Harmony
The role of nuclear energy meeting electricity needs in the 2 degree scenario
Harmony goal: ready to deliver more nuclear to ensure 2 degree scenario

- Level playing field
- Harmonised regulatory processes
- Effective safety paradigm

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

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

Global consumption of electricity

Source: 1945-1979, International Energy Agency databases and analysis
1980-2012, Energy Information Administration
IEA 2 degree scenario: electricity growth in low carbon scenario
IEA 2 degree scenario: generation mix

![Graph showing energy generation mix from 1945 to 2050. The graph indicates a significant increase in nuclear energy production, with a focus on the years 2020 to 2050.](image)

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%
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 status

Operating reactors
- building new
- planning new
- no new planned

Newcomer
- building new
- planning new

Phasing out

Legend: Operating reactors: building new, planning new, no new planned; Newcomer: building new, planning new; Phasing out
Global nuclear electricity output: Five years of growth since 2011

Preview: WNPR 2017
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

Source World Nuclear Association
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

LCOE plus System Cost
Ranges for France, Korea, UK and US, $/MWh, 7% discount factor
Levelised cost of electricity (LCOE)

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

$/MWh

Effective safety paradigm
(Energy accident fatalities for non-OECD countries)

The alternatives to nuclear are far more dangerous – even including accidents

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

Assumption: 91% capacity factor
Harmony programme 2016-2050
Deliver 1000 GW new nuclear capacity to 2050

<table>
<thead>
<tr>
<th>Period</th>
<th>Connection rate (GW per year)</th>
<th>Added capacity (GW)</th>
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</thead>
<tbody>
<tr>
<td>2016-2020</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>2021-2025</td>
<td>25</td>
<td>125</td>
</tr>
<tr>
<td>2026-2050</td>
<td>33</td>
<td>825</td>
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<tr>
<td></td>
<td>Total new nuclear capacity</td>
<td>1000 GW</td>
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</table>
The scale assumptions for low-carbon sources...

<table>
<thead>
<tr>
<th>Source</th>
<th>TWh generated in 2012</th>
<th>Additional TWh in 2050</th>
<th>Growth factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass and waste</td>
<td>439</td>
<td>+2651</td>
<td>7.0x</td>
</tr>
<tr>
<td>Geothermal</td>
<td>70</td>
<td>+985</td>
<td>15.0x</td>
</tr>
<tr>
<td>Wind (onshore)</td>
<td>505</td>
<td>+4880</td>
<td>10.7x</td>
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<tr>
<td>Wind (offshore)</td>
<td>15</td>
<td>+1352</td>
<td>91.1x</td>
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<tr>
<td>Solar PV</td>
<td>97</td>
<td>+3646</td>
<td>38.6x</td>
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<tr>
<td>Solar CSP</td>
<td>5</td>
<td>+3123</td>
<td>625.6x</td>
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<tr>
<td>Coal with CCS</td>
<td>13 (in 2020)</td>
<td>+3184</td>
<td>245.8x</td>
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<tr>
<td>Natural Gas with CCS</td>
<td>9 (in 2020)</td>
<td>+1786</td>
<td>199.4x</td>
</tr>
<tr>
<td>Biomass with CCS</td>
<td>7 (in 2025)</td>
<td>+67</td>
<td>10.6x</td>
</tr>
</tbody>
</table>
...often overlook established low carbon sources

<table>
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<tr>
<th>Source</th>
<th>TWh generated in 2012</th>
<th>Additional TWh in 2050</th>
<th>Growth factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear</td>
<td>2461</td>
<td>+4341</td>
<td>2.8x</td>
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<tr>
<td>Hydro</td>
<td>3672</td>
<td>+3256</td>
<td>1.9x</td>
</tr>
</tbody>
</table>

Nuclear and hydro: 84% of low-carbon today

Credible, strong growth of 2-3x to 2050
(Electricity as a whole grows 2x)
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Harmony Goals for a Sustainable Energy Future

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