EXECUTIVE SUMMARY

Towards a Sustainable Energy Strategy for India

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The paper presents India's energy trajectory from 2012 to 2047 with a view to highlighting the implications for energy security (import dependence) and the trajectory of carbon emissions (sustainablility). The projections are based on the latest IESS V.2 calculator, recently released by Niti Aayog.

The growth rate assumed for the scenarios is an average of 7.4 % per year over the thirty five years 2012 to 20147. Two scenarios are developed: a **Business as Usual (BAU) Scenario** and a **Low Carbon (LC) Scenario.**

Business as Usual

The Business as Usual Scenario allows for **some improvement** in energy efficiency over time and **a significant increase** in renewable energy production. It produces the following results.

The improvement in energy efficiency in the BAU is reflected in the fact that whereas GDP grows at 7.4 percent per year, total energy required grows only at 4.2 percent per year. The energy elasticity is .57 compared with .63 in the previous decade

The energy intensity of GDP falls from 0.24 kg of energy equivalent (kgoe) /$ in 2012 to 0.08 kgoe/$ in 2047 - a decline of 67 percent over 35 years. However, total energy demand increases **fourfold** over this period.

Since domestic energy supply cannot grow as fast, the import dependence in BAU increases sharply. **Import dependence for oil increases from 77 percent in 2012 to 90 percent in 2047 and even for coal it increases from 18 percent to 57 percent.**

The fourfold rise in total energy, with coa**l remain**ing the major source of energy, means that total carbon emissions rise in absolute terms. **Emissions per capita rise from 1.7 tonnes in 2012 to 5.9 tonnes in 2047**. The global target for 2050 is 2 tonnes per capita.

India's per capita emissions are currently well below those of Europe and the US and though they are projected to rise, they will still be below Europe and the US in 2030. However, those countries are saying that they will take action to ensure that their emissions get down to 2 tonnes per capita by 2050. *If they do take such action*, it means their trajectories will be showing a significant downward trend after 2025. China is now expected to peak in 2025. A rising trend for India will attract criticism even from developing countries.

This raises the question**: Can India do better, and through what actions and at what cost?**

Low Carbon Alternative

The low carbon alternative (LCA) is based on implementing 17 **energy savings options** in 8 energy using sectors which are identified in the IESS calculator as the maximum effort that is feasible. This is combined with a **stronger effort in expanding renewable energy** than in BAU.

The 17 energy saving options are listed in **Boxes 1 to 8** (attached). On the supply side, the electricity generation capacity in renewables (solar and wind) is expected to increase from 695 GW in 2047 in the BAU (which is already a very substantial volume) to 735 GW in LCA.

The main results are the following:

(i) Import dependence in oil falls from 90 percent in BAU to 60 percent in LCA.

(ii) Import dependence in coal falls from 57 percent to 19 percent.

(iii) Import dependence in all primary fuels falls from 59 percent to 22 percent.

(iv) The absolute level of emissions in 2047 falls from 10,027 million tonnes (MT) in BAU to 5616 MT in LCA.

(v) **Additional green energy supply contributes only 10 percent of the total reduction in emissions compared to the BAU.** Most of the reduction is due to the energy savings efforts.

(vi) Emission intensity of GDP falls to 0.59 tonnes/1000$ in 2032. This is 50 percent lower than in the base year, i.e., much more than the 33 - 35 per cent committed in our INDCs.

(vii) Emissions per capita in 2047 fall to 3.3 tonnes per capita. This is still higher than the 2 tonnes global target, but much better than in BAU.

(viii) Whereas in the BAU, India's emissions do not peak, in the LCA emissions peak at about 6000 tonnes in 2042 when India's per capita income will be around $9800**. This means India's emissions will peak at a lower per capita income than China's.**

(ix) Coal consumption also peaks at around 1739 million tonnes (MT) in 2042. In the BAU projection there is no peak; coal consumption reaches 2500 tonnes in 2042 and keeps rising to reach 2704 MT in 2047.

The Low Carbon Strategy, which emerges from the boldest possible energy saving efforts built into the Niti Aayog calculator, is clearly desirable from both the energy security perspective and the sustainability perspective. **The issue is what are the costs and how do we implement the shift?**

This paper argues that a large number of sector specific and also economy wide policy decisions are needed if the changes envisaged in the Low Carbon Strategy are to be achieved. These policy changes are listed in **Box 9** of the paper (attached). Orchestrating so many policy changes, some of which involve different levels of government, will be a major challenge. This aspect of the policy challenge is not well realized.

The capital costs of the transition can be tentatively estimated on the basis of information in the IESS Calculator. There are obviously large

uncertainties in such estimates since we cannot know how fast costs will fall over time, as new technologies evolve. However, two points are important: (a) Higher capital costs in the earlier years will be offset by lower fuel costs in future and (b) There are important health related co-benefits from moving to cleaner fuel technologies which have to be kept in mind.

A very rough estimate of the additional capital cost is about **1.5 %** of GDP per year in the first fifteen years. This could lead to lower investment in other sectors, which could lead to some loss in growth. However, this could be offset by new resource mobilization efforts, or by efforts to achieve higher total factor productivity growth stimulated by stronger reforms.

An important point to keep in mind is that if the developed countries do succeed in meeting the 2 tonnes per capita target, it will be because they have been able to bring about technological change which enables greater energy efficiency and a faster shift to greener fuels. These technologies will also be available for developing countries. We need to be open to adopting new technologies as they evolve.

The speed with which developing countries can achieve higher levels of mitigation will depend critically on the willingness of the industrialized countries to provide finance that can lubricate the transition.

Box 1. Potential Demand Reduction in Passenger Transport	2032	2047
BAU Scenario demand (Mtoe)	**167.3**	**278.8**
1. Smart Cities and better urban planning leading to 21% reduction in travel demand in cities	12.8%	22.0%
2. Shift from 14% rail share in 2012 to 19% in 2047.	2.8%	5.2%
3. Share of Public Road Transport to increase from 42% in 2012 to 79 %.	19.3%	23.6%
4. Share of EVs and FCVs to increase to 13% for buses, 44% for cars and 74% for two wheelers in 2047	5.7%	7.0%
Low Carbon Scenario Demand (Mtoe)	**99.3**	**117.8**

Box 2. Potential Demand Reduction in Freight Transport	2032	2047
BAU Scenario demand (Mtoe)	**126.5**	**208.7**
5. Dedicated Freight Corridors and Integrated Logistic Planning leading to 20% reduction in freight transport demand in 2047.	10.2%	17.6%
6. Reversing the trend of a declining share of freight being carried by rail and increasing it from 42% in 2012 to 45% in 2047.	10.4%	16.3%
Alternate Scenario Demand (Mtoe)	**100.3**	**138.0**

Box 3. Demand Reduction in Residential Buildings	2032	2047
BAU Scenario demand (Mtoe)	**73.0**	**125.9**
7. High rise buildings constituting 60% of the overall buildings space in 2047 from 34% in 2012	1.5%	3.5%
8. More than 80% of the buildings have energy efficient insulations compared to 0% in 2012.	1.4%	3.5%
9. Penetration of Smart Appliances (LED: 75% and other home appliances 80% in 2047 as against 3% in 1% respectively)	28.4%	33.3%
Alternate Scenario Demand (Mtoe)	**50.2**	**75.2**

Box 4. Potential Demand Reduction in Commercial Buildings	2032	2047
BAU Scenario demand (Mtoe)	**23.1**	**66.2**
10. Increasing share of High efficiency appliances to 80% in 2047 as against 0% in 2012.	7.9%	9.0%
11. Share of buildings with energy efficient insulation increases from10% in 2012 to 100% in 2047	2.8%	13.8%

Alternate Scenario Demand(Mtoe)	**20.7**	**51.2**

Box 5. Potential Demand Reduction in Industry	**2032**	**2047**
BAU Scenario demand (Mtoe)	**550.2**	**895.9**
12. Increasing in penetration of EE units best in class energy efficient technology (83% in Cement and 80% in Steel) and Improvement in SEC	12.0%	22.0%
13. Cement-SEC reduction due to shift to Grid Based Electricity	1.2%	1.8%
14. Steel-SEC reduction due to shift to Grid Based Electricity	5.0%	7.2%
Alternate Scenario Demand	**449.5**	**618.2**

Note: Savings in 13 and 14 arise from the reduced consumption of captive power which uses much more fossil fuel energy than grid sourced power where the share of fossil fuels is less.

Box 6. Potential Demand Reduction in Agriculture	**2032**	**2047**
BAU Scenario demand	**54.3**	**68.6**
15. Energy Efficiency improvements in tractors and Pumps and phase out of diesel pumps by 2047.	30.5%	33.2%
Alternate Scenario Demand	**37.7**	**45.8**

Box 7. Potential Demand Reduction in Cooking	**2032**	**2047**
BAU Scenario demand	**50.8**	**43.8**
16. Efficiency improvements in Cook stoves and switch to electricity and Induction based cook stoves	36.2%	25.6%
Alternate Scenario Demand	**32.4**	**32.6**

Box 8. Potential Demand Reduction in telecom	**2032**	**2047**
BAU Scenario demand	**15.9**	**15.8**
17. Efficiency improvements in BTS and switch to solar/electricity from diesel	45.2%	64%
Alternate Scenario Demand	**8.7**	**5.7**

Box 9
Areas of Action and Policy Intervention for a Low-Carbon Alternative: Levels of Government

	Area of Intervention	Policy Interventions	Level of Government
A.	**Energy Efficiency in Buildings**	1. Mandatory Energy Efficient Building Design	City & State Government.
		2. Implementing Energy Efficiency in New Buildings and Retrofits in old buildings	Central and State Government.
		3. Pricing of electricity to reflect costs and incentivize savings.	Central Govt for pricing of coal and State Electricity Commission for pricing of electricity.
		4. Setting mandatory energy efficiency standards for energy appliances.	Central Government.
		5. Encouraging rooftop SPV connections which can feedback into the grid.	State Electricity Distribution Companies.
		6. Introducing time of use electric metering to incentivize energy savings in peak hours.	State Electricity Regulatory Commissions.
		7. Tax Incentives for expenditure on retrofits and for installation of rooftop SPV.	Central Government.
		8. Financial incentives for manufacturers of Energy Efficient Appliances.	Central Government
		9. Provision of more testing and certification labs for standard with relevant technology upgrades and capacity building.	Central Government.

	Area of Intervention	Policy Interventions	Level of Government
B.	**Sustainable Urban Transport Solutions**	1. Sensible Land Use Planning in Cities	City Planning Authorities
		2. Urban property laws (sale and rental) which facilitate mobility	Central & State Govt.
		3. Ensuring provision of reliable and good quality bus	City Government & Road transport corporations.
		4. Provision of metros in large cities	City Corporations
		5. Rational planning of roads with features such as BRT, footpaths, cycle-ways, etc.	City Government
		6. Institution of disincentive parking charges in congested areas to discourage parking of private Vehicles.	City Government
		7. Differential taxation on buses and cars to incentivize public transport.	State & Central Government
		8. Imposition of "Congestion Charges" to allow private vehicle in congested areas.	City Government
		9. Improved fuel efficiency standards	Central Government
		10. Maintaining fuel price differentials which discourage private transport, i.e., petrol prices higher than diesel prices with a high tax ab initio on diesel powered cars.	Central Government
		11. Incentivizing electric vehicles and hybrid vehicles through differential taxation and preferential depreciation rates.	Central Government
		12. Increasing last mile connectivity of public transport through feeder buses, in economically backward areas to prevent concentration of slums near urban cores.	City Transport Corporations
		13. Introduction of smart transport infrastructure and smart traffic management to facilitate scale up of smart electric vehicles /driverless cars in future.	City Government and Central Government
		14. Support for IT ecosystem/Entrepreneurship for smart transport management and car sharing.	Central Government.

	Area of Intervention	Policy Interventions	Level of Government
C	**Sustainable Freight Transport Solutions**	1. Dedicated Freight Corridors and Integrated Logistic Planning. 2. Shifting freight to Rail. 3. Tariff Rationalisation in Rail based Freight 4. Fuel efficiency standards in Trucks 5. Efficiency in Railways wagons with higher axle loads and increased speeds. 6. Privatisation of Rail Freight	Central Government Central Government Central Government Central Government Central Government Central Government
D.	**Efficiency interventions in Industry**	1. Rationalization of fossil fuel pricing in the long term. 2. Pricing of carbon, water and health externalities on the Industrial products 3. Availability of 24x7 quality grid electricity for Industry to facilitate switch from coal based captive generation. 4. Setting up of more aggressive PAT targets for increasing energy efficiency 5. facilitation of transfer of low-carbon and energy efficiency technologies for steel and cement from Annex-1 to Annex 2 countries 6. Creation and augmentation of ecosystem of recycling and reuse of finished products	Central Government. Central Government Central Government & State Electricity Distribution companies. Central Government. Central Government. Central Government.
E.	**Minimizing Energy Use in Cooking and penetration of clean fuels**	1. Availability of Piped Natural Gas Infrastructure in tier-2 and tier-3 cities. 2. Availability of a robust LPG distribution infrastructure in rural areas 3. R&D Support and market incentives for usage of Clean Biomass Cook stoves 4. State of the art testing, monitoring and certification centers for cook-stoves in India	Central Government Central Government Central Government Central Government

	Area of Intervention	Policy Interventions	Level of Government
F.	**Energy Efficiency in Agriculture**	1. Availability of 24x7 metered and quality of grid electricity in Rural Areas. 2. Segregation of feeders from agriculture/ domestic consumption. 3. Financial incentives for the purchase of Solar based irrigation pumps. 4. Fast track support for rain-fed irrigation areas through techniques such as watershed management program to minimize water use and consequently energy use. 5. Support for Micro-irrigation programs to minimize water and energy use.	State Government and central government. State Government and central government. State Government, Nodal Agencies of the MNRE. Ministry of Water Resources.
G.	**Increasing RE Penetration in the Grid to 43% of electricity generation (Solar 401 GW, Wind 290 GW)**	1. Priority sector lending status for RE 2. Financial Incentives-Interest Rate Subsidies, Low Cost International Loans. 3. Mandatory adherence for RPO and Solar RPO targets by states. 4. Financial and Regulatory support for Balance of System (BOS) manufacturers. 5. Provision of Net Metering and Solar Buy back tariff policy for Solar Rooftop by States. 6. Pricing of externalities on fossil fuels.	Central Government. Central Government. State Government. Central & State Government. State Government & City Authorities. Central & State Government
H.	**Increasing Bio Energy in transport to 15%**	1. Financial support for research and development of second generation and advanced bio-fuel feedstock. 2. Long term blending policy and emissions standards. 3. Long term pricing policy for Bio-fuels	Department of Science and Technology/ Agriculture. Ministry of Road Transport. Ministry of Petroleum.

	Area of Intervention	Policy Interventions	Level of Government
I.	**Reducing T&D losses to 7.2% by 2047**	1. Upgradation of sub-transmission/distribution grid infrastructure and digitization of substations. 2. Advanced metering Infrastructure (AMI) deployment by utilities. 3. Deployment of HVDC lines for long distance transmission.	State Utilities/Central Govt. State Utilities Ministry of Power
J.	**Deployment of Energy Storage**	1. Time of Day pricing of grid based electricity. 2. Net Metering Support for Domestic Consumers. 3. Support for localization for storage.	Ministry of Power/State Govt. State Government. Central Government.