Switzerland: Economic aspects of a transition to a 1.5°C world

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7 October 2019

Outline

1. The questions we are asked relating to climate policy
2. Our workhorse: GEMINI-E3
3. Some results of our research

BACKGROUND: QUESTIONS WE ARE ASKED

Questions we were (and are) asked

- Is decarbonization possible?
- How much would it cost?
- What measures would it take?
- What have we achieved up to now?
- What will the economic impacts of climate change be?

⇒ **Policy-driven research**

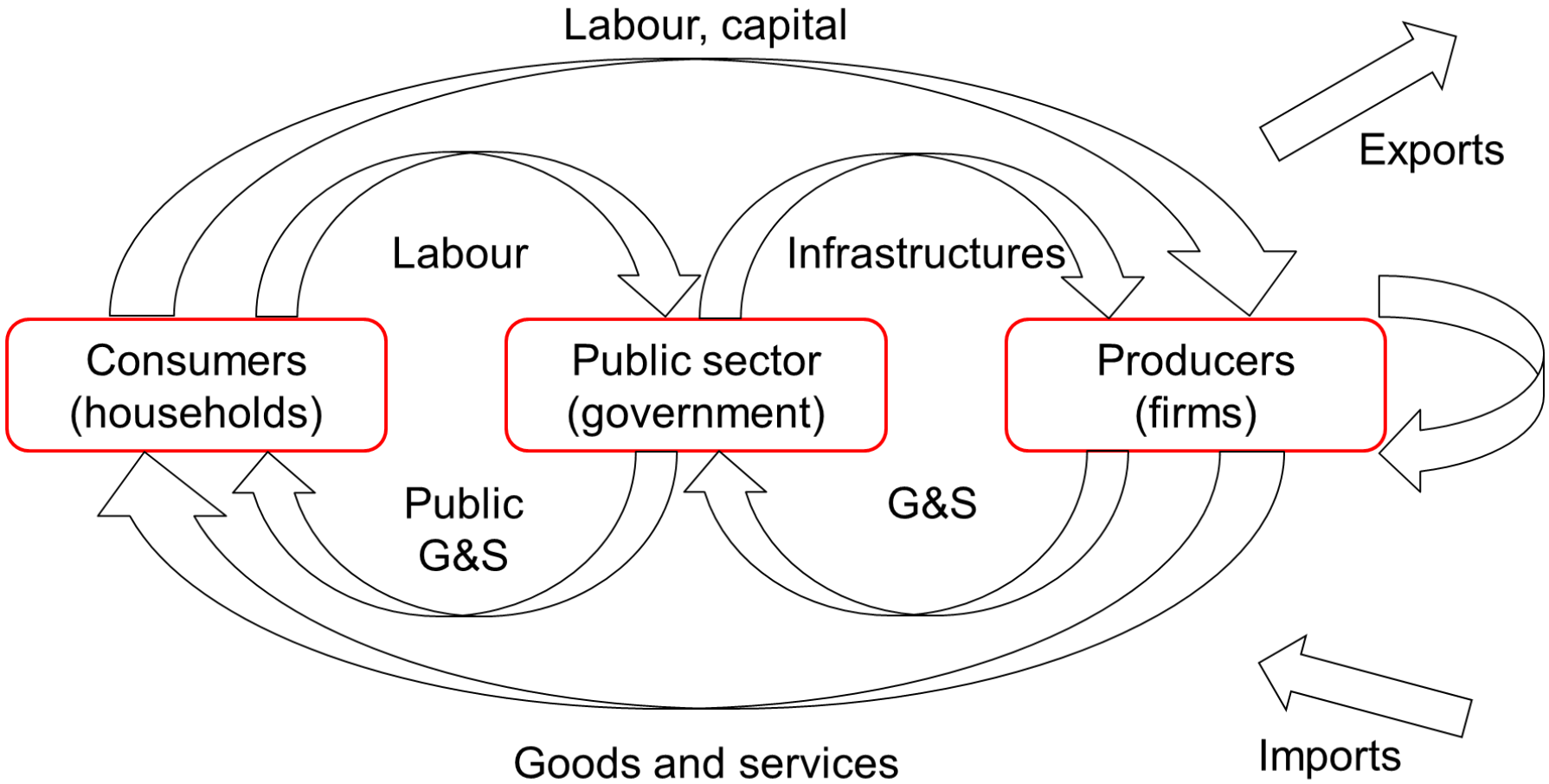
What we are expected to provide

- Quantitative results
- Generally forward looking (predictive), but rarely also backward looking (counterfactual)
- Economywide, with detailed results for sectors or policy instruments

OUR MODELS, e.g. GEMINI-E3

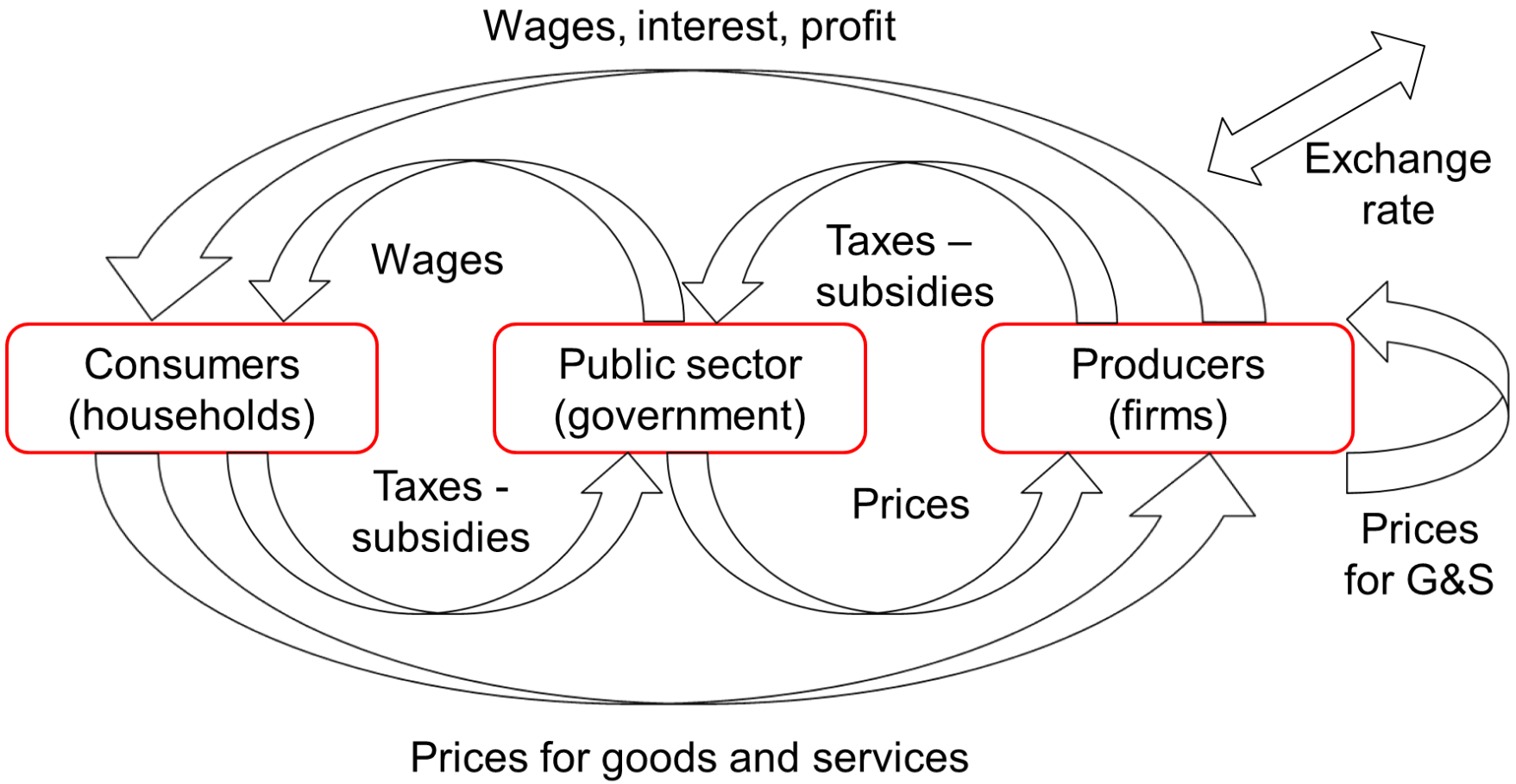
Real flows

- Macroeconomic, e.g. Switzerland as an open economy part of the World
- Grand categories:



Monetary flows

- Monetary flows match the real flows of goods, services, labour, capital
- Prices are endogenous (except some world prices, e.g. world energy prices)
- Grand categories:



Markets

- Production → supply of goods and services
- Consumption → final demand of G&S
- B2B → intermediate demand of G&S
- Markets: supply and demand for each G&S balance thanks to adjustments in prices; perfect competition
- Domestic and foreign G&S → international trade
- Markets for labour (→ wage), for capital (→interest rate)
- Taxes, subsidies, regulation…

Catch a parrot and teach him to say 'supply and demand', and you have an excellent economist.

Popular joke in 19th century

GEMINI-E3

- **G**eneral **E**quilibrium **M**odel of **I**nternational-**N**ational **I**nteractions between **E**conomy, **E**nergy and the **E**nvironment
- Sectoral and regional disaggregation, which can be simplified *ad hoc*

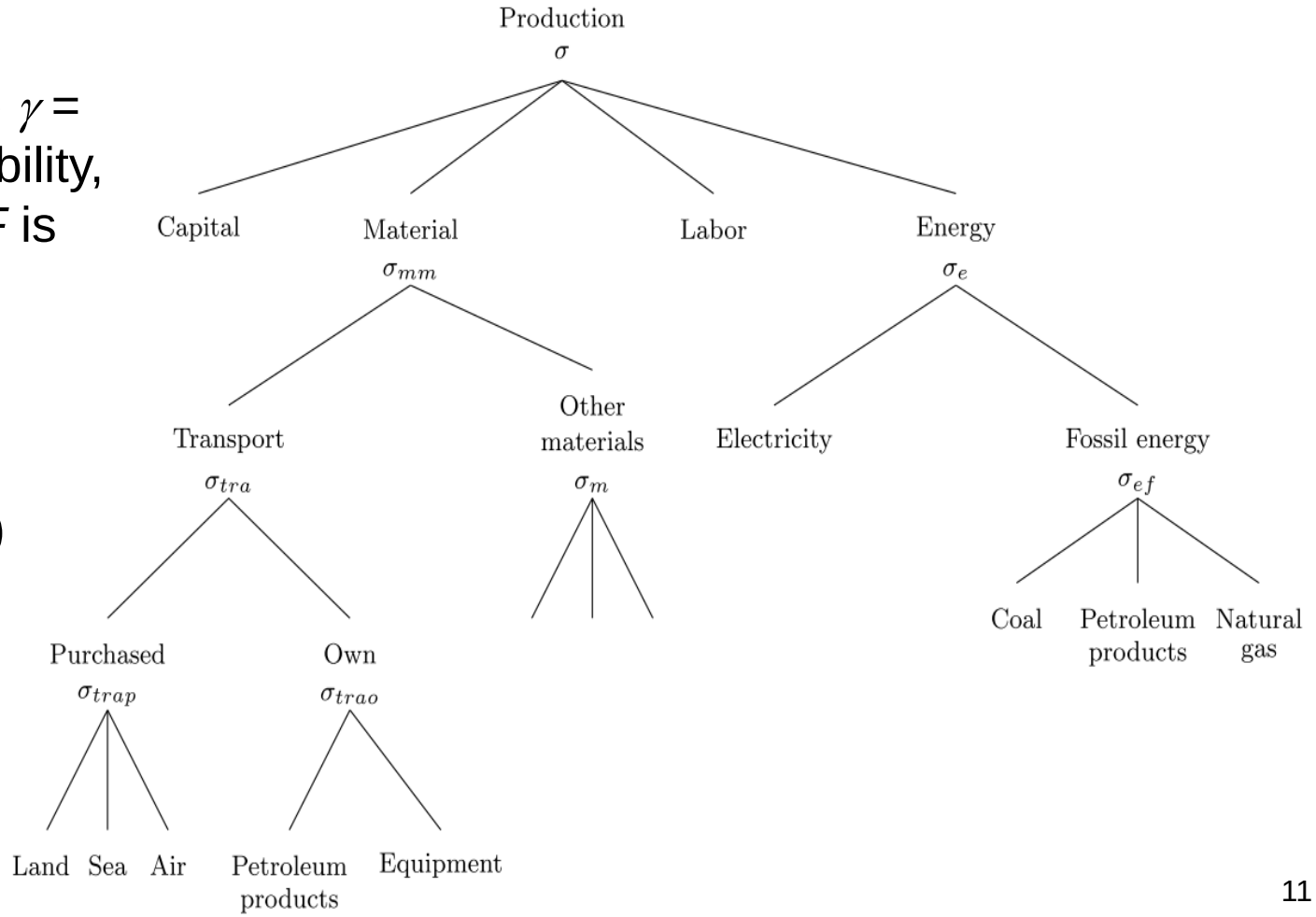
Sectors
Coal
Crude oil
Natural gas
Refined petroleum products
Electricity
Agriculture, forestry
Energy intensive industries
Other goods and services
Land transport
Sea transport
Air transport

Geographic regions
Switzerland
European Union (28)
United States of America
China
India
Brazil
Russia
Central and South America
Other Asian countries
Middle East
Africa
Rest of the World

GEMINI-E3: Production

$$Output = \left[\alpha_K K^{\gamma} + \alpha_L L^{\gamma} + \alpha_E \left(\left(\alpha_{EL} EL^{\gamma_E} + \alpha_{EF} EF^{\gamma_E} \right)^{1/\gamma_E} \right)^{\gamma} + \alpha_I I^{\gamma} \right]^{1/\gamma}$$

The α are value shares adding up to 1, the $\gamma = (\sigma - 1)/\sigma$ determine the degree of substitutability, *K* is capital, *L* is labour, *EL* is electricity, *EF* is fossil energy, *I* groups intermediate inputs



Production function

- Constant elasticity of substitution (CES)
- Input-output matrix for intermediates
- Productivities (not shown) and elasticities of substitution

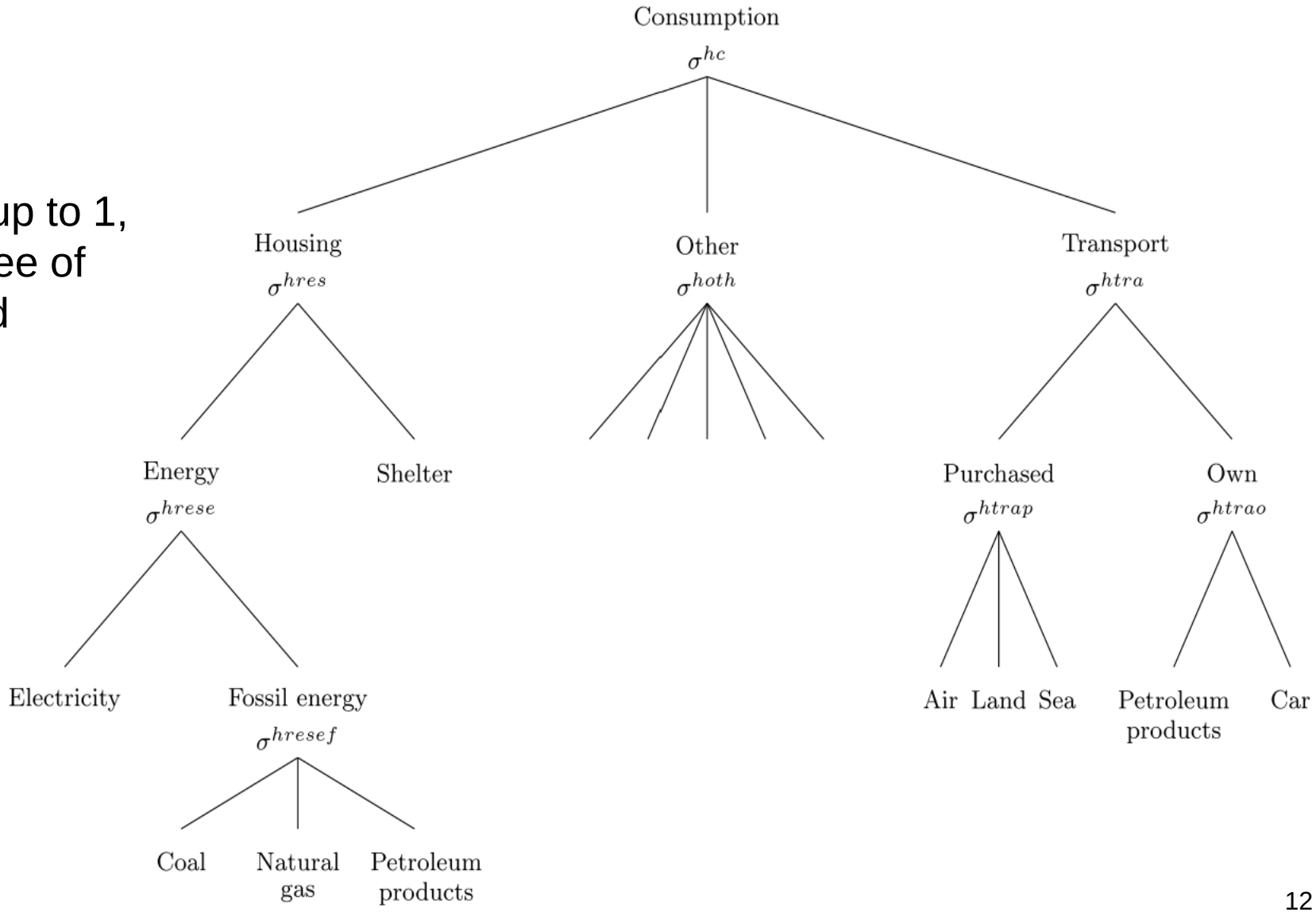
GEMINI-E3: Consumption

$$Welfare = \left[\sum_i \alpha_i G_i^{\gamma} \right]^{1/\gamma}$$

The α are value shares adding up to 1, $\gamma = (\sigma - 1)/\sigma$ determines the degree of substitutability, G_i are goods and services from sector *i*

Welfare function

- Constant elasticity of substitution (CES)
- Productivities and elasticities of substitution
- Serves to model consumer choices and to measure welfare changes



GEMINI-E3: costs

- Firms pay for their inputs and sell their products with a view to maximizing their profits; thus, they minimize their costs and respond to demand

$$Profit_i = p_i Output_i - p_K K - p_L L - p_{EL} EL - p_{EF} EF - \sum_j p_j I_j$$

- Households decide on labour, savings and purchases of G&S with a view to maximizing their welfare; they must balance their purchases with their income minus savings and taxes

$$p_K K + p_L L - Taxes = \sum_j p_j Q_j + Savings$$

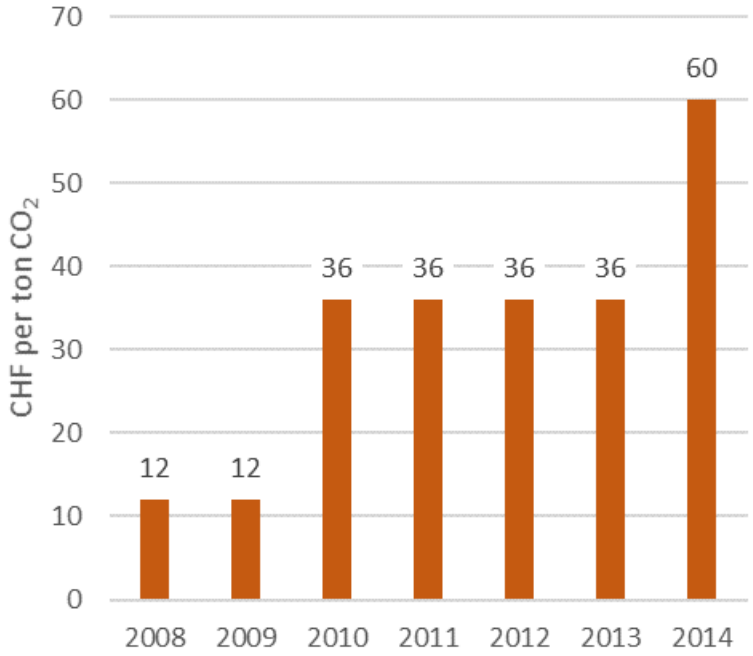
Vielle, Marc, Philippe Thalmann, "An ex-post evaluation of the effectiveness of the Swiss CO2 levy. Final report module B", Report for Federal Office for the Environment, EPFL/LEURE, Lausanne, 10 December 2015

Some results

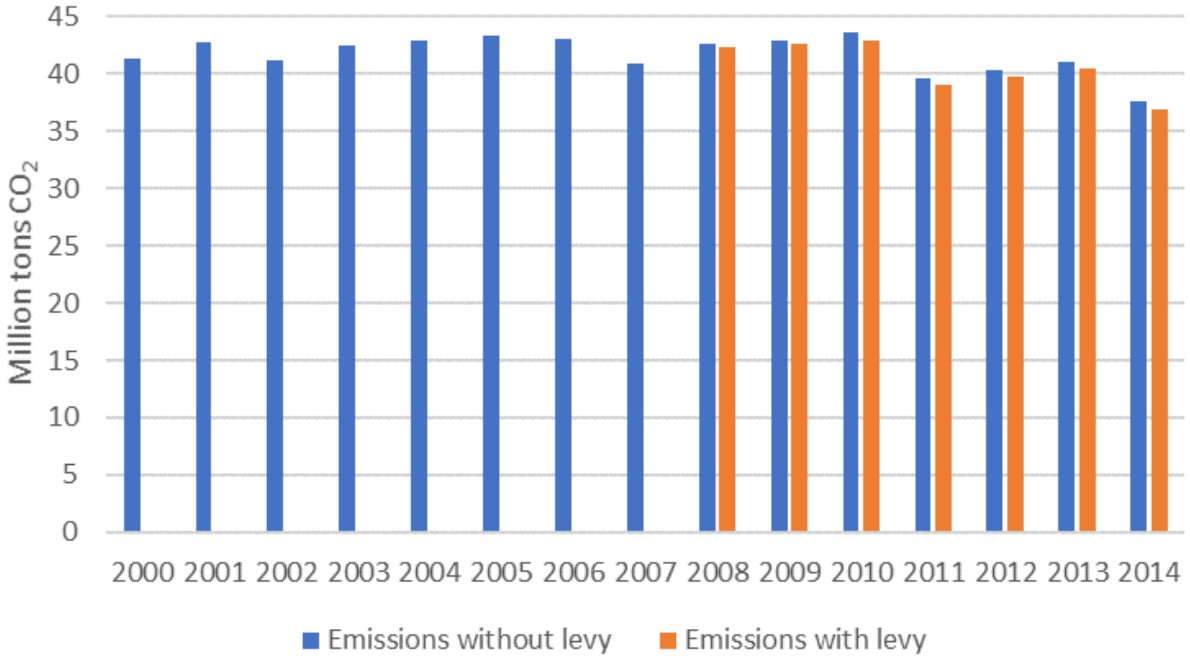
EFFECTIVENESS OF THE CO_2 LEVY

Effectiveness of CO_2 levy

Rate of CO_2 levy



CO_2 emissions without/with levy



In each sector *i*, a firm could be facing four different prices for its emissions of CO_2 depending on its situation: the CO_2 levy, the ETS price, a cost of abatement related to its offsetting commitment or nothing if its emissions are not covered by the CO_2 Act; hence, the average CO_2 price in sector *i* is:

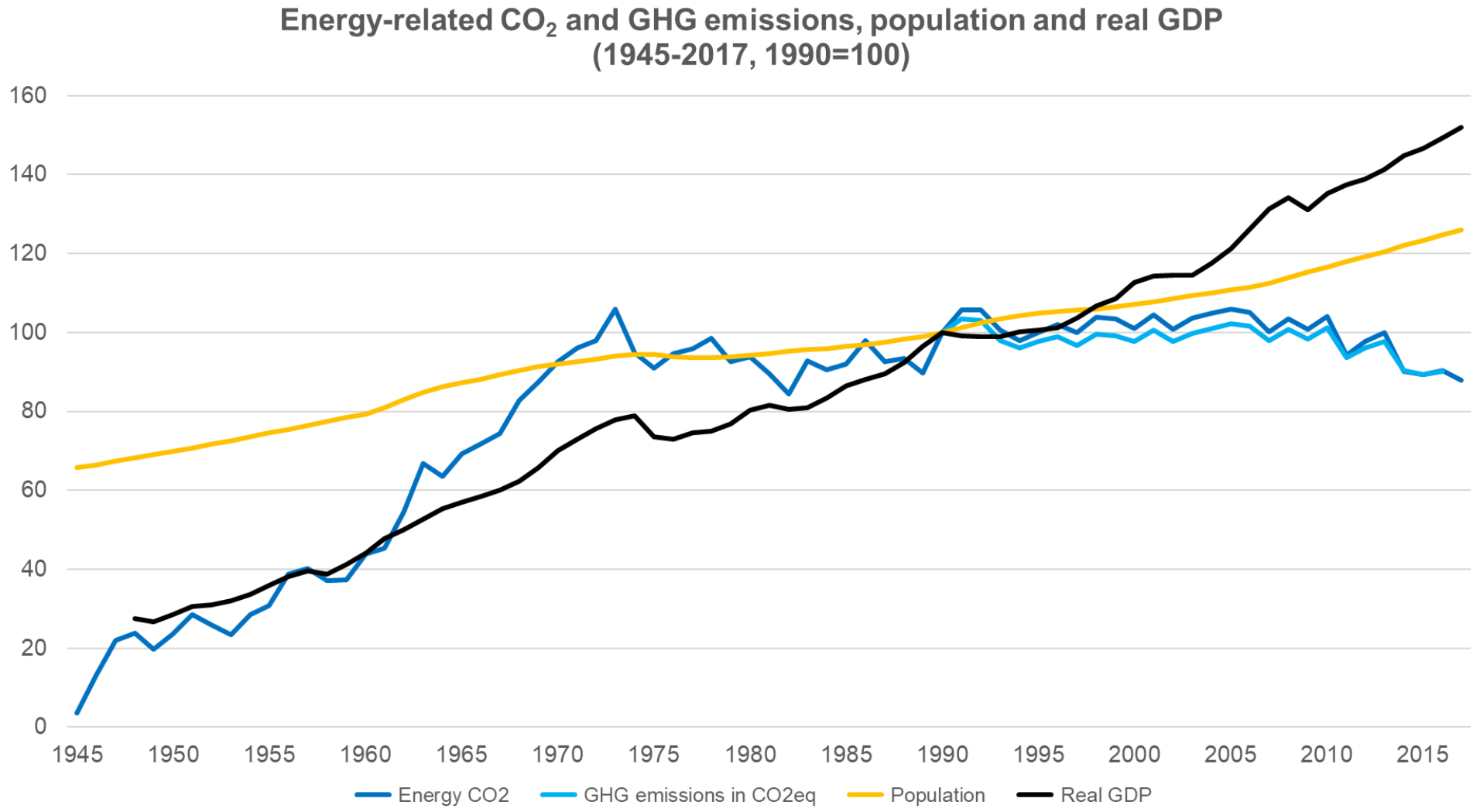
$$CO_2\ price_i = (1-\alpha_i-\beta_i-\mu_i)\cdot CO_2levy+\alpha_i\cdot PriceETS+\beta_i\cdot PriceNonETS+\mu_i\cdot 0$$

Vielle, Marc, and Philippe Thalmann, "Updated emissions scenarios without measures, 1990-2035", Report for Federal Office for the Environment, Lausanne, 12 October 2017

Some results

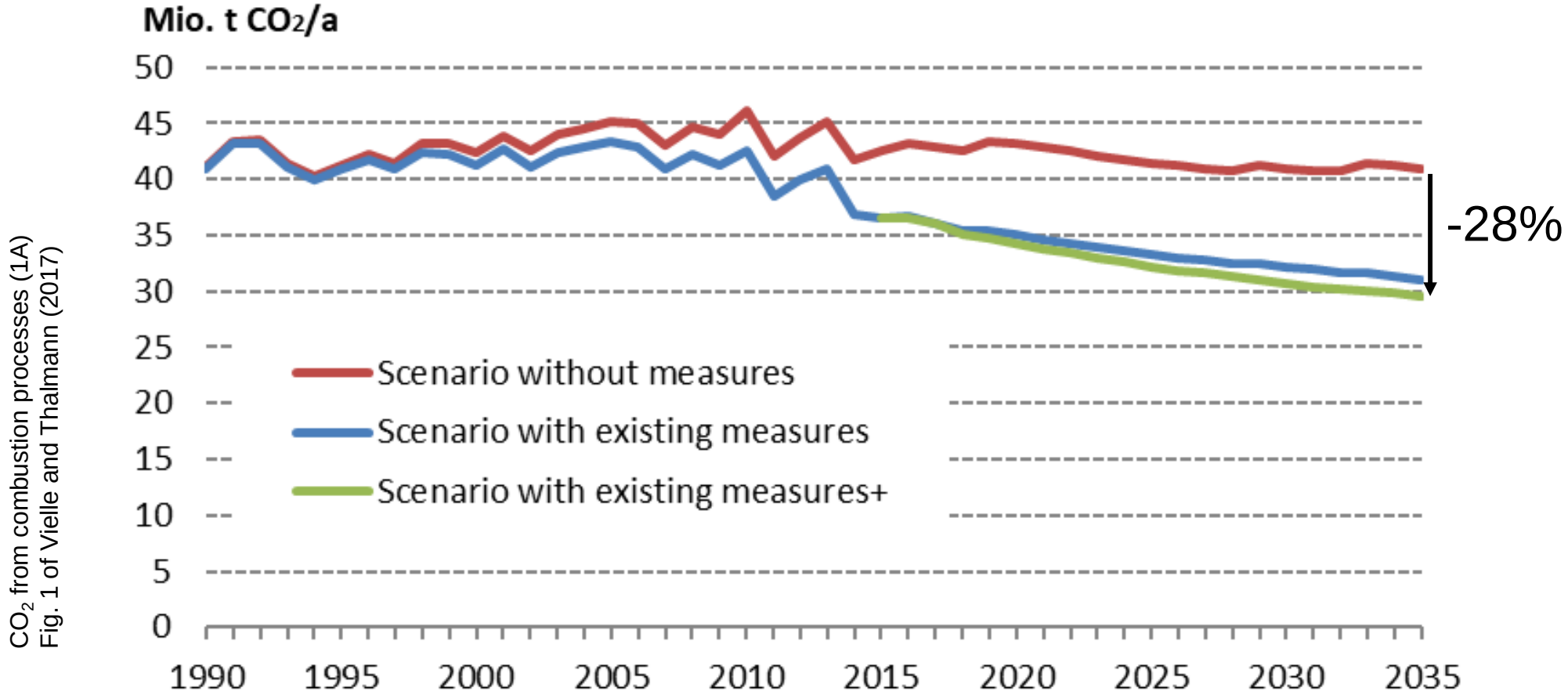
SWISS CO_2 EMISSIONS WITH AND WITHOUT MEASURES, 1990-2035

How much of the change in CO_2 emissions is due to climate & energy policy?



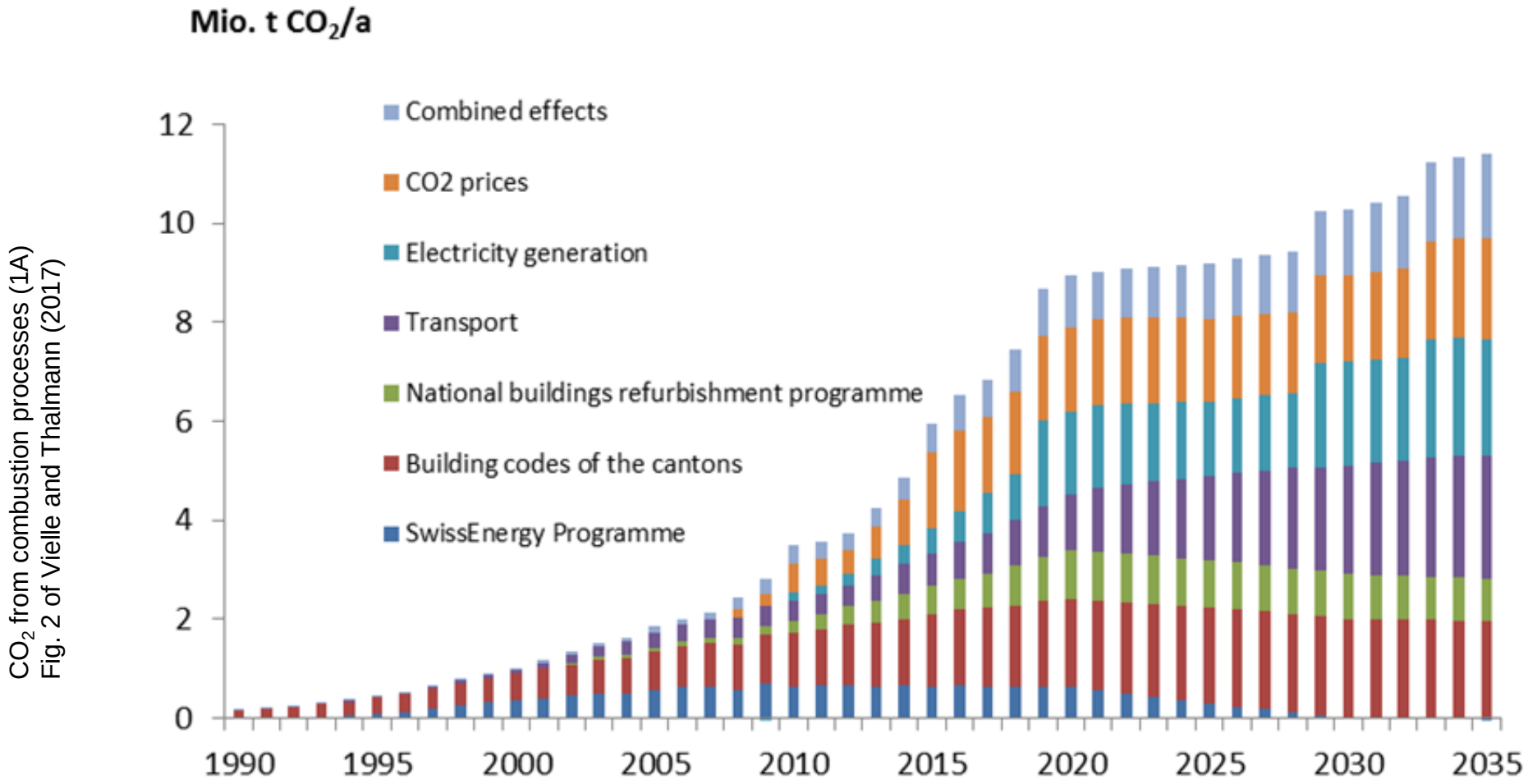
How much is attributable to policy?

Energy-related CO_2 emissions in a scenario without measures and two scenarios with existing and announced measures (1990-2035)



Effectivity of different components of energy and climate policy

Total reduction of CO_2 emission in scenario with decided measures compared to scenario without measures, by group of measures (1990-2035)



CO_2 from combustion processes (1A)
Fig. 2 of Vielle and Thalmann (2017)

Babonneau, Frédéric, Philippe Thalmann and Marc Vielle, "Defining deep decarbonization pathways for Switzerland: an economic evaluation", Climate Policy 18(1), 2018, 1-13 (published online 07 Nov. 2016, doi:10.1080/14693062.2016.1227952)

Schäppi, Bettina, Alexander Wunderlich, Jürg Füssler (INFRAS), Marc Vielle, and Philippe Thalmann (EPFL), “Pathways to deep decarbonisation – Results of a modelling exercise”, Final report for the Federal Office for the Environment, Zurich and Lausanne, 20 December 2016

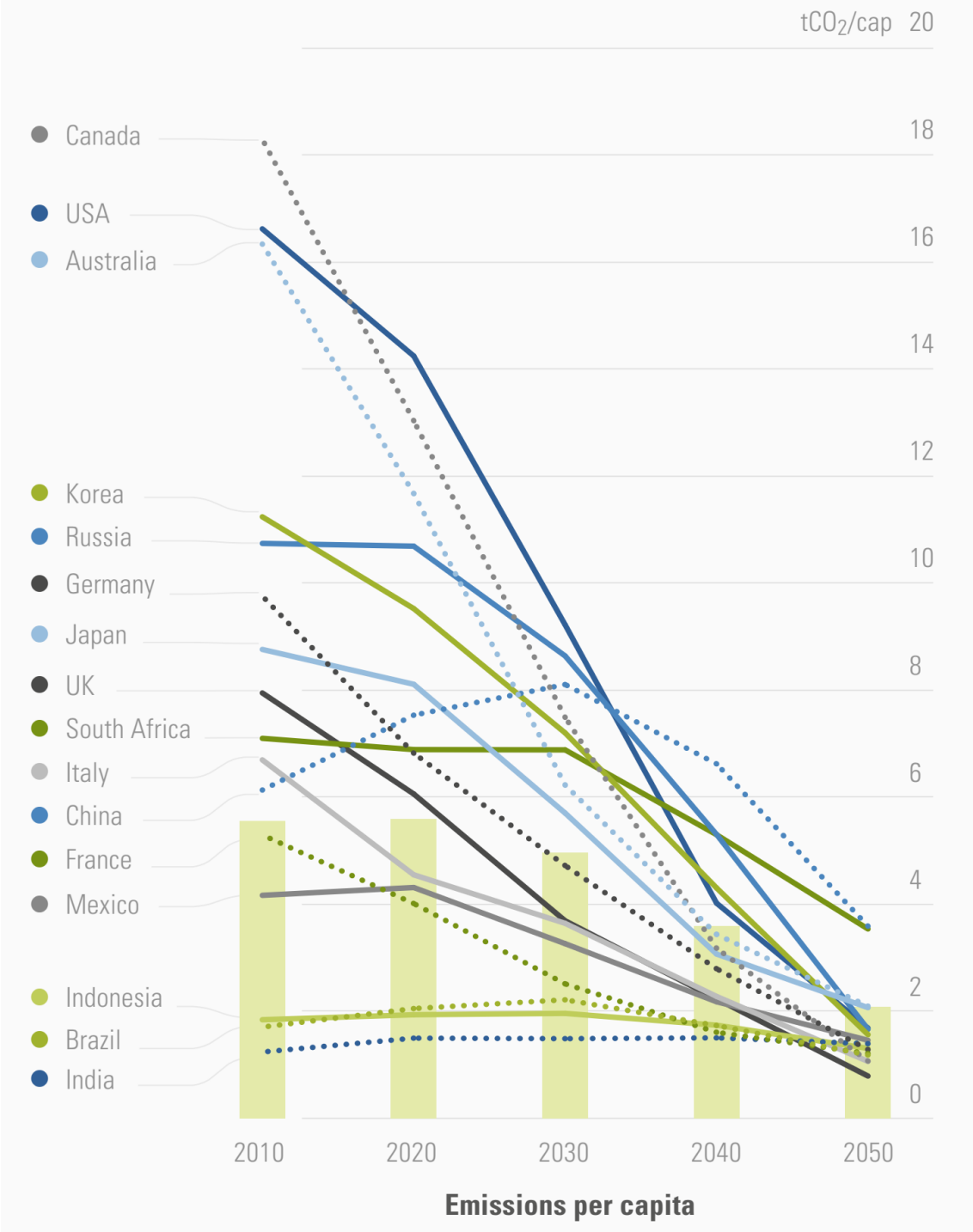
Vielle, Marc, Bettina Schäppi, Philippe Thalmann, and Jürg Füssler, "Simulations of proposed deep decarbonisation pathways – Phase 2: A contribution to Switzerland decarbonisation pathways", Report for the Federal Office for the Environment, Lausanne et Zurich, 20 December 2016

Some results

DECARBONISATION PATHWAYS FOR SWITZERLAND

Decarbonisation pathways for Switzerland

In parallel with *Deep Decarbonization Pathways Project* (DDPP) launched in October 2013 in view of COP21 (Paris)

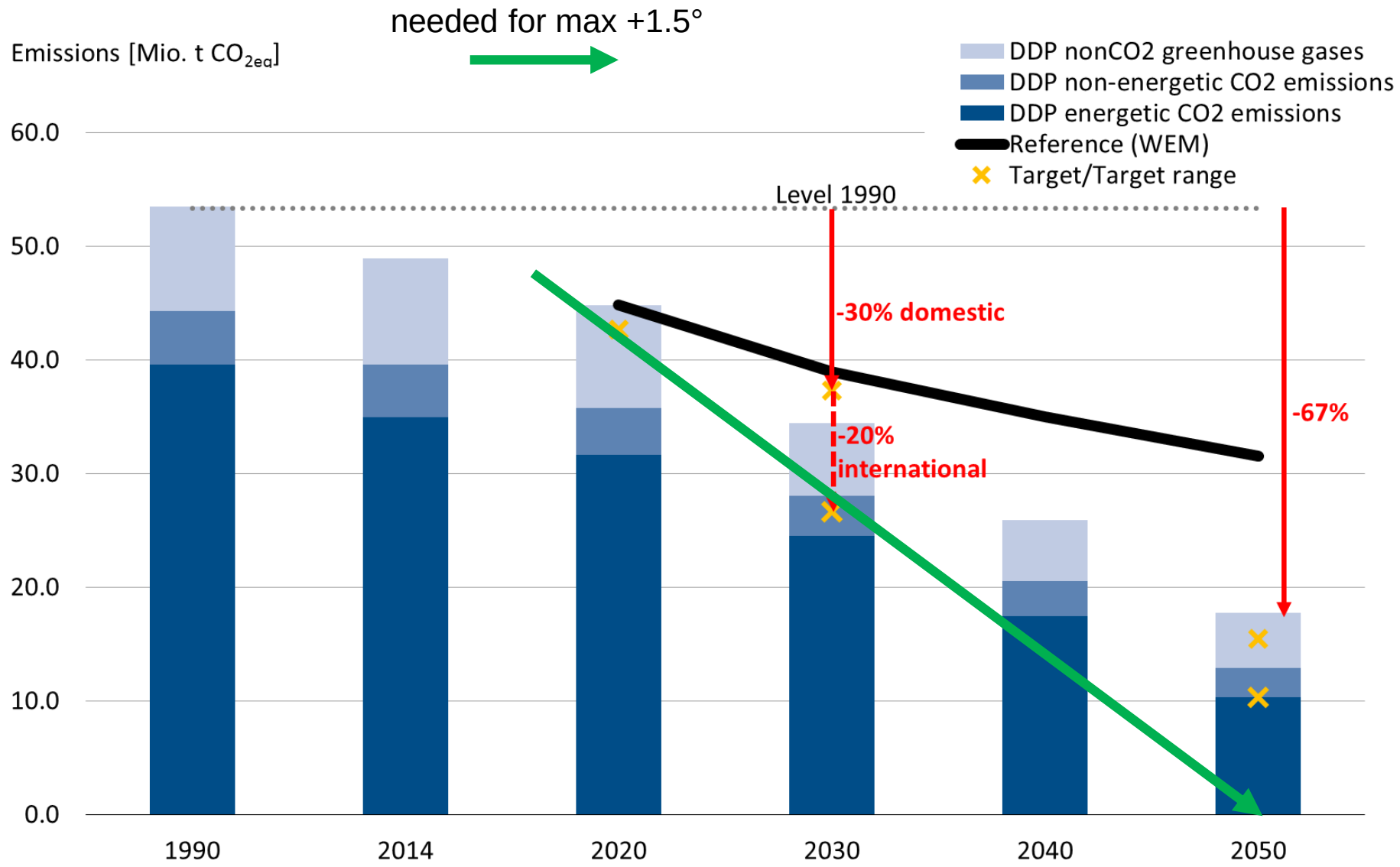


Deep Decarbonization Pathways Project (2015), Pathways to deep decarbonization 2015 report - executive summary, SDSN – IDDRI, Fig. 2

Decarbonisation pathways for Switzerland

- Ambitious but realistic target: **1-1.5 tCO_2eq/capita** in 2050 (all GHGs without air transport and without LULUCF)
- Same target as the "NEP" scenario of the Energy Perspectives (Prognos, 2012) and as the Swiss INDC for COP21
- This target was seen as compatible with **+2° warming**
- Imagine and calculate the instruments necessary to achieve this: use existing instruments plus generalised CO_2 levy

Deep decarbonisation pathways (for max +2°)



Schäppi et al. (2016)

EPFL Philippe Thalmann LEURE

How to get to 1t CO_2/capita in 2050

	2020	2030	2040	2050
CO_2 levy (CHF_{2013}/tCO_2)	177			
Price of CO_2 certificates (CHF_{2013}/tCO_2)	82			
Tax on gasoline and diesel (CHF_{2013}/l)	0.05			
Same CO_2 levy on all fossils (CHF_{2013}/tCO_2)		88	189	511
Social cost (% household consumption, relative to reference scenario)		0.11	0.42	0.78

Vielle et al. (2016). Scenario with induced technical progress (CCS is allowed)

511 CHF/tCO_2 with emissions of 1 tCO_2/capita on average in 2050 is comparable to 128 CHF/tCO_2 for current emissions of 4 tCO_2/capita

511 CHF/tCO_2 amount to 1.35 CHF/litre heating oil, which are added to the expected pre-CO_2-levy price of 1.40 CHF/litre in 2050

Kaya decomposition of central DDP

Mean annual rate of change per decade

	2010-2020	2020-2030	2030-2040	2040-2050
Population	+1.6%	+0.4%	+0.3%	+0.2%
Reference scenario (existing policies)				
GDP per capita	+0.1%	+1.3%	+1.2%	+0.9%
CO_2 emissions	-2.8%	-1.0%	-0.6%	-1.2%
Decarbonisation scenario with induced technical change				
GDP per capita	-0.1%	+1.0%	+0.9%	+0.7%
Energy intensity	-2.7%	-2.8%	-2.8%	-2.9%
Carbon intensity	-0.7%	-1.1%	-1.6%	-3.1%
CO_2 emissions	-1.9%	-2.5%	-3.4%	-5.1%

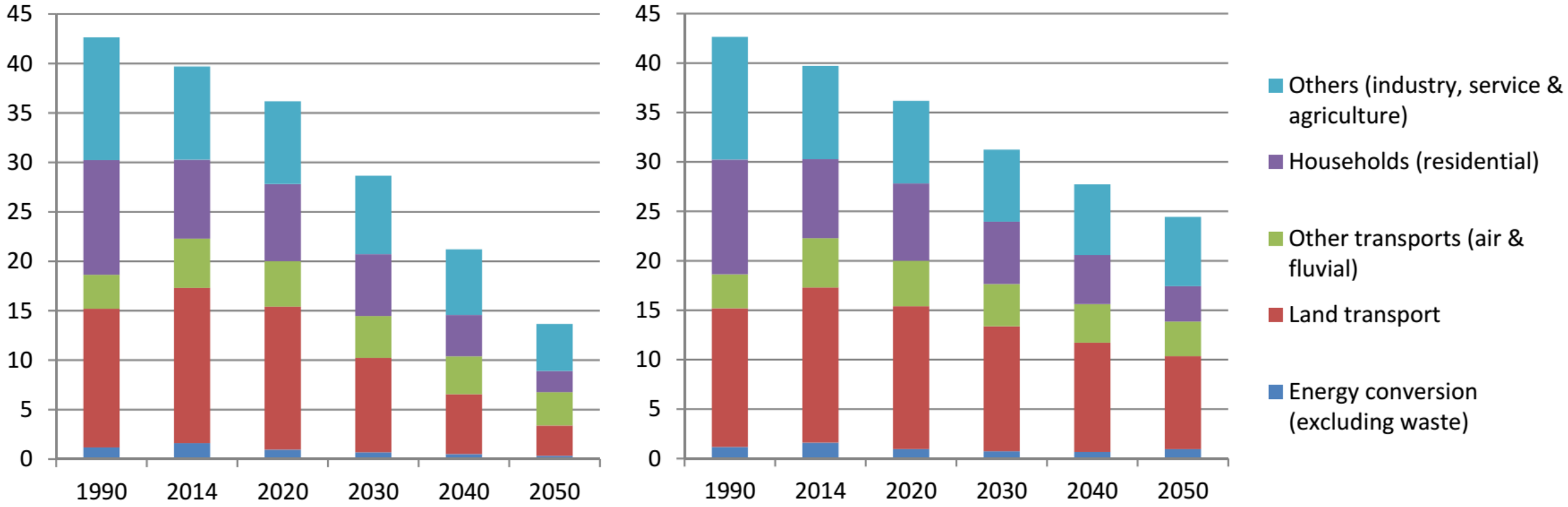
Vielle et al. (2016, unpublished table)

All sectors must contribute

CO_2 emissions (Mt)

Decarbonisation scenario
with induced technical progress

Reference scenario



Vielle et al. (2016, Fig. 2 + 15)

The cost depends on technological progress and what the ROW does

Swiss deep decarbonization scenario	Social cost in 2050 (% household consumption, relative to reference scenario)
Central (with CCS and induced technical progress)	-0.8%
Central without CCS	-1.1%
Central without induced technical progress	-0.8%
Central with international DDP	-1.3%

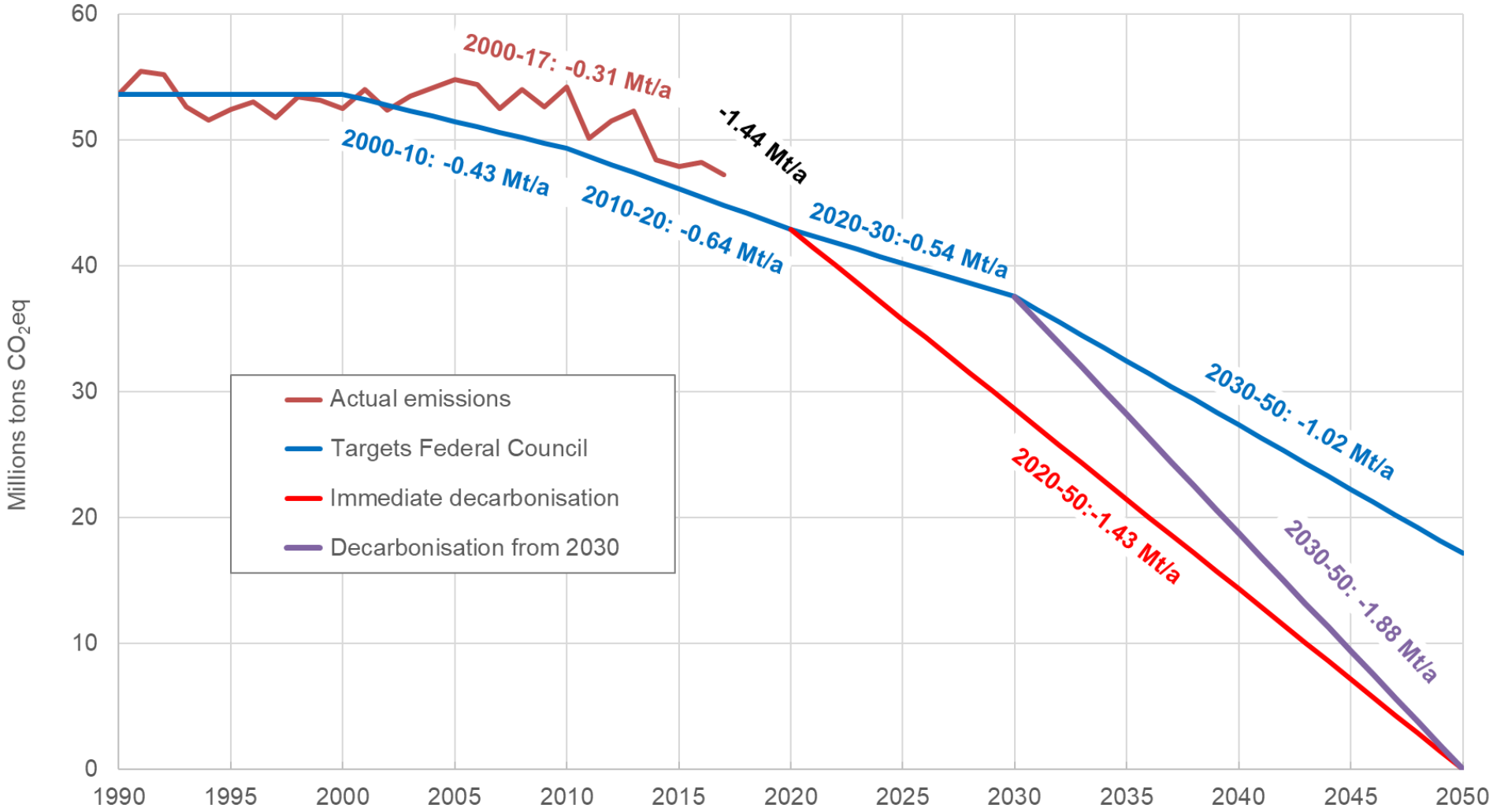
Vielle et al. (2016)

Take home messages

- Switzerland can reduce its energy CO_2 emissions to 1 t/capita and its total GHG emissions to 1.5 tCO_2eq/capita by 2050
- This would cost as much, in terms of welfare, as if households had to reduce their overall consumption by 1%
- Non-monetary benefits (e.g. less air pollution) are not yet taken into account
- The building sector will play a central role in decarbonisation, encouraged by an increasingly high price of fossil fuels
- Other sectors (mobility) must also contribute
- For the other countries, comparable scenarios have been calculated and proven

FINAL COMMENTS

The longer we wait, the greater the effort needed



What speaks for full decarbonisation by 2050

- GHG emissions decline (but not fast enough) for several reasons, even without strengthening climate and energy policy: technical progress, EU policies, slowing growth, energy prices
- Past and current policies have been timid
- Pushing firms and households to decarbonize through price signals will call for high taxes … this will be challenged
- Even with much high CO_2 tax rates, welfare costs are moderate
- The CO_2 tax could be kept lower by using its revenues to facilitate substitutions and strengthen effects

Conclusions

- No one modelled full decarbonisation of Switzerland yet!
- A 'New Climate Deal' is needed
- Example: decarbonisation of Swiss railway transportation between 1919 and 1950!

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vert'libéraux
verdi liberali

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LES VERTS
GRUENE.CH/VERTS.CH

Thank you for your attention

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Even with a small bucket:
everybody, every country must contribute !