STRENGTHENING ENERGY EFFICIENCY MECHANISM IN INDIAN RAILWAYS THROUGH PAT SCHEME

By

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Contents

National Action Plan on Climate Change (NAPCC)

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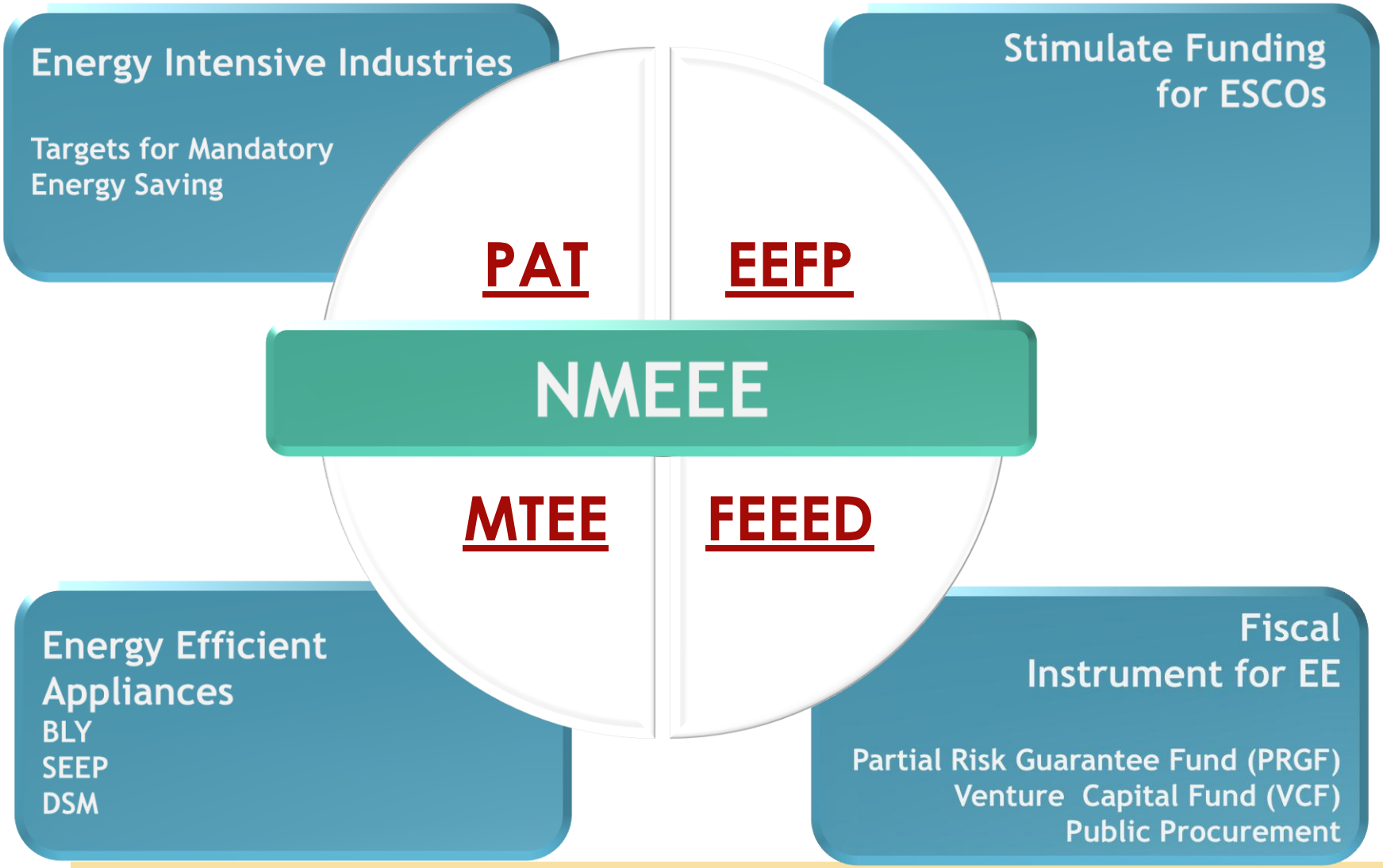
Nation Mission for Enhanced Energy Efficiency (NMEEE)



Regulatory Framework

Energy Conservation (EC) Act 2001

- **Norms for Energy Intensive Industries**
- Standard & Labeling
- Energy Conservation Building Code
- Demand Side Management
- Certification of Energy Professionals

Perform, Achieve & Trade

- A **market based regulatory instrument** to reduce specific energy consumption in industries, **to enhance the cost effectiveness** through tradable **energy saving certificates**.

- Section 14 (g): Establish norms
- Section 14 (n): Direction to Industries
- Section 14A: Energy Saving Certificates
- Section 26: Penalty & Enforcement
- Section 27: Adjudication

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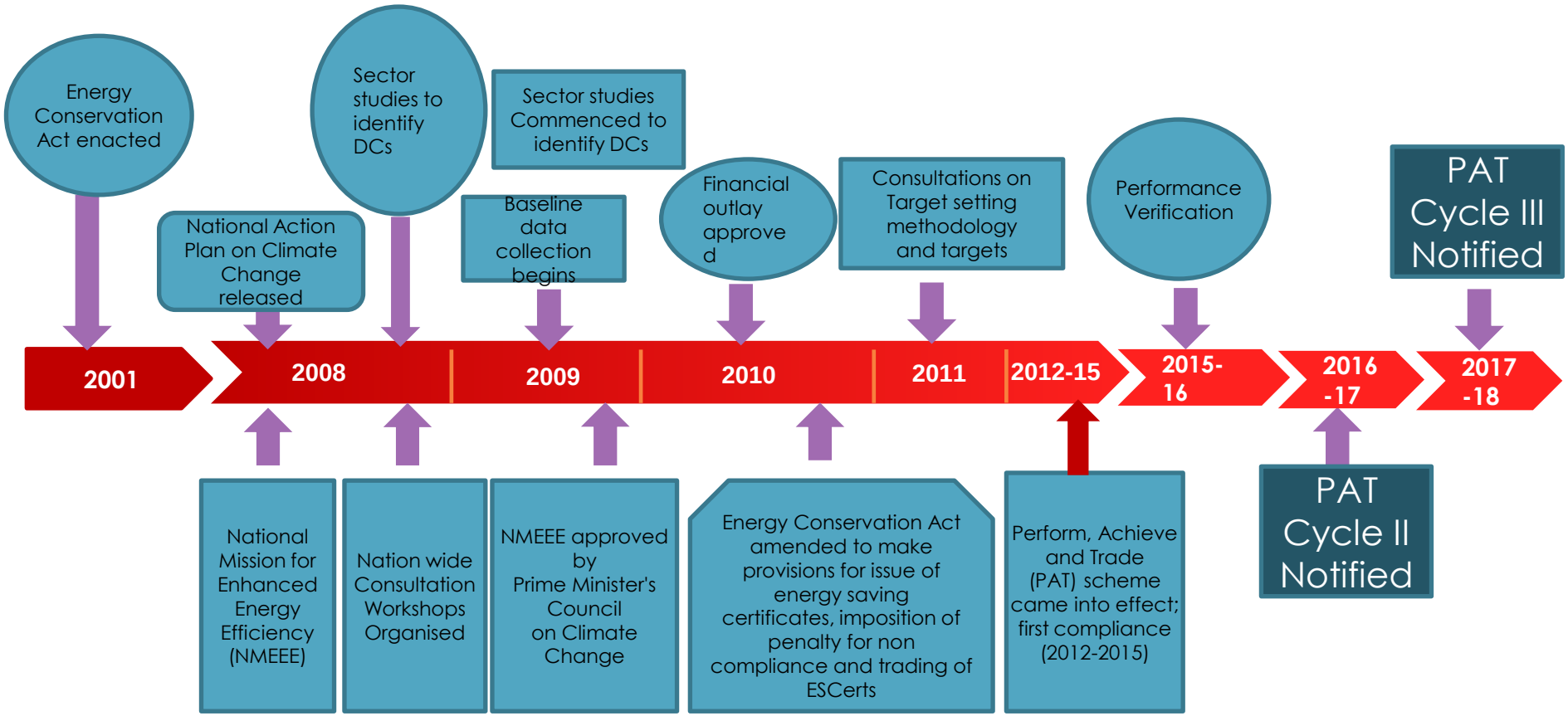
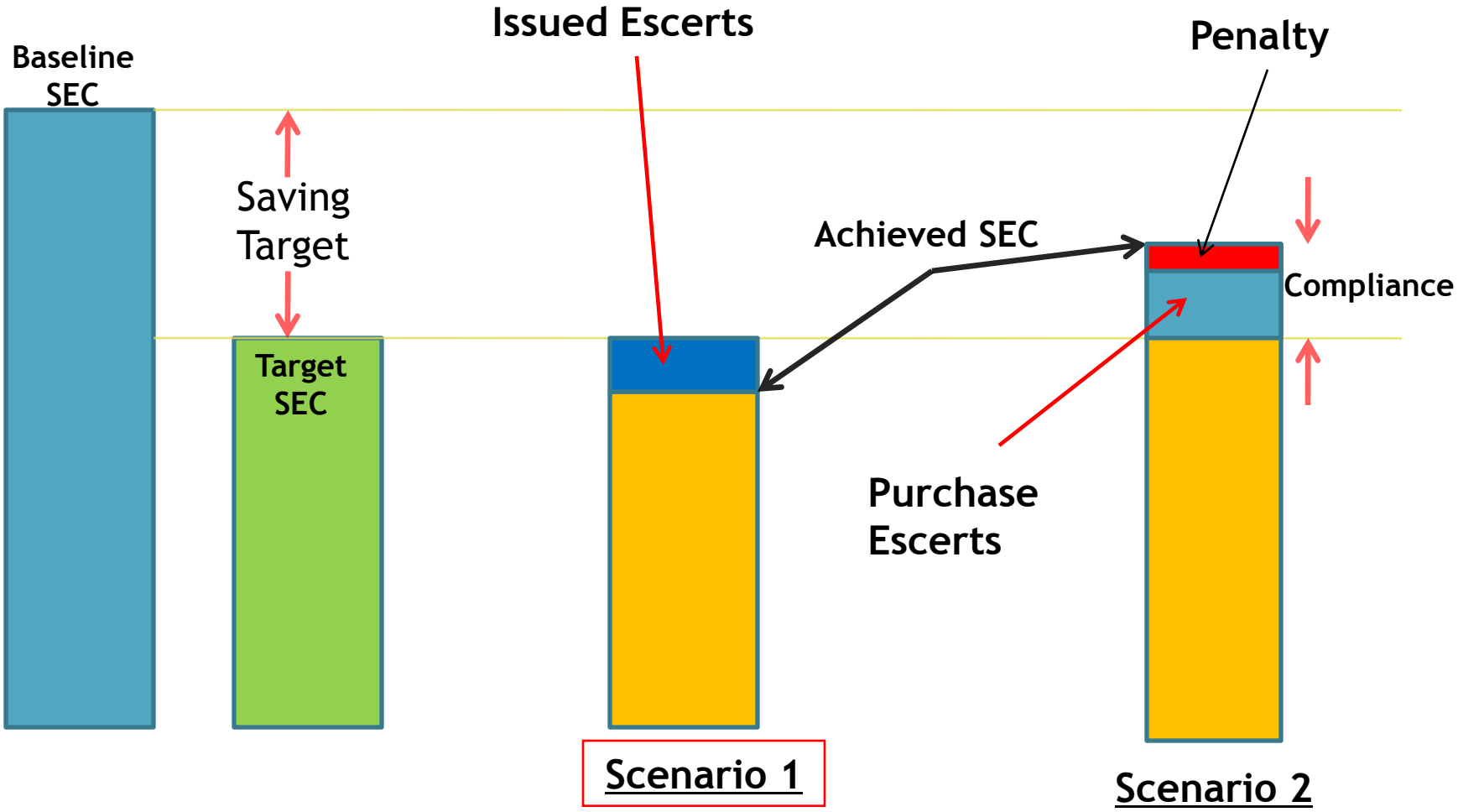
PAT Evolution



PAT- Salient features

- Regulatory instrument linked with market mechanism
  - Certification of energy saving
- Consultative approach
  - Ministries/DCs/Associations/FIs/Research Organizations
- Outreach/ Capacity Development
  - Workshops/Seminars/ Visits
- "Self – competing"
  - Unit specific targets
- Relative responsibility
  - Less target for more efficient and more for less efficient

Concept of Target, Compliance, ESCerts & Penalty



Sectoral Coverage

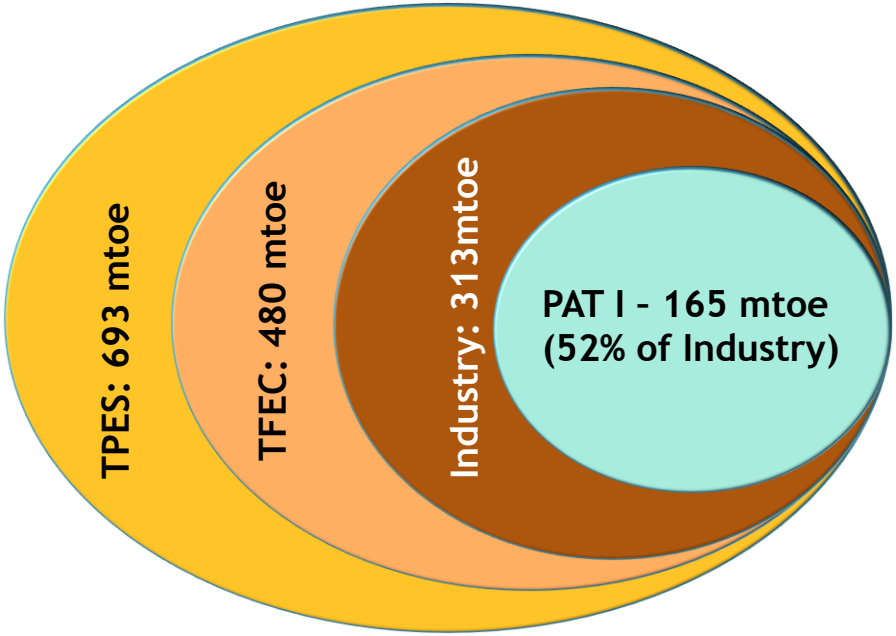
Criteria for Identification of Sectors

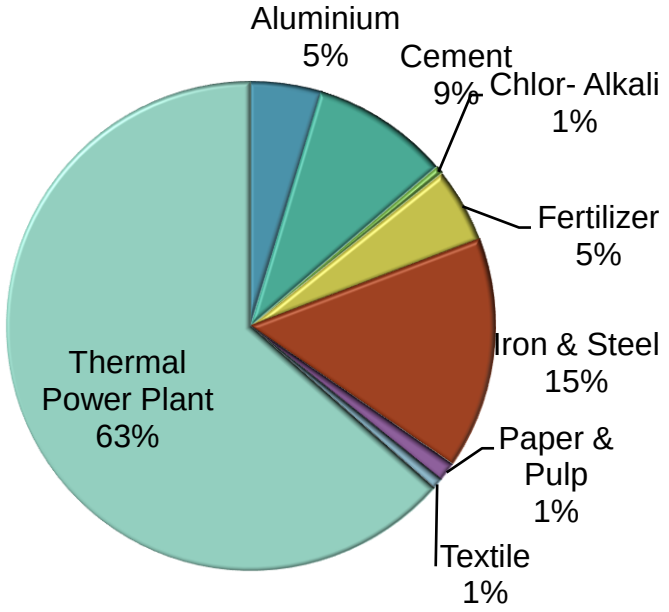
- Listed in Schedule of EC Act
- Intensity or quantity of energy consumed
- Amount of investment needed
- Capacity to invest
- Availability of energy efficient technology

Sectors in PAT Cycle I (2012-15)

1. Aluminum
2. Cement
3. Chlor Alkali
4. Fertilizers
5. Iron and Steel
6. Pulp and Paper
7. Textile
8. Thermal Power Stations

PAT 1 Coverage





TPES: Total Primary Energy Supply
TFEC: Total Final Energy Consumption
Industry includes Thermal Power Plants
mtoe: Million tonnes of Oil Equivalent

Baseline Year: 2010
Data Source: IEA and BEE

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PAT Cycle I- Notified Sectors

S. NO.	Sectors	Annual Energy Consumption Norm to be DC (mtoe)	No. of Identified DCs	Annual Energy Consumption (Million toe)	Share Consumption (%)	Apportioned Energy Reduction For PAT Cycle-1 (Million toe)
1	Power (Thermal)	30000	144	104.56	63.38%	3.211
2	Iron & Steel	30000	67	25.32	15.35%	1.486
3	Cement	30000	85	15.01	9.10%	0.815
4	Aluminium	7500	10	7.71	4.67%	0.456
5	Fertilizer	30000	29	8.20	4.97%	0.478
6	Paper & Pulp	30000	31	2.09	1.27%	0.119
7	Textile	3000	90	1.20	0.73%	0.066
8	Chlor- Alkali	12000	22	0.88	0.53%	0.054
	Total		478	164.97	100%	6.686

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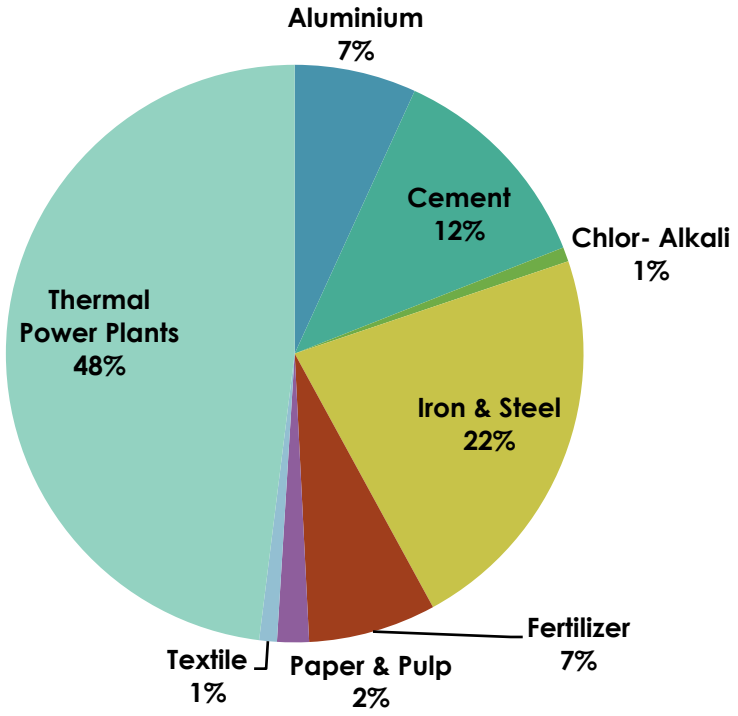
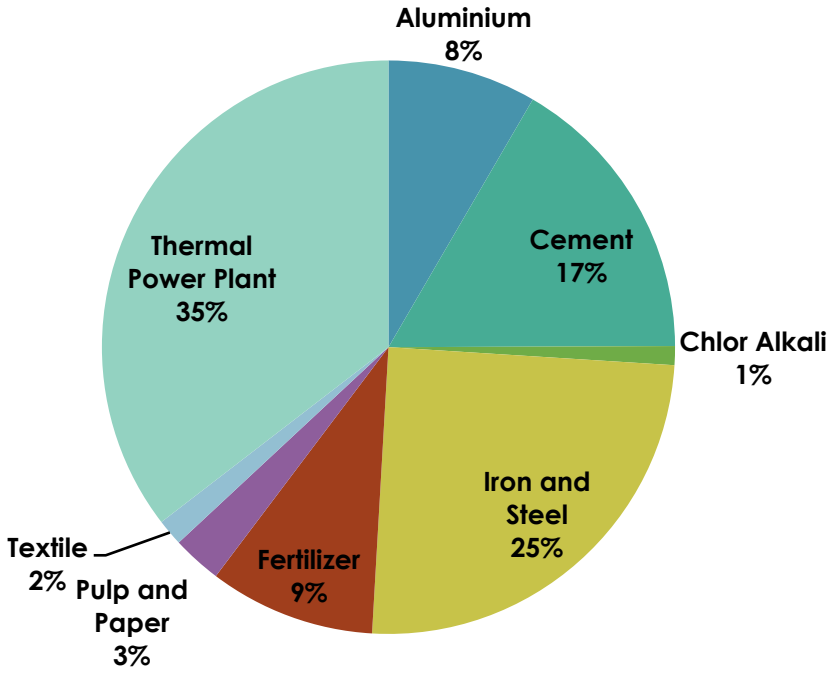
Sectoral Share of Target and Achievement

Target Energy Saving Share



Target : 6.686 mtoe

Achieved Energy Saving Share



Achieved : 8.67 mtoe

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Target Setting

Policy objectives

- INDC
  - Intended Nationally determined Contribution (INDC): reduction of emission intensity by 33-35% of GDP by 2030 from the base year of 2005
- GOALS
  - Reduction in energy intensity between 2016 and 2019 by 7 %

Realized Impacts – PAT 1 (2012-2015)

Energy Saving

8.67 mtoe
5635 MW

1.25% of India's total primary energy supply

Emission Reduction

31 million tonnes of CO_2

1.93% of India's emissions

Skill Development

Capacity building: **5000+** Engineers and operators

13718 Energy Auditors & Managers

219 Accreditation

Savings

Rs 9,500 Crores

from saved **energy consumption** and **avoided generation**

Investment

Encouraged investments for energy efficient technologies for domestic manufacturing

Rs 24,517 Crore invested

Sectoral Coverage: Cycle II and beyond

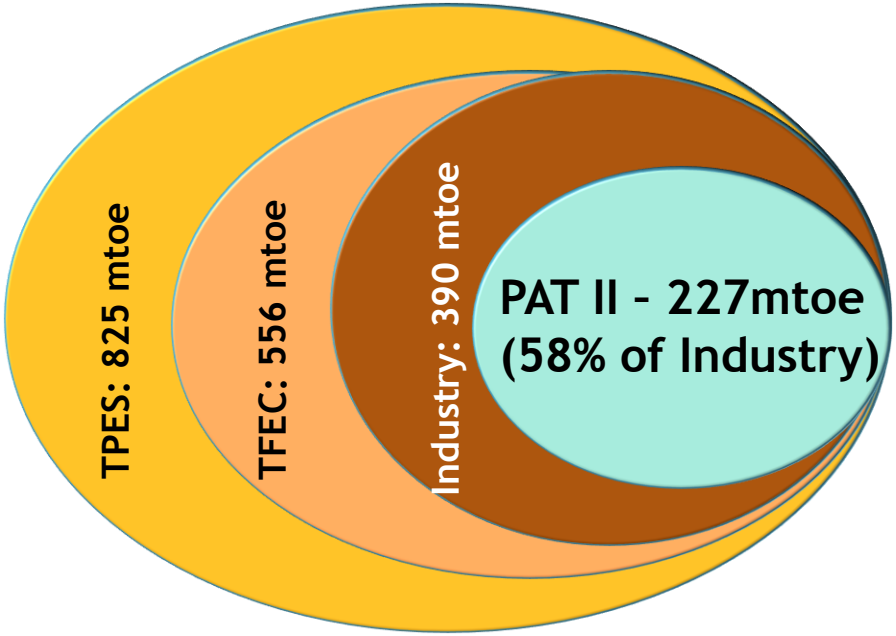
Additional Sectors in PAT Cycle II (2016-19)

1. Railways
2. Petroleum Refineries
3. Electricity Distribution Companies

Proposed Sectors in Coming Cycles of PAT

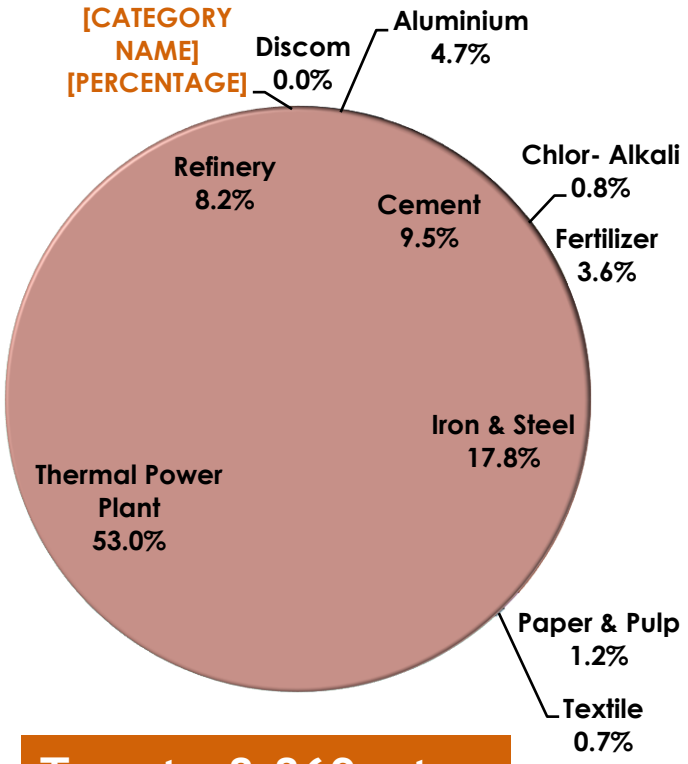
1. Chemicals
2. Commercial Buildings or Establishments
3. Hydel power stations, Electricity Transmission Companies
4. Petrochemical, Gas Crackers Naphtha Crackers
5. Port Trust
6. Sugar
7. Transport Sector (Industries and Services)

PAT 2 Coverage



TPES: Total Primary Energy Supply
TFEC: Total Final Energy Consumption
Industry includes Thermal Power Plants and Railways
mtoe: Million tonnes of Oil Equivalent

Target Energy Saving Share



Target : 8.869 mtoe

Baseline Year: 2014-15
Data Source: IEA and BEE

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PAT Cycle II- Notified sectors

Sr. No	Sector	No. of DCs in PAT I	Additional DC in PAT Cycle-II	Total no. of DCs PAT -2
1	Aluminum	10	2	12
2	Chlor-Alkali	22	3	24
3	Textile	90	14	99
4	Pulp & Paper	31	4	29
5	Iron & Steel	67	9	71
6	Fertilizer	29	8	37
7	Cement	85	27	111
8	Thermal Power Plants	144	22	154
9	Refinery	NA	18	18
10	DISCOMS	NA	44	44
11	**Railway**	**NA**	**22**	**22**
Total				621

PAT Cycle II
Baseline Year: 2014-15
PAT Cycle 2016-2019
Assessment Year: 2018-19

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Projected Outcome – PAT 2

Energy Saving

11407 MW
17.5 mtoe

2.09% of India's
total primary energy supply

Emission Reduction

60 million tonnes of CO_2

3-4% of India's emissions

Capacity building

12000+ Engineers and operators

15000 Energy Auditors & Managers

500 Accreditation

Savings

Monetary savings due to **energy**

Rs 19100 Crores

Investment

Encouraged investments for energy efficient technologies

Rs 30,000 Crore (Projected)

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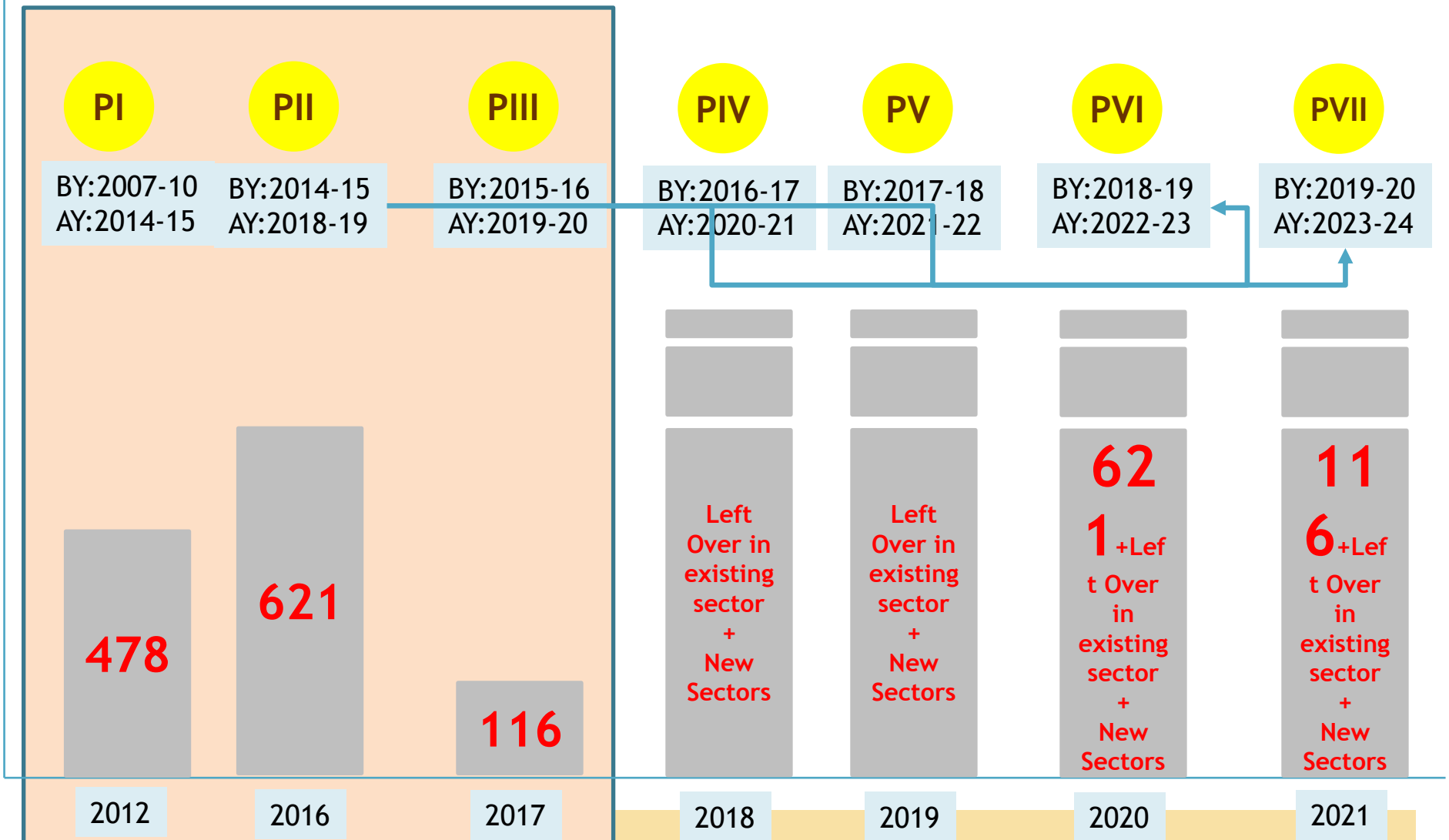
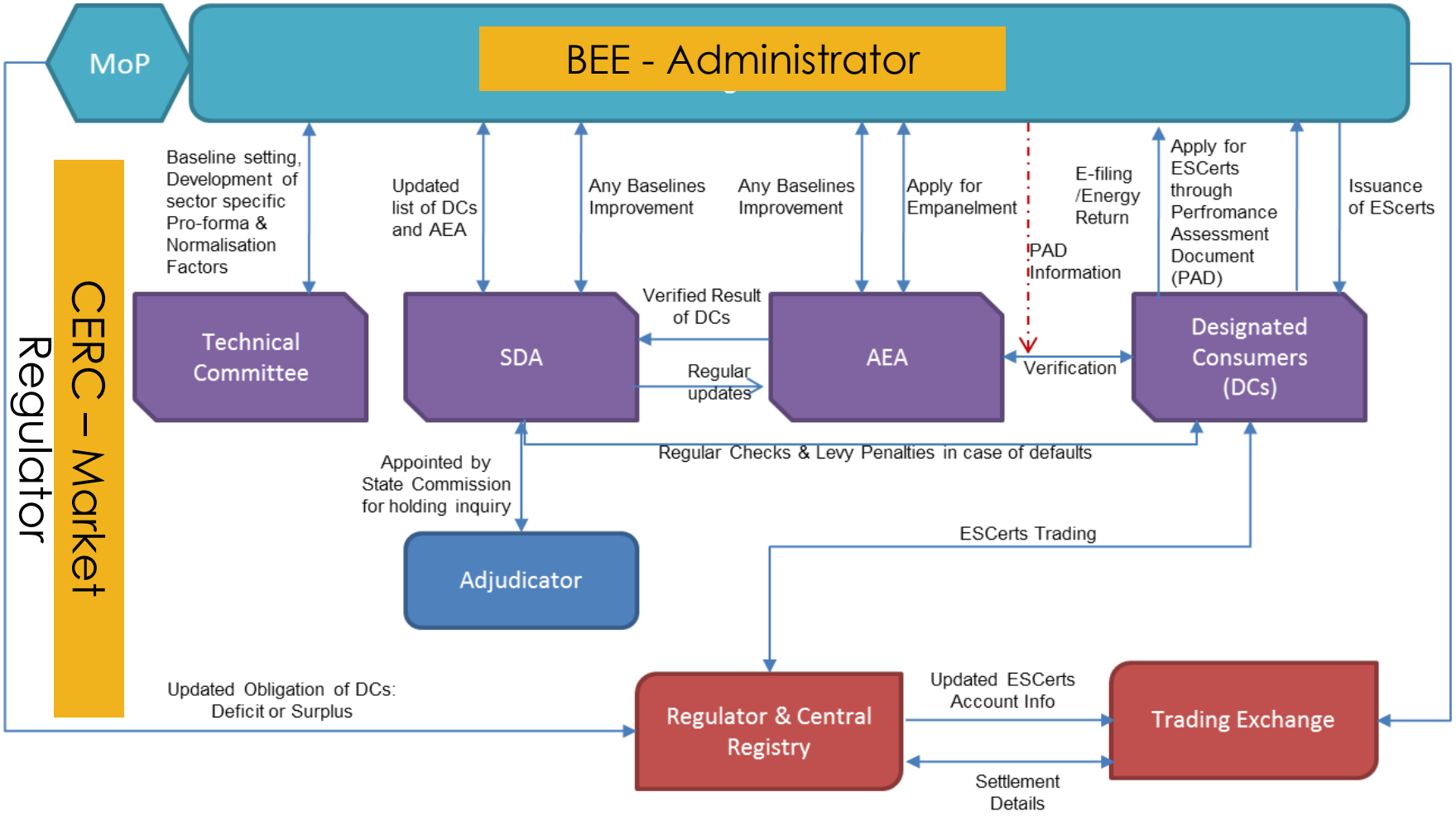
PAT II and Beyond (Rolling Cycle)



Institutional Structure



Industry & Media Viewpoint

"Excellent 'baseline' data established"

"Excellent methodology and formats for monitoring developed - ACC, Ultratech etc.. using these formats for regular monitoring"

The "Perform, Achieve and Trade" (PAT) mechanism is the most innovative and challenging initiative introduced under NMEEE (National Mission for Enhanced Energy Efficiency). FICCI

"It's really interesting. There's no other country in the world that's doing this so ambitiously." ***Noah Sachs, a law professor at the University of Richmond in Virginia,*** *who spent the spring studying the program.*

"The Indian program is particularly promising because it is a national, as opposed to a regional or statewide or provincial, program,", ***Richard Sandor, the chairman of Environmental Financial Products*** *a firm that has helped introduce several climate-related financial exchanges.*

Inclusion of Railways in PAT Scheme:

Comparison of Energy intensity in various Transport modes

- Railways is the most energy efficient mass transport system
- Energy intensity comparison- 2004-05

Pass.	**Railways**	**Taxis**	**Bus**
Terra Joule/ BPKM	71	1338	196
Freight	**Railways**	**HCVs**	
Terra Joule/ BTKM	91	1125	
Railways is 2.8 times energy efficient in Pass. Traffic and 12.4 times in Freight Traffic			

Railways – Energy Consumption Scenario

- Indian Railways
  - 3rd largest network
  - IR consumes about 2% of electricity and about 3% of diesel of the country.

- In 2015-16, IR consumed
  - 2894 Million litres. of diesel
  - 18.22 BU of electricity
  - Energy bill of about 25,800 Cr. INR, i.e. about 25% of Ordinary Working Expenses.
  - 9475 Cr. INR for electric traction & 16,100 Cr. INR for diesel traction.
  - Further 1,600 Cr. INR for Non- Traction power

Source: Annual Statistical Publication Railway 2015-16

Railways' INDC – Key targets

- To reduce emission intensity (i.e. tCO2 per million GTKM) by 32.6% in 2030 as compared to 2005 level
- Reduction in Emission Intensity to be achieved by 2030 mainly through improved Energy / Fuel efficiency in traction from 2013-14 level
  - Improvement in SEC, 4.8 % in Pass. and 13.2 % in Frt.
  - Improvement in SFC, 9.6 % in Pass. and 7.6 % in Frt.
- Use of 10% Solar Energy & Wind Energy by 2030
- Use of 5 % blending of bio fuels

Source: Annual Statistical Publication Railway 2015-16

Specific actions for IR in India's INDC

- ✓ Increase share of Railways in total land transportation from 36% to 45%.
- ✓ Construction of Dedicated Freight Corridor to reduce 457 million tonnes of CO2 in 30 years,
- ✓ To improve Specific Fuel / Energy consumption in Traction system,
- ✓ PAT scheme to be extended to railway sector,
- ✓ Production of energy efficient 3 phase locomotives and switchover to 100% from 2016-17 onwards.
- ✓ To install solar Power on land, roof tops, coaches.
- ✓ Bulk users like Railways to use 5% blending of bio-fuels

Percentage increment in Energy Consumption in traction Segment

- Over the years, the electricity consumption of Indian Railways is growing at the rate of **4 percent** and **3 percent** in case of diesel consumption as per year on year basis,

- Simultaneously, the railways network being electrified at pace of **3.7 percent** year on year basis to move towards low carbon emissions and proficient transport segment.

Source: Annual Statistical Publication Railway 2015-16

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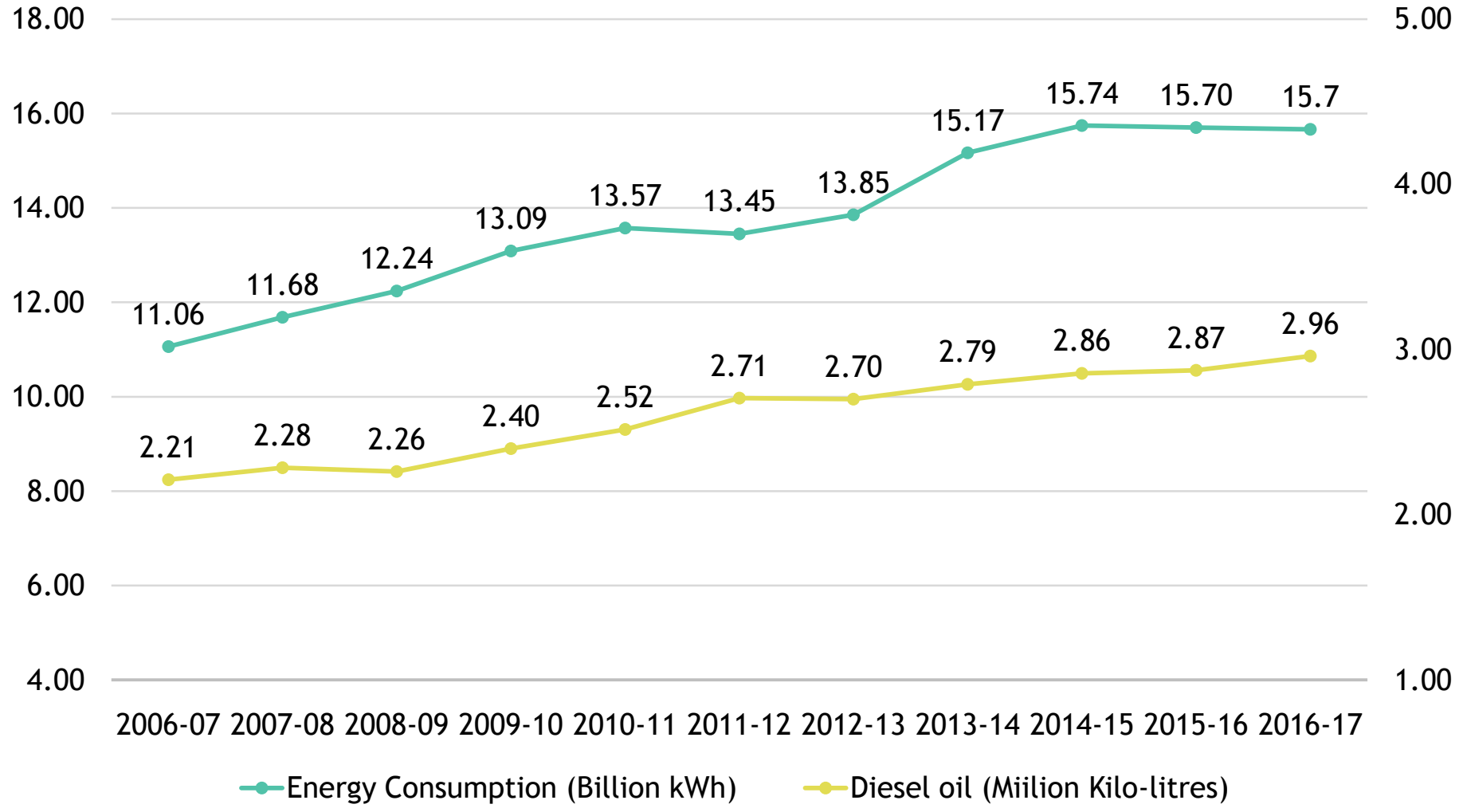
Indian Railways Energy Consumption (Traction) Trend



Source: Annual Statistical Publication Railway 2015-16

1. Aluminium;
2. Fertilizers;
3. Iron and Steel;
4. Cement;
5. Pulp and paper;
6. Chlor Akali;
7. Sugar;
8. Textile;
9. Chemicals;
10. Railways;
11. Port Trust;
12. Transport Sector (industries and services);
13. Petrochemicals, Gas Crackers, Naphtha Crackers and Petroleum Refineries;
14. Thermal Power Stations, hydel power stations, electricity transmission companies and distribution companies;
15. Commercial buildings or establishments;

As per the schedule of the Energy Conservation (EC) Act, 2001, industries in 15 energy intensive sectors are being identified as a "Designated Consumer (DC)".

Railways as Designated Consumer

As per earlier notification	As per amended notification
The electric traction sub –section (TSS) in each zonal Railway	All zonal railways having annual energy consumption for tarction of 70,000 metric tonne of oil equivalent (MTOE) per year and above
Diesel loco sheds in each zonal railways	
All six production units i. e. Integral Coach Factory, Rail Coach Factory, Chittaranjan Locomotive Works, Diesel Locomotive Works and Rail Wheel Factory	All six production units i. e. Integral Coach Factory, Rail Coach Factory, Chittaranjan Locomotive Works, Diesel Locomotive Works and Rail Wheel Factory
Workshop of IR consuming energy more than 30000 toe and above	Workshop of IR consuming energy more than 30000 toe and above

Railways as Designated Consumer

- Railways Sector DCs:-
  - 16 Zonal Railways for Traction having Annual Energy Consumption of 70,000 toe or above are notified as Designated Consumer.

S.No	Zonal Railway
1	Central
2	East Central
3	East Coast
4	Eastern
5	North Central
6	North Eastern
7	North Frontier
8	Northern
9	North Western
10	South Central
11	South East Central
12	South Eastern
13	Southern
14	South Western
15	West Central
16	Western

Railways as Designated Consumer

- Railways Sector DCs:-
  - 6 Production Units notified as Designated Consumer.

S.No	PRODUCTION UNIT
1	Chittaranjan Locomotive Works
2	Diesel Locomotive Works
3	Diesel Modernization Works
4	Integrated Coach factory
5	Rail Wheel Factory
6	Rail Coach Factory (Kapurthala)

Metric Adopted for Target Setting

- For Zonal Railway Traction:-

Zonal Railway			
Diesel		Electrical	
Passenger (Litres/1000GTKm)	Goods (Litres/1000GTKm)	Passenger (kWh/1000GTKm)	Goods (kWh/1000GTKm)
Target	Target	Target	Target

Metric Adopted for Target Setting

➢ For Production Units :-

- Energy consumption per unit of production i.e. Locomotives, Coaches, wheels etc. is considered as performance metric.

- All the energy consumption will be converted into toe and metric will be Kgoe /unit of production.

- For the time being Rail Coach Factory (Raebareili) now known as Modern Coach Factory has not been included in PAT II as the factory is in construction phase and not fully operational.

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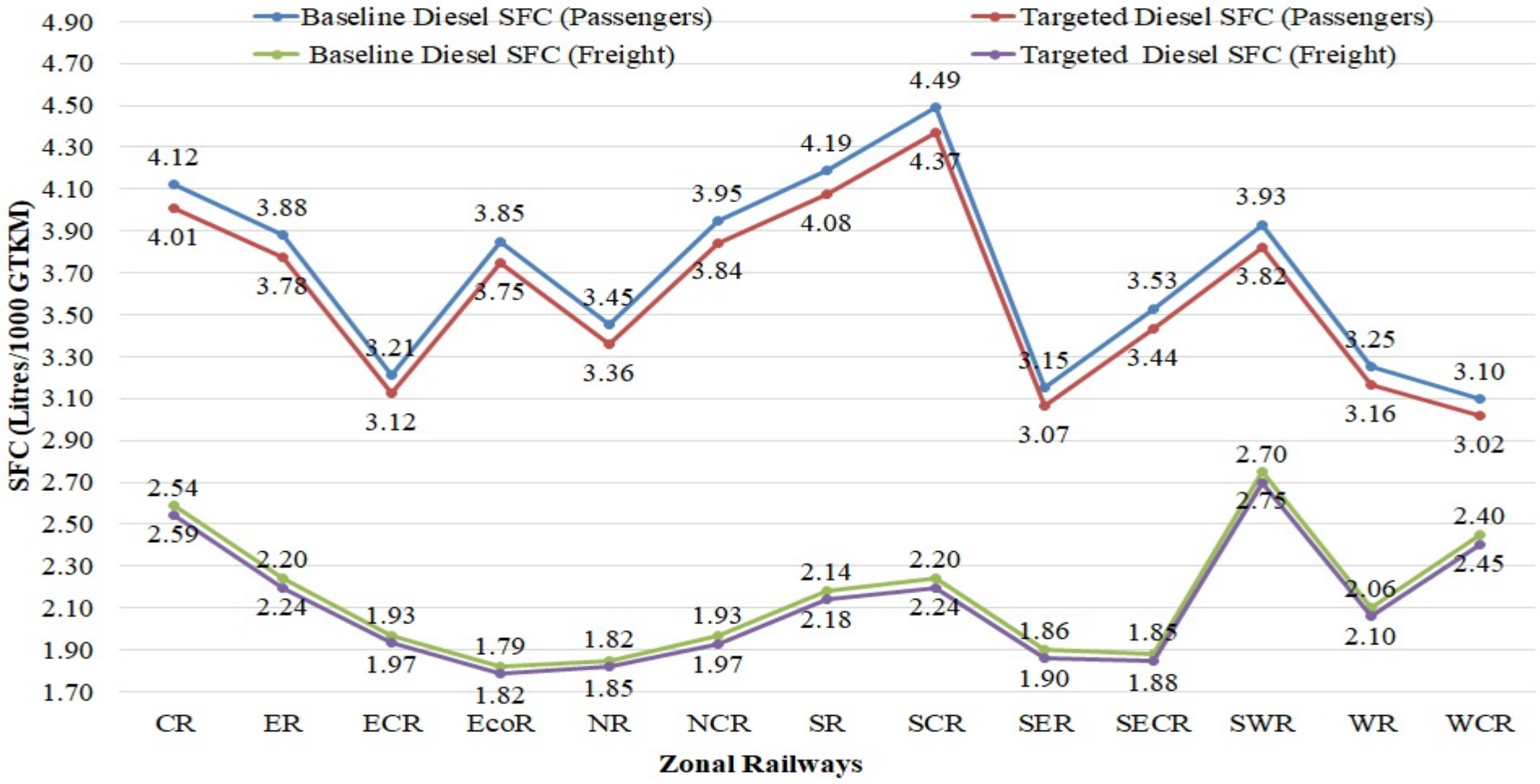
PAT Target-Fuel Consumption SFC (litre/1000GTKM) for targeted year (with Base line 2014-15)



Source: Annual Statistical Publication Railway 2015-16

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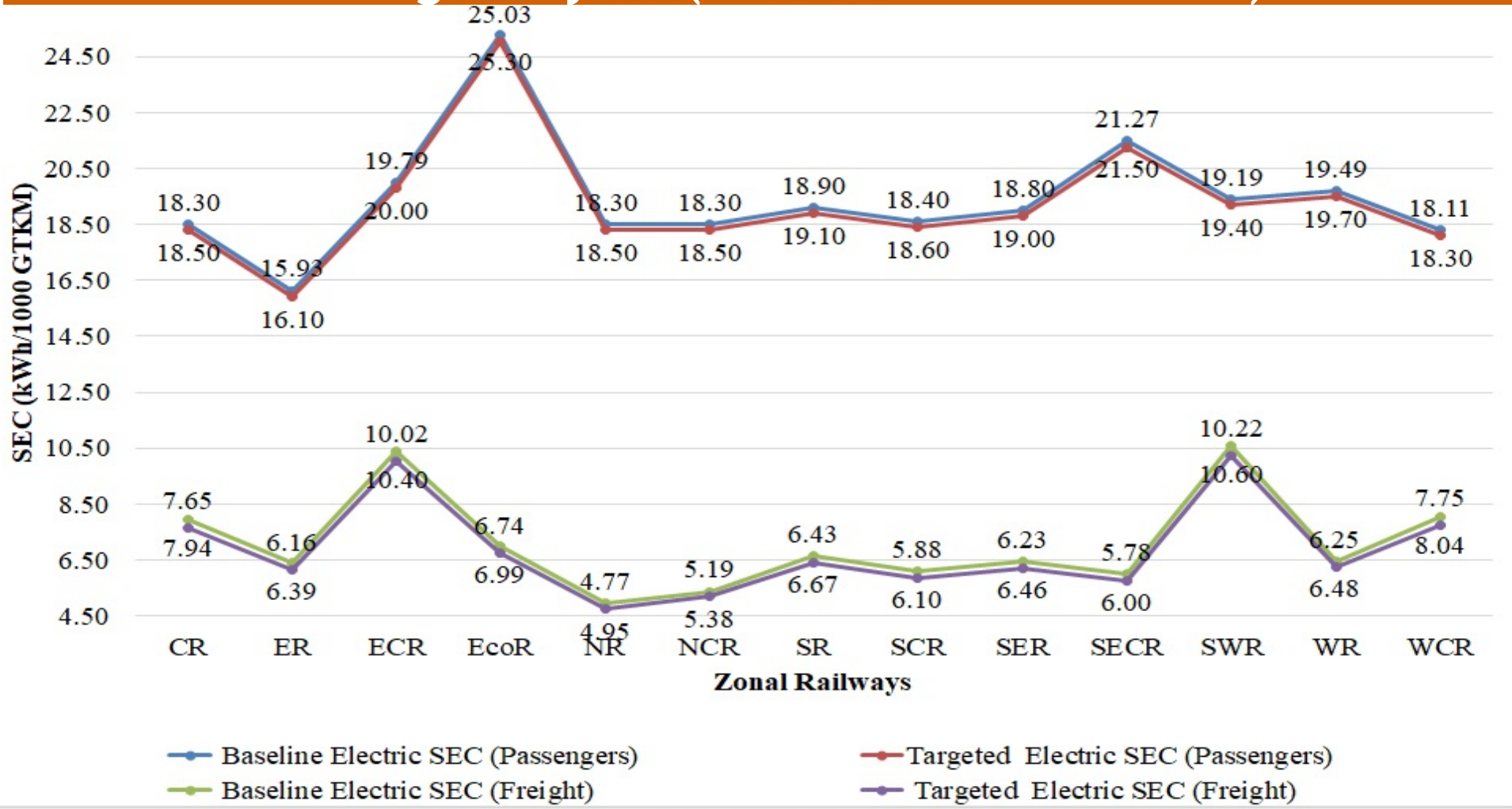
PAT target -Electricity Consumption in SEC (kWh/1000GTKM) for targeted year (with Base line 2014-15)



Source: Annual Statistical Publication Railway 2015-16

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Percentage reduction of SEC & SFC under PAT target

- Under PAT **cycle-II**, all 16 zonal Railways' specific energy/fuel consumption norms of electric & diesel traction were considered for setting up the target for reduction of following, considering base year as 2014-15 against a target year of 2018-19 are linked with INDC targets/projections.

  - 2.7 percent for diesel-passengers,
  - 1.9 percent for diesel-freight,
  - 1.1 percent for electric-passengers
  - 3.6 percent for electric-freight

- Looking at pace of Indian Railways energy consumption reduction, it is easily expected to achieve the PAT cycle-II targets with saving of **75,469** Ton of oil equivalent **(TOE)** by the end of 2018-19.

Source: Annual Statistical Publication Railway 2015-16

Percentage reduction of SEC & SFC under BAU

- Over the years, under **business as usual scenario** -the specific energy and fuel consumption of Indian Railways were reduced gradually i.e., as follows (considering year to year comparison from 2006 to end of 2015).

- 2.3 percent for diesel-passenger,
- 4.5 percent for diesel-freight,
- 1 percent for electric-passenger,
- 5.4 percent for electric-freight

Source: Annual Statistical Publication Railway 2015-16

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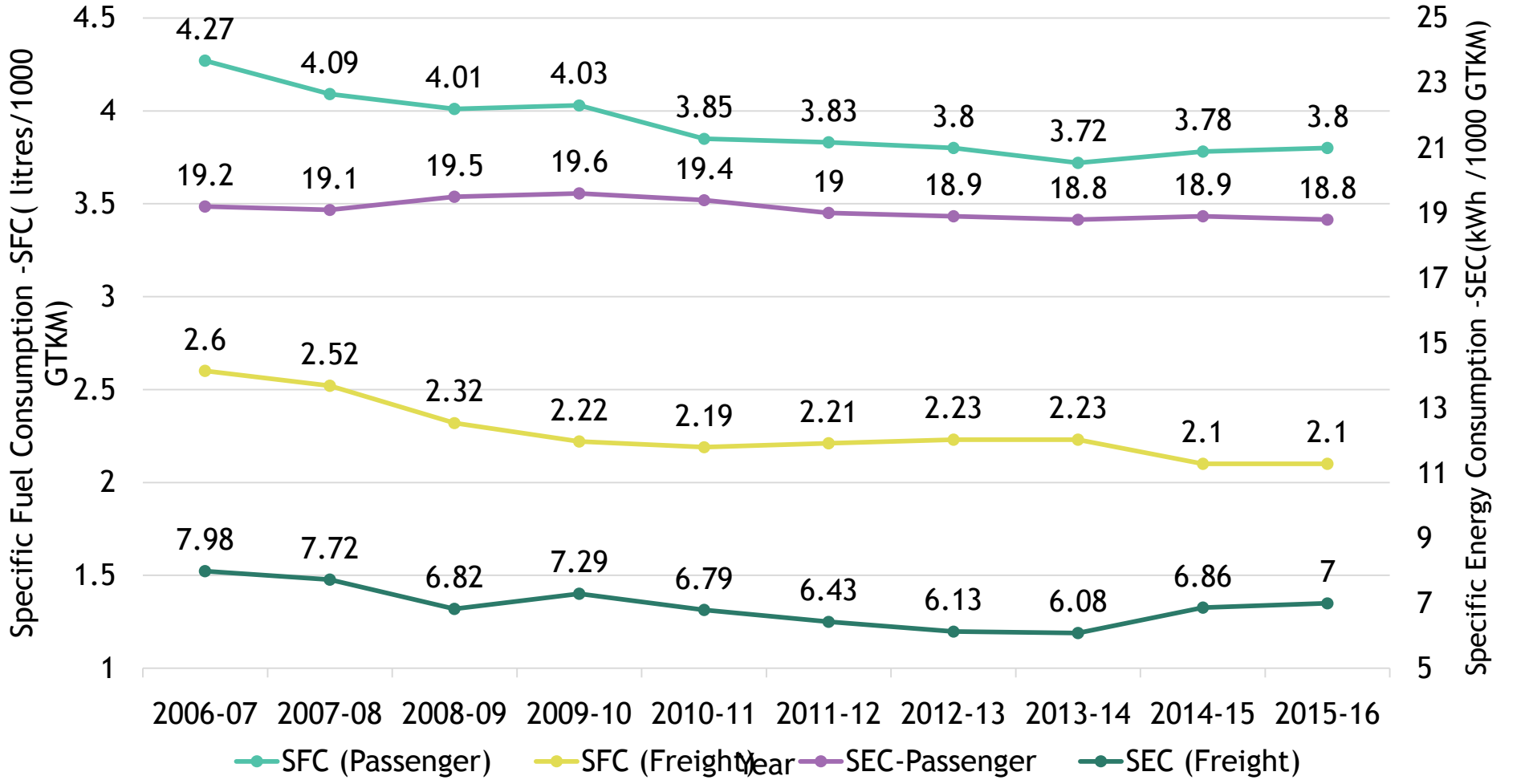
Reduction of Specific Energy/Fuel Consumption in Electric & Diesel Traction



Source: Annual Statistical Publication Railway 2015-16

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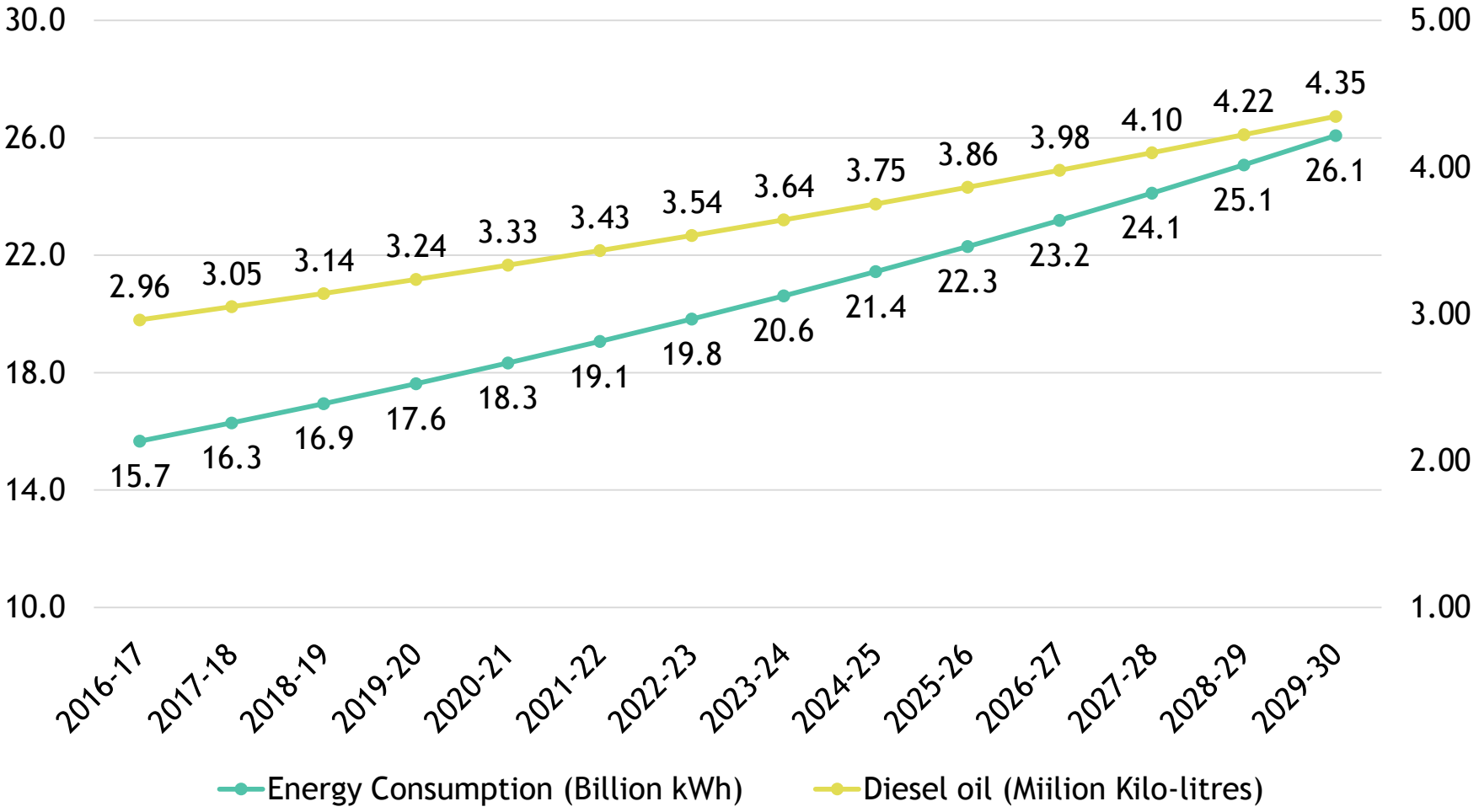
Indian Railways Energy Consumption (Traction) -Projection @ 2030



Source: Annual Statistical Publication Railway 2015-16

IR's Energy saving potential by PAT target (Cycle-V) -under BAU

- For moderating Indian Railways annual energy consumption in forthcoming years,

- **Railways may adopt the aggressive targets for specific energy/fuel consumption for zonal railways in next PAT cycle-V against as BAU /INDC scenario.**

- In case of BAU, it is expected that the energy consumption reduction as follows (considering base year as 2018-19 against a target year of 2022-23).
  - **7 percent** in diesel-passenger,
  - **13 percent** in diesel-goods,
  - **3 percent** in electric-passenger
  - **15 percent** in electric-goods

- Which is expected to save the energy of **2,99,716 Ton of oil Equivalent (TOE)** by end of 2022-23.

Source: Annual Statistical Publication Railway 2015-16

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IR's Energy saving potential by PAT target (Cycle-V) -under Aggressive side

- Whereas aggressive targets setup for specific energy/fuel consumption,

- it is projected to reduce the energy consumption as follows, considering base year as 2018-19 against a target year of 2022-23.

  - **10 percent** in diesel-passenger,
  - **15 percent** in diesel-goods,
  - **10 percent** in electric-passengers
  - **15.3 percent** in electric-goods

- Which is expected to save the energy of **4,30,776 Ton of oil Equivalent (TOE)** against business as usual scenario.

Source: Annual Statistical Publication Railway 2015-16

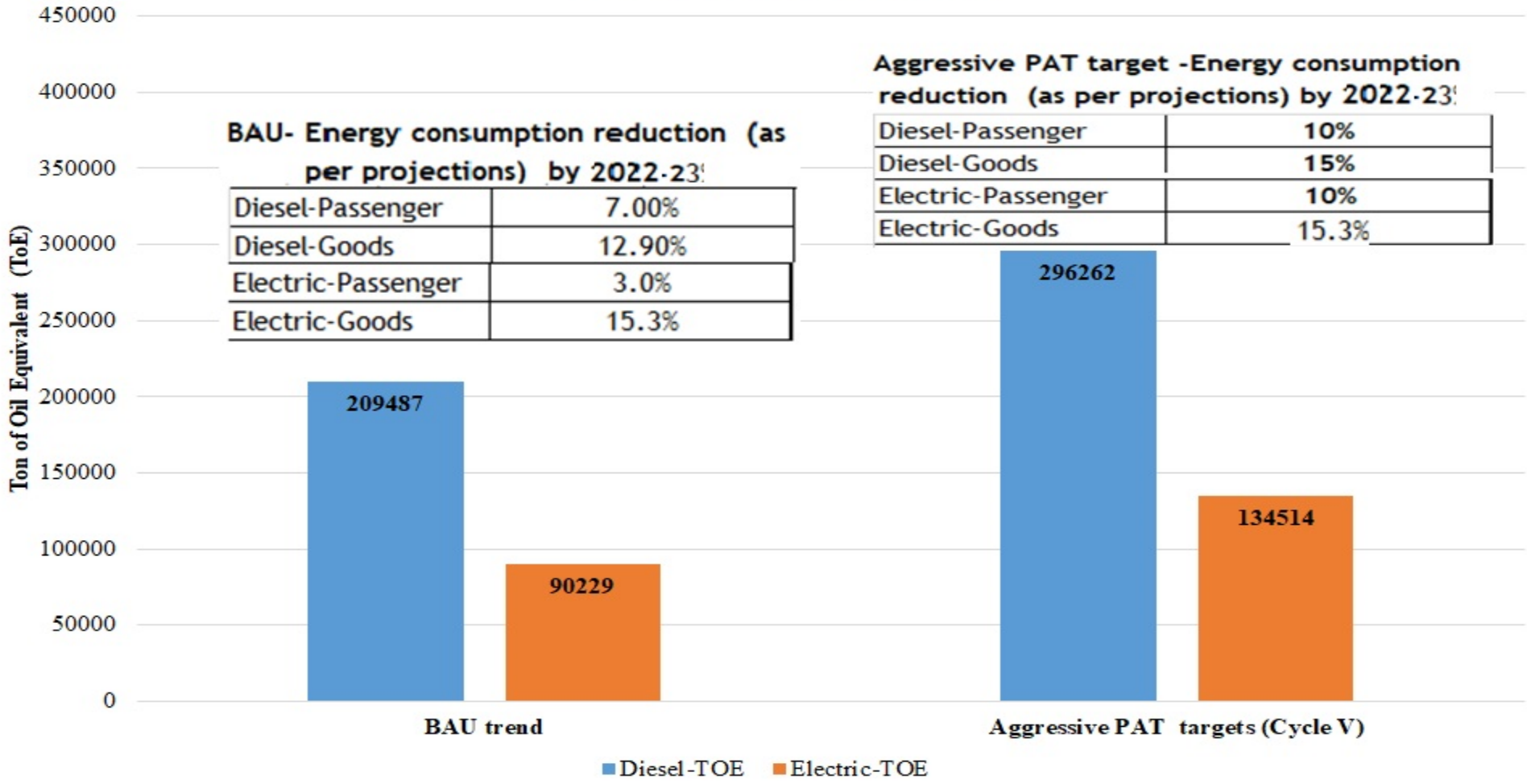
IR's Energy saving potential by PAT target (Cycle-V) in TOE by 2022-23 (with base line as 2018-19)

BAU- Energy consumption reduction (as per projections) by 2022-23

Diesel-Passenger	7.00%
Diesel-Goods	12.90%
Electric-Passenger	3.0%
Electric-Goods	15.3%

Aggressive PAT target -Energy consumption reduction (as per projections) by 2022-23

Diesel-Passenger	10%
Diesel-Goods	15%
Electric-Passenger	10%
Electric-Goods	15.3%



Source: Annual Statistical Publication Railway 2015-16

Indian Railways' initiatives for Energy Efficiency

- Indian Railways may also explore to adopt the aggressive and stringent targets in **PAT cycle-V** for paradigm shift of Indian railways by 2022-23 in energy consumption reduction.

- Zonal railways may explore to adopt the innovative technologies in rolling stock especially in **electric and diesel locomotives** for contributing **towards paradigm shift.**

- Additionally, IR planning for medium and long term scenario for traction area i.e.,

  - Introduce latest energy efficient technologies,
  - Produce only 3 phase regenerative type locomotives and EMU's
  - Take up manufacturing of new locomotives of 12000 HP with similar or better capabilities,
  - Speed up electrification to 24,000 kms by 2020
  - Progressively bring down diesel loco production

Source: Annual Statistical Publication Railway 2015-16

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Thank you