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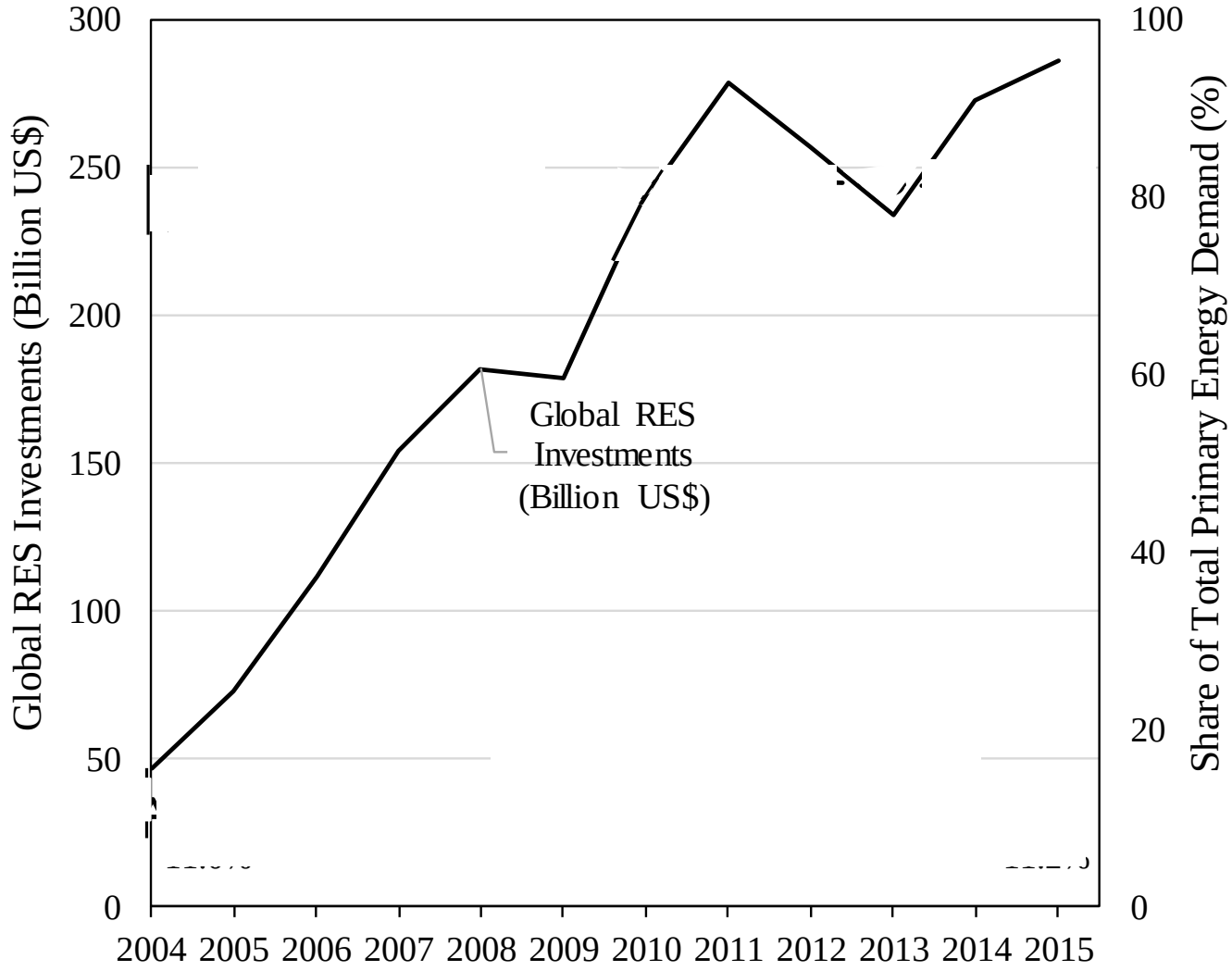
Bioenergy in the energy system – now and in the future

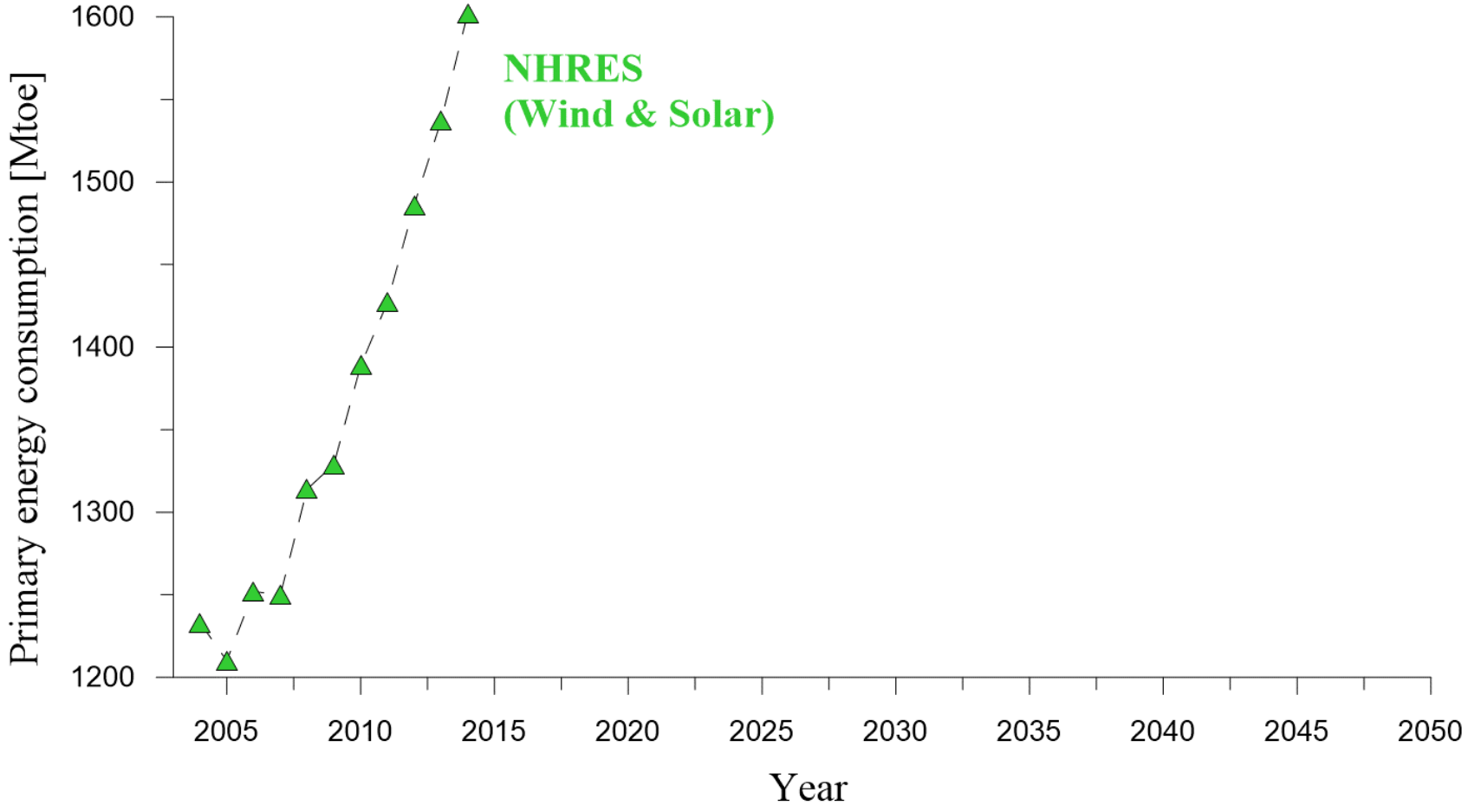
Filip Johnsson, Göran Berndes, Henrik Thunman et al.
Division of Energy Technology
Department of Space, Earth and Environment
Chalmers University of Technology
Sweden
filip.johnsson@chalmers.se

Forests and the climate – manage for maximum wood production or leave the forest as a carbon sink?
KSLA, Stockholm March 12-13, 2018

Global trends - Strong growth in RES investments

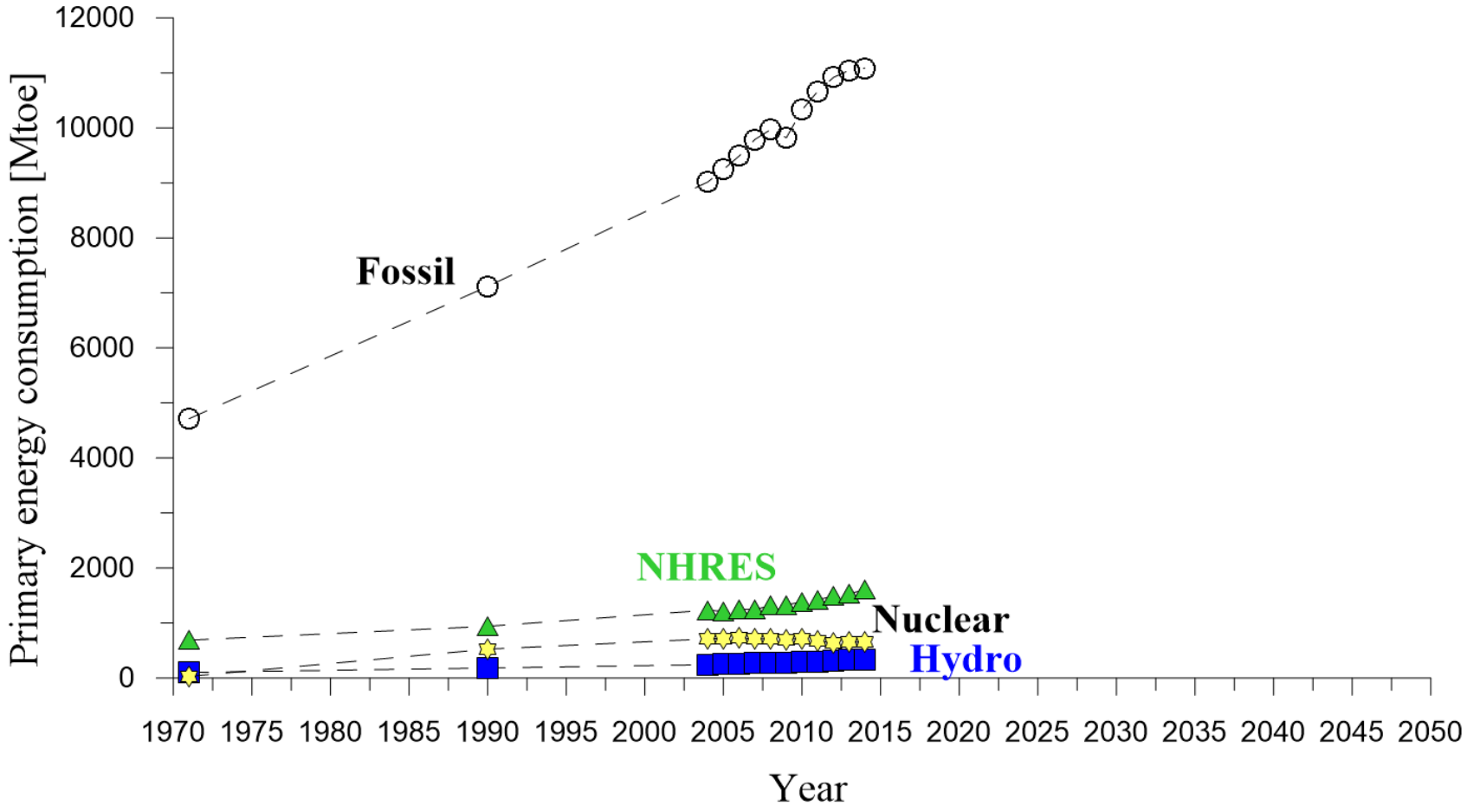


Global trends – renewables



NHRES=Non-hydro renewables

Global trends – fossil-fuel share



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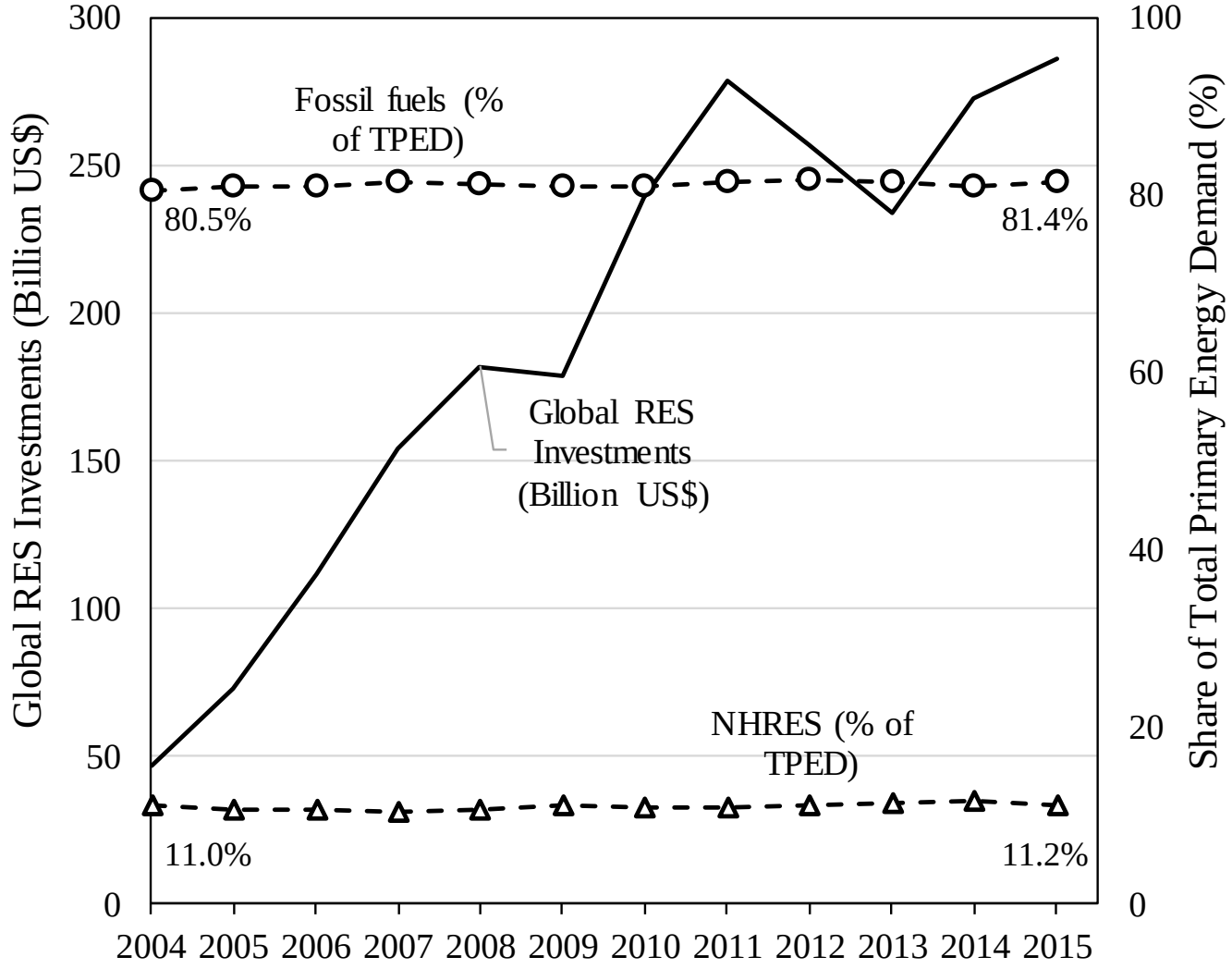
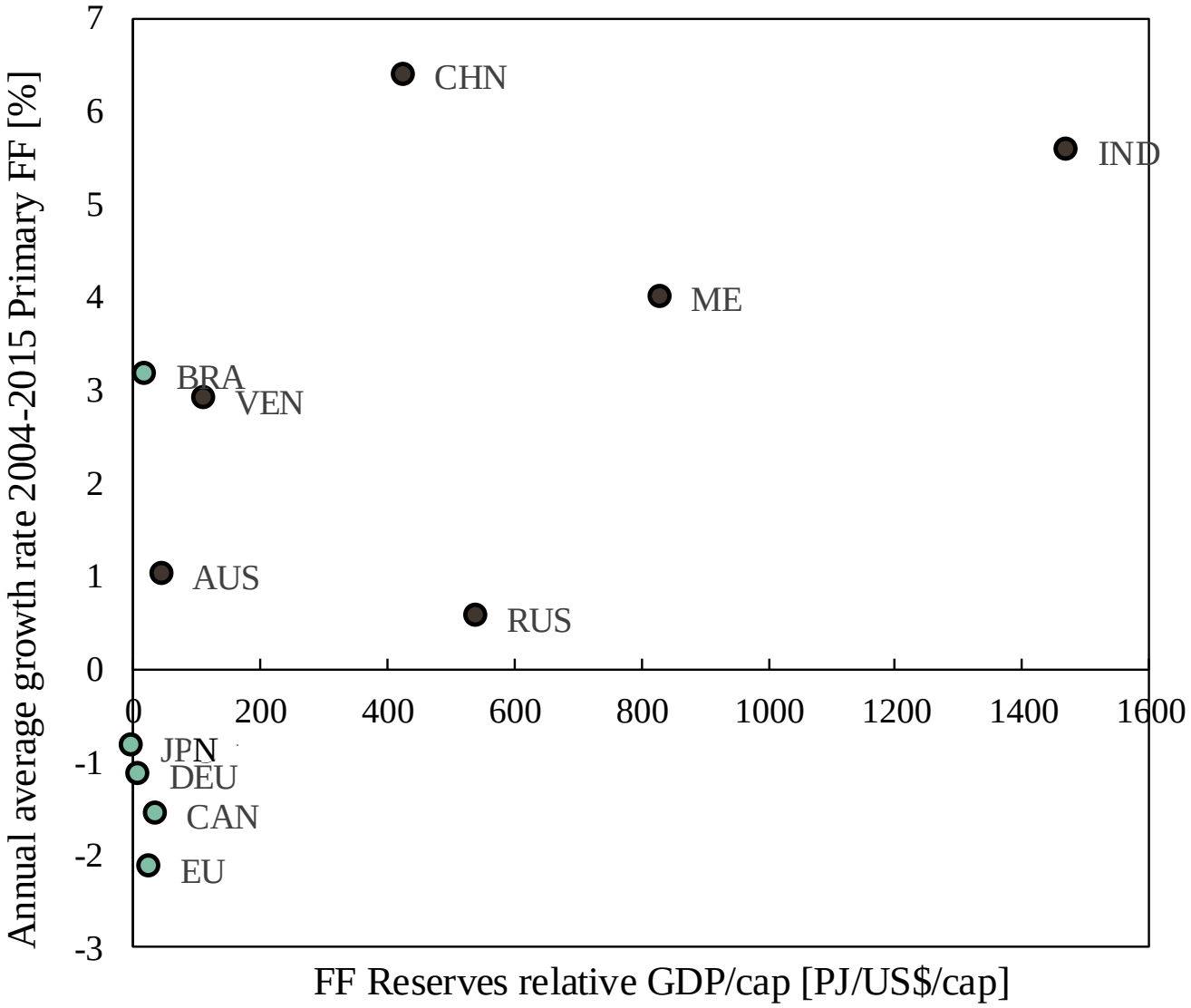
Strong growth in RES investments – zero reduction in fossil fuel share!



TPED = Total Primary Energy Demand

Johnsson et al. (forthcoming)

Annual growth in fossil-fuel supply *vs* Reserve size/GDP
Fossil-fuel rich regions and Fossil-fuel lean regions



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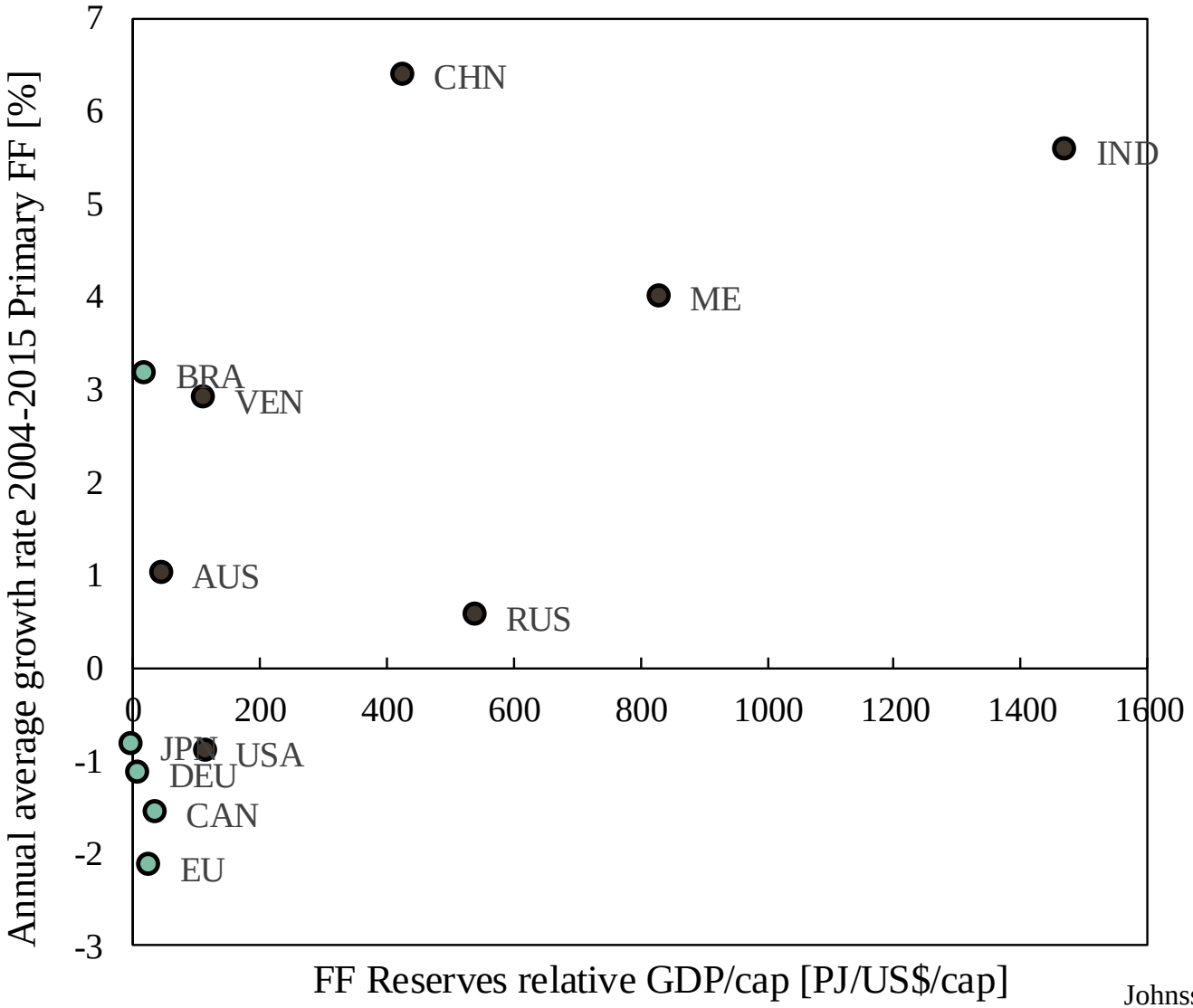

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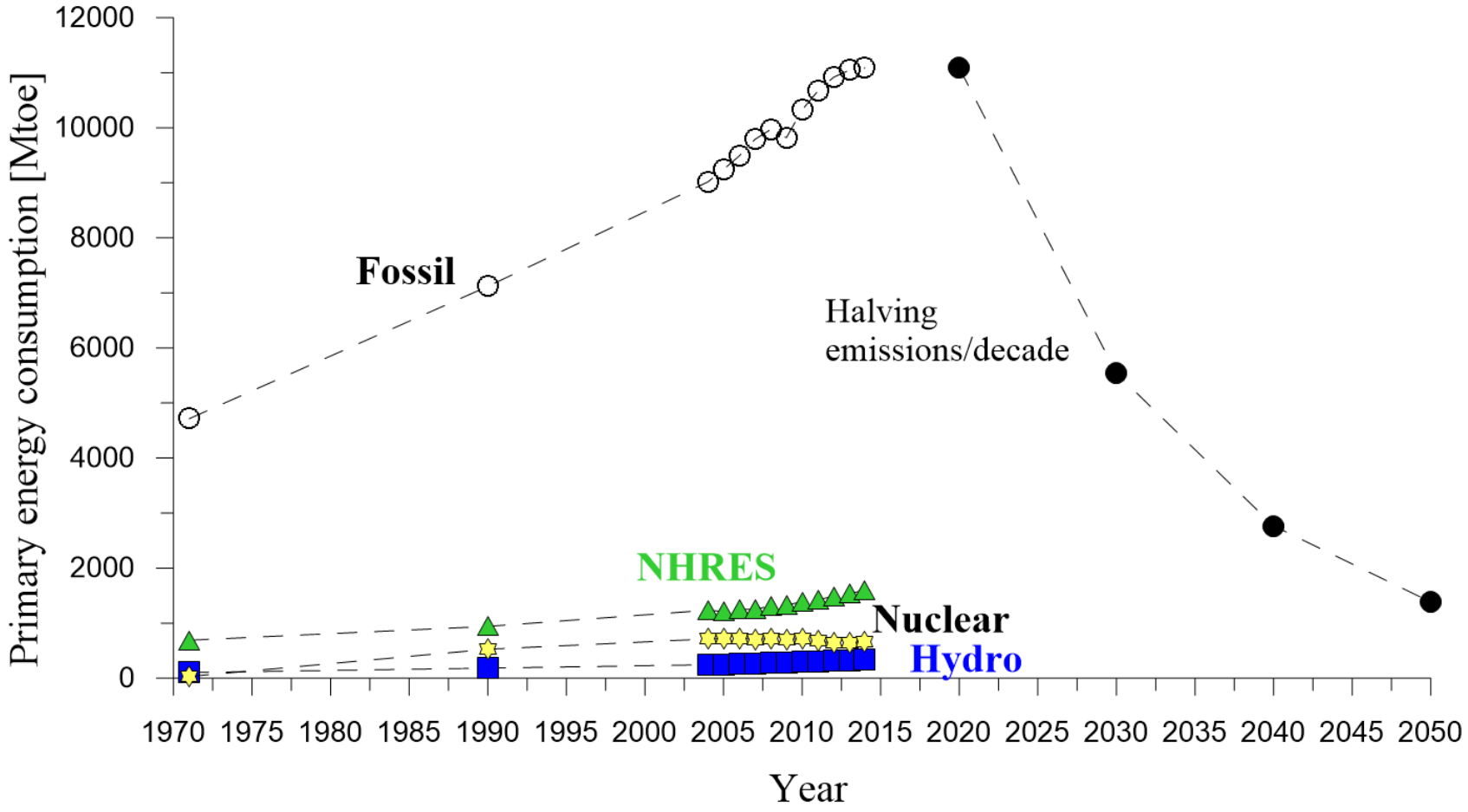
Global trends – fossil-fuel share

Transformative/disruptive transition required!



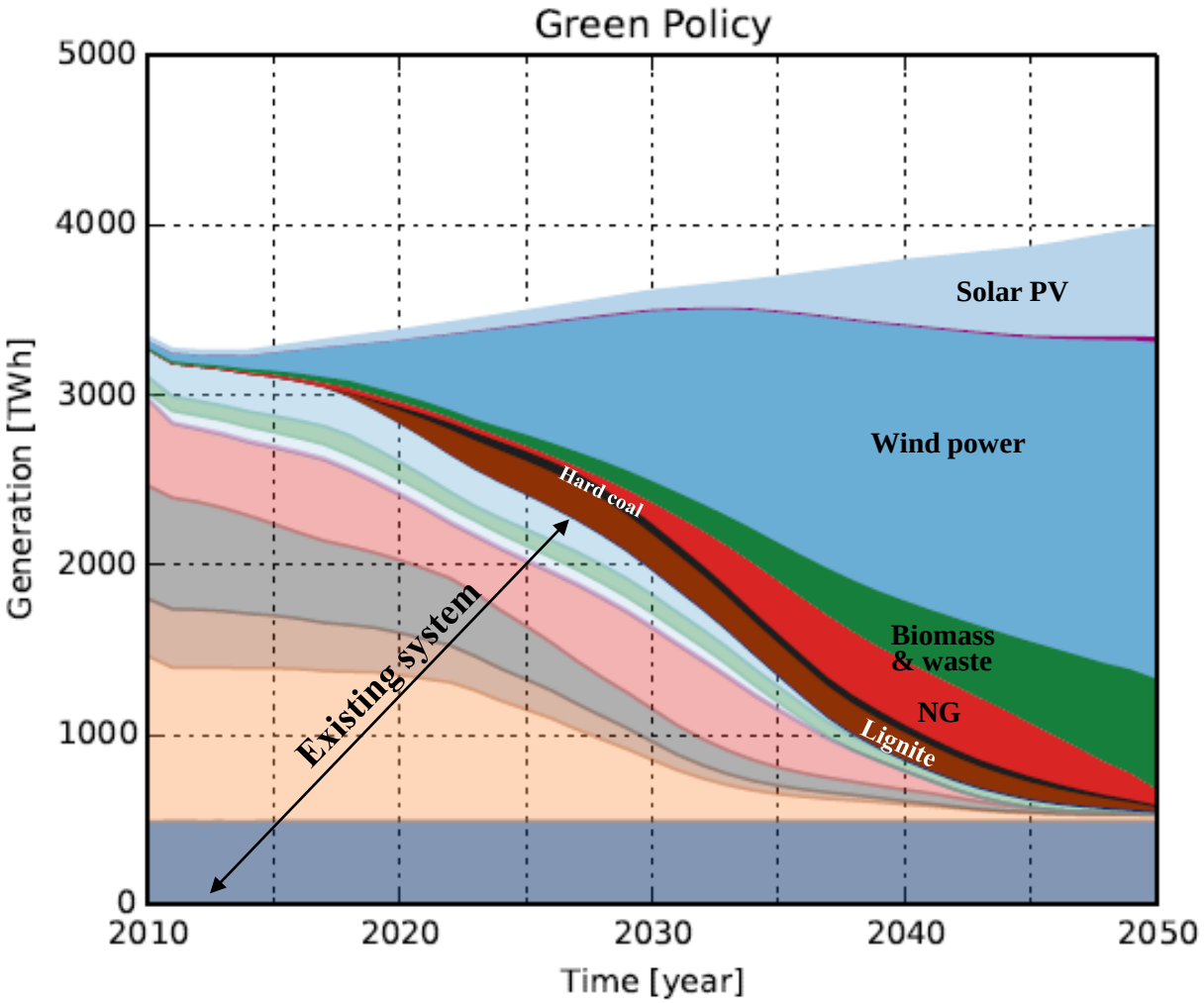
NHRES=Non-hydro renewables

Filled symbols correspond to halving emissions per decade as proposed by Rockström et al., Science, 24 March 2017, Vol 355, Issue 6331

Data from IEA

Johnsson et al. (forthcoming)

Europe (EU-27+NO+CH): Generation up to 2050
Green Policy scenario



Odenberger et al. (forthcoming)

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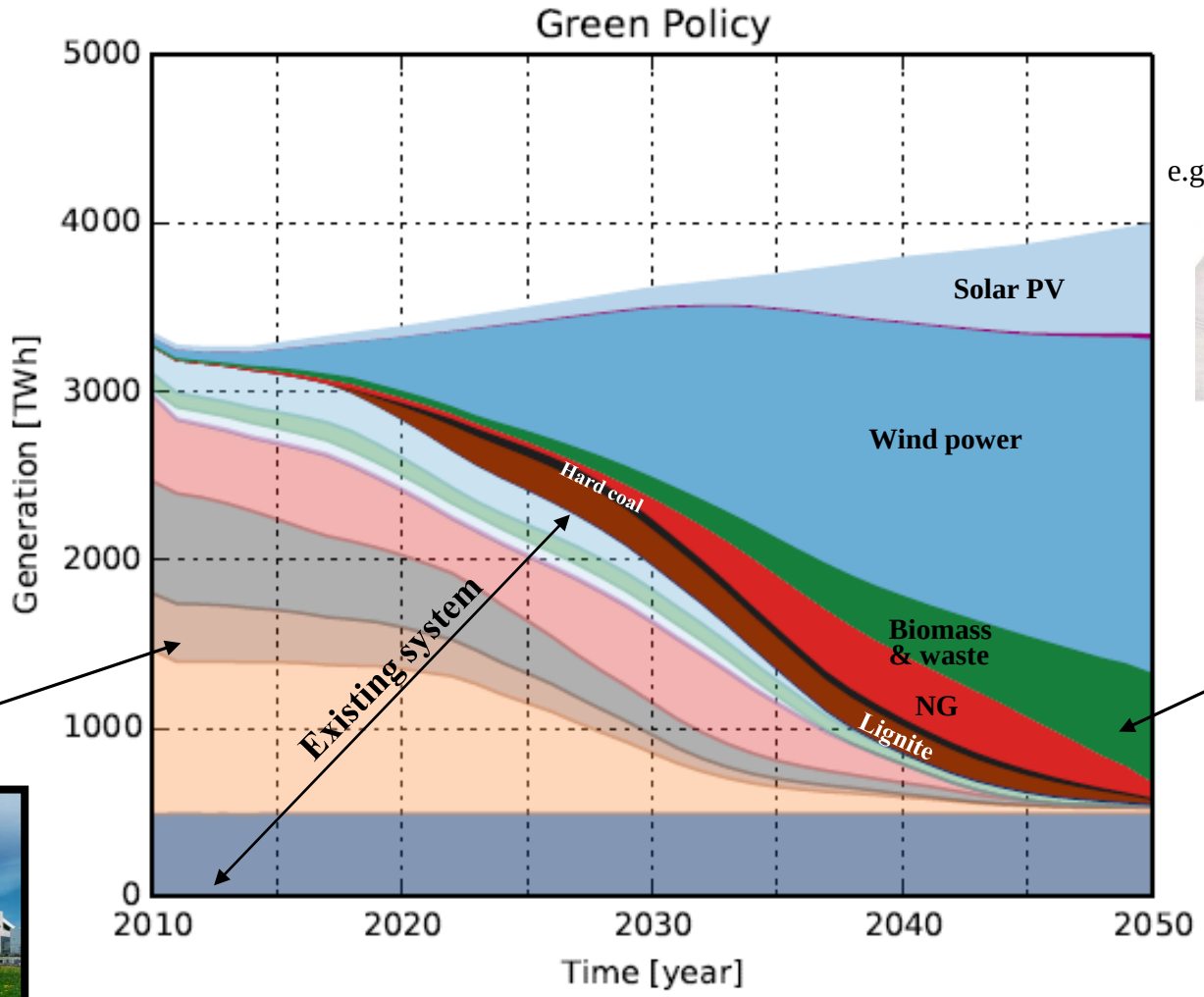
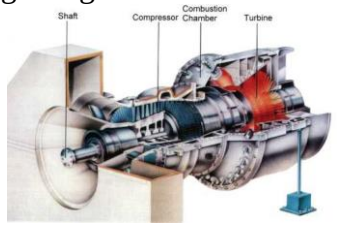


Thermal generation is base load

e.g. Lignite fired power plant

e.g. Biogas fired GT/CCGT



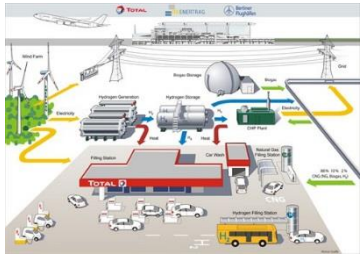
Thermal generation is load following and zero emission

Odenberger et al. (forthcoming)

Cross-sectoral integration

Variation management strategies required for maximizing the value of wind and solar PV

Shifting	Absorbing	Complementing
Electricity ⇒ Electricity • *Reduce curtailment and peak power* • *More even costs on diurnal basis*	***Electricity ⇒ Fuel and heat*** • *Reduce curtailment* • *Fewer low cost events*	***Fuel ⇒ Electricity*** • *Reduce peak power* • *More even costs on yearly basis*
Batteries	**Power-to-heat**	**Flexible thermal generation**
Load shifting	**Electrofuels**	**Reservoir hydropower**
Pumped hydro	**Power to gas (hydrogen)**	



Göransson, L., Johnsson, F. *Wind Energy* 2018 (in press)

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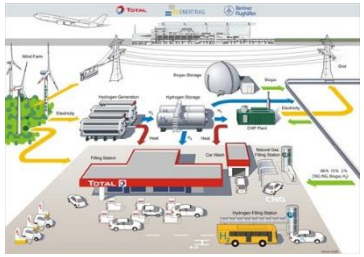
Zero net-carbon emitting
Carbon based fuels



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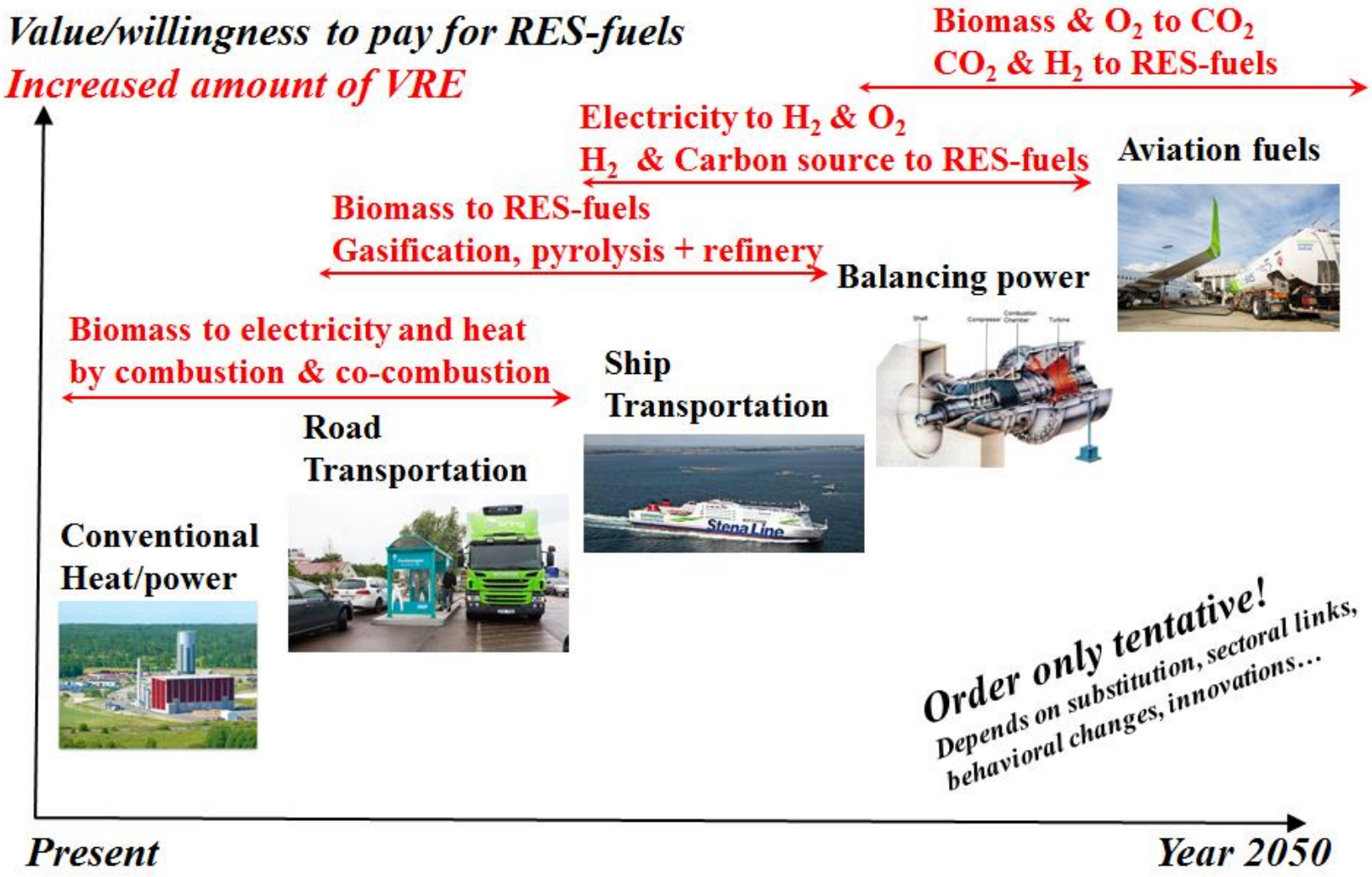
Value of carbon based fuels ("RES-fuels") without net-emissions to the atmosphere



Present

- Most of the forest bioenergy are in biomass-rich countries such as Sweden and Finland and used for **heat and electricity generation**
- Significant efforts to introduce various **support schemes** and to fund research activities to promote development of more **advanced** biomass-conversion technologies for production of **second generation biofuels**
  - not yet resulted in market conditions stable enough to overcome the risk and cost associated
  - lack of economic incentives preventing large-scale demonstration
  - “initial market killing” of demonstration of advanced concept by imports of biofuels

Technologies are available

Photo: Rob Vanstone

Transportation fuel can be produced @ 55 €-cent/litre

Example: The GoBiGas plant Göteborg (20MW)
Indirect gasification

Short term – accelerate development

- Ensure that biomass **markets are created** at a reasonable **low-risk** and prepare for next generation biomass fuel technologies
  - increased use of biomass for heat and electricity production
    ⇒ offer low-risk options for establishing a biomass-supply markets (CHP plants, co-firing biomass in coal power plants and the use of torrefied biomass in steel production)
  - **policies** for development of advanced biomass fuels must promote markets for least **some 20-30 production plants** for technology providers

Wood vs concrete – both needed!

Wood house, Sundbyberg, Sweden

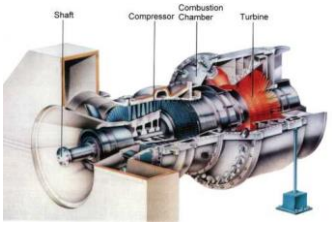
Concrete house, Göteborg, Sweden

Materials strategy has important implications for innovation systems

A strategy must also ensure development of zero-emission cement and concrete

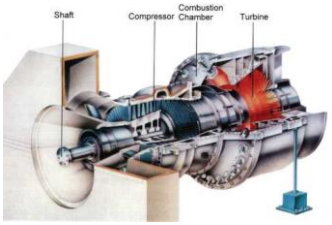
Intermediate term – towards zero emission systems

- Establish a **fossil-fuel strategy**



Intermediate term – towards zero emission systems

- Establish a **fossil-fuel strategy**
- **Establishment of markets for advanced biomass-fuel**. Make use of existing sites for fossil-fuel thermal plants, which will be sufficient for accommodate biomass plants for electricity or biofuel production and power plants with CCS (benefitting from knowledge and experience from thermal processes)

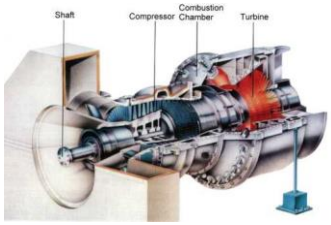


New CHP plant (Värtan, Stockholm), Stockholm Exergi

Long term – towards negative emissions

- Biomass used where carbon based fuels are difficult to replace and where the resulting CO_2 emissions are difficult to capture
  - e.g. aviation, long-distance ship transport and long-haul road freight
- Cascading biomass use – buildings, materials, fuels, energy
- Net-negative emissions: combination of forestry and other land-use management, capture and storage of CO_2 from biomass conversion (BECCS), and possibly Direct Air Capture (DAC)
  - BECCS, this will compete with other uses of renewable carbon where alternatives are difficult to find, including balancing power to increase the value of VRE





Summary

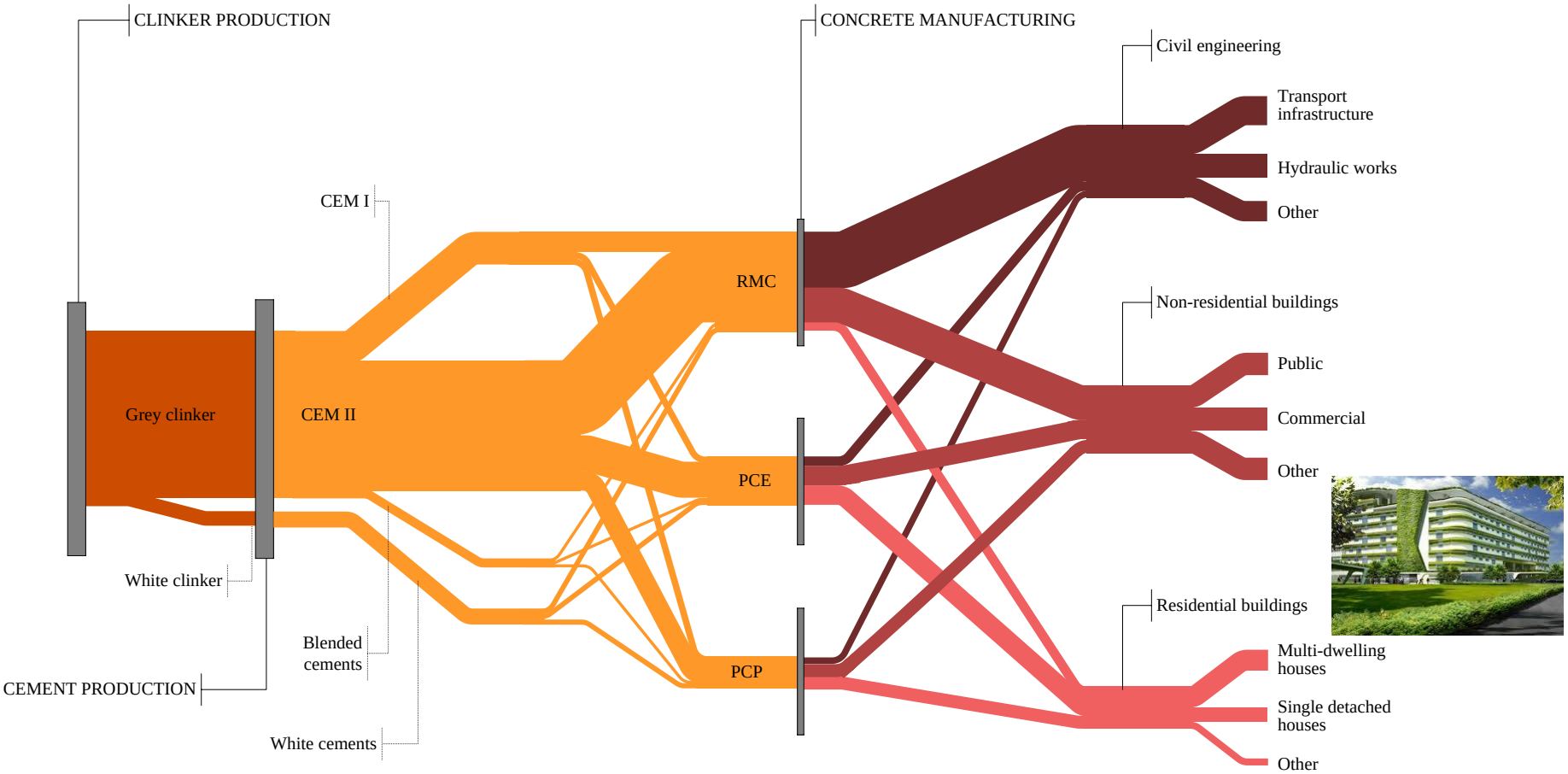
- **A fossil-fuel strategy** is required! Not only promote RES systems
  - CCS or leave fossil fuel in the ground
- **Time perspective**: pathways to meet temperature targets similar to forest management planning ⇒ long-term view on changes in forest carbon stocks
- **Carbon-based fuels** without net-emissions to atmosphere will be **increasingly valuable** ⇒ biomass sourced to sectors/actors with highest willingness to pay
  - character of demand and supply options change over time
- **Accelerate development** of **advanced biofuel** technologies now to ensure implementation in medium and longer term
- On the long term **biomass** may play a key role to achieve **net-negative emissions** (BECCS)
  - BECCS will compete with other uses of renewable carbon, e.g. aviation fuels and other uses where carbon capture is not feasible

Extras

- **Bioenergy supply-chain emissions** and the **forest carbon losses** within a certain region (typically a country) over a longer time-perspective << **carbon content** in the **fossil fuels replaced**
- Changes in biospheric carbon stock are taken into account when territorial emissions and removals of greenhouse gases are reported under the UN Climate Convention, the Kyoto Protocol and EU regulations.

Supply chain analysis

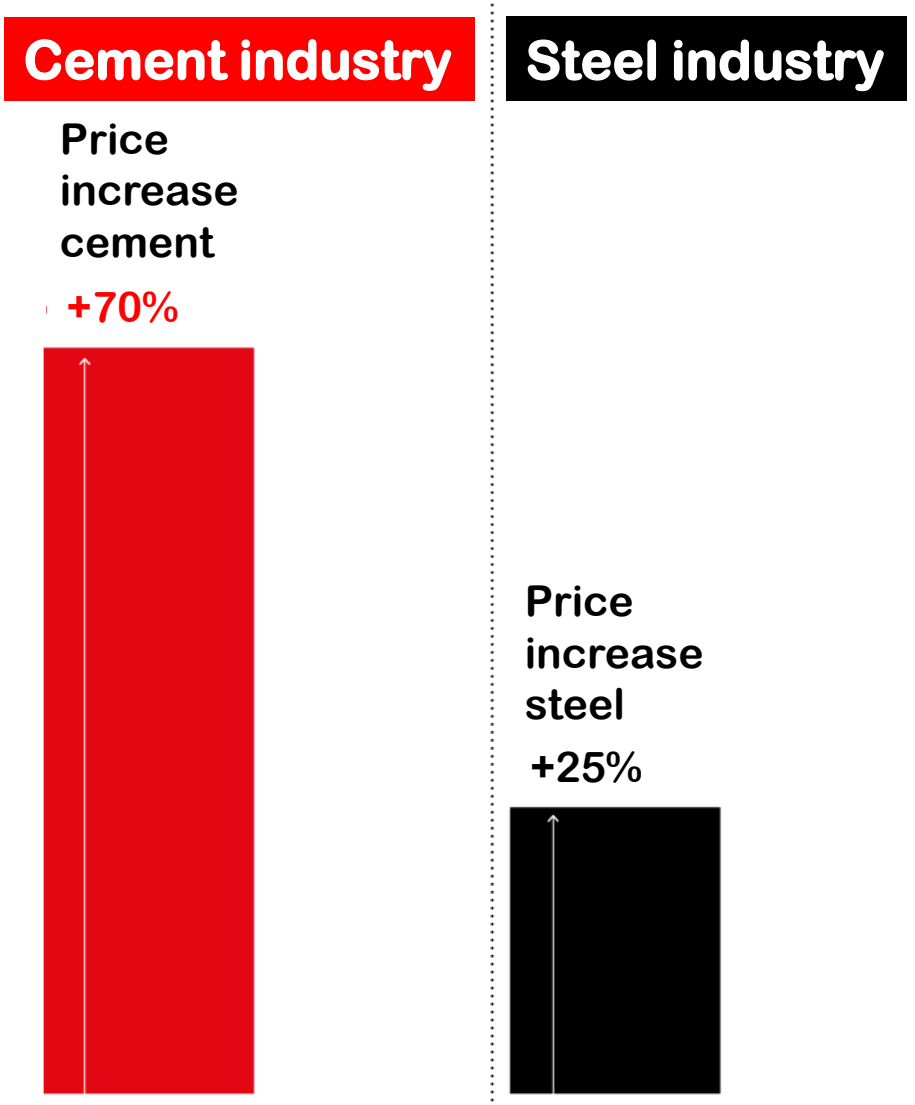
Cement (and steel) to building



Example - Nordic basic material industry (Cement & Steel)

Measures to comply with Year 2050 targets ~100€/ton CO_2

EU-ETS < 6 €/ton CO_2



Example - Nordic basic material industry (Cement & Steel)

Rootzén and Johnsson
Energy Policy 98 (2016) 459–469
Climate Policy 17, 6, (2017) 781-800
See also (in Swedish)
http://www.dn.se/debatt/plan-saknas-for-att-minska-basindustrins-klimatpaverkan/

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