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CONSEIL MONDIAL DE L'ÉNERGIE

World Energy Scenarios

2013 Annual Membership Meeting - USEA
May 2013

Promoting sustainable energy for the greatest benefit of all




World Energy Council – who we are

“The world energy leaders’ network”

- Truly global
- Inclusive and impartial
- Committed to our sustainable energy future since 1923

  - 93 national committees chaired by energy ministers, leading CEOs and practitioners
  - Represents over 3000 government, private sector and experts organisations
  - Flagship event: World Energy Congress, every three years – next in Daegu, South Korea, 2013

World Energy Scenarios to 2050: Building on track record & success

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WEC: more than two decades of scenarios expertise

- Cooperating with businesses, governments, international organisations, member committees

Building on previous WEC scenarios studies:

- Global Energy Perspectives 2000–2020 (1989)
- Energy for Tomorrow's World (1993)
- Global Energy Perspectives to 2050 and Beyond (1995)
- Global Energy Perspectives (WEC–IIASA, 1998)
- Energy for Tomorrow's World – Acting Now (2000)
- Drivers of the Energy Scene (2003)
- Deciding the Future: Energy Policy Scenarios to 2050 (2007)
- Global Transport Scenarios 2050 report (2011)

WEC Scenarios Project Process

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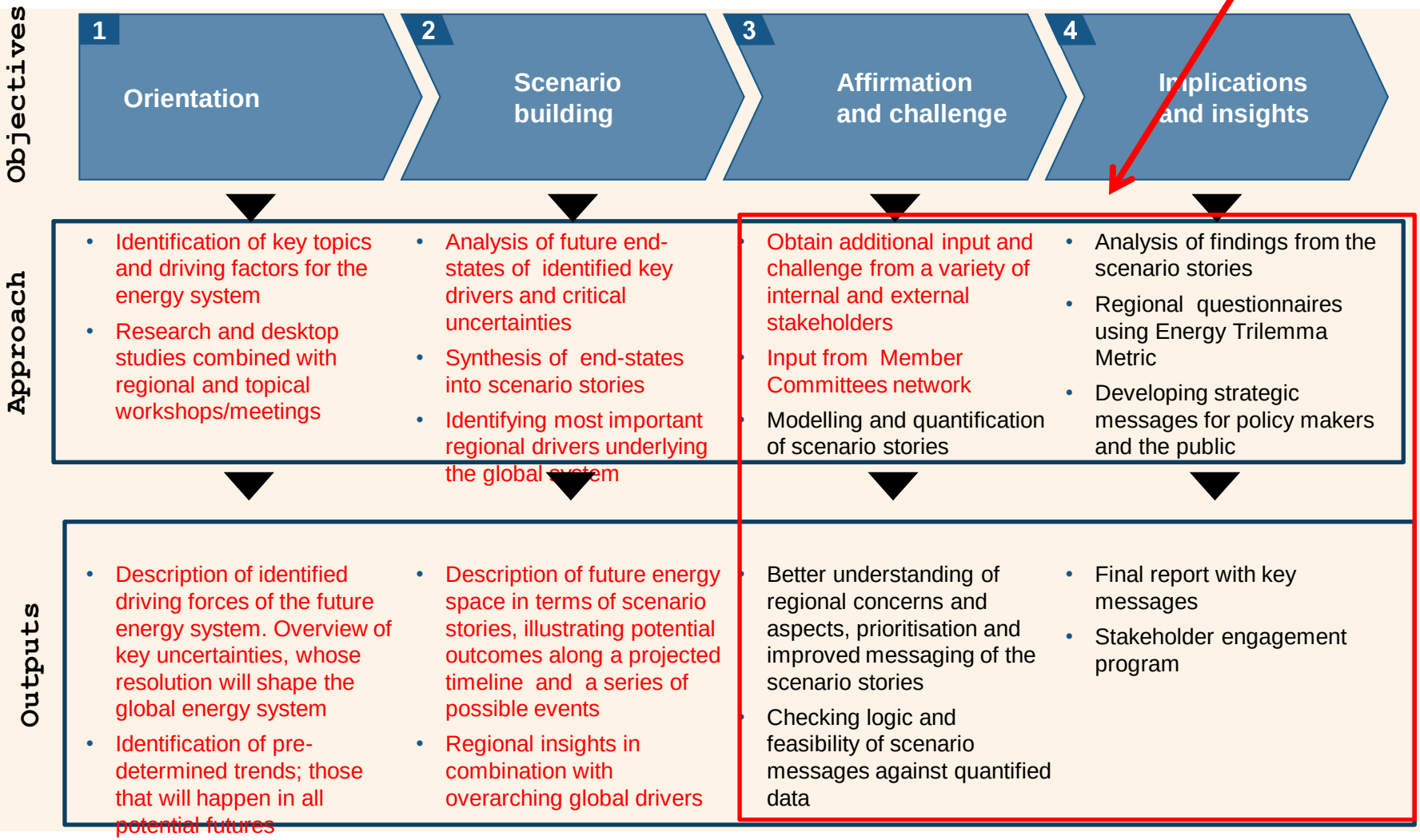
Now we are here

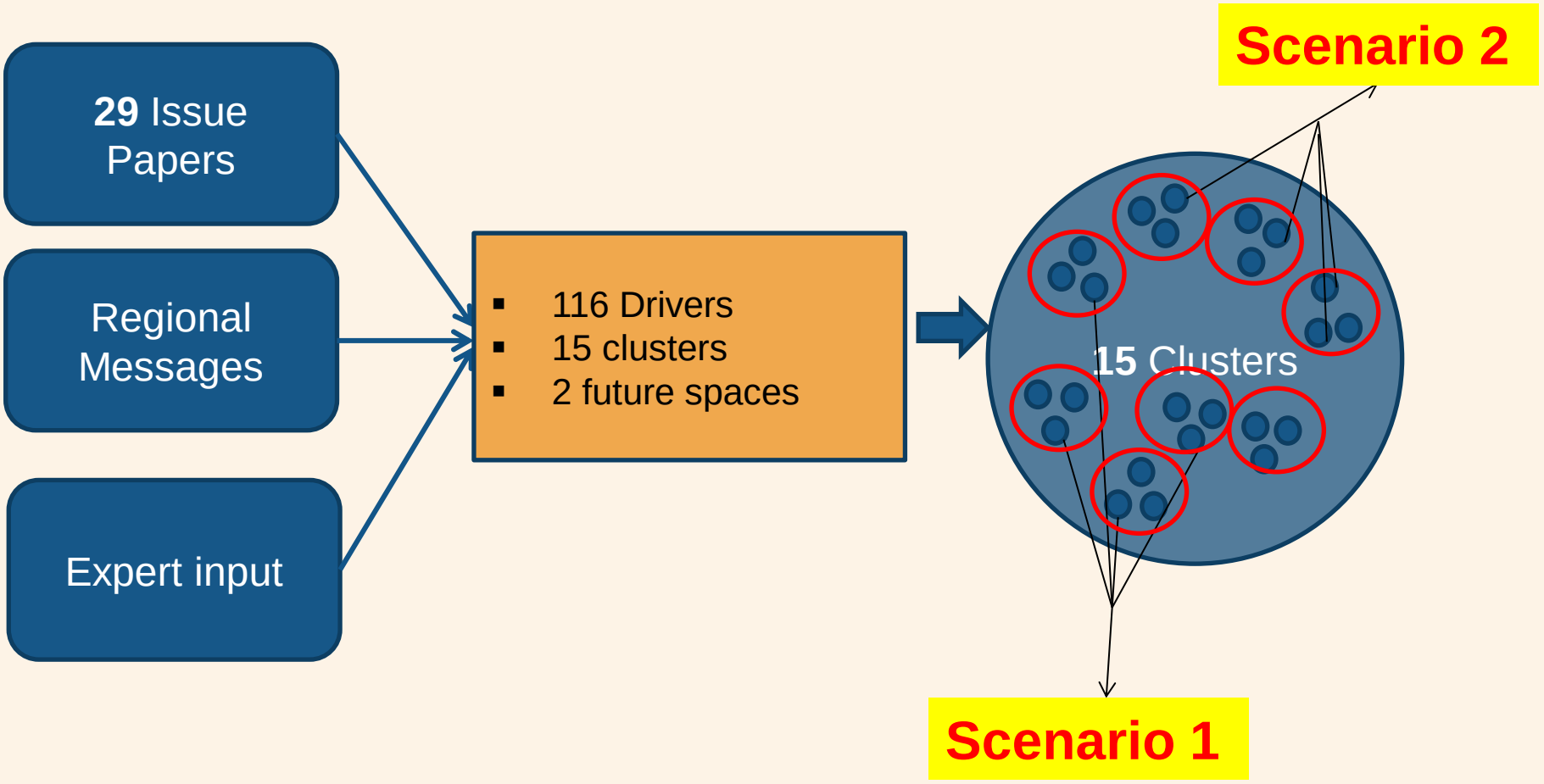


Laying the foundation: 5 Workstreams & 29 Issues

Economics Finance Trade	Energy Systems & Technologies	Resource Availability & Access	Consumer Behaviour & Acceptance	Government Policies
➢ Super-Cycles vs. Boom and Bust? ➢ Population & Megacities ➢ Investment in infrastructure ➢ Prices of energy-commodities-CO2 ➢ Rise of China ➢ Globalization & Trade	➢ Energy Efficiency ➢ Technology - supply & demand side ➢ Technology - Environmental ➢ Smart Grids (incl. interconnectivity) ➢ Renewables (true associated costs) ➢ Mobility (Report) ➢ Nuclear (Report)	➢ Reserves - coal, oil, gas, rare earths, etc. ➢ Security of supply & demand ➢ Geopolitics - MENA instability ➢ Competition for resources ➢ Energy-Water Nexus ➢ Energy Poverty ➢ Land use and access	➢ Costs vs Values ➢ Leadership - state vs. private groups ➢ Acceptance	➢ Climate change & Environment ➢ Competiveness, price, affordability ➢ Demand management & energy Efficiency ➢ Energy mix ➢ R&D ➢ Security of supply

- **Study Group was organised into 5 workstreams**
- **29 Lead authors, with co-authors worked on each issue**
- **447 page background document prepared**
- **Crucial in understanding the drivers of the energy system**

Scenario Building Process



Key Clusters

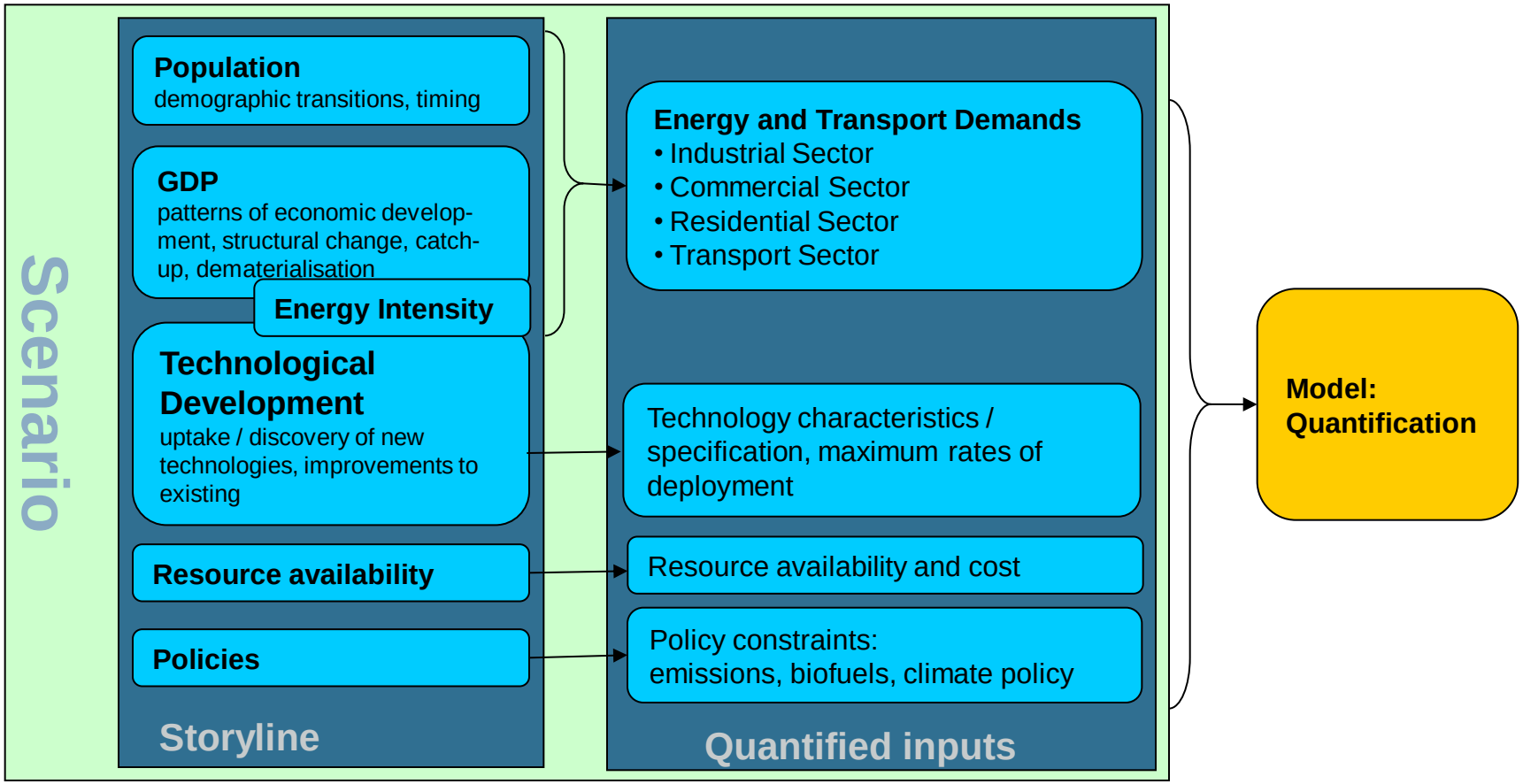
1. Role of State
2. Availability of Funds
3. Mitigation of CO2
4. Equality
5. Global Economics
6. Energy Prices
7. Consumer/citizen acceptance
8. Energy Efficiency
9. Technology developments
10. Security of supply
11. China and India
12. Energy Poverty
13. Energy Sources
14. Competition for resources
15. Skills shortages

Brief outline of Global Scenario stories

Jazz	Symphony
World where there is a consumer focus on achieving energy access, affordability, and individual energy security with the use of best available energy sources	World where there is a voter consensus on driving environmental sustainability and national energy security through corresponding practices and policies
Main players are multi-national companies, banks, venture capitalists, and price- conscious consumers	Main players are private and public-sector companies, local governments, NGOs, and environmentally-minded voters
Technologies are chosen in competitive markets	Governments pick technology winners
Energy sources compete on basis of price & availability	Select energy sources are subsidised and incentivized by governments
Higher GDP growth due to optimised (efficient) market practices.	Lower GDP due to non-optimal economic policies
Free-trade strategies lead to increased exports	Nationalistic strategies result in reduced exports/imports
Renewable and low carbon energy grows in line with market selection	Certain types of renewable and low carbon energy actively promoted by governments in the first part of the scenario period
In the absence of international agreed commitments Carbon market grows more slowly from bottom up based on regional, national and local initiatives.	Carbon market is top down based on an international agreement, with commitments and allocations.

Energy Model Framework: Key scenario drivers

- Evolutions of key scenario drivers are expressed in a **coherent storyline** of future economic and social developments
- Some drivers are **interdependent**, e.g. energy intensity
- Drivers must be **translated into quantified inputs** for the energy system models



Balancing the "Energy Trilemma"

"promoting an affordable, stable and environmentally sensitive energy system for the greatest benefit of all"

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Energy security

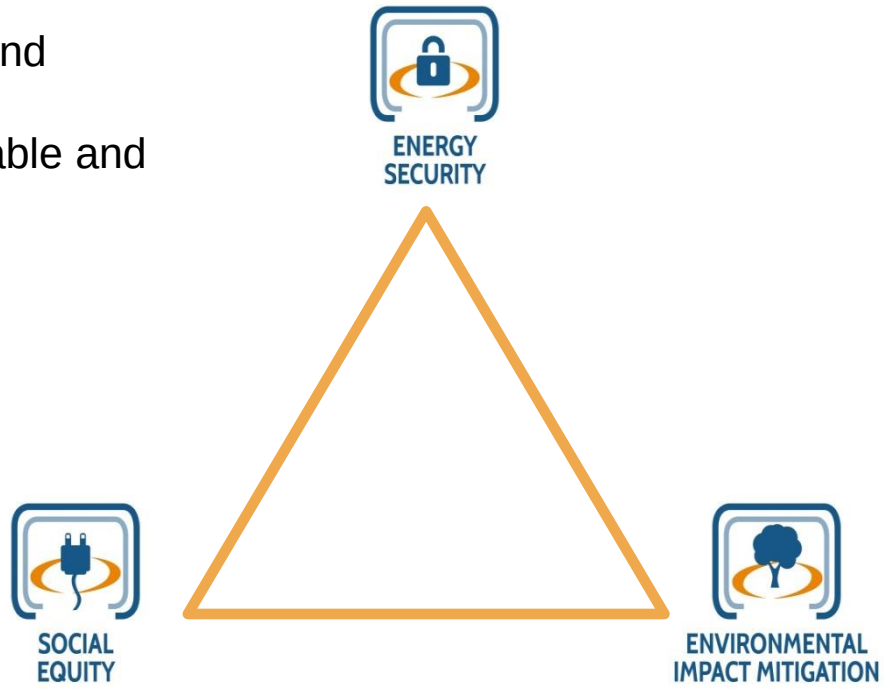
The effective management of primary energy supply from domestic and external sources, the reliability of energy infrastructure, and the ability of participating energy companies to meet current and future demand.

Environmental impact mitigation

Encompasses the achievement of supply and demand-side energy efficiencies and the development of energy supply from renewable and other low-carbon sources

Social equity

Accessibility and affordability of energy supply across the population



Mapping the scenarios around the trilemma

Social Equity (access and affordability)

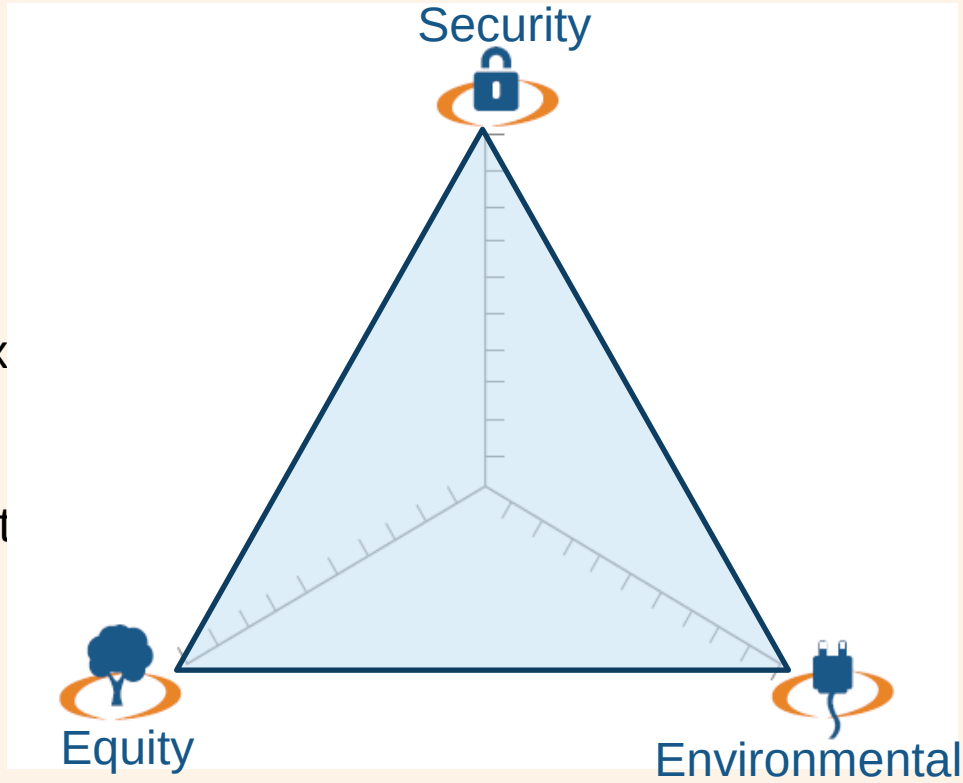
- Marginal electricity generation cost
- Marginal cost of petrol/diesel
- Costs vs. GDP
- Investment required
- Access (grid connections)

Energy Security

- Share of fuels in primary energy mix
- Diversity of supply
- Diversity of demand
- Reserve capacity (electricity product

Environmental Sustainability

- CO_2 emissions
- Competition for land (biofuels)
- Water use (unconventional oil and gas)



Model description and quantification of scenario stories

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- Modelling partner: **Paul Scherrer Institut**, Switzerland (PSI)
- Model used: GMM (**Global Multi-regional MARKAL** model)
- Model features: MARKAL (MARKet Allocation)
  Bottom-up, perfect foresight cost-optimization models
  Least-cost solutions
  Endogenous technological learning (ETL)
  8 Demand Sectors (detailed transport sector)
  Time horizon: 100 years, 10-year intervals
  Discount rate: 5% p.a. across all technologies
- Current regional split: North America (NAM), Latin America, Middle East and Africa (LAFM), Western Europe (WEUR), Former Soviet Union and Eastern Europe (EEFSU), Asia (ASIA), and Other OECD (OOECD)

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INDICATIVE MODELLING RESULTS: GLOBAL LEVEL

Latest Modelling results
Quantification of scenarios stories

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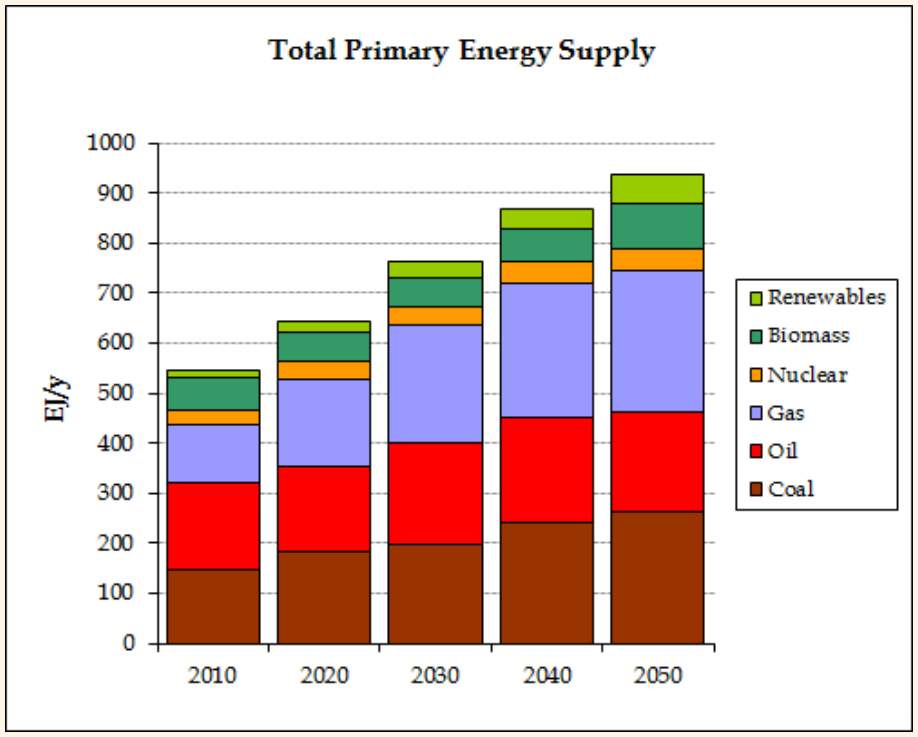

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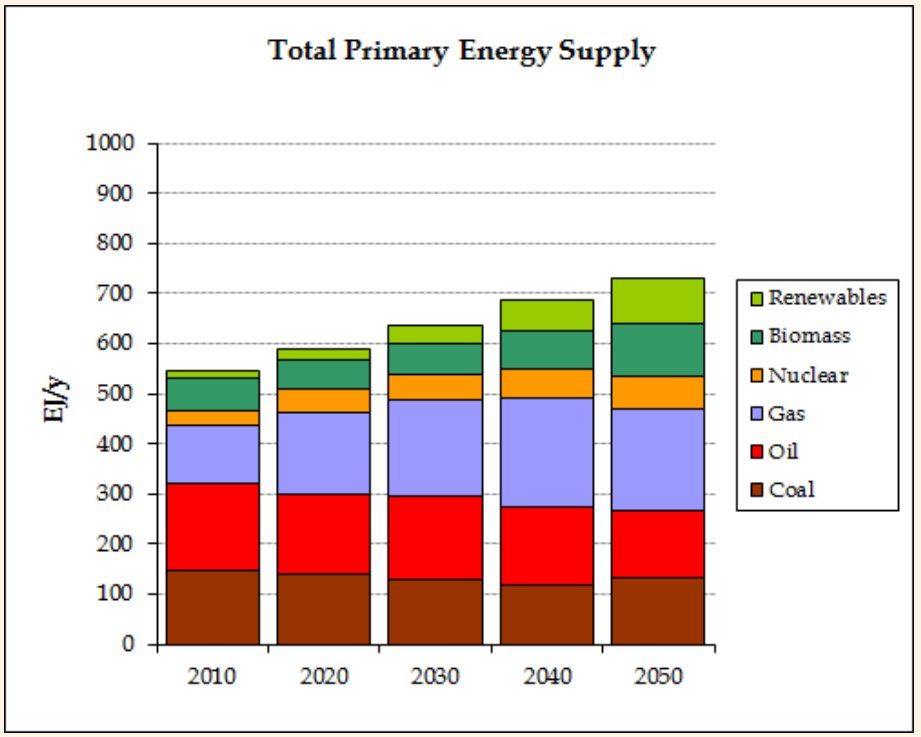

Source: PSI (2013): Latest modelling run as of 15 May 2013

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Quantification of scenarios stories

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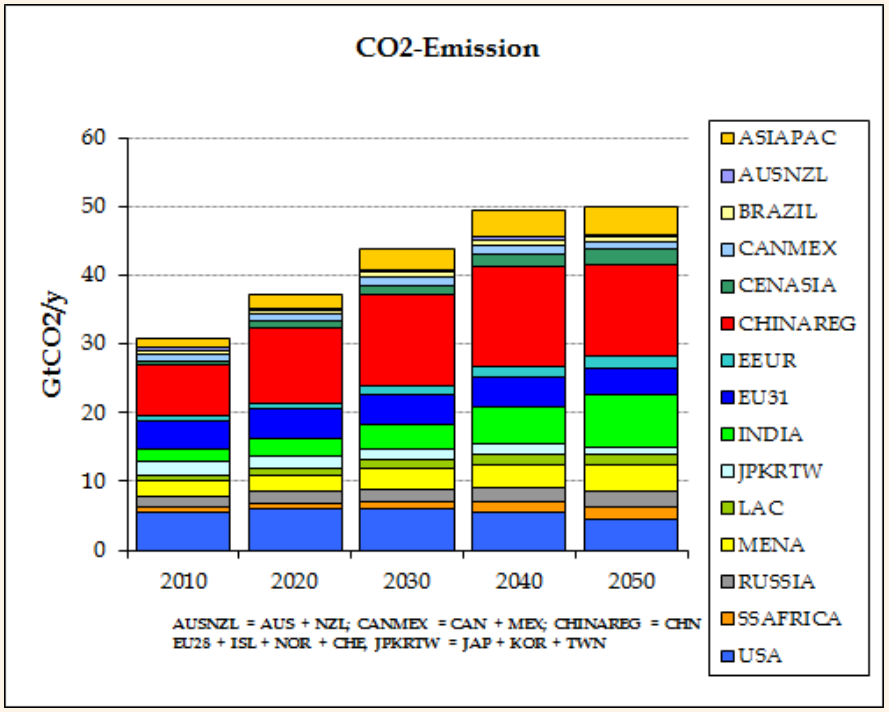

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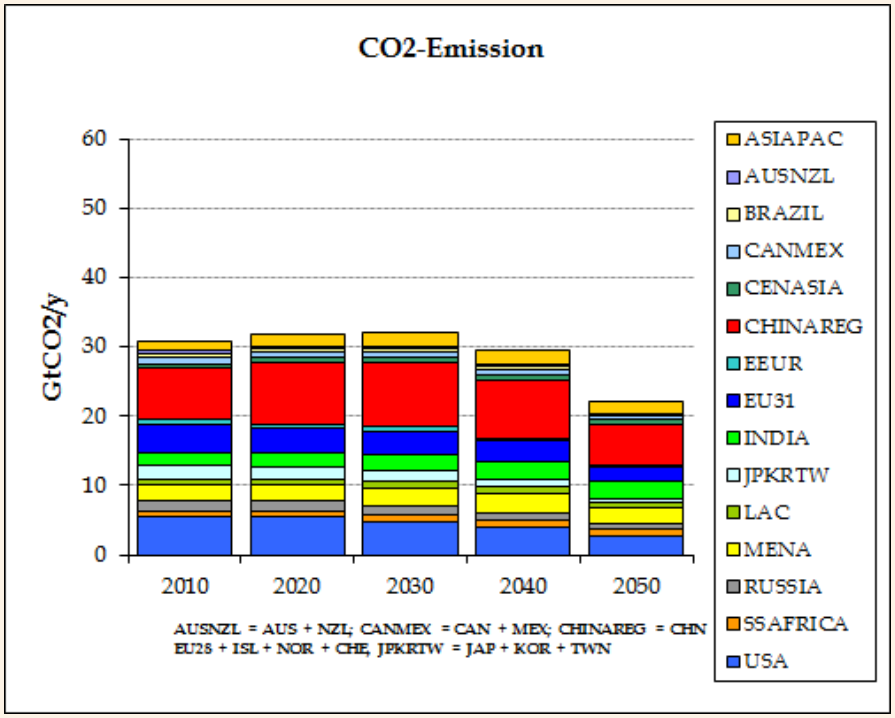

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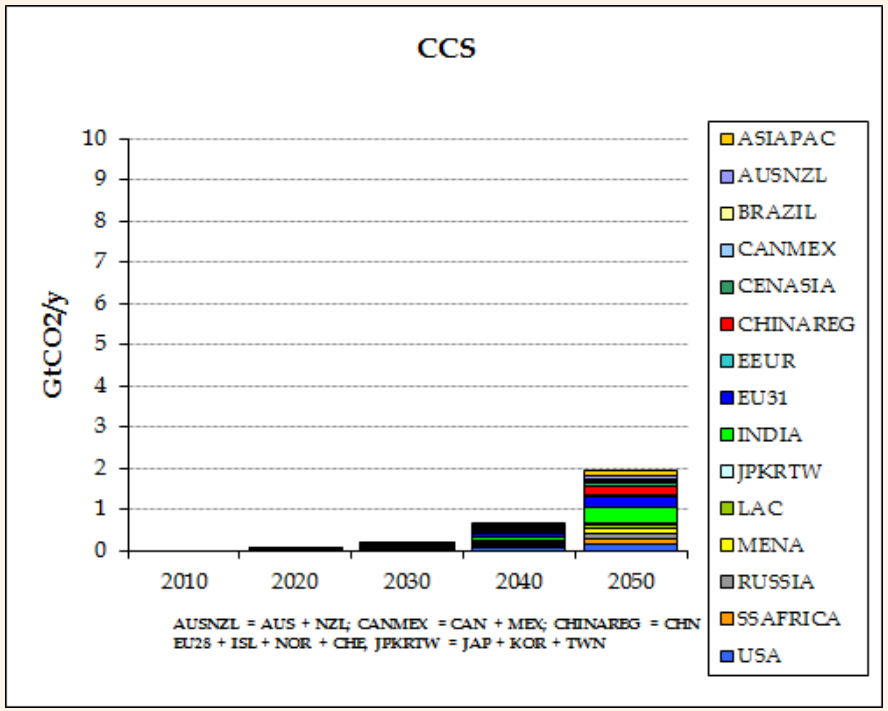

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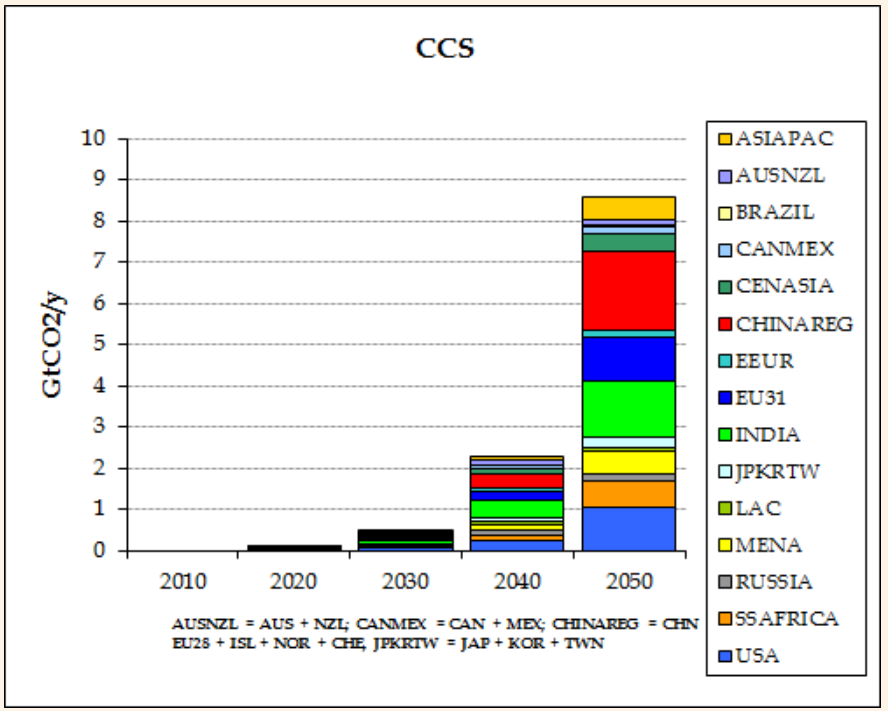

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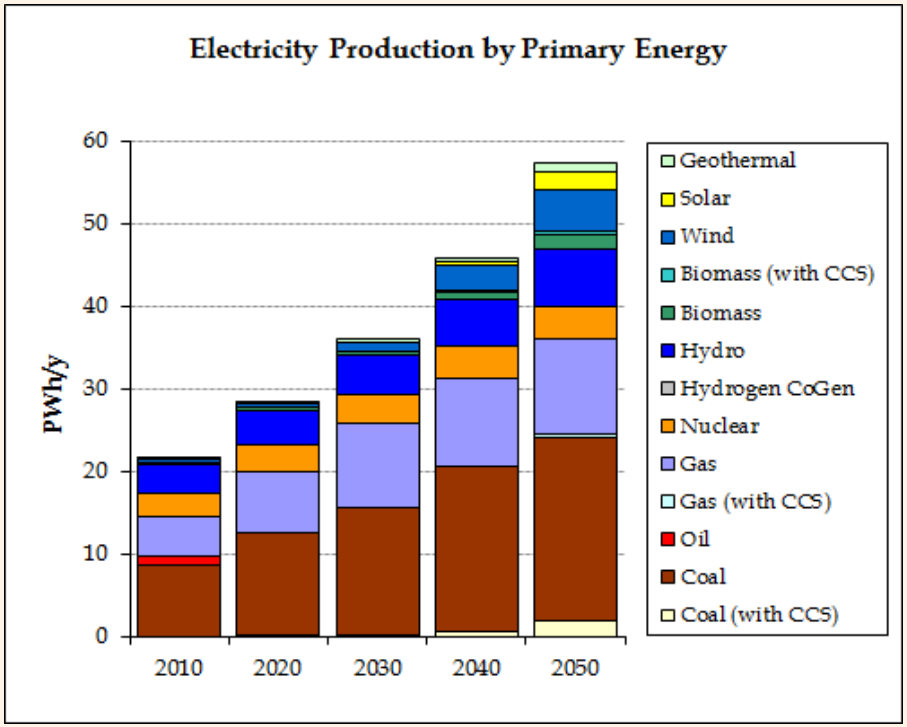

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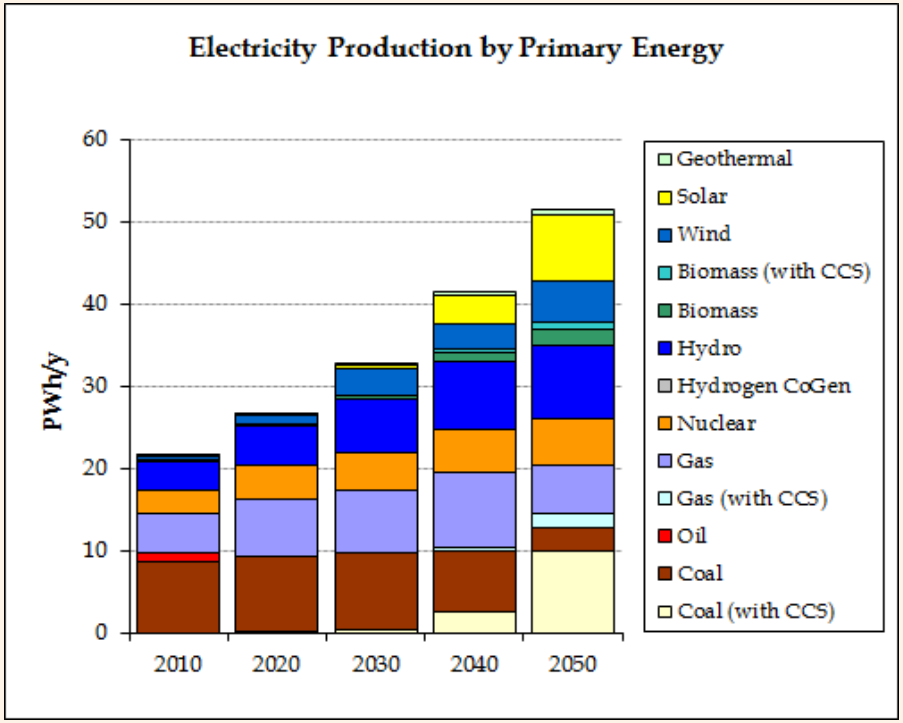

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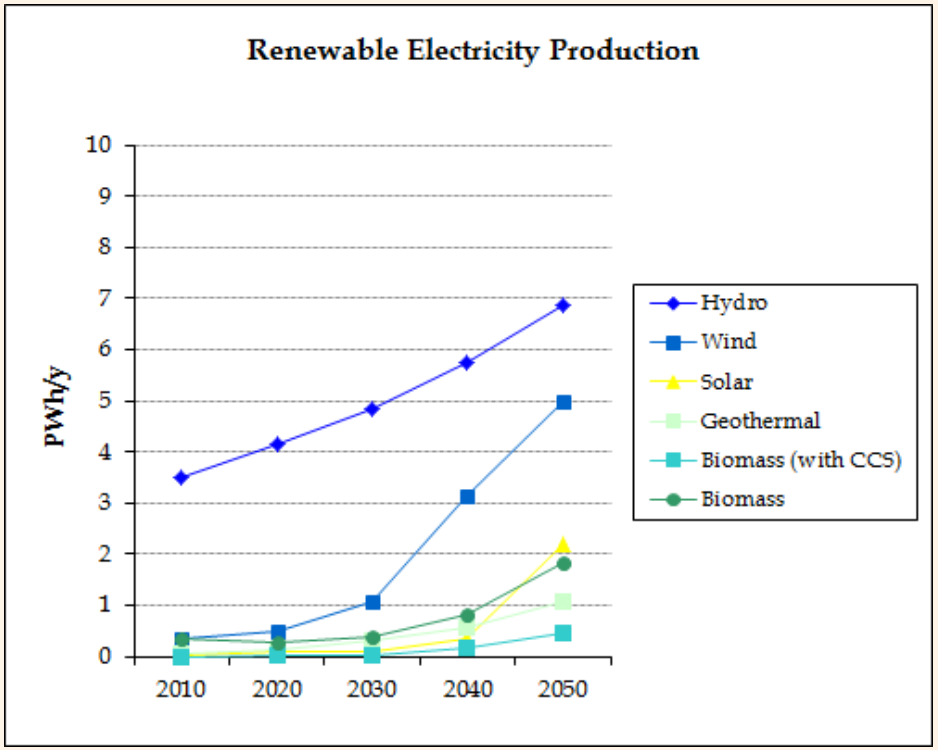

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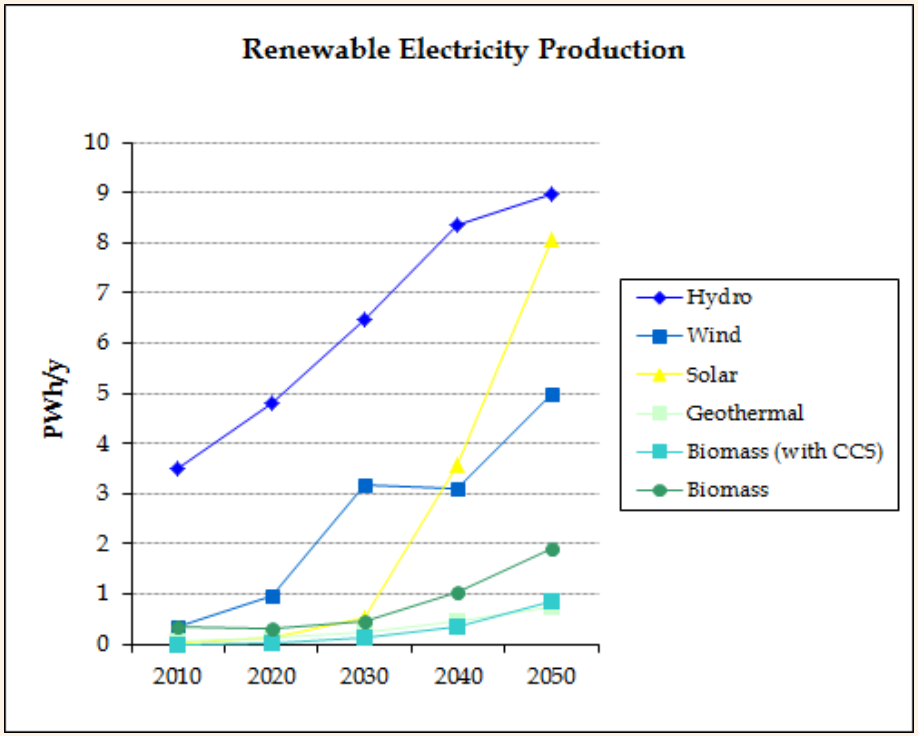

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INDICATIVE MODELLING RESULTS: USA

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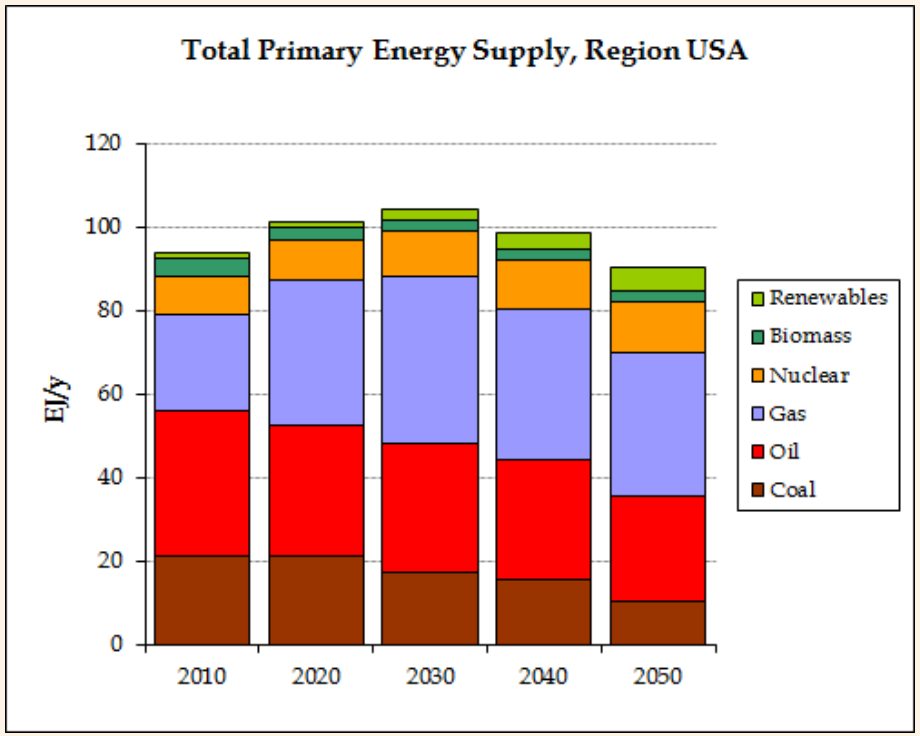

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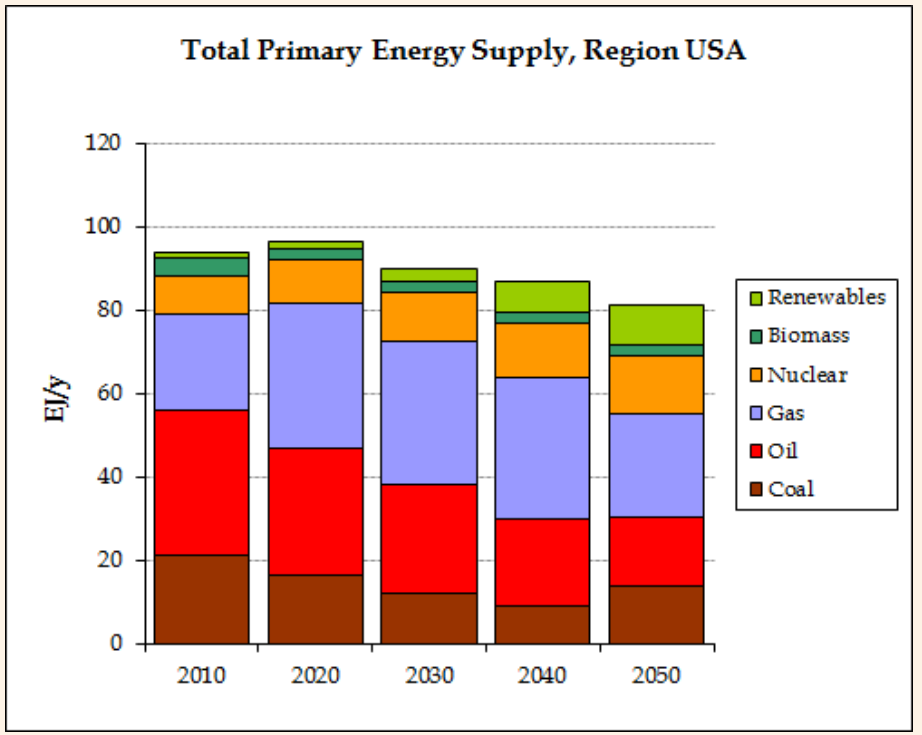

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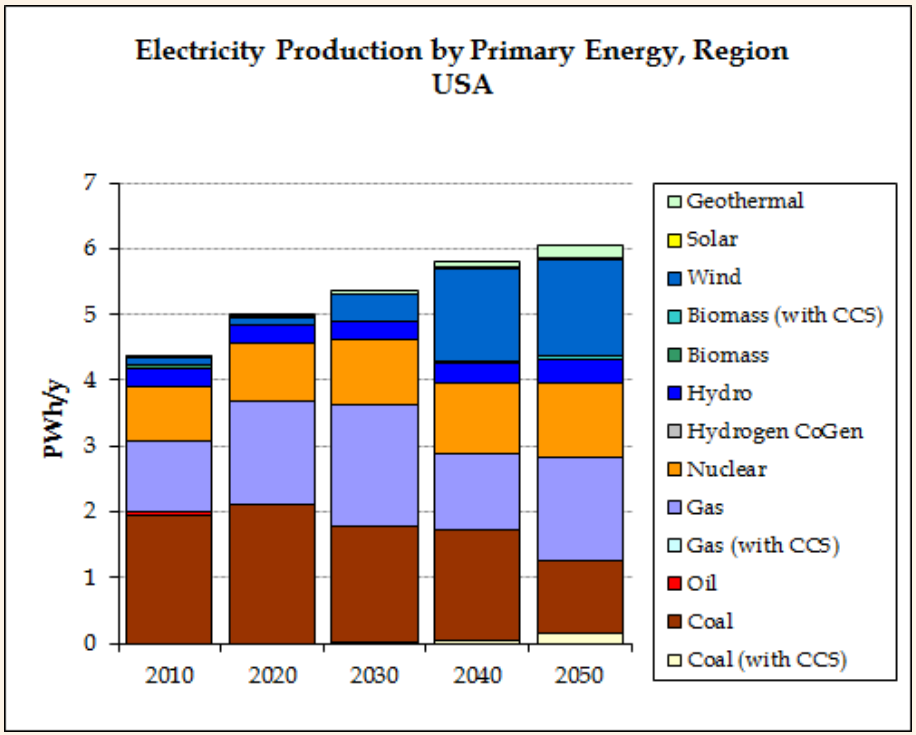

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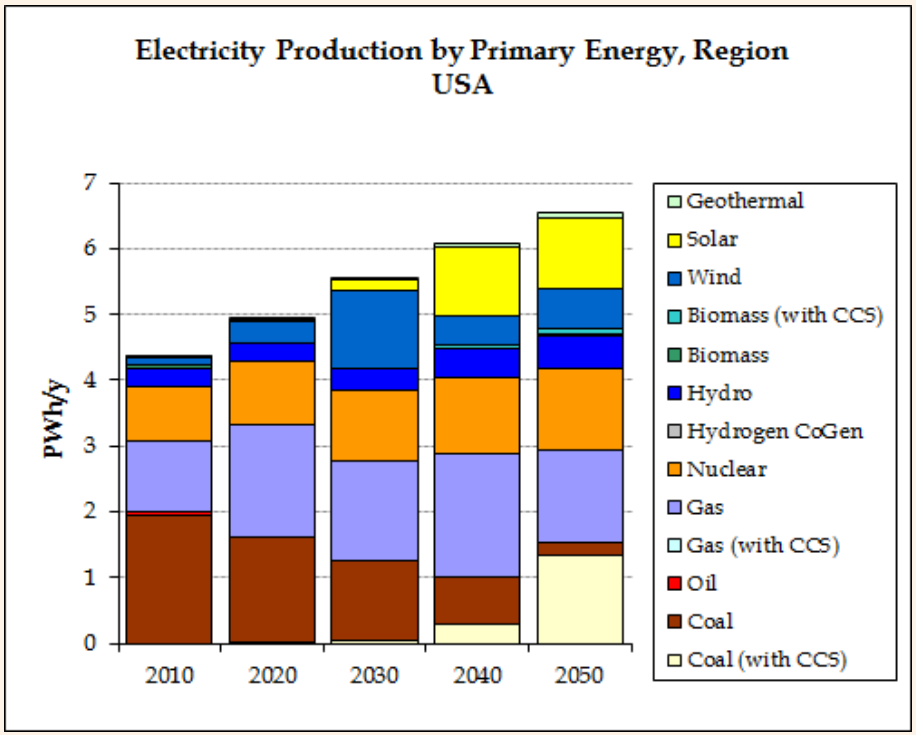

Source: PSI (2013): Latest modelling run as of 15 May 2013

North America scenario workshop

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Some key messages emerging:

- Fossil fuels, especially from unconventional sources, continue to play a major role for longer than expected by general public
- Gas in Transport
- Important role for CCS and CCUs in managing greenhouse gases
- Climate change policies and constraints need review
- Developments in power storage technologies are key
- Demand side management is required
- "new realism" emerging
- Transitions take time and a lot of capital
- Energy policy is an important driver of economic policy at international level