Energy Saving Efforts in Indian Ammonia Urea Plants

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Capacity & Production Of Fertiliser Products (2014-15)(in Million Tonne)

Products	Capacity	Production	Consumption	Gap
1. Urea	23.46	22.59	30.87	8.28
2. Amm. Chloride (ACl)	0.11	0.04	0.035	-0.005
3. Amm. Sulphate (AS)	0.64	0.59	0.43	-0.16
4. Calcium Amm. Nitrate	0.14	0.00	0.00	0.00
5. Single Super Phosphate	9.61	4.17	4.23	0.00
6. Di-Amm. Phosphate (DAP)	8.02	3.45	7.56	4.12
7. Complex Fertilisers (NP/NPK other than DAP)	6.60	7.83	8.21	0.38
8. Muriate of Potash (MoP)	-	-	2.78*	2.78
Total		38.66	54.11	15.45

Energy Intensity in Fertiliser Sector

- Ammonia-Urea segment of the industry is more energy intensive accounting for 85% of total energy consumption in the sector.

- In the ammonia-urea segment, production of ammonia accounts for 80% of the total energy required for production of urea.

Energy Saving Schemes Implemented in Ammonia-Urea Plants

Reforming Section

Reforming Section

- Reformer tubes of better metallurgy
- Additional Heat Recovery In Reformer Convection Zone - Installing Additional BFW Coil, Air Pre-heater
- Changing coil type exchanger to plate type heat exchanger for air preheater
- Modification in reformer burners
- Installation of Pre-reformer
- Installation of Reformer Exchanger

Purification Section

CO Shift Conversion

- LTS Guard With Heat Recovery

CO2 Removal Section

- Single Stage to Two Stage Regeneration
- Replacement of Solvent
- Hydaulic Turbine
- Change Over of Random Packing with Structured Packing
- Modification of Internals in Towers.

Ammonia Synthesis Section

Synthesis Section

- Purge Gas recovery
- Conversion of Converter from Axial to Axial Radial
- S-50 and S-300 Converters
- Additional Purification of Synthesis Gas
  - -Liquid Ammonia Wash of Make Up Synthesis Gas to remove impurities of CO_2 and moisture
  - -Drying of Synthesis Gas by Molecular Sieve
- Chilling of Make up Synthesis Gas to Save Compressor Power

Urea Plant

- High Efficiency Urea Reactor Trays/additional trays.
- Replacement of conventional Stripper with Bimetallic Stripper
- Heat Recovery from Vapours of Decomposer
- Installation of MP Pre-decomposer
- Installation of Pre-concentrator Before Vacuum Concentration Section.
- Urea Hydrolyzer
- Utilization of off gases from inert washing column (C-3) as fuel in reformer or boilers

Moving Machines

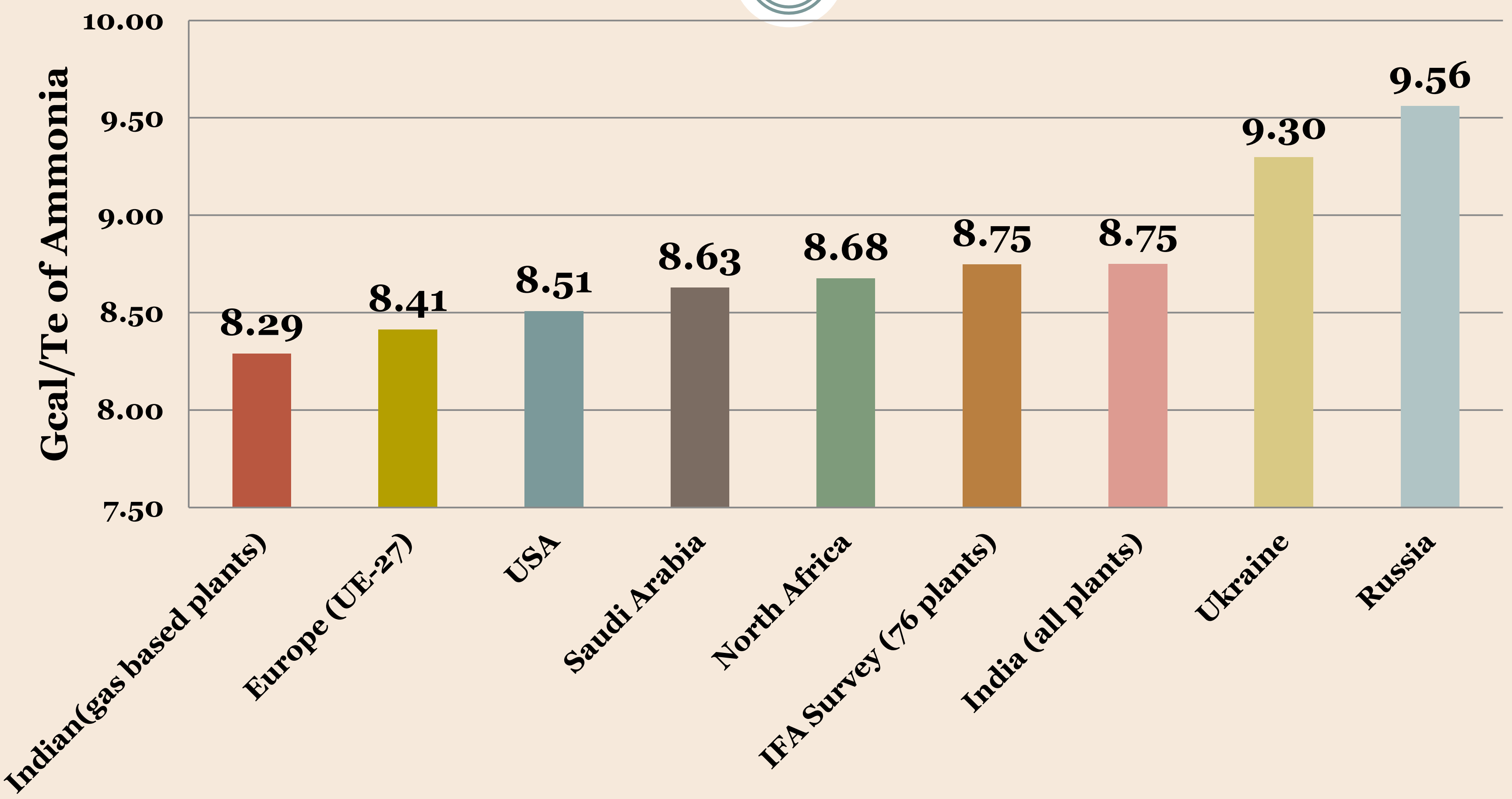
- Modification of Compressor Internals.
- Modification or Replacement of Turbines.
- Chilling of Air at Suction of Air Compressor.
- Replacement of Hydraulic Governors with Electronic Governors.

Miscellaneous Measures

- Provision of Gas Turbine for Air Compressor with HRU for Steam Generation
- Variable Frequency Drive
- Trimming of Pumps Impellers to match the Load Requirement
- Change of Drives of Pumps and Fans from Steam Turbine to Electric Motor
- Advance Process Control
- Load Management System

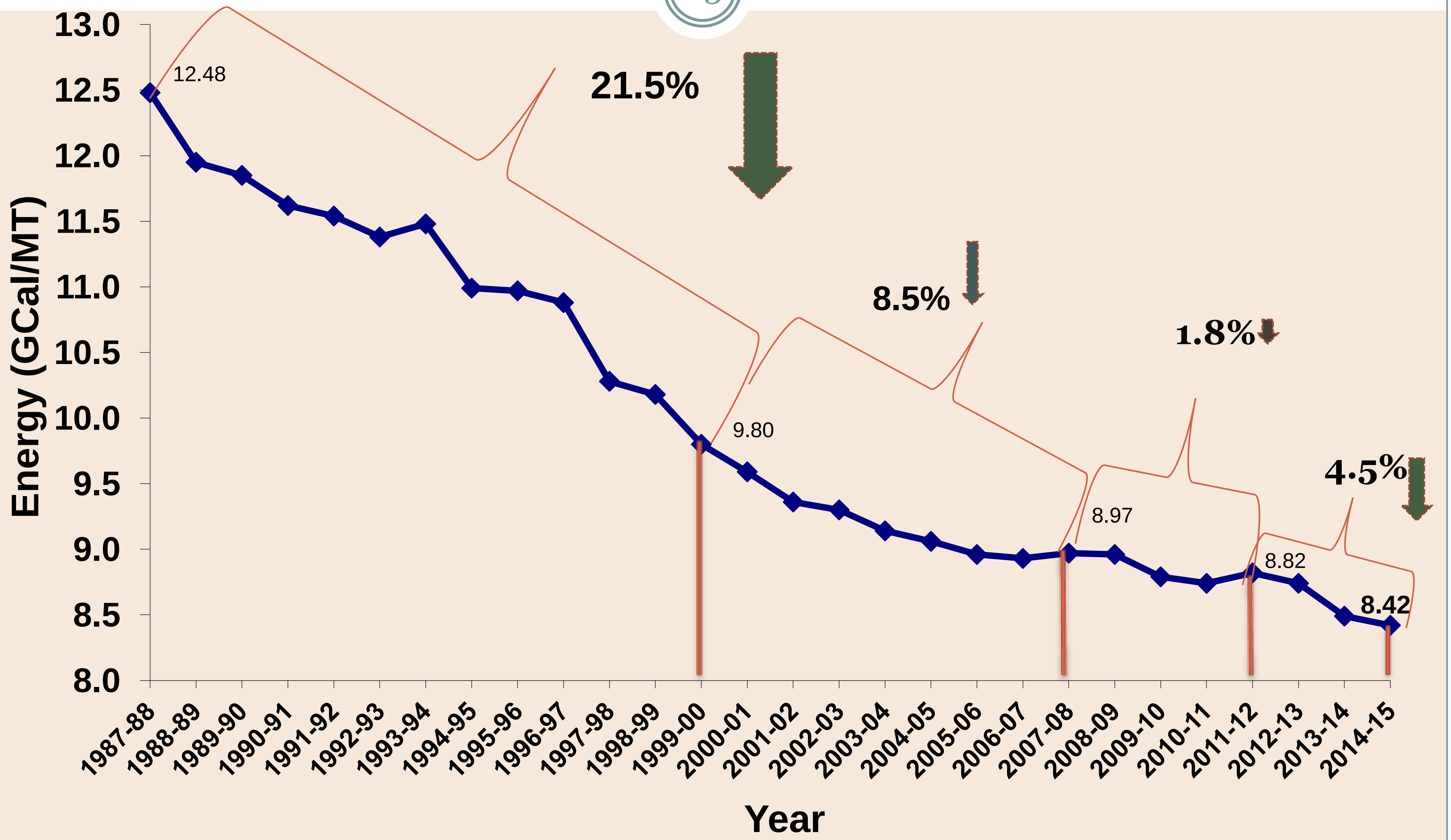
Performance of Ammonia-Urea Plants

Benchmarking of Ammonia Plant 2010-11

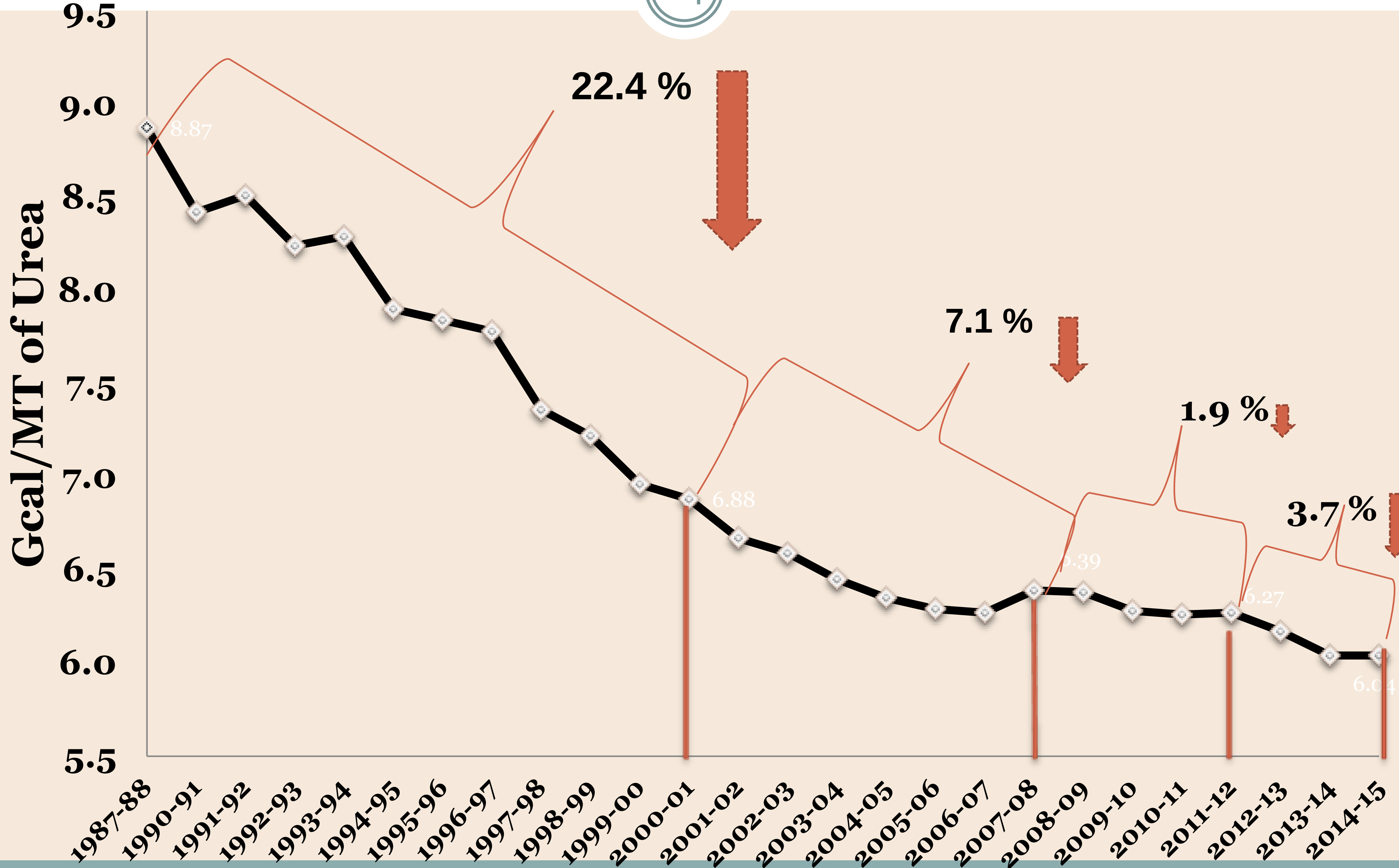


Source : FAI and Nitrogen +Syngas , Vol. 325, September-October 2013

Energy Consumption Trends in Ammonia Plants



Energy Consumption Trends in Urea Plants



Efficiency in End Use of Ammonia

- **More than 90 % ammonia used for production of urea.**

- **Specific consumption of ammonia is an indicator for efficient use of ammonia.**

- **Specific consumption of ammonia is also determinant in energy efficiency of urea plants.**

Specific Ammonia Consumption in Production of Urea

Year	Ammonia (t) / Urea (t)
1990 – 91	0.589
1996 – 97	0.584
2002 – 03	0.580
2003 – 04	0.579
2009 – 10	0.578
2012 – 13	0.577
2013 – 14	0.577

Potential Energy Savings Schemes for Ammonia-Urea Plants

Options Available for Energy Savings

- Recovery of Waste /Process Heat
- Retrofit /Replacement of existing equipment
- Installation of new devices/systems
- Change in operational philosophy

Recovery of Waste /Process Heat

1.	Replacement of existing combustion air type preheater with new plate type exchanger in the ammonia plant or Installation of add-on module on existing plate type combustion air preheater.
2.	NG fuel pre heater in ammonia plant
3.	Recovery of Purge gas
4.	VAM on Process Air Compressor suction/ CO2 Compressor suction chilling /GT air inlet

- **These schemes have already implemented by a number of plants and only a few unit may implement these.**
- **Waste heat recovery in reformer convection zone is limited by space availability in providing additional waste heat recovery coils.**

Retrofit of Existing Equipments

1.	Up-rating or modifications of compressors and turbine Generators including synthesis gas, refrigeration, or Carbon dioxide compressors

- **Number of plants have modified the internals of compressors and turbines during revamp of the plants.**
- **The modifications are subject to approval of OEMs.**

Replacement of Equipments

1.	Replacement of pumps and compressors with a new energy efficient pumps or compressors
2.	Replacement of Heat exchangers
3.	Replacement of air burner for secondary reformer

The schemes like replacement of compressors are capital intensive with longer payback period.

Installation of New Systems -Ammonia Plants

1.	Installation of MP Condensate Stripper in Ammonia plant
2.	Installation of new single stream turbine for synthesis gas compressor
3.	Installation of fuel gas expander with preheaters / power generators
4.	New additional MP Boiler in between ammonia converters.
5.	Ammonia recovery from Synthesis Loop LP purge gases
6.	Swap of solution of CO2 removal system from GV to OASE (aMDEA)
7.	Ammonia wash (syn gas drying) in compressor inter-stage and loop re-piping

The some schemes have been implemented in many plants.

Installation of New Systems -Urea Plants

1.	Installation of Vortex Mixture and conversion booster in urea reactor
2.	High Efficient Trays in urea reactor
3.	Installation of ammonia pre-heater in urea plant
4.	Installation of vacuum pre-concentrator
5.	HP split flow configuration Ejector and new HP carbamate condenser

Addition of trays and/or replacement with modified trays in urea reactor have been in practice since long. Ammonia pre-heaters or vacuum pre-concentrator have been installed by a number of plants during revamp.

Operational Improvements

1.	Changing drive from steam to power for CO2 compressor, BFW, semi lean pump condensing turbine, etc
2.	Reduction of Steam Carbon Ratio from 3.3 to 3.0 in primary reformer
3.	Saturated MP Steam Export from Synthesis Loop to urea plant

Changing drive from steam to power, steam/carbon ratio and saturated MP steam export form synthesis loop, require careful study of steam -power energy balance.

Other Schemes

1.	Minimization of heat losses by improving insulation
2.	Replacement of bellows in combustion air duct in primary reformer convection zone and dry ice cleaning of coils in primary reformer convection zone.
3	Use of Energy Efficient Lighting systems
4.	Replacing faulty steam traps and arresting steam leaks
5.	Installation of VFDs in MP BFW pump of HRSG -Payback period more than 11 years

Energy saving potential of such schemes is very low.

Conclusions

- There has been continuous efforts to modernize of ammonia and urea Plants.
- Various schemes have been implemented by fertiliser plants to improve process, utilize waste heat, process heat, improvement in machinery and equipments, and operational efficiency in fertiliser plants.
- There is overall reduction of energy of about 32% percent in ammonia urea plants from 1987-88 in spite of aging plants.
- During 2014-15, weighted average energy consumption of ammonia plant was 8.42 Gcal/MT and urea plant was 6.04 Gcal/MT.

Conclusions

- Further potential of energy saving through implementation of energy saving schemes is limited due to
  - Technical Feasibility in a plant
  - Replacement are highly capital intensive with very long payback period.

- Weighted Average Energy Consumption of existing urea plant is projected to reduce from 6.04 Gcal/MT urea (2014-15) to 5.97 Gcal/MT urea in the short term.

Thank you