Energy Efficiency Training - Mozambique

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Scheduled Topics

Day	Module	Topic
12 November 2020	**1.1**	**What is Energy Efficiency**
16 November 2020	1.3	EE Strategic Planning – Part 1
19 November 2020	1.4	Energy Audit and Management
24 November 2020	2.2	Energy Audit and Management for Buildings
26 November 2020	2.5	Energy Efficiency - HVAC systems

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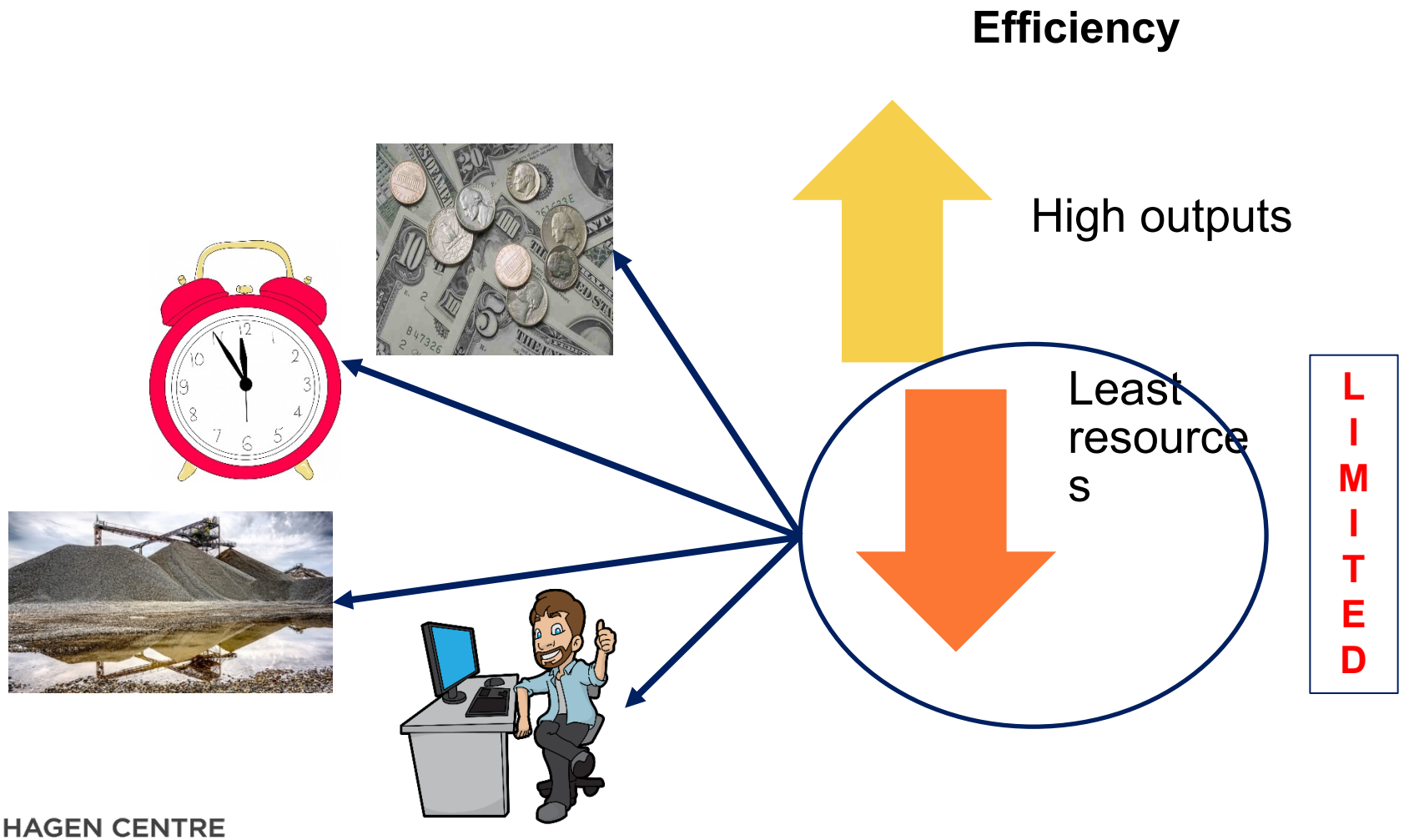
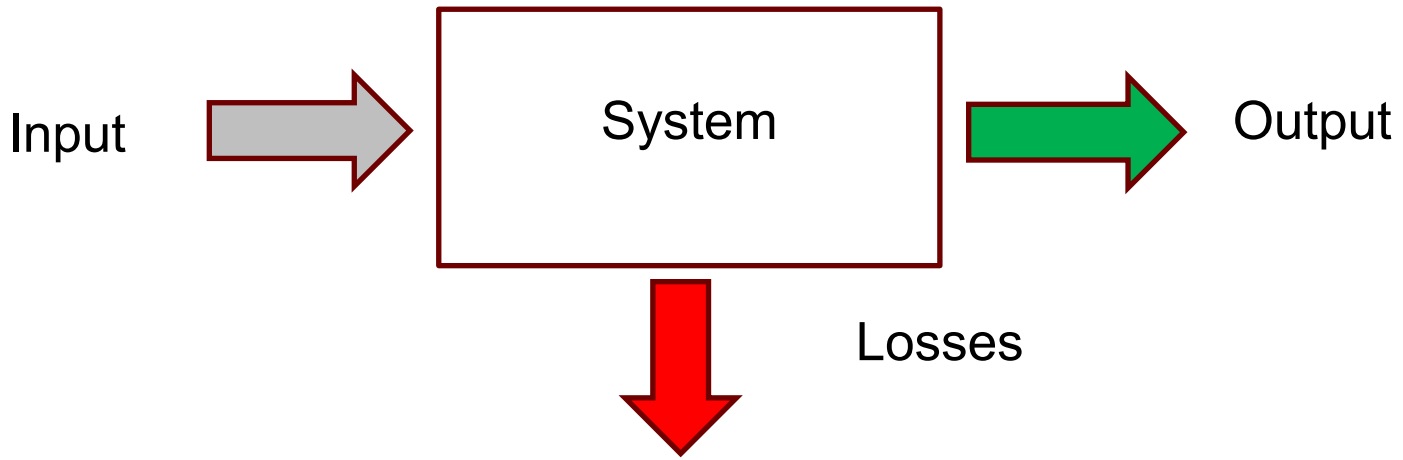
What is Energy Efficiency?

What is Energy Efficiency?



What is Energy Efficiency?

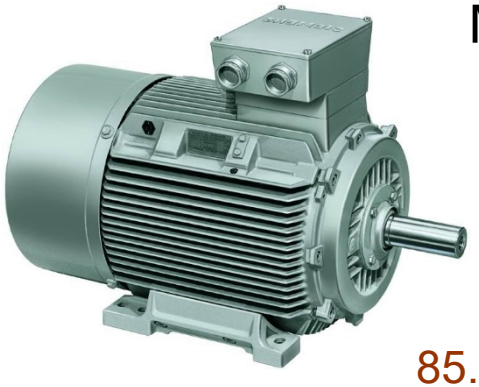
$$Energy\ Efficiency = \frac{Output\ (Performance, service, goods\ or\ energy\ )}{Input\ (Energy)}$$



Source: European Parliamentary Research Service, Gregor Erbach 2015

Energy Efficiency – system level

Electrical input



Mechanical output

- Pumps
- Compressors
- Fans and blowers
- Conveying belts,
- Agitators,
- Etc.

100 units of energy

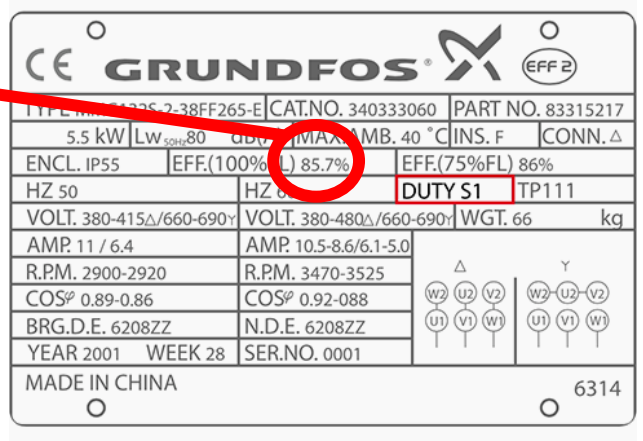
85.7 units of energy

Motor Efficiency = 85.7%

- Winding
- Rotor
- Bearings
- Magnetic Field
- Cooling
- Noise
- Vibration

Losses

14.3 units of energy



Source: Grundfos

Energy Efficiency – system level

Heat input

Heat output

- Process
- Steam
- Hot water

100 kcal input

90 kcal output

Boiler efficiency 90%

Losses

10 kcal

- Flue gas
- Moisture in air and fuel
- CO loss
- H2 loss
- Surface losses
- Ash and blow down losses

Also applicable to

- Pumps
- Compressors
- Furnaces
- Etc.

Energy Efficiency – different representations

System examples – component level	Energy Efficiency representation examples
Motors, Pumps, Boilers, Furnaces	%
Air compressors	%, cfm/kW, m^3/kW
Chiller and Air conditioning units	$\frac{kW\ refrigeration\ effect}{kW\ input}$ i.e. COP, $\frac{\frac{Btu}{h}refrigeration\ effect}{kW\ input}$ i.e. EER, $\frac{kW\ input}{Tons\ of\ refrigeration\ effect\ (TR)}$
Lighting	Lumens / W
Cement kiln	kcal / kg clinker

Energy Efficiency – different representations

System examples – industry level and national level	Energy Efficiency representation examples
Aluminium, Chloro Alkali, Paper, Cement, etc.	TOE consumed /Ton of product produced Cement: TOE/Ton of cement, kcal/Ton of cement,
Building	kWh / m^2 / year (or) kWh / ft^2 / year (or) kWh / person / year
National level	Energy Intensity = Joules / GDP

Specific energy consumption

Why do we need Energy Efficiency?

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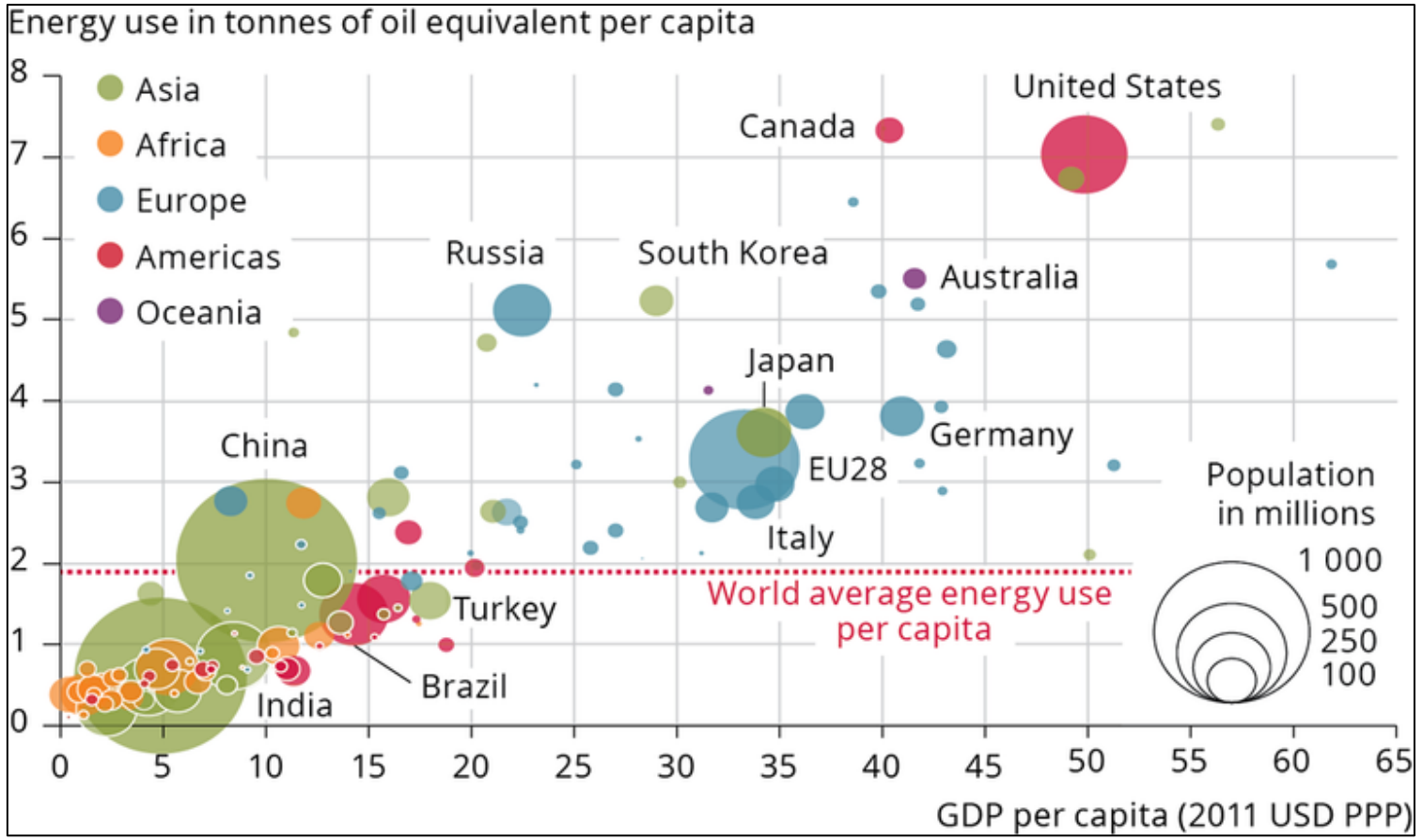
Why Energy Efficiency?



Source: European Environment Agency, 2011

Tackle negative impacts

- Climate change,
- Environment degradation,
- Resource depletion, etc.

Why Energy Efficiency? - benefits

Individual industry/building/service/ companies	• Minimize operating costs • Enhance profitability
National	• Energy imports can be reduced • Towards self sustainable
Society	• Reduced environmental impact • Improved quality of living

Why Energy Efficiency? - benefits

Examples:

- Energy efficiency interventions by the Ministry of Regional Development, Construction, Housing and Municipal Economy of Ukraine and Federal Ministry for Economic Cooperation and Development (BMZ) has resulted in 5-10 per cent reduction of the annual energy cost of the municipalities. ((BMZ), 2015)
- Energy efficiency studies of municipal water systems in India have indicated at least 25 per cent energy and monetary savings potential. ((IFC), 2008)
- Energy conservation measures in water utilities of Sharjah Electricity Water Authority have resulted in more than 56 per cent energy savings. (TERI, 2016)
- Local technological improvements of street lighting systems in Timeri, Guyana resulted in a 29.7 per cent lighting energy consumption reduction. (TERI, 2014)

Why Energy Efficiency? - benefits

Perform Achieve Trade (PAT) Mechansism (2012-2015) realized impacts

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 37,685 Crores ($5.8 Billion)

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

Investment

Encouraged investments for energy efficient technologies for domestic manufacturing

Rs 24,517 Crore ($3.8 Billion) invested

Source: Bureau of Energy Efficiency, India

Energy Efficiency opportunities

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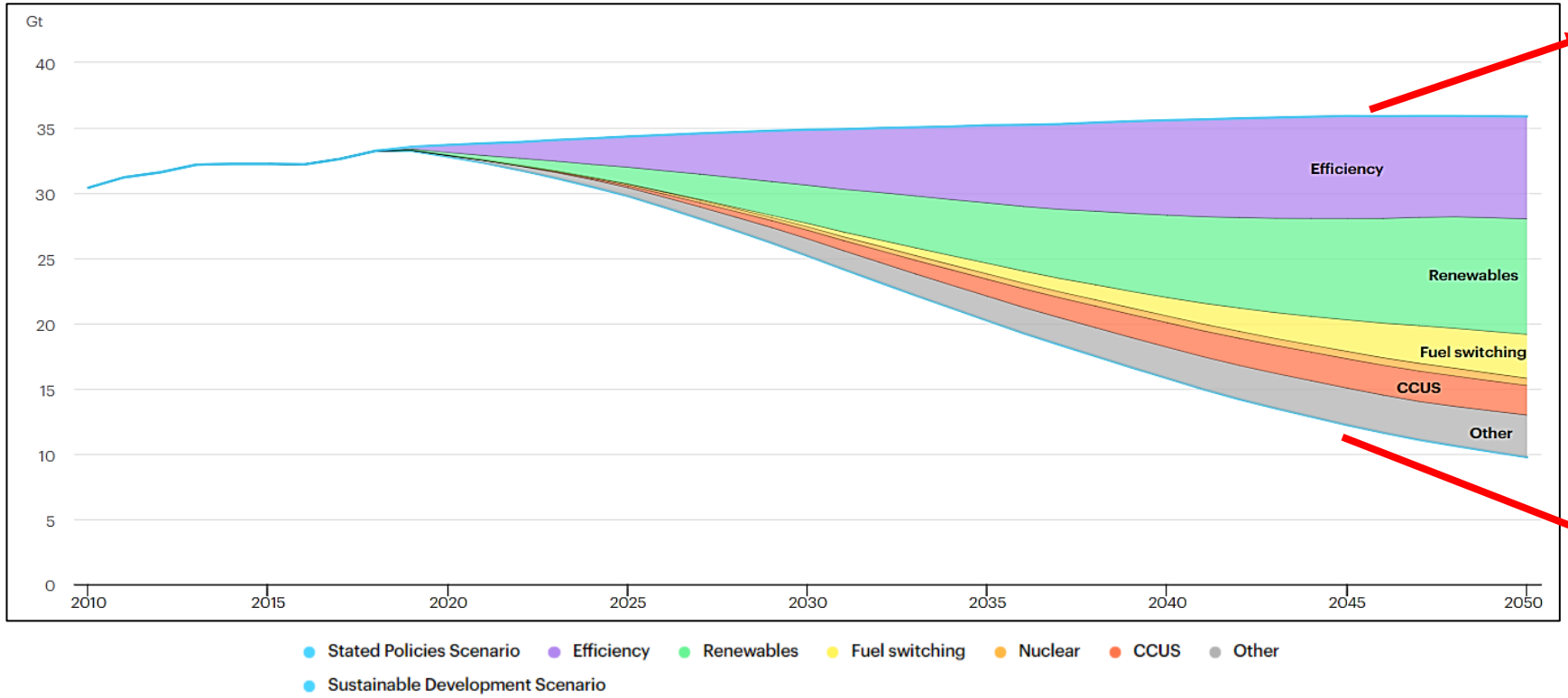
Energy Efficiency opportunities

CO_2 emissions reductions by measure in the Sustainable Development Scenario relative to the Stated Policies Scenario,



Stated Policy Scenario

Sustainable Development Scenario

Source: IEA, CO2 emissions reductions by measure in the Sustainable Development Scenario relative to the Stated Policies Scenario, 2010-2050, IEA, Paris

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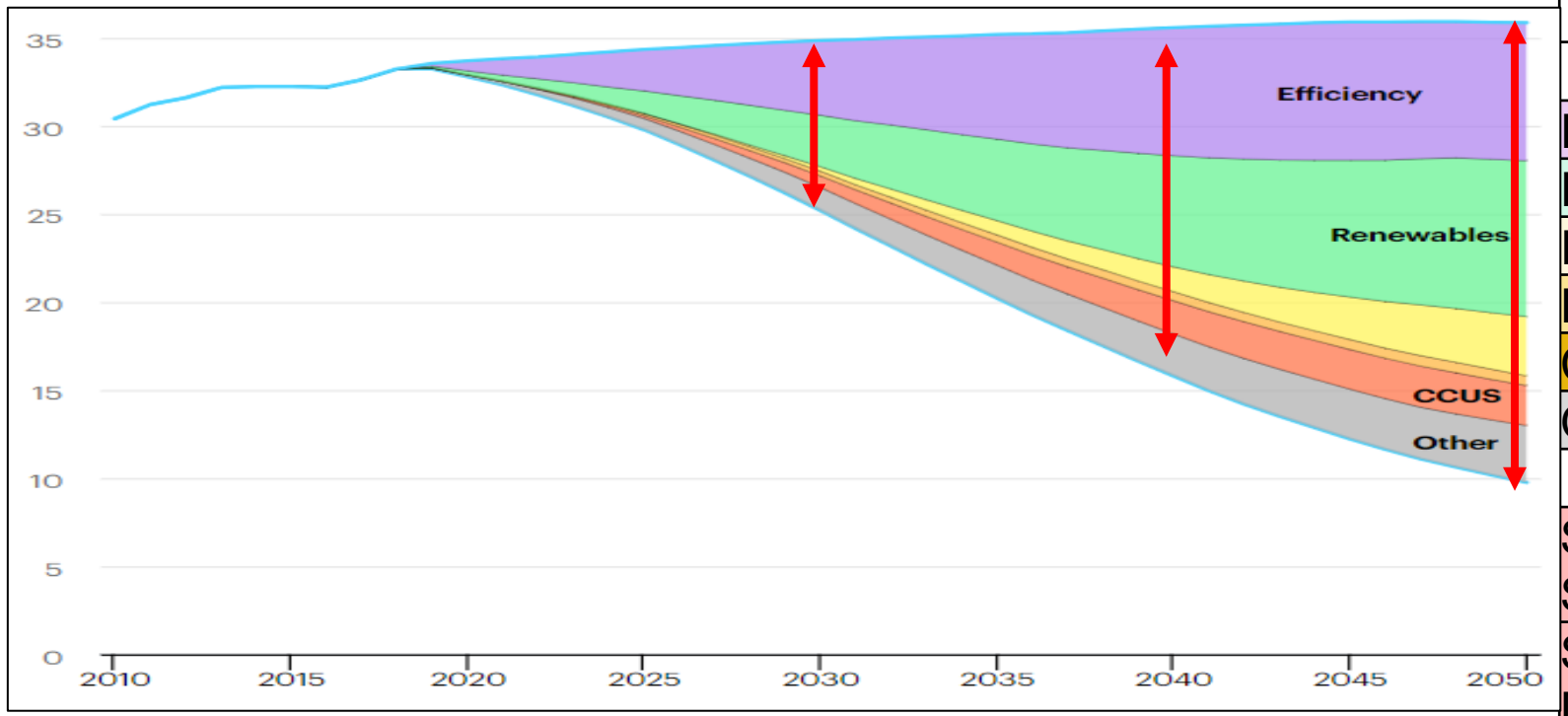
Energy Efficiency opportunities

CO_2 emissions reductions by measure in the Sustainable Development Scenario relative to the Stated Policies Scenario, 2010-2050



Share of reduction in %			
Sector	**2030**	**2040**	**2050**
Efficiency	41.7	36.8	30.8
Renewables	33.3	31.6	34.6
Fuel Switch	0.0	5.3	11.5
Nuclear	0.0	5.3	3.8
CCUS	8.3	10.5	7.7
Others	16.7	10.5	11.5
Stated Policy Scn.	35 Gt	36 Gt	36 Gt
Sustainable Development Scn.	25 Gt	16 Gt	10 Gt

Source: IEA, CO2 emissions reductions by measure in the Sustainable Development Scenario relative to the Stated Policies Scenario, 2010-2050, IEA, Paris

Energy Efficiency opportunities

- Country NDCs – 27.6% of countries mentioned Building Energy Efficiency
- New technologies
- Competitive market.

Energy Efficiency integration with Energy Access

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Integration with Energy Access

What is Energy Access ?

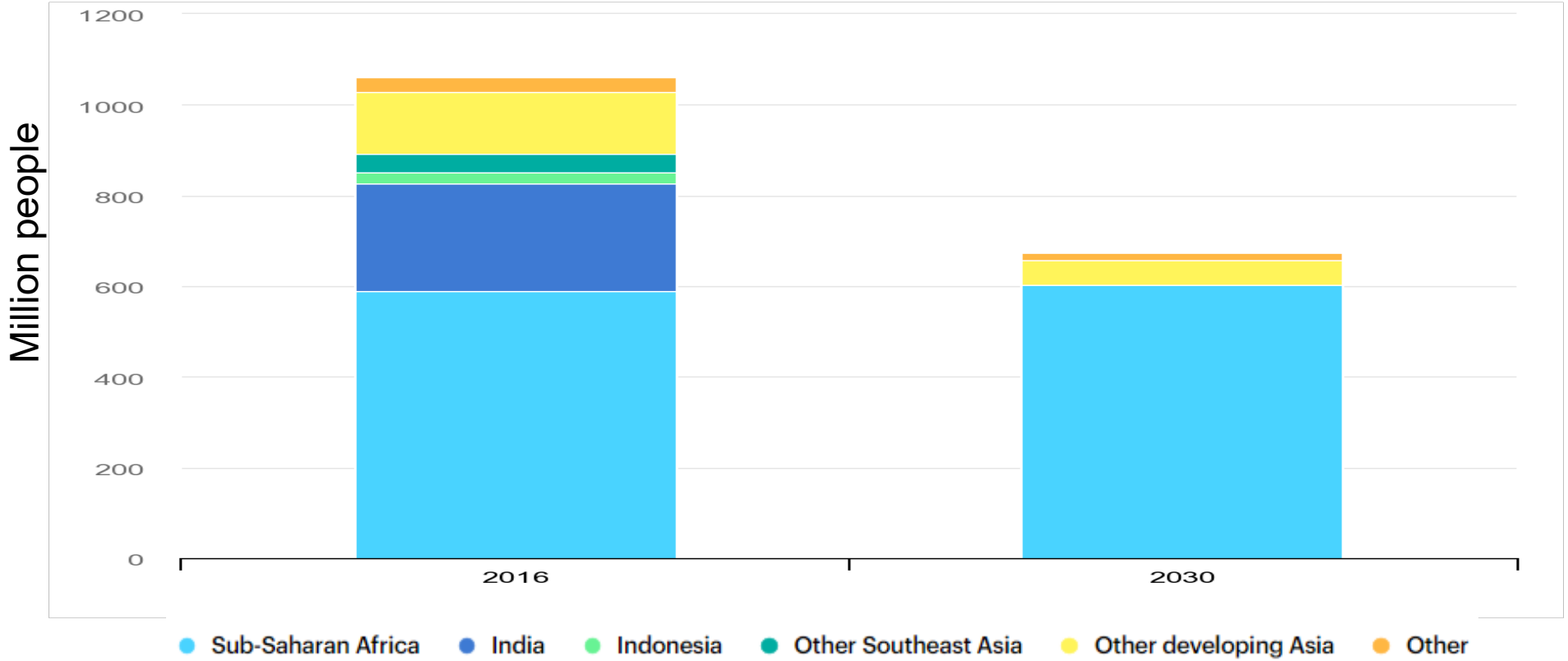
The IEA defines energy access as "*a household having reliable and affordable access to both clean cooking facilities and to electricity, which is enough to supply a basic bundle of energy services initially, and then an increasing level of electricity over time to reach the regional average*"

- Household access to a minimum level of electricity
- Household access to safer and more sustainable (i.e. minimum harmful effects on health and the environment as possible) cooking and heating fuels and stoves.
- Access to modern energy that enables productive economic activity, e.g. mechanical power for agriculture, textile and other industries
- Access to modern energy for public services, e.g. electricity for health facilities, schools and street lighting

Source: IEA,2020

Integration with Energy Access

- ¨600 million people in Africa alone – No access to electricity

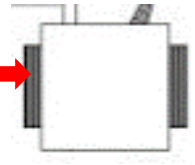


Source: IEA, *Population without access to electricity, 2016 compared to 2030 in the New Policies Scenario*, IEA, Paris

One Unit saved = Two Units generated !!

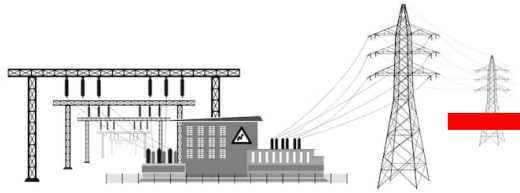
Generation

Generation
η_0= 28-35%

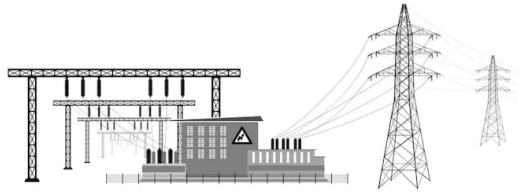


Step-up 400/800 kV
η_1= 99.5%

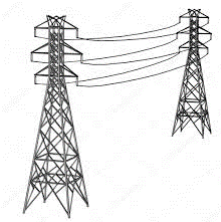
Transmission



EHV transmission and substation
400/800 kV η_2= 99%

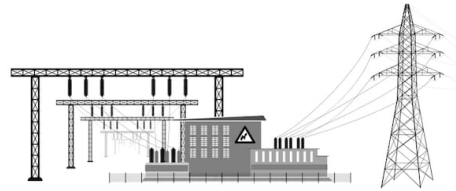


HV transmission and substation
220/400 kV η_3= 97.5%

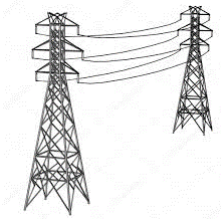


Sub-transmission 66/132 kV
η_4= 96%

Distribution – End use

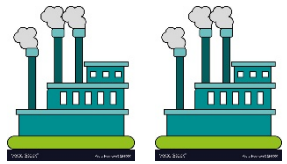


Distribution station - Step-down
11/33 kV η_5= 99.5%



Primary distribution link to end user
11/33kV η_6= 95%

End-use



Note: Values are indicative

Sources: BEE, India; https://images.app.goo.gl/kmMtVZQhCRRSACC19, https://images.app.goo.gl/HQ1rr5NVkv4e18p68, https://images.app.goo.gl/vhdX5W5KjaRk3NYe6, https://images.app.goo.gl/kzPVV1BTBi1SNeb98, https://images.app.goo.gl/hxqUwy29nHgCX4Cs7,

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IOne Unit saved = Two Units generated !!

Generation
η_0= 28-35%

A

100 kWh

Transmission and Distribution

$\eta 1 \times \eta 2 \times \eta 3 \times \eta 4 \times \eta 5 \times \eta 6$ = 50 – 83%

(usually 17-50% T&D losses)

Typical industrial plant distribution η_7= 95%

Overall Efficiency

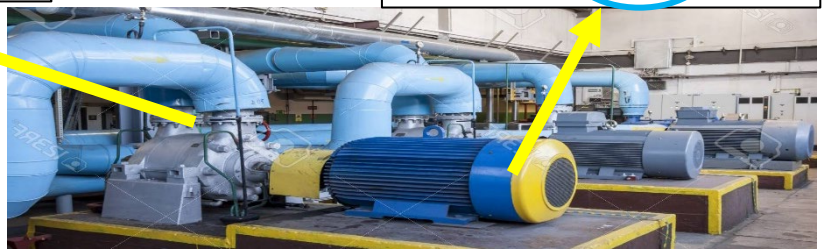
0.83 x 0.95 x 0.9 x 0.7 = 0.5 i.e. 50%

50 kWh

Pump
η_9= 70%

Motor
η_8= 90%

B



1 unit saved → $\frac{1}{50\%}$ →2 Units generated

Integration with Energy Access

Benefits of Energy Efficiency in Energy Access ?

- Avoid unwanted investments on new power plants
- Reduced demand – reduced pressure on transmission and distribution lines
- Saved energy in one location can thus be utilized to energy deprived locations.

Energy Efficiency integration with Renewable Energy

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Integration with Renewable Energy

Renewable energy

- Clean energy
- Natural source or processes – constantly replenished.

Solar PV

Solar thermal

Wind

Biomass

Hydro

Geothermal

Sources: NRDC; https://images.app.goo.gl/izAfMEFzdJdgFCCa7; https://images.app.goo.gl/r32QEJsXXb84PnRu9; https://images.app.goo.gl/HWuhkJ6fz8Xp4wXz5; https://images.app.goo.gl/mwg7kWo2WQEbxvru9; https://images.app.goo.gl/9YYoQzP8WpHqWj599;

Integration with Renewable Energy

Renewable energy is not Energy Efficiency - They may however support each other.

Renewable energy

Type of energy which is inexhaustible.

And

≠

Energy Efficiency

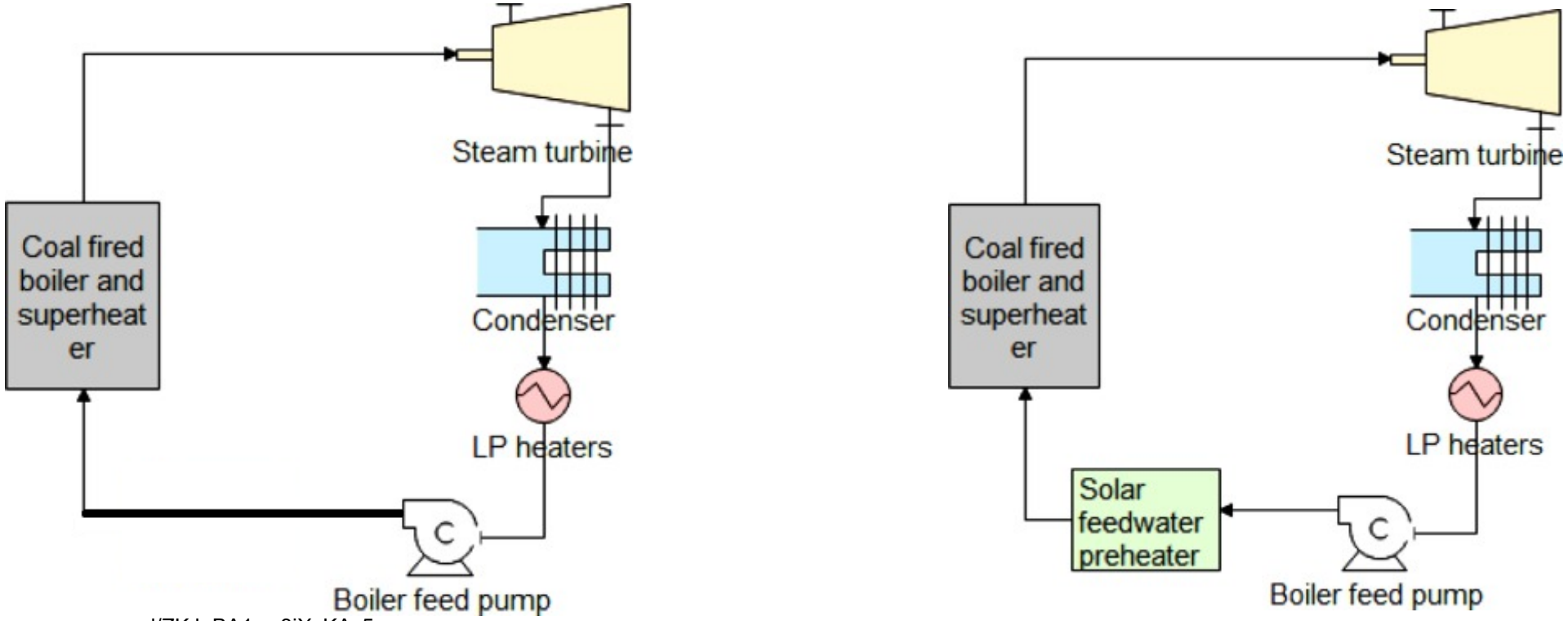
Utilising the existing energy irrespective of renewable or non renewable, judiciously. i.e. more work done with less energy and no loss in quality

Sources: https://images.app.goo.gl/gNHat1Umtr5Y7FGg7; https://images.app.goo.gl/12xxBFE8cpmc7cbN7;

Integration with Renewable Energy

Renewable Energy supports Energy Efficiency

- Reduced fossil fuel consumption.



Less Fuel

Sources: https://images.app.goo.gl/ZKJoBA1wu3iXcKAy5

Integration with Renewable Energy

Renewable Energy supports Energy Efficiency

- Similar applications for hotels, large kitchens, process industries, etc.
- Enables reduction in fossil fuel consumption.
- Lower fuel costs
- Cleaner environment.

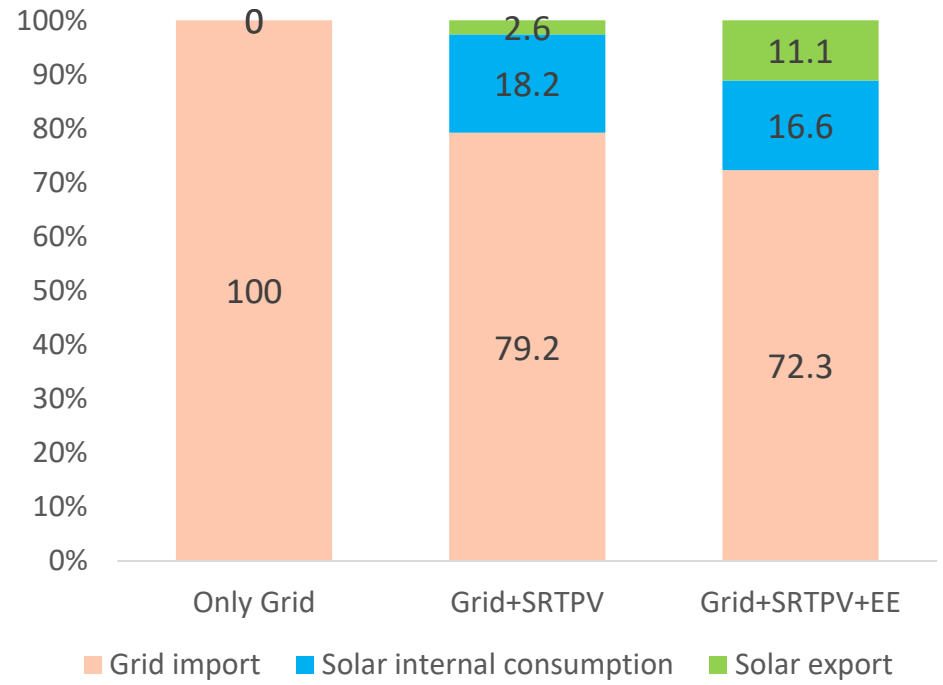
Sources: https://images.app.goo.gl/ZKJoBA1wu3iXcKAy5

Integration with Renewable Energy

Energy Efficiency supports Renewable Energy

Example – College building

- Annual electricity consumption : 65990 kWh
- Solar Roof Top PV installed capacity : 10kWp
- Energy Efficiency savings : 5256 kWh



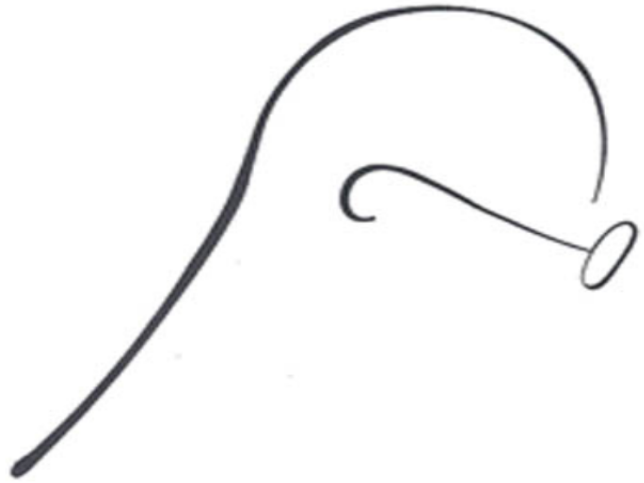
Sources: T E R I. 2015, Need Assessment Report, Bangalore: The Energy and Resources Institute. 23 pp., [Project Report No. 2015IB04]

Integration with Renewable Energy

EE and RE synergy benefits

- Use of RE minimizes reliance on fossil fuels.
- Reap benefits of feed-in tariffs by EE
- Reduced capacities / RE investment by being more efficient.

Sources: https://images.app.goo.gl/ZKJoBA1wu3iXcKAy5



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