Central European University
Department of Environmental Sciences and Policy

Mitigation opportunities in buildings

How can Africa benefit?

Diana Ürge-Vorsatz
Mark Levine

With Aleksandra Novikova

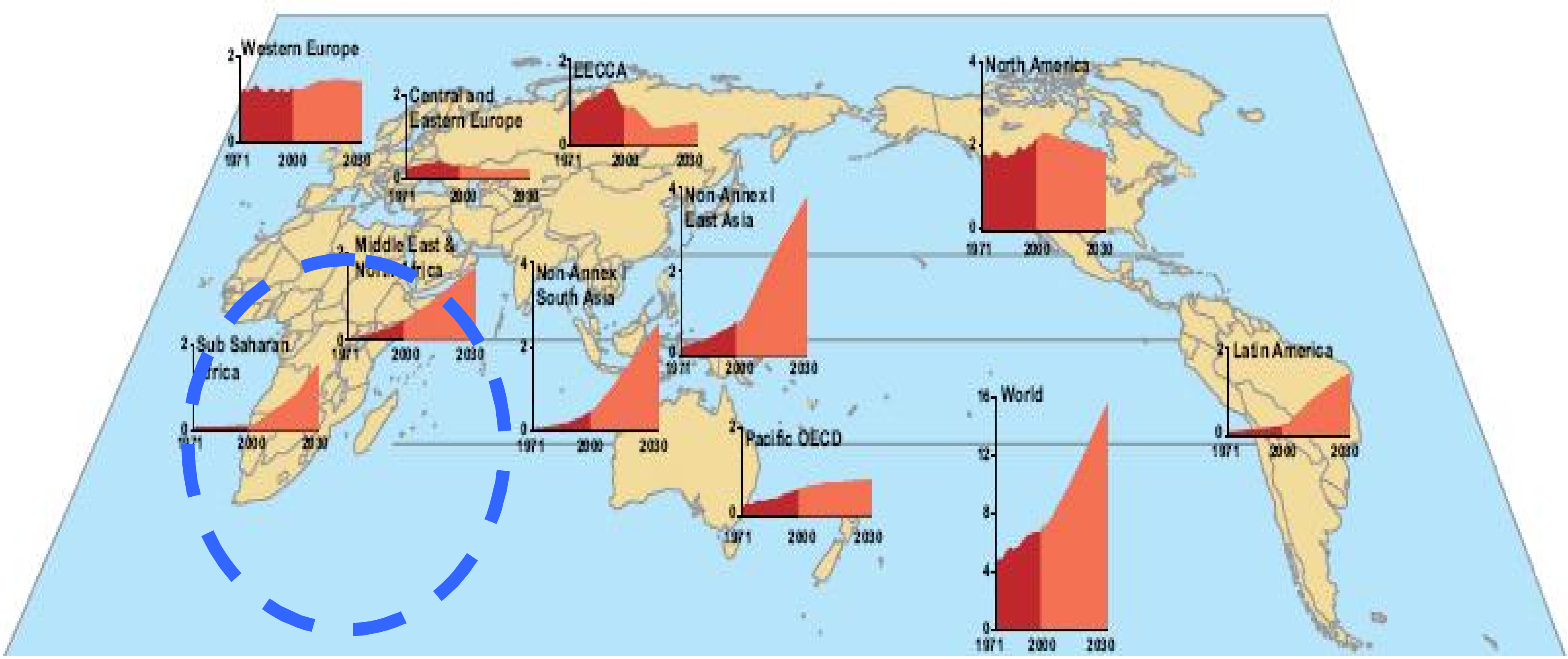
Nov 1, Cape Town

Outline

- Mitigation in the buildings sector: global and regional importance
- Potential and costs of GHG mitigation in buildings
- Co-benefits of GHG mitigation in bldgs: how can Africa benefit?
- Policies to improve energy-efficiency in Africa
- Conclusions

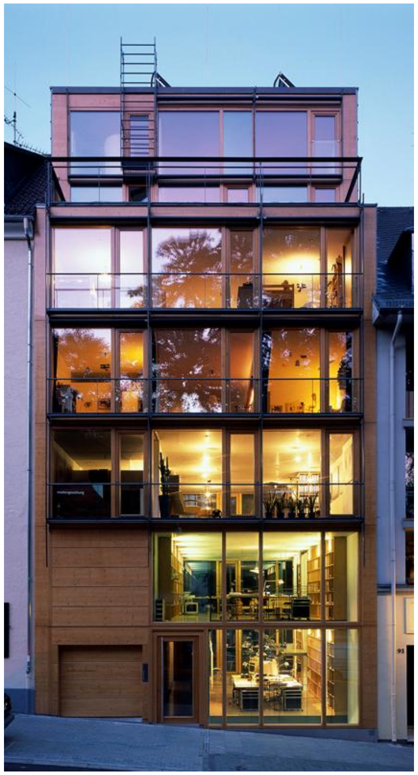
Buildings sector: global and regional importance

- In 2004, in Buildings were responsible for app. 1/3 of global CO_2 emissions



CO2 emissions including through the use of electricity
A1B scenario

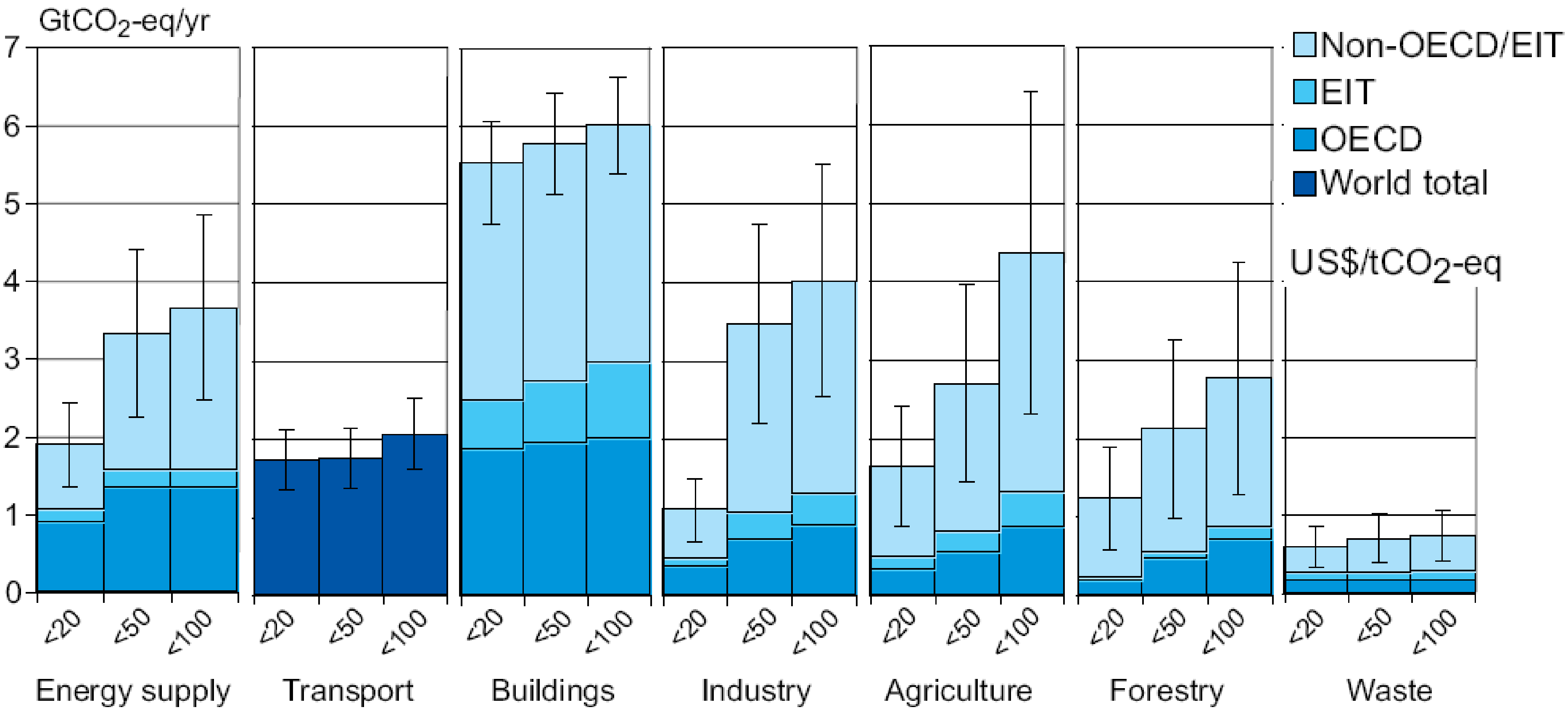
Potential and costs of GHG mitigation in developing countries



The importance of improved energy efficiency in GHG mitigation

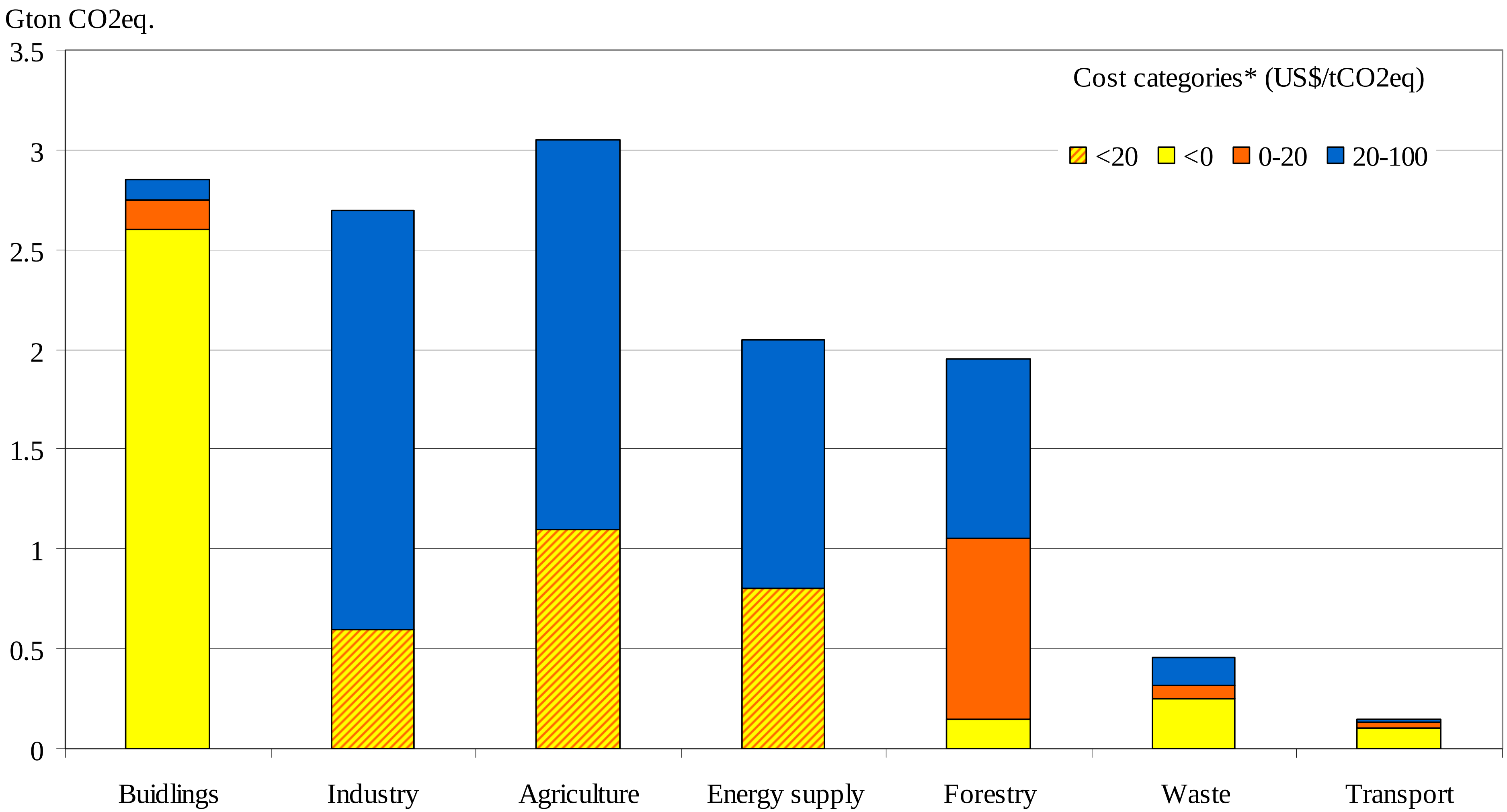
- If costs are taken into account, improved building efficiency becomes the most important instrument in our mitigation portfolio in the short- to mid-term

Sectoral economic potential for global mitigation for different regions as a function of carbon price, 2030



(potential at <US$100/ tCO_2-eq: 2.4 - 4.7 Gt CO_2-eq/yr)	*(potential at <US$100/ tCO_2-eq: 1.6 - 2.5 Gt CO_2-eq/yr)*	*(potential at <US$100/ tCO_2-eq: 5.3 -6.7 Gt CO_2-eq/yr)*	*(potential at <US$100/ tCO_2-eq: 2.5 - 5.5 Gt CO_2-eq/yr)*	*(potential at <US$100/ tCO_2-eq: 2.3 -6.4 Gt CO_2-eq/yr)*	*(potential at <US$100/ tCO_2-eq: 1.3 - 4.2 Gt CO_2-eq/yr)*	*(potential at <US$100/ tCO_2-eq: 0.4 - 1 Gt CO_2-eq/yr)*

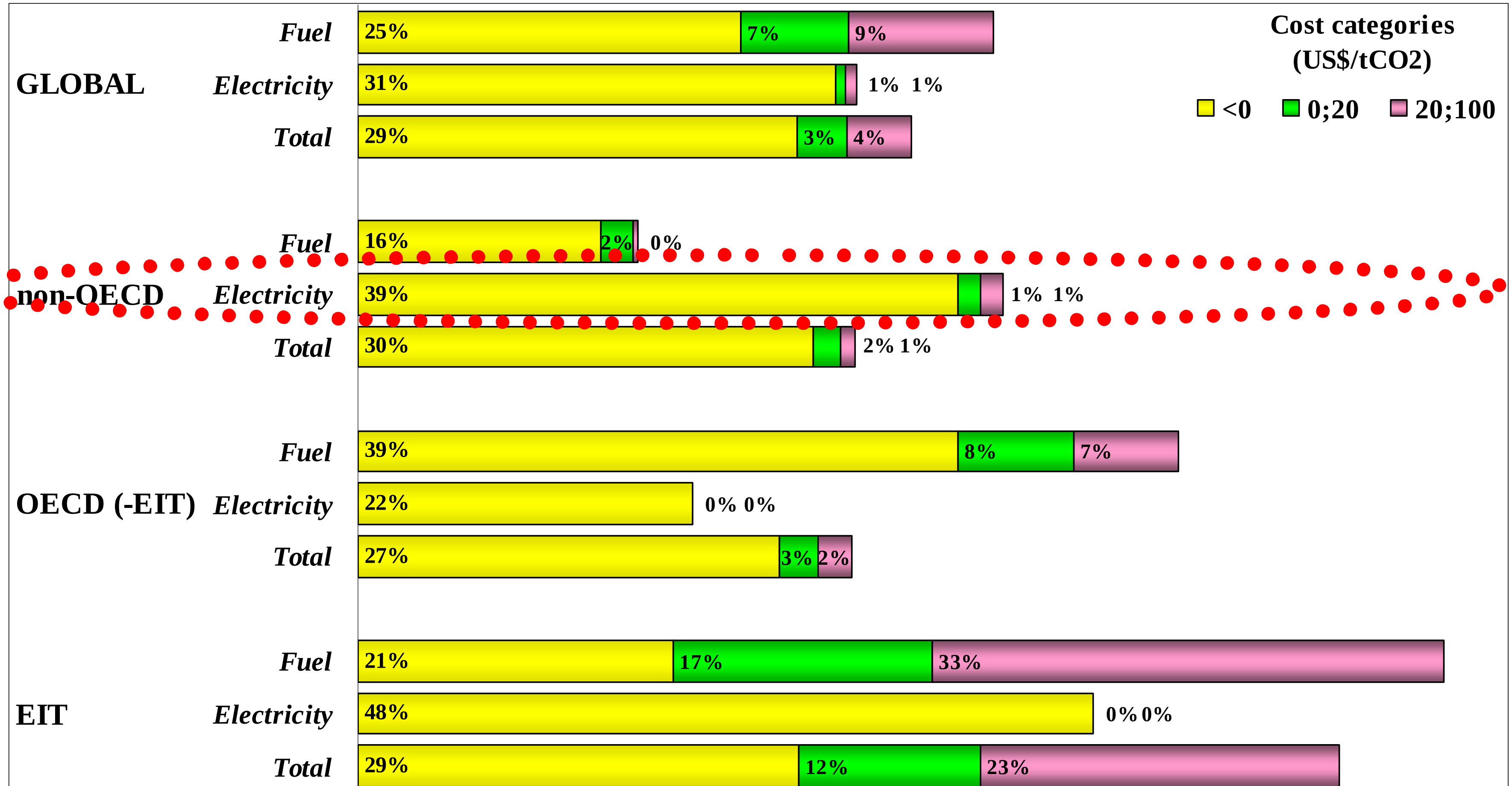
Estimated potential for GHG mitigation at a sectoral level in 2030 in different cost categories in developing countries



* For the buildings, forestry, waste and transport sectors, the potential is split into three cost categories: at net negative costs, at 0-20 US$/tCO2, and 20-100 US$/tCO2. For the industrial, forestry, and energy suppy sectors, the potential is split into two categories: at costs below 20 US$/tCO2 and at 20-100 US$/tCO2.

Constructed based on Chapter 11 results

Potential related to electric and fuel end-uses, 2020 (as shares of respective fuel- and electricity associated baseline CO2 emissions)



	Baseline Billion tons CO_2	Absolute values of potential in cost categories, Billion tons CO_2 (in US\$/tCO_2)			
		<0	0-20	20-100	Total <100
Global	11.1	3.2	0.35	0.45	4.0
Non-OECD	5.0	1.5	0.10	0.05	1.6
OECD (-IET)	4.8	1.3	0.10	0.10	1.6
EIT	1.3	0.40	0.15	0.30	0.85

Country/ region	Reference	Type of potential	Description of mitigation scenarios	Potential		Measures with lowest costs	Measures with highest potential	Notes
				Million tCO_2	Baseline (%)			
South Africa	De Villiers and Matibe, 2000 De Villiers, 2000	Technical	21 options: light practices; new & retrofits HVAC; stoves, thermal envelope; fuel switch in heaters; standards & labelling; for hot water: improved insulation, heat pumps, efficient use; solar heating.	41	23%	1. Energy star equipment; 2. Lighting retrofit; 3. New lighting systems.	1. Hybrid solar water heaters; 2. New building thermal design; 3. New HVAC systems.	[1] 6%; [4] Fr-ef.; [5] BY 2001; TY 2030.
		Economic		37	20%			
Croatia	UNFCCC NC1 of Croatia, 2001	Market	Electricity savings for not heating purposes (low energy bulbs, more efficient appliances, improved motors), solar energy use increase, thermal insulation improvement.	2	14%	1. Bulbs & appliances; 2. Solar energy use increase; 3. Insulation improvement	1. Insulation improvement; 2. Solar energy use increase; 3. Bulbs & appliances.	[1] n.a.
Studies providing information about both supply and demand-side options not separating them								
New EU Member States[a)]	Lechtenbohmer et al., 2005	Economic	Improvement in space and water heating, appliances and lighting, cooling/freezing, air-conditioning, cooking, motors, process heat, renewable energies, reduced emissions from electricity generation.	81	37%	n.a. (not listed in the study)	R: 1.Insulation; 2.Heating systems, fuel switch, DH&CHP; C: 1. Energy efficiency, 2. Renewables.	[1] 3-5%; [5] BY 2005; [7] C includes agriculture.
USA	Koomey et al., 2001	Market	Voluntary labelling, deployment programmes, building codes, new efficiency standards, government procurement, implementation of tax credits, expansion of cost-shared federal R&D expenditures.	898	37%	n.a. (The study did not examine a GHG potential supply cost curve).	1. Lighting; 2. Space cooling; 3.Space heating.	[1] 7%; [5] BY 1997.
Japan	Murakami et al., 2006	Technical	15 options: new and retrofit insulation, double glazing window, home appliances (water & space heating/cooling, lighting, cooking), PVs, solar heating, shift to energy efficient living style, low-carbon electricity generation.	46	28%	n.a. (not listed in the study)	1. Water heater; 2. Space heater; 3. Home appliances.	[1] n.a.; [7] R only.
Germany	Martinsen et al., 2002	Technical	Two options: fuel switch from coal and oil to natural gas and biomass and heat insulation.	31	26%	n.a. (not listed in the study)	1.Heat insulation; 2.Fuel switch from coal & oil to gas & biomass.	[1] n.a.; [5] BY 2002; [7] R only.

The importance of improved energy efficiency in GHG mitigation

- Energy efficiency is one of the most important options to reduce GHG emissions worldwide in the short- to mid-term
- If costs are taken into account, improved building efficiency becomes the most important instrument in our portfolio in the short- to mid-term
- The majority of technologies and know-how are widely available
- New buildings can achieve the largest savings
  - As much as 80% of the operational costs of standard new buildings can be saved through integrated design principles
  - Often at no or little extra cost
  - Hi-efficiency renovation is more costly, but possible

Co-benefits of GHG mitigation:

or how can Africa benefit?

Co-benefits of improved energy-efficiency in buildings

- co-benefits are especially abundant and strong in the buildings sector
- Co-benefits are often not quantified, monetized, or even identified by the decision-makers
- Esp. true in developing countries due to insufficient research, a priority role of other problems
- However, in developing countries they will be the key reason to pursue mitigation options
- The overall financial value of co-benefits may be higher than the value of the energy savings benefits

The key co-benefits for SSA

- Reduced morbidity and mortality
  - **App. 2.2 million deaths attributable to indoor air pollution each year from biomass** (wood, charcoal, crop residues and dung) and coal burning for household cooking and heating energy needs, in addition to acute respiratory infections in young children and chronic obstructive pulmonary disease in adults
  - In addition, women and children also bear the brunt of the work of collecting biomass fuel
- Poverty alleviation
  - Energy-efficient household equipment and low-energy building design helps households afford adequate energy services
  - Clean and efficient utilization of locally available renewable energy sources reduces/replaces the need for energy and fuel purchases, and improves energy security
- Employment creation
  - "producing" energy through energy efficiency or renewables is more employment intensive than through traditional ways
  - The European Commission estimates that a 20% reduction in EU energy consumption by 2020 can potentially create 1 mil new jobs in Europe, especially in the area of semi-skilled labour in the buildings trades
- new business opportunities
  - E.g. the ESCO industry is a lucrative business in many world regions
  - Ex. for developed countries the experts estimate a market opportunity of € 5–10 billion in energy service markets in Europe
- Reduced energy costs will make businesses more competitive
- Others:
  - Improved energy security
  - reduced burden of constrained capacities
  - Increased value for real estate
  - Improved energy services (lighting, thermal comfort, etc) can improve productivity

Why is early investment into energy-efficiency important?

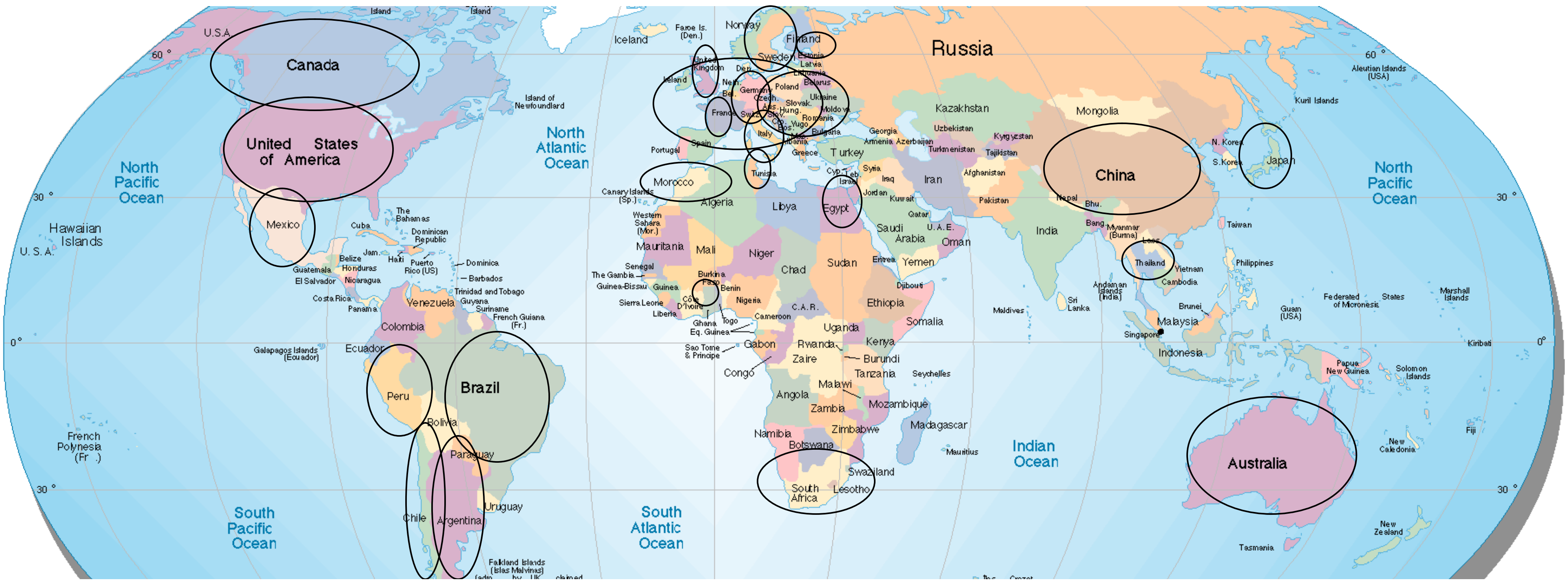
Table 11.17: *Observed and estimated lifetimes of major GHG-related capital stock*

Typical lifetime of capital stock			Structures with influence > 100 years
Less than 30 years	30-60 years	60-100 years	
Domestic appliances Water heating and HVAC systems Lighting Vehicles	Agriculture Mining Construction Food Paper Bulk chemicals Primary aluminium Other manufacturing	Glass manufacturing Cement manufacturing Steel manufacturing Metals-based durables	Roads Urban infrastructure Some buildings

Policies to capture the GHG mitigation potential in Africa

Background research

- Research questions:
  - Which policies achieve high energy savings and GHG reductions? Which are very cost-effective? What are the success factors? How all these apply to developing countries?



©1994 Magellan Geographix[SM] Santa Barbara, CA (800) 929-4MAP Robinson Projection

The impact and effectiveness of various policy instruments
Part 1: Control and regulatory mechanisms- normative instruments

Policy instrument	Country examples	Effec-tiveness	Energy or emission reductions for selected best practices	Cost-effectiveness	Cost of GHG emission reduction for selected best practices	Special conditions for success, major strengths and limitations, co-benefits
Appliance standards	EU, US, JP, AUS, Br, Cn	**High**	Jp: 31 M tCO_2 in 2010; Cn: 250 Mt CO_2 in 10 yrs US: 1990-1997: 108 Mt CO2eq, in 2000: 65MtCO_2 = 2.5% of el.use, Can: 8 MtCO_2 in total by 2010, Br: 0.38 MtCO_2/year AUS: 7.9 MtCO_2 by 2010	**High**	AUS: -52 \$/tCO_2 in 2020, US: -65 \$/tCO_2 in 2020; EU: -194 \$/tCO_2 in 2020 Mar: 0.008 \$/kWh	Factors for success: periodical update of standards, independent control, information, communication and education
Building codes	SG, Phil, Alg, Egy, US, UK, Cn, EU	**High**	HkG: 1% of total el.saved US: 79.6 M tCO_2 in 2000; EU: 35-45 MtCO_2, up to 60% savings for new bdgs UK: 2.88 MtCO_2 by 2010, 7% less en use in houses 14% with grants& labelling Cn: 15-20% of energy saved in urban regions	**Medium**	NL: from -189 \$/tCO_2 to -5 \$/tCO_2 for endusers, 46-109 \$/tCO_2 for Society	No incentive to improve beyond target. Only effective if enforced
Procurement regulations	US, EU, Cn, Mex, Kor, Jp	**High**	Mex: 4 cities saved 3.3 ktCO_2eq. in 1 year Ch: 3.6Mt CO_2 expected EU: 20-44MtCO_2 potential US:9-31Mt CO_2 in 2010	**High/ Medium**	Mex: \$1Million in purchases saves \$726,000/year; EU: <21\$/tCO_2	Factors for success: Enabling legislation, energy efficiency labelling and testing. Energy efficiency specifications need to be ambitious.
Energy efficiency obligations and quotas	UK, Be, Fr, I, Dk, Ir	**High**	UK: 2.6 M tCO_2/yr	**High**	Flanders: -216\$/tCO_2 for households, -60 \$/tCO_2 for other sector in 2003. UK: -139 \$ /tCO_2	Continuous improvements necessary: new energy efficiency measures, short term incentives to transform markets

The impact and effectiveness of various policy instruments
Part 2: Regulatory- informative instruments

Policy instrument	Country examples	Effec-tiveness	Energy or emission reductions for selected best practices	Cost-effectiveness	Cost of GHG emission reduction for selected best practices	Special conditions for success, major strengths and limitations, co-benefits
Mandatory labelling and certification programs	US, Jp, CAN, Cn, AUS, Cr, EU, Mex, SA	**High**	AUS: 5 Mt CO_2 savings 1992-2000, 81Mt CO_2 2000-2015, SA: 480kt/yr Dk: 3.568Mt CO_2	**High**	AUS:-30$/t CO_2 abated	Effectiveness can be boosted by combination with other instrument, and regular updates.
Mandatory audit programs	US; Fr, NZL, Egy, AUS, Cz	**High, variable**	US: Weatherisation program: 22% saved in weatherized households after audits (30% according to IEA)	**Medium/ High**	US Weatherisation program: BC-ratio: 2.4	Most effective if combined with other measures such as financial incentives, regular updates, Stakeholder involvement in supervisory systems
Utility demand-side management programs	US, Sw, Dk, Nl, De, Aut	**High**	US : 36.7 MtCO2in 2000, Jamaica: 13 GWh/ year, 4.9% less el use = 10.8 ktCO2 Dk: 0.8 MtCO2 Tha: 5.2 % of annual el sales 1996-2006	**High**	EU: - 255$/tCO2 Dk: -209.3 $/tCO2 US: Average costs app. -35 $/tCO2 Tha: 0.013 $/kWh	More cost-effective in the commercial sector than in residences, success factors: combination with regulatory incentives, adaptation to local needs & market research, clear objectives

The impact and effectiveness of various policy instruments
Part 3: Economic and market-based instruments

Policy instrument	Country examples	Effec-tiveness	Energy or emission reductions for selected best practices	Cost-effectiveness	Cost of GHG emission reduction for selected best practices	Special conditions for success, major strengths and limitations, co-benefits
Energy performance contracting/ ESCO support	De, Aut, Fr, Swe, Fi, US, Jp, Hu	**High**	Fr, S, US, Fi: 20-40% of buildings energy saved; EU:40-55MtCO_2 by 2010 US: 3.2 MtCO_2/yr Cn: 34 MtCO_2	**Medium / High**	EU: mostly at no cost, rest at <22$/t$CO_2$; US: Public sector: B/C ratio 1.6, Priv. sector: 2.1	Strength: no need for public spending or market intervention, co-benefit of improved competitiveness.
Cooperative/ technology procurement	De, It, Sk, UK, Swe, Aut, Ir, US,Jp	**High/Medium**	US: 96 ktCO_2 German telecom company: up to 60% energy savings for specific units	**Medium /High**	US: - 118 $/ t$CO_2$ Swe: 0.11$/kWh (BELOK)	Combination with standards and labelling, choose products with technical and market potential
Energy efficiency certificate schemes	It, Fr	**High**	I: 1.3 MtCO_2 in 2006, 3.64 Mt CO_2 eq by 2009 expected	**High**	Fr: 0.011 $/t$CO_2$ estimated	No long-term experience. Transaction costs can be high. Adv. Institutional structures needed. Profound inter-actions with existing policies. Benefits for employment.
Kyoto Protocol flexible mechanisms	Cn, Tha, CEE (JI &AIJ)	**Low**	CEE: 220 K tCO2 in 2000 Estonia: 3.8-4.6 kt CO_2 (3 projects) Latvia: 830-1430 tCO_2	**Low**	CEE: 63 $/t$CO_2$ Estonia: 41-57$/t$CO_2$ Latvia: -10$/t$CO_2$	So far limited number of CDM &JI projects in buildings. Success factors: Project bundling, Information & awareness campaigns, link to GIS

The impact and effectiveness of various policy instruments
Part 4: Fiscal instruments and incentives

Policy instrument	Country examples	Effec-tiveness	Energy or emission reductions for selected best practices	Cost-effectiveness	Cost of GHG emission reduction for selected best practices	Special conditions for success, major strengths and limitations, co-benefits
Taxation (on CO2 or household fuels)	Nor, De UK, NL, Dk, Sw	**Low/Medium**	De: household consumption reduced by 0.9 % 2003: 1.5 MtCO2 in total Nor: 0.1-0.5% 1987-1991 NL:0.5-0.7 MtCO2 in 2000 Swe: 5% 1991-2005, 3MtCO2	**Low**		Effect depends on price elasticity. Revenues can be earmarked for further efficiency. More effective when combined with other tools.
Tax exemptions/ reductions	US, Fr, Nl, Kor	**High**	US: 88 MtCO2 in 2006 FR: 1Mt CO2 in 2002	**High**	US: B/C ratio commercial buildings: 5.4 New homes: 1.6	If properly structured, stimulate introduction of highly efficient equipment and new buildings.
Public benefit charges	BE, Dk, Fr, Nl, US states	**Medium/ Low**	US: 0.1-0.8% of total el. sales saved /yr, 1.3 ktCO2 savings in 12 states NL: 7.4TWh in 1996 = 2.5 Mt CO2 Br: 1954 GWh	**High in reported cases**	US: From -53$/tCO2 to - 17$/tCO2	Success factors: Independent administration of funds, involvement of all stakeholders, regular evaluation/ monitoring& feedback, simple and clear progr. design, multi-year progrs
Capital subsidies, grants, subsidised loans	Jp, Svn, NL, De, Sw, US, Cn, UK, Ro	**High/Medium**	Svn: up to 24% energy savings for buildings, BR: 169ktCO2 UK: 6.48 MtCO2 /year, 100.8 MtCO2 in total Ro: 126 ktCO2/yr	**Low sometimes High**	Dk: – 20$/ tCO2 UK:29$/tCO2 for soc, NL: 41-105$/tCO2 for society	Positive for low-income households, risk of free-riders, may induce pioneering investments

The impact and effectiveness of various policy instruments Part 5: Support, information and voluntary action (to be cont.)

Policy instrument	Country examples	Effec-tiveness	Energy or emission reductions for selected best practices	Cost-effectiveness	Cost of GHG emission reduction for selected best practices	Special conditions for success, major strengths and limitations, co-benefits
Voluntary certification and labelling	De, Sw, US, Tha, Fr, Br	**Medium/ high**	Br: 6.5-12.2 $MtCO_2$ 1986-2005, US: 13.2 $MtCO_2$ in 2004, 884 $MtCO_2eq$ in total by 2012, Tha: 192 tCO_2	**High**	US: from -53 to - 53 $/$tCO_2$ Br: 20 $ Million saved	Effective with financial incentives, voluntary agreements and regulations, adaptation to local market is important.
Voluntary & negotiated agreements	Mainly Western Europe, Jp, US	**Medium/ High**	US: 88 $MtCO_2eq$ /yr US: 66.45 $MtCO_2eq$ in 2000 EU: 50 $ktCO_2$, 100 GWh/yr (300 buildings) UK: 14.4Mt CO_2, in 2004	**Medium**	Swe: 0.0166 $/kWh	Can be effective when regulations are difficult to enforce. Effective if combined with financial incentives, and threat of regulation. Inclusion of most important manufacturers, and all stakeholders, clear targets, effective monitoring important
Public leadership programs	NZL, Mex, US, Phil, Arg, Br, Ecu, SA, De Ghana	**Medium/ High**	De: 25% public sector CO_2 reduction in 15 yrs US: 2.3 $ktCO_2$/yr Br: 6.5-12.2 $MtCO_2$/ year Ghana: 27 MWh = 5tCO_2 (14% of baseline) Mex:9.6 $ktCO_2$/year (13% of baseline), 200 GWh/yr	**High/ Medium**	US DOE/FEMP estimates $4 savings for every $1 invested, EU: 13.5 billion $ savings by 2020 SA: 0.06$/kWh= 25$/tCO_2 Br: -0.07= -125 $/$tCO_2$	Can be used to demonstrate new technologies and practices. Mandatory programs have higher potential than voluntary ones. Clearly state, communicate and monitor, adequate funding and staff, involve building managers and experts

The impact and effectiveness of various policy instruments
Part 5: Support, information and voluntary action (cont.)

Policy instrument	Country examples	Effec-tiveness	Energy or emission reductions for selected best practices	Cost-effectiveness	Cost of GHG emission reduction for selected best practices	Special conditions for success, major strengths and limitations, co-benefits
Awareness, education, information	Dk, US, UK, Fr, CAN, Br, Jp, Swe	**Low/ Medium**	UK: 10.4ktCO2 annually Arg: 25% in 04/05, 355 ktep Fr: 40tCO2/ year Br: 2.23kt/yr, 6.5-12.2 MtCO2/ year with voluntary labeling 1986-2005 Swe: 3ktCO2/ year	**Medium / High**	Br: -66$/tCO2; UK: 8$/tCO2 (for all programs of Energy Trust)/ Swe: 0.018$/kWh	More applicable in residential sector than commercial. Deliver understandable message and adapt to local audience.
Detailed billing & disclosure programs	Ontario, It, Swe, Fin, Jp, Nor, Aus, Cal, Can	**Medium**	Max.20% energy savings in households concerned, usually app. 5-10% savings UK: 3% Nor: 8-10 %	**Medium**		Success conditions: combination with other measures and periodic evaluation. Comparability with other households is positive.

Country name abbreviations: Alg - Algeria, Arg- Argentina, AUS - Australia, Aut - Austria, Be - Belgium, Br - Brazil, Cal - California, Can - Canada, CEE - Central and Eastern Europe, Cn - China, Cr - Costa Rica, Cz - Czech Republic, De - Germany, Ecu - Ecuador, Egy - Egypt, EU - European Union, Fin - Finland, GB-Great Britain, Hkg -Hong Kong, Hu - Hungary, Ind - India, Irl - Ireland, It - Italy, JP - Japan, Kor - Korea (South), Mar- Morocco, Mex - Mexiko, NL - Netherlands, Nor - Norway, Nzl – New Zealand, Phil - Philippines, Pol - Poland, Ro- Romania, SA- South Africa, SG - Singapore, Sk - Slovakia, Svn - Slovenia, Sw - Switzerland, Swe - Sweden, Tha - Thailand, US - United States.

Conclusion

- Improved energy-efficiency could contribute the largest share in our mitigation task in the short- and mid-term
- In addition to climate change benefits, improved energy-efficiency can advance several development goals as well as strategic economic targets
  - E.g. Poverty alleviation, health improvement, women&children, business opportunities and job creation, energy security
- Thus, if no other mitigation activity is pursued, energy-efficiency is still worth promoting
- However, due to the numerous barriers public policies are needed to unlock the potentials and to kick-start or catalise markets
- Several instruments have achieved large emission reductions at large net societal benefits, often at double or triple negative digit cost figures *all over the world*
- However, each new building constructed at an energy-wasting manner will lock SAA into an energy-wasting future – action now is important

Central European University
Department of Environmental Sciences and Policy

Thank you for your attention!

Dr. Diana Ürge-Vorsatz

http://www.ceu.hu/envsci/staffDV.htm
Email: vorsatzd@ceu.hu