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Formulation of Industrial Energy Efficiency Policy and Related Instruments in Iran

United Nations Industrial Development Organization (UNIDO)

Special Report
Energy Standards in Developed Countries

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Abbreviations

EPA	Environmental Protection Agency
FIT	Feed in Tariff
GW	Gigawatt
IEA	International Energy Agency
MRV	Measuring, Reporting, Verifying
MW	Megawatt
MWh	Megawatt Hour
UK	United Kingdom
UNIDO	United Nations Industrial Development Organization
USA	United States of America
USD	US Dollar

1 INTRODUCTION

This report is prepared on direct request by the Iranian project partners through email dated 18/06/2015.

It shall include

1. Relating information and activities on setting energy standards or norms in developed countries like US and European countries;
2. General approach of developed countries on setting energy standards (for instance, whether it has been sector wide or equipment wide etc.);
3. Boundary of setting standards (e.g. it is limited to intensive industrial sectors or it is comprised all sectors including SMEs) are requested

2 OVERVIEW ENERGY STANDARDS IN DEVELOPED COUNTRIES

In this report the project team defines an energy standard as a regulation or recommendation (either obligatory or voluntary) limiting the amount of energy of

(i) industrial facilities or
(ii) end-user equipment or
(iii) buildings;

which transform input energy (either based on fossil fuels or renewable energy sources) into a specific output (product or service, e.g. ton of cement, ton of steel, cooling, heating, lighting etc.). The quality of the output shall be kept at the same level or be improved.

Standards can be either obligatory or voluntary. In the industrial sector which is exposed to international competition for their products (as in contrast to buildings and end-user equipment), standards are either voluntary or at least include flexibility to reach targets with external measures.

Sometimes standards refer to GHG emissions (instead of energy as an input) if climate change policy is the driver of establishing energy standards.

The authors screened various “developed” countries as well as countries with economies in transition such as

1. Brazil
2. Canada
3. China
4. Europe
5. Japan
6. Russia
7. South Africa
8. US

to identify the different forms of energy standards which have been implemented. The following sections summarize the most important findings (and does therefore not describe all initiatives of the countries above as this would go beyond the scope of this task)

3 ENERGY STANDARDS FOR INDUSTRIAL FACILITIES

3.1 CHINA

China imposed **voluntary** energy standards for industry. The top 10,000 Enterprise Program covers two thirds of China´s total energy consumption and includes approximately 15,000 industrial companies which use more that 10,000 **tons of coal equivalent** (tce) per year.

Selected 11th Five-Year Plan energy-efficiency targets.

	Unit	2000	2005	2010
Electricity generation				
Coal-fired	gce/kWh	392	370	355
Small &and medium generators	% (rated)	87		90–92
Wind turbine	% (rated)	70–80		80–85
Industry				
Raw steel	tce/t	0.906	0.760	0.730
Avg 10 non-ferrous metals	tce/t	4.809	4.665	4.595
Aluminum	tce/t	9.923	9.595	9.471
Copper	tce/t	4.707	4.388	4.256
Synthetic ammonia	tce/t	1.372	1.210	1.140
Soda	tce/t	1.553	1.503	1.400
Cement	tce/t	0.181	0.159	0.148
Construction ceramics	kgce/m2	10.04	9.9	9.2
Oil refining	kgce/t factor	14	13	12
Ethylene	kg standard oil/t	848	700	650
Coal-fired boilers	% (operational)	65		70–80
Pump	% (rated)	75–80		83–87
Air compressor	% (rated)	75		80–84
Appliances				
Room air conditioner	energy Energy-efficiency rate (EER)	2.4		3.2–4.0
Refrigerator	% (energy -efficiency indicator)	80		62–50
Household cookstoves	% (heat efficiency)	55		60–65
Household gas water heater	% (heat efficiency)	80		90–95
Transportation				
Railways	ton/mt km	10.41	9.65	9.4
Average automobile fuel economy	liter/100 km	9.5		8.2–6.7

Figure 1: Industrial energy standards China

3.2 EUROPE

The main standard setting policy for industry in Europe is the EU ETS where carbon allowances are allocated based on a **benchmarking system** (e.g. tCO2/t pro t clinker). Industrial companies receive "free" carbon allowances for a benchmark of the **best 10%** in class. If an industrial company requires more allwances it has to buy them either trough auctions or on the secondary market.

Some exemplary standards or benchmarks are presented in the table below:

Product benchmark	Definition of products covered	Definition of processes and emissions covered (system boundaries)	Benchmark value (allowances 1tCO2e/t)
Aluminium	unwrought non-alloy liquid	All processes directly or	1.514

	aluminium from electrolysis	indirectly linked to the production step electrolysis are included	
Grey cement clinker	Grey cement clinker as total clinker produced	All processes directly or indirectly linked to the production of grey cement clinker are included	0.766
White cement clinker	White cement clinker for use as main binding component in the formulation of materials such as joint filers, ceramic tile adhesives, insulation, and anchorage mortars, industrial floor mortars, ready mixed plaster, repair mortars, and water-tight coatings with maximum average contents of 0,4 mass-% Fe 2 O 3 , 0,003 mass-% Cr 2 O 3 and 0,03 mass-% Mn 2 O 3	All processes directly or indirectly linked to the production of white cement clinker are included	0.987
Facing bricks	Facing bricks with a density > 1 000 kg/m 3 used for masonry based on EN 771-1, excluding pavers, clinker bricks and blue braised facing bricks	All processes directly or indirectly linked to the production processes raw material preparation, component mixing, forming and shaping of ware, drying of ware, firing of ware, product finishing and flue gas cleaning are included	0.139
Refinery Products	Mix of refinery products with more than 40 % light products (motor spirit (gasoline) including aviation spirit, spirit type (gasoline type) jet fuel, other light petroleum oils/light preparations, kerosene including kerosene type jet fuel, gas oils) expressed as CO 2 weighted tonne (CWT)	All processes of a refinery matching the definition of one of the CWT process units as well as ancillary non-process facilities operating inside the refinery fence-line such as tankage, blending, effluent treatment, etc. are included. For the determination of indirect emissions, the total electricity consumption within the system boundaries shall be considered	0.0295

Figure 2: Industrial GHG emissions standards for EU ETS allowances allocation

3.3 INDIA

As described in second progress report Part 1/A: Energy Efficiency Certificates:

The industrial energy saving target on the national level is set at **6.6 million tons oil equivalent** (TOE) to be reached at the end of 1st PAT cycle (April 2012 –March 2015). The MoP and the BEE are breaking down the country wide target into **sectoral targets** on a **pro rata** basis related to the sectoral energy consumption. (e.g. the overall cement sector shall reduce 7.2% of the total 6.6 MOET). The **sectoral target is then disaggregated to each DC** within the sector[1]. Instead of applying a sector wide benchmark target for energy efficiency to the individual DCs the Government decided to implement separate energy saving targets for each DC because of wide differences of energy efficiency within the sectors[2] as shown in the next table.

	Sector	Range of SEC
a)	Power plant	2300 – 3400 kcal/kwh
b)	Fertilizer	5.86 – 9.11 Gcal/T of Urea
c)	Cement	665 – 900 Kcal/Kg of Clinker (Thermal) 66 – 127 KWH/ T (Elect)
d)	Integrated Steel	6.15 – 8.18 Gcal / tcs
e)	Sponge Iron	4.4 – 7.6 Gcal / T (Thermal) 72 – 135 KWH/T (Elect)
f)	Aluminum (Smelter) Aluminium (Refinery)	15875 – 17083 KWH/T 3.28 – 4.12 MKcal / T of Alumina
g)	Pulp & Paper	25.3 – 121 GJ/T
h)	Textile	3000 – 16100 Kcal/kg (Thermal) 0.25 – 10 KWH/Kg (Elect)
i)	Chlor-Alkali	2300 – 2600 kwh/ T of caustic soda

Figure 3: Overview of broad ranges of energy efficiency within the same industrial sector in India

Each DC is therefore obliged to reduce its specific energy consumption (SEC) by a certain value, which is based on its current SEC (or baseline SEC) within the sectoral bandwidth

$$Specific\ Energy\ Consumption\ (SEC) = \frac{net\ energy\ input\ into\ the\ DC's\ boundary}{total\ quantity\ of\ output\ exported\ from\ the\ DC's\ boundary}$$

The PAT system uses a gate to gate concept which means that the total energy input will be captured but excluding

(i) energy consumed in residential areas of the plant,
(ii) energy consumed for construction work and
(iii) energy originated from renewable resources.

The **baseline SEC** value is determined as follows

- Collecting consumption and production data from 2005-2010 (five years) and calculating preliminary SEC
- Normalizing preliminary SEC (using capacity utilization parameter)

[1] See BEE (2012), Dhingra (2011), MoP (2012b)

[2] Typically these differences are due to variations in production capacities and processes, raw material quality, product mix etc..

- Calculating baseline SEC by taking the average of the normalized SEC from 2007-2010 (three years)
- The baseline year for the first PAT cycle is 2009-2010

The **target SEC** value is determined as follows:

- Setting the best (sub-) sectoral baseline SEC as relative SEC 1
- Calculating other baseline SEC in relation to the best one (will be higher than 1)
- Allocating the sectoral target to each DC based on relative SECs (e.g. assuming the sectoral target is a reduction of 60,000 TOE and the relative SECs of 3 DCS is 1, 2, 3 the reduction target would be allocated 10,000:20,000:30,000 assuming that the production capacity is the same in each plant)

3.4 JAPAN

By the amendment of the "Act on the Rational Use of Energy" in 2010 the Government of Japan implemented **mandatory** energy efficiency targets in the **form of benchmarks**. It has also introduced an 1% annual energy efficiency obligation for all businesses. The benchmarks are based on sector studies and are final negotiated between the Government and the sector. It is not clear whether national or international benchmarks are used.

	Benchmark	Target
Blast furnace (BF)	Energy Consumption/crude steel production	under 0.531kl/t
Electric arc furnace (EAF) :Regular	(Energy consumption for iron manufacturing /crude steel production)+(Energy consumption for rolling process/rolled steel production)	under 0.143kl/t
Electric arc furnace (EAF) :Special	(Energy consumption for iron manufacturing /crude steel production)+(Energy consumption for rolling process/shipping volume)	under 0.36kl/t
Power generation (Thermal Power)	(1)Thermal efficiency at generating end by capability testing of declared power/design efficiency	upper 100.3%
	(2)Thermal power generation efficiency	non
Cement	(Energy Consumption during raw material processing/Raw material production (clinker-equivlent))+(Energy Consumption during calcination/clinker production)+(Energy consumption during blending process/cement output (portland cement equivalent))+(Energy consumption during shipment process/total shipment (various types of cement and clinker))	Under 3891MJ/t
Paper & Pulp Paper	Energy consumption/production	Under 8532MJ/t
Paper & Pulp Paperboard	Energy consumption/production	Under 4944MJ/t
Petroleum Refinery	Energy consumption for petroleum refining process/Σ throughputs of the different process unit × the product of average energy efficiency of different process unit based on CWB* coefficient) *CWB (Complexity-Weighted Barrel) is the benchmark which assesses the energy efficiency of refinery and has developed by Solomon	Under0.876
Petrochemical	(1)Energy consumption for ethylene process/ethylene production	Under 11.9 GJ/t
	(2)Equipment of steam production	(P)
Soda	(Energy consumption for electrolytic process/soda production from electrolytic process)+(Heat consumption for condensation process)/liquified soda production)	Under 3.45GJ/t

Figure 4: Industrial energy standards in Japan

4 ENERGY STANDARDS FOR END-USER EQUIPMENT

Typically end-user equipment and appliances refer to, household appliances (refrigerators, washing machines, ACs etc..), equipment used in commerce or industry (boilers, electric motors etc..)

The energy efficiency of vehicles is usually dealt with separately in specific standards.

4.1 EUROPE

European ecodesign regulations **require manufacturers** to decrease the energy consumption of their products by establishing minimum energy efficiency standards. By setting these standards at European level, manufacturers do not have to navigate through multiple national regulations when launching their products on the market.

The ecodesign requirements for individual product groups are created under the EU's Ecodesign Directive a process managed by the European Commission. **As an alternative**, industry sectors **may also sign voluntary agreements** to reduce the energy consumption of **their products**. The Commission formally recognises such agreements and monitors their implementation.

The following products are currently regulated

- Professional refrigerated storage cabintes
- Ventilation units
- Power transformers
- Domestic cooking appliances
- Heaters and water heaters
- Vacuum cleaners
- Computers
- Household tumble driers
- Circulators
- Water pumps
- Air conditioners and comfort fans
- Industrial fans
- Household dish washers
- Household washing machines
- Lighting products in the domestic and tertiary sectors
- Refrigerators and freezers
- Televisions
- Electric motors
- Set-top boxes etc

4.2 UNITED STATES OF AMERICA

The National Appliance Energy Conservation Act of 1987 established minimum efficiency standards for many common household appliances

In 2005, the Energy Policy Act (EPAct 2005) set new **mandatory standards** for 16 products and directed DOE to set standards via rulemaking for another five. In 2007, Congress passed the Energy Independence and Security Act (EISA 2007), enacting new or updated standards for 13 products. The US divides into the following four categories:

Consumer products:

- Battery Chargers
- Boilers
- Ceiling Fans
- Central Air Conditioners and Heat Pumps
- Clothes Dryers
- Clothes Washers
- Computer and Battery Backup Systems
- External Power Supplies
- Dehumidifiers
- Direct Heating Equipment
- Dishwashers
- Furnace Fans
- Furnaces
- Hearth Products
- Kitchen Ranges and Ovens
- Microwave Ovens
- Miscellaneous Refrigeration
- Pool Heaters
- Portable Air Conditioners
- Refrigerators and Freezers
- Room Air Conditioners
- Set-Top Boxes
- Televisions
- Water Heaters

Commercial and industrial products

- Automatic Commercial Ice Makers
- Clothes Washers
- Commercial Package Air Conditioners and Heat Pumps
- Commercial Packaged Boilers
- Compressors
- Computer Room Air Conditioners
- Distribution Transformers

- Electric Motors
- Fans and Blowers
- Packaged Terminal Air Conditioners and Heat Pumps
- Pumps
- Refrigerated Beverage Vending Machines
- Refrigeration Equipment
- Single Package Vertical Air Conditioners and Heat Pumps
- Small Electric Motors
- Unit Heaters
- Walk-In Coolers and Walk-In Freezers
- Warm Air Furnaces
- Water Heating Equipment

Lighting products

- Ceiling Fan Light Kits
- Certain Lamps
- Fluorescent Lamp Ballasts
- General Service Fluorescent Lamps
- General Service Incandescent Lamps
- General Service Lamps
- High-Intensity Discharge Lamps
- Illuminated Exit Signs
- Incandescent Reflector Lamps
- Light Emitting Diode Lamps
- Luminaires
- Medium Base Compact Fluorescent Lamps
- Metal Halide Lamp Fixtures
- Torchieres
- Traffic Signal Modules and Pedestrian Modules

Plumbing products

- Commercial Prerinse Spray Valves
- Faucets
- Showerheads
- Urinals
- Water Closets (Flush Toilets)

5 ENERGY STANDARDS FOR BUILDINGS

5.1 BRAZIL

In 2014, the Brazilian government introduced a **mandatory labeling** (no mandatory standards) (named PBE Edifica) for new buildings with more than 500m² gross floor area, necessary retrofits of existing buildings and optional for all other buildings. Three categories are assessed under PBE Edifica:

- Lighting
- Air-conditioning
- Enveloping of the building - walls and windows

Figure 5: Exampple for illustration of energy efficiency labeling in Brazil

5.2 EUROPE

In Europe energy standards for buildings are regulated in Directive 2010/31/EU on the energy performance of buildings.

- Energy performance certificates are to be included in all advertisements for the sale or rental of buildings. Energy performance certificates provide information for consumers on buildings they plan to purchase or rent. They include an energy performance rating and recommendations for cost-effective improvements

- EU countries must establish inspection schemes for heating and air conditioning systems or put in place measures with equivalent effect

- **All new buildings must be nearly zero energy buildings** by 31 December 2020 (public buildings by 31 December 2018), however each member state can define its own criteria for a zero energy building.

- EU countries must set minimum energy performance requirements for new buildings, for the major renovation of buildings and for the replacement or retrofit of building elements (heating and cooling systems, roofs, walls, etc.)

- EU countries have to draw up lists of national financial measures to improve the energy efficiency of buildings

5.3 USA

The U.S. does not have official national building codes which are developed through a federal or national process and adopted uniformly nationwide. Instead, there are recognized organizations that develop codes and standards that are adopted by state or local (municipal or county) governments, who may also modify model codes to meet their specific needs.

The International Code Council (ICC) is an organization of building code officials and other building safety professionals. ICC produces the most widely used set of model building codes in the U.S., known as the International codes, or I-codes. http://www.iccsafe.org/

The following 2 maps provide an overview of the status of adoption of energy standards for buildings in different states in the US.

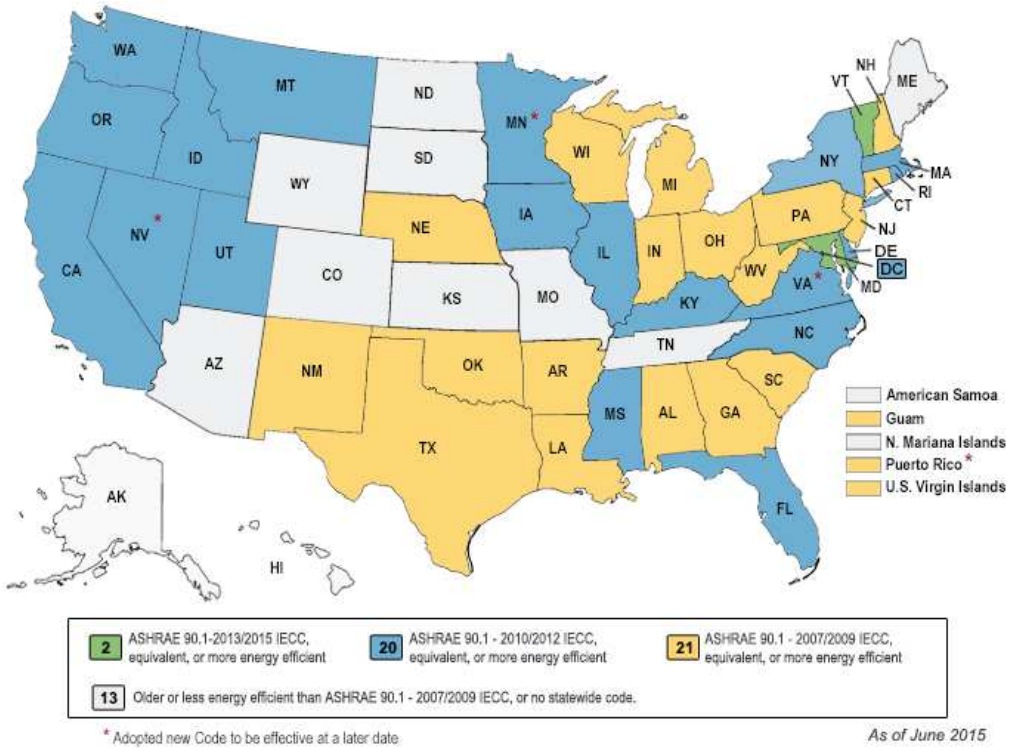

Figure 6: Status of adoption of energy standards for commercial buildings

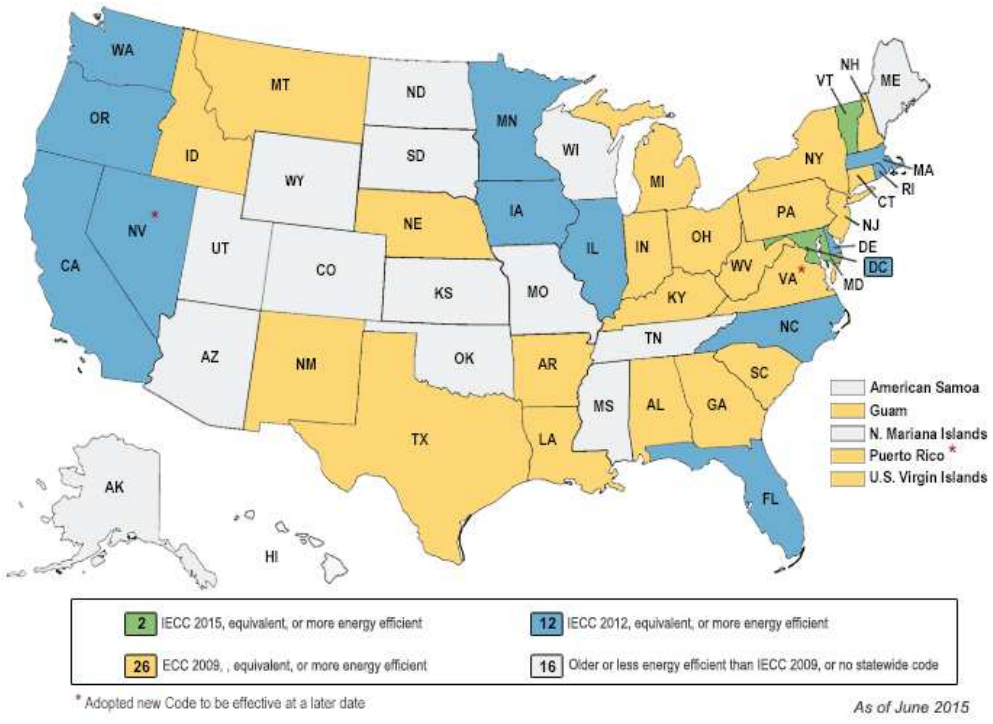

Figure 7: Status of adoption of energy standars for residential buildings

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