

# Energy Strategy 2050 – Yes we can!

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ME409 - Energy Conversion and Renewable Energy 2018/2019

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# Joint Activity Scenarios & Modelling



Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra

Swiss Confederation

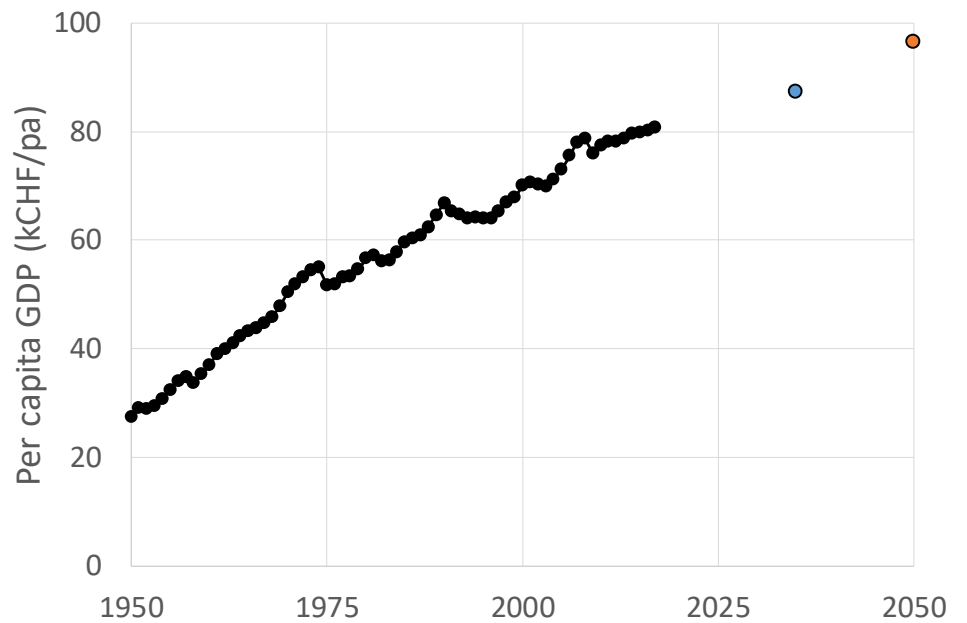
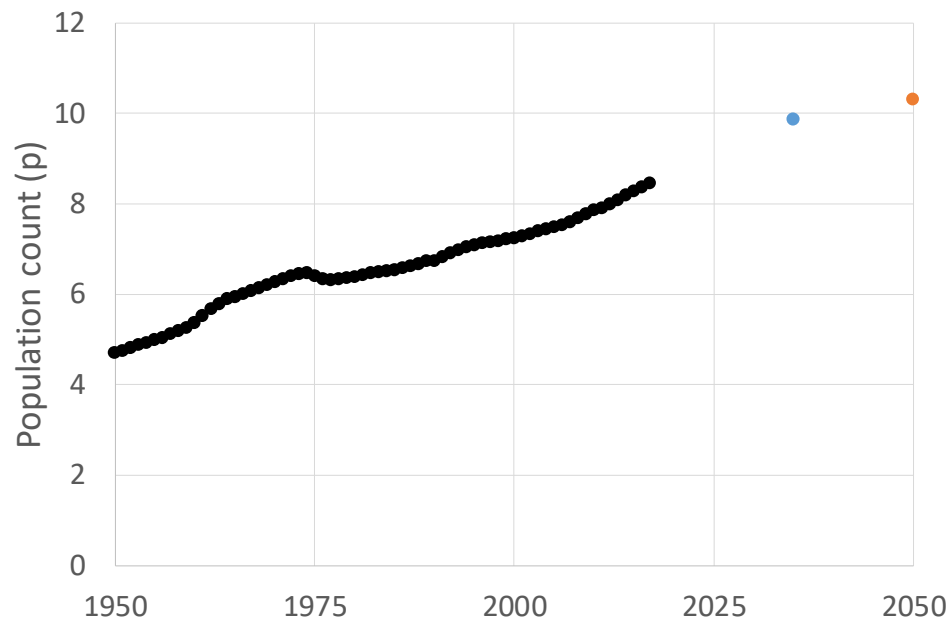
Innosuisse – Swiss Innovation Agency

## Outline

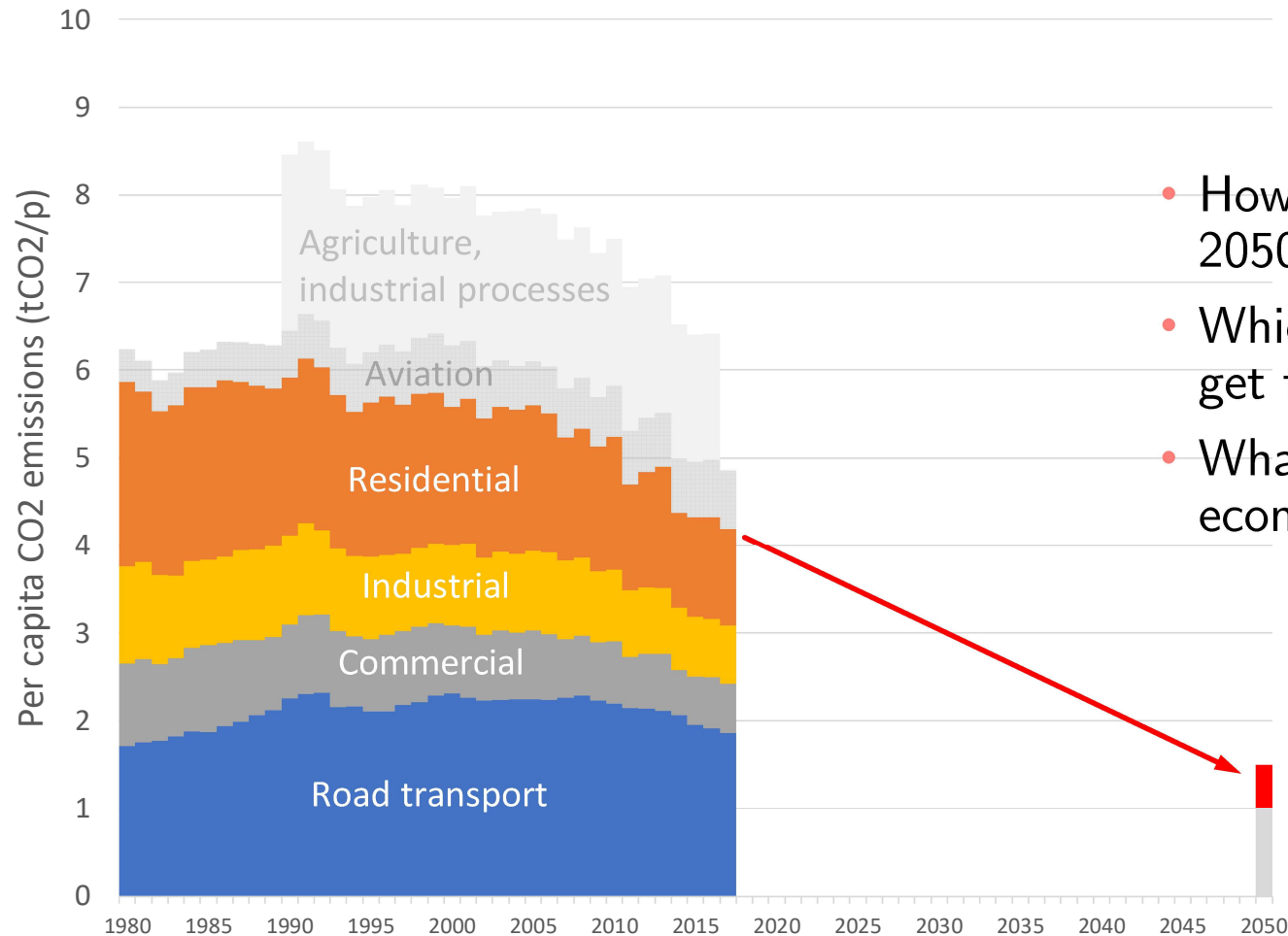
- **Introduction**
- **Energy system modelling**
- **Some results**
- **Measures**
- **Conclusions**

# Introduction

# Drivers: Population & GDP

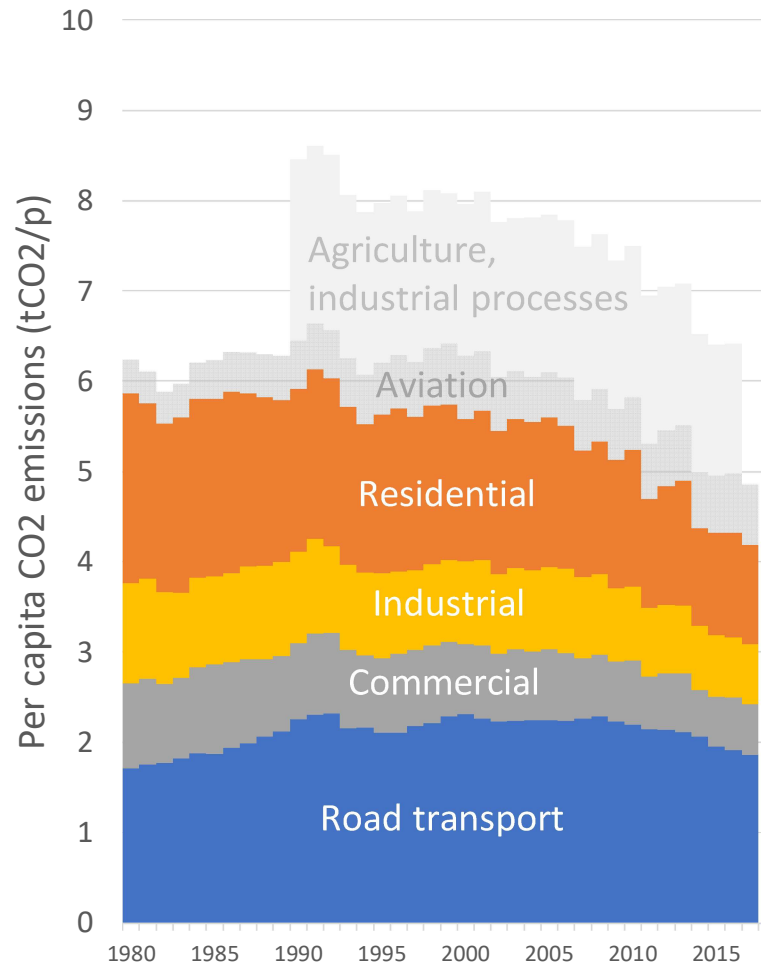


## Drivers: de-fossilization



- How does the optimal system in 2050 look like?
- Which measures are needed to get there?
- What is the impact on society, economy and environment?

# Don't forget aviation!



6.9

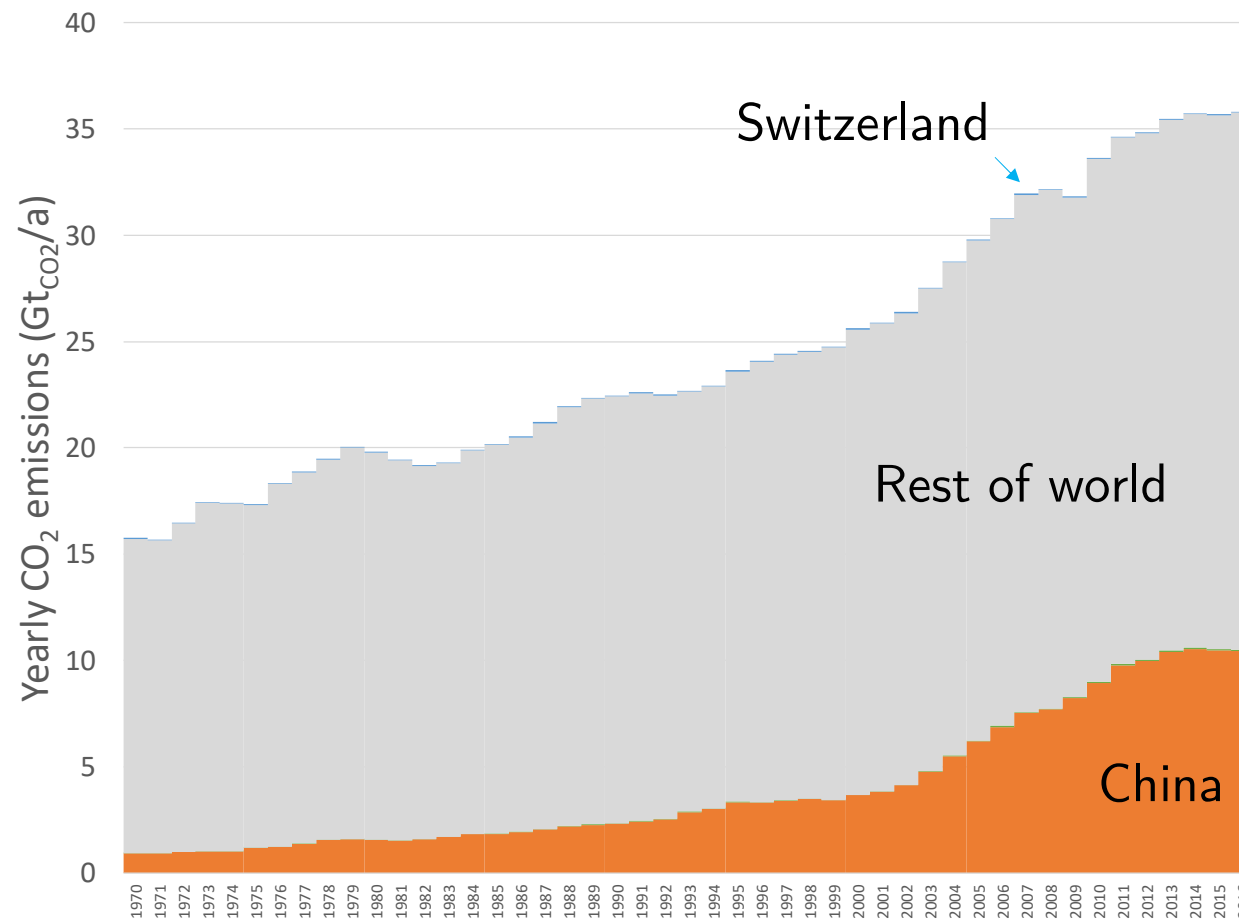


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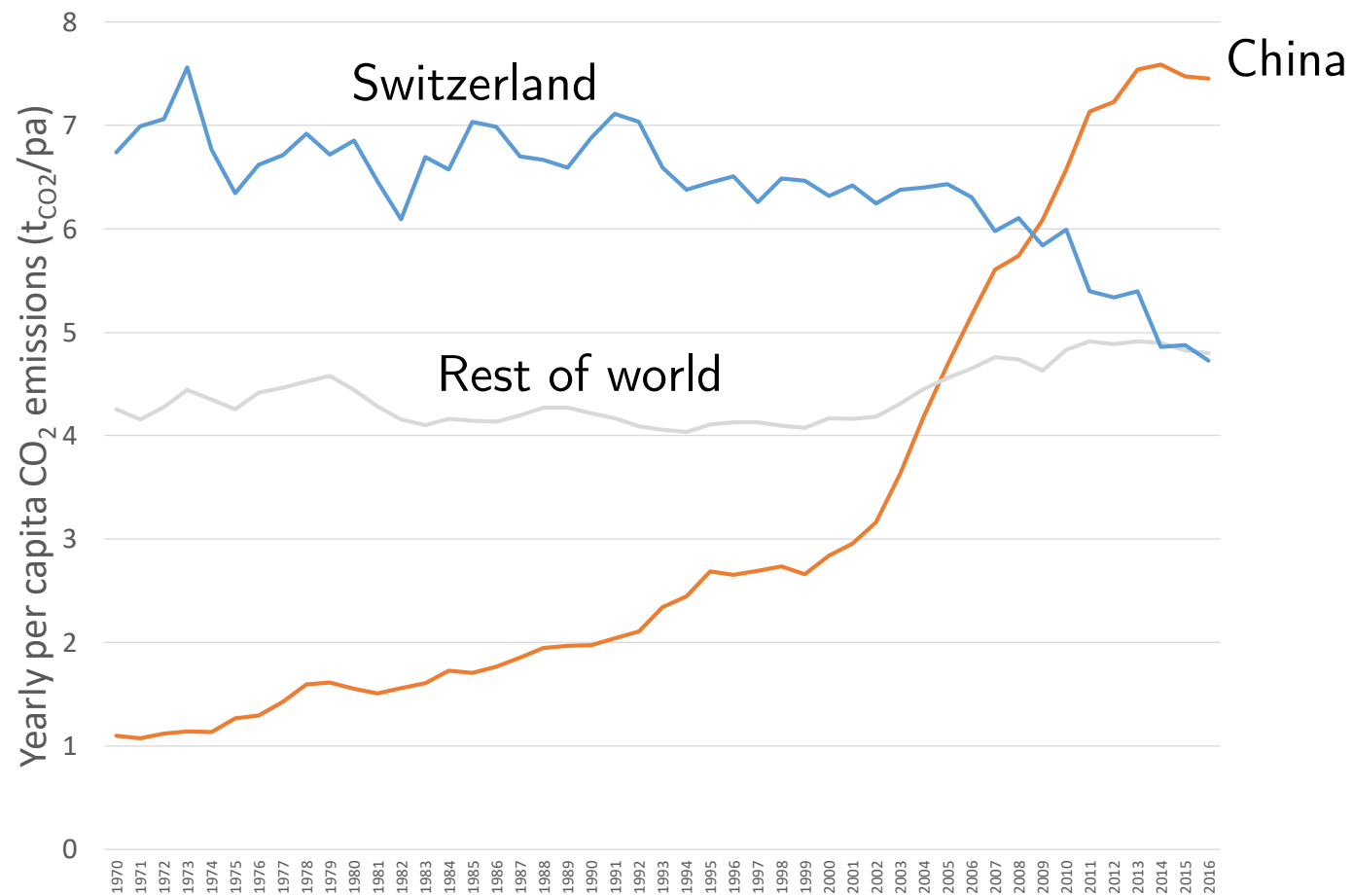


# Why should Switzerland do anything, we are so small!



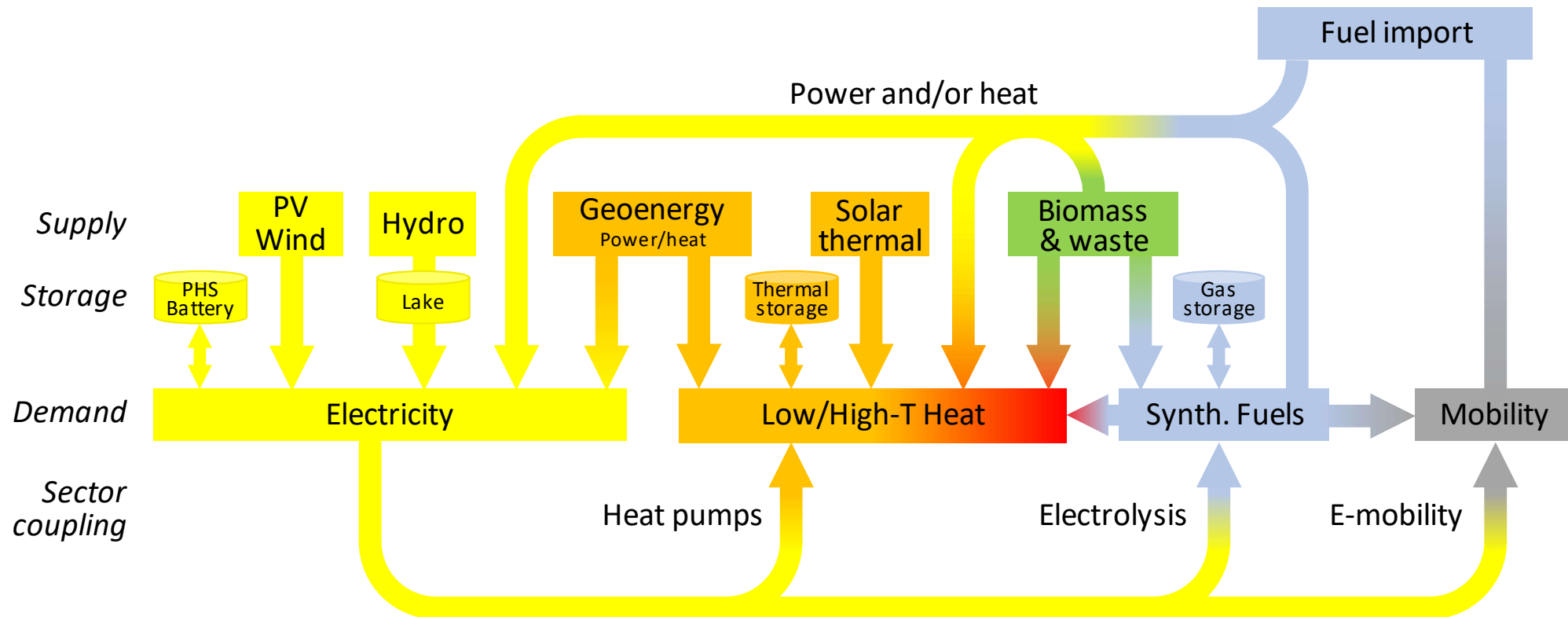


Because every Swiss citizen emits the same as every Chinese citizen!

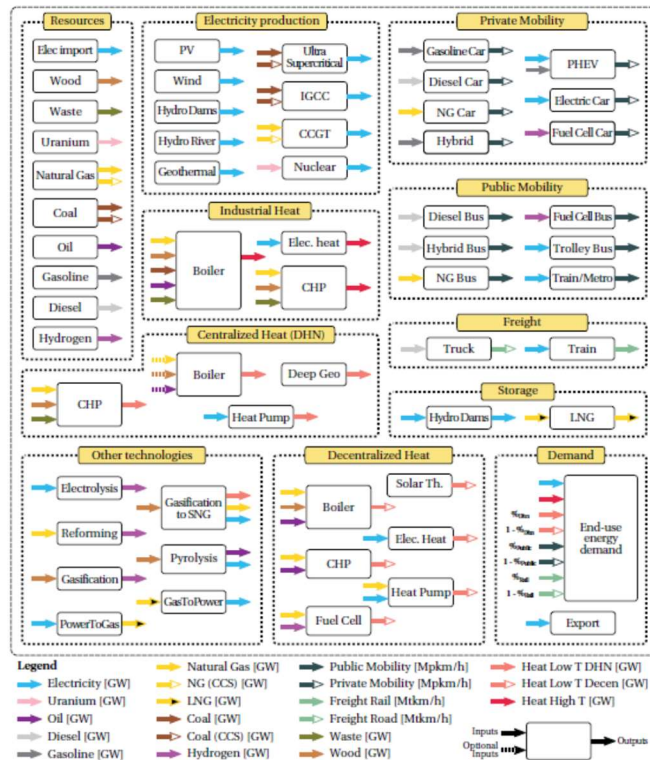


# Energy system modelling

# Blueprint of an energy system

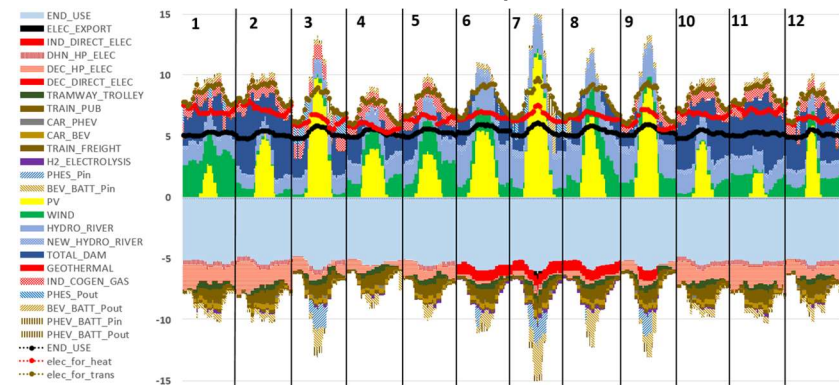


# Swiss Energyscope

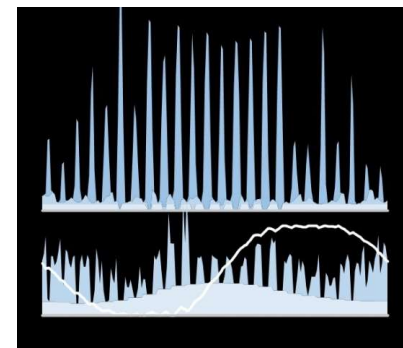


Stefano Moret's original model at monthly resolution

Gauthier Limpens

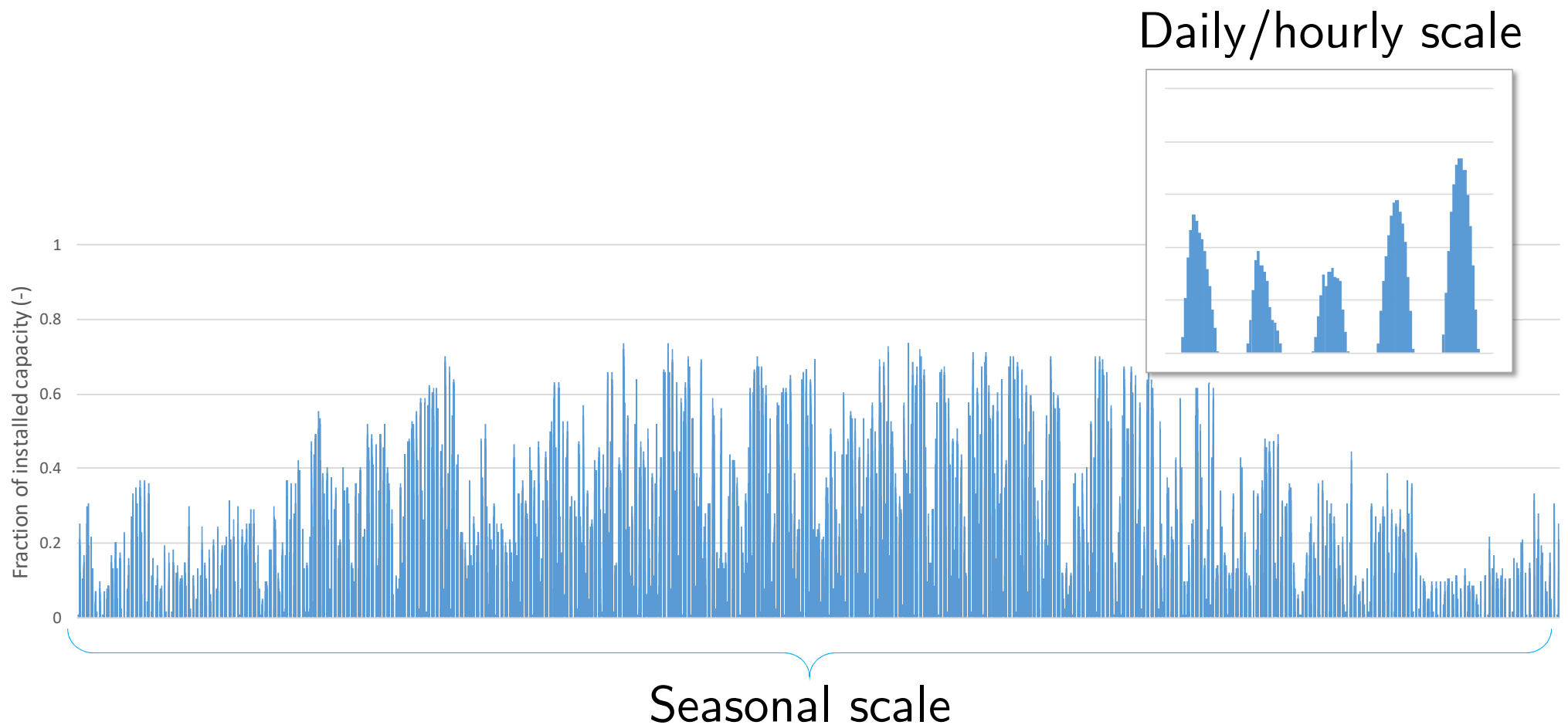


Inclusion of typical days to better capture the hourly/daily time scale

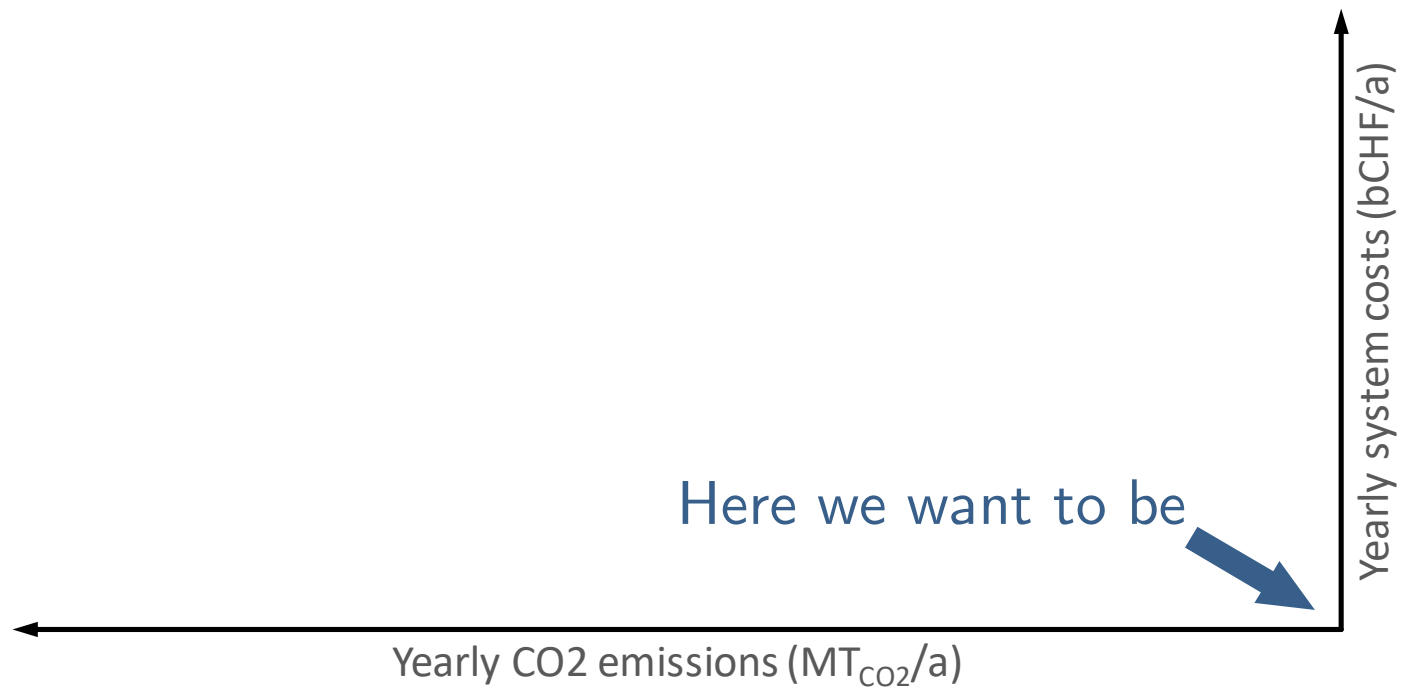


Myself

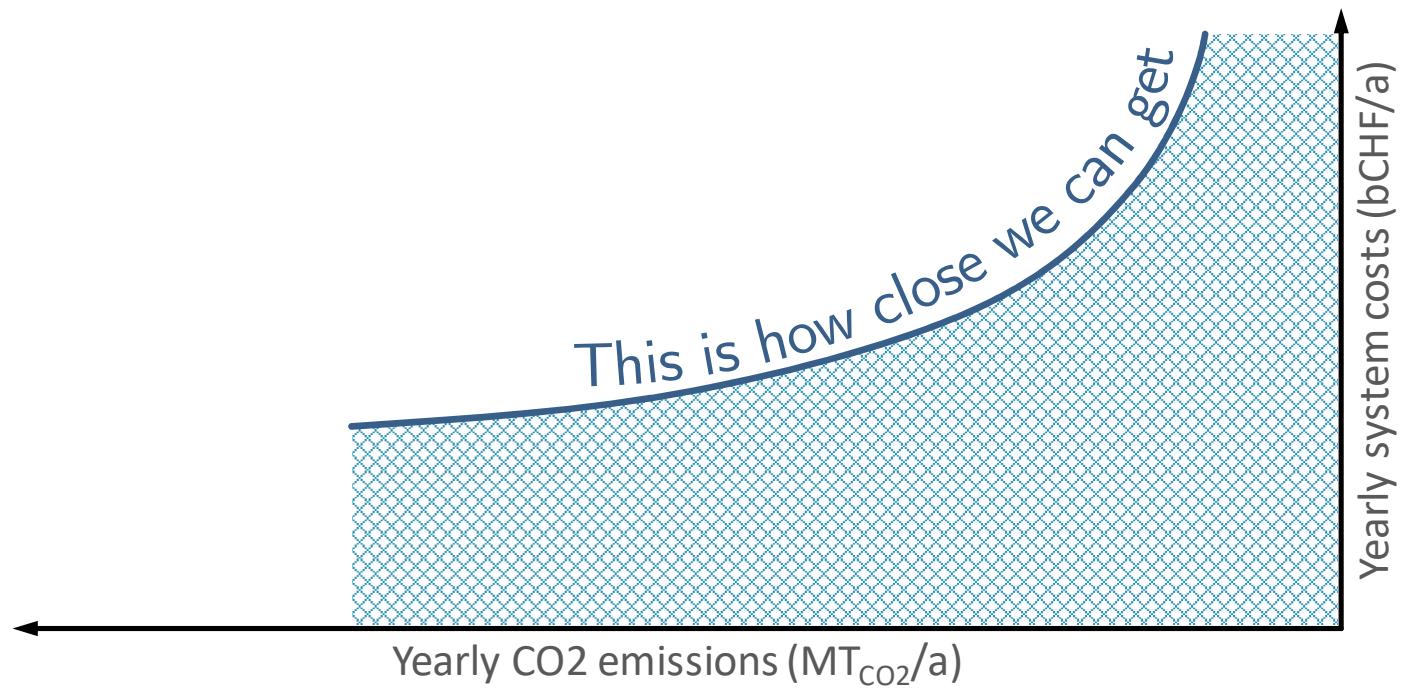
## The problem has (at least) two time scales



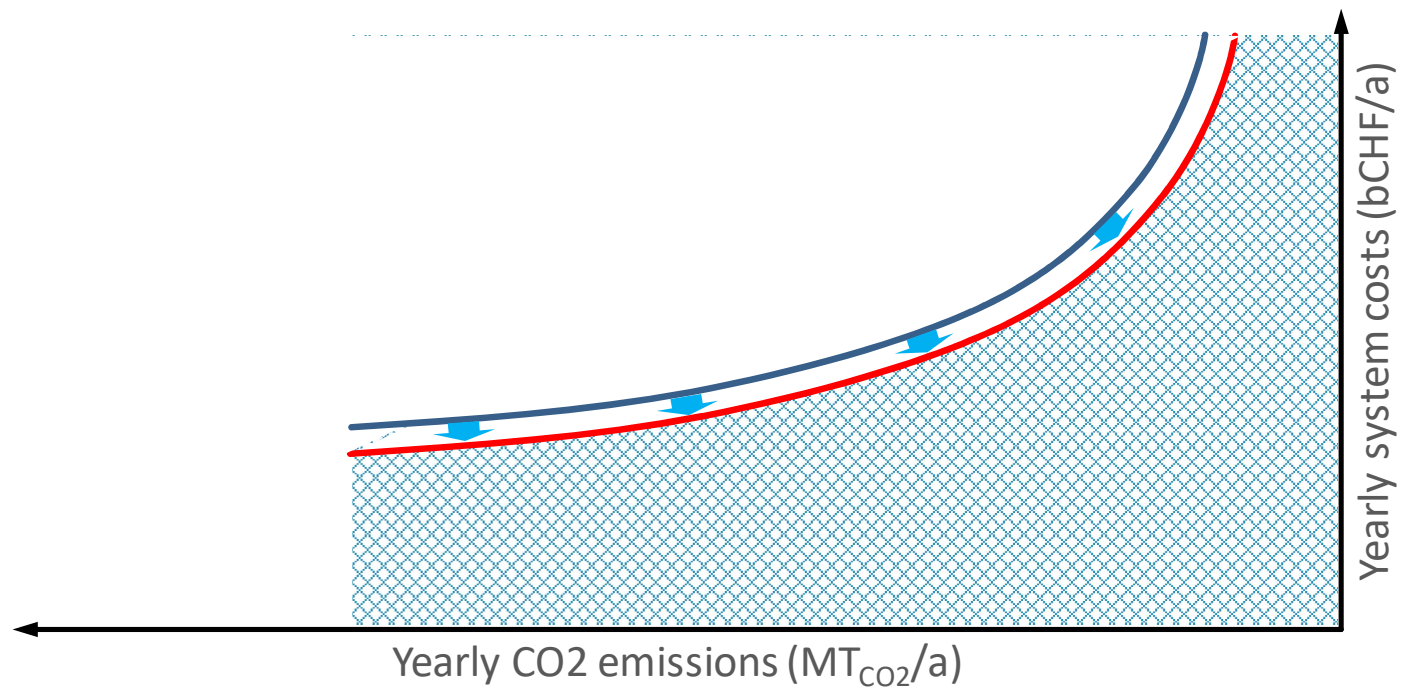
# Principle of Pareto frontier



# Principle of Pareto frontier



## New technologies can push the envelope





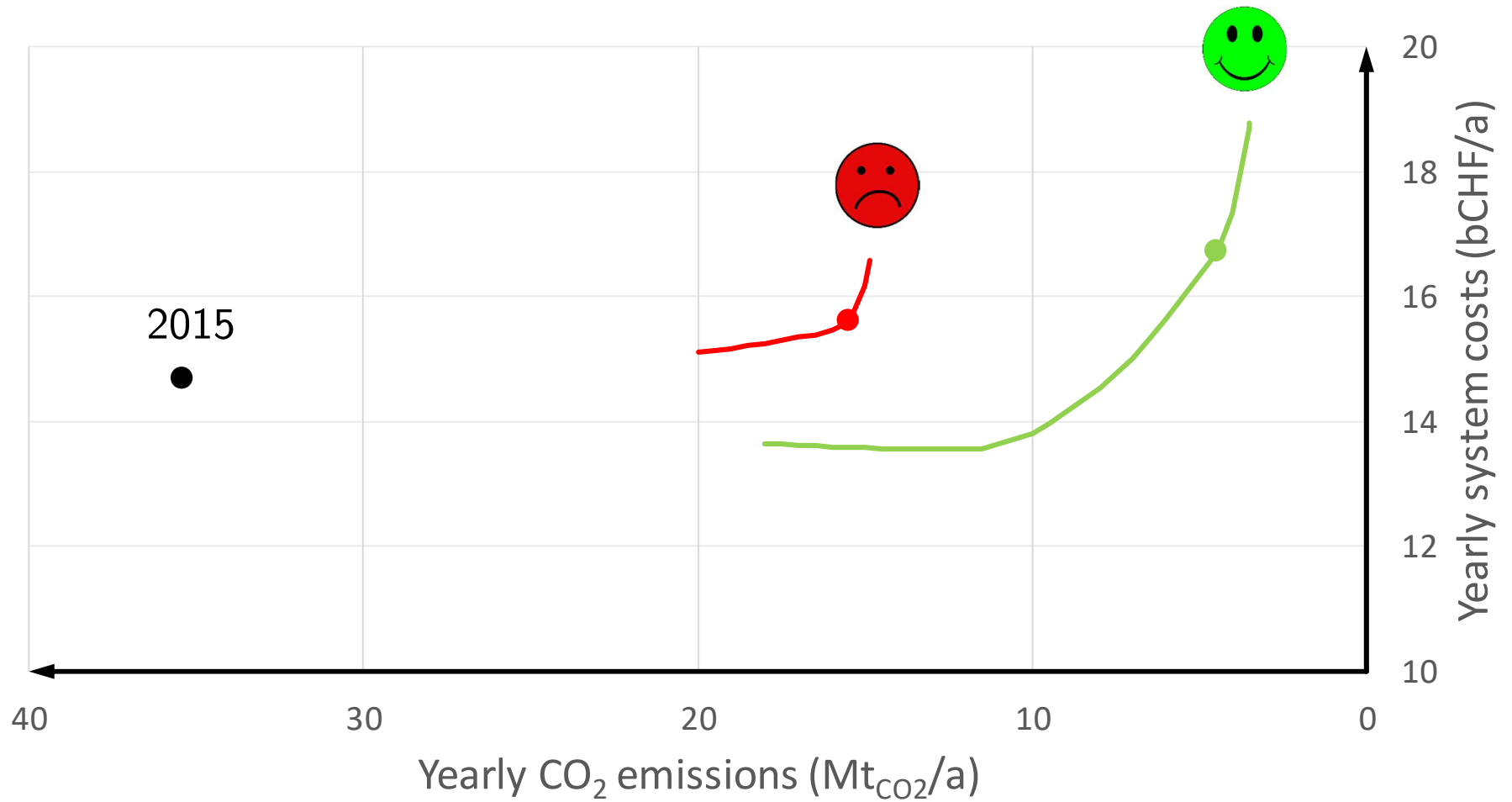
# Some results

# Scenarios



Technology	Bearish	Bullish
Hydro power	Production declines due to missing economic incentives and ecological concerns (e.g. Gewässerschutz)	Production grows as foreseen in the energy law
Wind	No growth due to public concerns on landscape	Production grows as foreseen in the energy law
Geothermal	Zero production due to public concerns on seismic risks	Production grows as foreseen in the energy law
Biomass	No growth	100 PJ as assumed by SCCER Biosweet
Seasonal storage	No deployment due to lack of infrastructure planning	Various types available (dam heightening, thermal, hydrogen, synthetic natural gas)

# Pareto frontier



# Electricity generation and consumption

2015



New renewables (PV, wind, geothermal)

Hydro power

Thermal power

Electricity storage (PHS, battery)

Electricity consumption

Electricity conversion (heat, gas, mobility)

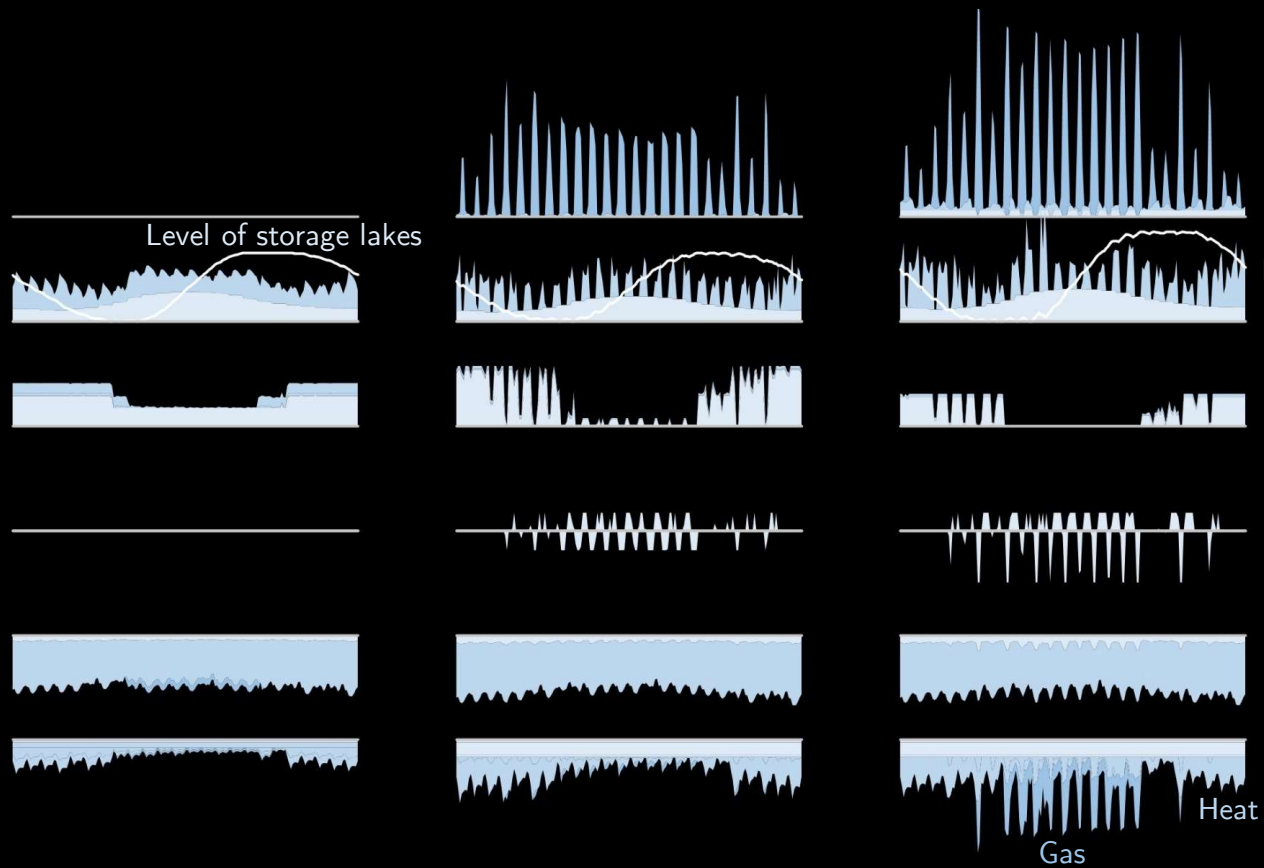
Level of storage lakes

Regulated hydro  
Run-off-river

Mobility

Gas

Heat



# Heat generation and consumption

2015



Power to heat

New renewables (solar, geothermal)

Cogeneration and boilers

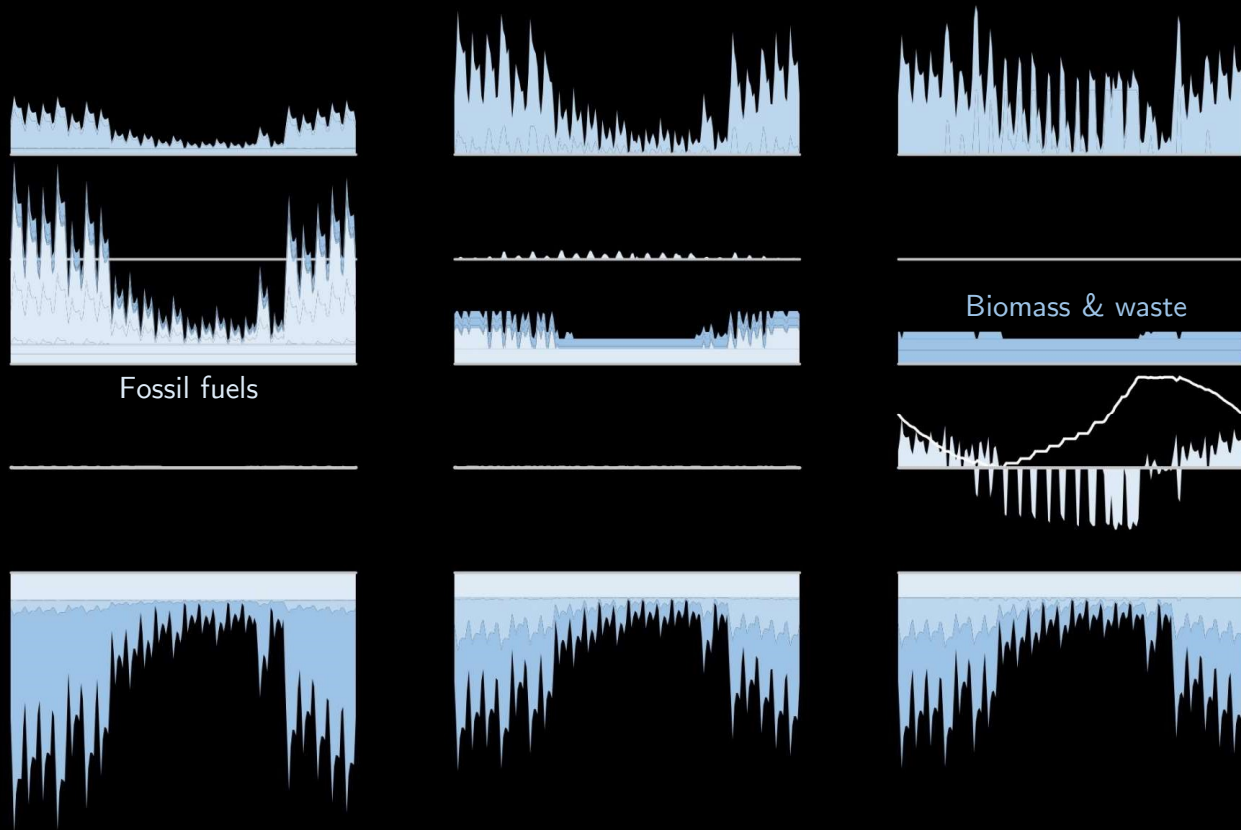
Seasonal thermal energy storage

Heat consumption

Fossil fuels

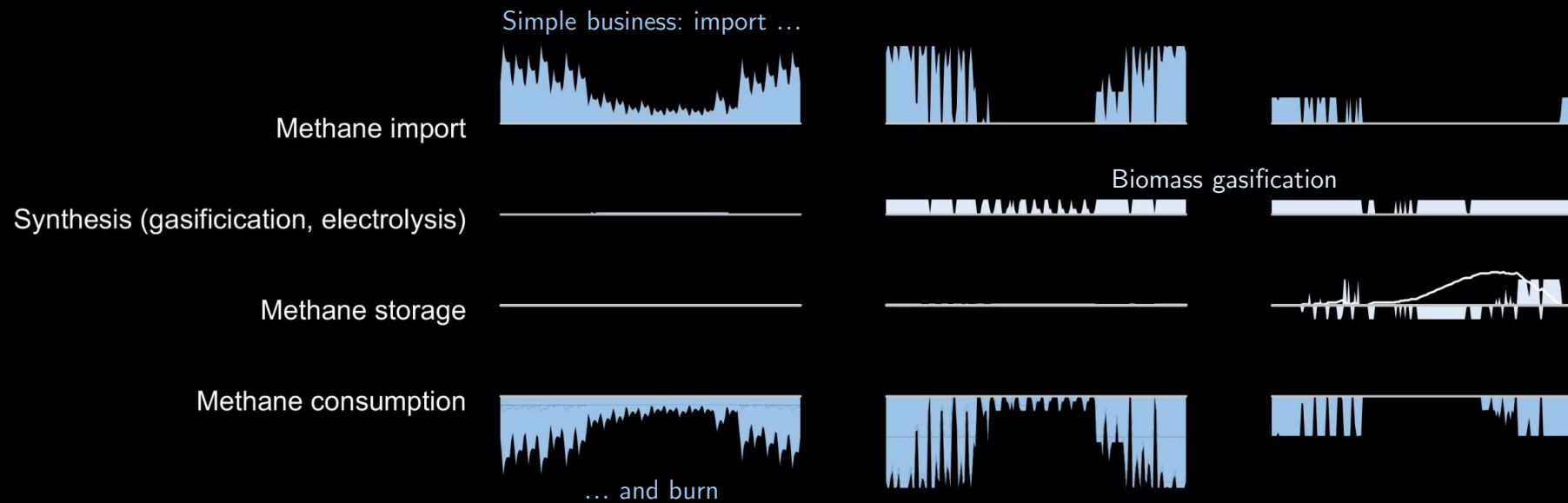
Biomass & waste

Process heat  
District heat  
Domestic heat



# Methane import/synthesis and consumption

2015



# Hydrogen and mobility

2015



Hydrogen is produced and stored in summer to feed FCEV throughout the year

Gasoline and Diesel vehicles  
are the first to go

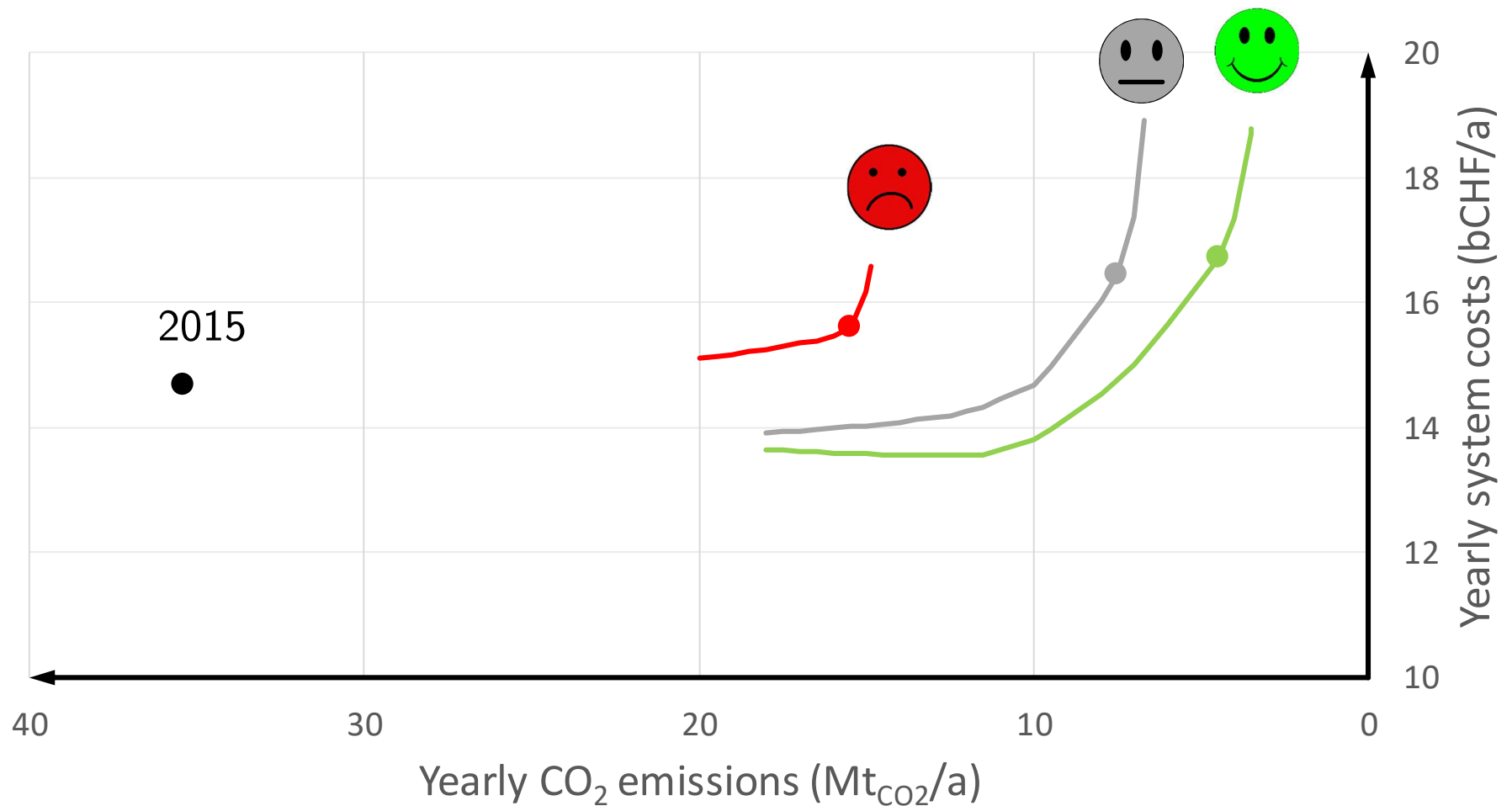


## First learning

- Deep de-fossilization is only possible for bullish scenario
- All power-to-X technologies play a role: heat pumps, e-mobility, hydrogen, synthetic natural gas
- Seasonal storage of various types appears: heightening of hydro dams, thermal, hydrogen, natural gas storage
- Question: what is exactly the benefit of seasonal storage?

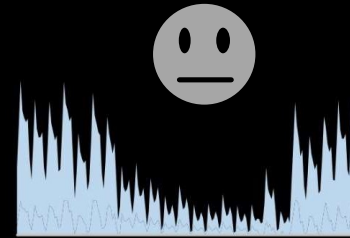


## Additional scenario: all seasonal storage turned off



# Heat & hydrogen

Power to heat

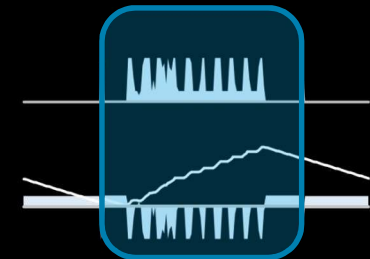
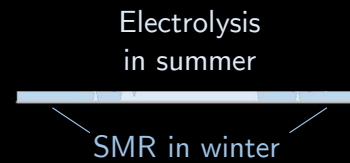


Seasonal thermal energy storage



Lack of seasonal storage limits use of PV in heat pumps and electrolyzers

Hydrogen production



Hydrogen storage



Hydrogen consumption



# Electricity generation and consumption



Therefore a lot of  
summer PV is curtailed

New renewables (PV, wind, geothermal)

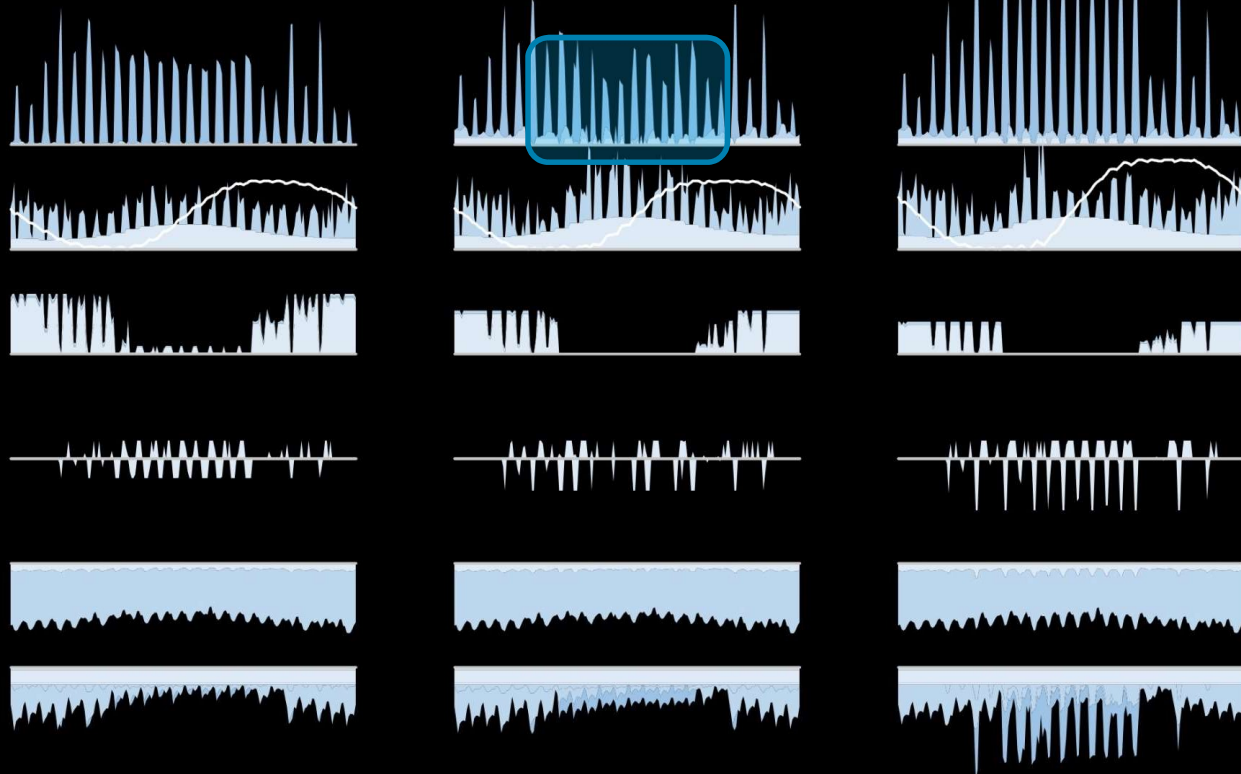
Hydro power

Thermal power

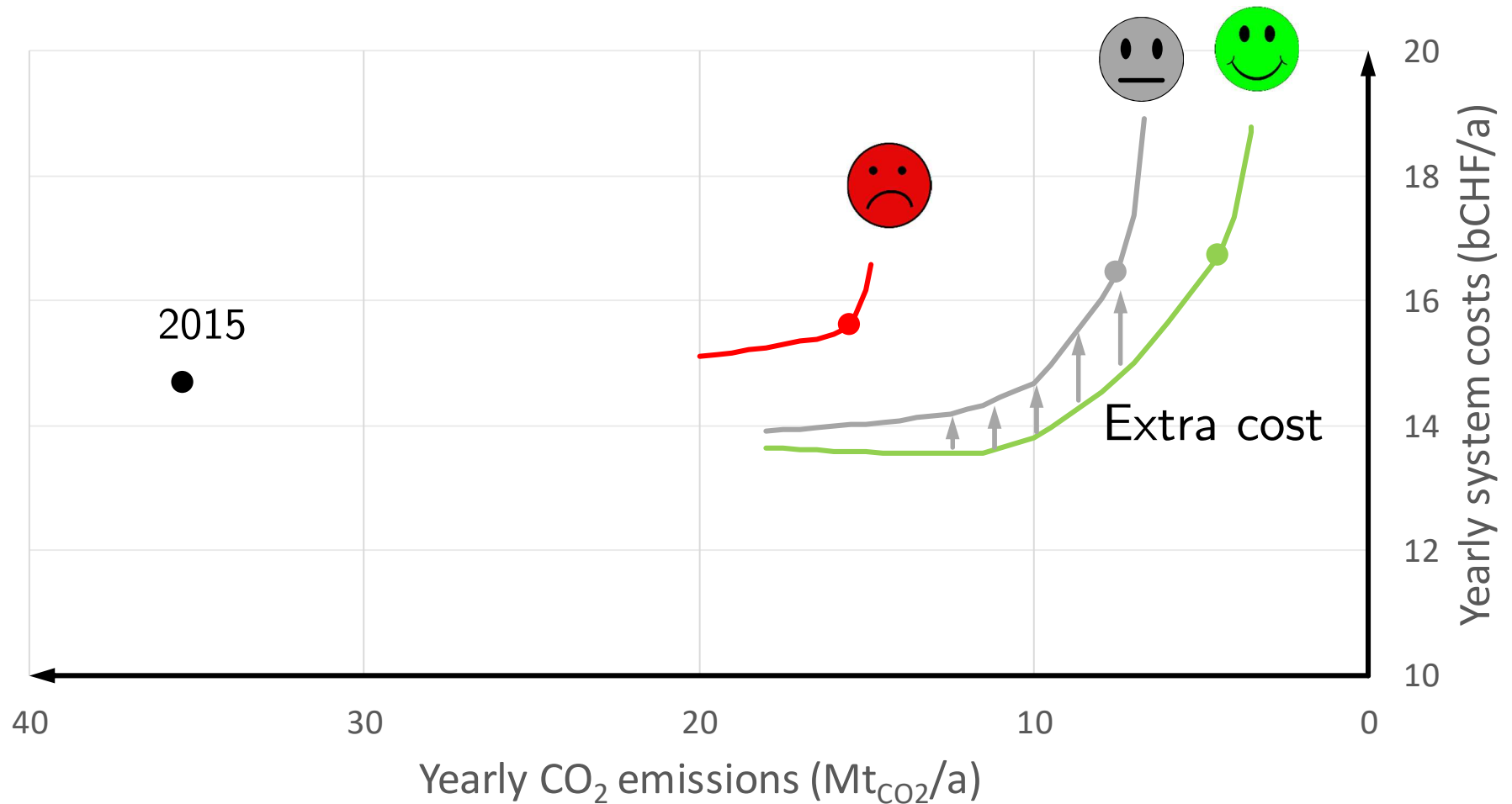
Electricity storage (PHS, battery)

Electricity consumption

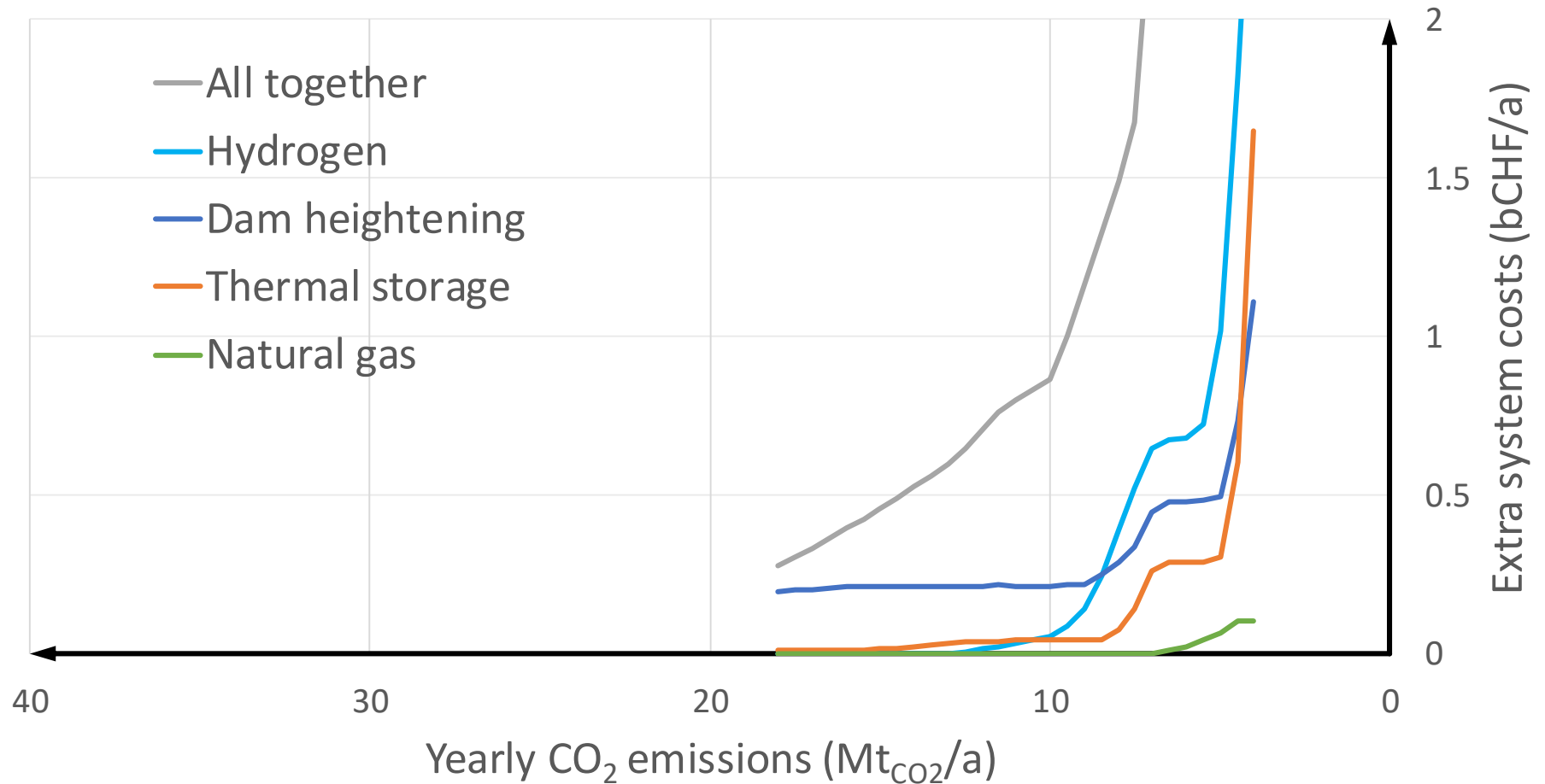
Electricity conversion (heat, gas, mobility)



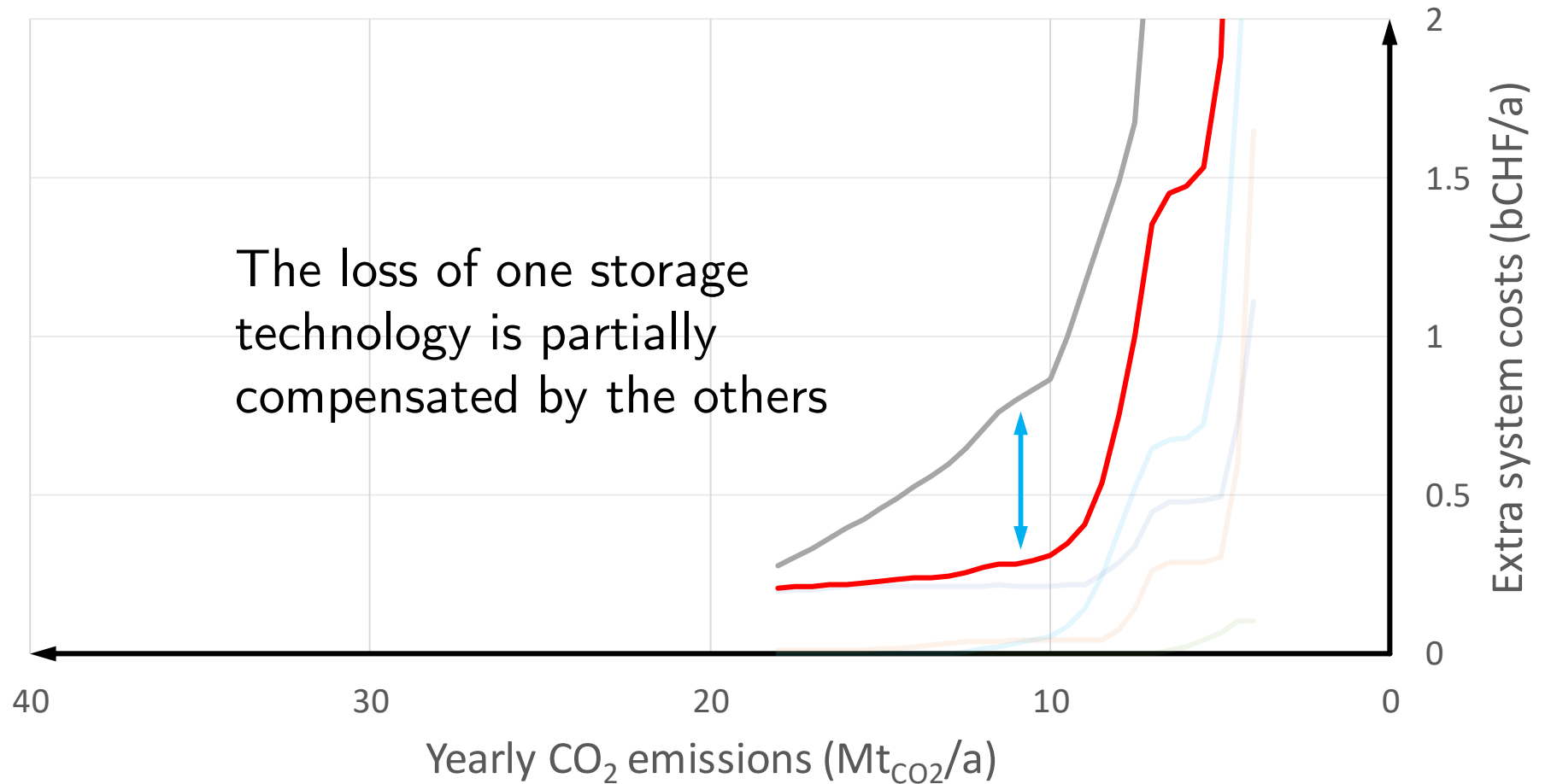
# What is the monetary value of seasonal storage?



## The cost of not having...



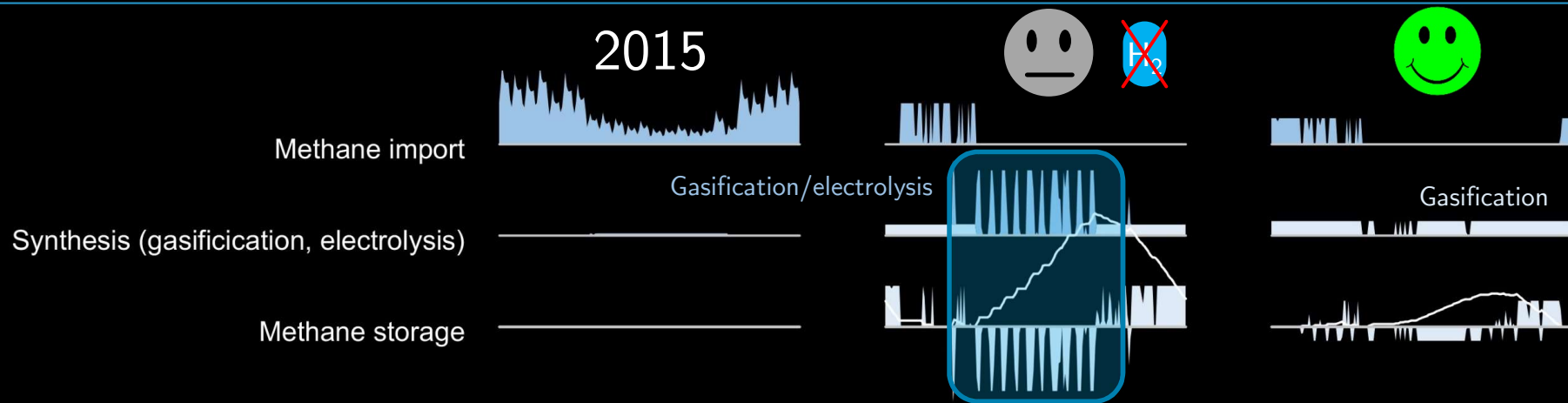
## The cost of not having seasonal storage



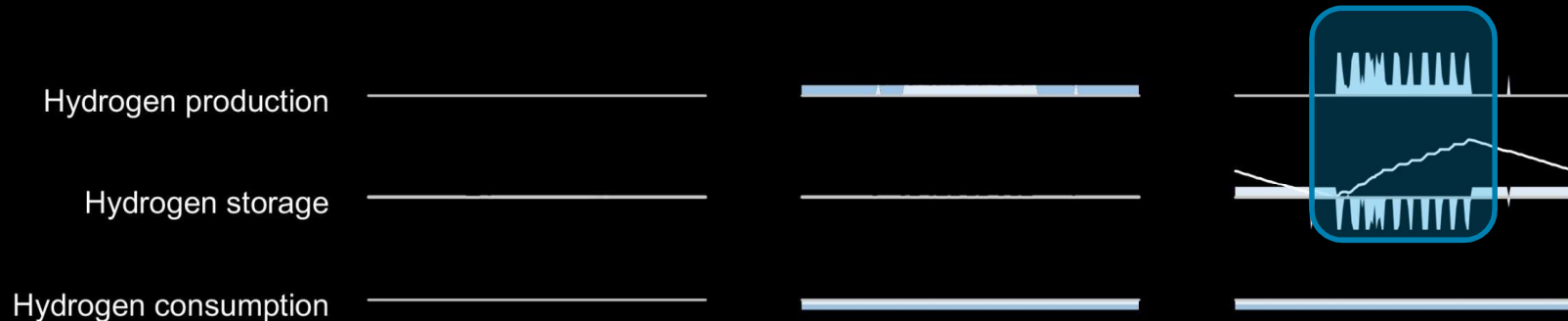
## Second learning

- Seasonal storage allows to reach deep de-fossilization at reasonable costs
- The value of the various technologies is different – but always beware that this depends very much on the cost assumptions!
- Taking away one technology can be partially compensated by the others
- Question: why natural gas synthesis & storage seems to be of little value?

# Natural gas & hydrogen



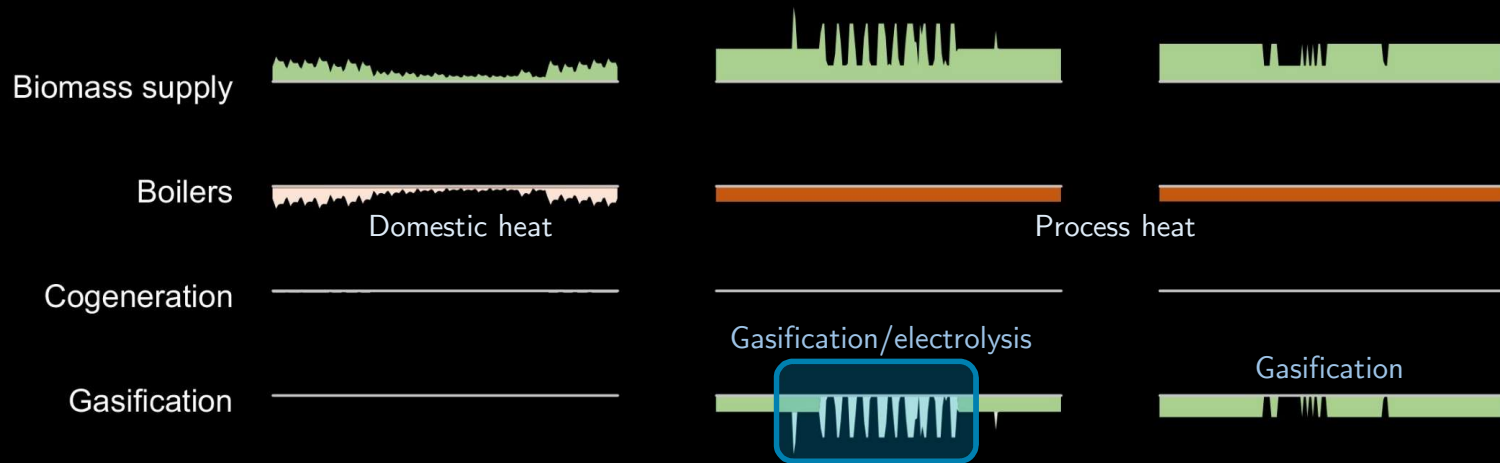
Lack of hydrogen storage boosts generation and storage of methane through gasification & electrolysis





# Where does biomass go to?

2015



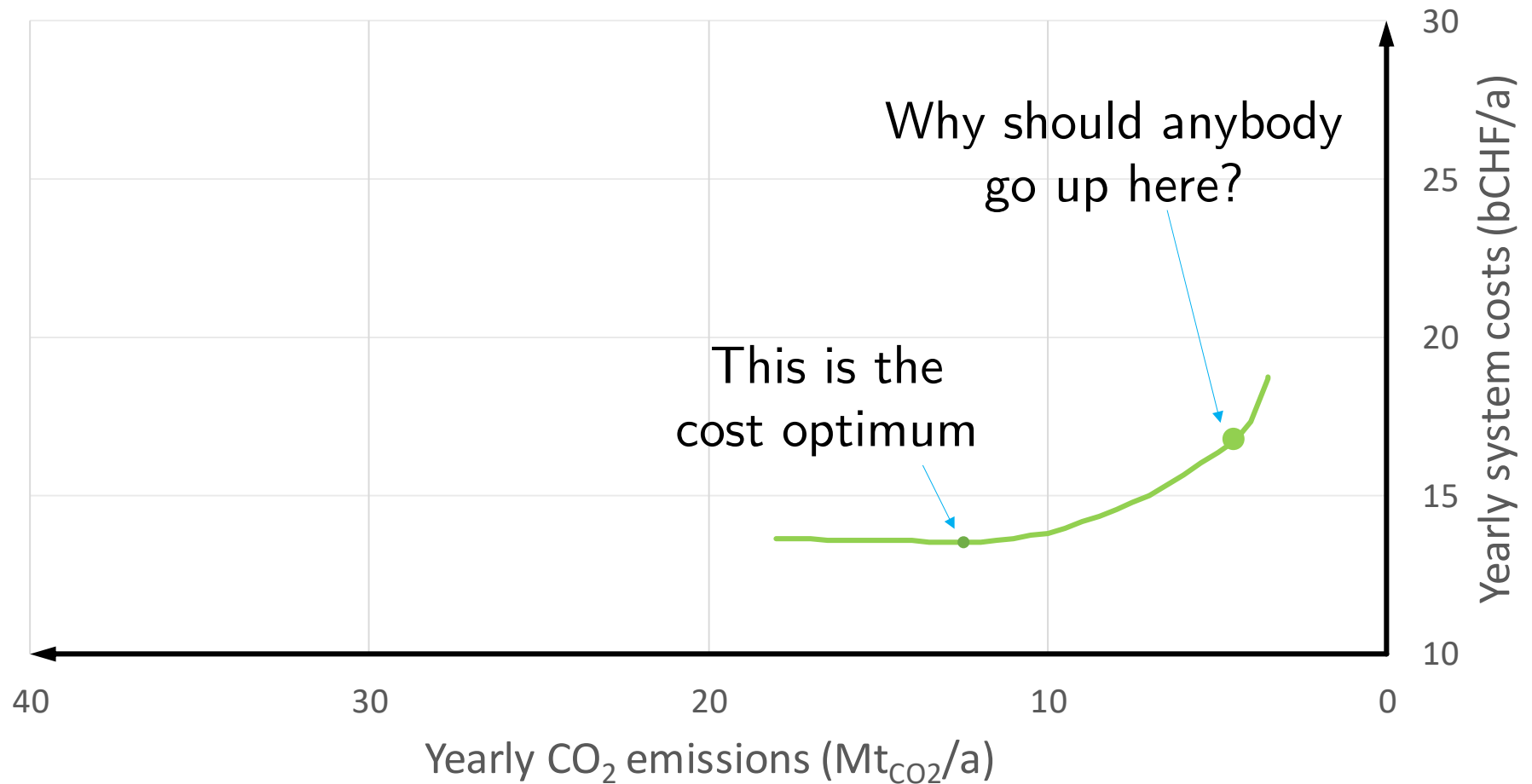
Biomass best used for generating  
high temperature heat and methane  
– not for lukewarm water!

## Third learning

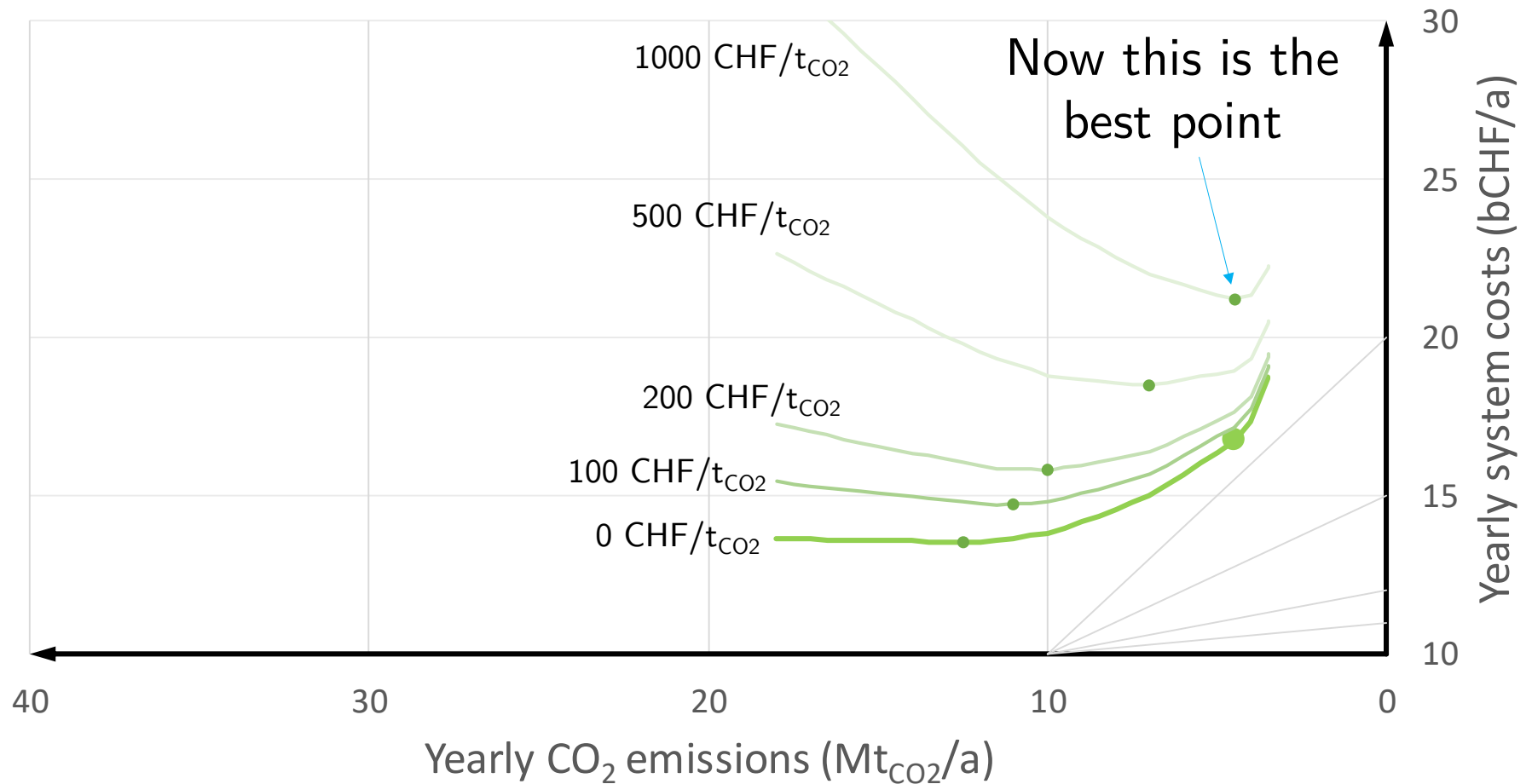
- Natural gas and hydrogen storage are doing a similar job
- Advantage of hydrogen is that water is an unlimited resource, carbon (through biomass) is not
- Natural gas storage technically easier than hydrogen? I guess, yes
- Use biomass in a smart way!

# Measures

## Measure to drive to low CO<sub>2</sub> emissions



## CO<sub>2</sub> price: Change the rule of the game!



## We will need additional measures

- Ban of internal combustion vehicles
- No oil and gas heaters in new buildings
- Strong push for district heating networks
- Etc.

# Conclusions

## So, how does the Swiss energy system 2050 look like?

- Photovoltaics is everywhere
- Battery and hydrogen mobility – easiest if we give up car ownership
- Domestic heat comes from heat pumps (and solar thermal collectors)
- Waste and biomass are most valuable resources – to be used smartly
- Seasonal storage of all kinds is essential to approach zero CO<sub>2</sub> emissions



## Take-home message

- Building or using an energy system model is only half the job – the fun starts only then!
- Start asking questions to the model: what if this technology was or was not available?
- Make every effort to understand the answer
- There may be multiple loops of questions & answers
- Visualization is the key to success – for you to understand the data and for the communication to others

# Questions?

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