

**GREEN
CHEMISTRY**

**Best Available Techniques (BAT),
Cleaner Production, Green Chemistry**

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Best Available Techniques Reference Documents (BREFs)

- BREF or "Best Available Techniques reference document (BAT)" means a document, resulting from the exchange of information organized pursuant to Article 13 of the **Industrial Emissions Directive (IED)** (2010/75/EU).
- BREFs are drawn up for defined activities and describing, in particular, applied techniques, present emissions and consumption levels, techniques considered for the determination of best available techniques.

IPPC Introduction

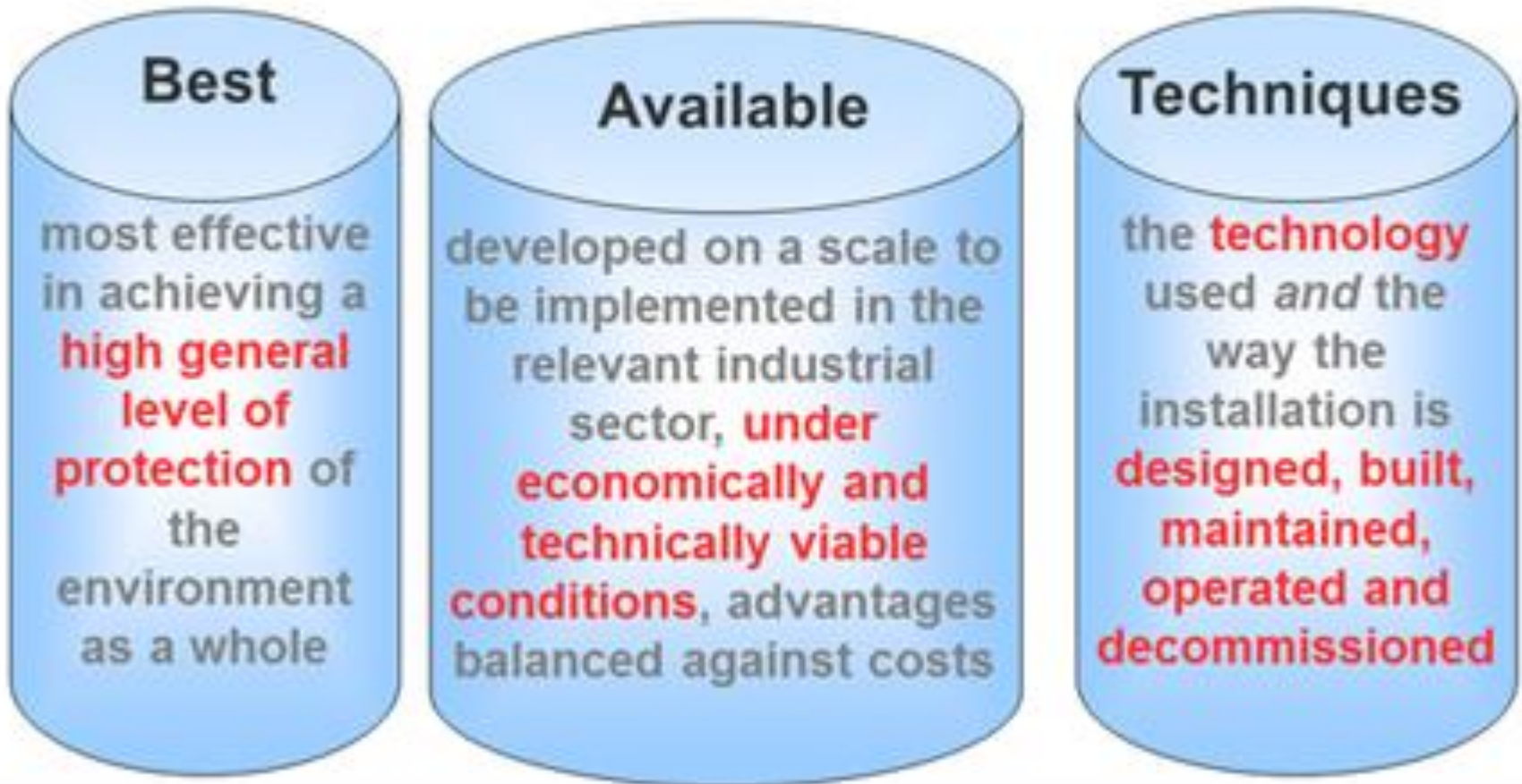
- The Directive 2008/1/EC (update of “the IPPC Directive” 96/61/EC) required industrial and agricultural activities with a high pollution potential to have a **single environmental permit** covering all their environmental impacts.
- This permit can only be issued if certain environmental conditions are met, so that the companies themselves bear responsibility for preventing and reducing any pollution they may cause.
- **IPPC: Integrated Pollution Prevention Control**

The Integrated Pollution Prevention and Control System

- The purpose is to prevent (minimize) pollution from **industrial activities**
- Achieve a high level of protection for the environment **as a whole**
- Installations must be operated according to an **integrated permit** issued by competent authorities, containing emission limit values based on **Best Available Techniques (BAT)**

Best Available Techniques

Best Available Techniques (BAT)



Environmental Scope

- Emissions to air
- Emissions to water
- Emissions to land
- Waste prevention and recovery
- Energy and water use
- Prevention and control of accidents
- Noise
- Vibration
- Heat
- Odor

Best Available Techniques Reference Documents (BREFs)

- BREF documents can be found on **The European IPPC Bureau** web page:
- <http://eippcb.jrc.ec.europa.eu/reference/>

The European IPPC Bureau web page

Name	Code	Adopted/Published Document	Formal draft	Kick off meeting report	Status
Ceramic Manufacturing Industry	CER	BREF (08.2007)			Review started
Common Waste Gas Treatment in the Chemical Sector	WGC		D1 (11.2019)	MR (09.2017 and 03.2018)	Review started
Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector	CWW	BREF BATC (06.2016)			Published
Economics and Cross-media Effects	ECM	REF (07.2006)			Document formally adopted
Emissions from Storage	EFS	BREF (07.2006)			Document formally adopted
Energy Efficiency	ENE	BREF (02.2009)			Document formally adopted
Ferrous Metals Processing Industry	FMP	BREF (12.2001)	D1 (03.2019)	MR (11.2016)	Document formally adopted

Contents of BREF documents



Standard BREF structure:

- Preface
- General information Chapter 1
- Process/techniques used..... Chapter 2
- Consumption and emission levels..... Chapter 3
- Candidate BAT Chapter 4
- BAT conclusions Chapter 5
- Emerging techniques Chapter 6
- Conclusions (suggestions for R&D)

“EKÖK (IPPC)-Entegre Kirlilik Önleme ve Kontrol”, Twinning Projesi



Bu proje Avrupa Birliđi ve Türkiye Cumhuriyeti tarafından finanse edilmektedir.



- BREF / MET’lerle ilgili Türkçe dokümanlar:
- <https://ippc.csb.gov.tr/bref-met-lerle-ilgili-turkce-dokumanlar-i-3333>
- Entegre Çevre İzni Yönetmeliđi Taslađı
- <http://webdosya.csb.gov.tr/db/ippc/icerikbelge/icerikbelge895.docx>

Resource Efficient and Cleaner Production (RECP)

- UNIDO's **Resource Efficient and Cleaner Production** (RECP) method entails the continuous application of preventive environmental strategies to processes, products and services in order to increase efficiency and reduce risks to humans and the environment.

Resource Efficient and Cleaner Production (RECP)

- RECP addresses the three sustainability dimensions individually and synergistically:
- a) heightened economic performance through improved productive use of resources,
- b) environmental protection by conserving resources and minimizing industry's impact on the natural environment,
- c) social enhancement by providing jobs and protecting the wellbeing of workers and local communities.

Resource Efficient and Cleaner Production (RECP)



PRODUCTION EFFICIENCY

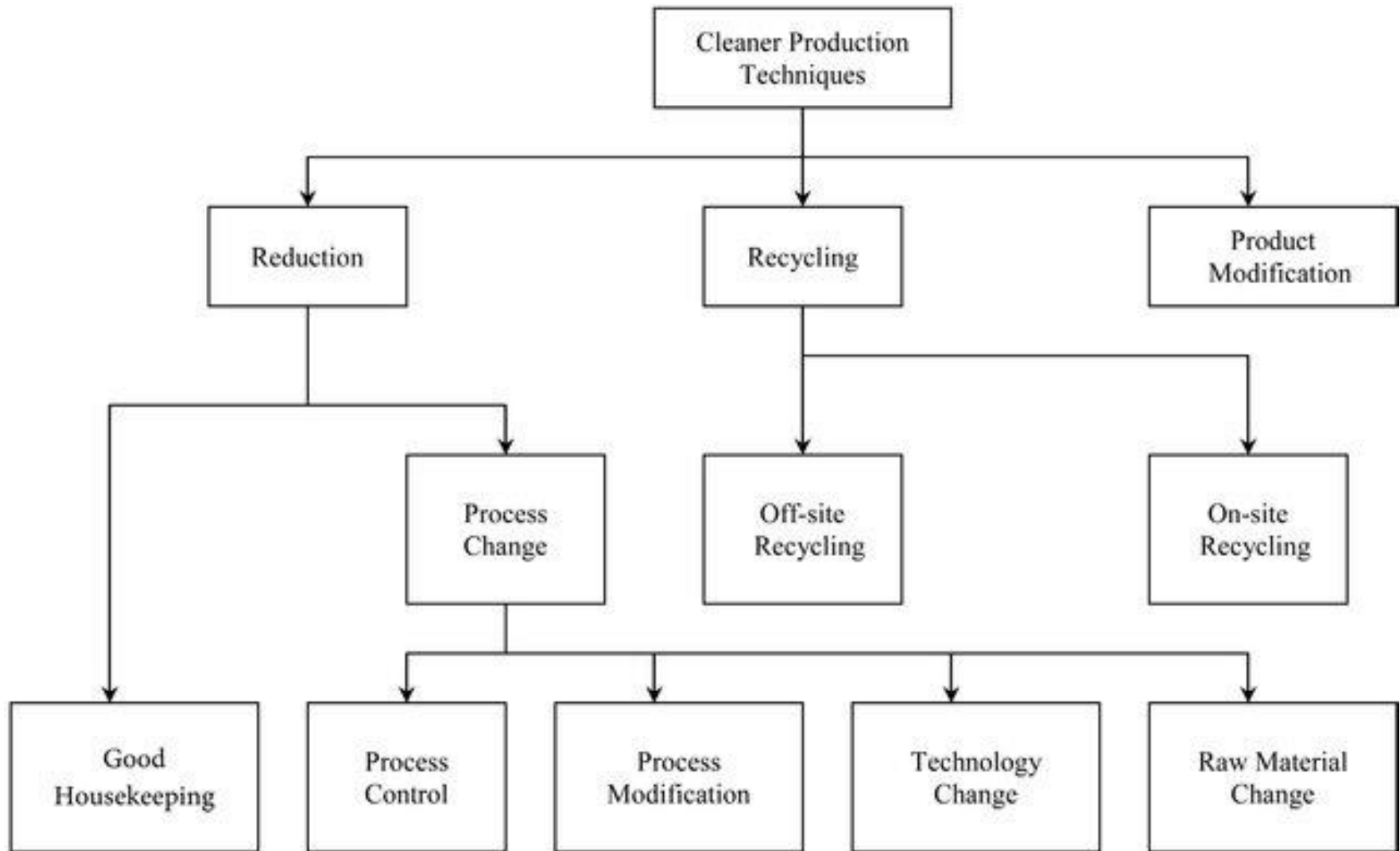
Improve the productive use of natural resources

ENVIRONMENTAL PROTECTION

Minimize the impact on nature

SOCIAL ENHANCEMENT

Support communities and reduce risks



Tools of Cleaner Production

- **Good Housekeeping**: appropriate provisions to prevent leaks and spills and to achieve proper, standardized operation and maintenance procedures and practices;
- **Input Material Change**: replacement of hazardous or non-renewable inputs by less hazardous or renewable materials or by materials with a longer service life-time;
- **Better Process Control**: modification of the working procedures, machine instructions and process record keeping for operating the processes at higher efficiency and lower rates of waste and emission generation;
- **Equipment Modification**: modification of the production equipment so as to run the processes at higher efficiency and lower rates of waste and emission generation;

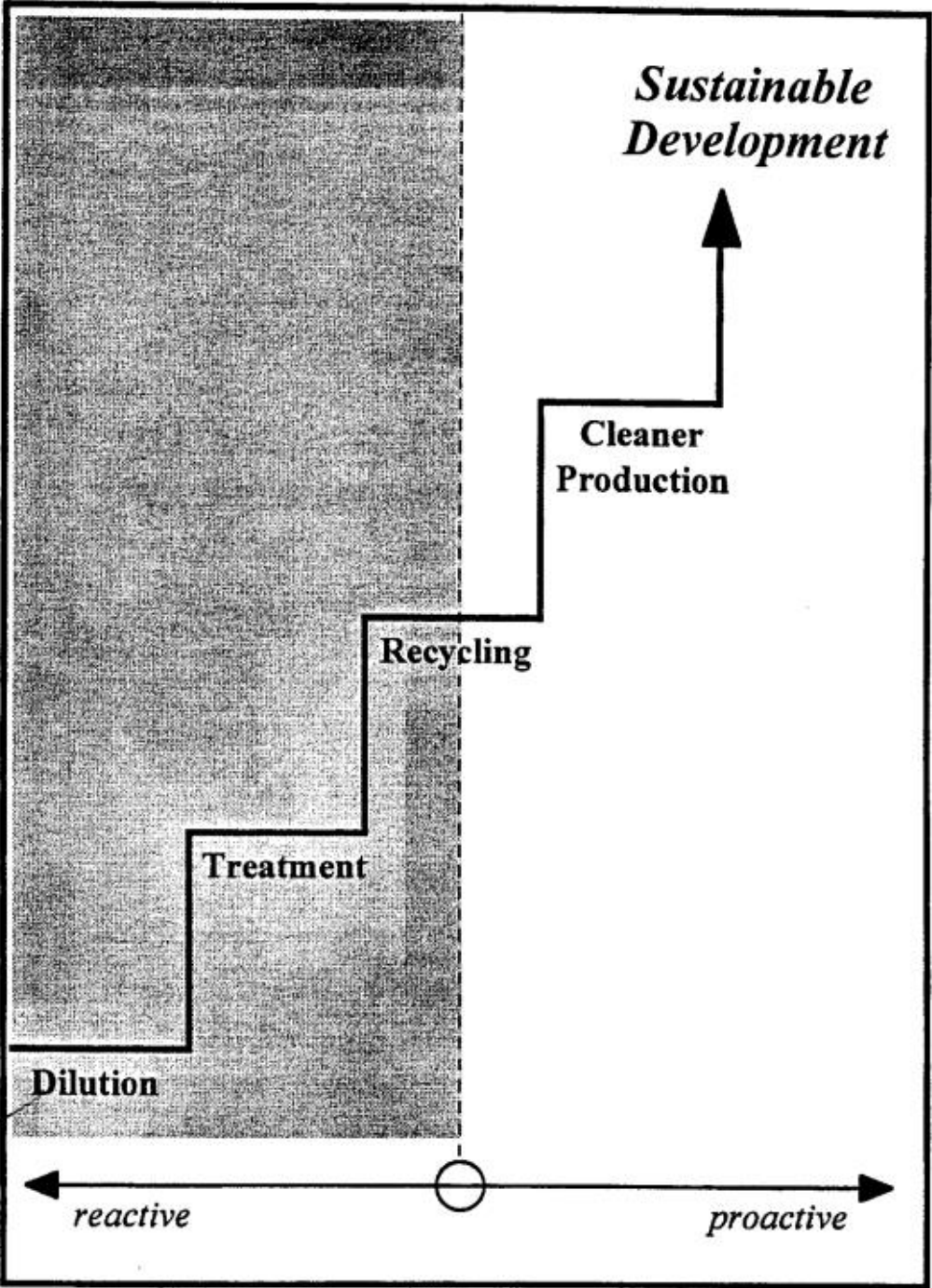
- **Technology Change**: replacement of the technology, processing sequence and/or synthesis pathway in order to minimize the rates of waste and emission generation during production;
- **On-Site Recovery/Reuse**: reuse of the wasted materials in the same process or for another useful application within the company;
- **Production of Useful By-Products**: transformation of previously discarded wastes into materials that can be reused or recycled for another application outside the company; and
- **Product Modification**: modification of product characteristics in order to minimize the environmental impacts of the product during or after its use (disposal) or to minimize the environmental impacts of its production.

Waste Hierarchy and Cleaner Production

Waste hierarchy and cleaner production



Cleaner production opportunities prevent and minimize waste and are the preferred option in the waste hierarchy.



SÜRDÜRÜLEBİLİR SİSTEMLER (SUSTAINABLE SYSTEMS)

SC: Sustainable Consumption (Sürdürülebilir Tüketim)

SP: Sustainable Production (Sürdürülebilir Üretim)

RC: Responsible Care (Üçlü Sorumluluk)

ALT SİSTEMLER (SUB – SYSTEMS)

ET: Environmental Technology (Çevre Teknolojileri)

EE: Environmental Engineering (Çevre Mühendisliği)

IPPC: Integrated Pollution Prevention Control (Entegre Kirlilik Önleme ve Kontrol)

IE: Industrial Ecology (Endüstriyel Ekoloji)

P2: Pollution Prevention (Kirliliğin Önlenmesi)

PSS: Product Service System (Ürün Servis Sistemi)

EMS: Environmental Management Strategy (Çevresel Yönetim Stratejileri)

PRENSİPLER (PRINCIPLES)

DE: Degradation (Bozundurma)

P: Purification (Aritma)

RU: Reuse (Yeniden Kullanım)

RG: Regeneration (Yenilenme)

RF: Remanufacturing (Yeniden Üretim)

RE: Recycling (Geri Dönüşüm)

RP: Repair (Onarım)

RV: Recovery (Geri Kazanım)

MRU: Minimization Resource of Usage (Kaynak Kullanımının Minimize Edilmesi)

R2: Renewable Resources (Yenilenebilir Kaynaklar)

SR: Source Reduction (Kaynakta Azaltma)

FX: Factor x (Faktör- x)

PP: "Polluter Pays" principle ("Kirleten Öder" Prensipleri)

HS: Health and Safety (Sağlık ve Güvenlik)

SRE: Social Responsibility (Sosyal Sorumluluk)

M: Mutualism (Kazan-kazan)

E2: Eco- efficiency (Eko-verimlilik)

EI: Ethical investment (Etik Yatırım)

R: Reporting to the Stakeholders (Paydaşları Bilgilendirme)

EA: Environmental Accounting (Çevre Muhasebesi)

YAKLAŞIMLAR (APPROACHES)

PC: Pollution Control (Kirlilik Kontrolü)

WM: Waste Minimization (Atık Minimizasyonu)

LCA: Life Cycle Assessment (Yaşam Döngüsü Değerlendirme)

ZW: Zero Waste (Sıfır Atık)

ED: Eco-design (Eko-tasarım)

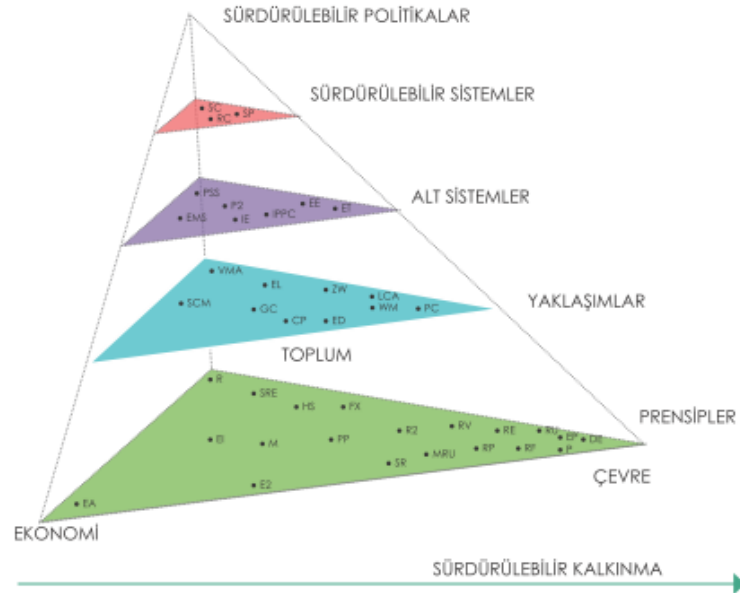
CP: Cleaner Production (Temiz Üretim)

EL: Environmental Legislation (Çevre Mevzuatı)

GC: Green Chemistry (Yeşil kimya)

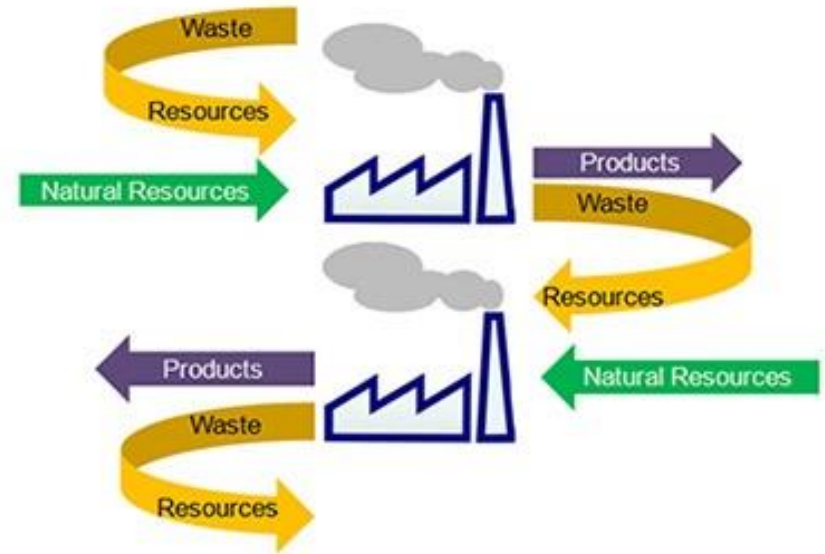
VEA: Voluntary Environmental Agreement (Gönüllü Çevresel Anlaşma)

SCM: Supply Chain Management (Tedarik Zinciri Yönetimi)



Industrial Symbiosis

Instead of being thrown away, surplus resources generated by an industrial process are captured then redirected for use as a 'new' input into another process by one or more other companies, providing a mutual benefit or symbiosis.



<https://www.international-synergies.com/our-approach/what-is-industrial-symbiosis/>

<https://resource.co/article/industrial-symbiosis-one-mans-waste-11903>

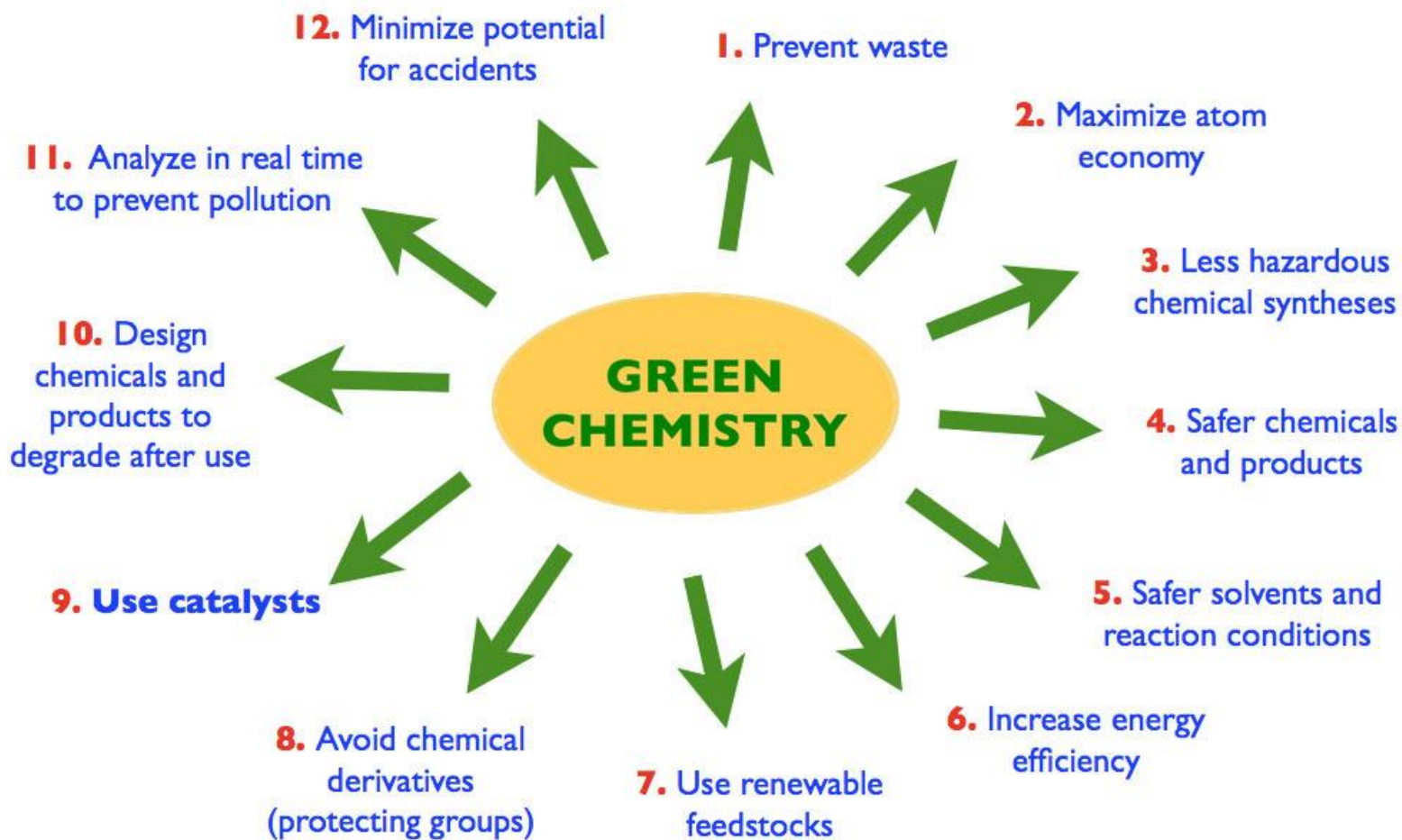
Green Chemistry

- Green chemistry is the design of chemical products and processes that reduce or eliminate the generation of hazardous substances.
- Green chemistry applies across the life cycle of a chemical product, including its design, manufacture, use, and ultimate disposal.
- Green chemistry is also known as sustainable chemistry.

Green Chemistry

- Prevents pollution at the molecular level
- Is a philosophy that applies to all areas of chemistry, not a single discipline of chemistry
- Applies innovative scientific solutions to real-world environmental problems
- Results in source reduction because it prevents the generation of pollution
- Reduces the negative impacts of chemical products and processes on human health and the environment
- Lessens and sometimes eliminates hazard from existing products and processes
- Designs chemical products and processes to reduce their intrinsic hazards

The Twelve Principles of Green Chemistry



Anastas and Warner (1998)

<http://ccvc.research.mcgill.ca/research/research.html>

Global Cleantech Innovation Index

Inputs to Innovation

A: General Innovation Drivers

- General innovation inputs
- Entrepreneurial culture

B: Cleantech-Specific Innovation Drivers

- Government policies
- Public R&D spending
- Access to private finance
- Infrastructure for renewables
- Cleantech industry organisations

Outputs of Innovation

C: Evidence of Emerging Cleantech Innovation

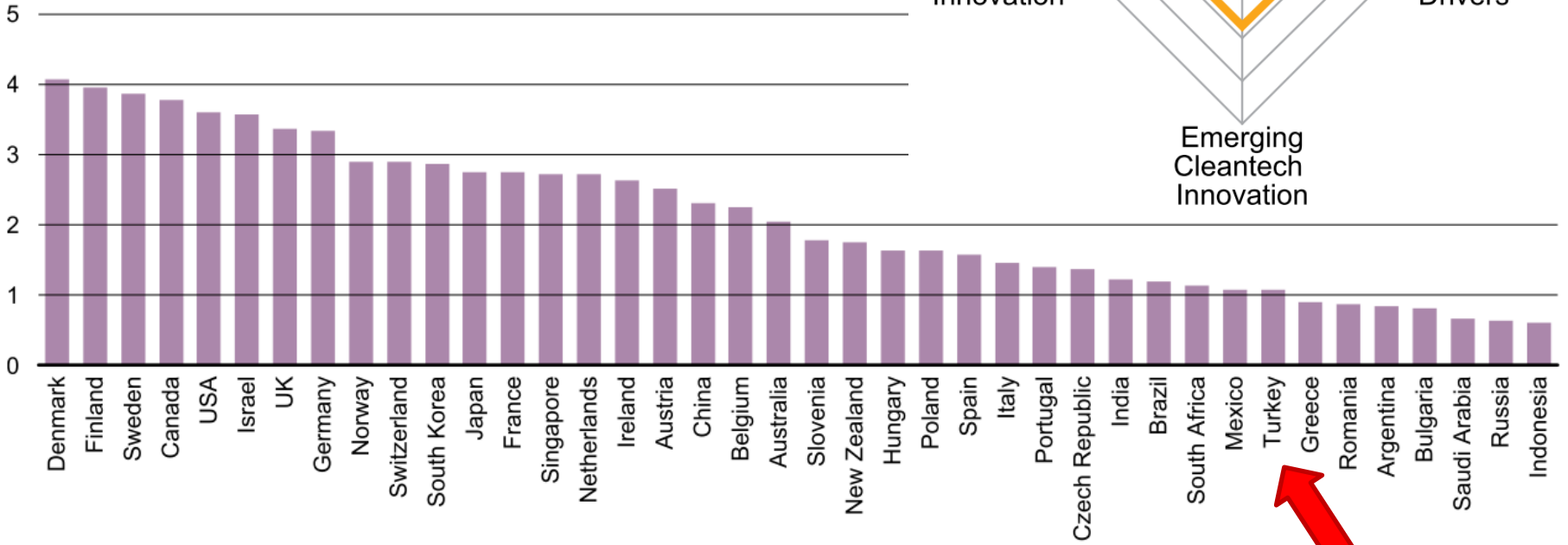
- Early-stage private investment
- High impact companies
- Environmental patents

D: Evidence of Commercialised Cleantech Innovation

- Company revenues
- Renewable energy consumption
- Late-stage investment and exits
- Listed cleantech companies
- Employees

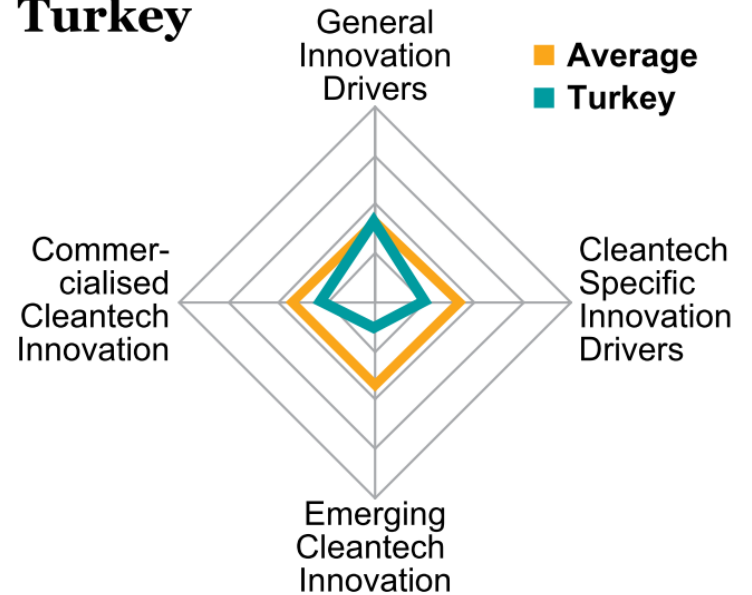
WWF Global Cleantech Innovation Index 2017 - Turkey

Figure 3: Cleantech Countries Innovation Index



Turkey ranks 33rd in the Index.

Turkey



Useful Resources of Cleaner Production & Resource Efficiency

- T.C. Bilim, Sanayi ve Teknoloji Bakanlığı, Verimlilik Genel Müdürlüğü, Temiz Üretim Bilgi Platformu:
- <http://www.temizuretim.gov.tr/referansbelgeler.aspx>