

# **COMPARING AND USING GLOBAL ENERGY SCENARIOS**

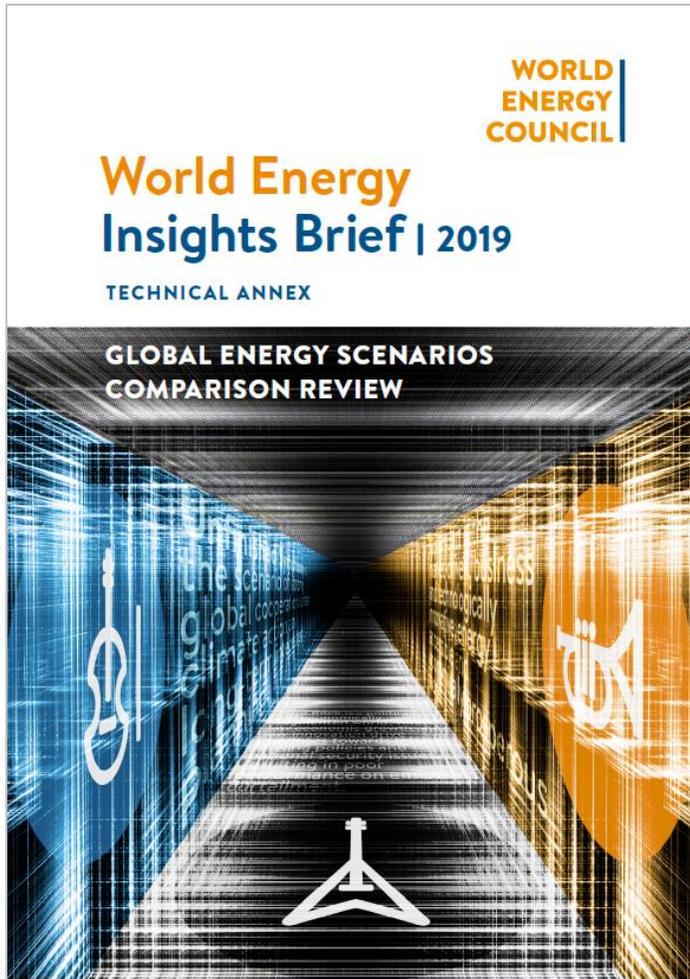
**IRENA, 2019 International Forum on  
Long-term Energy Scenarios for the Clean Energy Transition  
10 April, 2019 | Berlin**

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# Inevitable transition, deeply uncertain success



## A decade of experience in building and using global energy scenarios:

- Energy systems shaped by many and more diverse actors
- Energy transition part of a much wider Grand Transition, which is not all about energy
- Relying on quant. modelling and better forecasting to manage successful transition will be fatal, even in a data-rich era.

## It is timely for energy leaders to ask:

- What can we learn by contrasting the increasing richness of energy futures thinking?
- How do the Council's scenarios compare with global energy outlooks, scenarios and visions used by others?

*Global Energy Scenarios Comparison Review – released by Council in April 2019, available at <https://www.worldenergy.org/publications/>*

# World Energy Scenarios (2016): at glance

Multi-stakeholder, multi-stage process aimed at **useful and usable, technology- and resource-neutral global energy scenarios**. In 2016 our focus was on climate negotiations.

## PRE-DETERMINED FACTORS: The Grand Transition

-  Population / Workforce
-  New technologies
-  Planetary boundaries
-  Shift in power

## CRITICAL UNCERTAINTIES

-  Pace of innovation and productivity
-  Int'l governance & geo-political change
-  Priority given to climate change
-  'Tools for action' - markets vs state

## THREE ALTERNATIVE PATHWAYS to 2060



### Modern Jazz

Market mechanisms, technology innovation, energy access for all



### Unfinished Symphony

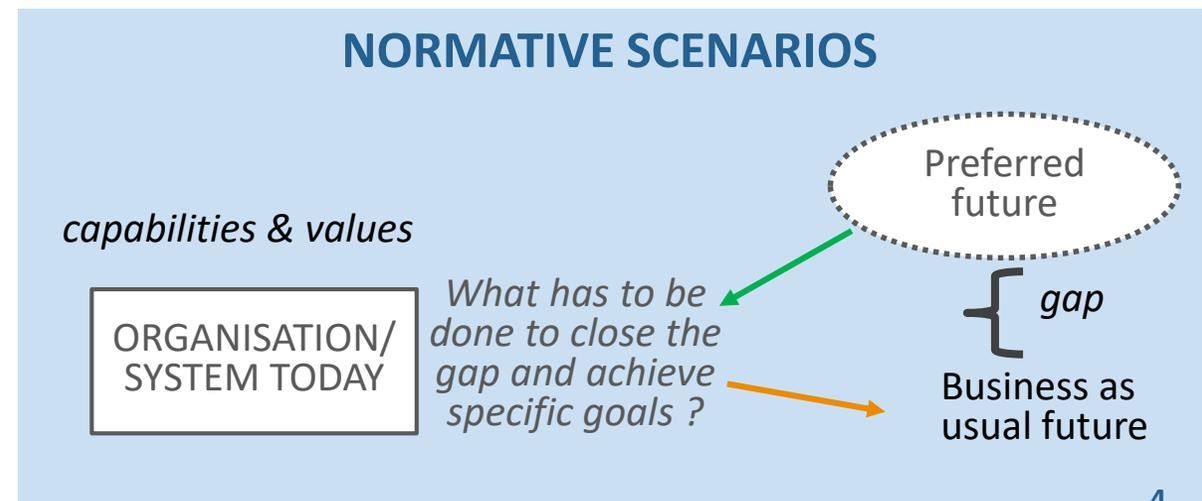
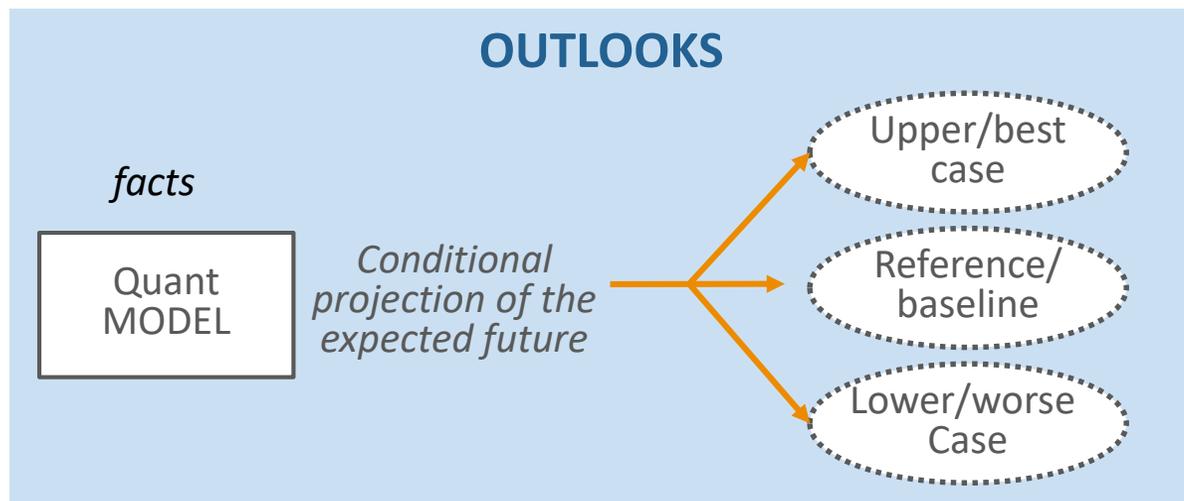
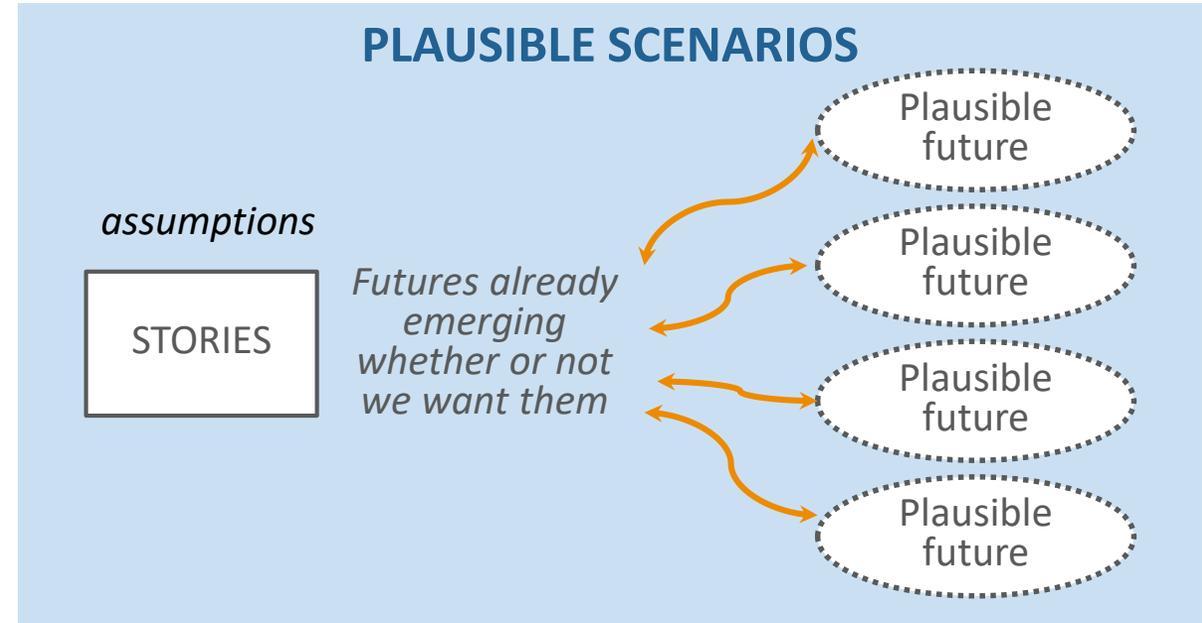
Strong policy, long-term planning, united climate action



### Hard Rock

Fragmented scenario, inward looking policies, low global cooperation

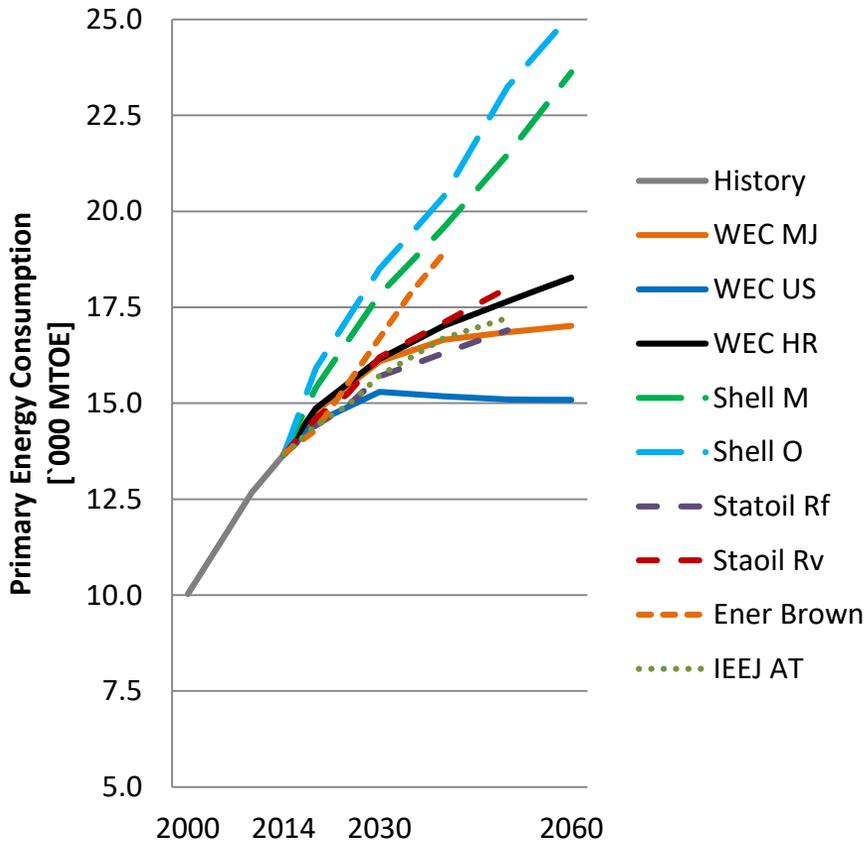
# Different types of global energy scenarios compared



# Primary Energy Demand

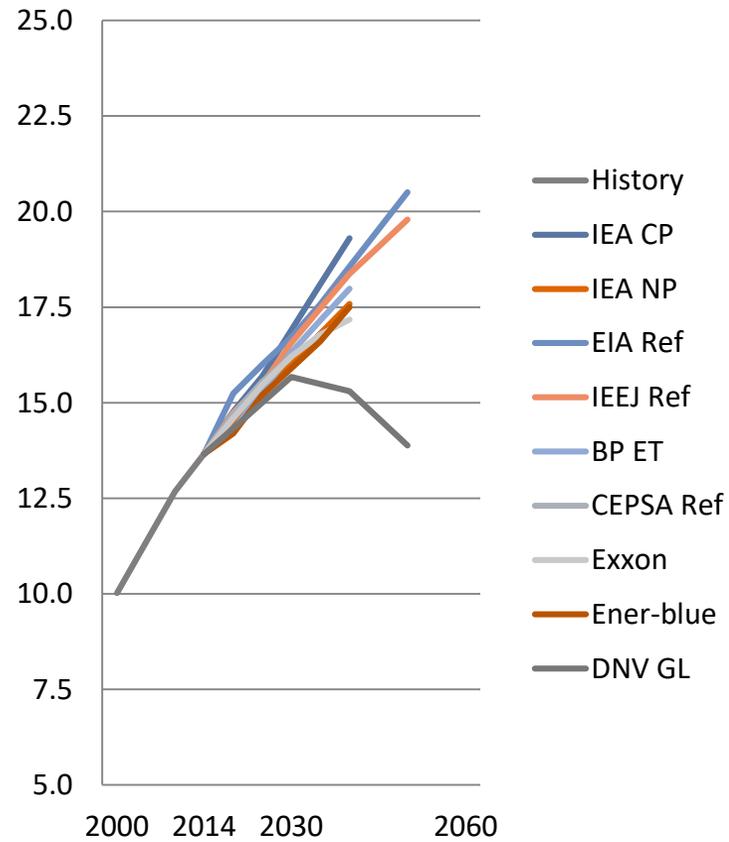
*Contrasting patterns and digging into different assumptions*

## Plausible Scenarios



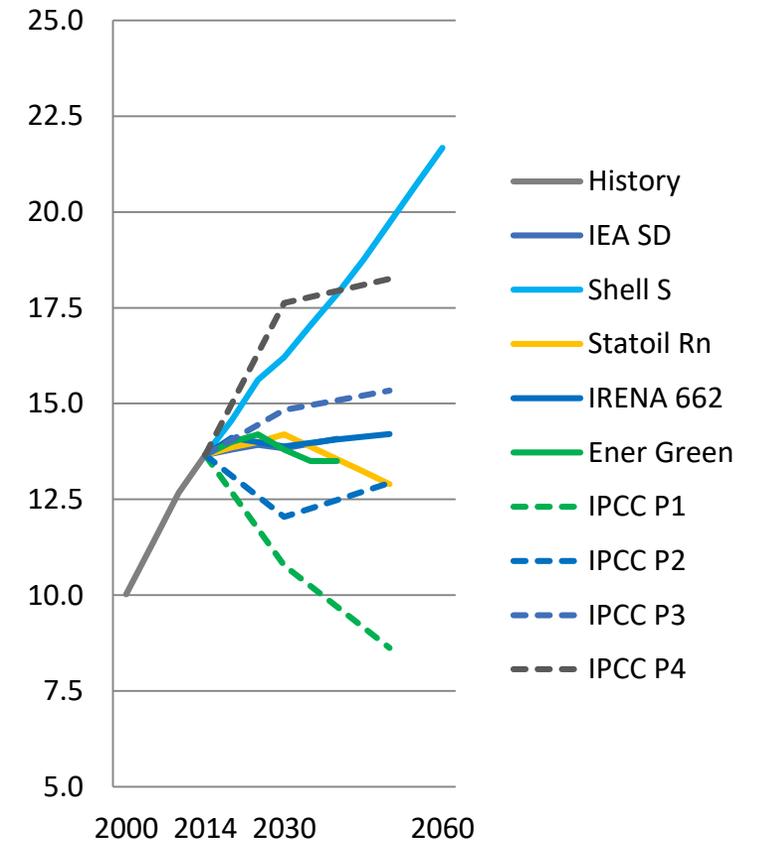
Plausible: WEC MJ (Modern Jazz), WEC US (Unfinished Symphony), WEC HR (Hard Rock), Shell M (Mountain), Shell O (Ocean), Statoil Rf (Reform), Statoil Rv (Rivalry), Ener-Brown, IEEJ AT (Advanced Technology)

## Outlooks



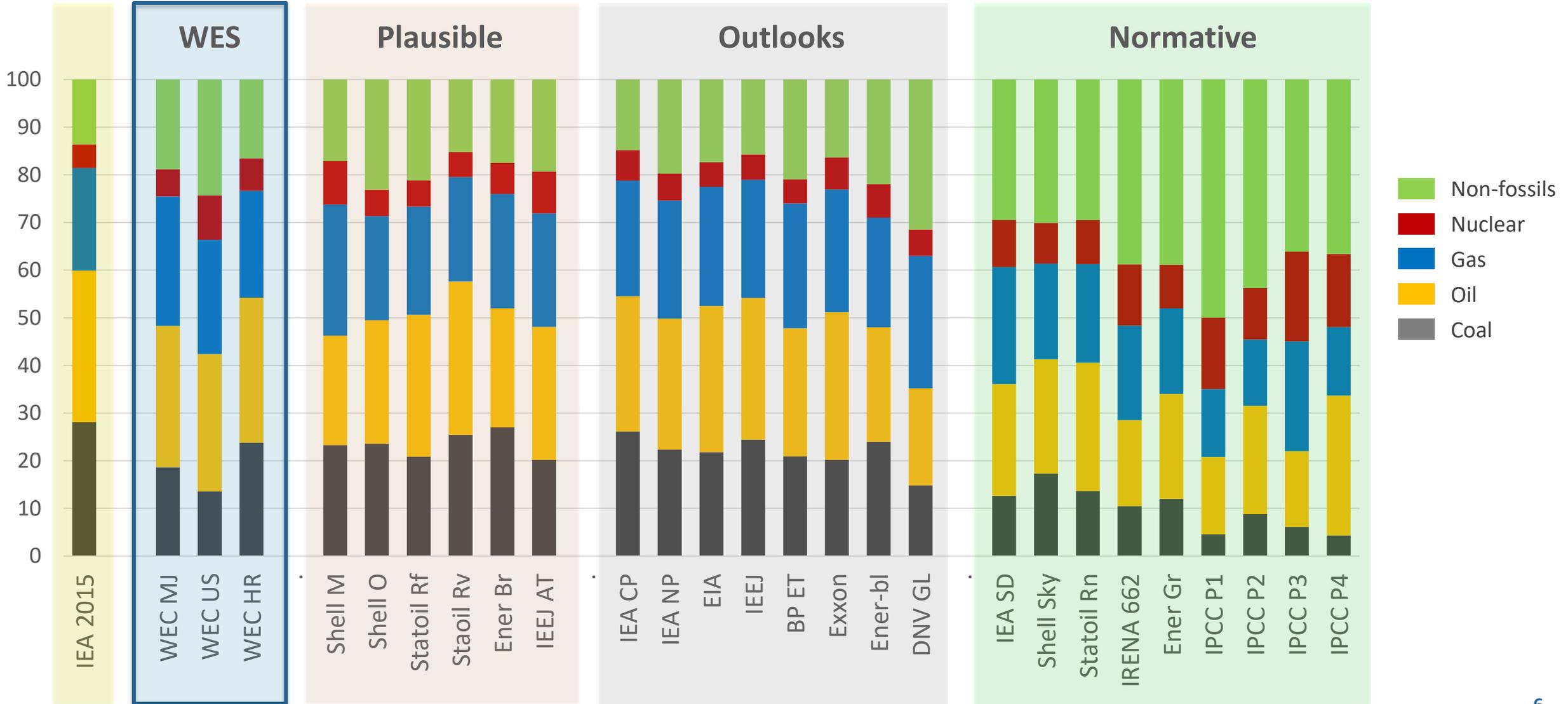
Outlooks: IEA CP (Current Policies), IEA NP (New Policies), EIA Ref (Reference), IEEJ Ref (Reference), BP (Evolving Transition), CEPSA Ref (Reference), Exxon (Reference), Ener-Blue, DNV GL

## Normative Scenarios



Normative: IEA SD (Sustainable Development), Shell S (Sky), Statoil Rn (Renewal), IRENA 662 (66% below 2°C), Ener-Green, IPCC P1 (Low Energy Demand), IPCC P2 (Sustainability), IPCC P3 (Middle of the Road), IPCC P4 (Fossil-Fuelled Development)

# Energy mix by 2040 (%)



# Comparing energy foresight : key insights

## Similarity on new realities

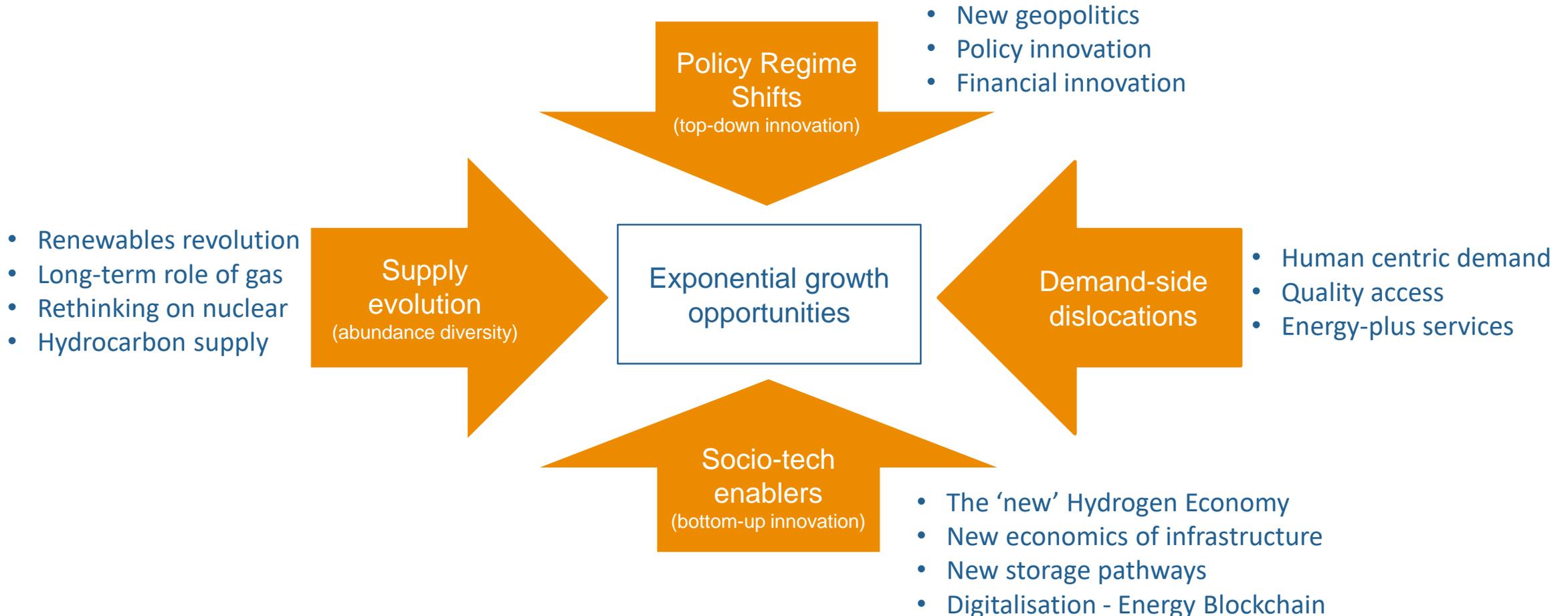
- Energy system is more **dynamic and diverse** – **social complexity makes transition management messier**
- **Globally coordinated action and policies** are key to accelerating successful global transitions
- Rapid growth of **renewables in acceleration of electrification**, however **fossil fuels** remain an important part of the global energy mix.
- New energy abundance is **shifting competition in diversification of energy mix** - increasing attention to **artificial/synthetic** fuels, incl. H2
- Normative assumptions: reduction in overall energy demand growth, a strong **role for governments**, regional **integration**, global **cooperation** and a high level of **investment** in energy infrastructures

## What new developments need to be added?

- **Regional demographic diversity is increasing**
- **Alternative storage pathways are emerging**
- **A wider sustainability and well-living agenda**
- Systems innovation is key and **not just about digital and converging technology** – financial, regulatory and institutional innovations
- **Digitalisation in energy shifts power from supply to demand side** - new consumers, energy-plus services, innovation in adjacent sectors
- **Whole systems costs** of accelerating electrification via renewables and digitalisation
- New **geopolitics** - data as the new oil, manufacturing revolution enabling new trade patterns
- **Shifting social norms, new consumer behaviours and environmental feedback loops**

# Global energy foresight refresh (2019)

- Global member network horizon scanning - **validation of ‘nuanced’ archetypes**
- **100+** thought leadership interviews, digging into **14 key themes of change**
- Creating three global stories to 2040 (launch at the 24<sup>th</sup> World Energy Congress)



# Using global energy scenarios is not straight-forward

*User-centric design in application – curating new experiences, combining with other tools*



## GLOBAL VIEW

**The Grand Transition:** Global energy scenarios to 2060 (2016)

**Global Energy Foresight Refresh** – scenarios to 2040 with ‘innovation twist’ (in progress 2019)



## REGIONAL PERSPECTIVES

Latin America & Caribbean scenarios (2016), Sub-Saharan Africa Perspective (2017)

European regional scenarios, **Middle East & Gulf States** with GCC focus (in progress 2019)



## SECTORAL PERSPECTIVES

Natural gas perspectives (2017)

**New Nuclear Insights Brief** (in progress 2019)



## FOCUSSED APPLICATION

Business Model Innovation: Mexico Pilot (2017)

Energy policy gaming (in progress, 2019)

**Constellations of Disruptions** (in progress, 2019)



## Using scenarios with other tools

*The Council is developing actionable insights and tools for impact to enable its members and users to manage successful energy transition*



**World Energy Scenarios:** a tool for bigger picture thinking, revealing deeper assumptions and reframing choices and options



**Energy Policy Trilemma:** policy pathfinding to manage security, equity and sustainability through transition



**Dynamic Resilience:** better prepare firms for new shocks and stresses and adapt whole systems to emerging and systemic risks



**World Energy Issues Monitor:** reality check - global, regional, national energy leaders perspectives on the key challenges



**Innovation Insights:** digging deeper into disruptive dynamics and moving transition innovation from the margins to mainstream

# Supporting slides

# Key objectives

- Provide the Council's members with evidence of the **quality and credibility of the Council's global scenario work**
- **Check the continued plausibility, relevance and challenge** of the existing global archetype scenarios
- Promote **wider understanding and use** of its global, regional and thematic scenarios, and **variety of choices**
- Prepare our members to **engage with leadership dialogues on visions of new energy futures**, which reflect preferences and are used to advocate for specific resource and/or energy technology pathways

# Methodology and scope

The comparison review is undertaken by mixing:

- **Comparison of numbers, assumptions & narratives** of global energy scenarios from peer group
- A **wider strategic thinking** shaped from **expert engagements and leaders dialogues insights**.

**Criteria used to select a benchmarkable set of global energy scenarios:**

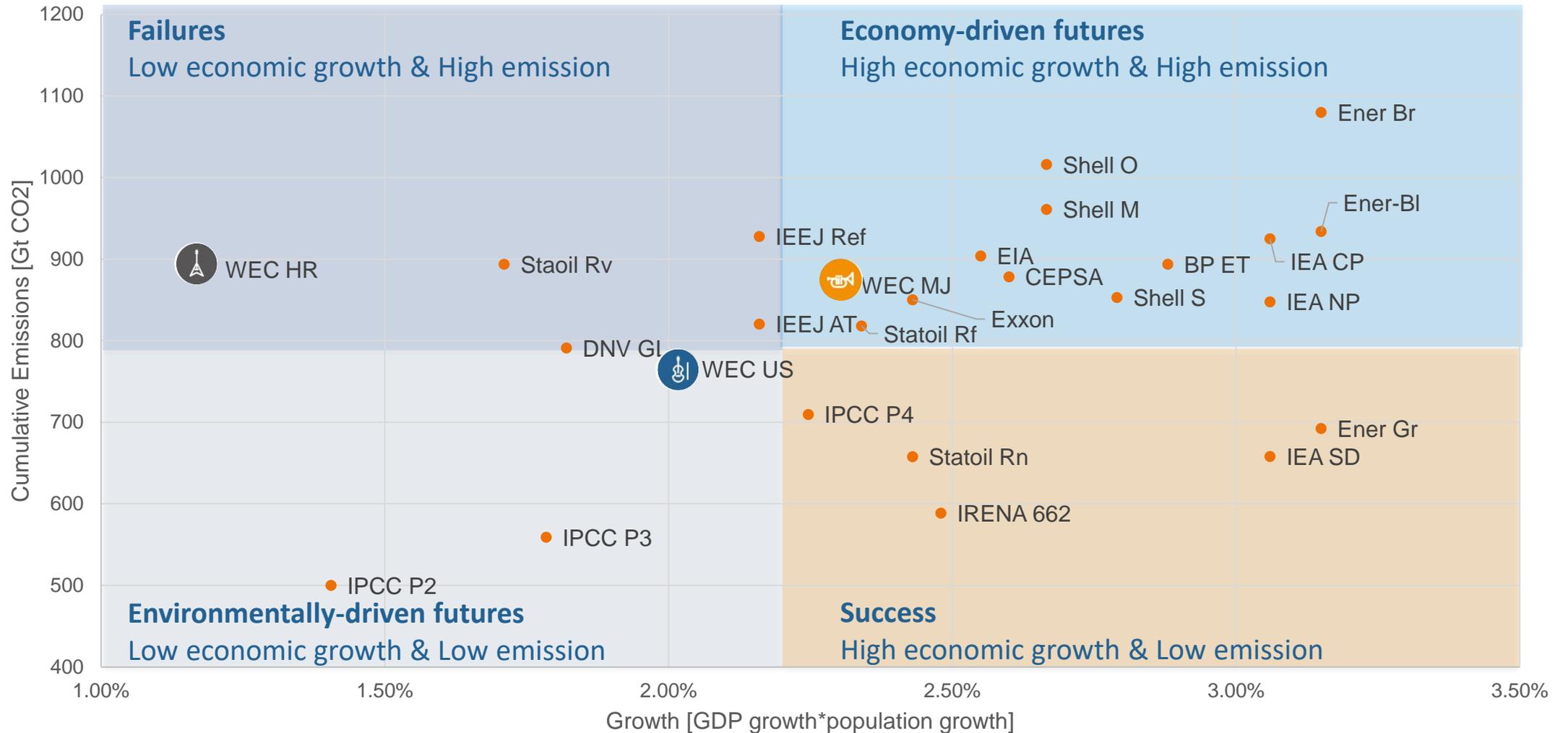
- Geographical focus: **global sets of scenarios** with no specific regional focus
- Minimum time horizon: **no earlier than 2030**
- Quantification and illustrative numbers: **no limitation to models used**
- Release date: recent reports published **no earlier than 2013**
- Energy system: representing **the whole energy system**

# Peer group selection

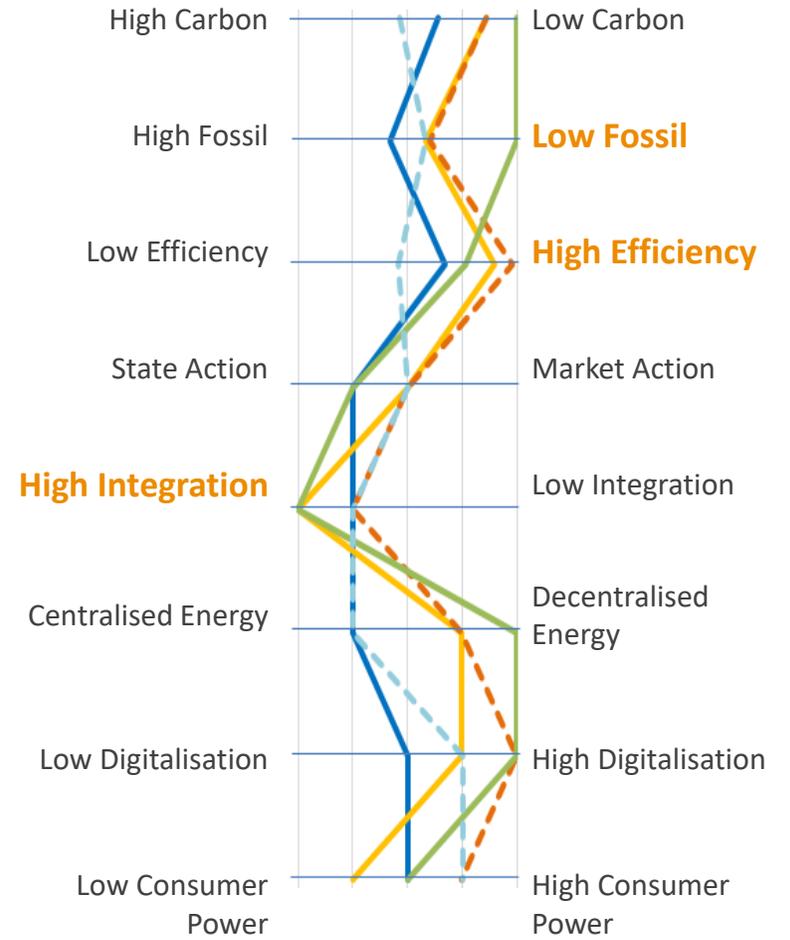
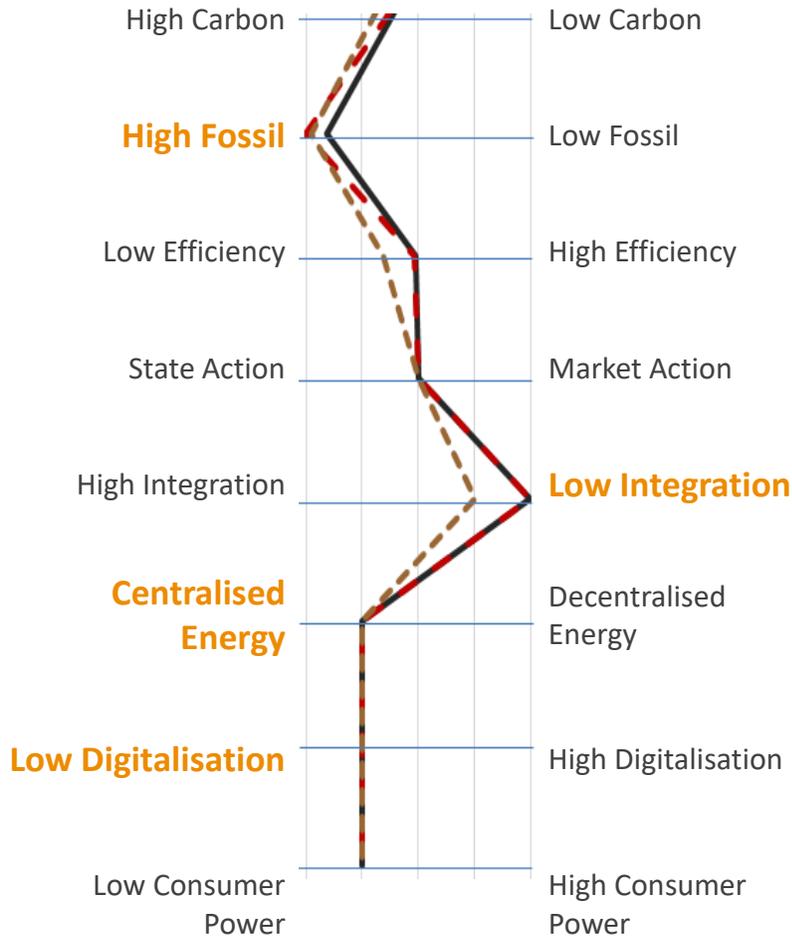
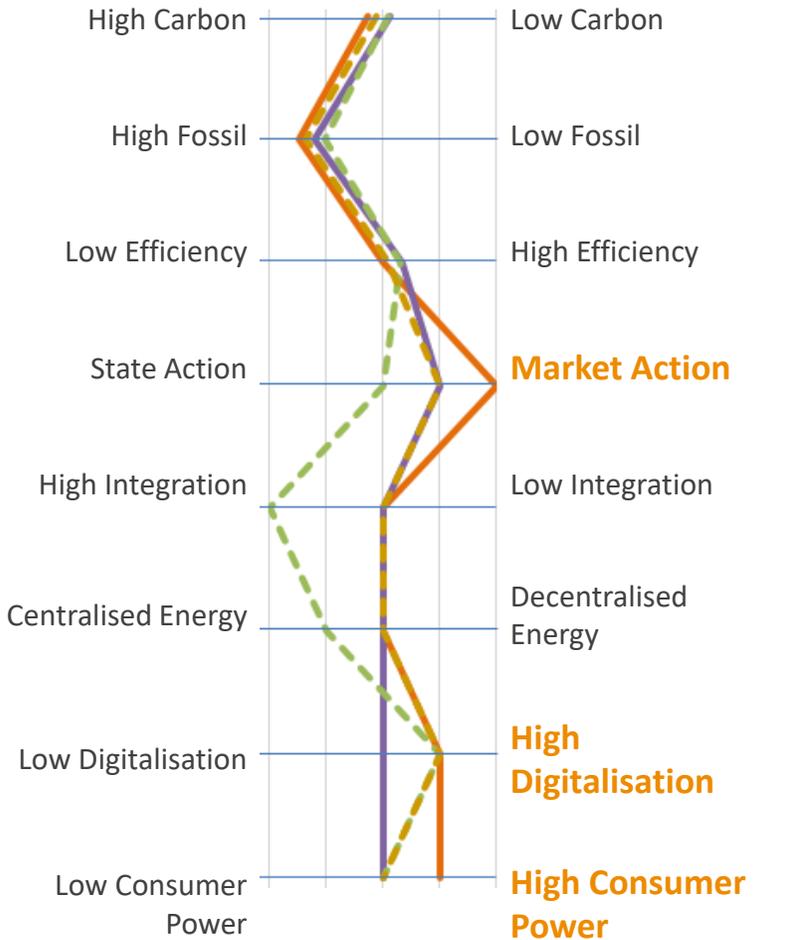
<i>Organisation / report</i>		<i>Names of energy futures</i>		
		Plausible scenarios	Outlooks	Normative scenarios
 <b>WEC</b> (2016) World Energy Scenarios to 2060		<ul style="list-style-type: none"> <li>• Modern Jazz (MJ)</li> <li>• Unfinished Symphony (US)</li> <li>• Hard Rock (HR)</li> </ul>		
 <b>Shell</b> (2013) New Lens Scenarios to 2100, Mountain, Ocean; SKY		<ul style="list-style-type: none"> <li>• Mountain (M)</li> <li>• Ocean (O)</li> </ul>		<ul style="list-style-type: none"> <li>• Sky (S)</li> </ul>
 <b>Statoil</b> (2017) Energy Perspectives to 2050		<ul style="list-style-type: none"> <li>• Reform (Rf)</li> <li>• Rivalry (Rv)</li> </ul>		<ul style="list-style-type: none"> <li>• Renewal (Rn)</li> </ul>
 <b>EIA</b> (2017) International Energy Outlook to 2040			<ul style="list-style-type: none"> <li>• Reference</li> </ul>	
 <b>IEA</b> (2017) World Energy Outlook to 2040			<ul style="list-style-type: none"> <li>• Current policies (CP)</li> <li>• New Policies (NP)</li> </ul>	<ul style="list-style-type: none"> <li>• Sustainable Development (SD)</li> </ul>
 <b>IEEJ</b> (2017) Outlook to 2050		<ul style="list-style-type: none"> <li>• Advanced Technology (AT)</li> </ul>	<ul style="list-style-type: none"> <li>• Reference</li> </ul>	
 <b>BP</b> (2018) Energy Outlook to 2040			<ul style="list-style-type: none"> <li>• Evolving Transition (ET)</li> </ul>	
 <b>CEPSA</b> (2017) Energy Outlook 2030			<ul style="list-style-type: none"> <li>• Reference</li> </ul>	
 <b>Exxon</b> (2018) Outlook for Energy: A View to 2040			<ul style="list-style-type: none"> <li>• Reference</li> </ul>	
 <b>Enerdata</b> (2018) Global Energy Scenarios to 2040		<ul style="list-style-type: none"> <li>• Ener Brown</li> </ul>	<ul style="list-style-type: none"> <li>• Ener Blue</li> </ul>	<ul style="list-style-type: none"> <li>• Ener Green</li> </ul>
 <b>IRENA</b> (2018) Perspective for energy transition				<ul style="list-style-type: none"> <li>• 66% chance &lt;2°C (662)</li> </ul>
 <b>DNV GL</b> (2018) Energy Transition Outlook			<ul style="list-style-type: none"> <li>• Reference</li> </ul>	
 <b>IPCC</b> (2018) Global Warming of 1.5°C				<ul style="list-style-type: none"> <li>• P1,P2,P3,P4</li> </ul>

# The carbon cost of growth\*

## CO2 emissions 2015-2040 vs economic growth



# Where do Council's scenarios stand: critical uncertainties



WEC Modern Jazz    Statoil Reform  
IEEJ Advanced Technologies    IEA New Policies

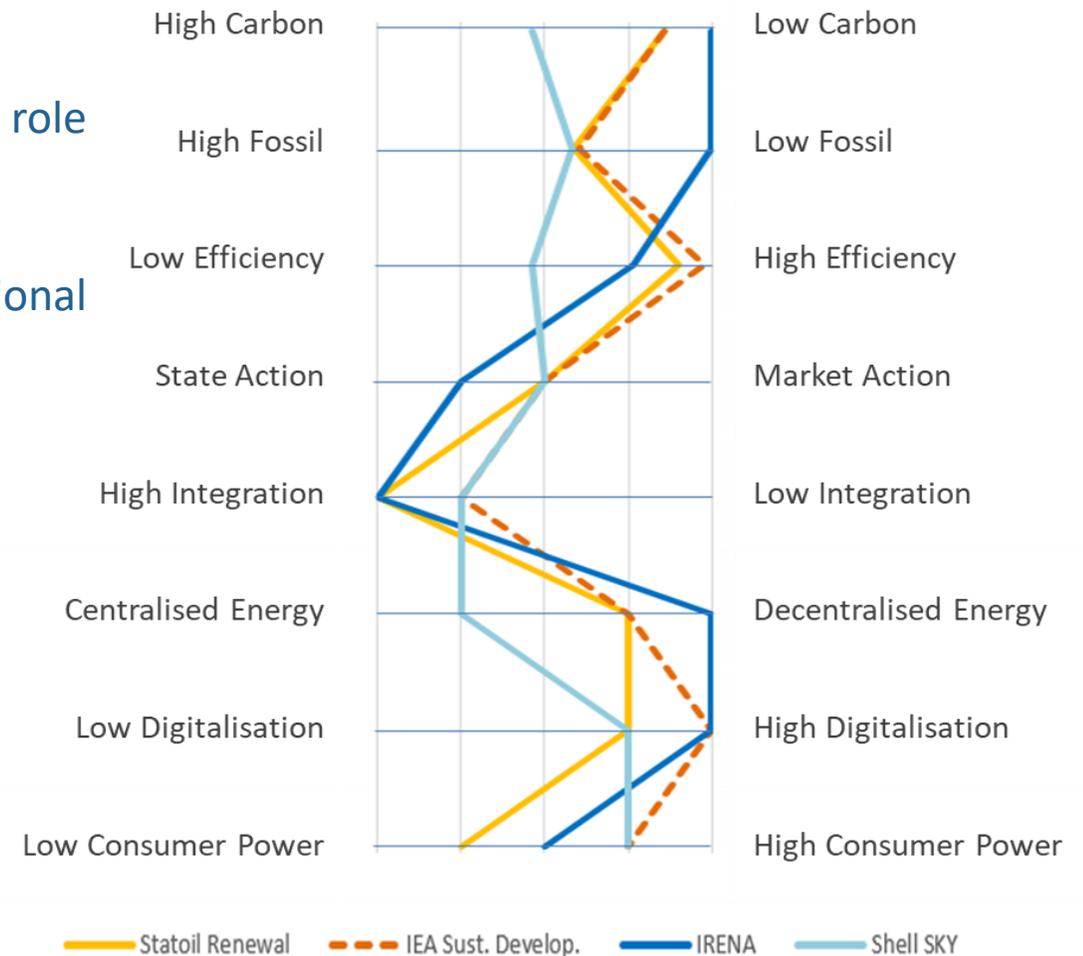
WEC Hard Rock    Statoil Rivalry  
IEA Current Policies

WEC US    Statoil Rn    IEA SD  
IRENA 662    Shell SKY

# How do normative scenarios achieve low emissions & high growth?

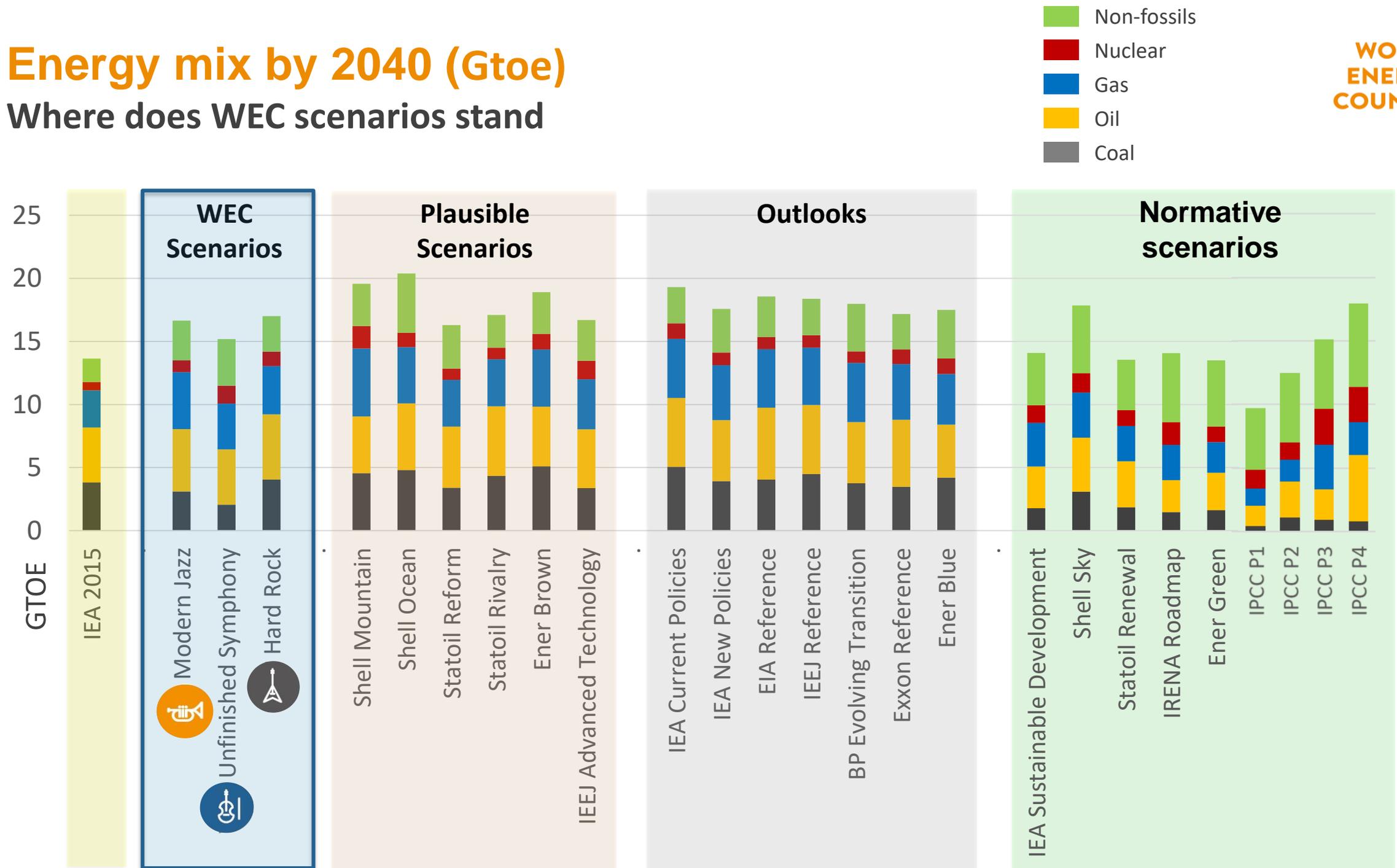
- Strong attention to **investments** and increasing **efficiency**
- Decarbonisation not only of production but also on **end use**
- Rapid uptake of **REN, fossil fuels**, esp. **gas** still play an important role
- **Digitalisation** accelerates low carbon economy
- Stringer role for **governments**, international **coordination** & regional **integration**.
- Differences in **consumer demand pull** for electrification varies
- **Nuclear** continues to play a major role
- **System-wide** rather than sectoral approaches
  - wide-spread of **EVs**; higher efficiency standards
  - industry switch to **electricity, hydrogen and CCS**;
  - **better market design**, smart **grid integration**, **demand-side management** and **cost-effective storage**.

Normative scenarios comparison



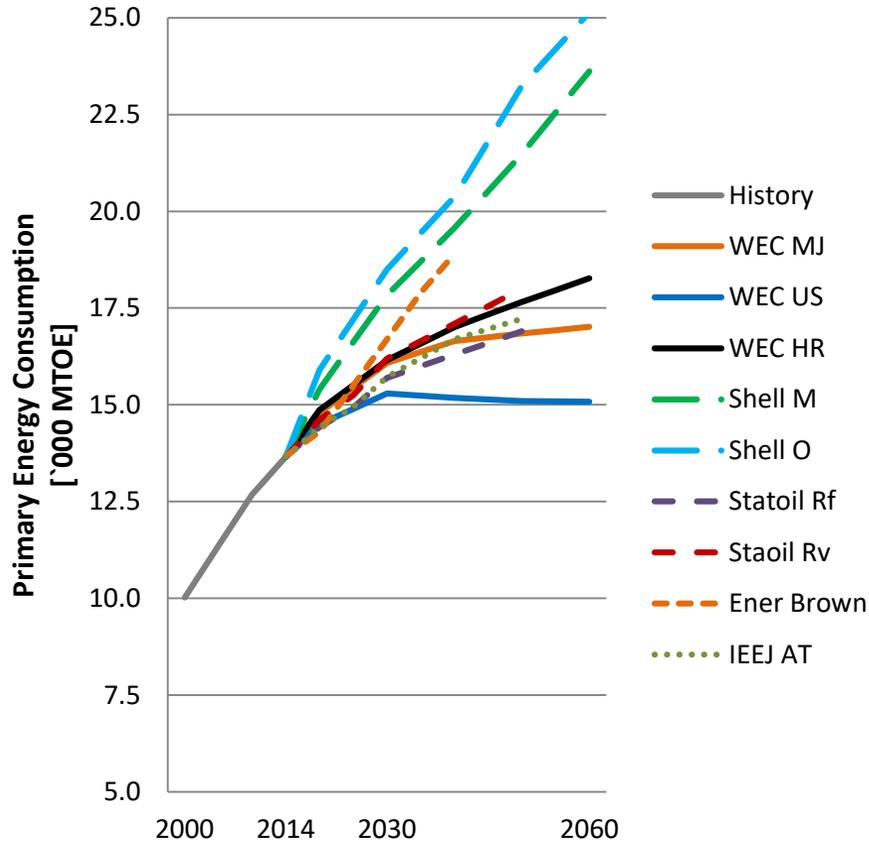
# Energy mix by 2040 (Gtoe)

## Where does WEC scenarios stand



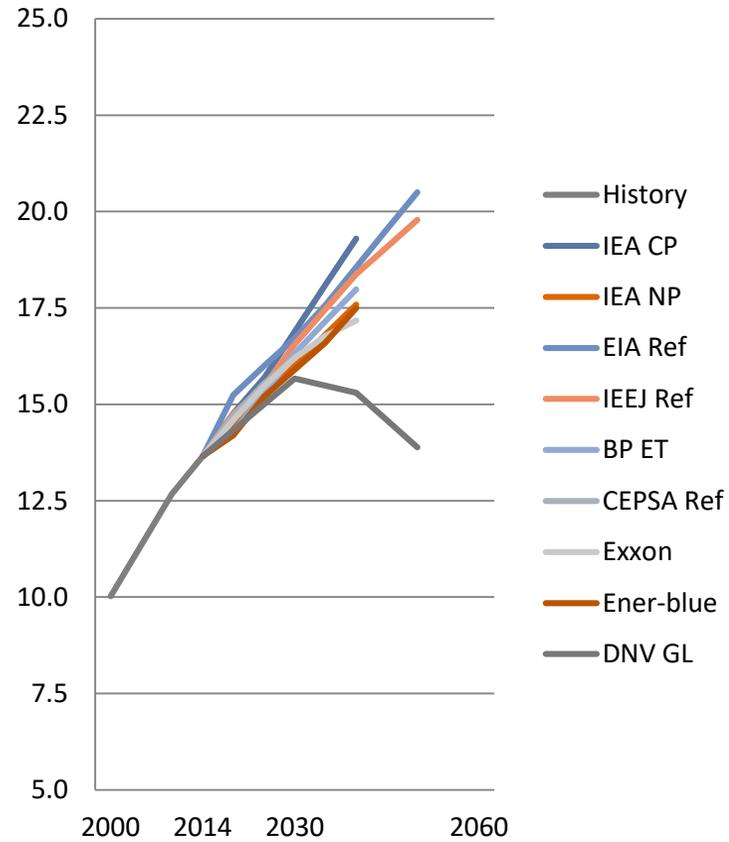
# Primary Energy Demand

## Plausible Scenarios



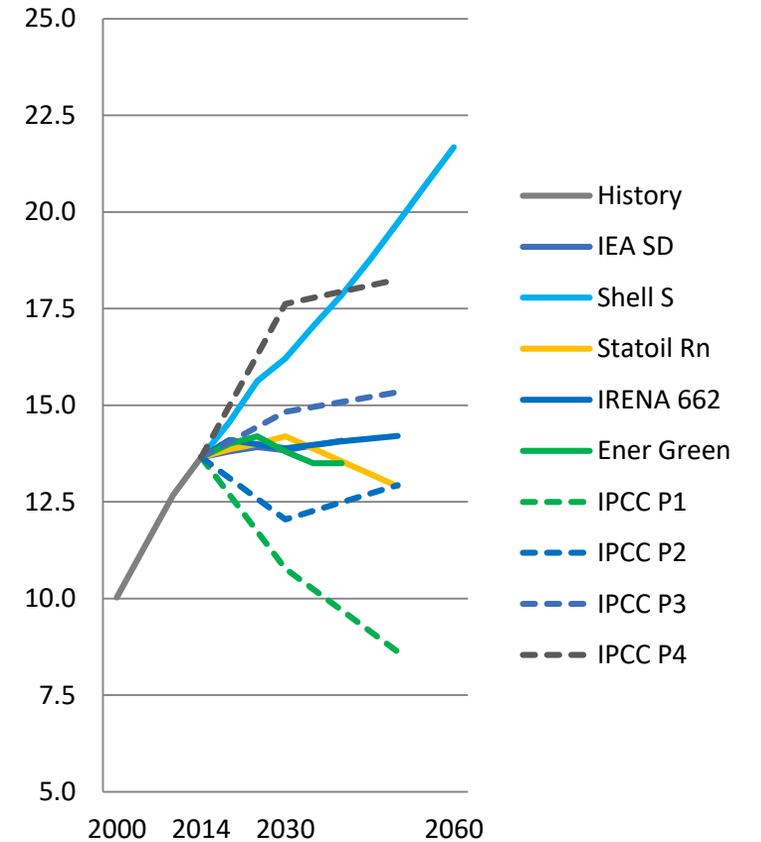
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## Outlooks



Outlooks: IEA CP (Current Policies), IEA NP (New Policies), EIA Ref (Reference), IEEJ Ref (Reference), BP (Evolving Transition), CEPSA Ref (Reference), Exxon (Reference), Ener-Blue, DNV GL

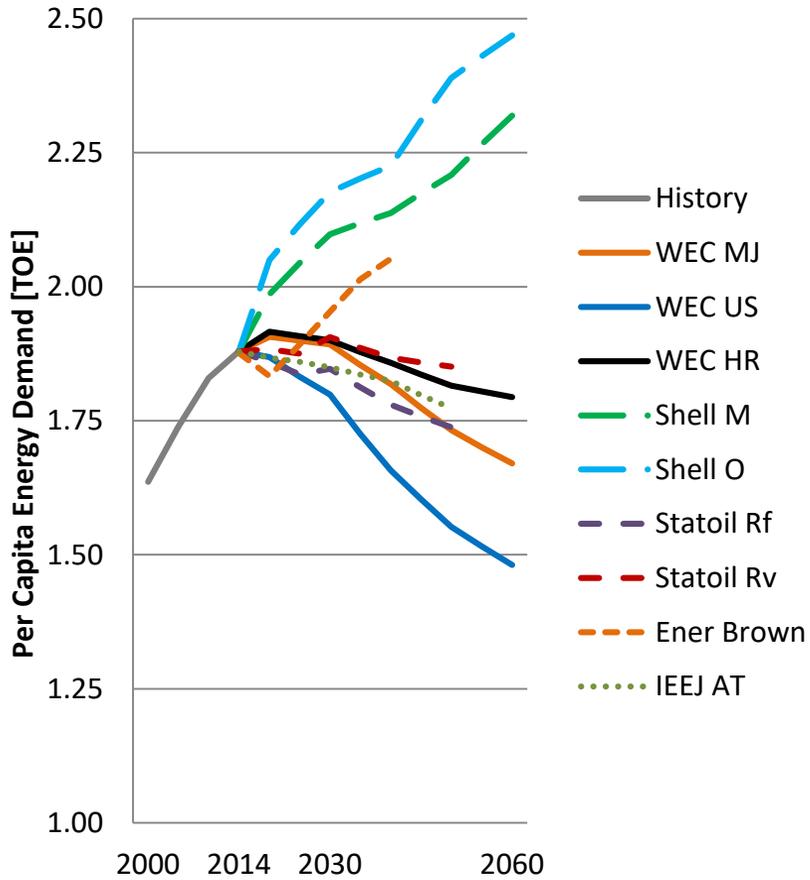
## Normative Scenarios



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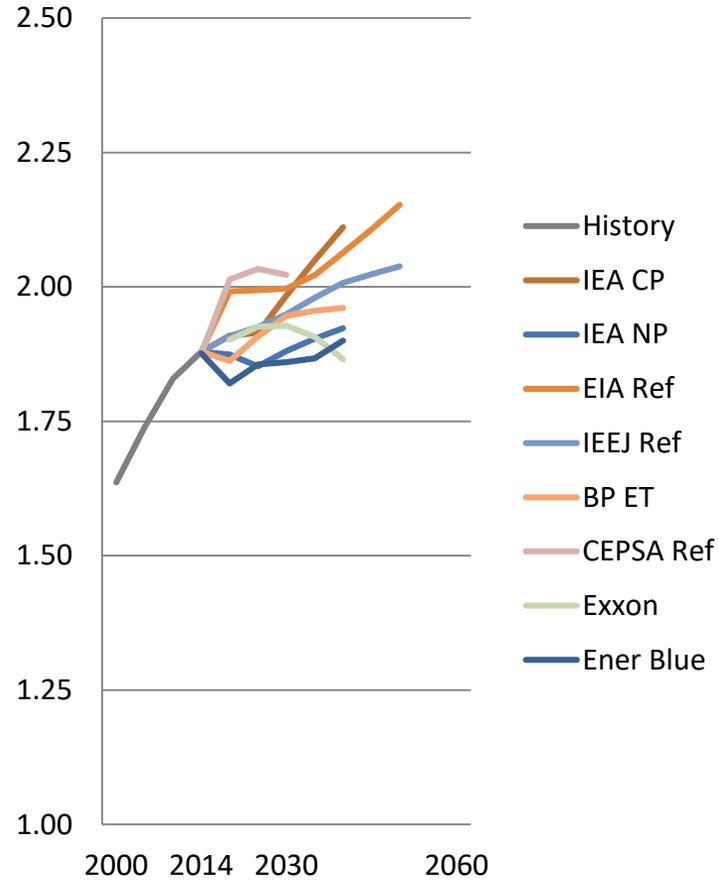
# Per Capita Primary Energy Demand

## Plausible Scenarios



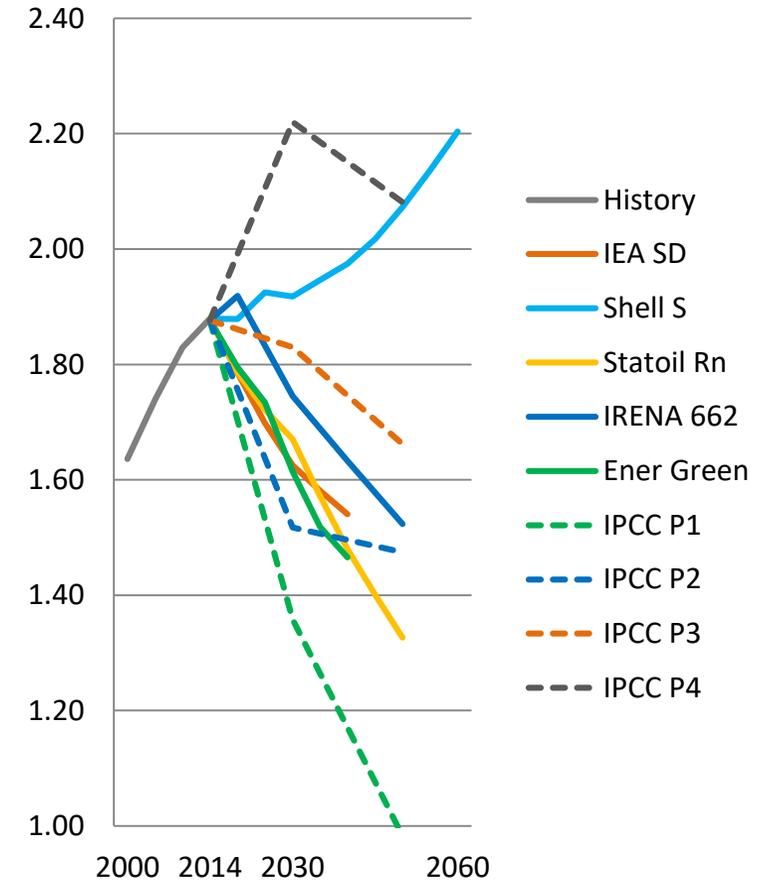
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## Outlooks



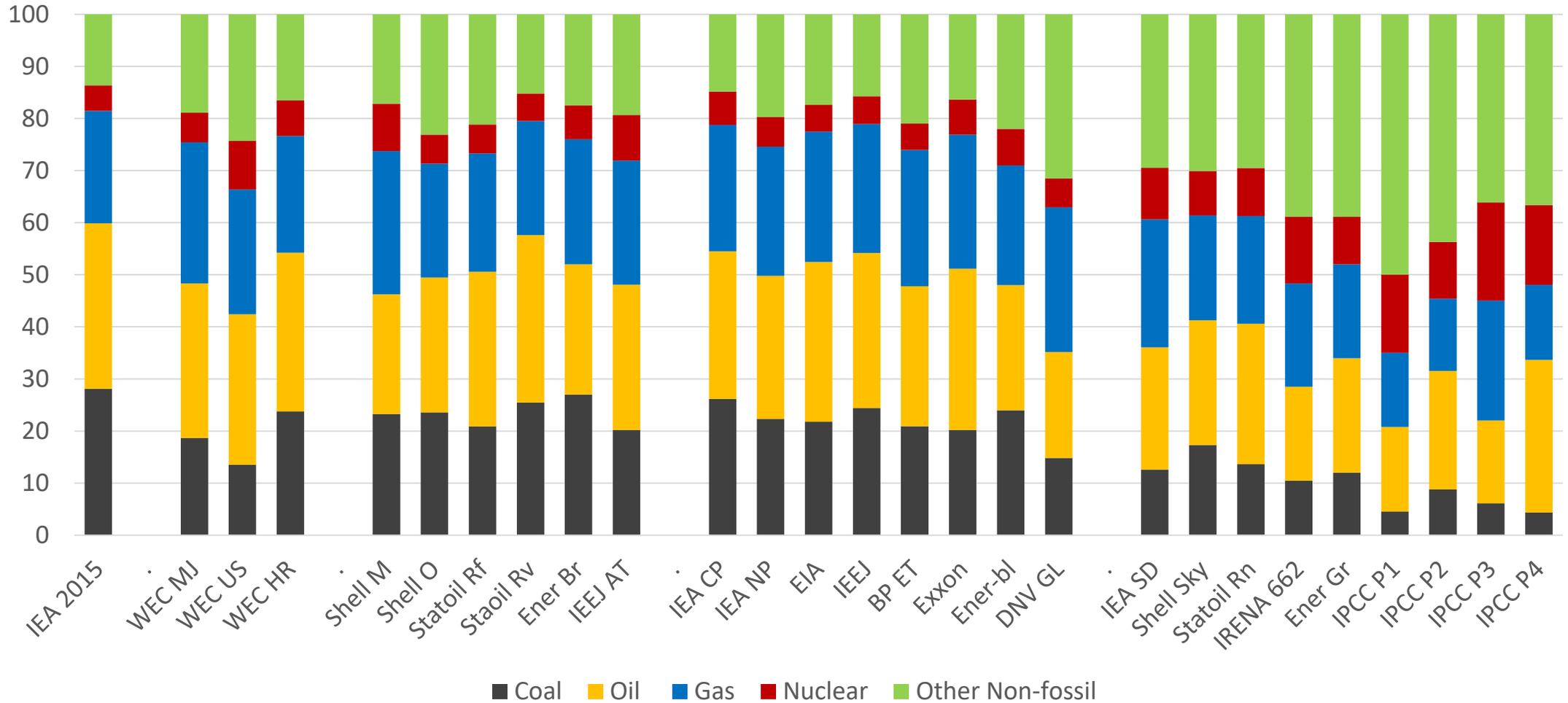
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# Energy mix by 2040 (%)



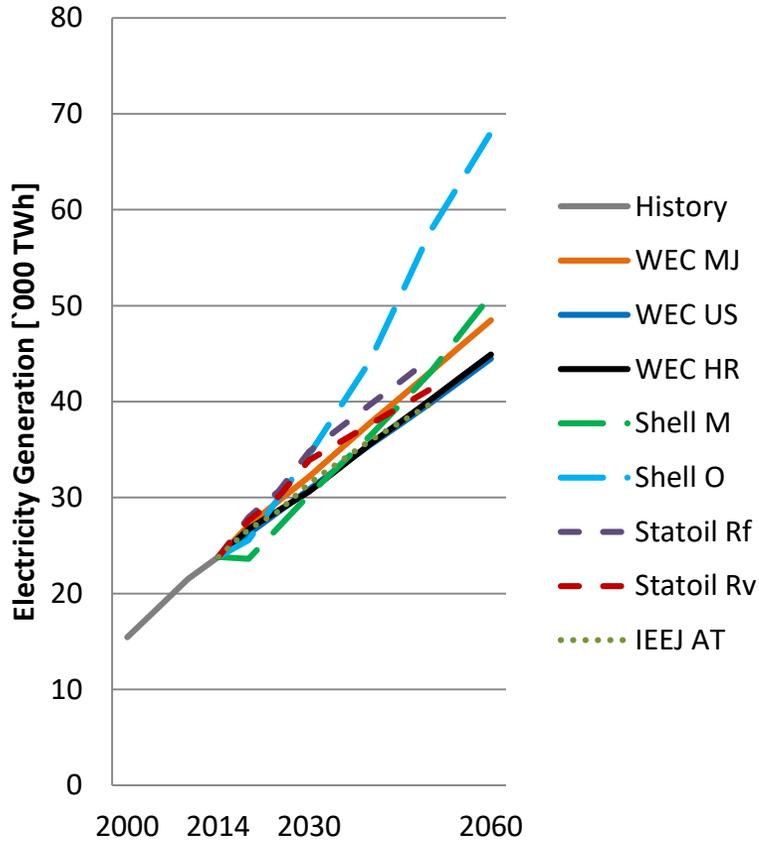
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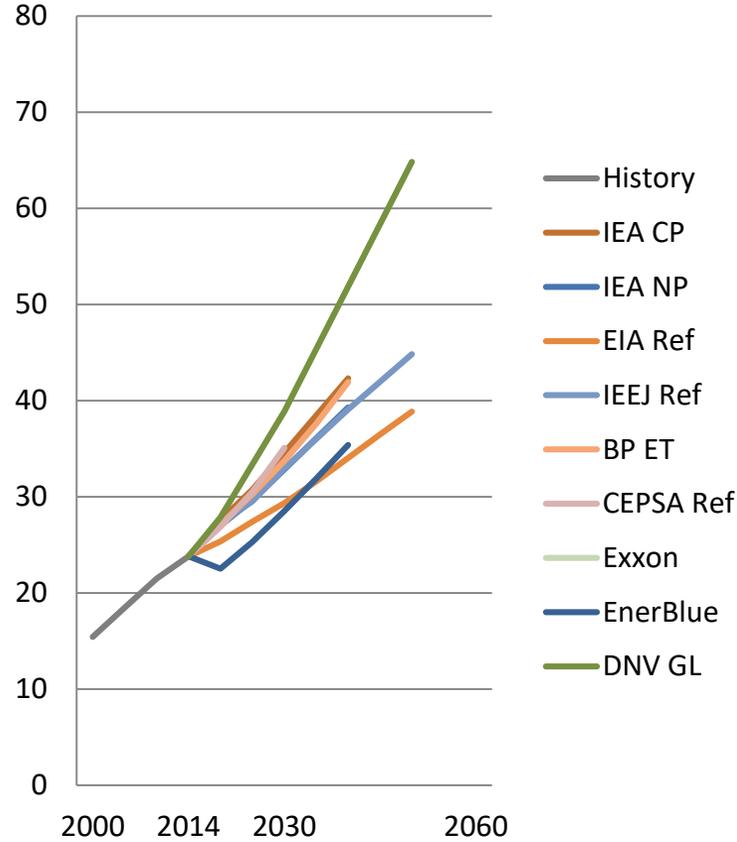
# Electricity Demand

## Plausible Scenarios



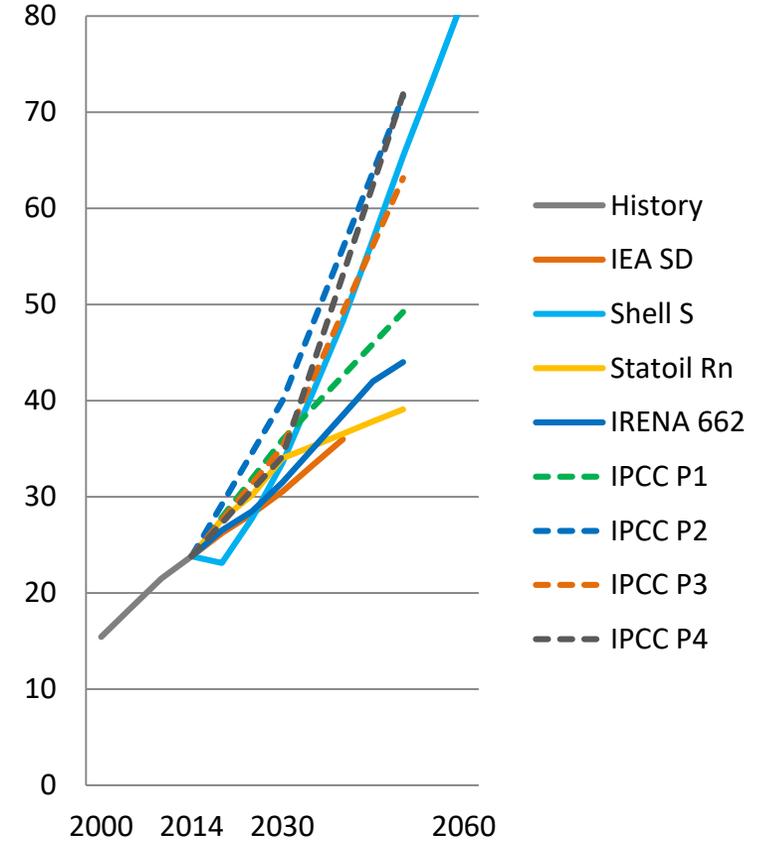
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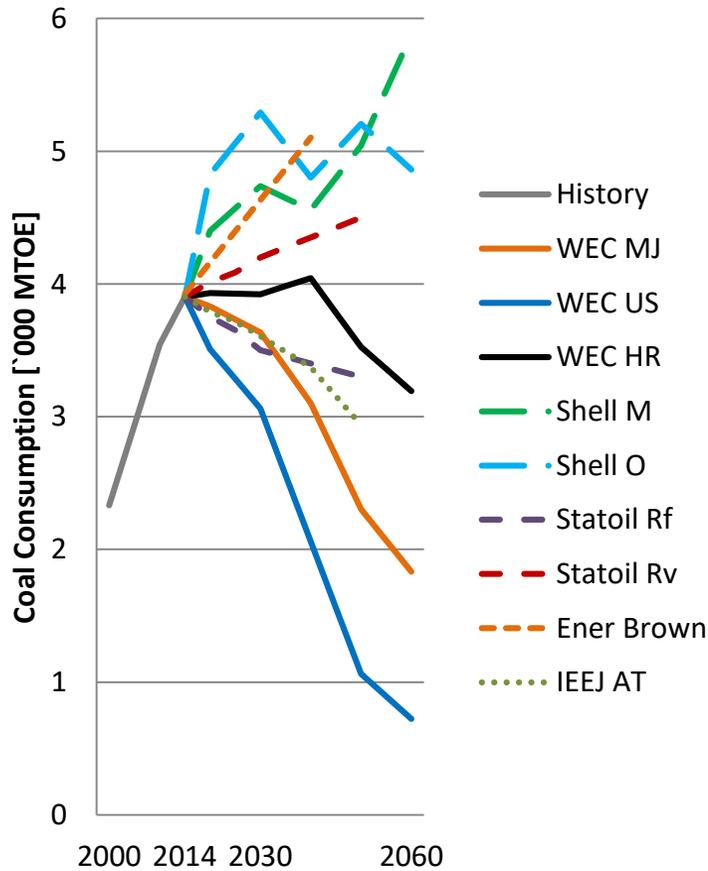
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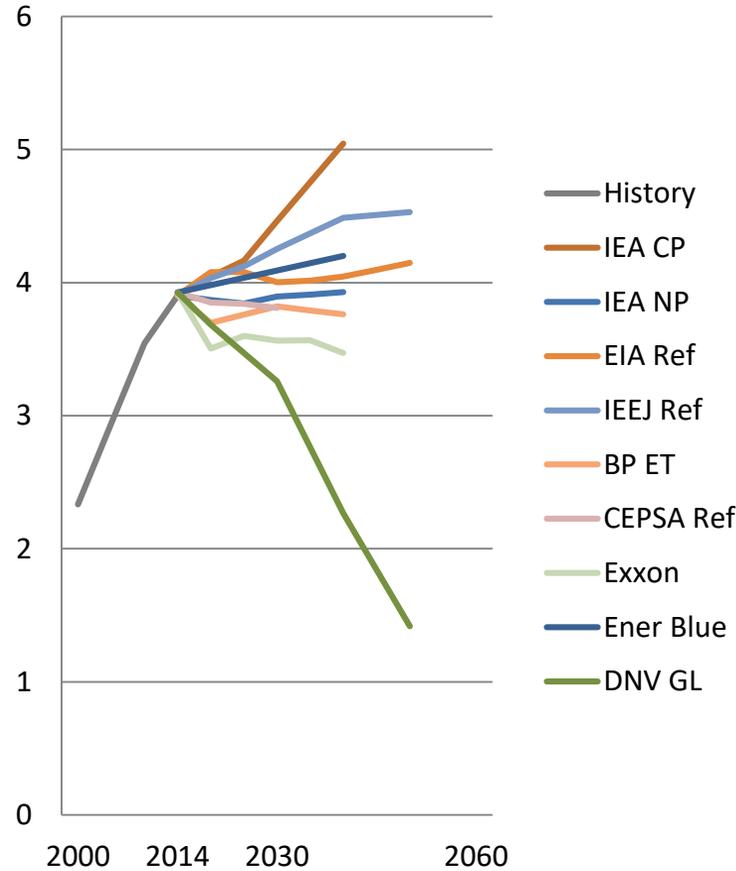
# Fossil Fuel – (1) Coal

## Plausible Scenarios



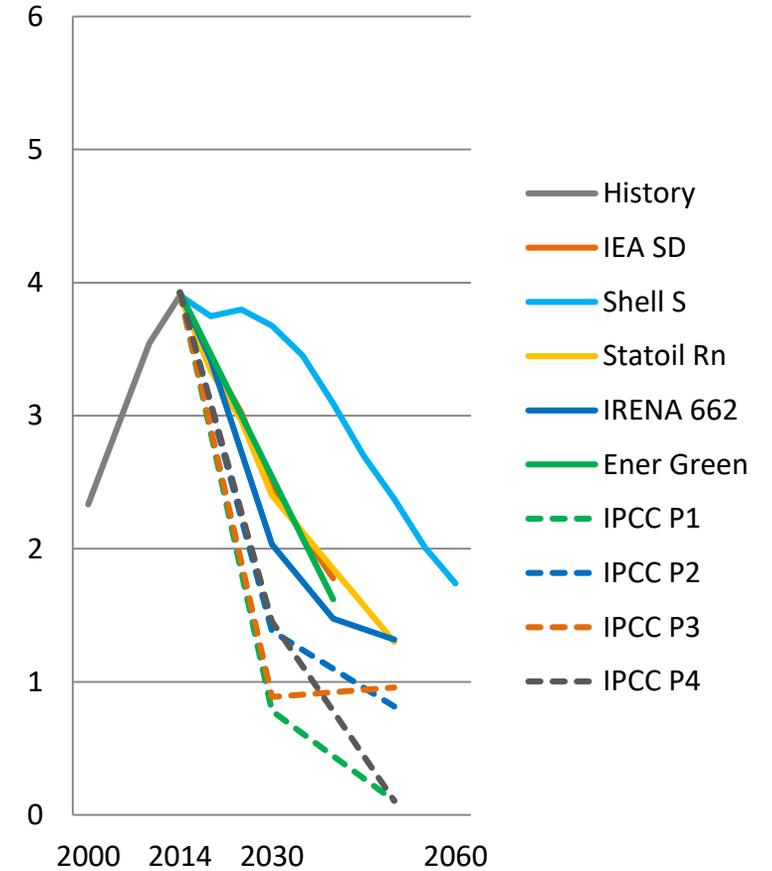
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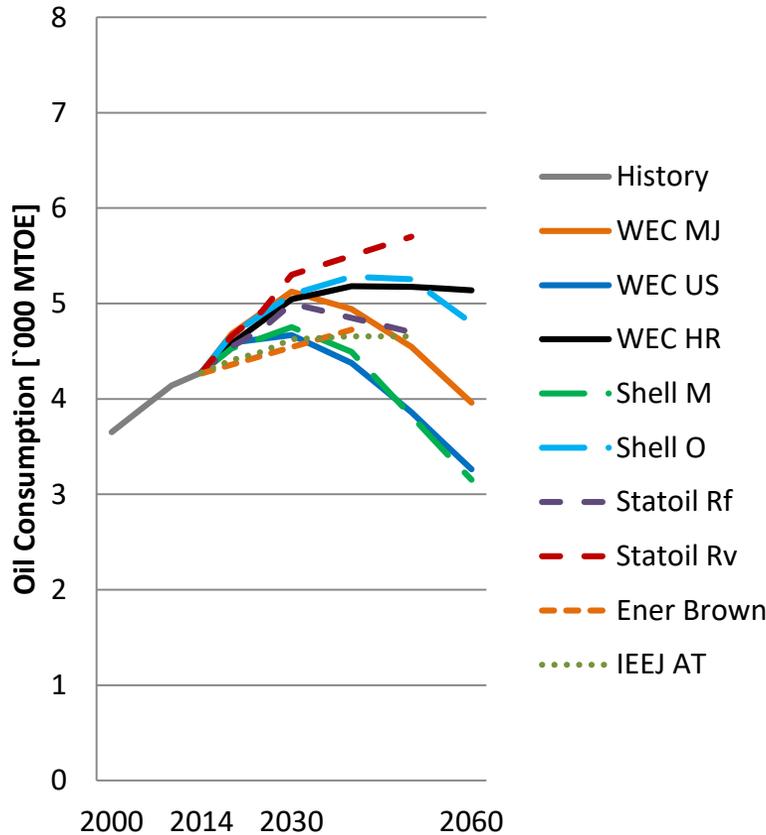
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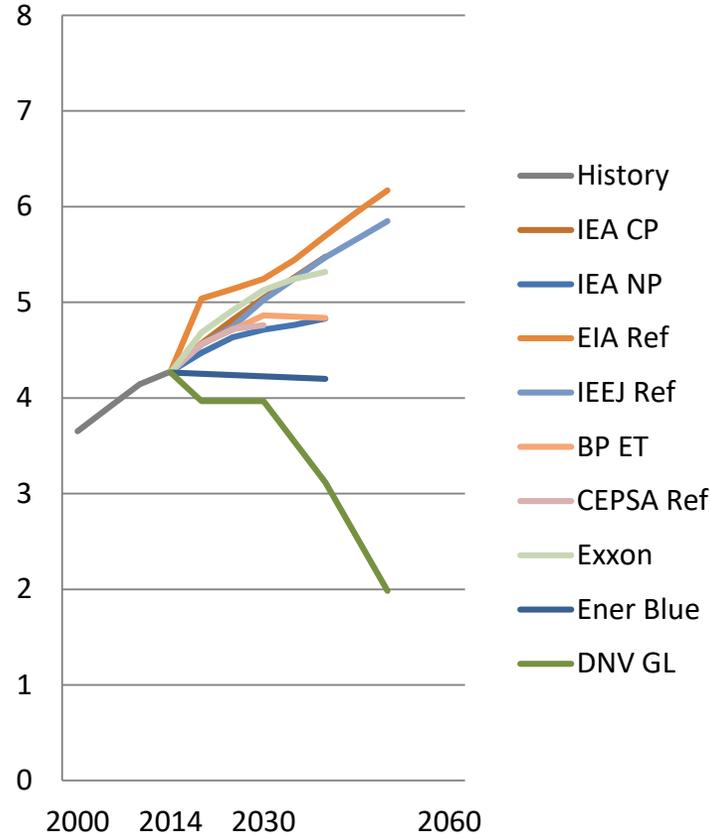
# Fossil Fuel – (2) Oil

## Plausible Scenarios



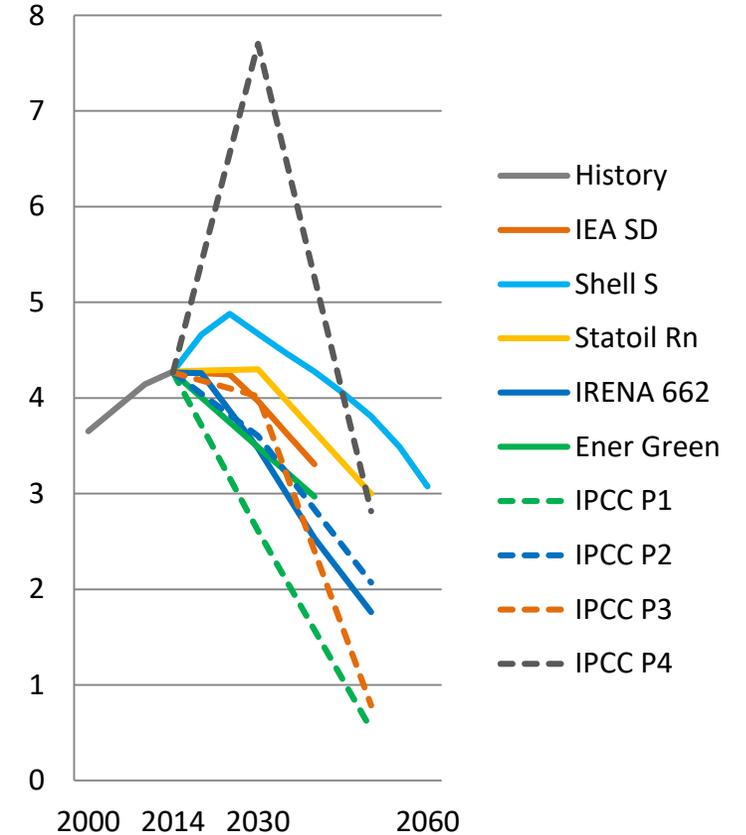
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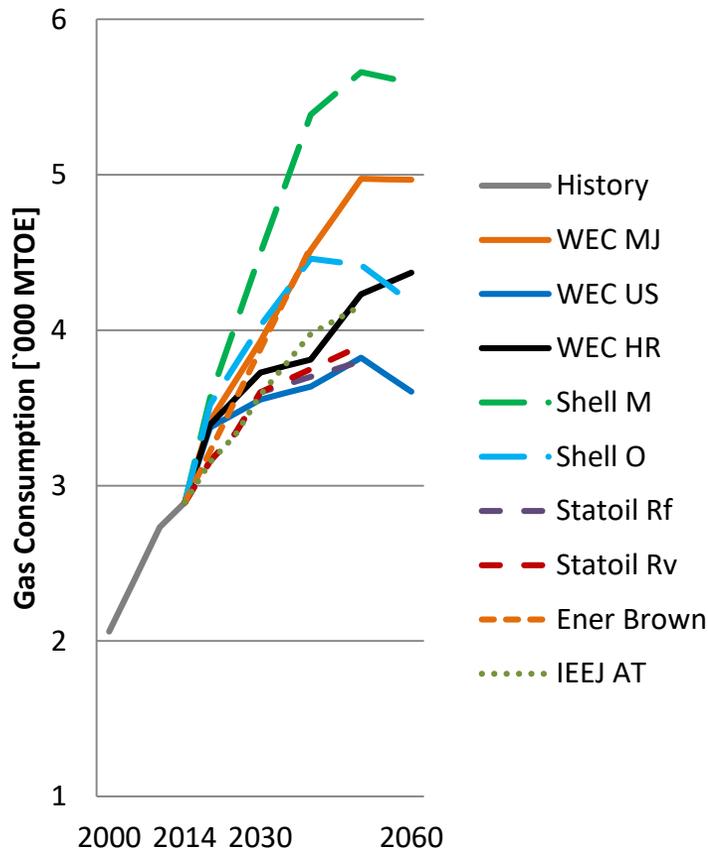
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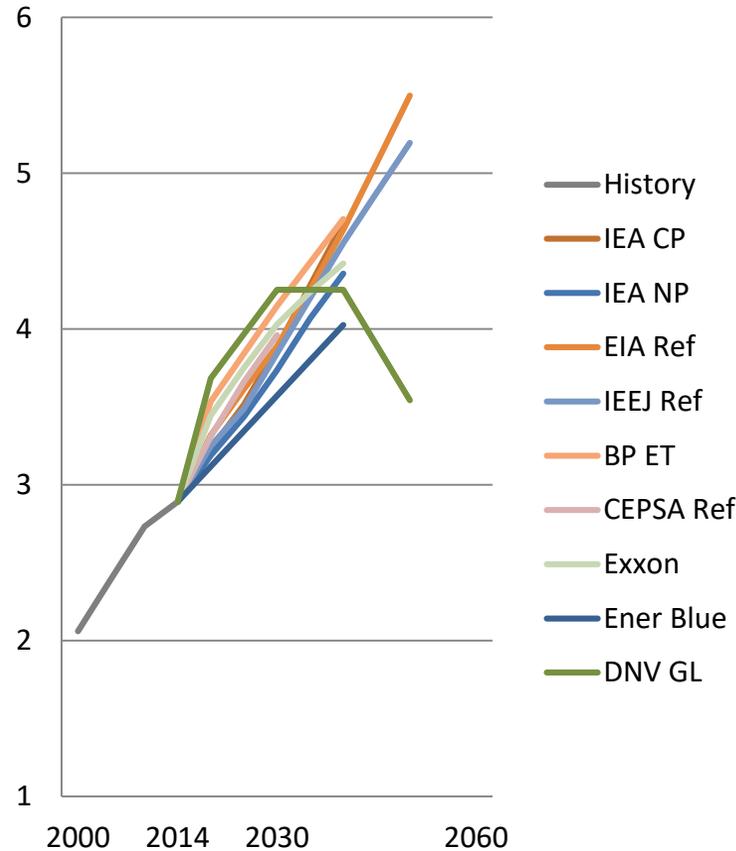
# Fossil Fuel – (3) Natural Gas

## Plausible Scenarios



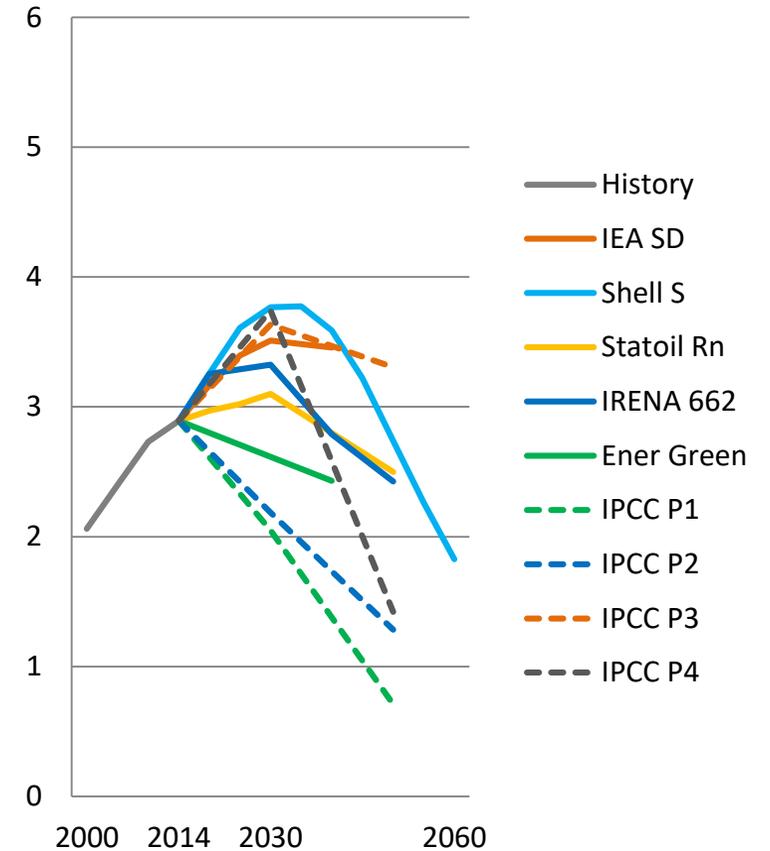
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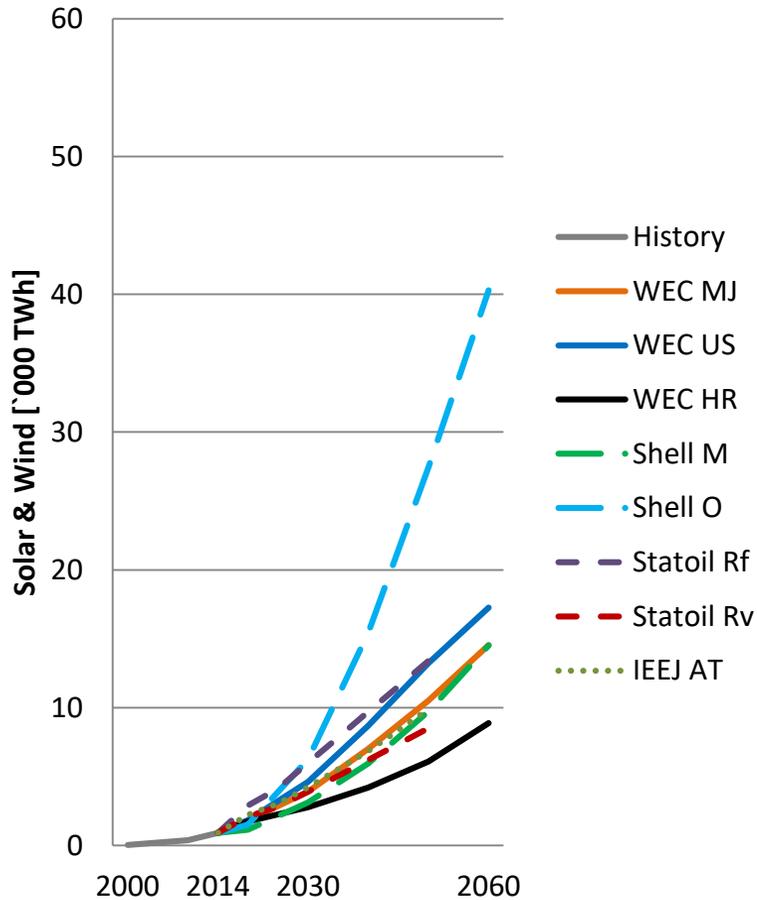
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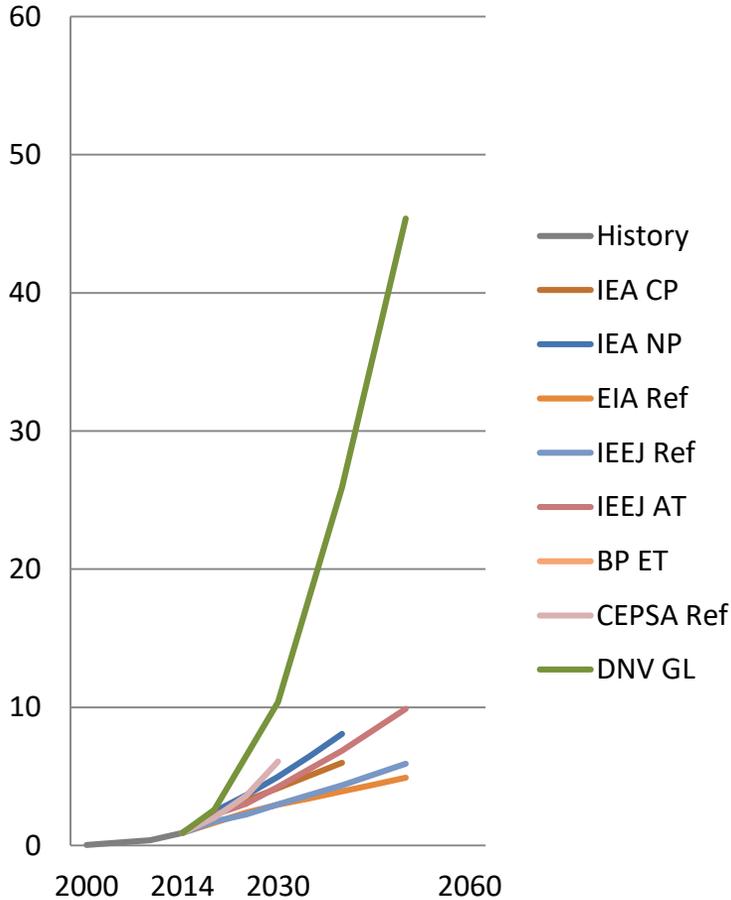
# Solar & Wind

## Plausible Scenarios



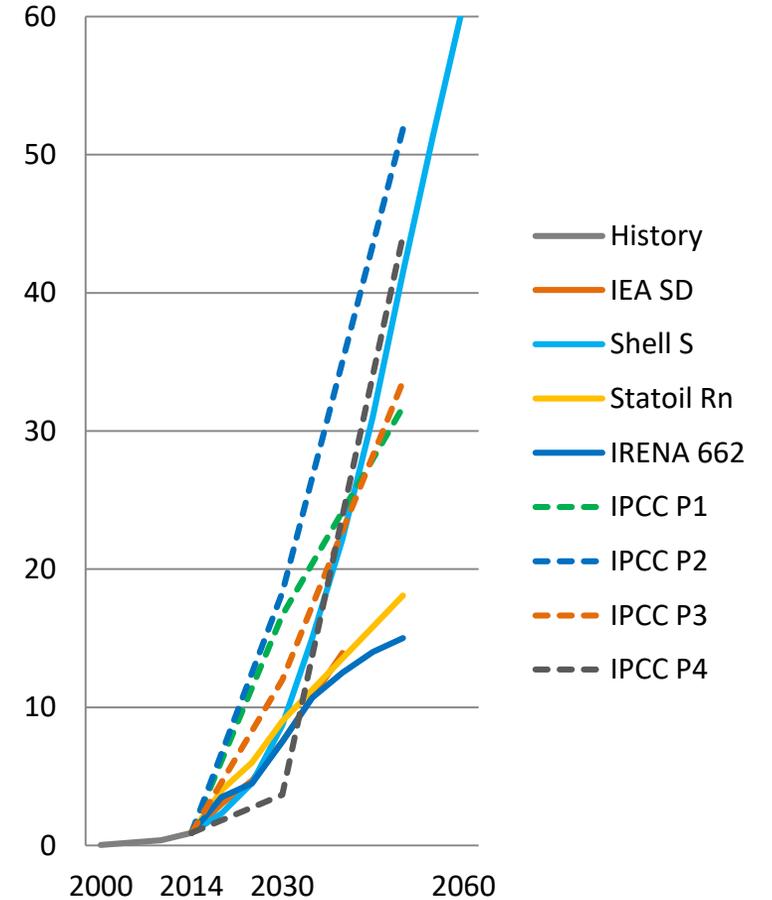
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## Outlooks



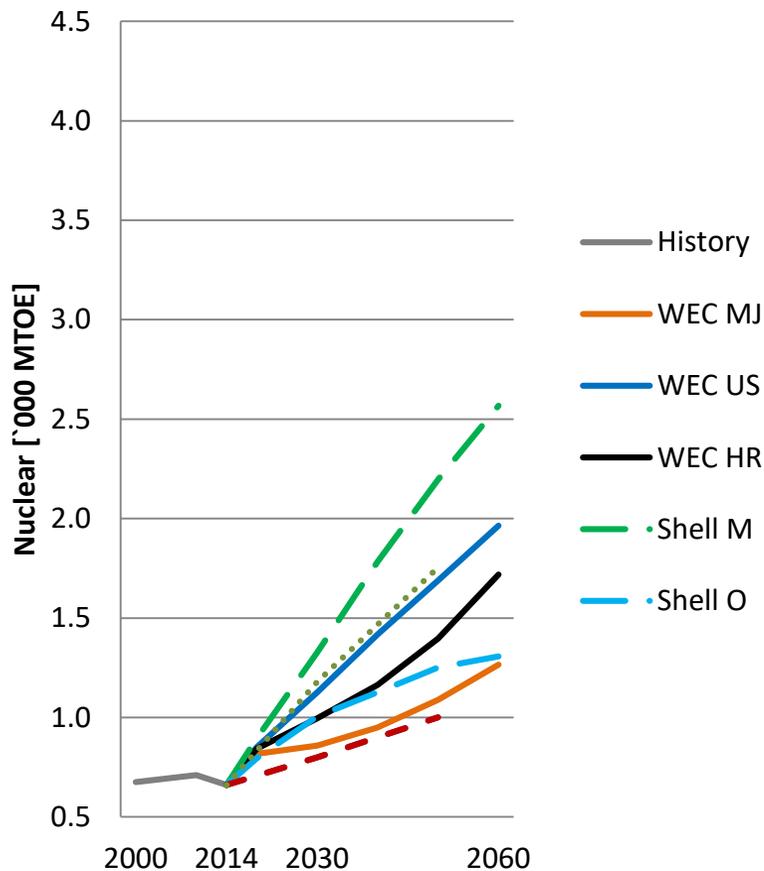
Outlooks: IEA CP (Current Policies), IEA NP (New Policies), EIA Ref (Reference), IEEJ Ref (Reference), BP (Evolving Transition), CEPSA Ref (Reference), Exxon (Reference), Ener-Blue, DNV GL

## Normative Scenarios



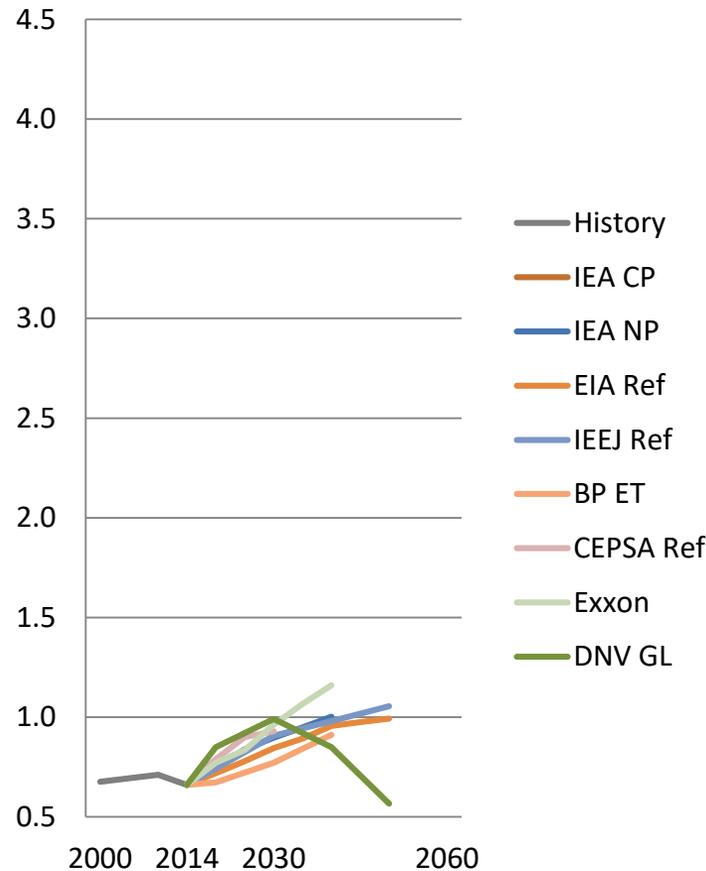
Normative: IEA SD (Sustainable Development), Shell S (Sky), Statoil Rn (Renewal), IRENA 662 (66% below 2°C), Ener-Green, IPCC P1 (Low Energy Demand), IPCC P2 (Sustainability), IPCC P3 (Middle of the Road), IPCC P4 (Fossil-Fuelled Development)

## Plausible Scenarios



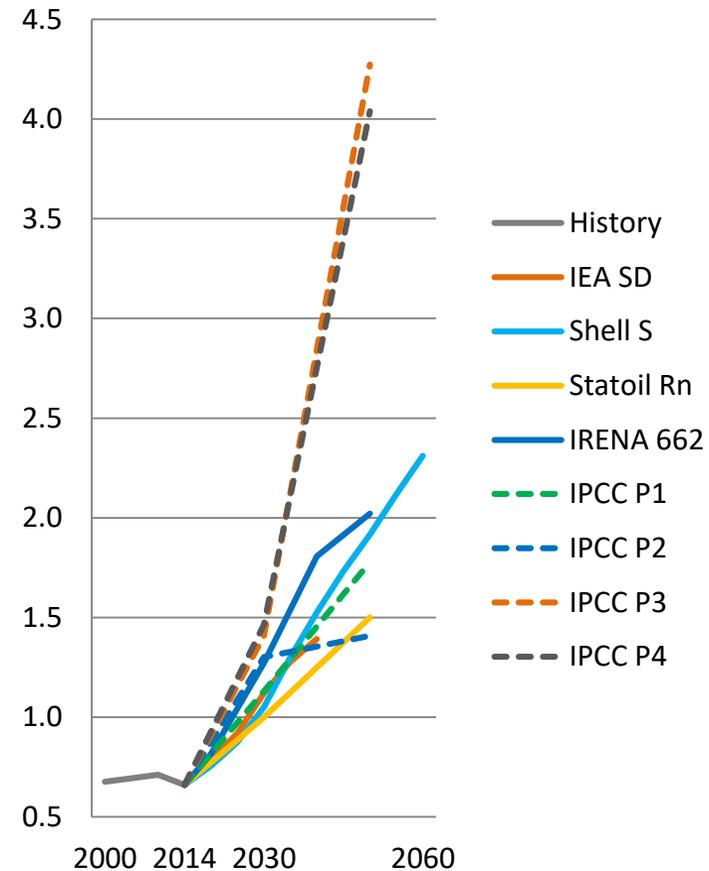
Plausible: WEC MJ (Modern Jazz), WEC US (Unfinished Symphony), WEC HR (Hard Rock), Shell M (Mountain), Shell O (Ocean), Statoil Rf (Reform), Statoil Rv (Rivalry), Ener-Brown, IEEJ AT (Advanced Technology)

## Outlooks



Outlooks: IEA CP (Current Policies), IEA NP (New Policies), EIA Ref (Reference), IEEJ Ref (Reference), BP (Evolving Transition), CEPSA Ref (Reference), Exxon (Reference), Ener-Blue, DNV GL

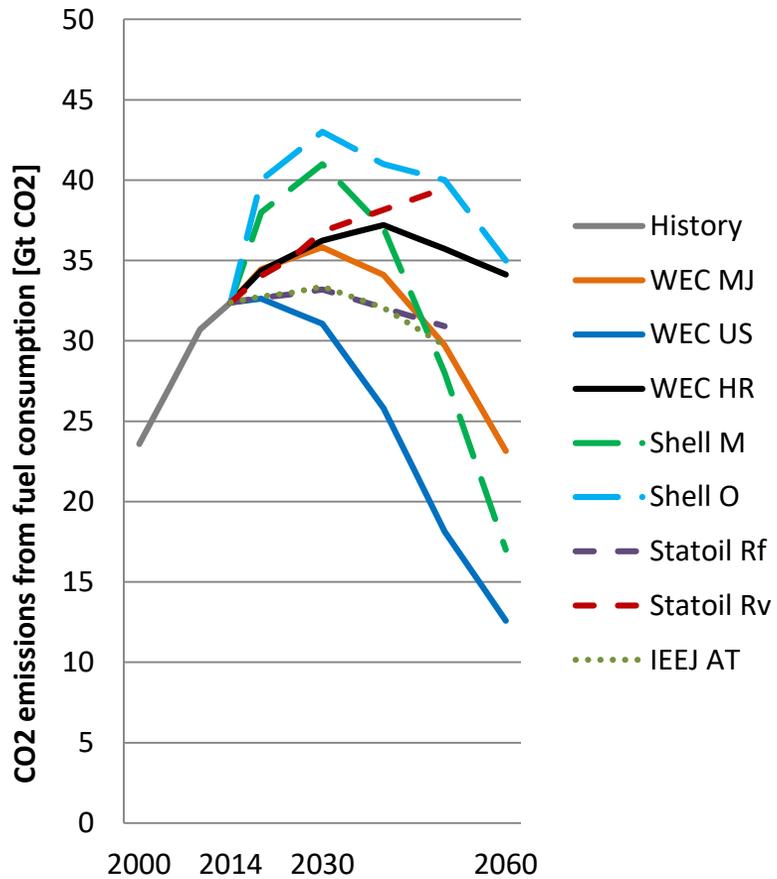
## Normative Scenarios



Normative: IEA SD (Sustainable Development), Shell S (Sky), Statoil Rn (Renewal), IRENA 662 (66% below 2°C), Ener-Green, IPCC P1 (Low Energy Demand), IPCC P2 (Sustainability), IPCC P3 (Middle of the Road), IPCC P4 (Fossil-Fuelled Development)

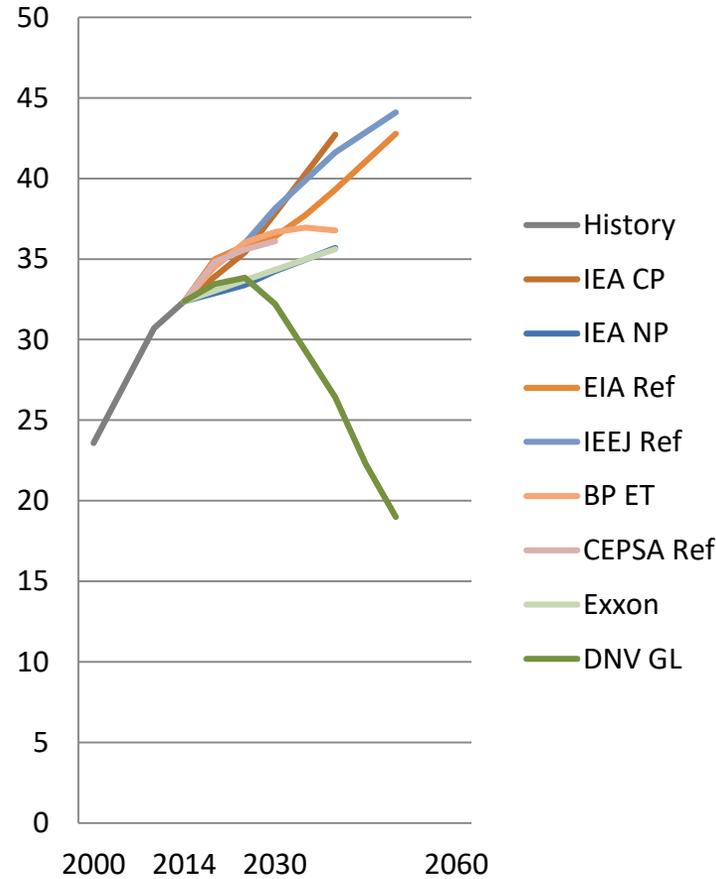
# CO2 emissions from fuel combustion

## Plausible Scenarios



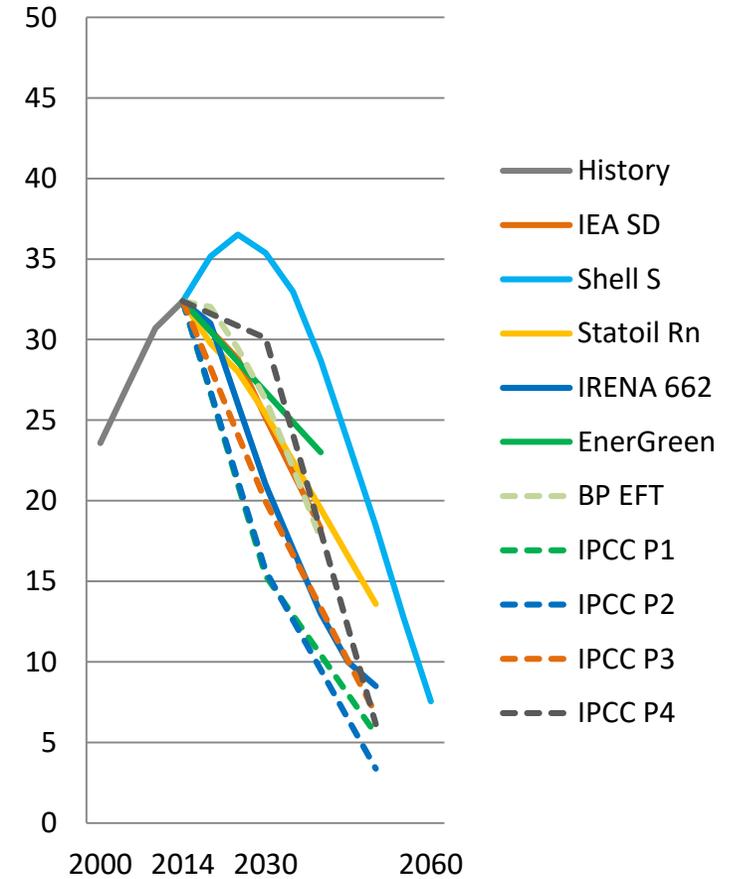
Plausible: WEC MJ (Modern Jazz), WEC US (Unfinished Symphony), WEC HR (Hard Rock), Shell M (Mountain), Shell O (Ocean), Statoil Rf (Reform), Statoil Rv (Rivalry), Ener-Brown, IEEJ AT (Advanced Technology)

## Outlooks



Outlooks: IEA CP (Current Policies), IEA NP (New Policies), EIA Ref (Reference), IEEJ Ref (Reference), BP (Evolving Transition), CEPSA Ref (Reference), Exxon (Reference), Ener-Blue, DNV GL

## Normative Scenarios



Normative: IEA SD (Sustainable Development), Shell S (Sky), Statoil Rn (Renewal), IRENA 662 (66% below 2°C), Ener-Green, IPCC P1 (Low Energy Demand), IPCC P2 (Sustainability), IPCC P3 (Middle of the Road), IPCC P4 (Fossil-Fuelled Development)

**Thank you**

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