DRN

Komisi Teknis Energi

OPTIMALISASI PENGEMBANGAN ENERGI BARU DAN TERBARUKAN MENUJU KETAHANAN ENERGI BERKELANJUTAN

Webinar Pusat Perancangan Undang-Undang
Badan Keahlian DPR RI
Senin, 12 Oktober 2020

MENINGKATKAN TINGKAT PENETRASI VRE UNTUK MENDUKUNG DEKARBONISASI SEKTOR KETENAGALISTRIKAN YANG MENDALAM

Ir. Hardiv Harris Situmeang, M.Sc., D.Sc.
Ketua Komisi Teknis Energi – Dewan Riset Nasional (DRN)

Paris Agreement

Art Illumination of Eiffel Tower gives voice to the demands for COP21 © 2015 Gary Braasch / World View

Global Goal of Keeping Warming Between 2 ^{0}C and 1.5 ^{0}C

Article 2

1. This Agreement, in enhancing the implementation of the Convention, including its objective, aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by:
   a) Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;
   b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production;
   c) Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.
2. This Agreement will be implemented to reflect equity and the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances.

SALINAN

PRESIDEN
REPUBLIK INDONESIA

UNDANG-UNDANG REPUBLIK INDONESIA
NOMOR 16 TAHUN 2016

TENTANG

PENGESAHAN *PARIS AGREEMENT TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE*
(PERSETUJUAN PARIS ATAS KONVENSI KERANGKA KERJA PERSERIKATAN BANGSA-BANGSA MENGENAI PERUBAHAN IKLIM)

DENGAN RAHMAT TUHAN YANG MAHA ESA

PRESIDEN REPUBLIK INDONESIA,

Pasal 2

Undang-Undang ini mulai berlaku pada tanggal diundangkan.

Agar setiap orang mengetahuinya, memerintahkan pengundangan Undang-Undang ini dengan penempatannya dalam Lembaran Negara Republik Indonesia.

Disahkan di Jakarta
pada tanggal 24 Oktober 2016
PRESIDEN REPUBLIK INDONESIA,
ttd.

JOKO WIDODO

Diundangkan di Jakarta
Pada tanggal 25 Oktober 2016
MENTERI HUKUM DAN HAK ASASI MANUSIA
REPUBLIK INDONESIA,
ttd.

YASONNA H. LAOLY

Paris Agreement Article 4 Paragraph 19
Paris Decision 1/CP.21 Paragraph 35

Paris Agreement Article 4 Paragraph 19

19. All Parties should strive to formulate and communicate long-term low greenhouse gas emission development strategies, mindful of Article 2 taking into account their common but differentiated responsibilities and respective capabilities, in the light of different national circumstances.

Paris Decision 1/CP.21 Paragraph 35

35. *Invites* Parties to communicate, by 2020, to the secretariat mid-century, long-term low greenhouse gas emission development strategies in accordance with Article 4, paragraph 19, of the Agreement, and *requests* the secretariat to publish on the UNFCCC website Parties' low greenhouse gas emission development strategies as communicated;

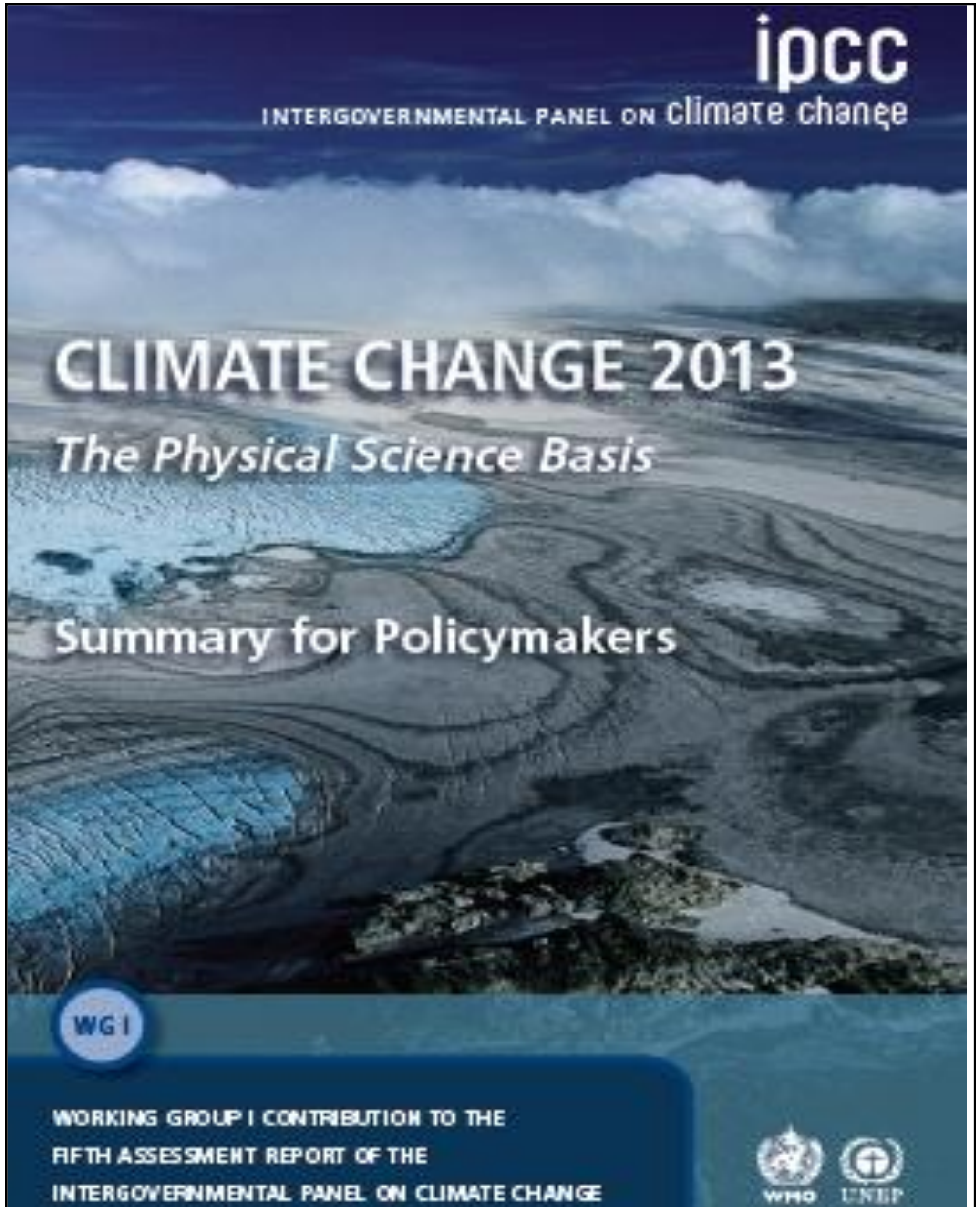
Indonesia 2050 Long-Term
Low Greenhouse Gas Emission
Development Strategies

Perlunya Dekarbonisasi Sektor Energi yang Mendalam

Characteristic of Post - Third Assessment Report Stabilization Scenarios

Category	CO_2 concentration at stabilization (2005 = 379 ppm) [b]	CO_2-equivalent Concentration at stabilization including GHGs and aerosols (2005 = 375 ppm) [b]	Peaking year for CO_2 emissions [a, c]	Change in global CO_2 emissions in 2050 (% of 2000 emissions) [a, c]	Global average temperature increase above pre-industrial at equilibrium, using "best estimate" climate sensitivity [d, e]	Global average sea level rise above pre-industrial at equilibrium from thermal expansion only [f]	Number of assessed scenarios
	ppm	ppm	Year	Percent	°C	metres	
I	350 – 400	445 – 490	2000 – 2015	-85 to -50	2.0 – 2.4	0.4 – 1.4	6
II	400 – 440	490 – 535	2000 – 2020	-60 to -30	2.4 – 2.8	0.5 – 1.7	18
III	440 – 485	535 – 590	2010 – 2030	-30 to +5	2.8 – 3.2	0.6 – 1.9	21
IV	485 – 570	590 – 710	2020 – 2060	+10 to +60	3.2 – 4.0	0.6 – 2.4	118
V	570 – 660	710 – 855	2050 – 2080	+25 to +85	4.0 – 4.9	0.8 – 2.9	9
VI	660 – 790	855 – 1130	2060 – 2090	+90 to +140	4.9 – 6.1	1.0 – 3.7	5

- Sea level rise under warming is inevitable
- Long time scales of thermal expansion & ice sheet response to warming imply that stabilisation of GHG concentrations at or above present levels will not stabilise sea level for many centuries


ipcc
INTERGOVERNMENTAL PANEL ON climate change
CLIMATE CHANGE 2013
The Physical Science Basis
Summary for Policymakers
WG I
WORKING GROUP I CONTRIBUTION TO THE
FIFTH ASSESSMENT REPORT OF THE
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
WMO
UNEP

B.5 Carbon and Other Biogeochemical Cycles

The atmospheric concentrations of carbon dioxide (CO_2), methane, and nitrous oxide have increased to levels unprecedented in at least the last 800,000 years. CO_2 concentrations have increased by 40% since pre-industrial times, *primarily from fossil fuel emissions and secondarily from net land use change emissions*. The ocean has absorbed about 30% of the emitted anthropogenic carbon dioxide, causing ocean acidification (see Figure SPM.4).

C. Drivers of Climate Change

Total radiative forcing is positive, and has led to an uptake of energy by the climate system. The largest contribution to total radiative forcing is *caused by the increase in the atmospheric concentration of CO_2 since 1750* (see Figure SPM.5). {3.2, Box 3.1, 8.3, 8.5}

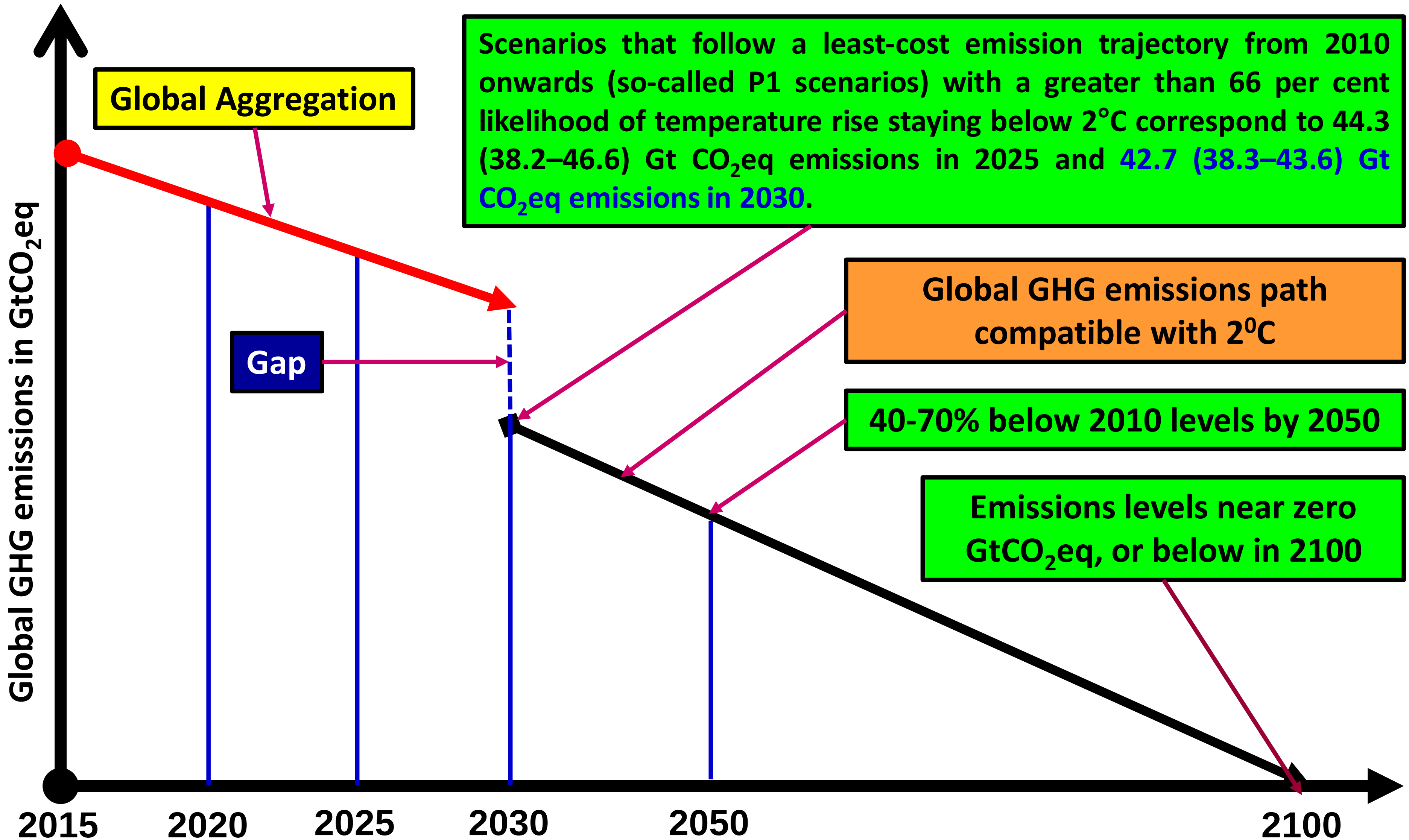
D.3 Detection and Attribution of Climate Change

Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise, and in changes in some climate extremes (Figure SPM.6 and Table SPM.1). *This evidence for human influence has grown since AR4. It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century*. {10.3–10.6, 10.9}

Summary for Policymakers
SPM.4 - Mitigation Pathways and Measures in the Context of Sustainable Development

Scenarios reaching atmospheric concentration levels of about 450 ppm CO_2eq by 2100 (consistent with a likely chance to keep temperature change below 2°C relative to pre-industrial levels) include substantial cuts in anthropogenic GHG emissions by mid-century through large-scale changes in energy systems and potentially land use (high confidence).

Scenarios reaching these concentrations by 2100 are characterized by lower global GHG emissions in 2050 than in 2010, 40 % to 70 % lower globally, and emissions levels near zero Gt CO_2eq or below in 2100.



[1)] Strongly Required: Pre-2020 and Post-2020 actions reinforce each other and in the same direction of higher ambition.

[2)] Scenarios that follow a least-cost emission trajectory from 2010 onwards (so-called P1 scenarios) with a greater than 66 per cent likelihood of temperature rise staying below 2°C correspond to 44.3 (38.2–46.6) Gt CO_2eq emissions in 2025 and 42.7 (38.3–43.6) Gt CO_2eq emissions in 2030.

INTERGOVERNMENTAL PANEL ON climate change

2018/24/PR

IPCC PRESS RELEASE

8 October 2018

Summary for Policymakers of IPCC Special Report on Global Warming of 1.5°C approved by governments

INCHEON, Republic of Korea, 8 Oct - Limiting global warming to 1.5ºC would require rapid, far-reaching and unprecedented changes in all aspects of society, the IPCC said in a new assessment. With clear benefits to people and natural ecosystems, limiting global warming to 1.5ºC compared to 2ºC could go hand in hand with ensuring a more sustainable and equitable society, the Intergovernmental Panel on Climate Change (IPCC) said on Monday.

"One of the key messages that comes out very strongly from this report is that we are already seeing the consequences of 1°C of global warming through more extreme weather, rising sea levels and diminishing Arctic sea ice, among other changes," said Panmao Zhai, Co-Chair of IPCC Working Group I.

The report finds that limiting global warming to 1.5°C would require "rapid and far-reaching" transitions in land, energy, industry, buildings, transport, and cities. Global net human-caused emissions of carbon dioxide (CO_2) would need to fall by about 45 percent from 2010 levels by 2030, reaching 'net zero' around 2050. This means that any remaining emissions would need to be balanced by removing CO_2 from the air.

2 Degree Celsius is Attainable?

Aggregate Effect of the Intended Nationally Determined Contributions: An Update

Synthesis Report by the UNFCCC Secretariat

FCCC/CP/2016/2 – 2 May 2016

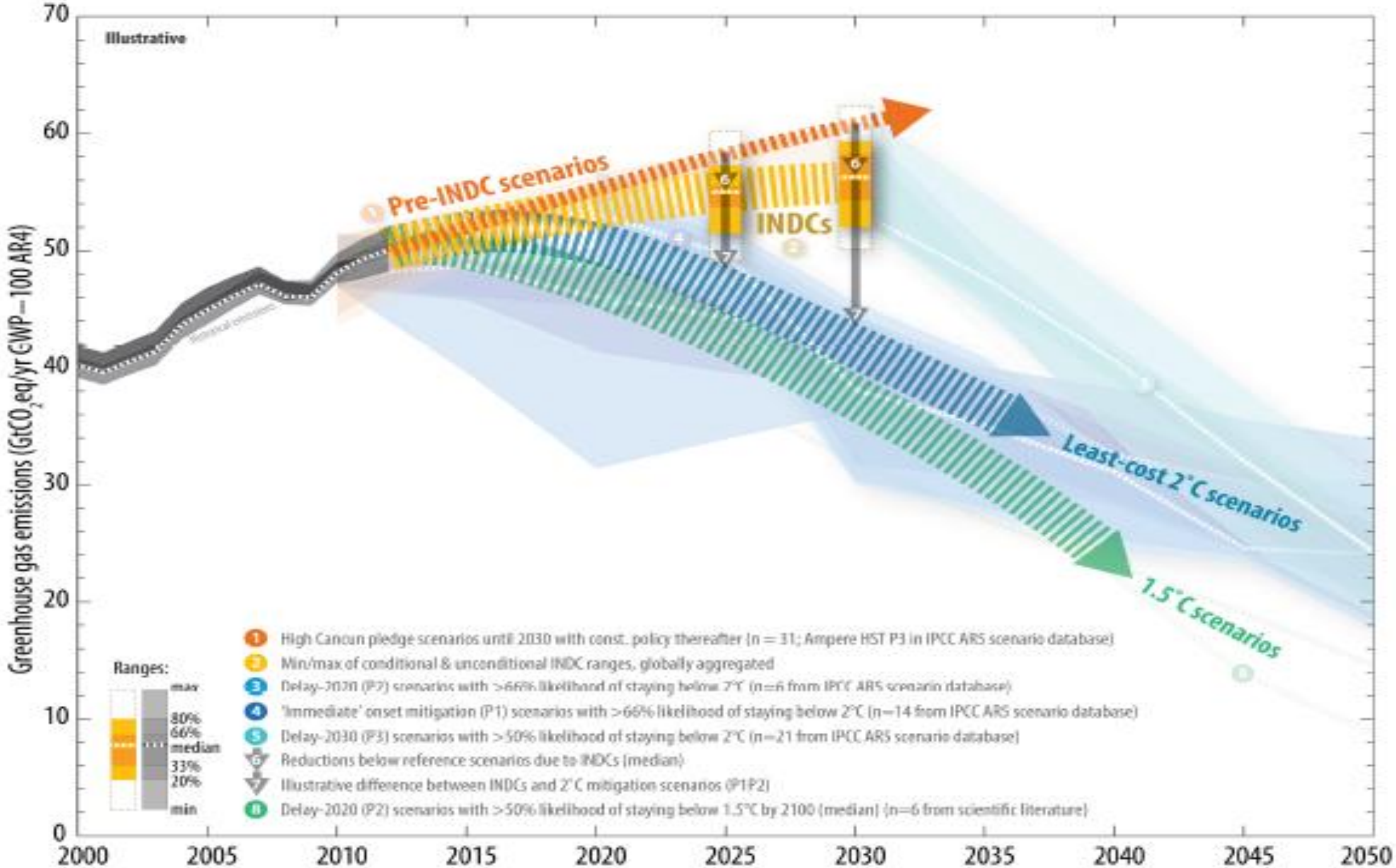
Aggregate Effect of the INDC: An Update

Synthesis report by the Secretariat - FCCC/CP/2016/2

Report - 02 May 2016

- The UN Climate Change Secretariat has published an update to its synthesis report on the collective impact of national climate action plans (Intended Nationally Determined Contributions, or INDCs), submitted by governments as contributions to global climate action under the Paris Agreement.
- Since the publication last October of the 1st synthesis report prepared ahead of the Paris Climate Change Conference, 42 additional countries submitted their INDCs. The updated report now captures the overall impact of 161 national climate plans covering 189 countries and covering 95.7% of total global emissions. (The European Union and its 28 member States submit a joint INDC.)
- There are 137 of the 161 INDCs (85%) which include an adaptation component, reflecting a common determination of governments to strengthen national adaptation efforts.
- INDCs are expected to deliver sizeable emission reductions and slow down emissions growth in the coming decade. However, these are still not enough to keep the global temperature rise since pre-industrial times to below 2, or preferably 1.5 degrees Celsius.

Comparison of Global Emission Levels in 2025 and 2030 Resulting from the Implementation of the INDC and under Other Scenarios



Sources: Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report scenario database, 1.5 °C scenarios from scientific literature (see footnote 18), IPCC historical emission database and intended nationally determined contribution quantification.
Abbreviations: AR4 = Fourth Assessment Report of the Intergovernmental Panel on Climate Change, GWP = global warming potential, INDC = intended nationally determined contribution, IPCC AR5 = Fifth Assessment Report of the Intergovernmental Panel on Climate Change, n = number of scenarios, yr = year.

UN environment

The Emissions Gap Report 2017

A UN Environment Synthesis Report

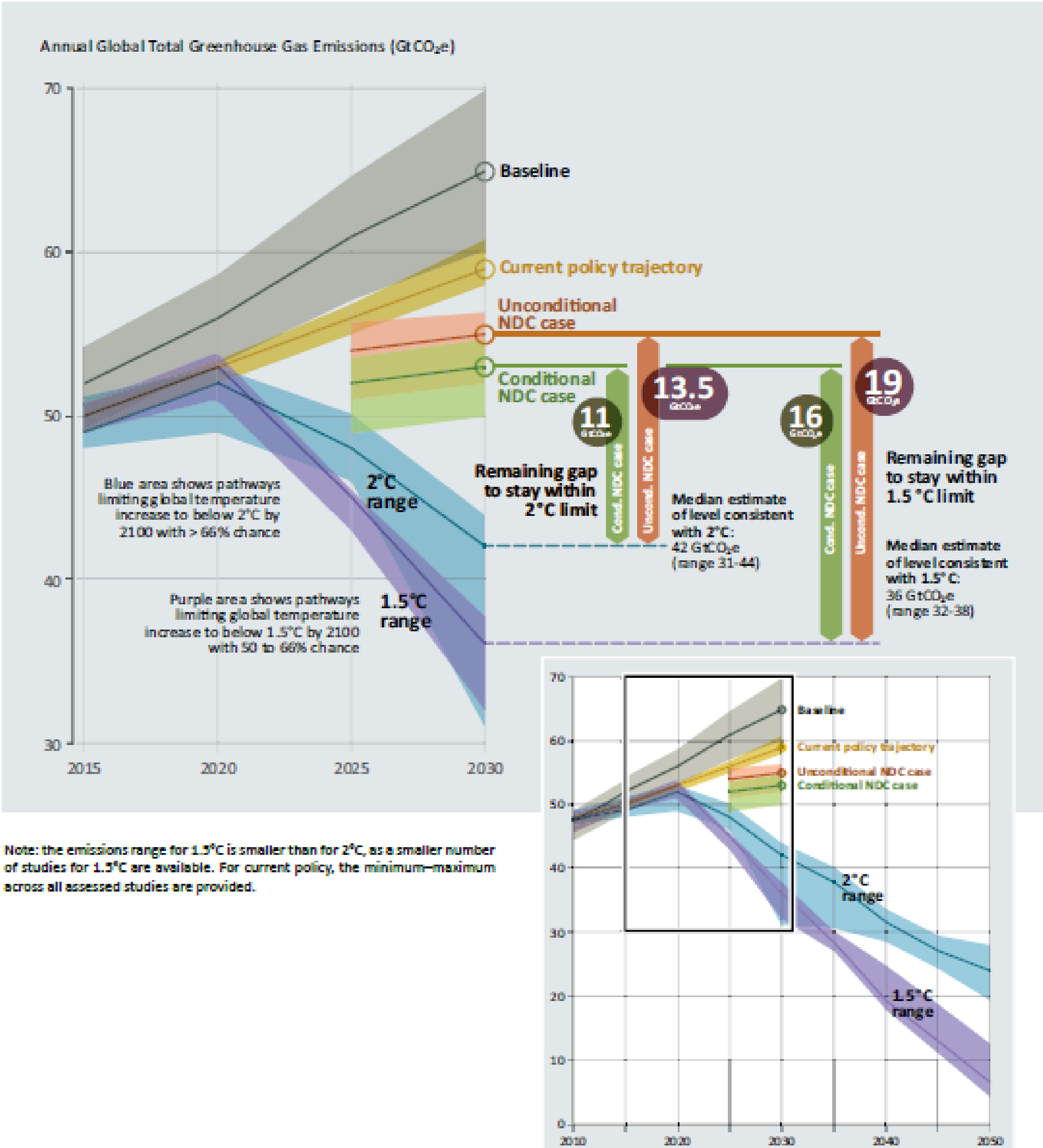


Figure ES.2

Global GHG emissions under different scenarios and the emissions gap in 2030 (median estimate and 10th to 90th percentile range).

Emission Reduction Options and Potential in the Energy Sector

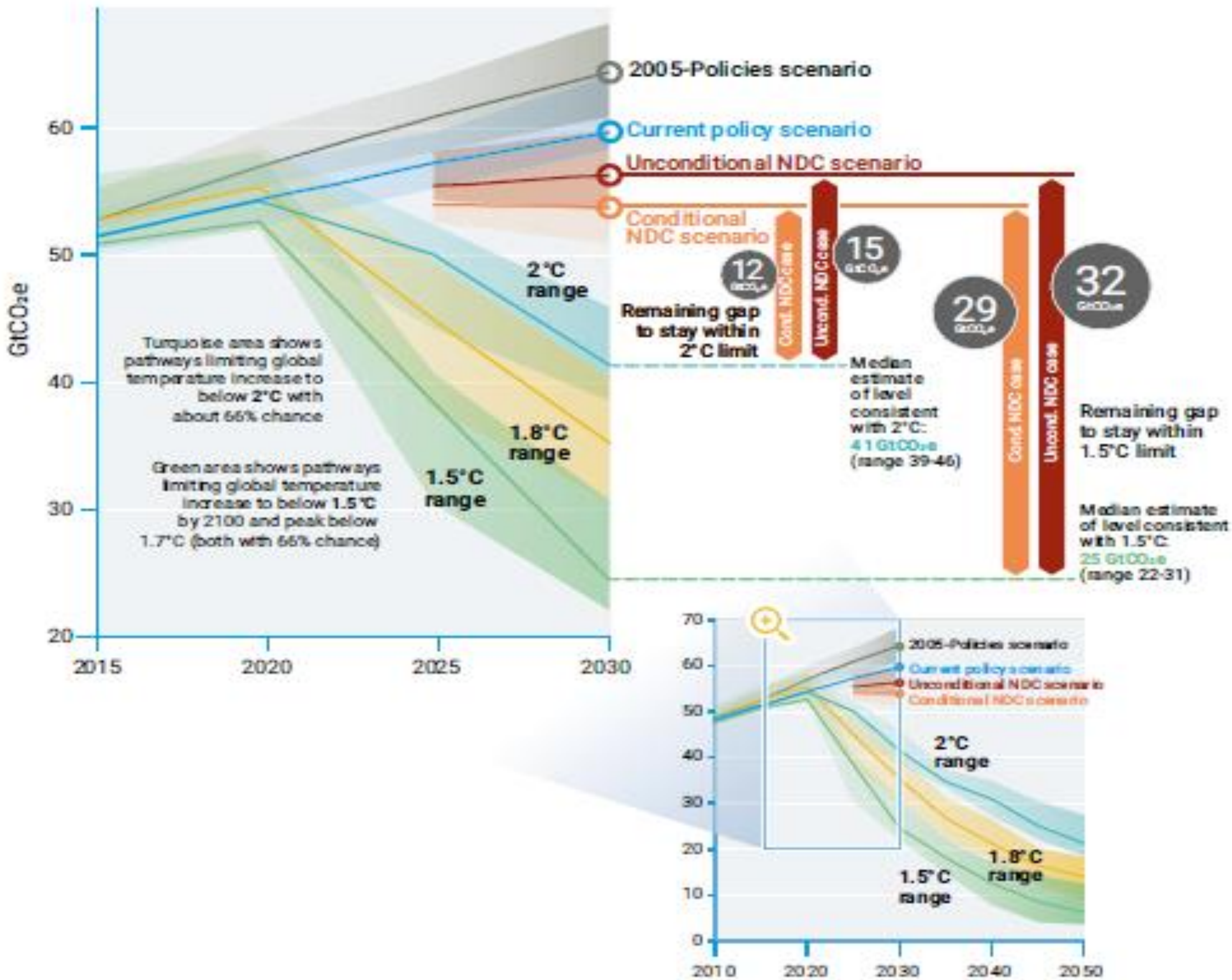
In the current policy scenario, energy sector emissions amount to 21.3 $GtCO_2$ in 2030, of which 16.3 $GtCO_2$ comes from power generation (IEA, 2016, USEPA, 2012). **Main options for reducing emissions in the energy sector are wind and solar energy. In addition, hydro, nuclear, geothermal, carbon capture and storage (CCS) and bioenergy combined with CCS can contribute.**

UN environment programme

Emissions Gap Report 2019

Executive Summary

Global GHG Emissions Under Different Scenarios & the Emissions Gap in 2030



SINGAPORE'S INTENDED NATIONALLY DETERMINED CONTRIBUTION (INDC)

In accordance with Decisions 1/CP.19 and 1/CP.20, Singapore communicates that it intends to reduce its Emissions Intensity by 36% from 2005 levels by 2030, and stabilise its emissions with the aim of peaking around 2030.

Singapore's Efforts. While Singapore is heavily dependent on fossil fuels, given its severe limitations on using alternative energy, Singapore had made early policy choices to reduce its GHG footprint by switching from fuel oil to natural gas, the cleanest form of fossil fuel, for electricity generation, even though it meant higher cost. Today, over 90% of electricity is generated from natural gas. Singapore prices energy at market cost, without any subsidy, to reflect resource scarcity and promote judicious usage. On top of this, and despite the challenges, the government is significantly increasing the deployment of solar photovoltaic (PV) systems.

Singapore intends to reduce its Emissions Intensity 36% below 2005 levels by 2030, and aims to achieve emissions peak around 2030.

List of Countries Committed to a Net-Zero Emissions Goal

Country	Target Date	Status
Bhutan	Currently Carbon Negative	Pledged towards the Paris Agreement
Canada	2050	Will propose to Parliament
Chile	2050	In Policy Document
Costa Rica	2050	In Policy Document
Denmark	2050	In Policy Document
European Union	2050	Under Discussion
Fiji	2050	Pledged towards the Paris Agreement
Finland	2035	In Policy Document
France	2050	In Law
Germany	2050	Under Discussion
Iceland	2040	In Policy Document
Ireland	2050	Under Discussion

Sources: i) World Economic Forum, 05 July 2019; and ii) 2019 Climate Home News Ltd., 14 June 2019.

List of Countries Committed to a Net-Zero Emissions Goal

Country	Target Date	Status
Japan	2050	Policy Position
Marshall Islands	2050	Pledged towards the Paris Agreement
New Zealand	2050	The Bill was Passed
Norway	2030	In Law
Portugal	2050	In Policy Document
Sweden	2045	In Law
Spain	2050	Proposed Legislation
The Netherlands	2050	Under Discussion
United Kingdom	2050	In Law
Uruguay	2030	In Policy Document

Sources: i) World Economic Forum, 05 July 2019; and ii) 2019 Climate Home News Ltd., 14 June 2019.

China: Peak CO_2 emissions before 2030 and reach carbon neutrality before 2060.

Source: Ranping Song, "4 Questions About China's New Climate Commitments", WRI, September 2020.

Federal Ministry for Economic Affairs and Energy

The 7th Energy Research Programme of the German Federal Government

ENERGY TRANSITION IN CONSUMPTION SECTORS

- Buildings and neighbourhoods
- Industry, commerce, trade and services
- Interfaces of energy research with mobility and transport

POWER GENERATION

- Photovoltaics
- Wind power
- Bioenergy
- Geothermal
- Hydropower and marine energy
- Thermal power plants

SYSTEM INTEGRATION: GRIDS, ENERGY STORAGE, SECTOR COUPLING

- Electricity grid
- Electrical energy storage
- Sector coupling

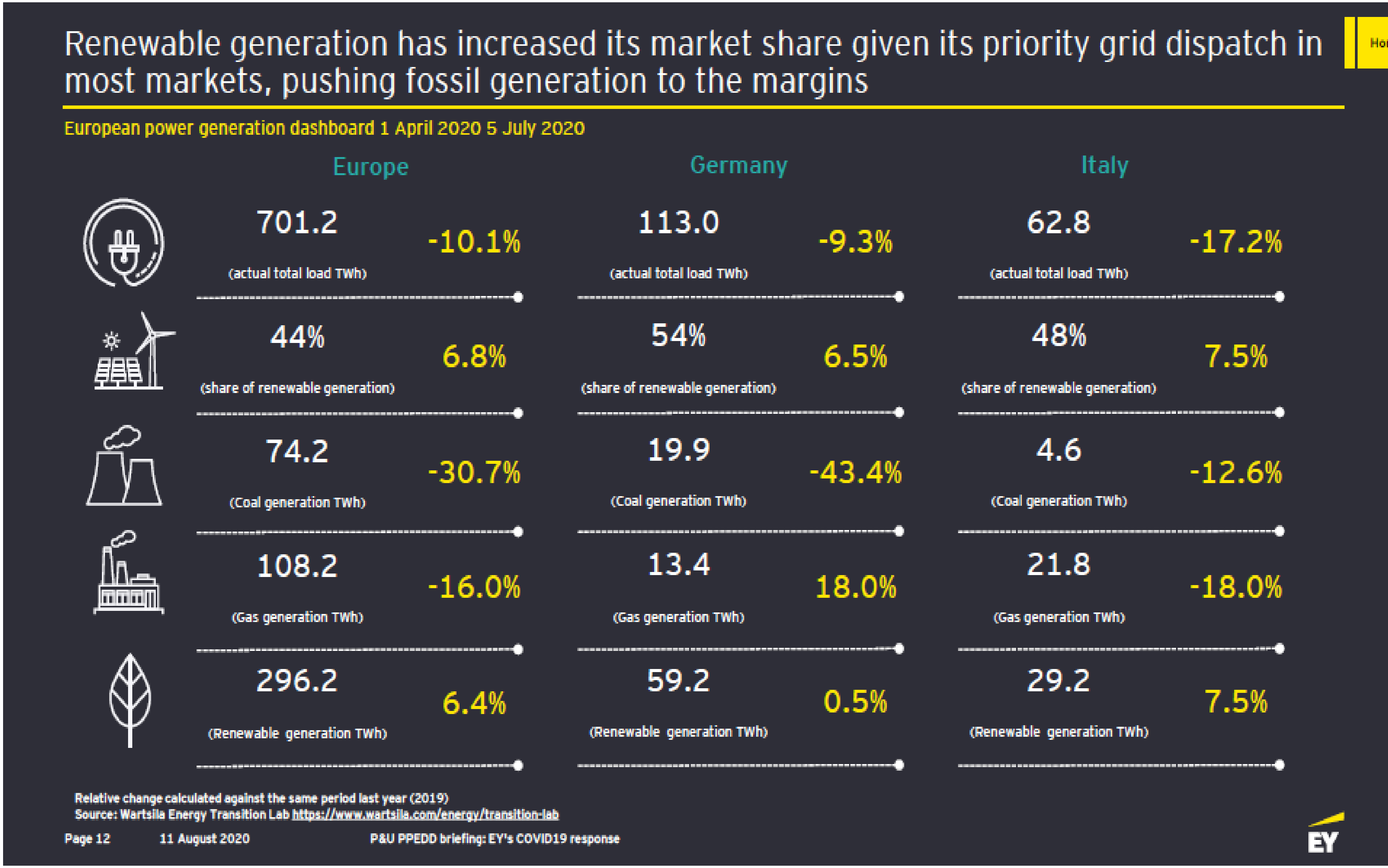
CROSS-SYSTEM RESEARCH TOPICS FOR THE ENERGY TRANSITION

- Energy system analysis
- Digitisation of the energy transition
- Resource efficient for the energy transition
- CO_2 technologies for the energy transition
- Energy transition and society
- Materials research for the energy transition

NUCLEAR SAFETY RESEARCH

- Reactor safety research
- Waste management and repository research
- Radiation research


COVID-19 crisis management for P&U companies
The better the question. The better the answer.
The better the world works.
EY
Building a better working world



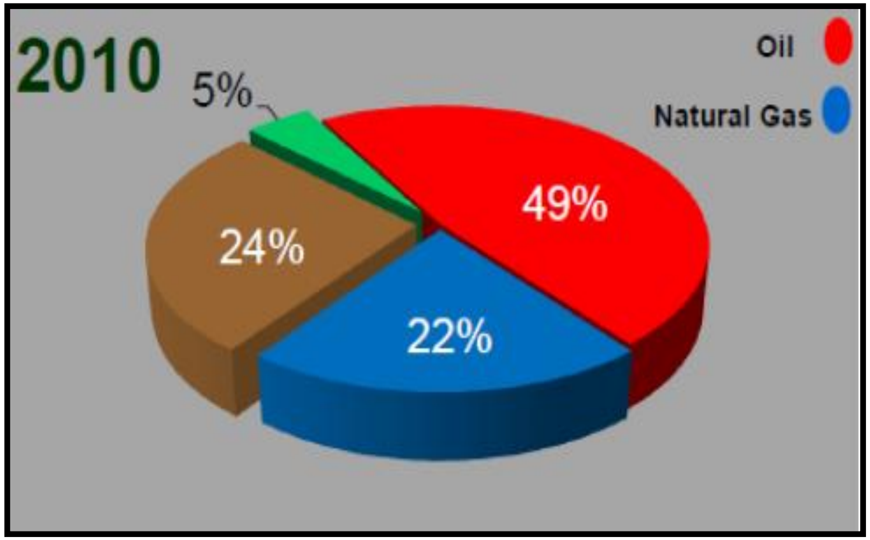
Source: Ernst & Young (EY), “COVID-19 crisis management for P&U companies”.

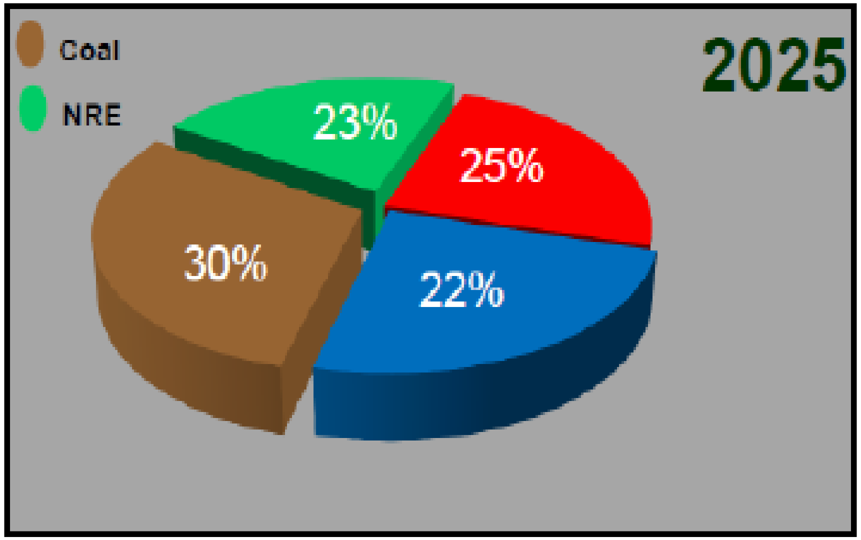
VISI → "TERWUJUDNYA PENGELOLAAN ENERGI YANG BERKEADILAN, BERKELANJUTAN, DAN BERWAWASAN LINGKUNGAN DENGAN MEMPRIORITASKAN PENGEMBANGAN ENERGI TERBARUKAN DAN KONSERVASI ENERGI DALAM RANGKA MEWUJUDKAN KEMANDIRIAN DAN KETAHANAN ENERGI NASIONAL"

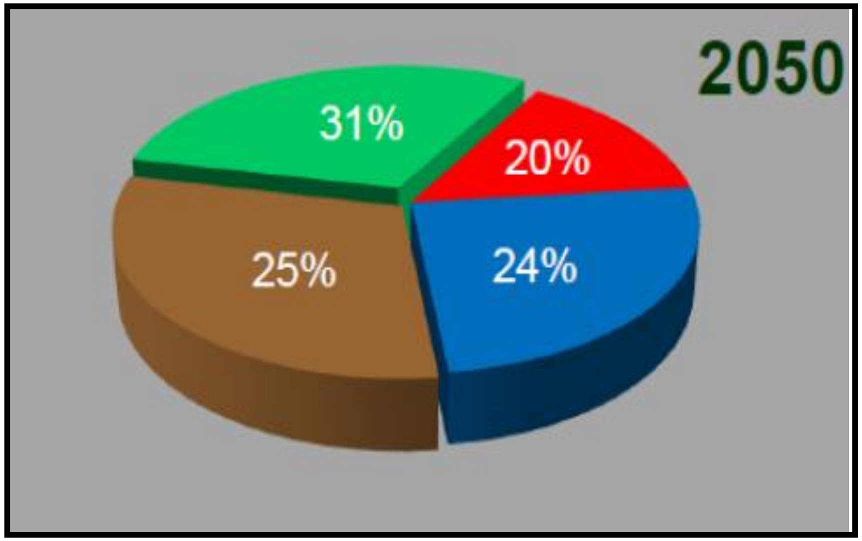
Rencana Umum Energi Nasional

- **National Energy Mix up to 2050**
- **Emisi GRK Tahun 2015-2050**
- **Penurunan Emisi GRK Tahun 2015-2050**

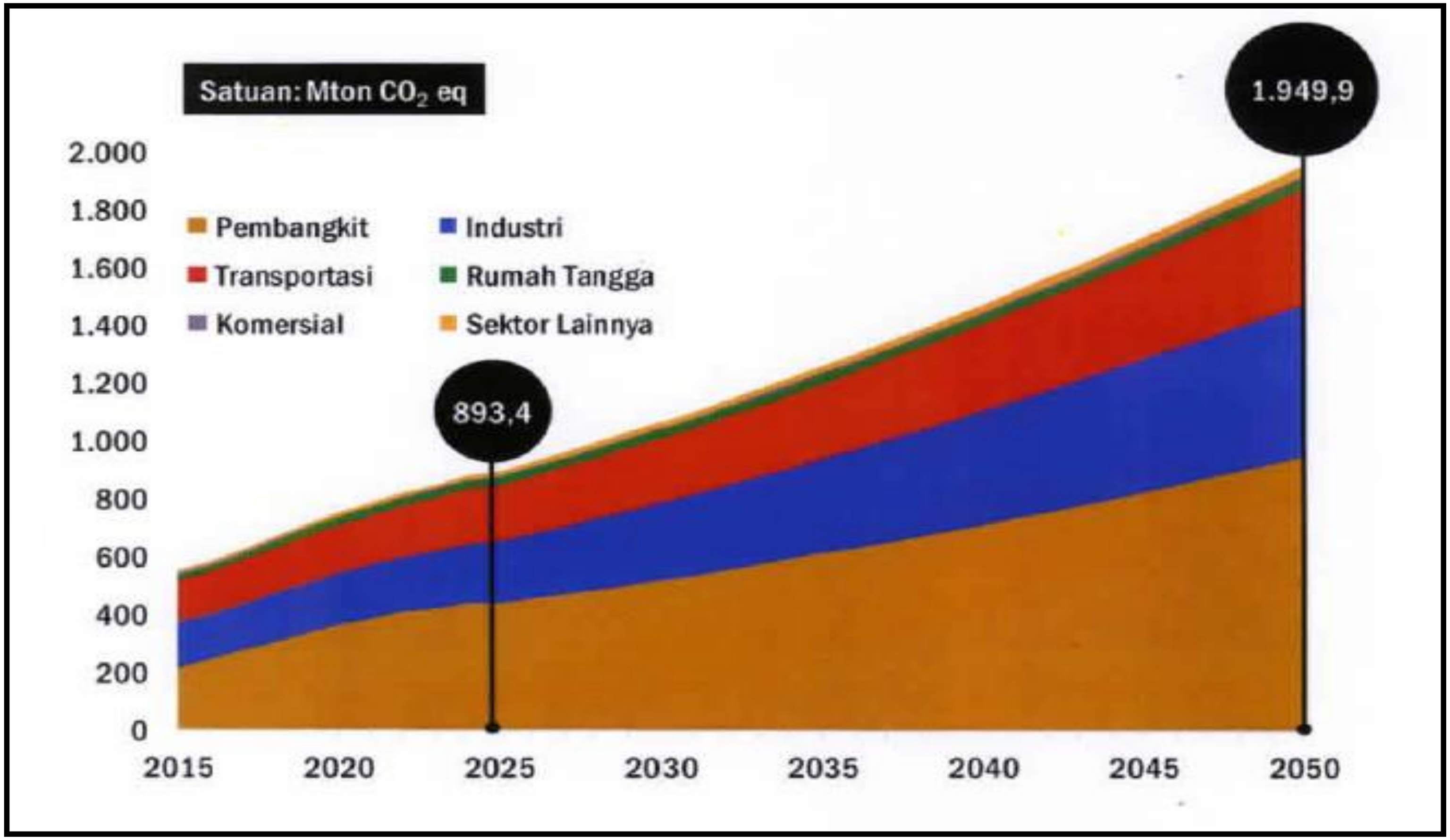
National Energy Mix Menuju 2050







Emisi GRK Tahun 2015-2050

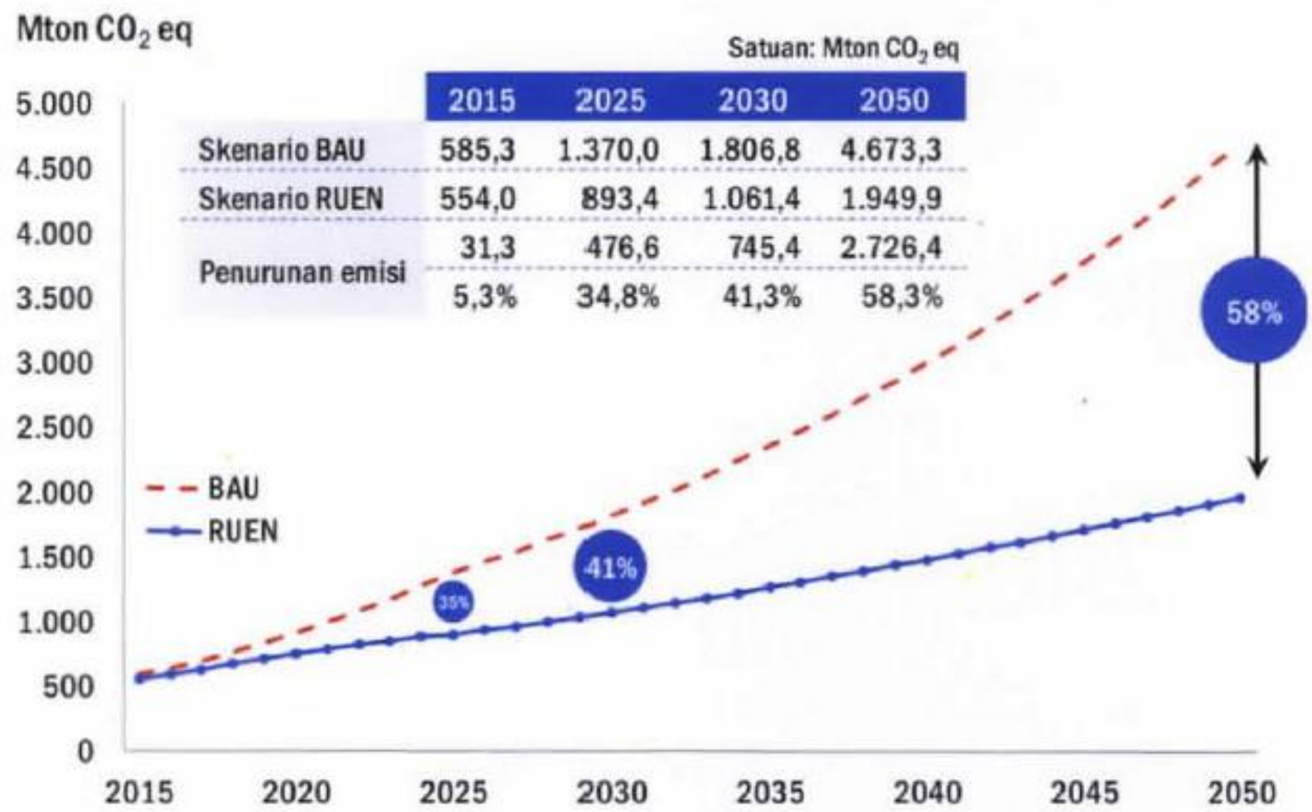


Sektor pembangkit listrik diproyeksikan akan menjadi penyumbang emisi terbesar, diikuti oleh sektor industri dan sektor transportasi. Proyeksi emisi GRK pada tahun 2025 sebesar 893 juta ton $C0_{2eq}$ dan tahun 2050 sebesar 1,950 juta ton $C0_{2eq}$, sebagaimana dapat dilihat pada gambar diatas.

Hasil pemodelan pencapaian sasaran KEN akan memberikan dampak penurunan GRK secara signifikan apabila dibandingkan dengan *Business as Usual* (BAU). Penurunan emisi GRK tahun 2025 sebesar 34,8% dan pada tahun 2050 sebesar 58,3%, sebagaimana dapat dilihat pada slide berikutnya.

Penurunan Emisi GRK Tahun 2015-2050

Sebagaimana yang dinyatakan pada RUEN yang terbaru, penurunan emisi GRK dalam RUEN sudah sejalan dengan *Nationally Determined Contribution* (NDC) Indonesia sebesar 29% pada tahun 2030 yang merupakan bagian dari komitmen Indonesia untuk turut mendukung upaya pengendalian peningkatan suhu global rata-rata di bawah 2°C.



Penurunan emisi GRK disebabkan oleh empat faktor: (1). Diversifikasi energi, dengan meningkatkan porsi energi terbarukan dan mengurangi porsi energi fosil; (2). Pemanfaatan teknologi batubara bersih (clean coal technology) untuk pembangkitan tenaga listrik; (3). Substitusi penggunaan energi dari BBM ke gas bumi; dan (4). Pelaksanaan program konservasi energi pada tahun-tahun mendatang. Penurunan emisi GRK dalam RUEN sudah sejalan dengan Nationally Determined Contribution (NDC) Indonesia sebesar 29% pada tahun 2030 yang merupakan bagian dari komitmen Indonesia untuk turut mendukung upaya pengendalian peningkatan suhu global rata-rata di bawah 2°C.

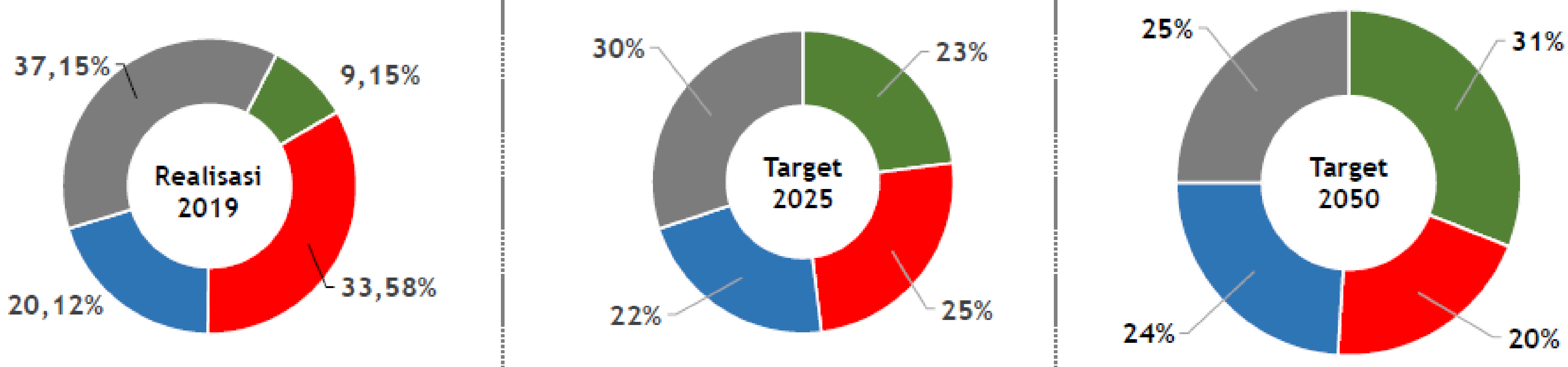
POTENSI DAN KAPASITAS TERPASANG EBT

SUMBER ENERGI	TOTAL POTENSI (GW) 417,8 GW	TOTAL PEMANFAATAN 10,4 GW (2,5%)
Surya	207,8 GW	0,15 GWp (0,07%)
Air	75 GW	6,08 GW (8,1%)
Bayu/angin	60,6 GW	0,15 GW (0,25%)
Bioenergi	32,6 GW	1,89 GW (5,8%)
Panas Bumi	23,9 GW	2,13 GW (8,9%)
Samudera	17,9 GW	0 GW*) (0%)

*) Penelitian Energi Samudera:

- Teknologi gelombang laut:
  - *Oscillating Water Column* (OWC) berpeluang ditempatkan di perairan selatan Enggano.
  - *Heaving Device* berpeluang di wilayah Mentawai.
- Teknologi energi panas laut: *Ocean Thermal Energy Conversion* (OTEC), di Perairan Bali Utara.
- Telah dilakukan *Feasibility Study* teknologi Arus Laut di Selat Alas (antara P. Lombok dan P. Sumbawa), Selat Sape (antara P. Sumbawa dan P. Komodo) dan Selat Pantar (antara P. Pantar dan P. Alor) oleh Balitbang ESDM

REALISASI DAN TARGET RENCANA UMUM ENERGI NASIONAL



1. Konsumsi Energi : 0,8 TOE/kap
2. Konsumsi Listrik : 1.084 Kwh/kap
3. Kapasitas Pembangkit Total : 69,7 GW*)

1. Konsumsi Energi : 1,4 TOE/kap
2. Konsumsi Listrik : 2500 Kwh/kap

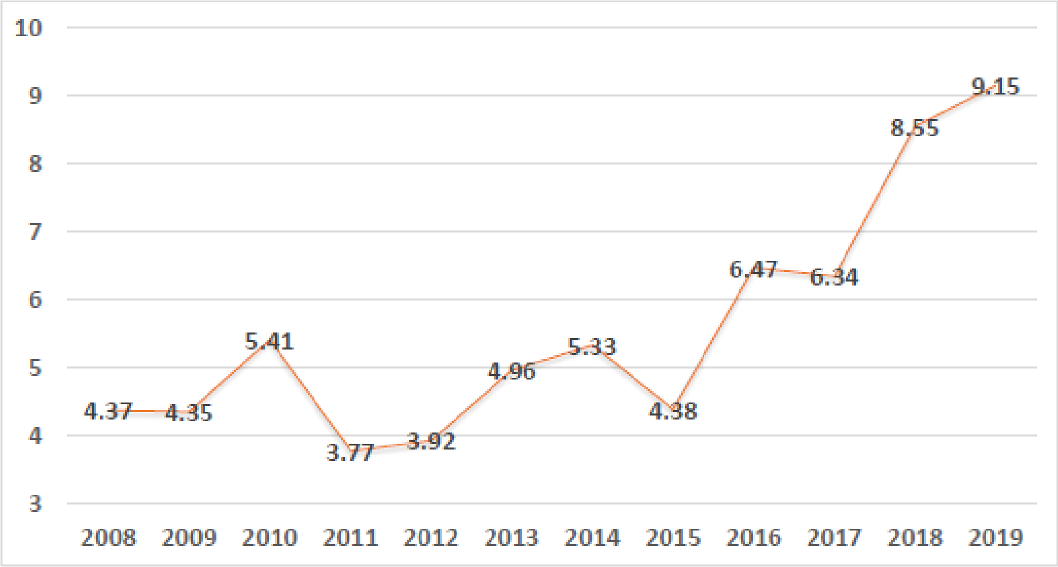
1. Konsumsi Energi : 3,2 TOE/kap
2. Konsumsi Listrik : 7000 Kwh/kap
3. Kapasitas Pembangkit Total: 443,1 GW*)

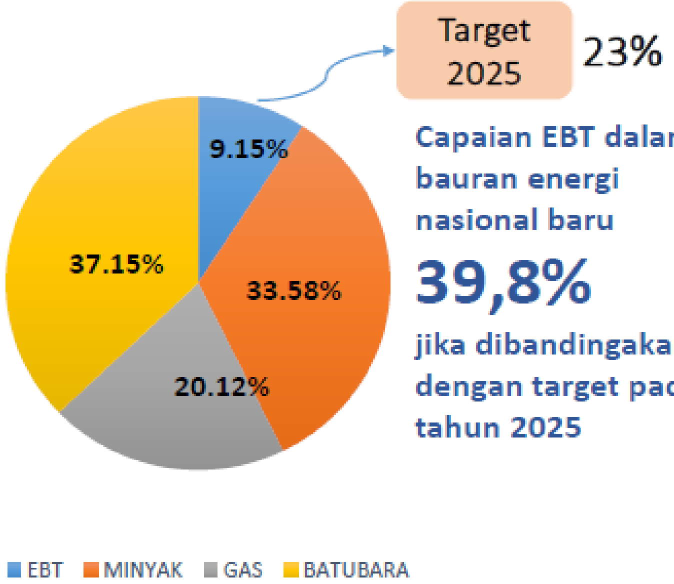
Batu Bara, Minyak Bumi, EBT, Gas Bumi

Realisasi pemanfaatan energi terbarukan baru mencapai 9,15%, masih jauh dari target Kebijakan Energi Nasional sebesar 23% pada 2025

TOE : Ton Oil Equivalent

PORSI EBT DALAM BAURAN ENERGI NASIONAL 2019





Capaian EBT dalam bauran energi nasional baru

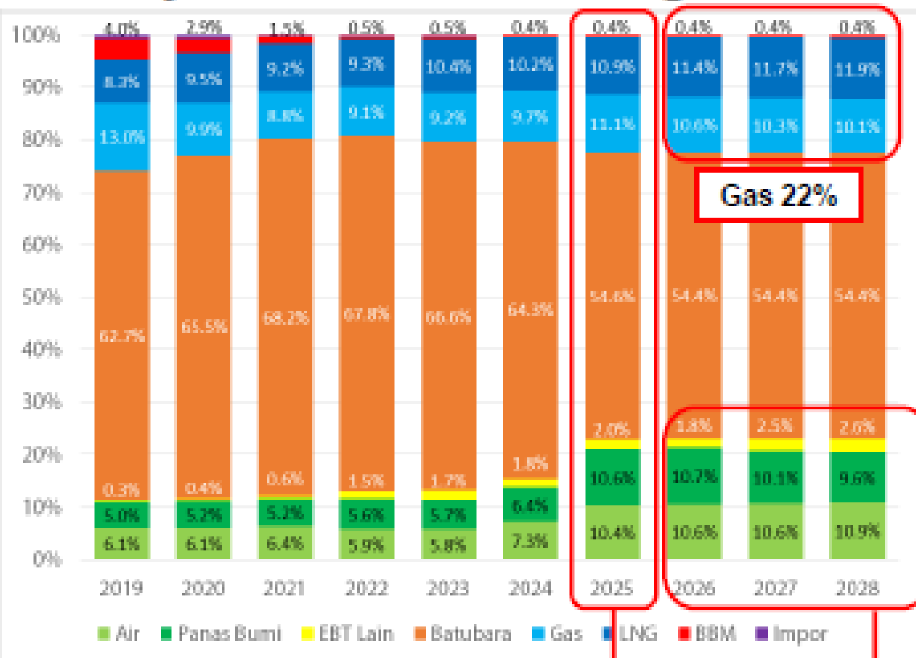
39,8%

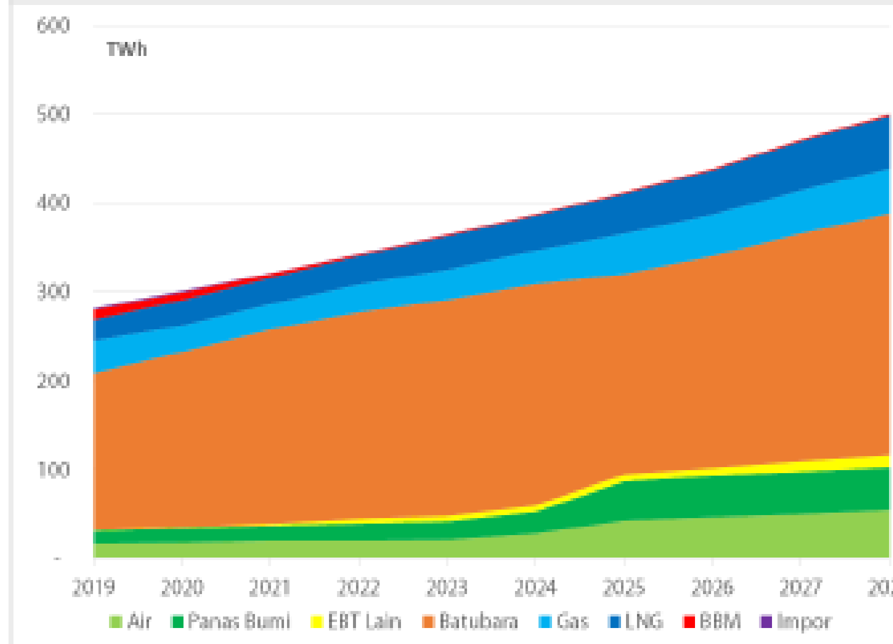
jika dibandingakan dengan target pada tahun 2025

Dalam bauran energi nasional, realisasi pemanfaatan energi terbarukan ini baru mencapai 9,15%, masih jauh dari target Kebijakan Energi Nasional sebesar 23% pada 2025

05| Komposisi Bauran Energi

Proyeksi Bauran Energi 2019-2028





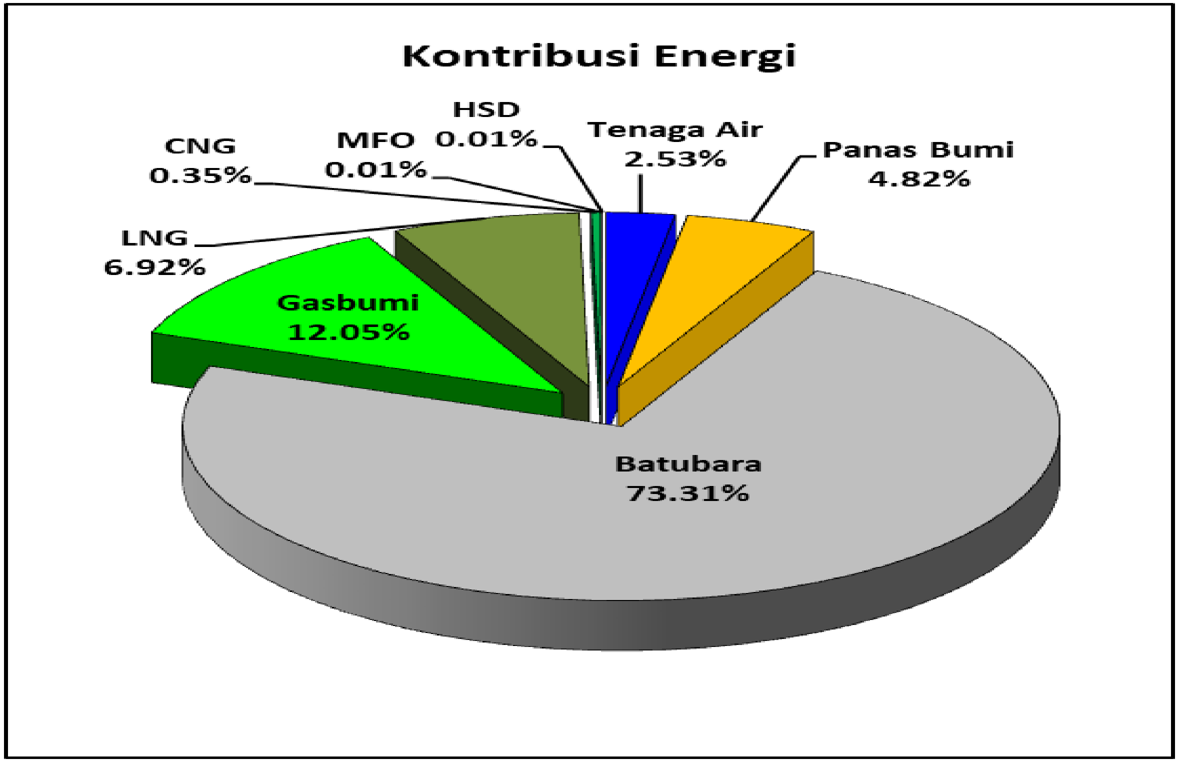
Jenis	RUPTL 2018-2027	RUPTL 2019-2028
EBT	23,0%	23,0%
Gas	22,2%	22,0%
Batubara	54,4%	54,6%
BBM	0,4%	0,4%
Jumlah	100%	100%

Target Bauran Energi Tahun 2025

EBT 23,2%

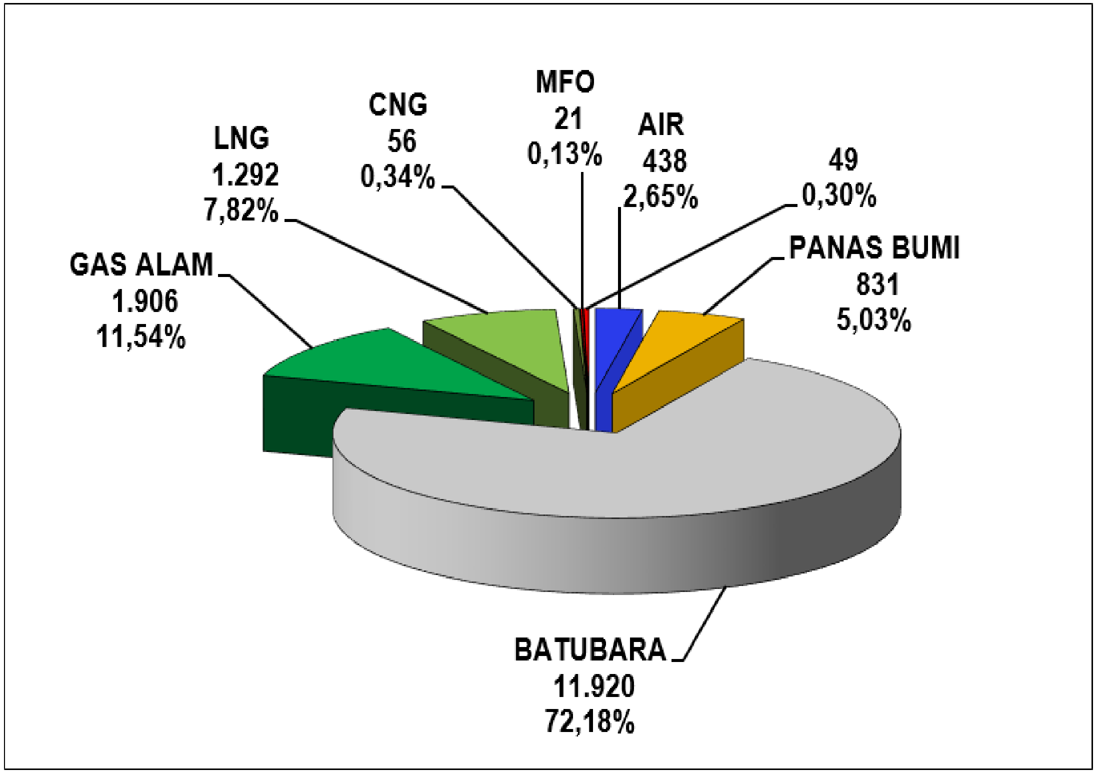
- Untuk menjaga bauran energi EBT 23,2% pada 2026-2028, diperlukan penambahan PLTS atap (PV *rooftop*) sekitar 3.200 MW (setara 1,6 juta pelanggan PLTS atap @ 2 kW).
- Target tersebut dapat tercapai dengan partisipasi masyarakat dan dukungan Pemerintah dalam pengembangan EBT, terutama PV *rooftop* yang harganya diperkirakan akan semakin menurun di masa depan.

Energy Mix Bulan Desember 2019



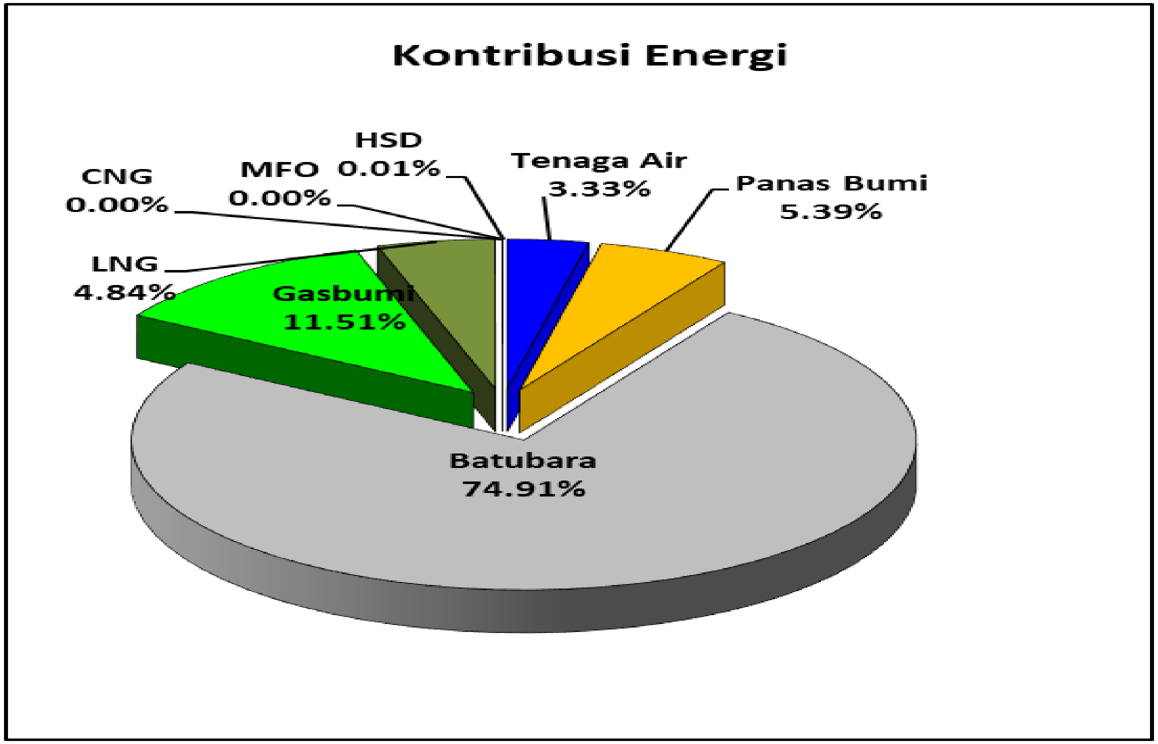
Sumber Data : Data ROT & Data Transaksi TRATL P2B
**) Data BBM diluar pemakaian BBM akibat pengoperasian PLTDG PESANGGARAN*

Energy Mix Bulan Januari 2020



Sumber Data : Data ROT & Data Transaksi TRATL P2B
**) Data BBM diluar pemakaian BBM akibat pengoperasian PLTDG PESANGGARAN*

Energy Mix Bulan Juni 2020



Sumber Data : Data ROT & Data Transaksi TRATL P2B
**) Data BBM diluar pemakaian BBM akibat pengoperasian PLTDG PESANGGARAN*

Energi Mix SJB Januari sd Agustus 2020

ENERGI PRIMER	Januari	Februari	Maret	April	Mei	Juni	Juli	Agustus	Jan - Agst
AIR	438	648	743	963	762	490	376	384	4.803
PANAS BUMI	831	737	773	794	819	793	819	823	6.389
BATUBARA	11.920	11.251	11.949	10.210	9.737	11.006	11.864	12.238	90.174
GAS ALAM	1.906	1.651	1.649	1.581	1.568	1.692	1.478	1.599	13.124
LNG	1.292	1.155	1.213	1.148	990	711	1.075	840	8.424
CNG	56	43	49	13	-	0	1	1	163
MFO	21	15	-	-	-	-	-	0	36
HSD	49,3	0,04	-	-	-	1,09	1	0,66	52
Total	16.513	15.501	16.374	14.710	13.875	14.692	15.613	15.886	123.165

To establish deep decarbonization pathway particularly for energy sector in supporting the strategic review of NDC to achieve the national emissions reduction target, *one of the key required actions*:

Deployment of low-carbon & zero-carbon energy technologies and renewable energy; greater role of energy efficiency & conservation from up-stream to down-stream (energy end-use - provide efficient transmission and distribution systems); and move the energy system towards using low-carbon energy sources (fuel switching) to improve national energy mix for its associated sectors (power, transport, industry, building, and households, etc.) to be imbedded in the long-term national energy program.

Strongly Required Deep Decarbonization of Energy Sector

Energy Sector

Meningkatkan Tingkat Penetrasi VRE ke Sistem Tenaga Listrik

[Associated Key Issues & Challenges in Moving Forward]

Three Trends Driving Transition in Global Energy Sector

[Tiga D]

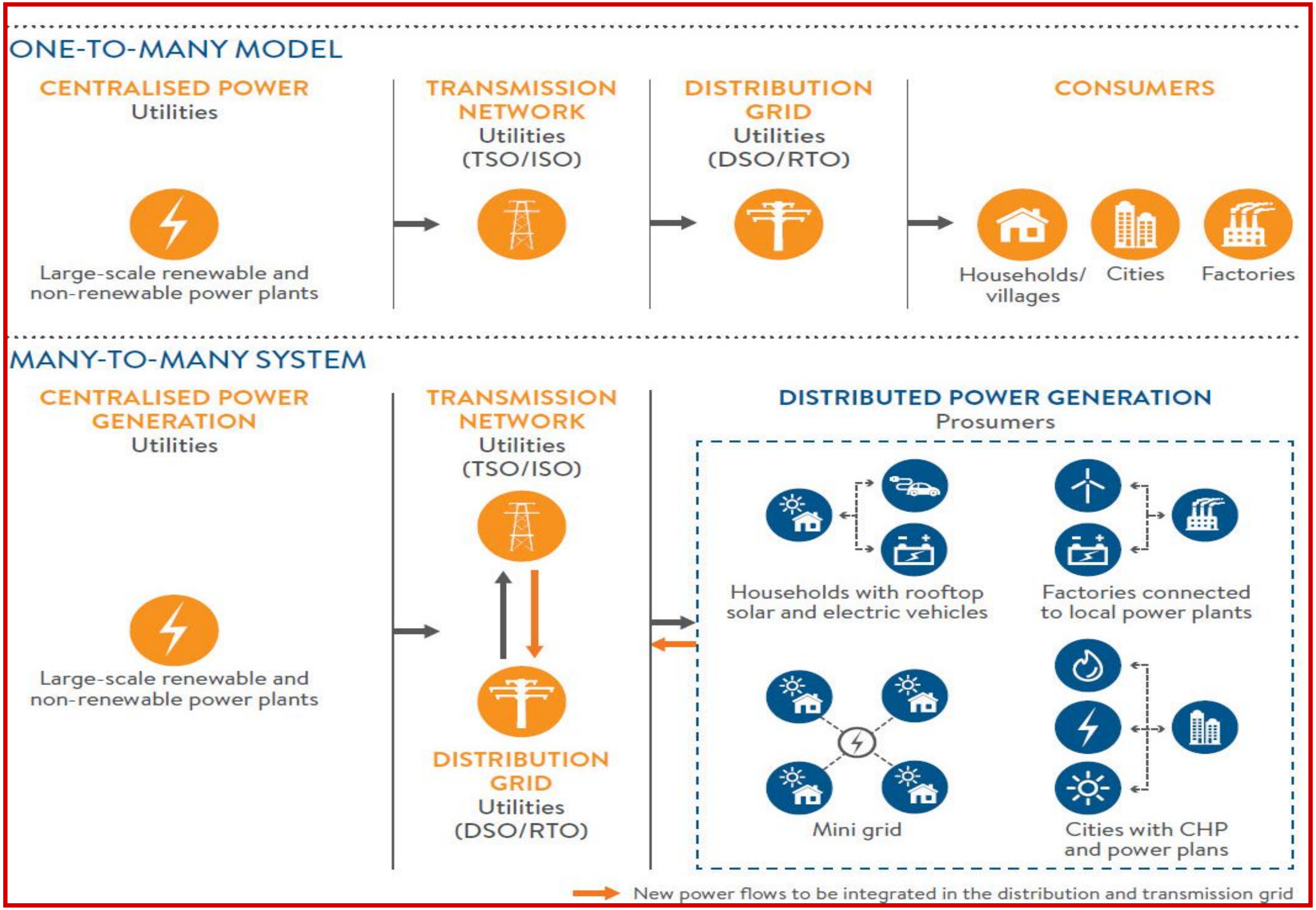
The global electricity sector is undergoing a large-scale transition, marked by 3 (three) inter-related and reinforcing trends impacting demand and supply of energy:

Decarbonisation with the shift towards lower-carbon energy generation and use. This is marked by a growth in natural gas (playing a bridging role), and renewables in energy supply and generation, particularly in distributed generation, as well as electrification of the mobility sector.

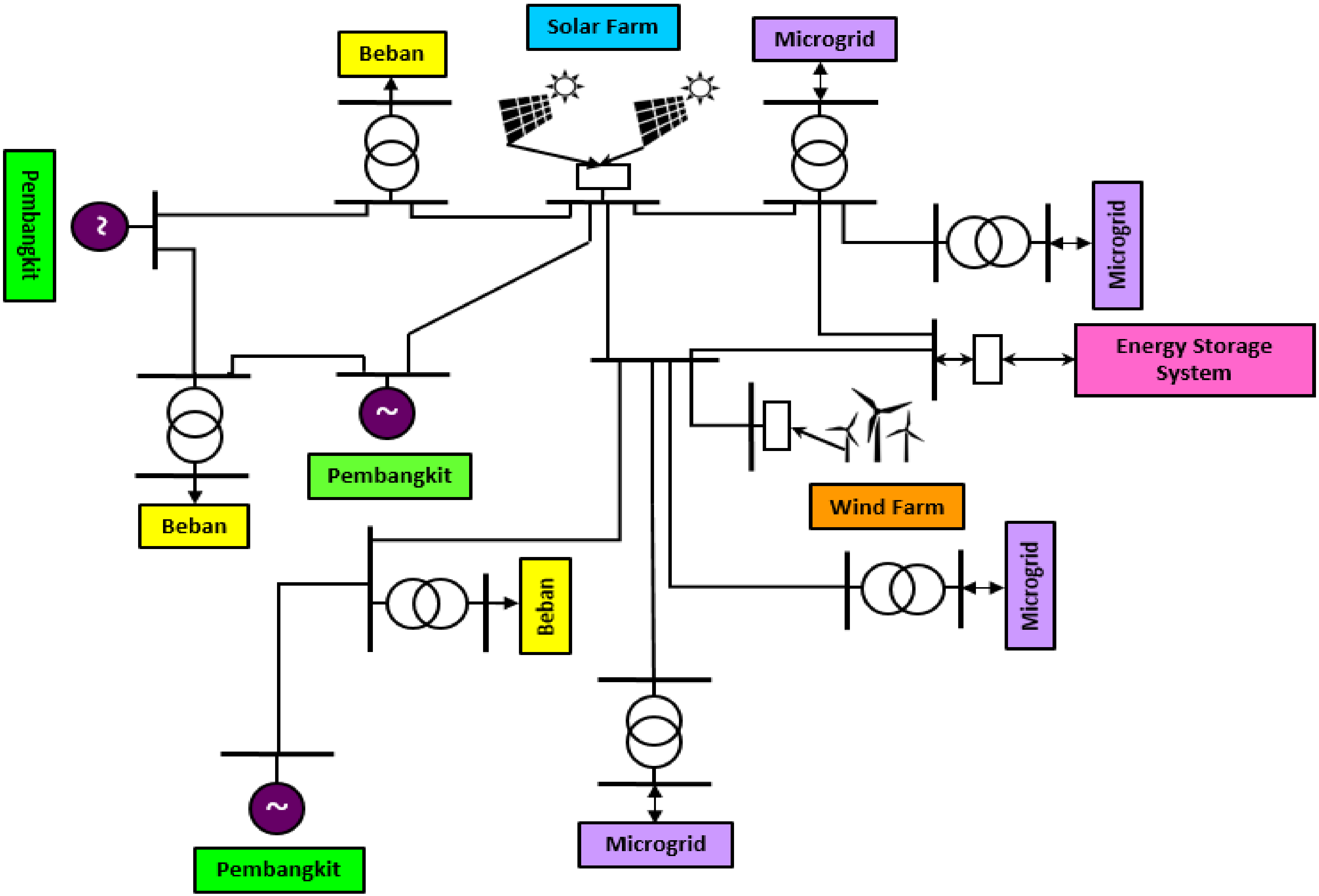
Digitalisation supported by the increase in information and communication technologies and the overall shift to an 'internet of things' that enables smart grids and optimized energy use and storage, greater efficiency and the integration of distributed energy resources, especially distributed generation.

Decentralisation marked by the greater adoption and availability of a distributed energy resources including new distributed generation sources, developments in energy storage, new market entrants and shifting consumer preferences.

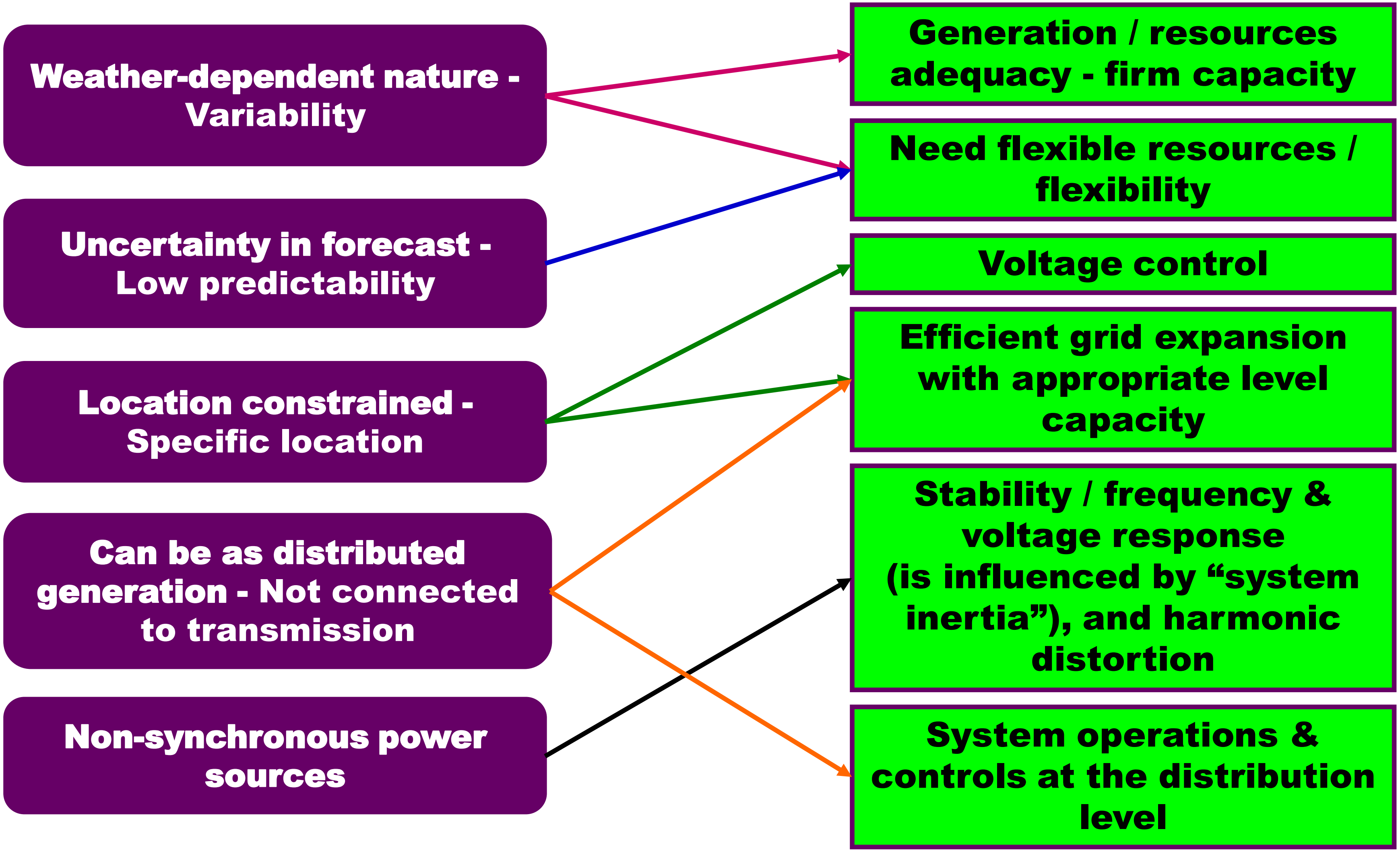
Evolution of the Electricity System



Contoh Perkembangan Sistem Tenagalistrik

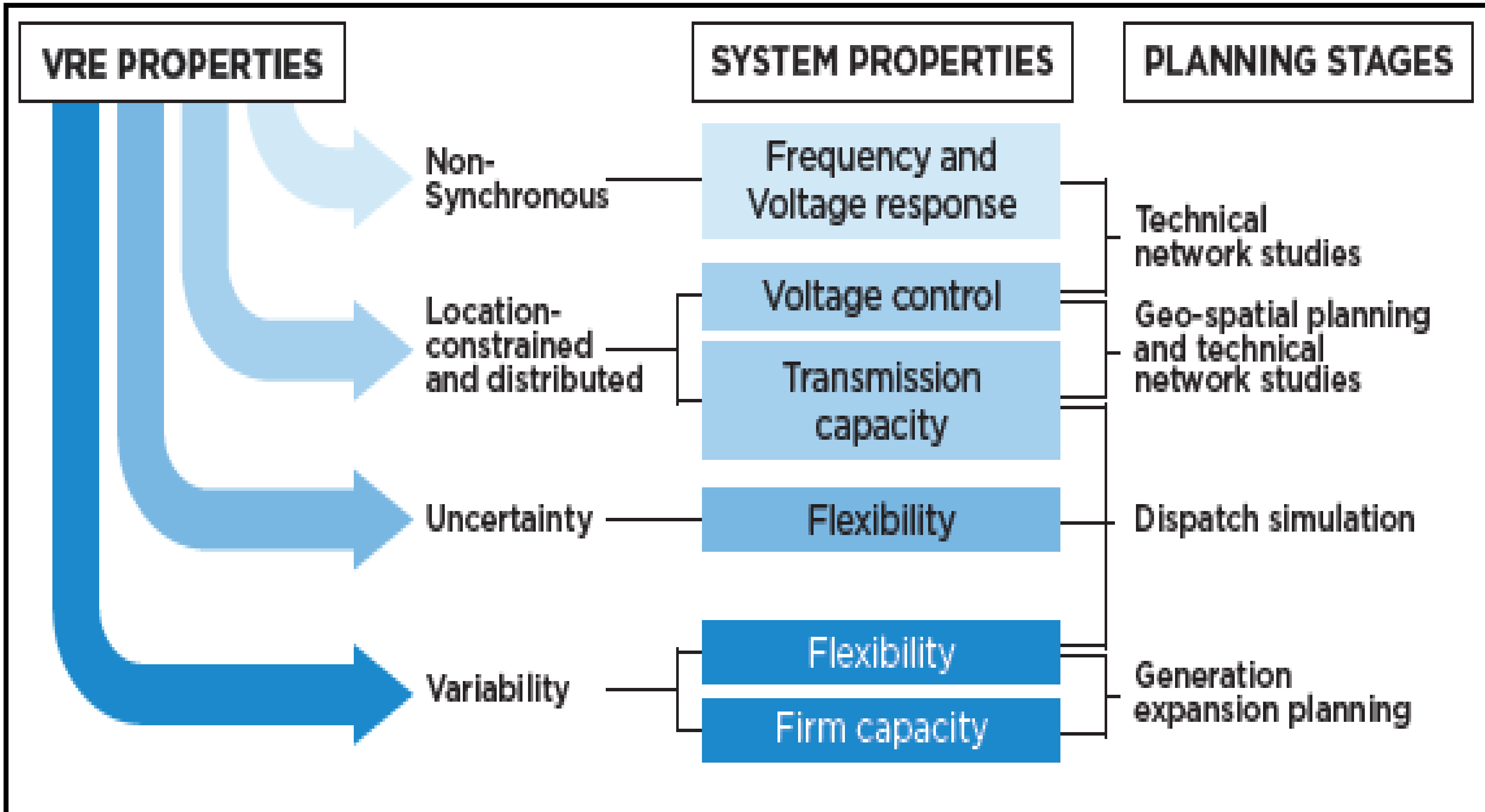


Key Properties of Variable Renewable Energy (VRE) and Its Associated Challenges[1)]



Please see other big challenges.

Key Links Between VRE, Power System Properties and Planning[1)]



The CAISO Duck Chart

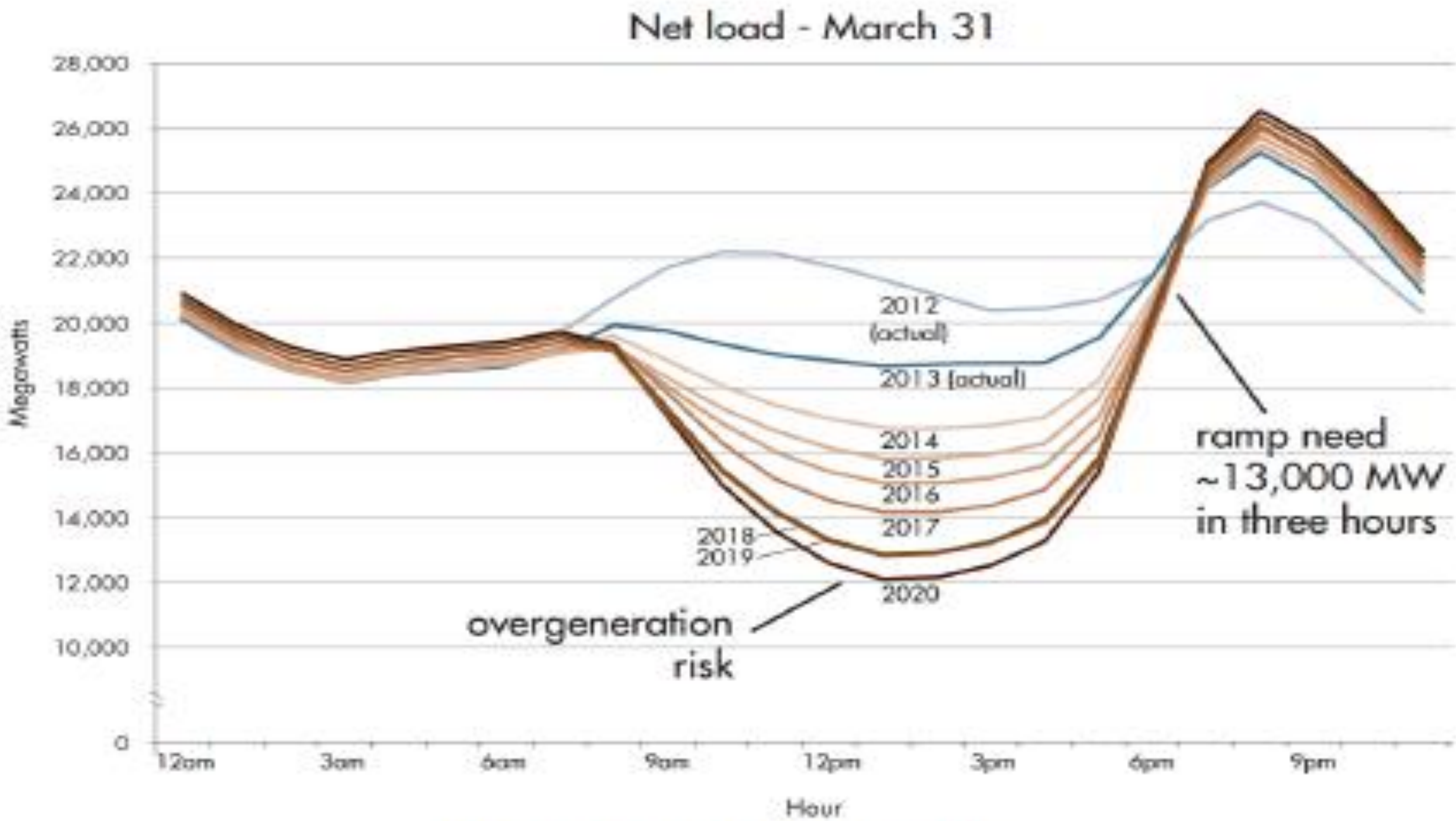


Figure 1. The CAISO duck chart

Source: CAISO 2013

*) **Source**: Paul Denholm, Matthew O'Connell, Gregory Brinkman, and Jennie Jorgenson, "Overgeneration from Solar Energy in California: A Field Guide to the Duck Chart", NREL Technical Report, NREL/TP-6A20-65023, November 2015.

Background: Why Ducks Lead to Overgeneration*)

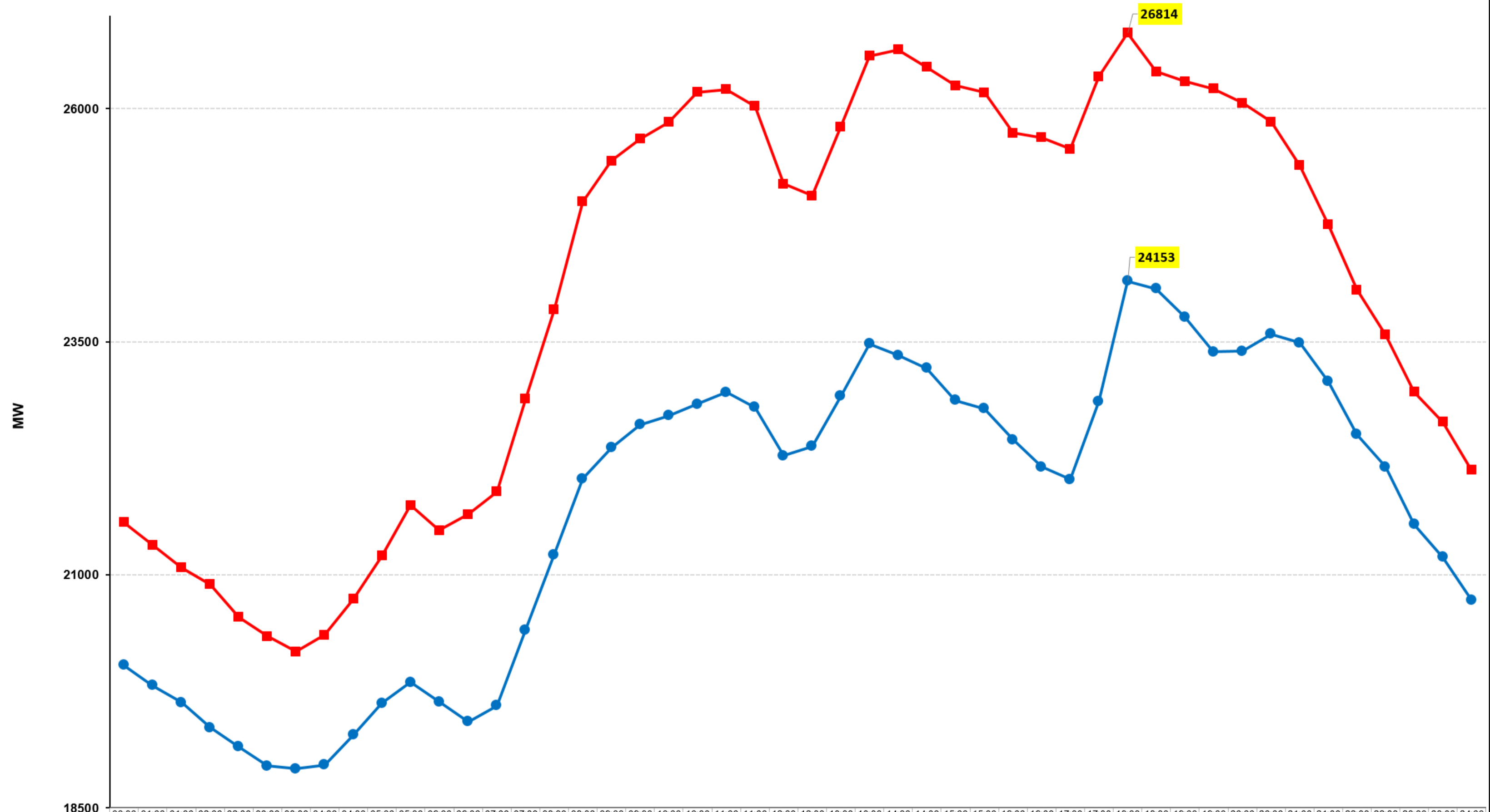
The CAISO duck chart itself illustrates the general challenge of accommodating solar energy and the potential for over generation and solar curtailment. In the chart, each line represents the net load, equal to the normal load minus wind and PV generation. The “belly” of the duck represents the period of lowest net load, where PV generation is at a maximum. The belly grows as PV installations increase between 2012 and 2020. While the amount of PV in 2020 is not shown directly, it can be estimated by comparing the 2012 curve to the 2020 curve. In this case, the normal load (i.e., no PV and adjustments for load growth) at about 1-2 p.m. on March 31, 2020 appears to be about 22,000 megawatts (MW), while PV is generating about 10,000 MW, leaving about 12,000 MW to be met with other resources. In this case, PV provides perhaps 45% of the total demand in this one hour. The duck chart also points to the period of over generation risk, which could result in curtailed energy.

*) Source: Paul Denholm, Matthew O'Connell, Gregory Brinkman, and Jennie Jorgenson, “Overgeneration from Solar Energy in California: A Field Guide to the Duck Chart”, NREL Technical Report, NREL/TP-6A20-65023, November 2015.

5 Key Technical Parameters that Determine the Flexibility of Dispatchable Plants[1)]

1. **The ramp rate** (or ramping gradient) of a power plant: the rate at which a generator can change its output (in MW/timeframe, e.g., minute or hour).
2. **Start-up times**: the time required for power to start up. Cold, warm and hot starts are distinguished depending on how long a power plant has been down.
3. **Minimum load levels**: the minimum generation at which a power plant can be operated stably before it needs to be shut down. A plant can adjust its output between this and its rated capacity.
4. **Minimum down and up times**: the lower limits of the time that a plant needs to be offline or online. In principle, these are not strict technical limits, but are supporting guidelines to avoid wear and tear that leads to high costs over the lifetime of a power plant.
5. **Partial load efficiency**: the reduced efficiency of a power plant operated below its rated capacity.

Langgam Beban Kerja April 2020 VS 2019



	00:30	01:00	01:30	02:00	02:30	03:00	03:30	04:00	04:30	05:00	05:30	06:00	06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30	12:00
Hari Selasa, 23 April 2019	21562	21323	21076	20898	20547	20343	20176	20356	20742	21204	21745	21478	21648	21892	22886	23846	25004	25439	25675	25858	26177	26209	26027	25196
Hari Kamis, 23 April 2020	20030	19812	19632	19364	19155	18951	18919	18963	19284	19624	19847	19640	19427	19599	20410	21217	22030	22362	22613	22707	22833	22958	22799	22279

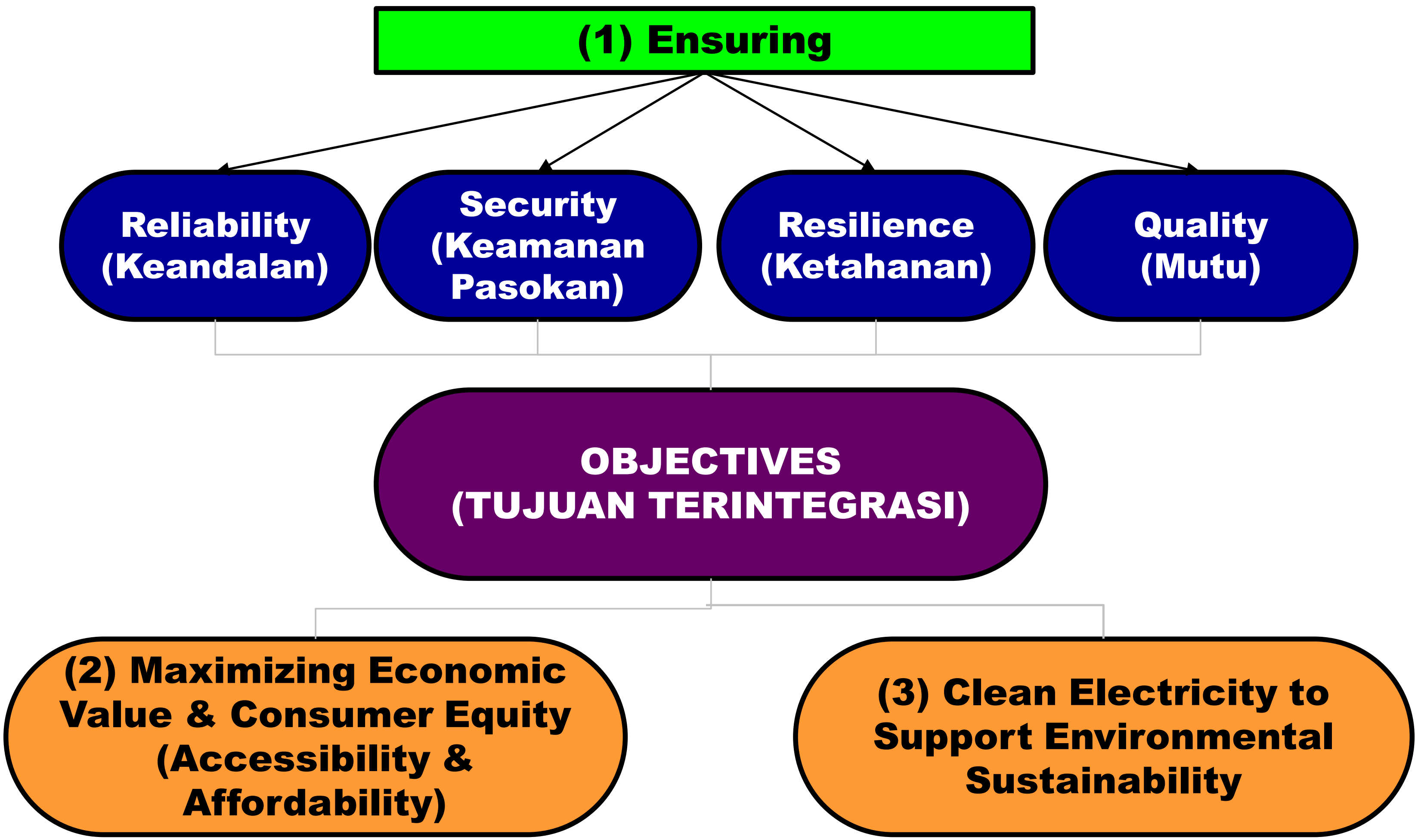
	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30	18:00	18:30	19:00	19:30	20:00	20:30	21:00	21:30	22:00	22:30	23:00	23:30	24:00
Hari Selasa, 23 April 2019	25069	25809	26568	26632	26445	26248	26172	25739	25691	25568	26346	26814	26398	26293	26214	26060	25859	25391	24756	24057	23576	22964	22639	22123
Hari Kamis, 23 April 2020	22377	22916	23479	23356	23218	22871	22784	22448	22158	22025	22861	24153	24068	23768	23393	23401	23585	23491	23076	22508	22160	21542	21191	20729

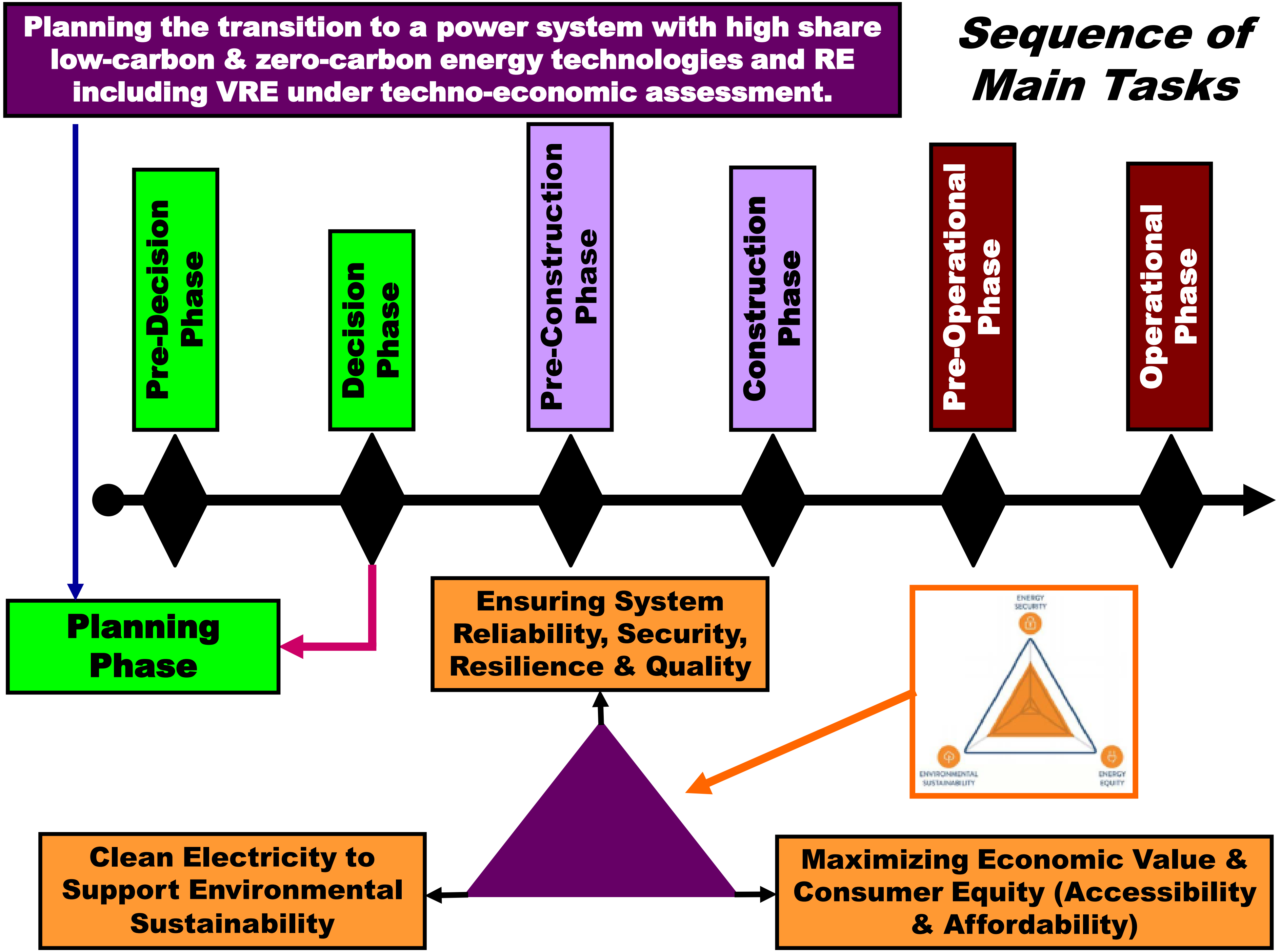
4 Basic Models for Industry Structure[2,3)]

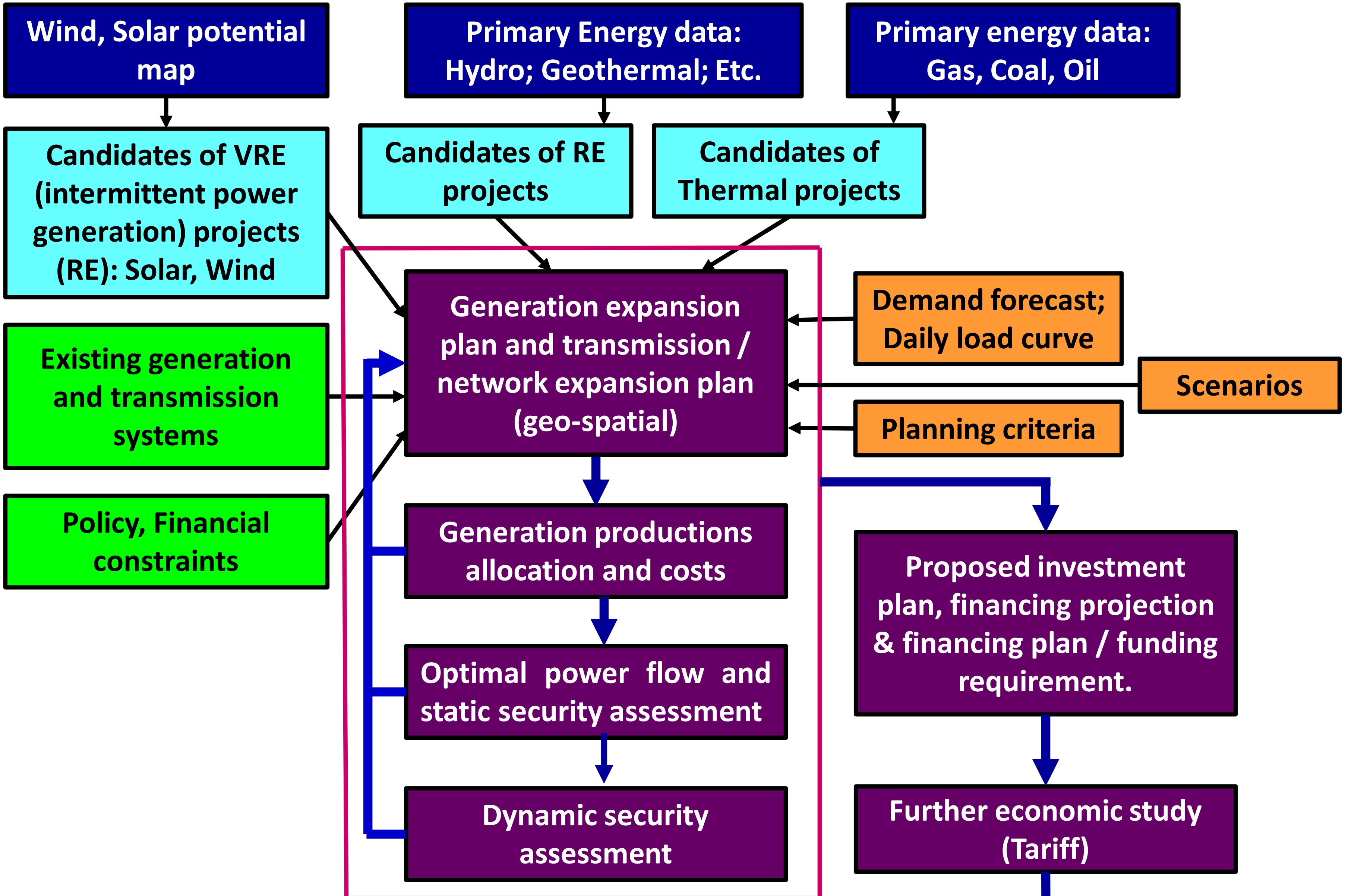
Key Items	Model 1	Model 2	Model 3	Model 4
Characteristic	Vertically Integrated Monopoly	Single Buyer	Wholesale Competition	Retail Competition
Definition	Monopoly at all levels	Competition in generation	Competition in generation and choice for DITSCOs	Competition in generation and choice for final consumers
Competing Generators	Tidak	Ya	Ya	Ya
Choice for Retailers?	Tidak	Tidak	Ya	Ya
Choice for Final Customers?	Tidak	Tidak	Tidak	Ya
Note	• No one may buy from independent generator. • All final customers are supplied by the incumbent utility	• Only the existing integrated monopoly in the assigned area is permitted to buy from IPP (the competing generators). • The design of PPAs is a major feature.	• DITSCOs are given the right to buy direct from IPPs, but they retain a local franchise over retailers customers. • IPP will need access to the transmission network through trading arrangement for the network.	• Permits all customers to choose their suppliers & are given the right to buy from IPP. • Access to transmission and distribution network are required.

- **Sequence of Main Tasks**
- **Principal States of Power System Operation**

DEKARBONISASI JANGKA PANJANG YANG MENDALAM TETAP MEMENUHI KESEIMBANGAN PASOKAN DAN PERMINTAAN SERTA MENJAMIN PEMENUHAN PILAR UTAMA




Planning the transition to a power system with high share low-carbon & zero-carbon energy technologies and RE including VRE under techno-economic assessment.
Sequence of Main Tasks
Pre-Decision Phase
Decision Phase
Pre-Construction Phase
Construction Phase
Pre-Operational Phase
Operational Phase
Planning Phase
Ensuring System Reliability, Security, Resilience & Quality
ENERGY SECURITY
ENVIRONMENTAL SUSTAINABILITY
ENERGY EQUITY
Clean Electricity to Support Environmental Sustainability
Maximizing Economic Value & Consumer Equity (Accessibility & Affordability)



System Planning Process

(***Hanya Sebagai Contoh General Practice***)

Characteristics of Selected Long-term Power Sector Planning Tools[1)]

	Dispatch or planning	Objective function	Generation or network	Stochastic modelling	Reliability considered	Renewable energy volatility	Forecasting errors	Hydro modelling*
AURORAxmp	D&P	not clear	G	Y (only for dispatch)	Y	Y		2
EGEAS	P		G	Y				0
WASP	P	system cost minimisation	G	Y	Y	N	N	1
EMCAS	D&P	system cost minimisation and maximisation of revenue of agents	G			scenario approach		1
GEM	P	system cost minimisation	G&N		Y	N	N	1
Optgen	P	system cost minimisation	G&N	Y	Y	Y	N	4
PLEXOS	D&P	system cost minimisation	G&N	Y	Y	Y	Y	2
Ventyx System	P	minimisation of net present	G&N	Y	Y	Y		2
Optimizer		value of revenue requirements						
UPLAN	D&P	system cost minimisation and maximisation of consumer surplus	G&N	Y	Y	Y	Y	3

Model Scenarios*)

[Hanya Sebagai Contoh]

Carbon Tax Scenario

- Various carbon taxes (13,25,50,75 $/tCO2) were imposed for both the Base scenario and the New Technology scenario.
- Effect of carbon tax was analyzed when lower generation limit was set on coal-fired power plant

New Technology Scenario

- Twenty likely and speculative new technologies using coal and gas were added to the Base scenario for application within the lifetime considered in the model
- CCS was included within these new technologies variants.

SCENARIOS

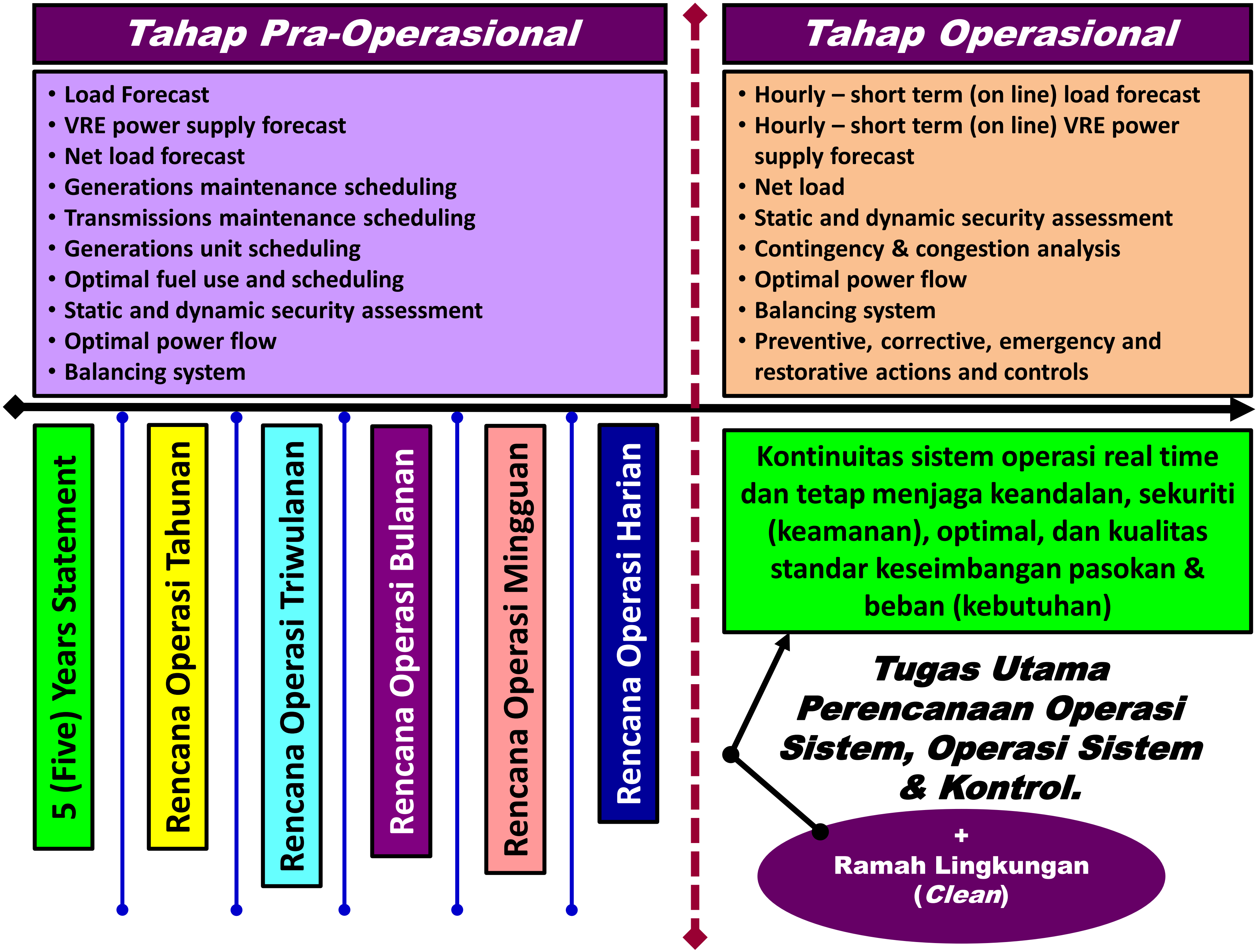
Base Scenario

- Only technologies either current in 2005 or included in the National Electricity Plan were included
- Current trend for renewables introduction was reflected in the model
- Constraints for some technologies were set according to the resource limit and the geographical limit

Total Carbon Emission Cap Scenario

Various total carbon emission caps (120%, 100%, 80%,60% compared to the 2004 level) were imposed on the Base scenario and New Technology scenario. Effect of total carbon emission cap was analyzed when lower generation limit set set on coal-fired power plant

*)**Source**: Andrew J Minchener, “The Korean Energy Strategy Project”, IEA CCC/133, April 2008.



Tahap Pra-Operasional
• Load Forecast
• VRE power supply forecast
• Net load forecast
• Generations maintenance scheduling
• Transmissions maintenance scheduling
• Generations unit scheduling
• Optimal fuel use and scheduling
• Static and dynamic security assessment
• Optimal power flow
• Balancing system
Tahap Operasional
• Hourly – short term (on line) load forecast
• Hourly – short term (on line) VRE power supply forecast
• Net load
• Static and dynamic security assessment
• Contingency & congestion analysis
• Optimal power flow
• Balancing system
• Preventive, corrective, emergency and restorative actions and controls
5 (Five) Years Statement
Rencana Operasi Tahunan
Rencana Operasi Triwulanan
Rencana Operasi Bulanan
Rencana Operasi Mingguan
Rencana Operasi Harian
Kontinuitas sistem operasi real time dan tetap menjaga keandalan, sekuriti (keamanan), optimal, dan kualitas standar keseimbangan pasokan & beban (kebutuhan)
Tugas Utama Perencanaan Operasi Sistem, Operasi Sistem & Kontrol.
+
Ramah Lingkungan
(Clean)

Principal States of Power System Operation[4)]

Operasi sistem dapat digambarkan (*describe*) oleh 3 (tiga) set persamaan generik, yaitu: (i) 1 set persamaan diferensial, dan (ii) 2 (dua) set persamaan aljabar, yaitu: (a) E (*equality constraints*), dimana keseimbangan daya aktif dan reaktif pada setiap bus (*node*), dan (b) I (*inequality constraints*) batasan kondisi operasi dari berbagai komponen sistem, seperti tegangan dan arus tidak boleh melebihi batasan maksimumnya.

Sebagaimana yang dideskripsikan pada slide selanjutnya, ada 5 (lima) kondisi operasi sistem tenaga listrik yaitu:

(1) Kondisi Normal: semua E (*equality constraints*) & I (*inequality constraints*) serta N-1 terpenuhi;

(2) Kondisi Siaga (*Alert*): semua E (*equality constraints*) & I (*inequality constraints*) terpenuhi, namun N-1 tidak;

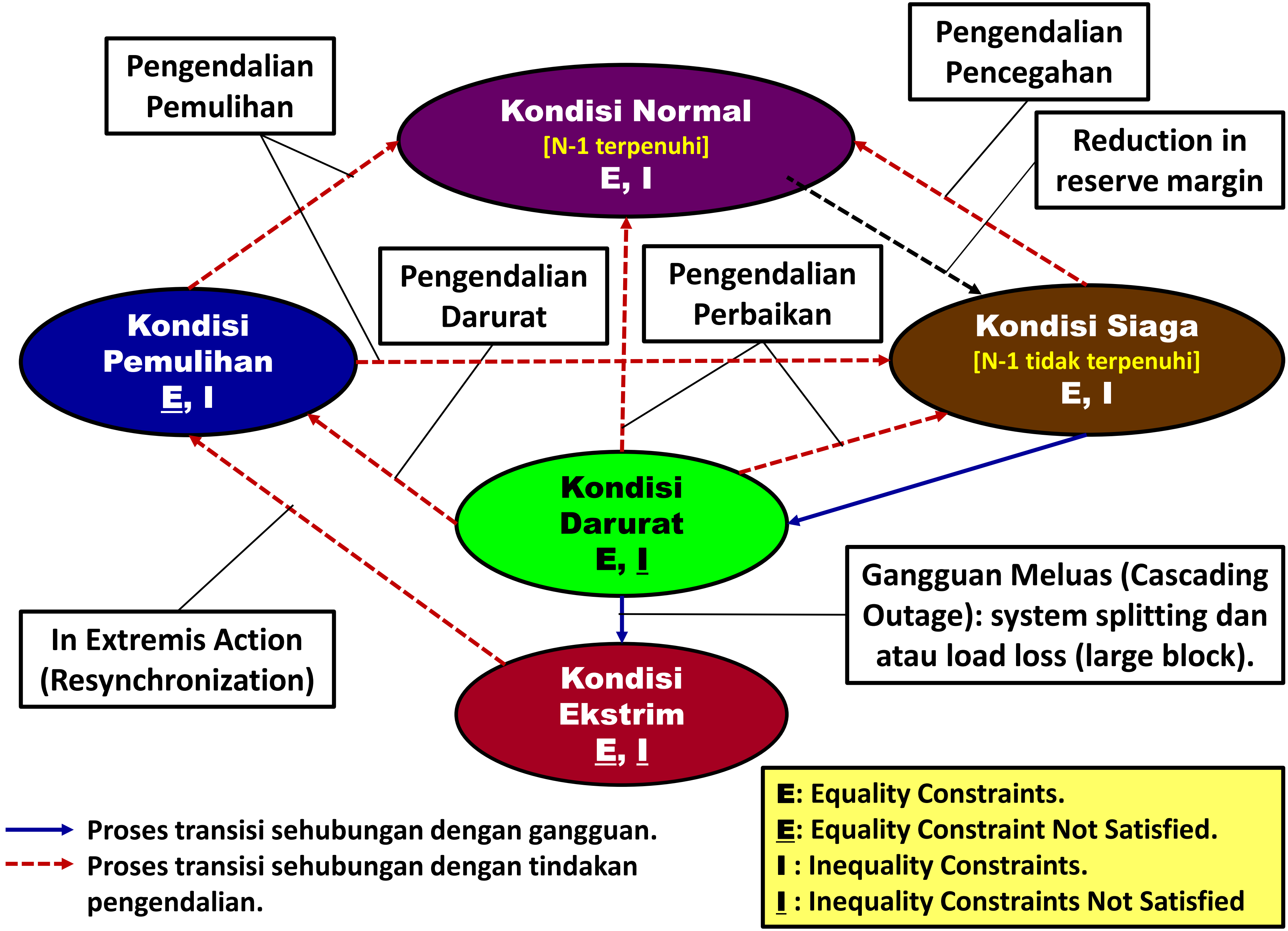
(3) Kondisi Darurat (*Emergency*): semua E (*equality constraints*) dapat terpenuhi, paling tidak ada satu I (*inequality constraints*) yang tidak terpenuhi disebabkan oleh adanya gangguan;

(4) Kondisi Ekstrim (*In Extremis*): pada kondisi ini kedua E (*equality constraints*) dan I (*inequality constraints*) tidak terpenuhi (violated); dan

(5) Kondisi Pemulihan (*Restorative*): merupakan kondisi transisi dimana I (*inequality constraints*) terpenuhi dari tindakan pengendalian darurat yang dilaksanakan, tetapi E (*equality constraints*) belum terpenuhi.

[*)] Fink & Carlsen, “Operating under stress and strain”, IEEE Spectrum, March 1978.

Principal States of Power System Operation



Balancing Act - Associated Key Issues

Potential reliability impacts of distributed resources (potential reliability concerns)[5)] : (i) visibility & controllability of distributed energy resources and the potential effects on forecast load; (ii) the ramping and variability of certain distributed energy resources and the resulting impacts on the base load and cycling generation; (iii) the ability to control reactive power; (iv) low-voltage ride-through (LVRT) and low-frequency ride-through and coordination with IEEE Standard 1547; (v) under-frequency load shedding (UFLS) and under voltage load shedding (UVLS).

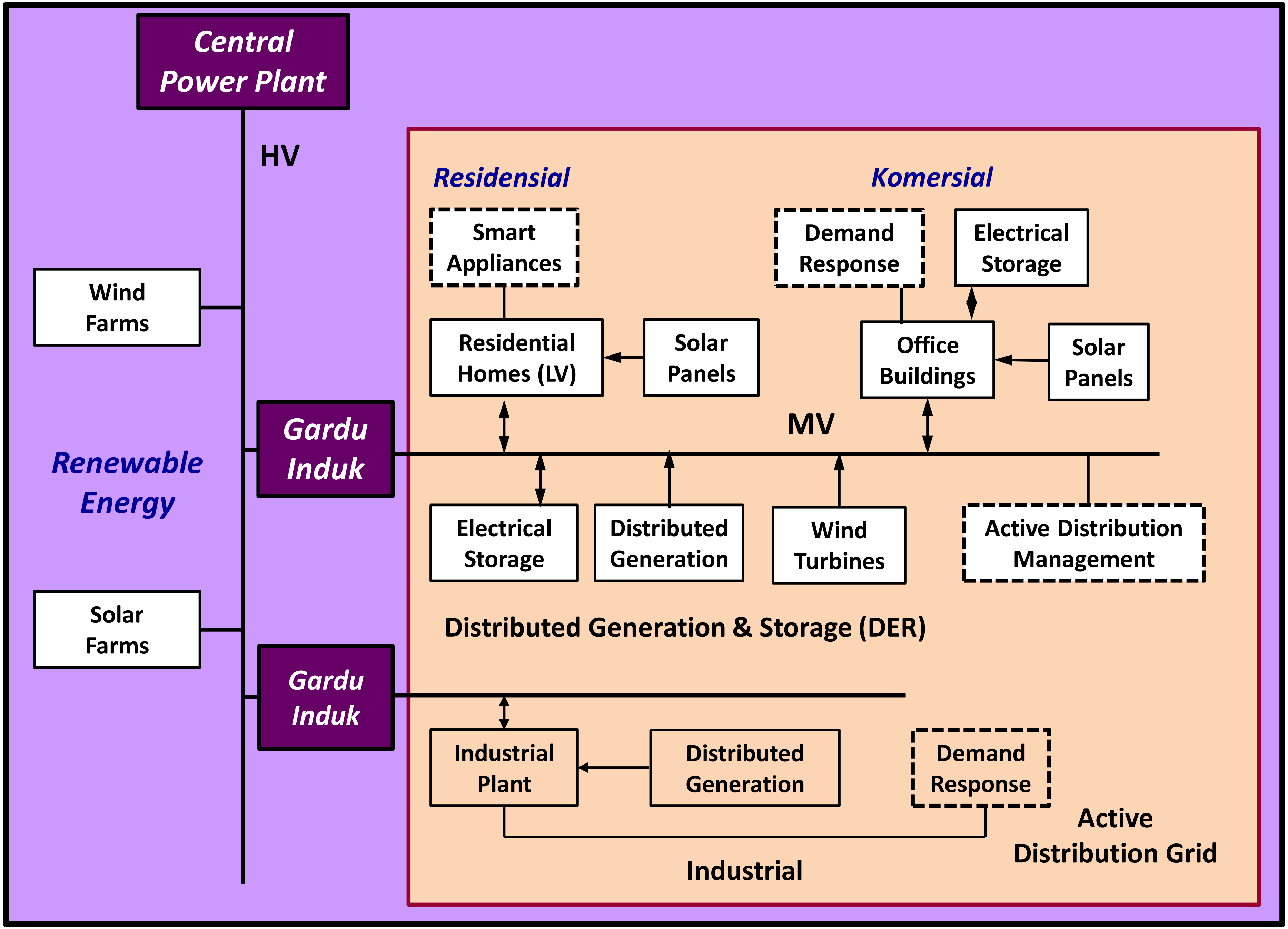
Operating consideration of integrating variable generation – Associated tasks related to bulk power system operation activities: (i) forecasting techniques must be incorporated into day-to-day operational planning and real-time operations routine and practice, including unit commitment and dispatch; (ii) the impact of securing ancillary services through larger balancing areas or participation in wider-area balancing management on bulk power system reliability must be investigated; (iii) operating practices, procedures, and tools will need to be enhanced and modified.

Some of recommended key elements to improve the integration of variable resources – To be operating practices, procedures, and tools (standard): (i) disturbance control performance; (ii) automatic generation control requirement; (iii) communication and coordination; (iv) capacity and energy emergencies; (v) reliability coordination, current-day operations; (vi) normal operating planning; (vii) monitoring system condition.

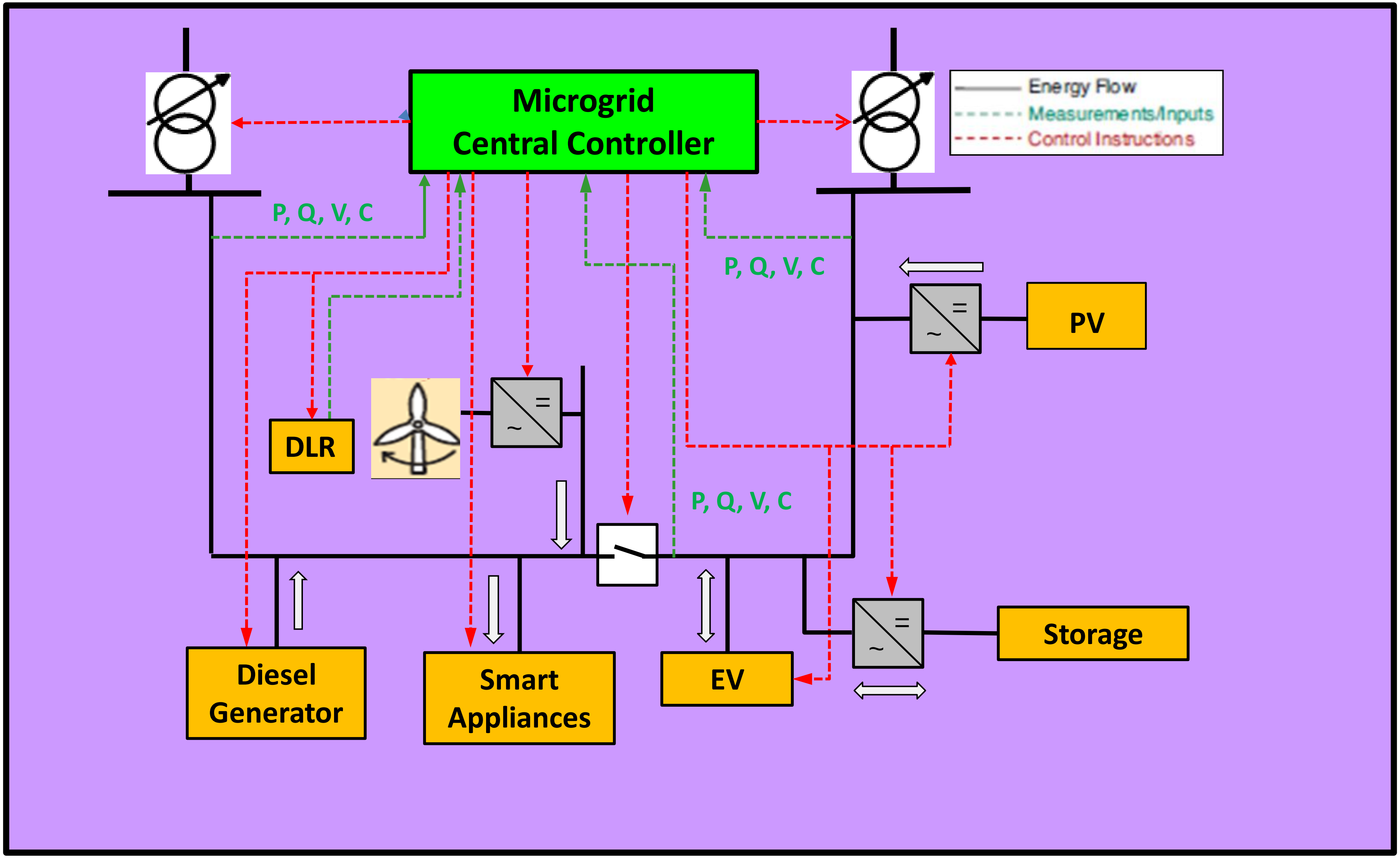
Microgrid dan Microgrid Controller

- ***DMS Integration with Microgrid Controllers / DERMS***

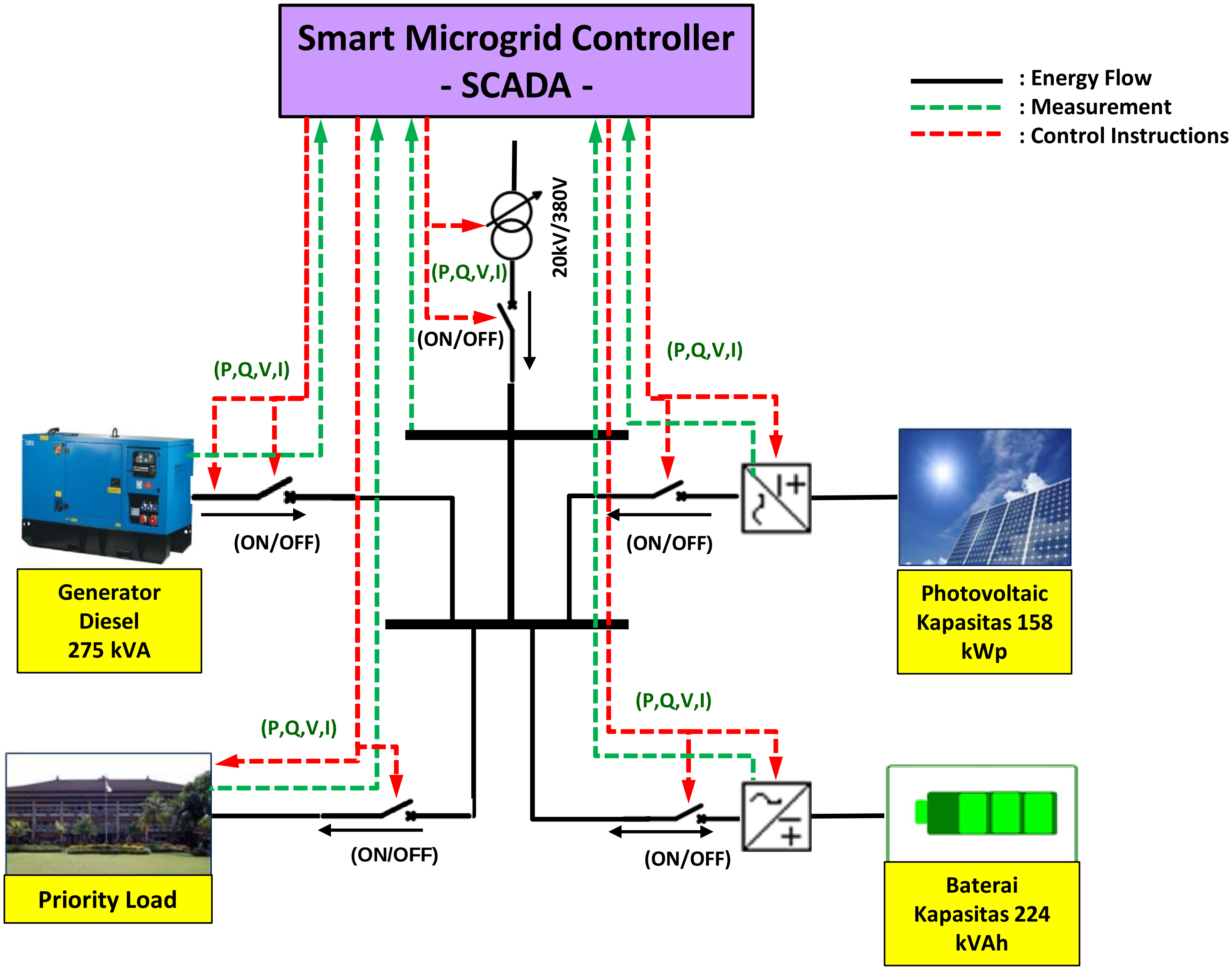
Contoh Komponen Microgrid[6)]



Contoh Arsitektur Fisik Microgrid[7)]



Smart Grid in Microgrid Kantor Gubernur Bali



Impact of Inverter Based Generation on Bulk Power System Dynamics and Short-Circuit Performance
[Key Associated Issues]

Synchronous ac rotating machine → Inverter-based resources (IBR) technologies

Electric power grids around the world are undergoing a significant change in generation mix.

Large System Impact Issues Related to Penetration of Inverter Based Resources
1. Voltage-Control/Reactive Support
2. Frequency Response and Control
3. Low-Short Circuit-Levels
4. Control and Grid Interactions
5. Planning Process
6. Modeling
7. Operations / Economic Issues
8. Etc.

Protective Relay Issues Related to Large Penetration of Inverter Based Resources
1. Inverter-Based Fault Currents and Voltage
2. Relay Element Response to Inverter-Based Fault Current and Voltage
3. Relay Scheme Selection Issues Caused by Inverter-Based Resources (IBR)
4. Short Circuit Issues Caused by IBR
5. Protection and Control (PRC) Reliability Standards Issues Caused by IBR

<u>Source</u>: IEEE Power & Energy Society, "Impact of Inverter Based Generation on Bulk Power System Dynamics and Short-Circuit Performance", Technical Report, PES-TR68, July 2018.

The Functional Use Cases of Microgrid Controllers[6)]

[Contoh]

➢ Frequency Control
➢ Voltage Control
➢ Grid Connected to Islanding Transition: Intentionally Islanding Transition
➢ Islanding to grid Connected Transition: Unintentionally Islanding Transition
➢ Islanding to Grid-Connected Transition: Resynchronization and Reconnection
➢ Energy Management: Grid Connected and Islanding
➢ Microgrid Protection
➢ Ancillary Services: Grid Connected
➢ Microgrid Black Start
➢ Microgrid User Interface and Data Management

Isu Utama Terkait for Moving Forward[8)]

Struktur & Operasi Microgrid
- Definisi / scope dan general features.
- Komponen dan perlengkapan terkait.
- Tipe / jenis microgrids.
- Fungsi microgrid dan manfaat.

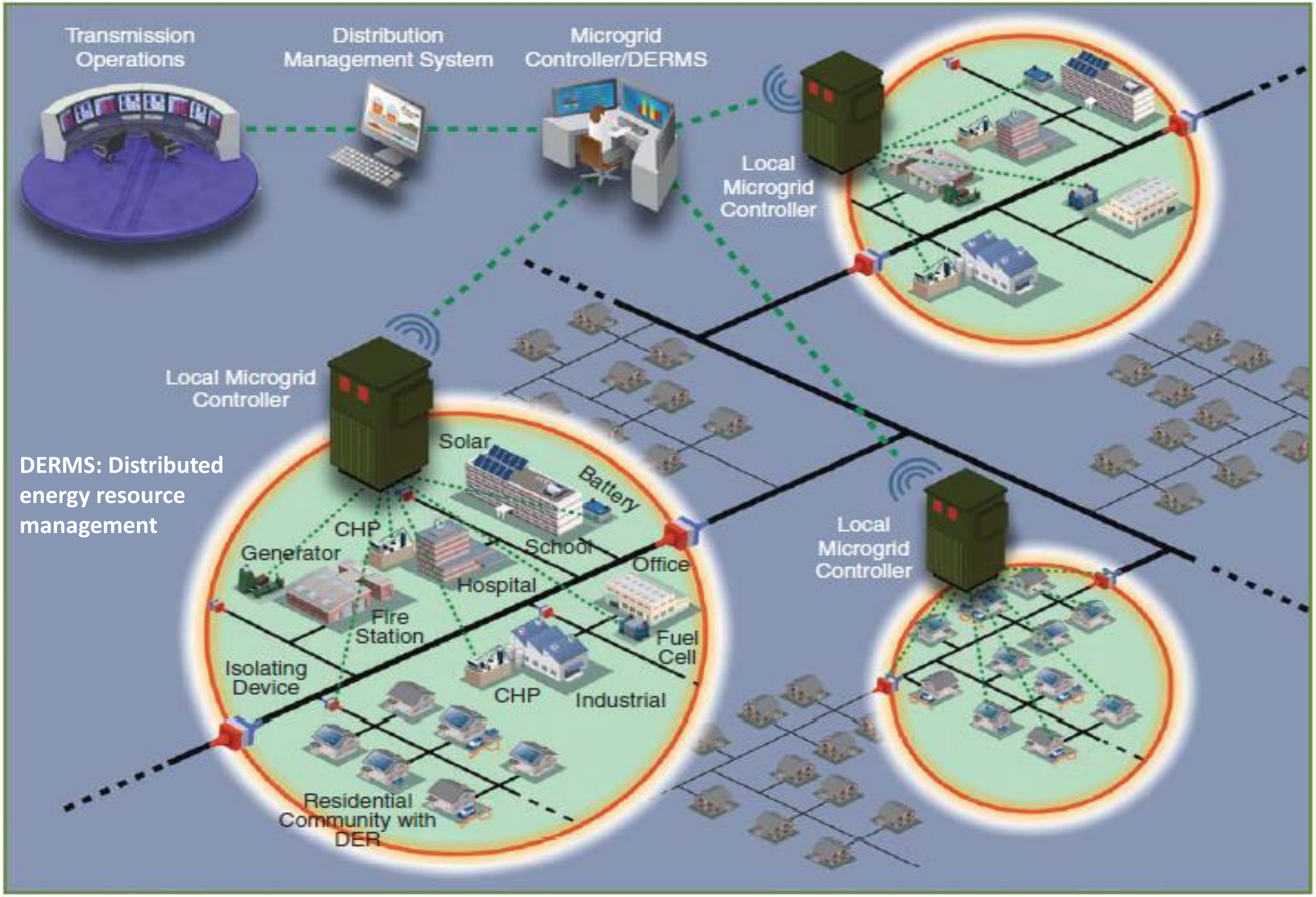
Struktur Sistem Kontrol & Operasi Microgrid
- Microgrid control system requirements.
- Microgrid control system function.
- Struktur sistem kontrol microgrid.

Standarisasi Fungsi Sistem Kontrol Microgrid
- Standardization benefits & activities.
- Standard requirement.
- Standardization process.
- Scope of a standardized functional specification.

Spesifikasi Fungsional Sistem Kontrol Microgrid
- Identifikasi fungsi utama sistem kontrol.
- Spesifikasi fungsi utama.

Testing dari Fungsi Utama
- Requirements for conformance testing.
- Approach dan protocols yang dipergunakan.

A Grid Interactive Microgrid Controller For Resilient Communities[9)]



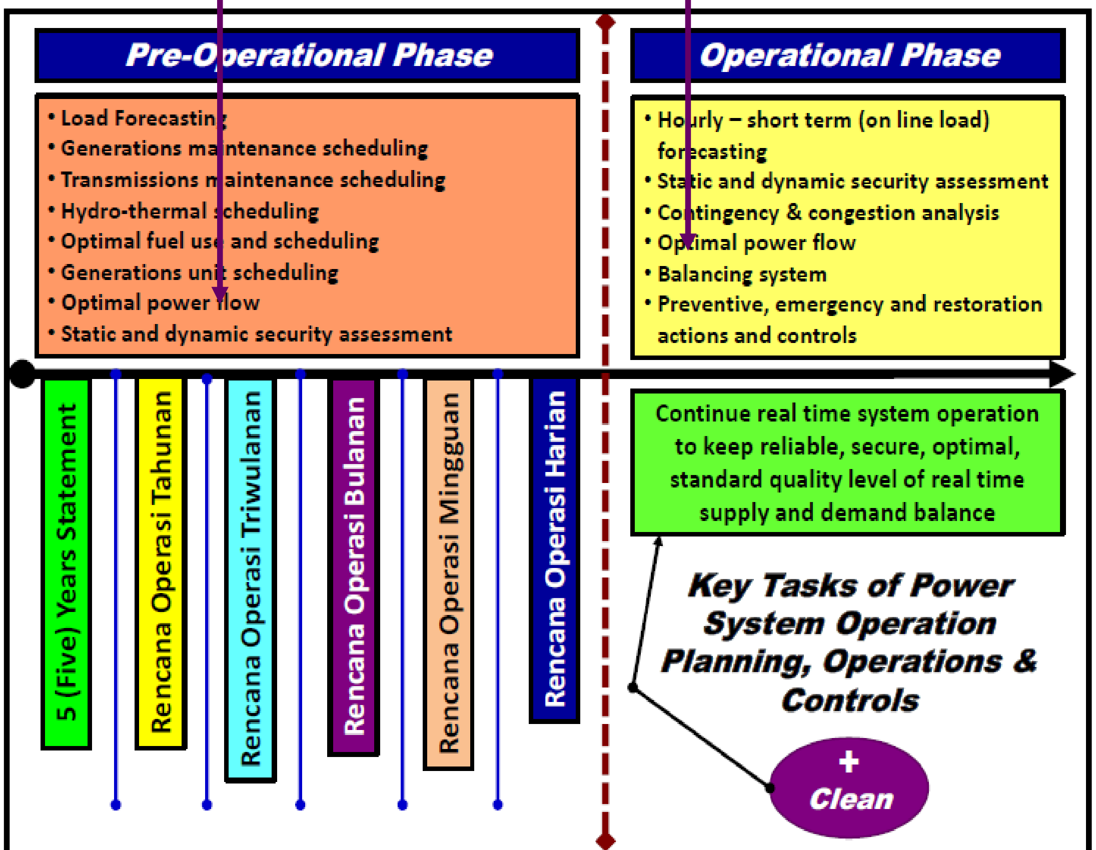
DERMS: Distributed energy resource management

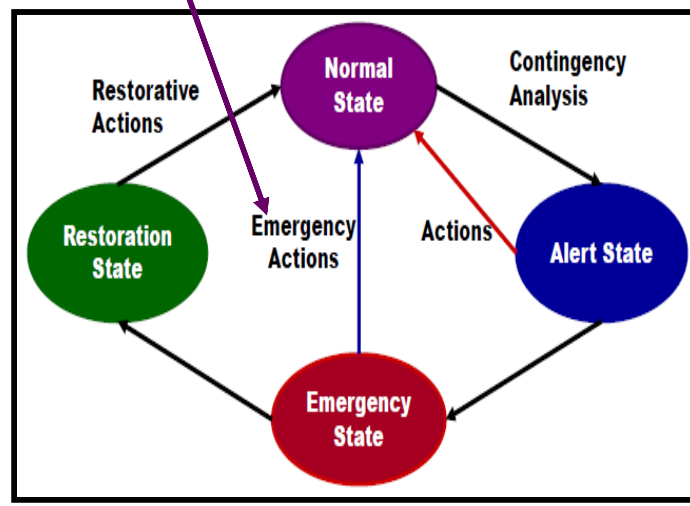
Source: Arindam Maitra, Annabelle Prat, Tanguy Hubert, Dean Weng, Kamaguru Prabakar, Rachna Handa, Murali Baggu, & Mark Mc Granaghan, "Microgrid Controllers", IEEE Power & Energy Magazine, Vol. 15, No. 4, July/August 2017.

Big Challenges

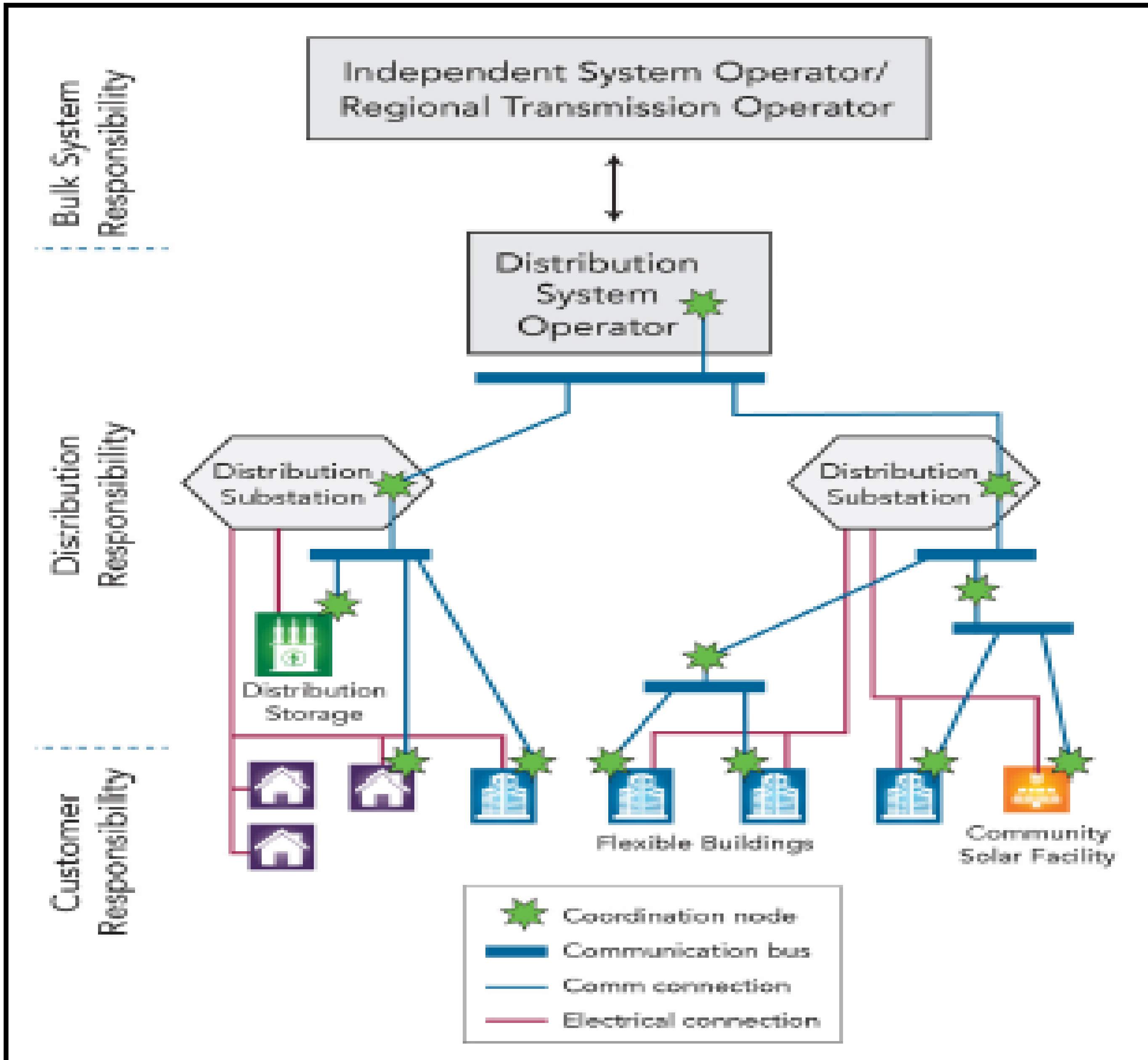
Participate in optimal power flow of interconnected system.

Participate in emergency state as a part of online emergency actions to stabilize the interconnected power system in emergencies.





Utility Architecture View with Layered Decomposition Coordination



Source: GRID Modernization Laboratory Consortium U.S. DOE, "Interoperability Strategic Vision", GMLC White Paper, March 2018

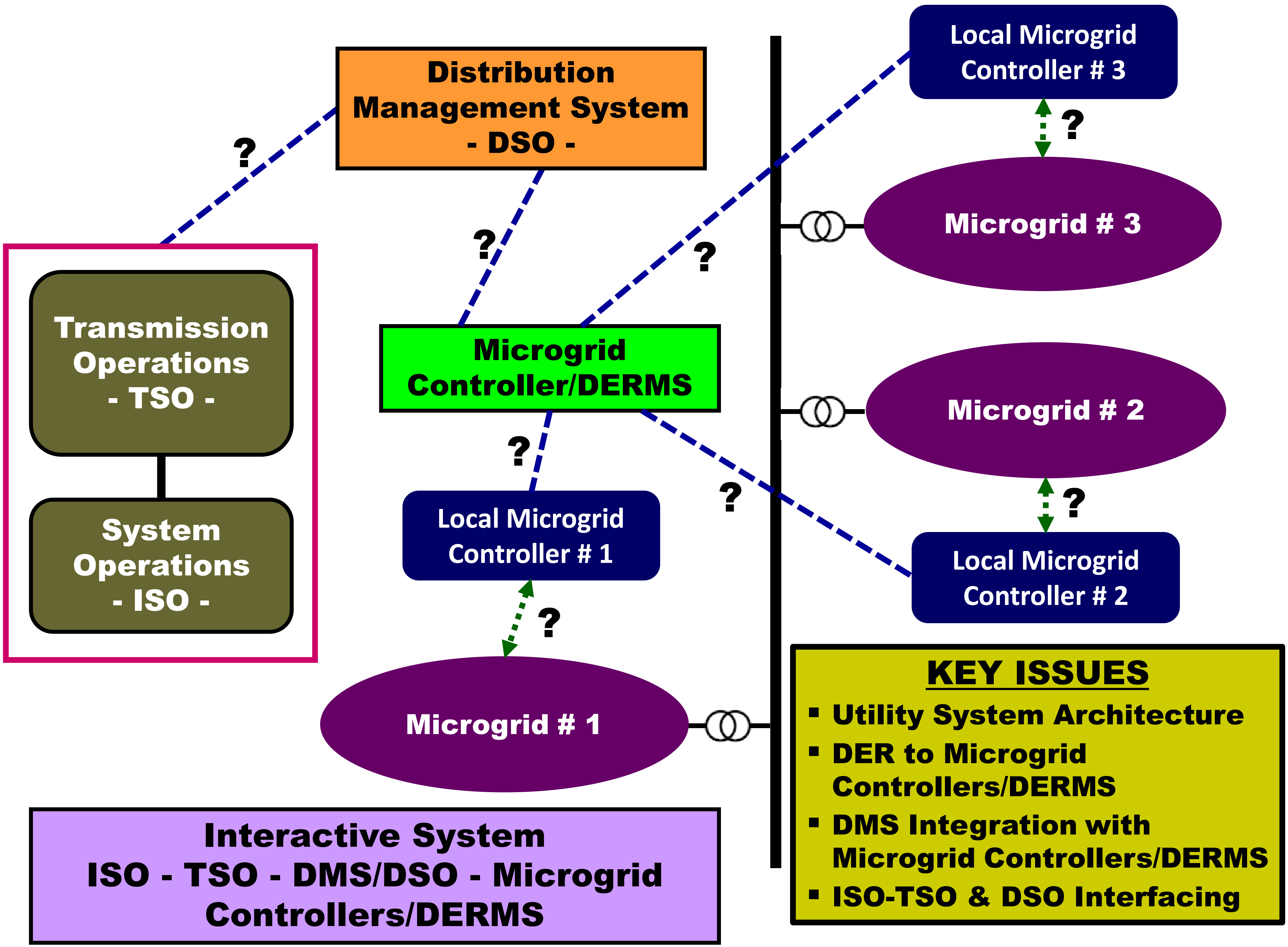
Interoperability

INTEROPERABILITY

The ability of two or more systems or components to exchange information and to use the information that has been exchanged.

VALUE OF INTEROPERABILITY

- **Reduces the cost and effort for system integration**
- **Improves grid performance and efficiency**
- **Facilitates more comprehensive grid security and cybersecurity practices**
- **Increases customer choice and participation**
- **Establishes industry-wide best practices**
- **It is a catalyst of innovation**


Distribution Management System - DSO -
Local Microgrid Controller # 3
?
?
?
Microgrid # 3
Transmission Operations - TSO -
Microgrid Controller/DERMS
?
Microgrid # 2
?
?
?
Local Microgrid Controller # 1
Local Microgrid Controller # 2
System Operations - ISO -
?
KEY ISSUES
Microgrid # 1
▪ Utility System Architecture
▪ DER to Microgrid Controllers/DERMS
▪ DMS Integration with Microgrid Controllers/DERMS
▪ ISO-TSO & DSO Interfacing
Interactive System ISO - TSO - DMS/DSO - Microgrid Controllers/DERMS

Associated Key Issues & Challenges in Moving Forward

Sangat dibutuhkan beberapa kegiatan utama dalam membangun jalur dekarbonisasi jangka panjang sektor ketenagalistrikan yang mendalam untuk percepatan transisi energi dalam mencapai sistem energi national jangka panjang rendah karbon yang berkelanjutan dan mendukung NDCs dalam mencapai target pengurangan emisi nasional mendukung pencapaian tujuan global Persetujuan Paris, dimana setidaknya selaras dengan lintasan emisi biaya paling rendah dari kenaikan suhu tetap di bawah 2°C (*a least-cost emission trajectory of temperature rise staying below* 2°C), dengan tujuan dan memenuhi pilar utama (1) Keandalan (*reliability*), keamanan pasokan (*security*), ketahanan (*resilience*), mutu (*quality*); (2) Harga yang terjangkau, kompetitif, aksesibilitas, ekonomis, memperkuat daya saing industri, dan mendukung pembangunan yang berkelanjutan; dan (3) Pasokan tenaga listrik yang berkelanjutan yang bersih-ramah lingkungan (*clean electricity supply*).

↓

DEKARBONISASI SEKTOR KETENAGALISTRIKAN YANG MENDALAM

↓

Meningkatkan Tingkat Penetrasi VRE ke Sistem Tenaga Listrik

- **Peningkatan tingkat kemampuan fleksibilitas sistem dengan penyediaan fasilitas *demand response, energy storage: pump-storage hydro, batteries*, ekspansi jaringan transmisi & distribusi dan komponen terkait dari integrasi jaringan interkonesi sistem tenaga listrik (*grid-interconnected power system*);**
- **Peningkatan tingkat digitalisasi untuk pertukaran informasi (*exchange information*) & aplikasi data, dan pengintegrasian interaksi kontrol sistem untuk mendukung peningkatan desentralisasi sistem pembangkitan dalam peningkatan integrasi variabel energi terbarukan ke integrasi jaringan interkoneksi sistem tenaga listrik untuk pemanfaatan potensinya dalam pengendalian operasi sistem tenaga listrik pada kondisi operasi: (a) Normal; (b) Siaga; (c) Darurat; dan (d) Pemulihan. Cakupan komposisi arsitektur kontrol/koordinasi (*control/coordination architectures*) terkaitnya terdiri dari: (i) *Coordination interaction* sistem kontrol lokal jaringan mikro dari sumber energi tersebar (*local microgrid controllers of distributed energy resources-DERs*) dengan sistem kontrol jaringan mikro/sistem manajemen sumber energi tersebar (*microgrid controller/distributed energy resources management system-DERMS*), (ii) *Coordination interaction* sistem manajemen sumber energi tersebar (*DERMS*) dengan sistem manajemen distribusi (*distribution management system-DMS*), (iii) *Coordination interaction* sistem manajemen distribusi-unit pengatur sistem distribusi (*DMS-DSO*) dengan pusat pengatur beban independen (*ISO*) & unit pengelola sistem transmisi (TSO).**

- **Memperhitungkan/mempertimbangkan: (a) Tingkat kemampuan fleksibilitas sistem yang selaras untuk mendukung penetrasi variabel energi terbarukan yang lebih tinggi (*higher flexibility requirements for higher renewable energy penetration*); (b) Adanya kemungkinan tidak dipergunakan/tidak dioperasikan lebih lanjut PLTU Batubara yang ada (*stranded assets of existing coal-based power plants*); (c) Adanya potensi memodifikasi PLTU Batubara yang ada menjadi pembangkit listrik yang lebih fleksibel berdasarkan efektivitas biaya dan tingkat kelayakan ekonominya (*converting the existing coal fired power plants into flexible power plants based cost effectiveness and economic viability*); (d) Dampak ekonomi-makro (*macro-economic impact*), (e) Kemungkinan adanya resiko keuangan (*financial risk*) dengan adanya kondisi kewajiban keuangan yang masih berlangsung (adanya *take or pa*y), dan biaya sosial yang ada (*existing financial obligations, and social costs*).**
- **Perlu ditinjau/dikaji kembali (*review*) dan diselaraskan (*enhance*) lebih lanjut:**

  (i) Rencana operasi sistem tahap pra-operasional dan tahap operasional;

  (ii) Operasi sistem real-time & kontrol yang tetap menjaga dan mempertahankan terjaminnya keandalan, sekuriti/kestabilan sistem (*static & dynamic*), optimal-ekonomis, mutu/kualitas, keseimbangan pasokan & beban, dan pemenuhan alokasi emisi: (a) sistem peramalan (prakiraan) beban jangka pendek (tergantung jangka waktu yang dibutuhkan) - setiap jam yang dilaksanakan *on-line* dan *off-line*, (b) analisa *static & dynamic security* yang secara regular dilaksanakan *on-line* dan *off-line*,

(c) analisa kontingensi (*on-line* dan *off-line*), (d) *pre-dispatch*, optimalisasi sistem (*optimal power flow*), (e) *real-time dispatch*, (f) *balancing system*, (g) pengendalian pencegahan, perbaikan, darurat dan pemulihan;

(iii) Sistem komunikasi, kontrol, pelaporan & pemantauan;

(iv) Sistem pengukuran (*metering system*);

(v) Manajemen / pengelolaan aset;

(vi) Standar teknis untuk aplikasi koneksi (*connection applications*);

(vii) Peningkatan penetrasi/perluasan penerapan variabel energi terbarukan tersebar.

- *The utility system architecture* dan reformasi sistem kelistrikan dibutuhkan untuk mendukung implementasi manajemen dan kontrol operasionalisasi integrasi jaringan interkoneksi sistem tenaga listrik (*to support implementation approach to integrated grid-interconnected power system management and control*), yaitu:

  (i) *Control center designs* (model pusat pengendalian) yang sesuai dengan fungsi dan tantangan yang baru (*under new functions and challenges*) untuk ISO-TSO, dan DMS-DSO; dan

  (ii) Sistem interaktif sebagai *coordination interactions*: (a) sistem kontrol lokal jaringan mikro dari sumber energi tersebar dengan sistem kontrol jaringan mikro/sistem manajemen sumber energi tersebar (DERMS), (b) integrasi DMS-DSO dengan sistem kontrol jaringan mikro/sistem manajemen sumber energi tersebar (DERMS), dan (c) ISO-TSO dan DMS-DSO.

- **Dibutuhkan penyediaan fasilitas interoperabilitas sistem untuk mendukung operasi sistem real-time & kontrol yang tetap menjaga dan mempertahankan terjaminnya keandalan, sekuriti/kestabilan sistem (*static & dynamic*), optimal-ekonomis, mutu/kualitas, keseimbangan pasokan & beban, dan pemenuhan alokasi emisi, misalnya penggunaannya untuk: (i) optimalisasi sistem (aliran daya yang optimal) dari integrasi jaringan interkoneksi sistem, dan (ii) pengendalian darurat online pada kondisi darurat untuk menstabilkan kondisi operasi sistem kembali ke kondisi normal.**
- **Identifikasi reformasi sistem kelistrikan termasuk pasar/market yang dibutuhkan, model struktur, kebijakan dan kerangka kerja terkait, peraturan yang diperlukan untuk mendukung peningkatan penetrasi variabel energi terbarukan tersebar ke integrasi jaringan interkoneksi sistem tenaga listrik agar optimalisasi operasi sistem tenaga listrik dapat tercapai, termasuk potensi partisipasinya pada tahap pengendalian pencegahan, perbaikan, darurat, dan pemulihan, termasuk pembentukan agregator & kerangka peraturan terkait, *grid connection code*, serta kebijakan penghematan energi & skema kewajiban efisiensi energi, arah & jalur kebijakan dan kerangka kerja untuk memfasilitasi transisi ini.**

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