

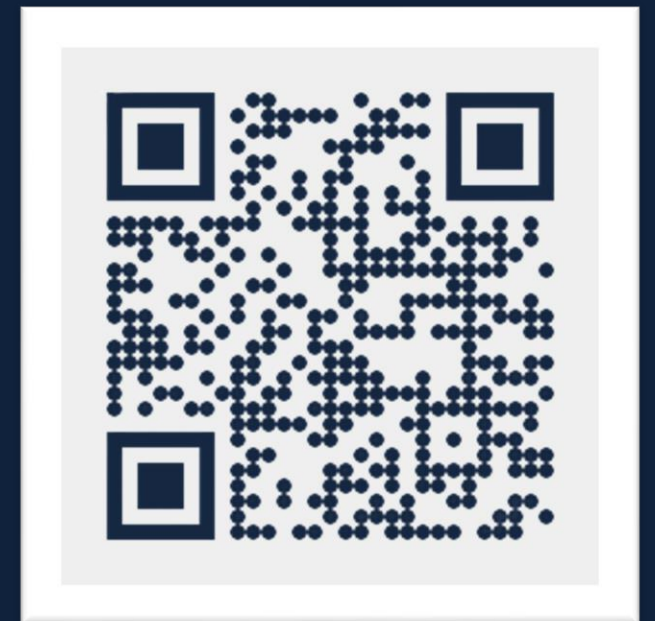


ELECTRIC MOBILITY & POWER SYSTEMS

Impacts and Mitigation Strategies in Developing Countries

Report launch

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May 30, 2023

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**Electric Mobility
& Power Systems**
Report Launch
May 30, 2023

TECHNICAL
REPORT

ELECTRIC MOBILITY & POWER SYSTEMS

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INTERSECTION OF E-MOBILITY & POWER SYSTEMS

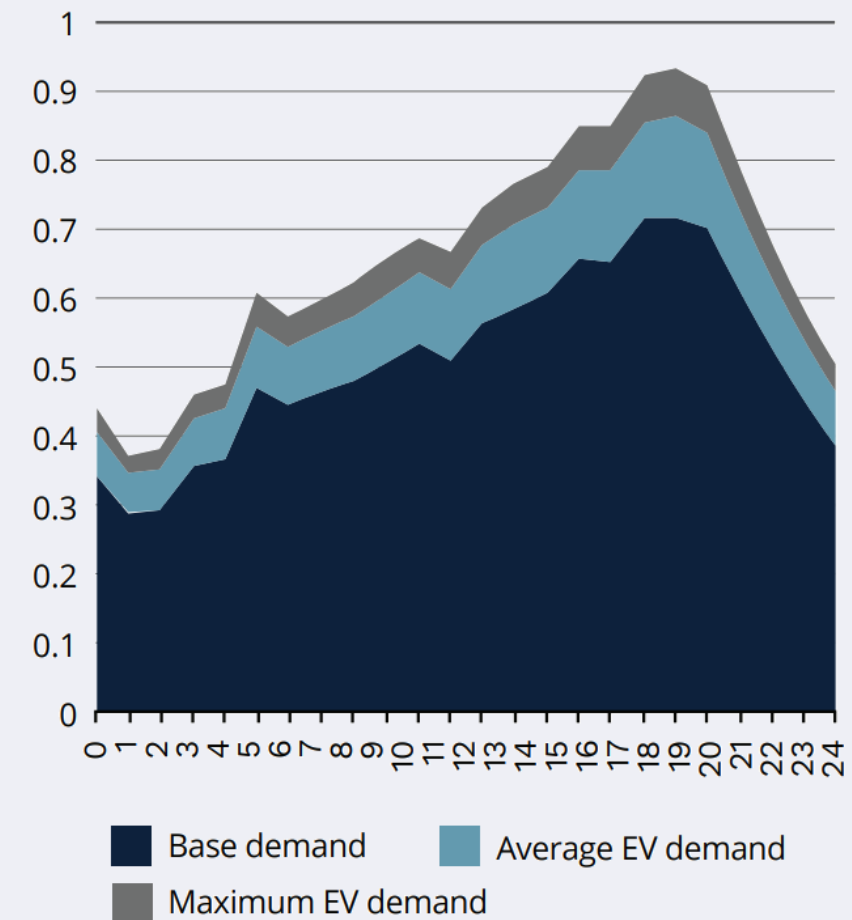
- E-Mobility is putting **energy & power systems** at the heart of the transport equation
- According to the IEA, the total number of EVs, excl. two/three-wheelers, will reach **240 million by 2030**
- EVs represent a **new type of load** for electric utilities and power system operators.
- E-Mobility will either **accelerate the energy transition** or **exacerbate the challenges** facing power systems. **This greatly depends on planning!**
- Electric utilities, system operators, regulators, and policymakers will need to take **comprehensive steps to prepare power systems**

IMPACTS ON THE POWER SYSTEM

Power Demand and Load Profile

- Increasing penetration of EVs will result in **additional electricity demand in the power system.**
- In absolute terms, the **additional EV charging load** will likely have a **marginal effect** on the aggregated power system demand.
- EV charging may have major consequences on the **power system load profile.**
- This is particularly significant in the **initial phases of E-Mobility market development** when there might be no incentives to charge the vehicles during off-peak hours.

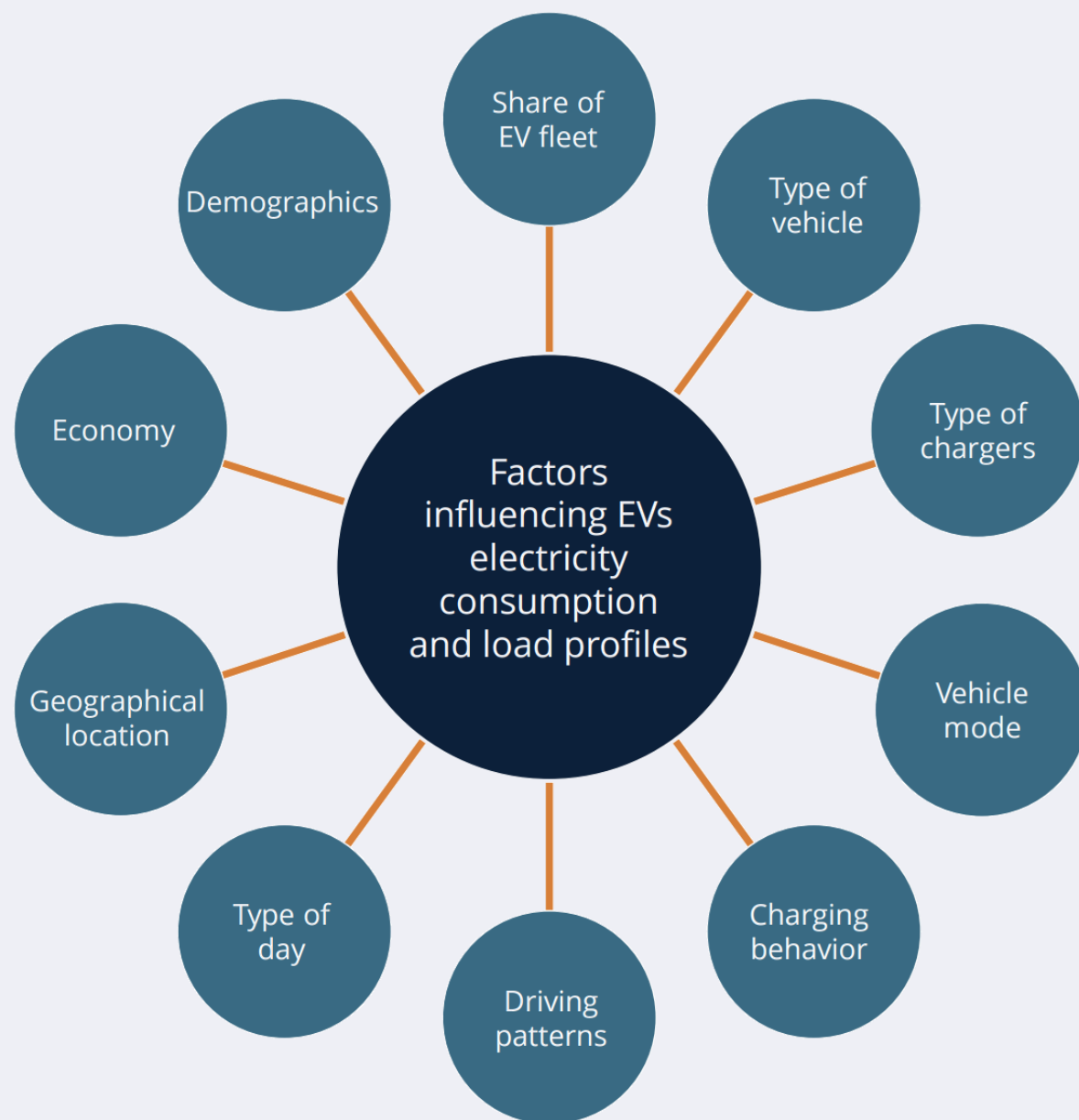
Feeder circuit load, 150 homes with 2 vehicles per household, with 25% electric-vehicle (EV) penetration, kilowatts



Source: Adopted from Engel et al. 2018.

IMPACTS ON THE POWER SYSTEM

Power Demand and Load Profile / Dev. Countries Perspective



- Charging load profiles depend on the charging patterns of final customers, which are affected by a series of social, technological, and economic characteristics.
- E-Mobility trends in dev. countries are driven by local specificities of power systems, users, and markets.

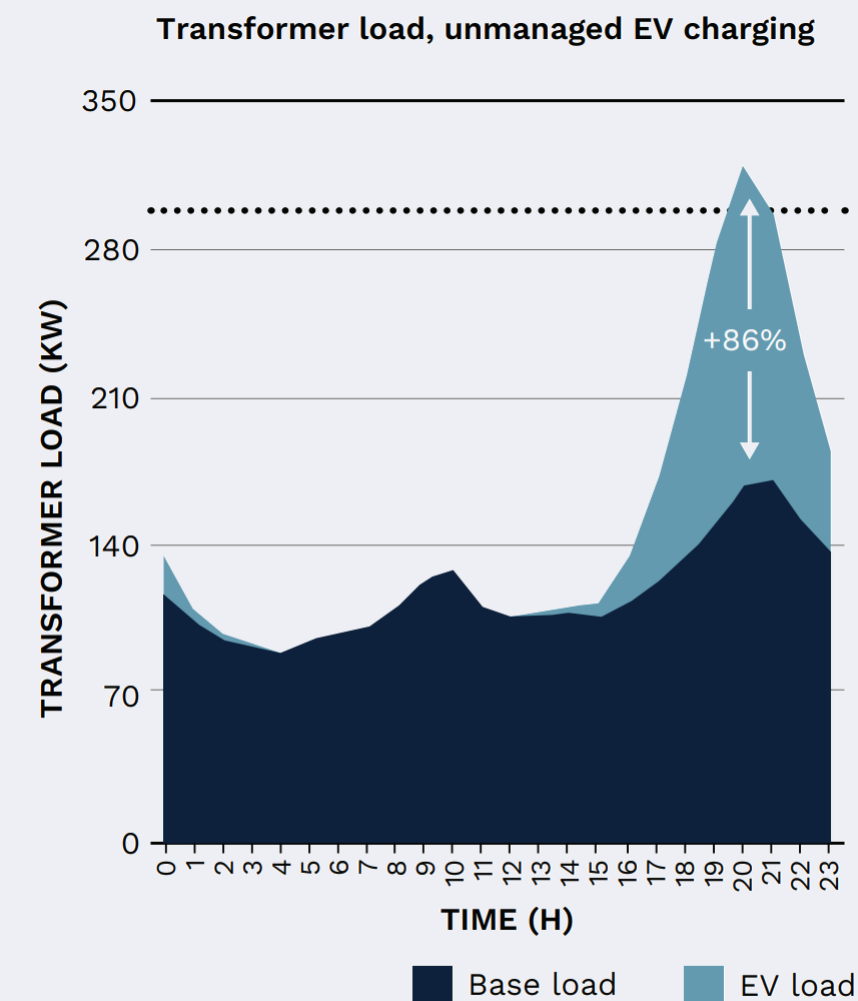
RECOMMENDATION

Planners and decision-makers need to consider the local social, economic, infrastructure, and cultural factors as these factors may influence not only the scale and type of adoption but also the operation of and charging of EVs.

IMPACTS ON THE POWER SYSTEM

Technical Impacts

- Out of all the segments of power systems, **the distribution grid is the most vulnerable** to the negative impacts of uncoordinated EV charging.
- Technical issues such as overloading of feeders and transformers, **may occur even at low levels of adoption** due to clustering of charging events.
- EV deployment may also impact the **transmission and generation** operation and expansion planning, although **it will likely be relatively minor** compared to that of the distribution grid.



Source: Adapted from EY, 2022.

IMPACTS ON THE POWER SYSTEM

Technical Impacts / Dev. Countries Perspective

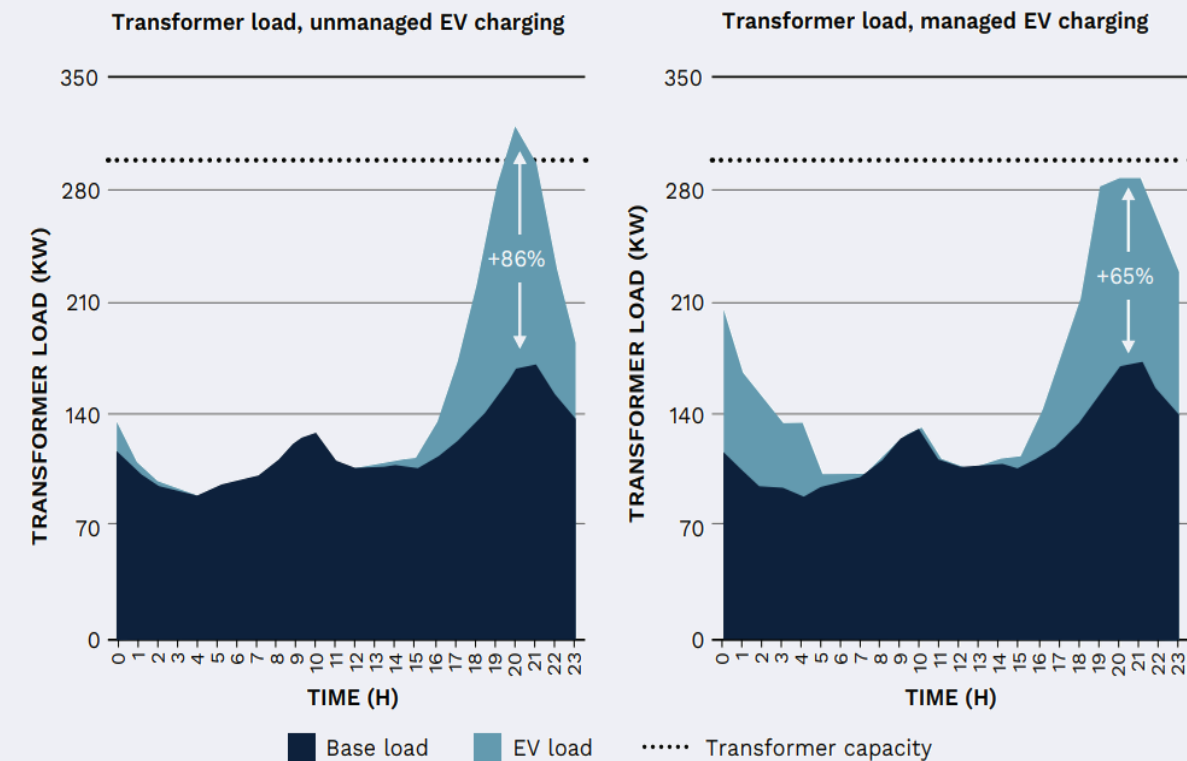
- In many developing countries, **power systems still fail to provide adequate services** and remain vulnerable to external shocks.
- In the developing countries **distribution system usually constitutes the weakest part of the power grid.**
- As a result, power grids in these countries may **require significant upgrades and reinforcements** to handle the increased demand caused by EVs.

RECOMMENDATION

Developing countries need to **prepare their power systems**, taking a comprehensive view of the current state and assessing E-Mobility challenges and opportunities in a **holistic manner.**

MITIGATION STRATEGIES

- With smart charging, EV load can be scheduled and modulated to shift the load to the most optimal time and space from the system operator's perspective, respecting the end-user preferences and power system constraints
- Smart-charging strategies might be divided into two groups:
 - (1) **behavioral load shift programs**
 - Time-of-Use Tariffs
 - Spatial Load-Shifting and Charging-Stations Planning
 - Indirect Incentives and Rewards Programs
 - (2) **technical solutions**
 - Storage and Battery Swapping Solutions
 - Vehicle-Grid Integration



Source: Adapted from EY, 2022.

MITIGATION STRATEGIES

Challenges and Opportunities for Developing Countries

- There are critical obstacles to introducing EV impacts mitigation strategies in developing countries, in particular:
 - Cost of grid infrastructure for smart methods;
 - Need for appropriately designed electricity markets.
- **Pilot projects** are the critical stage on a future roadmap for implementing recommended technological solutions.
- It can be expected that **benefits per EV over the long-term horizon can be far greater than estimates in developed markets.**

SUCCESSFUL PILOT

South Africa's national E-Mobility program, called **uYilo** is a prominent example of successful pilot projects in smart charging and E-Mobility advocacy.



Adopted from <https://www.uyilo.org.za/electric-vehicle-field-testing-programme/>

UTILITIES AND SYSTEM PLANNING

Role of Utilities

- Electric vehicle deployment can bring a series of **challenges and opportunities to all stakeholders:**
 - EV users,
 - charging station operators,
 - regulators,
 - policy makers,
 - electric utilities.
- Utilities need to undertake **comprehensive measures** to address a wide range of internal and external challenges and prepare the ground for the upcoming uptake.
- Being **prepared and proactive** is critical for utilities, especially in developing countries.

OUR ROLE

To prepare their assets and operations for the upcoming EV deployment, electric utilities and other stakeholders should **conduct comprehensive planning exercises.**

This is the area where **WBG support to client countries** may be the most beneficial in the long-term development of E-Mobility.

CONCLUSIONS & RECOMMENDATIONS

	EV Load	Power System Impacts	Mitigation Measures	Role of Utilities and Planning
Findings	<p>Marginal impacts on overall demand</p> <p>Significant impacts on load profiles if uncoordinated</p>	<p>Distribution segment most affected, with possible clustering</p> <p>Developing country systems most vulnerable</p>	<p>Innovative charging strategies to manage demand are highly relevant</p>	<p>Being prepared and proactive is critical for utilities, especially in developing countries</p>
Recommendations	<p>Anticipatory assessment of uptake should be performed, not only temporally but also spatially</p>	<p>Quality of the distribution assets needs to be assessed, analyzing potential risks and required reinforcements</p> <p>Risks of transmission system congestion should be assessed</p>	<p>Gradual introduction of smart charging solutions, starting with mature ones</p> <p>Better management could reduce investment needs</p>	<p>Integrated planning aligning power sector, transport and urban development goals is crucial to achieving a least-cost, resilient solution</p>



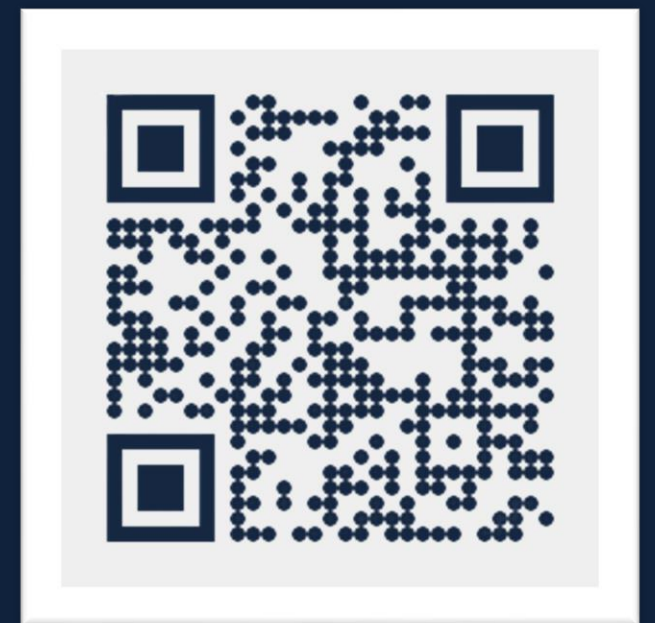
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THANK YOU.

For further information, please contact tkeskes@worldbank.org

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