

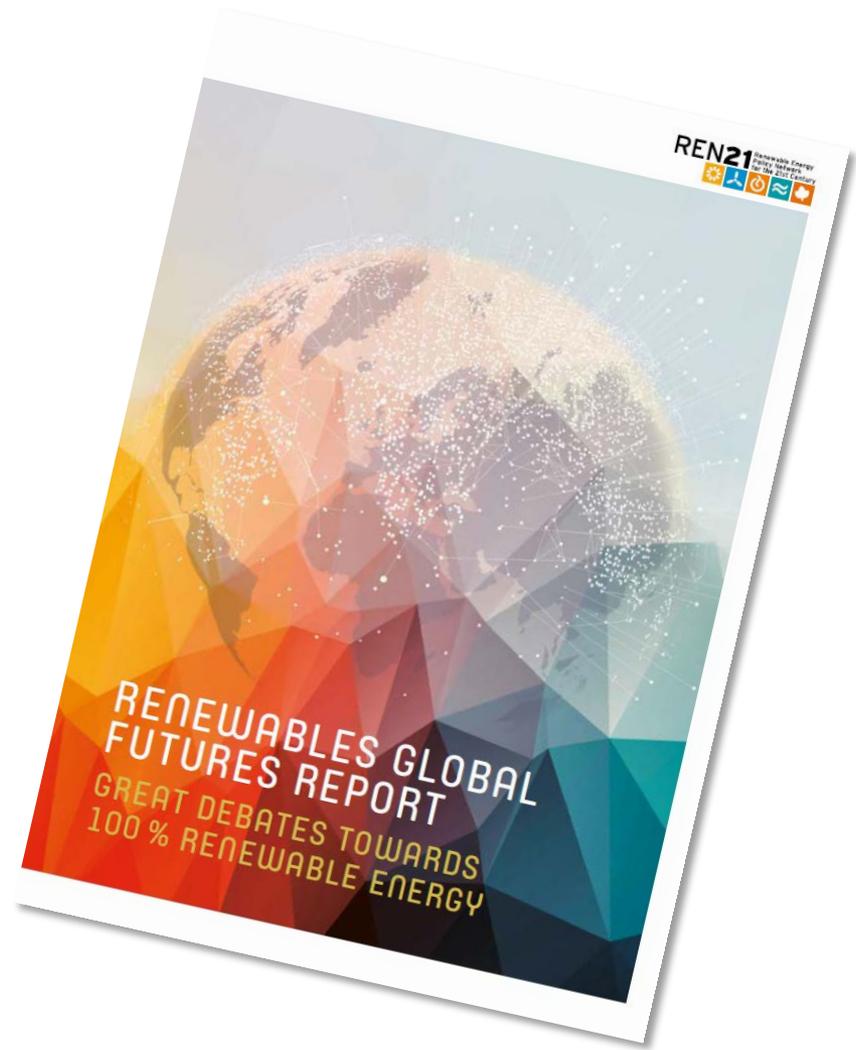
RENEWABLES GLOBAL FUTURES REPORT

GREAT DEBATES TOWARDS 100% RENEWABLE ENERGY



100% Renewables: Pipe dream or reality?

- 114 experts interviewed
- Conservative , moderate, progressive perspectives
- Giving their opinion on:
 - feasibility of 100% renewable energy future
 - macro-economic impact of such a future
- All regions of the world represented
- Not prescriptive but a starting point for debate
- 12 Great Debates



Regional Distribution of Interviewees

Interviewees were selected from the following regions:

- Africa
- Australia and Oceania
- China
- Europe
- India
- Japan
- Latin America and the Caribbean
- North America
- International experts and organisations

Overview of the Results – the 12 Great Debates

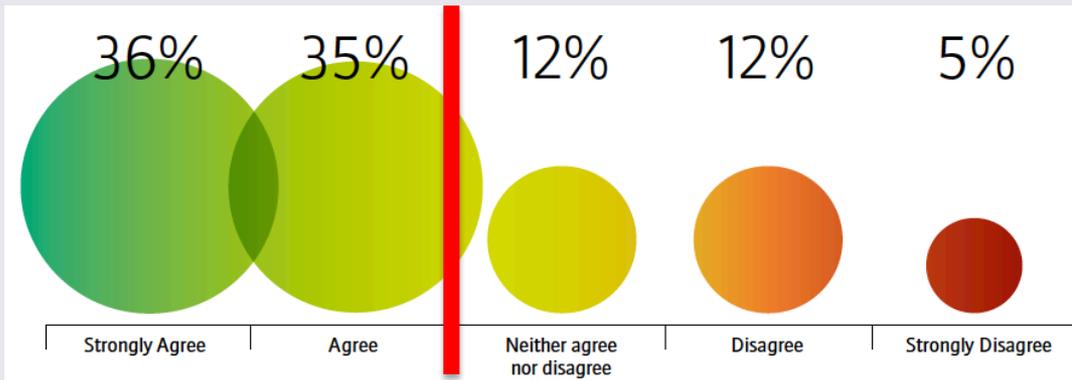
The analysis is structured in 12 chapters providing detailed analysis and a conclusion for each topic

1. 100% Renewables: A logical consequence of the Paris Agreement?
2. Global Energy Demand Development: Efficiency on a global level?
3. Renewable Power Generation: The winner takes all?
4. The Future of Heating: Thermal or electrical applications?
5. Renewables for Transport: Electrification versus biofuels?
6. Interconnection of Sectors: System thinking required
7. Storage: Supporter or competitor of the power grid?
8. Technology versus Costs: Which should come first?
9. Scaling-up Investments and Work Force: 100% renewables for socio-economic change
10. Utilities of the Future: What will they look like?
11. Mega Cities: Mega possibilities
12. Energy Access Enabled Through Renewables: How to speed up connections?

1. 100% Renewables: A logical consequence of the Paris Agreement?

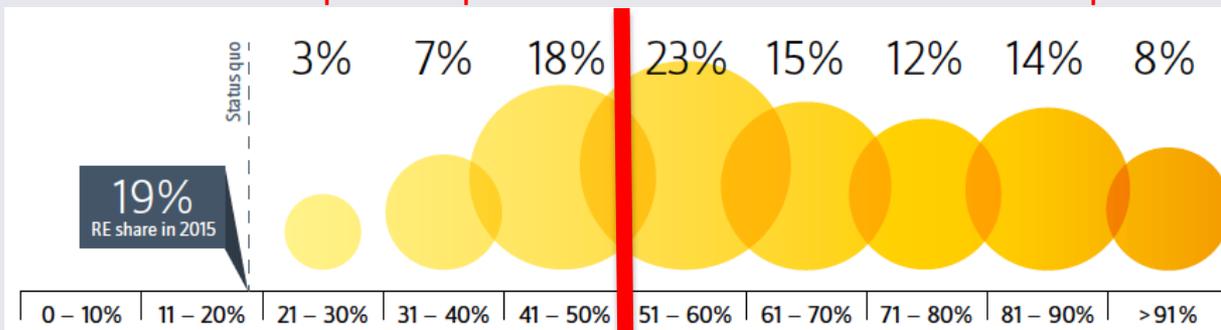
“Is the transition to 100% renewables on a global level feasible and realistic?”

- 71% agree with this statement



What will be the share of global renewable final energy consumption by 2050?

- 72% of the experts expect RE share will double or even triple with the next 3 decades.



1. 100% Renewables: A logical consequence of the Paris Agreement?

All of the energy experts agreed that renewable energy deployment will continue to expand in the future, and that the technical and economic potential of renewables are largely untapped.

However, when asked about the likelihood of achieving a 100% renewable energy future by 2050, there was no consensus.

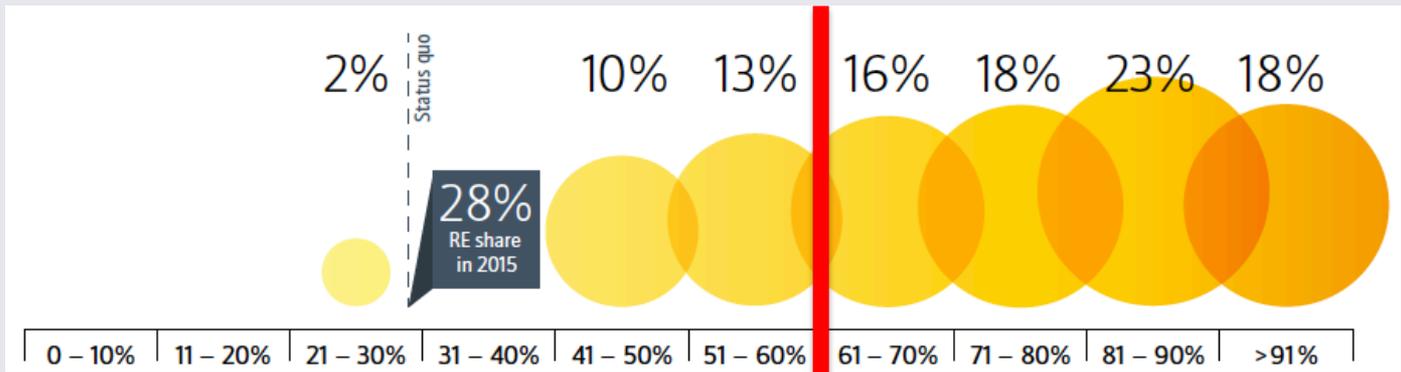
Despite the fact that more than two-thirds of all experts interviewed considered a 100% renewable energy future by midcentury to be both feasible and realistic, some remain unconvinced that a fully renewable energy supply is feasible, or even **necessary**.

100% Renewable is not yet a logical consequence for all energy experts.

3. Renewable Power Generation: The winner takes all?

What will be the estimated development of global renewable power generation share by 2050?

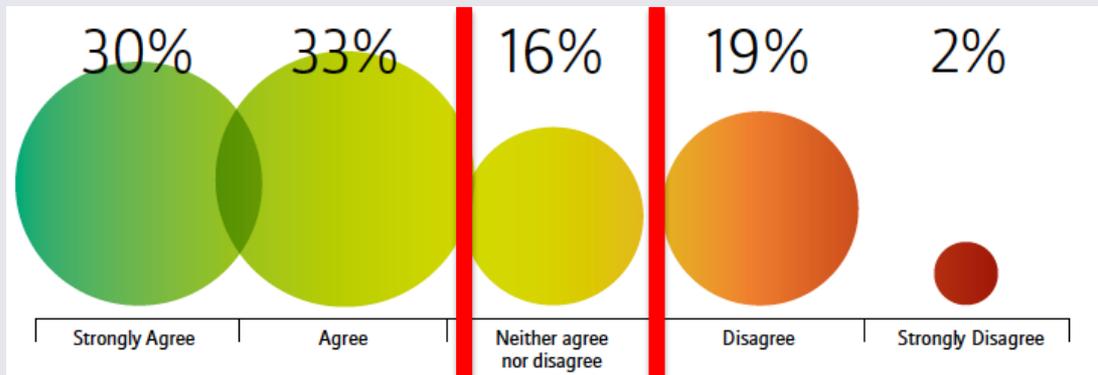
- 65% expect that renewable power generation will more than double within 30 years



3. Renewable Power Generation: The winner takes all?

Will decentralized power generation dominate over centralized generation by 2050?

- 63% expect decentralized generation to dominate over centralized plants
- 21% disagree



3. Renewable Power Generation: The winner takes all?

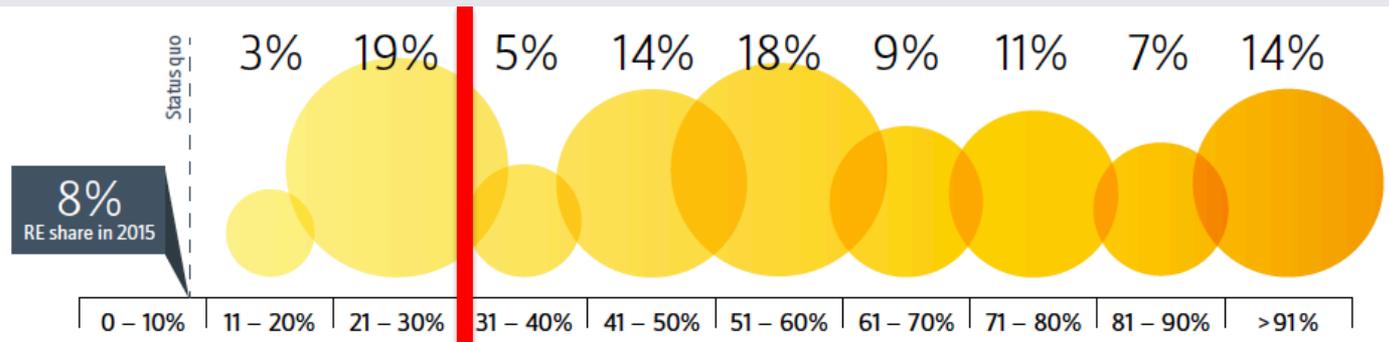
- The power sector is winning the race to a renewable energy future.
- Wind power is now among the cheapest new power plant technologies, and solar photovoltaic (PV) systems have achieved grid parity in many countries.
- Renewables significantly changed the way utilities operate over the past decade.
- Achieving 100% renewable energy systems will require a mix of many different technologies to cover the full range of needs.
- Technologies such as biomass, geothermal and hydro have largely been overshadowed by rapid growth of wind and solar.
- A debate how to stimulate the growth of all renewable power generation technologies is required to achieve resilient power systems.

Solar PV and Wind will dominate – but all RE and EE technologies are required for 100% RE.

4. The Future of Heating: Thermal or electrical application?

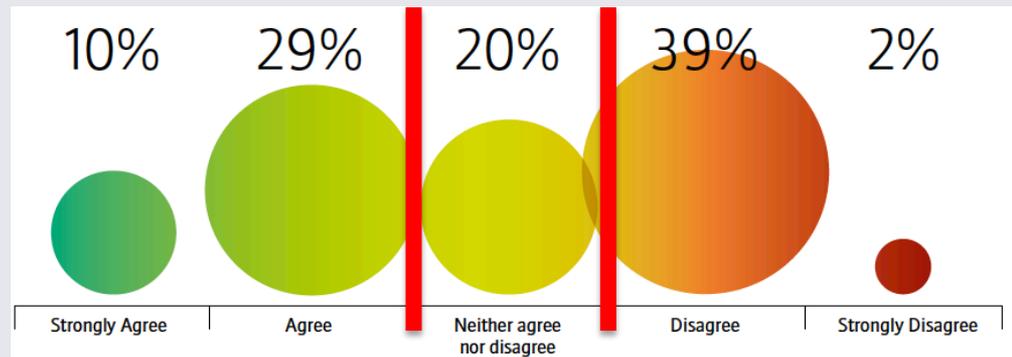
What will be the share of global renewable heating energy consumption by 2050?

- 78% expect the renewable heating share at least to triple within the next 30 years



“The electrification of the heating sector will continue and will lead to an almost complete electrification.”

- 39% agree
 - 41% disagree
 - 20% undecided
- >> the race is still wide open



4. The Future of Heating: Thermal or electrical application?

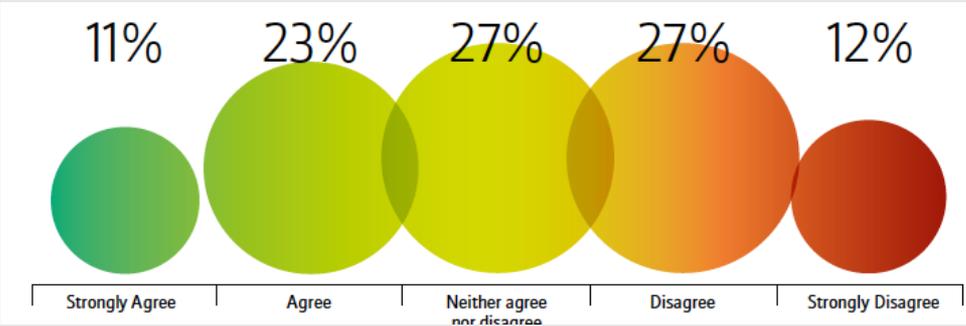
- Energy for heating currently represents over 40% of total final energy demand – a greater share than the entire power sector.
- Policies for the heating sector – with regard both to demand and supply – are required.
- Industrial process heat is universally needed, unlike heating of homes and offices, which are highly dependent on climate conditions.
- Heating and cooling technologies – both thermal and electrical - can help integrate more variable solar and wind power with demand side management and storage.
- Different technology options require different infrastructures:
District heating systems, power grid or gas pipeline distribution grid for hydrogen or renewable methane. / hydrogen distribution grids. Urgent debate needed given the long- term lead-time for installing the necessary infrastructure.

Not yet decided if the future of heating will be dominated by electrical or thermal applications.

8. Technology versus Costs: Which should come first?

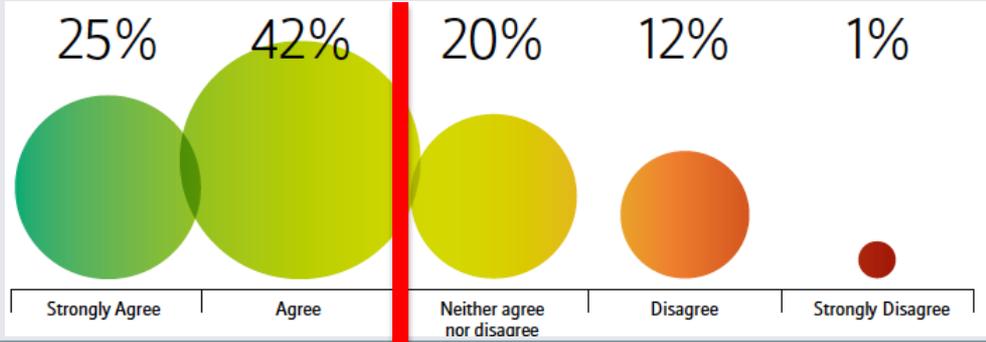
“In the coming decades, the price of oil per barrel over USD 100 per barrel is almost certain.”

- High certainty about the uncertainty of fossil fuel prices



“The cost for renewables will continue to fall and will out-pace all fossil fuels within the next 10 years.”

- 67% agreement that renewables will outpace fossil fuels within the next 10 years.



8. Technology versus Costs: Which should come first?

- The survey included many questions about future technology development. Only one-third of all interviewees completed this section, results were not included in this report.
- This suggests that most energy thought leaders are focused on financial and political aspects of the energy sector, while only a minority is involved in debates about strategic technology assessment. In order to find the most efficient and sustainable energy supply system, a dedicated technology debate is vital.

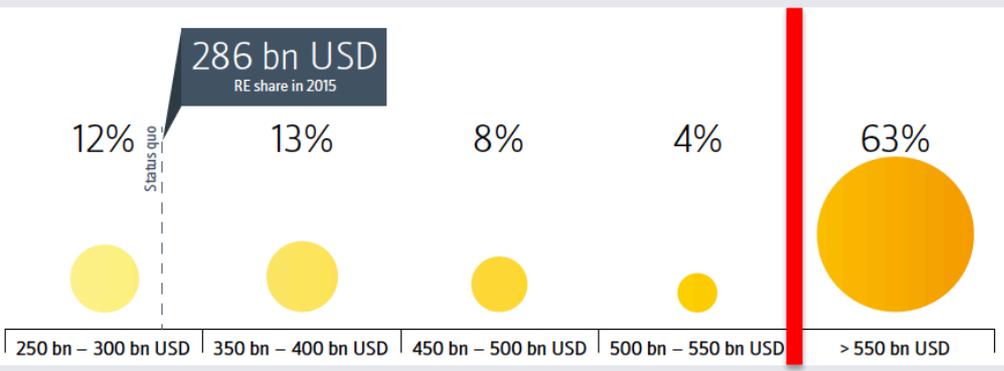
Key questions for a strategic technology debate:

- Which technology offers the most benefits for a specific application?
- And if this technology is currently expensive, how do we bring down costs?

9. Scaling-up Investments and Work Force: 100% renewables for socio-economic change

What will the annual global investment volume in renewable energy be by 2050?

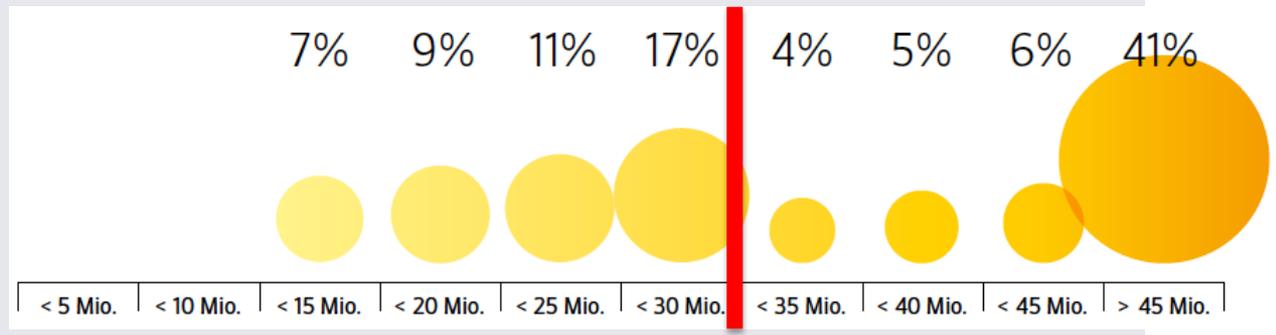
- 63% believe that the RE investment volume will at least double



How many people will be employed in this sector by 2050?

(8.1 million in 2016)

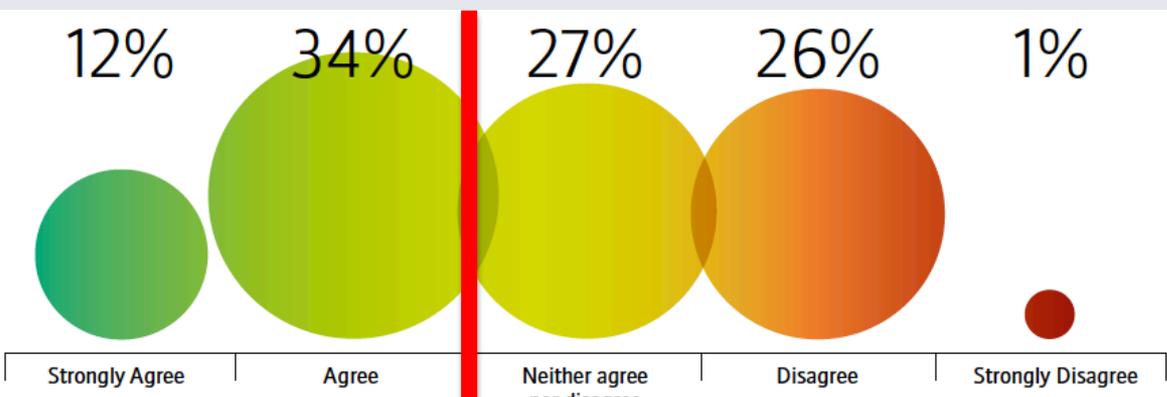
- 56% expect the workforce to quadruple by 2050



11. Mega Cities: Mega possibilities

“Decentralised energy technologies will play a significant role even in space-constrained megacities and will supply the majority of the power demand by 2050.”

- Almost half of all experts (46%) agree that renewable generation can play a role even in space constrained megacities.



11. Mega Cities: Mega possibilities

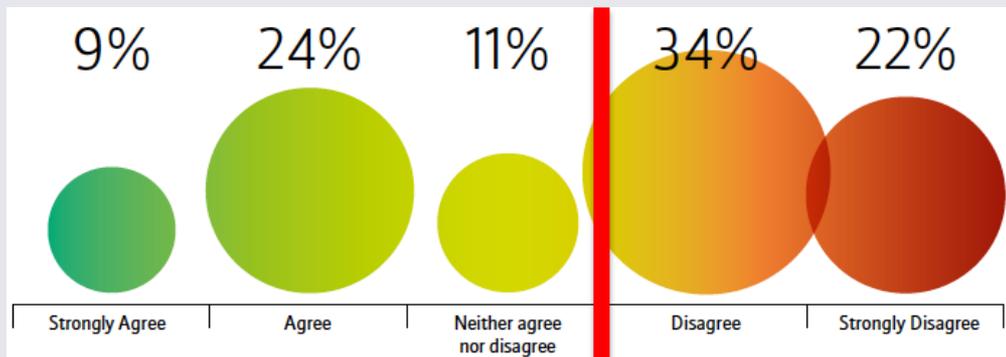
- One in every two people worldwide currently lives in an urbanised area. Thus, successful city-based projects are key for increased acceptance among the general public.
- There is a lack of imagination when it comes to envisioning large urban areas running on 100% renewable energy, and consequently whether attaining such a future is feasible in practice.
- Wind turbines, solar installations and bioenergy plants in rural areas and suburbs are becoming mainstream supply options in many countries.
- Is there really no place for renewable in megacities?
Innovative new ways to integrate solar equipment in the building envelop, wind farms in industrial areas and harbours, and offshore wind farms offer untapped options for renewable energy supply even in megacities.

The discussion about sustainable megacities is currently still focused on transport, waste and water, with renewable energy and energy efficiency increasingly being addressed in expert fora.

12. Energy Access Enabled Through Renewables: How to speed up connections?

“Decentralised renewable energy technologies will not be enough to give access to energy for all, meaning that large-scale conventional power plants are still required to provide energy access for all.”

- 66% believe that renewables can supply enough energy for developing countries



12. Energy Access Enabled Through Renewables: How to speed up connections?

- Renewables contribute significantly to making energy services increasingly available to people who currently lack access.

Key questions for the next level of the debate:

- The programs shall not stop at renewables for housing. How to accelerated and expand ongoing renewable energy market growth to keep pace with economic development?
- Renewable energy supply for the industry of rapidly growing economies such as China and India.
- How can energy gaps be filled during periods of rapid economic growth while avoiding expanded use of fossil fuels?

In conclusion

- More than 70% of the experts interviewed consider a global transition to 100% renewable energy to be both feasible and realistic.
- There is an overwhelming consensus that renewable power will dominate in the future, with many noting that even large international corporations are increasingly choosing renewable energy products either from utilities or through direct investment in their own generating capacity.
- Numerous companies, regions, islands and cities have set 100% renewable energy targets.

In conclusion (2)

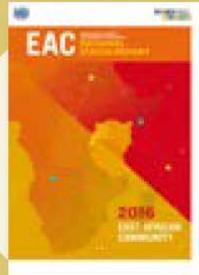
- **2/3 of the experts expect renewables to outpace the fossil fuel industry within one decade:**
Fossil fuel (infrastructural) projects need 5 to 10 years from the first proposal, to planning, approval process, construction till production start. In case renewable costs will develop as expected from most experts, the project will be uneconomic from the first day of production.
- While most experts see a 100% renewable energy supply technically and economically realistic, its unclear if this will be reached by 2050 or later.
- Unclear if the rapid RE market upscaling will develop fast enough to avoid dangerous climate change

We need an informed debate about the energy future so that can governments adopt the right policies and financial incentives to accelerate infrastructure investments, thereby facilitating large-scale renewable energy deployment.

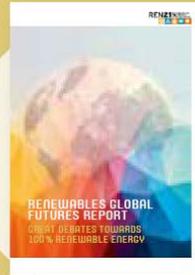
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