



Technical Paper:  
**Industrial Energy Efficiency & Material Substitution  
in Carbon-Intensive Sectors**

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The technical paper provides a synthesis of EE measures and material substitution potential in industry, and policy options to increase their adoption.

The objective of the paper is:

- to present state-of-the-art **EE measures** and **material substitution options** and their current level of implementation and
- to provide **country examples** from different regions and **international initiatives** and overall lessons learned and
- to identify **barriers to EE implementation** and propose suitable **policy options** to address them.

# Why Energy Efficiency – it is “Zeitgeist”

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*“The world’s first fuel.”*

International Energy Agency, 2013

*“Energy efficiency measures are becoming big business.”*

The Guardian, 2013

*“Investing in energy efficiency makes economic sense and the current financing gap represents a huge business opportunity.”*

Josué Tanaka, Managing Director for Energy Efficiency and Climate Change at the EBRD, 2015

*“Energy Conservation is the first solution to stop rising temperature. This is everyone’s responsibility.”*

Narendra Modi, Indian Prime Minister, 2015

*“The easiest way to save money is to waste less energy.”*

Barack Obama, US President, 2012

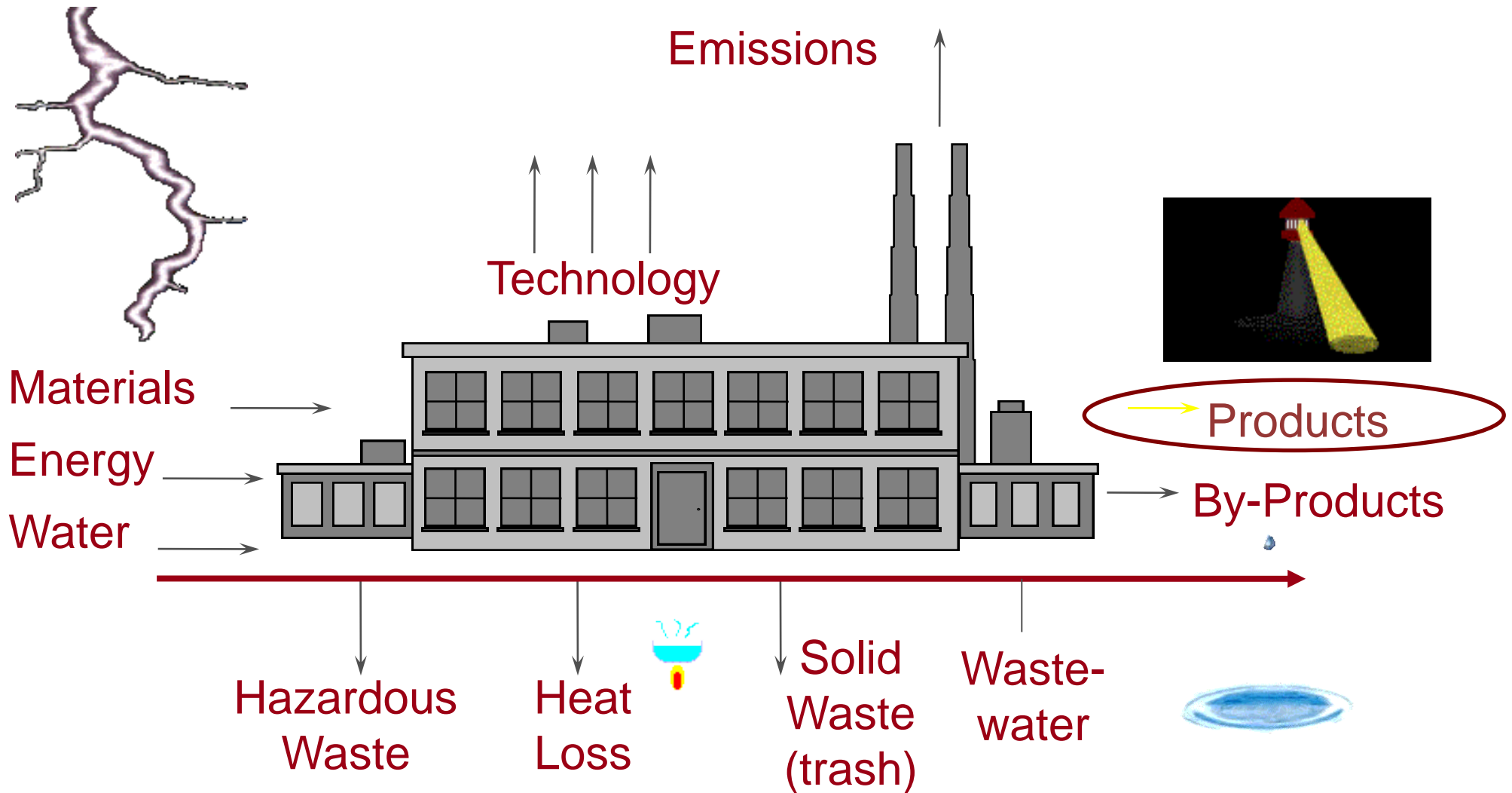
# What means efficiency?

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- Efficiency encompasses all changes that results in a **reduction of inputs** used for a given service or level of activity.
- This reduction in the input consumption is not necessarily associated to **technical changes**, since it can also result from a **better organization and management or improved economic efficiency** in the sector (e.g. overall gains of productivity).

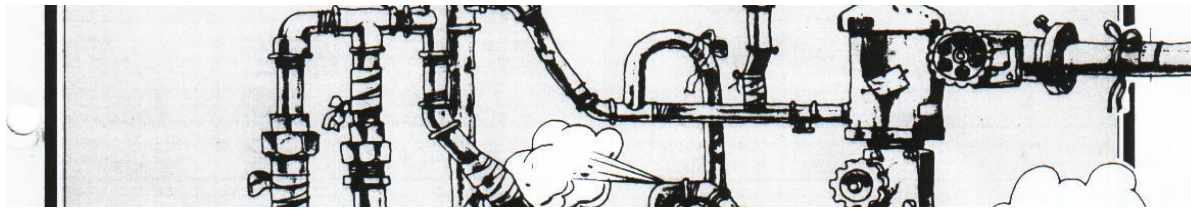
# It considers all inside aspects !!!



# Compressed Air

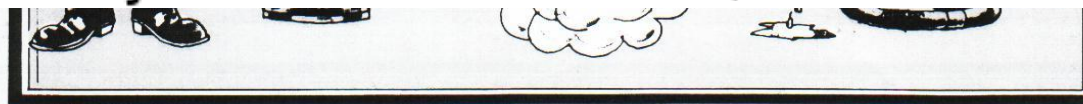


## The Cost of Compressed Air loss from leaks (100 Psi)



Leak size (mm)	Air loss (m <sup>3</sup> /year)	Cost/day	Cost/year
<1	27,494	\$0.79	\$289
1-3	139,196	\$4.00	\$1,462
3-5	508,343	\$14.62	\$5,338
>5	1,347,200	\$38.76	\$14,146

**Note: Annual figures assume the loss is constant throughout the year. Electricity costs are calculated at \$0.07/kW.h and 15kW.h/m<sup>3</sup> of compressed air.**

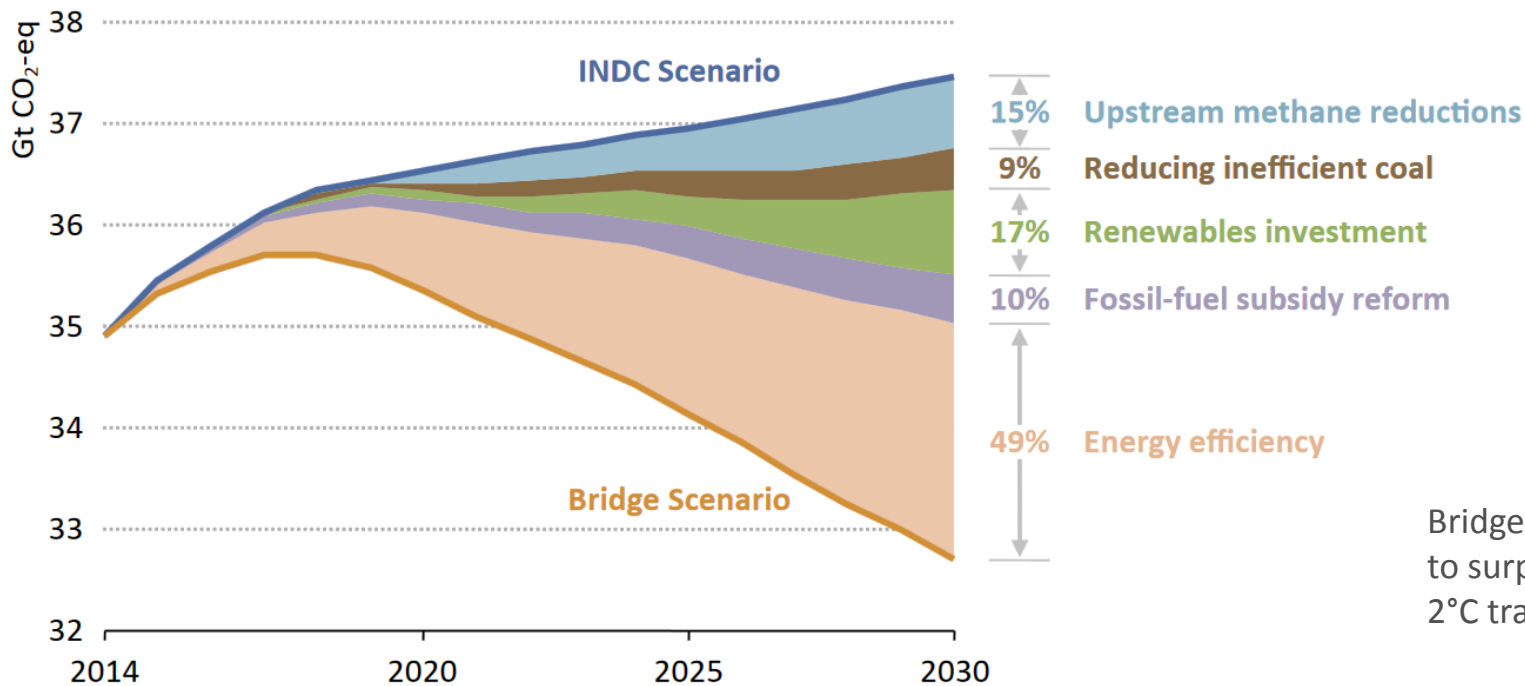


# Rationale for Increasing Energy Efficiency



- Money savings
- Profits / high return-on-investment
- Competitiveness / innovation
- Environmental benefits / reduction of GHG emissions

- Security of energy supply
- Independence from volatile energy prices
- Employment creation
- Image

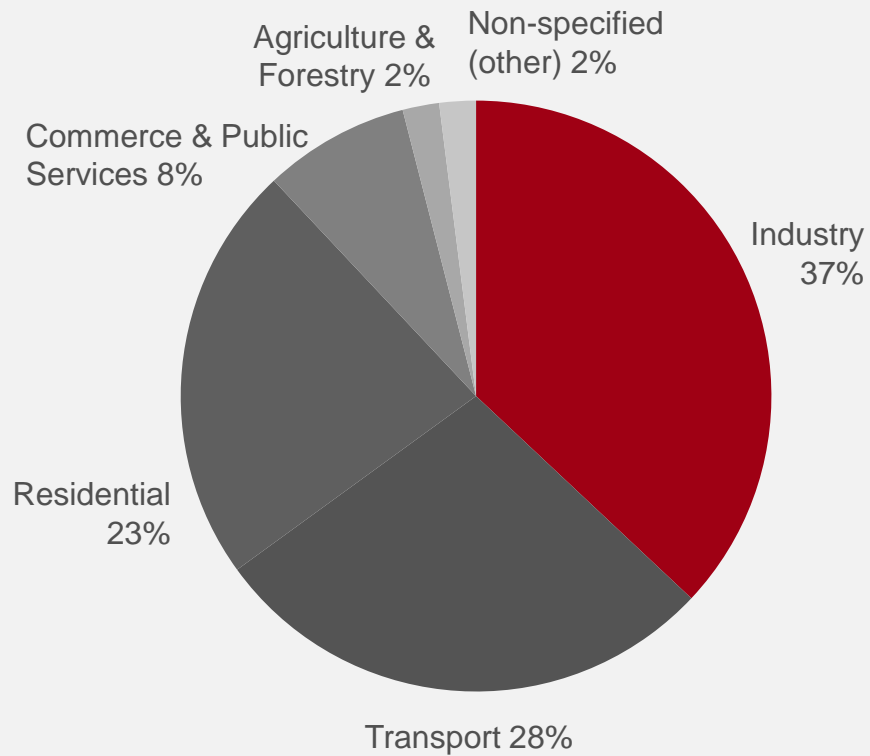


Source: IEA 2015

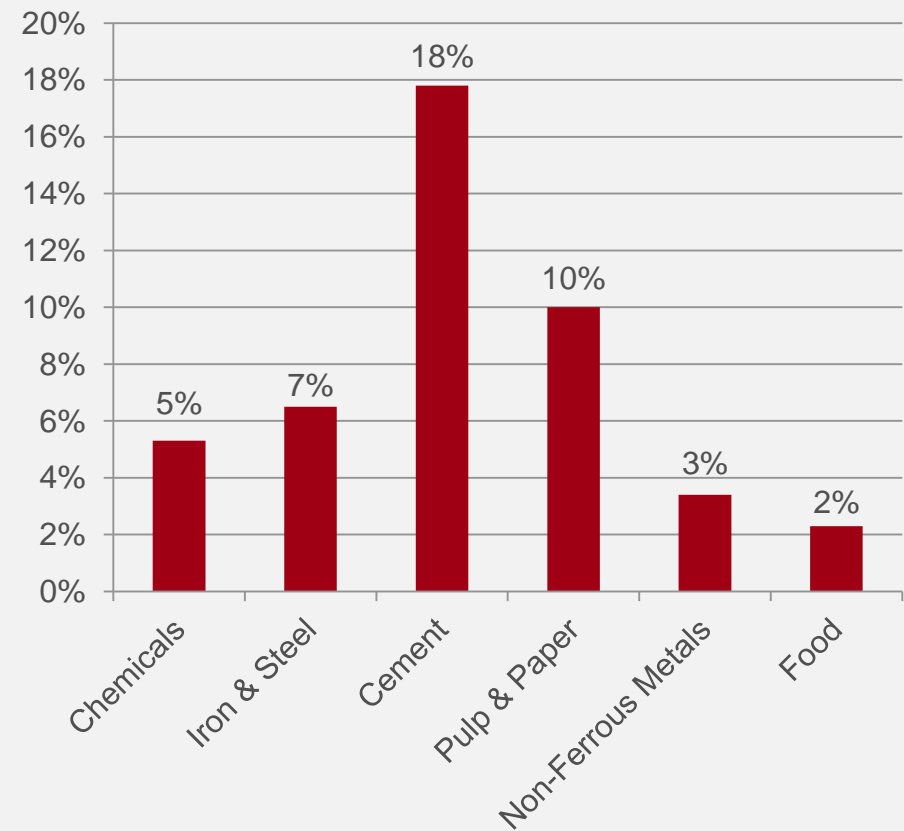
# Rationale for Increasing Energy Efficiency in Industry



Global final energy consumption, by sector (2014)



Average energy cost share of gross production value, Germany (2014)



Sources: IEA 2016a, Destatis 2017



# Key Message 1



## EE is essential to meet the Sustainable Development Goals (SDGs)

→ The achievement of at least 8 of the 17 SDGs can be supported by increasing energy efficiency (in industry) and material substitution.



## GHG emissions in industry can be reduced through:

### Implementation of EE Measures

- **Measures for cross-cutting technologies:**  
steam, motor drives, pumping systems, compressed air systems, heating, cooling, system EE
- **Measures for sector-specific processes:**  
chemicals, iron & steel, cement, pulp & paper, non-ferrous metals, food
- **Energy generation from industrial by-products:**  
waste heat recovery, electrification of production gases, use of biomass
- **Energy Management Systems (EnMS):**  
organizational (ISO 50001) & technical energy management

### Material Substitution

- **Fuel substitution:**  
fuel switch, waste heat recovery, less fuel demand
- **Substitution of production materials:**  
substitution of input material, reduction of material losses, design with less input material, light-weight design, longer-life products
- **Material recovery:**  
recycling, reuse

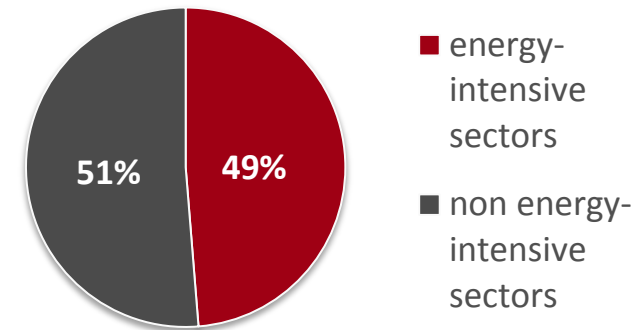


## EE in industry has been improved in the last years

- Large companies made significant progress in increasing EE, whereas SMEs face a number of difficulties due to limited resources (financing, time / personnel, etc.)
- Global energy-intensity improved in 2015 despite lower energy prices
  - 2.5% in emerging and developing countries (China: 5.6%)
  - 2% in industrialized countries
  - even higher improvements are needed to reach the 2°C target

## EE investments in energy-intensive industries must increase

- Investments in industrial EE in 2015: **USD 39 billion**
- of which in energy-intensive sectors: **USD 19 billion**



→ Investments of **USD 35 billion** annually would be needed in energy-intensive sectors by 2020 to reach international climate goals.  
(= 84% increase compared to 2015)

- industrial EE investments in 2015 were mainly undertaken in **cross-cutting technologies** and **EnMS**

→ More investment needed in **energy-intensive processes, waste-heat recovery** and generally in **SMEs**.

## **Financing** is a main hurdle for SMEs in implementing EE measures

- Especially in developing countries
- High up-front investment costs vs. limited (access to) financial resources

## **Training** is a main need for enhancing EE

- Technical personnel: engineers, auditors, certifiers, energy managers, etc.
- Enablers: financial institutions & policy-makers
- Training centers, training-of-trainers

## **Co-Benefits** increase acceptance of policies

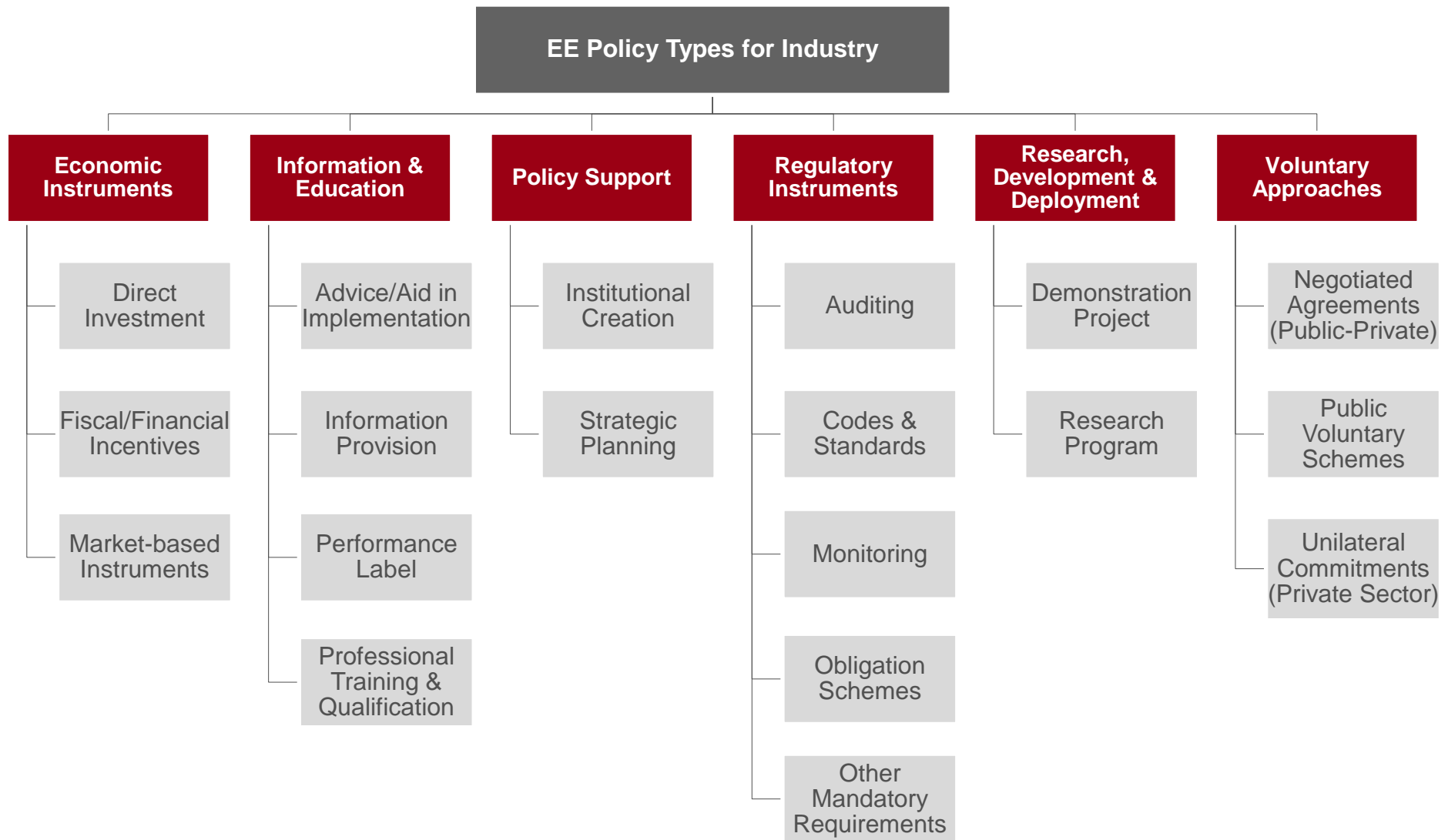
- Environmental benefits & air-quality improvements
  - Energy supply security
  - Improved competitiveness & technology innovation
  - Employment creation
-

## Method used for the analysis:

- Selection of 18 international organizations active in the field of EE in industry
- Analysis of key topics / activities and targeted aspects (financing, training, co-benefits) as presented on their websites

## Results:

	Focus on ...	Number
Activities	EnMS	9
	Policy design / implementation	9
	Technology transfer to developing countries	2
Training / Financing	Capacity building	12
	Financing aspects	2
Co-Benefits	Innovation / competitiveness	15
	Environmental benefits	10
	Energy supply security	7
	Employment generation	0



Source: IEA - EE Policies & Measures Database

# Case Studies - Insights



Country	China	EU	Germany	India	Mexico	Tunisia	US
Program	Top-1,000 Energy-Consuming Enterprises Program	Energy Efficiency Directive (EED)	KfW EE Financing Programs	Perform Achieve and Trade Scheme (PAT)	National Program for Systems to Save Energy - PRONASGEN	Promoting innovative EE measures in Tunisian industry	Better Plants Program
Fiscal / Financial Instruments	x		x				
Market-based Instruments				x	x		x
Information	x	x			x	x	x
Training	x				x	x	x
Regulatory Instruments	x	x	x		x	x	x
Research, Development & Deployment						x	x
Voluntary Approaches					x		x



## Success Factors



Long-term Planning



Proven Policies



Addressing Barriers



Locally Available Resources



Bunch of Aligned Policies



Focus on Co-Benefits



Technology Transfer to  
Developing Countries



Coordination of National and  
Regional Policies

In achieving EE improvements, the most successful countries are those that have set specific targets and designed adequate policies.

# Lessons Learned II



## Effective policies to address barriers

Barriers		Suitable Policies	
Lack of Financial Resources / Capital Access, Transaction Costs	Economic Instruments	Financial Incentives	
		Direct Investment	
		Market-based Instruments (e.g. certificates trading)	
Lack of Awareness / Understanding	Information	Information Campaigns Performance Label	
	Deployment	Demonstration Projects	
Lack of Technical Know-How	Education	Professional Training Aid in Implementation	
		Regulatory Instruments	Auditing Codes & Standards Monitoring Obligation Schemes
Deployment	Demonstration Projects		
Energy Price Subsidies	Economic Instruments		Fiscal Instruments (fading out of subsidies / carbon pricing)
			Structural Barriers
Access to Technology	Economic Instruments	Market-based Instruments (incl. technology transfer)	
		Research & Development	Research Programs
Equipment Downtimes, Technology Lock-In	Economic Instruments	Financial Incentives	
	Regulatory Instruments	Codes & Standards	

- Build a **platform for best practices**
  - how to address barriers effectively and sustainably
  - demonstration of technical and economical feasibility / co-benefits
- Establish a **policy database for EE in industry**
  - how have other countries in similar contexts addressed the issue
  - how can policies look like
  - input for further analyses on implementation of policies
- Develop **transnational cooperation** / networks of international institutions
  - create and benefit from synergies
  - strengthen technology transfer
  - coordinate policies

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- Destatis 2017: Kostenstruktur der Unternehmen im Verarbeitenden Gewerbe: Deutschland, Jahre, Wirtschaftszweige. [https://www-genesis.destatis.de/genesis/online;jsessionid=351E28D967BE579840242FE74A0C2F0E.tomcat\\_GO\\_2\\_2?operation=previous&levelindex=3&levelid=1489765299958&step=3](https://www-genesis.destatis.de/genesis/online;jsessionid=351E28D967BE579840242FE74A0C2F0E.tomcat_GO_2_2?operation=previous&levelindex=3&levelid=1489765299958&step=3)
- IEA 2015: World Energy Outlook Special Report. <https://www.iea.org/publications/freepublications/publication/WEO2015SpecialReportonEnergyandClimateChange.pdf>
- IEA 2016a: Key World Energy Trends. <https://www.iea.org/publications/freepublications/publication/KeyWorldEnergyTrends.pdf>
- IEA 2016b: Energy Efficiency Market Report 2016. [https://www.iea.org/eemr16/files/medium-term-energy-efficiency-2016\\_WEB.PDF](https://www.iea.org/eemr16/files/medium-term-energy-efficiency-2016_WEB.PDF)
- IEA - EE Policies & Measures Database. <http://www.iea.org/policiesandmeasures/energyefficiency/>

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