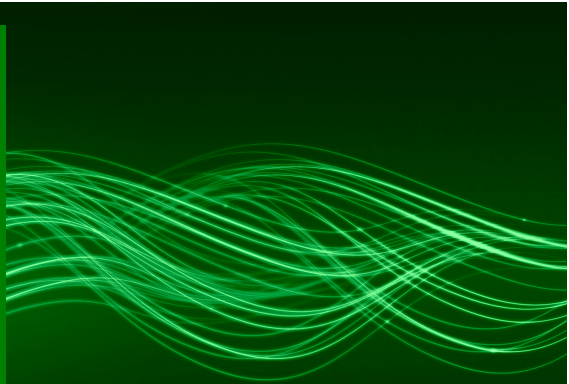
ETH zürich

Network Security Group
Department of Computer Science

Carbon-Aware Global Routing in Path-Aware Networks

Seyedali Tabaeiaghdaei
Simon Scherrer
Jonghoon Kwon
Adrian Perrig
ETH Zurich

e-Energy 2023, Orlando



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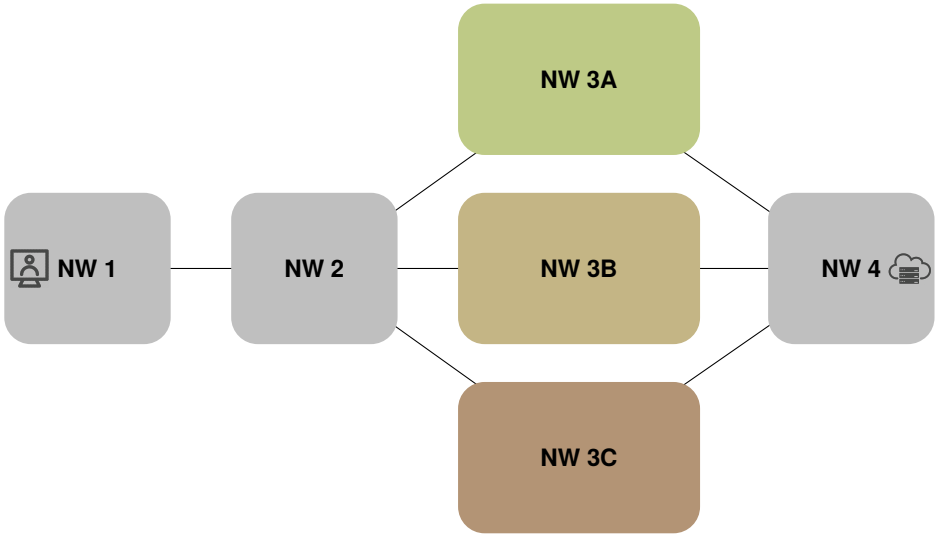

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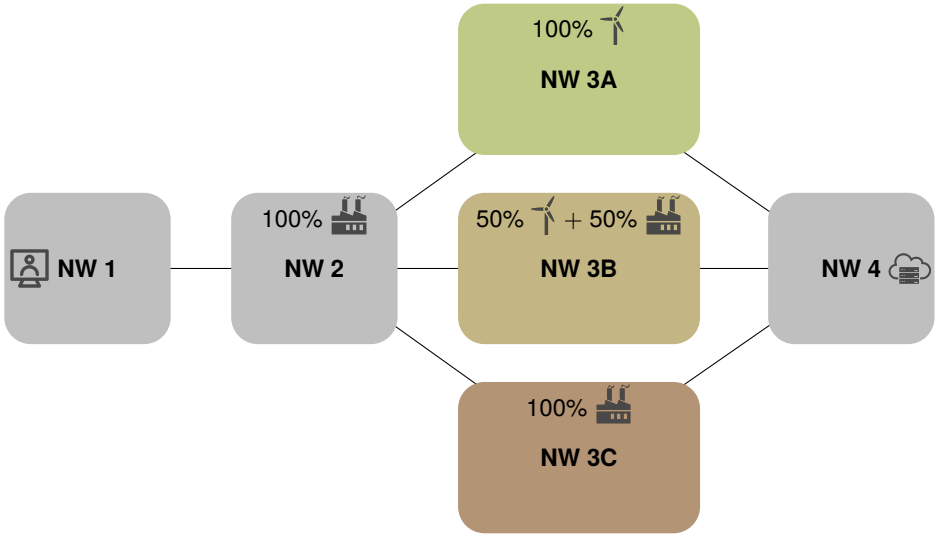

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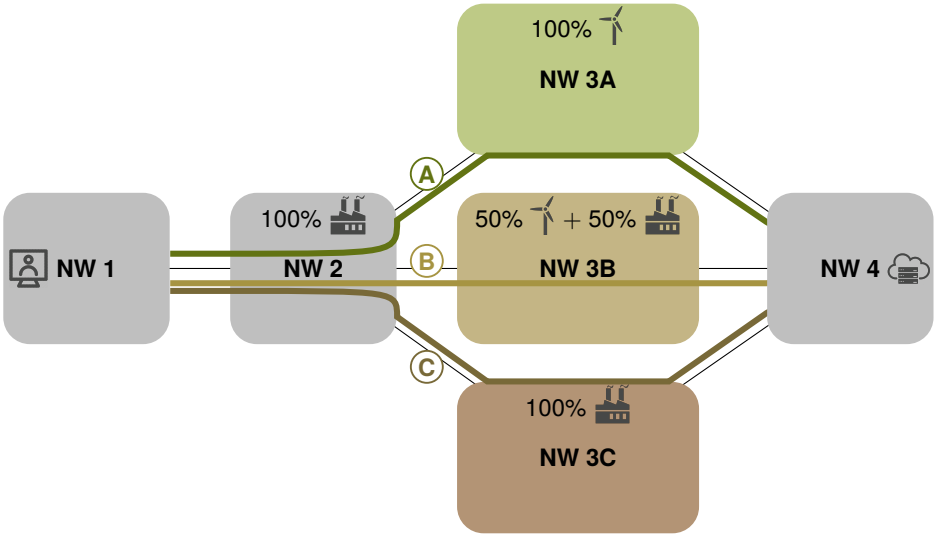

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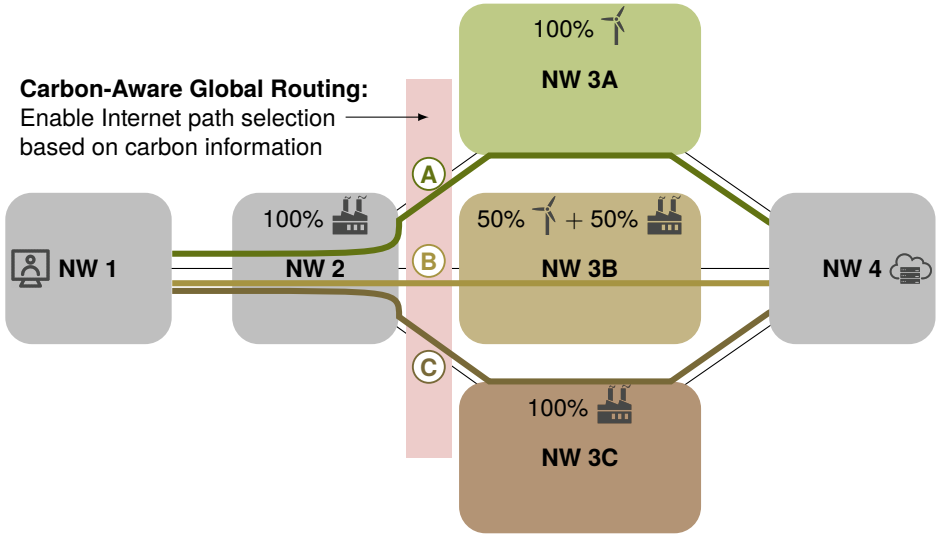

Our contribution: Carbon-Aware Global Routing with CIRo

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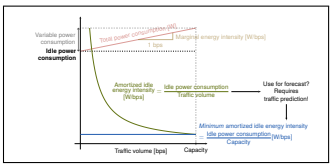
Model for carbon intensity of Internet paths



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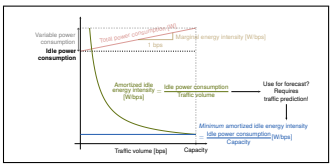

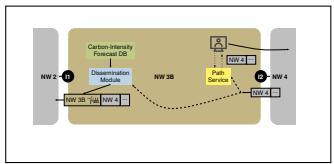

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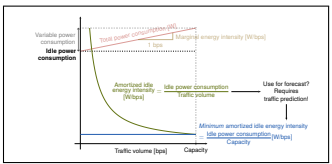

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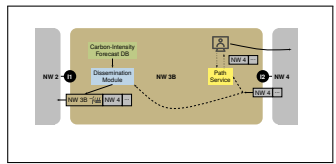
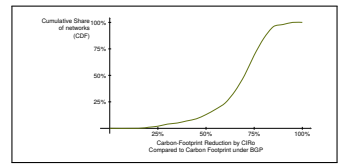


Carbon-Footprint Impact Analysis

Simulation on data-backed large-scale topology



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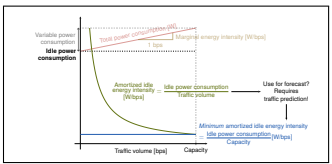

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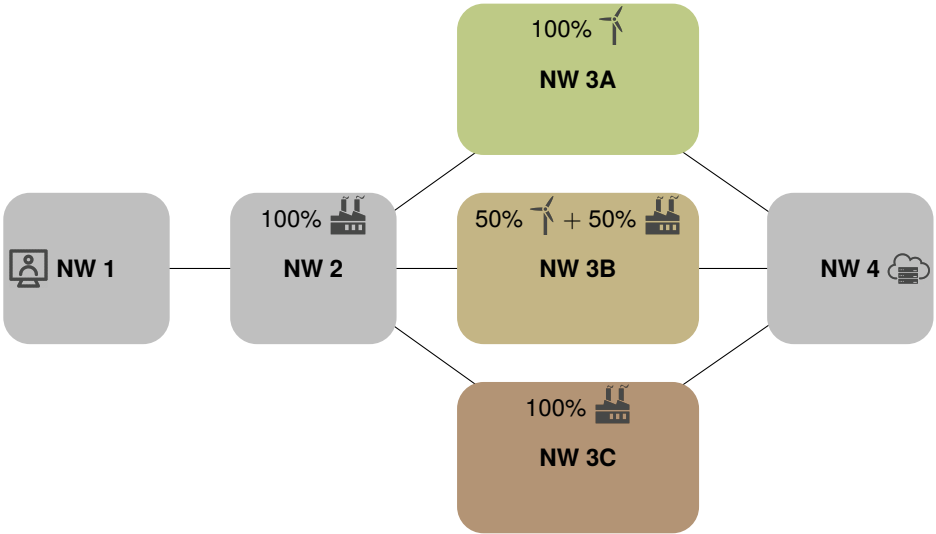

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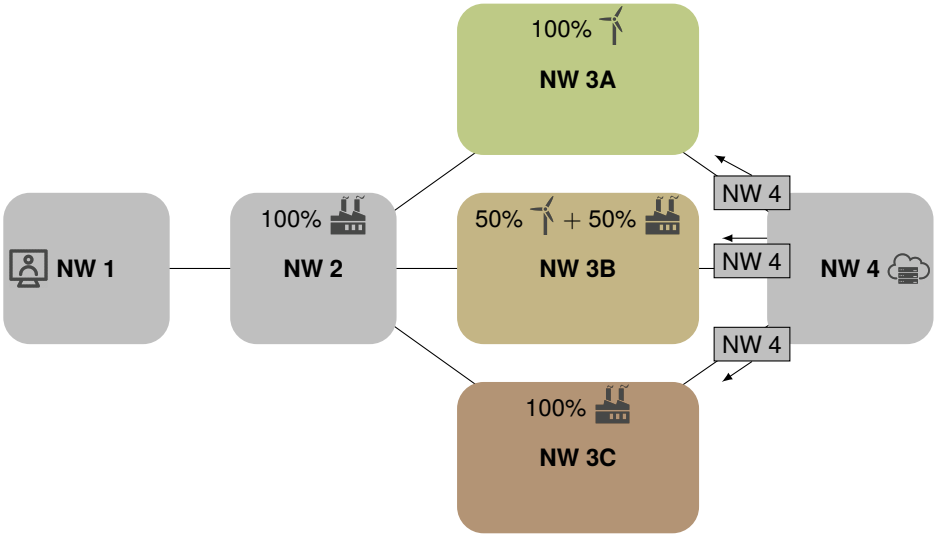

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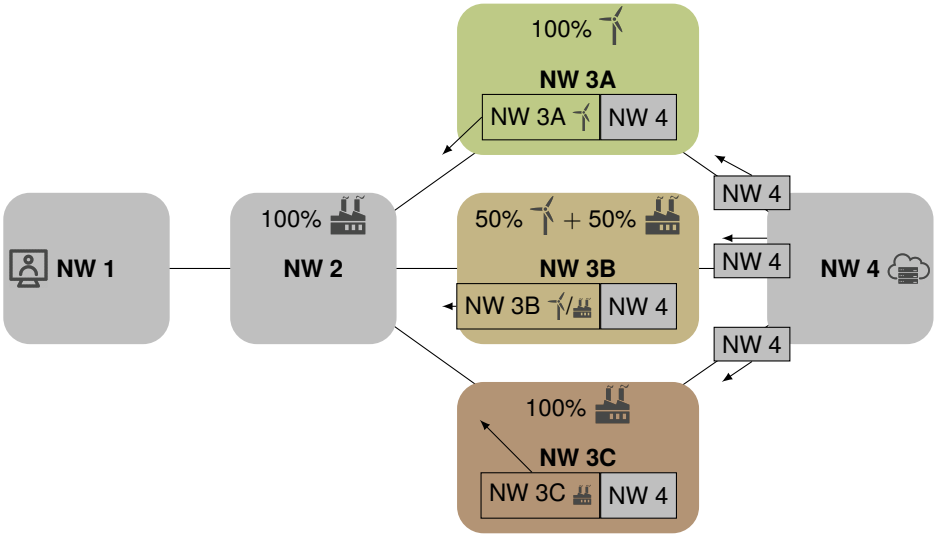

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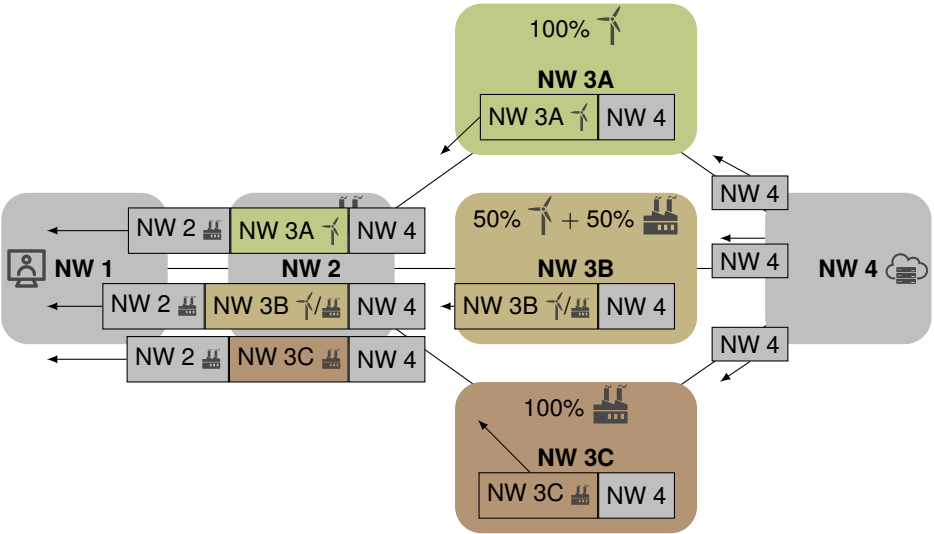

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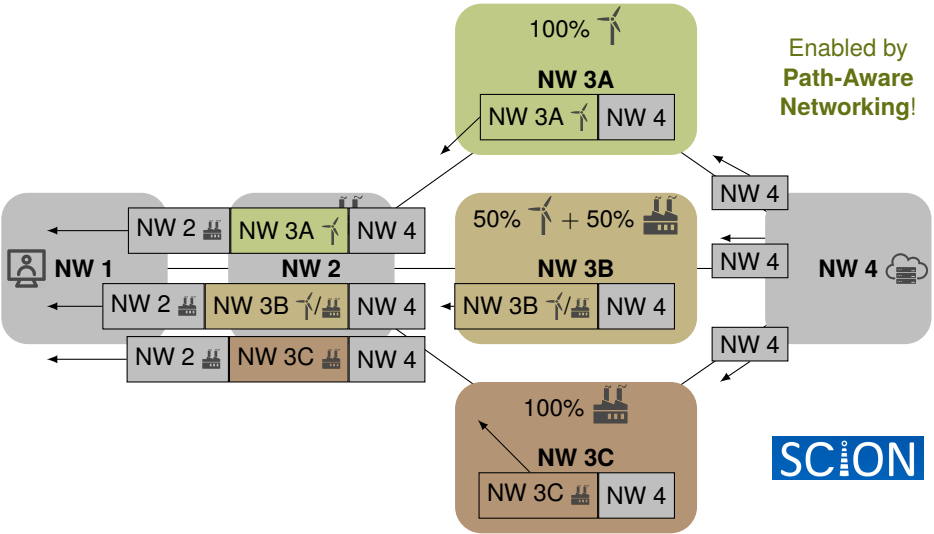

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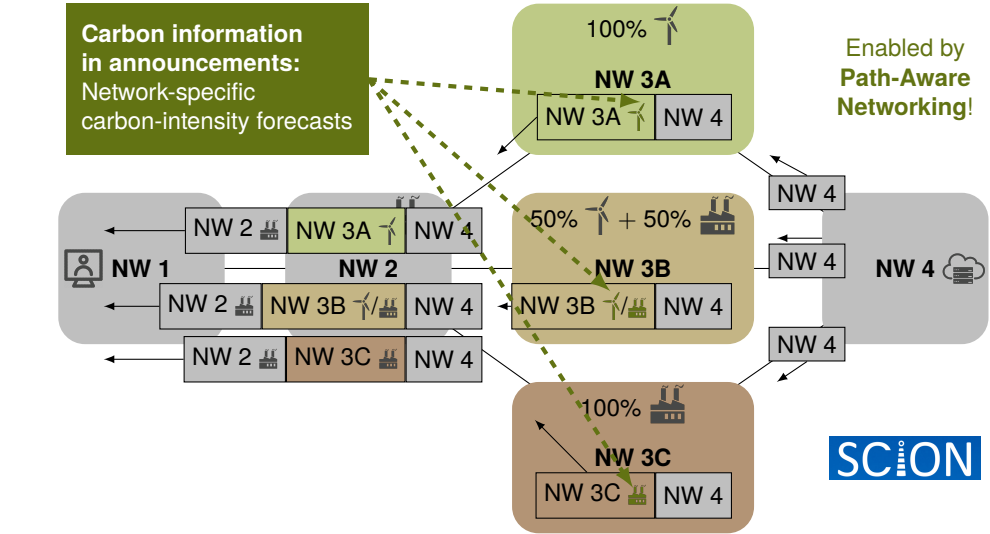

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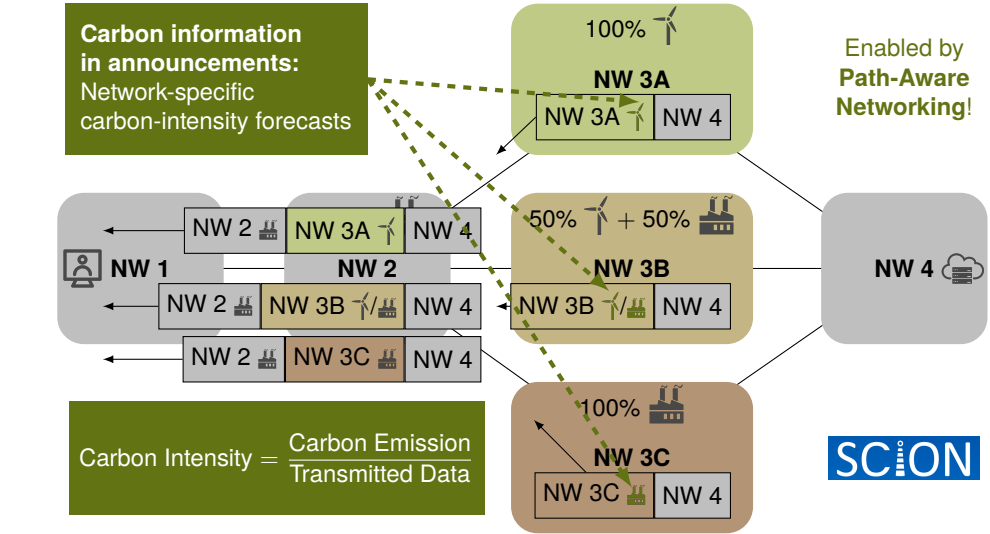

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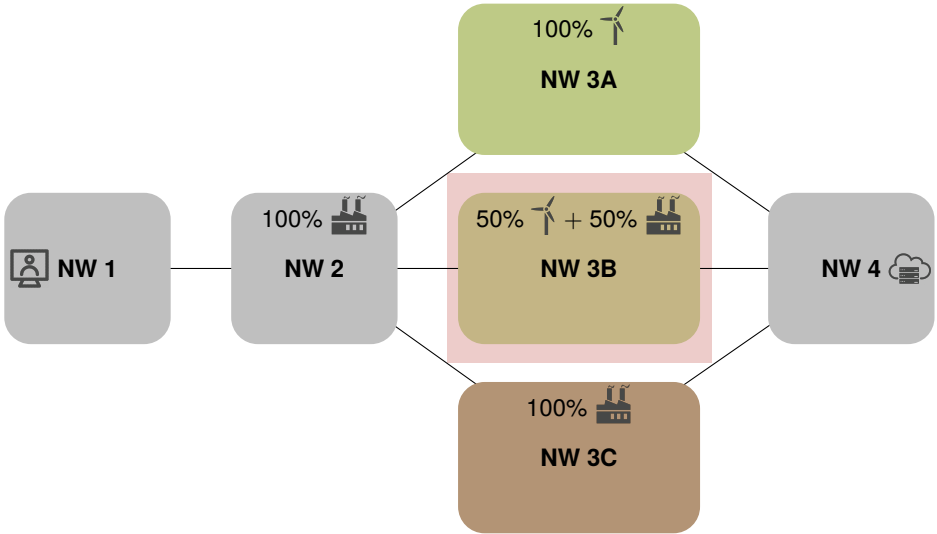

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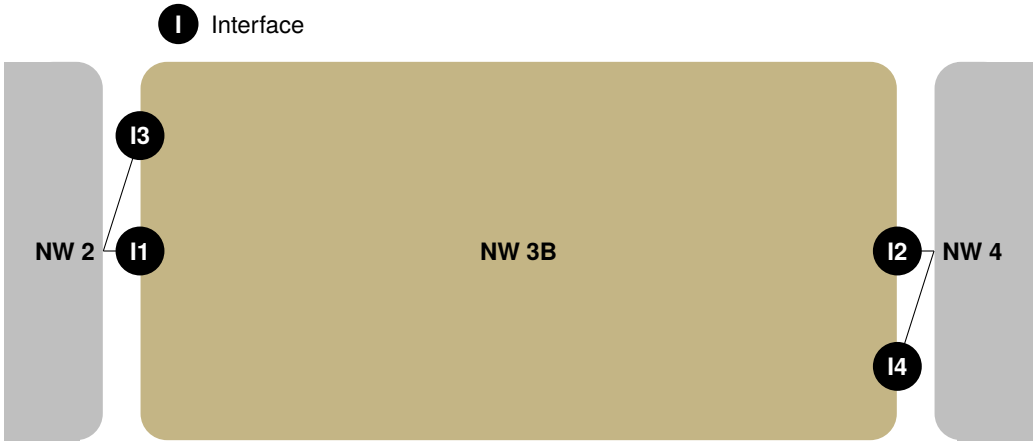

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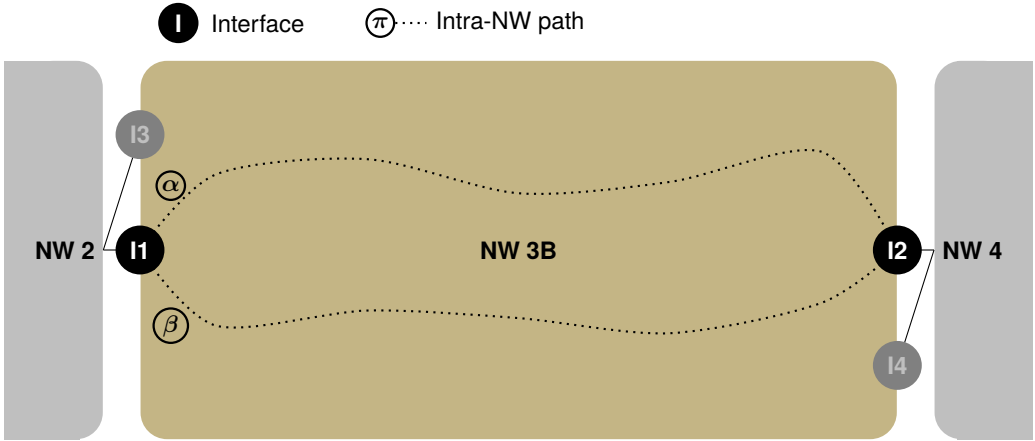

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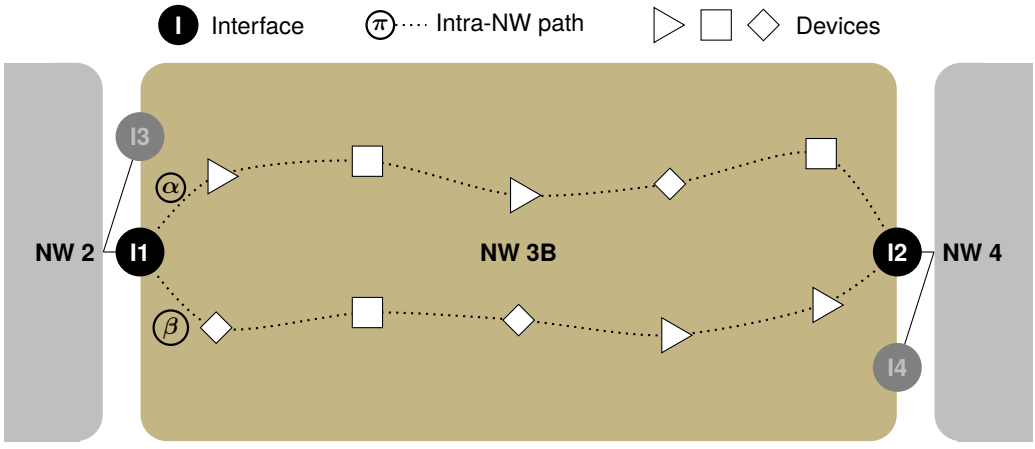

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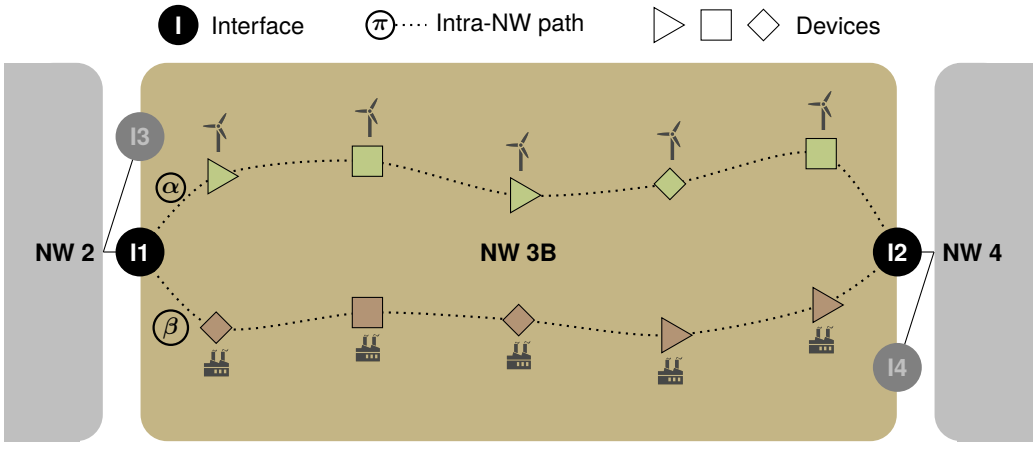

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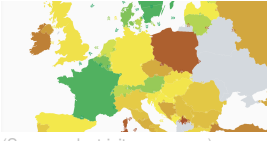

(Source: electricitymaps.com)

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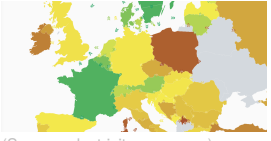

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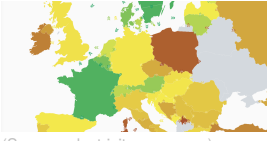

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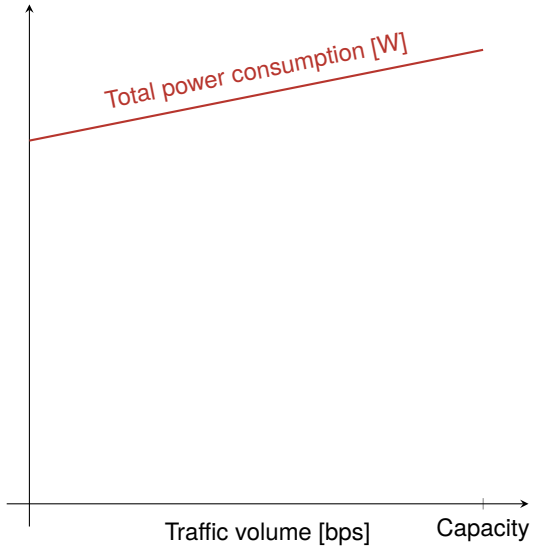

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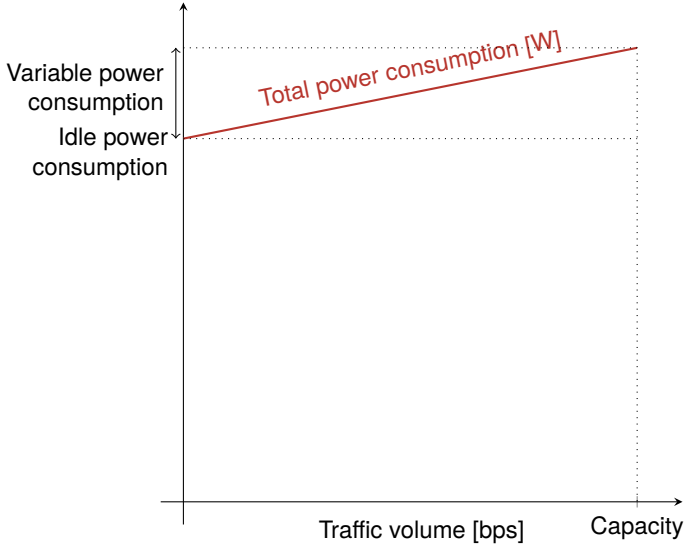

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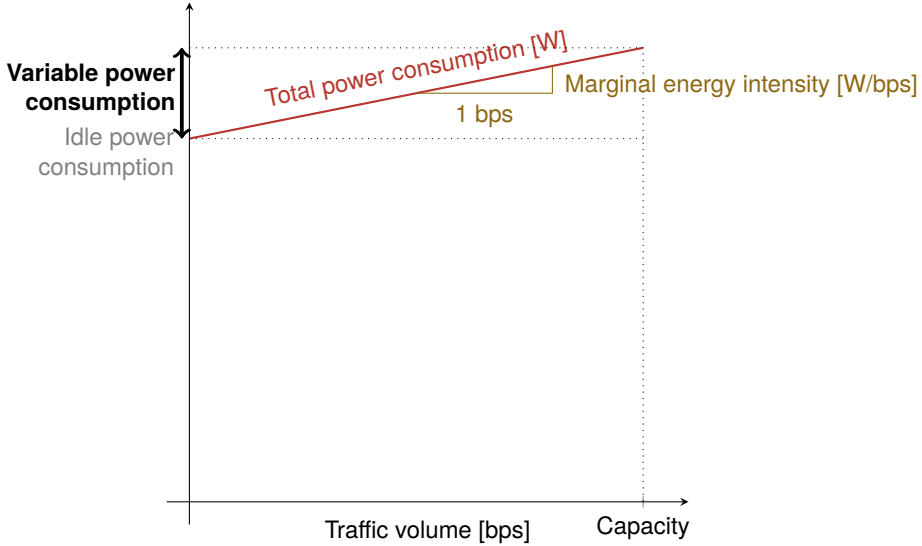

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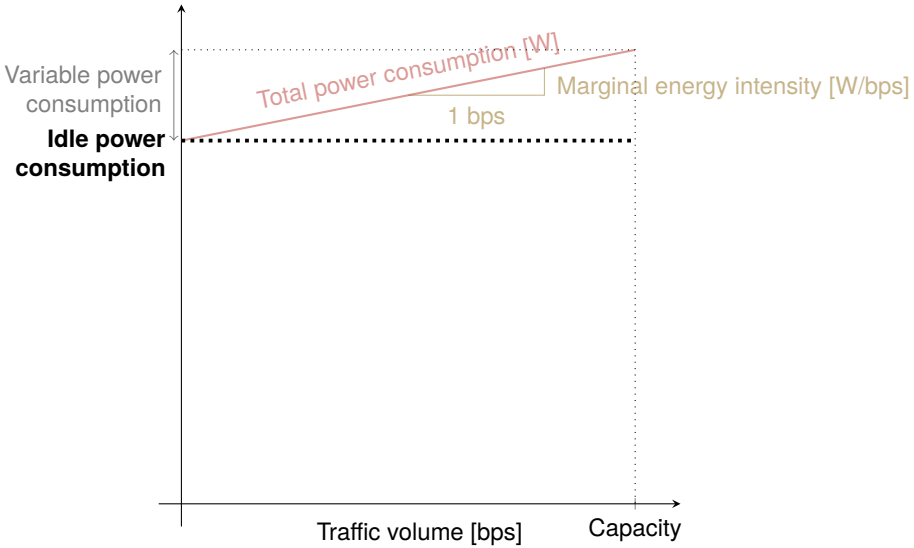

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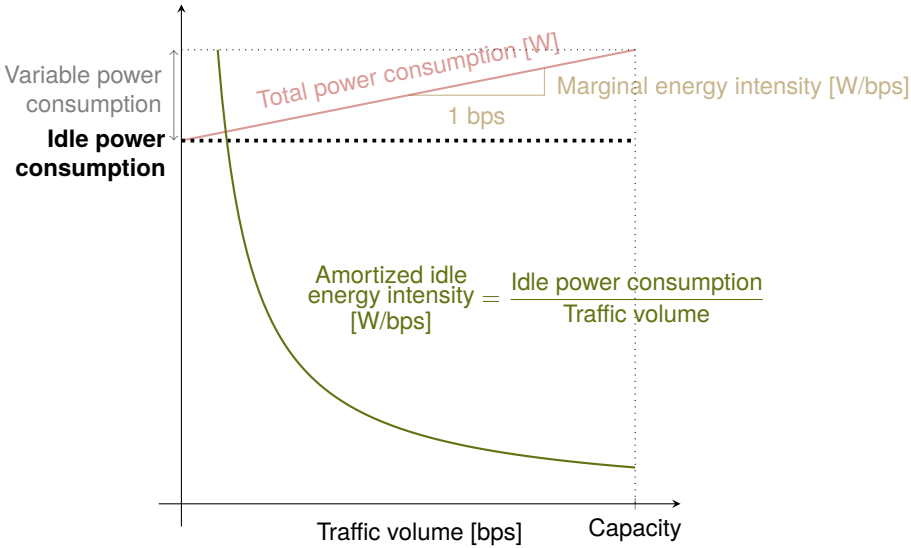

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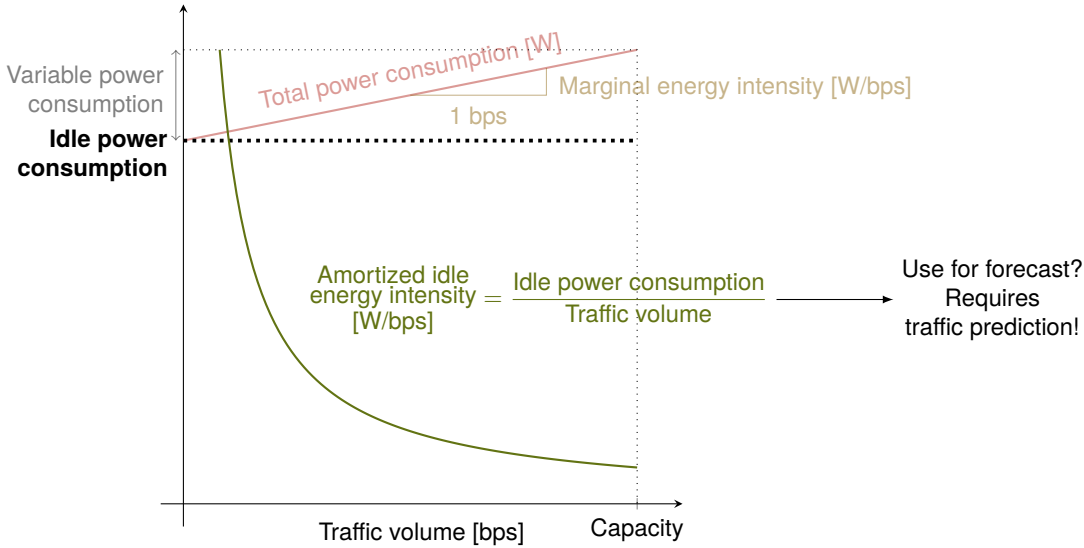

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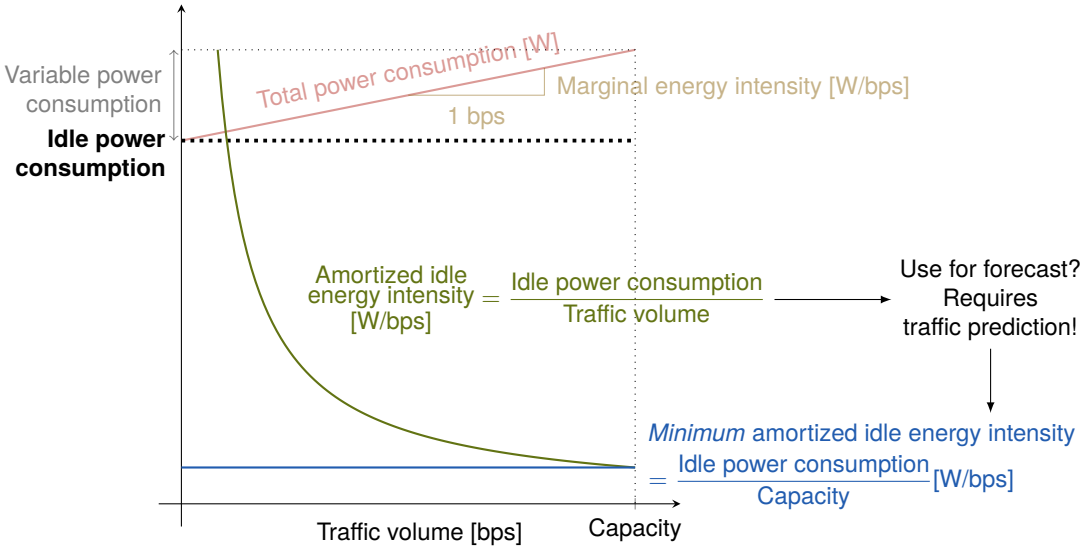

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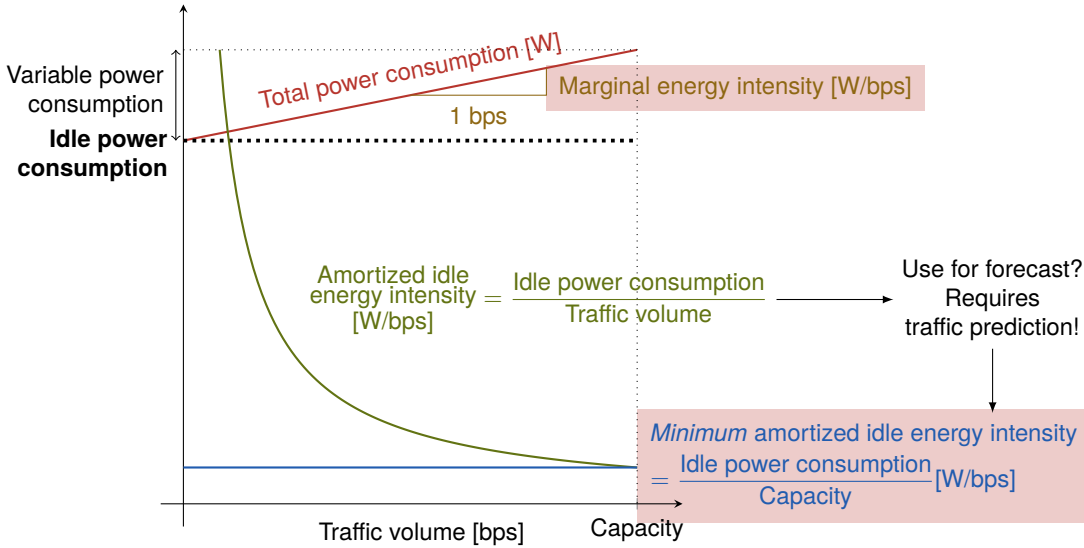
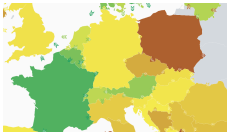


Carbon-Intensity Forecasting: Summary

Carbon intensity of devices



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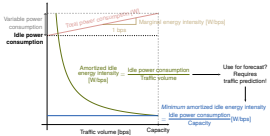

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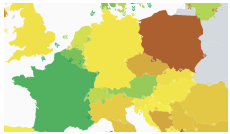
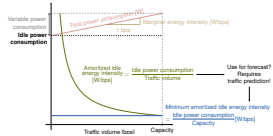
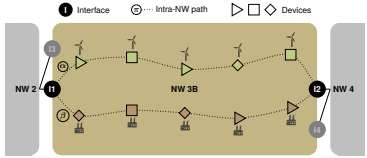




Carbon intensity of intra-network paths



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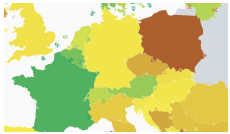
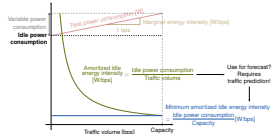
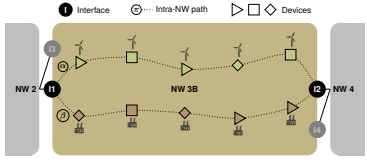
Carbon intensity of network
with respect to interface pair







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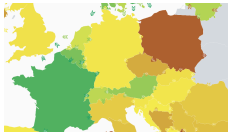

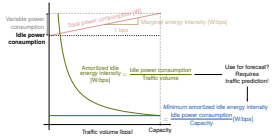

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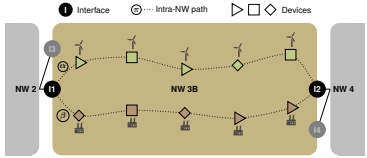
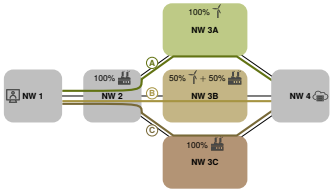
Carbon intensity of network with respect to interface pair



Carbon intensity of Internet path



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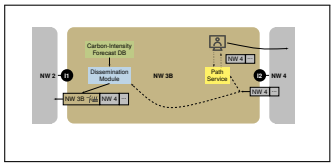

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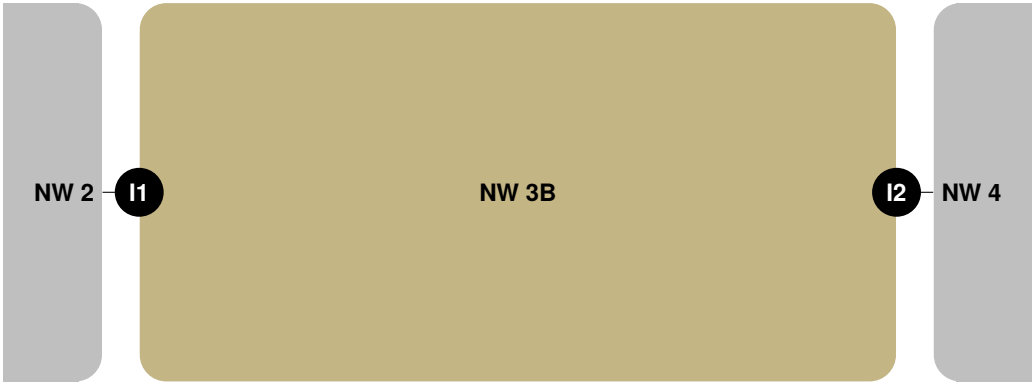

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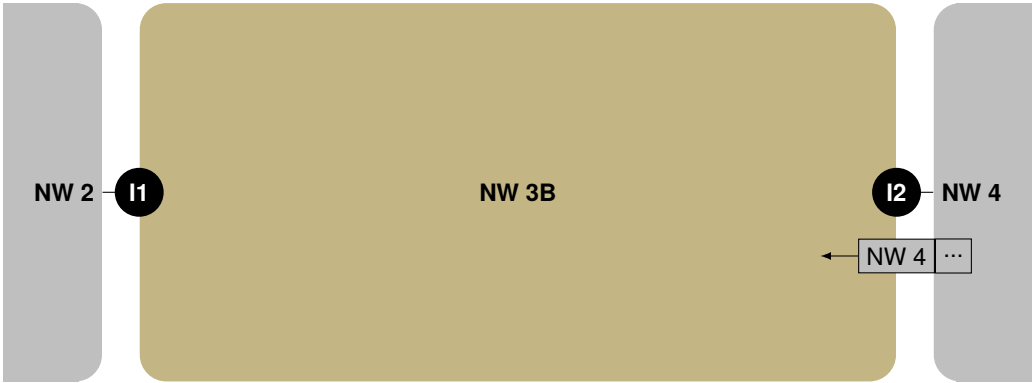

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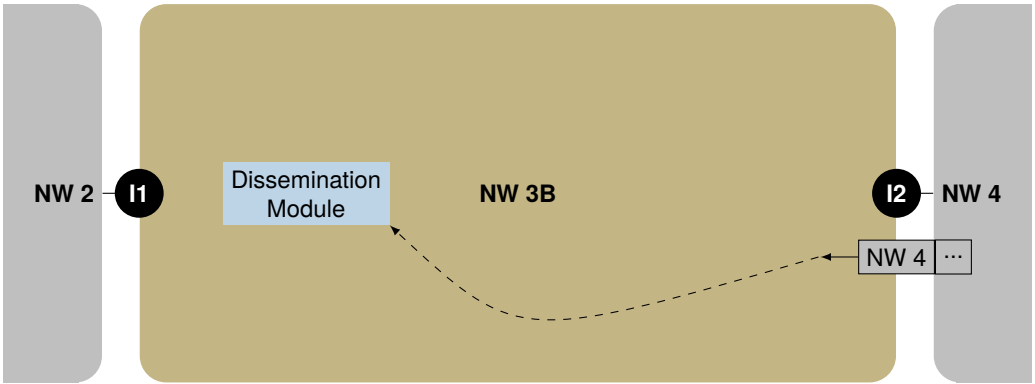

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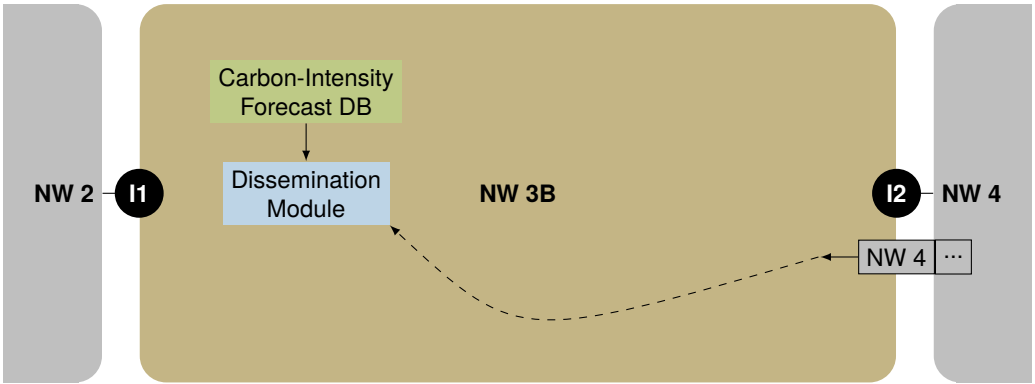

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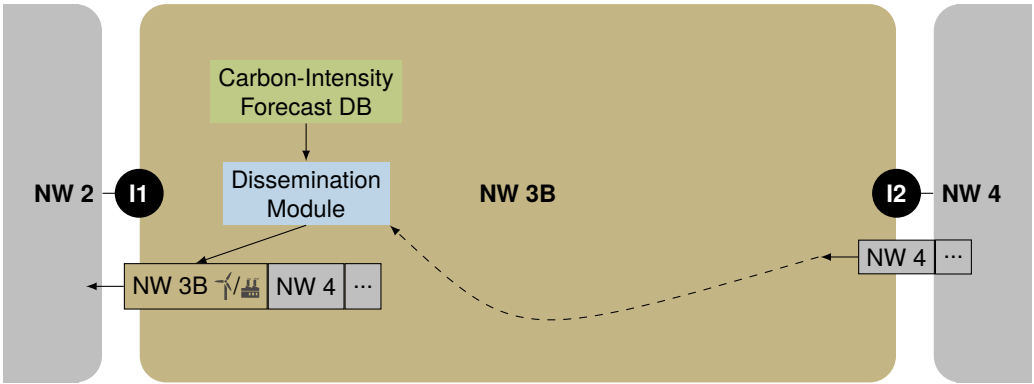

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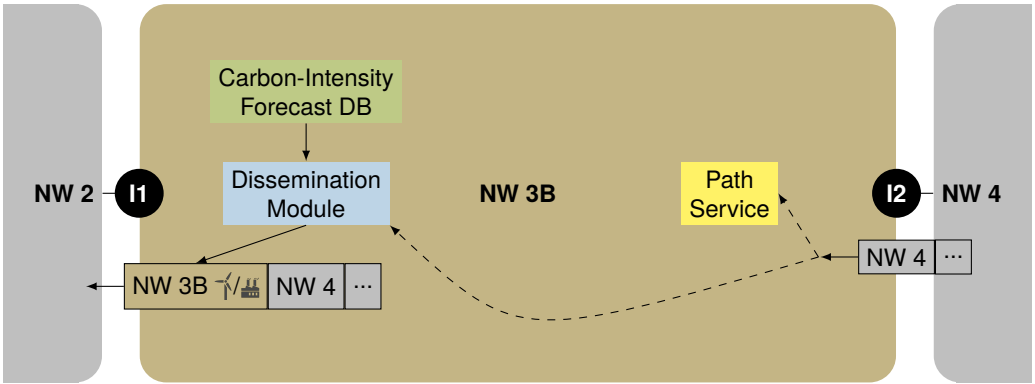

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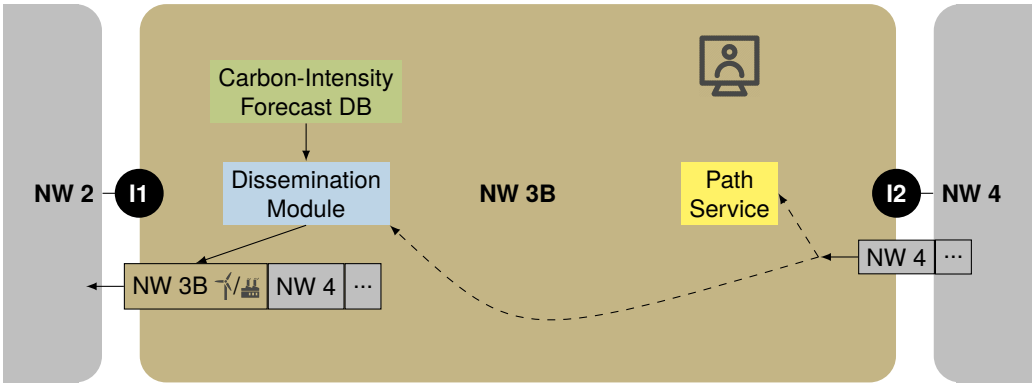

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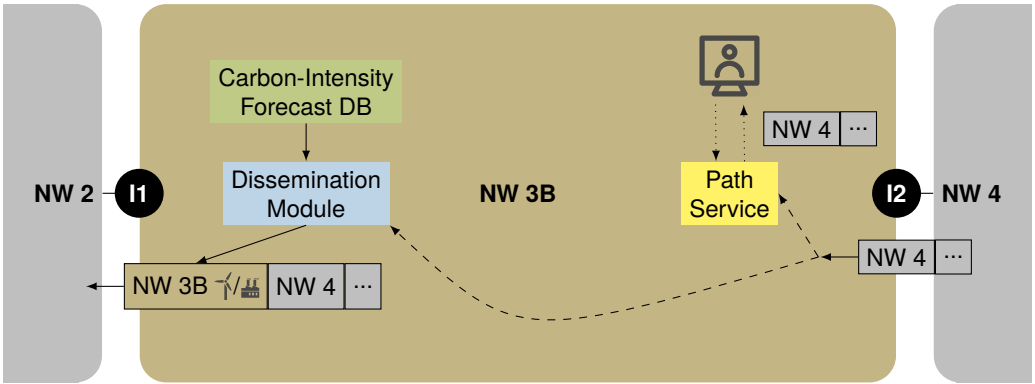

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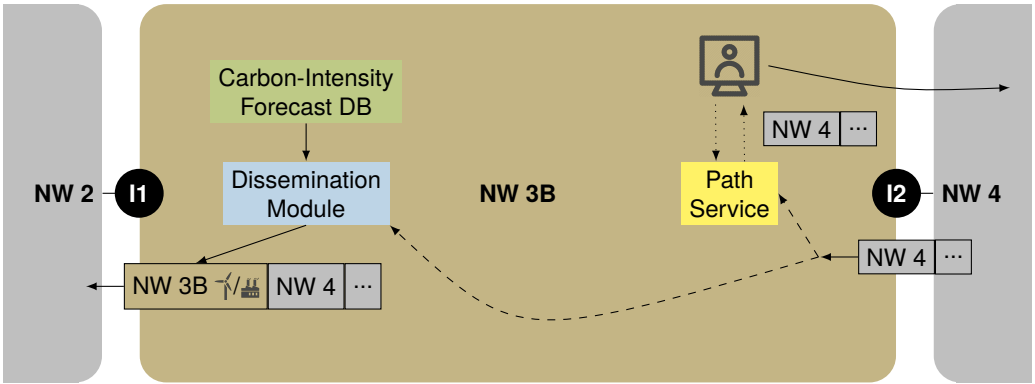

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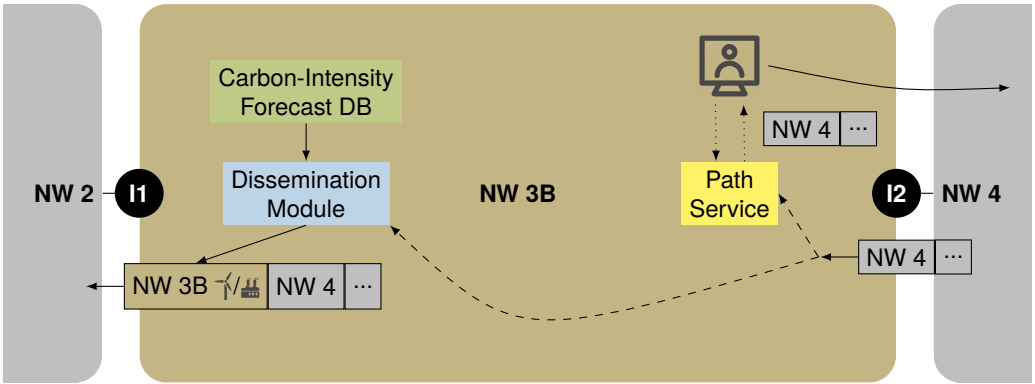

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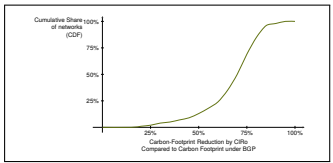

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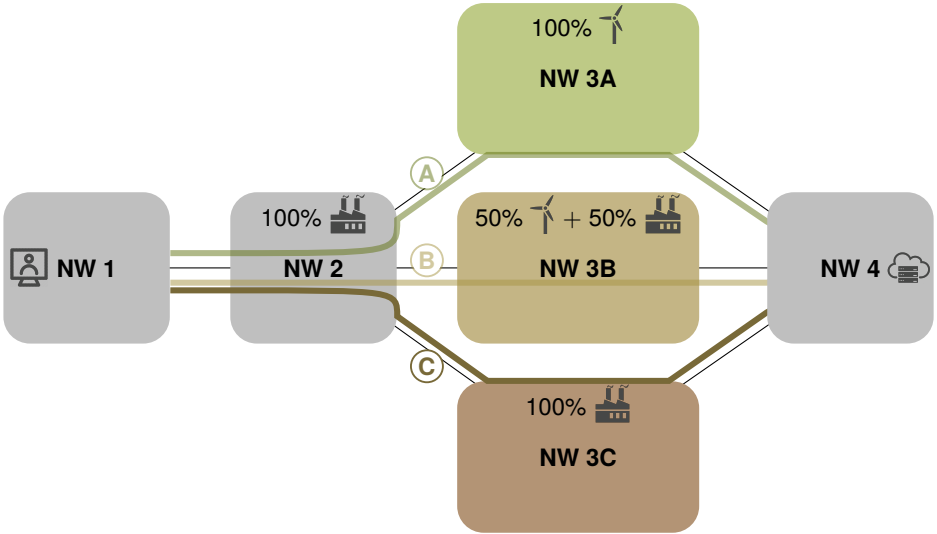

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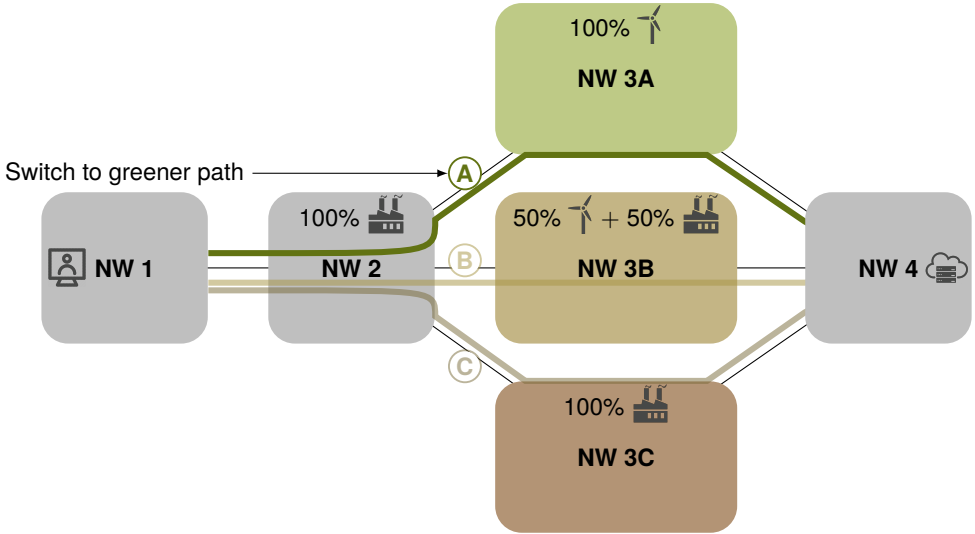

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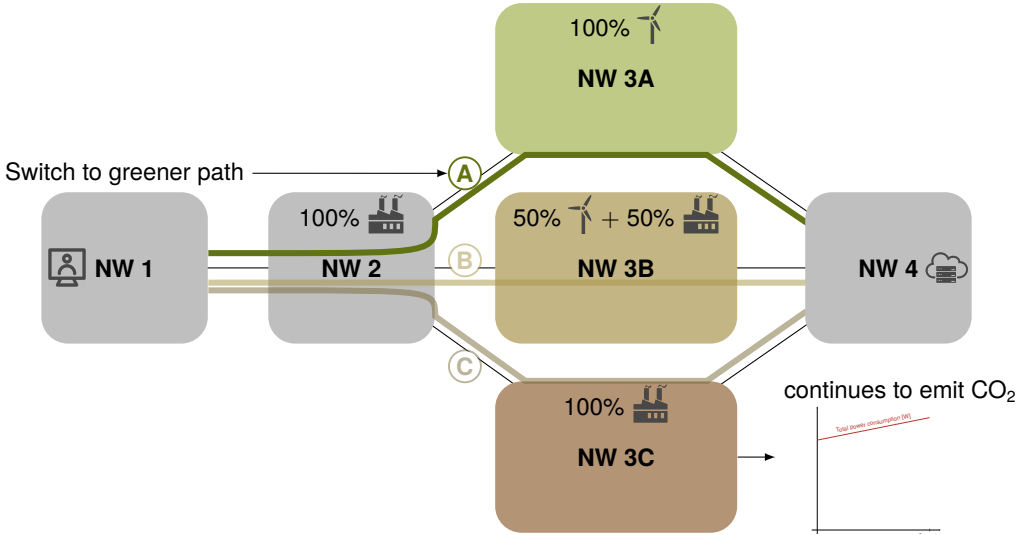

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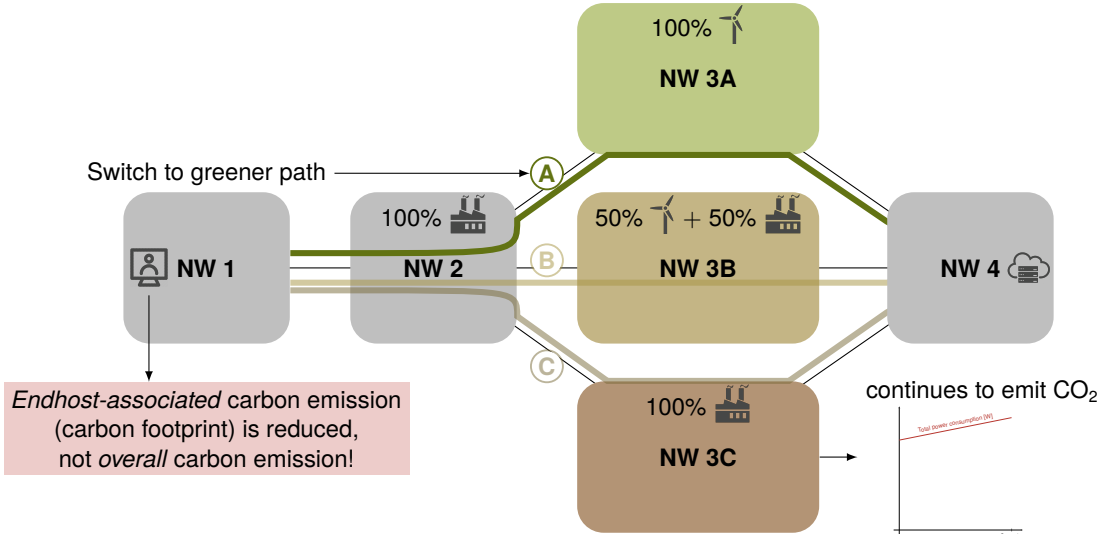

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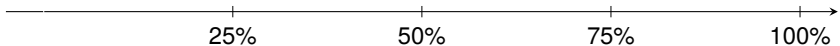

Carbon-Footprint Reduction by CIRo
Compared to Carbon Footprint under BGP

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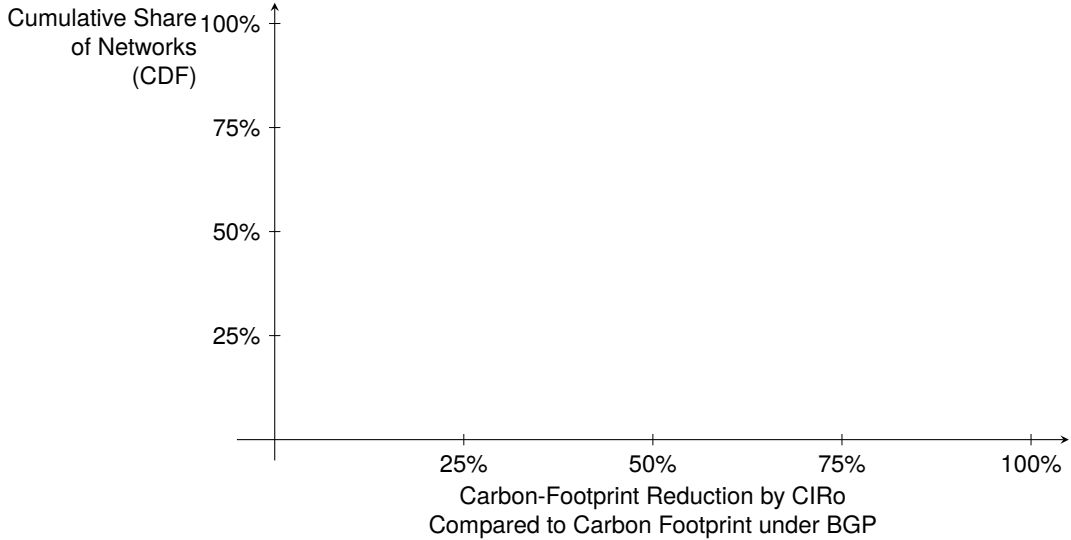

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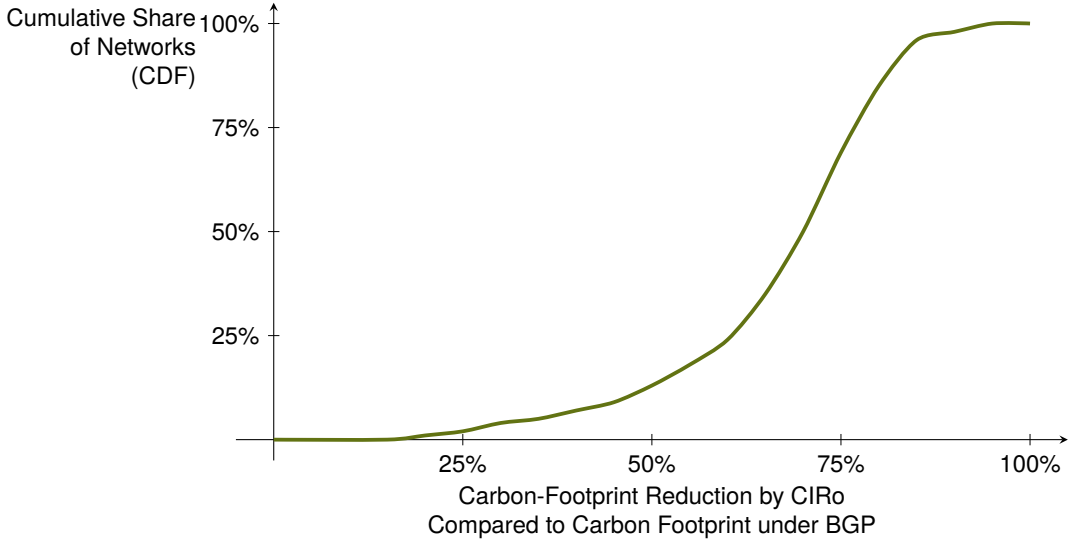

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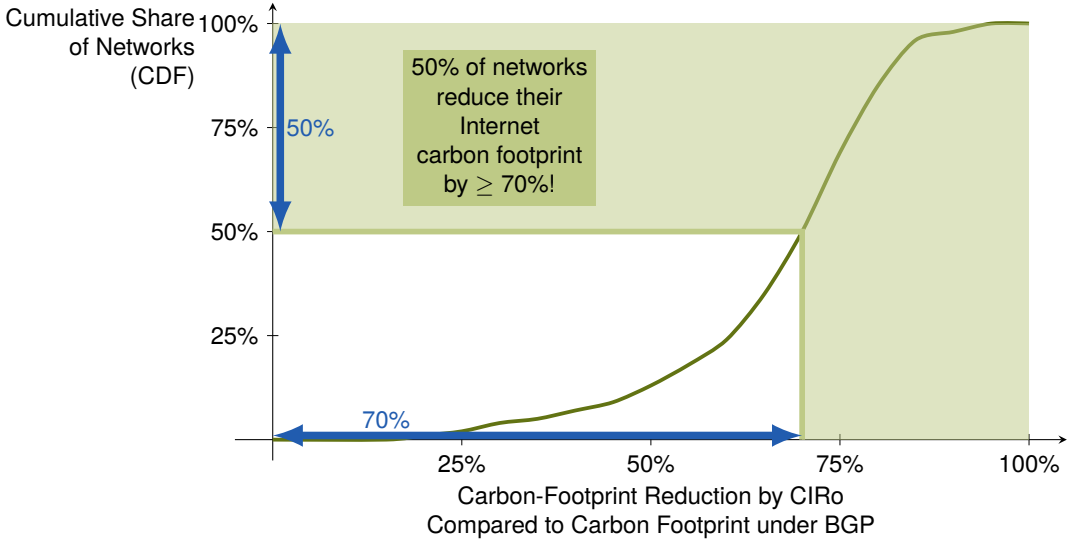

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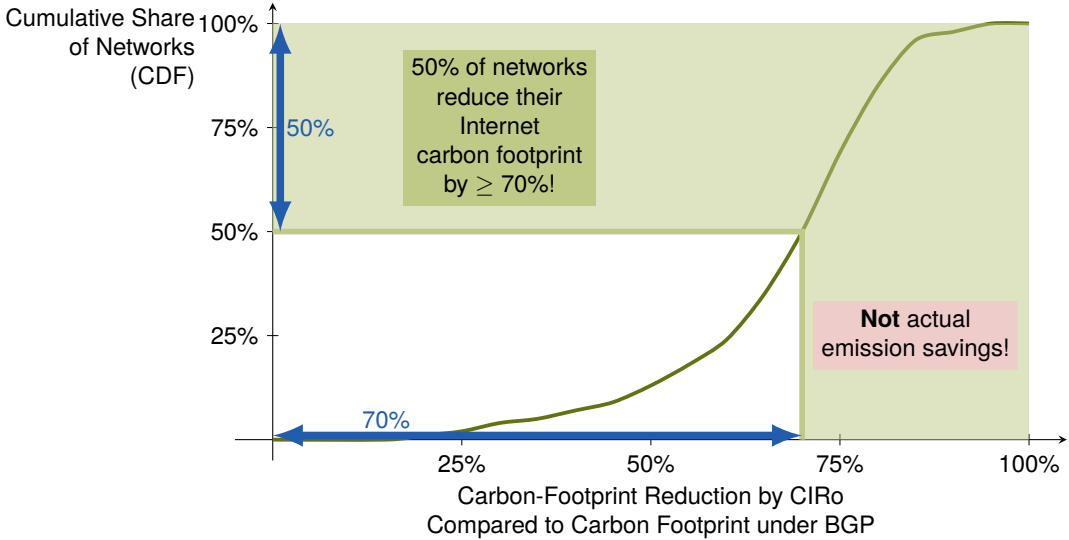

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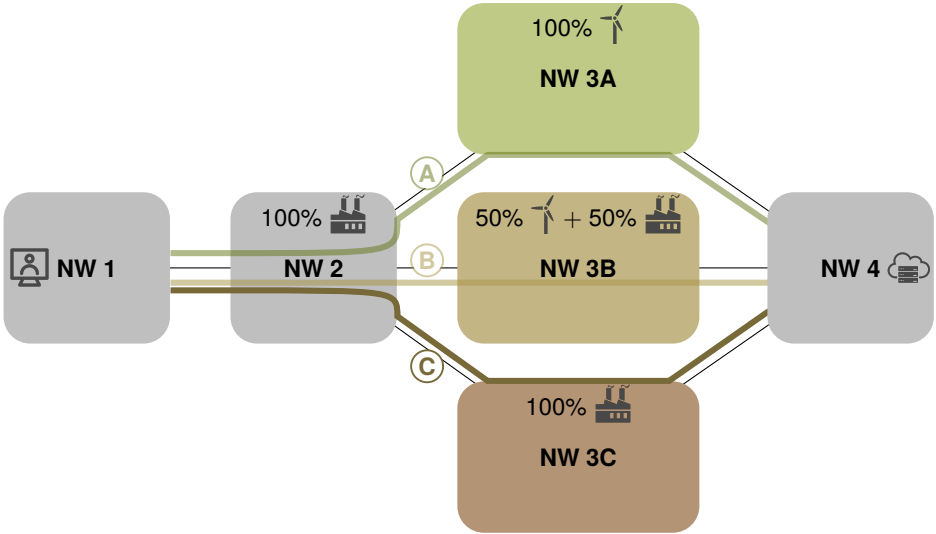

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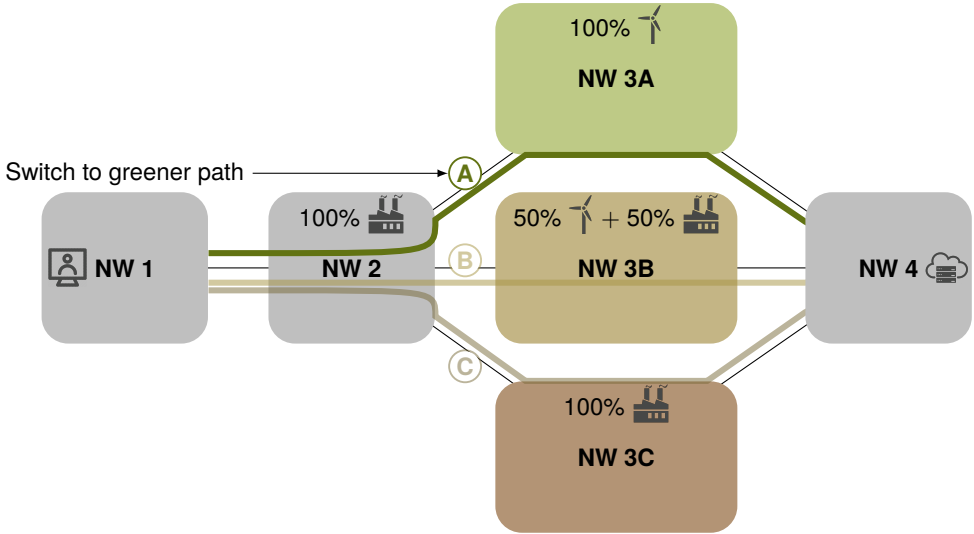

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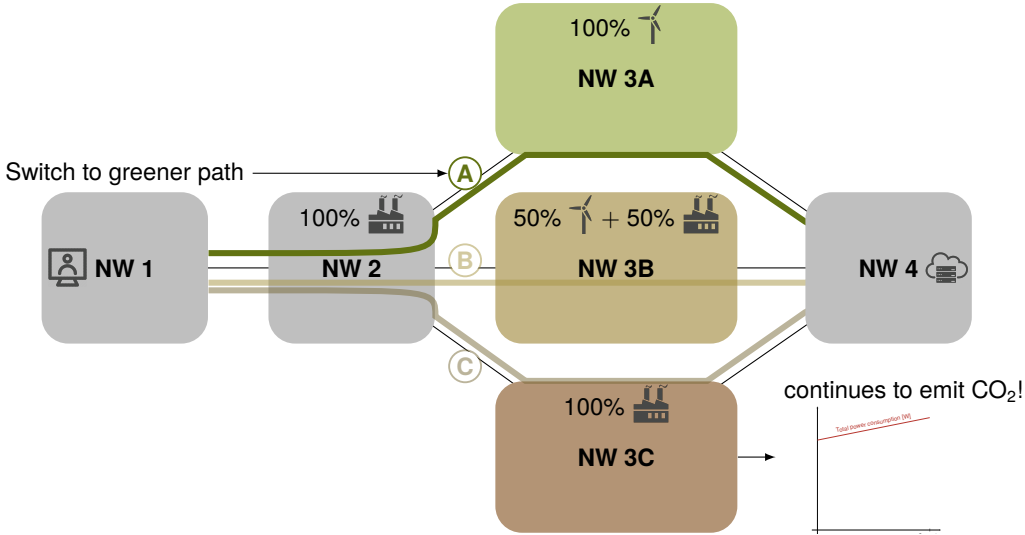

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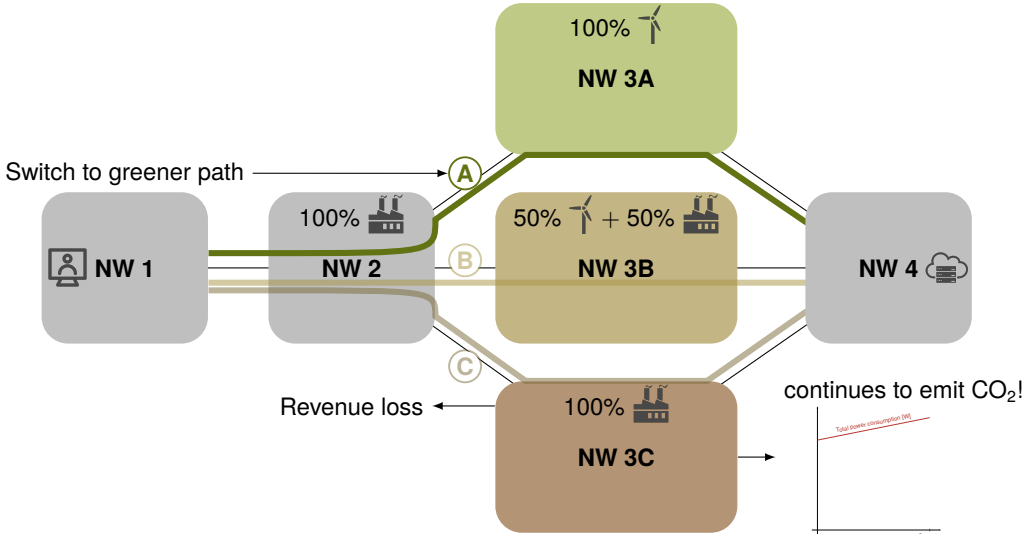

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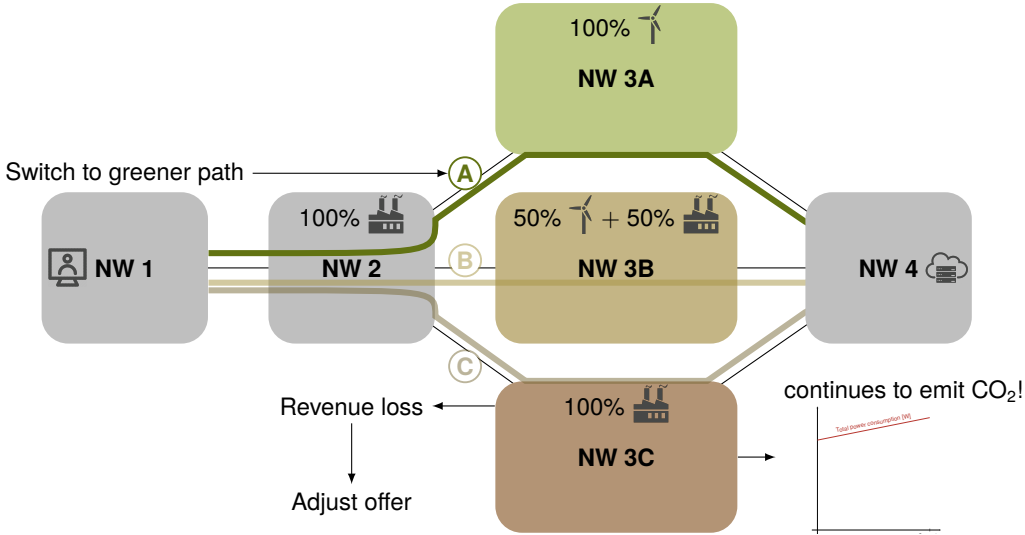

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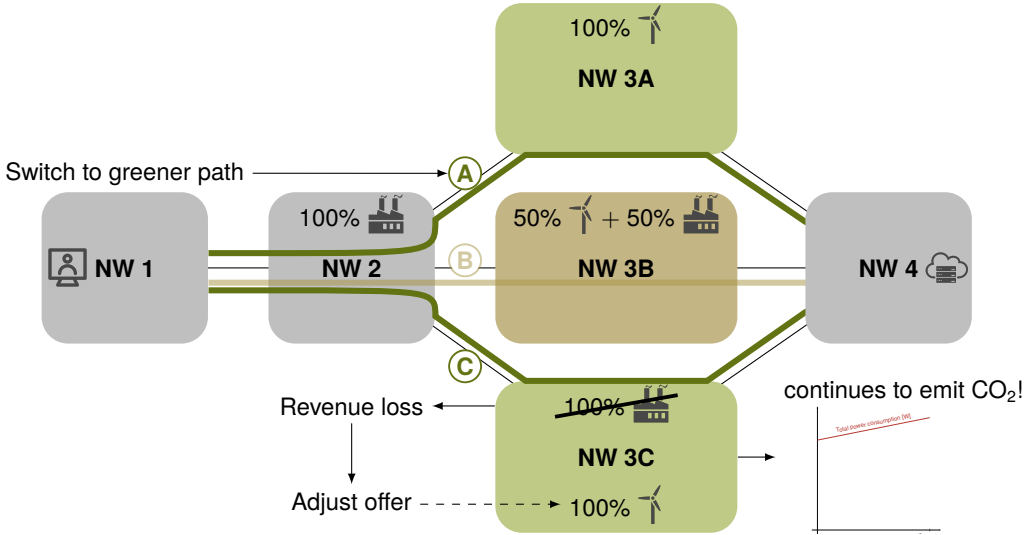

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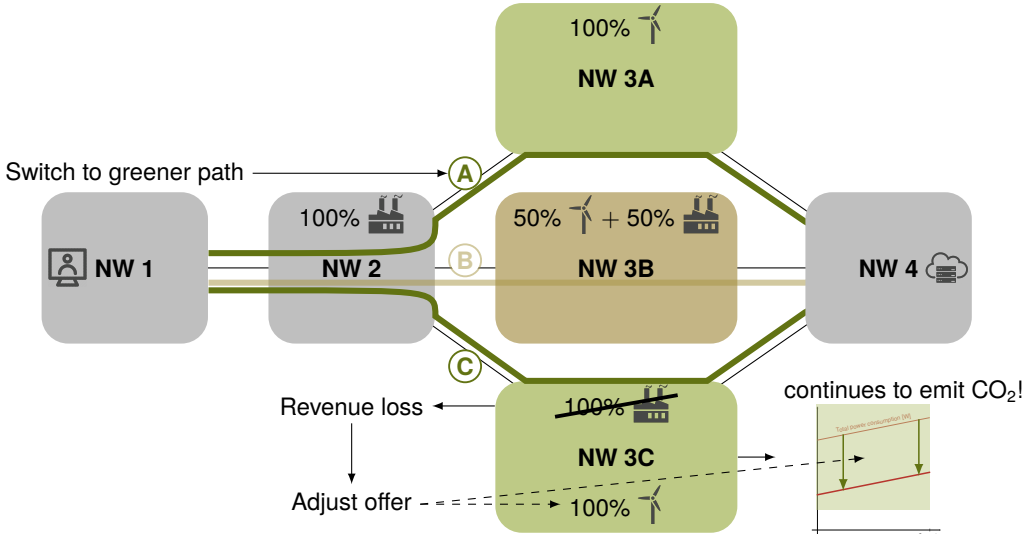

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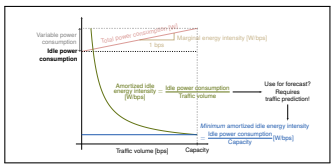

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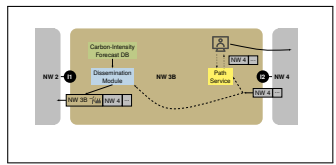

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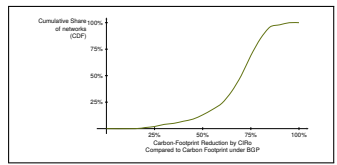

Additional Material

Carbon-Information Dissemination: Why Trust Carbon Information?

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Approach: Certify carbon information by *specialized* and *trusted* certification authorities

Carbon-Information Certification Authority

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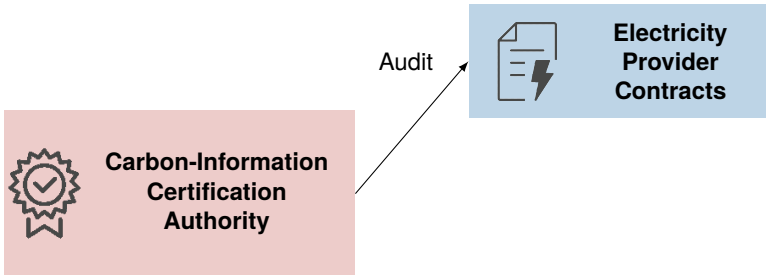

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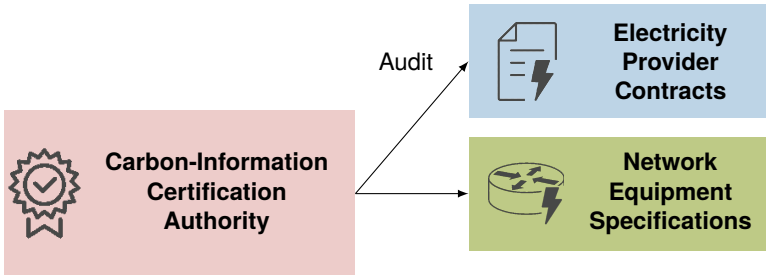

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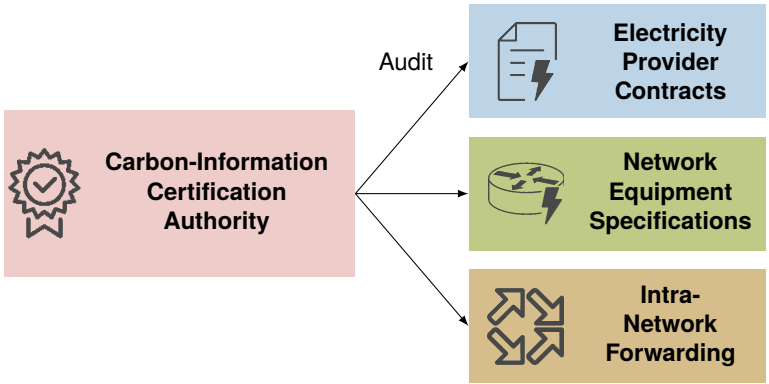

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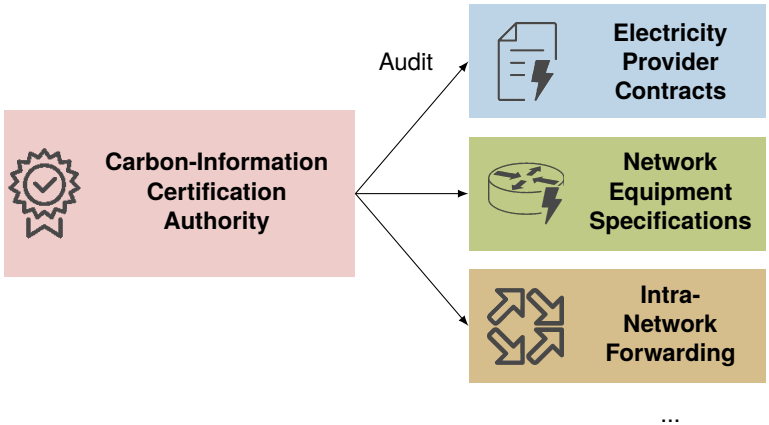
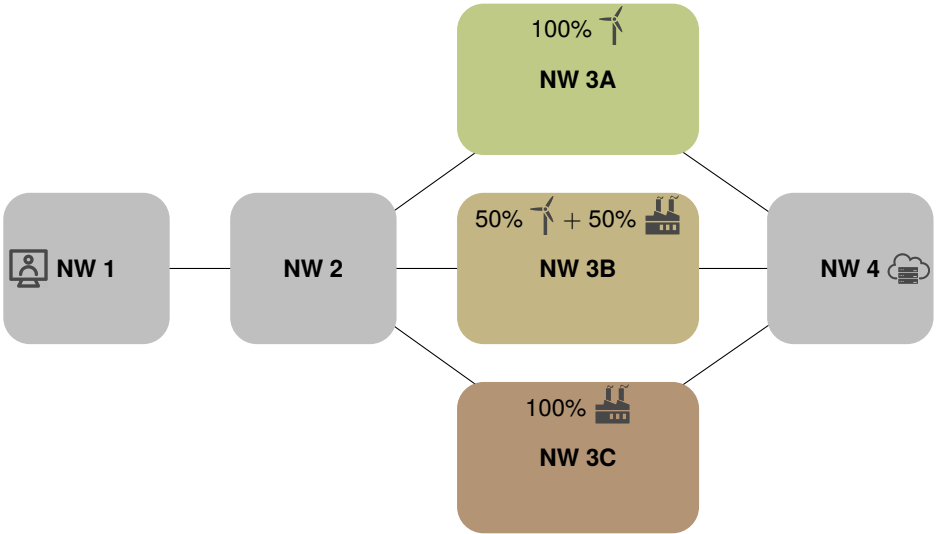


Carbon-Aware Global Routing with Traditional Internet Routing (BGP)?



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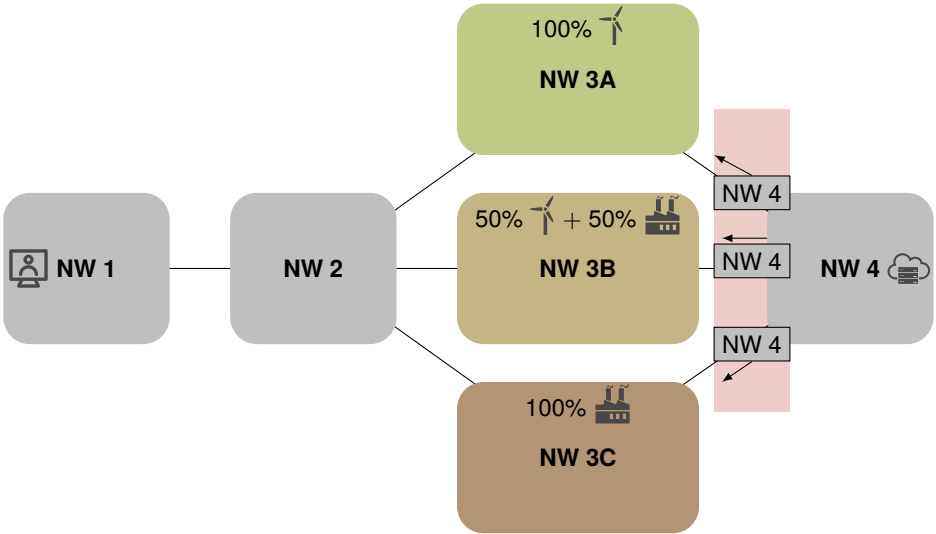

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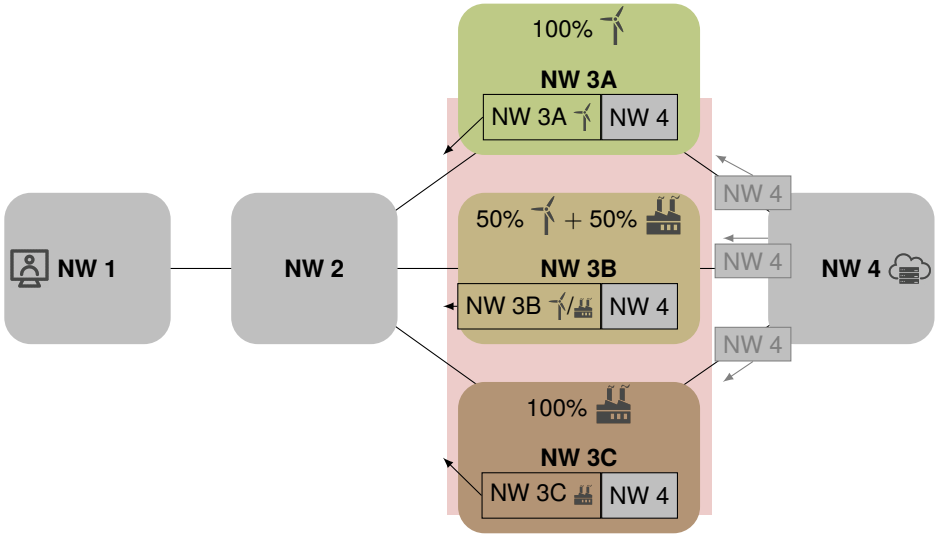

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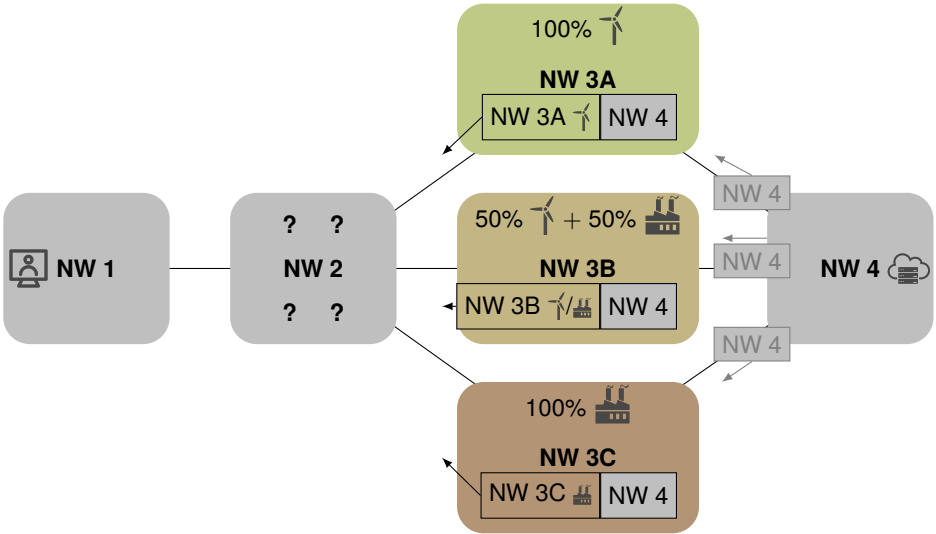

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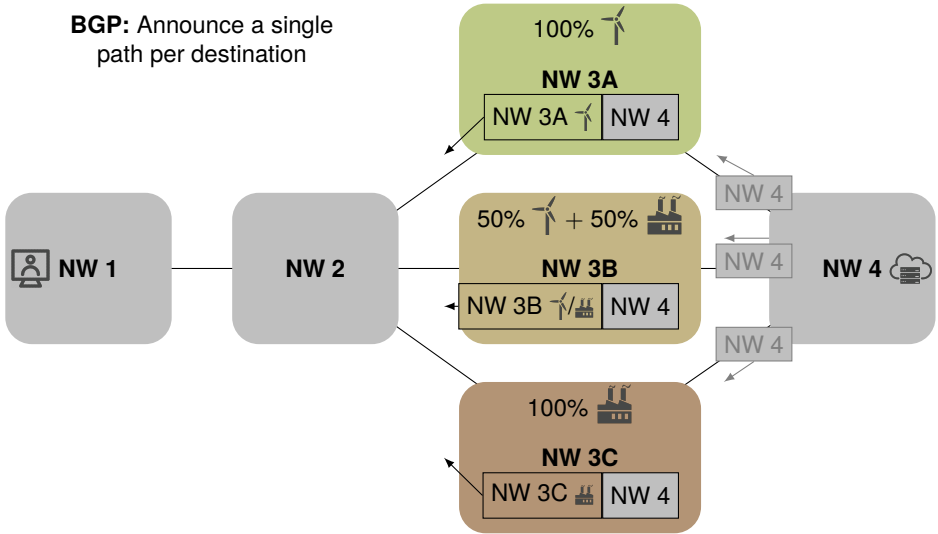

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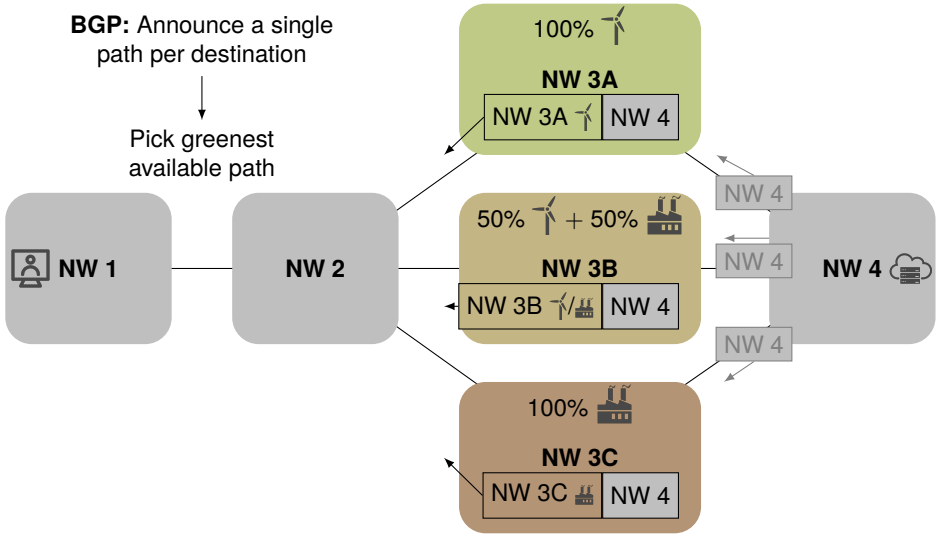

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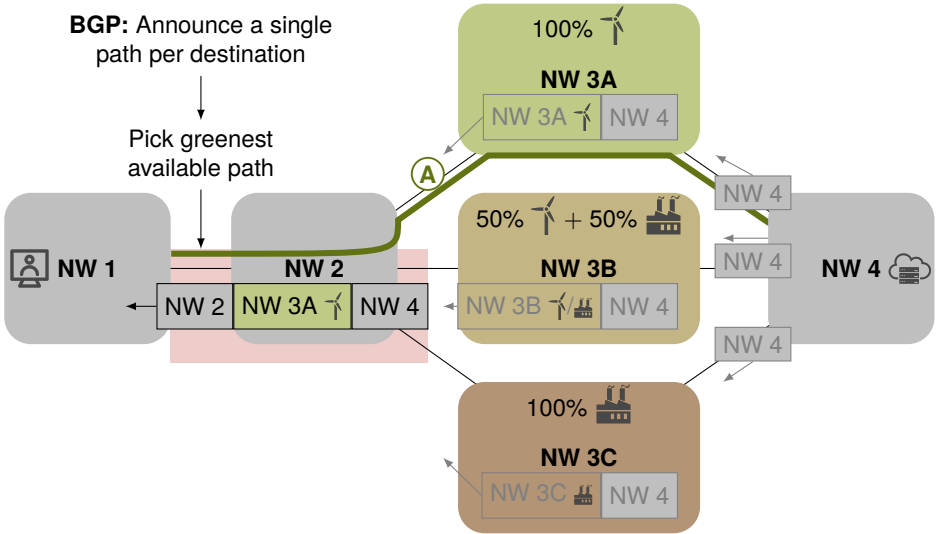

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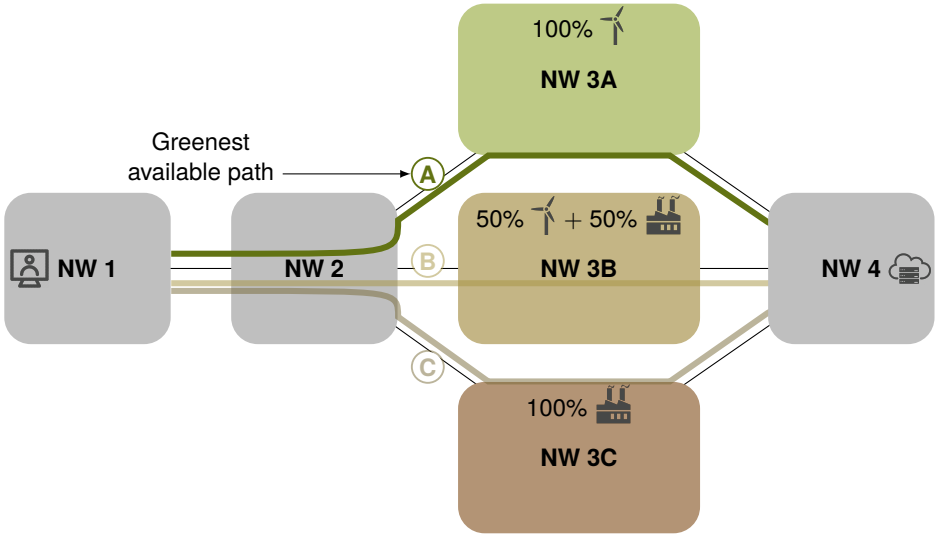

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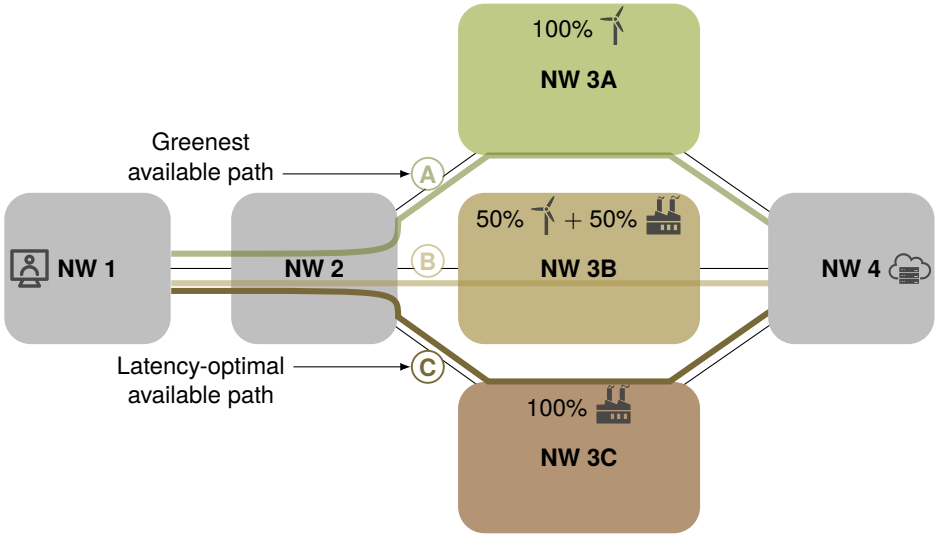

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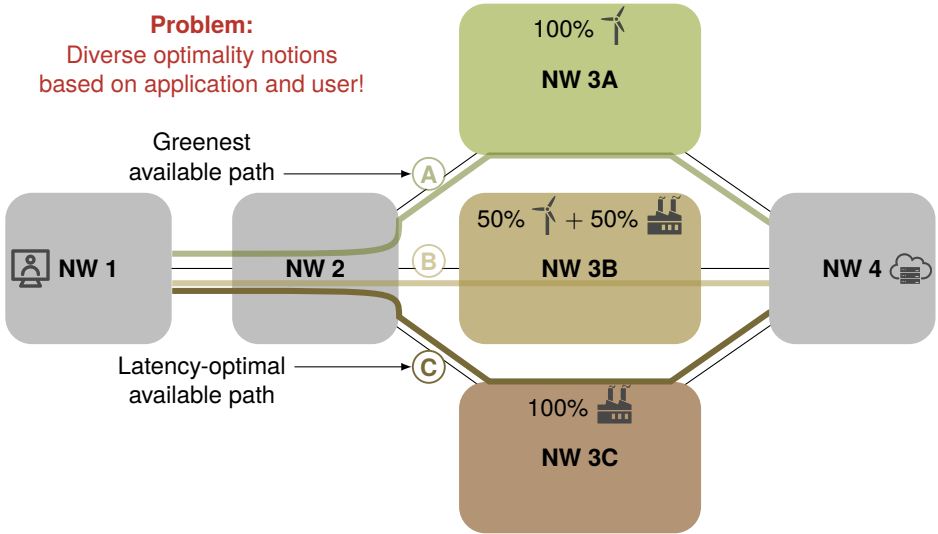

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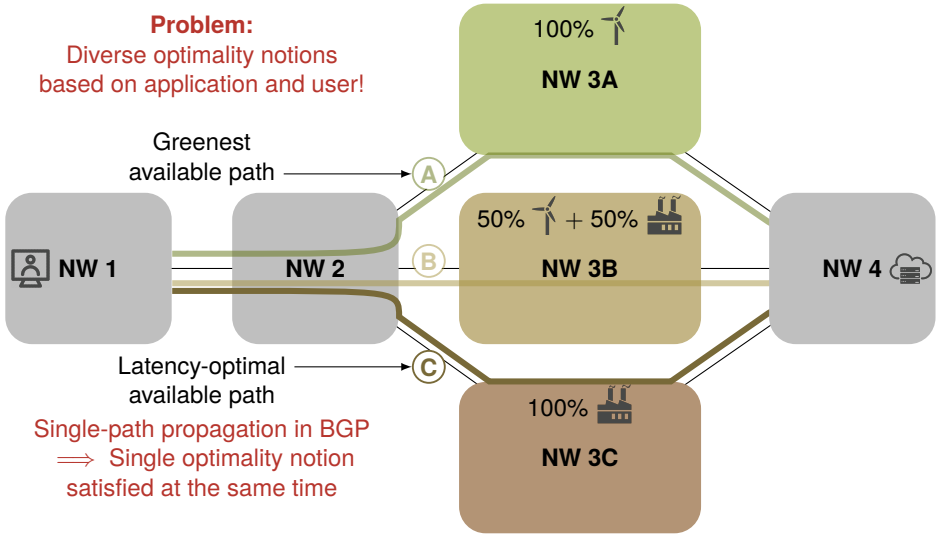

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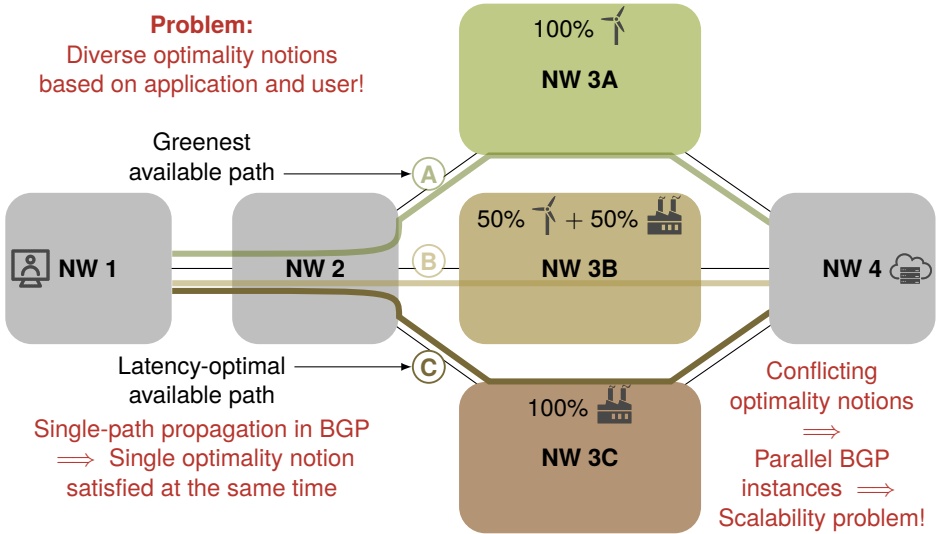

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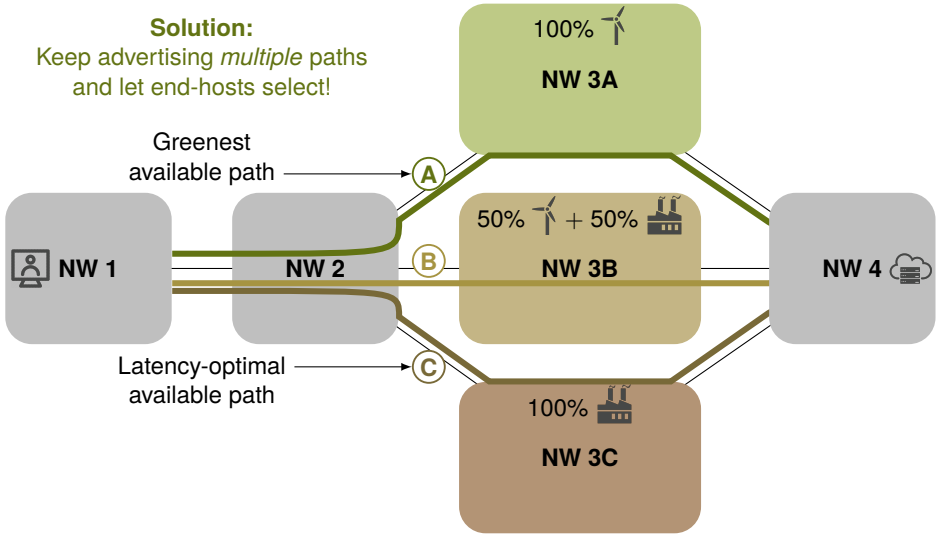

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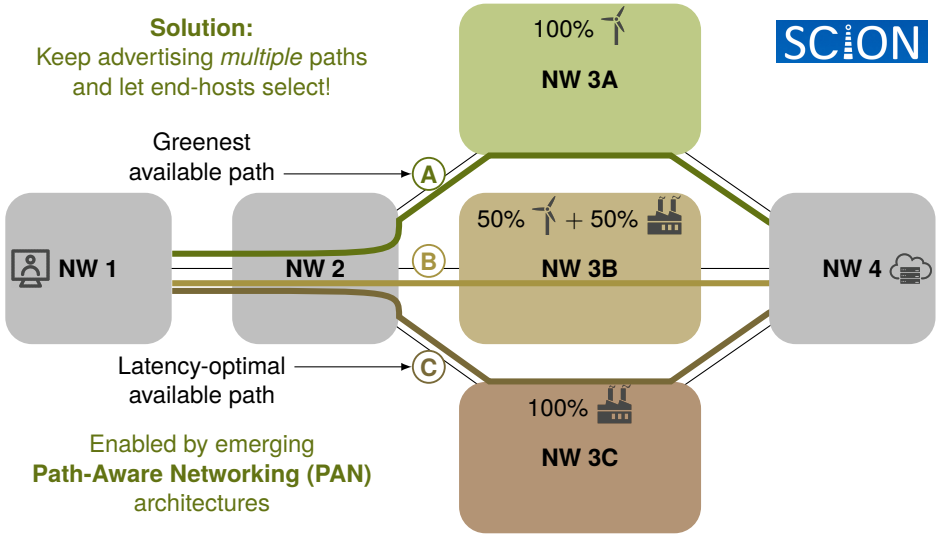

Impact Analysis: Overview of Approach

CAIDA Internet Core Topology (AS Level + Router Level)

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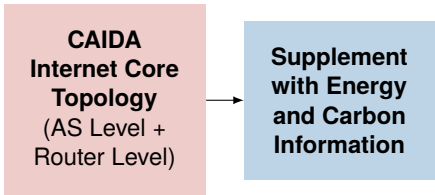

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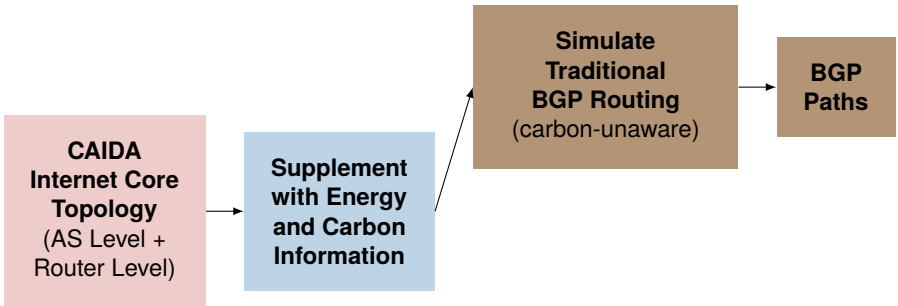

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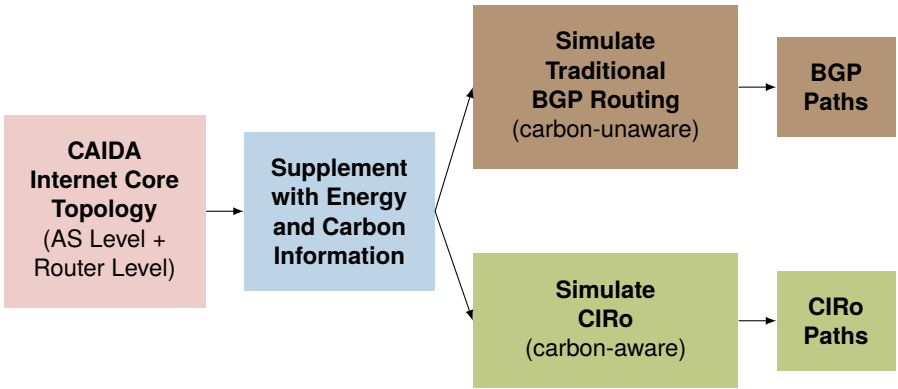

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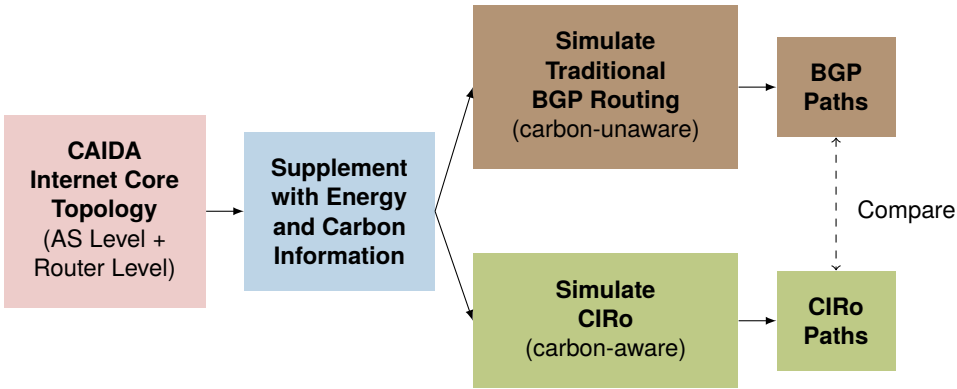

Impact Analysis: Difference in Greenest Path

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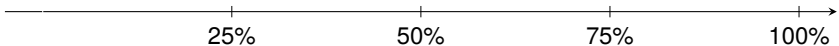
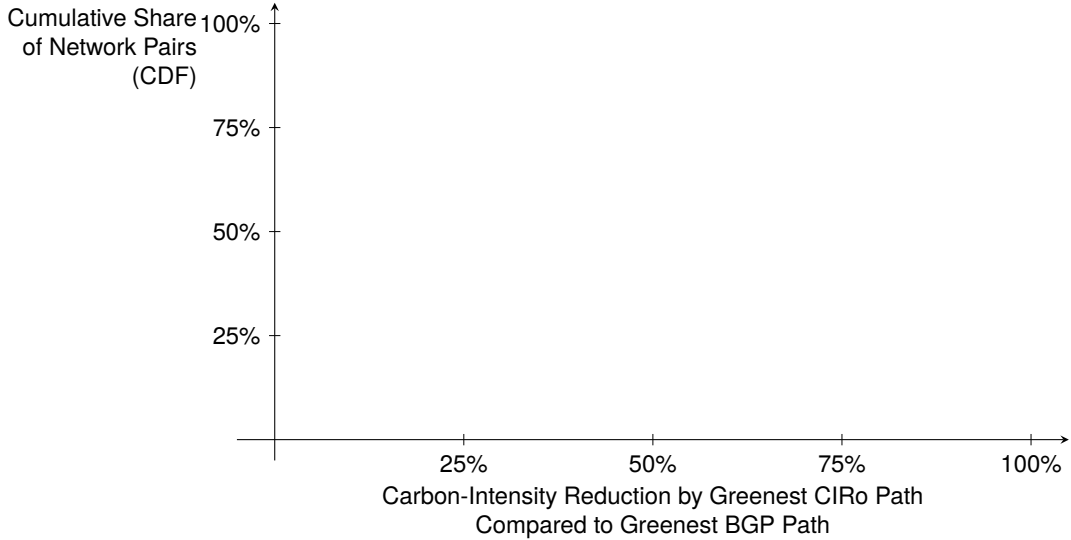
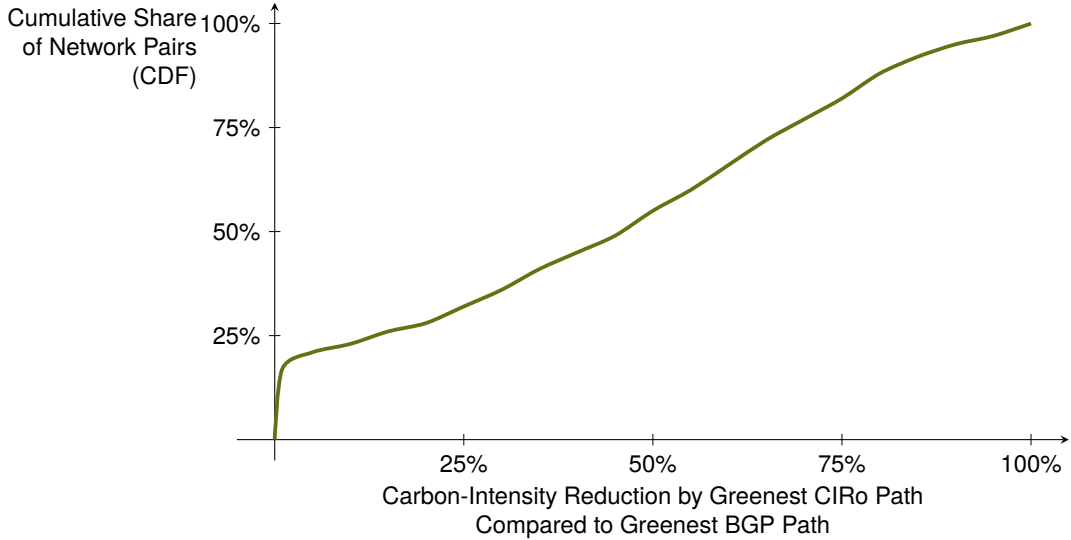


Carbon-Intensity Reduction by Greenest CIRo Path
Compared to Greenest BGP Path

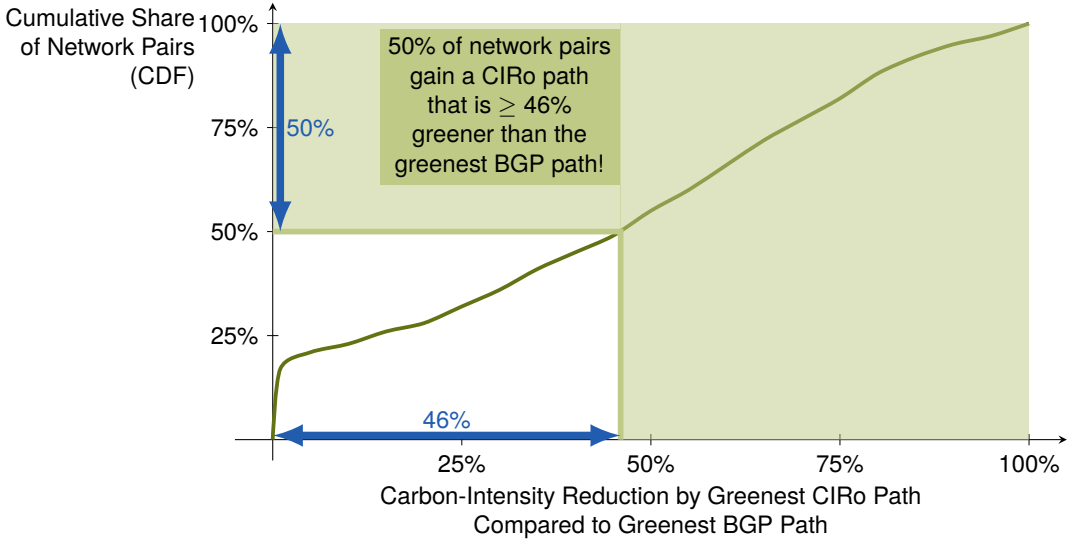
Impact Analysis: Difference in Greenest Path



Impact Analysis: Difference in Greenest Path

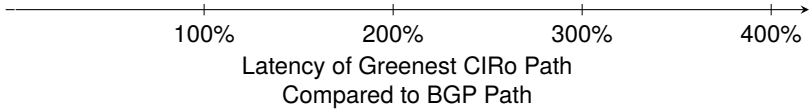


Impact Analysis: Difference in Greenest Path

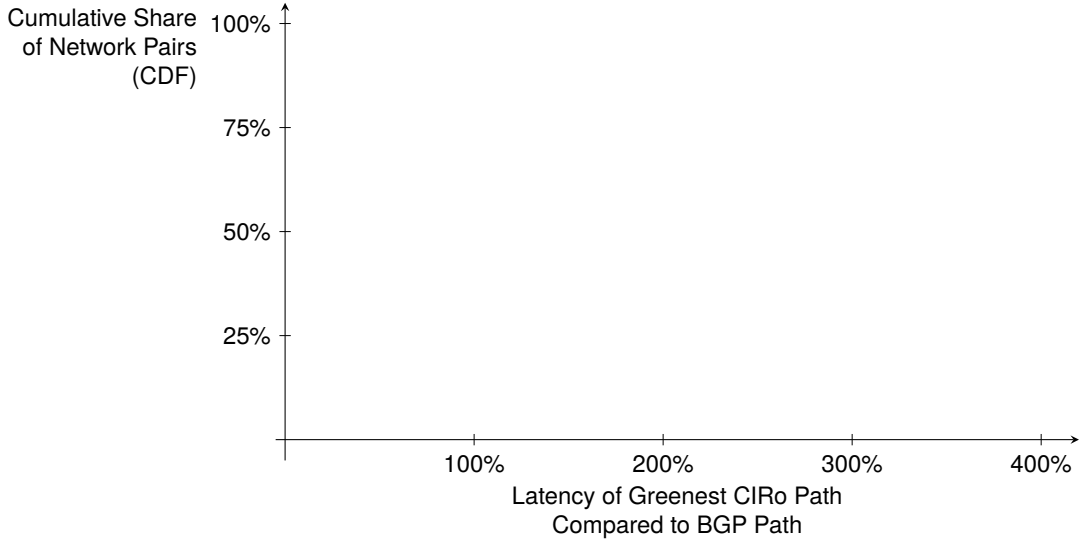


Impact Analysis: Carbon Intensity vs Latency

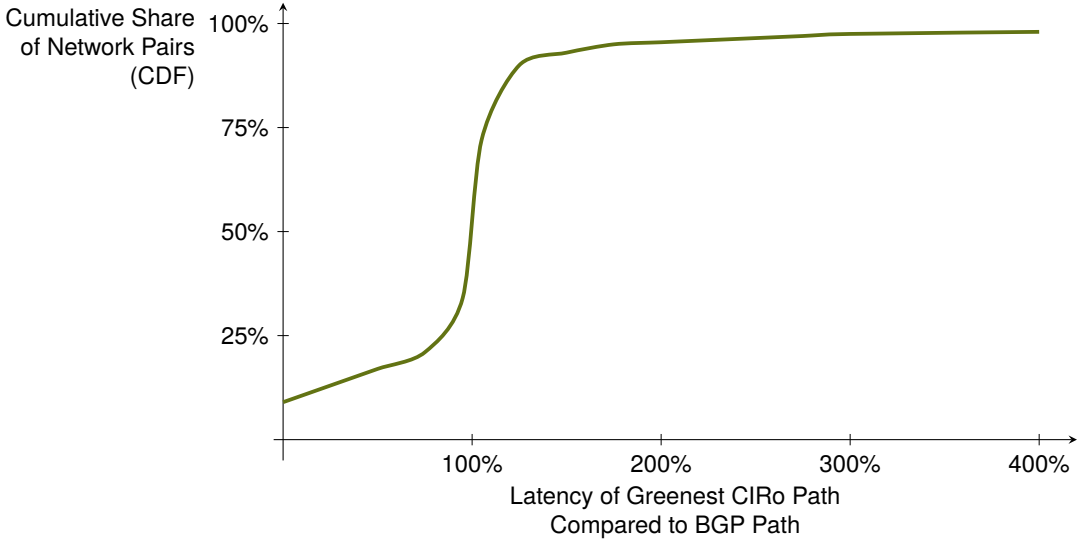
Impact Analysis: Carbon Intensity vs Latency



Impact Analysis: Carbon Intensity vs Latency



Impact Analysis: Carbon Intensity vs Latency



Impact Analysis: Carbon Intensity vs Latency