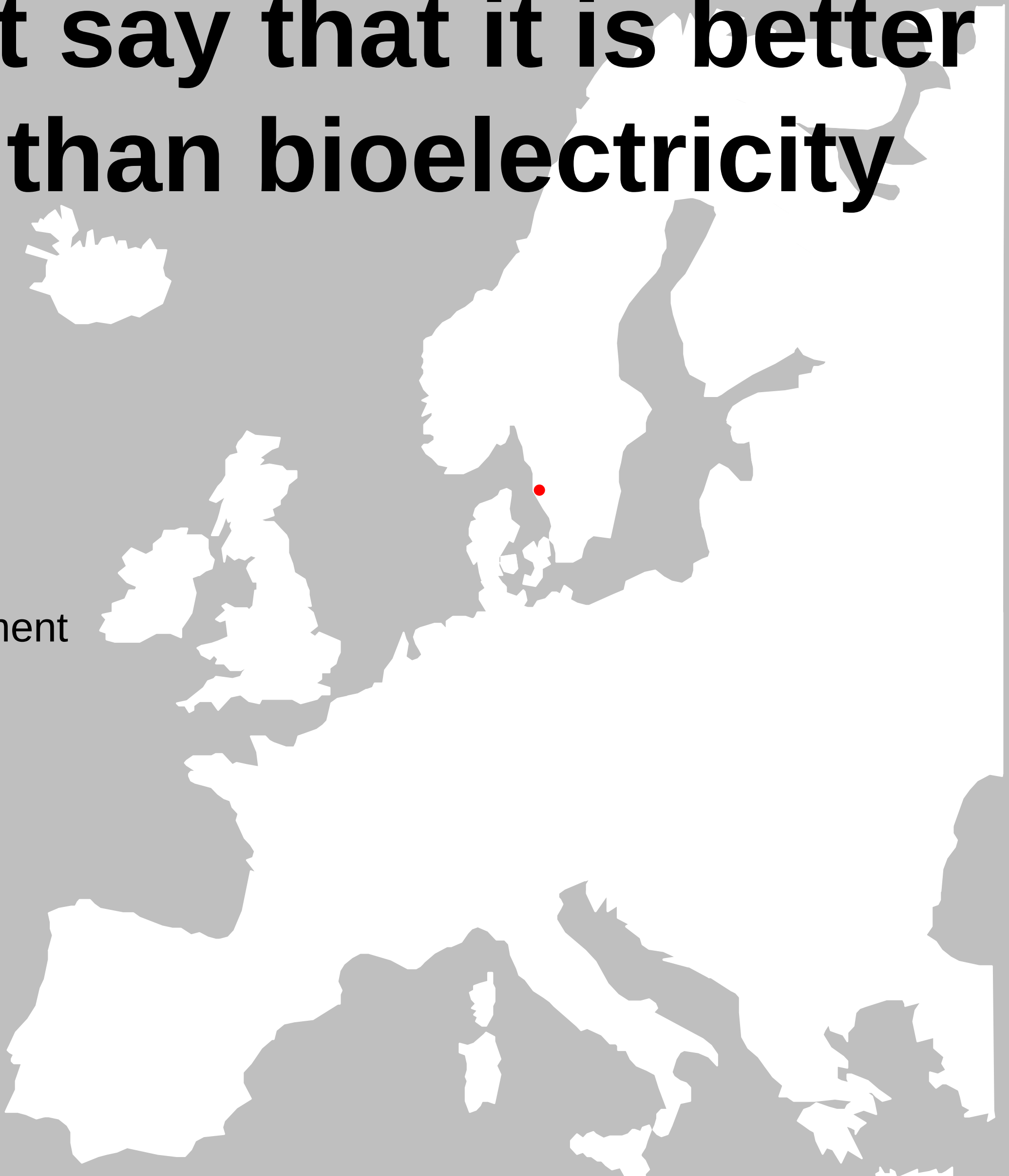
CHALMERS
UNIVERSITY OF TECHNOLOGY

Why you cannot say that it is better to use solar PV than bioelectricity



Filip Johnsson

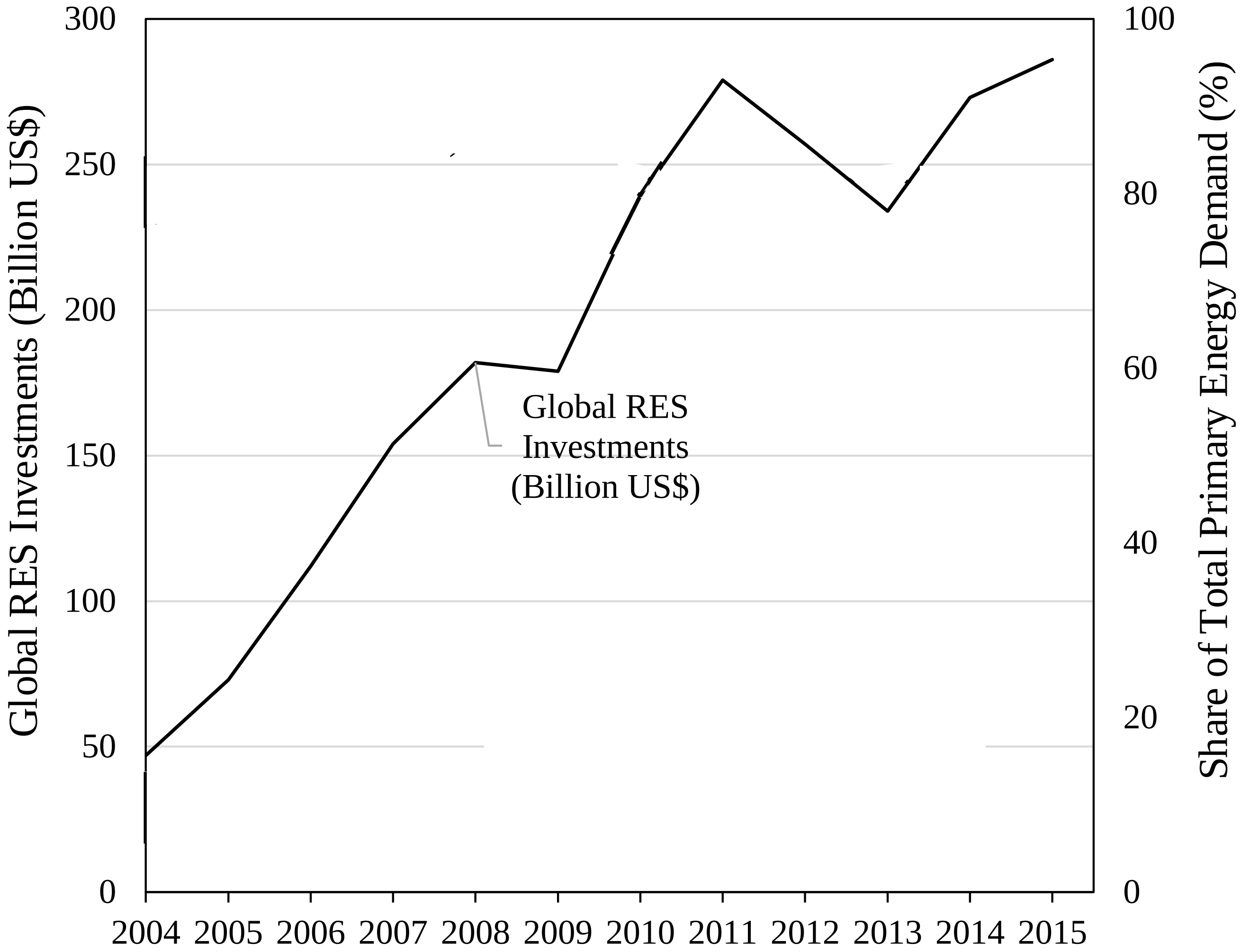
IEA
May 16, 2017

Division of Energy Technology
Department of Space, Earth and Environment
Sweden
filip.johnsson@chalmers.se

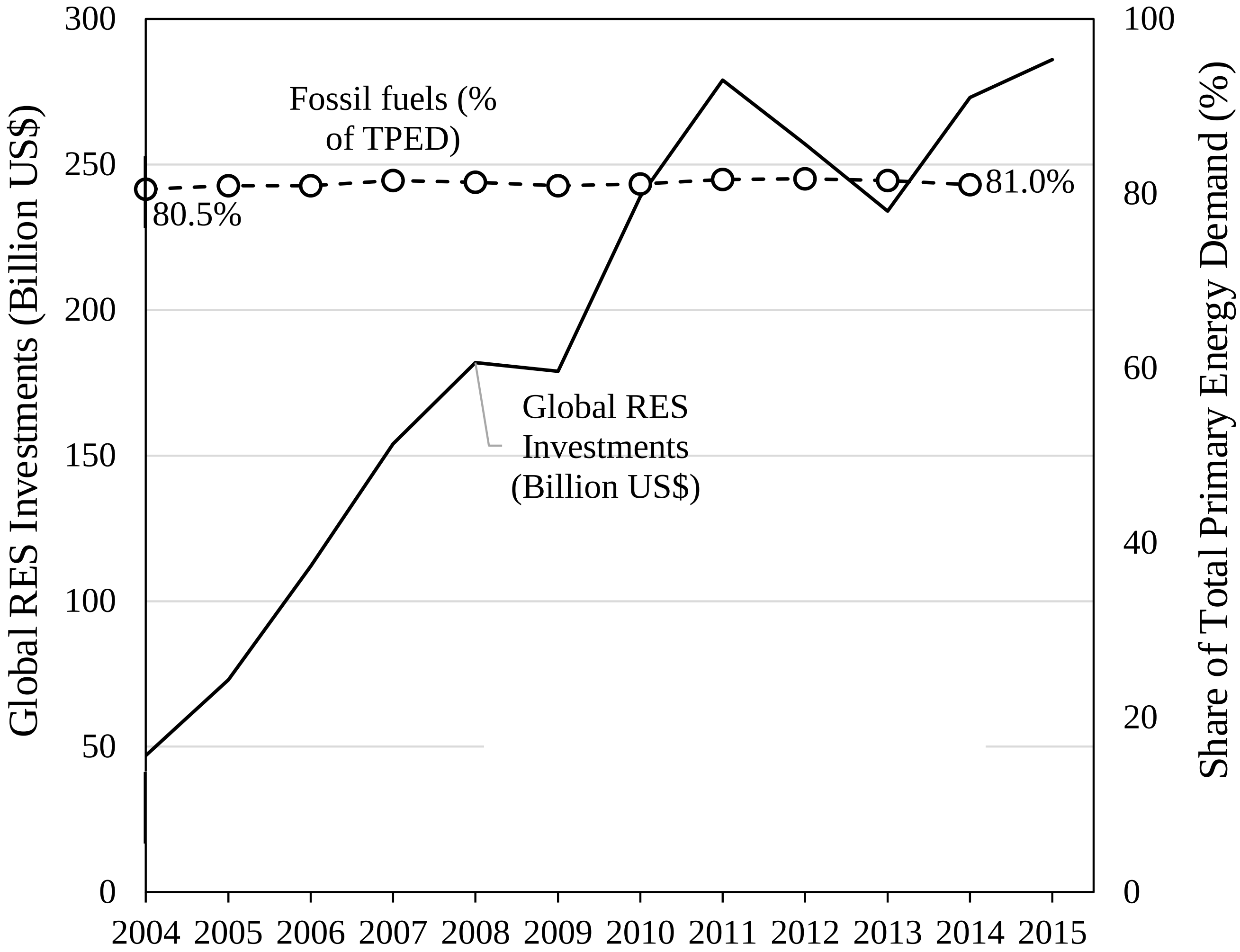
Why you cannot say that it is better to use solar PV than bioelectricity

- We need everything!
- Large differences in local conditions for different fuels and technologies
- Solar PV gets “saturated” - dependent on costly infrastructure
- Bioelectricity required for variation management of non-dispatchable electricity generation (PV and wind)
- Bioelectricity can kick-start transition – towards cross sectoral integration (energy-transportation-materials)
- Bioelectricty (and other biomass processes) offers carbon negatives (BECCS)

Strong growth in RES investments



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

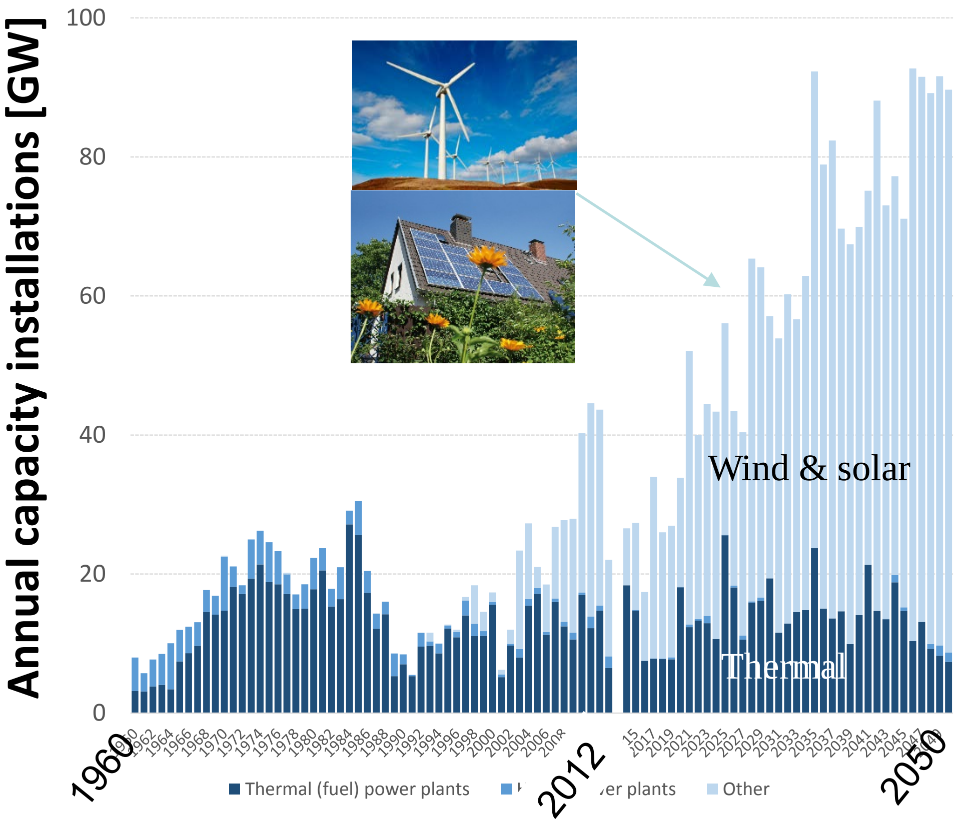


TPED = Total Primary Energy Demand

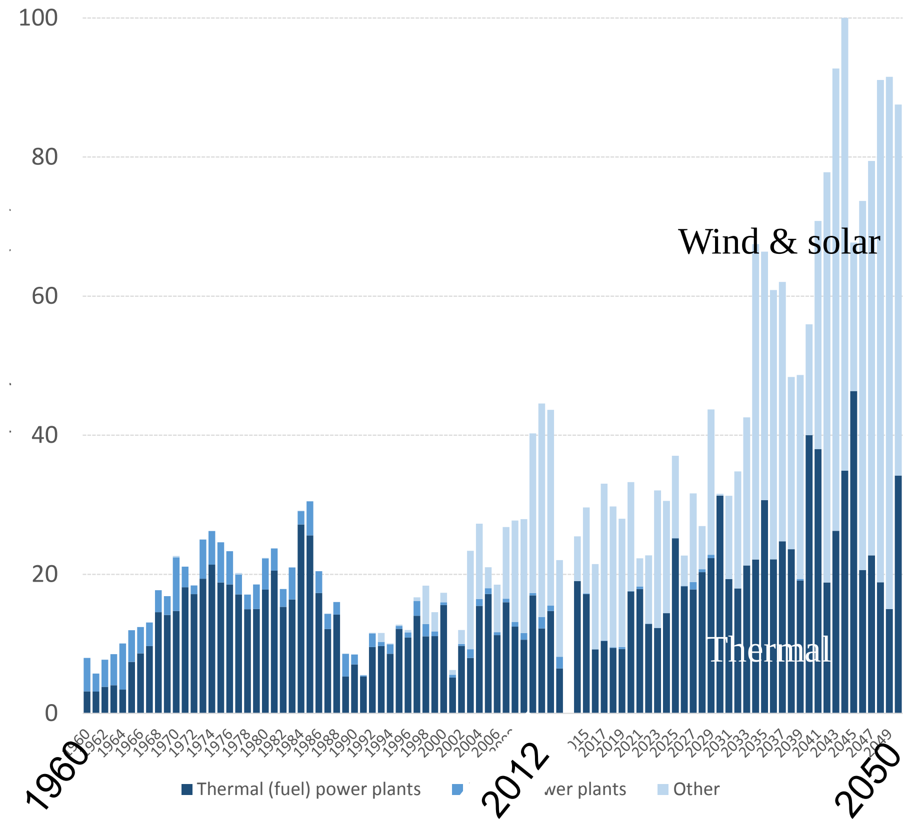
Johnsson et al. (forthcoming)

Europe (EU-27+NO+CH): Annual investments in electricity generation required to comply with emission reduction targets Historical *vs* up to 2050

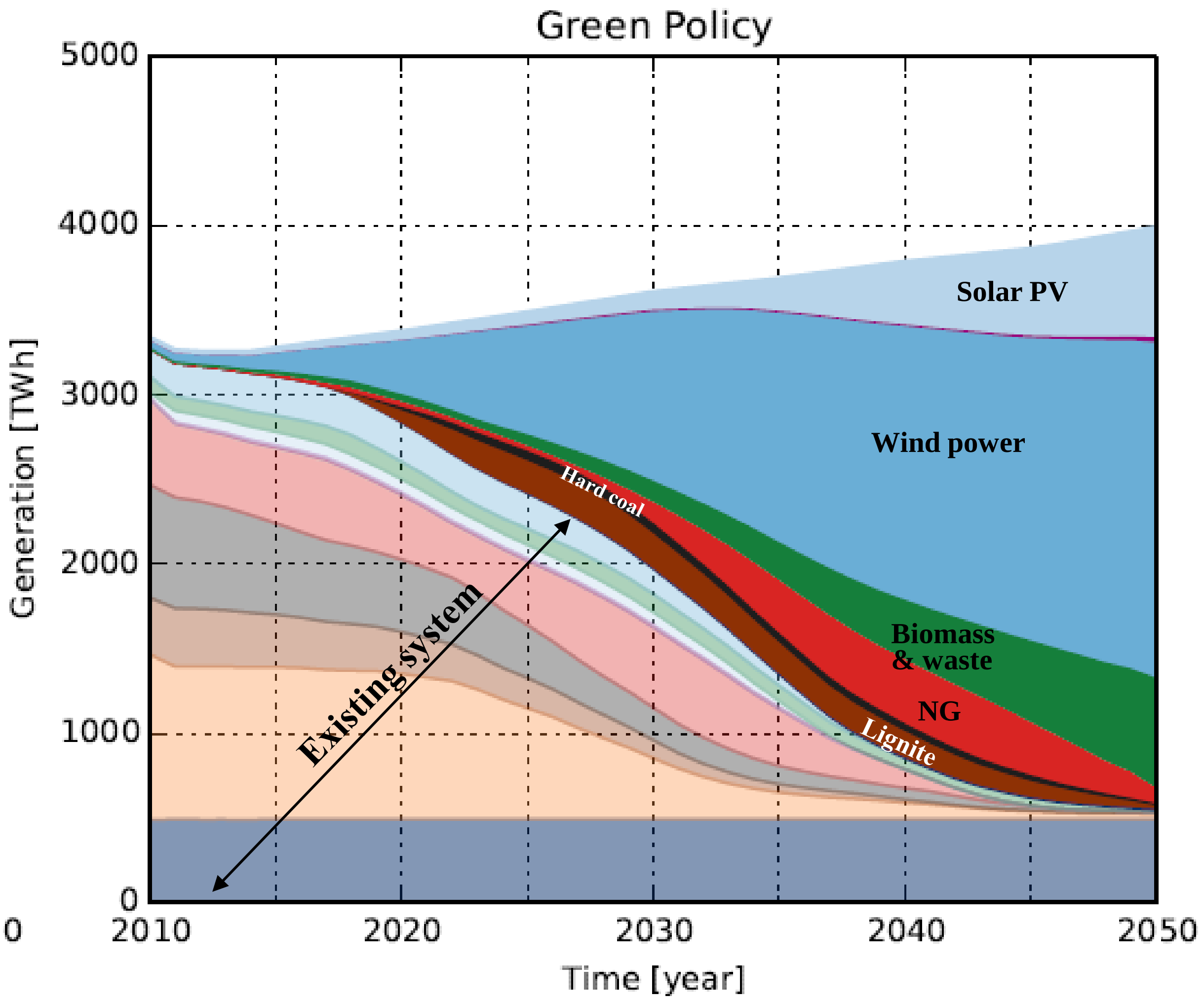
Green Policy 99% CO_2 reduction



Climate Market 93% CO_2 reduction

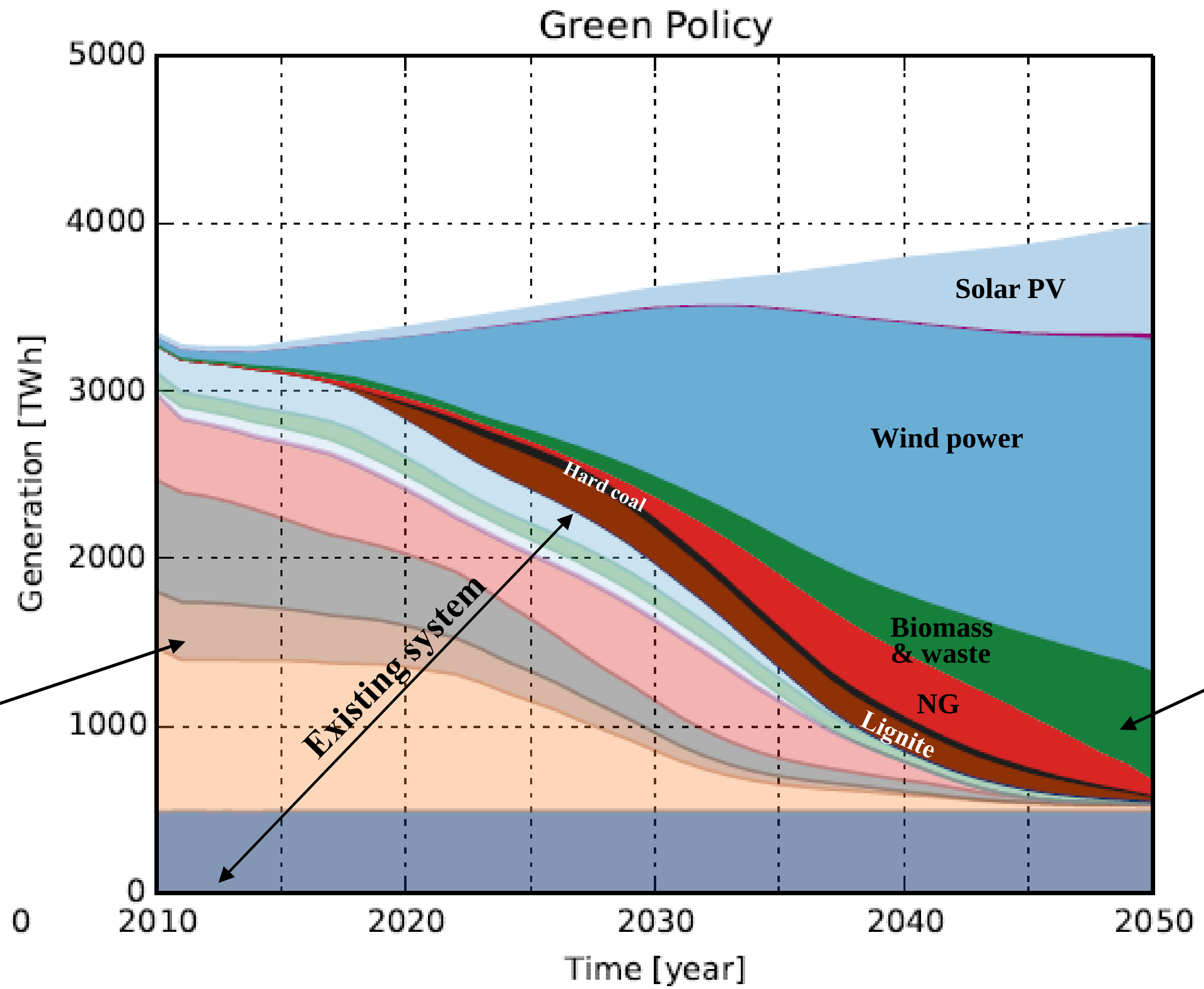


Europe (EU-27+NO+CH): Generation up to 2050
Green Policy scenario



Odenberger et al. (forthcoming)

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



Thermal generation is base load

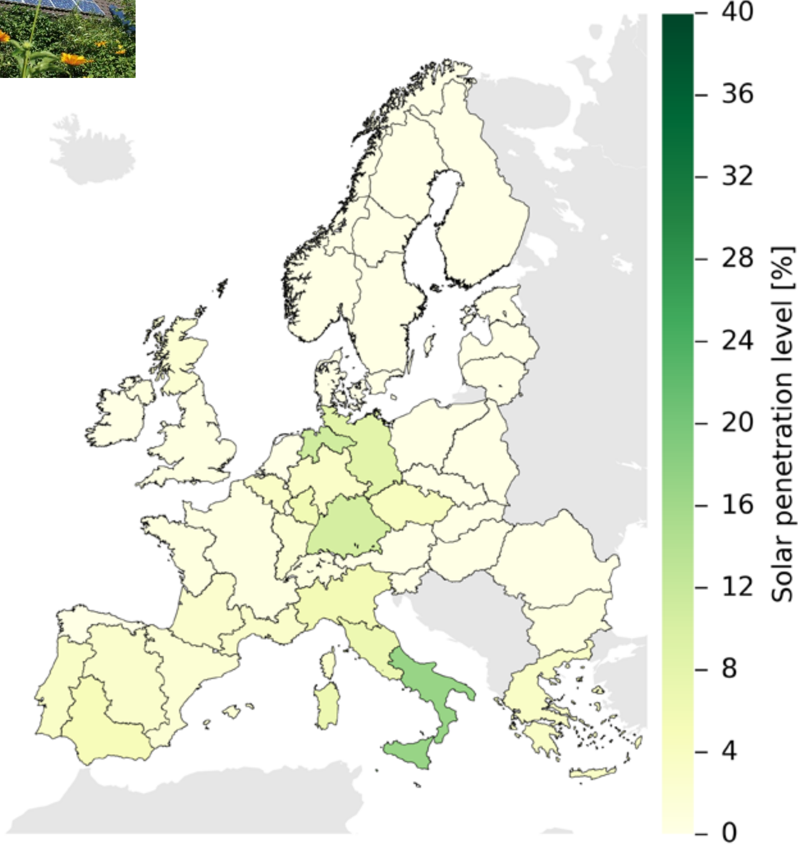
Thermal generation is load following

Odenberger et al. (forthcoming)

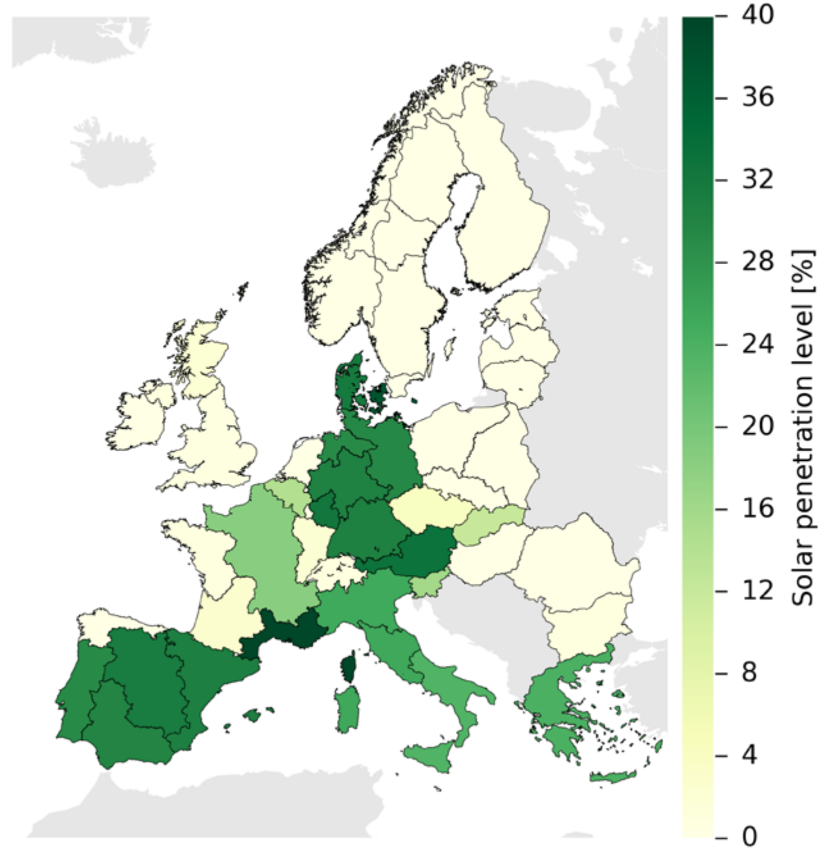
Large differences in local conditions for different fuels and technologies

Example Solar PV – two scenarios

Base case



Net metering case

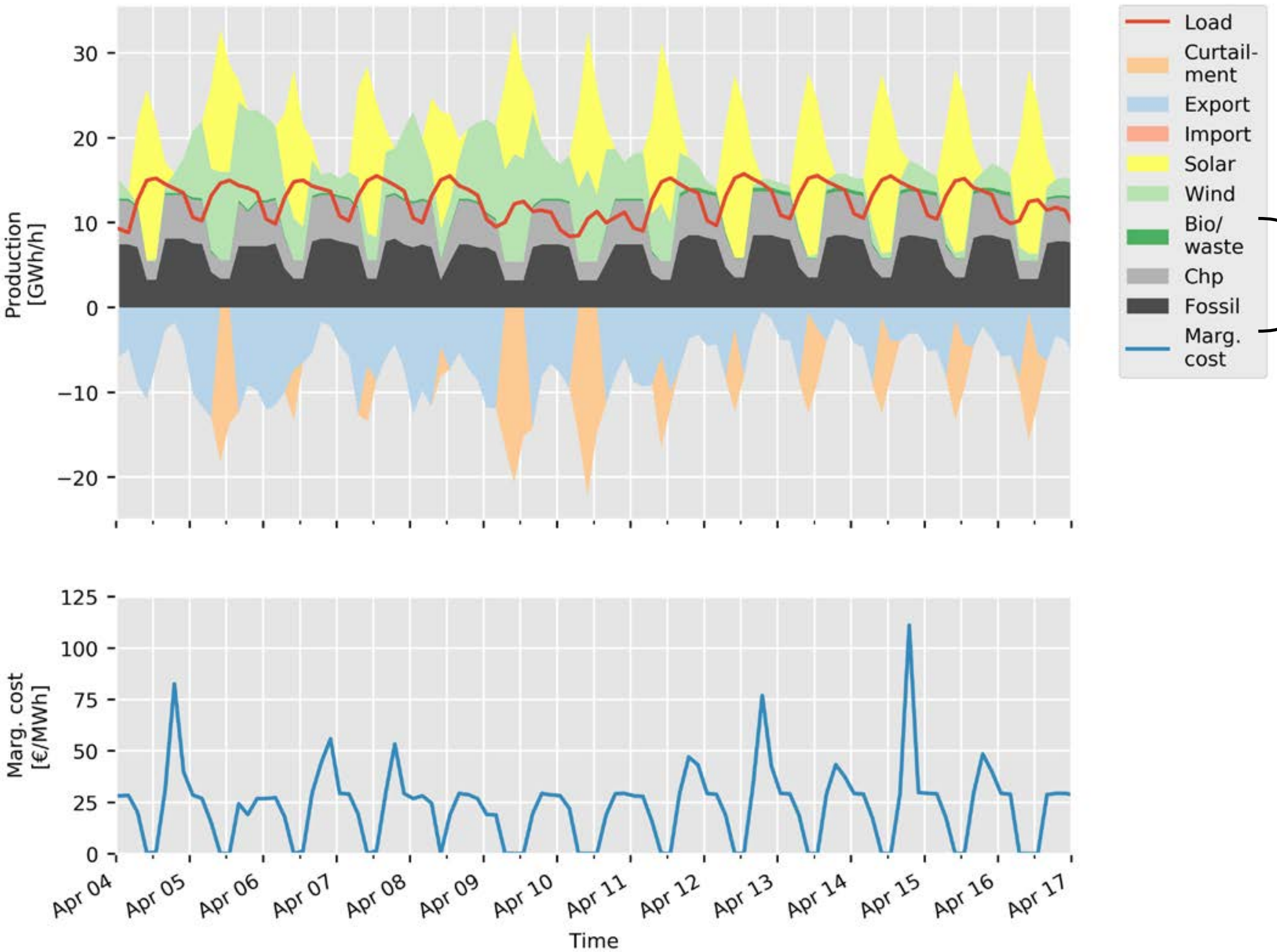


Penetration: annual electricity generation divided by total annual demand

Goop et al. (submitted)

Large variations in solar and PV generation

Example: Germany (DE4) Net metering scenario



Load following generation

Goop et al. (submitted)

Large penetration of Solar PV

- Solar PV gets “saturated” - depends on costly infrastructure if to avoid substantial curtailment

  diurnal and only summer ~1000 full load hours

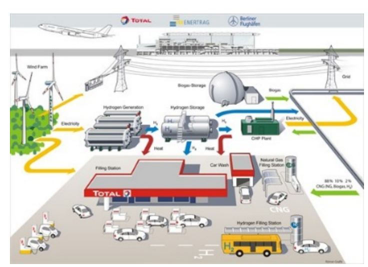
  >10% of annual energy from PV - all load covered by PV during peak generation, large storage required

  >30% of annual energy from PV - entire energy use covered by PV during summer time, seasonal storage required

  ⇒ requires significant infrastructure such as storage, cables control systems. Cost of PV not governed by PV panel cost, but by the cost of infrastructure

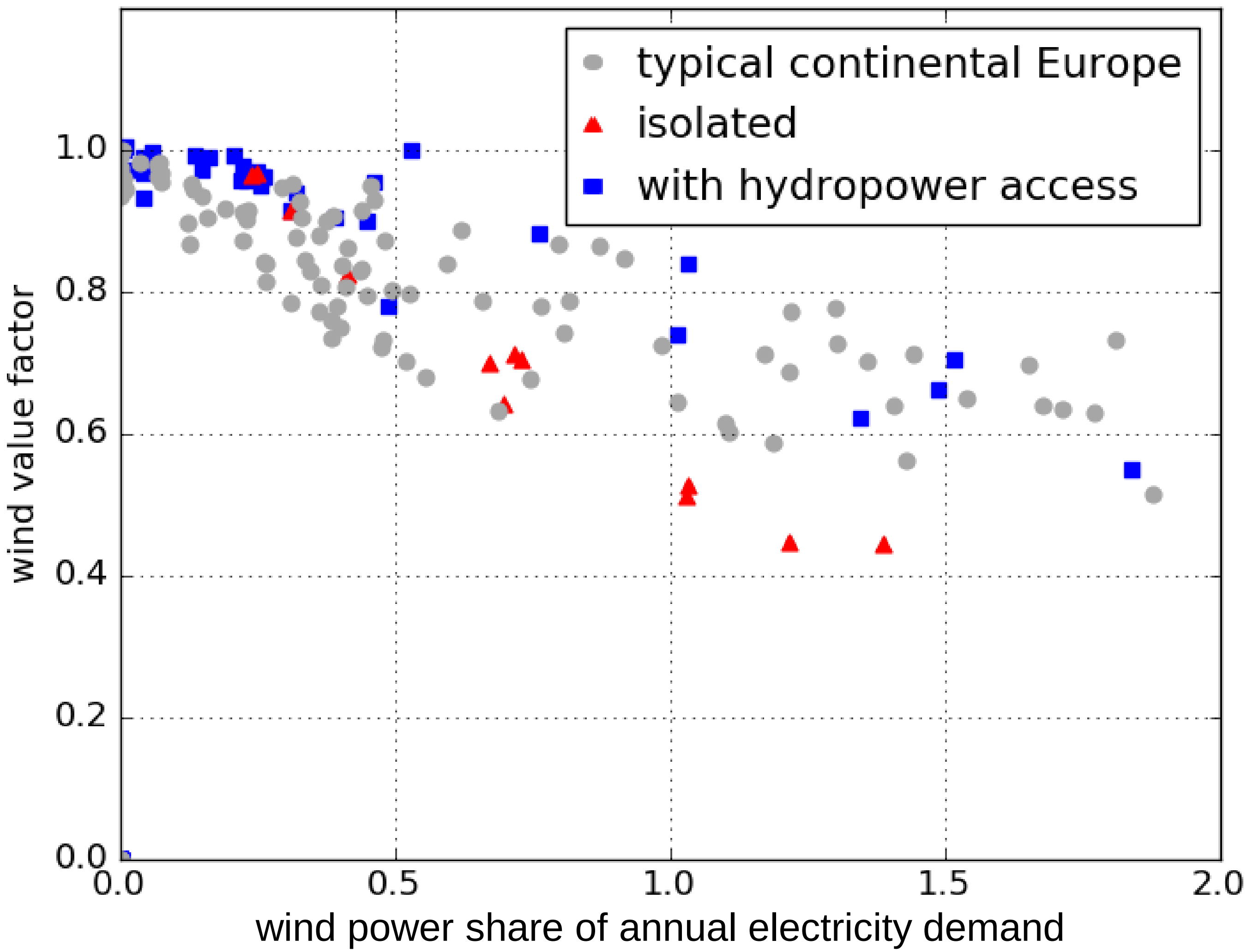
Variation management strategies required for maximizing the value of wind and solar PV

Shaping	Absorbing	Complementing
Electricity ⇒ Electricity • *Reduce curtailment and peak power* • *More even costs on diurnal basis*	***Electricity ⇒ Fuel and heat*** • *Reduce curtailment* • *Less 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. (submitted)

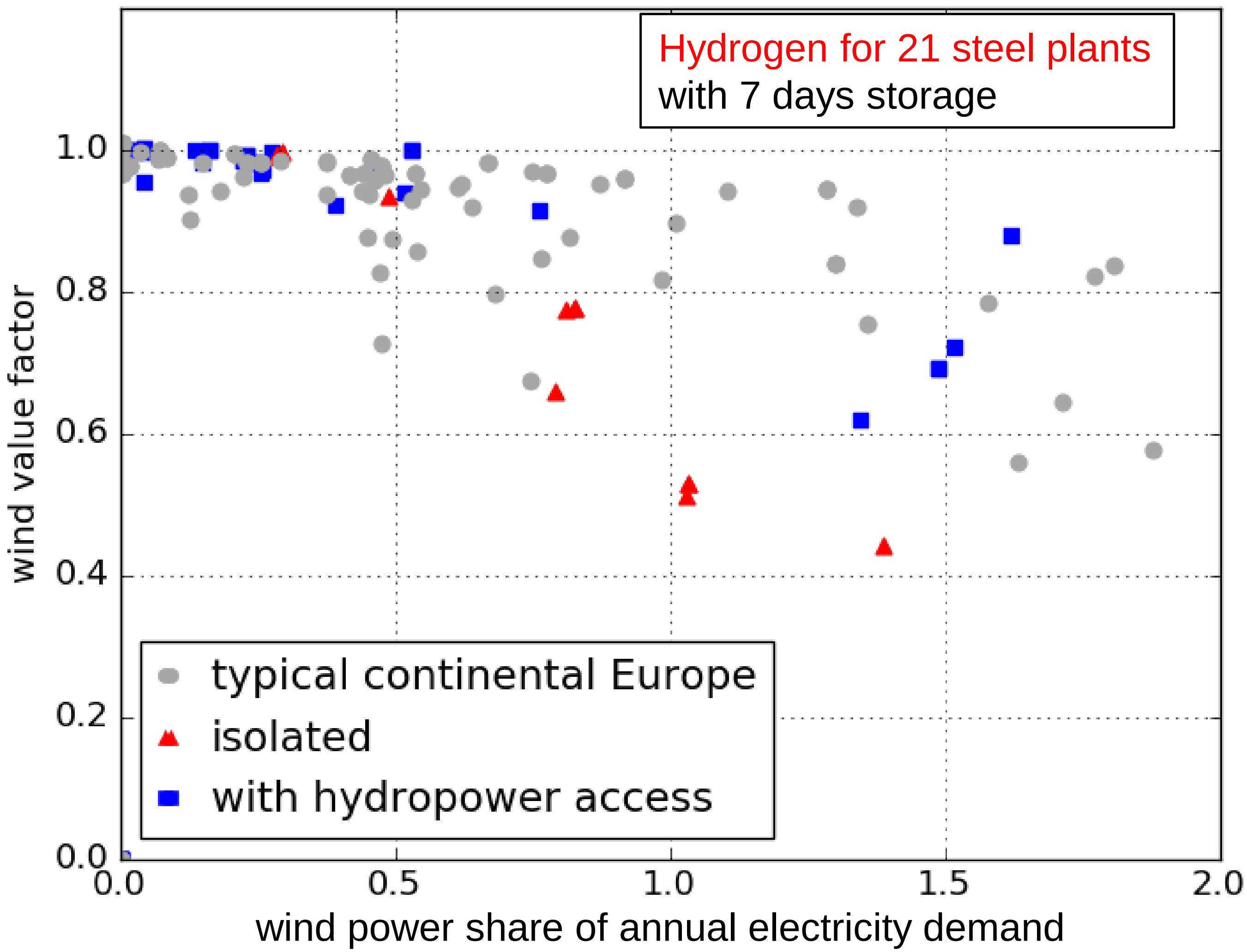
The value of wind power –without variation management



The **value factor** (0-1): ratio of the production weighted marginal cost of electricity to the time-weighted average

Göransson, L., Johnsson, F. (forthcoming)

The value of wind power – with variation management



The **value factor** (0-1): ratio of the production weighted marginal cost of electricity to the time-weighted average

Göransson, L., Johnsson, F. (forthcoming)

Biomass can kick-start transition to renewable system

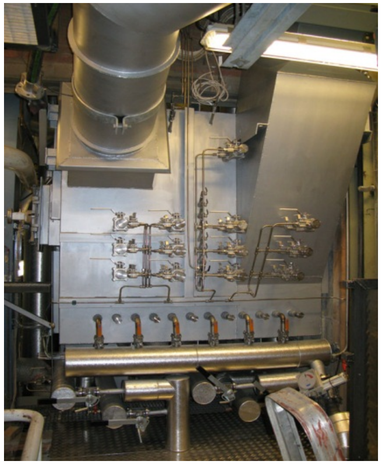
- Use of existing infrastructure
- Use of existing knowledge and know-how
- Towards production of different energy carriers and materials (cross-sectoral integration)

Towards sectoral integration – SNG production

Example GoBiGas 20 MW gasification

Chalmers lab reactor

Chalmers 2-4 MW
pilot plant



GoBiGas fas 1 Hisingen
20 MW SNG **demonstration** plant
Göteborg Energi

GoBiGas fas 2 Hisingen
80 MW SNG
Commercial plant
Gbg Energi

2008 2012 2016

BECCS
Example Sweden

In green: 33 biogenic point sources
> 300 kt/yr
CCS @ 85% capture rate
⇒ 20.1 Mt negative emissions (*cf.* Swedish total GHG emissions of 52 Mt, all sectors)

Karlsson et al.. (submitted)

Why you cannot say that it is better to use solar PV than bioelectricity

- We need everything!
- Large differences in local conditions for different fuels and technologies
- Solar PV gets “saturated” - dependent on costly infrastructure
- Bioelectricity required for variation management of non-dispatchable electricity generation (PV and wind)
- Bioelectricity can kick-start transition – towards cross sectoral integration (energy-transportation-materials)
- Bioelectricty (and other biomass processes) offers carbon negatives (BECCS)