



Wellington Scenarios
Workshop
17 February 2013
Promoting sustainable energy for the greatest benefit of all



Agenda- Part 1

BusinessNZ
Energy Council

 Member of the
World Energy Council



1. Scenarios
2. Symphony and Jazz Scenario stories
3. Trilemma Metric
4. Presentation of indicative modelling results
5. Discussion and reflection

This is a preliminary insight. The final report will be released at the
World Energy Congress in Daegu in October 2013

Why scenarios?

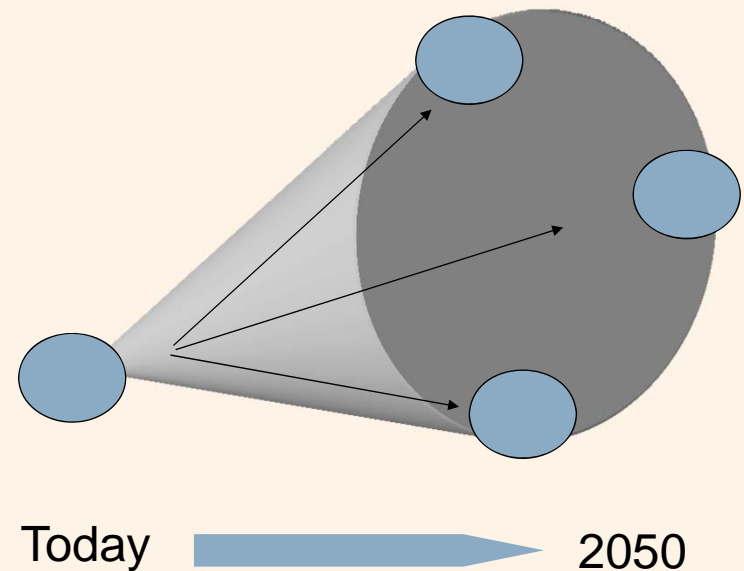
Scenarios can be used to explore the implications of different sets of assumptions and determine the degree of robustness of possible future developments.

"Scenarios provide alternative views of the future. They identify some significant events, main actors and their motivations, and they convey how the world functions. We use scenarios to explore possible developments in the future and to test our strategies against those potential developments."

- Royal Dutch Shell

"Scenarios are alternative images of how the future might unfold and are an appropriate tool with which to analyze how driving forces may influence future...outcomes and to assess the associated uncertainties."

- IPCC Special Report on Emissions Scenarios



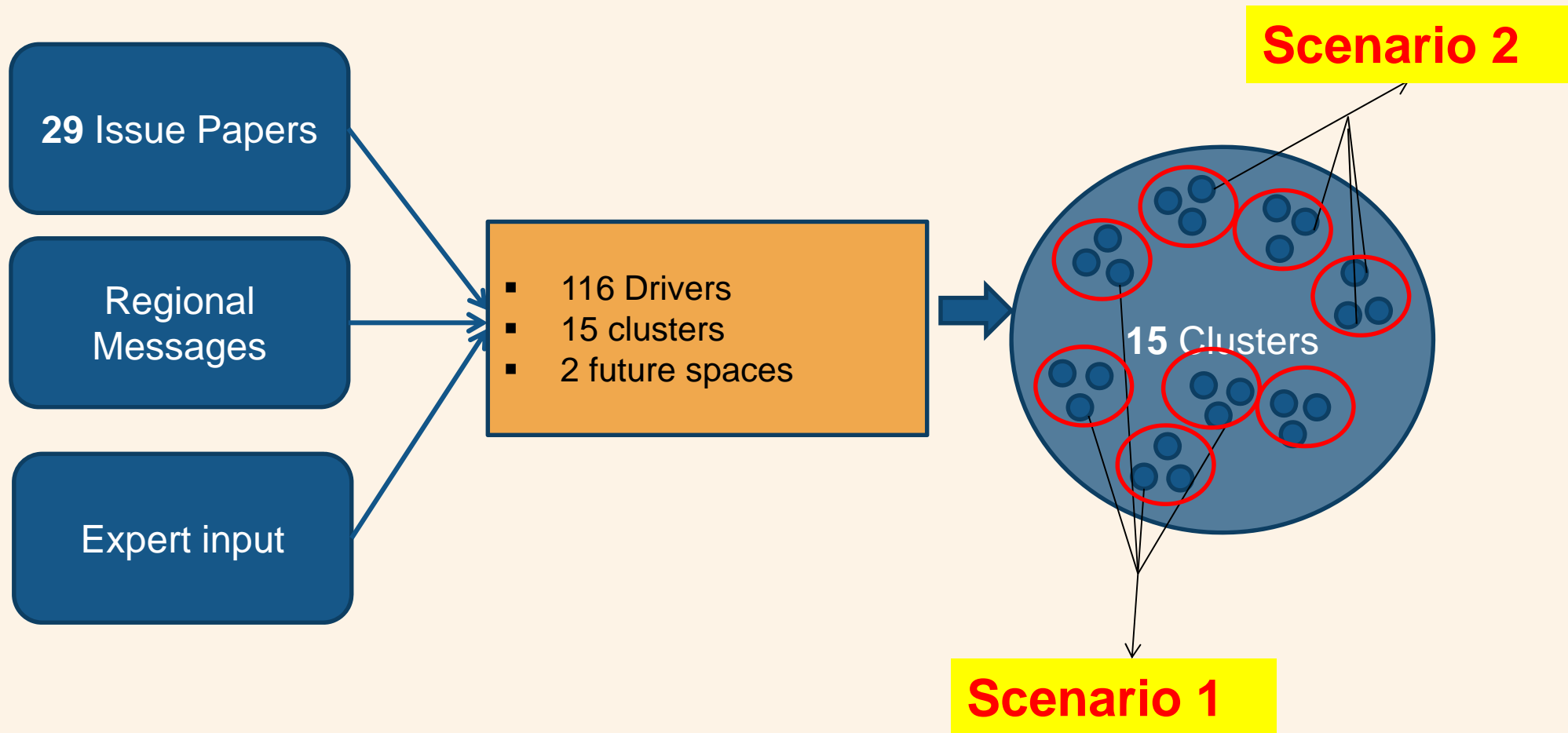
→ Identification of robust trends; 'what-if' assumptions about future, not forecast

Laying the foundation: 5 Workstreams & 29 Issues

Economics Finance Trade	Energy Systems & Technologies	Resource Availability & Access	Consumer Behaviour & Acceptance	Government Policies
<ul style="list-style-type: none"> ➤ Super-Cycles vs. Boom and Bust? ➤ Population & Megacities ➤ Investment in infrastructure ➤ Prices of energy-commodities-CO2 ➤ Rise of China ➤ Globalization & Trade 	<ul style="list-style-type: none"> ➤ Energy Efficiency ➤ Technology - supply & demand side ➤ Technology - Environmental ➤ Smart Grids (incl. interconnectivity) ➤ Renewables (true associated costs) ➤ Mobility (Report) ➤ Nuclear (Report) 	<ul style="list-style-type: none"> ➤ 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 	<ul style="list-style-type: none"> ➤ Costs vs Values ➤ Leadership - state vs. private groups ➤ Acceptance 	<ul style="list-style-type: none"> ➤ Climate change & Environment ➤ Competitiveness, 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/voter 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

WEC Scenarios

Deriving the scenario stories

- Two Scenarios stories are being developed, exploratory not normative, equally probable but differentiated, rather than good and bad
 - **Jazz:**
Trade based, consumer driven, focussed on access and affordability. achieving growth through low cost energy. Governments facilitate GHG actions.
 - **Symphony:**
Government led, voter driven, focussed on environmental goals and energy security, national and regional measures to increase share of renewables in energy mix. Binding international agreement on GHG emissions

WEC Scenarios

The Names



■ Jazz:

Jazz is a style of music, characterized by a strong but flexible rhythmic structure with solo and ensemble improvisations on basic tunes and chord patterns. In Jazz musicians have freedom to take the lead and improvise; others in the band will often follow.

■ Symphony:

A Symphony is a complex piece of music with a fixed structure composed to be played by a Symphony Orchestra. The Orchestra will have a conductor and 80 or so orchestra members will each have a specific role to play and score to follow.

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.

Doha Gateway

The Doha Gateway includes a timetable for 2015 global climate change agreement and increasing ambition before 2020. At Doha countries agreed a course for negotiating the "Durban Platform for Enhanced Action" (ADP), a new climate deal for all countries to be agreed by 2015 and to take effect in 2020.

In Symphony countries pass through the Gateway and successfully negotiate a global treaty because all countries are prepared to accept commitments and concessions.

In Jazz we work from the basis that these negotiations are not finalised and regions, countries, states and municipalities take their own sustainable development initiatives and pathways.

Balancing the “Energy Trilemma”

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

Energy security

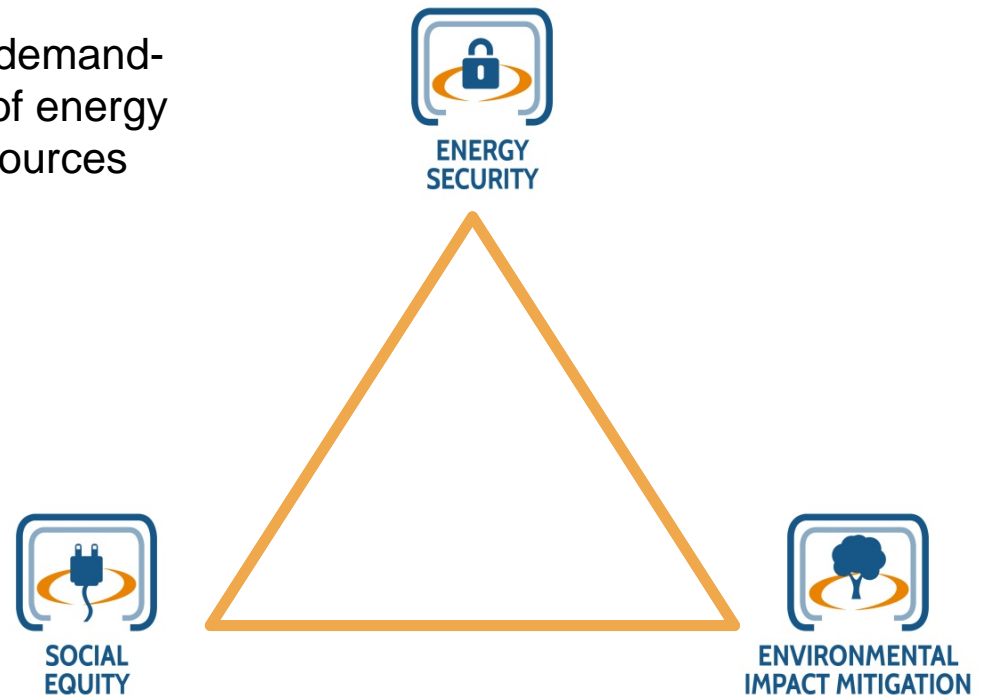
The effective management of primary energy supply from domestic and external sources, the reliability of energy infrastructure, and the ability of participating energy companies to meet current and future demand.

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)

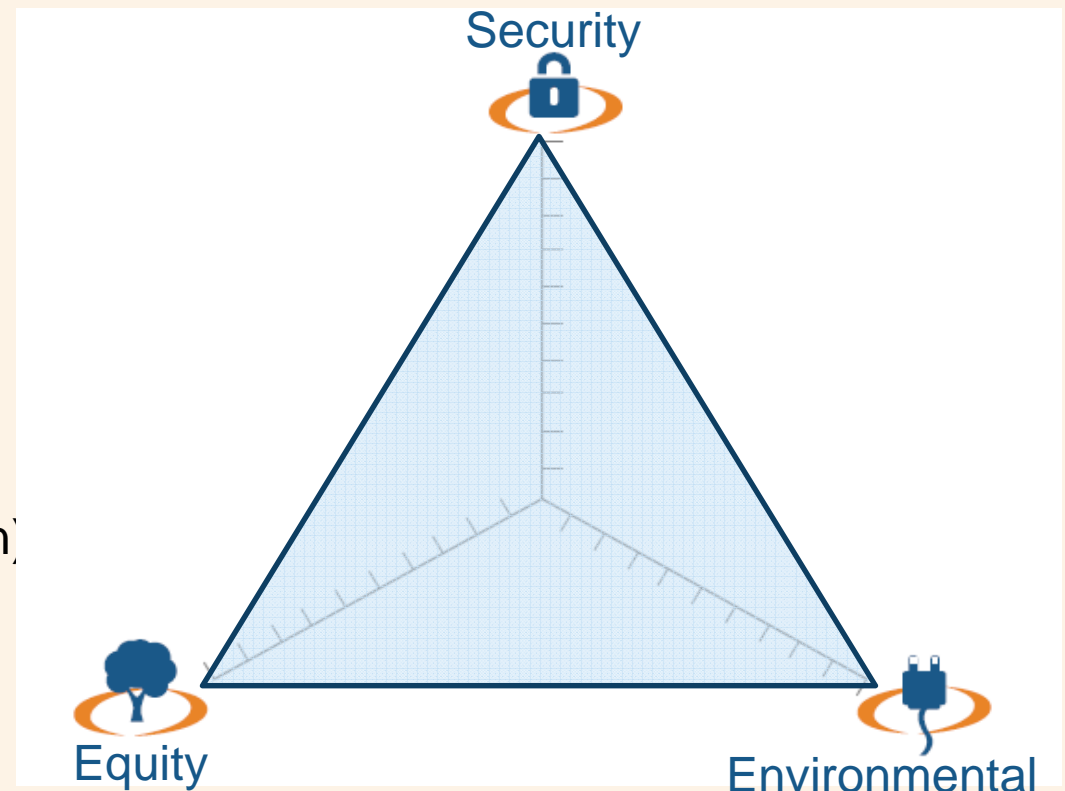
- Marginal electricity generation cost
- Marginal cost of petrol/diesel
- Costs vs. GDP
- Investment required
- Access (grid connections)

Energy Security

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

Environmental Sustainability

- CO₂ emissions
- Competition for land (biofuels)
- Water use (unconventional oil and gas)

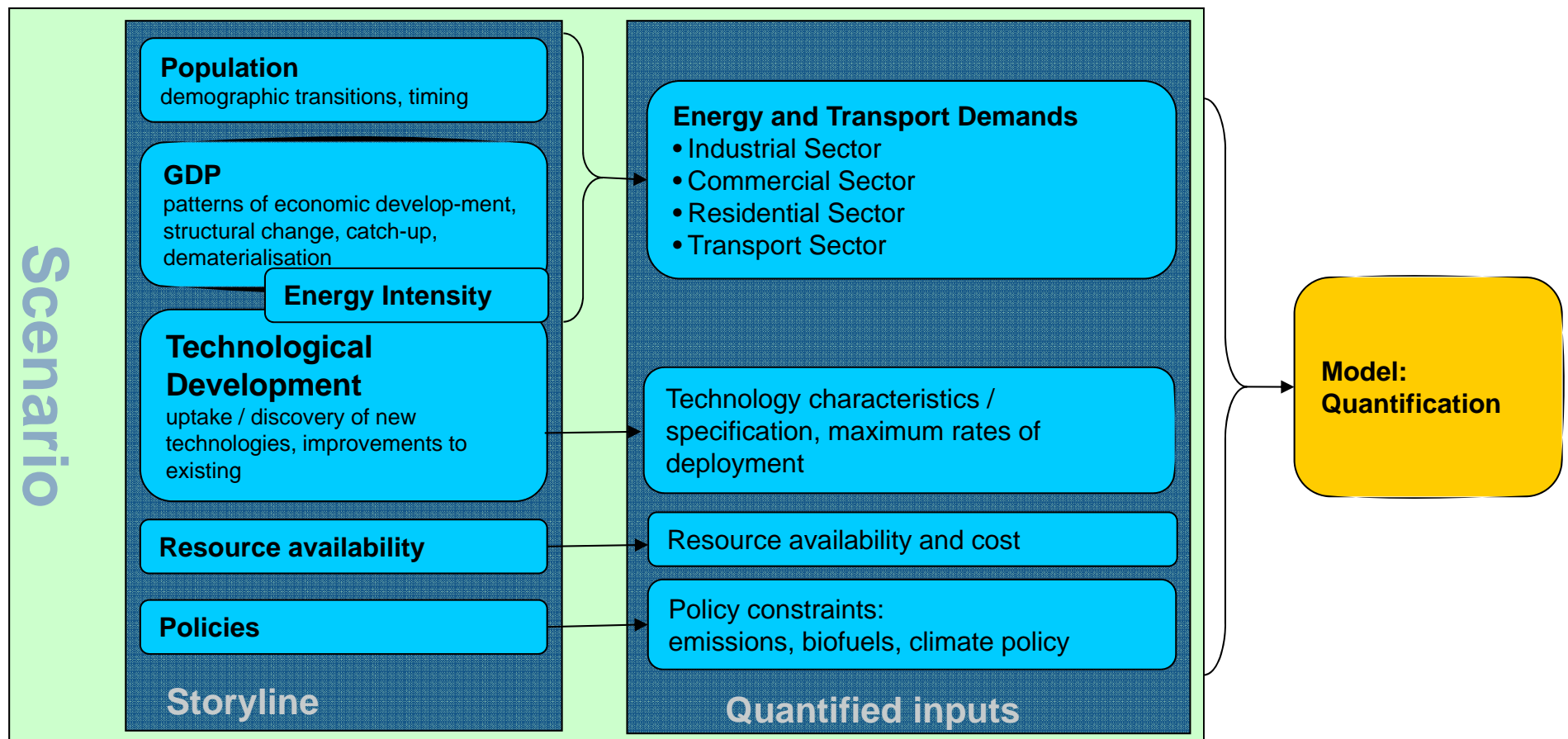


Model description and quantification of scenario stories

- 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

Energy Model Framework: Key scenario drivers

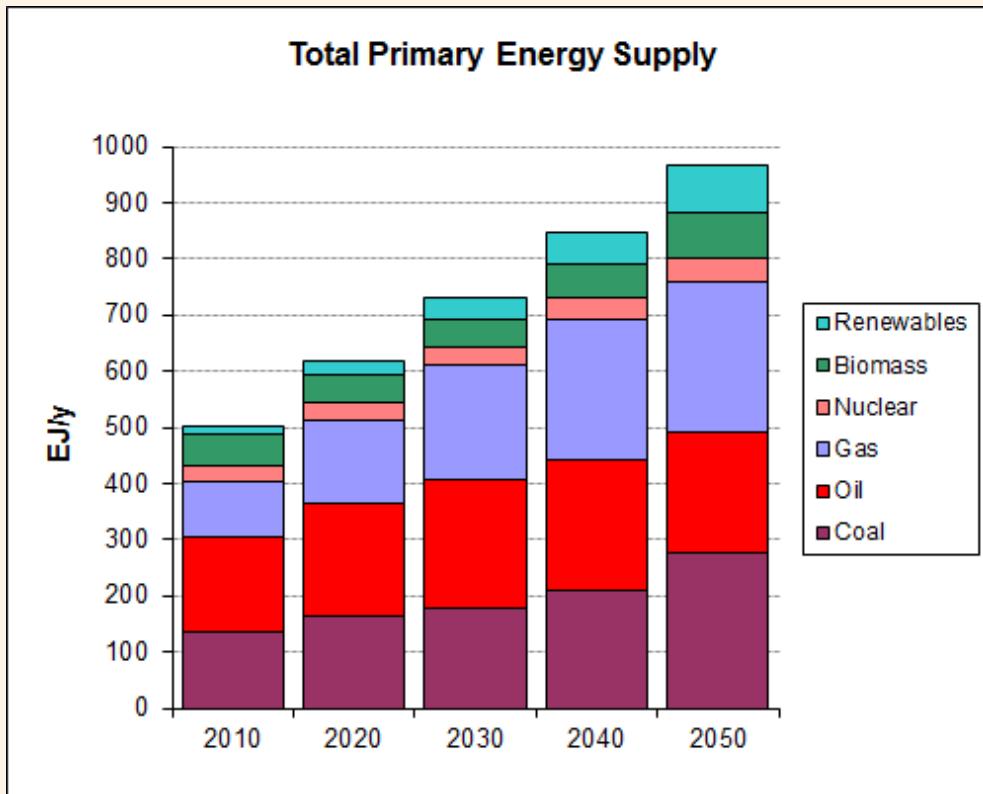
- Evolutions of key scenario drivers are expressed in a **coherent storyline** of future economic and social developments
- Some drivers are **interdependent**, e.g. energy intensity
- Drivers must be **translated into quantified inputs** for the energy system models



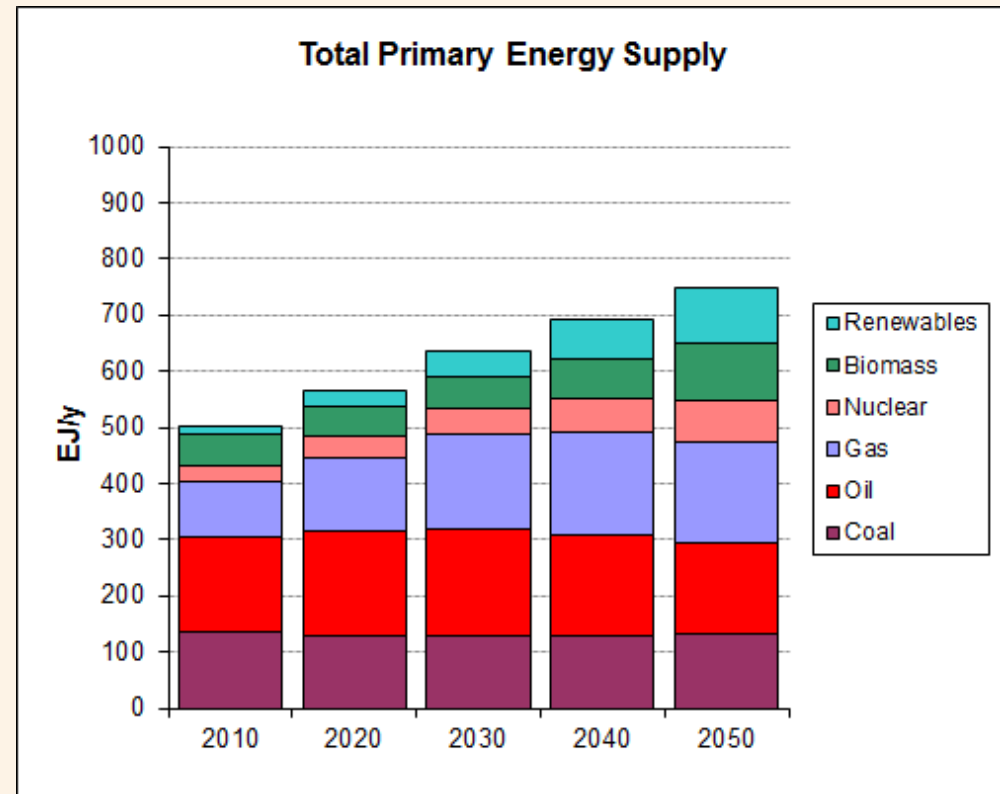
Latest Modelling results

Quantification of Scenarios: TPES

Jazz



Symphony



Source: PSI (2012)-Third modelling run (26 October 2012), Model run 4: amended model run for the symphony scenario only

Latest Modelling results

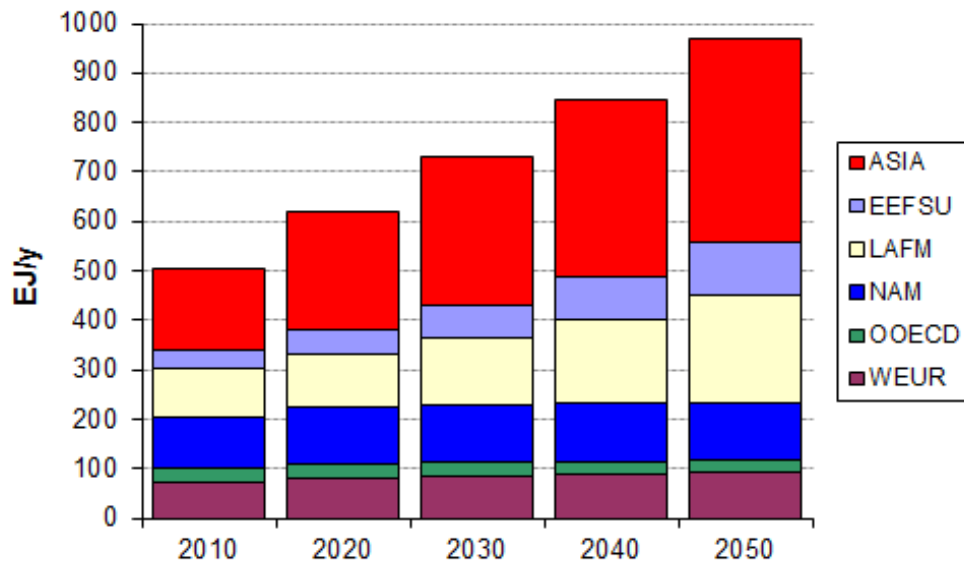
Quantification of Scenarios: TPES

by region

Jazz

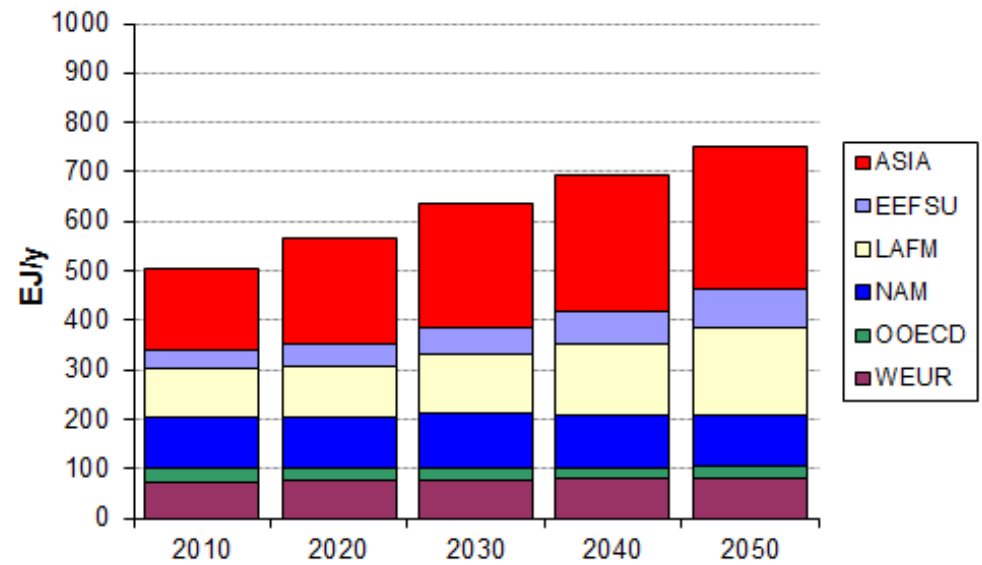
Symphony

Total Primary Energy Supply



ASIA: Asia; EEFSU: Former Soviet Union; LAFM: Latin America, Africa, Middle East;
NAM: North America; OECD: Other OECD; WEUR: EU-27 + Norway + Switzerland

Total Primary Energy Supply



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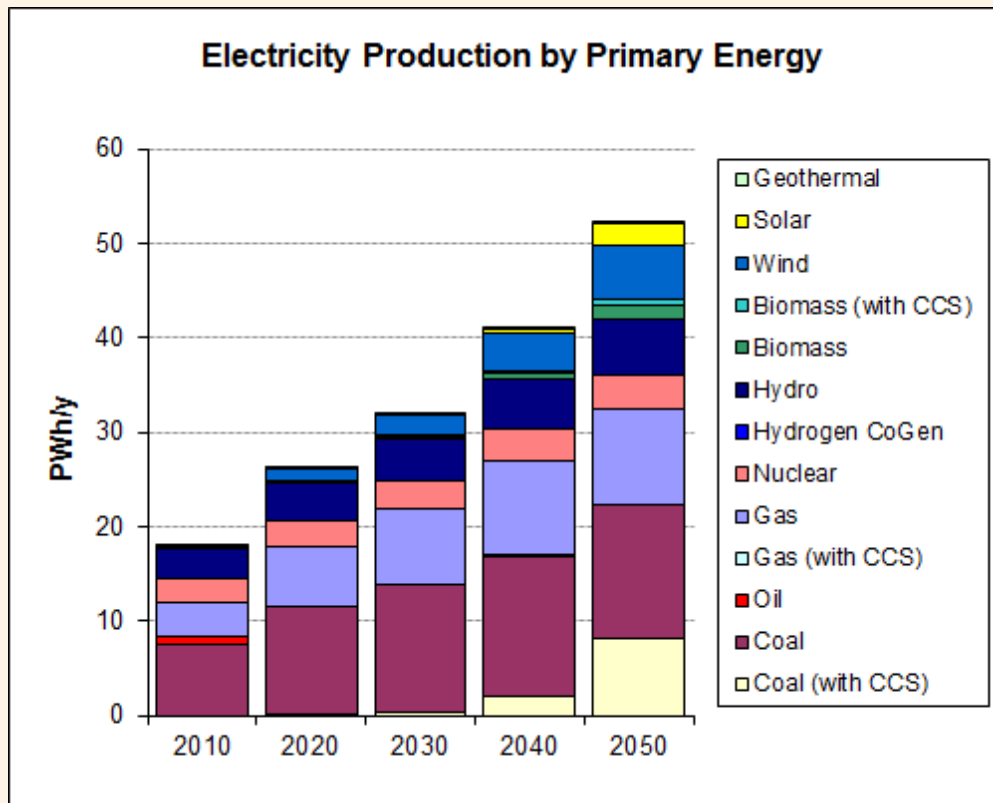
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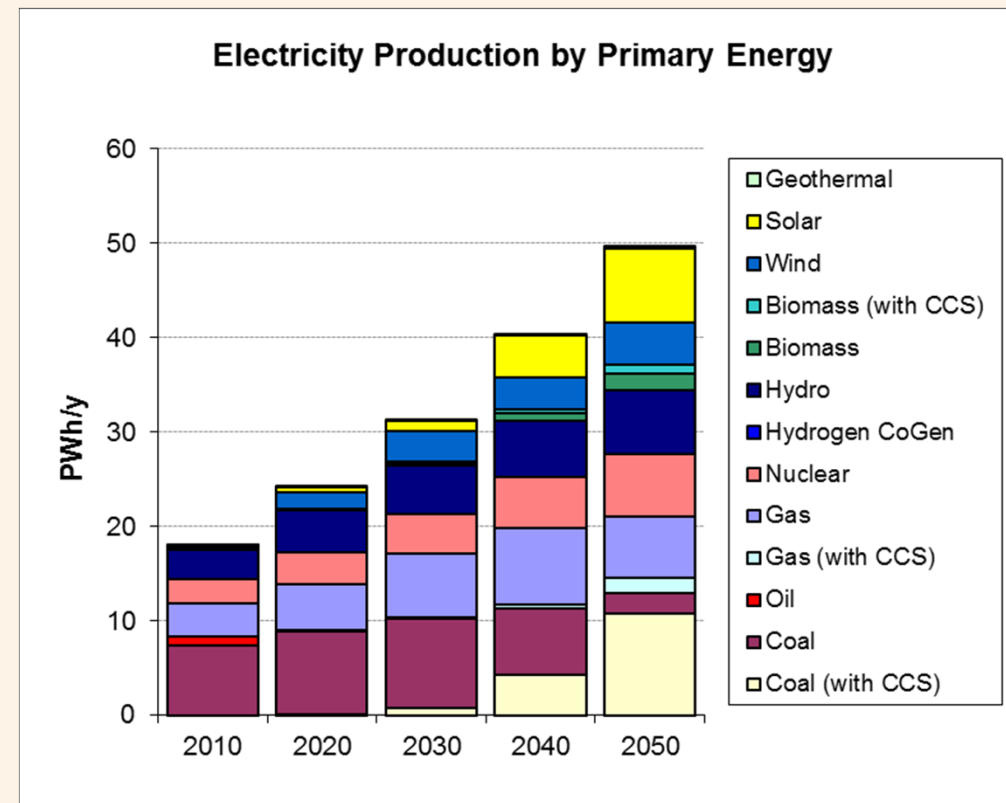
Amended run for the symphony scenario

Quantification of Scenarios: Electricity Production

Jazz



Symphony



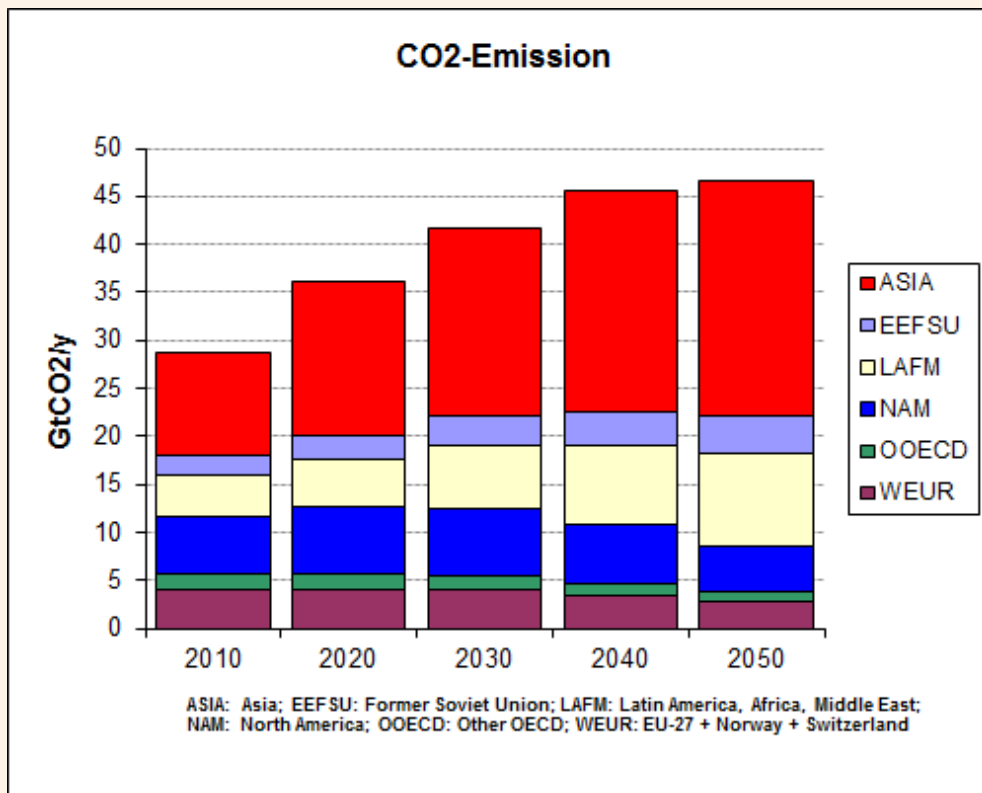
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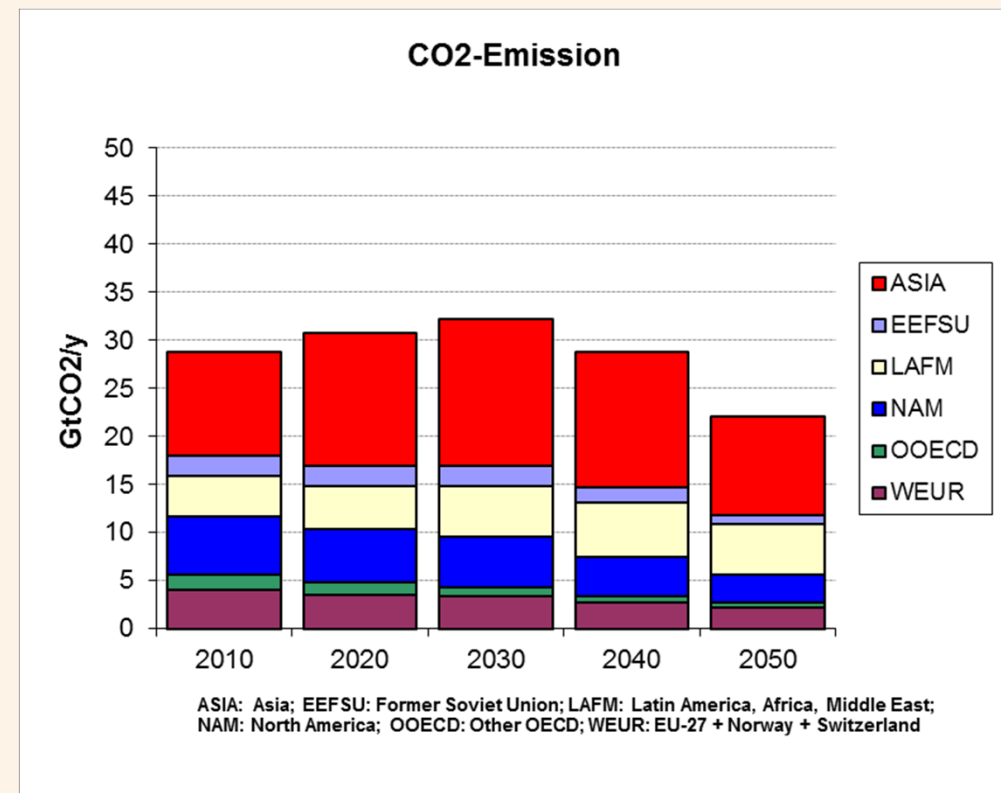
Amended run for the symphony scenario

Quantification of Scenarios: CO₂ emissions

Jazz



Symphony



Source: PSI (2012)-Third modelling run (26 October 2012), Model run 4: amended model run for the symphony scenario only

Balancing the “Energy Trilemma”

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

Energy security

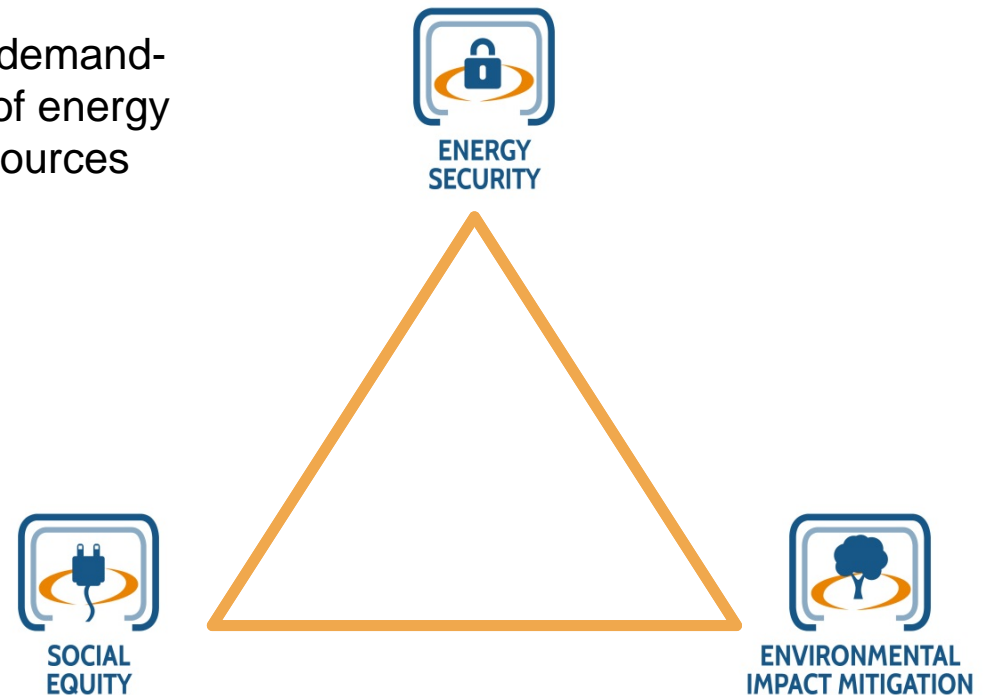
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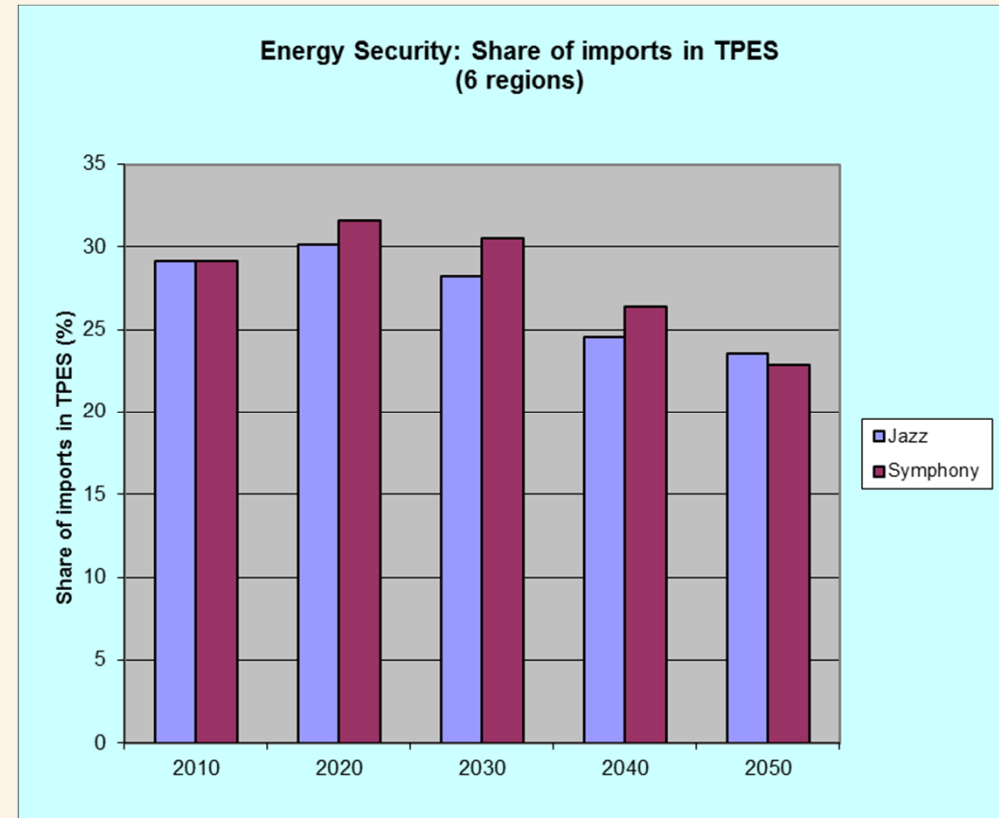
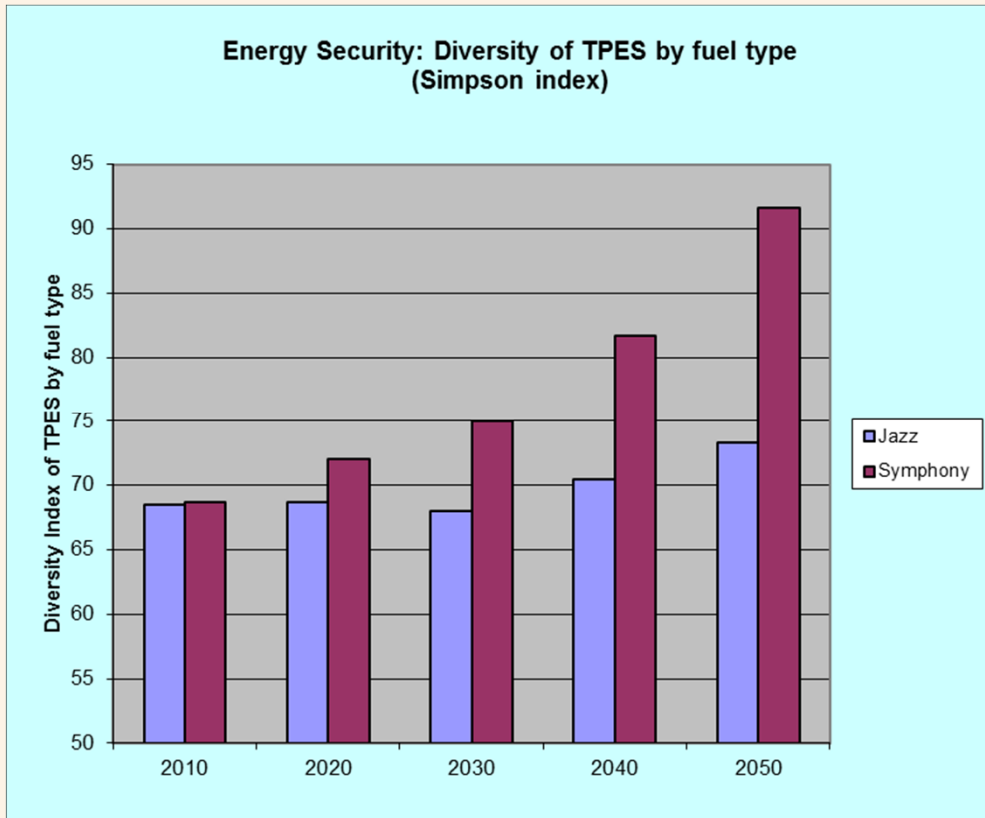
Social equity

Accessibility and affordability of energy supply across the population



Including the trilemma indicators

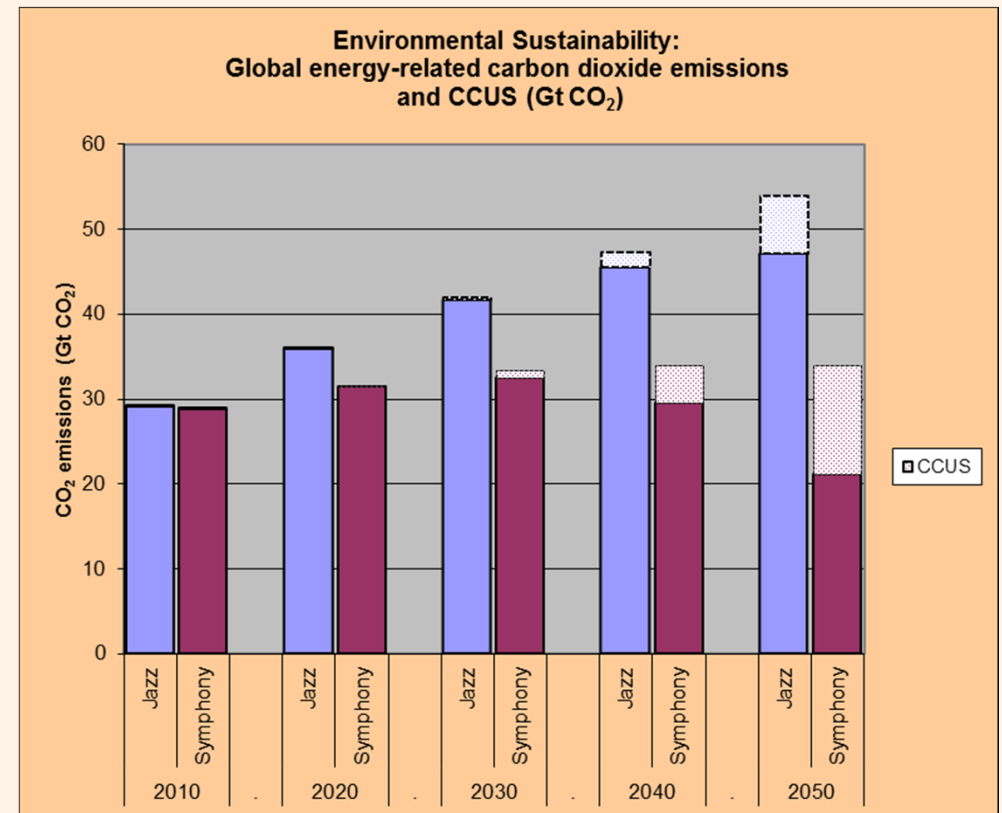
Energy Security



Source: PSI (2012)-Draft trilemma indicators, based on third modelling run (26 October 2012)

Including the trilemma indicators Environmental Sustainability

- Symphony has less carbon emissions, but more carbon-capture with storage (CCS); CCS may have social and environmental issues



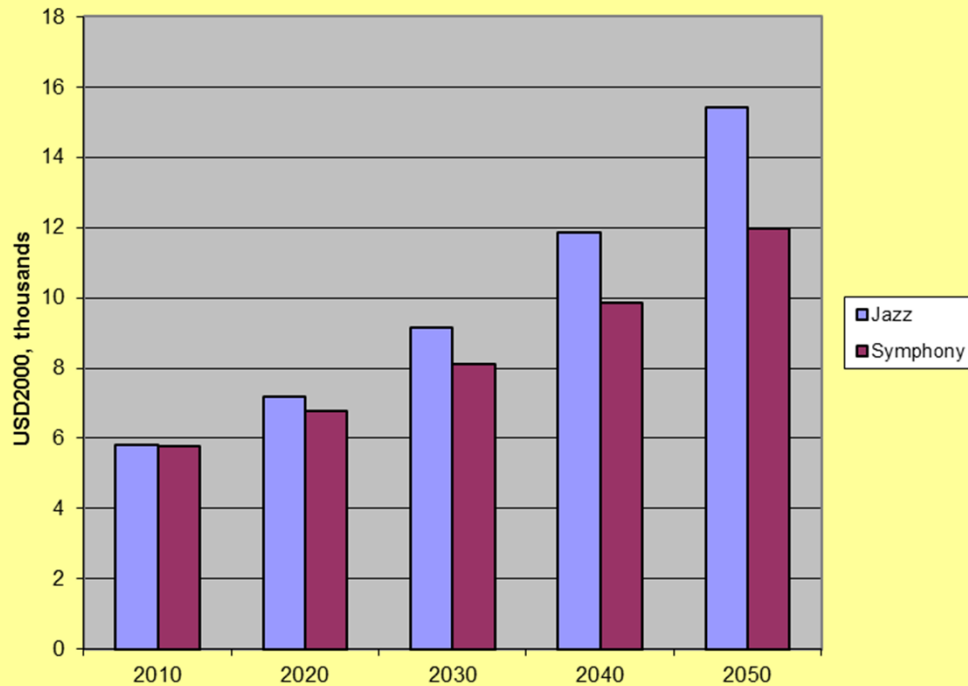
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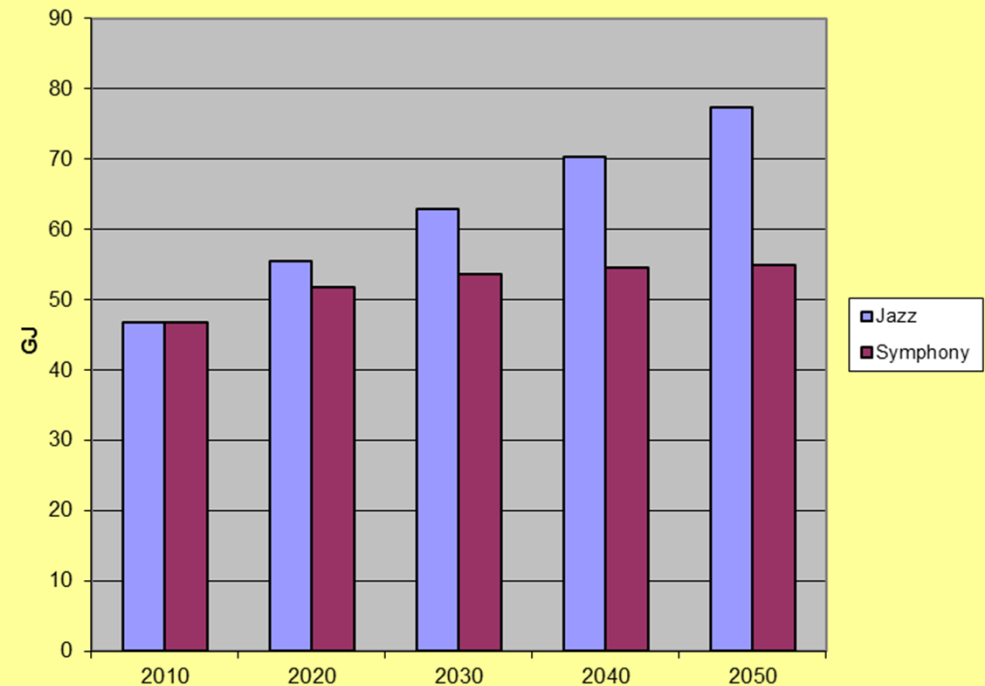
Social Equity

- Global income per capita-can be seen as a measure for affordability of energy
- Final energy per capita-measures access to retail energy

Social Equity: Global income per capita

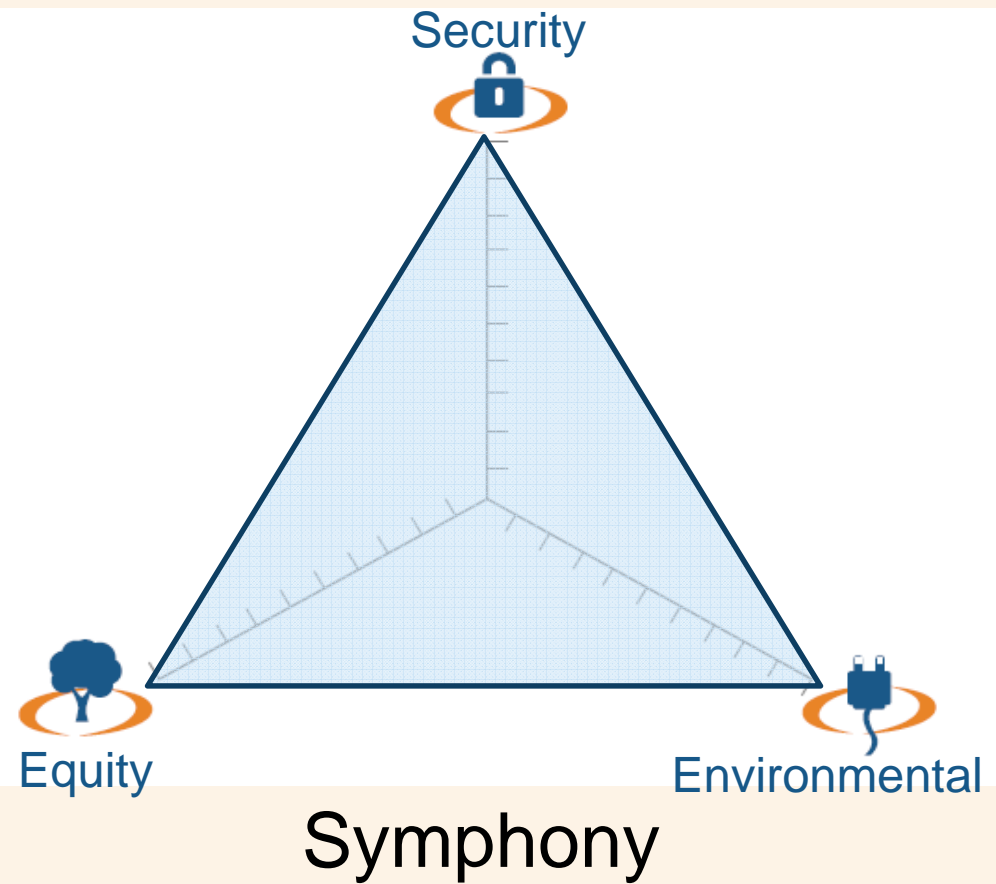
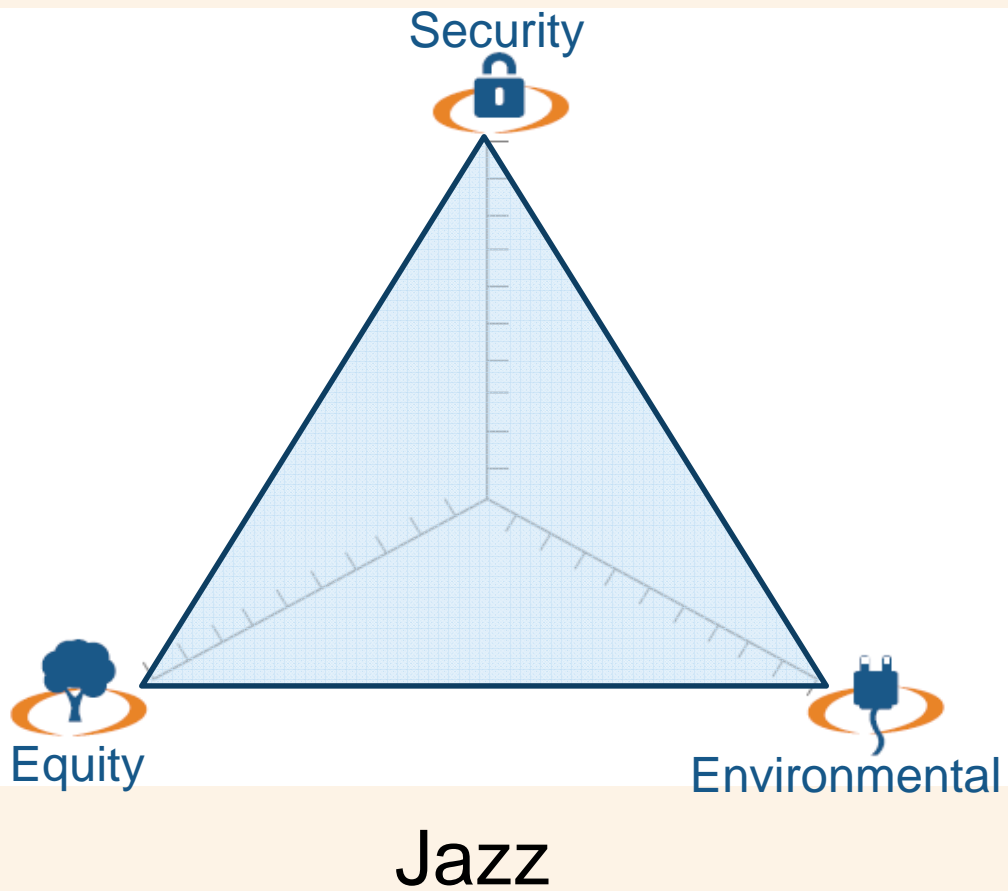


Social Equity: Final energy consumption per capita



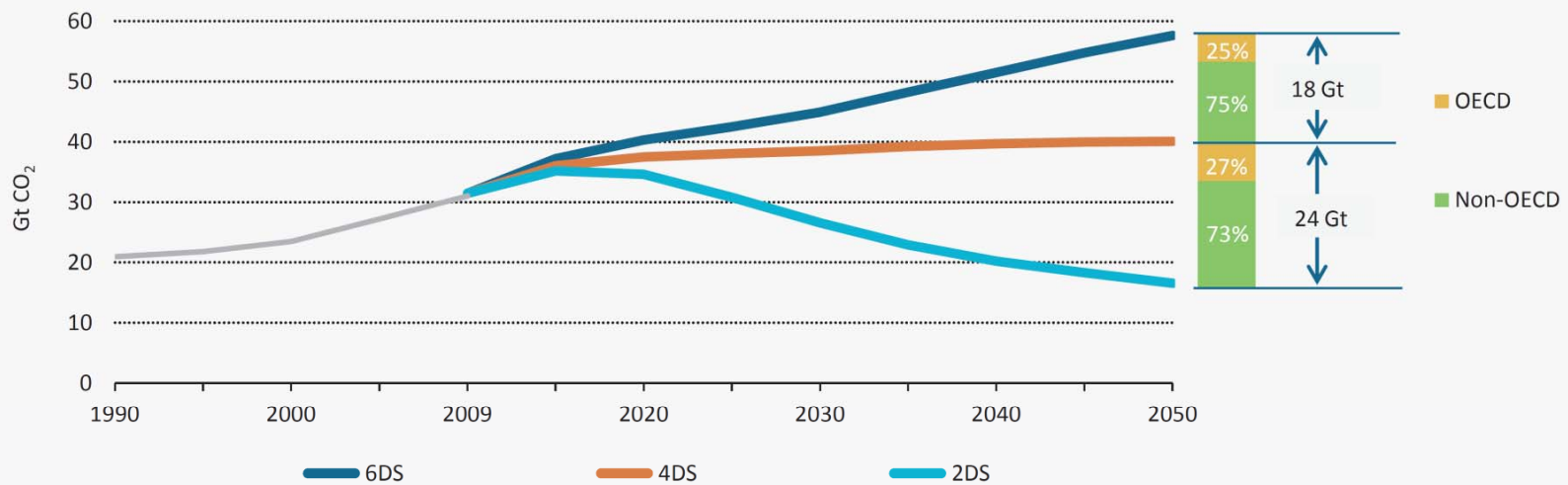
Source: PSI (2012)-Draft trilemma indicators, based on third modelling run (26 October 2012)

What do you think ?



CO₂ trajectories of the world and global warming

Figure 1.3 ETP 2012 scenario CO₂ emissions pathways



Key point Global energy-related CO₂ emissions in 2050 must be half of current levels to limit the global temperature increase to 2°C.

CO₂ trajectories of the world and global warming

- Where does the “Jazz” scenario lead in terms of climate change: +6°? even more?
where does the “Symphony” scenario lead in terms of climate change?
- GMM covers the carbon dioxide emissions from the energy sector, which constitute the major part of all emissions. Not covered emissions are:

Other greenhouse gases: Methane, NO_x, F-gases (HFCs, PFCs, SF₆, etc.)

Emissions from outside the energy sectors: from industry, deforestation, decay, agriculture

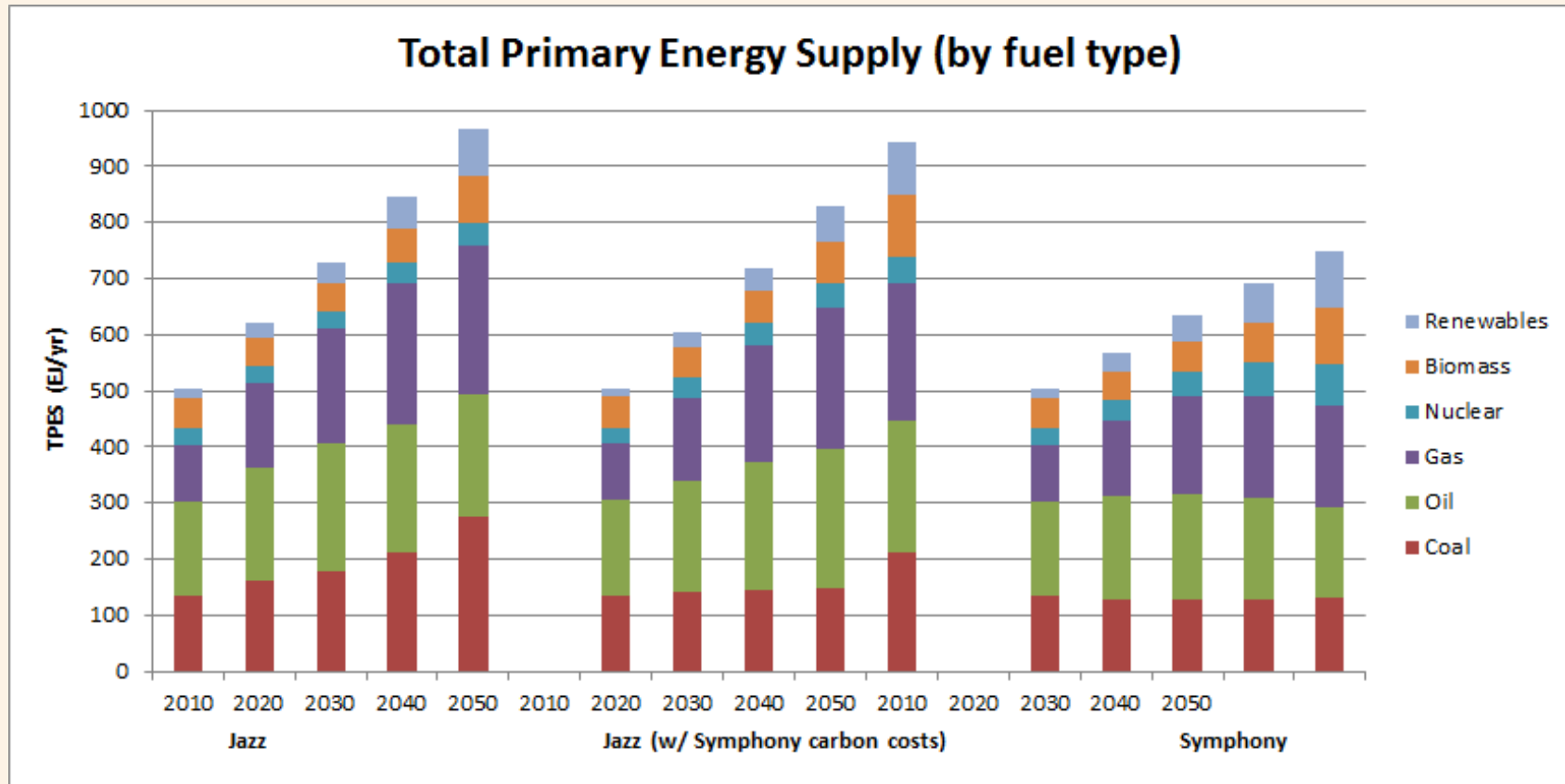
GMM has no climate module, but emissions may be compared with IEA's ETP 2012 scenarios

- **Jazz is between the 4- and 6-degree scenarios**
- **Symphony is between 2- and 4-degree**

CO₂ price assumptions

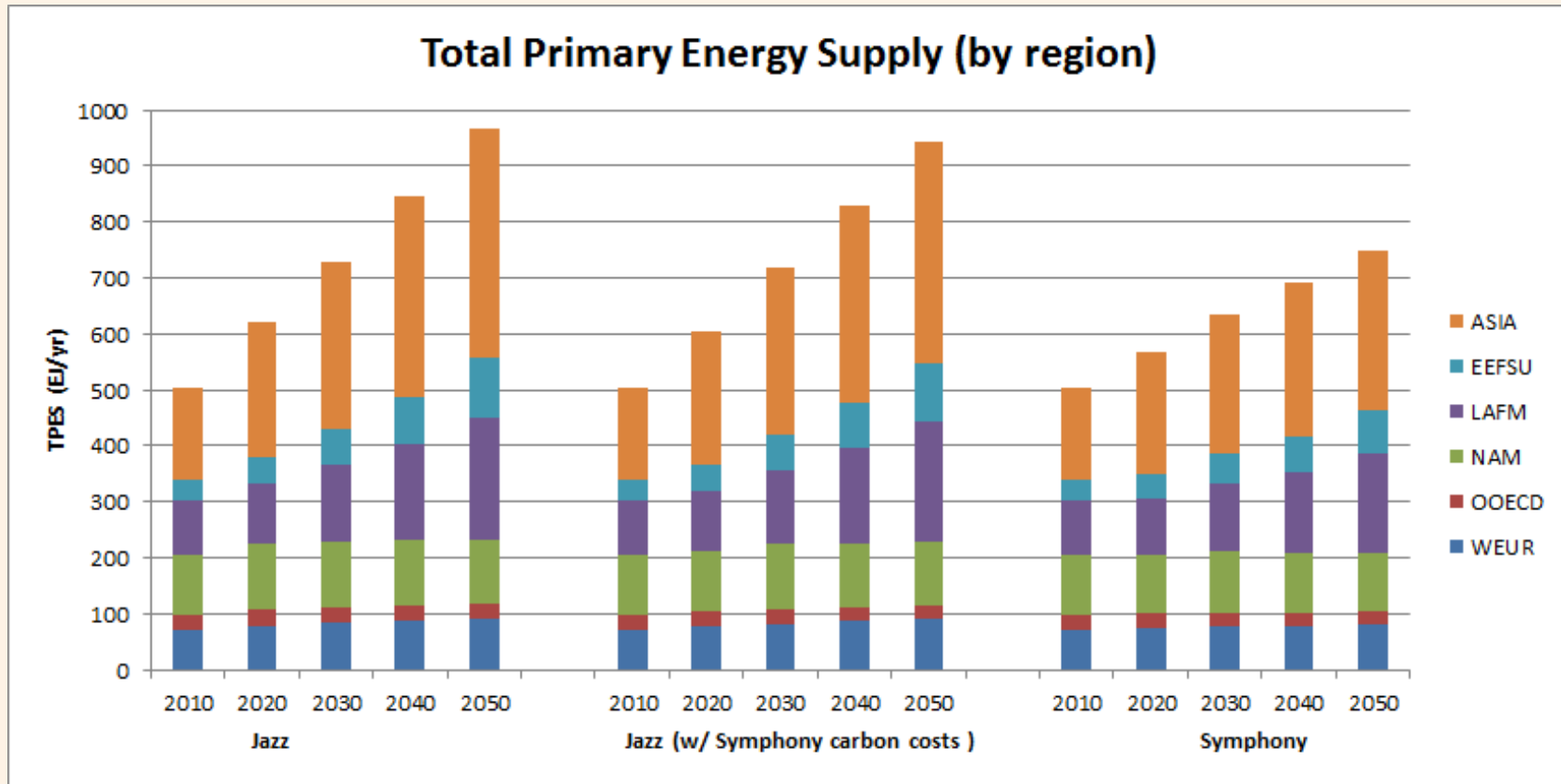
Cost of CO ₂		2010	2020	2030	2040	2050
Jazz						
ASIA	USD(2000)/tCO ₂	0	0	4	8	18
EEFSU	USD(2000)/tCO ₂	0	0	4	8	18
LAFM	USD(2000)/tCO ₂	0	0	4	8	18
NAM	USD(2000)/tCO ₂	0	0	12	17	22
OOECD	USD(2000)/tCO ₂	0	0	9	19	30
WEUR	USD(2000)/tCO ₂	0	0	12	24	35
Symphony						
ASIA	USD(2000)/tCO ₂	0	8	18	39	59
EEFSU	USD(2000)/tCO ₂	0	8	18	39	59
LAFM	USD(2000)/tCO ₂	0	8	18	33	55
NAM	USD(2000)/tCO ₂	12	17	22	43	55
OOECD	USD(2000)/tCO ₂	9	19	30	47	59
WEUR	USD(2000)/tCO ₂	12	24	31	47	63

Sensitivity analysis: Assumptions of Jazz with carbon costs of Symphony



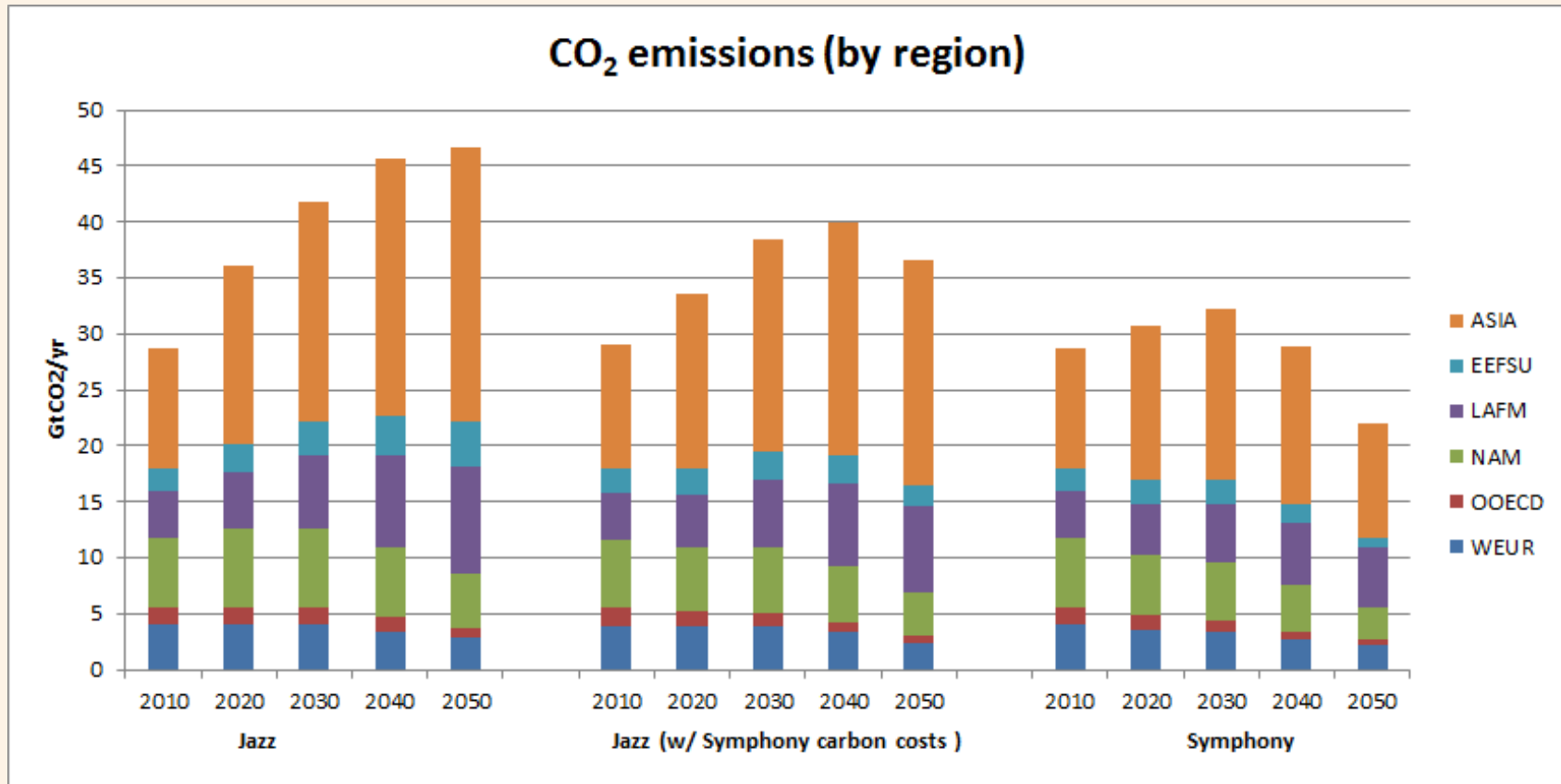
Source: PSI (2012)-Third modelling run (26 October 2012), Model run 4: amended model run for the symphony scenario only
in the middle: Jazz with early carbon cost

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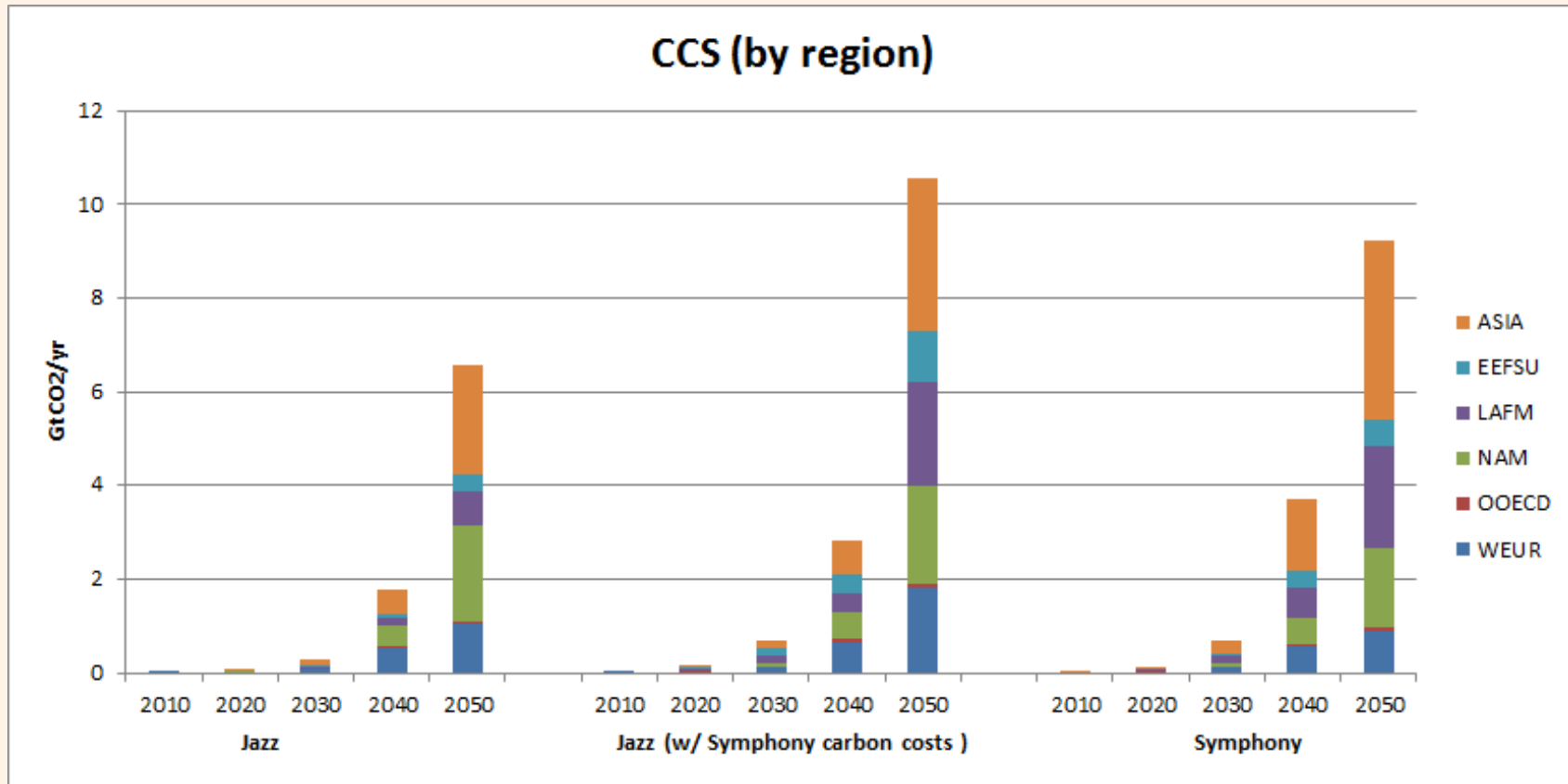
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Sensitivity analysis

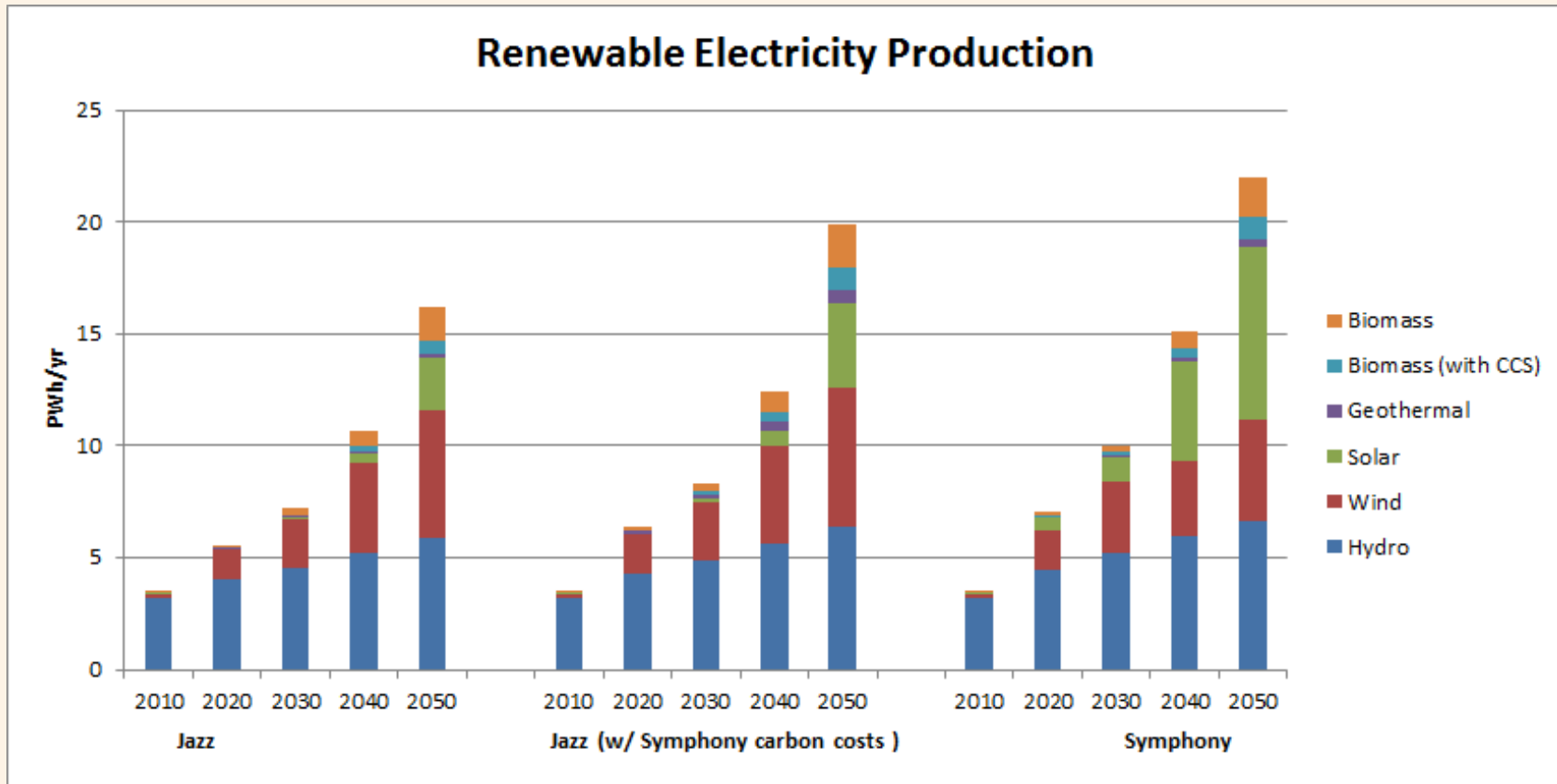
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Sensitivity analysis

Assumptions of Jazz with carbon costs of Symphony



Source: PSI (2012)-Third modelling run (26 October 2012), Model run 4: amended model run for the symphony scenario only in the middle: Jazz with early carbon cost

WEC Scenarios: Emerging messages

1. Oil:

- a) Will continue to remain dominant for transport
- b) Increase in importance of unconventional – oil sands, oil shale
- c) Refining sector reconfiguration – meeting demand in Asia

2. Gas:

- a) Increasingly important for power generation, especially in Europe & NAM
- b) Increasing reliance of Japan post-Fukushima – impact on Asian LNG
- c) Cost of Australian LNG projects will determine shift to gas in Asia
- d) Rise of shale gas

3. Coal:

- a) Important for power generation in India and China
- b) Possible CTL projects as demand for transport fuels soars?
- c) Increasing challenges around CCS

4. Nuclear:

- a) Matter of energy security
- b) Main drivers: government policy & NPT agreements
- c) Public resistance to nuclear

WEC Scenarios India Workshop: Emerging messages

- 
5. Renewables:
 - a) Solar: high potential, rural electrification
 - b) Wind: potential sites in China and India
 - c) Bottlenecks – transmission and distribution issues, Centre vs. State relations
 6. Energy efficiency
 - a) Last resort in face of demand outstripping supply?
 - b) Change in mindset of consumers
 - c) Cost implications across industries – capital required versus savings