Latest Trends in Renewable Energy in APEC economies

Joint EGNRET 58/EGEDA 34 meeting

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Presenter:

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International Renewable Energy Agency (IRENA)

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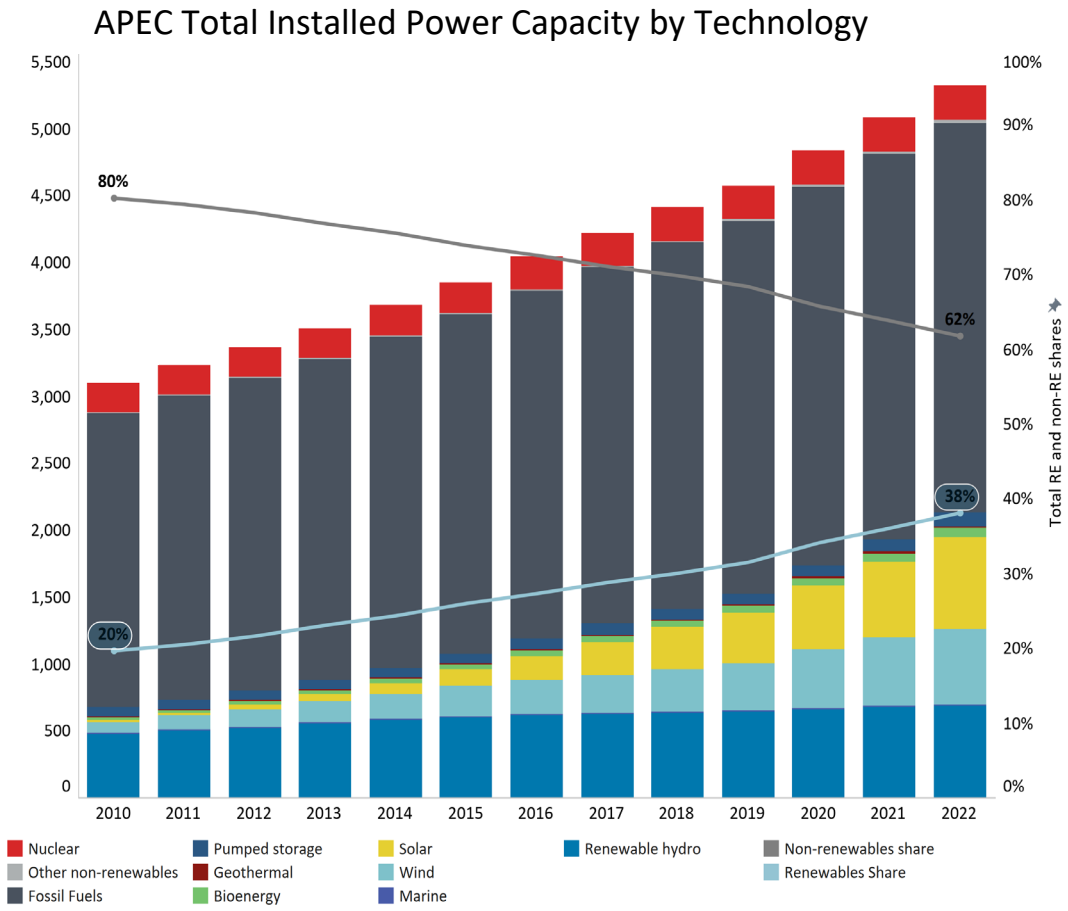
AGENDA

- Current energy situation in APEC economies based on latest statistics
- Renewable energy data collection and reporting challenges
- Improvement opportunities for APEC

Renewables are going at a faster rate than non-renewables



Trends in Power Capacity

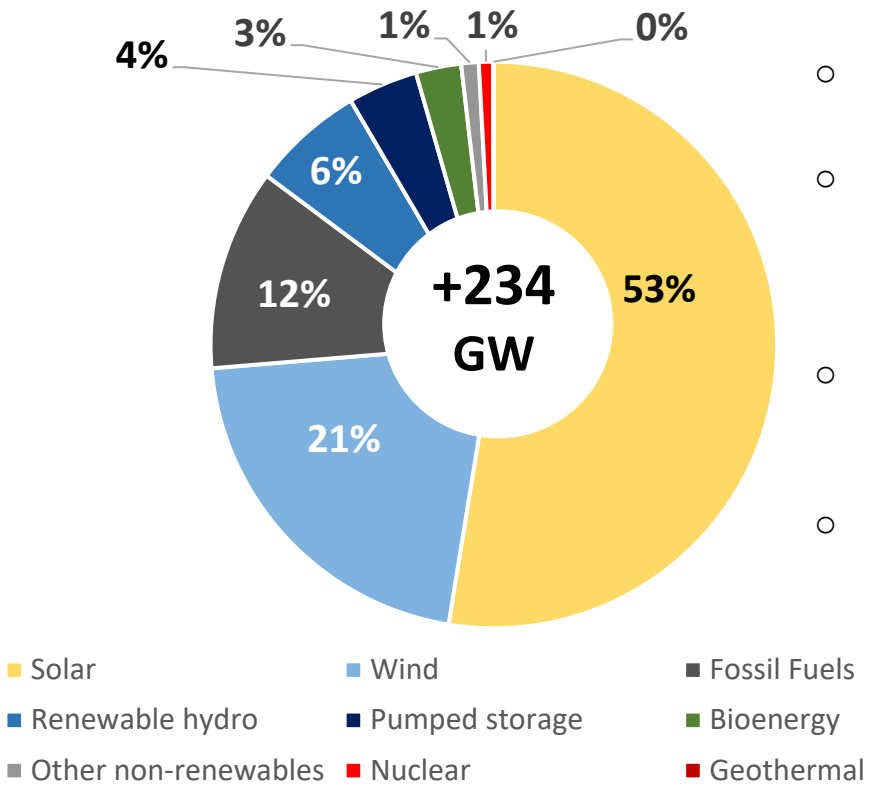
- APEC 21 total power capacity reached 5,300 TW in 2022 (3300 TW of non-renewables and 2000 TW of renewables)
- By end of 2022, non-renewables accounted for 62% of cumulative capacity compared to 80% in 2010.
- Share of renewables in total capacity increased from 20% in 2010 to 38% in 2022.
- By end of 2022, renewable hydropower still accounted for the largest share of renewable energy technologies (reaching 699GW), solar closely behind with 691 GW followed by wind (562 GW), bioenergy (70 GW) and geothermal (10GW).
- Renewables are going at a faster rate than non-renewables especially in recent years:

  2010-2022 CAGR non-RE +2%

  2010-2022 CAGR RE +10%

Renewables accounted for > 80% of capacity expansion in 2022

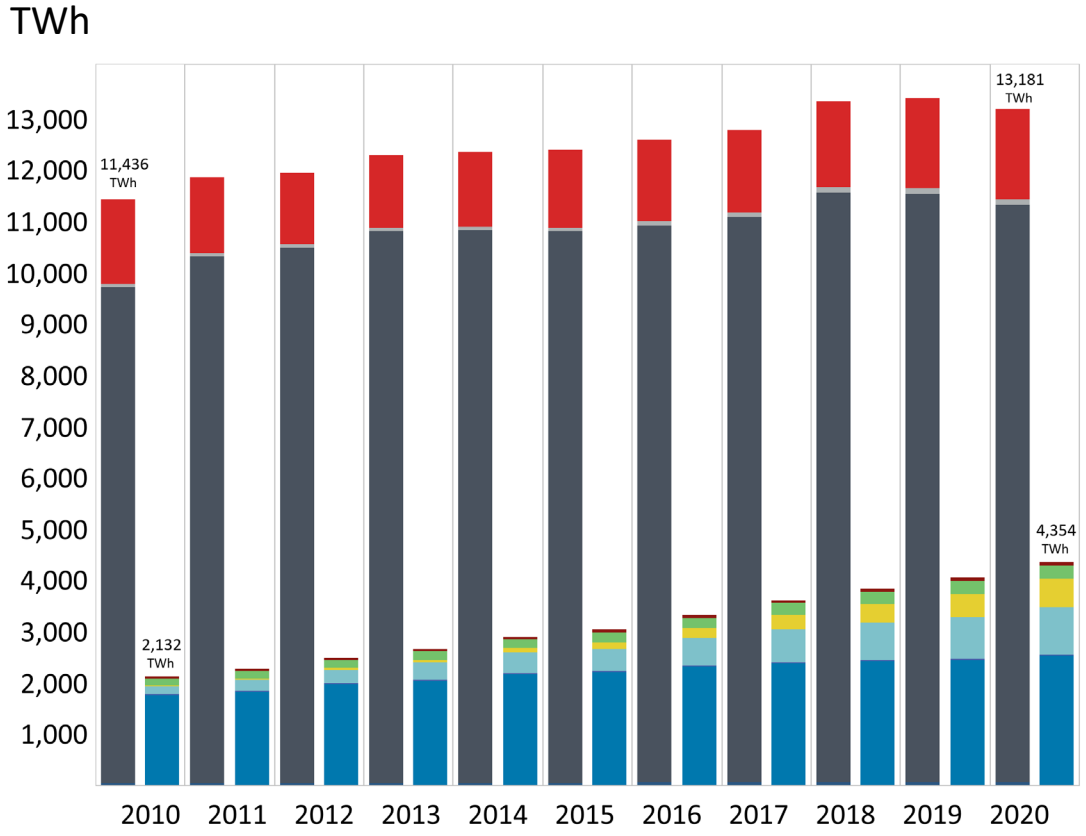
Net Capacity Additions in 2022 (APEC, total)



Latest year

- Renewable generation capacity increased by 194 GW (+11%) in 2022 accounting for 83% of net capacity additions
- Solar recorded it largest increase on record of +123 GW (more than 1/2 net additions) followed by wind with 49 GW (21% of additions), fossil fuels +27 GW (12% of net additions) and hydropower +24GW
- Solar and wind continued to dominate renewable capacity expansion, jointly accounting for 74% of all net additions in 2022
- Looking at APEC economies, China attributed to the largest addition of renewable capacity (+141GW), followed by the USA.

Renewable power generation doubled over the last decade



- Total renewable electricity production doubled over 2010-2020 reaching almost 4354 TWh in 2022
- Electricity from renewables grew at a CAGR of 7% from 2010 to 2020 compared to CAGR of 1% for non-renewables
- Among renewables, electricity from solar had the fastest CAGR of 44% from 2010-2022
- Share of renewables in electricity generation grew from 16% in 2010 to 25% in 2020

Electricity generation still largely depends on non-renewables

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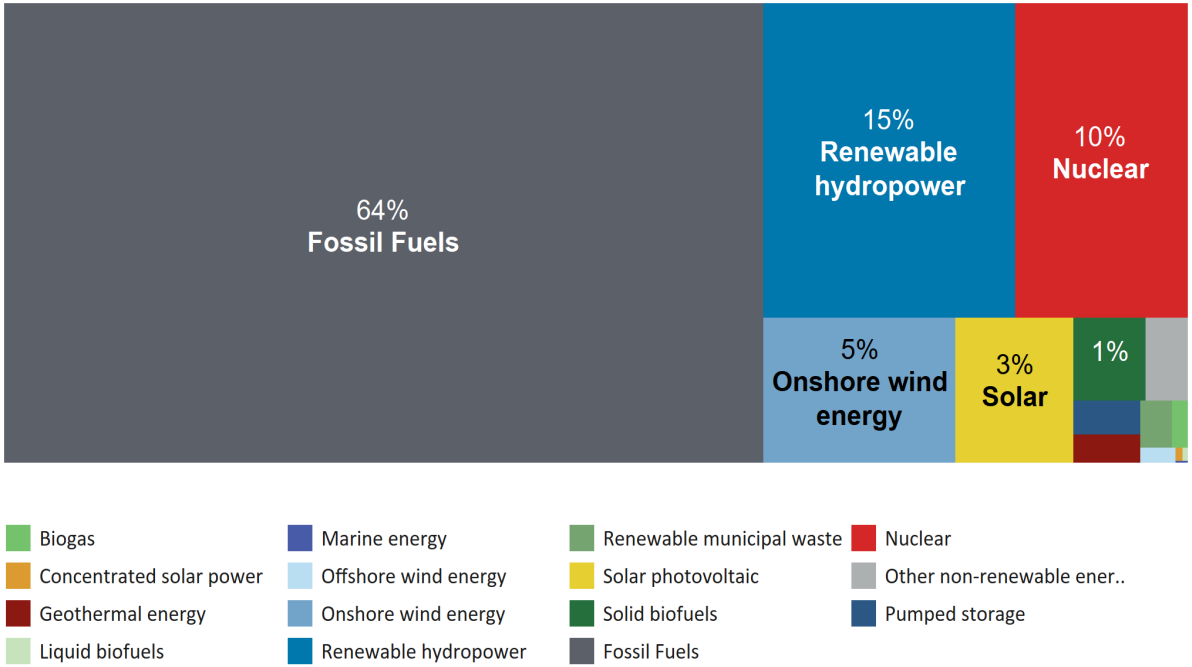
Breakdown of APEC Total Electricity Generation by Technology 2020

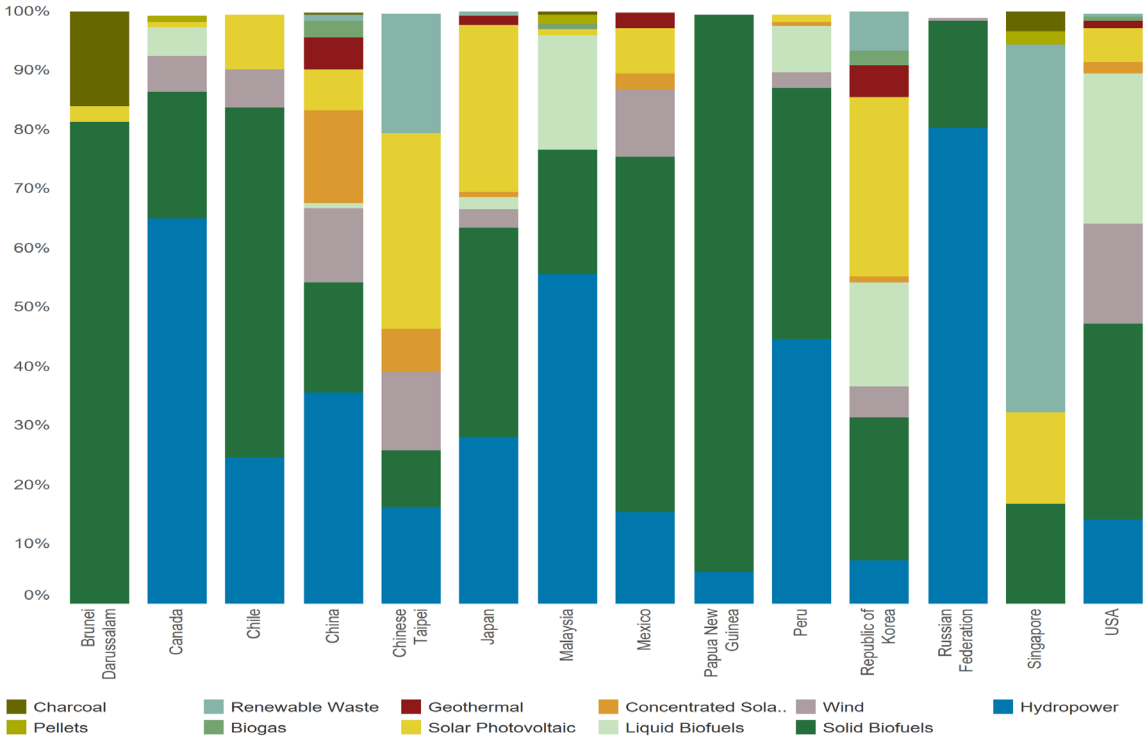


Latest year

- Reported APEC electricity generation (17 533 TWh)
- Fossil fuel sources accounted for 64% of electricity generation, followed by renewable hydropower 15% and nuclear 10% of total generation.

Technologies shares of TFREC varies across APEC economies

Selected APEC economies: Final renewable energy consumption by RE technology in 2020



- IRENA compiles renewable energy balances for most countries
- Data gaps still exist e.g. bioenergy end-use, distributed solar
- Challenges in measurement, collection or reporting of renewable energy data?

Access complete RE balances dataset from here

Source: IRENA 2023, www.irena.org/Statistics

Renewable Energy Data Collection and Reporting Challenges

Accurate data is required for measuring, monitoring & reporting

Example: APEC 21 Renewable Electricity from renewables in 2020
(IRENA /EGEDA reporting)

APEC 21 (TWh)	IRENA	EGEDA	*Diff*	
Total Renewable	4354	4316	38	
Solar	558	548	10	*distributed solar ?*
Wind	917	915	2	
Solid Biomass	193	172	21	*Estimation ? E.g MW -> GW, NVC ..etc*
Renewable Municipal waste	49		49	*missing: 50% of municipal waste= RE*
Liquid Biofuels	2		2	
Biogas	25	19	6	
Hydropower	2621	2584	37	*missing data*
Geothermal	62	63	-1	
Other renewables	0	33	-33	*Technology definition*

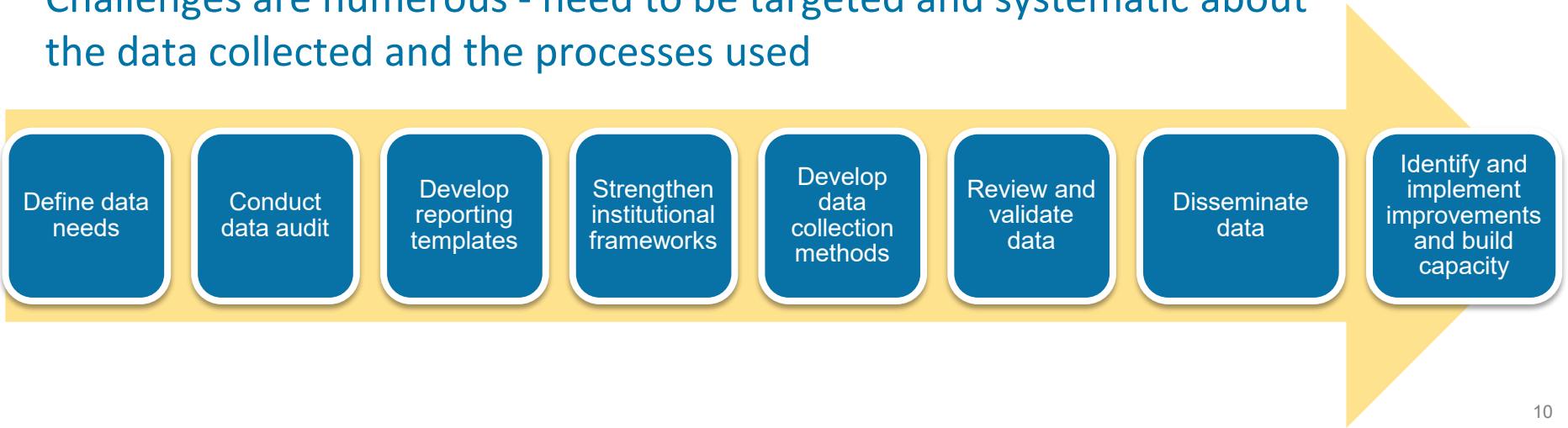
Accurate data collection at economy level is required for effective target monitoring and reporting at regional level

Renewable Energy Data Collection Challenges

Data collection challenges:

1. Institutional and human resource capacity
2. Technical challenges
3. Timeliness of data collection

Challenges are numerous - need to be targeted and systematic about the data collected and the processes used



What data are needed?

- Define renewable energy data collection needs based on:
  - National objectives for renewable energy data collection
  - The current and future relevance of RE products

Objective	Required data
To measure progress towards a renewable energy target (as a share of final energy consumption)	Annual energy balance showing renewable energy consumption, including its share of heat and electricity consumption
To monitor short-term trends in the markets for renewable energy	Quarterly renewable capacity statistics, investment statistics, cost and price statistics
To monitor and adjust a feed-in-tariff programme for rooftop solar photovoltaic installations	Monthly statistics on new rooftop solar photovoltaic installations, electricity prices and solar panel costs
To monitor energy access, measured as the share of the population with an electricity supply	Annual statistics on the number of households connected to the national electricity grid and sales of solar home systems
To measure energy security	Annual energy balance showing net imports of energy as a share of final consumption, by sector

Assess existing data and identify gaps

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Simplified example of an assessment

Flow	Electricity (on grid)	Electricity (off grid)	Solar thermal	Bioenergy
Production	electricity company, regulator, IPPs, industry associations	household surveys, retail surveys, IPPs	household surveys, retail surveys, planning authorities	household surveys, retail surveys, agricultural surveys
Trade	network operator	customs administration (equipment and biofuels)		
Supply	**Calculated**			
Transformation	electricity company, IPPs, industry associations	IPPs	electricity company, IPPs	wood and food processing enterprises
Losses	network operator, distribution company	IPPs		
Consumption	**Calculated**			
Industry	distribution company	enterprise surveys		
Households		household surveys, market surveys		
Services		enterprise surveys		
Other		enterprise surveys		agricultural surveys

- Identify other organizations that may already be collecting data, possible administrative data sources?

Appropriate data collection mechanisms are needed

Most energy data can be collected from four surveys

FLOW	SECTOR						
	Energy	Industry	Commerce	Services	Other (AFF)	Transport*	Households
Commodity production	Primary and secondary fossil fuels and primary renewable heat	Secondary fossil fuels, primary renewable heat, biofuels and waste		Waste, biofuels (solids, biogas)	Biofuels (solids, biogas)		Biofuels (solids, biogas) and primary renewable heat (solar water heating)
Commodity trade, stock changes and bunkers	Primary and secondary fossil fuels and biofuels	Primary and secondary fossil fuels and biofuels	Primary and secondary fossil fuels and biofuels	Primary and secondary fossil fuels and biofuels	Primary and secondary fossil fuels and biofuels	Primary and secondary fossil fuels and biofuels, international bunkers	
Electricity and heat production and associated transformation	Electricity and heat from all sources [MAIN ACTIVITY PRODUCERS]	Electricity and heat from all sources	Electricity from renewables (small-scale devices, such as solar PV, wind)	Electricity and heat from all sources, especially waste, biogas and solar PV	Electricity and heat from all sources, especially biofuels	Electricity from all sources (for rail)	Electricity from renewables (small-scale devices, such as solar PV, wind)
Other transformation	Primary to secondary fuel transformation	Primary to secondary fuel transformation					Charcoal production
Distribution losses	Electricity, heat and fuel losses	Electricity, heat and fuel losses		Electricity, heat and biogas losses	Electricity, heat and biofuel losses	Fuel losses	
Final consumption by sector	Own use and final sales of all energy types	Own use and final sales of all energy types	Own use of all energy types and final sales of fuels	Own use of all energy types and final sales of waste, biofuels, electricity and heat	Own use of all energy types and final sales of biofuels, electricity and heat	Own use of all energy types and final sales of secondary fossil fuels and biofuels	Own use of all energy types and final sales of biofuels

Fuel-specific survey

Trade data

Energy company survey

Enterprise survey

Household survey

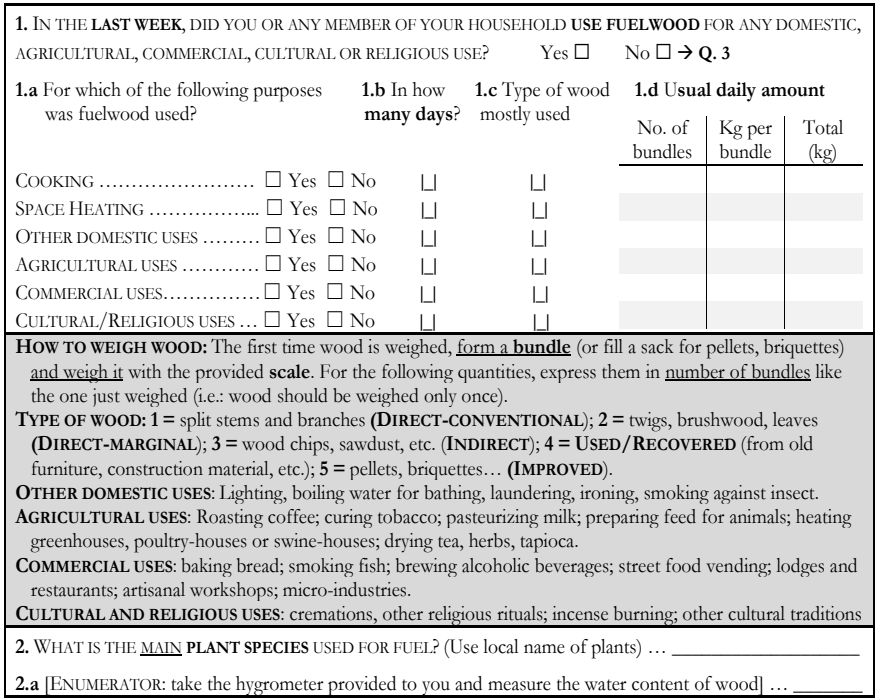
* Transport includes fuel retailing, as well as road, rail, air and shipping operators

Given costs of implementing surveys, explore whether existing data collection activities can be used before a new survey is conducted? Usage of administrative data sources for estimation?

Example: UN FAO WoodFuel Survey Module

Main topics include:

- Fuelwood use, collection and sales
- Charcoal use, production and sales
- ‘ Long’ and ‘short’ version available



1. IN THE **LAST WEEK**, DID YOU OR ANY MEMBER OF YOUR HOUSEHOLD **USE FUELWOOD** FOR ANY DOMESTIC, AGRICULTURAL, COMMERCIAL, CULTURAL OR RELIGIOUS USE? Yes ☐ No ☐ → **Q. 3**

1.a For which of the following purposes was fuelwood used?		**1.b** In how **many days**?	**1.c** Type of wood mostly used	**1.d Usual daily amount** No. of bundles	Kg per bundle	Total (kg)
COOKING ……	☐ Yes ☐ No	⌊⌋	⌊⌋			
SPACE HEATING ……..	☐ Yes ☐ No	⌊⌋	⌊⌋			
OTHER DOMESTIC USES ……	☐ Yes ☐ No	⌊⌋	⌊⌋			
AGRICULTURAL USES ……	☐ Yes ☐ No	⌊⌋	⌊⌋			
COMMERCIAL USES……	☐ Yes ☐ No	⌊⌋	⌊⌋			
CULTURAL/RELIGIOUS USES …	☐ Yes ☐ No	⌊⌋	⌊⌋			

HOW TO WEIGH WOOD: The first time wood is weighed, form a **bundle** (or fill a sack for pellets, briquettes) and weigh it with the provided **scale**. For the following quantities, express them in number of bundles like the one just weighed (i.e.: wood should be weighed only once).

TYPE OF WOOD: 1 = split stems and branches **(DIRECT-CONVENTIONAL)**; **2 =** twigs, brushwood, leaves **(DIRECT-MARGINAL)**; **3 =** wood chips, sawdust, etc. **(INDIRECT)**; **4 = USED/RECOVERED** (from old furniture, construction material, etc.); **5 =** pellets, briquettes… **(IMPROVED)**.

OTHER DOMESTIC USES: Lighting, boiling water for bathing, laundering, ironing, smoking against insect.

AGRICULTURAL USES: Roasting coffee; curing tobacco; pasteurizing milk; preparing feed for animals; heating greenhouses, poultry-houses or swine-houses; drying tea, herbs, tapioca.

COMMERCIAL USES: baking bread; smoking fish; brewing alcoholic beverages; street food vending; lodges and restaurants; artisanal workshops; micro-industries.

CULTURAL AND RELIGIOUS USES: cremations, other religious rituals; incense burning; other cultural traditions

2. WHAT IS THE MAIN **PLANT SPECIES** USED FOR FUEL? (Use local name of plants) … _____

2.a [ENUMERATOR: take the hygrometer provided to you and measure the water content of wood] … _____

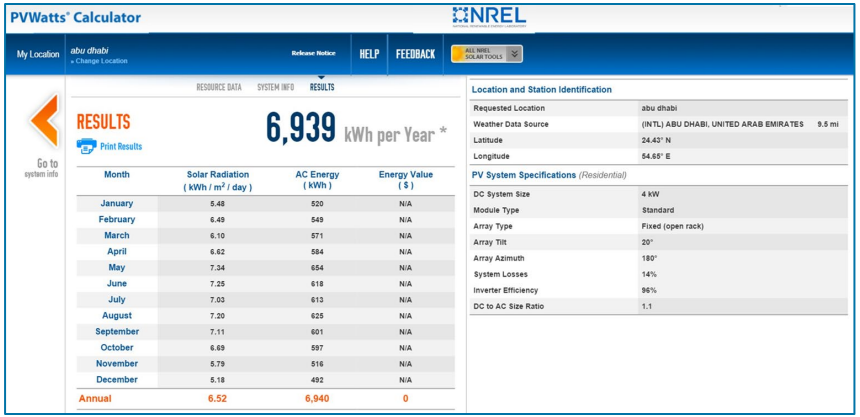
✓ *IRENA recommends the use of FAO WFSM for collecting data on woodfuel consumption + national ‘customisations’*

Example: Solar PV capacity

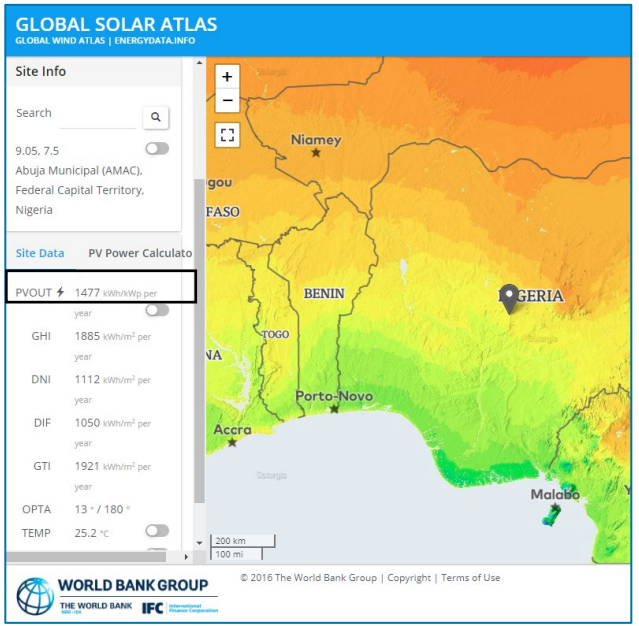
- If official statistics are not available (and assuming no solar cell manufacturing) use import data
- HS code 854140: Photosensitive Semiconductor Devices, Photovoltaic Cells and Light Emitting Diodes
- comtrade.un.org or trademap.org
- Conversion factor: 10W/kg

Example: Solar PV Generation

- Solar radiation x system size x efficiency x utilization
- Many tools available to estimate production



Source: http://pvwatts.nrel.gov



Source: https://globalsolaratlas.info

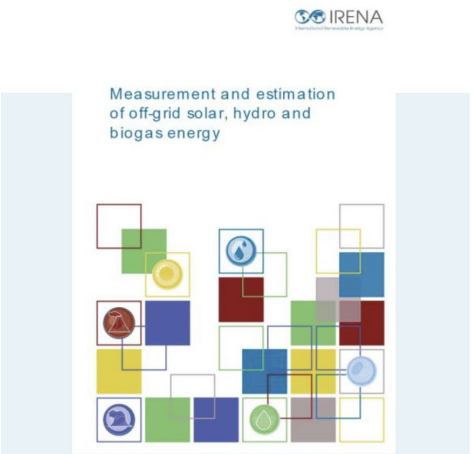
Solar water heaters – Production estimation

When the collector area and type is known

- Un-glazed collectors: 0.29 x GHI x A
- Glazed collectors for hot water: 0.44 * GHI * A
- Glazed collectors for hot water and space heating: 0.33 * GHI * A
- Where:
  - GHI= global horizontal irradiance (kWh/m^2 per year)
  - A = collector area m^2
- **Remember to convert kWh (thermal) to TJ!**

Source: IEA Solar Heating and Cooling Programme: http://www.iea-shc.org/Data/Sites/1/documents/statistics/Calculation_Method.pdf

IRENA Renewable Energy Data Collection Guides



Measurement and estimation of off-grid solar, hydro and biogas energy

Measuring small-scale biogas capacity and production

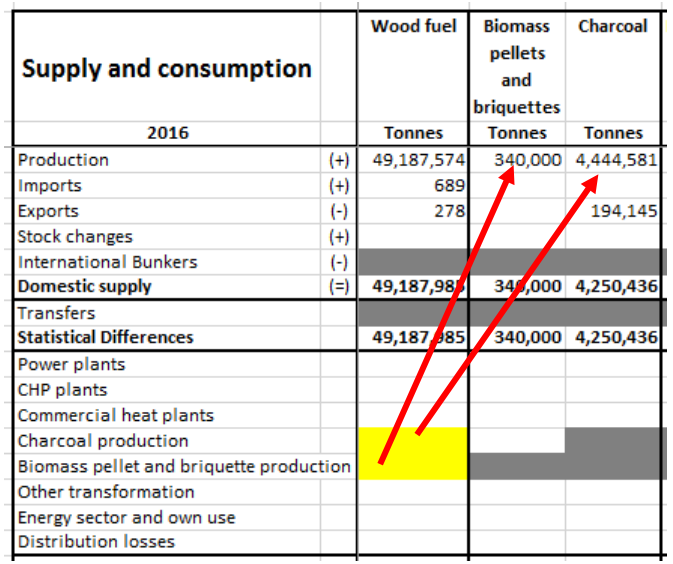
Capacity Needs Assessment for Renewable Energy Statistics

https://www.irena.org/Data/Capacity-building/Data-Collection-Guide

Validation to check data: complete, consistent, realistic?

Typical shortcomings/mistakes

- Figures don't add up (e.g. in transformation)
- Sudden or unexpected changes (due to changes in methodology, definitions or survey responses)
- Electricity production too high for capacity
- CHP reported as electricity production
- Auto-consumption missing (e.g. only electricity to the grid is counted)
- Direct uses of bioenergy missing



Supply and consumption		Wood fuel	Biomass pellets and briquettes	Charcoal
2016		Tonnes	Tonnes	Tonnes
Production	(+)	49,187,574	340,000	4,444,581
Imports	(+)	689		
Exports	(-)	278		194,145
Stock changes	(+)			
International Bunkers	(-)			
Domestic supply	(=)	**49,187,985**	**340,000**	**4,250,436**
Transfers				
Statistical Differences		**49,187,985**	**340,000**	**4,250,436**
Power plants				
CHP plants				
Commercial heat plants				
Charcoal production				
Biomass pellet and briquette production				
Other transformation				
Energy sector and own use				
Distribution losses				

Involve stakeholders in the review process to ensure that final numbers are accurate !

Mechanisms for Data Dissemination

- It is important that data is made easily accessible to all stakeholders
- This could include online platforms or publications such as a statistical yearbook
- Release data following a calendar
- Considerations: will all data be made publically available? Are there issues of confidentiality or levels of data access?

Data improvement opportunities in APEC are related to data collection, dissemination and communication across agencies

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Common improvement opportunity themes for renewable data

Round Table Discussion

Economy Capacity	Challenges	Examples of Good Practices
LEGAL AND INSTITUTIONAL FRAMEWORKS		
WELL-DEFINED DATA REQUIREMENTS		
SUFFICIENT SKILLED PERSONNEL		
CLEAR METHODOLOGIES AND PROCESSES		
APPROPRIATE DATA COLLECTION MECHANISMS		
ANALYSIS, REVIEW AND VALIDATION PROCEDURES		
MECHANISMS FOR DATA DISSEMINATION		

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Thank you

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A1. IRENA gets installed capacity data from various sources, with official values often showing a 2-year delay

Brunei Darussalam

	Official	Unofficial
Year-1	-	Media briefs/press Power plant databases
Year-2	IRENA questionnaire Department of Statistics	-
Notes	Small solar PV easy to track now, but will become harder in the future as it expands	

Indonesia

	Official	Unofficial
Year-1	ESDM Capaian Kinerja Sektor	Media briefs/press Power plant databases
Year-2	Handbook of Energy and Economic Statistics of Indonesia (HEESI) Lapoan Kinerja KESDM No questionnaire	-
Notes	ESDM is a good source for last year's capacity. Additional sources used to classify renewable energy (bioenergy, thermal) Off-grid not clear for PV own-use (except government) in HEESI No questionnaire process defined with the government	

A1. IRENA gets installed capacity data from various sources, with official values often showing a 2-year delay

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Malaysia

	Official	Unofficial
Year-1	SEDA Annual Reports and website	Media briefs/press Power plant databases
Year-2	MEIH Energy Statistics Handbook MEIH National Energy Balance MEIH Performance & Statistical Info on the Electricity Supply Industry No questionnaire	-
Notes	SEDA articles are the source for most y-1 data SEDA often outlines what was accepted into different schemes but not about what is commissioned/operating All the sources are good to double-check for y-2 No questionnaire process defined with the government	

A1. IRENA gets installed capacity data from various sources, with official values often showing a 2-year delay

Philippines

	Official	Unofficial
Year-1	DOE RE project list	-
Year-2	DOE Existing Plants ERC Net Metering Requests DOE Power Statistics No questionnaire	-
Notes	Great bioenergy split in list of existing plants Great list of existing plants Consistent and multiple sources to cross-check DOE's existing plants list is the preferred source along with the Net Metering requests (as these are not included in DOE) Quick data availability (all sources have info for y-1 by June) No questionnaire process defined with the government	

Singapore

	Official	Unofficial
Year-1	EMA Capacity Reports	Media briefs/press IRENA Estimates
Year-2	EMA SES No questionnaire	-
Notes	Latest data for y-1 comes out during or after March Good information per power plant, but missing fuel types No questionnaire process defined with the government	

A1. IRENA gets installed capacity data from various sources, with official values often showing a 2-year delay

Thailand

	Official	Unofficial
Year-1	DEDE Thai web site	Media briefs/press Power plant databases IRENA Estimates
Year-2	EGAT capacity EPPO Electricity Stats No questionnaire	-
Notes	DEDE Thai RE projects was the most useful, but the site seems to be down since 2022. Thus using unofficial sources No good official source for detailed power plants No official breakdown of thermal plants Fossil fuels by comparing EGAT installed capacity with previous year (additions). Confirmed with Platts. No questionnaire process defined with the government	

Viet Nam

	Official	Unofficial
Year-1	EVN Activities	Viet Nam Energy Partnership Group Viet Nam Energy Online
Year-2	EVN Annual Report No questionnaire	-
Notes	"Activities" presentations in the EVN website used for y-1. Careful to not consider the plants "in the grid" that are physically located in Lao PDR Other online sources help to fill-in the gaps The EVN annual report is most useful for y-2 capacity No questionnaire process defined with the government	

A2. Capacity data for APEC countries, extracts and examples

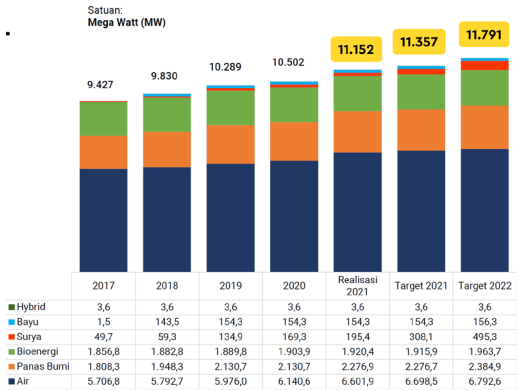
Brunei Darussalam

	2010	2011
Generation Capacity (MW)	741.90	745.90
Peak Demand (MW)	581.51	573.06
Production (GWh)	3,792.23	3,722.98
Increase in Production over Previous Year		
GWh	180.76	(69.25)
Percentage	5.01	(1.83)
Consumption (GWh)	3,327.57	3,389.44
Residential	1,181.43	1,201.70
Commercial	831.45	877.97
Government	705.81	733.87
Others	608.88	575.90
Increase in Consumption over Previous Year		
GWh	84.52	61.87
Percentage	2.61	1.86
Coverage in Electricity Supply (Percentage)	99.7	99.9

Source ： Ministry of Energy (Energy and Manpower) and Industry
https://deps.mofe.gov.bn/SitePages/eData%20library.aspx

A2. Capacity data for APEC countries, extracts and examples

Indonesia



	2017	2018	2019	2020	Realisasi 2021	Target 2021	Target 2022
Hybrid	3,6	3,6	3,6	3,6	3,6	3,6	3,6
Bayu	1,5	143,5	154,3	154,3	154,3	154,3	156,3
Surya	49,7	59,3	134,9	169,3	195,4	308,1	495,3
Bioenergi	1.856,8	1.882,8	1.889,8	1.903,9	1.920,4	1.915,9	1.963,7
Panas Bumi	1.808,3	1.948,3	2.130,7	2.130,7	2.276,9	2.276,7	2.384,9
Air	5.706,8	5.792,7	5.976,0	6.140,6	6.601,9	6.698,5	6.792,6

6.4.1 Power Plant Installed Capacity

(MW)

Year	On Grid								On Grid							
	Hydro PP	Steam PP	Gas PP	Combined Cycle PP	Geother-mal PP[1]	Diesel PP[1]	Gas Engine PP	Wind PP		Mycro Hydro PP	Mini Hydro PP	Solar PP	Coal Gasification PP	Waste PP	Biogas PP	Biomass PP	Total On Grid
2010	3,719.69	12,981.50	3,821.57	7,590.32	1,189.00	4,569.89	92.84	0.34		0.69	13.53	0.19	0.00	0.00	0.00	0.00	33,979.56
2011	3,880.83	16,318.00	4,236.02	8,480.97	1,226.00	5,471.93	169.54	0.93		5.93	57.66	1.16	41.00	26.00	0.00	0.00	39,915.97
2012	4,078.24	19,714.00	4,343.82	9,461.11	1,336.00	5,973.58	198.74	0.93		6.71	61.46	4.09	41.00	26.00	0.00	0.00	45,245.67
2013	5,058.87	23,812.53	4,389.08	9,852.21	1,343.50	5,935.00	448.12	0.63		29.69	77.05	9.02	6.00	26.00	0.00	0.00	50,987.69
2014	5,059.06	25,104.23	4,310.50	10,146.11	1,403.50	6,206.99	610.74	1.12		30.46	139.87	9.02	6.00	36.00	0.00	0.00	53,063.60
2015	5,068.59	26,447.58	4,495.56	10,293.47	1,438.30	3,824.07	1,101.23	1.46		90.15	148.71	36.94	0.00	15.65	54.72	1,671.29	54,687.72
2016	5,343.59	28,351.97	4,969.24	10,293.47	1,533.30	3,979.40	1,806.99	1.46		95.87	211.40	46.70	0.00	15.65	64.16	1,703.29	58,416.48
2017	5,343.59	30,768.07	4,976.24	10,418.47	1,808.30	4,396.35	2,264.85	1.46		103.76	240.55	54.48	0.00	15.65	100.62	1,740.54	62,232.93
2018	4,461.59	31,587.17	5,348.44	11,220.10	1,948.30	4,630.90	2,357.66	143.03		98.39	267.79	24.42	0.00	15.65	40.35	142.02	62,285.81
2019	4,620.52	34,737.17	5,348.44	11,669.54	2,130.70	4,779.68	2,842.03	153.83		99.49	311.14	105.03	0.00	15.65	42.15	147.02	67,002.40
2020	4,700.67	36,667.86	5,348.44	12,235.71	2,130.70	4,863.53	3,177.93	153.83		100.13	375.49	123.84	0.00	16.45	18.60	150.52	70,063.71

6.4.1 Power Plant Installed Capacity (Continued)

(MW)

Year	Off Grid											Grand Total On Grid + Off Grid
	Hydro PP[1]	Micro Hydro PP	Solar PP + PV	Wind PP	Biomass PP	Biogas PP		Hybrid PP	Solar-Powered Public Street Lighting [1]	Solar-Powered Energy Saving Lamp	Total Off Grid	
2018	938.00	6.88	28.19	0.48	1,616.52	68.26		3.58	5.28	7.58	2,668.99	64,954.80
2019	938.00	6.88	29.88	0.48	1,616.52	70.26		3.58	9.23	10.90	2,676.50	69,678.90
2020	938.00	26.30	34.55	0.48	1,616.52	101.82		3.58	16.04	10.90	2,732.14	72,795.85

A2. Capacity data for APEC countries, extracts and examples

Malaysia

Installed Capacity as of 31 December 2019

Unit: MW

		Hydro	Natural Gas	Coal	Diesel/ MFO	Biomass	Solar	Biogas	Others	Total
PENINSULAR MALAYSIA	TNB	2,556.5	2,230.0	0.0	0.0	0.0	0.0	0.0	0.0	4,786.5
	IPPs	20.0	9,040.4	12,180.0	0.0	0.0	0.0	0.0	0.0	21,240.4
	Co-Generation	0.0	945.9	0.0	0.0	12.4	0.0	1.9	79.0	1,039.2
	Self-Generation	2.1	20.9	0.0	39.4	100.6	8.1	0.4	0.0	171.5
	FiT	63.8	0.0	0.0	0.0	44.9	288.1	93.2	0.0	489.9
	LSS	0.0	0.0	0.0	0.0	0.0	614.9	0.0	0.0	614.9
	NEM	0.0	0.0	0.0	0.0	0.0	37.5	0.0	0.0	37.5
	Subtotal	**2,642.4**	**12,237.3**	**12,180.0**	**39.4**	**157.9**	**948.6**	**95.4**	**79.0**	**28,379.9**
SABAH	SESB	83.1	112.0	0.0	220.9	0.0	23.2	0.0	0.0	439.2
	IPPs	0.0	1,012.6	0.0	64.4	0.0	0.0	0.0	0.0	1,077.0
	Co-Generation	0.0	65.0	0.0	0.0	116.2	0.0	0.0	0.0	181.2
	Self-Generation	0.0	3.9	0.0	137.3	79.0	0.0	42.5	0.0	262.7
	FiT	6.5	0.0	0.0	0.0	25.8	34.4	9.6	0.0	76.3
	LSS	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	50.0
	NEM**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Subtotal	**89.6**	**1,193.5**	**0.0**	**422.6**	**221.0**	**107.6**	**52.1**	**0.0**	**2,086.4**
SARAWAK	SEB	3,458.1	583.6	1,103.9	97.5	0.0	0.1	0.0	0.0	5,243.3
	Co-Generation	0.0	389.0	0.0	0.0	0.0	0.0	0.0	0.0	389.0
	Self-Generation	0.0	0.0	0.0	17.0	61.7	0.0	0.5	5.1	84.3
	Subtotal	**3,458.1**	**972.6**	**1,103.9**	**114.5**	**61.7**	**0.1**	**0.5**	**5.1**	**5,716.6**
	Total	**6,190.1**	**14,403.4**	**13,283.9**	**576.5**	**440.6**	**1,056.3**	**148.0**	**84.1**	**36,182.8**
	Share (%)	**17.1%**	**39.8%**	**36.7%**	**1.6%**	**1.2%**	**2.9%**	**0.4%**	**0.2%**	**100.0%**

KAPASITI TERPASANG MENGIKUT JENIS BAHAN API DI MALAYSIA (MW)

INSTALLED CAPACITY BY FUEL TYPE IN MALAYSIA (MW)

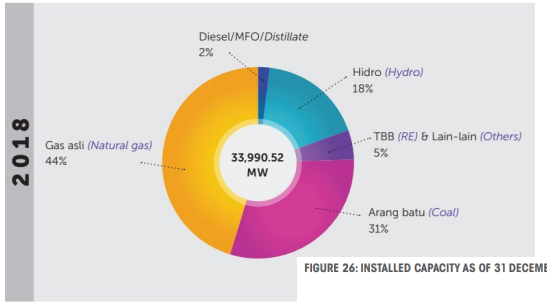
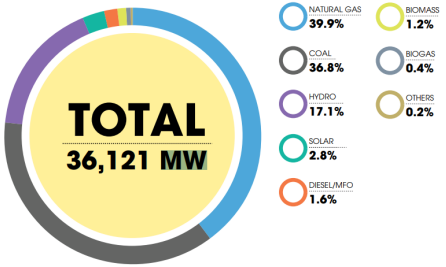


FIGURE 26: INSTALLED CAPACITY AS OF 31 DECEMBER 2019



Source: Power Utilities and IPPs

A2. Capacity data for APEC countries, extracts and examples

IRENA
International Renewable Energy Agency

Philippines

Summary of Renewable Energy (RE) Projects under the RE Act of 2008 (as of 31 December 2021)

Resources	No. of Projects		Potential Capacity MW		Installed Capacity MW	
	Commercial	Own-Use	Commercial	Own-Use	Commercial	Own-Use
Hydropower	414	2	12,113.480	1.560	1,106.776	-
Ocean Energy	8	-	24.000	-	-	-
Geothermal	37	-	883.200	-	1,928.070	-
Wind	108	1	14,822.030	1.000	442.900	0.010
Solar*	267	40	19,991.630	9.990	1,310.690	6.640
Biomass	61	21	219.140	3.100	614.106	175.271
Sub-total	**895**	**64**	**48,053.48**	**15.650**	**5,402.54**	**181.921**
GRAND TTAL	**959**		**48,069.13**		**5,584.46**	

Geothermal

	2017	2018	2019	2020
Installed Generating Capacity (MW)	1,916	1,944	1,928.0	1,928.1
Dependable Generating Capacity (MW)	1,752	1,770	1,792.3	1,753.1
Electricity Generation (GWh)	10,270	10,435	10,690.8	10,756.8

Hydropower

	2017	2018	2019	2020
Installed Generating Capacity (MW)	3,627	3,701	3,760.0	3,779.3
Dependable Generating Capacity (MW)	3,269	3,473	3,508.1	3,526.6
Electricity Generation (GWh)	9,611	9,384	8,025.5	7,192.0

Wind

	2017	2018	2019	2020
Installed Generating Capacity (MW)	427	427	427.0	442.9
Dependable Generating Capacity (MW)	383	427	426.9	442.9
Electricity Generation (GWh)	1,094	1,153	1,041.7	1,026.4

A2. Capacity data for APEC countries, extracts and examples

Singapore

Electricity Generation Capacity by Technology									Unit: MW
	2013	2014	2015	2016	2017	2018	2019	2020	2021[1]
Total Registered Generation Capacity	**12,433.8**	**12,909.1**	**13,394.5**	**13,445.0**	**13,615.5**	**13,652.2**	**12,563.6**	**12,021.1**	**12,033.3**
CCGT/Co-Gen/Tri-Gen	9,430.2	9,892.0	10,355.5	10,355.5	10,508.2	10,501.3	10,491.4	10,491.4	10,491.4
Steam Turbine	2,555.0	2,555.0	2,556.5	2,556.1	2,554.6	2,554.6	1,363.6	763.6	763.6
Open Cycle Gas Turbine	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0
Waste-To-Energy	256.8	256.8	256.8	256.8	256.8	256.8	256.8	256.8	256.8
Solar PV[3]	11.8	25.3	45.7	96.6	115.9	159.5	271.8	329.3	341.5
					-	-			
Of Which: Main Power Producers	**12,098.7**	**12,535.0**	**12,930.7**	**12,930.7**	**12,930.7**	**12,930.7**	**11,739.7**	**11,139.7**	**11,139.7**
CCGT/Co-Gen/Tri-Gen	9,120.9	9,557.2	9,952.9	9,952.9	9,952.9	9,952.9	9,952.9	9,952.9	9,952.9
Steam Turbine	2,541.0	2,541.0	2,541.0	2,541.0	2,541.0	2,541.0	1,350.0	750.0	750.0
Open Cycle Gas Turbine	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0
Waste-To-Energy	256.8	256.8	256.8	256.8	256.8	256.8	256.8	256.8	256.8
					-	-			
Of Which: Autoproducers	**335.1**	**374.1**	**463.8**	**514.3**	**684.8**	**721.5**	**823.9**	**881.4**	**893.6**
CCGT/Co-Gen/Tri-Gen	309.3	334.8	402.6	402.6	555.3	548.4	538.5	538.5	538.5
Steam Turbine	14.0	14.0	15.5	15.1	13.6	13.6	13.6	13.6	13.6
Open Cycle Gas Turbine	-	-	-	-	-	-	-	-	-
Solar PV	11.8	25.3	45.7	96.6	115.9	159.5	271.8	329.3	341.5

Sources: Energy Market Company (EMC), SP PowerGrid Ltd (SPPG) & Energy Market Authority (EMA)

Electricity Generation Capacity by Generator, 2(						Unit: MW
	2016	2017	2018	2019	2020	2021[1]
Total Registered Generation Capacity	**13,445.0**	**13,615.5**	**13,652.2**	**12,563.6**	**12,021.1**	**12,033.3**
Of Which: Main Power Producers						
Senoko Energy	**3,300.0**	**3,300.0**	**3,300.0**	**2,807.0**	**2,807.0**	**2,807.0**
CCGT/Co-Gen/Tri-Gen	2,807.0	2,807.0	2,807.0	2,807.0	2,807.0	2,807.0
Steam Turbine	493.0	493.0	493.0	-	-	-
Open Cycle Gas Turbine	-	-	-	-	-	-
YTL PowerSeraya	**3,100.0**	**3,100.0**	**3,100.0**	**2,402.0**	**2,402.0**	**2,402.0**
CCGT/Co-Gen/Tri-Gen	1,472.0	1,472.0	1,472.0	1,472.0	1,472.0	1,472.0
Steam Turbine	1,448.0	1,448.0	1,448.0	750.0	750.0	750.0
Open Cycle Gas Turbine	180.0	180.0	180.0	180.0	180.0	180.0
Tuas Power Generation[2]	**2,579.4**	**2,579.4**	**2,579.4**	**2,579.4**	**1,979.4**	**1,979.4**
CCGT/Co-Gen/Tri-Gen	1,979.4	1,979.4	1,979.4	1,979.4	1,979.4	1,979.4
Steam Turbine	600.0	600.0	600.0	600.0	-	-
Open Cycle Gas Turbine	-	-	-	-	-	-
SembCorp Cogen	**1,188.8**	**1,188.8**	**1,188.8**	**1,188.8**	**1,188.8**	**1,188.8**
CCGT/Co-Gen/Tri-Gen	1,188.8	1,188.8	1,188.8	1,188.8	1,188.8	1,188.8
Steam Turbine	-	-	-	-	-	-
Open Cycle Gas Turbine	-	-	-	-	-	-
Keppel Merlimau Cogen	**1,310.0**	**1,310.0**	**1,310.0**	**1,310.0**	**1,310.0**	**1,310.0**
CCGT/Co-Gen/Tri-Gen	1,310.0	1,310.0	1,310.0	1,310.0	1,310.0	1,310.0
Steam Turbine	-	-	-	-	-	-
Open Cycle Gas Turbine	-	-	-	-	-	-
PacificLight Power	**800.0**	**800.0**	**800.0**	**800.0**	**800.0**	**800.0**
CCGT/Co-Gen/Tri-Gen	800.0	800.0	800.0	800.0	800.0	800.0
Steam Turbine	-	-	-	-	-	-
Open Cycle Gas Turbine	-	-	-	-	-	-

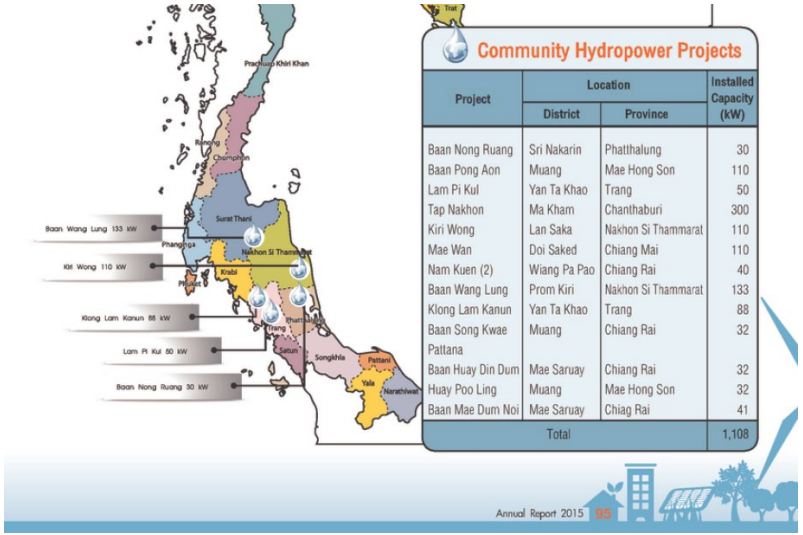
A2. Capacity data for APEC countries, extracts and examples

Thailand

TABLE 5.1-1Y
Installed Generating Capacity

Unit : MW

Year	EGAT	IPP	SPP	Imported	Total
2001	15,000	4,926	1,768	340	22,034
2002	15,000	7,071	1,768	640	24,479
2003	14,431	8,000	1,912	640	24,983
2004	15,422	8,000	1,994	640	26,056
2005	15,795	8,000	2,016	640	26,450
2006	15,795	8,610	2,062	640	27,106
2007	15,794	10,017	2,079	640	28,530
2008	15,021	12,152	2,079	640	29,892
2009	14,328	12,152	2,092	640	29,212
2010	14,998	12,152	2,182	1,588	30,920
2011	14,998	12,082	2,182	2,185	31,447
2012	14,996	12,714	2,608	2,282	32,600
2013	15,010	12,742	3,525	2,405	33,681
2014	15,482	13,167	3,615	2,404	34,668
2015	15,518	14,767	5,144	3,386	38,815
2016	16,385	14,949	6,345	3,878	41,556
2017	16,071	14,949	7,536	3,878	42,433
2018	15,790	14,949	8,757	3,878	43,374
2019	15,130	14,949	9,498	5,720	45,297
2020	16,037	14,249	9,474	5,721	45,480
2021	16,082	15,499	9,381	5,721	46,682



Community Hydropower Projects

Project	Location		Installed Capacity (kW)
	District	Province	
Baan Nong Ruang	Sri Nakarin	Phatthalung	30
Baan Pong Aon	Muang	Mae Hong Son	110
Lam Pi Kul	Yan Ta Khao	Trang	50
Tap Nakhon	Ma Kham	Chanthaburi	300
Kiri Wong	Lan Saka	Nakhon Si Thammarat	110
Mae Wan	Doi Saked	Chiang Mai	110
Nam Kuen (2)	Wiang Pa Pao	Chiang Rai	40
Baan Wang Lung	Prom Kiri	Nakhon Si Thammarat	133
Klong Lam Kanun	Yan Ta Khao	Trang	88
Baan Song Kwae Pattana	Muang	Chiang Rai	32
Baan Huay Din Dum	Mae Saruay	Chiang Rai	32
Huay Poo Ling	Muang	Mae Hong Son	32
Baan Mae Dum Noi	Mae Saruay	Chiag Rai	41
Total			1,108

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A2. Capacity data for APEC countries, extracts and examples

IRENA
International Renewable Energy Agency

Viet Nam

The 80MW Da Nhim Hydropower Plant Extension Project reaches the finish line

04/08/2021

At 8a.m. on 4 August 2021, Da Nhim - Ham Thuan - Da Mi Hydropower Joint Stock Company and related organizations have successfully synchronized the power unit H5 (80MW) of Da Nhim Hydropower Pl (Lam Dong province) to the power grid.

Update on signing of power purchase agree progress of wind power projects put into co operation (COD) in 2021

22/07/2021

Recently, EVN has signed power purchase agreements power plant projects with a total capacity of 8,144.88

POWER GENERATION

Installed capacity by fuel types

Power source	2019		2020	
	(MW)	(%)	(MW)	(%)
Hydropower	20,283	36.81%	20,774	29.98%
Coal fired	19,744	35.83%	21,554	31.10%
Gas fired + oil fired	8,857	16.07%	8,858	12.78%
Wind	369	0.67%	518	0.75%
Solar	4,669	8.47%	8,871	12.80%
Rooftop solar	320	0.58%	7,785	11.23%
Biomass	293	0.53%	365	0.53%
Imported	572	1.04%	572	0.83%
Total	**55,107**	**100%**	**69,297**	**100%**

A3. IRENA Questionnaire for installed capacity

IRENA
International Renewable Energy Agency

	2000	2001	2002	2003	2004	2005
ALL PLANTS: TOTAL (ON-GRID)						
ALL PLANTS: NON-RENEWABLE (ON-GRID)						
Fossil fuels						
Coal and peat						
Oil						
Natural gas						
Fossil fuels n.e.s.						
Nuclear						
Other (non-renewable)						
ALL PLANTS: RENEWABLE (ON-GRID)						
Hydropower						
Renewable hydropower						
Mixed plants						
Pumped storage						
Geothermal						
On-grid solar photovoltaic						
On-grid PV (<20kW)						
On-grid PV (20-1000kW)						
On-grid PV (>1MW)						
Concentrated solar power						
Marine energy (tide, wave and ocean)						
Wind energy						
Onshore wind energy						
Offshore wind energy						
Renewable municipal waste						
Solid biofuels						
Wood fuel						
Energy crops						
Wood waste						
Black liquor						
Straw						
Bagasse						
Rice husks						
Other vegetal and agricultural waste						
Renewable industrial waste						
Animal waste						
Primary solid biofuels n.e.s.						
Biomass pellets and briquettes						
Biogas						
Landfill gas						
Sewage sludge gas						
Other biogases from anaerobic fermentation						
Biogases from thermal processes						
Biogas n.e.s.						
Liquid biofuels						
Conventional biogasoline						
Advanced biogasoline						
Conventional biodiesel						
Advanced biodiesel						
Other liquid biofuels						
Capacity of solar water heaters ('000 m2)						

on-grid

ALL PLANTS: TOTAL (OFF-GRID)							
ALL PLANTS: NON-RENEWABLE (OFF-GRID)							
Fossil fuels							
ALL PLANTS: RENEWABLE (OFF-GRID)							
Hydropower							
Renewable hydropower							
Mixed plants							
Pumped storage							
Geothermal							
Off-grid Solar photovoltaic							
Marine energy (tide, wave and ocean)							
Onshore wind energy							
Solid biofuels							
Wood fuel							
Energy crops							
Wood waste							
Black liquor							
Straw							
Bagasse							
Rice husks							
Other vegetal and agricultural waste							
Renewable industrial waste							
Animal waste							
Primary solid biofuels n.e.s.							
Biomass pellets and briquettes							
Biogas							
Landfill gas							
Sewage sludge gas							
Other biogases from anaerobic fermentation							
Biogases from thermal processes							
Biogas n.e.s.							
Liquid biofuels							
Conventional biogasoline							
Advanced biogasoline							
Conventional biodiesel							
Advanced biodiesel							
Other liquid biofuels							

off-grid