

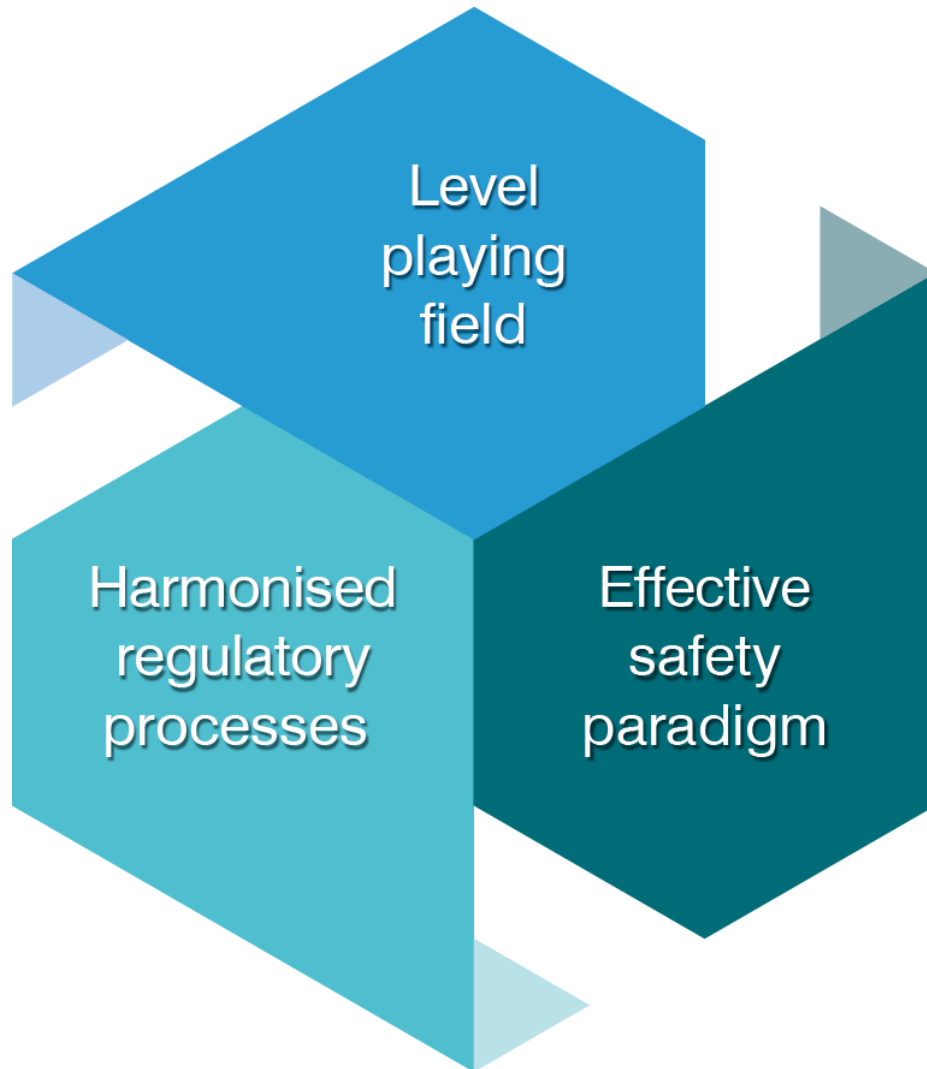
Harmony

The role of nuclear energy meeting electricity needs
in the 2 degree scenario



Harmony
May 2017

Harmony goal: ready to deliver more nuclear to ensure 2 degree scenario

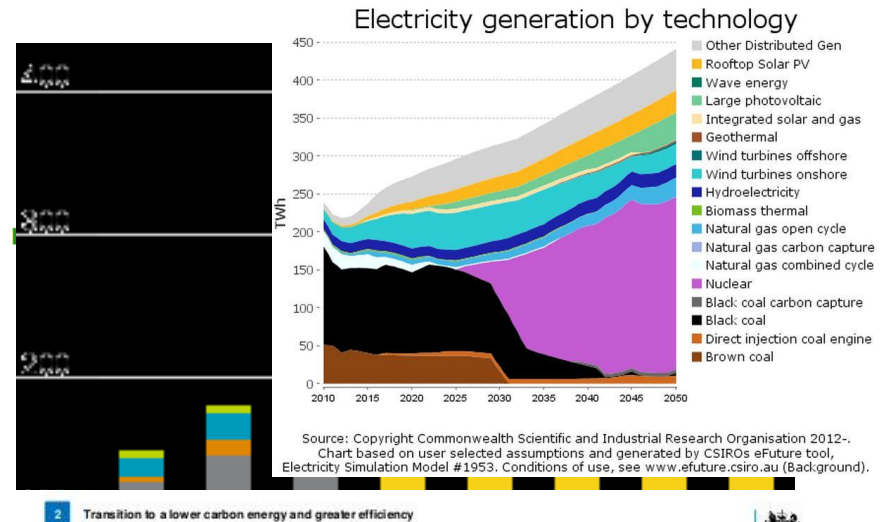
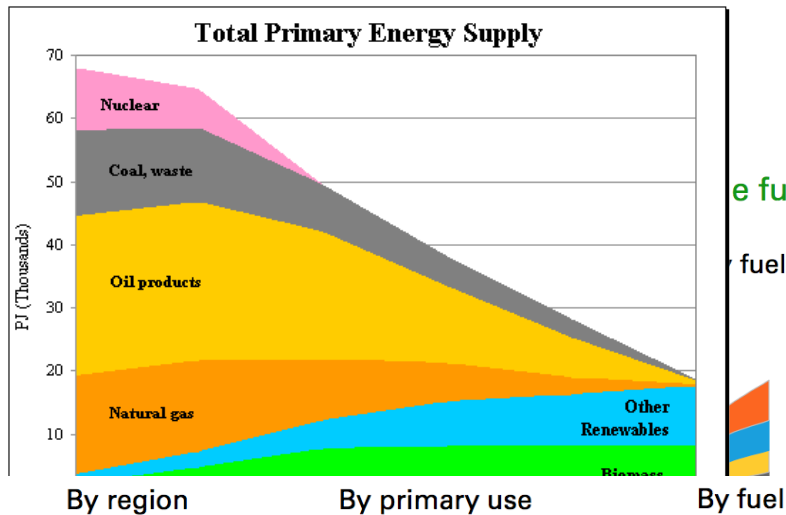


1000 gigawatt new nuclear capacity by 2050

25% of electricity supply 2050

Nuclear energy to deliver reliable, affordable and clean electricity

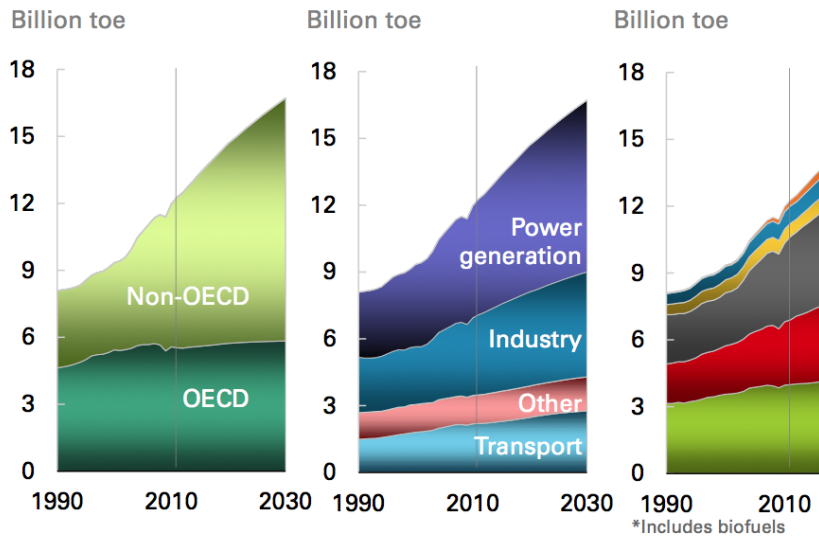
Many scenarios used to envisage the future



2 Transition to a lower carbon energy and greater efficiency

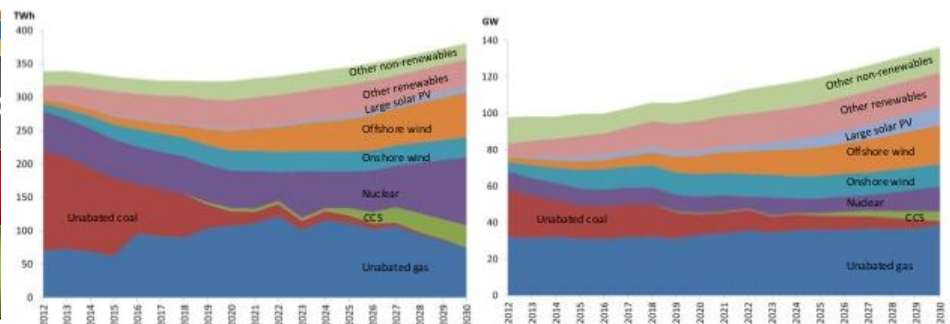
The future supply mix is projected to expand into nuclear, wind and other low carbon

Department
of Energy &
Climate Change



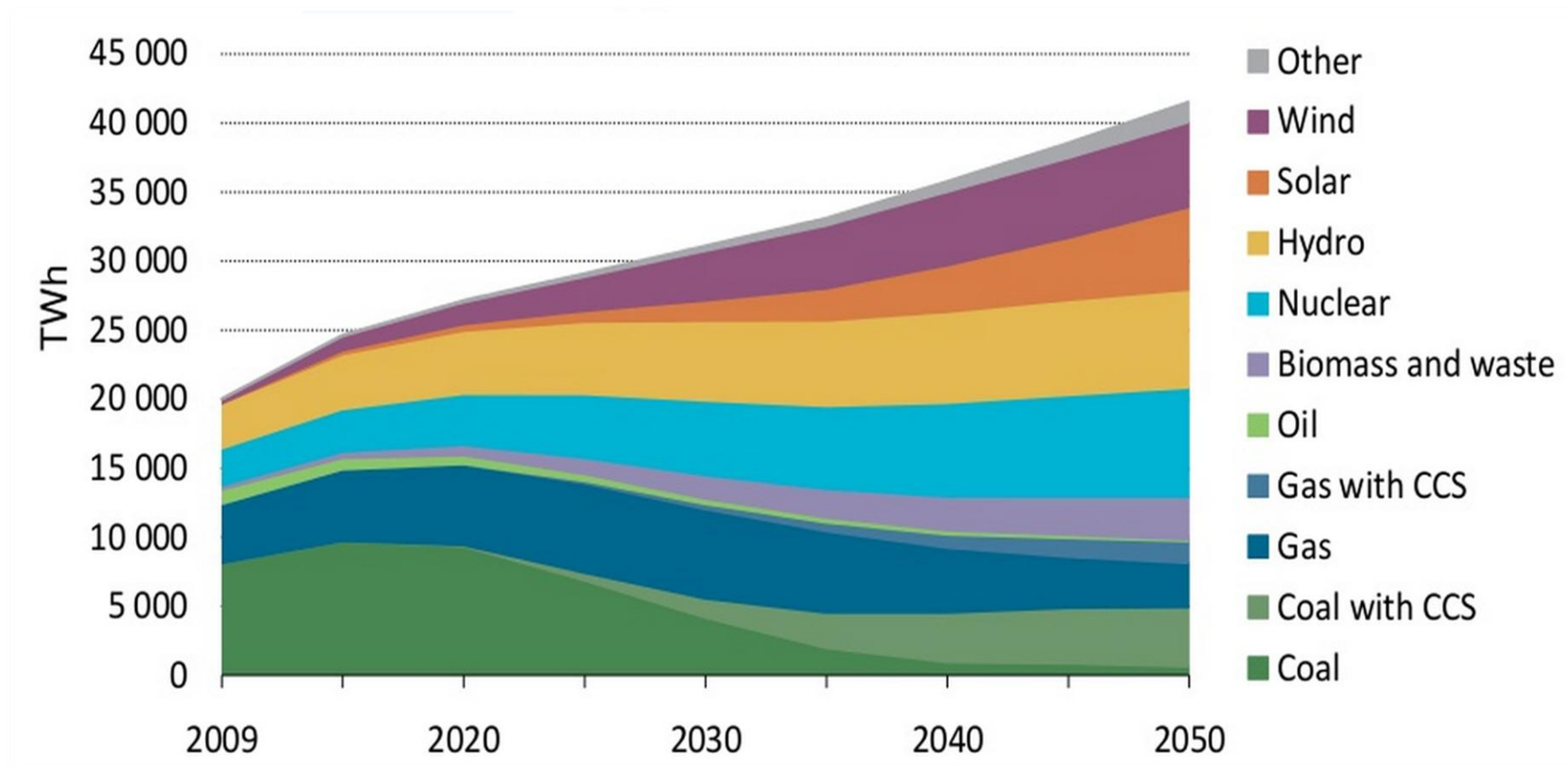
Projected future generation, 2012-30

Projected future capacity, 2012-30

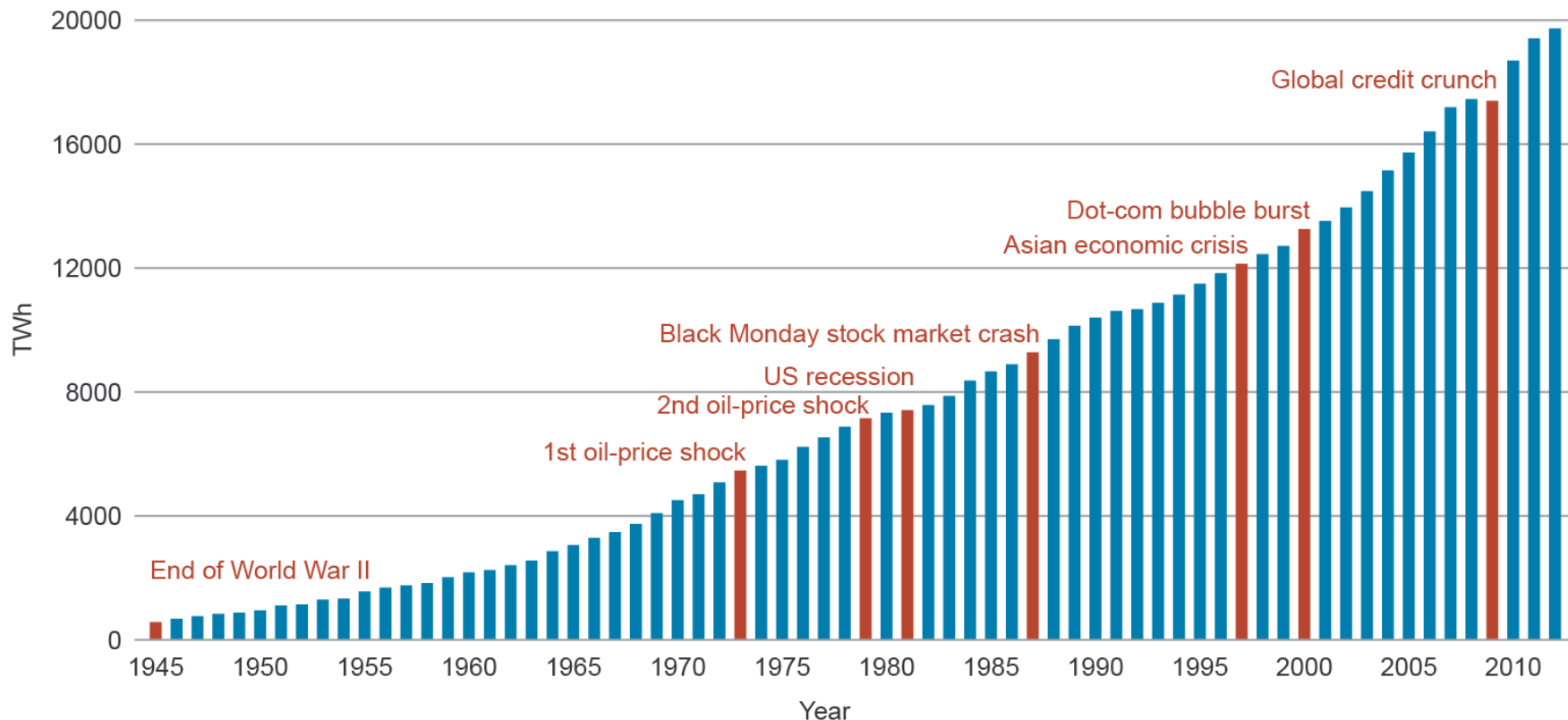


Source: DECC, December 2013 "EMR Delivery Plan", 100g 2030 scenario with central fossil fuel price projections and demand

IEA 2 Degree Scenario is a common benchmark

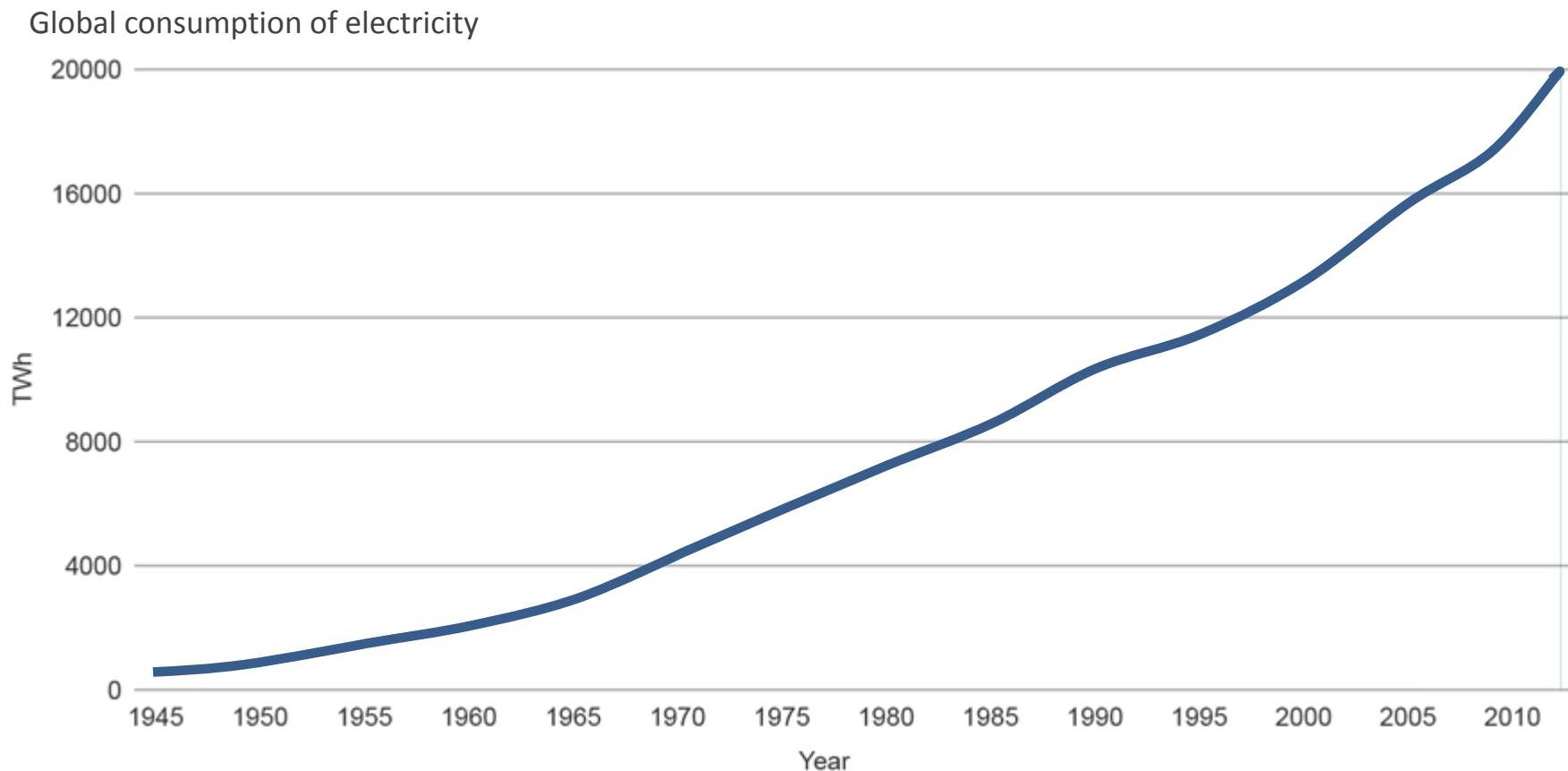


Accelerating rise in world electricity consumption



Source: 1945-1979, International Energy Agency databases and analysis
1980-2012, Energy Information Administration

Accelerating rise in world electricity consumption



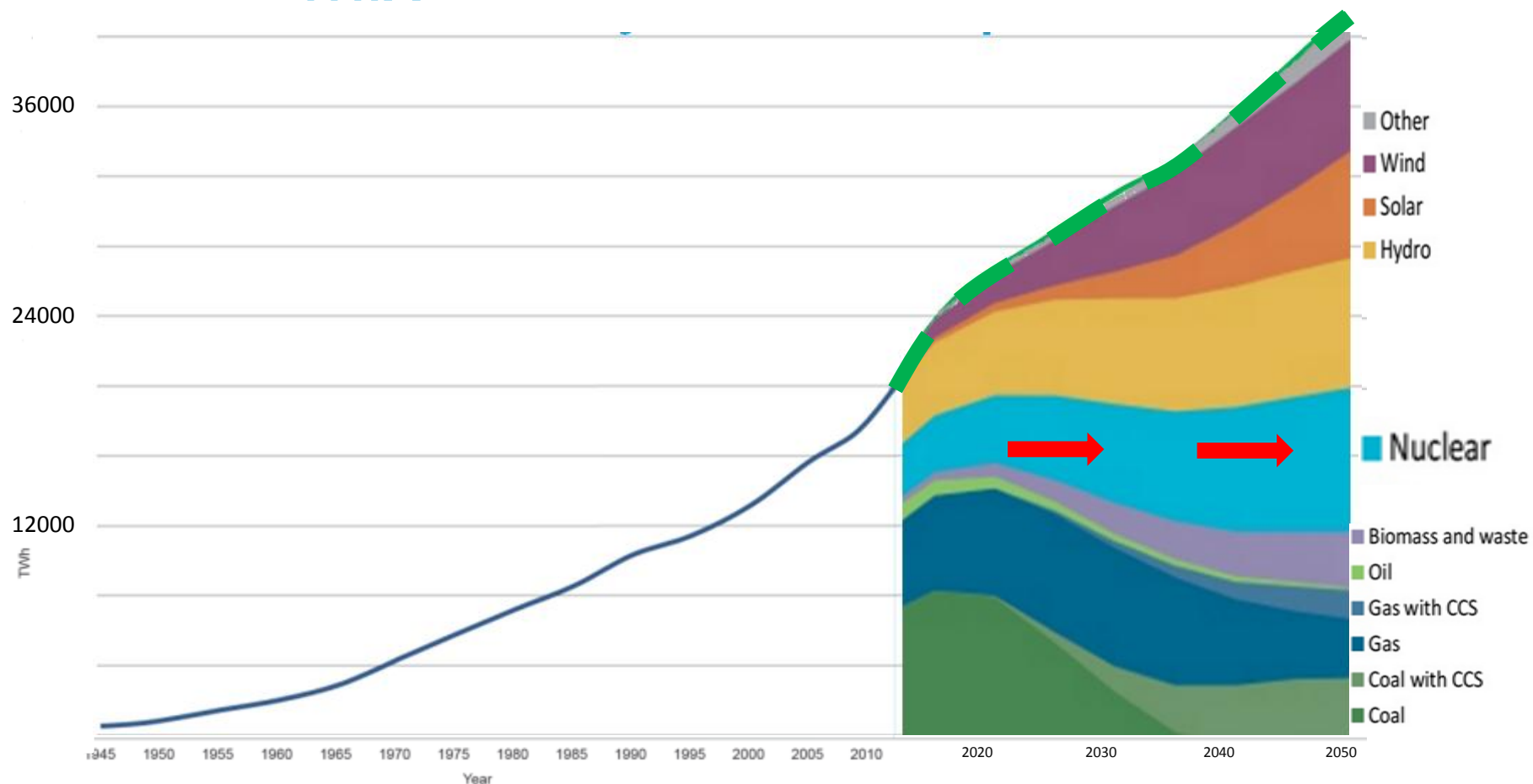
Source: 1945-1979, International Energy Agency databases and analysis
1980-2012, Energy Information Administration

IEA 2 degree scenario: electricity growth in low carbon scenario



Source: 1945-1979, International Energy Agency databases and analysis
1980-2012, Energy Information Administration

IEA 2 degree scenario: generation mix



Source: 1945-1979, International Energy Agency databases and analysis
1980-2012, Energy Information Administration

IEA: nuclear clean energy new build target more achievable than previously thought

Global nuclear industry: Harmony targets require 10 GW per year new capacity between 2016-2020. In past twelve months 11.3 GW has been connected to the grid.

International Energy Agency: “Nuclear power plant grid connections doubled in 2015. Furthermore, progress and construction times in 2015 show the long-term 2DS targets to be more achievable than previously thought.”

“Tracking Clean Energy Progress 2016”

Energy Technology Perspectives 2016

Nuclear makes major contribution in IEA World Energy Outlook

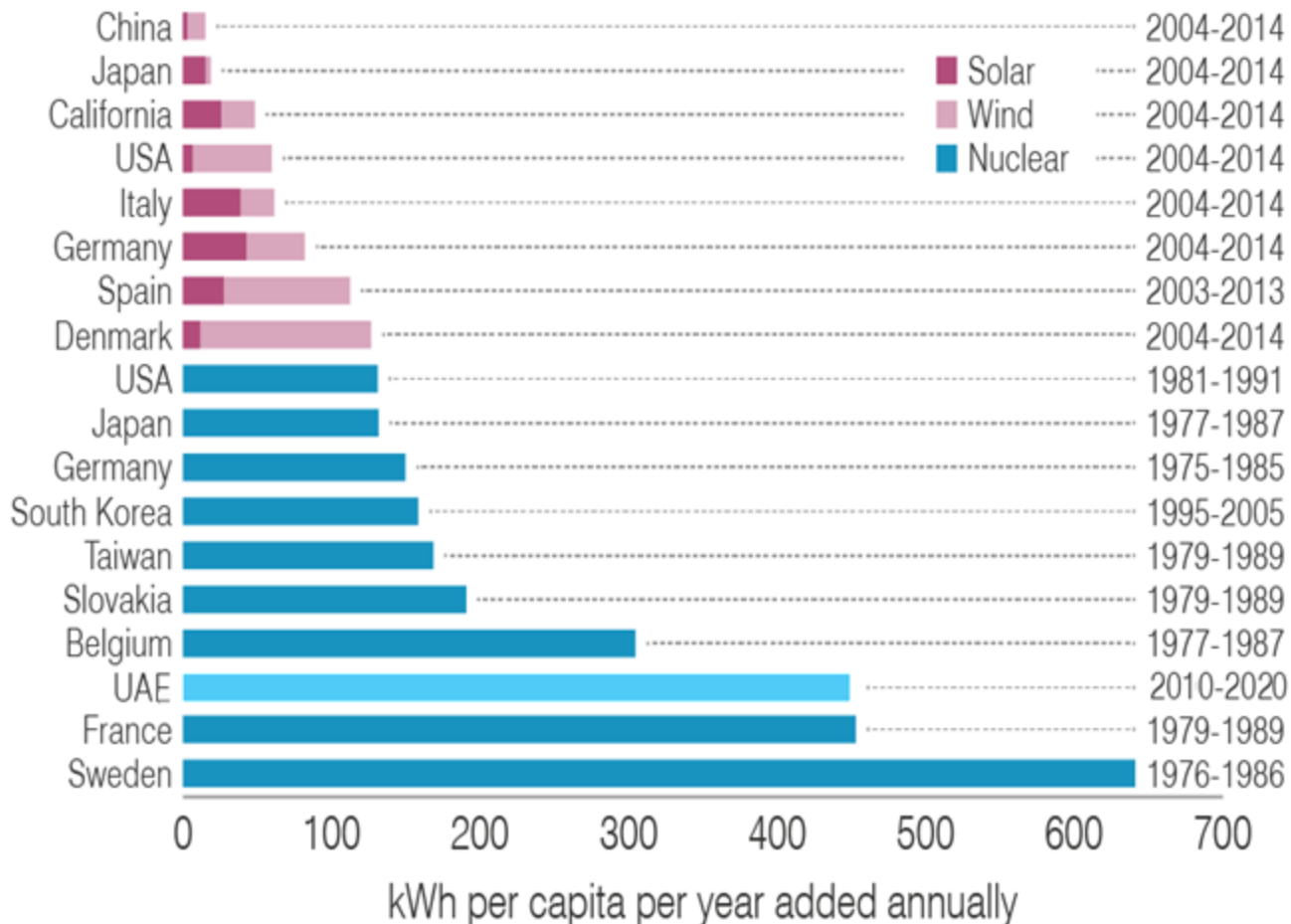
Global nuclear
generation output
increasing by
almost two and a
half times by 2040

Nuclear generation is a
cost-competitive low-
carbon generation
option. Cost for wind
and solar is 22-40 %
higher

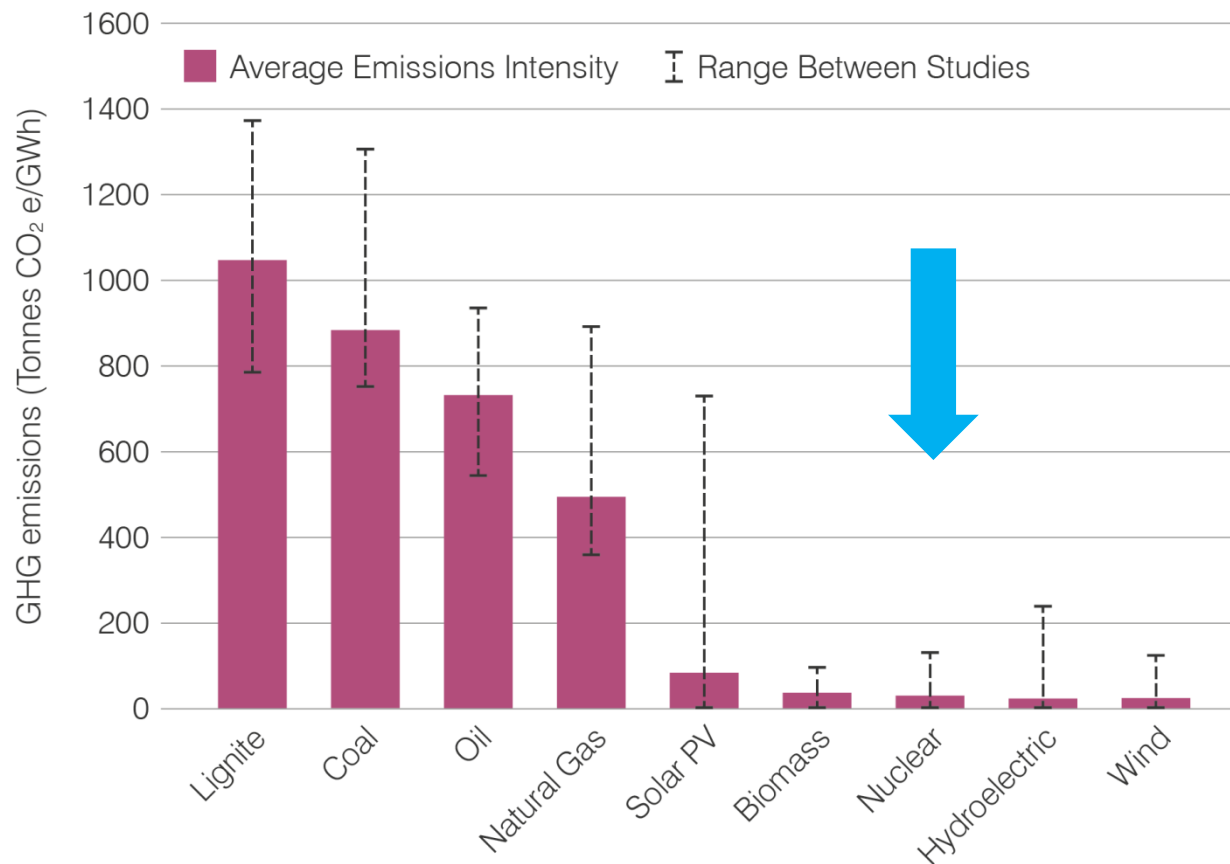
Low carbon energy sources
dominate the generation mix in
2040: hydro 20%, nuclear 18%,
wind 18% and solar PV 9%

IEA, World Energy Outlook, November 2016:
the 450 ppm scenario

Nuclear makes quick, lasting decarbonisation possible

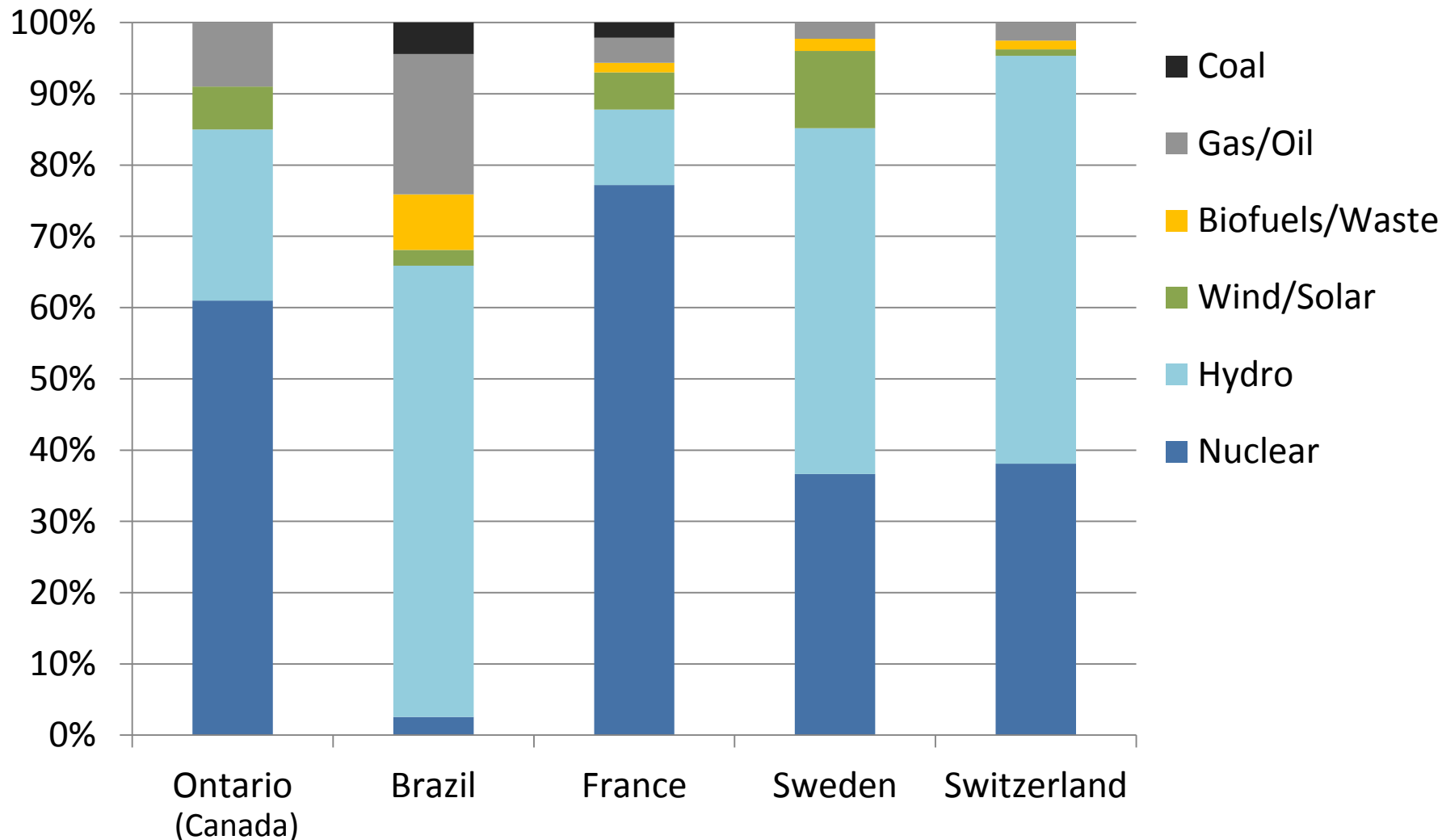


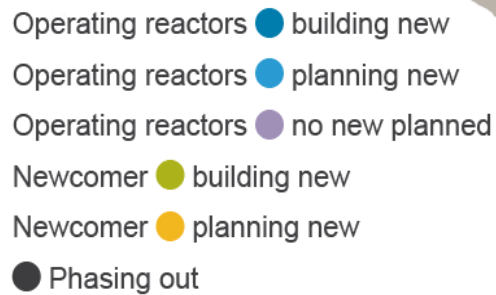
Decarbonising electricity generation – need for low life cycle emissions: Nuclear energy is among the best



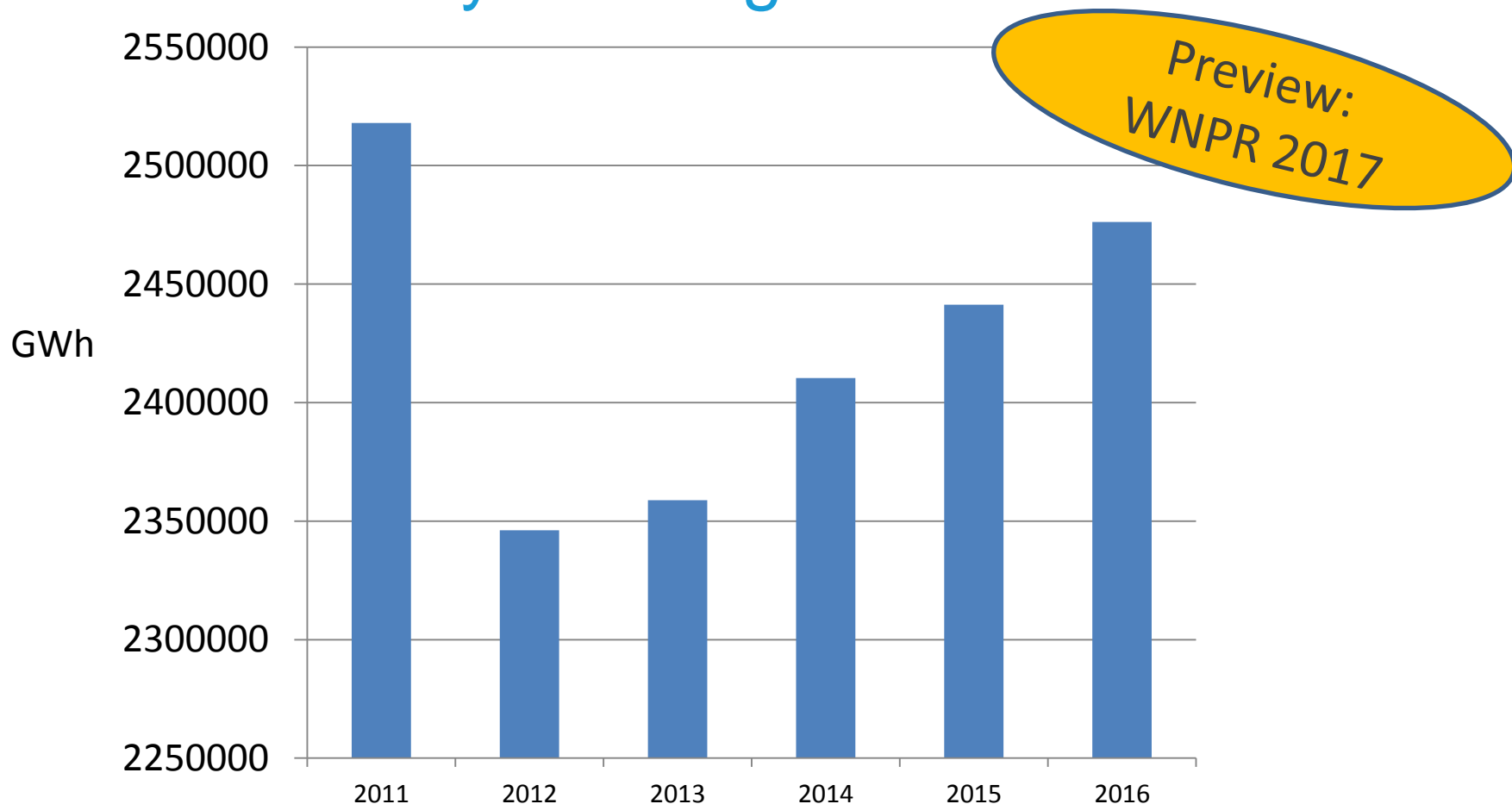
Source: World Nuclear Association meta study, incl. IPCC 2014

Nuclear is an important part of the low carbon solution





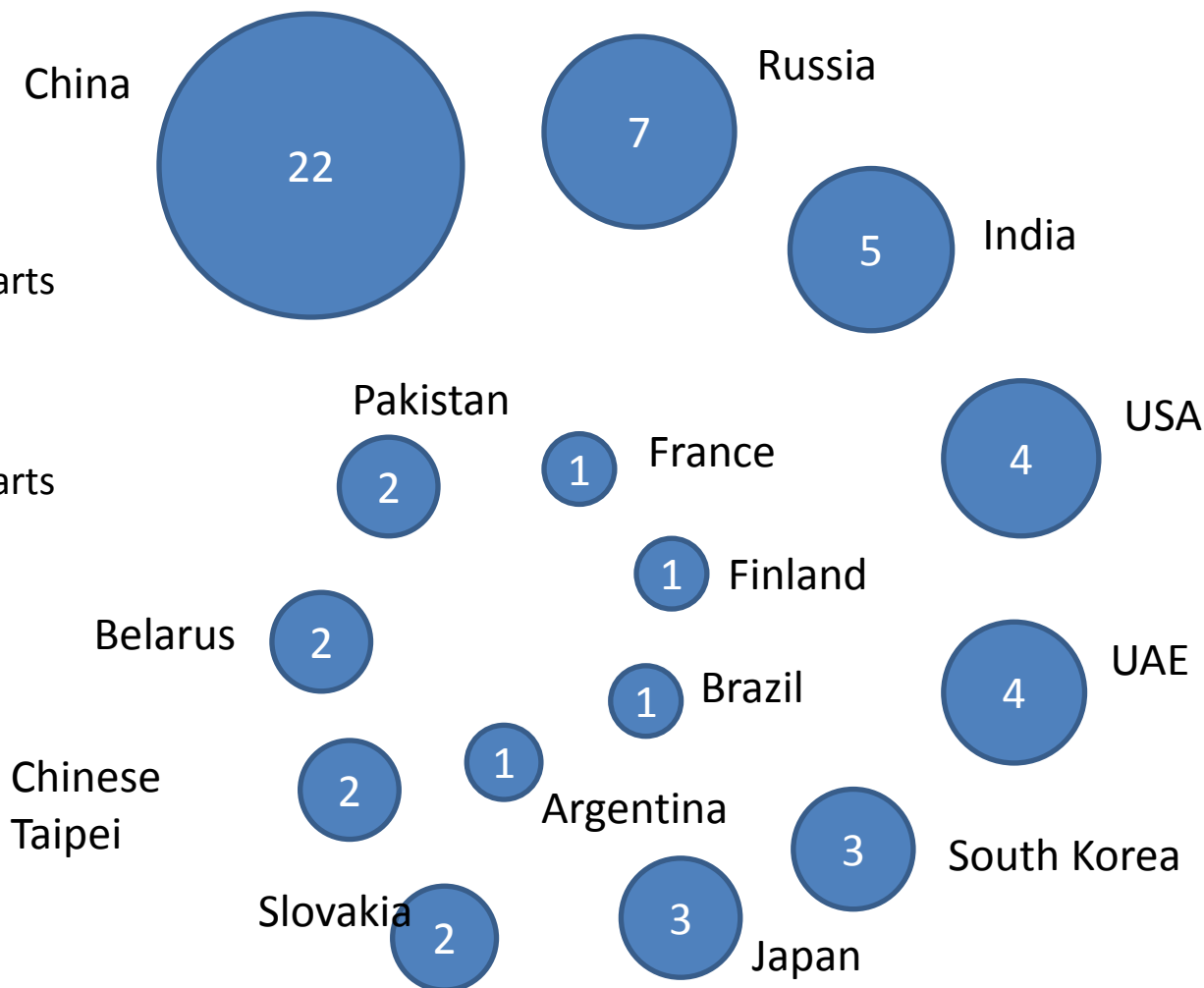
Global nuclear electricity output: Five years of growth since 2011



Highest level of construction in twenty five years: 60 reactors worldwide

China 2016:
5 reactor starts
2 construction starts

China 2015:
8 reactor starts
6 construction starts



New reactor start-ups in 2016

India

Kudankulam-2

USA

Watts Bar-2

South Korea

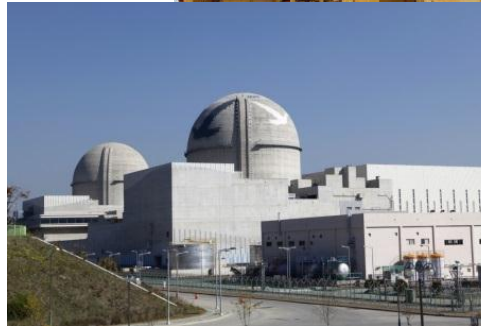
Shin-Kori-3

Russia

Novovoronezh 2-1

Pakistan

Chasnupp-3



New reactor start-ups in 2016

China

Changjiang-2

Fangchenggang-2

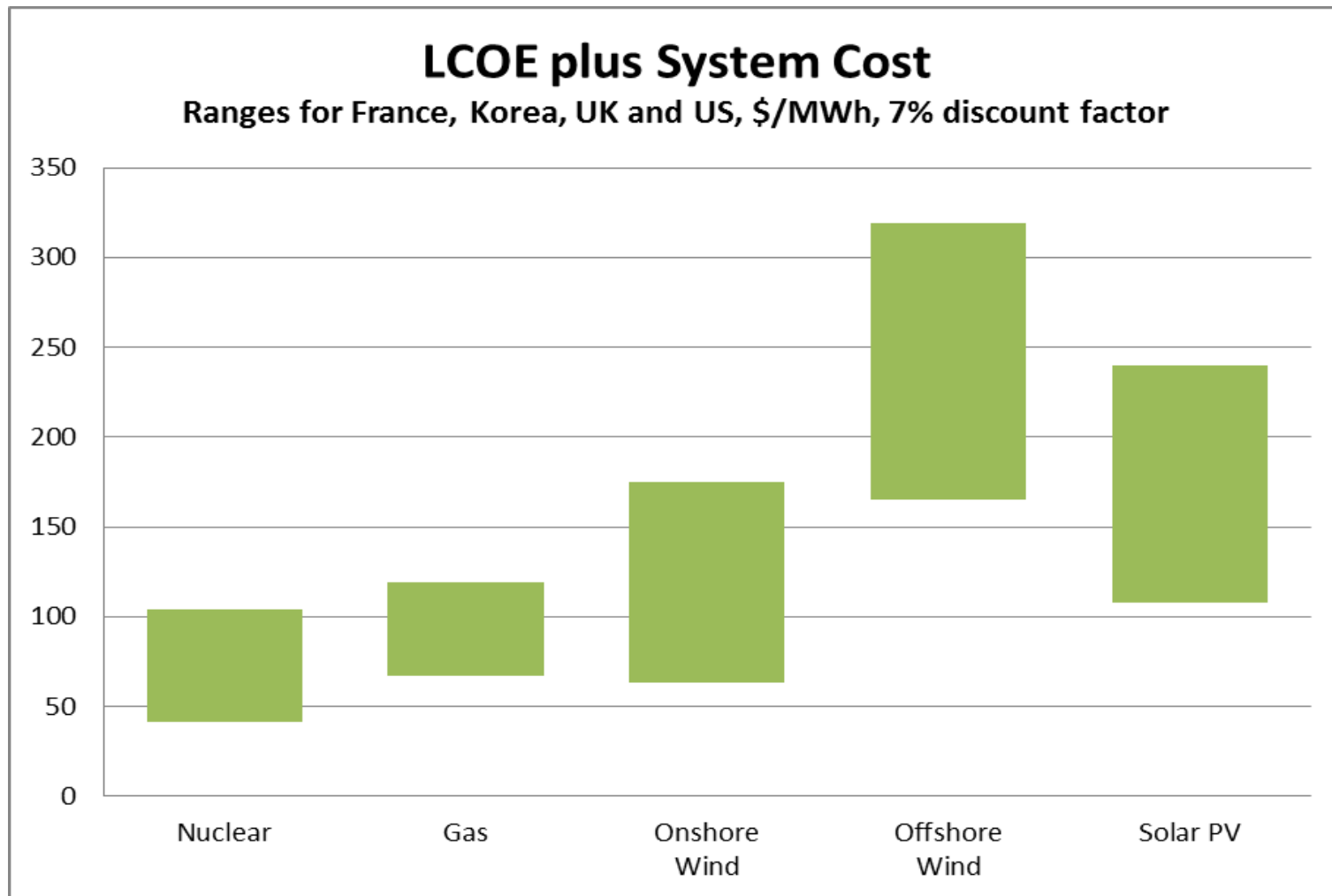
Fuqing-3

Hongyanhe-4

Ningde-4

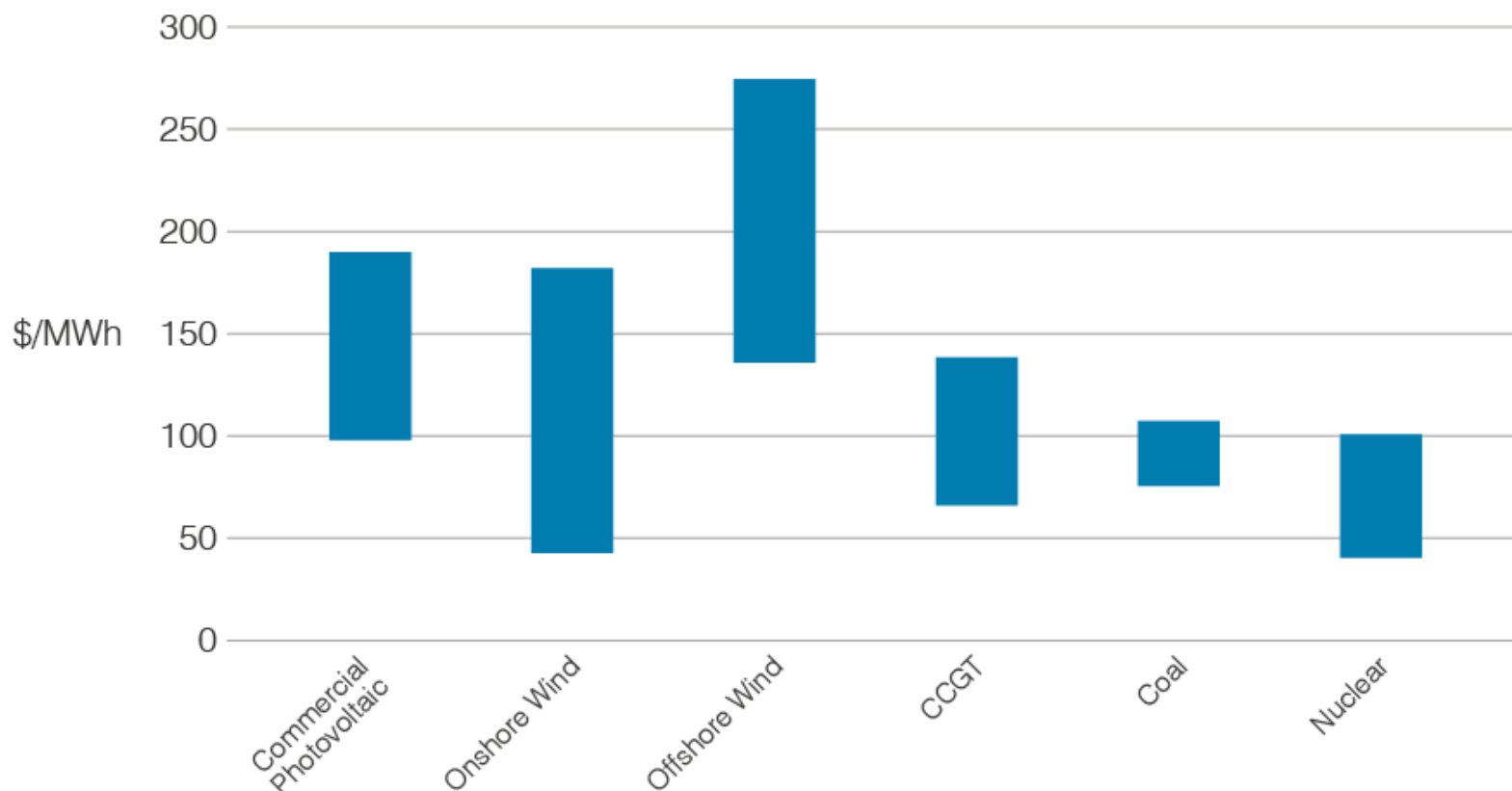


Levelised cost of electricity



Levelised cost of electricity (LCOE)

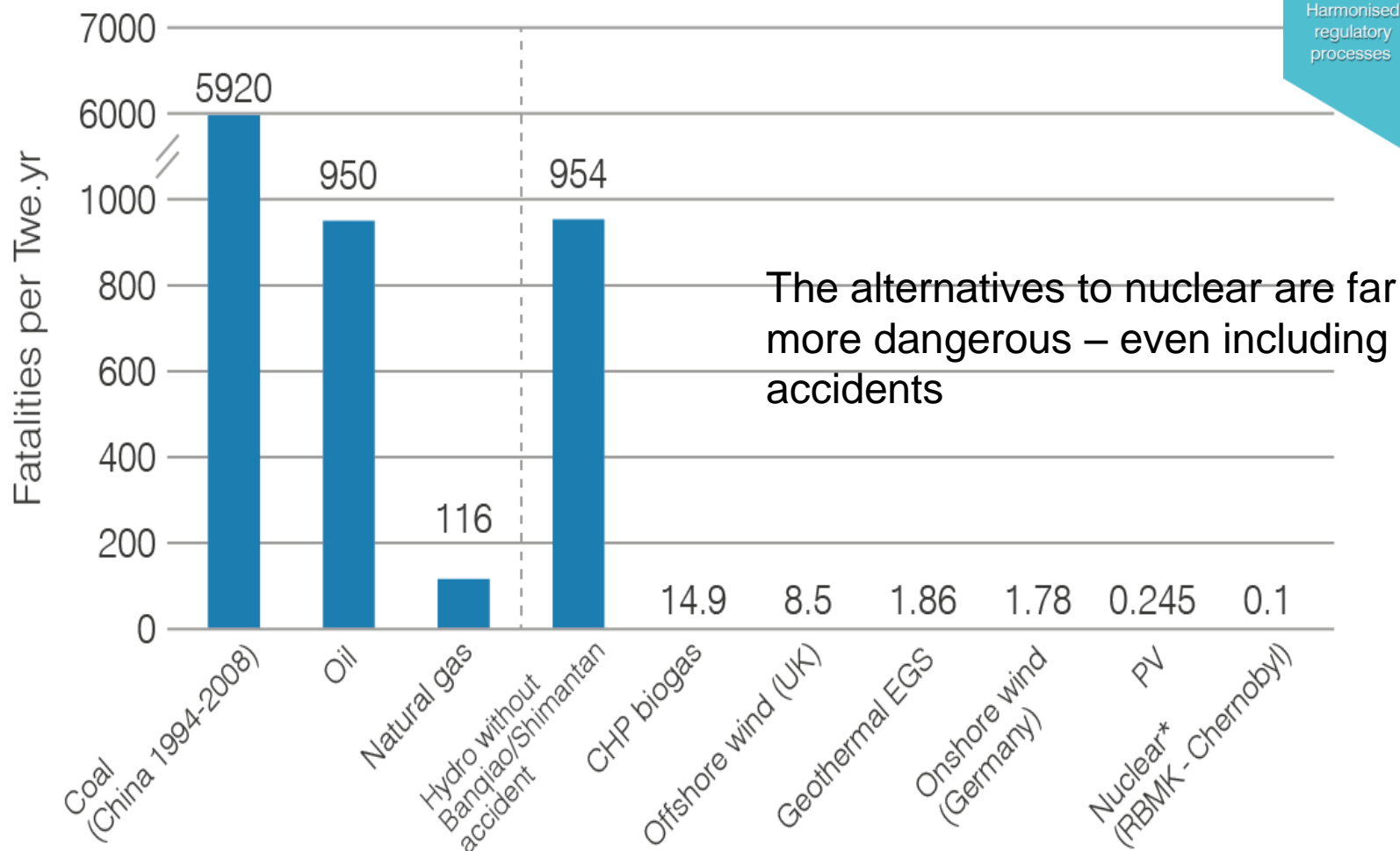
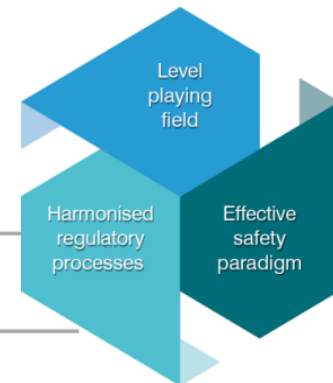
Levelised costs of electricity ranges (at 7% discount rate)



Source: *Projected Costs of Generating Electricity - 2015 Edition*, International Energy Agency and OECD Nuclear Energy Agency

Effective safety paradigm

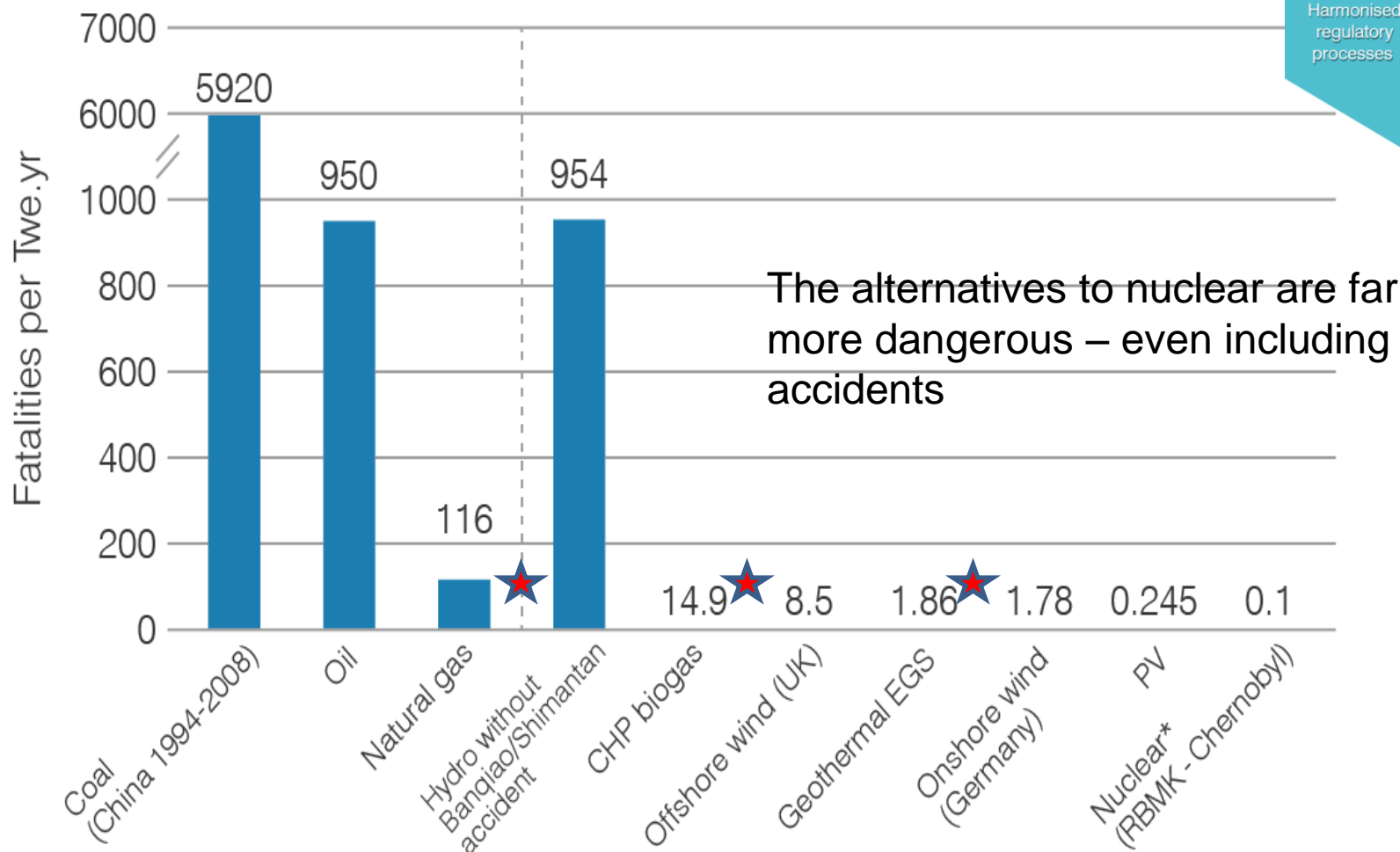
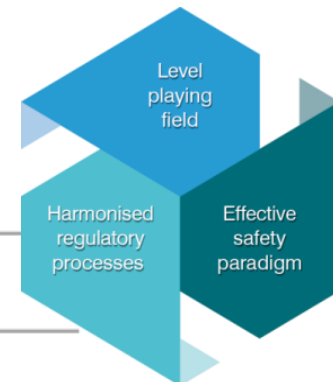
(Energy accident fatalities for non-OECD countries)



Source: Paul-Scherrer Institut. Data for nuclear accidents modified to reflect UNSCEAR findings/recommendations 2012 and NRC SOARCA study 2015

Effective safety paradigm

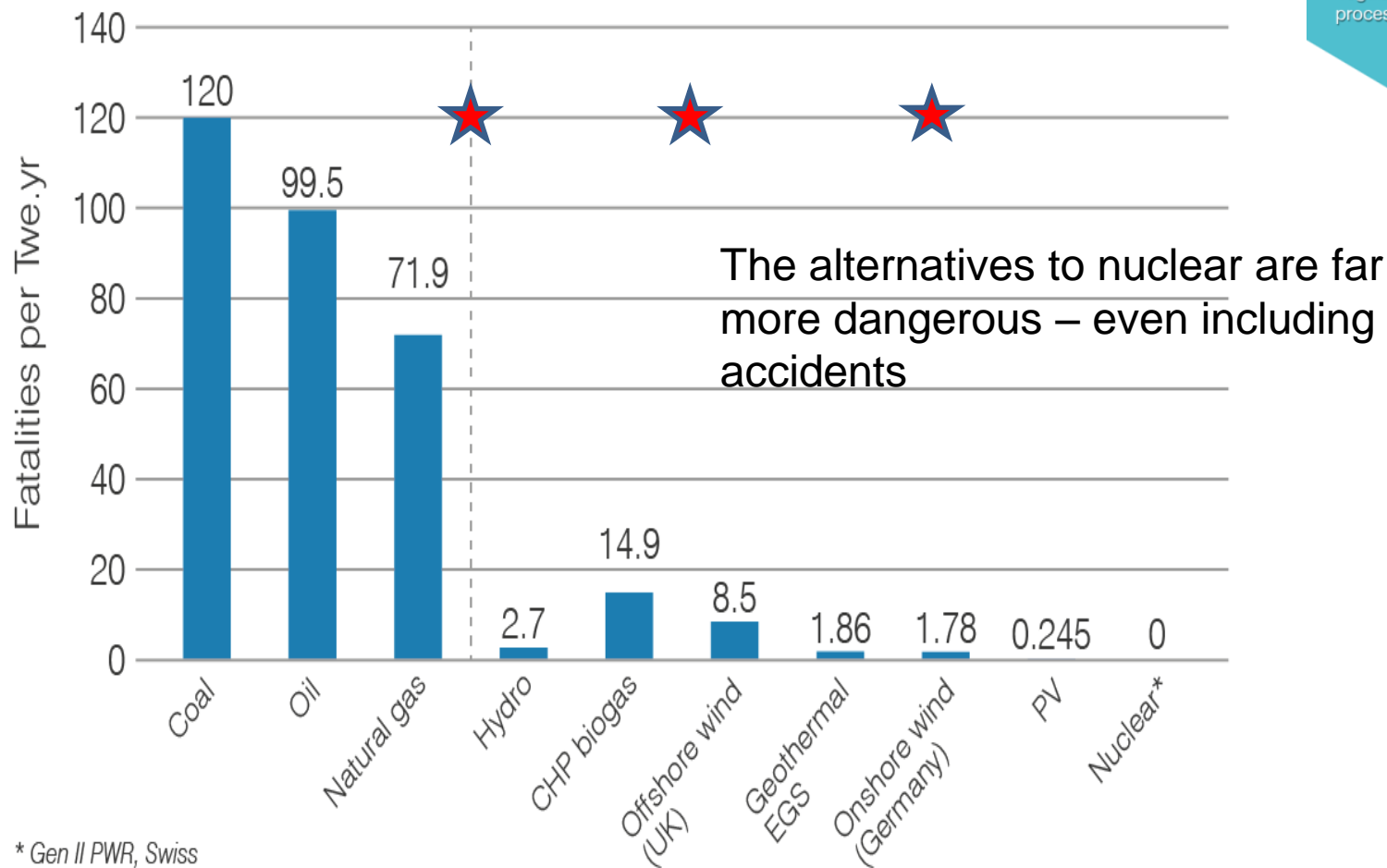
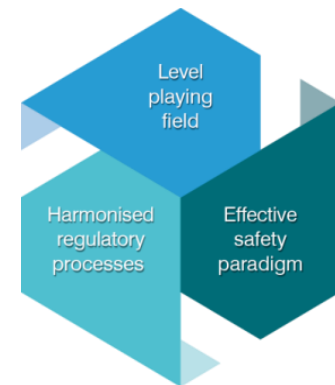
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Effective safety paradigm

(Energy accident fatalities for OECD countries)



Source: Paul-Scherrer Institut. Data for nuclear accidents modified to reflect UNSCEAR findings/recommendations 2012 and NRC SOARCA study 2015

The global nuclear industry: tackling barriers, engage in dialog, develop key actions

Level playing field:

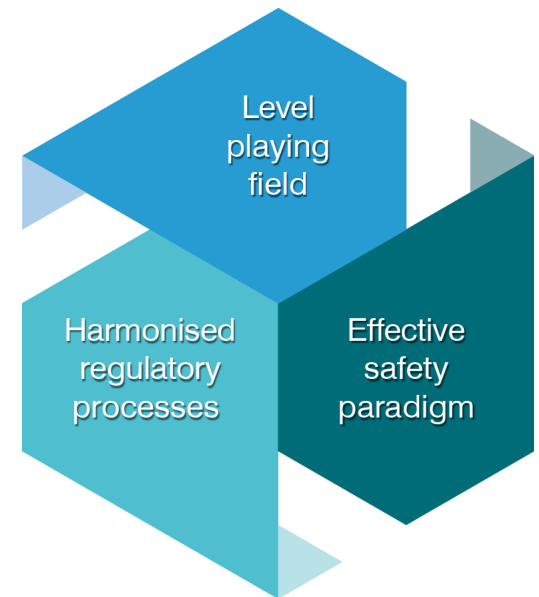
Establish a level playing field for all low-carbon technologies, valuing not only environmental qualities, but also reliability and grid system costs.

Harmonised regulatory processes:

Enhance standardisation, harmonise and update global codes and standards.
Timely licensing of new technologies.

Effective safety paradigm:

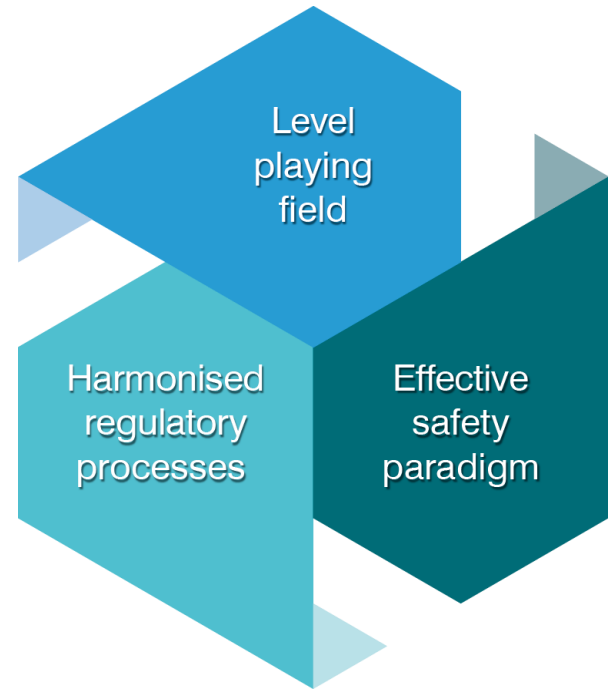
Increase genuine public wellbeing from a society perspective. Ensure global nuclear safety. Confidence in management of nuclear technology and operations.



Level playing field

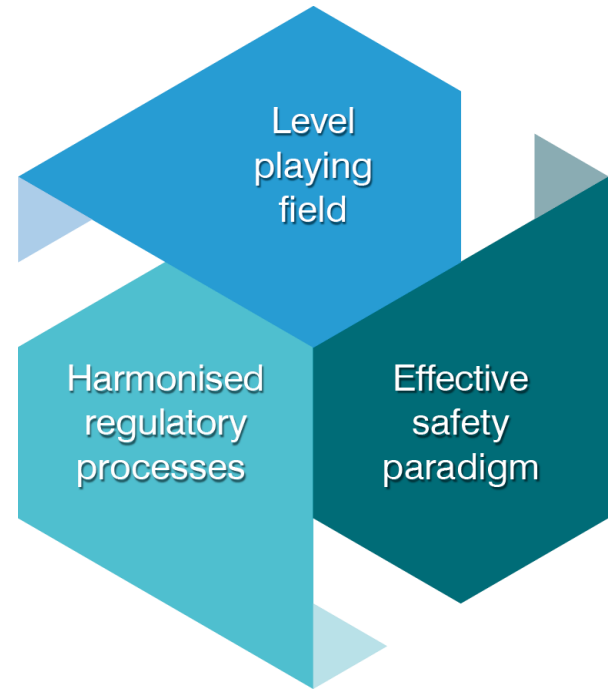
Markets should be reformed to:

- support capital investments
- include grid system costs
- eliminate nuclear-only taxes
- reform subsidies
- give credit for low carbon emissions
- value 24/7 reliability
- support innovative finance solutions



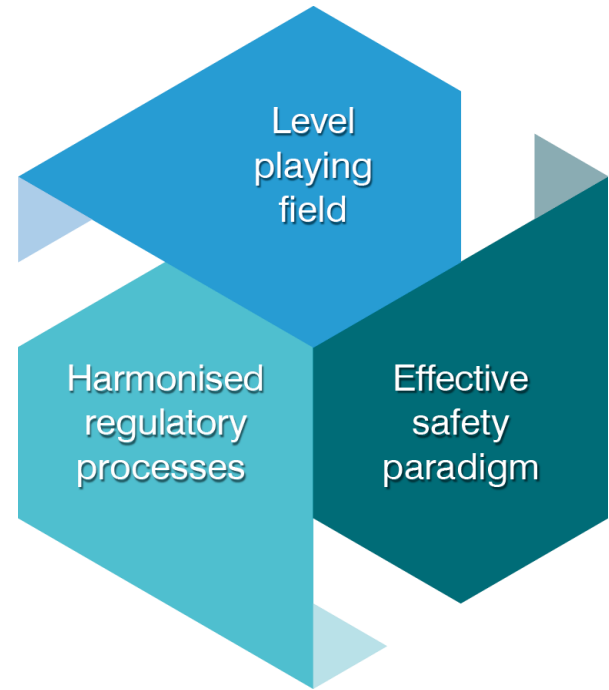
Harmonised regulatory processes

- enhance standardisation
- streamline licensing processes
- harmonise and update global codes and standards
- enabling international trade
- ensure efficient and effective safety regulation
- nuclear innovation: enable development and timely licensing of new technologies

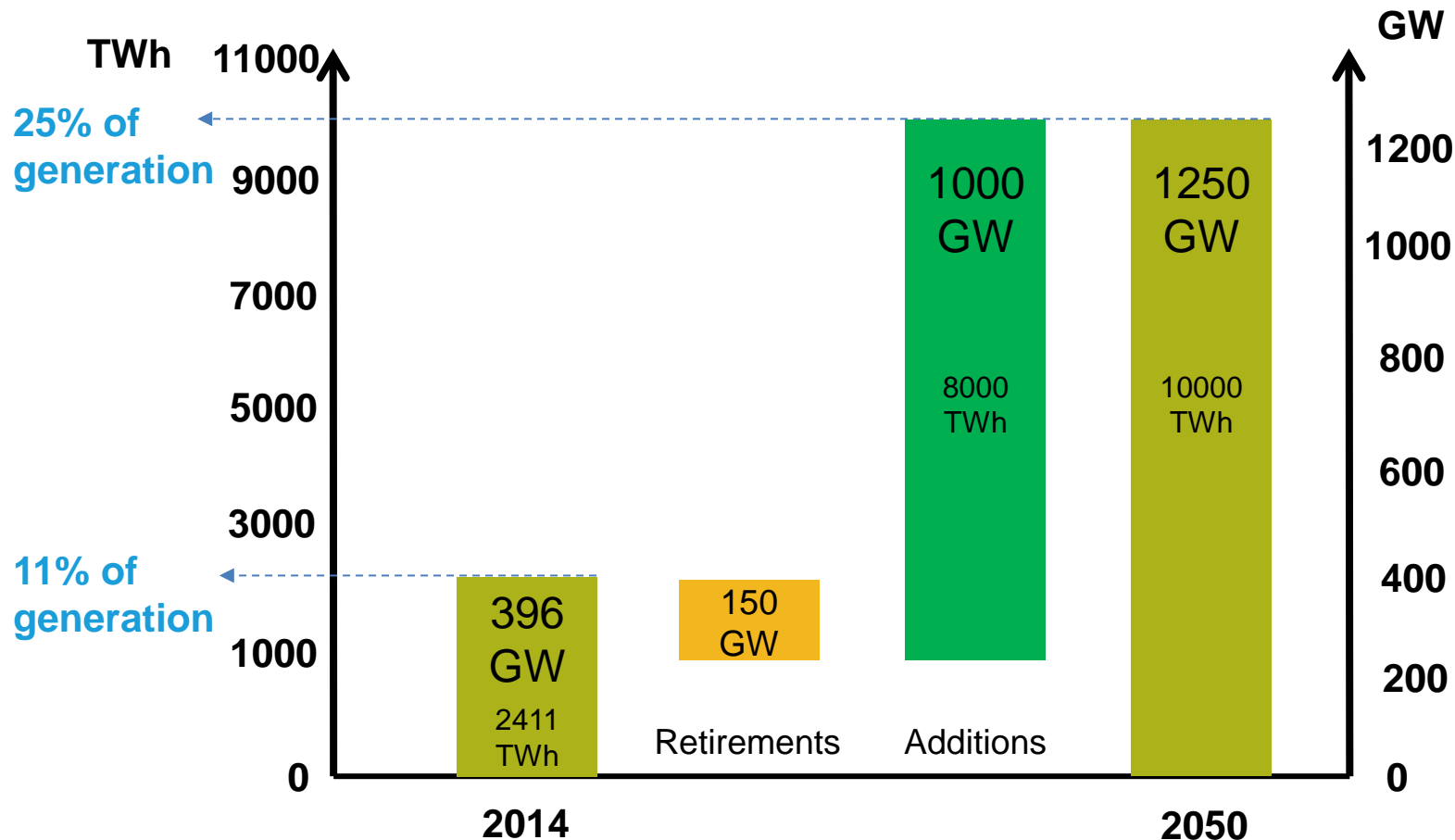


Effective safety paradigm

- Strong political and industry leadership to communicate long term benefit versus risk
- Embrace a holistic approach to society risks from electricity generation so that health and environmental benefits of all sources are maximised
- Recognise the health impacts of the alternatives to nuclear energy
- Introduce policies and response measures that genuinely increase public wellbeing – to limit overall impact, not just radiation
- Stop leading with the nuclear safety first message



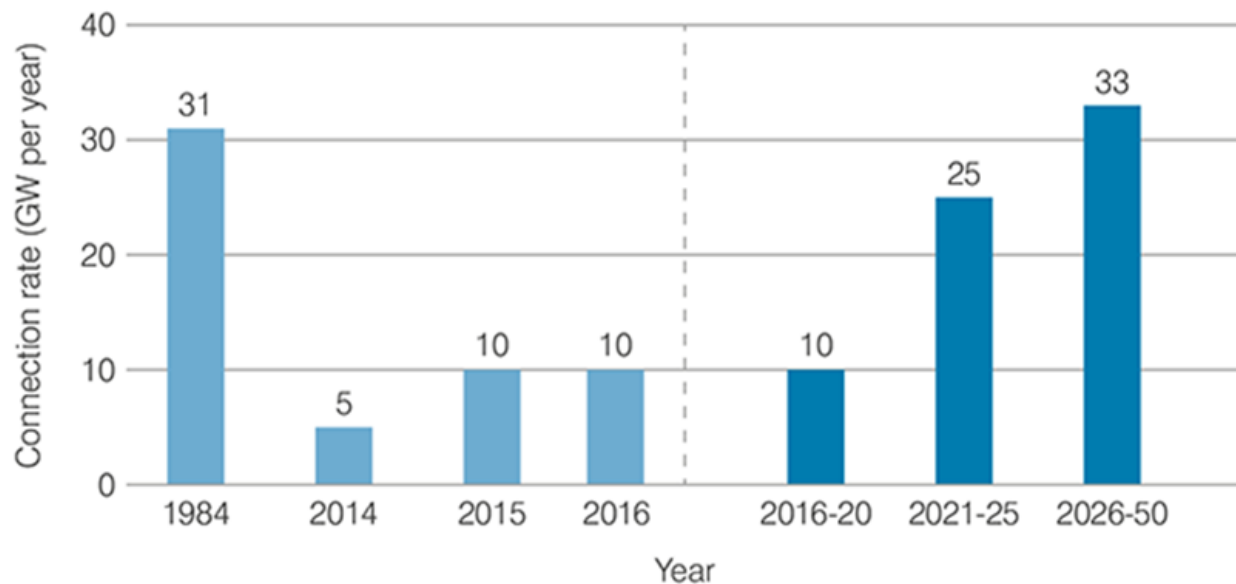
Harmony goal for new nuclear build is 1000 GW



Source: World Nuclear Association. Growth required for nuclear energy to supply 25% of electricity in 2050 under demand forecast of two-degree scenario (see IEA, 2015, Energy Technology Perspectives 2015).
Assumption: 91% capacity factor

Harmony programme 2016-2050

Deliver 1000 GW new nuclear capacity to 2050



Period	Connection rate	Added capacity
	GW per year	GW
2016-2020	10	50
2021-2025	25	125
2026-2050	33	825

Total new nuclear capacity	1000 GW
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The scale assumptions for low-carbon sources...

Source	TWh generated in 2012	Additional TWh in 2050	Growth factor
Biomass and waste	439	+2651	7.0x
Geothermal	70	+985	15.0x
Wind (onshore)	505	+4880	10.7x
Wind (offshore)	15	+1352	91.1x
Solar PV	97	+3646	38.6x
Solar CSP	5	+3123	625.6x
Coal with CCS	13 (in 2020)	+3184	245.8x
Natural Gas with CCS	9 (in 2020)	+1786	199.4x
Biomass with CCS	7 (in 2025)	+67	10.6x

...often overlook established low carbon sources

Source	TWh generated in 2012	Additional TWh in 2050	Growth factor
Nuclear	2461	+4341	2.8x
Hydro	3672	+3256	1.9x

Nuclear and hydro: 84% of low-carbon today

Credible, strong growth of 2-3x to 2050
(Electricity as a whole grows 2x)

The global nuclear industry: tackling barriers, engage in dialog, develop key actions

Level playing field:

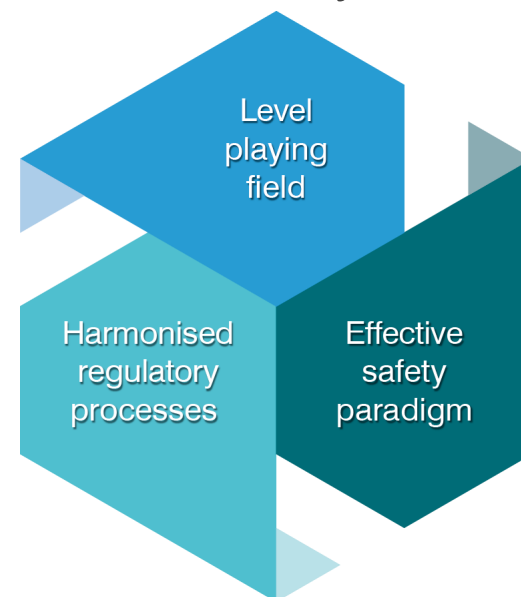
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Harmony Goals for a Sustainable Energy Future

Level playing field:

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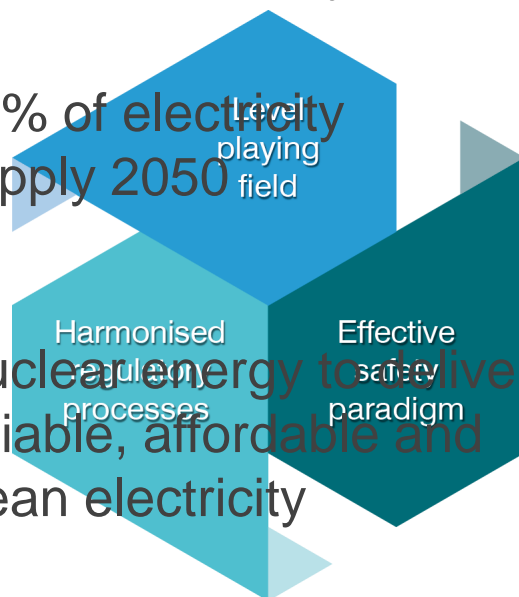
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1000 gigawatt new nuclear capacity by 2050

25% of electricity supply 2050

Nuclear energy to deliver reliable, affordable and clean electricity





www.world-nuclear.org