CURRENT & FUTURE ENERGY OUTLOOK MYANMAR

3 OPTIONS

1) Business as Usual (BAU) power generation development path which is based on current power planning practices, current policy objectives

2) Sustainable Energy Sector (SES) scenario, where measures are taken to maximally deploy renewable energy and energy efficiency measures to achieve a near 100% renewable energy power sector

3) Advanced Sustainable Energy Sector (ASES) scenario, which assumes rapid advancement and deployment of new and renewable technologies to 100% renewable energy power sector

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Figure 2 Installed Capacity and Average Demand (2000-14)

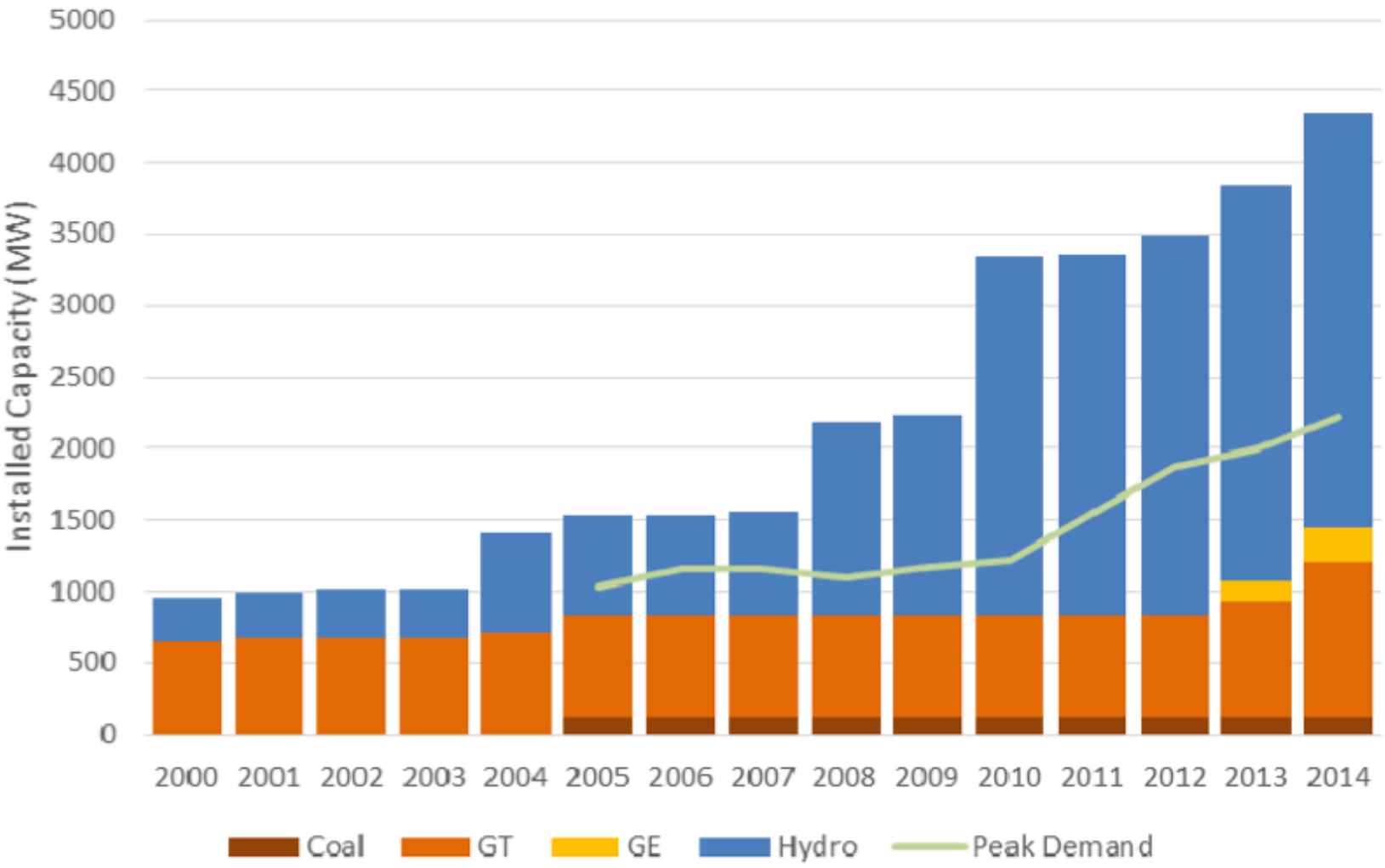

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Figure 3 Installed Capacity Share by Generation Type (2014)

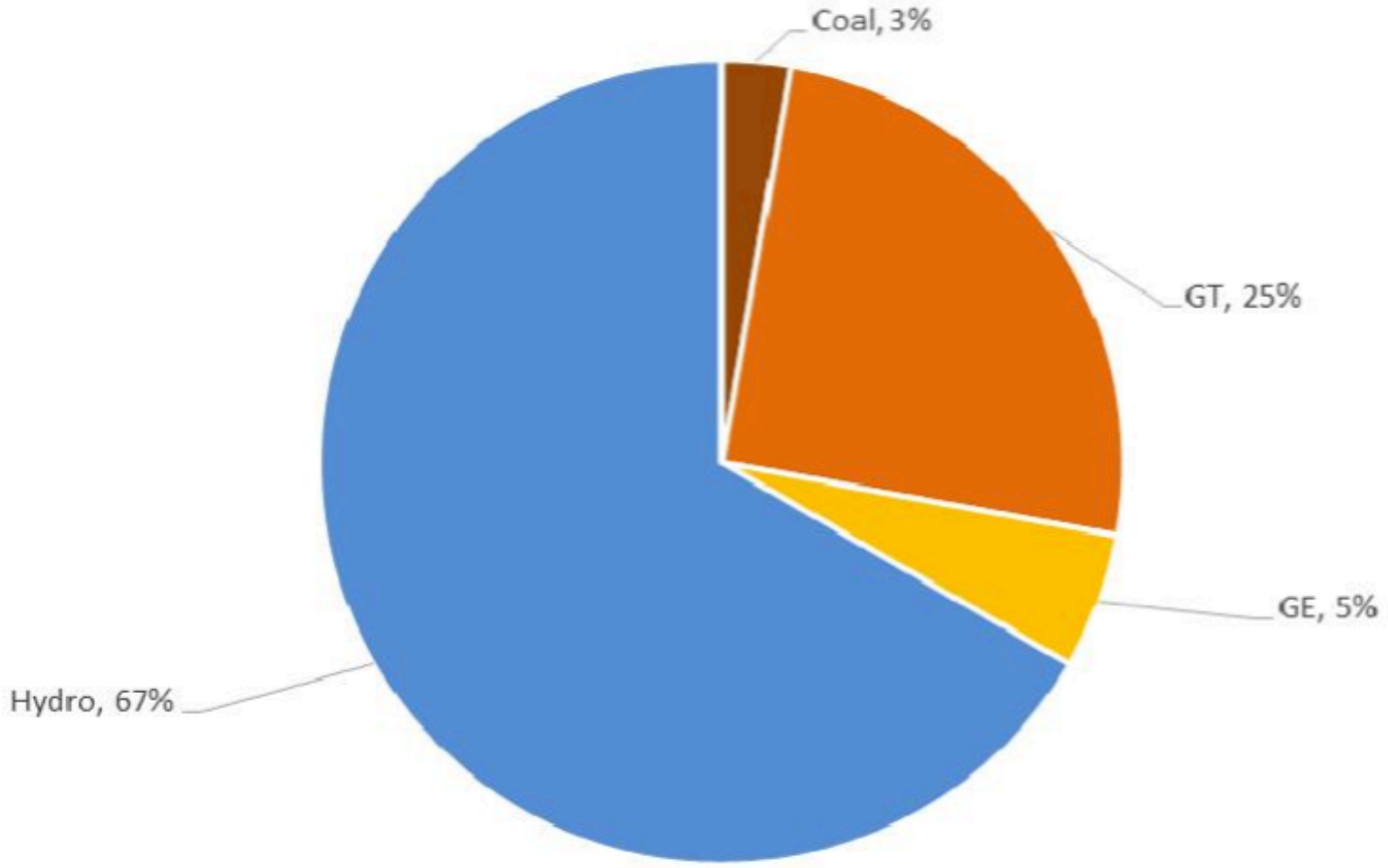

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Figure 4 Electricity Demand by Category (2000-14)

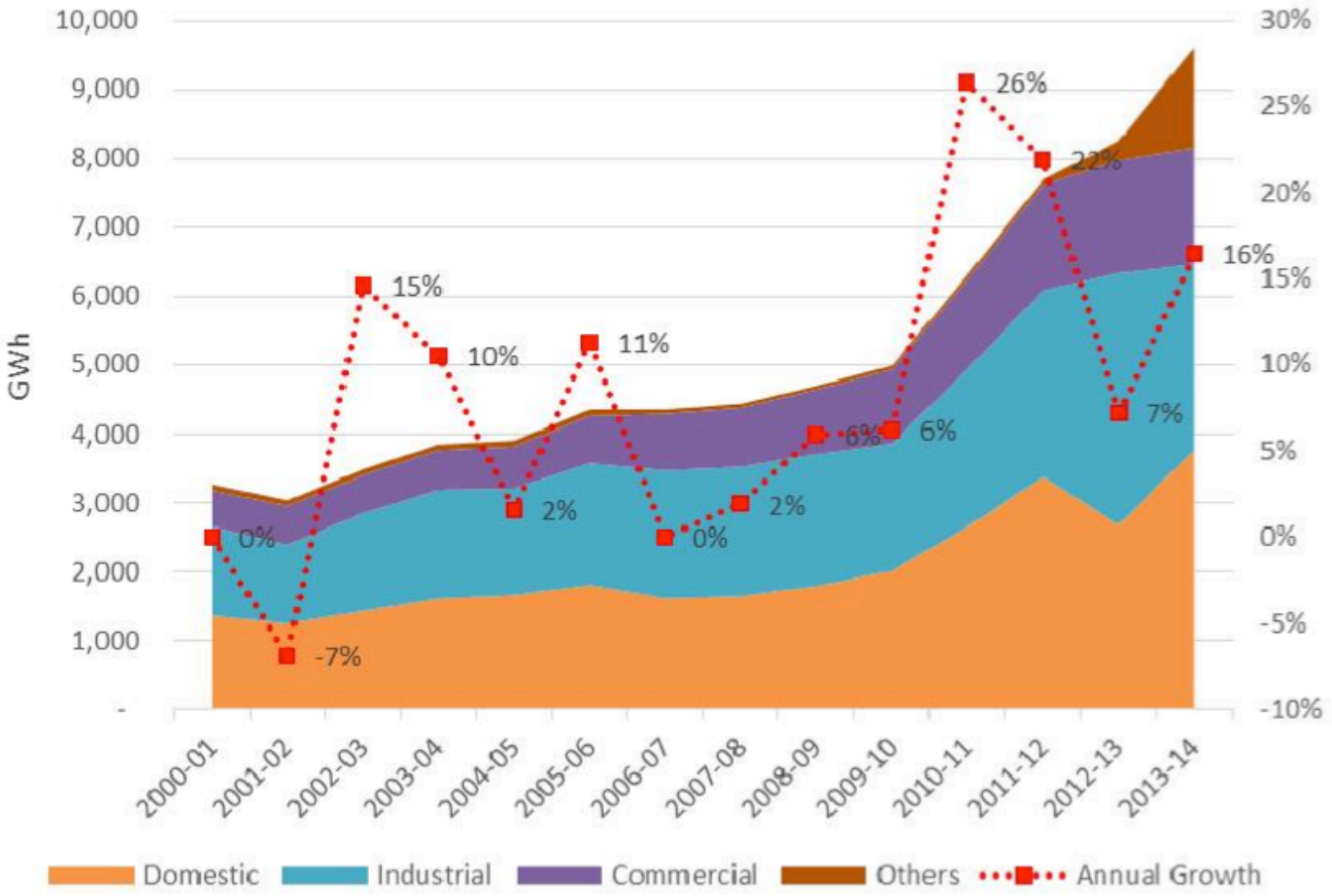

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Figure 5 Electricity Demand Shares by Category (2014)

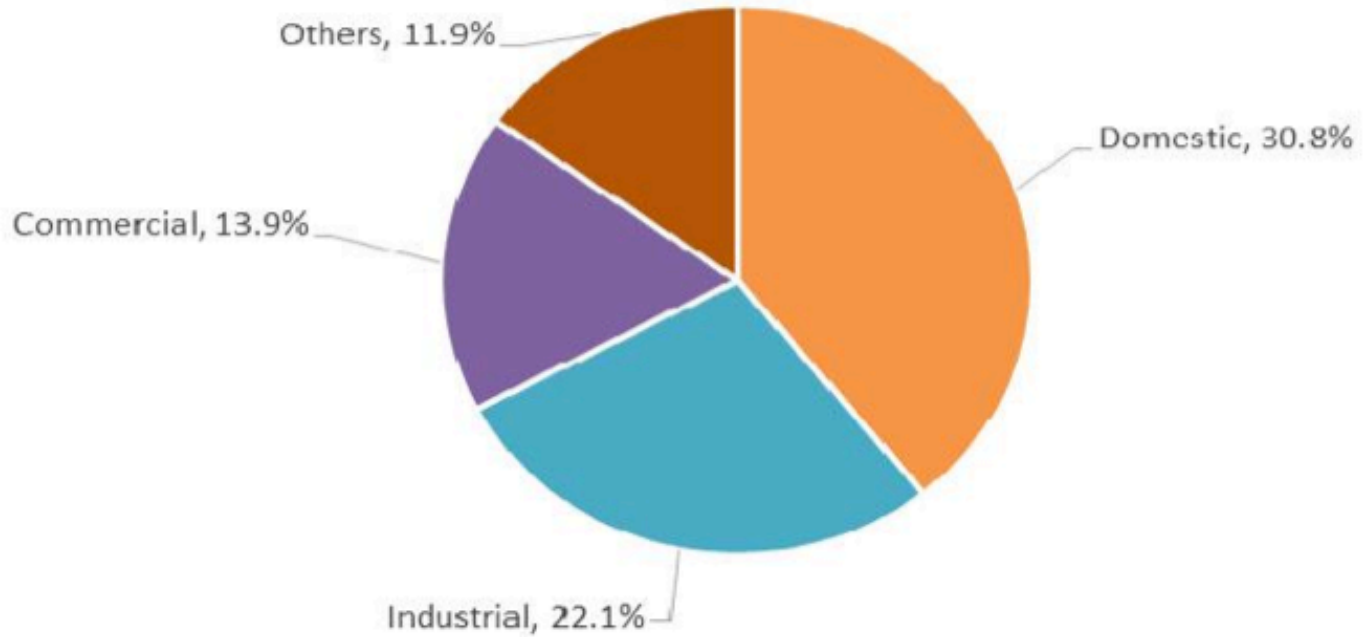

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Figure 6 Generation by Technology (2000-2014)

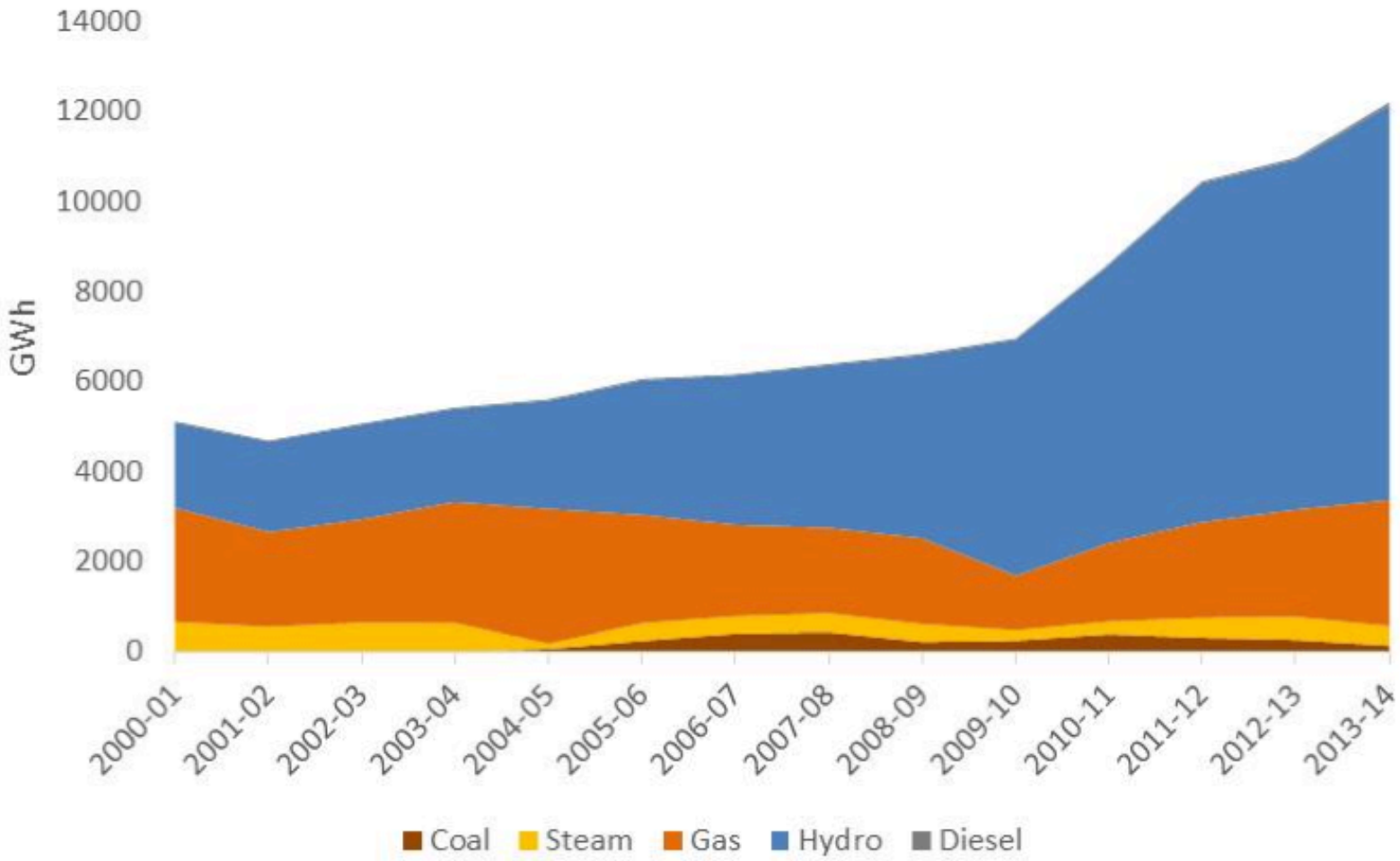

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Figure 7 Generation Shares (2013-14)

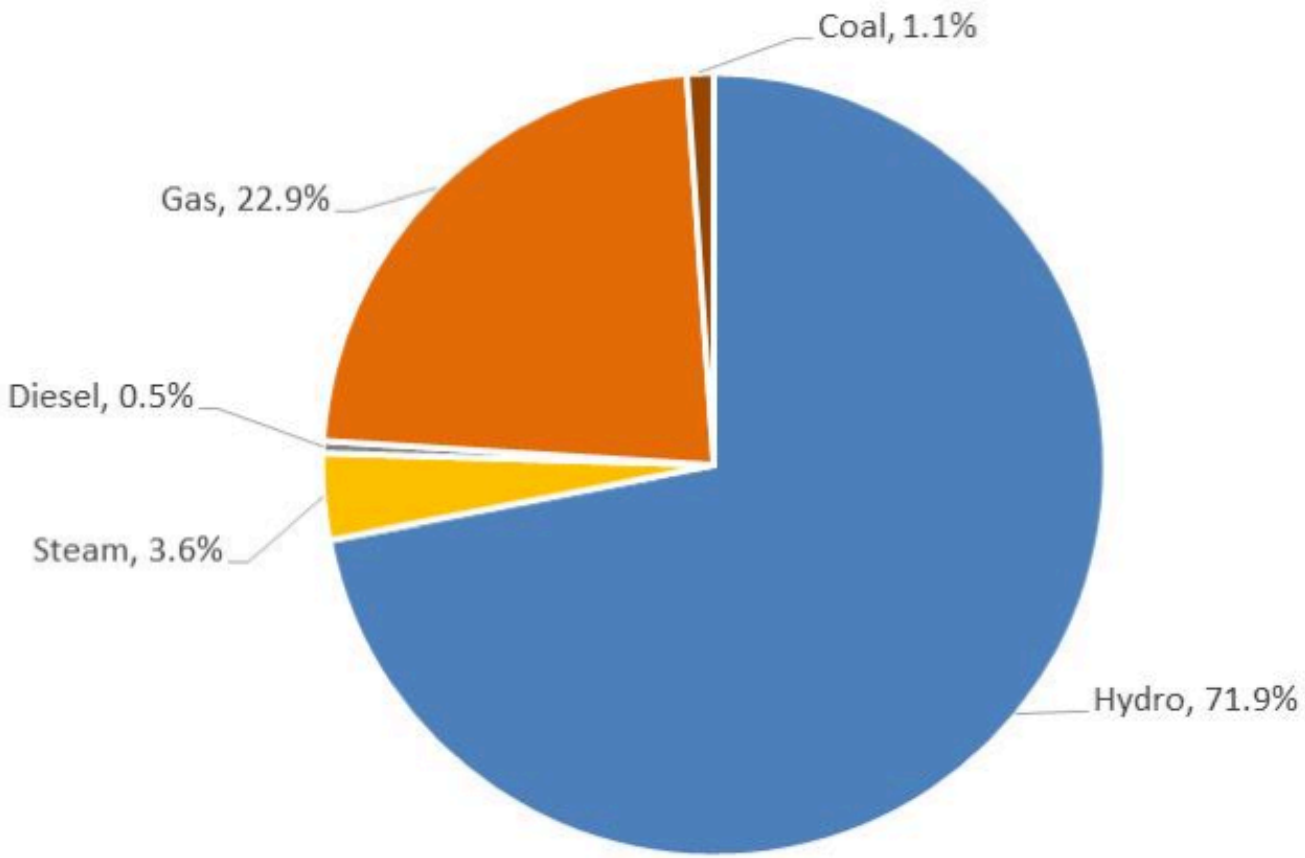


Table 1 Summary of Current Generation Projects (2014)

Development Stage	Numbers of Projects	Installed Capacity, MW
Hydropower		
Existing	24	3,011
Under Construction	7	1,662
Joint Venture Agreement (JVA)	4	12,700
Memorandum of Agreement (MOA)	3	6,970
Memorandum of Understanding (MOU)	2	8,583
Planning / Proposal	4	783
Steam / Gas Fired		
Existing	14	915
Under Construction	12	1,255
JVA		
MOA		70
MOU	4	1,899
Planning / Proposal	1	106
Coal Fired		
Existing	2	128
Under Construction		
JVA		
MOA		
MOU	12	10,090
Planning / Proposal	10	8,770
Renewable Energy		
Wind MOU	25	4,032
Solar MOU	4	530
Geothermal MOU	5	200

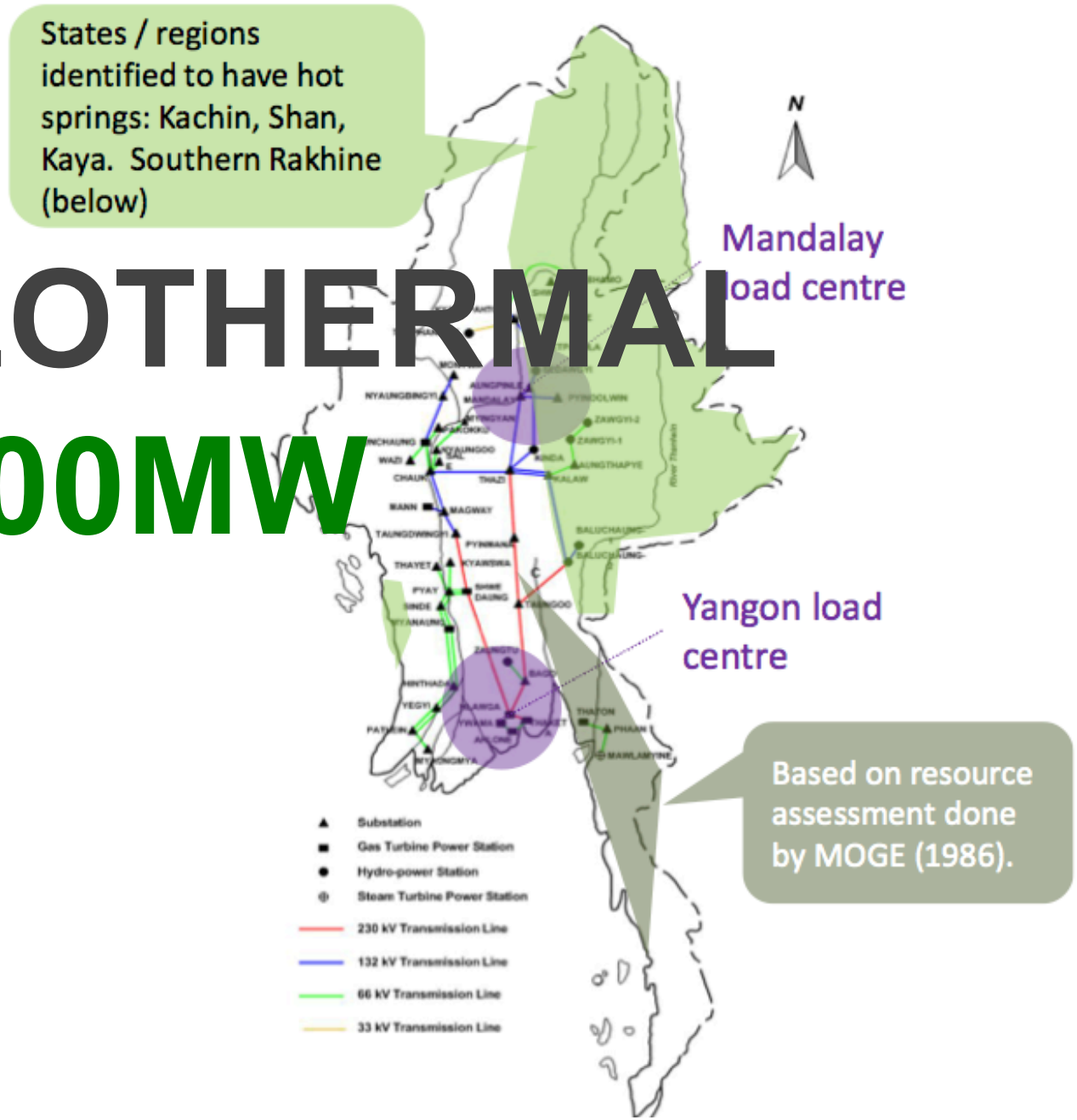
HYDRO ≈ 50 GW

STEAM/GAS≈ 4 GW

COAL≈ 19 GW

RENEWABLES≈ 5 GW

Figure 22 **Locations in Myanmar with Geothermal Potential**



GEOTHERMAL

≈ 500MW

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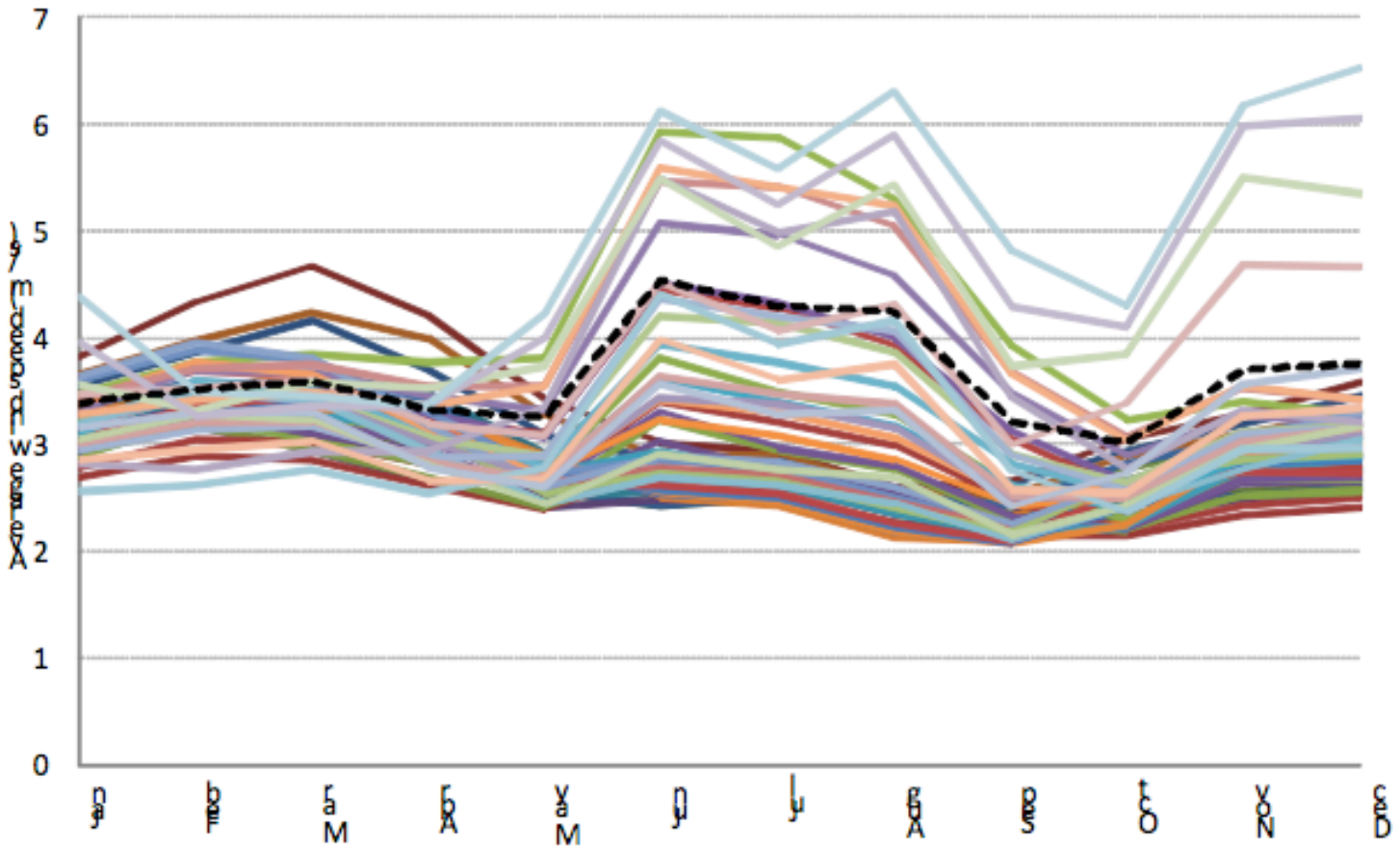
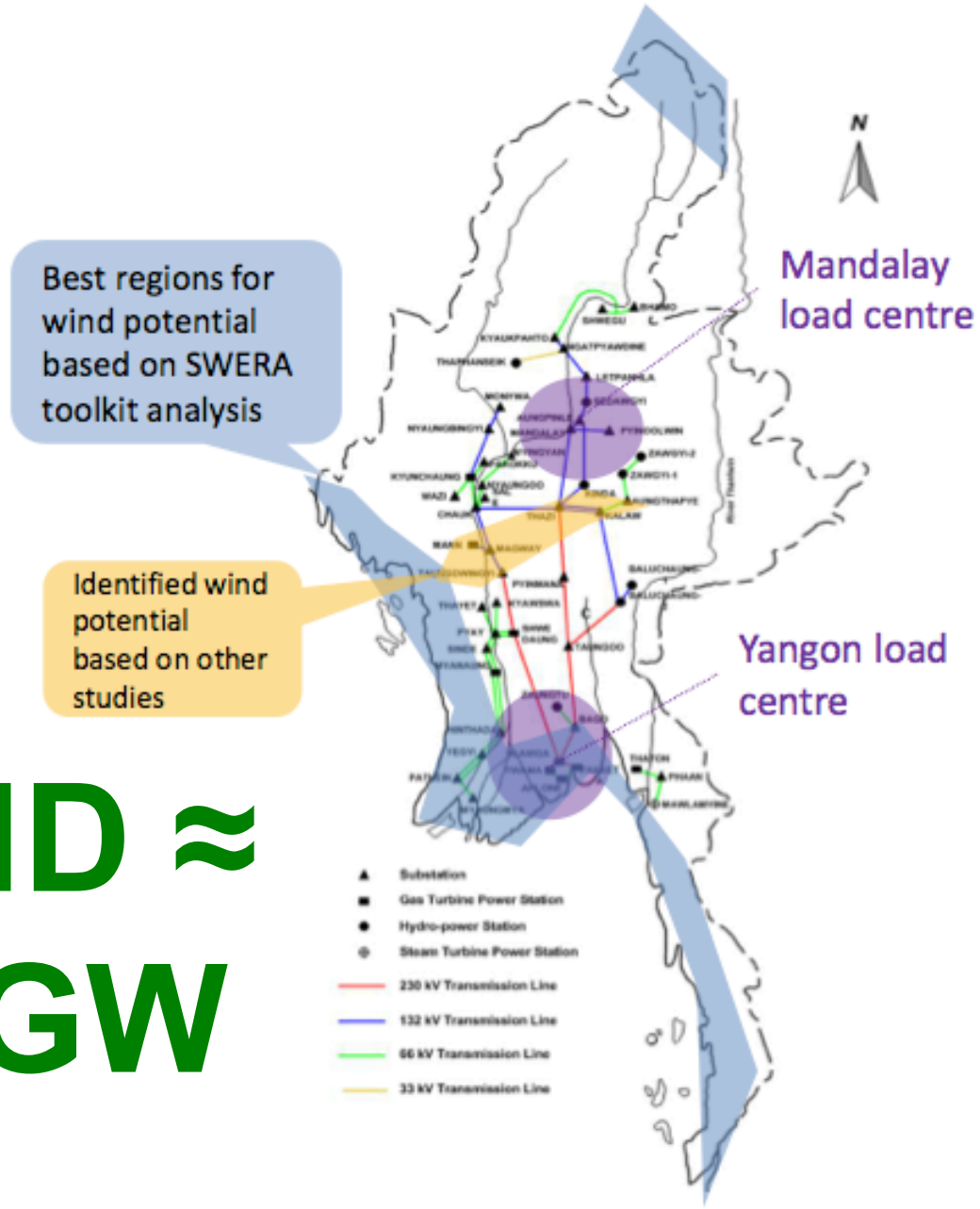
WIND

Figure 17 Monthly Wind Speeds for Selected Locations in Myanmar



Source: NASA Atmosphere Science Data Centre, obtained via the SWERA Geospatial Toolkit

Figure 18 **Locations in Myanmar with Highest Wind Potential**



WIND ≈ 34 GW

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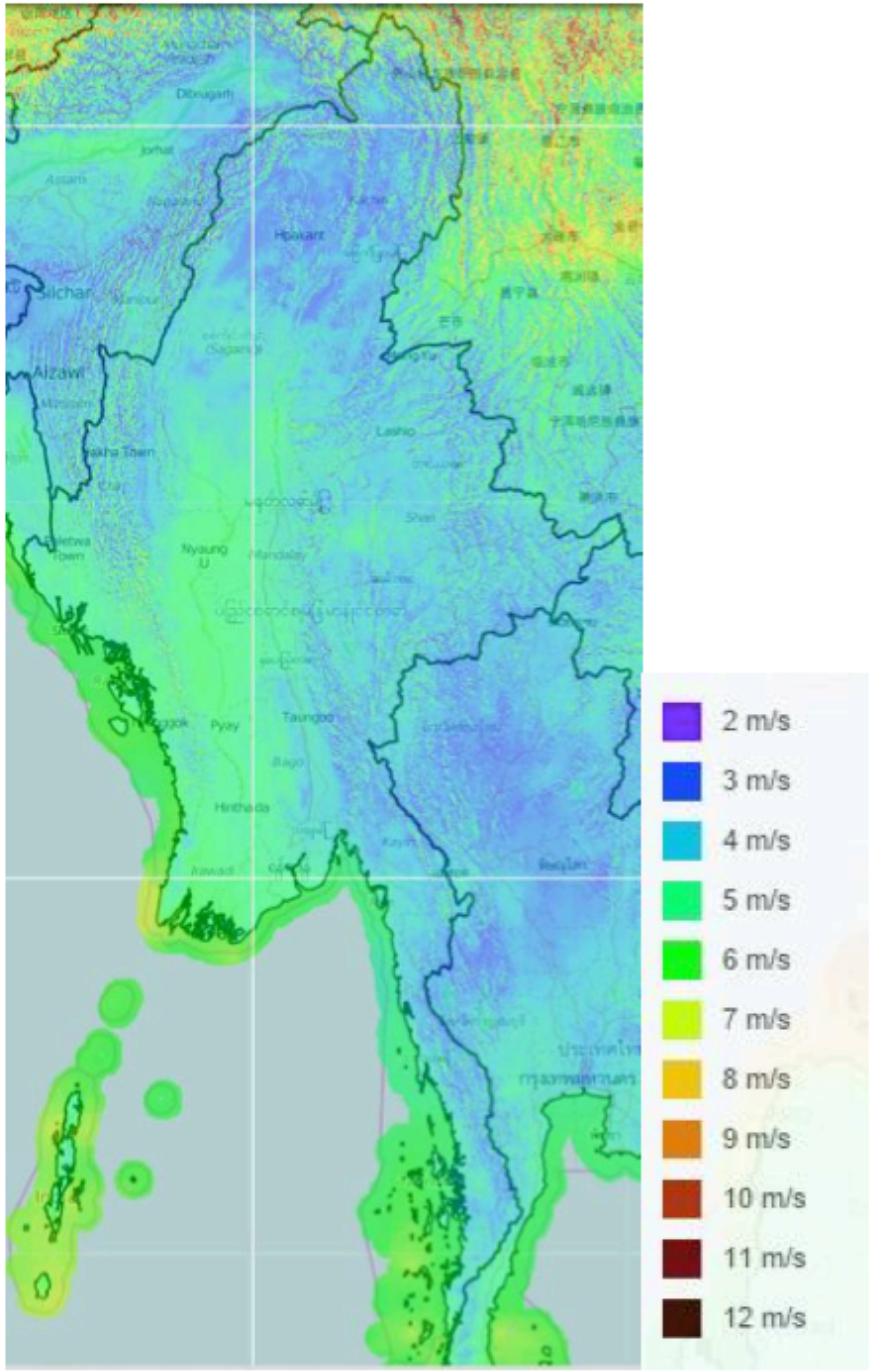
WIND

Figure 16 Average Wind Speed 1km at 100 m AGL DTU (2015)



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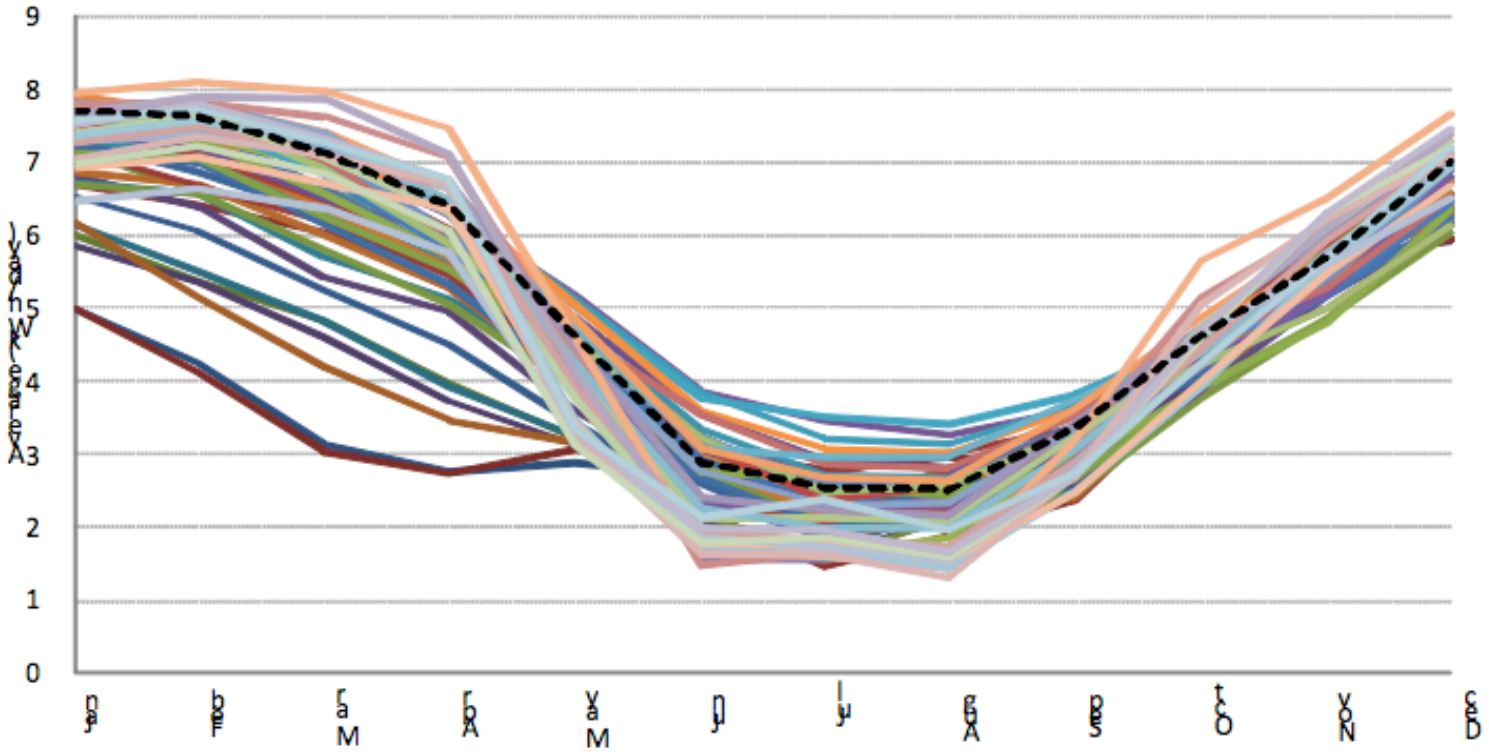
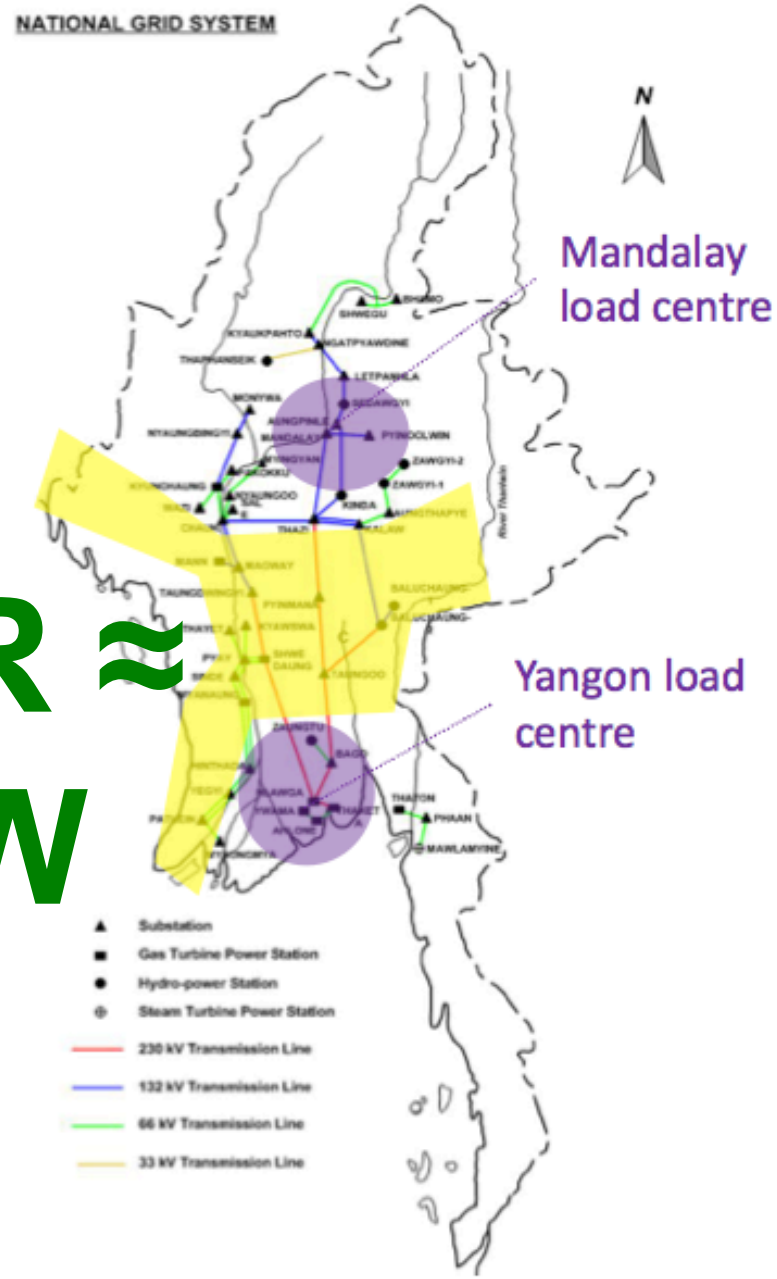
SOLAR

Figure 20 **Monthly Irradiance Levels for Selected Locations in Myanmar**



Source: NASA Atmosphere Science Data Centre, obtained via the SWERA Geospatial Toolkit

Figure 21 Best DNI Solar Irradiation Locations in Myanmar



SOLAR ≈ 27 GW

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SOLAR

Figure 19 **3TIER's Global Solar Dataset (3km in W/m^2) for GHI**

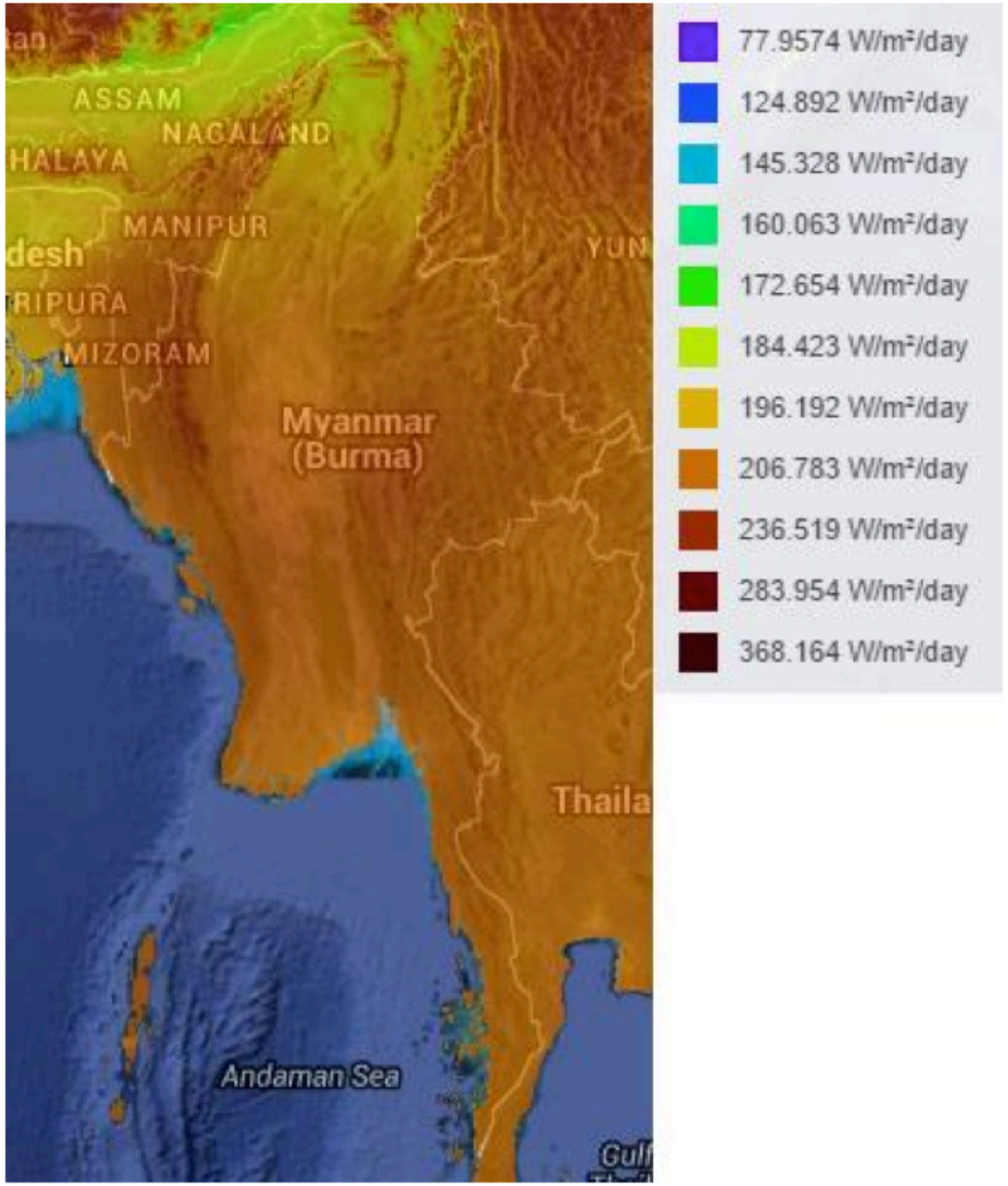

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Table 4 Myanmar Biogas Energy Potential

Livestock	2010 Production[a] (million heads)	Daily Manure Production Factor (kg/animal)	Substrate Quantity (kg/day)	Dry Matter Factor (%)	Total Dry Matter Available (kg/day)	Mean Biogas Yield Factor (m^3/kg dry matter)	Daily Biogas Production (m^3/day)
Buffalo	3.09	8.00	24,720,000	16	3,955,200	0.250	988,800
Cattle	14.02	8.00	112,160,000	16	17,945,600	0.250	4,486,400
Pigs	9.30	2.00	18,600,000	17	3,162,000	4.200	13,280,400
Chicken	153.20	0.08	12,256,000	25	3,064,000	0.575	1,761,800
Total							**20,517,400**

kg = kilogram, m^3 = cubic meter.

Source: Renewable Energy Developments and Potential in Myanmar, ADB, 2015

BIOMASS≈ 6 GW

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Figure 23 Seasonal Renewable Energy Generation Profiles

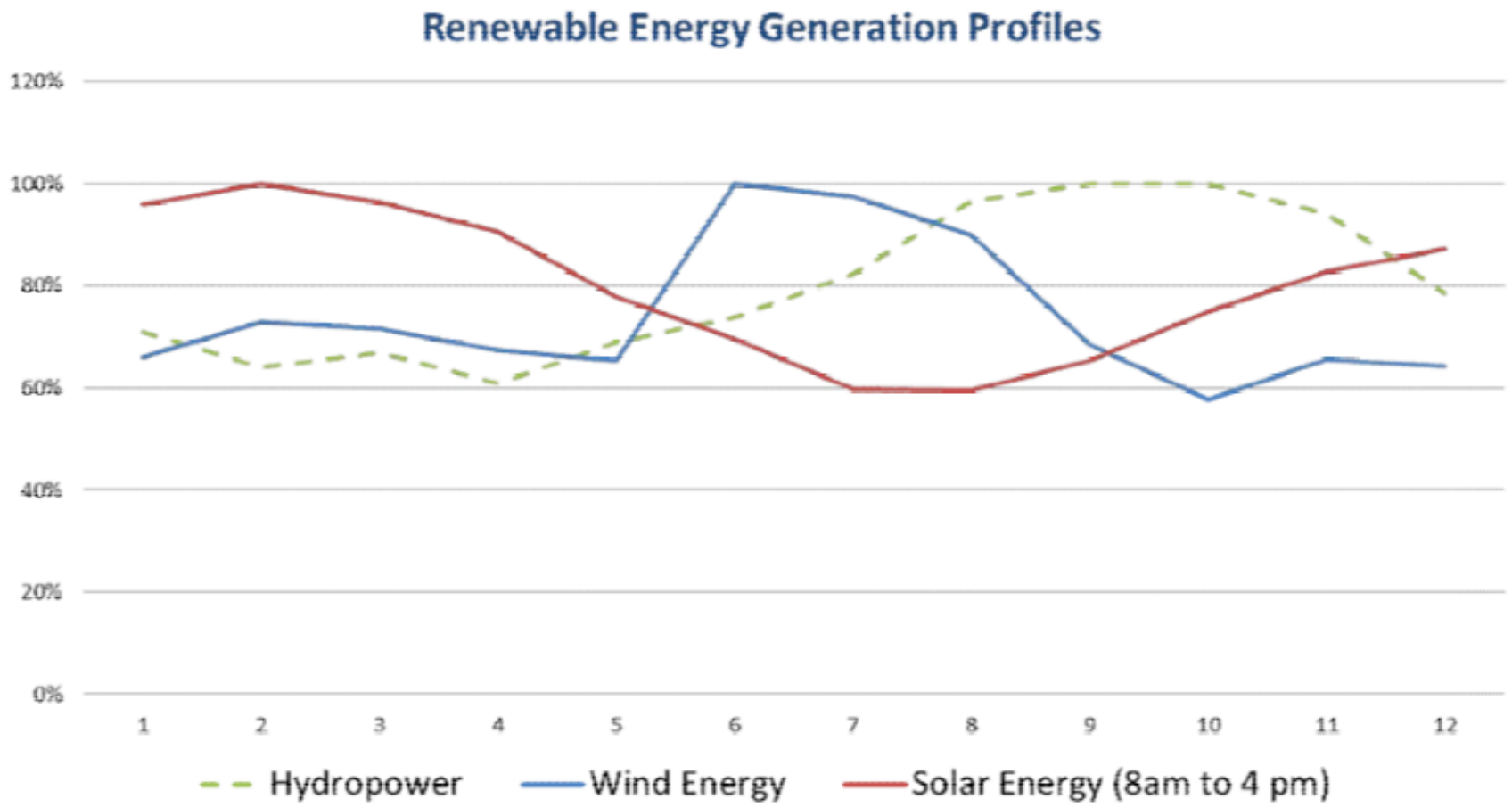


Table 5 Summary of Estimated Renewable Energy Potential (Compiled from Various Sources and Analysis)

Myanmar	Potential (MW)	Source and comments
Hydro (Large)	46,000	See Section 3.4
Hydro (Small)	231	See Section 3.4
Pump Storage	0	Lack of studies available
Solar	26,962 MW	Renewable Energy Developments and Potential in the Greater Mekong Subregion (ADB, 2015)
Wind Onshore	33,829	Renewable Energy Developments and Potential in the Greater Mekong Subregion (ADB, 2015)
Wind Offshore	No information available	Lack of studies available
Biomass	6,899	IES projections based on data from Renewable Energy Developments and Potential in the Greater Mekong Subregion (ADB, 2015)
Biogas	4,741	IES projections based on data from Renewable Energy Developments and Potential in the Greater Mekong Subregion (ADB, 2015)
Geothermal	400	See Section 3.7
Ocean	1,150	Ocean renewable energy in Southeast Asia: A review (2014), based on kW/m wave potential, 2300km coastline, 10% efficiency

SCENARIOS

Figure 28 Myanmar GDP Projection

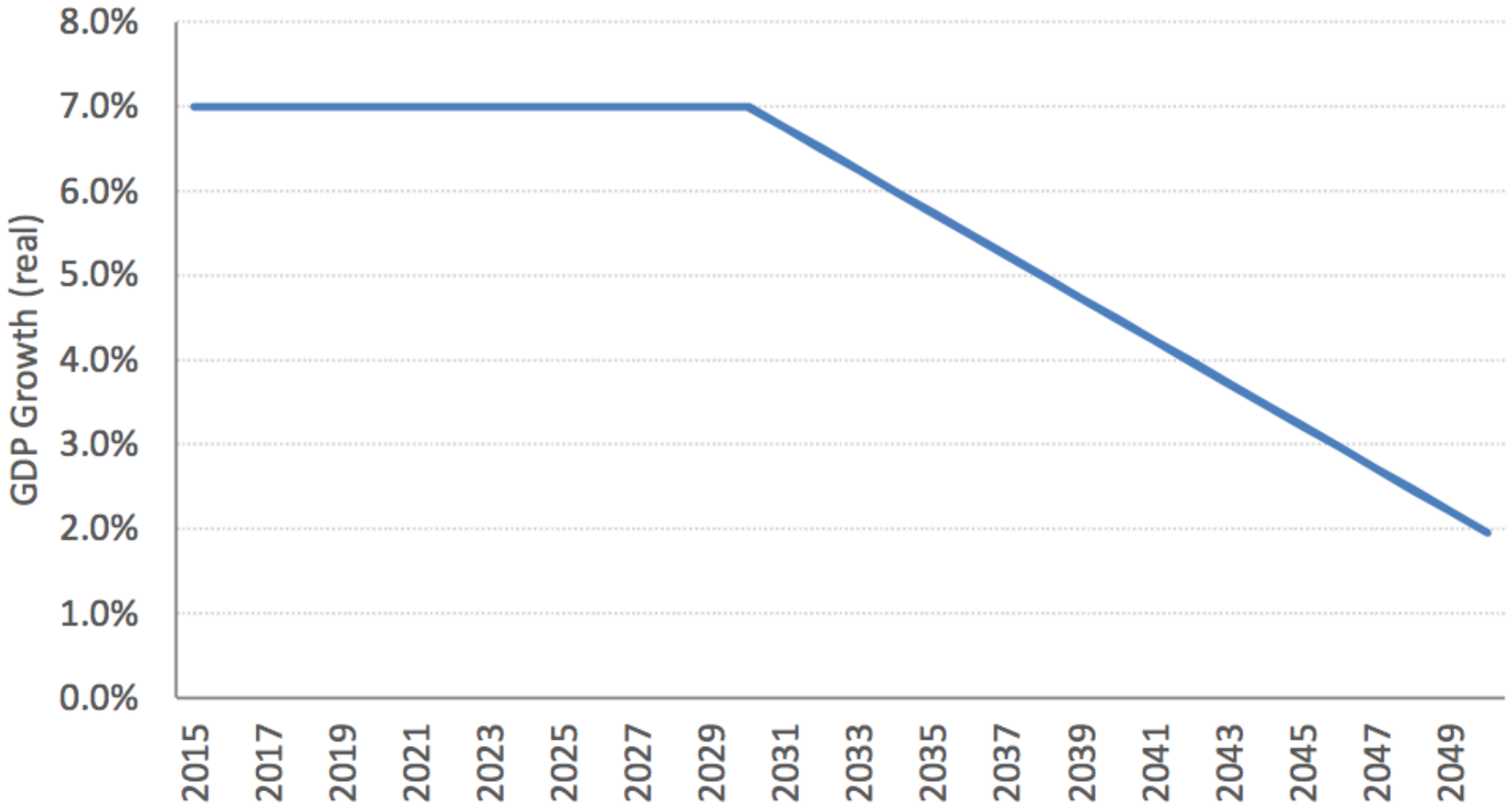
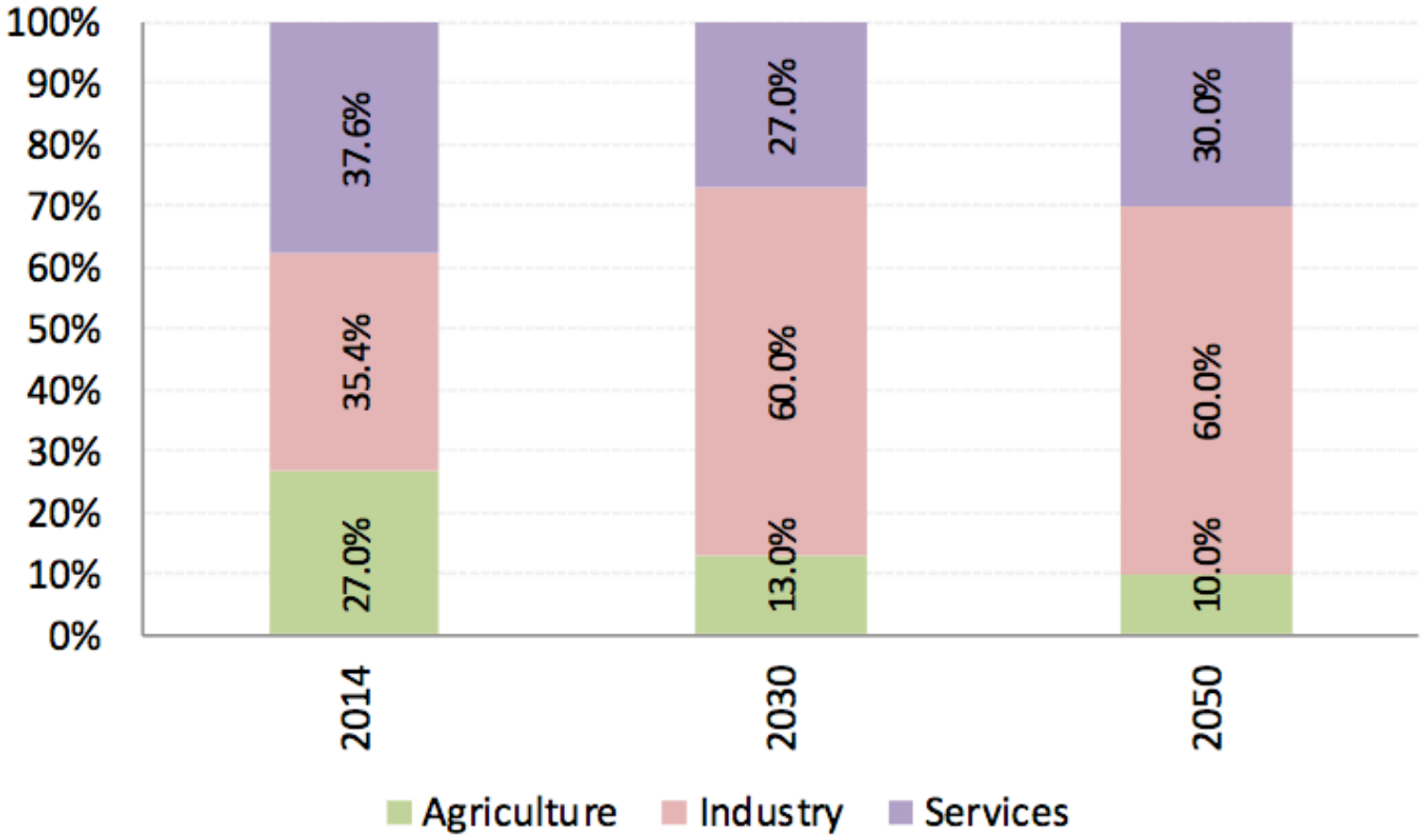


Figure 29 Myanmar GDP Composition



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DEMAND DRIVERS

Table 8 Myanmar Demand and Demand Drivers (BAU)

No.	Aspect	2015-30	2030-40	2040-50
1	Demand Growth (pa)	10.8%	5.8%	3.5%
2	GDP Growth (Real, pa)	7.0%	5.6%	3.1%
3	Electrification Rate (Population)	62.6%	97.0%	98.8%
4	Population Growth	0.56%	0.12%	-0.13%
5	Per Capita Consumption (kWh)	421	1,056	1,885
6	Electricity Elasticity*	4.02	2.51	1.79
7	Electricity Intensity (kWh/US$)	0.123	0.181	0.235

2015-30	2030-40	2040-50	2015-30	2030-40	2040-50
9.3%	5.8%	2.3%	8.4%	6.0%	2.9%
7.0%	5.6%	3.1%	7.0%	5.6%	3.1%
49.3%	78.4%	84.5%	41.4%	58.7%	60.0%
0.56%	0.12%	-0.13%	0.56%	0.12%	-0.13%
365	839	1,496	339	736	1,334
3.48	2.30	1.78	3.23	2.17	1.81
0.106	0.144	0.186	0.099	0.126	0.166

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Figure 76 Myanmar Per Capita Consumption Comparison (kWh pa)

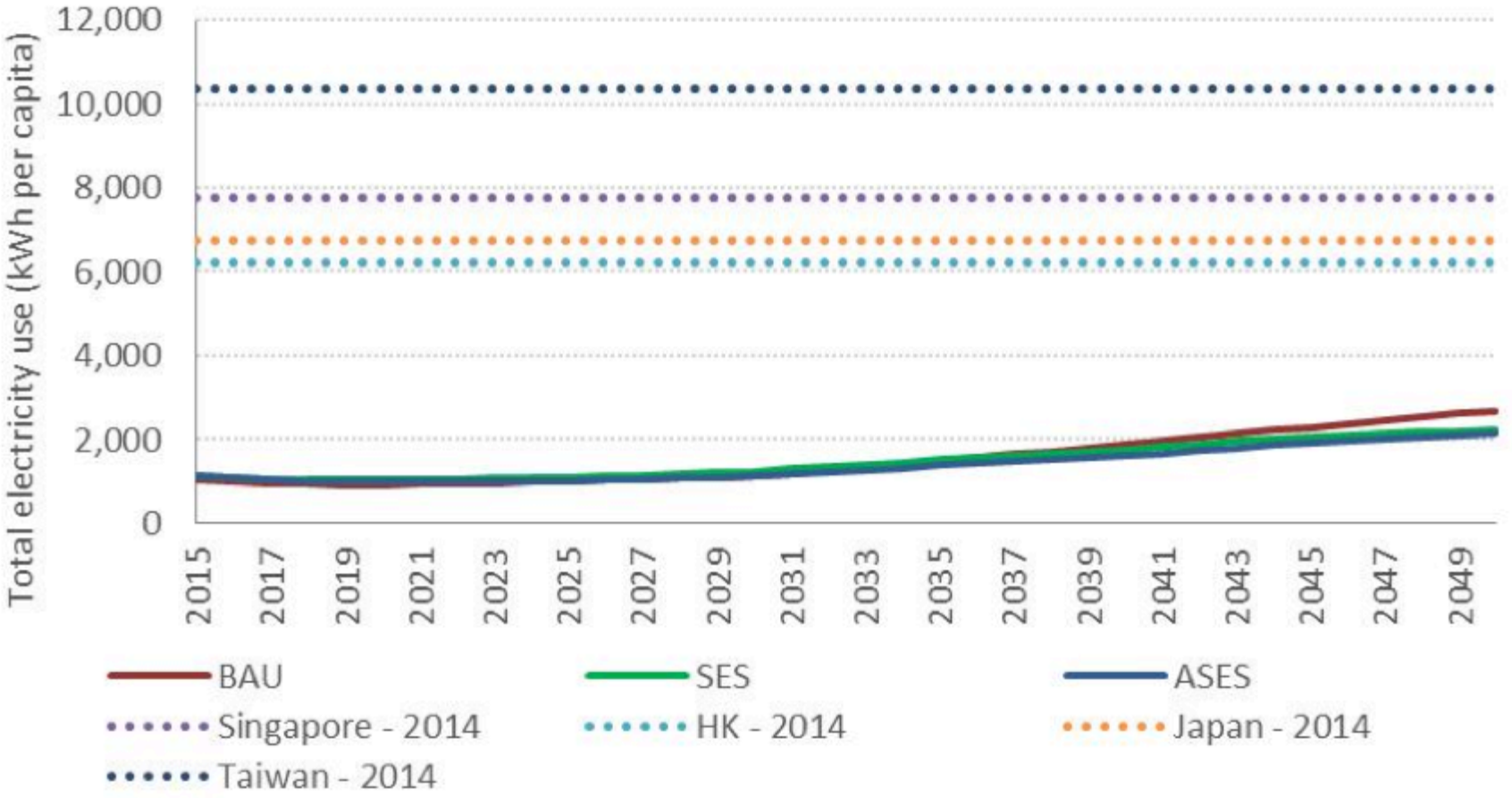

Figure 31 Myanmar Projected Electricity Demand (2015-50, BAU)

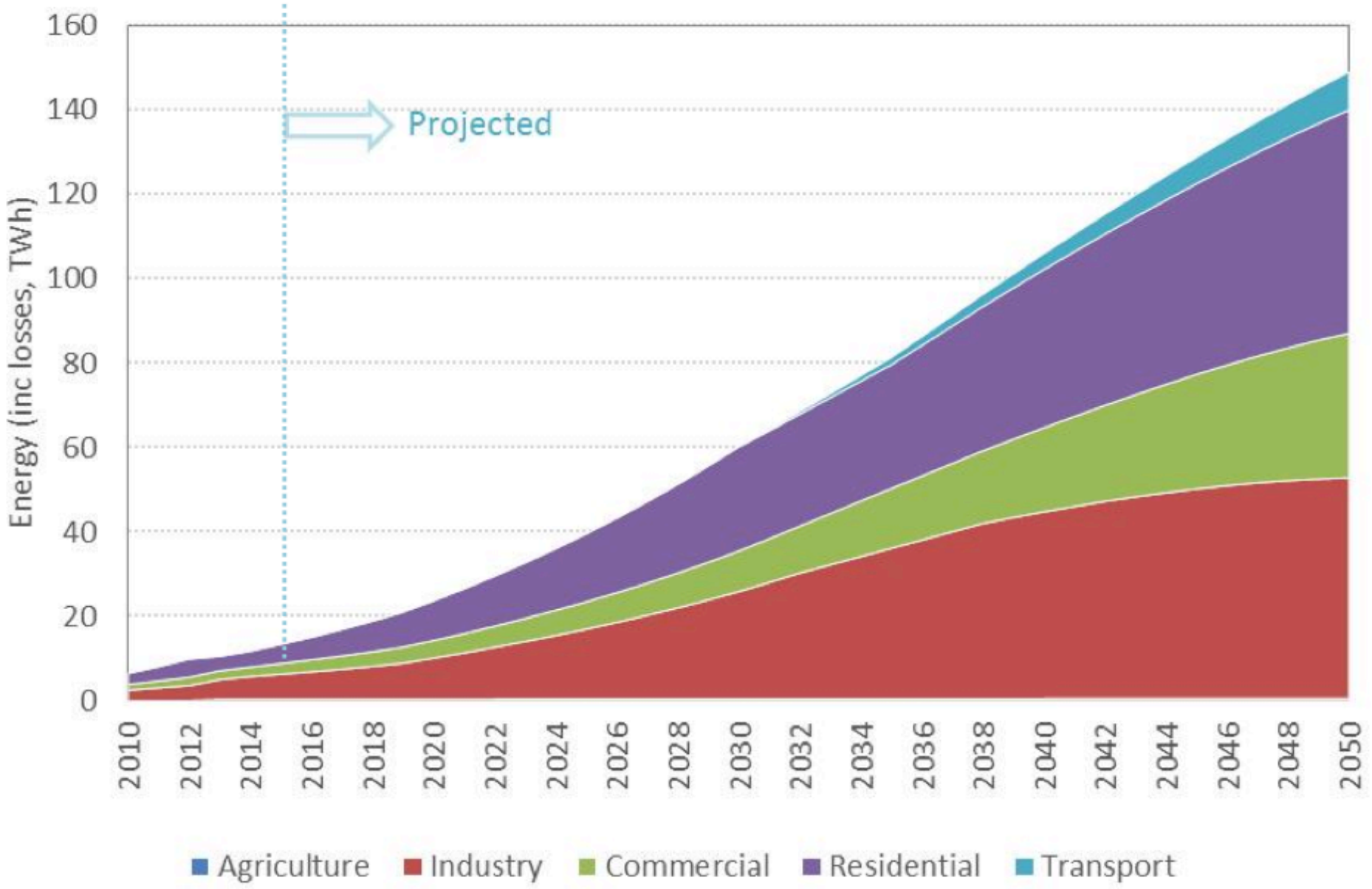

Figure 44 Myanmar Projected Electricity Demand (2015-2050, SES)

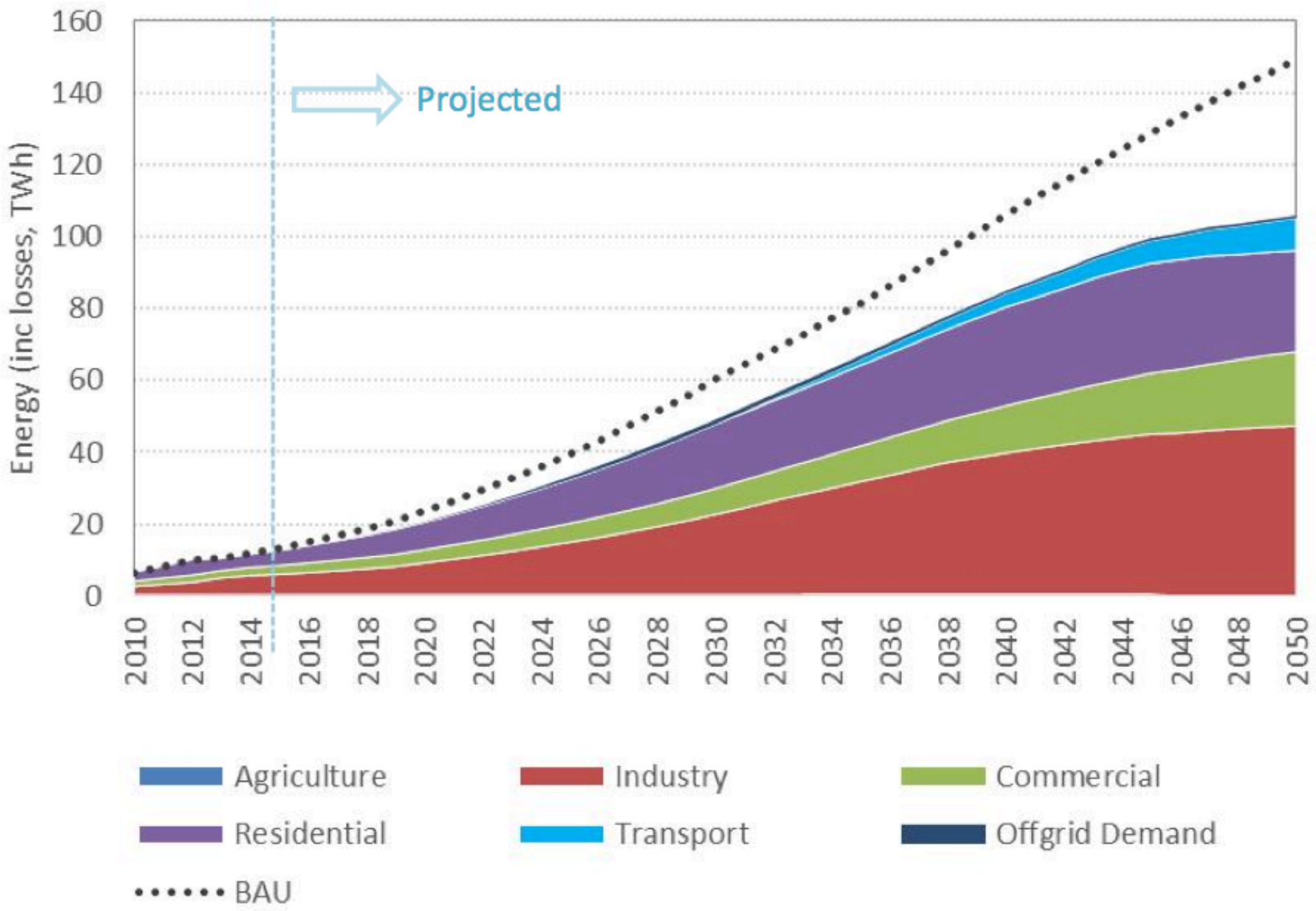

Figure 58 Myanmar Projected Electricity Demand (2015-2050, ASES)

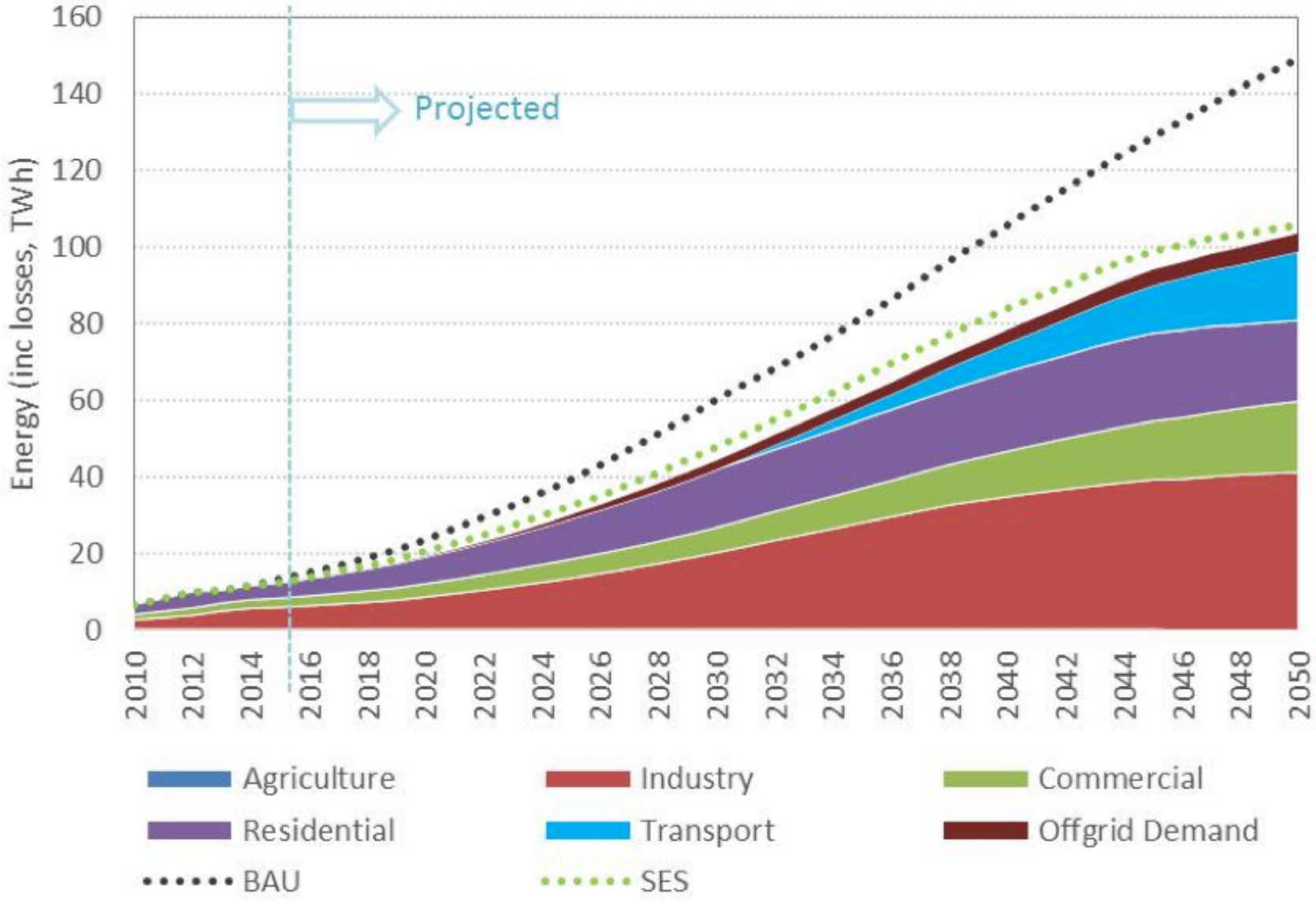

Figure 32 Myanmar Projected peak Demand (MW, BAU)

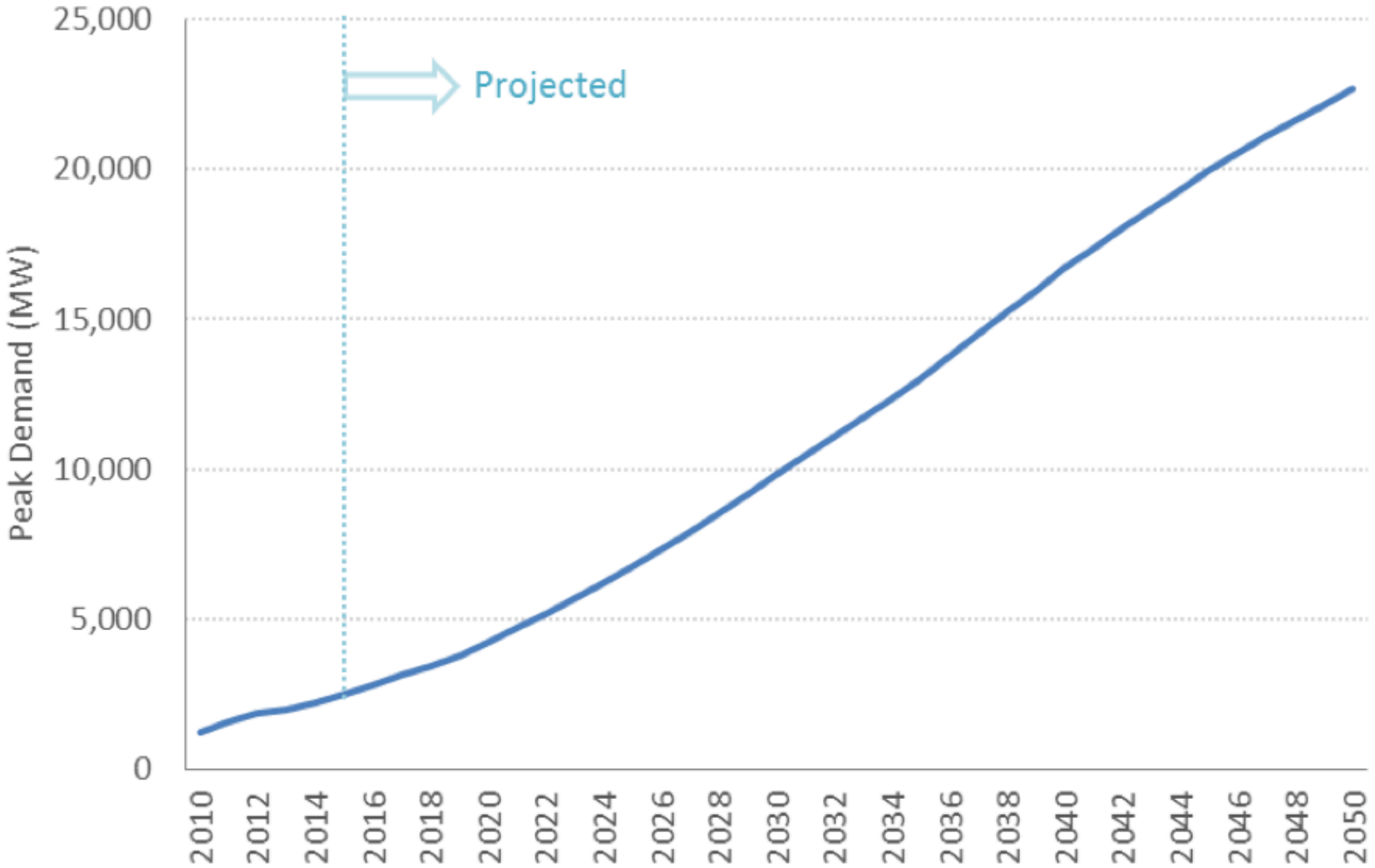

Figure 45 Myanmar Projected Electricity Demand (SES, MW)

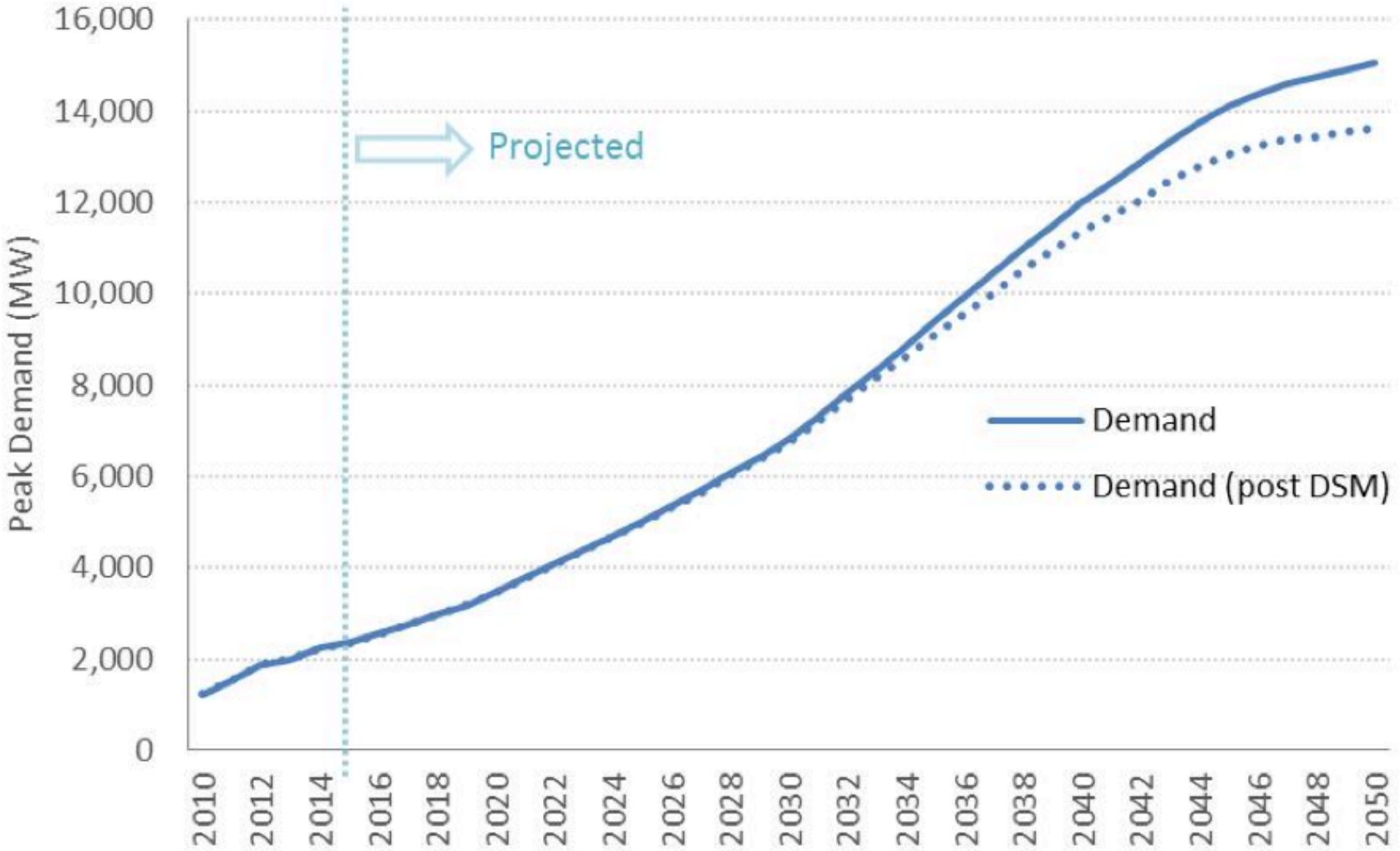

Figure 59 Myanmar Projected Electricity Demand (ASES, MW)

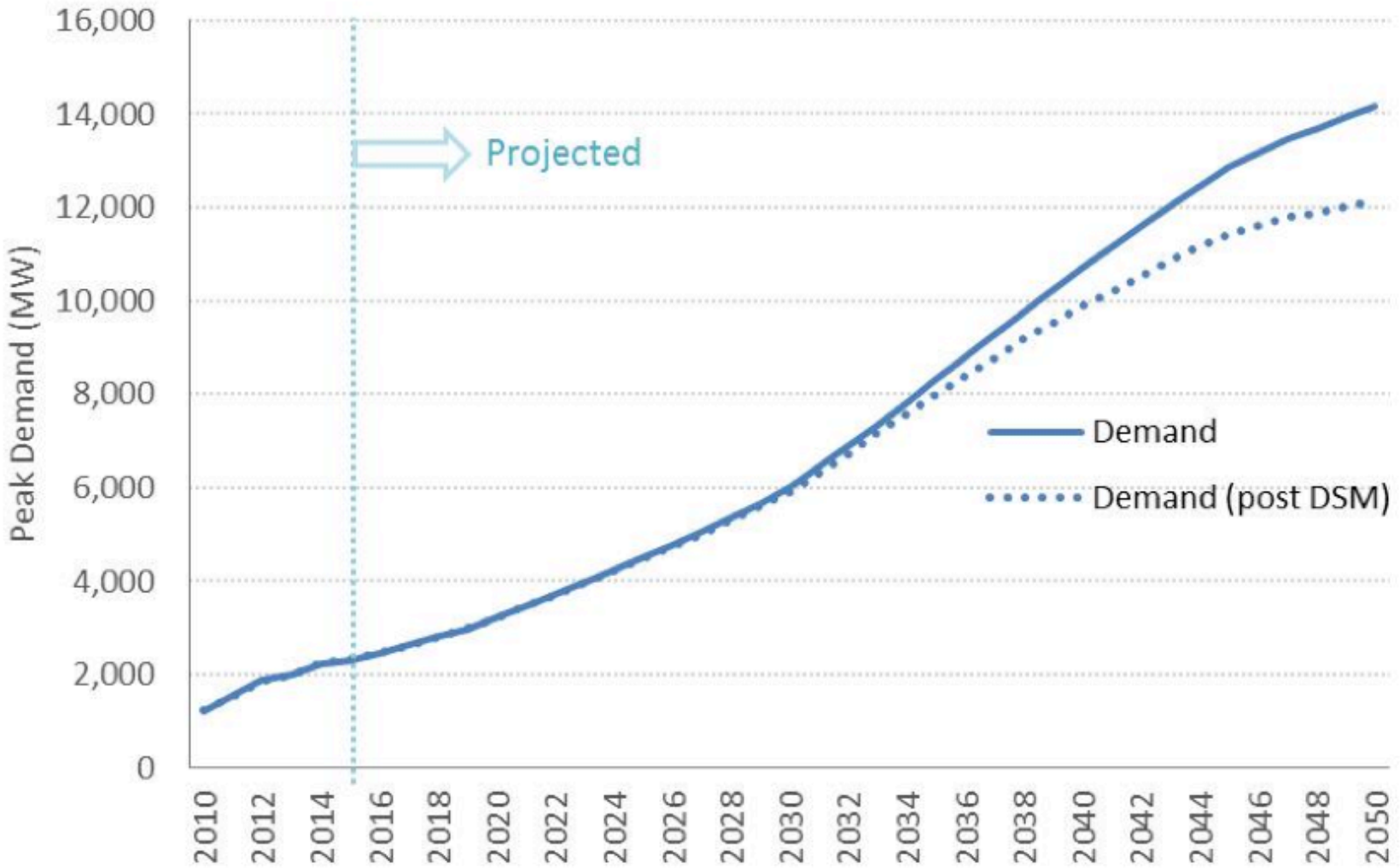

Figure 37 Myanmar Imports and Exports (BAU)

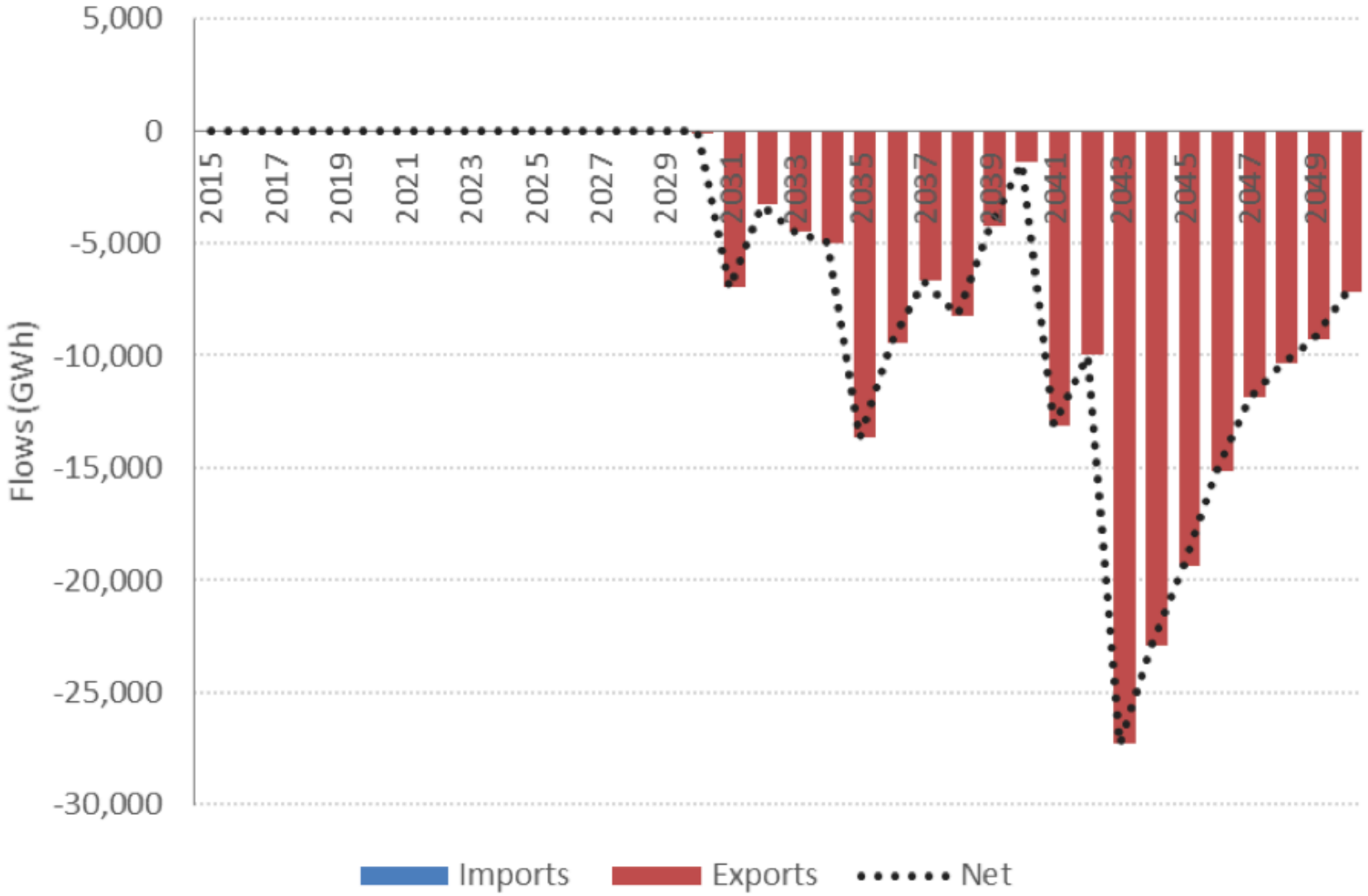

Figure 50 Myanmar Imports and Exports (SES)

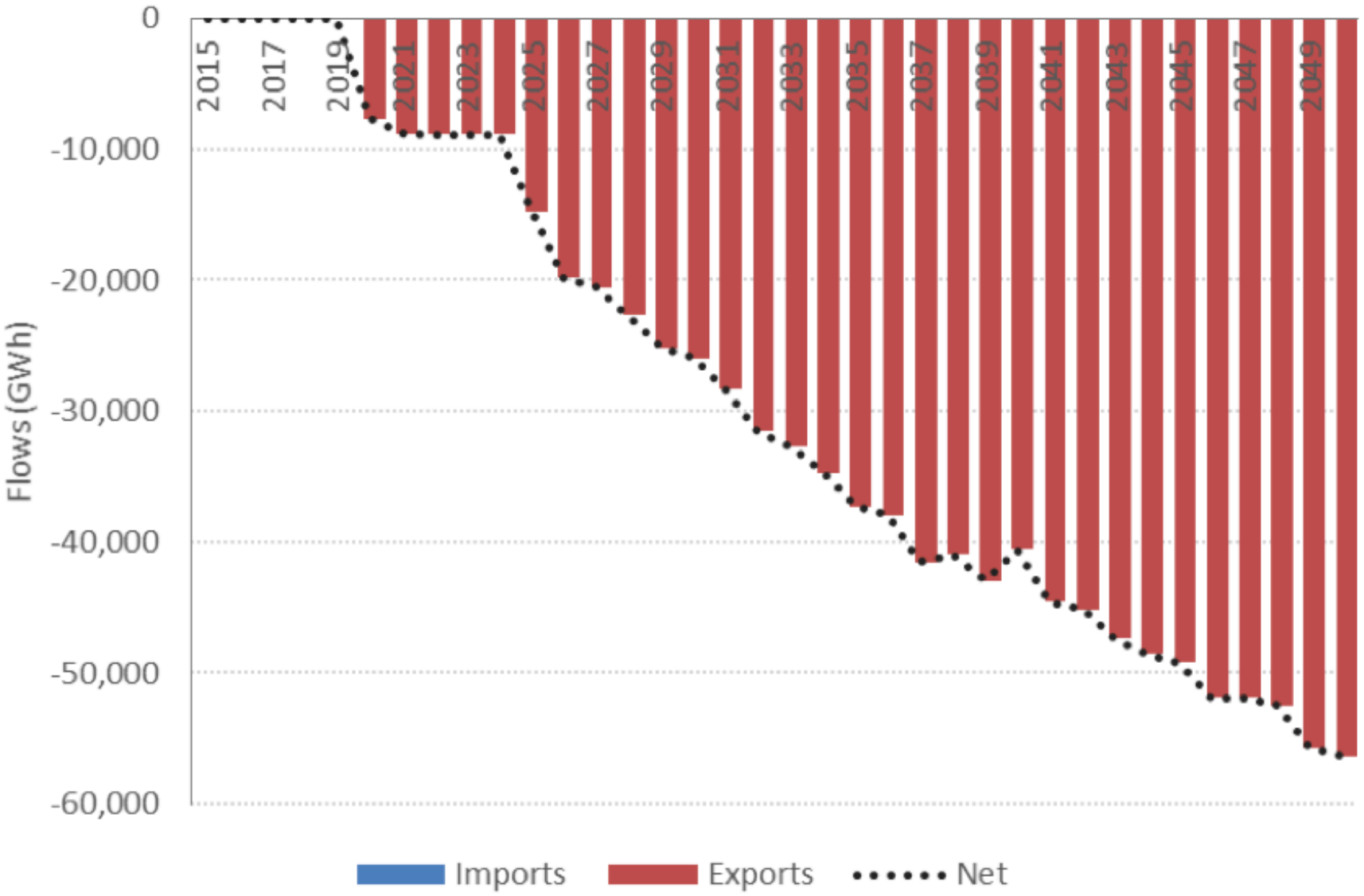

Figure 64 Myanmar Imports and Exports (ASES)

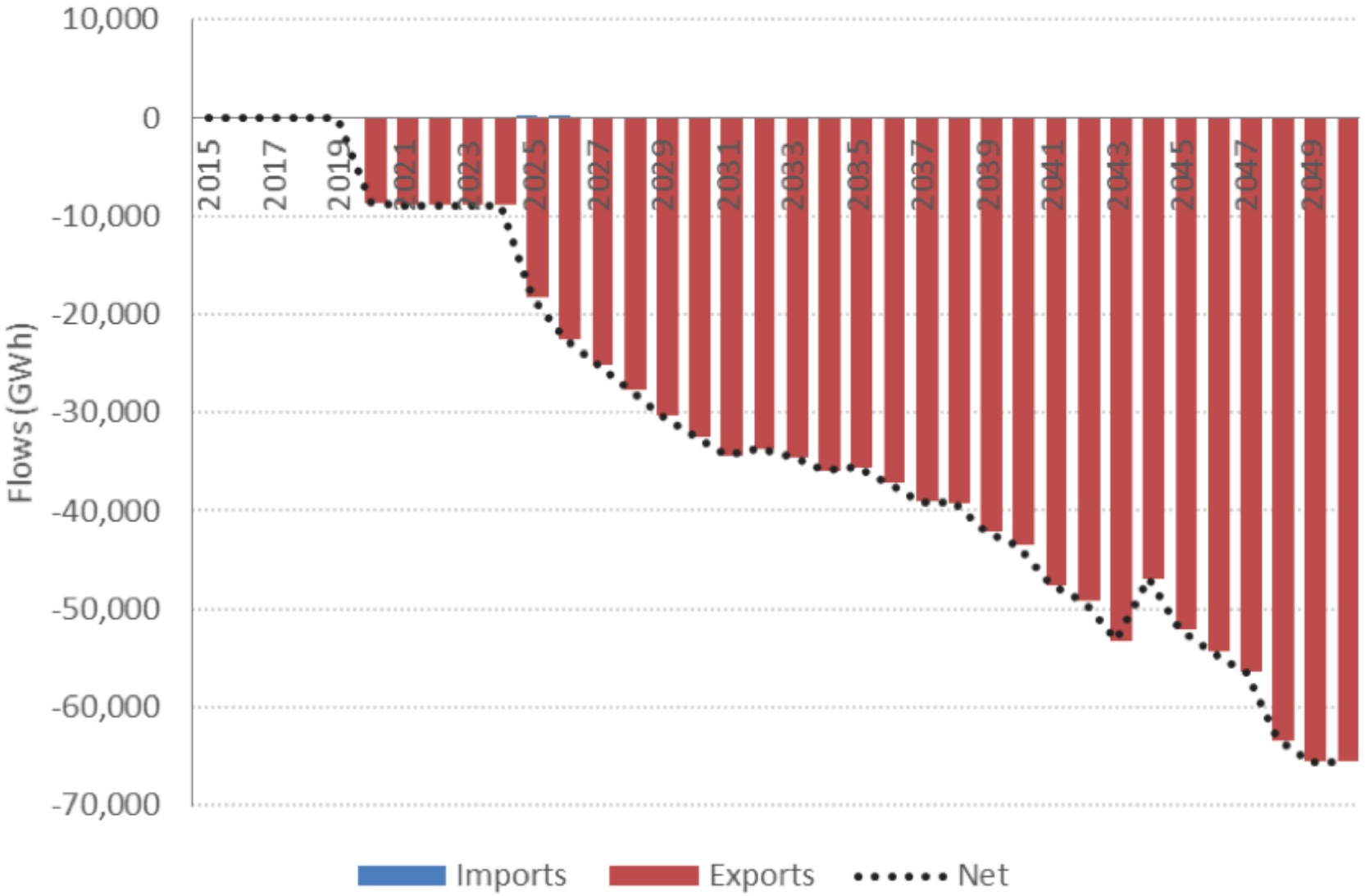

Figure 87 Myanmar Imports and Exports (GWh)

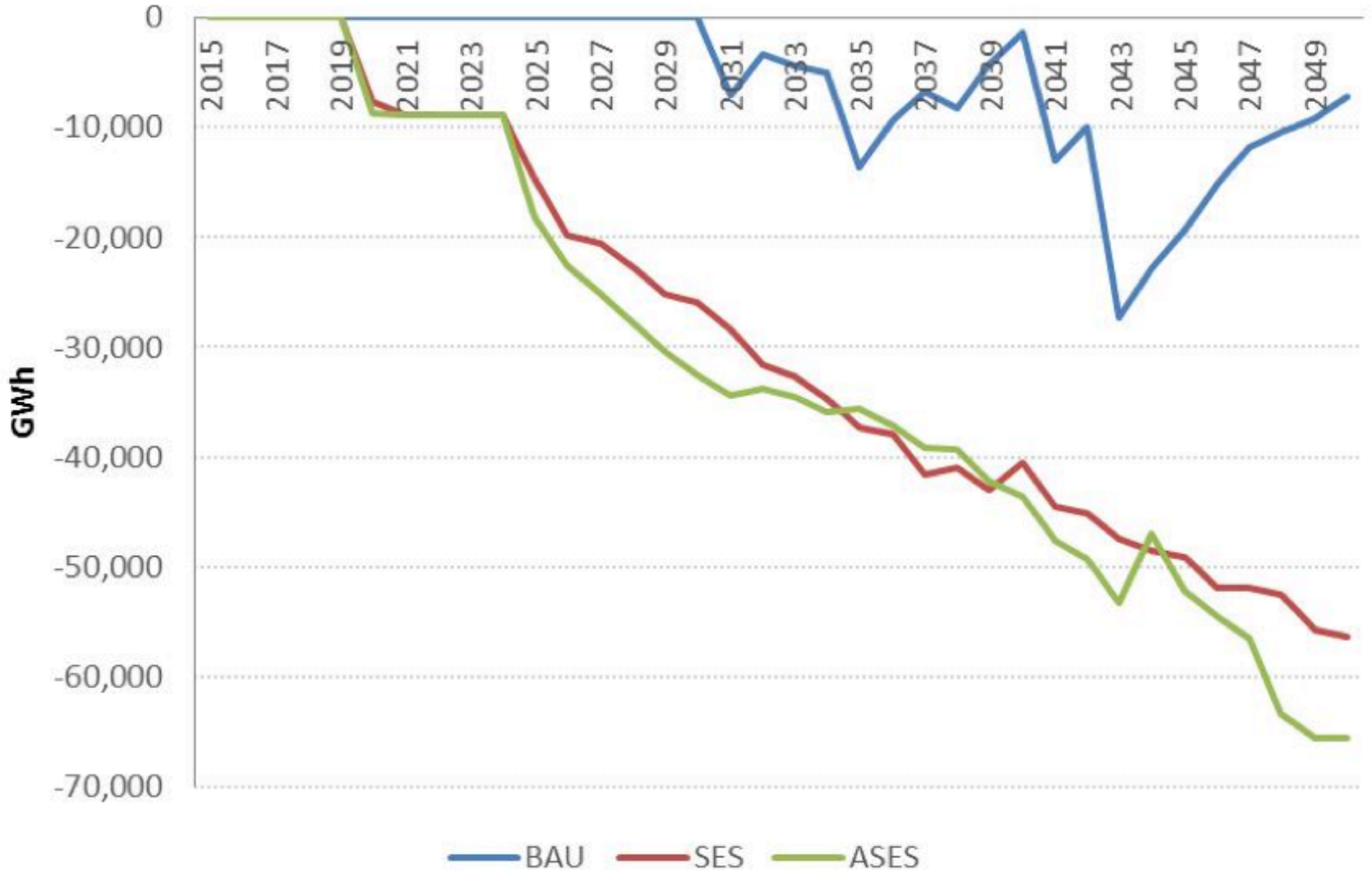

Figure 29 Regional Transmission System Model of GMS

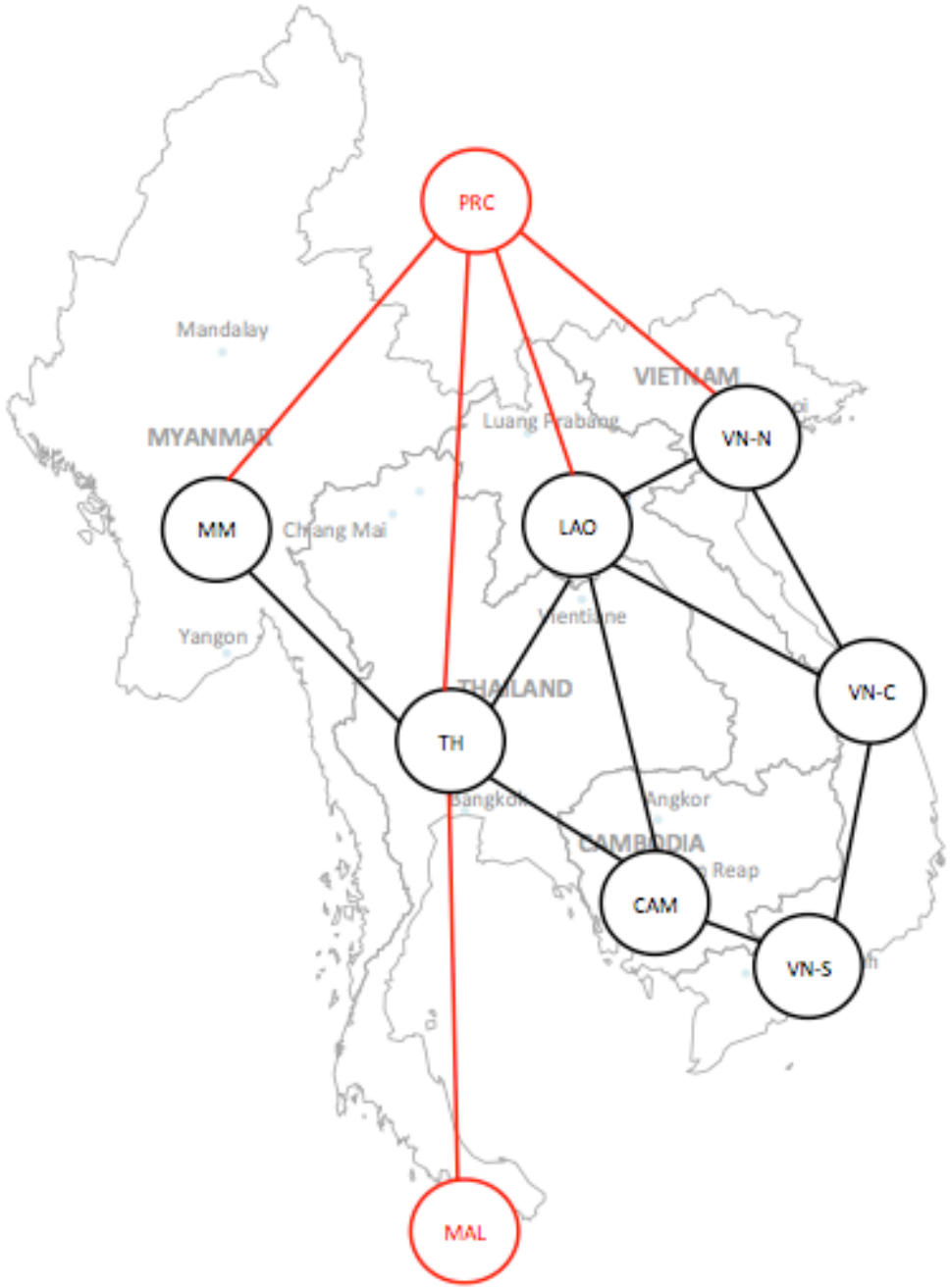

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Figure 33 Myanmar Installed Capacity (BAU, MW)

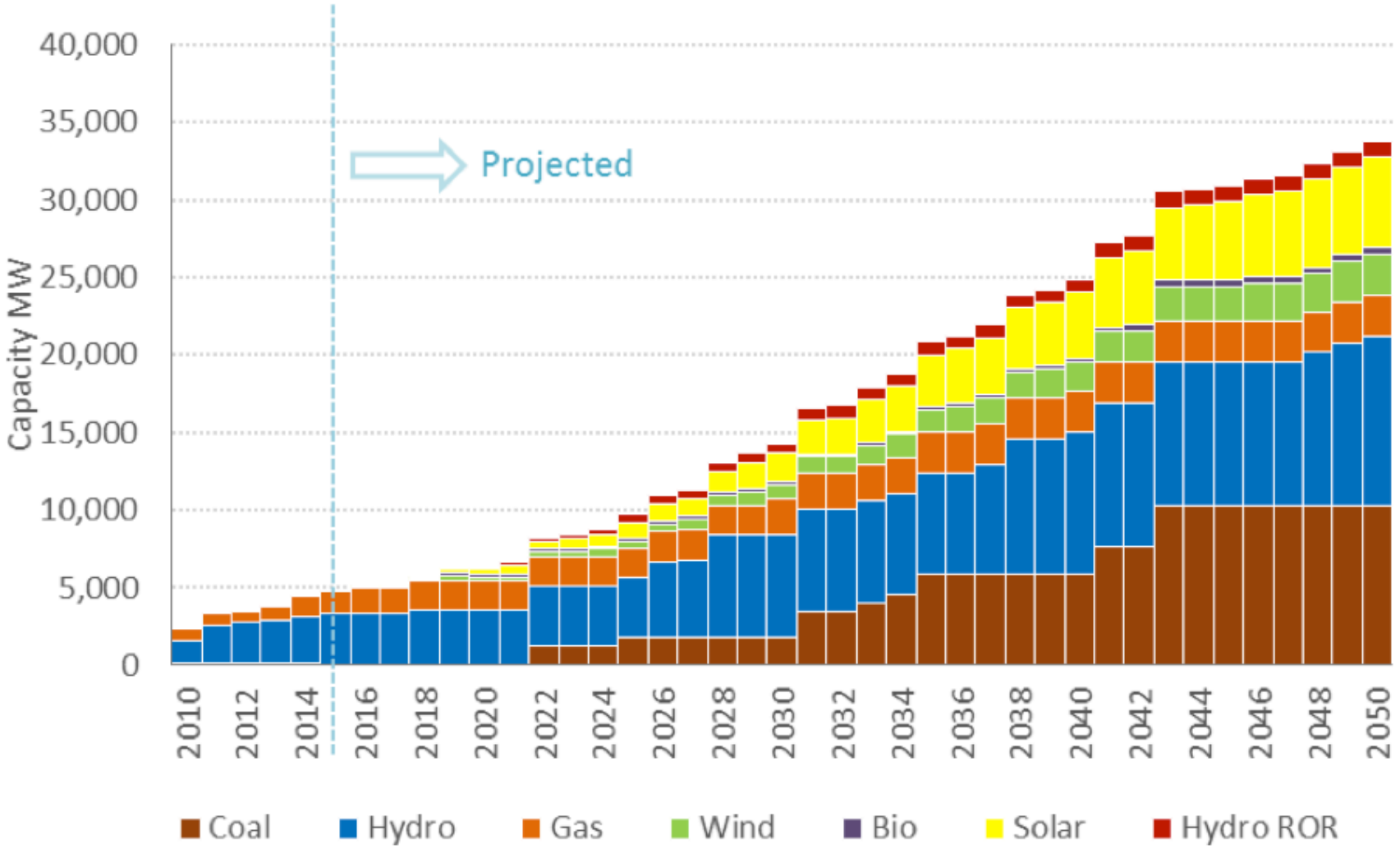

Figure 46 Myanmar Installed Capacity by Type (SES, MW)

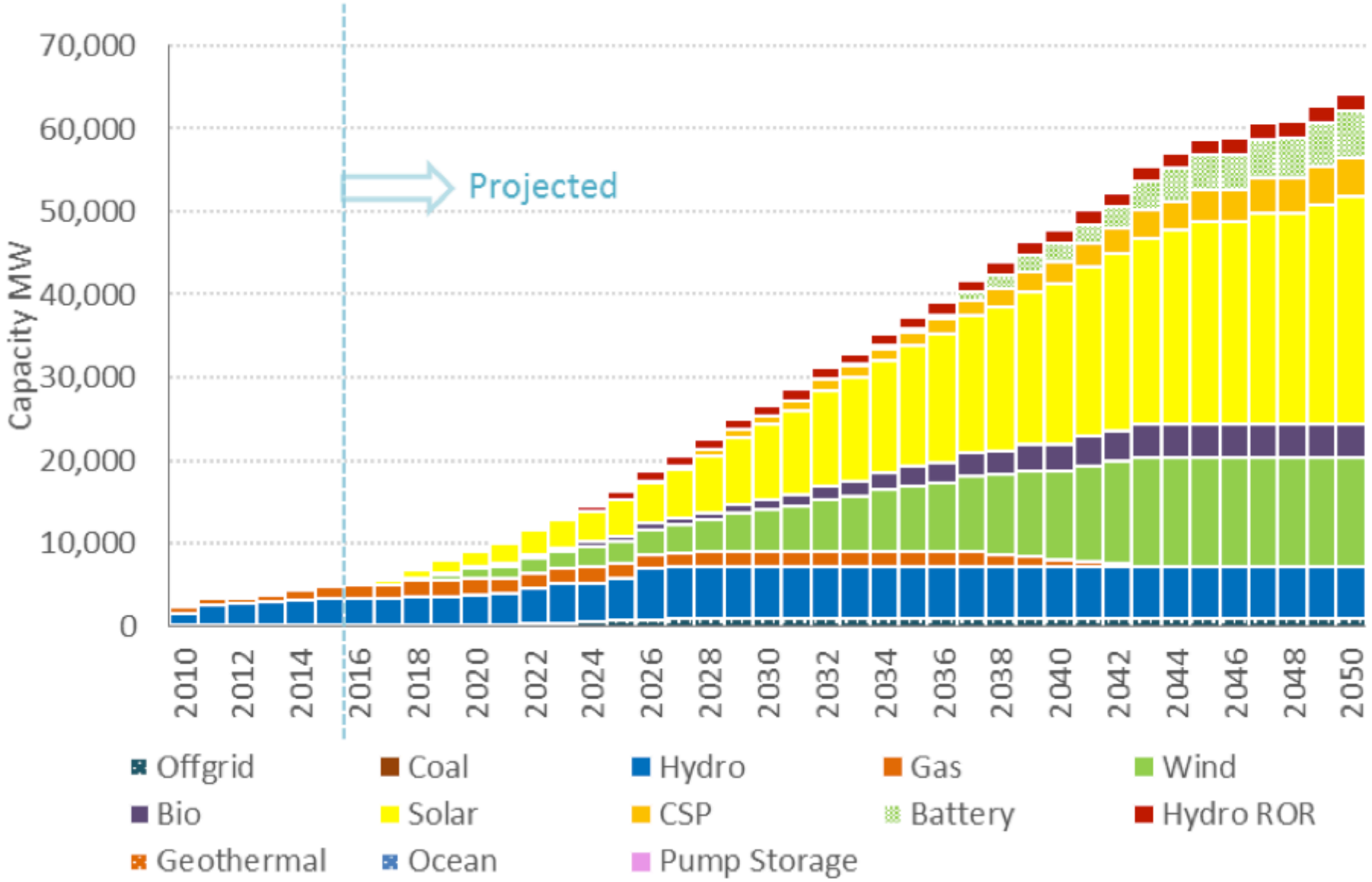

Figure 60 Myanmar Installed Capacity by Type (ASES, MW)

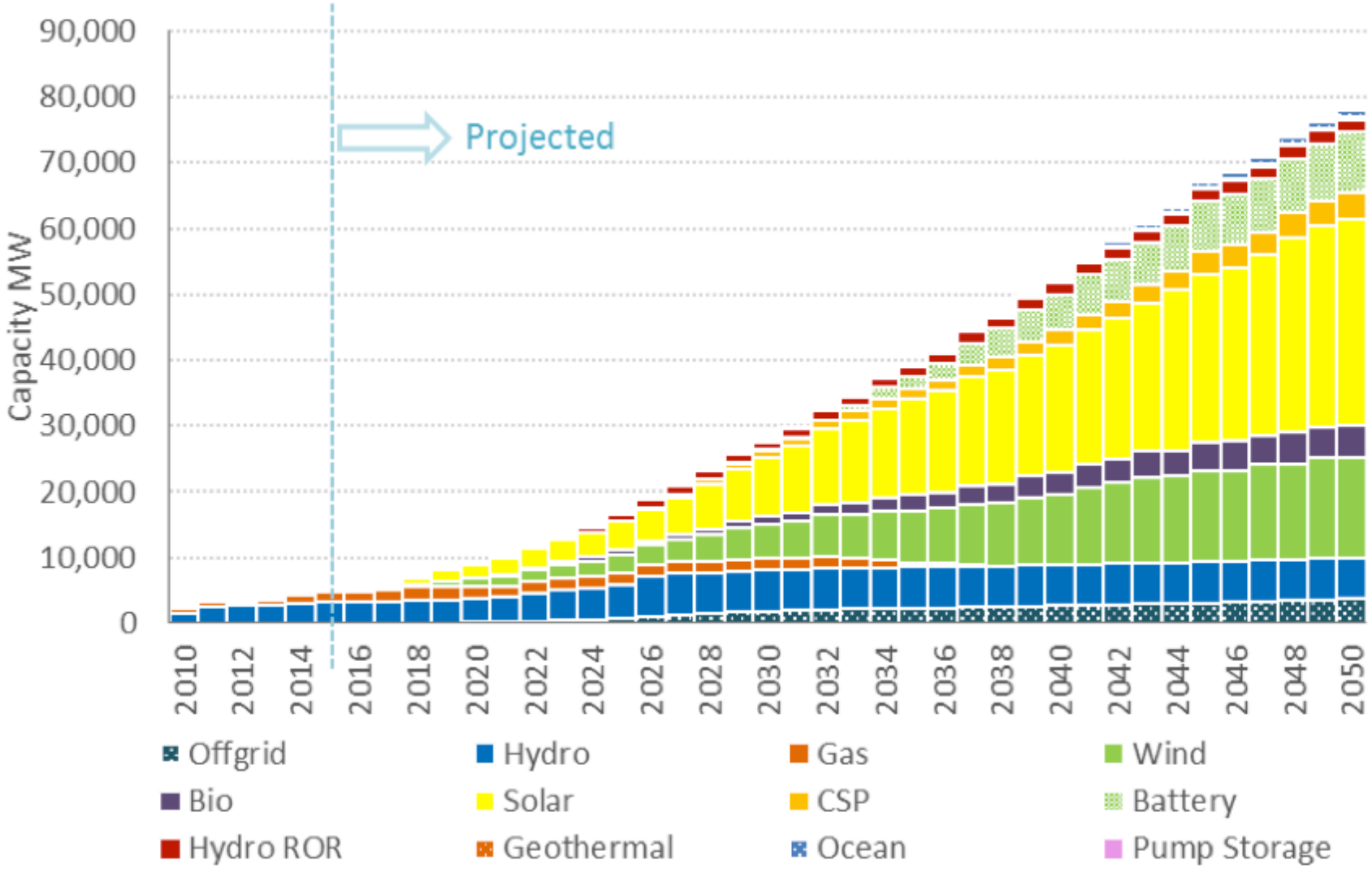

Figure 34 Myanmar Installed Capacity Mix Percentages (BAU, %)

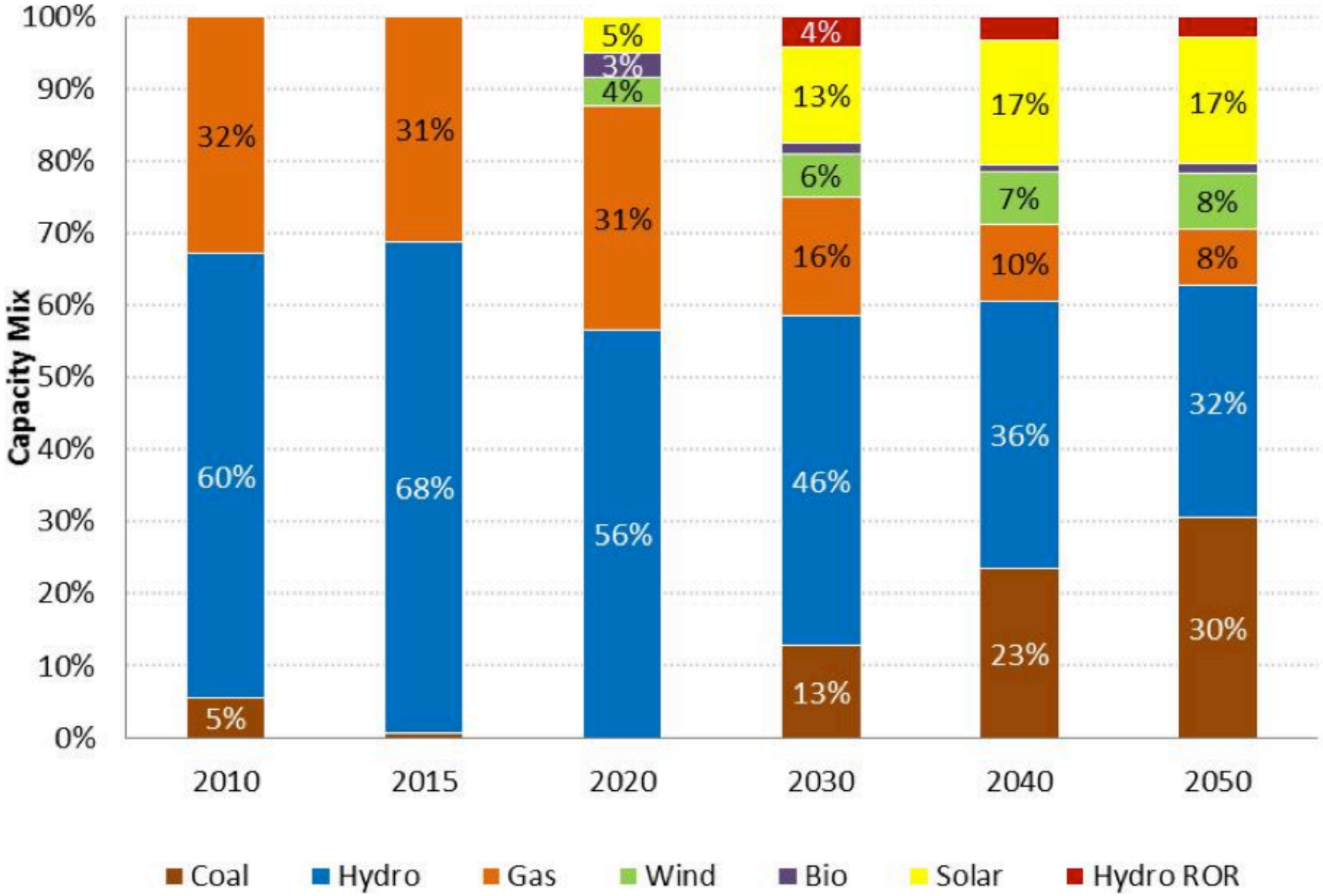

Figure 47 Myanmar Capacity Shares (SES, %)

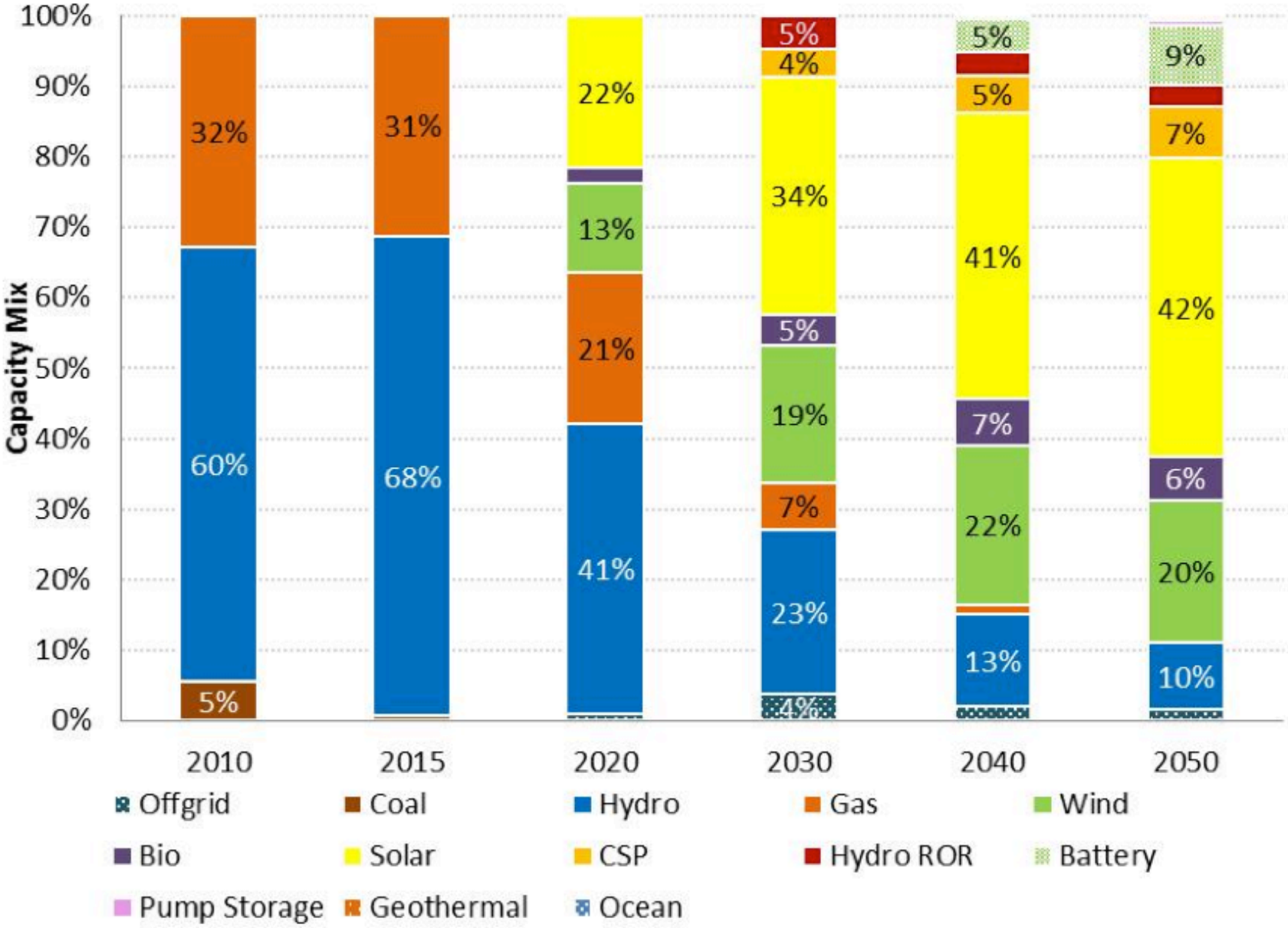

Figure 61 Myanmar Capacity Shares (ASES, %)

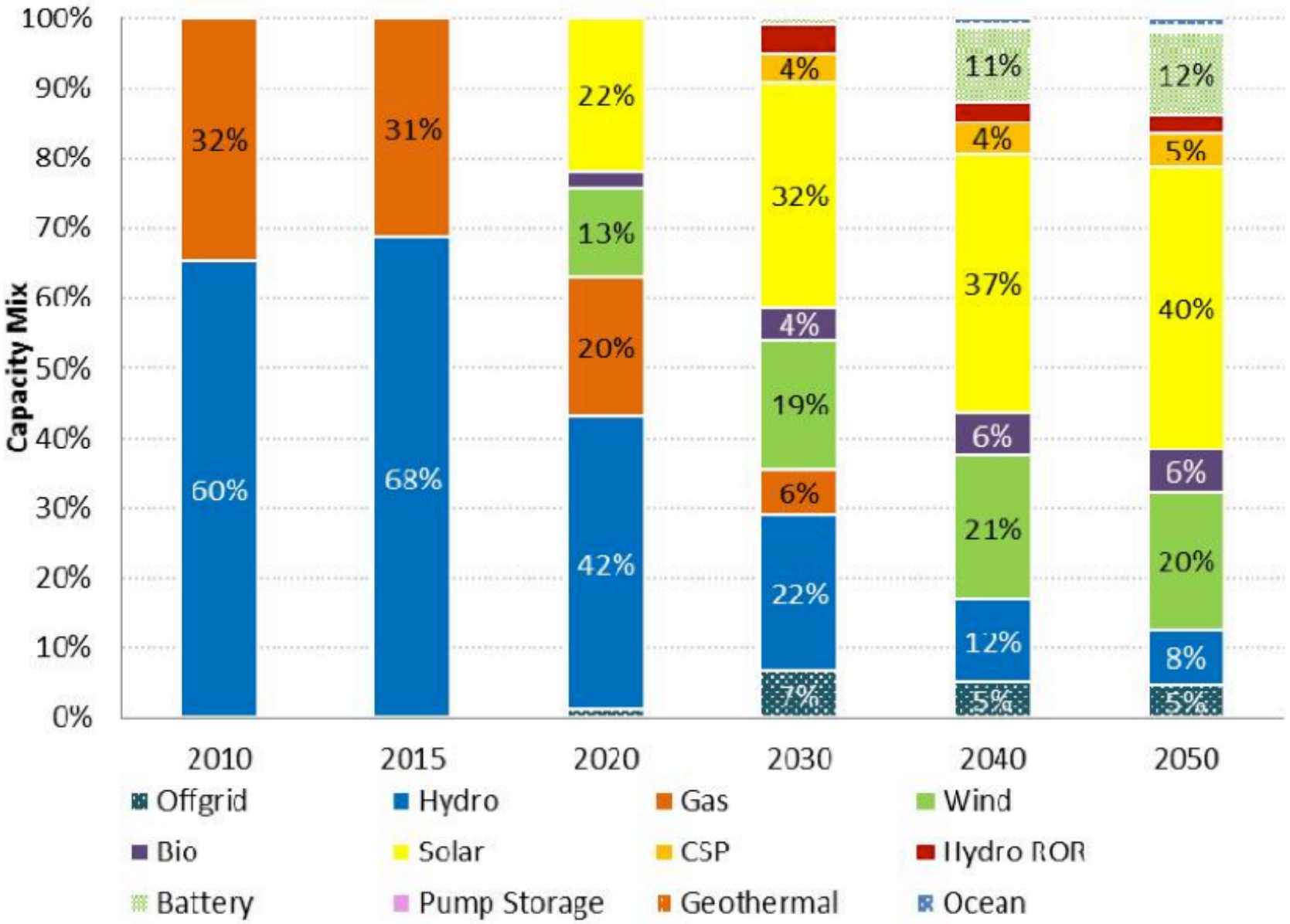

Figure 35 Myanmar Generation Mix (BAU, GWh)

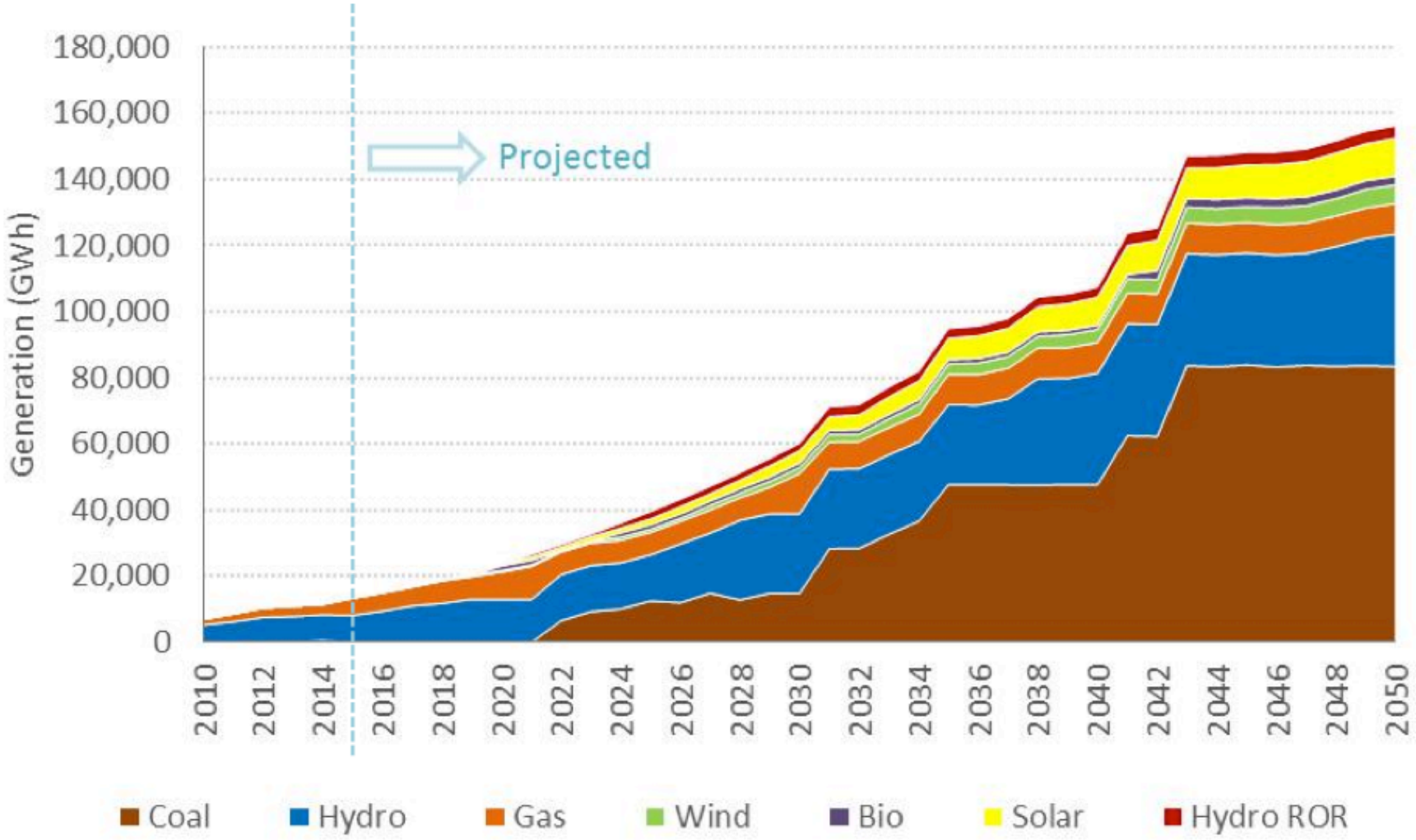

Figure 48 Myanmar Generation Mix (SES, GWh)

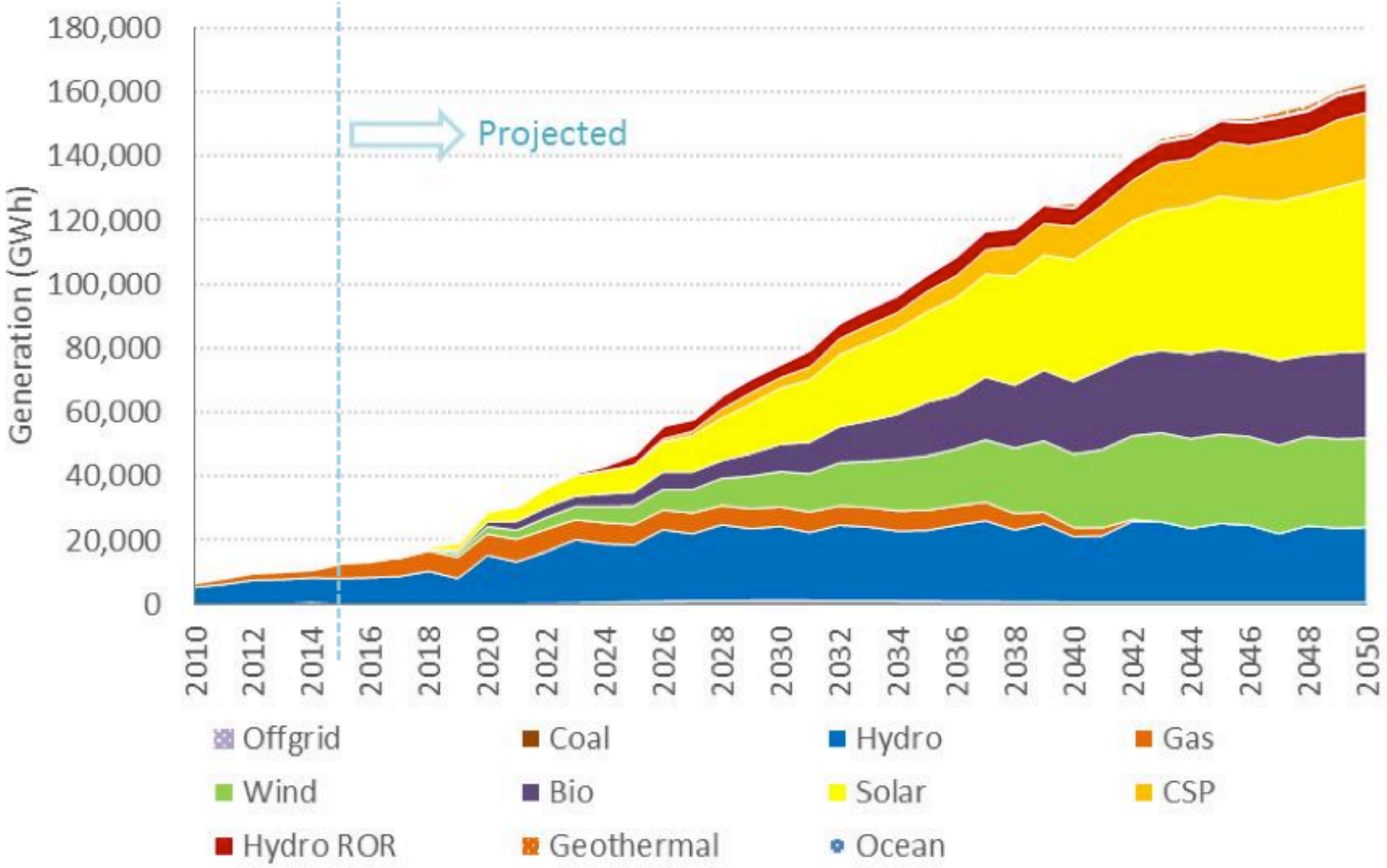

Figure 62 Myanmar Generation Mix (ASES, GWh)

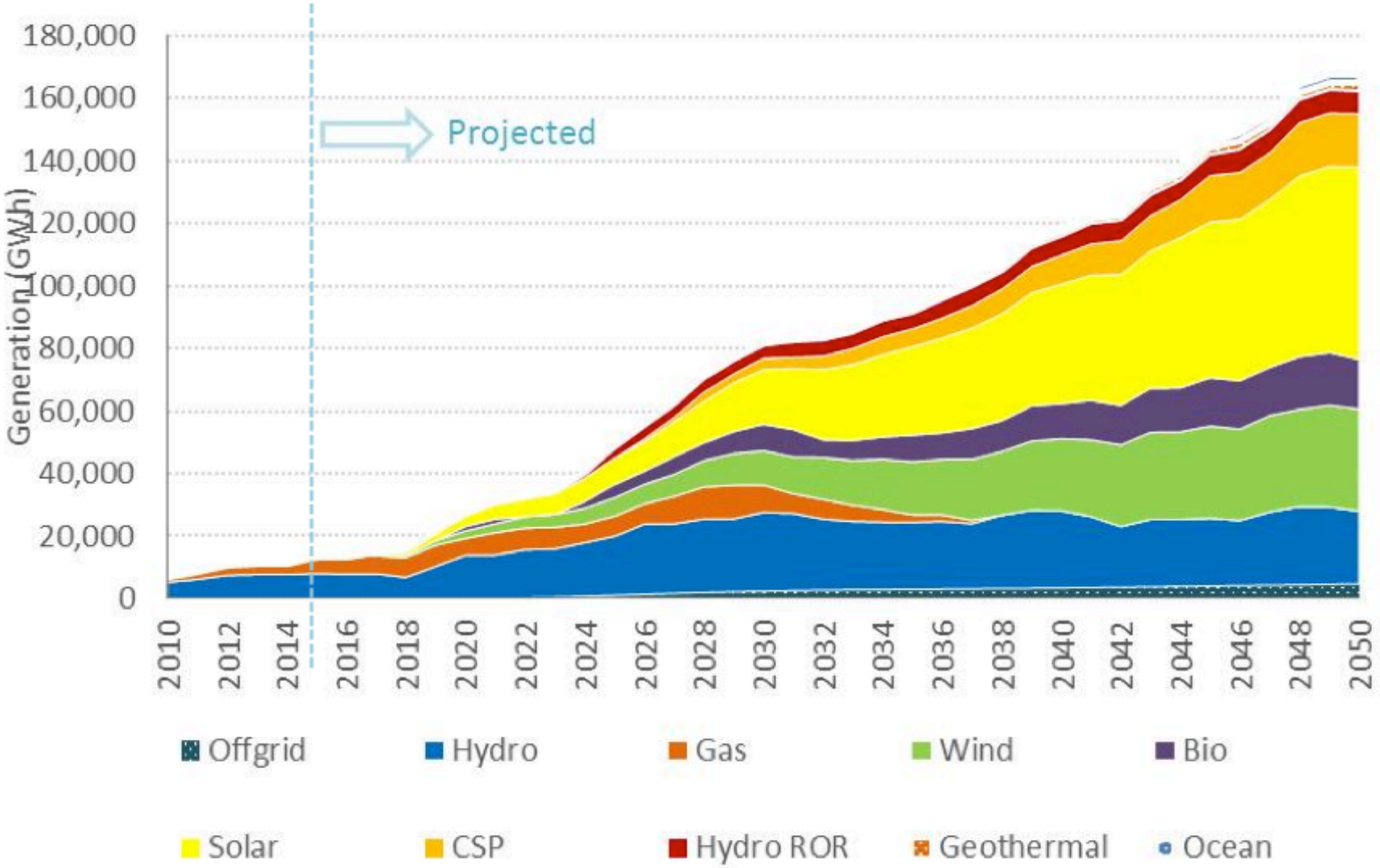

Figure 38 Myanmar Installed Capacity by Generation Type (BAU, MW)

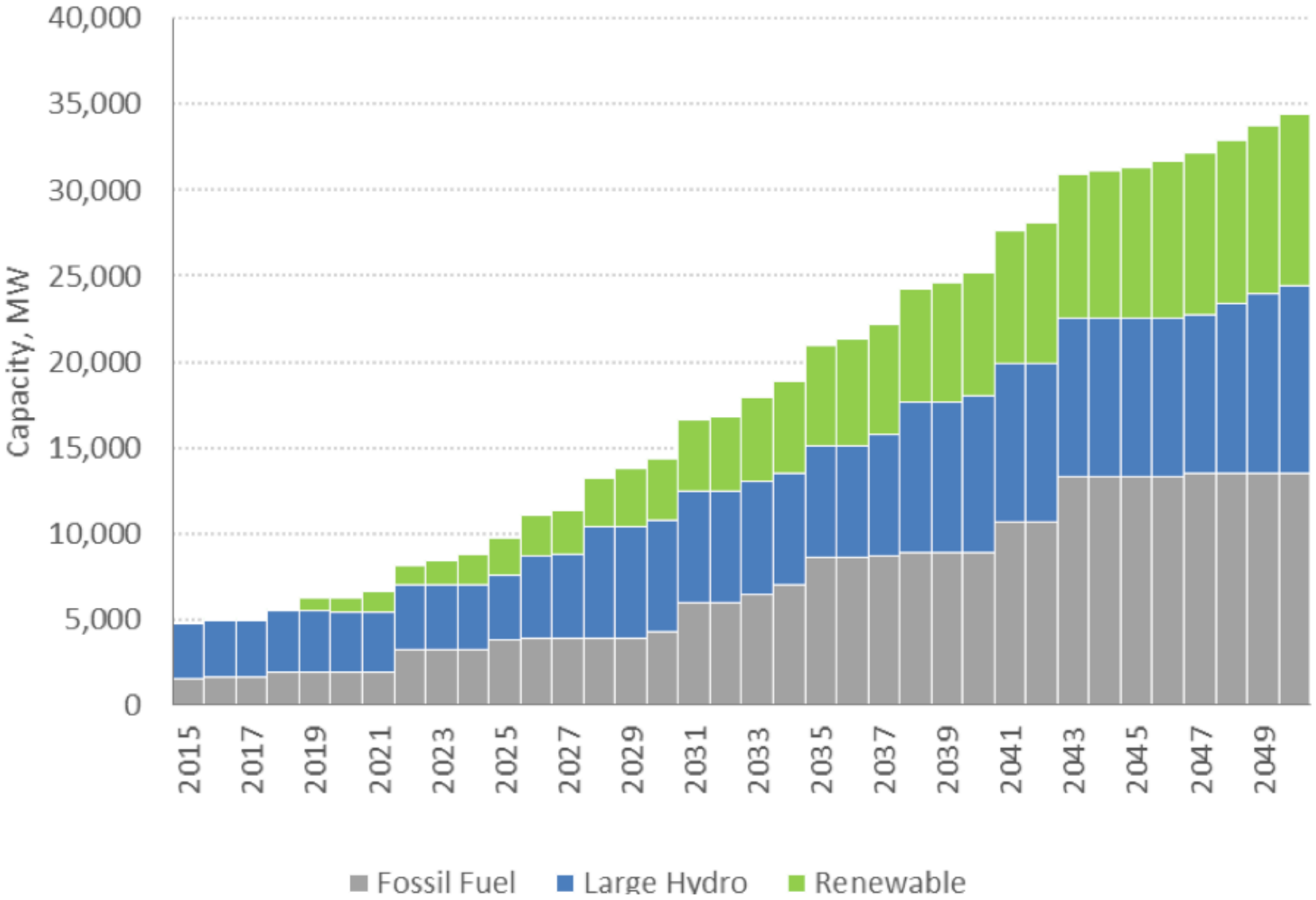

Figure 51 Myanmar Installed Capacity by Generation Type (SES, MW)

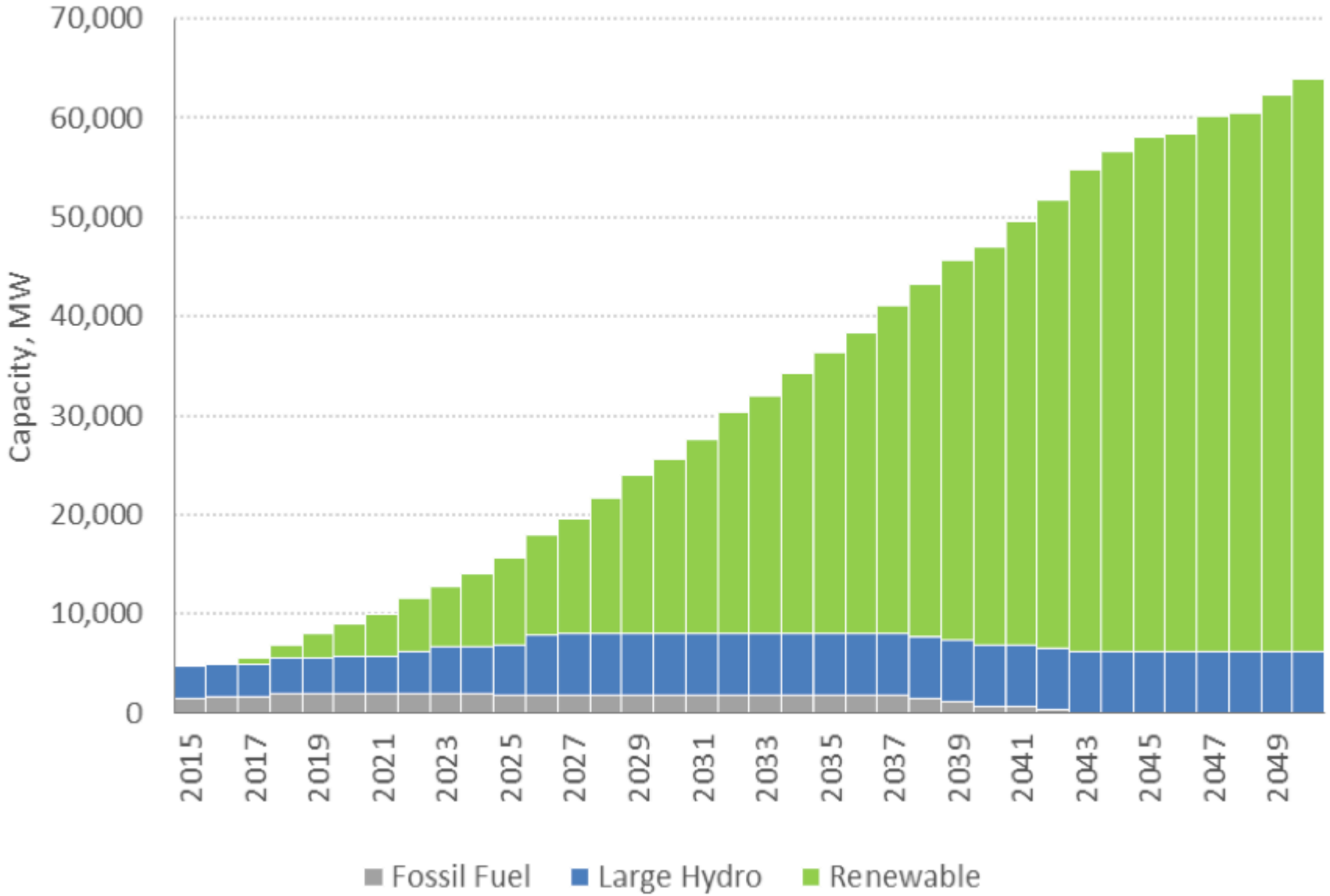

Figure 65 Myanmar Installed Capacity by Type (ASES, MW)

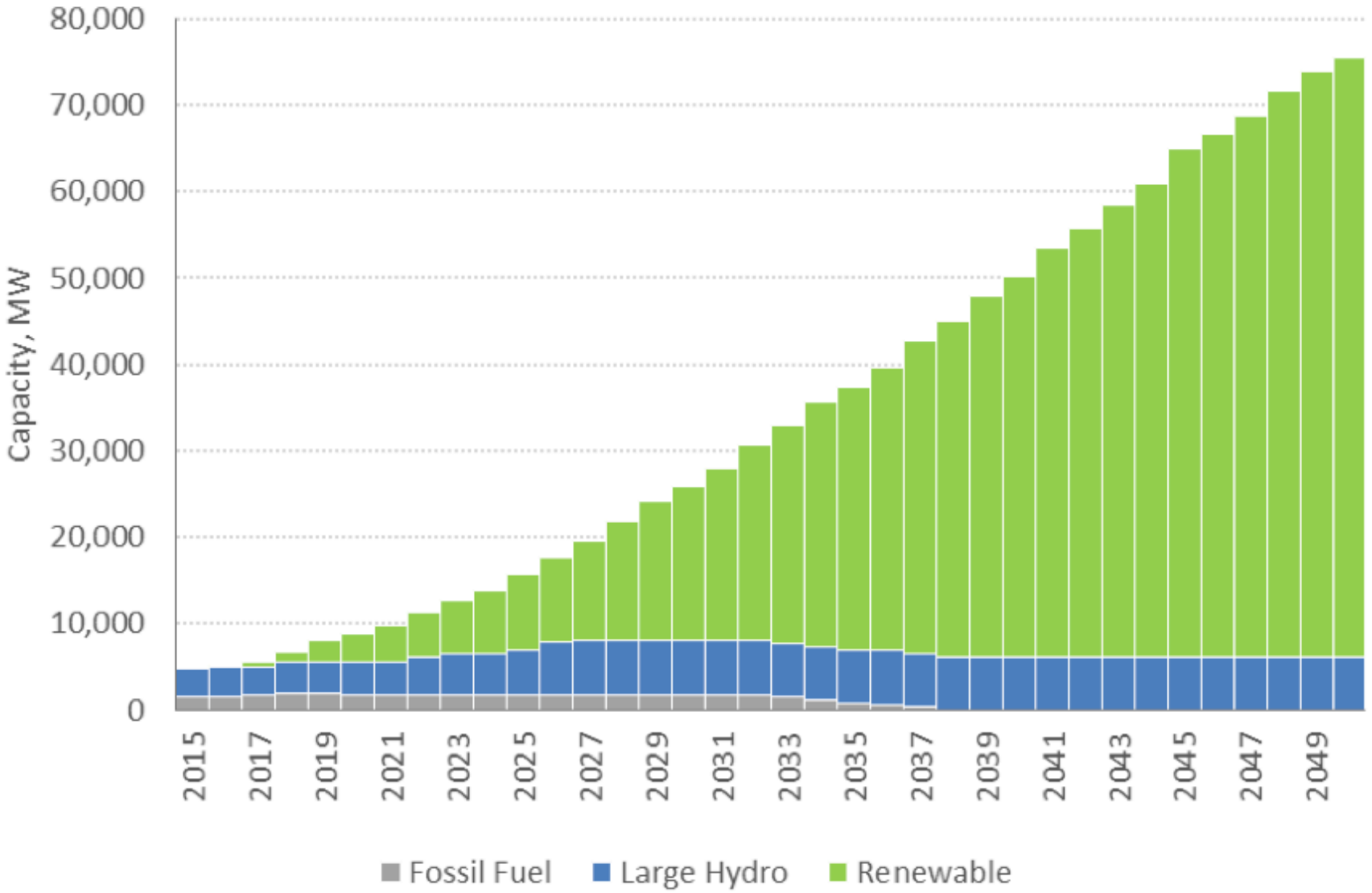

Figure 83 Myanmar Security of Supply Measure: Energy Reserve

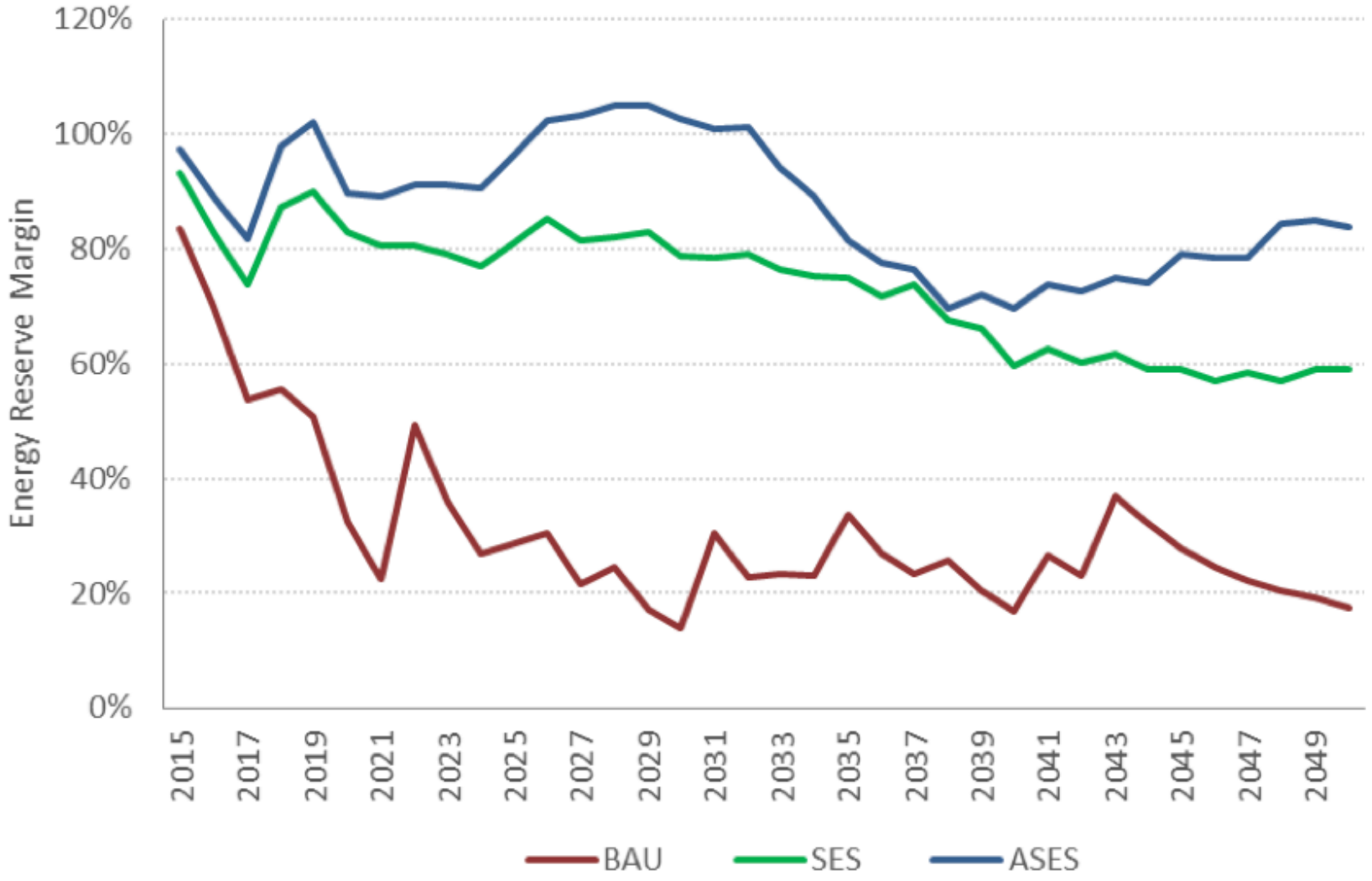

Figure 84 **Myanmar Security of Supply Measure: Percentage of Electricity Generated by Domestic Resources**

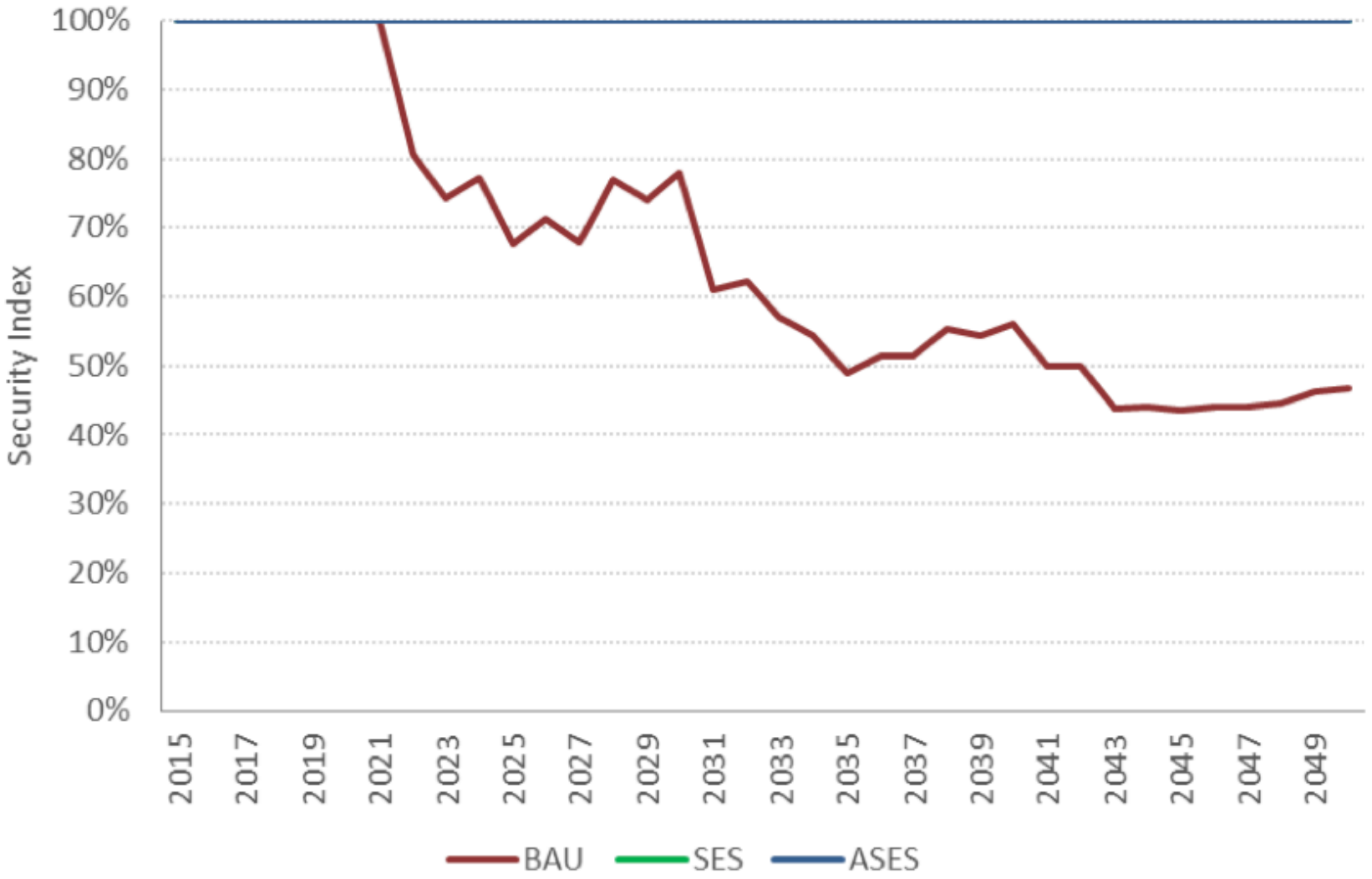

Figure 78 Myanmar Renewable Generation Mix Comparison

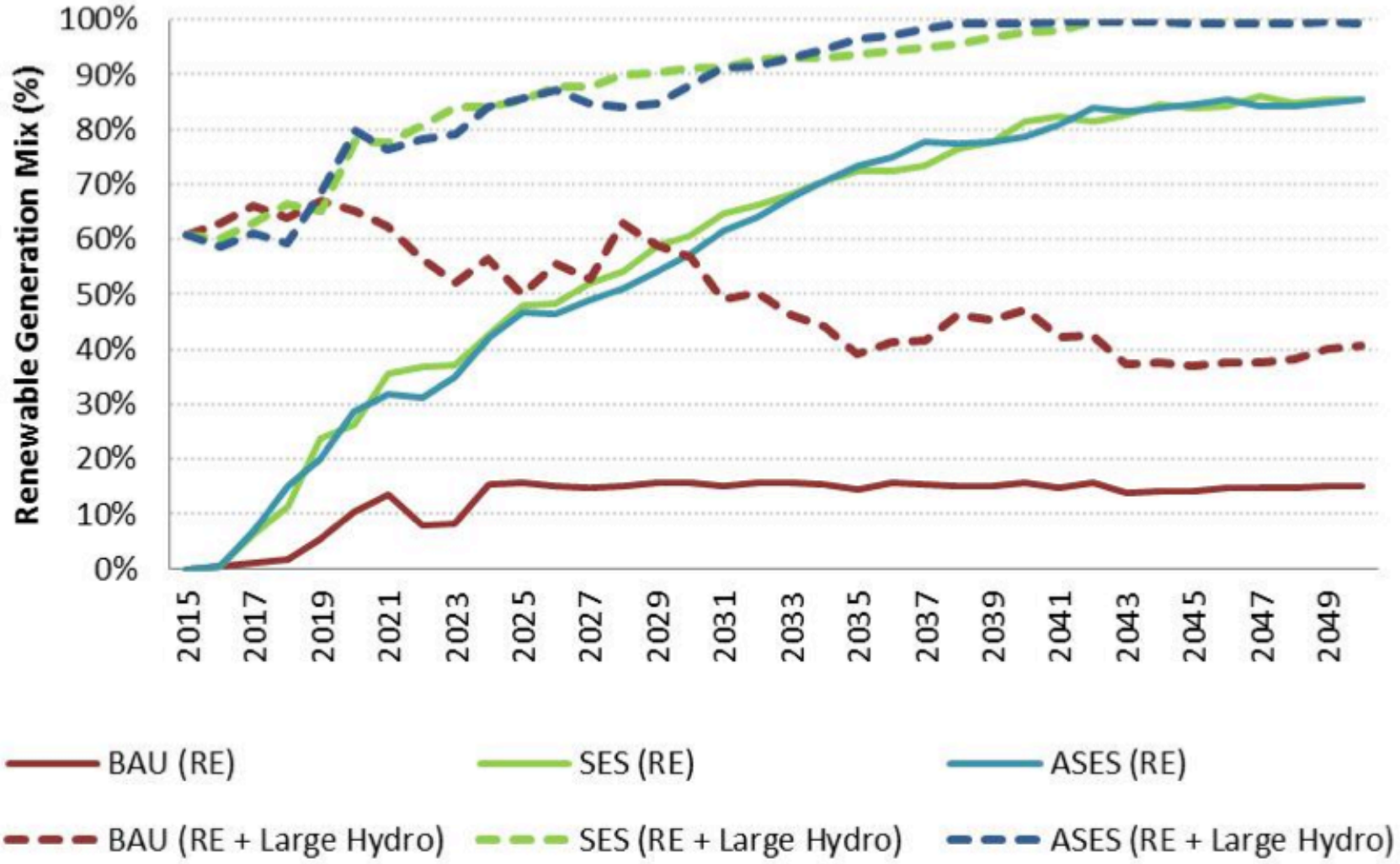

Figure 75 Myanmar Electricity Access Rate Comparison

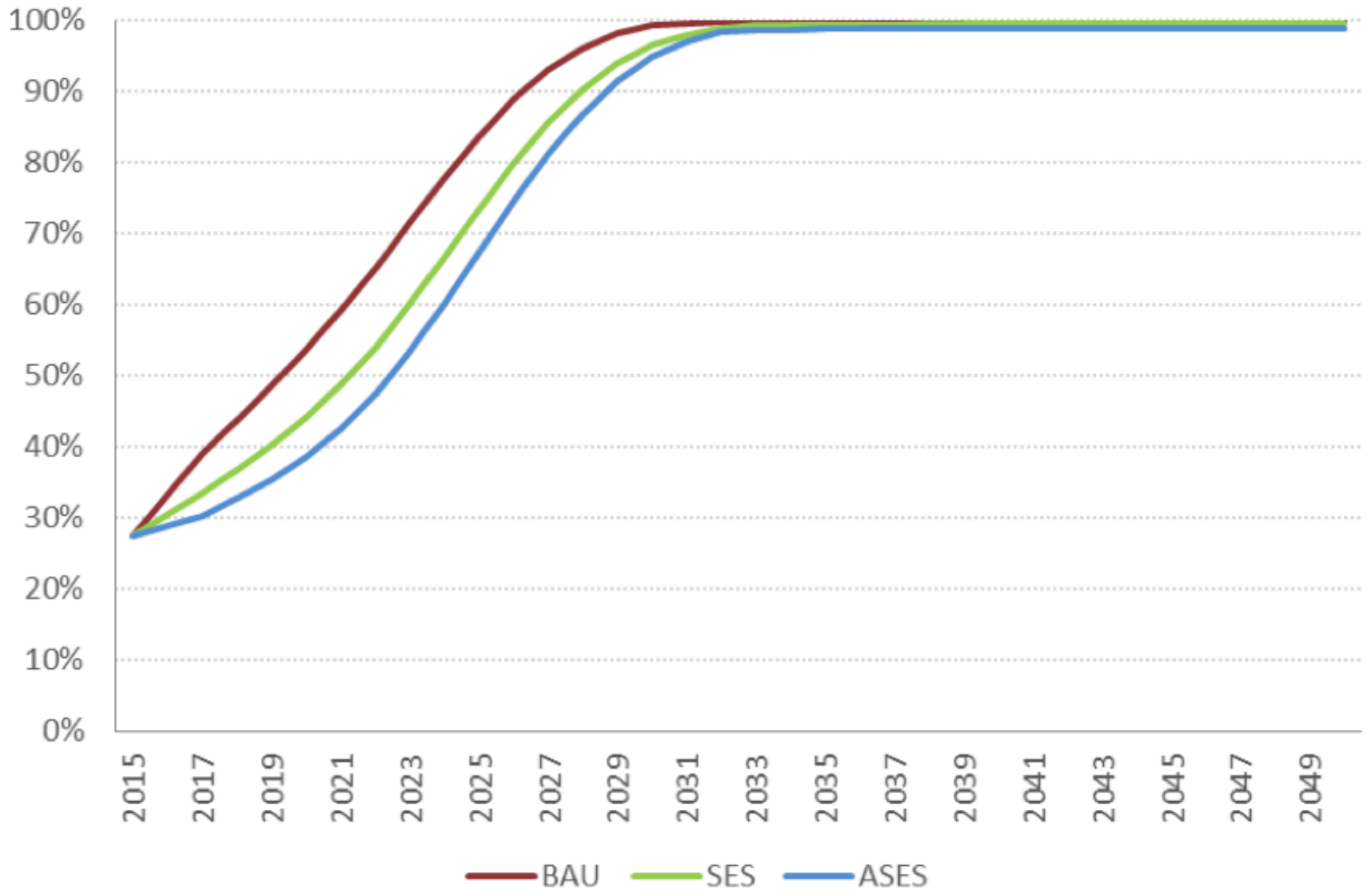

Figure 80 Myanmar Carbon Emissions Comparison

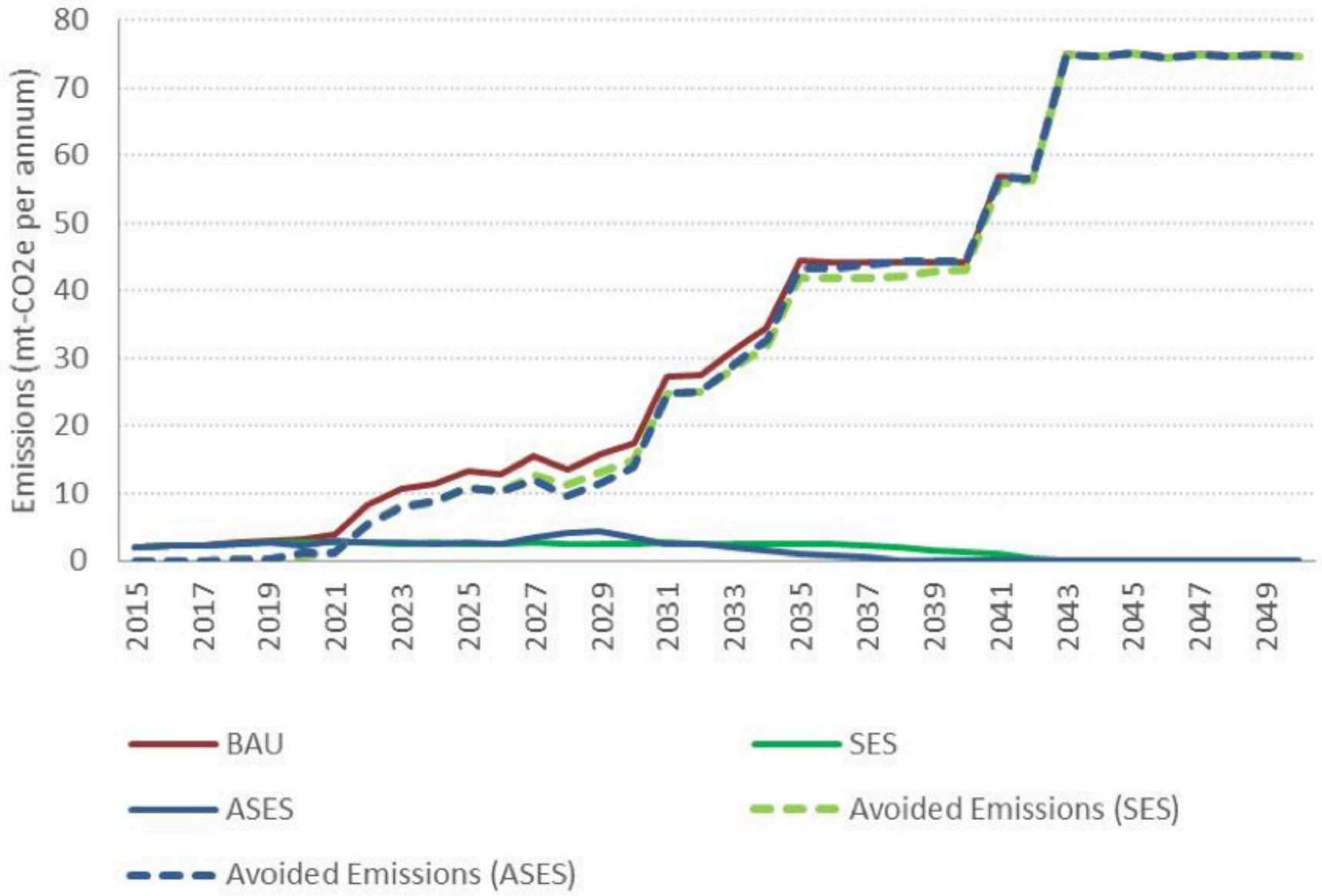

Figure 94 Myanmar Cumulative Investment by Type (BAU, Real 2014 US$)

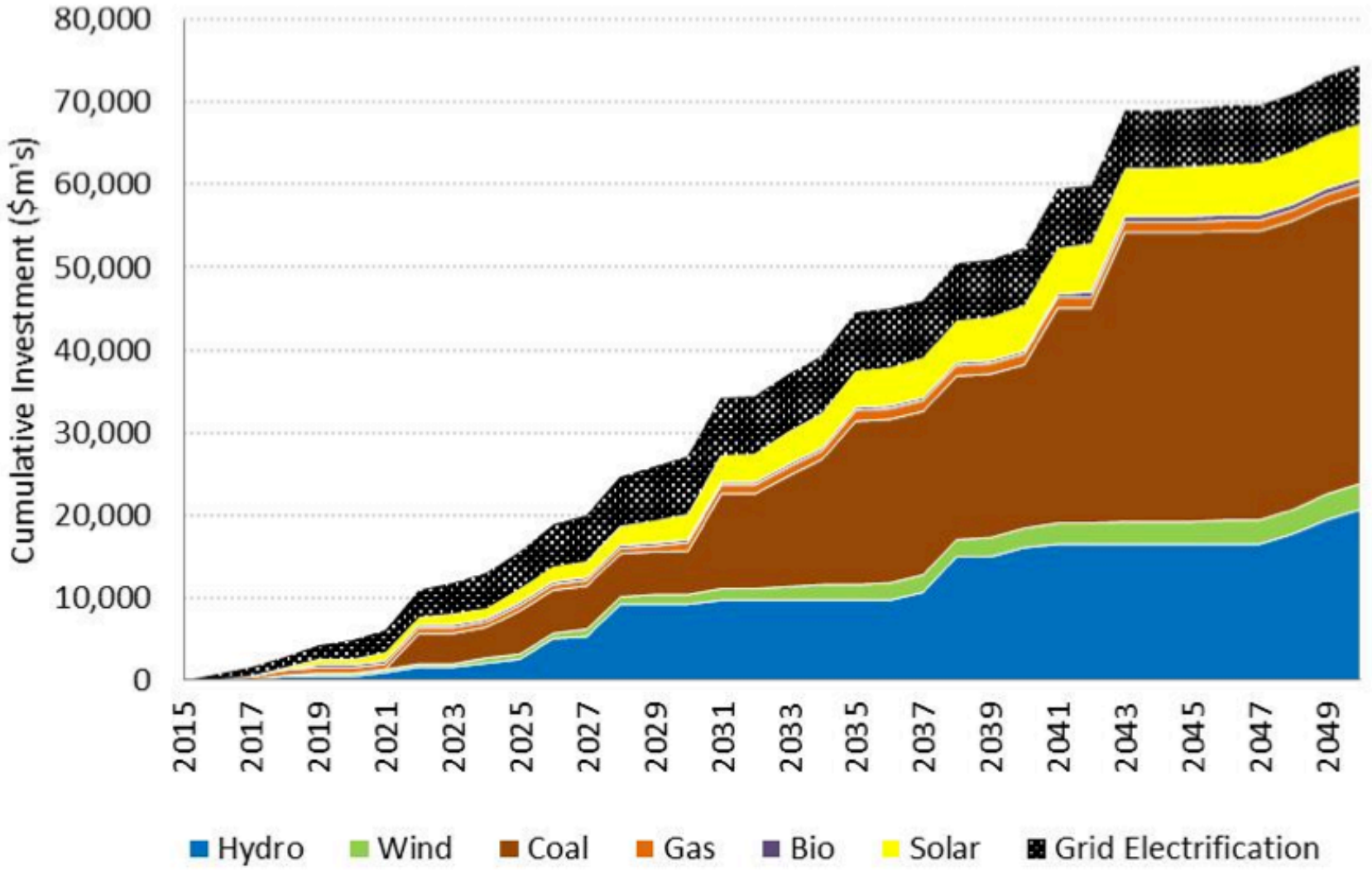

Figure 95 Myanmar Cumulative Investment by Type (SES, Real 2014 US$)

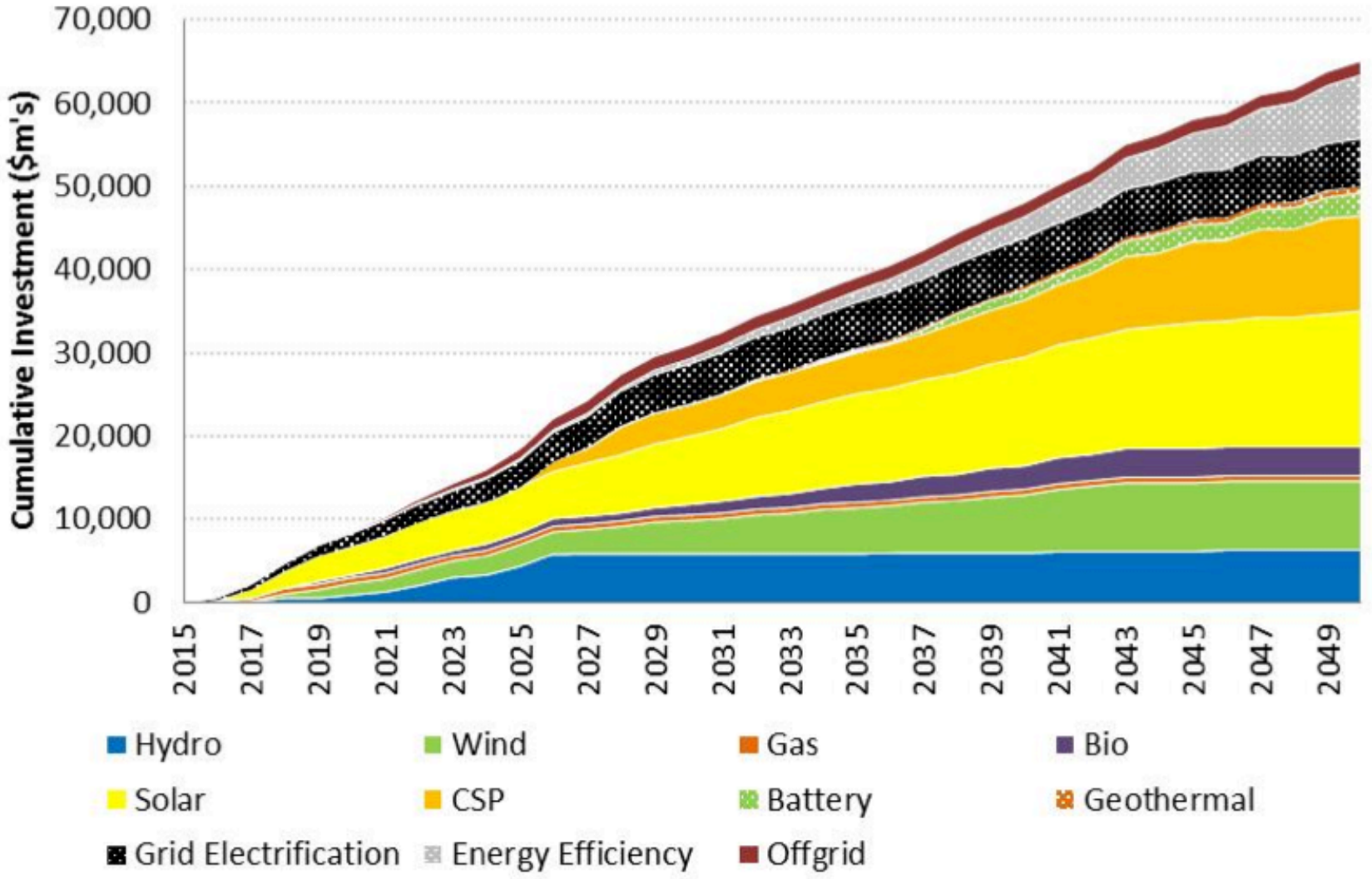

Figure 96 Myanmar Cumulative Investment by Type (ASES, Real 2014 US$)

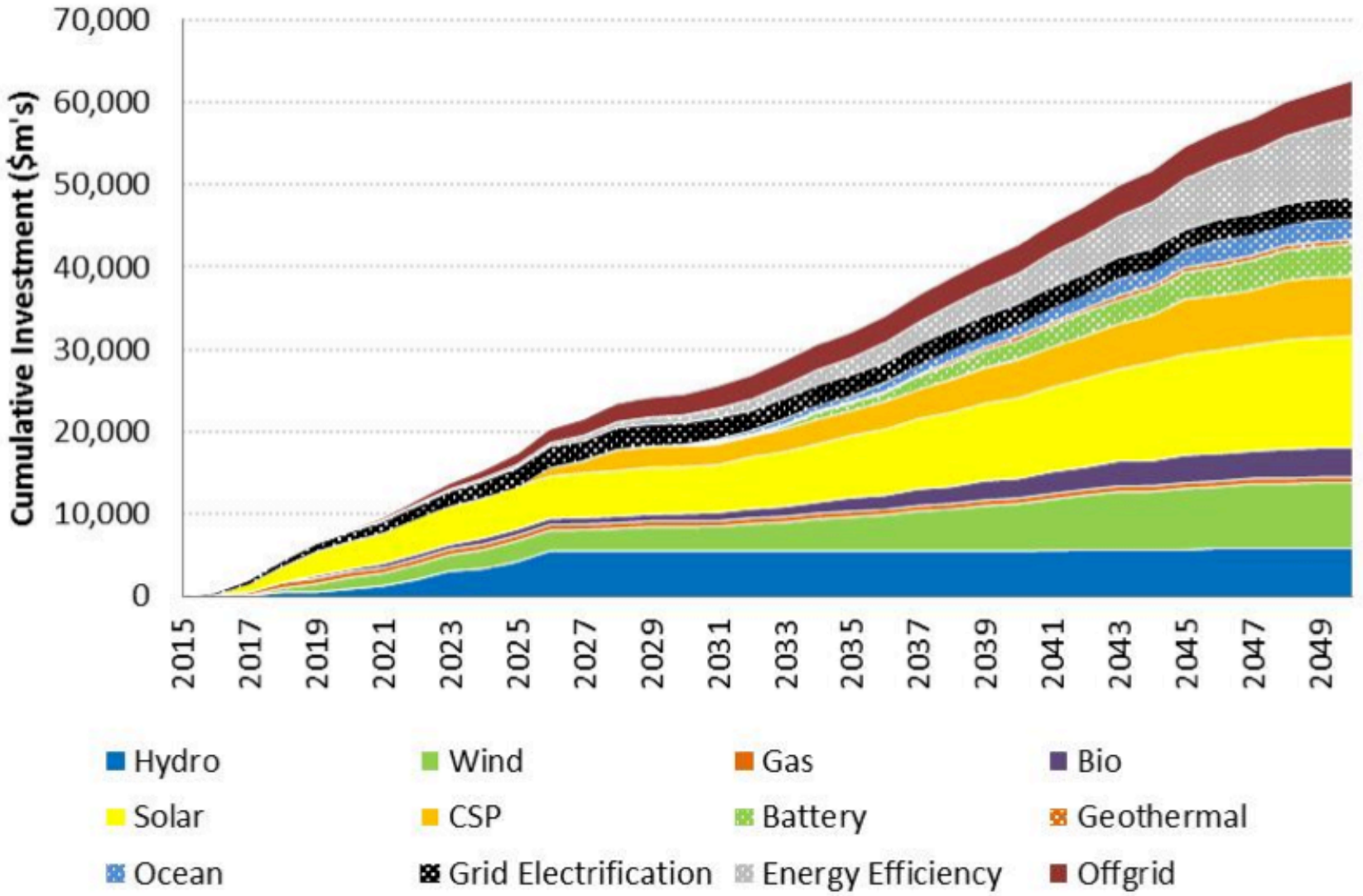

Figure 93 Myanmar Cumulative Investment (Real 2014 US$)

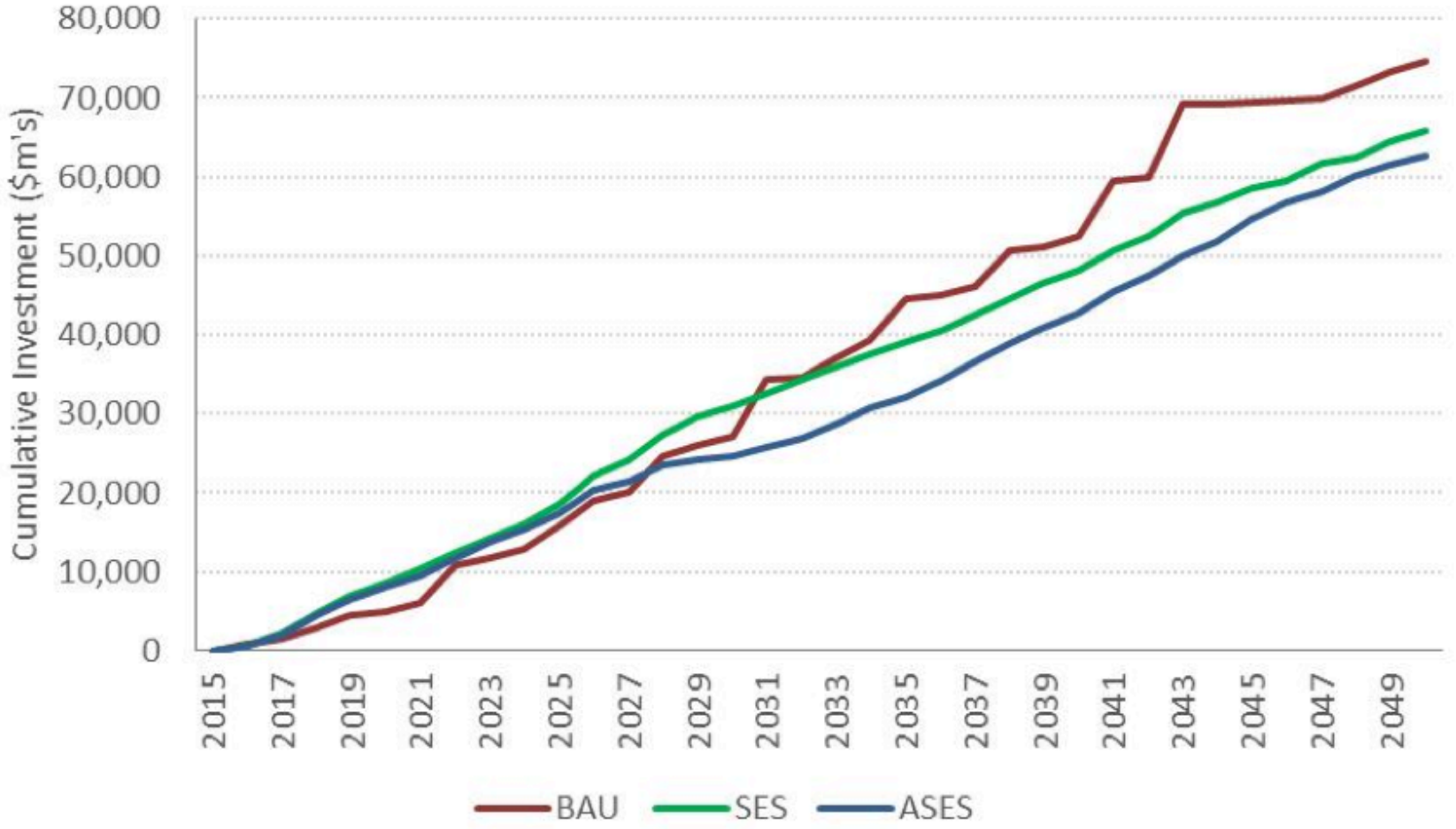

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Figure 97 Myanmar Cumulative Investment of BAU (Real 2014 US$)

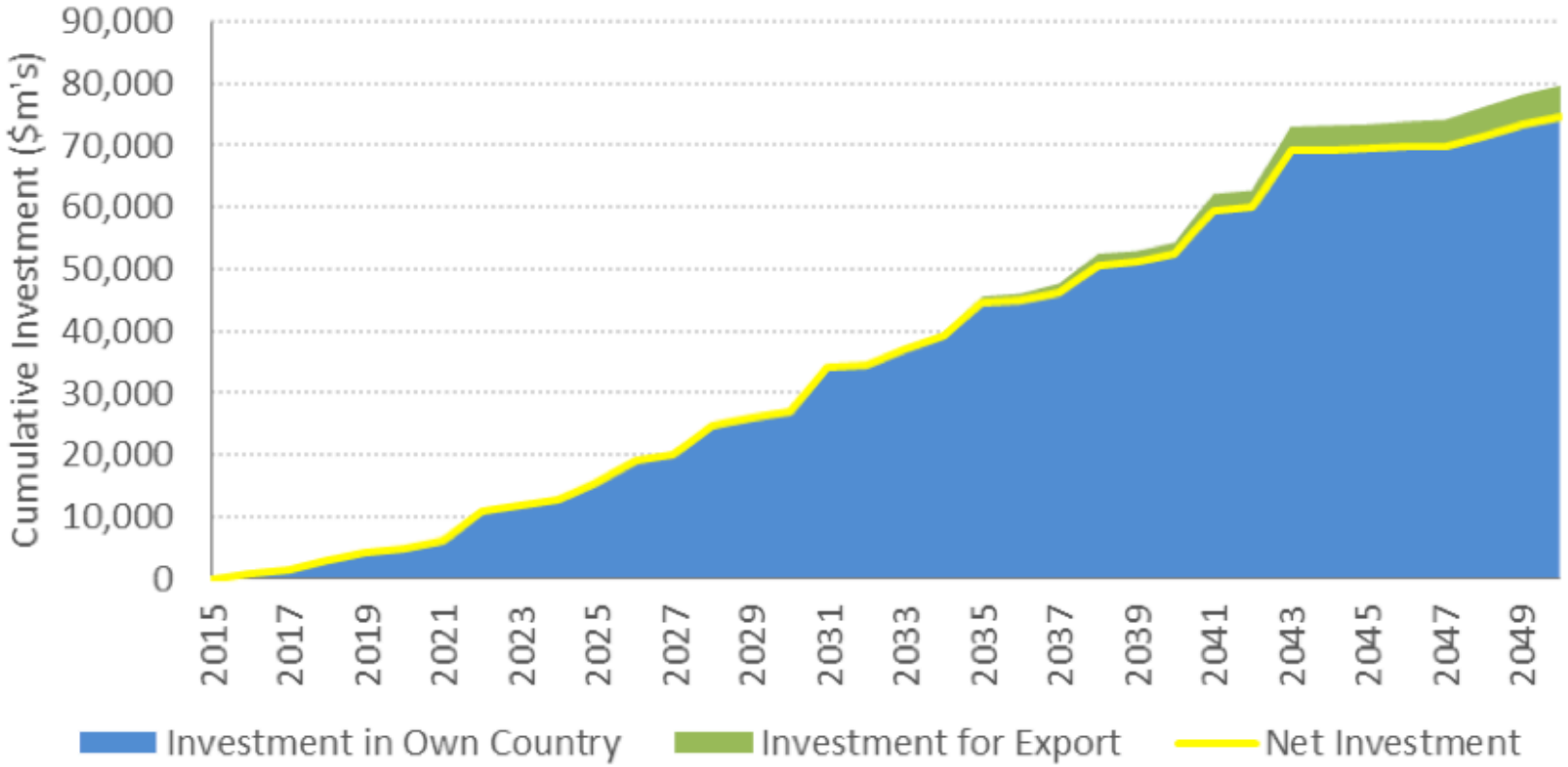

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Figure 98 Myanmar Cumulative Investment of SES (Real 2014 US$)

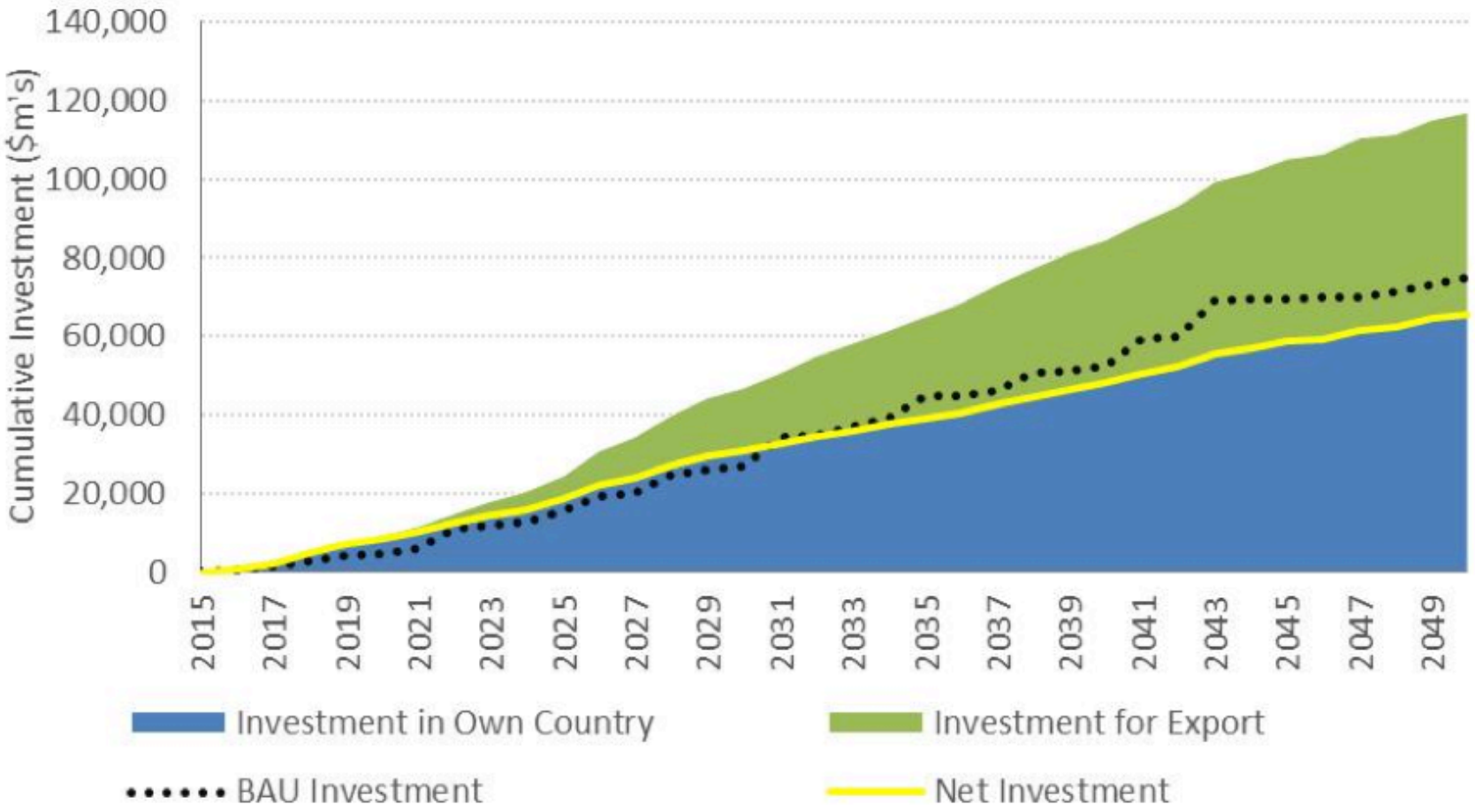

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Figure 99 Myanmar Cumulative Investment of ASES (Real 2014 US$)

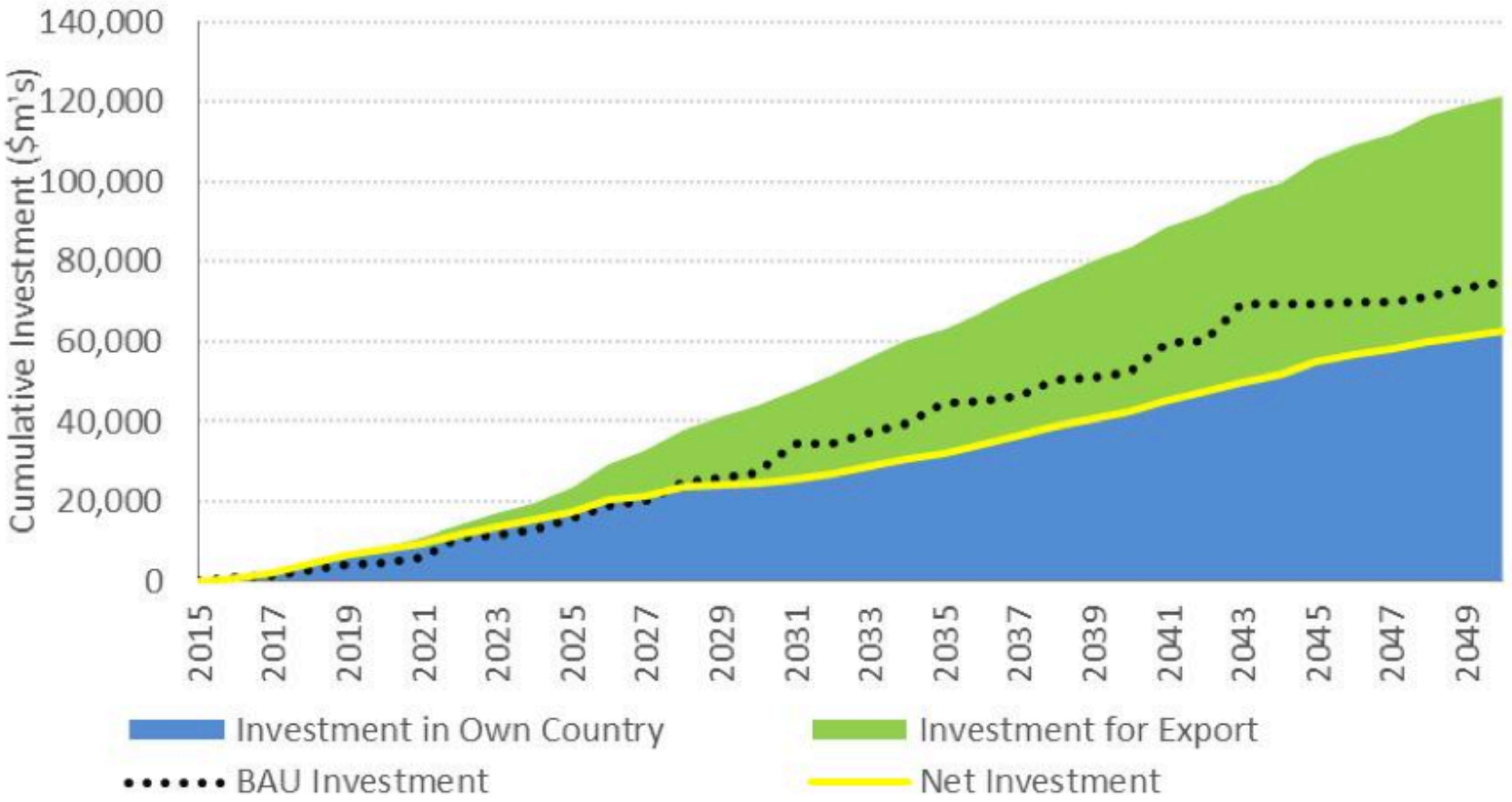

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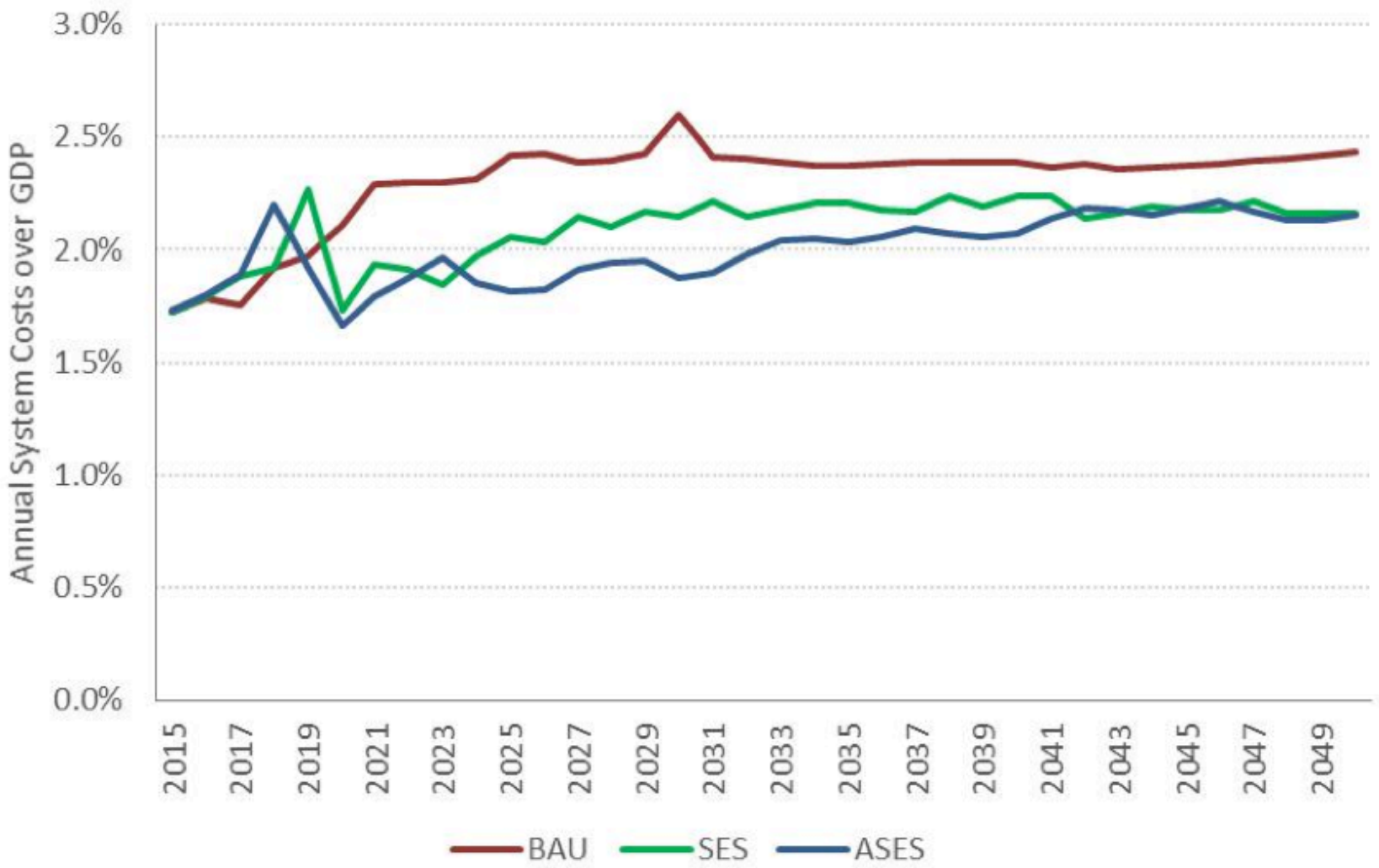
Figure 100 Total System Cost over GDP



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BY 2050

$74 billion BAU

VS.

$66 billion SES

VS.

$63 billion (Real 2014 USD) ASES

ADDITIONAL $6 billion is required FOR ELECTRICITY EXPORT

In the SES, ADDITIONAL $51 billion is required FOR EXPORT TO THAILAND

ASES also requires $59 billion IN MYANMAR FOR EXPORT TO NEIGHBOURING COUNTRIES

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BY 2050

$74 billion BAU

vs.

$66 billion SES

vs.

$63 billion (Real 2014 USD) ASES

The BAU investment (75%) to coal and hydro projects

SES (and ASES) some 42% (33%) is directed to solar and battery system technologies, with 13% to wind and other significant investments in energy efficiency measures, bioenergy and off-grid.

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BY 2050

BAU from 2015 to 2050 would be accompanied by the creation of some **1.4 mill job** years (28% man., 57% constr., 11% oper. & maint. and 4% fuel supply)

SES 3,2 mill job years (31% , 59%, 10% & 0.1%)

ASES 3,8 job years (30%, 60%, 9% & 0.1%)

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Figure 113 Total Job Creation Comparison BAU, SES and ASES

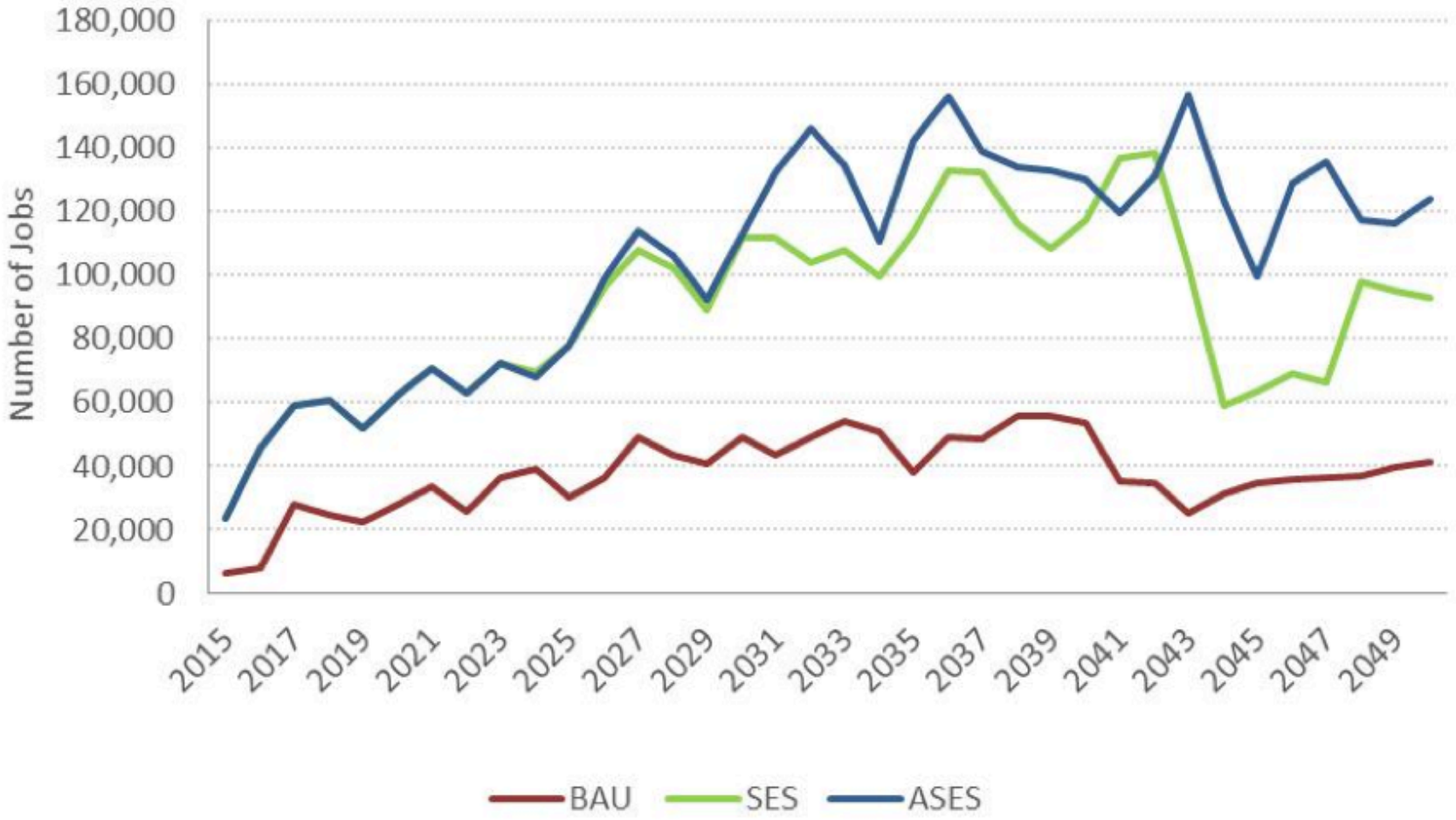


Figure 89 Myanmar LCOE Composition in BAU

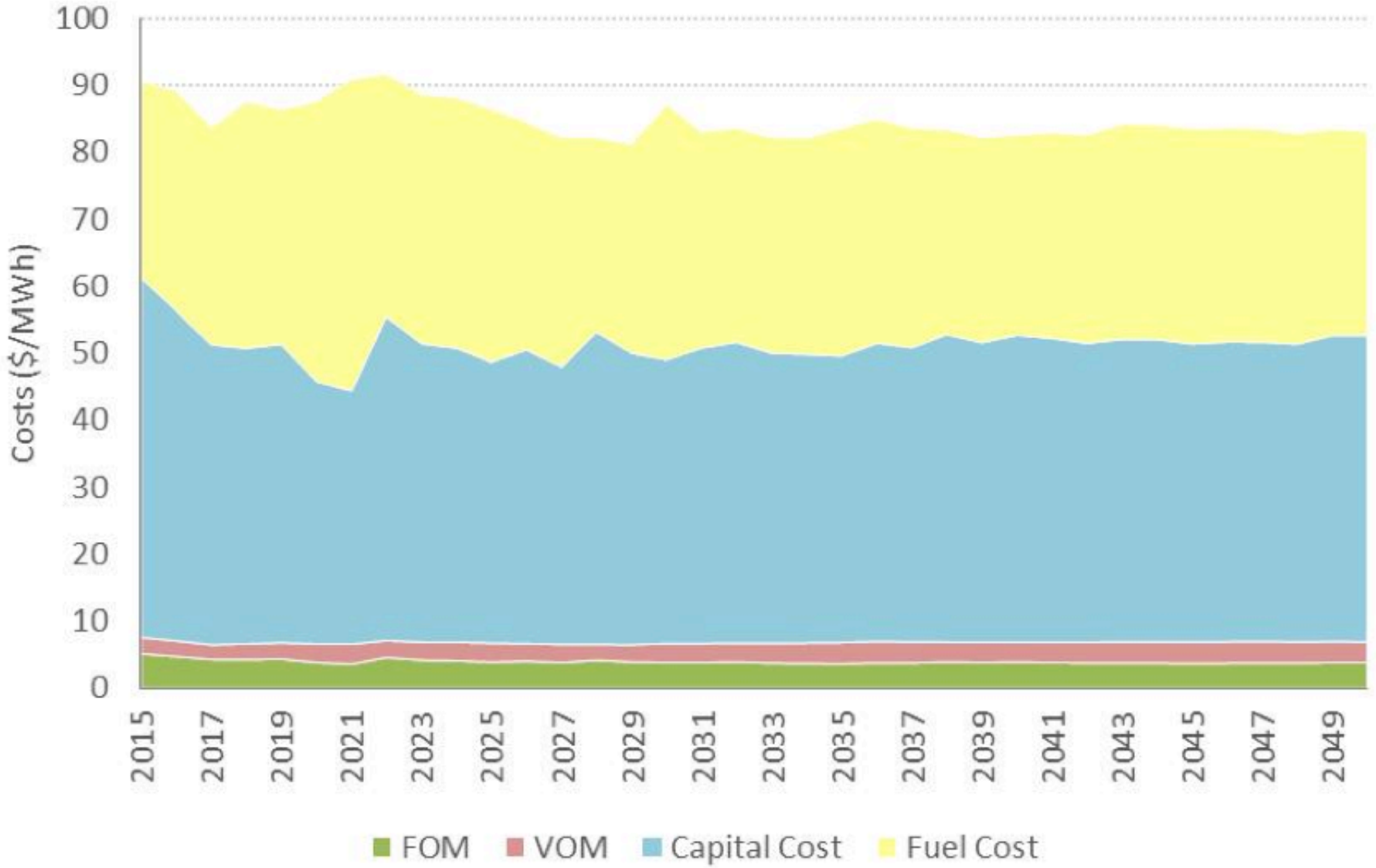


Figure 90 Myanmar LCOE Composition in SES

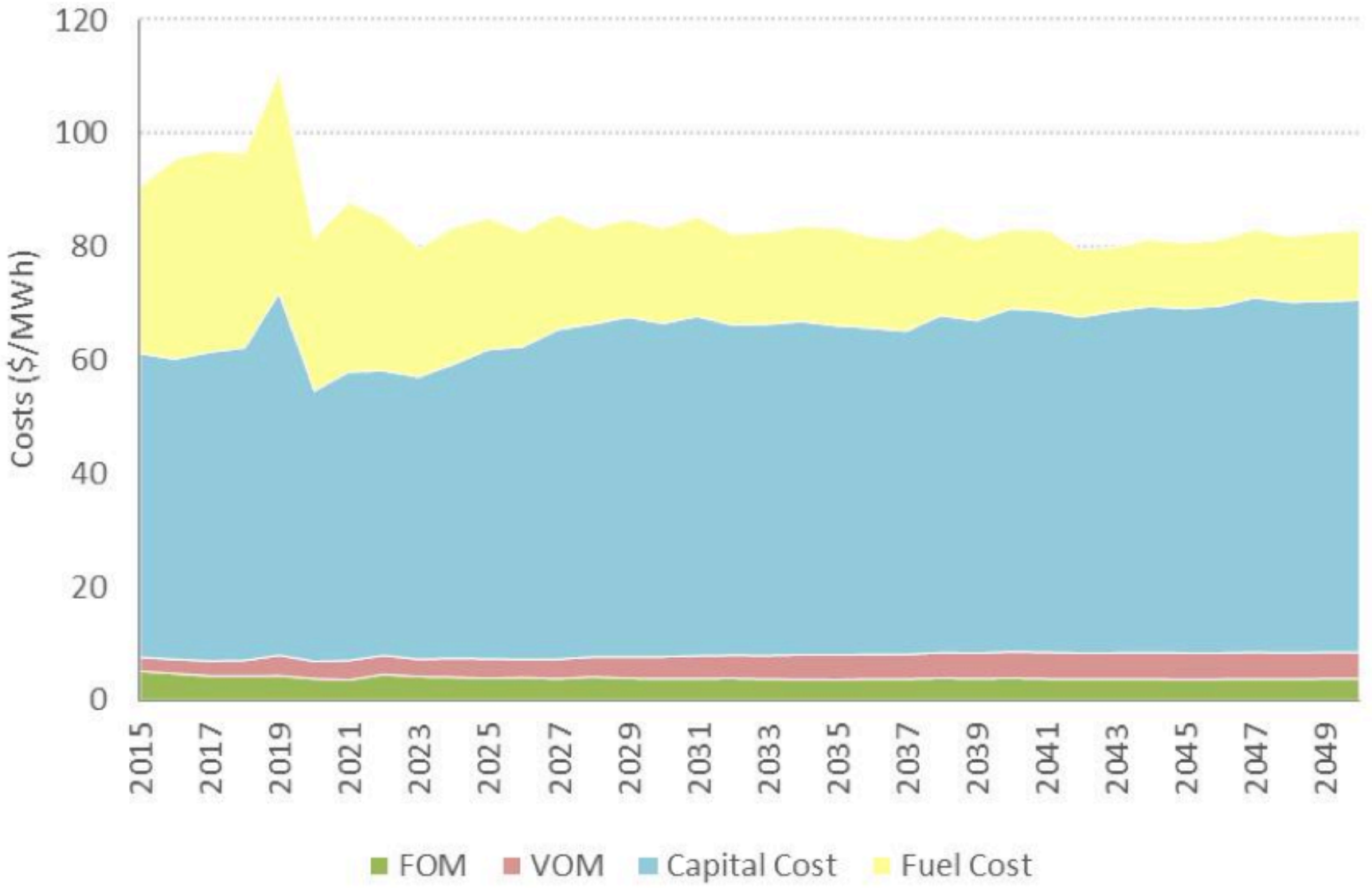


Figure 91 Myanmar LCOE Composition in ASES

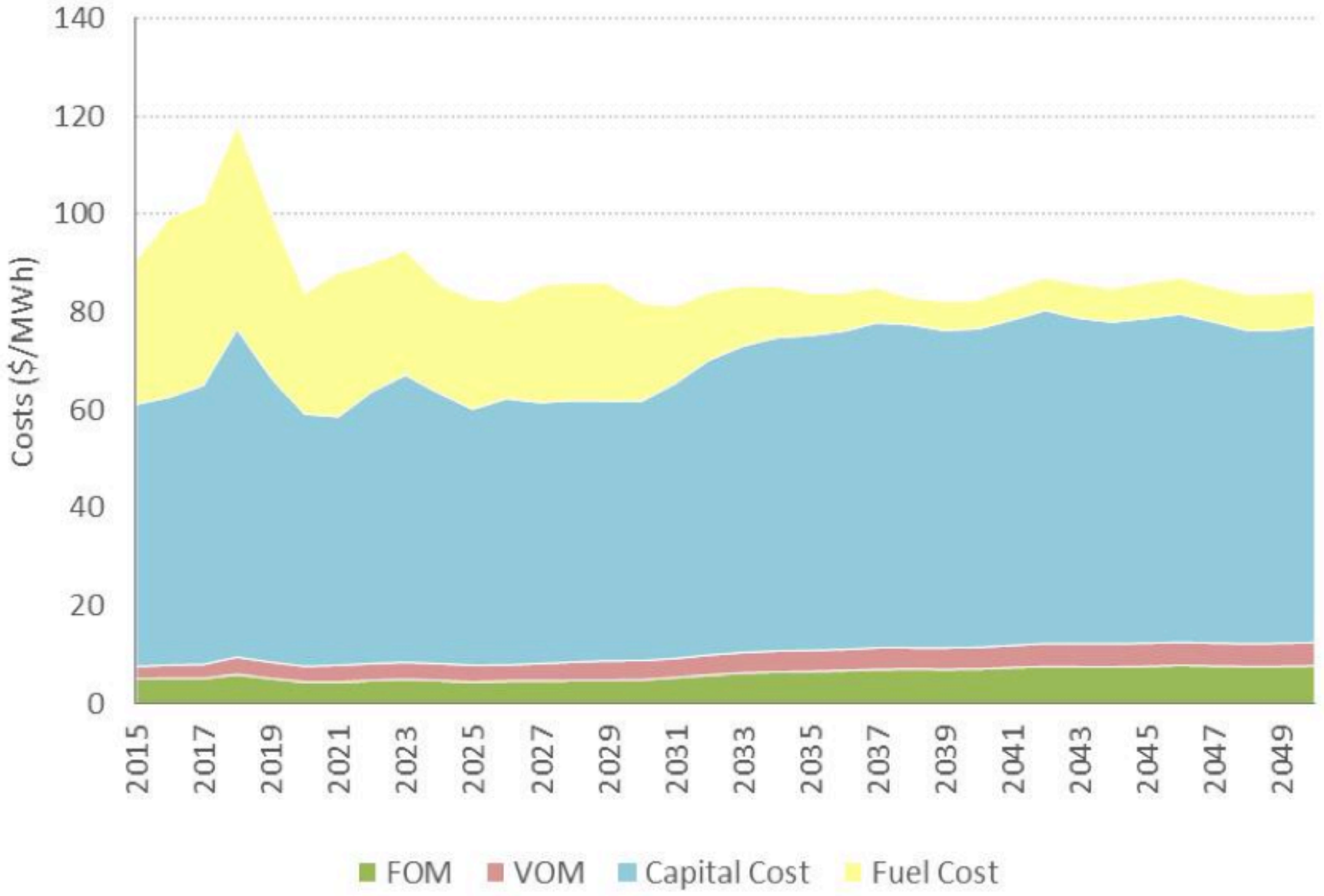
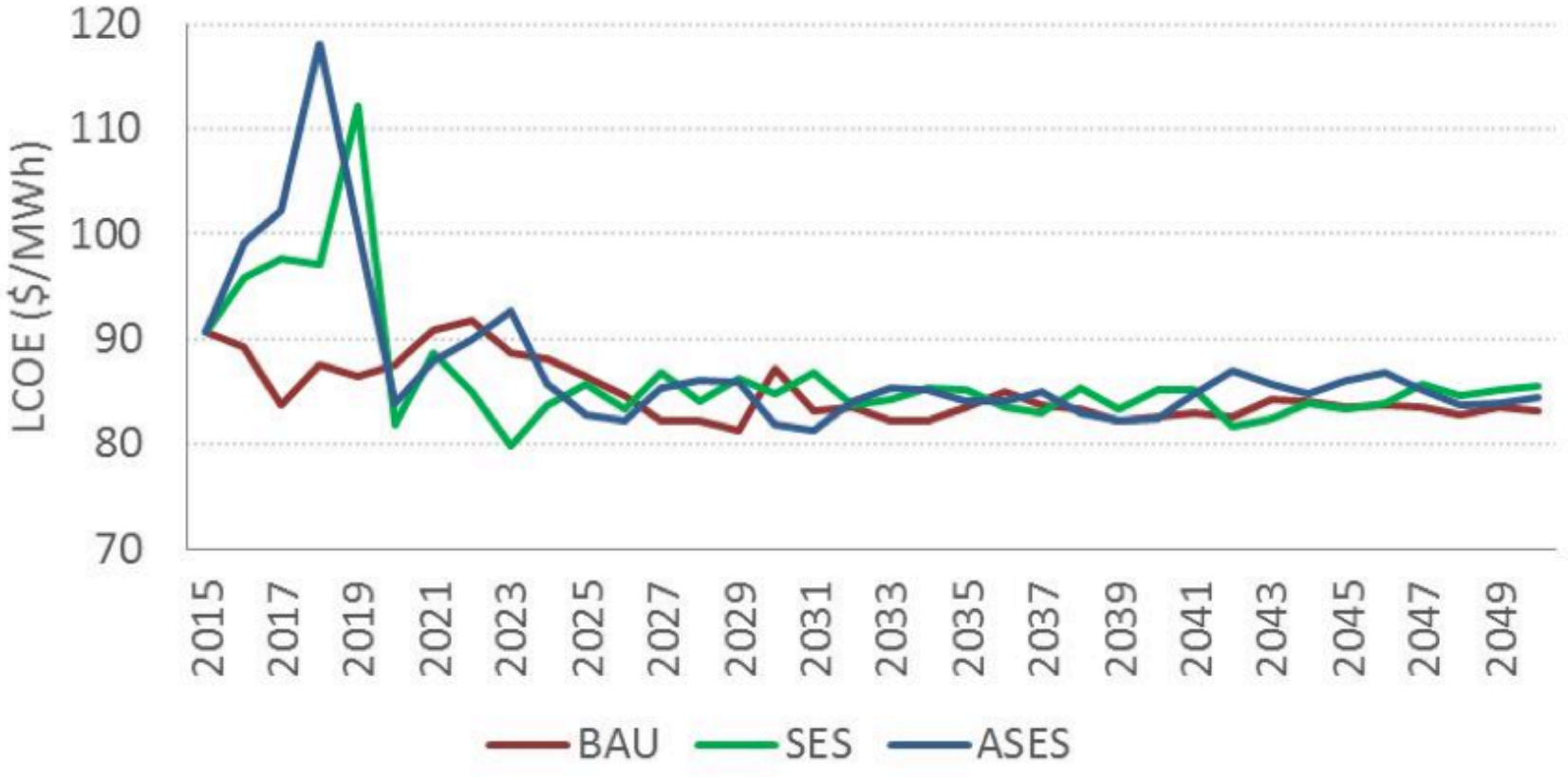


Figure 88 Myanmar LCOE for Generation



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BY 2050

Levelised cost of electricity (LCOE)

By 2050 the LCOE in all three scenarios: **BAU, ASES and SES** averages **US$82/MWh** from 2020 trends towards .

The Sustainable Energy Sector Scenarios driven by investment in more expensive renewable energy technologies (battery storages deployed further from the grid, CSP and bio generation technologies)

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CHALLENGES

1) Lack of a fully transparent institutional and legal framework to support exploration, development, and deployment renewable energies
2) There are no specific renewable energy incentives at present
3) Subsidised cost of electricity and petroleum products that discourages investments into renewable energy
4) Lack of human resource capacity
5) Lack of adequate transmission and distribution infrastructure

CHALLENGES

5) Competition from cheaper gas alternatives (Myanmar has the 10th largest gas reserves of any country)
6) Lack of information and educational programs
7) Inadequate inter-governmental cooperation in the electricity market generally

WAY FORWARD

1) Comprehensive and transparent energy and energy efficiency policies regulatory framework
2) Electricity pricing policies and mechanisms that encourage investment in generation technologies, transmission and distribution equipment and end use energy consumption.
3) Detailed assessments of renewable energy potential and publicy the results

WAY FORWARD

4) Knowledge transfer and capability building in renewable energy technologies and energy efficiency for policy makers, energy industry and education institutions staff
5) Investments in ICT systems to allow for greater real-time monitoring, control and forecasting of power system, smart-grid technology and renewable energy systems and tools
6) Measures to encourage cross-border power trade in the region to exploit scattered renewable energy resource potentials
7) Measures to improve power planning in the region

MAIN MESSAGES

100% RENEWABLE ENERGY GENERATION MIX IS **REALISTIC** BY 2050

100% RENEWABLE ENERGY GENERATION MIX CAN BE ACHIEVED WITH **LESS COSTS** THAN CURRENT PLAN AND PROVIDE ELECTRICITY CHEAPER/EQUAL PRICE

100% RENEWABLE ENERGY GENERATION MIX CAN PROVIDE MYANMAR A HIGHER **ENERGY SECURITY** INDEX (BIGGER DOMESTIC SHARE) AND RESERVE MARGIN

MAIN MESSAGES

100 % RENEWABLE ENERGY MIX LEADS TO **ZERO EMISSIONS** BY 2042 WHILE BAU CONTINUES TO EMIT 75 MILLION TONNES OF CO2 EMISSIONS ANNUALLY

100% RENEWABLE ENERGY GENERATION MIX CREATES **3 TIMES MORE JOBS** THAN BAU

100% RENEWABLE/SUSTAINABLE ENERGY MIX VERY LIKELY LEADS TO **LESS ADVERSE ENVIRONMENTAL AND SOCIAL IMPACTS**

END OF PART III
QUESTIONS?
COMMENTS?