Session 1: Portfolio of mitigation options - Defining a common ground for assessments

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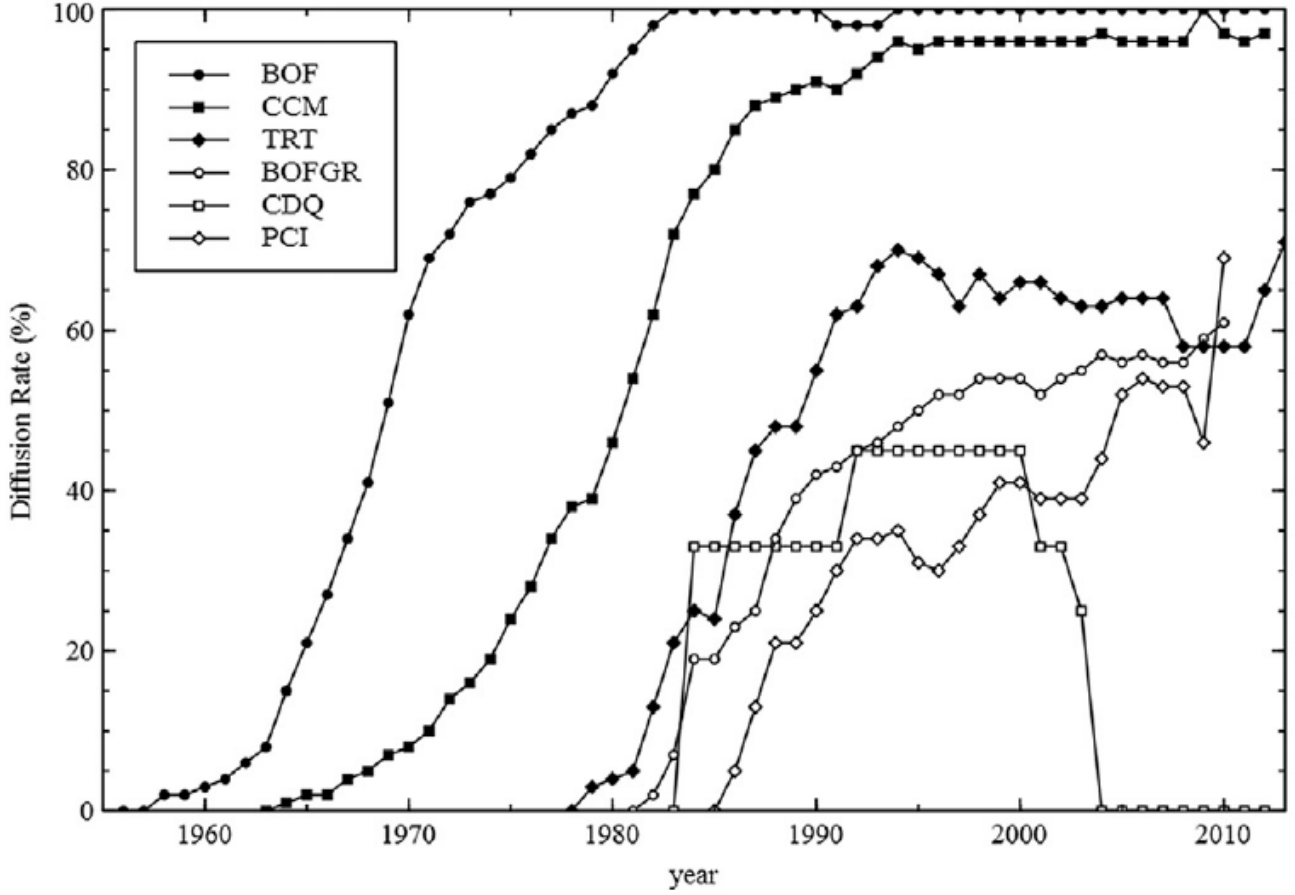
Diffusion of major steelmaking innovations in Germany 1950-2013 (Arens and Worrell 2014)



BOF diffusion

- 1953: Market entry in Austria
- 1958: Market entry in GER
- 1964: 8% market share in GER
- 1970: ~70%
- 1983: 100%

Abbreviations

BOF: Basic oxygen furnace

CCM: Continous casting machinges

TRT: top pressure recovery turbine

BOFGR: BOF gas recovery

CDQ: Coke dry quenching

PCI: Pulverized coal injection

EU 2011 low carbon roadmap and sector roadmaps

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Numerous GHG mitigation roadmaps by EC and associations assessed

Still confidential; to be published as Friedrichsen, Erdogmus (2017): Comparative Analysis of options and potential for emission abatement in industry – Summary of study comparison and Study factsheets, Fraunhofer ISI, Karlsruhe

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Emission reduction in comparison

Still confidential; to be published as Friedrichsen, Erdogmus (2017): Comparative Analysis of options and potential for emission abatement in industry – Summary of study comparison and Study factsheets, Fraunhofer ISI, Karlsruhe

Some first conclusions from the comparison

Still confidential; to be published as Friedrichsen, Erdogmus (2017): Comparative Analysis of options and potential for emission abatement in industry – Summary of study comparison and Study factsheets, Fraunhofer ISI, Karlsruhe

Structuring mitigation options in basic materials industries

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Structuring mitigation options in basic materials industries – BAT and BNAT

	Clusters of mitigation options	BAT	BNAT
Materials industry	**Energy Efficiency** (modernization and replacement)	• *Oxy-fuel burners* • *Use of waste heat* • *Shoe press in paper dewatering*	• *Primary aluminium: inert anodes* • *Low-carbon cement*
	Fuel switch	• *Clinker: Lignite -> waste/biomass* • *Steam: Natural gas/ biomass* • Natural gas DRI-EAF	• *Steel: RES-H2 DRI-EAF*
	End-of-pipe (CCS)	• *CCS cement* • *CCS steel*	• *CCS steel TRT*
downstream	**Recycling and re-use**	• *Paper recycling* • *Electric steel* • *NFM-recycling*	• *Cement recycling (to replace clinker)*
	Material efficiency (downstream)	• *Construction: less over-dimensioning* • *Longer living products*	• *Carbon reinforced concrete* • *Longer living products*
	Material substitution (downstream)	• *Construction: Wood, clay and straw replacing concrete and steel*	• *Low-carbon cement*

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Structuring mitigation options in basic materials industries – increm. and radical

	Clusters of mitigation options	Incremental change (modernization)	Radical change (mostly replacement of plant)
Materials industry	**Energy Efficiency** (modernization and replacement)	• *Shoe press in paper dewatering* • *Oxy-fuel burners*	• *Primary aluminium: inert anodes* • *„Low-carbon cement“*
	Fuel switch	• *Clinker: Lignite -> waste/biomass* • *Steam: Natural gas/biomass*	• *Steel: RES-H2 DRI-EAF* • *Steel: DRI-EAF*
	End-of-pipe (CCS)	•*CCS cement*	
	Recycling and re-use	• *Paper recycling* • *Glass recycling*	• *Cement recycling (to replace clinker)* • *Electric steel*
downstream	**Material efficiency** (downstream)	• *Construction: less over-dimensioning*	• *Carbon reinforced concrete*
	Material substitution (downstream)	*?*	• *„Low-carbon cement“* • *Construction: Wood, clay and straw replacing concrete and steel*

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Structuring mitigation options in basic materials industries

	Clusters of mitigation options	BAT	BNAT
Materials industry	**Energy Efficiency** (modernization and replacement)	• Sk…	…les
	Fuel switch		
	End-of-pipe (CCS)		
downstream	**Recycling and re-use**		
	Material efficiency (downstream)		
	Material substitution (downstream)	Ste…	

- *Are elements missing?*
- *Can you think of additional technologies that fit well/ not well in this cluster?*
- *Is "climate friendly production process" a cluster for itself?*
- *What additional dimensions are interesting to compare across mitigation clusters?*

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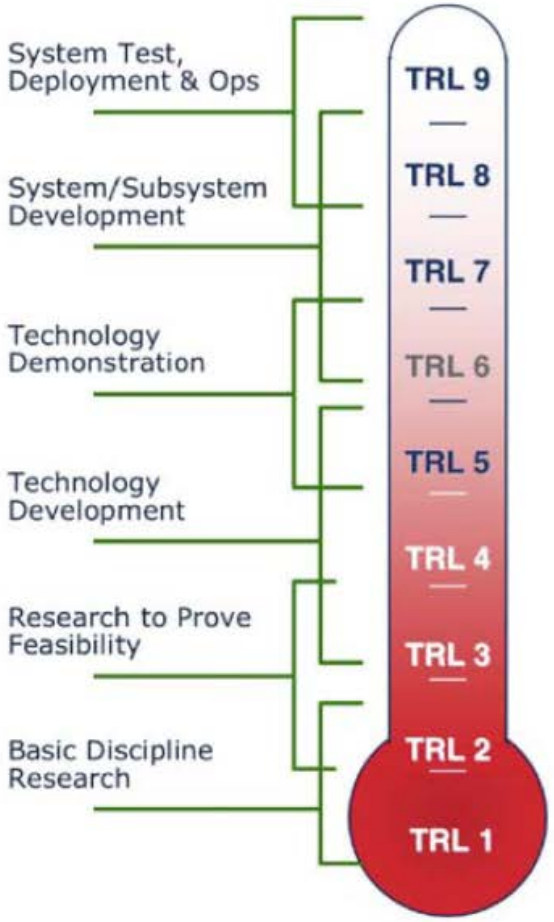
Use **technology readiness levels** (TLR) for monitoring and for more targeted policies?



Actual system "proven" through successful system and/or mission operations

Actual system completed and :qualified" through test & demonstration (in the operational environment

System prototype demonstration in the planned operational environment

System/subsystem model or prototype demonstration in a relevant environment (Ground or Space)

Component and/or breadboard validation in relevant environment

Component and/or breadboard validation in 'laboratory' environment

Analytical and experimental critical function and/or characteristic proof-of-concept

Technology concept and/or application formulated

Basic principles observed and reported

Example from NASA by Mankins (2009)

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Research questions to address

- How broad a **portfolio** is required to tackle the climate challenge and does it include options with different mitigation costs? How important are **innovations** and what can be done with **available technology**?
  - What is a suitable framework for assessing the impact of mitigation options in basic materials sector?
  - What are credible, innovative technological options for emissions reductions in the materials sector (including long shot solutions)?
  - What is the reduction potential of the individual options until 2050?
  - What is the state of the selected technologies in the **innovation cycle** (e.g. lab scale experiments? Pilots? Etc.)?

Summary and discussion

First theses to test:

- *The remaining energy efficiency potential from BAT is low (<10%)*
- *Remaining energy efficiency potential from BNAT is likely low to medium (<20%)*
- *Downstream options (material substitution and efficiency) received less attention, but might be an important part of a climate friendly materials sector*
- *Ambitious reduction pathways (-80% compared to 1990) require BNAT and solutions at the material end-user such as material efficiency or substitution or CCS*

***Discussion**:*

- *What is a useful typology of mitigation options in basic materials?*
- *Can inclusion of Technology Readiness Levels in assessments facilitate more targeted policy recommendations?*
- *Where are the main research gaps?*
- *What is needed to provide useful policy advice?*

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Thank you for your attention!

More information:

Fleiter, Rehfeldt, Pfluger (2016): A transition pathway for Germany's industry – what role for energy efficiency? Eceee industrial summer study 2016, Berlin

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