WORKSHOP ON ENERGY RETROFITTING OF BUILDINGS – IEA ENERGY EFFICIENCY CONFERENCE

Energy Modelling Lab | Viegand Maagøe | Energiforsk

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OVERALL ENERGY EFFICIENCY MESSAGES

- Energy efficiency reduces demand for energy supply technologies, fuels and grid infrastructure
- *Accelerating energy efficiency's role in a net zero pathway would reduce accumulated final energy consumption by 28%, accumulated CO_2-emissions with 18%*, and accumulated air pollution with 21% up to 2050 compared with a scenario with half the energy efficiency increase per year
- Early action matters: CO_2-emissions and air pollution increase with 16% compared to NZE if energy efficiency increase is delayed 10 years
- Energy efficiency is the most effective measure to quickly improve energy security and lower electricity prices
- In a scenario with very high natural gas prices, a 5% reduction in electricity demand could lower average EU wholesale prices by about 20% in 2023.

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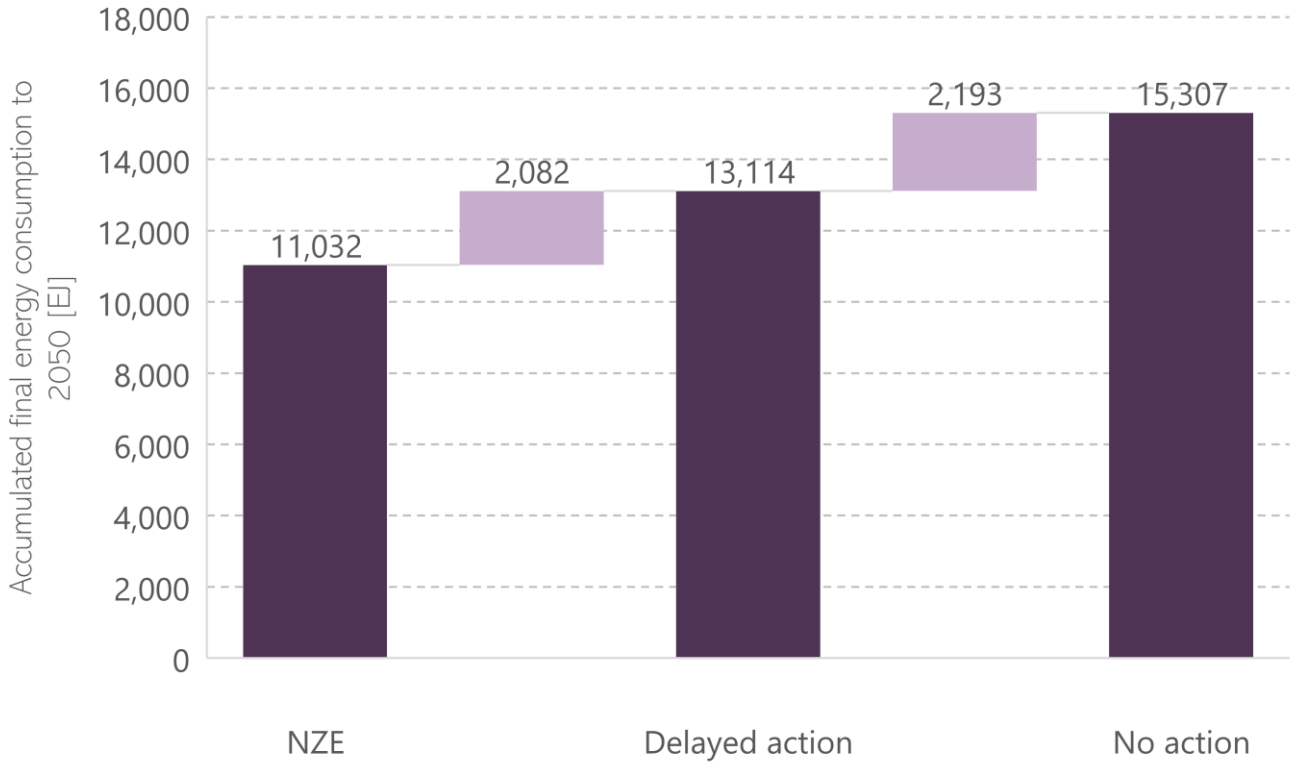
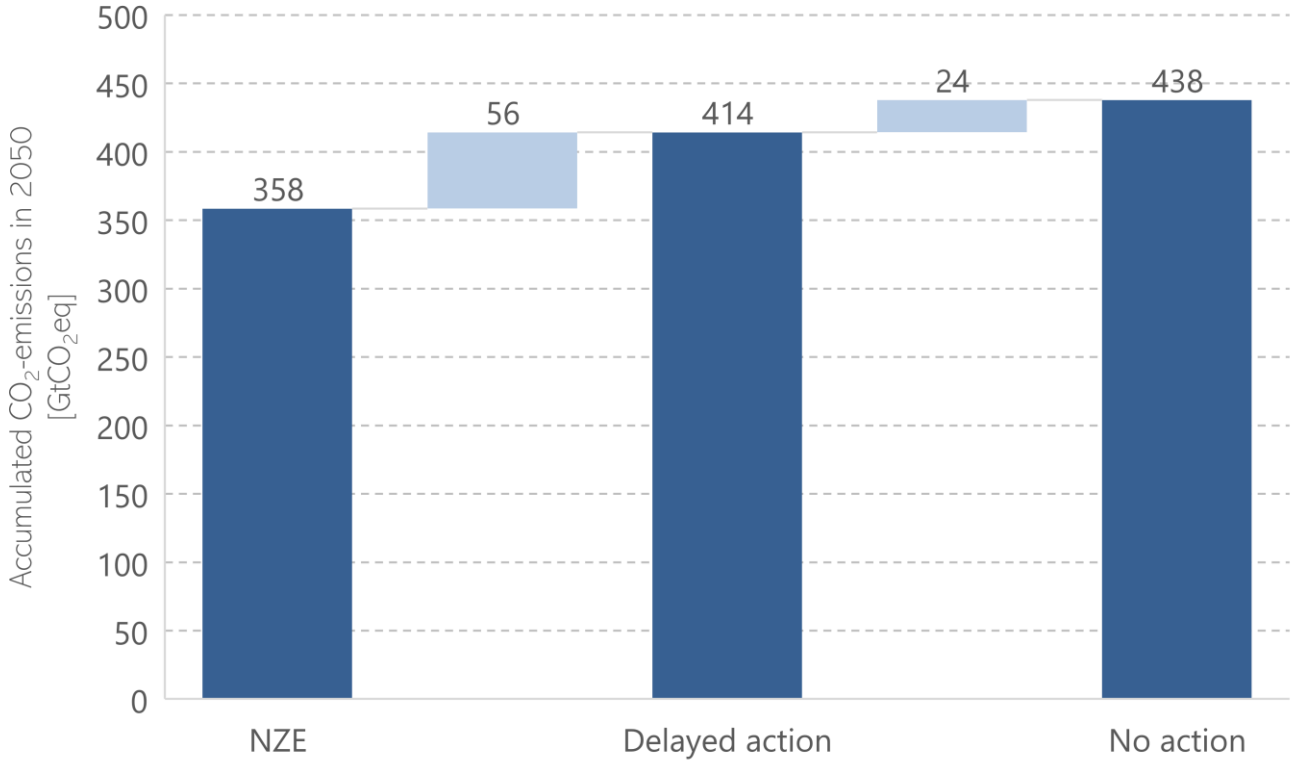
A LOW ENERGY EFFICIENCY PATHWAY WOULD INCREASE FINAL ENERGY CONSUMPTION BY 39%

- 4300 EJ (39%) extra fuel consumption is needed if lower energy efficiency improvement up to 2050 will be obtained
- 19% extra fuel consumption if action is delayed



CO2-EMISSIONS INCREASE BY 16% IF ACTION IS DELAYED BY 10 YEARS

- Up to 79 Gt CO_2eq (22%) extra CO_2-emissions would occur if low rate of energy efficiency improvements occur
- Late action increases CO2-emissions with 56 Gt CO_2eq (16%)



A 5% ELECTRICITY DEMAND REDUCTION REDUCE WHOLESALE EUROPEAN ELECTRICITY PRICES BY 5-40%

- Energy efficiency is the quickest way to reduce reliance on imported fossil fuels
- In a scenario with very high natural gas prices, a 5% reduction of classic electricity demand across European countries would reduce wholesale electricity prices 5-40% in 2023.
- Tripling the deployment of renewable electricity in generation compared with current national plans* would have a significantly lower impact on prices

**all countries except Germany where current plans were used as they are already very ambitious*

NOTE: the results are based on non-IEA modelling conducted by EA Energianalyse outside of this project, using the Balmorel Power market model.

European natural gas prices are assumed to be €XX/GJ throughout the period (for reference spot prices on April 29 are around €29/GJ)

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ENERGY EFFICIENCY MESSAGES FOR HOUSEHOLDS

- Replacing all main appliances in the current household stock with 2030-BAT-technologies can reduce power demand by 31 to 121 TWh by region*
- With the SDS scenario power mix in 2030, these savings equal to a CO_2eq. reduction by 4 to 42 Mt by region*
- Choosing heat pumps with higher efficiency could save 6 TWh/year in US alone
- Switching 50% of gas heated households in Europe to heat pumps could save 25% of imported gas from Russia
- Reduced air pollution in NZE scenario (SDS data used) can reduce the cost of global health impacts by almost €500 bn in 2030. The largest savings are in Africa (€260 bn) and in Asia Pacific (€190 bn)

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* Considered regions: Africa, China, EU, India, US

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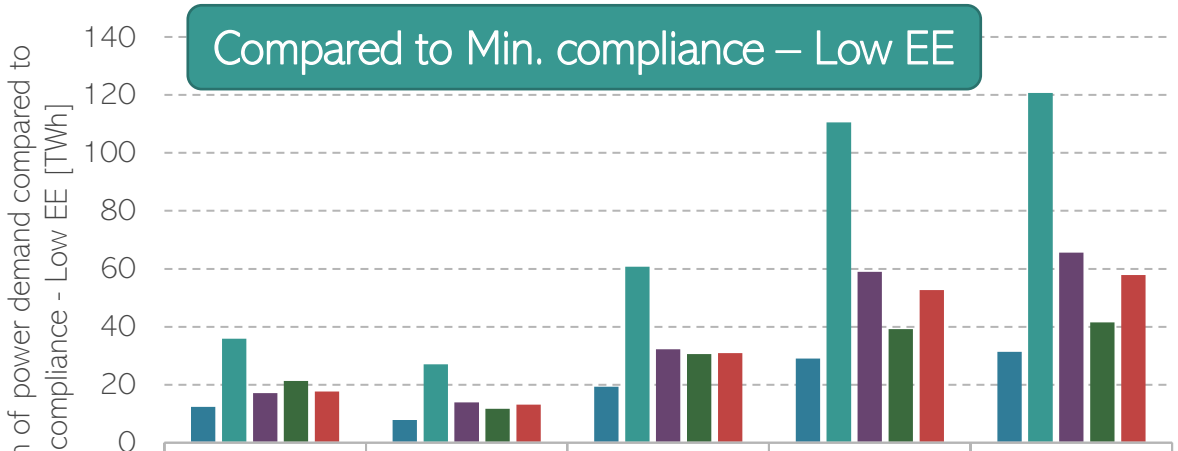
POWER DEMAND IN THE FIVE REGIONS CAN BE REDUCED BY 104 TO 317 TWH

- Replacing all main appliances in households with efficient **new technologies** compared to minimum compliant alternatives yield substantial power demand reductions across different regions (*% compared to SDS power demand in buildings in 2030*):
  - Africa: 8-31 TWh (*1.1 – 4.4%*)
  - China: 27-121 TWh (*1 – 4.3%*)
  - EU: 14-66 TWh (*0.7 – 3.1%*)
  - India: 12-41 TWh (*1.4 – 5%*)
  - US: 13-58 TWh (*0.6 – 2%*)

Issue: competition with growing market of cheap, inefficient secondhand equipment



	High EE Min. compliance	Low EE Median	High EE Median	Low EE BAT	High EE BAT
Africa	12	8	19	29	31
China	36	27	61	110	121
Europe	17	14	32	59	66
India	21	12	31	39	41
US	18	13	31	53	58

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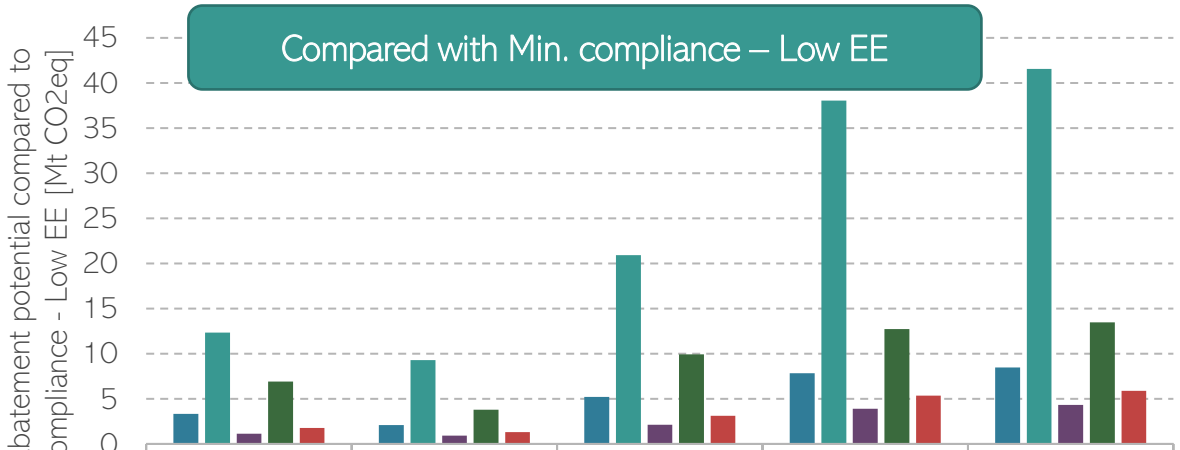
CHINA CAN SAVE 42 MT CO_2EQ IN 2030 IF HIGH ENERGY EFFICIENCY IS OBTAINED IN CURRENT STOCK

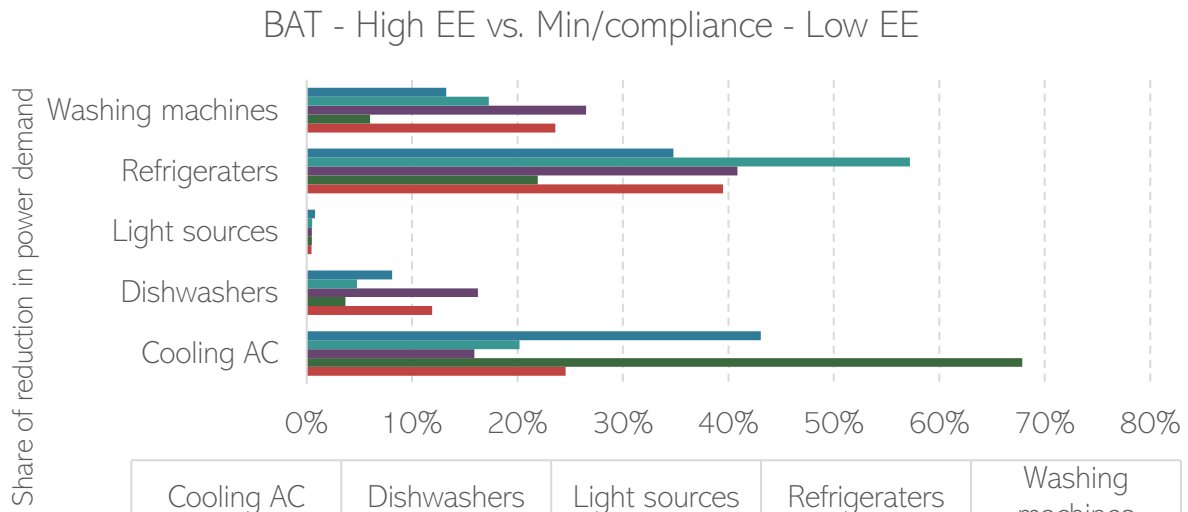
- Energy efficient technologies in households have high potential for CO_2 reduction especially in regions with a high CO_2-intensity in the power mix (assumed intensity in parenthesis):
  - Africa: 3-8 Mt CO_2eq (0.27 Mt CO_2eq/TWh)
  - China: 12-42 Mt CO_2eq (0.34 Mt CO_2eq/TWh)
  - EU: 1-4 Mt CO_2eq (0.07 Mt CO_2eq/TWh)
  - India: 7-13 Mt CO_2eq (0.32 Mt CO_2eq/TWh)
  - US: 2-6 Mt CO_2eq (0.10 Mt CO_2eq/TWh)



	High EE	Low EE	High EE	Low EE	High EE
	Min. compliance	Median		BAT	
Africa	3	2	5	8	8
China	12	9	21	38	42
Europe	1	1	2	4	4
India	7	4	10	13	13
US	2	1	3	5	6

HIGHEST SAVINGS IN AIR CONDITIONERS IN INDIA AND AFRICA, REFRIGERATORS FOR ALL OTHER REGIONS

- Comparing least to highest efficient technologies shows different power demand reductions per appliance across regions
- Appliances with largest savings potential per region:
  - Cooling: India 68%, Africa 43%
  - Refrigerators: China 57%, Europe 41%, US 39%
- Light sources show no significant contribution



	Cooling AC	Dishwashers	Light sources	Refrigeraters	Washing machines
Africa	43%	8%	1%	35%	13%
China	20%	5%	1%	57%	17%
Europe	16%	16%	0%	41%	27%
India	68%	4%	0%	22%	6%
US	25%	12%	0%	39%	24%

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ENERGY EFFICIENCY MESSAGES FOR BUILDINGS

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- Building net zero buildings from now on instead of refurbishing these buildings to net zero standard in 2030, would save €7000 bn and reduce the global CO_2 emissions until 2030 by more than 5 Gt
- The largest potential for CO_2 reduction in the new buildings are in China (2000 Mt) and North America (660 Mt)

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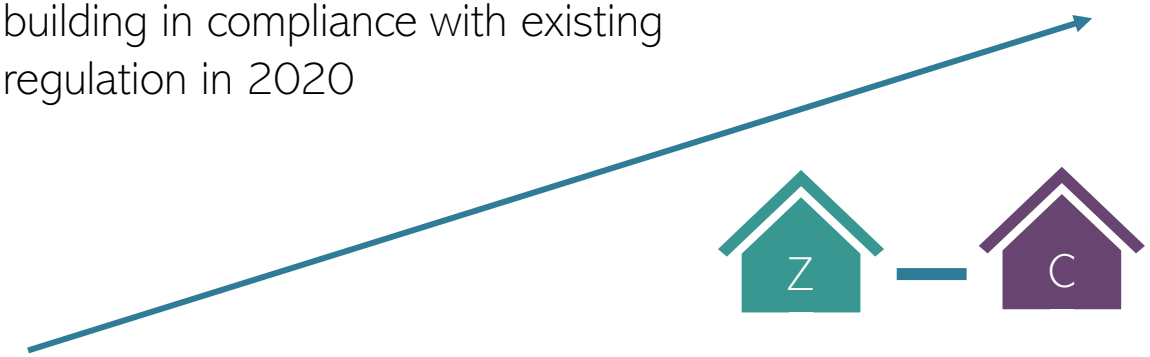
Assuming 60 bill. m^2 of new buildings from 2020 to 2030

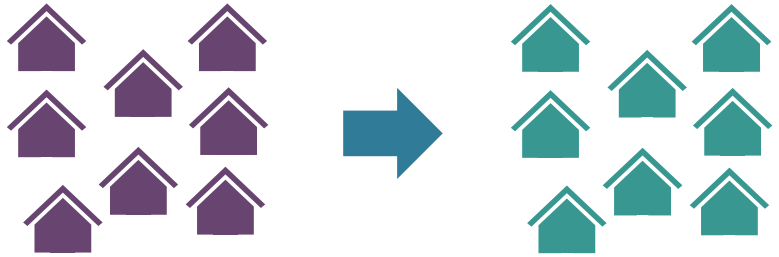
Estimation of extra cost from building NZEB already from today compared to building in compliance with existing regulation in 2020



2020 — 2030

Extra cost of building NZEB
7,500 bill. EURO

Refurbishment costs
15,000 bill. EURO



An estimated price (Euro) of retrofitting all buildings* into Zero-carbon ready buildings in 2030.

*Build between 2020-2030 in the low-efficiency scenario.

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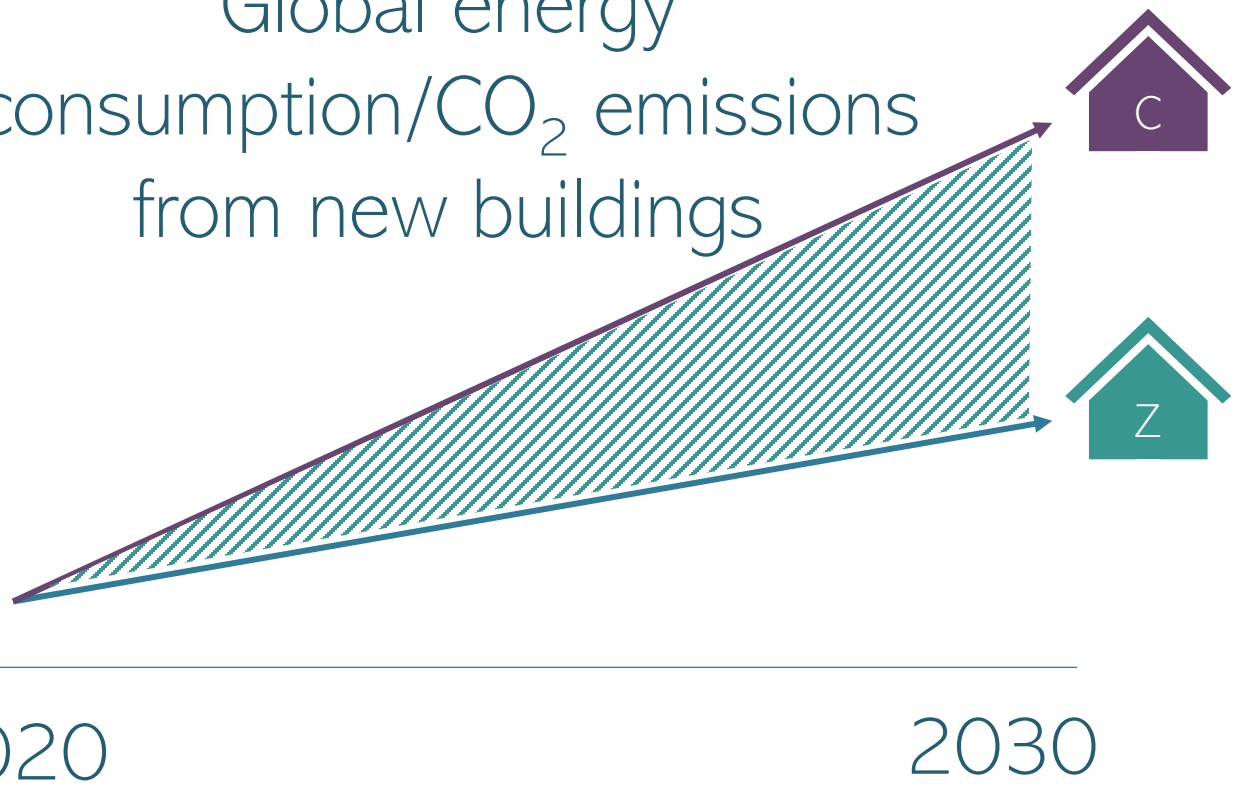
Global energy consumption/CO_2 emissions from new buildings



Cumulated saved energy and CO_2 - emission in the period from 2020 to 2030 if all new buildings from 2020 onwards were NZEB standard

Saved energy and emissions: 85 EJ and 5 Gt CO_2

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DIGITALISATION

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All numbers for 2030:

- Digitalisation of water heaters, heat pumps, ACs, and batteries has a shifting potential globally up to *2200 TWh per year and with potential CO2-emission reductions up to 465 MtCO2eq per year.*
- Smart charging of electric cars can provide up to 43 GWs of Peak power capacity reduction
- Overall costs of energy production can be reduced with up to 62 USD per year – more can be saved if including the reduction in necessary transmission line investments
- Due to high savings and load shifting potential, water heaters should be one of the first products to digitalize

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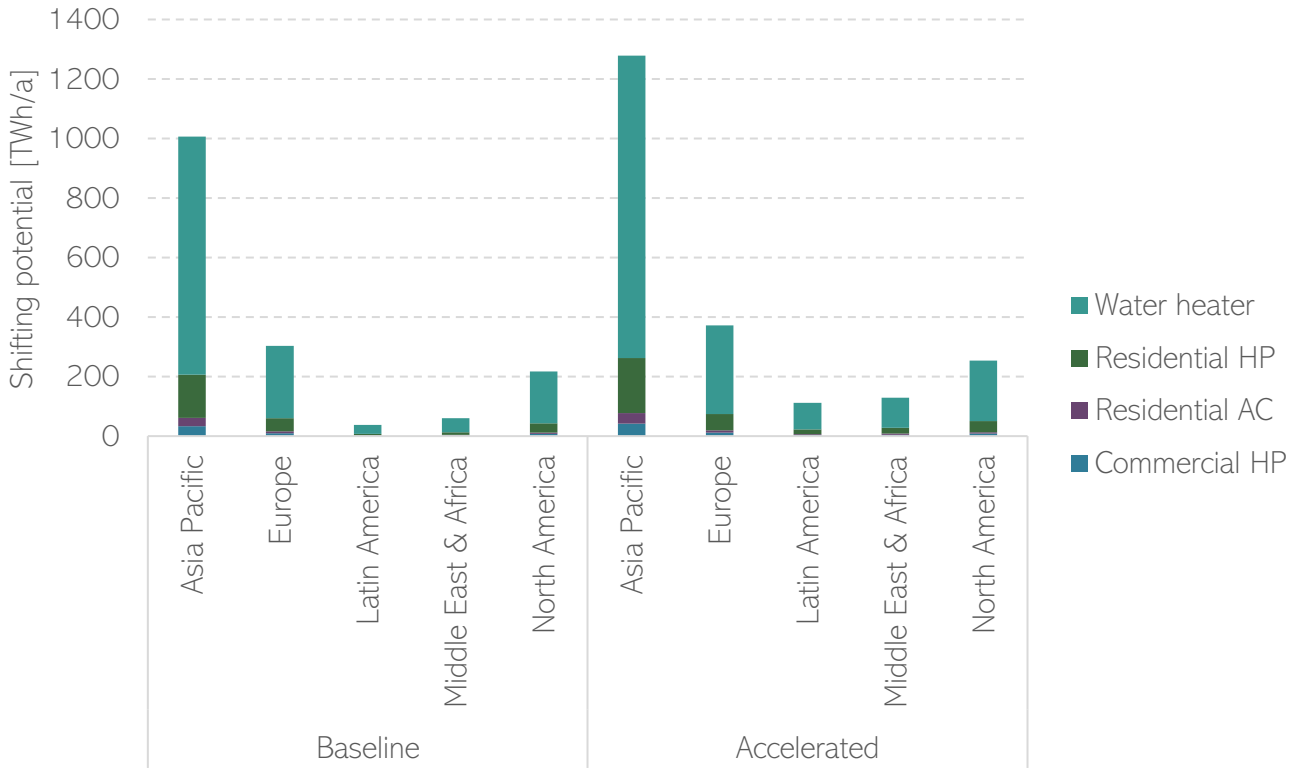
SHIFTING POTENTIAL RANGES FROM 38 TO 1300 TWH/A DEPENDING ON REGION

- The overall shifting potential ranges from 1680 to 2140 TWh per year
- The main shifting potential in all regions are the water heaters covering 80% of the total shifting potential followed by the residential HP with 15% of the potential
- The total shifting potential corresponds to between 11% and 15% of the electricity consumption in buildings in the STEPS scenario in 2030
- Due to high savings and load shifting potential, water heaters should be one of the first products for governments and efficiency advocates to consider pursuing activities that encourage connectivity and intelligence



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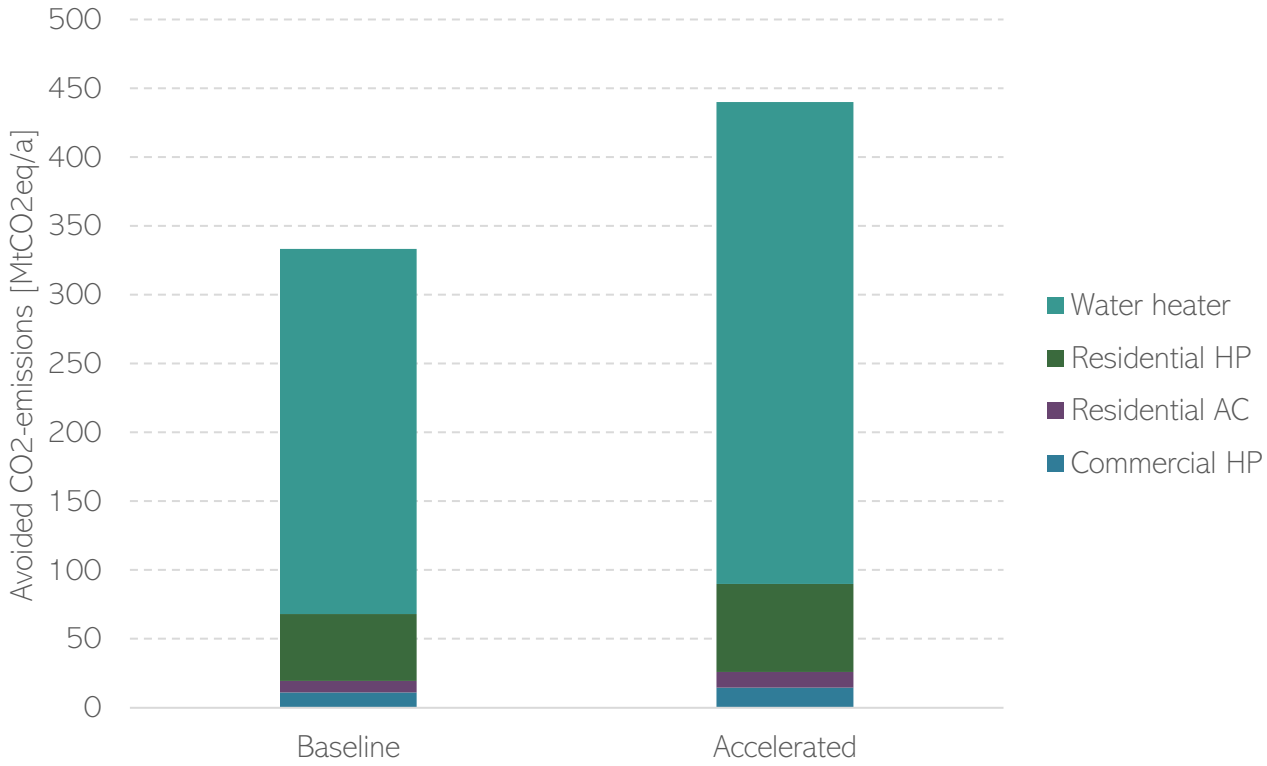
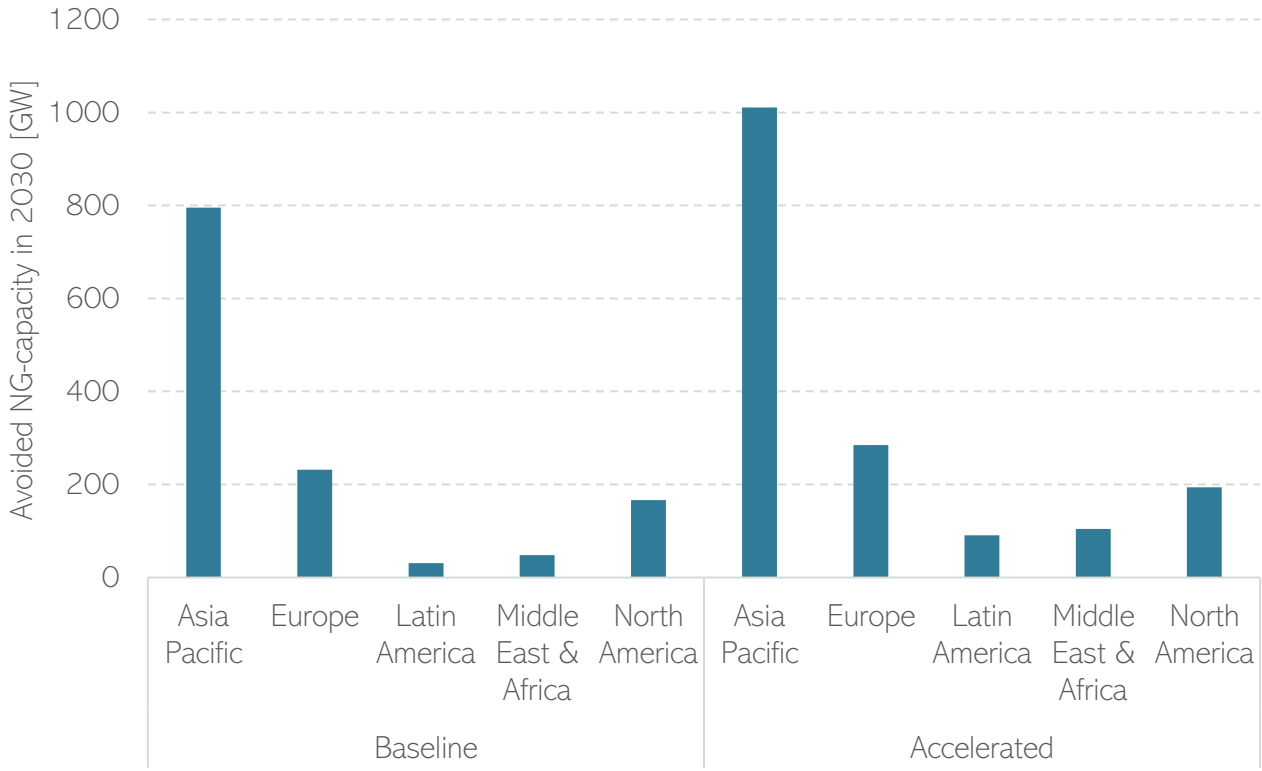
WATER HEATERS HAVE THE BIGGEST POTENTIAL FOR REDUCING CO2-EMISSIONS UP TO 350 MTCO2EQ/A BY 2030

- When assuming the shifting potential is reducing natural gas consumption, the overall CO_2-emissions are reduced
- The overall CO_2-emission reductions ranges from 330 to 440 $MtCO_2eq$ depending on scenario
- Water heaters provides the biggest shifting potential and thereby CO_2-emission reductions



INSTALLATION OF PEAK POWER TECHNOLOGIES AS NATURAL GAS CAN BE REDUCED WITH UP TO 1000 GW DEPENDING ON REGION

- The shifting potential can be recalculated to reduction in natural gas installations, showing an overall reduction of 1270 to 1680 GW of natural gas capacity
- Asia pacific has a high potential for reducing installation, following the potential for shifting the peak



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We make the world of energy smarter! Through cooperation and dialogue, we conduct energy research, providing new knowledge to create value for business, customers and the wider community

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Viegand Maagøe (VM) is a highly specialised consulting company within the field of energy efficiency, sustainable design of products and appliances, and development and implementation of energy efficiency measures at national, European, and global level.

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Energy Modelling Lab (EML) is a small consultancy company specialised in developing and building energy system models, data manipulation, scenario and policy analysis

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