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Note on the Institutional Publication

1. This note is submitted to provide Members with additional information on the envisaged IRENA institutional publication. It is aimed at stimulating debate and seeking input from different stakeholders, to help shape IRENA's publication, to complement the existing renewable energy related reports, and to add value for the intended audience.

Introduction

2. The need for an institutional IRENA publication has been identified as an important instrument to fulfill IRENA's strategic goal to become an authoritative global voice for renewable energy. Strong support for such a publication has been voiced by Members and, as a result, its development is envisaged in IRENA's Work Programme for 2013. In preparation for this important undertaking, consultations within IRENA have taken place in recent months to articulate the concept, which will be further discussed with external stakeholders in the coming months.

3. The overall goal of IRENA's annual publication is to inform high-level policy-making on the key issues and trends facing renewable energy. In line with IRENA's mandate, the primary audience for the report is policymakers, but the publication should also be relevant to industry, investors and civil society. The publication will be forward-looking, and will convey the long-term vision to transition from the existing energy system and infrastructure to one based on renewable energy sources. At the same time, the publication will lay out a short to medium-term pathway for what is achievable in the next five to ten years, identifying, among other issues, major investment opportunities and the scope for more efficient and effective policy intervention. The findings will go beyond the merely descriptive, be practical, stimulate normative debate, and seek to catalyze government action, rather than making broad policy recommendations.

4. Specifically, the publication will address the following four areas:

- **Forward-looking analysis**. There is a number of existing publications that provide comprehensive, credible and relevant information on the state of renewables. The IRENA publication will complement these efforts with a forward looking analysis to inform policy-making and stimulate debate on key issues in renewable energy policy, markets, finance, technology and innovation.
- **Topical in-depth analysis**. In order to keep abreast of developments in the rapidly changing sector of renewable energy, the publication will provide an in-depth analysis of a particular topic or set of topics that are of relevance for the next five to ten years. These topics could include regional or country-grouping analysis, such as Islands or GCC Countries, or focus on specific subjects such as policies and enabling environments, markets, finance, technology and innovation.
- **Emerging opportunities**. This section would feature a select number of emerging issues that have the potential to become game changers in the coming years to put them on the "radar" of the audience. The topics would be selected from a wide range of issues, from new technologies, to new business models and investment opportunities, to innovative policy approaches or financing. Examples could include regional integration of grids, emerging investment in renewable energy in the GCC region, or technical topics like desalination or energy storage. "Radar", while not immediately actionable, would allow IRENA to claim early ownership on issues and to position itself as a leading, forward-looking organization
- **Indicators**. Measuring progress in the deployment of renewable energy is an important tool allowing policy makers to assess the success of public policies creating an enabling environment for renewable energy investment and deployment. Indicators serve as a tool for tracking the contribution of renewable energy to the priorities and targets that countries have set in areas such as economic growth, energy security, energy access and climate mitigation. Indicators, unlike simple measures of levels, allow relative comparisons, adjusting for chosen variables such as the size of economy, population, exploitable renewable energy potential, etc. They can be used as building blocks for composite indices, which provide an aggregate measure of numerous assessments, both quantitative and qualitative. Many renewable energy indicators and indices have been developed, assessing mostly investment environment. Broader relevant indices include the Energy Development Index of the IEA, and the Human Development Index of the UNDP. IRENA will complement the existing renewable energy indicators measuring progress in all countries, pointing to success stories. These indicators will be accompanied by an analytical text identifying elements crucial for the achievement of success.

5. The publication will capitalize on IRENA's comparative advantage of near universal membership, convening power and exclusive mandate to advise governments on renewable energy policy. An active and continuous participation of Members is invited to ensure that the publication serves its intended purpose and become an essential tool for policy makers and other stakeholders.

6. In order to facilitate discussion, a prototype of institutional publication is articulated below. The content is intended to illustrate its outline and characteristics, and does not necessarily reflect the subjects that will be contained in the upcoming publication.

Institutional Publication Prototype

1. State of renewable energy and future trends

Key point: 2012 marks renewable energy industry as the year of a clear transition from support dependence to a business opportunity, a shift from mature European markets and falling support schemes towards many large and rapidly growing economies where renewable resources are abundant, where they make good practical and economic sense, and where every new capacity is an essential prerequisite of further economic growth.

2012 was a year of mixed fortunes for renewable energy. Costs of maturing renewable energy technologies continued to fall rapidly but industries were going through difficult times of consolidation. Deployment of solar photovoltaics was difficult to keep under control in some countries, but preliminary annual investments figures for new renewable generation show a decline for the first time ever. Governments around the globe in their statements showed unprecedented commitment to renewable sources yet policy support schemes have seen cuts in many countries. These signals were an implication of renewable energy 'coming of age'. With falling costs, lower levels of investments are now needed to secure new capacities and the reduced governmental support is still enough to create a level playing field. But first estimates indicate that 2012 was yet another record year for new renewable energy installations around the world.

2012 was the year of adolescence of renewable energy - a time of significant changes when the renewable energy industry started its clear transition from supported industry to an industry that stands on its own competitive feet in the market place. And just like in any transition, there were winners and losers along the way but that was the price to pay for the industry to become healthier and stronger. Deployment is increasingly starting to reach regions and countries where renewable energy makes practical and economic sense – where resources are excellent and abundant, where alternatives are costly, where infrastructure is not locked-in and where demand has not yet been served.

In this transition, renewable energy will change the lives of more people than ever before. If clean renewable power and heat can reach people that never before had access to these services, and if large and still growing megacities can decrease their air pollution and carbon emissions thanks to renewable energy deployment, then these benefits will have been delivered to many more people than the developed world counts right now.

Most of the future inhabitants of this planet will live in countries that are currently developing. It is therefore important that these countries are empowered with the knowledge, technical capacities and resources to choose sustainable strategies for their growth. Investments in their power generation today will define these sectors for the next 20-30 years, the related infrastructure will remain even longer. New buildings and their heating and cooling systems will be locked-in for the next 50-100 years, so the choices made today are important. In some of these countries and regions renewable energy uptake is already happening. China, India and Brazil are successfully enlarging their portfolios of renewable energy sources; Latin America is continuing to develop its already sizeable renewable energy capacity; South-East Asia is learning from its champions how to better use, among others, its abundant bioenergy and geothermal resources; Africa is re-discovering its hydropower potential while profiting from newly economical options for off-grid renewable power; and the GCC countries are investing in a remarkable transition from oil and gas, to solar technologies.

Distributed renewable energy solutions that are now affordable are poised to become a game changer. Growing and developing markets can take advantage of these solutions to create a new more decentralized infrastructure that can improve energy services for hundreds of millions people, who become not only consumers but also producers of energy, enabling productive uses and improving their livelihoods.

2012 was the year of a new renewable energy reality when industry made its first steps without any help, the first steps of what will be a journey of sustainable and equitable growth for all. 2013 has already seen some good news. Extending the production tax credit for wind in the United States will help to bring in larger investments into this technology. New targets announced by China imply that the country plans to install at least 10GW of solar generation in 2013, supporting the production of local solar PV manufacturers. With this target China is poised to become the largest solar PV market in 2013.

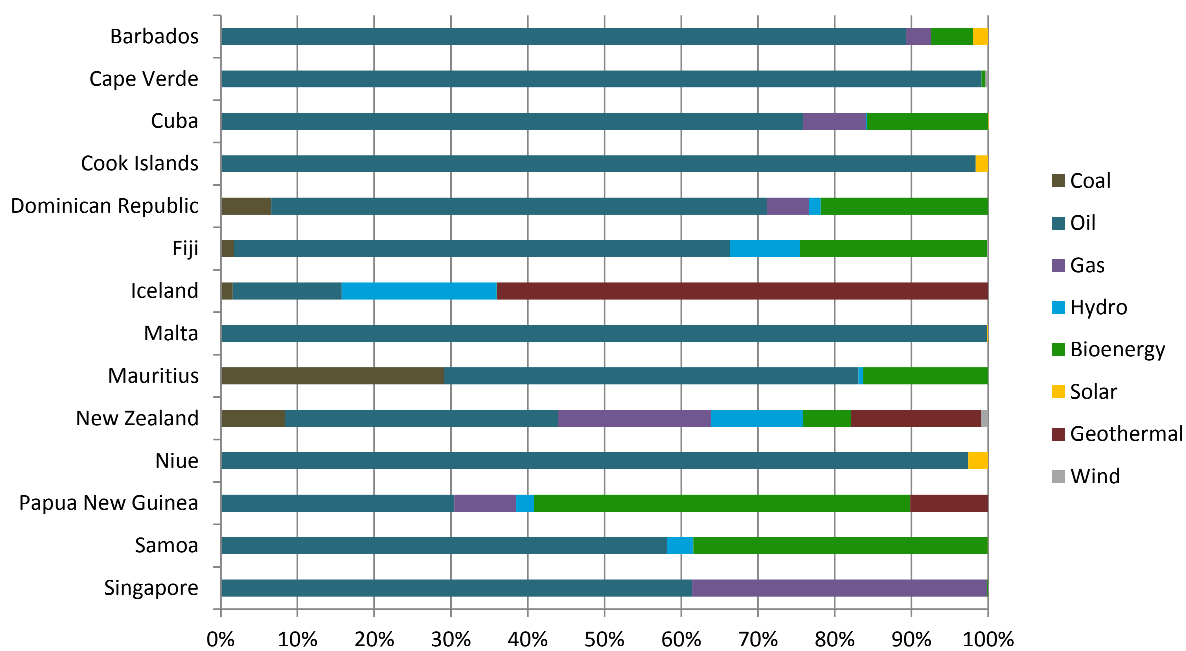
2. "In Focus"

Renewable energy future in islands

Key point: Islands can exploit their abundant renewable energy potential to create affordable, clean and secure energy systems. Due to their size they can achieve this transition faster than large land-based countries. Not only can they transform their power and heat sectors but they can also be front-runners in the electrification of road transport. The essential prerequisites to such transformation are enabling policy frameworks, building the necessary skills and capacity for deployment in order to ensure buy-in by local communities, effective locally-driven deployment and the associated local value creation.

Islands are almost universal: most countries have islands, some countries are islands and several countries have areas that are so remote that they can be described like virtual islands. Their sizes, climates, natural resources and economic powers differ but in many respects they face similar issues. Many islands share challenges related to shipping, isolated power grids, high levels of dependence on imported fossil fuels and high costs of energy infrastructure due to isolation and limited scope for economies of scale.

Figure 1: Composition of primary energy consumption in selected islands



Source: IRENA analysis based on data from IEA, UNSD.

Costs of imports, due to high and volatile fossil fuel prices, can represent up to 20% of GDP in island countries. High dependence on imported fossil fuels also poses serious energy security threats, exacerbated by the particularities of islands settings. Current energy consumption of islands, as shown in Figure 1, is heavily dominated by oil, mostly imported, with some gas and coal in wealthier island countries and a significant use of geothermal in countries endowed with this resource. Biomass, mostly in traditional uses, plays an important role in the residential sector of many islands. Several islands have adopted solar water heaters in a significant way.

Most islands possess a significant renewable energy potential, typically solar or wind, but some also bioenergy, geothermal and hydropower, as shown in Table 1. Most of these can be economically viable in island settings and, if needed, the existing diesel generators can serve for improving the reliability of power generation or as a part of transitory solutions towards fully renewable systems. Waste management, which is an issue for many islands, can incorporate economical waste-to-energy processes that can help generate power and, if needed, heat.

Table 1: Renewable energy potentials in selected islands

	Wind	Solar	Hydro	Biomass	Geothermal	Ocean
Australia	High	High	High	High	High	High
Bahamas	Medium	High	Unknown	Medium	Unknown	Low
Comoros	Medium	High	High	Unknown	High	Unknown
Grenada	High	High	Low	Low	High	Low
Haiti	High	High	High	Low	Unknown	Low
Japan	High	High	High	High	High	High
Kiribati	Medium	High	Unknown	Low	Low	Medium
Madagascar	High	High	High	Medium	Low	High
Maldives	Medium	High	Unknown	Medium	Unknown	Low
Federated States of Micronesia	Medium	High	Medium	Low	High	Medium
Nauru	Medium	High	Unknown	Unknown	Unknown	Medium
Palau	Medium	High	Low	Low	Unknown	Medium
Sao Tome and Principe	Low	High	Medium	Unknown	Unknown	Unknown
Saint Lucia	High	High	Low	Low	High	Low
Saint Vincent and the Grenadines	High	High	Medium	Low	High	Low
Tonga	Medium	High	Unknown	Low	Medium	Medium
Vanuatu	Medium	High	Low	Low	High	Medium

Unknown potential High potential Medium potential Low potential

Source: IRENA Country Profiles

Enabled by the falling costs of renewable energy technologies, many islands see renewable energy as an indigenous source that could stimulate the sustainable growth of their economies, reduce the costs of imports, and reduce the adverse environmental impact of their energy sectors. Renewable energy deployment could become an important part of local economies, integrated both through upstream supply chain, such as the production of some equipment components, and downstream energy related services, such as maintenance. Moreover, due to the decentralized nature of renewable energy technologies, these can enable energy services for people without previous access, allowing for productive uses and wealth creation.

Due to the relatively small power and heat demand in most islands, the transition towards renewable energy can be relatively quick. In small islands, decentralized diesel generators can be replaced with decentralized solar, wind and bioenergy solutions, equipped with batteries or backed-up by the diesel generators. Such changes can be achieved in a matter of months. For example, the Rokkashomura-Futamura wind power station in Aomori Japan, presented at the workshop “Accelerating renewable energy deployment in the Pacific region - meeting the challenges” that IRENA co-organized with the Government of Japan in Okinawa in May 2012, operates in an island mode. It consists of 51MW of wind power and 34MW of batteries. It was the only part of the Northern Tohoku electricity system that continued to operate in the aftermath of the Great East Japan Earthquake in March 2011.

In larger islands, power plants on the grid take longer to build, but solar and wind still have short lead times compared to fossil fuel facilities. They provide variable power, but can be managed by using pumped hydro storage if geography allows for its construction, or systems of storage, like in the Canary island of El Hierro. Bioenergy, hydropower and geothermal power can serve as base load. They typically need several years of development. However, several megawatts of capacity can represent the entire power system of an island, which corresponds to just one wind farm, or one renewable energy power plant. Islands with a heavy load of air-conditioning could take advantage of rapidly falling costs of PV panels - their peak production corresponds to peak demand for air-conditioning.

In planning the transition towards renewable energy power-based systems, it is important to assess available local renewable resources as well as the size and profile of the load, and choose an optimum economical solution, keeping in mind that a mixed portfolio of energy sources provides a higher degree of energy security than a single source. Careful grid integration of variable renewable sources is needed and the operation of the grid needs to adjust to the portfolio of renewable sources feeding the grid.

Based on the favorable climate and low industrial heat demand the heat sector on islands is often-times relatively small. Cooking demand can be covered by biogas solutions or ethanol if it can be locally produced. Water heating can be covered by solar water heaters both in residential and commercial sectors. For example, in Grenada solar water heaters are mandated in all governmental and commercial buildings.

Traditional open-air sun drying can be replaced by modern uses of solar and geothermal technologies to preserve fruit, vegetables or fish. In case of demand for industrial heat, geothermal and bioenergy solutions can deliver heat of relatively high temperatures. Waste from agriculture, forestry and food production can be a suitable feedstock for the co-generation of heat and power, e.g. in Mauritius where bagasse, a by-product of sugar production, is used for electricity and heat co-generation, covering heat and power demands of sugar factories. Excess power is sold to the grid. Power production from bagasse currently covers 20% of power demand of the island.

The transport sector remains relatively difficult to decarbonize. The large shipping requirements of islands imply that the transport sector will always represent an important share of their energy demand. Wind and solar-aided vessels can partly relieve fuel demand. Use of biofuels can help in islands where they can be produced locally (e.g. from sugarcane, coconut or oil-palm residues). Biofuels can also play an important role in road transport. Electrification of road transportation could contribute in a significant way to lowering oil imports and improving energy security. Distances travelled on islands are typically smaller than in land-based countries, so the logistics of charging stations is simpler. An island setting is therefore ideal for the adoption of electric transport, provided it can be charged by sustainably produced electricity. Moreover, local power systems can take advantage of electric vehicles batteries and integrate them as a part of load management solutions.

Many islands are aware of their renewable energy potential and would like to secure for their inhabitants cheaper and cleaner supply of energy. But issues like remoteness and the related high transportation costs, small market size, and challenging climate with high salinity, humidity and risks of tropical storms can make renewable energy deployment more complex on islands than on main-land context. Islands therefore need adapted solutions, such as coatings protecting against salinity, or wind turbines with two blades for higher stability against hurricanes.

The governments of many island countries have established targets for renewable energy deployment in the power sector, shown in Table 2, but also in transport or overall renewable energy consumption targets. In order to achieve these goals, governments will need to create an environment enabling the rapid adoption of renewable energy sources. Resource assessments and pre-feasibility studies for renewable projects are important for attracting the attention of private investors. In places with monopoly utilities, these need to be given incentives to transition towards renewable sources. The entry of independent power producers needs to be enabled by establishing standard power purchase agreements.

Table 2: Targets for renewable penetration in power generation in selected island countries

Country	Targeted year	Targeted percentage
Barbados	2012	30%
Cape Verde	2020	50%
Cook Islands	2015	50%
	2020	100%
Dominican Republic	2015	10%
	2020	25%
Grenada	2020	20%
Jamaica	2020	15%
Maldives	2015	50%
Mauritius	2025	35%
Niue	2020	100%
St. Vincent and the Grenadines	2015	30%
	2020	60%
Seychelles	2020	5%
	2030	15%
Solomon Islands	2015	50%
Timor-Leste	2020	50%
Tonga	2012	50%
Tuvalu	2020	100%

Source: IRENA Country Profiles

Governments need to raise awareness about the benefits of the adoption of renewable energy sources, pointing to improved energy access and affordability, as well as opportunities for the creation of local value, for example in the manufacturing of some equipment components, installation and maintenance. Skills required for these jobs need to be developed and governments need to play a role in establishing training for technicians and engineers.

Governments also need to take the lead in establishing technology standards, which ensure good performance and longevity of renewable installations contributing in turn to the buy-in of inhabitants. Building codes and vehicles or fuel standards can help speed up the adoption of renewable energy on a household level. These measures should be reinforced by energy efficiency standards to lower the demand for power and fuels.

Despite the clear commitment of many governments of island countries to the scale-up of renewable energy, financing of projects has proved challenging due to difficult fiscal positions of governments and small size of local markets. Access to capital is limited, sovereign guarantees are often challenging, transaction costs are high. Pooling of several projects across countries or regions could potentially create economies of scale. This is particularly valid for projects based on the same technology and in the same stage of development. Local availability of loans or leasing schemes can be an effective catalyst for small-scale renewable energy solutions, which are cost-effective, compared to fossil solutions. Repaying loans or paying lease can be done using money saved through the reduced use of fossil fuels.

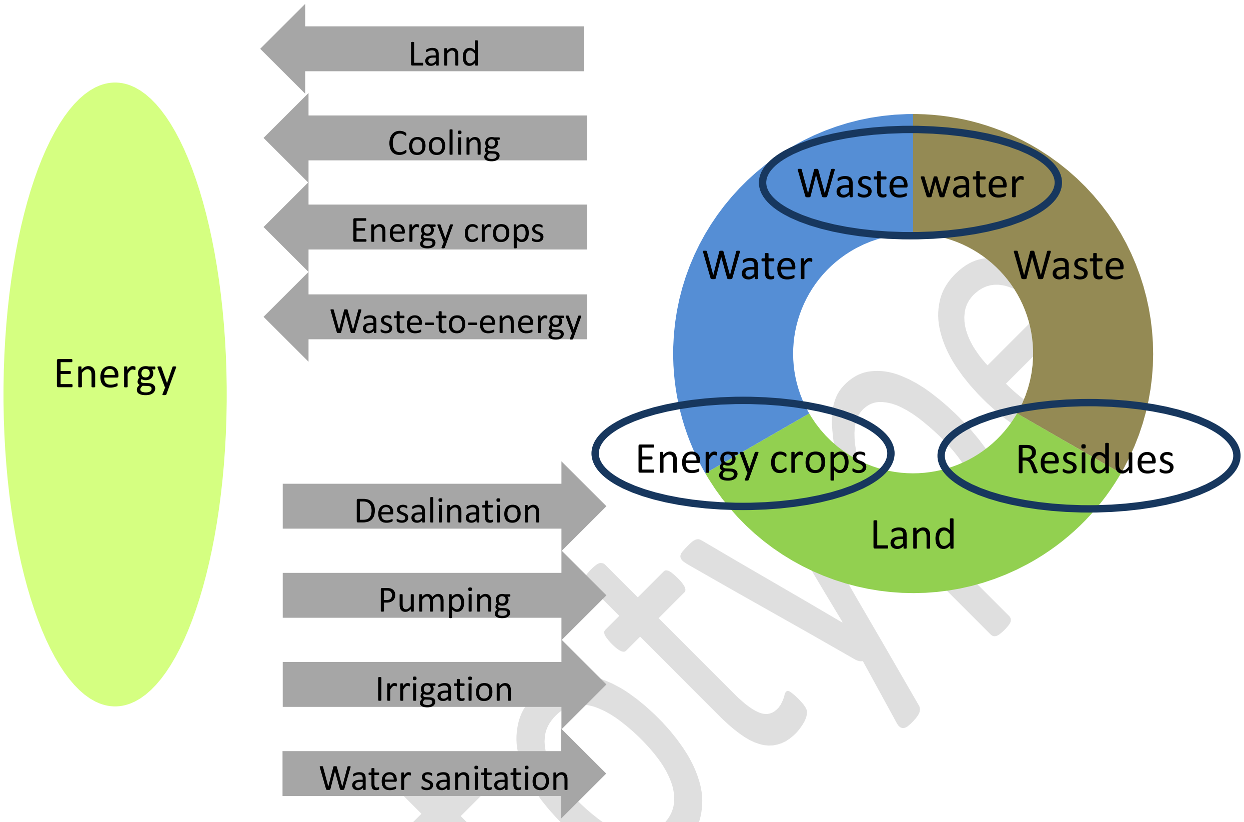
3. "Radar"

Interactions between energy, water, land and waste on islands

Key point: An integrated approach to the development of renewable energy taking into account interactions between water, land and waste management practices is a prerequisite for the sustainable development of islands. Such an approach enables the development of a sustainable tourism industry, which is typically energy and resource intensive, but often an important source of income for islands. Best practices of management of local resources identified on islands can serve as pioneer examples to improve the sustainability and economics of renewable energy projects even in larger, land-based settings.

By choosing renewable energy deployment, islands are ensuring sustainable development and energy security. Energy efficiency comes hand-in-hand with this effort, reinforced by the fact that resources can be scarce on islands. Important savings can be achieved by lowering amounts of goods shipped to islands, which can help lower fuel consumption in the transport sector. Countries can aim to develop an integrated approach to the management of islands' resources, use them efficiently by taking into account all competing uses, recycle waste and recuperate its energy as much as possible to avoid their costly shipping out of islands. Such management requires careful consideration of optimal uses of energy, water, land and management of waste. This is even more important in islands that have, or are aiming for, a large tourism industry, which is typically energy and water intensive and produces extensive waste. During the workshop "Accelerating Renewable Energy Developments within the Caribbean" which IRENA held jointly with the Caribbean Electric Utility Services Corporation in September 2012 in Bermuda, a need for ample power availability, strengthened grid and water processing like desalination were identified as prerequisites for the development of the tourism industry as a source of income for islands.

Figure 2: Interactions between energy, water, land and waste



Source: IRENA

The interaction between energy and water is a most pertinent one. In suitable geographical conditions on any given island, water can be used for energy production in hydropower and pumped-storage plants. Water loss during hydropower energy production is small. Generating electricity in this manner does not preclude other uses of water. Water supply systems can be combined with energy production and storage, having a positive impact on the economics of such projects. Water is consumed in several phases of renewable energy technologies' supply chains: during the production of some components of equipment, for cooling of some plants, and during the maintenance phase, for example for cleaning solar panels. These levels of consumption are low, except for the cooling of some concentrating solar plants but these are not suitable for islands due to the humid environment. Significant water consumption occurs for energy crops which need irrigation. These should however be avoided in islands with a shortage of land and water.

On the other hand, energy can help improve water supply in several ways. Desalination, often necessary in islands, is a very energy intensive activity. Energy is needed for water pumping and to drive irrigation systems. Sanitation procedures for water also require a certain energy input. All of these needs can be met with renewable energy solutions.

Land requirements for renewable energy plants are not larger than those for fossil plants, with the exception of solar and wind technologies. However, solar PV, which is suitable on islands mostly for distributed use can be out on rooftops. Wind turbines require relatively large land areas, but this land can be used simultaneously for other purposes, like agriculture.

Waste can be a precious and low-cost source of energy, if managed properly. The biodegradable part of waste can feed bio-digesters for the production of biogas that can further serve for cooking, thereby decreasing the need for traditional uses of biomass in places where these still exist. Waste water from households and hotels, and also sewage sludge from agriculture can contribute to the production of biogas. Bio-slurry left over after the digestion process can be used in agriculture as a high-quality organic fertilizer, replacing inorganic fertilizers that need shipping.

On larger islands with significant agriculture or forestry, residues from these activities can feed gasification plants for the production of electricity or co-generation plants for the production of electricity and heat. In many places, waste and residues used to be disposed of by burning. Recuperation of energy valorizes residues and wastes, and creates an indigenous clean source of energy.

Separation of the biodegradable part of waste is key to the successful introduction of waste-based technologies. Islands can impose regulations for hotels, which produce extensive food waste, for the separation of waste in order to ensure a stable supply of feedstock for bio-digesters. Other measures can include the introduction of biodegradable plastics in order to minimize creation of non-degradable waste that is costly to dispose of.

Best practices in an integrated approach to the development of renewable energy and uses of water, land, and waste management identified in islands can be scaled-up and adjusted for land-based countries and regions. Multiple uses of the same project, for example for water supply or flood control and power generation, can improve the economics of power plants. The valorization of biodegradable waste, forestry and agricultural residues creates an indigenous source of energy and income and saves costs of disposal. The integrated approach, therefore, implies higher security, better economics and improved sustainability of renewable energy projects.

4. Indicators

As an example, this paper presents a "renewable electricity generation per capita" indicator for the year 2010. However, a broader set of indicators will be developed for the first publication. Over time, indicators will be further improved, and their scope will be enlarged.

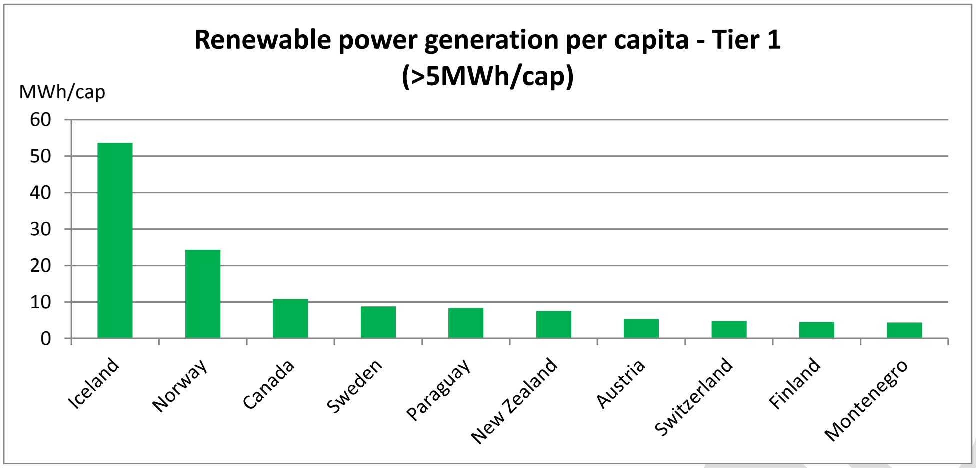
Renewable power generation per capita

Key point: Independent of level of wealth, countries with abundant hydropower and geothermal potential can use these resources to meet the majority of their power demand due to their low costs and technological maturity. Several low income countries have a significant hydropower production per capita. Abundance of inexpensive and clean power can spur the establishment of industries, as demonstrated in Iceland or Norway, or this power can represent an attractive cross-border business opportunity, like in Paraguay.

The aim of this indicator is to present the progress countries have made in renewable power generation relative to their population sizes. Uneven economic development levels result in uneven power consumption levels; types of industries also have a significant impact. Equally important, diverse availability of renewable sources results in diverse deployment patterns. To complement the analysis, it is crucial to put into perspective the total power generation per capita as well as the penetration of renewable sources in the power generation of countries.

The results of renewable power generation per capita show a clear division of countries into three tiers: countries with renewable power generation above 5MWh per capita, above 1MWh per capita and below 1MWh per capita. For comparison, the cross-countries average of total power generation per capita in 2010 stood at 4.55MWh, up from 3.86MWh in the year 2000. Most of the developed countries currently consume between 5MWh to 8MWh of electricity per capita per year, with several countries reaching 15MWh per capita and the highest consumers, Norway and Iceland standing at 25.4MWh/cap and 53.6MWh/cap, respectively. Many developing countries consume less than 1MWh per capita, not correcting for those people who do not have access to power.

Figure 3: Tier 1 – Renewable power generation per capita (>5MWh/capita)



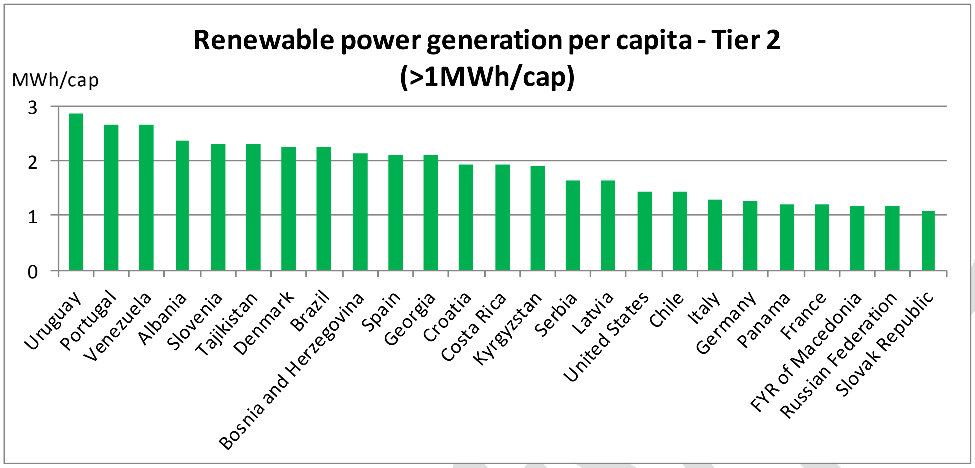
Source: IRENA analysis based on data from IEA, UNSD, UNPD.

As shown in Figure 3, Tier 1 contains 10 countries, mostly developed. They have a higher than 50% share of renewable sources in their power generation mix, except for Finland, where renewable sources cover 30% of power generation. The indicator leader, Iceland, represents a special case in many respects. It is endowed with enormous and easily accessible geothermal and hydropower resources that are not costly. The inexpensive power and heat acts as an enabler for the establishment of energy-intensive industries. Industries consume 85% of power in the country, implying very high per capita power consumption. Iceland covers 100% of its power needs using renewable sources, 74% by hydropower and 26% by geothermal.

Countries with excellent performance in this indicator, almost exclusively attributable to hydropower, are Norway, Canada, Paraguay, Switzerland and Montenegro. Hydropower represents for each of them at least 90% of their renewable power production. These countries take advantage from the fact that the abundant hydropower resources are often the most economical option for power generation. Norway takes advantage of these resources to support energy-intensive industries. Paraguay exports over 80% of its production, making hydropower a profitable cross-border business. The other Tier 1 countries - Sweden, New Zealand, Austria and Finland, use a portfolio of renewable energy sources for their successful deployment. In all of them, hydropower still represents a sizeable share, 50%-80%, however, bioenergy and wind and, in the case of New Zealand, also geothermal power, complement hydropower in an important way.

Tier 2 countries, shown in Figure 4, are characterized by per capita renewable power production larger than 1MWh, but smaller than 5MWh. This category includes 25 countries spanning across different income levels and continents. Many are hydropower-based, while some also exploit the wind power in a significant way (e.g. Portugal, Denmark, Spain, the United States). Brazil and the United States belong to the Tier 2, despite their very large populations, reflecting their substantial renewable energy production. On the other hand, China, the global champion in absolute level of renewable power production, falls behind in per-capita terms, producing about 0.6MWh of renewable power per capita.

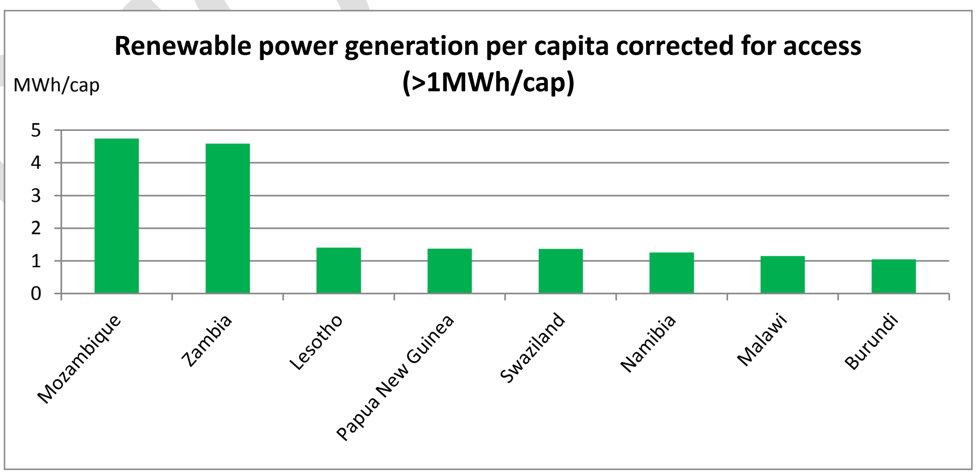
Figure 4: Tier 2 – Renewable power generation per capita (>1MWh/capita)



Source: IRENA analysis based on data from IEA, UNSD, UNDP.

The issue of access to power has a significant influence on this indicator. In fact, several other countries have a sizeable renewable power production per capita when we take into account only the population who in practice has access to power, as shown in Figure 5. Such countries reconfirm that hydropower is to date the most viable and technologically mature renewable power generation sources for countries with suitable potential.

Figure 5: Renewable power generation per capita corrected for access (>1MWh/capita)



Source: IRENA analysis based on data from IEA, UNSD, UNPD.

Despite rapid development of non-hydropower renewable generation sources, hydropower, for the moment, proves its supremacy over other sources due to its technological maturity, availability in many locations and advantageous economics. However, risks related to reliance on one source should not be underestimated. Many countries relying on hydropower suffer power shortages during dry years, especially when they do not have spare hydropower capacity. It is therefore important to introduce other renewable energy resources to countries' portfolios as related technologies become economically viable. Wind power is starting to make significant per capita contributions in some developed countries that invested early on into this resource. Geothermal power can make a significant contribution in places with excellent hydrothermal resources like Iceland, New Zealand or Papua New Guinea.