Central Asia –South Asia Connectivity

Impact of Afghanistan Power Master Plan on Interconnection Options

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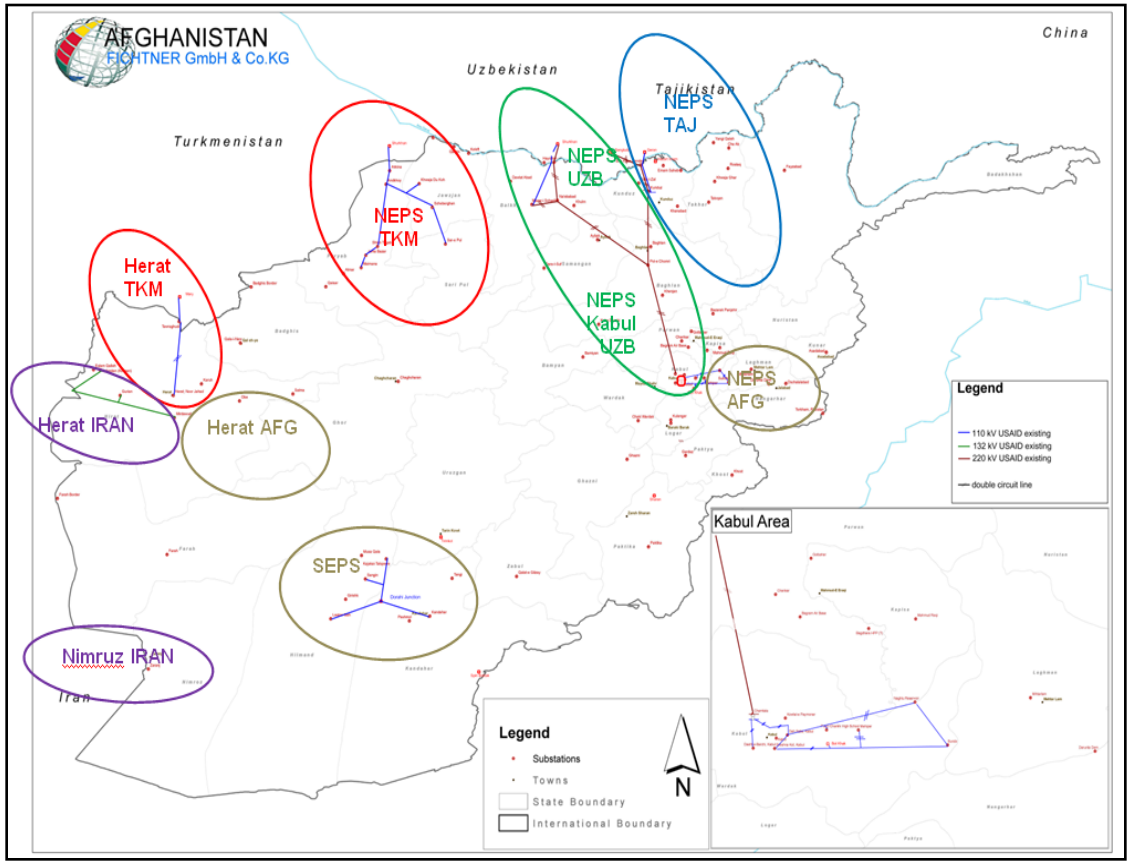
Afghanistan (AFG) Power Sector Master Plan

- ADB implemented Technical Assistance TA 7637 with Afghanistan Ministry of Energy and Water as counterpart
- $1.5 million financing from Japanese Fund for Poverty Reduction
- Study conducted Dec 2011 to Feb 2013 by Consultant Fichtner of Germany
- Main findings:
  - AFG demand to grow from 850MW (2011) to 3500MW (2032)
  - Current island mode of operation to move to integrated AFG grid
  - Imports (70% of 2011 demand) will continue to be required as domestic projects are being developed.
  - Importing to integrated grid requires asynchronous interconnection to neighboring countries
  - An integrated AFG grid with strong connectivity to Central Asia allows AFG be a transit country between Central Asia and Pakistan

Existing AFG power system, situation 2011/2012



- 9 islands fed from different systems
- Electrification rate 30 %
- Peak load 850MW
- Annual consumption 3800GWh
- 70% of the energy covered by imports

System characterized by a shortage of power supply and increasing demand and requirement for grid connection

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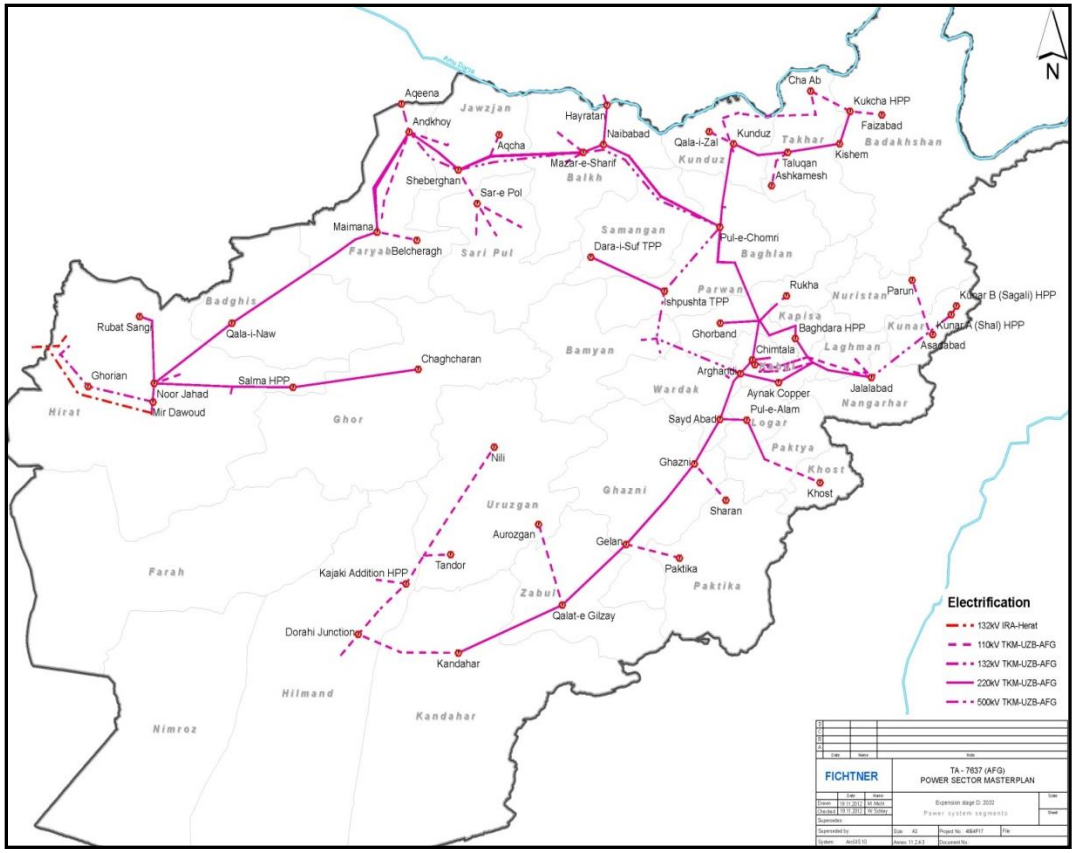
Proposed AFG System 2032



- Integrated transmission network of Afghanistan
- Share of domestic production increases to 67 %
- About 83 % of the population will have access to power
- Peak load of about 3500 MW
- Annual energy consumption of 18400 GWh
- Power exchange options with neighboring systems

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How to Meet AFG Demand

- Domestic generation + import from neighboring power systems will be required to cover the expected demand growth.
- Local Generation (2,800 MW planned)
  - Hydropower. 12 potential hydro power options available. Kunar 1st priority @ >1,000MW
  - Gas and Coal. Seberghan gas and Bamyan coal identified (1,600MW)
  - Renewable energy for off grid solutions
- Import from neighboring systems continue to be needed.
- Breakdown of 2011 imports of 2,250GWh as
  - 57% Uzbekistan
  - 22% Iran
  - 16% Turkmenistan
  - 4% Tajikistan

Future Import Potential

Turkmenistan

- Ongoing project TKM-AFG interconnector to supply 300 MW to northwest Afghanistan (220kV line rated at 500kV)
- Possible increase of supply on the new interconnector up to 1000 MW
- Continue to supply of regions in Herat

Uzbekistan

- Continue imports 300 MW over existing 220kV line

Tajikistan

- Continue summer import up to 300 MW over existing 220kV line

Iran

- Continue in feed to bordering regions Nimruz and Herat

Development of Afghan Transmission system

- **Main source for electrical power, after own generation, will continue for medium term to be imports from Turkmenistan, Uzbekistan, Tajikistan, Iran**
- **Problem to be solved:**
  - ***How to interconnect Afghan unified grid with Turkmenistan (operates with Iran), Uzbekistan (operates with CAPS) , Tajikistan (Island Operation)***
- **Options: Synchronous or Asynchronous Interconnection**

<u>Synchronous interconnection</u>

- **Requires Turkmenistan and Tajikistan will reconnect to CAPS**

<u>Asynchronous interconnection</u>

- **By HVDC back-to-back schemes**

<u>Combination</u>

Synchronize with one and HVDC back to back with rest. But:

- **Which one?**
- **Complex and lengthy process**

Proposed Asynchronous Operation

- **Uzbekistan, Tajikistan and Turkmenistan interconnections will be connected to a common HVDC hub at Pul-e-Khumri (PUK).**
- **PUK Hub to be built in stages with separate convertors for interconnection with TKM, UZB, TAJ**

Benefits of HVDC back to back

- **Modular technology- built in stages to meet needs**
- **Facilitates integration of remote diverse resources**
- **Controllable -power injected where needed**
- **No stability distance limitation**
- **Lower losses than HVAC transmission**
- **Facilitates power wheeling to Pakistan**

Example of HVDC Back-to-Back Hub: Tres Amigas Super Station

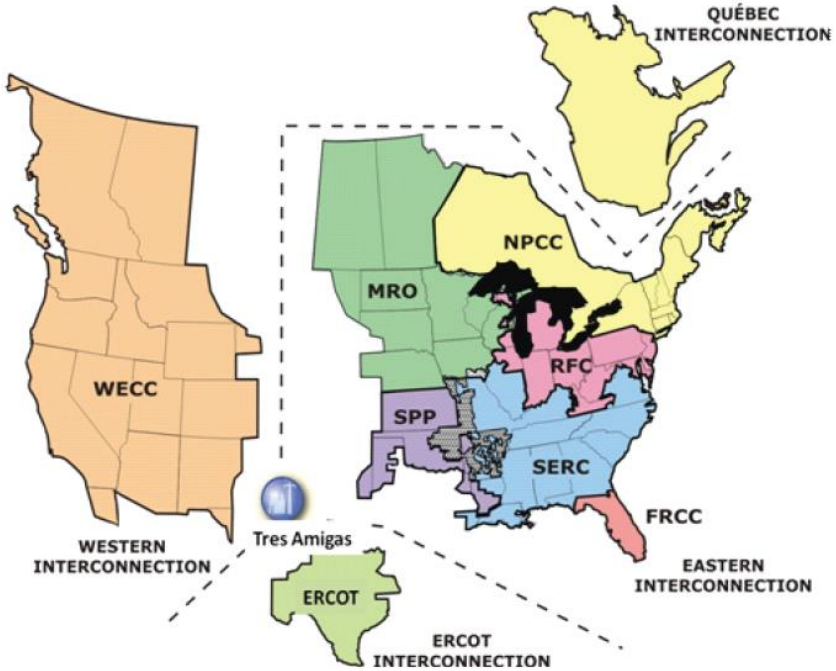
Three-way 5000 MW interconnection between three independent power networks in the USA

Today's situation:

- Three asynchronous power systems
- Connected by several HVDC Back-to-Backs
- Weak networks in parts

Tres Amigas Super Station:

- One 5000 MW Back-to-Back superstation
- Consisting of 6 independent HVDC B2B converters
- Step-by-step construction and operation
  - Initial Back-to-Back between WECC and SPP
  - Three VSCs support and reinforce networks
  - Three LCCs increase transmission ability



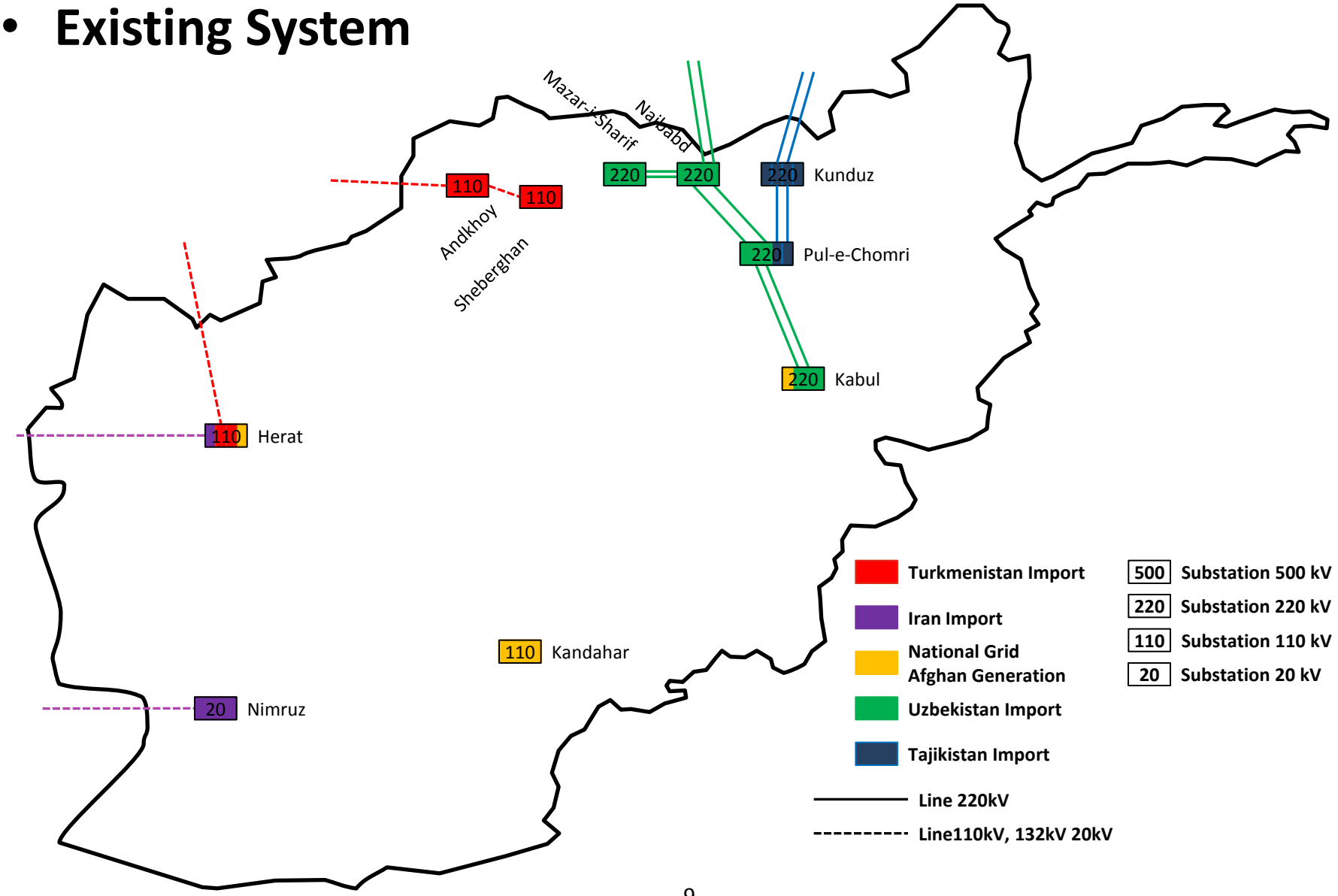
Advantages:

- Increased exchange capacity (allows for renewable energy implementation)
- Reinforcement of weak networks
- Real time power order control

Courtesy:CIGRE

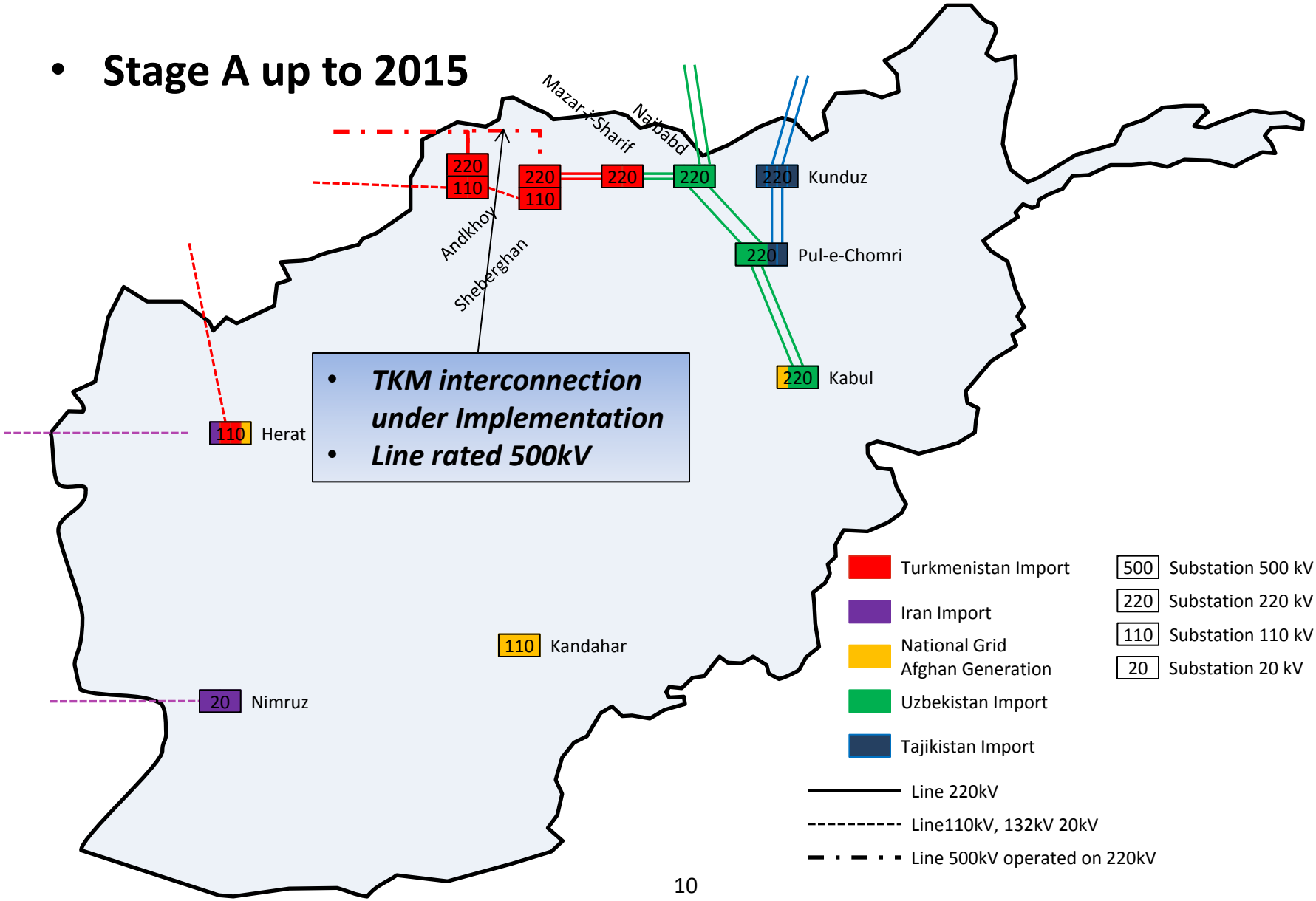
Major Transmission Projects: Geographical representation (1)

- **Existing System**



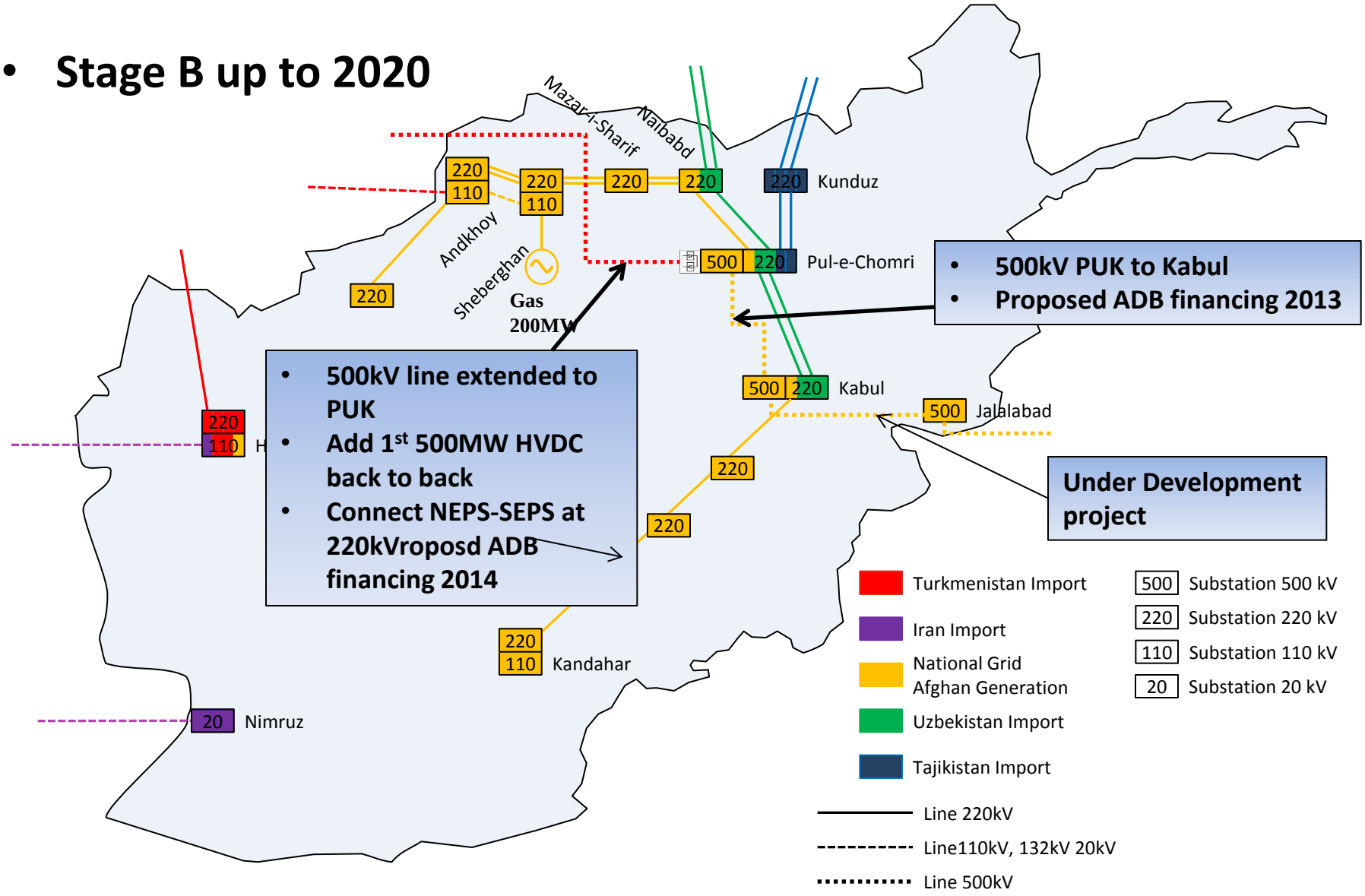
Major Transmission Projects: Geographical representation (2)

- **Stage A up to 2015**



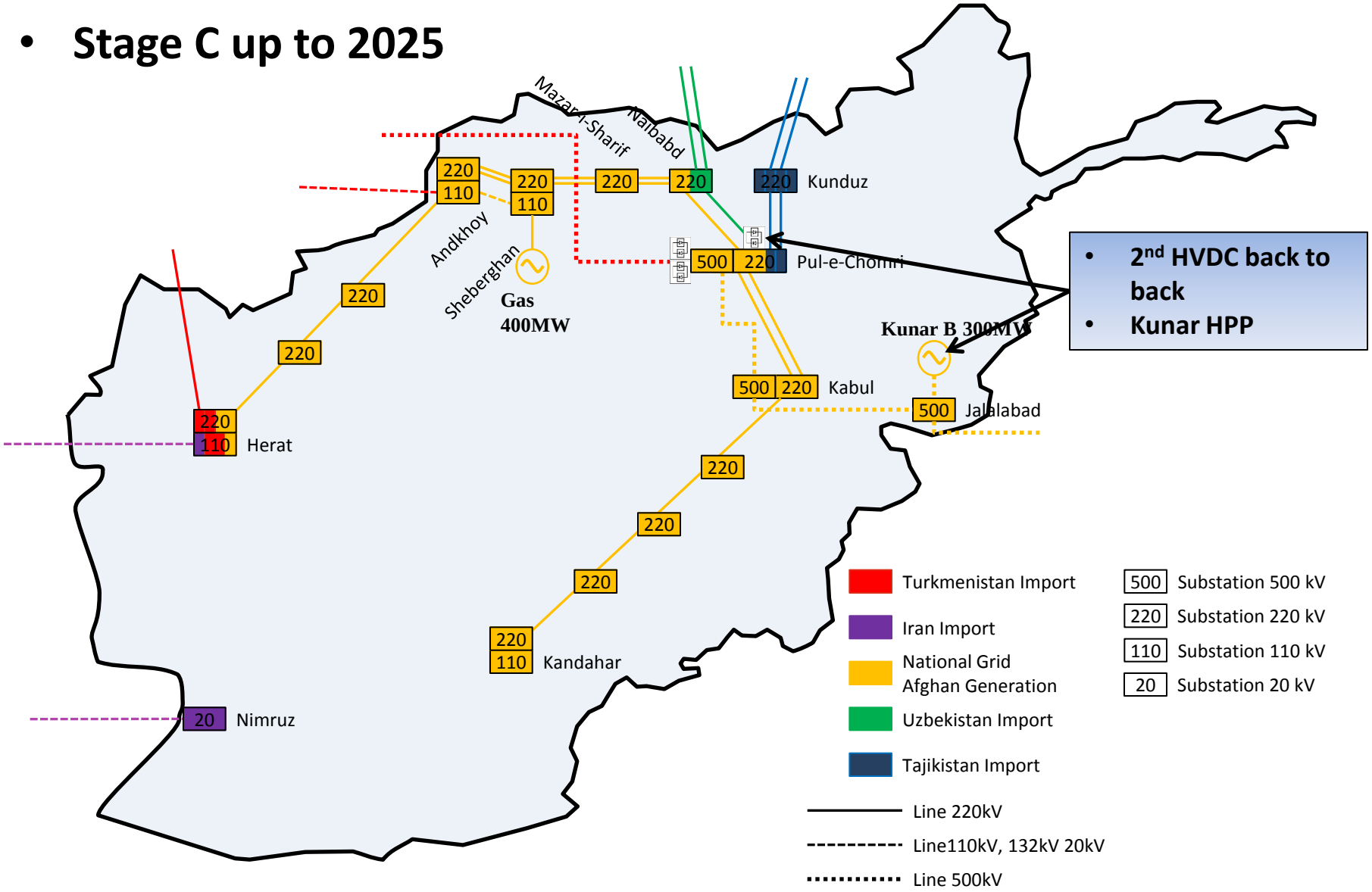
Major Transmission Projects: Geographical representation (3)

- **Stage B up to 2020**



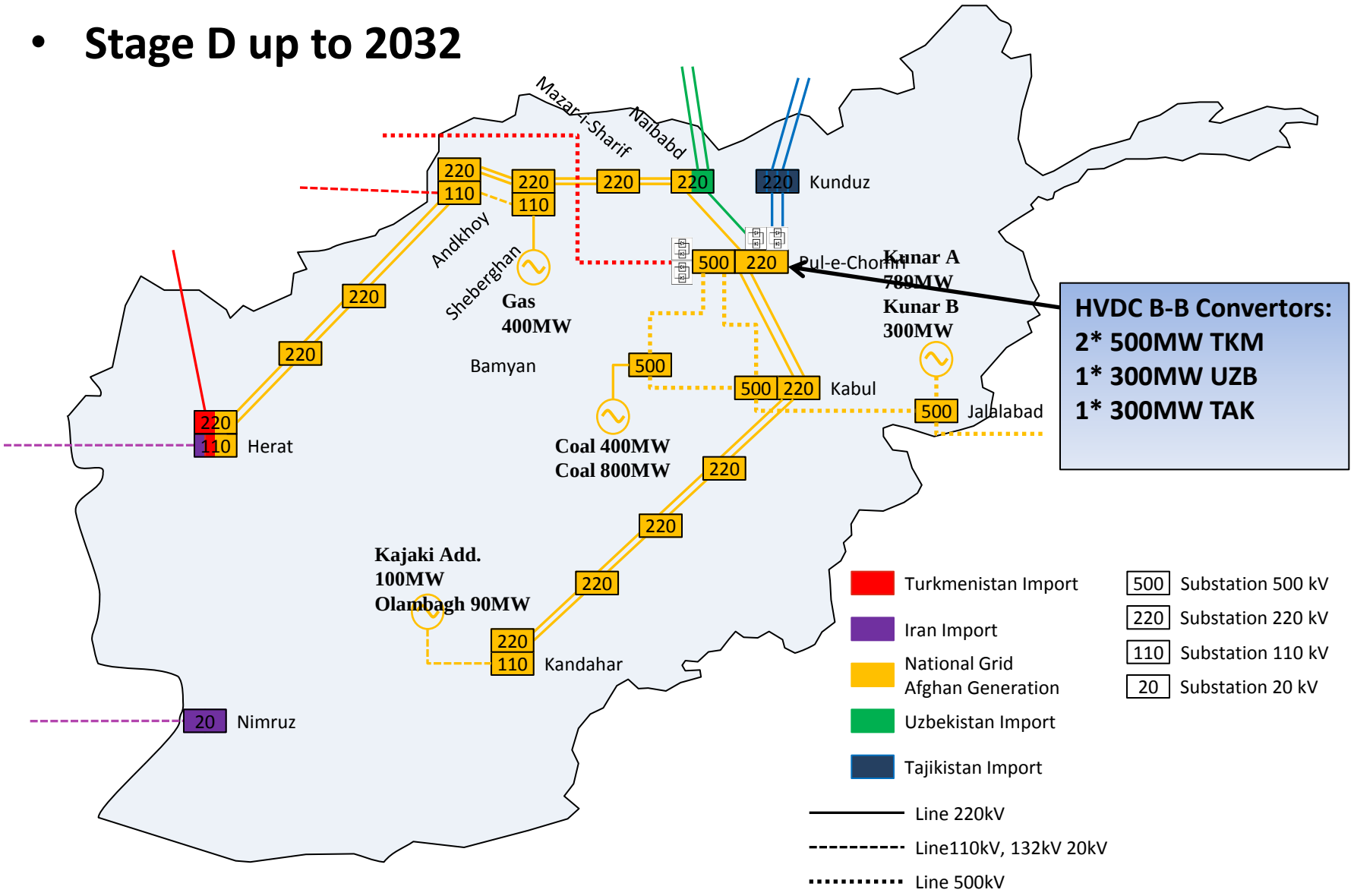
Major Transmission Projects: Geographical representation (4)

- **Stage C up to 2025**

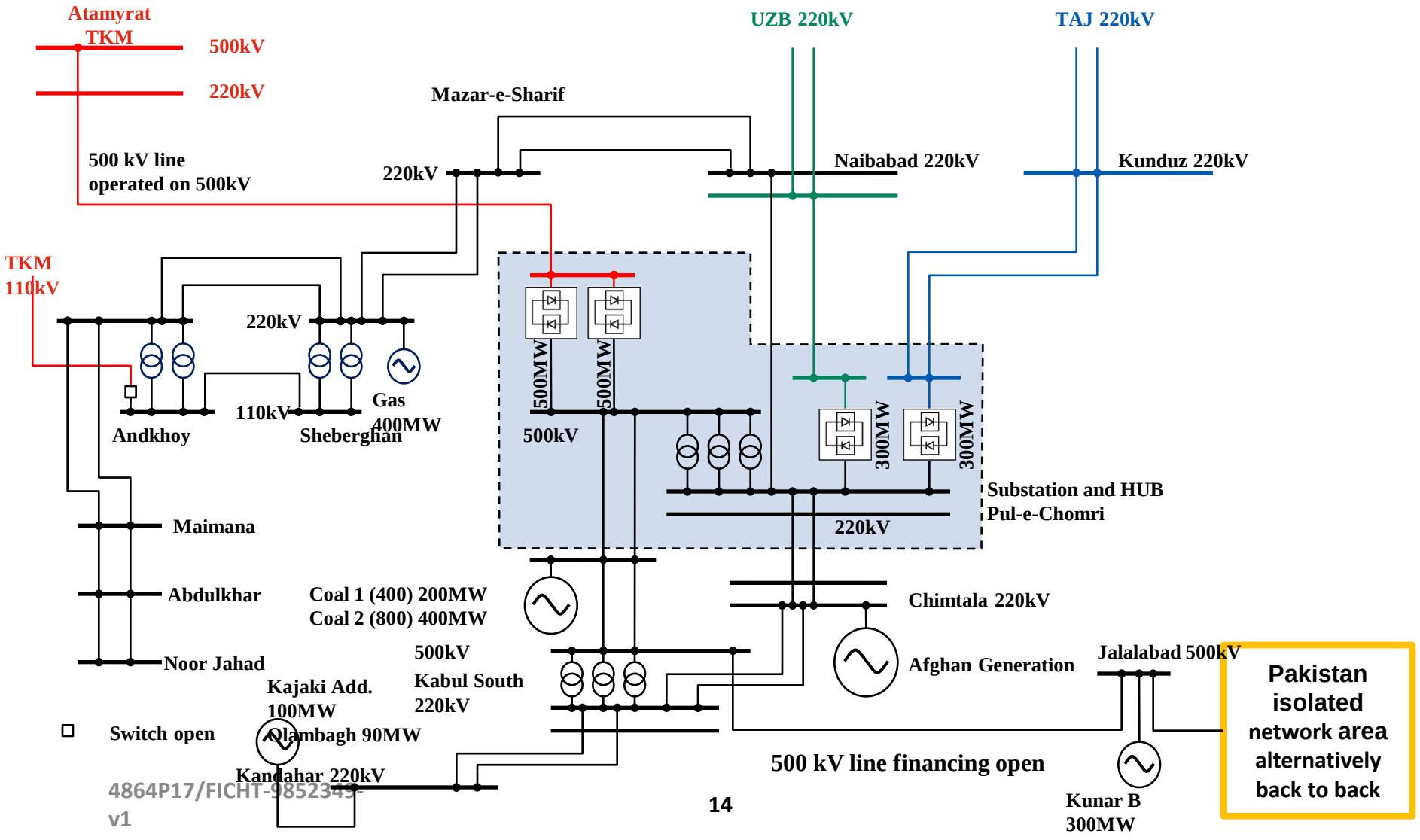


Major Transmission Projects: Geographical representation (5)

- **Stage D up to 2032**



Transmission Development to 2032



Developments and Benefits

Ongoing and under Processing

By 2018/19

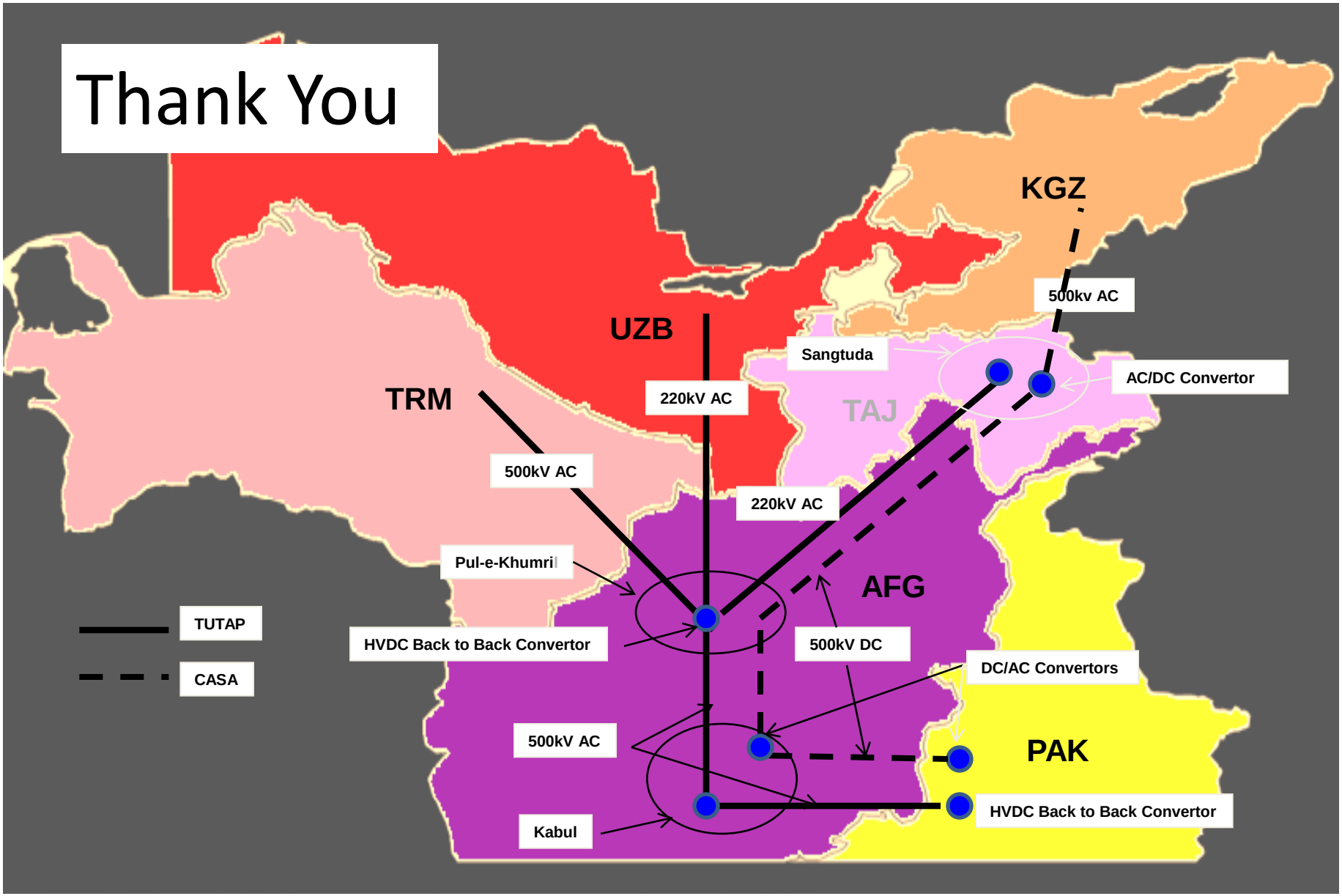
- *500kV connection will exist from TKM to Kabul.*
- *500kV connection to PAK possible*

Planned & Potential Projects

- Add HVDC back to back convertor modules in PUK to allow UZB and TAJ supply AFG grid.

Benefits

- Export countries can wheel power to PAK without dependency on other export countries
- PAK can agree separate PPAs with each export country resulting in Year round supply
- TKM can supply TAJ winter demand.


Thank You
KGZ
500kv AC
UZB
Sangtuda
AC/DC Convertor
TRM
220kV AC
TAJ
500kV AC
220kV AC
Pul-e-Khumri
AFG
TUTAP
HVDC Back to Back Convertor
500kV DC
CASA
DC/AC Convertors
500kV AC
PAK
HVDC Back to Back Convertor
Kabul