INSTITUT FÜR ENERGIE- UND UMWELTFORSCHUNG HEIDELBERG

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EleCity

The Electrified City – Sustainable Cities in the Context of Energy Transition

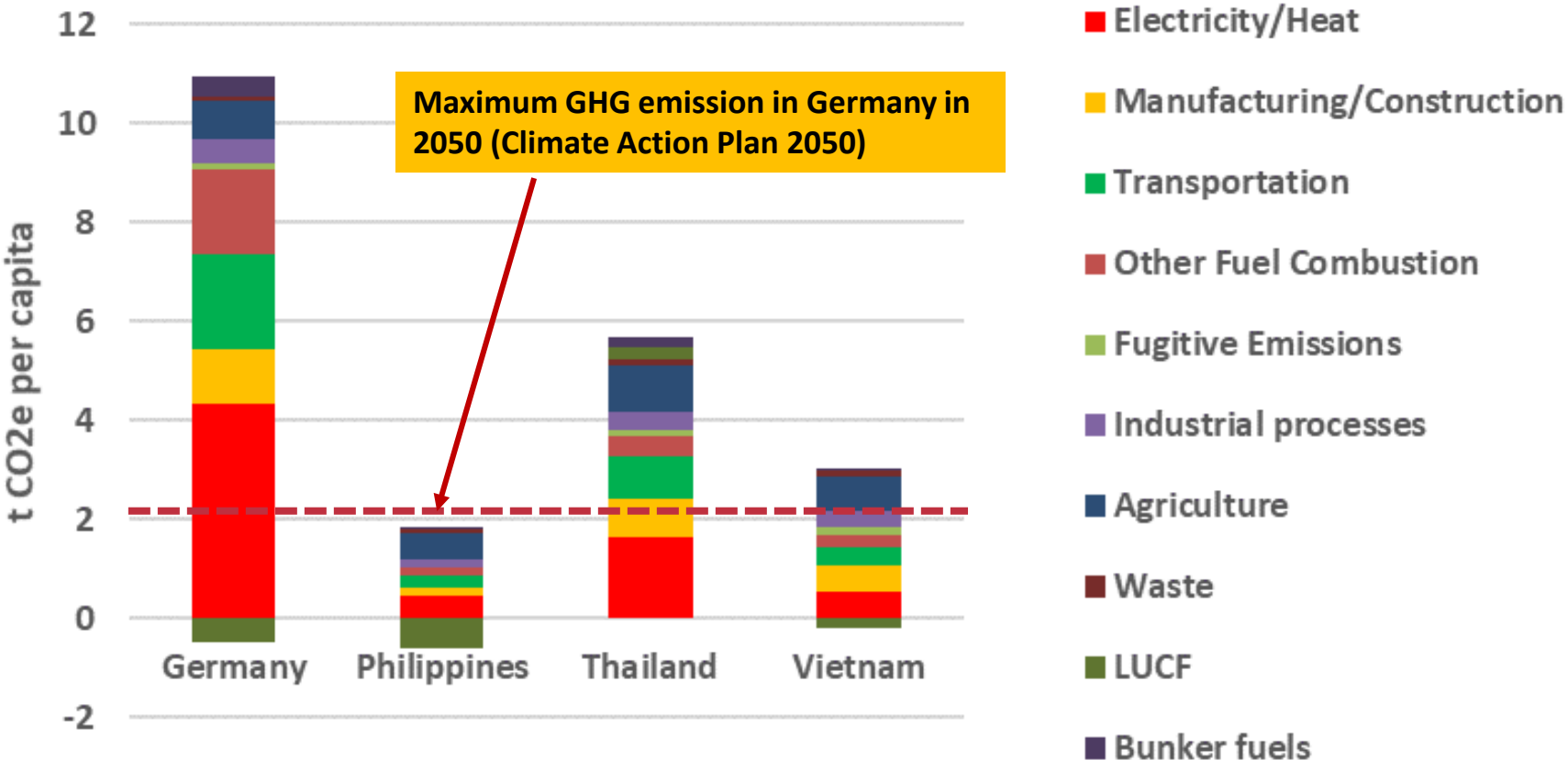
Potentials for electrification and energy efficiency in industry and commerce

EleCities Travelling Conference Hanoi, Manila, Bangkok

Bernd Franke, November 2017

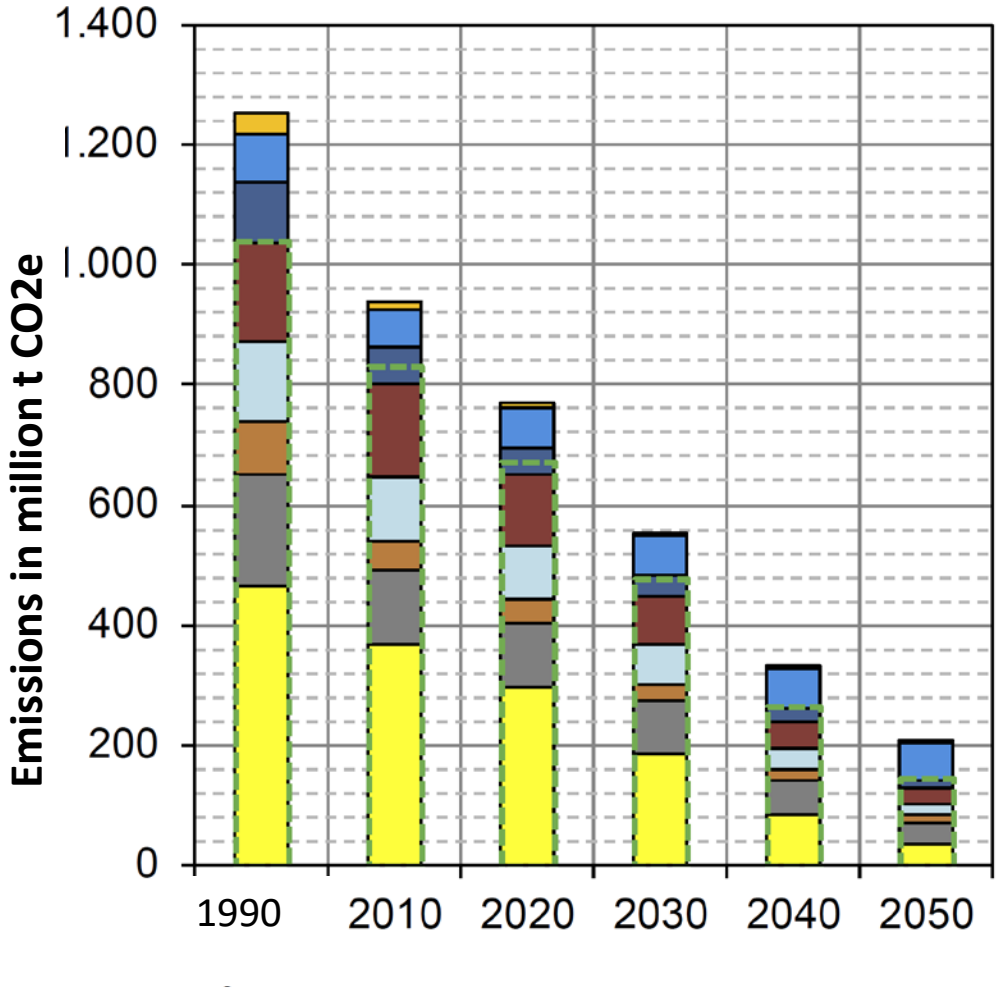
Contents

GHG emissions per capita (t CO_2e), 2014



Source: http://cait.wri.org

GHG emissions in Germany: Baseline scenario

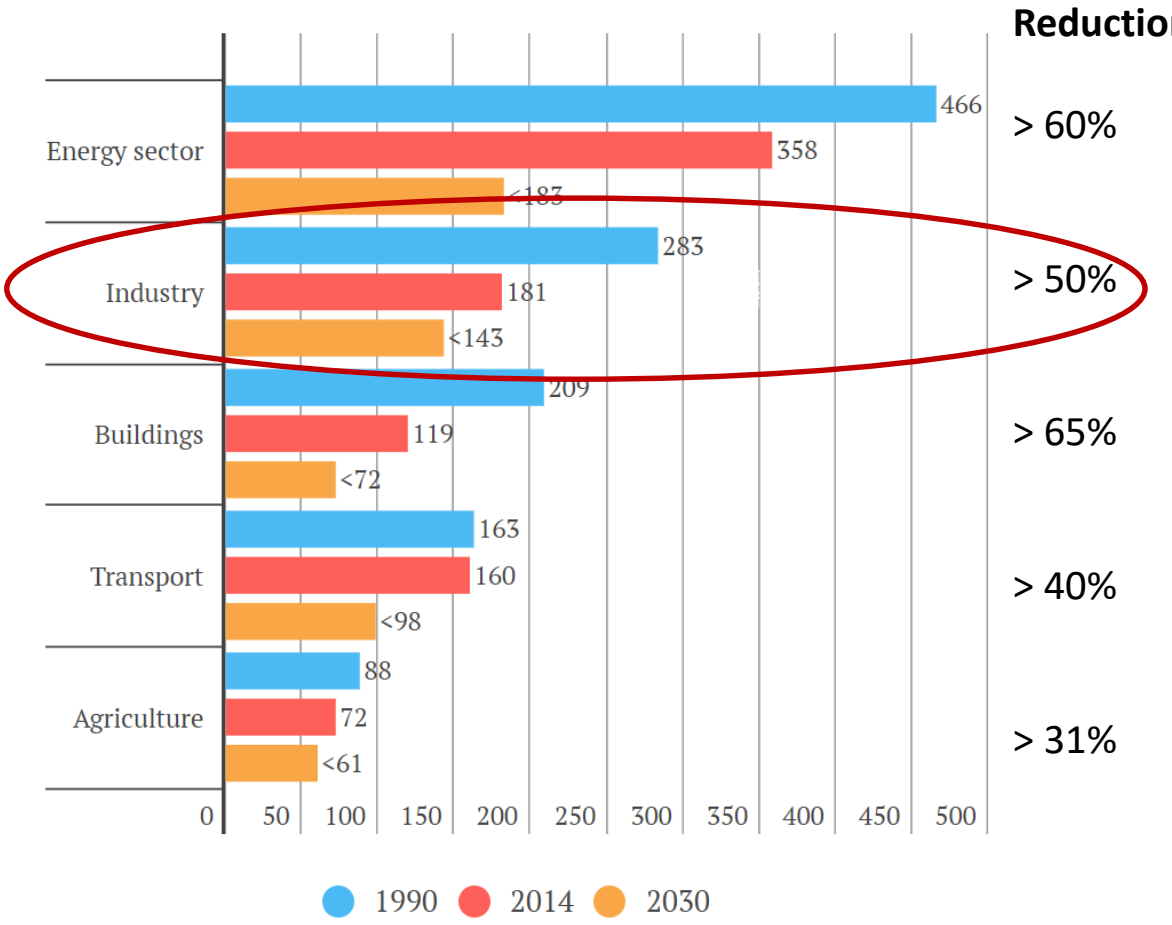


- **Direct GHG emissions from industry processes (e.g. cement) will decline rapidly**
- **Energy sector becomes almost complete decarbonized**

- Waste
- Agriculture
- Industry processes
- Transportation
- Residential sector
- Commerce, service sector
- Industry
- Energy sector
- Energy processes

Source: www.bmwi.de/Redaktion/DE/Artikel/Energie/langfrist-und-klimaszenarien.html

GHG emissions targets in Germany until 2030



Reduction from 1990 - 2030 in %

> 60%

> 50%

> 65%

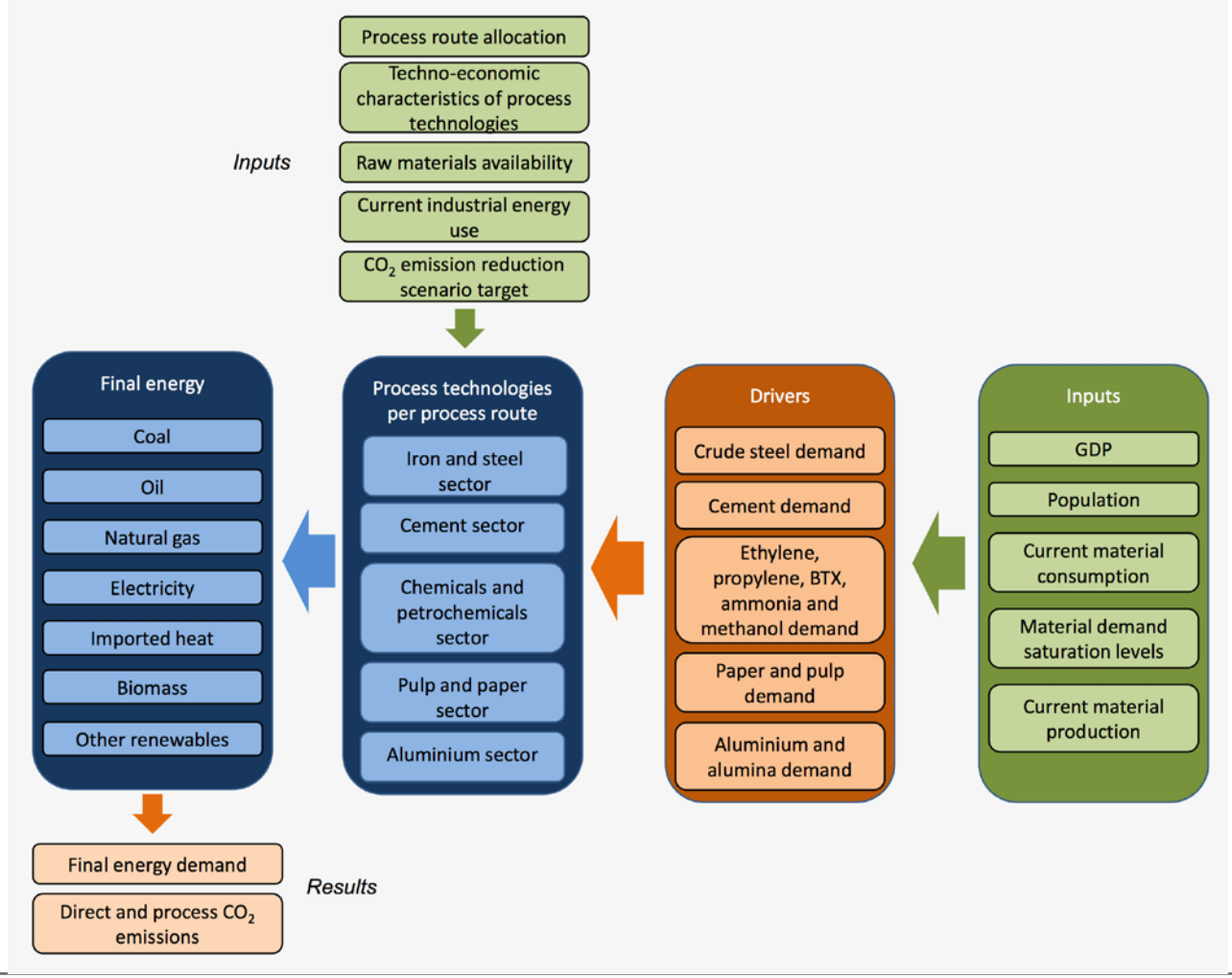
> 40%

> 31%

How to put it into action?

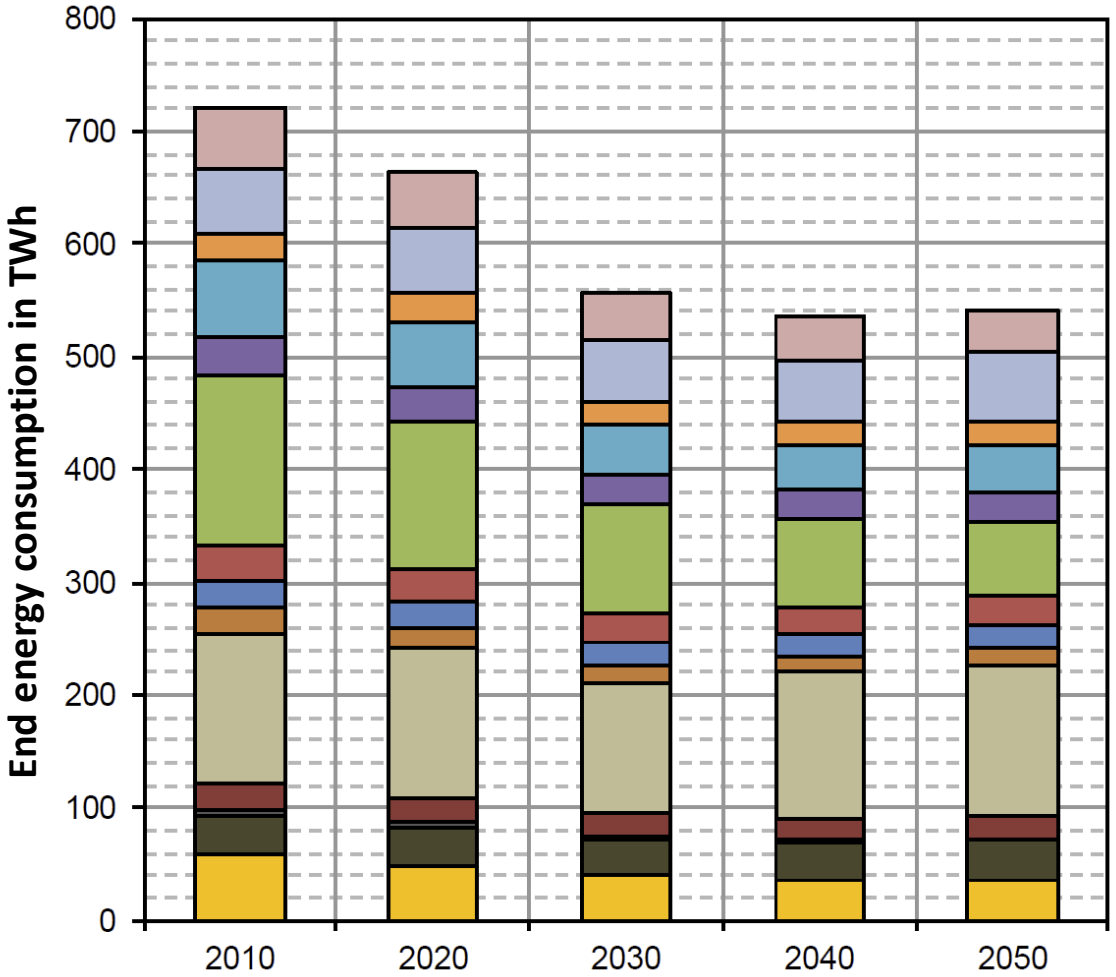
Source: http://www.bmub.bund.de/en/topics/climate-energy/climate/national-climate-policy/greenhouse-gas-neutral-germany-2050/

Modelling of energy consumption in industry



Source: https://www.iea.org/etp/etpmodel/industry/

End energy consumption in industry [2010-2050] by sub-sector, scenario calculations for Germany



- Mineral processing
- Other
- Other chemical industry
- Paper industry
- Non-ferrous metal foundries
- Metal production
- Metal processing
- Mechanical engineering
- Rubber and plastics
- Basic chemical materials
- Glass and ceramics
- Mining/quarrying
- Motor vehicle construction
- Food / tobacco

Industry GDP growth: 0.7% per year
(more vehicles and machines, less primary)

Source: www.bmwi.de/Redaktion/DE/Artikel/Energie/langfrist-und-klimaszenarien.html

Summary of long-term scenario calculations for Germany 2010 to 2050 (baseline)

Results for the industrial sector

- Increased industrial GDP (bn. €): 423 → 561 (+ 33%)
- Reduced number of employees (mio.) 8.9 → 5.1 (- 43%)
- Reduced end energy demand [TWh]: 720 → 542 (- 25 %)
- Reduced GHG emissions [mio. t CO_2e]:
  prior to CCS *140 → 71 (- 50%)*
  after CCS (- 35 mio. t CO_2e) *140 → 36 (- 75%)*

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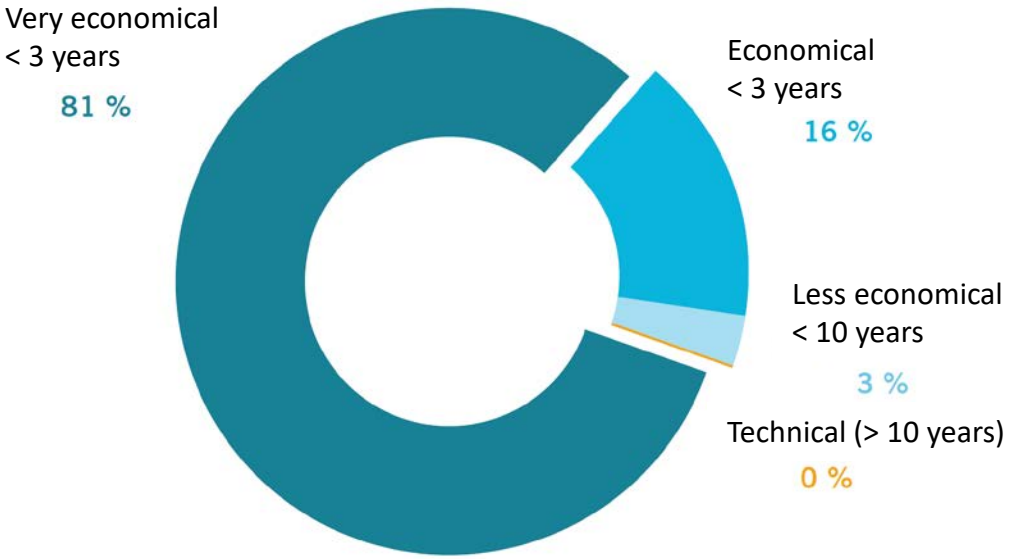
2. **Energy efficiency in industry and commerce**
3. ifeu‘s experience in promoting the energy transition
4. Country comparison
5. Ideas for joint research

Motors, pumps and lighting, green IT

End energy consumption in industry and commerce, 2015

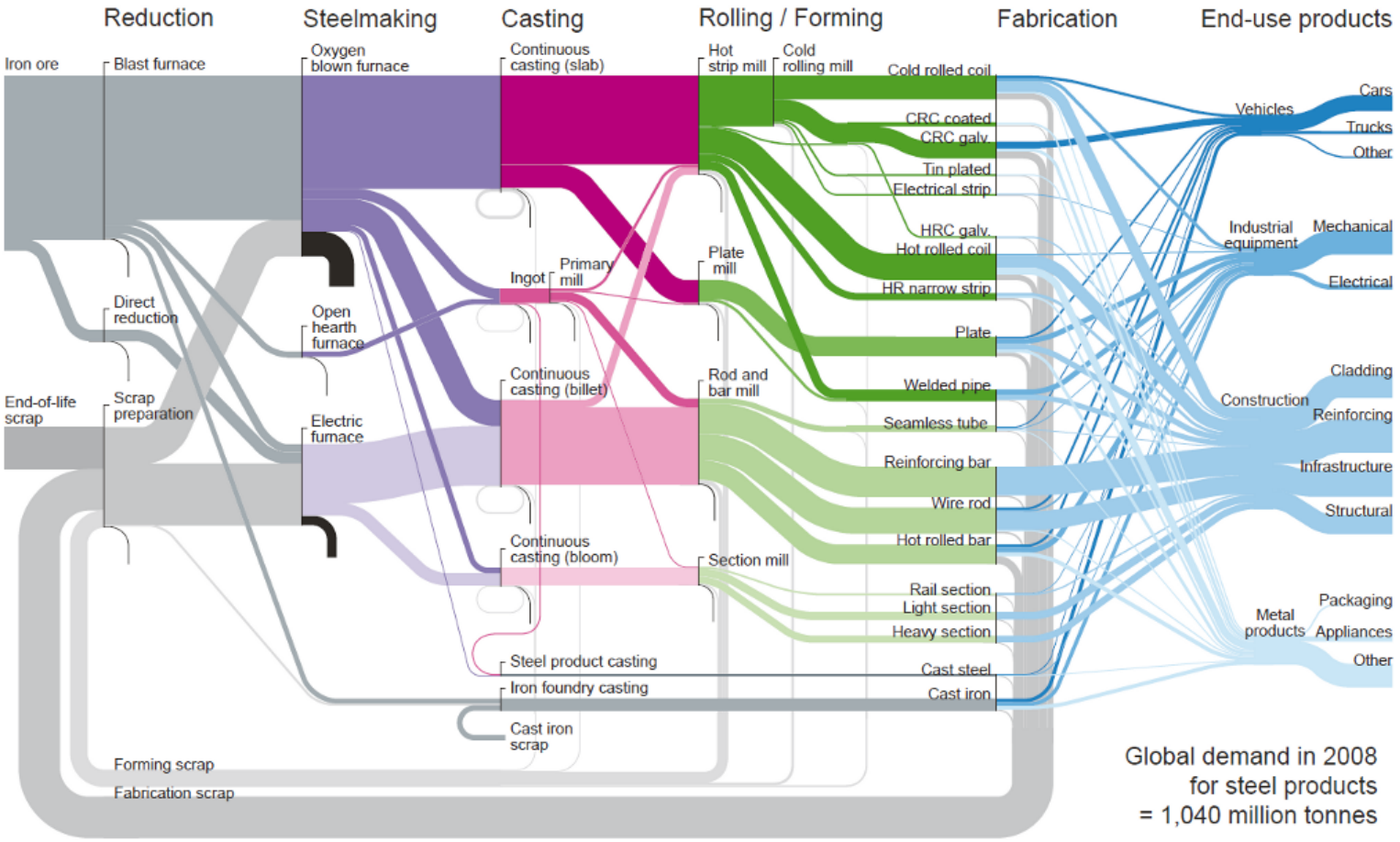
- 44% of total consumption in Germany
- electrical motors account for 2/3 of electricity in industry
- lighting and IT services

Investment in energy efficient technologies pays off quickly *(amortization time in years)*



Source. https://www.ifeu.de/wp-content/uploads/Energieeffizienz-2017_170613_web.pdf

Scrap metal reycling with electric furnaces

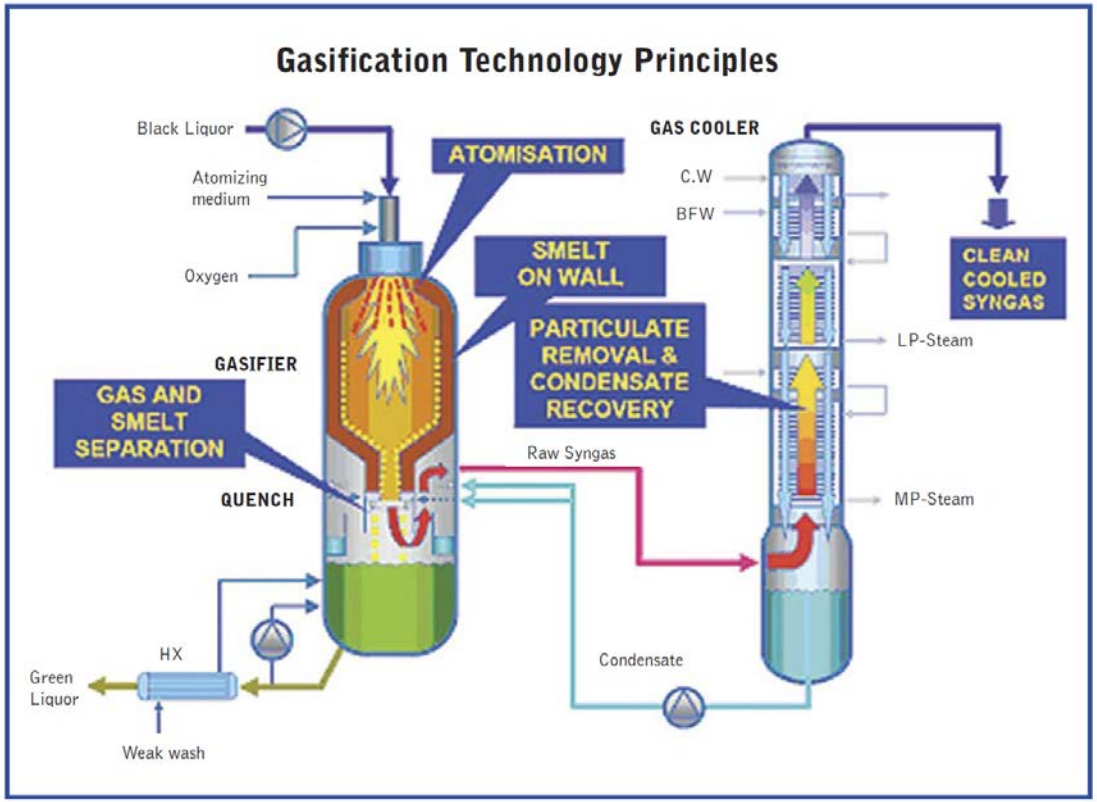


source: both eyes open web pres., p.7, www.botheyesopen.com

seen on: www.knowtheflow.com

Pulp and paper industry

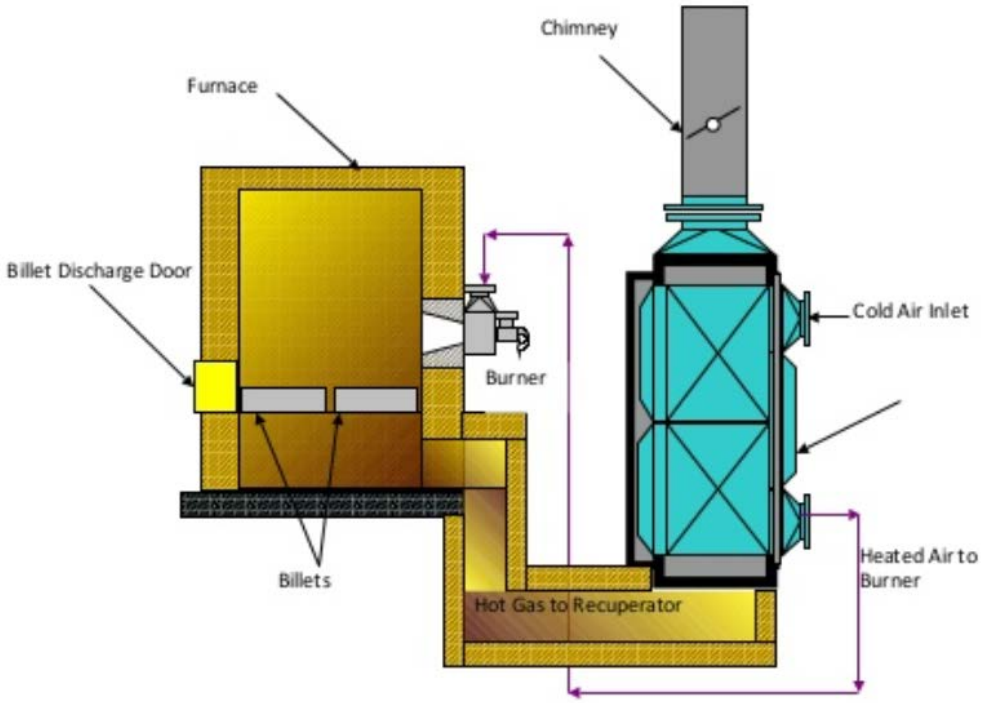
- Black liquor gazification
- Represents a second generation biofuel
- 50% implentation projected for Germany by 2050 (baseline scenario)



Source: http://www.ieabioenergy.com/wp-content/uploads/2013/10/Black-Liquor-Gasification-summary-and-conclusions1.pdf

Metal industry

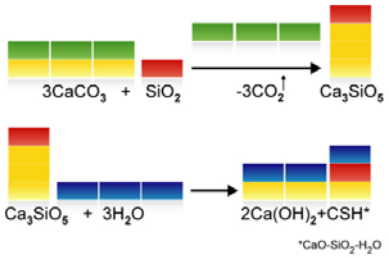
- Waste heat utilization in rolling mill furnaces
- 53% implentation in Germany by 2050 (baseline scenario)



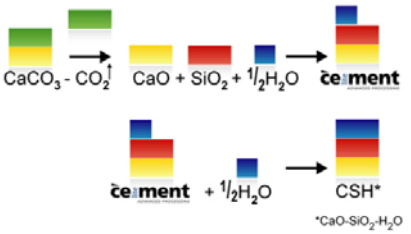
Source: https://de.slideshare.net/eecfncci/energy-efficiency-in-steel-rolling-mills-of-nepal

Cement industry

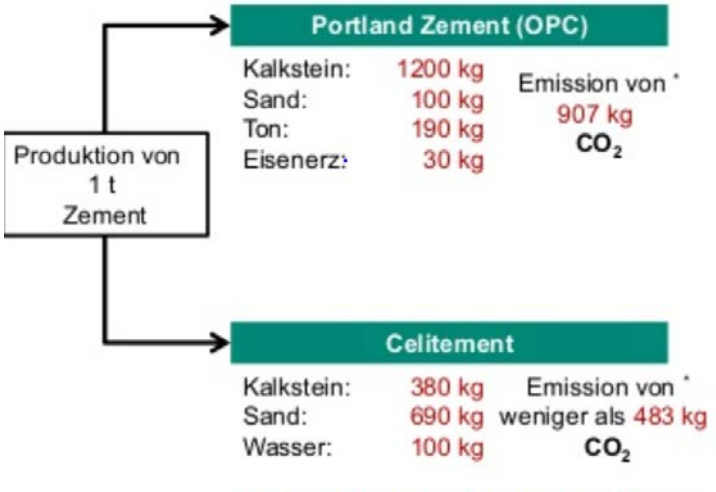
- **Alternative cement**
  Celitement, assume 53% implentation in Germany by 2050 (baseline)
- **Recycling of concrete**
  reduces energy and resource demand



Ordinary portland cement



Celitement



About 50% reduction in energy demand and CO_2 emissions

Source: https://celitecement.de

Aluminium production: wettable cathodes and inert anodes

- **Wettable cathodes:**
  20-25% reduction in energy demand; 65% implementation in Germany by 2050 (baseline scenario)
- **Inert anodes:**
  Carbon anodes: about 400 kg carbon anodes are consumed per tonne of aluminum;

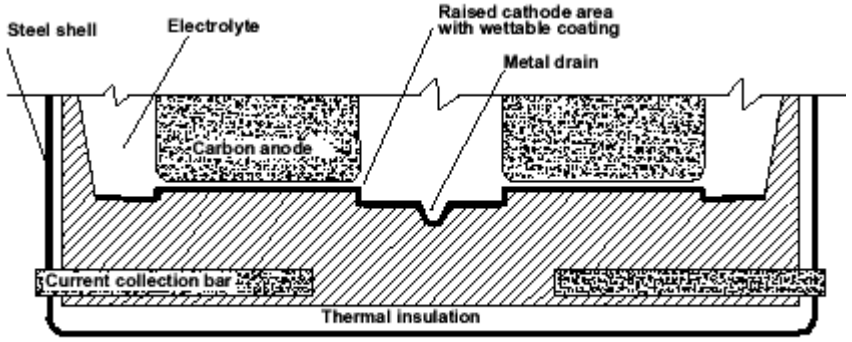
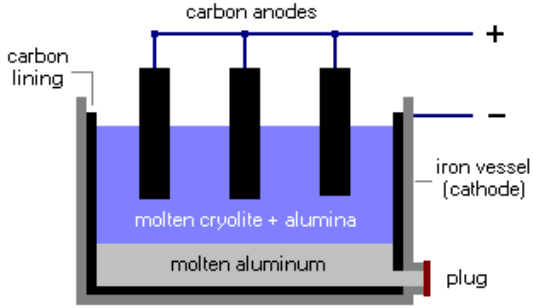


Figure 2. Schematic view of the conceptual cathode design.

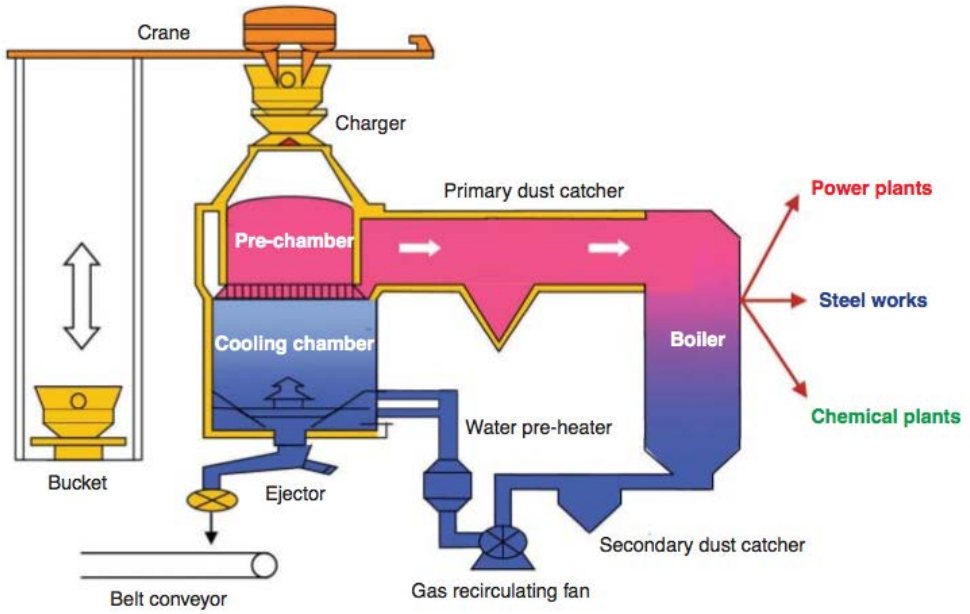


Replacing carbon anodes with ceramic materials

Source: http://www.ieabioenergy.com/wp-content/uploads/2013/10/Black-Liquor-Gasification-summary-and-conclusions1.pdf

Coke dry quenching (CQD)

- CDQ may use up to 40% less energy. Approximately 1.5 GJ heat/t-coke (400 - 500 kg high temperature steam/t-coke) and 0.55 GJ electricity/t-coke can be recovered.
- 45% implementation in Germany by 2050 (baseline scenario)



CDQ process flow

Source: NEDO, 2006, Clean Coal Technologies in Japan

Source: http://ietd.iipnetwork.org/content/coke-dry-quenching

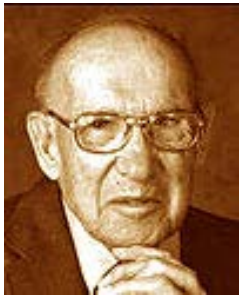
Demand side management

- **Icehouses** can be cooled below maximum temperature (e.g. to -40°C) when renewable electricity is available (e.g. daytime PV).
- Flexible electricity use in **sewage treatment plants** (e.g. pumps, sludge dewatering).
- Pre-heating of materials in **metal manufacturing**.
- Fine-tuning electricity demand in **food and beverage** industry.

 Source: http://www.dsm-bw.de/fileadmin/content/Downloads/Brosch%C3%BCren/161222_Flyer_DSM_BW_Projektergebnisse.pdf

Last but not least: Controlling

“If you can’t measure it, you can’t manage it.”



Peter Ferdinand Drucker (1909-2005)

US-economist and pioneer of modern management education

Instruments to implement the transition

- **Rules and regulations**
  (e.g. efficiency standards)
- **Grants and subsidies**
  (e.g. financing of energy energy efficient technologies, energy audits)
- **Pricing policies**
  (e.g. GHG emissions trading, carbon tax)
- **Strategies**
  (increasing material efficiency by recycling, research in energy efficient technologies, enabling market access by public procurement e.g. low-CO_2-cement)

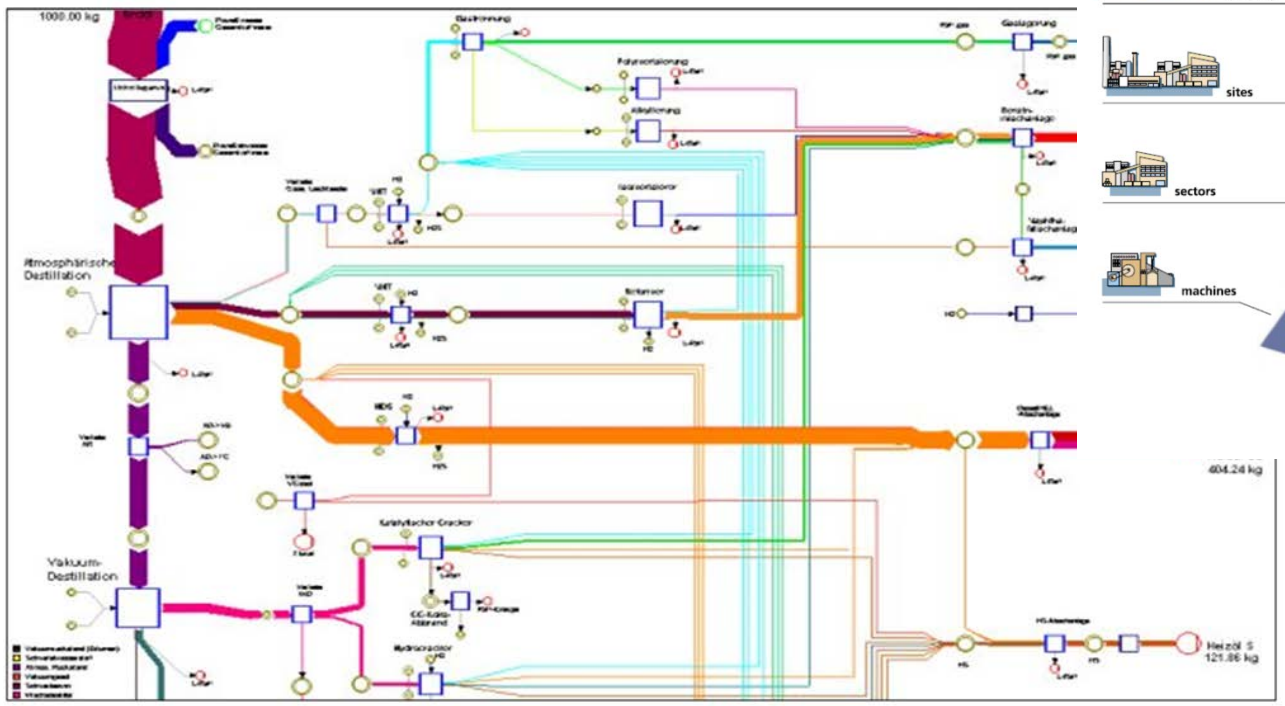
Contents

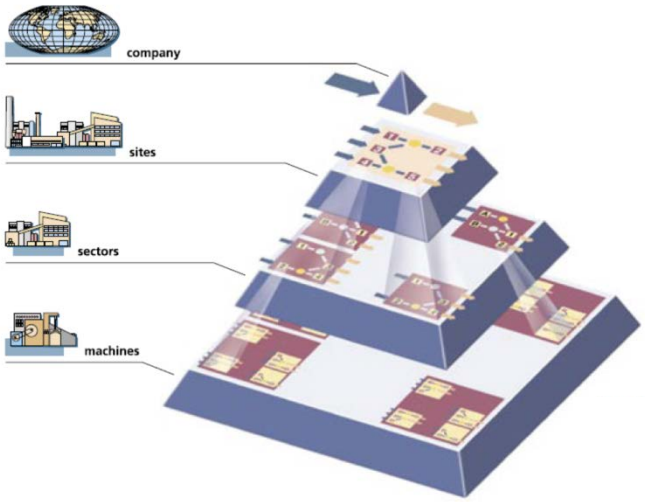
ifeu experience in promoting energy efficiency and low-carbon development in industry

- **Life-cycle assessment (LCA) of products and services**
  (e.g. ecoprofiles for edana/Brussels, LCA for Tetra Pak® cartons)
- **Corporate carbon footprint, company audits**
  (e.g. ZhongTai Chemical Co., Urumqi/China)
- **Developing sector-specific tools**
  (e.g. building material calculator, Rwanda)
- **Low-carbon strategies for cities including the industrial sector**
  (e.g. energy master plan Heidelberg)
- **Development and evaluation of government policies**
  (e.g. Market Incentive Program, BMWi, Berlin)
- **Integrating load management into urban planning**
  (e.g. MoMa, Model City Mannheim, BMU, Berlin)

Areas of Expertise: Umberto®

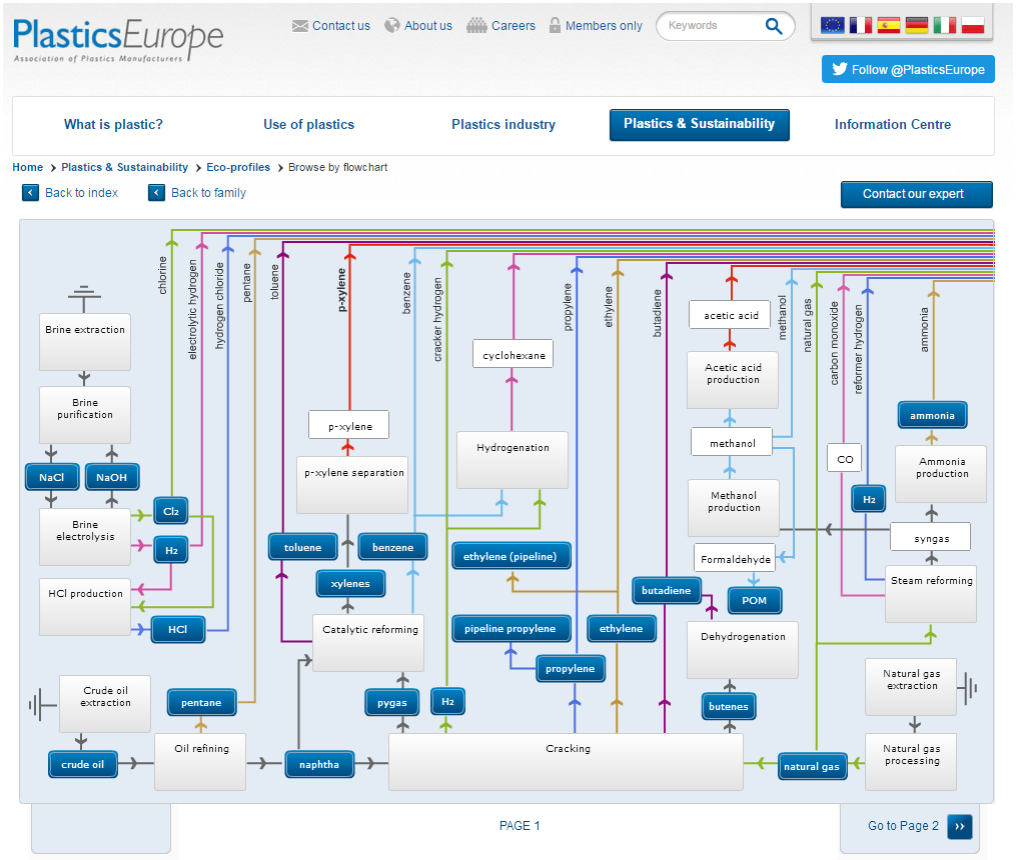
ifeu Helped Develop Software Tool Umberto® for Industrial Flow Analysis

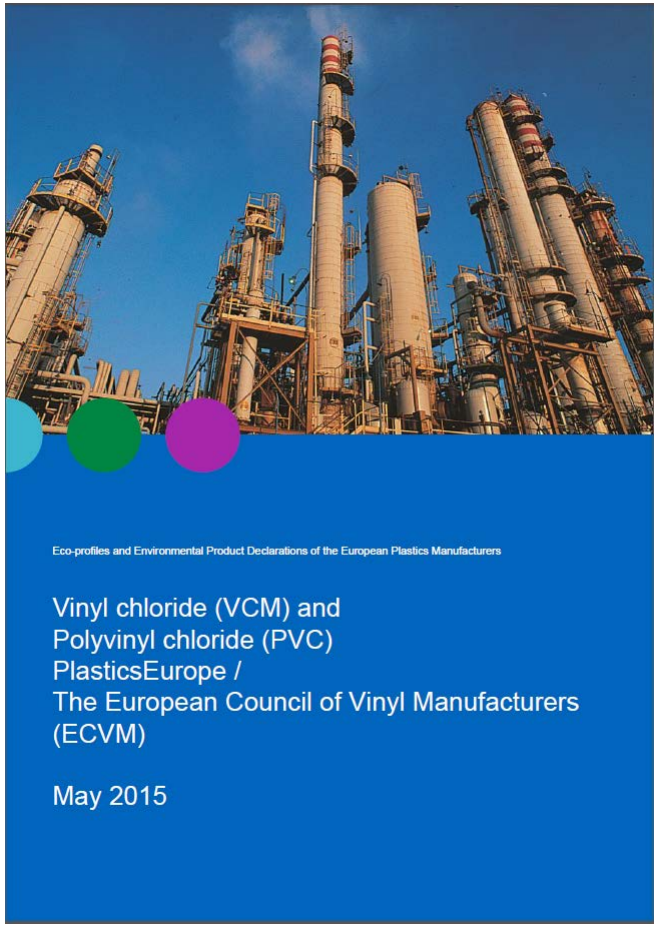




Simplified module of a refinery

Areas of Expertise: Ecoprofiles





Areas of Expertise: Corporate carbon accounting

Corporate GHG emissions are separated into three different scopes:

Direct emissions

Indirect emissions

scope 1

GHG emissions from sources that are **owned or controlled** by the company.

Example:
direct emissions from heating (natural gas, light fuel oil, etc.)

scope 2

GHG emissions from the generation of **purchased electricity** (only the direct emissions from the combustion in the electricity plant)

Example:
electricity consumption of the company's production

scope 3

GHG emissions from sources that are **not owned or controlled** by the company.

Example:
purchased products and services, end-of-life treatment of sold products, use of sold products

Areas of Expertise: Corporate carbon accounting

Basic calculation approach:

Two key parameters for reductions

Activity data
(e.g. procurement of LDPE in kg)

company's contributions

For example:
- Lower energy consumption
- Use of different materials
- Efficiency

×

Emission factor
(e.g. GHG emissions per kg LDPE)

Supplier/industry contributions

For example:
- Greening of the grid (IEA)
- Plasticseurope: Higher efficiency

=

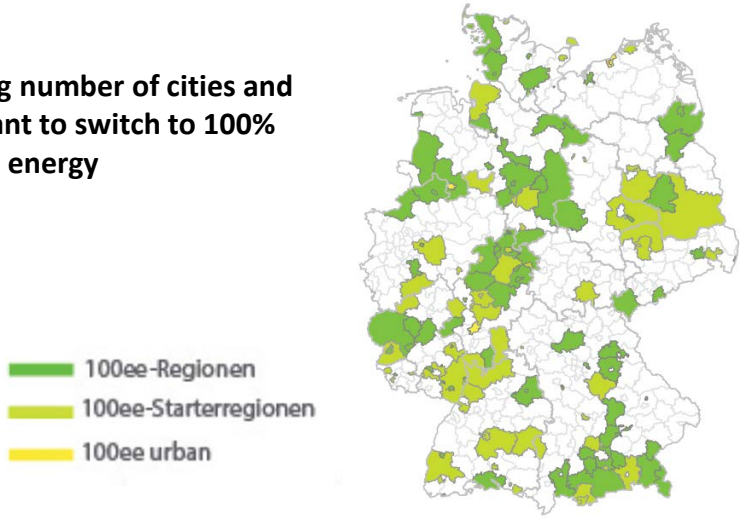
Carbon footprint
(total GHG emissions as CO_2-equivalents)

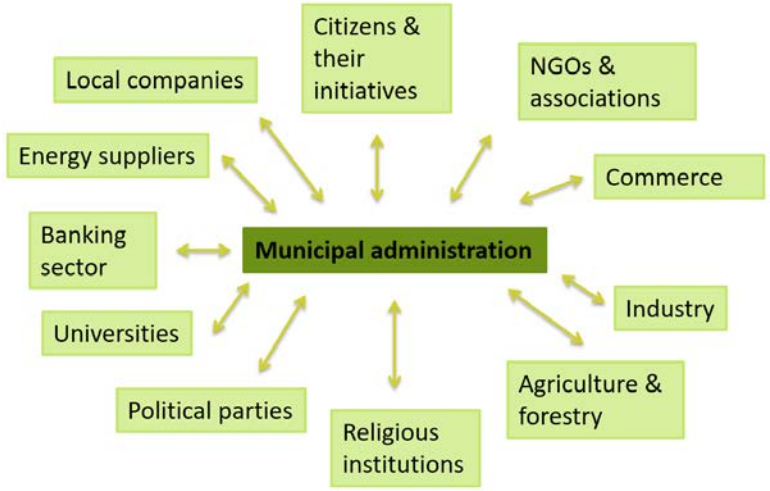
Areas of Expertise:
Municipal climate protection plans

Catalogue of measures
Buildings: 18
Mobility 30
Energy: 20
Products and services: 14
University: 10
Education: 14
Consumption/food: 6

Networking with stakeholders

An growing number of cities and regions want to switch to 100% renewable energy

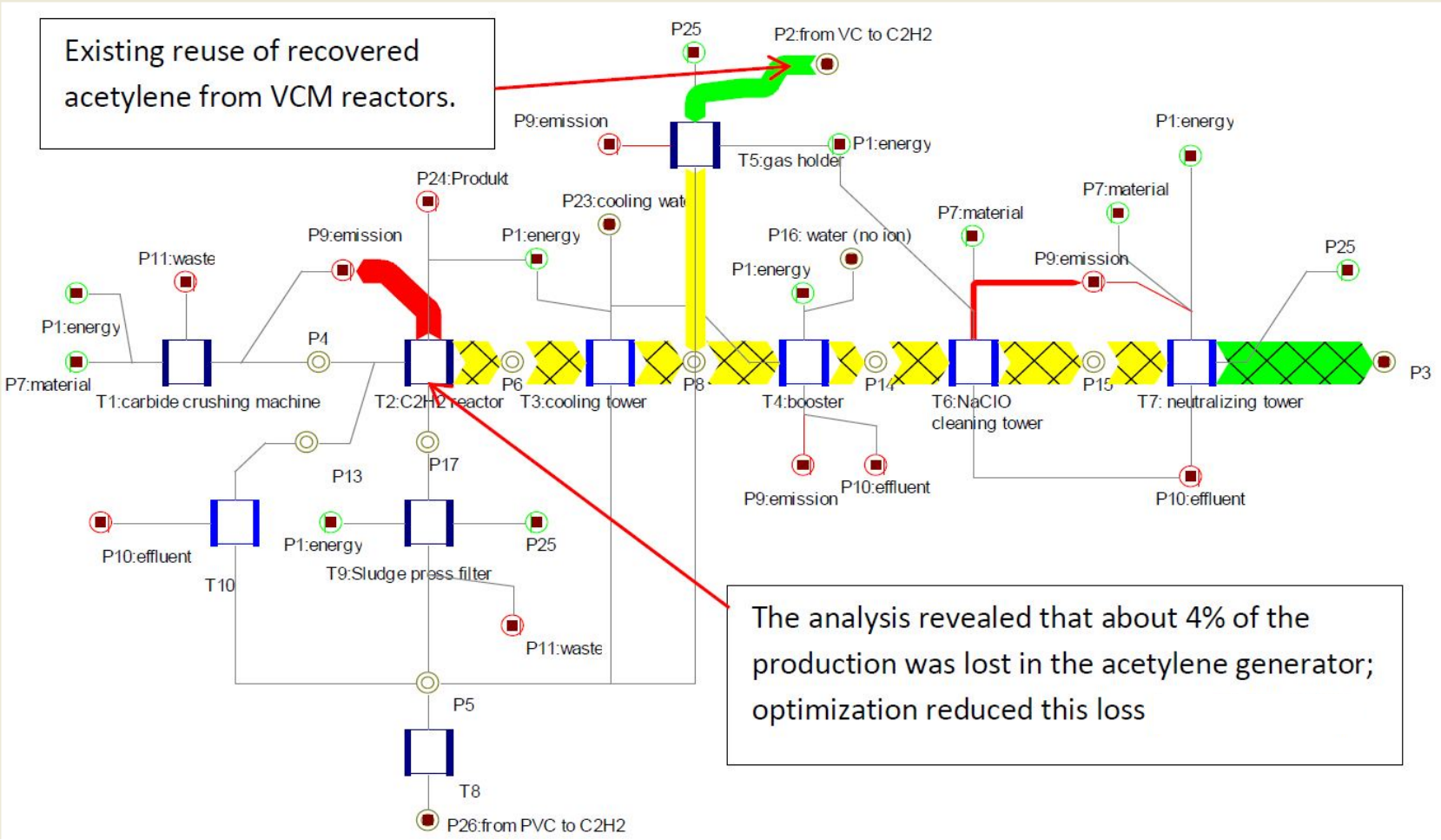




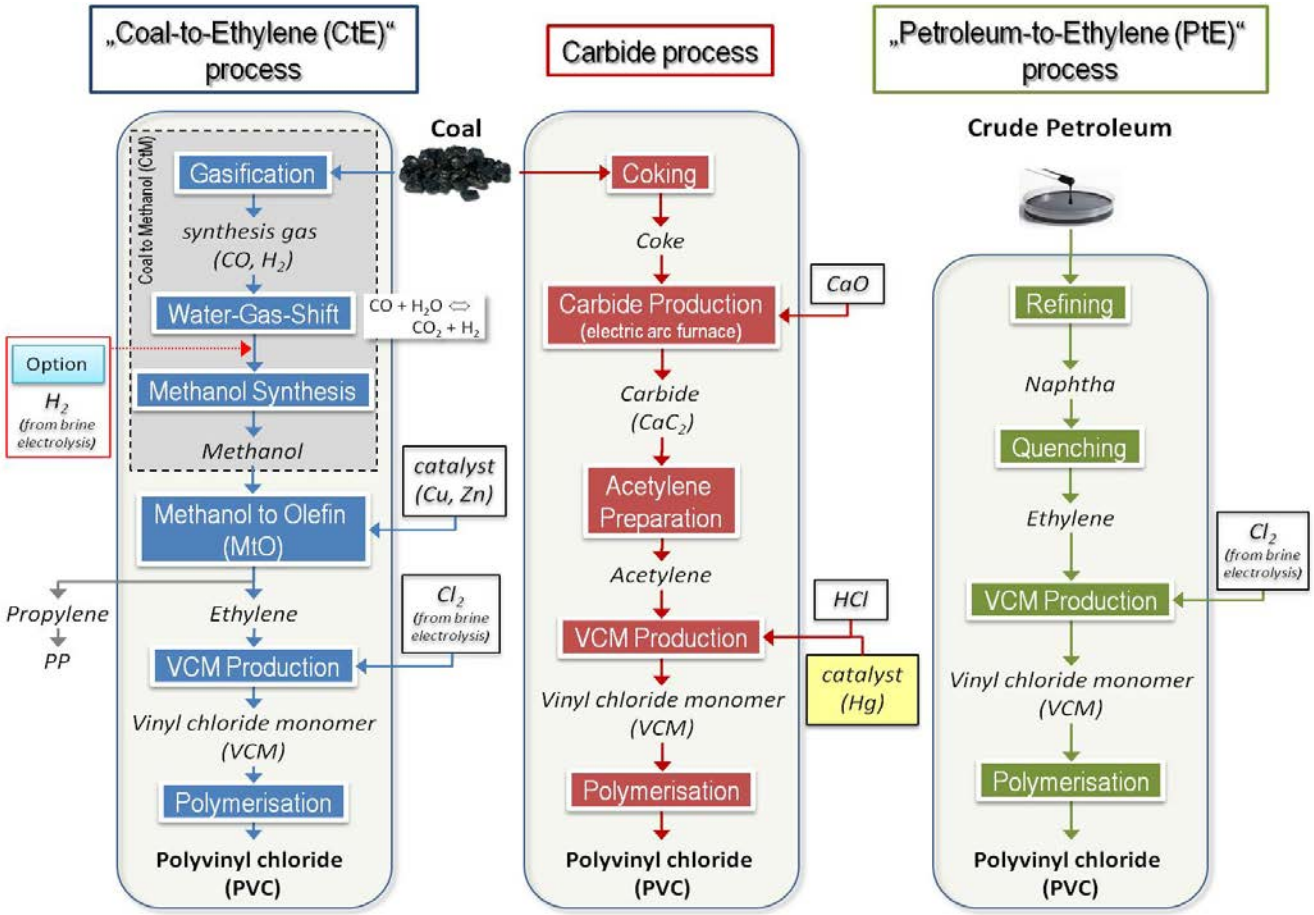
Source: http://www.100-ee.de/index.php?id=182

Audit: Xinjiang ZhongTai Chemical (Group) Co., Ltd. Urumqi/Xinjiang, PR China

Audit result:
Improvement of Acethylene Recovery at ZhongTai



Process alternatives:
Alternative processes for PVC production



Audit: Efficient Energy and Water Use at Bemz tile manufacturing in Kigali/Rwanda

Bemz Ltd. produces about **2.500 tonnes of tiles** per year using sand, cement, stones, and water. While water is being recycled, about 700 m^3 of water must be purchased per year, at 4,700 RWF per m^3 (5.90 €/m^3), 7 times the price of WASAC. Additional **rainwater harvesting** is possible and will cut costs.

Pressure sprayer will reduce water consumption and **save gasoline** for water pumping (currently 10 L/d) with **additional electricity consumption** of 7.300 kWh/a. The **net savings for water and gasoline** (about 2,600 €) would be substantial. However, intermittent supply of electricity and voltage fluctuations will affect production. **Reliance on electricity as the main energy source is therefore a risk.**

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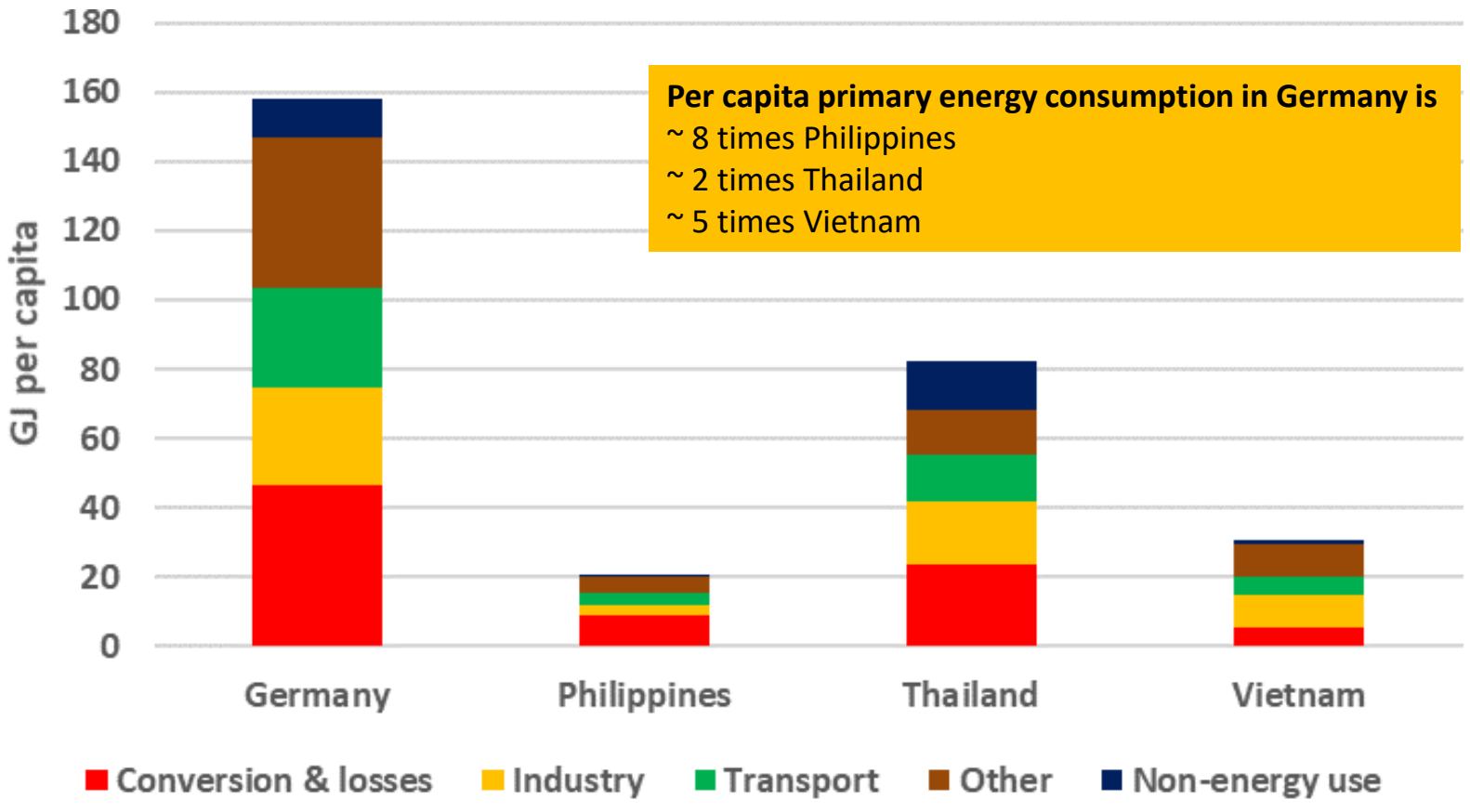
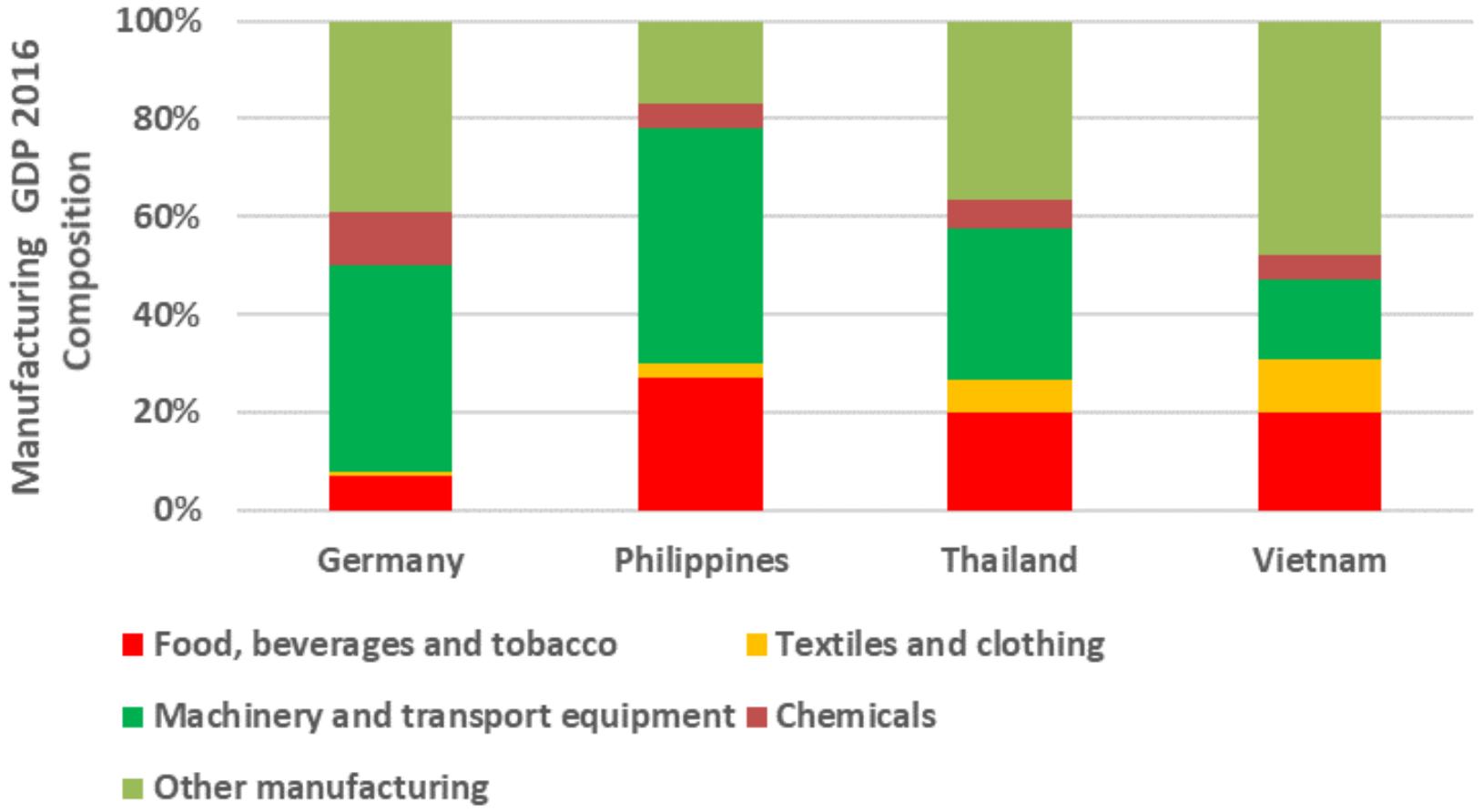
Primary energy consumption [GJ/capita], 2014



Per capita primary energy consumption in Germany is
~ 8 times Philippines
~ 2 times Thailand
~ 5 times Vietnam

Source: https://www.iea.org/statistics/statisticssearch/

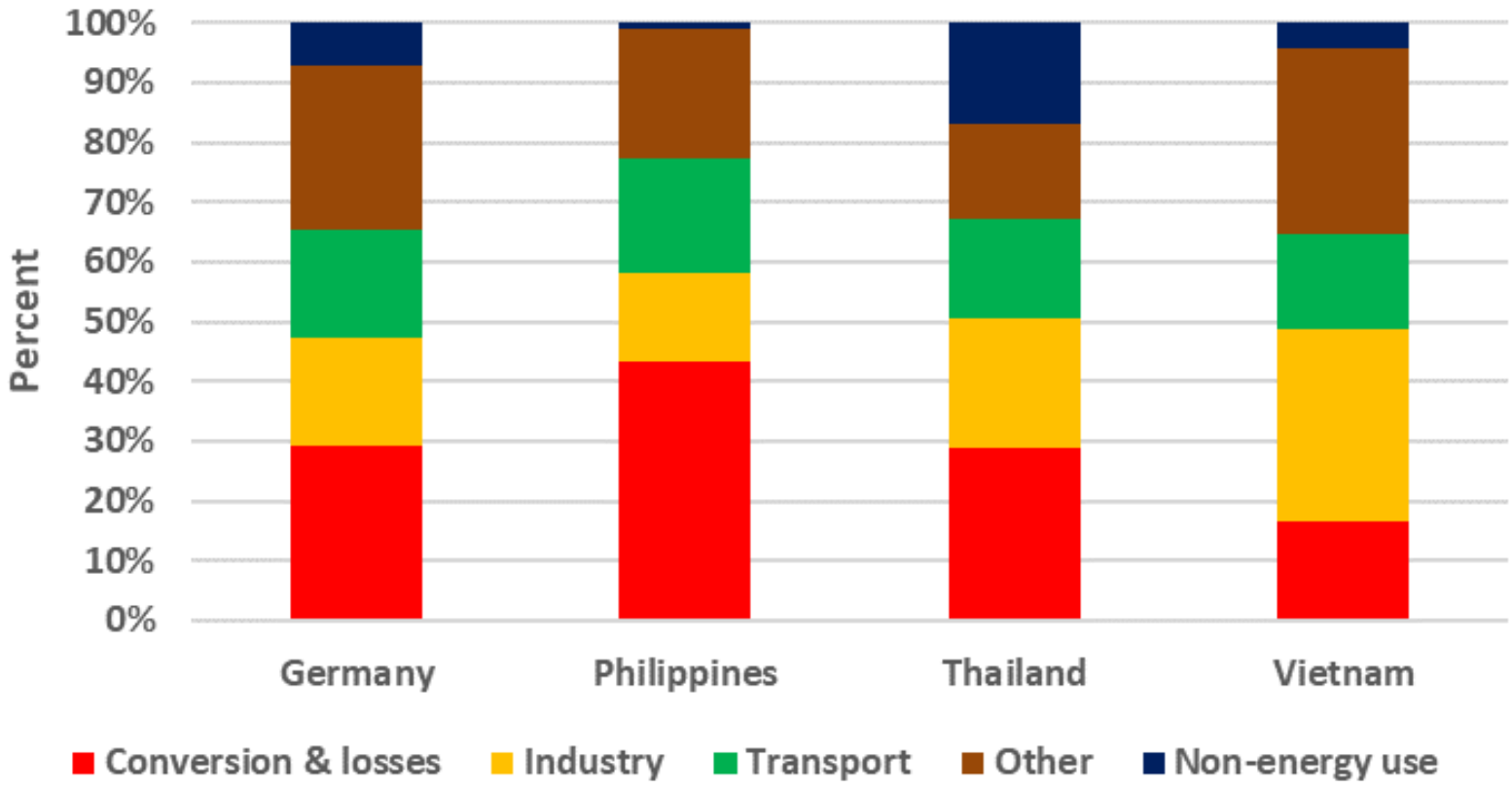
Manufacturing GDP composition, 2012



 Source: http://wdi.worldbank.org/table/4.3#

Primary energy consumption by sector, 2014

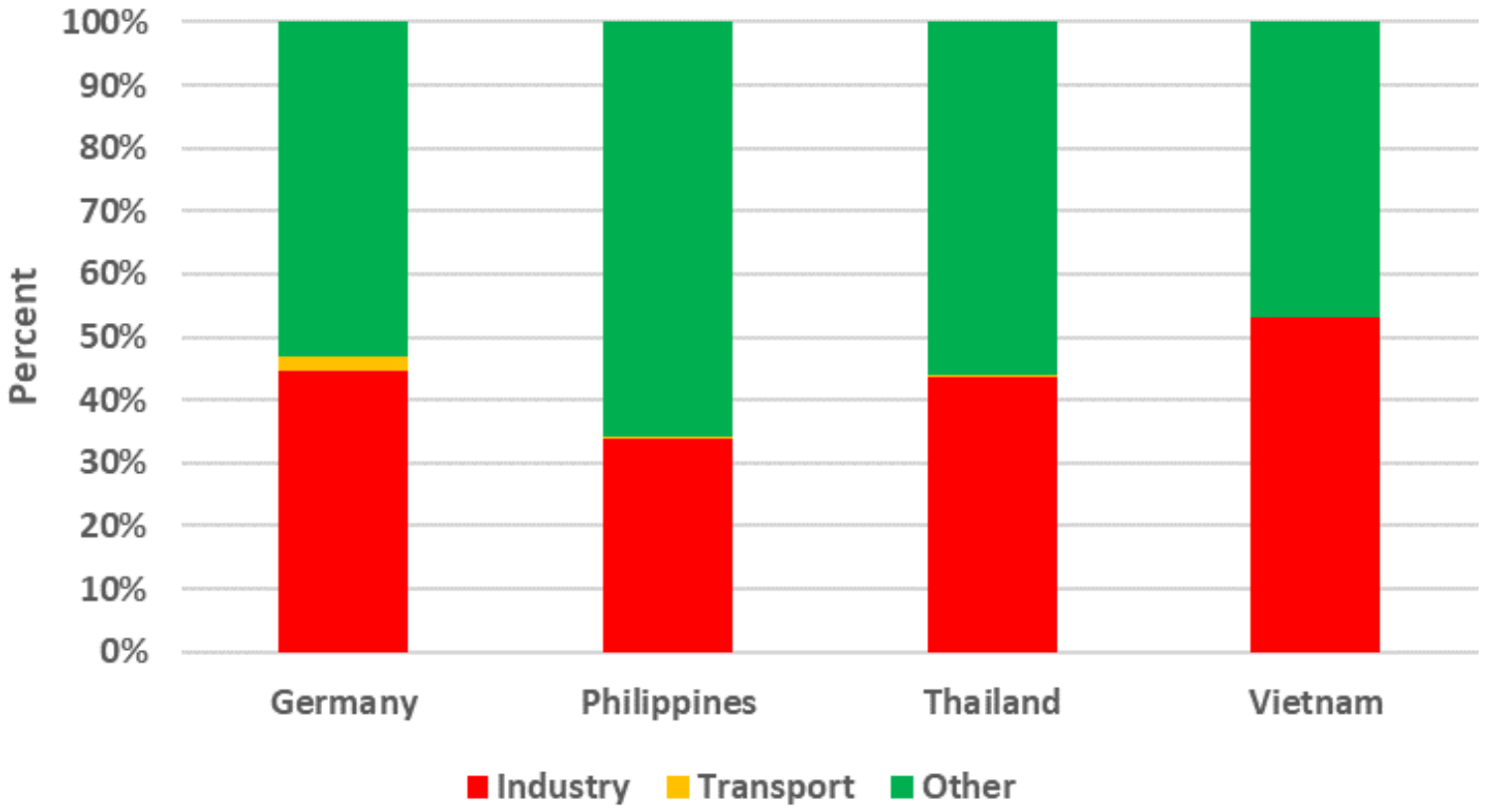
Share of the industrial sector is in the range of 15% to 32%. Conversion & losses attributable to industry are additional.



Source: https://www.iea.org/statistics/statisticssearch/report/?country=GERMANY&product=balances&year=2014

Electricity consumption by sector, 2014

The share of the industrial sector is in the range of 43% to 52%.



Source: https://www.iea.org/statistics/statisticssearch/

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Joint research topics

- **Energy and GHG balance** for the industrial sector of the city
- Perform **carbon footprints** and/or **audits** for representative companies
- Develop **transition strategies** for increases energy efficiency and renewable energy use in the industrial sector
- Analyze the **CHP potential** in the city, matching heat and electricity production and demand
- Analyze specific issues of **energy efficiency in commerce**, e.g. adressing waste heat from data centers
- Identify and test **load management** in industry and commerce
- Support **capacity building** activities for cleaner and energy efficient production

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Thank you for your attention! Questions?

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