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Carbon Capture and Storage Program

The role of CCS in a Finnish low-carbon economy

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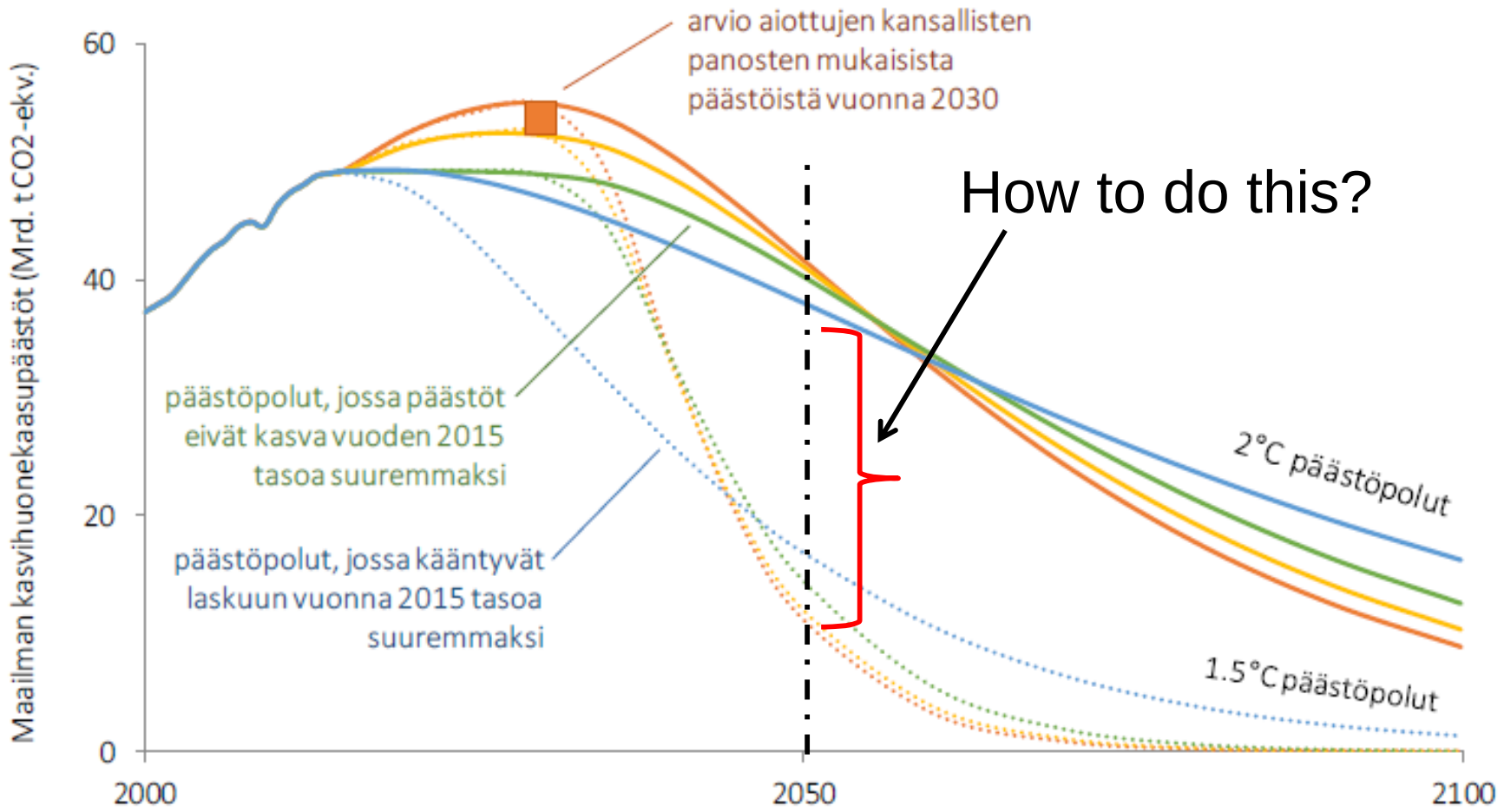
CCSP Final results seminar 13.10.2016

Meeting the targets of the Paris COP21 agreement requires early action



Source: Ekholm & Lindroos 2016. http://tietokayttoon.fi/julkaisu?pubid=13604

Background of the CCSP scenario work

- Scenario work of Low Carbon Finland 2050 platform (Tekes Green Growth Programme) as a starting point
  - Supported the formulation of Finland's Low Carbon Roadmap 2050

- Selected Low Carbon 2050 scenarios were updated to take into account
  - New information and data on different CCS concepts and applications that have been assessed in the CCSP
  - EU's 2030 climate and energy policy framework
  - Updated information on investments (nuclear, forest industries, etc.), phase down of old ones, etc.

Alternative low carbon 2050 scenarios

Four different storylines

1. **Growth**
2. **Stagnation**
3. **Save**
4. **Change**

In addition:

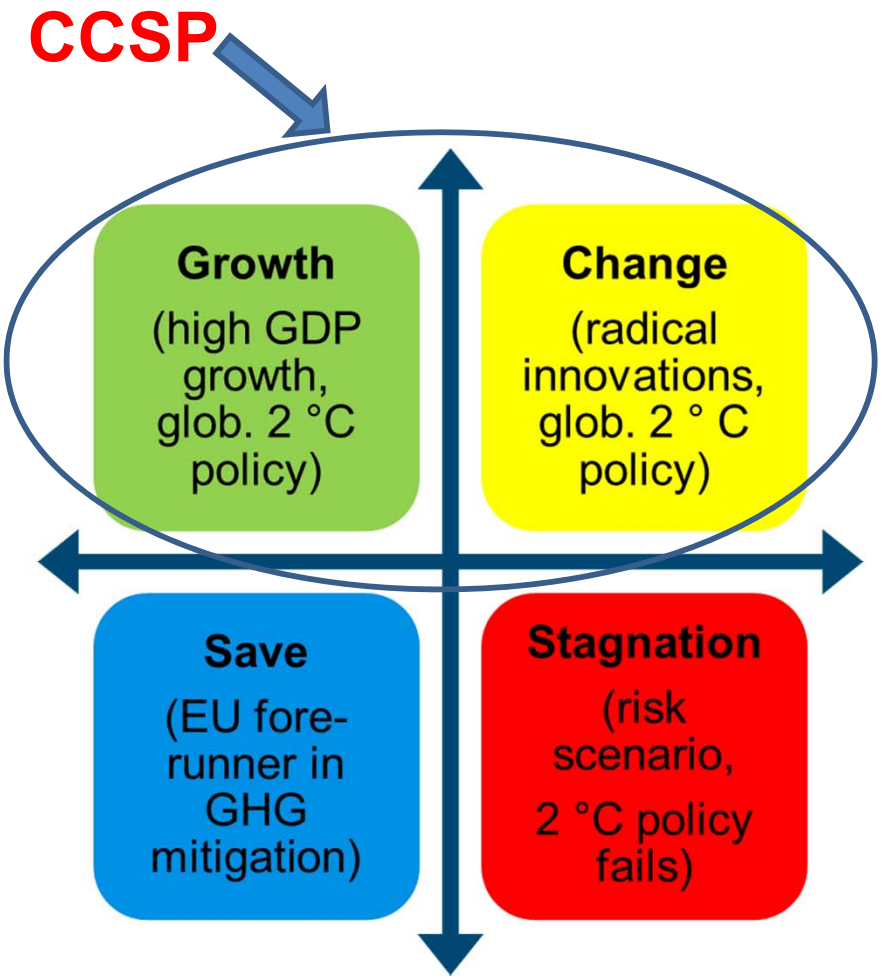
1. **Baseline** based on the ”officilal” national 2013-15 baseline, including the 2030 policy framework
2. **Base-80%** (the same as Baseline, but with -80 % GHG mitigation)

CCSP-scenarios:

1. **Updated Baseline ja Base-80 %**
2. **Updated Growth and Change scenarios**

Description of the Low Carbon Finland 2050 scenarios

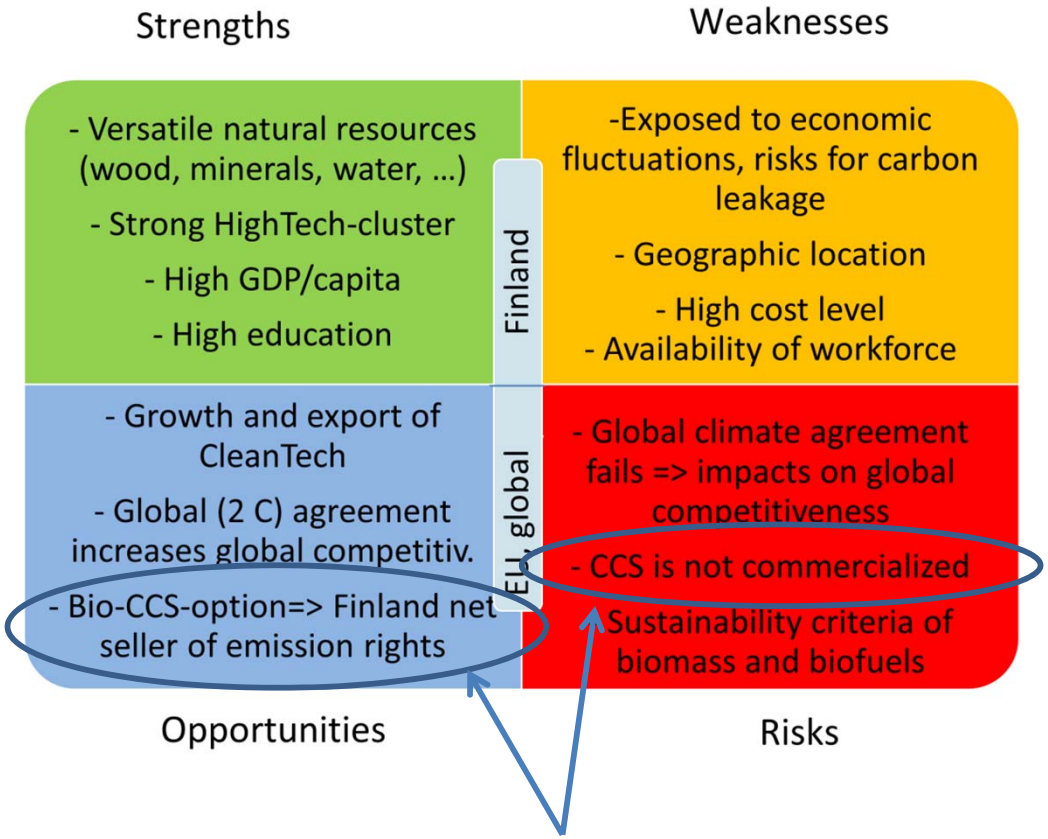
- **80% GHG mitigation target** by 2050 is achieved in all the scenarios both in Finland in the EU (expect in the Baseline)
- **Global climate agreement** is implemented in all the scenarios, expect in Stagnation
- **New technology development and implementation** rapid (Growth and Change) or conservative (Save and Stagnate)
- **The industrial structure in Finland** comparable with today's structure (Base-80%, Save), strongly renewing (Growth, Change), reducing production (Stagnate)
- **Community structure** no urban sprawl (Growth), high urban sprawl (Change) or small urban sprawl (other scenarios)



SWOT analysis for Low Carbon Finland 2050

www.lowcarbonplatform.fi

- **Finland is able to achieve the low carbon targets but not alone.** There are several alternative pathways.
- **Accelerated new technology development and implementation may increase Finland's competitiveness.** Finland's strengths are related to the natural resources and strong cleantech cluster. Also high GDP/capita and high level of education are advantages.
- The greatest **uncertainties** are related to commercialization of CCS early enough and to **possible implementation of sustainability criteria of wood based biomass in future energy and climate policies**.



Good and bad …

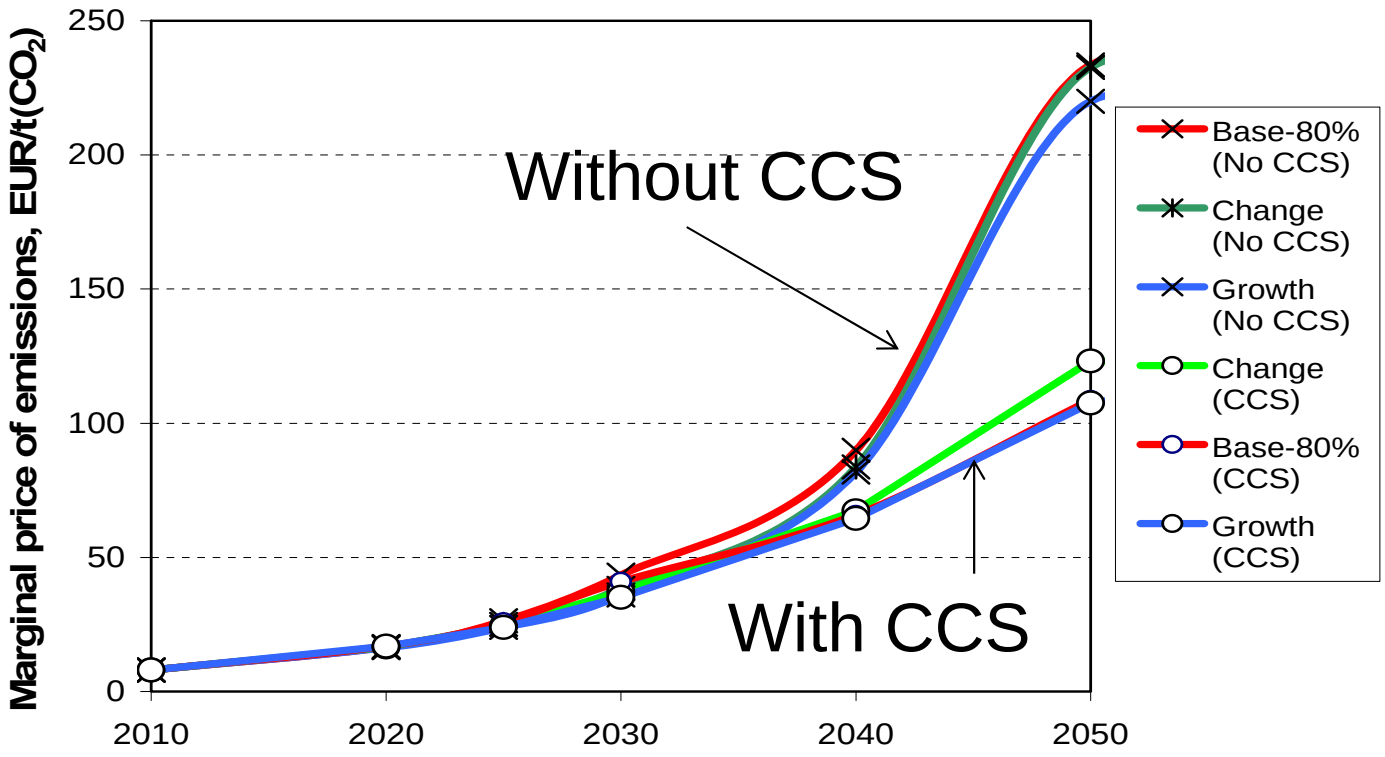
CCSP results on technological performance and cost were used in CCSP scenario calculations

- Global TIMES-VTT energy system model was used in the quantitative scenario analysis
- Comparison of Finland with Europe
- EU emission trading included (and global 2 degree C mitigation)
- Geological storages (on-shore and off-shore) and cross-border transport (ship, pipe) included
- CO_2 capture modelled in power and heat production and industrial processes (steel, cement, pulp, biofuel, oil refining, chemical, …)

To study the role of CCS the CCSP scenarios were run with and without CCS

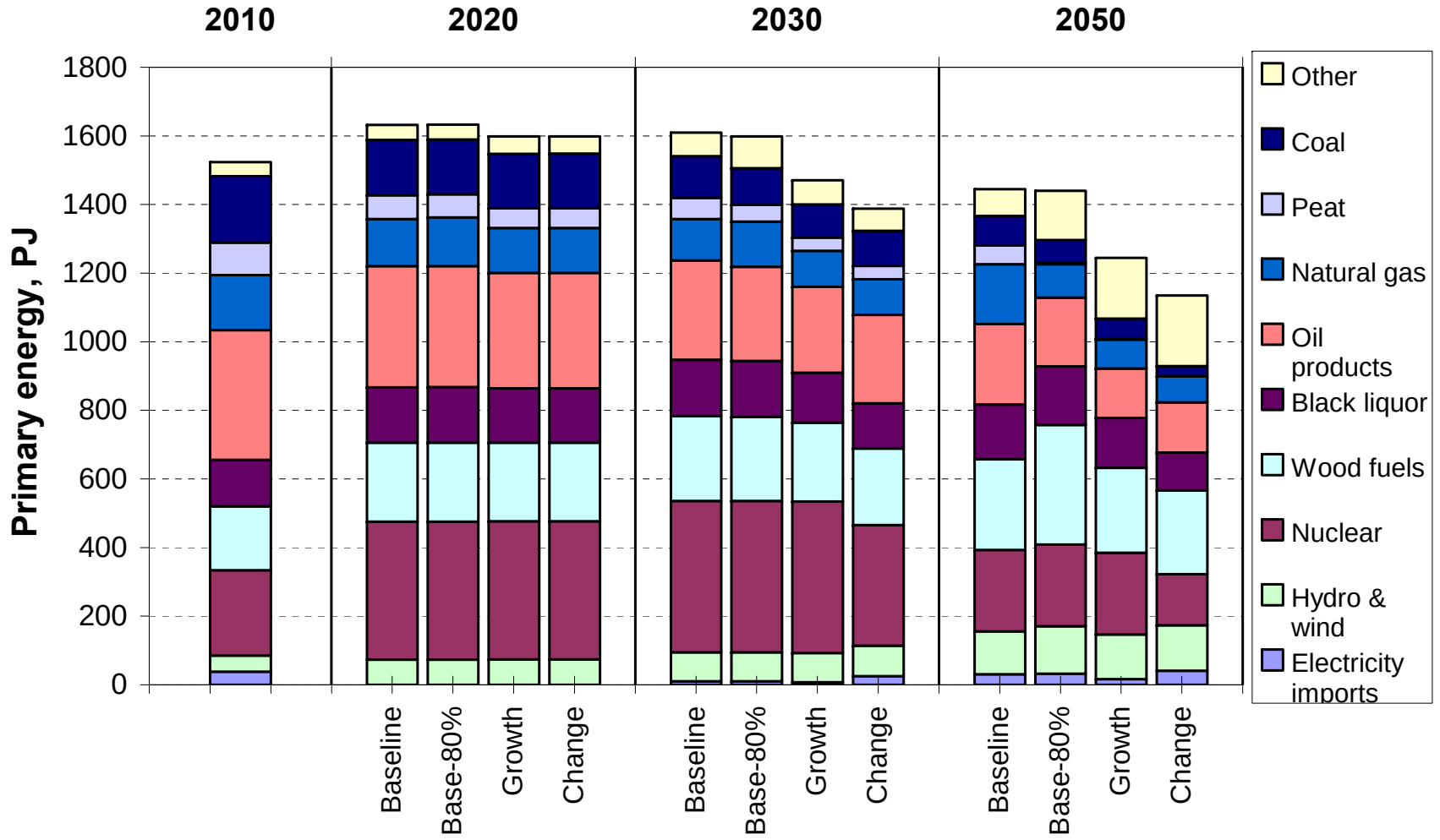
- In Base-80% scenario existing industrial and other economical structures result in higher CO_2 emissions
- In Growth scenario, CCS competes with rapidly developing other clean technologies
- In Change scenario only the bio-CCS is allowed. In addition the share of nuclear is the lowest.

CO_2 price doubles in those cases CCS is excluded

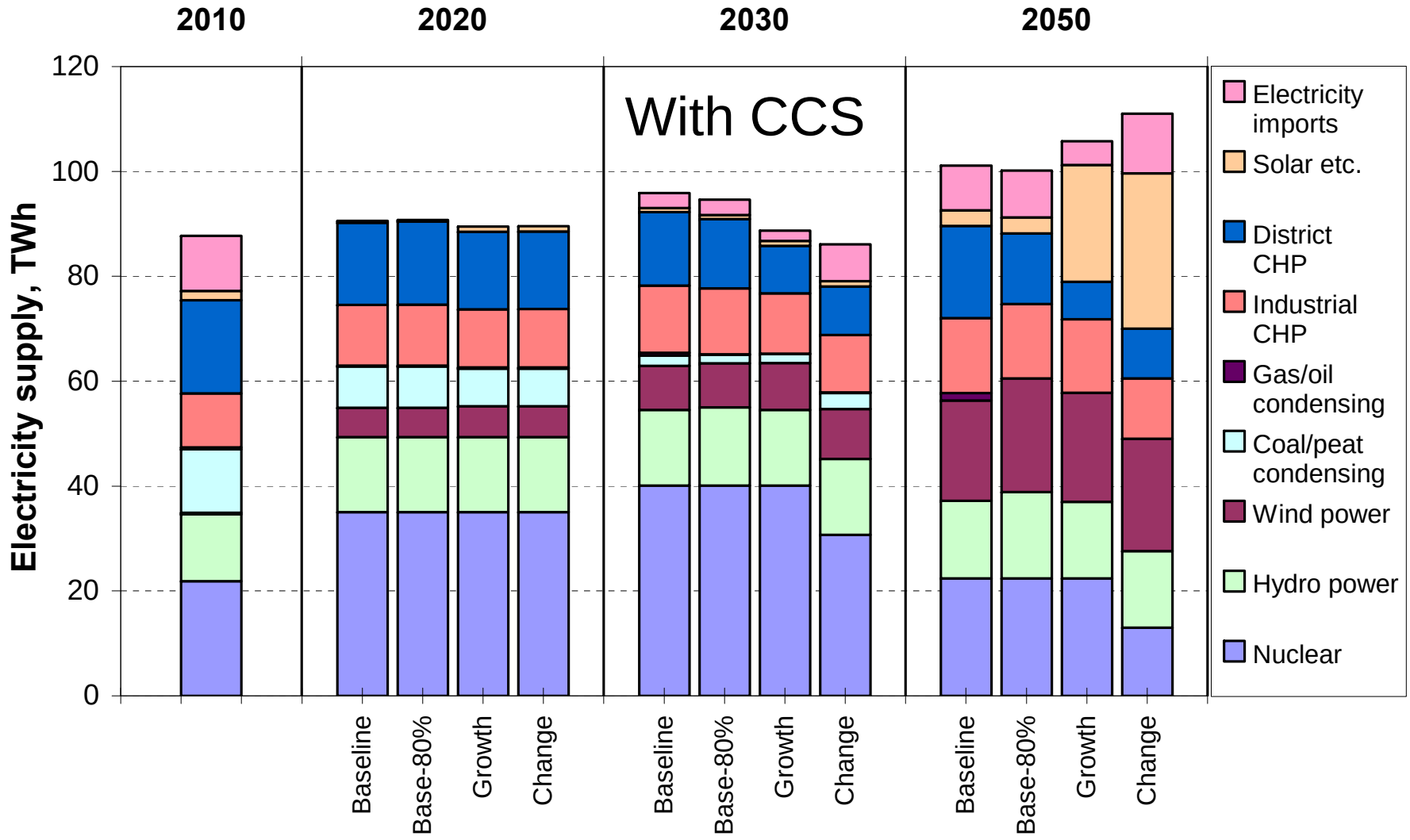


Remarkable phase-out of fossil based energy also in those cases where CCS is included

The primary energy use decreases in all the scenarios but especially in the Change scenario with the lowest nuclear share



Electricity demand increases due to electrification of the energy system



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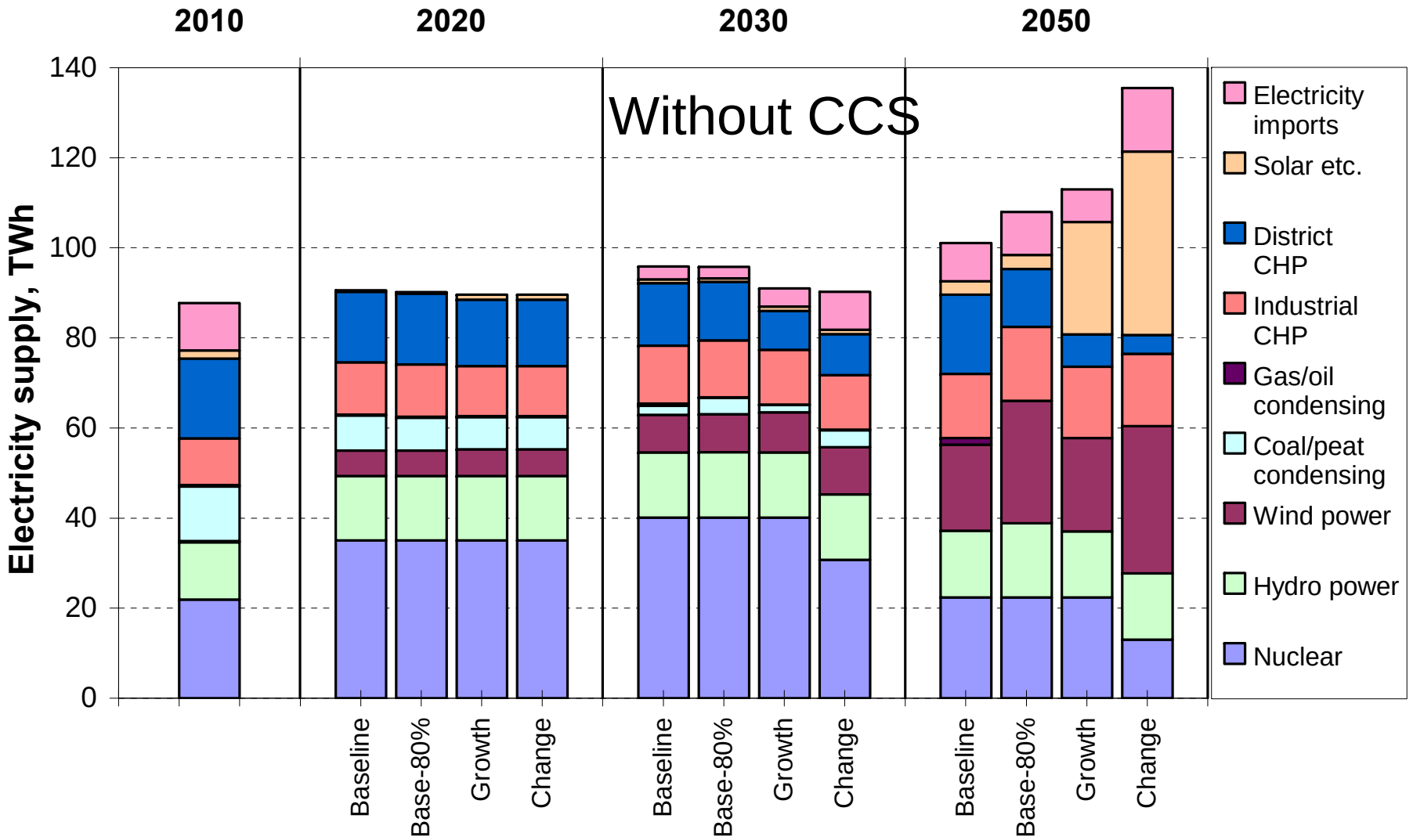
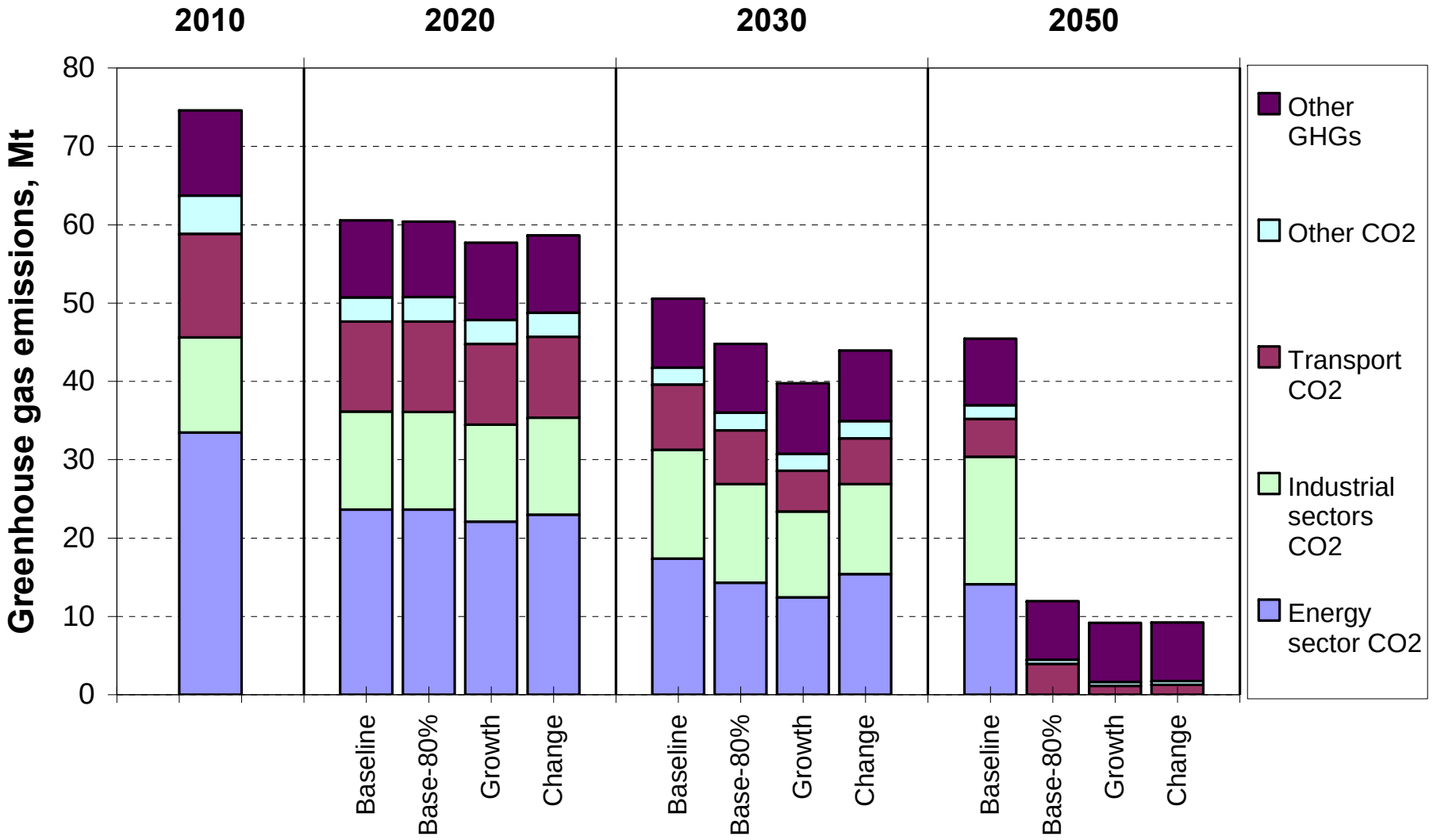
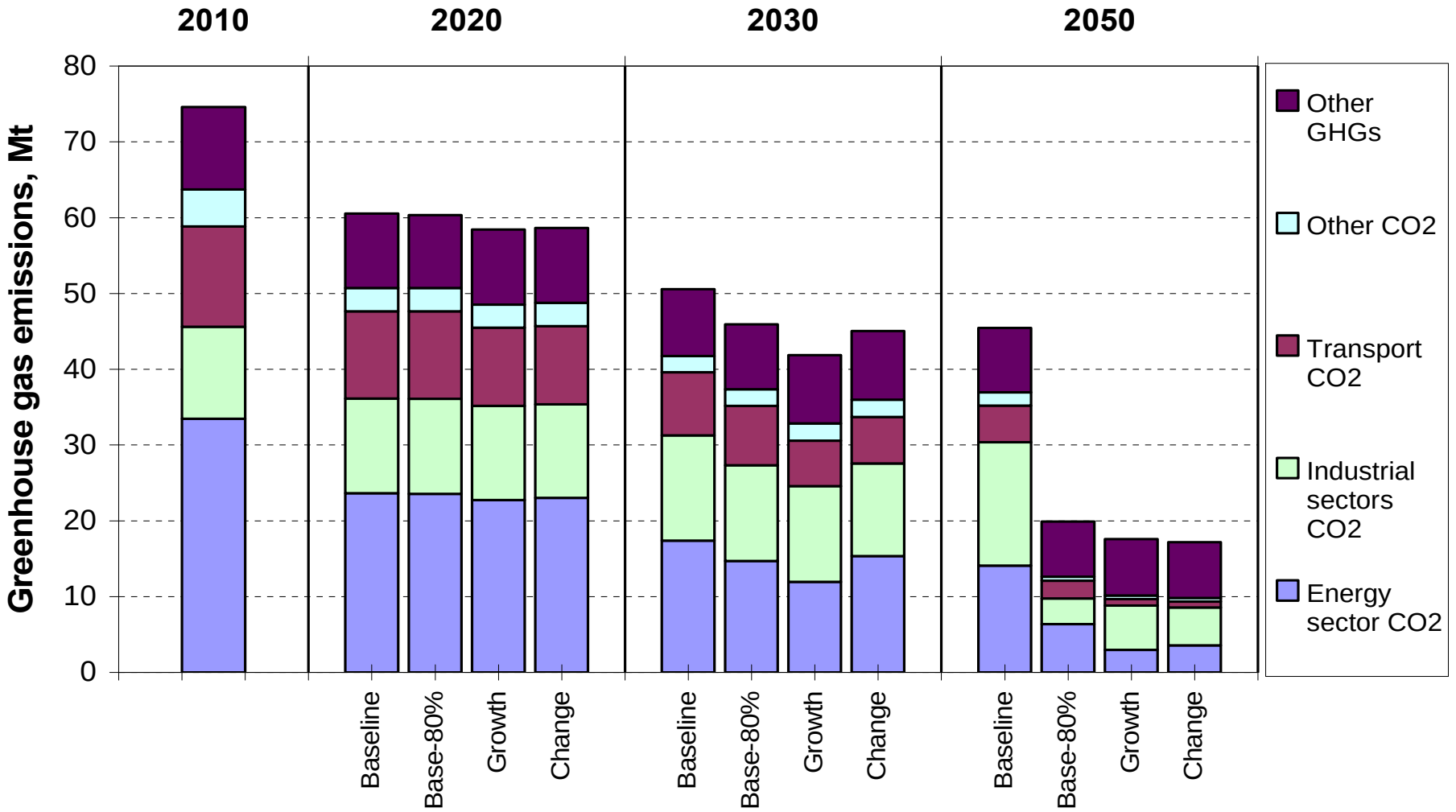


With CCS Finland could be net seller of emission allowances

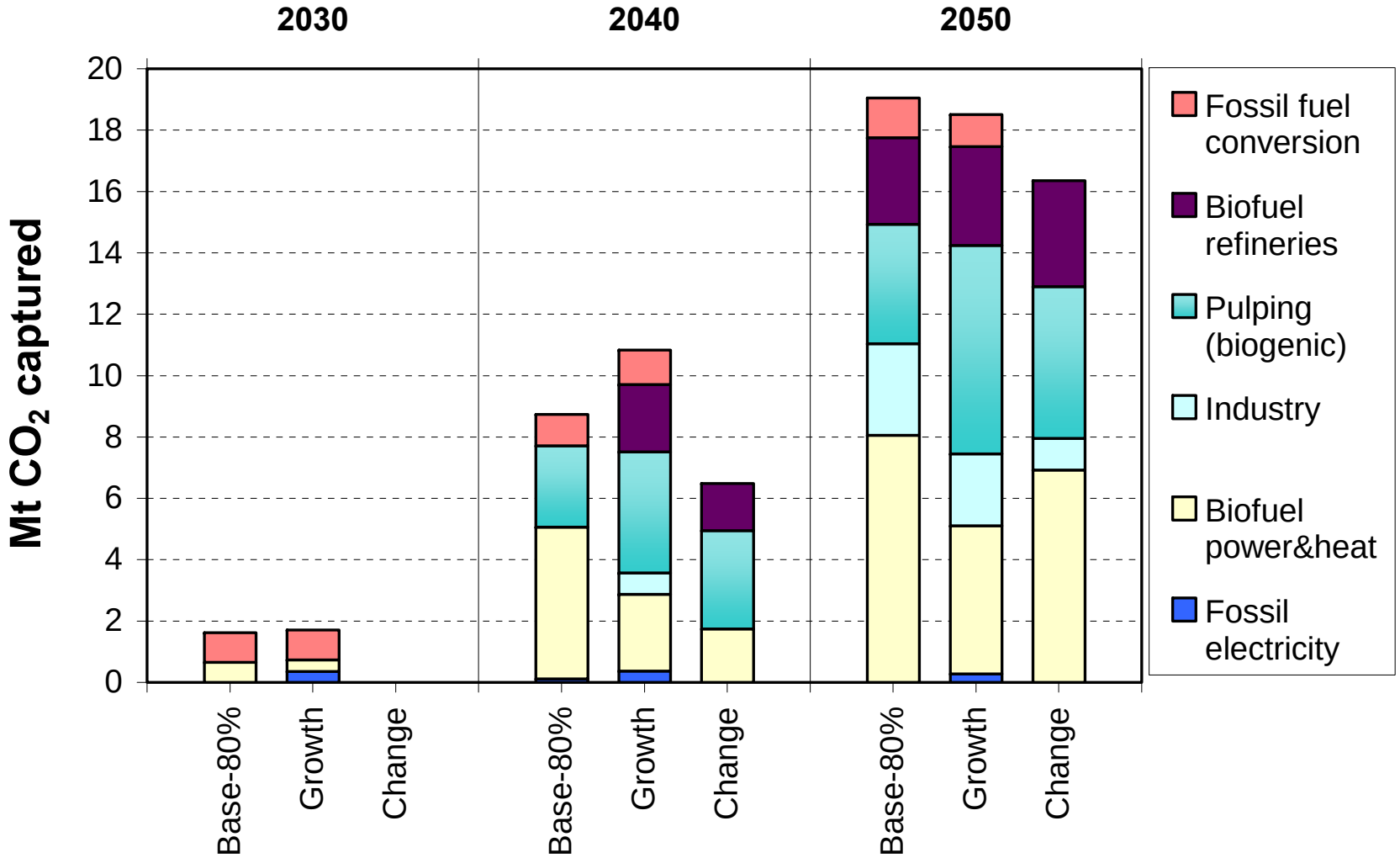


Without CCS Finland would need to buy emission allowances



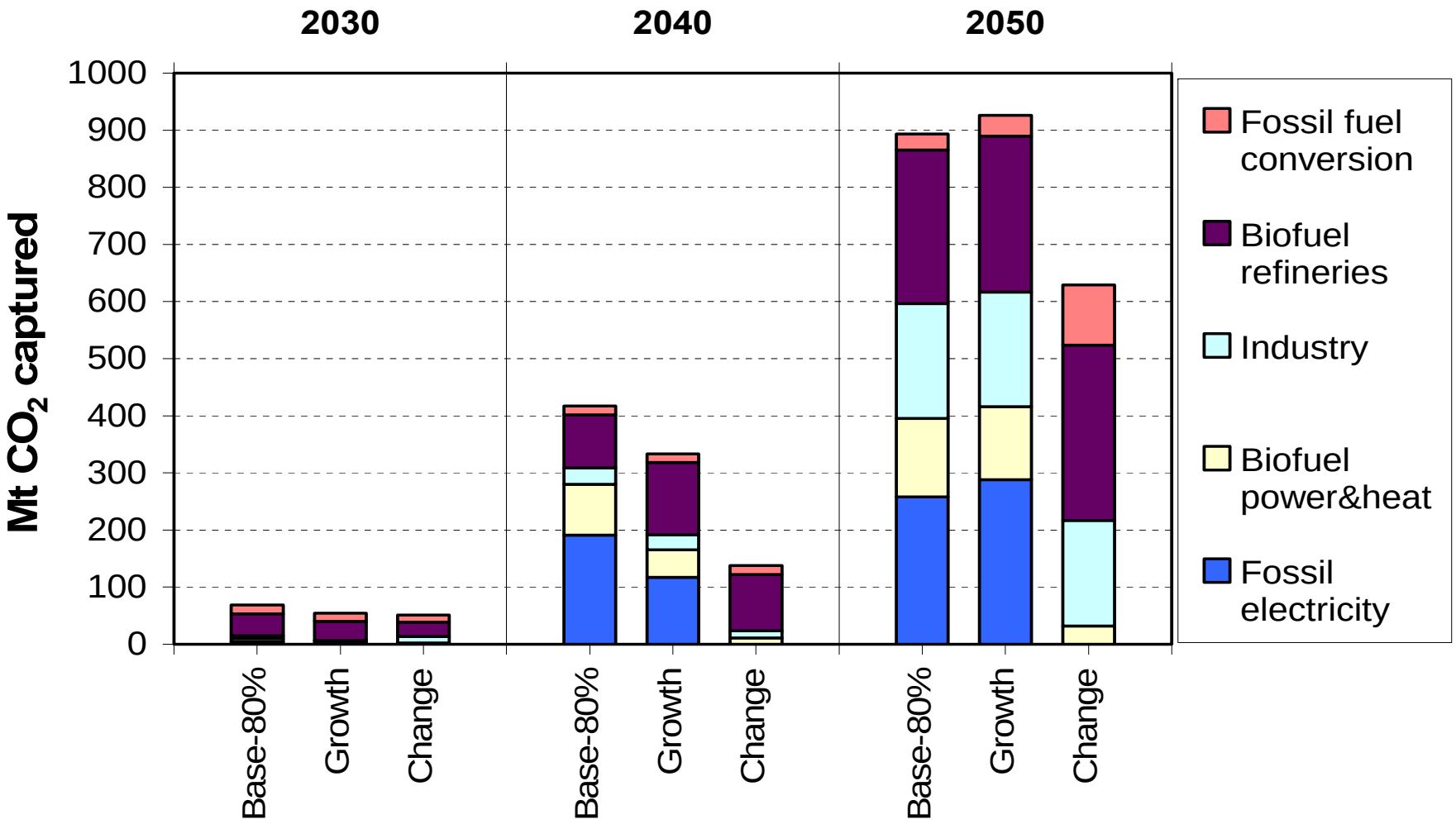
The role of CCS: Finland

- Base-80% slower implementation of renewables increases the demand of CCS
- In Change scenario only the bio-CCS (and industrial) allowed

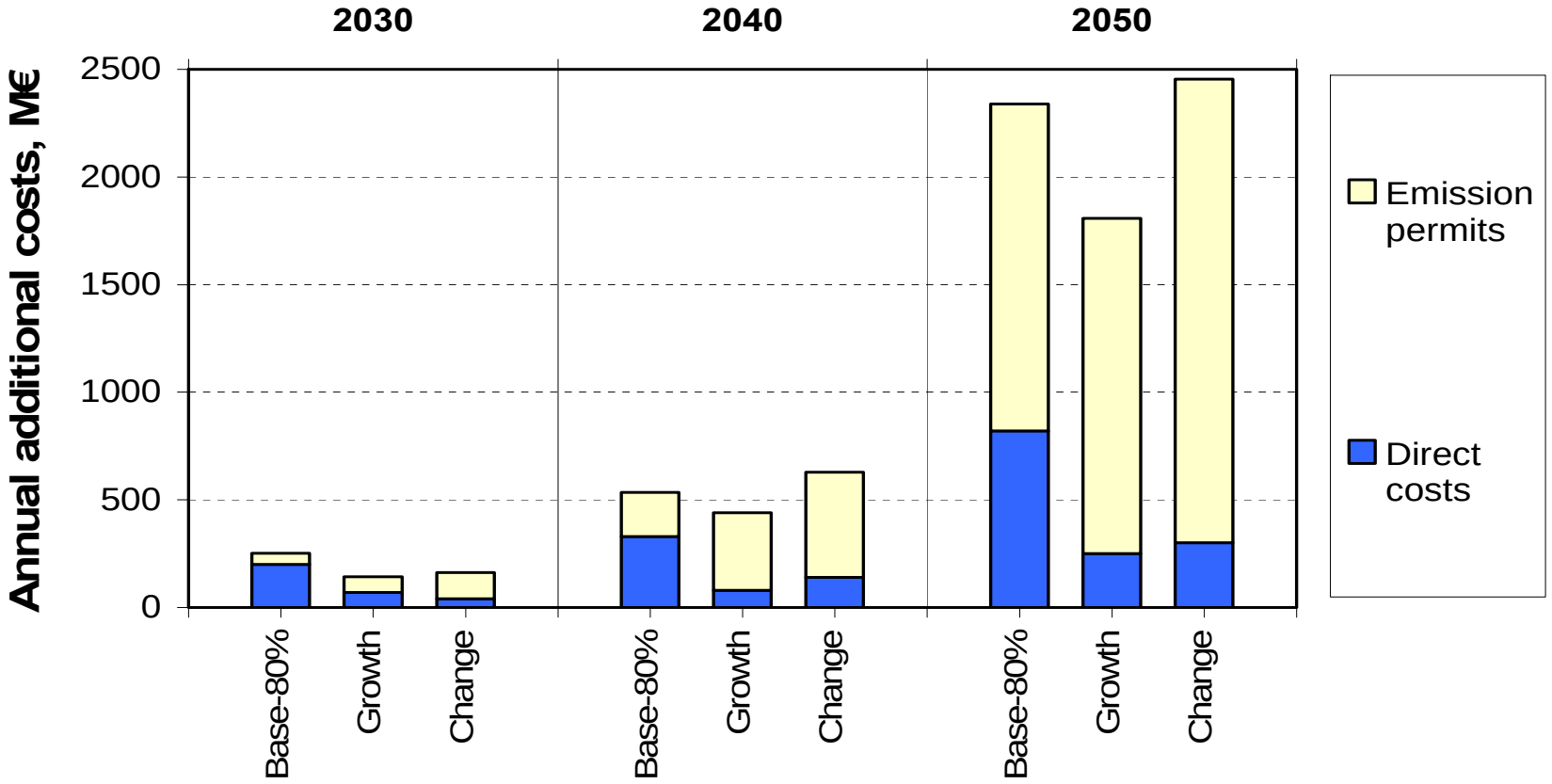


The role of CCS: Europe

- Unlike in Finland fossil-CCS would be needed up to 2050
- Bio-CCS also important in advanced biofuel production



In Finland excluding CCS would increase the direct annual cost 200–800 M€/a by 2050 and additional burden from weaker emission allowance balance up to 2100 M€



On the European level, excluding CSS would increase the direct annual costs by €45–60 billion in 2050

Conclusions

- The greatest uncertainties are related to commercialization of CCS early enough in the transition to the low carbon societies both in Finland and Europe. Many industrial processes would be very difficult to decarbonize without CCS.

- Meeting the Paris climate targets requires very early actions with deep GHG emission reductions. CCS is a good option for that.

- Bio-CCS (BECCS) is an excellent opportunity for Finland (and also Sweden) but requires changes in the existing policy frameworks