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Sustainable Transport for Low Carbon Society in Nepal: Institutional and Other Challenges

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Contents

- Key areas of intervention for low carbon transport development
- Institutional implications
- The case of electrified low carbon transport development in a developing country - Nepal

Key factors behind carbon emission from transport sector

- CO_2 emission from Transport = $\sum EF*FI*MS*TD$

  where

  EF = Emission factor

  FI = Fuel Intensity

  MS = Modal Structure

  TD= Transport Demand

Low carbon transport requires…

- Lower EF: Less carbon intensive fuels
- Lower FI: Low carbon and more energy efficient transport technologies and infrastructure (e.g., better road quality)
  => Renewable energy based and energy efficient transport options
- More efficient MS: Larger share of mass/public transport and non-motorized transport

  => Investment in long term capital intensive infrastructure
- Reduction in TD:

⇒ Transport demand management policies; road/congestion pricing

⇒ TD = f(GDP, Pop, Prices, regulatory conditions)

Low carbon & energy efficient transport technologies and infrastructure

- Institutional capacity and commitment:
  - To formulate and implement vehicle fuel efficiency standard (lacking in most developing countries)
  - To promote production/supply of low carbon fuels

    (often constrained by supply infrastructure (natural gas, battery recharging stations) and limitation of domestic production (biofuels))
  - To design tax and subsidy policies to discourage ownership and use of carbon and energy intensive vehicles and encourage use of low carbon energy efficient technologies
  - To raise awareness about low carbon transport technologies (LCTT)
  - To maintain the quality of existing transport infrastructure (relation between poorly designed/ maintained roads and fuel economy of vehicles)
    - LCS a much bigger issue than modal shift and vehicular fuel efficiency
    - Poor capacity of transport sector institutions in many DCs for maintenance.

Development of transport infrastructure for low carbon modal shift (1)

- Need for a dedicated institution with adequate authority and resources (funding and human)
- Existing transport planning, policies and institutions mainly road oriented; institutions for railways and mass transport much weaker, under funded!
- Integrating transport planning with both urban/land use planning and energy planning and policy.

  => Electrified transport and low carbon electricity supply

  - Multi-sectoral coordination-- an institutional challenge

Development of transport infrastructure for low carbon modal shift (2)

- From economic perspective, mass transport system (e.g., railways) can be a cheaper option over a long run; still could face the financing barrier.

  => Issue of huge upfront investment and management

  - Government capacity limited

  => Rigid government control and interference in public-owned infrastructure

  - Uncertainty in pricing (regulated) and profitability to private investors

  -

- Need to identify appropriate model for financing/building, ownership and operation

  ⇒Public Private Partnership?

  - Public investment and private management?

Institutional capacity and carbon finance benefits

- Weak institutional capacity to benefit from international carbon finance mechanisms eg. CDM.
- Not many CDM transport projects (high CDM transaction costs – partly responsible)

Transport Demand Management

- TD = f(GDP, Pop, prices, regulations)
- Demand reduction -- a big challenge when both GDP and population growing.
- TD can offset carbon reduction due to efficiency improvement and modal shift
- Efficiency improvement => rebound effect
- Institutional capacity to formulate and implement TD management/reduction; achieve behavioral change
- Need to integrate IT, urban and transport planning to reduce TD.
- Low carbon transport development - a multisectoral activity
- Fuel pricing, congestion pricing, vehicle pricing /quota policy, other TD management and control policies (Singapore example).
- Al these need strong institutional capacity.

Transport system electrification and hydropower development as a low carbon strategy:

Financial and institutional implications

Case of Nepal

Ram M. Shrestha and Shree Raj Shakya

Overview of energy and transport sectors in Nepal

- Transport mainly road based, negligible share of railways.
- Large area of the country lack road access.

- Over 90% of national export revenue spent on energy import
- Hydropower potential of 83,000 MW; only less than 1% currently harnessed

- Nepal Transport Policy (2001/02), emphasized the promotion of electricity based transport system throughout the country with private sector participation.
- Recently, the GoN has come up with the long term plan to introduce electric railway system in Nepal (RITES/SILT, 2010).

- Five year plans (8th, 9th and 10th) emphasized on the expansion of the government owned electric trolley bus service operating inside the Kathmandu valley . However, no such expansion has materialized and the trolley bus service became dysfunctional by 2004.
- On the other hand, electric 3-wheelers (operated by the private sector) is still in operation inside the Kathmandu valley.

- Huge shortage in electricity supply at present

Transport Electrification Scenarios

Road freight and passenger transport demand under base case during 2005-2050

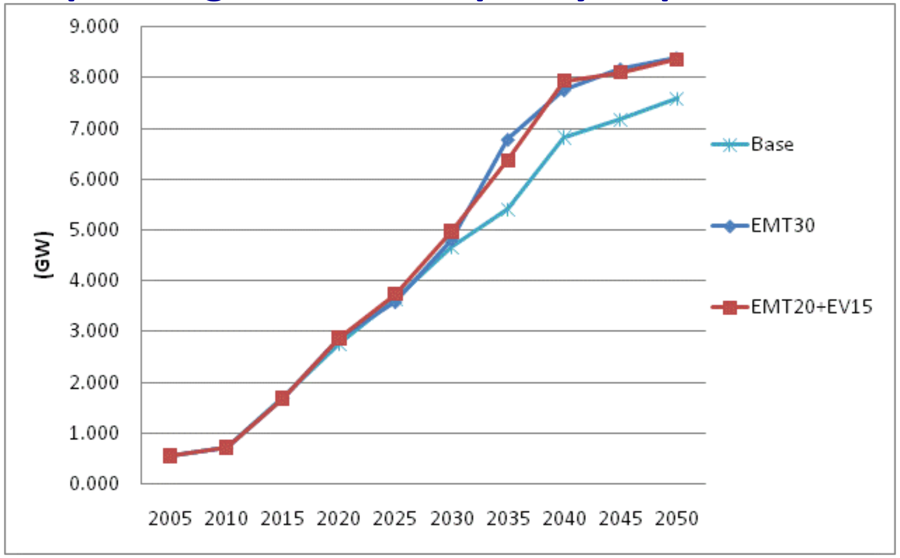
Sub-region	Transport Type	2005	2010	2015	2020	2030	2050	Ratio 2050/2005
Kathmandu valley	Land Freight (billion ton-km)	0.3	0.5	0.6	0.8	1.2	2.0	6.0
	Land Passenger (billion passenger-km)	4.1	5.8	8.1	10.9	17.8	34.8	8.4
Nepal	Land Freight (billion ton-km)	2.2	3.0	4.2	5.7	9.7	19.1	8.6
	Land Passenger (billion passenger-km)	20.8	30.0	44.4	63.0	112.0	231.7	11.1

Share of transport demand served by Electric Mass Transport System (Electric Train/MRT), %

		2015	2020	2025	2030	2035	2040	2045	2050
EMT30	EMT		10.0	13.3	16.7	20.0	23.3	26.7	30.0
EMT20+EV15	EMT		10.0	11.7	13.3	15.0	16.7	18.3	20.0
	EV	10.0	10.7	11.4	12.1	12.9	13.6	14.3	15.0

Implications of transport electrification for hydropower development

Annual hydropower generation capacity requirement during 2005-2050.



Scenario	2020		2030		2050		Cumulative Total (2005-2050)
	GW	TWh	GW	TWh	GW	TWh	TWh
Base case	2.76	13.87	4.66	24.04	7.592	35.72	885.33
EMT30	2.88	14.19	4.82	24.85	8.391	39.95	983.11
EMT20+EV15	2.87	14.50	4.98	25.86	8.364	39.15	970.03

- Additional hydropower generation capacity required: 799 MW under EMT30 and 772 MW under EMT20+EV15 by 2050.

Investment implications of transport electrification

Undiscounted Hydropower Investment Cost (million 2005 US$)

Case	Annual Investment Cost							Cumulative Additional Investment	
	2020	2025	2030	2035	2040	2045	2050	2005-2030	2005-2050
Base	5,899	11,462	23,288	45,076	105,863	224,829	625,728		
EMT30	6,032	11,509	24,043	56,075	115,007	254,178	682,630	2,780	394,378
EMT20 +EV15	6,150	11,870	24,595	53,596	120,551	249,559	682,195	6,540	390,665

Undiscounted Electric Mass Transport Investment Cost (million 2005 US$)

Case	Annual Investment Cost							Cumulative Additional Investment	
	2020	2025	2030	2035	2040	2045	2050	2005-2030	2005-2050
EMT20 +EV15	9.2	14.6	22.7	30.7	41.3	53.6	67.2	175	1,028
EMT30	9.2	16.7	27.2	41.0	57.8	77.9	100.8	197	1,401

- Who bear Investment? Public or Private
- Is Foreign Direct Investment possible?
- Policies to attract Private investment – attractive price for PPA, guaranteed market, investment incentives

Implications of transport electrification (Fossil Fuel Saving)

Undiscounted Fuel (Gasoline, Diesel, LPG) Cost in the transport sector (million 2005 US$)

Case	Annual Fuel Cost							Cumulative Decrease in Fuel Cost	
	2020	2025	2030	2035	2040	2045	2050	2005-2030	2005-2050
Base	1,140	1,652	2,281	2,987	3,818	4,728	5,728		
EMT30	1,026	1,433	1,906	2,406	2,960	3,523	4,137	2,634	20,770
EMT20 +EV15	984	1,380	1,842	2,353	2,885	3,467	4,142	3,368	22,570

- Decrease in the spending for imported fossil fuels by 20.2% under EMT30 and 21.9% under EMT20+EV15.
- Reduction in Economic Vulnerability

Energy implications of transport electrification (TPES and TFEC)

Cumulative TPES during 2005-2050 in different scenarios (Mtoe)

Scenario	Petroleum Products	Hydro	Total
Base Case	102.3	74.8	562.0
EMT30	90.0	**83.0**	548.9
EMT20+EV15	89.5	**81.9**	545.6

- Reduction in c**umulative petroleum product requirement: 12% in EMT30** and **12.5% in EMT20+EV15**.
- Increase in **cumulative supply** of **hydropower: 11% in EMT30** and **9.6% in EMT20+EV15**.
- Decrease in **cumulative TPES** during 2005-2050: **2.32% in EMT30 and 2.92% in EMT20+EV15**.

Annual final energy consumption in the transport sector (Mtoe).

Scenario	2020	2030	2040	2050
Base Case	**1.04**	**1.83**	**2.76**	**3.75**
EMT30	**0.99**	**1.67**	**2.42**	**3.15**
EMT20+EV15	**0.98**	**1.66**	**2.42**	**3.19**

- D**ecrease trend of annual final energy consumption** in the **transport sector** up to **15.9% under EMT30** and up to **15% under EMT20+EV15.**
- Energy **efficiency improvement.**

GHG and local pollutant emission implications of transport electrification

GHG emission from transport sector under different scenarios (10^6 tons).

Scenario	2020	2030	2050	Cumulative Total (2005 – 2030)	Cumulative Total (2005 - 2050)
Base case	3.26	5.70	11.46	74.11	244.37
EMT30	3.01	4.95	8.68	68.71	205.76
EMT20+EV15	2.91	4.81	8.69	66.96	201.95

- **Decrease in cumulative GHG emission from transport sector:**
  - **7.3% under EMT30** and **9.6% under EMT20+EV15** during 2005-2030.
  - **15.8% under EMT30** and **17.4% under EMT20+EV15** during 2005-2050.

Cumulative environmental pollutants emission from Transport Sector during 2005-2050 in different scenarios (10^6 tons).

Scenario	CO	NO_X	SO_2	NMVOC
Base case	14.22	1.57	0.56	1.14
EMT30	9.64	1.28	0.50	0.91
EMT20+EV15	10.08	1.41	0.55	0.95

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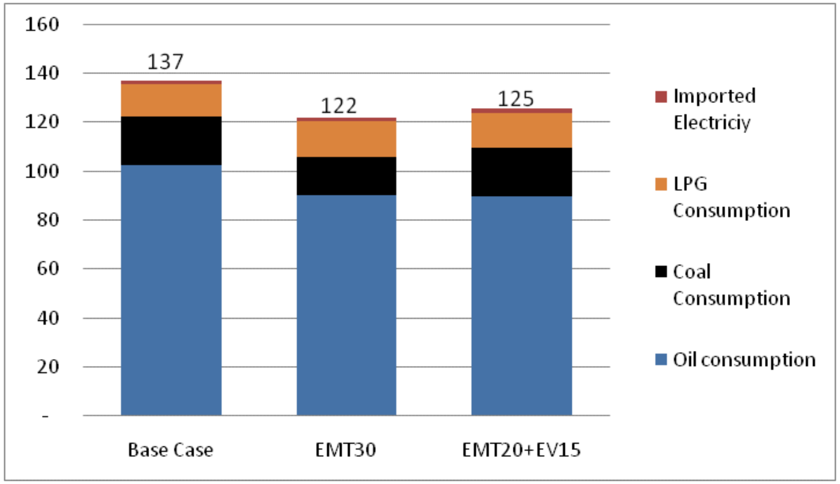
Implications of transport electrification (Energy Security)

Cumulative energy import energy during 2005-2050 (Mtoe)



- Decrease in cumulative total imported energy: 11.1% in EMT30 and 8.5% in EMT20+EV15
- Enhanced energy security due to low carbon transport development

Shannon-Weiner Index for cumulative TPES

Case	Base Case	EMT30	EMT20 +EV15
Shannon-Wiener Index	1.128	1.130	1.150

- No significant effect on the energy supply diversity

Institutional coordination: a major challenge

- Institutions to be involved:
  - Ministry of Energy
  - Ministry of Water Resources
  - Ministry of Transport (Railway Dept?)
  - Ministry of Finance
  - Ministry of Environment
  - Nepal Electricity Authority
  - Private investors (domestic and foreign)
  - Financial institutions
  - Local governments

- Hydropower development and transport electrification need to be integrated

Nontrivial institutional coordination problem!

Status of Railway Transport in Nepal: An Overview

The country has the total physical railway line of **57 km**.

-Nepal Railways Company (NRC), a government agency owns the **53-kilometer narrow-gauge rail line**, which is composed of two sections:

i)A **32-kilometer section** between Jaynagar in India to Janakpur in Nepal (Passenger traffic)

ii) A **21-kilometer portion** from Janakpur to Bijalpura
(not in operation at present).

- Negligence of non-road transport options; dominance of the road option.

Story of electric ropeway and trolley bus in Nepal : Institutional problems

- Ropeway: Lack of policy commitment at the implementation level is a major barrier. As a result, the public sector Hetauda Ropeway was closed in the later half of 1990's.
- However, the success of privately operated Manakamana Ropeway in central Nepal is a ray of hope for the future.
- **Trolley bus: in 2001 the Trolley Bus Service between Bhaktapur and Kathmandu providing services to over 3.6 million people in a year (CEN 2001) came to a halt. The reasons behind:**
  - **lack of political commitment on the government policy,**
  - **mismanagement and**
  - **political high handling of Trolley Bus Management System.**

Financing and Regulatory Challenges

- Huge shortage of electricity at present
- Uncertainty in purchase of IPP power; power pricing
- Financial guarantee?
- Weak regulatory framework and inefficient retail pricing
- Massive institutional and regulatory reforms needed for a low carbon transport development
- Capacity to benefit from international carbon finance lacking

Final remarks

- Institutional capacity to deal with low carbon society financing and management – a major constraint
- Innovative approaches and good practices need to be up-scaled (example: congestion pricing and funding for road maintenance in London)
- Often low carbon options are financially no regret options; upfront investment and institutional capacity for effective operation and management of the facilities- a bigger challenge in developing countries
- The "hydropower only" policy of the country can deprive it carbon benefits from low carbon electrified mass transport development.

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Thank you