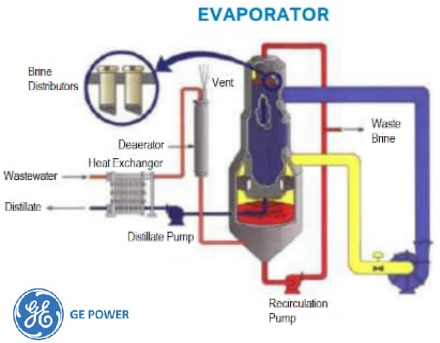
**Brine Concentrators**

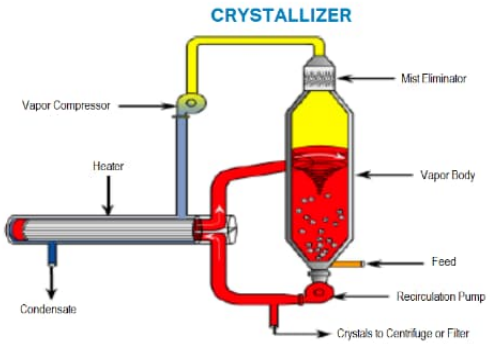
**Spray Dryers**

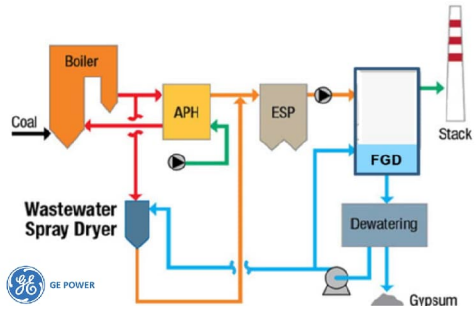
**Evaporation Ponds**

**Deep Well Injection**




# Holistic Approach to ZLD - 4Rs

**Reduce:** Modify pump seals, modify wash sequences, or adjust dewatering system setpoints to reduce wastewater volumes or concentrations.
**Reuse**: Modify plant water balance to recycle process water as a source of makeup water, wash water, or flush water.
**Reconfigure**: Utilize materials of construction to permit operation at higher chloride concentrations, modify FGD chemistry to produce wetter product for disposal.
**Retrofit:** Stabilize wastewater for landfill disposal, install ash dewatering basin with sluice recycle, or implement in-duct wastewater evaporation system.

# Utilize Materials of Construction

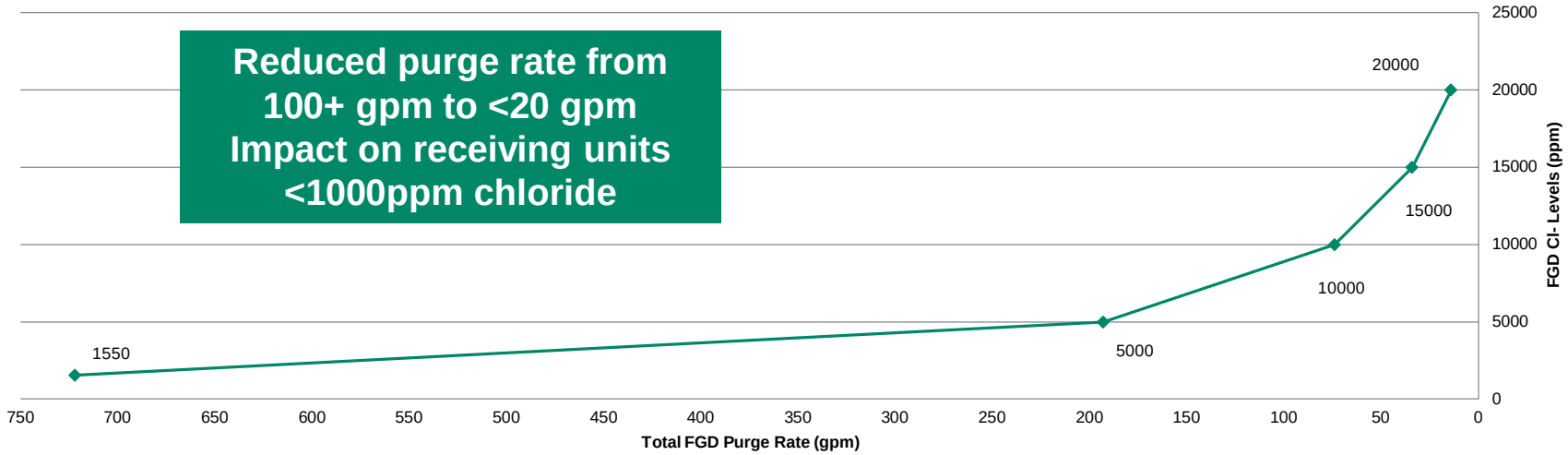
## Reduce, Reconfigure, Recycle

- Station with 3 units: 1 large, 2 smaller ~ 1600 MW total
- Larger unit designed to purge ~200 gpm through WWTS to outfall
- WWTS required extensive upgrade for ELG compliance
- FGD MOC's included Stebbins Tile, PVC/FRP, C276/Hastelloy, Rubber Lined Pumps

**SOLUTION**

Plant wide water balance and sensitivity analysis → Revealed chlorides could be cycled up in larger unit to reduce purge rate → Smaller stream could be used as makeup to smaller units → Chlorides co-disposed in existing solids blending system.

# Purge rate versus FGD chloride concentrations




| Common FGD MOCs | Practical Cl Limits |
|---|---|
| 316L | <10,000 ppm |
| 317L | <15,000 ppm |
| 2205 | <25,000 ppm |
| FRP/Stebbins | >25,000 ppm |

# Process Troubleshooting & Modifications
## Reduce FGD Wastewater

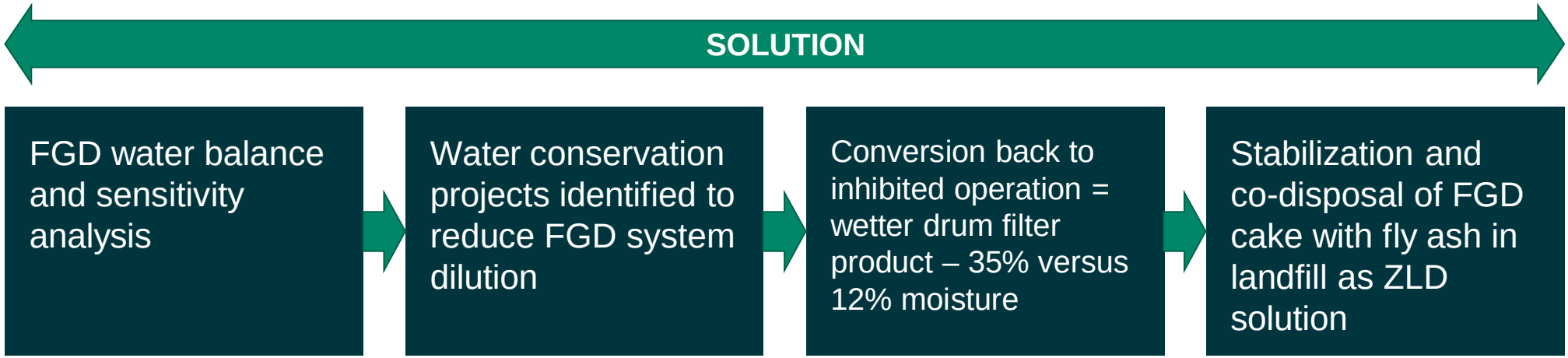
- 1400 MW station – LSFO operation
- FGD system produced excessive gypsum fines causing high moisture in gypsum and high-volume wastewater purge rate
- Fines determined to be caused by potential crystal modifier in limestone reagent

**SOLUTION:**
- Changed source of limestone reagent
- Reduced WW purge by 10x
- Gypsum product met moisture spec


# Reagent Conversion & Co-disposal

## Reduce, Reconfigure

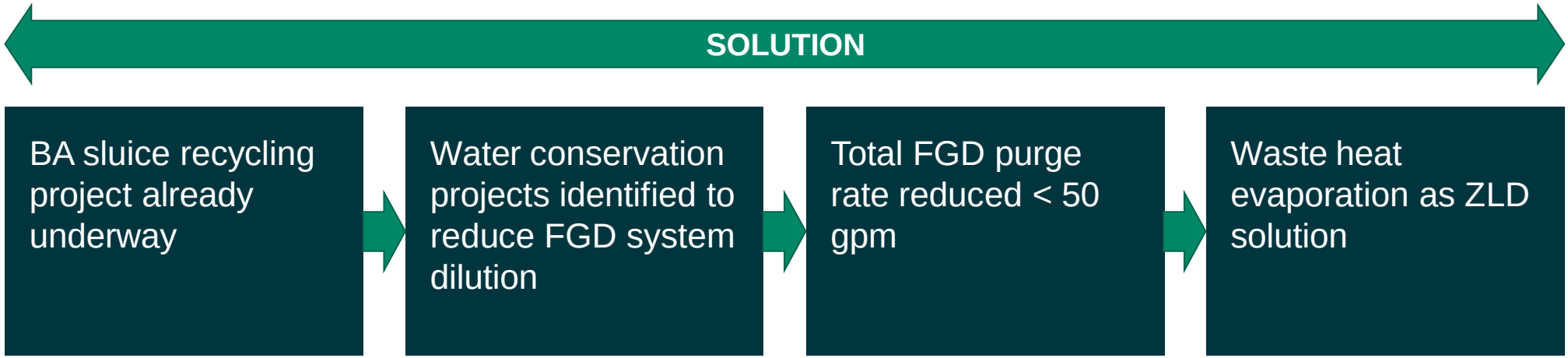
- Station with 2 units: 1080 MW total
- 150 gpm LSFO FGD chloride purge
- Minimal gypsum sales; Fly ash co-disposed with unsold gypsum in landfill



# In-Duct Wastewater Evaporation

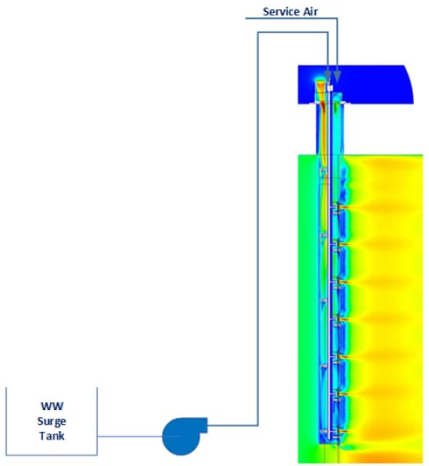
## Reduce, Reconfigure

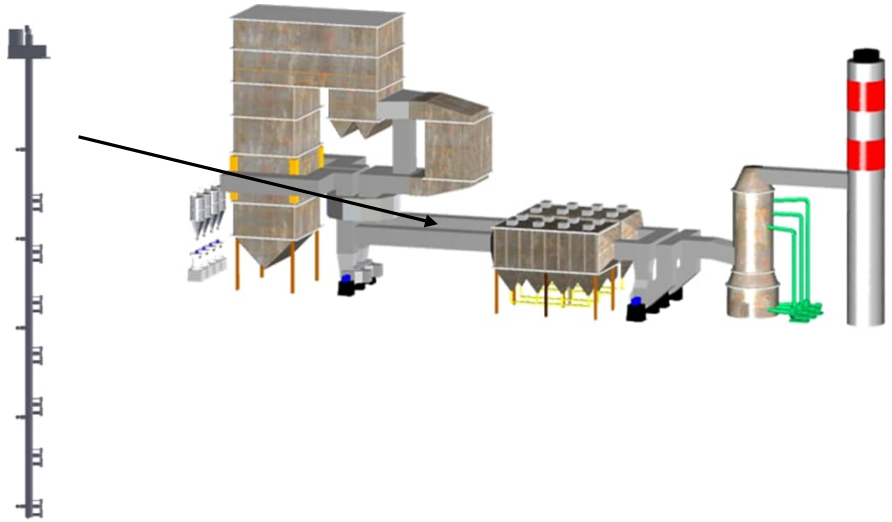
- Station with 2 units: 1 large, 1 small ~ 517MW total
- FGD and BA transport water collected in settling pond with outfall to river
- Pond not compliant with CCR; outfall not compliant with ELG



# In-Duct Wastewater Evaporation

- Lower cost, simpler alternative to SDE for streams < 25 gpm
- FGD purge stream injected into flue gas between economizer and particulate control device
- Wastewater evaporates – TDS forms particulates for capture downstream



## Conclusion

- ZLD is proposed to be BAT for FGD and BA WW no later than 2029
- Existing, previously compliant systems may require upgrades to retain compliance
- Water balance tightening necessary to lower wastewater flows and lower the cost of compliance
- Alternative, economic approaches to ZLD exist and can be used to help extend the life of plants