CHAPTER 13

INFRASTRUCTURE ASSOCIATED WITH RENEWABLE ENERGY

This chapter focuses on infrastructure that is associated with the energy transition, particularly new infrastructure required to support the development of renewable energy such as transmission lines (trunk lines, new connections), access roads and the development of smart grids with energy storage systems/facilities. The chapters in this guidance concerned with types of renewable energy (chapters 5-10) all highlight that the construction of transmission lines and access roads are amongst the main causes of environmental and social impacts.

13.1 EXISTING SEA GUIDANCE/GUIDELINES FOR INFRASTRUCTURE ASSOCIATED WITH THE ENERGY TRANSITION

An international survey of existing SEA guidelines conducted for the IAIA was unable to identify any guidelines specifically focused on infrastructure specifically associated with the energy transition and specifically with the development of renewable energy. However, many EIA and some SEA guidelines refer to the general impacts of roads, transmission lines, and ports, harbours and terminals.

Roads

The Mekong River Commission has produced guidelines for the integrated planning and design of economically sound and environmentally friendly roads in the Mekong River floodplains[1].

Transmission lines

EIA and SEA guidelines for transmission lines have been published for several countries: Germany, Southern Africa, Surinam, and the USA. Marshall and Fischer (2006) discuss regional electricity transmission planning and tiered SEA in Scotland[2]. The International Finance Corporation's *Environmental, Health and Safety Guidelines for Electric Power Transmission and Distribution* are a very useful reference document with general and industry specific examples of good international industry practice[3].

Ports, harbours and terminals

With regard to the energy transition, ports, harbours and terminals are likely to be developed or upgraded/expanded mainly in connection with exporting green hydrogen and ammonia. The International Finance Corporation's *Environmental, Health and Safety Guidelines for Ports, Harbours and Terminals* provide a useful reference source with general and industry specific examples of good international industry practice[4].

13.2 TYPES OF TRANSMISSION LINES AND POWER GRIDS

A transmission line is the long conductor (either overground supported by pylons (Figure 13.1), or underground/sub-marine) with special design (bundled) to carry bulk amount of generated power at very high voltage from one station to another as per variation of the voltage level. Design must take account of key factors including voltage drop, transmission efficiency, line loss, etc. These values are

[1] MRC (2011)

[2] Bundesnetzagentur (2021) EnvSC (1999); Bundesnetzagentur (2021) MRC (2011); NIMOS (2005); USAID/CCAD/EPA (2011a.b.c); and Marshall & Fischer (2006).

[3] IFC (2007c)

[4] IFC (2017)

affected by line parameters R, L and C[5] of the transmission line. There are three types of transmission line length (Table 13.1)

Figure 13.1: High voltage transmission line crossing conifer forest land, Oregon, USA

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Table 13.1: Lengths categories of transmission lines
(Source: www.electrical4u.com)

Type of transmission line	Features
Short line	• A length less than 80km (50 miles) • Voltage level less than 69 kV • Capacitance effect is negligible • Only resistance and inductance are taken in calculation capacitance is neglected.
Medium line	• A length more than 80 km (50 miles) but less than 250 km (150 miles) • Operational voltage level is from 69 kV to approx 133 kV • Capacitance effect is present • Distributed capacitance form is used for calculation purpose.
Long line	• A length more than 250 km (150 miles) • Voltage level is above 133 kV • Line constants are considered as distributed over the length of the line

A ***power grid*** is a country's network of power generation, transmission and delivery, conducting electricity from power plants to homes and businesses across a country (e.g., Figures 13.2 (China) and 13.3 (USA)). It includes energy utility companies and energy suppliers and the infrastructure to generate and distribute power. The grid may be a single national network, or several regional grids that may be interconnected.

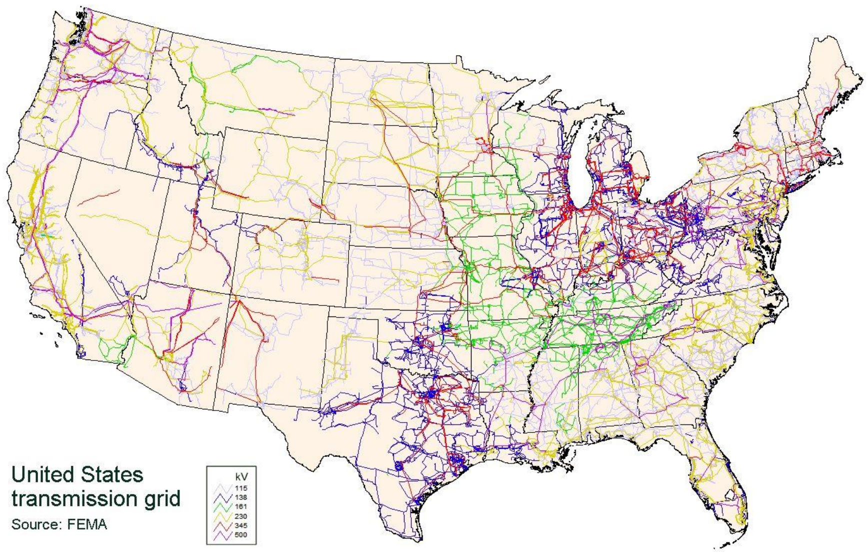
Figure 13.2: China's power grid

Figure redacted pending securing copyright permission to use. If you have an image showing this spatial distribution that you can provide (with permission to use – please indicate the credit to cite) we would be delighted if you can send it.

[5] A transmission line is modelled with a resistance (R) and inductance (L) in series with a capacitance (C) and conductance (G) in parallel. The resistance and conductance contribute to the loss in a transmission line.

Figure 13.3: USA power grid

Source: Source: Federal Emergency Management Agency (FEMA), USA (available at: https://commons.wikimedia.org/wiki/File:UnitedStatesPowerGrid.jpg



A grid ensures best practice use of energy resources, provides greater power supply capacity, and makes power system operations more economical and reliable. The generating stations are interconnected to reduce the reserve generation capacity, known as a spinning reserve, in each area.

A ***smart grid*** is an electricity network that uses digital and other advanced technologies to monitor and manage the transport of electricity from all generation sources to meet the varying electricity demands of end users. Smart grids coordinate the needs and capabilities of all generators, grid operators, end users and electricity market stakeholders to operate all parts of the system as efficiently as possible, minimising costs and environmental impacts while maximising system reliability, resilience, flexibility and stability.

Despite some recovery from the economic disruption caused by the Covid-19 pandemic, investment in smart grids need to more than double through to 2030 to get on track with the Net Zero Emissions by 2050 Scenario, especially in emerging market and developing economies[6].

According to analysis of available data[7], the total length of transmission circuits worldwide is estimated at 4.7 million kilometres, and the length of distribution grids between 88 and 104 million km. China accounts for 41% of the expansion of global transmission grids, and 32% of the expansion of distribution grids since 1980. In 2017, China's electricity grids were approximately as large as the grids of all western industrialized countries combined. The globally installed capacity of transformers is estimated between 36 and 45 Teravolt-Ampere, with transmission and distribution transformers accounting for above 40% each, and generator step-up transformers for the rest.

In 2023, worldwide, there were 7 million circuit Km[8] of power transmission lines and 110 million Km of power distribution lines[9]. As a 'rule of thumb' each TWH pa of electricity use globally is supported by 225 km of power transmission lines (interquartile range of 175-275 km per TWH pa). Another 'rule of

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6 Smart Grids – Analysis - IEA

7 Kalt *et al*. (2021)

8 *What are circuit kilometres?* One 'network kilometre' of power transmission lines may carry one circuit kilometre, two circuit kilometres or sometimes (rarely) three circuit kilometres, suspended from the same towers. In turn, each circuit kilometre may contain two large conductors (e.g., a high voltage direct current, HVDC), three conductors (3-phase AC) or sometimes (rarely) six conductors where the 3-phase AC is disaggregated to promote transmission efficiency. This makes the 'length' of a transmission line a somewhat debatable concept.

9 Power transmission and distribution kilometers by country? - TSE (thundersaidenergy.com)

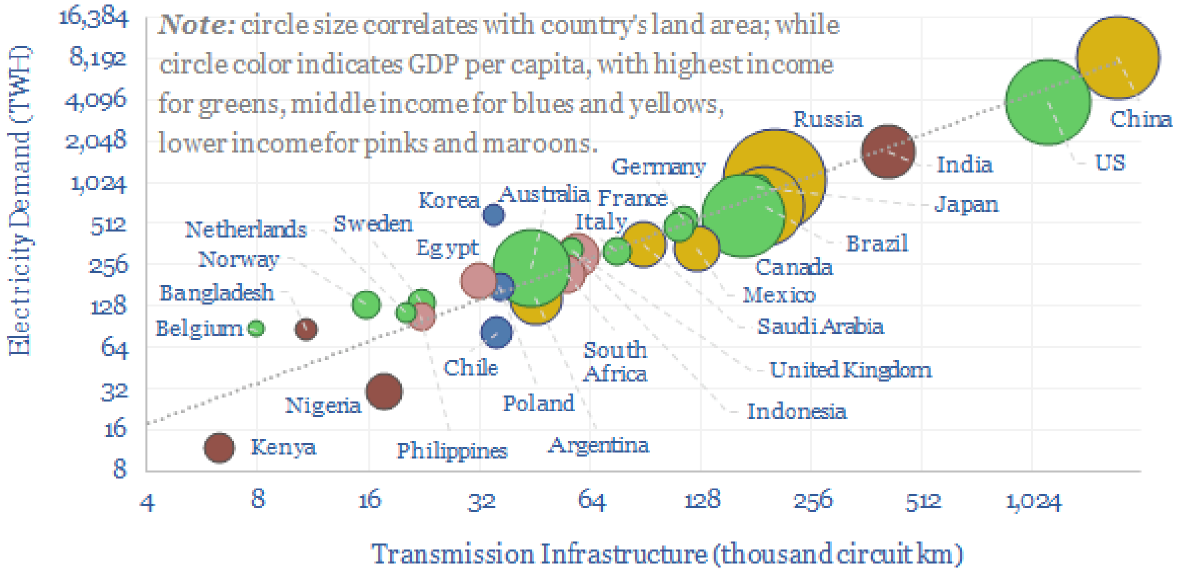
thumb' is that each TWH pa of electricity use is supported by almost 4,000 km of distribution lines. The cut-off between transmission and distribution is a little bit blurry but ,generally,100kV lines can be considered as transmission lines and <50kV lines as distribution lines. Globally, on average, countries have 16 km of distribution lines per km of transmission lines[10]. Generally, large, developed countries tend to have a higher share of large-scale transmission, due to greater availability of financing for larger and more efficient grid infrastructure. Countries tend to have longer power transmission networks per unit of delivered electricity when (a) population density is lower (b) GDP per capita is lower and (c) average voltages of the transmission system are lower.

Using the above rules of thumb above, Thunder Said Energy (a research consultancy for energy technologies) estimates that each 1 GW of new, utility-scale renewables might warrant constructing or upgrading around 500 km of transmission lines and 8,000 km of distribution infrastructure. However, the requirements will clearly vary case by case and depend on regional backlogs. A far-offshore wind project clearly has different network impacts from rooftop solar[11].

Figure 13.4 shows power transmission and distribution Km by country across 30 key countries which comprise 80% of global electricity use.

Figure 13.4: Transmission infrastructure and electricity demand for a range of countries

Source: [Power transmission and distribution kilometers by country? - TSE (thundersaidenergy.com)]



To achieve the energy transition, most electricity transmission systems around the world will need massive expansion, upgrades, shifts in technology used, and accommodation to the type of electricity that is transmitted (for instance high voltage dc). Investments in the types of transmissions systems taking place now may limit future options. There may be issues for projects to connect to electricity grids (so that they are on-grid or grid-tied) that are designed for larger utility scale projects. Also, the potential for grid connections between countries could have huge benefits (financial, environmental, social) if done properly. There are already examples of essentially 'stranded' renewable energy projects that cannot get their energy to markets due to grid constraints. After 20 years of effort, the USA has only recently finalised the first decision on a grid expansion.

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[10] Power transmission and distribution kilometers by country? - TSE (thundersaidenergy.com)

[11] Power transmission and distribution kilometers by country? - TSE (thundersaidenergy.com)

13.3 ACCESS ROADS

All renewable energy developments are likely to require access roads (including bridges), particularly in the preparatory stage, e.g. to bring in equipment (e.g. drilling rigs for geological investigation of selected sites, earth-moving equipment and construction materials), to transport labour to sites and for maintenance purposes (Figure 13.5). In an inhabited area, existing roads may be capable of being used, but may require upgrading (e.g., to accommodate wide or heavy loads). But there may be a need to extend the existing road network. In many cases, new renewable energy facilities may be located in remote areas, requiring the construction of new access roads. Such roads may require to be constructed across difficult terrain (e.g., mountainous land) and it may not be possible to avoid traversing sensitive and protected areas.

There are no internationally agreed specifications for such access roads. But they certainly can lead to serious environmental and socio-economic impacts (discussed in section 13.6) which need to be mitigated and managed. But it must also be recognised that access roads can also bring benefits to local populations and communities.

Some authorities (national or local) may set out specifications for such access roads (e.g., national standard specifications in South Africa[12], and specifications set by county councils in the UK[13]) setting out requirements covering, for example, design issues, management of materials (e.g. for blasting), safety, fences and barriers, drainage, earthworks, surfacing, footways, traffic signs, lighting, etc.).

Figure 13.5: Constructing access road to Amethyst hydropower scheme, New Zealand

Source: Amethyst Hydro Access Road | Earthworks, Rock Supply and Placement, Roading - MBD Contracting

Figure redacted pending securing copyright permission to use. If you have an image showing this spatial distribution that you can provide (with permission to use – please indicate the credit to cite) we would be delighted if you can send it.

13.4 ENERGY STORAGE FACILITIES

An electric power grid operates based on a delicate balance between supply (generation) and demand (consumer use). One way to achieve this balance is to store electricity during periods of relatively high production and low demand, then release it back to the electric power grid during periods of lower production or higher demand. In some cases, storage may provide economic, reliability, and environmental benefits. Depending on the extent to which it is deployed, electricity storage can help the utility grid to operate more efficiently, reduce the likelihood of drops in voltage in the electrical power supply system (brownouts) during peak demand, and allow for more renewable resources to be built and used.

The need for storage is a particular concern with regard to solar and wind power. When the electric grid has all the energy it needs at a given time, but it's a sunny or windy day and solar and wind energy systems are still generating electricity, it makes sense to store the surplus. Then, when the sun has set and the wind isn't blowing, that stored surplus energy can be discharged to continue supporting power needs.

Energy can be stored in a variety of ways, including:

[12] COTO Standard Specification - Department-of-Transport

[13] Specification for highway works for new developments (leicestershire.gov.uk)

- ***Pumped hydroelectric*** (currently the most widely used technology with significant additional potential in several regions) Electricity is used to pump water up to a reservoir. When water is released from the reservoir, it flows down through a turbine to generate electricity.
- ***Compressed air*.** Electricity is used to compress air at up to 1,000 pounds per square inch and store it, often in underground caverns. When electricity demand is high, the pressurized air is released to generate electricity through an expansion turbine generator.
- ***Flywheels*.** Electricity is used to accelerate a flywheel (a type of rotor) through which the energy is conserved as kinetic rotational energy. When the energy is needed, the spinning force of the flywheel is used to turn a generator. Some flywheels use magnetic bearings, operate in a vacuum to reduce drag, and can attain rotational speeds up to 60,000 revolutions per minute.
- ***Batteries*** (the most scalable type of grid-scale storage and the market has seen strong growth in recent years). Similar to common rechargeable batteries, very large batteries can store electricity until it is needed (Figure 13.6). These systems can use lithium ion, lead acid, lithium iron or other battery technologies (see Box 13.1).
- ***Thermal energy storage*.** Electricity can be used to produce thermal energy, which can be stored until it is needed. For example, electricity can be used to produce chilled water or ice during times of low demand and later used for cooling during periods of peak electricity consumption.
- ***Others***: In addition to these technologies, new technologies are currently under development, such as flow batteries, supercapacitors, superconducting magnetic energy storage, molten salt[14] and hydrogen (discussed separately in Chapter 14).

Figure 13.6: Hornsdale Power Reserve (a Tesla facility), South Australia

Figure redacted pending securing copyright permission to use. If you have an image showing this spatial distribution that you can provide (with permission to use – please indicate the credit to cite) we would be delighted if you can send it.

Box 13.1: Batteries

The most common type of battery used in grid energy storage systems are lithium-ion batteries. Lithium-ion batteries include five components:

- an anode (typically graphite coated onto aluminium foil);
- a cathode (either nickel-magnesium-cobalt or nickel-cobalt-aluminum; lithium-iron-phosphate; and blended onto copper foil);
- a separate barrier between the anode and cathode;
- an electrolyte solution to transport lithium ions; and
- current collectors made of copper and aluminium that connect the battery to wires.

An additional advantage of batteries is their use in “mini-grids,” which can help individuals and communities keep the lights on for extra hours when the grid falls temporarily offline due to blackouts or natural disasters.

In some countries (e.g. USA), instead of batteries, fossil fuel-powered “peaker plants” are often used to supply energy during high-demand periods. Despite being used infrequently, these plants are inefficient and highly polluting, and contribute greatly to carbon emissions.

[14] Molten Salt Storage for Power Generation - Bauer - 2021 - Chemie Ingenieur Technik - Wiley Online Library

By 2023, the USA is predicted to have deployed 20.5 GwH of energy storage capacity between 2013 and 2023, followed by China (10 GwH) and Japan (8.3 GwH) (see Table 13.2).

Table 3.2: Projected energy storage deployment between 2013 and 2023
(Source: Energy storage deployment forecast by country 2023 | Statista)

Country	Projected capacity (GwH)
USA	20.5
China	10
Japan	8.3
Australia	6.6
Germany	4.3
UK	2.6
India	2
South Korea	1.5
Canada	1.3
Rest of World	8.1

According to the U.S. Department of Energy, the USA had more than 25 gigawatts of electrical energy storage capacity as of March 2018. Of that total, 94% was in the form of pumped hydroelectric storage, and most of the latter capacity was installed in the 1970s. The 6% of other storage capacity was in the form of battery, thermal storage, compressed air, and flywheel[15].

13.5 PORTS, HARBOURS AND TERMINALS

The energy transition will involve reducing (and ideally eliminating) our dependence on fossil fuels as energy sources. Coal, oil, and gas need to be transported from where they are extracted to where they are consumed – within countries or internationally - by road, rail, sea and pipelines. Where fossil fuels are exported or imported by sea, this involves ports, harbours and terminals. Sometimes these are dedicated stand-alone facilities, e.g., Richard Bay coal terminal in South Africa (Box 13.2); in other cases they are part of general ports that handle a wide range of other cargoes.

As regards fossils fuels, this guidance focuses only on retiring coal-fired power plants and the closure of associated coal mines and the cessation of use of ports, harbours and terminals for coal transport.

[15] Electricity Storage | US EPA

Box 13.2: Richards Bay Coal Terminal, South Africa

Richards Bay Coal Terminal (RBCT) in South Africa is one of the leading coal export terminals in the world. RBCT was established in 1976 with an original capacity of 12 million tons per annum (Mt/a). It has since expanded to an advanced 24-hour operation with a design capacity of 91 Mt/a, and handles coal from 65 collieries and brought by rail. RBCT is positioned at one of the world's deep seaports and handles large volumes of coal and vessels. The 276 ha site currently 2.2 km long, 6 berths and 4 shiploaders, with a stockyard capacity of 8.2 Mt. It is currently visited by more than 900 vessels per year.

Source: Global Markets: Richards Bay Coal Terminal to export 74M tons of coal this year (mozambiqueminingpost.com)

Figure 13.7: Richards Bay coal terminal, South Africa

Figure redacted pending securing copyright permission to use. If you have an image showing this spatial distribution that you can provide (with permission to use – please indicate the credit to cite) we would be delighted if you can send it.

Source: Who We Are – Richards Bay Coal Terminal (rbct.co.za)

13.6 IMPACTS OF TRANSMISSION LINES AND ACCESS ROADS

The environmental and socio-economic impacts of both transmission lines and access roads are discussed in detail for different types of renewable energy development in chapters 5 (hydropower), 6 (wind), 7(solar), 8 (bioenergy), 9 (geothermal) and 10 (tidal).

13.6.1 Environmental and socio-economic impacts of transmission lines and access roads

Tables 3.3 and 3.4 summarise, respectively, the main environmental and socio-economic impacts associated with transmission lines and access roads.

Table 13.3: Key environmental impacts associated with transmission lines and access roads.

Issue	Impacts	Applies mainly to transmission lines and/or access roads
Land clearing - deforestation	• Soil erosion • Landslips • Sedimentation of rivers • Loss of and fragmentation of habitats, and loss of biodiversity • Loss of services (terrestrial and aquatic)	• Both • Roads • Roads • Both • Roads
Biodiversity	• Fragmentation of habitats caused my single and multiple linear disturbances. Often transmission lines and roads occur together • Increased access to protected areas • Poaching and wildlife trafficking	• Both
Quarries and borrow-pits	• Digging for rock or gravel can also release pollutants other harmful substances into the surrounding environment (particularly surface and ground water) • Land degradation and loss of vegetation • Noise from blasting and crushing • Dust • Waste from unwanted materials • Lack of restoration to prevailing conditions	• Both
Marine habitat disturbance	• Seabed and marine habitat disturbance/scouring and water quality impacts (when constructing underwater cable foundations associated with offshore wind	• Offshore transmission line
Wildlife deaths	• Collisions with vehicles • Collisions with power lines and electrocutions • Increased access leading to poaching	• Roads • Transmission lines • Both
Waste	• Waste soil and rock (spoil) from excavation/routing works and levelling transmission pylon sites	• Both
Noise	• Noise (during road and line construction (including underwater and due to vessel movement in case of off-shore wind); • Vibration and dust during construction	• Both • Roads
Visual and aesthetic impacts	• Impacts on landscape	• Transmission lines
Herbicide use	• Impacts of herbicides used to control vegetation on the right-of-way	• Transmission lines but can be used on road margins

Table 13.4: Key socio-economic impacts associated with transmission lines and access roads.

Issue	Impacts	Applies mainly to transmission lines and/or access roads
Land use	• Limitations/restrictions on land use along easement routes and beneath transmission lines (e.g., no agriculture, tree planting or buildings). For indigenous peoples, this can include impeded access to spiritual, cultural, and economic relationships with their land.	• Transmission lines
Fishing	• Affects on fishing (e.g., reduced yields/catches) and other aquatic-based activities or reliant livelihoods (for offshore wind transmission cables	• Offshore transmission cables
Health and safety	• Health and safety issues related to high overhead voltage cables, during construction of lines or underground/underwater cables; and due to roads, quarries and borrow-pits (accidents due to increased presence of vehicles – particularly during construction, and operation of equipment) • Health effects associated with electromagnetic fields (EMF)	• Both • Transmission lines
Jobs	• Job opportunities for local people • Opportunity for vulnerable groups and indigenous communities to acquire new skills through working on transmission line construction and road building. • There may be gender gaps with women where they are under-represented	• Both
Labour rights	• Infringement of labour rights during transmission line and road construction, mainly where there is a demand to undertake excessive overtime and successive days of work without sufficient rest	• Both
Tensions and conflicts	• Tensions can arise when transmission lines are built—particularly since the electricity generated is not distributed locally (hydropower projects are typically permitted as generating facilities and are not allowed to distribute electricity to local communities). • Conflicts between the workforce and the local population and exposure to anti-social behaviour; • Conflicts within the local population can arise for a range of reasons, often relating to issues of inequity, including, for example: compensation measures (which may arise from a lack of clarity on cut-off dates), eligibility criteria or entitlement provisions (e.g., duration); access to and extent of training and support; and access to and extent of project benefits. • There is a risk of conflict between communities and project developers if the latter do not secure the free prior and informed consent (FPIC) to projects and	• Transmission lines • Both • Both • Both

Issue	Impacts	Applies mainly to transmission lines and/or access roads
	their associated transmission lines from indigenous communities	
Community cohesion and engagement	• Impacts to or loss of community resources (e.g., gardens, land, forest, fisheries) and community assets (e.g., community meeting areas, culturally significant features);	• Both
Land acquisition risks	• Associated with acquiring land for roads, substations, and transmission lines	• Both
Cultural	• Cultural, religious, and archaeological sites can be destroyed or access to them restricted when land is acquired for transmission lines	• Both

Box 13.1 discusses some of the challenges associated with transmission lines in Nepal.

Box 13.1: Challenges of constructing transmission lines in Nepal, and the case of the New Butwal – Lamahi 400 kV transmission line

(contributed by Ajay Mathema (SchEMS, Nepal)

Transition lines prioritized. The Government of Nepal (GoN) has prioritised the construction of transmission lines to 'evacuate' or transport electricity generated by hydropower projects across the country. Environmental requirements for transmission line projects have been eased. The Environmental Protection Regulations 2020 now require only an Initial Environmental Examination (IEE) rather than a full EIA for all sizes and scales of transmission line.

Land acquisition (for Rights of Way, RoW) across private land is a major challenge. Electricity Rules require both vertical and horizontal clearance beneath and adjacent to conductor wires to ensure safety and smooth operation of transmission lines. A right-of-way (RoW) is negotiated with the landowner that imposes restrictions on the use of land (e.g., on the height of vegetation and buildings that can be constructed) and offers compensation (typically 15 – 25% of the land's value) to landowners. The restrictions significantly depress the value of the land and financial institutions will not accept such land as collateral, further limiting its financial potential. As a result, many landowners are reluctant to have the transmission line pass through their land and transmission line projects have faced strong resistance from the public, significantly delaying construction and leading to uncertainties in the overall energy infrastructure development. Land is purchased from landowners for towers and substations.

Routing transmission lines through forest areas. This alternative has given rise to a new set of concerns and trade-offs, particularly related to the environment, the integrity of forest ecosystems (through land clearing) and loss of habitats and biodiversity – as exemplified by the proposed New Butwal – Landhi 400 kV transmission line – see below. Many animal species rely on forested areas for shelter, food, and breeding, and their displacement and habitat fragmentation due to the transmission line can disturb the delicate ecological balance.

****

The proposed 400 kV New Butwal – Lamahi transmission line project in Lumbini Province.

This 160 km transmission line is estimated to require the clearing of about 180,000 trees along its corridor. Nearly 97% of the transmission line alignment passes through the forests on the foothills of the Churiya Hill range. Traditionally, transmission line projects in Nepal clear the vegetation along the RoW to comply with the Electricity Rule 1003 and to ensure the safe and efficient operation of the transmission land while minimizing potential hazards (e.g. fire) and disruption caused by encroachments or incompatible constructions.

The project intends to minimize impacts on the forest by avoiding removal of ground vegetation as well as minimizing the clearance or trimming of trees (to only those above 20m) - by increasing the height of the towers to 90m. Forest sampling showed that 20% out of the 180,000 trees along the transmission line corridor are taller than 20m and will require either removal or trimming.

The project also aims to minimize vegetation removal for tower construction and stringing operations. Drones will be used for stringing. Vegetation clearance will be limited to a 200m stretch of the RoW at every 4 km, requiring 40 clearance sites which will cover a combined area of 36.8 ha. Taking all factors into account, including trees above 20m, construction work, stringing, and substation sites, the total number of trees expected to be removed along the corridor will be approximately 45,000 (25% of all trees). Most of the trees to be persevered are Sal - a protected species. This approach will also minimise disturbance to forest habitats and the delicate, erosion-prone geology of Churiya hill range.

It is estimated that the proposed taller towers and using advance construction technology will increase project costs by 40%, making it one of the most expensive transmission line projects. This significant increase in expenses may not be feasible for the GoN.

13.7 IMPACTS OF ELECTRICITY STORAGE

Storing electricity can provide indirect benefits. For example, electricity storage can be used to help integrate more renewable energy into the electricity grid. Electricity storage can also help generation facilities to operate at optimal levels and reduce use of less efficient generating units that would otherwise run only at peak times. Further, the added capacity provided by electricity storage can delay or avoid the need to build additional power plants, transmission and distribution infrastructure, or access road - which have associated environmental impacts.

Potential negative impacts of electricity storage will depend on the type and efficiency of storage technology. For example, batteries use raw materials such as lithium and lead, and they can present environmental hazards if they are not disposed of or recycled properly. In addition, some electricity is wasted during the storage process. Plus, demand for these rare metals in batteries is leading to a boom in their mining and the associated environmental impacts associated with such mining.

From a social perspective, mining for rare metals is often associated with violations of the human rights of communities (e.g., rights to land, livelihood, ability to undertake traditional cultural practices, forced and child labour).

13.8 IMPACTS OF PORTS, HARBOURS AND TERMINALS ASSOCIATED WITH THE ENERGY TRANSITION

With regard to the energy transition, new ports, harbours and terminals are likely to be developed or existing ones upgraded/expanded mainly in connection with exporting green hydrogen and ammonia. Liquid natural gas (LNG) terminals are also being built for the transport of natural gas as a transition fuel for electricity generation, away from coal and diesel. But, as pressure and commitments increase to retire coal-fired coal plants and as associated coal mines are closed, existing coal terminals are likely to be closed, possibly repurposed (e.g., to export green hydrogen), or may have potential to convert to other purposes (e.g. as leisure marinas or industrial tourism sites). See also IFC EHS Guidelines for Ports, Harbours and Terminals[16].

There are two main types of environmental and social impacts associated with ports and harbours that may affect the port area itself and/or the surrounding area: those arising from construction when developing or upgrading/expanding facilities; and those linked to operating the facilities.

[16] Environmental, Health, and Safety Guidelines for Ports, Harbors, and Terminals (ifc.org)

Environmental impacts can include:

- Local air and water pollution (e.g. spillages and discharges from ships)
- Noise from ships engines and machinery used to load/unload cargoes; and from vehicles/trains delivering to the port;
- Underwater noise and vibration and blasting during construction;
- Dredging required to deepen access to the port and disposal of dredged materials;
- Biodiversity impacts to sensitive marine and terrestrial habitats (e.g., mangroves. Seagrass, coral) and protected areas such as important bird areas (IBAs);
- Water quality impacts;
- Hydrology impacts and changes to coastal geomorphology and sedimentation dynamics;
- Waste management – ballast water, slops, wastewater, hazardous materials;
- Air pollution; exhausts of greenhouse gases and particles, CO_2, NO_x and SO_2 from the ship's main and auxiliary engines; and from trains/vehicles
- Traffic congestion in and around the port and feeder roads
- Widespread contamination of sediments;
- Vulnerability to climate change impacts – increased storms, sea level rise;
- Health and safety impacts during construction and operations;
- Impacts at sea due to:
  - Ships wash;
  - Collisions between vessels and marine animals;
  - Noise from ships engines and propellors;
  - Marine accidents;
  - Anchoring and mooring.

From a social perspective, ports, harbours and terminals can support and benefit local, regional and national economies through their role in creating jobs and transporting goods. Their operators/owners can also partner with communities to offer workforce development programmes, protect the environment and coordinate on land use planning to incorporate community amenities.

However, ports can also create potential challenges for near-port communities who are disproportionately impacted by port operations and related transportation systems. Construction may involve an influx of workers from elsewhere which carries with it the potential for conflict with local communities. In addition, while ports are major economic engines for local, regional, and national economies, these economic benefits may not be equitably distributed. The near-port communities may not receive a fair share of the economic benefits that flowing to the region or national economy.

Ports may also require acquisition of land, often from nearby communities and this must be done in a fair and equitable manner consistent with best international practices (e.g., IFC Performance Standard 5). Ports can also cause conflicts with local fishing communities regarding access and landing points. Transport congestion can arise during port construction and persist throughout the life of the port.

Ports can also impact important terrestrial and marine areas important to indigenous peoples and their use of those lands. In recognition of indigenous rights and the need for respect, cooperation, partnership and the need for establishing meaningful dialogue for better informed port decisions, the Government of Canada is amending the Canada Marine Act to recognize indigenous groups alongside port users and communities and to establish new advisory bodies and governance mechanisms to assure environmental and social sustainability of port infrastructure and operations[17]

Where existing coal ports, harbours and terminals are closed, this may offer opportunities to restore sites to their former ecological status. Or they may be repurposed for other commercial use or for leisure/tourism.

Closure will inevitably have impacts on the local or regional economy and on jobs and livelihoods. Repurposing may offer new economic and job opportunities – but different skills are likely to be

[17] [Proposed legislative changes to support building stronger supply chains - Canada.ca]

required. It should recognsied that port closures related to coal transport and coal mining are still in their infancy and many new initiatives are under development to reinvent ports to become “ports of the future” and energy hubs for green hydrogen and ammonia[18].

[18] How ports can be transformed into energy hubs of the future | World Economic Forum (weforum.org)