"well below 2 degrees": *The potential role of novel demand-side approaches in deep mitigation*

CENTER FOR CLIMATE CHANGE
AND SUSTAINABLE ENERGY POLICY

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IEW, Cork, June 3, 2016

Overview

- Introduction: emerging literature on non-mainstream options
- Challenging the role of demand-side efforts in IAMs:
  - What is not covered by scenarios but could make a difference
- Highlights from non-technological and/or non-price opportunities from AR5
- Further novel demand-side approaches and opportunities…?

Acknowledgments to: Elisabeth Boles, MIT, Souran Chatterjee, CEU 3CSEP

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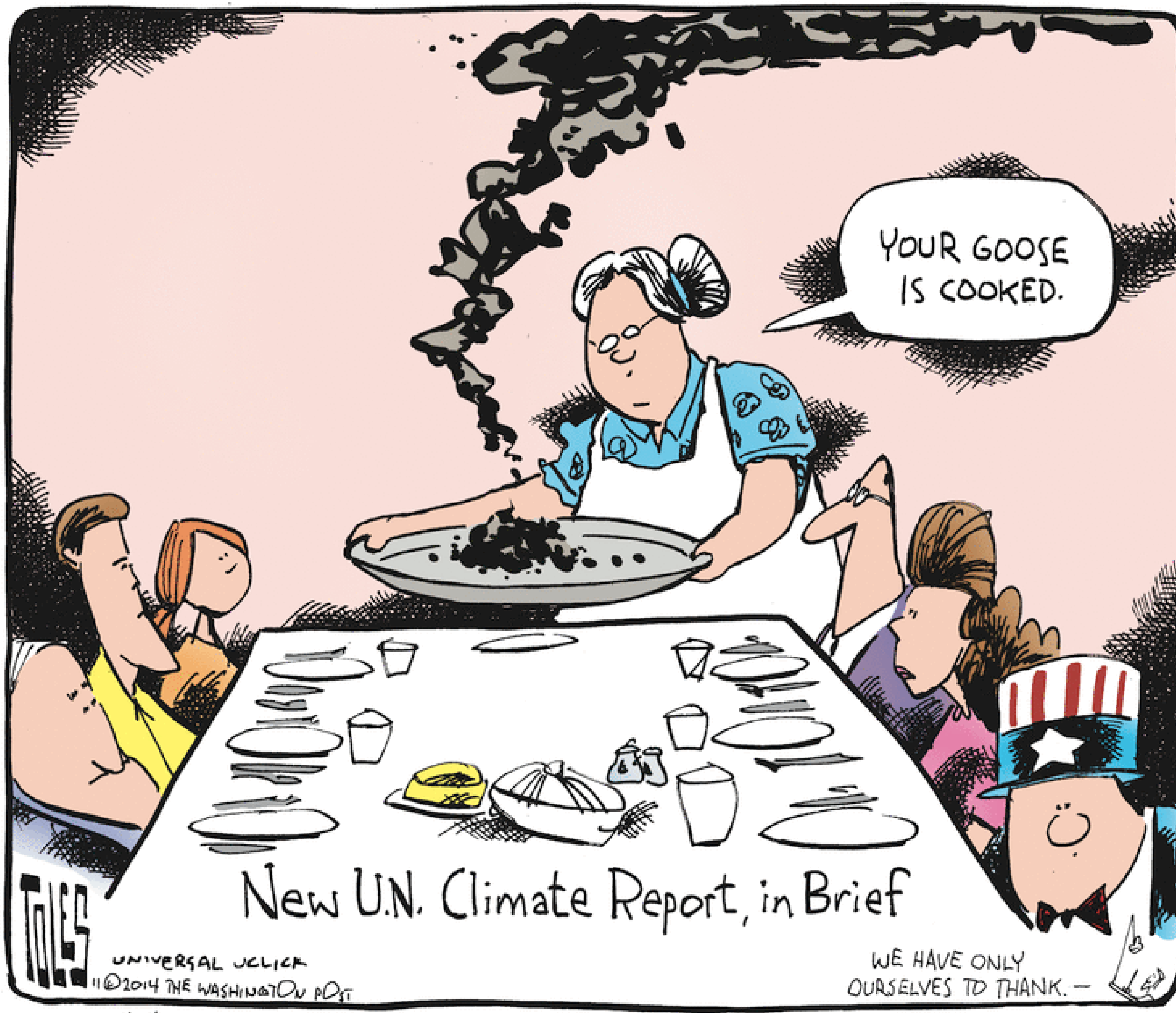
The “other side” of AR5 pathways


YOUR GOOSE IS COOKED.
New U.N. Climate Report, in Brief
WE HAVE ONLY OURSELVES TO THANK. —
TOLES
UNIVERSAL UCLICK
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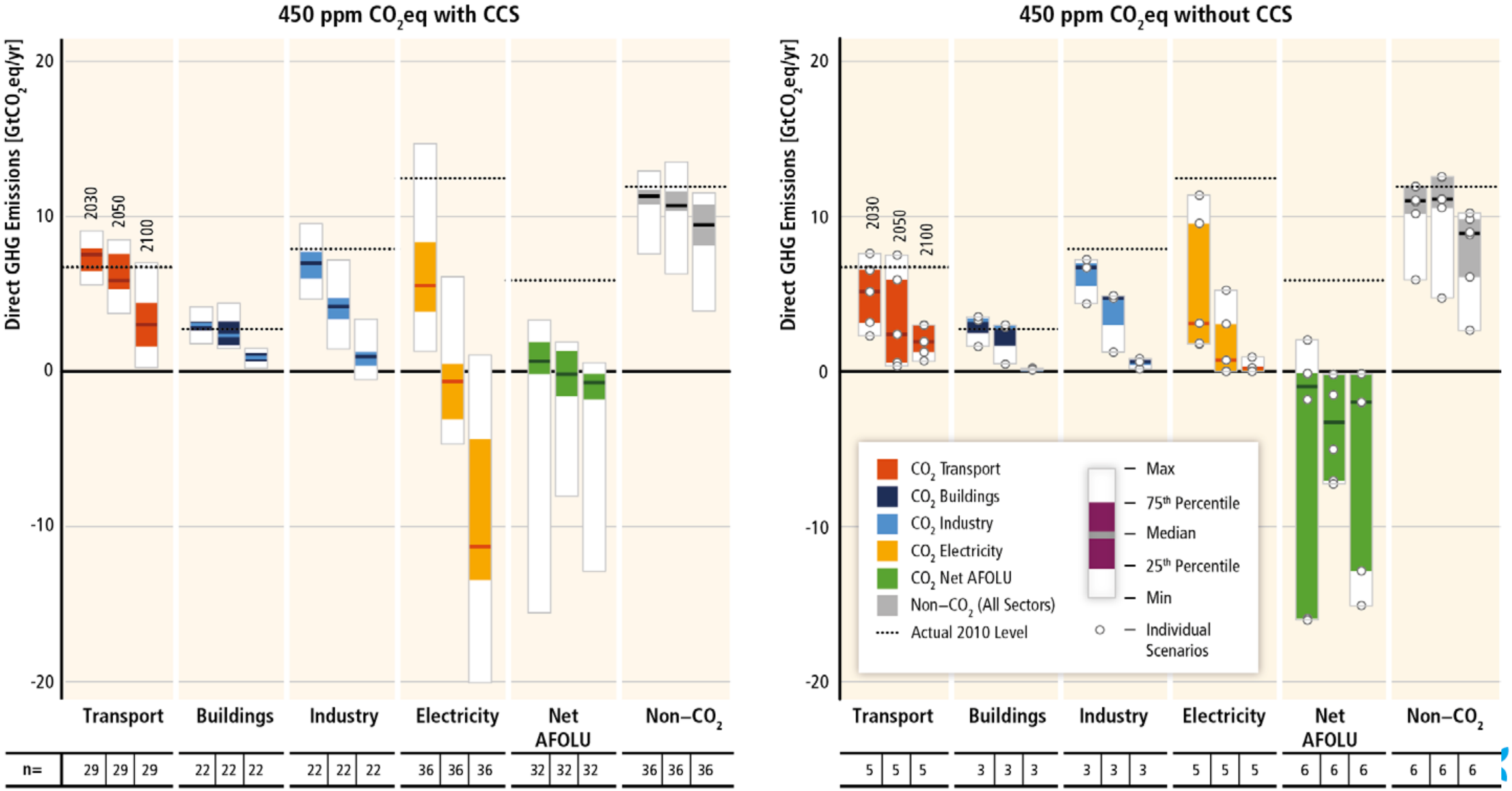
11.4.14

Figure 6.35. Direct emissions in 450 ppm CO2eq scenarios with and without using CCS



Source: IPCC AR5 WGIII

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Challenged by Creutzig et al. 2016

- of the 400 scenarios reviewed in AR5 that limit warming to 2°C, 344 (86%) rely on negative emission technologies, in particular on BECCS
- Several of these imply massive changes in land use patterns and have raised many concerns since AR5
- Could the demand-side fill the gap?
- The AR5 also showed that the solution space is much more flexible if demand is kept at bay or reduced

*Felix Creutzig, Blanca Fernandez, Helmut Haberl, Radhika Khosla, Yacob Mulugetta, Karen C. Seto.(2016) B***eyond technology: demand-side solutions to climate change mitigation.** In Annual Review of Environment and Resources.

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Supply or demand-side problem?

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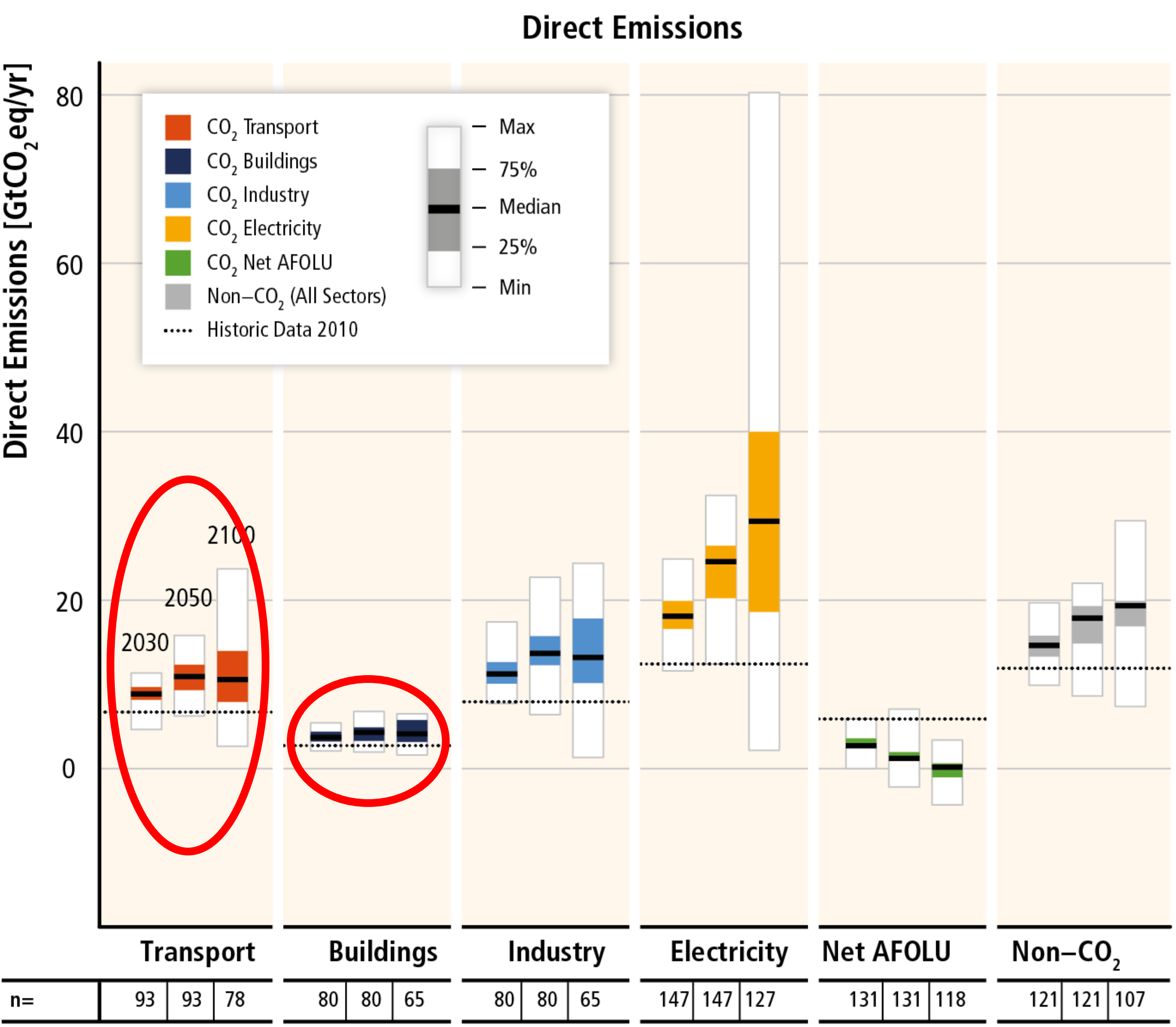
Baseline Scenarios: Direct vs. Indirect Emission Accounting



Source: Volker Krey, using IPCC AR5 Figure SPM.10,

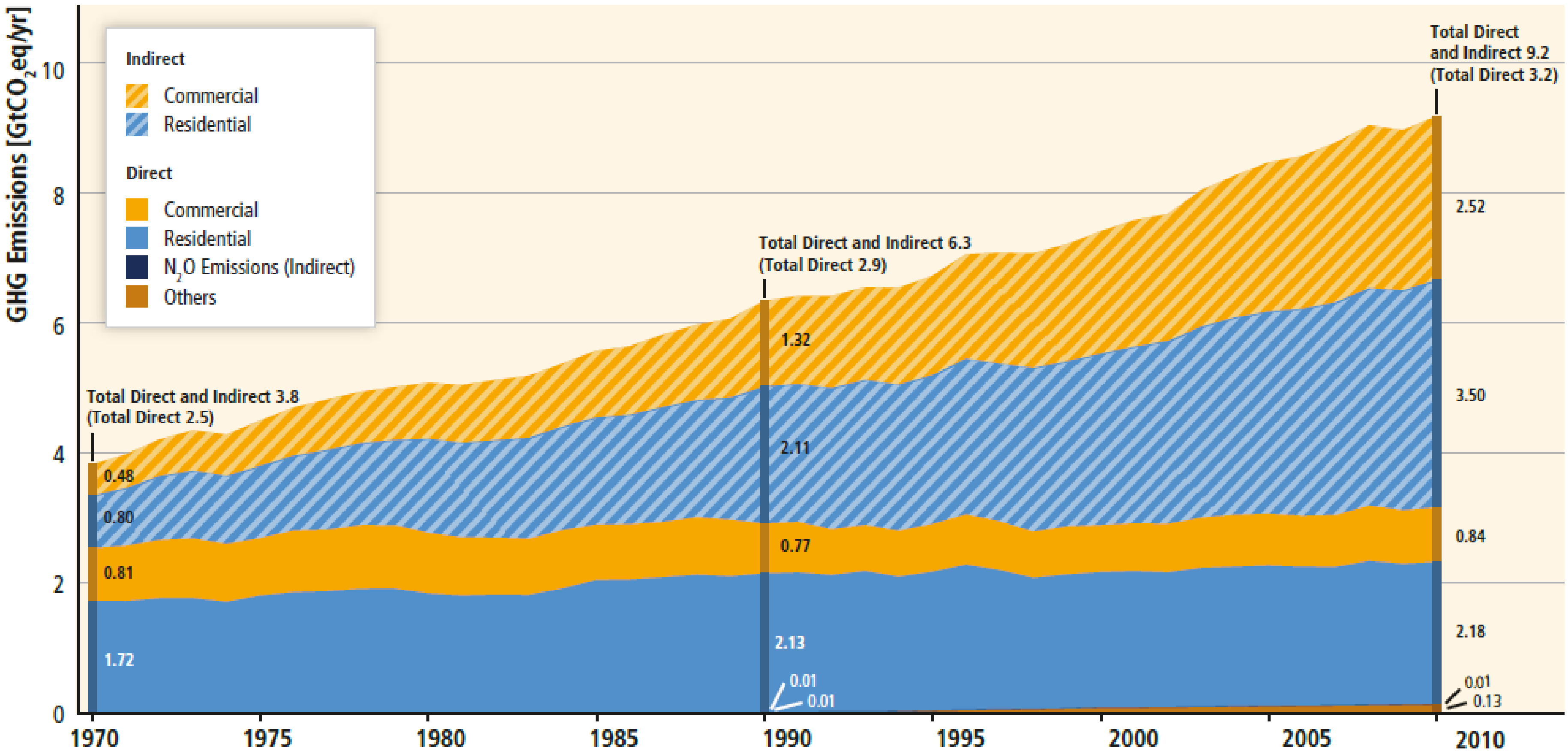


Figure 9.1 | Direct and indirect emissions (from electricity and heat production) in the building subsectors (IEA, 2012a; JRC/PBL, 2013; see Annex II.9).

Source: IPCC AR5 WGIII

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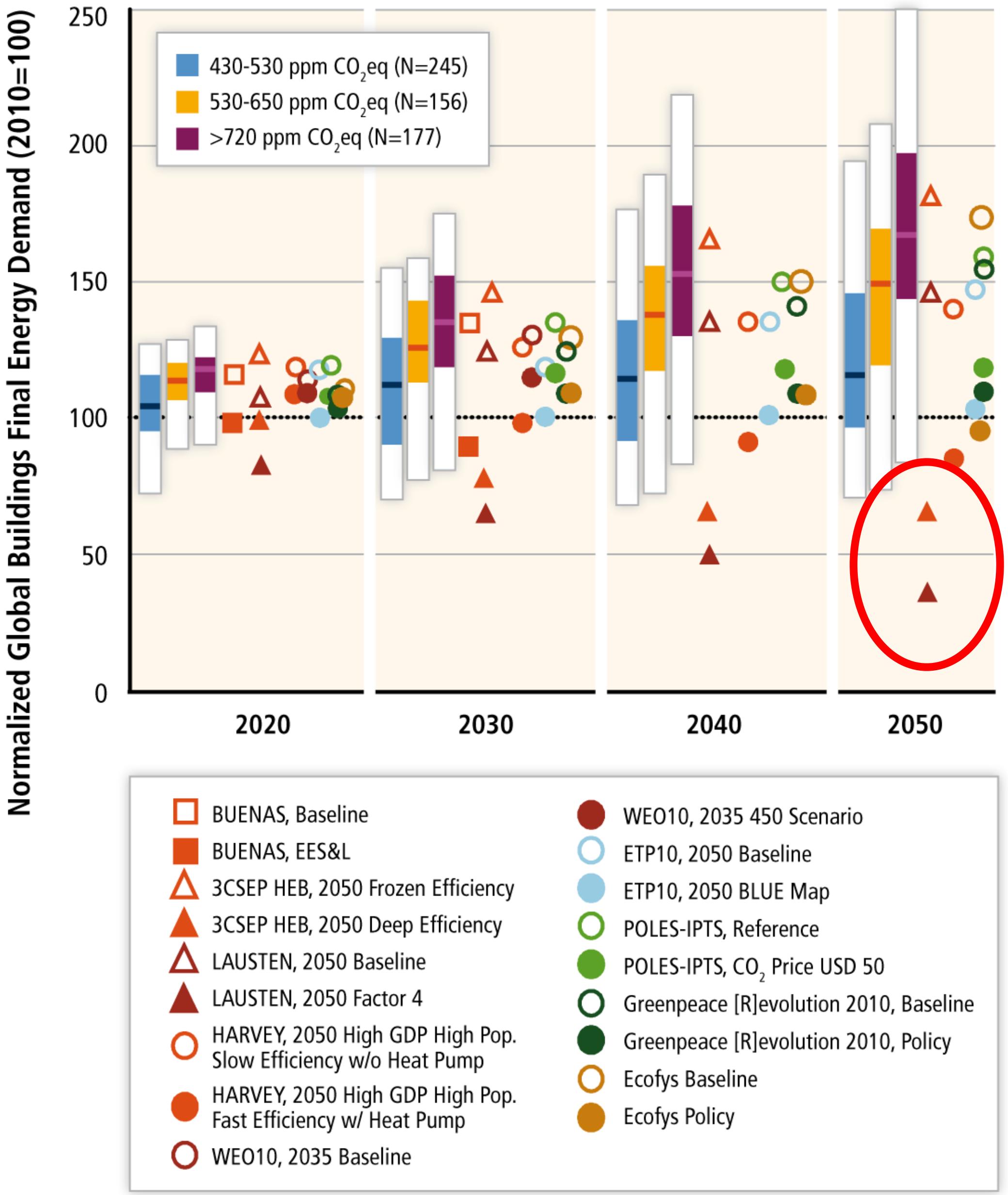

Energy efficiency in buildings can substantially lower sectoral energy use; thermal uses are most reducible

for further details on mitigation options and potentials, see Chapter 9

Source: IPCC AR5 WGIII

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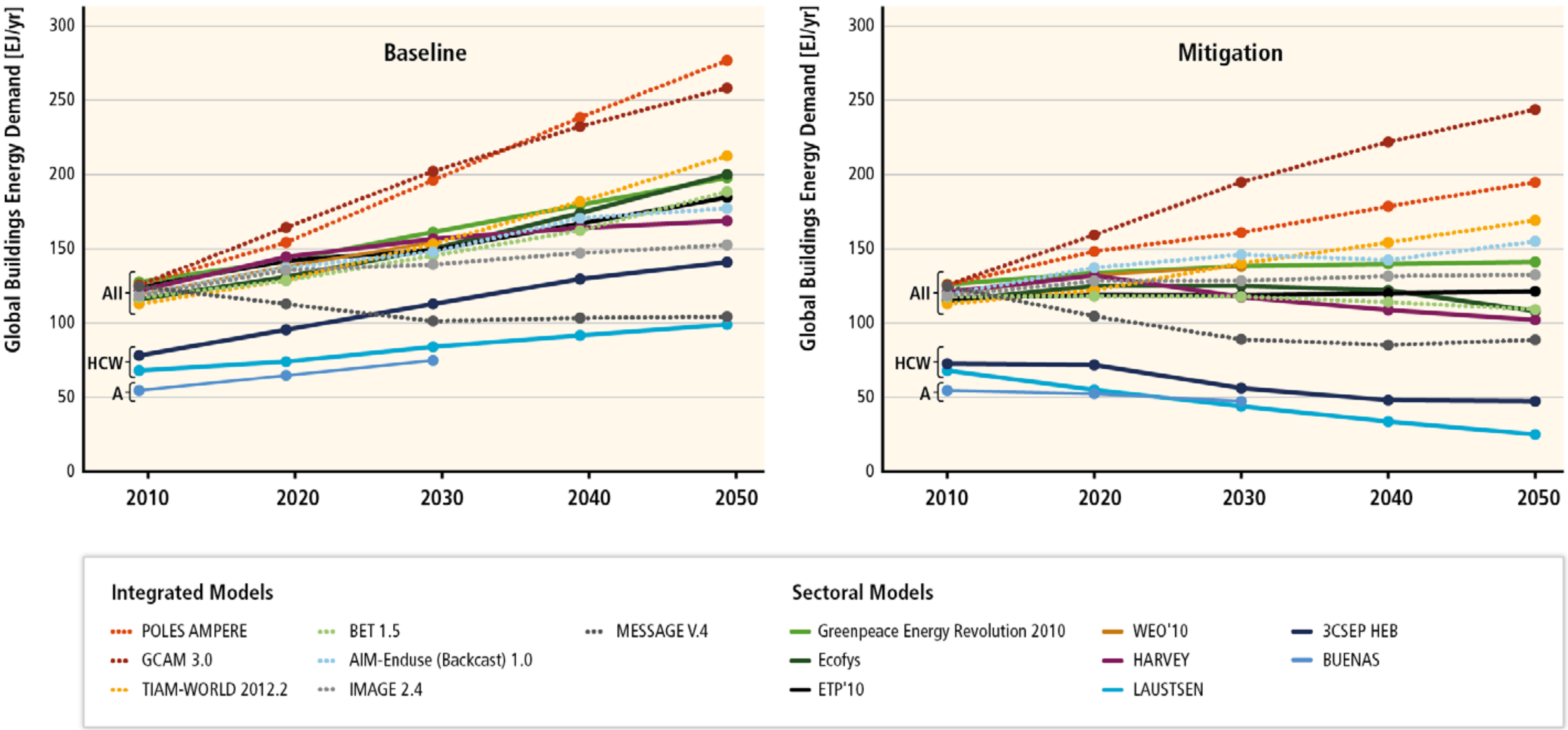

Source: IPCC AR5 WGIII, Chapter 9

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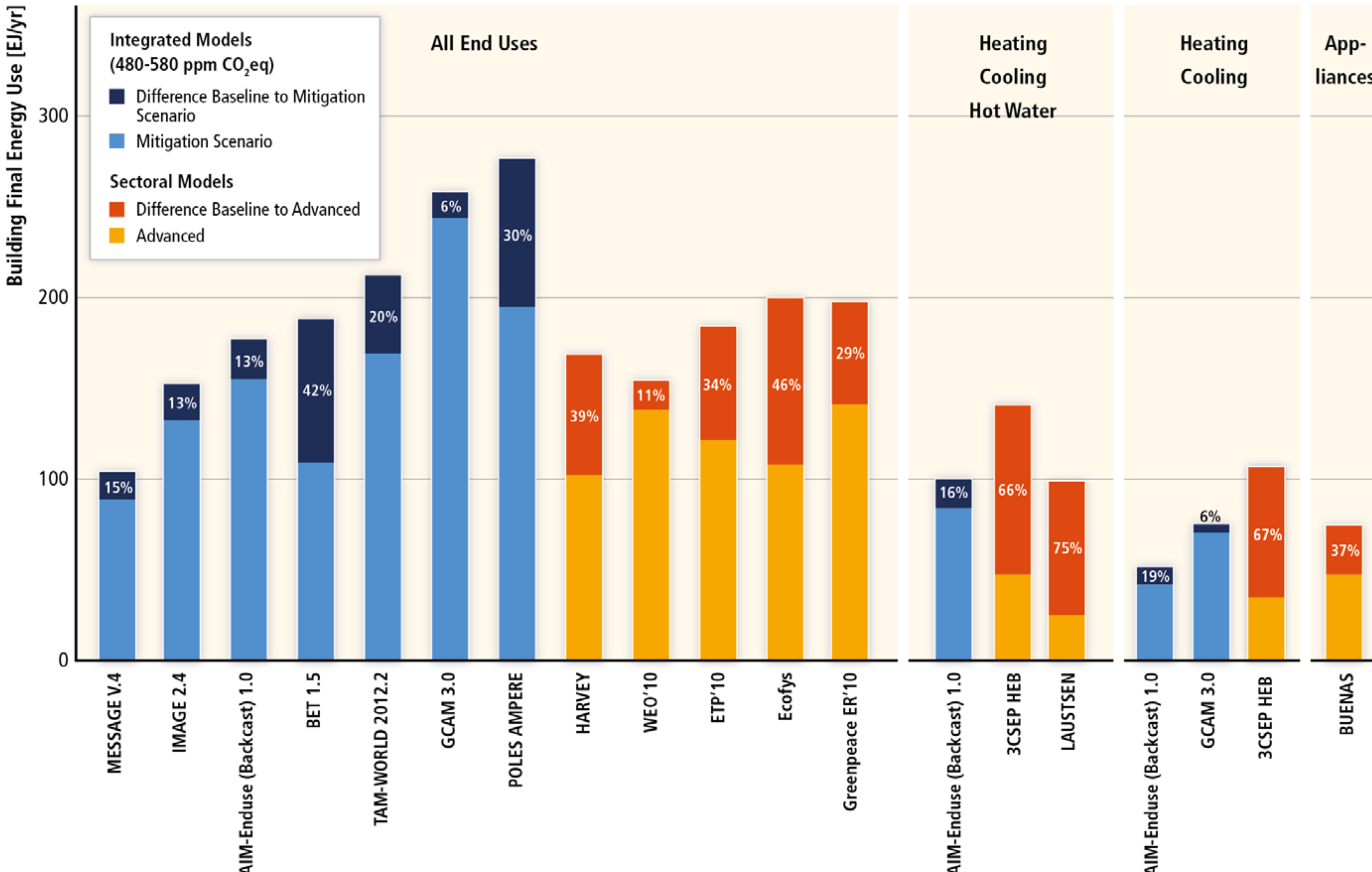
Figure 9.21 Building final energy use in EJ / yr in 2050 (2030 for BUENAS and WEO'10) for advanced scenarios, modelling four groups of building end-uses as compared to reference



Source: IPCC AR5 WGIII, Chapter 9

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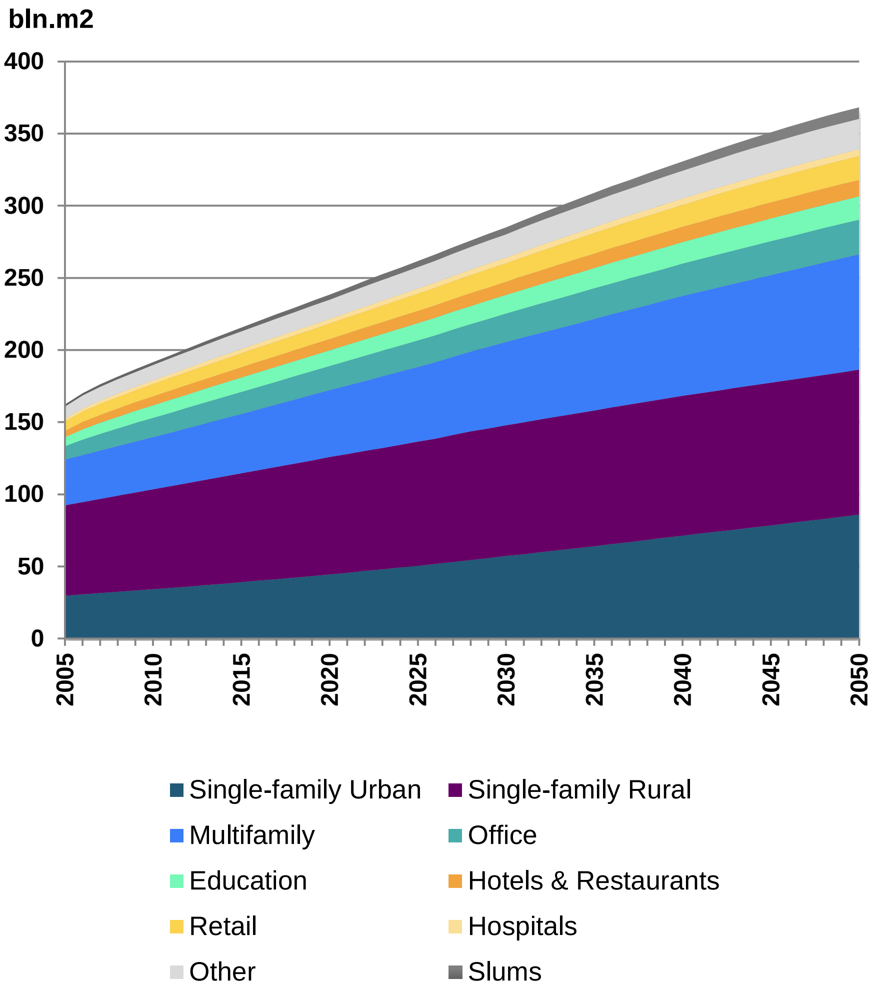
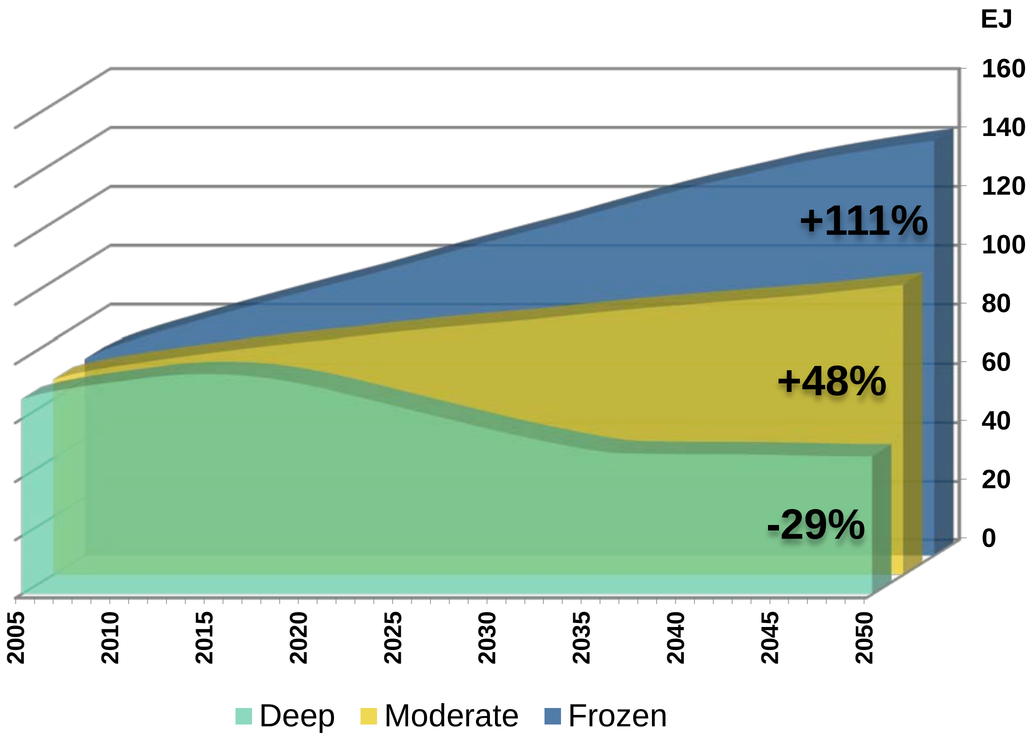
World floor area



World final thermal energy use



Source: *Diana Urge-Vorsatz, Ksenia Petrichenko, Miklos Antal, Maja Staniec, Michael Labelle, Eren Ozden, Elena Labzina (2012)* ***Best Practice Policies for Low Energy and Carbon Buildings. A Scenario Analysis.*** *Research report prepared by the Center for Climate Change and Sustainable Policy (3CSEP) for the Global Best Practice Network for Buildings*

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Challenging energy models regarding their ability to show deep opportunities in the building sector

- Do models covering the building sector really understand the frontiers of know-how in architecture? (such as nearly-zero and passive buildings)?
- Proposal: move away from modeling building COMPONENTS to building SYSTEMS (i.e. better to use performance-based approaches to building energy modeling, at least for heating/cooling)
- How are we projecting the building energy future?

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55.000 Passive Houses exist in 28 European member countries

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International PASSIVE HOUSE Association iPHA

Passive House Institute

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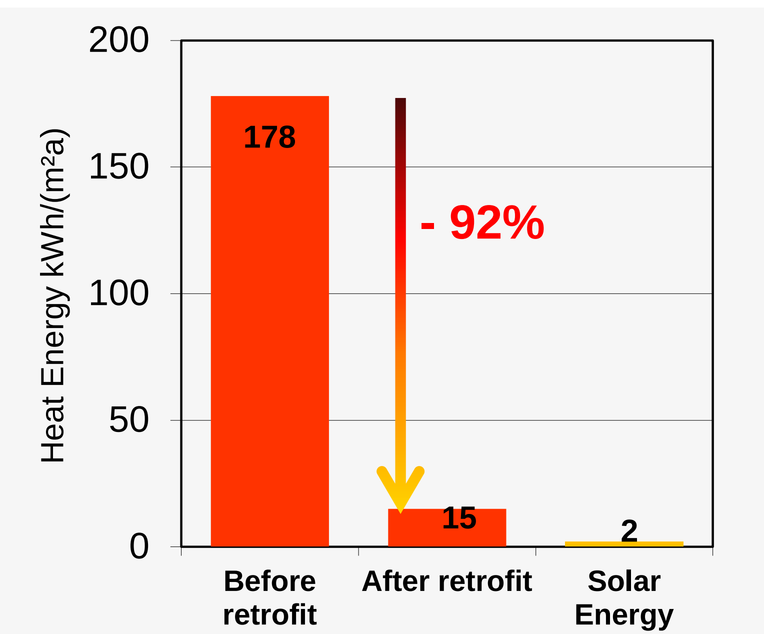

Historic building Eberlgasse
Retrofit to Passive House

Net floor area 668.3 m²
Wall U-value 0.089 W/m²K

Heating demand from 178 kWh/m²a to 15 kWh/m²a
Primary energy demand: 108 kWh/m²a
for heating, hot water, household electricity

Owner: Andreas Kronberger Unternehmensberatung
Building physics: Schöberl & Pöll GmbH

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EnerPHit Zertifizierte Modernisierung Passivhaus Institut classic | plus | premium

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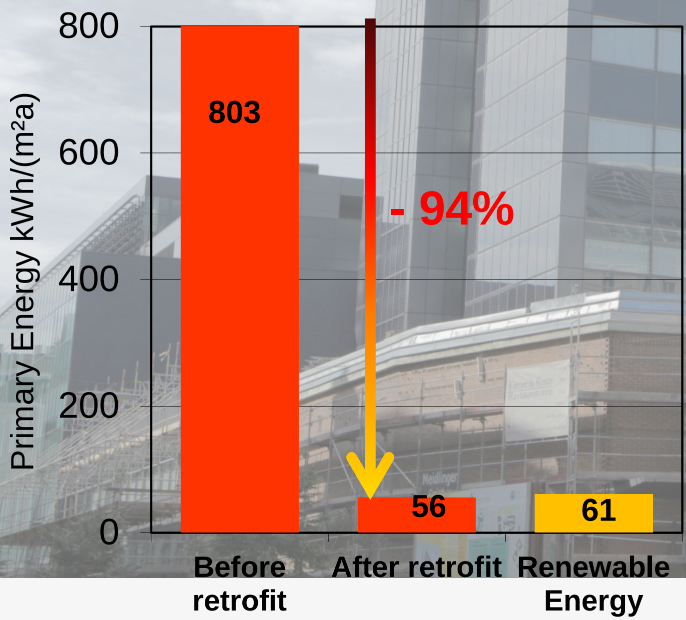
First retrofit to Passive House Plus

Office building **Technical University Vienna**
Architect: Arch. DI Gerhard Kratochwil
Building physics: Schöberl & Pöll GmbH
Owner: BIG Bundesimmobilien gesmbH

Treated floor area: 7,322 m² = 80,000 ft²
Heating demand: 14 kWh/m²a = 4.4 kBTU/ft²a
Heat load: 9 W/m² = 2.85 BTU/ft²
Primary energy: 56 kWh/m²a = 17.75 kBTU/ft²a



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World's largest Passive House city district

Zero-Emission-City areal **Heidelberg-Bahnstadt**

116 ha, 1,700 flats

Passive House as Standard for urban development

www.heidelberg-bahnstadt.de

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Belgian Energy provider Elia
Brussels mandated Passive House in January 2015
Sinds 2010:
all public buildings are passivehouse
+ 12%
-17%
Brussels : Energy & CO2 per inhabitant
>2015:
all new building must achieve Passivehouse standard
Brussels
High rise renovation to full PH
Brussels Environnement Ministry
PASSIVHAUS Austria
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New York City may go Passive

NYC Mayor De Blasio

A Roadmap for New York City's Buildings:

"The City Government will implement leading edge performance standards for new construction that cost effective achieve highly efficient buildings, **looking to Passive House to inform the standards**"

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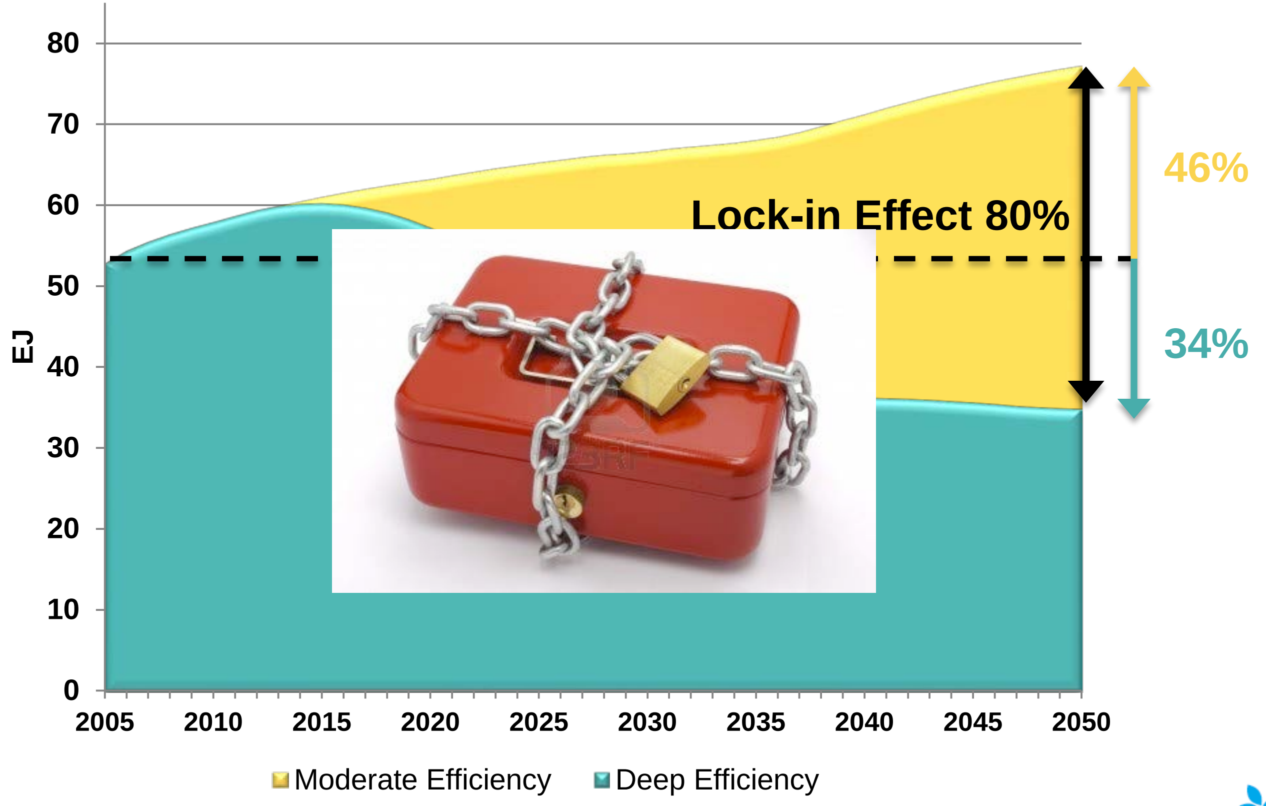
The Lock-in Risk: global heating and cooling final energy in two scenarios



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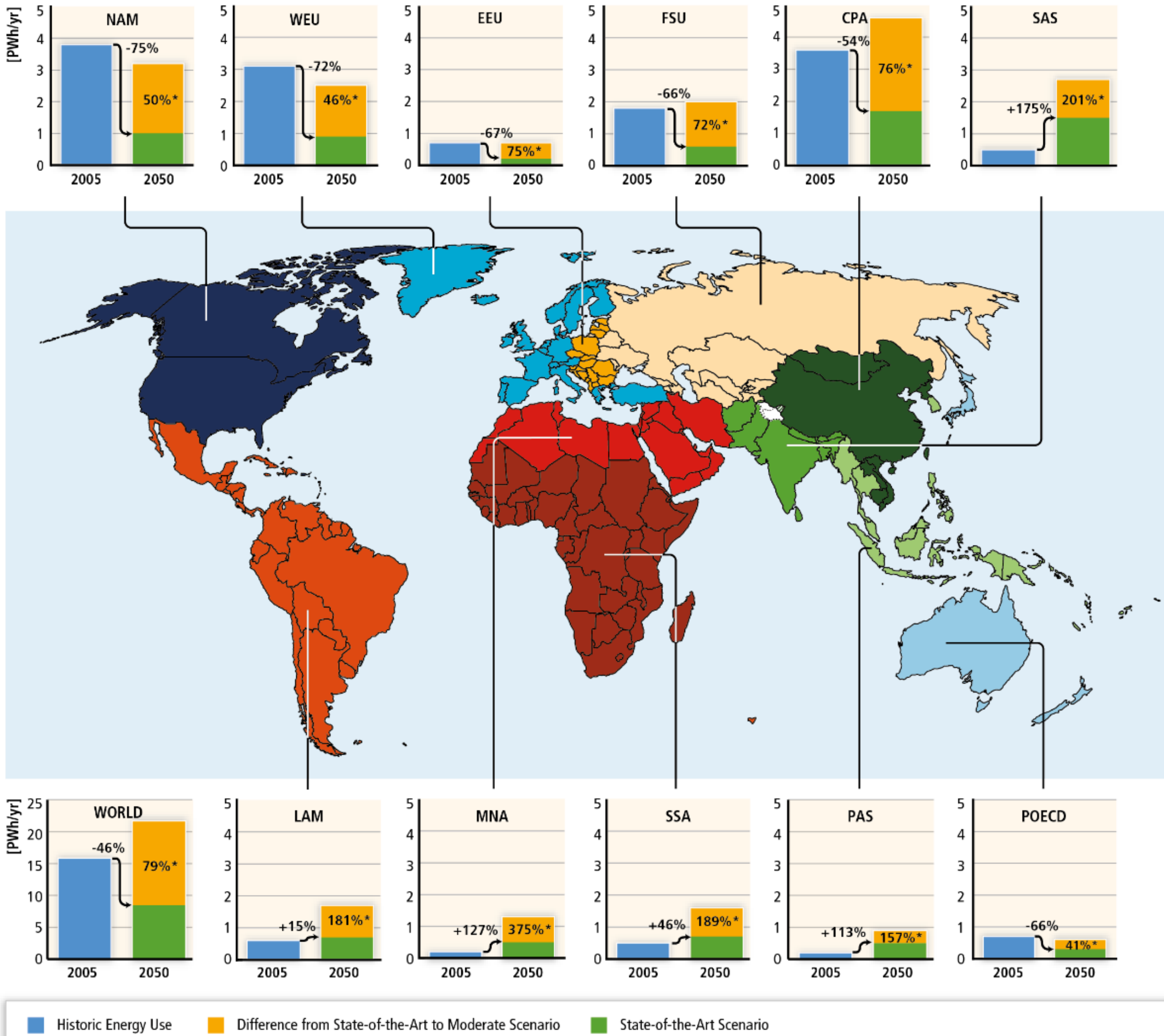
The lock-in risk: heating and cooling energy demand by two scenarios



Source: IPCC AR5 WGIII, Chapter 9

Further questioning energy modeling: working in traditional silos vs allowing for different systemic approaches

- sectoral breakdown – inherited from economic statistics; is this still the best (or at least only) way to organize energy (end) use?
- E.g. urban systems
  - The role of urban planning, interactions between buildings and transport; role of density
  - Eliminating UHI – effect on emissions/energy use?
- ICT
  - 10% of global electricity consumption is for IT
  - If the cloud were a country, it would have the 5th largest electricity demand in the world.
  - “information efficiency”?
- E.g. food systems

Food systems

- *The industrial food system is responsible for 44 to 57% of all global GHG emissions (Grain, 2011)*
  - Agriculture, industry, transport, buildings, services
- In EU, transport of food accounts for at least 6% of global GHG emissions. (Grain, 2011)
- processing and packaging of food accounts for between 10-11% of GHG emissions, while refrigeration of food accounts for 3-4% of total emissions and food retail another 2%. (Grain, 2011)
- In North America, 42% of food was wasted
  - But cross-sectoral savings often remain uncaptured
    - Reducing food waste
    - Dietary shifts
    - ?

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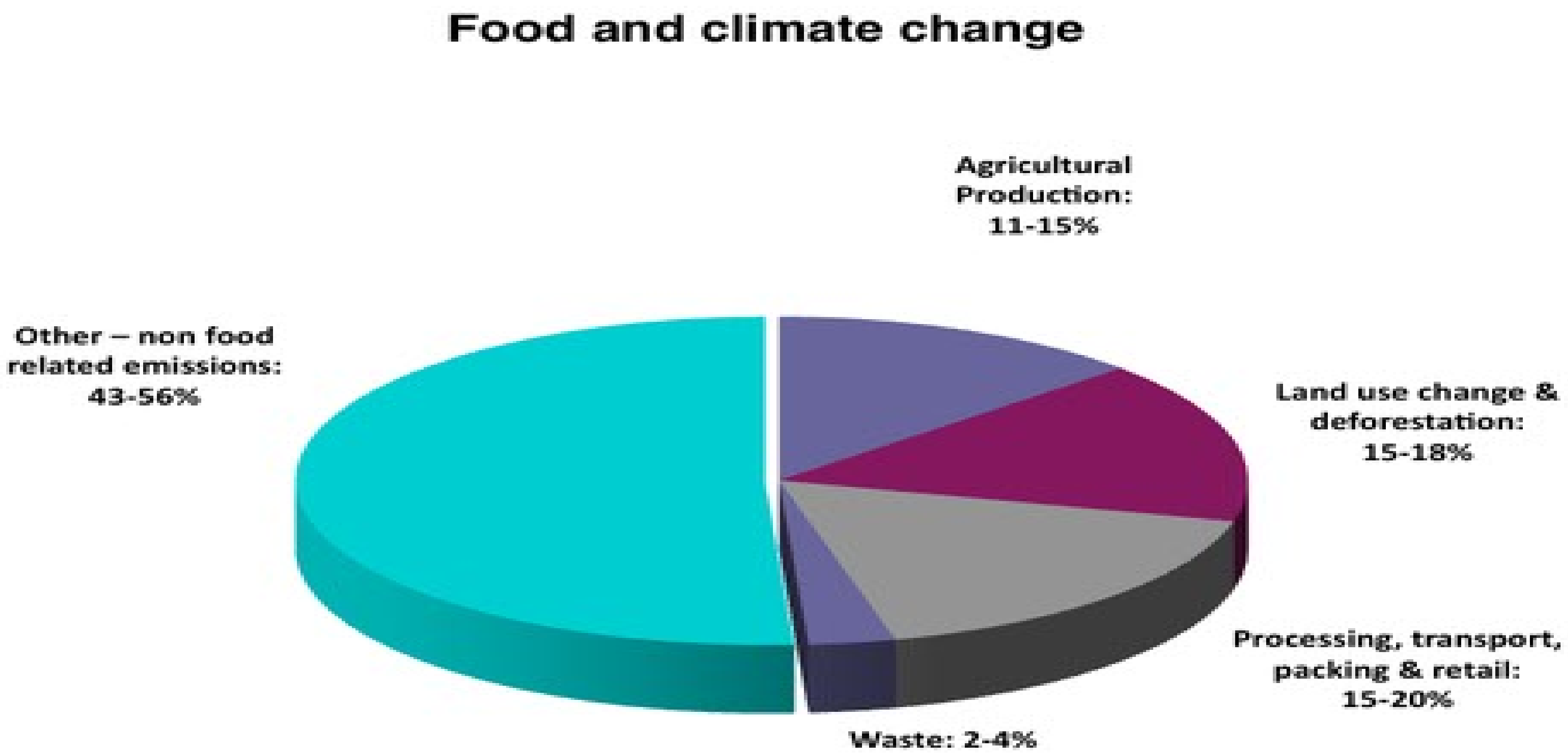

Source: Grain 2011: file:///C:/Users/USER/Downloads/grain-4357-food-and-climate-change-the-forgotten-link.pdf

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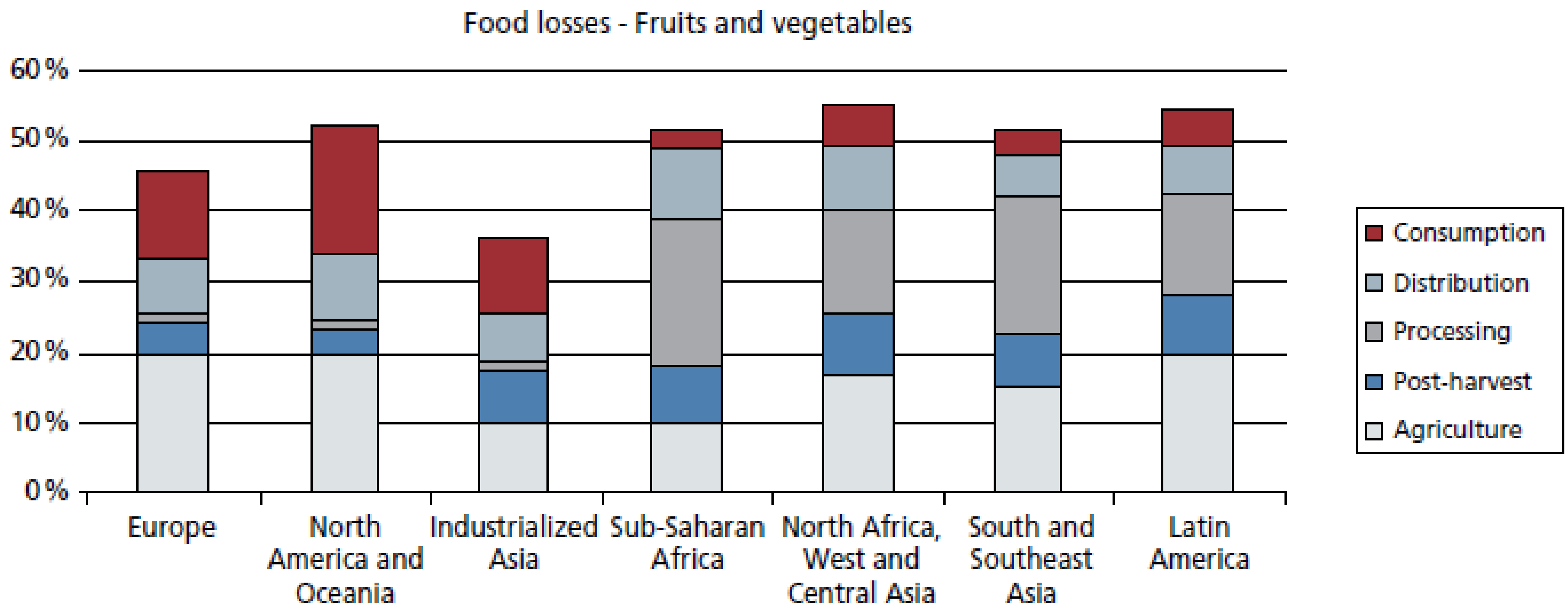
Figure 6. Part of the initial production lost or wasted at different stages of the FSC for fruits and vegetables in different regions



Source: FAO

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Further challenging integrated energy modeling 2: technology vs. behavior/culture/values

- Factors of 3 to 10 differences in residential energy use for similar dwellings with same occupancy and comfort levels (Zhang et al., 2010), and up to 10 times difference in office buildings with same climate and same building functions with similar comfort and health levels
- the use of 'part-time‘ and 'part-space' indoor climate conditioning, using mechanical systems only for the remaining needs when passive approaches cannot meet comfort demands can reach energy use levels below 30 kWhe / m2 / yr as a world average (TUBESRC, 2009; Murakami et al., 2009), as opposed to the 30 – 50 kWhe / m2 / yr achievable through fully automatized full thermal conditioning (Murakami et al., 2009; Yoshino et al., 2011).

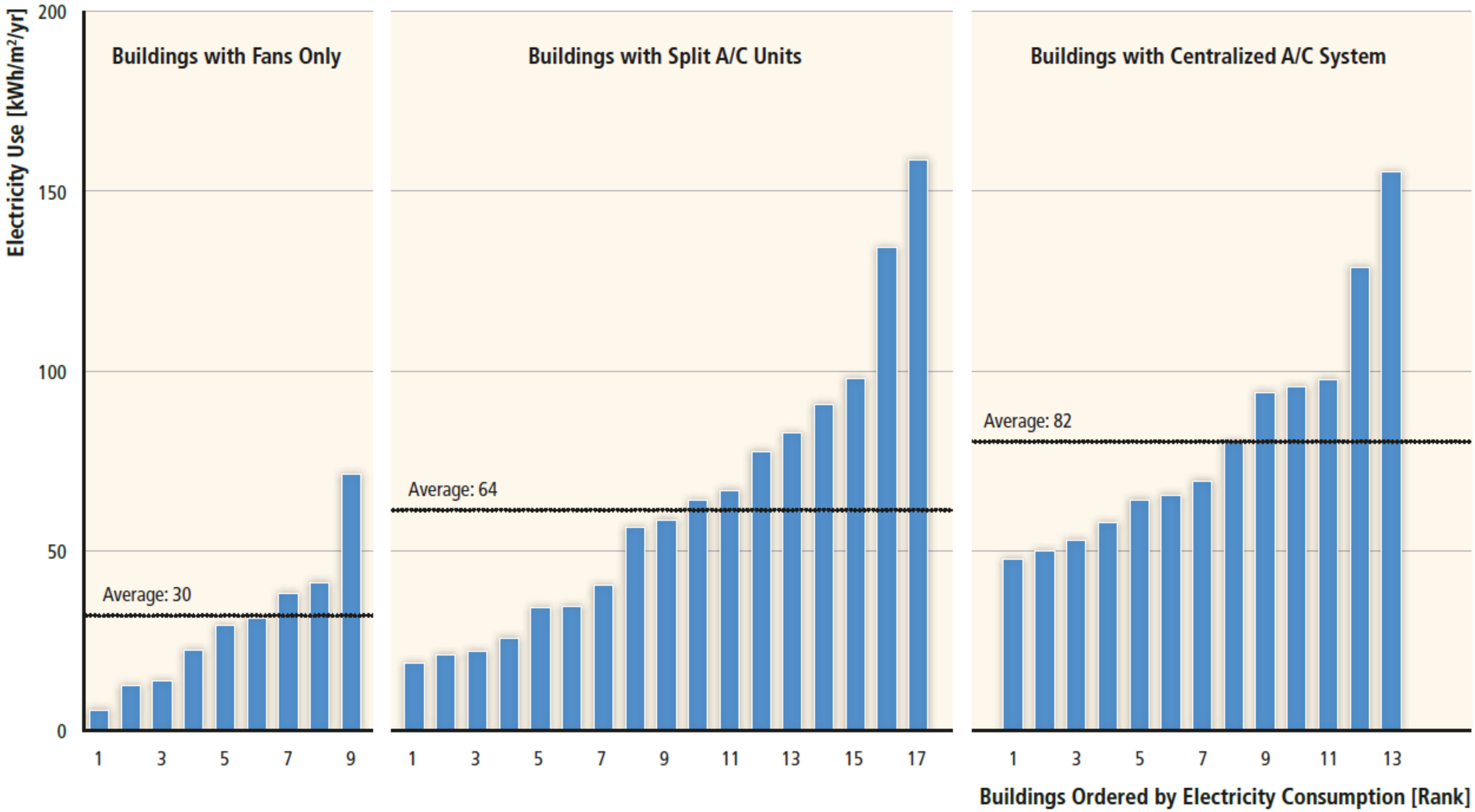

Figure 9.10 | Annual total electricity use per unit of floor space of buildings on a university campus in Beijing, China, 2006 (Zhang et al., 2010).

Source: IPCC AR5 WGIII, Chapter 9

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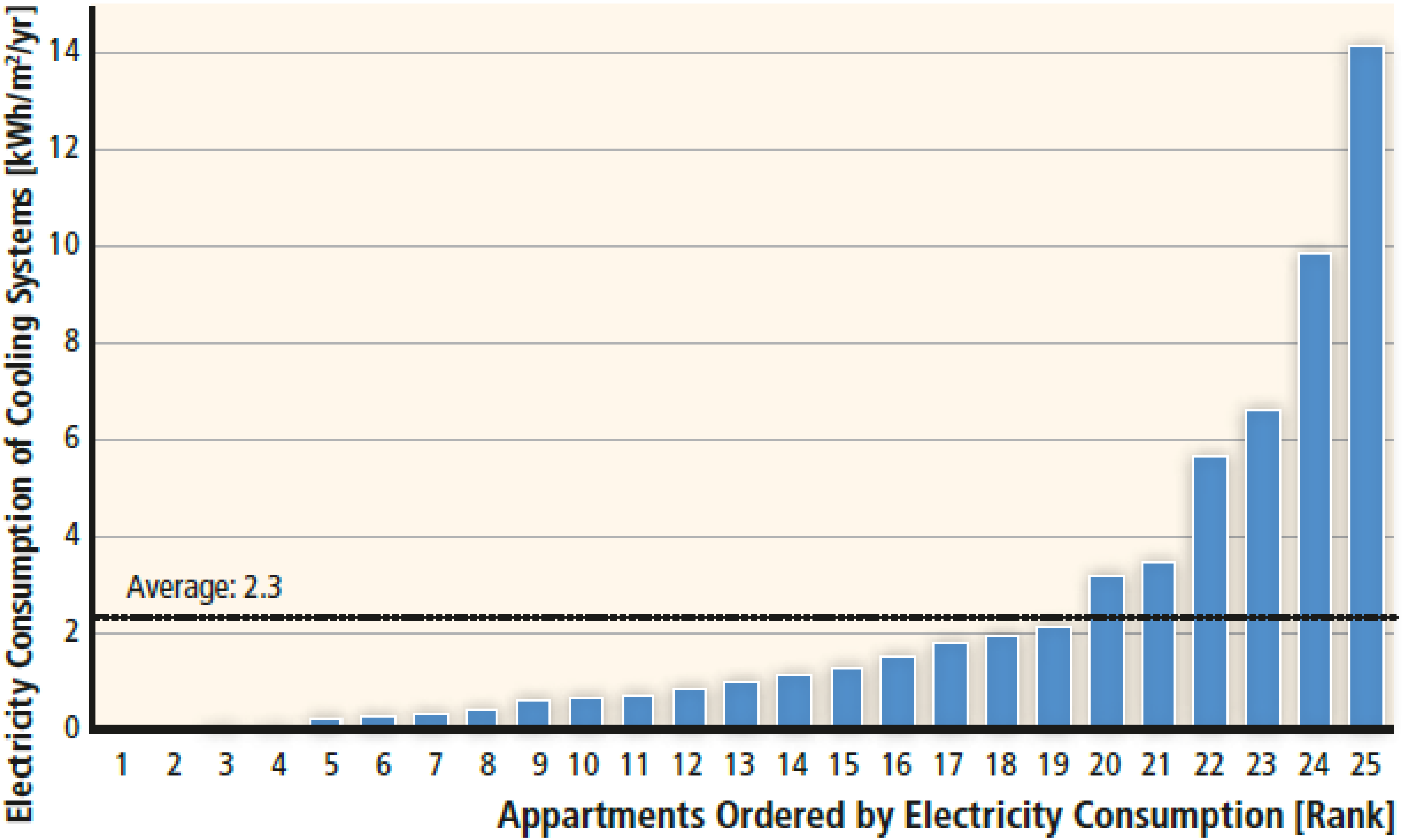

Figure 9.9 | Annual measured electricity per unit of floor space for cooling in an apartment block in Beijing (Zhang et al., 2010).

Source: IPCC AR5 WGIII, Chapter 9

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Behaviour, lifestyes vs technology cont.

- Dress codes: AC thermostat setting from 28 to 24 will more than triple AC power use in Zurich and double in Rome. “Cool Biz” of Japan enables the higher setting
- Many more examples – point is to go beyond price-driven demand changes as sole behavioural option, as well as purchasing behavior to increase penetration of advanced technologies
- E.g. Lord Stern’s example: average car in the city is utilized less than 8% of the time; with less than a third of seat occupancy – i.e. just above 2% average utilization factor. Using parking space, urban space, resources to manufacture, dispose of, etc. Is really the winning strategy to optimize the fuel/efficiency of this vehicle, rather than incentivising shared ownership/use systems?

Challenging the frontiers of demand-side energy modeling 3.

- In general, are the effects of the shared economy captured? Future opportunities?
- Driverless mobility?
- Driverless smart/intelligent transport and shipping systems, replacing even public transport systems?
- In general, how much are we capturing the gigantic optimization opportunities through IOT, Big Data, Web 2.0, ubiquitous remote sensors, etc….?
- Information efficiency?
- CDRU?

Further non-technological, non-price opportunity examples

based on Creutzig et al 2016, Annual Reviews

Demand side measures	Examples
Semi-detached and three story buildings have been shown to be significantly more efficient in terms of operational energy than single-story freestanding units.	In Sydney, Australia, low-rise attached housing has 15-20% lower energy use than detached housing with the same number of bedrooms
Behavioral changes, depending on the type of end use	Savings from heating loads of 10–30% are possible for changes in thermostat setting
	Cooling savings of 50–67% are recorded with measures such as substituting air conditioning with fans in moderately hot climates with tolerable brief heat exposures.
	Increasing the thermostat setting from 24°C to 28°C reduces annual cooling energy use by more than a factor of three for a typical office building in Zurich, by more than a factor of two in Rome and by a factor of two to three if increased from 23°C to 27°C for the night-time in residential Hong Kong

Source:Creutzig et al 2016 Annual Reviews

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Demand side measures	Examples
By shorter showers, switch from bathing to showering	Hot water savings of 50%
By turning off not needed lights	Lighting energy savings of 70%
Smaller fridge/fridge-freezer volumes and elimination of a second fridge	Refrigerator energy savings of 30-50%
With cold compared to hot water washing	Clothes washers energy savings of 60–85%
Dishwasher (by fully loaded operation versus typical part-load operation)	Dishwashers energy savings of 75%

Source:Creutzig et al 2016 Annual Reviews

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Summary points

- For WB2C scenarios it is crucial that energy modeling is advanced to better integrate:
  - Frontiers of technologies and know-how
    - E.g. passive buildings
  - Frontiers of 21st century opportunities for optimization and service provision
    - IOT, web 2.0, big data, ubiquitous sensors, etc.
  - The increasing opportunities through the shared economy
  - Opportunities through behavior, lifestyle change, cultural change
  - Analyse also in other systemic frameworks than traditional economic sectors; e.g. food systems and urban systems
  - The quantification (and minimization?) of the lock-in risk
- Other: emission reporting (modeling) and attribution need to reflect both “extreme” attribution approcahes

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Thank you for your attention

A HVG engedélyével

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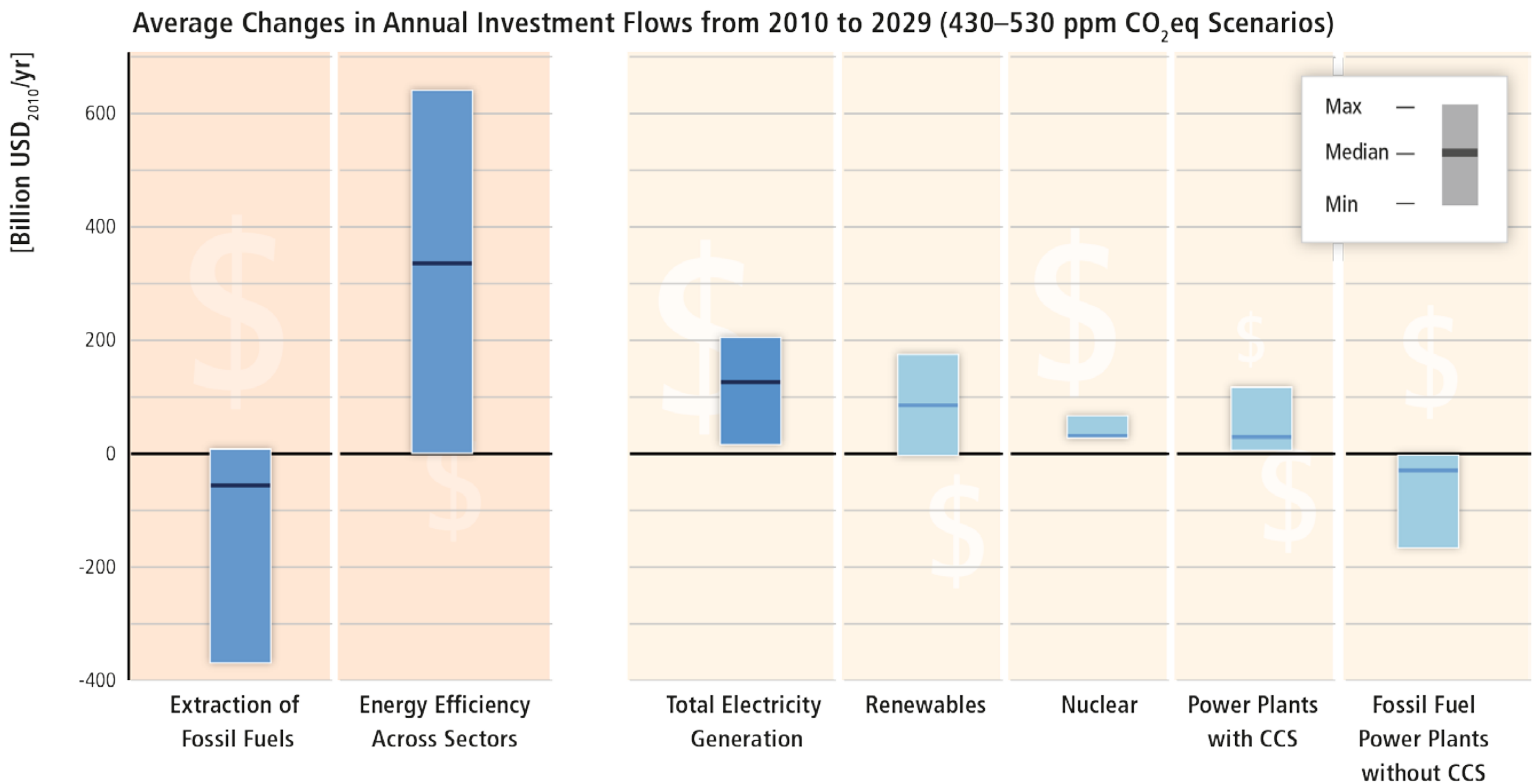
Supplementary slides

IPCC AR5: Substantial reductions in emissions will require large changes in investment patterns



Based on Figure 16.3

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New business models are needed

- What we really need are ingeneous **new business models** whose profits are not from converting raw natural resources to sellable consumer goods; but rather decouple (or minimize the link between) well-being from more resource consumption
- Recent ideas that come close but are not quite what I mean are:
  - Social media – replacing much travel? (good or bad…?)
  - Airbnb, uber, etc – the sharing economy?
- More business platforms needed for utilizing unwanted, grown-out, etc products that have not reached the end of their lifetimes but cannot easily find their new owner
  - Also needs a cultural change, but partially ongoing
- More business profiting form repair and good maintenance, lending, rather than selling new and encouraging early breakdown or replacement
- Business ideas utilizing or minisiing waste streams – such as the 50% of the food in the EU that we ends up as waste
  - are there solutions that still supply the choice of fresh food an hour before closure but eliminate waste? Could we better predict demand?
- More utilization of IT for more optimization (such as trafiic jams, unnecessary trips to where we do not want to go but have to; more teleworking, teleeducation; more optimization in transport and aviation)
- Can businesses profit from a more quality spending of time rather than consumption? (community-building, family, local travel, eco-tourism, etc)

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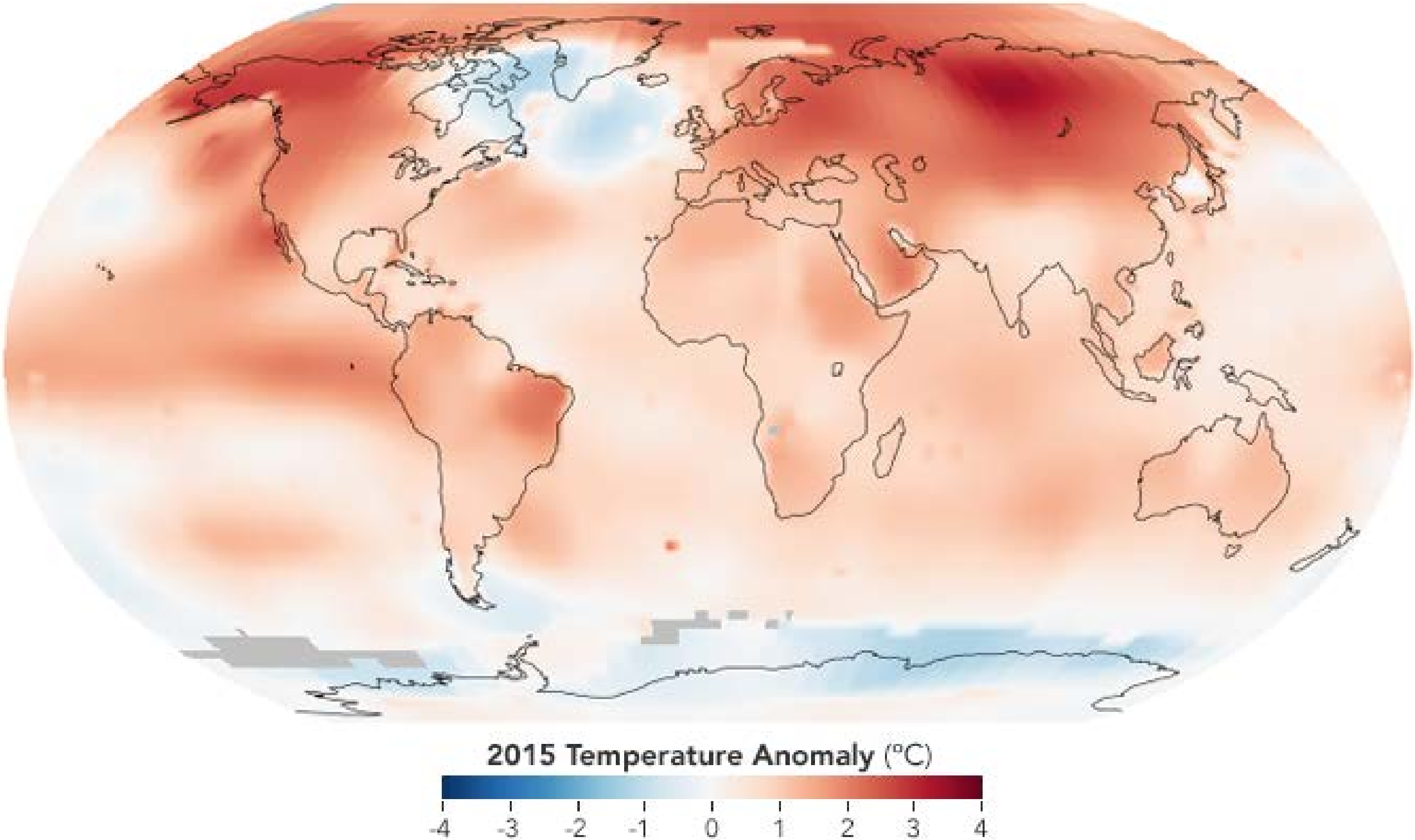
2015 was the warmest year ever recorded on Earth



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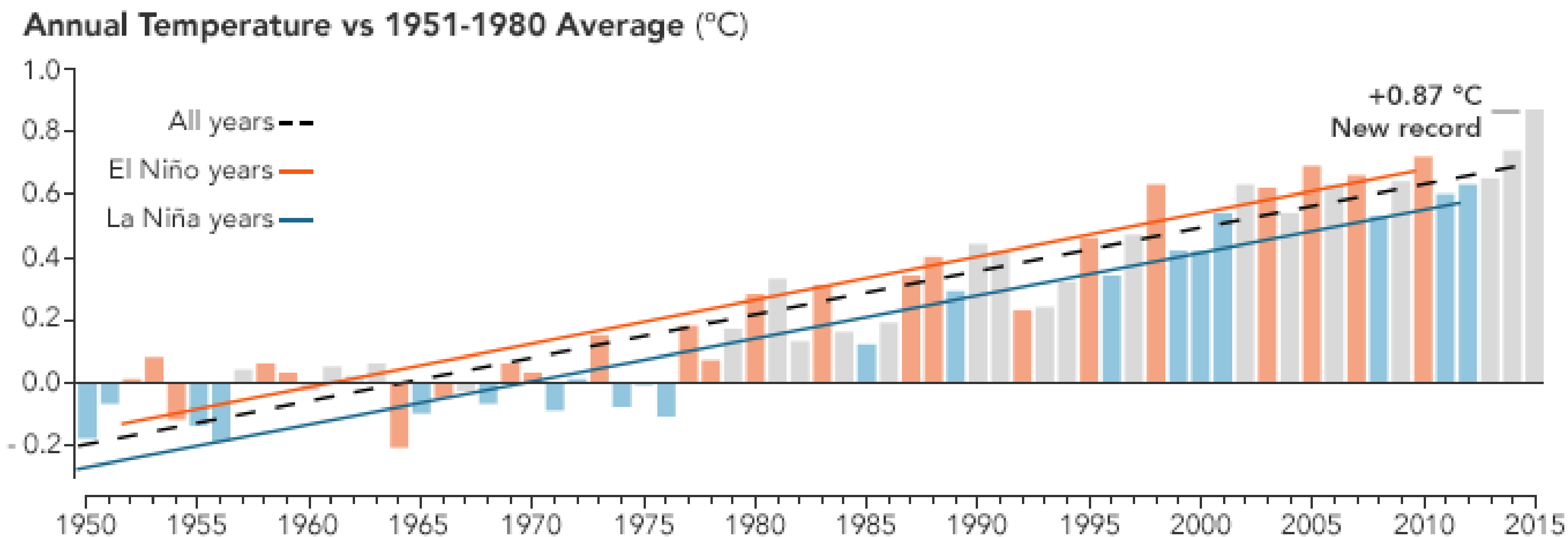
Annual Temperature vs 1951-1980 Average (°C)
1.0
0.8
0.6
0.4
0.2
0.0
- 0.2
All years
El Niño years
La Niña years
+0.87 °C
New record
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

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Estimates for mitigation costs vary widely.

- Reaching 450ppm CO_2eq entails consumption losses of 1.7% (1%-4%) by 2030, 3.4% (2% to 6%) by 2050 and 4.8% (3%-11%) by 2100 relative to baseline (which grows between 300% to 900% over the course of the century).
- This is equivalent to a reduction in consumption growth over the 21st century by about 0.06 (0.04-0.14) percentage points a year (relative to annualized consumption growth that is between 1.6% and 3% per year).
- Cost estimates exlude benefits of mitigation (reduced impacts from climate change). They also exclude other benefits (e.g. improvements for local air quality).

Source: IPCC 2014, AR5 WGIII

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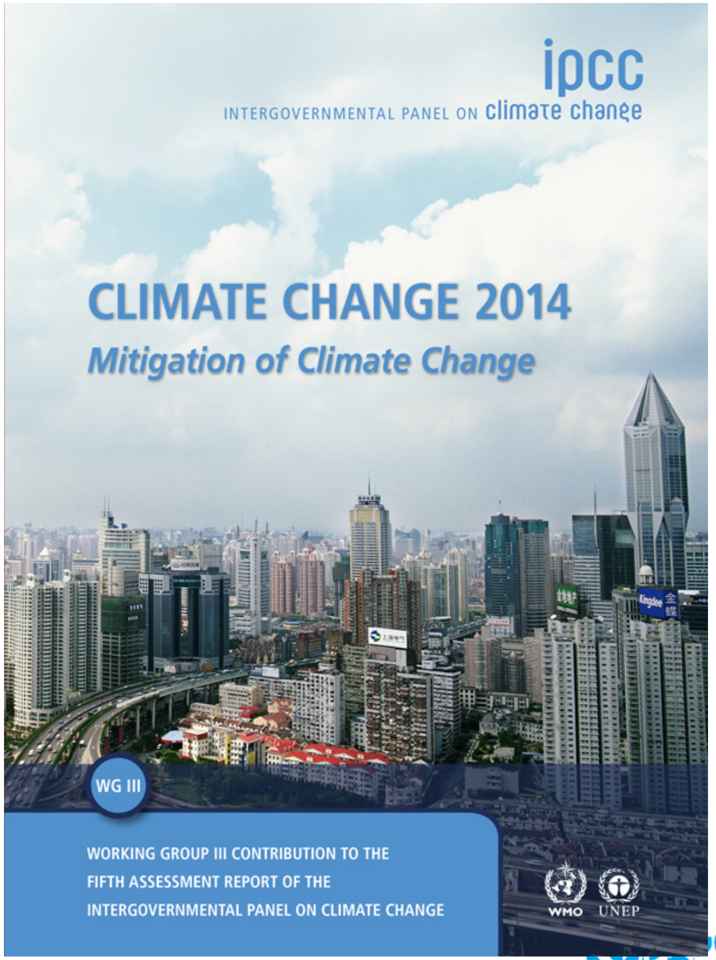
The Fifth Assessment Report: 2013 – 14
Mitigation: Working Group III

AR5: the largest assessment in human history
1 Summary for Policymakers
1 Technical Summary

16 Chapters
235 Authors
900 Reviewers
More than **2000** pages
Close to **10,000** references
More than **38,000** comments



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