CURRENT & FUTURE ENERGY OUTLOOK LAO PDR

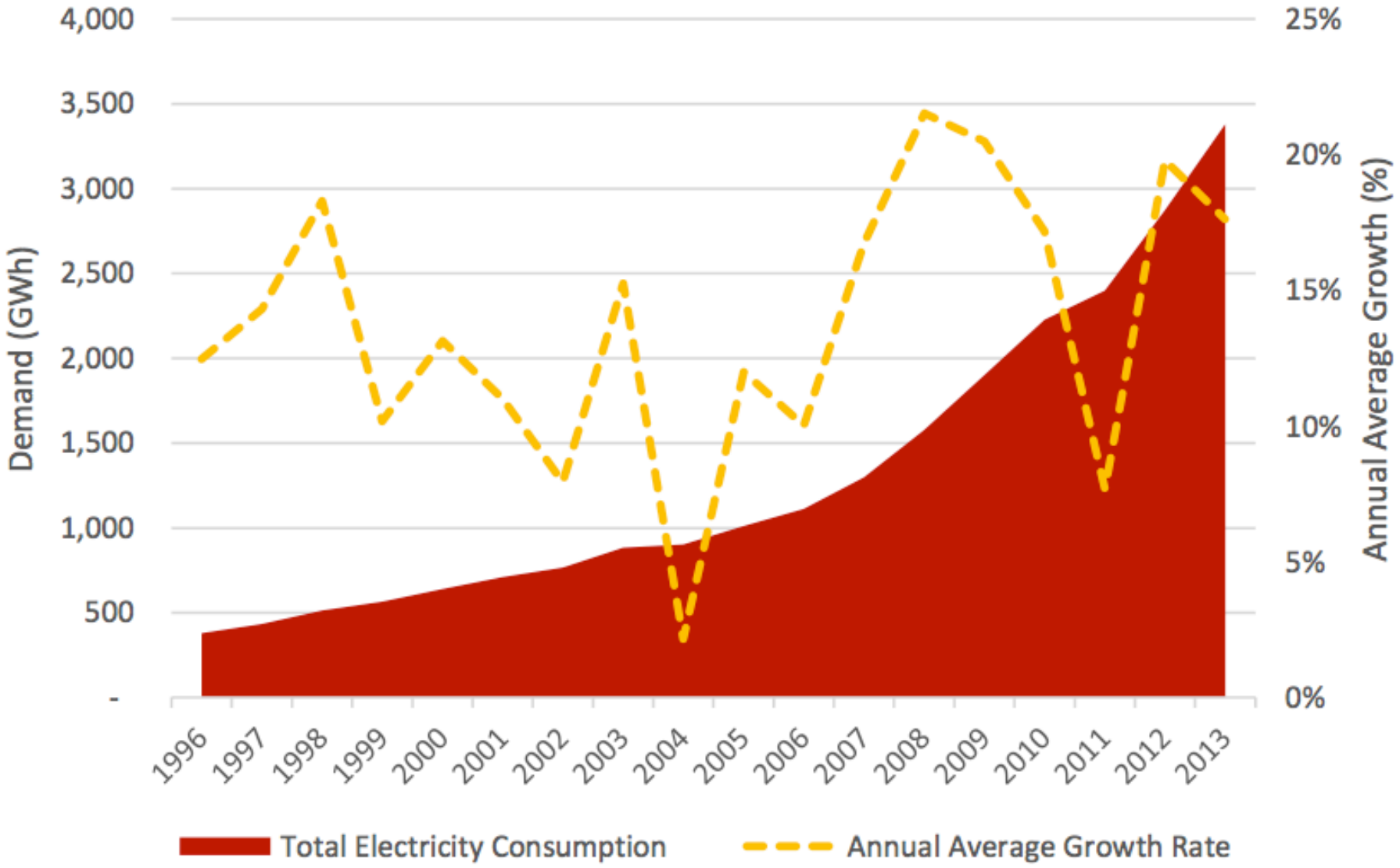
3 OPTIONS

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

Figure 4 Electricity Demand Growth (1996-2013)



Source: Electricity Statistics 2013, Electricite Du Laos, 2014

Figure 5 Electricity Demand Shares by Category (2013)

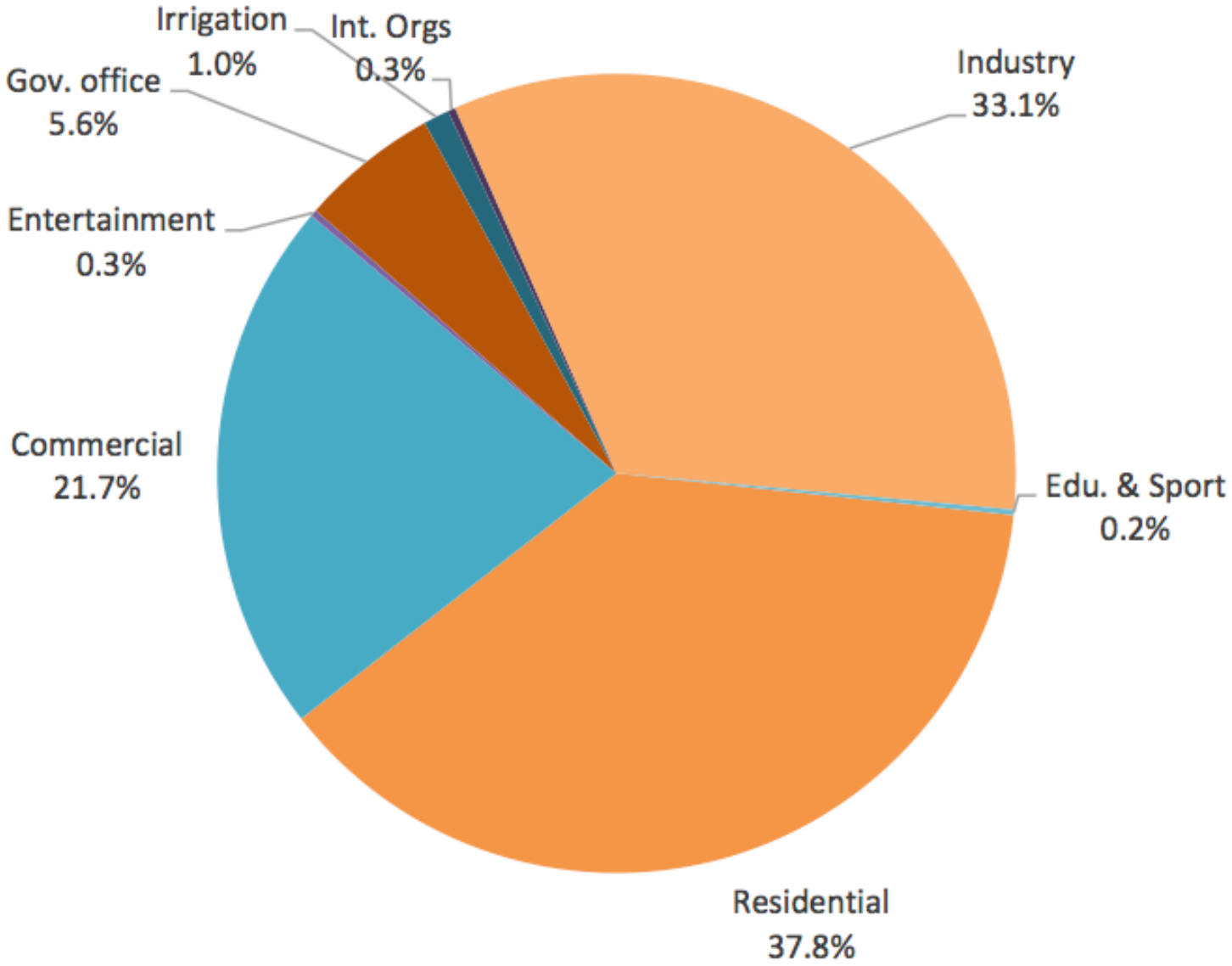


Figure 7 **Generation, Imports and Exports (1991-2012)**

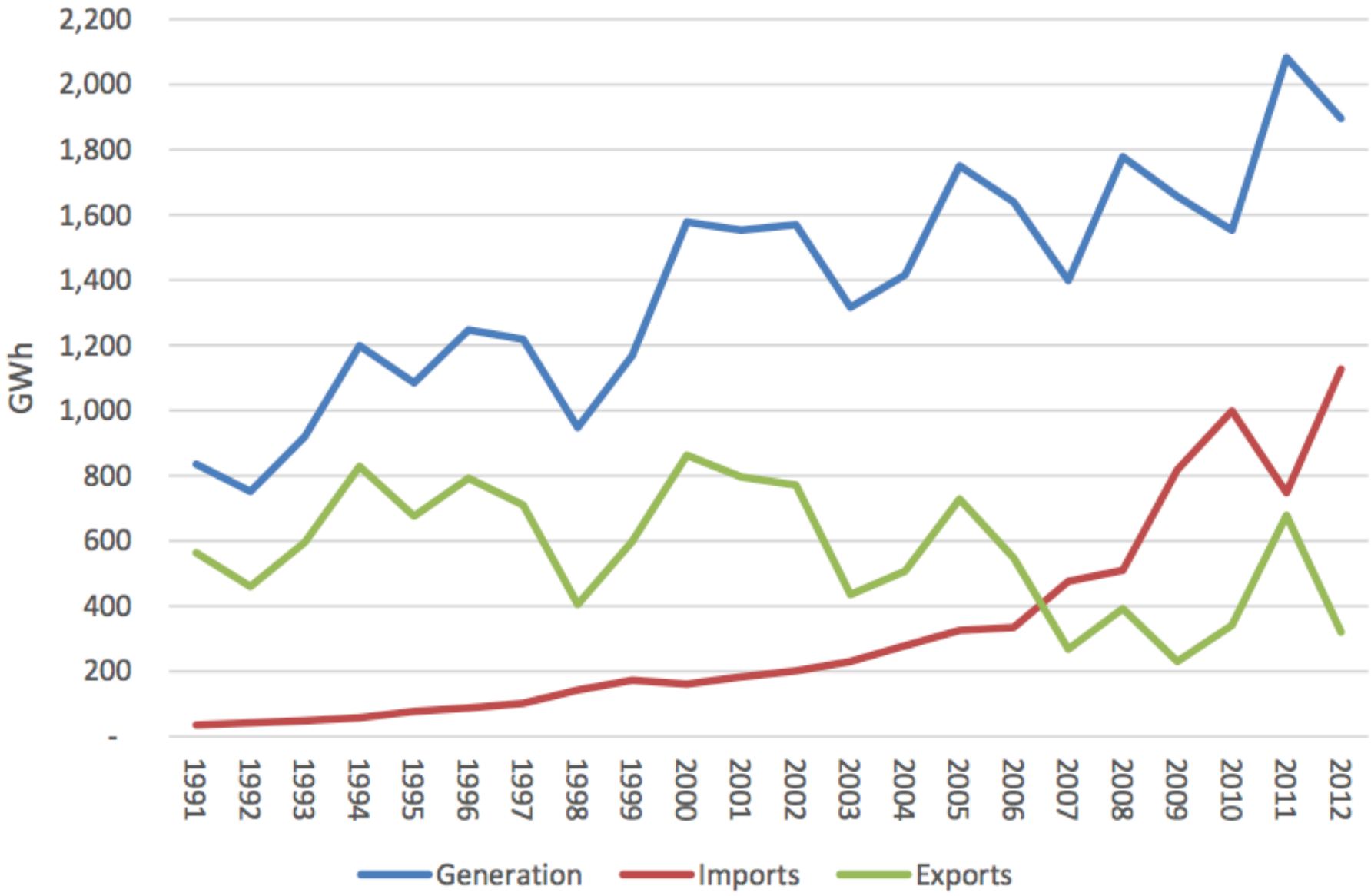


Figure 8 Export and Import Shares by Country (2013)

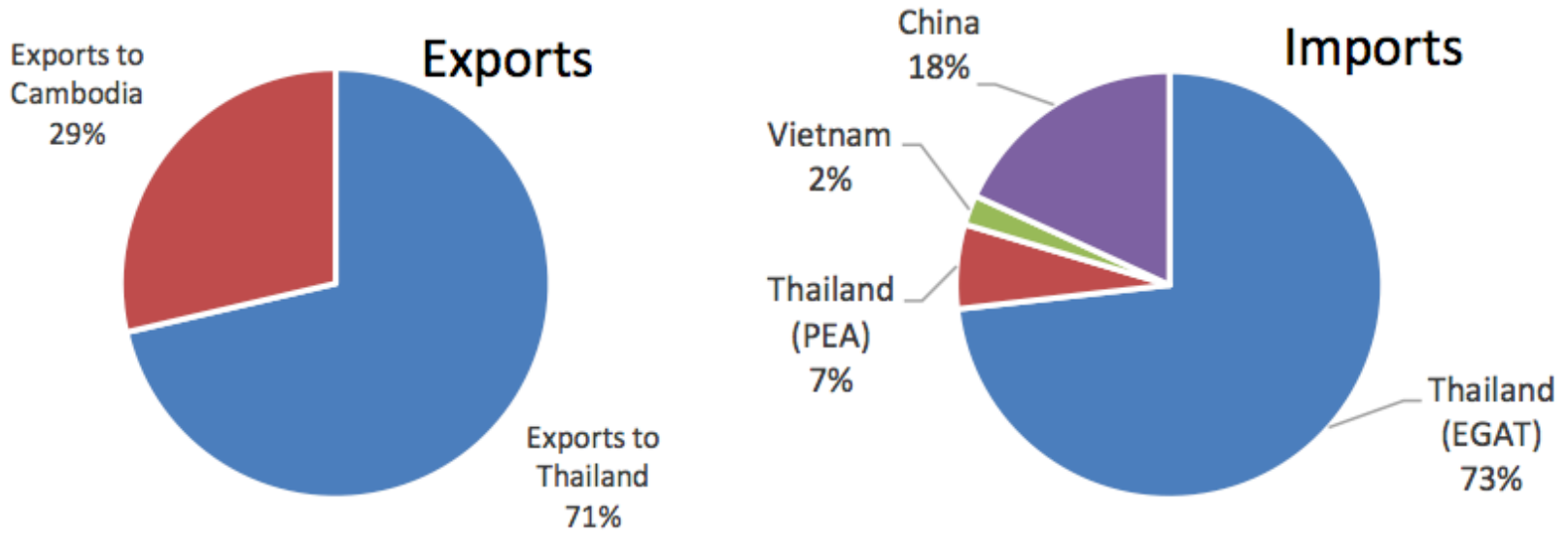
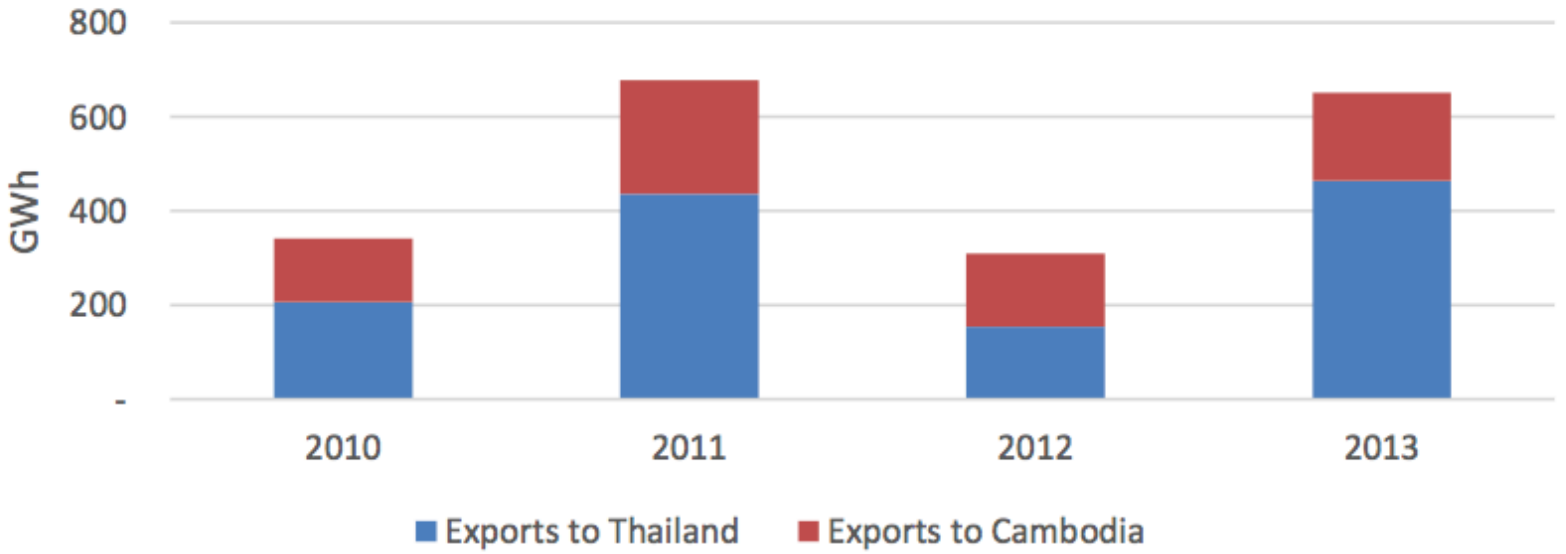


Figure 9 Historical Annual Exports (2010-13)



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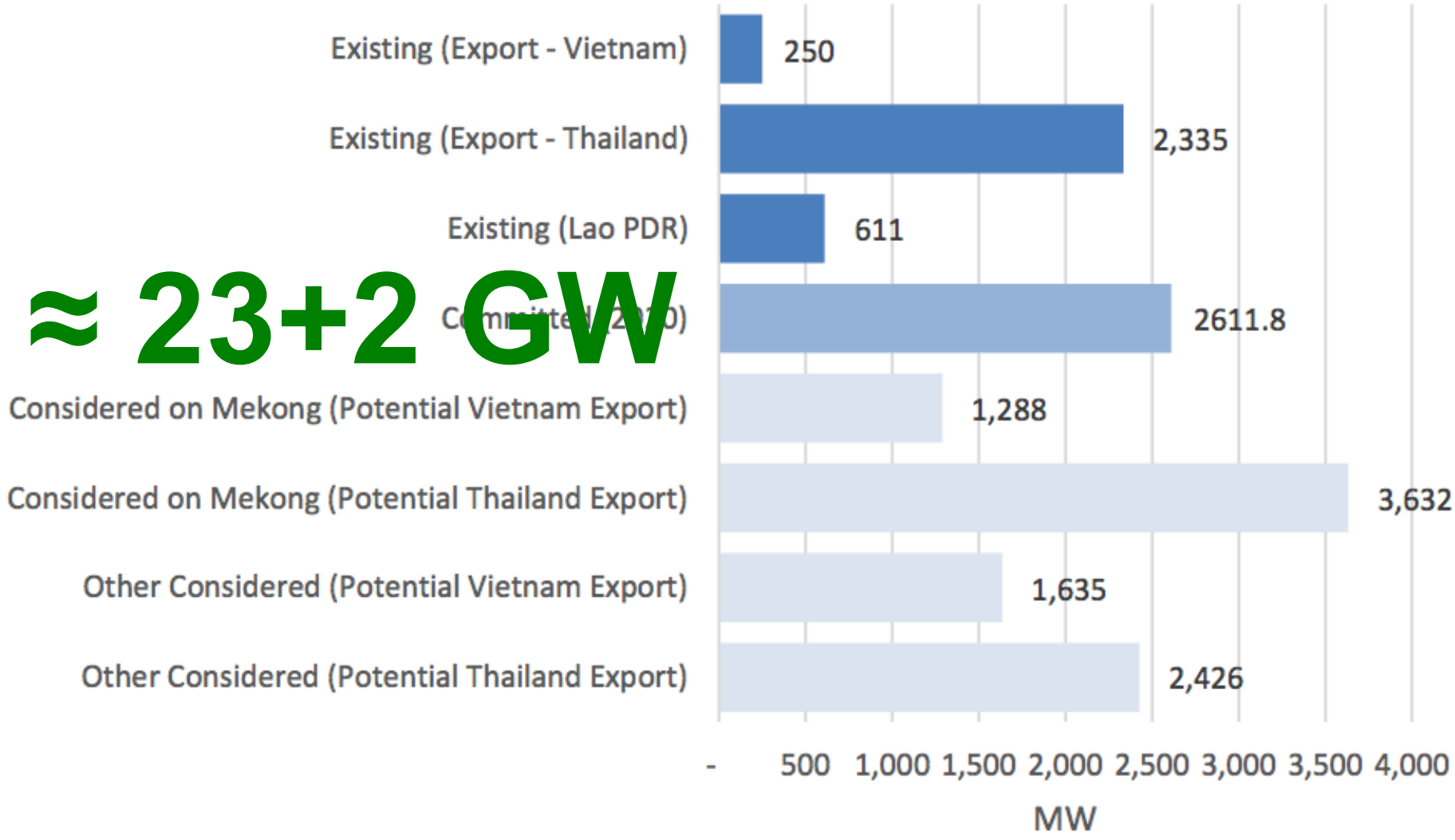
HYDRO

Figure 13 Lao PDR Hydro Projects: Existing, Committed and Considered (2014)



≈ 23+2 GW

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WIND ≈ 27 GW

Table 3 Wind Resource Potential in Lao PDR[9]

		Poor	Fair	Good	Very Good	Excellent
Parameter	**Unit**	**< 6 m/s**	**[6, 7) m/s**	**[7, 8) m/s**	**[8, 9) m/s**	**>= 9 m/s**
Land Area	km^2	184,511	38,787	6,070	671	35
% total	%	80.2%	16.9%	2.6%	0.3%	0.0%
Potential	MW	na	155,148	24,280	2,684	140

Source: Wind Energy Resource Atlas of Southeast Asia, TrueWind Solutions, 2001

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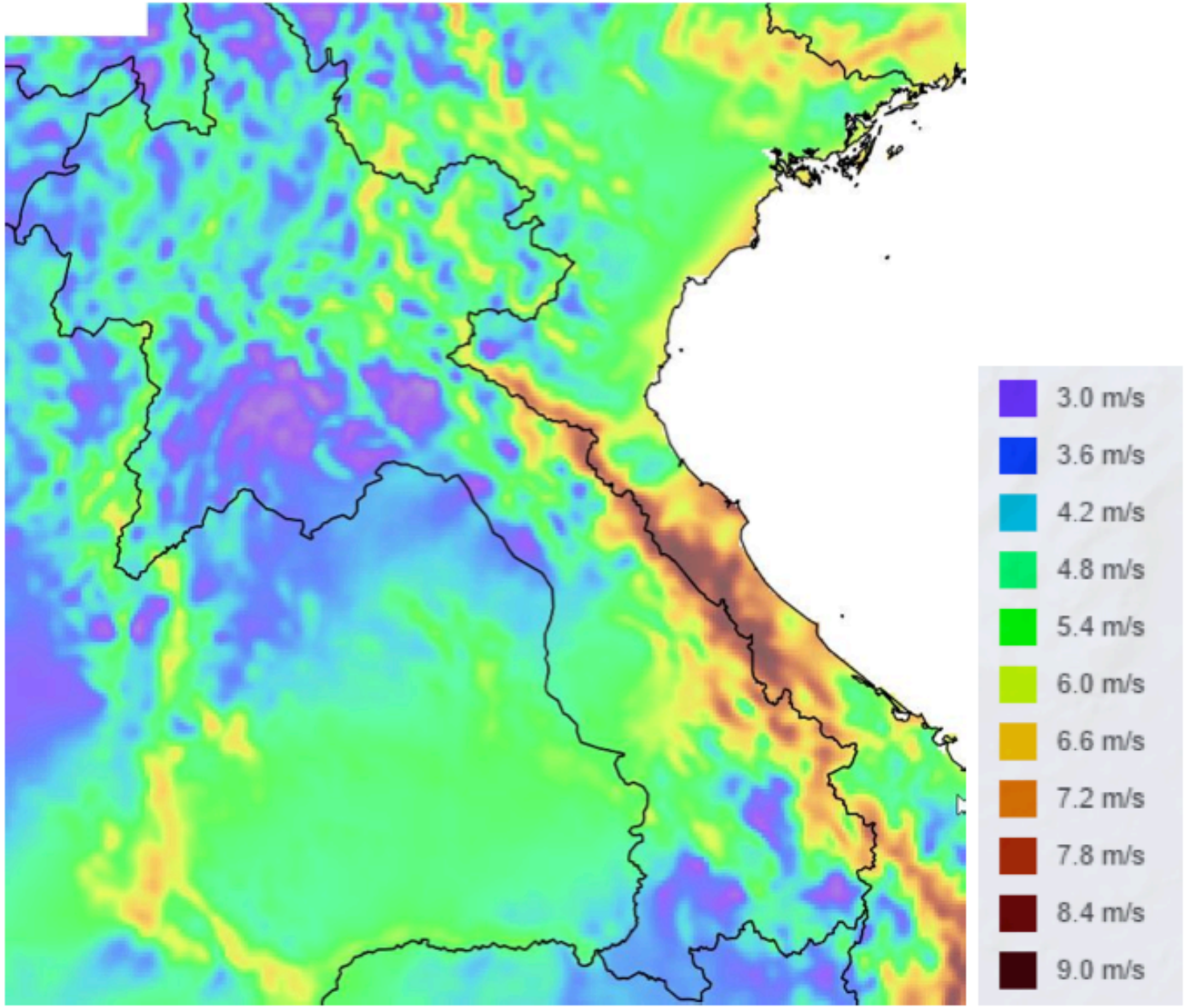
Figure 14 3TIER's Global Wind Dataset 5km onshore wind speed at 80m height [12]



Source: 3TIER's Global Wind Dataset (accessed via IRENA Global Atlas)

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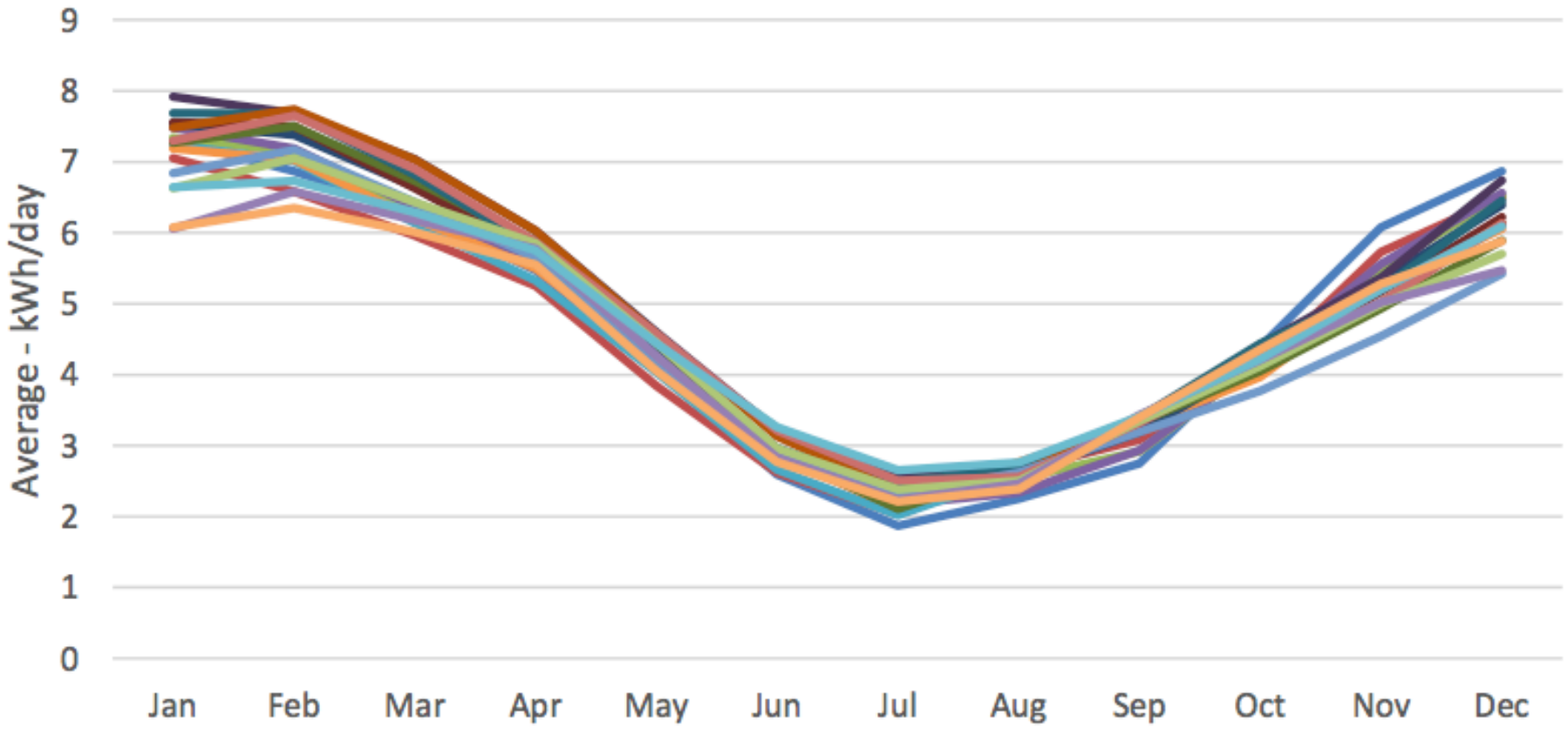
SOLAR

Figure 17 Monthly DNI Levels for Selected Locations in Lao PDR



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

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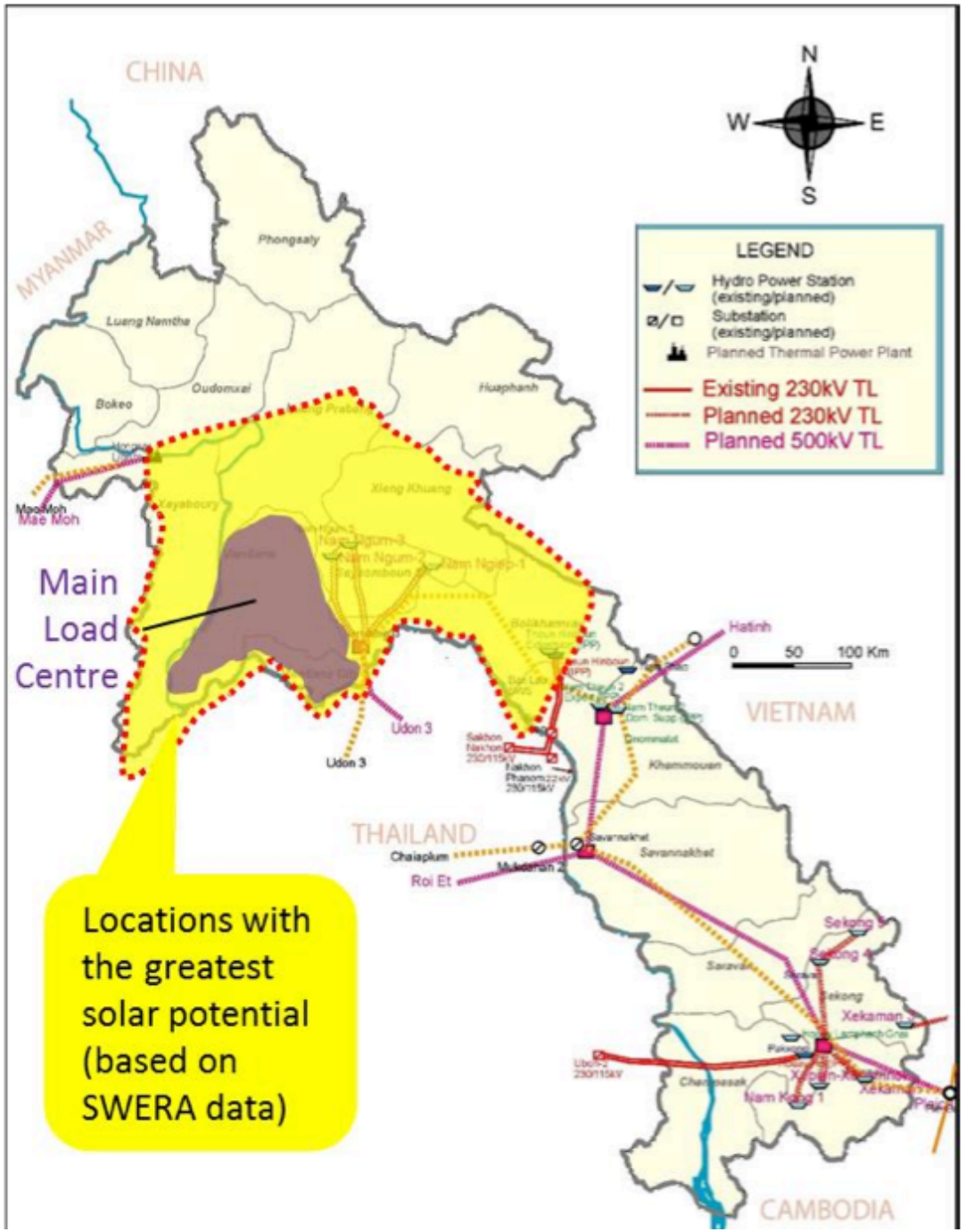
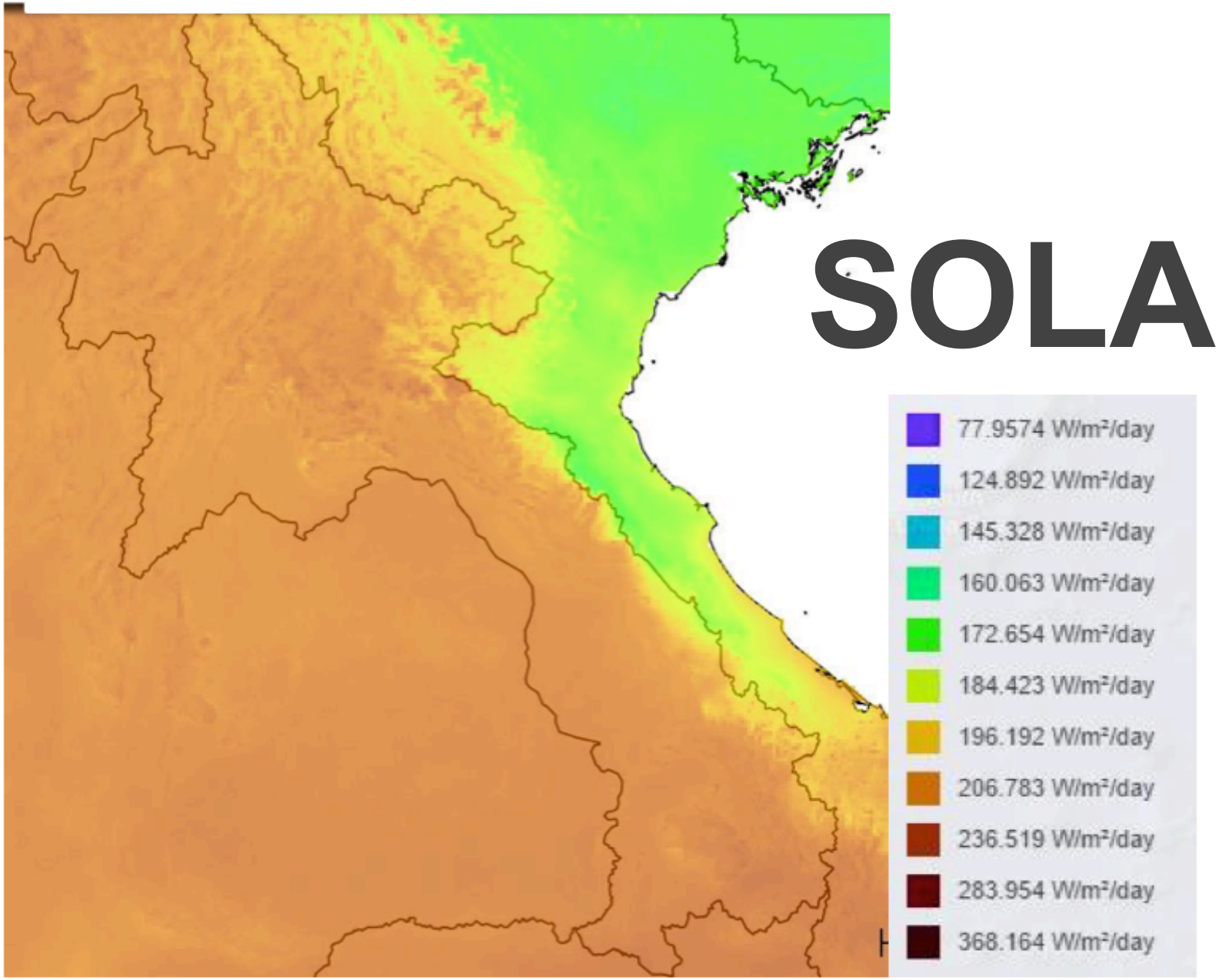
SOLAR ≈ 11 GW

Figure 18 **Main Locations with DNI Solar Power Potential in Lao PDR**



Locations with the greatest solar potential (based on SWERA data)

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



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Source: 3TIER's Global Solar Dataset (accessed via IRENA Global Atlas)

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BIOMASS≈ 2,4 GW

Table 5 Energy Potential from Agriculture and Forestry Residues

Biomass sources	Type of fuel	Equivalent energy (GWh/yr)
Rice husk	Combustive	2,108
Rice straw	Biogas	1,030
Husbandry	Biogas	3,269
Forest residues	Combustive	12,500
Total	**Various**	**18,907**

Table 6 Lao PDR Biogas Technical Potential

Livestock	Net Dry Matter Available (kg/day)	Mean Biogas Yield Factor (m3/kg)	Daily Biogas Production (m3/day)	Energy Content per Day (kWh/day)
Buffalo	1,094.337	0.25	273,584	1,641,505
Cows	1,359,147	0.25	339.787	2,038,721
Pigs	192.835	4.20	809,908	4,859,448
Total	**2,646,319**		**1,423,279**	**8,539,674**

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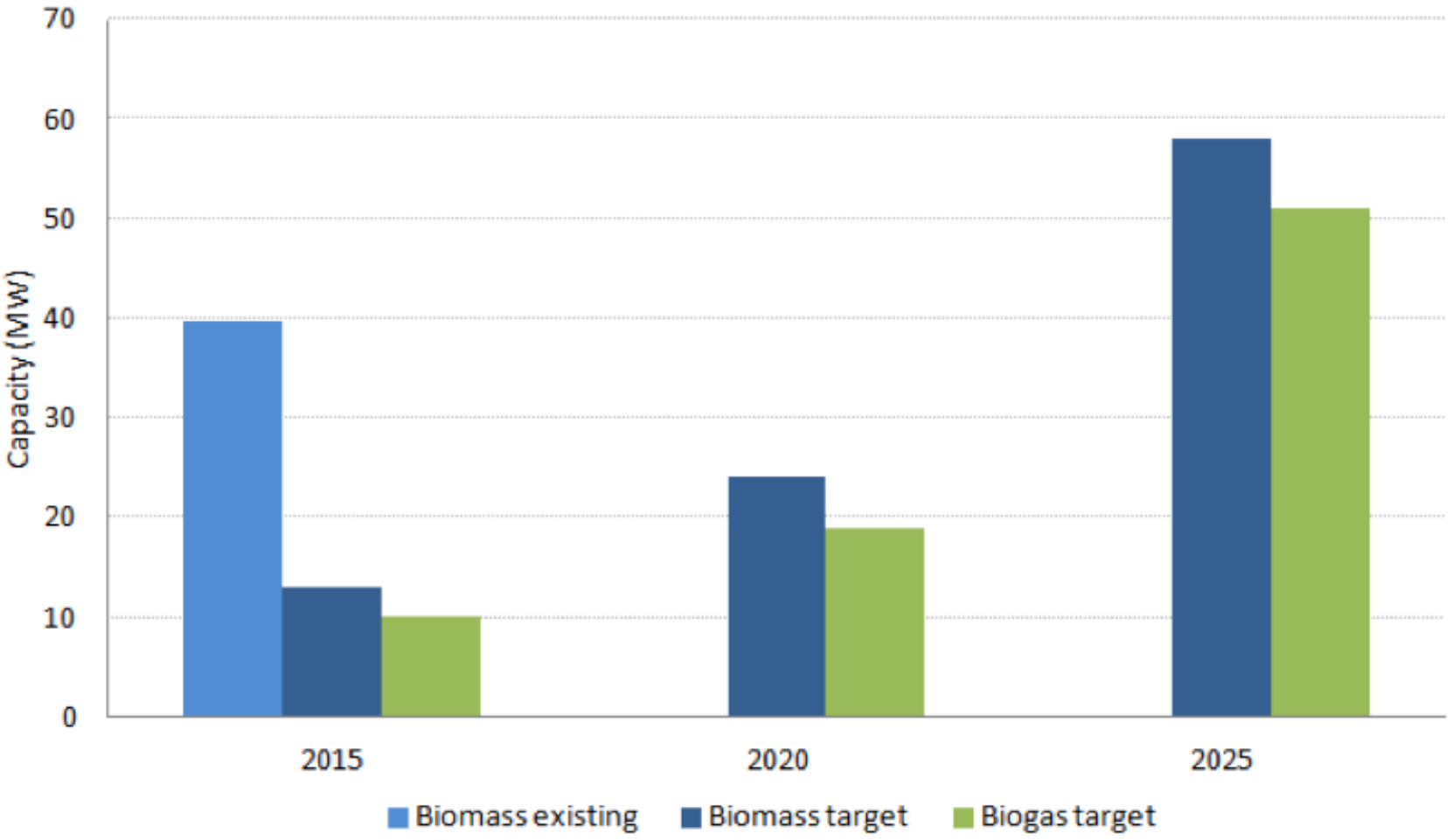
BIOMASS

Figure 20 Current Biomass and Biogas Developments and Targets (MW)



Source: Country Presentation on Status of Bioenergy Development in Lao PDR, IEA, IRENA, FAO, 2014

Figure 21 Seasonality in Renewable Resource Profiles and National Demand

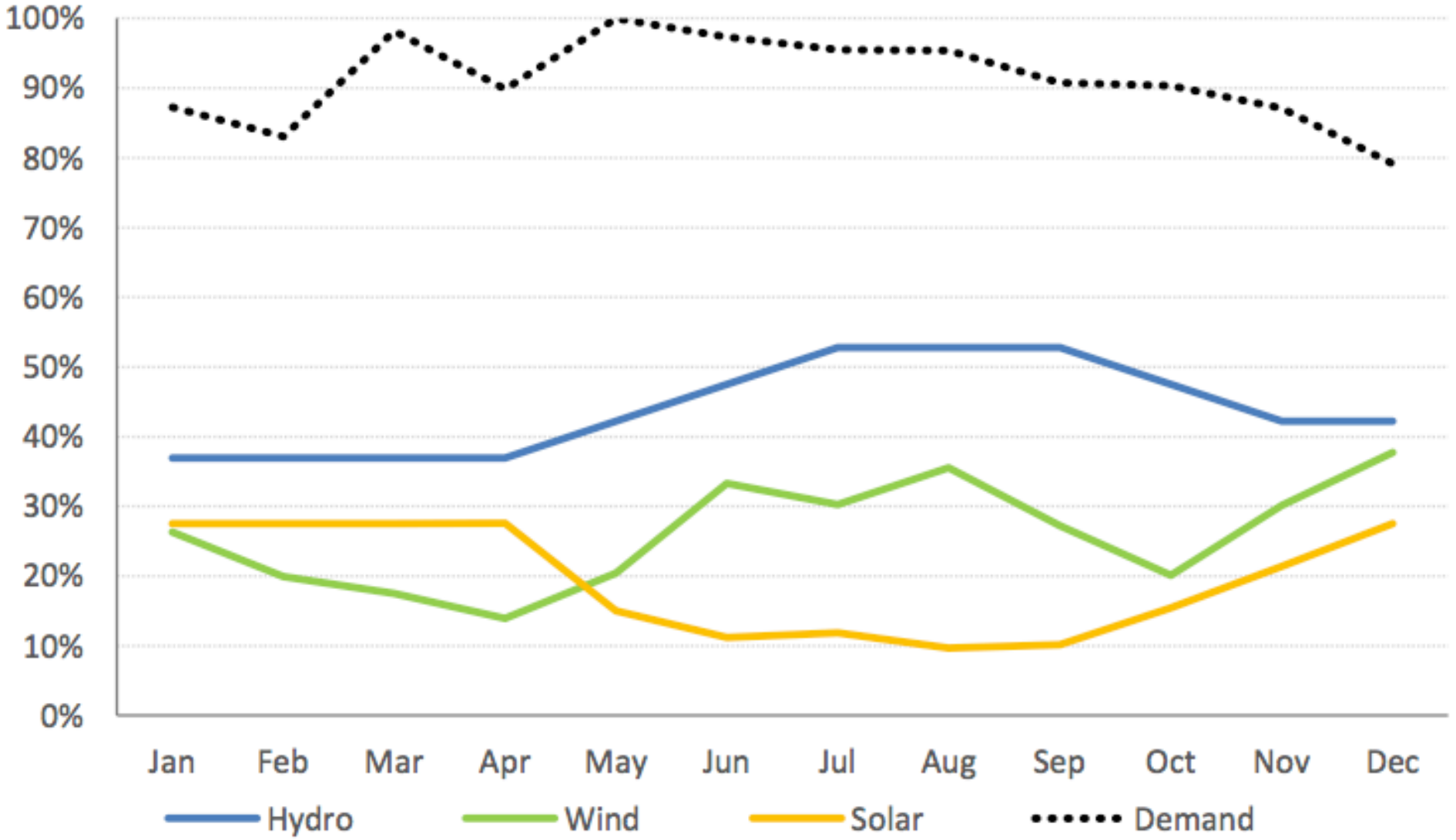


Table 7 Summary of Estimated Renewable Energy Potential (Compiled from Various Sources and Analysis)

Resource	Potential (MW)	Source and comments
Hydro (Large)	23,000	Lao hydropower potential and policy in the GMS context (EDL)
Hydro (Small)	2,000	Sites smaller than 15 MW. The Need for Sustainable Renewable Energy in Lao PDR (Vongchanh)
Pump Storage	-	Given the abundance of conventional hydro potential there has been little focus in Lao PDR to assess the potential of this technology.
Solar	At least 11,000	IES assessment based on various sources set out in 3.5.
Wind Onshore	27,104	Resource above 7m/s. Wind Energy Resource Atlas of Southeast Asia (TrueWind Solutions, 2001)
Wind Offshore	0	Not applicable
Biomass	1,271	IES projections based on data from Renewable Energy Developments and Potential in the Greater Mekong Subregion (ADB, 2015)
Biogas	1,146	IES projections based on data from Renewable Energy Developments and Potential in the Greater Mekong Subregion (ADB, 2015)
Geothermal	59	Lao PDR Energy Sector Assessment, Strategy, and Road Map (ADB, 2013)
Ocean	-	Not applicable

SCENARIOS

Figure 26 Lao PDR GDP Projection

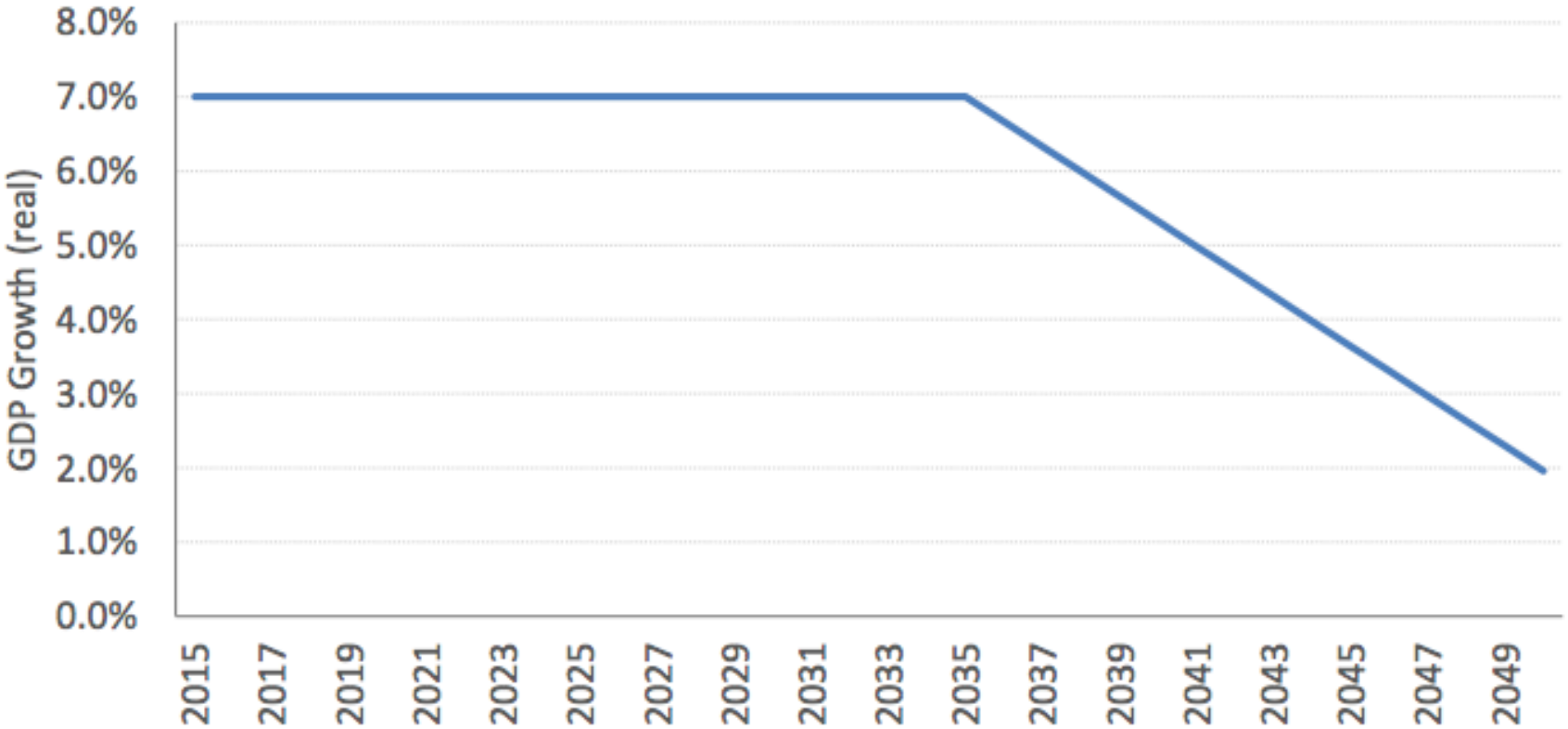
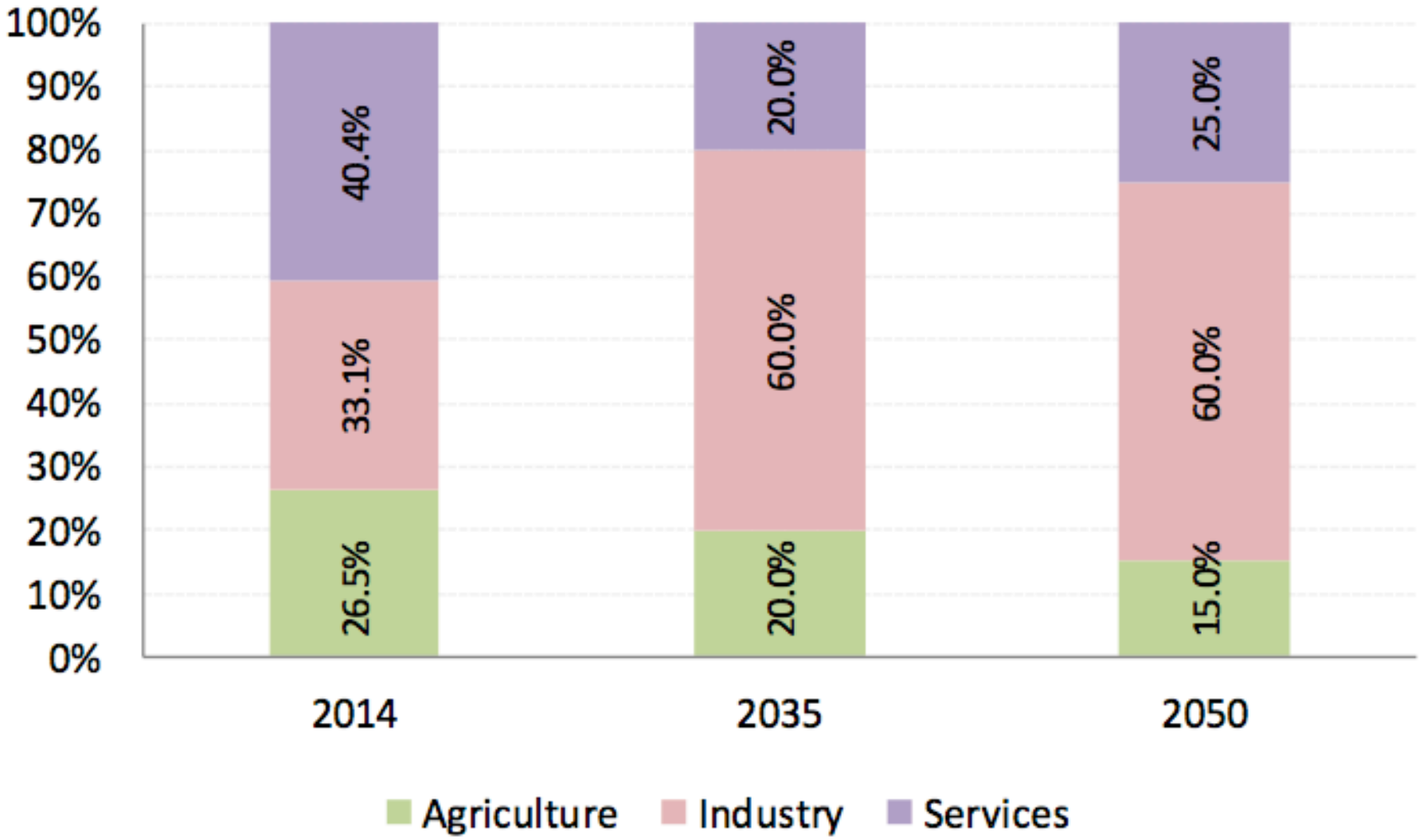


Figure 27 Lao PDR GDP Composition



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DEMAND DRIVERS

Table 10 Lao PDR Demand and Demand Drivers (BAU)

No.	Aspect	2015-30	2030-40	2040-50
1	Demand Growth (pa)	9.7%	5.5%	3.1%
2	GDP Growth (Real, pa)	7.0%	6.5%	3.5%
3	Electrification Rate (Population)	62.6%	97.0%	98.8%
4	Population Growth	1.54%	1.07%	0.78%
5	Per Capita Consumption (kWh)	1,322	3,009	3,995
6	Electricity Elasticity*	7.70	2.28	1.33
7	Electricity Intensity (kWh/USD)	0.337	0.454	0.464

2015-30	2030-40	2040-50	2015-30	2030-40	2040-50
7.3%	5.8%	2.3%	6.4%	6.0%	2.9%
7.0%	6.5%	3.5%	7.0%	6.5%	3.5%
49.3%	78.4%	84.5%	41.4%	58.7%	60.0%
1.54%	1.07%	0.78%	1.54%	1.07%	0.78%
1,204	2,637	3,382	1,115	2,358	3,052
7.01	2.19	1.28	6.49	2.12	1.29
0.307	0.398	0.392	0.284	0.356	0.354

Figure 71 Lao PDR Per Capita Consumption Comparison (kWh pa)

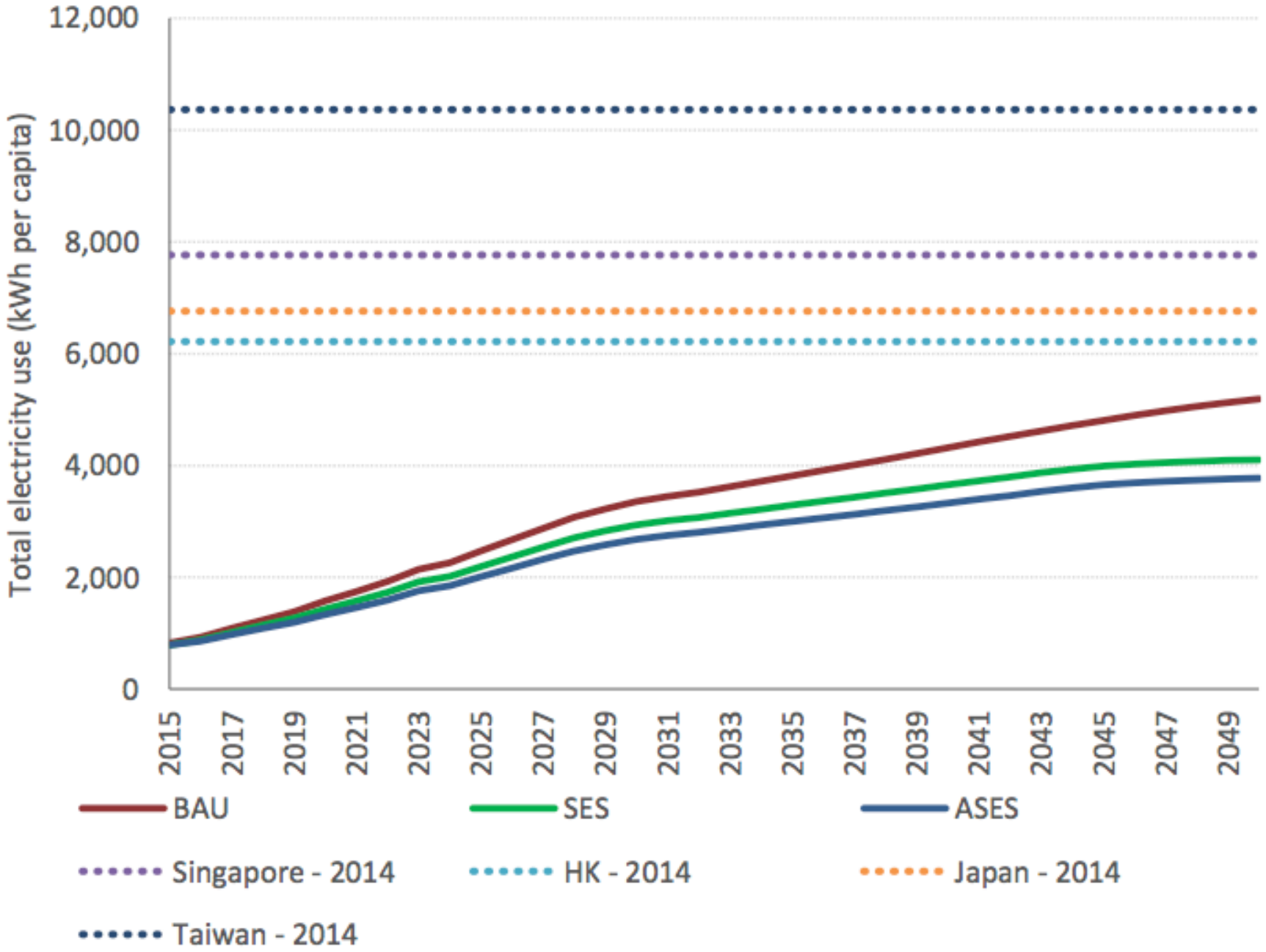

Figure 29 Lao PDR Projected Electricity Demand (2015-50, BAU)

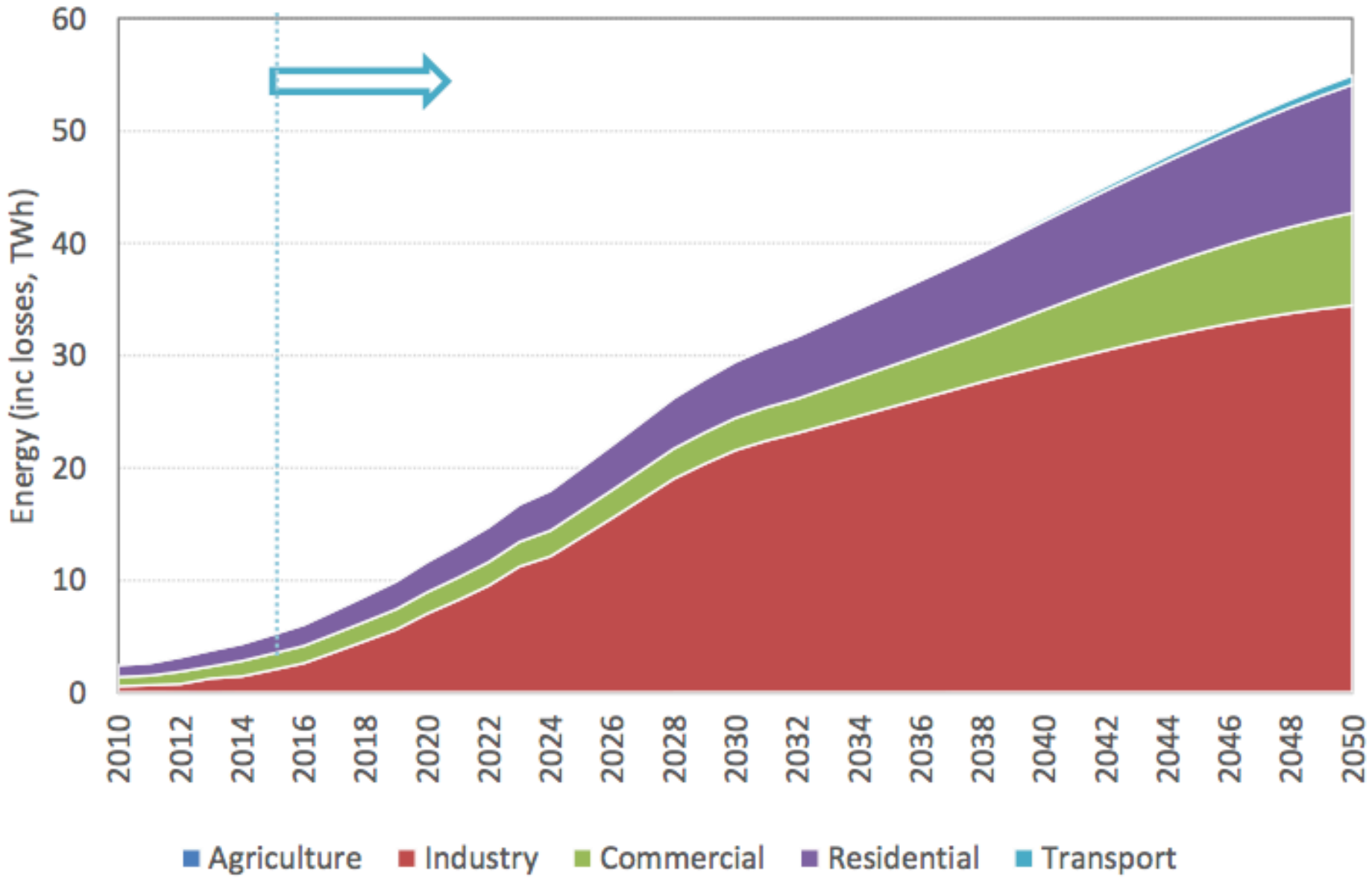

Figure 42 **Lao PDR Projected Electricity Demand (2015-50, SES)**

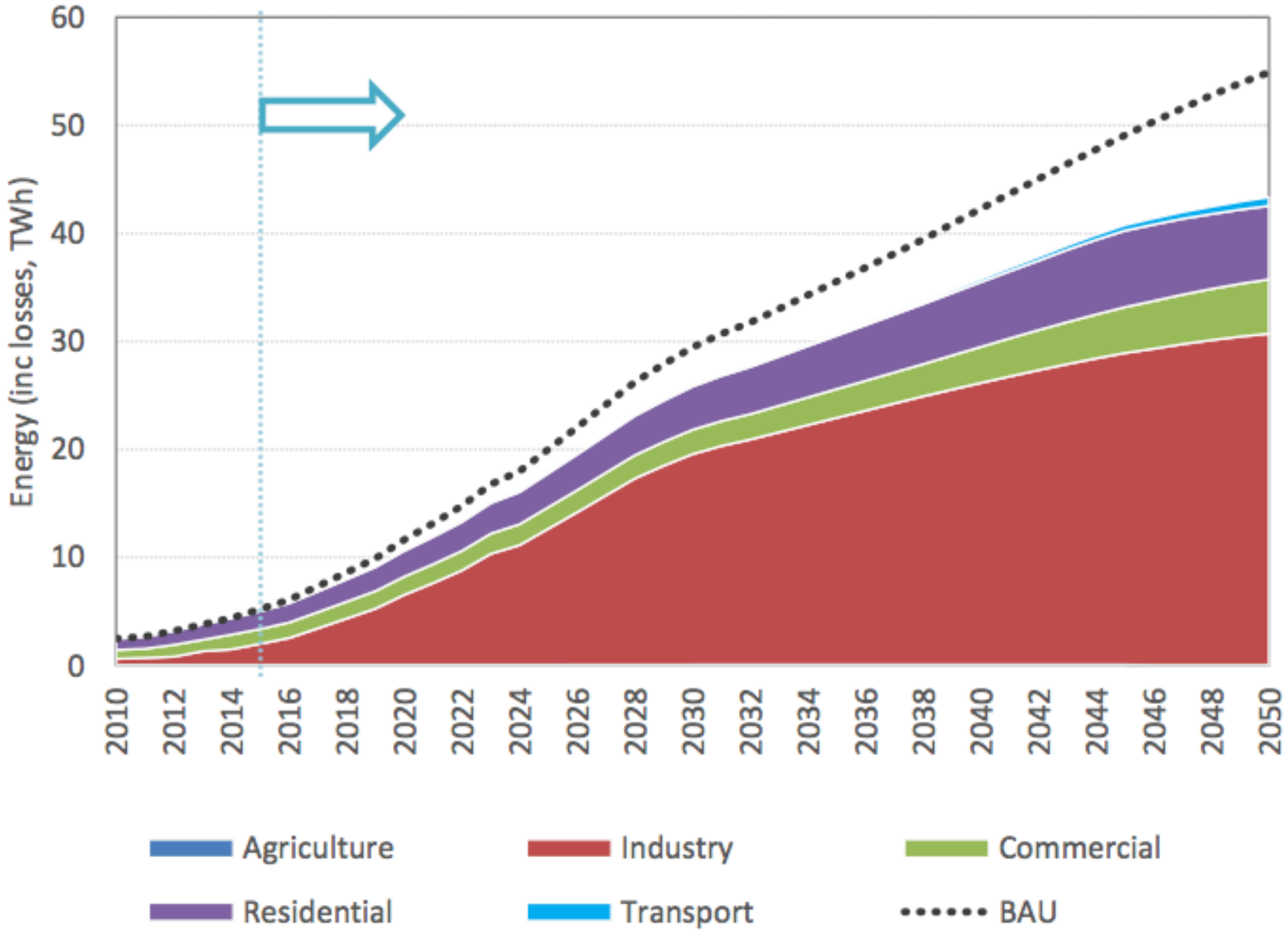

Figure 55 Lao PDR Projected Electricity Demand (2015-50, ASES)

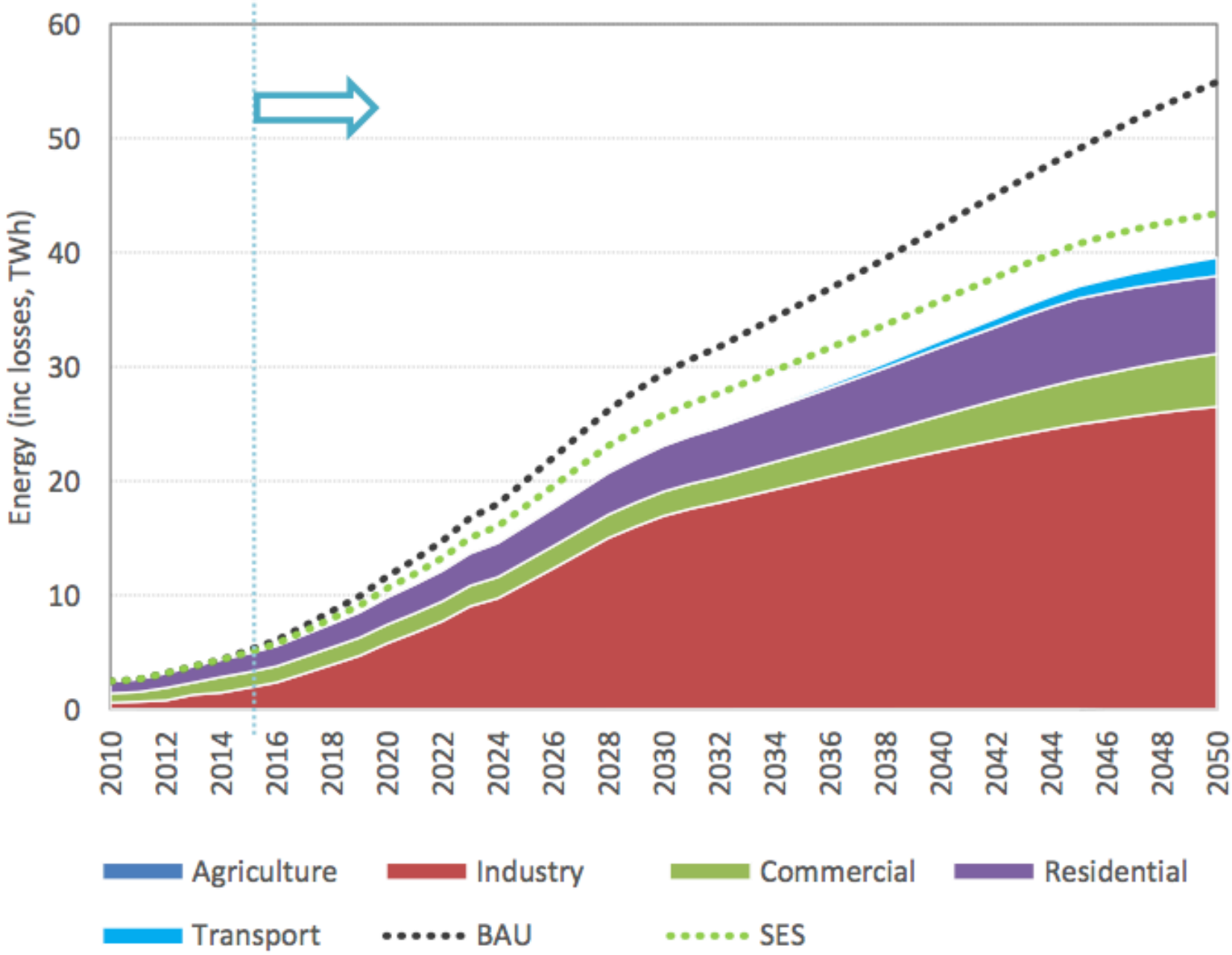

Figure 68 Lao PDR Electricity Demand Comparison

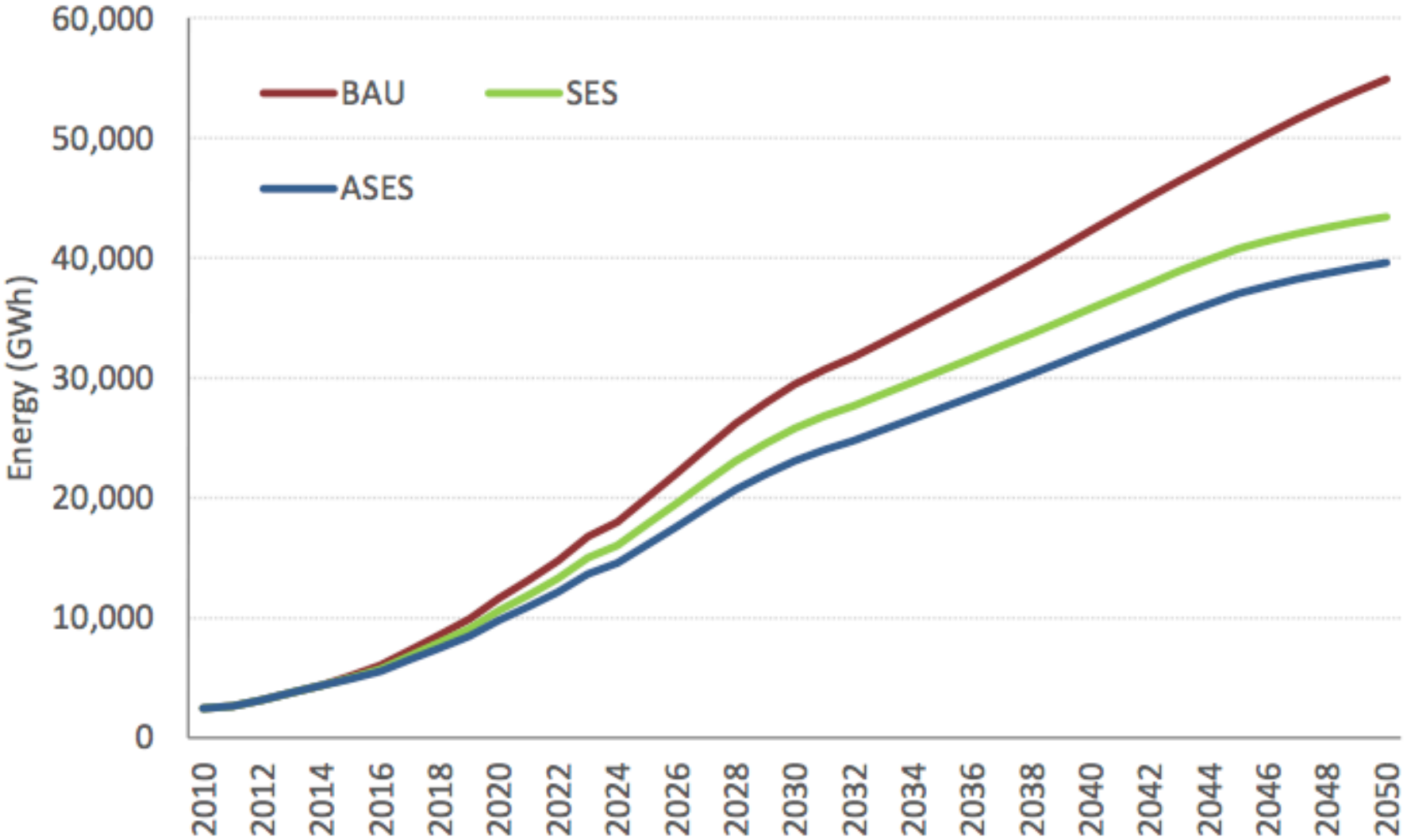

Figure 30 Lao PDR Projected peak Demand (BAU)

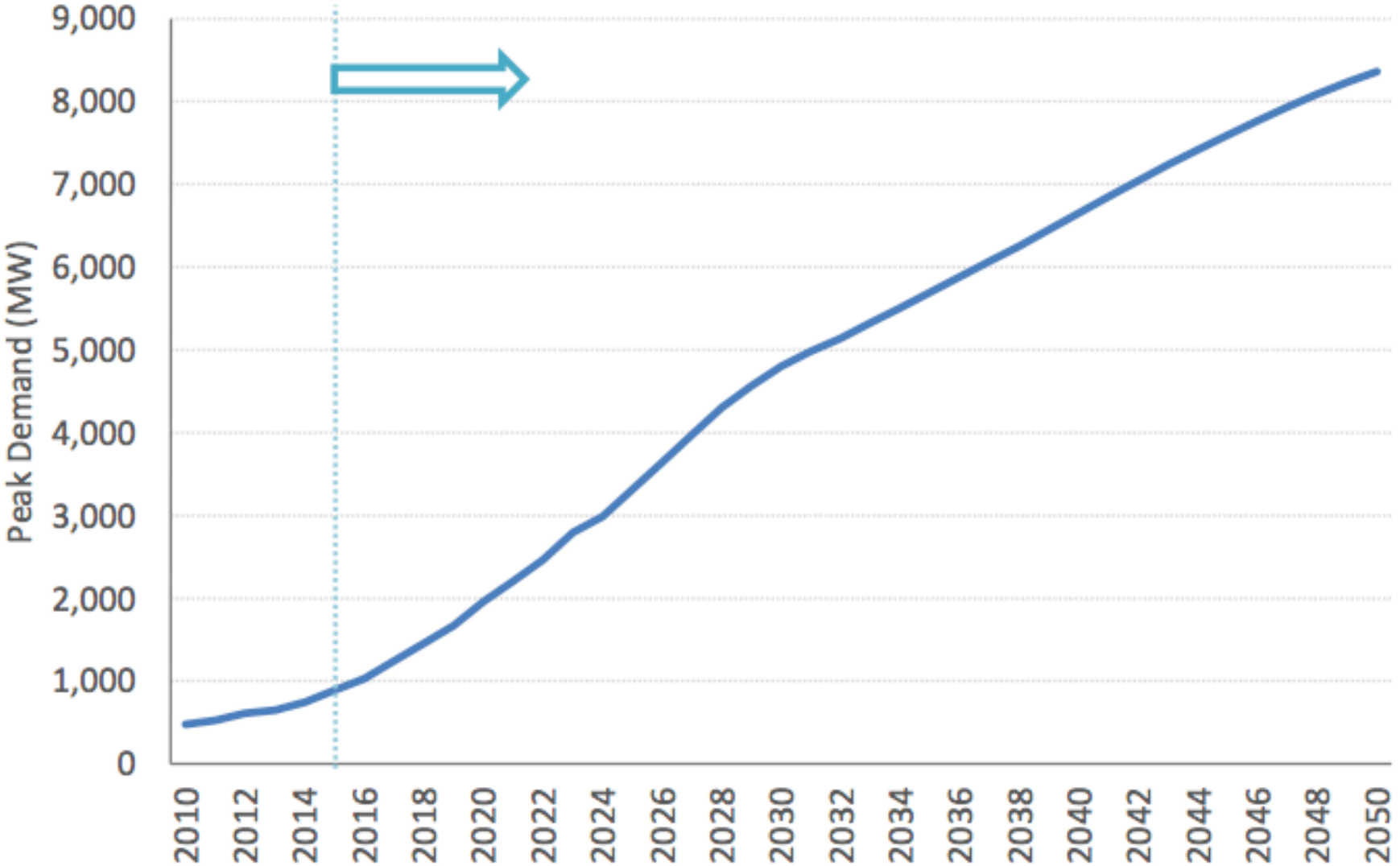

Figure 43 Lao PDR Projected Electricity Demand (SES, MW)

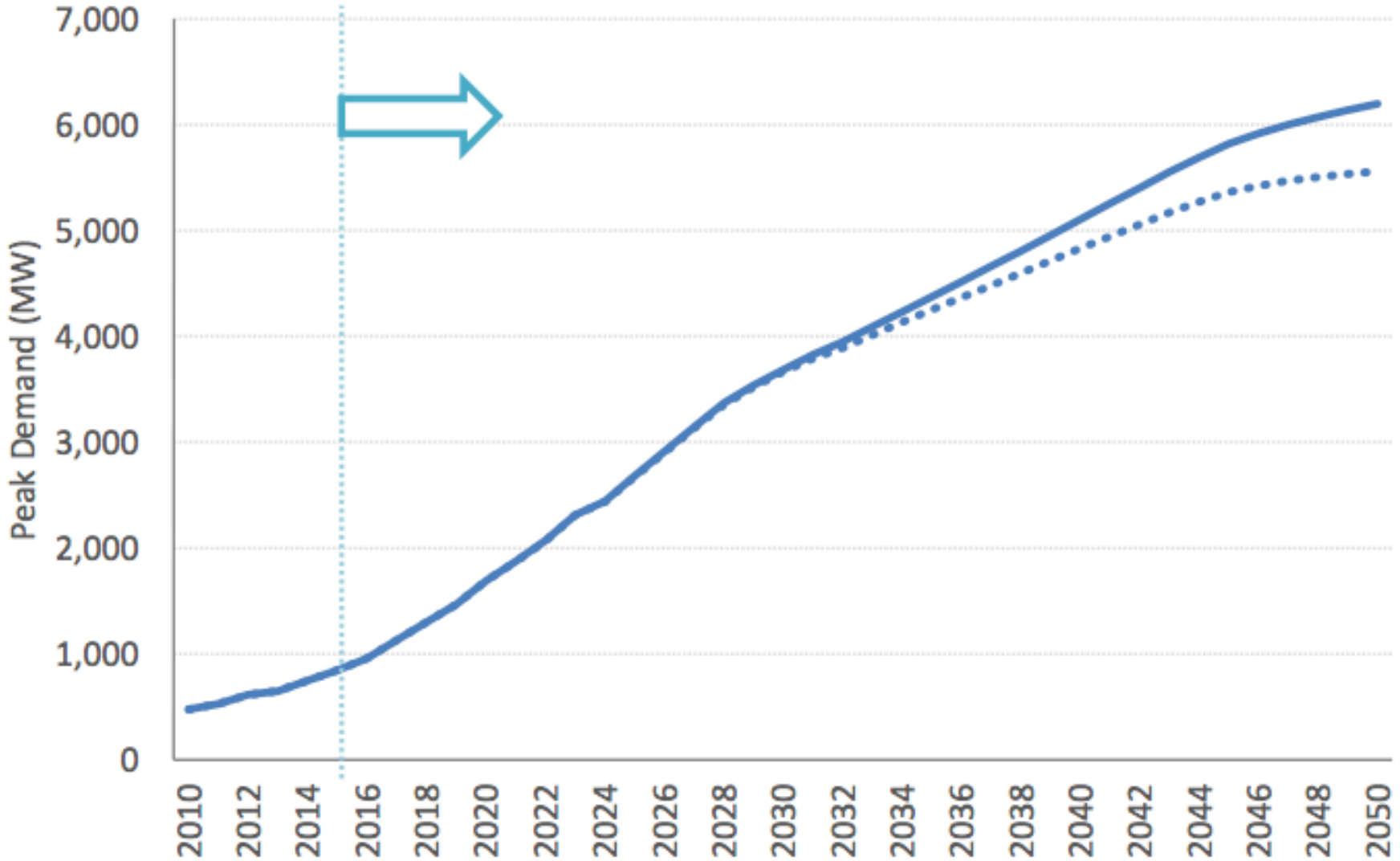

Figure 56 Lao PDR Projected Electricity Demand (ASES, MW)

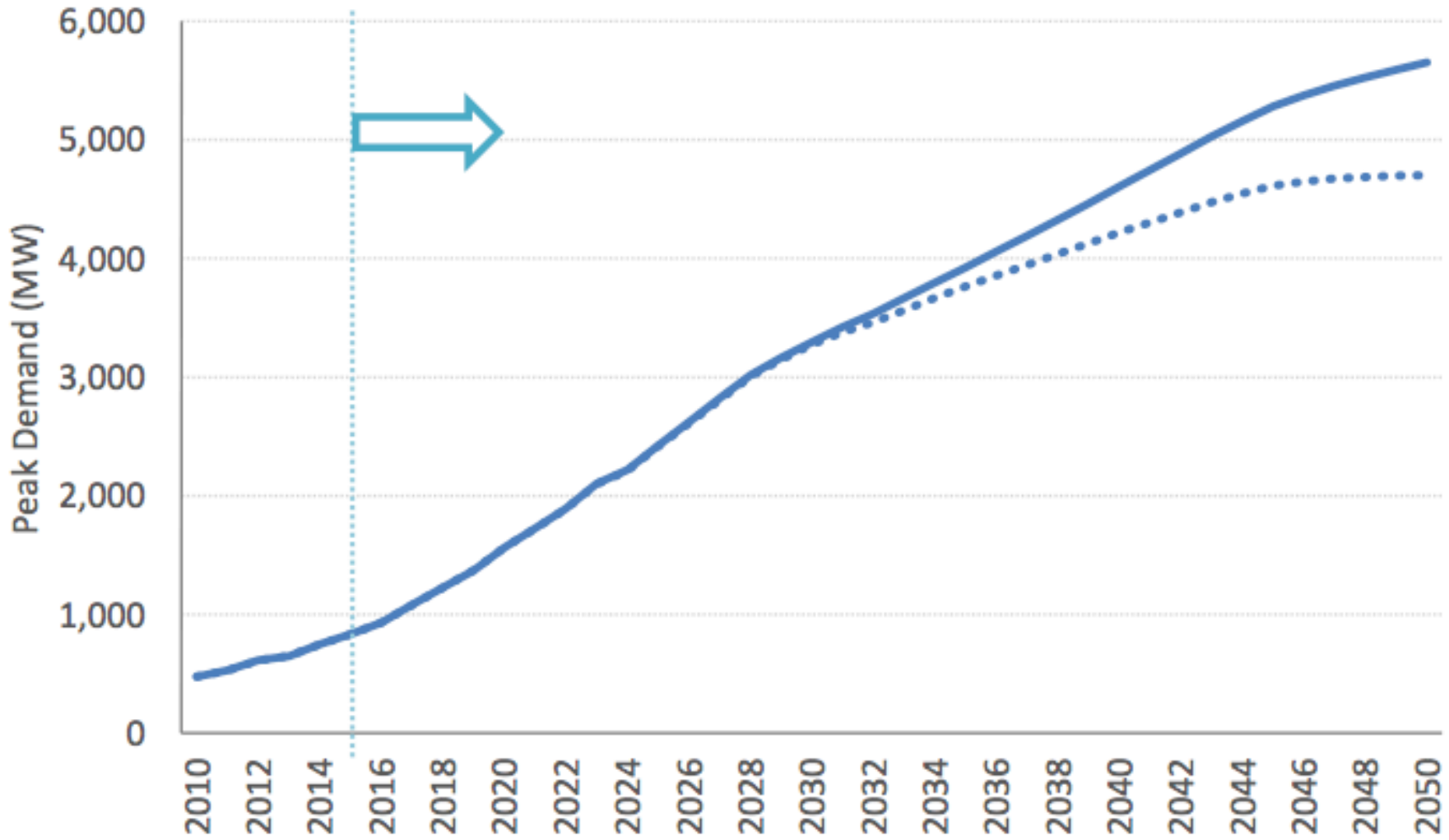

Figure 70 Lao PDR Peak Demand Comparison

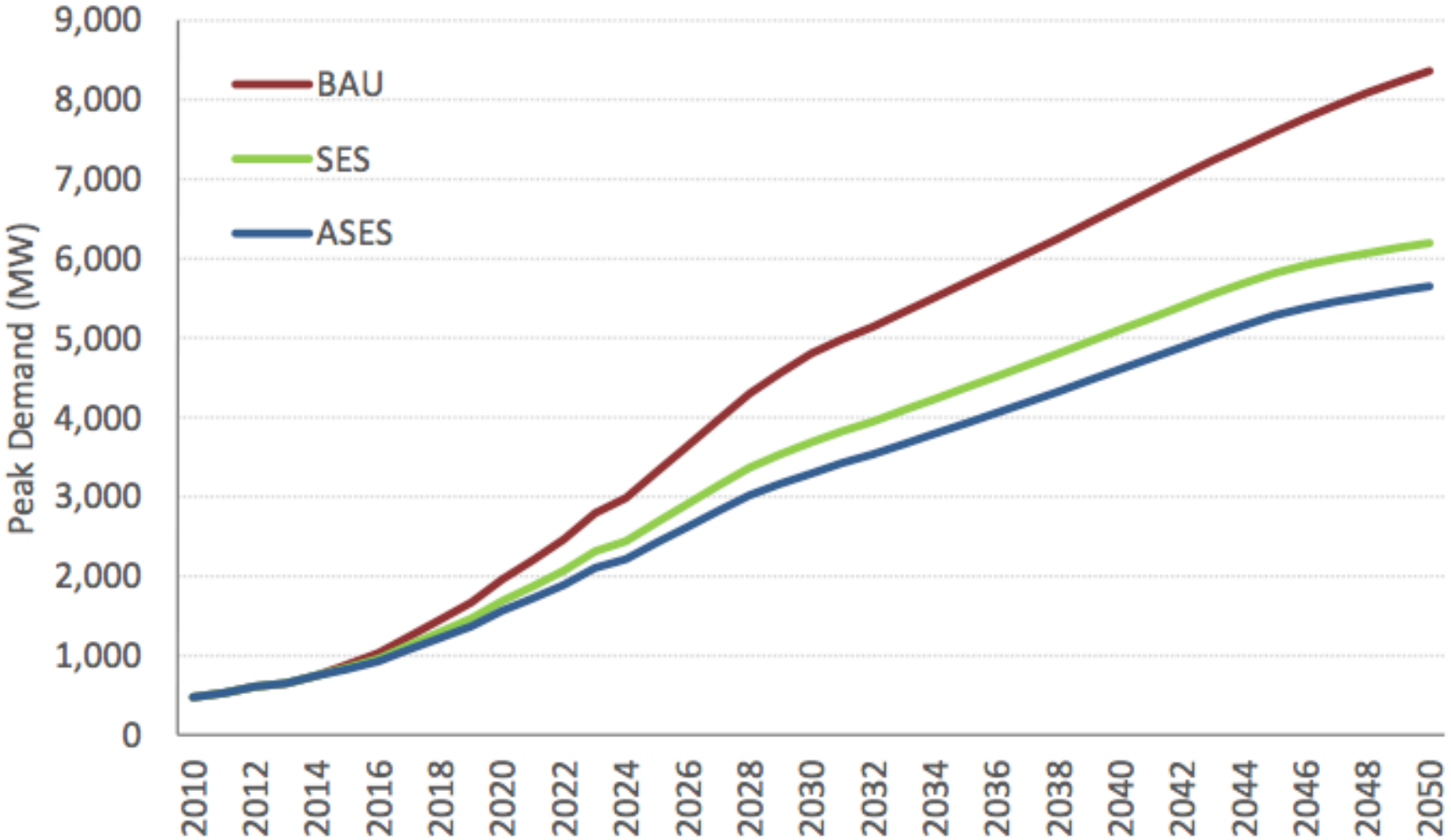

Figure 35 **Lao PDR Imports and Exports (BAU)**

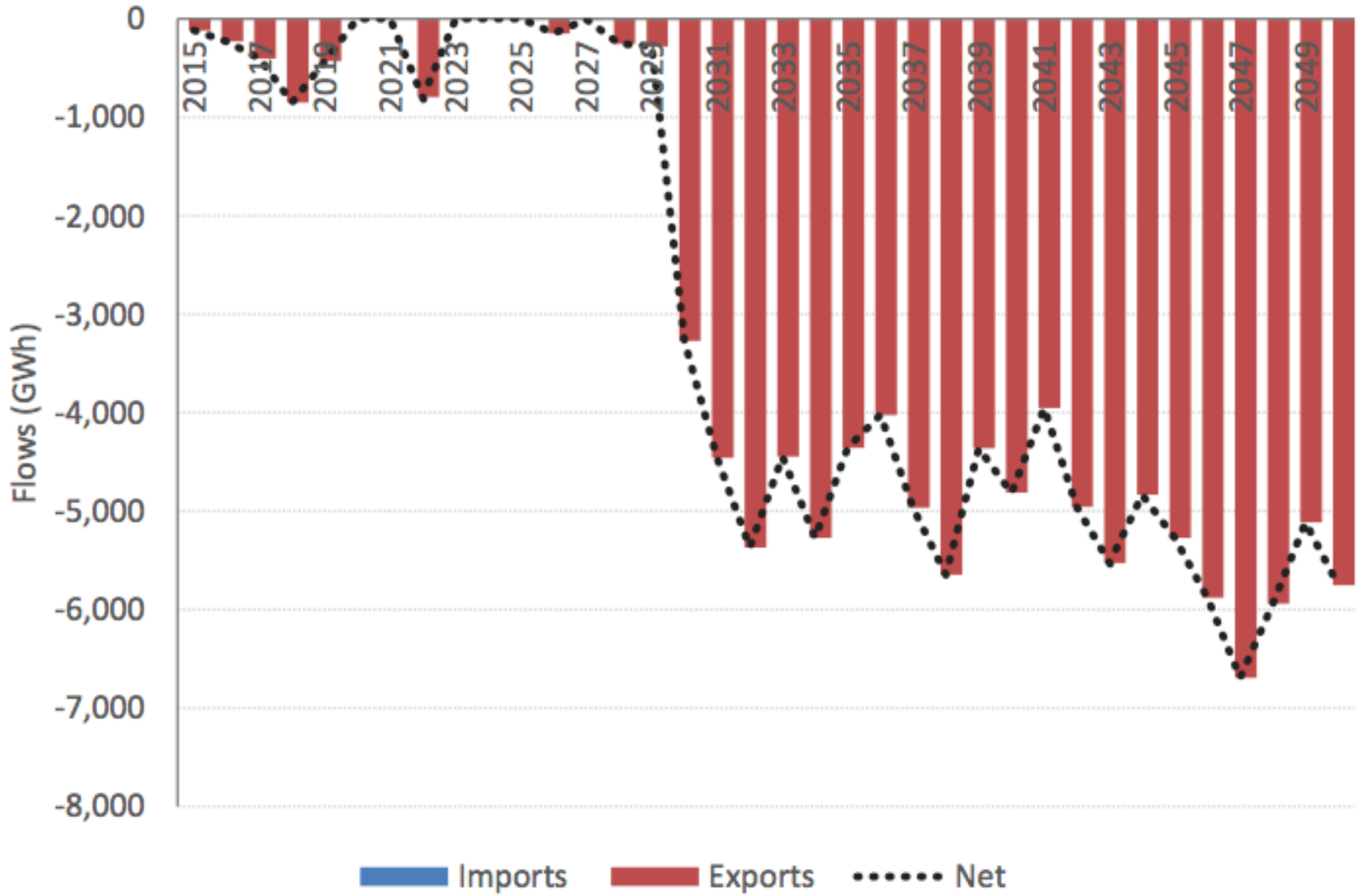

Figure 48 Lao PDR Imports and Exports (SES)

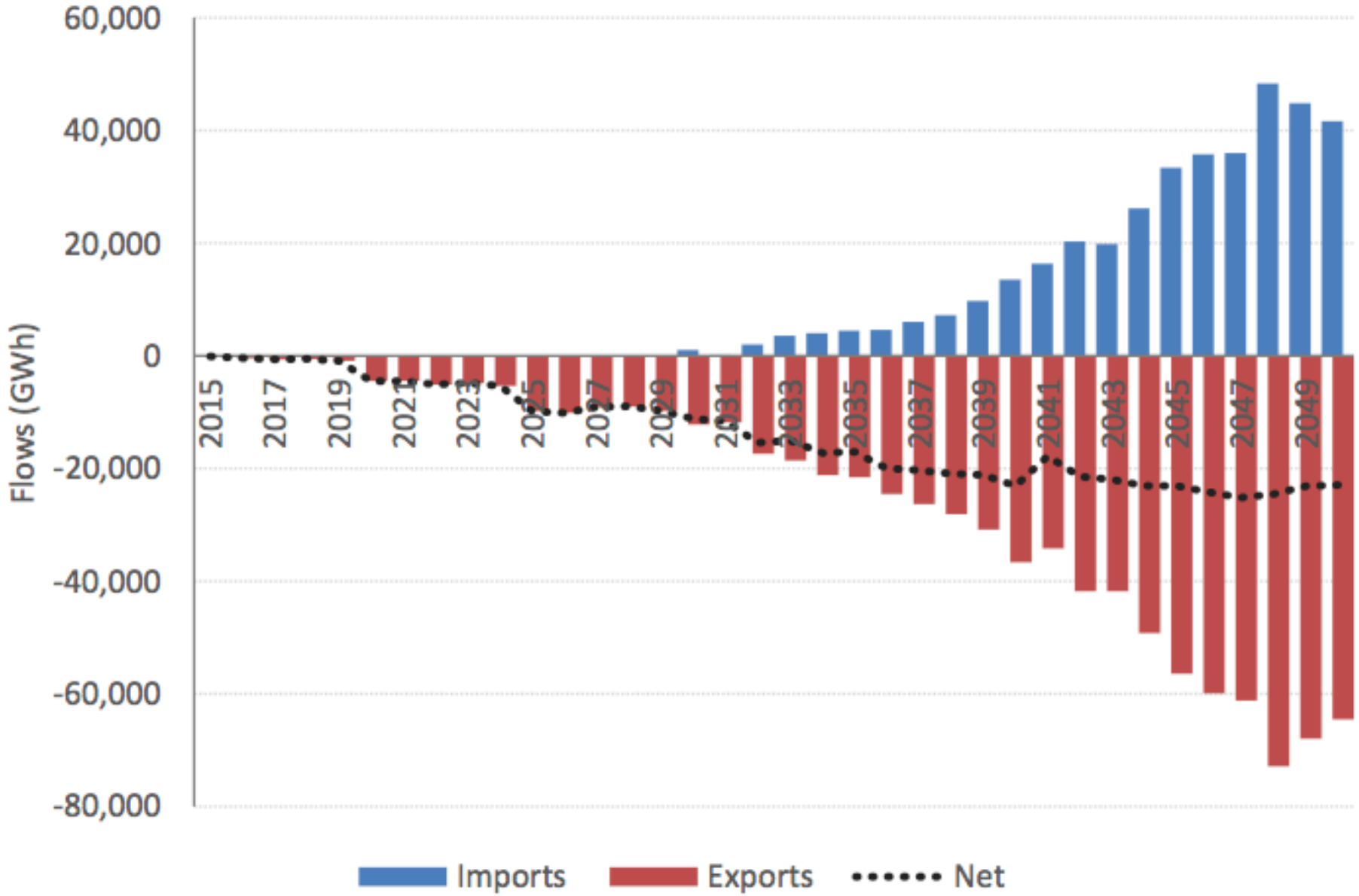

Figure 61 **Lao PDR Imports and Exports (ASES, GWh)**

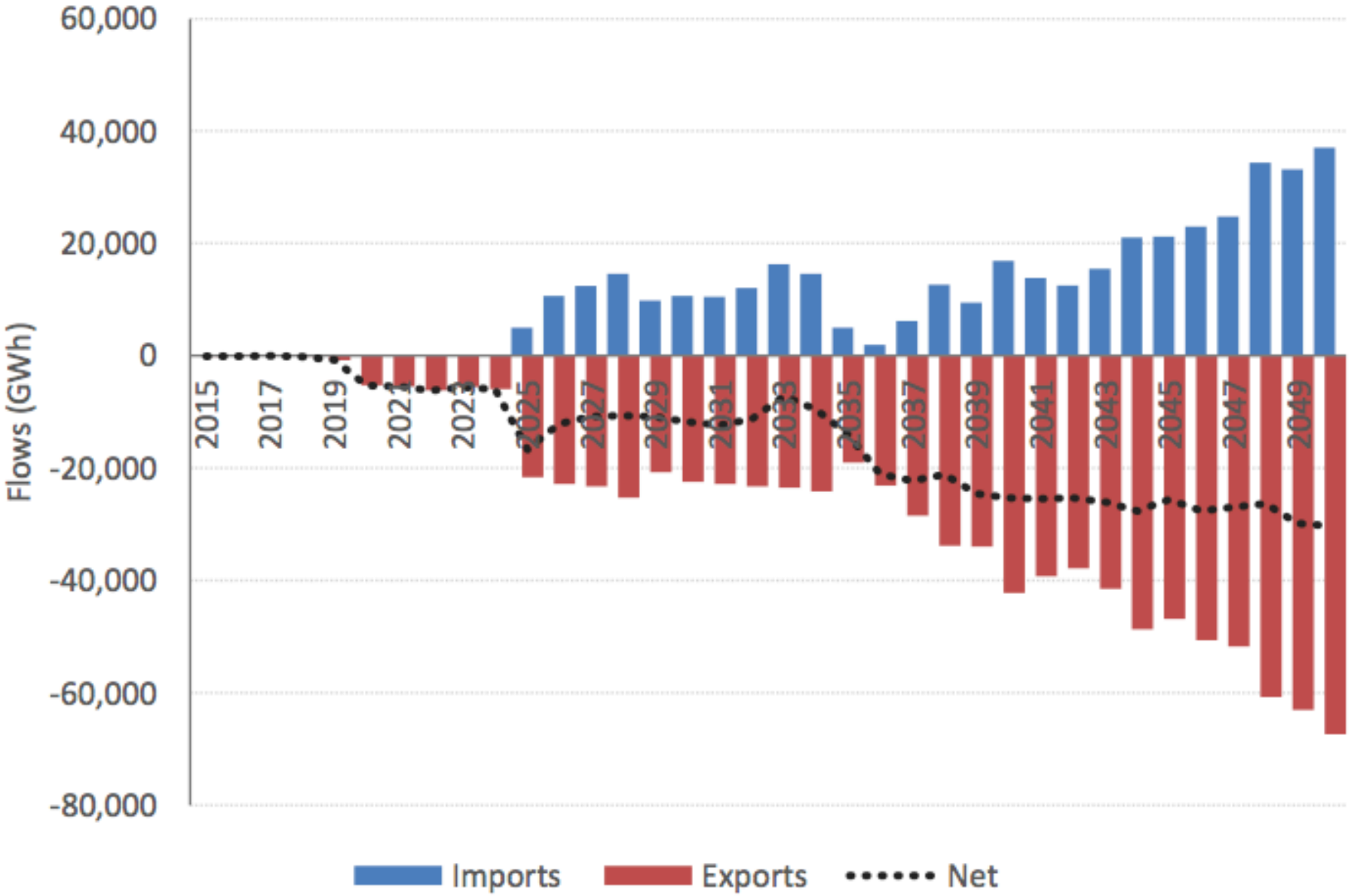

Figure 82 Lao PDR Imports (positive) and Exports (negative) (GWh)

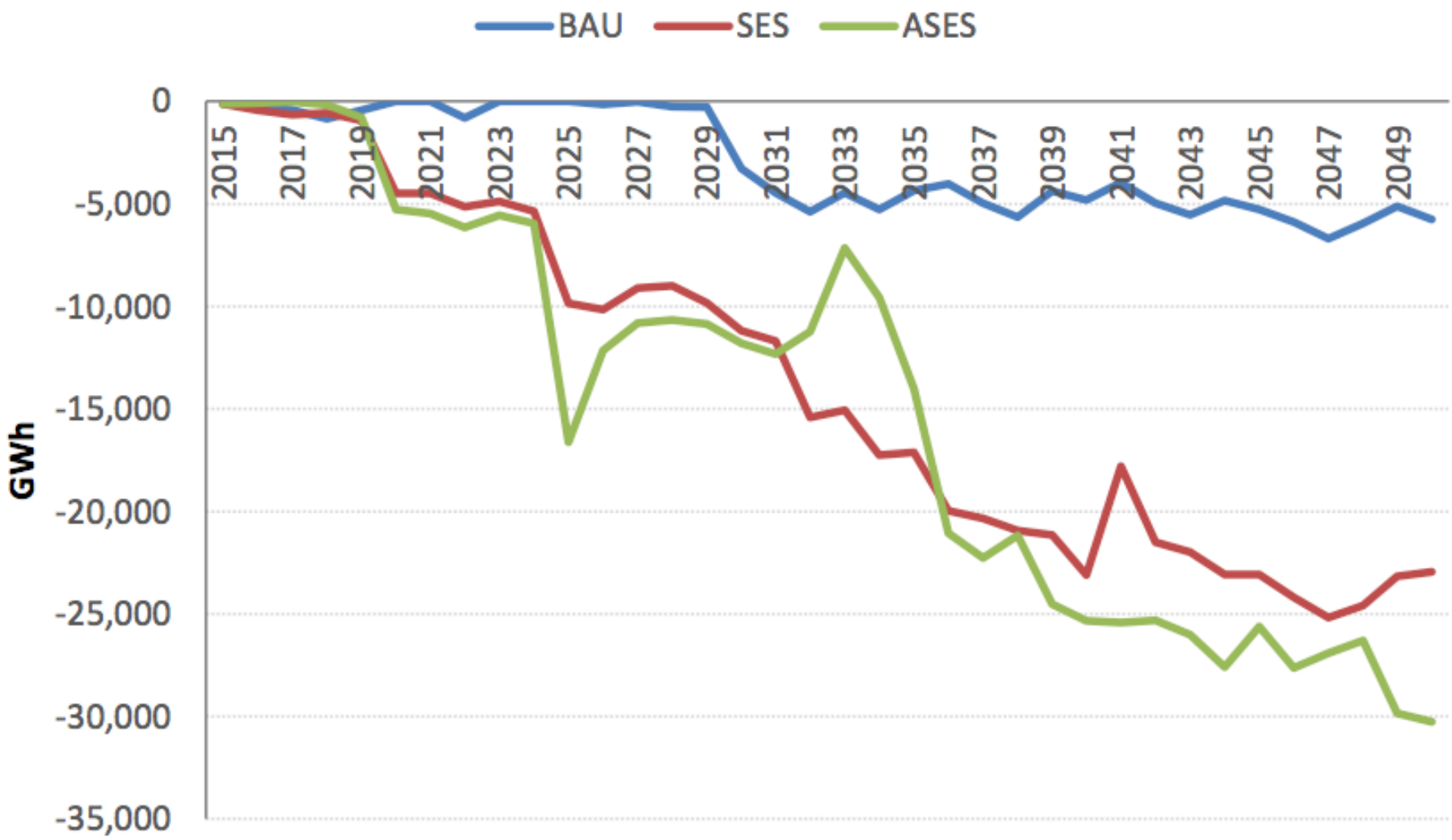

Figure 29 Regional Transmission System Model of GMS

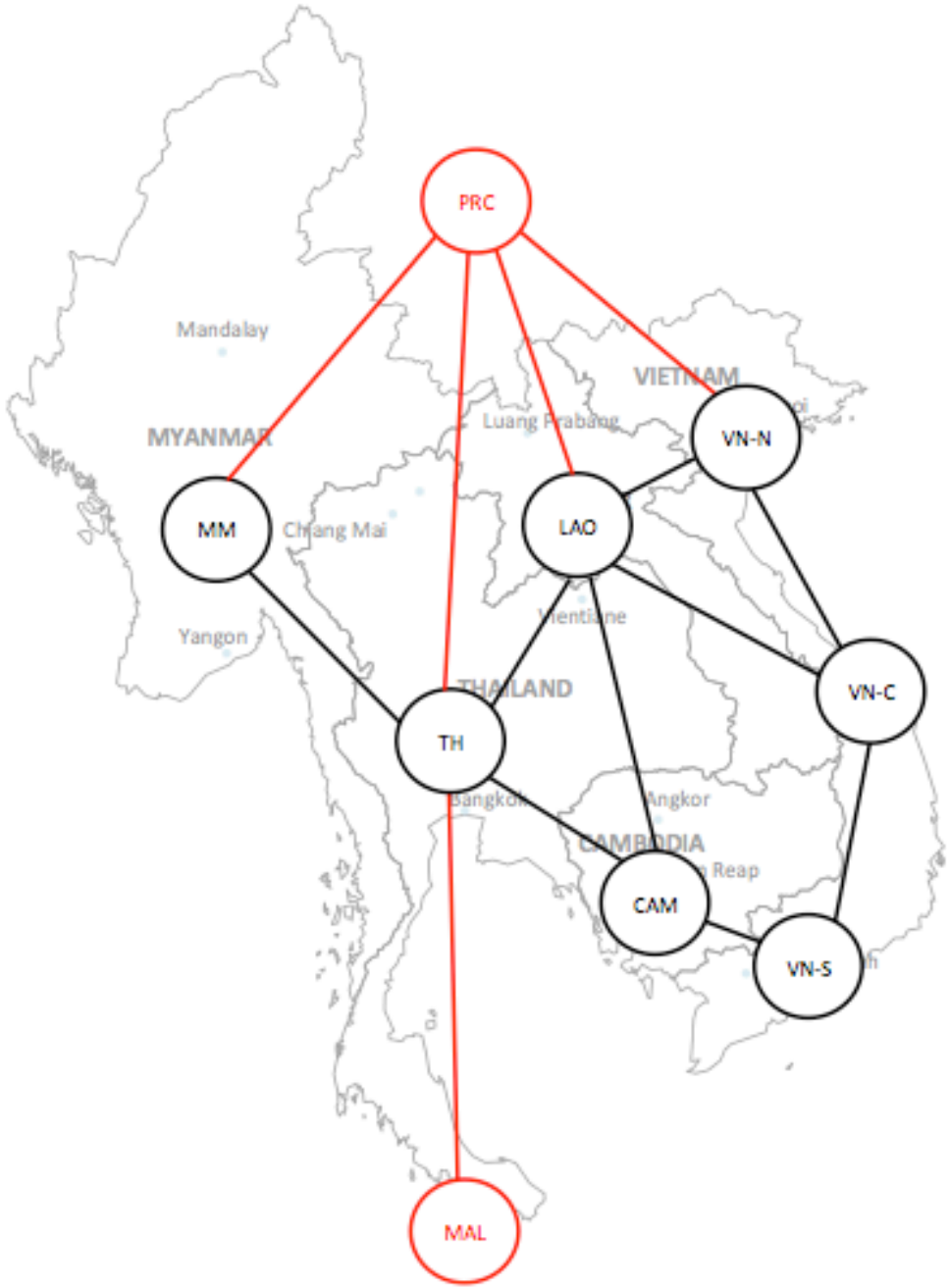

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Figure 31 Lao PDR Installed Capacity (BAU, MW)

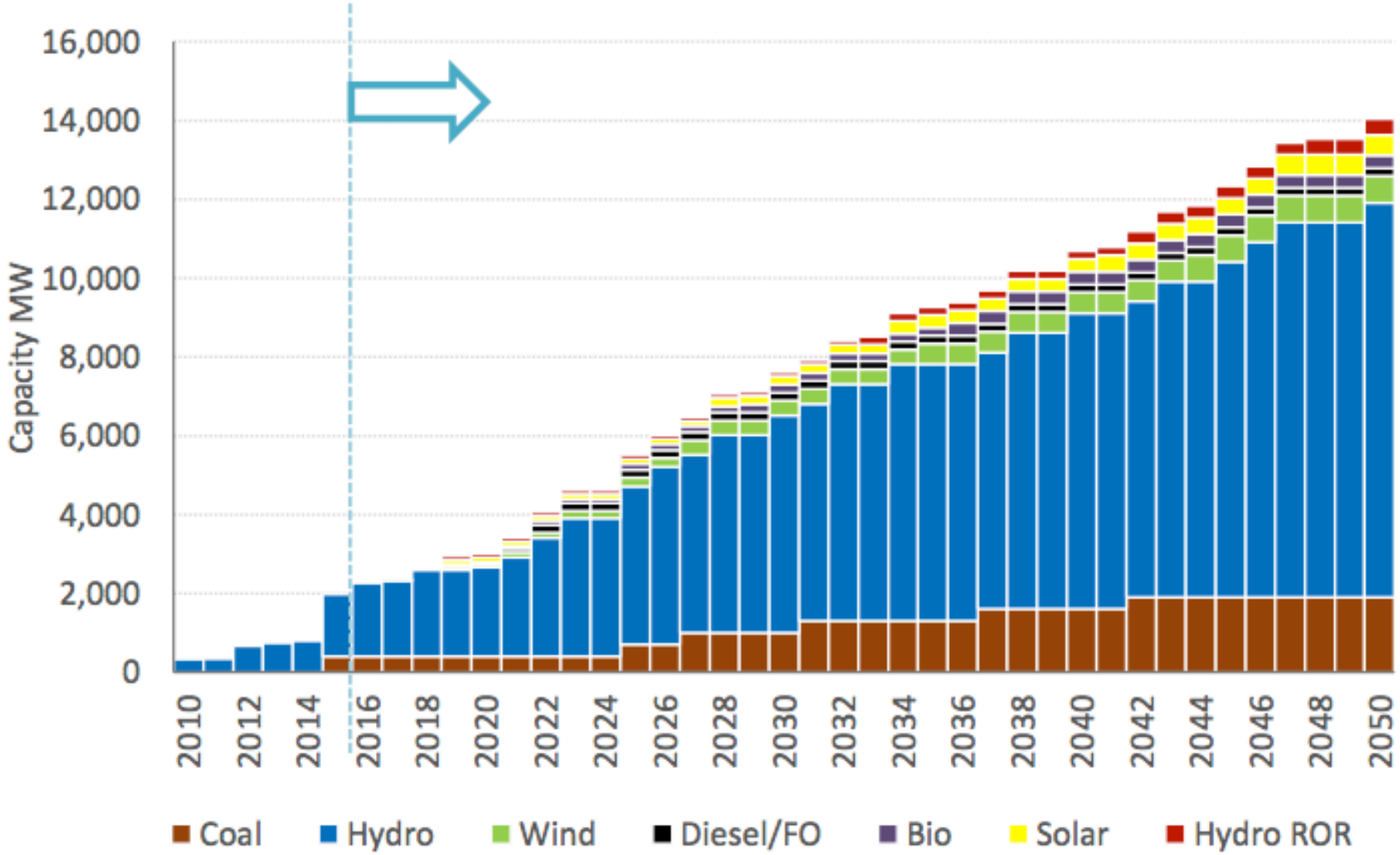

Figure 44 Lao PDR Installed Capacity by Type (SES, MW)

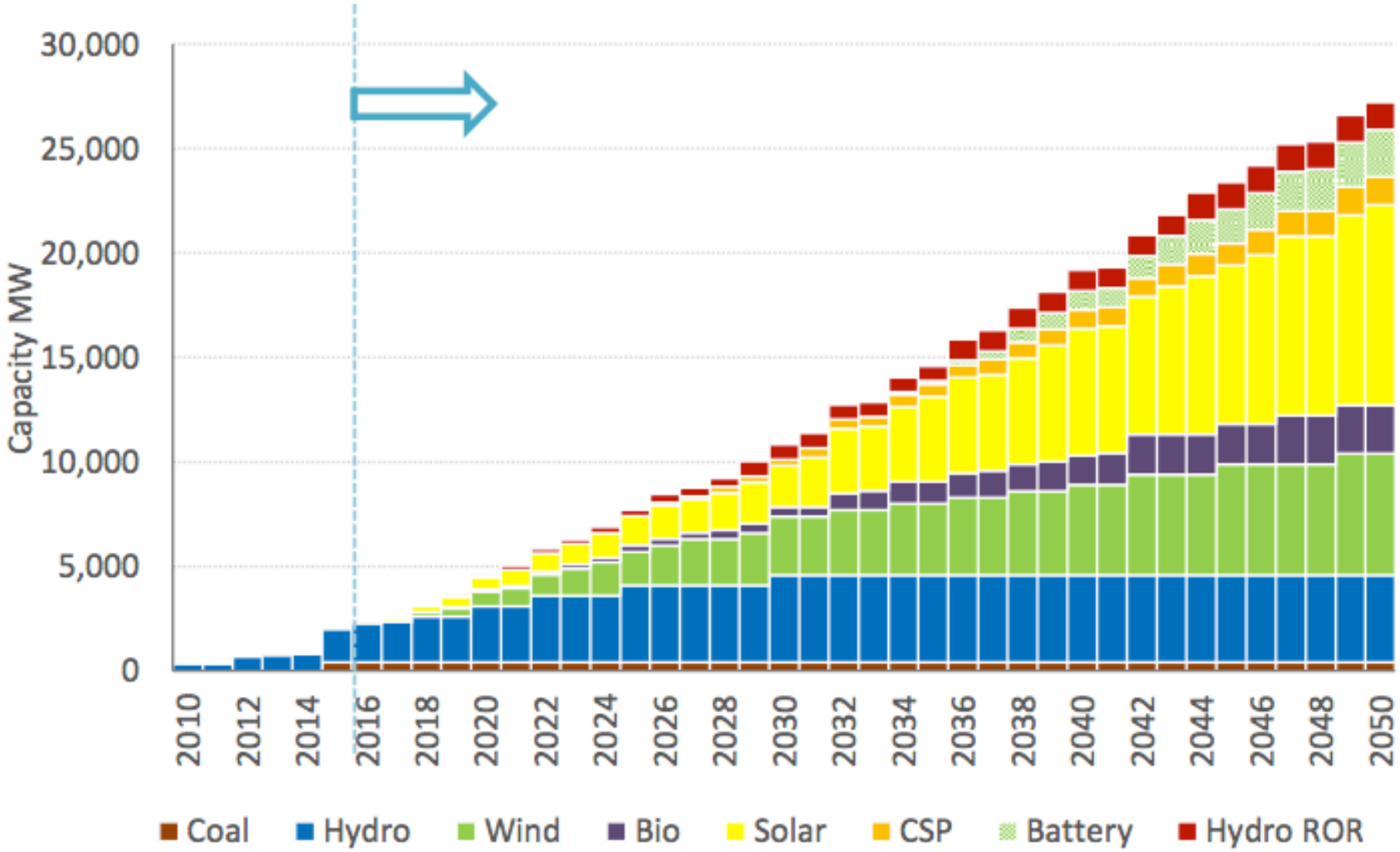

Figure 57 Lao PDR Installed Capacity by Type (ASES, MW)

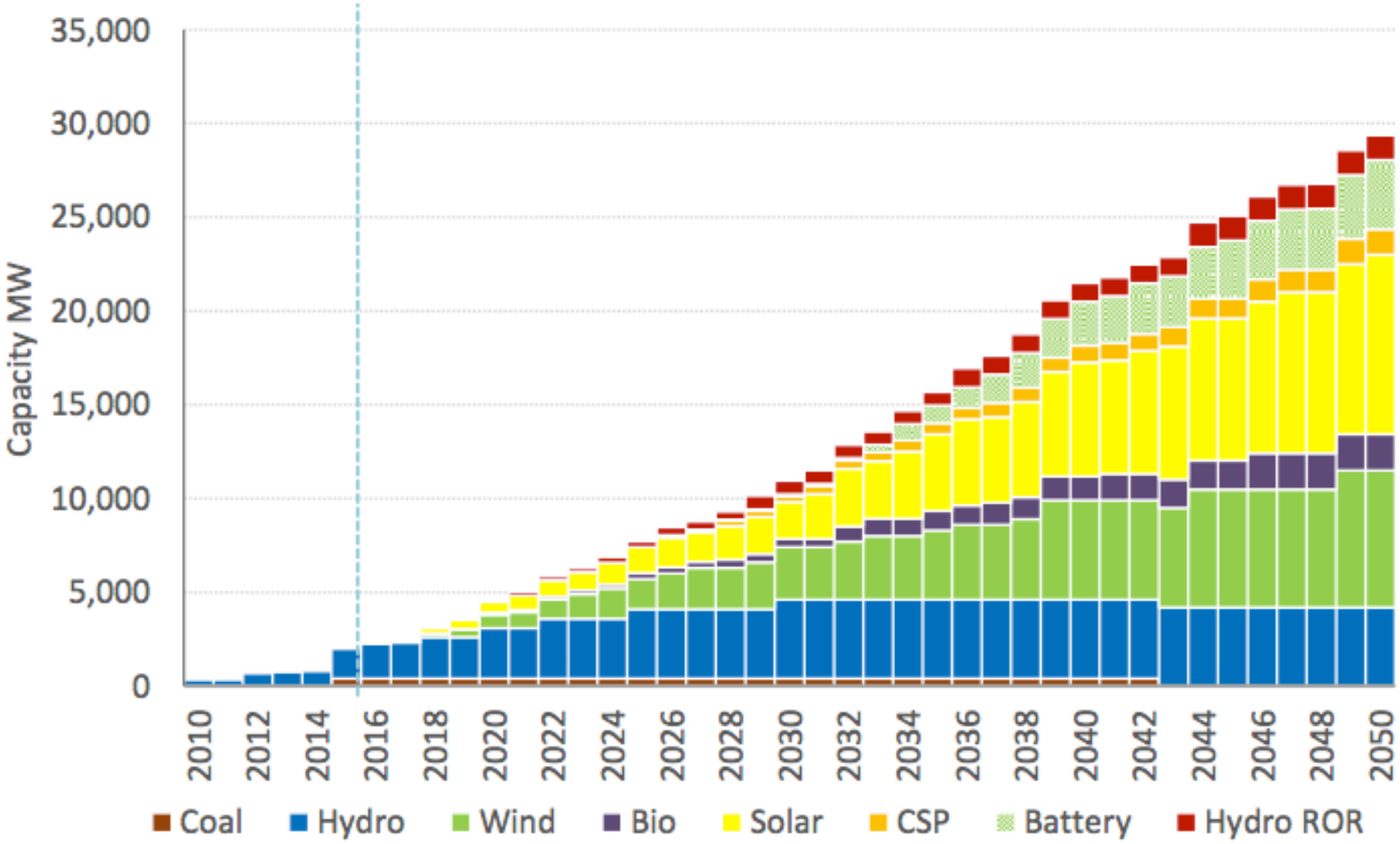

Figure 32 **Lao PDR Installed Capacity Mix Percentages (BAU, %)**

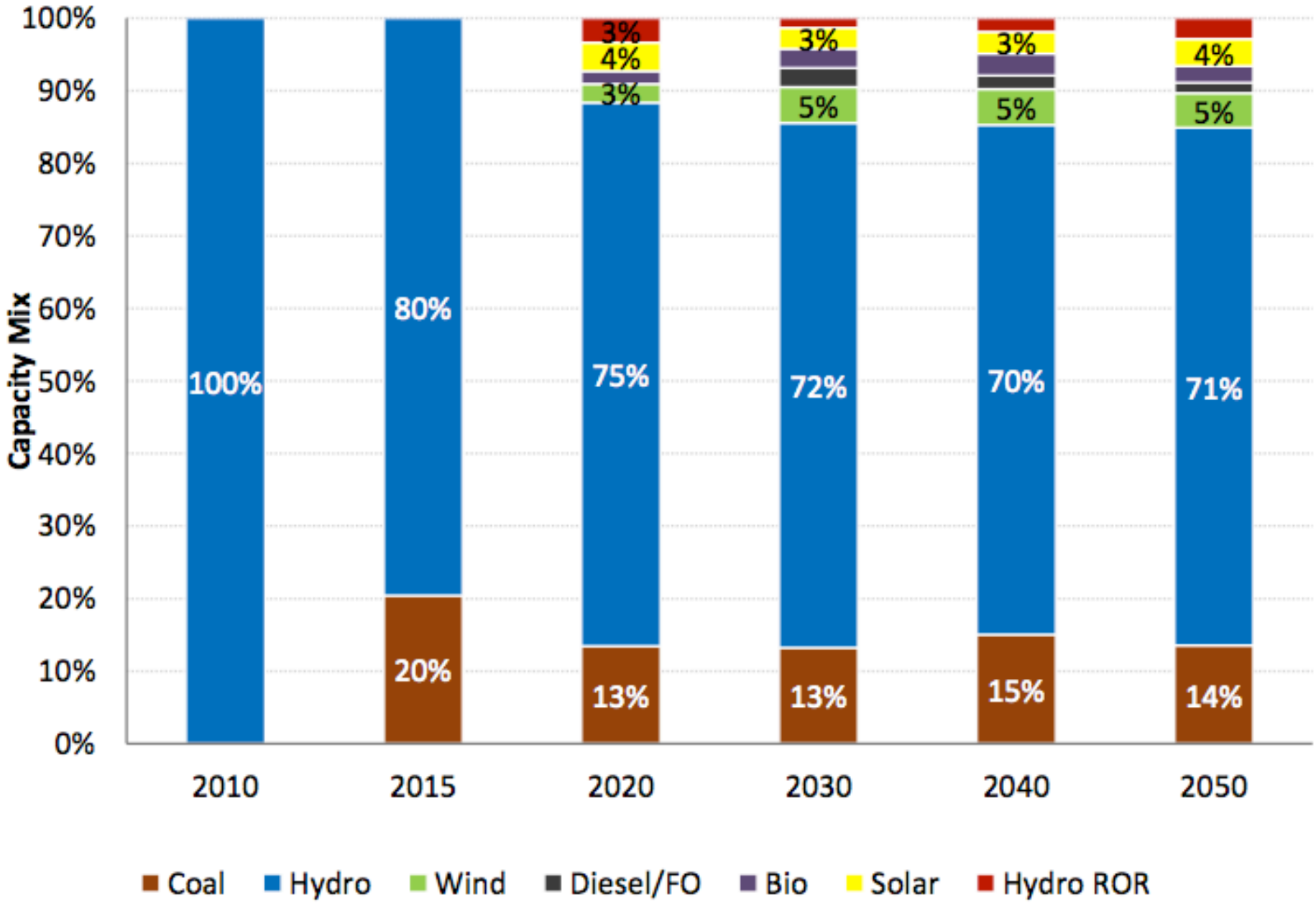

Figure 45 Lao PDR Capacity Shares (SES, %)

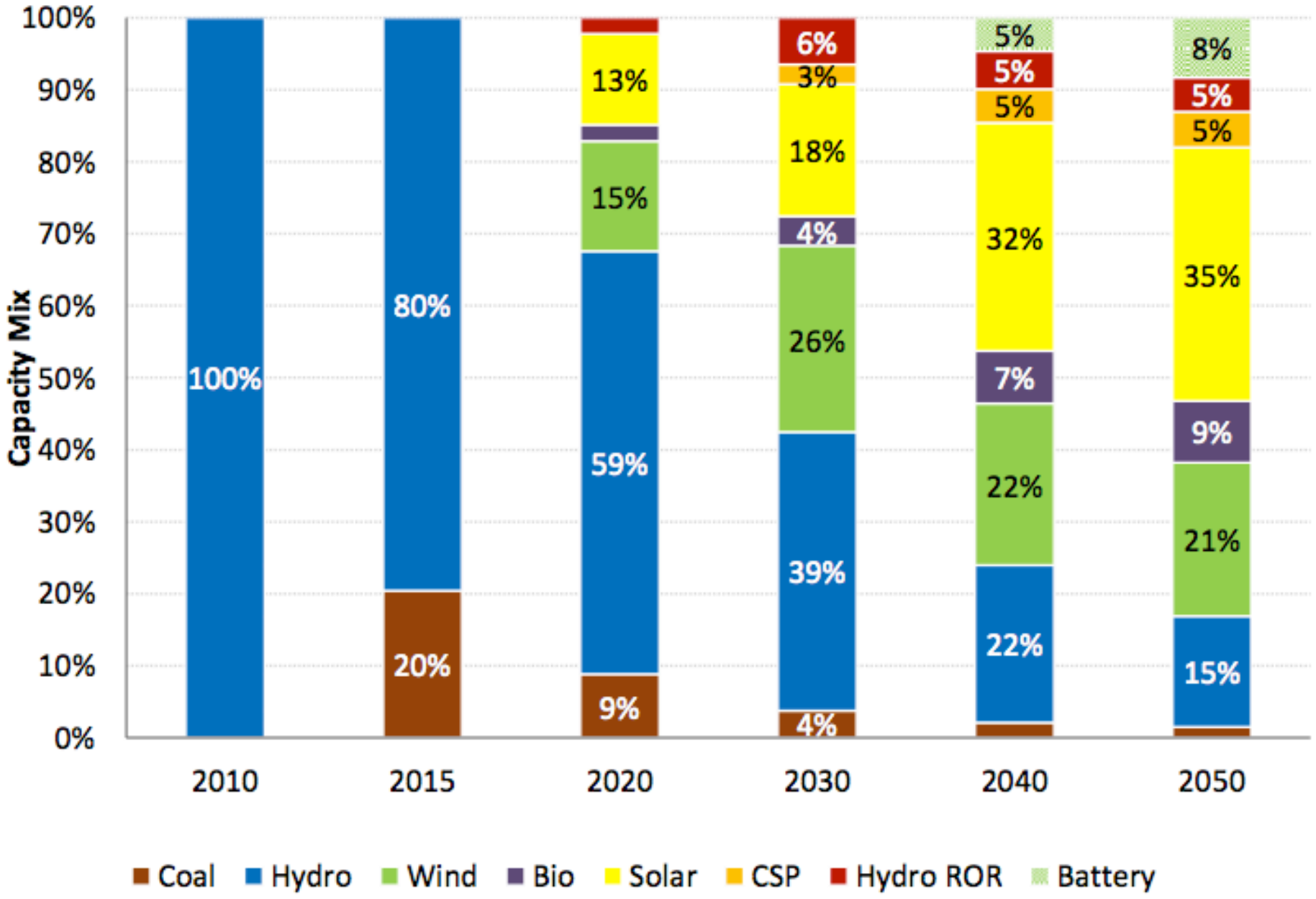

Figure 58 Lao PDR Capacity Shares (ASES, %)

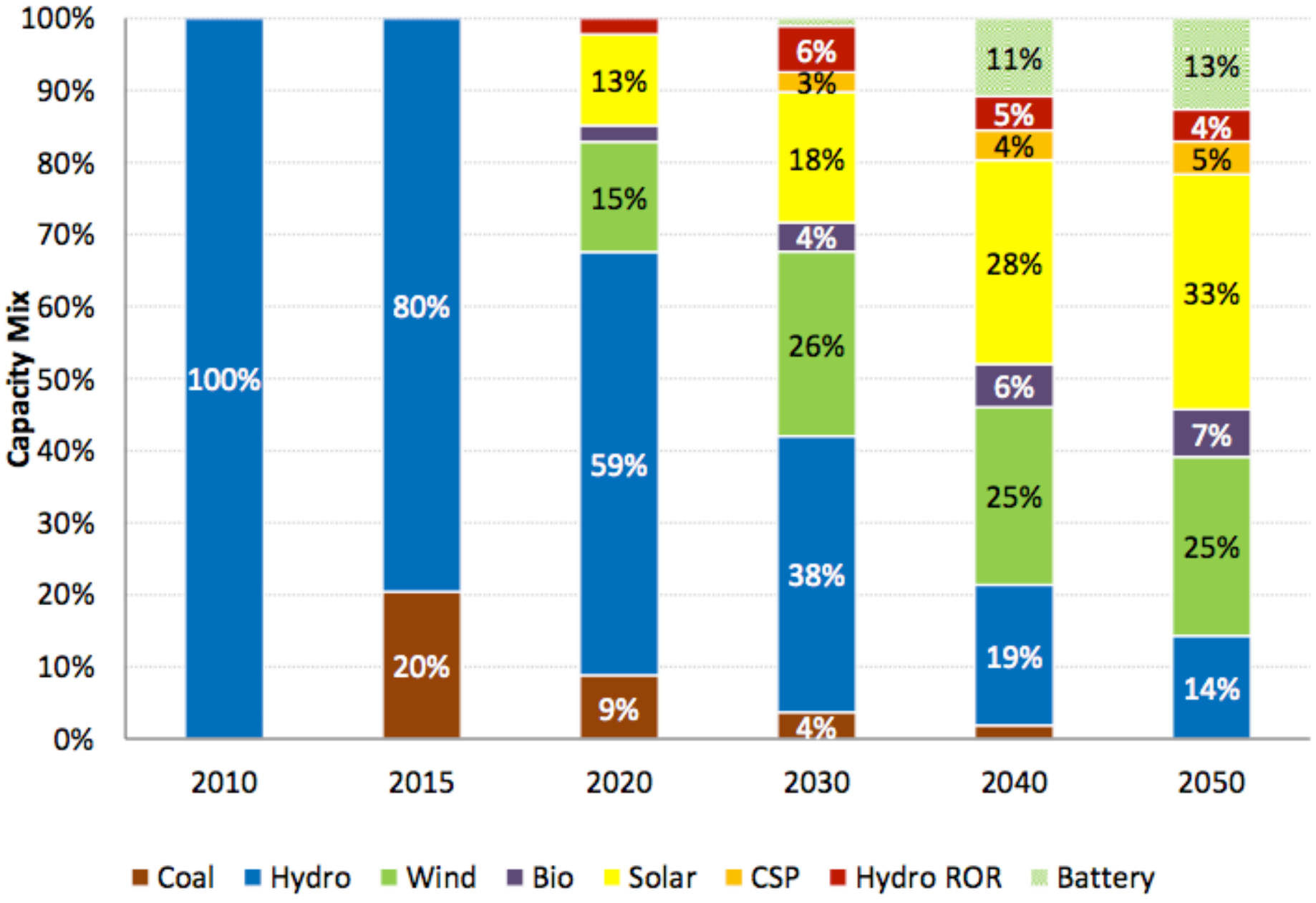

Figure 33 Lao PDR Generation Mix (BAU, GWh)

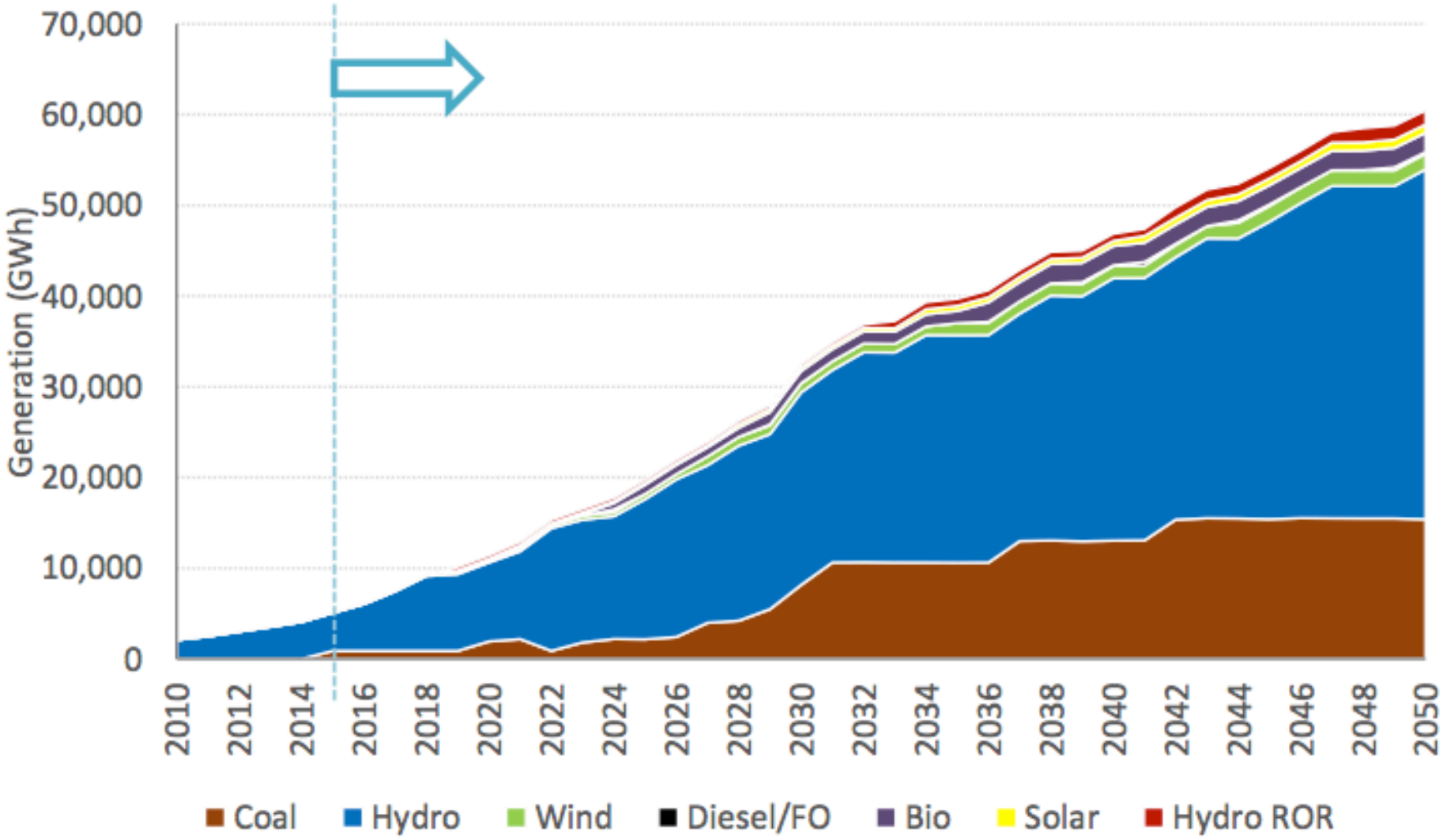

Figure 46 Lao PDR Generation Mix (SES, GWh)

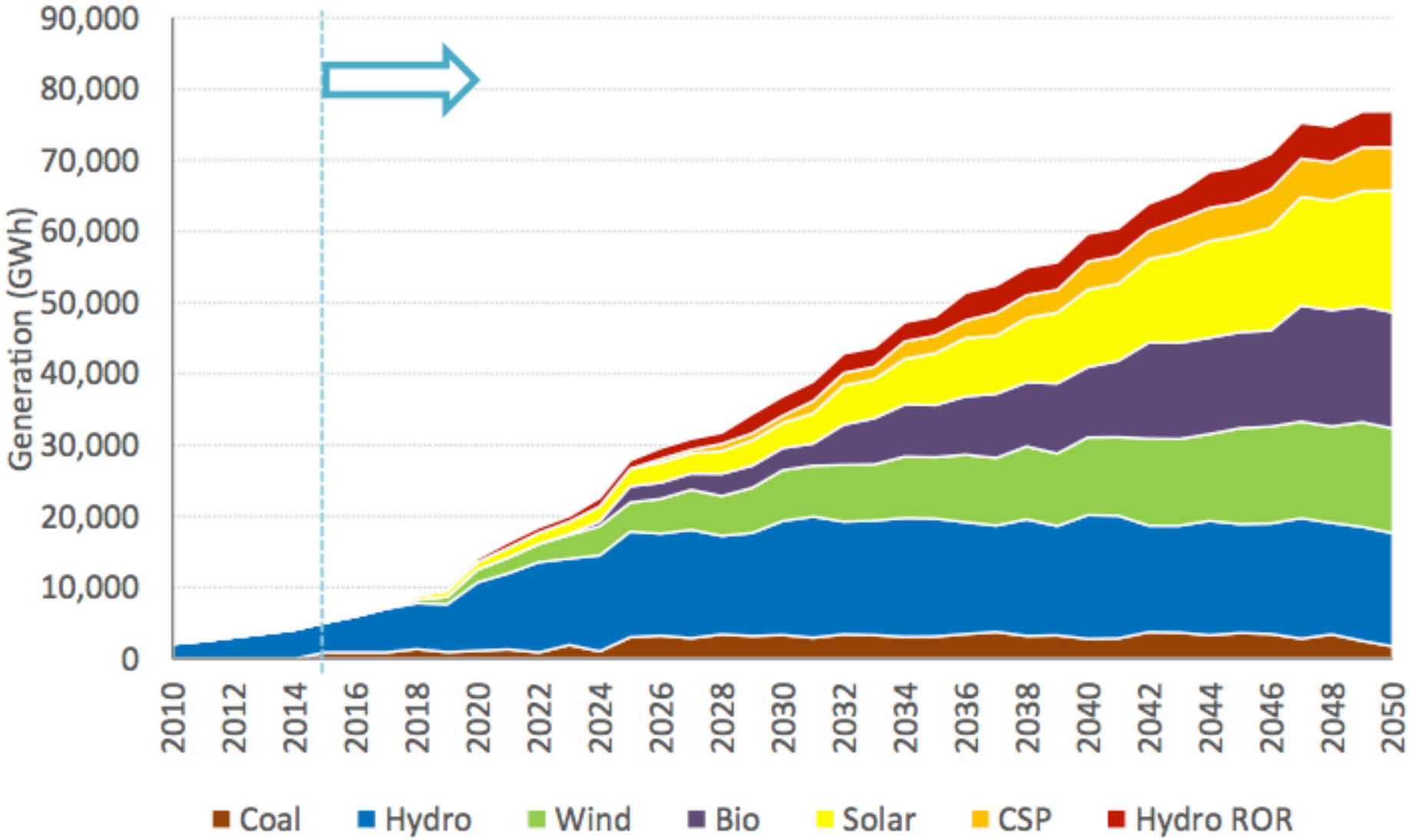

Figure 59 Lao PDR Generation Mix (ASES, GWh)

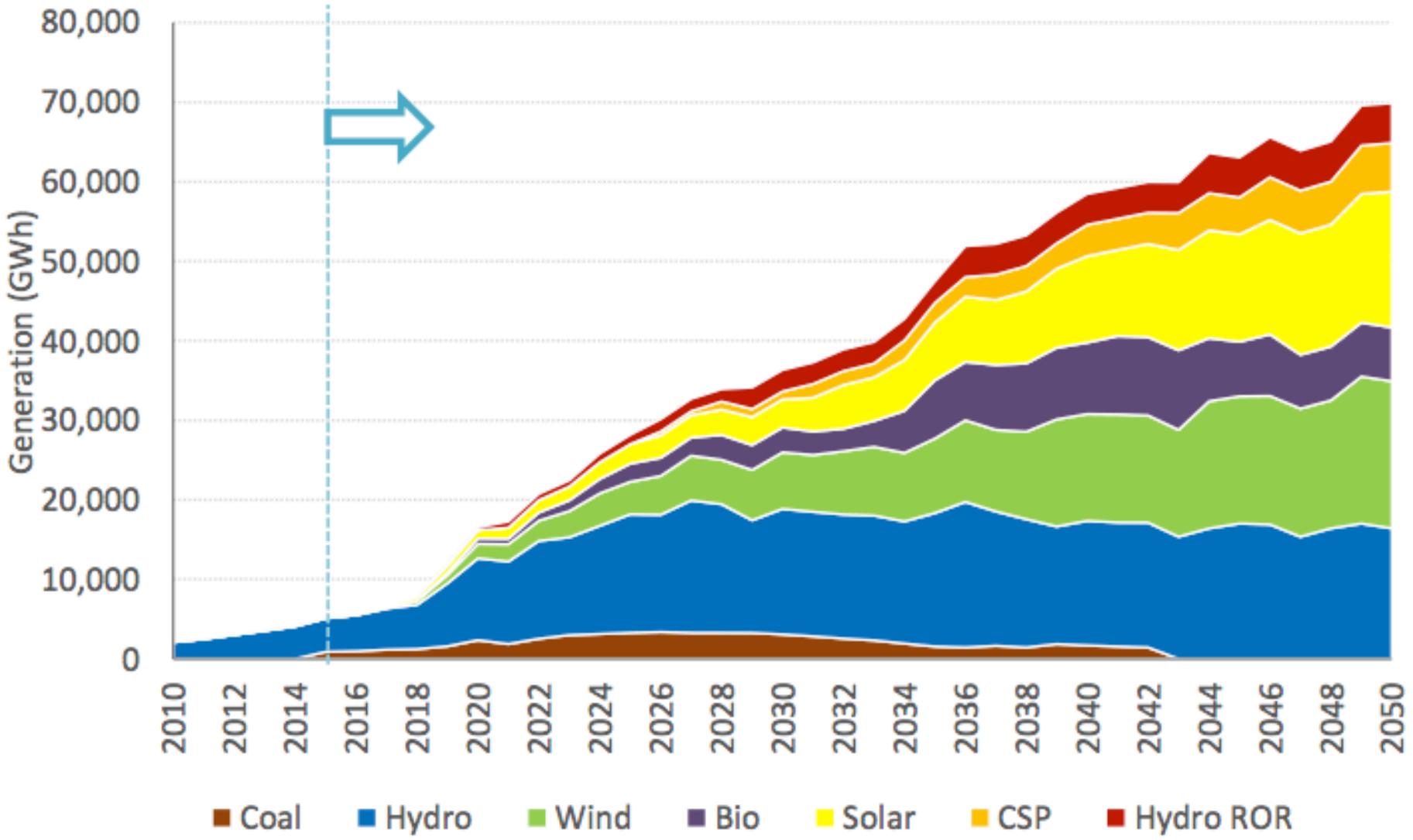

Figure 36 Lao PDR Installed Capacity by Generation Type (BAU, MW)

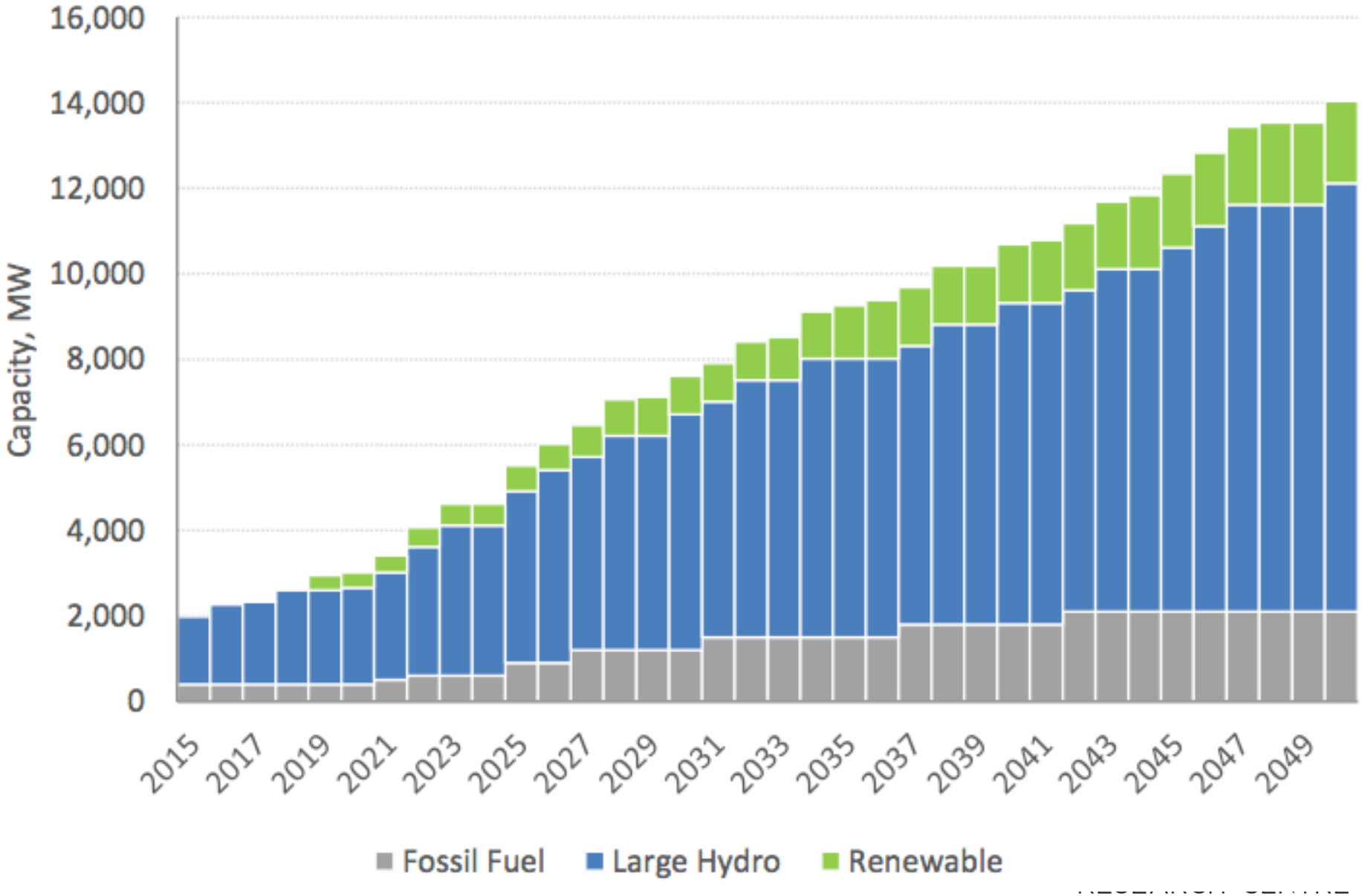

Figure 49 Lao PDR Installed Capacity by Generation Type (SES, MW)

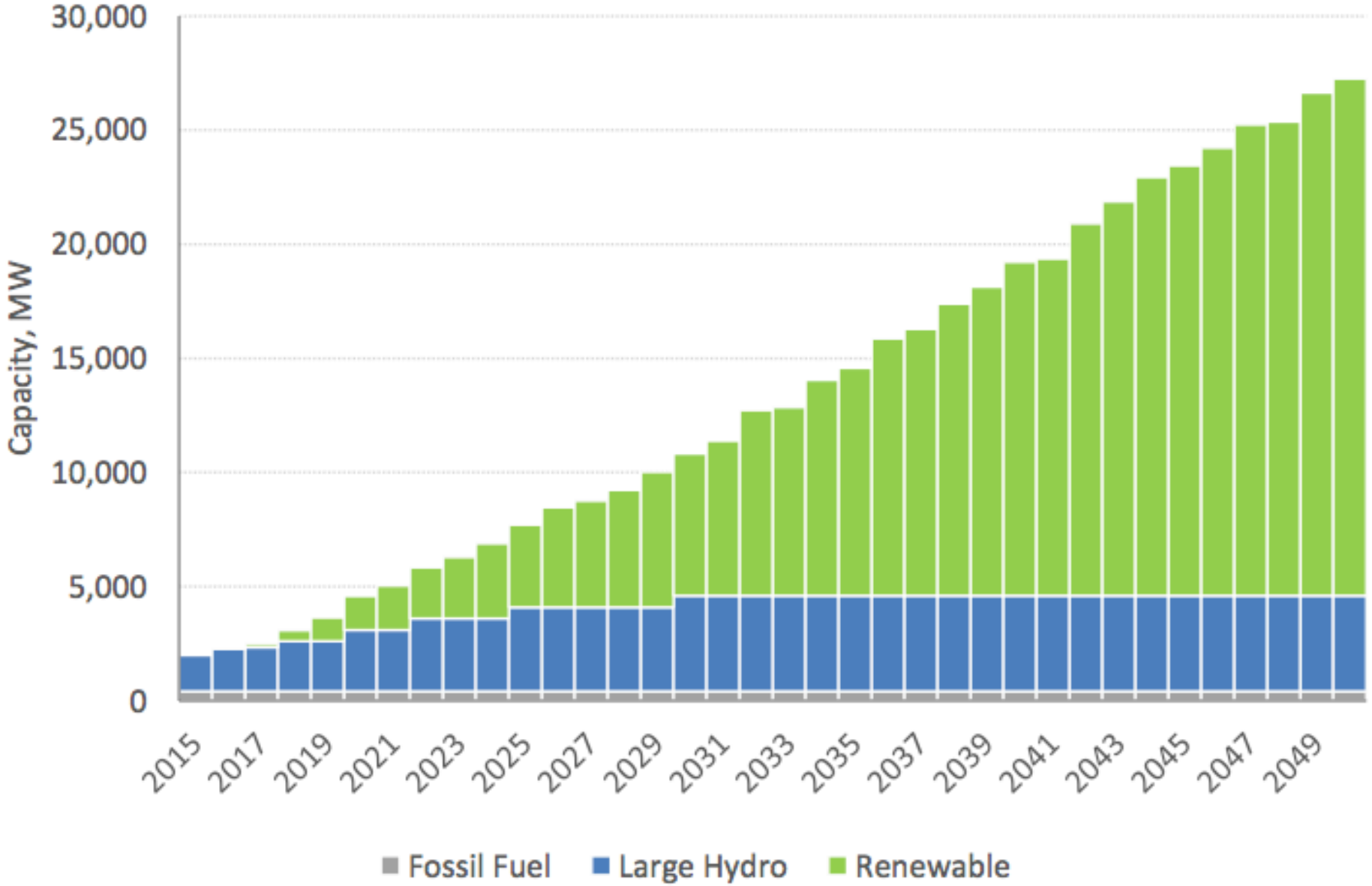

Figure 62 Lao PDR Installed Capacity by Type (ASES, MW)

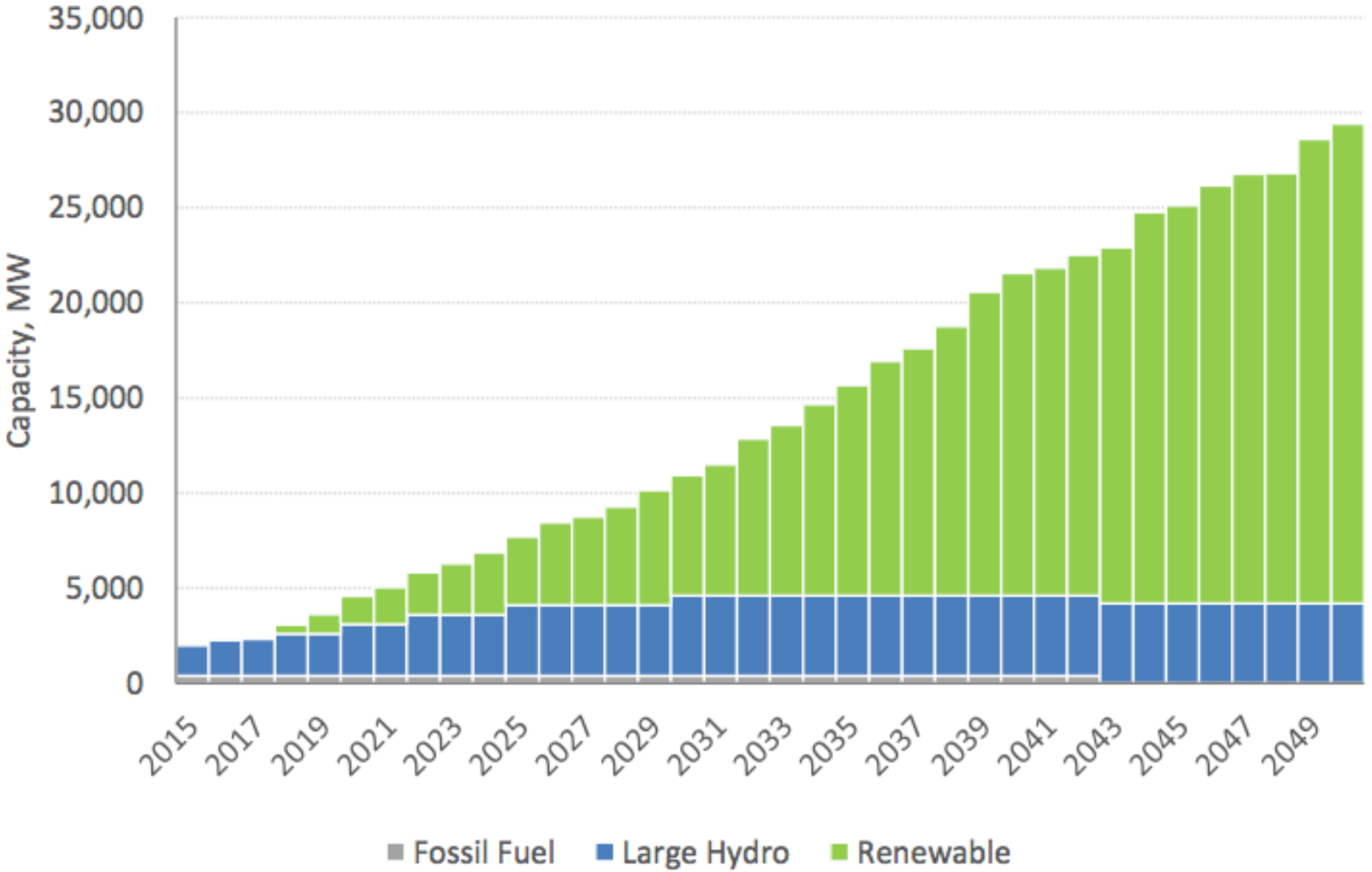

Figure 78 Lao PDR Security of Supply Measure: Energy Reserve

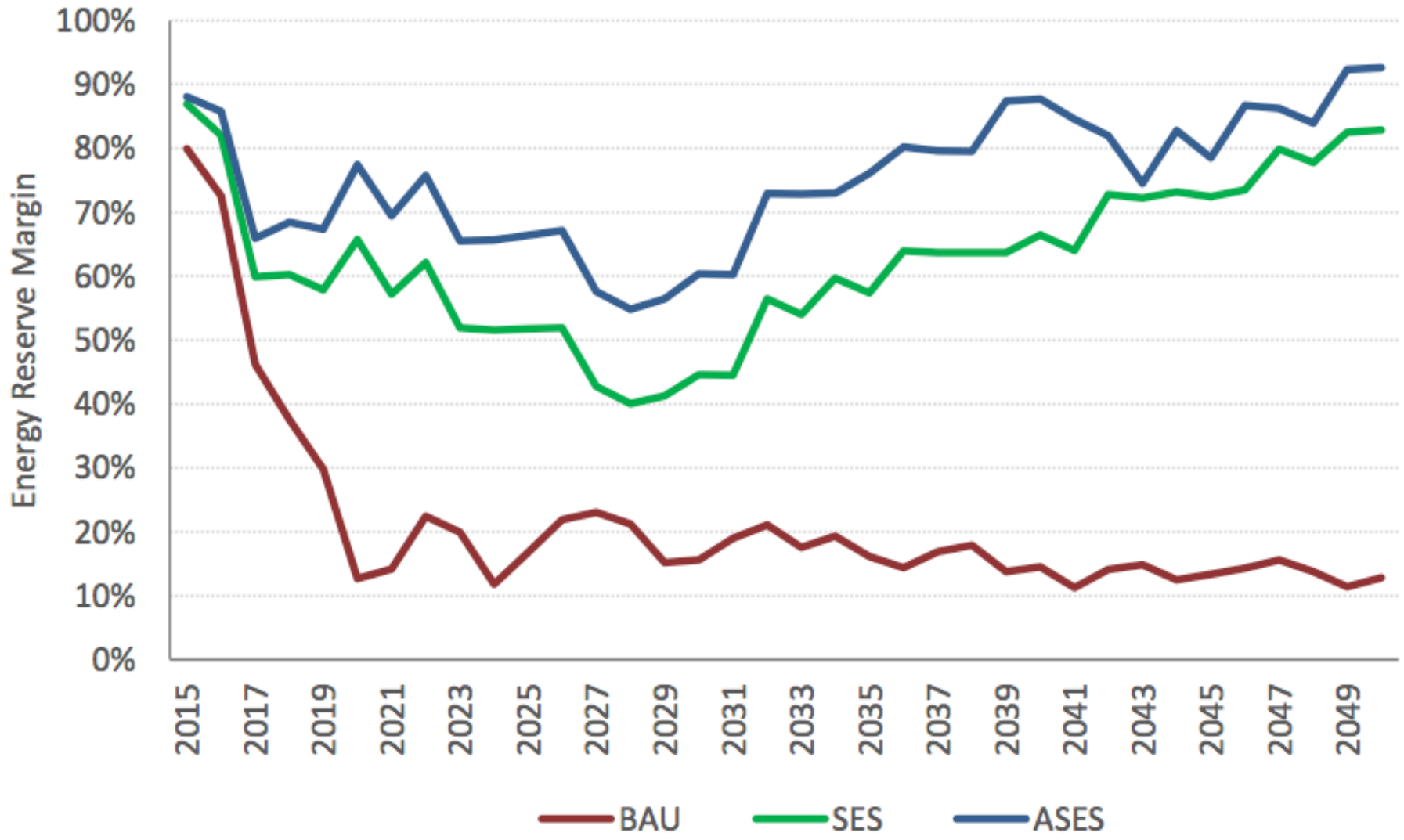

Figure 79 **Lao PDR Security of Supply Measure: Percentage of Electricity Generated by Domestic Resources**

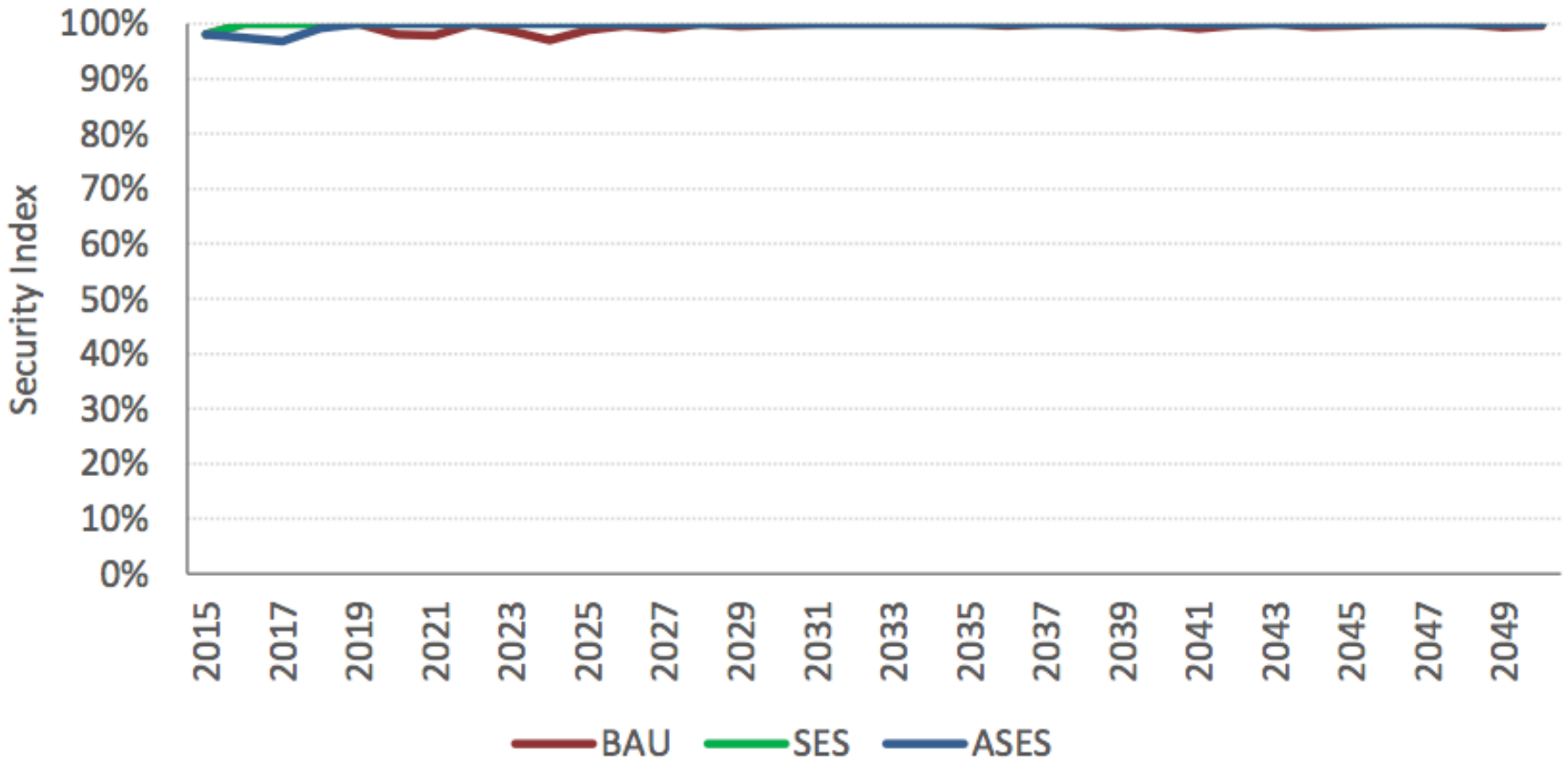

Figure 73 **Lao PDR Renewable Generation Mix Comparison**

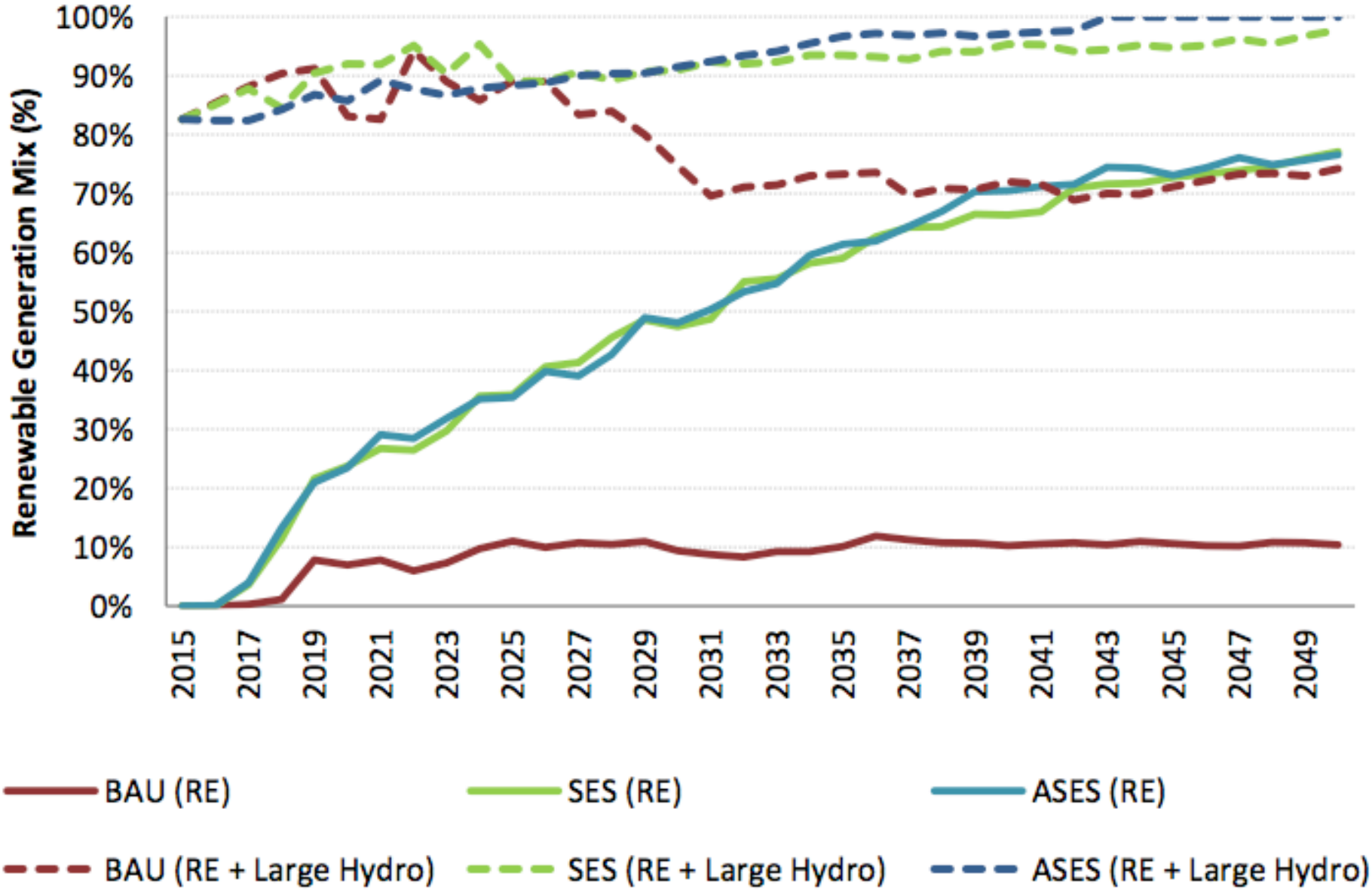

Figure 75 Lao PDR Carbon Emissions Comparison

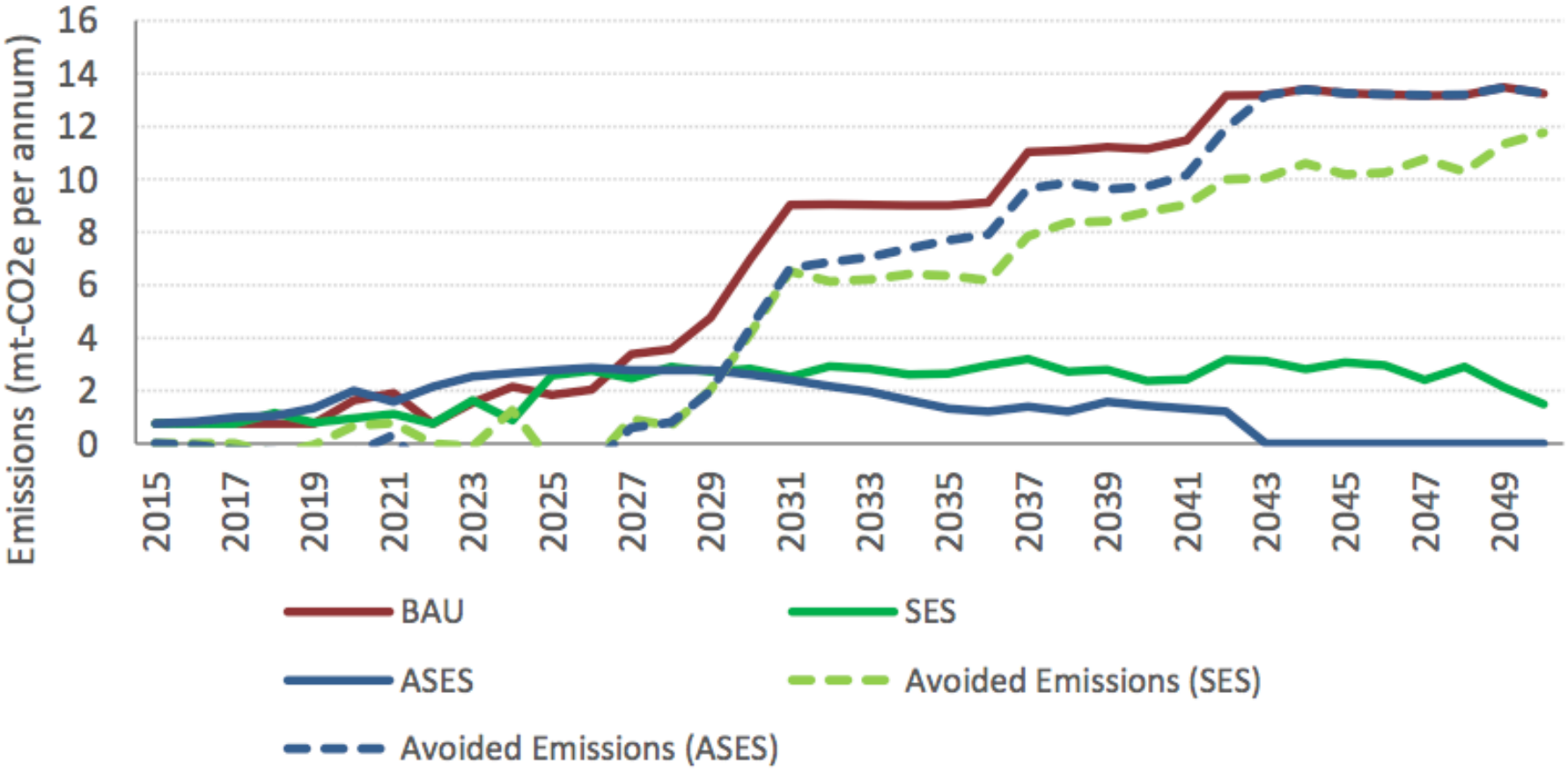

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Figure 88 Lao PDR Cumulative Investment by Type (BAU, Real 2014 USD)

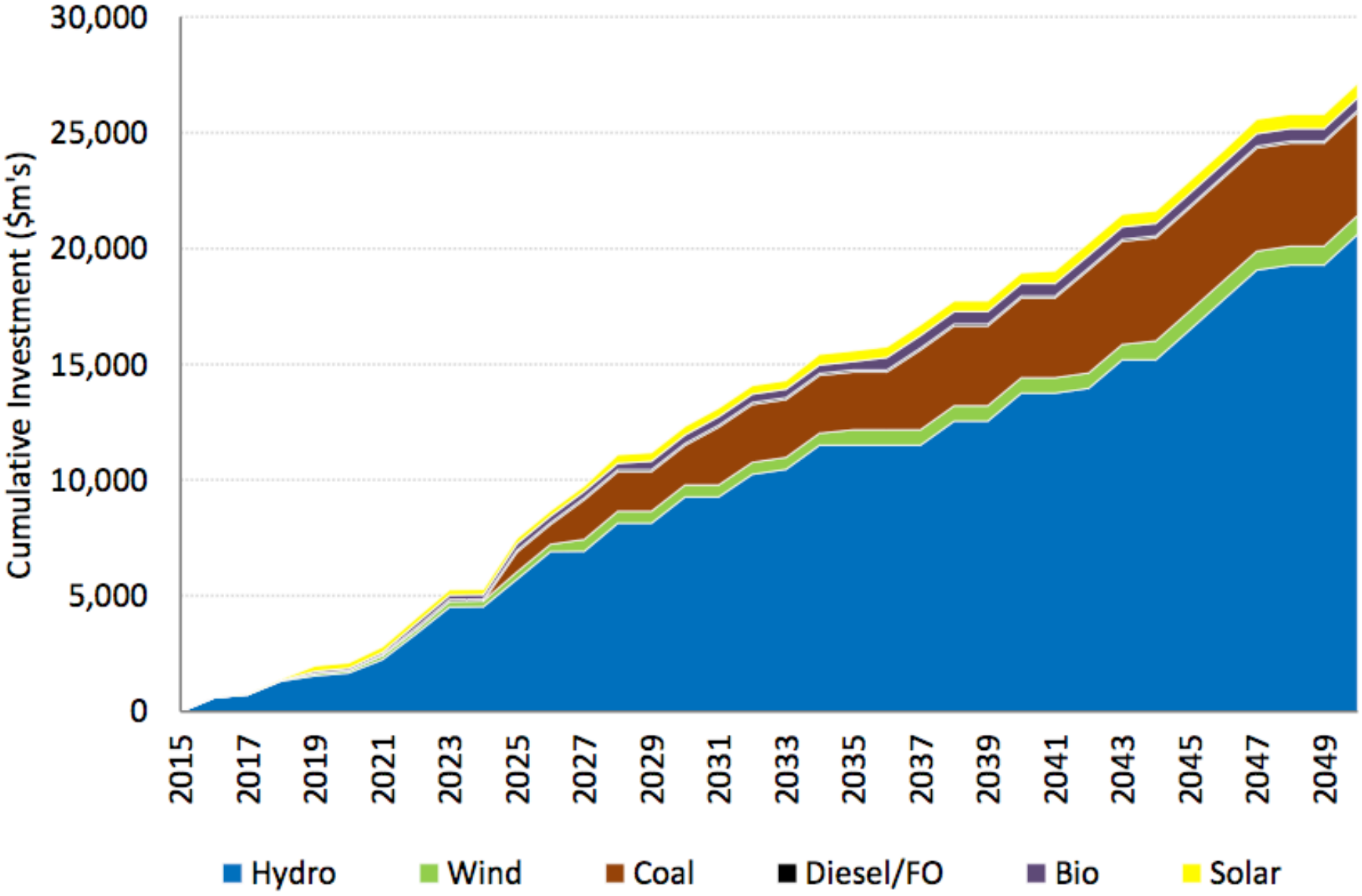


Figure 89 Lao PDR Cumulative Investment by Type (SES, Real 2014 USD)

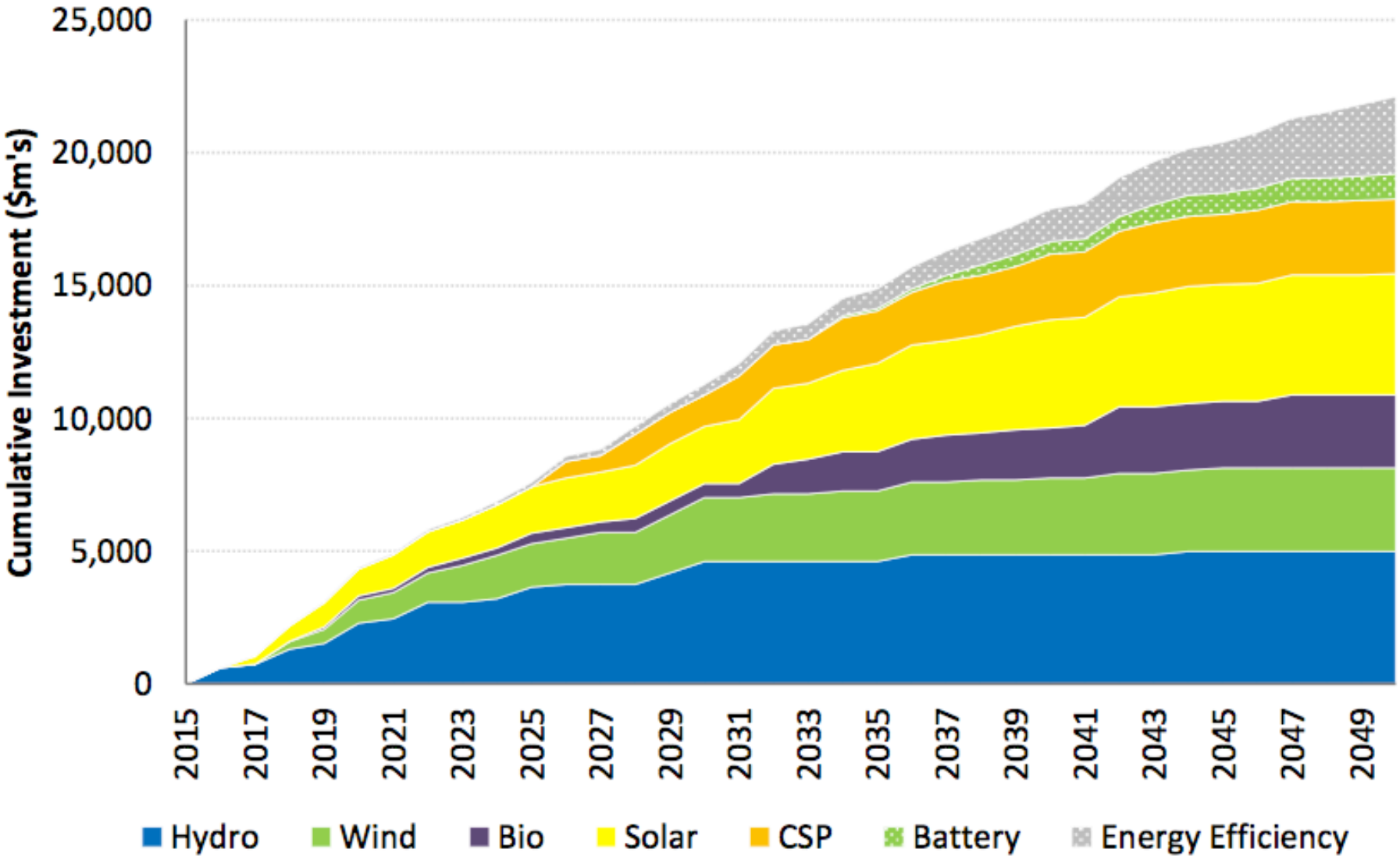


Figure 90 Lao PDR Cumulative Investment by Type (ASES, Real 2014 USD)

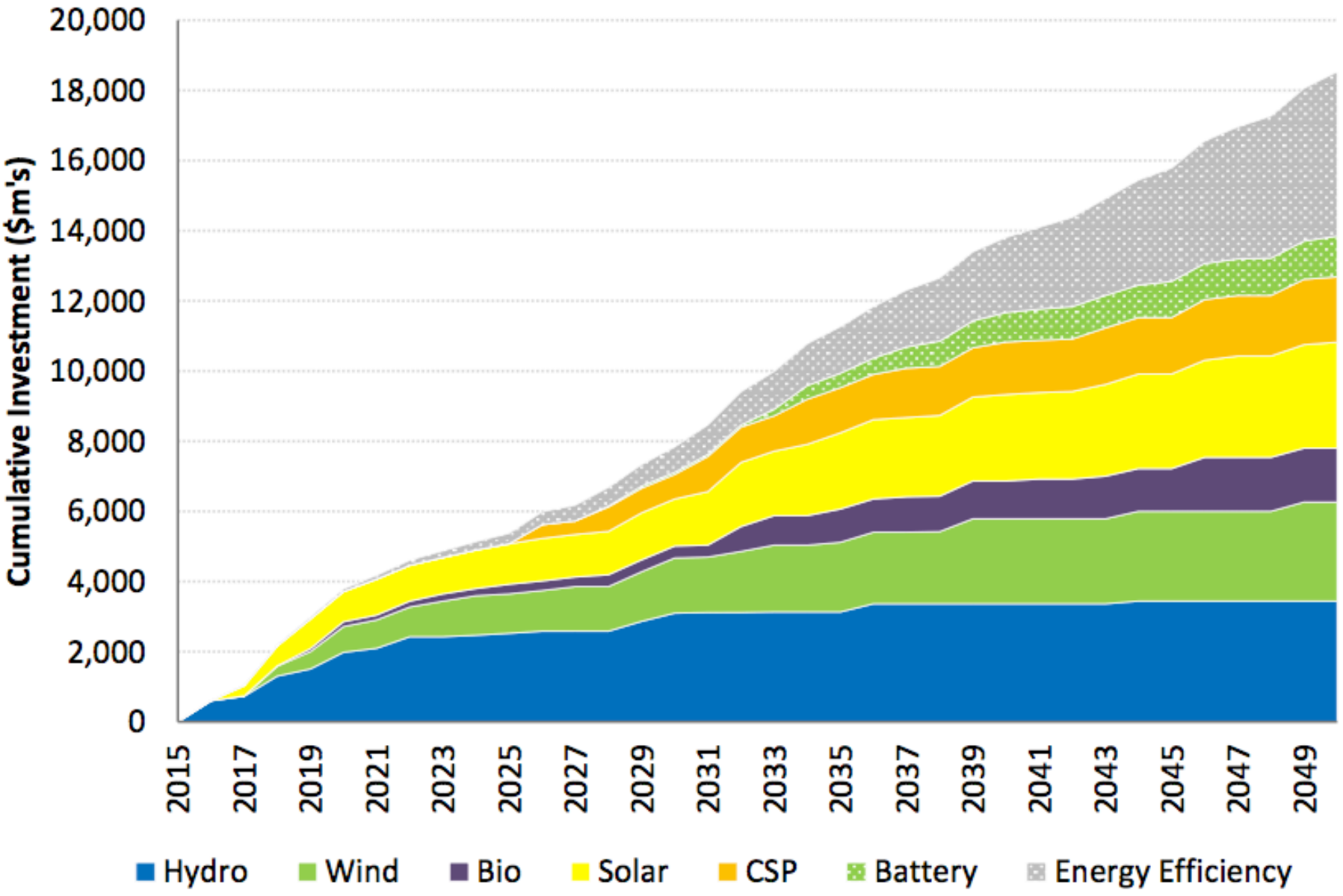


Figure 87 Lao PDR Cumulative Investment (Real 2014 USD)

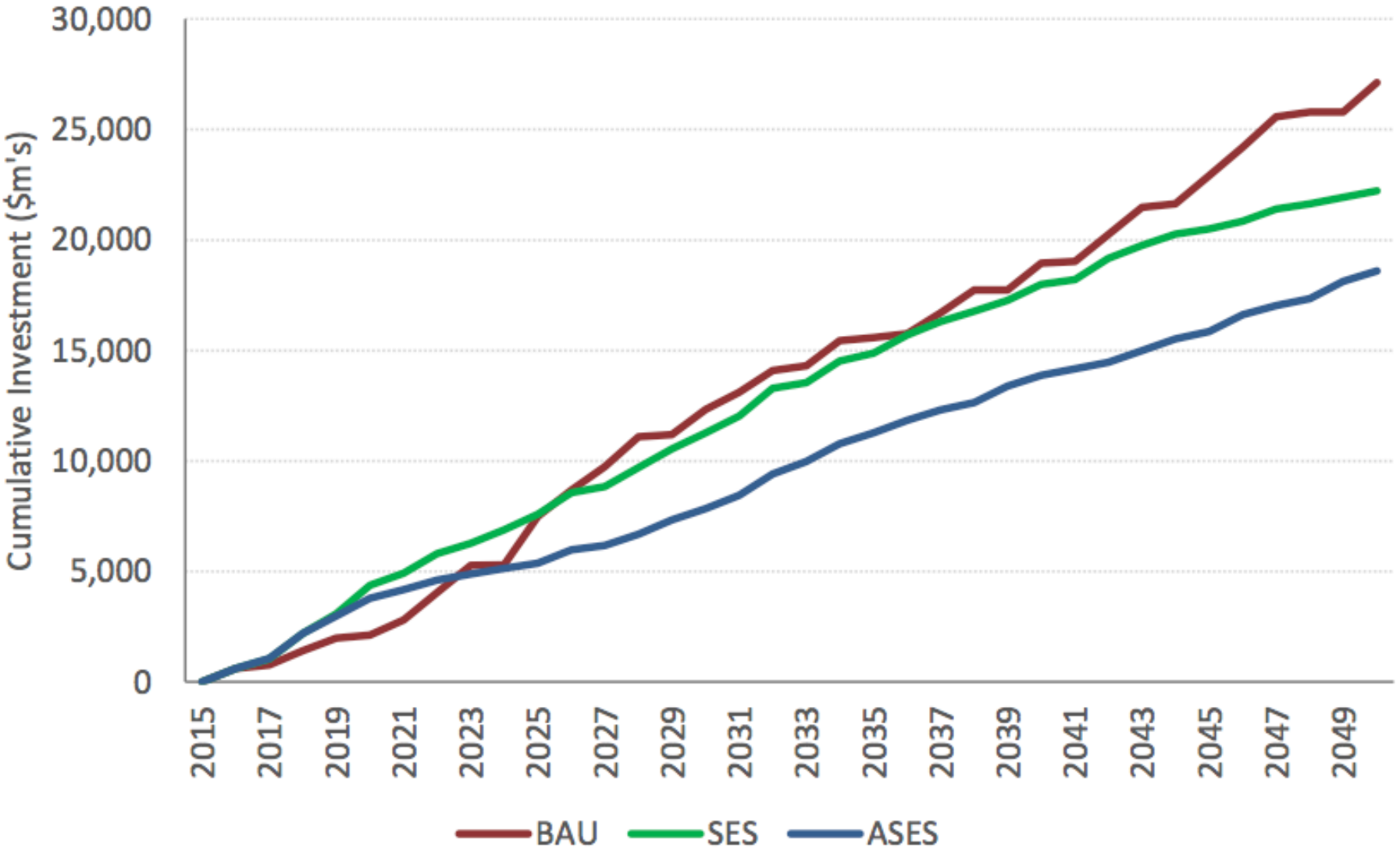


Figure 91 Lao PDR Cumulative Investment of BAU (Real 2014 USD)

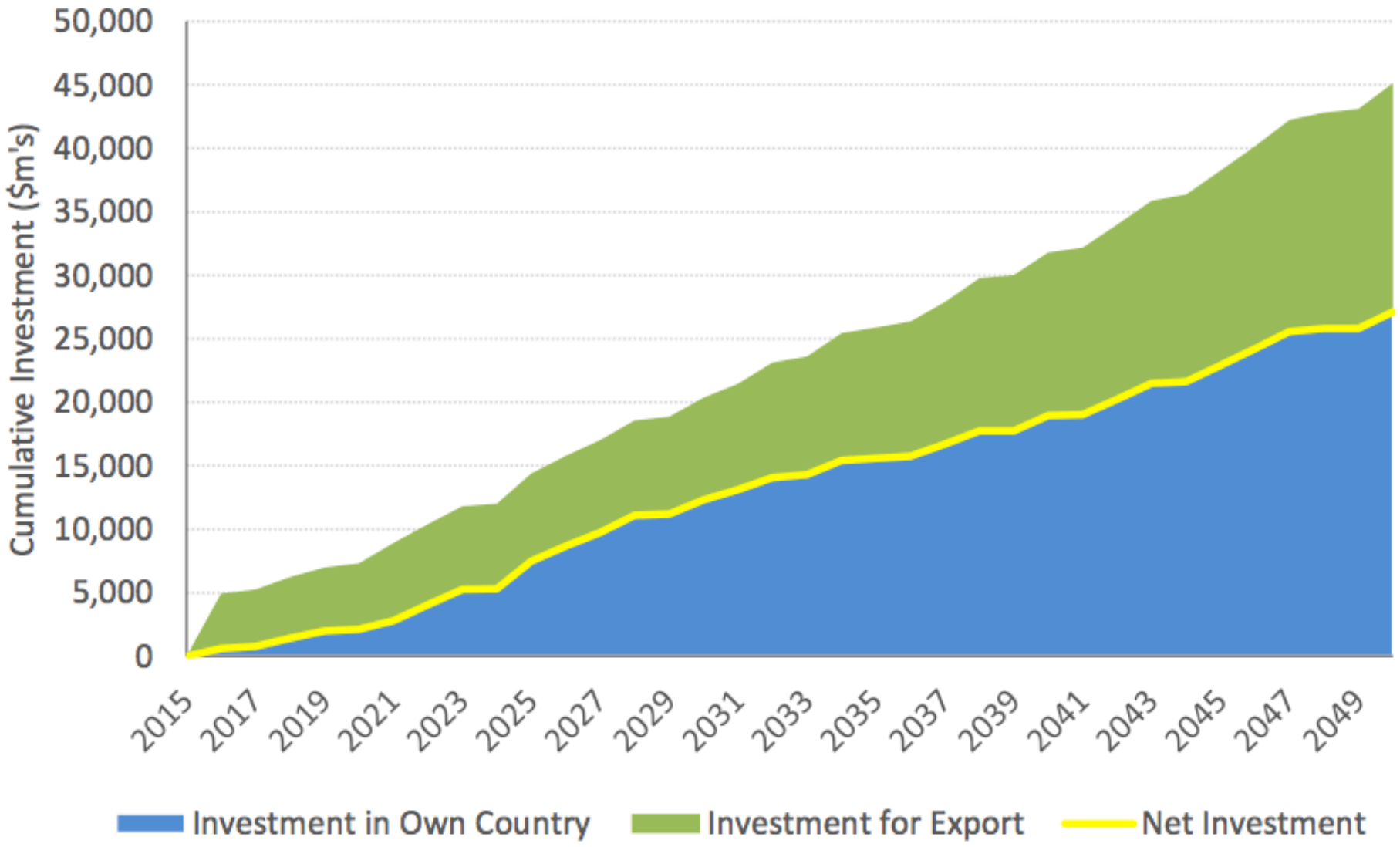


Figure 92 Lao PDR Cumulative Investment of SES (Real 2014 USD)

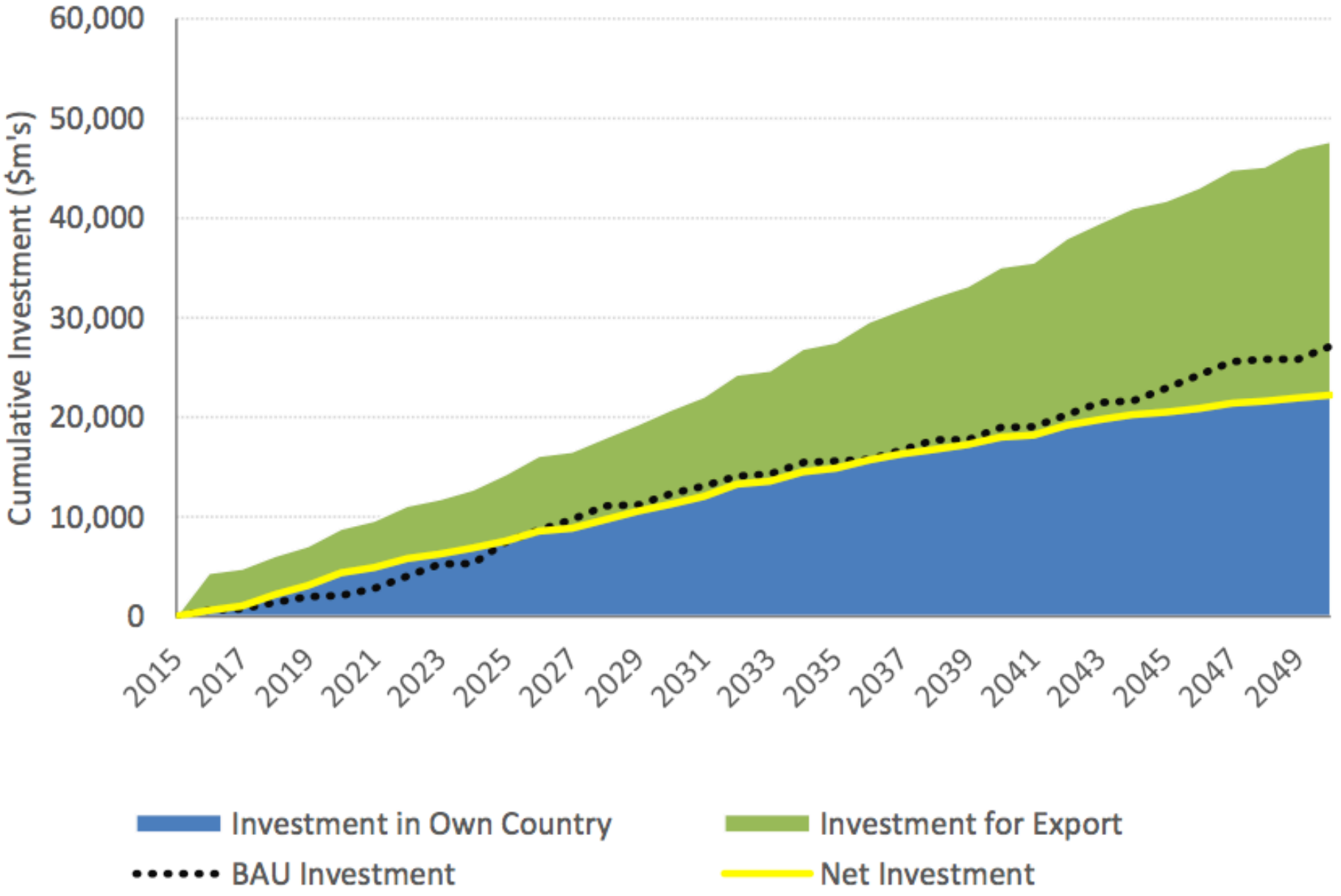


Figure 93 Lao PDR Cumulative Investment of ASES (Real 2014 USD)

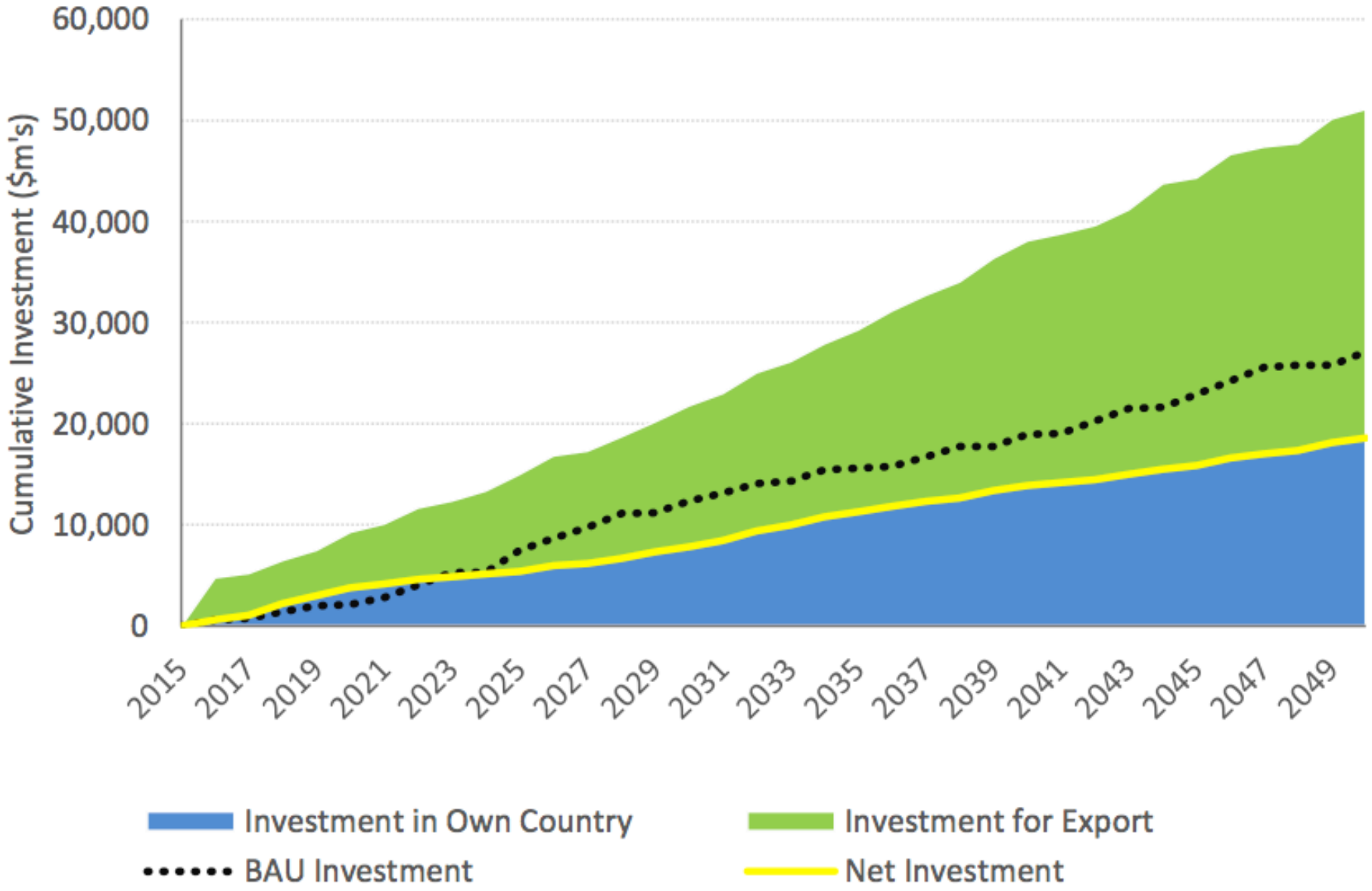
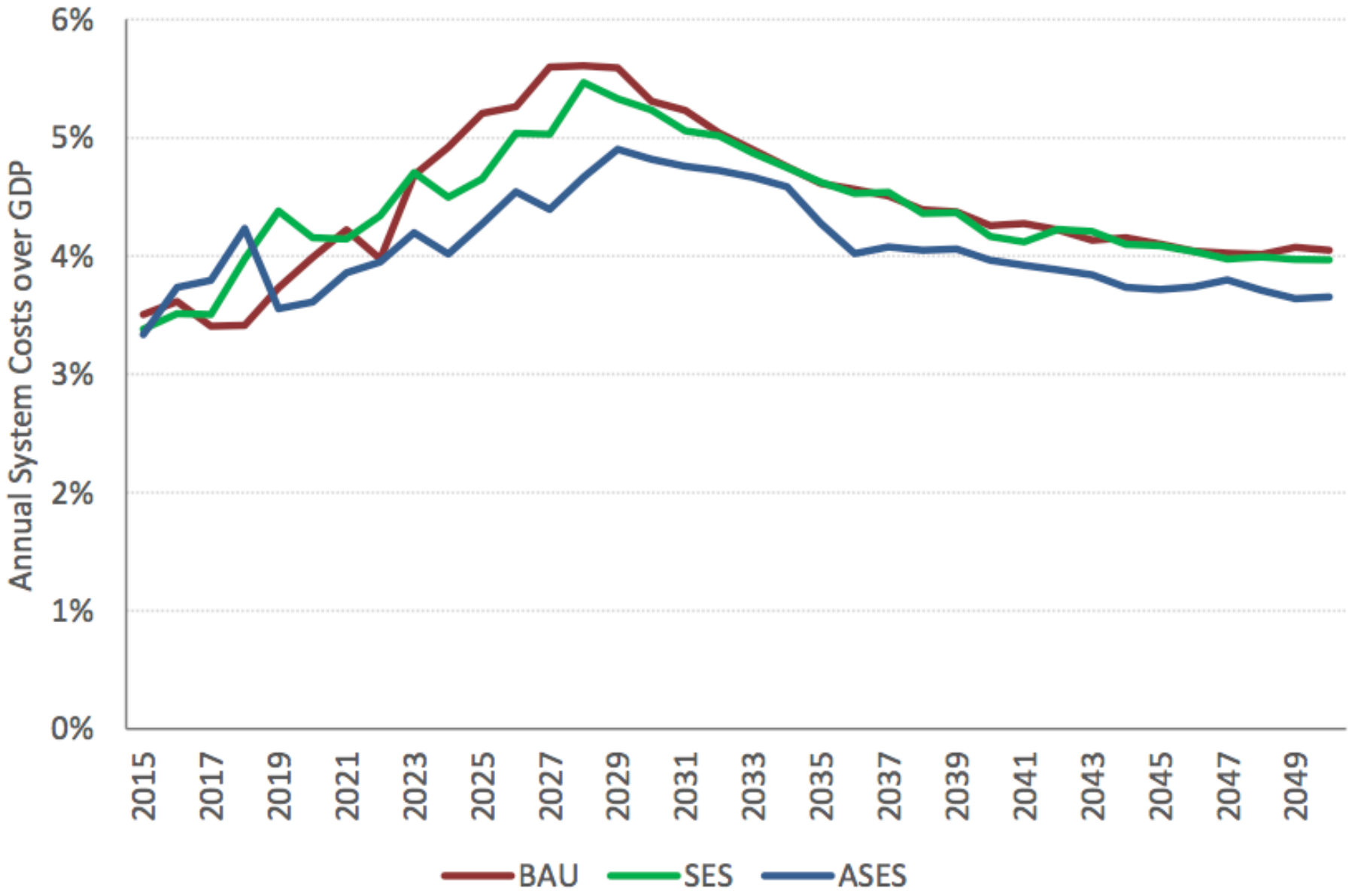


Figure 94 Total CAPEX, OPEX and Energy Efficiency over GDP



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BY 2050

$27 billion BAU

VS.

$22 billion SES

VS.

$19 billion (Real 2014 USD) ASES

ADDITIONAL $18 billion is required FOR ELECTRICITY EXPORT

In the SES, ADDITIONAL $25 billion is required FOR EXPORT

ASES also requires $32 billion FOR EXPORT

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BY 2050

$27 billion BAU

vs.

$22 billion SES

vs.

$19 billion (Real 2014 USD) ASES

The BAU investment (92%) to coal and hydro projects

SES some 38% **(and ASES)** (32%) is directed to solar and battery system technologies, with 13% (15%) to wind and other significant investments in energy efficiency 13% (25%) measures, 22%(18%) hydro and bioenergy

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BY 2050

BAU from 2015 to 2050 would be accompanied by the creation of some **475,452 job** years (44% man., 44% constr., 14% oper. & maint. And 2% fuel supply)

SES 1,24 mill job years (33% , 56%, 11% & 0.3%)

ASES 1,4 job years (33%, 56%, 10% & 0.2%)

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Figure 107 Total Job Creation Comparison BAU, SES and ASES

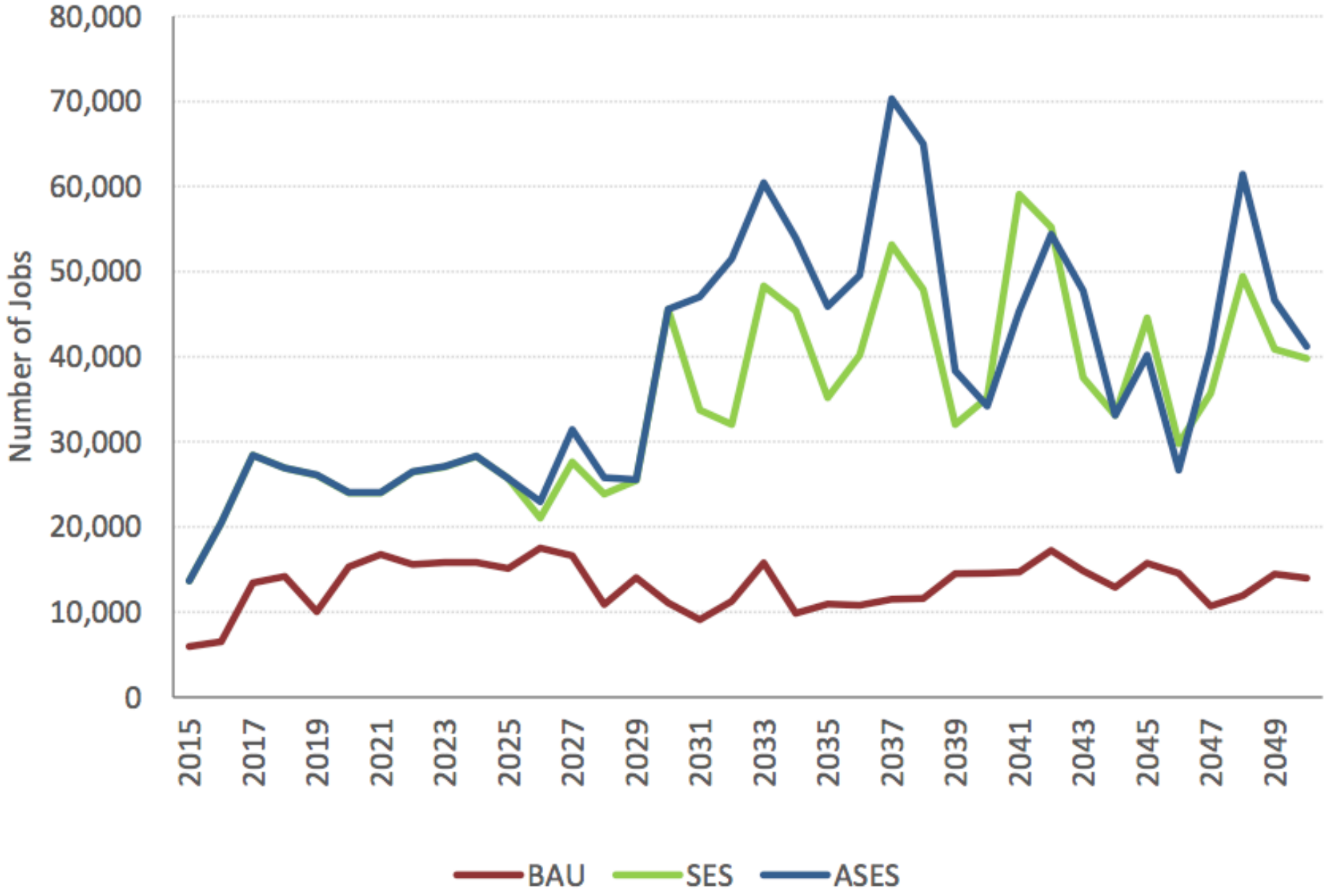


Figure 84 Lao PDR LCOE Composition in BAU

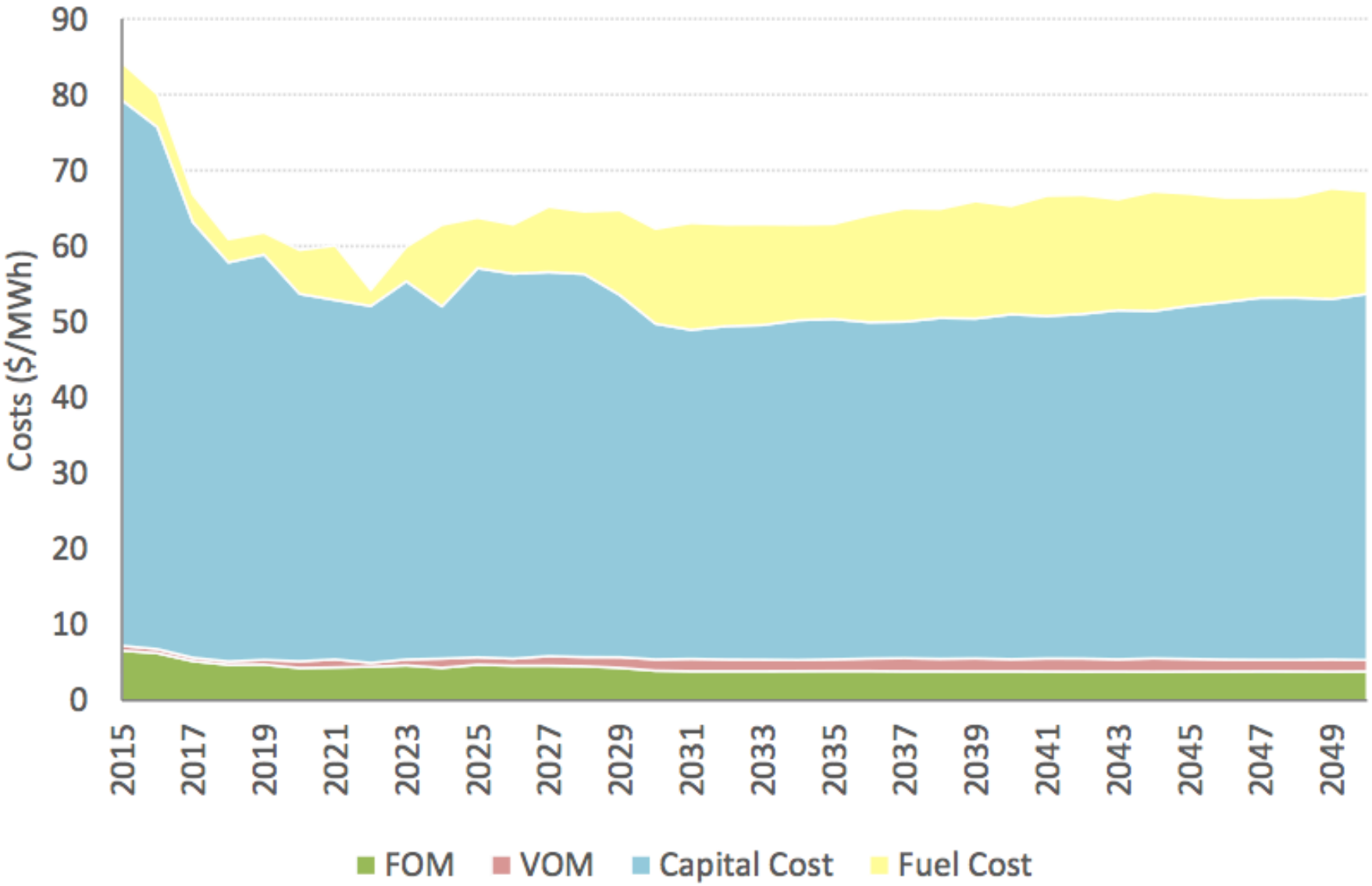


Figure 85 Lao PDR LCOE Composition in SES

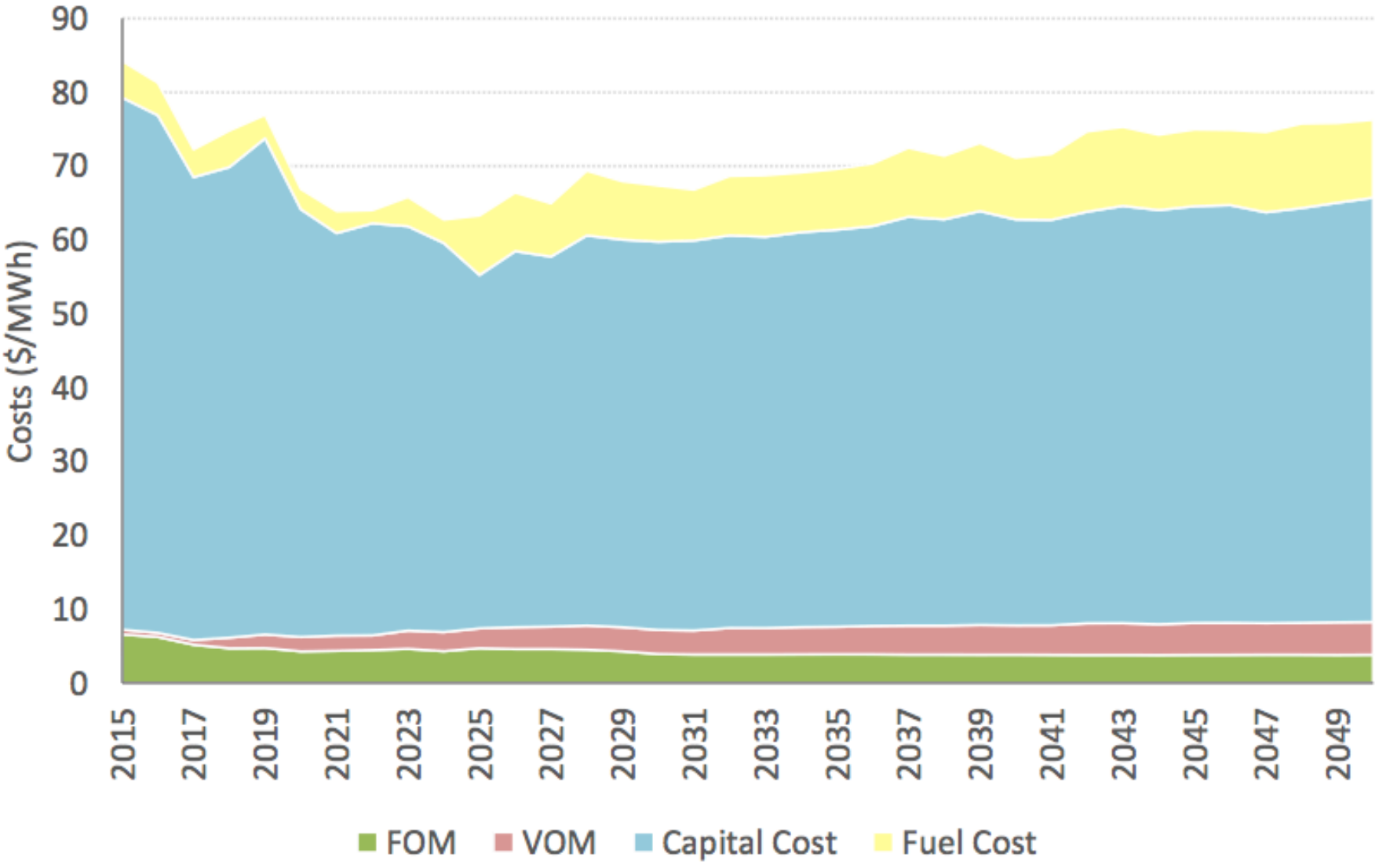


Figure 86 Lao PDR LCOE Composition in ASES

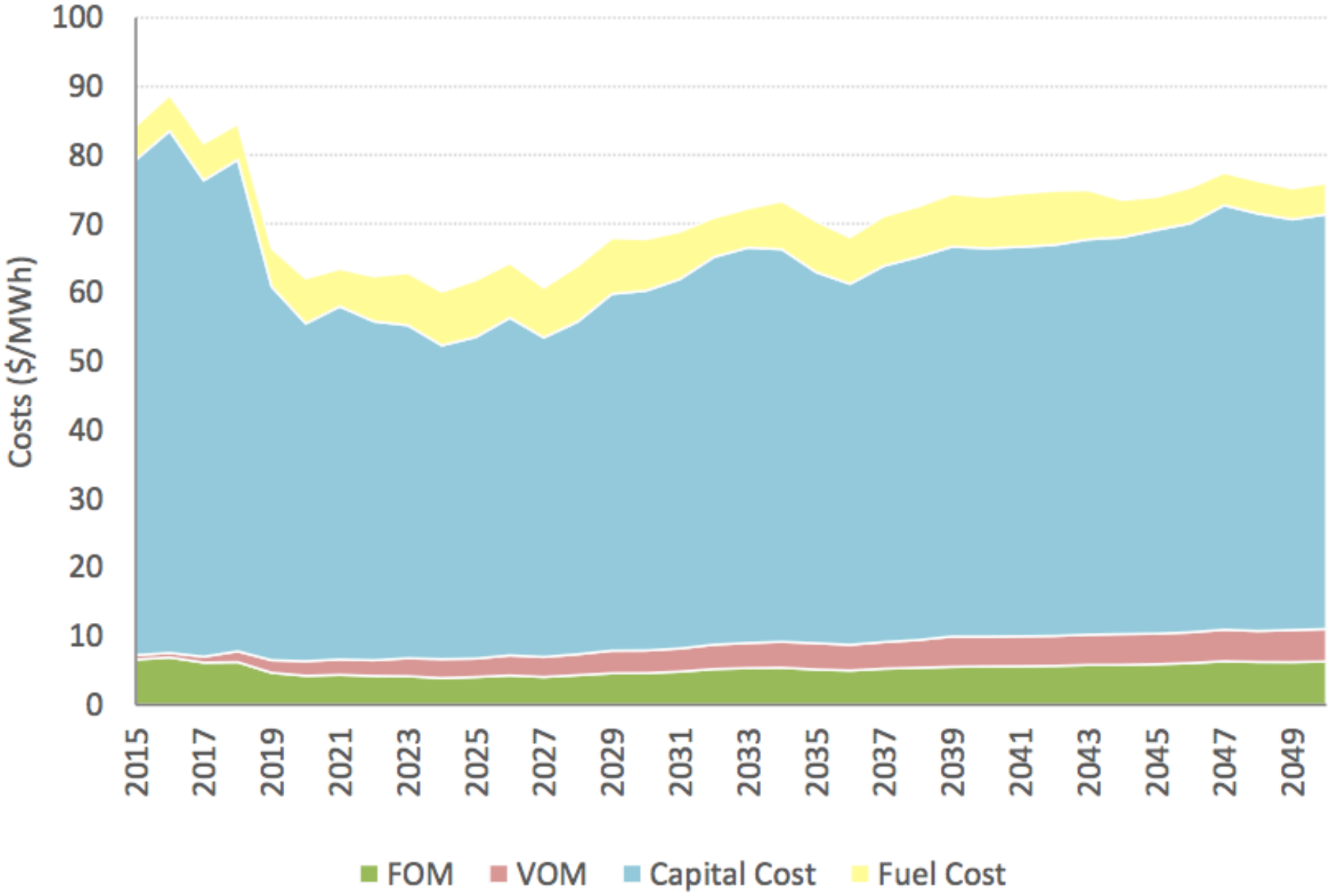
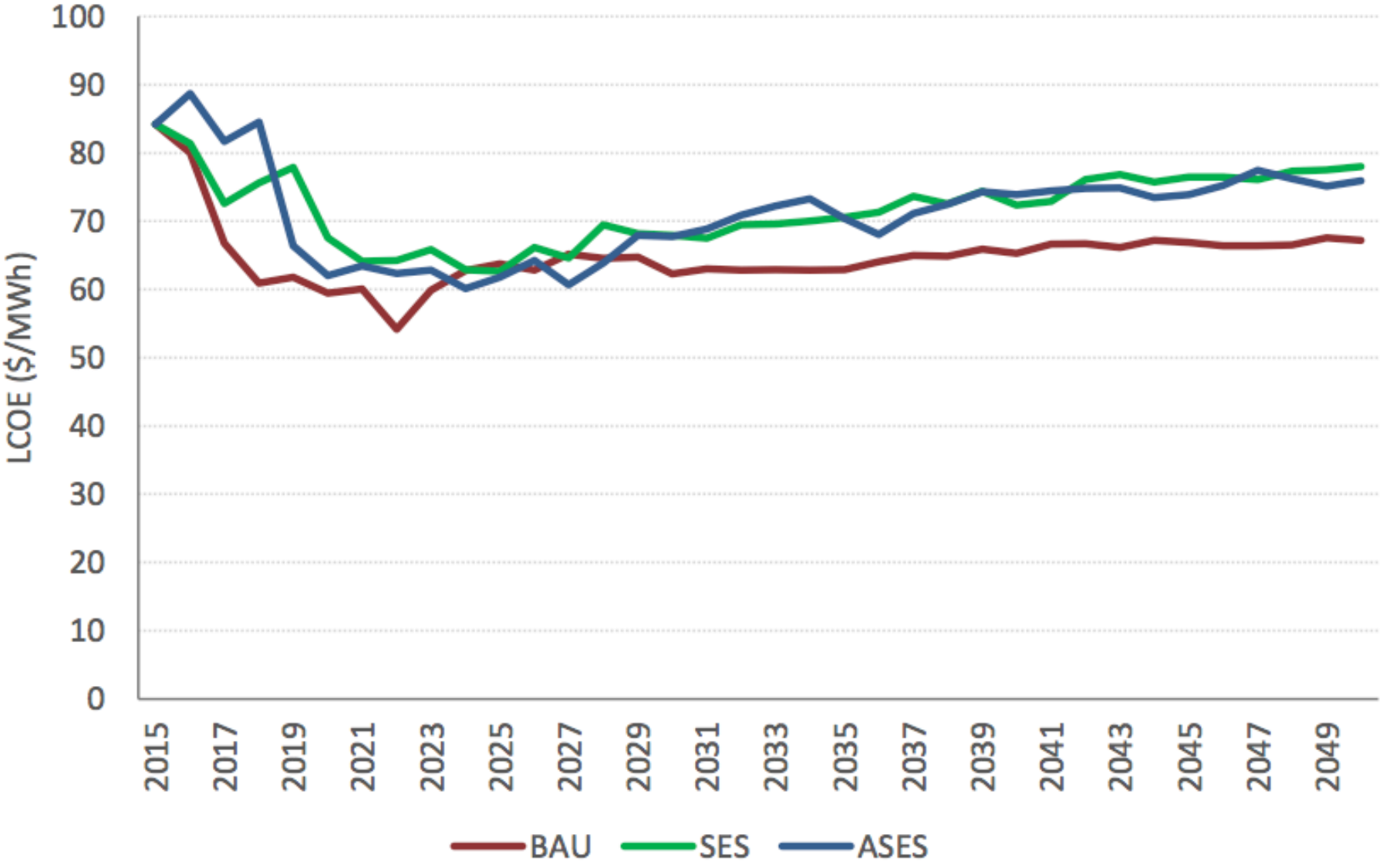


Figure 83 Lao PDR LCOE for Generation



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University of Turku

BY 2050

Levelised cost of electricity (LCOE)

By 2050 the LCOE in all three scenarios: **BAU, ASES and SES** averages **US$ 6,5-7,5/MWh** with sustainable energy scenarios slightly more costly.

→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) Limited focus on energy efficiency as electricity demand ramps up in line with expected GDP growth over the next 10 years. (guidelines and integration of energy efficiency measures into existing energy policy direction.)
2) Lack of specific policies or strategies and incentives for renewable energy promotion
3) Lack of specific regulations and laws on renewable energies
4) Renewable energy policy not yet clearly stated in NSEDP, strategies on growth and poverty reduction

CHALLENGES

5) Lack of public funding support for the renewable energy sector, especially for research and development
6) Insufficient knowledge and understanding on renewable energy
7) Insufficient information on renewable energy potential for provincial level
8) Unclear responsibilities and approval of renewable energy projects
9) Electricity access rate in remote areas is still low due to high cost of grid extension

CHALLENGES

Other barriers to the development of renewable energy include:

10) Awareness barriers among policy makers;
11) Significantly higher capital investment costs compared to conventional fuels;
12) Technical barriers including expertise and lack of standards for renewable energy systems
13) Lack of effective and considered measures relating to adverse social and environmental impacts of large scale hydropower projects.

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 CUMULATIVE COSTS*** THAN CURRENT PLAN AND PROVIDE ELECTRICITY AT A NEARLY EQUAL PRICE

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

MAIN MESSAGES

100 % RENEWABLE ENERGY MIX LEADS TO **ZERO EMISSIONS** BY 2043 (ASES) WHILE BAU CONTINUES TO EMIT 12-13 MILLION TONNES OF CO2 EMISSIONS ANNUALLY

100% RENEWABLE ENERGY GENERATION MIX CREATES **2-3 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?