Asia-Pacific
Economic Cooperation

2017/EWG/EGNRET48/005

Asia Pacific Energy Research Centre Update

Purpose: Information
Submitted by: APERC

APEC
VIET NAM
2017

48th Expert Group on New and Renewable Energy Technologies Meeting
Jeju, Korea
29-30 March 2017

APEC EGNRET 48 Meeting
Jeju, Korea, 28-30 March, 2017

APERC Update

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Structure

- ✓ Modelling improvements
- ✓ Renewables analysis improvements
- ✓ Renewables potential assessment
- ✓ Other updates

Modelling improvements

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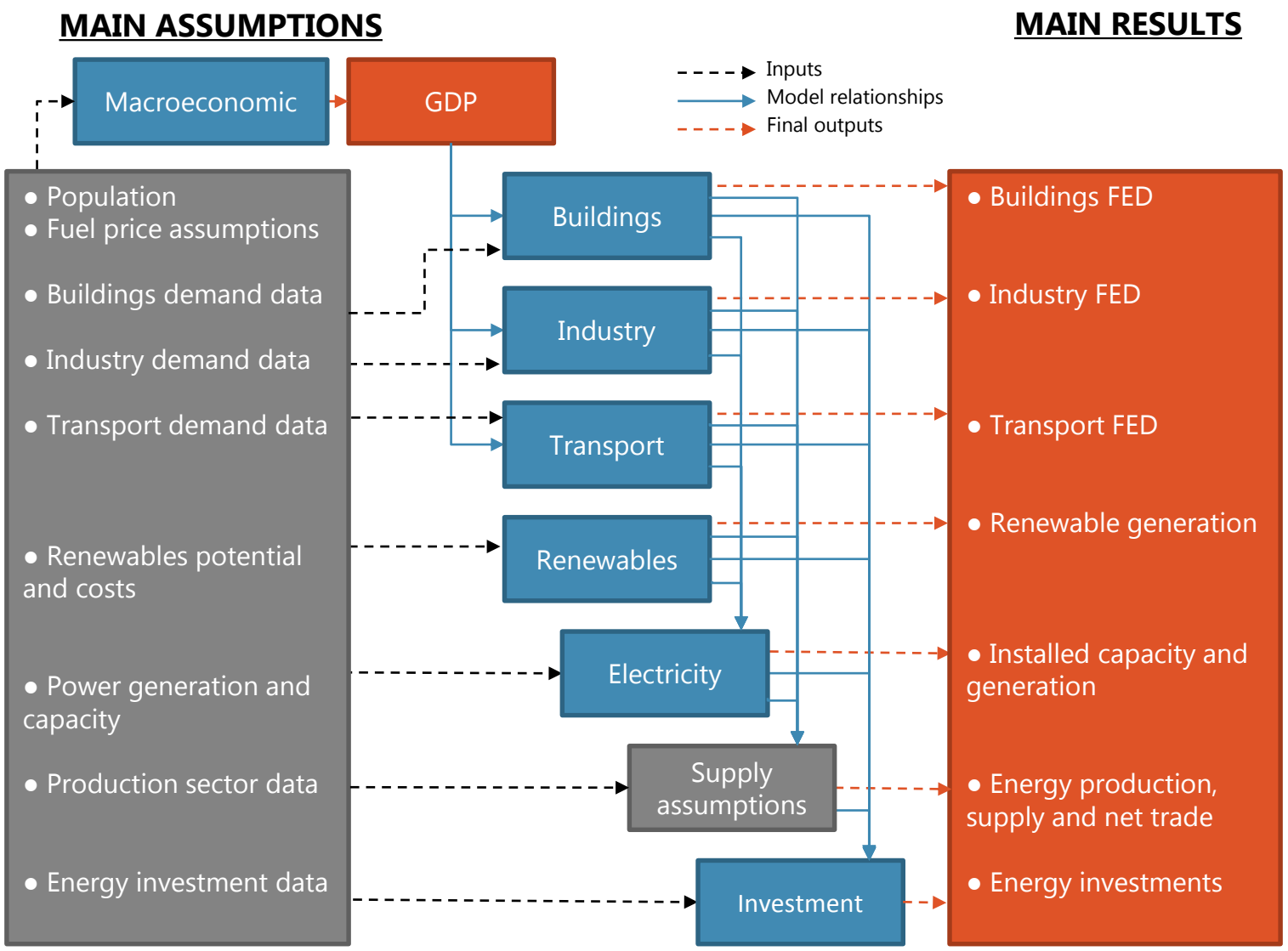
6th and 7th Edition of the Outlook: comparison

	6th edition	7th edition
Economies	21	21
Sub-regions	7	7
Scenarios	BAU + 3	BAU + 2
No. of models	7	10
No. of fuels	12	29
Outlook period	From 2013 to 2040	From 2015 to 2050

Further updates expected, as at 2017.03.24

6th Edition of the Outlook: model structure



7th Edition of the Outlook: DRAFT model structure

Working document, no referencing or citing

7th Edition of the Outlook: sectoral model updates (1)

- **Macroeconomic:**
  - Use OECD GDP forecasts (where available),
- **Buildings:**
  - Activity driven model (space/water heating, space cooling, lighting, appliances),
  - Extensive work underway to address Commercial buildings end-use data unavailability,
- **Transport:**
  - Light Trucks and Buses added, taxis are considered
  - Activity driven model,
  - Modal shift,
  - More detailed fuels analysis,

7th Edition of the Outlook: sectoral model updates (2)

- **Industry:**
  - Bottom-up approach
  - Moving away from ISIC,
  - Energy-intensive sub-sectors are physical output driven, other sub-sectors - value added,
- **Renewables:**
  - Dedicated model no more,
  - Integration with Electricity and Demand sectors,

7th Edition of the Outlook: sectoral model updates (3)

- **Supply:**
  - Production and trade forecast
- **Electricity:**
  - Extensive list of technologies, including Renewables,
  - Improved time-resolution
- **Heat:**
  - New model will accommodate commercial heating and cooling,
- **Investment:**
  - Demand sector investments, e.g. difference between reference and high efficiency appliances,

7th Edition of the Outlook: draft assumptions (1)

✓ Engaging the economy experts to review and comment our modelling assumptions

Renewables assumptions for RESIDENTIAL & COMMERCIAL BUILDINGS & POWER in 20_USA		Indicator	Unit	2015	BAU					Comments
					2020	2030	2040	2050	2015-2050,%	
RESIDENTIAL BUILDINGS										
Solar Thermal	Water heating	CAPEX	$	3,300	3,000	2,600	2,600	2,600	-0.7%	Avg. size: 2m^2, 200L
		Solar factor	SF	2.5	3.0	3.5	3.5	3.5	n/a	
Bioenergy	2015 Tech-Econ. potential and future market uptake		TWh, %						n/a	
	Solid biomass boiler: Space & Water heating	CAPEX	$	4,700	4,900	5,100	5,300	5,500	0.5%	Avg. size:
		Fuel cost	$/t	245	250	260	270	280	0.4%	36kBTU/h = 10.5kW
		Efficiency	%	78%	80%	81%	83%	84%	n/a	
	Biogas boiler: Space & Water heating	CAPEX	$	4,050	5,900	5,900	5,900	5,900	1.1%	Avg. size:
		Fuel cost	$/1,000m^3	150	160	170	180	190	0.7%	36kBTU/h = 10.5kW
		Efficiency	%	82%	90%	90%	90%	90%	n/a	
Geothermal	Ground source heat pump: Space heating & cooling & Water heating	CAPEX	$	12,500	17,500	17,500	17,500	17,500	1.0%	Avg. size:
		Efficiency heating	COP	3.2	3.6	3.8	4.0	4.2	n/a	36kBTU/h = 10.5kW, EER is
		Efficiency cooling	EER	14.2	17.1	21.0	24.0	26.0	n/a	[kBTU/h / kWh]

7th Edition of the Outlook: draft assumptions (2)

Renewables assumptions for RESIDENTIAL & COMMERCIAL BUILDINGS & POWER in 20_USA		Indicator	Unit	2015	BAU				
					2020	2030	2040	2050	2015-2050,%
POWER GENERATION									
Hydro	Large hydro	CAPEX	$/kW	2,411	2,411	2,411	2,411	2,411	0.0%
		OPEX	$/kW/yr.	24	24	24	24	24	0.0%
		Capacity factor	%	42.6%	42.7%	42.7%	42.8%	42.8%	na
	Medium hydro	CAPEX	$/kW	3,020	3,020	3,020	3,020	3,020	0.0%
		OPEX	$/kW/yr.	44	44	44	44	44	0.0%
		Capacity factor	%	50.0%	50.0%	50.0%	50.0%	50.0%	n/a
	Small hydro	CAPEX	$/kW	3,620	3,620	3,620	3,620	3,620	0.0%
		OPEX	$/kW/yr.	73	73	73	73	73	0.0%
		Capacity factor	%	88.0%	88.0%	88.0%	88.0%	88.0%	n/a
Wind	Wind onshore	CAPEX	$/kW	1,644	1,630	1,600	1,560	1,530	-0.2%
		OPEX	$/kW/yr.	46	46	46	46	46	0.0%
		Capacity factor	%	32.7%	33.2%	34.2%	35.0%	35.0%	n/a
	Wind offshore	CAPEX	$/kW	6,331	6,170	5,870	5,590	5,310	-0.5%
		OPEX	$/kW/yr.	76	76	76	76	76	0.0%
		Capacity factor	%	37.7%	38.2%	39.2%	40.0%	40.0%	n/a
Solar	Solar PV: Residential	CAPEX	$/kW	3,690	3,460	3,030	2,660	2,330	-1.3%
		OPEX	$/kW/yr.	32	32	32	32	32	0.0%
		Capacity factor	%	11.2%	11.4%	12.0%	12.5%	12.5%	n/a
	Solar PV: Commercial	CAPEX	$/kW	3,090	2,890	2,540	2,230	1,950	-1.3%
		OPEX	$/kW/yr.	27	27	27	27	27	0.0%
		Capacity factor	%	12.2%	12.4%	13.0%	13.5%	13.5%	n/a
	Solar PV: Utility	CAPEX	$/kW	2,480	2,320	2,040	1,790	1,570	-1.3%
		OPEX	$/kW/yr.	21	21	21	21	21	0.0%
		Capacity factor	%	13.2%	13.4%	14.0%	14.5%	14.5%	n/a
	Concentrated Solar Power	CAPEX	$/kW	4,168	3,940	3,530	3,160	2,830	-1.1%
		OPEX	$/kW/yr.	69	69	69	69	69	0.0%
		Capacity factor	%	28.2%	28.4%	29.0%	29.5%	29.5%	n/a
Bioenergy	Solid biomass	CAPEX	$/kW	3,765	3,765	3,765	3,765	3,765	0.0%
		OPEX	$/kW/yr.	141	141	141	141	141	0.0%
		Capacity factor	%	68.2%	68.2%	68.2%	68.2%	68.2%	n/a

7th Edition of the Outlook: timeline (draft)

Expert Economy Review of model results	Oct 2017
EWG review of Vol II	Sept 2018
EWG review of Vol I	Oct 2018
Outlook 7th edition released	April 2019

Renewables analysis improvements

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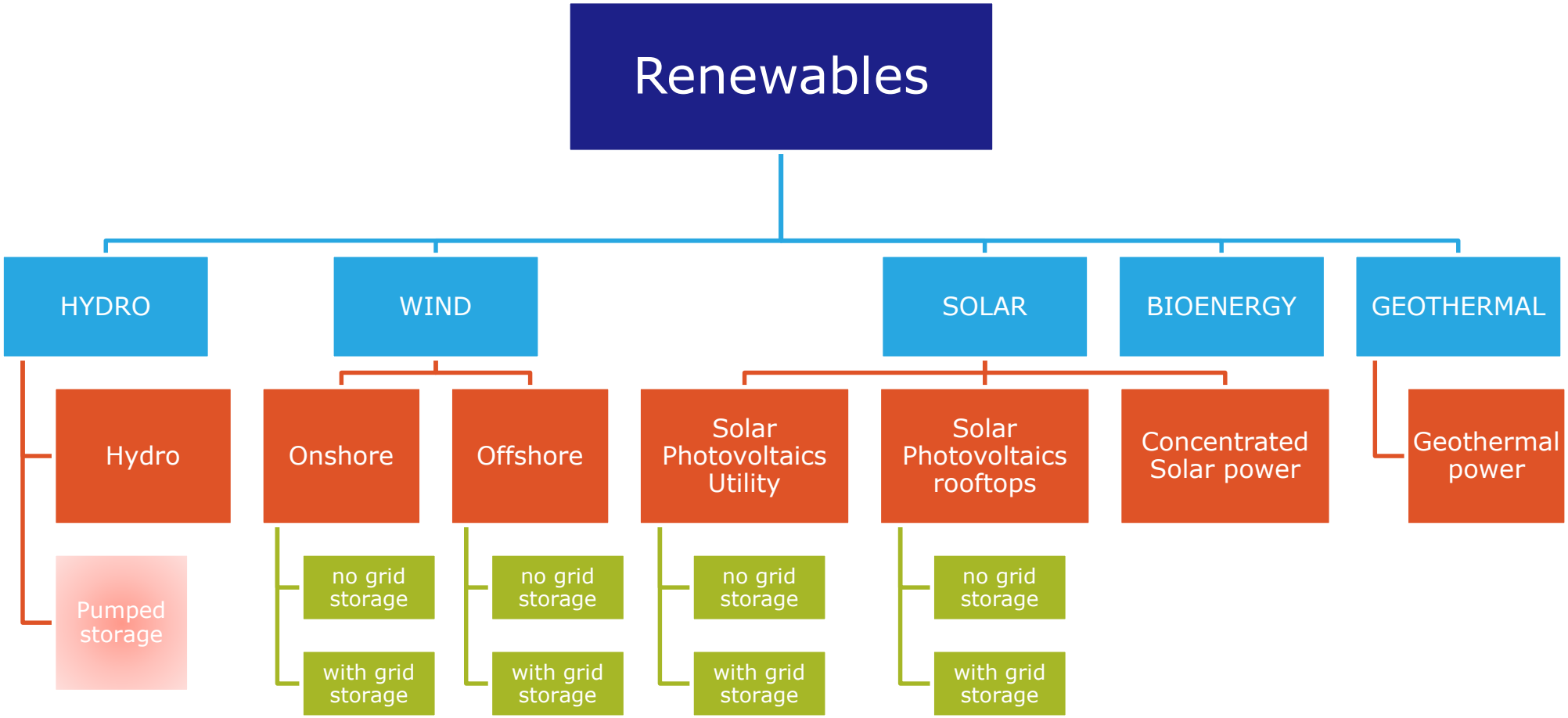
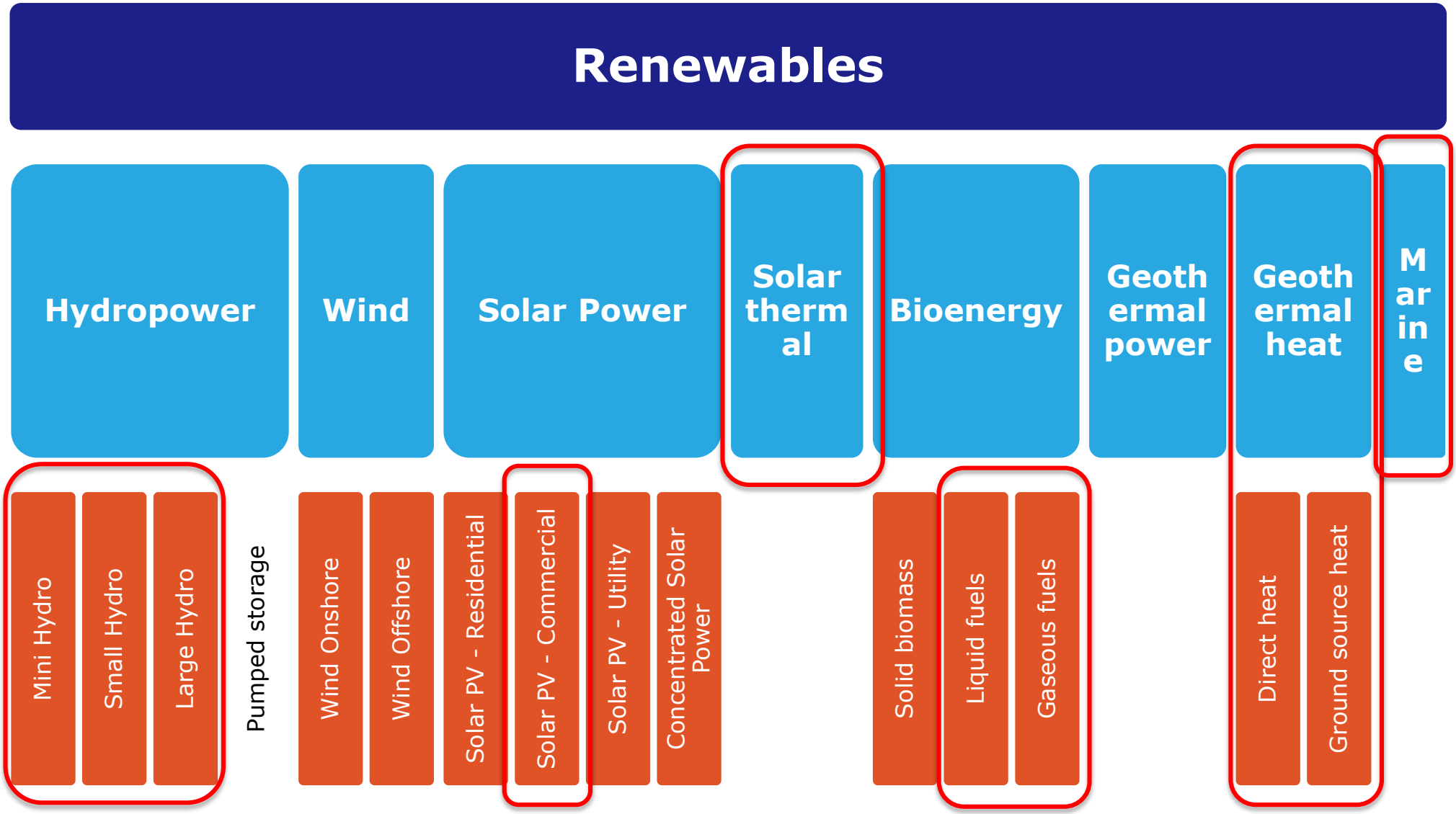
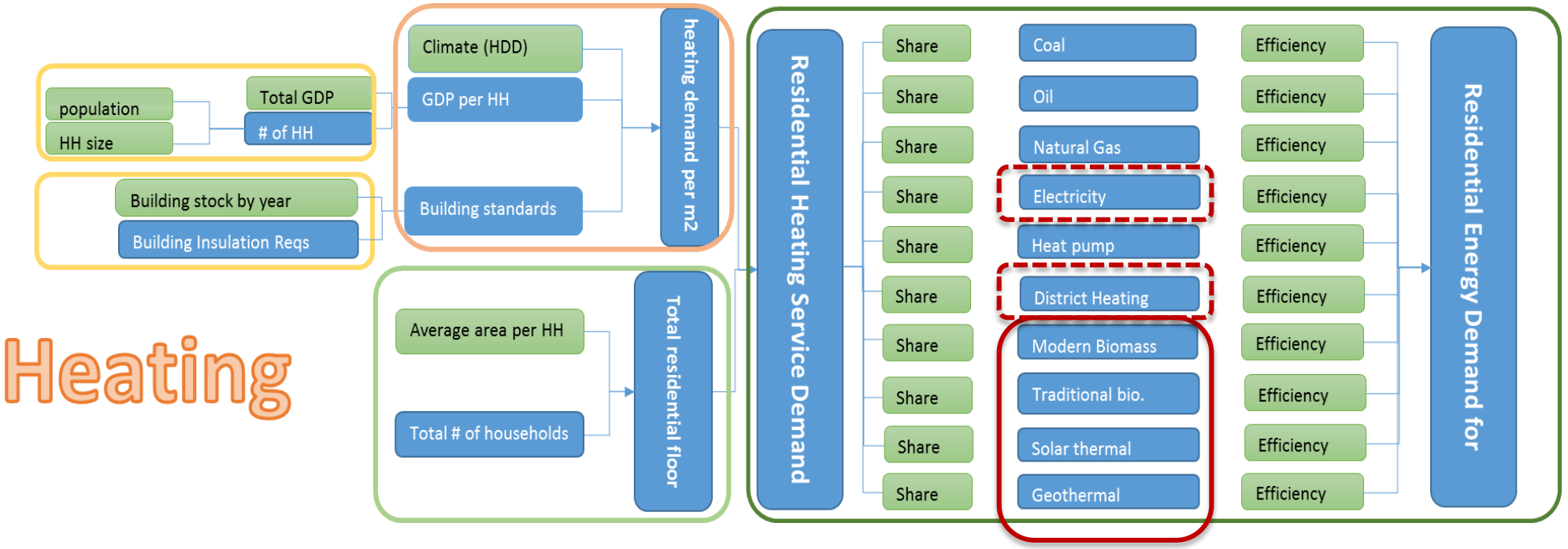
Renewable Energy technologies in the 6th Edition



Renewable Energy technologies



Space heating demand breakdown



Renewables potential assessment

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Solar rooftop PV and heat potential assessment **(draft)**

Estimates for Residential Rooftop solar PV and heat potential,

- ✓ An economy is split in urban and rural (urbanisation rate),
- ✓ Per capita floor size for urban and rural to calculate floor areas,
- ✓ Building footprints based on average floor count,
- ✓ Assume 1:1 ratio for footprint and roof area,
- ✓ Assume 10-25% of roof area is suitable for installations,
- ✓ Account for efficiency change from 2015 to 2050,
- ✓ Use average or regional insolation data,
- ✓ For max solar heat case:
  - ✓ Assume 3m2 solar water heater collector size, however requires 8m2 of roof,
  - ✓ Remaining area is covered with Solar PV with 80-90% density factor.

Note:

Solar rooftop potential assessment: 21_VN **(draft)**

A trial calculation for Residential sector in Viet Nam:

- ✓ All urban areas roofs are covered by Solar Water Heaters (SWH),
- ✓ In rural areas Solar PV is 20-35%, gradually declines

Note:

Industrial solar rooftop potential assessment **(draft)**

Estimates for Industrial Rooftop solar PV and heat potential,

- ✓ Industry is split into sub-sectors,
- ✓ Individual plants with known production are assessed in sub-sectors,
  - ✓ Assessment includes Value Added/Physical Output and Buildings footprint,
- ✓ Assume 10-30% of roof area is suitable for installations,
- ✓ Calculate the Value Added/Physical Output per $1m^2$ of roof by sector,
- ✓ Account for efficiency change from 2015 to 2050,
- ✓ Use average or regional insolation data,
- ✓ For max solar heat case:
  - ✓ Assume solar heating installations with 80% density,
  - ✓ Assume Solar PV installation with 80-90% density.

Note:

Biomass Supply Potential

For 7th Outlook, estimates for biomass supply potential will be included covering agricultural and forestry residues and animal wastes. Initial estimates for municipal solid waste might also be considered.

- Used the FAO database for agriculture production, area harvested, livestock and forestry production

Source: Pinterest

Estimating biomass potential from agricultural residues

Projection for the total harvested area until 2050
Total Harvested Area = f (GDP, POP, Capital Stock)

↓

Assume the productivity using its historical trend (logarithmic trend)

↓

Production by crops = Harvested area * Productivity

↓

Agriculture Residual = Production * Emission Rate (Waste)

↓

Residual Available = Agriculture Residual * Available Rate

Source: https://greenheatug.wordpress.com/page/2/

Source: biomassmagazine

Estimating biomass potential from forestry residues

Projection for forest area = f(POP, Capital Stock)

Industrial wood = f(forest area, GDP Industry)
Wood fuel = f(forest area, industrial wood)
Wood chips = f(forest area, industrial wood)

Forest Residual = Wood Production * Emission Rate (Waste)

Residual Available = Production Residual * Available Rate

Source: woodpelltesolutions.co.uk

Source: energybook.info

Estimating biomass potential from animal waste

Projection for Livestock Per Capita = f(historical trend logarithmic)

↓

Number of Livestock = livestock per capita * Population

↓

Animal Waste = Number of Livestock * Emission Rate (Waste)

↓

Animal Waste Available = Animal Waste * Available Rate

Source: woodpelltesolutions.co.uk

Source: energybook.info

Estimating biomass potential from municipal solid waste

Projection for municipal solid waste =
f(Waste per capita, POP, GDP per capita)

Available Municipal Waste = Volume of Municipal Waste * Recovery Rate

Note:

Higher recovery rate is assumed for developed economies with waste segregation policy/program.

In the case of Japan, the recovery rate is 50%.

Source: http://www.esru.strath.ac.uk/EandE/Web_sites/03-04/biomass/background%20info4.html

Source: care2.com

Other updates

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Other updates

- **APERC – IEEJ: Renewable Heating and Cooling Study**
  - Calibrating fuel-based coefficients for temperature analysis,
  - IEEJ is preparing technical potential for Solar Thermal and Ground Source Heat Pumps in Industry,
  - Not-choice model, but potential-based uptake of RE for buildings,
  - Preliminary results are expected before the Annual Conference,
- **APERC has joined REN21**
  - First data submissions and chapter review for GSR2017,
- **APERC to support Chinese Taipei with "Filling the gap" project**
  - Quantitative analysis,
  - Data on costs, potentials, best practices, financing mechanisms etc.?

Thank you!

http://aperc.ieej.or.jp/

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