

South Asia Regional Energy Partnership (SAREP)

Presentation

on

International Experiences and Best Practices in Regional Power System Planning and Developing Regional Institutional Mechanism

Working Session III- “Need For Regional, Complementary Approach to meet the Clean Energy Transitions Plans through Coordinated, Complementary Regional Electricity Generation and Transmission Planning“

10.00 - 12.05 Hrs, 19, June 2023

Presented by

Rajiv Ratna Panda, Power Market Specialist, SAREP

SAGE-RIS-USAID-SAREP Workshop on “Prospects of Clean Energy Transformation and Role of Coordinated Generation and Transmission Planning for Optimal and Sustainable Cross Border Energy Trade in South Asia”

17-19, June 2023 , Le Meridien, New Delhi, India

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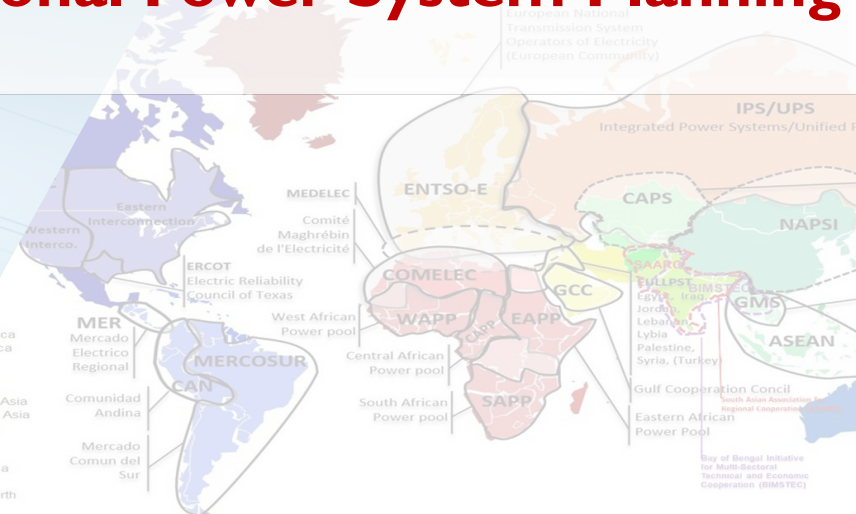
Regional Grid Integration Initiatives

01

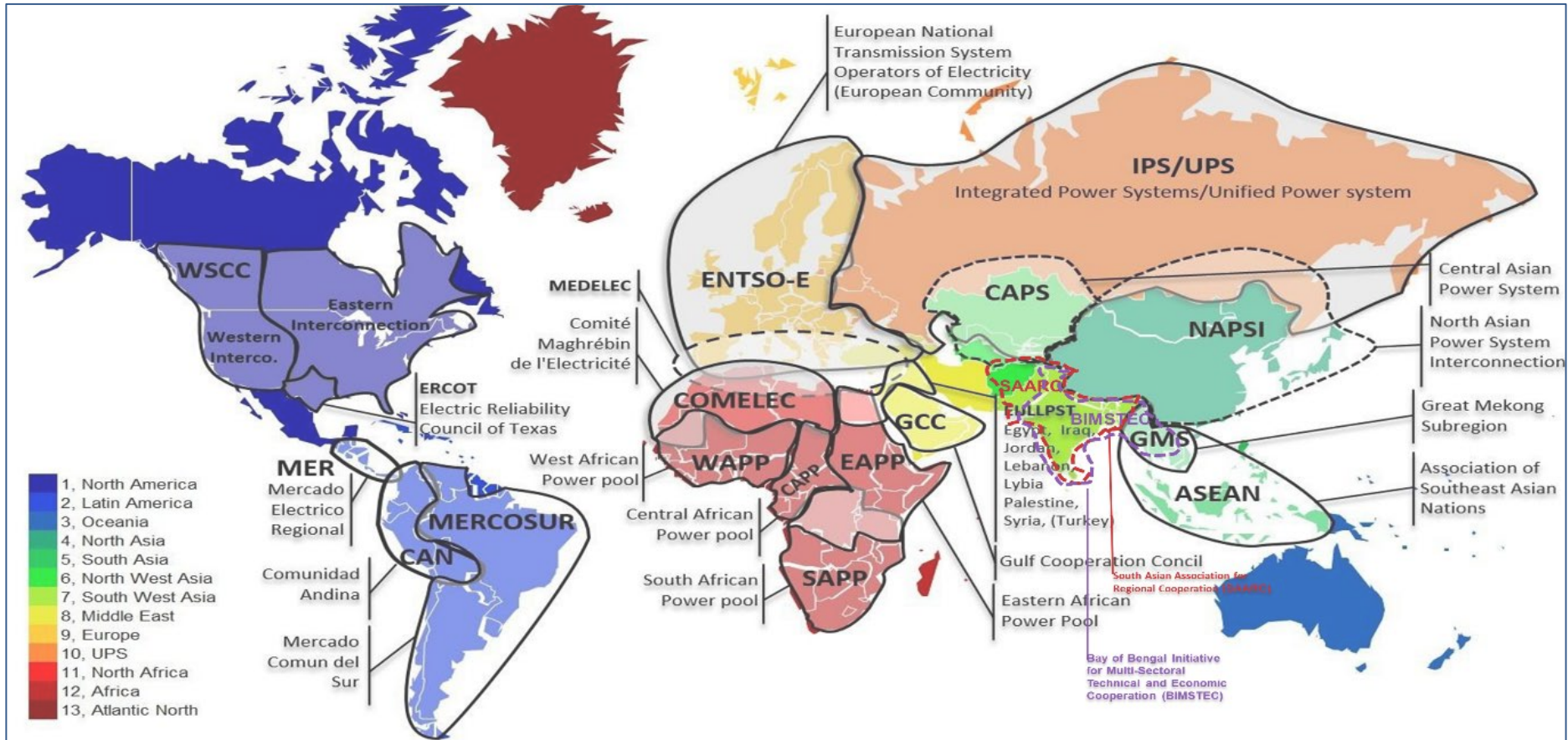
Institutions Facilitating Regional Power System Planning



PLANNING

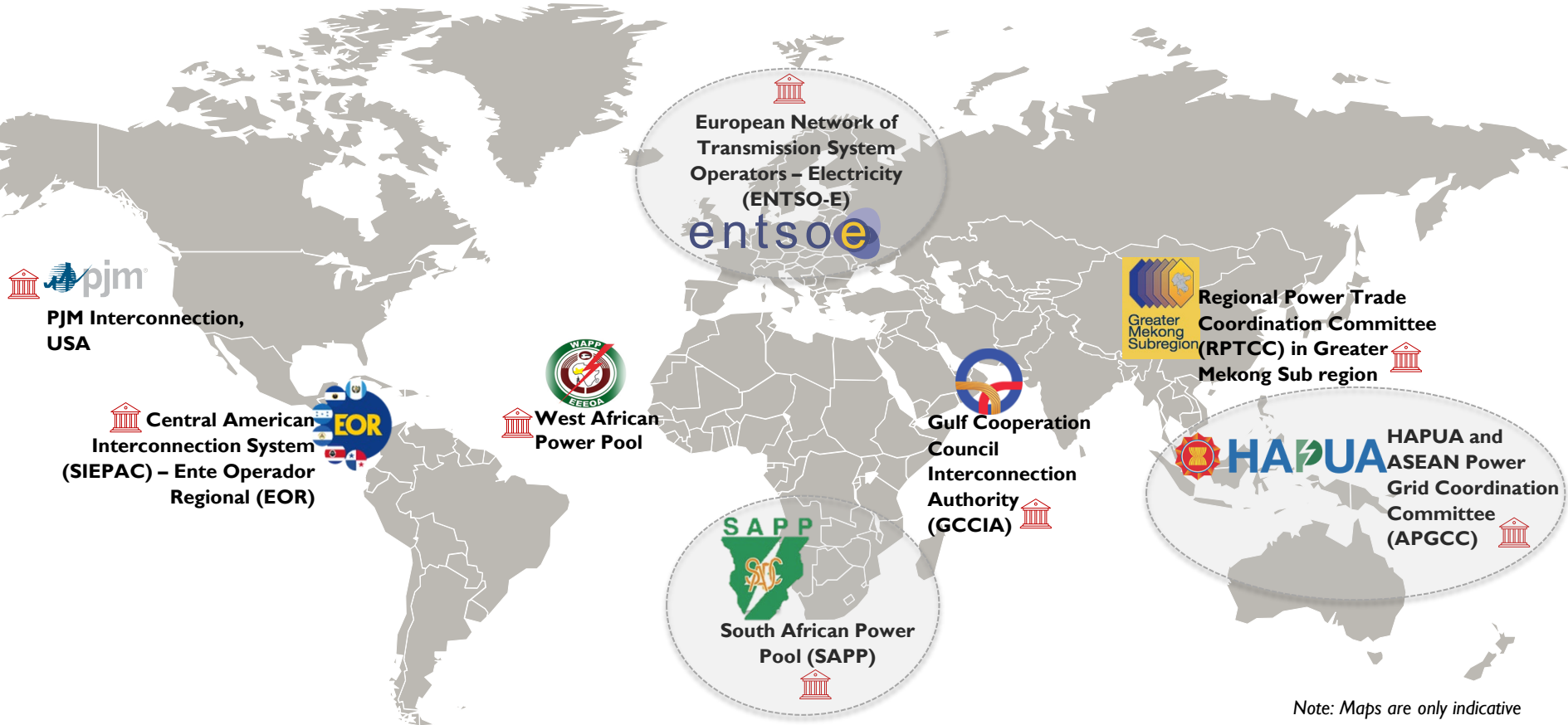


Regional Grid Integration Initiatives across the Globe

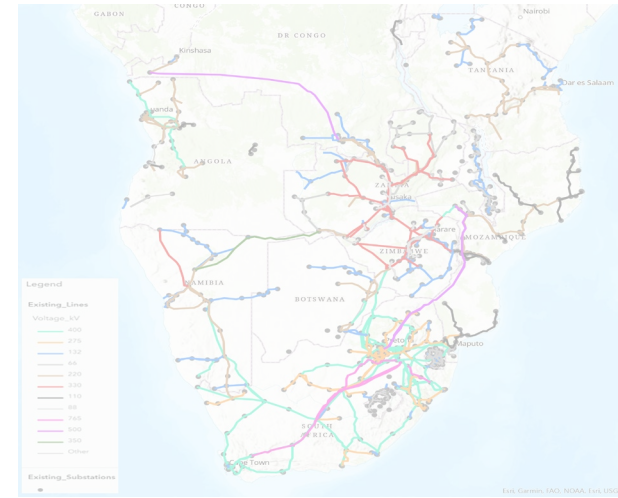
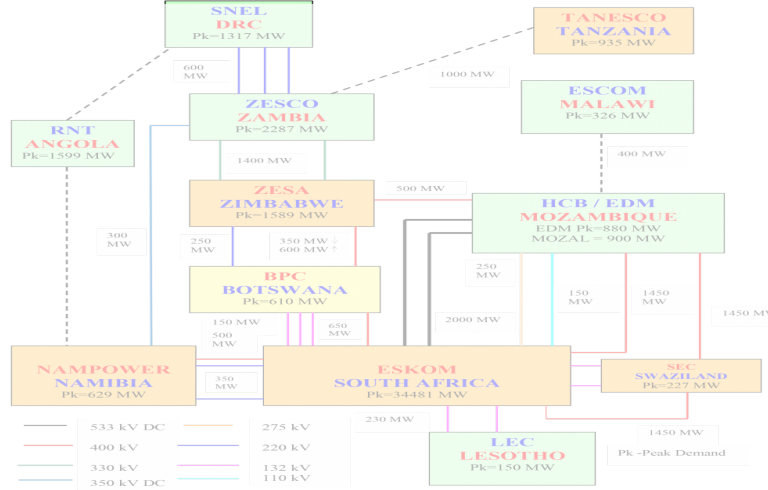


Source : Envisioning Trans-Regional Energy Connectivity between the South Asia Region – Southeast Asia Region – Gulf Region – Prospects and Opportunities , Power system development and Economics, Global electricity network Feasibility study, Reference: 775, September 2019, CIGRE report on "Global electricity network-Feasibility study", and further modification on the image by adding SAARC and BIMSTEC Region

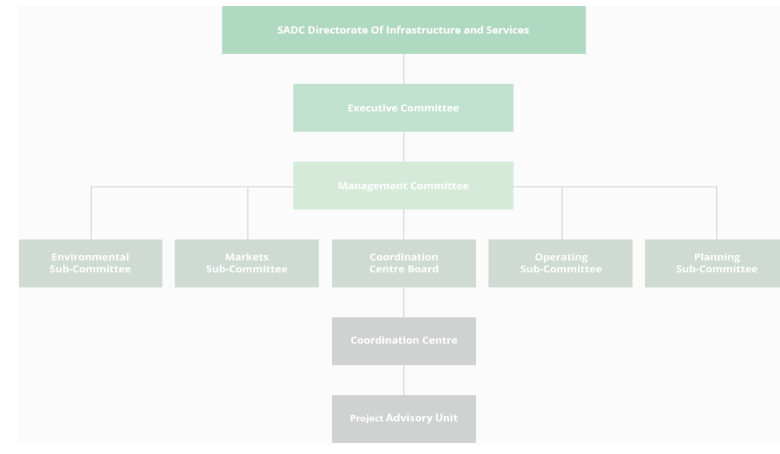
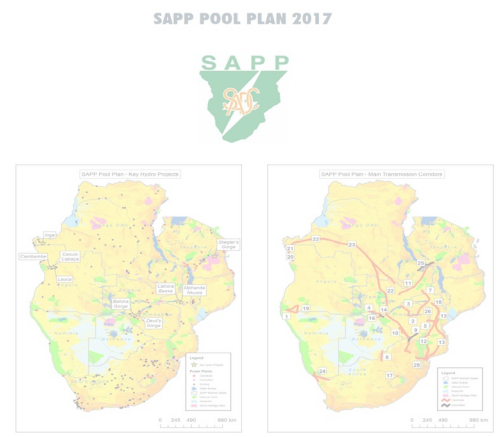
International Experience and Best Practices of Regional Institutions Facilitating Regional Power System Planning



Note: Maps are only indicative



02.1 Southern African Power Pool (SAPP)



Southern African Power Pool (SAPP)



12 Countries | **80 GW Gen. Capacity** | **Coal (59%)**,
Hydro (24%) | **10.9 GW of X Transmission Capacity**
9394 GWh CBET in 2020 | **21% Competitive market** | **79% bilateral transactions**

Source: SAPP Annual Report 2020, SAPP Annual Report 2021, IRENA-Planning and prospects for renewable power: Eastern and Southern Africa

Introduction

- Established in **1995** 🏛️, under the Southern African Development Community (SADC).
- National power utilities of 12 countries** are members.
- Inter-Governmental MoU, the Inter-Utility MoU
- Based in **Harare, Zimbabwe** (SAPP Co-ordination Centre)

Key Roles

- Coordinate and cooperate in the **planning, development and operation of their generation and transmission facilities** for mutual benefit.
- Develop **integrated generation and transmission plan, every 2 years**
- Transmission improvements for regional trade
- Facilitate trading in the Day Ahead Market (DAM)
- 4 Sub-Committee (Planning, Operation, Market, Environment)

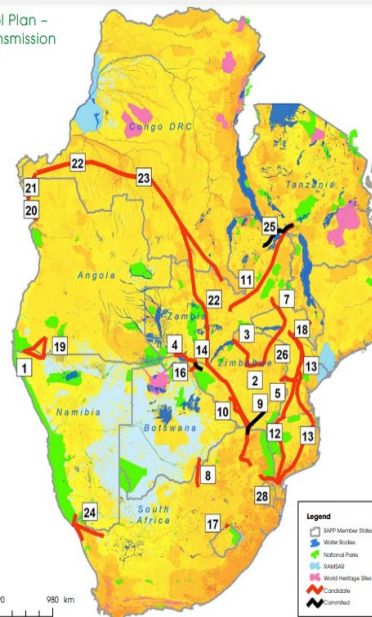
Source: SAPP Pool Plan-2017, SAPP Planning Sub-Committee

SAPP Planning Sub-Committee

- Establishment and updating of common planning & reliability standards
- Review every 2 years an overall **integrated generation and transmission plan**, based on individual member's plans
- Improvement required for interconnected system
- Determination of transfer capability limits between systems

Source: SAPP Planning Sub-Committee

SAPP Pool Plan – Main Transmission Corridors



Source: SAPP Pool Plan-2017, SAPP Planning Sub-Committee, IRENA-Planning and prospects for renewable power: Eastern and Southern Africa

SAPP Pool Plan aims to identify a core set of **generation and transmission** investments of **regional significance** that can provide adequate electricity supply to the region under different scenarios, in an **efficient and economically, environmentally and socially sustainable manner** and support enhanced **integration & power trade** in the SAPP region

By 2040
RE share to reach 41%-54%
Peak demand 51 GW to 115 GW (2.2 x)



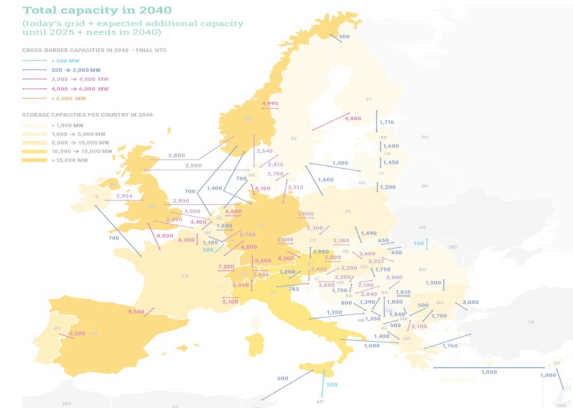
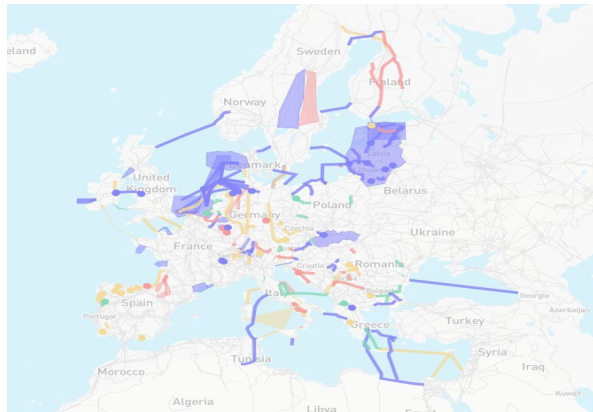
A Power System for a Carbon Neutral Europe



02.2



European Network of Transmission System Operators for Electricity (ENTSO-e) Ten-Year Network Development Plan (TYNDP-2022)





35 Countries (EU 27+) | **1156** GW Gen. Capacity
 Fossil (35%), Renewable (51%), Nuclear (11%)
93 GW of X Border Transmission Capacity
404 TWh X Border Exchange in 2021 | (Within ENTSO-E) |
 25.5 TWh (ENTSO-E external) | **429** TWh total

Source: ENTSO-E, ENTSO-E TYNDP 2022, ENTSO-E Statistical Factsheet 2021

Introduction

- Established in 2008, as a successor of six regional associations of TSO (ETSO, ATSOI, UKTSOA, NORDEL, UCTE and BALTSO)
- 39 Members from 35 countries are part of ENTSO-E
- ENTSO-E Vision: A Power System for a Carbon Neutral Europe, Based in Brussels, Belgium.

Source: ENTSO-E, ENTSO-E Members, The EU aims to be climate-neutral by 2050.

Key Roles

- Development & implementation of **network codes**.
- Development of Ten-year Network Development Plan (TYNDP) (Extensive->100 experts in 40 different countries across Europe & beyond)
- Facilitating **cross-border network development**
- Enhancing **creation of the Internal Electricity Market**.
- 6** Committee (System Development , System Operations, Market, Research Development & Innovation , Legal and Regulatory, Information & Communication Technologies)
- Plays a central role for EU's climate-neutral by 2050.

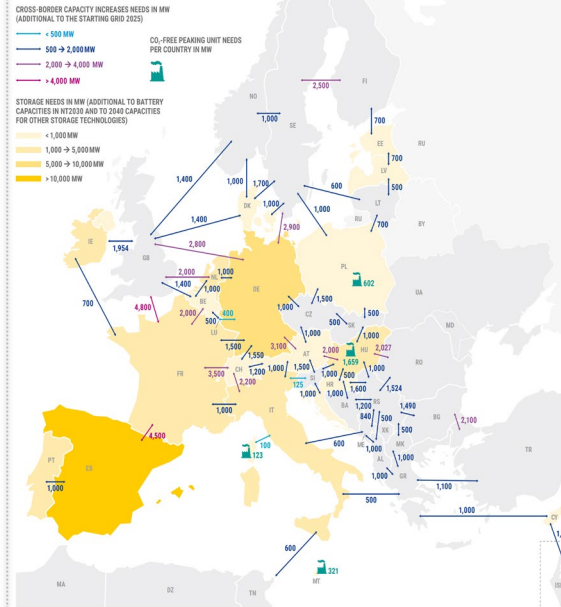
Source: ENTSO-E Objectives, ENTSO-E Governance, ENTSO-E Legal Mandates

ENTSO-E System Development Committee

- Ten-Year Network Development Planning (TYNDP)
- Regional Investment Plans, Scenario Building, European Resource Adequacy Assessment, Seasonal Outlooks, Connection Network Codes
- Data Models - Market and Networks, Asset Implementation & Management

Source: ENTSO-E System Development Committee, TYNDP Website

Opportunities for increases in cross-border transmission, storage and peaking units capacity in 2040



Source: ENTSO-E TYNDP, High-Level Report TYNDP 2022, Final Version - May 2023, TYNDP 2022 Scenario Report - Version April 2022, ENTSO-E Statistical Factsheet 2021

TYNDP is a **long-term plan**, released on a **biennial basis** as per Regulation (EU) 2019/943, on how the **electricity transmission grid is expected to evolve** in Europe to implement the **EU climate & energy goals**.

- X Border Transmission Capacity**
184 / 204 GW (2030 / 2040)
- Electricity Peak Demand - 740** GW (2050) , **471** GW (2021)
- X Border Exchange**
1182 / 1267 TWh/year (2030 / 2040)
- Gen. Capacity**
~ 3650 GW By 2050

02.2 TYNDP- Development Process, Regional Optimal Benefits for Achieving Climate Goals

Introduction to the TYNDP 2022

The Process behind the Ten Year Network Development Plan at ENTSO-E

Defining up to three most plausible futures, which we call **Scenarios**

Project collection and identification

Process of European Projects of Common Interest led by the European Commission

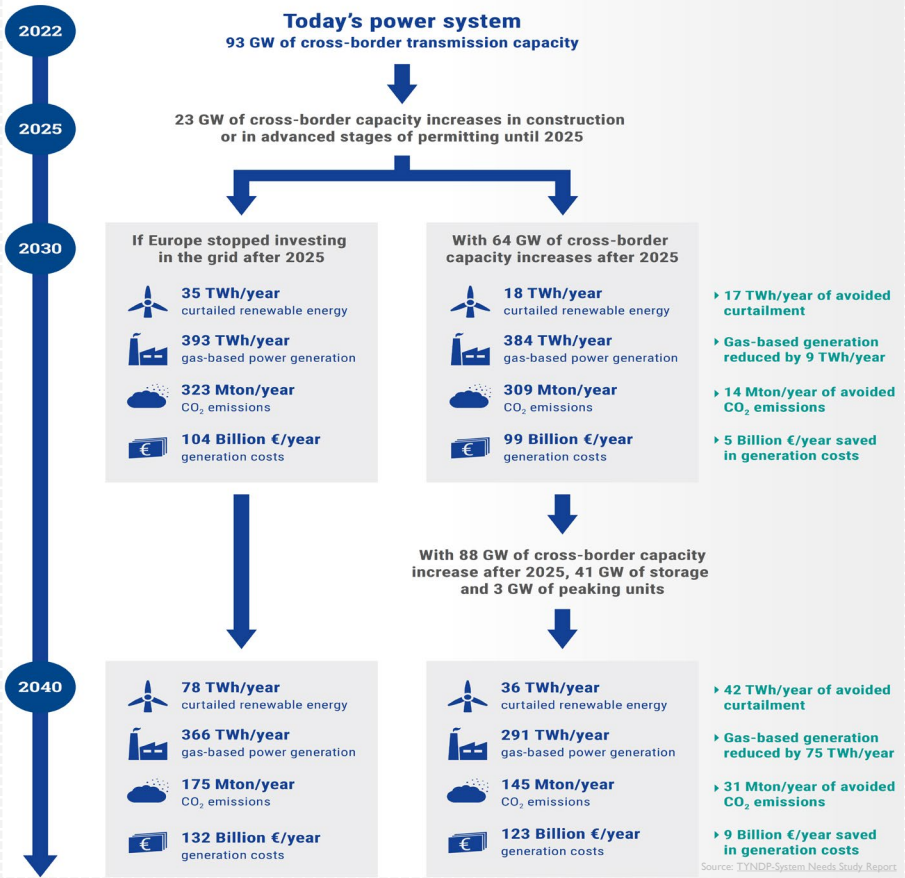
Projects of common Interest Process



Identification of the needs based on our scenarios

Cost benefits analysis of projects

Source: ENTSO-E TYNDP



Source: TYNDP-System Needs Study Report

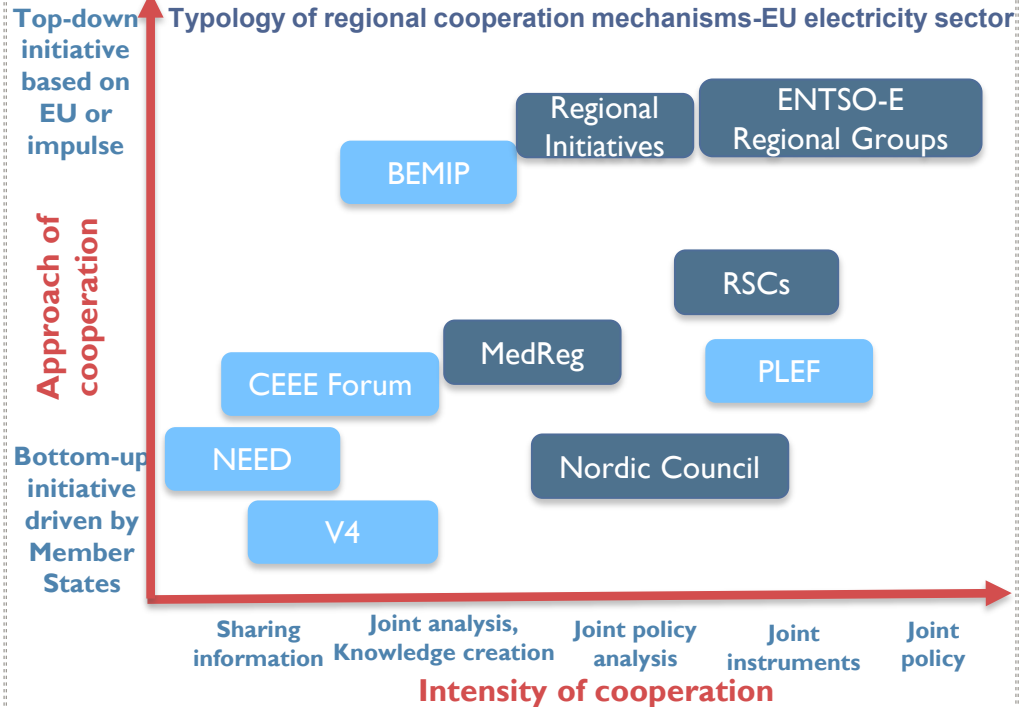
Regional Planning leads to Optimal strategy for Achieving Climate Goals, 42 TWh/year of Renewable Curtailment avoided, 9 Billion Euro/Year saved in generation cost

Typology of regional cooperation mechanisms in the EU electricity sector: Overall EU Approach

Co-Existence of Various institutional apparatus

- ❑ **Top-down** approach supplemented by **Bottom-up initiative**
- ❑ Institutional Platforms under **Formal Regional Intergovernmental Organisations** (EU, ENTSOe)
- ❑ **Institutional Platforms** among countries as dialogue forum
- ❑ **Informal Institutional networks** for advocacy, building consensus.

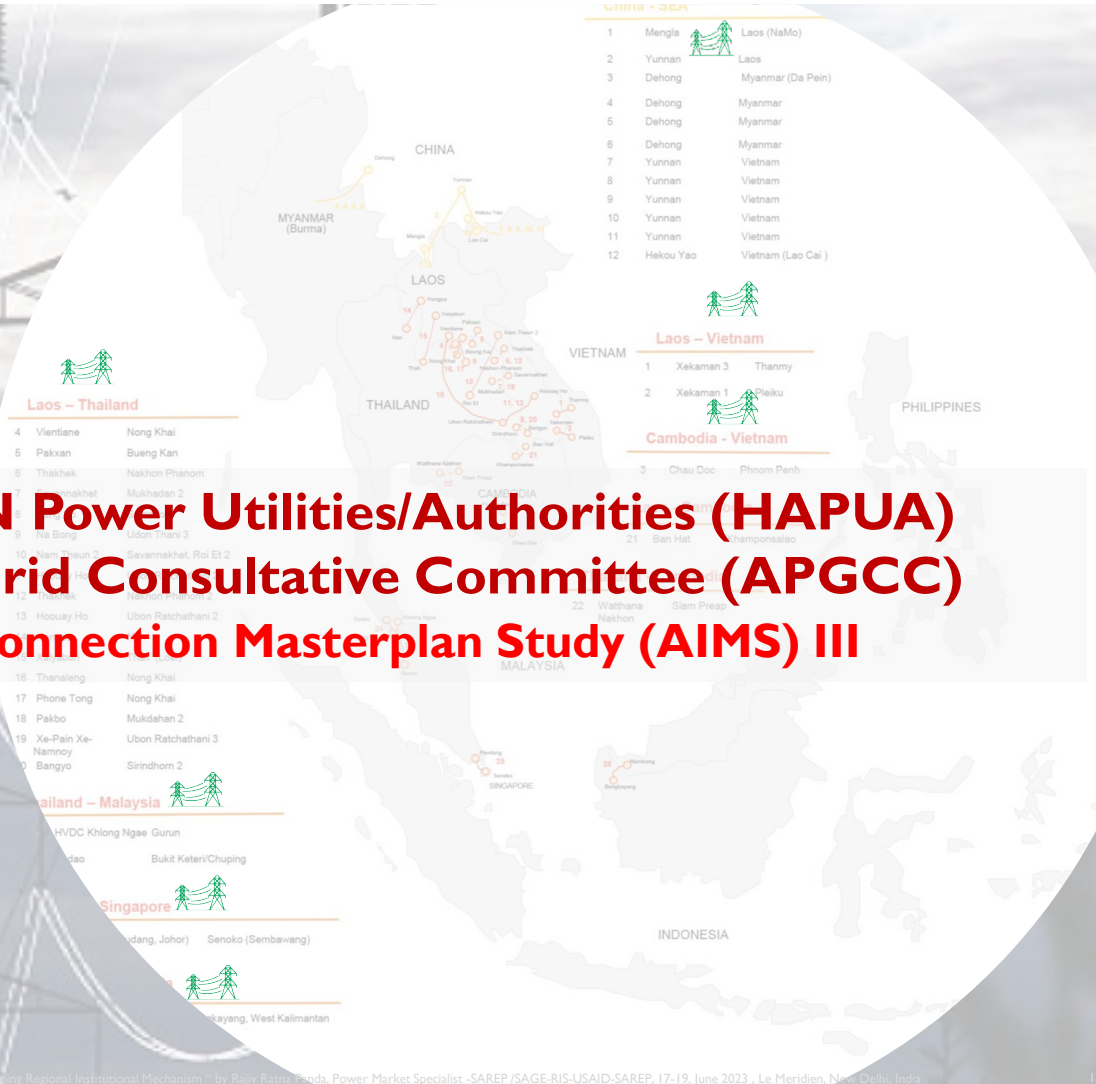
A collective Multi-institutional/Platform based regional approach helps in tapping potential of Regional Optimisation and Social Welfare at a regional level and in overall planning



Source: Cross-border cooperation for interconnections and electricity trade



Heads of ASEAN Power Utilities/Authorities (HAPUA) ASEAN Power Grid Consultative Committee (APGCC) ASEAN Interconnection Masterplan Study (AIMS) III





Heads of ASEAN Power Utilities/Authorities (HAPUA)- ASEAN Power Grid Consultative Committee (APGCC) ASEAN Interconnection Masterplan Study (AIMS) III

10 Countries | 285 GW Gen. Capacity | Fossil (66%) ,
RE (33%) | 7.7 GW of X Transmission Capacity
49 TWh CBET in 2021/22

Multilateral CBET (LTMS) in existence | No Market CBET

Source: Envisioning Trans-Regional Energy Connectivity between the South Asia Region – Southeast Asia Region – Gulf Region – Prospects and Opportunities

- HAPUA  established in 1981
- Members consist of representatives from ASEAN countries and the HAPUA Utilities.
- MoU (2007) on the ASEAN Power Grid (APG):-
 - Mandates HAPUA for implementation of MoU
 - Creation of ASEAN Power Grid Consultative Committee  (APGCC) (was established 2007)
 - ASEAN Interconnection Master Plan Study

Source: MoU on ASEAN Power Grid, TOR of APGCC, (2021-2025) ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 Phase II, 7TH ASEAN Energy Outlook

Key Roles

- APGCC is an organization body under HAPUA
- HAPUA WG -Transmission / APG : To Review and update the ASEAN Interconnection Masterplan Study (AIMS), identification of feasible interconnection project and to implement the recommendations AIMS. AIMS-I (2003), AIMS-II (2007), AIMS-III (Under Preparation)
- 5 HAPUA Working Group (WG) (Transmission / ASEAN Power Grid (APG), Generation & Renewable Energy, Distribution and Power Reliability & Quality , Policy Studies & Commercial Development , Human Resources)

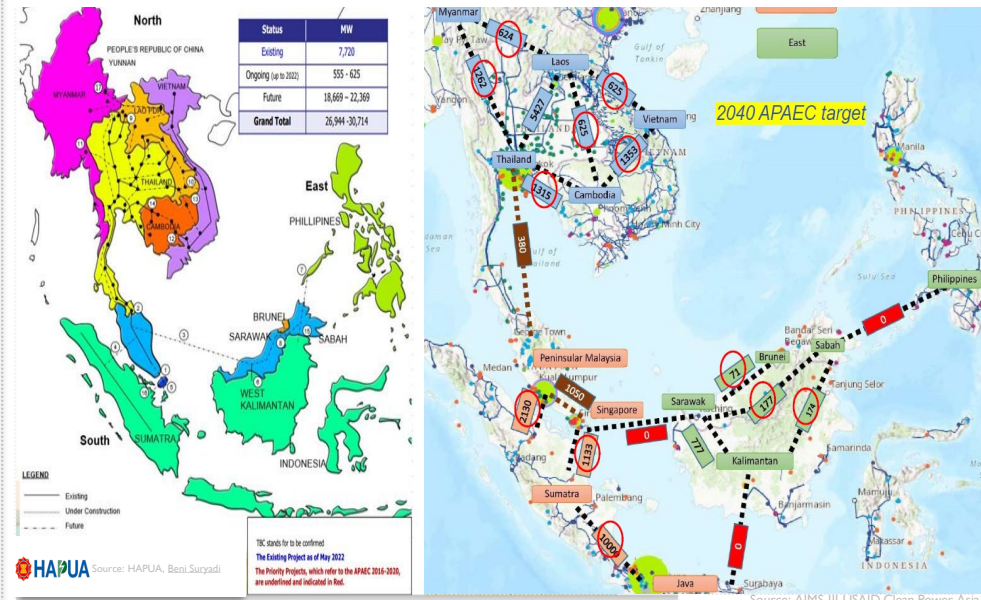
Source: HAPUA-APGCC, HAPUA Working Groups, MoU on ASEAN Power Grid, AIMS-III-USAID_Clean Power Asia

ASEAN Power Grid Consultative Committee (APGCC)

- Facilitates and assist the HAPUA Council in the implementation of the MoU on the ASEAN Power Grid (APG)
- Support, promote and provide guidelines to the conduct of relevant Studies
- To prepare annual and multi-year plans for the development of the APG

Source: MoU on ASEAN Power Grid, TOR of APGCC, (2021-2025) ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 Phase II, 7TH ASEAN Energy Outlook

ASEAN Interconnection Masterplan Study (AIMS) III



Special Planning Needs with Special Mechanism

Institutional Mechanism-Multilateral CBET (South-East Asia): A Beginning of a new Renaissance

Lao PDR, Thailand, Malaysia, Singapore (LTMS) Trade

LTMS-PIP WG

Task Force 1-
Technical
viability
Study led by
Malaysia



Task Force 2
Legal &
regulatory
led by
Singapore



Task Force 3
Commercial
Arrangement led
by
Thailand



Task force 4
Tax and tariff
Structure led by
Lao PDR



Planning : As a first step, each country developed a **grid study- to confirm technically possible** -100 MW trade from Lao PDR to Singapore

Ownership and Fairness - Each country **led a Particular Task Force**

Energy Purchase & Wheeling Agreement (EPWA)

Source: SAEB, Presentation on The ASEAN Power Grid: Strategic Plan under the APAC, 2016-2025 by Dr. Tawarat Saitabur, ASEAN Power Grid Summit, 2018 22nd May 2018, Vietnam, Lao PDR, Clean Power: An e-Presentation by Sanyouk Phansuwan

Lao PDR, Thailand, Malaysia, Singapore (LTMS) Multi Lateral Trade Project



Phase-I
100 MW
Trilateral
Lao-Thailand
Malaysia
32.8 GWh
traded between
2018-21

Phase-II
100 MW
Multilateral
Lao-Thailand
Malaysia-
Singapore
23 June 2022

Singapore-fully
liberalised
power market
4 GW import
Plan by Singapore

As of 31 July
2022, **72 GWh**
of electricity
traded.



03

South Asian Electricity Sector, Cross Border Electricity Trade , Climate Ambitions and Current Planning Processes

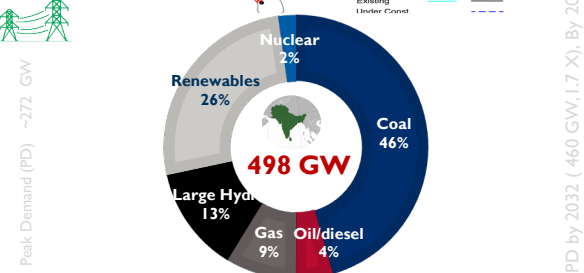
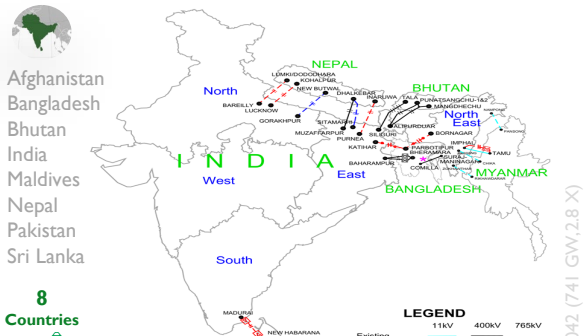
Project

Pathway

Pathway

Pathway B

Power Sector

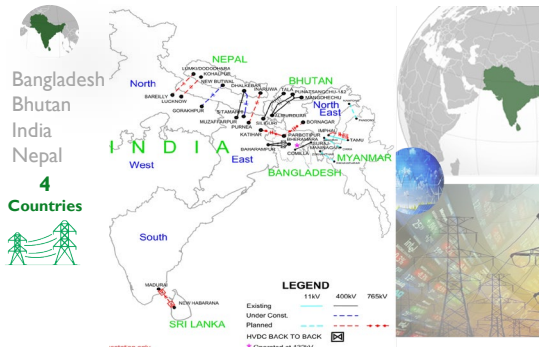


I Installed Capacity- 496 GW(2023) | Fossil Dominance-289 GW(~60%) | Coal Dominated-225 GW(45%) | Natural gas (9%), Oil (4%) based IRE-190 GW (38%) | RE-Hydro:129 GW (26%)

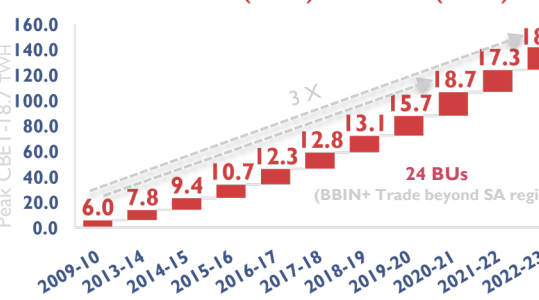
I ~4.5 GW of x Border Interconnection | ~ 10 X increase in xBI | Total 43.8 GW of xBI by 2036/2040

Fossil Domination | Diverse Fuel Mix | 44% Co2 from power sector | Rapid Expansion in X Border Interconnection Planned

CBET



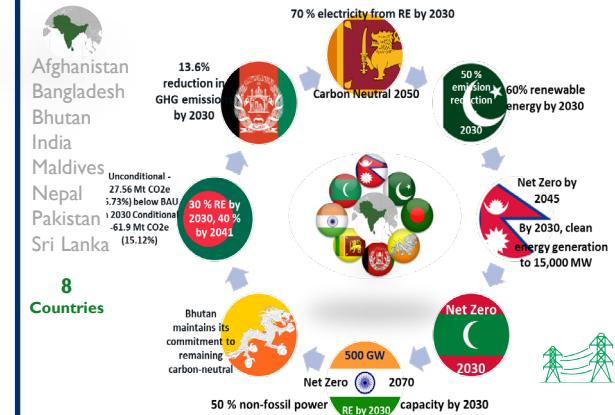
South Asia (BBIN) CBET BUs (TWH)



Bilateral, Mix of G-G & Commercial, CBET Through PX (Only in Asia), Bidirectional, Trilateral CBET Upcoming

Large CBET Potential | CBET low compared to other regions | ASEAN 49 TWH | EU 404 TWH | South Asia 24 TWH

Climate-Induced Energy Sector Transformation



- World's 1st Carbon Neutral Country-Bhutan**
- Net Zero by 2030-Maldives**
- Net Zero by 2045-Nepal**
- Carbon Neutral by 2050-Sri Lanka**
- 30% RE by 2030 and 40% RE by 2041-Bangladesh**
- 15 GW clean energy by 2030-Nepal**
- Net Zero by 2070-India**
- 500 GW RE Installed Capacity by 2030-India**

OSOWOG initiative will also accelerate the rapid deployment of Solar in South Asia and Beyond

Large-scale clean energy transition | Regional approach will be optimal | Opportunity for developing regional energy projects

Present Planning Arrangements in South Asia (SA) to meet the Clean Energy Transitions Plans & Net Zero Goals

- Country level planning to meet the **Clean Energy Transitions Plans and Countries' energy security** .
- Limited **Integrated, Regional Planning** to meet the scale of Net Zero & Clean energy Transitions goals **collectively for regional energy security** .
- Need for **Coordinated, Complementary, Regional** Electricity Generation & Transmission Planning for **optimal strategies** to achieve goals.
- Desirable to have **Regional Level Institutional Network Platform** in South Asia for **facilitating regional planning & supplementing the bilateral/formal efforts** for long term sustainability.

Existing Arrangements are at Bilateral Level for Cross Border Grid Planning

Bilateral G-t-G level arrangements are already in vogue in South Asia to facilitate CB Trade

India-Bangladesh; India-Nepal;
India-Bhutan, India-Myanmar,
Nepal-Bangladesh

Committees- JWG and JSC have been constituted to carry out discussions under these

Procedure For Approval & Facilitating Import/Export (Cross Border) Electricity by Designated Authority (DA) also specifies such arrangements

Joint Technical Team Transmission (JTT-T)

Joint Operation Committee (JOC)

Regional Level Institutional Platform to discuss and cooperate in a collective manner in for **Coordinated, Complementary, Regional Planning shall bring better Harmony , Trust , Convergence, Enhanced Sprit of Coordination & Cooperation.**

04

Recommendations and Way Forward

04 Five Point Recommendations and Way Forward

1. Develop A broad “ **South Asia Plan of Action for Energy Cooperation and Roadmap**“ for coming five years.
2. Develop “ **South Asia (BBIN) Electricity Generation and Transmission Master Plan (SAEG-TMP)** “ to achieve **Clean Energy & Net Zero Goals** and enhance cross border electricity trade in the most **optimal, economical and sustainable manner** which enhances **regional energy and climate security**. (to be updated and reviewed in every two year)
3. Create “ **South Asia Network for Integrated Power System Planning and Operation (SANIPO)** “ , a regional level institutional network platform to facilitate regional power system planning, operation, capacity building, knowledge exchange & facilitating/coordinating the development of SAEG-TMP as needed.
 1. Act as a facilitator, advisor, shall aim to arrive at decisions through mutual discussions and consensus building.
 2. Complement and supplement existing bilateral planning cooperation, planning under any existing Intergovernmental regional institutions amongst countries in South Asia in the matters of Power System planning and operation.
 3. Power System Planning/Operation Institutions of SA Countries & professional as the members of SANIPO.
4. Consolidate the practices, develop “ **South Asia Power System Planning & Operation Guidance Manual** “.
5. SANIPO Annual Flagship Training Course on “ **Integrated Regional Power System Planning and Operation** “

Thank You



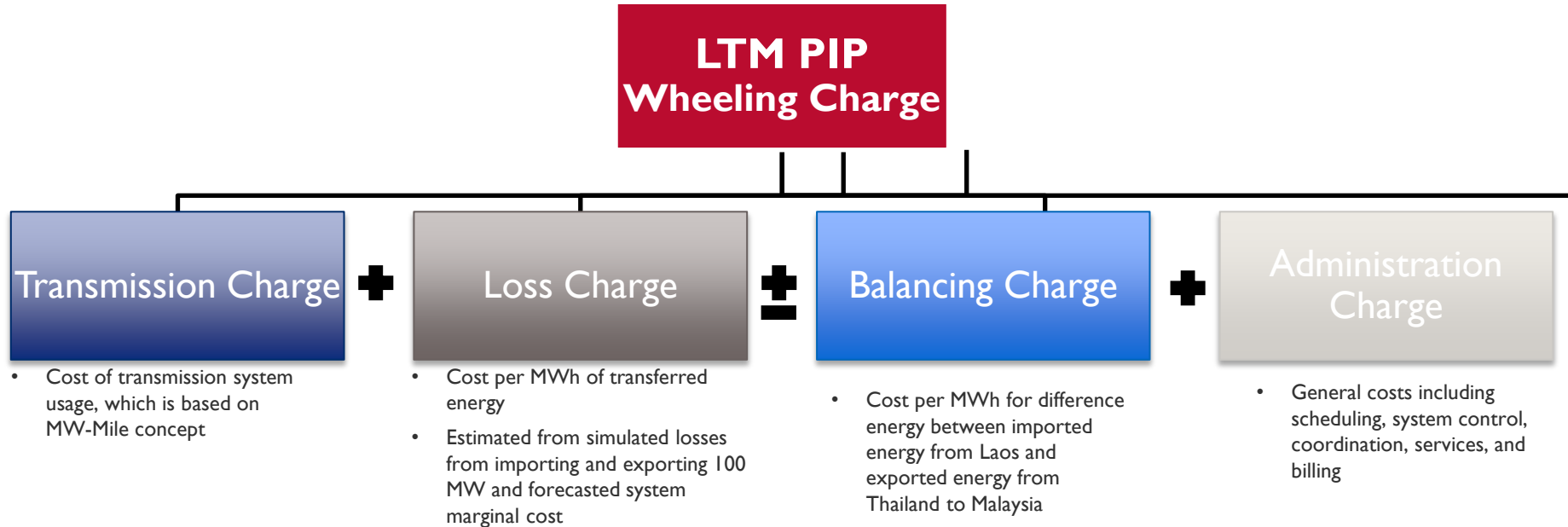
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LTMS Project: Wheeling Charge Methodology

Wheeling charge comprised of **a) transmission- the distance of the trade (megawatts mile); b) loss charge-a loss charge (charged per megawatt hour); c) balancing charge (also per megawatt hour); and d) administrative charges- a fixed administrative charge.**



¹ Source: Establishing Multilateral Power Trade in ASEAN, IEA, August 2019 (page 48)

Reference - IEA (2019), "Integrating Power Systems across Borders", IEA, Paris, www.iea.org/publications/reports/integratingpowersystemsacrossborders/

Source: Lao PDR – Thailand – Malaysia – Singapore on Power Integration Project (LTMS-PIP) related various sources, [web link](#) [weblink](#) [web link](#) [web link](#)

Existing and committed interconnections and respective capacities (MW) in 2019



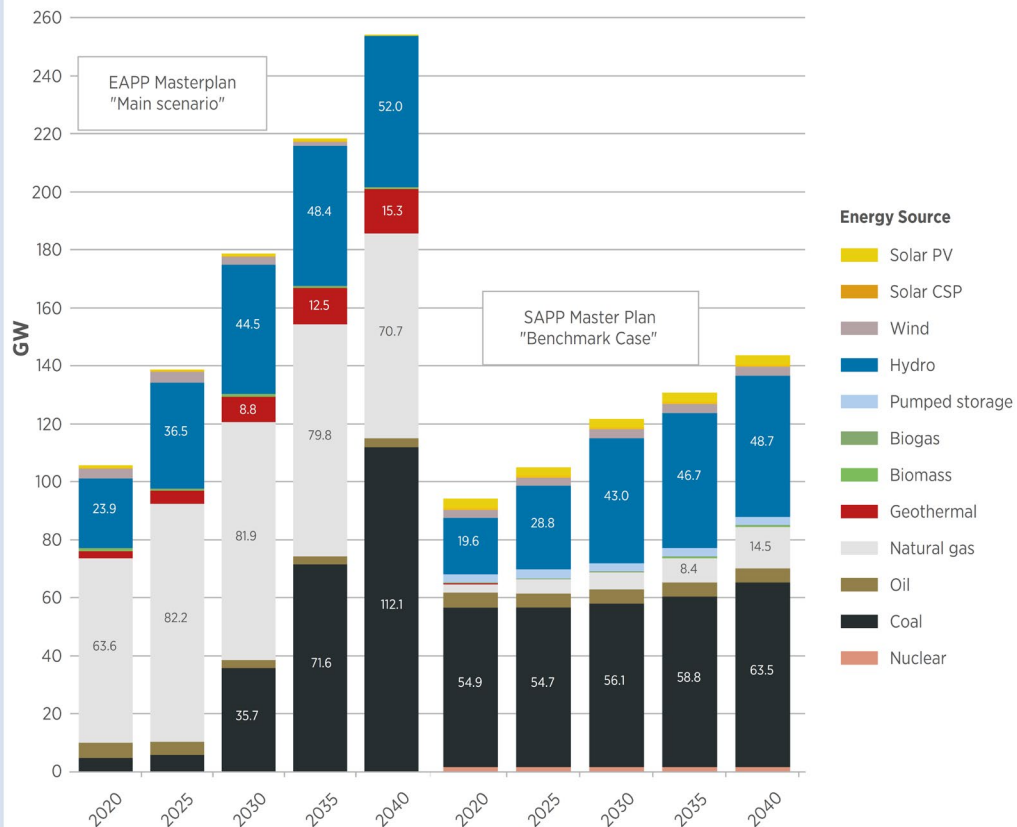
Country Pair	Project Details	Capacity (MW)
Zambia - Zimbabwe	[Zizabona] Livingstone-Victoria Falls, 330AC	400
	Kariba North-Kariba South, 330AC	1400
Tanzania - Zambia	[ZTK] Kasama Nakonde-Tunduma Mbeya, 400AC	750
Tanzania - Uganda	Masaka-Kyaka, 132AC/220AC	431
South Africa - Zimbabwe	[Mozisa] Nzhelele-Triangle, 400AC	500
South Africa - Eswatini	Mahamba-Normandie/Edwaleni-Camden, 132AC/400AC	1344
Rwanda - Uganda	Mbarara-Birembo, 220AC	363
Namibia - Zambia	[Zizabona] Gerus-Sesheke, 400AC	650
Namibia - South Africa	Kokerboom-Aries/Harib-Aggenies, 400/220AC	241
	Obib-Oranjepond-Gromis 400kV, 400AC	750
Mozambique - Zimbabwe	[Mozisa] Inchope(Matambo-Songo)-Orange Grove (Triangle-Msoro), 400AC	400
	Songo - Bindura, 400AC	500
Mozambique - Zambia	Songo-Msoro, 400AC	200
Mozambique - South Africa	Apollo-Songo, 533HVDC	1200
	Maputo (Motrac)-Arnot/Ressano Garcia-Komatipoort, 400AC/132AC	1386
Mozambique - Eswatini	Maputo-Edwaleni/Maputo-Edwaleni2/Matola-Kalanga, 400AC/400AC	1613
Lesotho - South Africa	Maboti-Tweespruit/Khukhuna-Clarens, 132AC/132AC	217
Kenya - Uganda	Bujagali/Tororo-Lessos, 400AC	400
Kenya - Tanzania	[ZTK] Kenya -Tanzania (Isinya-Arusha) 400AC	600
Ethiopia - Sudan	Existing Sudan-Ethiopia, AC	200
Ethiopia - Kenya	Ethiopia border-Suswa, 500HVDC	2000
DRC - Zambia	Lumumbashi-Luano, 220AC	120
Djibouti - Ethiopia	Existing Ethiopia-Djibouti, 220AC	180
Botswana - Zimbabwe	[Zizabona] Pandamatenga-Victoria Falls, 330/400AC	400
	Phokoje-Insukamini/Francistown-Marvelm, 400/220AC	1630
Botswana - South Africa	[BOSA] Isang-Watershed B, 400AC	800
	Gaborone-Kopfontein/Gaborone-Spitskop/Segoditshane-KOFF, 132AC	129
	Phokoje-Matimba, 400AC	420
Angola - Namibia	[ANNA] Omatando-Xangongo/Baynes-Cahama, 400AC/400AC	700

Status

Existing (as of 2019) Committed

Source: (EAPP_2014; SAPP_2017) ; IRENA-Planning and prospects for renewable power: Eastern and Southern Africa

EAPP and SAPP's capacity mix until 2040 based on the respective master plans' reference plans



Source: (EAPP_2014; SAPP_2017) ; IRENA-Planning and prospects for renewable power: Eastern and Southern Africa

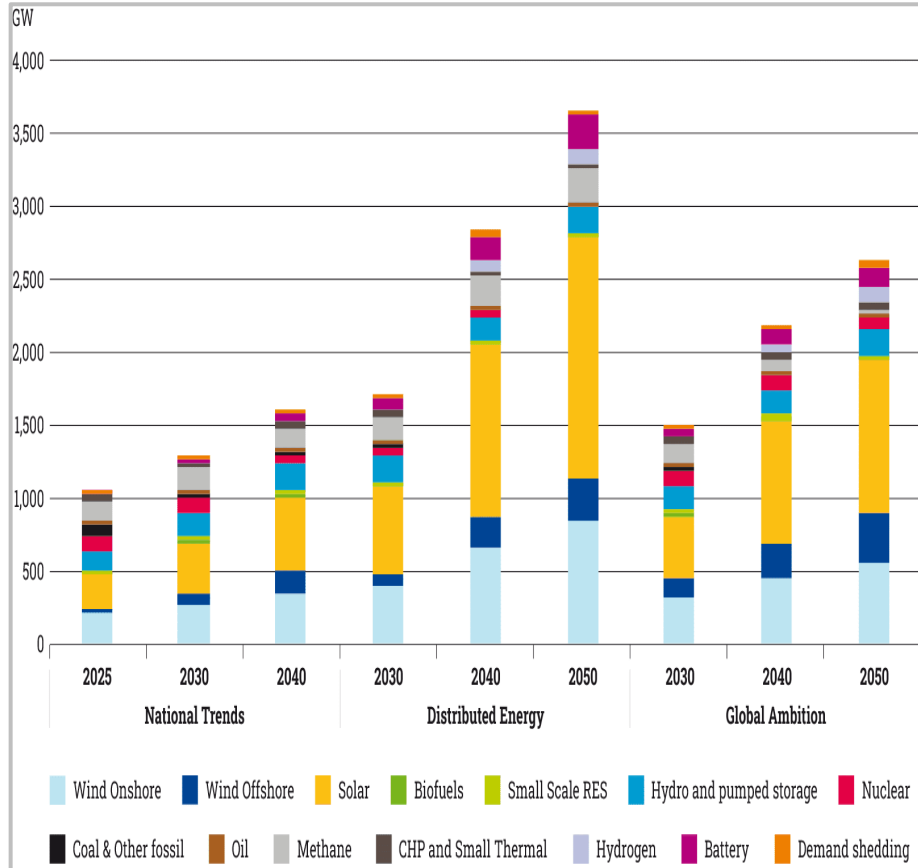
Comparison of the 2040 capacity share for EAPP's "main" and SAPP's "benchmark" scenarios, with renewable scenarios; MW values in parenthesis

EAPP

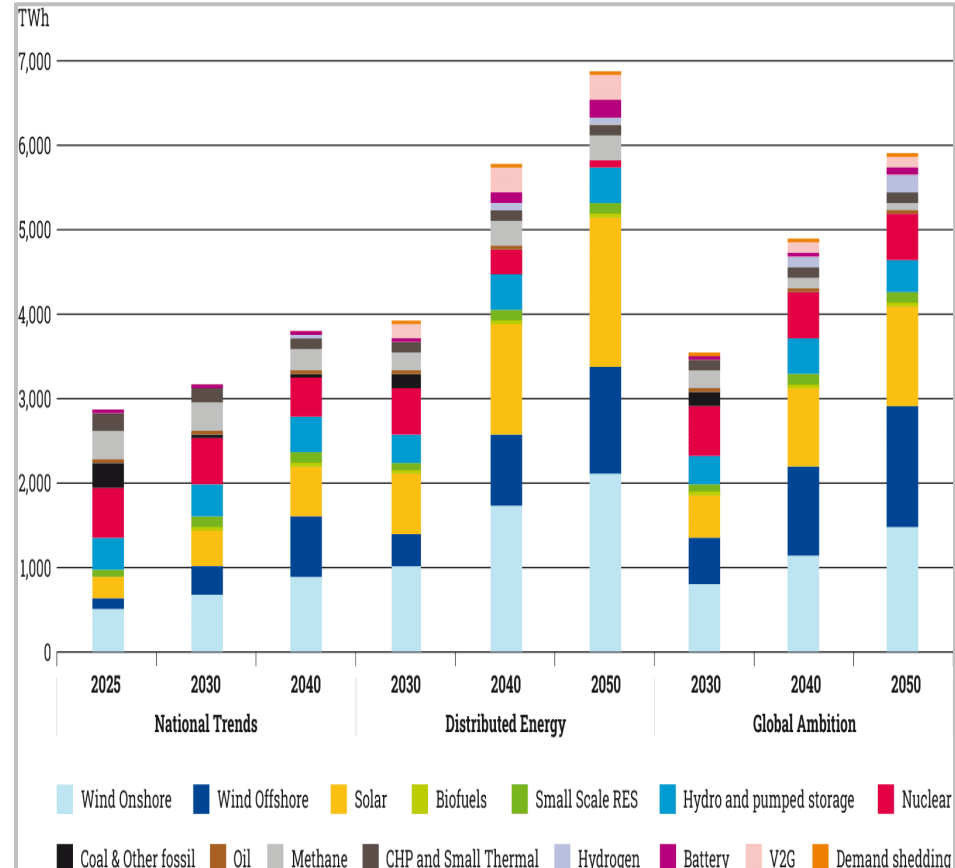
SAPP

	Main	Renewable	Benchmark	Realistic Integration	High RE sensitivity (SC4)
Biogas	0.1% (150)	0% (150)	0% (18)	0% (18)	0% (18)
Biomass	0.2% (452)	0.1% (452)	0.1% (81)	0.1% (141)	0.5% (727)
Geothermal	6% (15 300)	3.9% (15 300)	0.1% (200)	0.2% (200)	0.1% (200)
Hydro	20.5% (52 038)	14.6% (57 153)	34.7% (48 745)	33.5% (42 462)	27.5% (42 390)
Pumped storage	0% (0)	0% (0)	2.1% (2 912)	2.3% (2 912)	1.9% (2 912)
Solar	0.2% (575)	0.1% (575)	2.7% (3 746)	2.9% (3 646)	12.1% (18 676)
Wind	0% (0)	33.8% (132 262)	2.1% (2 994)	2.4% (2 994)	11.9% (18 287)
Total RE share	26.9%	52.6%	41.8%	41.3%	54.0%
Coal	44.1% (112 073)	19.4% (76 078)	45.2% (63 454)	45.3% (57 419)	36.7% (56 520)
Natural gas	27.8% (70 710)	27.2% (106 611)	10.3% (14 538)	10.3% (13 108)	0% (0)
Oil	1.2% (2 935)	0.7% (2 935)	3.5% (4 912)	3.9% (4 924)	0% (0)
Thermal (exl. Coal)	0% (0)	0% (0)	0% (0)	0% (0)	10.2% (15 700)
Total thermal share	73.0%	47.4%	59.0%	59.5%	46.9%
Nuclear	0% (0)	0% (0)	1.3% (1800)	1.4% (1800)	1% (1570)
Others (waste and peat)	0.1% (183)	0% (183)	0% (0)	0% (0)	0% (0)

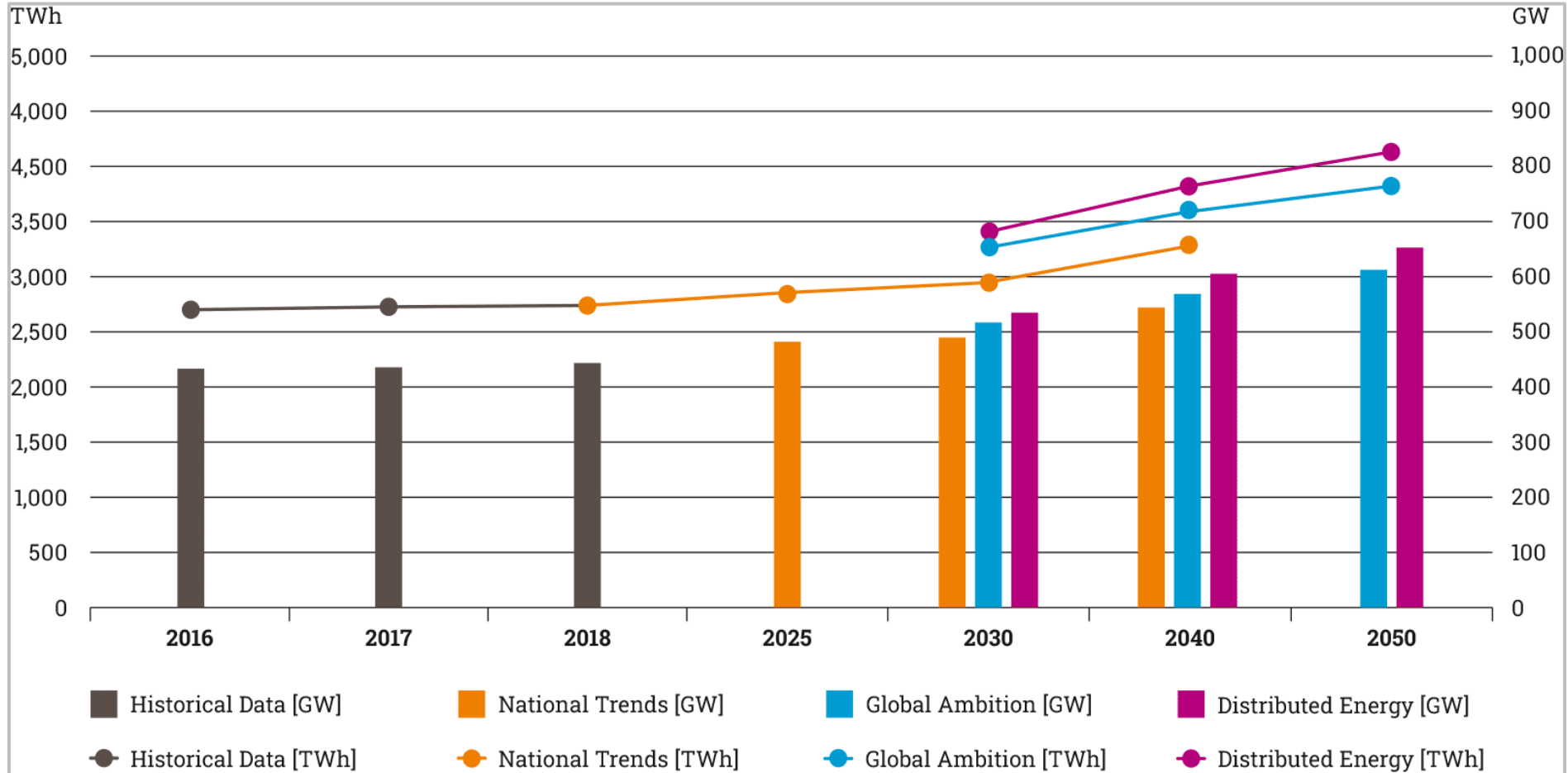
Capacity mix for EU27 (including prosumer PV, hybrid and dedicated RES for electrolysis)



Power generation mix for EU27 (including prosumer PV, hybrid and dedicated RES for electrolysis)



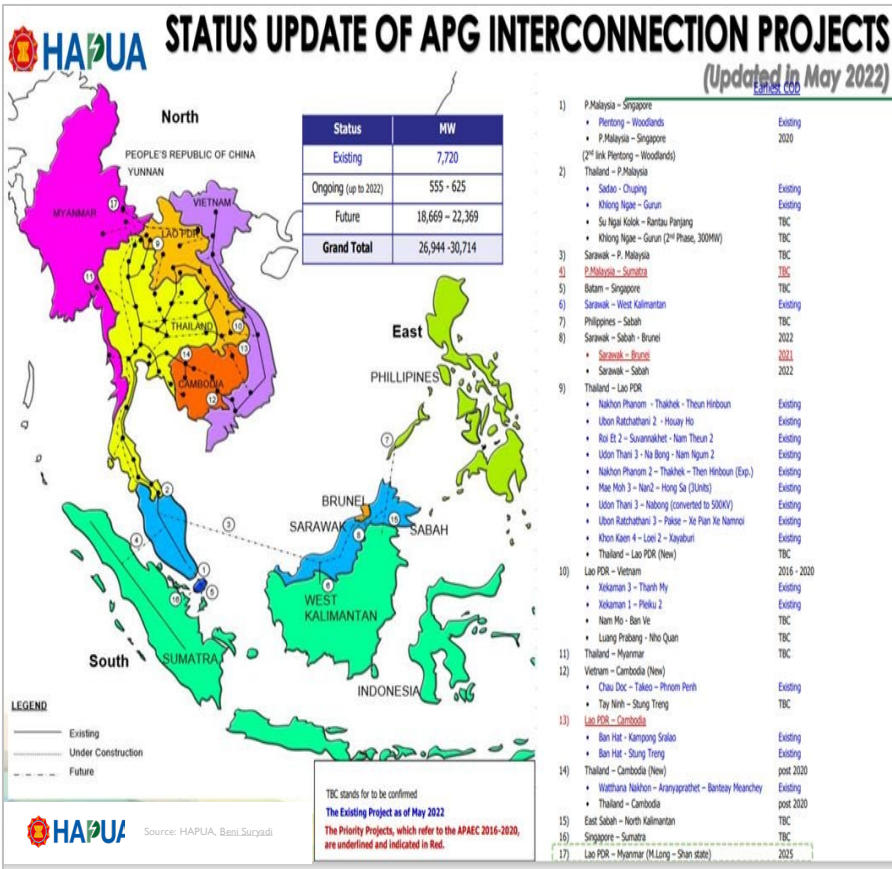
Evolution of average electricity demand and peak (including transmission and distribution losses) for EU27



Source: ENTSO-E TYNDP, High-Level Report TYNDP 2022, Final Version - May 2023, TYNDP 2022 Scenario Report - Version April 2022

ASEAN Interconnection Projects Electricity Import (+) / Export (-) Balance in LCO Scenario

ASEAN Interconnection Projects Electricity Import (+) / Export (-) Balance in LCO Scenario



	Net Import/Export (GWh)				% of Domestic Generation			
	2025	2030	2040	2050	2025	2030	2040	2050
Brunei Darussalam	-526	-3,504	-3,504	875	8.34	36.89	34.12	12.27
Cambodia	-2,468	-71	-2,055	-14,197	21.71	0.61	11.46	45.01
Indonesia	-1,519	-624	1,115	7,271	0.45	0.16	0.22	1.15
Lao PDR	-4,575	-8,349	-8,901	-58,326	10.09	16.33	16.29	54.26
Malaysia	-1,765	-686	-12,215	-27,851	0.95	0.35	5.62	11.07
Myanmar	-6,326	-8,603	-7,850	-7,634	22.01	23.44	19.83	17.86
Philippines	0	-294	2,433	4,380	0.00	0.20	1.34	1.93
Singapore	3,199	4,225	8,067	9,198	6.09	7.68	13.74	15.69
Thailand	58,850	52,357	58,512	48,953	46.38	32.51	27.40	15.96
Vietnam	-44,869	-34,451	-35,602	37,330	14.71	10.64	8.95	8.37

Source: ZTH ASEAN Energy Outlook