Renewable Energy – How can it contribute to securing safe and sustainable energy in the north?

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CEDREN

Centre for Environmental Design of Renewable Energy

CENTRE FOR ENVIRONMENT-FRIENDLY ENERGY RESEARCH





Content of presentation

- Briefly about CEDREN
- Climate change and link to energy production
- Introducing the IPCC and the SRREN report
- Global and regional potential for renewable energy (RE)
- Cost of renewable energy
- GHG emissions from fossil vs RE energy sources
- Transformation to a sustainable energy system
- Renewable energy options in the north
- Integration with the European system
- Summary






Centre for environmental design of renewable energy - CEDREN

SINTEF

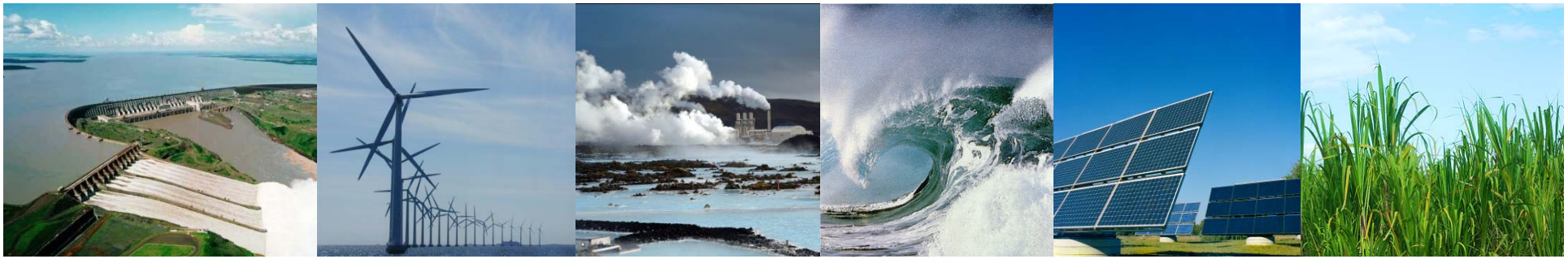
NTNU
100 skapende år

NINA

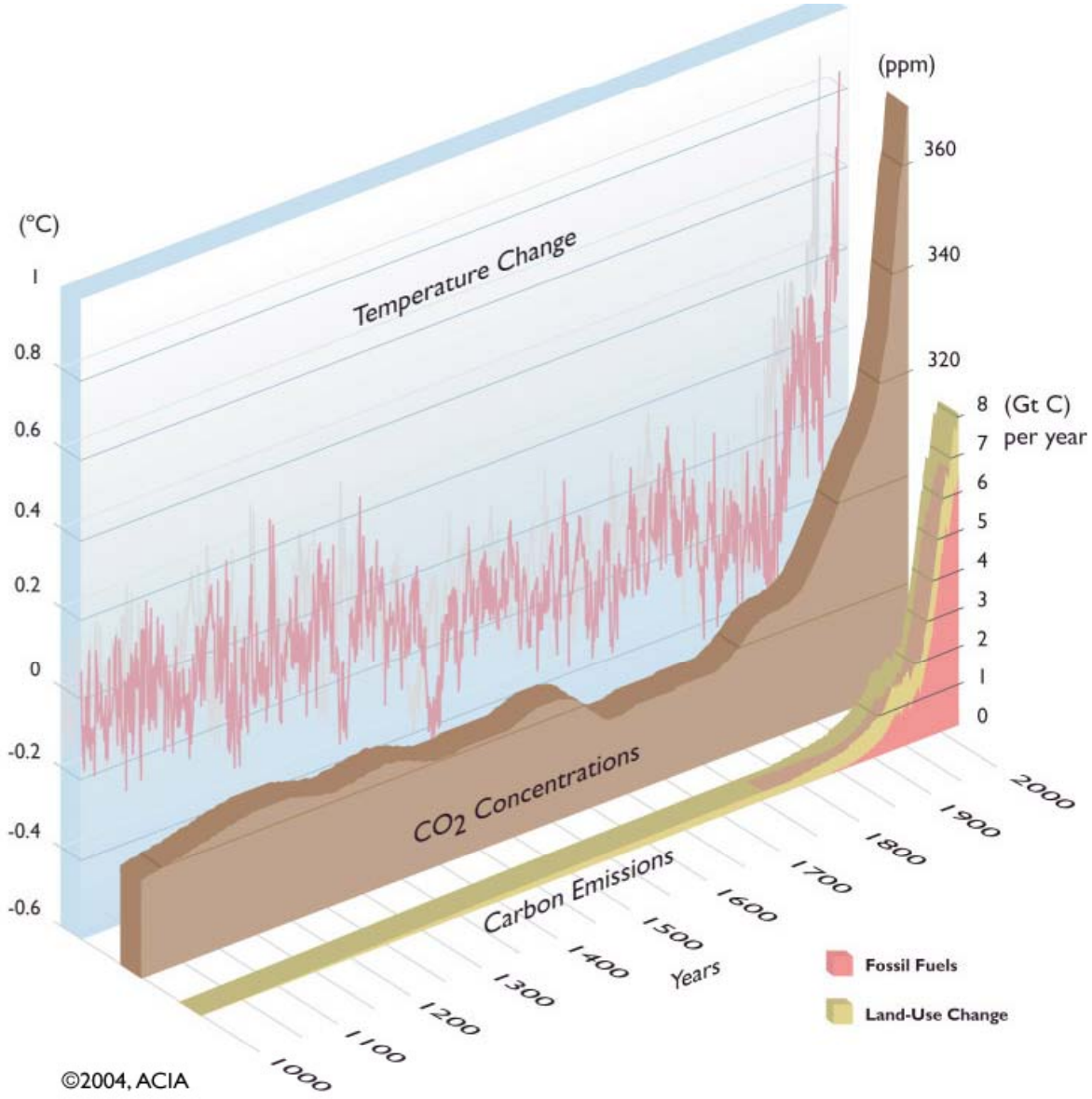
NATURHISTORISK MUSEUM
UNIVERSITETET I OSLO

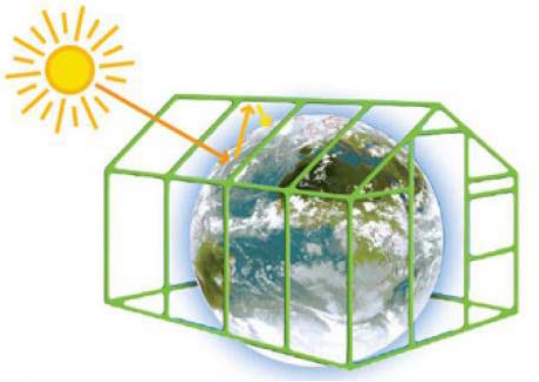
NIVA

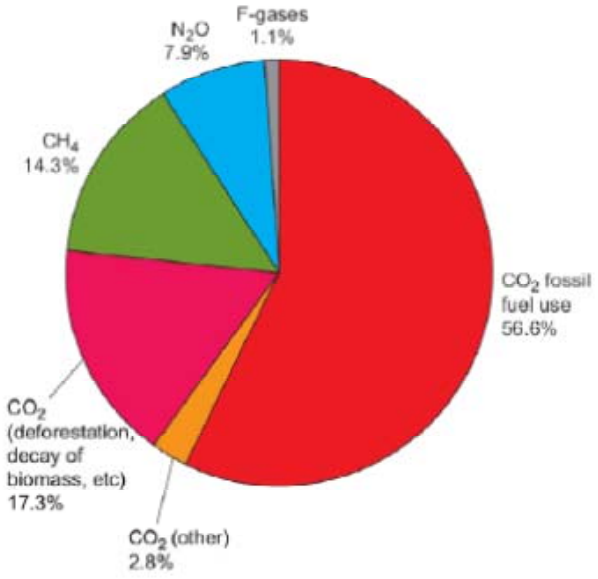
uni Research



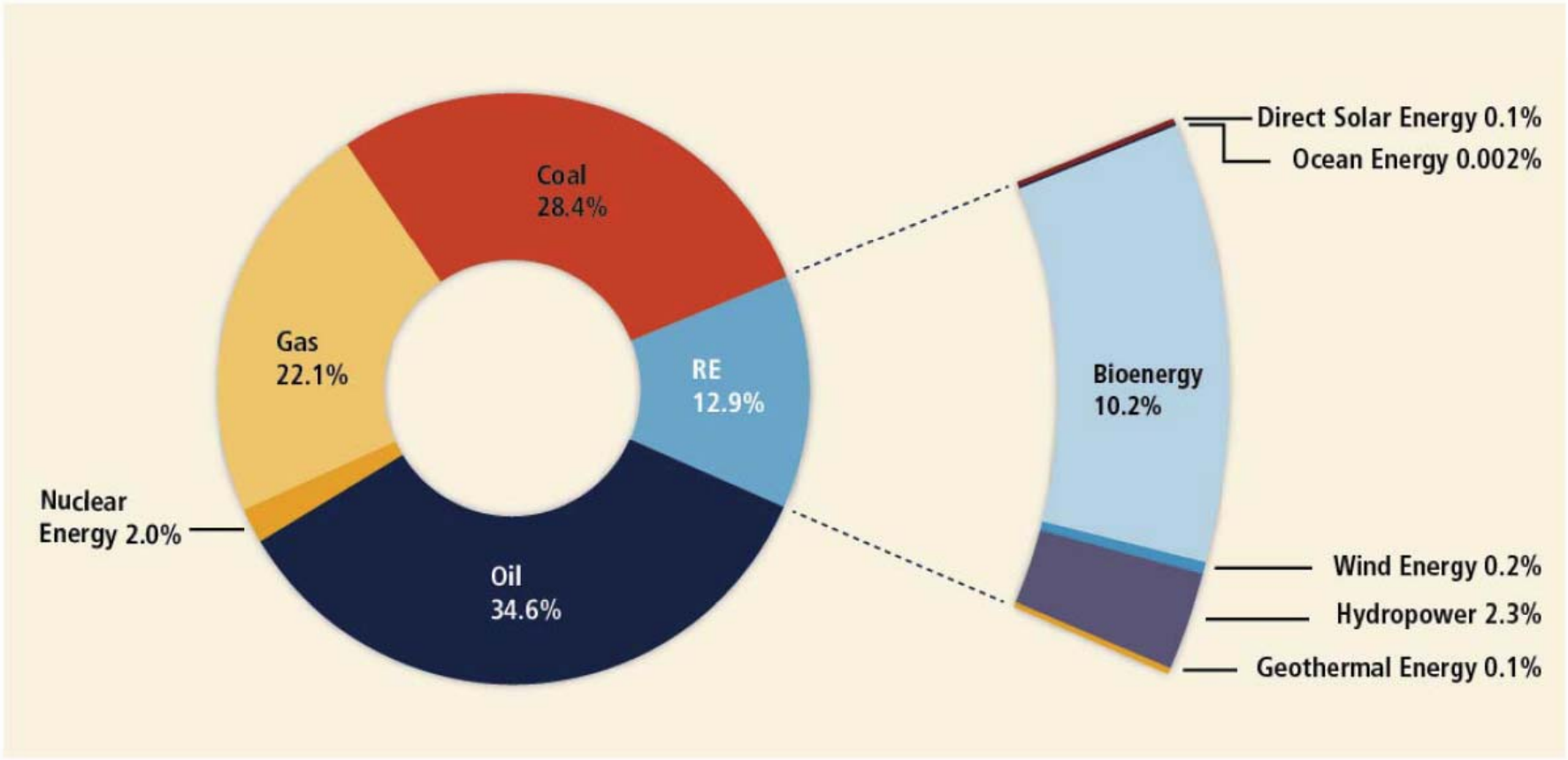
The background – a changing climate - since 1900 (Source: ACIA)





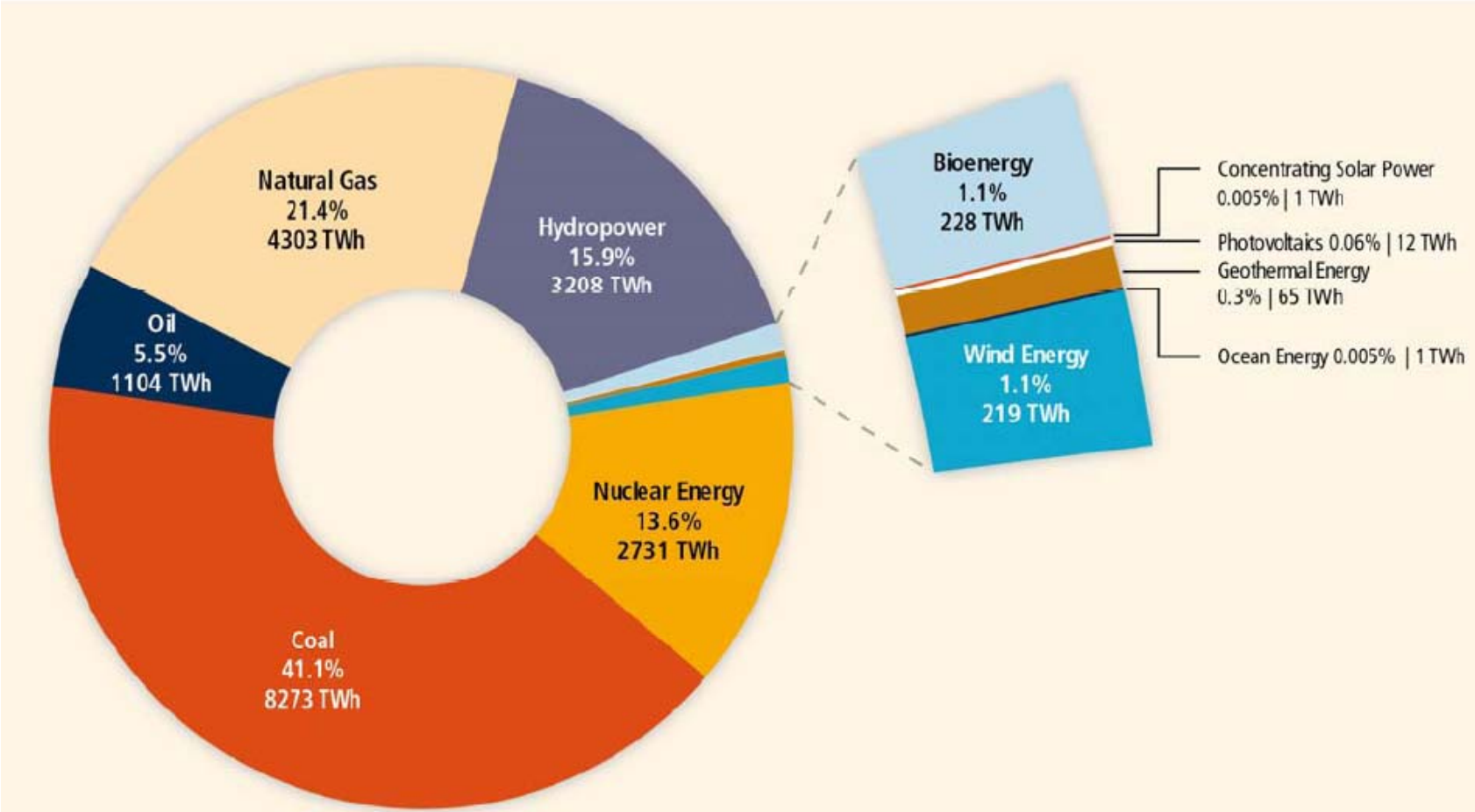


The current global energy system is dominated by fossil fuels



Shares of energy sources in total global primary energy supply in 2008 (492 EJ) Modern biomass contributes 38% of the total biomass share. Underlying data for figure has been converted to the 'direct equivalent' method of accounting for primary energy supply

Share of World Electricity Production (2008)

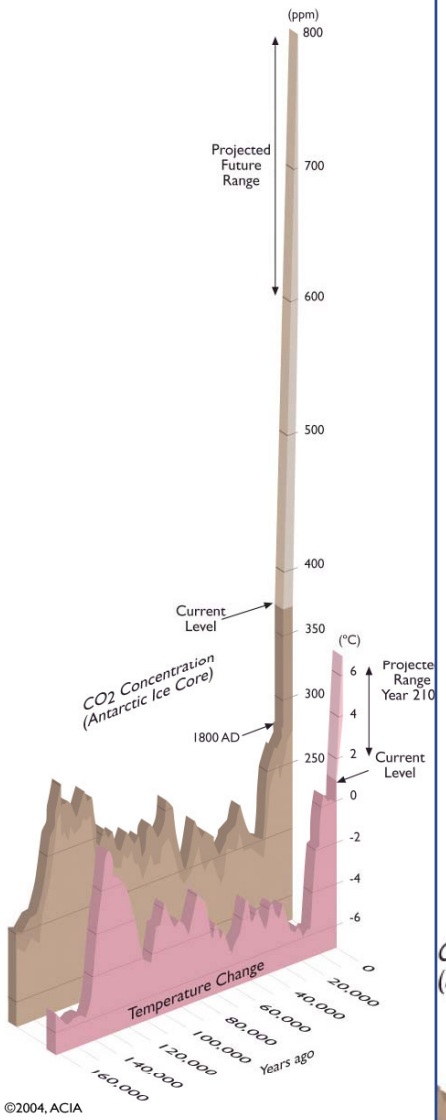


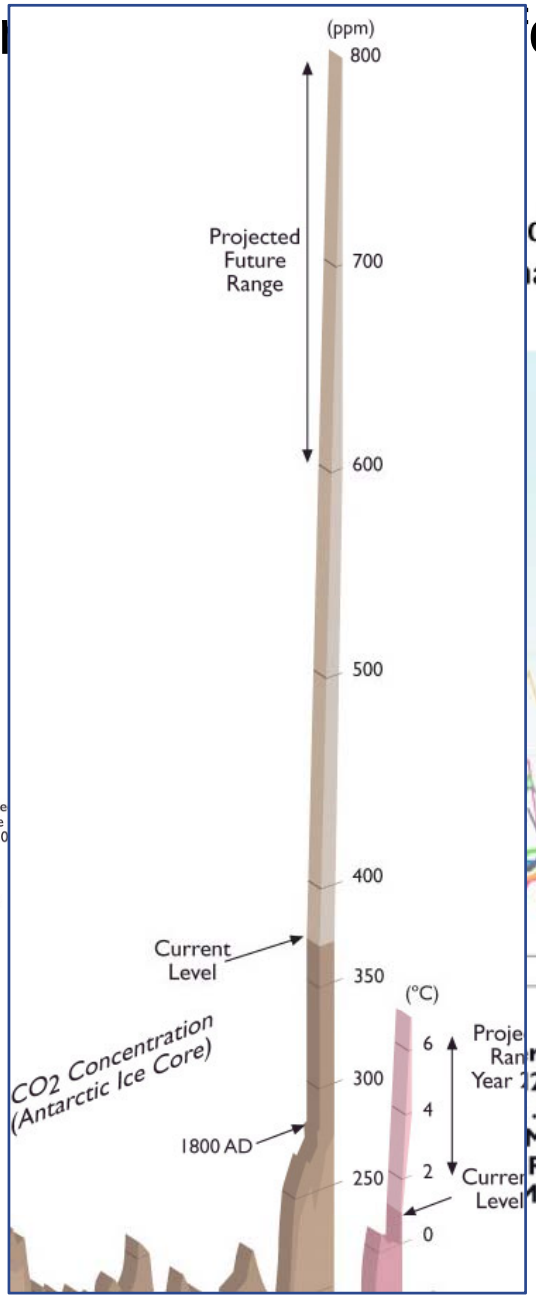
Global electricity production in 2008:
20,181 TWh
or 72.65 EJ
14.7% of total

RE contributed to approximately 19%
Hydropower 16% + Other RE 3%

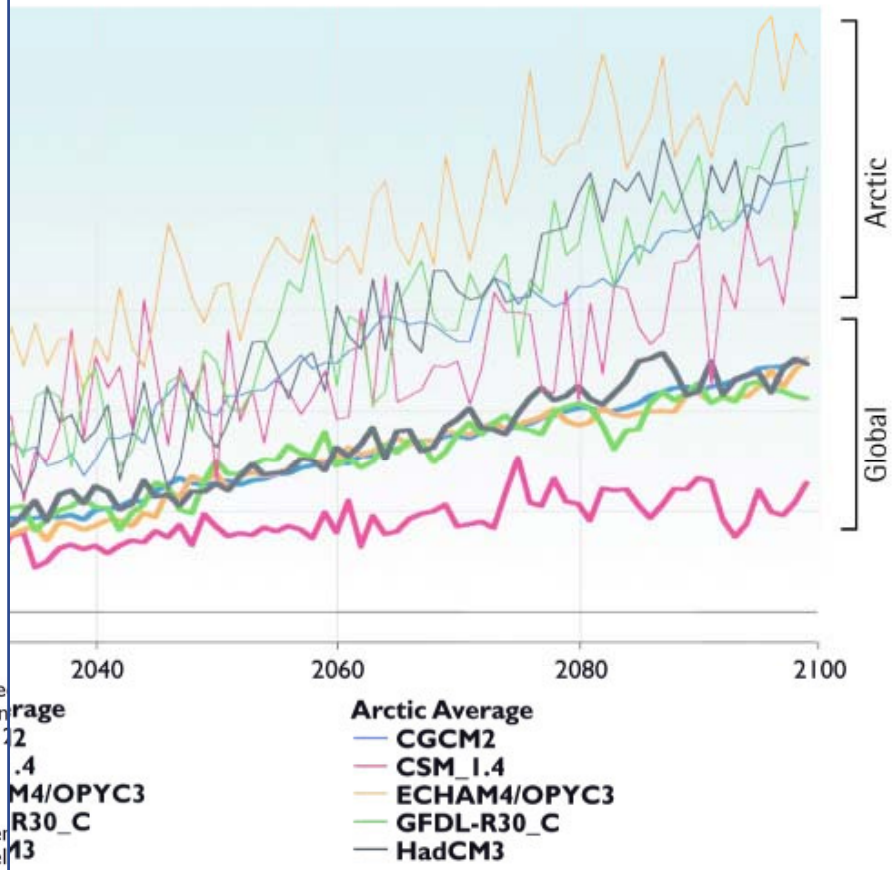
Nuclear 14%
Carbon based 68%

Temper or the future (Source: ACIA)





d Surface Air Temperature Change
ange from 1981–2000 Average)



Climate change and energy – A Summary

- Global temperature has been rising and this seems to continue
- Probably caused by increasing GHG concentrations in the atmosphere
- Burning of fossil fuel is by far the main contributor to GHG emissions
- Global energy consumption is predicted to increase rapidly the next decades
- Today's energy system depend strongly on fossil fuels

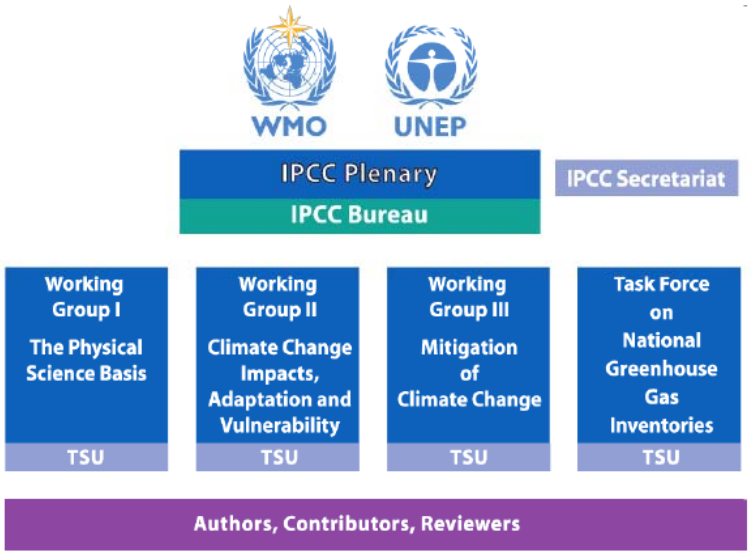
→ Reduction in GHG concentration is necessary to stop global warming

A possible strategy for mitigation of global warming, according to IPCC:

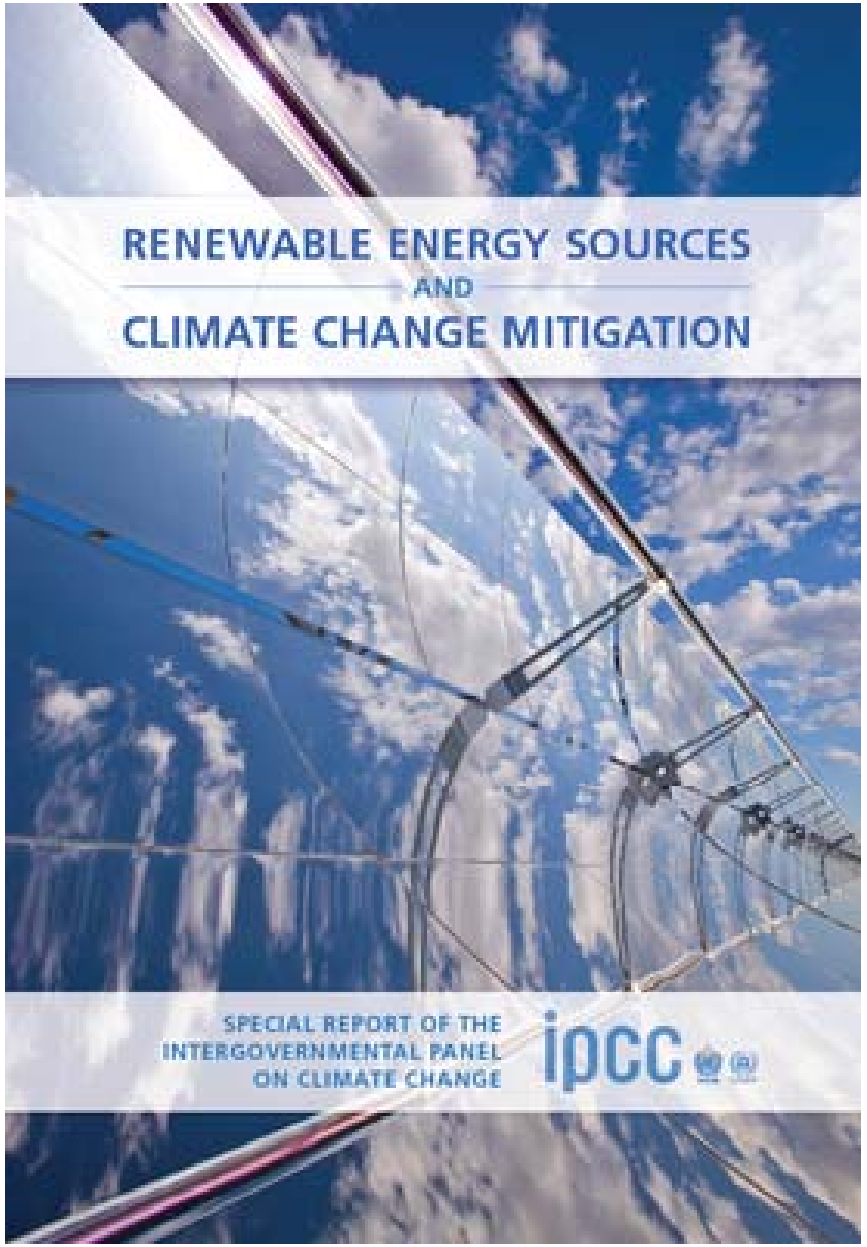
→ Reduced use of fossil fuels and a change to renewable energy

IPCC decided to study the mitigation potential in a Special Report (2008)

The Structure of the IPCC



SRREN was prepared for WG III



In 2008 IPCC decided to produce a **Special Report on Renewable Energy Sources and Climate Change Mitigation**

The report (SRREN) was finished in 2011 and printed in 2012
It will also be an input to Assessment Report 5 (AR5) in 2014

The structure of the SRREN

Special Report on Renewable Energy Sources and Climate Change Mitigation

1.Renewable Energy and Climate Change	Introductory Chapter
2. Bioenergy	Technology Chapters
3. Direct Solar Energy	
4. Geothermal Energy	
5. Hydropower	
6. Ocean Energy	
7. Wind Energy	
8. Integration of Renewable Energy into Present and Future Energy Systems	Integrative Chapters
9. Renewable Energy in the Context of Sustainable Development	
10. Mitigation Potential and Costs	
11. Policy, Financing and Implementation	






Structure in the six Technology Chapters (Ch 2-7)

- Introduction
- Resource potential *(including impact of climate change on resource potential)*
- Technology and applications
- Global and regional status of market and industry development
- Integration into broader energy system
- Environmental and social impacts
- Prospects for technology improvement and innovation
- Cost trends
- Potential deployment






Conclusions regarding RE potential (in SPM)

"The global technical potential of RE sources will not limit continued growth in the use of RE

A wide range of estimates are provided in the literature, but studies have consistently found that the total global technical potential for RE is substantially higher than global energy demand

The technical potential for solar energy is the highest among the RE sources, but substantial technical potential exists for all six RE sources"






What is the cost of Renewable Energy?

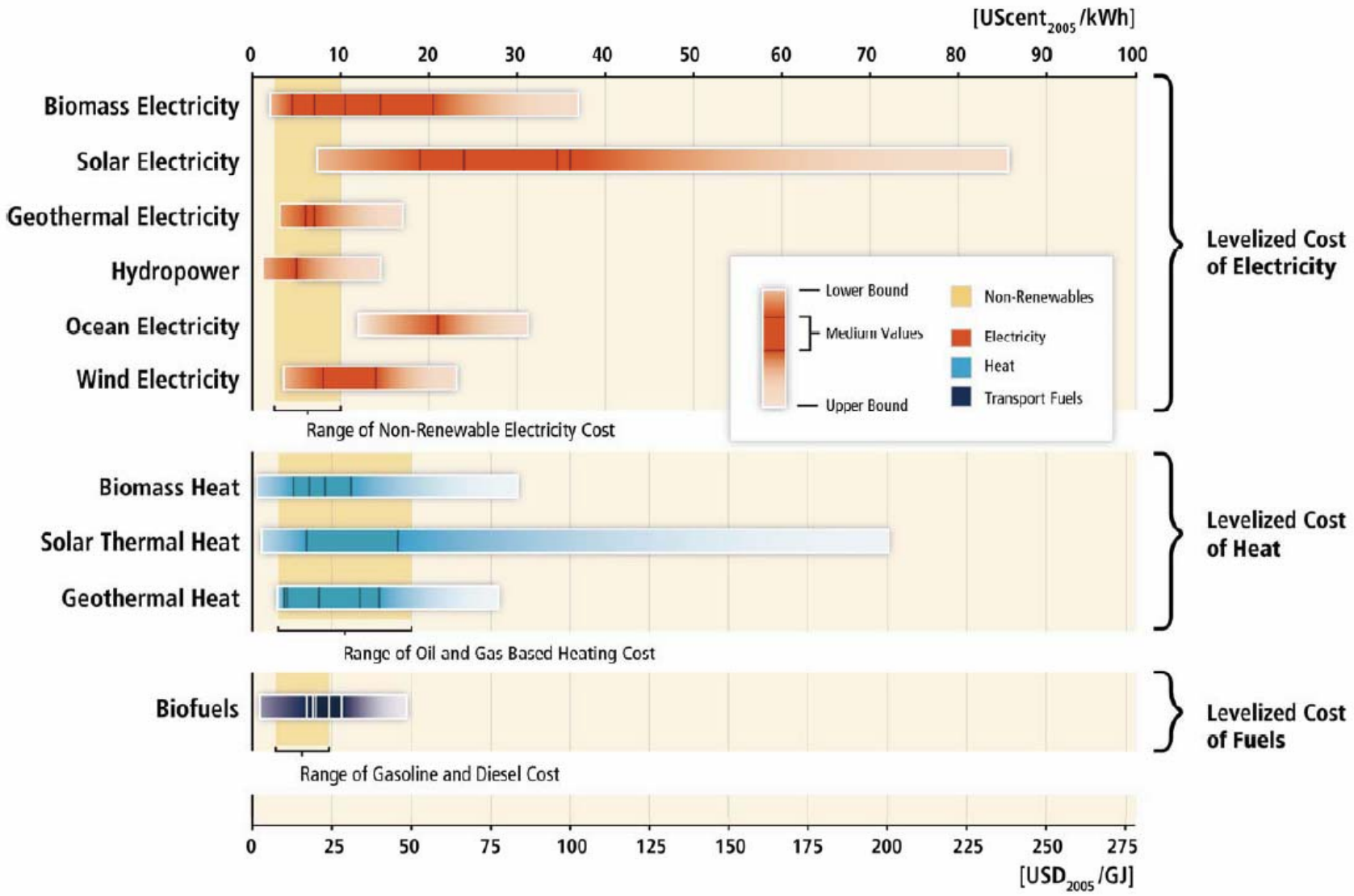
The cost of energy is of vital importance for deciding which technology that will be deployed in the future. It is necessary to know real (not subsidized) cost and also the expected development of cost over time

Cost estimate prediction in SRREN was done for 2010, 2030 and 2050

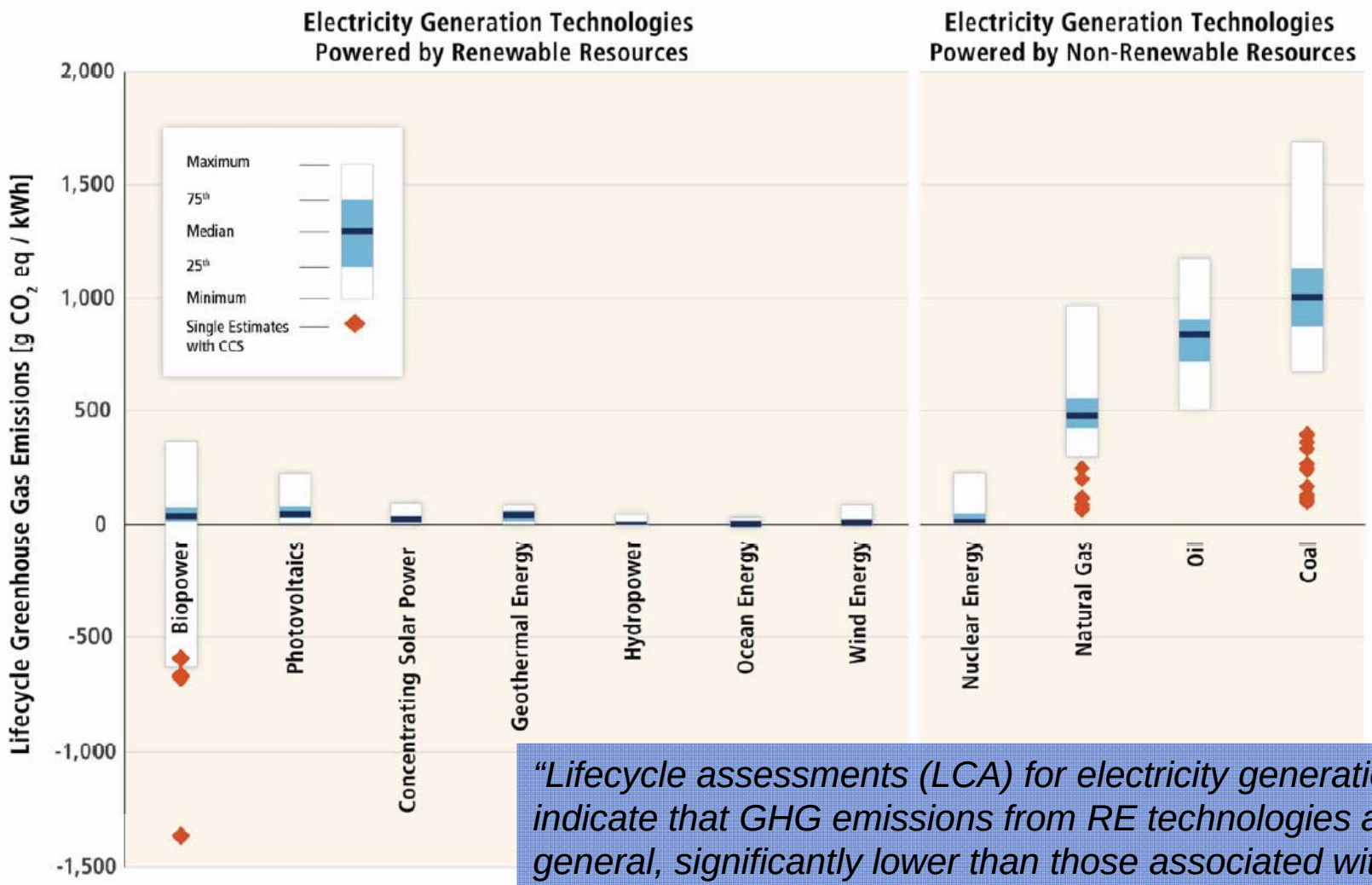
Cost estimates are given as Levelized Cost of Energy (LCOE)

$$LCOE = \frac{\text{Total Life Cycle Cost}}{\text{Total Lifetime Energy Production}}$$

Range of Levelized Cost of Energy (LCOE) for various types of RE



Lifecycle GHG emissions of RE technologies are, in general, considerably lower than those of fossil fuel options



"Lifecycle assessments (LCA) for electricity generation indicate that GHG emissions from RE technologies are, in general, significantly lower than those associated with fossil fuel options, and in a range of conditions, less than fossil fuels employing CCS"

RE integration into the future energy system

Few, if any, fundamental technical limits exist to the integration of a majority share of RE, but advancements in several areas are needed:

- **Transmission and distribution infrastructure**
- **Energy storage technologies**
- **Demand side management**
- **Improved forecasting of resource availability**

Some key findings in SRREN (Summary for Policymakers)

"*There are multiple options for lowering GHG emissions from the energy system while still satisfying the global demand for energy services, including energy conservation and efficiency, fossil fuel switch, RE, nuclear and CCS*"

"*Close to 80 percent of the world's energy supply could be met by renewables by mid-century if backed by the right enabling public policies*"

Some key findings in SRREN (Summary for Policymakers)

"*As well as having a large potential to mitigate climate change, RE can provide wider benefits such as social and economic development, energy access, a secure energy supply, and reducing negative impacts on the environment and health*"

"*Under most conditions increasing the share of RE in the energy mix will require policies to stimulate changes in the energy system*"

Some key findings in SRREN (Summary for Policymakers)

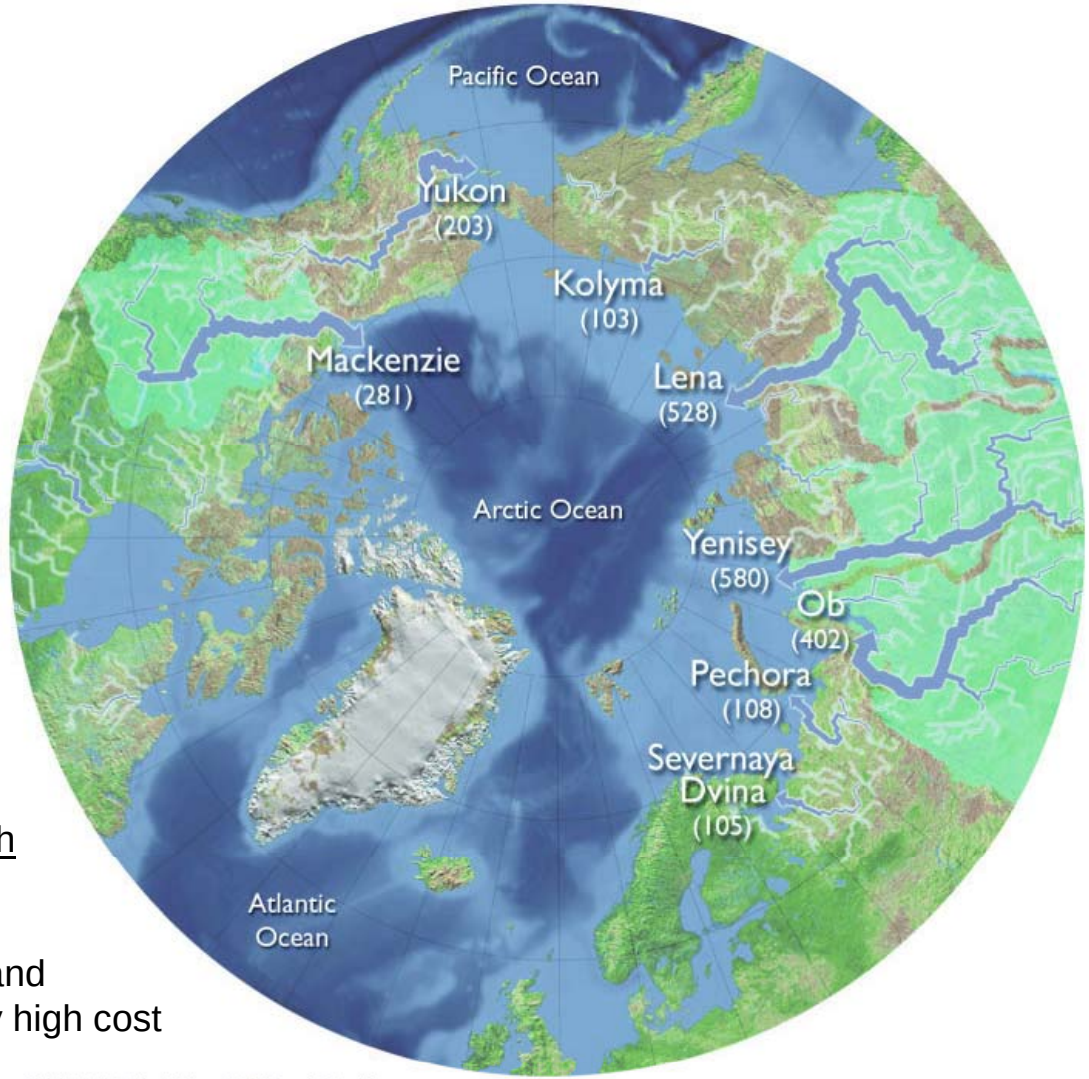
"*Increasing the share of renewables requires additional short-term and long-term integration efforts. Studies clearly show that combining different variable renewable sources, and resources from larger geographical areas, will be beneficial in smoothing the variability and decreasing overall uncertainty for the power system*"

"*There is a need for advanced technologies to optimize the infrastructure capacity for renewables. Additionally, there is a need for balancing supply and demand, like advanced demand and supply forecasting and plant scheduling*"

A view towards the Arctic / High North region

RE Technologies (SRREN)

2. Bioenergy
3. Direct Solar Energy
4. Geothermal Energy
5. Hydropower
6. Ocean Energy
7. Wind Energy



©2004, ACIA / Map ©Clifford Grabhorn

Not all will be applicable in the High North

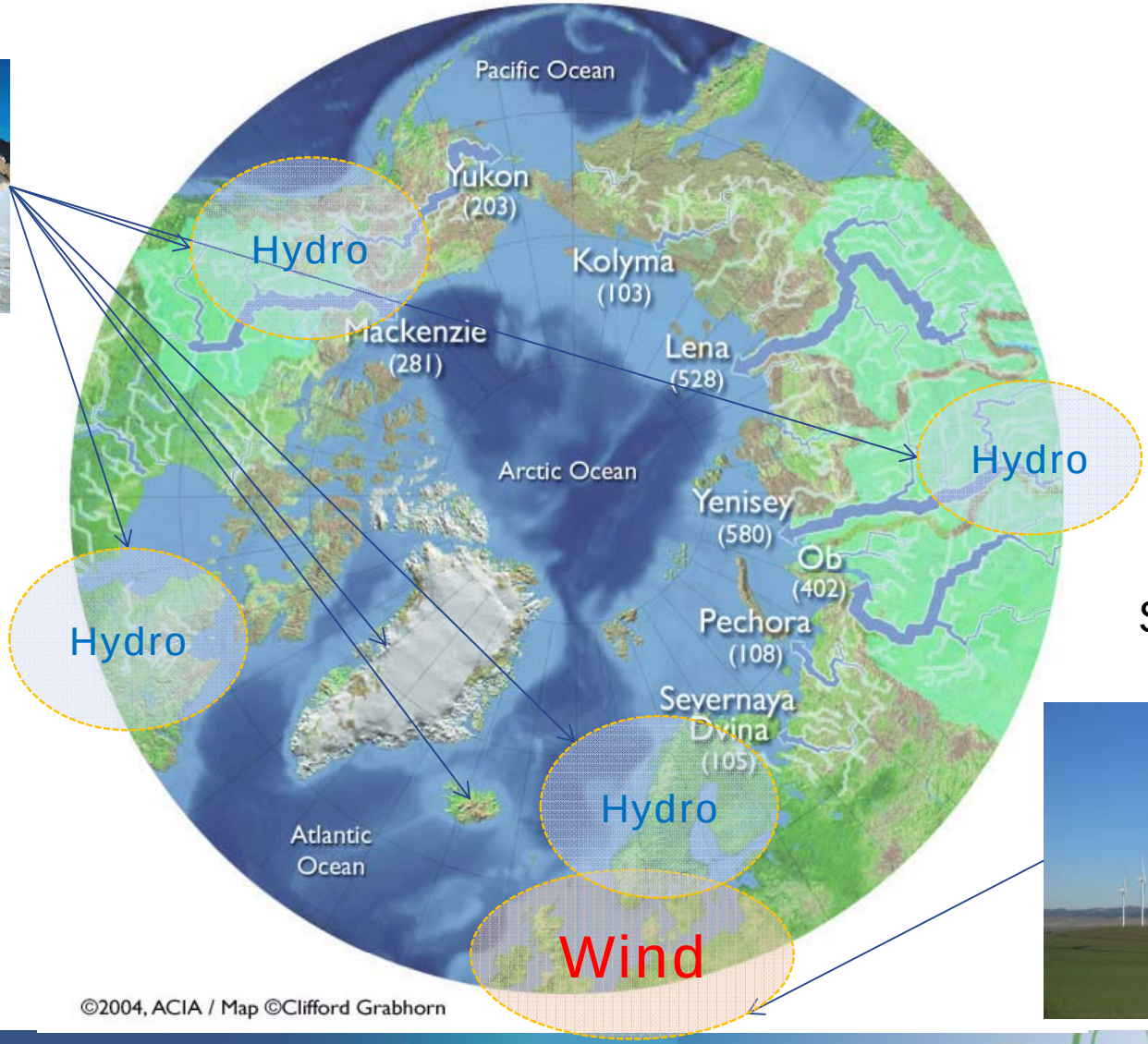
- Bio-energy: Low potential in High North
- Direct solar: Low potential, High cost
- Geothermal: Low potential outside Iceland
- Ocean energy: Unknown potential, very high cost

Most important RE in Arctic region in the future?

(For Large-scale electricity production)

Hydropower

Norway
Sweden
Finland
Iceland
Canada
Russia
Greenland
…



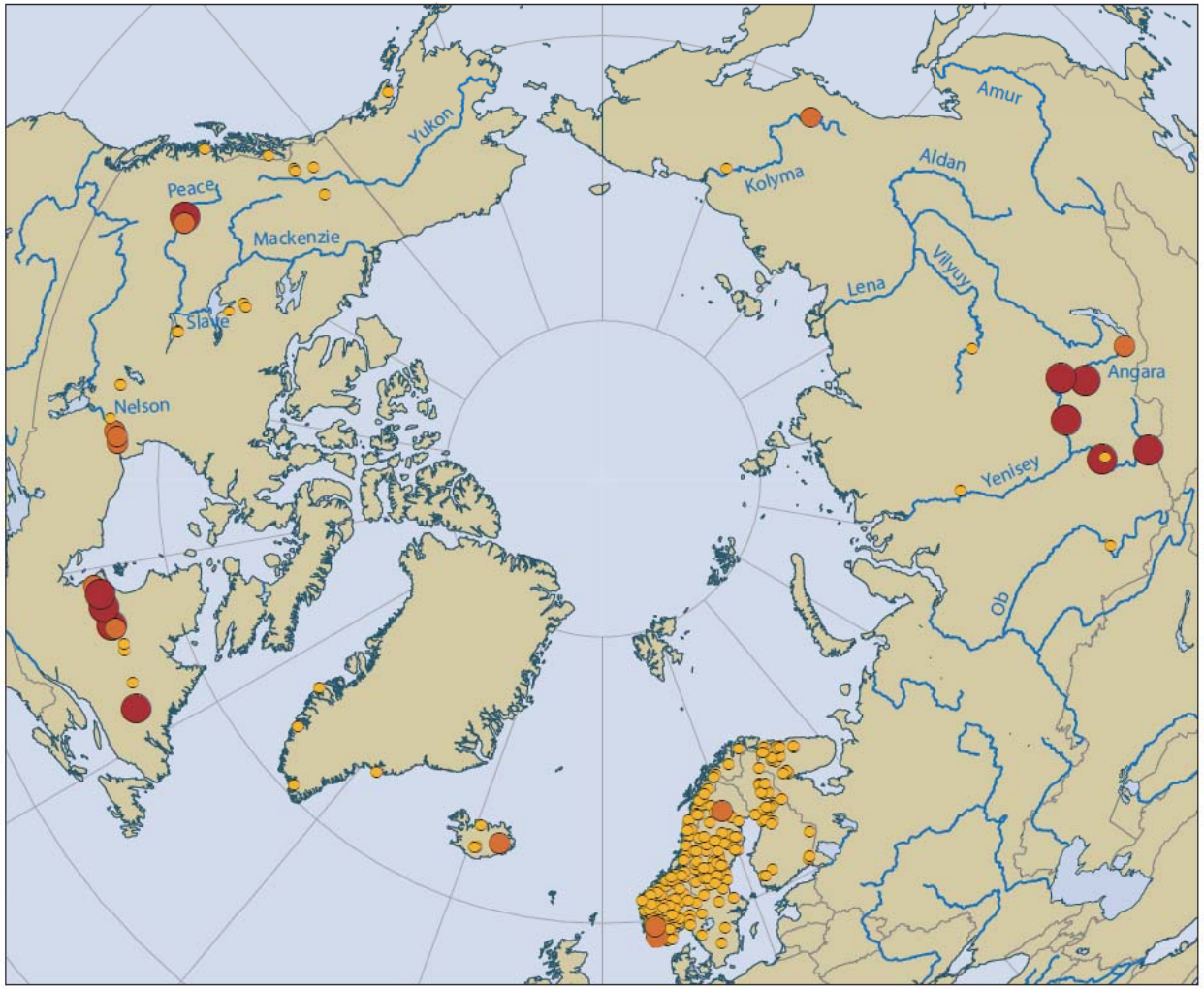
Wind

Canada
Alaska
Russia
Scandinavia
…

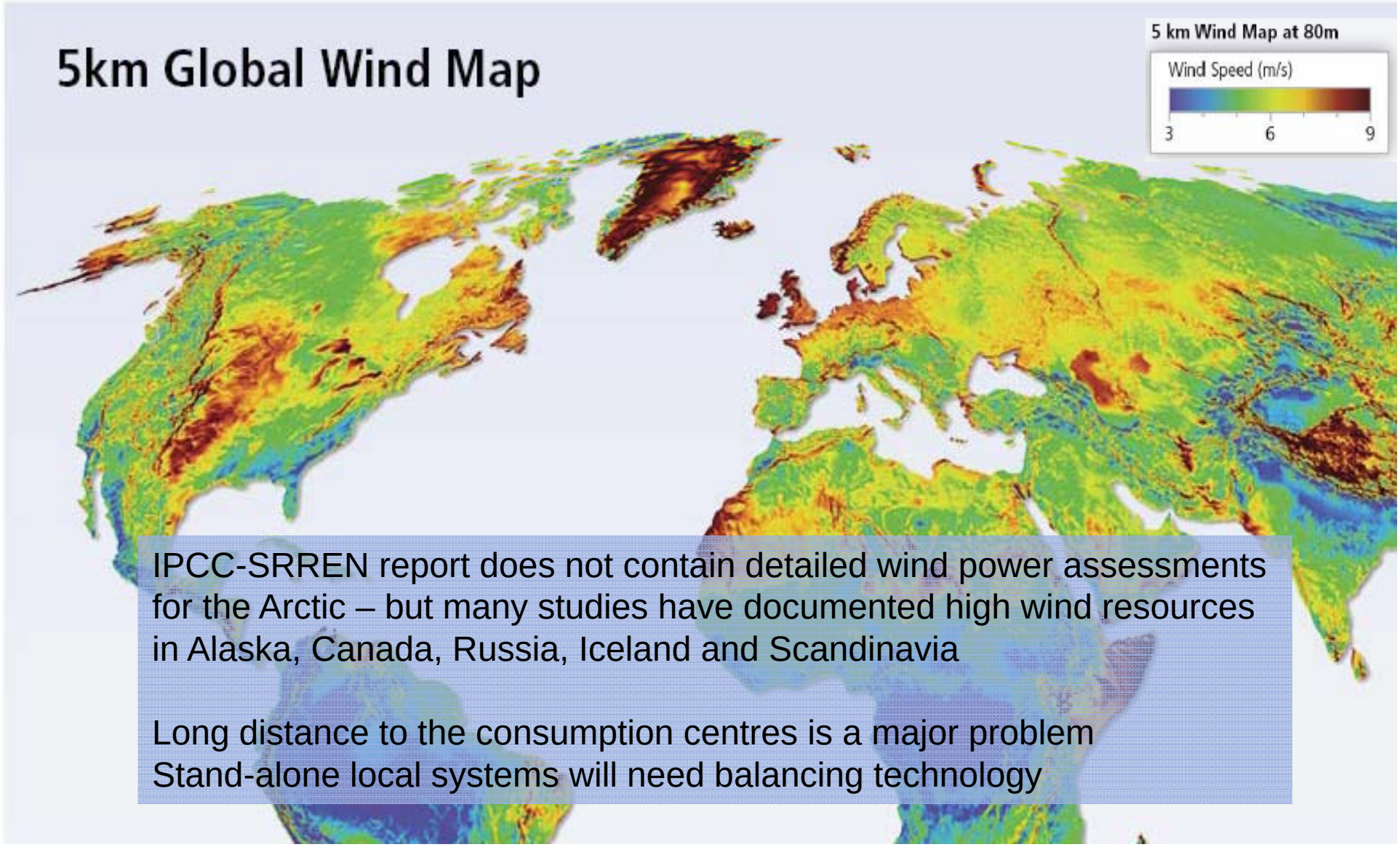
Existing hydropower development in the Arctic

Greenland power stations added based on GRIS report (FS 10-10-2011)
Relevant river names added (FS 10-10-2011)

NOTE: Burn the Book to check and alter color consistancy.



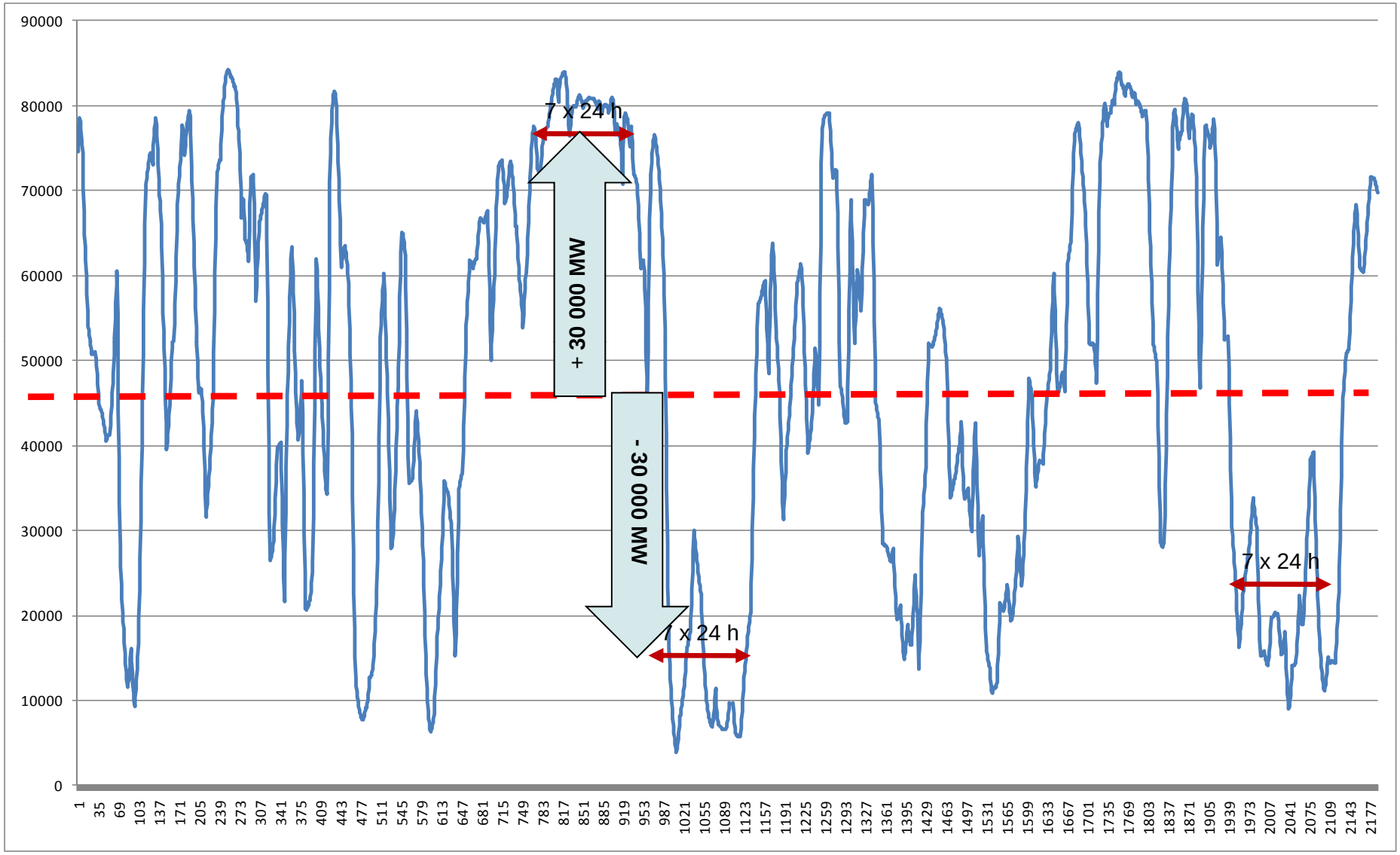
Wind Map (IPCC-SRREN)



IPCC-SRREN report does not contain detailed wind power assessments for the Arctic – but many studies have documented high wind resources in Alaska, Canada, Russia, Iceland and Scandinavia

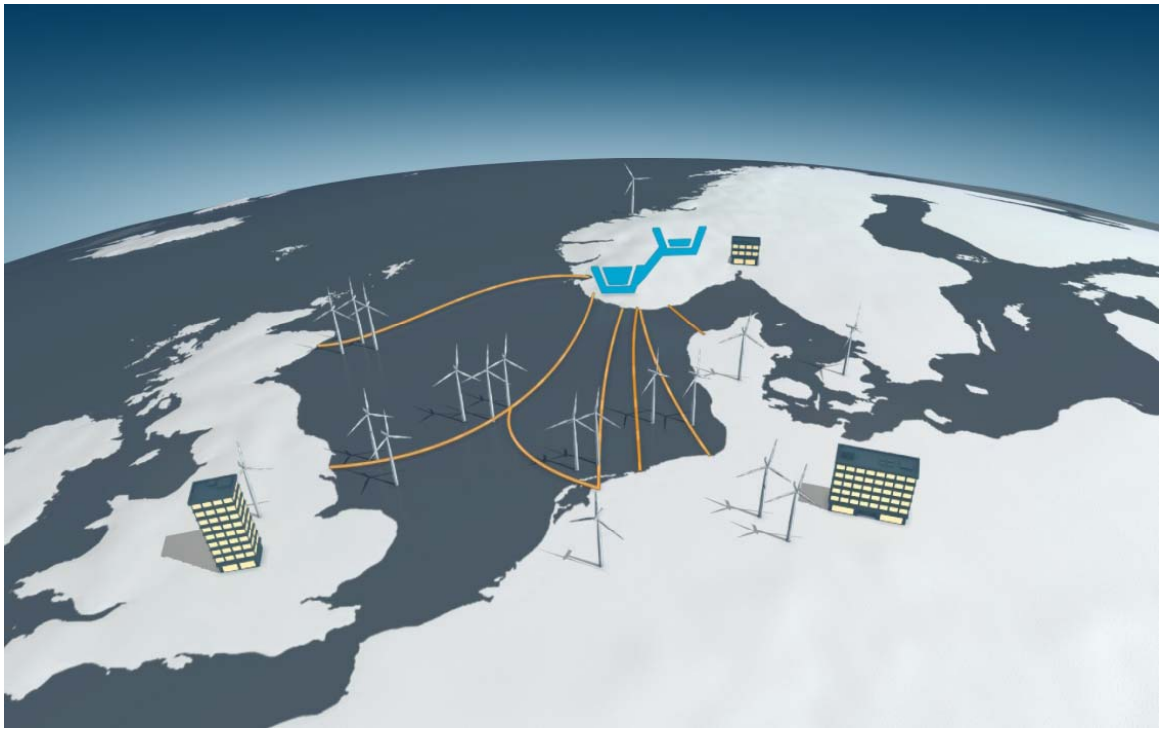
Long distance to the consumption centres is a major problem
Stand-alone local systems will need balancing technology

Wind Power is highly variable – needs balancing



Securing a high penetration of variable RE in a given grid

Norwegian storage hydro or pumped storage in a future wind driven Europe



Norway as a “Green Battery” for Europe

Summary and conclusions

Mitigation of Climate Change is only possible by reducing GHG emissions (some say up to 85% down by 2050)

A change from fossil fuel based energy systems to renewable energy is needed

Renewable energy development is possible – Also in the High North

Most important RE sources in the high north are most probably

- **Hydropower**
- **Wind power**

Hydro and wind is a good match – both seasonally and short term interaction

But - Energy storage and new transmission lines are needed

Renewable energy (Wind, Hydro) is sustainable even with climate change

Thank you for listening!

You can download the SRREN at http://srren.ipcc-wg3.de/

http://www.cedren.no/

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Centre for Environmental Design of Renewable Energy