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INTERGOVERNMENTAL PANEL ON climate change

CLIMATE CHANGE 2014

Mitigation of Climate Change

Energy Systems

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WMO UNEP

Scope (Chapter 7)

Issues related to mitigation of GHG from energy supply sector – all energy extraction, conversion, storage, transmission, and distribution processes that deliver final energy to end-use sectors *(industry, transport, and building, agriculture and forestry, dealt with in ch. 8-11)*

Based on SRREN Figure 1.7

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GHG emissions trend

- **Energy supply sector - largest and fastest growing contributor to GHG emissions** (driven by rapid economic growth and increased share of coal)
- **Without mitigation policies, energy-related CO_2 emissions expected to continue to increase**
- **Multiple options exist to reduce emissions**

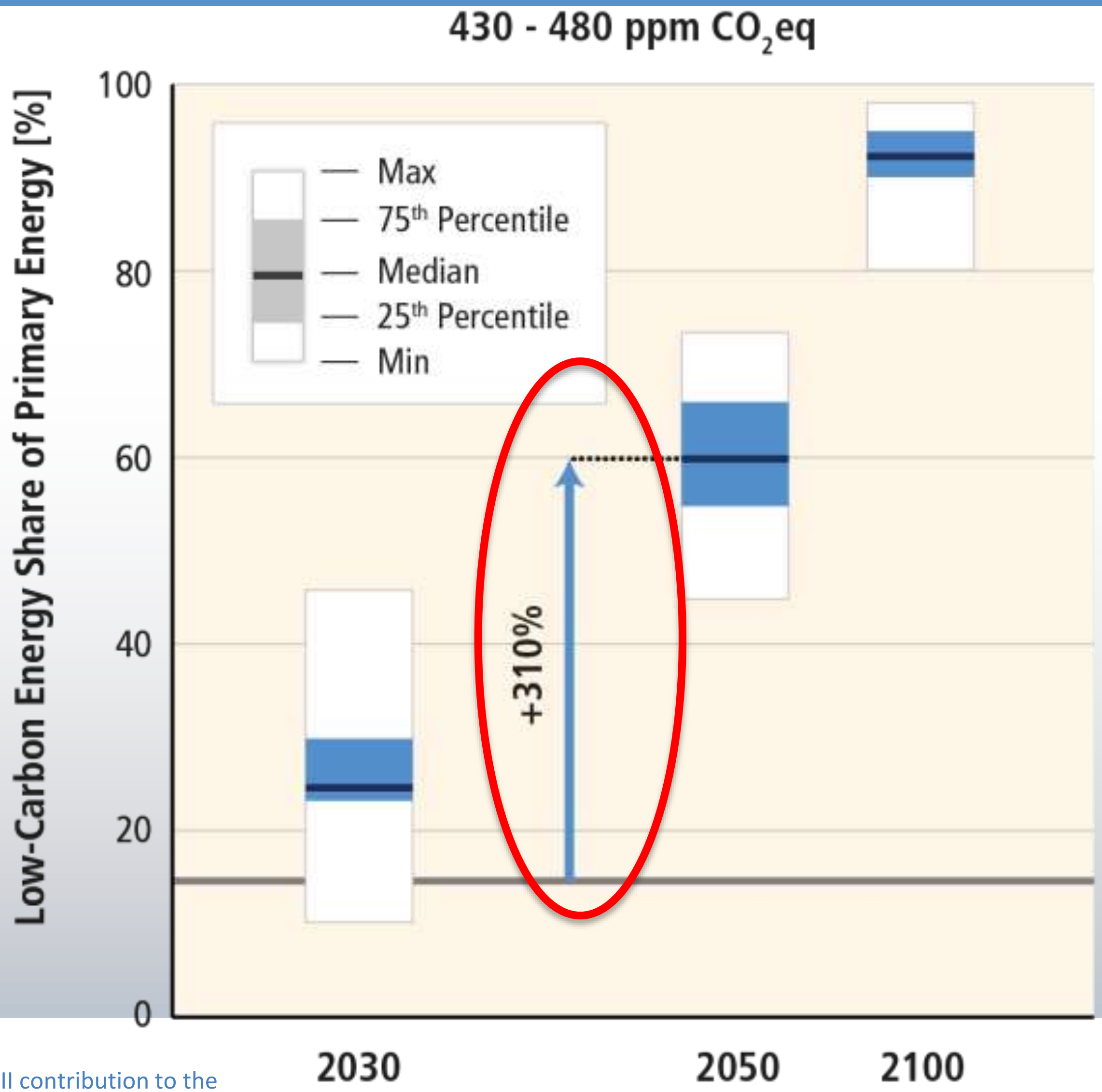
ed on SRREN Figure 1.7

Achieving low stabilization levels

- Requires **fundamental transformation of energy supply system,** and long-term substitution of unabated fossil fuel conversion technologies by low-GHG alternatives
- **Decarbonizing electricity supply will play an important role**
  - Renewable energy technologies (RE)
  - Nuclear
  - Carbon capture and storage (CCS) (coal & bioenergy)
  - Fuel switching (coal to natural gas)
  - Direct emission reduction in fossil fuel chain

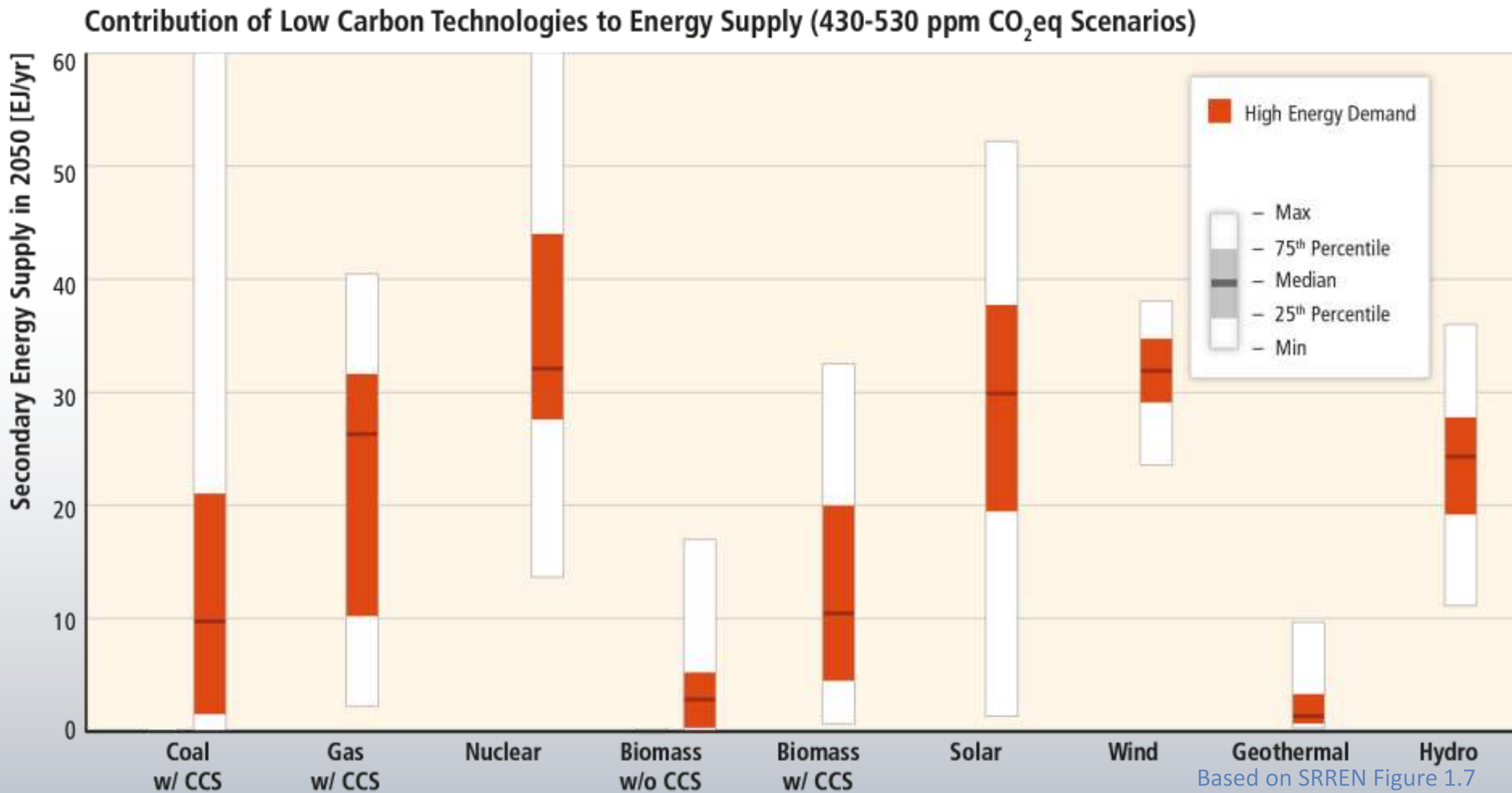
Based on SRREN Figure 1.7

Mitigation involves substantial upscaling of low-carbon energy



Based on Figure SPM.4

Contribution of Low Carbon Technologies to Energy Supply



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Renewable Energy Technologies

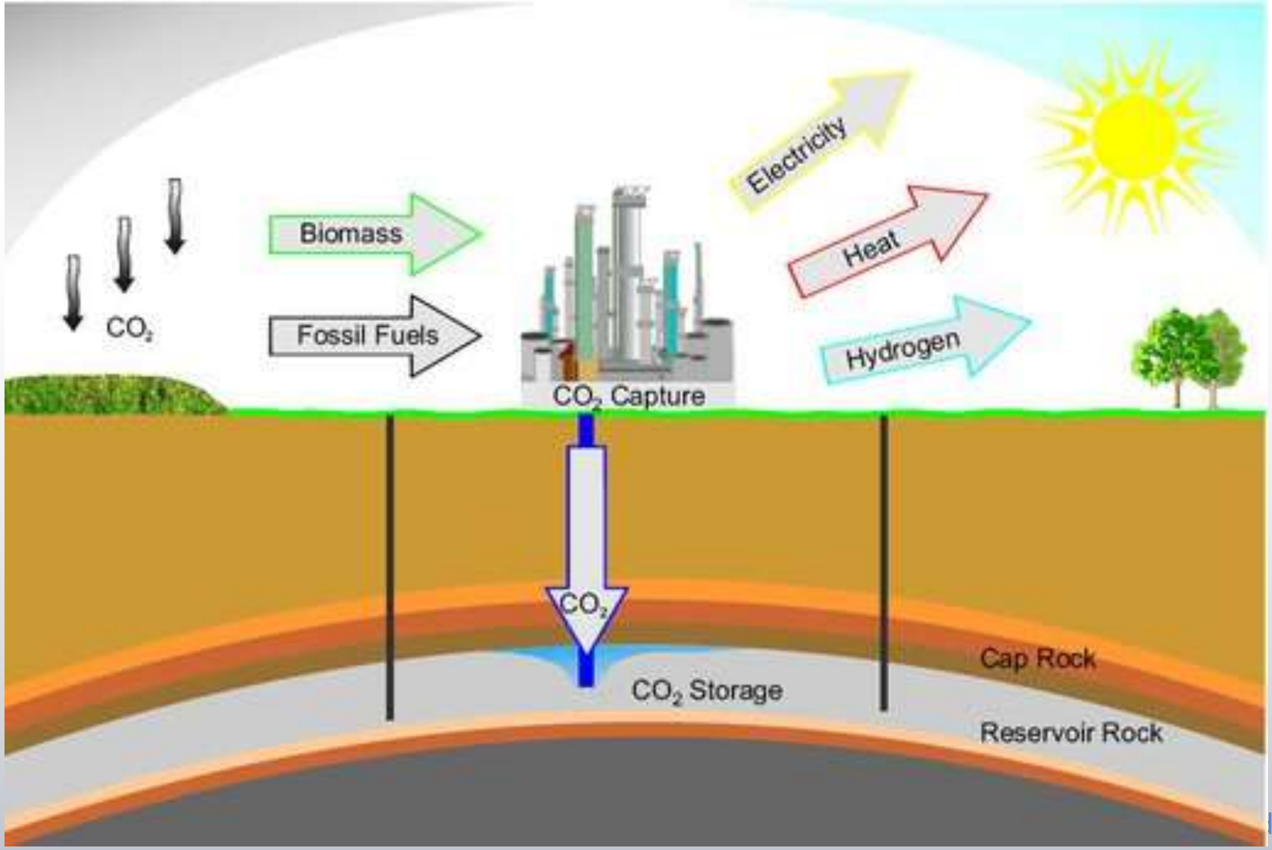
- **Many have substantially advanced (performance & cost)** and matured for large scale deployment
- But **many still need direct support** (e.g., FiT) and/or indirect support (e.g. high carbon prices)
- **Co-benefits:** reduction of air and water pollution, local employment, few severe accidents, improved energy access and security
- **Infrastructure & integration challenges**

Nuclear Energy

- **Low GHG emission technology** with specific emissions below approximately 100 gCO_{2eq} per kWh on a life-cycle basis
- **Barriers:** operational safety and proliferation risks, unresolved waste management issues, financial and regulatory risks
- **New fuel cycles and reactor technologies** can address some of these issues and are under development

Carbon dioxide capture & storage (CCS)

- **Could reduce specific CO_{2eq} life-cycle emissions of fossil power plants**



l on SRREN Figure 1.7

Source:http://kraftwerkforschung.info

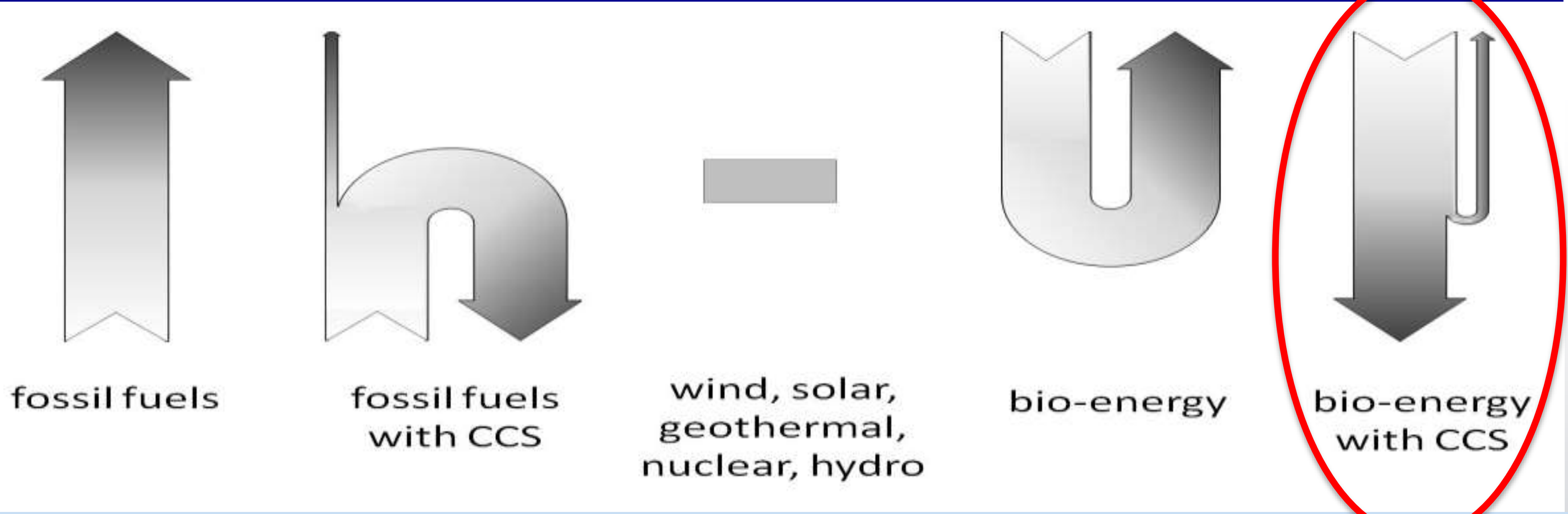
Carbon dioxide capture & storage (CCS)

- **Could reduce specific CO_{2eq} life-cycle emissions of fossil power plants**
- Though not yet applied at scale to a large, commercial fossil-fired generation facility, **all components exist and in use** in various parts of fossil energy chain
- Needs economic **incentives**, as well as **regulations** on storage
- **Growing body of literature** to address concerns on operational safety and long-term integrity of storage and transport risks

Based on SRREN Figure 1.7

Bioenergy CCS (BECCS)

- **Offers prospect of negative emissions –** important in many low-stabilization scenarios



Carbon flow schematic for different energy systems, with and without CCS

Source: Elrapto, https://upload.wikimedia.org/wikipedia/commons/3/3e/Carbon_flow.jpg

Bioenergy CCS (BECCS)

- **Offers prospect of negative emissions –** important in many low-stabilization scenarios
- Technological challenges: e.g. upstream provision of biomass
- Large financing challenges
- Currently **no plants have been built and tested at scale**

Based on SRREN Figure 1.7

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Fuel Switching

- Near-term emissions can be reduced by **replacing coal-fired with highly efficient natural gas combined cycle (NGCC) plants or combined heat and power (CHP) plants (**if fugitive emissions associated with extraction and supply are low) (50% reduction based on LCA)

Based on SRREN Figure 1.7

Reducing direct emissions from fossil fuel chain

- **Can be reduced through various measures**: capture or oxidation of coal bed methane, reduction of venting and flaring in oil & gas systems, energy efficiency improvements and use of low-GHG energy sources in the fuel chain

Based on SRREN Figure 1.7

Emission trading & taxes

- **GHG pricing** can support the adoption of low GHG energy technologies
- **Technology policies** (e.g., feed-in tariffs) have proven successful in increasing the share of RE technologies

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Success factor of energy policies

- Capacity building (human & institutional)
- Removal of financial barriers
- Development of a solid legal framework
- Sufficient regulatory stability

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Energy infrastructure in DCs

- **Still undeveloped and not diversified** (Especially in LDCs)
- **Associated co-benefits**: local employment creation, income generation for poverty alleviation, building of technical capability and knowledge transfer
- **Risks**: distributive impacts of higher prices for low carbon energy might become a burden on low income households

Based on SRREN Figure 1.7

Knowledge gaps

- **Important knowledge gaps still exist but can be reduced with further R&D:** technological challenges, risks and co-benefits associated with up-scaling and integration of low carbon technologies into future energy systems, and resulting costs.
- Research on economic efficiency of climate-related energy policies limited.

Based on SRREN Figure 1.7

Conclusion

- **No silver bullet**
- A good mix of low carbon solutions will be required
- Challenge is immense due to “locked-in” effects
- Strong policy commitment and technological innovation essential

Based on SRREN Figure 1.7

Acknowledgement

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Based on SRREN Figure 1.7

Thank you!