International Energy Agency

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INTERNATIONAL LOW-CARBON ENERGY TECHNOLOGY PLATFORM

Assessing the Market for Energy Efficiency Technologies

An IEA Methodology

16 June 2015

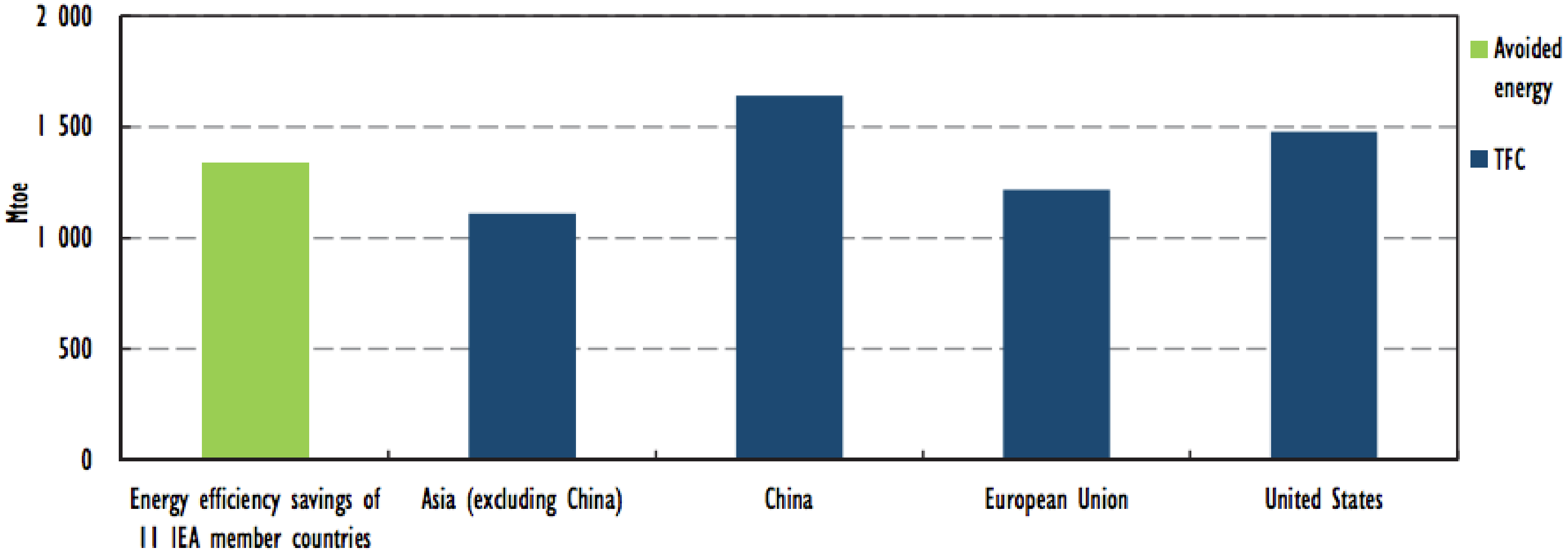
www.iea.org

Questions for workshop participants

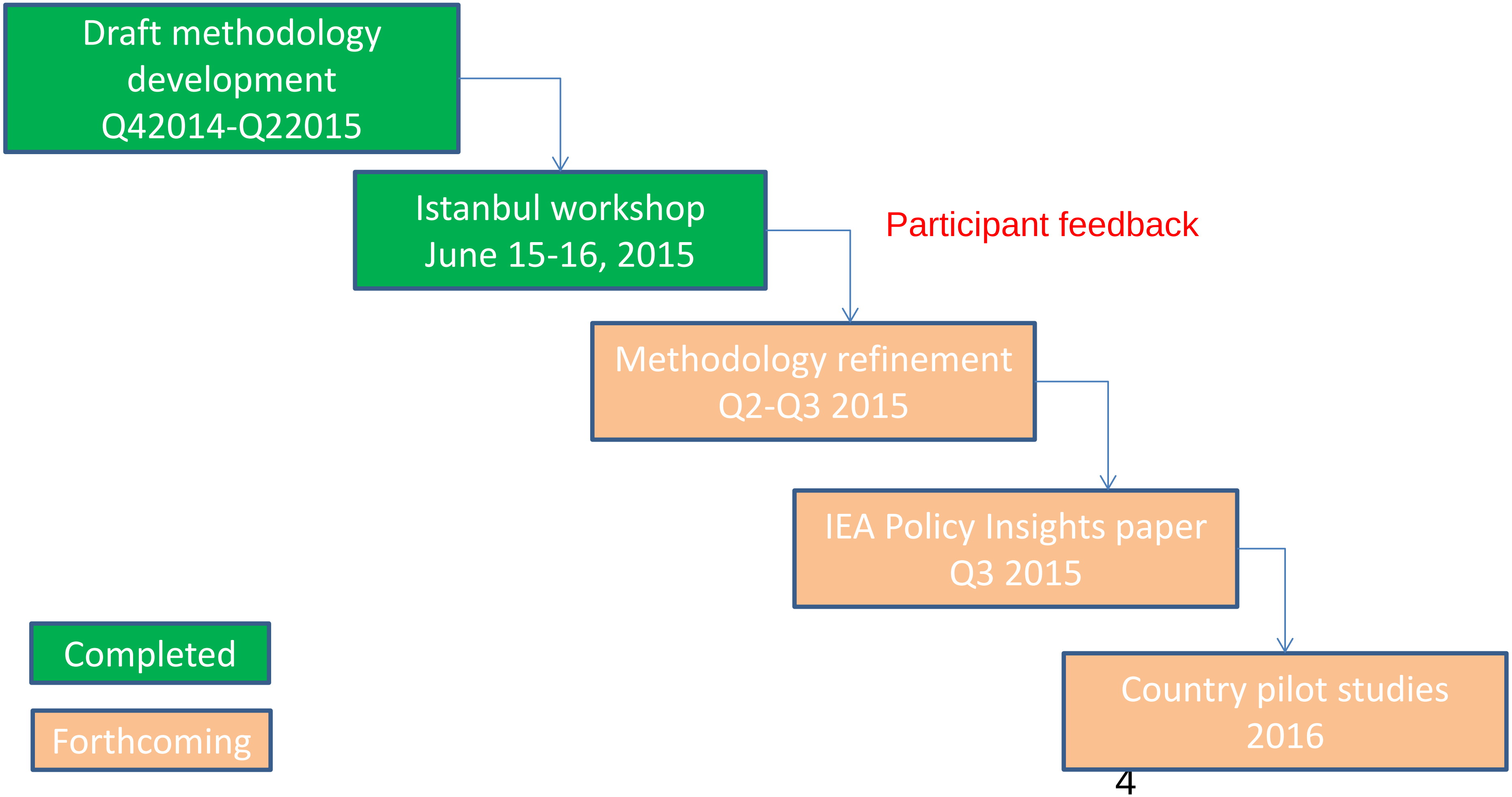
1. If your country has energy indicators established, how do they compare to the indicators recommended here?
2. If your country has EET penetration metrics established, how do they compare to the methods proposed here?
3. Do the proposed sectors, subsectors, and end uses of energy within the methodology align well with your priorities and are they realistic for your country?
4. Are the administrative, modeling, survey, and other data requirements feasible for your country?
5. Do you have capacity in place to complete each step of the methodology as proposed?
6. Do you foresee any major barriers or challenges to implementing such a methodology in your country?

Energy efficiency: the "first fuel"

Energy efficiency savings compared to TFC in selected regions and countries, 2011



Project stages and goals



Draft methodology development
Q42014-Q22015

Istanbul workshop
June 15-16, 2015

Participant feedback

Methodology refinement
Q2-Q3 2015

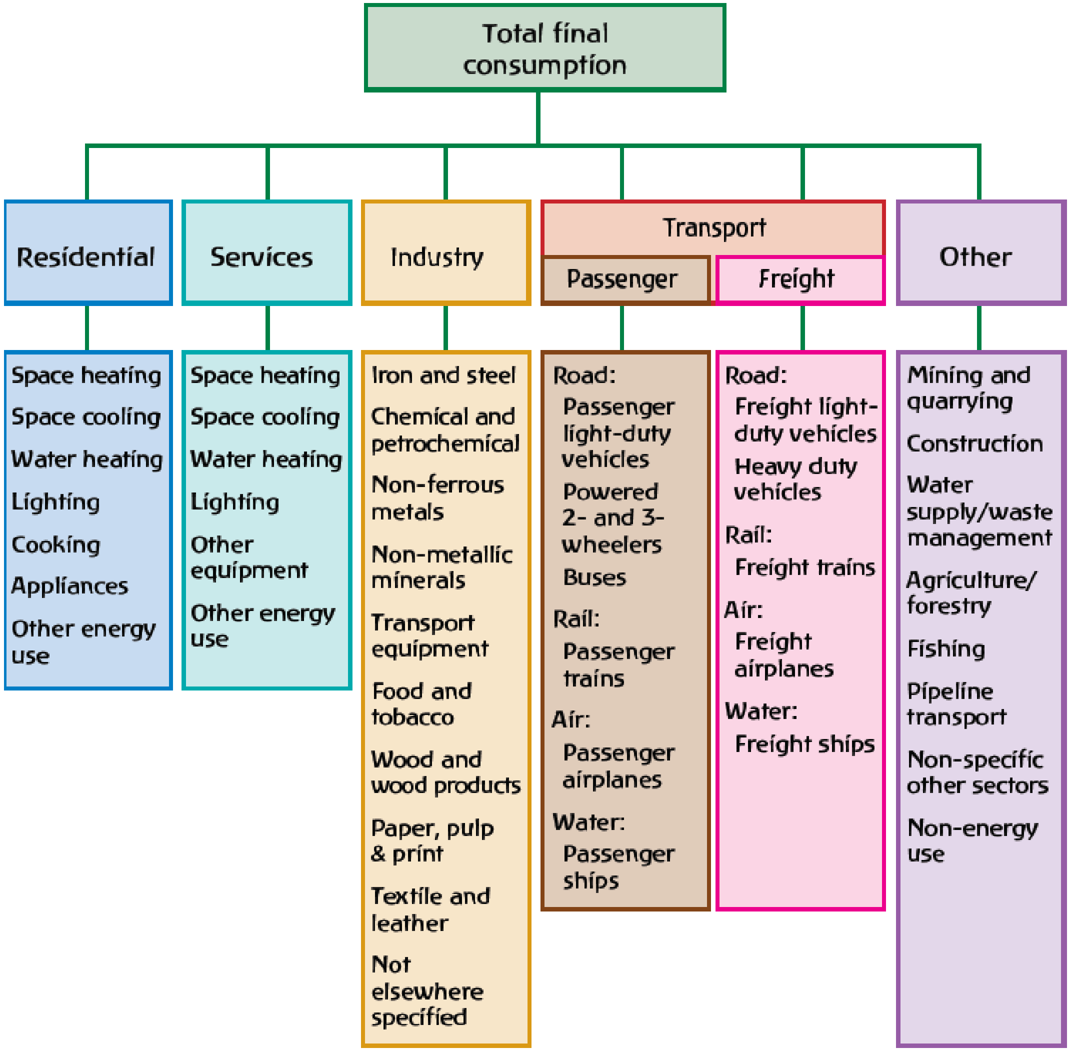
IEA Policy Insights paper
Q3 2015

Country pilot studies
2016

Completed

Forthcoming

EET market heterogeneity



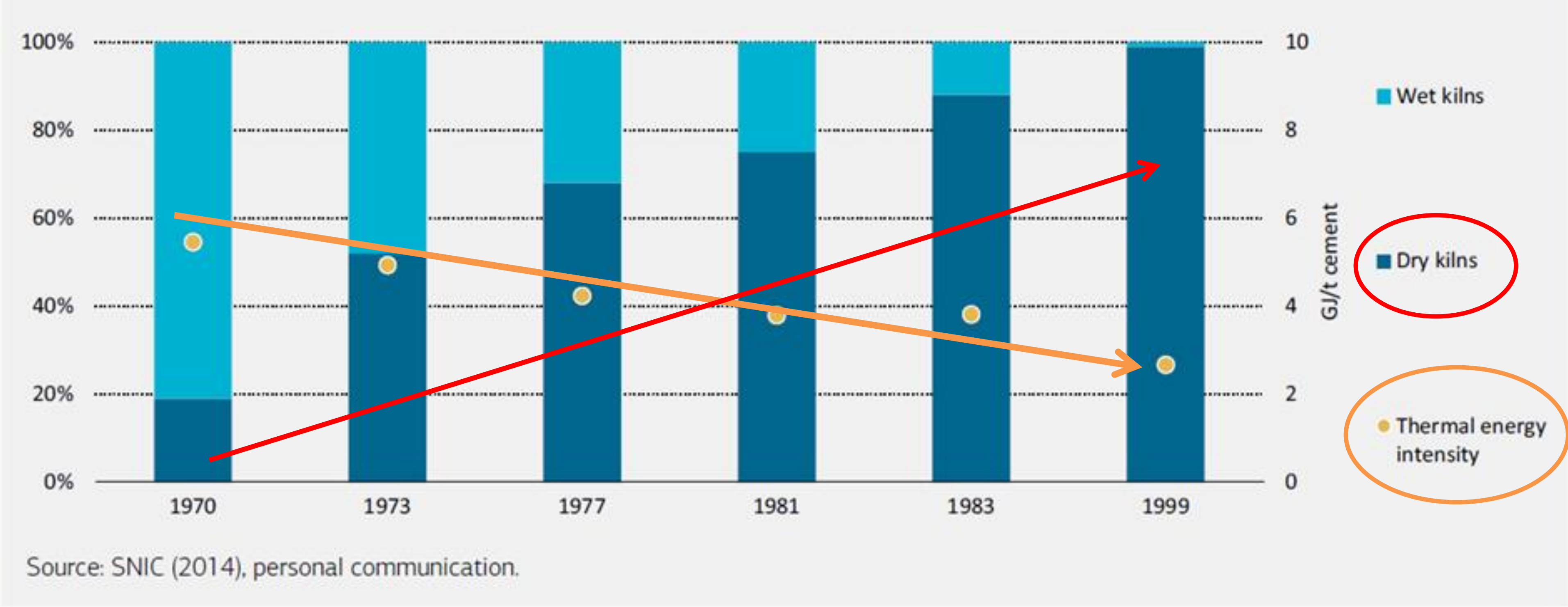
- Total final consumption
  - Residential
    - Space heating
    - Space cooling
    - Water heating
    - Lighting
    - Cooking
    - Appliances
    - Other energy use
  - Services
    - Space heating
    - Space cooling
    - Water heating
    - Lighting
    - Other equipment
    - Other energy use
  - Industry
    - Iron and steel
    - Chemical and petrochemical
    - Non-ferrous metals
    - Non-metallic minerals
    - Transport equipment
    - Food and tobacco
    - Wood and wood products
    - Paper, pulp & print
    - Textile and leather
    - Not elsewhere specified
  - Transport
    - Passenger
      - Road:
        - Passenger light-duty vehicles
        - Powered 2- and 3-wheelers
        - Buses
      - Rail:
        - Passenger trains
      - Air:
        - Passenger airplanes
      - Water:
        - Passenger ships
    - Freight
      - Road:
        - Freight light-duty vehicles
        - Heavy duty vehicles
      - Rail:
        - Freight trains
      - Air:
        - Freight airplanes
      - Water:
        - Freight ships
  - Other
    - Mining and quarrying
    - Construction
    - Water supply/waste management
    - Agriculture/forestry
    - Fishing
    - Pipeline transport
    - Non-specific other sectors
    - Non-energy use

How does it work?

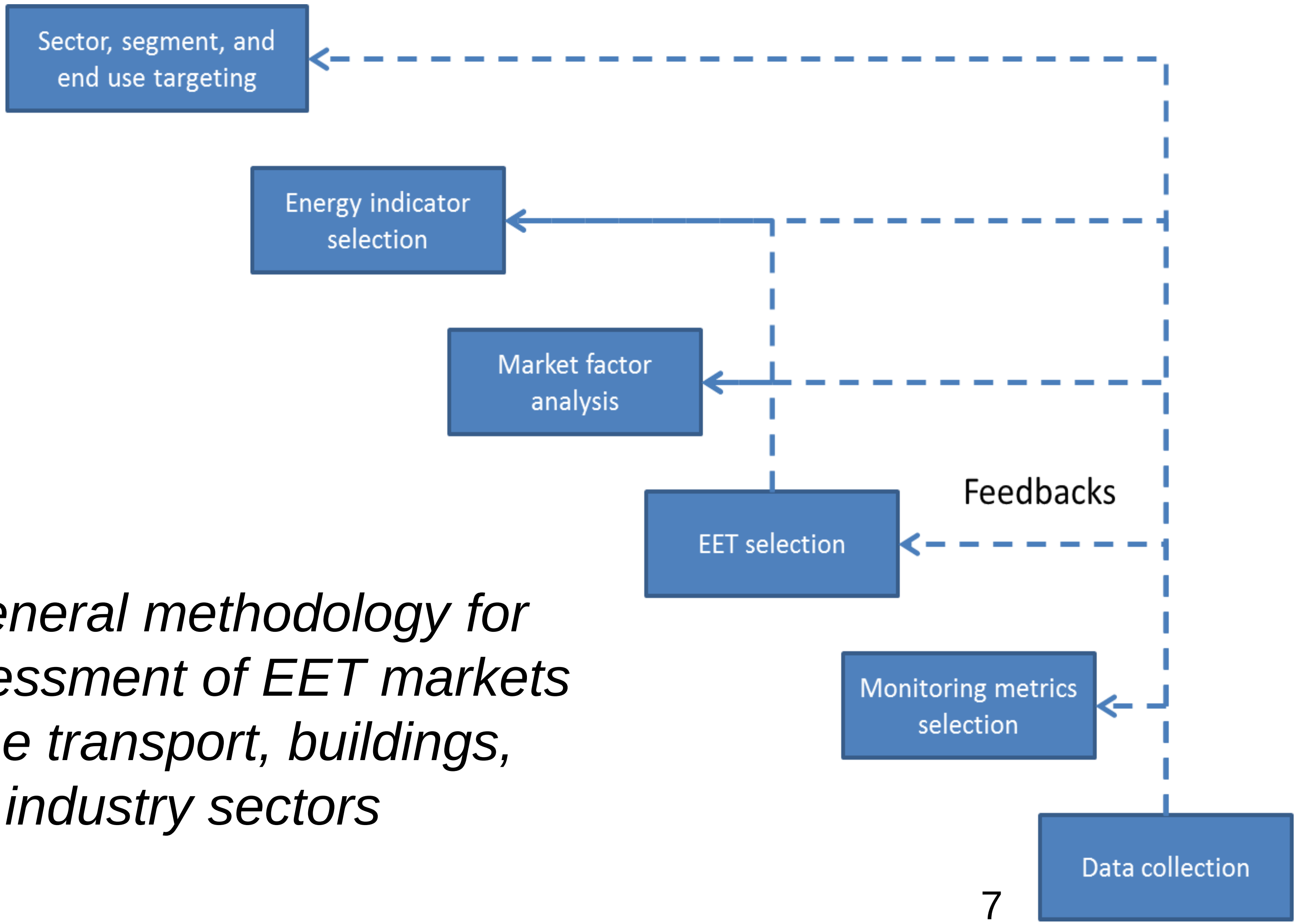
Energy indicator tracks energy use trends

EET penetration tracks efficiency progress

Thermal Energy Intensity of Cement Manufacturing in Brazil



Source: SNIC (2014), personal communication.



Sector, segment, and end use targeting

Energy indicator selection

Market factor analysis

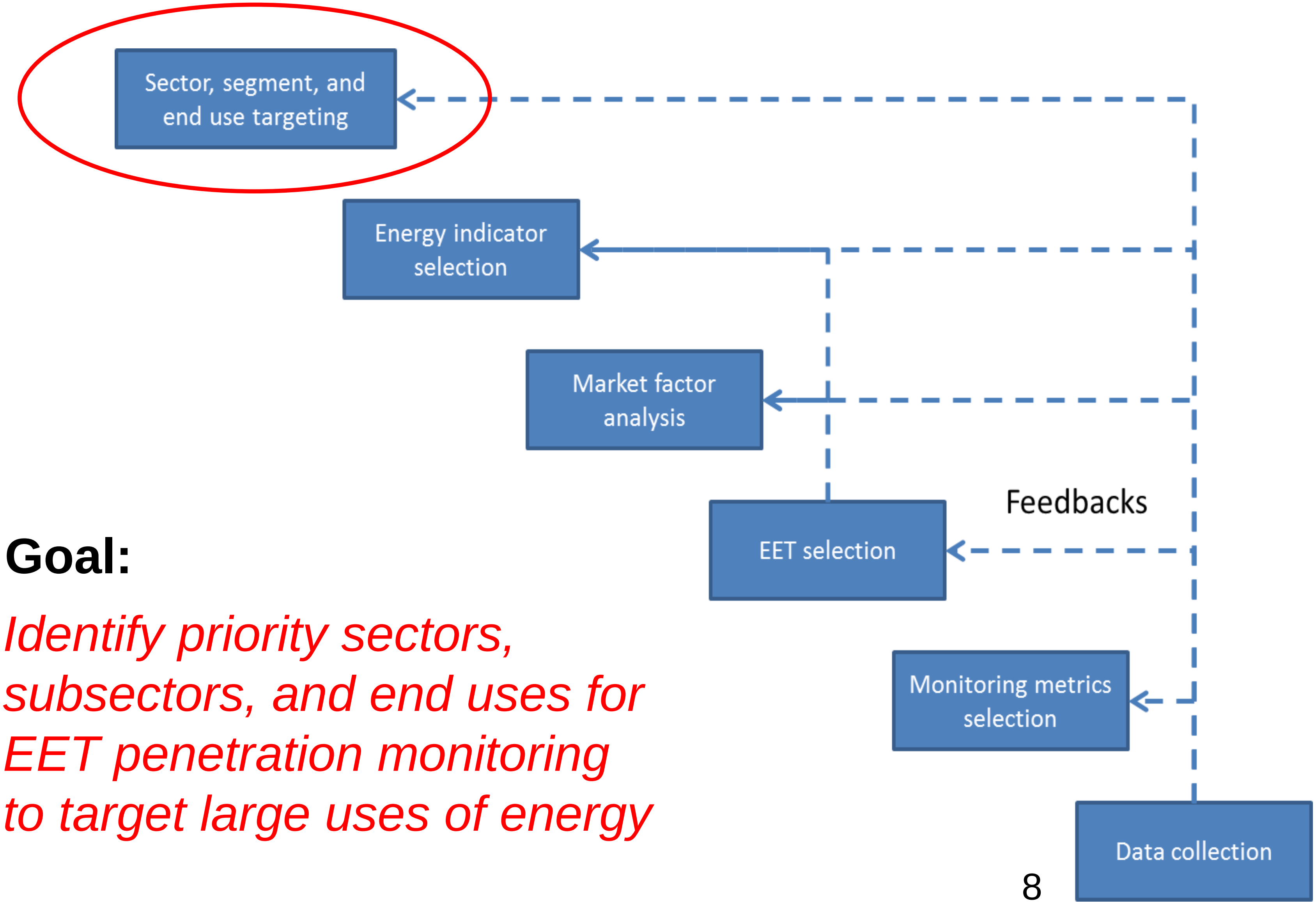
EET selection

Monitoring metrics selection

Data collection

Feedbacks

A general methodology for assessment of EET markets in the transport, buildings, and industry sectors



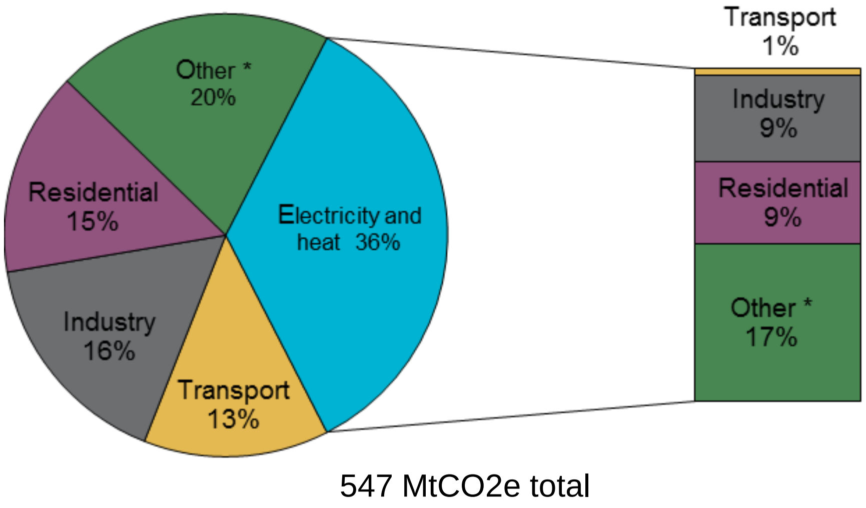
Goal:

Identify priority sectors, subsectors, and end uses for EET penetration monitoring to target large uses of energy

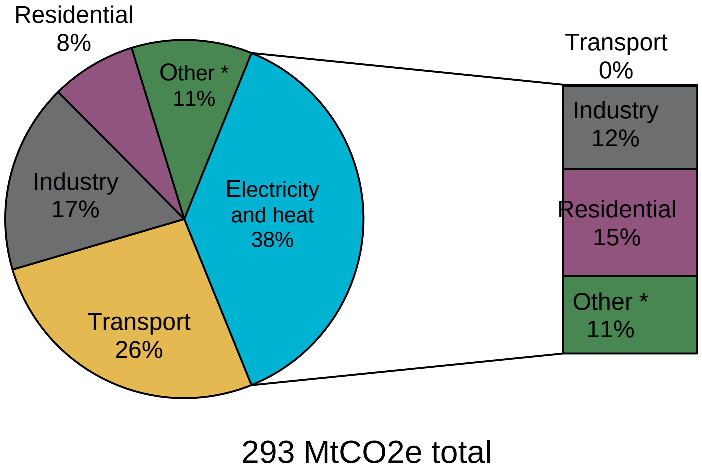
How to identify priority sectors and subsectors?

- National energy statistics for sectors/subsectors

CO$_2$ emissions by sector in the ETC region (2012)



CO$_2$ emissions by sector in the SEMED region (2012)

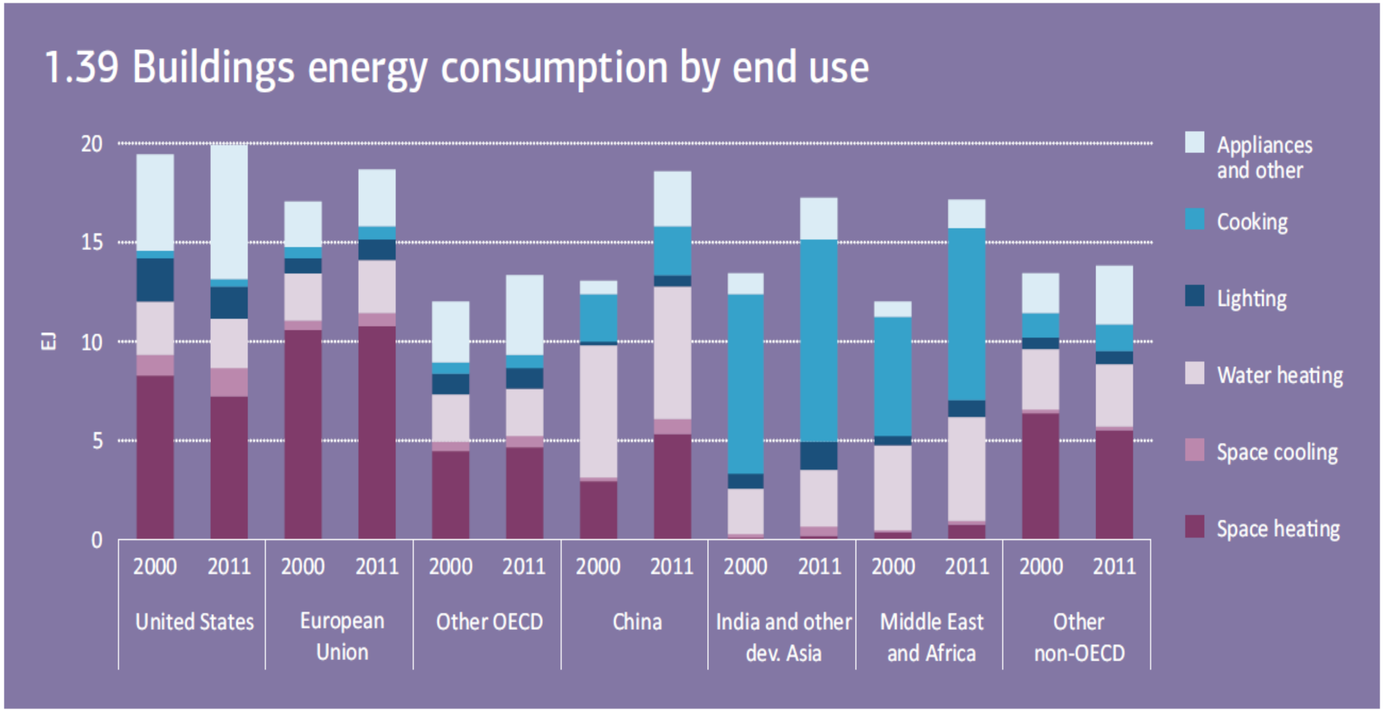


Note: Other includes commercial/public services, agriculture/forestry, fishing, energy industries other than electricity and heat generation, and other emissions not specified elsewhere.
Source: IEA (2014f), *CO$_2$ Emissions from Fuel Combustion*, OECD/IEA, Paris.

How to identify priority subsectors and end uses?

- Sector energy use and technology models

1.39 Buildings energy consumption by end use

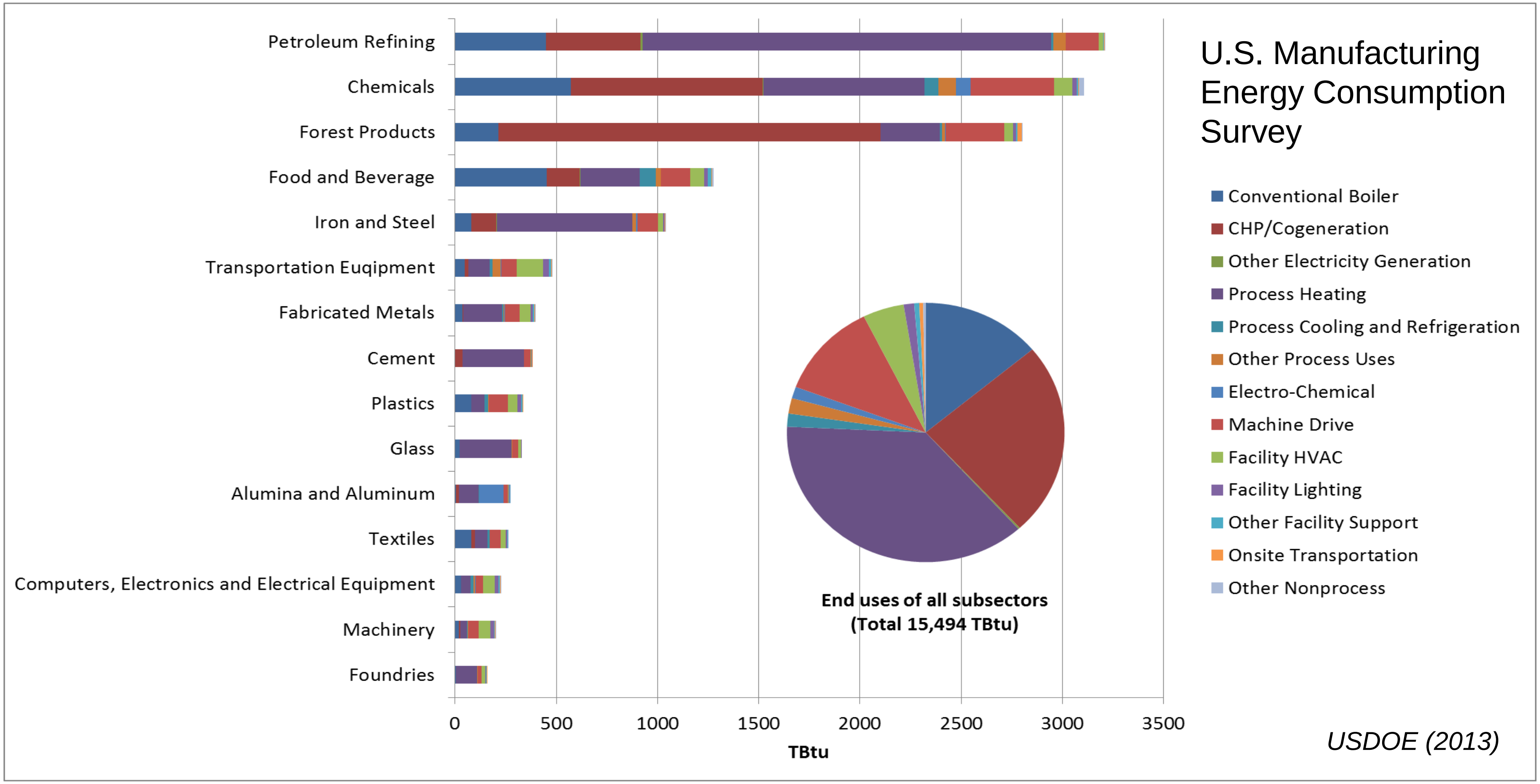


IEA building end use modeling for different countries and regions

IEA (2014)

How to identify priority subsectors and end uses?

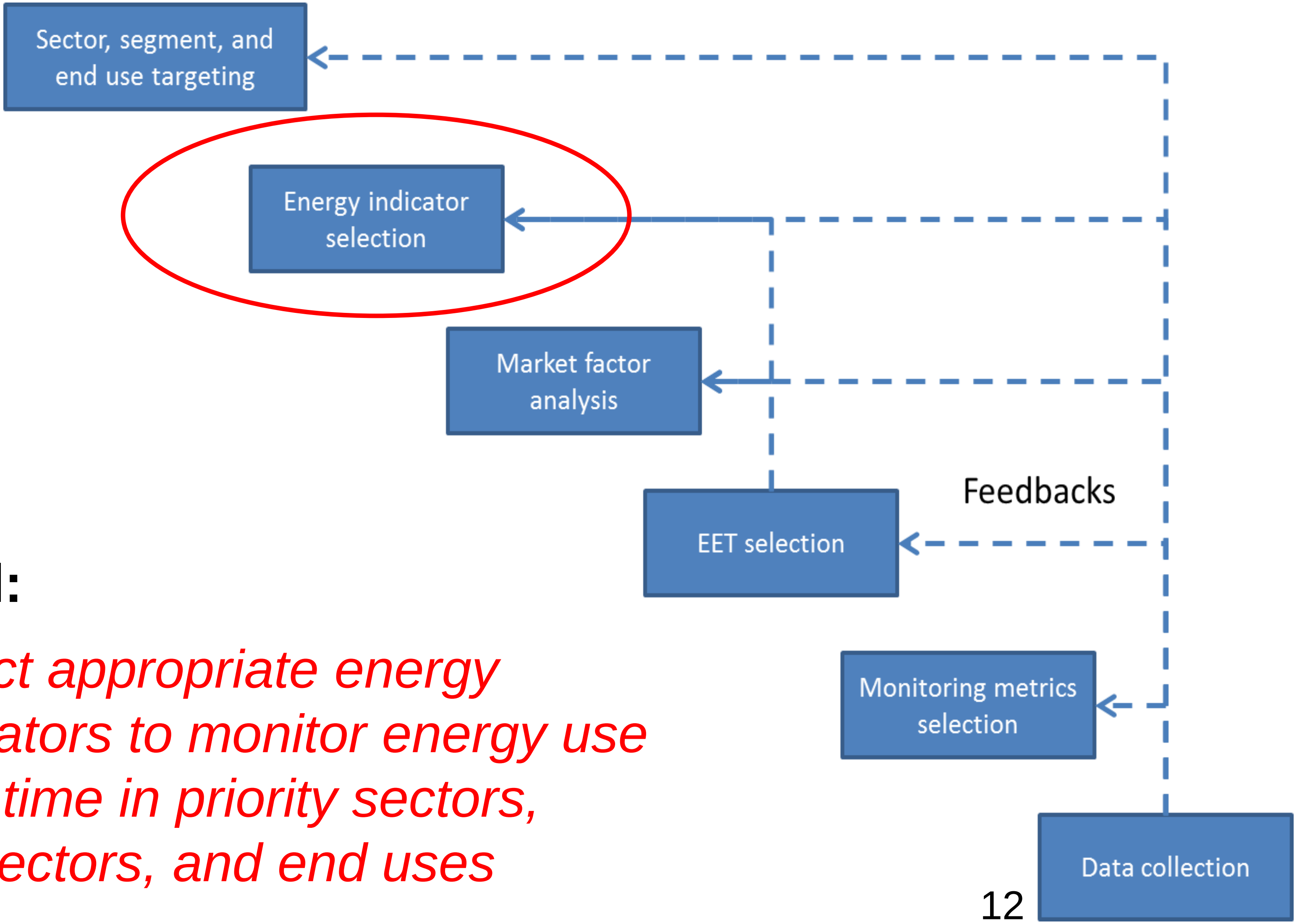
- **Surveys, measurements, and audits**



U.S. Manufacturing Energy Consumption Survey

End uses of all subsectors (Total 15,494 TBtu)

USDOE (2013)

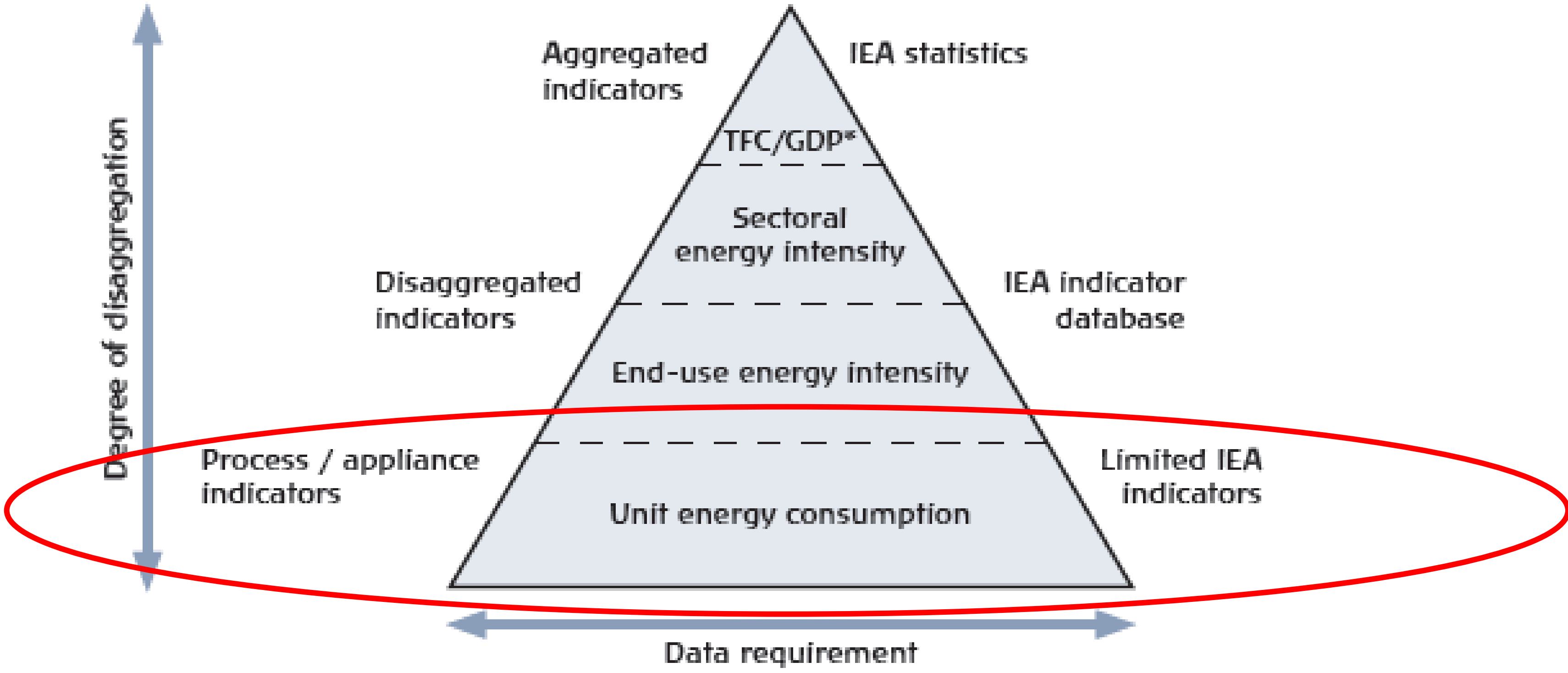


Goal:

Select appropriate energy indicators to monitor energy use over time in priority sectors, subsectors, and end uses

The “pryamidal” approach

Figure 3.5 • *Schematic representation of the IEA energy indicators pyramid*



* Gross Domestic Product

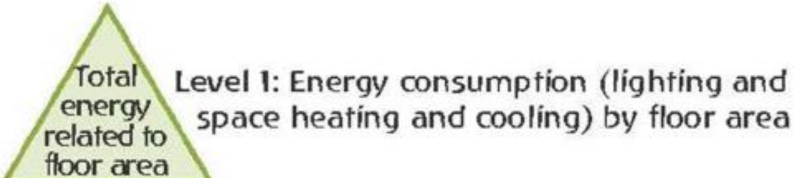
Monitoring of EET penetrations typically requires this!

IEA (2014)

Energy Efficiency Indicators

Residential Pyramid: Per Floor Area

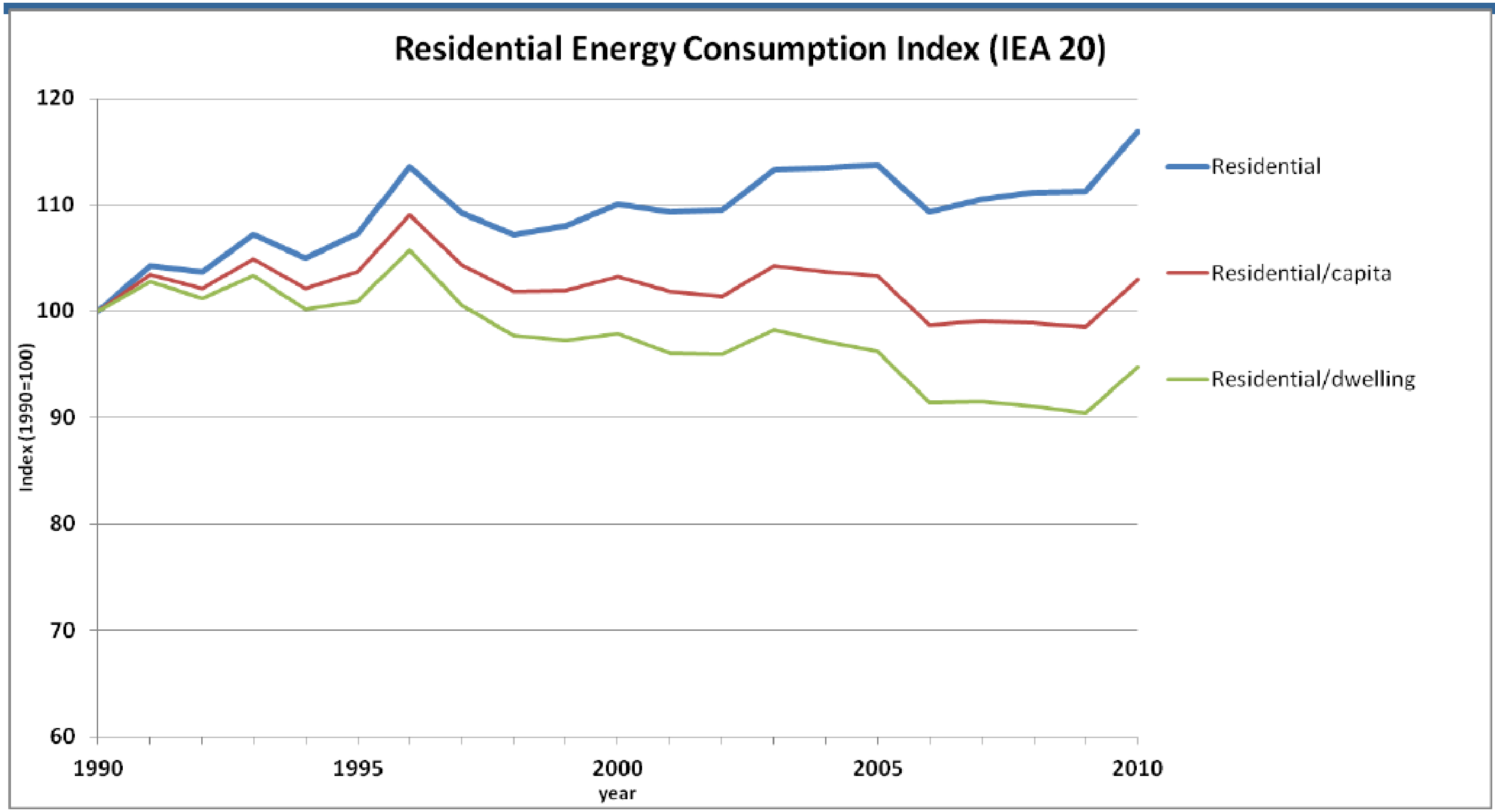
Figure F.1 • Residential sector pyramid based on floor area



Total energy related to floor area

Level 1: Energy consumption (lighting and space heating and cooling) by floor area

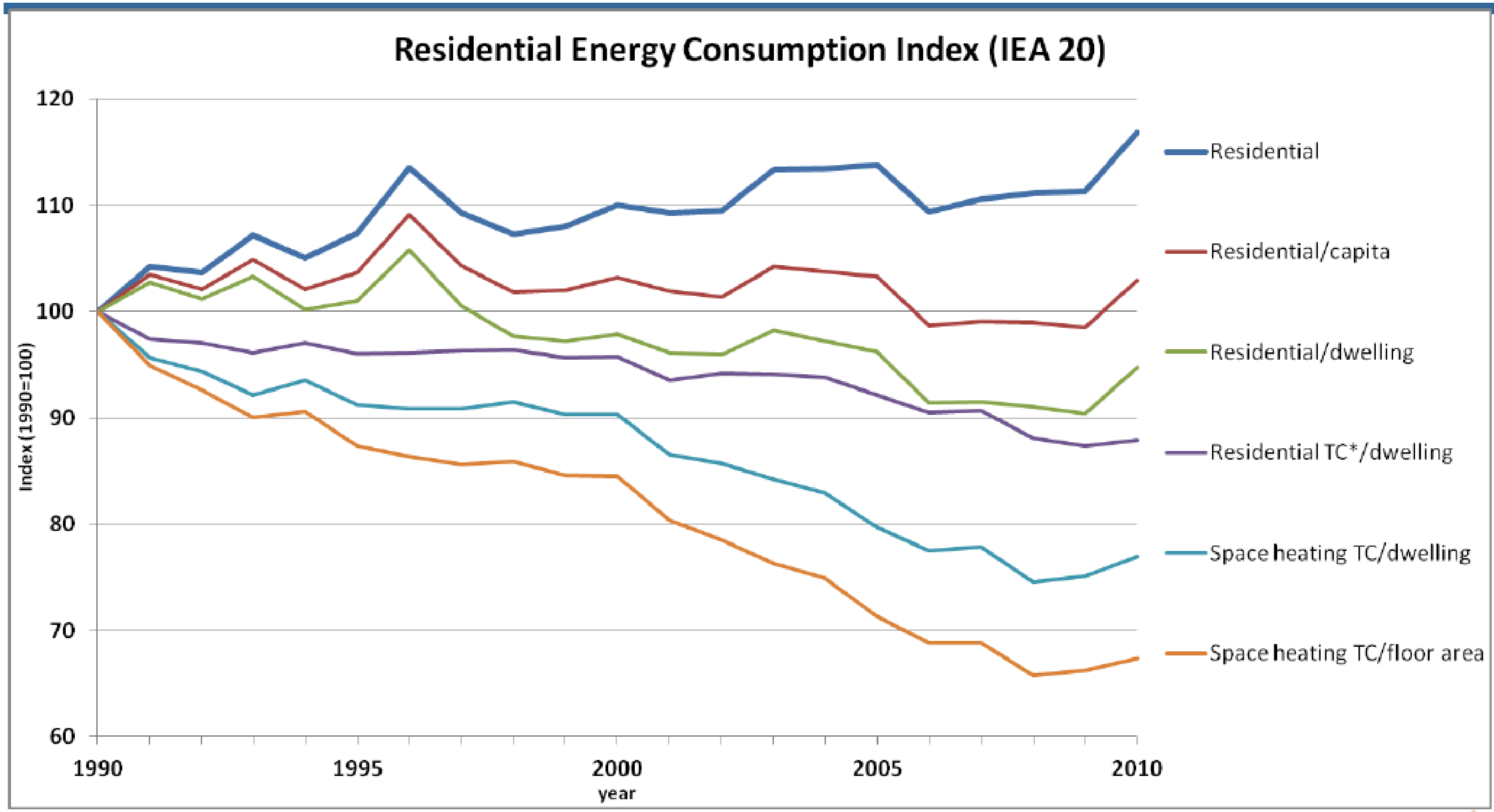
… energy balances, coupled to macroeconomic information, explain basic energy consumption patterns



Data for IEA 20 (Australia, Austria, Canada, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Japan, Netherlands, Norway, Slovakia, Spain, Sweden, Switzerland, UK, USA).

Source: IEA energy balances.

… but we need more disaggregated data to get the full picture



Residential Energy Consumption Index (IEA 20)

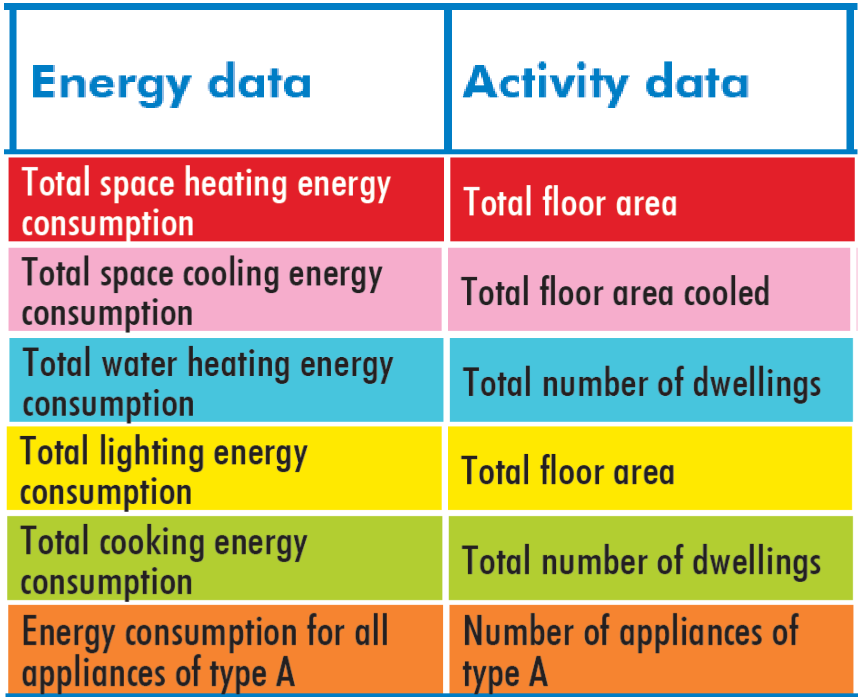
* Temperature correction using heating degree days

Data for IEA 20 (Australia, Austria, Canada, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Japan, Netherlands, Norway, Slovakia, Spain, Sweden, Switzerland, UK, USA).

Source: IEA energy indicators database.

Building sector energy indicators

- Follows well-established protocols for sector segmentation and activity bases at the end use level

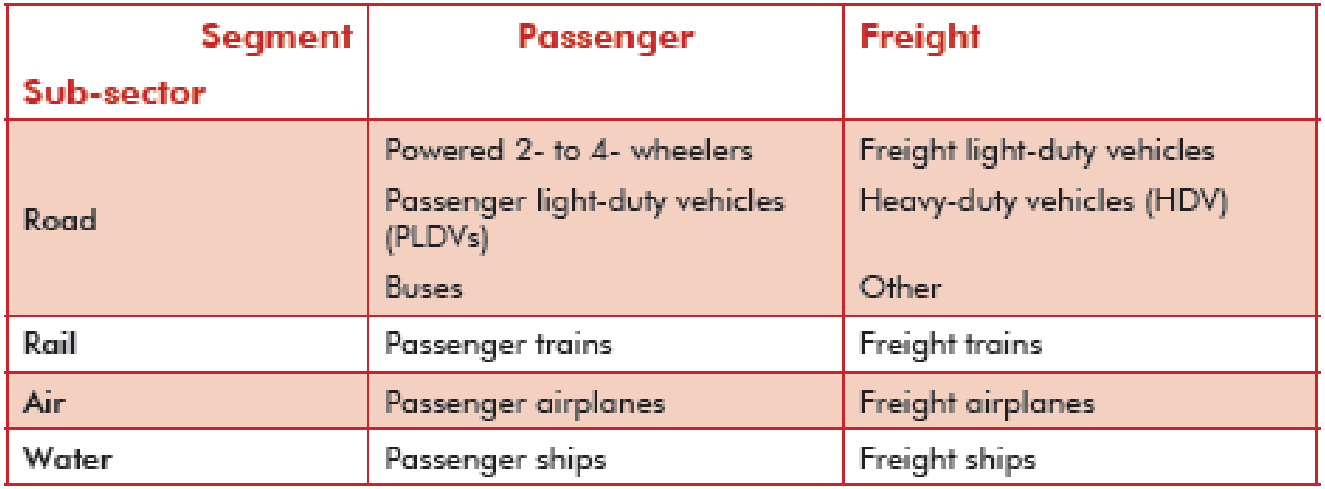


Energy data	Activity data
Total space heating energy consumption	Total floor area
Total space cooling energy consumption	Total floor area cooled
Total water heating energy consumption	Total number of dwellings
Total lighting energy consumption	Total floor area
Total cooking energy consumption	Total number of dwellings
Energy consumption for all appliances of type A	Number of appliances of type A

IEA (2014)

Transport sector energy indicators

- **Follows well-established protocols for sector segmentation and activity bases**
- **Supporting data and models compatible with technology-level monitoring**

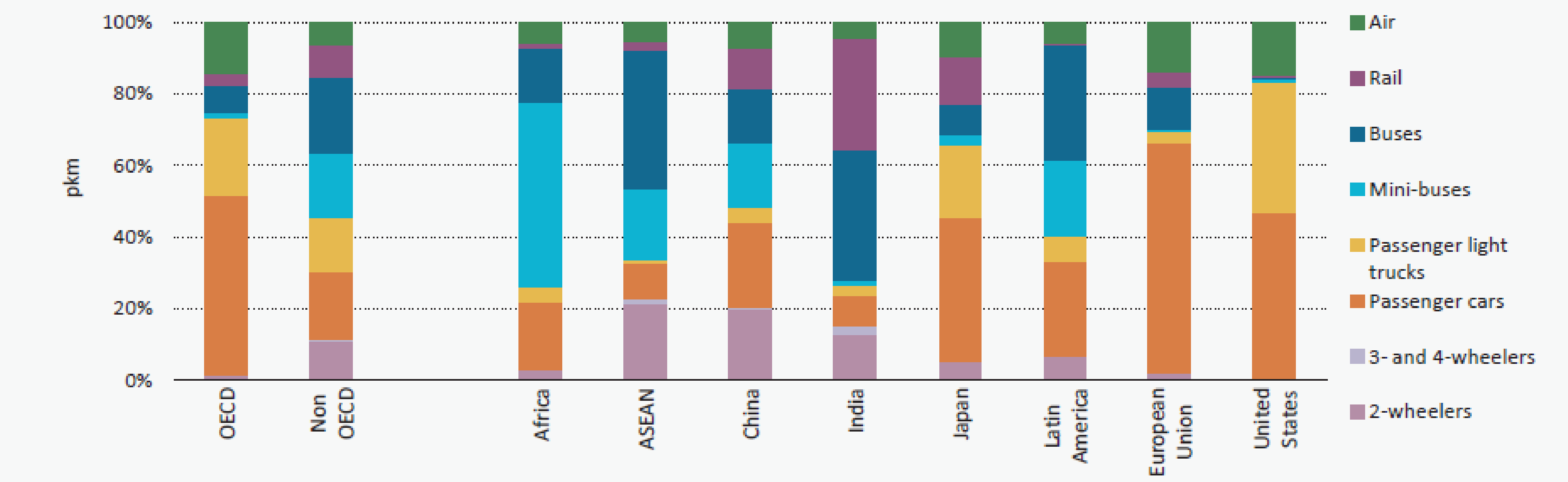


Segment Sub-sector	Passenger	Freight
Road	Powered 2- to 4- wheelers Passenger light-duty vehicles (PLDVs) Buses	Freight light-duty vehicles Heavy-duty vehicles (HDV) Other
Rail	Passenger trains	Freight trains
Air	Passenger airplanes	Freight airplanes
Water	Passenger ships	Freight ships

Activity basis	Passenger-km	Ton-km

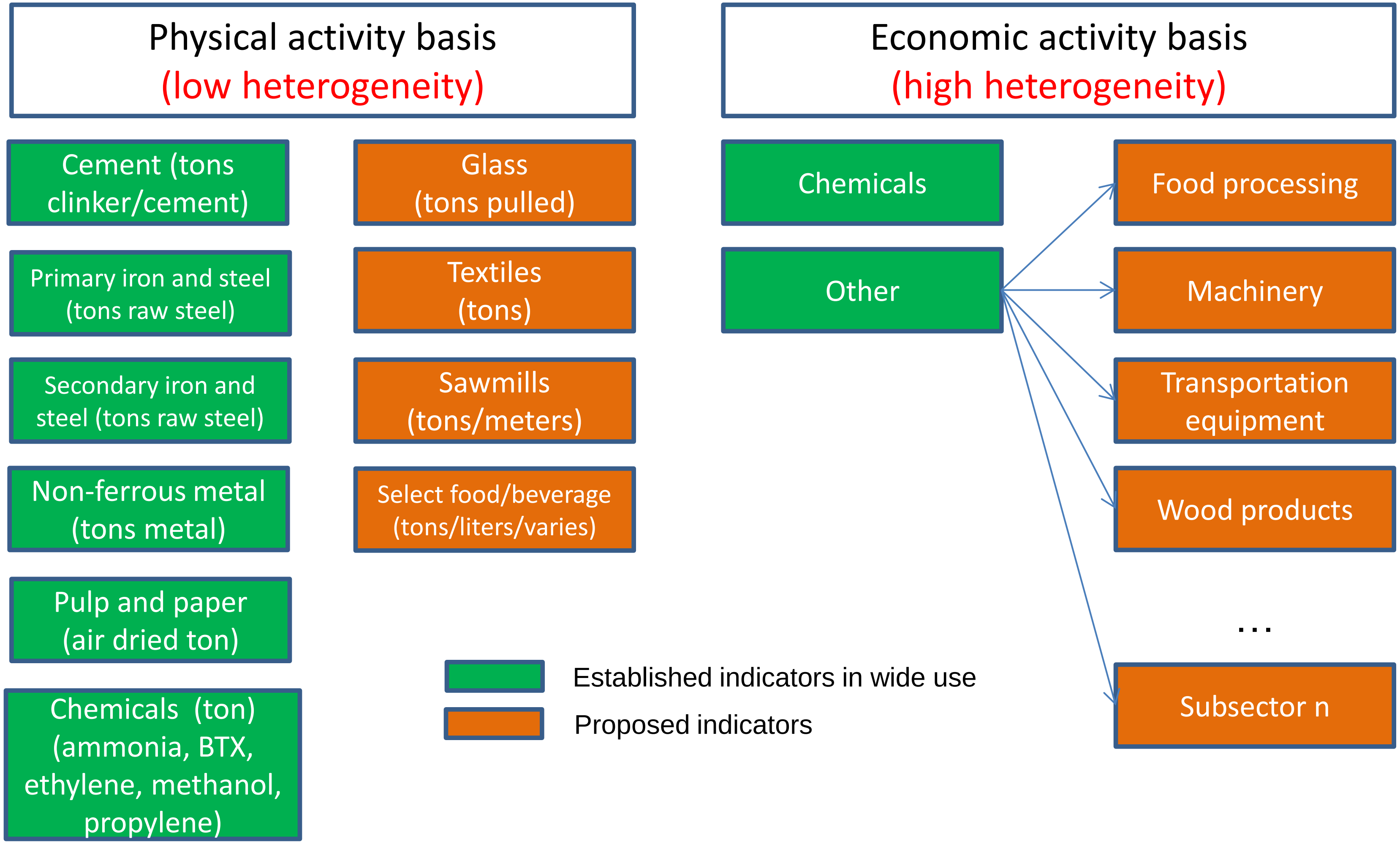
IEA (2014)

Transport activity example



Notes: Shares are based on estimated total passenger-kilometres, nationally and regionally, for each mode. ASEAN is Association of Southeast Asian Nations.

Industrial sector energy indicators



Physical activity basis
(low heterogeneity)

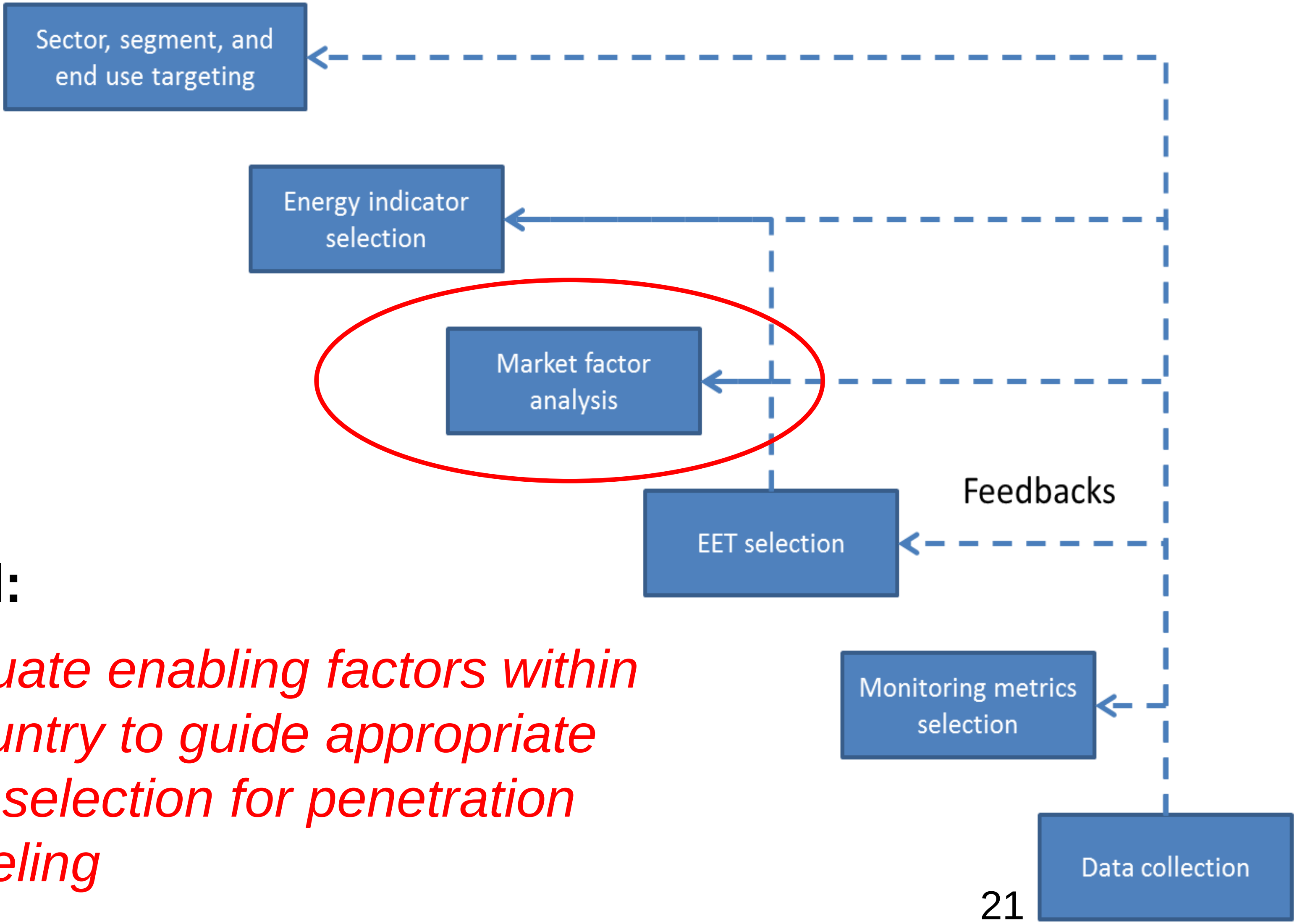
- Cement (tons clinker/cement)
- Primary iron and steel (tons raw steel)
- Secondary iron and steel (tons raw steel)
- Non-ferrous metal (tons metal)
- Pulp and paper (air dried ton)
- Chemicals (ton) (ammonia, BTX, ethylene, methanol, propylene)
- Glass (tons pulled)
- Textiles (tons)
- Sawmills (tons/meters)
- Select food/beverage (tons/liters/varies)

Economic activity basis
(high heterogeneity)

- Chemicals
- Other
  - Food processing
  - Machinery
  - Transportation equipment
  - Wood products
  - …
  - Subsector n

🟩 Established indicators in wide use

🟧 Proposed indicators



Sector, segment, and end use targeting

Energy indicator selection

Market factor analysis

EET selection

Feedbacks

Monitoring metrics selection

Data collection

Goal:

Evaluate enabling factors within a country to guide appropriate EET selection for penetration modeling

Creating an enabling environment for RE&EE

Admin. / Regul.

- Set clear, long-term policy goals
- Establish dedicated national agencies for RE&EE, and for energy data collection
- Ensure flexibility in national energy grid, generation, transmission
- Avoid contradictory policies, e.g. phase out fossil fuel subsidies

Financial/ Economic

- Allow for flexible response to market developments
- Clarify, assign risks, benefits of RE&EE projects
- Enable varied financing methods

Technical

- Target portfolio of technologies best suited to national circumstances/resources
- Foster national systems of innovation
- Encourage technology import and export
- Modernise national energy infrastructure

Social

- Involve local communities in RE&EE projects
- Ensure appropriate project siting, RE pricing
- Ensure long-term approach to human capacity, skills development

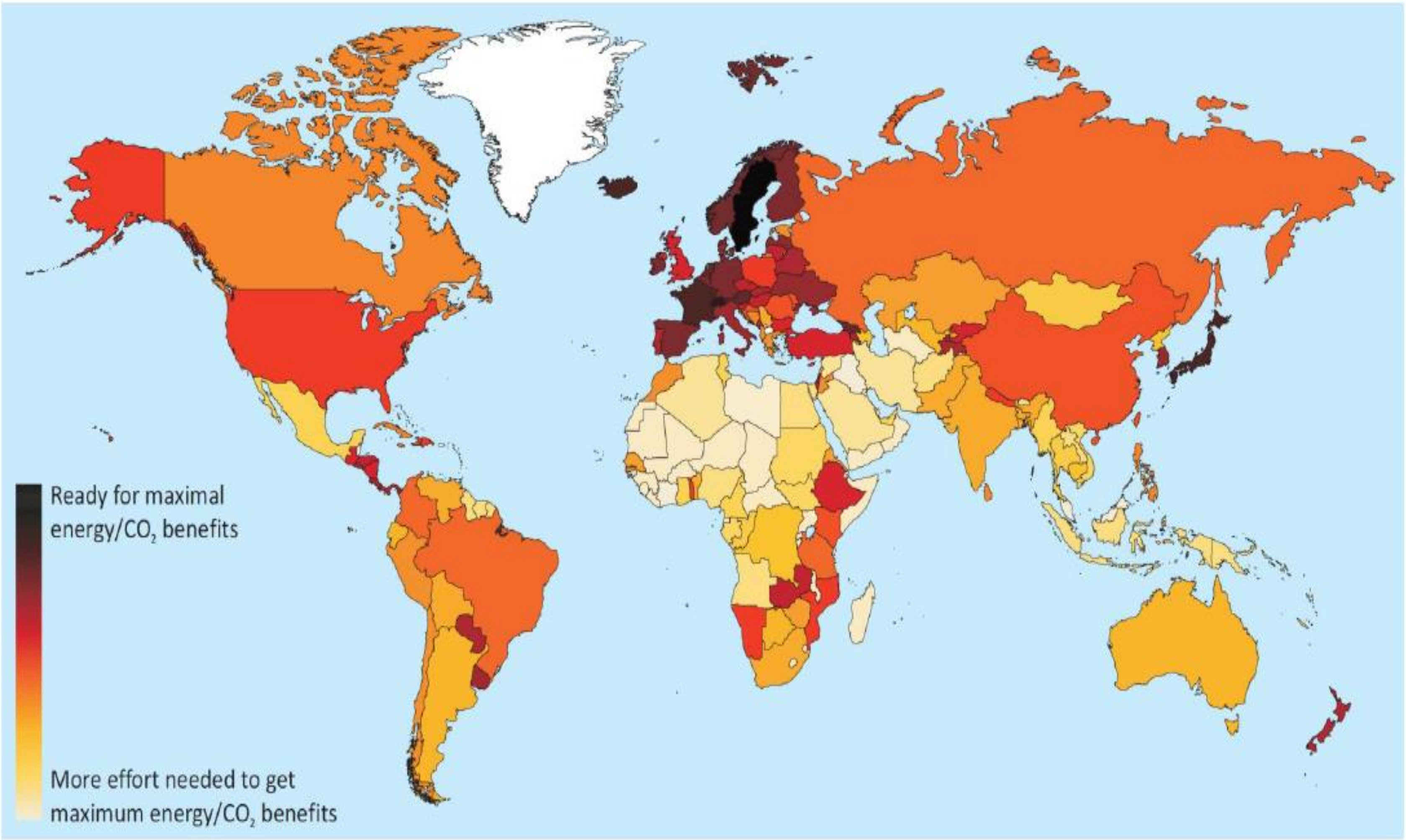
Environ.

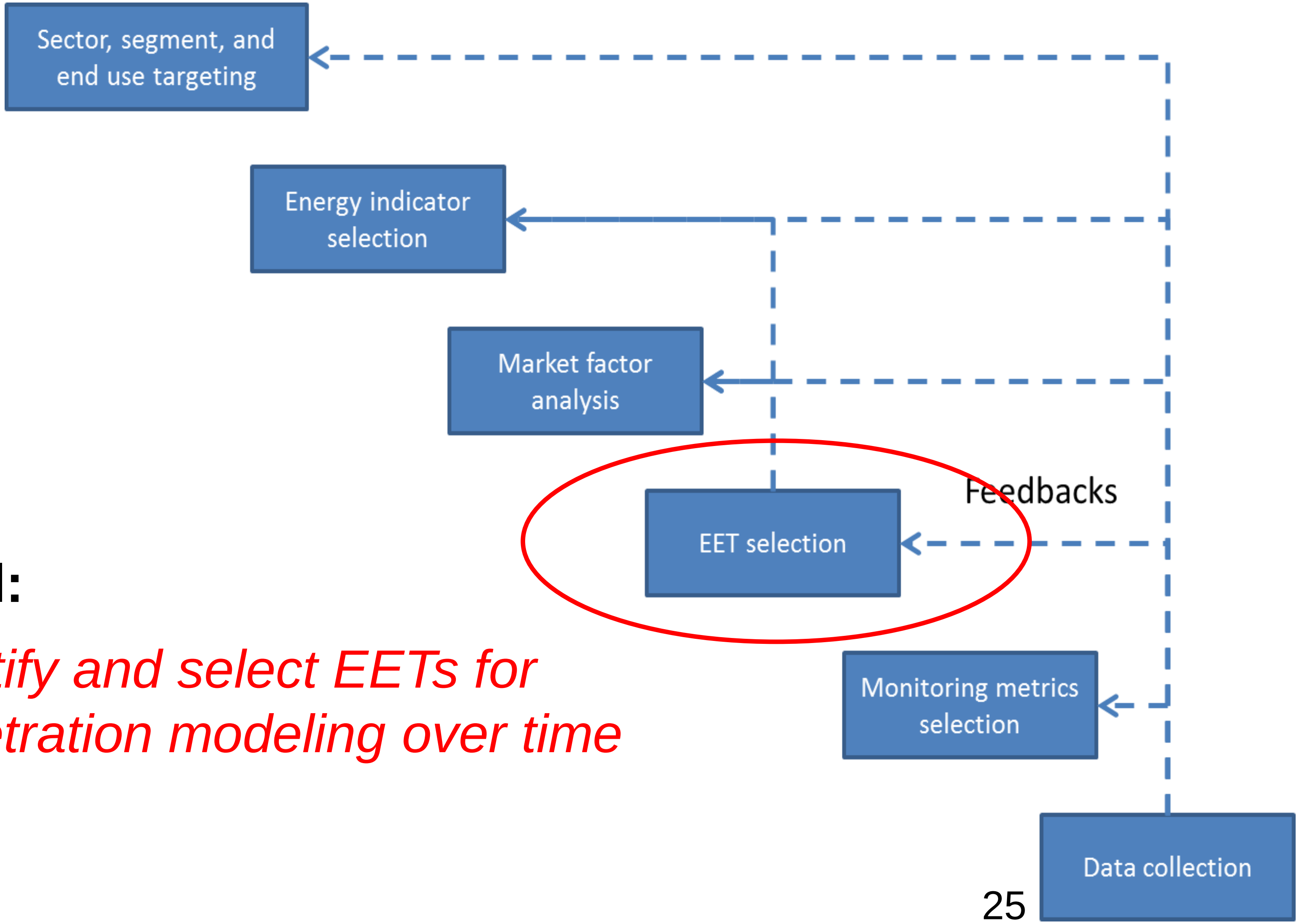
- Manage trade offs between energy goals and other areas
- Develop codes, standards, certifications to stimulate uptake
- Develop GHG reduction targets, put a price on carbon
- Optimise access to international clean energy financing

Enabling factor analysis example (building envelopes)

Climate
Hot climate
Cold climate

Low-Carbon Electric Transport Maximisation IndeX

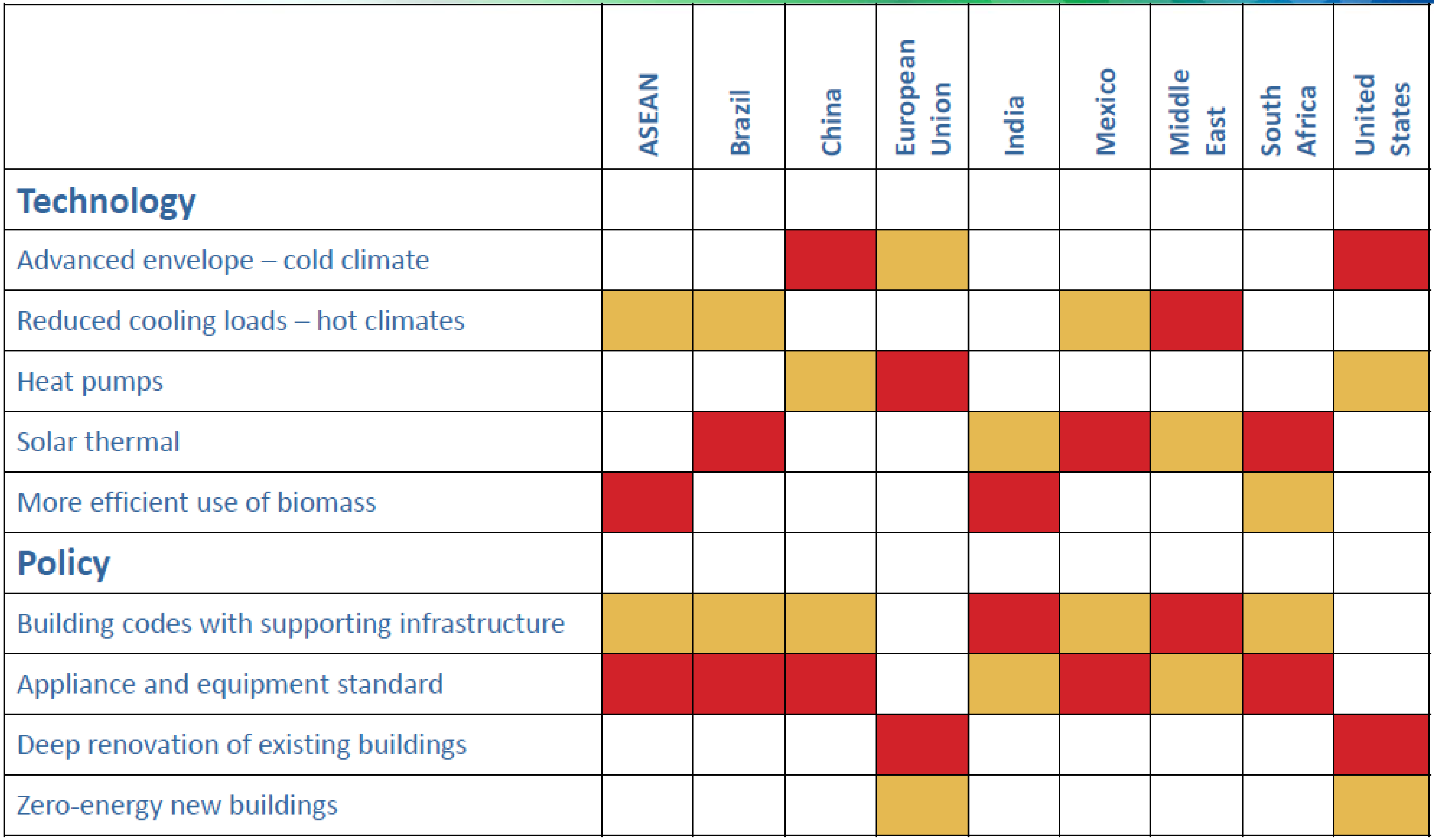




Goal:

Identify and select EETs for penetration modeling over time

Priority building technologies



	ASEAN	Brazil	China	European Union	India	Mexico	Middle East	South Africa	United States
Technology									
Advanced envelope – cold climate			🟥	🟨					🟥
Reduced cooling loads – hot climates	🟨	🟨				🟨	🟥		
Heat pumps			🟨	🟥					🟨
Solar thermal		🟥			🟨	🟥	🟨	🟥	
More efficient use of biomass	🟥				🟥			🟨	
Policy									
Building codes with supporting infrastructure	🟨	🟨	🟨		🟥	🟨	🟥	🟨	
Appliance and equipment standard	🟥	🟥	🟥		🟨	🟥	🟨	🟥	
Deep renovation of existing buildings				🟥					🟥
Zero-energy new buildings				🟨					🟨

Note: Recommendations limited to top two for technology and policy, all items could be relevant for most countries. Red indicates immediate priority, while gold indicates second priority.

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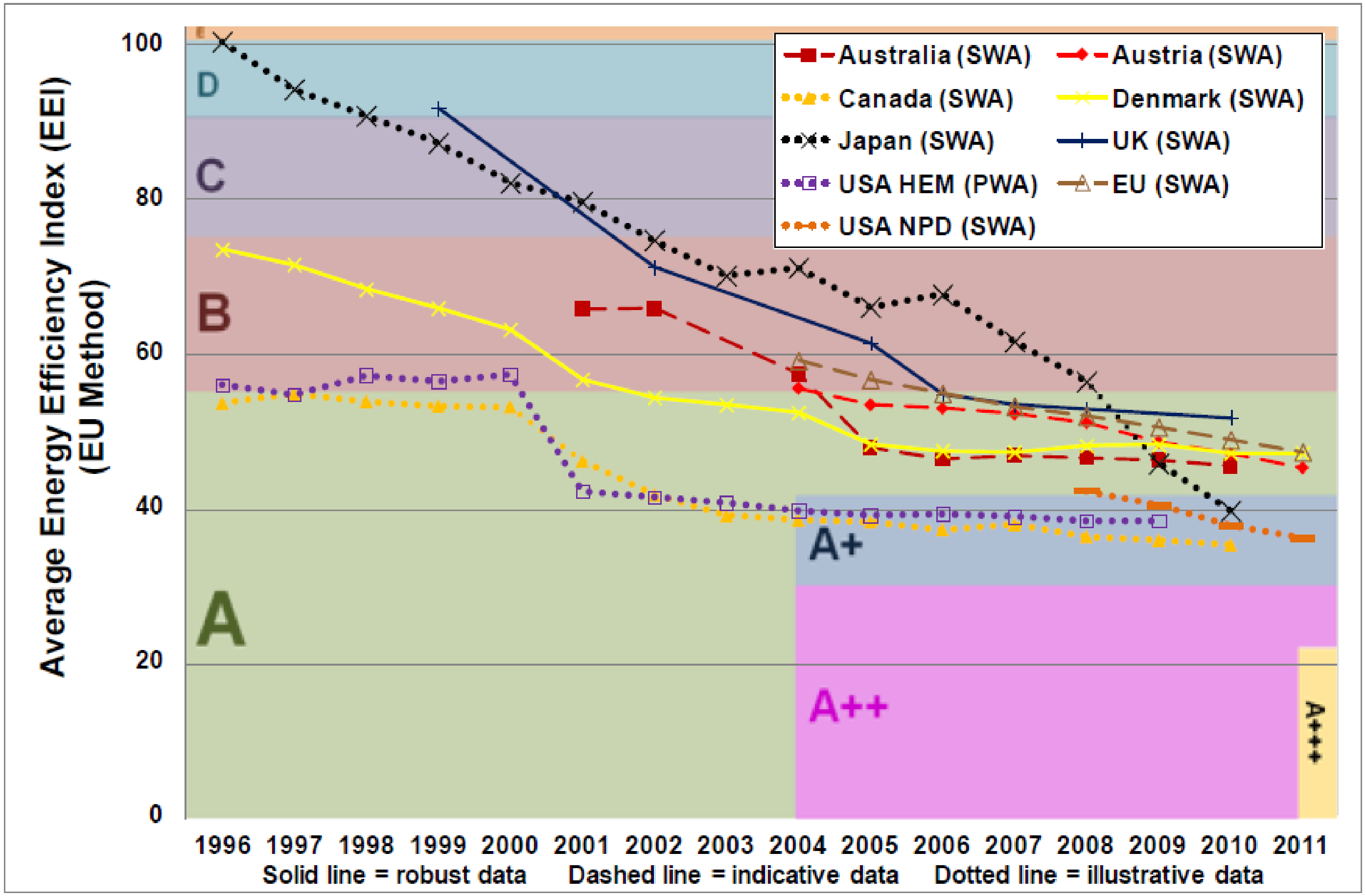
GBPN
Global Buildings Performance Network

COPENHAGEN CENTRE ON ENERGY EFFICIENCY
SE4ALL EE HUB

UCD DUBLIN

Comparative Refrigerator/Freezer Energy Efficiency Index (EU EEI)

(SWA: Sales weighted average
PWA: Product weighted average)



- EEI accounts for different sizes/types giving a comparable efficiency metric
- Same graph overlaid with EU label boundaries

Where to get data?

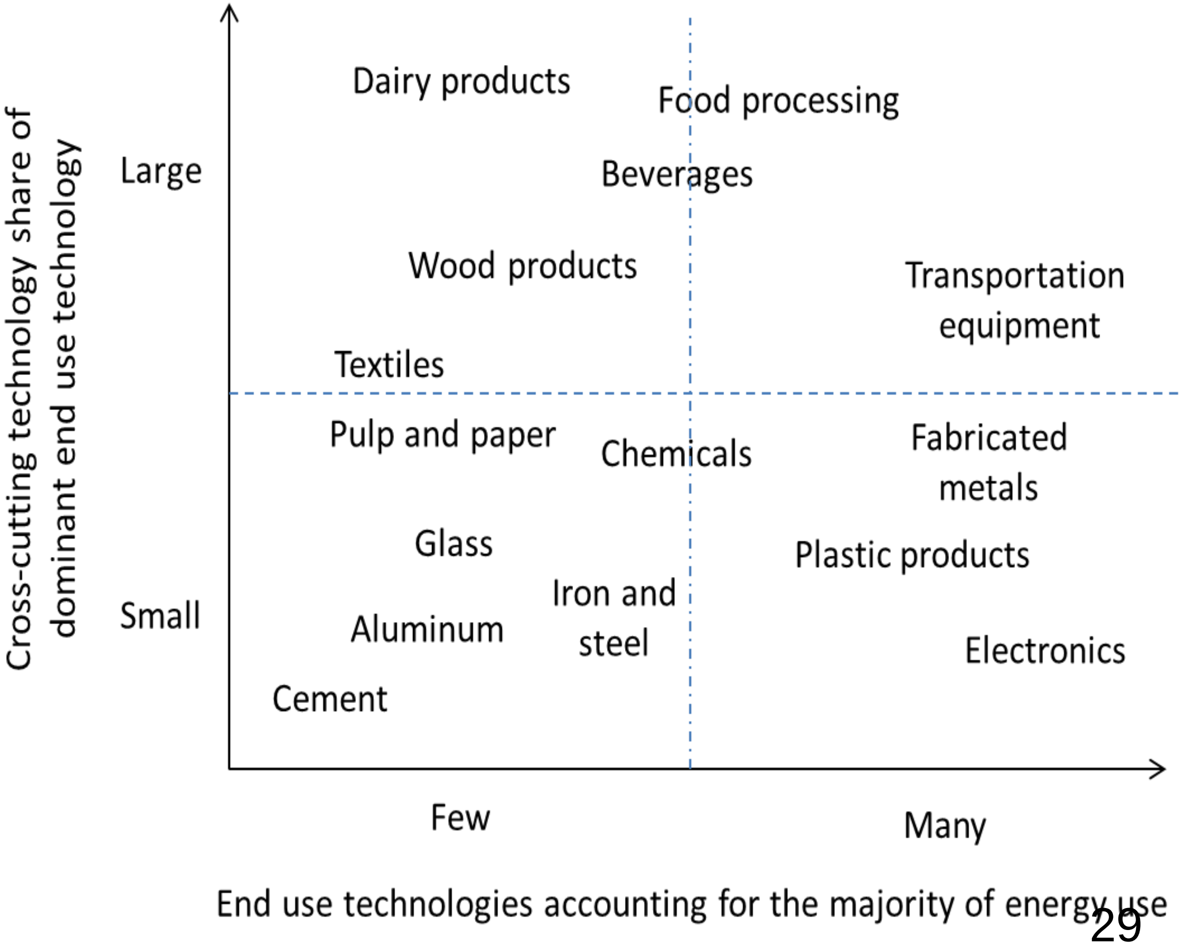
- Appliance efficiency labels and standards
- Approved technology lists for government tax rebates
- Best practice technology reports and guidebooks
- Energy demand system models
- Government research
- Industry associations
- Nonprofit research/advocacy groups
- Utility efficiency rebate programs

Industrial technology strategy

Pumps

Boilers and steam

Motor systems



Cross-cutting technology share of dominant end use technology

Large

Small

Dairy products

Food processing

Beverages

Wood products

Transportation equipment

Textiles

Pulp and paper

Chemicals

Fabricated metals

Glass

Plastic products

Iron and steel

Aluminum

Electronics

Cement

Few

Many

End use technologies accounting for the majority of energy use

USDOE (2013)

Industrial technology strategy

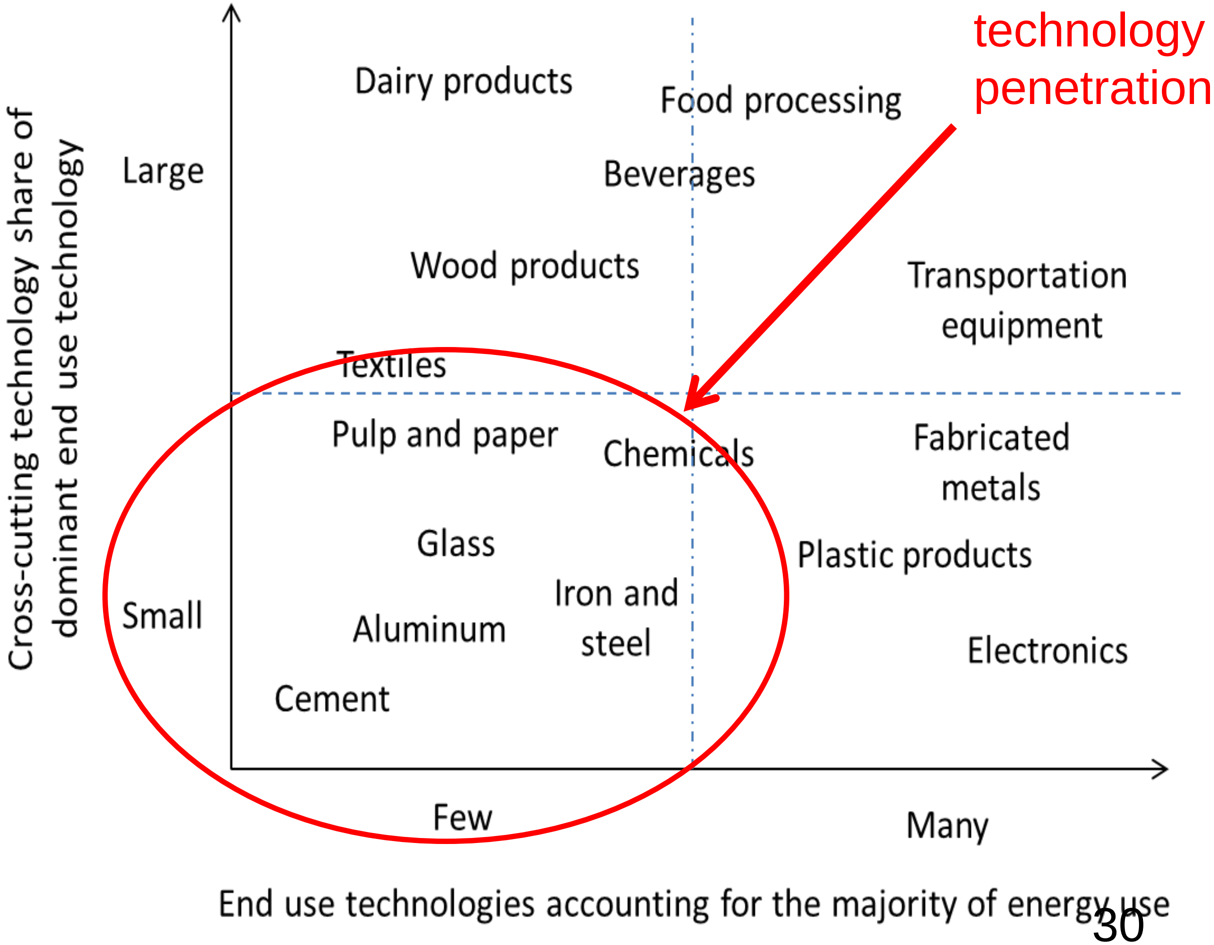
Pumps

Boilers and steam

Motor systems

USDOE (2013)

Process-specific technology penetrations



Cross-cutting technology share of dominant end use technology

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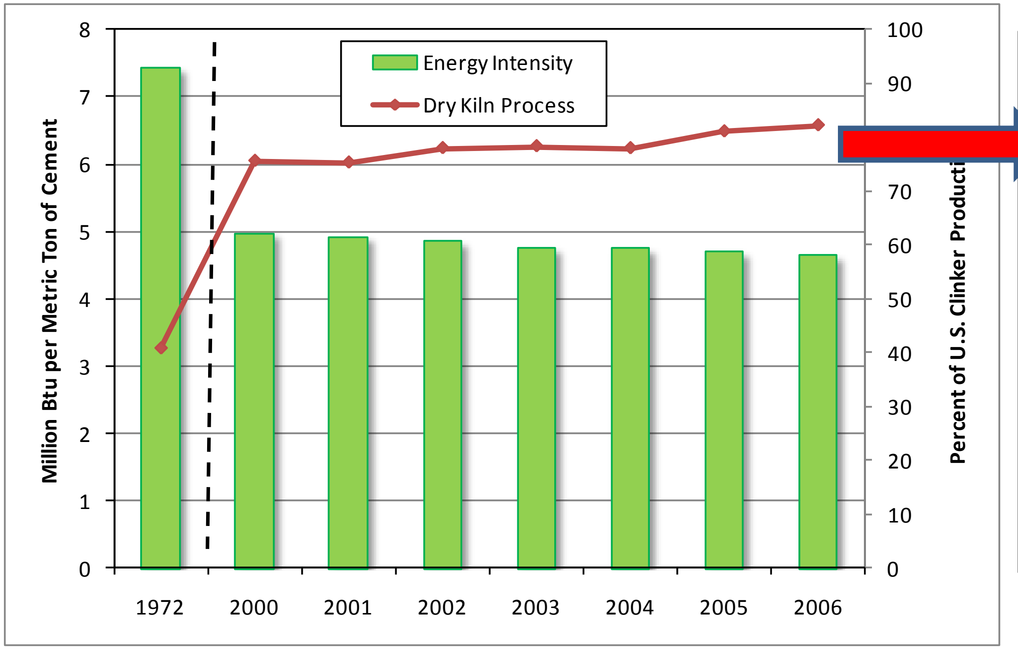
End use technologies accounting for the majority of energy use

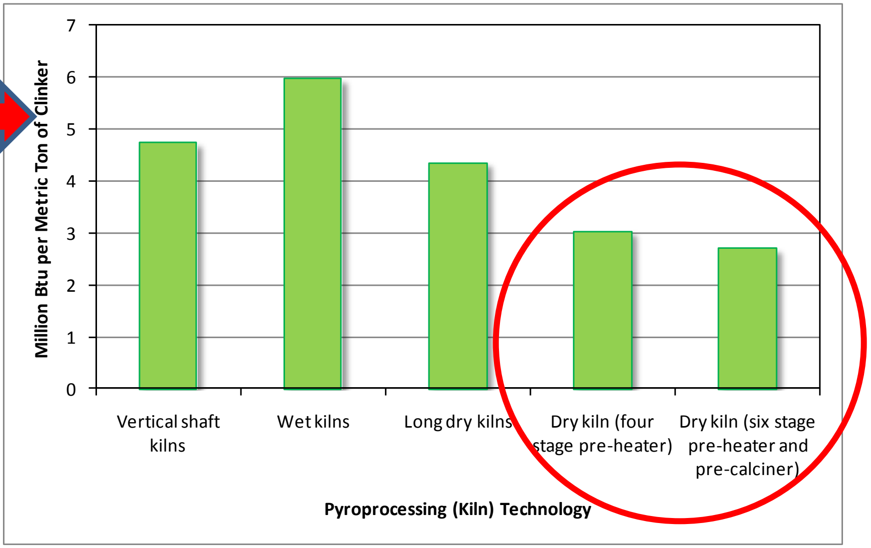
Process-specific technology example

Energy intensity of U.S. cement manufacturing



Note: *vertical dashed line indicates a break in the time series*
Sources: PCA (2007), USGS (2010)

Energy intensity differences among kiln technologies



Source: IEA (2007)

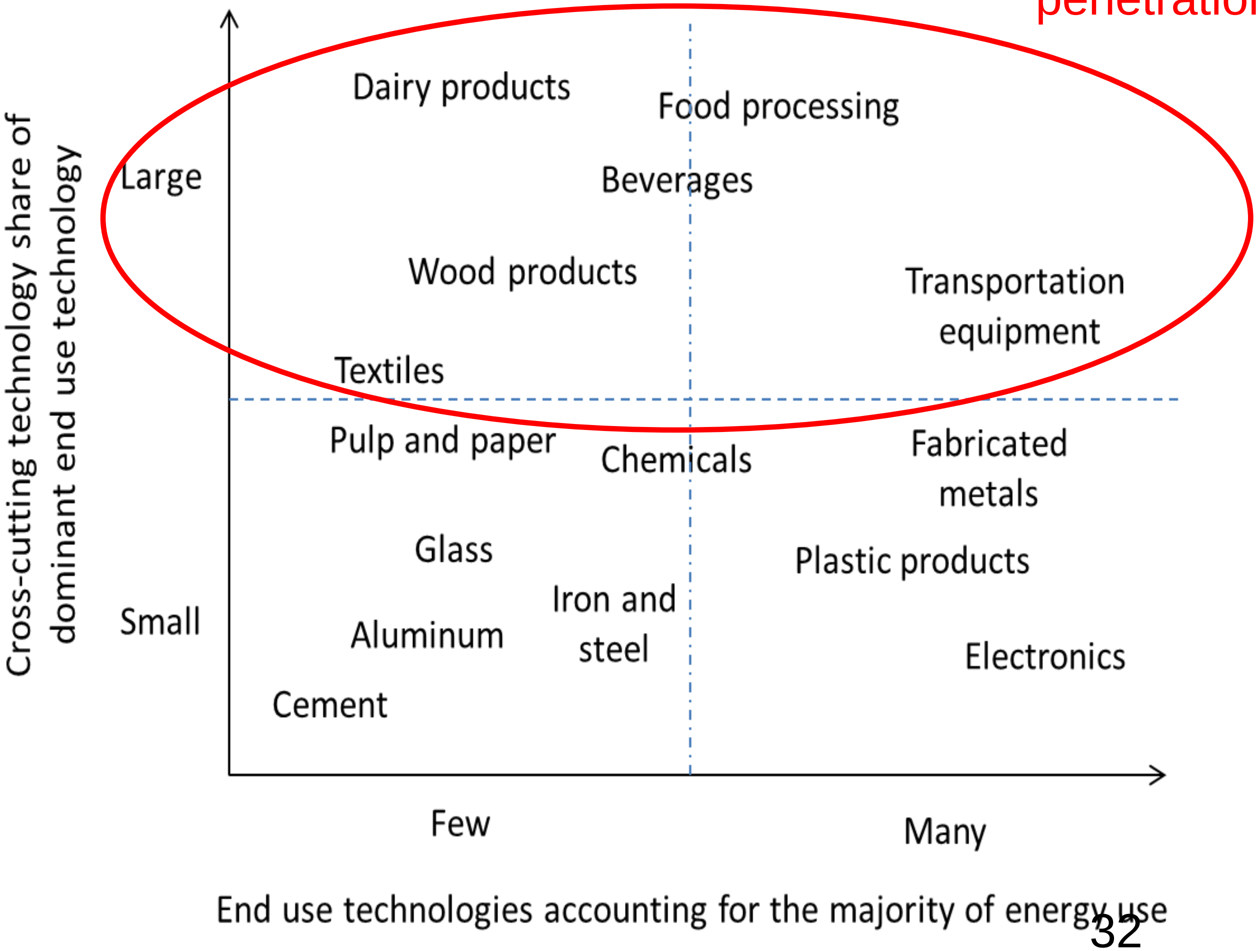
EETs for kilns

Industrial technology strategy

Pumps

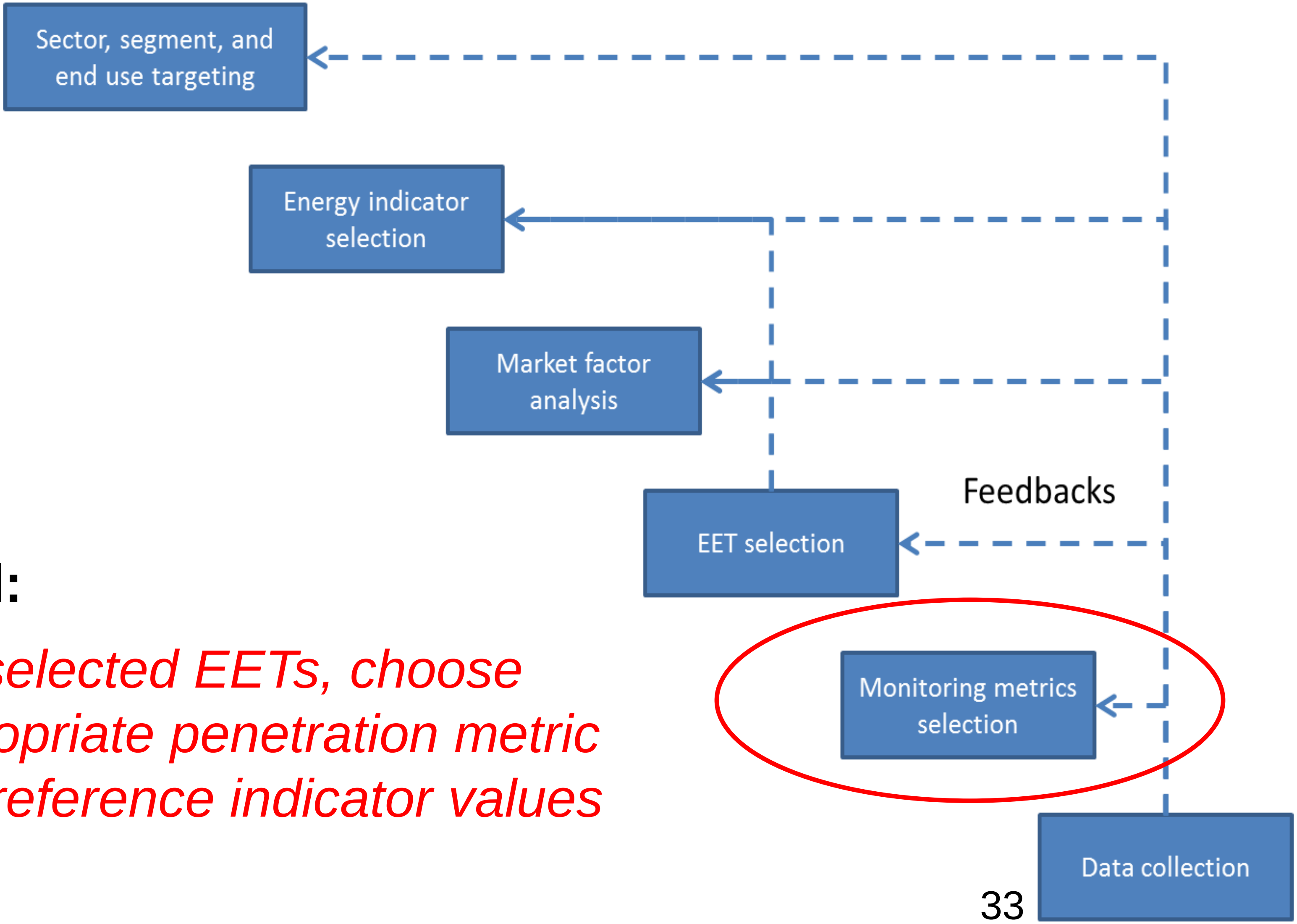
Boilers and steam

Motor systems



Cross-cutting technology penetrations

USDOE (2013)



Goal:

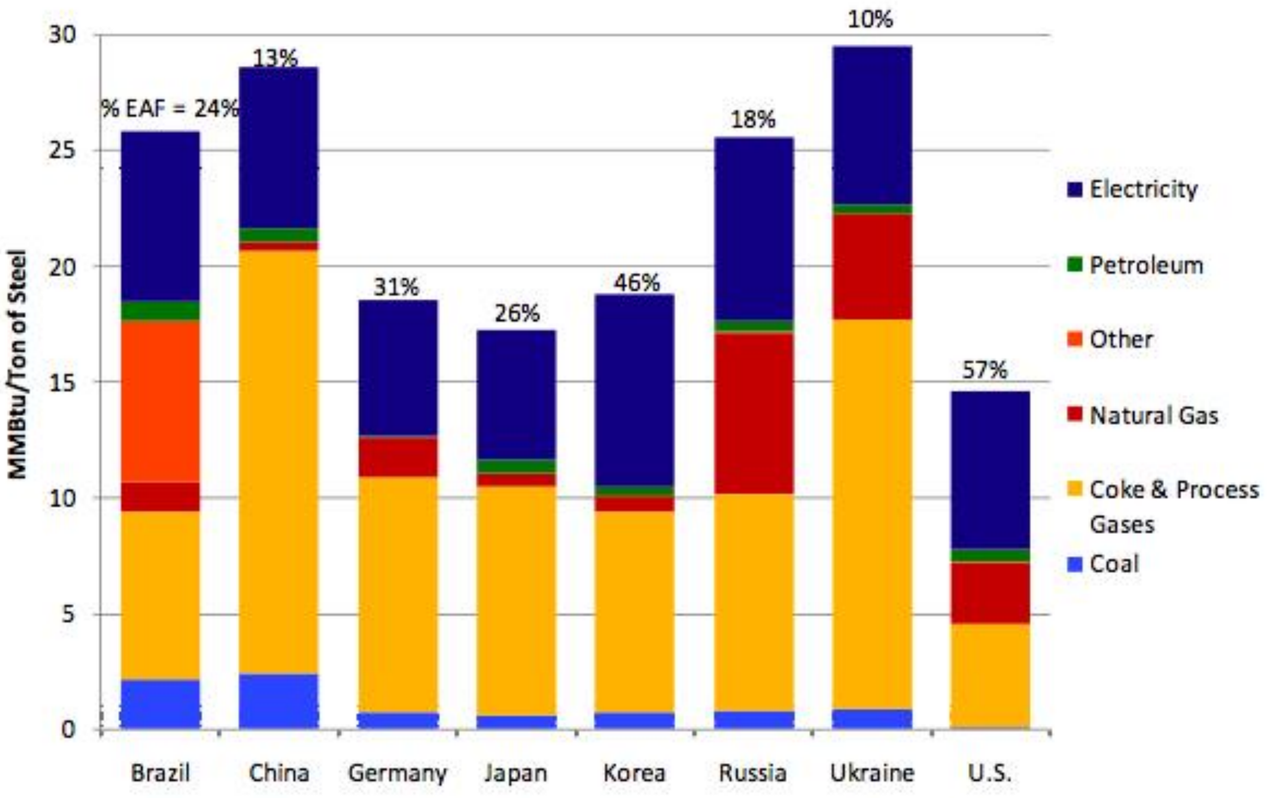
For selected EETs, choose appropriate penetration metric and reference indicator values

Penetration basis

Basis	Advantages	Disadvantages
% of activity basis (e.g., percent of clinker production from dry kilns)	Correlates well to energy use Ease of interpretation	May be difficult to obtain from available data May require additional measurement or estimates

Percent of activity basis example

Figure 2.4. Energy Intensity Comparisons of Major Global Steel Producers and Percentage of Electric Arc Furnace (EAF) Production, 2006

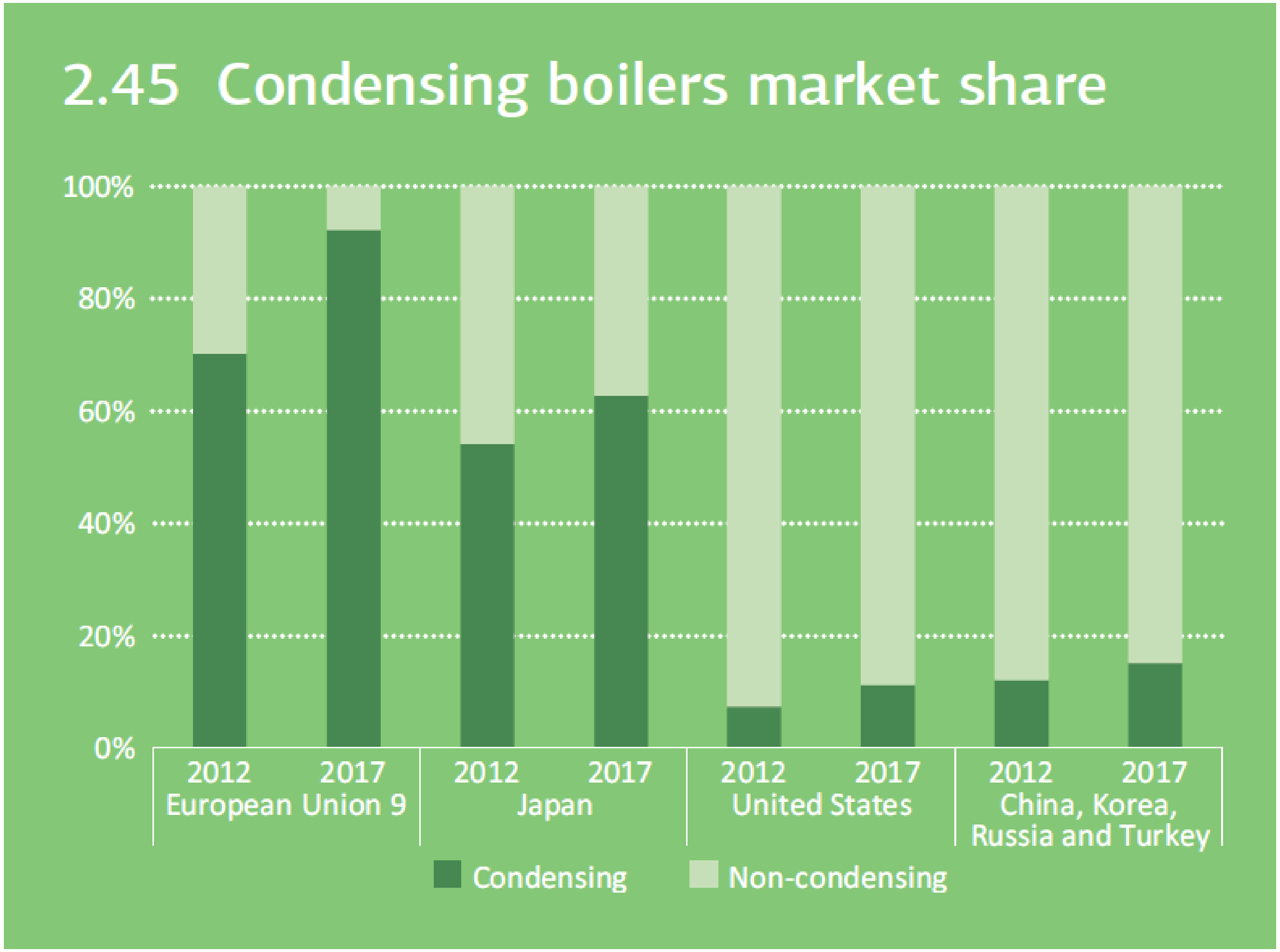


Source: US DOE (2011)

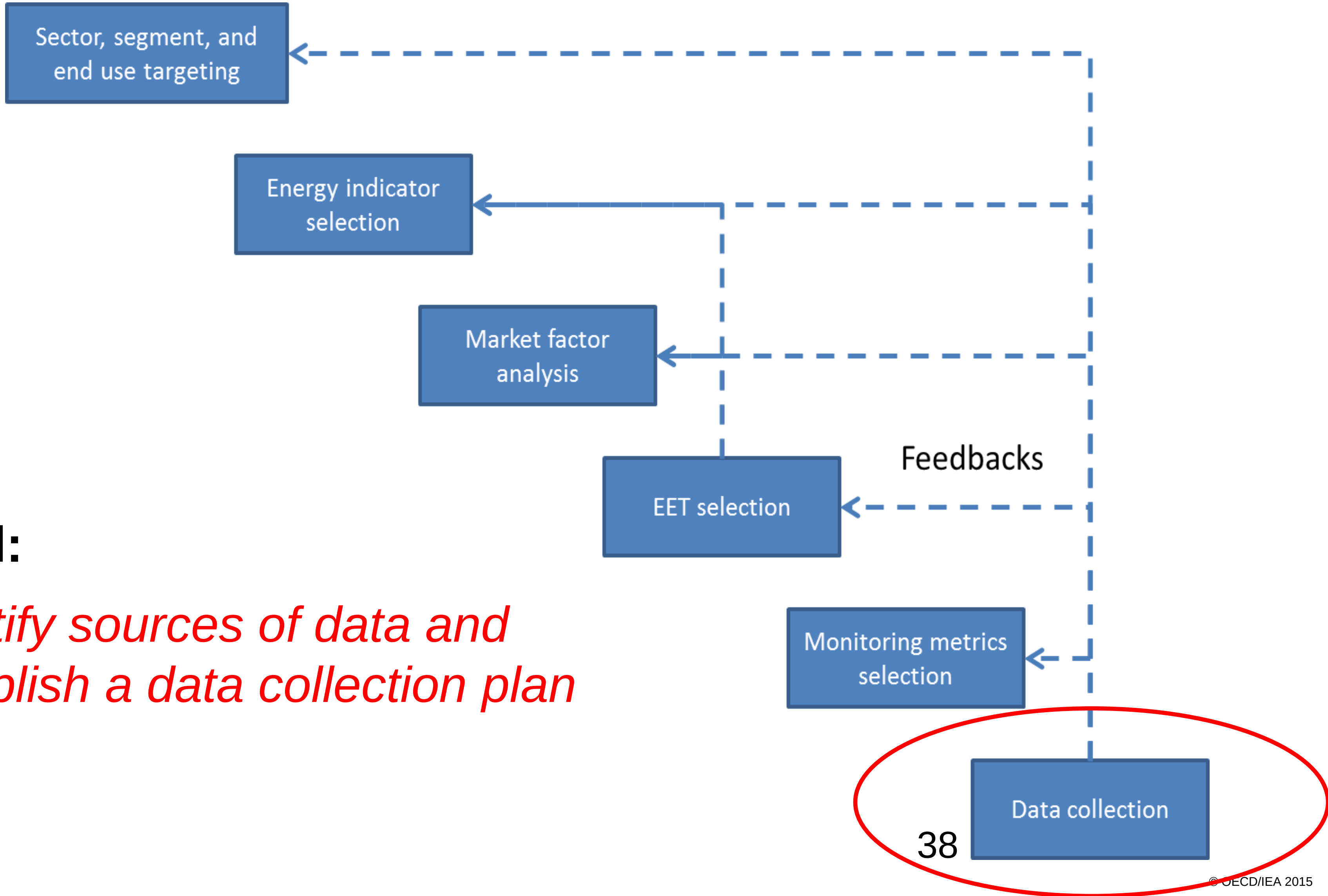
Penetration basis

Basis	Advantages	Disadvantages
% of activity basis (e.g., percent of clinker production from dry kilns)	Correlates well to energy use Ease of interpretation	May be difficult to obtain from available data May require additional measurement or estimates
% of stock basis (e.g., % of passenger vehicles that are electric vehicles)	Obtainable from market data or surveys Ease of interpretation	Can be less well correlated to energy use
% of ownership basis (e.g., % of homes with an energy efficient computer)	Obtainable from market data and surveys	Can be less well correlated to energy use Less easy to interpret

Percent of stock example



IEA (2015)



Goal:

Identify sources of data and establish a data collection plan

EET market assessment data sources

Source	Examples
Administrative	National and regional offices on: energy, trade, commerce, census, building and construction, transport, vehicle registrations, others
Audits and measurements	Building energy use audits; appliance standards and testing programs; vehicle efficiency and pollution testing programs; industrial energy audits; process equipment testing and standards programs; building/plant energy/operations information systems.
Market research	Private and public market studies related to consumer behavior, technology adoption, emerging codes and standards, market and stock projections, technology trends
Industry associations	World Steel, World Business Council on Sustainable Development, Consumer Electronics Association, Alliance of Automobile Manufacturers, others
Surveys	Business energy consumption surveys, fueling station surveys, consumer purchasing surveys, others

Summary

- Monitoring of EET markets is an important strategy for tracking progress toward energy and climate goals
- EET markets are highly diverse, so national priorities must be established
- Data collection and analysis capabilities require substantial investment, but flexibility exists depending on country capabilities
- Pilot studies will apply and refine the methodology
- Participant feedback is encouraged in Sessions 7 and 8

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Background

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Assessing RE&EE Technology Markets

The IEA and the EBRD, in collaboration with the FAO and with the support of the Turkish Ministry of Energy and Natural Resources, is holding a workshop for national experts from countries in the SEMED and ETC regions on 15-16 June in Istanbul

- This will workshop focus on: a) integrated national policy development for EE and RE, and agrifood technologies; and b) guidance for collection and assessment of data on the domestic potential for technology deployment in the RE, EE and agrifood sectors.
- This slide deck serves as background material for the sessions of the workshop focused on means of assessing the market penetration and potential of RE&EE technologies. The Istanbul workshop on 15-16 June provides an opportunity to share and discuss the preliminary elements of the methodology, and to seek feedback from workshop participants on the usability of the proposed methodology.
- The slide deck is for use by workshop participants only and is not to be further distributed (the full report will be freely available later in 2015).
- After an introduction, this slide deck is structured as follows:
    - Assessing the market penetration of RE technologies;
    - Assessing the market penetration of EE technologies;
    - Data sources for RE&EE market assessments.

Introduction

- This project seeks to provide straightforward and flexible frameworks for understanding and monitoring of market penetrations of renewable energy (RE) technologies and energy efficient (EE) technologies in support of national energy goals and policies
- Separate frameworks for RE and EE technologies are proposed to reflect differences in markets, enabling factors, data sources, and technologies
- Guidance is provided on implementing the frameworks, sources of data for RE and EE technology marketing, and additional information sources for effective monitoring programs
- Examples are provided to illustrate the frameworks

Benefits

- **The benefits of using these frameworks include:**
  - Quantitative metrics for monitoring of progress toward RE and EE deployment goals
  - Improved understanding of the relationships between national energy generation, energy demand, and the uptake of key RE and EE technologies
  - Improved understanding of market opportunities, barriers, and enabling factors related to RE and EE technology deployment
  - Consistency in monitoring methods over time, which enables clearer interpretation and communications of progress
  - Identification and establishment of important national data sources for monitoring of RE and EE technology markets

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Methodology for assessing energy efficiency technology markets

9 June 2015

www.iea.org

Introduction to EE Methodology

- The following slides summarise a general methodology for assessing EE technology (EET) markets through identifying priority uses of energy and appropriate technologies for tracking within a country.
- The methodology is presented in stepwise fashion, with the approach, examples, and potential data sources highlighted at each step. These slides will be presented and explained in more depth during the 15-16 June workshop.
- They are being shared in advance to give participants a preview of the session content, and to encourage consideration of some key questions to be discussed during the workshop, which are presented on the next slide.

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Overview of EE Methodology

www.iea.org

Background: IEA-EBRD Collaboration on Renewable Energy & Energy Efficiency Technologies (2014-2016)

- The increased deployment of energy efficiency (EE), renewable energy (RE) and other low-carbon and climate technologies can bring a range of valuable co-benefits. These include the more effective management of natural resources, enhanced national energy security, reduced local air pollution and related health benefits, increased access to modern energy services for national populations, stimulation of sustainable economic development and reduction of greenhouse gas emissions.
- Accelerating the deployment of low-carbon technologies is contingent on policies that facilitate innovation and relieve barriers to implementation. In many countries, the uptake of such technologies may be hindered by a range of barriers, such as: (i) the need for enhanced policy and regulatory frameworks; (ii) capacity constraints; (iii) a lack of reliable baseline information on market penetration and potentials; and (v) limited access to clean energy and climate technology investment opportunities.
- The International Energy Agency (IEA) and the Finance and Technology Transfer Centre for Climate Change (FINTECC) of the European Bank for Reconstruction and Development (EBRD) are collaborating on a set of activities aimed at supporting the market penetration of climate technologies in the Central Asian, Caspian and Black Sea (ETC)* regions, as well as in the Middle East and North African (MENA/SEMED)* regions. This collaboration is supplemented by key technical contributions from the Food and Agriculture Organization (FAO) on climate technologies in the agrifood and water sectors.
- One of the key pillars of the IEA-EBRD collaboration, together with the FAO, is to consider means or methodologies for assessing the market penetration of RE&EE technologies. Under the collaboration, the IEA is preparing a detailed methodology, covering market assessments of both RE&EE technologies, which will be released later in 2015. In parallel, the FAO is preparing a methodology for assessment of climate, or low-carbon technologies in the agrifood sector.

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* This refers to a grouping of 10 countries collectively referred by the EBRD as Early Transition Countries (ETC): Armenia, Azerbaijan, Belarus, Georgia, Kyrgyz Republic, Moldova, Mongolia, Tajikistan, Turkmenistan and Uzbekistan, as well as to Kazakhstan. ** For the purposes of the IEA-EBRD collaboration, the MENA focus is limited to a grouping of four countries collectively referred to by the EBRD to as South Eastern Mediterranean (SEMED): Egypt, Jordan, Morocco and Tunisia.

Why assess EET markets?

- **Assessment of EET markets enables:**
  - Tracking of progress toward energy efficiency goals
  - Understanding drivers behind energy use trends
  - Identification of EET market opportunities and barriers
  - Improved energy system analysis and data collection capabilities

Guiding principles

- Leverages IEA work on energy indicators and technology assessment
- Leverages elements of established efficiency programs and methods
- Based on data that are feasibly collected
- Flexibility in approach to accommodate different capabilities
- Consistency with common energy statistics and sector assessment methods
- Applicable to any sector, subsector, end use

EET market heterogeneity

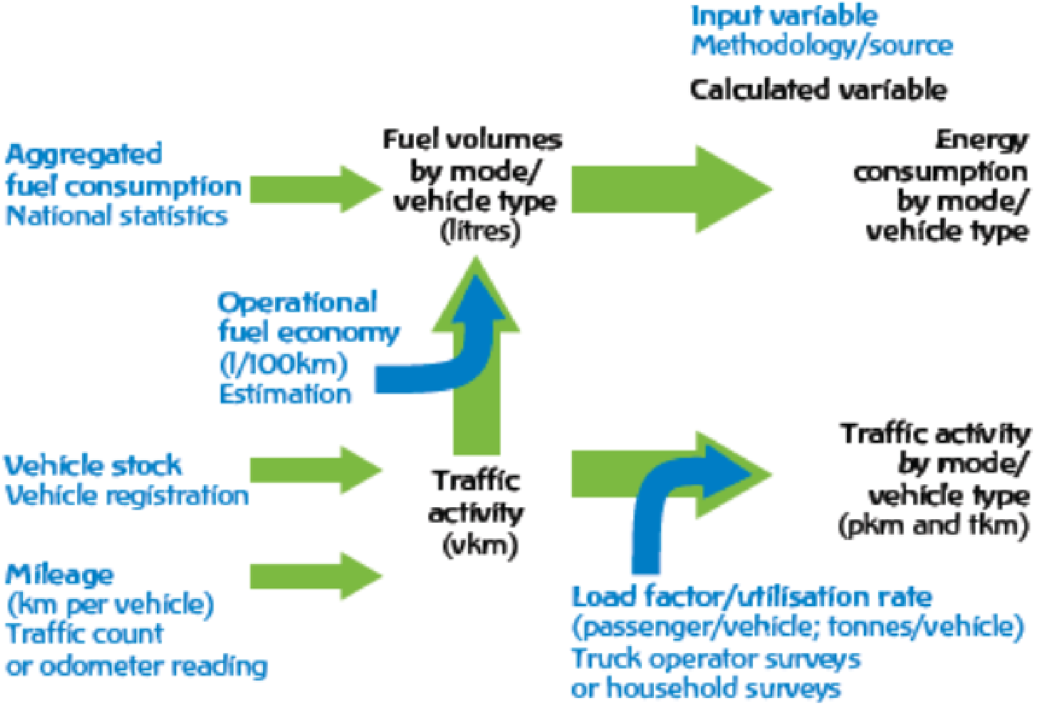
Sector	Subsector	End use/Segment
Transport	Road	Passenger 2-4 wheelers
		Passenger light duty vehicles
		Buses
		Heavy duty vehicles (freight)
	Rail	Passenger trains
		Freight trains
	Air	Passenger planes
		Freight planes
	Water	Passenger ships
		Freight ships
Buildings	Residential	Space heating
	Commercial	Space cooling
		Water heating
		Lighting
		Cooking
		Appliances

EET market heterogeneity

Sector	Subsector	End use/Segment
Industry	Aluminum	Boiler systems
	Cement	Process heating
	Chemicals	Refrigeration systems
	Food and beverage	Facility HVAC
	Glass	Facility lighting
	Iron and steel	Compressed air systems
	Pulp and paper	Fan systems
	Textiles	Machine drives
	Wood products	Pump systems
	Other	Other

How to identify priority subsectors and end uses?

- **Sector energy use and technology models**



Input variable
Methodology/source

Calculated variable

Aggregated fuel consumption
National statistics

Fuel volumes by mode/ vehicle type (litres)

Energy consumption by mode/ vehicle type

Operational fuel economy (l/100km)
Estimation

Vehicle stock
Vehicle registration

Traffic activity (vkm)

Traffic activity by mode/ vehicle type (pkm and tkm)

Mileage (km per vehicle)
Traffic count or odometer reading

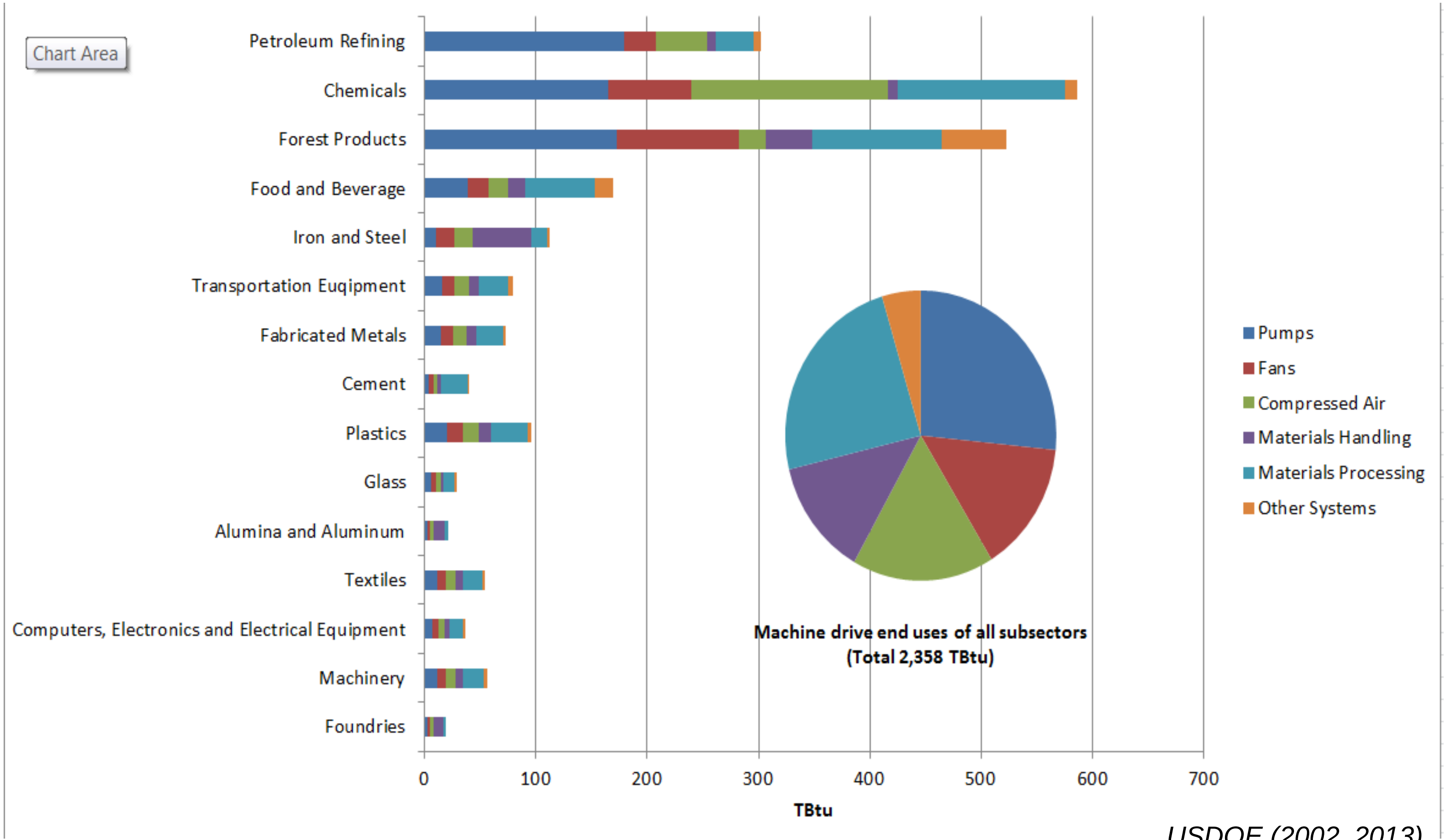
Load factor/utilisation rate (passenger/vehicle; tonnes/vehicle)
Truck operator surveys or household surveys

IEA Mobility Model (MoMo) for transport

IEA (2014)

How to identify priority subsectors and end uses?

- Engineering analysis and technical literature



Machine drive end uses of all subsectors
(Total 2,358 TBtu)

USDOE (2002, 2013)

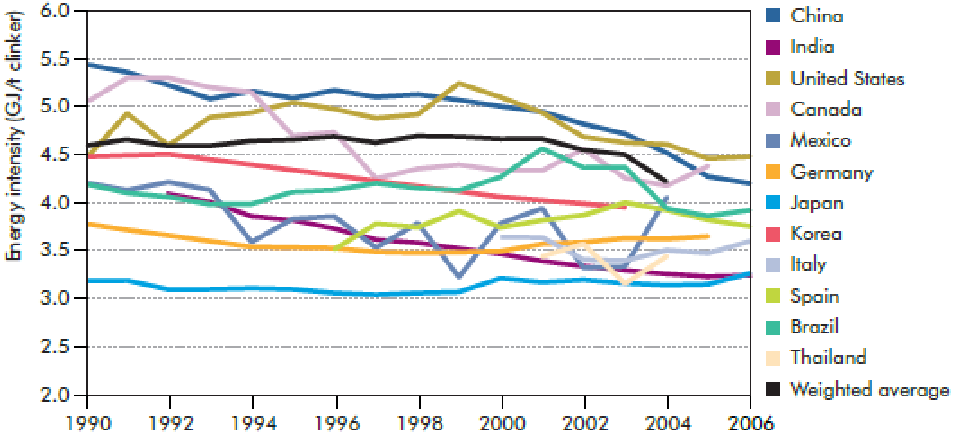
Summary

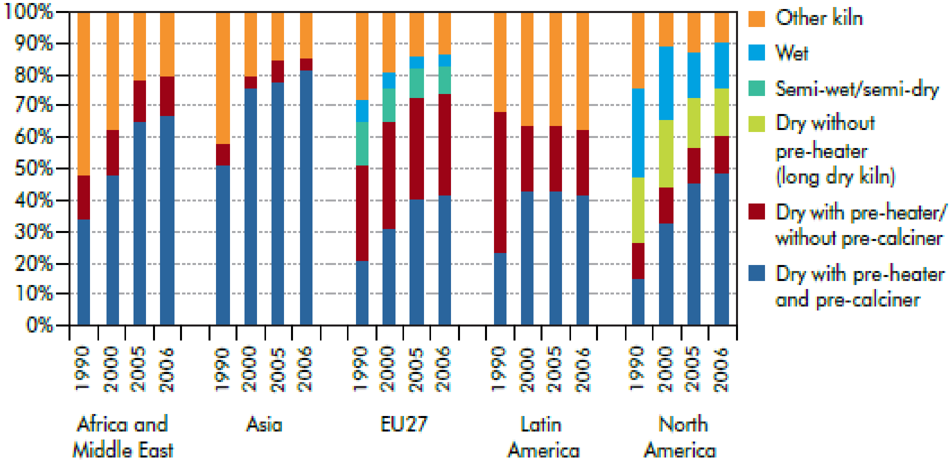
Approach	Advantages	Disadvantages
National energy statistics	Consistent source of data Calibrated/balanced Typically robust	Subsector resolution varies End use resolution is rare
Models	Can be technology-rich Can quantify causal linkages Support scenario analysis	Input data quality can vary Capacity must be built Transparency can be an issue
Surveys, audits, and measurements	Primary data from representative samples Enable model calibration Can capture behavioral factors	Detail, accuracy = cost, time Improved coverage = cost, time
Engineering analyses	Can generate reasonable proxy data Grounded in physical relationships Can be transparent and replicable	Limited by time, origin, methods Can introduce uncertainties Theory doesn't equal practice

Energy indicator selection

- **General principles:**
  - Relies on the IEA pyramidal approach as proven foundation
  - Adds tiered approach where necessary
  - Relies on physical activity bases whenever possible (e.g., energy/ton crude steel) to align with current practice
  - Designed for commonly available, or reasonably obtainable, energy and activity data as inputs

Technological change example (cement)





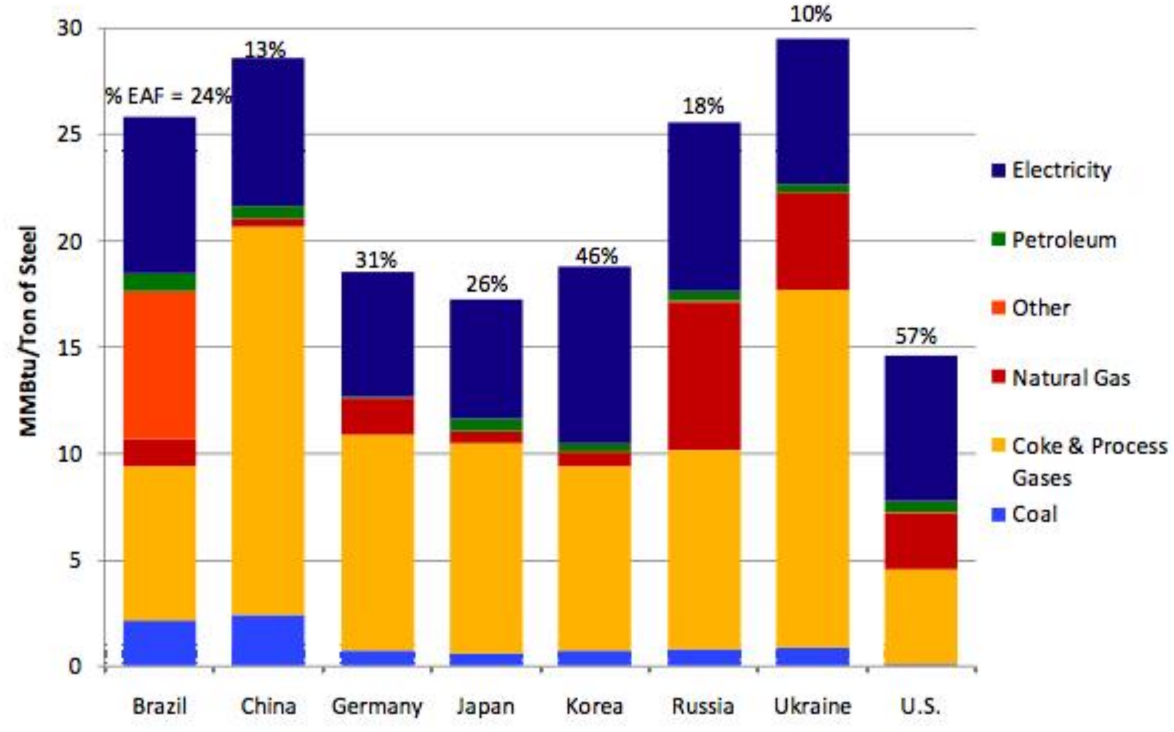
Source: CSI (2008).

- Shares of energy-efficient dry kiln technologies have increased in major world regions

Source: IEA (2009)

Understanding structural change (iron and steel)

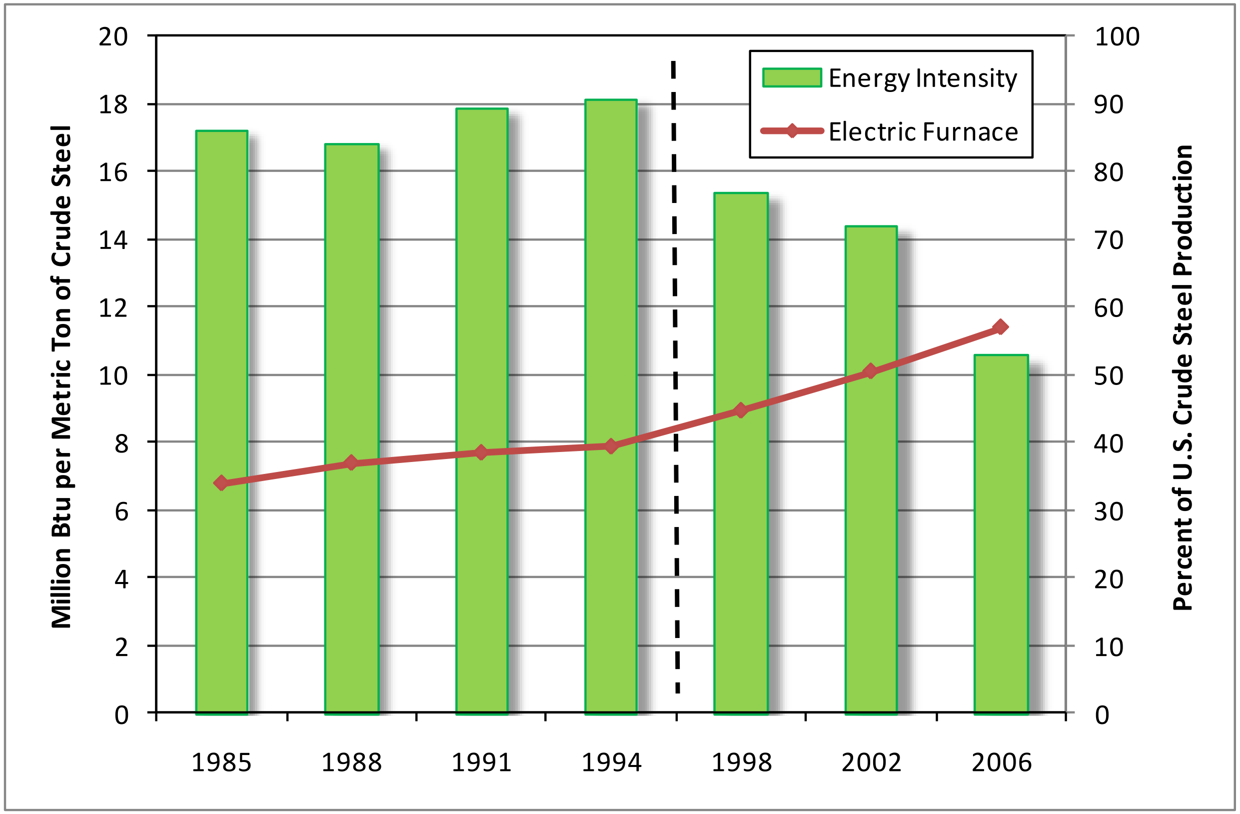
Figure 2.4. Energy Intensity Comparisons of Major Global Steel Producers and Percentage of Electric Arc Furnace (EAF) Production, 2006



Source: US DOE (2011)

Structural change example

Energy intensity of U.S. iron and steel manufacturing



- U.S. energy intensity heavily influenced by structural shift to secondary steel
- Disaggregation level for indicators should take major structural factors into account

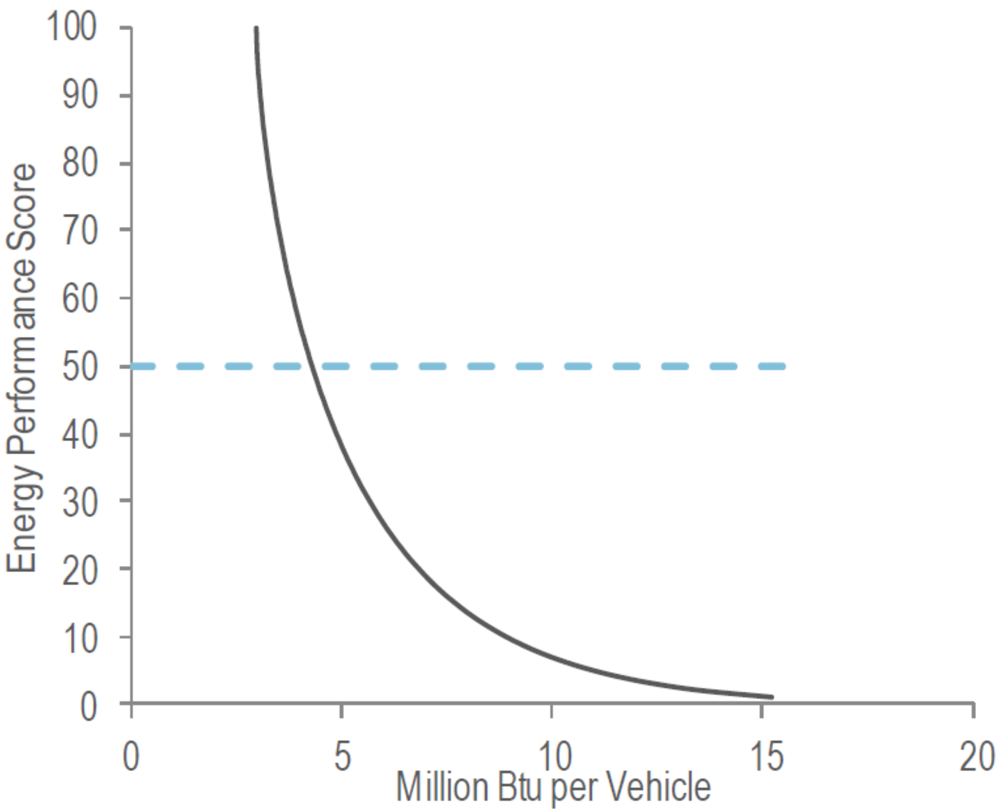
Note: vertical dashed line indicates a change in the time period between data points. Sources: U.S. DOE (2010), USGS (2010), World Steel (2010)

Activity basis comparison

Activity basis	Advantage	Disadvantage
Physical output	• Direct measure of energy intensity • Relatable to specific processes • Consistent units over time • Ease of interpretation	• Can be challenging to relate physical output to energy use • Not applicable to heterogeneous industries • Requires detailed data • Requires standardization in reporting
Economic output	• Easily obtainable • Reasonable for stable industries • Can help identify large trends	• Economic value can change based on market factors • Requires price normalization for regional comparisons • Difficult to decompose • Interpretation challenging

Dealing with industrial heterogeneity

Energy Performance Indicator for Automobile Assembly



USEPA (2015)

U.S. ENERGY STAR for Industry Plant Label:

- Based on <u>statistical model</u> to relate industry energy use and production outputs
- Automobile industry normalized to wheelbase
- Government and plant reported data

Enabling factor analysis

- **What is an enabling environment?**
  - An enabling environment refers to factors which support EETs such as policy, legal and regulatory tools, wider energy and economic policies and strategies, social factors such as the dissemination of information and social acceptance, technical and infrastructure factors, and financing and market conditions.

Why assess enabling factors?

- It can help establish screening criteria and preconditions for EET candidacy in different market segments to make EET selection more strategic;
- It can help identify basic information needs for characterizing EETs such that alignment with enabling factors is confirmed
- It can help identify specific factors that currently barriers to an enabling environment for a given EET, which should be addressed in the future; and
- It can help establish a systematic approach for EET selection that can evolve as enabling factors change over time;

Technical EET market factors for buildings

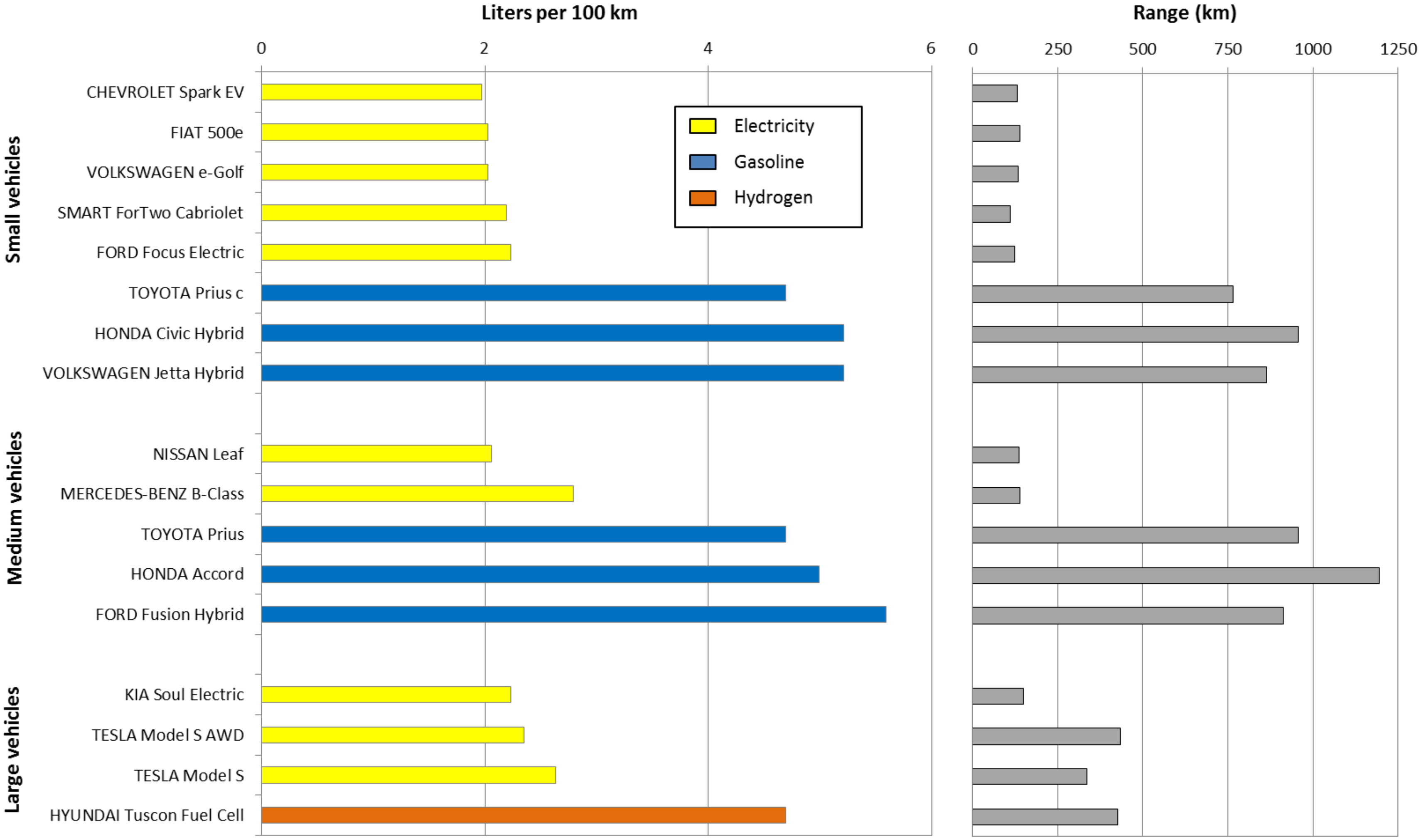
- **Climate**
  - Hot/dry; hot/humid; cold
- **Construction type**
  - Existing; new
- **Dwelling type**
  - Residential (single family; multi-unit)
  - Commercial (office, retail, etc.)
- **Vintage**
- **End use**
  - Space heating, space cooling, water heating, lighting, cooking, appliances

Technical EET market factors for transport

- **Vehicle type**
  - Road, air, rail, water
- **Segment**
  - Passenger, freight
- **Fuel supply infrastructure**
  - Petroleum, natural gas, hydrogen, electricity
- **Driving range requirements**
- **Climate (hot requires cooling)**
- **Size class**
- **Transit infrastructure**
  - Roadways (and type), rail, waterways

Technical factor analysis example

Appropriate vehicles may vary based on infrastructure, fuel, and performance factors



Technical EET market factors for industry

- **Industry subsectors**
  - Iron and steel, cement, chemicals
- **Subsector structure**
  - Primary vs. secondary steel, etc.
- **Fuel supply and delivery systems**
  - Coal, natural gas, district steam, etc.
- **Heat and steam demand size and load profiles**
- **Production capacities**
- **Vintage**
- **Climate**
- **End uses**
  - Process heat, steam, motor systems, HVAC, lighting, refrigeration

Enabling factors to consider

- Technical and infrastructure factors
- Financial and market factors
- Social factors
- Regulatory and institutional factors
- Environmental factors

The rationale for EET monitoring

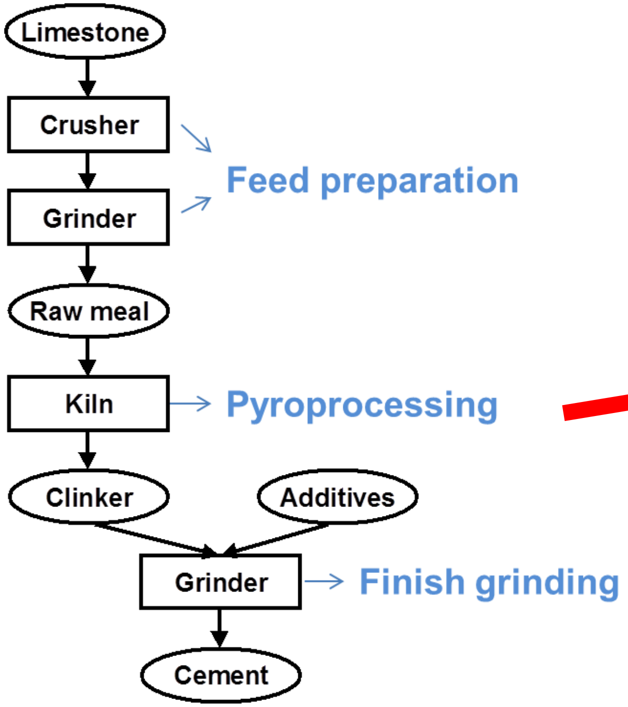
- Measure progress toward energy efficiency goals
- Understand how adoption of key EETs within a region affect this progress
- Assess the effectiveness of policies and conditions designed to promote an enabling environment
- Identify barriers to the enabling environment
- Guide future decisions and policies related to accelerating EET adoption.

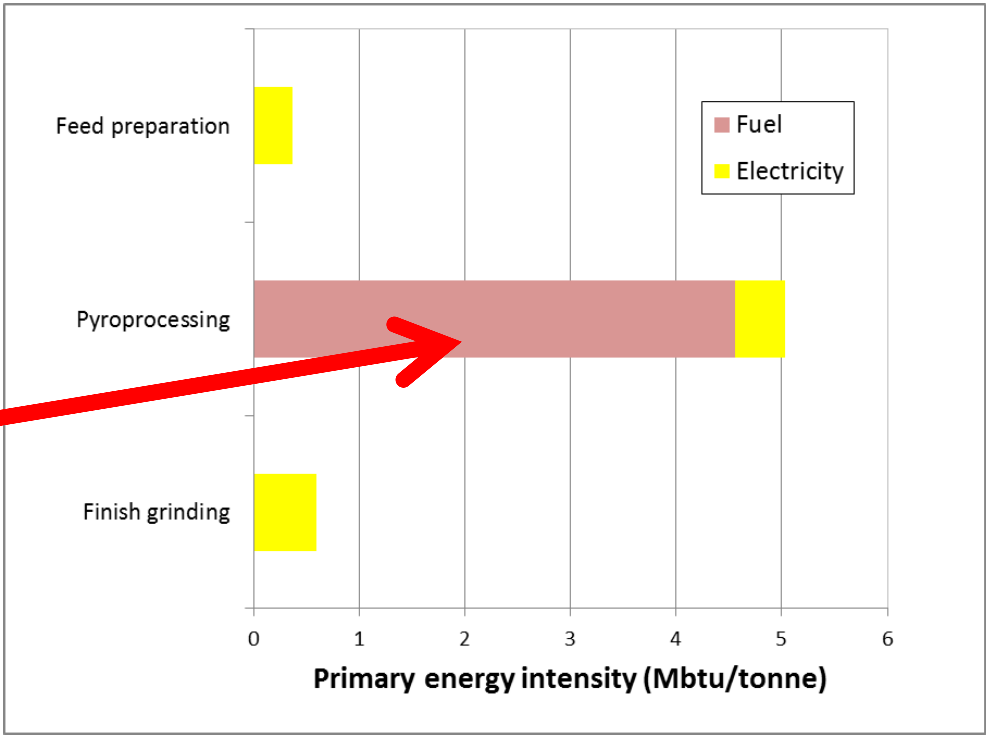
Guiding principles

- Leverage EET information from existing programs
- Identify data elements ahead of time
- Include just best practice technologies (BPTs) or also best available techniques (BATs)?
- Informed by the feasibility of collecting consistent and credible penetration data over time
- Choose one or a few EETs for tracking within a priority subsector
- Leverage existing readiness/maturity ratings

Process-specific technology example

Simplified cement process flow diagram





Source: Worrell and Galitsky (2009)

Cross-cutting example: electric motors

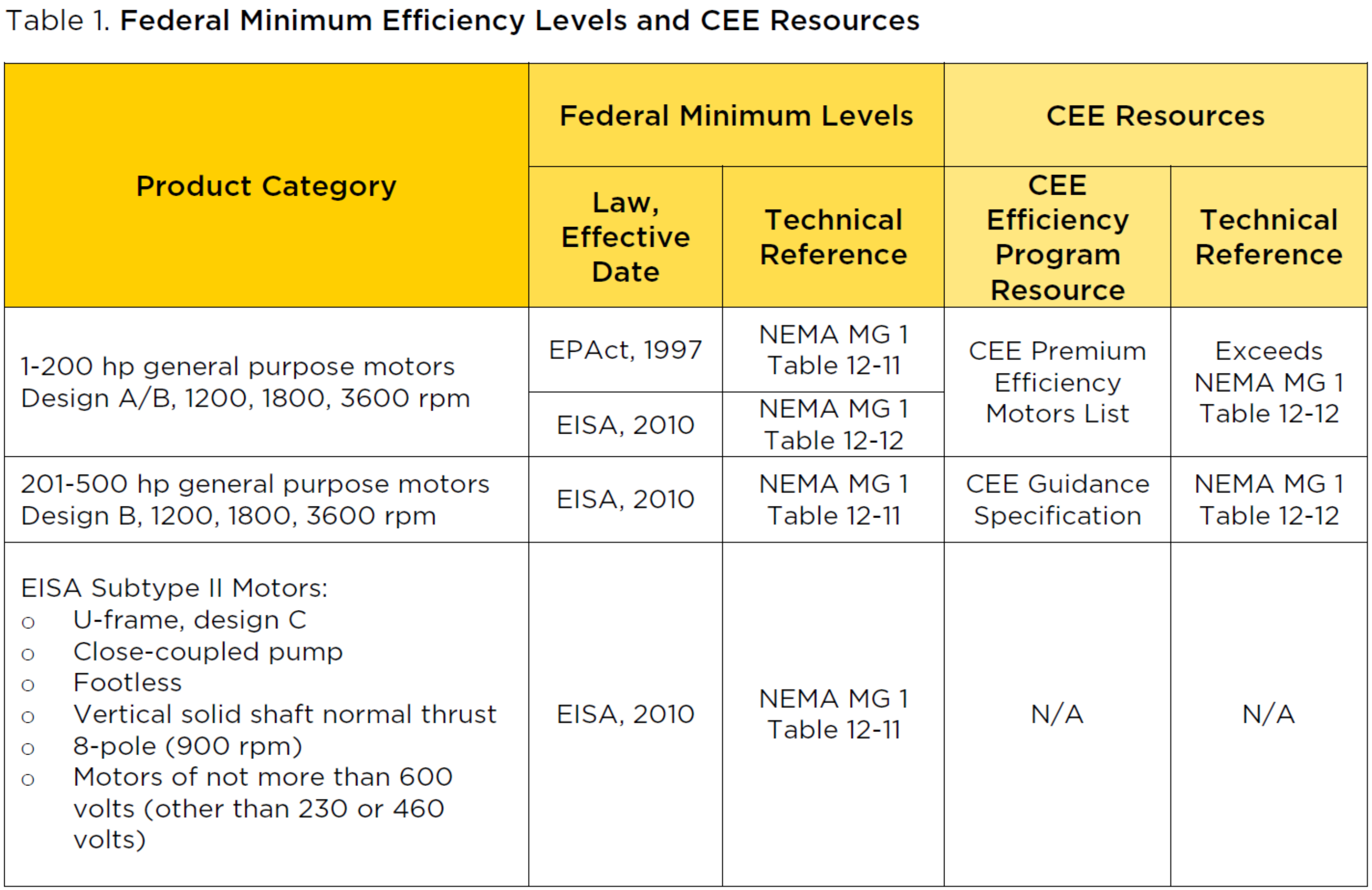
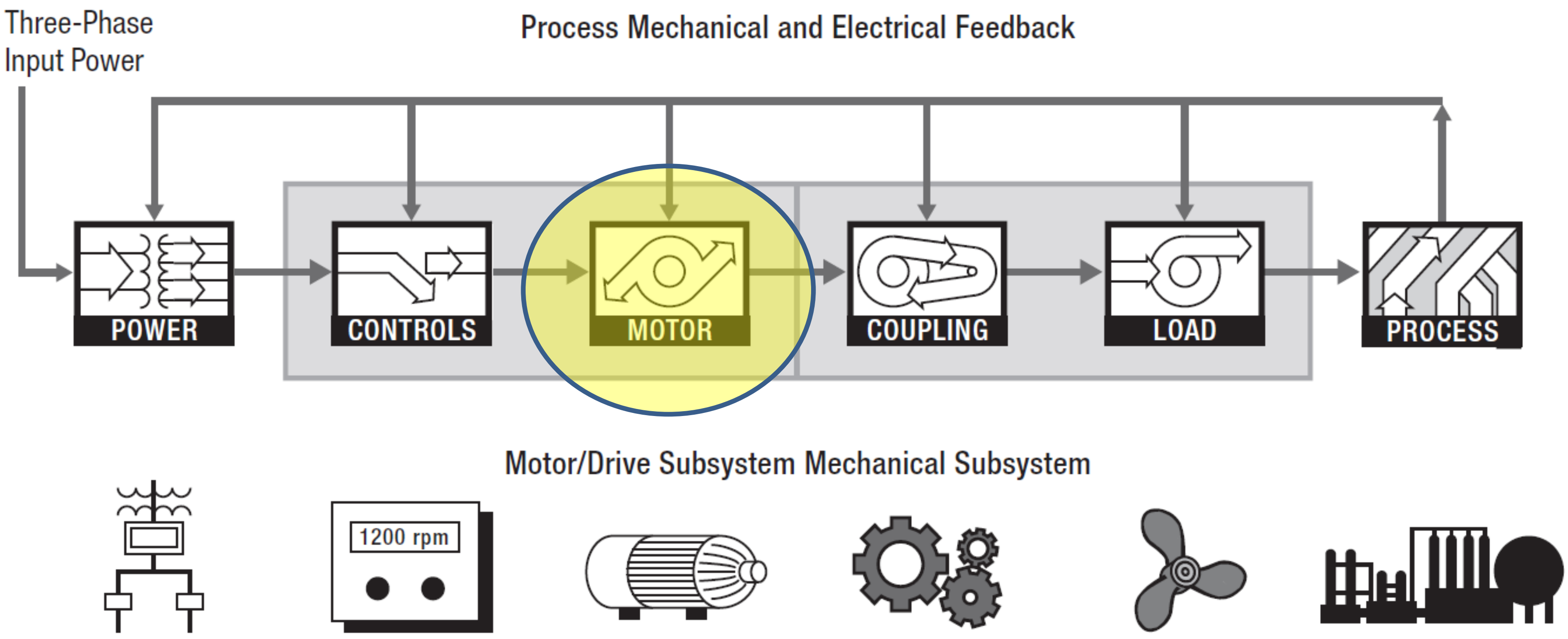


Table 1. **Federal Minimum Efficiency Levels and CEE Resources**

Product Category	**Federal Minimum Levels**		**CEE Resources**	
	Law, Effective Date	**Technical Reference**	**CEE Efficiency Program Resource**	**Technical Reference**
1-200 hp general purpose motors Design A/B, 1200, 1800, 3600 rpm	EPAct, 1997	NEMA MG 1 Table 12-11	CEE Premium Efficiency Motors List	Exceeds NEMA MG 1 Table 12-12
	EISA, 2010	NEMA MG 1 Table 12-12		
201-500 hp general purpose motors Design B, 1200, 1800, 3600 rpm	EISA, 2010	NEMA MG 1 Table 12-11	CEE Guidance Specification	NEMA MG 1 Table 12-12
EISA Subtype II Motors: ○ U-frame, design C ○ Close-coupled pump ○ Footless ○ Vertical solid shaft normal thrust ○ 8-pole (900 rpm) ○ Motors of not more than 600 volts (other than 230 or 460 volts)	EISA, 2010	NEMA MG 1 Table 12-11	N/A	N/A

Source: CEE (2013)

Efficient components vs. efficient systems



Source: U.S. DOE (2013)

Technologies vs. management

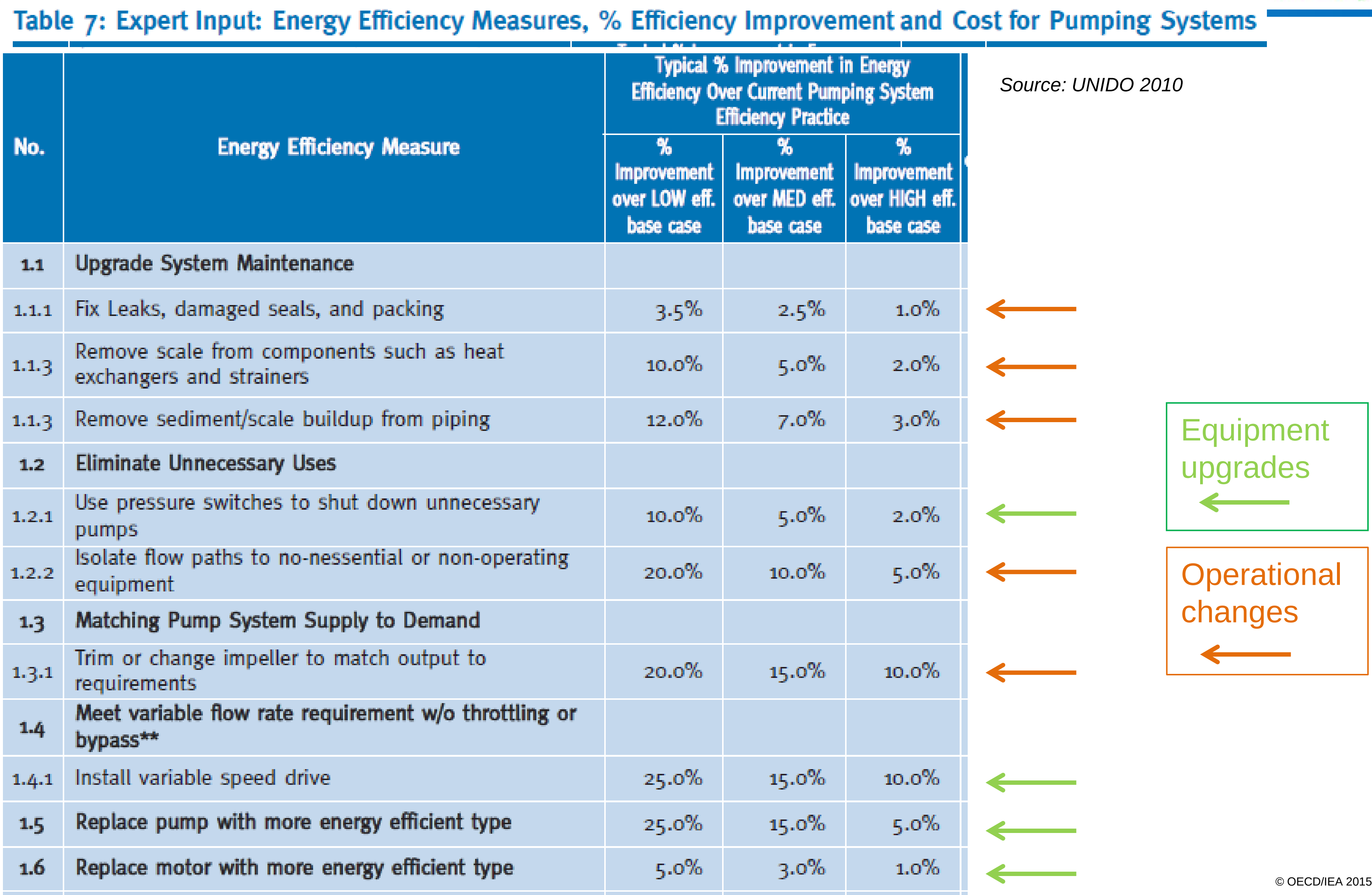


Table 7: Expert Input: Energy Efficiency Measures, % Efficiency Improvement and Cost for Pumping Systems

No.	Energy Efficiency Measure	Typical % Improvement in Energy Efficiency Over Current Pumping System Efficiency Practice			
		% Improvement over LOW eff. base case	% Improvement over MED eff. base case	% Improvement over HIGH eff. base case	
1.1	**Upgrade System Maintenance**				
1.1.1	Fix Leaks, damaged seals, and packing	3.5%	2.5%	1.0%	🟧 ←
1.1.3	Remove scale from components such as heat exchangers and strainers	10.0%	5.0%	2.0%	🟧 ←
1.1.3	Remove sediment/scale buildup from piping	12.0%	7.0%	3.0%	🟧 ←
1.2	**Eliminate Unnecessary Uses**				
1.2.1	Use pressure switches to shut down unnecessary pumps	10.0%	5.0%	2.0%	🟩 ←
1.2.2	Isolate flow paths to no-nessential or non-operating equipment	20.0%	10.0%	5.0%	🟧 ←
1.3	**Matching Pump System Supply to Demand**				
1.3.1	Trim or change impeller to match output to requirements	20.0%	15.0%	10.0%	🟧 ←
1.4	**Meet variable flow rate requirement w/o throttling or bypass****				
1.4.1	Install variable speed drive	25.0%	15.0%	10.0%	🟩 ←
1.5	**Replace pump with more energy efficient type**	25.0%	15.0%	5.0%	🟩 ←
1.6	**Replace motor with more energy efficient type**	5.0%	3.0%	1.0%	🟩 ←

Source: UNIDO 2010

Equipment upgrades 🟩 ←

Operational changes 🟧 ←

Percent ownership example

Energy technology presence in the U.S. food processing industry (US DOE 2013)			
	Number of establishments		
Energy saving technology	In Use	Not in Use	%
Computer Control of Building Wide Environment	1849	10454	15%
Computer Control of Processes or Major Energy-Using Equipment	3723	8548	30%
Waste Heat Recovery	1602	10457	13%
Adjustable - Speed Motors	6834	5150	57%
Oxy - Fuel Firing	454	11004	4%

Establishing reference indicator values

1. **For transport, reference energy indicator values may be directly computable from technology data and statistics using transport models**

IEA MoMo Transport Model

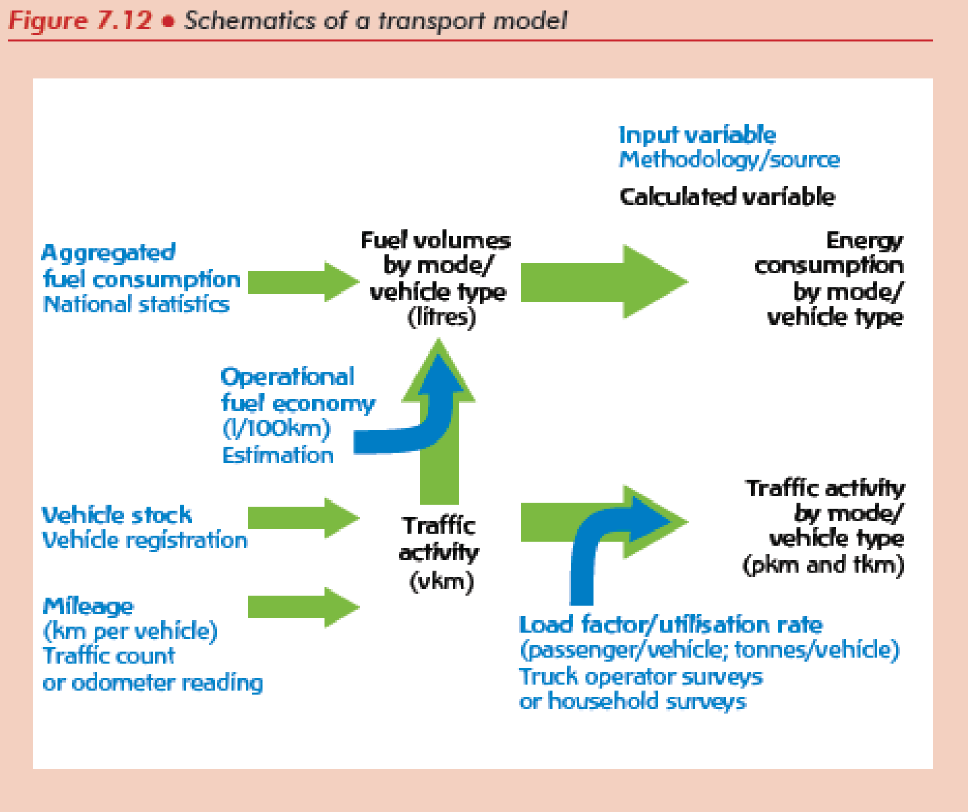


Figure 7.12 • Schematics of a transport model

Establishing reference indicator values

2. **For buildings and industry, energy indicators are not directly computable from technology data and statistics due to system complexities**
   - A "decoupled" approach is necessary, in which reference indicators are set at base year values and penetrations of major BATs for energy-dominant processes are monitored over time