Climate Compatible Growth

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How can Lao PDR become the Low-Carbon "Battery of Asia"?

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Summary

The Lao People's Democratic Republic (PDR) has the ambition to become the "battery of Asia" through exporting its hydro- and coal-powered electricity to neighbouring countries. However, increasing electricity exports needs to incorporate low-carbon electricity generation and transport infrastructure, if Lao is to meets its ambition while satisfying its local demand and climate targets.

This briefing examines Lao's electricity generation projections and policies, and examines the material requirements for building projected systems. Challenges for future electricity requirements are described, alongside proposed governance actions to support low-carbon development.

Building the required low-carbon electricity and transport systems involves renewable energy capacity additions, using low-carbon construction materials and securing their supply. Industrial capacity needs to be prepared and strategically planned to supply more electricity and transport system components domestically. Resource acquisition can be a challenge since Lao is landlocked, making it dependant on trade with its neighbours. Thus, revising supply chains and local governance is required.

Key Policy Recommendations

- Lao People's Democratic Republic (PDR) expansion of the electricity sector needs to limit the dependency on coal and take advantage of the potential for renewables to stay in line with the NDCs.
- Local material demand for steel and cement exceeds the local production capacity for building electricity systems.
- Further examination of material requirements for building new electricity generation and transport systems is advised. This could identify opportunities for building local capacity to supply materials and installation needs, providing local jobs.
- Surveys showed that local government knowledge of low-emission strategies is not widespread, while ministry boundaries are being blurred by the electrification of transport and industry. Reviewing the government structure to promote cross-sector coordination is advised.
- Reliability, completeness, and standardization of openly-available Lao statistics need to be improved.

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Introduction

The transition to low-carbon energy requires radical infrastructure changes, including building low-carbon electricity generation plants, increasing storage, and building infrastructure for electric vehicles (EVs). Assessing the material implications of building these systems helps limit embodied emissions and increase security of supply.

The Lao People's Democratic Republic (PDR) (hereafter Lao) has the ambition to become the "battery of Asia" by exporting electricity to neighbouring countries. Export projects are being developed by foreign private investors. Power exports increases should reach 15 GW by 2030 –10 GW to Thailand and 5 GW to Viet Nam, Cambodia, and Myanmar [1]. These plans require thinking holistically about material and labour inputs.

This policy brief explores the systems required to achieve Lao's "battery of Asia" ambition. It also discusses the challenges of achieving this ambition in a low-carbon way, while maintaining desired levels of socio-economic development.

Table 1 shows the power trade with neighbouring countries in 2017.

COUNTRY	IMPORT	EXPORT	
		IN OPERATION	COMMITTED
Thailand	462	4,260	9,000
Viet Nam	18	250	5,000
Cambodia		10	200
Myanmar		10	
Yunnan, China	68		
Malaysia			100
Singapore			
TOTAL	**548**	**4,530**	**14,300**

Table 1: Power trade in 2017 in Lao PDR (in MW). Source: [2]. Committed means two countries are implementing signed memorandums of understanding. The existing capacity was 6,441 MW.

In its Nationally Determined Contributions (NDCs) [3], Lao has committed to unconditionally reducing greenhouse gas emissions (GHG) in 2030 by 60% compared to a predefined business-as-usual (BAU) scenario. Actions include reducing land-related emissions and increasing hydropower capacity. Further plans are conditional to international support, including developing electricity capacity of wind and solar (1 GW) and biomass (300 MW) and reducing total final energy consumption by 10%.

Lao is slowly recovering from the COVID-19 economic effects, but faces economic difficulties associated with public debt and rising fuel and food prices [4]. Suggested measures to combat these effects include promoting high-value manufacturing goods and agricultural products, and increasing available infrastructure to benefit businesses [4]. Further, the adoption speed of EVs is planned to reach 1% of the total vehicles by 2025 and over 30% in 2030 [5]. Implementing these measures requires an efficient electricity system and infrastructure that limits embodied emission lock-ins.

The methodology of this brief includes a literature review of academic documents, national reports, and policies. In addition, a joint analysis was conducted of national statistics

[1] Developed by authors 1 and 3. A model that combines material intensities of different power plants with projected power plant capacity over time to determine the amount of materials that will be needed and their environmental and socio-economic implications.

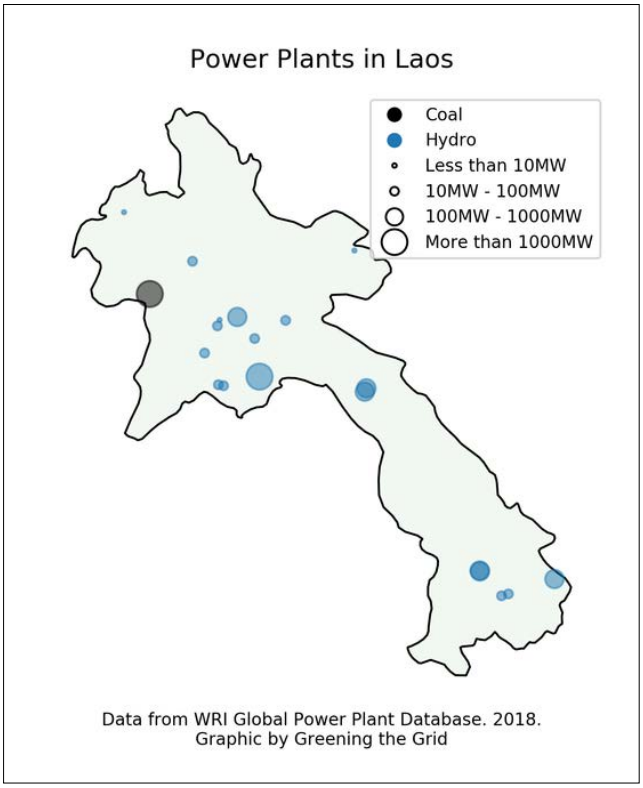
[2] Developed by Climate Compatible Growth (CCG). They are simple and open-source energy system models using the Open Source Energy Modelling System (OSeMOSYS) and country-specific data. They serve as a starting point for energy system modelling of most developing countries in Asia, Africa, and South America.

on manufacturing and materials needed for electricity systems using preliminary results from the model Mat-dp (Material Demand Projections) [6] using the scenarios from Starter Data Kits [7]. Preliminary comments are showcased from ongoing ministry surveys on material use[3].

Electricity generation in Lao

Lao's electricity production relies mostly on the Mekong river and its tributaries, which have high hydropower potential. Coal electricity generation persists, and Lao has not joined coal phase-out pledges [8]. In 2017, from Lao's 6,948 MW of electricity capacity, hydropower represented 73%, coal 26%, and biomass less than 1% [9]. Power demand should increase 13% annually until 2030.

Figure 1 shows the existing hydro and coal power plants in Lao by size.



Wind and solar power are under development. Lao is planning 2–3 GW of wind projects by 2030. Eight additional projects are under field investigation. Since 2017, there are 700 kW of grid-connected solar projects and 3 MW of solar for commercial operation. Floating solar on hydropower reservoirs and irrigation dams are being considered [9].

> *"Lao [...] is currently facing [...] economic difficulties associated to public debt and rising fuel and food prices"*

Industry and trade in Lao

Lao is a net material importer. Construction materials (cement and metals) and fossil fuels were among the highest imports in 2015 [10]. Yet, Lao could become a net exporter of primary materials [10]. In 2015, material extraction grew due to the construction of a hydropower plant and increased mining [10]. Non-metallic mineral extraction accounted for half of the total domestic extraction, reflecting a transition away from an agriculture-based economy. Current trade flows depend on neighbouring countries, mainly Thailand. In 2019, Lao mostly exported electricity, followed by copper products, and imported mainly oil products, bovine animals, beverages, and diesel trucks and parts [11].

[3] Thirty Lao ministry surveys are being carried out on the topic of material use in Lao, including whether and how materials needed for building electricity systems are considered in energy planning. These surveys are part of the authors' CCG Southern Partner Fund project. Final survey results will be published separately once these surveys have been completed.

Local industry includes mainly primary materials and some finished products. **Figure 2** shows mineral manufacturing, i.e., primary materials. Top soil and lignite have the highest production by mass, followed by limestone, iron, gypsum, and potash. **Figure 3** shows the finished products manufactured in Lao in 2020. Leather, animal food, salt, ice, and tobacco have the highest production by mass. Drinking water and beer have the highest production by volume.

> *"Lao could become a net exporter of primary materials."*

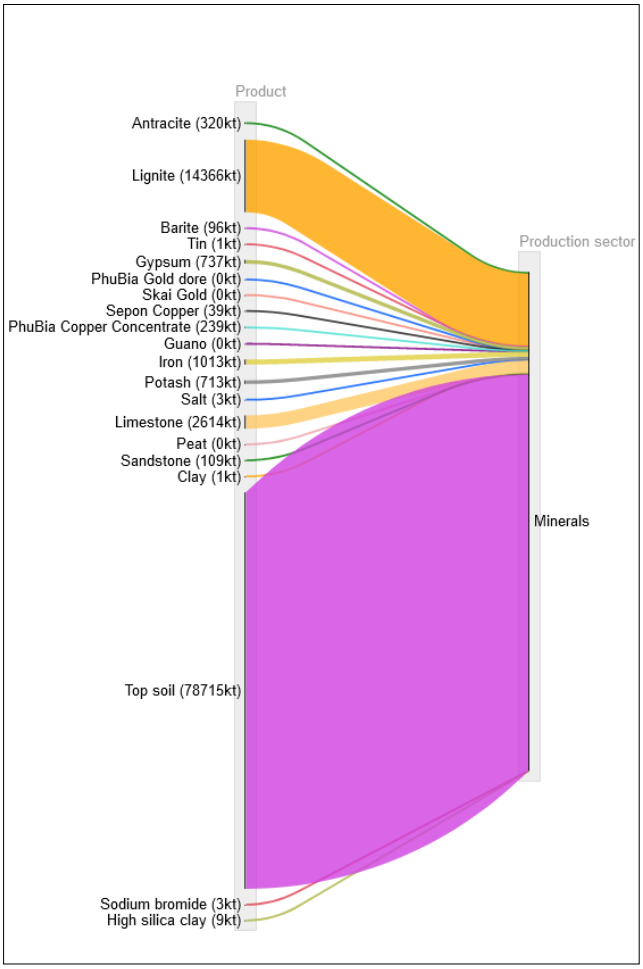


Figure 2: Manufacturing of minerals in Lao PDR in 2020. Data source: [12]. Unit conversions and figure made by the authors of this brief.[4] Units: kilotonnes (kt).

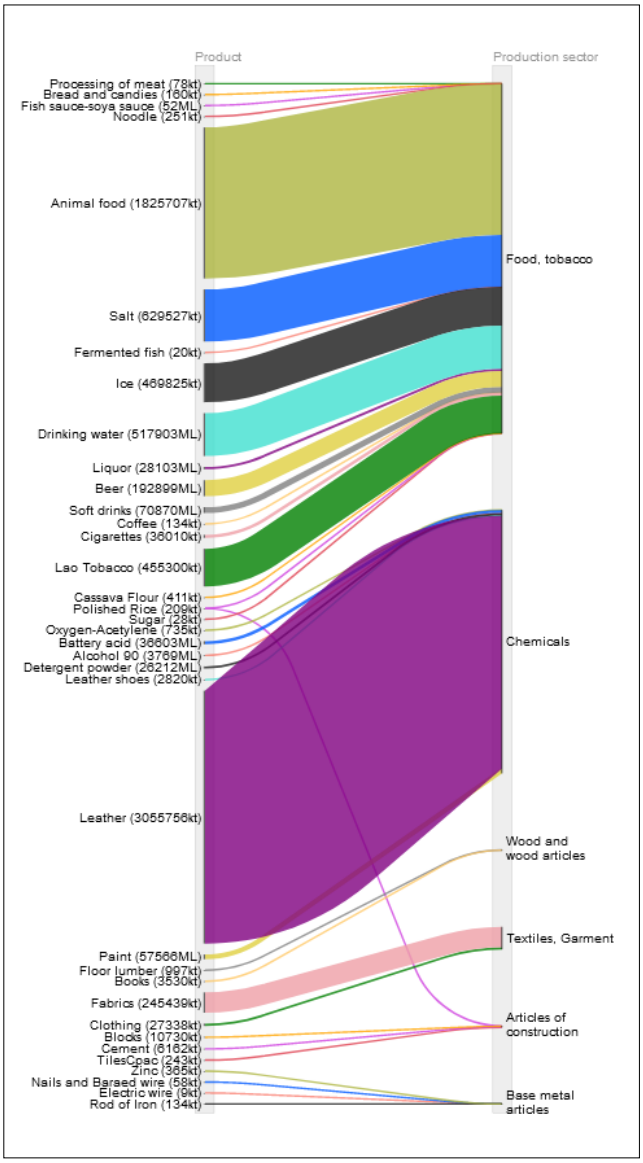


Figure 3: Finished product manufacturing in Lao PDR in 2020. Data source: [12] manufacturing and handicraft products. Unit conversions and figure made by the authors of this brief.[5] Units: kilotonnes (kt) for solids and million litres (ML) for liquids.

[4] The Zinc + Lead category was removed given the units.

[5] The products Medicine, Plastic goods, Wood furniture, Rattan furniture, and Agri tools were removed from this figure, since only monetary units were reported instead of mass or volume.

Materials needed for the future electricity system in Lao

The model Mat-dp [6] was employed to do a preliminary analysis on the materials needed for electricity system projections based on three publicly available scenarios: a fossil fuel (FF) scenario (i.e., not switching away from FFs), a least-cost scenario, where technology prices change and are optimised, and a net-zero scenario, where no FF capacity is added after 2045.

Figure 4 shows the installed capacity of the scenarios. Coal and hydropower are widely used, with hydropower replacing coal at different levels for the low-carbon and net-zero scenarios.

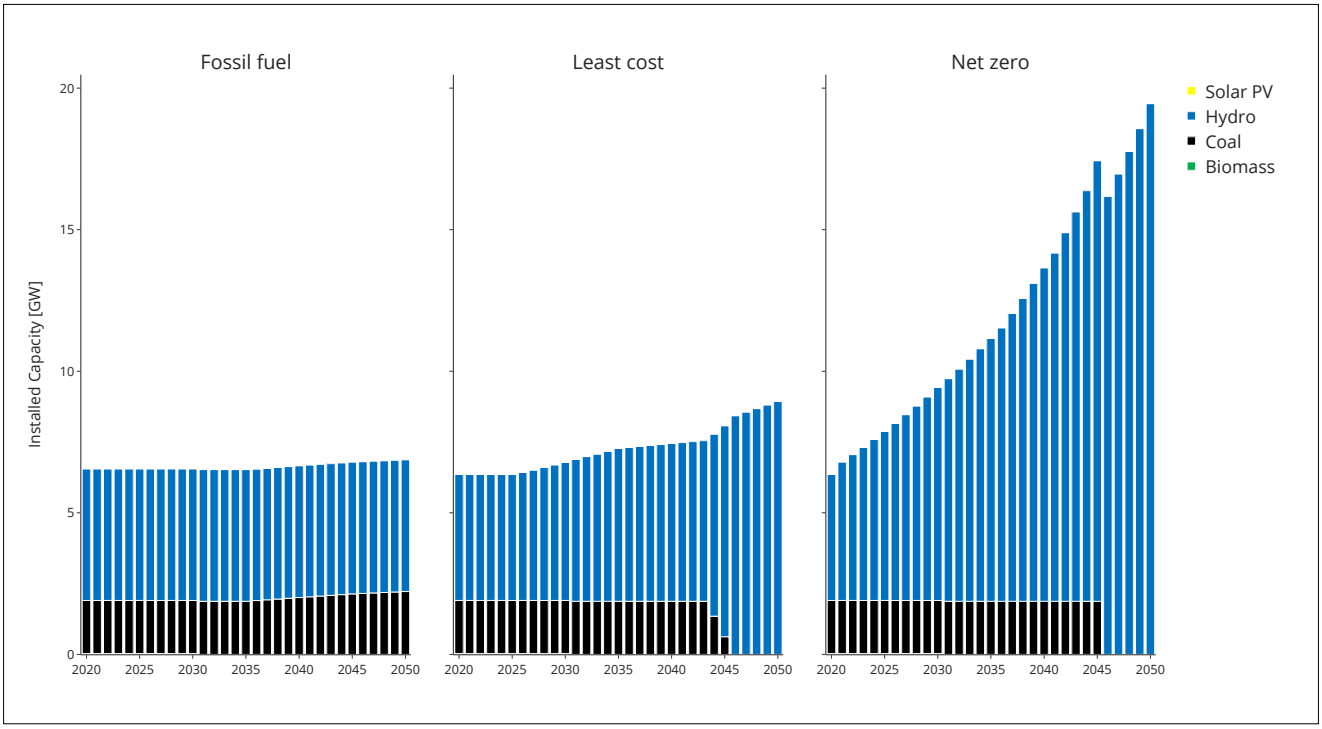


Figure 4: Projected installed capacity (GW) for Lao PDR using the starter kit scenarios.

Figure 5 shows the materials projected for building projected electricity capacity. The materials with the highest demand are cement and steel, given their large use for hydropower. The highest resulting embodied emissions[6] from these materials are for steel (6.3 Mt CO_2e) in the Net Zero scenario by 2050, whose emissions are 1.5 times those of cement (4.1 Mt CO_2e).

Comparing the required materials to local production, 6.5 Mt of cement were produced in 2020, while cement demand for electricity ranged from 1,096 Mt in 2020 to 4,136 Mt in 2050, depending on the scenario. In turn, although steel production was not reported in Lao statistics, the only steel company has an annual production capacity of 0.35 Mt [13]. Steel demand for electricity ranged from 766 Mt in 2020 to 2,823 in 2050. Thus, Lao does not have enough local capacity to manufacture key electricity system materials.

[6] Calculated using Mat-dp based on emission intensities of materials.

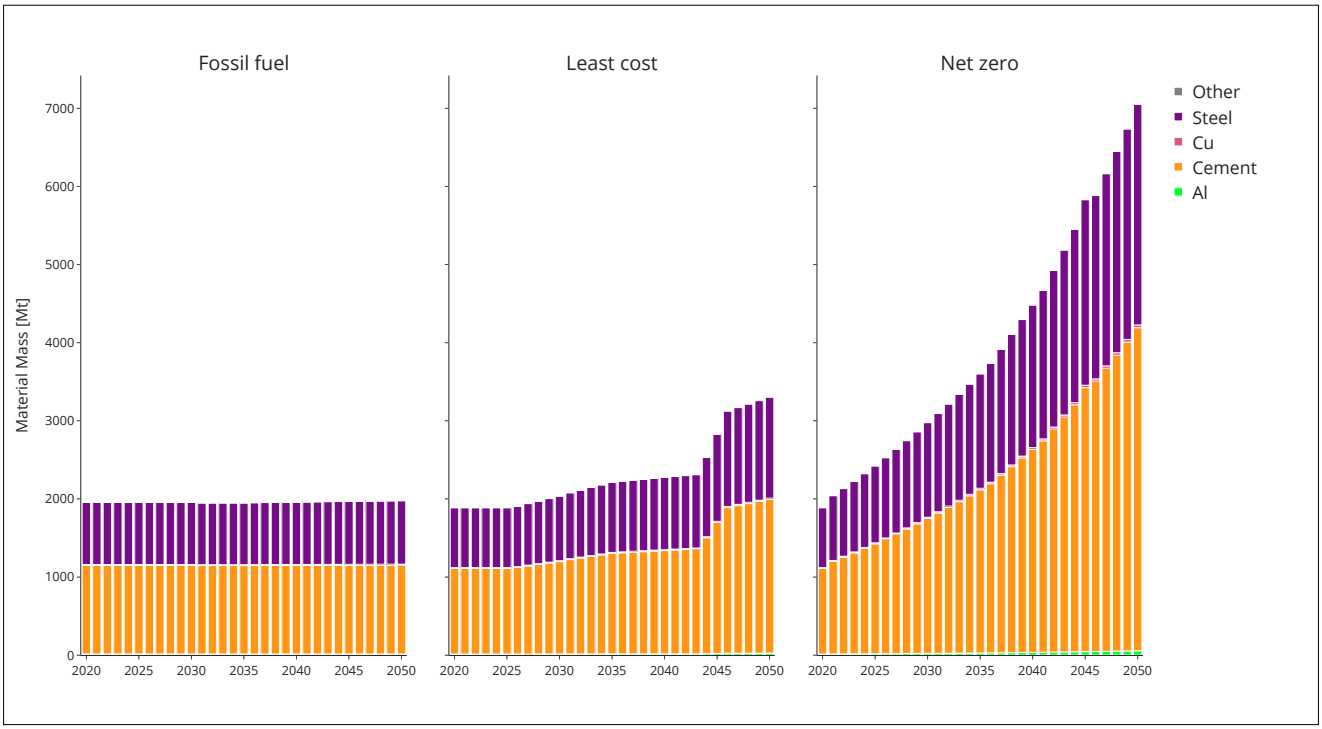


Figure 5: Mass of materials needed based on Mat-dp results for building the projected electricity generation capacity in each scenario.

The material amounts identified highlight that cement and steel are strategic industries whose industrial activity could increase. These industries provide materials for more than just electricity, (e.g., buildings) and could be a focus of industrial policies on emission reductions.

> *"Lao does not have enough local capacity to manufacture key electricity system materials."*

Challenges for becoming the "battery of Asia"

Material production has benefitted the economy , as highlighted by the shift away from an agriculture-based economy, with industrial capacity catching up with local demand. Material production investments alongside industrial efficiency may reduce emissions and industrial power needs.

Preliminary comments from material use surveys of ministries have shown that materials are rarely considered in energy planning. Most of the focus on materials at ministry level regards energy efficiency or biofuels. Materials such as chemicals or cement are only included in industrial policies. The surveys also reveal that knowledge of NDCs is not widespread within ministerial staff. Improving information sharing of government strategies and commitments across ministries is needed to encourage effective action at subnational government levels. As transitions occur, traditional ministry boundaries are being blurred. For example, transport electrification, its

infrastructure, or the potential electrification of industrial processes are all relevant areas for multiple government ministries. This presents opportunities for redefining tasks and boundaries to increase the efficiency of changes.

Some material provision for electricity relies on external sources, since electricity infrastructure investments are driven by foreign investment. Laws regulating investments in electricity generation and transmission assets (e.g., [14] and [15]) provide financial and non-financial benefits, for example, no import duty on equipment and raw materials. While foreign investment has helped expand the electricity generation capacity, the use of foreign materials and experts help explain why local officials do not consider material provision in energy planning.

Additional challenges associated with existing infrastructure come with changing seasons and climatic effects on hydropower. Lao relies on power imports during the peak of the dry season (January–April). Domestic demand peaks during April–May (at low hydropower generation), resulting in industry brownouts. Work to reduce import dependency due to seasonality is ongoing [9]. Additional risks may be posed by climate change effects. Studies for hydropower plants are usually conducted, highlighting expected impacts (e.g., floods in monsoon catchments like Nam Ngiep [16]), yet no government plans, as far as the authors are aware, have mentioned climate change effects on hydropower generation.

Overcoming the challenges: conclusions and recommendations

The expansion of the electricity sector needs to limit the dependency on coal and use existing renewable potential to stay in line with Nationally Determined Contributions (NDCs). Based on this brief's findings, the following recommendations can help achieve this aim:

- **Local material demand for steel and cement exceeds the local production capacity for building electricity systems.**
- **Further examination of material requirements for building new electricity generation and transport systems is advised.** This could identify opportunities for building local capacity to supply materials and installation needs, providing local jobs.
- Surveys showed that local government knowledge of low-emission strategies is not widespread, while ministry boundaries are being blurred by the electrification of transport and industry. **Reviewing the government structure to promote cross-sector coordination is advised.**
- **Reliability, completeness, and standardization of openly-available Lao statistics need to be improved.**

[7] Lao's GDP yearly growth rate was between 7 and 8% between 2009 and 2016 [17].

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