Template for non-Party stakeholders' inputs for the Talanoa Dialogue

Question 2 - Where do we want to go?

Where do we want to go?

Vision of the future for your organization and/or sector in terms of its possible role in achieving the 1.5/2 degrees' goal and a net-zero emission world by this mid-century [Maximum 300 words]

In order to achieve the temperature goal of 1.5°C we need to fully decarbonise our economy and society by 2050. This ultimately means a transition to 100% Renewable Energy and a complete phase out of fossil fuels. Although this vision has gained momentum in the recent years, commitments fall short of their own ambitions. Just recently, the International Energy Agency wrote that global CO2 emissions have reached a historic high, after having remained flat for three years. We are not on track of the Paris goals.

Both present and future generations rely on us to set the path for a just future, offering resilience to climate change and socio-economic development. Both can only be achieved by a just transition to 100%RE. Doing so is nothing short of a transformational change, but one utterly needed if we are yet to achieve the Paris goals.

Possible and potential new commitments and pledges of to achieve the 1.5/2 degrees' goal and a net-zero emission world by this mid-century [Maximum 300 words]

To achieve this 100% RE vision, policy makers must set and fully commit to a 100% RE target and embed across policy areas and in SDG processes. They need to follow a "Leave No One Behind" approach to energy policy, ensure adequate participation across all stakeholder groups, including civil society in order to build the necessary capacity, ownership and avoid duplication of efforts, enhance renewable energy in the cooking sector, prioritise energy efficiency, re-direct fossil fuel subsidies by utilising public finance and strengthen change agents and pioneers.

Foreseen positive impact of these commitments once they are realized, including contributions to the sustainable development agenda [Maximum 300 words]

Transitioning to 100% Renewable Energy will not only set the world on track again to achieve the Paris goals, by enabling a full decarbonisation of our economy and society, but it will also support us in achieving all 17 Sustainable Development Goals (SDGs). To name but two, transitioning to 100% RE means achieving SG 1: No Poverty. RE can provide electricity to even the most marginalised communities at the least cost and makes it thus truly affordable for all. The booming market for off-grid solar systems in Africa meanwhile demonstrated how fast renewable energy could grow and become a source of income for rural households. Likewise, enhanced use of RE in the cooking sector will enable countries to reduce diseases related to outdoor and indoor pollution and significantly support the functioning of health facilities in rural areas (SDG 3). The current focus on improved cooking is not enough to fully realise this potential and can only be seen as an interim solution.

Marrakech Partnership

Global Climate Action

World Future Council

Where do we want to go?

The 100% Renewable Energy Vision

01 April 2018

1. Introduction

In 2015, during COP21 in Paris, 195 states committed to limit global climate change to well below 2°C, in order to stop the adverse effects of climate change on our planet. For many island states and countries with vulnerable coastal zones, the committed goal is to stop the temperature rise at 1.5°C. For some of these countries, exceeding these temperatures threatens their very existence. Predictions show that warming above these temperatures would unleash a series of catastrophic impacts to life as we know it. While our chances of limiting warming to 2°C are looking increasingly slim (with some reports noting it is already unavoidable to keep warming below the 1.5°C threshold), research indicates that this goal is achievable if we fully decarbonise our economy and society by no later than 2050.

This ultimately means a transition to 100% Renewable Energy and a complete phase out of fossil fuels. While this vision has gained international support over the last years, most notably by the 48 member states of the Climate Vulnerable Forum (CVF) pledging to transition to 100%RE before mid-century (Marrakech Communiqué of COP 22), existing policy measures and legal frameworks that aim at implementing these commitments fall short of their own ambitions.

In fact, the International Energy Agency just recently published their annual Global Energy and CO2 Status Report which found that global emissions grew by 1.4% in 2017. After remaining flat for three consecutive years, this means global emissions have reached a historic high of 32.5 gigatonnes (Gt)[1]. This was partly caused by a surge in energy demand by 2.1% driven by the developing countries of Asia. More than 70% of this growth came from fossil fuels with gas being the fastest-growing. Even coal consumption has increased again, after having declined for two years[2]. In spite of ambitious political commitments we are therefore far from being on track to meet the Paris goals. And this trend will only continue in light of the global population growth projections over the next decades.

This outlook means that the 100%RE vision must prevail if we are yet to achieve the Paris goals. And there is hope. Despite the renewed increase of fossil fuel consumption, renewables have still been the fastest-growing source of new energy. Although global emissions have risen, Germany's emissions have decreased by 0.5% in 2017, due to the country's increased deployment of wind farms[3].

This is, however, not enough to honor climate commitments. Therefore, this Talanoa Dialogue submission aims to set out why 100%RE must become the new norm and outlines actions and policies

[1] OECD/IEA, Global Energy and CO2 Status Report 2017, 2018, p. 1: http://www.iea.org/publications/freepublications/publication/GECO2017.pdf.
[2] The Guardian, Good news about renewables: but the heat is still on to cut fossil fuels, 25.03.2018: https://www.theguardian.com/environment/2018/mar/25/renewables-good-news-heat-on-cut-fossil-fuel-use?CMP=share_btn_link.
[3] Bundesumweltministerium, Klimabilanz 2017: Emissionen gehen leicht zurück, 27.03.2018: https://energy.economictimes.indiatimes.com/news/renewable/germanys-carbon-emissions-decline-due-to-more-wind-power/63497193.

which need to be implemented to do so. As a last step, the submission outlines how we can finance a just transition to 100% Renewable Energy utilising public finance institutions.

2. The Vision of 100% Renewable Energy

A complete and just transition towards 100% Renewable Energy by 2050 at the latest is nothing short of a transformational change of how we think about and consume energy. Yet, it is one utterly needed, if we are yet to achieve the target of limiting global warming to well below 2°C, as outlined in the Paris Agreement. Luckily, a shift to 100%RE is no longer an utopian ideal, as evidenced by the seismic changes in energy markets in recent years. "We are on the verge of a profound and urgently necessary shift in the way we produce and use energy"[4]—away from consumption of fossil resources towards Renewable Energy.

Both present and future generations rely on us to set the path towards a future which is not threatened by climate change. In fact, 100%RE offers more than just resilience to climate change and temperature rise; it can serve as a means for socio-economic development. It can help "create an equitable society for today's and future generations"[5]. As such, achieving 100%RE does not only mean achieving the Paris goals, but it also supports the implementation of each of the 17 Sustainable Development Goals (SDGs). To do so, we need a holistic approach for the transition, which will rely on policy-makers implementing the following 7 key enabling policy recommendations[6]:

- Set a 100% RE target and embed it across policy areas and in SDG processes;
- Set a "leave no one behind" approach to energy policy;
- Ensure adequate civil society participation and capacity building;
- Enhance renewable energy in the cooking sector;
- Prioritise energy efficiency;
- Re-direct fossil fuel subsidies;
- Strengthen change agents and pioneers.

3. The actions needed

1. Set a 100%RE target

The first step must be to actually set a formal political 100%RE target which demonstrates the political commitment to the vision and can provide stakeholders with an understanding of the long-term vision. Governments on all levels must be aware, however, that one glove does not fit all, and the target as well as its long-term vision will mean different things in different settings. To make this target and long-term vision a success it is crucial to engage with a wide range of stakeholders across all sectors from an early stage onwards. By doing so, momentum is being created alongside synergies and partnerships and most importantly – ownership. It is notable that this multi-stakeholder process must not only include representatives from local and national Government bodies, but also industry,

[4] World Future Council, How to achieve 100% Renewable Energy – Policy Handbook, September 2014, p. 1. https://www.worldfuturecouncil.org/file/2016/01/WFC_2014_Policy_Handbook_How_to_achieve_100_Renewable_Energy.pdf
[5] World Future Council / Brot für die Welt, 100% Renewable Energy for Sustainable Development, June 2017, p.4. https://www.worldfuturecouncil.org/file/2017/09/100SDG_v11_low-quality.pdf
[6] World Future Council / Brot für die Welt, 100% Renewable Energy for Sustainable Development, June 2017, p 5. https://www.worldfuturecouncil.org/file/2017/09/100SDG_v11_low-quality.pdf

academia and civil society. Only by creating the ownership—and in the process build capacities—can the target be implemented within a feasible timeframe. Having a multi-stakeholder process developing the 100%RE long-term vision can on the one side legitimate the Government, but can also serve as a tool for stocktaking of initiatives to avoid duplicating efforts. Most importantly, engaging relevant stakeholders from the beginning ensures that realistic 100%RE targets can be set and met most efficiently.

In an early phase of such a process, stakeholder groups are best positioned to identify relevant change agents and pioneers that are crucial for setting and implementing the 100%RE target. Collaboration with local stakeholders also enables cost-effective integration of RE projects and fosters knowledge and technology transfer across regions. In many regions, intensive stakeholder engagement can help to spread awareness of and increase support for renewables and the 100%RE vision. Lastly, having a multi-stakeholder process creates ownerships among all participating groups who therefore will have an inherent interest in implementing the vision.

Therefore, setting a 100%RE target can only be the first step. The next step is to effectively implement the target by creating cross-stakeholder ownership for vision the long-term strategy. By doing so a Government can likewise increase efficiency of technical and administrative resources, reduce duplication of efforts and reduce investment risks often associated with Renewable Energy such as uncertainty around returns, short-term gains etc. By “increasing investment certainty, setting ambitious targets can also help attract domestic and international investors ultimately making it easier to achieve the target and phase out of fossil fuels”[7]. It should be noted that 100%RE is not dependent on future innovation. Research and early case studies have shown that 100%RE is both possible, affordable and achievable with today’s technologies[8].

Ultimately, however, building a 100%RE vision tailored to regional and national contexts takes time, and can only be done through collaborative efforts.

2. 100%RE to Leave No One Behind

The transition to 100%RE is both a necessary condition and a driver for sustainable development that truly leaves no one behind. Transitioning to 100%RE has unprecedented co-benefits. By embedding the 100%RE target across policy areas and SDG processes, policy-makers have the opportunity to set a “Leave No One Behind” approach to energy policy which goes far beyond a just transition. In fact, 100%RE is a means for socio-economic development and can help to “create an equitable society for today’s and future generations”[9]. The transition invalidates the traditional belief that fossil fuel deployment leads to socio-economic development, and presents a clear, and feasible alternative that benefits everybody, including the most marginalised of communities.

The SDGs were adopted by the UN General Assembly in September 2015 under the Agenda 2030. In contrast to the previous Millennium Development Goals (MDGs), the SDGs recognise the need for

[7] World Future Council / Brot für die Welt, 100% Renewable Energy for Sustainable Development, June 2017, p. 7. https://www.worldfuturecouncil.org/file/2017/09/100SDG_v11_low-quality.pdf
[8] World Future Council, How to achieve 100% Renewable Energy – Policy Handbook, September 2014, p. 5. https://www.worldfuturecouncil.org/file/2016/01/WFC_2014_Policy_Handbook_How_to_achieve_100_Renewable_Energy.pdf
[9] World Future Council / Brot für die Welt, 100% Renewable Energy for Sustainable Development, June 2017, p. 4. https://www.worldfuturecouncil.org/file/2017/09/100SDG_v11_low-quality.pdf

affordable, reliable and sustainable energy for all (SDG7). This offers the opportunity to raise the ambition of this particular SDG by talking about renewable energy and not "just" sustainable energy. A comprehensive report on how 100%RE can do help to achieve all 17 SDGs and most of the 169 targetscan be read in the accompanying material section – 100%RE and SDG written by the World Future Council and Brot für die Welt. To name but two examples, transitioning to 100% RE can greatly contribute to achieving SDG 1: No Poverty. RE can provide electricity to even the most marginalised communities at the least cost and makes it thus truly affordable for all. The booming market for off-grid solar systems in Africa meanwhile demonstrates how fast renewable energy can grow and become a source of income for rural households. Likewise, enhanced use of RE in the cooking sector will enable countries to reduce diseases related to outdoor and indoor pollution and significantly support the functioning of health facilities in rural areas (SDG 3). The current focus on improved cooking is not enough to fully realise this potential and can only be seen as an interim solution.

3. Financing 100%RE

Transitioning to 100% Renewable Energy by 2050 requires investments. Estimations calculate annual ivestmentsin the order of $1.5 to $2 trillion.[10] Although the costs of Renewable Energy has recently declined sharply and further downturns can be expected, current global investments are stagnating at approximately $250 billion. The reason for that is not a lack in green investment finance (Green Bonds), there is however a lack in bankable projects to attract green investors.[11]

Therefore, additional monetary support must be provided in order to bring the global expansion of RE to the necessary scale, i.e. guarantees to make the risks predictable to private (Green Bond) investors and repayment-free grants for RE investments which are not yet financially viable / competitive. The grants could also be used to decrease the price of the RE towards a level which is in line with the principle from SDG 7: affordable energy for all.

However, funding from public budgets, including instruments such as emissions trading or CO2 taxes, is not a realistic option to cover the gap of around $1.25 to 1.75 trillion. An additional innovative financing mechanism is required and can be established through cooperation between the non-industrialised countries, the Multilateral Development Banks (MDBs), the Green Climate Fund (GCF), or other financial institutions, and the Central Banks of the industrialized countries. The MDBs, together with non-industrialised countries, should develop national roadmaps for a sustainable 100% RE strategy, identifying the financing requirements (guarantees and grants) required for each country. Subsequently, the MDBs should issue the corresponding amount of 'Standardized Green Climate Bonds'. Central Banks should be ready to guarantee these and also to purchase and hold such bonds. Since these Standardized Green Climate Bonds will be virtually repayment free, the MDBs will receive new funding to facilitate additional RE investments. The resulting planning and income security will reduce perceived investment risks and would thus open additional investment opportunities for private finance at low yet sustainable interest rates.

Central Banks played a key role in managing the banking crisis by adding unprecedented amounts of new bonds to their balance sheets, without losing their independence or endangering monetary

[10] World Future Council, Unlocking the trillions to finance the 1.5°C Limit, Future Finance – Policy Brief, 09/2017. https://www.worldfuturecouncil.org/file/2017/11/WFC-Policy-Brief-09_2017-Unlocking-the-trillions_Merged-Version-1.pdf

[11] IRENA, Scaling up renewable energy investment in emerging markets, January 2018, p.3 (White Paper).

stability. The annual margin available to Central Banks for purchases of new MDB Standardized Green Bonds lies within "normal" growth in their balance sheets and can be estimated at least to a global total value of approximately $300 billion.[12] Central Banks from a few industrialized countries could and should already initiate such a new Standardized Green Climate Bond system. Not least because the Bank of England and the ECB have recently stressed that Central Banks' need to expand their mandate to include global climate protection and the purchase of new MDB/GCF Green Climate Bonds by the ECB is permissible under existing EU Treaties.

4. Conclusion

Transitioning to 100% Renewable Energy will not only set the world on track again to achieve the Paris goals, by enabling a full decarbonisation of our economy and society, but it will also support us in achieving all 17 Sustainable Development Goals (SDGs). This effect will be most notable, when focusing on co-creating a joint 100%RE vision and long-term strategy across stakeholder groups which will create ownership among stakeholders to implement the strategy and reach even the most marginalised of communities.

In a nutshell, Governments on all levels need to step up and show that they are willing to set binding 100%RE targets and follow through with them. To do so, it is of crucial importance that they enable a multi-stakeholder approach including civil society, pioneers, change makers, industry, businesses, and academia. This will create ownership across all sectors which will therefore have a stake in actually implementing the 100%RE long-term vision. Eventually, the 100%RE target will be implemented and thereby enabling communities to reap the vast co-benefits. Finally, Governments should be open to learning from other communities, regions or countries, where 100%RE policies have been implemented, or lessons from roadmap development or progress stocktaking can be learned.

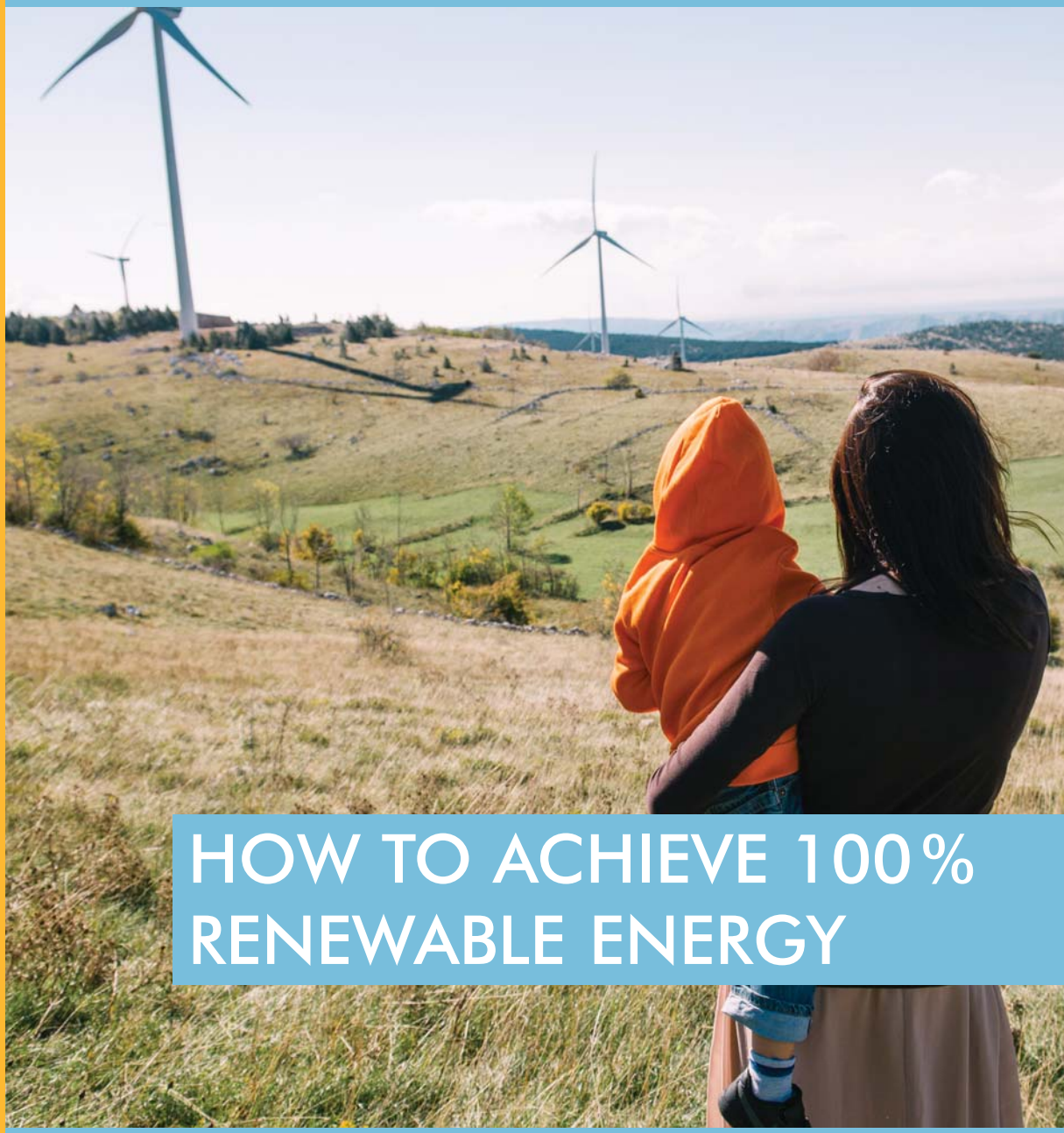
[12] World Future Council, 09/2017

POLICY HANDBOOK

World Future Council

100% RENEWABLES

VOICE OF FUTURE GENERATIONS



HOW TO ACHIEVE 100% RENEWABLE ENERGY

IMPRINT

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Commissioned by:
The World Future Council
published September 2014

Photos:
Cover: viki2win / Shutterstock, p. 6: World Future Council, p. 9: (from left to right) World Future Council, Katja Zimmermann / World Future Council, Heinrich Boell Foundation Kenya, p. 10: Mykhaylo Palinchak / Shutterstock, p. 42: Cabildo de El Hierro, p. 43: Gorona del Viento, back cover: deENet

Design: Anja Rohde
Print: oeding print GmbH

ClimatePartner klimaneutral
Druck | ID: 53192-1304-1004

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FOREWORD

100 % Renewable Energy – the only option we have

Evidence of imminent total-system change in energy markets has become clearer in recent months. Systemic risks of oil supply, climate shock and financial collapse threaten tomorrow's economies and mean businesses and policy makers face huge challenges in fuelling tomorrow's world.

We are on the verge of a profound and urgently necessary shift in the way we produce and use energy. This shift will move the world away from the consumption of fossil resources toward cleaner, renewable forms of power. Renewable Energy (RE) technologies are blowing the whistle on oil dependency and spark economic and social renaissance.

The question is: Do we make this transition from fossil resources to RE on our own terms, in ways that maximize the benefits to us today and to future generations, or do we turn our heads away and suffer the economic and social shocks that rising prices and market volatility will create – as it has done so often in the past?

Both present and future generations are relying on our actions right now to create a future less reliant on dirty energy. Our dependence upon fossil resources has built a system that lacks diversity and security, threatens the health of our citizens, jeopardizes the stability of the earth's climate, and robs future generations of clean air, clean water, and energy independence. By turning to 100 % renewable energy today, we alleviate a host of ills that beset us.

Now is the time to act

Decisions taken by politicians today will have a major influence on the world of tomorrow. Investments in fossil fuels today will lock us and future generations into a dangerous system. Especially countries in the Global South have the potential to leapfrog and build a future-just and sustainable energy system.

Taking action today – on our own terms – enables us to profit from the transition to 100 % RE in right now as well as in the future. We create the new industries and new jobs we will need in the future today. We benefit now while creating a sustainable future for our children and grandchildren.

Solutions exist

The good news is that solutions exist. The popularity of renewable energy is already skyrocketing as millions of people around the world use it to generate electricity, to heat and cool buildings and to produce a variety of cleaner vehicle fuels. From North America to Europe, Africa, Asia and Oceania, communities, islands, cities and countries demonstrate that making the transition to 100 % RE is a political decision and an ethical imperative – the technical options already exist. I champion these pioneers as incubators and catalysts of the kind of change that needs to be replicated.

While being an inspiration, the move towards 100 % renewable energy is still taking place in scattered communities and regions around the globe.

Policy makers have taken up measures nowhere near proportional to the urgency to act. Therefore this policy handbook serves as a tool to push us over the verge to a fossil free world. It is a valuable and necessary source of inspiration and knowledge for policy makers to take action.

Jeremy Leggett, Social Entrepreneur and Author

ACKNOWLEDGMENTS

The World Future Council would like to thank the many researchers and experts who assisted in providing information for the preparation of this report:

Haruhiko Dohman, Ph. D. student at Rikkyo University, and a research associate at the Institute for Sustainable Energy Policy (ISEP) in Tokyo, Japan.

Hironao Matsubara, senior research associate at the Institute for Sustainable Energy Policy (ISEP) in Tokyo, Japan.

Jansenio Delgado, Energy Expert at the Ecowas Center for Renewable Energy and Energy Efficiency (ECREEE), in Praia, Cape Verde.

Dr. M. Khaliquzzaman, Consultant at the World Bank in Dhaka, Bangladesh.

Tetsunari Iida, Executive Director of the Institute for Sustainable Energy Policy (ISEP), in Tokyo, Japan.

Pia Buschmann, Projektmanagement, deENet Kompetenz-netzwerk dezentrale Energietechnologien, Germany

All participants of the WFC Parliamentary Hearing on "Building Political Will on 100% Renewable Energy" in Brussels (March 2014): http://power-to-the-people.net/wp-content/uploads/2014/03/Participants-List.pdf

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EXECUTIVE SUMMARY

A transition is underway around the world: Away from an energy system powered by increasingly expensive and unsustainable fossil fuel resources toward one powered fully by abundant, local, and affordable renewable energy sources. In the years ahead, this transition is poised to improve the quality of life for millions, reduce harmful greenhouse gas emissions, and help forge a world that is more just toward both current and future generations. This report provides an overview of some of the early pioneers leading the way toward such a future.

The rising economic, health-related, and environmental costs of burning fossil fuels, combined with the accelerating impacts of climate change are introducing a new urgency into global efforts to rapidly diversify away from fossil fuels. As the most recent Intergovernmental Panel on Climate Change (IPCC) reports highlight, **in order to ensure planetary habitability for today's and future generations, we urgently need to build societies powered by safe, affordable, and sustainable energy.** More than 2/3 of global GHG emissions originate from the burning of fossil resources such as oil, gas and coal. In order to remain below a 2 degrees Celsius increase compared to pre-industrial temperatures, it will be necessary to move to a fully decarbonized energy sector by 2050. **The close interconnection between our current energy system and the emerging climate crisis demonstrates that energy is not only the key problem we need to solve; it is also the solution.**

Fossil and nuclear resources are by definition non-renewable. They are a one-time endowment, one that current generations have to use prudently and intelligently in order to transition to a world powered entirely by renewable energy resources. **This will require a paradigm shift in how we think about energy,** a shift from a system based on extracting energy sources from the ground, towards one based on harnessing natural and abundant flows from the air, the water, and the sun. It is the challenge of this century to make this transition a reality.

The goal of fully transitioning the world's total energy mix toward renewable energy sources is no longer a utopian ideal: **it is being achieved in a number of places around the world today.** Hundreds of jurisdictions across the globe have set 100% renewable energy (RE) targets and are beginning the journey toward a fully fossil- and nuclear-free society.

In the process, these pioneers have been incubators of regionally appropriate best practices and policies. This policy handbook takes a closer look at these early pioneers to provide inspiration and concrete examples to other jurisdictions that are aiming to embark on the same transformation. **It analyzes case studies to identify drivers, barriers as well as facilitating factors and, from these, it derives policy recommendations to finally enable their transfer to other jurisdictions around the world.**

This policy handbook examines eight (8) case studies in detail, with a few additional examples along the way, structured in four categories:

Cities & Communities	■ Frankurt am Main, Germany ■ San Francisco, California
Regions & States	■ Fukushima Prefecture, Japan ■ Rhein-Hunsrück District, Germany
National Governments	■ Cape Verde ■ Denmark
Island Governments	■ Tuvalu ■ El Hierro, Spain

Key Findings

As many case studies covered in this report demonstrate, achieving **100% RE is both possible and affordable, and can be achieved with today's technologies,** although continued technological improvement and innovation in business models will no doubt make the transition easier, and faster. 100% RE means that all energy needed within the electricity, heat and transport sector in the particular region is coming from renewable sources.

The first step toward achieving 100% is to set a formal political target. Setting an ambitious, long-term renewable energy target demonstrates political commitment, and can provide both stakeholders and the population an understanding of the long-term vision for the jurisdiction. It catalyses change by providing an official mandate for action. Further, this report highlights the **importance of engaging with a wide range of stakeholders early and often in order to build momentum, and create the synergies and partnerships across society that will make the strategy a success.** The case studies in the report demonstrate that achieving **100% RE requires political will,** and the awareness among political decision makers that a 100% renewable energy future is both realistic, and achievable.

A further conclusion that emerges from this report is that so far, **too little emphasis has been placed on increasing the share of renewable energy in both the heating/cooling as well as the transport sectors.** With regard to heating and cooling, the potential is tremendous and technologies are readily available in many parts of the world. But most policies and official government strategies continue to underestimate the potential of harnessing these resources, whether via solar hot water, air-heating and cooling systems, heat pumps, electric heat storage, waste heat recovery, or the development of district heating and cooling systems. With the exception of a few jurisdictions such as Denmark, Germany, and Sydney, Australia, too few governments are making the increased use of renewable energy sources in the heating and cooling sectors a priority.

This applies to an even greater degree for transportation: **too few jurisdictions have begun to tackle the challenge of increasing the share of renewable energy sources in the transport sector.** With a few exceptions, most efforts to increase the share of renewable energy have left the transport sector almost untouched, focusing instead on the electricity sector.

Resulting from the analysis of the case studies this policy handbook highlights **five (5) key findings** that serve as transferable policy lessons. These key findings include both benefits and requirements that can be useful for other governments around the world in establishing and achieving a 100% renewable energy target.

#1: Achieving 100% RE can generate significant cost savings

100% RE is both financially and economically advantageous, generating a wide range of benefits for both citizens and governments. The benefits range from savings on fossil fuel imports, improved energy and economic security, as well as reduced energy and electricity costs for governments, local residents and businesses.

#2: 100% RE strategies are not just for the wealthiest countries

The goal of achieving 100% RE is not only for wealthy or industrialised countries – it is taking root in countries and jurisdictions in all four corners of the globe, including in Africa, the Asia-Pacific region, as well as Latin America. 100% RE provide a plethora of development benefits that have a high priority among governments across the world. Since almost 3 billion people suffer from both, erratic or no access to electricity and reliance on inefficient and polluting solid biomass fuels for cooking, 100% reliable, affordable and efficiently used renewables are the only realistic, long-term options for ensuring a more decent livelihood for all.

#3: Transitioning to 100% RE can mitigate risks and make countries more resilient

The report finds that **transitioning to 100% RE can also make economies more resilient,** reducing their exposure to external factors such as rising fossil fuel prices. In times of geopolitical tensions and climate change, this is one of the key drivers for governments to take action.

#4: Committing to 100% RE can generate new economic activity, create jobs, and improve quality of life

In addition to cost savings, **100% RE generates new economic activity and improves quality of life.** Case studies suggest that demonstrating a clear commitment to transitioning 100% to renewable energy can help stimulating job creation, create new business models and opportunities as well as generate new sources of domestic revenue for both citizens and businesses.

#5: Achieving a fully 100% RE system will require significantly expanding RE in the heating/cooling and transport sectors

The case study analyses suggest that **a significant expansion of RE in both the transport and heating/cooling sectors will need to become a strategic priority for governments to achieve 100% RE.** In line with this, the analyses show that achieving 100% RE on a sustainable basis will likely require storing excess energy in the form of either heat or electricity in individual homes and businesses and that this will require a higher level of integration between these different sectors than in the past. The total generation supplied by electricity systems should be greater than 100% the majority of the time to allow the transport and heating sector to be integrated.

WFC Parliamentary Hearing on "Buiding Political Will for 100% Renewable Energy" in Brussels, March 2014

Recommendations for policy makers

Based on the key findings that serve as transferrable policy lessons, the policy handbook lays out **five (5) recommendations for policy makers** to help jurisdictions around the world in achieving 100% RE targets. These include:

#1: Make energy efficiency a top priority

All case studies suggest that making energy efficiency a top priority is a critical part of achieving a 100% renewable energy future. **By developing more efficient energy infrastructure, it becomes easier to develop, finance, and integrate the remaining infrastructure required to meet a jurisdiction's energy needs with locally available renewable resources.** This can significantly reduce the total investment requirements for reaching the target and support decoupling economic growth from the growth in greenhouse gas emissions.

#2: Electrify the heating/cooling and transport sector

Achieving 100% RE will require increasing the interconnection between the electricity, the heating/cooling, as well as the transport sectors, allowing renewable electricity to be channeled to a wider range of dispatchable end-uses such as in thermal systems or in electric vehicles. Case studies suggest that **shifting the reliance of the heating as well as the transport sector to a greater reliance on electricity should be a policy priority in the decades ahead.**

#3: Maximize opportunities for citizen participation and the development of new business models

At the heart of a successful 100% RE strategy, it is fundamental to allow open participation in the development and financing of energy infrastructure. Governments must implement inclusive policy frameworks that allow new business models to emerge and foster sustained citizen engagement. **By providing market access to a wide range of stakeholders, policy makers can help build positive synergies across the region and build further momentum.**

#4: Educate and inform citizens and businesses

Implementing a 100% RE strategy requires the participation of a variety of stakeholders, which makes both the breadth and the depth of awareness crucial to long-term success. **Educating and informing the public as well as businesses facilitates building public support and acceptance.** As local opposition to energy infrastructure can be a major barrier to achieving 100% RE, educating citizens, fostering engagement, and improving public outreach must be a top priority for policy makers.

#5: Adopt an integrated approach to fiscal, economic & energy policy

A successful 100% RE strategy requires an integrated approach across policy areas such as fiscal, energy, economic, as well as infrastructure policy. Additionally, this includes an approach that reaches across different governance levels. It entails collaboration across government departments, as well as between all levels of society. Policy makers must therefore increase the coherence of their policy and planning and deepen the policy dialogue between previously distinct sectors and government departments in order to sustain the political and economic momentum required to achieve 100%.

1. INTRODUCTION

In his speech before the German Physics Society in 1995, member of the German Parliament and long-time advocate of solar energy, Hermann Scheer posed a question to the representatives, who had recently published a report demonstrating that renewable energy could potentially supply as much as 30% of the total energy mix. He asked the members of the Society: "Why not 100%?"[1]

Almost twenty years later, this question is beginning to be answered, as jurisdictions around the world begin the journey towards an energy system powered entirely by renewable energy sources (RES). This includes jurisdictions at all levels, ranging from local and municipal governments, provincial and state governments, islands, as well as national governments.

There are a number of factors fuelling these various developments toward 100% renewable energy regions. These include the rapid reduction in the cost of renewable energy technologies; a growing awareness of the finite nature of fossil fuels such as coal, natural gas, oil as well as of mineral resources such as uranium; reducing the harmful impacts of the current energy system on our air, water, and soil resources; and growing concerns over global climate change, among others. And beyond all of these various drivers and motivations, there is a growing awareness that our current energy system, dominated as it is by fossil and nuclear energy sources, is leaving an unsustainable legacy for future generations.

In response to these and many other related factors, jurisdictions around the world are beginning to launch into a fundamental restructuring of their energy systems. **By doing so, these early pioneers are demonstrating that a new energy paradigm is possible, and that the transition to a renewably powered society can be a positive one from an economic, social as well as from an environmental perspective.** This is a profound shift, and although it is relatively recent, it is rapidly gaining momentum. As this movement continues to build, there is a growing need to provide policy makers and decision makers with concrete examples to draw from, both as a source of inspiration, and as a source of insight into the kinds of technological, social, cultural, economic, as well as financial transformations involved in making such a profound transition possible.

It is in this spirit that this report has been prepared: to demonstrate that supplying 100% of a jurisdiction's electricity needs, and eventually, 100% of total energy needs, is a realistic option: it is technically and financially achievable, and can bring a wide range of benefits to citizens, businesses, local economies, governments and to the environment.

As a sign of the growing recognition of this potential, a prominent article published in Scientific American in 2009 suggested that the sun, the wind, and the rain could power the entire world's energy needs.[2] In 2012, the National Renewable Energy Laboratory (NREL) in the U.S. released a series of major reports

1 Scheer (2001), p. 181

2 Jacobsson, M. Z., Delucci, M. A. (November 2009), Scientific American. Available at: http://www.scientificamerican.com/article/a-path-to-sustainable-energy-by-2030/

demonstrating that an 80% renewable electricity future was both technically and financially achievable.[3] Similar reports have been published by PricewaterhouseCoopers (PWC)[4], Greenpeace International[5] and WWF[6] as well as in Germany,[7] and for island regions around the world.[8]

What was once seen as unachievable has now become a leading topic of technical research and applied science; and as this report demonstrate, it is also becoming a top priority for many governments around the world. Regions, communities and nations across the globe are already proving that it is possible to commit and successfully transition to 100% renewable energy. In the process, these pioneers have been incubators of best practices and policies. This handbook analyzes a number of these case studies and derives policy recommendations to finally enable policy makers to replicate the benefits of this development in other constituencies. **The guiding question of the report is therefore: How can policy makers achieve 100% RE?**

Approach of this report:

The report builds on the work that the World Future Council has conducted in the past two years. Apart from in-depth research, it reflects the insights and conclusions resulting from a variety of World Future Council's parliamentary hearings on similar subjects.

In October 2012, the WFC hosted a parliamentary hearing on "100% Renewable Energy in European Regions" in the Danish Nordic Folkecenter, which resulted in the establishment of the Global 100% RE Campaign. Particular input and expertise was taken from policy workshops Denmark, October 2012, San Francisco, USA, April 2013, Tanzania, Oct 2013 and Kenya, February 2014.

Finally, research for this report has been conducted in conjunction with a high-level Parliamentary Hearing in Brussels in March 2014.[9] The workshop brought together Members of the European Parliament and Member States, energy experts, researchers, city planners, politicians, as well as members of civil society groups.



3 Mai, T., Sandor, D., Wiser, R., Schneider, T. (2012). Renewable Electricity Futures Study: Executive Summary. NREL/TP-6A20-52409-ES. Golden, CO. Available at: http://www.nrel.gov/docs/fy13osti/52409-ES.pdf

4 PwC/PIK/IIASA/ECF (2010), 100% renewable electricity: A roadmap to 2050 for Europe and North Africa, available at: http://www.pwc.ch/user_content/editor/files/publ_energy/pwc_percent_renewable_electricity.pdf

5 Greenpeace/GWEC/EREC (2012): Energy [R]evolution, available at: http://www.greenpeace.org/international/en/campaigns/climate-change/energyrevolution/

6 WWF/Ecofys (2011): The Energy Report, available at: http://wwf.panda.org/what_we_do/footprint/climate_carbon_energy/energy_solutions22/renewable_energy/sustainable_energy_report/

7 Klaus, T., C. Vollmer, et al. (2010). Energieziel 2050 – 100% Strom aus erneuerbaren Quellen. Dessau, Umweltbundesamt. Available at: http://www.iass-potsdam.de/sites/default/files/files/study_buergerbeteiligung_und_kosteneffizienz_0.pdf

8 Marin, C., Alves, L. M., Zervos, A. (2005). 100% Renewable Energy Sources: A Challenge for Island Sustainable Development, UNESCO. Available at: http://www.unescocan.org/pdf/100RES.pdf

9 http://power-to-the-people.net/2014/03/european-politicians-across-party-lines-call-for-long-term-100-target-for-renewable-energy/

2. THE ROLE OF TARGET SETTING

Targets play a central role in global, national, and local renewable energy policy and strategy. Since the 1970s, jurisdictions around the world have adopted targets to diversity their energy mix, boost the share of renewable energy sources, and reduce their reliance on imported energy resources. Setting an ambitious, long-term renewable energy target also demonstrates political commitment, and can provide both stakeholders and the population as a whole a clearer view of the long-term vision for the region, as well as a better understanding of how they fit within it. It catalyses change by providing an official mandate for action.

Identifying and communicating a 100% renewable energy target has a number of additional advantages: it can help engage a wide range of stakeholders; it can ensure a more efficient deployment of both technical and administrative resources, and reduce the risks of duplication and competing policy goals; it can help give key stakeholders (such as utilities, or private investors) the confidence required to make large investments, such as in transmission and distribution grids. By increasing investment certainty, setting ambitious targets can also help attract domestic and international investors, ultimately making it easier to achieve the target. Experience in the European Union and in many other jurisdictions around the world demonstrates that targets can also help build awareness, both among external audiences as well as among the citizens in the local area. This awareness can be essential to building public support among local citizens and businesses to help to achieve the objective.

It is also important to highlight that there are different kinds of 100% targets, including targets for 100% renewable electricity, such as in Cape Verde; 100% strategies that are being implemented in parallel with a 100% carbon neutral strategy, such as in Frankfurt; 100% targets for renewable energy in rural electrification, such as in Bangladesh; and finally, there are more comprehensive targets that aim to supply 100% of total energy needs with renewable energy sources, such as Denmark. This variety of 100% targets provides a tremendous potential for knowledge sharing and collaboration, and for identifying transferable policy lessons that may be applicable in other contexts.

It is important to highlight that target setting alone is not sufficient to ensure effective implementation. As shown by a number of unmet targets in several jurisdictions around the world, targets need to be credible and achievable. Moreover, targets are more likely to be achieved when they are supported by a stable policy and regulatory framework as well as by a clear, step-by-step roadmap with indicators and regular progress reports.

3. CASE STUDIES

This section includes a number of case studies drawn from jurisdictions around the world that have either developed, or implemented a 100% renewable energy strategy. In some cases, such as in Tuvalu and in Cape Verde, the implementation is still underway and is at a relatively early stage of development; in other cases, such as in Rhein-Hunsrück in Germany, the 100% renewable electricity target has already been surpassed and efforts are now underway to extend this success to both the heating and transportation sectors.

Selection criteria for choosing the case studies:

1. **Applicability:** the jurisdiction must have formally adopted a clear target to supply 100% of either their electricity, heating/cooling, or transportation needs from renewable energy sources (RES), and it underscores transferrable policy elements that may be useful for policy makers in other regions;
2. **Geographic Representativeness:** the case studies should capture a broad range of jurisdictions from different parts of the world (Asia Pacific, Africa, the Americas, and Europe);
3. **Diversity in Energy Targets:** the case studies should include jurisdictions that focus not only on electricity, but also on renewable energy heating, cooling, and transportation;
4. **Levels of Government:** the case studies should include different levels of government, including city and community level initiatives, state or regional governments, national governments, as well as island regions.

The eight (8) major case studies included are:

1. **Cities and Communities**
   a. Frankfurt am Main, Germany
   b. San Francisco, United States
2. **Regions and States**
   a. Rhein-Hunsrück, Germany
   b. Fukushima Prefecture, Japan
3. **National Governments**
   a. Cape Verde
   b. Denmark
4. **Island Governments**
   a. Tuvalu
   b. El Hierro, Spain

Each case study begins with a brief snapshot of the current energy mix, the current electricity mix, or both depending on the data available for each jurisdiction. It also includes a table indicating the extent to which the three main components of energy use in each jurisdiction are covered: 1) electricity, 2) heating/cooling supply, and 3) transportation. In order to ultimately achieve a truly 100% renewable energy system, each of the three different sectors needs to be included, and integrated into the overall strategy. Currently, most of the 100% strategies being implemented around the world focus on the electricity sector, and on increasing the share of solar, wind, hydro, and bioenergy in the overall electricity mix. A few jurisdictions, such as Rhein-Hunsrück in Germany and Costa Rica, have begun to adopt a more holistic approach, accelerating the use of renewable energy in the heating and transportation sectors as well. This is recognized in a summary table at the beginning of each case study that identifies according to a simple Green-Yellow-Red framework:

Symbol	Definition
	A high priority, featuring a wide range of policies, projects, and regulations supporting the transition to 100%; clear political recognition and widespread awareness and visibility.
	Identified as part of the energy strategy, but not in a significant way; unclear policy and regulatory framework; absence of significant business, community, and political support, or momentum.
	Little or no mention in the energy strategy; lack of any meaningful policy or regulatory framework; absence of any significant recognition, public awareness, momentum.

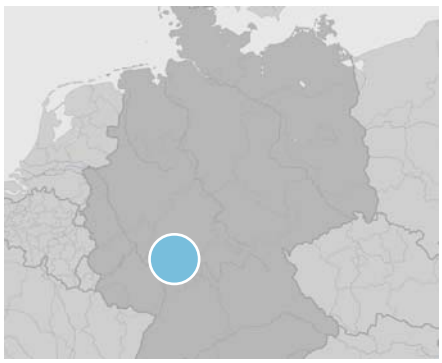
The goal of this color-coded scheme is to provide a quick overview of where additional efforts are likely to be required in the years ahead, and to provide readers with insight into which different jurisdictions are demonstrating additional leadership by including both heating/cooling needs as well as transportation in the overall energy strategy.

At the end of the case studies (island regions, city governments, regional and state-level governments, and national governments), a separate analysis discusses the commonalities and driving forces across the cluster and identifies common threads, as well as important differences.

Finally, noteworthy examples of ambitious renewable energy strategies are included in dedicated text boxes throughout the report. These provide important additional examples of 100% renewable energy strategies, and are drawn from all over the world including Sumba in Indonesia, Costa Rica, rural communities in Bangladesh, the 100% Regions Network in Germany, as well as Sydney, Australia.

3.1 Cities and Communities

3.1.1 Frankfurt am Main, Germany

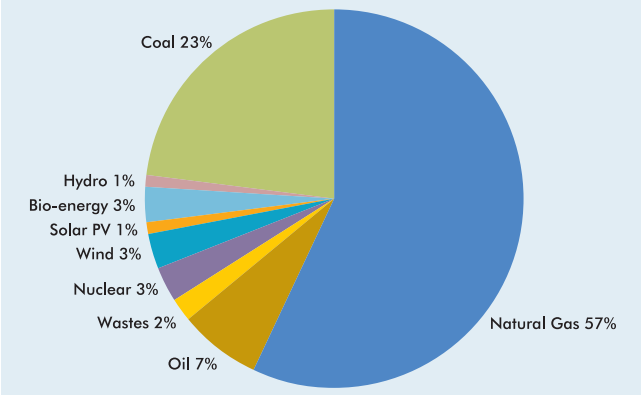


Average Temperature Range	–1 Celcius to 26 Celcius
Size (sq. km)	248.3 km^2
Population Size	687,775 (2012)
Political Status	City

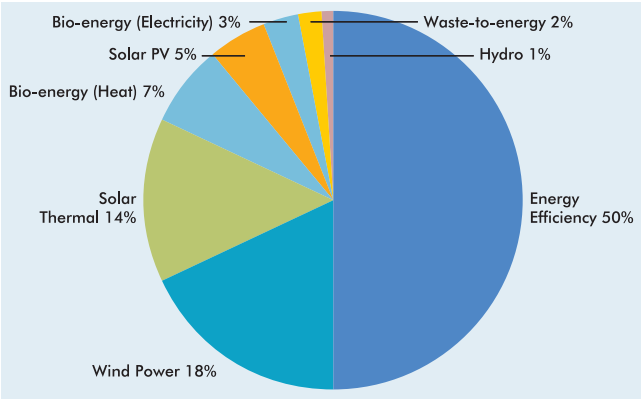
Sector	Focus
Electricity	●
Transportation	●
Heating/Cooling	●

ENERGY STRATEGY

Frankfurt's Electricity Supply Mix (2010)
Total = 5,702 GWh



Breakdown of Contributions to Frankfurt's 100% Plan: 2050



Annual Electricity Demand: 5,702 GWh (2010)
Electricity Access Rate: 100%
Peak Demand (MW): –

Sources:
http://www.100-ee-kongress.de/fileadmin/redaktion/100-ee-kongress/Praesentationen/F7_Neumann.pdf
http://www.masterplan100.de/fileadmin/user_upload/content/pdf/ER_FlyerMasterplan.pdf

Key Elements of the 100% Renewable Energy Strategy

Technical Aspects

Due to the fact that Frankfurt is a relatively dense urban area, city representatives and local experts determined that in order to supply 100% of its energy needs from renewable energy sources, Frankfurt would need to rely on neighbouring communities and the surrounding rural area in order to reach its target. Currently, the Master Plan envisions that approximately 25% of the target will be met with supply from within the City, 25% from outside the City, and total energy consumption will be decreased by 50%, thereby making it possible to supply 100% of the City's total energy needs from renewable energy sources.

There are a few key elements to Frankfurt's 100% strategy:[10]

- Increasing energy efficiency by 50%
- Expanding combined heat and power (CHP)
- Increasing the role of solar (both thermal and PV), wind, and the use of local organic wastes for both heating and power generation

In addition, there are a number of pilots underway, including the initiative to develop a Virtual Power Plant (VPP), which would be designed to integrate several small generators into a interconnected network capable of adjusting to fluctuations in RE output.[11] A core element of Frankfurt's approach is that it is approaching the 100% strategy in both a top-down as well as a bottom-up way, involving local citizens and businesses in achieving its objectives while establishing a clear vision in its city-wide Master Plan.

Political Aspects

In addition to being a global financial centre, for several decades Frankfurt has positioned itself as a leader in sustainability and climate protection. In 1985, it founded one of the first municipal energy and climate protection agencies, which has worked extensively on promoting energy efficiency in local buildings and the adoption of combined heat and power systems. As with many other case studies included in this report, Frankfurt's 100% renewable energy target is closely connected to its climate strategy; they feature mutually reinforcing components and policy objectives.[12]

The City of Frankfurt also has a strong track record to build on: between 1990 and 2012, the City managed to reduce its emissions by 15% while the economy grew by over 50%.[13] This success, combined with political leadership at the City level, have helped push Frankfurt's strategy forward, making it a leading city within Germany in terms of adopting a holistic approach to energy and climate policy.

In 2008, the Frankfurt City Council agreed to implement a list of fifty energy saving and climate protection measures. The current Master Plan includes a dynamic array of projects and initiatives designed both to reduce emissions and to increase the adoption of renewable energy and energy efficiency technologies. Together, it is these various initiatives that will help Frankfurt reach its ambitious 100% target.

Frankfurt benefits from a highly educated workforce, and a citizenry that broadly supports climate action and the continued expansion of energy efficiency and renewable energy. In addition, both the federal and

10 http://www.frankfurt.de/sixcms/media.php/738/Klimaschutzkonzept_web.pdf

11 In German: http://www.frankfurt.de/sixcms/detail.php?id=2855&_ffmpar[_id_inhalt]=9276189

12 In German: http://www.ifeu.de/energie/pdf/Masterplan_100Prozent_Klimaschutz_ifeu.pdf

13 Interview with Andrea Graf, Project Manager Masterplan 100% climate protection, City of Frankfurt on http://www.go100percent.org/cms/index.php?id=136

state-level governments have provided funds to help support Frankfurt's 100% strategy, demonstrating the important role that supportive frameworks at the national and regional levels can play. The City's Energy Agency is in the process of elaborating on its Master Plan, a strategy whose implementation foresees the involvement of architects, engineers, consultants, local businesses, public buildings such as schools and hospitals, as well as local residents. As highlighted above, Frankfurt's strategy is designed to be participatory, and to involve as many actors as possible in its realization. This is an important aspect of its success, and a valuable example to other jurisdictions seeking to implement a 100% strategy.

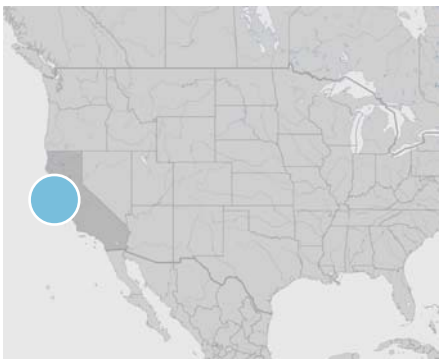
Another core aspect of Frankfurt's strategy is that it involves increasing awareness within local schools through a wide range of onsite projects in schools across the city. This helps create a wider consciousness among the city's youth, a fact that will no doubt play an important role in maintaining the momentum in the decades ahead.

Barriers and Solutions

There were many critics of the strategy at the beginning, many who argued that such a strategy was too ambitious, and would not succeed. Others were concerned that certain aspects, such as increasing energy efficiency, were incompatible with Frankfurt's building stock, which is comprised of many old heritage buildings. Frankfurt's city staff overcame many of these barriers by moving forward gradually, engaging stakeholders, and by clearly communicating the results and the impacts to the wider population. Pilot projects helped create awareness, and over time, these individual projects began to generate more than simply electricity and heat: they began to generate momentum.

As an indicator of its success, since 1990 when Frankfurt began to implement its climate and energy strategy, it has saved an estimated EUR 100 Million in energy costs, a number that is projected to continue increasing as energy efficiency and conservation efforts continue. Among the main beneficiaries of this are local residents and businesses, who now pay lower energy costs. Hereby, Frankfurt as well as many other case studies in the report, demonstrates that an ambitious energy and climate strategy can provide significant cost savings to both governments and local residents. The fact that the local government can already point to specific cost savings has been a powerful factor in maintaining momentum, and sustaining public and administrative support for the strategy.

3.1.2 San Francisco, U.S.



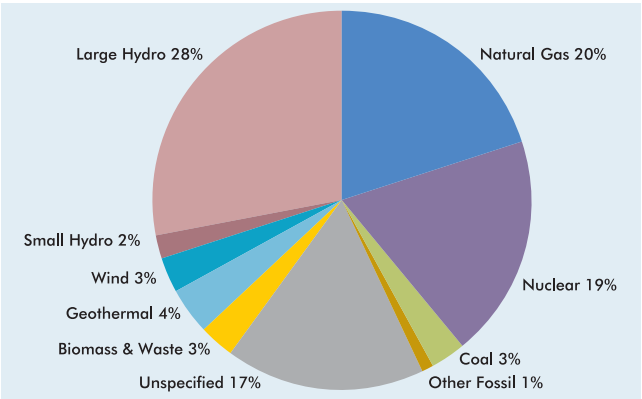
Sector	Focus
Electricity	
Transportation	
Heating/Cooling	

Source: http://www.pge.com/myhome/edusafety/systemworks/electric/energymix/

Average Temperature Range	8 Celcius to 21 Celcius
Size (sq. km)	121 km^2
Population Size	825,863 (2012)
Political Status	City-County

ELECTRICITY MIX

San Francisco's Electricity Supply (2010)
Total = 6,094 GWh



Annual Electricity Demand: 6,094 GWh
Electricity Access Rate: 100%
Peak Demand (MW): 970 MW

Key Elements of the 100% Renewable Energy Strategy

Technical Aspects

In an attempt to leave a positive legacy for the future of San Francisco, the outgoing Mayor Gavin Newsom set out a vision in December 2010 to obtain 100% of the city's electricity from RES-E by 2020.[14] This target has been adopted and endorsed by the new Mayor Edwin Lee and has led to the creation of a Mayoral Task Force in early 2011. In an effort to bring a wide range of different stakeholders and perspectives to the table, and to ensure that the ultimate recommendations received support from both business as well as civil society groups, the Task Force included stakeholders from all sectors including direct citizen representation.[15]

San Francisco's strategy focuses on three key components:

1) improving energy efficiency,
2) increasing distributed renewable energy (RE) generation within the City, and
3) providing all San Francisco electricity customers with a 100% renewable energy power purchasing option from new or existing electricity providers.

It is important to point out that, as of mid-2014, San Francisco's 100% target remains a political target rather than a binding legal target, and that it is being layered on top of an existing series of initiatives, programs, and incentives at the City, State, and federal levels.

While the primary focus of the strategy is on electricity, San Francisco has also undertaken a range of efforts in the transportation and heating sectors: the public transportation infrastructure is powered by either electricity or biodiesel, and the City has also developed plans to support electric vehicle charging infrastructure.[16] The City now has over twenty-five (25) combined heat and power (CHP) installations totalling 60 MW of installed capacity (SFPUC 2011). These initiatives, while not yet consolidated around a coherent renewable heating or transportation strategy, indicate that policy makers and local stakeholders are making efforts to expand their efforts beyond electricity.

Overview of key projects

- Hetch Hetchy hydro reservoir (over 400 MW of installed capacity, supplying roughly 20% of load)
- 7.36 MW of Municipally-owned solar PV projects;
- 15.7 MW of distributed solar PV within the City's limits (residential and commercial);
- 3.5 MW biogas cogeneration project at the City's wastewater treatment plant

Additionally, in the last few years, a program called CleanPowerSF has been launched to establish a Community Choice Aggregator (CCA), a new business model designed to provide all residential customers in San Francisco with a 100% renewable energy supply option.[17] In many U.S. states, citizens are still unable to switch electricity service providers, either because of existing rules and regulations or because alternative providers are not available within their service area. San Francisco's CCA program is designed to enrol residential ratepayers into the 100%

14 New York Times, December 14 2010: "San Francisco Eyes Goal of 100% Green Power by 2020".
Available at: http://www.nytimes.com/gwire/2010/12/14/14greenwire-san-francisco-eyes-goal-of-100-green-power-by-39895.html
15 San Francisco Mayor's Renewable Energy Task Force: Recommendations Report, (September 2012). Prepared by the San Francisco Department of Environment.
Available at: http://www.sfenvironment.org/sites/default/files/fliers/files/sfe_re_renewableenergytaskforcerecommendationsreport.pdf
16 See: http://sfwater.org/index.aspx?page=516
17 See: http://sfwater.org/index.aspx?page=577

RE option, and provide them with the ability to opt-out if they desire to do so.

Political Aspects

While the outgoing Mayor set out the 100% objective in 2010 and the Mayoral Task Force provided recommendations for achieving a 100% target by 2020, the only objective that has been officially endorsed by San Francisco is the target to have a GHG-free electricity mix by 2030, adopted in Ordinance 81-08 (SFPUC 2011).

There are many factors behind the adoption of San Francisco's energy and climate targets:

- the strong environmental and energy consciousness of the City's residents, as well as of its political and business leaders;
- a long-standing commitment to reducing carbon and other emissions (the City achieved its Kyoto commitment of reducing GHG emissions by 7% below 1990 levels);
- the creation of "green" jobs and increased economic activity;
- enhancing the City's resilience, a consideration that has grown in prominence both in the wake of California's electricity crisis, and more recently, Hurricane Sandy;
- Reducing vulnerability to volatile fossil fuel prices

An interesting feature of San Francisco's efforts to achieve a 100% power mix centres around its emphasis on customer driven approaches rather than binding rules and mandates. This is reflected in the City's promotion of the CleanEnergySF program (see above). Given the dominance of a large electricity supplier in the market, the long-term success of San Francisco's 100% strategy will require either active participation from the leading utility, or a significant reduction of its market share as a supplier of electricity to the City.

The financing of the many programs, measures, and initiatives that will help achieve the target, come from a wide variety of sources. These include traditional rate increases, tax incentives, tapping into existing renewable energy and energy efficiency funds, as well as out of the municipal government's budget.

Barriers and Solutions

San Francisco faces a few major challenges to achieve its 100% RE target: First, the target itself has yet to be formally adopted in law or enshrined in any particular statute. This will likely need to be overcome in order to generate the broad based support required to achieve the 100% target. Second, in contrast to many of the other jurisdictions covered in this report, San Francisco has limited ability to regulate the power suppliers that currently provide the bulk of its power demand. Utilities and electricity service providers are largely regulated at the state level, while a host of legacy contracts and agreements continue to hamper any wholesale change of the electricity sector. Moreover, the establishment of the Community Choice Aggregator, a centrepiece of the city's efforts to move to a 100% renewable electricity mix, continues to face a number of hurdles.

A further challenge in San Francisco is that two thirds of residential homes are in multi-family buildings and over 60% of households rent, rather than own, their residence. This makes it challenging to overcome split incentives between residents and building owners to improve energy efficiency. A related challenge has been providing workable financing solutions for individuals and families situated in multi-family residential units. Some of the solutions that have emerged to address these challenges are green leases, virtual net metering, as well as community-based solar financing schemes that allow individuals to get together to finance larger projects in locations other than their primary residence. All of this suggests that San Francisco will have to rely more on innovative approaches, and increased citizen and business leadership in order to succeed.

Sydney, Australia

In 2013, the city of Sydney, Australia (Population: 4.6 Million) launched a Green Infrastructure Plan that included an objective to supply 100% of its electricity, heating and cooling needs from renewable energy sources by 2030. In contrast to many other jurisdictions, the Sydney Master Plan puts a strong emphasis on the integrated use of bio-energy sources such as biomass, biogas as well as waste sources from forestry and agriculture, and in particular the use of 'tri-generation' – the integrated production of heating, electricity and cooling. It is expected that tri-generation powered by local waste and bio-energy resources will represent up to 70% of Sydney's target, with the remaining 30% largely supplied by local solar PV and wind power projects.

In order to implement its 100% objective, the City identified thirteen (13) 'enabling actions,' specific measures that will ultimately drive the implementation of the strategy. City staff also commissioned detailed mapping analyses of the City according to many different layers, including electricity and gas demand, available floor space, thermal energy demand, etc. These detailed analyses helped ensure that the results of the analysis were robust, data-driven, and that the 100% strategy was both realistic, and achievable.

The example of Sydney demonstrates that in order to get to 100%, you need a detailed plan: having a clear, data-driven strategy helps identify any challenges or barriers in advance, engage specific stakeholders, adopt concrete implementation measures, and to quantify the contribution of individual measures to the success of the strategy as a whole.

Source: http://www.sydney2030.com.au/wp-content/uploads/Decentralised-Energy-Master-Plan-%E2%80%93-Trigeneration-%E2%80%93-Adopted-15MB.pdf

3.2 Regions and States

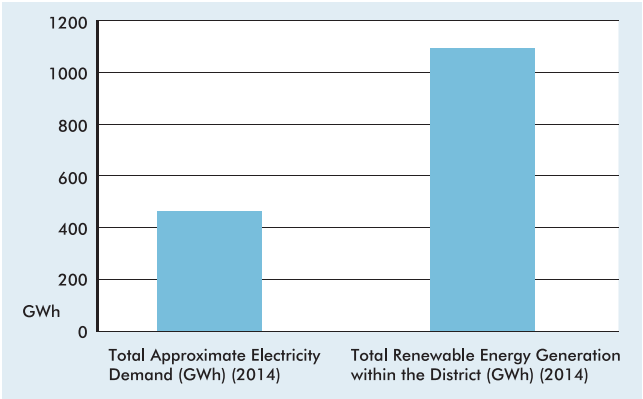
3.2.1 Rhein-Hunsrück, Germany

Sector	Focus
Electricity	
Transportation	
Heating/Cooling	

Average Temperature Range	1 Celcius to 17 Celcius
Size (sq. km)	963 km^2
Population Size	104,000 (2012)
Political Status	Regional District

ELECTRICITY MIX

Rhein-Hunsrück RES-E supply already supplies over 200% of demand



Annual Electricity Demand: 460 GWh
Electricity Access Rate: 100%
Peak Demand (MW): 683 MW

Key Elements of the 100% Renewable Energy Strategy

Technical Aspects

As of early 2012, the District of Rhein-Hunsrück officially began producing more than 100% of its electricity needs, crossing an important milestone on the way to creating a truly 100% renewable energy system.[18] Its ambitious push into renewable energy, which dates back over two decades, has rapidly turned it into a leader in Germany, where it is engaged in a friendly competition with a growing number of other +100% regions across the country. In early 2014, it is estimated that Rhein-Hunsrück already produced over 230% of its total electricity needs, exporting the surplus to the regional and national grid, or re-directing it into local transportation, hydrogen or methane production.

The current projects are broken down into a number of different technology areas:

Overview of key projects

- Over 2.000 individual solar PV systems
- Over 100 wind turbines across the region
- 17 biomass CHP facilities

In addition, Rhein-Hunsrück has undertaken a wide range of other measures and projects to help achieve its objectives. These include:

- Replacing old oil heating units with solar, biomass, and heat-pump technologies in public buildings;
- Developing an integrated regional plan for the harvesting of woody biomass and related biomass wastes;
- Expanding and retrofitting of district heating networks across the region to use a greater share of RES in their heat supply;
- Developing new biogas projects, some of which are designed to feed their gas directly into the local natural gas network;
- Increasing the use of geothermal heat pumps in both public and private buildings;
- Demonstration projects in hydrogen fuel cells and electric vehicles

With all of these various initiatives and projects underway, and the recent addition of a major new wind farm in the region, Rhein-Hunsrück has already demonstrated that a 100% renewable electricity future is not only possible, but that it can be profitable too.

Political Aspects

Rhein-Hunsrück benefits from a unique combination of leadership at the political and administrative levels as well as a broad pool of expertise and engagement at the local citizen level. Together, these factors have helped generate the momentum required to turn its strategy into a reality. After commissioning and drafting a few reports and strategy documents, the District is now fully engaged in the implementation of the 100% vision, a vision that now extends into the education of its youth and local training programs for local residents.

As other case studies in this report have already demonstrated, policy coherence across governance level is crucial to successfully achieve 100% RE. Rhein-Hunsrück benefits from the continued presence of national policies, such as Germany's Renewable Energy Sources Act, as well as from federal incentives for renewable energy heating, and energy efficiency improvements.

In addition to supplying over 100% of its electricity needs with RES-E, Rhein-Hunsrück has adopted a

18 http://www.taipei.diplo.de/contentblob/3433492/Daten/2068218/DownloadPresentationFleck.pdf

number of parallel targets. These include a target to have a 100% carbon neutral power supply, an objective to supply 100% of its electricity and heating needs from local, decentralized sources, as well as a broader objective to reduce the amount of money that it spends on imported energy and fuels. It is estimated that as of 2011, the District as a whole spent approximately EUR 290 Million per year on fossil fuels, including oil and natural gas sources. By 2050, the District aims to localize approximately EUR 250 Million of these expenditures, keeping more money in the local economy while supporting local job creation and innovation. Indeed, the early successes of Rhein-Hunsrück demonstrate that attempting to achieve a 100% RE target can bring not only significant environmental benefits, but also substantial economic and financial benefits, helping reduce the region's reliance on imported energy while generating more jobs and revenue within the District. This makes Rhein-Hunsrück a powerful example to other jurisdictions around the world.

Barriers and Solutions

In contrast to some of the other case studies included within this report, Rhein-Hunsrück benefits from having robust grid connections with neighbouring districts. From a technical standpoint, this enables the District to generate more than 100% of its domestic electricity needs, because it does not need to invest in all the system balancing, demand response, storage, and network intelligence architecture that other, more isolated jurisdictions would.

Rhein-Hunsrück demonstrates that achieving a 100% is therefore more attractive for interconnected regions, for two primary reasons: 1) it is less costly than in isolated systems, and 2) it is less technically challenging. The example of Rhein-Hunsrück could therefore help motivate other interconnected regions to do same, and benefit from the same positive economic, financial, environmental, energy security and job creation benefits that this District in Germany has been able to harness.

Ultimately, one of the challenges that Rhein-Hunsrück faces in the years ahead is to continue to expand the ability of its local energy and electricity system to make better and more efficient use of its excess power. Over time, the region aims to use more of its electricity locally, taking up as much of its surplus renewable electricity and putting it to productive uses either in its residential, commercial, and industrials sectors, or in its heating and transportation systems. Indeed, if there is one aspect that is conspicuous by its absence in Rhein-Hunsrück is that the District has not yet developed a clear strategy to transition its transportation sector to a greater reliance on renewable energy sources, an omission found in many of the other case studies included in the report. This indicates that far greater efforts will be needed in this sector in the years ahead. By using its surplus renewable electricity, it is possible that Rhein-Hunsrück could begin allocating more of its domestically generated electricity into electric vehicles, for instance, thereby helping the District as whole to achieve a truly 100% renewable energy system.

3.2.2 Fukushima Prefecture, Japan

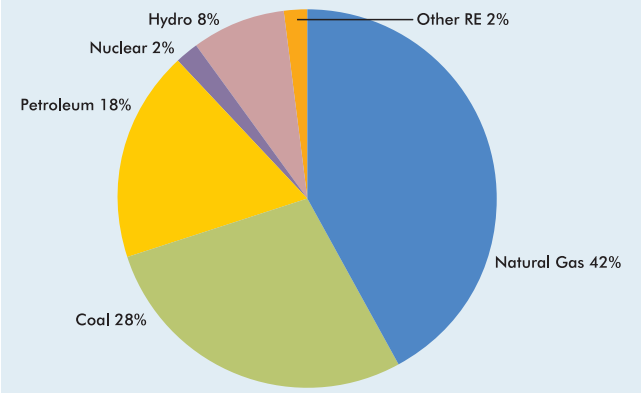
Sector	Focus
Electricity	
Transportation	
Heating/Cooling	

Source: http://www.stat.go.jp/data/nenkan/zuhyou/y1018000.xls

Average Temperature Range	25 Celcius to 31 Celcius
Size (sq. km)	13,783 km^2
Population Size	Approx. 2 Million (2012)
Political Status	Prefecture of Japan

ELECTRICITY MIX

Electricity Mix in Japan (%) 2012
Total = 289 TWh



Annual Electricity Demand in Fukushima Prefecture (2011): 4,135 GWh[19]
Electricity Access Rate: Effectively 100%
Peak Demand in Fukushima Prefecture (MW) (2013): 2,760 MW

19 http://www.stat.go.jp/data/nenkan/zuhyou/y1018000.xls

Key Elements of the 100% Renewable Energy Strategy

Technical Aspects

In 2009, the Fukushima prefecture already procured 20% of its electricity from renewable energy sources, making it a leader within Japan well before the devastating tsunami struck the region.[20] In August 2011, five months after the meltdown at the Fukushima Dai-ichi nuclear power plant, the government of the Fukushima prefecture published a Vision for the Revitalization of the region.[21] In this vision, the report stated that the Prefecture "will seek to ensure great progress in the field of renewable energy and aim to make strong advances in resource conservation, energy saving, and recycling …" The plan lays out a broad strategy with many different components aimed at achieving energy self-sufficiency in the region.

In March 2012, Fukushima Prefecture built on this vision and formally announced its target to supply 100% of its future electricity needs from renewable energy sources by 2040. While the details of the strategy are still being articulated, the ambition of the Prefecture is clear.

Overview of key projects

- 5,920 MW of solar PV capacity
- 260 MW of solar thermal capacity
- 1,225 MW of wind power capacity
- 260 MW of hydro power capacity
- 300 MW of geothermal power capacity

Projects already underway include over 100 MW of wind power projects, a 65 MW geothermal project, a 40 MW biomass project, as well as a series of demonstration projects.[22] The strategy also envisions the development of solar hot water systems, pellet stoves for on-site heating, as well biomass and micro-hydro systems. In addition, there is also discussion of setting up model communities for the implementation and demonstration of smart grid concepts.

In addition to the focus on renewable electricity supply, the strategy also anticipates a significant contribution from energy efficiency, projecting a reduction in electricity demand of over 15% over the same period (2012–2040).

Political Aspects

In the wake of the Fukushima nuclear crisis, the government of Fukushima Prefecture quickly mobilized to establish a new, positive, and future-oriented vision for the people of the region. In the months after the crisis, this led to the adoption of a far-reaching plan to re-build infrastructure in the region, increase support for child-care, strengthen educational services, and to provide a stronger and more positive vision for the future of the Prefecture. The 100% renewable energy strategy is at the heart of these revitalization efforts.

In the strategy published in December 2012,[23] the region declared its intention to *"take action to build a safe, secure and sustainable society free from nuclear power through dramatic advances in renewable energy."* This strategy included four (4) objectives:

20 See (in Japanese only): http://www.pref.fukushima.lg.jp/download/1/plan_for_revitalization2_outline.pdf
21 See : http://www.pref.fukushima.lg.jp/download/1/plan_for_revitalization2_outline.pdf
22 See: Japan Times, November 11 2013: http://www.japantimes.co.jp/news/2013/11/11/national/floating-wind-farm-debuts-off-fukushima/#.Ut-3YIU1igQ; see also: http://www.asiabiomass.jp/english/topics/1307_06.html
23 See (in Japanese): http://wwwcms.pref.fukushima.jp/pcp_portal/contents;jsessionid=001E4A95E6F70AD350FC8D0110A1C11F?CONTENTS_ID=36894

1. Expansion of renewable energy, including solar, wind, geothermal, hydropower and biomass
2. Investment in R&D
3. Fostering the development of a cluster of renewable energy-related industries
4. Local production and use of renewable energy through smart communities and citizen investment.

Together, these policy objectives will be instrumental in guiding the on-going evolution of Fukushima's strategy as it builds a new future for itself in the years ahead.

There are many driving forces behind the adoption of Fukushima's 100% renewable energy target. These include, among others:

- Recovering from the devastation caused by tsunami and rebuilding a sustainable society
- Reviving and strengthening community bonds around a new, positive vision for the region
- Creating leading industries for a new era of energy and environmental sustainability
- Building a forward-looking and disaster-resilient community
- Harnessing breakthroughs in renewable energy to build a new society
- Building resilience against external shocks

While the actual policy mechanisms and financing strategies have yet to be fully articulated, in the near-term, the region will benefit from the continued presence of Japan's national feed-in tariff policy, which enables individual developers and investors to connect to the grid and supply renewable energy into the system. The region is also benefiting from a wide range of re-development and revitalization funds, which will contribute to different flagship projects across the Prefecture and further contribute to the achievement of the 100% target.

Barriers and Solutions

Despite having adopted an aggressive renewable energy target for the region, Fukushima continues to face a range of challenges to achieve its 100% renewable energy target.

First, due to the on-going nuclear contamination efforts, the region has had to deal with significant out-migration, a lingering stigma associated with the region and its products (particularly agricultural), and the erosion of the traditional bonds that held communities together. As a result, the revitalization strategy has to focus on a broader set of issues than simply the transformation of the energy and electricity mix – what is envisioned is a transformation of the region as a whole.

On a more technical level, achieving the target will likely require expanding transmission capacity with other regions of Japan, something that it cannot do alone. Achieving its own objectives will therefore require closer cooperation with neighbouring regions and potentially further collaboration between the regional electricity supply companies. Progress toward this objective has begun and far more is expected in the years ahead as some of the larger RE projects begin to be connected to the grid.

Another difficulty relates to financing, and particularly to the availability of cost-effective insurance options for large-scale renewable energy projects. There is currently a significant gap in risk insurance coverage for projects in the Pacific region, and in the wake of Fukushima this remains a challenge that project developers have to face.

Also, given that the bulk of the projects planned are ultimately supported by Japan's national feed-in tariff framework, it remains dependent on the continued support for the FIT at the national level. However, in light of the strong commitment of the Prefectural government to the 100% strategy, it is likely that they will continue to push forward and develop alternative mechanisms irrespective of developments at the national level.

Ultimately, building a more positive vision for the future of the region will take time, and a significant amount of effort and collaboration between the local and the national government, as well as a shared commitment to reconstruction and revitalization among citizens, stakeholders, utility representatives, and government officials.

In line with that, one of noteworthy phenomena is that community power is rising all over Fukushima since the Fukushima Dai-ichi nuclear power accident. Among them are AiPower, based in Aizu region in Fukushima that had been launched already in summer 2011 and the "9th Generation", which widely involves various local actors such as citizens, local business, farmers, engineers, financial institute, co-op, local politicians, local media, artists and designers.

Local and regional visionaries have been steadily developed their idea to become energy independent in create a 100% renewable region. Such community power initiatives in Fukushima have been fostered and strengthened through networking platforms supported by national non-profit organisations and under the community powers support program by the Ministry of Environment since 2011.

One concrete example was the "International Community Power Conference 2014 in Fukushima" hosted by the Institute for Sustainable Energy Policy (ISEP), which has resulted in the "Fukushima Community Power Declaration". On this platform, participants explored and developed synergies between various sectors from local to national level.

100% Renewable Energy Regions Network in Germany

In 2007, communities and regions across Germany gathered to establish a formal network of 100% renewable energy regions. This network now includes more than 140 different communities, cities, and regions that have established 100% renewable energy targets. Admission into the network is based on a 99-point scoring system that includes 33 different criteria. Every year, the 100% RE regions meet in Kassel in central Germany to convene all the different stakeholders and participants, including other representatives from communities around the world that make up the 100% renewable energy movement.

Since its launch, the 100% RE Regions Network has helped increase awareness of the climate, energy security, financial, as well as economic benefits of pursuing a 100% strategy both within Germany and around the world. It provides individual cities and regions with the tools and expert networks required to achieve their objectives, and acts as a central coordinating point for members of the 100% RE Regions Network. One of the key lessons learnt is that providing a common platform for communities helps to communicate experiences, activities and visions on 100%RE more effectively. Consequently, seemingly scattered local actions are powerfully bundled and given political weight as a common movement.

3.3 National Governments

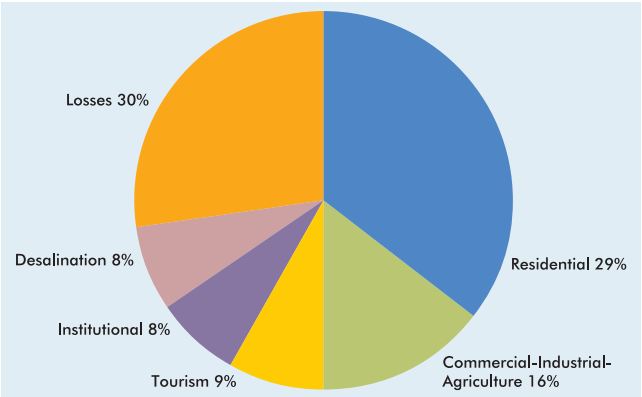
3.3.1 Cape Verde

Average Temperature Range	18 Celcius to 29 Celcius
Size (sq. km)	4,033 km² (across nine inhabited islands)
Population Size	491,875 (2010)
Political Status	Republic of Cape Verde

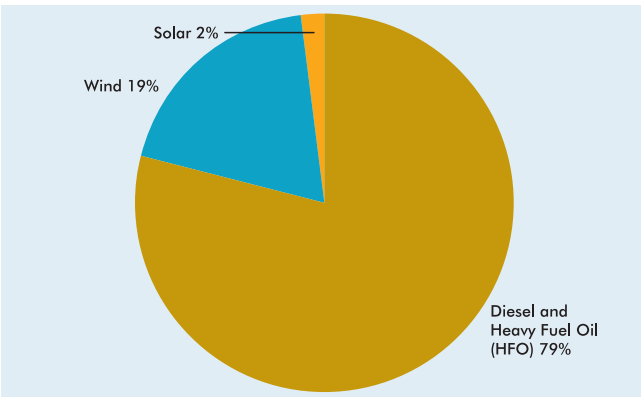
Sector	Focus
Electricity	●
Transportation	●
Heating/Cooling	●

ELECTRICITY MIX

Breakdown of Electricity Demand in 2010 (%)
Total: 318 GWh



Generation Mix in Cape Verde (GWh) 2012: Total=403 GWh



Installed Capacity: 113 MW
Electricity Access Rate: Approx. 95 %

Sources:
http://www.electra.cv/index.php/Download-document/55-Relatorio-e-Contas-2012.html
http://www.electra.cv/index.php/Download-document/55-Relatorio-e-Contas-2012.html

Key Elements of the 100% Renewable Energy Strategy

Technical Aspects

The development of Cape Verde's 100% strategy emerged in three different steps. Faced with a rapidly rising fuel import bill (for diesel and heavy fuel oil), it set out a target to supply 25% of its electricity needs from renewable energy sources by 2012.[24] A detailed analysis conducted for the Government concluded that it would be economically beneficial to set a higher target, due primarily to the rapid growth in energy demand (both electricity and fuels) and the rising costs of imports. The report proposed a target of 50% by 2020, and included a parallel target to reach 100% on one of its nine (9) islands, the island of Brava, as a demonstration project.[25] More recently, in collaboration with the IFaS[26], a leading energy storage firm based in Germany, a further and much more ambitious plan has been drafted indicating that it may be even more cost-effective to achieve a 100% RE target by 2020, instead of the original 50% target.

The initial 50% strategy launched by the Government of Cape Verde was remarkable for a number of reasons, and provides valuable guidance for other countries interested in pursuing a high-penetration renewable energy goal: first, it identified a number of specific renewable energy development zones (REDZ) in collaboration with local stakeholders where projects could be located and cost-effectively integrated into the grid; it provided specific generation (GWh) and capacity (MW) targets for each renewable energy technology, by site, for every island; and finally, it developed preliminary estimates of what the strategy as a whole would cost, based on different scenario analyses for the growth in demand, the current and future costs of RE technologies, and the future costs of imported fuels.[27]

The 100% strategy builds on these previous estimates and outlines the total supply requirements. Since Cape Verde is comprised of a collection of islands, the strategy includes a focus on both new sources of generation, as well as a combination of energy storage systems.[28]

Island	Technology			
	Solar PV	Wind	Battery Storage	Seasonal Storage (pumped hydro)
Boa Vista	35 MW	35 MW	9 MW	1,600 MWh
Brava	2 MW	1 MW	1 MW	70 MWh
Fogo	10 MW	7 MW	2 MW	550 MWh
Maio	10 MW	3 MW	1 MW	280 MWh
Sal	39 MW	17 MW	9 MW	1,200 MWh
Santiago	168 MW	112 MW	30 MW	7,700 MWh
Santo Antao	12 MW	3 MW	3 MW	250 MWh
Sao Nicolau	3 MW	2 MW	1 MW	110 MWh
Sao Vicente	64 MW	16 MW	10 MW	900 MWh
Total	343 MW	196 MW	66 MW	12,660 MWh

24 ECREEE 2011, http://www.ecowrex.org/system/files/documents/2011_summary-of-cape-verde-renewable-energy-plan_ecreee.pdf
25 Brito 2013, http://www.ecreee.org/sites/default/files/event-att/100x_apresentacao_jb_para_ecreee.pdf
26 Institut für angewandtes Stoffstrommanagement
27 ECREEE 2011, http://www.ecowrex.org/system/files/documents/2011_summary-of-cape-verde-renewable-energy-plan_ecreee.pdf
28 Brito 2013, http://www.ecreee.org/sites/default/files/event-att/100x_apresentacao_jb_para_ecreee.pdf

The total investment necessary to achieve the 100% strategy using pumped hydro storage is estimated at EUR 1.272 Million[29], with all generation and storage projects included, to replace the anticipated electricity needs of Cape Verde by 2020. This results in a levelized cost of energy (LCOE) of between EUR 0.104/kWh and 0.189/kWh depending on which island is considered, which is significantly less than both the current LCOE of electricity generation using heavy fuel oil (EUR 0.19/kWh), and diesel (EUR 0.30/kWh). The 100% strategy in Cape Verde is therefore projected to result in a net cost savings for the government.

In addition to several wind projects already built or underway, Cape Verde has already signed contracts for two utility scale solar PV projects with a total installed capacity of 7.5 MW.[30] This includes a 5 MW project near the capital Praia, as well as a 2.5 MW project on the island of Sal.

However, it is estimated that in order to achieve the 100% RE target in Cape Verde, significant investments in power storage and demand response are going to be needed. Based on the current strategy, this will involve synthetic methane production using wind power, pumped hydro, as well as the coordinated dispatching of various loads across the country (demand response) such as desalination plants and bottling factories. These projects will enable Cape Verde to make use of excess supply in the network, help stabilize the grid, and help it integrate a higher share of renewable energy into its various island systems.[31] The case of Cape Verde demonstrates that achieving 100% in isolated systems involves a far higher level of power system engineering and investment planning than achieving 100% in interconnected regions. Achieving 100% on a sustainable basis, across the electricity, transport, as well as heating/cooling sectors, will ultimately require advanced system monitoring as well as dynamic dispatching capabilities such as demand response to continuously adapt to short-term fluctuations in supply and demand. Solving these technical challenges, as Cape Verde and many other jurisdictions are beginning to do, will be at the heart of successful 100% RE strategies.

Political Aspects

In 2006, the Government of Cape Verde passed Law Decree No. 30, which set out licensing procedures for independent power producers (IPPs) and auto-producers. This was an important step, as Cape Verde realized it would need external investment to support its renewable energy development goals. After a few years of capacity building efforts, planning, and local stakeholder engagement, Cape Verde passed its 2011 law, which set out its renewable energy policy framework in greater detail. Over the course of these various legislative developments, the Government of Cape Verde worked closely with a range of consulting firms and international research institutes to refine the strategy, and identify future opportunities.

So far, the majority of renewable energy projects in Cape Verde (with the exception of two utility scale solar PV projects with a total installed capacity of 7.5 MW)[32] are owned and operated by Cabeólica, which has projects on four of the country's nine islands. Cabeólica has signed a number of 15-year power purchase agreements (PPAs) with the national utility company, Electra. The projects are project financed on a 70–30 debt-equity structure. After the 15-year contract period, projects will receive a lower tariff of between 20–30% less than the original tariff value. The contract also includes a 5-year renewable service agreement contract to ensure that maintenance is completed. The Public-Private Partnership (PPP) structure, by bringing together a strong set of

29 See slide 22: http://www.ecreee.org/sites/default/files/event-att/100x_apresentacao_jb_para_ecreee.pdf
30 See Martifer Solar: http://www.martifersolar.com/countCv.php
31 Brito 2013, http://www.ecreee.org/sites/default/files/event-att/100x_apresentacao_jb_para_ecreee.pdf
32 See Martifer Solar: http://www.martifersolar.com/countCv.php

local and international partners, was found to be an important component in obtaining the financing for the project.

The total investment in Cabeólica projects to date, which include 25.5 MW of wind power capacity spread over four islands (Santiago, Sao Vicente, Sal, and Boavista) have totalled over EUR 60 Million. The financing for Cabeólica projects came from a wide range of sources, including the European Investment Bank, the African Development Bank, the Africa Finance Corporation, Finnfund, the Government of Cape Verde, as well as a few private sector partners.[33]

Significantly, one of the key components for successfully attracting capital to the project was the establishment of a dedicated escrow account.[34] This account ensures that the payments are made on time, and that the funds are clearly allocated, and transparently managed. Additional components that have supported the success of Cape Verde's strategy is that it offers a complete tax exemption for the first five years of each RE project's operational life, with 50% reduction offered for the following five years. The fiscal framework in Cape Verde also involves waiving export duties on certain RE products and components, and some of the projects have also benefited from concessional financing from the Portuguese Government.

Notwithstanding Cape Verde's leading position in wind power, the majority of the technical renewable energy potential remains in solar power. The primary consultant report that laid out the original 50% strategy for the Government of Cape Verde identified over 2.000 MW of solar PV potential across the various REDZ, over six (6) times the estimated wind power potential.

Another important dimension of the Cabeólica projects is that public consultations were held in each of the four islands where wind projects were built and comprehensive Environmental and Social Impact Assessments (ESIAs) were conducted.[35] This included a process to engage local landowners in particular in the siting of the projects, and in the designation of the REDZ. This makes Cape Verde a leader not only in terms of its targets and the detail of its overall strategy, but also in its environmental stewardship and citizen engagement efforts.

Barriers and Solutions

Despite its current leadership position as one of the jurisdictions in the world with the highest wind power penetration, Cape Verde has had to overcome a wide range of policy-related, technical as well as operational hurdles.

In the mid-2000s, it ran a number of unsuccessful renewable energy bidding processes, failing to attract foreign investment. In response, the Government partnered with a privately managed, donor-funded infrastructure company, to finance a series of projects across the country. This led to the establishment of a Public Private Partnership for wind power development described above.[36]

Second, the relatively small size of the islands combined with limited road access made the construction and planning of the wind power projects difficult. Also, integrating the projects into each island system required individualized grid impact analyses and careful balancing of the trade-offs between turbine size, road access, grid capacity, output profiles, and a host of other factors.

Another aspect of Cape Verde's success can be traced to the awareness-raising efforts of the government,

33 Vilar 2012, http://www.ecreee.org/sites/default/files/renewable_energy_in_west_africa_0.pdf
34 Cabeolica 2013, http://www.ecreee.org/sites/default/files/event-att/cabeolica_2013_ecreee_regional_workshop_v6_final.pdf
35 Cabeolica 2013, http://www.ecreee.org/sites/default/files/event-att/cabeolica_2013_ecreee_regional_workshop_v6_final.pdf
36 Vilar 2012, http://www.ecreee.org/sites/default/files/renewable_energy_in_west_africa_0.pdf

and the reinforcement provided by local media coverage of renewable energy development in the country. This virtuous cycle has helped create stronger public support for renewable energy in Cape Verde, and a broader awareness of the issues related with its high dependency on fossil fuel imports.

Further challenges that emerged and had to be solved relate to transporting the various turbine units to each of the project construction sites – this proved challenging, not only because of the limited road access but also because of the size restrictions at the various ports and the lack of available warehousing capacity to safely store the turbine blades and tower components. This required extensive of logistical planning, and experienced project management.

Also, like many other countries around the world, Cape Verde faced a significant lack of a local trained workforce to assist with construction and development of key projects. Partly in response to these initial challenges, certain firms in the country have undertaken a number of training related initiatives in partnership with private sector partners and related research institutes to build the local capacity and train local residents to manage and operate wind parks sustainably in the long-term.

Finally, a number of challenges emerged relating to grid stability, frequency and voltage control, as well as the effective dispatching of personnel to address issues as needed. Grid integration on the smaller Santo Antao project, for instance, has seen a significant learning curve, with a steady decrease in voltage and frequency events as both project operators and the grid operator learn to better integrate variable wind power into the network.[37]

In the long term, wind power alone is anticipated to supply between 20–50% of total power needs across Cape Verde's nine (9) islands. This will require a range of technical improvements in communication and control systems, closer cooperation with the grid operator, as well as continued performance of the individual wind projects. The current grid stability and spinning reserve requirements limit wind penetration to approximately 40–50%. Dispatching and spinning reserve optimization is therefore being developed, and the wind power will need to be further complemented both by other RE technologies, such as solar PV, as well as by storage and demand response technologies.

Indeed, while the international focus is often on the wind turbines and solar panels being installed, the Government of Cape Verde recognizes that it must plan for a substantial increase in demand side management, demand response, as well as electricity storage systems to improve the integration of higher volumes of renewable energy. In order to reach the 100% target, these technical solutions will need to be a central part of the mix. This is particularly important for island regions, where achieving 100% of renewable energy in the mix on both a daily and a seasonal basis will require that it exceeds 100% of total demand during many hours of the day, and many days of the year, and that it intelligently manages this surplus power via integrated storage and demand response solutions. This will therefore require both short-term and long-term storage, as well as advanced load management solutions, to adapt to both daily as well as seasonal fluctuations in the availability of renewable energy.

Finally, in order to truly turn Cape Verde into a 100% renewable energy archipelago, it will need to significantly increase its efforts to transition both its heating/cooling sectors, as well as in its transportation sector toward a greater use of local renewable energy sources.

37 Graça 2013, http://www.ecreee.org/sites/default/files/event-att/workshop_regional_cedeao_energia_eolica_electricwind.pdf

Rural Bangladesh

Bangladesh is one of the countries in the world with the highest population densities, at approximately 1,000 inhabitants per square kilometre. Currently, only 40% of rural homes in Bangladesh have access to electricity, with approximately 15 million households still awaiting electrification. The population of the country as a whole is approximately 154 million.

With the continued decline in solar module costs, the high cost of transmission and distribution infrastructure due to the many rivers that crisscross the country, and the persistently high costs of diesel for power generation and of other fossil fuels used for lighting such as kerosene, Bangladesh has tremendous potential for the widespread deployment of onsite solar home systems (SHS). The Government has established a goal of increasing electricity access in rural Bangladesh to 100%, a goal that is being implemented almost exclusively with the use of solar home systems (SHS) due to economic advantages.

Bangladesh now features a well-established supply chain of local installers, suppliers, and lenders supporting the deployment of SHS to the country's poorest residents. There are now over 2 million solar home systems in Bangladesh, making it one of the largest markets in the world for distributed solar PV deployment. Recent estimates indicate that there are approximately 40,000 rural families receiving a new system every month, and a target has been set to achieve a total of 2,5 Million SHS by the end of 2014. Most systems installed range from 10 W to 135 W, and cost less than USD $ 1.000. Assuming an average system size of approximately 50 W, this translates into a total installed solar PV capacity in the country of over 100 MW.

This far-reaching initiative has been facilitated through a number of international partnerships, turning Bangladesh into a leading example of harnessing renewable energy sources to improve access to modern and sustainable energy services.

Costa Rica

Costa Rica (population: 4.5 Million) currently supplies approximately 93% of its total electricity needs from renewable energy sources, mostly from domestic hydro. However, despite the many advantages of hydropower, it also presents significant hydrological risk for the electricity system, exposing the country to the risk of decreasing rainfall in the years ahead and a growing reliance on fossil fuels. In response, Costa Rica has developed a strategy to help diversify its electricity mix by developing other forms of renewable energy, such as solar, biogas, geothermal, and wind power, with the aim of supplying 100% of its electricity from renewable energy sources by 2021. This is coupled to a parallel target to be 'carbon neutral' by the same date.

The country's current plan will see the state-owned monopoly, The Instituto Costarricense de Electricidad (ICE) purchase power from independent power producers in Costa Rica over 15-year contracts. This will result in a gradual decentralization of the electricity system as it moves toward its combined energy and climate objective.

In addition to its focus on achieving 100% RE in the electricity sector, Costa Rica is encouraging the broader adoption of electric vehicles in order to gradually do the same in the transportation sector. It is currently offering targeted incentives for the import and sale of EVs as well as for the development of charging infrastructure. Given that transportation represents approximately 44% of final energy consumption, efforts to diversify away from oil are a critical part of Costa Rica's long-term objectives. Combined with its abundant renewable energy resources, the shift to electric mobility in Costa Rica will help gradually transition both its electricity and its transportation system to a greater reliance on local and sustainable energy sources.

Sources: http://www.renenergyobservatory.org/uploads/media/Costa_Rica_Producto_1_y_2__Ing__01.pdf
http://news.co.cr/costa-rica-committed-to-renewable-energy/15673/

3.3.2 Denmark

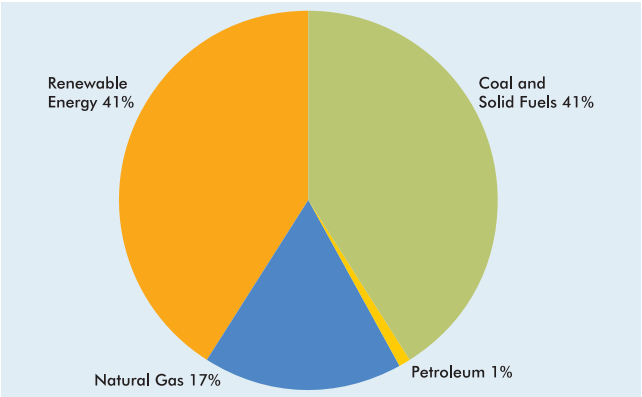
Sector	Focus
Electricity	
Transportation	
Heating/Cooling	

Source: http://ec.europa.eu/energy/publications/doc/2013_pocketbook.pdf

Average Temperature Range	0 Celcius to 16.7 Celcius
Size (sq. km)	42,915 km^2
Population Size	5,627,235 (2014 est.)
Political Status	Kingdom of Denmark

ELECTRICITY MIX

Denmark's Electricity Generation Mix (2011)
Total = 34.5 TWh



Annual Electricity Demand: 38.6 TWh
Electricity Access Rate: 100%
Peak Demand (MW): 14,116 MW

Key Elements of the 100% Renewable Energy Strategy

Technical Aspects

Denmark's energy and climate strategy includes an ambitious target of meeting 100% of electricity and heating needs with renewable energy sources by 2035. In the electricity system, this will involve a significant expansion in both wind and solar power as well as the continued deployment of combined heat and power (CHP) systems. Specifically in the heating sector, Denmark plans to expand the use of both renewable sources of gas (such as biogas) as well as other renewable forms of heating such as solar thermal, ground-source heat pumps, and wood-based biomass in the country's district heating network as well as in individual homes and businesses.

Denmark's strategy is not limited to electricity and heat: it aims to phase out fossil fuel use *entirely* in all energy sectors (including transportation) by 2050. Under current projections, this will involve a massive expansion in the use of electric vehicles[38] and continued growth in the use public transit. The current share of renewable energy in the transportation mix was estimated at less than 1% in 2011,[39] compared to a share of approximately 40% in the electricity mix. Thus, by shifting more of transportation energy needs onto the electricity system, Denmark will make progress toward achieving its overall 100% renewable energy target.

Another important component of Denmark's strategy is a strong, economy-wide focus on energy efficiency. Current EU plans envision a 20% reduction in energy use by 2020, and efforts continue to be made to increase energy efficiency in existing buildings via extensive retrofitting and in new buildings by raising the standards on all new construction in the country.

In order to achieve its 100% objectives, Denmark is relying heavily on a broader electrification of its energy sectors, combining the heating and cooling, transportation and end-use sectors. This will involve, among other aspects, converting greater volumes of the country's abundant wind resources into thermal form (e.g. funnelling more wind power into the district heating system as well as into on-site water heaters) as well as into electric battery storage for the transportation system.[40] Denmark also envisions a significant increase in the use of solar thermal technologies to supply heat directly into the country's district heating systems. Due to a combination of high electricity prices and high taxes on fossil fuels, the solar thermal market has grown from approximately 19.000 m^2 of solar collector space in 2000 to over 300.000 m^2 in 2012, making it an increasingly important contributor to the country's heat supply mix.[41] Plans are also underway to expand the use of renewable energy in its island regions, such as the Faroe Islands.[42] Combined with plans to expand transmission links with neighbouring Germany and Sweden to allow greater imports and exports of renewable electricity, and a motivated industrial, commercial, and residential sector, Denmark has the human, the natural, as well as the technological capital to make its transition a success.

Political Aspects

Denmark has a long history of leadership on energy and climate change, initially as a pioneer in wind power technologies and then as a major proponent of concerted action on climate change at both the European level and on the international stage. This

38 http://www.ens.dk/en/policy/danish-climate-energy-policy
39 http://ec.europa.eu/energy/publications/doc/2013_pocketbook.pdf
40 http://www.ens.dk/sites/ens.dk/files/policy/danish-climate-energy-policy/our_future_energy.pdf
41 http://solarthermalworld.org/content/long-term-experiences-solar-district-heating-denmark-2013
42 http://www.nordicenergy.org/wp-content/uploads/2013/11/Wind-Power-Based-Pumped-Storage_Pre-Feasibility-Study_Suduroy-Faroe-Islands_2013.pdf

leadership is now reflected in Denmark's domestic energy policy, which aims at a complete 100% transition of the energy system toward renewable energy technologies.

An important factor underpinning Denmark's 100% strategy is the high level of energy and environmental awareness among both its citizens and its politicians. This awareness has been cultivated over several decades since the 1973 oil crisis (and indeed before), helping create and maintain public support for a comprehensive energy strategy based on fully harnessing domestically available renewable energy resources. Denmark also benefits from a relatively small population, a highly educated workforce, and a number of world-class companies and research institutes to support the implementation of its strategy.

Like many of the other case studies included in this report, Denmark expects that the strategy will save them money over business as usual. Estimates included in the country's future energy plan indicate planned investments of approximately EUR 750 Million (5.6 Billion Danish Krone) by 2020, with expected savings in energy costs of over EUR 920 Million (6.9 Danish Krone) over the same period, making the launch of the strategy a direct saving for the government, businesses, as well as local residents.[43]

In addition to a feed-in tariff and a net metering framework, many of the policy measures rely heavily on fiscal policy, including the use of what are sometimes called 'green taxes' or environmental taxes.[44] For instance, Denmark levies a number of taxes on fossil fuels and has special taxes on environmental externalities such as carbon pollution, which increase the costs of gasoline, diesel, coal, as well as heating oil. Collectively, these taxes serve to make it more attractive to use local, renewable sources of energy instead of continuing to rely on fossil energies. Denmark also offers special tax incentives and in some cases even cash grants to encourage specific technologies, such as electric vehicles. This combined use of regulatory instruments, fiscal instruments, and an overarching national energy strategy represents the core of Denmark's 100% plan. For both its coherence, comprehensiveness and its clarity of purpose, it provides a valuable example for other countries seeking to re-orient their economies toward a more sustainable, renewably powered future.

Barriers and Solutions

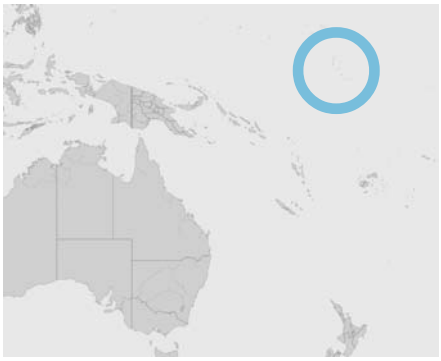
Despite the clear vision underpinning Denmark's strategy, there remain a few key challenges. Some have argued that high taxes and high energy costs in Denmark[45] will make it difficult to maintain public support for the 100% strategy, particularly for lower income residents in the country. Others are sceptical that the country will be able to phase out the use of coal in its district heating network completely by 2030, as currently planned.[46] Also, adding significant additional volumes of wind power into the network will require expansions in transmission capacity with its neighbours Germany and Sweden, and greater cooperation on cross-border electricity trade, developments that take time and resources.

However, despite these concerns, the political commitment at the local and national level in Denmark remains strong.[47] And in light of estimates conducted for the government, Denmark plans to actually save money by implementing its 100% renewable energy strategy. To keep its strategy on track, and keep the momentum behind it in the years and decades ahead, it will be important that these economic benefits are shared with citizens.

43 http://www.ens.dk/sites/ens.dk/files/policy/danish-climate-energy-policy/our_future_energy.pdf
44 http://www.docufin.fgov.be/intersalgnl/thema/publicaties/documenta/2011/BdocB_2011_Q2e_Larsen.pdf
45 http://ec.europa.eu/energy/doc/2030/20140122_swd_prices.pdf
46 http://www.ens.dk/sites/ens.dk/files/policy/danish-climate-energy-policy/our_future_energy.pdf
47 http://www.kebmin.dk/node/840

3.4 Island Governments

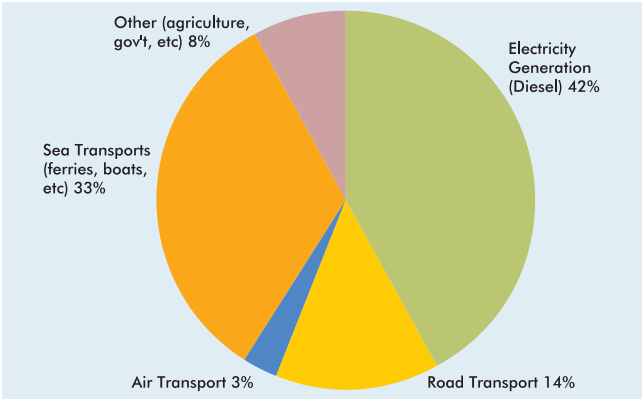
3.4.1 Tuvalu



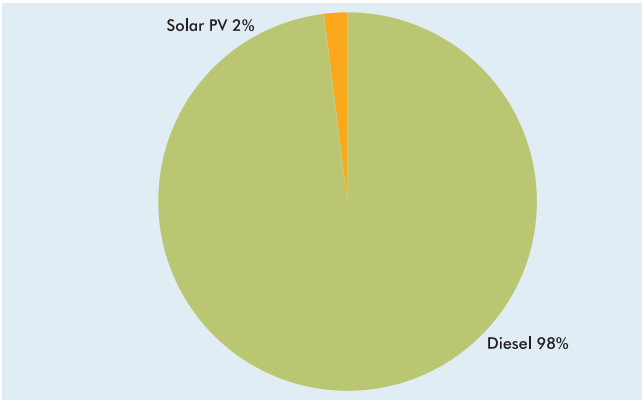
Average Temperature Range	25 Celcius to 31 Celcius
Size (sq. km)	26 km^2 (over nine coral islands)
Population Size	11,200 (2012)
Political Status	Nation State, Member of the British Commonwealth

Sector	Focus
Electricity	
Transportation	
Heating/Cooling	

Oil Use By Sector (2012)



Electricity Mix (2012)



Annual Electricity Demand: 4,900 MWh
Electricity Access Rate:
100% on Funafuti, the main island;
estimated 94% countrywide
Peak Demand (MW): over 1000 kW

Key Elements of the 100% Renewable Energy Strategy

Technical Aspects

Currently, the electricity system in Tuvalu is fragmented due to the geography of the atoll on which Tuvalu stands. The main island has three diesel generators with a total installed capacity of approximately 1,800 kW, while each of the outer islands has diesel capacity ranging from 148–220 kW. The estimated levelised cost of generation from these diesel units in Tuvalu was USD $ 1.05/kWh in 2010–11, while the average price paid for power was approximately USD $ 0.48/kWh after subsidies.[48] This suggests that like other islands covered in this report such as Cape Verde, achieving a 100% RE target is likely to result in a net cost saving for Tuvalu.

Overview of key projects

- 66 kW grid-connected solar PV system at the desalination plant;
- 46 kW off-grid solar PV system at Motofua Secondary School on the island of Vaitupu, combined with a 533 kWh battery system, perated on a hybrid basis with diesel back up;[49]
- 42 kW grid-connected solar PV system at another desalination plant;
- 40 kW solar PV system on top of the capital city's football stadium;
- small biogas systems making use of farm wastes;
- 65 kW solar PV system in Funafuti, the capital;
- Solar hot water systems, solar streetlights, as well as solar ovens are also being promoted.

Political Aspects

In 2009, the government of Tuvalu adopted the country's National Energy Policy (NEP), setting out the objective to supply 100% of its electricity needs with renewable energy sources (RES) by 2020.[50] According to the Majuro Declaration, signed by members of the Pacific Islands Federation on September 5th 2013, Tuvalu aims to supply between 60–95% of its power needs using solar PV systems, 0–40% using wind power, and an additional 5% using imported biodiesel.[51] The Declaration also aims to reduce electricity demand by 30% on the main island of Funafuti through a range of energy efficiency improvements. While many elements of the strategy have yet to be fully articulated, several different initiatives are underway to help it achieve its objectives and it is benefiting from a wide range of different international supports.

Tuvalu has recently established the Renewable Energy and Energy Efficiency Unit (REEEU) within the Tuvalu Electricity Corporation (TEC), the national utility. The aim of this new Unit is to help Tuvalu reduce its dependence on imported diesel, improve the efficiency of the power system, reduce carbon emissions, improve the overall operational effectiveness of TEC, and develop a strategy for the increased development of solar and wind power generation on the island.[52]

There are many factors behind the adoption of Tuvalu's 100% renewable energy target:

- Reducing dependence on imported diesel fuels
- Reducing exposure to volatile fuel prices
- Increase the island nation's energy security by improving the efficiency and sustainability of the electricity system
- Promoting access to modern energy services

48 http://www.theprif.org/sites/theprif.org/files/TISIP%20Final%20Report.pdf
49 See: http://www.sma.de/fileadmin/content/global/Products/Documents/Referenzanlagen/REFTUVALU-AEN122110.pdf
50 http://www.e8.org/upload/File/tuvalu_solar_power_project_final.pdf
51 http://www.majurodeclaration.org/the_declaration
52 See: http://www.reegle.info/profiles/TV

A wide range of partners and funding agencies has supported Tuvalu's renewable energy development efforts, including the International Union for the Conservation of Nature (IUCN), the e8 Group,[53] the International Renewable Energy Agency (IRENA), UNDP-GEF, the World Bank, the United Arab Emirates, the Danish, Japanese as well as New Zealand governments. The financing of the strategy is anticipated to come from a wide variety of sources.

Tuvalu's National Energy Policy is analogous to a Renewable Portfolio Standard, requiring the national utility to supply 100% of overall electricity demand with renewable energy sources by 2020. The strategy will likely rely on external development funds, as well as on investments by the Tuvalu Electric Corporation. As such, most projects will likely remain partially or fully government owned. Although the current RE penetration remains limited to a few per cent of total supply, the projects currently under development are expected to bring the supply to 30–40% of the total mix by 2015.

Barriers and Solutions

Tuvalu faces a few major challenges to achieve its 100% RE target. Like many other small island developing states (SIDS), Tuvalu remains heavily dependent on international development assistance. It is estimated that in 2010, fully 55% of the Tuvalu Electric Corporation's total income came from development partner grants rather than from electricity tariffs.[54] And while efforts are underway to bring tariffs more closely in-line with generation costs, this remains a major challenge.

Another challenge is that according to the World Bank, between 2008 and 2011, domestic revenue was sufficient to fund only 40% of total Government expenditures.[55] This means that new infrastructure investments in the electricity sector have to be largely if not exclusively funded by donors and other international development partners. Ensuring that sufficient funding is available, particularly for long-term operation and maintenance (O&M) costs will be essential to the long-term sustainability of the renewable energy strategy. Indeed, budgeting for these "life-cycle costs" is often challenging for small islands like Tuvalu.[56] The prevalence of maintenance issues with domestic rainwater collection infrastructure on individual households suggests that even for immediate needs like water, the appropriate maintenance fails to be provided. This indicates that a significant challenge in the years ahead in Tuvalu will be to ensure sufficient resources to support the maintenance of key RE infrastructure, including both on-going and preventive maintenance.

Another important challenge in Tuvalu has been securing access to land. Due to the limited availability of land, the government is attempting to find a way to ensure that the grant-funded projects can be focused on roof-mounted solar PV systems rather than ground-mounted systems. This has raised important issues about how the individual homeowners, or building owners, will be compensated for hosting solar PV projects on their roof, and how routine maintenance will be performed.

Further challenges to achieving its 100% target include the lack of comprehensive information about the current electricity system's characteristics, such as disaggregated load data that would allow utility representatives to run simulations and modelling exercises, and other requirements for the successful integration of high shares of variable renewable energy generation.[57] These capacities and skills will

53 http://www.globalelectricity.org/upload/File/07293_brochure_energyinaction-7_0_final.pdf
54 http://www.theprif.org/sites/theprif.org/files/TISIP%20Final%20Report.pdf
55 http://www.theprif.org/sites/theprif.org/files/TISIP%20Final%20Report.pdf
56 See page 40 on http://www.theprif.org/sites/theprif.org/files/TISIP%20Final%20Report.pdf
57 http://www.ppa.org.fj/wp-content/uploads/2013/09/Tuvalu-Tariff-Review-Request-for-Proposal.pdf

need to be developed in partnership with international experts to ensure that Tuvalu is successful in meeting its ambitious targets.

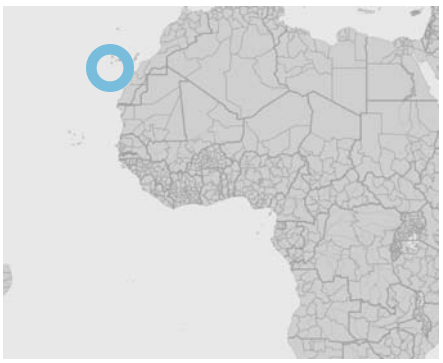
In order to overcome these challenges, Tuvalu has taken a number of different measures. Throughout this process, two key components have been the strong political will domestically, and sustained support from a wide range of donors internationally. This applies as much to the provision of financial resources as knowledge and training. Also, securing the support of key actors in Tuvalu, in particular representatives of the Tuvalu Electricity Corporation (TEC) has proved essential.

With strong international support for Tuvalu's ambition to achieve its 100% RE target and the modest sums required to reach the objective, Tuvalu is well positioned to reach its 100% target. In the process, it will have established a cleaner and more resilient electricity system, be less exposed to rising fossil fuel prices, and better equipped to continue to raise awareness about the importance of tackling global climate change.

Sumba, Indonesia

One island in Indonesia adopted an ambitious plan to supply the entire island with 100% renewable energy as part of a broader strategy to empower local residents, spur economic development and support public services such as electrification. With 700.000 inhabitants, Sumba has demonstrated what is possible with the right combination of political will, and support from local and international agencies. One agency that has been at the forefront of this initiative is Hivos, a local NGO that has led a series of stakeholder engagement initiatives to spread awareness of, and build support for, the 100% strategy. The organization has worked with the private sector, the Indonesian government as well as other civil society organizations to jointly implement the strategy. When the initiative was launched a few years ago, only 25% of the local population had access to electricity. After three years of efforts, electricity access has been increased to over 40% of the population and is continuing to grow. Most of the projects being developed are relying on solar PV, biogas, or micro-hydro systems. The Indonesian Ministry of Energy has taken responsibility for the implementation of the strategy, and efforts are now underway to increase both domestic as well as foreign investment. Both the Asian Development Bank as well as the Dutch and Norwegian governments have contributed financially to support the initiative.

3.4.2 El Hierro, Spain

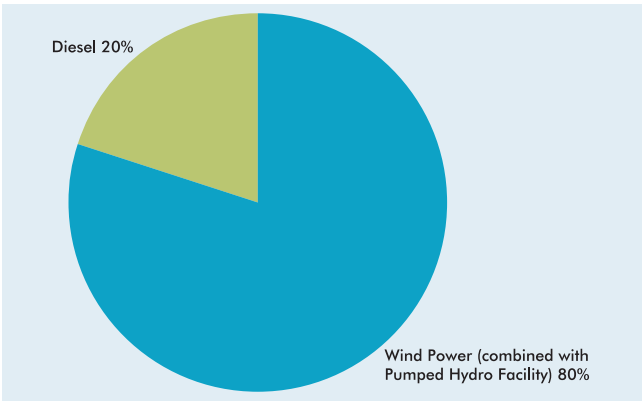


Average Temperature Range	25 Celcius to 31 Celcius
Size (sq. km)	278 km^2
Population Size	10,700 inhabitants
Political Status	Autonomous Community of Spain

Sector	Focus
Electricity	
Transportation	
Heating/Cooling	

ELECTRICITY MIX[58]

El Hierro Electricity Mix (2014):
Total=35 GWh/year



Peak Demand (MW) (2011): 7.56 MW[59]

58 Since its inauguration on June 27 2014, the wind-powered pumped hydro project is expected to produce approximately 80% of the total electricity needs on the island on an annual basis. See also (in Spanish): http://www.goronadelviento.es/index.php?accion=articulo&IdArticulo=147&IdSeccion=89

59 http://www.renewableenergyworld.com/rea/news/article/2012/10/creating-a-hybrid-hydro-wind-system-on-a-spanish-island

Key Elements of the 100 % Renewable Energy Strategy

Technical Aspects

El Hierro's 100 % renewable energy strategy is anchored in its unique climate and geology. It benefits from stable and relatively strong winds throughout the year, and has appropriate island topography for the development of a large pumped hydro storage system. As such, the majority of its 100 % target is now being met by a 11.5 MW wind farm, whose output is coupled to the functioning of a pumped hydro facility situated in a volcanic crater. When the winds are strong and the output from the farm exceeds the island's demand, the excess electricity is used to pump water into the empty crater for storage. When the winds are weak, or absent, the water stored in the reservoir is released and run through hydro turbines (four units with a combined capacity of 11 MW) to produce electricity. In this way, the pumped hydro system acts as a battery bank for the whole island. Another component of the system are the desalination plants that produce water for the island's residents – the plants will be operated in an integrated manner with the wind farm, ensuring that the water supply for the island is also generated in a clean and sustainable way.

Another component of the strategy is to replace the island's 4,500 cars with electric vehicles, in order to further reduce reliance on imported fuels and promote sustainable development on the island. Finally, a focus has also emerged on encouraging the island's agricultural industry to make greater use of bio-digesters in order to make use of local resources more efficiently.

Political Aspects

In the early 1980s, El Hierro decided to adopt a development model that placed a greater emphasis on the respect of the natural environment and the conservation of natural resources. In 1997, El Hierro was the first of the Canary Islands to adopt a sustainable development plan, a move that earned it a UNESCO biosphere designation in 2000.[60] Now, in the face of the global climate crisis and persistently high fossil fuel prices, El Hierro's ambitions have grown and it now aims to transition its entire electricity and transport system to renewable energy sources, while maintaining the ecological integrity of its island ecosystem.

The current electricity generation cost on El Hierro is estimated at USD $ 0.32/kWh, providing significant opportunity for lower cost alternatives to displace the diesel generation on the island. The island's oil use is currently approximately 40,000 barrels per year, totalling approximately USD $ 4 Million in annual fuel import costs. Estimates suggest that the project will save the island approximately $ 2.5 Million in diesel costs every year.[61] The remainder is currently used in the island's transportation system. However, once the vehicle fleet is transitioned to rely on domestically produced electricity, this will effectively eliminate the island's reliance on diesel power.[62] This will not only save the island millions of dollars per year in imported fuels: it will also reduce its exposure to fossil fuel price volatility, making it more resilient to external shocks and strengthening the local economy by keeping more of its income in the region. This positive economic impact that the transition to renewable energy is projected to have on the island is a powerful factor in maintaining the momentum at both the local and the political levels.

60 http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/biosphere-reserves/europe-north-america/spain/isla-de-el-hierro/
61 http://www.greenbiz.com/blog/2014/03/03/how-small-spanish-island-became-renewable-energy-pioneer-el-hierro
62 The current diesel generators are expected to remain in place and to serve as an emergency back-up system.

There are several interconnected factors that have helped turn El Hierro into a leading example of a 100% renewable energy island. These include:

- a long tradition of environmental leadership
- a sustained political vision
- a high level of environmental awareness among the population, including about the potential consequences of climate change
- a desire for greater self-sufficiency.

The initiative on El Hierro has been a product of the close cooperation between the island government of the Canaries (which owns a 60% stake in the project), the Instituto Tecnológico de Canarias (which owns 10%), and a private Spanish energy and utility group (which owns the remaining 30%).

Inauguration, July 2014

Barriers and Solutions

The Canary Islands are relatively isolated, approximately 300 kilometers from the coast of West Africa. This remoteness makes it more costly to import power system components such as generators, turbine towers, and distribution system infrastructure; it also makes it more expensive to fly in technical experts, such as engineers and project developers. This was partly overcome by partnering with, and building on the existing capacities of, the Instituto Tecnológico de Canarias (ITC), a local institute based in the main island Gran Canaría that provided significant technical and strategic support over the course of the project. Drawing on the expertise of the ITC made it possible to develop a cluster of expertise in the Canary Islands. This cluster of experts is beginning to reach out to other islands across the Canaries to help them reduce their reliance on imported fuels and increase the share of renewable energy in the overall mix.

On the regulatory side, the Canary Islands' previous Electricity Act had a clause limiting the total share of wind power in any individual island system to 12%.[63] This was originally included in order to ensure grid stability at a time when expertise in the field of wind power integration was less advanced. This restriction was eventually overcome by coupling the wind system on El Hierro with the integrated hydro storage system.

Additionally, despite the ongoing implementation of the wind-hydro system, analysts from the Canary Islands estimate that the total share of energy provided by the system will be approximately 80%. This indicates that El Hierro will need additional generation sources such as solar PV, and will need to expand efforts to adopt electric vehicles to reduce oil use in the transportation sector.[64] El Hierro will also face challenges similar to Cape Verde in supplying 100% of electricity needs on a daily as well as on a seasonal basis, a challenge that will require a far higher level of system integration and network intelligence than for interconnected systems such as Rhein-Hunsrück in Germany. Like Cape Verde, El Hierro will have to produce more than 100% of its total

63 http://www.unescocan.org/pdf/100RES.pdf
64 http://www.renewableenergyworld.com/rea/news/article/2012/10/creating-a-hybrid-hydro-wind-system-on-a-spanish-island?page=all

electricity needs most of the time, and store the excess in either its pumped hydro system, or divert it into others forms, such as thermal storage or in the form of desalinated water, which can be readily stored and dispatched.

Finally, developing and implementing the integrated wind-hydro hybrid system that forms that core of El Hierro's renewable energy strategy required a significant investment of time and resources that would have been difficult for a small island like El Hierro, with a population of just over 10,000 inhabitants. In achieving success, the support of both local and international institutes, of business partners, as well as funding bodies such as the European Union played an important if not invaluable role. Also the role of expertise will be particularly valuable for island regions around the world that are seeking to transition their systems to 100% renewable energy, in particular in light of the integration and storage challenges highlighted above. Overcoming these challenges will require developing solutions that are carefully adapted to the local context, and to the local energy demand requirements, and load patterns. A detailed system analysis, and a high level of planning and modeling to ensure that energy demand can be met 24 hours per day, and 365 days per year will be necessary.

Wind Farm in El Hierro

4. KEY FINDINGS

Drawing on the wide range of case studies above, there are a number of transferable policy lessons that can be useful for other governments around the world in establishing and achieving a 100% renewable energy target. This section highlights **five (5) key findings.**

Key Finding #1	Achieving 100% renewable energy can generate significant cost savings

There are quite a few positive economic and financial impacts of a 100% strategy that can be seen in several examples in this report, among them Cape Verde, Frankfurt, Rhein-Hunsrück District, Denmark and Tuvalu: These jurisdictions have managed to reduce their consumption of expensive and volatile fossil energy sources such as diesel and fuel oil, substituting them with local renewable energy resources. This represents direct cost savings for governments and utilities, as many renewable energy technologies are now cheaper than imported fossil resources. Energy consumers, e.g. in Cape Verde and Tuvalu, benefit from lower energy prices and enhance access to sustainable energy specifically in island-states and isolated areas. **Contrary to many arguments that transitioning fully to a renewably powered system would be too costly, case studies in this report demonstrate that the economics can be highly positive.**

In times of rising geopolitical tensions, significant energy price volatility, and global climate change, this benefit is a strong driver for 100% RE. Case studies analyses have shown that the reduction of fossil fuel imports and related economic savings are one of the key motivations for policy makers to implement a 100% RE target.

By reducing dependency on imported energy resources, an ambitious RE strategy can improve a jurisdiction's economic and energy security, bringing a wide range of direct and indirect benefits.

In many cases, the cost savings would be even higher if the substantial savings produced by offsetting fossil fuel subsidies were included in the calculation. In many countries, every litre of gasoline or diesel used for transportation or power generation translates into a direct loss for the government and burden for the national trade balance. It is estimated that annual fossil fuel subsidies aimed at reducing end-use prices alone (so-called 'consumption subsidies') totalled USD $ 530 Billion in 2012.[65] 100% RE would therefore be a solution for many governments around the world to build economic and social resilience, save money, and meet development goals.

Key Finding #2	100% strategies are not just for the wealthiest countries

As case studies like Bangladesh and Cape Verde or the example of Sumba in Indonesia are showing, a 100% renewable energy strategy can be a cost-effective solution to meet energy needs in jurisdictions at all levels of development. While some of these jurisdictions may need to rely more on external technical and financial support, the case studies demonstrate that **a 100% target is technically achievable in any country or jurisdiction, regardless**

65 See: http://www.economist.com/news/finance-and-economics/21593484-economic-case-scrapping-fossil-fuel-subsidies-getting-stronger-fuelling

of economic strength or GDP. In fact, small islands like Tuvalu in the South Pacific are demonstrating that least developed countries can experience significant direct benefits through the reduction of diesel imports, which consume a growing share of many island governments' budgets.

In addition, achieving 100% RE can provide a wide range of benefits that have a high priority among governments across the world, including reduced air pollution and health impacts, new and sustainable jobs, reduced freshwater demand as well as reduced fossil fuel import dependence. It can also produce a number of important health-related benefits in the least developed regions: since almost 3 billion people, mainly in South Asia and Sub-Saharan Africa suffer from both, erratic or no access to electricity and reliance on inefficient and polluting biomass fuels for cooking, increasing access to reliable, affordable and efficient renewables is essential to ensuring a more decent livelihood for all. This is also evident in the example of Bangladesh, where the Government, in partnership with a number of donor agencies, is achieving most of its rural electrification objectives using stand-alone solar home systems financed jointly between the end-user and international donor funds.

Key Finding #3	Transitioning to 100% RE can mitigate risks and make countries more resilient

The analysis of almost all case studies concludes that building resilience is one of the key benefits for countries, regions, districts, cities and communities around the world. 100% renewable energy systems mitigate risks by reducing the exposure to volatile fossil fuel prices, the risk of fuel supply disruption, as well as the risk of excessive import dependency. Cities like San Francisco, regions like Rhein-Hunsrück District and Fukushima, countries like Cape Verde and Denmark as well as islands like El Hierro and Tuvalu have identified this as one of the key motivations to phase out fossil fuels.

One of the lessons from El Hierro is that a holistic approach that integrates RE also in the transport sector can lead to a more resilient local economy. By transitioning its vehicle fleet to rely on domestically produced electricity, the island will effectively eliminate its reliance on diesel power. This will not only save the island millions of dollars per year in imported fuels: it will also reduce its exposure to fossil fuel price volatility, making it more resilient to external shocks and strengthening the local economy by keeping more of its income within the local economy in the region.

In an era of rapidly accelerating climate change, the awareness among policy makers of the additional risks and impacts of climate change is growing. By significantly reducing harmful emissions, **the transition to 100% renewable energy can be a powerful solution to increase the economic, social and infrastructural resilience to global climate change.** As a result, transitioning to 100% renewable energy can be understood as both mitigation (a way of reducing carbon emissions) *and* adaptation (a way of creating a society more resilient to external disruptions).

Key Finding #4	Committing to 100% RE can generate new economic activity, create jobs and improve life quality

Beyond generating economic savings for governments and citizens (see finding 1), 100% RE can also generate new economic activity, stimulate job creation and lead to clear improvements to quality of life. New business models for scaling up RE and providing energy services can help harness locally-produced energy sources and improve reliability. Models like San Francisco`s Community Choice Aggregator can help communities take greater control of their energy future; and the opening of the electricity market to independent power producers such as citizens and cooperatives seen in countries like Germany and Denmark can generate new forms of

local wealth and a greater degree of local ownership, and engagement. In Fukushima, the 100% RE strategy has catalysed several community power initiatives, and engaged a wide range of stakeholders who had not been part of the energy sector in the past.

Furthermore, the case studies also suggest **that improving energy efficiency and increasing reliance on locally available energy resources can have a direct positive impact on local economies,** including a host of positive multiplier effects as more money circulates within the region. This can be seen in the case of Rhein-Hunsrück in Germany, where its 100% strategy has already provided a significant boost to local economic activity and generated additional income for the District.

As jurisdictions embark on the journey towards 100%, they simultaneously develop a host of skills and technical knowledge that can be highly valuable both domestically as well as internationally. This was seen in the case of Cape Verde as well as El Hierro in the Canary Islands, where the local research institute ITC has become a hub for knowledge sharing and for providing advisory services to other island governments. The local expertise developed in the process of achieving a 100% target can therefore be valuable in its own right, and lead to spin-offs in both technological as well as in technical or consulting services.

Key Finding #5	Achieving a fully 100% RE system will require significantly expanding RE in the heating/cooling and transport sectors

As highlighted throughout the report, to date, far too little emphasis has been given to increasing the share of renewable energy sources in both the heating/cooling as well as the transport sector. First attempts and valuable lessons learnt can be found in Denmark, Costa Rica, San Francisco, Sydney, El Hierro as well as in Rhein-Hunsrück District. These examples suggest that **the significant expansion of RE in both the transport and heating/cooling sectors will need to become a strategic priority to achieve 100% renewable energy.**

In line with that, the analyses specifically of El Hierro and Rhein-Hunsrück District show that achieving 100% RE on a sustainable basis will require storing excess power in the form of heat in individual homes and businesses, in both hot water and refrigeration, allocating it to electric vehicles and other forms of storage, as well as offloading it into desalination, water pumping systems, demand response networks, and a host of other flexible loads. The total generation supplied by the energy and electricity systems should therefore be greater than 100% RE the majority of the time. This suggests that in order to achieve 100% RE on a stand-alone basis, electricity will need to be managed far more dynamically than in the past, and that electricity demand will need to become increasingly dispatchable.

This is an area where policy makers around the world need to devote more resources and attention, as the potential in both areas is tremendous, and in some cases even larger than in the electricity sector alone. This may involve increasing coordination between the electricity sector and the transport sector through the deployment of electric vehicle charging infrastructure, as seen in Costa Rica and San Francisco, or between the heating and the electricity sectors, as seen in Denmark and in Sydney Australia. Also the case of El Hierro suggests, the expansion of RE in other sectors like the transport sector can also lead to a more resilient and strong local economy.

5. RECOMMENDATIONS FOR POLICY MAKERS

Based on the analyses and five key findings outlined above, there are a number of policy recommendations that can help decision-makers in their efforts to set and achieve 100% RE targets. The first step in some jurisdictions is likely to be the hardest one, which is gathering the political support required to set a binding 100% RE target. As highlighted earlier in the report (see section 2), setting the 100% RE target is essential to catalyse action, and to mobilise stakeholders. Establishing a target can help provide a clear political mandate for action, helping streamline the process, attract investment, and improve coordination across multiple different actors and sectors. This is a common aspect across all of the case studies examined.

Once this first step has been achieved, jurisdictions can then start to identify specific policies that will help them achieve their objective. This may involve adopting a feed-in tariff to encourage more citizen investment in renewable energy supply, as in Germany, or developing a specific investment plan to support electric vehicle charging infrastructure, as in Costa Rica; it could also include broader measures such as undertaking ecological tax reform, to put a price on polluting sources of energy while encouraging investment in cleaner alternatives, as seen in Denmark. Ultimately, which policies are adopted will depend on the local context, the local energy mix, as well as on the available renewable energy potential.

Note that the recommendations included here are not jurisdiction specific: they are aimed at highlighting policy guidelines for a successful transition to a 100% renewable energy system.

#1 Make energy efficiency a top priority

A 100% RE target addresses both energy efficiency and energy generation. No region will meet its 100% RE target without simultaneously improving its energy efficiency. As a number of the case studies suggest, making energy efficiency a top priority is a critical part of achieving a 100% renewable energy future. Energy efficiency makes a 100% RE strategy easier and less costly to achieve, more sustainable in the long term, and supports the broader objective of decoupling economic growth from the growth in energy use.

In many of the case studies, such as in San Francisco, and in Frankfurt, energy efficiency has been identified as the cheapest way to help achieve the 100% RE target. In addition, jurisdictions like Denmark demonstrate that maximizing efficiency is not only about reducing energy needs but can also involve developing combined heat and power (CHP) infrastructure, and district heating networks, which can increase the full-cycle efficiency of delivered heat. These system-level approaches can be particularly important in reducing energy consumption in dense urban areas, by providing a more sustainable way to supply both residential and commercial heating and cooling needs. **By developing more efficient energy infrastructure,** including appliances and other end-use devices, **it becomes easier to develop, finance, and integrate the remaining infrastructure required to meet a jurisdiction's energy needs with locally available renewable resources.**

#2 Electrify the heating/cooling & transport sectors

Achieving 100% RE will require increasing the interconnection between the electricity, the heating/cooling, as well as the transport sectors. This allows renewable electricity to be channeled to a wider range of dispatchable end-uses such as in thermal systems, alternative forms of storage, or in electric vehicles. The examples of Denmark, Sydney, El Hierro and Costa Rica suggest that **transitioning the heating as well as the transport sectors to a greater share on electricity will need to become a policy priority in the decades ahead.** Further, the analyses of the case studies show that electrifying a greater share of the transportation sector will increase not only implementation flexibility, but also technical and engineering flexibility in achieving a 100% renewable energy target. In other words, the move toward greater electrification of heating and transport is likely to make it easier for jurisdictions to achieve their 100% RE targets.

Denmark for instance integrates renewable electricity in the heating sector through combined heat and power (CHP) fuelling its district heating infrastructure. Besides being highly efficient, this approach has added the benefit of being easily turned on and off, which gives it the flexibility needed to work well with an all RE system. Further, district heating infrastructure provides a form of decentralised storage for excess renewable power.

The example of Costa Rica shows that the electrification of the transport sector is key to mitigate climate change. Given that transportation represents approximately 44% of final energy consumption, efforts to diversify away from oil are a critical part of Costa Rica's long-term objectives and a key part of its efforts to tackle climate change. Combined with its abundant renewable energy resources, the shift to electric mobility in Costa Rica will help gradually transition both its electricity and its transportation system to a greater reliance on local and sustainable energy sources.

In line with that El Hierro experienced that a holistic approach that integrates RE also in the transport sector can lead to a more resilient local economy. By transforming the transport sector toward relying on domestically produced electricity, the island will effectively eliminate its dependence on diesel power. **One of the key lessons from these case studies is that a holistic approach combining the heating, power and transport sectors provides the foundation for a more reliable and robust energy supply system.**

#3 Maximize opportunities for citizen participation and the development of new business models

As seen throughout the case studies, adopting a 100% RE target can help mobilize thousands of actors across the economy toward achieving the target. This should be supported by implementing specific open-access and inclusive policies such as feed-in tariffs, offering targeted incentives, and by creating long-term investment certainty for citizens, local businesses as well as for international investors. Governments should aim to create inclusive policy frameworks that allow new business models to emerge as well as new forms of citizen engagement. **By providing market access to a wide range of stakeholders, policy makers can help build positive synergies across the region and help sustain the momentum required to achieve 100%.**

These new synergies can be seen in Germany's 100% RE regions network, in Frankfurt, Rhein-Hunsrück District, Denmark, San Francisco as well as in Fukushima Prefecture in Japan, where citizens, utilities and local businesses are partnering with research institutes, project developers, civil society groups as well as local governments. By providing market access to new stakeholders that have not been part of the energy

sector in the past, innovative business models emerge that help facilitate the transformation of the energy system. In other words, achieving a 100% RE target can enable policy makers to deliver simultaneously on a wide range of non-climate-related priorities.

An open-access energy system enables and strengthens cooperation, and a collective awareness of both the challenges, and the solutions available to overcome them. Moreover, as local opposition to energy infrastructure (in particular transmission projects) can be a major barrier to 100% RE, local and regional involvement of citizens and businesses help policy makers to overcome this hurdle and build public support.

The analyses of the German and Danish case studies in particular demonstrate clearly that participatory policy approaches can help a great deal to attract investments and to accelerate the transformation of the energy sector. Thus, **the transition to 100% RE is not just a switch from the combustion of fossil fuels to renewables: it is also an opportunity to strengthen and diversify the energy market, stimulate new forms of socio-economic development, and enable a wider range of stakeholders and citizens to participate in the financing and ownership of energy infrastructure.**

#4 Educate and inform citizens and businesses

As the case of Germany's 100% RE Regions, including Frankfurt and Rhein-Hunsrück District as well as Cape Verde and many others demonstrate, public awareness and education is absolutely critical to long-term, sustained success of a 100% RE strategy. As highlighted in the previous section, implementing **a 100% RE strategy requires the participation of a wide variety of stakeholders; this makes both the breadth and the depth of awareness crucial to long-term success.** Thus, educating citizens, improving awareness campaigns, and deepening public outreach must become higher priorities for policy makers seeking to achieve 100%.

This underscores the importance of the local education system, the role of the media, as well as the importance of citizens having open access to data and information. As the example of Frankfurt highlights, the engagement of local schools through a wide range of onsite projects and pilots is crucial to build a wider consciousness among the city's youth. In Cape Verde, media has helped create stronger public support for renewable energy, and a broader awareness of the issues related with its high dependency on fossil fuel imports.

The role of governments can also include publishing regular reports and updates, such as those prepared by the Federal Environment Ministry in Germany, or by the Danish Energy Agency in Denmark, to ensure transparency and improve access to information. Finally, direct engagement with citizens and businesses through conferences and consultations, as well as direct stakeholder engagement and participation in projects should be a central component of any successful, long-term 100% RE strategy to debunk myths around RE and educate people about the benefits.

#5 Adopt an integrated approach to fiscal, economic, and energy policy

The case studies included in this report suggest that only integrated strategies that adopt a long-term approach and that involve a broad spectrum of different government departments and agencies will succeed. As such, in order to be successful, a fully 100% RE strategy will require an integrated approach across policy areas such as fiscal, energy, economic, as well as infrastructure policy. Case studies such as Sydney, Frankfurt, Denmark and Cape Verde demonstrate that **a greater coordination between different levels of government is required.** In the process, **policy makers should aim to increase the coherence of their policy and planning processes**

and deepen the policy dialogue between previously distinct sectors and government departments. For instance, this can involve increasing the collaboration between the electricity and transportation sectors, or between the construction industry and the heating and cooling sectors.

As the case of Sydney demonstrates, an integrated approach can involve undertaking detailed sectoral analysis, and engaging stakeholders from each sector in the development and implementation of the strategy. Also, as seen in San Francisco, achieving the target without an integrated approach may not be possible in many cases, due to the prominent role played by certain traditional actors. This makes it important to engage stakeholders from different sectors early, and often, in the development and implementation of the strategy.

Further, achieving a 100 % RE target may require the cooperation of different Ministries, or government departments, that have not had a history of collaborating together. In the case of Denmark, for example, a core element underpinning its transition is its fiscal policy, which integrates the external costs of pollution into energy prices. This makes non-renewable resources in most sectors costlier than using renewable resources, thereby accelerating the transition through a better alignment of economic and environmental incentives. Similar lessons can be learnt from Cape Verde. An important component that has supported the success of Cape Verde's strategy is that it offers a tax exemption for the first five years of each RE project's operational life, with 50 % reduction offered for the following five years. The fiscal framework in Cape Verde also involves waiving export duties on certain RE products and components; some of the projects have also benefited from concessional financing, all of which help accelerate the transition to renewable energy technologies. However, in order to be adopted, these kinds of fiscal and economic policies required coordination from a wide range of different government departments.

The principle of policy coherence must also apply to the different government levels. Examples like Frankfurt, Rhein-Hunsrück District, Denmark and Fukushima prove that national and federal policies can trigger and support action on the regional and local level. In line with that, San Francisco and Sydney face bigger challenges due to the lack of policy coherence across governance levels.

All of these different examples demonstrate that a more holistic and integrated approach to fiscal, economic, and energy policy across governance levels is going to be necessary to achieve the transformation to 100 % renewable energy.

6. CONCLUSION: BUILDING THE POLITICAL WILL

The overall goal of this report is to outline solutions and implementation strategies that enable political decision makers at the national, regional and local levels to spearhead the energy transition. The analyses show that the importance of policies and regulatory frameworks cannot be overstated. Setting clear policy targets is hereby essential to provide investment security, mobilize stakeholders as well as improve the allocation of resources.

Based on case studies analyses, the policy handbook highlights five key findings that serve as transferable policy lessons. These key findings include both benefits and requirements that can be useful for other governments around the world in establishing and achieving a 100% renewable energy target.

#1	Achieving 100% RE can generate significant cost savings
#2	100% RE strategies are not just for the wealthiest countries
#3	Transitioning to 100% RE can mitigate risks and make countries more resilient
#4	Transitioning to 100% RE can generate new economic activities, create jobs, and improve quality of life
#5	Achieving a fully 100% RE system will require significantly expanding RE in the heating/cooling and transport sectors

Key Findings of 100% RE Case Study Analyses

Political decision makers are uniquely positioned to shape, advance and implement the sustainable development agenda based on 100% RE within their constituencies, countries and beyond. They can lead the development of relevant legislation and policies, monitor implementation, ensure oversight, accountability, and transparency. As elected representatives, they can help define the fiscal and budgetary priorities in a way that directly advances the goal of achieving 100% RE, and advances the goal of intergenerational equity. Indeed, as many of the case studies included in this report suggest, the transition to 100% will be a crucial part of forging a world that is more just, both toward current as well as toward future generations.

This policy handbook identifies five policy recommendations that can help policy makers in local, regional and national governments on all continents to realize 100% RE:

#1	Make energy efficiency a top priority
#2	Electrify the heating/cooling and transport sectors
#3	Maximize opportunities for citizen participation and the development of new business models
#4	Educate and inform citizens and businesses
#5	Adopt an integrated approach to fiscal, economic & energy policy

Policy Recommendations for achieving 100% RE

This publication underscores the fact that building political will is essential to catalyzing the transformation toward 100% RE. In his book "A Solar Manifesto", Hermann Scheer anticipated the rise of 100% renewable energy regions, and the potential role that they could play in mobilizing support for renewable energy worldwide: *"A … city or region that accomplished the transformation to solar energy … could start an avalanche by such an example, and with it, could cause political changes far beyond its own borders."*[66]
As Scheer understood well, **efforts to create societies entirely powered by renewable energy sources would generate countless virtuous cycles, as jurisdictions learn from one another and begin**

66 Scheer (2001), p. 244

moving toward a more sustainable paradigm. At the heart of these efforts is a movement of growing **awareness:** awareness of the increasing risks of our existing carbon-intensive growth paradigm; awareness of global climate change; and awareness of real, affordable alternatives.

As the case studies in this report show, continuously building **this awareness, both among citizens and political decision makers, is arguably a precondition to creating the kind of political will required to sustain and intensify the implementation of 100% RE strategies in the years ahead.** Indeed, it is noteworthy that in many of the case studies examined in this report, the political momentum has been maintained by citizens and civil society. This suggests that with the right level of awareness and education, the momentum can be created and sustained through increasing collaboration between stakeholders, including local businesses, media and civil society groups.

Building on these lessons, there are a number of specific actions that stakeholders and decision makers can take to help build the political will for 100% renewable energy:

- ✔ Inform and educate citizens and business leaders about the concrete possibility of a 100% renewable energy future
- ✔ Analyse the cost savings, environmental benefits, and improved economic security of a 100% renewable energy strategy
- ✔ Clearly communicate the economic advantages of renewable energy
- ✔ Build alliances across political parties and across sectors
- ✔ Engage citizens and investors

Policy Recommendations to build political will for 100% RE

As the various case studies have demonstrated, the motivations for establishing a 100% renewable energy target are diverse. They range from a growing awareness of the need to demonstrate leadership on tackling global climate change, to a desire for greater energy independence, to a need to reduce the vulnerabilities of relying on increasingly expensive fossil energy sources. Any attempt to build political will therefore need to take into consideration these local circumstances, develop a narrative that is compatible with the context and draw on the arguments that are most likely to be successful in each jurisdiction.

The vision provided by the emergence of 100% renewable energy regions is an inspiring one: it demonstrates that supplying 100% of a jurisdiction's energy needs with renewable energy sources is both technically and financially feasible, and can be achieved with today's technologies both by industrialized countries as well as in the Global South. The critical step is for policy makers at all levels to begin developing and implementing the policy frameworks required to support this transformation. In light of the tremendous inertia present in the global energy system, achieving 100% will not happen without good policies and a clear vision: it is only by putting these in place that governments can mobilize both the financial as well as the technological resources required to make this transition a reality.

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100% RENEWABLE ENERGY FOR SUSTAINABLE DEVELOPMENT

HOW 100% RE SUPPORTS THE

SUSTAINABLE DEVELOPMENT GOALS

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PUBLISHED JUNE 2017

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PHOTO CREDITS

P. 13: Africa Solar Designs.
P. 29: Nathalie Betrams, for Greenpeace.
P. 33: Nathalie Betrams, for the World Future Council.
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EXECUTIVE SUMMARY

Sustainable development can only be reached by transitioning to 100% Renewable Energy (RE). In fact, 100% RE is more than just replacing fossil with renewable sources in today's energy system. It can serve as a means for socio-economic development and help create an equitable society for today's and future generations. Hereby, it supports the implementation of each sustainable development goal (SDG). The wide-range of co-benefits linked to RE development reveal once again the strong interdependency among all aspects of sustainable development and therefore the need for a comprehensive, cross-silo and integrated policy approach for the attainment of any SDG.

In light of the vast benefits related to RE development and its instrumental role in supporting sustainable development, it becomes essential that policy makers and development organizations embrace the 100% RE message and integrate a 100% strategy into their development plans. The key policy recommendations to achieve this goal are:

- SET A 100% RE TARGET AND EMBED IT ACROSS POLICY AREAS AND IN SDG PROCESSES
- SET A "LEAVE NO ONE BEHIND" APPROACH TO ENERGY POLICY
- ENSURE ADEQUATE CIVIL SOCIETY PARTICIPATION AND CAPACITY BUILDING
- ENHANCE RENEWABLE ENERGY IN THE COOKING SECTOR
- PRIORITIZE ENERGY EFFICIENCY
- RE-DIRECT FOSSIL FUEL SUBSIDIES
- STRENGTHEN CHANGE AGENTS AND PIONEERS

INTRODUCTION

WHAT IS THE OBJECTIVE OF THIS PAPER?

This paper describes the vital relationship between renewable energy (RE) and sustainable development. In particular, it demonstrates how supporting the transition to 100% RE is both a necessary condition and a driver for sustainable development that leaves no one behind. Hereby, it unveils how transitioning to 100% RE is a prerequisite for ensuring a life of dignity, unlocking access to many substantive rights as well as procedural rights.

This report is addressed to civil society organizations, policy makers, development agencies and community leaders involved in sustainable development especially in countries in the Global South. It aims at supporting them in understanding the role of renewable energy in driving sustainable development and at determining pathways to include renewable energy into their development strategies.

In particular, this paper examines how a transition to 100% RE can contribute to the achievement of the 17 Sustainable Development Goals and can be directly relevant to many of the 169 targets. While the need to transition to 100%RE, and in so doing, harvesting the benefits in meeting many of the SDGs equally applies to the industrialized world, this paper focuses on the social, economic and political context of the Global South. Based on this analysis, this report presents the most significant policy recommendations to incorporate 100% RE into sustainable development strategies of developing and emerging economies.

WHY IS THIS ANALYSIS RELEVANT AND TIMELY?

Energy is a prerequisite of development and for a life of dignity. Access to energy is essential to overall human progress, social welfare, technological advancement and unlocks access to many human rights. Without reliable access to energy, societies would have never reached the standards of living that many countries across the world enjoy today. While it would be naïve to understate the vital role that fossil fuel energy played in improving livelihoods, it would be irresponsible, short-sighted and dangerous to ignore the threats of climate change, environmental degradation and concentration of political and economic power that this type of fossil-fuel-dependent development produced. To ensure that energy can continue to play its fundamental role in driving development, supporting human progress and improving livelihoods across the world, a fundamental shift is needed. The link between energy and development now necessarily becomes the link between "renewable" energy and development. In the light of this shift, understanding the relationship between a fully renewable-energy-based future and sustainable development becomes paramount.

Fortunately, signs of this shift are increasingly evident today. In 2013, for the first time the world added more capacity for renewable power (143 GW) than coal, natural gas, and oil combined (141GW)[1]. Only two years later, in 2015, for the first time in history, total investment in renewable power and fuels in the Global South in 2015 exceeded that in the Global North. The Global South, including China, India and Brazil, committed a total of USD 156 billion (up 19% compared to 2014). By contrast, RE investment in the Global North as a group declined by 8% in 2015, to USD 130 billion[2]. As the world undergoes an inevitable transformation towards a renewable future, an analysis of the relationship between 100% RE and sustainable development in Global South countries becomes extremely relevant and timely, especially as other major international provisions such as the SDGs and the Paris Agreement start to get implemented.

The Sustainable Development Goals, ratified in 2015, included two goals of utmost relevance: SDG7 Affordable and Clean Energy and SDG13 Climate Action[3]. These goals lay emphasis on the urgency to transform the energy sector as an essential and necessary element for both climate change mitigation and sustainable development. In the same year, the Paris Climate Agreement was stipulated. As of February 2017, a record of 131 countries already ratified the agreement and therefore officially pledged to make their contribution to limit the global temperature increase to 1.5 °C above pre-industrial levels[4]. Commitment to renewable energy also reached an unprecedented level when more than 1000 mayors from across the world committed to a 100% RE future at COP21 in Paris[5]. At the same time, the Africa Renewable Energy Initiative (AREI) was launched in Paris to "accelerate, scale-up and harness the continent's huge potential of renewable energy sources" by "widening

RENEWABLE ENERGY IS NOT ONLY THE BEST OPTION FROM AN ENVIRONMENTAL POINT OF VIEW BUT, ESPECIALLY TODAY, ALSO FROM AN ECONOMIC, SOCIAL AND GEOPOLITICAL PERSPECTIVE

access to clean energy services, improving human well-being and putting African countries on a climate-friendly and sustainable development pathway"[6].

More recently a revolutionary achievement was reached when the Climate Vulnerable Forum (CVF) vision was launched at the COP22 in Marrakech, which saw 48 countries from Asia, Africa, Caribbean, the pacific and South America declaring that they "strive to meet 100% domestic renewable energy production as rapidly as possible while working to end energy poverty, protect water and food security, taking into consideration national circumstances"[7 8].

The large commitment to RE from around the world does not come unexpectedly. A wide range of drivers are making a transition to a renewable energy world necessary and the best option not only from an environmental point of view but, especially today, also from an economic, social and geopolitical perspective[9].

Beyond mitigating climate change, air pollution and the violation of planetary boundaries, a transition to a 100% RE future makes sense from a cost perspective. For example in the US, the wholesale price of one solar panel in 2016 was about $0.65 per watt, compared with $0.74 per watt in 2015 and $4 per watt in 2008[10]. This means that in only eight years the price of solar technology has become 6 times cheaper. A recent article by Bloomberg showed how in 2016 solar power became the cheapest form of new electricity in Global South countries for the first time[11]. While this has happened in isolated projects in the past, only now unsubsidized solar is beginning to outcompete coal and natural gas on a larger scale, especially in emerging markets where new solar projects are cheaper than coal[11].In 2016, solar electricity production established "record after record", for example by producing electricity for $64 per megawatt-hour in India or $29.10 per megawatt hour in Chile, being roughly half the price of competing coal power[11].

These developments are very encouraging. With capital costs declining and essentially no fuel costs occurring as sun and wind is available for free (with the exemption of

BEYOND MITIGATING CLIMATE CHANGE, AIR POLLUTION AND THE VIOLATION OF PLANETARY BOUNDARIES, A TRANSITION TO A 100% RE FUTURE MAKES SENSE FROM A COST PERSPECTIVE

IN THE US, THE WHOLESALE PRICE OF ONE SOLAR PANEL IN 2016 WAS ABOUT $0.65 PER WATT, COMPARED WITH $0.74 PER WATT IN 2015 AND $4 PER WATT IN 2008[10]. THIS MEANS THAT IN ONLY EIGHT YEARS SOLAR TECHNOLOGY HAS BECOME 6 TIMES CHEAPER

biomass), 100% RE comes within reach also for indebted or weak economies. For countries – often landlocked regions – that depend on importing fossil resources to produce energy, a transition to 100% RE can improve the nation´s balance sheet, harnessing local energy sources. This in turn can also have a significant role in mitigating the geo-political tensions which are often driven by economic interest and power contests over areas rich in fossil fuels. The most notable example is the Middle East where many tensions and wars are strongly linked to economic interests often also related to oil and gas, including the recent devastating war in Syria[12 13].

Further, the 100% RE transition is about building a new positive narrative: a viable alternative exists and everyone can benefit from it. It is an alternative which leaves no one behind. Its implementation mostly depends on the political will and the commitment of communities around the world. While historically economic development has been strongly correlated with increasing fossil fuel deployment and GHG emissions, a 100% RE future decouples that correlation and offers a real chance to sustainable development. At the core of the 100% RE campaign lays the strong belief that leaders around the world need to build on this positive message rather than remaining trapped in trying to patch old and broken patterns of development that proved harmful and unsustainable. 100% RE is the only viable option for a sustainable future that leaves no one behind.

Setting a 100% RE goal goes well beyond simply promoting renewables. In fact, identifying and communicating a 100% RE target can help engage a wider range of stakeholders as it provides a common vision; it can help streamlining efforts and ensure a more efficient deployment of both technical and administrative resources. It can also reduce the risks of duplication and competing policy goals and can help give key stakeholders (such as utility providers, or private investors) the confidence required to make large investments, such as in transmission and distribution grids. By increasing investment certainty, setting ambitious targets can also help attract domestic and international investors, ultimately making it easier to achieve the target and in fact, phase out of fossil fuels. Furthermore, experience from many jurisdictions around the world demonstrates that clear targets can also help build awareness, both among external audiences as well as among the actors in the local area. This awareness can be essential to building public support among local citizens and businesses to help to achieve the objective[14 15].

100% RENEWABLE ENERGY

BUILDING A NEW POSITIVE NARRATIVE

A viable alternative exists, everyone can benefit from it and no one is left behind

Its implementation mostly depends on the political will and the commitment of communities around the world

It decouples the traditional correlation between increasing fossil fuel deployment and development and offers a real chance for sustainable development

SDGs & 100% RENEWABLE ENERGY

100% RE DEVELOPMENT REQUIRES STRONG CROSS-SECTORAL, TRANSREGIONAL AND TRANSNATIONAL PARTNERSHIPS

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CITIES ARE THE PIONEERS AND THE MOST PROMISING CHANGE AGENTS OF THE 100% RE MOVEMENT

11 SUSTAINABLE CITIES AND COMMUNITIES

THE DECENTRALISED NATURE OF 100% RENEWABLE ENERGY HELPS REDUCING INQUALITIES WITHIN AND AMONG COUNTRIES

10 REDUCED INEQUALITIES

SUPPORTING THE TRANSITION TO 100% RE IS BOTH A NECESSARY CONDITION AND A DRIVER FOR SUSTAINABLE DEVELOPMENT THAT LEAVES NO ONE BEHIND

1 NO POVERTY

100% RENEWABLE ENERGY CAN PROVIDE RELIABLE ACCESS TO ENERGY AT THE LOWEST POSSIBLE COSTS.

2 ZERO HUNGER

RE CAN PROVIDE ENERGY FOR ALL SEGMENTS OF THE FOOD CHAIN AND PROVES TO BE BENEFICIAL ESPECIALLY FOR REMOTE AND RURAL AREAS.

3 GOOD HEALTH AND WELL-BEING

RE IS ONE OF THE MOST VIABLE OPTIONS TO PROVIDE ENERGY TO HOSPITALS, HEALTH FACILITIES AND HEALTH POSTS, WHICH HAS A DIRECT IMPACT ON MANY PEOPLE'S HEALTH.

4 QUALITY EDUCATION

RE IS FUNDAMENTAL IN SUPPORTING STUDENTS BY PROVIDING ELECTRICITY DURING DARK HOURS OR FREEING UP TIME FROM CHARCOAL COLLECTION.

5 GENDER EQUALITY

100% RE CAN ENHANCE SUBSTANTIVE AND PROCEDURAL RIGHTS FOR WOMEN AND GIRLS AND ACHIEVE GENDER EQUALITY

6 CLEAN WATER AND SANITATION

BUILDING A 100% RE INFRASTRUCTURE IS A MEAN AND A PREREQUISITE TO ENSURE ACCESS TO CLEAN WATER AND SANITATION FOR ALL

7 AFFORDABLE AND CLEAN ENERGY

ACCESS TO 100% RENEWABLE ENERGY IS A PREREQUISITE FOR DEVELOPMENT AND A LIFE OF DIGNITY

8 DECENT WORK AND ECONOMIC GROWTH

100% RE BOOSTS INCLUSIVE AND SUSTAINABLE ECONOMIC GROWTH, CREATES EMPLOYMENT AND DECENT WORK FOR ALL

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

PROMOTING INCLUSIVE AND SUSTAINABLE INDUSTRIALIZATION ENTAILS EXPANDING RENEWABLE ENERGY INFRASTRUCTURE

100% RE AND THE SDGs: FINDING KEY LINKS

The following chapter examines how 100% RE can contribute to the achievement of the SDGs and is of direct relevance for meeting most of the 169 targets. The SDGs were adopted by the UN General Assembly in September 2015 in the Agenda 2030. Unlike the previous Millennium Development Goals, the SDGs recognize explicitly (with SDG 7- Ensure access to affordable, reliable, sustainable, and modern energy for all) the key role of renewable energy in upholding sustainable development[16]. While only SDG 7 explicitly refers to energy, there are numerous interlinkages between all SDGs: none of them can succeed in isolation. Given the integrated and organic nature of sustainable development, these linkages and synergies are extremely important and should not be overlooked[17].

While this analysis aims at demonstrating how renewable energy can support each of the 17 goals and therefore be instrumental for sustainable development that leaves no one behind, it is worth mentioning that there are also trade-offs and dangers. Expanding biomass as a source of energy for instance may lead to major cultivations of energy crops which in turn endanger particular biodiversity and therefore SDG 15. Or in order to reduce inequalities (SDG10) globally and foster innovation and sustainable industrialization (SDG9) particularly in the Global South, the priority must be to build renewable energy industries in those countries. So far, many African, Southern American or South East Asian countries depend on importing all equipment, the necessary investment capital as well as the expertise to build a renewable energy infrastructure. Instead of achieving sustainable development, this may create and foster dependencies and inequalities.

While these concerns need to be taken into account and tackled to leave no one behind, the following analysis demonstrates how all aspects of development are in fact strongly interlinked and how a comprehensive, cross-silo approach is necessary to reach any sustainable development goal.

END POVERTY IN ALL ITS FORMS

1 NO POVERTY

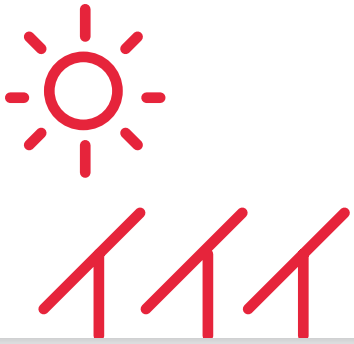
Renewable Energy is proved to provide reliable energy access at the lowest possible cost. Thereby it can benefit the most impoverished and isolated communities.

ACCESS TO RENEWABLE ENERGY IS A PREREQUISITE FOR ENDING POVERTY

100% RE HELPS ADVANCING HUMAN RIGHTS AND PROVIDE SERVICES AT THE LOWEST POSSIBLE COSTS. TAPPING ITS POTENTIAL CAN BENEFIT THE MOST IMPOVERISHED AND ISOLATED COMMUNITIES

LIFTING MILLIONS **OUT OF POVERTY**

89 million people in Africa and Asia are getting acces to energy through off-grid solar power. This provides enough power to lift 21 million individuals to the first rung of the energy ladder.



INCLUSIVE MARKET

The booming market of off-grid solar systems in Africa demonstrated how fast renewable energy could grow and reach even the remotest rural communities.

PRODUCTIVE ENERGY

RE can become a tool to generate income for rural households and enterprises.

RENEWABLE ENERGY ENABLES

ENTERPRISE DEVELOPMENT IN RURAL COMMUNITIES

PROVIDING THEM WITH THE RESOURCES TO ESCAPE EXTREME POVERTY AND HUNGER

SDG 1
END POVERTY IN ALL ITS FORMS EVERYWHERE

Access to modern energy services must be regarded as a prerequisite for ending poverty and achieving a life of dignity. This applies to substantive human rights such as access to water, good nutrition, health, shelter, education. RE plays a crucial role in providing this at the lowest possible costs. Gaining access to energy through RE can enormously benefit the most impoverished and isolated communities. Rural communities are often left without reliable access to energy as it is either too expensive to connect to the main power grid often several kilometres away or it is very expensive to purchase fuels that need to be transported to remote locations.

Thousands of examples demonstrate how communities across various Global South countries have benefited from gaining access to the RE resources available within their own region[18] and the role RE played in alleviating poverty and improving livelihoods[17 19 20]. Across several case studies, RE development proved to be extremely effective in reducing poverty and hunger in three key ways.

ACCESSIBLE, LEAST COST AND INCLUSIVE SOURCE OF ENERGY

Accessibility. RE is accessible across regions and countries. Unlike fossil fuel energy which is concentrated and available only in some regions and often monopolized by large corporations and private interests, RE is a resource that communities, even the most isolated rural ones, can seize and benefit from. The modular and decentralized nature of RE allows for great flexibility. Even the smallest communities can have a small solar system installed or an off-grid mini-grid and gain control over their own energy supply, without the need to abide to large corporations in charge of large, centralized energy distribution[18].

Least Cost. Today, RE is often the least cost option for electricity production in many regions across the world[11 21], and it is definitely the cheapest option for off-grid rural electrification[14]. According to a recent Bloomberg report, off-grid solar power is providing accessible and low cost energy access to about 89 Million people in Africa and Asia and provides enough power to "lift 21 million individuals to the first rung of the energy ladder"[22]. It is estimated that consumers save about $3.15 for every dollar spent on small solar PV (smaller than 10W) in Africa[22]. This economic advantage is thanks to the impressive fall in the cost of solar PV: 80% reduction since 2009 and continuing another 60% by 2025[23] even without considering externalities. Several Global South countries, ranging from Costa Rica to India and China, are progressively moving away from fossil fuels as they recognize the unprecedented cost competitiveness of renewable energy[24].

SOLAR POWER IS OFTEN THE CHEAPEST OPTION FOR OFF-GRID, RURAL ELECTRIFICATION[19]. THIS IS ALSO THANKS TO THE IMPRESSIVE FALL IN THE COST OF SOLAR PV: 80% REDUCTION SINCE 2009 AND CONTINUING ANOTHER 60% BY 2025. HERE IS AN EXAMPLE OF A SMALL SOLAR PANEL INSTALLATION IN THE TIRAS MOUNTAINS IN NAMIBIA

Recent cost reductions have made renewable energy the least cost option for off-grid electrification in many rural areas in countries of the Global South[17]. Several studies already demonstrate the economic advantages of 100% RE scenarios[14], including a recent study which demonstrates how a 100% Renewable Electricity future for Central and South America based on a combination of hydro, solar and wind is actually the least cost option[14]. Based on a levelised cost of electricity perspective, which takes into account life-cycle costs, costs values for electricity in the 100% RE scenario range from 56 €/MWh to 62 €/MWh, which according to this study are more cost competitive than other existing alternatives.

Inclusivity. RE can provide fast an inclusive access to basic energy needs. The booming market of off-grid solar systems in Africa demonstrated how fast renewable energy could grow and reach even the remotest rural communities. This is an extremely important factor to consider when judging the effectiveness of an energy technology compared to another in reducing poverty. For example, the Pay as you go (PAYG) modality allows off-grid customers in African countries to obtain a solar home system for a marginal initial down payment[26]. The rest of the payments are made in daily, weekly or monthly instalments and in many cases through mobile banking. Thanks to this innovative business model implemented across Africa by companies like M-Kopa, Mobisol or Azure millions of families in Africa have now access to electricity. While major investments in large projects, hence in centralised systems, are driven mainly by multilateral agencies and large developers who rely on long-term power purchase agreements, decentralized renewable energy systems such as solar home system can be extremely rapid in allowing rural communities to access electricity, especially if supported by local enterprises and favouring policies[26]. For example, from its launch in 2012 until 2015, M-KOPA Solar has brought energy to over 150,000 households in Kenya, Uganda and Tanzania[27]. This is vital to follow the principle of leaving no one behind.

ENERGY FOR PRODUCTIVE USES

Several experiences demonstrate how RE used for productive uses can actually benefit the development of communities and provide them with the resources to escape extreme poverty and hunger[29 30]. RE can in fact support several productive activities and as such become an effective tool for generating income for rural households and enterprises. RE demonstrated to be one the most effective instruments to enable enterprise development in rural communities, and in so doing to be highly effective in leveraging people out of poverty[30].

A recent report by the European Union Energy Initiative Partnership Dialogue Facility (EUEI PDF) explores in a comprehensive manner the benefits of productive of renewable energy use (PURE) in supporting agricultural, commercial and industrial activities that generate income[30]. Table 1 below shows some of the examples of various energy services and their income generating value. For example, electric-powered farm equipment can considerably benefit rural farm incomes. Farm machinery such as water pumps, fodder choppers, threshers, grinders, and dryers, increases average yields per acre, improves cropping intensities, increases cost efficiency and productivity, decreases labour time consumed, increases areas for cultivation, and results in higher crop growth.

FARM EQUIPMENT POWERED BY RENEWABLES CAN CONSIDERABLY BENEFIT RURAL INCOMES, **INCREASE AVERAGE YIELDS PER ACRE, COST EFFICIENCY AND PRODUCTIVITY**

ENERGY SERVICES	INCOME GENERATING VALUE	RENEWABLE ENERGY SOURCES
IRRIGATION	Better yields, higher value crops, greater reliability, growing when the market prices are higher.	Wind, PV solar, biomass, micro-hydro.
ILLUMINATION	Reading, extending operating hours.	Wind, PV solar, biomass, micro-hydro, geothermal.
GRINDING, MILLING, HUSKING	Create value-added product from raw agricultural commodity.	Wind, PV solar, biomass, micro-hydro.
DRYING, SMOKING (PRESERVING WITH PROCESS HEAT)	Create value-added, preserve product to enable selling in higher-value markets.	Biomass, solar heat, geothermal.
EXPELLING	Produce refined oil from seeds.	Biomass, solar heat.
TRANSPORT	Reaching markets.	Biomass (biodiesel).
TV, RADIO, COMPUTER, TELEPHONE	Entertainment businesses, education, access to market news, coordination with suppliers and distributors.	Wind, PV solar, biomass, micro-hydro, geothermal.
BATTERY CHARGING	Wide range of services for end-users (phone charging business).	Wind, PV solar, biomass, micro-hydro, geothermal.
REFRIGERATION	Selling cooled products, increasing the durability of the products.	Wind, PV solar, biomass, micro-hydro.

TABLE 1: EXAMPLES OF VARIOUS ENERGY SERVICES AND THEIR INCOME GENERATING VALUE AS SUMMARIZED BY EUEI PDF 2015 REPORT[30]

POWERING BANGLADESH WITH SOLAR PV

Bangladesh is one of the most densely populated countries in the world, with 162 million inhabitants on a territory of 147,570 km2. At the beginning of the century, Bangladesh was one of the most impoverished countries of the world, with 42% of the population considered extremely poor. Moreover, the country was standing at a crossroads in terms of energy access, which further constrained the socio-economic development of the population. Only 30% of the people of Bangladesh had access to electricity. Therefore, for the area not connected to the gird, life came to a standstill after sunset. Even for those connected to the grid supply was hardly reliable due to the lack of power generation capacity (3115 MW in 2002). Furthermore, overall demand for electricity was rising by about 10 per cent annually. Infrastructure was deficient, poorly managed and could not reach many rural areas (where 75% of the population lives) due to inaccessibility and remoteness. To revert the situation, in the year 2000 the government of Bangladesh set the target to provide 100% energy access through cheap and reliable electricity by 2020. This target was seen as a strategic articulation of the government's aspiration to fight against chronic poverty and attain middle-income country status. Not surprisingly, renewable energy played a critical role in the energy transformation of Bangladesh. Because of its cost-competitive nature, renewables off-grid solutions became the most suitable energy resource other than conventional fossil fuels to provide energy access to the rural population. Today, more than 4 million Solar Home Systems (SHS) have been installed in the country, benefitting over 24 million rural people. Bangladesh today presents a much brighter energy scenario to the one it had two decades ago, when the energy sector was one of the largest bottlenecks for the socio-economic development of the country. Most of the urban population has now access to electricity (nearly 99%). In rural areas, 62% of the population has access to electricity. The country has 13,265 MW capacities. An electricity generation of 7,787 MW, of which 4,049 MW comes from the public sector, 3270 MW from the private sector, and 468 MW is imported. If current trends persist, SHS alone are expected to generate 1000 MW by 2020. Meanwhile, Bangladesh has maintained an impressive track record on growth and development, too. In the past decade, the economy has grown at nearly 6 percent per year, and extreme poverty has dropped by nearly a third[28].

END HUNGER, ACHIEVE FOOD SECURITY AND IMPROVED NUTRITION AND PROMOTE SUSTAINABLE AGRICULTURE

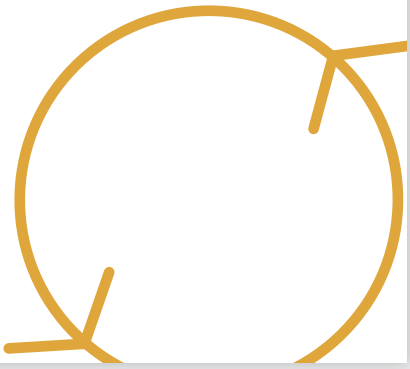
RE technologies can help communities provide energy for primary production, food processing and preservation and finally cooking. As such, integrating RE into all segments of the food chain can be extremely beneficial especially for remote and rural areas.

100% RE TECHNOLOGIES ARE ENHANCING FOOD SECURITY AROUND THE WORLD

100% RE CAN HAVE A DIRECT IMPACT ON FOOD SECURITY BY PROVIDING ENERGY TO SUPPORT ALL SECTIONS OF THE FOOD CHAIN, INCREASING CROP YIELDS IN THE MOST IMPOVERISHED REGIONS OF THE WORLD

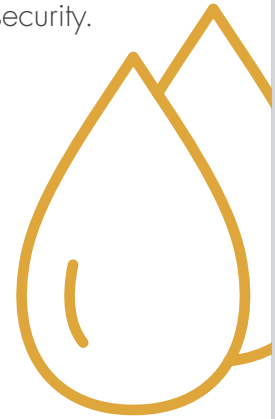
EVERY STEP
OF THE FOOD CHAIN

100% RE technologies help communities provide energy for primary production, food processing and preservation as well as cooking.



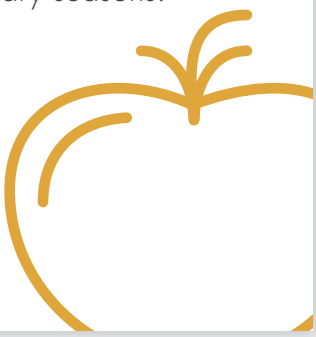
WATER PUMPING
STRESS

Water pumping for agriculture often puts stress on the electricity demand, especially during peak times and hence dangers food security.



RESILIENT
FOOD SYSTEMS

Decentralized RE-based pumping options can create much more resilient communities and avoid blackouts due to excessive electricity demand, especially during extreme dry seasons.



OFTEN SEEN AS HAVING NEGATIVE IMPACTS,
BIOENERGY, WHEN MANAGED SUSTAINABLY, LOCALLY AND EFFICIENTLY
CAN PROVIDE A LOCALISED SOLUTION TO ENHANCING ENERGY AND FOOD SECURITY

SDG 2
END HUNGER, ACHIEVE FOOD SECURITY AND IMPROVED NUTRITION AND PROMOTE SUSTAINABLE AGRICULTURE

RE can have a direct impact on food security by providing energy to support all sections of the food chain. For example, pumping technologies can help support agricultural activities in the most impoverished regions of the world and increase crop yields. Further, RE technologies can help communities provide energy for primary production such as solar or wind-based water pumping for irrigation, biofuels, solar-based desalination, harvest storage (solar or geothermal based food drying, solar cooling and refrigeration), food processing and preservation (mechanical processing driven by RE, RE-driven refrigeration, heating which can help to improve productivity and reduce food waste) and finally cooking (RE based cooking). As such, integrating RE into all segments of the food chain can be extremely beneficial especially for remote and rural areas.

For example in East Africa, especially in Kenya, the use of wind pumps significantly improved food security and family incomes. In Colombia, small hydropower for rice crop irrigation instead of diesel generators allowed farmers considerable savings[30]. In many countries, water pumping for agriculture often puts stress on the electricity demand, especially during peak times and hence dangers food security. Substituting centralized on-grid systems with decentralized RE-based pumping options can actually create much more resilient communities and avoid blackouts due to excessive electricity demand, especially during the more frequent climate anomalies such as extremely dry seasons[31].

While bioenergy can actually provide a localised solution to transform rural economies while enhancing energy and food security, it is often seen negatively because it can also threaten the latter. Additionally in a lot of countries, crops produced for bioenergy use are exported and thus not available for local markets[32]. However, when managed sustainably, locally and efficiently, bioenergy development can create new markets and generate employment opportunities that could positively affect incomes and poverty reduction, while also contributing to environmental objectives. In general, several examples show that energy produced from biomass can contribute to food security as long as it is sustainably produced and managed. For example, the production of bioenergy in integrated food–energy systems is one such approach. Intercropping Gliricidia (a fast-growing, nitrogen-fixing leguminous tree) with maize in Malawi or with coconut in Sri Lanka is substantially improving yields of agricultural products while also providing sustainable bioenergy feedstock. As opposed to what might appear counterintuitive, such an integrated food-energy industry can enhance food production and nutrition security, improve livelihoods, conserve the environment and advance economic growth[31].

IN EAST AFRICA, ESPECIALLY IN **KENYA**, THE USE OF WIND PUMPS SIGNIFICANTLY IMPROVED FOOD SECURITY AND FAMILY INCOMES

IN **COLOMBIA**, SMALL HYDROPOWER FOR RICE CROP IRRIGATION INSTEAD OF DIESEL GENERATORS ALLOWED FARMERS CONSIDERABLE SAVINGS

CLIMATE CHANGE IMPACT ON FOOD SECURITY

THE LINK BETWEEN ENERGY AND FOOD SECURITY IS ALSO FOUND IN HOW THE ENERGY SECTOR, THE LARGEST CONTRIBUTOR OF CO2 EMISSIONS, IS AFFECTING THE WORLD'S CLIMATE[19 31]

EXTREME WEATHER CONDITIONS IMPACT AGRICULTURE

Climate change increases the frequency and intensity of natural disasters such as droughts, floods and storms. These extreme events can destroy large crops, disrupt ecosystems and make it increasingly difficult to grow crops. Extreme weather events can also negatively affect the infrastructure required for collection and storage purposes, which can put further stress onto farmers and local communities.

VOLATILE FOOD PRICES AND UNRELIABLE FOOD PRODUCTION

The food production affected by a changing climate leads to an increase in the food market prices, as well as to volatile and unreliable food production. Therefore, the world´s population is at risk of a lack of access to good quality and healthy food. The poorest parts of the world are often the most exposed and most vulnerable ones. Climate change will affect first and above all those who are least equipped, exacerbating poverty and mining the socio-economic stability of those countries often already suffering from arduous economic and climatic conditions.

OCEAN ACIDIFICATION AND IMPACT ON FISHERIES

Many fisheries already face multiple stresses, including overfishing and water pollution. Climate change may add new stresses. In particular, temperature changes could lead to significant impacts, one in particular being ocean acidification. Carbon dioxide is absorbed by oceans, resulting in ocean acidification, which reduces the size and abundance of shellfish, which in turn leads to decreased fisheries output and eventually to changes in prices and availability for consumers.

ENSURE HEALTHY LIVES AND PROMOTE WELL-BEING FOR ALL AT ALL AGES

3 GOOD HEALTH AND WELL-BEING

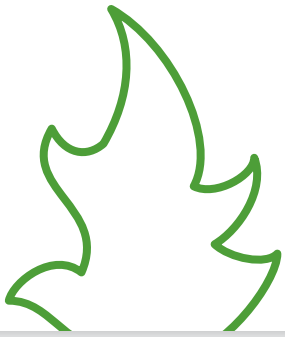
RE not only reduces significantly outdoor and indoor pollutions, but it also proved to be one of the most viable options to provide energy to hospitals, health facilities and health posts, especially in remote rural areas in the Global South. This has a direct impact on the health of thousands of people who access hospitals in the Global South every day.

100% RENEWABLES ARE CRITICAL IN DECREASING AIR POLLUTION AND PROVIDING ENERGY TO HEALTH CENTERS

BY TRANSITIONING TO 100% RENEWABLE ENERGY COUNTRIES CAN REDUCE DISEASES RELATED TO OUTDOOR AND INDOOR POLLUTION AND SIGNIFICANTLY SUPPORT THE FUNCTIONING OF HEALTH FACILITIES IN RURAL AREAS

OUTDOOR AIR POLLUTION

Outdoor air pollution, a health challenge that was estimated to cause 3 million premature deaths worldwide in 2012, can be addressed by transitioning from fossil fuel combustion to RE.

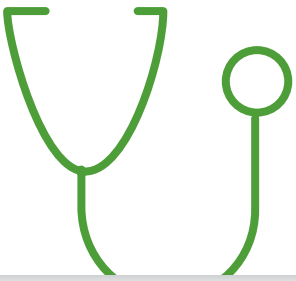


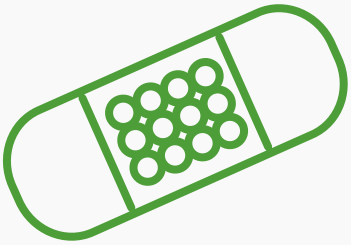
INDOOR AIR POLLUTION

Indoor air pollution results in 4 million premature deaths. Transitioning to more efficient cookstoves and RE based cooking methods can play a crucial role in mitigating this health impact.

ENERGY FOR HEALTH CENTERS

Health workers in electrified clinics have reported results such as fewer infections, fewer delays in providing life-saving care, more timely blood transfusions, and more successful child deliveries.





ON-SITE RE GENERATION FOR HEALTH CENTERS PLAYS A KEY ROLE

IN ENSURING ECONOMICALLY VIABLE AND RELIABLE ELECTRICITY TO PROVIDE HEALTH SERVICES FOR ALL

SDG 3
ENSURE HEALTHY LIVES AND PROMOTE WELL-BEING FOR ALL AT ALL AGES

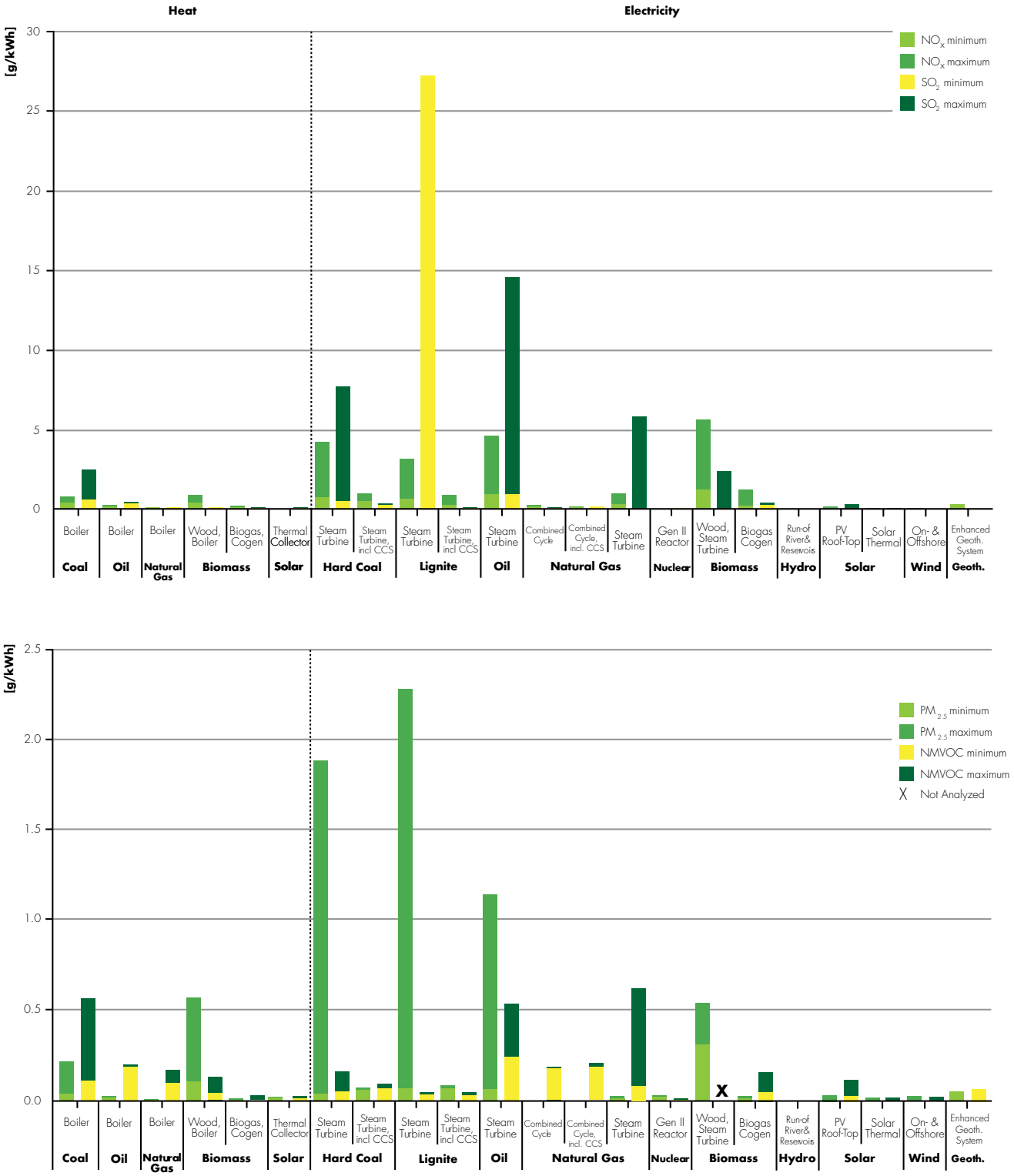
Renewables can positively impact health and well-being mostly in three ways.

DECREASE OUTDOOR AIR POLLUTION

Fossil fuel combustion is one of the major causes of outdoor air pollution[33]. According to the World Health Organization, air pollution is a major environmental risk to health. By reducing air pollution levels, countries can reduce the burden of disease from stroke, heart disease, lung cancer, both chronic and acute respiratory diseases, including asthma and several allergies. The lower the levels of air pollution, the better the cardiovascular and respiratory health of the population will be, both long- and short-term. Outdoor air pollution in both cities and rural areas was estimated to cause 3 million premature deaths worldwide in 2012. Most importantly, 88% of those premature deaths occurred in low- and middle-income countries. Reducing outdoor emissions from household coal and biomass energy systems, agricultural waste incineration, forest fires and certain agro-forestry activities (e.g. charcoal production) would reduce key rural and peri-urban air pollution sources in developing regions[34]. As shown in the following figure the emission of NOx, SO2, PM and NMVOC (non-methane volatile organic compounds) tend to be much higher for Coal, Oil, Lignite and Natural gas than for non-combustive renewable energies in terms of grams emitted per kWh energy produced. Biomass is the only renewable option, which may have a higher level of pollution. However, drastic increase in RE deployment such as hydro, wind, and solar would significantly lower these emissions and therefore have major health benefits[35].

88% OF PREMATURE DEATHS CAUSED BY OUTDOOR POLLUTION OCCURRED IN LOW- AND MIDDLE-INCOME COUNTRIES

REDUCING OUTDOOR EMISSIONS FROM HOUSEHOLD COAL AND BIOMASS ENERGY SYSTEMS, AGRICULTURAL WASTE INCINERATION, FOREST FIRES AND CERTAIN AGRO-FORESTRY ACTIVITIES (E.G. CHARCOAL PRODUCTION) WOULD REDUCE KEY RURAL AND PERI-URBAN AIR POLLUTION SOURCES IN DEVELOPING REGIONS



CUMULATIVE LIFECYCLE EMISSIONS PER UNIT OF ENERGY GENERATED OF (A) NOX AND SO2 AND (B) NMVOC AND PM2.5 FOR CURRENT ELECTRICITY SUPPLY TECHNOLOGIES[35]

REDUCE INDOOR AIR POLLUTION

According to the World Health Organization (WHO), around 3 billion people heat their homes and cook using solid fuels (i.e. wood, charcoal, coal, dung, crop wastes) on open fires or traditional stoves[36]. Most are impoverished, and live in low- and middle-income countries. These inefficient cooking and heating practices produce high levels of indoor air pollution which includes a range of health damaging pollutants such as fine particles and carbon monoxide[37 36]. The WHO estimates that every year over 4 million people die prematurely from illness attributable to the household air pollution from cooking with solid fuels. In poorly ventilated dwellings, smoke in and around the home can exceed by 100 times the acceptable levels for fine particles. Exposure is particularly high among women and young children, who spend the most time near or inside their domestic dwellings[36]. More than 50% of premature deaths due to pneumonia among children under five are caused by the particulate matter (soot) inhaled from household air pollution[38].

Therefore promoting a transition to much more efficient cookstoves and to cooking methods based on clean and modern RE can play a crucial role in mitigating the impact on health, especially to children and women. The narrative on cooking needs to move beyond more efficient and modern cookstoves. While these are definitely better than traditional cook stoves or open fire, they can solve the issue only partially and temporarily. Concrete results also in terms of indoor air pollution reduction can only be achieved with a shift from simply improved cook stoves and LPG (liquefied petroleum gas (LPG) to truly alternative cooking solutions such as renewable electricity (e.g. solar home systems), biogas, and Power-to-Gas (P2G). A recent WFC report provides further details on this critical issue[39].

RENEWABLE BASED
COOKING METHODS

Exposure to indoor air pollution is particularly high among women and young children, who spend the most time near or inside their domestic dwellings

The narrative on cooking needs to move beyond more efficient and modern cookstoves

Results can only be achieved with a shift from simply improved cook stoves and LPG (liquefied petroleum gas (LPG) to truly alternative cooking solutions such as renewable electricity

PROVIDE ENERGY TO HOSPITALS AND HEALTH CARE CENTRES

RE proved to be one of the most viable options to provide energy to hospitals, health facilities and health posts, especially in remote rural areas in the Global South. This has a direct impact on the health of thousands of people who access hospitals in the Global South every day[40]. According to a recent report by the WHO, on average, one in four sub-Saharan health facilities had no access to electricity. Only 8% of health facilities and 34% of hospitals had what could be called "reliable" access to electricity (without prolonged interruptions in the past week)[40]. Yet, access to modern renewable energy demonstrated to significantly support the functioning of health facilities in rural areas, by generating electricity for medical devices, appliances and facility support functions (e.g. cooling, lighting and water pumping) and by providing energy for sterilisation and for space and water heating[17 41]. It was actually reported that health workers in electrified clinics – even with very small PV systems – have reported results such as fewer infections, fewer delays in providing life-saving care, more timely blood transfusions, and more successful child deliveries[41].

Successful examples of on-site RE generation for hospitals and its key role in ensuring economically viable and reliable electricity exist. An example is the university hospital of Mirebalais in Haiti, which has 1,800 solar panels on its rooftop[42]. The WHO recently highlighted the increasing role of solar power in health facilities[43]. In fact, a recent review of sub-Saharan African health facilities found a trend towards increasing use of onsite PV solar either as a primary or backup electricity source. In Uganda, some 15% of hospitals used PV solar to complement grid electricity access, and in Sierra Leone, 36% of all health facilities and 43% of hospitals used solar systems in combination with other electricity sources. In Liberia, a country with little grid coverage beyond the capital city, the pace of solar electrification has exceeded that of other power sources; in 2012, more first-line public health clinics used PV solar than generators as their primary energy source. While PV systems are limited in capacity, they appeared to offer somewhat greater reliability: more solar-equipped clinics reported having electricity available on the day they were surveyed compared with those using diesel generators as their primary source. The interest in solar has been stimulated by the increasing range of direct current (DC) medical devices and appliances that can be charged from PV solar panels, such as solar refrigerators for vaccine refrigeration. A number of inexpensive portable solar systems options exist that were specifically designed for off-grid health clinics' basic lighting and communications needs, particularly to support childbirth and emergency services[43].

A RECENT REVIEW OF SUB-SAHARAN AFRICAN HEALTH FACILITIES FOUND A TREND TOWARDS INCREASING USE OF ONSITE PV SOLAR

IN LIBERIA, A COUNTRY WITH LITTLE GRID COVERAGE BEYOND THE CAPITAL CITY, THE PACE OF SOLAR ELECTRIFICATION HAS EXCEEDED THAT OF OTHER POWER SOURCES; IN 2012, MORE FIRST-LINE PUBLIC HEALTH CLINICS USED PV SOLAR THAN GENERATORS AS THEIR PRIMARY ENERGY SOURCE

ENSURE INCLUSIVE AND QUALITY EDUCATION FOR ALL AND PROMOTE LIFELONG LEARNING

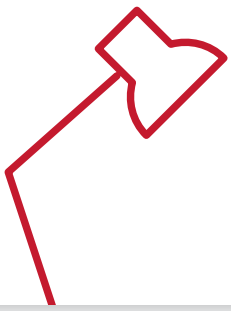
Renewable Energy can be installed where schools and educational centres are located and it is fundamental in supporting students learning in a variety of ways, from electricity for lighting during dark hours to freeing up time from charcoal or firewood collection.

IMPROVED ACCESS TO ENERGY HAS A DIRECT CORRELATION WITH EDUCATIONAL ACHIEVEMENTS

AND 100% RENEWABLE ENERGY IS THE FASTEST AND MOST INCLUSIVE APPROACH FOR REACHING THAT

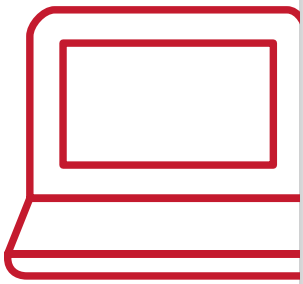
IT'S ALL ABOUT **ACCESS**

Renewable energy can provide access to millions of students in a fast and affordable way, without having to wait for the national infrastructure to be expanded or upgraded.



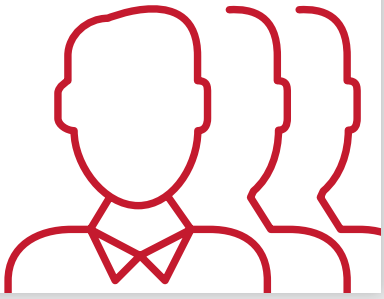
INFORMATION AND POWER

RE provides low cost electricity production to power computers and other devices to access information and facilitate communication.



ENERGY TO **RECRUIT TEACHERS**

The reliable and affordable source of electricity provided by RE can motivate teachers and qualified professionals to consider moving to these communities.



ACCESS TO RE OPTIONS FOR COOKING AND ELECTRICITY CAN **FREE UP TIME FOR STUDYING AND ENSURE SAFETY** FOR MANY CHILDREN WHO DEDICATE THEIR TIME TO WOOD AND CHARCOAL COLLECTION

4 QUALITY EDUCATION

SDG 4
ENSURE INCLUSIVE AND QUALITY EDUCATION FOR ALL AND PROMOTE LIFELONG LEARNING

SOLAR PV SYSTEM IN CIPTAGELAR, AN INDIGENOUS COMMUNITY IN THE RAIN FOREST OF WEST JAVA, INDONESIA, INSTALLED BY GREENPEACE IN 2015

Several experiences demonstrate the positive correlation between improved access to energy and educational achievements. Yet, about 300 million pupils attend schools that do not have access to electricity[17]. Using renewable energy technologies is the fastest and cheapest way to provide energy access. They can be installed where schools and educational centres are located without waiting for the national infrastructure to be expanded or upgraded. Hereby, it is fundamental in supporting students learning in a variety of ways[17]. First of all, renewable-based electricity for lighting which allow students to study during dark hours has proven to be extremely important to improve their performance. It is estimated that the deployment of about 600,000 solar lights in Africa provided 765 million pupils extra study hours in 2014, which resulted in improved performance and greater motivation and attendance[17]. A number of practical examples exist. For instance in the village of Littoral in Cameroon, solar kits were installed in all 50 houses of the village as well as the dispensary. Each house had an independent solar kit with one solar panel, 6 to 10 LED bulbs, a battery, one charge controller, one protection kit against power surges, one scaffolding and other required material for electric installation. As children could now study in the evening, their school performance improved significantly, with a recorded rise in scores (from E to C)[30].

RE can also provide a low cost option for electricity production to power computers and other devices to access information and facilitate communication, which have demonstrated to benefi students considerably[17 30]. For example in the Surkhet District in Nepal, a project completed in 2013 demonstrated how the use of energy from photovoltaic systems for lighting and for powering computers is the cheapest option for rural areas and allows students to improve their performance while the measures also helped to significantly reduce the emission of toxic gases from the current use of kerosene lamps[44].

IN LITTORAL, CAMEROON, SOLAR KITS INSTALLED IN ALL HOUSES ALLOWED CHILDREN TO STUDY IN THE EVENING, WHICH **IMPROVED THEIR SCHOOL PERFORMANCE SIGNIFICANTLY**

The lack of electricity in schools especially in rural areas also leads to difficulties for finding enough and qualified teachers. Many African countries for example report that teachers express a strong preference for urban postings, mainly due to concerns about teaching conditions and quality of accommodation[45]. Governments therefore find it more difficult to supply quality education services in rural areas. As teachers prefer to teach in urban areas, rural schools

are often left with empty posts, or have longer delays in filling posts. Even if posts are filled, rural schools may have fewer qualified teachers, if the better qualified teachers have a greater choice of jobs. Sometimes the rural schools have less experienced teachers, as the more experienced teachers find ways to move to the more desired schools. In Tanzania, experiences also proved that the quality of teaching may be lower, if teachers have limited access to electricity. Rural teachers often have less access to support services than their urban counterparts, and fewer opportunities to attend in-service course[45 46].

Further, it is important to remember that many children especially in Africa dedicate their time to wood and charcoal collection, which often leaves them less time for education and can be dangerous particularly for girls and young women being exposed to violence (rape, sexual harassment, and abduction). Access to RE options for cooking and electricity can be an alternative that would free up time for studying and ensure safety[17 39].

GOVERNMENTS FIND IT MORE DIFFICULT TO SUPPLY

QUALITY EDUCATION SERVICES IN RURAL AREAS DUE TO LACK OF ENERGY SERVICES

Many African countries report that teachers prefer urban postings, due to teaching conditions and quality of accommodation.

As teachers prefer to teach in urban areas, rural schools are often left with empty posts, or have longer delays in filling posts.

Often, rural schools have less experienced teachers, as the more experienced teachers can choose more desired schools.

ACHIEVE GENDER EQUALITY AND EMPOWER ALL WOMEN AND GIRLS

RE projects are often an opportunity to involve women and allow them to be the drivers of change. As the energy sector transitions from fossil-fuel dominated systems toward more efficient, sustainable renewable-based systems, new opportunities for a more inclusive energy job market are emerging which increases the role and participation of women.

100% RE CAN ENHANCE SUBSTANTIVE AND PROCEDURAL RIGHTS FOR WOMEN AND GIRLS AND ACHIEVE GENDER EQUALITY

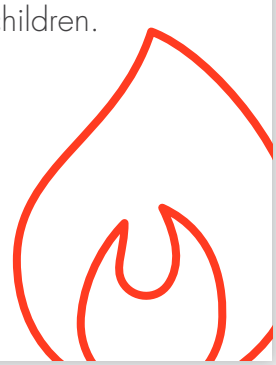
RE FEATURES MORE GENDER EQUALITY THAN THE BROADER ENERGY SECTOR. ACCORDING TO A SURVEY, WOMEN REPRESENT AN AVERAGE 35% OF THE WORKFORCE, COMPARED TO ONLY 20-25% OF THE OVERALL ENERGY INDUSTRY'S WORKFORCE

TIME OF **COLLECTION**

A reliable access to energy through RE would greatly decrease the amount of time women and girls spend providing energy for the household, which would increase the amount of time they spend on their education.

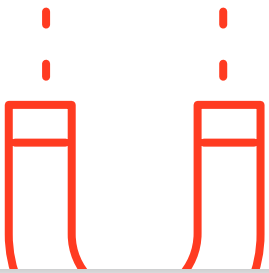
EXPOSURE TO **SMOKE**

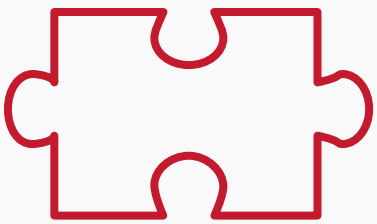
The adoption of clean cook stoves using clean and renewable fuel can prevent the majority of deaths and diseases attributable to indoor air pollution, which mainly affect women and children.



INCLUSIVE ENERGY

As the energy sector transitions from fossil-fuel dominated systems toward more efficient, sustainable renewable-based systems, new opportunities for a more inclusive energy job market are emerging.





AS A SECTOR THAT REQUIRES A VARIETY OF SKILLS ALONG THE ENTIRE VALUE CHAIN, **RENEWABLES CAN GIVE WOMEN A GREATER ROLE** TO PLAY COMPARED TO TRADITIONAL ENERGY SCENARIOS

5 GENDER EQUALITY

SDG 5
GENDER EQUALITY AND EMPOWER ALL WOMEN AND GIRLS

SUBSTITUTING TRADITIONAL BIOMASS FUELS WITH RE OPTIONS ALLOWS WOMEN TO SPEND LESS TIME COLLECTING WOOD. RE-BASED COOKING CAN ALSO REDUCE THE DANGEROUS LEVELS OF INDOOR AIR POLLUTION TO WHICH THEY ARE EXPOSED DAILY WHILE COOKING. FURTHERMORE, SEVERAL RE PROJECTS ARE OPPORTUNITIES FOR WOMEN TO ENGAGE AND BECOME THE DRIVERS OF CHANGE

Providing energy access through 100% RE is an opportunity to enhance substantive as well as procedural rights, particularly for women and girls and achieve gender equality.

First, women in the Global South, for example in sub-Saharan Africa, are often in charge of collecting fuels for cooking, mostly wood and cow dung. In rural areas, women often spend several hours a day collecting fuelwood loads of 20 kg or more. Also in cities, women living on an often very tight household income have to buy charcoal or kerosene and have to spend a considerable amount of energy and time on the demanding task of proving energy for the household. Collection time has a significant impact on the livelihoods, limiting the opportunity for women and children to improve their education and engage in income-generating activities. Many children, especially girls, are withdrawn from school to attend to domestic tasks related to biomass use among other things, having to neglect their education and thus restricting their economic opportunities[36]. Therefore, fuel collection reduces the time women have available for rest or contributing to other aspects of livelihood strategies. Furthermore, women are also in charge of other time and energy consuming activities, such a water collection and food processing[47 41].

Secondly, women are also responsible for cooking for their families and therefore they are the ones that are most exposed to the polluting smokes from traditional cook stoves or open fire which disproportionately affect women's health compared to men's. it has been shown that higher levels of lung and eye diseases are suffered by women compared to men[47]. These are attributed to the longer hours of exposure to smoke in kitchens. The adoption of clean cook stoves using clean and renewable fuel is expected to prevent the majority of deaths and diseases attributable to indoor air pollution, which mainly affect women and children[41]. Therefore, access to RE for lighting, cooking, and productive activities can actually help them to save time and can have a significant positive effect on women's education, well-being, literacy, nutrition, health, economic opportunities, and involvement in community affairs which can, in return, benefit all family members[47].

Thirdly, RE projects are often an opportunity to involve women and allow them to be the drivers of change. In fact, as the energy sector transitions from fossil-fuel dominated systems toward more efficient, sustainable renewable-based systems, new opportunities for a more inclusive energy job market are emerging. This may include an increasing role and participation of women[48]. For example, a pilot project in West Bengal has helped women to become solar entrepreneurs by providing them with training to manage and operate solar lantern charging stations. Women can

charge lanterns, for example, and then rent them out to customers such as fishermen needing light on their boats at night. The project began in response to surveys about the impact of solar photovoltaic systems (PV) in West Bengal that showed a huge demand for service facilities, but a gap in their provision because the technically skilled male youth often migrated to the cities. At the same time, the survey revealed that women were interested in understanding the technical aspects of PV systems. The project therefore trained women on technical aspects of PVs and troubleshooting; entrepreneurial issues such as need assessment, market research, and managing micro-enterprises; and institutional issues like networking, among others. Because of the training, women have reported feeling empowered to become skilled solar entrepreneurs who can contribute to household income and wellbeing. As a result of the project many of the women have engaged in self-driven initiatives involving further training and formation of self-help groups. This has brought them in contact with other potential women entrepreneurs and helped them to tap a wider range of resources, including government schemes for women entrepreneurship development[41].

Lastly, a recent IRENA research indicates that RE features more gender equality than the broader energy sector. In fact, among the 90 companies from more than 40 countries that participated in a survey, representing the entire value chain of the sector (including, manufacturing, installation, operations and maintenance, consulting and policy making), women represent an average 35% of the workforce. In the overall energy industry, women only account for 20-25% of the workforce, which might reflect more opportunities for and a greater interest in women in the sustainability field. As a new and fast-growing sector that requires a variety of skills along the entire value chain, renewables could give women opportunities to gain a greater role compared to traditional energy scenarios[49].

WOMEN PLAY A CRUCIAL ROLE IN THIS TRANSITION AND

WOMEN-LED INITIATIVES HAVE EVIDENCED THEIR KEY ROLE AS DRIVERS OF RE DEVELOPMENT WITHIN THEIR COMMUNITIES

In summary, the transition to a 100% RE can create a wide range of benefits and opportunities for women, recognizing and respecting their rights, including green job generation, opportunities for community and entrepreneurial participation, and increasingly better health conditions. Women play a crucial role in this transition and women-led initiatives and projects related to RE access have demonstrated success and evidenced the key role of women as drivers of this transition within their communities[41].

A PILOT PROJECT IN WEST BENGAL HAS HELPED WOMEN TO BECOME SOLAR ENTREPRENEURS

BY PROVIDING THEM WITH TRAINING TO MANAGE AND OPERATE SOLAR LANTERN CHARGING STATIONS. WOMEN CAN CHARGE LANTERNS, FOR EXAMPLE, AND THEN RENT THEM OUT TO CUSTOMERS SUCH AS FISHERMEN NEEDING LIGHT ON THEIR BOATS AT NIGHT

ENSURE ACCESS TO WATER AND SANITATION FOR ALL

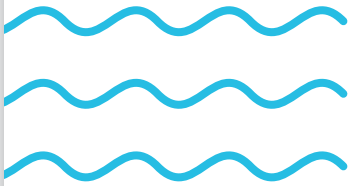
Renewable Energy can be vital in overcoming water related challenges. By shifting away from fossil fuels not only water quality and aquatic life can be improved, but RE can be used to pump water for irrigation and drinking purposes, even in the most remote and driest regions.

BUILDING A 100% RE INFRASTRUCTURE IS A MEAN AND A PREREQUISITE TO ENSURE ACCESS TO CLEAN WATER AND SANITATION FOR ALL

IN COUNTRIES WHERE WATER SCARCITY IS ALREADY AN ISSUE, THE REAL SOLUTION TO THEIR WATER AND ELECTRICITY CHALLENGES IS A SHIFT FROM COAL AND NUCLEAR ENERGY TOWARDS RENEWABLE ENERGY AND ENERGY EFFICIENCY

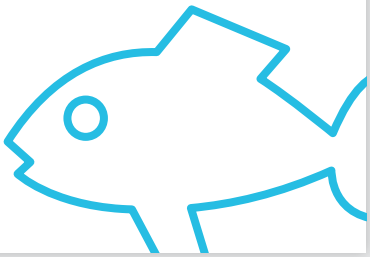
WATER PUMPING
WITH RENEWABLES

Renewable energy-based technologies can be an economic and resilient option to access, treat and pump water for multiple purposes from drinking to agricultural irrigation, even in the most remote and driest regions.



AQUATIC LIFE
AND WATER QUALITY

Coal mining can have detrimental impacts on aquatic life and the livelihoods of local populations. Locally produced Renewable energy can significantly improve the quality of water.



MINE TAILINGS
POLLUTANTS

Surface-mined coal produces large volumes of mine tailings containing pollutants that can leach into groundwater.

FROM A LIFE-CYCLE PERSPECTIVE POWER GENERATION AND PROCESSING THROUGH **RENEWABLE SOURCES ARE UP TO 200 TIMES LESS WATER-INTENSIVE** THAN FROM FOSSIL-FUELS

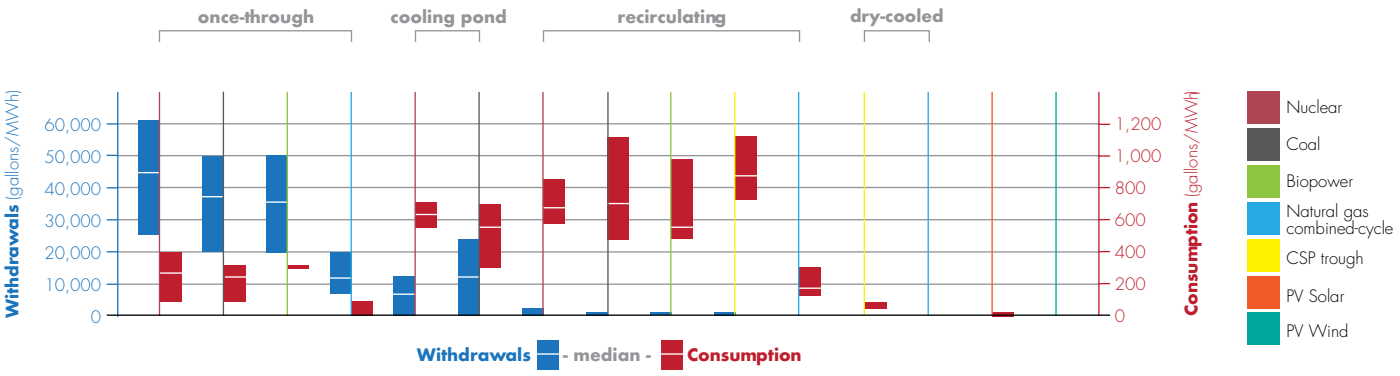
6 CLEAN WATER AND SANITATION

SDG 6
ENSURE ACCESS TO WATER AND SANITATION FOR ALL

Building a 100% RE infrastructure is a mean and in fact a prerequisite to ensure access to clean water and sanitation for all[31 50].

First, renewables are often much less water-intensive from a life-cycle perspective[51]. Currently energy supply accounts for nearly 15% of global freshwater withdrawals per year mostly because of water intensive processes for fuel extraction, processing and power generation, such as coal power generation[31]. For producing a MWh of electricity, RE technologies such as wind and solar require much less water than conventional thermoelectric generation where substantial quantities of water are needed for cooling. Solar PV or wind could withdraw up to 200 times less water than a coal power plant to produce the same amount of electricity[31]. Desalination is often seen as a solution for the water crises and from all available energy sources, solar energy is the one that correlates best with the demand for water. Geothermal and concentrating solar power (CSP) have higher water needs for operation as they also need cooling, yet recent advancement in dry cooling have shown that water use for CSP plants can be reduced significantly. Compared to other RE sources, bioenergy does necessitate substantial water inputs depending on feedstock production[31].

In many Global South countries water scarcity is already an issue[52]; therefore, a careful assessment on the impact on water resources is essential when addressing the sustainability of energy options. For example, in India, 79% of new energy capacity is expected to be built in areas that already face water scarcity or water stress. The problem is that water-intensive coal power production is planned to remain a key energy source to meet rapidly expanding power needs in spite of the evident water scarcity issues. For example, the country plans to build a cluster of 71 coal plants in the Vidarbha region of Central Maharashtra, a highly water-stressed area where lack of water for irrigation has been documented in the last decade[31]. Another example is coal power in South Africa. Despite its continuous struggle with water scarcity, in 2012 coal-fired electricity generation contributed to over 90% of South Africa's electricity. The main coal electricity producer of the country called Eskom in one-second uses the same amount of water as a single person would use within one year (based on access to the minimum 25 litres of water per day[53]. Yet a Greenpeace report clearly demonstrates how "the real solution to South Africa's water and electricity crisis is not incremental improvements in coal technology, it is an Energy [R]evolution: a shift away from coal and nuclear energy, and towards renewable energy and energy efficiency"[53]. As renewable energy technology may also



WATER USE (WITHDRAWALS AND CONSUMPTION) IN ELECTRICITY GENERATION BY FUEL AND COOLING TECHNOLOGY[137]

require water at some stage along the supply chain, they have to be used in highly efficient ways. The selection of RE technology must be water sensitive.

Secondly, renewable energy-based technologies can be an economic and resilient option to access, treat and pump water for multiple purposes from drinking to agricultural irrigation, even in the most remote and driest regions[31]. For example, in Africa's Sahel region, the lack of energy means that many of the region's 68 million inhabitants have to find ways to transport water from as far as 10 kilometres every day. Although the region receives limited annual rainfall, the water table is at distance from the surface that allow water pumping (about 100 metres). However, for the pumping they need energy, which is often unavailable in many remote areas far from the grid. After a programme was launched to deploy solar-based water pumping solutions, it is estimated that today nearly 3 million people in the region benefit from the use of these pumps[31].

Further examples include powering desalination plants in dry regions with RE technologies such as in the Middle East and North Africa (MENA) region and the installation of solar PV over canals and reservoirs to minimise allocation of new land resources and to reducing evaporative losses of water. For example, in India, a 1 MW solar plant was developed over a 750 metre stretch of a canal system, producing 1.53 GWh of electricity annually and saving 9 million litres of water from evaporation every day. Covering 10% of the 19 000 kilometre canal network with solar panels could potentially conserve 4 400 hectares and save about 20 billion litres of water every year[31].

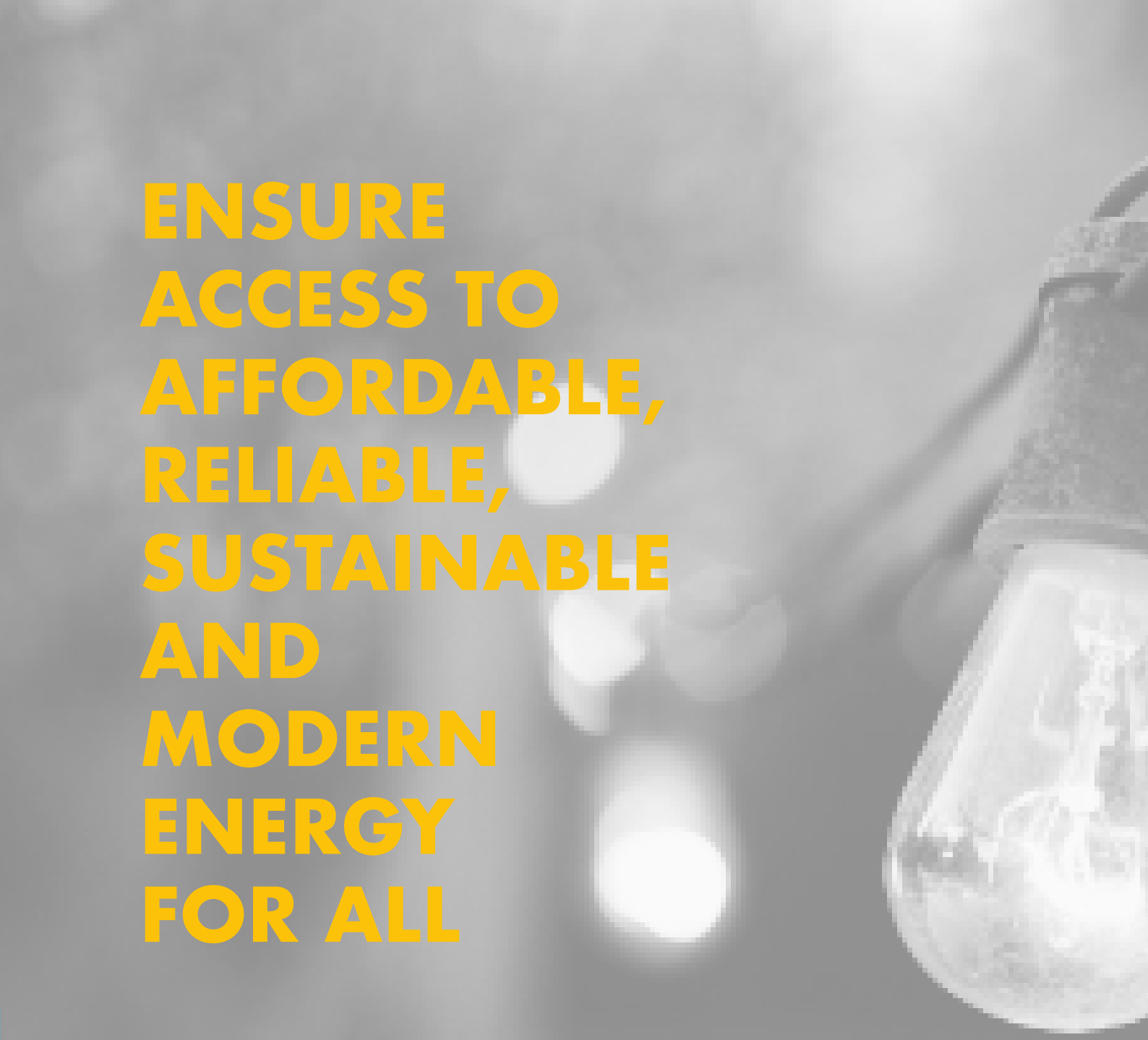
Lastly, the extraction and transportation of fossil fuels pose risks to the quality of water resources and the health of aquatic ecosystems[54]. For instance surface-mined coal produces large volumes of mine tailings containing pollutants that can leach into groundwater. An example can be found in Borneo, where water acidity has increased substantially due to intensive coal mining, with detrimental impacts on aquatic life and the livelihoods of local populations. Similarly, in South Africa the Olifants River catchment area has experienced more than 100 years of coal mining[53]. The river is showing signs of serious water pollution, soil erosion and reduced agricultural production. Very similar effects are recorded in the Vaal River catchment also in South Africa due to coal mining[53]. Similar water contamination issues are common also during oil and natural gas drilling, when seepage and major spills of retention ponds pose threats of polluting water with heavy metals and high-salinity water[55, 56].

IMPACT OF CLIMATE CHANGE

CLIMATE CHANGE, WHICH IS MOSTLY DRIVEN BY FOSSIL FUEL EMISSIONS, WILL ENORMOUSLY IMPACT FRESH WATER RESOURCES[58]. A TRANSITION TO 100% RE IS THE ONLY VIABLE SOLUTION TO MITIGATE GLOBAL WARMING AND ITS IMPACT ON WATER RESOURCES. IN PARTICULAR, CLIMATE CHANGE WILL AFFECT FRESHWATER SECURITY IN THREE KEY WAYS:

- Global warming increases the amount of water that the atmosphere can hold, which in turn can lead to more and heavier rainfall when the air cools. Although more rainfall can add to fresh water resources, heavier rainfall leads to more rapid movement of water from the atmosphere back to the oceans, reducing our ability to store and use it.
- Higher temperatures leads to the melting of inland glaciers. This will increase water supply to rivers and lakes in the short to medium term. However, this will cease once these glaciers have melted.
- In the sub-tropics, climate change is likely to lead to reduced rainfall in what are already dry regions. The overall effect is an intensification of the water cycle that causes more extreme floods and droughts globally.

ENSURE ACCESS TO AFFORDABLE, RELIABLE, SUSTAINABLE AND MODERN ENERGY FOR ALL



7 AFFORDABLE AND CLEAN ENERGY

More than one billion people do not have access to these services but it is essential to overall human progress, social welfare, technological advancement and unlocks access to many human rights. Without reliable access to energy, societies would have never reached the standards of living that many people across the world enjoy today.

ACCESS TO 100% RENEWABLE ENERGY IS A PREREQUISITE FOR DEVELOPMENT AND A LIFE OF DIGNITY

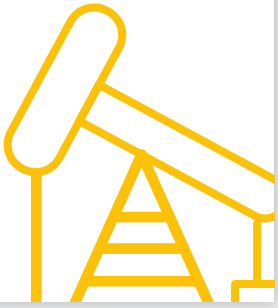
TO ENSURE THAT ENERGY CAN CONTINUE TO PLAY ITS FUNDAMENTAL ROLE IN DRIVING DEVELOPMENT AND IMPROVING LIVELIHOODS ACROSS THE WORLD, WE NEED TO SHIFT TO 100% RENEWABLE ENERGY

SUSTAINABLE IS **RENEWABLE**

Sustainable energy must be defined as renewable energy, which safeguards human rights, respects planetary boundaries, supports local communities, and ensures a just distribution of benefits.

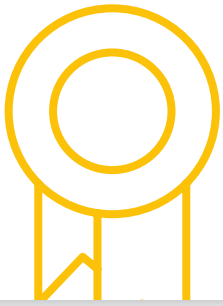
ONLY WAY **FORWARD**

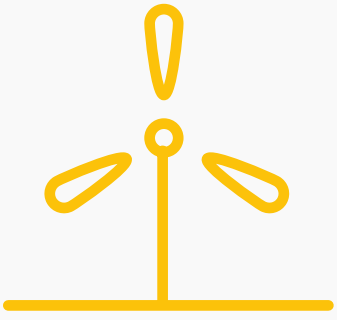
It is short-sighted and dangerous to ignore the threats of climate change, environmental degradation and concentration of political and economic power linked to fossil-fuel-dependent development.



DRIVERS OF CHANGE

Governments across the developing world are pioneering this paradigm shift and are leading the charge with strong committments and decisive action towards 100% renewable energy.





MORE THAN ONE BILLION PEOPLE DO NOT HAVE ACCESS TO ENERGY SERVICES. OVERCOMING THIS IS

ESSENTIAL TO OVERALL HUMAN PROGRESS, SOCIAL WELFARE, TECHNOLOGICAL ADVANCEMENT AND HUMAN RIGHTS

7 AFFORDABLE AND CLEAN ENERGY

SDG 7
ENSURE ACCESS TO AFFORDABLE, RELIABLE, SUSTAINABLE AND MODERN ENERGY FOR ALL

WITHOUT RELIABLE ACCESS TO ENERGY, SOCIETIES WOULD HAVE NEVER REACHED THE STANDARDS OF LIVING THAT MANY PEOPLE ACROSS THE WORLD ENJOY TODAY

Access to energy is a prerequisite of development and for a life of dignity. Energy services include lighting and electricity, cooking, heating and cooling, mechanical energy and mobility. More than one billion people do not have access to these services. However, as this report underlines, they are essential to overall human progress, social welfare, technological advancement and unlock access to many human rights. Without reliable access to energy, societies would have never reached the standards of living that many people across the world enjoy today. While it would be naïve to understate the vital role that fossil fuel energy played in improving livelihoods, it would be irresponsible, short-sighted and dangerous to ignore the threats of climate change, environmental degradation and concentration of political and economic power that this type of fossil-fuel-dependent development produced. To ensure that energy can continue to play its fundamental role in driving development and improving livelihoods across the world, a fundamental paradigm shift is needed. The link between energy and development now inevitably becomes the link between "renewable" energy and development. And sustainable energy must be defined as renewable energy, which safeguards human rights, respects planetary boundaries, supports local communities and marginalized groups, and ensures a just distribution of benefits today and in the future. In the light of this shift, understanding the relationship between a fully renewable-energy-based future and sustainable development becomes paramount. The targets of SDG Seven also recognize this. While international cooperation should be enhanced to facilitate access to renewable energy, infrastructure and technologies should be expanded and upgraded to supply modern and sustainable energy[59].

AFRICAN HEADS OF STATES LAUNCHED THE AFRICA RENEWABLE ENERGY INITIATIVE (AREI) TO **"ACCELERATE, SCALE-UP AND HARNESS THE CONTINENT'S HUGE POTENTIAL OF RENEWABLE ENERGY SOURCES"**

Governments across the developing world are in fact pioneering this paradigm shift. In Paris during COP21, African Heads of States launched the Africa Renewable Energy Initiative (AREI) to "accelerate, scale-up and harness the continent's huge potential of renewable energy sources" by "widening access to clean energy services, improving human well-being and putting African countries on a climate-friendly and sustainable development pathway"[6]. One year later, in November 2016 at COP22 in Marrakech,

further achievements were reached when 48 Climate Vulnerable Forum (CVF) countries declared that they "strive to meet 100% domestic renewable energy production as rapidly as possible while working to end energy poverty, protect water and food security, taking into consideration national circumstances"[7 8].

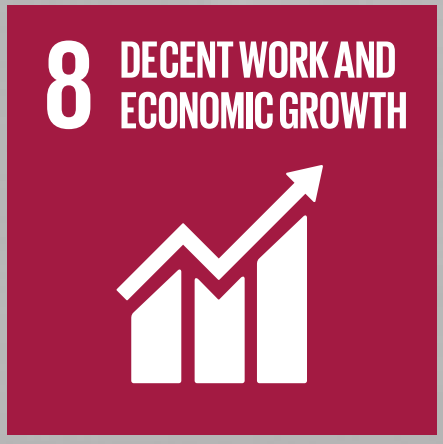
As also shown by this report, various expected benefits of a transition to 100% RE are presumed to be closely aligned with the drivers that motivates it[9]. A driver and ultimately a benefit may be the imperative of reducing the incidence of respiratory illness, which can be realized through reduced air pollution, and which is achieved in part by substituting fossil-fired power generation with renewable energy. There are different ways to categorise these drivers and benefits:[60 61 62 63]

- macro-economic effects, including macro-economic impulses such as investment and industry turnover; gross effects such as employment in the renewables industry; impact on current accounts from reduced fossil fuel imports; and net effects such as overall net change in GDP and employment from renewable energy technology deployment;
- system-related benefits such as avoided environmental damages;
- and distributional effects.

ENERGY CONTINUES TO PLAY ITS FUNDAMENTAL ROLE IN IMPROVING LIVELIHOODS ACROSS THE WORLD AND **THE LINK BETWEEN ENERGY AND DEVELOPMENT NOW INEVITABLY BECOMES THE LINK BETWEEN "RENEWABLE" ENERGY AND DEVELOPMENT**

48 CLIMATE VULNERABLE FORUM (CVF) COUNTRIES DECLARED THAT THEY **"STRIVE TO MEET 100% DOMESTIC RENEWABLE ENERGY PRODUCTION AS RAPIDLY AS POSSIBLE WHILE WORKING TO END ENERGY POVERTY, PROTECT WATER AND FOOD SECURITY**, TAKING INTO CONSIDERATION NATIONAL CIRCUMSTANCES"

PROMOTE INCLUSIVE AND SUSTAINABLE ECONOMIC GROWTH, EMPLOYMENT AND DECENT WORK FOR ALL



Several comprehensive studies and experiences demonstrate the huge employment potential related to RE development and reveal how the employment potential for each MW of installed capacity for renewable energy technology is consistently higher than for fossil fuels. For every job lost due to a phase out of fossil fuels, even more jobs emerge in the RE sector.

RE DEVELOPMENT HAS AN IMPRESSIVE EMPLOYMENT POTENTIAL THAT STEADILY INCREASES YEAR AFTER YEAR

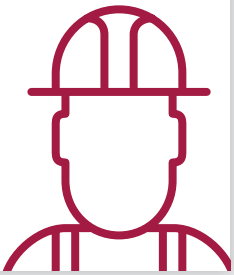
STUDIES ESTIMATED THAT DOUBLING THE SHARE OF RENEWABLES BY 2030 COULD INCREASE EMPLOYMENT IN THE SECTOR TO BEYOND 24 MILLION PEOPLE COMPARED TO A BUSINESS AS USUAL SCENARIO (13.5 MIO.)

A TRANSITION TO **MORE JOBS**

The employment potential for each MW of installed capacity for renewable energy technology is consistently higher than for fossil fuels. For every job lost due to a phase out of fossil fuels, more jobs emerge in the RE sector.

GOOD **LOCAL JOBS**

Each section of the RE value chain requires skills and workforce capabilities, which stimulates local business and employment. In India, solar PV creates more jobs per unit of energy produced than any other energy source.



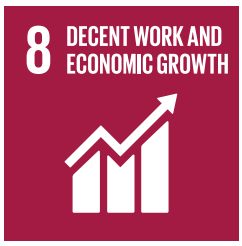
ENHANCING HUMAN **WELL-BEING**

RE also increases human well-being, taking into account environmental, social and economic dimensions. Doubling the share of renewables would increase this indicator by 3.7%.

UNLIKE TRADITIONAL CENTRALIZED FOSSIL FUEL DEVELOPMENT RE CREATES HUGE

OPPORTUNITIES FOR EMPLOYMENT IN REMOTE RURAL AREAS

REACHING IN AN INCLUSIVE MANNER THE MOST MARGINALIZED COMMUNITIES



SDG 8
PROMOTE INCLUSIVE AND SUSTAINABLE ECONOMIC GROWTH, EMPLOYMENT AND DECENT WORK FOR ALL

Several comprehensive studies and experiences demonstrate the huge employment potential related to RE development[64 49 65 66 67]. According to a recent IRENA study, the RE sector accounted for 8.1 million jobs worldwide in 2015 (without including large-scale hydropower, which alone accounted for 1.3 million jobs)[49]. Solar PV was the RE technology that created the largest number of jobs in 2015, followed by liquid biofuel and wind energy. The IRENA study also estimated that doubling the share of renewables by 2030 could increase employment in the sector to beyond 24 million people compared to a business as usual scenario which would see an increase in RE jobs to only 13.5 million by 2030[17]. In fact, several studies reveal how the employment potential for each MW of installed capacity for renewable energy technology is consistently higher than for fossil fuels. For example, average employment (jobs per megawatt of average capacity) over life of facility for solar PV ranges from about 7 to 11 jobs per MW of capacity, for biomass and wind up to 3 jobs per MW and for coal and gas only a maximum of 1 job per MW[68]. Hence, for every job lost due to a phase out of fossil fuels, even more jobs emerge in the RE sector.

Especially in Global South countries, which often have high level of unemployment especially among youth and considerable potential for economic growth, RE can be instrumental in providing opportunities for local job creation and economic development. For example, a report prepared by the Indian Council on Energy, Environment and Water (CEEW) showed how also in India solar photovoltaic (PV) creates more jobs per unit of energy produced than any other energy source[69]. Considering the huge issue of unemployment in a country with a growing population and labour force, renewable energy development is in fact a desirable solution. Furthermore, the study also found that smaller projects up to 5 MW in size provide the most employment opportunities per MW of installed capacity. This means that a decentralized, small-scale approach to RE development can actually be the most beneficial for India's labor market. In fact, employment in India is expected to increase substantially as it is scaling up its ambition for solar PV and wind deployment. Meeting its 2022 target of 100 GW of solar alone is expected to create 1.1 million jobs[65].

While it was estimated that doubling the share of renewables in the global energy mix by 2030 would increase global GDP by up to 1.1% or USD 1.3 trillion[65], RE development is not only about economic growth measured merely in terms of GDP growth. As explained comprehensively in a recent IRENA report, RE development increases "overall welfare" defined as a composite indicator of human well-being which takes into account environmental (GHG emissions and resource consumption), social (employment and health and education) and economic (consumption and investments) dimensions. Doubling the share of renewables would create an increase of this welfare indicator by 3.7% (compared to 1.1% GDP improvement)[65]. The effect of doubling the share of renewables on GDP growth is thus already remarkable. The effect on overall welfare, however, is even much stronger.

Additionally, RE development creates economic growth and opportunities to leverage local industries and create value that is localized and benefits local communities[66]. As described previously for SDG 1 and 2, the use of RE for productive uses (e.g. small-scale manufacturing, agro-food chain processes, refrigeration, and communication devices) is one of the best instruments to boost local business and create opportunities for employing and economic development even in the most marginalized and remote rural areas. It is important to note the ILO and human rights standards, specifically rights of indigenous people must be followed as in every other sector. Furthermore, RE allows creating value and jobs along all segment of the value chain, including project planning, procurement, manufacturing, transport, installation, grid connection, operation and maintenance, support services and decommissioning. All these different sections of the value chain require wide range of skills and workforce capabilities, which stimulate local business and employment[66]. This aspect of renewable energy is essential when considering the goal of creating decent jobs and inclusive growth that creates a diverse work force, giving opportunities to all to contribute along the different sections of the value chain.

The unique strength about RE development is that, unlike traditional fossil fuel development based on a centralized approach to development, it can create huge opportunities for employment also in remote rural areas, therefore leaving no one behind and reaching and benefiting in a decentralized and inclusive manner the most marginalized communities. A recent study by IRENA estimates that reaching the objective of universal access to modern energy services by 2030 could create 4.5 million jobs in the off-grid renewables-based electricity sector alone[64]. However, it is important to note that following the concept of a just transition that aims at protecting those whose jobs, income, and livelihoods are at risk as a consequence of the phase out of fossil fuel based energy production, must be adequately addressed. Social dialogue as an institutional process of discussion between trade unions, employers, and governments, as well as communities and all other relevant community groups can help to achieve this goal. Building an institutional setting where those affected by the transition can discuss, decide on, and be provided with resources to design responses to the challenges of the transition is a fundamental tool for achieving decent work, economic growth and finally strengthen democracies and social support for change.

Several examples demonstrate how developing off-grid solutions can create opportunities for employment and development. For example, stand-alone solar PV expansion in Bangladesh, India and Kenya proved very effective in creating local jobs. In 2015 only, Bangladesh, added an estimated 700,000 solar home systems (SHS), raising the total cumulative installations in the country to 4.5 million. The workforce in this sector has increased by 13% to reach 127,000 jobs, a quarter of which are in manufacturing, with the remaining spread across distribution, installation and after-sales services. Similarly, India created 73,000 jobs along the off-grid solar PV value chain, according to the last available estimates. In India, several companies that build, install and maintain stand-alone systems are rapidly growing and creating jobs. For example in Africa MKOPA has sold over 300,000 SHSs in Kenya, Uganda, and the United Republic of Tanzania and created more than 700 full-time jobs along with 1,500 sales representatives[49].

Another example is biogas, often used for cooking and heating applications in rural settings[49]. The SNV Biogas programme in Vietnam, for instance, has installed over 150,000 digesters since 2003, creating around 4 jobs per installation during the construction phase. Another examples, is an improved watermills programme in Nepal, which created an estimated 8,500 jobs in operation and maintenance alone, feeding electricity into mini-grids to supply almost 900 households while also providing motive power for agro-processing. In India, some 4.68 million family-size dung-based biogas plants were installed in 2013 giving jobs to 85,000 people, while in China 42.8 million household biogas plants systems were installed by the end of 2011 creating close to 90 000 direct and indirect jobs along the biogas value chain[49].

REACHING UNIVERSAL ACCESS TO MODERN ENERGY BY 2030 COULD CREATE

4.5 MILLION JOBS IN THE OFF-GRID RENEWABLES-BASED ELECTRICITY SECTOR

Finally, solar and onshore wind technologies offer opportunities for mixed, multipurpose land use. Increasingly, solar PV and onshore wind projects are being developed on land that supports other industries. In Japan, the concept of co-production of food and energy (known as “solar sharing”) was first developed in 2004. Special structures are being deployed involving rows of PV panels mounted above ground and arranged at certain intervals to allow enough sunlight for photosynthesis and space for agricultural machinery. Similarly, the areas around solar PV and onshore wind plants are being used for farming and grazing activities, allowing farmers to diversify their income sources[31].

BUILD RESILIENT INFRASTRUCTURE, PROMOTE SUSTAINABLE INDUSTRIALIZATION AND FOSTER INNOVATION

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

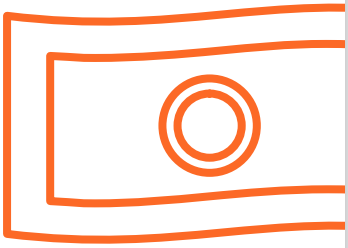
Industry is a major market for energy and industrial energy demand has a big impact on the energy sector. Countries in the Global South could pioneer low-carbon development, decoupling carbon emissions from industrialization.

PROMOTING INCLUSIVE AND SUSTAINABLE INDUSTRIALIZATION ENTAILS EXPANDING RENEWABLE ENERGY INFRASTRUCTURE

DEVELOPING AN INDUSTRY REQUIRES RELIABLE ELECTRICITY. RENEWABLE ENERGY CAN PROVIDE THAT THE CHEAPEST, FASTEST AND IN THE MOST EFFICIENT WAY

ATTRACTIVE **INVESTMENT**

RE attracts considerable amounts of investment especially in Global South countries which in return inevitably thrusts innovation, industry and infrastructure development.

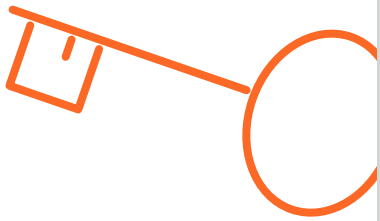


LEAPFROGGING IN THE **GLOBAL SOUTH**

In 2015, investments in renewables in Global South countries outweighed those in industrialized economies. China, India and Brazil committed a total of $156 billion, up 19% in 2014, while industrialized countries invested $130 billion, down 8%.

INNOVATIVE **BUSINESS MODELS**

Decentralised RE solutions can create value locally and boost local enterprises, which can progressively play an important role in extending access through the adoption of innovative business models.



A 100% RE FUTURE WILL REQUIRE DECENTRALISED DEVELOPMENT DRIVEN BY SMALL SCALE INVESTMENTS THAT **ALLOW COMMUNITIES TO CREATE THEIR OWN ENERGY, USE IT AND SHARE IT**.

SDG 9
BUILD RESILIENT INFRASTRUCTURE, PROMOTE SUSTAINABLE INDUSTRIALIZATION AND FOSTER INNOVATION

Many governments in developing and emerging economies prioritize industrialization, primarily to create employment. Industry is a major market for energy and developing an industry determines the demand for the energy sector. Tanzania for instance titles its national five year development plan "Nurturing Industrialization for Economic Transformation and Human Development"[69]. Such plans require reliable electricity. Renewable energy can provide that the cheapest, fastest and in the most efficient way. Hereby, countries in the Global South could pioneer low-carbon developments, decoupling carbon emissions from industrialization. Further, as already highlighted in SDG 8, the renewable energy industry provides major employment opportunities along the value chain. Promoting inclusive and sustainable industrialization therefore entails expanding renewable energy infrastructure.

In fact, RE already attracts considerable amounts of investment especially in Global South countries which in return inevitably thrusts innovation, industry and infrastructure development. In 2015, investments in renewables excluding large hydro in Global South countries outweighed that in industrialized economies[70]. The Global South including China, India and Brazil committed a total of $156 billion, up 19% in 2014, while industrialized countries invested $130 billion, down 8%. India saw its commitments rise 22% to $10.2 billion, while Brazil ($7.1 billion, down 10%), South Africa ($4.5 billion, up 329%), Mexico ($4 billion, up 105%) and Chile ($3.4 billion, up 151%) all joined it in the list of the top 10 investing countries in 2015[70]. Considering investments made in new renewable power and fuels relative to annual GDP, the top five countries included Mauritania, Honduras, Uruguay, Morocco and Jamaica[71].

The transition to a 100% RE future will require massive infrastructure transformations. The advantage of many Global South countries is that they are not locked-in fossil-fuel infrastructure and they can leapfrog industrialized countries by developing the infrastructure compatible with a long-term 100% RE vision[72]. This is particularly true for the so-called Least Developed Countries. Infrastructure that will need to be developed is very different from the prevalent type of infrastructure existing today mainly in industrialized and emerging economies, which is large-scale centralized, fossil fuel dominant type of infrastructure, driven by corporate investors. A 100% RE future will require infrastructural development based on decentralized, distributed and smart energy production systems driven by locally-based, small scale investments that allow communities to create their own energy, use it and share it locally. In places like Africa this often means off-grid, decentralized, bottom-up developments. This structural shift is fundamental to create sustainable and inclusive infrastructure for everyone, one that can benefit even the most marginalized communities

Secondly, the transition to a 100% RE future means innovation, especially regarding new, innovative business models that can drive the expansion of off-grid renewable energy market. Africa for example is already seeing the development of innovative business model to provide communities with access to renewable energy (see Box below). There is growing evidence that decentralised RE solutions can create value locally and boost local enterprises, which can progressively play an increasingly important role in extending access through the adoption of innovative business models. Furthermore, many of the technical and commercial skills required can be developed locally, thereby enhancing the sustainability of local economic activities and overall economic independence and resilience[64].

MANY GLOBAL SOUTH COUNTRIES ARE NOT LOCKED-IN FOSSIL-FUEL INFRASTRUCTURE AND THEY CAN **LEAPFROG INDUSTRIALIZED COUNTRIES WITH A LONG-TERM 100% RE VISION**

BUSINESS INNOVATION IN AFRICA FOR OFF-GRID DEVELOPMENT

IN AFRICA, SEVERAL NEW BUSINESSES ARE DRIVING INNOVATION BY PROVIDING ALTERNATIVE SOLUTIONS TO ALLOW COMMUNITIES TO ACCESS RENEWABLE ENERGY [73] [74]

SOLINC EAST AFRICA

Solinc is the East Africa's first solar-panel manufacturing plant. Established in 2011, Solinc makes solar panels from 20W to 300W. Beyond being the first one of its kind in the region, the company's innovative thinking resides in how it started to also assemble complete home solar kits that include batteries, phone chargers and LED lights. The plant's current manufacturing capacity is 140,000 solar panels per year, and it plans to double its capacity by 2018. The products are sold in Kenya, Uganda and Tanzania through a network of independent dealers. Solinc also supplies solar companies such as M-KOPA and Mobisol, which sell to customers using pay-as-you-go models.

UGESI GOLD

With a keen focus on poor or rural communities, the South African company introduces a unique solar battery charging station. Instead of households connecting to the grid, off-grid stations or SolarTurtles are used to charge battery packs, which are then carried home. Ugesi Gold gives an apt description on its website, using the analogy of a water well: "The SolarTurtle serves as the source of electricity (well), which the local community visits with batteries (buckets) for recharging"[73]. The company's energy distribution packs are designed to be owned and operated by women from off-grid communities. This way it also helps create entrepreneurs. In 2014, the SolarTurtle won the Climate Solver award from the WWF.

M-KOPA SOLAR

This pay-as-you-go solar energy company connects 550 new households across Kenya, Tanzania and Uganda to solar power each day, and up to autumn 2016 it has connected more than 375,000. The company provides M-KOPA's entry-level packages, which include home solar system featuring a battery, phone-charging facility, lightbulb, and a chargeable radio. In order to obtain the system, customers make a $34 deposit, and pay off the balance over a 12-month period in daily usage credits of about $0.50, paid to the company via mobile money, very much like a pay-as-you-go SIM card.

In 2015, M-KOPA began selling other products to encourage customers to continue their subscription once the solar-system is paid off. The products include a 16-inch solar-powered TV, bicycle, smartphone, water tank and a cooking stove. M-KOPA also offers loans to pay school fees. Households who have paid off their solar-system then essentially use that system as collateral to acquire these additional products, most of which contribute to sustainable energy usage.

AFRICAN RENEWABLE ENERGY DISTRIBUTOR

African Renewable Energy Distributor's (ARED) Mobile Solar Kiosk consists of off-grid kiosks offering a range of mobile phone services including charging, mobile money transfers, airtime sales and plans including Wi-Fi distribution. ARED is planning to have around 400 of these Mobile Solar Kiosks offering a license fee deal to partners that would like to expand on its franchise model, therefore maximising its outreach potential.

REDUCE INEQUALITY WITHIN AND AMONG COUNTRIES

The decentralized nature of RE can help remote communities access energy by establishing low cost off-grid renewable energy solutions such as mini-grids or stand-alone solutions that allow them to be independent from the centralized grid. This can play a major part in decreasing the inequality between urban and rural areas and inevitably lead to a much fairer and equitable distribution of resources across regions.

100% RENEWABLE ENERGY REDUCES INQUALITIES WITHIN AND AMONG COUNTRIES

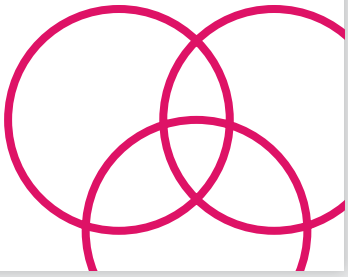
100% RE IS MODULAR AND FLEXIBLE. IT ALLOWS ALL COUNTRIES TO HARVEST ABUNDANT AND CLEAN RENEWABLE ENERGY, DISTRIBUTED WITHIN THEIR OWN BORDERS, CLOSE TO THEIR COMMUNITIES AND ACCESSIBLE BY EVERYONE

ENERGY **PROSUMERS**

With RE technologies anyone can become a *prosumer*, which enables citizens to become independent from other energy providers and provide access to energy at the necessary speed and scale as well as location

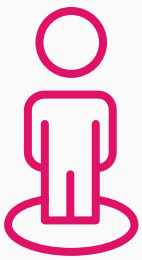
A FAIRER **DISTRIBUTION**

The decentralised nature of RE can play a major part in decreasing the inequality between urban and rural areas and inevitably lead to a much fairer and equitable distribution of resources across regions.



INTERGENERATIONAL **JUSTICE**

With 100% RE, current generations invest in the future providing cheap and sustainable energy for decades to come and it allows intergenerational justice by ensuring equal access to common resources.



THE TRANSFORMATION TOWARDS A 100% RE FUTURE MUST FOLLOW A UNIVERSALLY COHESIVE **PEOPLE-CENTERED, COMMUNITY-DRIVEN AND FUTURE-JUST APPROACH**

10 REDUCED INEQUALITIES

SDG 10
REDUCE INEQUALITY WITHIN AND AMONG COUNTRIES

IN ORDER TO OVERCOME INEQUALITIES, IT IS CRUCIAL TO MAKE TECHNOLOGIES AND HENCE THE CAPITAL TO ACCESS THE TECHNOLOGIES AVAILABLE FOR ALL.

THIS IS ONLY POSSIBLE WITH RE TECHNOLOGIES DUE TO THEIR MODULAR AND FLEXIBLE NATURE

The current fossil fuel based system leaves billions of people without any energy access and even more with very unreliable conditions. This causes severe inequalities within and among countries. In order to overcome this, it is crucial to make technologies and hence the capital to access the technologies available for all. This is only possible with RE technologies due to their modular and flexible nature. Fossil fuels are highly monopolized as it is cheaper per unit of output to exploit them at large scale than small scale. Transitioning to 100% RE is therefore the fastest and most effective way to provide universal equal access, which leaves no one behind.

It also holds opportunities to create competition, innovation and hence new business models that allow equal sharing of benefits. As RE technologies are decentralized, any individual or community can become a "prosumer", i.e. not only a consumer but also producer of energy. This can enable citizens to become independent from other energy providers and can provide access to the needed energy at the necessary speed and scale as well as location. In many countries, rural communities are left without reliable energy access as on-grid connectivity to the centralized distribution system is missing or too expensive. The decentralized nature of RE can help these remote communities access energy by establishing low cost off-grid renewable energy solutions such as mini-grids or stand-alone solutions that allow them to be independent from the centralized grid. This can play a major part in decreasing the inequality between urban and rural areas and inevitably lead to a much fairer and equitable distribution of resources across regions[75]. In fact, large fossil-fuel-based infrastructure projects often prioritize the demands of industrial consumers and urban centres over the basic needs of the poor[54]. As described by a report from the American NGO International Rivers, the large centralized investment approach to help Global South countries can "overwhelm the absorptive capacity of the governments and civil societies of poor countries" and "can entrench the power of vested interests, and encourage corruption rather than democratic control"[76].

As a contrast, the International Energy Agency has highlighted the importance of decentralized RE solutions and found that 70% of rural areas are best electrified "either with mini-grids (65% of this share) or with small, stand-alone off-grid solutions (the remaining 35%)." IEA estimated that globally $32billion per year would need to be invested from 2010-2030 to achieve universal access to electricity, and the majority of this amount, about two-thirds, would need to be invested in mini-grid and off-grid solutions.

Several examples demonstrate how decentralized, community-based renewable energy projects can help marginalized communities generate income and therefore help reduce inequalities and create the enabling conditions for fairer economic growth[76].

The district of Kasese in Uganda for instance with approximately 130,000 households is radically transforming. By 2020, Kasese will supply the energy needs of its population by only renewable sources. This ambitious target will be achieved by adopting a people-centered approach, with a wide variety of renewable sources such as biomass, solar, geothermal and mini-hydroelectric technologies. This will help the region overcome health issues strongly connected to the uncontrolled use of charcoal, firewood and kerosene, the main energy sources used for cooking and domestic electricity production. By implementing a decentralised RE system in the region, several clean energy businesses have been started since 2012, creating jobs for locals. They sell solar equipment, construct solar hubs, build biogas systems, improve cook stoves and deliver mini-hydro projects. The number of businesses in the local green economy has increased from five to 55 since 2012, and at least 1,650 people have been trained in the process[77].

Another example is the Solar Electric Light Fund (SELF), a non-profit organization that is working in more than 20 countries to install solar energy systems in rural and poor areas. One of their projects is an innovative drip-irrigation system in Benin that is powered by photovoltaics. Farmers are able to grow crops throughout the long dry season, greatly improving their food security, which has helped to improve their standard of living of these rural communities enormously[78]. The international organization Practical Action has also been helping to provide many forms of RE to poor residents of Asia and Africa. For example, they have helped villages in Sri Lanka install a wind turbine that provides electricity for the entire community. This has had benefits beyond simple access to power[78]. Villagers pooled their resources to install and manage the turbine, they received technical education and, as a result, a number of steady jobs were created. Installing a local turbine also means people no longer have to travel long distances and pay large amounts to recharge batteries that they regularly use. This is creating opportunities to fight inequality between rural and more urbanized regions, as well as gender inequalities.

Further, a transition to 100% RE is a matter of intra- and intergenerational justice. While the fossil fuel based energy system primarily benefitted some people living today, future generations have to bear the costs. 100% RE turns this around as current generations invest in the future providing cheap and sustainable energy for decades to come. It allows intergenerational justice by ensuring equal access to common resources which we have enjoyed and inherited from our ancestors. Meanwhile, impacts of climate change are already being acutely experienced by people around the world today. The effects of climate change are making it extremely difficult to ensure "development that meets the

BY 2020, KASESE, IN UGANDA, WILL SUPPLY THE ENERGY NEEDS OF ITS POPULATION BY ONLY RENEWABLE SOURCES BY ADOPTING A PEOPLE-CENTERED APPROACH, WITH A WIDE VARIETY OF RENEWABLE SOURCES SUCH AS BIOMASS, SOLAR, GEOTHERMAL AND MINI-HYDROELECTRIC TECHNOLOGIES

needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland 1987). The effects of climate change threaten people's subsistence rights such as right to food, water, shelter. It is not a coincidence that it is primarily the most climate vulnerable countries taking the leadership to transition to 100% RE[7]. The transformation must consequently equally follow a universally cohesive people-centered, community-driven and future-just approach. Rather than fuelling the same system with different resources, governments must follow the concept of leaving no one behind and provide sustainable access to energy services for all.

In addition to that, particular countries or specific corporations that control the monopolized fossil fuel resources take over oil and gas reserves or coal mines and concentrate the benefits in the hands of a few[76], often without accounting for the social and environmental damage on local communities[53 79]. As the political power is usually with those monopolists, externalities are not regulated, which leads to enormous inequalities between those that dominate well-confined fossil fuel reserves and those who depend on them[12 80]. Many communities end up depending on large, distant energy companies to access the power they need within a regulatory framework that only poorly protects consumer rights. On a global scale, entire regions and countries find themselves being at the mercy of oil and gas exporting countries, often in the hands of authoritarian regimes. All of this inevitably creates imbalances, geopolitical tensions and unfair relationships of dependence among countries. As explained later in this report, this also threatens security and peace in many countries which has also a huge effect on inequality, as the poorest people are often the most vulnerable and most affected by political instability and wars[12].

While 100% RE can break up these dependencies due to their modular and decentralised nature, there is also the danger of creating new dependencies. Renewable resources are available everywhere but the technologies and related capital to harvest them is not yet equally distributed. As currently observed in many Global South countries, skills, capital and technologies are imported from industrialized countries to build up the RE infrastructure. Therefore, robust regulation especially of financial markets, investments and political support for technology transfer, access to finance as well as education and capacity building is necessary to overcome inequalities with the transition to 100% RE.

100% RENEWABLE ENERGY

A MATTER OF INTRA- AND INTERGENERATIONAL JUSTICE

With 100% RE current generations invest in the future providing cheap and sustainable energy for decades to come

It allows intergenerational justice by ensuring equal access to common resources which we have enjoyed and inherited from our ancestors

100% RE requires a paradigm shift that builds an energy system that leaves no one behind

THE INEQUALITY OF CLIMATE CHANGE

There is strong link between inequality and climate change[81] [82]. The carbon-intensive, fossil fuel based western world is the number one contributor to global warming. Yet, they will be the one least affected by it. In fact, poorer nations remain the most vulnerable[55]. First, because they are not equipped with the economic and technological means to adapt and respond to climate change. Second, because they are often situated in areas most affected by climate change such as tropical or arid regions. This is creating an unfair situation were the perpetrators, the rich western countries, suffer the least, and the victims, who contributed the least to GHG emissions, have to bear the largest and most dangerous consequences of climate change such extreme weather events, stronger cyclones, larger and longer heatwaves, droughts, unpredictable storms, and unbearable temperatures increase.

All of these will affect food security, political stability and the overall socio-economic welfare of a large number of developing nations. Entire regions risk becoming inhabitable, generating unprecedented migrations, stripping people apart from their homeland in the search for a habitable place to live. This is what can unquestionably be called the inequality of climate change. Countries around the world, developed countries above all, have the moral duty to take immediate action and decarbonize their economies as soon as possible: a 100% RE future is the only viable and responsible option ahead.

MAKE CITIES INCLUSIVE, SAFE, RESILIENT AND SUSTAINABLE

95% of urban expansion in the next decades is forecast to take place in the developing world and, during the next two decades, the urban population of the world's two most impoverished regions (South Asia and Sub-Saharan Africa) is expected to double. CO2 will proportionally follow these growth rates and any meaningful action to decrease emissions will need to happen in cities.

CITIES ARE THE PIONEERS AND THE MOST PROMISING CHANGE AGENTS OF THE 100% RE MOVEMENT

SHIFTING TOWARDS A 100% RE FUTURE WILL IMPACT THE RELATIONSHIP BETWEEN CITIES AND THEIR SURROUNDING RURAL AREAS, ENABLING THE CREATION OF UNIQUE SYNERGIES THAT CAN BENEFIT BOTH

REDUCING **POLLUTION**

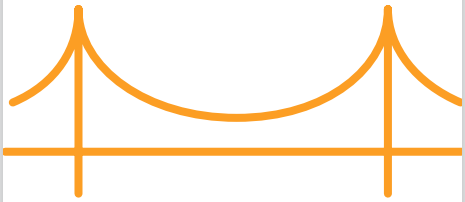
Renewable energy can significanty reduce pollution in cities. 98% of cities in low- and middle income countries with more than 100'000 inhabitants do not meet WHO air quality guidelines.

SUSTAINABLE **TRANSPORT**

A shift to 100% RE transport can have a hugely beneficial impact on cities. Traffic congestion, which affects Global South countries the most, has a wide ringe of negative effects on economic growth, productivity, health and well-being.

RURAL-URBAN **SYNERGIES**

Large cities have the know-how while rural areas count on large areas to produce RE. Cooperation between a city and its surrounding area helps both in terms of sustainable energy development and climate protection.



RENEWABLE ENERGY CAN
INCREASE THE RESILIENCE OF CITIES AND MAKE THEM LESS DEPENDENT FROM EXTERNAL RESOURCES

SDG 11
MAKE CITIES INCLUSIVE, SAFE, RESILIENT AND SUSTAINABLE

Cities and urban areas around the world account for about 65% of global energy demand and 70% of energy-related carbon dioxide (CO2) emissions[83]. Cities in emerging economies will account for 70% of global growth in energy use up to 2030[83]. According to UN Habitat, approximately 95 % of urban expansion in the next decades is forecasted to take place in the developing world. In the meantime, during the next two decades, the urban population of the world's two most impoverished regions (South Asia and Sub-Saharan Africa) is expected to double[84]. Any meaningful action to decrease CO2 emissions and mitigate climate change will therefore need to happen in cities.

RE options can actually offer a wide range of benefits to urban development, primarily pollution reduction. Cities are often the most affected by the polluting use of fossil fuels to run their industries, to heat and cool their homes and to fuel their cars, especially in Global South countries. According to a WHO estimate, 98% of cities in low- and middle income countries with more than 100'000 inhabitants do not meet WHO air quality guidelines. Most of the 3 million premature deaths worldwide every year caused by outdoor air pollution, made of high concentrations of small and fine particulate matter, occur in cities and urban areas[85].

Furthermore, cities in Global South countries are also the ones who are the most affected by traffic congestion. The increase in population coupled with rapid urbanization, increase in motorization, urban sprawling, poor public transport, lack of resources and of adequate urban planning have led to the creation of increasingly congested cities especially in the developing world[86]. Traffic congestion has a wide-range of negative effects both on local economic growth and productivity as well as on health, safety and well-being. As further summarized in the next page, a shift to 100% RE transport can have a hugely beneficial impact on cities.

Shifting towards a 100% RE future will impact the relationship between cities and their surrounding rural areas, enabling the creation of unique synergies that can benefit both. In fact, urban and rural areas face different challenges and opportunities during an energy transition and in addressing climate change issues. Yet, a closer look reveals that their challenges and opportunities are complementary in many ways, which leads to great potential in the relationship between cities and regions. Cooperation between a city and its surrounding area, for example, holds advantages for both sides in terms of sustainable energy development and climate protection. Large cities (characterized by dense infrastructure and high population numbers) would not be able to fully meet their energy demands—even if reduced—by producing their own renewable energy. The available surface area strictly within city limits (on roofs, for example) is too limited. Yet, cities are richly equipped with know-how, investment capital and pools of varied competencies (especially in the services sector), all of which are important in promoting energy efficiency, energy savings, climate-friendly mobility, and decentralized energy production. By comparison, rural areas may have at their disposal relatively large areas to produce RE. Sustainable development of this resource offers investment opportunities for cities and revenue opportunities for regions to generate and sell the surplus energy they produce. Apart from this, there are many other ways in which cities and surrounding areas could cooperate to achieve a sustainable transition to 100% RE such as city-hinterland mobility, climate change mitigation and adaptation efforts. Cooperation is not only favourable for city-hinterland partnerships, but also for villages that are too small to produce sufficient or balanced mix of RE.

Further, due to their decentralized character, renewable energy may reverse or at least slow down urbanisation processes, reducing the pressure on cities. Currently, especially in the Global South, people leave rural areas mainly because there is a lack of infrastructure for basic services and related to that, limited job opportunities. Due to the above mentioned dynamics, rural areas may benefit from a 100% RE system which may lead to less people migrating to cities.

Lastly, RE can also increase the resilience of cities and make them less dependent from external resources. A 100% RE future can help communities develop the autonomy they need and to create space for more leadership in cities. As stressed recently by the New Urban Agenda, cities often know best. While they are often given the responsibility to solve the problems closer to people, they often neither have the financial means nor the power to solve the issues they face. Taking a lead in terms of RE targets can be a catalyst of change and a leverage force to move cities forward in their struggle to gain greater control over their jurisdictions and to become the leaders of change[87].

THE BENEFITS OF A 100% RE TRANSPORT IN CITIES

THERE ARE SEVERAL POSITIVE BENEFITS RELATED TO RENEWABLE-ENERGY-BASED TRANSPORT

First of all, its direct impact on health: by substituting combustion engine vehicles with electric vehicles, cities can reduce enormously their levels of air pollution and exposure to dangerous exhaustion smokes. The positive impact on health goes beyond air pollution. Renewable urban transport is also about prioritizing active mobility[88] such as cycling and walking, which has considerable benefits to health and overall physical and mental well-being. Lastly, it is also about noise pollution. According to the World Health Organization[89], noise is second only to air pollution in the impact it has on health. It has a significant negative impact in terms of hearing loss and disorders, heart disease, learning problems in children and sleep disturbance. A major uptake of electric vehicles, combined with more cycling, more walking, more public transport and less motor vehicles per capita (e.g. via adoption of car sharing systems), can reduce noise pollution enormously.

Beyond the direct positive effects on health and well-being, supporting and stimulating sustainable mobility and renewable transport solutions is also about innovation, technological development and business development. It means promoting innovation in industry and policy for the commercialization of electric and hydrogen vehicles. It also means incentivizing new business models. Currently car companies focus their efforts on selling cars. In the future, it will be less about ownership and more about the service of mobility. This means that future business models of car companies will need to be built on selling quality mobility and not cars. With the advent of self-driving cars and expanded car-sharing systems less people will be interested in owning a car. Rather they will want to buy a service, a way to move from point A to point B, not simply a car. Consequently, cars will cease to be seen as a status symbol but rather as a simple, safe and effective means of transport. Furthermore, with electric self-driving cars and electric car sharing systems, cities can be not only less polluted but also considerably less congested as car sharing and self-driving systems allow for a much more effective distribution of vehicles across the city and a much lower number of vehicles per capita[90].

Lastly, Global South countries have suffered a lot from urban sprawling[86]. This is a great problem in the Global South, damaging peri-urban areas and ecosystems, creating car-dependent patterns of mobility and an extremely inefficient and wasteful use of space. Strategies to improve transport and mobility towards a 100% RE future are also about creating denser and compact cities, which would help solve the issues related to sprawling.

ENSURE SUSTAINABLE CONSUMPTION AND PRODUCTION PATTERNS

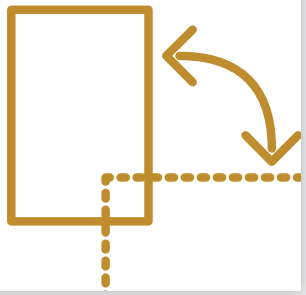
Continuing to rely on wood-based products (whether it is firewood, pellets, charcoal, or others) will become less and less sustainable. A rapid transition towards 100% RE is ever more urgent to create sustainable, long-term patterns of consumption and production.

100% RENEWABLE ENERGY ALLOWS SUSTAINABLE AND EFFICIENT NATURAL RESOURCE MANAGEMENT

LIMITING GLOBAL WARMING TO 1.5°C REQUIRES 85% OF FOSSIL FUEL RESERVES TO REMAIN IN THE GROUND. TRANSITIONING TO 100% RE IS THEREFORE INEVITABLE TO MEET THIS TARGET

TURNING WASTE **INTO RESOURCES**

In low-income countries 65% of the waste is organic. There is a lot of potential for these countries to create renewable energy from waste, which can be treated to produce biogas and be used as a source of energy.



DOMESTIC **BIOGAS SYSTEMS**

Domestic biogas production systems have demonstrated a wide range of positive impacts: they decrease GHG and pollutant emissions, they are cost-effective, and, when used for cooking, reduce firewood usage significantly.

ENHANCING **FOOD SECURITY**

With additional logistical and operational efforts to support domestic biogas systems, the daily feeding rate in some countries could gradually be increased from 2 to 5 kg, to produce 150 minutes of cooking time.

WITH HIGH RATES OF POPULATION GROWTH,
WOOD-BASED PRODUCTS WILL BECOME LESS AND LESS SUSTAINABLE
REGARDLESS OF HOW EFFICIENTLY IT IS HARVESTED, PRODUCED, OR CONSUMED

SDG 12
ENSURE SUSTAINABLE CONSUMPTION AND PRODUCTION PATTERNS

In order to limit global warming to 1.5°C and ensure sustainable development that leaves no one behind, natural resources must be managed and used much more efficiently and in fact conserved. At current levels of CO2 emissions, the world would use up the carbon budget for a good chance – a 66% probability – of keeping global temperature rise below 1.5°C before 2021[91]. The known fossil fuel reserves significantly exceed these budgets. Limiting global warming to 2°C requires 68% and to 1.5°C 85% of reserves must remain in the ground[92]. Transitioning to 100% RE is therefore inevitable. Further, it supports the goal to reduce waste, especially food waste as it becomes a resource, whose value can always be recovered. In low-income countries most of the waste is organic (about 65%)[93]. This means that there is a lot of potential for countries in the Global South to actually create renewable energy from this organic component of waste, and often at low cost. This organic waste can be treated to produce biogas through anaerobic digestion which can be used as a source of energy. domestic biogas production systems are widely available and have demonstrated a wide range of positive impacts, such as less GHG and pollutant emissions which benefits the health especially of women and children most exposed to indoor smokes from cooking[94]. They also offer a cost-effective solution, especially for rural areas which have large quantities for organic waste that would otherwise be left unused. women and children also have more time available as they would not have to spend time collecting firewood and charcoal for cooking. plus, the digestate, i.e. the solid component remaining from the process, can be used as a fertilizer for agricultural purposes[95].

Several examples exist. Nepal has installed approximately 250,000 domestic biogas plants installed between 1993 and 2013. A national program in Kenya has targeted the installation of 8,000 domestic plants in a period of 4.5 years, and a similar programme in Tanzania has targeted the construction of 12,000 new domestic biogas plants for the 2008-2013 period (200/month)[94]. Another example is a project run by the International Fund for Agricultural Development that has been changing farmer's lives in rural china. Farmers in Fada, a village in China's Guangxi province, each built their own plants to channel waste from household toilets and nearby shelters for animals into a sealed tank. As the waste ferments, gas is captured and used in cooking. Forests are being protected because demand for firewood has been reduced, saving 56,000 tons of firewood per year. Over five years, area farmers increased tea production from 400 to 2,500 kilograms a day and average income in the village quadrupled to more than $1 per day[78]. The city of Dar es Salaam serves as another example[95] where kitchen waste amounts to about 42% of the household waste and is a potentially valuable source for the production of biogas. In only two years, from 2006 to 2008, 31 Compact Biogas Systems (CBS) have been installed in Tanzania and Uganda, which produce gas from food waste. Assuming that in Tanzania a household produces 1 kg of food leftovers and 1 kg of fruit and vegetable peelings per day, this 2 kg of kitchen waste should be able to generate roughly 170 L of biogas per day, equivalent to a 45-minutes burning period. This burning period represents about a third of the average cooking time of 2.5 h per day for a household with five members. This solution was also extremely cost effective. In fact, although the price of 850000 TZS (420 US$) for each household biogas system is the main barrier to wide distribution of this technology in Tanzania, the payback period is low; estimated to be roughly three years based on an average household saving of around 336 kg charcoal per year-equivalent to 276000 TZS (136 US$). With additional logistical and operational efforts, the daily feeding rate could gradually be increased from 2 to 5 kg, to produce 0.67 m3/d of gas or 150 minutes of cooking time. Consequently, all cooking fuel could be replaced by biogas and the payback period would drop to only one year.

Lastly, the largest source of energy in the Global South is currently biomass, such as fuelwood, charcoal, agricultural waste and animal dung. In some countries, up to 90% of the household energy consumption comes from biomass[36]. Yet, much of the biomass for use in cook stoves (whether efficient or not) is not sustainably harvested. Moreover, it is often not "renewable" due to unsustainable rates of deforestation, soil loss, and desertification. Most critically, continued reliance on wood-based fuels as the primary cooking fuel is unsustainable in the medium to long-term simply due to demographics: the population of Sub-Saharan Africa (SSA) alone is projected to almost triple by 2060, reaching as high as 2.7 billion, up from 1 billion in 2015. At such a high rate of population growth, continuing to rely primarily on wood-based products (whether firewood, pellets, charcoal, or others) will become less and less sustainable, regardless of how efficiently the biomass is harvested, produced, or consumed[39]. Therefore a rapid transition towards 100% RE, also in the cooking sector, is ever more urgent to create sustainable, long-term patterns of consumption and production.

RECYCLING AND RESOURCE MANAGEMENT FOR A 100% RE FUTURE

WHILE THE SOURCES OF RE ARE BY DEFINITION INEXHAUSTIBLE SUCH AS THE SUNLIGHT AND THE WIND, THE MATERIALS THAT ARE NEEDED TO MANUFACTURE SOLAR PANELS AND WIND TURBINES ARE NOT

Therefore, a careful management of the material resources needed to manufacture these RE technologies become extremely important, especially for a 100% RE future, which will require a considerable increase in material consumption for the production of solar panels, wind turbines, batteries and all related technologies and equipment. A circular economy approach to the production and distribution of RE technologies will be fundamental to ensure their long-term viability. A study by the WWF published in 2014[96] examined carefully the most critical supply bottlenecks of non-energy raw materials related to the transition to a 100% RE future. Some critical supply restrictions were identified for material such as lithium and cobalt, used abundantly for batteries. Other materials such as indium, gallium and tellurium used in solar PV or copper used for transition grids and electric motors were also found to be relatively critical and, although alternatives exist, these should be carefully managed to avoid future shortages. Rare earth metals, including neodymium and yttrium, which are needed for wind turbines, are expected to exceed the demand. Yet their availability is considered critical for geopolitical reasons, as they are mostly concentrated in certain geographical areas such as for example in China.

Most importantly, this report concludes that overall resource scarcity in a 100% RE future will be substantially smaller than in a scenario with much lower RE penetration. However, policy action that prioritizes recycling of RE technologies and improvements in material efficiencies are extremely important and necessary in light of the increase in precious materials needed for RE technology manufacturing. Furthermore, improvements in the recycling of RE technologies will be fundamental and will need to be complemented by the exploration of alternative, less supply-restrictive materials.

TAKE URGENT ACTION TO COMBAT CLIMATE CHANGE AND ITS IMPACTS

The global energy system accounts for approximately three-fifths of all anthropogenic GHG emissions and the electricity sector accounts for over 40% of man-made (combustion related) CO2 emissions. It is evident that if any meaningful reduction in GHG emissions is to be achieved, a major restructuring of the carbon intensive energy sector is necessary.

A TRANSITION TO 100% RE TO MITIGATE THE MOST DEVASTATING EFFECTS OF CLIMATE CHANGE IS EVER MORE URGENT

IMPLEMENTING THE PARIS AGREEMENT REQUIRES A RAPID SHIFT TO 100% RENEWABLE ENERGY IN ALL COUNTRIES

EMISSIONS MUST FALL **STARTING NOW**

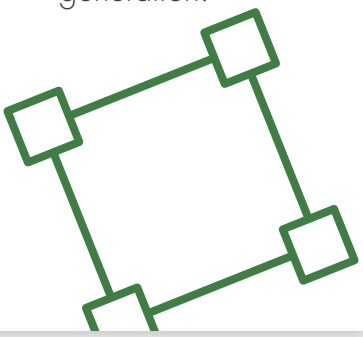
To keep global warming below 2 degrees Celsius, emissions need to reach net zero by 2070 and they must fall steeply, starting immediately. This can be done only through a complete shift from fossil fuels to RE sources.

EMISSIONS FROM THE **ENERGY SYSTEM**

CO2 emissions from fossil fuel use are the main contributor to total GHG emissions and, the global energy system accounts for approximately three-fifths of all anthropogenic GHG emissions.

BUILDING RESILIENCE BY **DIVERSIFICATION**

100% RE increases resilience in the face of climate change, by decreasing the dependence from remote energy resources or increasing energy diversity through a distributed and decentralized generation.



A MAJOR RESTRUCTURING OF THE CARBON INTENSIVE ENERGY SECTOR IS NEEDED AND **RE OFFERS AN IMMEDIATE SOLUTION TO REDUCE GHG EMISSIONS CONSIDERABLY**

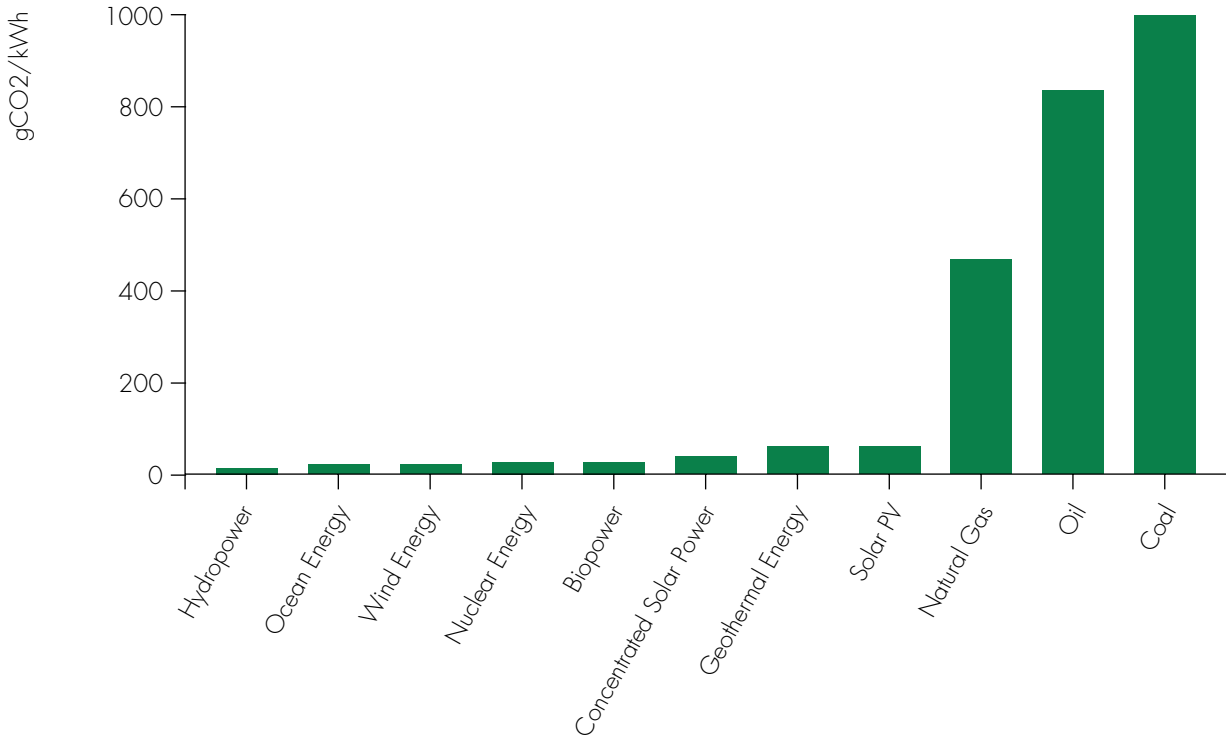
13 CLIMATE ACTION

SDG 13
TAKE URGENT ACTION TO COMBAT CLIMATE CHANGE AND ITS IMPACTS

A transition to 100% RE to mitigate the most devastating effects of climate change is ever more urgent, especially as Global South countries will be the ones to be hit the hardest. As reported by the Guardian: "Low-income countries will remain on the frontline of human-induced climate change over the next century, experiencing gradual sea-level rises, stronger cyclones, warmer days and nights, more unpredictable rains, and larger and longer heatwaves"[55].

GHG emissions from industrialized countries are the major cause of climate change. Major emitters thus have the responsibility to take action mitigating climate change. Meanwhile, Global South countries can transition to a 100% RE future contributing to mitigate climate change, avoiding the mistakes committed in the past by industrialized countries and realizing development co-benefits.

According to recent reports, for staying below 2°C, emissions need to reach net zero by around 2070, and for 1.5°C they must do so by 2050. In both cases emissions must fall steeply, starting immediately[92]. This can be done only through a complete shift to RE sources and a stop of fossil fuel investments. Research from WWF points to a minimum of 42% RE by 2030[97] and the 2015 Energy [R] evolution scenario from Greenpeace suggests 100% RE by 2050 to stay below the 1.5° C target[98]. In fact, CO2 emissions from fossil fuel use are the main contributor to total GHG emissions and the energy sector is the main contributor to global GHG emissions. The global energy system accounts for approximately three-fifths of all anthropogenic GHG emissions and the electricity sector accounts for over 40% of man-made (combustion related) CO2 emissions[17]. It is evident that if any meaningful reduction in GHG emissions



MEDIAN GHG EMISSION IN G CO2/KWH FOR ELECTRICITY GENERATION TECHNOLOGIES[35]

A 36% RE SHARE CAN REDUCE CO2 EMISSIONS BY UP TO 12GT WORLDWIDE, REDUCING GHG EMISSIONS CONSIDERABLY COMPARED TO BUSINESS-AS USUAL SCENARIOS.

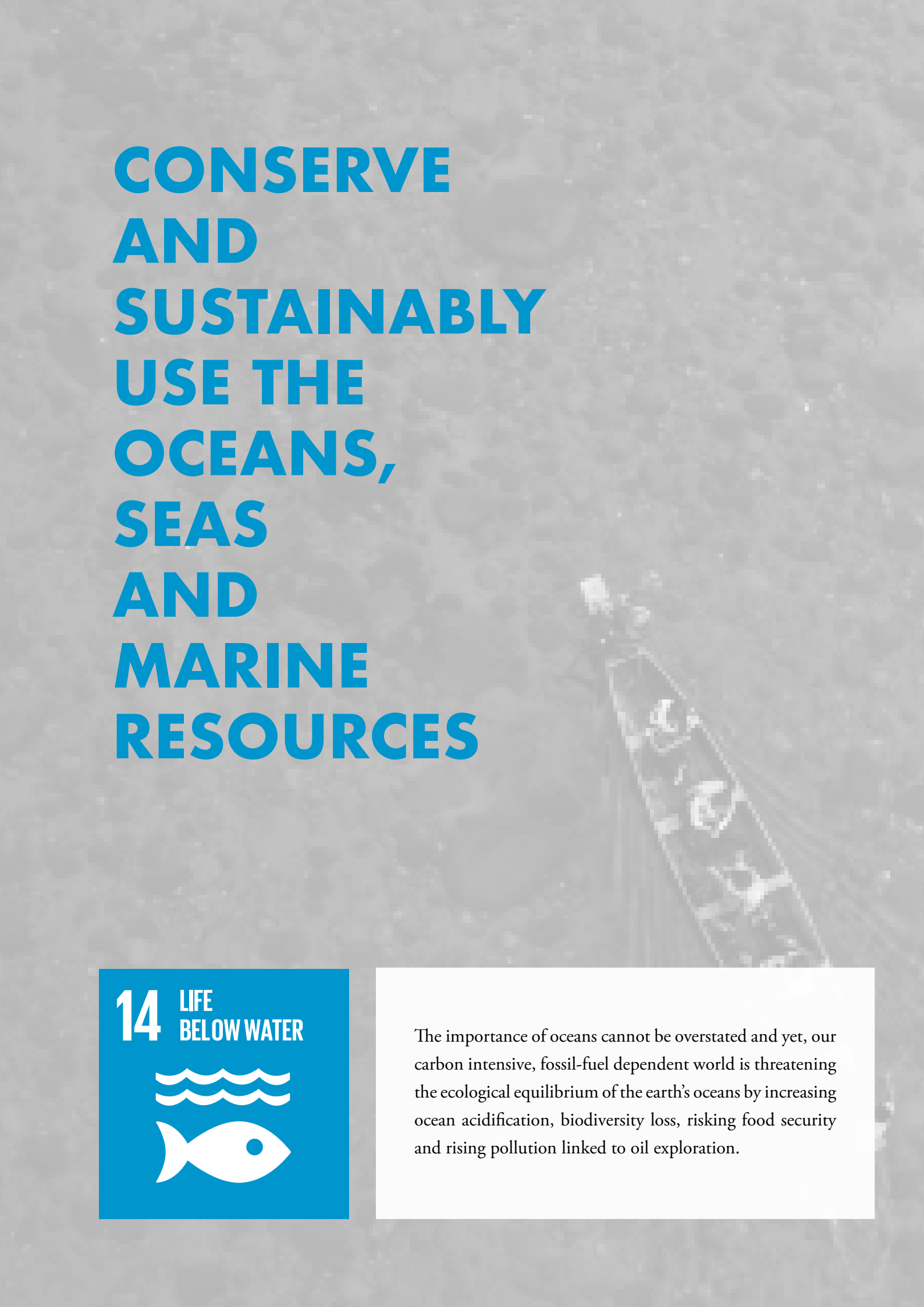
is to be achieved, a major restructuring of the carbon intensive energy sector is necessary. RE offers an immediate solution to reduce GHG emissions considerably. A recent IRENA study that a 36% RE share can reduce CO2 emission by up to 12Gt worldwide compared to business-as usual scenarios. This would already represent more than half of the required reduction to limit global warming to below 2° C.

Life cycle assessment (LCA) studies provide a well-established framework to compare different energy technologies in terms of their environmental impacts throughout the supply chain, from manufacturing through to operation and decommissioning. A useful outcome of LCA studies is a comparison of lifecycle GHG emissions in terms of kg CO2e/kWh for different electricity generation technologies. A very comprehensive report published by the World Nuclear Association (WNA, 2011) compared life cycle GHG emissions for different electricity generation sources based on 21 highly reliable studies. The life cycle analyses accounted for emissions from all phases, i.e. from construction to decommissioning. The results are summarized in Figure 7. It can be observed how RE technologies, in particular hydro and wind are significantly better performing than fossil fuel options.

A 100% RE future also increases local resilience in the face of the growing risks related to climate change. First, by enabling communities to use local RE sources and decrease the risks related to being strongly dependent from remote resources and those related to extreme weather events interrupting power supply. Second, deployment of RE increases the diversity of the energy sources. Through a distributed and decentralized generation, RE contributes to the flexibility of the system and its resistance to central shocks, which are expected to become more frequent with climate change such as unexpected storms, floods and droughts. The larger variety of energy sources used (e.g. wind, solar, geothermal, hydro), the distribution of sources over a considerably larger geographical area, the higher number of supply corridors, and a largest share of energy coming from domestic RE are indeed all major advantages for future energy security and resilience, especially considering the variable of climate change. In general, risks appear to increase if a supply chain is reliant on a limited number of companies, technologies and markets, while resilience increases if the number of companies, networks and connections is greater since this creates alternative options[99]. As such, RE has an important benefit in terms of energy resilience and autonomy, particularly in the face of increasing risks related to climate change.

THROUGH DISTRIBUTED AND DECENTRALIZED GENERATION **RE INCREASES RESISTANCE TO CENTRAL SHOCKS, WHICH ARE EXPECTED TO BECOME MORE FREQUENT WITH CLIMATE CHANGE**

CONSERVE AND SUSTAINABLY USE THE OCEANS, SEAS AND MARINE RESOURCES



14 LIFE BELOW WATER

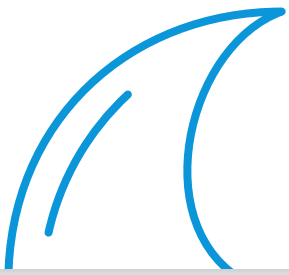
The importance of oceans cannot be overstated and yet, our carbon intensive, fossil-fuel dependent world is threatening the ecological equilibrium of the earth's oceans by increasing ocean acidification, biodiversity loss, risking food security and rising pollution linked to oil exploration.

100% RENEWABLE ENERGY IS INEVITABLE FOR CONSERVING AND SUSTAINABLY USING OCEANS, SEAS AND MARINE RESOURCES

ENERGY PRODUCTION CAN DIRECTLY AND INDIRECTLY IMPACT THE SEAS AND OCEANS ON WHICH MUCH OF LIFE DEPENDS

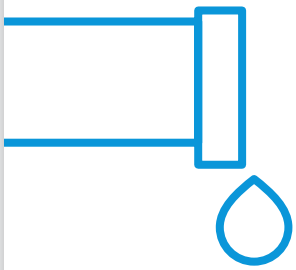
OCEAN **ACIDIFICATION**

100% RE has a considerable beneficial effect on limiting ocean acidification and therefore in preserving marine ecosystems.



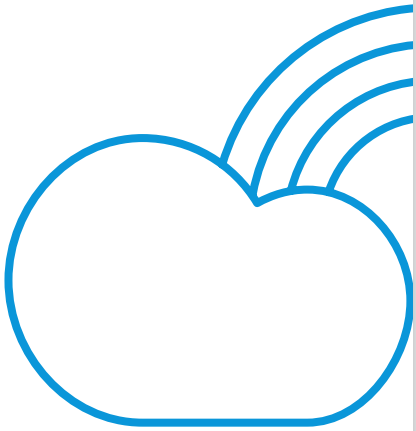
EXPLORATORY **OIL POLLUTION**

100% RE helps reducing oil pollution. Currently, oil exploration contaminates streams and rivers, destroys forests and leads to biodiversity loss.



A MUCH NEEDED **TRANSITION**

100% Renewable Energy protects communities whose employment and livelihoods depend on marine resources.



TRANSITIONING TO 100% RE
IS FUNDAMENTAL TO
CONSERVE AND USE OCEANS, SEAS AND MARINE RESOURCES SUSTAINABLY

14 LIFE BELOW WATER

SDG 14
CONSERVE AND SUSTAINABLY USE THE OCEANS, SEAS AND MARINE RESOURCES

OCEAN ACIDIFICATION LIMITS THE CAPACITY OF THE OCEAN TO ABSORB CO2 FROM HUMAN EMISSIONS, THEREFORE **AGGRAVATING EVEN MORE THE ISSUE OF GLOBAL WARMING**

The way energy is produced can directly and indirectly impact the seas and oceans on which much of life depends. In fact, the importance of oceans cannot be overstated: they cover over 70% of the planet, represent over 99% of the earth's living space and provide food security for billions. They also produce half the world's oxygen and are the major regulator of the earth's climate through their absorption and release of heat energy, absorbing some 87% of the extra energy that greenhouse gases create in the atmosphere and 30% of the anthropogenic co2 emissions[100]. Yet, a carbon-intensive, fossil-fuel dependent world is threatening the ecological equilibrium of the earth's oceans primarily in the following ways:

First, a major source of concern is ocean acidification, i.e. the ongoing decrease in the pH of the oceans, caused by the uptake of carbon dioxide (CO2) from the atmosphere rising as a result of human activities, such as burning of fossil fuels. A report published in 2013 by the International Geosphere-Biosphere Programme[101] examined the impacts of ocean acidification such as disruption of ecosystems and marine biodiversity, including tropical coral reef loss, which will affect biodiversity, tourism, food security and shoreline protection especially for many of the world's most vulnerable countries. The unprecedented rate of acidification has deleterious consequences on shellfish, molluscs, warm water corals and fisheries. These can affect food security (especially as large part of the world's population depends on fishing) and lead to revenue declines, loss of employment and livelihoods, and indirect economic costs. Furthermore, ocean acidification limits the capacity of the ocean to absorb CO2 from human emissions therefore aggravating even more the issue of global warming. The report also acknowledges that reducing CO2 emissions is the only way to minimise long-term, large-scale risks. Again, a transition to 100% RE, with RE having a much lower CO2 emission per energy output, could therefore have a considerable beneficial effect on limiting ocean acidification and therefore in preserving marine ecosystems.

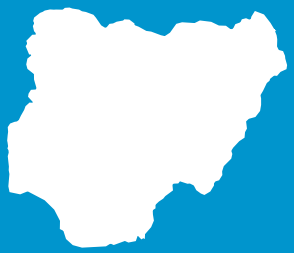
Second, both onshore and offshore oil exploration has had a series of extremely negative impacts on marine ecosystems throughout the past decades[102]. An example from Africa is the oil explorations in the Niger Delta, the biggest oil-producing region in Africa[103] [104]. It has had disastrous impacts on the environment in the region and has adversely affected people inhabiting that region. The Niger Delta is in fact an incredibly well-endowed ecosystem which contains one of the highest concentrations of biodiversity on the planet. It consists of diverse ecosystems of mangrove swamps, fresh water swamps, rain forest and is the largest wetland in Africa and among the ten most important wetland and marine ecosystems in the world. Yet, due to oil pollution, the area is now characterized by contaminated streams and rivers, forest destruction and biodiversity loss, which all contributed to make the area an ecological wasteland. This has affected and still affects

the livelihood of the indigenous people who depend on the ecosystem services for survival and has led to increased poverty and displacement of these people. The Niger Delta region is today one of the five most severely petroleum damaged ecosystems in the world. Studies have shown that the quantity of oil spilled over 50 years is up to 13 million barrels, which is about three times more than the record Deep Water Horizon spill (4.1-4.9 million barrels)[56]. Immense tracts of the mangrove forests, which are especially susceptible to oil have been destroyed. An estimated 5 to 10% of Nigerian mangrove ecosystems have been wiped out either by settlement or oil. The rainforest, which previously occupied some 7,400 km² of land, has disappeared as well. Spills in populated areas often spread out widely, destroying crops and aquacultures through contamination of the groundwater and soil. The consumption of dissolved oxygen by bacteria feeding on the spilled hydrocarbons also contributes to the death of fish. In agricultural communities, often a year's supply of food can be destroyed instantaneously. People in the affected areas complain about health issues including breathing problems and skin lesions; many have lost basic human rights such as health, access to food, clean water, and an ability to work[105].

This shows that transitioning to 100% RE is inevitable to conserve and use oceans, seas and marine resources sustainably. Renewable technologies significantly reduce and even avoid negative impacts on this ecosystem. However, it is necessary for any 100% RE strategy to assess its potential impacts on oceans, seas and marine resources. This is particularly the case when offshore wind or CSP technologies are included.

OIL SPILLS IN POPULATED AREAS OFTEN SPREAD OUT WIDELY, DESTROYING CROPS AND AQUACULTURES THROUGH CONTAMINATION OF THE GROUNDWATER AND SOILS.

IN AGRICULTURAL COMMUNITIES, OFTEN A YEAR'S SUPPLY OF FOOD CAN BE DESTROYED INSTANTANEOUSLY



THE **NIGER DELTA REGION** IS ONE OF THE MOST PETROLEUM DAMAGED ECOSYSTEMS IN THE WORLD. THE QUANTITY OF OIL SPILLED OVER 50 YEARS IS UP TO 13 MILLION BARRELS, (THREE TIMES MORE THAN THE RECORD DEEP WATER HORIZON SPILL)

SUSTAINABLY MANAGE FORESTS, COMBAT DESERTIFICATION, HALT AND REVERSE LAND DEGRADATION, HALT BIODIVERSITY LOSS

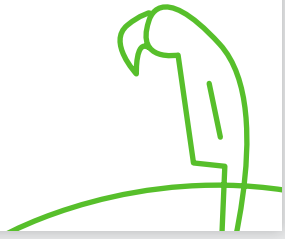
A major and rapid uptake of RE is the only sustainable solution to limit the increasing effects of climate change on the ecosystems and biodiversity, whose delicate equilibrium is greatly disrupted even by the smallest changes in average temperature. Climate change is predicted to be the greatest long-term threat to biodiversity.

100% RENEWABLE ENERGY ARE ESSENTIAL TO MANAGE FORESTS SUSTAINABLY, COMBAT DESERTIFICATION AND HALT AND RESERVE LAND DEGRADATION AND BIODIVERSITY LOSS

AS CLIMATE CHANGE IS THE GREATEST LONG-TERM THREAT TO LIFE ON LAND, THE TRANSITION TO 100% RE IS A PREREQUISITE TO PROTECT IT

MITIGATING **CLIMATE CHANGE**

100% RE is essential reduce global warming. Climate change can shift between 5 to 20% of the Earth's terrestrial ecosystems, in particular cool conifer forests, tundra, scrubland, savannahs, and boreal forest.

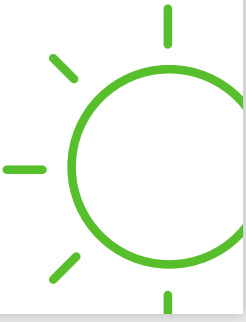


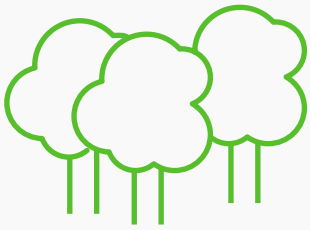
MITIGATE **DESERTIFICATION**

100% RE helps mitigating climate change induced desertification, which has huge impacts on biodiversity.

ENHANCE SUSTAINABLE **COOKING**

Renewable based solutions for cooking are already available and can provide a better option for communities to alleviate the stress that the use of wood, crop residues and untreated coal puts on their ecosystems.





IT HAS BEEN PROVEN THAT
RENEWABLE ENERGY TECHNOLOGIES HELP CONSERVING BOTH WATER AND LAND ECOSYSTEMS

SDG 15
SUSTAINABLY MANAGE FORESTS, COMBAT DESERTIFICATION, HALT AND REVERSE LAND DEGRADATION, HALT BIODIVERSITY LOSS

First of all, a major and rapid uptake of RE is the only sustainable solution to limit the increasing effects of climate change on the ecosystems and biodiversity, whose delicate equilibrium is greatly disrupted even by the smallest changes in average temperature. In fact, climate change is predicted to be the greatest long-term threat to biodiversity. Increased global temperatures and changes in rainfall patterns will result in more frequent and severe floods and droughts especially in countries, geographically situated in areas that are more vulnerable such as tropical or arid areas[106].

A recent study[107] reports that, among many other effects, climate can induce changes in vegetation communities that are predicted to be large enough to affect biome integrity (a biome is a distinct biological community that has formed in response to a shared physical climate). A shift of 5 to 20% of Earth's terrestrial ecosystems is estimated, in particular cool conifer forests, tundra, scrubland, savannahs, and boreal forest. According to this study, large portions of Amazonian rainforest could be replaced by tropical savannahs. Further, at higher altitudes and latitudes, alpine and boreal forests are expected to expand northwards and shift their tree lines upwards at the expense of low stature tundra and alpine communities. Increased temperature and decreased rainfall mean that some lakes, especially in Africa, might dry out. As explained previously, oceans are predicted to warm and become more acidic, resulting in widespread degradation of tropical coral reefs.

Climate change induced desertification will also have huge impacts on biodiversity, which will inevitably affect precious ecosystem services and therefore societies across the globe. Communities in the Global South will be the most affected also considering that populations in drylands often live under the worst economic conditions. Soil degradation in drylands exacerbates the problem even more and leads to a decline in the fertility of land, reduces crop production and can trigger a cycle of environmental degradation, impoverishment, migration and conflicts, often also putting the political stability of affected countries and regions at risk[108].

Beyond climate change and its related impacts, how communities produce and consume energy has other considerable effects on land biodiversity and ecosystems. For example, in Global South countries, especially in rural areas, 2.5 billion people rely on biomass, such as fuelwood, charcoal, agricultural waste and animal dung, to meet their energy needs for cooking. In many countries, these resources account for over 90% of household energy consumption[39]. This increased dependence on the use of wood, crop residues and untreated coal in Global South countries has a lot of negative implications also on the environment. For example, the reliance on biomass fuels results in reduced agricultural productivity by depriving the soil of recycled nutrients that would have been available from tree, crop and animal residues and could be a cause of deforestation and desertification in some areas[109]. Further, Sub-Saharan Africa continues to have the highest average per-capita wood consumption in the world, with an estimated 0.69m3/year. Estimates for highly forested countries like the Democratic Republic of the Congo (DRC) are closer to 1 m3/year. This compares to a global estimated average of 0.27m3/ year. According to surveys undertaken in Tanzania, which is currently believed to be the largest charcoal producer in sub-Saharan Africa, it is estimated that on current trends and in the absence of direct government intervention, virtually all of Tanzania's publicly-owned forests will be depleted by 2028. The sheer rate of cooking related wood consumption, when combined with anticipated population growth, makes the concerns over deforestation real, and increasingly urgent[39]. Reliance on wood and charcoal for cooking has a number of well-recorded negative effects, including deforestation, soil erosion, loss of many critical ecosystem services, loss of biodiversity, loss of food sources from indigenous plants and animals, etc. Compound to these various impacts is the fact that most areas deforested for either firewood or charcoal production are rarely replanted, resulting in further negative impacts while undermining the local ecosystems' capacity to recover[39].

Yet, several solutions based on more sustainable renewable energy options for cooking exist and could provide a much better option for communities and their ecosystems.

For example, bio-digesters in Nepal can reduce firewood consumption by 57%. On average individual households that have switched to biogas have reduced about 3 tonnes of fuelwood per year, avoiding 4.5 tonnes of CO2 emissions per year[17]. A recent WFC reports provides more details on the topic of renewable-based cooking and its benefits[39].

Furthermore, fossil fuel extraction has vast effects on biodiversity and ecosystems. Unless the transformation towards a 100% RE future gains further momentum, by 2035, oil demand is projected to increase by over 30%, natural gas by 53%, and coal by 50%. This will have increasingly negative impact on biodiversity and on ecosystems around the world. While it is often assumed that restoration after extraction (including drilling and all forms of mining) can return an area close to its predisturbance state, ecosystem disturbance and degradation resulting from direct or indirect effects of extraction can have "profound and enduring impacts on systems at wider spatial scales"[54]. Among the direct effects are local habitat destruction and fragmentation, visual and noise disturbance, pollution. Indirect effects can extend several kilometres from the extraction source and include human expansion into previously wild areas, introduction of invasive species and pathogens, soil erosion, water pollution, and illegal hunting. Gas and oil transportation can also be environmentally damaging, particularly in countries with weak governance, and can lead to deforestation, water contamination, and soil erosion. Spills in marine environments can have severe environmental impacts over wide areas. Deforestation driven by road construction is also a major source of impact on land, ecosystems and wildlife, especially considering that in the future, fossil fuels will be increasingly extracted from more remote and previously undisturbed areas. Unconventional sources, such as coal seam gas and tar sands, threaten currently undeveloped regions that are extremely biodiverse. Furthermore, the corporations of the fossil fuel extraction industry are economically and politically powerful, while many countries in areas of high biodiversity risk under fossil fuel exploration are characterized by weak governance and poor implementation of environmental regulations[54]. The Niger Delta example mentioned previously exemplifies this point.

In summary, RE options have a considerably less damaging impact both on water and land ecosystems. To demonstrate this scientifically and comprehensibly, a recent study[110] developed an Eco-indicator which calculates life cycle impact based on 11 categories that incorporate carcinogens (C), respiratory organics (RO), respiratory inorganics (RI), climate change (CC), radiation (R), ozone layer depletion (OL), ecotoxicity (E), acidification/eutrophication (A/E), land use (LU), minerals (M) and fossil fuels (FF). The overall eco-impact comparison is shown in Figure 8 where every technology is arranged with highest value indicating that much times of the lowest values. As an example, an oil power plant contributes almost 154 times the eco-impact of the hydrokinetic plant to generate every 1 kWh of electricity.

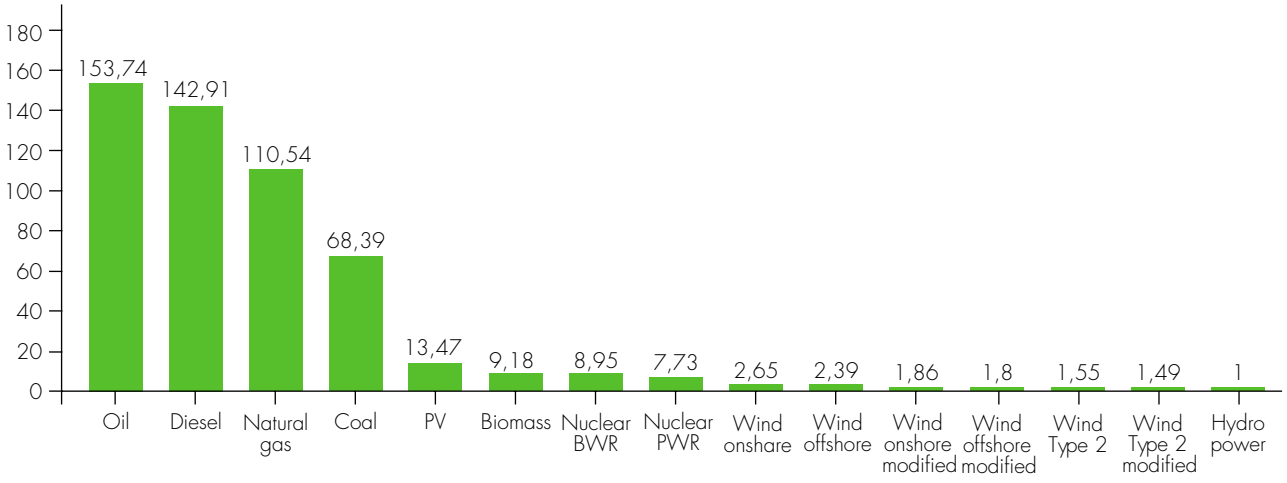


FIGURE 8: TOTAL ECO-IMPACT VALUES DERIVED FROM LIFE CYCLE IMPACT ASSESSMENT OF MAJOR POWER GENERATION TECHNOLOGIES[110]

PROMOTE JUST, PEACEFUL AND INCLUSIVE SOCIETIES

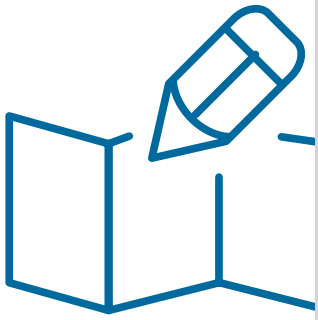
The close link between justice, peace, sustainable development and energy can be proven and oil is, in many cases, the main trigger-factor for conflicts: when oil revenues are not legally overseen, corruption is incentivized, oil is in many cases the main financing vehicle of warfare and the high dependence on rents generated by fossil fuels leads to a stagnation of socioeconomic development.

100% RENEWABLE ENERGY PROMOTES JUST, PEACEFUL AND INCLUSIVE SOCIETIES

BY REDUCING OUR DEPENDENCY ON FOSSIL FUELS AND INSTEAD DECENTRALIZING THE ENERGY SYSTEM, A TRANSITION TOWARDS 100% RE CAN IMPROVE ENERGY AUTONOMY OF COUNTRIES, REDUCE CURRENT CONFLICTS AND PREVENT THE EMERGENCE OF NEW ONES

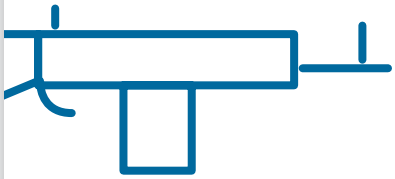
SUPPORTING ENERGY **INDEPENDENCIES**

100% RE Renewable Energy change the static concept of energy exporter vs. energy importer and transition countries. Countries can be producers of their own energy demand.



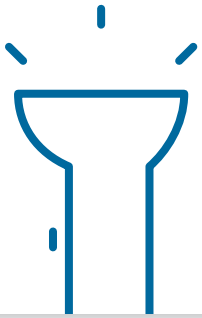
REDUCING **DOMESTIC CONFLICTS**

100% Renewable energy promote local development, self-determination and identity, while ensuring communities' control over local environmental impact mitigation and management.



BUILDING ENERGY **DEMOCRACIES**

The flexible and modular nature of RE allows going beyond national security of energy supply and rather bringing energy resources and infrastructure under public or community ownership or control.



ENERGY SYSTEMS SHOULD SERVE THE NEEDS OF THE WORLD'S PEOPLE,

AN ENERGY TRANSITION TO 100% RE WILL BE ADVANCED BY A SHIFT TO PUBLIC AND COMMUNITY CONTROL

SDG 16
PROMOTE JUST, PEACEFUL AND INCLUSIVE SOCIETIES

IN THE FUTURE MORE CONFLICTS MAY ARISE, ESPECIALLY BECAUSE THE GLOBAL CONVENTIONAL OIL PRODUCTION PEAKED IN 2006 AND SINCE THEN PRODUCTION HAS BEEN IN DECLINE

There is actually a close link between justice, peace, sustainable development and energy. While there are certainly diverse causes for the existence of conflicts, many of them are connected with access to oil and gas fields[111]. In fact, oil is often considered the main trigger-factor for conflicts following three mechanisms[111]. First, when oil revenues are not legally overseen, corruption is incentivized, which weakens political institutions and subtracts effectiveness to public bureaucracy. Second, oil is in many cases the main financing vehicle of warfare. Third, the high dependence on rents generated by fossil fuels leads to a stagnation of socioeconomic development due to highly volatile market prices of fossil fuels.

Furthermore, tensions and conflicts over the possession and exploitation of oil and gas resources have considerably influenced international geopolitical dynamics. For powerful countries such as the US, China, the EU and Russia, the high dependence on oil constantly frames their foreign policies, which has dramatic consequences for the international community. The necessity of covering the energy requirements of their large populations and military forces has exceeded their domestic exploitation capability, forcing them to look abroad. In some cases, this justified acts of intervention or even war declarations to countries with vast oil and gas reserves: the war in Iraq is one example[112]. In other cases, this meant the establishment of commercial relations with countries, whose governments turned over time into authoritarian regimes and with concentration of vast amounts of fossil fuels; that is the case in Venezuela[113] and some Asian and Arabic countries[114], which were benefited by the necessities of international powers. On the other side, this dependency led states to engage in conflicts with their own population. For example, indigenous peoples from Central American states, including Colombia and Bolivia in the South, experienced tensions with their governments[115]. Many of the planet´s remaining natural resources are on indigenous lands, which thereby become targets for global corporations seeking to exploit these natural resources[116]. Conflicts emerged due to either a lack of intention to consult the indigenous peoples over the extraction activities in their lands or because the extractive activities have a considerable environmental impact on their livelihoods[116 114].

The concern is that in the future more conflicts may arise, especially because the global conventional oil production peaked in 2006 and since then production has been in decline[114]. The risk of new armed-conflicts over this valuable natural resource is likely to grow within the next years[114], especially in specific areas such as the Gulf Region where oil is highly concentrated. Additionally, there is a growing threat parallel to the related-oil- issues, which is the new reliance on nuclear energy, and possibly on nuclear weapons. As an example, Iran is turning its attention to nuclear power to cover its population´s energy requirements, which are originally covered by crude oil and natural gas[114]. This shift allows Iran to remain a major crude oil exporter, and gives the government an element of security – and of power- before the international community.

In light of this situation, there is one truth: the most impoverished people, often from the rich-in-natural-resources yet poorest countries, will be mostly affected by new conflicts and the environmental impact derived from the dependency on oil and nuclear power[117]. Moreover, the systematic violation of liberties and constitutional guarantees typical of authoritarian governments is ironically fuelled or sustained by the oil revenues. The inhabitants of countries affected by external war action have to face broken institutions and weakened democracies and remain often abandoned by their own state and increasingly dependent on humanitarian action[118].

While the path to peace and justice relies upon different measures, peace and security can be improved considerably across the world simply by decreasing the over-reliance of countries on oil and gas[111]. Unlike fossil fuels, which are characterized by the uneven geographical distribution of natural reserves, RE is abundant across regions and countries. By reducing the over dependence on fossil fuels reserves and instead decentralizing the energy structure, a transition towards 100% RE can improve the energy autonomy of countries and reduce current conflicts and prevent the emergence of new ones. In order to ensure this for the long-term however, any 100% RE strategy must build on the principle of efficiency and recycling regarding the necessary resources used in the RE technology.

Lastly, a transition to 100% RE can also support better institutions and governance structures through what is known as energy democracy[9]. Energy democracy goes beyond national security of energy supply to bringing energy resources and infrastructure under public or community ownership or control. The term is grounded on the basic understanding that "the decisions that shape our lives should be established jointly and without regard to the principle of profit"[9]. A growing number of experts and communities believe that de-carbonization of the energy economy is critical not only for mitigating climate change but also for achieving a more just, sustainable and resilient economy. In addition, some experts note that an equitable, ecologically sound energy system should serve the needs of the world's peoples, and that an energy transition will be advanced by a shift to public and community control. The distributed nature of RE – which theoretically are public goods accessible to all – helps to facilitate this process[9].

CONFLICT DRIVES
ON FOSSIL FUELS

Oil is often considered the main trigger-factor for conflicts

Oil is in many cases the main financing vehicle of warfare

Dependence on rents from fossil fuels leads to a stagnation of socioeconomic development

REVITALIZE THE GLOBAL PARTNERSHIP FOR SUSTAINABLE DEVELOPMENT

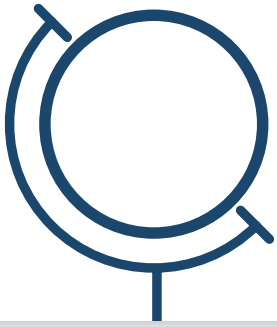
RE development requires strong cross-sectoral, transregional and transnational partnerships as well as a continuous exchange of solutions, best practises and lessons learnt. Therefore, strengthening renewable energy partnerships goes hand in hand with improving the partnerships necessary for the implementation of the SDGs.

100% RE DEVELOPMENT REQUIRES STRONG CROSS-SECTORAL, TRANSREGIONAL AND TRANSNATIONAL PARTNERSHIPS

STRENGTHENING RENEWABLE ENERGY PARTNERSHIPS GOES HAND IN HAND WITH IMPROVING THE PARTNERSHIPS NECESSARY FOR THE IMPLEMENTATION OF THE SDGS AND IT DEPENDS ON COLLABORATIONS BETWEEN LOCAL ACTORS AND OTHER REGIONAL, NATIONAL AND INTERNATIONAL STAKEHOLDERS AND GOVERNMENTS

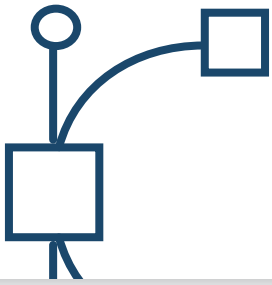
CONNECTING GLOBAL **FRAMEWORKS**

RE development and all related initiatives and projects can serve as a connector between the climate targets such as the ones of the Paris Agreement and all the SDGs.



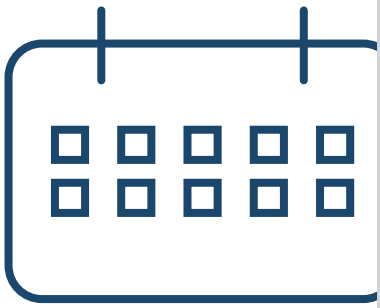
IMPLEMENTING **POINTS OF CONTACT**

Finance, information and communication technology, capacity building, data, monitoring and accountability are essential to both the formation of partnership for the goals and RE development targets.



TRACKING AND **MONITORING**

Several RE projects need specific monitoring strategies to ensure energy targets are met on time, which can also benefit the establishment of tracking processes for SDGs monitoring.



THE CAPACITY BUILDING OPPORTUNITIES NEEDED TO BRING RE TARGETS FORWARD

CAN BE BENEFICIAL FOR SDGS IMPLEMENTATION AND VICE VERSA

17 PARTNERSHIPS FOR THE GOALS

SDG 17
REVITALIZE THE GLOBAL PARTNERSHIP FOR SUSTAINABLE DEVELOPMENT

THE POINTS OF INTERSECTION BETWEEN RE DEVELOPMENT AND THE IMPLEMENTATION OF SDGS CAN BE USED PARTICULARLY TO

SPUR THE WIDE-RANGE OF COMMITMENTS NEEDED FOR THE EFFECTIVE IMPLEMENTATION OF THE SDGS

RE development requires strong cross-sectoral, transregional and transnational partnerships as well as a continuous exchange of solutions, best practises and lessons learnt[119]. In fact, the effective and rapid implementation of a 100% RE target depends on a strong collaboration between local actors and other regional, national and international stakeholders and governments[119 15]. Therefore, strengthening renewable energy partnerships goes hand in hand with improving the partnerships necessary for the implementation of the SDGs.

Furthermore, RE development and all related initiatives and projects can be the connector between the climate targets such as the ones of the Paris Agreement and all the SDGs. As demonstrated so far in this report, there are several points of intersection between RE development and the implementation of SDGs. This can be particularly effective to spur the wide-range of commitments needed for the effective implementation of the SDGs. In fact, the implementation of 100% RE targets can be a unique catalyser, bringing together the interests of different groups ranging from gender equality to children rights, from food security to biodiversity, from labour organizations to peace and security groups.

Finance, information and communication technology, capacity building, data, monitoring and accountability are all listed as essential to the formation of partnership for the goals[16]. These are actually also fundamental aspects of any RE development target and several examples show the importance of these for the energy transition[14 15]. For example, supporting RE projects and targets is incredibly beneficial for mobilizing finance especially at the local and community level, for example through community-based energy projects[15]. It is also important for communication and information technology as demonstrated earlier in this report because RE can provide access to electricity to power communication devices also in the most remote and isolated regions[30]. Further, capacity building is often a key requirement to achieve a 100% RE target[15], which is for example necessary to train local actors to use new technology or to support local policy makers in providing new legislative frameworks to advance RE and relevant targets. The capacity building opportunities needed to bring RE targets forward can therefore be beneficial for SDGs implementation and vice versa. Data, monitoring and accountability are also important for RE development. Several RE projects need specific monitoring strategies to ensure energy targets are met on time. Again, a mutually beneficial relationship could be established between tracking progress of RE targets and SDGs monitoring.

POLICY RECOMMENDATIONS

TO ACHIEVE 100% RENEWABLE ENERGY AND SUSTAINABLE DEVELOPMENT AT THE SAME TIME

- SET A 100% RE TARGET AND EMBED IT ACROSS POLICY AREAS AND IN SDG PROCESSES
- SET A "LEAVE NO ONE BEHIND" APPROACH TO ENERGY POLICY
- ENSURE ADEQUATE CIVIL SOCIETY PARTICIPATION AND CAPACITY BUILDING
- ENHANCE RENEWABLE ENERGY IN THE COOKING SECTOR
- PRIORITIZE ENERGY EFFICIENCY
- RE-DIRECT FOSSIL FUEL SUBSIDIES
- STRENGTHEN CHANGE AGENTS AND PIONEERS

POLICY RECOMMENDATIONS

Taking into account the many interlinkages between RE and sustainable development described so far, it becomes clear that integrating a 100% RE vision into development plans is in fact instrumental for the achievement of the SDGs. If any meaningful and long-term impact is to be achieved, the path towards sustainable development cannot be separated from the one towards 100% RE.

In light of this, leaders and communities across the world are urged to bring forward two key messages. Firstly, given the unprecedented threats of climate change and environmental degradation, they cannot delay to fully embrace a 100% RE for all message. Leaders from around the globe need to set a visionary, long-term 100% RE target, one that can once and for all set society on the right path towards sustainable development. By setting a 100% RE goal, as opposed to indeterminately promoting RE, they can support cohesion across parties and a much broader engagement across different stakeholders' groups; they can streamline efforts and resources by creating a unified vision for which different parties can finally synergize and work together. Furthermore, a 100% RE goal can create the necessary supporting environment to stimulate investments in renewables and widespread commitment to leave fossil fuels behind.

Secondly, leaders and communities across the world need to make clear that moving towards a 100% RE future is not only about transitioning from one form of energy to another, but about a much broader and inclusive socio-economic transformation towards a sustainable future.

1. SET A 100% RE TARGET AND EMBED IT ACROSS POLICY AREAS AND IN SDG PROCESSES

TARGET GROUP

Organizations and local communities engaged in the implementation of the SDGs / Policy makers / Development organizations.

As demonstrated throughout this report, RE development is fundamental to many other areas well beyond the energy sector. It can boost local productivity, improve livelihoods, stimulate local enterprises and industry, support gender equality, support agricultural process and stimulate innovation and technological development. It can be a tool to ensure substantive rights as well as procedural rights. Therefore, RE policies should not be separated and considered as an isolated, stand-alone area but on the contrary, any energy policy framework should be embedded in a national economic development plan and integrated in other policy areas. A transition to 100% RE should be regarded as a mean to achieve other policy priorities. Hence, policy makers must ensure that all RE benefits are taken into account and measured carefully when supporting a particular policy over another one. A silo approach to policy making would be restrictive and short-sighted, given that energy development overlaps largely with many other policy areas. Active efforts should be made to integrate 100% RE policies in other areas such as social and economic welfare, industry, employment, research and education, innovation and health. In order to do this, it is recommended to map the co-benefits of 100% RE to unveil the links among different development priorities and support the creation of cross-sectoral approach to policy making. Further, countries must in this effort review their development priorities and make sure they integrate 100% RE into all policy areas where it remained neglected or unexplored.

In particular, the countries that already demonstrated commitment to the 100% RE target such as the 48 countries of the Climate Vulnerable Forum are the ones that should first embed a 100% RE target into their national policymaking plans. These countries can pioneer this approach, ensuring that the 100% RE target is integrated across å agendas and that its implementation plan spans across departments, ministries, offices and covers different policy areas.

Further, priorities and programs relevant to the implementation of the SDGs and its targets should incorporate and in fact build on the 100% RE target. This includes mainstreaming 100% RE in the national plans, which countries are invited to develop and submit for a review progress in reaching the SDGs. The High-Level Political Forum in 2018 provides an ideal platform for this as it particularly follows up and reviews progress regarding the transformation towards sustainable and resilient societies with a special focus on energy. As confirmed in this report, supporting the uptake of RE across communities is an extremely effective instrument to stimulate the achievement of many other SDGs. Only a cross-sectoral, wide-ranging approach can help the rapid and effective achievement of the SDGs.

2. SET A "LEAVE NO ONE BEHIND" APPROACH TO ENERGY POLICY

TARGET GROUP
Policy makers.

Energy is essential to improve people's livelihoods, standards of living and overall comfort. Energy policies should focus on setting a human rights based "leave no one behind" approach, i.e. one that prioritizes that all parts of societies, including the most marginalized, can access energy and can equitably and fairly reap the multiple benefits that come with it. Access to modern energy services must be regarded as a prerequisite for a life of dignity. The only low cost, democratic and effective solution is decentralized, community-based RE development. In Global South countries, this means prioritizing off-grid development via stand-alone RE solutions (such as solar home systems) or micro-grid systems for small villages. Providing access to finance for everyone to enhance renewable energy must therefore be a core policy approach.

3. ENSURE ADEQUATE CIVIL SOCIETY PARTICIPATION AND CAPACITY BUILDING

TARGET GROUP
Organizations and local communities engaged in the implementation of the SDGs / Policy makers / Development organizations.

For the achievement of the SDGs and for a transition towards 100%RE, participation of the whole spectrum of civil society, including stakeholders from the environment, climate, development, faith and justice movement is indispensable. A participatory approach is needed to ensure participatory justice but also to manage the transition effectively. Unlike fossil-fuel-based societies, whose development and functioning mostly depends on large corporation investments and large centralized distribution systems, the decentralized structure of RE requires a much more distributed and participatory system of operation. All citizens and communities become part of a much flatter system of production and exchange of energy, made up of many small-scale initiatives and projects rather than few large ones. Within this context, civil society engagement is essential to ensure communities are supported in this transformational process. Inclusive mobilization and engagement of local actors as well as capacity building are all crucial elements of a fair and effective transition. In particular, capacity building must target legislators, government officials and civil society. All stakeholders need to become familiar with the policy changes needed to ensure a successful transition towards 100% RE. This is essential to ensure that local stakeholders build the capacity themselves to drive the transition forward as they are the only ones that can truly understand the local context and enable internal forces to support the transformation needed.

While the exchange of best practises and policy solutions is warranted, these cannot be simply imposed from above but need to be tailored to the specific local conditions and gain legitimacy from the buy-in and commitments of all local communities. Civil society organizations (CSOs) and churches can be instrumental in this process and governments must commit to support an inclusive multi-stakeholder process that continuously includes and informs all relevant CSOs. For this purpose, specific taskforces and formalized channels to involve all local actors and CSOs should be established to ensure an inclusive and fair process of engagement. Additionally the transformations needed to move towards 100% RE cannot be achieved by importing human capital and technologies, but by making sure that countries build their own domestic capacity and expertise to support such a transition within their own means. This should be perceived as a unique opportunity to mobilize local actors and further strengthen local CSOs and small enterprises, which can lead to spin-offs in innovation and local industry development.

4. ENHANCE RENEWABLE ENERGY IN THE COOKING SECTOR

TARGET GROUP
Organizations and local communities engaged in the implementation of the SDGs / Policy makers / development organizations.

Considering the multiple issues related to cooking in Global South countries, especially health concerns, impacts on local ecosystems and women's and children's rights, energy policies need to move beyond the narrative of clean cooking stoves and explore truly sustainable RE-based options for cooking. While the promotion of more efficient cook stoves remains an important interim solution and deslivers considerable results in certain Global South countries, focusing on improved cook stoves is neither a truly long-term nor a truly sustainable solution to the challenge of cooking. Much of the biomass for use in cook stoves (whether efficient or not) is not sustainably harvested; moreover, it is often not "renewable" due to unsustainable rates of deforestation, soil loss, and desertification. Further, they continue to contribute to a host of other social and economic problems, including gender inequality, low child literacy rates, as well as low labour market participation rates, all of which hinder economic diversification, entrench social injustices, and undermine long-term economic prosperity. Policies and local projects should start to recognize the tremendous potential

of alternative cooking solutions such as renewable electricity (e.g. solar home systems), biogas, and Power-to-Gas (P2G). In particular, biogas can offer a notable advantage also over the electric cooking pathways since in contrast to solar systems, which have a displacement rate of between 10% and 40%, the displacement rate for households equipped with biogas is higher, ranging between 66% and 80%. This means that in practical terms, biogas systems have proved to be more effective at actually reducing reliance on firewood, charcoal and other fuels than electric pathways. Another technology that deserves further investigation is P2G. While P2G may not be competitive with conventional natural gas delivered by pipeline, the preliminary results of a recent WFC report[39] found that it is broadly cost-competitive with current LPG prices and that it could provide a more cost-effective option to meet cooking needs than either mini-grid based electricity supply or SHS.

5. PRIORITIZE ENERGY EFFICIENCY

TARGET GROUP

Policy makers / Development organizations.

A 100% RE target addresses both energy efficiency and energy generation. No jurisdiction will meet its 100% RE target without simultaneously improving its energy efficiency. Or putting it in other words: increasing energy productivity, meaning the output achieved from energy consumed, is essential to achieve 100% RE and meet the ambition of the SDG framework. System-level approaches can be particularly important in reducing energy consumption. By developing more efficient energy infrastructure, including different sectors, appliances and other end-use devices, it becomes easier to develop, finance, and integrate the remaining infrastructure required to meet a jurisdiction's energy needs with locally available renewable resources. Studies have found that prioritizing energy efficiency in the Global South could slow the growth of their energy demand by more than half by 2020 to 1.4% a year, from 3.4%. This would leave demand about 25% lower in 2020 than it would otherwise have been[120]. Just by using existing technologies that would pay for themselves in future energy savings, consumers and businesses could save about $600 billion a year by 2020[121].

6. RE-DIRECT FOSSIL FUEL SUBSIDIES TO FUND SUSTAINABLE DEVELOPMENT

TARGET GROUP

Policy makers.

Fossil-fuel consumption subsidies worldwide amounted to about $325 billion in 2015, dropping from $493 billion in 2014. Despite this drop, the amount incentivizing fossil fuels is still more than double the $150 billion spent on support to renewable energy[122]. While research suggests that removing all consumer fossil fuel subsidies would decrease global carbon emissions anywhere between 6–8% by 2050 already, this can be even increased by using this money to build renewable energy[123]. Fossil fuel subsidies represent just under half of the budget needed to fund universal energy access, doubling the share of renewable energy in the global energy mix, and doubling the rate of improvement in energy efficiency by 2030[124]. This shows that using money that is currently used to subsidize fossil fuels, which in fact undermine sustainable development, could fill the SDG financing gap.

7. STRENGTHEN CHANGE AGENTS AND PIONEERS

TARGET GROUP

Organizations and local communities engaged in the implementation of the SDGs / Policy makers / Development organizations.

A substantially increasing number of municipalities, cities, regions and countries have committed to a 100% renewable energy future. As of late 2016, more than 300 cities, municipalities and regions including Frankfurt, Vancouver, Sydney, San Francisco, Copenhagen, Oslo, Scotland, Kasese in Uganda, Indonesia's Sumba island and the Spanish Island of El Hierro have demonstrated that transitioning to 100% RE is a viable political decision[125]. Many of these municipalities and regions are setting the 100% RE target as they consider it not only a technically and economically feasible option but an ethical imperative in the face of global climate change. During COP 21 in Paris in December 2015, nearly 1000 Mayors and councillors pledged to reach the 100% Renewable Energy target within their municipalities[126]. Sixteen countries with small-island states in the lead are planning to fully decarbonize their electricity system and achieve 100% renewable electricity within the next decades (Aruba, Cape Verde, Cook Island, Costa Rica, Denmark, Fiji, Tokelau, Niue, Saint Lucia, Papua New Guinea, Samoa, Solomon Islands, Tuvalu, Vanuatu)[125]. At the COP22 in Marrakesh, 48 developing countries pledged to "strive to meet 100% domestic renewable energy production as rapidly as possible while working to end energy poverty, protect water and food security"[7]. These pioneers are needed to exemplify that the transformation is possible and beneficial. Change agents that are the driving force behind these success stories must be strengthened and supported. While organizations and local communities engaged in the implementation of the SDGs need to create bundles of lighthouse projects, governments and development agencies must build on these learnings and successes. For this, inclusive policy dialogues and consultations between strategic partners must be established and facilitated.

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